

2017 CSDMS Annual Meeting: Modeling Coupled Earth & Human Systems - The Dynamic Duo

The **Community Surface Dynamics Modeling System** serves as a
Science Gateway
to support the
development, integration, archiving & dissemination of software to
define Earth's surface dynamics

Jai Syvitski, CSDMS *Outgoing* Director

Greg Tucker, CSDMS *Incoming* Director



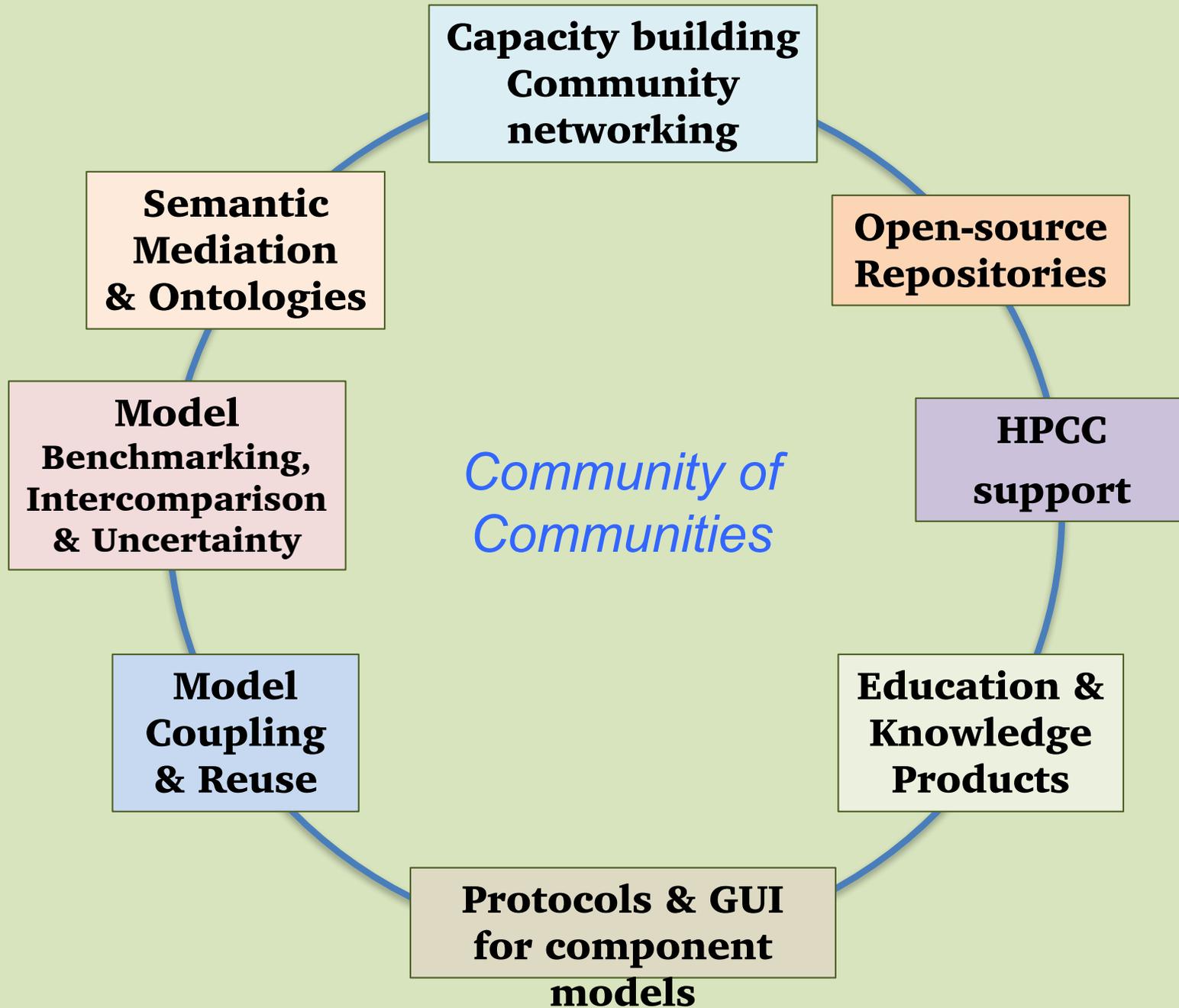
CSDMS
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

FUNDAMENTAL QUESTIONS MOTIVATING CSDMS SCIENTISTS:

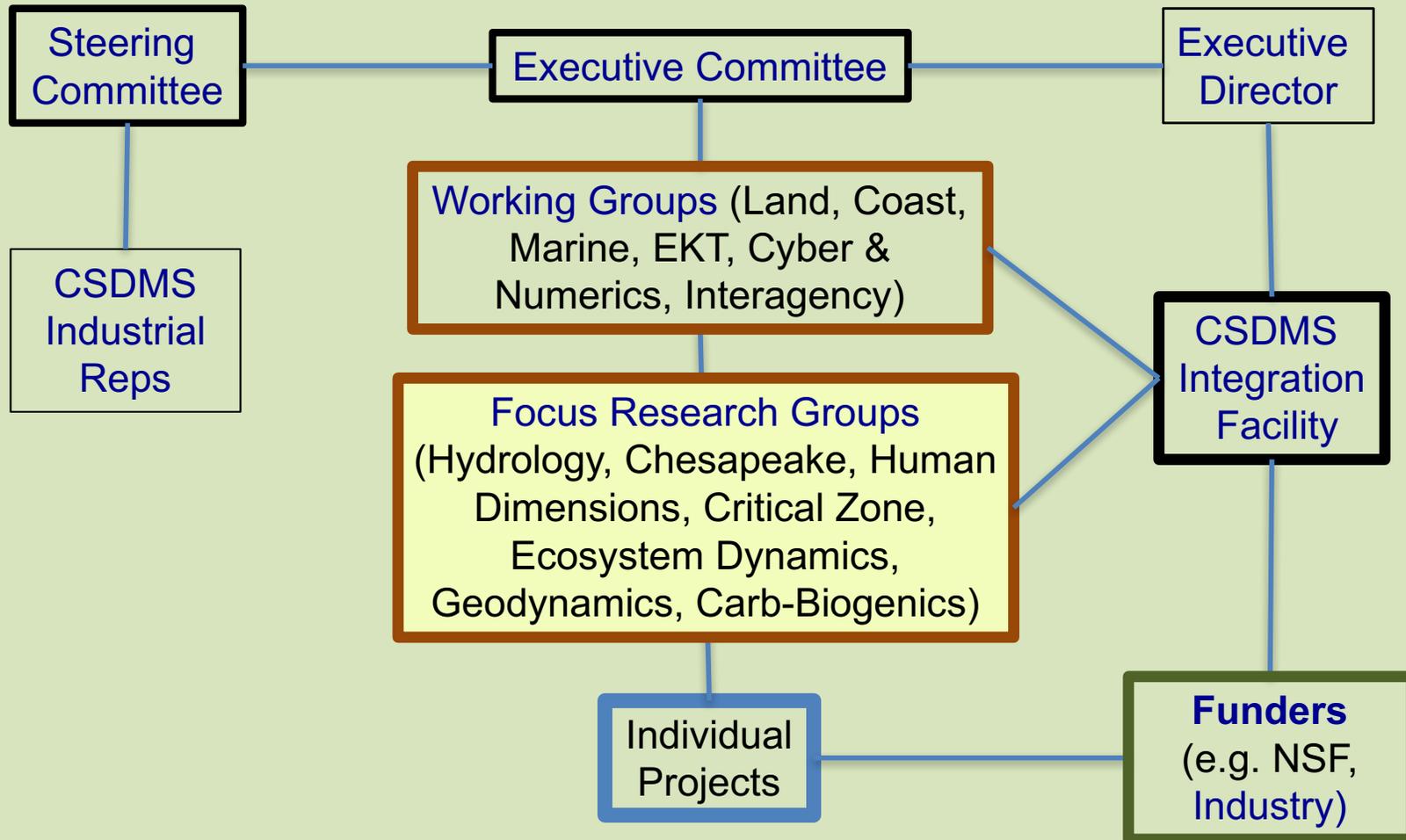
1. How do **TRANSPORT PROCESSES** interact with properties of morphology, geology, ecology, climatology, oceanography and human activities?
2. What processes support self-organization and **PATTERN FORMATION** in surface systems?
3. How do **MATERIAL FLUXES** and **SURFACE EVOLUTION** vary across time and space scales? How are these fluxes recorded in **SEDIMENTARY DEPOSITS**?
4. How are physical, ecological & human processes **COUPLED** within **SURFACE SYSTEMS** and constrained by Earth's interior and Earth's atmospheric dynamics?



