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AGU 2011 Fall Meeting

December 05 - 09, 2011

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Monday, December 05, 2011

Time	Session Info
8:00 AM-12:20 PM, Halls A-C (Moscone South), **A11A. Aerosol, Cloud Properties, Atmospheric Rivers, and Precipitation in California: CalWater I Posters**	
8:00 AM-12:20 PM	**A11A-0057. A global atmospheric river climatology as simulated by the Community Atmosphere Model version 5 (CAM5), compared to results from reanalyses.** J. Nusbaumer; D.C. Noone
8:00 AM-12:20 PM, Halls A-C (Moscone South), **B11D. Observatory Enabled Science and the Earth System Modeling Era Posters**	
8:00 AM-12:20 PM	**B11D-0516. The Virtual Watershed Observatory: Cyberinfrastructure for Model-Data Integration and Access *(Invited)*** C. Duffy; L.N. Leonard; L. Giles; G. Bhatt; X. Yu
8:00 AM-12:20 PM, Halls A-C (Moscone South), **ED11A. Bridging the Gap Between Geoscience Education and Careers in the 21st Century: Teaching, Fieldwork, and Student Retention I Posters**	
8:00 AM-12:20 PM	**ED11A-0761. Modern Process Studies in Kongsfjord, Svalbard: Arctic Geoscience Research Experience for U.S. Undergraduates (Svalbard REU)** R.D. Powell; J. Brigham-Grette
8:00 AM-12:20 PM, Halls A-C (Moscone South), **IN11A. Creating Decision Support Products in a Rapidly Changing Environment Posters**	
8:00 AM-12:20 PM	**IN11A-1267. Extraction of Suspended Sediments from Landsat Imagery in the Northern Gulf of Mexico** D.M. Hardin; M. Drewry; M.Y. He; S. Ebersole
8:00 AM-12:20 PM, Halls A-C (Moscone South), **IN11B. Current Capabilities and Future Needs of Near Real Time Data I Posters**	
8:00 AM-12:20 PM	**IN11B-1281. Processing Direct Broadcast Data to Reduce Latency of Aqua AMSR-E Products** K. Regner; H. Conover; B. Beaumont; M. Teague; S.J. Graves; D.M. Hardin
8:00 AM-10:00 AM, Room 305 (Moscone South), **P11G. Planetary Atmospheres and Their Evolution I**	
8:00 AM-10:00 AM	**P11G-01. A Coupled General Circulation Model of the Archean Earth** E.T. Wolf; O.B. Toon
8:00 AM-10:00 AM, Room 3016 (Moscone West), **H11I. Fractures, Fracture Networks, and Fractured Media I: Transport Properties and Alteration Processes**	

<table>
<tr><td>8:00 AM-10:00 AM</td><td>H11I-03. A likely-universal model of fracture density and scaling justified by both data and theory. Consequences for crustal hydro-mechanics P. Davy; C. Darcel; R. Le Goc; O. Bour</td></tr>
<tr><td colspan="2">8:00 AM-10:00 AM, Room 302 (Moscone South), ED11D. Climate Literacy: Engaging and Evaluating Public and K-12 Audiences Around Complex and Contentious Earth Systems Science</td></tr>
<tr><td>8:00 AM-10:00 AM
(Conflict)</td><td>ED11D-05. How Do We Communicate Both the Knowns and Unknowns of Climate Change? P. Hamilton; C. Selin; R. Garfinkle</td></tr>
<tr><td colspan="2">8:00 AM-10:00 AM, Room 2007 (Moscone West), S11C. Active Fault Data as Input for Seismic Hazard Analysis (SHA) I</td></tr>
<tr><td>8:00 AM-10:00 AM
(Conflict)</td><td>S11C-05. Building the GEM Faulted Earth database (Invited) N.J. Litchfield; K.R. Berryman; A. Christophersen; R.F. Thomas; B. Wyss; J. Tarter; M. Pagani; R.S. Stein; C.H. Costa; K.E. Sieh</td></tr>
<tr><td colspan="2">8:00 AM-10:00 AM, Room 2004 (Moscone West), B11G. Natural Wetlands: Observations and Modeling of Distributions and Methane Dynamic I</td></tr>
<tr><td>8:00 AM-10:00 AM</td><td>B11G-07. Modeling methane emissions from Alaskan Yukon River Basin from 1986 to 2005 by coupling a large-scale hydrological model and a process-based methane model X. Lu; Q. Zhuang</td></tr>
<tr><td colspan="2">8:00 AM-10:00 AM, Room 305 (Moscone South), P11G. Planetary Atmospheres and Their Evolution I</td></tr>
<tr><td>8:00 AM-10:00 AM</td><td>P11G-08. The Nitrogen Constraint on Habitability of Planets of Low Mass M-stars F. Tian</td></tr>
<tr><td colspan="2">10:20 AM-11:50 AM, Room 3011 (Moscone West), C12A. Ongoing Climate Change in the Polar Latitudes as Motivation for a Proposed International Polar Decade I</td></tr>
<tr><td>10:20 AM-11:50 AM</td><td>C12A-01. The IPD and the Need for Sustained Observations and Coordinated Analyses in Polar Regions (Invited) L.D. Hinzman</td></tr>
<tr><td colspan="2">10:20 AM-12:20 PM, Room 302 (Moscone South), ED12A. Communicating Research, Outreach Activities, and Their Impacts I</td></tr>
<tr><td>10:20 AM-12:20 PM</td><td>ED12A-05. Cool learnings – extending and communicating polar science to students and the community. (Invited) C.E. Tweedie</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Halls A-C (Moscone South), H13C. Seasonal Effects of Climate Variability and Change on Hydrological and Biogeochemical Processes I Posters</td></tr>
<tr><td>1:40 PM-6:00 PM</td><td>H13C-1236. Combined land use and climate change impact on Surface and Ground water resources in the Rio Cobre and Great River basin, Jamaica S.G. Setegn; A.M. Melesse; O. Grey; D. Webber</td></tr>
</table>

1:40 PM-6:00 PM, Halls A-C (Moscone South), **NH13E. Landslide Characterisation and Forecasting: Structural Controls, Field Mapping, Remote Sensing Methologies, Modelling, and Risk Analysis II Posters**	
1:40 PM-6:00 PM	**NH13E-1411. Regional Assessment of Storm-triggered Shall Landslide Risks using the SLIDE (SLope-Infiltration-Distributed Equilibrium) Model** Y. Hong; D.B. Kirschbaum; H. Fukuoka
1:40 PM-6:00 PM, Halls A-C (Moscone South), **PP13A. Cenozoic Climate: From Proxy Reconstructions to Model Assessments I Posters**	
1:40 PM-6:00 PM	**PP13A-1821. SPECMAP Chronology in 2011** L.A. Hinnov; S.R. Meyers
1:40 PM-6:00 PM, Halls A-C (Moscone South), **MR13A. Lower Mantle Thermal Conductivity: Experiment, Computation, and Implications for Mantle Dynamics I Posters**	
1:40 PM-6:00 PM	**MR13A-2185. Lattice thermal conductivity: Computations and theory of the high-temperature breakdown of the phonon-gas model** T. Sun; P.B. Allen
1:40 PM-6:00 PM, Halls A-C (Moscone South), **T13F. Tectonics, Erosion, and Paleoclimate: Insights from Geochemistry, Paleobiology, Geochronology, and Modeling I Posters**	
1:40 PM-6:00 PM	**T13F-2481. Fjord erosion, Quaternary sedimentation and isostatic rebound in western Scandinavia** P. Steer; R.S. Huismans; S. Gac; F. Herman
1:40 PM-3:40 PM, Room 305 (Moscone South), **P13G. Planetary Radar Investigations: Observations, Theory, Lab Measurements, Field Analogues, and Future Opportunities II**	
1:40 PM-3:40 PM	**P13G-02. Exploring the topography and structure of Saharan linear dunes: Implications for characterizing dunes on Titan** T.G. Farr; E. Heggy; J. Radebaugh
1:40 PM-3:40 PM, Room 306 (Moscone South), **SA13C. Drivers of the Equatorial Ionospheric Climatology, Variability, and Irregularities I**	
1:40 PM-3:40 PM	**SA13C-05. Determination of the Sharp, Longitudinal Gradients in Equatorial ExB Drift Velocities Associated with the 4-cell, Non-migrating Structures** ***(Invited)*** D.N. Anderson
1:40 PM-3:40 PM, Room 2006 (Moscone West), **B13I. Biogeodynamics and Earth System Sciences II**	
1:40 PM-3:40 PM	**B13I-07. The Evolution of Volcanic Ocean Islands and Biota** ***(Invited)*** W.E. Dietrich; M.E. Power; T. Perron
1:40 PM-3:40 PM, Room 2012 (Moscone West), **T13I. Linkages Among Orogenic Processes in Cordilleran Systems II**	

1:40 PM-3:40 PM	**T13I-08. Deformation, deposition, and surface uplift in the hinterland of the Central Andes, Bolivia** A. Leier; N. McQuarrie; C.N. Garzione; J.M. Eiler
4:00 PM-6:00 PM, Room 3022 (Moscone West), **DI14A. Advances in Computational Modelling in Geoscience I**	
4:00 PM-6:00 PM	**DI14A-01. Keeping it Together: Advanced algorithms and software for magma dynamics (and other coupled multi-physics problems)** ***(Invited)*** M. Spiegelman; C.R. Wilson

Tuesday, December 06, 2011

Time	Session Info
8:00 AM-12:20 PM, Halls A-C (Moscone South), **C21A. Ice Cores and Paleoclimate Posters**	
8:00 AM-12:20 PM	**C21A-0460. Refugium for surface life on Snowball Earth in a nearly-enclosed sea? A finite element approach for sea-glacier invasion** A.J. Campbell; E.D. Waddington; S.G. Warren
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP21A. Evaluating Hydrodynamics and Sediment Transport in Lowland Rivers I Posters**	
8:00 AM-12:20 PM	**EP21A-0651. Will the Atchafalaya River Capture the Lower Mississippi River?** D. Edmonds
8:00-8:00 AM	**EP21A-0654. Integrated Biogeomorphological Modeling Using Delft3D** Q. Ye; B.(. Jagers
8:00-8:00 AM	**EP21A-0655. How to Include Steep Bank Retreat in 2D/3D Morphological Models?** B.(. Jagers; A. Spruyt; E. Mosselman
8:00-8:00 AM	**EP21A-0658. A New Channel-Resolving Reduced-Complexity Delta Model** M. Liang; V.R. Voller; C. Paola
8:00-8:00 AM	**EP21A-0661. Global riverine sediment flux predictions, the WBMsed v2.0 model** S. Cohen; A.J. Kettner; J.P. Syvitski; B. Fekete
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP21B. Fluvial Morphodynamics, Channels Patterns, and Megafans I Posters**	
8:00 AM-12:20 PM	**EP21B-0671. Self-formed levees and floodplains in an annular flume** R. Teske; M.G. Kleinhans; C. Roosendaal
8:00-8:00 AM	**EP21B-0672. Self-formed braid bars in a numerical model** F. Schuurman; M.G. Kleinhans
8:00-8:00 AM	**EP21B-0675. Numerical Simulation of Sediment Plug Formation in Alluvial Channels** A.J. Posner; J.G. Duan

8:00-8:00 AM	**EP21B-0676. Experimental rivers: from braided to meandering by addition of cohesive floodplain material** W.M. Van Dijk; W.I. van de Lageweg; M.G. Kleinhans
8:00-8:00 AM	**EP21B-0685. Reversal in Migration of Gravel-Sand Transition** W. Kim
8:00-8:00 AM	**EP21B-0694. Hydraulic geometry of meandering, alluvial sand-bed streams: the roles of washload, vegetation and natural bank armoring** G. Parker; E. Eke
8:00-8:00 AM	**EP21B-0701. Detached eddy simulation (DES) of turbulence and suspended sediment transport in lateral separation eddies in the Colorado River in Grand Canyon** M.W. Schmeeckle
8:00-8:00 AM	**EP21B-0704. High Plains Aquifer as Megafans? - Perspective from Spatial Distribution of Hydraulic Conductivity** W. Luo; D.T. Pederson
8:00-8:00 AM	**EP21B-0707. From Incised Valleys to Coarse Alluvial Streams - North Shore of Lake Superior, Minnesota** D. Cazanacli
8:00 AM-12:20 PM, Halls A-C (Moscone South), **H21B. Fractures, Fracture Networks, and Fractured Media IV Posters**	
8:00 AM-12:20 PM	**H21B-1090. Permeability Evolution of Fractured Anhydrite Caused by Chemical and Mechanical Alteration** R.L. Detwiler; J.E. Elkhoury; P. Ameli
8:00 AM-12:20 PM, Halls A-C (Moscone South), **H21F. Remote Sensing Applications in Hydrology V Posters**	
8:00 AM-12:20 PM	**H21F-1205. SENSITIVITY OF ACTIVE AND PASSIVE MICROWAVE OBSERVATIONS TO SOIL MOISTURE DURING GROWING CORN** J. Judge; A. Monsivais-Huertero; P. Liu; R.D. De Roo; A.W. England; K. Nagarajan
8:00 AM-12:20 PM, Halls A-C (Moscone South), **NH21B. Natural Hazards General Contributions Posters**	
8:00 AM-12:20 PM	**NH21B-1516. Dam-Break Flooding and Structural Damage in a Residential Neighborhood: Performance of a coupled hydrodynamic-damage model** B.F. Sanders; H.A. Gallegos; J.E. Schubert
8:00 AM-12:20 PM, Halls A-C (Moscone South), **T21A. Birth, Growth, and Maturity of a Continental Margin: Modeling, Observing, and Interpreting the Evolution of a Margin I Posters**	
8:00 AM-12:20 PM	**T21A-2318. 3D Numerical Models for Faulting Patterns in Oblique Rifts** E. Choi; W.R. Buck
8:00 AM-10:00 AM, Room 103 (Moscone South), **U21C. Data and Information Quality Really Matters in the Era of Predictive and Often Contentious Science I (Video On-Demand)**	
8:00 AM-10:00 AM	**U21C-03. Prediction uncertainty reflects both data input quality and model software sophistication** ***(Invited)*** J. Syvitski

8:00 AM-10:00 AM, Room 303 (Moscone South), **EP21D. Debris Flows: From Hazard Mitigation to Landscape Evolution I**	
8:00 AM-10:00 AM	**EP21D-06. Debris Flow Models With Vertical Redistribution** J.N. Mcelwaine; J. Kowalski
8:00 AM-10:00 AM, Room 3016 (Moscone West), **H21I. Hydrological, Geomorphological, Biological, and Geochemical Processes in Karst Aquifers I**	
8:00 AM-10:00 AM	**H21I-07. Coupled Thermo-Hydro-Chemical (THC) Modeling of Hypogene Karst Evolution in a Prototype Mountain Hydrologic System** A. Chaudhuri; H. Rajaram; H.S. Viswanathan; G. Zyvoloski
8:00 AM-10:00 AM, Room 3011 (Moscone West), **C21D. Modeling of the Cryosphere I**	
8:00 AM-10:00 AM	**C21D-08. Nested modeling of high-order ice dynamics in outlet glaciers of the Greenland Ice Sheet** S.J. Marshall; S. Adhikari
10:20 AM-12:20 PM, Room 303 (Moscone South), **EP22A. The Physics of Granular and Turbulent Flows in Geomorphology I**	
10:20 AM-12:20 PM	**EP22A-07. Coupled large eddy simulation and discrete element model of bedload motion** D. Furbish; M.W. Schmeeckle
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP23A. Challenges on Scaled Physical Modeling of Sediment Transport I Posters**	
1:40 PM-6:00 PM	**EP23A-0721. Downscaling discharge variability: how well can daily flow characteristics be predicted based on lower resolution flow data?** A.J. Kettner; I. Overeem; S. Cohen; J. Syvitski
1:40-1:40 PM	**EP23A-0724. Co-evolution of bed topography, flow turbulence and sediment transport: insights from a high resolution large-scale experimental study** A. Singh; E. Foufoula
1:40-1:40 PM	**EP23A-0727. Reynolds-mediated scale effects on the modeling of turbidity currents** J. Imran; S. Khan; C. Pirmez; G. Parker
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP23B. Predictive Understanding of Coupled Interactions Among Water, Life, and Landforms I Posters**	
1:40 PM-6:00 PM	**EP23B-0733. Controls of dunefield stabilization rate: dunefield age and sediment supply** T.E. Barchyn; C. Hugenholtz
1:40-1:40 PM	**EP23B-0749. Human Amplified Natural Change: An approach for vulnerability assessment and mitigation planning** P. Wilcock; P. Belmont; K.B. Gran
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP23C. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models I Posters**	

1:40 PM-6:00 PM	**EP23C-0755. Establishing Denudation Chronology through Weathering Geochronology** S.B. Riffel; P.M. Vasconcelos; K.A. Farley; I.O. Carmo
1:40-1:40 PM	**EP23C-0757. Erodibility controls on the vertical and horizontal scalings of topography : a case study in the Himalayas** V. Godard; P. Steer
1:40-1:40 PM	**EP23C-0766. Integrating Field Measurements and Numerical Modeling to Investigate Gully Network Evolution** F.K. Rengers; G.E. Tucker
1:40-1:40 PM	**EP23C-0767. Adding geochemical and isotope tracers to models of hillslope evolution: valuable constraints or monumental headache?** S.M. Mudd; K. Yoo; M.D. Hurst; B.A. Weinman; K. Maher
1:40-1:40 PM	**EP23C-0768. Turning rock into saprolite: Linking observations and models of vadose zone dynamics and chemical weathering** A.L. Langston; G.E. Tucker; R.S. Anderson; S.P. Anderson
1:40-1:40 PM	**EP23C-0769. Physical and Statistical Diagnostics for Verification of Hillslope Sediment Transport Models** V. Ganti; P. Passalacqua; E. Foufoula
1:40-1:40 PM	**EP23C-0774. Lacustrine sediments in Lake Ohau, central South Island, New Zealand – An archive of erosion, earthquakes and paleoclimate since the Late Glacial** P. Upton; M.J. Vandergoes; J. Howarth; R.H. Levy
1:40-1:40 PM	**EP23C-0778. Morphodynamic Modeling of Gravel Bed Rivers: a Step -Length Based Approach** A. Kasprak; J.M. Wheaton
1:40 PM-6:00 PM, Halls A-C (Moscone South), **H23B. Combining Learnings From Natural Releases of CO2 for CO2 Storage: Processes, Impacts, and Scale I Posters**	
1:40 PM-6:00 PM	**H23B-1258. Diffuse CO_2 Emanations from a Deep Magmatic Source—Multiphase Dynamics, Soil Impacts, and Lessons for Sequestration Monitoring** D.A. Stonestrom; C.A. Werner; M.S. Schulz; J.F. Howle; C.D. Farrar; T.R. Smith; J.D. Rogie
1:40 PM-6:00 PM, Halls A-C (Moscone South), **H23D. Computational Sciences and Water Applications in Hydrology and Groundwater Management II Posters**	
1:40 PM-6:00 PM	**H23D-1295. An Inverse Modeling Plugin for HydroDesktop using the Method of Anchored Distributions (MAD)** D.P. Ames; C. Osorio; M.W. Over; Y. Rubin
1:40 PM-6:00 PM, Halls A-C (Moscone South), **H23F. Hydrological, Geomorphological, Biological, and Geochemical Processes in Karst Aquifers II Posters**	

<table>
<tr><td>1:40 PM-6:00 PM</td><td>H23F-1346. Using time-lapse electrical resistivity tomography to visualize conduit-matrix exchange a sink-rise system of a semi-confined karst aquifer S.B. Meyerhoff; F. Fiebig; R.M. Maxwell; A. Revil; M. Karaoulis; J.B. Martin; W.D. Graham</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Halls A-C (Moscone South), H23G. Recent Advances in Data Assimilation and Remote Sensing for Land Surface Hydrology II Posters</td></tr>
<tr><td>1:40 PM-6:00 PM</td><td>H23G-1367. Downscaling Satellite-based Passive Microwave Observations Using the Principle of Relevant Information and Auxiliary High Resolution Remote Sensing Products K. Nagarajan; J. Judge; J. Principe</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Halls A-C (Moscone South), IN23C. The Really Long Tail of Geochemistry, Geochronology, and Other Sample-Based Data Posters</td></tr>
<tr><td>1:40 PM-6:00 PM</td><td>IN23C-1462. Maximizing data holdings and data documentation with a hierarchical system for sample-based geochemical data L. Hsu; K.A. Lehnert; J.D. Walker; C. Chan; J. Ash; A.K. Johansson; T.A. Rivera</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Halls A-C (Moscone South), PA23C. Shapers of the Debate: What Happens to Science in the Hands of Stakeholders II Posters</td></tr>
<tr><td>1:40 PM-6:00 PM</td><td>PA23C-1756. The Science-Policy Link: Stakeholder Reactions to the Uncertainties of Future Sea Level Rise H. Plag; B. Bye</td></tr>
<tr><td colspan="2">1:40 PM-3:40 PM, Room 303 (Moscone South), EP23D. The Physics of Granular and Turbulent Flows in Geomorphology II</td></tr>
<tr><td>1:40 PM-3:40 PM
(Conflict)</td><td>EP23D-03. Investigating bedload transport at the grain scale (Invited) E. Lajeunesse; M. Houssais; L. Malverti; F. Charru</td></tr>
<tr><td colspan="2">1:40 PM-3:40 PM, Room 307 (Moscone South), P23F. The Geophysical and Atmospheric Science of Extrasolar Planets II</td></tr>
<tr><td>1:40 PM-3:40 PM
(Conflict)</td><td>P23F-03. Climate destabilization on tidally locked exoplanets E.S. Kite; E. Gaidos; M. Manga</td></tr>
<tr><td colspan="2">1:40 PM-3:40 PM, Room 2012 (Moscone West), T23F. Birth, Growth, and Maturity of a Continental Margin: Modeling, Observing, and Interpreting the Evolution of a Margin II</td></tr>
<tr><td>1:40 PM-3:40 PM</td><td>T23F-08. Strain evolution and the relative role of heat and strain rate during continental rupture (Invited) A.D. Huerta; J. Crane; E. Rheams</td></tr>
<tr><td colspan="2">4:00 PM-6:00 PM, Room 2011 (Moscone West), T24C. Tectonics, Erosion, and Paleoclimate: Insights from Geochemistry, Paleobiology, Geochronology, and Modeling IV</td></tr>
<tr><td>4:00 PM-6:00 PM</td><td>T24C-03. The Impact of Drainage Reorganization on Cenozoic Topography B.J. Yanites; T.A. Ehlers</td></tr>
<tr><td colspan="2">5:00 PM-6:00 PM, Room 104 (Moscone South), C24A. Nye Lecture (Video On-Demand)</td></tr>
</table>

5:00 PM-6:00 PM (Conflict)	**C24A-01. We Are All Engineers Now: Delivering Useful Projections Of Sea Level Rise** W.T. Pfeffer
4:00 PM-6:00 PM, Room 303 (Moscone South), **EP24A. Geophysical Mass Flows: Field Data, Physical Models, and Simulations I**	
4:00 PM-6:00 PM (Conflict)	**EP24A-05. Variation of deposition depth with slope angle in snow avalanches: Measurements from Vallée de la Sionne** ***(Invited)*** J.N. Mcelwaine; B. Sovilla
4:00 PM-6:00 PM, Room 3018 (Moscone West), **H24D. Landscape System Response Under Change II**	
4:00 PM-6:00 PM (Conflict)	**H24D-05. Widespread hillslope gullying on the southeastern Tibetan Plateau: Human or climate-change induced?** ***(Invited)*** J.D. Pelletier; J. Quade; R. Goble; M. Aldenderfer
4:00 PM-6:00 PM, Room 2002 (Moscone West), **B24C. Rapid Vegetation Shifts in Drylands: An Ecohydrological and Ecogeomorphic Perspective II**	
4:00 PM-6:00 PM (Conflict)	**B24C-07. Ecohydrologic function and disturbance of desert ephemeral stream channels** D. Bedford; M. Macias; D.M. Miller; A. Newlander; K.S. Perkins; D.R. Sandquist; S. Schwinning
4:00 PM-6:00 PM, Room 3018 (Moscone West), **H24D. Landscape System Response Under Change II**	
4:00 PM-6:00 PM (Conflict)	**H24D-07. Spatial Variations in Carbon Storage along Headwater Fluvial Networks with Differing Valley Geometry** ***(Invited)*** E.E. Wohl; K.A. Dwire; L.E. Polvi; N.A. Sutfin; R.A. Bazan

Wednesday, December 07, 2011

Time	Session Info
8:00 AM-12:20 PM, Halls A-C (Moscone South), **ED31A. Education General Contributions I Posters**	
8:00 AM-12:20 PM	**ED31A-0703. INTEGRATING RESEARCH AND EXTENSION FOR THE NSF-REU PROGRAM IN WATER RESOURCES** J. Judge; K. Migliaccio; B. Gao; S. Shukla; R. Ehsani; E. McLamore
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP31A. Climate Change and Landscape Response I Posters**	
8:00 AM-12:20 PM	**EP31A-0803. Modeling the rate and style of Arctic coastal retreat along the Beaufort Sea, Alaska** K.R. Barnhart; R.S. Anderson; I. Overeem; C.W. Wobus; G.D. Clow; F.E. Urban; A.L. Lewinter; T.P. Stanton

8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP31B. Debris Flows: From Hazard Mitigation to Landscape Evolution II Posters**	
8:00 AM-12:20 PM	**EP31B-0819. Controls on the Erosional Efficiency of Granular Flows** S.W. McCoy; G.E. Tucker
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP31D. Human Societies and Landscape Evolution Since the Last Glacial Maximum I Posters**	
8:00 AM-12:20 PM	**EP31D-0847. Dynamic Drainage Networks and Discharge Histories in North America over the Last Glacial Cycle: Implications for Geomorphic Change and Early Human Settlement Patterns** A.D. Wickert; R.S. Anderson; J.X. Mitrovica; A.J. Kettner; C.M. Lee
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP31E. The Physics of Granular and Turbulent Flows in Geomorphology III Posters**	
8:00 AM-12:20 PM	**EP31E-0867. An analytical framework for aeolian saltation** M.D. Reitz; D.J. Jerolmack
8:00 AM-12:20 PM, Halls A-C (Moscone South), **G31B. Small Is Beautiful: The Chase for Low Amplitude Signals I Posters**	
8:00 AM-12:20 PM	**G31B-0965. Using Empirical Orthogonal Functions to Quantify and Predict Small Global and Regional Common Modes of the Global Geodetic Reference Frame** H. Plag; C.W. Kreemer; G. Blewitt; W.C. Hammond
8:00 AM-12:20 PM, Halls A-C (Moscone South), **H31A. Landscape System Response Under Change III Posters**	
8:00 AM-12:20 PM	**H31A-1136. Modelling the future evolution of incised coastal gullies using a coupled terrestrial-coastal landscape evolution model.** C.R. Hackney; S.E. Darby; J. Leyland
8:00 AM-12:20 PM, Halls A-C (Moscone South), **H31B. Postwildfire Landscape Response: Thresholds, Connectivity, and Evolving Processes II Posters**	
8:00 AM-12:20 PM	**H31B-1152. Capturing the Initiation and Spatial Variability of Runoff on Soils Affected by Wildfire** D.A. Martin; A.D. Wickert; J.A. Moody
8:00 AM-10:00 AM, Room 3016 (Moscone West), **H31K. Interactions, Feedbacks, and Hydrologic Response to Climate Variability and Change I**	
8:00 AM-10:00 AM (Conflict)	**H31K-02. A Long-term Reach-Scale Monitoring Network for Riparian Evapotranspiration, Rock Creek, Kansas *(Invited)*** H. Rajaram; J.A. Solis; D.O. Whittemore; J.J. Butler; E. Reboulet; S. Knobbe; M. Dealy
8:00 AM-9:00 AM, Room 304 (Moscone South), **NG31A. Complex Networks in Geosciences I**	
8:00 AM-9:00 AM (Conflict)	**NG31A-02. "Universal" Recession Curves and their Geomorphological Roots *(Invited)*** M. Marani; B. Biswal

8:00 AM-10:00 AM, Room 102 (Moscone South), **IN31C. Advances in Metadata Generation and Applications for Earth Sciences I**	
8:00 AM-10:00 AM	**IN31C-05. Model and Interoperability using Meta Data Annotations** ***(Invited)*** O. David
9:00 AM-10:00 AM, Room 304 (Moscone South), **NG31B. Pattern Formation in Earth System Sciences I**	
9:00 AM-10:00 AM	**NG31B-02. Self-organization of tidal deltas** ***(Invited)*** S. Fagherazzi
8:00 AM-10:00 AM, Room 104 (Moscone South), **U31C. Polydisciplinary Innovation in Water Resources Modeling and Prediction (Video On-Demand)**	
8:00 AM-10:00 AM (Conflict)	**U31C-07. A Services-Oriented Architecture for Water Observations, Modeling and Visualization** D.R. Maidment
8:00 AM-10:00 AM, Room 2005 (Moscone West), **H31I. Developing the Science for High Resolution Water Energy Biogeochemical Cycle Modeling I**	
8:00 AM-10:00 AM (Conflict)	**H31I-07. 'age' of water: a physics based, fully coupled, distributed model for watershed assessment** G. Bhatt; X. Yu; C. Duffy; A. Kemanian; M. Kumar; L.N. Leonard
9:00 AM-10:00 AM, Room 304 (Moscone South), **NG31B. Pattern Formation in Earth System Sciences I**	
9:00 AM-10:00 AM (Conflict)	**NG31B-03. Roughness controls patterns of sediment transport, vegetation and groundwater in a desert dune field** ***(Invited)*** D.J. Jerolmack; R.C. Ewing; F. Falcini; R.L. Martin; C. Masteller; C.B. Phillips; M.D. Reitz
8:00 AM-10:00 AM, Room 303 (Moscone South), **EP31F. Fluvial Morphodynamics, Channels Patterns, and Megafans II**	
8:00 AM-10:00 AM	**EP31F-08. Sorting out meandering and braiding: discriminating formative conditions and stratigraphy** ***(Invited)*** M.G. Kleinhans; W.I. van de Lageweg; F. Schuurman; W.M. Van Dijk
10:20 AM-12:20 PM, Room 3016 (Moscone West), **H32C. Hydrology and Earth Sciences in Developing World Communities I**	
10:20 AM-12:20 PM	**H32C-02. "Developing" Hydrology or Hydromorphology: A modern research agenda that can inform the trenches** ***(Invited)*** U. Lall
10:20 AM-12:20 PM, Room 104 (Moscone South), **U32A. Coupled Processes in the Arctic System: Feedbacks, Amplification, and Impacts on Midlatitudes I (Video On-Demand)**	
10:20 AM-12:20 PM	**U32A-06. Toward the Understanding of Water and Land-surface Feedbacks in a Warm Permafrost Environment** W.R. Bolton; L.D. Hinzman

1:40 PM-6:00 PM, Halls A-C (Moscone South), **A33D. The Role of Aersols in the Climate-Cryosphere System I Posters**	
1:40 PM-6:00 PM	**A33D-0252. Seasonal and inter-annual variability of aerosol optical properties during 2005-2010 over Red Mountain Pass and Impact on the Snow Cover of the San Juan Mountains** R.P. Singh; R. Gautam; T.H. Painter
1:40 PM-6:00 PM, Halls A-C (Moscone South), **B33E. Identifying and Quantifying Change in Ecological Systems II Posters**	
1:40 PM-6:00 PM	**B33E-0506. A population growth model forced by random, episodic disturbances** S.D. Peckham
1:40 PM-6:00 PM, Halls A-C (Moscone South), **B33F. Interacting Biogeochemical Cycles: Linking Carbon, Water, and Nutrient Fluxes From Organisms to Globe III Posters**	
1:40 PM-6:00 PM	**B33F-0540. Regional and Global Controls and Potential Significance of Dissolved Silica Retention in Lakes and Reservoirs** J. Harrison; P. Frings; D.J. Conley
1:40 PM-6:00 PM, Halls A-C (Moscone South), **C33B. Modeling of the Cryosphere III Posters**	
1:40 PM-6:00 PM	**C33B-0637. Numerical modeling of the permafrost temperature evolution in Alaska during the 21st century.** E.E. Jafarov; V.E. Romanovsky; S.S. Marchenko
1:40 PM-6:00 PM, Halls A-C (Moscone South), **ED33B. Scientist Participation in Science Communication II Posters**	
1:40 PM-6:00 PM	**ED33B-0779. Let's Talk About Water: Film Screenings as an Entrée to Water Science** R.P. Hooper; L. Lilienfeld; J. Arrigo
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP33A. Coastal Geomorphology and Morphodynamics I Posters**	
1:40 PM-6:00 PM	**EP33A-0912. Surface adhesion and fine sediment trapping in deltaic wetlands** R.C. Littlewood; T. Witlen; J. Michael; C. Paola
1:40 PM-6:00 PM, Halls A-C (Moscone South), **G33B. Mass Transport and Mass Distribution in the Earth System II Posters**	
1:40 PM-6:00 PM	**G33B-0993. Modeling Earth Deformation from Monsoonal Flooding in Bangladesh using Hydrographic, GPS and GRACE Data** M.S. Steckler; S.L. Nooner; S.H. Akhter; S.K. Chowdhury; S.V. Bettadpur; L. Seeber
1:40 PM-6:00 PM, Halls A-C (Moscone South), **GC33B. Regional Climate Impacts 5: Urbanization Dynamics Across a Changing Planet II Posters**	

1:40 PM-6:00 PM	**GC33B-1080. Remote Sensing of Urban Land Cover/Land Use Change, Surface Thermal Responses, and Potential Meteorological and Climate Change Impacts** D.A. Quattrochi; G. Jedlovec; P.J. Meyer
1:40 PM-6:00 PM, Halls A-C (Moscone South), **IN33B. Environmental Monitoring Challenges in Sensor Networks and Hydroinformatics II Posters**	
1:40 PM-6:00 PM	**IN33B-1468. Incorporating Spatial Support to Improve Interoperability of Shared Water Data** R.P. Hooper; M. Piasecki; D.W. Valentine; I. Zaslavsky; A. Bedig; A. Couch; Y. Choi
1:40 PM-6:00 PM, Halls A-C (Moscone South), **NG33C. Pattern Formation in Earth System Sciences II Posters**	
1:40 PM-6:00 PM	**NG33C-1516. Hierarchical structure of river networks revisited** S. Zanardo; I. Zaliapin; E. Foufoula; W.E. Dietrich; M. Ghil
1:40-1:40 PM	**NG33C-1519. Hydrologic Connectivity as a Window into Pattern Conditions and Formation Processes in Aquatic Ecosystems** L.G. Larsen; J. Choi; M.K. Nungesser; J.W. Harvey
1:40-1:40 PM	**NG33C-1521. Self-Organized Intermittency (or Destruction) of Shallow Seabed Sorted Patterns** A. Murray; E.B. Goldstein; G. Coco
1:40 PM-6:00 PM, Halls A-C (Moscone South), **OS33A. Coastal Response to Sea Level Changes I Posters**	
1:40 PM-6:00 PM	**OS33A-1631. Impact of Sea Level Rise on the Attenuation of Hurricane Storm Surge by Wetlands in Corpus Christi, TX.** C. Ferreira; J.L. Irish; F. Olivera
1:40-1:40 PM	**OS33A-1636. 1,100 years after an earthquake: modification of the earthquake record by submergence, Puget Lowland, Washington State** M.E. Arcos
1:40 PM-6:00 PM, Halls A-C (Moscone South), **OS33C. Particle Dynamics and Sedimentary Processes in Estuarine and Coastal Environments I Posters**	
1:40 PM-6:00 PM	**OS33C-1679. Modeling sediment transport processes and residence times in the shallow coastal bay complex of the Virginia Coast Reserve** I. SAFAK; P.L. Wiberg
1:40 PM-6:00 PM, Halls A-C (Moscone South), **PA33A. Managing Scarce Water Resources: From Conflict to Cooperation II Posters**	
1:40 PM-6:00 PM	**PA33A-1818. Water in the Balance: Changing Freshwater Availability as Viewed from Space** J.S. Famiglietti; M. Rodell; K. Voss; S.C. Swenson; D.P. Chambers; M. Lo; J.T. Reager; S. Ho; C. De Linage; R. Matthew
1:40 PM-6:00 PM, Halls A-C (Moscone South), **T33A. Alaska Region Tectonic, Sedimentary, and Climatic Processes I Posters**	

1:40 PM-6:00 PM	**T33A-2371. An Evaluation of Neogene Sedimentation on the Surveyor Fan, Gulf of Alaska: Geochemical, Mineralogical, and Rock Magnetic Provenance Variation in Alaskan Abyssal Plain Sediments** J.M. Jaeger; A.D. Ullrich
1:40 PM-2:40 PM, Room 305 (Moscone South), **EP33E. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models II**	
1:40 PM-2:40 PM (Conflict)	**EP33E-02. Quantifying Landscape Evolution From Terrestrial LiDAR and Environmental Process Monitoring** S. DeLong; W.M. Henderson; B.P. Murphy; I.N. Yokelson
1:40 PM-3:40 PM, Room 3012 (Moscone West), **H33K. Threats on Water: Chemical and Isotope Monitoring and Integrated Modeling of Water Quality Across Scale in Ecohydrological Systems I**	
1:40 PM-3:40 PM (Conflict)	**H33K-02. Accounting for heterogeneity of nutrient dynamics in riverscapes through spatially distributed models *(Invited)*** W.M. Wollheim; R.J. Stewart
1:40 PM-3:40 PM, Room 303 (Moscone South), **EP33D. Fluvial Morphodynamics, Channels Patterns, and Megafans IV**	
1:40 PM-3:40 PM (Conflict)	**EP33D-03. Hydrodynamic and Morphodynamic indicators in a long tidal river: the Fly River example.** A. Canestrelli; S. Lanzoni; S. Fagherazzi
1:40 PM-2:40 PM, Room 305 (Moscone South), **EP33E. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models II**	
1:40 PM-2:40 PM (Conflict)	**EP33E-03. Experimental testing of landscape models *(Invited)*** C. Paola
1:40 PM-3:40 PM, Room 3014 (Moscone West), **H33L. Uncertainty Assessment, Optimization, and Sensitivity Analysis in Integrated Hydrologic Modeling as Applications of HydroInformatics II**	
1:40 PM-3:40 PM	**H33L-03. The "How" of Environmental Modeling: Toward Enhanced Transparency and Refutability** M.C. Hill; D. Kavetski; M.P. Clark; M. Ye; M. Arabi; D. Lu; L. Foglia; S. Mehl
1:40 PM-3:40 PM, Room 3009 (Moscone West), **C33F. Mountain Glaciers and Their Response to Climate I**	
1:40 PM-3:40 PM (Conflict)	**C33F-04. Subglacial topography and ice volume for western Canadian glaciers from a bed stress model and mass balance fields *(Invited)*** G.K. Clarke; F.S. Anslow; A.H. Jarosch; V. Radic; B. Menounos; T. Bolch; E. Berthier
1:40 PM-2:40 PM, Room 305 (Moscone South), **EP33E. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models II**	

1:40 PM-2:40 PM (Conflict)	**EP33E-04. Experimental insights on the effects of varying discharge on fluvial landscape evolution** W.I. van de Lageweg; W.M. Van Dijk; M.G. Kleinhans
1:40 PM-3:40 PM, Room 2006 (Moscone West), **B33L. Understanding Early Neoproterozoic Transitions I**	
1:40 PM-3:40 PM	**B33L-05. Modelling the carbon cycle though Neoproterozoic Earth system changes** ***(Invited)*** C.J. Bjerrum; D.E. Canfield
1:40 PM-3:40 PM, Room 102 (Moscone South), **IN33E. Semantic, Linked Data, and Drupal-Based Solutions for Science II**	
1:40 PM-3:40 PM	**IN33E-07. Collaboration Portals for NASA's Airborne Field Campaigns** ***(Invited)*** H. Conover; A. Kulkarni; M. Garrett; M. Goodman; W.A. Petersen; M. Drewry; D.M. Hardin; M. He
4:00 PM-5:00 PM, Room 305 (Moscone South), **P34B. Nanocrystalline Materials on Earth and Mars II**	
4:00 PM-5:00 PM	**P34B-02. Secondary minerals and regolith profiles in basaltic rocks in northeastern US and in Svalbard, an Arctic Mars analogue site** ***(Invited)*** S.L. Brantley; T.A. Yesavage; E. Bazilevskaya
4:00 PM-6:00 PM, Room 103 (Moscone South), **NG34A. Scaling and Fractals After Mandelbrot: On the Frontiers of the Geosciences I (Video On-Demand)**	
4:00 PM-6:00 PM	**NG34A-03. Scaling Properties of Shoreline Change: Process Implications** ***(Invited)*** A. Murray; E. Lazarus; A.D. Ashton; S.F. Tebbens; S.M. Burroughs
4:00 PM-6:00 PM, Room 3009 (Moscone West), **C34A. Alaska and British Columbia Glaciers: A Glaciological Update I**	
4:00 PM-6:00 PM	**C34A-04. Projections of the climate-forced deglaciation of western Canada using a regional glaciation model** ***(Invited)*** G.K. Clarke; F.S. Anslow; A.H. Jarosch; V. Radic
4:00 PM-6:00 PM, Room 2006 (Moscone West), **B34A. Connecting the Landscape to Aquatic Ecosystems: Linking Watershed Models and Ecosystem Services II**	
4:00 PM-6:00 PM	**B34A-05. CLIMATE IMPACTS ON RESERVOIR OPERATIONS FOR FISH SUSTAINABILITY ON THE SACRAMENTO RIVER** L. Saito; R.J. Caldwell; B. Rajagopalan
4:00 PM-6:00 PM, Room 2004 (Moscone West), **B34D. Improving Predictions of the Global Carbon Cycle and Climate in Earth System Models: New Mechanisms, Feedback Sensitivities, and Approaches for Model Benchmarking III**	

4:00 PM-6:00 PM	**B34D-06. Mutli-Scale Synthesis and Terrestrial Model Intercomparison Project – A Systematic Approach for Evaluating Land -Atmosphere Flux Estimates** ***(Invited)*** D.N. Huntzinger; W.M. Post; K.M. Schaefer; A.R. Jacobson; C.R. Schwalm; R.B. Cook; A.M. Michalak
4:00 PM-6:00 PM, Room 3003 (Moscone West), **GC34B. Regional Climate Impacts 6: Dynamics of Climate Change and Their Impacts on the Hydrological Cycle at Regional Scales**	
4:00 PM-6:00 PM	**GC34B-08. Accelerating the Development of Land Surface Hydrological Modeling to Address Societal Needs: Application of an Integrated Data and Modeling Framework to California** ***(Invited)*** J.S. Famiglietti; M. Lo; H. Kim; J. Edman; B.F. Sanders; S. Castle; Z. Liu; N.L. Miller; R.S. Singh; D.W. Valentine; I. Zaslavsky

Thursday, December 08, 2011

Time	Session Info
8:00 AM-12:20 PM, Halls A-C (Moscone South), **A41D. Orographic Precipitation: Measurement, Mechanisms, and Impact on Landforms Posters**	
8:00 AM-12:20 PM	**A41D-0115. Connecting hydrology and suspended sediment transport with precipitation in the Nepal Himalayas** ***(Invited)*** C. Andermann; S. Bonnet; A. Crave; P. Davy; R. Gloaguen; L. Longuevergne
8:00-8:00 AM	**A41D-0119. Mountain growth, orographic precipitation, and the formation of high-plateaus. Insights from numerical modeling experiments** ***(Invited)*** D. Garcia-Castellanos
8:00 AM-12:20 PM, Halls A-C (Moscone South), **EP41D. The Long Road To Flat: Toward Understanding the Drivers and Quantifying Change in Orogens I Posters**	
8:00 AM-12:20 PM	**EP41D-0637. A Simple Model for the Post-Orogenic Evolution of Mountain Ranges and Foreland Basins** P. Van Der Beek; G.E. Tucker
8:00-8:00 AM	**EP41D-0648. Reconciling Geodetic Deformation and Long-term Exhumation Rates Across the Western Greater Caucasus** B. Avdeev; N.A. Niemi
8:00 AM-12:20 PM, Halls A-C (Moscone South), **GC41C. Regional Climate Impacts 7: Environmental, Socioeconomic, and Climatic Changes in Northern Eurasia and Their Feedbacks to the Global Earth System---The Role of Remote Sensing and Integrative Studies I Posters**	
8:00 AM-12:20 PM	**GC41C-0840. Prediction And Predictability Of Trend In Temperature Change In China Using Bayesian Multimodel Ensemble Approach** C. Miao; Q. Duan
8:00 AM-12:20 PM, Halls A-C (Moscone South), **GC41D. Weather-Driven Renewable Energy I Posters**	

8:00 AM-12:20 PM	**GC41D-0859. Applying land surface – atmosphere interactions to improving wind energy forecasting systems** J.L. Williams; R.M. Maxwell; L. Delle Monache; J.K. Lundquist
8:00 AM-12:20 PM, Halls A-C (Moscone South), **H41C. Developing the Science for High Resolution Water Energy Biogeochemical Cycle Modeling II Posters**	
8:00 AM-12:20 PM	**H41C-1040. How Much Do Initial Conditions Really Matter? Effects of Model Spin-Up on Coupled Groundwater–Surface Water Simulations** I.M. Ferguson; R.M. Maxwell
8:00 AM-10:00 AM, Room 3012 (Moscone West), **H41I. Advances in Hydrometeorological Predictions and Applications I**	
8:00 AM-10:00 AM	**H41I-01. A Comparison of Statistical and Dynamical Downscaling of Winter Precipitation Over Complex Terrain** E.D. Gutmann; R. Rasmussen; C. Liu; K. Ikeda; D.J. Gochis; M.P. Clark; J. Dudhia; G. Thompson
8:00 AM-10:00 AM, Room 3011 (Moscone West), **C41F. Cryosphere-Atmosphere Energy Exchanges: Advances in Modeling and Observation I**	
8:00 AM-10:00 AM (Conflict)	**C41F-06. An Improved Fractional Snow Covered Area Parameterization for the Community Land Model and its Effects on Simulated Climate.** S.C. Swenson; D.M. Lawrence
8:00 AM-10:00 AM, Room 3009 (Moscone West), **C41G. Glacier Surging and Ice Streaming: Fast Flow and Instabilities II**	
8:00 AM-10:00 AM (Conflict)	**C41G-06. Surface and Subglacial Measurements of a "Spring Event" at Engabreen, Norway** P.L. Moore; K.A. Christianson; N.R. Iverson; J. Winberry; D.O. Cohen; S. Anandakrishnan; M. Jackson
8:00 AM-10:00 AM, Room 303 (Moscone South), **EP41E. Challenges on Scaled Physical Modeling of Sediment Transport II**	
8:00 AM-10:00 AM (Conflict)	**EP41E-05. Scaling of Turbidity Currents and Riverine Flows for Laboratory Experiments: similarities and differences *(Invited)*** M.H. Garcia
9:40-10:00 AM	**EP41E-06. Unscaled experiments in morphodynamics *(Invited)*** C. Paola
10:20 AM-12:20 PM, Room 103 (Moscone South), **EP42A. Sharp Lecture (Video On-Demand)**	
10:20 AM-12:20 PM (Conflict)	**EP42A-01. Patterns and processes in landscapes: Surprises from Earth and beyond *(Invited)*** T. Perron

10:20 AM-12:20 PM, Room 3020 (Moscone West), **H42B. Evapotranspiration: Land-Atmosphere interactions and Transport in the ABL III**	
10:20 AM-12:20 PM (Conflict)	**H42B-01. Remotely-Sensed Estimates of Regional and Global Evaporation and Latent Heating** ***(Invited)*** J.S. Famiglietti; C.A. Clayson; E.F. Wood
10:20 AM-12:20 PM, Room 3010 (Moscone West), **H42D. Freshwater, Ecosystem, and Agriculture Sustainability Under Climate and Land Use Change I**	
10:20 AM-12:20 PM (Conflict)	**H42D-01. The water-energy-food-climate-economics nexus: solving hunger and resource scarcity** ***(Invited)*** U. Lall
10:20 AM-12:20 PM, Room 2018 (Moscone West), **H42G. The Past, Present, and Future of Global and Regional Droughts I**	
10:20 AM-12:20 PM	**H42G-08. Tree-Ring Extension of Precipitation Variability for Eastern Nevada: Implications for Drought Analysis in the Great Basin Region, USA** F. Biondi; S.D. Strachan
1:40 PM-6:00 PM, Halls A-C (Moscone South), **B43F. Understanding Terrestrial Ecosystem Carbon Fluxes, Structure, and Dynamics by Model Data Syntheses Across Space and Time I Posters**	
1:40 PM-6:00 PM	**B43F-0360. Regional Eco-hydrologic Sensitivity to Projected Amazonian Land Use Scenarios** R.G. Knox; M. Longo; K. Zhang; N.M. Levine; P.R. Moorcroft; R.L. Bras
1:40 PM-6:00 PM, Halls A-C (Moscone South), **ED43B. Impacts of Over a Decade of CAREER Awards IV Posters**	
1:40 PM-6:00 PM	**ED43B-0553. Computing in Hydraulic Engineering Education** J.G. Duan
1:40-1:40 PM	**ED43B-0569. Using sediment transport and river restoration to link research and education, and promote K-12 female involvement in STEM fields** E.M. Yager; K. Bradley-Eitel
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP43A. Earth and Planetary Surface Processes: Planetary, Glacial, and Miscellaneous I Posters**	
1:40 PM-6:00 PM	**EP43A-0660. A Hamiltonian model of landscape evolution** C.P. Stark
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP43B. Earth and Planetary Surface Processes: Rivers, Sediment, Hydraulics II Posters**	
1:40 PM-6:00 PM	**EP43B-0687. Internal Process Time-Scales During Development Of Experimental Alluvial Fans Under Different Discharges, Basin Slopes, And Sediment Feed Rates.** K.B. Strom; P. Hamilton; D.C. Hoyal

1:40-1:40 PM	**EP43B-0693. The real cause of the suspended sediment transport - river discharge hysteresis loop, in the Nepal Himalayas** C. Andermann; S. Bonnet; A. Crave; P. Davy; R. Gloaguen; L. Longuevergne
1:40 PM-6:00 PM, Halls A-C (Moscone South), **EP43C. Earth and Planetary Surface Processes: Hillslope, Tectonic, and Weathering III Posters**	
1:40 PM-6:00 PM	**EP43C-0700. Modelling effects of tree population dynamics, tree throw and pit-mound formation/diffusion on microtopography over time in different forest settings** Y.E. Martin; E.A. Johnson; J. Gallaway; O. Chaikina
1:40 PM-3:40 PM, Room 303 (Moscone South), **EP43D. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models III**	
1:40 PM-3:40 PM	**EP43D-01. Modeling fluxes and form in landslide-prone terrain *(Invited)*** J.J. Roering; A.M. Booth; J.D. Stock
1:40 PM-6:00 PM, Halls A-C (Moscone South), **GC43D. Sea Level Change I Posters**	
1:40 PM-6:00 PM	**GC43D-0968. On Early Holocene Ice-Sheet/Sea-Level Interactions** T.E. Tornqvist; M. Hijma
1:40 PM-6:00 PM, Halls A-C (Moscone South), **H43C. Global Precipitation Measurement, Validation, and Applications III Posters**	
1:40 PM-6:00 PM	**H43C-1222. Toward the Estimation of High-Resolution Daily Precipitation in Complex Regions – The Study of Intertwined Physiographic, Vegetative, and Climatologic Factors for PRISM Enhancement** C. Hsu; R. Cifelli; R.J. Zamora; L.E. Johnson
1:40 PM-6:00 PM, Halls A-C (Moscone South), **P43C. Using the Earth as a Guide to Extraterrestrial Planetary Surfaces II Posters**	
1:40 PM-6:00 PM	**P43C-1692. Insights from experimental groundwater sapping channels for early Martian hydrological conditions** W.A. Marra; D.A. Wesselman; W.J. Poos; M.G. Kleinhans
1:40 PM-6:00 PM, Halls A-C (Moscone South), **T43E. Formation and Deformation of the Mediterranean Basins, Margins, and Arcs I Posters**	
1:40 PM-6:00 PM	**T43E-2421. Drilling below the salt in the Western Mediterranean Sea: the GOLD project** M. Rabineau; A.W. Droxler; J. Kuroda; N. Eguchi; D. Aslanian; K. Alain; C. Gorini
1:40 PM-3:40 PM, Room 3005 (Moscone West), **OS43D. Coastal Response to Sea Level Changes II**	
1:40 PM-3:40 PM	**OS43D-05. Characteristic Timescales of Shoreface Response to Sea-Level Rise** A.D. Ashton; A. Ortiz; P. Lane; J.P. Donnelly