2.0 Functions



CSDMS Governance



For every CSDMS IF \$, NSF gives 13\$ to CSDMS-affiliated projects (\$64M/5 yr).
Other agencies increase this 13:1 force multiplier.



Capacity building, Community networking

150 members added per year
from 550+ Institutions (academic, government,
industry) located in 69 countries

United States	914	Norway	9	Sweden	5	Ghana	2	Burma	1
China	80	Argentina	8	Switzerland	5	Mexico	2	Cambodia	1
United Kingdom	77	Poland	8	Vietnam	5	Philippines	2	Ecuador	1
Canada	44	Portugal	8	Iran	4	Saudi Arabia	2	Iraq	1
India	43	Belgium	7	Israel	4	Singapore	2	Jordan	1
France	40	Chile	7	Malaysia	4	Thailand	2	Kazakhstan	1
Netherlands	38	Denmark	6	Russia	4	United Arab Em.	2	Kenya	1
Italy	30	Japan	6	Taiwan	4	Uruguay	2	Morocco	1
Germany	29	New Zealand	6	Hungary	3	Venezuela	2	Nepal	1
Spain	17	Nigeria	6	Peru	3	Algeria	1	Qatar	1
Australia	14	Pakistan	6	Romania	3	Armenia	1	South Africa	1
Brazil	12	Colombia	5	Turkey	3	Austria	1		
Indonesia	12	Egypt	5	Cuba	2	Bolivia	1		
South Korea	12	Greece	5	El Salvador	2	Bulgaria	1		
Bangladesh	11	Ireland	5						

Working Groups

Terrestrial	740
Coastal	580
Marine	370
EKT	240
Cyber	220

Focus Research Groups

Hydrology	590
Geodynamics	150
Carbonate & Biogenics	110
Human Dimensions	100
Critical Zone	95
Chesapeake	80
Ecodynamics	80

Initiatives

Coastal Vulnerability	110
Continental Margins	60



Functions

**Capacity building
Community
networking**



New Group Co-Chairs:

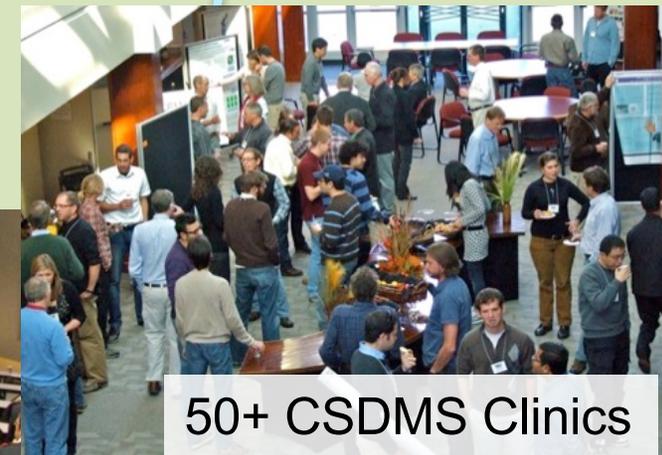
Kim de Mutsert- Ecosystems Dyn. FRG

Moira Zellner- Human Dimensions FRG

Mary Hill- Hydrology FRG

Scott Peckham-

Cyber & Numerics WG



UNDERWORLD2

Kudryavtsev Model

FROST MODEL

PyDeltaRCM

SiStER

CLUMONDO

LaMEM

DynEarthSol3D

AnugaSed

RivMAP

DAKOTATHON

MCPM

ILAMB

**Open-source
Repositories**

River Network Bed-Material Sed

SLAMM

- Diffusive → ADM → SWEM → RANS → LES → DNS
- Boussinesq → non-hydrostatic → non-Boussinesq
- FDM → FVM → FEM; Explicit → implicit
- 1D → 2D → 3D
- Eulerian → Lagrangian → PIC
- Steady-state → Non-steady state; Abiotic → Biotic
- Newtonian → non-Newtonian
- Depositional → Post-depositional
- Time marching → Compute & drift → Event-based
- Local → regional → global
- Social Science (e.g. ABM, IAM, GEM, LULC)

Domain	Models	Tools	Compliant
Terrestrial	80	75	7
Coastal	61	7	7
Marine	49	7	4
Hydrology	62	45	20
Carbonate & Biogenics	3	4	1
Climate	12	4	2
Geodynamics	13	1	1



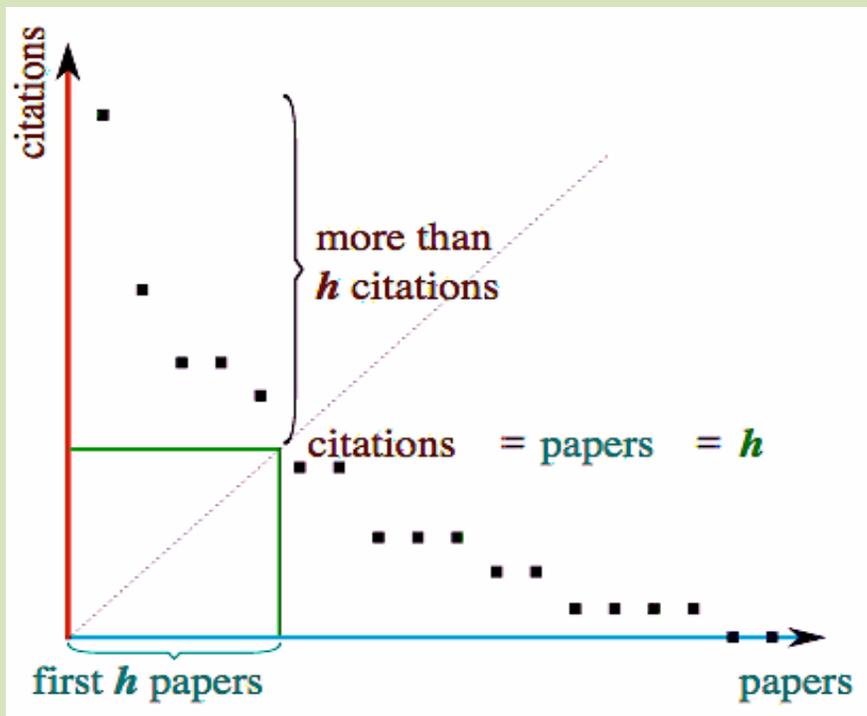
csdms-contrib

Models & tools by CSDMS members
csdmssupport@colorado.edu



CSDMS provides:

- 1) **Citation Indices** for both **model overview** and **model application** pubs.
- 2) **Model Metadata** including a DOI (Digital Object Identifier) for each stable model version
- 3) **Model Code**
- 4) **Version Control** through Github.



**Open-source
Repositories**

Model info

Authors [\[Expand\]](#)

Source code [\[Collapse\]](#)

- [Go to external source code site](#)

DOI [\[Collapse\]](#)

- [Download CHILD version:](#)

2010.07.06

Doi: 10.1594/IEDA/100102

Model citations [\[Collapse\]](#)

Citation indicesCHILD

Citations: 4171

h-index: 28

QR-code [\[Collapse\]](#)



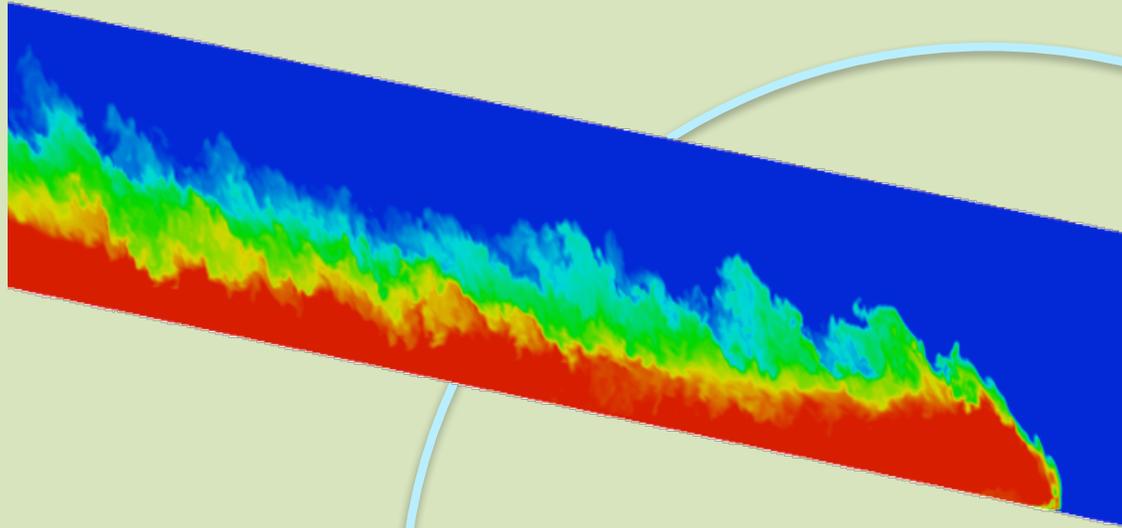
[Link to this page](#)