1:40 PM-3:40 PM, Room 303 (Moscone South), **EP43D. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models III**	
1:40 PM-3:40 PM	**EP43D-06. Spatial variation of glacial erosion rates in the St. Elias range, Alaska, inferred from a realistic model of glacier dynamics** R.M. Headley; B. Hallet; G. Roe; E.D. Waddington
3:10-3:25 PM	**EP43D-07. Constraints on the uplift history of the Bolivian Andes from channel profile morphology and numerical modeling.** ***(Invited)*** N.M. Gasparini; K.X. Whipple
3:25-3:40 PM	**EP43D-08. Using Neighborhood-Algorithm Inversion to Test and Calibrate Landscape Evolution Models** M.C. Perignon; G.E. Tucker; P. Van Der Beek; G.E. Hilley; R. Arrowsmith
4:00 PM-6:00 PM, Room 301 (Moscone South), **EP44A. Evaluating Hydrodynamics and Sediment Transport in Lowland Rivers II**	
4:00 PM-6:00 PM (Conflict)	**EP44A-02. Evolution and stability of tidal river bifurcations** ***(Invited)*** M.G. Kleinhans
4:00 PM-6:00 PM, Room 303 (Moscone South), **EP44B. Quantifying Geomorphic Processes and Landscape Evolution: Linking Observations and Models IV**	
4:00 PM-6:00 PM (Conflict)	**EP44B-02. Of Rock Damage and the Regolith Conveyor Belt: A Geomorphologist's View of the Critical Zone** R.S. Anderson; S.P. Anderson; G.E. Tucker
4:00 PM-6:00 PM, Room 3014 (Moscone West), **H44C. Fate and Transport of Emerging Contaminants, Microorganisms, Colloids, and Engineered Nanoparticles in the Environment II**	
4:00 PM-6:00 PM (Conflict)	**H44C-02. Mathematical Modeling of the Subsurface Behavior of Quantum Dot Nanoparticles in the Presence of Stabilizing Polymers** M.D. Becker; Y. Wang; K.D. Pennell; L.M. Abriola
4:00 PM-6:00 PM, Room 301 (Moscone South), **EP44A. Evaluating Hydrodynamics and Sediment Transport in Lowland Rivers II**	
4:00 PM-6:00 PM (Conflict)	**EP44A-05. Transient response of sand bedforms to changes in flow** R.L. Martin; D.J. Jerolmack
4:00 PM-6:00 PM, Room 3020 (Moscone West), **H44F. Moving Towards a Unified Threshold -based Hydrological Theory I**	
4:00 PM-6:00 PM (Conflict)	**H44F-05. Thresholds in vegetation responses to drought: Implications for rainfall-runoff modeling** C. Tague; A.L. Dugger
5:15-5:30 PM	**H44F-06. Thresholds in Xeric Hydrology and Biogeochemistry** ***(Invited)*** T. Meixner; P.D. Brooks; S.C. Simpson; C.D. Soto; F. Yuan; D. Turner; H. Richter

4:00 PM-6:00 PM, Room 301 (Moscone South), **EP44A. Evaluating Hydrodynamics and Sediment Transport in Lowland Rivers II**	
4:00 PM-6:00 PM (Conflict)	**EP44A-07. Hydrographic and suspended sediment measurements of the Mississippi River plume during the historic 2011 flood: a coupled satellite analysis and boat survey approach to determine an efficiency factor for sediment trapping in the nearshore zone.** F. Falcini; C. Li; M. D'Emidio; C. Lutken; L. Macelloni; A. Salusti; D.J. Jerolmack
4:00 PM-6:00 PM, Room 3020 (Moscone West), **H44F. Moving Towards a Unified Threshold -based Hydrological Theory I**	
4:00 PM-6:00 PM (Conflict)	**H44F-07. A Framework for Quantifying and Understanding the Type of Topographic Dependence and Degree of Time-Instability in Catchment-Scale Soil Moisture Patterns** J.D. Niemann; M.L. Coleman
4:00 PM-6:00 PM, Room 3007 (Moscone West), **OS44B. Particle Dynamics and Sedimentary Processes in Estuarine and Coastal Environments II**	
4:00 PM-6:00 PM	**OS44B-08. Contrasts in Sediment Delivery and Dispersal from River Mouth to Accumulation Zones in High Sediment Load Systems: Fly River, Papua New Guinea and Waipaoa River, New Zealand** A.S. Ogston; J.P. Walsh; R.P. Hale

Friday, December 09, 2011

Time	Session Info
8:00 AM-12:20 PM, Halls A-C (Moscone South), **IN51B. Data Management Strategies for Airborne Science Data Posters**	
8:00 AM-12:20 PM	**IN51B-1578. Pre-Mission, Mission and Post Mission Data Management for NASA Field Campaigns** M. He; M. Goodman; M. Drewry; S.J. Graves; D.M. Hardin
8:00 AM-12:20 PM, Halls A-C (Moscone South), **PP51C. Reconstruction and Modeling of Global Climate Evolution of the Last 21,000 Years I Posters**	
8:00 AM-12:20 PM	**PP51C-1868. Late Glacial and Holocene Fire History From Radiocarbon Dating of Charcoal in Valley-Bottom Sediments in Small Watersheds of the Oregon Coast Range** S.T. Lancaster; W.T. Frueh
8:00 AM-12:20 PM, Halls A-C (Moscone South), **SA51D. Using Ground Magnetometer Arrays for Studies of Currents of the Ionosphere and Inner Magnetosphere II Posters**	
8:00 AM-12:20 PM	**SA51D-1982. Magnetometer-inferred, Equatorial, Daytime Vertical ExB Drift Velocities Observed in the African Longitude Sector** D.N. Anderson; E. Yizengaw

8:00 AM-10:00 AM, Room 305 (Moscone South), **EP51D. Coastal Geomorphology and Morphodynamics II**	
8:00 AM-10:00 AM	**EP51D-02. A Coupled Economic and Physical Model of Coastal Adaptation and Abandonment: Are human occupied coastlines a bubble waiting to burst?** ***(Invited)*** D. McNamara; A. Keeler
8:00 AM-10:00 AM, Room 301 (Moscone South), **EP51C. Climate Change and Landscape Response II**	
8:00 AM-10:00 AM	**EP51C-04. Climate change and mountain-front morphology: Estimating Late Glacial to Holocene erosion rates from the shape of fault-bounded hillslopes** G.E. Tucker; S.W. McCoy; A.C. Whittaker; G. Roberts; S.T. Lancaster; R.J. Phillips
8:00 AM-10:00 AM, Room 303 (Moscone South), **EP51E. High-Resolution Spatial Data Processing, Analysis, and Visualization: Emerging Techniques and Applications II**	
8:00 AM-10:00 AM	**EP51E-05. Distinguishing grass from ground using LiDAR: Techniques and applications** J.D. Pelletier; T. Swetnam; S.A. Papuga; K. Nelson; P.D. Brooks; A.A. Harpold; J. Chorover
8:00 AM-10:00 AM, Room 305 (Moscone South), **EP51D. Coastal Geomorphology and Morphodynamics II**	
8:00 AM-10:00 AM	**EP51D-07. Investigating the Geomorphic Behavior of the Cape Canaveral Coast Through High-Resolution Beach Monitoring, Sediment Analysis, Oceanographic Observations, and Numerical Modeling** P.N. Adams; J.M. Jaeger; R.A. MacKenzie; S.W. Kline; B.J. Maibauer; N.G. Plant; M.B. Gravens; T.P. Pierro; J. Shaffer
10:20 AM-12:20 PM, Room 301 (Moscone South), **EP52A. Climate Change and Landscape Response III**	
10:20 AM-12:20 PM (Conflict)	**EP52A-01. Transient bedrock channel evolution across a precipitation gradient: A case study from Kohala, Hawaii.** ***(Invited)*** N.M. Gasparini; J. Han; J.P. Johnson; J.A. Menking
10:20 AM-12:20 PM, Room 305 (Moscone South), **EP52B. Coastal Geomorphology and Morphodynamics III**	
10:20 AM-12:20 PM (Conflict)	**EP52B-01. Biogeomorphology of tidal landforms: physical and biological processes shaping the tidal landscape** ***(Invited)*** M. Marani; A. D'Alpaos; C. Da Lio
10:20 AM-12:20 PM, Room 301 (Moscone South), **EP52A. Climate Change and Landscape Response III**	
10:20 AM-12:20 PM (Conflict)	**EP52A-02. Modeling the Glacial-Interglacial Impact of the Pacific Trade Wind Inversion on the Geomorphology and Hydrology of the Big Island of Hawaii** D. Ward; J. Galewsky

10:20 AM-12:20 PM, Room 305 (Moscone South), **EP52B. Coastal Geomorphology and Morphodynamics III**	
10:20 AM-12:20 PM (Conflict)	**EP52B-02. Hydrodynamic and suspended sediment transport controls on river mouth morphology *(Invited)*** F. Falcini; A. Piliouras; D.J. Jerolmack; J.C. Rowland; C. Paola
10:20 AM-12:20 PM, Room 303 (Moscone South), **EP52C. High-Resolution Spatial Data Processing, Analysis, and Visualization: Emerging Techniques and Applications III**	
10:20 AM-12:20 PM	**EP52C-03. Quantifying temporal and spatial scales and patterns in experiments *(Invited)*** M.D. Reitz; E. Lajeunesse; A. Limare; O. Devauchelle; F. Metivier; D.J. Jerolmack
10:20 AM-12:20 PM, Room 301 (Moscone South), **EP52A. Climate Change and Landscape Response III**	
10:20 AM-12:20 PM	**EP52A-04. The Impact of Vegetation on the Long-term Landform Evolution of the Chilean Coastal Ranges** R. Walcott; T. Dunai
10:20 AM-12:20 PM, Room 2006 (Moscone West), **G52A. Reference Systems, Data, and Models for Global Geodesy I**	
10:20 AM-12:20 PM	**G52A-06. Facilitating Joint Analysis of Data from Several Systems Using Geophysical Models *(Invited)*** H. Plag; W.C. Hammond; G. Blewitt
10:20 AM-12:20 PM, Room 301 (Moscone South), **EP52A. Climate Change and Landscape Response III**	
10:20 AM-12:20 PM (Conflict)	**EP52A-07. Why do mountain river meanders reflect typhoon climatology? *(Invited)*** C.P. Stark
10:20 AM-12:20 PM, Room 305 (Moscone South), **EP52B. Coastal Geomorphology and Morphodynamics III**	
10:20 AM-12:20 PM (Conflict)	**EP52B-07. Turning the tide: experimental creation of tidal channel networks and ebb deltas** R. Terwisscha van Scheltinga; M.G. Kleinhans; A. Baar; M. Van Der Vegt; H. Markies
1:40 PM-6:00 PM, Halls A-C (Moscone South), **A53A. Aerosol Properties and Their Relevance to Climate Processes: Techniques, Laboratory and Field Observations, and Modeling IV Posters**	
1:40 PM-6:00 PM	**A53A-0304. Implications of Meteoritic Dust In The Upper Stratosphere** R.R. Neely; J.M. English; O.B. Toon; S. Solomon; M.J. Mills; J.P. Thayer
1:40 PM-6:00 PM, Halls A-C (Moscone South), **H53E. Imbalance of Water in Nature Posters**	
1:40 PM-6:00 PM	**H53E-1460. Imbalance in the Hydrologic Cycle—Open Systems, Ebbs and Flows, and Multi-Stable States *(Invited)*** D.A. Stonestrom

1:40 PM-6:00 PM, Halls A-C (Moscone South), **H53K. Water Quality in River Systems II Posters**	
1:40 PM-6:00 PM	**H53K-1563. A Stochastic Approach to Vertical Dispersion of Coarse Sediments in Turbulent Open-Channel Flows** D. Chen; H. Sun; Y. Zhang
1:40 PM-3:40 PM, Room 3014 (Moscone West), **H53P. Riparian and Stream Network Processes Across Hydrologic Regimes II**	
1:40 PM-3:40 PM	**H53P-01. Dry and Drier: Ecological Implications of Hydrologic and Geomorphic Differences among Perennial, Intermittent, and Ephemeral Streams** ***(Invited)*** E.E. Wohl
1:40 PM-3:40 PM, Room 3016 (Moscone West), **H53O. Recent Advances in Remote Sensing and Modeling in Rivers and Streams for Understanding and Predicting Riverine Dynamics II**	
1:40 PM-3:40 PM	**H53O-02. The fusion of terrestrial laser scanning and optical bathymetric mapping to monitor braided river morphodynamics** R.D. Williams; J. Brasington; D. Vericat; M. Hicks
1:40 PM-3:40 PM, Room 303 (Moscone South), **EP53A. From Rock to Clay: Evolution of Grain-Size Distributions in Geomorphic Systems II**	
1:40 PM-3:40 PM	**EP53A-03. Sorting out abrasion in a gypsum dune field** ***(Invited)*** D.J. Jerolmack; M.D. Reitz; R.L. Martin
2:25-2:40 PM	**EP53A-04. A PROCESS-BASED MODEL FOR THE EVOLUTION OF A GRAIN-SIZE DISTRIBUTION** C. Le Bouteiller; F. Naaim; N. Mathys
1:40 PM-3:40 PM, Room 3020 (Moscone West), **H53L. Coupled Physical and Chemical Transformations Affecting the Performance of Geoenergy Systems II**	
1:40 PM-3:40 PM	**H53L-06. Towards a complete description of the hydrologic cycle: Large scale simulations with the open-source, parallel, ParFlow hydrologic model.** ***(Invited)*** R.M. Maxwell; L.E. Condon; S.J. Kollet; I.M. Ferguson; J.L. Williams
1:40 PM-3:40 PM, Room 303 (Moscone South), **EP53A. From Rock to Clay: Evolution of Grain-Size Distributions in Geomorphic Systems II**	
1:40 PM-3:40 PM (Conflict)	**EP53A-07. Comparing particle-size distributions in modern and ancient sand-bed rivers** ***(Invited)*** E.A. Hajek; R.M. Lynds; S.V. Huzurbazar
1:40 PM-3:40 PM, Room 102 (Moscone South), **IN53D. Interoperability Solutions in Earth Science Data Systems II**	
1:40 PM-3:40 PM (Conflict)	**IN53D-07. The CUAHSI Community Hydrologic Information System** ***(Invited)*** D.G. Tarboton; D.R. Maidment; I. Zaslavsky; D.P. Ames; J.L. Goodall; R.P. Hooper; J.S. Horsburgh

1:40 PM-3:40 PM, Room 305 (Moscone South), **EP53B. Submarine Channel Systems: Flow Dynamics and Sedimentary Deposits II**	
1:40 PM-3:40 PM	**EP53B-09. Flow Processes and Sedimentation Associated with Erosion and Filling of Sinuous Submarine Channels** D.R. Pyles; M. Tomasso; D. Jennette
4:00 PM-6:00 PM, Room 305 (Moscone South), **EP54B. Land-Sea Interactions in Tropical Delta Regions in Transition II**	
4:00 PM-6:00 PM (Conflict)	**EP54B-01. Global Overview On Delivery Of Sediment To The Coast From Tropical River Basins *(Invited)*** J.P. Syvitski; A.J. Kettner; G.R. Brakenridge
4:00 PM-6:00 PM, Room 303 (Moscone South), **EP54C. Soil Erosion Across Time, Space, and Climate II**	
4:00 PM-6:00 PM (Conflict)	**EP54C-01. Co-evolution of Soils and Landforms: Erosion Modelling over Decadal Timescales for Disturbed Lands** G.R. Willgoose; G.R. Hancock; S. Cohen
4:00 PM-6:00 PM, Room 3016 (Moscone West), **H54E. Recent Advances in Remote Sensing and Modeling in Rivers and Streams for Understanding and Predicting Riverine Dynamics III**	
4:00 PM-6:00 PM (Conflict)	**H54E-01. Radar and Satellite Remote Sensing for Global and Regional Flood Prediction and Water Cycle Studies *(Invited)*** Y. Hong; R.F. Adler; J.J. Gourley
4:00 PM-6:00 PM, Room 305 (Moscone South), **EP54B. Land-Sea Interactions in Tropical Delta Regions in Transition II**	
4:00 PM-6:00 PM (Conflict)	**EP54B-02. The impact of an Indonesian river system on tropical coastal ecosystems: synthesis of results** P. Hoekstra; A. Hoitink; F. Buschman; A. Tarya; M. Van Der Vegt; R. Nagtegaal; C. Mannaerts
4:00 PM-6:00 PM, Room 3016 (Moscone West), **H54E. Recent Advances in Remote Sensing and Modeling in Rivers and Streams for Understanding and Predicting Riverine Dynamics III**	
4:00 PM-6:00 PM (Conflict)	**H54E-02. Exploring river - wave dominated delta evolution applying a model-coupling approach** F. Xing; A.J. Kettner; A.D. Ashton; E. Hutton; J. Syvitski
4:00 PM-6:00 PM, Room 3009 (Moscone West), **C54B. Ground-Based and Unmanned Aircraft Systems (UAS) Observations and Techniques in Polar Regions II**	
4:00 PM-6:00 PM	**C54B-03. Testing of SIR (a transformable robotic submarine) in Lake Tahoe for future deployment at West Antarctic Ice Sheet grounding lines of Siple Coast** R.D. Powell; R.P. Scherer; I. Griffiths; L. Taylor; J. Winans; K.D. Mankoff

4:00 PM-6:00 PM, Room 305 (Moscone South), **EP54B. Land-Sea Interactions in Tropical Delta Regions in Transition II**	
4:00 PM-6:00 PM	**EP54B-05. The Role of Vegetation in the Forms of Tropical Lowland Deltas** ***(Invited)*** R.L. Slingerland; D.A. Edmonds
5:15-5:30 PM	**EP54B-06. The late-Holocene progradation of the Mahakam Delta, Indonesia – A case study of tidal, tropical deltas** R. Dalman; D. Ranawijaya; T. Missiaen; S. Kroonenberg; J. Storms
5:30-5:45 PM	**EP54B-07. Imaging beneath the skin of large tropical rivers: System morphodynamics of the Fly and Beni Rivers revealed by novel sub-surface sonar, deep coring, and modelling** ***(Invited)*** R.E. Aalto; M. Grenfell; J.W. Lauer

Final ID: A11A-0057

A global atmospheric river climatology as simulated by the Community Atmosphere Model version 5 (CAM5), compared to results from reanalyses.

J. Nusbaumer; [1, 2]; *D. C. Noone;* [1, 2];

1. Atmospheric and Oceanic Sciences, University of Colorado, Boulder, CO, United States.
2. Cooperative Institute for Research in the Environmental Sciences, Boulder, CO, United States.

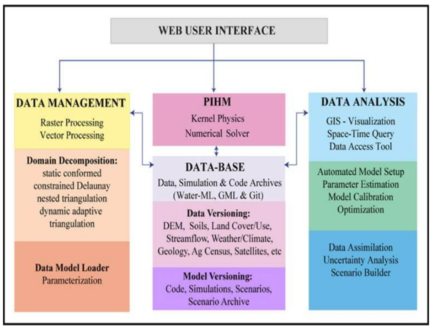
Body: Atmospheric Rivers (ARs) are long, thin horizontal filaments of elevated moisture transport that can sometimes extend from the tropics up through the subtropics and into the midlatitudes. Understanding the dynamics and hydrology of ARs helps evaluate their role in the global climate system, especially given their presence in the relatively dry subtropics. ARs have also been known to cause extreme precipitation events, particularly for the west coast of the United States, so getting a better grasp on their variability on different time-scales could help forecasters more effectively predict the likelihood of one of these extreme events in the future. One of the major questions regarding ARs is how they might change as the climate warms, with particular concerns on future hydroclimatic changes along with potential influences on the radiative budget of the subtropics. Before changes in ARs in association with climate change can be evaluated in climate model projections, verifying that the models can accurately capture the relevant features of ARs and the frequency with which they occur in the present climate need to be established. This study examines the skill with which the Community Atmosphere Model version 5 (CAM5) can generate an accurate global AR climatology, and how this climatology compares to climatologies from the NCEP-NCAR and MERRA reanalyses. The model itself was chosen partially due to the presence of basic aerosol indirect effects in the model parameterizations. This study also examines how the simulation of ARs depends on the model resolution, dynamical core, and detection algorithm used to define the atmospheric rivers. It is found that the climatology of moist filaments simulated by CAM5 is similar to those of the reanalyses. This result is also fairly robust against changes in the dynamical core and model resolution, although the detection method chosen does appear to change the details of the final result. There also appears to be regional biases in the CAM5 simulation, which could indicate some potential issues if the model is used to study atmospheric rivers in a particular location. Still, results show that CAM5 is capable of simulating ARs, and suggests simulations of changes in atmospheric rivers with a changing global climate will be robust.

Final ID: B11D-0516

The Virtual Watershed Observatory: Cyberinfrastructure for Model-Data Integration and Access ***(Invited)***

C. Duffy; [1]; *L. N. Leonard;* [1]; *L. Giles;* [1]; *G. Bhatt;* [1]; *X. Yu;* [1];
1. Civil & Environmental Engineering, Penn State University, State College, PA, United States.

Body: The Virtual Watershed Observatory (VWO) is a concept where scientists, water managers, educators and the general public can create a virtual observatory from integrated hydrologic model results, national databases and historical or real-time observations via web services. In this paper, we propose a prototype for automated and virtualized web services software using national data products for climate reanalysis, soils, geology, terrain and land cover. The VWO has the broad purpose of making accessible water resource simulations, real-time data assimilation, calibration and archival at the scale of HUC 12 watersheds (Hydrologic Unit Code) anywhere in the continental US. Our prototype for model-data integration focuses on creating tools for fast data storage from selected national databases, as well as the computational resources necessary for a dynamic, distributed watershed simulation. The paper will describe cyberinfrastructure tools and workflow that attempts to resolve the problem of model-data accessibility and scalability such that individuals, research teams, managers and educators can create a WVO in a desired context. Examples are given for the NSF-funded Shale Hills Critical Zone Observatory and the European Critical Zone Observatories within the SoilTrEC project. In the future implementation of WVO services will benefit from the development of a cloud cyber infrastructure as the prototype evolves to data and model intensive computation for continental scale water resource predictions.



Workflow for model-data integration framework as a web service.

Final ID: ED11A-0761

Modern Process Studies in Kongsfjord, Svalbard: Arctic Geoscience Research Experience for U.S. Undergraduates (Svalbard REU)

R. D. Powell; [1]; *J. Brigham-Grette;* [2];
1. Dept. Geol. & Environ. Geosci., Northern Illinois Univ., De Kalb, IL, United States.
2. Department of Geosciences, University Massachusetts, Amherst, MA, United States.

Body: The Svalbard REU (Research Experience for Undergraduates) program focuses on understanding how high latitude glaciers, meltwater streams, and sedimentation in lakes and fjords respond to changing climate. Since summer of 2004, six under-graduate students have been selected to participate in the summer field program. Students work on individual projects and in close conjunction with faculty advisors and other student researchers. They formulate their own research questions, develop their project, and complete their field research during a five-week program on Svalbard, Norway. Following the summer program, students complete their projects at their home institution during the following academic year as a senior thesis. A spring symposium brings all participants back together again with their final results.
The most recent field season was completed in Kongsfjord (79N) showing that the contemporary studies of tidewater glacier margins provide an unparalleled opportunity for introducing motivated third year undergraduate students to the challenges and rewards of polar geoscientific field research. Rates of rapid change in this high-latitude Arctic environment emphasize the complexity of the Earth System at the interface of the ocean, atmosphere and cryosphere. Given background information in glacial and marine geology, glaciology, hydrology, climatology and fjord oceanography not routinely offered in undergraduate curricula, students develop the science questions to be addressed and establish a field plan for instrumentation and sampling. Working together in small boats in one of the most challenging natural environments, the students expand their leadership skills, learn the value of teamwork and collaborative data sharing while maintaining a strong sense of ownership over their individual science projects. The rigors of studying an actively calving tidewater glacier also builds on their outdoor skills, especially when it is necessary to improvise and become resourceful due to instrumentation failures or weather-related delays. Self-confidence and problem solving skills emerge from both field and laboratory research operations when students draw upon and expand their base of practical knowledge via trial and error. Logistical facilities in Ny Alesund offer an international experience with opportunities for dialog with scientists of a wide variety of disciplines working at research stations representing more than 12 different European and Asian countries. The program is funded by the NSF’s Office of Polar Programs and has close ties and collaboration with the Norwegian University in Svalbard (UNIS) and Norsk Polar Institute scientists. NSF also funds a science teacher as a PolarTREC participant.

URL: http://www.mtholyoke.edu/proj/svalbard/welcome.shtml

Final ID: IN11A-1267

Extraction of Suspended Sediments from Landsat Imagery in the Northern Gulf of Mexico

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2. Geological Survey of Alabama, Tuscaloosa, AL, United States.

Body: The Sediment Analysis Network for Decision Support (SANDS) project is utilizing enhancement methods to highlight suspended sediment in remotely sensed data and imagery of the Northern Gulf of Mexico. The analysis thus far has shown that areas of suspended sediments can be extracted from Landsat imagery. In addition, although not an original goal of SANDS, the analysis techniques have revealed oil floating on the water’s surface. Detection of oil floating on the surface through remotely sensed imagery can be helpful in identifying and understanding the geographic distribution and movement of oil for environmental concerns.
Data from Landsat, and MODIS were obtained from NASA Earth Science Data Centers by the Information Technology and Systems Center at the University of Alabama in Huntsville and prepared for analysis by subsetting to the region of interest and converting from HDF-EOS format (in the case of MODIS) to GeoTiff. Analysts at the Geological Survey of Alabama (GSA) working with Landsat data initially, employed enhancement methods, including false color composites, spectral ratios, and other spectral enhancements based on the mineral composition of sediments, to combinations of visible and infrared bands of data. Initial results of this approach revealed suspended sediments. The analysis technique also revealed areas of oil floating on the surface of the Gulf near Chandeleur Island immediately after Hurricane Katrina in 2005. True color Landsat imagery compares the original Landsat scene to the same region after enhancement. The areas of floating oil are clearly visible. The oil washed out from oil spills on land. This paper will present the intermediate result of the SANDS project thus far.

URL: http://sands.itsc.uah.edu/

Final ID: IN11B-1281

Processing Direct Broadcast Data to Reduce Latency of Aqua AMSR-E Products

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1. ITSC, UAHuntsville, Huntsville, AL, United States.
2. Columbus Technologies, Greenbelt, MD, United States.

Body: Standard data products from NASA's Advanced Microwave Scanning Radiometer for Earth Observing Systems (AMSR-E) have served the climate research community well since the launch of the Aqua satellite in 2002. But the time from observation until swath products are made available to end users (approximately 12-15 hours after observation) diminishes their usefulness to such disciplines as weather prediction and nowcasting, natural hazards monitoring, disaster relief, and agricultural monitoring. To address the needs of these communities, NASA's Earth Science Division built the Land Atmosphere Near-real-time Capability for EOS (Earth Observing Systems), or LANCE, which generates products from several instruments, including AMSR-E, flying aboard the Aqua, Aura and Terra satellites. As for the standard products, the raw satellite data is transmitted from satellite to the EOS Data and Operations System (EDOS), via ground stations in Alaska and Norway, for distribution to the processing elements. The LANCE AMSR-E system generates a variety of Level-2 swath products using essentially the same science algorithms as are used for the standard science products, but with predictive rather than definitive ephemeris. The average latency for these LANCE AMSR-E swath products is approximately three hours from observation; most of this latency is due to the wait time for the on-board recorder to transmit data to the ground. One of the recommendations arising from the first meeting of the LANCE User Working Group was for the data centers to investigate the feasibility of processing direct broadcast data. Since direct broadcast data is transmitted directly from the satellite to the ground and attainable by anyone with ground receiving equipment and in direct line of sight to the satellite, the wait time associated with ground station contacts is eliminated, thereby significantly reducing latency for these datasets. However, direct broadcast data provide limited geographic coverage, in contrast to the global coverage available from the LANCE products. This presentation will describe recent efforts at the AMSR-E data processing center to reduce data latency and also provide a comparative assessment of the three types of AMSR-E products.

Final ID: P11G-01

A Coupled General Circulation Model of the Archean Earth

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2. Laboratory for Atmospheric and Space Physics, Boulder, CO, United States.

Body: We present results from a new coupled general circulation model suitable for deep paleoclimate studies. Particular interest is given to the faint young Sun paradox. The model is based on the Community Earth System Model maintained by the National Center for Atmospheric Research [1]. Prognostic atmosphere, ocean, land, ice, and hydrological cycle models are coupled. A new correlated-k radiative transfer model has been implemented allowing accurate flux calculations for anoxic atmospheres containing high concentrations of CO2 and CH4 [2, 3]. This model represents a significant improvement upon one-dimensional radiative-convective climate models used previously to study ancient climate [4]. Cloud and ice albedo feedbacks will be accurately quantified and new constraints on Archean surface temperatures will be revealed.

References

[1] Collins W.D. et al. "Description of the NCAR Community Atmosphere Model (CAM 3.0)." NCAR Technical Note, 2004.
[2] Toon O.B., McKay, C.P., Ackerman, T.P. "Rapid Calculation of Radiative Heating Rates and Photodissociation Rates in Inhomogeneous Multiple Scattering Atmospheres." J. Geo. Res., 94(D13), 16287 - 16301, 1989.
[3] Mlawer, E.J., et al. "Radiative transfer for inhomogeneous atmospheres: RRTM, a validated correlated-k model for the longwave." J. Geo. Res., 102(D14), 16663 - 16682, 1997.
[4] Kasting J.F., Pollack, J.B., Crisp, D. "Effects of High CO2 Levels on Surface Temperature and Atmospheric Oxidation State of the Early Earth." J. Atm. Chem., 1, 403-428, 1984.

Final ID: H11I-03

A likely-universal model of fracture density and scaling justified by both data and theory. Consequences for crustal hydro-mechanics

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Body: We discuss the parameters that control fracture density on the Earth. We argue that most of fracture systems are spatially organized according to two main regimes. The smallest fractures can grow independently of each others, defining a “dilute” regime controlled by nuclei occurrence rate and individual fracture growth law. Above a certain length, fractures stop growing due to mechanical interactions between fractures. For this “dense” regime, we derive the fracture density distribution by acknowledging that, statistically, fractures do not cross a larger one. This very crude rule, which expresses the inhibiting role of large fractures against smaller ones but not the reverse, actually appears be a very strong control on the eventual fracture density distribution since it results in a self-similar distribution whose exponents and density term are fully determined by the fractal dimension *D* and a dimensionless parameter γ that encompasses the details of fracture correlations and orientations. The range of values for *D* and γ appears to be extremely limited, which makes this model quite universal.
This theory is supported by quantitative data on either fault or joint networks. The transition between the dilute and dense regimes occurs at about a few tenths of kilometers for faults systems, and a few meters for joints. This remarkable difference between both processes is likely due to a large-scale control (localization) of the fracture growth for faulting that does not exist for jointing.
Finally, we discuss the consequences of this model on both flow and mechanical properties. In the dense regime, networks appears to be very close to a critical state.

Final ID: ED11D-05

How Do We Communicate Both the Knowns and Unknowns of Climate Change?

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2. Consortium for Science, Policy and Outcomes, Arizona State University, Tempe, AZ, United States.
3. Science & Social Change, Science Museum of Minnesota, St. Paul, MN, United States.

Body: The overwhelming consensus amongst climatologists is that anthropogenic climate change is underway, but leading climate scientists also anticipate that over the next 20 years research will only modestly reduce the uncertainty about where, when and by how much climate will change. Uncertainty about these aspects of climate change and their impacts presents not only scientific challenges but social, political and economic quandaries as well. The Science Museum of Minnesota (SMM) in partnership with the Consortium for Science, Policy and Outcomes at Arizona State University, the Institute on the Environment at the University of Minnesota, and the Institute for the Future in Palo Alto, CA proposes to create a major national touring science exhibition that focuses both on informing the public on what is known about climate change and on how to plan for the future in light of the uncertainties identified above.

The scientific and educational communities understand that climate change will test the resilience of societies especially because of the uncertainties regarding where, when and by how much climate will change. Yet the civic space for such conversations is circumscribed. Various interest groups are actively engaged in sowing doubt and confusion in the public's mind about the existence of anthropogenic climate change. Consequently, some in the scientific community find the mention of uncertainty in association with climate change as an anathema because of concerns about potentially eroding public understanding and acceptance of the reality of anthropogenic climate change.

SMM and its partners are interested in the perspectives of the scientific community with respect to the proposed exhibition. This session will engage participants in a dialog around a number of questions: How should we discuss the uncertainties of climate change while still communicating the scientific consensus on climate change? How do we gain the confidence of the scientific community to get the balance right between the reality of climate change and the uncertainty of how it will manifest itself? How might this project help reopen the presently stifled U.S. civic conversation about climate change? SMM and its partners seek your insights into these and other critical climate change education questions.

URL: www.smm.org

Final ID: S11C-05

Building the GEM Faulted Earth database *(Invited)*

N. J. Litchfield; [1]; *K. R. Berryman;* [1]; *A. Christophersen;* [1]; *R. F. Thomas;* [1]; *B. Wyss;* [2]; *J. Tarter;* [2]; *M. Pagani;* [2]; *R. S. Stein;* [3]; *C. H. Costa;* [4]; *K. E. Sieh;* [5];

1. GNS Science, Lower Hutt, New Zealand.
2. GEM Foundation, Pavia, Italy.
3. USGS, Menlo Park, CA, United States.
4. Universidad Nacional de San Luis, San Luis, Argentina.
5. Earth Observatory of Singapore, Nanyang Technological University, Singapore, Singapore.

Body: The GEM Faulted Earth project is aiming to build a global active fault and seismic source database with a common set of strategies, standards, and formats, to be placed in the public domain. Faulted Earth is one of five hazard global components of the Global Earthquake Model (GEM) project. A key early phase of the GEM Faulted Earth project is to build a database which is flexible enough to capture existing and variable (e.g., from slow interplate faults to fast subduction interfaces) global data, and yet is not too onerous to enter new data from areas where existing databases are not available. The purpose of this talk is to give an update on progress building the GEM Faulted Earth database.

The database design conceptually has two layers, (1) active faults and folds, and (2) fault sources, and automated processes are being defined to generate fault sources. These include the calculation of moment magnitude using a user-selected magnitude-length or magnitude-area scaling relation, and the calculation of recurrence interval from displacement divided by slip rate, where displacement is calculated from moment and moment magnitude. The fault-based earthquake sources defined by the Faulted Earth project will then be rationalised with those defined by the other GEM global components.

A web based tool is being developed for entering individual faults and folds, and fault sources, and includes capture of additional information collected at individual sites, as well as descriptions of the data sources. GIS shapefiles of individual faults and folds, and fault sources will also be able to be uploaded. A data dictionary explaining the database design rationale, definitions of the attributes and formats, and a tool user guide is also being developed. Existing national databases will be uploaded outside of the fault compilation tool, through a process of mapping common attributes between the databases. Regional workshops are planned for compilation in areas where existing databases are not available, or require further population, and will include training on using the fault compilation tool. The tool is also envisaged as an important legacy of the GEM Faulted Earth project, to be available for use beyond the end of the 2 year project.

Final ID: B11G-07

Modeling methane emissions from Alaskan Yukon River Basin from 1986 to 2005 by coupling a large-scale hydrological model and a process-based methane model

X. Lu; [1]; *Q. Zhuang;* [1];
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Body: Much progress has been made in methane modeling for the Arctic, there is still a large uncertainty in the emission estimate due to spatial variability of water table depth resulting from complex topographic gradient and variations in methane production and oxidation due to complex freezing and thawing processes. Here we extended an extant emission module within a biogeochemistry model, the Terrestrial Ecosystem Model (TEM) to including a large-scale hydrology model, the variable infiltration capacity (VIC) model. The VIC model provides required inputs including freezing and thawing fronts, soil temperature and moisture, to the methane simulation module. The effect of topography on the soil moisture redistribution is explicitly considered by using the TOPMODEL approach. The methane production, oxidation and transport are calculated in the soil profile at each 1 centimeter depth step and 1-hour time step. The coupled modeling framework is applied to the Yukon River Basin at a spatial resolution of 1km from 1986-2005. The simulations show that the average annual net emissions of CH4 from the region are 4.01 Tg CH4 yr-1. There is a large interannual variability in CH4 emissions during the study period and it is closely related to climate changes. El Nino phenomena usually lead to positive emission anomalies, while decreases in net CH4 emissions may be associated with strong La Niña events. The precipitation was found more closely related to the CH4 dynamics than soil temperature and active layer depth during the 1986-2005. The study highlights the importance of the effects of soil freezing and thawing process and the microtopography information in quantifying the dynamics of CH4 emissions from the complex landscape in the region.

Final ID: P11G-08

The Nitrogen Constraint on Habitability of Planets of Low Mass M-stars

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Body: The traditional habitable zones around stars are defined based on the stability of liquid water over geological timescales. Being too far away from the stars, the planet would be incapable of maintaining a warm surface and thus no liquid water. Being too close to the star, the planet would experience a 'runaway' greenhouse phase, during which its oceans could be lost quickly, and end up similar to our sister planet, Venus.

The definition of tranditional habitable zones does not consider the availability of other elements important for life. All life as we know it needs nitrogen. Our calculations of upper planetary atmospheres show that nitrogen could be lost rapidly from planetary atmospheres with CO2 concentrations lower than certain threshold. This suggests that life on planets around low mass M-stars may be selflimiting, and planets of low mass M-stars are less favorable places to search for life than G- or K-type stars.

Final ID: C12A-01

The IPD and the Need for Sustained Observations and Coordinated Analyses in Polar Regions ***(Invited)***

L. D. Hinzman;[1];

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Body: The framework of the International Polar Decade (IPD) could support cooperation, data sharing and collaboration needed to understand the rapidly changing polar environment. The Arctic is experiencing rapid transitions in the atmosphere, the terrestrial regions and in the Arctic Ocean, perhaps greater than has been observed in recorded history. We were fortunate to convene the beginning of the Fourth International Polar Year (IPY) at the same time we experienced a record low in summer sea ice extent in the Arctic Ocean. This serendipitous occurrence of enhanced and coordinated observations at a time when a record minimum occurred focused public attention on the polar regions and permitted higher level system analyses that would not otherwise have been possible. The international commitment towards dense observations of the Arctic Ocean during IPY led to comprehensive documentation of the record sea ice minimum and its aftermath and repercussions throughout the Arctic system. Many other cryospheric processes are also changing on relatively rapid time scales, but these may not be statistically significant or even consistent over the short time frame of the IPY. In order to document and understand the system-scale changes occurring in high latitudes, it is necessary to engage in longer-term observations and analyses. Many of these processes display a very small or subtle signal of climate warming amidst the noise of large inherent variability. Although precipitation in the form of snow is projected to increase, that change is difficult to document due to very large year to year variability. Permafrost is warming in most places throughout the Arctic, but in many cases that change is on the order of tenths of a degree per decade. Although we can project trends in variables, the consequences and interactions between variables are more difficult to reliably document. In order to more confidently predict interactions between processes, and to quantitatively describe the mechanisms associated with critically important feedback processes, we must invest in long-term monitoring. We must maintain observations and conduct synthetic analyses on the many inter-dependent processes that collectively comprise the polar systems. Defined intensive observation periods with agreed-upon temporal and spatial extent during the IPD is appropriate to help focus these efforts. Regional studies, such as comparative analyses of the Barents and Bering Seas would provide a contextual framework for promoting international collaboration. Thematic studies, such as quantifying changes in circumpolar precipitation regimes, would focus efforts upon particularly problematic challenges.

Final ID: ED12A-05

Cool learnings – extending and communicating polar science to students and the community. ***(Invited)***

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Body: Why should scientists incorporate education and extend communicate the results of their research to the general public? – Because it is the right thing to do; it is easy, fun and usually effective; can feedback to strengthen and improve research; and from an environmental science perspective – badly needed as evidenced by some of the very strange and ill-informed decisions society is making that will affect future generations for many years to come. This presentation focuses on two case studies that extended the research activities from a relatively young and small university research lab to two minority student and community audiences.

The first case study focuses on the educational and outreach experience gained by minority graduate and undergraduate students and teachers participating in an Antarctic system Science study abroad course. Students completed an online class, visited with NSF and other federal agencies in Washington DC, and experienced Patagonia and the Antarctic Peninsula on a month long capstone field course. Participants also visited the classrooms of over 750 students in El Paso, Texas before and after their trip to Antarctica, and prepared a museum exhibit that has now been visited by thousands of people. Most participants have progressed to graduate school or careers in the sciences and several have already acquired substantial funding for research – largely because of their demonstrated capacity to link research, education and outreach.

The second case study describes several instances where the provision of scientific data, information and other resources were extended through cyberinfrastructure to the community of a relatively small Inuit village in northernmost Alaska. Here science data products have been used to enhance town planning and other decision making, and improve the safety of hunters participating in traditional activities such as the Spring subsistence whale harvest. This takes place on sea ice that is more dynamic and does not ‘behave’ in the same way as elders pass on orally to the younger generation due to the impacts from climate change.

Final ID: H13C-1236

Combined land use and climate change impact on Surface and Ground water resources in the Rio Cobre and Great River basin, Jamaica

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2. Life sciences, The University of the West Indies, Kingston, Jamaica.

Body: Possible adverse impacts of land use and climate change on one hand and population pressure, extended droughts, and environmental degradation on the other hand are major factors limiting water resources availability in the watersheds of Jamaica. The main objective of this study is to analyze the combined impact of land use/ land cover changes as well as climate change on the hydrological processes and water recourses availability in the Rio Cobre and Great River basins. A spatially distributed model SWAT was calibrated and validated in the basin and used for the study of land use and climate change impacts in the watersheds. Different land cover types were tested to analyze its impact on the hydrology of the watershed. The main land cover parameters considered within the Great and Rio Cobre River Watershed includes Agriculture, Tourism, Water, Road Infrastructure, Population, Forestry and land cover Information. The outputs of different Global climate model (GCM) were downscaled to the watershed level and used for assessing the impact of climate change on water resources availability in the area. The analysis of climate change impact on the surface and ground water resources of the basin indicated that the basin will experience a change in water balance due to changes in the major climate variables in the forthcoming decades. The direction of streamflow change follows mainly the direction of changes in rainfall. Many of the models show statistically-significant declines in mean annual streamflow (up to 60% reduction in streamflow) for the different time-periods and scenarios. The combined effect of climate and land-use/land-cover change on the hydrological processes and water recourses variability is an important step to develop sustainable adaptation strategy.

Final ID: NH13E-1411

Regional Assessment of Storm-triggered Shall Landslide Risks using the SLIDE (SLope-Infiltration-Distributed Equilibrium) Model

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2. NASA Goddard Space Flight Center, Greenbelt, MD, United States.
3. Kyoto University, Kyoto, Kyoto, Japan.

Body: The key to advancing the predictability of rainfall-triggered landslides is to use physically based slope-stability models that simulate the dynamical response of the subsurface moisture to spatiotemporal variability of rainfall in complex terrains. An early warning system applying such physical models has been developed to predict rainfall-induced shallow landslides over Java Island in Indonesia and Honduras. The prototyped early warning system integrates three major components: (1) a susceptibility mapping or hotspot identification component based on a land surface geospatial database (topographical information, maps of soil properties, and local landslide inventory etc.); (2) a satellite-based precipitation monitoring system (http://trmm.gsfc.nasa.gov) and a precipitation forecasting model (i.e. Weather Research Forecast); and (3) a physically-based, rainfall-induced landslide prediction model SLIDE (SLope-Infiltration-Distributed Equilibrium). The system utilizes the modified physical model to calculate a Factor of Safety (FS) that accounts for the contribution of rainfall infiltration and partial saturation to the shear strength of the soil in topographically complex terrains.

The system's prediction performance has been evaluated using a local landslide inventory. In Java Island, Indonesia, evaluation of SLIDE modeling results by local news reports shows that the system successfully predicted landslides in correspondence to the time of occurrence of the real landslide events. Further study of SLIDE is implemented in Honduras where Hurricane Mitch triggered widespread landslides in 1998. Results shows within the approximately 1,200 square kilometers study areas, the values of hit rates reached as high as 78% and 75%, while the error indices were 35% and 49%.

Despite positive model performance, the SLIDE model is limited in the early warning system by several assumptions including, using general parameter calibration rather than in situ tests and neglecting geologic information. Advantages and limitations of this model will be discussed with respect to future applications of landslide assessment and prediction over large scales. In conclusion, integration of spatially distributed remote sensing precipitation products and in-situ datasets and physical models in this prototype system enable us to further develop a regional early warning tool in the future for forecasting storm-induced landslides.

URL: http//hydro.ou.edu

Final ID: PP13A-1821

SPECMAP Chronology in 2011

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Body: The chronology methodology introduced by SPECMAP revolutionized Earth history research. Time calibration ("tuning") of paleoclimatic proxies to astronomical forcing models is now a major player in defining the Pleistocene geological time scale. There is additional information in the contributing data that bears on SPECMAP chronology that the original procedures did not emphasize. This was observed by Thomson (1990), who found that coherence in the obliquity band of the SPECMAP stack decays significantly back through time. Here we decompose the stack to identify the source(s) of this decay in an effort to quantify astronomically tuned chronology uncertainty. We focus on the phasing of precession signals in stratigraphy as a leading cause of uncertainty, and 'minimal tuning' procedures as a solution to the problem. [Reference: Thomson, D, 1990, Phil. Trans. R. Soc. Lond. A, 332(1627), 539-597.]

Final ID: MR13A-2185

Lattice thermal conductivity: Computations and theory of the high-temperature breakdown of the phonon-gas model

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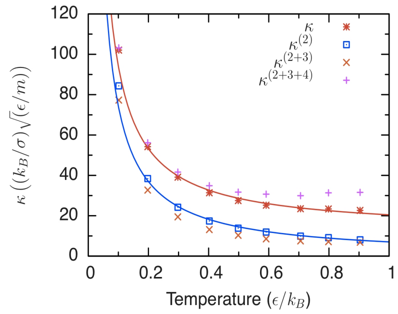
Body: We use classical molecular dynamics to evaluate the thermal conductivity $\kappa(T)$ from the heat-flux correlation $\langle \mathbf{j}(0)\mathbf{j}(t)\rangle$ for a 2-D Lennard-Jones triangular lattice. Our work, which follows Ladd, Moran, and Hoover (Phys. Rev. B {\bf 34}, 5058 (1986)), finds large deviations from the Eucken-Debye result $\kappa(T)=A/T$ predicted by the phonon-gas model, even though phonon quasiparticles are fairly well-defined. The main source of deviations comes from higher-order (anharmonic) terms in the heat-flux operator $\mathbf{j}$. By separating different orders of terms $\mathbf{j} = \mathbf{j}^{(2)} + \mathbf{j}^{(3)} + \ldots$, we examine various separate contributions to $\kappa(T) \approx \kappa_{22} + \kappa_{23} + \ldots$, both from the harmonic and the anharmonic heat fluxes. We find that $\kappa_{22}(T) \approx A/T$ follows quasiparticle theory fairly well, but important terms from κ_{23} and κ_{24} are independent of T in the classical (high T) limit. We use diagrammatic perturbation theory applied to the quantum Kubo formula, to check and explain the T-dependence found numerically from anharmonic heat fluxes. We also demonstrate the importance of vertex correction in obtaining the correct quasiparticle coefficient of $1/T$.



Thermal conductivity at various temperatures. A function A + B/T is used to fit $\kappa(T)$ and $\kappa^{(2)}(T)$, shown in solid lines. We find $\kappa (T) = 12.27 + 8.18/T$, $\kappa^{(2)} = −0.43 + 7.47/T$. The total thermal conductivity $\kappa (T)$ saturates at high temperatures, while $\kappa^{(2)}(T)$ largely obeys the 1/T law.

Final ID: T13F-2481

Fjord erosion, Quaternary sedimentation and isostatic rebound in western Scandinavia

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2. Geologisches Institut, ETH Zürich, Zürich, Switzerland.

Body: Quaternary topographic evolution of western Scandinavia is investigated in relation to fjord erosion, offshore sedimentation, and induced flexural motion. Erosion is computed on the Sognefjord by identification and interpolation of the flat surfaces that border the fjord. We found a mean erosion of ~300 m averaged for the Sognefjord basin, with up to 2.2 km in its main stream. Erosion deduced from geophysical relief gives a similar averaged erosion, when computed using a sliding window with a radius of ~1 km, while it correlates best with the erosion deduced from the flat surface for a radius of ~2 km. Still using the geophysical relief, we find that the total volume of fjord erosion of western Scandinavia is 70.000 km3 or 115.000 km3, for a radius of 1 or 2 km, respectively. It represents between 45 % and 70 % of the total volume of erosion ~160.000km3, deduced from Quaternary sediment deposits offshore Norway, including the Naust formation, the North Sea Fan and Plateau, and the Channel of Norway. Isostatic vertical motion induces by theses transfers of mass is computed using a realistic map of effective elastic thickness. Our results indicate a maximum onshore uplift of 400 to 600 m in the main fjord region, and an offshore subsidence of 1200 m in the North Sea Fan and Naust Formation. Putting back all the sediments onshore induces a vertical motion up to 900 m in the main fjord area. Our results indicate that fjords were mainly shaped during the Quaternary, probably because of a cooling of climate. Our findings are not compatible with a shaping of fjord induced by a Neogene uplift. They even implies that another source of erosion is required to match the volume of erosion with Quaternary sediment, which can be possibly explained by a glacial “buzzsaw” erosion affecting the entire topography.

Final ID: P13G-02

Exploring the topography and structure of Saharan linear dunes: Implications for characterizing dunes on Titan

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2. Department of Geological Sciences, Brigham Young University, Provo, UT, United States.

Body: Tens of thousands of sand dunes encircle the equatorial latitudes of Saturn’s moon Titan, as seen by the Cassini Radar and visible-NIR instruments. These are linear in form, comparable in size and morphology to large linear dunes in the Egyptian Sahara. Studies of linear dunes in the Sahara can therefore assist in understanding the characteristics and formation of Titan’s dunes. High-resolution topographic profiles of the Egyptian dunes indicate winds draw dune sands into broad stable plinths with steep summits that shift with recent winds. The summits of the Qattaniya Dunes west of Cairo are drawn out into crescents along the dune long axis from dominant, northerly winds on a NNW-trending crestline. Ground penetrating radar surveys show equally spaced layers within the dune, suggesting continuous, regular wind regimes formed the dunes. Larger dunes of the Great Sand Sea south of Siwa Oasis exhibit generally similar topographic profiles and fine layering although numerous flanking features complicate the overall morphology. These analyses can be related to studies of wind pattern effects on Titan’s dune forms, residence time of sands within dunes on Titan, and the creation and maintenance of evolved dune forms across Titan. Studies of the effects of morphology and internal structure of these dunes on terrestrial radar remote sensing observations will yield additional information concerning Titan's dunes. Scattering models, for example, seek to explain the radar returns from Titan’s dunes based on geometry and sand composition so it is valuable to understand the effects of these parameters on terrestrial dunes.

Final ID: SA13C-05

Determination of the Sharp, Longitudinal Gradients in Equatorial ExB Drift Velocities Associated with the 4-cell, Non-migrating Structures ***(Invited)***

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Body: Previous studies have established the existence of a 4-cell, longitude pattern in equatorial F region ionospheric parameters such as TEC and electron densities and in daytime, equatorial ExB drift velocities. A recent paper, for the first time, quantified the longitude gradients in ExB drift associated with the 4-cell tidal structures and confirmed that these sharp gradients exist on a day-to-day basis. Using the Ion Velocity Meter (IVM) on the Communication/Navigation Outage Forecast System (C/NOFS) satellite to obtain daytime, vertical ExB drift velocities, it was found, for example, that for October 5, 6 and 7, 2009 in the Atlantic sector, the ExB drift velocity gradient was about 1m/sec/degree. For March 23, 24 and 25, 2009 in the Peruvian sector, it was about -4m/sec/degree. This talk summarizes past observations of the sharp longitude gradients in vertical ExB drift velocities and the effect of these sharp gradients on theoretically-calculated ion density distributions as a function of latitude and longitude. We also present initial, ground-based magnetometer-inferred vertical ExB drift velocities from the LISN (Low-latitude Ionospheric Sensor Network) chain of magnetometers at 295 E. geographic longitude and 310 E. geographic longitude that provide the day-to-day and seasonal variability in ExB drifts at the boundary between the Peruvian longitude sector and the Atlantic longitude sector. The advantages of these continuous, daytime observations are discussed.

Final ID: B13I-07

The Evolution of Volcanic Ocean Islands and Biota *(Invited)*

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2. Integrative Biology, University of California, Berkeley, Berkeley, CA, United States.
3. Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technologyy of California, Berkeley, Cambridge, MA, United States.

Body: Species or taxon abundances on ocean island archipelagoes consistently show a power law dependency on island area. Nearly 50 years ago, MacArthur and Wilson proposed a theory to explain this dependency, focusing on the equilibrium species number that arises from the balance of immigration and extinction. Subsequent studies have strongly supported this revolutionary theory, applying it to ecological islands ranging in scale from cobbles to sub-continents. The MacArthur and Wilson theory assumes speciation on islands was unimportant, yet studies of remote ocean islands, where endemics dominate many taxa, suggest that simultaneous evolution of organisms and their islands is a first order process influencing species richness. Molecular clock studies now allow tracking of species radiation events across islands, in many cases showing evidence of progression from older to younger islands. Recently efforts have been made to add speciation to the MacArthur and Wilson model (most notably by Whittaker et al., 2008, J.Biogeogr), specifically tying it to the time and physical evolution of ocean islands. This challenges evolutionary scientists, ecologists, and geoscientists to develop mutually useful understanding of how island evolution drives speciation. Volcanic ocean islands over mantle plumes (e.g. Hawaii, Society, Galapagos, Marquesas, and Samoa island chains) present the possibility of a well-defined age succession, observable physical changes, and abundant endemics. These island chains present some appealing constraints: active island construction typically is about 1 million years and in most cases the oldest island is about 5 million years. Once the islands are sufficiently tall and wide they can increase precipitation by over 3 times relative to the open ocean. But this precipitation is commonly non uniform, with windward sides much wetter, and, if islands attain sufficient height, maximum precipitation occurring below the island peak. Coarsely, islands build, subside, erode, and disappear. Their topography can be characterized by a power-law relation of a cone with a mean slope of about 6 degrees throughout their evolutionary history. But local geologic history (e.g. subsidence, uplift, climate and erosion) differ significantly and is not easily inferred from island topography alone. The wet, extensively dissected Hawaiian islands and relatively dry, minimally dissected Galapagos islands offer sharp contrasts in island evolution, and, correspondingly, in species abundance and radiation histories. We see the biggest challenge in explicitly coupling island and biotic evolution the linking of speciation to specific quantitative attributes of landscapes. Would islands themselves evolve differently in the absence of life? We propose that in the absence of life soil mantles would be thin to absent, chemical weathering rates may be slower, eroded sediment would be coarser, and shallow landsliding may be less frequent on bedrock dominated slopes. These are small differences, however, that would not seem to alter volcanic ocean island evolution significantly.