Other models by this author [\[Expand\]](#)



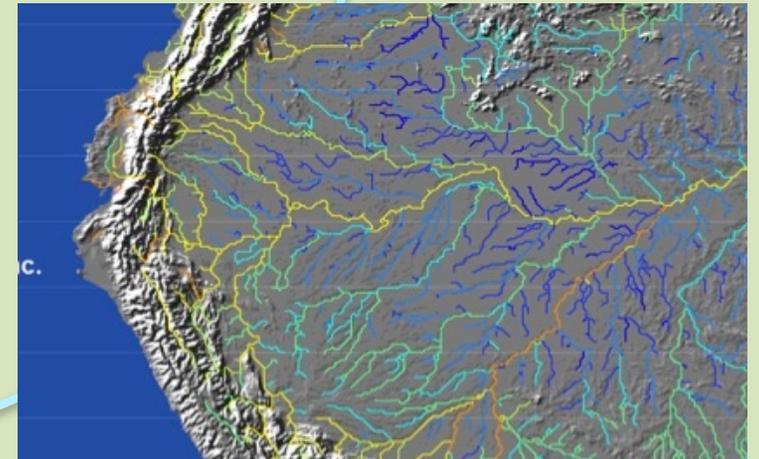
CSDMS Functions

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



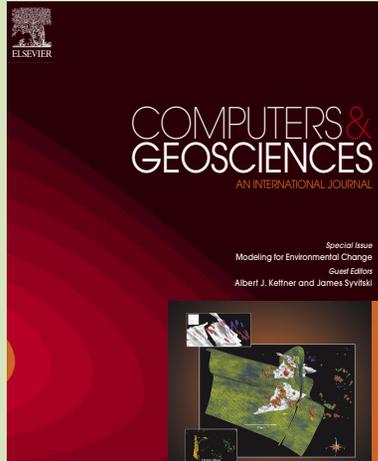
**HPCC
support**

<i>Beach:</i>	<i>RAM/core</i>	<i>IC bandwidth</i>	<i>Peak TFLOPS</i>
704-3GHz cores,	2-4 GB/c,	21GB/s,	8TFlop/s
<i>Janus:</i>			
16,416-3.2GHz cores,	2 GB/c,	40GB/s,	153TFlop/s
<i>Summit:</i>			
9,960-3.3GHz cores,	5-42 GB/c,	100GB/s,	>400TFlop/s



CSDMS Functions

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



CSDMS Special Issues

- 1 Marine Transport Modeling
- 2 Stratigraphic Modeling
- 3 Modeling Environmental Change
- 4 Model Uncertainty & Sensitivity

On Line Services

- ✧ Student labs (31)
- ✧ Modeling short courses (9)
- ✧ Lectures (300+);
- ✧ Textbooks (6)
- ✧ Global domain datasets (84)
- ✧ 145 movies on the CSDMS YouTube channel
- ✧ Science on a Sphere (9 datasets and labs)
- ✧ 600+ daily views of the CSDMS web portal on average

Education & Knowledge Products



EKT Repository: Quantitative toolbox

- Tagged by **concepts**: heat flow, diffusion, flow routing, mass continuity, shallow water equations, settling rates, drag force, flocculation, fluid flow, Darcy's flow, stability/torque balance, compaction, waves, uncertainty
- Tagged by **discipline**: hydrology, sedimentology, geomorphology, oceanography, general climate/earth science/global change.
- Tagged by **domain**: terrestrial, coastal, marine
- Tagged by **level**: K6-12, undergraduate, graduate
- Tagged by **model difficulty progression**: examine data or simulation movies → complete a simple calculation → carry out a 3-5 parameter model exercise → model a realistic case study.