Final ID: T13I-08

Deformation, deposition, and surface uplift in the hinterland of the Central Andes, Bolivia

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2. Geologie and Geodynamik, Universitat Tubingen, Tubingen, Germany.
3. Earth and Environmental Sciences, University of Rochester, Rochester, NY, United States.
4. Geological and Planetary Sciences, Caltech, Pasadena, CA, United States.

Body: Paleoelevation histories from mountain belts like the Central Andes of Bolivia provide important constraints on the timing and geodynamic mechanisms associated with surface uplift. New stable isotope data from paleosol carbonate nodules in the Altiplano and Eastern Cordillera of the Central Andes of Bolivia indicate a previously undocumented episode of surface uplift occurred in the region between ca. 24 and 17 Ma. Oxygen isotope and clumped-isotope thermometry values from paleosol carbonate in strata >24 Ma suggest paleoelevations as low as sea-level. Paleosol carbonate in strata ca. 17 Ma have oxygen isotope and clumped-isotope thermometry values, which using modern lapse rates, indicate an increase in elevation of approximately 3 km. Relatively undeformed Oligocene and Miocene strata overlap faulted Paleozoic rocks of the Bolivian Eastern Cordillera, indicating deposition and surface uplift post-dated and was decoupled from upper crustal deformation. Together, geological data from the area record an initial period of deformation and exhumation, a subsequent period of sediment deposition and overlap, and then an episode of surface uplift that was not accompanied by upper crustal deformation. We propose accommodation for the Oligocene-Miocene strata was associated with mantle and lowermost crustal processes, and the subsequent increase in surface elevation was an isostatic response to removal of dense material through delamination or drip. Combined with existing data sets in the Central Andes, these new data suggest multiple, regionally-variable, and diachronous periods of surface uplift occurred within the Central Andes during the Cenozoic Era.

Final ID: DI14A-01

Keeping it Together: Advanced algorithms and software for magma dynamics (and other coupled multi-physics problems) ***(Invited)***

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Body: A quantitative theory of magma production and transport is essential for understanding the dynamics of magmatic plate boundaries, intra-plate volcanism and the geochemical evolution of the planet. It also provides one of the most challenging computational problems in solid Earth science, as it requires consistent coupling of fluid and solid mechanics together with the thermodynamics of melting and reactive flows. Considerable work on these problems over the past two decades shows that small changes in assumptions of coupling (e.g. the relationship between melt fraction and solid rheology), can have profound changes on the behavior of these systems which in turn affects critical computational choices such as discretizations, solvers and preconditioners. To make progress in exploring and understanding this physically rich system requires a computational framework that allows more flexible, high-level description of multi-physics problems as well as increased flexibility in composing efficient algorithms for solution of the full non-linear coupled system.

Fortunately, recent advances in available computational libraries and algorithms provide a platform for implementing such a framework. We present results from a new model building system that leverages functionality from both the FEniCS project (www.fenicsproject.org) and PETSc libraries (www.mcs.anl.gov/petsc) along with a model independent options system and gui, Spud (amcg.ese.ic.ac.uk/Spud). Key features from FEniCS include fully unstructured FEM with a wide range of elements; a high-level language (ufl) and code generation compiler (FFC) for describing the weak forms of residuals and automatic differentiation for calculation of exact and approximate jacobians. The overall strategy is to monitor/calculate residuals and jacobians for the entire non-linear system of equations within a global non-linear solve based on PETSc's SNES routines. PETSc already provides a wide range of solvers and preconditioners, from parallel sparse direct to algebraic multigrid, that can be chosen at runtime. In particular, we make extensive use of PETSc's FieldSplit block preconditioners that allow us to use optimal solvers for subproblems (such as Stokes, or advection/diffusion of temperature) as preconditioners for the full problem. Thus these routines let us reuse effective solving recipes/splittings from previous experience while monitoring the convergence of the global problem. These techniques often yield quadratic (Newton like) convergence for the work of standard Picard schemes.

We will illustrate this new framework with examples from the Magma Dynamic Demonstration suite (MADDs) of well understood magma dynamics benchmark problems including stokes flow in ridge geometries, magmatic solitary waves and shear-driven melt bands. While development of this system has been driven by magma dynamics, this framework is much more general and can be used for a wide range of PDE based multi-physics models.

Final ID: C21A-0460

Refugium for surface life on Snowball Earth in a nearly-enclosed sea? A finite element approach for sea-glacier invasion

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Body: Photosynthetic eukaryotic algae are thought to have survived during so-called Snowball Earth events. Where such organisms persisted is not immediately clear. With net accumulation of ice at polar regions and net sublimation at the tropical regions thick ice called sea glaciers flowed from the poles toward the equator, covering the global ocean, and prohibiting the transmission of light.

In regions of net sublimation, sea glaciers may have been unable to fully penetrate long narrow embayments, or inland seas. Our previous work showed that refugia could exist at the landward ends of some idealized seas with uniform width.

Here, we solve for penetration lengths of sea glaciers entering narrow channels with more realistic geometries by solving ice flow equations using a finite element model. Channel geometries containing narrow straits near the entrance (e.g. the Red Sea) restrict the ability of the sea glacier to penetrate the channel. This allows narrow channels to provide refugia under a wider variety of conditions.

Final ID: EP21A-0651

Will the Atchafalaya River Capture the Lower Mississippi River?

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Body: The Old River Control Structure (ORCS) was built in the 1960s to prevent the Atchafalaya River from capturing the lower Mississippi River. The 2011 flood on the Mississippi River tested ORCS and renewed concerns about what would happen to the rivers if ORCS failed. Most consider capture a foregone conclusion if ORCS failed, but this hypothesis has never been tested. A viable alternative hypothesis is that the discharge distribution between the Atchafalaya and Mississippi would stabilize at the relative proportions predicted by recent theory such that both channels transmit water. To test these hypotheses I conducted numerical experiments of the Mississippi-Atchafalaya rivers in the absence of ORCS using Delft3D. All model runs have evolving beds and are depth-integrated. The grid is 2D in planform and follows the banks of each river. The channel walls are fixed, tributaries are not included, and there are no floodplains. At the upstream boundary I specify the water discharge and sediment fluxes. The incoming discharge carries two grain sizes, one noncohesive (200 microns) and one cohesive (15 microns). At the downstream boundaries water surface elevations are set to zero. The initial bed topography in each river comes from 2004 and 2006 hydrographic surveys of the Mississippi and Atchafalaya, respectively. I conducted 7 experiments where the discharge upstream of ORCS (Q_{up}) is steady, but varies among experiments from 5000 $m^3 s^{-1}$ to 50000 $m^3 s^{-1}$. Results show that the response of the rivers depends strongly on Q_{up}. When Q_{up} > 15000 $m^3 s^{-1}$ there is net flow capture by the Atchafalaya, and the capture rate increases with increasing Q_{up}. But when Q_{up} < 15000 $m^3 s^{-1}$ there is net flow capture by the Mississippi. The rates of capture for different values of Q_{up} can be used to calculate if capture would occur for a realistic, unsteady hydrograph.

Final ID: EP21A-0654

Integrated Biogeomorphological Modeling Using Delft3D

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Body: The skill of numerical morphological models has improved significantly from the early 2D uniform, total load sediment models (with steady state or infrequent wave updates) to recent 3D hydrodynamic models with multiple suspended and bed load sediment fractions and bed stratigraphy (online coupled with waves). Although there remain many open questions within this combined field of hydro- and morphodynamics, we observe an increasing need to include biological processes in the overall dynamics. In riverine and inter-tidal environments, there is often an important influence by riparian vegetation and macrobenthos. Over the past decade more and more researchers have started to extend the simulation environment with wrapper scripts and other quick code hacks to estimate their influence on morphological development in coastal, estuarine and riverine environments. Although one can in this way quickly analyze different approaches, these research tools have generally not been designed with reuse, performance and portability in mind. We have now implemented a reusable, flexible, and efficient two-way link between the Delft3D open source framework for hydrodynamics, waves and morphology, and the water quality and ecology modules. The same link will be used for 1D, 2D and 3D modeling on networks and both structured and unstructured grids. We will describe the concepts of the overall system, and illustrate it with some first results.

URL: http://oss.delft3d.nl

Final ID: EP21A-0655

How to Include Steep Bank Retreat in 2D/3D Morphological Models?

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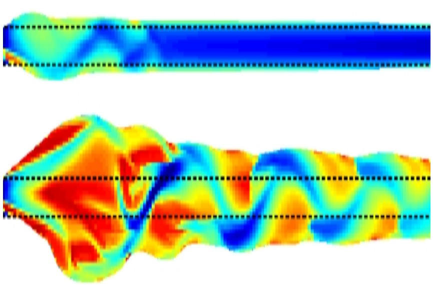
Body: State-of-the-art 2D/3D morphological models like open source Delft3D include an increasing number of features, such as multiple cohesive and non-cohesive sediment fractions, bed load and separate suspended load (including density effects), sediment fraction interaction processes such as hiding and exposure, ripple and dune predictors, consolidation, and bed composition stratigraphy. However, this and similar models have been developed for simulating morphological changes under the assumption that horizontal scales are large compared to the vertical scale and that the processes affecting the bed are hence dominantly vertical fluxes. However, near banks and steep slopes the processes have a significant horizontal component: a crucial aspect in the simulation of meandering rivers. Although simple or engineering solutions have been added to many of these models to get some erosion of dry areas, scientifically based bank erosion formulations are generally lacking in these models. Although such formulations may be complex and non-deterministic, that is not the main reason why they haven't been implemented: resolving the shift of bank-lines on the grid is the main problem.

Defining bank-lines along the nearest grid lines of a rectangular computational grid leads to staircase lines that impede any reasonable determination of the hydraulic loads on the banks. An adaptive curvilinear boundary-fitted grid may at first glance seem to solve this problem, but arbitrary bank retreat and advance deform such a grid prohibitively within a few bank-line update steps and cause stationary features of the landscape (e.g. a bridge or local sediment composition) to move with the grid or to diffuse due to numerical limitations. We have therefore chosen a new approach in which shifting bank-lines are followed as separate moving objects on a fixed grid, using local immersed-boundary techniques to solve the flow and sediment transport in the vicinity of the bank-lines.

We show some results and discuss the way forward: e.g. how to combine the immersed-boundary solution with over bank flows, and how to build up and erode into stratigraphy.

URL: http://oss.delft3d.nl



Final ID: EP21A-0658

A New Channel-Resolving Reduced-Complexity Delta Model

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Body: Sedimentary delta formation varies over a wide range of time and space scales. In this situation detailed modeling of every aspect of the system can be extremely expensive which, due to the resulting complexity, may only lead to limited physical insights. The alternative is to develop reduced-complexity models that attempt to retain the key dynamics and phenomena in delta morphodynamics through employing approximate but physically reliable descriptions of the governing transport equations.

We developed a cellular rule-based model, using a “directed” random-walk to determine the flow field, coupled with empirically based sediment transport schemes. In each time step, water packets are routed through the domain via a random walk guided by a set of rules, which combines a direct simplification of the shallow-water equations and a first-order representation of flow inertia. A flow field is computed by accumulating the trajectories of all the packets and an estimate for the water surface obtained. Following an Exner equation combining bedload and suspended lade components is used to update the sediment deposition. Bedload is estimated by empirical formulas, based on the flow field properties, and suspended load is simulated by an additional random walk in which particles follow the flow and deposit where a critical condition is met. Smoothing is added to account for down-slope sediment transport.

Preliminary results provide physically reasonable 3-dimensional topographical features, as well as dynamics processes like channel avulsions and bifurcations. Model runs simulating a complete delta development usually take less than an hour. Stratigraphy is also recorded to compare with field and experimental measurements. Current model tests focus on the effects of sediment cohesion on channel avulsions by changing sand/mud ratio. Despite the limited physics presented by a few set of simple rules, the flexibility of the modeling framework allows each building block to be updated separately. This will allow for the ready extension of the model to include additional phenomena such as waves and tides.

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Global riverine sediment flux predictions, the WBMsed v2.0 model

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Body: Quantifying fluxes of sediment to oceans, inland water bodies and within catchments is a key feature in many earth-sciences disciplines (fluvial and catchment geomorphology, oceanography, coastal, deltaic etc.). Globally continuous measurements of sediment fluxes are scarce and numerical models are often limited, providing small or point scale predictions only.

WBMsed is a spatially and temporally explicit global riverine model predicting suspended and bedload sediment fluxes based on the WBMplus water balance and transport model (part of the FrAMES biogeochemical modeling framework). The model incorporates climate input forcings to calculate surface and subsurface runoff for each grid cell. The prediction of fluvial sediment fluxes is highly dependent on how well its transport medium, riverine water, is simulated. Analyses indicate that average water discharges are well predicted by the WBMplus model. However, daily freshwater predictions are often over or under predicted by up to an order of magnitude, significantly affecting the accuracy of sediment flux simulation capabilities of WBMsed. Therefore, WBMsed v.2.0 incorporates a floodplain reservoir component that improves high temporal resolution water discharge simulations.

Here we will present the model, discuss its prediction capabilities and limitations and highlight potential applications for the broader earth-sciences community including coupling with other models.

Final ID: EP21B-0671

Self-formed levees and floodplains in an annular flume

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Body: Various river channel patterns have been produced in experiments recently, including dynamic meandering. The key to produce more realistical patterns is the formation of levees and sedimentary floodplain. However, experiments to date only produced wide floodplains or bedload-generated levees and overbank splays, but not the classical levee with decaying thickness and particle size away from the channel. The objective of our work is to understand the subtle balance between inundation level, flow velocity and sediment properties, and to design experimental conditions that form levees in channel pattern experiments.

We designed and built an annular flume with floodplains, where flow is driven by vanes in the preformed channel. The channel sediment was mobile and developed a transverse bed slope in response to the strong spiral flow. The transverse water surface gradient and the level of inundation controlled the flow on the floodplain. We experimented with sediments varying in diameter and density to obtain levees and floodplain under constant forcing and depth.

The flow on the floodplain developed horizontal circulation when shallow relative to the channel, and vertical (spiral) flow when it was deeper. Silt-sized silica flour was either not entrained from the bed onto the floodplain, or suspended so much that the floodplain was covered entirely. A channel-flanking levee only formed in a very narrow range of flow depth and velocity for this sediment. Preliminary tests with low-density sediment did not form levees for channel flow conditions with mobile bed sediment. The difficulty in forming levees, and some numerical modelling with tides, suggest that fluctuating water levels due to floods or tides are conducive to levee formation.

URL: http://www.geo.uu.nl/fg/mkleinhans

Final ID: EP21B-0672

Self-formed braid bars in a numerical model

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Body: Braided rivers have highly variable bar dimensions, bar shapes and bar dynamics, as can be seen in the Brahmaputra–Jamuna in Bangladesh and the Waimakariri in New Zealand. Our objective is to understand the necessary conditions for predicting detailed braid bar morphology and dynamics, and to determine the effects of physical and non-physical numerical settings.
We used the two-dimensional morphological model Delft3D to produce braid bar patterns. This model solves quasi-3D flow including near-bed secondary flow due to streamline curvature, sediment transport including effects of transverse slope, and mass conservation of sediment. We consider our physics-based nonlinear numerical model complementary to field studies and experiments.

We search for the simplest possible initial situation and least amount of boundary conditions that reproduce braid bars, in order to identify what physics and boundary conditions are required. We used different values for grid resolution, transverse bed slope effect and perturbation, and different sediment transport formulas. Also, we identified the difference in braid bar shape and dynamics between 2D depth averaged flow and 3D flow in a sigma grid. Model runs were started from a plane bed with dimensions and constant boundary conditions based on an empirical channel pattern stability diagram. A small random perturbation is added to the upstream discharge partitioning across the inflow boundary (1%) and on the initial bed level (5 mm).

Our results show the reproduction of the essential features of real braid bars including planform shape, length/width ratio, interaction between compound and unit bars, and bartails (seen as ‘wings’ on both downstream sides). The conditions are sufficient to produce realistic bar patterns. Regardless of the settings, initially, relative small sized bars with a high mode (mode 7-8) develop in the entire reach, which advect out of the model. At the same time, relatively high bars (80% of the mean waterdepth) are initiated upstream, migrating downstream and gradually occupying the entire reach, whilst bars grow and mode reduces. Eventually a braid bar pattern with steady statistics is reached. The results show that a 2D or 3D grid affects how dominating the upstream formed bars are on the final bar pattern. Moreover, the braid bars remain more dynamic in the 3D computations. The grid resolution has a major effect on the detailed bar shapes and dynamics but not on the general dimensions. Furthermore, the transverse bed slope strongly affects the bar height. The formative time scale of bars is strongly related to the nonlinearity of the sediment transport equation. The discharge and bed level perturbations have minor effects. The braid bar patterns as well as channel dimensions and other statistics are in good agreement with natural data.

We conclude that self-formed braided bar patterns in our numerical model are realistically reproduced by using the simplest possible initial and boundary conditions. The formation of a braid bar pattern in general strongly depends on the width-depth ratio and the detailed braid bar shape and dynamics are affected by the model settings.

Final ID: EP21B-0675

Numerical Simulation of Sediment Plug Formation in Alluvial Channels

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Body: A sediment plug is the aggregation of sediment in a river reach that completely blocks the original channel resulting in plug growth upstream by accretion and flooding in surrounding areas. Sediment plugs historically form over relatively short periods, in many cases a matter of weeks. Although sediment plugs are much more common in reach constrictions associated with large woody debris, the mouths of tributaries, and along coastal regions, this investigation focuses on sediment plug formation in an alluvial river.

During high flows in the years 1991, 1995, 2005, and 2008, a sediment plug formed in the San Marcial reach of the Middle Rio Grande. The Bureau of Reclamation has had to spend millions of dollars dredging the channel to restore flows to Elephant Butte Reservoir. The hydrodynamic and sediment transport processes, associated with plug formation, occurring in this reach are driven by 1) a flow constriction associated with a rock outcrop, 2) a railroad bridge, and 3) the water level of the downstream reservoir.

The three-dimensional hydrodynamic model, Delft3D, was implemented to determine the hydrodynamic and sediment transport parameters and variables required to simulate plug formation in an effort to identify hydro- and morphodynamic thresholds. Several variables were identified by previous studies as metrics for plug formation. These variables were used in our investigation to detect the relative magnitude of each process. Both duration and degree of high flow events were simulated, along with extent of cohesive sediment deposits, reservoir level, and percent of fines in suspended sediment distribution.

Results of this analysis illustrate that this model is able to reproduce the sediment plug formation. Model calibration was based on measured water levels and changes in bathymetry using both sediment transport and morphologic change parameters. Changes to hydraulic and sediment parameters are not proportional to morphologic changes and are asymptotic in their response. These results suggest that there are thresholds to predict plug formation and that the contribution of specific variables to plug formation is not uniform.

Sediment plug formation is a costly and dangerous phenomenon, especially in large alluvial rivers. This investigation yielded specific insights into the hydrodynamic and morphologic processes occurring during sediment plug formation. These insights can be used to reduce the risk of plug formation and predict the locations and times of other sediment plugs.

Final ID: EP21B-0676

Experimental rivers: from braided to meandering by addition of cohesive floodplain material

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Body: Braided rivers are relatively easily formed in the laboratory, whereas self-formed meandering rivers have proven very difficult to form. Our objective is to create self-formed dynamic braided and meandering rivers in a laboratory, and to quantitatively compare the resulting morphology and deposits. We applied a transverse moving inlet funnel for flow and sediment at the upstream boundary, mimicking meanders migrating into the control section. Conditions in the meandering and braided experiment were exactly equal except that slightly cohesive silt-sized silica flour was added to the feed sediment of the meandering channel. This was to test the hypotheses that 1) meandering rivers have relatively narrower and deeper channels due to bank cohesion, and 2) floodplain-filling sediment fills potential chute channels that would otherwise lead to braiding.

Our experiments were conducted in a flume of 10x6 meter, which was split up into two separate fluvial plains (each 10x3 m). The parallel setups have identical cycled discharge regimes with a longer duration low flow and a shorter duration high flow simulating floods. The bed sediment consisted of a poorly sorted sediment mixture ranging from fine sand to fine gravel. The evolution was recorded by high-resolution line-laser scanning and digital Single Lens Reflex (SLR) camera used for channel-floodplain segmentation and particle size estimation.

In agreement with earlier work, the experimental river without silica flour evolves from alternate bars to a fully braided river. With silica flour added to the feed, a meandering system evolved with frequent chute cut-offs that nevertheless remained mostly single-thread. The silica flour introduces cohesive self-formed floodplains, causes narrower channels and fills potential chutes. Large bends developed with scroll bar complexes and sinuosity reached maxima of 1.4. In contrast, the non-cohesive experiment is dominated by much more rapid channel shifting and displacement, so that much more sediment was reworked. Apparently, the lack of bank cohesion allowed more sediment to be available within the channels, which in turn enhanced the braiding tendency. We conclude that the increase of fine cohesive material leads to a decrease in chute cutoffs and the tendency to braid. The upstream moving inflow boundary was a necessary condition for dynamic meandering and braiding.

Final ID: EP21B-0685

Reversal in Migration of Gravel-Sand Transition

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Body: Downstream lithofacies change is an important key to interpret fluviodeltaic depositional environment, which can be recognized by lithologic features, such as grain-size. It has been generally accepted that changes in the downstream position of grain-size transition (e.g., gravel-sand transition) are attributed to variations in basinal forcing (e.g., climate variation, sea-level change and basin subsidence), factors that also cause shoreline migration. However, no quantitative model for predicting evolution of fluviodeltaic strata thoroughly incorporates lithofacies boundaries and allows their free individual migrations. In this presentation, I present a delta evolution model to provide the quantitative understanding of the relationship between the external moving boundary (delta shoreline) and the internal moving boundaries (grain-size transitions). By treating internal coarse to fine grain-size transitions as moving boundaries, the model is capable of accurately predicting the dynamic interactions between the upstream river reaches with different dominant grain-sizes and the downstream shoreline migration in response to base-level changes. For simplicity, the model employs one grain-size transition between the upstream gravel-bed reach and the downstream sand-bed reach and constant rates of water discharge, sediment supply, and relative sea-level rise. Test runs with ranges of sediment supply rates and relative sea-level rise rates show cases for retreat of the gravel-sand transition while the shoreline is still prograding, and thus reveal the condition for reversal in migration of the internal grain-size boundary against the direction of a growing fluviodeltaic system. The model can be used to provide baseline conditions for uniform migration direction of both internal lithofacies transitions and shoreline in fluviodeltaic systems that can be used to accurately assess the trajectory of grain-size transition in sedimentary strata as a proxy for environmental change.

URL: http://www.ig.utexas.edu/people/staff/delta/research/

Final ID: EP21B-0694

Hydraulic geometry of meandering, alluvial sand-bed streams: the roles of washload, vegetation and natural bank armoring

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Body: The great majority of single-channel meandering, alluvial sand-bed streams have well-vegetated floodplains. The channel and floodplain co-evolve by means of migration and floodplain deposition. Natural armoring of eroding banks due to e.g. slump blocks, vegetal encroachment on point bars and overbank deposition of washload all play roles in establishing hydraulic geometry. Here we present a first model that includes these factors.

Final ID: EP21B-0701

Detached eddy simulation (DES) of turbulence and suspended sediment transport in lateral separation eddies in the Colorado River in Grand Canyon

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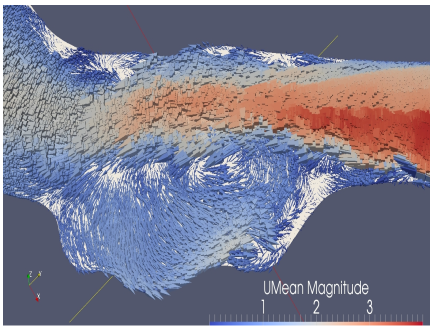
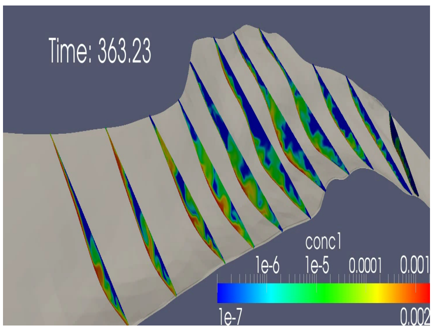
Body: DES is applied to flow in a rapid and lateral separation eddy in Grand Canyon using the Spalart and Allmaras subgrid stress and RANS closure. DES is a hybrid large eddy simulation (LES) and Reynolds-averaged Navier-Stokes (RANS) technique. The RANS portion of the flow extends only a very short distance above the bed where grid length scales are too large to resolve the turbulent motions necessary to correctly calculate the momentum transport. A wall viscosity approach, utilizing a local bed roughness scale, is used to account for the hydraulically-rough bed. The convective terms are discretized using central differences, with a small proportion of upwinding in zones of high shear to prevent pressure-velocity decoupling. A two-dimensional depth-averaged flow model is utilized to determine the local water surface elevation of the three-dimensional, DES, finite volume grid.
Suspended sediment is modeled using the advection-diffusion equation under the assumption that the sediment velocity is equal to the modeled DES fluid velocity minus the particle settling velocity. Sediment diffusivity is assumed to be the subgrid or RANS viscosity. The Smith and McLean suspended sediment boundary condition is utilized to calculate the influx of suspended sediment from the bed based upon the local, instantaneous boundary shear stress at each time step. The model currently calculates the flux of five grain sizes and grain size distribution of the be evolves by a mixing depth model.
Model results compare favorably with published ADCP measurements of flow during the high flow experiment of 2008. In addition to the position of the large eddy recircultion cell, the model captures two smaller eddy cells. Turbulence structures produced at the shear layer between the main flow and the eddy zone rapidly become three-dimensional with no-preferred orientation of vorticity. The influx of suspended sediment to the largest eddy zone, upstream of the point of reattachment is relatively constant in time. Whereas, the output of sediment from the eddy by the return flow occurs in pulses. The strength of the eddy return flow appears to be a key determinant of the outflow of suspended sediment and the overall rate of deposition or erosion in the eddy.

URL: http://youtu.be/MSK3I9825iA





Final ID: EP21B-0704

High Plains Aquifer as Megafans? - Perspective from Spatial Distribution of Hydraulic Conductivity

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Body: High Plains Aquifer (HPA) is one on the largest fresh water aquifers in the world and accounts for 30% of the groundwater used for irrigation in the United States. It consists mainly of hydraulically connected geologic units of late Tertiary to Quaternary age, produced from weathering, erosion, and fluvial transportation and deposition processes associated with the post-Paleozoic uplift of the Rocky Mountains, and represents a mountain front megafan deposition environment.

We use an innovative method to map the hydraulic conductivity (K) of the aquifer based on surface drainage patterns and a dynamic equilibrium assumption. Under dynamic equilibrium conditions developed over long time scales, the groundwater discharge and seepage induced weathering processes prepare and precondition the rocks for preferential erosion in areas weakened by weathering. The erosion further concentrates groundwater flow at the points of incision due to higher and directional groundwater gradients, guiding further valley development. The resulting drainage system thus reflects the underlying groundwater flow patterns. This linkage between valley development and the groundwater flow system develops a unique overall drainage dissection pattern over geologic time that is controlled by the interplay between surface water, topography, and subsurface aquifer properties. We can thus estimate K based on drainage dissection pattern derived from DEM data.

Our K result is generally consistent with previous USGS data but shows much greater detail of its spatial distribution. As K is a function of grain size, its spatial distribution can also indirectly reflect the sediment size distribution. The spatial distribution of K reveals the following: (1) In general, the higher values of K were located closer to the Rocky Mountains, consistent with the large sediment grain sizes that would be expected in a mountain front environment. (2) The high K value near the Platte and Arkansas rivers are also prominent, reflecting the larger sediment particles in their alluvial deposits. This could be caused by the interplay between episodic nature of uplift, continental tilting, and climatic conditions, coupled with the meandering of river systems, producing intervals of projection of coarser sediments into lower stream reaches. These spatial distribution characteristics of K suggest that HPA may be deposited as a mountain front megafan or a series of mega fans.

Final ID: EP21B-0707

From Incised Valleys to Coarse Alluvial Streams - North Shore of Lake Superior, Minnesota

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Body: Most streams flowing into Lake Superior on the North Shore of Minnesota are relatively short and, in geologic terms, very young. Their valleys were recently carved or “re-carved” in the moraine deposits of the late Wisconsin phase as level of Glacial Lake Duluth (a precursor of Lake Superior) dropped rapidly (about 8 to 9 thousand years ago) to near present levels. A bedrock ridge, approximately parallel to Lake Superior shoreline, separates some of the streams into two sections with strikingly different characteristics: in the upstream sections (an elevated plateau) the streams have small gradients, deep channels, and wide meanders, similar to low-land rivers, while in the downstream sections, which is the focus of this study, the streams are steep, confined by deep and wide valleys with boulder size bed material, similar to some of the mountain streams. In some cases, the bedrock is commonly exposed in the streambed or banks while in some other cases thick, coarse (cobble to block size) deposits cover most of the streambed. Poplar River is a prime example of the latter. Steep, shallow, with boulder size bed material protruding above the water surface, in mountain river terminology the downstream section of the Poplar River resembles the plane-bed type. It lacks defined banks and although the bottom of the valley is few times wider than the stream, there is no floodplain. The stream valley is essentially the only source of sediment, a bimodal glacial till consisting of mostly cobble to boulder particles in matrix of clay, silt and fine sand. Delivery mechanism is mostly through landslide, hillslope failure due stream lateral mobility, and, to a lesser extent, lateral ravines. While the stream has than enough energy to carry nearly all the fine sediment (only a small fraction is trapped into streambed) all the way downstream (into Lake Superior), threshold computations based on discharge data would suggest that the coarse particles are only rarely mobilized, during extreme (snowmelt) flows, placing Poplar River into “transport limited” category. It appears that after an initial fast valley incision phase, as more coarse sediment armored the valley bottom, the overall channel incision has slowed down to a quasi steady state. The channel continued eroded laterally into valley sides, triggering landslides and widening the valley bottom. Despite the large size of the dominant sediment the channel planform and dynamic shares some characteristics with alluvial streams: lateral mobility, migrating meanders, cut-offs, and avulsions.

Final ID: H21B-1090

Permeability Evolution of Fractured Anhydrite Caused by Chemical and Mechanical Alteration

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Body: Geologic carbon sequestration requires competent structural seals (caprock) to prevent leakage over decadal time scales. Injection of large volumes of CO_2 perturbs the target formation from chemical and mechanical equilibrium leading to the possible creation or enhancement of leakage pathways. We investigate the potential for leakage pathways (fractures) to grow over time under reservoir conditions in a series of anhydrite (Ca_2SO_4) cores. To simulate a potential leakage event in the laboratory, we fractured and jacketed the cores, and placed them in a flow-through reactor vessel. A high-pressure syringe pump applied confining stresses ranging from 7 to 17 MPa and another syringe pump pushed water through the sample at a constant flow rate with pressure control at the outlet. Effluent was sampled periodically and analyzed for Ca^{2+} and SO_4^{2-} using an ion chromatograph. Before and after each experiment, we characterized the surfaces of the fractures using a high-resolution optical profilometer and a scanning electron microscope. Careful alignment of the surfaces during optical profiling allowed reproduction of the fracture aperture before and after each experiment.

We present results from several experiments each carried out under different conditions in similar fractured anhydrite cores. One involved a well-mated pre-existing fracture and results showed that the permeability of the fractured core was similar to the intact rock matrix (O(10^{-18} m^2); chemical alteration of the core was largely limited to the inflow face of the core and the fracture surfaces remained largely unaltered.
To enhance permeability during subsequent experiments, we imposed a small (380 µm) shear displacement between the fracture surfaces resulting in a four-order-of-magnitude increase in initial permeability. The first of these was run at a constant flow rate of 0.6 ml/min for a period of 7 days. The measured pressure gradient within the core increased slowly for a period of 4 days followed by a rapid increase in differential pressure corresponding to a two-order-of-magnitude decrease in permeability. During the experiment, the diameter of the core decreased by ~300 µm at the inlet and a skin of gypsum ($Ca_2SO_42H_2O$) was created along the length of the fracture. Dissolution of anhydrite and transition to gypsum of additional anhydrite weakened the fracture surfaces leading to closure of the fracture with a corresponding reduction in aperture and permeability. Additional experiments explore the influence of flow at a lower flow rate, which, in the absence of a large confining stress, has been shown to lead to the development of dissolution channels or wormholes.

URL: http://detwiler.eng.uci.edu

Final ID: H21F-1205

SENSITIVITY OF ACTIVE AND PASSIVE MICROWAVE OBSERVATIONS TO SOIL MOISTURE DURING GROWING CORN

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Body: Soil moisture (SM) in the root zone is a key factor governing water and energy fluxes at the land surface and its accurate knowledge is critical to predictions of weather and near-term climate, nutrient cycles, crop-yield, and ecosystem productivity. Microwave observations, such as those at L-band, are highly sensitive to soil moisture in the upper few centimeters (near-surface). The two satellite-based missions dedicated to soil moisture estimation include, the European Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission and the planned NASA Soil Moisture Active/Passive (SMAP) [4] mission. The SMAP mission will include active and passive sensors at L-band to provide global observations of SM, with a repeat coverage of every 2-3 days. These observations can significantly improve root zone soil moisture estimates through data assimilation into land surface models (LSMs). Both the active (radar) and passive (radiometer) microwave sensors measure radiation quantities that are functions of soil dielectric constant and exhibit similar sensitivities to SM. In addition to the SM sensitivity, radar backscatter is highly sensitive to roughness of soil surface and scattering within the vegetation. These effects may produce a much larger dynamic range in backscatter than that produced due to SM changes alone.

In this study, we discuss the field observations of active and passive signatures of growing corn at L-band from several seasons during the tenth Microwave, Water and Energy Balance Experiment (MicroWEX-10) conducted in North Central Florida, and to understand the sensitivity of these signatures to soil moisture under dynamic vegetation conditions. The MicroWEXs are a series of season-long field experiments conducted during the growing seasons of sweet corn, cotton, and energy cane over the past six years (for example, [22]). The corn was planted on July 5 and harvested on September 23, 2011 during MicroWEX-10. The size of the field was 0.04 km2 and the soils at the site were Lakeland fine sand, with 89% sand content by volume. The crop was heavily irrigated via a linear move irrigation system. Every 15-minute ground-based passive and active microwave observations at L-band were conducted at an incidence angle of 40°. In addition, concurrent observations were conducted of soil moisture, temperature, heat flux at various depths in the root zone, along with concurrent micrometeorological conditions. Weekly vegetation sampling included measurements of LAI, green and dry biomass of stems, leaves, and ears, crop height and width, vertical distribution of moisture in the canopy, leaf size and orientation, other phonological observations. Such observations at high temporal density allow detailed sensitivity analyses as the vegetation grows.

Final ID: NH21B-1516

Dam-Break Flooding and Structural Damage in a Residential Neighborhood: Performance of a coupled hydrodynamic-damage model

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Body: The Baldwin Hills dam-break flood and associated structural damage is investigated in this study. The flood caused high velocity flows exceeding 5 m/s which destroyed 41 wood-framed residential structures, 16 of which were completed washed out. Damage is predicted by coupling a calibrated hydrodynamic flood model based on the shallow-water equations to structural damage models. The hydrodynamic and damage models are two-way coupled so building failure is predicted upon exceedance of a hydraulic intensity parameter, which in turn triggers a localized reduction in flow resistance which affects flood intensity predictions. Several established damage models and damage correlations reported in the literature are tested to evaluate the predictive skill for two damage states defined by destruction (Level 2) and washout (Level 3). Results show that high-velocity structural damage can be predicted with a remarkable level of skill using established damage models, but only with two-way coupling of the hydrodynamic and damage models. In contrast, when structural failure predictions have no influence on flow predictions, there is a significant reduction in predictive skill. Force-based damage models compare well with a subset of the damage models which were devised for similar types of structures. Implications for emergency planning and preparedness as well as monetary damage estimation are discussed.

URL: http:/sanders.eng.uci.edu

Final ID: T21A-2318

3D Numerical Models for Faulting Patterns in Oblique Rifts

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Body: Observations have established that the pattern of faulting, crustal thinning, and vertical deformation in various areas of continental extension is quite different. In particular, numerous faults created during oblique rifting exhibit difference in spacing and orientation of faults and transfer zones with obliquity. We conduct a series of 3D numerical experiments to understand the mechanics behind different faulting patterns in oblique rifts with different pre-rift thermal structures. The thermal structures are represented by the width and thickness of a weak zone (i.e., a thermally thinned part in lithosphere). Obliquity, defined as the angle between the strike of the weak zone and an extension direction, is another control parameter. Models reflect only the rheological contrast due to temperature variation although full-fledged thermo-mechanical coupling is desirable. Our model results are compared with analogue models for oblique rifting as well as observations on oblique rift systems known to have started with different thermal conditions such as Gulf of Suez and Gulf of California.

Final ID: U21C-03

Prediction uncertainty reflects both data input quality and model software sophistication *(Invited)*

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Body: Recently Syvitski et al. (2011, The Sedimentary Record, v. 9) put forth three concepts related to earth surface modeling: 1) Prediction, as opposed to cataloging, is a major step in the evolution of geoscience; 2) Quantitative modeling provides a framework in which researchers express their predictive ideas in a precise, consistent format; and 3) Models are an encyclopedia of what we know, and often reveal what we cannot yet quantify. This burgeoning field of earth surface science has proportioned itself into three loose fields of endeavor: 1) those that provide data for model initialization and model boundary conditions; 2) those that develop the algorithms, the numerical models and even the middle ware that links models and input data; and 3) the observational specialists that provide test case data that can be used to judge the skill of a model or parts of a model. This 'modern' way of conducting geoscience requires a team approach offering diverse expertise. Uncertainties associated with this workflow are not always understood or appreciated or transparent — leading to poor or over interpretation of model results. To avoid this perception, uncertainties associated with input data must be involved in the model runs, model-run uncertainties must also be expressed independent of the input data uncertainties, and finally model skill testing must be appreciated with full knowledge of uncertainties associated with test case data. While methods have been developed to cope with geo-model skill (ensemble model run averaging or intercomparison; data ingestion schemes to deal with model drift), workflow uncertainty studies are seldom carried out (i.e. is the expense worth the effort?). Prediction uncertainty examples will be presented based on experience from the Community Surface Dynamics Modeling System 'CSDMS' community.

Final ID: EP21D-06

Debris Flow Models With Vertical Redistribution

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Body: The destructive power of debris flows is enormous and hence there is a need for quantitative models that can accurately describe their behavior and predict their flow paths, heights, velocities and corresponding impact pressures. The dynamics of a debris flows is effected by the pore pressure, which can be measured in experiments and in the field, but existing theories to not model this well. We introduce a new class of shallow debris flow models that includes an equation for the vertical distribution of material and show how this gives predictions of the pore pressure and can effect flow mobility.

Debris flows exhibit different flow forms depending on water and solid concentration, particle size distribution and the topography of the flow path. The complex interplay between the fluid and solids of a whole range of different grain sizes leads to physical phenomena such as the development of a front with large boulders, lateral levee formation and, due to a varying fraction of particles being in suspension, an effective basal fluid pressure that can exceed the pure fluids hydrostatic pressure. Large scale debris flow data of the Illgraben torrent, Switzerland, show that a varying basal fluid pressure is characteristic for the snout of debris flows with a granular front and significantly affects basal shear stresses. A comprehensive mathematical debris flow model that explains all the observed phenomena will be extremely complicated; if it is achievable at all. However, promising approaches exist that successfully describe some of the effects in simple situations. Yet the observed basal fluid pressure data in granular front flows is not explained satisfactorily up to this point. One reason for this is that any change of the effective basal fluid pressure is associated with an internal redistribution of the solids above, and hence is caused by relative motion between the phases within the flowing body. However, this inter-component slip is usually neglected in the existing debris flow models. In this paper, we present a theory that explicitly allows for small slip in any direction. Starting from mixture theory, we derive an extended shallow flow system formulated in terms of bulk mixture mass, depth-averaged concentration, depth-averaged velocity and the vertical center of mass of the solid phase. The system reduces to the well-known shallow water equations in the limit of a pure fluid. By tracking the vertical center of mass of the solid component we are able to model sedimentation and resuspension processes, and consequently, also variations in the basal fluid pressure. We conclude this paper with a brief comparison of the model with observations of natural debris flow from the Illgraben torrent.

Final ID: H21I-07

Coupled Thermo-Hydro-Chemical (THC) Modeling of Hypogene Karst Evolution in a Prototype Mountain Hydrologic System

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Body: Hypogene karst systems are believed to develop when water flowing upward against the geothermal gradient dissolves limestone as it cools. We present a comprehensive THC model incorporating time-evolving fluid flow, heat transfer, buoyancy effects, multi-component reactive transport and aperture/permeability change to investigate the origin of hypogene karst systems. Our model incorporates the temperature and pressure dependence of the solubility and dissolution kinetics of calcite. It also allows for rigorous representation of temperature-dependent fluid density and its influence on buoyancy forces at various stages of karstification. The model is applied to investigate karstification over geological time scales in a prototype mountain hydrologic system. In this system, a high water table maintained by mountain recharge, drives flow downward through the country rock and upward via a high-permeability fault/fracture. The pressure boundary conditions are maintained constant in time. The fluid flux through the fracture remains nearly constant even though the fracture aperture and permeability increase by dissolution, largely because the permeability of the country rock is not altered significantly due to slower dissolution rates. However, karstification by fracture dissolution is not impeded even though the fluid flux stays nearly constant. Forced and buoyant convection effects arise due to the increased permeability of the evolving fracture system. Since in reality the aperture varies significantly within the fracture plane, the initial fracture aperture is modeled as a heterogeneous random field. In such a heterogeneous aperture field, the water initially flows at a significant rate mainly through preferential flow paths connecting the relatively large aperture zones. Dissolution is more prominent at early time along these flow paths, and the aperture grows faster within these paths. With time, the aperture within small sub-regions of these preferential flow paths grows to a point where the permeability is large enough for the onset of buoyant convection. As a result, a multitude of buoyant convection cells form that take on a two-dimensional (2D) maze-like appearance, which could represent a 2D analog of the three-dimensional (3D) mazework pattern widely thought to be characteristic of hypogene cave systems. Although computational limitations limited us to 2D, we suggest that similar process interactions in a 3D network of fractures and faults could produce a 3D mazework.

Final ID: C21D-08

Nested modeling of high-order ice dynamics in outlet glaciers of the Greenland Ice Sheet

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Body: Classical shallow-ice approximation models of ice sheet dynamics are adequate and efficient for large parts of the continental ice sheets, but they are theoretically questionable at high resolutions (ca. 1 km). Perhaps more importantly, the shallow-ice approximation does not give a good representation of ice flow in important sectors of the ice sheet, such as the ice sheet margins and in marine-based outlet glaciers, which appear to be most sensitive to interannual and decadal-scale climate variability. We couple a high-order, finite-element model of glacier dynamics with a 3D, thermomechanical ice sheet model to provide an improved representation of Greenland Ice Sheet outlet glaciers. The large-scale ice sheet model provides boundary conditions for ice velocity, thickness, and effective viscosity at the upstream boundary of the finite element model. The boundary location is determined by the inland position at which vertical shear becomes the dominant deformation mechanism, at which point a full Stokes solution is unnecessary. The coupled model better resolves the dynamics and high velocities that characterize the major outlet glaciers of the Greenland Ice Sheet.

Final ID: EP22A-07

Coupled large eddy simulation and discrete element model of bedload motion

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Body: We combine a three-dimensional large eddy simulation of turbulence to a three-dimensional discrete element model of turbulence. The large eddy simulation of the turbulent fluid is extended into the bed composed of non-moving particles by adding resistance terms to the Navier-Stokes equations in accordance with the Darcy-Forchheimer law. This allows the turbulent velocity and pressure fluctuations to penetrate the bed of discrete particles, and this addition of a porous zone results in turbulence structures above the bed that are similar to previous experimental and numerical results for hydraulically-rough beds. For example, we reproduce low-speed streaks that are less coherent than those over smooth-beds due to the episodic outflow of fluid from the bed. Local resistance terms are also added to the Navier-Stokes equations to account for the drag of individual moving particles. The interaction of the spherical particles utilizes a standard DEM soft-sphere Hertz model. We use only a simple drag model to calculate the fluid forces on the particles.

The model reproduces an exponential distribution of bedload particle velocities that we have found experimentally using high-speed video of a flat bed of moving sand in a recirculating water flume. The exponential distribution of velocity results from the motion of many particles that are nearly constantly in contact with other bed particles and come to rest after short distances, in combination with a relatively few particles that are entrained further above the bed and have velocities approaching that of the fluid. Entrainment and motion “hot spots” are evident that are not perfectly correlated with the local, instantaneous fluid velocity. Zones of the bed that have recently experienced motion are more susceptible to motion because of the local configuration of particle contacts.

The paradigm of a characteristic saltation hop length in riverine bedload transport has infused many aspects of geomorphic thought, including even bedrock erosion. In light of our theoretical, experimental, and numerical findings supporting the exponential distribution of bedload particle motion, the idea of a characteristic saltation hop should be scrapped or substantially modified.

URL: http://youtu.be/L4wTtlIa3ho

Final ID: EP23A-0721

Downscaling discharge variability: how well can daily flow characteristics be predicted based on lower resolution flow data?

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Body: Publicly available daily water discharge observations are only obtainable for a small set of rivers and availability is ever decreasing since the early 1980s. And of those rivers that do get monitored daily, often only monthly or yearly average water discharges are published. However, with a global increase in population the need for high temporal resolution water discharge data is more acute then ever; e.g. to validate and calibrate hydrological or flood prediction models.

To address this shortage of high temporal resolution data, we developed empirical relations based on a global database of 100 rivers, all of which have average discharges >30 m^3/s, and record lengths ≥10years of daily discharge data. Total drainage basin area of the database represents 22% of the Earth's land surface; including both smaller and larger river basins (ranging from 500 to 4 * 106 km^2). Rivers are distributed over 3 different climate zones, the Arctic, Temperate and Tropical Zones, and include both mountainous areas and lowlands. Daily, monthly and annual standard deviations, variance and coefficient of variation are calculated for each of the rivers.

Analyzes indicate that daily discharge standard deviation can be predicted with great confidence (R^2>0. 90) based on yearly standard deviation, monthly standard deviation or long-term average water discharge. The coefficient of variation of the daily discharge versus these lower temporal resolution data has a similar significance (R^2>0.90), which indicates that our findings for river discharge relationships are scale invariant. An example is provided showing how these empirical relations can be applied to validate the predictability of numerical hydrological models.

Final ID: EP23A-0724

Co-evolution of bed topography, flow turbulence and sediment transport: insights from a high resolution large-scale experimental study

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Body: A series of laboratory experiments in a large-scale experimental channel (55m long, 2.75 m wide) at SAFL/NCED were conducted for the purpose of understanding and quantifying the dependence of sediment transport variability on near-bed turbulence, bed topography and particle-size distribution, and derive stochastic transport models which reproduce the observed micro- to macro-scale dynamics. An integrated summary of the main findings of this series of experiments will be presented with special emphasis on the following results: (a) it was demonstrated that bedload sediment transport at very small time scales can be an order of magnitude larger or smaller than the long-time average and this variability was quantified within a multiscaling framework similar to that of fully developed turbulence; (b) bed morphodynamics, and especially characteristic scales of bedforms, can be inferred from measurements of turbulent velocity fluctuations above the bed suggesting that turbulence can serve as a proxy for the prediction of bedform dynamics; and (c) the nature of scaling and the degree of complexity and non-linearity in bed elevation fluctuations and sediment transport rates depends on the bed shear stress, with implications for parameterization of predictive models. The main thrust of this work lies in understanding the complexity of interacting processes (bed topography, turbulence and sediment transport) over a range of scales and enabling the prediction of unresolved or unobserved small scale variability, e.g., important for biologic activity in rivers, from larger scale measurements.

Final ID: EP23A-0727

Reynolds-mediated scale effects on the modeling of turbidity currents

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Body: Field observations of turbidity currents are rare due to the unpredictable nature of these flows. To understand the flow and sedimentation mechanisms of turbidity currents, researchers have depended on modeling at a small scale, either through laboratory experiments or numerical simulations. The problem of scaling associated with the modeling of turbidity currents has been recognized, but has not been explored adequately. Scale physical modeling of fixed-bed open channel flow considers Froude similarity alone by ensuring rough turbulent flow in the model. In case of a mobile bed model, the Shields' number is also typically matched. Non-dimensionalization of the governing equations of turbidity currents lead to two controlling dimensionless numbers, namely, the densimentric Froude number (\textbf{Fr}) and the Reynolds number (\textbf{Re}). Following observations are made from the analysis of the non-dimensional governing equations and boundary conditions: (i) scale-invariant results can be obtained for a conservative density current flowing over a rough boundary by satisfying the densimetric Froude similarity alone; (ii) in case of purely depositional flows, the Reynolds-mediated scale effects appear in the bottom boundary condition of the flow velocity and concentration but the effects of Reynolds number may not be strong; (iii) The Reynolds effect becomes more significant for mixed erosional and depositional turbidity currents as it appears in the entrainment rate of sediment as well. Numerical simulations of turbidity currents are conducted by imposing the densimetric Froude similarity as well as the combined densimetric Froude and Reynolds similarities at different scales. The simulation results confirm that satisfying the densimetric Froude similarity alone can produce scale-invariable results for conservative density currents over rough bed, but not for turbidity currents. Perfect matches of results at different scales can occur for turbidity currents only when combined densimetric Froude and Reynolds similarities are satisfied.

Final ID: EP23B-0733

Controls of dunefield stabilization rate: dunefield age and sediment supply

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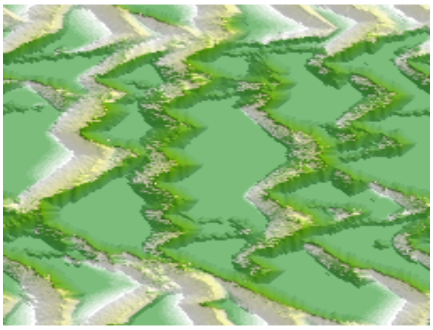
Body: Many dunefields transition between active (bare) and stable (vegetated) configurations, driven by changes in aridity and wind power. As such, dunefield activity is commonly used as a geo-indicator of palaeoclimate. However, many dunefields show a lagged response to climate, or have coincident active and stable portions, suggesting that additional variables modulate climate forcings. Dunefield stabilization is a complex process involving feedbacks between coupled biological and geomorphic systems. For example: vegetation shelters the surface, reducing transport; transport results in topographic change, which reduces vegetation growth. These feedbacks lead to dune morphodynamics that have characteristic scaling. We use a dunefield simulation model to examine the process of stabilization under three different climate shifts. We demonstrate the effects of varying pre-stabilization dunefield age and sediment supply. Regardless of the magnitude of the climate shift, young dunefields stabilized quicker than older dunefields. Dunefields with less sediment stabilized quicker than those with more sediment. However, longest stabilization times corresponded to a 'sweet spot' of moderate sediment supply and dunefield age. Stabilization time was controlled by the characteristic dune sizes and collisions between dunes, which are a function of the characteristic scaling of parabolic dunes. Most large dunefields have variability in age and sediment supply, our results suggest that stabilization times (and responsiveness to climate shifts) vary across large dunefields. Reconstructions of paleoclimate based on dunefield activity should, therefore, consider additional variables such as sediment supply and age that may control lag times in system response.



Parabolic dunes mid-stabilization. Wind blowing from left to right.

Final ID: EP23B-0749

Human Amplified Natural Change: An approach for vulnerability assessment and mitigation planning

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Body: Addressing the environmental impacts of agricultural development is made difficult by the scale and complexity of the natural system, the pervasive human alteration of that system, the contingent and nonlinear nature of system response, and the web of natural-human interactions driving social, economic, and regulatory decisions over periods of decades to centuries. One of the most difficult challenges is determining those locations within the landscape that are most sensitive to change. One approach is the concept of human-amplified natural change (HANC), a hypothesis that states that areas of the landscape that are most susceptible to human, climatic, and other external changes are those that are undergoing the highest rates of natural change. High variability in system response implies that there are locations and moments that are especially vulnerable to changes in climate and human actions. These ‘critical areas’ are not only essential to understand for mitigation purposes, but also serve as targeted locations in which to monitor change in an accelerated environment. Under the HANC hypothesis, it is these locations that should be the focus for both research and management.

We explore the HANC hypothesis using the case of sediment delivery to the Upper Mississippi River. Work on Lake Pepin, a natural lake on the Mississippi River, has shown that sediment supply has increased ten-fold over the past 150 years. This period corresponds with widespread implementation of drainage and row cropping in the Minnesota River Basin, the primary contributor of sediment to the Upper Mississippi. Although this development is clearly important, the watershed was geologically primed to produce large amounts of sediment as it incises through soft glacial sediments in response to a base level fall associated with the carving of the Minnesota River valley over 13,000 years before present. The nearly complete transformation of the land surface, vegetation, and hydrology over the past two centuries has increased already large sediment loadings by a factor of four to five.