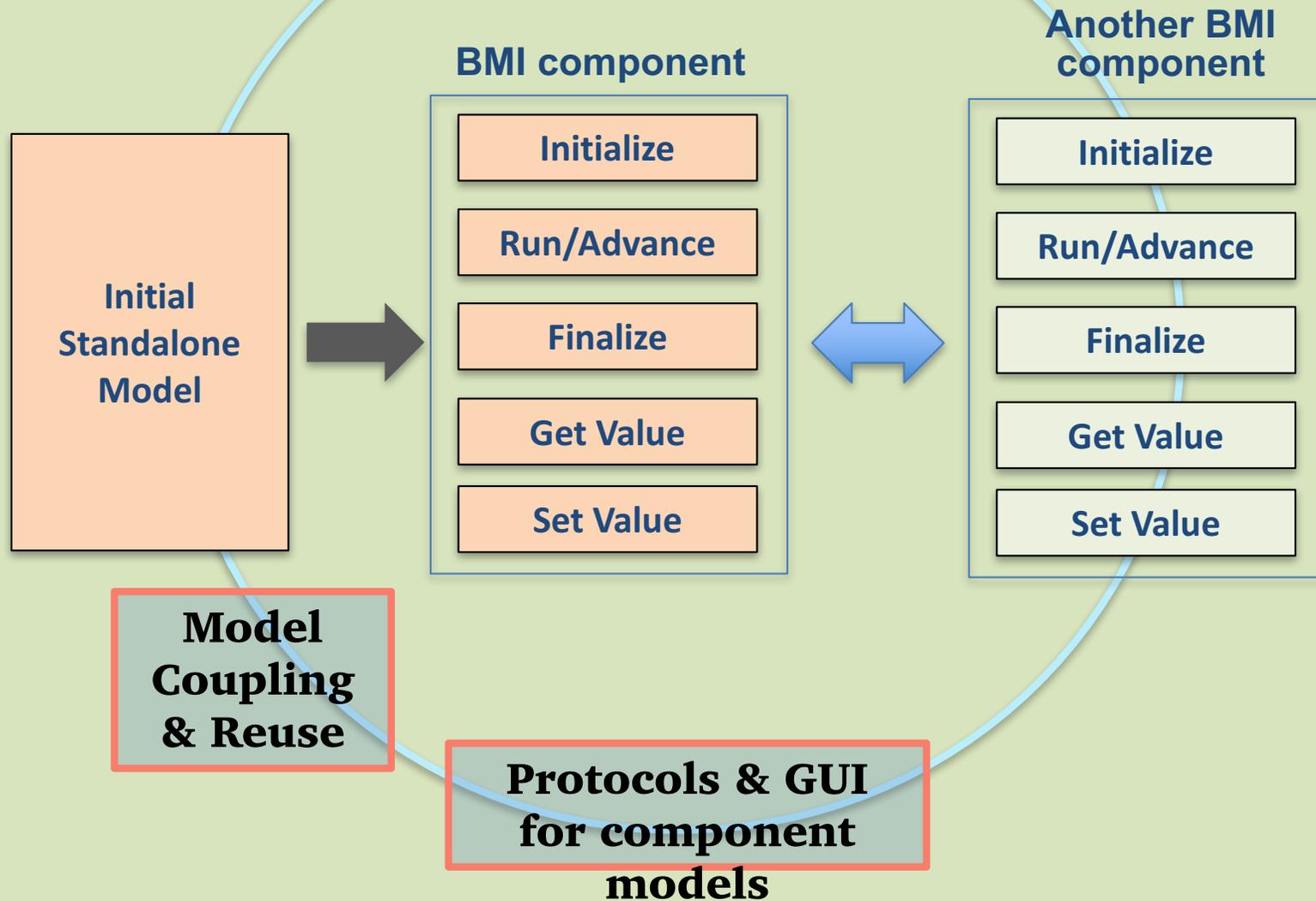
**Education &
Knowledge
Products**



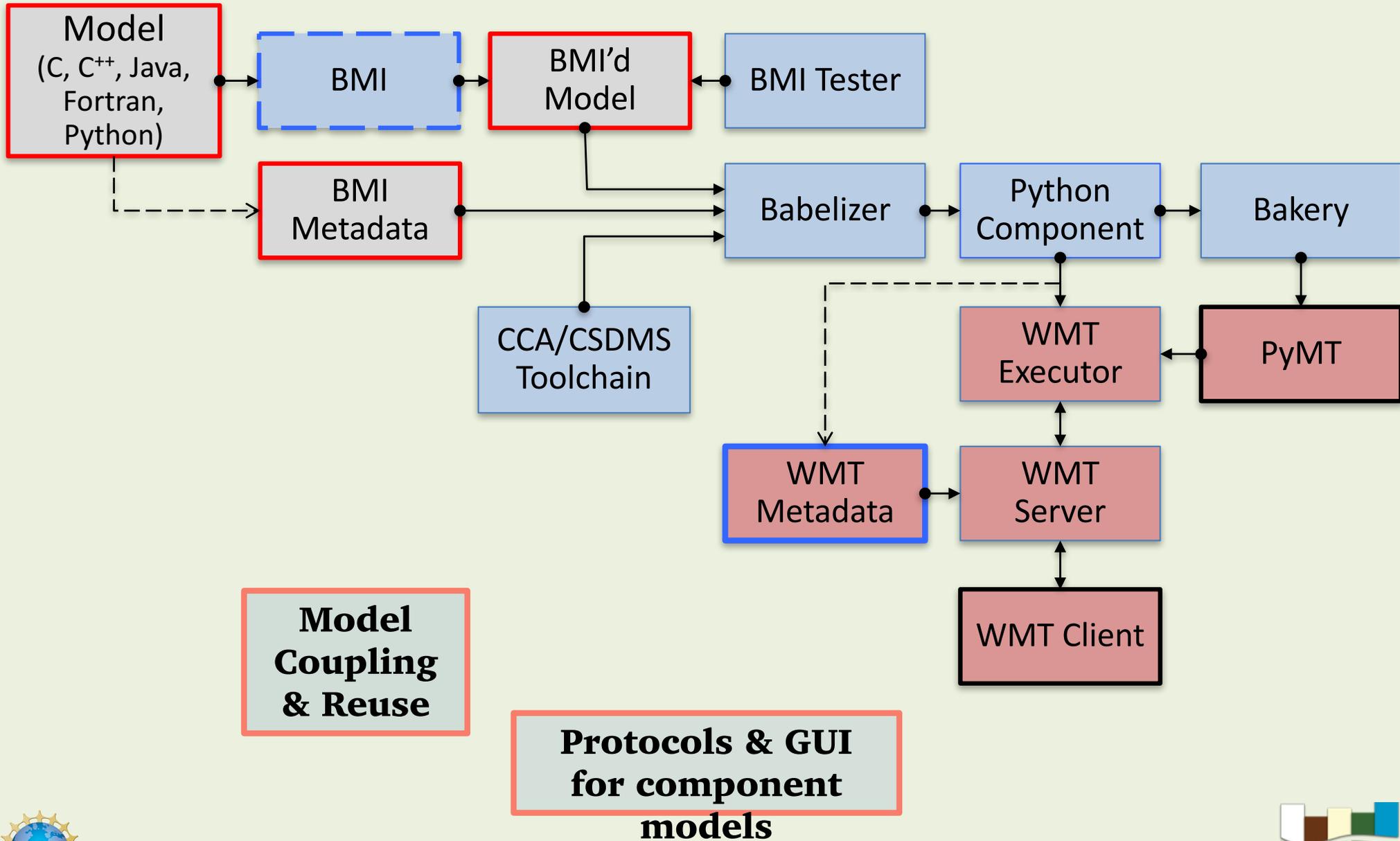
CSDMS Functions

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

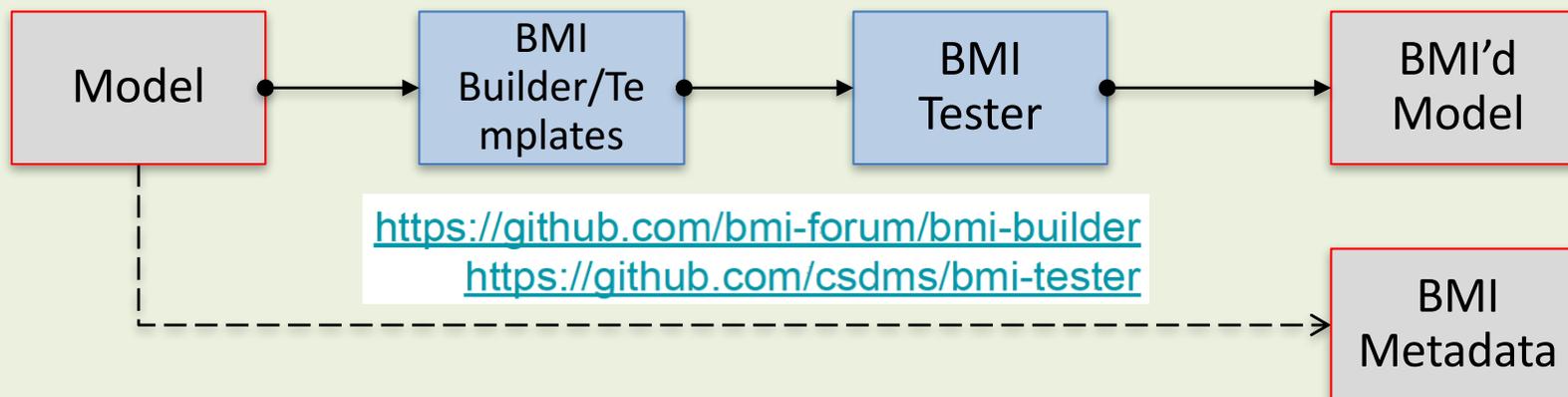
CSDMS Basic Model Interface or BMI standard is a distillation of key ingredients of major coupling systems.



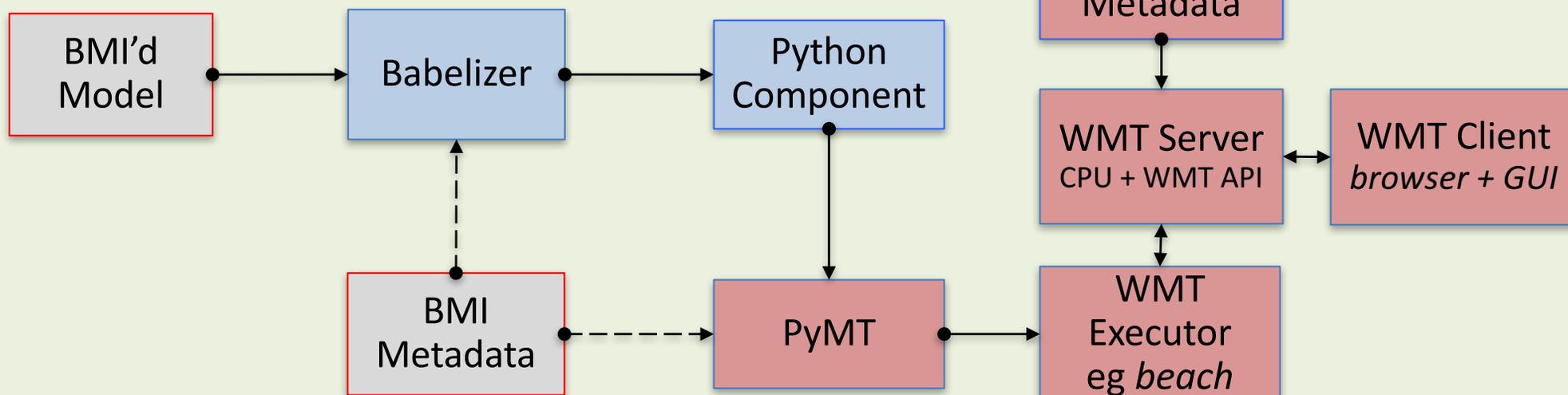
The CSDMS Process: Model → Component → WMT - PyMT



CSDMS Tools help developers add a BMI to their model.



The CSDMS Babelizer makes a BMI'd model speak Python, and consists of Babel, Bocca, Ccaffeine, and CSDMS scripts.