A combination of geochemical fingerprinting and a sediment mass balance for a major subwatershed of the Minnesota have demonstrated that, although the sediment loading remains very large, the dominant source of sediment has shifted from agricultural fields to accelerated erosion of stream banks and bluffs. The likely cause of these elevated erosion rates is increased river flow, which results from both changing precipitation patterns and pervasive changes to upland hydrology. Because of the geologic history and setting, these near-channel areas are vulnerable to accelerated erosion, and hydrologic changes in the upper watershed have had large impacts on sediment loading.

Final ID: EP23C-0755

Establishing Denudation Chronology through Weathering Geochronology

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Body: Planar landforms – erosion surfaces - are used as temporal markers in denudation chronology. These surfaces are interpreted as the result of long-term weathering and denudation controlled by a specific base level within a given time-interval characterized by long-term tectonic stability. The presence of several planar landforms at distinct elevations is interpreted as evidence for distinct denudation events, separated by periods of tectonic reactivation and crustal uplift. We selected an area in the Paraná-La Plata basin, southern Brazil (25°S lat.) to investigate if the application of weathering geochronology by the $^{40}Ar/^{39}Ar$ and (U-Th)/He methods could permit differentiating different elevation landsurfaces. We dated supergene Mn oxyhydroxides by $^{40}Ar/^{39}Ar$ geochronology and coexisting supergene Fe oxyhydroxides by the (U-Th)/He method from one of the three regional landsurfaces – The First, Second, and Third Paraná plateaus – previously identified in this area. Two sites were sampled from the Second Paraná Plateau: a ferricrust at Serra das Almas (7 hand specimens of goethite at 1080 m of altitude) and deeply weathered ferricretes and saprolites at Vila Velha (11 hand specimens of cryptomelane and 14 of goethite at 910 m of altitude). The Serra das Almas sites hosts a stratified weathering profile with ferricrust, and mottle zone. The Vila Velha site results from intense weathering that led to the precipitation of well-crystallized supergene minerals precipitated within fractures in the saprolites. The geochronological results are correlatable between the two sites and the two distinct methods ($^{40}Ar/^{39}Ar$ and (U-Th)/He), and they reveal three generations of weathering and mineral precipitation: Late Eocene-Oligocene, Early Miocene, and Pleistocene. The geochronological results suggested that the Second Paraná Plateau formed by regional erosion during the Oligocene, and that this landsurface has been continuously exposed to weathering and erosion since then. The preservation of Oligocene lateritic profiles suggests that after the Oligocene erosion has been restricted to channel incision, permitting the formation and preservation of deeply stratified weathering profiles (lateritic profiles) in the interfluves. Although weathering initiated in the Oligocene, during the Miocene and Pliocene favourable climatic conditions drove large-scale dissolution and re-precipitation of supergene minerals, promoting the formation of the lateritic profiles that characterize the Second Paraná Plateau.

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Erodibility controls on the vertical and horizontal scalings of topography : a case study in the Himalayas

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Body: Understanding the scaling properties of topography in actively uplifting areas is a major issue in quantitative geomorphology. Analytical formulations of non-glaciated landscape evolution clearly demonstrate that metrics such as local relief or drainage density are explicitly related to the spatial distribution of tectonic uplift, precipitation, erodibility and local slope across the landscape. However, in most regions, these parameters are seldom documented with enough resolution and precision to allow a systematic and statistically significant investigation of their relationships with both horizontal and vertical scaling properties of topography. A notable exception is the Himalaya of central Nepal, where the last 20 years of tectonic and geomorphological research have produced one of the densest regional data-set and documented major gradients in uplift and precipitation across the range [e.g. Lavé and Avouac, 2001; Bookhagen and Burbank, 2006]. The purpose of our study is to use this data in order to develop a detailed investigation of the influence of the erodibility parameter in controlling the structure and texture of the landscape.

We first build on the derivation of total catchment relief of Tucker and Whipple [2002] to include the contribution of precipitation in addition to uplift, erodibility. Then, by minimizing the misfit between observed and predicted catchment relief, we assess the erodibility parameter for each second or third order catchment in our area of investigation. The resultant erodibility map (1) matches the distribution of geological units and (2) reveals a number of interesting second order patterns, such as along-strike fluctuations in the Lesser Himalayas and a significant decrease in erodibility coincident with the location of the MCT zone. This latter result possibly highlights the effect of intense schistosity and fracturation on large scale erosion efficiency [Molnar et al., 2007]. Then to assess the influence of erodibility on landscape horizontal wavelength, we compute for each catchment a normalized roughness. This morphological index has the advantage of being unbiased by arbitrary definitions of channel inception or local relief. As predicted by theoretical formulations, we observe that both the horizontal wavelength and vertical relief of the landscape are sensitive to the U/K ratio. Our results suggest that, in combination with usual metrics based on the vertical development of the landscape (i.e. channel or hillslope gradients), the analysis of the variability in horizontal wavelengths holds a significant potential to resolve uplift and erodibility in tectonically active areas.

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Integrating Field Measurements and Numerical Modeling to Investigate Gully Network Evolution

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Body: With the advent of numerical modeling the exploration of landscape evolution has advanced from simple thought experiments to investigation of increasingly complex landforming processes. A common criticism of landscape evolution modeling, however, is the lack of model validation with actual field data. Here we present research that continues the advancement of landscape evolution theory by combining detailed field observations with numerical modeling. The focus of our investigation is gully networks on soft-rock strata, where rates of morphologic change are fast enough to measure on annual to decadal time scales.

Our research focuses on a highly transient landscape on the high plains of eastern Colorado (40 miles east of Denver, CO) where convective thunderstorms drive ephemeral stream flow, resulting in incised gullies with vertical knickpoints. The site has yielded a comprehensive dataset of hydrology, topography, and geomorphic change. We are continuously monitoring several environmental parameters (including rainfall, overland flow, stream discharge, and soil moisture), and have explored the physical properties of the soil on the site through grain size analysis and infiltration measurements. In addition, time-lapse photography and repeat terrestrial lidar scanning make it possible to track knickpoint dynamics through time. The resulting dataset provides a case study for testing the ability of landscape evolution models to reproduce annual to decadal patterns of erosion and deposition.

Knickpoint erosion is the largest contributor to landscape evolution and the controlling factor for gully migration rate. Average knickpoint retreat rates, based on historic aerial photographs and ongoing laser surveying, range between 0.1 and 2.5 m/yr. Knickpoint retreat appears to be driven by a combination of plunge-pool scour, large block failure, and grain-by-grain entrainment of sediment from the wall. Erosion is correlated with flash floods in the summer months.

To test our understanding of landscape evolution in this setting, we compare the data with predictions from 1D and 2D models of landscape evolution that encompass our working hypotheses. Here, we present a 1D model of gully channel evolution. The model is built on equations for continuity of water, entrained sediment, and resting sediment. Knickpoint erosion is modeled as resulting from a combination of Mohr-Coulomb failure and sapping erosion. Our initial results show that gullies are most erosive from the edge of a knickpoint downstream through a plunge pool zone, and they become depositional downstream as the flow widens and shear stress declines. The channel topography is a result of this pattern of erosional and depositional zones in the gullies; therefore, knickpoint dynamics control both sediment delivery rates and downstream channel form. As expected, knickpoint erosion correlates well with rainfall and runoff intensity; however, it shows surprisingly little correlation with soil moisture.

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Adding geochemical and isotope tracers to models of hillslope evolution: valuable constraints or monumental headache?

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Body: Landscapes evolve through time, both in terms of their geomorphology and their geochemistry. Past studies have highlighted that topography suffers from the problem of equifinality: the topographic configuration of landscapes can be the result of many different, yet equally plausible, erosion histories. In hillslope soils the properties and chemistry of the soils themselves could provide additional constraints on landscape evolution. Here we present results from a combination of modelling and field studies that seek to quantify the co-evolution of hillslope morphology and the solid state chemistry of hillslope soils. The models follow large numbers of individual particles as they are entrained into a physically mobile soil layer, weathered, and accumulate isotopes such as 10Be and 21Ne. We demonstrate that multiple hillslope properties mitigate (but do not eliminate) the problem of equifinality and demonstrate the importance of accounting for individual particle residence times and ages in interpretation of both isotope and weathering data.

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Turning rock into saprolite: Linking observations and models of vadose zone dynamics and chemical weathering

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Body: Chemical weathering of rock into saprolite requires contact between water and unweathered rock, which occurs frequently but discontinuously in the unsaturated zone. Saprolite is a direct precursor to mobile regolith, and the distribution and rate of saprolite development play a role in sediment production on hillslopes. We strive to understand both the timing and spatial distribution of saprolite development in the subsurface, which is controlled by the delivery of fresh water to unweathered rock. We hypothesize that climate has a strong control on delivery of water to saprolite in the vadose zone, and hence on the rate of saprolite formation. In addition, the rate of water delivery is strongly modulated by the local fracture field, lending a strong heterogeneity to water delivery and weathering rates. To test this hypothesis, we link observations of moisture content in soil and saprolite with a numerical model of vadose zone dynamics. The moisture measurements are taken in the Boulder Creek watershed in central Colorado. This 1160 km2 catchment, which is underlain by fractured crystalline rocks (mainly granodiorite), ranges in elevation from high alpine peaks at 4120 m to the Colorado piedmont at 1480 m.

The complex hydrologic architecture of the unsaturated zone necessitates a model that can incorporate multiple permeabilities to represent the variable flow paths in the soil, saprolite, and fractures. Therefore, we employed VS2DI, a Richards equation-based model, on two-dimensional hillslopes to visualize flow paths in the unsaturated zone and calculate volumetric moisture content at observation points. We ran multiple simulations investigating the relative roles of fracture spacing and variable timing and intensity of precipitation.

Model experiments suggest that fractures are the primary pathway for delivering water deep below the subsurface. Where fracture density is higher, more water is delivered to the deep subsurface, allowing more chemical weathering at depth. Our results also indicate that both the intensity and total magnitude of precipitation events affect the flow paths of water in the subsurface. The effects of water flux in the subsurface on chemical weathering are modeled using a linear first-order reactive-transport model for albite dissolution. This reactive-transport model reveals the importance of timing and magnitude of precipitation on chemical weathering rates, as well as the importance of fractures on the spatial distribution of weathering in the unsaturated zone. The results indicate that the development of saprolite is strongly controlled by the temporal distribution of precipitation throughout the year. Water reaches deeper into unweathered rock when precipitation is concentrated during one season rather than being evenly distributed throughout the year. This finding suggests an intriguing link between the saprolite development and changing climate in mountain environments.

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Physical and Statistical Diagnostics for Verification of Hillslope Sediment Transport Models

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Body: Hillslope sediment transport models express sediment flux at a point as a function of some topographic attributes of the system, such as slope, curvature, soil thickness, etc., at that point only (referred here as “local” transport models) or at an appropriately defined vicinity of that point (referred here as “non-local” transport models). Local, nonlinear transport models have been derived from a physical viewpoint of force balance on a single grain of the hillslope (applicable at a point scale), whereas the non-local transport models have been derived from a statistical viewpoint of taking into account the variability and spatial heterogeneity of hillslopes (assuming the non-existence of a representative elementary volume where the flux can be computed). The question arises as to: (1) how to choose the proper class of models (local, nonlinear vs. non-local, linear) for a given hillslope, (2) what quantitative metrics to use for verification, and (3) at what scales to verify the chosen model? We demonstrate that the two different classes of models discussed above reproduce equally well the steady-state equilibrium profile, rendering it a poor discriminatory validation metric, but exhibit inherent differences related to: (a) scale-dependence of model parameters, and (b) physical reasoning stemming from the assumed spatial heterogeneity of the hillslopes and the sediment transport processes involved. We argue that a comprehensive validation framework requires the use of both physical and statistical metrics and discuss experimental settings that can aid with the physical validation aspects of a model. We present the idea of scale-dependent verification metrics and invoke the derivation of sub-grid scale closures as a means of applying and validating models at different scales.

Final ID: EP23C-0774

Lacustrine sediments in Lake Ohau, central South Island, New Zealand – An archive of erosion, earthquakes and paleoclimate since the Late Glacial

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Body: Located east of the main divide in the central Southern Alps, the Mackenzie Lakes, Ohau, Pukaki and Tekapo, occupy fault controlled glacial valleys and contain a high resolution sedimentary record of the last ~16 ka. Recorded in these sediments are climatic events, earthquakes along the Alpine Fault to the northwest, the landscape response following Alpine Fault earthquakes and land use changes. It is possible that earthquakes on smaller, more proximal faults such as the Ostler Fault and the Irishman Creek Fault are also preserved in one or more of the lakes.

We focus this study on Lake Ohau, the smallest and shallowest of the three lakes. A 5 m core collected from the distal end of Lake Ohau at a depth of 60 m comprises finely laminated, light and dark sediment couplets. Preliminary estimates of sedimentation rate = c. 5 mm/yr suggest that the core contains a record of approximately the last 1000 years. We use HydroTrend, a climate-driven hydrological model, coupled to Sedflux, a basin filling stratigraphic model, to simulate sediment deposition within the lake basin. A high resolution simulation, run at daily timesteps over the last 60 years and constrained by measured climate parameters, is compared to the top 30cm of the core which has been dated to this time interval. Our results show that the laminations within the core represent large storm events rather than an annual layering.

Much of the catchment of Lake Ohau is located within 30-50 km of the Alpine Fault, within the region expected to experience shaking strong enough to generate significant landsliding (≥MM8 shaking intensity) and thus create a wealth of sediment available to be transported through the sedimentary system. Following an earthquake, the next major rain event will transport the first pulse of that sediment into Lake Ohau. Comparison with recognised earthquake signals in offshore cores suggest that this pulse is likely to form a coarser grainsize layer (Gomez et al., 2007). Subsequent storms will transport much of the landslide generated material, likely as sediment with a higher than usual proportion of mud (Dadson et al., 2005). Our Sedflux models show how these two deposit types will distribute through the lake basin.

The last 3 events on the Alpine Fault occurred in A.D. 1717 (~7.9), ~1640 (~7.6) and ~1460 (~7.9) (Wells et al., 1999; Sutherland et al., 2007). The epicentre of the most recent of these is closest to Lake Ohau and this event should be most obvious in the lake record. We include earthquake generated sediment production into the simulations by assuming a four fold increase in sediment production close to the rupture, based on measurements following the ChiChi earthquake in Taiwan (Hovius et al., 2011), and an exponential decay in landsliding away from the fault.

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Morphodynamic Modeling of Gravel Bed Rivers: a Step-Length Based Approach

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Body: Quantifying gravel bed river morphodynamics over decadal to centennial timescales is integral to making informed stream management and restoration decisions. Factors such as land use and climate shifts over such timescales may drastically alter stream evolution – with major implications for in-channel and riparian habitat. Due to these longer-term changes, field-based studies are often unable to fully capture morphologic shifts. Scenario-based morphodynamic modeling has emerged as a viable means of quantifying gravel bed river evolution, yet current models fall short with regard to their ability to predict changes in stream morphology over the timescales in question and with adequate spatial resolution, a problem due largely to the computational overhead they require. While the computing power required to quantify sediment transport has hindered previous modeling efforts, field-based research suggests a potential improvement: sediment is often mobilized downstream with characteristic step-lengths. Here we introduce a morphodynamic model which drives sediment transport using a step-length based approach, negating the need for frequent recalculation of sediment dynamics in the flow, and correspondingly reducing computational overhead. Upon application of this model to the River Feshie (UK), we observe that it accurately reproduces many bed morphologies observed during annual RTK-GPS and terrestrial lidar surveys. Subsequently, we utilize this new model to quantify morphologic outcomes under various discharge and sediment regimes. By utilizing simple step-length based sediment transport distributions, the formation and preservation of bed morphologies can be accurately predicted with less computational overhead than offered in previous morphodynamic modeling efforts. The knowledge gained from scenario-based modeling using this new scheme may aid in the management and restoration of gravel bed streams under shifting discharge and sediment regimes.

Final ID: H23B-1258

Diffuse CO_2 Emanations from a Deep Magmatic Source—Multiphase Dynamics, Soil Impacts, and Lessons for Sequestration Monitoring

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Body: Naturally occurring emissions of nearly pure CO_2 at Mammoth Mountain, California, have been suggested as an analog of possible leakage from large-scale carbon capture and sequestration operations. Impacts of sustained elevated levels (>20%) of soil CO_2 are greater than the observable forest dieback. Repeated soil-transect studies six and 22 years after onset of CO_2 emissions demonstrate substantial degradation of base-cation status in the area of active emission. Detailed time series of soil-gas pressures, CO_2 concentrations and fluxes, water contents, and snow-cover dynamics show large short-term (minutes-to-days) variability and switching between quasi-stable states, suggesting countercurrent gas and liquid movement within a shared fracture-pore network. Single fluid phase (Darcian-Fickian) approaches are inadequate to explain the gross features of the measured time series; engineering equations developed for two-fluid-phase flow reactors are more likely to apply. Micrometeorological data show that atmospheric forcing affects total CO_2 fluxes. Data presented here show that interactions among the atmospheric boundary layer, water in all its forms (snowpack, percolating soil moisture, groundwater), and upward moving CO_2 must be taken into account so that changes in surface CO_2 concentrations and fluxes due to hydrologic perturbations can be differentiated from those due to changes in sources at depth.

URL: http://www.usgs.gov/science/author.php?author=Long+Valley+Observatory

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An Inverse Modeling Plugin for HydroDesktop using the Method of Anchored Distributions (MAD)

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Body: The CUAHSI Hydrologic Information System (HIS) software stack is based on an open and extensible architecture that facilitates the addition of new functions and capabilities at both the server side (using HydroServer) and the client side (using HydroDesktop). The HydroDesktop client plugin architecture is used here to expose a new scripting based plugin that makes use of the R statistics software as a means for conducting inverse modeling using the Method of Anchored Distributions (MAD). MAD is a Bayesian inversion technique for conditioning computational model parameters on relevant field observations yielding probabilistic distributions of the model parameters, related to the spatial random variable of interest, by assimilating multi-type and multi-scale data. The implementation of a desktop software tool for using the MAD technique is expected to significantly lower the barrier to use of inverse modeling in education, research, and resource management. The HydroDesktop MAD plugin is being developed following a community-based, open-source approach that will help both its adoption and long term sustainability as a user tool. This presentation will briefly introduce MAD, HydroDesktop, and the MAD plugin and software development effort.

Final ID: H23F-1346

Using time-lapse electrical resistivity tomography to visualize conduit-matrix exchange a sink-rise system of a semi-confined karst aquifer

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Body: The Santa Fe River Basin is a complex watershed containing hydrologic regions of confined, semi-confined and unconfined karst aquifer. Each region has unique characteristics that lead to difficulty in describing how groundwater and surface water interact. In the semi-confined region, the Santa Fe River is entirely captured by a sinkhole then flows through various karst windows and emerges as a spring 6 kilometers to the south. Recent work has developed a working hypothesis to describe how groundwater and surface water interact in the karst aquifer during high and low flow. In this study, we are interested in the semi-confined region and visualizing how groundwater and surface interactions control overall flow. Using electrical resistivity tomography, a time lapse study was conducted at two locations to study changes in conductivity during groundwater and rain flow driven events over a six-week time period. Our results reflect the locations of known karst conduits. Changes in resistivity during rainfall infiltration and in karst and matrix flow over time provide insight into exchange dynamics. These observations provide details about the surface water-groundwater exchange in a complicated, semi-confined, sink-rise system.

Final ID: H23G-1367

Downscaling Satellite-based Passive Microwave Observations Using the Principle of Relevant Information and Auxiliary High Resolution Remote Sensing Products

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Body: Hydrometeorological models simulate the atmospheric and hydrological processes at scales of 1- 10 km that are significantly influenced by the local and regional availability of soil moisture. Microwave observations at frequencies < 10 GHz are highly sensitive to changes in near-surface moisture and have been widely used to retrieve soil moisture information. While satellite-based active microwave observations are available at spatial resolutions of hundreds of meters, with temporal resolutions of several weeks, passive observations are obtained only at tens of kilometers with temporal resolutions of sub daily to 2-3 days. The European Space Agency-Soil Moisture and Ocean Salinity (ESA-SMOS) and the near-future NASA-Soil Moisture Active Passive (SMAP) missions will provide unprecedented passive microwave observations of brightness temperatures (TB) at the L-band frequency of 1.4 GHz. These products will be available at spatial resolutions of about 40-50 km and need to be downscaled to 1 km to merge them with models for data assimilation and to study the effects of land surface heterogeneity such as dynamic vegetation conditions.

Very few studies have directly downscaled coarse-resolution TB observations to match model scales. Since downscaling is an ill-posed problem, additional information is required at the fine scales and some studies have leveraged auxiliary high-resolution remote sensing (RS) products in downscaling TB. Most of the above studies involve a) physical models that are computationally intensive when extended to global scales, or b) multi-scale algorithms that impose hierarchical models on TB assuming spatial homogeneity, or c) statistical algorithms that are based on second-order statistics such as variances and correlations. These approaches are therefore sub-optimal when applied to the real data or extended to regional/global scales. Optimal downscaling requires computationally-efficient algorithms that retain information from higher-order moments, especially under heterogeneous land surface conditions. Novel transformation functions leveraging physical relationships and recent advances in signal processing techniques can be used to transform information from high-resolution RS products into TB.

In this study, a downscaling methodology was developed using the Principle of Relevant Information (PRI) to downscale observations of TB from 50 km to 200 m using observations of land surface temperature, leaf area index, and land cover at 200 m. The PRI provides a hierarchical decomposition of image data that is optimal in terms of the transfer of information across scales and is therefore a better alternative to methods that use second-order statistics only. Non-parametric probability density functions and Bayes' rule was used to transform information from the RS products into TB. An Observing System Simulation Experiment was developed under heterogeneous and dynamic vegetation conditions to generate synthetic observations at 200m to evaluate the downscaling methodology and the transformation functions.

Final ID: IN23C-1462

Maximizing data holdings and data documentation with a hierarchical system for sample-based geochemical data

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Body: Sample-based measurements in geochemistry are highly diverse, due to the large variety of sample types, measured properties, and idiosyncratic analytical procedures. In order to ensure the utility of sample-based data for re-use in research or education they must be associated with a high quality and quantity of descriptive, discipline-specific metadata. Without an adequate level of documentation, it is not possible to reproduce scientific results or have confidence in using the data for new research inquiries. The required detail in data documentation makes it challenging to aggregate large sets of data from different investigators and disciplines.

One solution to this challenge is to build data systems with several tiers of intricacy, where the less detailed tiers are geared toward discovery and interoperability, and the more detailed tiers have higher value for data analysis. The Geoinformatics for Geochemistry (GfG) group, which is part of the Integrated Earth Data Applications facility (http://www.iedadata.org), has taken this approach to provide services for the discovery, access, and analysis of sample-based geochemical data for a diverse user community, ranging from the highly informed geochemist to non-domain scientists and undergraduate students. GfG builds and maintains three tiers in the sample based data systems, from a simple data catalog (Geochemical Resource Library), to a substantially richer data model for the EarthChem Portal (EarthChem XML), and finally to detailed discipline-specific data models for petrologic (PetDB), sedimentary (SedDB), hydrothermal spring (VentDB), and geochronological (GeoChron) samples. The data catalog, the lowest level in the hierarchy, contains the sample data values plus metadata only about the dataset itself (Dublin Core metadata such as dataset title and author), and therefore can accommodate the widest diversity of data holdings. The second level includes measured data values from the sample, basic information about the analytical method, and metadata about the samples such as geospatial information and sample type. The third and highest level includes detailed data quality documentation and more specific information about the scientific context of the sample. The three tiers are linked to allow users to quickly navigate to their desired level of metadata detail. Links are based on the use of unique identifiers: (a) DOI at the granularity of datasets, and (b) the International Geo Sample Number IGSN at the granularity of samples. Current developments in the GfG sample-based systems include new registry architecture for the IGSN to advance international implementation, growth and modification of EarthChemXML to include geochemical data for new sample types such as soils and liquids, and the construction of a hydrothermal vent data system. This flexible, tiered, model provides a solution for offering varying levels of detail in order to aggregate a large quantity of data and serve the largest user group of both disciplinary novices and experts.

URL: http://www.geoinfogeochem.org/

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The Science-Policy Link: Stakeholder Reactions to the Uncertainties of Future Sea Level Rise

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Body: Policy makers and stakeholders in the coastal zone are equally challenged by the risk of an anticipated rise of coastal Local Sea Level (LSL) as a consequence of future global warming. Many low-lying and often densely populated coastal areas are under risk of increased inundation. More than 40% of the global population is living in or near the coastal zone and this fraction is steadily increasing. A rise in LSL will increase the vulnerability of coastal infrastructure and population dramatically, with potentially devastating consequences for the global economy, society, and environment. Policy makers are faced with a trade-off between imposing today the often very high costs of coastal protection and adaptation upon national economies and leaving the costs of potential major disasters to future generations. They are in need of actionable information that provides guidance for the development of coastal zones resilient to future sea level changes. Part of this actionable information comes from risk and vulnerability assessments, which require information on future LSL changes as input. In most cases, a deterministic approach has been applied based on predictions of the plausible range of future LSL trajectories as input. However, there is little consensus in the scientific community on how these trajectories should be determined, and what the boundaries of the plausible range are. Over the last few years, many publications in Science, Nature and other peer-reviewed scientific journals have revealed a broad range of possible futures and significant epistemic uncertainties and gaps concerning LSL changes. Based on the somewhat diffuse science input, policy and decision makers have made rather different choices for mitigation and adaptation in cases such as Venice, The Netherlands, New York City, and the San Francisco Bay area. Replacing the deterministic, prediction-based approach with a statistical one that fully accounts for the uncertainties and epistemic gaps would provide a different kind of science input to policy makers and stakeholders. Like in many other insurance problems (for example, earthquakes), where deterministic predictions are not possible and decisions have to be made on the basis of statistics and probabilities, the statistical approach to coastal resilience would require stakeholders to make decisions on the basis of probabilities instead of predictions. The science input for informed decisions on adaptation would consist of general probabilities of decadal to century scale sea level changes derived from paleo records, including the probabilities for large and rapid rises. Similar to other problems where the appearance of a hazard is associated with a high risk (like a fire in a house), this approach would also require a monitoring and warning system (a "smoke detector") capable of detecting any onset of a rapid sea level rise.

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Investigating bedload transport at the grain scale *(Invited)*

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Body: Bedload transport, which results from the motion of particles rolling, sliding or saltating along the bed of a stream, is of fundamental importance for river morphodynamics as (1) it may represent an important fraction of the total sediment flux transported in a river; (2) it is involved in many aspects of morphologic changes in rivers including bank erosion and bedforms development. However, despite the large number of works addressing the problem, most of the bedload transport laws proposed in the literature consist of semi-empirical equations derived from a fit of data acquired in flume experiments, with little consideration of the physics at the grain scale. Accordingly, our objective is to describe bedload transport at the grain scale. This is achieved by developing an experimental apparatus allowing the investigation of the motion of bedload particles under steady and spatially uniform turbulent flow above a flat sediment bed of quartz grains. We report the results of two series of experiments.

The first one involves a bed of sediment of uniform grain size. Using a high-speed video imaging system, we record the trajectories of the moving particles and measure their velocity, the length and duration of their flights, as well as the surface density of the moving particles. The experimental results support the erosion-deposition model of Charru [2006] and allow the calibration of the involved coefficients. In particular, noting τ^*, the Shields number, and $\tau_{\rm c}^*$, the threshold Shields number, we find that
(1) the surface density of moving particles increases linearly with $\tau^* - \tau_{\rm c}^*$;
(2) the average particle velocity increases linearly with $\tau^{*1/2} - \tau_{\rm c}^{*1/2}$, with a finite nonzero value at threshold;
(3) the flight duration scales with a characteristic settling time with no significant dependence on either τ^* or the settling Reynolds number;
(4) the flight length increases linearly with $\tau^{*1/2} - \tau^{*1/2}_{\rm c}$.

The experiments are then repeated with a sediment bed composed of a bimodal mixture of small and large quartz grains. In this case, the sediment flux not only depends on the shear stress but also on the relative proportion of small and large grains on the bed. Our results show that a minor modification of the erosion-deposition model is sufficient to capture this effect.\\

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Final ID: P23F-03

Climate destabilization on tidally locked exoplanets

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Body: We show that strong day-night surface temperature contrasts on planets with surfaces allow positive feedbacks that can potentially destabilize planetary climate. Geologically rapid 10^3 - fold atmospheric pressure shifts may be possible.

Habitable-zone planets maintain stable surface liquid water over geological time through equilibrium between greenhouse-gas consumption by weathering, and resupply by other processes. All reported small-radius exoplanets, and anticipated M-dwarf habitable-zone rocky planets, should be tidally locked. We will discuss two different feedbacks that can destabilize climate equilibrium on planets in 1:1 spin-orbit resonance. (1) If small changes in pressure alter the temperature distribution across a planet's surface such that the weathering rate goes up when the pressure goes down, a runway positive feedback between pressure, surface temperature, and weathering rate near the substellar point takes place - *enhanced substellar weathering instability* (ESWI). (2) When decreases in pressure increase the fraction of surface area above the melting point (through reduced advective cooling of the substellar point), and the corresponding increase in volume of liquid causes net dissolution of the atmosphere, further decreases in pressure can occur. This *substellar dissolution feedback* (SDF) can also cause a runaway climate shift. We use an idealized energy balance model to illustrate the scope of these instabilities. In this simplified model, the weathering runaway can shrink the habitable zone. Mars may have undergone a weathering runaway in the past. Substellar dissolution is usually a negative feedback or weak positive feedback on changes in atmospheric pressure, and can only cause runaway changes for small, deep oceans and highly soluble atmospheric gases. Both instabilities are suppressed if the atmosphere has a high radiative efficiency. Our results are most relevant for atmospheres that are thin, have low greenhouse-gas radiative efficiency, and where the principal greenhouse gas is also the main constituent of the atmosphere.

These results identify a new pathway by which habitable-zone planets can undergo rapid climate shifts and become uninhabitable.

URL: http://www.climatefutures.com

Final ID: T23F-08

Strain evolution and the relative role of heat and strain rate during continental rupture ***(Invited)***

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Body: The evolution of strain during continental rupture can be quite complex, and may be due to changes in far-field stresses, or due to the naturally evolving strength profile of the lithosphere. Here we use a 2-d finite element model to examine the relative impact of strain rate versus the initial thermal structure of the lithosphere on the evolution of rift systems.

Model results indicate that the initial thermal structure of the lithosphere has first-order control on the rifting evolution and subsequent rupture, while stretching rate places a second-order control on the rifting evolution. Three styles of rift-to-rupture evolution are recognized as distinguished by the location of rupture and the amount of strain accommodated prior to rupture. Style 1 is distinguished by limited strain prior to rupture that is located in the center of the rifted region; style 2 is distinguished by moderate amount of strain prior to rupture that is located near the edge of the rifted region, and style 3 is distinguished by extensive rifting without transition to rupture. In general, cool upper mantle temperatures are associated with style 1, moderate upper mantle temperatures and slower strain rates are associated with style 2, while hot upper mantle temperatures are associated with style 3.

Detailed tracking of the modeled rifts provides key insights to the importance of the interaction between the evolving thermal structure, strength profile, and rift geometry. For example, the West Antarctic Rift System displayed an early stage of wide rifting, followed by a transition to rifting across a narrow region. Numerical simulations of the region suggest that this transition in rifting style was the natural result of the evolving thermal/strength structure of the lithosphere, and no change in plate motions nor impingement of a thermal plume is necessary to explain the strain evolution.

Final ID: T24C-03

The Impact of Drainage Reorganization on Cenozoic Topography

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Body: Landscape evolution and the resulting sedimentary deposits are controlled by the development and organization of drainage basins. As a landscape evolves within a climatic and tectonic environment, drainage reorganization events can occur, where one river basin grows at the expense of another. The added discharge downstream of a river capture location will generate a transient topographic response. The records of these events are preserved the sedimentary record and modern topography. Drainage reorganization has been proposed to occur in a number of major drainage systems around the world including the Colorado, Rhine, Snake, Yellow, Yangtze, Indus, and Zambezi rivers as well as a number of smaller rivers. Yet little work has focused on quantifying the topographic and erosional consequence of such events.

Here we propose a simple model that quantifies the impacts of drainage capture on the evolution of a drainage basin. The model is based on the inverse slope-contributing drainage area relationship observed in rivers throughout the world and describes the expected river elevation change as drainage area is added (and therefore slopes lowered) by a capture event. Furthermore, we develop a numerical model of drainage capture that quantifies the transience of erosion and sediment production based on a shear stress dependent fluvial incision and sediment transport model. Our focus here is on quantifying the impact of capture of the Rhine/Aare river system (~45,000 km2) during the late Pliocene/early Pleistocene. Our models suggest 500-800 m of river elevation change (lowering profiles) occurred over short time periods (less than a million years), contributing as much as 0.4 mm/yr of erosion to the Alpine foreland and Swiss Alps when averaged over the last few million years. The predicted incision magnitudes are consistent with incision measured from the elevation of Pliocene and early Pleistocene river gravels, suggesting that the majority of incision across northern Switzerland can be explained by drainage reorganization. We also present estimates of incision magnitudes for other capture events around the world, and show that the erosion impacts of drainage reorganization events are capable of producing significant pulses of sediments out of the basin. This has implications for the interpretation of sedimentary deposits and their relation to tectonic and climatic changes.

Final ID: C24A-01

We Are All Engineers Now: Delivering Useful Projections Of Sea Level Rise

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Body: Sea level rise is among the most tangible and potentially costly global changes facing society in the near future. Much of the uncertainty in future sea level rise lies in the determination of glacier and ice sheet contributions through melting of ice and through the discharge of icebergs directly into the ocean. As a consequence, many aspects of modern glaciological research have come to be motivated wholly or in part by the need to solve societally relevant problems involving future changes in sea level. To this extent, glaciology has become – temporarily – an applied science, in which the motivating questions are not purely scientific but practical in nature, and entail goals, deadlines and constraints that may or may not mesh comfortably with the skills, resources, and interests of the glaciological research community. This shift in motivation has subtle but important effects on how the glaciological community conducts research: we are no longer fully at liberty to explore only those problems that we judge to be the most intellectually stimulating and novel, or even the most likely to produce immediate results. We are obliged, at least if we are going to claim to be serving a critical societal need, to take on the entire spectrum of problems pertinent to sea level rise: the exciting with the mundane, the low-hanging fruit with the high-hanging, the tractable with the intractable. And in those intractable cases, and in other situations where the path to a solution is unclear, we must explore alternatives to our conventional approaches, and seek the means, if not to actually obtain solutions, to at least constrain the outcome and reduce the uncertainty of future knowledge. This broadening of methods is very much an engineer's approach to problem solving, but it also fits the philosopher/physicist P.W. Bridgman's definition of the scientific method as "Doing your damnedest, no holds barred."

Final ID: EP24A-05

Variation of deposition depth with slope angle in snow avalanches: Measurements from Vallée de la Sionne ***(Invited)***

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Body: The snow surface height was precisely measured, with a laser scanner, before and after the passage of two dry-mixed avalanches in Vallée de la Sionne during the winter of 2005–2006. The measurements were used to calculate the depth of the deposited snow along each entire avalanche path with a height resolution of 100 mm and a horizontal resolution of 500 mm. These data are much more accurate than any previous measurements from large avalanches and show that the deposit depth is strongly negatively correlated with the slope angle. That is, on steep slopes the deposit is shallow, and on gentle slopes the deposit is deep. The time evolution of the snow depth, showing the initial erosion and final deposition as the avalanche passed, was also observed at one position using a frequency-modulated continuous wave radar. Measurements at a nearby position gave flow speed profiles and showed that the avalanche tail consists of a steady state subcritical flow that lasts for about 100 s. Eventually, the tail slowly decelerates as the depth slightly decreases, and then it comes to rest. We show that the dependency between the slope angle and the deposition depth can be explained by both a cohesive friction model and the Pouliquen hstop model.

Final ID: H24D-05

Widespread hillslope gullying on the southeastern Tibetan Plateau: Human or climate-change induced? *(Invited)*

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Body: Drainage basins adjacent to the upper Tsangpo Valley on the southeastern Tibetan Plateau are pervasively gullied. These gullies expose a stratigraphic record alternating between slow aggradation and stability (i.e. soil development) for much of the Quaternary, suggesting that gullying was recent and unprecedented within at least the past 10-100 ka. In this paper we date the initiation of gullying at five sites in the region using optically-stimulated luminescence (OSL). We also test alternative hypotheses for gully initiation using numerical landform evolution modeling. OSL ages constrain the initiation of gullying to be mid-to-late Holocene in age. This period coincides with the onset of pastoralism in the upper Tsangpo Valley. Numerical modeling suggests that a reduction in vegetation density during the colder and drier conditions of Pleistocene glacial intervals did not trigger gullying because the reduction in vegetation density and hence rates of colluvial deposition in valleys coincided with an unusually dry period capable of less fluvial erosion from valleys. As such, low-order valleys most likely did not incise prior to the mid-to-late Holocene because an approximate balance was maintained between colluvial deposition and fluvial erosion in low-order valleys. Vegetation changes associated with the onset of pastoralism, however, triggered gullying because such changes lowered the rate of colluvial deposition in valleys without a corresponding decrease in fluvial erosion. The results of this paper provide insight into how drainage basins may respond to climatic and anthropogenic perturbations in semi-arid climates of moderate relief and underscore the dramatic landscape response that can occur when geomorphic thresholds are crossed.

Final ID: B24C-07

Ecohydrologic function and disturbance of desert ephemeral stream channels

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Body: In response to rare high-intensity or long duration rainstorms, runoff in desert ephemeral channels can redistribute water through landscapes and potentially serve as a resource subsidy. We are using transect studies, mapping, monitoring and manipulation experiments to investigate the ecohydrologic relations of these pervasive features with vegetation in the eastern Mojave Desert, USA. We focus on a gently sloping piedmont transected by a ~100 year old railroad that alters natural channel flow by diverting it through staggered culverts to areas downslope of the railroad. This creates three distinct ecohydrologic zones: 1) relatively undisturbed areas above the railroad, 2) areas below the railroad that receive enhanced flow where water is diverted through culverts (enhanced zones), and 3) areas below the railroad where water flow from upslope has been blocked (deprived zones). In all areas we found that vegetation cover and density are higher adjacent to stream channels and decrease with distance from the channels. Relative to the undisturbed areas, vegetation cover is higher in the enhanced areas, and lower in the deprived. Species-specific vegetation changes included higher cover of the drought deciduous sub-shrub Ambrosia dumosa in deprived zones and higher cover of the evergreen drought-tolerant shrub Larrea tridentata in enhanced zones. Using simulated channel runoff experiments, we found that most Larrea within 3 m, and Ambrosia within 1.5 m of an undisturbed stream channel physiologically responded to a water pulse and the responses persisted for over a month. Less pronounced responses were seen adjacent to channels in the deprived zones, and did not persist as long. Electrical resistance imaging of the watering experiments shows that water infiltrates vertically in channels and spreads laterally at depth; vegetation use of channel water in the deprived zones appears to be reduced. While we have no information on the pace of vegetation change due to channel modifications (diversions), we hypothesize that increased channel flow causes rapid changes that favor evergreen shrubs whose physiology and phenology allow them to utilize short pulses of moisture, while reduction or elimination of channel flow causes slower vegetation changes as plants become decoupled from the resource additions provided by runoff in channels. Furthermore, these deprived zones essentially operate in an enforced drought mode that likely favors drought-deciduous vegetation. Our results suggest that the spatial distribution of channels and conditions that generate runoff are key contributors to vegetation responses at the landscape scale, and are critical for understanding impacts of land use and climate change in this sensitive arid ecosystem. Further work will determine if the disturbances examined here extend outside the relatively small physical footprint affected by channel redistribution, blockage, and diversion.

Final ID: H24D-07

Spatial Variations in Carbon Storage along Headwater Fluvial Networks with Differing Valley Geometry ***(Invited)***

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Body: We distinguish multiple valley types along headwater fluvial networks in the Colorado Front Range based on valley geometry (downstream gradient and valley-bottom width relative to active channel width) and the presence of biotic drivers (beaver dams or channel-spanning logjams associated with old-growth forest) capable of creating a multi-thread channel pattern. Valley type influences storage of fine sediment, organic matter, and carbon. Deep, narrow valleys have limited storage potential, whereas wide, shallow valleys with multi-thread channels have substantial storage potential. Multi-thread channels only occur in the presence of a biotic driver. Given the importance of headwater streams in the global carbon cycle, it becomes important to understand the spatial distribution and magnitude of carbon storage along these streams, as well as the processes governing patterns of storage. We compare carbon stored in three reservoirs: riparian vegetation (live, dead, and litter), instream and floodplain large wood, and floodplain soils for 100-m-long valley segments in seven different valley types. The valley types are (i) laterally confined valleys in old-growth forest, (ii) partly confined valleys in old-growth forest, (iii) laterally unconfined valleys with multi-thread channels in old-growth forest, (iv) laterally unconfined valleys with single-thread channels in old-growth forest, (v) laterally confined valleys in younger forest, (vi) recently abandoned beaver-meadow complexes with multi-thread channels and willow thickets, and (vii) longer abandoned beaver-meadow complexes with single-thread channels and very limited woody vegetation. Preliminary results suggest that, although multi-thread channel segments driven by beavers or logjams cover less than 25 percent of the total length of headwater river networks in the study area, they account for more than three-quarters of the carbon stored along the river network. Historical loss of beavers and old-growth forest has thus likely resulted in continuing loss of carbon storage in these headwater river networks.

Final ID: ED31A-0703

INTEGRATING RESEARCH AND EXTENSION FOR THE NSF-REU PROGRAM IN WATER RESOURCES

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Body: Providing positive and meaningful research experiences to students in their undergraduate years is critical for motivating them to pursue advanced degrees or research careers in science and engineering. Such experiences not only offer training for the students in problem solving and critical thinking via hands-on projects, but also offer excellent mentoring and recruiting opportunities for the faculty advisors. The goal of the Research Experience for Undergraduates (REU) Program in the Agricultural and Biological Engineering Department (ABE) at the University of Florida (UF) is to provide eight undergraduate students a unique opportunity to conduct research in water resources using interdisciplinary approaches, integrating research and extension. The students are selected from diverse cultural and educational backgrounds.

The eight-week REU Program utilizes the extensive infrastructure of UF – Institute of Food and Agricultural Sciences (IFAS) through the Research and Education Centers (RECs). Two students are paired to participate in their own project under the direct supervision of one of the four research mentors. Four of the eight students are located at the main campus, in Gainesville, Fl, and four remaining students are located off-campus, at the RECs, where some of the ABE faculty are located. The students achieve an enriching cohort experience through social networking, daily blogs, and weekly video conferences to share their research and other REU experiences. The students are co-located during the Orientation week and also during the 5-day Florida Waters Tour. Weekly group meetings and guest lectures are conducted via synchronously through video conferencing. The integration of research and extension is naturally achieved through the projects at the RECs, the guest lectures, Extension workshops, and visits to the Water Management Districts in Florida.

In the last two years of the Program, we have received over 80 applicants, from four-year and advanced degree offering institutions and a variety of majors such as Geology, Meteorology, Environmental Sciences & Engineering, Civil Engineering, Water Resources, Agricultural Engineering, Physics, Geography, Chemical Engineering, to name a few. This model of providing integrated research and extension opportunities in hydrology where not all the REU participants are physically co-located, is unique and can be extended to other disciplines.

Final ID: EP31A-0803

Modeling the rate and style of Arctic coastal retreat along the Beaufort Sea, Alaska

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Body: In Arctic landscapes, modern surface warming has significantly altered geomorphic process rates. Along the Beaufort Sea coastline bounding Alaska's North Slope, the mean annual coastal erosion rate has doubled from ~7 m/yr for 1955-1979 to ~14 m/yr for 2002-2007. Locally the erosion rate reaches 30 m/yr. A robust understanding of the processes that govern the rate of erosion is required in order to predict the response of the coast and its adjacent landscape to a rapidly changing climate, with implications for sediment and carbon fluxes, oilfield infrastructure, and animal habitat.

On the Beaufort Sea coast, bluffs in regions of ice-rich silt-dominated permafrost are abundant. This type of coast is vulnerable to rapid erosion due to its high ice content and the small grain size of bluff sediment. The bluff material at our study site near Drew Point is 64% ice, making the bluff susceptible to thermal erosion. Liberated sediment is removed from the system in suspension and does not form sheltering beaches or barrier islands which would provide a negative feedback to erosion. During the sea ice-free season, relatively warm waters abut the bluff and ocean water melts a notch into the 4-m tall bluffs. The bluffs ultimately fail by the toppling of polygonal blocks bounded by mechanically weak ice-wedges that are spaced roughly 10-20 m apart. The blocks then temporarily armor the coast against further attack.

We document the style and the drivers of coastal erosion in this region through simultaneous measurements of the oceanic and atmospheric conditions, and time-lapse imagery. We extract proxies for erosion rate from time-lapse imagery of both a degrading block and a retreating bluff from the summer of 2010, and compare the proxy record with environmental conditions and melt rate models. These observations verify that the dominant process by which erosion occurs is thermal insertion of a notch, toppling of blocks, and subsequent melting of the ice in the block. The annual retreat rate is governed by the length of the sea ice-free season, water and air temperatures, and the water level history, including both storm surge and wave height.

Motivated by these observations, we developed a numerical model to capture the evolution of the permafrost bluffs on the North Slope. We honor the high ice content of the bluff materials and the role of the toppled block in temporarily armoring the coast. We employ a positive degree day algorithm to drive subaerial melt, and a modified iceberg melting algorithm to determine rate of notch incision. Our model is first applied to the 2010 coastal retreat history, and is then used to address field and remote sensing observations over a variety of timescales. Finally, we employ the model to explore expected changes in coastal retreat rates in a range of climate scenarios that include increases in the duration of sea-ice free conditions, warming ocean temperatures, and changes in storm frequencies.

Final ID: EP31B-0819

Controls on the Erosional Efficiency of Granular Flows

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Body: In mountainous terrain, steep valleys can be a dominant component of the drainage network structure. There is mounting evidence that episodic scour by debris flows and related granular flows represent significant erosional processes in this portion of the landscape. We use discrete element modeling of granular flows to investigate interactions between the flow and the subjacent bed. A guiding aim is to quantify how changes to channel and flow properties, such as channel slope, flow depth, grain size and grain shape influence the erosive potential of a granular flow. We find that there is a large range of slopes (15°-30° for our simulated material) in which steady flow is possible. In this range of slopes, the gravitational energy is compensated by energy dissipated within the flow and into the bed. This indicates that debris-flow-channel slope should encode debris-flow erosion rates. Large changes in flow properties and distributions of particle-bed contact properties are observed as slopes increase beyond the point at which the material is stable. For all slopes, the distributions of particle contact time are dominated by binary collisions; however, there is a conspicuous increase in the probability of longer contacts for flows at inclines near the angle of repose. The shift to longer contact times indicates there is an increase in the number force chains present in more slowly moving flows. Particle-bed contact force distributions for flows on inclines just steeper than the angle of repose have the same form as static piles, in which some particle-bed contact forces are an order of magnitude greater than the mean contact force. As inclination increases, the frequency of multi-particle impacts (i.e. force chains) decreases, and as a result, the distributions become narrower and impact forces much greater than the mean impact force are not observed. Despite the narrowing of the impact force distribution with increasing inclination, we observed a nonlinear increase in the mean bed-normal impact forces as a function of slope, which was largely a result of increasing particle velocities and a marked shift in the point of maximum shear rate from the near surface down to the flow-bed interface. In contrast, particle impact flux increases with gradient at small slopes, but then decreases linearly as slope increases beyond a threshold value of 18°. Nonetheless, erosion rate, which scales as the product of impact force and impact flux, increases as a function of slope. Surprisingly, smaller and thinner flows generate higher impact forces relative to their weight. These results provide elements needed to relate field-measureable parameters to the erosional efficiency of impact wear by debris flows.

Final ID: EP31D-0847

Dynamic Drainage Networks and Discharge Histories in North America over the Last Glacial Cycle: Implications for Geomorphic Change and Early Human Settlement Patterns

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Body: During the last glacial cycle, changing ice masses altered topography, moving drainages and coastlines by hundreds of kilometers or more. These changes had wide-reaching implications for geomorphic evolution and human interactions with the hydrologic system. We present results from the coupling of ice sheet histories, geophysical models, and hydrologic analyses to reconstruct flow and sediment transport as the major ice sheets grew and waned. We show how our model results compare to geological data, and how they can be used to create a predictive model of archaeological site locations as people entered the Americas.

We coupled ice sheet histories with a state-of-the-art model of global response to changing surface loads [*Kendall et al.*, 2005] to reconstruct continental-scale drainage networks and coastlines over the last glacial cycle. The combination of changes in global ocean volume, basal pressure gradients under the ice sheets, and geophysical responses to loading—including flexural isostasy, geoid deflection, and true polar wander—caused continental-scale drainage basin reorganization. We then used the model HydroTrend [*Kettner and Syvitski*, 2008], with ice mass balances, proglacial lake positions, and paleoclimate general circulation model results as inputs, to simulate river water and sediment discharges over the last glacial cycle through each of our reconstructed drainage basins.

We compared these results to geologic data from the Mississippi River drainage basin as a case study. Our predicted time-series of water and sediment discharges correlates with the alluvial history of the Upper Mississippi and the transition of the Lower Mississippi from a braided to a meandering system. Our results also place hard numbers on water and sediment discharges to the Gulf of Mexico over the last glacial cycle. We compare these with paleoceanographic data to assess the accuracy of the ice and solid earth models that we use and to understand quantitatively the impacts of climatic and drainage pattern changes on freshwater fluxes to the Gulf and deposition at the mouth of the Mississippi.

Our hydrologic and coastline reconstructions show where ancient people would have had access to water. Humans entered North America through Beringia, the then-exposed platform of land connecting Alaska and easternmost Russia. As archaeologists believe that these people traveled the coast in boats and paleoclimate data show that this region was arid, reconstructions of coastlines and river networks provide possible locations of cultural sites. We show how our work can help to pinpoint locations for underwater archaeological exploration and therefore lead us closer to answering questions on the origins of humans in the Americas.

Final ID: EP31E-0867

An analytical framework for aeolian saltation

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Body: The process of aeolian saltation has been a focus of extensive research, but analytical solutions for the balance between the flux of grains and the adjustment of the wind velocity profile have yet to be described. Because several of the functional relationships between variables could not be known a priori, as for example the splash functions of the impact-induced ejection of grains from the bed, the process has been studied primarily through experiments and numerical modeling. Grain-scale experiments have now however yielded robust empirical relationships for functions such as splash function distributions, and we can use these relationships to make the aeolian saltation process analytically tractable.
We construct an analytical framework for steady state saltation in terms of a threshold height, above which the wind velocity is strong enough to carry a grain from reptation to saltation. This threshold height is raised as the wind profile magnitude is lowered by the increasing number of saltating grains being accelerated by the wind, until the number of grains being demoted below this threshold equals the number being promoted. Grain demotion results from the loss of energy to collisions with the bed, while grain promotion results from the distribution of splash-ejected grains that exceed the threshold height. The balance of these populations at steady state determines both the total number of grains in saltation and the saturated wind velocity profile, while the approach to this balance describes the transient evolution to this state. We also formulate the critical impact Shields stress, defined as the stress below which transport ceases (as opposed to the higher critical fluid Shields stress at which transport is initiated). The difference between the critical fluid and impact Shields stresses also implies the existence of a minimum population of saltating grains.
Finally, we extend our developed framework to comment on related open questions. We test the dependence of grain flux and trajectory lengths and speeds on the erodibility of the bed, and compare these results with experimentally observed differences in scaling. We also compare our results to findings for saltation under water, where collision-induced entrainment is significantly reduced but not absent, in terms of differences in grain flux and trajectory lengthscales.

Final ID: G31B-0965

Using Empirical Orthogonal Functions to Quantify and Predict Small Global and Regional Common Modes of the Global Geodetic Reference Frame

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Body: The International Terrestrial Reference Frame (ITRF) is given as a set of globally distributed reference stations with coordinates and constant velocities, which form a so-called secular reference polyhedron. A sub-set of these reference stations has been observed for a decade or more with GPS, revealing small but significant deviations of the actual station motion from the linear reference model. These deviations are caused by surface loading, tectonic deformations, major earthquakes, and modeling errors affecting the analysis results. If not accounted for appropriately, these deviations can mask small geophyscial signals. We use Empirical Orthogonal Function (EOF) analysis of the coordinate time series for the reference stations to determine common modes in these deviations. In the interval from 2000.0 to 2011.0 the time series for a global set of about 65 ITRF reference stations are almost gap-free and the stations are stable. The coordinate time series were determined in a precise point positioning approach using the GIPSY software and global parameters determined by the Jet Propulsion Laboratory (JPL), and the AMBIZAP method was applied to resolve ambiguities. The daily free solutions were aligned to ITRF using the transformation parameters determined by JPL. Translations of the free solutions with respect to ITRF are absorbed by the transformations, and the remaining common modes are translation free. The time series are scrutinized for outliers and steps prior to the analysis. Predicted surface loading signals and displacements fields of major earthquakes are used to identify those common modes that are caused by these processes. The temporal and spatial stability of the common modes is assessed by performing EOF analysis on sub-intervals. Temporal instabilities result from changes in the GPS system, equipment changes at the tracking stations, and changes in the global analysis providing the transformation parameters. The predictive capabilities of the EOF modes is assessed by using common modes to predict reference station motions outside the analysis interval. The predictive capabilities of EOF modes determined from a long data set are found to be on the order of weeks. Thus, these modes can be used to predict common modes for low-latency applications and to reduce their effect on geodetic time series. The spatial smoothness of the lower EOF modes allows for a spatial interpolation so that these modes can be modeled for non-reference stations.

Final ID: H31A-1136

Modelling the future evolution of incised coastal gullies using a coupled terrestrial-coastal landscape evolution model.

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Body: Numerical models of landscape evolution provide powerful tools to assess the impacts that changes in driving forces may have on a landscape. Historically, models of coastal- and terrestrial-landscape evolution have been kept separate. Considering that the driving forces of coastal and terrestrial erosion are projected to change under future climate change scenarios, it is somewhat surprising that the impacts of these changes and the interaction between terrestrial and coastal processes has yet to be fully explored within a numerical modelling framework.

In this paper we present a modified version of the Channel-Hillslope Integrated Landscape Development (CHILD) model which incorporates a new module describing the retreat of coastal soft-cliffs. This new cliff retreat model is founded on the underlying premise that wave energy is the key factor driving soft cliff erosion. Specifically, we assume that the rate of cliff retreat (in any year) is a function of the accumulated wave energy above a threshold. Since it is driven by wave energy regimes, the cliff retreat model is well suited for impacts analyses using future wave climates developed by modifying the statistical properties of baseline wave spectra in accordance with climate change predictions. This allows straightforward analysis of the impacts not only in terms of altered wave heights (including adjustments forced by seasonal tides, surges and longer-term sea-level rise), but also changes in storm intensity, duration and inter-storm period.

In this paper we report the findings from a validation study which compares the predictions from the coupled terrestrial-coastal CHILD model with data from a series of incised coastal gullies (known locally as ‘Chines’), found along the south west coast of the Isle of Wight, UK. These features are ideally suited to this study as their evolution is controlled by both terrestrial and coastal processes; namely rates of knickpoint recession and cliff retreat. Chines are highly dynamic features, responding to changes in either of the aforementioned processes.

Final ID: H31B-1152

Capturing the Initiation and Spatial Variability of Runoff on Soils Affected by Wildfire

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Body: Rainfall after wildfire often leads to intense runoff and erosion, since fire removes ground cover that impedes overland flow and water is unable to efficiently infiltrate into the fire-affected soils. In order to understand the relation between rainfall, infiltration, and runoff, we modified a camera to be triggered by a rain gage to take time-lapse photographs of the ground surface every 10 seconds until the rain stops. This camera allows us to observe directly the patterns of ground surface ponding, the initiation of overland flow, and erosion/deposition during single rainfall events. The camera was deployed on a hillslope (average slope = 23 degrees) that was severely burned by the 2010 Fourmile Canyon Fire near Boulder, Colorado. The camera's field of view is approximately 3 m^2. We integrate the photographs with rainfall and overland flow measurements to determine thresholds for the initiation of overland flow and erosion. We have recorded the spatial variability of wetted patches of ground and the connection of these patches together to initiate overland flow. To date we have recorded images for rain storms with 30-minute maximum intensities ranging from 5 mm/h (our threshold to trigger continuous photographs) to 32 mm/h. In the near future we will update the camera's control system to 1) include a clock to enable time-lapse photographs at a lower frequency in addition to the event-triggered images, and 2) to add a radio to allow the camera to be triggered remotely. Radio communication will provide a means of starting the camera in response to non-local events, allowing us to capture images or video of flash flood surge fronts and debris flows, and to synchronize the operations of multiple cameras in the field. Schematics and instructions to build this camera station, which can be used to take either photos or video, are open-source licensed and are available online at http://instaar.colorado.edu/~wickert/atvis. It is our hope that this tool can be used by other researchers to better understand processes in burned watersheds and other sensitive areas that are likely to respond rapidly to rainfall.

URL: http://instaar.colorado.edu/~wickert/atvis

Final ID: H31K-02

A Long-term Reach-Scale Monitoring Network for Riparian Evapotranspiration, Rock Creek, Kansas *(Invited)*

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Body: Riparian evapotranspiration (RET) is an important component of basin-wide evapotranspiration (ET), especially in subhumid to semi-arid regions, with significant impact on water management and conservation. In narrow riparian zones, typical of much of the subhumid to semi-arid U.S., direct measurement of RET by eddy correlation is precluded by the limited fetch distance of riparian vegetation. Alternative approaches based on water balance analyses have a long history, but their accuracy is not well understood. Factors such as heterogeneity in soil properties and root distributions, and sparse measurements, introduce uncertainties in RET estimates. As part of a larger effort aimed at improving understanding of basin-wide RET using scaling theories, we installed a continuous monitoring system for water balance estimation at the scale of a single (~100 m long) reach along Rock Creek in the Whitewater Basin in central Kansas. The distinguishing features of this site include a vadose zone with fine-grained soils underlain by a phreatic zone of coarse gravel embedded in clay, overlying karst bedrock. Across the width (~40 m) of the riparian zone, we installed one transect of four wells screened at the bottom of the alluvium (6-7 m depth), each accompanied by a soil moisture profiler with capacitance sensors at 4 vertical levels above the local water-table elevation (~2.5 m depth) and a shallow well screened just below the water table. All wells were instrumented with pressure transducers for monitoring water levels. Additional sets of all sensors were installed at the upstream and downstream ends of the study reach. Initial results from the monitoring network suggest significant complexities in the behavior of the subsurface system at the site, including a high degree of heterogeneity. All deep wells show a rapid response to streamflow variations and nearby pumping. However, the shallow water-table wells do not respond rapidly to either. Both the shallow wells and soil moisture sensors record diurnal fluctuations in response to RET during the growing season. The soil moisture sensors at depths less than 1 m respond rapidly to precipitation events. The piezometric head in the bedrock and deep alluvial wells is about 0.5 m higher than in the shallow wells, suggesting upward flow across a clay unit that comprises the lower 3-4 m of the alluvium. The hydrology of the system suggests that recharge of soil moisture by precipitation could often be more important than stream-aquifer interaction as a supply of RET. A distributed temperature sensing (DTS) system installed to investigate the spatial variability of groundwater-surface water interaction revealed isolated locations of groundwater seepage into the stream under low flow conditions. These preliminary observations suggest that the bedrock and lower alluvium act like a confined aquifer that is well connected to the stream, while the shallow alluvium acts like an unconfined aquifer recharged by both precipitation and upward leakage from the confined system, and depleted by RET. We also present results from a simplified numerical model to illustrate the controls on water balance.

Final ID: NG31A-02

"Universal" Recession Curves and their Geomorphological Roots *(Invited)*

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Body: The basic structural organization of channel networks, and
of the connected hillslopes, have been shown to be intimately linked to basin responses to rainfall events, leading to geomorphological theories of the hydrologic response. Here, We identify a previously undetected link between the river network morphology and key recession curves properties. We show that the power-law exponent of -dQ/dt vs. Q curves is related to the power-law exponent of N(l) vs. G(l) curves (which we show to be connected to Hack's law), where l is the downstream distance from the channel heads, N(l) is the number of channel reaches exactly located at a distance l from their channel head, and G(l) is the total length of the network located at a distance greater or equal to l from channel heads. We then generalize the power-law expressions of recession curves, to identify "universal" curves, independent of the initial moisture conditions and of basin area, by making the -dQ/dt vs. Q curve non-dimensional using an index discharge representative of initial moisture conditions. We subsequently rescale the geomorphic recession curve, N(l) vs. G(l), producing a collapse of the geomorphic recession curves constructed from the DTM's of 67 US study basins. Finally, by use of the specific discharge u = Q/A, we link the two previous results and define the specific recession curves, whose collapse across basins within homogeneous geographical areas lends further, decisive, support to the notion that the statistical properties of observational recession curves bear the signature of the geomorphological structure of the networks producing them.

Final ID: IN31C-05

Model and Interoperability using Meta Data Annotations *(Invited)*

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Body: Software frameworks and architectures are in need for meta data to efficiently support model integration. Modelers have to know the context of a model, often stepping into modeling semantics and auxiliary information usually not provided in a concise structure and universal format, consumable by a range of (modeling) tools. XML often seems the obvious solution for capturing meta data, but its wide adoption to facilitate model interoperability is limited by XML schema fragmentation, complexity, and verbosity outside of a data-automation process. Ontologies seem to overcome those shortcomings, however the practical significance of their use remains to be demonstrated. OMS version 3 took a different approach for meta data representation. The fundamental building block of a modular model in OMS is a software component representing a single physical process, calibration method, or data access approach. Here, programing language features known as Annotations or Attributes were adopted. Within other (non-modeling) frameworks it has been observed that annotations lead to cleaner and leaner application code. Framework-supported model integration, traditionally accomplished using Application Programming Interfaces (API) calls is now achieved using descriptive code annotations. Fully annotated components for various hydrological and Ag-system models now provide information directly for (i) model assembly and building, (ii) data flow analysis for implicit multi-threading or visualization, (iii) automated and comprehensive model documentation of component dependencies, physical data properties, (iv) automated model and component testing, calibration, and optimization, and (v) automated audit-traceability to account for all model resources leading to a particular simulation result. Such a non-invasive methodology leads to models and modeling components with only minimal dependencies on the modeling framework but a strong reference to its originating code. Since models and modeling components are not directly bound to framework by the use of specific APIs and/or data types they can more easily be reused both within the framework as well as outside. While providing all those capabilities, a significant reduction in the size of the model source code was achieved. To support the benefit of annotations for a modeler, studies were conducted to evaluate the effectiveness of an annotation based framework approach with other modeling frameworks and libraries, a framework-invasiveness study was conducted to evaluate the effects of framework design on model code quality. A typical hydrological model was implemented across several modeling frameworks and several software metrics were collected. The metrics selected were measures of non-invasive design methods for modeling frameworks from a software engineering perspective. It appears that the use of annotations positively impacts several software quality measures. Experience to date has demonstrated the multi-purpose value of using annotations. Annotations are also a feasible and practical method to enable interoperability among models and modeling frameworks.

Final ID: NG31B-02

Self-organization of tidal deltas *(Invited)*

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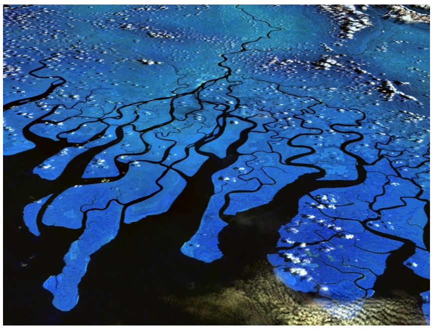
Body: Tidal deltas are characterized by a dendritic network of distributaries that transport water and sediments to the ocean. Here, I show that the distributaries self-organize to uniformly redistribute the tidal prism across the entire delta system. The 2 opposite mechanisms of channel formation by avulsion and channel abandonment drive the entire delta toward a critical state at which every channel is close to the silting threshold. Under these conditions the delta reaches self-organized criticality, with changes of its planimetric channel distribution occurring across several spatial scales

URL : people.bu.edu/sergio



Final ID: U31C-07

A Services-Oriented Architecture for Water Observations, Modeling and Visualization

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Body: Water models of many disciplines are constructed using different programming languages, computer environments and geographic locations. These models need to be linked to observational data describing water properties, such as discharge, water level, and quality, which are accessible as regularly recorded time series of gaged information, or irregularly recorded time sequences of water sample information. These data come from networks of observation sites operated by multiple institutions in many geographic locations. Model results and observational data need to be visualized as maps, charts and animations. This paper examines the hypothesis that water observations, model input and output, and visualizations, can all be expressed as standardized web services, such as those of the Open Geospatial Consortium. It is further hypothesized that the interaction among these services can orchestrated through a web services "hub" that serves to schedule the information flows among the various component services internally, and also serves as a source for information services to external users. Representative sample problems are used to examine the validity of these hypotheses.

URL: http://www.caee.utexas.edu/prof/maidment

Final ID: H31I-07

'age' of water: a physics based, fully coupled, distributed model for watershed assessment

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Body: Understanding the spatial distribution of processes in a watershed is critical to manage water resources and ecosystem functions. Clearly, this banks on our ability at simulating multiple physical and biological phenomena and predictions of various spatially distributed hydrologic states and fluxes across the watershed. Various multi-scale applications of Penn State Integrated Hydrologic Modeling System (PIHM) have demonstrated the model skill to simulate processes accounting for spatially explicit information associated with topography, climate, vegetation, soil and geology. The various level of heterogeneity in space and time makes it complex to interpret the hydrology of the watershed due to the volume of data involved. We use the ‘age’ of water as a concept that fundamentally combines the response of various hydrologic processes leading to the characterization of a watershed. Nonetheless it also allows a unique way to validate the process representation and calibration. The model system was applied to Shale Hills - Susquehanna critical zone observatory in Pennsylvania. Deuterium isotope samples collected for the rainfall events in 2009 - 2010 were used to force the PIHM water quality model. Isotope concentration measurements of the samples collected from groundwater and streamflow were used to validate the model predictions along with other hydrologic variables such as streamflow, soil moisture and groundwater levels. The model results show spatial heterogeneity in the aging process and a strong annual cycle in the streamflow response. The hydrology of a watershed is a major driver of processes affecting nutrient cycling and the fluxes of dissolved and colloidal components such as N, P, C, and sediments in water. Towards a spatially explicit representation of nutrient cycling and vegetation processes in watershed, algorithms from the models Cycles and CropSyst will be coupled to the water cycling and landscape segmentation of the model PIHM.

URL: http://www.pihm.psu.edu

Final ID: NG31B-03

Roughness controls patterns of sediment transport, vegetation and groundwater in a desert dune field ***(Invited)***

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Body: Spatial variations in sand flux determine: dune migration rates, size and type; accumulation rates; and grain size sorting. It has been observed in some dune fields that sand transport rates are highest at the upwind margin, and decline downwind for several kilometers. Although it is well known that abrupt changes in surface roughness (e.g., dunes) trigger growth of an internal boundary layer (IBL), the implications for sand flux have not been quantitatively explored. Here we combine IBL and sediment transport theory, with repeated airborne altimetry surveys and field observations, to demonstrate that IBL development controls the downwind pattern of sand flux at White Sands, New Mexico. Results explain the observed sediment accumulation rate, and also shed light on the origin and evolution of the dune field. Declining sand transport downwind triggers an abrupt change in vegetation density, which in turn drives changes in groundwater depth and salinity in accordance with recent ecohydrologic theory. Thus, roughness from the dunes themselves is responsible for large-scale changes in dune dynamics, vegetation and hydrology. We expect that IBL development exerts a similar control on sand flux patterns in any dune field for which abrupt changes in roughness occur.

Final ID: EP31F-08

Sorting out meandering and braiding: discriminating formative conditions and stratigraphy *(Invited)*

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Body: For various river channel patterns, the necessary formative conditions differ, but how is not entirely understood. Furthermore, not only the morphology and dynamics differ, but also the resulting stratigraphy differs, of which understanding is required to infer past environmental conditions and predict reservoir behaviour. Our objective is to identify the necessary and sufficient conditions for forming dynamic meandering and braided rivers. We reproduced both patterns experimentally and with a physics-based numerical model, and produced synthetic stratification from bed elevation maps and control lacquer peels for the experiments.

Experimental meandering was produced using a mixture of poorly sorted sediment and silt-sized silica flour and a transversely moving inflow boundary. Braiding was produced in exactly the same conditions but without the silica flour. These experiments represent gravel-bed rivers in nature, where both experimental meandering and braiding channels were close to the transition between the types. Onset meandering was also produced in the numerical model (Delft3D) with a similar transversely moving inflow boundary, whilst braided rivers formed with fixed inflow or some noise on the transverse discharge distribution at the inflow boundary.

The silica flour deposited on crevasse splays and in chute channels, forming new floodplain. This caused much less chute cutoffs and stronger banks. The resulting meandering river formed multiple sets of scroll bars forming pointbars, overlain by splays and floodplain. The braided river, in contrast, showed mid-channel bars and multiple active channels, faster and more haphazard bar and channel migration, and frequent chute cutoffs. Apart from the floodplain, stratification in meandering rivers consisted of sigmoidally stratified units formed by scroll bars and channel fills, usually formed after chute cutoff. Braided rivers had similar units but much smaller and more. In both cases the highest preservation potential is in the deepest channels.

We conclude that some floodplain-filling sediment or vegetation is required for meandering to prevent chute cutoffs to lead to weak braiding, but, more importantly, that some dynamics are required at the upstream boundary, where periodic perturbation causes meandering whilst stochastic perturbation causes braiding. Furthermore, morphology and stratification in braided gravel-bed rivers have much smaller morphological and stratigraphic units relative to average channel width than the meandering rivers, even though active bar dimensions are comparable.

URL : http://www.geo.uu.nl/fg/mkleinhans

Final ID: H32C-02

"Developing" Hydrology or Hydromorphology: A modern research agenda that can inform the trenches *(Invited)*

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Body: The pace of change in the developing world is dramatic. As the “developed” economies focus on environmental restoration, the developing countries are marked by a rapid transformation of the landscape accompanied by pressures of resource extraction and development. At one level, the considerations for large water projects are not fundamentally different than those that were faced when the United States or Australia underwent a rapid development cycle. On closer inspection, we note that in countries such as India and China the recent development pressures come at a time when the cumulative effects of past modification of the hydrologic system – water quantity, quality, ecosystem functioning – have already led to significant degradation of function. Even this situation is not dissimilar to what was experienced in parts of Europe at one time. However, the combination of population pressures, a segregated economy, and the local pressures induced by globalization and global environmental changes are unprecedented. The emergence of the movements towards “small is beautiful” and the push towards decentralized infrastructure in this setting are consequently not a surprise. However, the broad replication of such measures without significant planning, regulation or scientific information that connects local, watershed and river basin impacts could lead to a hydromorphic transformation that is unprecedented in the history of man. The interplay between water and humans has shaped watersheds and societies for millennia, and hydromorphology refers directly to the nascent science of how the spatio-temporal dynamics of such systems plays out given the geometric and geological constraints of a river basin, and the operational, ever changing climate. Theories of such evolution may be self-evident, but need to be formally developed. The developing world provides an amazing opportunity to both develop such a laboratory, and to also influence the course of its evolution for synergistic improvements in the long term outcomes for humans and watershed systems. I discuss how an interdisciplinary, experimental and theoretical approach to hydromorphology could be fostered with a developing country focus, and could potentially inform environmental restoration goals in developed countries as an end point.

Final ID: U32A-06

Toward the Understanding of Water and Land-surface Feedbacks in a Warm Permafrost Environment

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Body: The Arctic, including Alaska, is currently experiencing an unprecedented degree of environmental change. Increases in both the mean annual surface temperature and precipitation have been observed. The combination of the recent increase in air temperature and precipitation have led to "unstable" or "warm" permafrost conditions. This warm and unstable permafrost condition is particularly sensitive to changes in both the surface energy and water balances. The observed climatic changes are expected to continue into the next century. As such, most of the current or expected changes (related to climate, permafrost, and vegetation distributions) will be experienced in areas underlain with warm, unstable permafrost.

Themokarst topography forms whenever ice-rice permafrost thaws and the ground subsides into the resulting voids. Extensive areas of active thermokarst activity are currently being observed in these warm, unstable permafrost environments. The important processes involved with thermokarsting include surface ponding, surface subsidence, changes in drainage patterns and related erosion. In this study, we will present a conceptual model of the development of thermokarst features, emphasizing the resulting feedbacks and connections between hydrologic processes and a dynamic surface topography.

Final ID: A33D-0252

Seasonal and inter-annual variability of aerosol optical properties during 2005-2010 over Red Mountain Pass and Impact on the Snow Cover of the San Juan Mountains

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4. JPL, Pasadena, CA, United States.

Body: Growing body of evidence suggests the significant role of aerosol solar absorption in accelerated seasonal snowmelt in the cryosphere and elevated mountain regions via snow contamination and radiative warming processes. Characterization of aerosol optical properties over seasonal snow cover and snowpacks is therefore important towards the better understanding of aerosol radiative effects and associated impact on snow albedo. In this study, we present seasonal variations in column-integrated aerosol optical properties retrieved from AERONET sunphotometer measurements (2005-2010) at Red Mountain Pass (37.90° N, 107.72° W, 3368 msl) in the San Juan Mountains, in the vicinity of the North American Great Basin and Colorado Plateau deserts. The aerosol optical depth (AOD) measured at 500nm is generally low (< 0.2) in the climatological monthly means but exhibits strong seasonal variability with very low background values of about 0.05 during winter season, but is found to significantly increase more than 5-6 times during summer months with values up to 0.3-0.4. Together with the spectral variations in AOD, the Angstrom Wavelength Exponent (α) typically varies in the range of 1-2 indicating the dominance of fine-mode particulates. However, during summer months, nearly 30% of α values are observed below 0.5 thus suggesting an increased influx of coarse-mode aerosols compared to other seasons. The higher AOD and lower α is most likely a result of the summer-time enhanced convection and upslope pollutant transport. In addition, the possibility of the observed increased coarse-mode influence associated with mineral dust influx cannot be ruled out, due to westerly-airmass driven transport from arid/desert regions as suggested by backward trajectory simulations. A meteorological coupling is also found in the summer season between AOD and column water vapor retrieved from AERONET with co-occurring enhanced water vapor and AOD. Based on column measurements, it is difficult to ascertain the aerosol composition, however, the summer-time enhanced aerosol loading as presented here is consistent with the increased dust deposition in the San Juan mountain snow cover as reported in recent studies. In summary, this study is expected to better understand the seasonal and inter-annual aerosol column variations and is an attempt to provide an insight into the effects of aerosol solar absorption on accelerated seasonal snowmelt in the San Juan mountains.

Final ID: B33E-0506

A population growth model forced by random, episodic disturbances

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Body: As a first step to quantify and better understand the nature of thresholds in ecosystems, a prototype population dynamics model has been developed and analyzed for the case where a population is subjected to random, episodic disturbances. This model assumes that disturbances occur at random times (following a Poisson event process) and have random magnitudes that determine the fraction of the population that survives the disturbance. Disturbances may be events such as fire, drought, disease or infestation. Between disturbances, the model assumes that population growth is deterministic and can be modeled by an exponential or logistic equation. The model is characterized by time, t, and four other parameters: the initial population size, N_0, the per capita growth rate, r, the expected number of disturbance events per unit time, λ, and $\mu = E(X)$, where X is the random fraction (between 0 and 1) of the population that survives a given disturbance. What is nice about this simple, stochastic model is that it is mathematically tractable and clearly exhibits threshold behavior that can be computed explicitly in terms of the model parameters. In particular, the long-term behavior of the model is characterized by an easily-computed {\bf indicator} that is a function of the model parameters. Whenever the model parameters are such that this indicator is less than zero, the expected value of the random population size declines over time and is unsustainable. But whenever it is greater than zero, the expected population size grows, despite the random disturbances. The case where the indicator is zero therefore represents a type of {\bf critical threshold} for this problem that determines whether or not the population is likely to survive the disturbances. A number of analytic results will be presented along with numerical results from a large number of simulations.

Final ID: B33F-0540

Regional and Global Controls and Potential Significance of Dissolved Silica Retention in Lakes and Reservoirs

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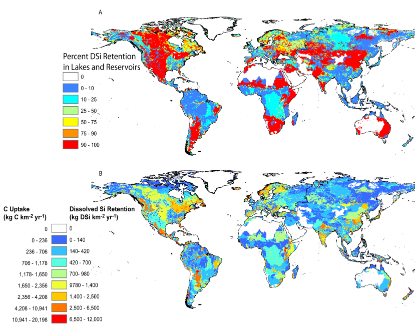
Body: DSi availability can exert a strong influence on phytoplankton community structure and composition in freshwaters and the coastal zone. Recent work suggests that through reservoir construction, humans have dramatically altered the efficiency with which dissolved silica is transported downstream through watersheds to the coastal zone. Lentic water bodies (lakes and reservoirs) offer favorable conditions for DSi burial in sediments. However, the patterns and controls of lentic DSi removal at regional to global scales remain largely unexplored and un-quantified. In this paper we describe, evaluate, and apply a new, spatially explicit, annual-scale, global model of lentic DSi removal called SiRReLa (Silica Retention in Reservoirs and Lakes). Through the model development process, it was determined that lentic DSi removal is significantly correlated with DSi loading and water mean residence time. Lake eutrophication status was also significantly related to DSi retention efficiency. The SiRReLa Model incorporates smaller lakes and reservoirs than have been included in previous global analyses, and also allows for separate treatment and analysis of reservoirs and natural lakes. Model runs for the mid-1990s indicate:
1) Lentic systems are indeed important sinks for DSi and are conservatively estimated to remove 84.1 Tg DSi yr-1 from watersheds globally, roughly 22% of all DSi inputs to surface waters (~380 Tg DSi yr-1). Small lakes and reservoirs (< 50 km2) were critical in the analysis, retaining 80% (67.3 Tg DSi yr-1) of the global total.
2) Although reservoirs occupy just 6% of the global lentic surface area they retained approximately 35% of the total DSi removed by lentic systems, due to a combination of higher drainage ratios (catchment surface area: lake or reservoir surface area) greater DSi loading rates in reservoirs than in lakes, and a tendency to occur in eutrophied regions.



Final ID: C33B-0637

Numerical modeling of the permafrost temperature evolution in Alaska during the 21st century.

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Body: An increasing amount of ground temperature data from permafrost observation stations in Alaska provides a valuable dataset for detailed analysis and modeling of permafrost current dynamics. The ground temperature data from fourteen boreholes were used to forecast permafrost thermal state by the end of the current century. We studied variations in ground thermal conditions in Alaska based on measurements and modeling. The model was forced with an ensemble of GCMs dataset downscaled to 2 by 2 km spatial resolution. At the initial stage of the modeling we calibrated modeled temperatures using ground temperature measurements. During the calibration, we used a composite of five climate models with an A1B emission scenario for present-day climate conditions. Initial temperature profiles were equilibrated according to the measured ground temperatures.

We analyzed ground temperature dynamics from 1980 to 2010 and tried to address how the ecosystem and snow properties affect the ground temperature regime for different permafrost zones. The modeled mean annual ground temperatures (MAGT) at 20m depth for five GCM composite forcing with an A1B emission scenario show a gradual increase up to 5^oC for permafrost stations in discontinuous permafrost zone and a more pronounced MAGTs increase up to 7^oC for stations in the continuous permafrost zone by the end of current century. The factual increase in MAGT varies significantly for different ecosystems. The increase of the modeled active layer depth depends on several factors such as thickness of the upper organic layer, snow depth and on the amount of available soil moisture in the thawed zone and varies from station to station.

Final ID: ED33B-0779

Let's Talk About Water: Film Screenings as an Entrée to Water Science

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Body: "Let's Talk about Water" is a film symposium designed to bring together experts and the public to talk about the complex water issues facing society. The format of the event is quite simple: a panel of experts and the audience view a water documentary (such as "FLOW", "Liquid Assets", or "Gasland") together and there is an extended moderated discussion period following the film between the panel and the audience.

Properly handled, this simple format can be very effective. A film creates a context of subject and language for the discussion--it gets the audience and the panel on the same page. The moderators must actively manage the discussion, both challenging the panelists with follow up questions, asking questions to simplify the language the expert is using, and passing a question among panelists to bring out different points of view. The panelists are provided with the film in advance to view and, most importantly, meet the day before the event to discuss the film. This makes for a much more convivial discussion at the event. We have found that these discussions can easily be sustained for 90 to 120 minutes with active audience participation.

This format has been applied at college campuses with a target audience of lower-level undergraduates. Student clubs are engaged to help with publicity before the event and to assist with registration and ushering during the event. Appropriate classes offer extra credit for student attendance to ensure a strong turnout. A Hollywood film ("Chinatown" in southern California, "A Civil Action" in Boston) is shown on campus during the week preceding the event to help advertise the event. The event itself is typically held on a Saturday with a morning screening of the film. The audience is provided with index cards and pencils to write down questions they have about the film. A lunch is provided during which the questions are organized and used to initiate different discussion themes. The discussion begins with points raised by the movie (are these issues real? Do they apply here? What are the scientific, engineering, and policy solutions to these problems?) and then segues into a discussion about career opportunities in the water sector. Our past events at UC Irvine and at UMass Boston have been successful in attracting large audiences and have been viewed positively by attendees.

URL: http://www.letstalkaboutwater.com

Final ID: EP33A-0912

Surface adhesion and fine sediment trapping in deltaic wetlands

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Body: It is commonly believed that wetland vegetation can be a significant control acting to increase sediment deposition in coastal wetlands, but this effect is poorly understood and quantified. Field observations and limited flume studies with model vegetation have suggested possible mechanisms by which this effect may occur. Here, I describe new experiments inspired by field observations of substantial amounts of fine sediment collected on vegetation stems and leaves. Sediment is allowed to collect on surfaces in a stirred container, and the sediment-retaining properties of different surfaces are investigated. Preliminary results suggest that sticky microbial biofilms, combined with the extremely high surface area provided by dense marsh vegetation, may be responsible for a significant amount of wetland deposition. Such an effect would be in addition to, and complimentary to, any purely fluid-mechanical effect caused by baffling or trapping of flow through vegetation leading to reduction in sediment transport. I combine surface-adhesion measurements with surface-encounter predictions that incorporate simplified fluid mechanics for flow through vegetation. Results may have implication for restoring sediment-starved deltas.

Final ID: G33B-0993

Modeling Earth Deformation from Monsoonal Flooding in Bangladesh using Hydrographic, GPS and GRACE Data

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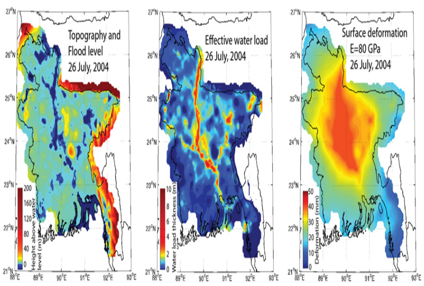
Body: The Ganges, Brahmaputra and Meghna Rivers converge in Bangladesh with annual discharge second only to the Amazon. Most of the flow occurs during the summer monsoon causing widespread flooding. The impounded water represents a large surface load that is the second largest seasonal anomaly in the GRACE gravity field. Continuous GPS stations in Bangladesh record seasonal vertical motions up to 6 cm due to the water load. We have used GRACE water mass estimates and surface water monitoring to calculate the seasonal load together with GPS observations of seasonal deformation due to this load in order to invert for lithospheric properties.

To estimate the water load in Bangladesh, we use >300 daily river gage measurements of water level and >1200 weekly groundwater level measurements from wells from 2003-2010. The total impounded water mass is partitioned between surface water and groundwater by using the SRTM DEM. The seasonal water loads calculated from the surface data and from GRACE are in excellent agreement. They show that seasonally ~100GT of water are stored in Bangladesh (7.5% of annual discharge), but can reach 150GT during extreme events. These water loads cause elastic deformation with a large lateral extent. To calculate effect of water loads beyond Bangladesh and our surface water data, we project GRACE solutions to estimate the water mass in irregular blocks that represent the major areas of flooding and groundwater storage in the surrounding region (West Bengal, Bihar, Assam, Myanmar). We use the water load to make calculations of the deformation at all of our 18 continuous GPS sites to provide an improved areal coverage of the surface deformation that is improved from our previous work. The net result of these improvements is a better fit to the data, resulting in a significant decrease in the estimated value for Young's modulus (E) and hence the strength of the lithosphere beneath Bangladesh.

Going beyond determining an average value of E, we have begun modeling the depth-dependence of E and thus the lithospheric structure beneath the Ganges-Brahmaputra Delta. We will present initial calculations using a simple 3-layer parameterization of E for the sediments, crust and mantle. The main goals are to resolve the sediment thickness and Moho depth beneath the Ganges-Brahmaputra Delta.



Final ID: GC33B-1080

Remote Sensing of Urban Land Cover/Land Use Change, Surface Thermal Responses, and Potential Meteorological and Climate Change Impacts

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Body: City growth influences the development of the urban heat island (UHI), but the effect that local meteorology has on the UHI is less well known. This paper presents some preliminary findings from a study that uses multitemporal Landsat TM and ASTER data to evaluate land cover/land use change (LULCC) over the NASA Marshall Space Flight Center (MFSC) and its Huntsville, AL metropolitan area. Landsat NLCD data for 1992 and 2001 have been used to evaluate LULCC for MSFC and the surrounding urban area. Land surface temperature (LST) and emissivity derived from NLCD data have also been analyzed to assess changes in these parameters in relation to LULCC. Additionally, LULCC, LST, and emissivity have been identified from ASTER data from 2001 and 2011 to provide a comparison with the 2001 NLCD and as a measure of current conditions within the study area. As anticipated, the multi-temporal NLCD and ASTER data show that significant changes have occurred in land covers, LST, and emissivity within and around MSFC. The patterns and arrangement of these changes, however, is significant because the juxtaposition of urban land covers within and outside of MSFC provides insight on what impacts at a local to regional scale, the inter-linkage of these changes potentially have on meteorology. To further analyze these interactions between LULCC, LST, and emissivity with the lower atmosphere, a network of eleven weather stations has been established across the MSFC property. These weather stations provide data at a 10 minute interval, and these data are uplinked for use by MSFC facilities operations and the National Weather Service. The weather data are also integrated within a larger network of meteorological stations across north Alabama. Given that the MSFC weather stations will operate for an extended period of time, they can be used to evaluate how the building of new structures, and changes in roadways, and green spaces as identified in the MSFC master plan for the future, will potentially affect land cover LSTs across the Center. Moreover, the weather stations will also provide baseline data for developing a better understanding of how localized weather factors, such as extreme rainfall and heat events, affect micrometeorology. These data can also be used to model the interrelationships between LSTs and meteorology on a longer term basis to help evaluate how changes in these parameters can be quantified from satellite data collected in the future. In turn, the overall integration of multi-temporal meteorological information with LULCC, and LST data for MSFC proper and the surrounding Huntsville urbanized area can provide a perspective on how urban land surface types affect the meteorology in the boundary layer and ultimately, the UHI. Additionally, data such as this can be used as a foundation for modeling how climate change will potentially impact local and regional meteorology and conversely, how urban LULCC can or will influence changes on climate over the north Alabama area.

URL: http://www.nsstc.org/ghcc/index.html

Final ID: IN33B-1468

Incorporating Spatial Support to Improve Interoperability of Shared Water Data

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Body: As scientists gain experience with using modern informatics to access and to share data, some limitations in the metadata descriptions of the spatial and environmental context of these observations are becoming apparent that were not immediately obvious. For hydrologists, the archetype for sampling stations is the gage on the river. Simply plotting the gage on a map provides a great deal of context for data interpretation: the position in the river network (e.g., stream order) is evident and the watershed defined by the gage can be evaluated for properties such as land cover and slope.

The spatial context for other instruments is not so apparent and the concept of “spatial support” of a measurement becomes important. For example, a tipping bucket raingage literally measures a few square centimeters of area and a soil-moisture probe a few cubic decimeters of soil. However, the scientist who placed these instruments in the field likely interprets these measurements to have a much larger spatial extent. Indeed, the more useful value to convey to other scientists is this subjective interpretation of the measurement—its presumed spatial support. One common example includes basin-average precipitation, but spatial support may also be based on a variety of properties such as soil type, soil horizon, or landscape position.

In this paper, we examine how the Open Geospatial Consortium’s Observations and Measurement information model (also published as ISO19156) can capture the concept of spatial support in particular, and, more broadly, capture the environmental context for water measurements. The O&M model can be stated as: An Observation is an action whose result is an estimate of the value of some property of the feature-of-interest, obtained using a specified procedure. Within this model, the feature-of-interest holds most promise for capturing the intent of the scientist in making the measurement. For example, the purpose of deploying a soil-moisture probe is not to simply measure the soil moisture immediately around the probe; instead the feature-of-interest is the soil horizon or other feature that the scientists believes the measurement to be indicative of. This use of feature-of-interest differs from how other communities have applied this information profile. This difference has implications for data interoperability that will be examined.

URL: http://www.cuahsi.org

Final ID: NG33C-1516

Hierarchical structure of river networks revisited

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Body: River networks are known to exhibit a self-similar (s-s) structure which often serves as the basis for simulating hydrologic response across a range of scales. The exact nature of this s-s structure has been in debate and several models have been postulated to date including the Shreve model, the Tokunaga s-s model and the Random Self-similar Network (RSN) model. These models have subtle differences with important consequences in hydrologic response simulation studies. The purpose of the present study is to: 1) rigorously test the hypotheses of self-similarity and more strict Tokunaga self-similarity; 2) estimate the spatial distribution of Tokunaga parameters; 3) determine whether the distribution of side branches is geometric, as established for the Shreve random networks. We analyzed an extensive dataset, which includes 50 large American river basins sampling the different climatic and topographic regions of the country. Drainage areas span from 290 km^2 to 7200 km^2 while the Horton-Strahler orders of their river networks span from 6 to 9. The analysis was performed for all the 50 catchments as well as each of their sub-catchments, for a total of more than 1500 river networks. It was shown that 88% of the networks do exhibit self-similarity, 59% of the networks considered do exhibit Tokunaga self-similarity, and, for these, the pair of Tokunaga parameters showed a surprisingly low variability across sites. As for the geometric distribution of side branches, it was shown how the validity of such hypothesis clearly depends on the order of the network. We expect our study to provide a strong basis for improved river network modeling.

Final ID: NG33C-1519

Hydrologic Connectivity as a Window into Pattern Conditions and Formation Processes in Aquatic Ecosystems

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Body: Patterned aquatic ecosystems exhibit different types and degrees of hydrologic connectivity, from isolated open-water patches in some inland marshes, to cross-slope strings and flarks of striped fens, to along-slope ridges and sloughs of low-gradient subtropical wetlands, to dendritic channels of coastal marshes. The nature and degree of this connectivity are closely linked to landscape function. For example, hydrologic connectivity perpendicular to river channel thalwegs relates to the exchange of sediment and nutrients between channels and floodplains, whereas connectivity parallel to a dominant flow direction affects fish migration or the likelihood of contaminant transport. Characteristics of hydrologic connectivity reflect not only the results of landscape pattern but also the mechanisms responsible for pattern creation. Quantifying those connectivity characteristics provides a robust means to identify landscapes likely formed under a consistent set of processes or to compare the output of landscape simulation models to actual landscapes in order to determine whether the models capture the most relevant landscape formation processes. However, established methods for quantifying isotropic patch connectivity are often ill suited for strongly patterned landscapes or hydroscapes in which directional flow is important. Using graph theory principles, we developed two alternative indices of directional hydrologic connectivity: the maximum flow index (MFI) and directional connectivity index (DCI), which quantify the connectivity of flow paths along a particular axis of interest. The MFI is sensitive to the existence of any hydrologic connection along the direction of interest, whereas the DCI is sensitive to the linearity of connections along that direction. Curves of directional connectivity over a range of angular bearings provide a quantitative, information-dense representation of landscape structure that can be related to subtle differences in the physical-biological feedbacks driving landscape pattern formation. Case-study application of the DCI and MFI to simulated and actual images of the Everglades ridge and slough landscape revealed that directional hydrologic connectivity has declined significantly over the last seventy years, probably due to hydrologic perturbations. Connectivity responds more rapidly than slough area. Here and elsewhere, the DCI and MFI can serve as a window into landscape formation processes, early-warning indicators of aquatic landscape degradation, and indicators of landscape responses to restoration efforts.

Final ID: NG33C-1521

Self-Organized Intermittency (or Destruction) of Shallow Seabed Sorted Patterns

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Body: The instability mechanism and finite-amplitude interactions leading to the emergence of shallow seabed 'sorted bedforms'—100 m to km scale swaths of coarse sediment, sharply segregated from fine sand domains, and arranged in sometime striking patterns—has been addressed. Here we present the results of recent numerical-model experiments revealing unanticipated modes of pattern formation in the long-term evolution of fields of sorted bedforms. These experiments suggest that given long periods (years) of stationary hydrodynamic forcing, sorted bedform patterns would become progressively more organized, which would consequently lead to the destruction of the pattern. Given stationary forcing and constant sediment deposition or erosion rates, sorted bedform fields reach a steady state in which self-organized dynamics maintain conditions that are marginal for the maintenance of the pattern, producing spatio-temporal intermittency ('Self-Organized Intermittency'). If storms (large-wave events) punctuate the hydrodynamic forcing, the pattern intermittency disappears. However, the scale of the pattern that storm conditions tend to produce is larger than that produced by the calm-weather forcing, and alternating between long calm periods and short storms tends to produce a superposition of two pattern wavelengths, with each wavelength dominating at different times, and sometimes with a long-term drift toward the dominance of the larger-scale pattern.

In this model, sorted bedforms arise not from an interaction between topography (bathymetry), flow, and sediment flux, as in most morphodynamic systems, but from an interaction between seabed grain-size composition and sediment fluxes. Larger wave-generated ripples (decimeter to meter scale) form where the seabed is coarser, and these larger roughness elements cause stronger, larger-scale turbulence and therefore higher sediment fluxes in those areas. Higher saturated fluxes of fine sediment over coarse areas tends to winnow fine sediment from where the bed is coarser than average, and leads to preferential deposition where the bed is already finer. Previous experiments (Coco et al. 2007a) show that when the ratio of coarse to fine sediment in the seabed as a whole is too low, sorted patterns cannot form; wave-generated ripples do not reach sufficient size in areas of the seabed that are slightly coarser than the average to produce the increase in sediment flux with increasing bed coarseness that drives the sorting instability. In our recent investigations of long-term pattern evolution, increasing pattern organization is accompanied by a decreasing average proportion of coarse sediment in the active layer. This tendency toward fining of the active layer drives the pattern destruction or intermittency described above.

Comparisons with observed sorted bedform characteristics in various locations suggest that these processes may be relevant to the long-term evolution of these patterns in nature.

Final ID: OS33A-1631

Impact of Sea Level Rise on the Attenuation of Hurricane Storm Surge by Wetlands in Corpus Christi, TX.

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Texas has historically faced severe hurricanes with Ike being the most recent major storm example. It is believed that coastal wetlands might reduce the impact of the storm surge on coastal areas, acting as a natural protection against hurricane flooding, especially for small hurricanes and tropical storms. Considering the expected rise in the mean sea level, wetland composition and spatial distribution are also expected to change as the environmental conditions change along the coast. We analyzed a range of Intergovernmental Panel on Climate Change (IPCC) projections for sea level rise (SLR) to simulate wetland alterations and evaluate their impact on hurricane storm surge. The analyses was conducted for Corpus Christi Bay using a pre-validated, physically based, hydrodynamic model (ADCIRC) and a wind and pressure field model (PBL) representing the physical properties of historical hurricane Bret. The calculations were performed using an unstructured numerical grid with 3.3 million nodes covering part of the Atlantic Ocean and the entire Gulf of Mexico (resolution from 2000 km to 50 meters at the coast). Wetlands are represented in the numerical model through their influence on the frictional resistance proprieties and bathymetric changes. To characterize the wetland types and their spatial distribution along the coast, we used six different land use databases from the National Land Cover Dataset (NLCD) (1992, 2001), the National Wetlands Inventory (NWI) (1993) and the Coastal Change Analysis Program (C-CAP) (1996, 2001, 2006). The wetland degradation by SLR was spatially simulated using empirical relations for water levels/tides and ecosystem resilience. The choice of wetland database resulted in surge variations of less than 0.1 m in locations inside Corpus Bay. Preliminary studies considering IPCC scenarios (B1, A1F1, B1FI) for 2030 and 2080 plus predicted local subsidence showed that, although the SLR scenarios for 2030 did not affect surge considerably inside the bay (SLR increase removed after simulation), the greater degradation of the wetlands caused by SLR on the 2080 scenarios (0.80 m SLR + subsidence) resulted in surges on the order of 0.3 m higher for Hurricane Bret in selected locations. Future work includes performing analyses using different storm conditions (forward speed, central pressure and storm radius), additional and less conservative SLR scenarios, damage assessment and also include the effects of waves using the coupled version of ADCIRC with UNSWAN.

Final ID: OS33A-1636

1,100 years after an earthquake: modification of the earthquake record by submergence, Puget Lowland, Washington State

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Body: Crustal faults may pose a complicated story for earthquake reconstruction. In some cases, regional tectonic strain overprints the record of coseismic land-level changes. This study looks at the record of earthquakes at two sites in the Puget Lowland, Gorst and the Skokomish delta, and how post-earthquake submergence modified the paleoseismic records. The Puget Lowland is the slowly subsiding forearc basin of the northern Cascadia subduction zone. A series of active thrust faults cross this lowland. Several of these faults generated large (M7+) earthquakes, about 1,100 years ago and both field sites have submerged at least 1.5 m since that time. This submergence masked the geomorphic record of uplift in some areas, resulting in a misreading of the zone of earthquake deformation and potential misinterpretation of the underlying fault structure.

Earthquakes ~1,100 years ago uplifted both field localities and altered river dynamics. At Gorst, a tsunami and debris flow accompanied uplift of at least 3 m by the Seattle fault. The increased sediment load resulted in braided stream formation for a period after the earthquake. At the Skokomish delta, differential uplift trapped the river on the eastern side of the delta for the last 1,100 years resulting in an asymmetric intertidal zone, 2-km wider on one side of the delta than the other. The delta slope or submergence may contribute to high rates of flooding on the Skokomish River.

Preliminary results show the millennial scale rates of submergence vary with the southern Puget Lowland submerging at a faster rate than the northern Puget Lowland. This submergence complicates the reconstruction of past earthquakes and renders assessment of future hazards difficult for those areas that are based on uplifted marine platforms and other coastal earthquake signatures in several ways. 1) Post-earthquake submergence reduces the apparent uplift of marine terraces. 2) Submergence makes zones of earthquake deformation appear narrower. 3) The record of older earthquakes may have been submerged and destroyed by coastal processes. 4) Submergence leads to the burial and destruction of coastal deposits, e.g. tsunami deposits. 5) In areas where uplift alters drainage patterns, submergence may simply obscure the changes.

Final ID: OS33C-1679

Modeling sediment transport processes and residence times in the shallow coastal bay complex of the Virginia Coast Reserve

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Body: Patterns of sediment transport and particle residence times influence the morphology and ecology of shallow coastal bays in important ways. The Virginia Coast Reserve (VCR), a barrier island-lagoon-marsh system on the Eastern Shore of Virginia, is typical of many shallow coastal bay complexes that lack a significant fluvial source of freshwater and sediment. Sediment redistribution within the bays in response to storms and sea-level rise, together with the dynamics of marsh and lagoon-bottom plants, largely governs the morphological evolution of this system. There are also important feedbacks between sediment and ecosystem dynamics. This is particularly true in the VCR, which is relatively unaffected by human activities. As a step towards evaluating the impact of hydrodynamics on sediment and ecological processes in the VCR, a single unified model that accounts for circulation, surface waves, wave-current interaction, and sediment processes is employed. This three-dimensional unstructured grid finite-volume coastal ocean model (FVCOM) is validated with field observations of wind- and tide-induced water flow (water level and current velocities) in Hog Island Bay, centrally located within the VCR. Here, the resulting patterns of sediment transport and particle residence times over event and seasonal time scales are presented. Water and particle exchange within the VCR and between the VCR and the ocean is examined with the Lagrangian particle-tracking module in FVCOM. We focus on three bays with strongly varying bathymetry and coastline geometry, which are also located along a gradient of nitrogen input to the system. The results indicate that residence time of particles within the system vary greatly depending on the location of particle release, bay morphology, and wind conditions. The implications for morphologic evolution and ecosystem response to climate and land-use changes are evaluated.

Final ID: PA33A-1818

Water in the Balance: Changing Freshwater Availability as Viewed from Space

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8. Planning, Policy and Design, University of California, Irvine, Irvine, CA, United States.

Body: Over the last decade, satellite observations of Earth's water cycle, in particular, those from NASA's GRACE (Gravity Recovery and Climate Experiment) mission, have provided an unprecedented view of recent changes in freshwater availability. In particular, the human fingerprint of water management practices such as groundwater use and reservoir storage is abundantly clear, and raises many important issues for climate, water, food and economic security. Moreover, the worldwide depletion of groundwater aquifers and their transboundary nature points to the great potential heightened conflict in the very near future. In this talk we review the basics of how the GRACE mission observes world water resources, what new information the mission has provided since its launch in 2002, and what the implications are for the future of water availability. Several hotspots for water stress, including implications for regional security and conflict, will be highlighted.

URL: www.ucchm.org

Final ID: T33A-2371

An Evaluation of Neogene Sedimentation on the Surveyor Fan, Gulf of Alaska: Geochemical, Mineralogical, and Rock Magnetic Provenance Variation in Alaskan Abyssal Plain Sediments

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Body: Glaciated orogenic belts such as those of southeastern Alaska provide ideal environments in which to investigate climate-tectonic interactions because of significant glacigenic sediment production and transport along an active plate boundary. The sedimentary record of this interaction has a high potential for preservation in adjacent basins like the Gulf of Alaska because of a reduced transport distance from sediment source to deepwater sink. The Surveyor Fan in the northern Gulf of Alaska contains seismic stratigraphic evidence of a substantial shift in sedimentation type and source. Based on limited age control from DSDP Site 178 this shift occurs at ~1 Ma, which approximately correlates to increased glacial sediment input and accelerated exhumation of onshore terranes. This coincides with significantly increased global glaciation following the Mid-Pleistocene Transition (MPT). We hypothesize that the compositional changes in Surveyor Fan fine-grain sediments observed at Site 178 are related to intensified glaciation at 1 Ma, which resulted in focused erosion along the windward side of the St. Elias Range, as well as formation of cross-shelf sea valleys that isolated sediment transport pathways to the Surveyor Channel. Here, we address this hypothesis by developing preliminary source terrane signatures of fine-grained sediment and applying them to offshore sediments of the Surveyor Fan at DSDP Site 178. This is done by employing multiple analytical tools shown to be effective in previous provenance studies, including trace and major elemental geochemistry, quantitative mineralogy, and environmental magnetic properties. The results of these analyses indicate that the provenance of the likely source end-members (Orca and Valdez Groups of the Prince William Terrane, the Chugach Terrane, and the Kulthieth/Poul Creek Formations) along the windward side of the St. Elias Range can be differentiated using a combination of these techniques. Fine-grained sediments from the Orca and Valdez Groups (OVG) of the Prince William Terranes and the Kulthieth Formation of the Yakutat Terrane represent relatively more mafic and felsic compositional end members, respectively, with Chugach Terrane samples of intermediate composition, but with distinct environmental magnetic properties. Poul Creek Formation samples are most similar to the Kultieth, but with the addition from a more mafic source. Samples of the youngest onshore source, the Yakataga Formation, reflect a mixing of sources. DSDP 178 samples are of an intermediate composition between felsic and mafic end members, but with no apparent bulk fine-grain compositional difference between Upper and Mid-Lower Fan constituents. However, the variability in elemental composition is significantly decreased in Upper Fan sediments supporting the hypothesis that transport pathways to Site 178 were isolated following the MPT at ~ 1 Ma.

Final ID: EP33E-02

Quantifying Landscape Evolution From Terrestrial LiDAR and Environmental Process Monitoring

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Body: Landscape evolution models are often calibrated using field data that is inferred from current landscape configuration, from relict landforms such as terraces, or from spatially-averaged millennial or longer timescale landscape development rates. Recent approaches that include a combination of repeat terrestrial laser scanning (TLS) and deployment of environmental sensors can provide topographic and environmental data that can both inform many of the parameters of landscape evolution models and be used for comparison to model outputs. We present cm-scale models of landscape change and quantification of environmental forcing (precipitation, hydrology, etc.) from rapidly changing landscapes. These were generated from repeat TLS scans in badlands, severely burned first-order drainage basins, and ephemeral channels. From these maps, we can determine magnitudes and patterns of erosion and deposition, and directly link the observed changes to specific environmental forcing events. These observations of landscape change can be reliably made at a centimeter-level precision, across areas up to thousands of square meters. Additionally, environmental sensors can reliably measure precipitation, channel discharge, overland flow, soil moisture, and other factors that influence landscape change at very short timescales. By employing the latest in field monitoring techniques we can replace inference with quantification of surface processes. This has great promise in bringing together field and theoretical geomorphology.

Final ID: H33K-02

Accounting for heterogeneity of nutrient dynamics in riverscapes through spatially distributed models ***(Invited)***

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2. Complex Systems Research Ctr, Univ New Hampshire, Durham, NH, United States.

Body: Numerous types of heterogeneity exist within river systems, leading to hotspots of nutrient sources, sinks, and impacts embedded within an underlying gradient defined by river size. This heterogeneity influences the downstream propagation of anthropogenic impacts across flow conditions. We applied a river network model to explore how nitrogen saturation at river network scales is influenced by the abundance and distribution of potential nutrient processing hotspots (lakes, beaver ponds, tributary junctions, hyporheic zones) under different flow conditions. We determined that under low flow conditions, whole network nutrient removal is relatively insensitive to the number of hotspots because the underlying river network structure has sufficient nutrient processing capacity. However, hotspots become more important at higher flows and greatly influence the spatial distribution of removal within the network at all flows, suggesting that identification of heterogeneity is critical to develop predictive understanding of nutrient removal processes under changing loading and climate conditions. New temporally intensive data from in situ sensors can potentially help to better understand and constrain these dynamics.

Final ID: EP33D-03

Hydrodynamic and Morphodynamic indicators in a long tidal river: the Fly River example.