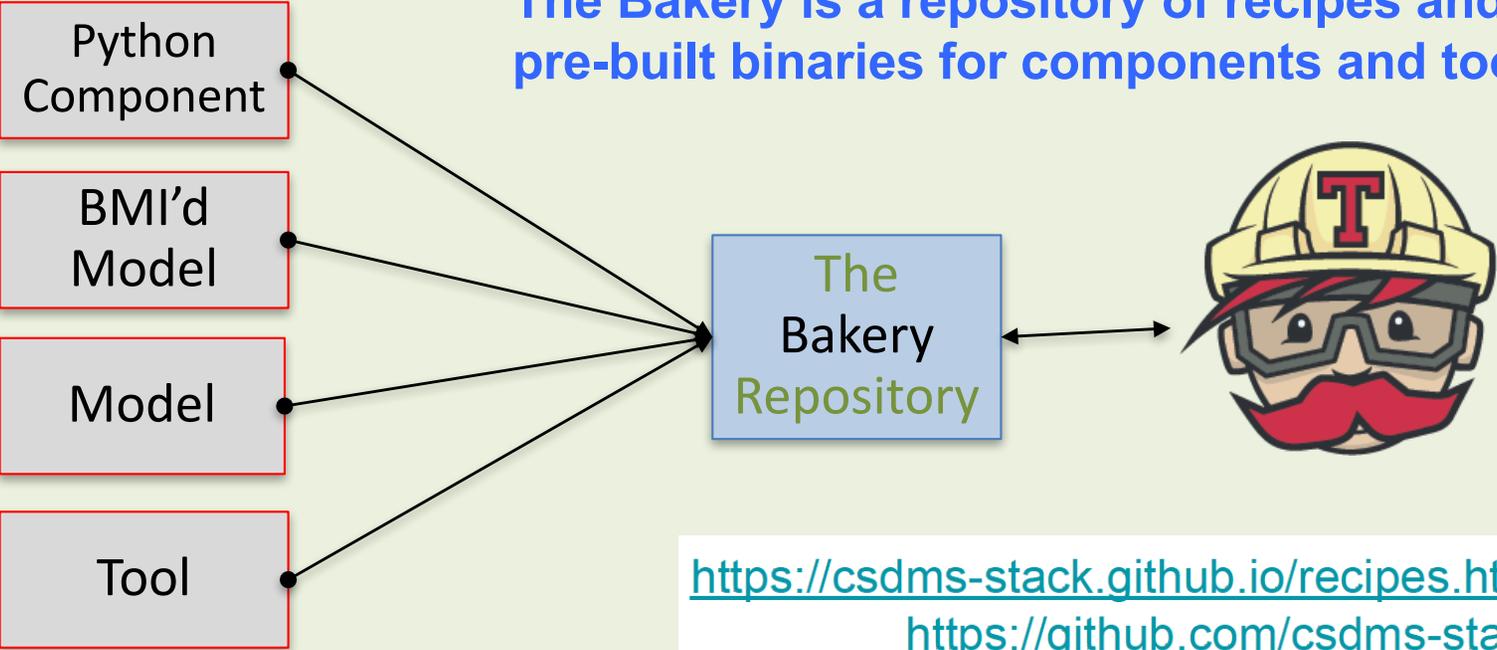


<https://github.com/csdms/pymt>
<https://github.com/bmi-forum/babelizer>

PyMT forms the basis of the executor portion of the model-coupling triad.



The Bakery is a repository of recipes and pre-built binaries for components and tools



**Model
Coupling
& Reuse**

**Protocols & GUI
for component
models**



**Semantic
Mediation
& Ontologies**

**Model
Benchmarking,
Intercomparison
& Uncertainty**

Standard Names uses a variable naming template:

object name + [**operation name**] + **quantity name**

Developers provide a *mapping dictionary* of I/O variables using CSDMS Standard Names, and a *Model Metadata File* with units, grid type, etc



A Multilevel Parallel Object-Oriented Framework for:

- Design Optimization
- Parameter Estimation
- Uncertainty Quantification
- Sensitivity Analysis

✧ *DAKOTATHON uncertainty tool*

✧ *ILAMB benchmarking tool*

Initial CSDMS Initiators & heroes

1st CSDMS meeting 2002, Boulder



CSDMS DC-Agency meeting 2003



Pat Wiberg



Greg Tucker



Brad Murray



Chris Paola



Rudy Slingerland



Dave Furbish



Jai Syvitski

Community Surface Dynamics Modeling System (CSDMS)

Implementation Plan Workshop

Minneapolis, Minnesota

2nd CSDMS meeting 2004

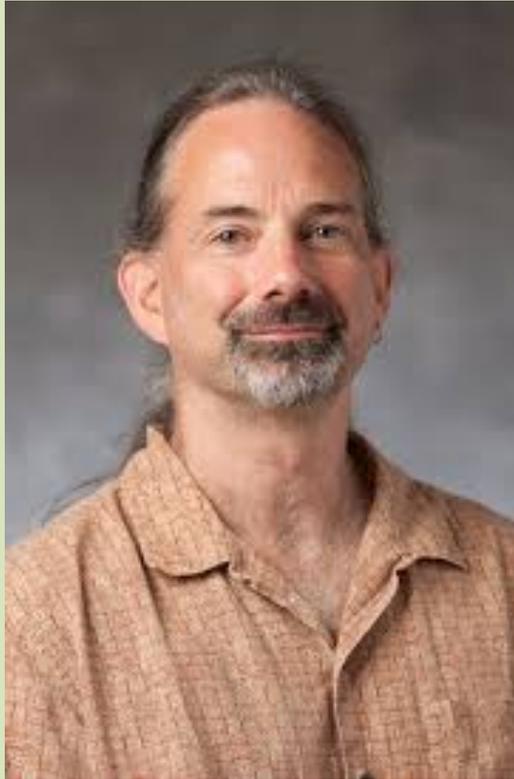
May 8 - 10, 2004



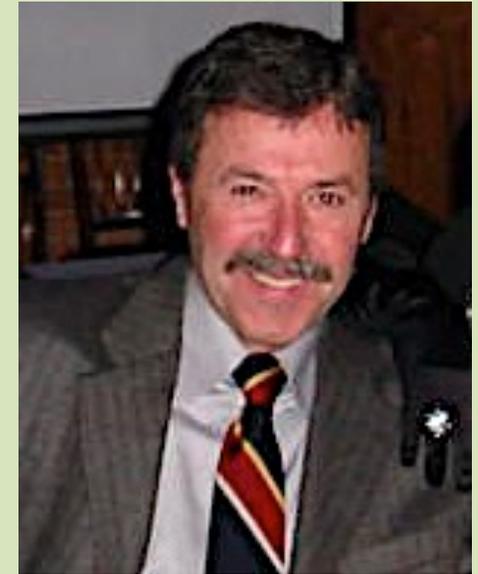
We herald in new CSDMS leadership with the recent and unanimous election of Professor Brad Murray as SC Chair and thank Professor Pat Wiberg for her wisdom, insight and kindness