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Body: A two-dimensional numerical model is used to analyze the spatial and temporal variation of various hydrodynamic and morphodynamic indicators in the tidal reach of the Fly River (Papua New Guinea). The tidal range and water discharge largely varies along the river, decreasing from the apex toward the confluence with the Strickland River. As a consequence, also the maximum shear stress within a tidal cycle, significative from both a hydrodynamic and morphodynamic point of view, decreases in the upstream direction. Moreover, the model provides interesting information on how sediment fluxes are modulated by the tide, and how maximum concentration of suspended sediment varies along the tidal river. The importance of separately modeling both the cohesive and non-cohesive sediment is discussed.

Final ID: EP33E-03

Experimental testing of landscape models *(Invited)*

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Body: Morphodynamic experiments, whether scaled or unscaled, come into their own as a means of testing models as opposed to being used as analogs (i.e. models themselves) for field systems. In principle, a mechanistic model should contain within it explicit or implicit information on how the dynamics depends on scale, so unless a model depends on dynamics that does not occur at laboratory scales, it should be testable experimentally. The advantages of laboratory morphodynamics – repeatability, controlled conditions, (usually) shorter time scales, and more complete data sets – then outweigh the disadvantages of reduced scale and (often) exclusion of some of the processes that occur in the field. We will review examples of experimental tests of theoretical model predictions: qualitative and quantitative; deterministic and statistical; and in erosional and depositional landscapes. One additional underutilized possibility for experimental systems is as end members in explicit investigations of how morphodynamics changes across scale.

Final ID: H33L-03

The “How” of Environmental Modeling: Toward Enhanced Transparency and Refutability

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5. Civil Engineering, Colorado State University, Fort Collins, CO, United States.
6. Civil Engineering, University of California, Davis, CA, United States.
7. Civil Engineering, California State University, Chico, CA, United States.

Body: This work proposes that environmental models would be made more effective by establishing a base set of model fit, sensitivity, and uncertainty measures for which results are reported consistently, along with any other methods considered, and as innovations in model analysis continue. Indeed, there have been many innovations in model analysis in recent decades. While innovation is important, when every subfield within environmental modeling and almost every report uses different model analysis methods, the models are difficult to compare and the utility and limitations of the models are more often obscured than elucidated because few are familiar with the analysis method. Adoption of a base set of consistently used methods can be thought of as contributing to the “how” for achieving the model transparency and refutability encouraged by recent essays describing general goals and philosophies for environmental modeling. The base set of methods proposed here includes very computationally frugal methods that are most accurate when the model is sufficiently linear. Computationally frugal methods are advantageous when considering models with long execution times typical when considering environmentatl systems. Recent work indicates that many of the nonlinearities that have caused so much trouble in the past are numerical artifacts without validity to real world system dynamics. It appears that robust models absolved of such artifacts can often be fruitfully evaluated using linear methods. Second, situations in which the computationally frugal methods fail are generally apparent rather quickly, so little time is lost relative to the effort required by the computationally demanding methods. Comparisons of local methods to selected computationally expensive methods demonstrate the relative utility of both. Establishing a base set of linear and nonlinear methods provides a foundation that is expected to increase utility of environmental model results and interest in sensitivity analysis and uncertainty methods. The increased utility and interest would benefit all developers and users of environmental models, including policy makers and resource managers.

URL: http://wwwbrr.cr.usgs.gov/projects/GW_ModUncert/

Final ID: C33F-04

Subglacial topography and ice volume for western Canadian glaciers from a bed stress model and mass balance fields *(Invited)*

G. K. Clarke; [1]; *F. S. Anslow;* [2]; *A. H. Jarosch;* [3]; *V. Radic;* [1]; *B. Menounos;* [4]; *T. Bolch;* [5]; *E. Berthier;* [6];

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3. Centre for Climate & Cryosphere, Univ Innsbruck, Innsbruck, Austria.
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5. Institut für Kartographie, Technische Univ Dresden, Dresden, Germany.
6. OMP/LEGOS, Univ Toulouse & CNRS, Toulouse, France.

Body: We describe a method to estimate the thickness of glacier ice using information derived from the measured ice extent, surface topography, and surface mass balance. The approach assumes that ice within individual glacier flowsheds has a well-defined yield stress and that the bottom stress is simply related to the ice thickness and surface slope. The shortcomings of this yield stress approach are well known, among them that when the ice slope is small (as it is near dome-like flow divides) the ice thickness expression becomes singular. A completely different approach to estimate subglacial topography is to assume that thickness varies smoothly and that, between points of known thickness, it can be adequately estimated by simple interpolation. Our objective approach combines the strengths of both methods, is computationally fast, and fully automated. We use our ice-thickness method to estimate the subglacial topography for all glaciers in western Canada that lie south of 60N and from this we estimate the present ice volume for each glacier and the total volume of all glaciers in the region. The total glaciated area ca. AD2005 is 26,728 km^2 and we shall present the total ca. AD2005 ice volume and a map of estimated bed topography for the entire study region.

Final ID: EP33E-04

Experimental insights on the effects of varying discharge on fluvial landscape evolution

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Body: River floods are known to have large impacts on fluvial morphology as the capacity to carry water and rework sediment during these events is large. However, recent experimental findings are conflicting: some suggest that varying discharge contributes to a more single-thread pattern whereas others suggest that discharge variations cause multiple threads to be active, and yet others show no significant effect on the morphology. Our objective is to study the effect of varying discharge on experimental river patterns with otherwise similar conditions, and to quantitatively compare the resulting morphology and deposits.
Our experiments were conducted in a flume of 10x6 meter, which was split up into two separate fluvial plains (each 10x3 m). Fluvial landscape evolution was recorded by high-resolution line-laser scanning and digital Single Lens Reflex (SLR) camera used for channel-floodplain segmentation and particle size estimation. The bed sediment consisted of a poorly sorted sediment mixture ranging from fine sand to fine gravel.
First, a braided and meandering river pattern evolved for identical and constant boundary conditions, except that slightly cohesive silt-sized silica flour was added to the feed sediment of the meandering channel. A second set of experiments had an identical cycled discharge regime with a long-duration low flow and a short-duration high flow.The varying discharge largely affected the fluvial landscape by biasing the morphology towards the high flow conditions. This was reflected by an increase of the bar wave length with nearly a factor 2. Also, the depth of maximum erosion increased, which affects the preservation potential. The meandering and braided patterns responded differently to the floods. The noncohesive sediment combination with varying discharge results in a higher degree of braiding when compared to constant discharge. This was observed as a higher number of re-activating channels during high flow. In contrast, the silica flour acted as floodplain builder, which was more efficiently distributed during floods. As a result, the system with slightly cohesive sediment remained mostly confined to one migrating meandering channel that developed scroll bars, channel fills, splays and levees.
We conclude that the response to varying discharge depends on the availability and cohesion of fine floodplain-forming sediment in combination with the potential of high flows to re-activate residual channels.

Final ID: B33L-05

Modelling the carbon cycle though Neoproterozoic Earth system changes ***(Invited)***

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Body: The Neoproterozoic–Cambrian records major changes in geochemical proxies as a result of a profound reorganization of the Earth system. Extensive glaciations and the first oxygenation of the deep ocean with a shift from sulfidic/ferruginous conditions to more oxic conditions was accompanied by the radiation of the first animals. The reorganization was also recorded in enigmatic large-amplitude fluctuations in the isotopic composition of marine carbonate carbon ($\delta^{13}C_{IC}$), were only some are associated with major known glaciations. The carbon isotope events seem to grow in amplitude through the Neoproterozoic culminating in the Shuram anomaly - the largest in Earth history. The $\delta^{13}C_{IC}$ events are also accompanied by changes in the isotope composition of marine organic carbon ($\delta^{13}C_{OC}$), where the co-variation of $\delta^{13}C_{IC}$ and $\delta^{13}C_{OC}$ seems to evolve from markedly positive relationship over a subdued $\delta^{13}C_{OC}$ variation and an almost inverse pattern. There is limited understanding as to why or how the structure of these isotope events evolved over time and how these events may tie to the reorganization of the Earth system.

We use our published quantitative model of the Shuram anomaly to explore carbon cycle dynamics during the Neoproterozoic. By changing in pre-event atmosphere-ocean chemistry we explore which factors contribute to the observed patterns of the large Neoproterozoic carbon isotope events. In particular, decreasing atmospheric CO_2 and a slight increase of oxygen together with an increasing CO source from rising DOC concentrations results in progressively larger event amplitudes with changing co-variation between $\delta^{13}C_{IC}$ and $\delta^{13}C_{OC}$, culminating with the structure observed for the Shurum-Wonaka anomaly in the Ediacaran.

In our model, the carbon isotope excursions were driven by methane from sediment-hosted clathrate hydrate deposits. Being a powerful greenhouse gas, methane increased temperature and melted icecaps. These combined to produce a negative ^{18}O anomaly, while the higher temperatures also accelerated the weathering of continental rocks, drawing down atmospheric CO_2. Lowered CO_2, in turn, reduced the isotope fractionation between DIC and organic carbon during primary production if the pre-event CO_2 was relatively low. The ratio of CO_2 and CH_4 may at times have reached a critical transition where atmospheric organic haze with anti greenhouse properties developed. The lowered temperatures would have curtailed hydrate outgassing and lead to extensive glaciation at the nadir of the isotope event.

Final ID: IN33E-07

Collaboration Portals for NASA's Airborne Field Campaigns ***(Invited)***

D. M. Hardin; [1]; *H. Conover;* [1]; *A. Kulkarni;* [1]; *M. Garrett;* [1]; *M. Goodman;* [2]; *W. A. Petersen;* [2]; *M. Drewry;* [1]; *M. He;* [1];

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2. Earth Science Office, NASA MSFC, Huntsville, AL, United States.

Body: The University of Alabama in Huntsville (UAH), in collaboration with the Global Hydrology Resource Center, a NASA Earth Science Data Center, has provided information management for a number of NASA Airborne Field campaigns, both hurricane science investigations and satellite instrument validation. Effective field campaign management requires communication and coordination tools, including utilities for personnel to upload and share flight plans, weather forecasts, a variety of mission reports, preliminary science data, and personal photos. Beginning with the Genesis and Rapid Intensification Processes (GRIP) hurricane field campaign in 2010, we have provided these capabilities via a Drupal-based collaboration portal. This portal was reused and modified for the Midlatitude Continental Convective Clouds Experiment (MC3E), part of the Global Precipitation Measurement mission ground validation program. An end goal of these development efforts is the creation of a Drupal profile for field campaign management.

This presentation will discuss experiences with Drupal in developing and using these collaboration portals. Topics will include Drupal modules used, advantages and disadvantages of working with Drupal in this context, and how the science teams used the portals in comparison with other communication and collaboration tools.

Final ID: P34B-02

Secondary minerals and regolith profiles in basaltic rocks in northeastern US and in Svalbard, an Arctic Mars analogue site *(Invited)*

S. L. Brantley; [1]; *T. A. Yesavage;* [1]; *E. Bazilevskaya;* [1];
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Body: Data reported from the Mars Rovers, previous missions, and remote sensing have yielded a body of exciting evidence documenting that a Critical Zone nourished by water may also exist or have existed on Mars. However, the extent to which weathering is responsible for secondary mineral formation on Mars is not clear. We are investigating plagioclase and pyroxene weathering and precipitation of iron oxyhydroxides and clays in regolith profiles developed on rocks of basaltic composition from three different sites (Pennsylvania, Virginia, Svalbard), located in very different climatic conditions. Two of these sites were formed under a cool temperate climate, while the Svalbard profile is formed in a dry polar climate that has been identified as a Mars analogue. The two sites located in the northeastern US show similar rates of plagioclase dissolution, while slower rates were observed at Svalbard. Depth of weathering is also much greater in Pennsylvania and Virginia than in Svalbard, where weathering has only proceeded since the last glaciation. Nonetheless, weathering in Svalbard is accelerated by spalling of altered surfaces, presumably due to temperature cycling. We are using a variety of techniques including Fe isotope measurements to better understand secondary mineral precipitation in regolith. Knowledge of the climatic effects upon these processes on Earth can ultimately be applied to better understand weathering mechanisms on Mars.

Final ID: NG34A-03

Scaling Properties of Shoreline Change: Process Implications *(Invited)*

A. Murray; [1]; *E. Lazarus;* [2]; *A. D. Ashton;* [3]; *S. F. Tebbens;* [4]; *S. M. Burroughs;* [5];
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2. Senator George J. Mitchell Center for Environmental and Watershed Research, University of Maine, Orono, ME, United States.
3. Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA, United States.
4. Department of Physics, Wright State University, Dayton, OH, United States.
5. Department of Physics, University of Tampa, Tampa, FL, United States.

Body: Using shoreline-change measurements of two open-ocean reaches of the North Carolina Outer Banks, U.S.A., we explore an existing premise that shoreline change on a sandy coast is a self-affine signal, wherein patterns of change are scale-invariant. Wavelet analysis confirms that the mean variance (spectral power) of shoreline change can be approximated by a power law at alongshore scales from tens of m up to a few kilometers. In some systems, a power law reflects the presence of a unifying process or interaction that spans the scales of the power law. Classic examples include turbulent fluids, networks of interacting faults/Earthquakes, and fluvially sculpted landscapes. However, an approximately linear portion of a spectrum in a log-log plot does not necessarily indicate a scale-free, dominant process, as the shoreline-change spectrum exemplifies; distinct processes dominate different scale ranges within the range of the approximate power law. Why an amalgamation scale-dependent processes often produces an approximately linear portion of a spectrum remains an intriguing question.

The shoreline-change spectra also illustrates the point that deviations from approximate power-law scaling can also be interesting. At scales of kilometers to tens of kilometers, the spectra exhibit a maximum of the variance (not related to finite-domain-size effects). Both the magnitude of the variance in this broad peak, and the spatial scale at which that maximum occurs, increase when shoreline change is measured over longer time scales (up to decadal). The scaling relationship between the time and spatial scales of this peak suggest a large-scale diffusion of coastline shape (possibly driven by gradients in alongshore sediment flux related to large-scale coastline curvature). Recent analysis of shoreline curvature and change in curvature for shoreline changes spanning hurricane-related wave events shows that large-scale coastline-shape anti-diffusion can occur during extreme storms (possibly related to the oblique wave incidence during these storms and a consequent instability in large-scale coastline shape). This storm-related coastline roughening is apparently counteracted in the longer term by coastline smoothing (possibly by gradients in alongshore sediment flux arising from the long-term wave climate).

Comparing the time-scale-dependent magnitude of shoreline-change variance at scales greater than a few kilometers with the time-independent variances at smaller scales suggests that interactions occurring on large scales produce cumulative changes in shoreline location (e.g. long-term erosion)—rather than the much better studied processes causing shoreline changes on smaller scales.

Final ID: C34A-04

Projections of the climate-forced deglaciation of western Canada using a regional glaciation model *(Invited)*

G. K. Clarke; [1]; *F. S. Anslow;* [2]; *A. H. Jarosch;* [3]; *V. Radic;* [1];

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3. Centre for Climate & Cryosphere, Univ Innsbruck, Innsbruck, Austria.

Body: Over the last century, the mountain glaciers of Alberta and British Columbia, Canada, experienced substantial mass wastage. This trend is expected to continue through the 21st century and cause a dramatic decrease in the number, area, and volume of glaciers. We are completing a modeling study that simulates the dynamic response of all (>17,000) currently-existing glaciers to climate-forced changes in their mass balance. As inputs we require a digital elevation model of the deglacierized surface topography and temporally-evolving temperature and precipitation fields, downscaled to the 200 m resolution of the regional glaciation model. For the time span 1979–2005 we derive our downscaled climate from the North American Regional Reanalysis (NARR). The downscaled temperature assumes a time- and space-varying thermal lapse rate which is calculated from the NARR. The downscaled precipitation uses the linear theory of orographic precipitation together with NARR wind velocity and moisture content fields. Where necessary we apply bias adjustments to the precipitation field based on comparison with station data. The downscaling methods and their validation are fully described in Jarosch et al. [*Clim. Dyn.*, 2010]. For the pre-NARR interval 1902–1978, we base our climate forcing on the Climate Research Unit TS2.1 dataset and for future projections (2005–2100) we use GCM output for the A2, A1B, and B1 emissions scenarios. A recent assessment of GCM performance for northwestern North America [Radic and Clarke, in press] has led us to favor six GCMs among all GCMs from the IPCC AR4. It is not challenging to simulate climate-forced ice dynamics but extremely challenging to do this properly. The greatest sources of error are associated with uncertainty in the mass balance model and bed topography. A robust conclusion of our study is that more than 50% of existing ice volume will disappear by 2100.

Final ID: B34A-05

CLIMATE IMPACTS ON RESERVOIR OPERATIONS FOR FISH SUSTAINABILITY ON THE SACRAMENTO RIVER

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Body: The propagation of the endangered winter-run Chinook salmon fishery on the Sacramento River in California is an ongoing concern that may be exacerbated by climate change. The construction of numerous dams on the river (most notably, Shasta Dam and Reservoir in 1945) prevented the salmon from reaching their native cold-water spawning habitat, causing populations to decline. Since 1989, operations at Shasta Dam have attempted to provide cold-water habitat downstream of the dam to promote salmon spawning. We have partnered stochastic weather generation with two-dimensional hydrodynamic modeling of reservoir operations to examine the feasibility of meeting downstream temperature targets for the salmon fishery. Stochastically generated climate and inflow scenarios created with historical data from 1994 to 2007 are input into a CE-QUAL-W2 model of the reservoir that can simulate reservoir operations, including selective withdrawal from multiple gates to meet water delivery and temperature targets. Results of these simulations will be presented. Ultimately, simulated outflows and release temperatures from the reservoir will be used with statistical models of stream temperature to examine the feasibility of meeting Sacramento River temperature targets at Balls Ferry under different future climate scenarios. We also plan to partner reservoir simulation results with bioenergetics scope for growth models to assess impacts of climate and reservoir operations on upstream and downstream fisheries. The goal of the integrated modeling system is to provide seasonal and longer time-scale planning tools to operators on the river that will assist in the maintenance of cold-water supply for salmon. Once complete, the framework will allow testing of alternative operating criteria to meet the thermal requirements on the river.

Final ID: B34D-06

Mutli-Scale Synthesis and Terrestrial Model Intercomparison Project – A Systematic Approach for Evaluating Land-Atmosphere Flux Estimates *(Invited)*

D. N. Huntzinger; [1]; *W. M. Post;* [2]; *K. M. Schaefer;* [3, 4]; *A. R. Jacobson;* [4, 5]; *C. R. Schwalm;* [1]; *R. B. Cook;* [2]; *A. M. Michalak;* [6];

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5. Earth System Research Lab, National Oceanic and Atmospheric Administration, Boulder, CO, United States.
6. Department of Global Ecology, Carnegie Institution for Science, Stanford, CA, United States.

Body: Our understanding of how carbon is exchanged between terrestrial ecosystems and the atmosphere is gained from direct observations and experiments, as well as through modeling activities. Although models vary in their specific goals and approaches, their central role within carbon cycle research is to provide a better understanding of the mechanisms currently controlling carbon exchange. The multi-scale synthesis and intercomparison project (MsTMIP) has an overall goal of providing feedback to the TBM community to improve the diagnosis and attribution of carbon fluxes at regional and global scales. This project builds upon current and past synthesis activities by developing an integrative framework that all TBMs can use as a tool to continually evaluate overall model performance against a consistent set of observational constraints. The ability of the models to partition changes in estimated carbon flux among drivers such as climate variability, nutrient limitation, land management, and recovery from historical land use and disturbance is fundamental to understanding the terrestrial carbon cycle and improving terrestrial biospheric models. Therefore, in combination with baseline simulations, or a model's best estimate of carbon flux, the MsTMIP activity includes a series of sensitivity simulations that are designed to isolate the impact of specific drivers on model results. Over 18 different TBMs are participating in the study and will be submitting simulation results for the time period 1980 to 2010. A key component of the MsTMIP activity is to evaluate model performance against observations, inversions, and other model estimates through a set of quantitative performance measures and metrics based on inventory and flux tower-based observations. By prescribing standard spin-up procedures, input data sets, and output parameter formats, we quantify and diagnose any biases and uncertainties in TBM estimates of regional and global carbon budgets resulting from differences in model formulation and parameterization. This information will ultimately aid in improving model predictions of land-atmosphere carbon exchange.

URL : http://nacp.ornl.gov/MsTMIP.shtml

Final ID: GC34B-08

Accelerating the Development of Land Surface Hydrological Modeling to Address Societal Needs: Application of an Integrated Data and Modeling Framework to California *(Invited)*

J. S. Famiglietti; [1, 2]; *M. Lo;* [1]; *H. Kim;* [1]; *J. Edman;* [1]; *B. F. Sanders;* [4, 1]; *S. Castle;* [1]; *Z. Liu;* [2]; *N. L. Miller;* [3, 1]; *R. S. Singh;* [5, 1]; *D. W. Valentine;* [6, 1]; *I. Zaslavsky;* [6, 1];

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5. Geography, University of California, Berkeley, Berkeley, CA, United States.
6. San Diego Supercomputer Center, University of California, San Diego, San Diego, CA, United States.

Body: While the development of hydrological and land surface models has progressed rapidly over the last few decades, a significant acceleration in model development is still required in order to address critical issues of water, energy and food availability and security. In particular, major advances are needed in the areas of observations (e.g. of water cycle variability and change, and of subsurface soils and hydrogeology), model development (e.g. of models that integrate the major components of the human and managed water cycles), data assimilation (e.g. of algorithms that can readily incorporate in situ and remote observations of asynchronous space-time frequency) and of a framework for integrating models and data (e.g. for access to data and simulation results, for running models, and for performing analyses). In this presentation we discuss these needs in detail, and highlight recent efforts in California to develop a prototype framework that can be applied across scales up to continental and global scales.

URL : www.ucchm.org

Final ID: A41D-0115

Connecting hydrology and suspended sediment transport with precipitation in the Nepal Himalayas *(Invited)*

C. Andermann; [1, 3]; *S. Bonnet;* [1, 2]; *A. Crave;* [1, 2]; *P. Davy;* [1, 2]; *R. Gloaguen;* [3]; *L. Longuevergne;* [1, 2];

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Body: The transfer of precipitation into rivers involves temporary water storage in reservoirs such as soils, groundwater, snow and glaciers, where different residence times influence the hydrological cycle. Precipitation in the Nepal Himalayas is strongly controlled by orographic effects, and describes a strong north-south (10 fold) rainfall gradient. Around 80% of the annual rainfall occurs during the monsoon season (June-September). The spatio-temporal distribution of precipitation has numerous consequences for surface processes and water availability, and the very clear seasonality - monsoon and non-monsoon - exerts a very distinct annual hydrological cycle. Suspended sediments volumes in rivers, draining large orogens, are mainly controlled by the transport capacity of rivers and by the mobilization of material in the upstream areas, for example by landsliding. In particular, the occurrence of erosion and associated highly concentrated suspended sediment fluxes in rivers are closely tied to monsoon precipitation.
In this contribution we discuss the dependency of suspended sediment concentration and hydrology on precipitation, in the major drainage basins of the Nepal Himalayas. First, we show that the APHRODITE (Asian Precipitation-Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources) precipitation dataset is the best available for this region. Second, we show analysis of daily hydrological and climatological records (~30 yr dataset) for the major drainage basins of the Nepal Himalayas (12 gauging stations), which reveal an annual anticlockwise precipitation-discharge hysteresis loop. This loop we observe in both glaciated and unglaciated catchments. This implies the temporal storage capacity of water in a transient reservoir, whose estimated characteristic response time (~45 days) and diffusivity (~1 m^2/s) is typical for fractured basement aquifers. The storage capacity represents ~25 km^3 for all of Nepal, whereas we also estimate snow and glacier melt contribution to be ~14 km^3/yr. Third, on the basis of these information we discuss the suspended sediment fluxes and their relation with precipitation and flood events. We explain the reason and cause of an observed annual discharge-sediment concentration hysteresis effect and show that sediment fluxes and storm discharge are linearly related. From the clear relationship between storm discharge and sediment fluxes we propose a new sediment transport rating model, allowing us to deduce basin wide denudation rates, ranking from 0.1 to 5.9 mm/yr. Last we discuss these denudation rates in the context of basin characteristics and propose a new conceptual model of mobilization and transportation of material within the monsoonal discharge cycle.

Final ID: A41D-0119

Mountain growth, orographic precipitation, and the formation of high-plateaus. Insights from numerical modeling experiments *(Invited)*

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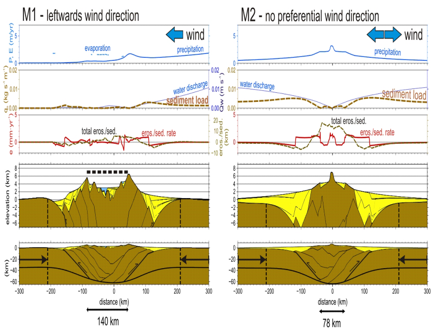
Body: Orographic precipitation is thought to exert a significant control on the growth of orogens, namely on the distribution of tectonic uplift and deformation in the multi-million-year time-scale. Computer tectonic models based on simple physical laws predict that the concentration of erosional surface mass removal in either side of an orogen can have a significant impact on the how tectonic deformation propagates within the orogenic building. Proxies or simple formulations of climatic processes such as precipitation and evaporation are key to such coupled tectonic/climatic models.

Intramountain high plateaus are extreme cases of climatic control on sediment flow, because they often consist of internally-drained (endorheic) basins that trap most erosional products within the orogen. Such intramountain sediment accumulation leads to high-plateaus characterized by high topography and, in spite of the compressional tectonics, low relief. The development of high-plateaus has been extensively studied in relation to the tectonic setting and to inherited structures in the crust, but in this presentation I will concentrate on the potential climatic controls. Computer modeling results will be shown suggesting that a preexisting dry climate, through its effects on surface transport and orogenic evolution, may significantly modify tectonic deformation and contribute to the later formation of a high plateau. This is due to the following feedback: (1) dry climatic conditions at the early stages of orogenesis favor the tectonic defeat of rivers draining the orogen, promoting internal drainage (endorheism); (2) endorheism extends the life of intramountain basins maximizing the mass trapped within the orogen, rising lithostatic stress underneath and expelling fault deformation towards the flanks of the orogen; and (3) this propagation of deformation further isolates the central parts of the orogen from incoming precipitation, reinforcing sediment trapping and topographic leveling of the intramountain region. This suggests that internal drainage and high-plateaus might be a natural stage of orogenesis undergoing dry climatic conditions. Data reporting dry climate prior to the Altiplano suggest that aridity may be a cause for its growth, rather than just as a consequence of it.

URL: https://sites.google.com/site/daniggcc/research-interests/high-plateaus



Comparison between the evolution predicted by two tectonic models differing only in their climatic setting: orographic precipitation (left) and non preferential wind direction (right). Note the formation of an extensive high plateau in the model to the left, despite all tectonic parameters are identical to the model in the right side. The amount of tectonic shortening imposed to both models is the same, but the period of activity and the location of each fault is sensitive to where erosion and sedimentation occur, and therefore to the distribution of precipitation and evaporation.

Final ID: EP41D-0637

A Simple Model for the Post-Orogenic Evolution of Mountain Ranges and Foreland Basins

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2. Cooperative Institute for Research in Environmental Sciences (CIRES) and Department of Geological Sciences, University of Colorado, Boulder, CO, United States.

Body: Many mountain ranges show a surprisingly dynamic pattern of landscape evolution during their post-orogenic phase. Although one might expect a simple, monotonic decline in relief, erosion rate and sediment flux over time, evidence from several inactive mountain ranges shows alternating sequences of deposition and erosion in the adjacent foreland basins, accompanied by variations in relief and exhumation rate in the ranges themselves, as recorded by thermochronology data. Examples include the Rocky Mountains of Colorado, the Pyrenees, the Western Alps, and the Atlas Mountains. Here, we explore the possible origins of post-orogenic landscape dynamics using a simple mathematical model of a range and basin pair, which are coupled through the mass fluxes in and out of the basin (controlled by the range and basin relief as well as their erosional response times) and the flexural isostatic response of the lithosphere to range thickening and erosion. The analysis highlights the importance of mass balance. In particular, a switch from basin erosion to renewed sedimentation requires either an increase in sediment influx from the range, a decrease in sediment outflux beyond the basin margin, or both. Although it is widely understood that post-orogenic changes in erosion and sediment flux can have multiple causes (including climate change, regional tectonic uplift or tilting, or changing lithology as rocks are exhumed), an important implication of our analysis is that the impact of such changes must differ in sign or magnitude between the range and the basin in order to be recorded. In particular, renewed sedimentation in the basin, without an obvious tectonic control, requires the ratio of range to basin response times to decrease sufficiently to offset the increase in basin relief due to the isostatic response to range erosion. This requirement places an important constraint on viable explanations for alternating sequences of deposition and erosion in a decaying mountain-basin pair.

Final ID: EP41D-0648

Reconciling Geodetic Deformation and Long-term Exhumation Rates Across the Western Greater Caucasus

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Body: Low modern geodetic strain rates and minimal instrumentally recorded seismicity in the western Greater Caucasus contradict the the high topography, deep exhumation, and young low-temperature thermochronometric ages indicative of active tectonic deformation in this mountain range. We use new and existing low-temperature thermochronometric data to show that the rate of present-day convergence across the range is sufficient to sustain observed rates of long-term exhumation and topographic growth. Thus, it is possible that the western Greater Caucasus has existed in an erosional steady state since shortly after the onset of exhumation of the range in Pliocene.

We employ a Markov chain Monte Carlo algorithm to estimate the parameters of a thermokinematic model constrained by thermochronometric data and a focal mechanism solution from the 1991 Racha earthquake. We find that the thermochronometric data are best fit by exhumation commencing at ~4 Ma and driven by 3-5 mm/y of overthrusting on the Main Caucasus thrust dipping 40-45° at the surface and becoming flat at a depth of 15-20 km. This long-term exhumation model was compared with active rates of convergence in the western Greater Caucasus using an elastic half-space deformation model to estimate the geometry and rate of slip on a buried dislocation that best fits the observed geodetic velocity field. The estimated active slip of 4-7 mm/y is comparable to the long-term rate of overthrusting and is, therefore, sufficient to produce the observed rock uplift. Up to 4 mm/y excess of active convergence may potentially be consumed by underthrusting of the Transcaucasus or on faults south of the Main Caucasus thrust.

We conclude that high rates of rock uplift observed in the western Greater Caucasus are the result of focused shortening occurring on a single fault. This differs from the deformation style of the eastern Greater Caucasus, where a larger amount of shortening is distributed across the width of the range with slip occurring on numerous north and south-verging thrusts, resulting in lower uplift rates, lower relief, and lower exhumation. We hypothesize that this difference in tectonic styles is a result of differences in the lithosphere of the eastern and western Transcaucasus. To the west, the Greater Caucasus are juxtaposed against an ancient strong and buoyant micro-continent, while on the east, they are faulted against a Jurassic island arc that is likely to have a thinner, less competent lithosphere.

Final ID: GC41C-0840

Prediction And Predictability Of Trend In Temperature Change In China Using Bayesian Multimodel Ensemble Approach

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Body: Climate models are being used to simulate climate of the past and to predict that of the future. Different models provide different estimates of the climate. Many studies have indicated that multimodel ensemble approach would provide climate prediction with better skills. This study uses the Bayesian multimodel approach developed by Duan and Phillips (2010, JGR) to study the trend in temperature change in China using climate simulations from the Climate Model Intercomparison Projection Phase 3 (CMIP3). Observed data from 1960-1999 are used for this study. The trend is estimated based on change in 10-year moving average temperature. Bayesian weights are computed for each 10-year period. The change in Bayesian weights is analyzed. The suitability of using the weights computed from the past data to predict temperature in the future is evaluated.

Final ID: GC41D-0859

Applying land surface – atmosphere interactions to improving wind energy forecasting systems

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Body: Wind energy has emerged as an important source of renewable energy. Accurate forecasts of wind speeds are critical for harnessing energy from wind effectively. We present an approach for improving wind speed forecasts by evaluating uncertainty in observable quantities, and analyzing how these uncertainties propagate between coupled fields. This three-part approach employs the fully-coupled hydrologic and atmospheric modeling system ParFlow-WRF to dynamically simulate feedbacks between the subsurface, surface and atmosphere to generate physically-based wind speed forecast ensembles. We use a semi-idealized ensemble simulation to demonstrate that by reducing uncertainty in subsurface hydraulic conductivity – a controlling factor for soil moisture distribution – we reduce uncertainty in soil moisture, latent heat flux and wind speed. We further examine a non-idealized simulation ensemble using forcing data from the North American Regional Reanalysis at a location near the west coast of the United States comparing model simulation results with observed data and generating probabilistic wind speed forecasts based on the deterministic ensemble forecast outputs to improve forecast utility. We also perform a spatial analysis on these results using cross-variograms showing spatial cross-correlation between simulated results for hydraulic conductivity and soil moisture distribution; soil moisture and latent heat flux; and latent heat flux and wind speed. Finally, we analyze propagation of uncertainty and sensitivity of subsurface, surface and atmospheric variables including soil moisture sensible and latent heat fluxes, temperature and wind speed using an ensemble Kalman filter data assimilation technique to develop methods for optimizing data collection plans, both spatially and temporally.

Final ID: H41C-1040

How Much Do Initial Conditions Really Matter?

Effects of Model Spin-Up on Coupled Groundwater–Surface Water Simulations

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Body: Spatially distributed observations of pressure head or soil saturation are rarely available to initialize numerical models. As a result, transient simulations are commonly initialized by driving the model repeatedly over a given period until the model reaches an equilibrium state. This type of "spin-up" approach notably ignores the transient conditions preceding the study period, resulting in biased initial conditions. While previous work has clearly demonstrated that biases in initial conditions affect shallow soil moisture and land-atmosphere fluxes in land surface models, effects of model spin-up on coupled surface-subsurface watershed simulations has not been previously quantified.

Here we evaluate the impact of model spin-up on simulated groundwater storage, stream discharge, and land surface water and energy budgets in the fully-integrated groundwater–surface water–land surface model ParFlow. We compare multi-year transient simulations and seasonal ensembles simulations of the Little Washita watershed for three initializations, including a multi-year transient spin-up, an equilibrium spin-up, and a simple interpolation-based initialization scheme based on topographical considerations. Biases in groundwater storage persist for several years, resulting in persistent biases in streamflow and evapotranspiration. Idealized cases are used to further illustrate sensitivities of simulated streamflow and land-atmosphere fluxes as well as model calibration to subsurface initialization. Results highlight the critical need for improved model initialization for advancement and application of integrated hydrologic modeling.

Final ID: H41I-01

A Comparison of Statistical and Dynamical Downscaling of Winter Precipitation Over Complex Terrain

E. D. Gutmann; [1]; *R. Rasmussen;* [1]; *C. Liu;* [1]; *K. Ikeda;* [1]; *D. J. Gochis;* [1]; *M. P. Clark;* [1]; *J. Dudhia;* [2]; *G. Thompson;* [1];

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2. MMM, NCAR, Boulder, CO, United States.

Body: Statistical downscaling is widely used to improve spatial and or temporal distributions of meteorological variables from regional and global climate models. This downscaling is important because climate models are spatially coarse (50-200km), and often misrepresent extremes in meteorological variables such as temperature and precipitation that are important to hydrologic models. However, these downscaling methods rely on current estimates of the spatial distributions of these variables, and largely assume that the small-scale spatial distribution will not change significantly in a modified climate. Here we compare data typically used to derive spatial distributions of precipitation (PRISM) to a high-resolution (2km) weather model (WRF) under current climate in the mountains of Colorado. We show that there are regions of significant difference in November-May precipitation totals (~100%) between the two, and discuss possible causes for these differences, including a new observation which shows WRF to be substantially more accurate in at least one location. We then present a simple statistical downscaling based on the 2km WRF data applied to a series of regional climate models from the North American Regional Climate Change Assessment Program (NARCCAP), and validate the downscaled precipitation data with observations at 65 SNOw TELemetry (SNOTEL) sites throughout Colorado for the winter seasons from 1988 to 2000. Finally, we use this statistical downscaling method to compare precipitation from a 36km model under an imposed warming scenario to dynamically downscaled data from a 2km model using the same boundary conditions. While the statistical downscaling improved the domain average precipitation and spatial distribution compared to the original 36km model, the changes in the spatial pattern of precipitation did not match the changes in the dynamically downscaled 2km model ($r^2=0.05$). This points to a serious deficiency in current statistical downscaling techniques. We suggest that it is possible to derive a better statistical downscaling from a dynamically downscaled model than it is from observations alone by leveraging additional model data such as the 500mb height, upper level wind direction, and vertical temperature gradients.

Final ID: C41F-06

An Improved Fractional Snow Covered Area Parameterization for the Community Land Model and its Effects on Simulated Climate.

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1. NCAR, Boulder, CO, United States.

Body: Fractional snow covered area (FSCA) represents unresolved spatial variability of snow cover within a grid cell of the Community Land Model (CLM), the land component of the Community Earth System Model (CESM). Measured values of FSCA are typically significantly higher during the snow accumulation season than during the melt season. Using satellite observed FSCA from MODIS, we demonstrate that the current parameterization in CLM fails to capture the asymmetry in FSCA during accumulation and depletion events. We show that an improved formulation can capture the observed behavior, leading to lower FSCA values during the melt season. In this presentation, we will describe the new FSCA parameterization and its effects on the fluxes of energy and moisture between the land and atmosphere in simulations performed with CLM and CESM.

Final ID: C41G-06

Surface and Subglacial Measurements of a "Spring Event" at Engabreen, Norway

P. L. Moore; [1]; *K. A. Christianson;* [2]; *N. R. Iverson;* [1]; *J. Winberry;* [3]; *D. O. Cohen;* [1]; *S. Anandakrishnan;* [2]; *M. Jackson;* [4];

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2. Geosciences, Penn State University, University Park, PA, United States.
3. Geological Sciences, Central Washington University, Ellensburg, WA, United States.
4. Norwegian Water and Energy Directorate (NVE), Oslo, Norway.

Body: Diverse instrumentation on the surface and at the bed of Engabreen, Norway, recorded the glacier's response to a large spring melt event in May 2011, shortly after the start of a warm period. A static GPS station on the lower part of the ablation area recorded 0.4 m of uplift peaking around 2100h GMT on day 130. Approximately 1500 m upglacier from the GPS station, large excursions were recorded in subglacial instruments near a subglacial access point, beginning at approximately 0400h GMT the following morning. At the subglacial access point, basal water pressure initially declined rapidly by 0.2 MPa and then climbed steadily 0.5 MPa, reaching or exceeding local ice overburden pressure for several hours before slowly returning below overburden. During the water-pressure low, shear stress on a smooth granite tablet installed flush with the bed surface increased by only a few kilopascals, consistent with prior measurements indicating that ice-bed friction is only weakly dependent on effective stress.At the onset of this water-pressure excursion, seismic energy recorded in a broadband instrument a few meters from the subglacial access point increased abruptly by two orders of magnitude and remained elevated for the remainder of the measurement period. Most of the events accounting for the increased activity had rapid onset, short period, and much high-frequency content, suggesting that ice or rock fracture was the source. This interpretation is supported by an increase in acoustic emissions from the rock tablet at the bed surface. These measurements may describe a "spring event" in which an inefficient linked-cavity drainage system is overwhelmed with an input of water, causing cavity expansion, glacier uplift, and the eventual development of a more efficient arborescent drainage system.Instruments in the the rock panel,which is located on a flat portion of the bed away from large cavities, initially recorded a decline in water pressure and an increase in shear stress as adjacent cavities were expanding, either due to uplift of cavity roofs or increased sliding speed. The increase in seismic and acoustic activity during this period may indicate enhanced erosion and/or debris comminution accompanying the spring event.

Final ID: EP41E-05

Scaling of Turbidity Currents and Riverine Flows for Laboratory Experiments: similarities and differences ***(Invited)***

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2. Ven Te Chow Hydrosystems Laboratory, University of Illinois, Urbana, IL, United States.

Body: Riverine flows are commonly studies in the laboratory with the help of Froude scale models. While Froude scaling ensures similarity between model and prototype regarding flow velocity magnitude and distribution, the presence of a movable erodible bed makes it necessary to use another criterion to ensure similarity of sediment transport. This results in the need to use material that has a smaller specific gravity than the sediment in the protototype (e.g. crushed walnut shells, coal). Often times the model has to be "tilted" in order to have measurable flow depths and sediment transport. However, scale effects can still manifest themselves through the development of bedforms in the model that do not correspond to those observed in nature for the equivalent flow conditions. On the other hand, turbidity currents, capable of transporting sediment for very long distances in lakes, reservoirs and the ocean, have to be modeled with help of a densimetric Froude number or equivalently the Richardson number. Unlike the case of riverine flows, light weight materials can not be used to model turbidity currents since this would result in volumetric concentrations that are too large and make the suspension non-dilute. Examples of small scale models of the Tanana River in Alaska and lake sedimentation by turbidity currents generated by the disposal of mining tailing in Labrador, Canada, will be presented. Interpretation of physical modeling results and potential scale effects will be discussed together with some of the challenges associated with physical modeling of sediment transport phenomena.

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Final ID: EP41E-06

Unscaled experiments in morphodynamics ***(Invited)***

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Body: It has been clear for some time that because of limitations involving sediment grain size, cohesion, and the physical properties of water it is not feasible to create rigorously scaled experiments of any but a very narrow range of morphodynamic systems. Yet experimental studies of a many kinds of morphodynamic phenomena proliferate, largely because they exhibit forms and behaviors similar to those seen at field scales, which themselves often show similarity over many orders of magnitude in scale. This is a kind of natural similarity across scales (scale independence) that is quite distinct from similarity imposed by forcing the governing dimensionless variables to match. The main challenges these observations lead to include: (1) the origin and limits of natural scale independence and (2) the relation of what we term external scale independence (similarity of systems of differing overall scale) and internal scale independence (similarity of different parts of one system at different scales).

Final ID: EP42A-01

Patterns and processes in landscapes: Surprises from Earth and beyond *(Invited)*

T. Perron; [1];
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Body: Patterns in landscapes have enthralled geologists for more than a century, for both their visual appeal and the expectation that they record the underlying processes that shape Earth's surface. Until recently, however, direct comparisons between theory and topographic observations have been rare due to a scarcity of high-resolution topographic measurements, a lack of constraints on long-term process rates, and the difficulty of describing the nonlinear dynamics of evolving landscapes in a way that is both flexible enough and simple enough to make testable predictions. New developments are changing this situation. Acquisition of meter-resolution topographic data for a growing number of sites has allowed measurements of patterns and characteristic scales in landscapes, providing a clear target for models of landscape evolution. Models are efficient enough to make predictions of landscape form under simplified but reasonable combinations of processes and boundary conditions. And measurements of long-term erosion rates make it possible to calibrate some models. I will describe several surprising results that have emerged from these recent developments. First, topography driven by incising river networks often appears fractal, but some of the most revealing characteristics of landscapes are features that break this scale invariance, such as quasi-periodic landforms, tributary networks that form at a characteristic minimum scale, and asymmetric landforms generated by climate gradients. Second, studies of transient landscape evolution are revealing the mechanisms by which these patterns emerge, and some of the mechanisms are strikingly similar to conceptual models proposed many decades ago. Principles drawn from fluid dynamics provide a unifying framework for comparing landscape patterns with model predictions across landscapes with similar landforms but varied climatic and geological contexts. Third, both models and measurements suggest that landforms can have multiple equilibrium states, which can lead to hysteresis in properties as basic as drainage density. There may be fundamental limits to how much we can read from a landscape. Finally, spacecraft missions have revealed planetary landscapes apparently shaped by erosional mechanisms that also occur on Earth, which provide a far-reaching test of our ability to connect landscape patterns with processes. Analyses of drainage networks on Titan show how even images of landforms, when combined with theory constrained by measurements on Earth, can be used to estimate characteristics ranging from short-term rainfall rates to long-term erosional exhumation. One of the most substantial challenges that remains is to close the gap between the bulk parameters typically used in models, which we are now beginning to relate to topographic patterns, and measurable landscape characteristics such as rock type, rainfall distribution, and species composition. Field and laboratory studies are narrowing this gap, and the efforts I will describe provide a framework for exploring more direct connections among local characteristics, external forcing, and emergent patterns in landscapes.

Final ID: H42B-01

Remotely-Sensed Estimates of Regional and Global Evaporation and Latent Heating *(Invited)*

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4. Dept. of Civil and Environmental Engineering, Princeton University, Princeton, NJ, United States.

Body: Remote sensing of regional-to-global scale evaporation, evapotranspiration and latent heat (ELH) fluxes remains a critical research area for closing water and energy budgets, for characterizing interannual variability and long-term water cycle change, and on land, for regional-scale water management. In this presentation we report on large-scale estimates of oceanic and terrestrial ELH derived from remote sensing and from integrating remotely-sensed observations with models of surface energy balance and land surface processes. Geographical and interannual variations are discussed, as is the potential for identifying emerging longer-term trends. Differences in estimation approaches give rise to considerable inter-model differences. However, differences between model estimates are far smaller than the difference between the observation based ELH estimates described here, and those from IPCC ensemble simulations. Implications for water cycle acceleration and its characterization in climate models are discussed.

URL : http://www.nasa-news.org/

Final ID: H42D-01

The water-energy-food-climate-economics nexus: solving hunger and resource scarcity *(Invited)*

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Body: A nexus refers to the core or to interconnectivity across issues. Addressing the boundary interactions of traditional sectors in an interconnected world as human activities change the physical boundaries of land and climate is an emerging academic and governance discourse. Through contrasting examples from the US and India, I shed light on the descriptive aspects of these connections and feedbacks that define potential impacts or traps for societies, and ponder whether a massive conceptual or numerical Earth System Model can help inform outcomes, or whether there are dominant links at particular scales (physical, social, economic or biological) that characterize the emergent dynamics and define critical equilibrium or transient solutions in certain places. However, the real question is what next given the definition of the nexus? Here, I argue that given the current valuation and management structure of different resource sectors and the associated information flows and sensitivities, the interlinked energy-climate issues can emerge as useful drivers of improved productivity in water-food systems, thus promoting resource and environmental sustainability while promoting economic development. Thus, levers can be found that help steer the course of these complex interacting systems towards desirable sectoral outcomes.

Final ID: H42G-08

Tree-Ring Extension of Precipitation Variability for Eastern Nevada: Implications for Drought Analysis in the Great Basin Region, USA

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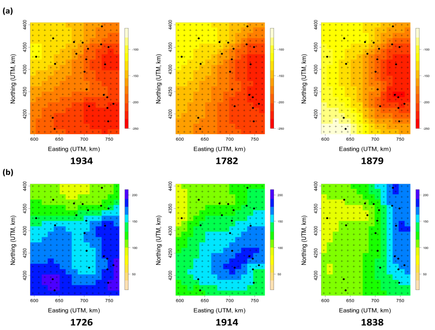
Body: In the Great Basin of North America, ecotonal environments characterized as lower forest border sites are ideally suited for tree-ring reconstructions of hydroclimatic variability. A network of 22 tree-ring chronologies, some longer than 800 years, from single-leaf pinyon (Pinus monophylla) tree-ring samples for eastern Nevada, in the central Great Basin of North America was used to analyze long-term precipitation variability. The period in common among all tree-ring chronologies, i.e. 1650-1976, was used to reconstruct October-May total precipitation using the Line of Organic Correlation (LOC) method. Individual site reconstructions were then combined using spatio-temporal kriging to produce annual maps of drought on a 12x12 km grid. Hydro-climatic episodes were numerically identified and modeled using their duration, magnitude, and peak, to estimate the likelihood of severe and sustained drought in this region. According to a numerical scoring rule explained in detail by Biondi et al. 2008, the most remarkable episode in the entire reconstruction was the early 1900s pluvial, followed by the late 1800s drought. The 1930s 'Dust Bowl' drought was in 8th position, making it one of the more remarkable episodes in the past few centuries. This result is consistent with other studies that show how regional drought severity varies going from western to eastern Nevada, and directly addresses the needs of water managers with respect to planning for 'worst case' scenarios of drought duration and magnitude. For instance, it is possible to analyze which geographical areas and hydrographic basins are more likely to be impacted during the most extreme droughts, at the annual (see Figure) or multiannual timescale. In the semi-arid western USA, multi-century long dendroclimatic records with km-scale spatial resolution can therefore provide water managers with a quantitative evaluation of climate episodes well beyond the envelope of instrumental records, thereby increasing the ability to design management practices for single watersheds with the objective to achieve drought resiliency.

URL: http://dendrolab.org



Pseudo-color maps of spatio-temporal kriging estimates for (a) the three driest years and (b) the three wettest years in the 1650-1976 proxy record of October-May total precipitation anomalies. The location of tree-ring chronologies (solid black circles) and 12-km grid points (black crosses) is also shown.

Final ID: B43F-0360

Regional Eco-hydrologic Sensitivity to Projected Amazonian Land Use Scenarios

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2. Provost Office, Georgia Institute of Technology, Atlanta, GA, United States.
3. Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, MA, United States.

Body: Given business as usual land-use practices, it is estimated that by 2050 roughly half of the Amazon's pre-anthropogenic closed-canopy forest stands would remain. Of this, eight of the Amazon's twelve major hydrologic basins would lose more than half of their forest cover to deforestation. With the availability of these land-use projections, we may start to question the associated response of the region's hydrologic climate to significant land-cover change.

Here the Ecosystem-Demography Model 2 (EDM2, a dynamic and spatially distributed terrestrial model of plant structure and composition, succession, disturbance and thermodynamic transfer) is coupled with the Brazilian Regional Atmospheric Model (BRAMS, a three-dimensional limited area model of the atmospheric fluid momentum equations and physics parameterizations for closing the system of equations at the lower boundary, convection, radiative transfer, microphysics, etc). This experiment conducts decadal simulations, framed with high-reliability lateral boundary conditions of reanalysis atmospheric data (ERA-40 interim) and variable impact of land-use scenarios (SimAmazonia). This is done by initializing the regional ecosystem structure with both aggressive and conservationist deforestation scenarios, and also by differentially allowing and not-allowing dynamic vegetation processes. While the lateral boundaries of the simulation will not reflect the future climate in the region, reanalysis data has provided improved realism as compared to results derived from GCM boundary data. Therefore, the ecosystem response (forest composition and structure) and the time-space patterns of hydrologic information (soil moisture, rainfall, evapotranspiration) are objectively compared in the context of a sensitivity experiment, as opposed to a forecast.

The following questions are addressed. How do aggressive and
conservative scenarios of Amazonian deforestation effect the regional patterning of hydrologic information in the Amazon and South American Convergence Zone, and does forest response in these regions influence that patterning of hydrologic information?

Final ID: ED43B-0553

Computing in Hydraulic Engineering Education

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Body: Civil engineers, pioneers of our civilization, are rarely perceived as leaders and innovators in modern society because of retardations in technology innovation. This crisis has resulted in the decline of the prestige of civil engineering profession, reduction of federal funding on deteriorating infrastructures, and problems with attracting the most talented high-school students. Infusion of cutting-edge computer technology and stimulating creativity and innovation therefore are the critical challenge to civil engineering education. To better prepare our graduates to innovate, this paper discussed the adaption of problem-based collaborative learning technique and integration of civil engineering computing into a traditional civil engineering curriculum.

Three interconnected courses: Open Channel Flow, Computational Hydraulics, and Sedimentation Engineering, were developed with emphasis on computational simulations. In Open Channel flow, the focuses are principles of free surface flow and the application of computational models. This prepares students to the 2nd course, Computational Hydraulics, that introduce the fundamental principles of computational hydraulics, including finite difference and finite element methods. This course complements the Open Channel Flow class to provide students with in-depth understandings of computational methods. The 3rd course, Sedimentation Engineering, covers the fundamentals of sediment transport and river engineering, so students can apply the knowledge and programming skills gained from previous courses to develop computational models for simulating sediment transport. These courses effectively equipped students with important skills and knowledge to complete thesis and dissertation research.

Final ID: ED43B-0569

Using sediment transport and river restoration to link research and education, and promote K-12 female involvement in STEM fields

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Body: The focus of this CAREER award is to better understand and predict the mechanics of sediment transport, to link research and education through courses and shared field sites, and to increase female interest in STEM fields. To accomplish the education component of this proposal we have focused on the following three activities: 1) a Keystone course on the scientific method, 2) a Women Outside with Science (WOWS) camp and 3) a permanent field site for research and education on river processes. In the Keystone Course, students investigated the impact of roughness addition, in sediment-starved river reaches (e.g. downstream of dams), on the retention of gravel used for spawning. They developed research questions and hypotheses, designed and conducted a set of scaled laboratory flume experiments, analyzed their data and wrote a draft manuscript of their results. Student feedback was overwhelmingly positive on the merits of this course, which included hands-on learning of the following: basic sediment transport and fluvial geomorphology, applied statistics, laboratory methods, and scientific writing skills. Students sometimes struggled when flume experiments did not progress as planned, and in the analysis and interpretation of complex data. Some of the students in the course have reanalyzed data, conducted additional experiments and are currently rewriting the manuscript for submission to a peer-reviewed journal. Such a course fundamentally links research and teaching, and provides an introduction to research for advanced undergraduates or beginning graduate students. We have also run one summer WOWS camp, which was a ten day camping and inquiry based research experience for 20 female junior-high and high-school students. The girls studied climate change and water related issues, worked on a restoration project on the Little Salmon River, met with a fish biologist and did fish habitat surveys and studied water quality along the North Fork of the Payette River while on a raft trip. The girls also met with women working in various STEM careers as part of an evening program and afterwards indicated that the raft trip and career night were highlights of the program. A key reason for the success of this camp was working with an already established outdoor science school that focuses on teaching scientific inquiry to K-12 students. Finally, we are establishing a permanent field installation of bedload sediment traps, suspended sediment monitoring, and flow measurements in Reynolds Creek Experimental Watershed, a USDA research site just outside of Boise, Idaho. This site will be used to better understand the mechanics of sediment transport in steep streams and will be linked to teaching through graduate class and general public field trips.

Final ID: EP43A-0660

A Hamiltonian model of landscape evolution

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Body: As a landscape erodes by fluvial and hillslope erosion, patterns of drainage self-organize into a hierarchy of catchments and paired channel networks. It has been argued that a variational principle aka “optimization” drives such organization, but the idea has largely failed to catch on -- in part because a variational equation or “energy functional” in the classical sense could not be formulated in a satisfying fashion.

Here the problem is approached in a new way that leads to the following conclusions: (1) landscape erosion is essentially a 3-D moving boundary problem that can be written as a 3-D anisotropic Hamilton-Jacobi equation; (2) it can be simplified into a 2-D problem which waves of lateral erosion propagate into the landscape as “knickfronts”; (3) in channels, the speed of knickfront motion aka upstream knickpoint propagation is a function of the vertical erosion rate divided by the gradient; (4) knickfront migration is equivalent to wavefront motion in optics; (5) as such, the collision of knickfronts at drainage divides is equivalent to the formation of shocks (caustics); (6) the cumulative effect of multiple knickfront collisions is to drive drainage divide motion; (7) the minimized quantity in the variational principle is the time taken for knickfronts to arrive at drainage divides; (8) as such, there is no need to invoke optimization in an ad hoc fashion; rather, it arises naturally; (9) when used to describe the first-arrival times of knickfronts, the Hamilton-Jacobi model can be rewritten as an eikonal equation; (10) ultimately, catchment shape dynamics and the long-term reorganization of drainage networks are described by solutions of this eikonal equation.

This Hamiltonian model of landscape evolution are explored here using both analytical tools and numerical simulations (using fast-marching as a means to solve its eikonal form). Comparison is made to real-world catchments that exhibit signs of rapid divide migration and catchment reorganization.

Final ID: EP43B-0687

Internal Process Time-Scales During Development Of Experimental Alluvial Fans Under Different Discharges, Basin Slopes, And Sediment Feed Rates.

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Body: The evolution of distributive channel systems such as alluvial fans and deltas occurs over a variety of time and length scales ranging from geologic down to turbulent. Data presented in this abstract focuses on describing fan dynamics on intermediate timescales where turbulent fluctuations are averaged out and large scale processes such as climate and base level are assumed constant. For the experiments, 180-degree unconstrained fans are developed in a 3m x 3m tank under different basin slopes, water discharges, and sediment input rates. For each experiment, these three variables are all held constant and the fan is left to naturally develop. Even though input conditions are held constant, fan development progresses in a rather dynamic way as it adjust to the initial conditions. Construction mechanisms of the overall average fan morphology through channel, sheet, and lobe deposits, bifurcation, and avulsion are dependent on input conditions. The overall morphologic features observed during fan development under the different combinations of discharge, sediment input rate, and basin slope are documented. This is done at a 30 sec time interval with an overhead camera. Geometries and times scales for the overall fan area and internal processes creating this bulk form are captured from the images to better understand the time-scales over which different morphodynamic processes are important.

Final ID: EP43B-0693

The real cause of the suspended sediment transport - river discharge hysteresis loop, in the Nepal Himalayas

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Body: Suspended sediment- river discharge hysteresis effects are observed over a wide range of different environments and time scales. This effect is generally interpreted as the result of variations in sediment supply which is directly coupled to sudden slope failure linked to storms, earthquakes and/or to glacial melt processes. In the Nepal Himalayas sediment fluxes are closely associated with the monsoon season. The distinct wet and dry season in Nepal controls the hydrological cycle and exerts a strong influence on the availability of water, river discharge and vegetation cover. The repartition of precipitated water in to direct surface runoff and temporally stored water is of major importance for physical and chemical erosion processes. Additional, the extreme high relief energy provides a landscape constantly close to failure.

In this contribution we discuss for the case of the Nepal Himalayas, (1) the occurrence of sediment flux events, (2) how suspended sediments are mobilized and transported and (3) denudation rates derived from these fluxes. We present ~30 years of daily data of precipitation and discharge for the major drainage basins of Nepal. Relating discharge with suspended sediment concentrations reveals a very well defined annual clockwise hysteresis effect, which we observe for both glaciated and unglaciated basins. Probability density distribution of the specific storm runoff sediment fluxes (normalized by the mean flux), reveals that all rivers have the same magnitude distribution behavior with respect to their means, independent from their size and location. The density function describes a power law with a slope ~1, but high fluxes describe a different behavior with a slope of ~2. Hence, mathematically the mean transport depends not on the extreme events, simply because the probability of large events has only little impact with respect to the moderate events. Through the separation of the daily hydrographs into direct storm discharge and baseflow (applying the local minimum method) we show that the hysteresis is rather an effect of dilution than limit of supply. These suspended sediment fluxes are linearly related with storm runoff, which implies that annual sediment fluxes and consequently the mobilization of material, is primarily controlled by the quantity and intensity of storm events. From this observation we derive a new suspended sediment rating model, allowing us to calculate denudation rates from the river discharge hydrograph. Calculated denudation rates in the Nepal Himalayas range from 0.1 -5.9 mm/year. Spatially, denudation seems to be controlled by precipitation intensity and to a lesser degree by relief or other catchment characteristics. Last we propose a new conceptual model of mobilization and transportation of material within the monsoonal discharge cycle.

Final ID: EP43C-0700

Modelling effects of tree population dynamics, tree throw and pit-mound formation/diffusion on microtopography over time in different forest settings

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Body: Herein we conduct a followup investigation to an earlier research project in which we developed a numerical model of tree population dynamics, tree throw, and sediment transport associated with the formation of pit-mound features for Hawk Creek watershed, Canadian Rockies (Gallaway et al., 2009). We extend this earlier work by exploring the most appropriate transport relations to simulate the diffusion over time of newly-formed pit-pound features due to tree throw. We combine our earlier model with a landscape development model that can incorporate these diffusive transport relations. Using these combined models, changes in hillslope microtopography over time associated with the formation of pit-mound features and their decay will be investigated.

The following ideas have motivated this particular study: (i) Rates of pit-mound degradation remain a source of almost complete speculation, as there is almost no long-term information on process rates. Therefore, we will attempt to tackle the issue of pit-mound degradation in a methodical way that can guide future field studies; (ii) The degree of visible pit-mound topography at any point in time on the landscape is a joint function of the rate of formation of new pit-mound features due to tree death/topple and their magnitude vs. the rate of decay of pit-mound features. An example of one interesting observation that arises is the following: it appears that pit-mound topography is often more pronounced in some eastern North American forests vs. field sites along the eastern slopes of the Canadian Rockies. Why is this the case? Our investigation begins by considering whether pit-mound decay might occur by linear or nonlinear diffusion. What differences might arise depending on which diffusive approach is adopted? What is the magnitude of transport rates associated with these possible forms of transport relations? We explore linear and nonlinear diffusion at varying rates and for different sizes of pit-mound pairs using a numerical modelling approach. Model results suggest that longevity of pit-mound features is dependent on: (i) magnitude/dimensions of initial pit-mound features for forests in different regions; (ii) defining appropriate pit-mound diffusion rates for these different forests (unfortunately, almost no appropriate field observations exist for calibration of these transport relations). In the next stage of this research, we will combine our earlier model of forest disturbance/tree population dynamics, tree throw and pit-mound formation with the numerical model LandMod (Martin, 1998, 2000, 2007); the latter will be used to simulate pit-mound diffusion over time. In this way, we can observe changes in hillslope microtopographic signatures over time that are found in different forest settings.

Final ID: EP43D-01

Modeling fluxes and form in landslide-prone terrain *(Invited)*

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Body: Landslides dramatically alter the Earth's surface over short timescales. The mass transfer associated with a limited number of slope failures can dominate the sediment budget of a region for decades or longer. The initiation, failure geometry, and runout of individual landslides depend on a range of factors and cannot be predicted from current models. Given these realities of landslide behavior over human timescales, it is challenging to reasonably represent these processes in landscape evolution models. Here, we evaluate the ability of two landslide models, both of which are formulated to apply at geomorphic timescales, to generate topographic patterns and sediment flux rates observed in natural landscapes.

Episodic debris flow activity is ubiquitous in steep, low-order mountainous catchments and generates valley networks with low concavity. A physically-based model for debris flow incision (Stock and Dietrich, GSA Bull, 2006) proposes that incision rates depend on the frequency, volume, and velocity of debris flows as well as the density of trigger sites and the state of bedrock weathering in low-order valleys. Valley slope angles are predicted to decline with drainage area according to how these properties vary spatially. We calibrated the model for a well-studied small catchment in the Oregon Coast Range using cosmogenic radionuclide erosion rates and then analyzed the slope-area signature of low-order valleys across much of the Central Oregon Coast Range to explore spatial variations in baselevel lowering. This endeavor shows that baselevel lowering rates vary significantly due to patches of resistant bedrock, drainage reorganization, and tectonic forcing. In regions with weak sedimentary bedrock, earthflows can reduce hillslope gradients, promote gullying, and dominate sediment yield through their downslope translation. A one-dimensional, physically-based model for earthflow-prone hillslope evolution (Booth and Roering, JGR, in press) incorporates earthflow, gully, and soil creep transport and predicts that average hillslope gradient increases nonlinearly with erosion rate. We applied the model to interpret catchment adjustment in the wake of a well-characterized knickpoint in the Waipaoa River, New Zealand. The model predicts the spatial pattern of erosion rate in the catchment based on average gradients and can be further tested by characterizing the morphology of individual hillslopes.

Landslide models that integrate across multiples events or episodes of landslide activity should be crafted with testable (and thus rejectable) morphologic and sediment flux constraints. Airborne lidar and erosion rates from cosmogenic radionuclides have greatly facilitated this endeavor although additional constraints are needed.

Final ID: GC43D-0968

On Early Holocene Ice-Sheet/Sea-Level Interactions

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Body: Early Holocene sea-level change constitutes an imperfect, yet potentially valuable analog for future sea-level rise, given the rapidly disintegrating land-based ice under climate conditions of high-latitude Northern Hemisphere warming. The associated rates of eustatic sea-level rise (cm/yr order of magnitude) fall within the range of predictions for the latter part of the next century. However, the early Holocene eustatic sea-level history is otherwise rather poorly understood. Recent impetus has been provided by new records of both relative sea-level (RSL) change and ice-sheet retreat that are sometimes difficult to reconcile in terms of timing and magnitude of change.

We first summarize the state-of-the-art on early Holocene sea-level change and then identify key near-term research needs. Recent studies have identified a number of decimeter to meter-scale sea-level jumps, several of which have been linked to catastrophic drainage of proglacial Lake Agassiz and the 8.2 ka cooling event. It is increasingly clear that this occurred by means of two successive jumps, separated by up to a few centuries, and only the latter (and final) one coinciding with the 8.2 ka climate event proper. We show that a considerable research effort, including near-field, intermediate-field, and far-field localities across the globe is needed to fully understand the timing and magnitude of these sea-level jumps. Accomplishing this goal would in addition offer a unique opportunity for rigorous testing of gravitational theory and associated sea-level fingerprinting that plays a critical role in predicting future sea-level change.

A more enigmatic sea-level jump that has been identified around 7.6 ka has received renewed interest both by means of new RSL data from Fennoscandia and reconstructions of Laurentide Ice Sheet retreat. However, the proposed ~5 m abrupt rise in eustatic sea level cannot be detected in relatively nearby, detailed RSL records from NW Europe, thus presenting a conundrum. Given the potentially large freshwater fluxes involved, this issue clearly needs to be resolved.

Future progress as envisioned above will require more sophisticated sea-level studies worldwide, with decimeter-scale vertical resolution and sub-centennial scale temporal resolution. A particular challenge for the early Holocene is the diminishing role of coral records – compared to earlier stages of deglaciation – due to a lack of vertical resolution. On the other hand, the sparseness of coastal peat records before 6 to 8 ka presents another obstacle. A combination of increased prospecting offshore and targeting new types of sea-level indicators therefore deserves to be encouraged.

Finally, all new field studies should be conducted in tandem with efforts to further refine glacial isostatic adjustment (GIA) models. Within this context, we foresee a primary focus on (1) optimizing site selection for the collection of new RSL records by means of GIA model predictions; (2) converting local observations of RSL rise into eustatic signals, including volumes and sources of meltwater discharge; and (3) capitalizing on gravitational fingerprint theory as outlined above.

Final ID: H43C-1222

Toward the Estimation of High-Resolution Daily Precipitation in Complex Regions – The Study of Intertwined Physiographic, Vegetative, and Climatologic Factors for PRISM Enhancement

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Body: Precipitation data with accurate, high spatial-temporal resolutions are crucial for modeling occurrences of extreme precipitation events and for improving our understanding of basin-scale hydrology. Currently, with the various deficiencies inherited from the precipitation data sources of rain gauge measurements, radar estimates, and satellite estimates, high quality precipitation estimation is very difficult to derive. The PRISM (Parameter-elevation Relationships on Independence Slopes Model) interpolation method, for example, is based on the relationship of physiographic effects and rain gauge data. While PRISM can account for phenomena such as terrain-induced climate transitions, cold air drainage and inversions and coastal effects, it cannot adequately capture spatial variations in the orographic precipitation gradient during years when more than 70% of the precipitation occurred on days with extreme events, especially for areas with sparse networks of climate stations. To improve the model, we are developing a non-linear approach involving the applications of remote sensing and data mining techniques. This study focuses on analyzing the influence of the factors such as vegetation feedback, water vapor path, air temperature, wind direction, and wind speed on precipitation at various scales in addition to the geomorphologic factors used in PRISM. These predictor variables are measured with the accumulated downstream watershed covering downstream variability and seasonal fluctuation for their respective rain gauge stations. Preliminary analysis of this data reveals that the integrated factors of spring temperature, summer rainfall, and Leaf Area Index (LAI obtained from MODIS) in May seem to have moderate to weak relationships with the precipitation of the following winter and spring depending on resolution and location. More testing of these relationships at different scales are underway. To resolve the problem of unevenly distributed rain gauge stations, the Tropical Rainfall Measurement Mission (TRMM) 3B-42 data is downscaled based on MODIS Enhanced Vegetation Index and on water vapor data from the GOES satellite. The downscaled data is then bias-corrected based on the rain gauge data and converted to point data to fill the gaps in the areas where rain gauge stations are sparsely installed. This study is executed for two “atmospheric river” days, two summer days, and two spring days. The comparison of the spatial distribution pattern of the daily precipitation generated using local regression method for “atmospheric river” days and “non-atmospheric river” days aims not only to show the improvement of PRISM but also aims to discovering physical principles that can be used to develop a high-resolution daily precipitation model in the second phase.

Final ID: P43C-1692

Insights from experimental groundwater sapping channels for early Martian hydrological conditions

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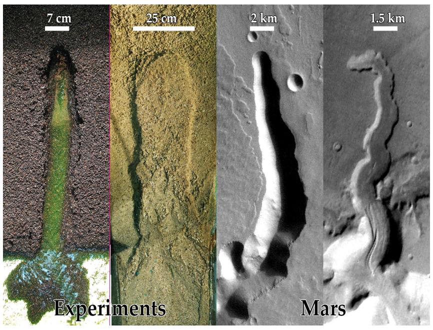
Body: Terrestrial analogues for morphological features on Mars can be used to estimate periods and nature of liquid surface water, which can be used to abduce early Martian climate conditions. Channels and box-canyons on Mars show morphological element similar to presumed sapping groundwater-fed channels on Earth which are formed under specific hydrological conditions. However the formative mechanisms of such channels, which are key in inferring corresponding climate conditions, are heavily debated even for the terrestrial cases.
Here, we conducted experiments of groundwater sapping systems and similar hydrological systems are created in a laboratory facility to acquire detailed insights in the hydrological and morphological processes related to groundwater sapping. The experiments were carried out in a 0.4 m by 1.5 m and a 1.2 m by 5 m setup. Sapping channels were produced within a few hours allowing tests with various boundary conditions. Larger grain sizes result in higher hydraulic conductivity but lower sediment mobility. In order to establish similar morphologies as in reality, the experiments were scaled to dimensionless sediment mobility by varying slope and using lightweight plastic sediment. Hydraulic conductivity was scaled using sediments with different grain sizes and grain-size distributions. The parameter space and potential scaling effects were further explored by hydrological modelling in Hydrus-2D.
The experiments show that groundwater sapping induces a combination of mass-movement and fluvial processes which results in distinct areas with characteristic morphological features, namely a collapsing head wall with slumps, a low-sloping area characterised by debris flows induced by the actual groundwater sapping and an area further downstream with fluvial activity as the flow reaches velocities above the threshold of motion. The observed experimental morphologies correspond qualitatively well with morphologies found on Mars and Earth and are useful analogues for Martian channels. Ongoing experimental and numerical work relates scaled and Martian morphology to the properties of the sediments and the necessary and sufficient hydrological boundary conditions.



Two experimental channels produced by groundwater sapping (left half) and two possible channels on Mars produced by groundwater sapping (right half). Both the experimental as the Martian channels show deep and shallow morphologies.

Final ID: T43E-2421

Drilling below the salt in the Western Mediterranean Sea: the GOLD project

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Body: In recent years the Gulf of Lion within the western Mediterranean Sea has become a unique natural laboratory to study both the evolution and interaction of deep processes (geodynamics, tectonics, subsidence, isostasy) and surficial processes (river behavior, sedimentary fluxes, sea-level changes, climatic impacts). We present the three main objectives for the GOLD deep drilling project at the foot of the continental slope (2400 m water depth) in the Gulf of Lion, the only place where the complete high-resolution history of the last 30 Ma of Mediterranean history is recorded in some 7.7 km of sedimentary archive

1) For the substratum: the upper continental crust thins to less than 5 km, and changes laterally to a relatively thin crust with high velocities whose precise nature is still undetermined (Gailler et al., 2009). The aim of the drilling is to reach this crucial zone, which is essential for the understanding of margin formation and the evolution of sedimentary basin (Aslanian et al., 2009).

2) The drilling will allow the dating and characterization of the impact of climate variations on sedimentation in the deep basin. For the Miocene and older sediments the drilling, will yield information about the nature, paleoenvironments and age of deposits enabling an astronomically-tuned Neogene time scale to be refined for the period of Aquitanian through Langhian interval. The Messinian extreme event represents a unique crisis in Earth history. It is a unique case to study the impact of sea-level drop (more than 1000 m, one order of magnitude greater than Late Quaternary glaciations) on sedimentary river behavior, deltaic and evaporitic deposition and ensuing biotic crisis. Deep drilling with the R/V Chikyu is the only way to go through the complete series of evaporites in the Provence Basin, sample the initiation and evolution of the crises, the first deposits related to the lowering of sea-level on the one hand and to the salinity crisis on the other.

3) The drilling will represent a first-class opportunity to study the microbial communities and processes in extremely deep marine sediments of the Mediterranean Sea, so-called “the deepest biosphere”. This site is particularly interesting to address the susceptinility and adaptability of life in environmental extremes since many extraordinary conditions such as high P, high T°, salt layers and fossilized organic matter, are predicted in GOLD-1 site. It would represent an opportunity to reach the biotic fringe and determine the limits of life in terms of depth, physicochemical constraints, isolation and their interactive impact.

Finally, the drilling could be a site for a deep instrumented observatory

Final ID: OS43D-05

Characteristic Timescales of Shoreface Response to Sea-Level Rise

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Body: On open ocean, wave-dominated, sandy coasts, the response of the shore to sea-level rise is dominated not by inundation, but rather by the dynamic response of sediment transport processes to perturbations of the sea level. In a regime of sea level change, the predominant response of the wave-dominated shoreface depends upon the time-dependent response of the shoreface itself to changes in sea level as well as the potential changes to the shoreline. On a barrier coast, persistent, long-term changes to the shoreline are caused by storm overwash, which transports marine sediment landward, moving the shoreline boundary. Raised sea levels increase the impact and frequency of this overwash as relative barrier elevation is reduced.

Overall, sediment transport processes on the shoreface remain poorly understood, complicating predictions of equilibrium shoreface shapes and even net sediment transport directions. However, presuming an equilibrium geometry, energetics-based, time-averaged relationships for cross-shore sediment transport provide a framework to understand the characteristic rates and types of shoreface response to perturbations to either the sea level or the shoreline boundary. In the case of a sea-level rise, we find that the dominant perturbation for a barrier system is not the sea-level rise itself, but rather the movement of the shoreline by overwash. The characteristic response time of the shoreface itself increases significantly at depth, suggesting that the lower shoreface response to a sea level change can be significantly delayed.

We estimate the importance of extreme events on shoreface evolution by analyzing decade-long data series of wave characteristics along different open ocean coasts with barriers (Florida Gulf Coast, North Carolina, Marthas Vineyard). Analogous to the effect of floods in fluvial systems, although storm events can move significant sediment, the infrequency of the larger events limits their effect on the shoreface—the morphologically significant event for shoreface evolution has a return interval of less than two years. However, numerical simulations of tens of thousands of synthetic storm strikes at the same locations suggest that the return interval of storm events expected to cause significant overwash is longer, on the order of at least 50 years. To study the interactions between the characteristic timescales of shoreface evolution and barrier overwash, we apply a numerical model of barrier profile evolution that couples shoreface evolution with barrier overwash. This integrated model provides a tool to understand the response of barrier systems to changes in sea level over the late Holocene to the modern. The model also investigates the potential behavior of barrier systems as they (and their human occupants) respond to predicted increased rates of sea-level rise over the coming centuries.

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Spatial variation of glacial erosion rates in the St. Elias range, Alaska, inferred from a realistic model of glacier dynamics

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Body: Glaciers have been principal erosional agents in many tectonically active orogens throughout much of the recent geological past. The St. Elias Mountains in southeastern Alaska are a surface expression of a highly convergent, complex orogen that was likely glaciated for much of its history. We examine the Seward-Malaspina Glacier system, part of one of the largest temperate glacier systems in the world, and focus on the Seward Throat, which is a narrow passage of the glacier through the St. Elias Mountains. It is within this region that we examine the pattern of erosion where ice velocities are exceptionally high. The glacier surface velocities and elevations, which are known, provide constraints for a numerical, full-stress flowband model that enables us to infer the glacier thickness, which is not easily measured on temperate glaciers, and the corresponding sliding velocity and other basal properties. This in turn allows us to produce one of the first studies of the current spatial distribution of erosion under an active glacier; erosion rates are inferred using the flow model guided by glaciological observations and several commonly invoked erosion laws that depend upon the sliding velocity and basal shear stress. The spatial variation of current erosion rates is strongly controlled by the geometry of the glacier and less influenced by other factors, such as the equilibrium line altitude or the choice of erosion law. Inferred erosion rates are highest within the narrow, central portion of the Seward Throat, consistent with both local and regional geological observations. The numerical model used in conjunction with surface glaciological measurements is a powerful tool for investigating ice thickness, basal properties, and the spatial variation of glacial erosion rates for many temperate glaciers, where little is known aside from surface properties. The glaciological data and model results have potential use for inferring local regions of active uplift in the vicinity of the Seward Throat and for investigating the role of glacial erosion within the broader tectonic setting of the St. Elias Mountains.

Final ID: EP43D-07

Constraints on the uplift history of the Bolivian Andes from channel profile morphology and numerical modeling.

(Invited)

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Body: In this study we couple channel profile analysis with numerical experiments using the CHILD landscape evolution model to explore possible uplift histories of the Eastern Cordillera of the Bolivian Andes. The region has extremely high relief, with elevations dropping by about 4,000 meters in a 45 km distance. An orographic precipitation gradient results from this steep topographic front, and rainfall rates in the region vary from over 3 m/yr to less than 0.5 m/yr. We explore the morphology of fluvial channels, focusing on patterns in channel concavity (the downstream change in channel gradient) and channel steepness normalized by drainage area (k_{sn}). Our study includes both the large channels that drain across the entire topographic front, as well as shorter channels whose headwaters do not tap the highest, driest parts of the region. The largest channels have five regions with distinct morphology, which moving from upstream to downstream are: Region 1 where the channel has normal concavity and low k_{sn}; Region 2 where the channel is convex and k_{sn} increases downstream; Region 3 where the channel has normal concavity and high k_{sn}; Region 4 where the channel is highly concave and k_{sn} decreases downstream; and Region 5 where the channel has normal concavity and low k_{sn}. Notably, the transition between regions 4 and 5 occurs where the channels leave the steep topographic front. The upper convex reaches of the large channels (region 2) likely record a past acceleration in uplift rate to which the channels are still responding. The shorter channels are lacking the upper three regions that are present in the largest channels, and thus do not record this increase in uplift rate. However, many of the smaller channels exhibit patterns very similar to region 4; they are highly concave with declining k_{sn} towards the edge of the topographic front. The regional precipitation pattern could contribute to the formation of highly concave reaches in the largest rivers, as has been recently argued. However, the shorter rivers that head within the high precipitation zone experience more uniform rainfall and would not be so affected. Given that we observe a similar pattern of high concavity and decreasing k_{sn} toward the range front in both the large and small channels, we can conclude that the high concavity region results from a tectonic, not a climatic effect. Specifically, this region of high concavity suggests that uplift rates decline toward the range front, as might be expected from a large fold. In addition, this high-concavity zone may have been enhanced by a more recent decrease in uplift rate, but this is less certain. These interpretations are supported by our numerical modeling experiments, which proved particularly useful for deciphering the role of precipitation versus uplift patterns in transient channel morphology.

Final ID: EP43D-08

Using Neighborhood-Algorithm Inversion to Test and Calibrate Landscape Evolution Models

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Body: Landscape evolution models use mass transport rules to simulate the development of topography over timescales too long for humans to observe. The ability of models to reproduce various attributes of real landscapes must be tested against natural systems in which driving forces, boundary conditions, and timescales of landscape evolution can be well constrained. We test and calibrate a landscape evolution model by comparing it with a well-constrained natural experiment using a formal inversion method to obtain best-fitting parameter values.

Our case study is the Dragon's Back Pressure Ridge, a region of elevated terrain parallel to the south central San Andreas Fault that serves as a natural laboratory for studying how the timing and spatial distribution of uplift affects topography. We apply an optimization procedure to identify the parameter ranges and combinations that best account for the observed topography. Through the use of repeat forward modeling, direct-search inversion models can be used to convert observations from such natural systems into inferences of the processes that governed their formation. Simple inversion techniques have been used before in landscape evolution modeling, but these are imprecise and computationally expensive. We present the application of a more efficient inversion technique, the Neighborhood Algorithm (NA), to optimize the search for the model parameters values that are most consistent with the formation of the Dragon's Back Pressure Ridge through repeat forward modeling using CHILD.

Inversion techniques require the comparison of model results with direct observations to evaluate misfit. For our target landscape, this is done through a series of topographic metrics that include hypsometry, slope-area curves, and channel concavity. NA uses an initial Monte Carlo simulation for which misfits have been calculated to guide a new iteration of forward models. At each iteration, NA uses n-dimensional Voronoi cells to explore the parameter space and find the zones of best-fit, from which it picks new parameter values for the forward models. As it proceeds, the algorithm concentrates sampling around the cells with the best-fit models. The resulting distribution of models and misfits in multi-parameter space can then be analyzed to obtain probability density distributions for each parameter.

Preliminary results suggest that, when combined with robust algorithms for the calculation of the misfit, NA quickly centers the parameter search around values that capture the key features of the observed topography. The ability of NA to provide probability distributions for parameter values gives an indication of uncertainty in each, and can be used to guide field measurements for model testing. This application of advanced inversion techniques for landscape evolution modeling is a significant step towards the use of more formal mathematical methods in geomorphology that are already applied by other disciplines in the geosciences.

Final ID: EP44A-02

Evolution and stability of tidal river bifurcations *(Invited)*

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Body: At bifurcations, water and sediment are partitioned, so that long-term evolution of fluvial and deltaic channels is determined by the bifurcation stability. Recent work in fluvial environments showed that bifurcations are commonly unstable so that avulsion results. For tidal rivers it could be argued that the discharge fluctuation enhances transport so that it simply closes of faster than in steady flow, but it could also be argued that tidal phase differences between the bifurcates cause a residual flow that counteracts the closing trend and keeps both bifurcates open.

A physics-based numerical model (Delft3D) was used to model fixed-bank fork-shaped bifurcations with and without tides, and with short and long length relative to tidal wavelength. In all cases the bifurcations remained as unstable as without tides and ended invariably in avulsion. Tidal bifurcations unbalanced more rapidly than fluvial bifurcations, because of the increased ebb current and nonlinearity of sediment transport. On the other hand, discharge partitioning at the final bifurcation was much less asymmetrical with tides than without. Tidal wave deformation and production of higher harmonics in the longer channels affected sediment partitioning in the unstable phase but seems to have no effect on equilibrium morphology. Significant phase differences between the bifurcates caused a tidal floss effect, which scoured the bifurcation. In conclusion, symmetrical bifurcations affected by tides are unstable, but their final equilibrium is more symmetrical than without tides unless bifurcates have significant tidal phase differences.

Furthermore I modelled growing deltas with self-formed distributary channels with and without cohesive sediment and with and without tides. Here, tides cause the flow to be more focussed in fewer and larger channels, whilst the few bifurcations are relatively stable. Combined fluvial discharge and tidal ebb flow in the channels transports more sediment than in fluvial-only cases. Moreover, these channels prograde and aggrade by growing levees, whilst sedimentation in between channels is reduced relative to non-tidal cases. In contrast to the fixed bifurcations, tidal bifurcates build levees that stabilise them more than fluvial bifurcates. This suggests that bifurcation stability depends on the rate of delta building and the stability of channel banks.

URL : http://www.geo.uu.nl/fg/mkleinhans

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Of Rock Damage and the Regolith Conveyor Belt: A Geomorphologist's View of the Critical Zone

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Body: Models of hillslope evolution require rules for the rate of detachment of rock into the mobile regolith layer, for the rate of mobile regolith transport, and for channel incision or aggradation rates that serve as boundary conditions. The evolution of material as it passes through the weathered zone is typically ignored, making it difficult to cast proper rules for production of mobile regolith. The current rules are therefore insufficient to address critical zone evolution, in which the chemical, mechanical, and hydrologic properties of the rock and the regolith matter. These properties evolve as rock is weathered during exhumation, and they continue to evolve as particles ride the conveyor belt of mobile regolith downslope. Models that honor specific processes involved in the evolution of rock as it passes through the CZ will both advance models of landscape evolution, and provide context for ecological and hydrological investigations.

Physical processes responsible for progressive damage of rock during exhumation in the current CZOs include frost cracking and tree root cracking. If we define damage as the density of flaws within the rock, we require rules governing the rate of generation of new flaws, which will vary with climate, depth, and the present state of damage. We envision a "damage-limited system" in which the likelihood of release of rock fragments into mobile regolith depends on the accumulated damage in the subjacent rock.

In most temperate and alpine settings relevant to the present CZOs, the ratio of a rock's residence time in the damage zone to the duration of a climate oscillation is such that a rock parcel will experience the full spectrum of Quaternary climates. This requires that we address both climate history and the damage and transport rates associated with all Quaternary climates.

We present numerical models for rock damage, mobile regolith production, and hillslope profile evolution. These models are motivated by the Boulder Creek CZO Gordon Gulch catchment, in which strong contrasts in CZ development occur on north-facing and south-facing slopes that likely reflect differences in both the thermal state and the tree cover of the landscape. We illustrate a rule set in which periglacial processes dominate by employing a modified rule for frost cracking to capture the damage of rock as it is exhumed, and a formula for frost heave to address transport of mobile regolith. Rates of both damage and transport are functions of mean annual temperature (MAT) that we constrain with numerical calculations that include both phase change and variations in material properties. Climate is dependent on slope angle, and oscillates between glacial and interglacial MATs. The resulting hilltop is asymmetrical in profile, and in thicknesses of both mobile regolith and damage zone, matching qualitatively the characteristics of Gordon Gulch. Climate swings result in oscillations of mobile regolith thickness that are greatest at the base of hillslopes. Interpretation of 10Be, and of downslope profiles of regolith properties, must honor such climatically modulated behavior.

Final ID: H44C-02

Mathematical Modeling of the Subsurface Behavior of Quantum Dot Nanoparticles in the Presence of Stabilizing Polymers

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Body: As the manufacture and use of nanomaterials become more prevalent, the development of mathematical models capable of predicting nanomaterial transport and retention in subsurface systems is crucial to assessing their environmental fate. To enhance aqueous solubility, nanoparticle production often involves the use of a surfactant or other stabilizing agent. The presence of stabilizing agents, whether natural or synthetic, could significantly influence nanoparticle mobility and fate in the subsurface.

In this study, quantum dot (QD) mobility experiments were performed in columns packed with three size fractions of Ottawa sand (d50 = 125, 165, and 335 μm) at two different pore-water velocities (0.8 m/d and 7.6 m/d). The QDs synthesized for these experiments consisted of a CdSe core embedded in a CdZnS shell with a poly(acrylic acid)-octylamine (PAA) coating to promote suspension stability. The QDs were negatively charged (measured zeta potential ca. -35 mV) with a hydrodynamic diameter of approximately 30 nm. Experimental observations consistently revealed low amounts of QD deposition near the column inlet, results that were inconsistent with expectations based upon clean bed filtration theory. This phenomenon was hypothesized to be related to competitive adsorption of residual aqueous PAA to the sand surface. A systematic modeling approach was undertaken to explore mechanisms controlling the transport and deposition of QDs in the presence of competitively adsorbing aqueous PAA. The model incorporated a coupled system of equations governing the fate and transport of both nanoparticles and chemical additives. QD retention was described using a modification of a traditional clean bed filtration governing equation that assumes irreversible first-order attachment and incorporates a maximum or limiting retention capacity. Simultaneous transport and adsorption of PAA were modeled using a traditional advection-dispersion-reaction equation that incorporates a first-order kinetic adsorption rate and a limiting adsorption capacity. The transport equations were coupled through a Langmuir-type blocking term that accounts for the sand surface area occupied by both attached QD nanoparticles and preferentially adsorbed PAA. The resulting model successfully captured experimental observations, including the delayed breakthrough of QDs, as well as the atypically low QD deposition near the column inlet. Coupled model fitting results showed trends in fitted QD deposition rate and capacity as a function of velocity and grain size that were consistent with previous experimental observations of nanoparticle transport and attachment. This work highlights the importance of accounting for the effects of stabilizing agents when attempting to predict the environmental fate of engineered nanomaterials.

Final ID: EP44A-05

Transient response of sand bedforms to changes in flow

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Body: Lowland rivers commonly experience discharge variability spanning more than an order of magnitude, producing correspondingly large changes in bed morphology. However, field and lab studies indicate that bedform geometries lag changes in flow, producing hysteretic relationships between bed morphology, roughness, and water discharge. The ability of bedforms to maintain equilibrium with hydrodynamic flow variability thus depends on the timescale of transient bedform adjustment to flow. Here, we present results of flume experiments carried out at the Saint Anthony Falls Laboratory, University of Minnesota, in which we continuously tracked adjustment of sand bedform morphologies to abrupt changes in water discharge. We show how the timescale of bedform adjustment is driven by three primary factors: 1. directionality of adjustment, 2. preexisting bedform geometry, and 3. sediment flux. Directionality of adjustment (rising versus falling water discharge) determines whether bedforms grow quickly by irreversible merger (rising flows) or shrink slowly through secondary bedform cannibalization of relict larger bedforms (falling flows). Preexisting bedform geometry (height and length) determines the amount of bed deformation required for adjustment to new equilibrium, and sediment flux determines the rate at which this change is affected. These three factors all favor faster adjustment of bedforms to rising flows. We experimentally demonstrate this bedform adjustment hysteresis through a variety of increasing and decreasing discharge changes, across both sand ripple and dune regimes. Finally, we propose and validate a simple conceptual model for estimating the adjustment timescale based on sediment flux and equilibrium bedform geometry.

Final ID: H44F-05

Thresholds in vegetation responses to drought: Implications for rainfall-runoff modeling

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Body: While threshold behavior is often associated with soil and subsurface runoff generation, dynamic vegetation responses to water stress may be an important contributor to threshold type behavior in rainfall runoff models. Vegetation water loss varies with vegetation type and biomass and transpiration dynamics in many settings are regulated by stomatal function. In water limited environments the timing and frequency of stomatal closure varies from year to year as a function of water stress. Stomatal closure and associated fine time scale (hourly to weekly) plant transpiration may appear as threshold (on/off) behavior. Total seasonal to annual plant water use, however, typically show a continuous relationship with atmospheric conditions and soil moisture. Thus while short-time scale behavior may demonstrate non-linear, threshold type behavior, continuous relationships at slightly longer time scales can be used to capture the role of vegetation mediated water loss and its associated impact on storage and runoff. Many rainfall runoff models rely on these types of relationships. However these relationships may change if water stress influences vegetation structure as it does in drought conditions. Forest dieback under drought is a dramatic example of a threshold event, and one that is expected to occur with increasing frequency under a warmer climate. Less dramatic but still important are changes in leaf and root biomass in response to drought. We demonstrate these effects using a coupled ecosystem carbon cycling and hydrology model and show that by accounting for drought driven changes in vegetation dynamics we improve our ability to capture inter-annual variation in streamflow for a semi-arid watershed in New Mexico. We also use the model to predict spatial patterns of more catastrophic vegetation dieback with moisture stress and show that we can accurately capture the spatial pattern of ponderosa pine dieback during a early 2000s drought in New Mexico. We use these simulations to derive characteristics of threshold water stress conditions where vegetation structural responses become significant for runoff predictions.

Final ID: H44F-06

Thresholds in Xeric Hydrology and Biogeochemistry ***(Invited)***

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Body: Due to water limitation, thresholds in hydrologic and biogeochemical processes are common in arid and semi-arid systems. Some of these thresholds such as those focused on rainfall runoff relationships have been well studied. However to gain a full picture of the role that thresholds play in driving the hydrology and biogeochemistry of xeric systems a full view of the entire array of processes at work is needed. Here a walk through the landscape of xeric systems will be conducted illustrating the powerful role of hydrologic thresholds on xeric system biogeochemistry. To understand xeric hydro-biogeochemistry two key ideas need to be focused on. First, it is important to start from a framework of reaction and transport. Second an understanding of the temporal and spatial components of thresholds that have a large impact on hydrologic and biogeochemical fluxes needs to be offered. In the uplands themselves episodic rewetting and drying of soils permits accelerated biogeochemical processing but also more gradual drainage of water through the subsurface than expected in simple conceptions of biogeochemical processes. Hydrologic thresholds (water content above hygroscopic) results in a stop start nutrient spiral of material across the landscape since runoff connecting uplands to xeric perennial riparian is episodic and often only transports materials a short distance (100's of m).

This episodic movement results in important and counter-intuitive nutrient inputs to riparian zones but also significant processing and uptake of nutrients. The floods that transport these biogeochemicals also result in significant input to riparian groundwater and may be key to sustaining these critical ecosystems. Importantly the flood driven recharge process itself is a threshold process dependent on flood characteristics (floods greater than 100 cubic meters per second) and antecedent conditions (losing to near neutral gradients). Floods also appear to influence where arid and semi-arid surface waters maintain their perennial character. Perennial conditions are themselves a threshold process (is the stream wet or dry?). The presence and absence of surface flow on one semi-arid river (the San Pedro river, Arizona) displays power-law characteristics that speak to some scale invariant properties of surface groundwater interactions in river systems. These interactions of surface and groundwater also play a significant role in maintaining biogeochemical conditions in riparian ecosystems.

Final ID: EP44A-07

Hydrographic and suspended sediment measurements of the Mississippi River plume during the historic 2011 flood: a coupled satellite analysis and boat survey approach to determine an efficiency factor for sediment trapping in the nearshore zone.

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Body: During the 2011 Mississippi River (MR) flood, sediment carried to sea by the River had the potential to combat wetland loss in some areas. The movement and fate of river sediments is determined by a combination of river plume momentum, and coastal and offshore currents [Walker, 1996; Walker et al., 2005; Rego et al., 2010]. We therefore used a coupled satellite analysis and boat survey approach in order to track mixing and transport of MR plume sediments during one of the largest recorded floods in history. During the flood crest in June of 2010, MR discharge was held at a constant and large value for several weeks, providing a unique experiment that allowed us to study plume structure under steady flow conditions. Sea surface temperature, height, and color data from satellites were employed in order to quantify river plume dispersion, surface sediment concentration [Peckham, 2008; Shi and Wang, 2009] and sediment migration pathways in the nearshore zone for the Mississippi and Atchafalaya Rivers, for the duration of the flood. The boat survey measured current velocity, salinity, temperature and sediment concentration of the MR plume, during the peak of the flood. Although plumes emanating from the MR Delta should contribute significant sediment to the coastal zone [cf. Wright and Nittrouer, 1995; D'Sa and Ho, 2008], our investigation shows that the focused jet of the MR during the flood penetrated the coastal current and contributed little to the coastal sediment budget. Collected data allowed calculation of the hydrodynamic structure of the plume and thus its Potential Vorticity. We show that a novel PV, recently described by Falcini and Jerolmack [2010], works as an efficiency factor: the fraction of sediment emitted from each river plume that is trapped in the nearshore zone (and on marshes) is directly related to the PV of each river effluent. This relation may help to better understand and predict how future floods, or human-constructed river diversions, will contribute to land building on the Delta. Theoretical results and data we collected can also be useful for testing and verification of numerical models in the future.

Final ID: H44F-07

A Framework for Quantifying and Understanding the Type of Topographic Dependence and Degree of Time-Instability in Catchment-Scale Soil Moisture Patterns

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Body: Soil moisture is a key state variable in hydrology. It affects the partitioning of available energy between sensible and latent heat fluxes and the partitioning of rainfall between infiltration and overland flow. Spatial variability of soil moisture within a region or catchment is also important to the hydrologic behavior of that region or catchment. For example, the magnitude of spatial variability has been shown to affect regional rates of evapotranspiration, and the spatial structure of soil moisture patterns is known to affect the runoff production of a catchment. Topography has been shown to be a dominant control on soil moisture patterns at the catchment scale, but its influence often varies between catchments. Some soil moisture patterns depend most strongly on the hillslope orientation with wetter areas occurring on hillslopes that are more protected from the sun (e.g., the Cache la Poudre dataset). Other soil moisture patterns depend on the valley configuration with wetter areas occurring in the valley bottoms (e.g., the Satellite Station dataset). Still other patterns exhibit time-instability with the type of topographic dependence changing in time (e.g., the Tarrawarra dataset). This research aims to identify the local climatic and catchment characteristics that determine the type of topographic dependence and the strength of time instability in soil moisture patterns. A conceptual model is developed that estimates soil moisture patterns by assuming that the processes that affect soil moisture at any given point are in equilibrium. This assumption allows the spatial pattern of soil moisture to be estimated as a function of the spatial-average soil moisture. The model includes infiltration, lateral unsaturated flow, groundwater recharge, and evapotranspiration. The spatial variations in soil moisture that are produced by these processes are then described as functions of various topographic attributes. The model is tested through application to three catchments with extensive soil moisture data (Tarrawarra, Satellite Station, and Cache la Poudre), and it is shown to reproduce a substantial portion of the observed variation in each dataset. An index is then developed to measure the type of topographic dependence (hillslope orientation or valley configuration), and another index is developed to measure the strength of time instability. The dependence of these indices on various catchment characteristics is then explored. Based on this methodology, it is observed that the saturated horizontal hydraulic conductivity must be relatively small in order for hillslope orientation to dictate the pattern of soil moisture variation. A higher potential evapotranspiration value promotes the occurrence of such patterns, but it is usually not sufficient to make the hillslope orientation the dominant type of variation. The strength of time instability increases primarily with the difference between the exponents in the equations that determine the horizontal unsaturated hydraulic conductivity and the radiation-induced evapotranspiration from the degree of soil saturation.

Final ID: OS44B-08

Contrasts in Sediment Delivery and Dispersal from River Mouth to Accumulation Zones in High Sediment Load Systems: Fly River, Papua New Guinea and Waipaoa River, New Zealand

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Body: The relationships between sediment-transport processes, short-term sedimentary deposition, subsequent burial, and long-term accumulation are critical to understanding the morphological development of the continental margin. This study focuses on processes involved in formation and evolution of the clinoform in the Gulf of Papua, Papua New Guinea in which much of the riverine sediment accumulates, and comparison to those processes active off the Waipaoa River, New Zealand that form mid-shelf deposits and export sediment to the slope.

In tidally dominated deltas, sediment discharged from the river sources must transit through an estuarine region located within the distributary channels, where particle pathways can undergo significant transformations. Within the distributaries of the Fly River tidally dominated delta, near-bed fluid-mud concentrations were observed at the estuarine turbidity maximum and sediment delivery to the nearshore was controlled by the morphology and gradient of the distributary. El Niño results in anonymously low flow and sediment discharge conditions, which limits transport of sediment from the distributaries to the nearshore zone of temporary storage. Because the sediment stored nearshore feeds the prograding clinoform, this perturbation propagates throughout the dispersal system.

In wave-dominated regions, transport mechanisms actively move sediment away from the river source, separating the site of deposition and accumulation from the river mouth. River-flood and storm-wave events each create discrete deposits on the Waipaoa River shelf and data has been collected to determine their form, distribution, and relationship to factors such as flood magnitude or wave energy. In this case, transport pathways appear to be influenced by structurally controlled shelf bathymetry.

In both cases, the combined fluvial and marine processes can initiate and maintain gravity-driven density flows, and although their triggers and controls differ vastly, these flows play a significant role in the morpholigcal development of the continental margin. These sites, synthesized with examples from multiple other environments, provide a basis for understanding the interactions between physical processes responsible for the transport of sediment from river mouths to the sites of ultimate deposition.

Final ID: IN51B-1578

Pre-Mission, Mission and Post Mission Data Management for NASA Field Campaigns

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Body: Field research campaigns are essential for observing and measuring actual Earth system phenomena and validating computer models that simulate Earth systems. Ultimately, field data have a wide variety of application in basic and applied research. Due to the nature of data collection during a field campaign the resulting data sets are discontinuous over the designated geographic region as well as in time. The management of aircraft based data must take these factors into consideration.

The Global Hydrology and Resource Center (GHRC) and IT researchers at the University of Alabama in Huntsville have participated in a number of NASA field campaigns since 1998. For example The Genesis and Rapid Intensification Processes (GRIP) experiment was a recent NASA Earth science field experiment conducted in summer 2010 to better understand how tropical storms form and develop into major hurricanes. NASA used the DC-8 aircraft, the WB-57 aircraft, and the Global Hawk Unmanned Airborne System (UAS) configured with a suite of remote sensing instruments used to observe and characterize the lifecycle of hurricanes. This campaign capitalized on a number of ground networks, airborne science platforms (both manned and unmanned), and space-based assets.

Due to this history and expected participation in future campaigns; the GHRC is recognized as one of the main NASA data centers for this category of data. At the GHRC data from successive field campaigns are tied together through common procedures, consistent metadata, and archival systems making it easy to access data from instruments that have been employed across several missions. These data are also valuable when preparing for new field campaigns. This paper will focus on data management strategies employed prior to the mission, during the mission and after mission timeframes.

Final ID: PP51C-1868

Late Glacial and Holocene Fire History From Radiocarbon Dating of Charcoal in Valley-Bottom Sediments in Small Watersheds of the Oregon Coast Range

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Body: A large number (N = 351) of radiocarbon dates of charcoal from valley-bottom sediments in headwater valleys of the southern Oregon Coast Range provides the basis for a new index of fire frequency during the past 17,000 years in this steep landscape covered by dense coniferous forest. Study areas were chosen for their relative lack of recent forest disturbance by harvest or fire, and sampling of stream banks and terrace risers was random, weighted by deposit volume and bank or riser area. This sampling methodology was designed to characterize sediment residence times within valley-bottom storage, and the overall shape of the calibrated age distribution is therefore assumed representative of the dependence of charcoal preservation probability on calibrated age. A proxy record of fire history in the study areas is obtained by fitting a gamma distribution to the weighted mean calibrated charcoal ages by the method of moments; calculating the relative difference between the fit and the normalized histogram, with 50-year bin-widths, of charcoal ages; and smoothing that relative difference with a gaussian distribution, the standard deviation of which is at least two bin-widths and inversely proportional to the value of the fit distribution at larger ages. The calibrated charcoal age mean and variance of 1900 yrs BP and 7.39 x 106 yr2, respectively, yield shape and scale parameters of the fit gamma distribution of 0.490 and 3880 yrs, respectively. This heavy-tailed distribution indicates that probabilities of charcoal evacuation are not simply proportional to relative volume of encasing sediment deposits but, rather, decrease with deposit age. The smoothed proxy record of relative fire frequency has a global maximum at 7700 BP and prominent local maxima at 600 BP and 5700 BP, in order of decreasing magnitude; a global minimum at 4500 BP and local minimum at 1800 BP roughly bracket a period of fluctuating but relatively low fire frequency during the period 5000–1500 BP. Although resolution in the late glacial to early Holocene is limited, the record shows a high relative fire frequency during the late glacial before dipping 10,000–9000 BP. The 7700 BP maximum and 1800 BP minimum are consistent with another fire history from lake sediments northeast of our sites in the Oregon Coast Range. Other features appear to contradict that record but to support of climate change inferences based on other climate proxies.

Final ID: SA51D-1982

Magnetometer-inferred, Equatorial, Daytime Vertical ExB Drift Velocities Observed in the African Longitude Sector

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Body: A recent paper has investigated the sharp longitude gradients in the dayside ExB drift velocities associated with the 4-cell, non-migrating structures thought to be connected with the eastward propagating, diurnal, non-migrating (DE3) tides. Observations of vertical ExB drift velocities obtained from the Ion Velocity Meter (IVM) on the Communication/Navigation Outage Forecast System (C/NOFS) satellite were obtained in the Western Pacific, Eastern Pacific, Peruvian and Atlantic sectors for a few days during the months of October, March and December, 2009. Respective ExB drift velocity gradients at the cell boundaries for these 4 longitude sectors were a.) -1.3m/sec/degree, b.) 3m/sec/degree, c.) -4m/sec/degree and d.) 1m/sec/degree and were observed on a day-to-day basis. In this talk, we estimate the longitude gradients in the dayside, vertical ExB drift velocities from magnetometer H-component observations in the African sector. We briefly describe the technique for obtaining realistic ExB drift velocities associated with the difference in the H-component values between a magnetometer on the magnetic equator and one off the magnetic equator at 6 to 9 degrees dip latitude (delta H). We present magnetometer-inferred, dayside ExB drift velocities obtained from the AMBER (African Meridian B-field Education and Research) magnetometer chain in the East Africa (Ethiopian) longitude sector and the West African (Nigerian) longitude sector. We compare the longitude gradients in ExB drift velocities in the African sector with the C/NOFS- observed longitude gradients mentioned above. We also discuss the advantages of using ground-based magnetometer observations to infer ExB drift velocities compared with the C/NOFS satellite observations.

Final ID: EP51D-02

A Coupled Economic and Physical Model of Coastal Adaptation and Abandonment: Are human occupied coastlines a bubble waiting to burst? ***(Invited)***

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Body: Policy discussions of adaptation by coastal residents to increasing rates of sea level rise and changing frequency of damaging storms have focused on community land use planning processes. This view neglects the role that market dynamics and climate change expectations play in the way coastal communities choose among risk mitigation options and manage land use decisions in an environment of escalating risks. We use a model coupling physical coastal processes with an agent-based model of behavior in real estate and mitigation markets to examine the interplay of climate-driven coastal hazards, collective mitigation decisions, and individual beliefs. The physical component model simulates barrier island processes that respond to both storms and slow scale dynamics associated with sea level rise. The economic component model is an agent-based model of economic behavior where agents are rational economic actors working off different assessments of future climate-driven events. Agents differentially update their beliefs based on a) how much emphasis they give to observed coastal changes and b) how much weight they give to scientific predictions. In essence, agents differ along a spectrum of how much they believe that the past is the best guide to the future and how quickly they react to new information. We use the coupled model to explore three questions of interest to coastal policy. First, how do the interplay of costal processes, beliefs, and mitigation choices affect the level and stability of real estate prices? Second, how does this interplay affect the incentives for community investments in shoreline protection? Third, how do expectations and reactions to observed events, as well as mitigation investments, affect the built environment in circumstances when climate risks reach very high levels? This last question relates to a key aspect of climate change adaptation on the coast – when does mitigation give way to abandonment as an optimal adaptation strategy? Results suggest that subjective expectations about climate risk and about the effectiveness of mitigation in high-risk environments are critical in determining when the market starts to reflect the possibility that property might no longer be inhabitable. Results will be presented that contrast the dynamics of abandonment over a range of sea level rise and storminess scenarios.