Pat Wiberg
SC Chair 2012-2017



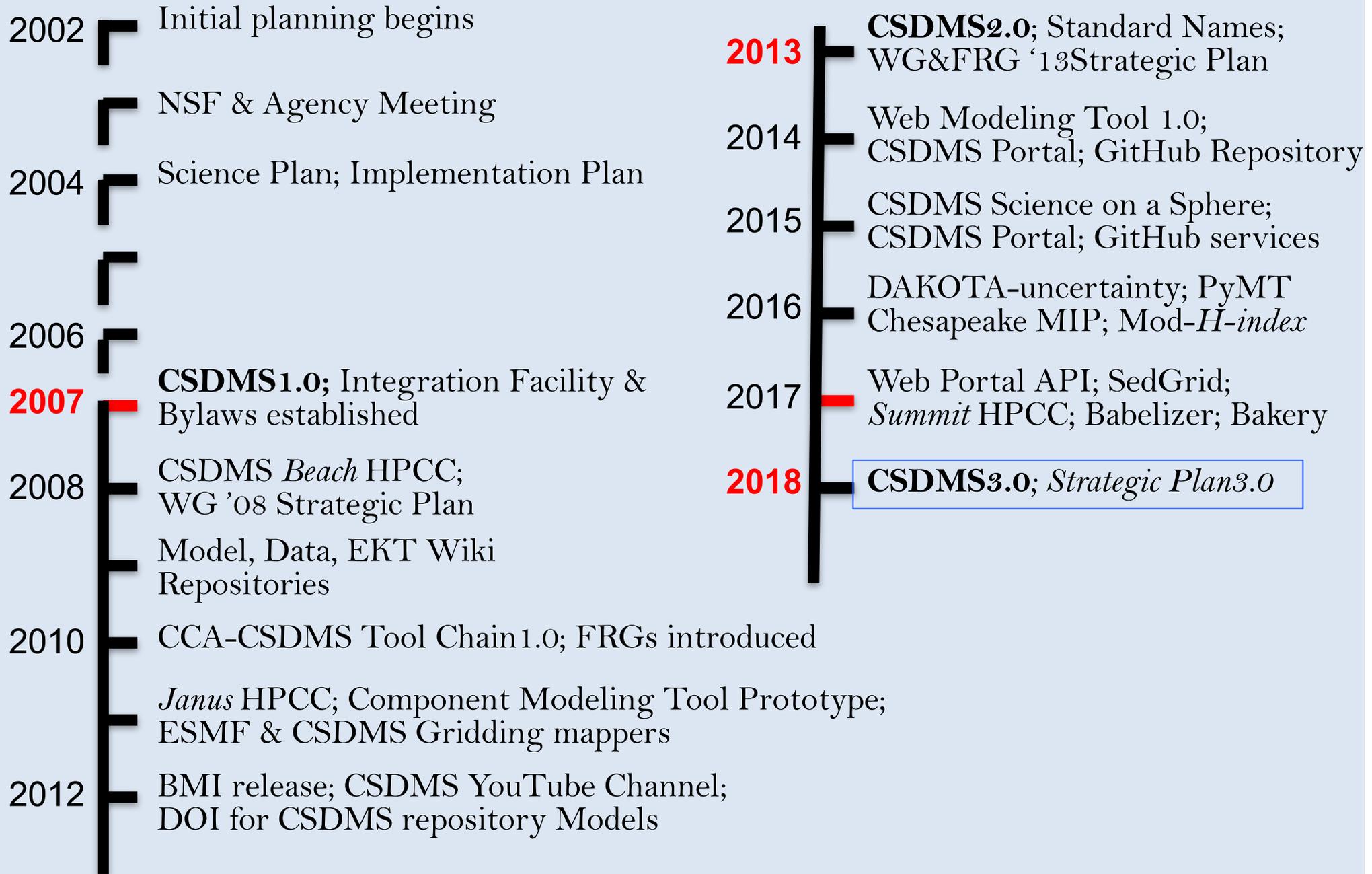
Brad Murray
SC Chair 2017—



Rudy Slingerland
SC Chair 2007-2012



CSDMS History



2017 CSDMS Integration Facility Staff & Associates



Greg Tucker
Incoming Director



Lynn McCready
Executive Assistant



Eric Hutton
Senior Software
Engineer



Irina Overeem
Education Officer



Albert Kettner
Cyber Com & Data



Mark Piper
Software Engineer



Mariela Perignon
Software Engineer



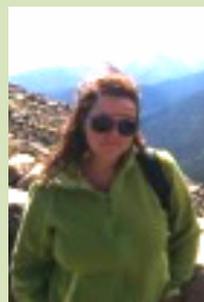
Chris Jenkins
Marine Data



Kimberly Rogers
Human Dimensions



Bob Brakenridge
Dir, Flood Observatory



Chrystal Pochay
Accountant



Chad Stoffel
IT



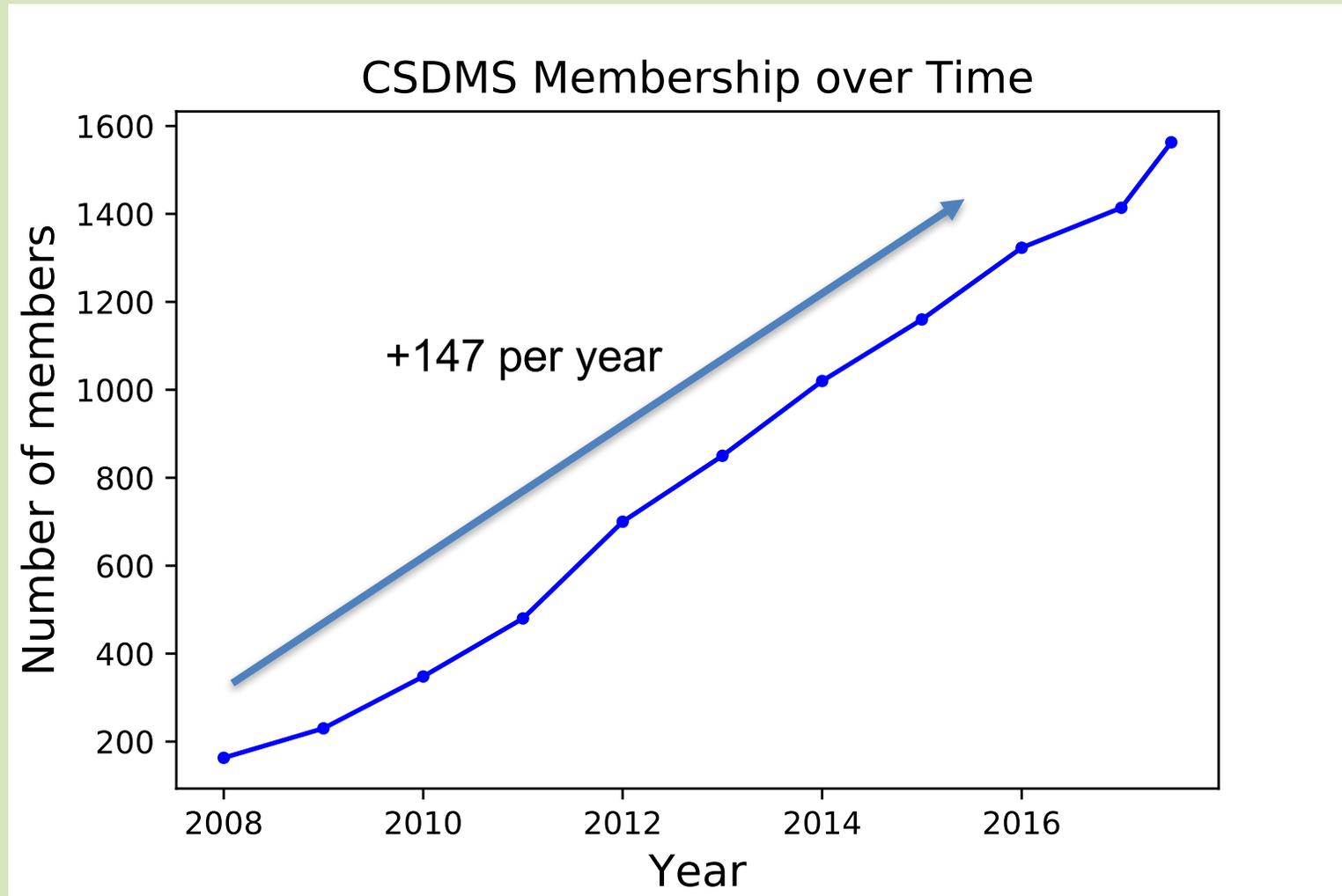
2017 CSDMS Annual Meeting:
Modeling Coupled Earth & Human Systems
- The Dynamic Duo

CSDMS 3.0:

**Learning from the past,
Looking forward to the future**

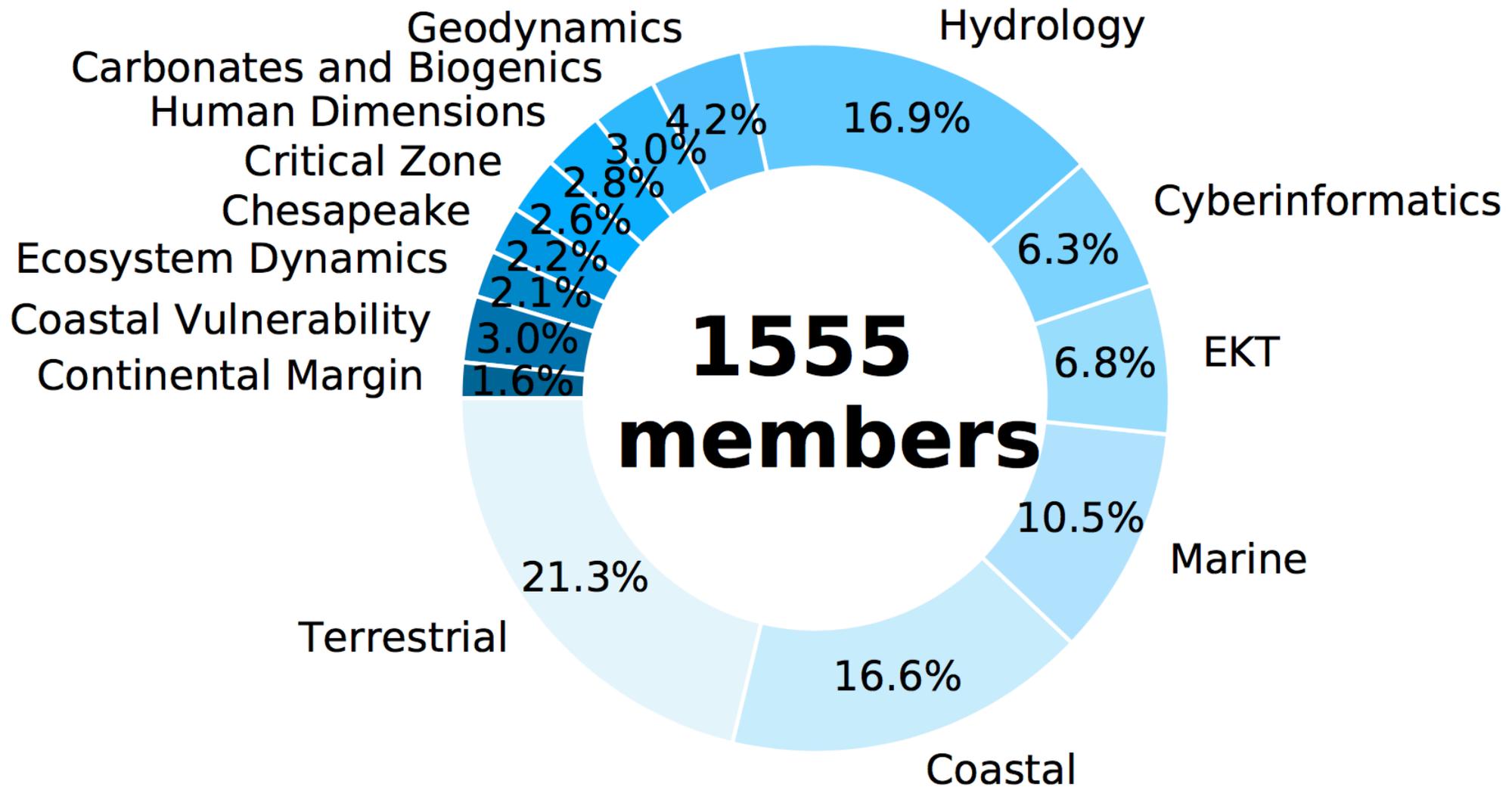


CSDMS: a growing community



“In a world of almost infinite data, it is code and software that turn data into information and knowledge.” – Teal (2017)





“The grand challenges of today ... require convergence: the merging of ideas, approaches and technologies from widely diverse fields of knowledge to stimulate innovation and discovery..” – (NSF, 10 Big Ideas)



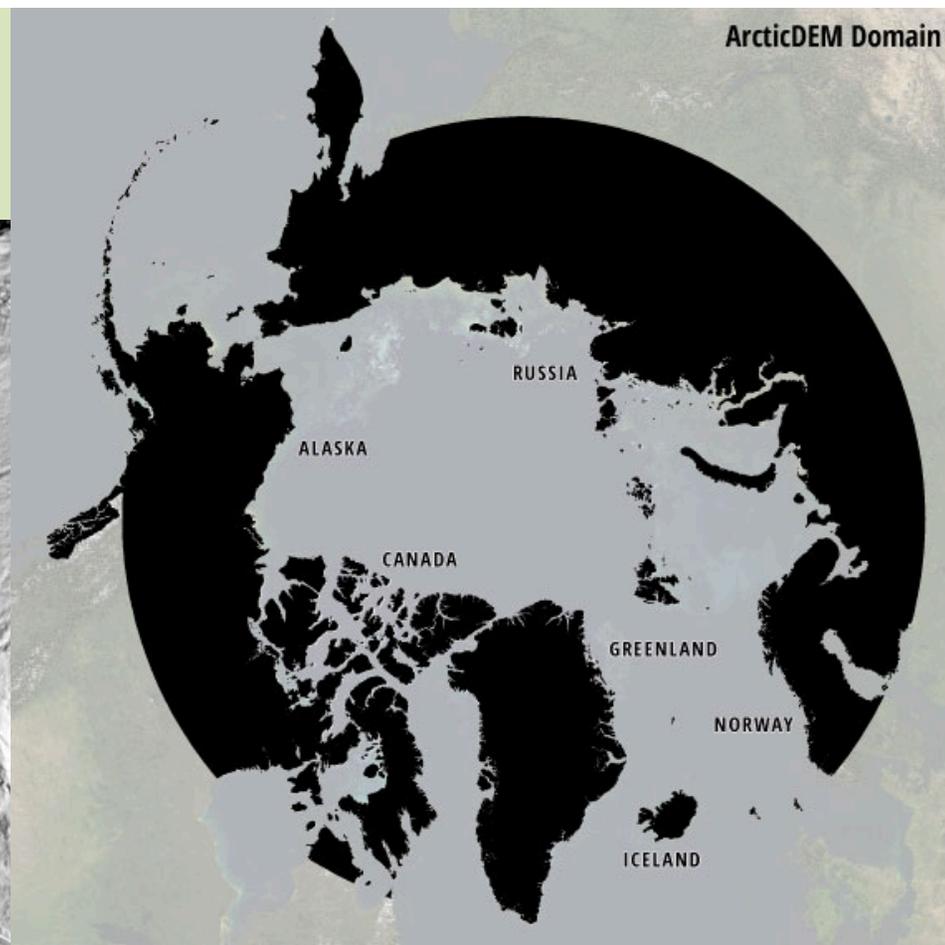
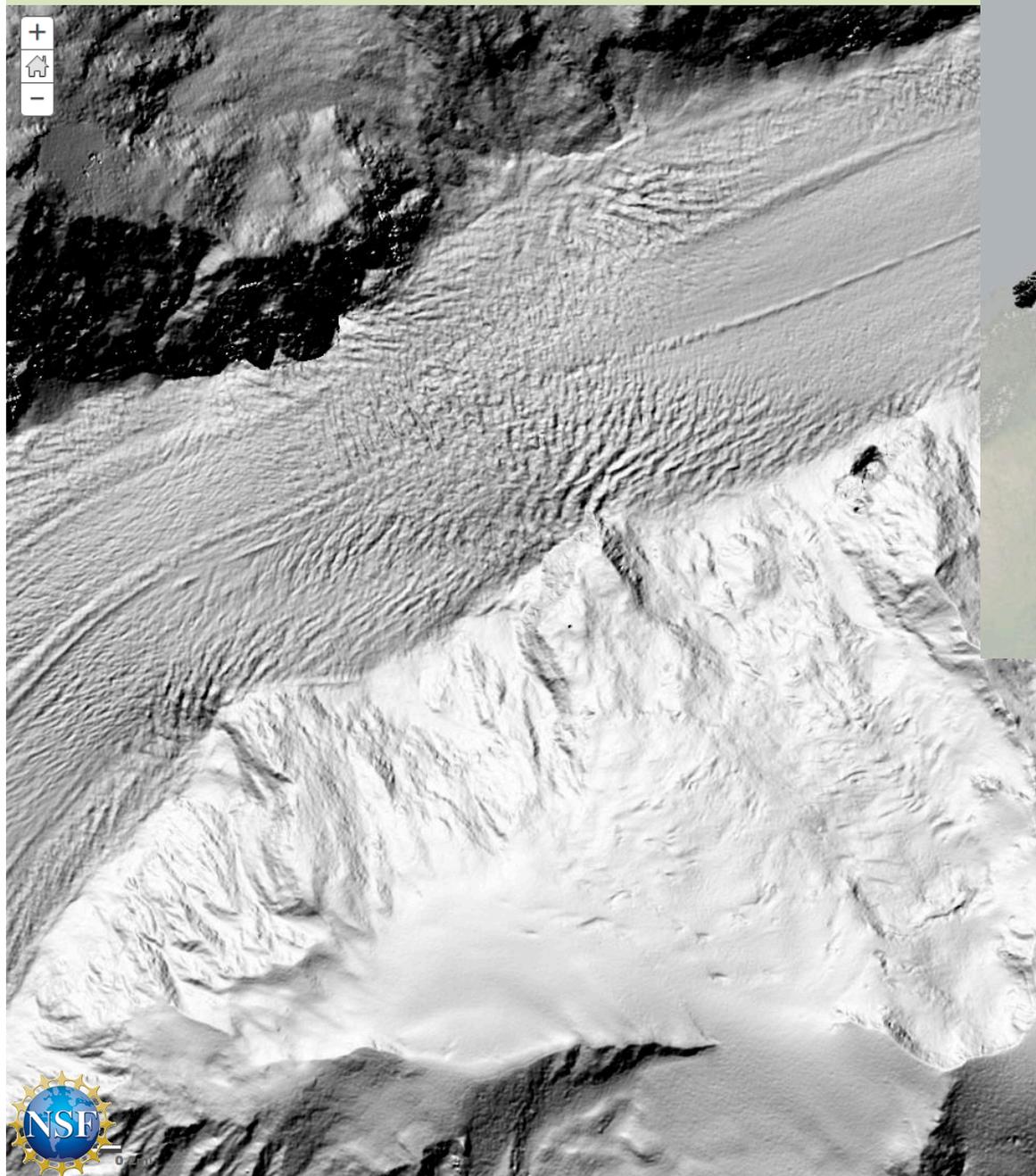
2016 Annual Meeting: Capturing Climate Change