Final ID: EP51C-04

Climate change and mountain-front morphology: Estimating Late Glacial to Holocene erosion rates from the shape of fault-bounded hillslopes

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Body: The existence of well-preserved Holocene bedrock fault scarps along active normal faults in the Mediterranean region and elsewhere suggests a dramatic reduction in rates of rock weathering and erosion that correlates with the transition from glacial to interglacial climate. We test and quantify this interpretation using a case study in the Italian Central Apennines. Holocene rates are derived from measurements of weathering-pit depth along the Magnola scarp, where previous cosmogenic ^{36}Cl analyses constrain exposure history. To estimate the average hillslope erosion rate over $\sim$10^5 years, we introduce a simple geometric model of normal-fault footwall slope evolution. The model predicts that the gradient of a weathering-limited footwall hillslope is set by fault dip angle and by the ratio of slip rate to erosion rate; if either slip or erosion rate is known, the other can be derived. Applying this model to the Magnola fault yields an estimated average weathering rate on the order of 0.2-0.4 mm/yr, more than 10x higher than either the Holocene scarp weathering rate or modern regional limestone weathering rates. A numerical model of footwall growth and erosion, in which erosion rate tracks the oxygen-isotope curve, reproduces the main features of hillslope and scarp morphology and suggests that the hillslope erosion rate has varied by about a factor of 30 over the past one to two glacial cycles. We conclude that preservation of carbonate fault scarps reflects strong climatic control on rock breakdown by frost cracking.

Final ID: EP51E-05

Distinguishing grass from ground using LiDAR: Techniques and applications

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Body: Standard protocols exist for extracting bare-earth Digital Elevation Models (DEMs) from LiDAR point clouds that include trees and other large woody vegetation. Grasses and other herbaceous plants can also obscure the ground surface, yet methods for optimally distinguishing grass from ground to generate accurate LiDAR-based raster products for geomorphic and ecological applications are still under development. Developing such methods is important because LiDAR-based difference products (e.g. snow thickness) require accurate representations of the ground surface and because raster data for grass height and density have important applications in ecology. In this study, we developed and tested methods for constructing optimal bare-earth and grass height raster layers from LiDAR point clouds and compared the results to high-quality field-based measurements of grass height, density, and species type for nearly 1000 precisely geo-referenced locations collected during the acquisition of a >200 km^2 airborne LiDAR flight of the Valles Caldera National Preserve (New Mexico). In cases of partially bare ground (where the skewness of return heights above a plane fit to the lowest first returns is sufficiently large), a planar fit to the lowest first returns provides a good method of producing an accurate bare-earth DEM and the statistics of the first returns above that planar fit provide good estimates of the mean and variance of grass height. In areas of relatively thick grass cover, however, a fit to the lowest first returns yields a bare-earth DEM that may be a meter or more above the actual ground surface. Here we propose a method to solve this problem using field-measured correlations among the mean, variance, and skewness of grass heights. In this method, the variance and skewness of the differences between LiDAR first returns and a 10m^2 planar fit to the lowest first returns is used, together with field-based correlations of grass height statistics, to estimate the mean grass height. A bare-earth DEM that corrects for the effects of dense vegetation can then be constructed by subtracting the estimated mean grass height from the mean of the LiDAR first returns. We illustrate two applications of this method. First, spectral analysis of grass height raster products of Valles Caldera reveal fractal patterns that reflect the roles of geomorphology (e.g. height above active channel) and small-scale disturbances on grass growth and hence on the spatial variations in grass height. Second, snow thicknesses mapped by airborne LiDAR in the Valles Caldera systematically under-predict the actual snow thickness in riparian areas because the ground-surface in the snow-off DEM fails to represent the true ground surface in areas of tall, dense grass. By comparing a grass-corrected LiDAR-derived snow thickness map to the results of snow survey data acquired during the time of the snow-on LiDAR flight, we show that the techniques we developed minimize this problem.

Final ID: EP51D-07

Investigating the Geomorphic Behavior of the Cape Canaveral Coast Through High-Resolution Beach Monitoring, Sediment Analysis, Oceanographic Observations, and Numerical Modeling

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5. National Aeronautics and Space Administration, Kennedy Space Center, FL, United States.

Body: The salient of Cape Canaveral interrupts a relatively straight, sandy, passive margin coastline that extends nearly 400 km from the St. Johns River mouth to the St. Lucie Inlet along the Florida Atlantic coast. OSL dating indicates that the modern cape has been prograding rapidly since the LGM and subtle topographic features, inland from the modern cape, suggest that this salient has persisted over several sea level cycles since the early Pleistocene. Dynamic shoreline change over the past decade at the Kennedy Space Center (KSC) is threatening critical NASA infrastructure and has prompted officials to develop a mitigation strategy through a partnership among researchers from the U.S. Geological Survey, the U.S. Army Corps of Engineers, private coastal engineering firms, and the University of Florida. Since May 2009, the research team has assembled data on decadal to event-scale shoreline change (dGPS), beach and nearshore morphodynamics (dGPS and Argus), beach sedimentary character (grain size analysis), wave climate and transformation (ADCP), and inner shelf bathymetry (Echo Sounding) in an effort to assess dune vulnerability and flooding risk. In addition, SWAN numerical modeling simulations offer insight into the influence of irregular bathymetry (cape-associated shoals) on the alteration of spatial patterns of wave energy flux during a decadal shift in deep-water wave climate. Beach-fx, modeling of cross-shore profile evolution is being applied to evaluate the performance of alternative protective measures, estimate project costs, and examine ecological influences of the proposed alternative protective measures. By combining contemporaneous data of coastal geomorphic and sedimentary response to wave forcing with numerical model results that explore a range of climate scenarios, we aim to develop a useful understanding of the coastal geomorphic behavior at KSC that can be used to make a mitigation recommendation.

Final ID: EP52A-01

Transient bedrock channel evolution across a precipitation gradient: A case study from Kohala, Hawaii. ***(Invited)***

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2. Jackson School of Geosciences, The University of Texas, Austin, TX, United States.
3. Department of Geological Sciences, Central Washington University, Ellensburg, WA, United States.

Body: This study uses observations from the Kohala Peninsula, on the Big Island of Hawaii, and numerical modeling, to explore how precipitation gradients may affect fluvial bedrock incision and channel morphology. Orographic precipitation patterns result in over 4 m/yr of rainfall on the wet side of the peninsula and less than 0.5 m/yr on the dry side. These precipitation patterns likely strongly contribute to the observed channel morphology. Further, the region is subsiding, leading to prolonged transient channel evolution. We explore changes in a number of channel morphologic parameters with watershed averaged precipitation rate. We use PRISM precipitation data and data from isohyets developed from historic rain gauge data. Not surprisingly, valley depth, measured from a 10 meter DEM, increases with spatially averaged precipitation rate. We also find that channel profile form varies with precipitation rate, with drier channels exhibiting a straight to slightly concave channel form and wetter channels exhibiting a convex to concave channel form. The precipitation value at which this transition in channel profile form occurs depends on the precipitation data-set used, highlighting the need for more accurate measurements of precipitation in settings with extreme precipitation patterns similar to our study area. The downstream pattern in precipitation is likely significant in the development of the convex-concave profile form. Numerical modeling results support that precipitation patterns such as those observed on the wet-side of the Kohala Peninsula may contribute to the convex-concave profile form. However, we emphasize that while precipitation patterns may contribute to the channel form, these channel features are transient and not expected to be sustained in steady-state landscapes. We also emphasize that it is fluvial discharge, as driven by precipitation, rather than precipitation alone, that drives the processes shaping the channel form. Because fluvial discharge is integrative, relatively extreme precipitation gradients are required to produce anomalous channel profile forms.

Final ID: EP52B-01

Biogeomorphology of tidal landforms: physical and biological processes shaping the tidal landscape *(Invited)*

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2. Geosciences, University of Padova, Padova, Italy.
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Body: The equilibrium states and transient dynamics of tidal landforms are the result of many concurring physical and biological forcings, such as tidal range, wind climate, sediment supply, vegetation and microphytobenthos development, and rates of relative sea level rise (RSLR). A 0D model of the coupled elevation-vegetation dynamics is used to explore the relative role of the physical and biological factors shaping these systems. We find that salt marshes exposed to large tidal ranges are more stable, and therefore more resilient to increasing rates of RSLR, than marshes subjected to low tidal ranges and that subtidal platforms in macrotidal systems are less exposed to wind-induced erosion processes than their counterparts in systems with smaller tidal fluctuations. Notably, we find that vegetation crucially affects both the equilibrium marsh

elevation, through dissipation of wind waves and organic accumulation, and marsh resilience to accelerations in RSLR rates, important differences being associated with different vegetation types. Furthermore, our results show that the existence and stability of equilibrium states fundamentally depend on the local wind and tidal regime, even within the same tidal system. Finally, we propose a modelling framework to study how biological evolution lead to the emergence of tidal landforms as we know them.

Final ID: EP52A-02

Modeling the Glacial-Interglacial Impact of the Pacific Trade Wind Inversion on the Geomorphology and Hydrology of the Big Island of Hawaii

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Body: The interaction of the subsiding, subtropical limb of the Hadley circulation and the easterly North Pacific trade winds establishes a persistent thermal inversion about halfway up the eastern flank of the Big Island of Hawaii. This restricts convective rainfall to the lower elevations, resulting in stream channels that cross an order-of-magnitude rainfall gradient, active ephemerally above the inversion and perennially below it. Above the inversion–capped cloud layer, precipitation is on the order of 400 mm/yr, and the landscape features thin, weakly-developed soils, gentle hillslopes, and ephemeral, shallowly incised bedrock streams and grassland gullies. Below the inversion, where rainfall is >3000 mm/yr, the perennial streams run through 50- to 100-m-deep gulches, with steep forested walls covered by thick tropical soils that are prone to landsliding. Meter- to 50-meter waterfalls are common downstream of the inversion layer, and incision of the deep gulches may proceed by upstream migration of these knickpoints from the coast. The positions of these knickpoints likely reflect the history of lava flows in these catchments, base level changes due to landsliding at the coast, and the statistics of water and sediment discharge above and below the trade inversion and through time.

This landscape has evolved entirely in the last 0.3 Ma, and thus under conditions of glacial-interglacial climate oscillations. During glacial periods, the inversion's average elevation was likely depressed, although the magnitude of this depression is not well-constrained. An ice cap that was present on Mauna Kea altered the hydrology of the upper slopes of the mountain, providing a continuous source of meltwater to channels that, in the modern setting, are active only during winter storms and rare hurricane strikes. The frequency and intensity of such storms during glaciations are also not well-known.

To quantify these effects, we would like to use climate models to inform landscape evolution models. A key difficulty in coupling these types of models is the separation of time and spatial scales involved. Global climate models typically run on grids of 1 degree or more, at temporal resolution of seconds and run lengths of years to decades. Landscape evolution models (LEMs) reside at the other end of both dimensions, with typical spatial resolutions of meters to km and temporal resolutions of years or decades. The entire duration of a climate model run may be shorter than the timestep of a typical LEM.

We report initial results from our efforts to bridge the relevant scales by downscaling large-scale climate model output for last-glacial and modern times with NCAR's regional-scale Weather Research and Forecasting (WRF) model. The predicted precipitation fields are input to a hydrologic model to generate realistic discharge statistics useful for landscape modeling. This modeling chain may be validated for the modern climate using atmospheric observations, including the modern distribution of inversion height, and USGS stream gauge data. For glacial periods, the ability of the weather model to correctly predict snowlines on Mauna Kea provides a first-order point of calibration.

Final ID: EP52B-02

Hydrodynamic and suspended sediment transport controls on river mouth morphology *(Invited)*

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3. University of Minnesota, Minneapolis, MN, United States.

Body: The strikingly varied growth habits of river mouths building into standing bodies of water present a compelling pattern formation problem, which is also of great practical relevance for managing fragile coastal wetlands. Falcini and Jerolmack [2010] recently developed a novel potential vorticity (PV) theory to investigate the hydrodynamic conditions that form elongate channels in river deltas and lakes. Here we introduce a generalized 2.5-dimensional PV theory that relates sedimentation patterns to the internal vorticity and suspended sediment concentration fields within a sediment-laden jet. A key result is that lateral advection of sediment is directly proportional to internal jet vorticity, revealing how high-PV jets build elongated channels by focused levee deposition. A new analysis of experimental data shows that spatial variations in PV control sedimentation patterns at a river mouth. We derive a new bulk PV parameter, and demonstrate its ability to delineate channel morphologies of natural systems.

Final ID: EP52C-03

Quantifying temporal and spatial scales and patterns in experiments ***(Invited)***

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3. Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA, United States.

Body: The study of landscape evolution often meets with the difficulty of characterizing systems with data of limited temporal or spatial resolution, where boundary conditions may also be poorly constrained. Experiments can provide a useful testing ground for the development of reliable methods of quantification, and experimental delineation of the scales associated with system processes can also inform the translation between experimental and natural systems. We present our approach to quantifying the driving processes in experimental geomorphic systems by describing the methods that have proven useful in our work, with examples from two sets of experiments. In the primary set of experiments, braided rivers are studied using repeat three-dimensional topography scans, obtained through the novel use of an optical technique, which will also be briefly described. Braided rivers provide a particularly powerful example of the usefulness of experiments in elucidating patterns and order in systems which at first glance may seem too complex to be amenable to process-oriented description. Metrics used in quantifying the braided rivers are separated into those that describe unit processes such as channel geometry organization, timescales of channel movement, and bifurcation stability, and those that describe bulk system statistics of the evolving landscape and the self-organizing number and spacing of its channels. We will also draw a few examples from a second set of experiments, in which alluvial fans are studied primarily through two-dimensional image processing, with many methods similar to those used for the braided rivers. In the fan experiments, examples of measured quantities include metrics of the memory of channel locations, the manner of channel movement, and shoreline growth trends. Dominant spatial and temporal scales emerge, which we can relate to fan dynamics.

Our presented methods allow us to measure intrinsic system spatial and temporal scales that provide keys to understanding the driving processes and their hierarchies. These methods are useful generally and could be applied to the quantification of a range of natural or experimental systems.

Final ID: EP52A-04

The Impact of Vegetation on the Long-term Landform Evolution of the Chilean Coastal Ranges

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Body: We assess the topographic response to vegetation density along a 1600 km climatic transect ranging from hyper-arid to humid temperate conditions along the Chilean coastal ranges. Using a new method of statistical analysis of topography we provide insights into the relationship between vegetation and sediment transport. Specifically, we find the following relationship between vegetation density (or its absence) and landscape form: (1) where vegetation is currently absent (< 26°S) topographic form is insensitive to aspect; (2) in regions with moisture limited vegetation cover, aspect is an important parameter determining hill slope steepness on a local and regional scale; (3) where vegetation cover is currently aspect-insensitive (> 38°S) the steepness of hillslopes is only aspect-sensitive where it isotropic (plutonic) lithologies. We conclude that equilibrium hillslopes that are vegetated are steeper on average than barren hillslopes within the same climatic zone. This implies that hillslopes whose vegetation density is decreased or disturbed by climate change or human activity will remain out of equilibrium until either the mean slope is lowered or vegetation density is restored.

Final ID: G52A-06

Facilitating Joint Analysis of Data from Several Systems Using Geophysical Models ***(Invited)***

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Body: The changes in Earth's geometry, gravity field, and rotation are observed with a portfolio of techniques spanning from point-geodetic methods to in situ and space-borne gravity sensors, and surface imaging methods for land, ice and ocean surfaces. Although the time-variability of Earth's geometry, gravity field, and rotation are caused by the same Earth system processes, this fundamental link between the different observations is not yet widely explored in geodesy for the analysis and interpretation of the geodetic observations. We will discuss how the use of a simple Earth system model can aid the joint analysis of GPS, InSAR and GRACE observations. Thus, we will consider the case of three observing systems sampling two geophysical parameters with different spatial and temporal resolution. Making best use of these observations requires a model that can assimilate the geodetic observations and propagate the state of the system model in a way consistent with the geodetic observations. Key issues to address include differences in the reference frames and modeling used for the different observation types.

Final ID: EP52A-07

Why do mountain river meanders reflect typhoon climatology? ***(Invited)***

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Body: A key to understanding how climate change may influence landscapes in the future is to look for links between landscape morphology and the climatology that has prevailed over the recent past. Quantitative links have proven elusive. Recently, a correlation has been shown to exist between “storminess” and the sinuosity of mountain rivers averaged on a catchment scale (Stark et al, 2010). In this work, it was argued (1) that mean sinuosity reflects the tendency of eroding channels to meander, (2) that this tendency is enhanced by greater frequencies of heavy rainfall and flooding, and (3) that the basic physical mechanism for this is the dual effect of stronger flood erosion rates coupled to enhanced rainfall weakening of hillslopes. Doubt has been cast on this study by some, because the mean sinuosities observed by Stark et al are low (1.0 to 1.3) compared to those seen in demonstrably meandering channels (2 to 3 and higher). In addition, questions remain as to how faster meandering (an instantaneous rate) leads to greater sinuosity development (a property that evolves over the long-term and likely over several glacial-interglacial cycles). Here, these and other questions are addressed. Mean sinuosities are indeed low, but the full probability distribution of sinuosities often includes very high values - notably in catchments where channel meanders are well-developed to the point of cut-off. The reasons why faster meandering leads to greater sinuosity development over time and over several climatic cycles will be explored in more depth during presentation.

Stark, C. P. et al. The climatic signature of incised river meanders. Science, 327:1497-1501, 2010.

Final ID: EP52B-07

Turning the tide: experimental creation of tidal channel networks and ebb deltas

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Body: Tidal channel networks, estuaries and ebb deltas usually formed over a period longer than observations cover. Much is known about their characteristics and formation from linear stability analyses, numerical modelling and field observations. However, experiments are rare whilst these provide data-rich descriptions of their evolution in fully controlled boundary and initial conditions. Our objective is to ascertain whether tidal basins can be formed in experiments, what possible scale effects are, and whether morphological equilibrium of such systems exist.

We experimentally created tidal basins with simple channel networks and ebb deltas in a 1.5 m^2 square basin with a fixed tidal inlet and initially flat sediment bed in the basin raised above the bed of the sea. Rather than create tides by varying water level, we tilted the entire basin over the diagonal. The advantage of this novel method is that the bed surface slopes in downstream direction both during flood and ebb phase, resulting in significant transport and morphological change in the flood phase as well as the ebb phase. This overcomes the basic problem of earlier experiments which were entirely ebb-dominated, and reduces the experiment time from months to hours.

Ebb deltas formed in sand were entirely bedload dominated whereas light-weight plastics showed much more suspension. Channels bifurcated during channel deepening and backward erosion to form a network of three orders. The tidal prism increased as more sediment was moved from basin to ebb delta, so that evolution accelerated initially. Given that most experiments were close to beginning of sediment motion, the rate of change, the size of the channels and the final length of channels and delta were very sensitive to the tidal amplitude, tidal period and water depth in the basin. The final situation was invariably below the threshold for sediment motion except in the inlet and first-order channels, suggesting that other forcings such as storm waves, sea level rise or biological actors would be required to sustain dynamic morphology.

URL: www.geo.uu.nl/fg/mkleinhans

Final ID: A53A-0304

Implications of Meteoritic Dust In The Upper Stratosphere

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5. Aerospace Engineering Sciences, University of Colorado, Boulder, CO, United States.

Body: Significant levels of extinction in the upper stratosphere and mesosphere have recently been observed by remote sensing observations. Comparisons are made with observations from SAGE II, the NOAA lidar located in Mauna Loa, HI and model-derived profiles from Whole Atmosphere Community Climate Model (WACCM) coupled with the Community Aerosol and Radiation Model for Atmospheres (CARMA). This comparison strongly suggests that the observed extinction is in part from meteoritic dust and needs to be accounted for in the retrievals of stratospheric observations by remote sensing instruments. Without this correction, the amount of scattering in the upper atmosphere is underestimated by as much as 12%. Such extinction biases retrieval algorithms for extinction profile measurements used to make assessments of upper atmospheric optical depth and may lead to an underestimate of the entire radiative forcing of this region. Possible solutions for these problem may include calibrating instruments in higher regions of the atmosphere where the molecular extinction becomes dominant or including information about the extinction of this aerosol within retrievals.

Final ID: H53E-1460

Imbalance in the Hydrologic Cycle—Open Systems, Ebbs and Flows, and Multi-Stable States *(Invited)*

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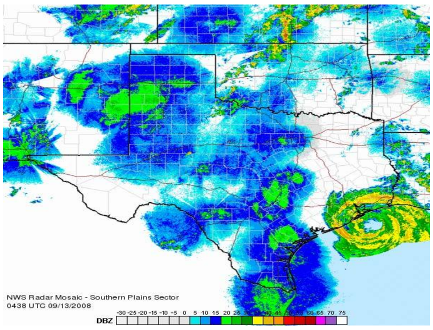
Body: The hydrosphere is characterized by extraordinarily large-scale chemostasis and hydrostasis. The interconnected oceans hold >95% of the planetary water in circulation and have not greatly changed in volume since the Proterozoic, despite tectonic motions of super-continental proportions. Similarly, the chemistry of the ocean has remained relatively constant since the proliferation of widespread multicellular life and abundant oxygen some 0.6 billion years ago. Ancient humans recognized that “All rivers runneth to the sea, yet the sea doth not filleth up.” The solution to this paradox is the 17th-century paradigm of the hydrologic cycle; however, the commonly made corollary assumption of hydrologic balance disappears upon analysis across the entire range of observations available through ground-based networks, satellite imaging, and proxy data on paleo-hydrologic states (chemical, isotopic, tree-rings, speleothems, etc.). Water imbalance as the normative state is supported by theoretical consideration of hydrologic responses to superimposed steady-, periodic-, and irregular forcings such as geothermal gradients, diurnal and annual cycles, and orbital irregularities. Hydrologic systems are open across all scales with respect to thermal-energy throughput and are often far from equilibrium. Temporal-spatial variations of thermal inputs and stores coupled with feedbacks from interacting biologic and geologic processes lead to chaotically punctuated water imbalances with profound consequences for ecosystem succession, water resources, long-term agricultural sustainability, and acute risk from floods and droughts. Imbalance in hydrologic systems through time is evident from studies of soils and sediments and from data on deep unsaturated zones in tropical to arid regions; these studies reveal repeated cycles of salinity accumulation and pluvial flushing and shifting frequencies of floods and droughts. Anthropogenic intensification of the hydrologic cycle—with attendant amplification of variance—is increasing the imbalance in hydrologic systems, making scientifically based understanding of its causes and effects, rooted in disequilibrium dynamics and holistic modeling of planetary processes, imperative for supporting efforts to mitigate and adapt.

URL : http://www.usgs.gov/science/



Imbalace of water in the Southern High Plains.

Final ID: H53K-1563

A Stochastic Approach to Vertical Dispersion of Coarse Sediments in Turbulent Open-Channel Flows

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Body: This study proposes a novel formula to calculate sediment vertical dispersion in turbulent solid-liquid flows, by developing a fractional advection-diffusion equation (fADE) to characterize the dynamics of sediment particles. The fADE is a generalization of the traditional ADE where the first-order spatial derivative is replaced with a fractional derivative of order α ($0<\alpha<1$). Most previous investigations into sediment dispersion in steady sediment-laden flows apply the classic or improved Rose equations, which were derived from the traditional ADE by assuming the Fick's first law. Recent observations in field and laboratory studies however have indicated that large errors may arise from the traditional ADE when applied to flows with coarse sediments and/or high turbulence. Instead, dispersive flux is most likely a space nonlocal process, since particle vertical jumps with turbulence are not constrained to the local area defined by the representative elementary volume. Based on field measurements in the Las Vegas Wash as well as a set of published experimental data, the present study has revealed the preliminary relationships among fractional-orders, particle sizes, and turbulence intensity.

Final ID: H53P-01

Dry and Drier: Ecological Implications of Hydrologic and Geomorphic Differences among Perennial, Intermittent, and Ephemeral Streams *(Invited)*

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Body: Research in dryland streams on several continents indicates great diversity of form and process. Although features common to many dryland streams exist, very few of these features are unique to dryland environments. Differences in the flow regime of dryland streams compared to wetter environments are more likely to create distinctive physical disturbance regimes that strongly influence riverine biota. The spatial and temporal flow variability of intermittent and ephemeral streams in particular creates challenges and opportunities for riverine biota. A conceptual framework based on spatial and temporal variability of flow, as reflected in hydrologic connectivity and a flashiness index, is used to examine differences in habitat and resource distribution and stability among perennial, intermittent, and ephemeral streams. The intermediate disturbance hypothesis suggests that some types of perennial streams support greater biotic diversity than intermittent and ephemeral streams. The limited connectivity and stability associated with spatially and temporally fluctuating flows can result in high levels of endemism in intermittent and ephemeral streams. Effective management and conservation of these dryland streams requires understanding of the drivers of flow regime (climate, substrate, topography), the spatial and temporal patterns of flow and the associated patterns of hydraulics, sediment dynamics, and water chemistry, and the potential bottlenecks for species or community persistence if these patterns are altered by human resource use.

Final ID: H53O-02

The fusion of terrestrial laser scanning and optical bathymetric mapping to monitor braided river morphodynamics

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Body: <p>In recent years, Terrestrial Laser Scanning (TLS) has emerged as a new technology that has transformative potential for mapping morphological change in braided rivers. TLS makes it possible to acquire precise, reach-scale topographic datasets that can be used to recover centimeter scale channel morphology. When coupled with a suitable bathymetric mapping technique, high-resolution Digital Elevation Models (DEMs) can be produced for both wet and dry areas of the braidplain. Since TLS surveys can be undertaken at frequencies commensurate with individual flood events, sequences of DEMs can then be used to investigate sediment transport rates, using the morphological approach. In turn, these reach-scale datasets can be used to understand braided river morphodynamics and to provide boundary conditions for morphodynamic modeling.</p>

<p>A unique dataset that records the evolution of a 2.5 x 0.7 km braided reach of the Rees River, New Zealand, from September 2009 to May 2010, has recently been generated. Topographic data were acquired after ten flood events, using a combination of two remote sensing methodologies. Dry areas of the braidplain were surveyed using TLS with dual-frequency GPS mounted on an Argo Amphibious All Terrain Vehicle. Bathymetry was mapped using an empirically calibrated optical method, based on non-metric vertical aerial photos acquired from a helicopter and an acoustic depth survey along primary anabranches. The availability of the Rees River dataset provides a sequence of braided rivers DEMs that are unprecedented in their three-dimensional resolution, precision and spatial extent.</p>

<p>In this paper we describe the methodology that has been developed to monitor the evolution of the Rees River. DEMs were produced using a three step process that involved (i) the construction of ground level DEMs from TLS data; (ii) the derivation of water surface elevations; and (iii) the mapping of channel bed levels using optical bathymetric mapping. The morphological change resulting from the integration of each event are then revealed by subtracting the two [after and before] surface models, to generate DEMs of Difference. The DEMs of Difference are rich in detail, revealing spatially coherent patterns of erosion and deposition, and indicate that the study reach slowly aggraded during the study period.</p>

Final ID: EP53A-03

Sorting out abrasion in a gypsum dune field *(Invited)*

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Body: Grain size distributions in eolian settings are the result of both sorting, and abrasion of grains by saltation. The two are tightly coupled because mobility of particles determines abrasion rate, while abrasion affects the mobility of particles by changing their mass and shape; few field studies have examined this quantitatively. We measured grain size and shape over a 9-km transect downwind of a line sediment source at White Sands National Monument, a gypsum dune field. The sediment source is composed of rod-like (elongate), coarse particles whose shapes appear to reflect the crystalline structure of gypsum. Dispersion in grain size decreases rapidly from the source. Coarse particles gradually become less elongate, while an enrichment of smaller, more elongate grains is observed along the transect. Transport calculations confirm that White Sands is a threshold sand sea in which (1) the predominant particle diameter reflects grains transported in saltation under the dune-forming wind velocity, and (2) smaller, elongate grains move in suspension under this dominant wind. Size-selective transport explains first order trends in grain size; however, abrasion changes the shape of saltating grains and produces elongate, smaller grains that are spallation/breaking products of larger particles. Both shape and size changes saturate 5-6 km downwind of the source. As large particles become more equant, abrasion rates slow down because protruding regions have been removed. Such asymptotic behavior of shape and abrasion rate has been observed in theory and experiment, and is likely a generic result of the abrasion process in any environment.

Final ID: EP53A-04

A PROCESS-BASED MODEL FOR THE EVOLUTION OF A GRAIN-SIZE DISTRIBUTION

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Body: The grain-size distribution of a natural material (such as river sediments, avalanche deposits) results from the processes it has undergone and is the record of its history. In particular, it is strongly influenced by erosive processes at various time scales that tend to reduce the grain sizes. Is it therefore possible to extract some information about these erosive processes from the observation of the resulting grain-size distributions?

We developed a new model that describes the temporal evolution of a grain-size distribution of particles which are subject to various erosive processes. Each process is modeled through a frequency of occurrence (or breakage frequency) and a daughter-distribution. The daughter-distribution is the size distribution of the new particles created by one erosive event. This model is very general and can be applied to any system of particles with any type of erosive processes. Here we present an application to sediment transport where sediments are subject to two processes: surface abrasion and fragmentation. Breakage frequencies and daughter-distributions are determined using independant experiments and theory.

The model predictions show that abrasion or fragmentation each create specific patterns in the grain-size distribution. We then compare these predictions to real grain-size distributions, that were obtained from two sets of experiments in a circular flume and in a tumbling mill, with varying sediment velocity and lithology. Qualitative and quantitative comparison provides information about the magnitude and time-scale of both abrasion and fragmentation in the real case. In particular, it demonstrates that both processes are active, but that fragmentation is only efficient at a short time scale whereas abrasion is the dominant process on a longer time scale. Moreover, the characteristic time scale of the fragmentation and the magnitude of both abrasion and fragmentation appear to depend on the sediment velocity and on the lithology.

We therefore believe that such a model is a powerful and adaptable tool for testing erosive process hypothesis against real data.

Final ID: H53L-06

Towards a complete description of the hydrologic cycle: Large scale simulations with the open-source, parallel, ParFlow hydrologic model. *(Invited)*

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Body: Integrated hydrologic models are growing in application and show significant promise in unraveling connections between the surface, subsurface, land-surface and lower atmospheric systems. Recent advances in numerical methods, coupled formulation and computing power have all enabled these simulation advances. Here, I will discuss the modeling platform ParFlow, an integrated hydrologic model that has been coupled to land surface and atmospheric models. I will then discuss a recent application of this model to a large, Continental-Scale domain in North America at high resolution that encompasses both the Mississippi and Colorado watersheds. Details will include techniques for model setup and initialization, in addition to results that focus on understanding fluxes, feedbacks and systems dynamics. Additional anthropogenic complications such as the effects of pumping, irrigation and urbanization will be discussed and a path forward for integrated simulations of the hydrologic cycle will be presented.

Final ID: EP53A-07

Comparing particle-size distributions in modern and ancient sand-bed rivers *(Invited)*

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3. Department of Statistics, University of Wyoming, Laramie, WY, United States.

Body: Particle-size distributions yield valuable insight into processes controlling sediment supply, transport, and deposition in sedimentary systems. This is especially true in ancient deposits, where effects of changing boundary conditions and autogenic processes may be detected from deposited sediment. In order to improve interpretations in ancient deposits and constrain uncertainty associated with new methods for paleomorphodynamic reconstructions in ancient fluvial systems, we compare particle-size distributions in three active sand-bed rivers in central Nebraska (USA) to grain-size distributions from ancient sandy fluvial deposits. Within the modern rivers studied, particle-size distributions of active-layer, suspended-load, and slackwater deposits show consistent relationships despite some morphological and sediment-supply differences between the rivers. In particular, there is substantial and consistent overlap between bed-material and suspended-load distributions, and the coarsest material found in slackwater deposits is comparable to the coarse fraction of suspended-sediment samples. Proxy bed-load and slackwater-deposit samples from the Kayenta Formation (Lower Jurassic, Utah/Colorado, USA) show overlap similar to that seen in the modern rivers, suggesting that these deposits may be sampled for paleomorphodynamic reconstructions, including paleoslope estimation. We also compare grain-size distributions of channel, floodplain, and proximal-overbank deposits in the Willwood (Paleocene/Eocene, Bighorn Basin, Wyoming, USA), Wasatch (Paleocene/Eocene, Piceance Creek Basin, Colorado, USA), and Ferris (Cretaceous/Paleocene, Hanna Basin, Wyoming, USA) formations. Grain-size characteristics in these deposits reflect how suspended- and bed-load sediment is distributed across the floodplain during channel avulsion events. In order to constrain uncertainty inherent in such estimates, we evaluate uncertainty associated with sample collection, preparation, analytical particle-size analysis, and statistical characterization in both modern and ancient settings. We consider potential error contributions and evaluate the degree to which this uncertainty might be significant in modern sediment-transport studies and ancient paleomorphodynamic reconstructions.

Final ID: IN53D-07

The CUAHSI Community Hydrologic Information System ***(Invited)***

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6. Consortium of Universities for the Advancement of Hydrologic Science, Inc, Boston, MA, United States.

Body: Hydrologic information is collected by many individuals and organizations in government and academia for many purposes, including general monitoring of the condition of the water environment and specific investigations of hydrologic processes. Comprehensive understanding of hydrology requires integration of this information from multiple sources. The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) has developed a Hydrologic Information System (HIS) to provide better access to data by enabling the publication, cataloging, discovery and retrieval of hydrologic data using web services. This paper describes HIS capability developed to promote data sharing and interoperability in the Hydrologic Sciences with the purpose of enabling hydrologic analyses that integrate data from multiple sources. The CUAHSI HIS is an Internet based system comprised of hydrologic databases and servers connected through web services as well as software for data publication, discovery and access. The system that has been developed provides new opportunities for the water research community to approach the management, publication, and analysis of their data systematically. The system's flexibility in storing and enabling public access to similarly formatted data and metadata has created a community data resource from public and academic data that might otherwise have been confined to the private files of agencies or individual investigators. Additionally, HIS provides an analysis environment within which data from multiple sources can be discovered, accessed and integrated. The CUAHSI HIS serves as a prototype for the infrastructure to support a network of large scale environmental observatories or research watersheds, and indeed, components of the CUAHSI HIS have now been adopted or modified for use within the Critical Zone Observatory (CZO) network. Software and further information may be obtained from http://his.cuahsi.org.

URL : http://his.cuahsi.org

Final ID: EP53B-09

Flow Processes and Sedimentation Associated with Erosion and Filling of Sinuous Submarine Channels

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Body: Sinuous submarine channels are common on all of Earth's siliciclastic continental margins. Approaches to studying flow processes and sedimentation of gravity flows in sinuous submarine channels is limited to direct measurements of the modern seafloor, physics-based numerical models, analytical solutions, physical experiments. While these approaches provide insight, no study documents distinctions in flow properties and sedimentation associated with erosion and filling of a natural sinuous submarine channel. Measurements from the modern seafloor cannot be used as their lifespan exceeds that of humans. Therefore, a sinuous submarine channel can not be monitored through its lifespan. However, outcrops of sinuous submarine channels and their fill contain a record of the erosional and depositional stages of the channel's evolution. The Beacon Channel of the Brushy Canyon Formation crops out on multiple cliff faces revealing two complete bends in the sinuous submarine channel.

This study uses measurements from a 3D exposure to document how flow properties and sedimentation differ between erosional and filling stages of channels. Two units, recording the sequential evolution of the channel are documented. Unit 1 records gravity flows that deepened and laterally migrated the channel. These gravity flows were mud-rich with a wide grain-size distribution. Flow heights exceeded the depth of the channel resulting in the deposition of levees. Strong secondary flow is evident with a helical pattern reversed to subaerial channels. Point bars have coarsening upward grain-size profiles. Point bars and levees were deposited by tractive processes. Unit 2 records gravity flows that filled the channel. These gravity flows were sand-rich with a relatively narrow grain-size distribution. Flow heights scaled to the depth of the channel, and they contain no evidence for secondary flow. Associated strata are horizontal and deposited primarily from suspension.

Final ID: EP54B-01

Global Overview On Delivery Of Sediment To The Coast From Tropical River Basins ***(Invited)***

J. P. Syvitski; [1]; *A. J. Kettner;* [1]; *G. R. Brakenridge;* [1];
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Body: Depending on definition, the tropics occupy between 16% and 19% of the earth's land surface, and discharge ~18.5% of the earth's fluvial water runoff. These flow regimes are driven by three types of sub-regional climate: rainforest, monsoon, and savannah. Even though the tropics include extreme precipitation events, particularly for the SE Asian islands, the general rainfall pattern alternates between wet and dry seasons as the ITCZ follows the sun and where annual monsoonal rain occurs. ITCZ convective rainfall is the dominant style of precipitation but this can be influenced by rare intra-tropical cyclone events, and by atmospheric river events set up by strong monsoonal conditions. Though a rainy season is normal (for example, portions of India discharge in summer may reach 50 times that of winter), the actual rainfall events are in the form of short bursts of precipitation (hours to days) separated by periods of dry (hours to weeks). Some areas of the tropics receive more than 100 thunderstorms per year. Rivers respond to this punctuated weather by seasonal flooding. For the smaller island nations and locales (e.g. Indonesia, Philippines, Borneo, Hainan, PNG, Madagascar, Hawaii, Taiwan) flash floods are common. Larger tropical river systems (Niger, Ganges, Brahmaputra, Congo, Amazon, Orinoco, Magdalena) show typical seasonally modulated discharges. The sediment flux from tropical rivers is approximately 17% to 19% of the global total — however individual river basins offer a wide range in sediment yields reflecting highly variable differences in their hinterland lithology, tectonic activity and volcanism, land-sliding, and relief. Human influences also greatly influence the range for tropical river sediment yield. Some SE Asian Rivers continue to be greatly affected by deforestation, road construction, and monoculture plantations. Sediment flux is more than twice the pre-Anthropocene flux in many of these SE Asian countries, especially where dams and reservoir emplacements do not impact sediment delivery, as is the case in most temperate regions.

Final ID: EP54C-01

Co-evolution of Soils and Landforms: Erosion Modelling over Decadal Timescales for Disturbed Lands

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Body: Landform evolution models (LEMs) have largely ignored temporal changes in the soils. Likewise fluvial erosion models have typically ignored temporal changes in soils. In both cases these changes in soils and erosion rates may be independent of (e.g. weathering of soils/rock particles), or dependent on (e.g. armouring due to selective entrainment) the fluvial erosion process. Typically, LEMs and erosion models have implicitly assumed that soils are constant in time and at equilibrium. This may be true for undisturbed sites but is unlikely to be true for disturbed sites. The high erosion rates on poorly managed agricultural lands typically lead to coarsening of the surface (i.e. desertification) over relatively short periods of time such as decades, so ought to be considered as part of any erosion assessment. For unnatural constructed landforms the issue is even more dramatic. Many of the mine and nuclear waste rehabilitation problems examined by the authors using LEMs over the last 20 years show, in the field, significant evolution of the surface erodibility at the decadal timescale. We conclude that the evolution of soils must be modeled explicitly to be able to predict landscape evolution over the decadal timescale. Some insights based on our recent work in quantitative pedogenesis models will be presented and we will show how current approaches used in LEMs are deficient, and propose a route forward. We will show that there are two important pedogenic timescales, (1) the surface of the soil and (2) the entire soil profile. We conclude that we must consider several timescales for soil evolution, that for the entire profile, and that for the surface alone. The evolution of the soil surface is an order of magnitude faster process than that of the entire profile. The evolution of the soil surface is likely to be dominant at the decadal timescale.

Final ID: H54E-01

Radar and Satellite Remote Sensing for Global and Regional Flood Prediction and Water Cycle Studies ***(Invited)***

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Body: Better understanding of the spatial and temporal distribution of precipitation, soil moisture, and evapotranspiration is critical to climatic, hydrological, and ecological applications. Recent development of radar and satellite remote-sensing techniques provides a unique opportunity for better observing these hydrological variables for regions where ground measurements are limited. We will present several applications of the remotely sensed products at global and regional for high-impact disasters (flood/landslide) prediction and hydrological cycle simulation through the integrated observation and modeling research framework.

URL : http://hydro.ou.edu
http://eos.ou.edu

Final ID: EP54B-02

The impact of an Indonesian river system on tropical coastal ecosystems: synthesis of results

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Body: Sediment input by tropical rivers into coastal waters appears to be one of the main driving factors for changes in coastal morphology and ecology. In the present study we focus on the Berau river basin (NE Borneo, Indonesia). The Berau river delta is made up of network of tidal rivers and estuarine channels that debouch into a relatively shallow shelf sea or lagoon with coral reefs. It is one of the most biologically rich marine sites in the world.The transfer of water and sediment from upland river catchments towards coastal waters and its impact on reef systems is studied by an interdisciplinary consortium of Dutch and Indonesian scientists (2006-2012).

Local sediment supply varies due to the monsoonal climate and ENSO events but is increasingly affected by human-induced changes in land-use patterns.In our study we focus on the origin, transport and fate of (fresh) water and suspended matter (SPM. At the apex of the channel network, field measurements of flow division suggest that the tidally averaged flow division depends on tidal range. In combination with the results of an idealized hydrodynamic and barotropic junction model we have determined that in particular the depth, length, the e-folding length scale of the channel width and the hydraulic roughness of the channels are crucial factors in the distribution of water and SPM. At tidal junctions though more local (and intratidal) processes will become relevant as well, such as the presence of a secondary circulation. Due to a limited degree of mixing in the estuarine channels, in the river mouth water masses are frequently stratified giving way to the development of buoyant plumes. According to our field measurements and model simulations with a three-dimensional hydrodynamic model (ECOMSED), it is evident that tidal currents play a major role in the behaviour of these plumes. Tides affect the plume by causing vertical mixing, by stratifying the plume due to tidal straining and by transporting fresh water to the Northeast, toward the delta front barrier reef.

Based on ecological parameters such as, e.g. coral cover and partial mortality, a clear zonation in coral reefs is observed. In zone 1, the coastal lagoon, coastal reefs are facing a turbid and low light environment. The delta front barrier reef belongs to an intermediate zone (zone 2), whereas the oceanic reefs are subject to the most favourable conditions for delta growth (zone 3). In further detail, coral cores provide a useful proxy to assess the time-dependent changes in sediment supply since they incorporate terrigenous sediments in their skeleton. Coral cores covering a period of almost 30 years demonstrate that sediment supply towards coral reefs clearly diminishes during El Nino years. However, and for the time being, the coral cores show no evidence of a significant increase in overall sediment load in recent years.

Final ID: H54E-02

Exploring river - wave dominated delta evolution applying a model-coupling approach

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Body: Deltas are the important interface between continents and oceans, providing home to over half a billion people. The unique environment supports a wide variety of diverse ecosystems and is highly susceptible to a broad spectrum of interacting forces. Therefore it is critical to understand its current and future changes, especially against the background of climate change and human impact, something that could be explored by studying its historical evolution process. Delta evolution is mainly governed by: a) sediment load supply from its contributing river, and 2) ocean dynamics (e.g. waves, tides). Fluvial sediment supply to a delta fluctuate over time either e.g. due to shifts in climate or, on shorter time scales, due to human interference (e.g. deforestation which could increase sediment supply or the emplacement of dams and reservoirs that reduces the sediment supply). How does this affect the morphology of a delta? Waves interact on deltas by dispersing fluvial sediment, reshaping its shoreline. For instance, deposited sediments could become resuspended by wave interaction, and as a result the majority of the fluvial sediment will be deposited on the opposite side from the dominant wave direction. So will these wave activities significantly influence delta evolution?

To study this, we explored hypothetical delta evolution scenarios given the following boundary conditions: a medium size upstream drainage basin (~80,000km2) with, as base case, a typical Mediterranean climate. The analysis is done through coupling two numerical models, HydroTrend and CEM. HydroTrend, a climate-driven hydrological transport model, is applied to replicate freshwater and sediment flux to the delta, and subsequently a coastline evolution model (CEM) is applied to simulate the according changes in the delta's coastline morphology. A component-modeling tool (CMT) developed by CSDMS, is used to couple the models for this study. Several scenarios are considered by stepwise increasing fluvial sediment supply (change in climate) under random timing in inland, combining oceanic wave actions.

Preliminary model experiments will be presented demonstrating: 1) the capability of the CMT to couple models that represent different process domains and were developed and designed independently (i.e. without the intentions of such coupling), 2) the impact of changes in fluvial sediment on deltas, and 3) the importance of wave activities on coastline evolution.

Final ID: C54B-03

Testing of SIR (a transformable robotic submarine) in Lake Tahoe for future deployment at West Antarctic Ice Sheet grounding lines of Siple Coast

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Body: A remotely operated vehicle (ROV) has been custom-designed and built by DOER Marine to meet scientific requirements for exploring subglacial water cavities. This sub-ice rover (SIR) will explore and quantitatively document the grounding zone areas of the Ross Ice Shelf cavity using a 3km-long umbilical tether by deployment through an 800m-long ice borehole in a torpedo shape, which is also its default mode if operational failure occurs. Once in the ocean cavity it transforms via a diamond-shaped geometry into a rectangular form when all of its instruments come alive in its flight mode. Instrumentation includes 4 cameras (one forward-looking HD), a vertical scanning sonar (long-range imaging for spatial orientation and navigation), Doppler current meter (determine water current velocities), multi-beam sonar (image and swath map bottom topography), sub-bottom profiler (profile sub-sea-floor sediment for geological history), CTD (determine salinity, temperature and depth), DO meter (determine dissolved oxygen content in water), transmissometer (determine suspended particulate concentrations in water), laser particle-size analyzer (determine sizes of particles in water), triple laser-beams (determine size and volume of objects), thermistor probe (measure in situ temperatures of ice and sediment), shear vane probe (determine in situ strength of sediment), manipulator arm (deploy instrumentation packages, collect samples), shallow ice corer (collect ice samples and glacial debris), water sampler (determine sea water/freshwater composition, calibrate real-time sensors, sample microbes), shallow sediment corer (sample sea floor, in-ice and subglacial sediment for stratigraphy, facies, particle size, composition, structure, fabric, microbes). A sophisticated array of data handling, storing and displaying will allow real-time observations and environmental assessments to be made. This robotic submarine and other instruments will be tested in Lake Tahoe in September, 2011 and results will be presented on its trials and geological and biological findings down to the deepest depths of the lake. Other instruments include a 5m-ling percussion corer for sampling deeper sediments, an ice-tethered profiler with CTD and ACDP, and in situ oceanographic mooring designed to fit down a narrow (30cm-diameter) ice borehole that include interchangeable packages of ACDPs, CTDs, transmissometers, laser particle-size analyzer, DO meter, automated multi-port water sampler, water column nutrient analyzer, sediment porewater chemistry analyzer, down-looking color camera (see figure), and altimeter.

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The Role of Vegetation in the Forms of Tropical Lowland Deltas ***(Invited)***

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Body: Numerical experiments using a morphodynamic model (Delft3D) simulating the unsteady, non-uniform turbulent transport and deposition of sediment show that sediment cohesion plays a major role in determining the shapes, cumulative number of distributaries, and wetland areas of river-dominated deltas. We conducted 30 simulations in which a steady river discharge of 1000 m^3 s^{-1} carried varying equilibrium concentrations of two grain sizes (cohesive mud and noncohesive sand) into a standing body of water devoid of waves, tides, and buoyancy. The basin had an initial slope of 0.000375 and initial depths that range from 1 to 3.5 meters. Various degrees of cohesion were simulated by varying the bed shear stress necessary for mud re-entrainment. Elongate deltas with rugose shorelines and topographically rough floodplains are created if the incoming sediment is highly cohesive. Fan-like deltas with smooth shorelines and flat floodplains are created by less cohesive sediment. Highly cohesive sediment creates resistant levees that confine the flow, thereby causing sediment deposition basinward of the levee termini and progradation of channels far into the basin. Less cohesive sediment creates levees that are “leaky” and water is fed to the entire delta topset through numerous crevasses. Although tropical lowland vegetation was not modeled per se, we conjecture that its effect will be similar. Small patches of vegetation in critical areas should bind sediment, thereby stabilizing river mouth bars and cause more distributary channel bifurcations. Root-binding on levees should reduce the frequency and occurrence of delta-top leakage and crevasses. Because delta planform morphology is determined by the number and hydraulic geometry of its distributary channels, it follows that tropical lowland deltas should be more rugose that arid deltas, all other factors being equal. Pre-Devonian deltas built prior to the rise of land plants seem to support this idea: braid-deltas are thought to be more common during that time. If true, then perturbations to vegetation due to changes in sediment, salt, and nutrient fluxes and relative sea level rise could significantly modify tropical lowland deltas. Further work should be directed towards determining the two-way coupling between the ecological communities of the delta top and the geomorphic substrate.

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The late-Holocene progradation of the Mahakam Delta, Indonesia – A case study of tidal, tropical deltas

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Body: The Mahakam Delta is an oft-cited example of a mixed fluvial-tidally influenced delta. Yet the distinct separation of the tide-dominated delta plain and the fluvial distributaries make the delta unique amongst tidally influenced deltas. The delta prograded an average of 60 km over the last 5000 years. Most sediment transport is induced by tidal currents and fluvial discharge, which resulted in a distinct, dense network of distributary and tidal channels. In order to characterize the Holocene sedimentary architecture we describe a dataset of 10 new cores and a large survey of very high-resolution, shallow seismics. The seismics are recorded using an echosounder with a novel parametric source, allowing subsurface penetration in excess of 15 m while achieving a vertical resolution of 0.2 m.

Distinct sedimentary facies are described in detail for delta plain, delta front, distributary and mouthbar deposits. A notable difference in stratal pattern has been observed between the inner and outer tide-dominated delta plain facies. The inner tidal channels cut deeply into the underlying deltafront deposits and form a distinct heterogenic laterally accreting and intercutting facies. Whereas the outer tide-dominated delta plain deposits accrete conformably on the marine deltafront facies and show a much more homogenous sedimentary architecture. The continual reworking of the inner tide-dominated delta plain results in a patchwork of deposits greatly varying in thickness and age albeit with a similar silty clay lithology.

The area of the present-day delta was largely flooded after the early to mid-Holocene transgression, our data indicate that a small branch of fluvial distributaries was active on the current delta plain around 5 ka. Subsequently, the northernmost fluvial distributary built out rapidly over a period of 3 kyrs. The southern distributaries built out later, from 2 ka to the present. The mouthbar deposits in the south are significantly thicker than in the northern branch, indicating a strong spatial differentiation in subsidence or in paleobathymetry. The outbuilding of the fluvial distributaries provided the shallow, sheltered and vegetated areas which allowed rapid aggradation and progradation of the tide-dominated delta plain. Records of avulsions are not found in the Mahakam Delta due to the rapid infill of the delta and floodplain, inhibiting the creation of a possible superelevation of the fluvial channels. The tidal plain processes are sufficiently capable of trapping sediment and consequently aggrading to keep up with the fluvial distributaries. Additionally, the tidal discharge in the main distributaries and strong bank stabilising vegetation have kept the main distributaries in place during the entire progradational event. Little to no lateral shifting has occurred over the entire period despite the large number of distributaries active currently. In general channel networks in tidal deltas with strong vegetation seem to be dominantly controlled by mouthbar induced bifurcations and not by nodal avulsions or lateral migration.

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Imaging beneath the skin of large tropical rivers: System morphodynamics of the Fly and Beni Rivers revealed by novel sub-surface sonar, deep coring, and modelling ***(Invited)***

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Body: Tropical rivers dominate Earth's fluvial fluxes for water, carbon, and mineral sediment. They are characterized by large channels and floodplains, old system histories, prolonged periods of flooding, and a clay-dominated sediment flux. However, the underlying bed & floodplain strata are poorly understood. Available data commonly stem from skin-deep approaches such as GIS analysis of imagery, shallow sampling & topographic profiling during lower river stages. Given the large temporal & spatial scales, new approaches are needed to see below lag deposits on mobile sandy beds & deep into expansive floodbasins. Furthermore, such data are needed to test whether we can interpret large tropical river morphology using analogies to small temperate systems. Systems in a dynamic state of response to sea level rise or an increase/contrast in sediment load would provide especially valuable insight.

Last August we conducted a field campaign along the Fly and Strickland Rivers in Papua New Guinea (discharge ~5,350 CMS) and this September we investigated the Beni River in Northern Bolivia (discharge ~3,500 CMS). Results were obtained using a novel measurement method: a high-power (>4kW) dual-frequency SyQwest sub-bottom profiler customized to best image 10-20m below the river/lake bed in shallow water. We were able to distinguish sandy deposits from harder clay and silt lenses and also collected bed grab samples to verify our sonar results. Deep borehole samples (5-15m), bank samples, and push cores confirmed observations from the sonar profiling. We simultaneously collected side-scan sonar imagery plus DGPS records of water/bed elevations that could be used to parameterize numerical models.

We have now analyzed these results in some detail. Findings for the Fly River include: 1) The prevalence of hard clay beneath the bed of the Lower Fly River and many locations along the Strickland River, retarding migration; 2) Unusual bed morphology along the lower Middle Fly River, where the channel negotiates "dog-leg" meanders and traverses a bed composed of a stacked sequence of fine layers; 3) An ancient channel network buried below the current bed of Lake Murray, indicating a ~10m rise in the Strickland River near that location; 4) The prevalence of clay in many of our deep cores throughout the Strickland, Fly, and Lake Murray floodplains; and 5) 14-C dating of deep cores which indicates that the entire Fly River system aggraded >10m rapidly during the mid Holocene. It appears that clay units dominate large portions of the channel bed. Furthermore, this clay often appears to control the morphodynamics of the channel -- as observed in the field and substantiated with modelling in Delft3D.

We have recently completed a similar sonar/coring survey of 100s of km of the Beni River in Northern Bolivia. Particular attention was paid to the subsurface structure of meander bends, with an aim of understanding the controls on migration rates in this rapidly evolving system. Results are compared to GIS and modelling analyses of channel migration.

We conclude with a synthesis of how cohesive clay-rich lithology can potentially play a major role in orchestrating the channel morphodynamics and Holocene evolution of a range of large tropical rivers.