Results from breakout group discussions → CSDMS 3.0

**→ *Model-Data Synthesis in Earth-Surface
Science and Applications***

Toward a more predictive science of the earth's surface

ArcticDEM: high-resolution (1-5 m), pan-Arctic, repeatable satellite photogrammetry

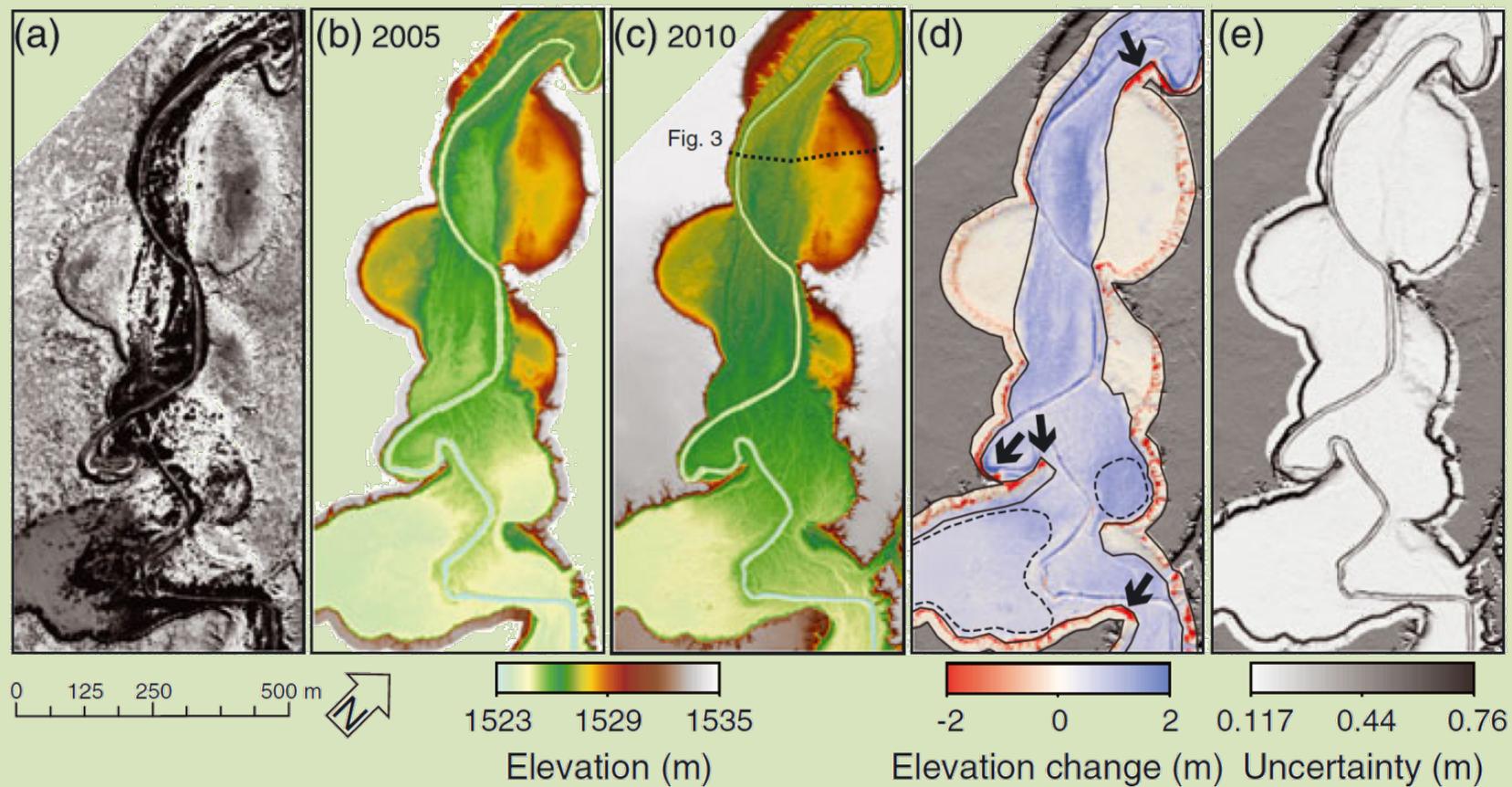


<https://www.pgc.umn.edu/data/arcticdem/>



Example of LiDAR differencing for change detection

Rio Puerco, NM, LiDAR difference images
2010 minus 2005



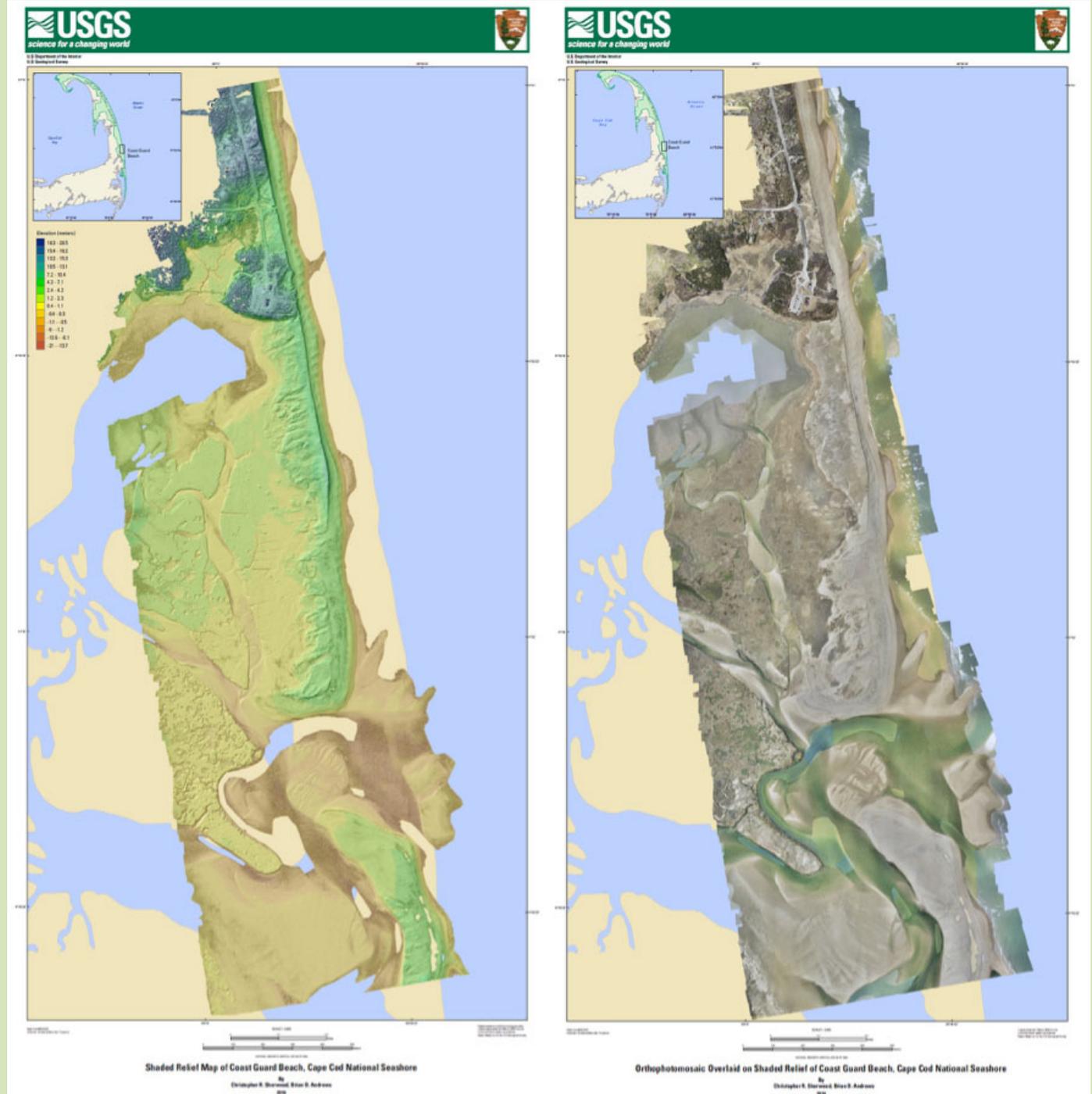
(Perignon et al., 2013)



First USGS Coastal Maps from Unmanned Aerial Systems

By Chris Sherwood

June / July 2016

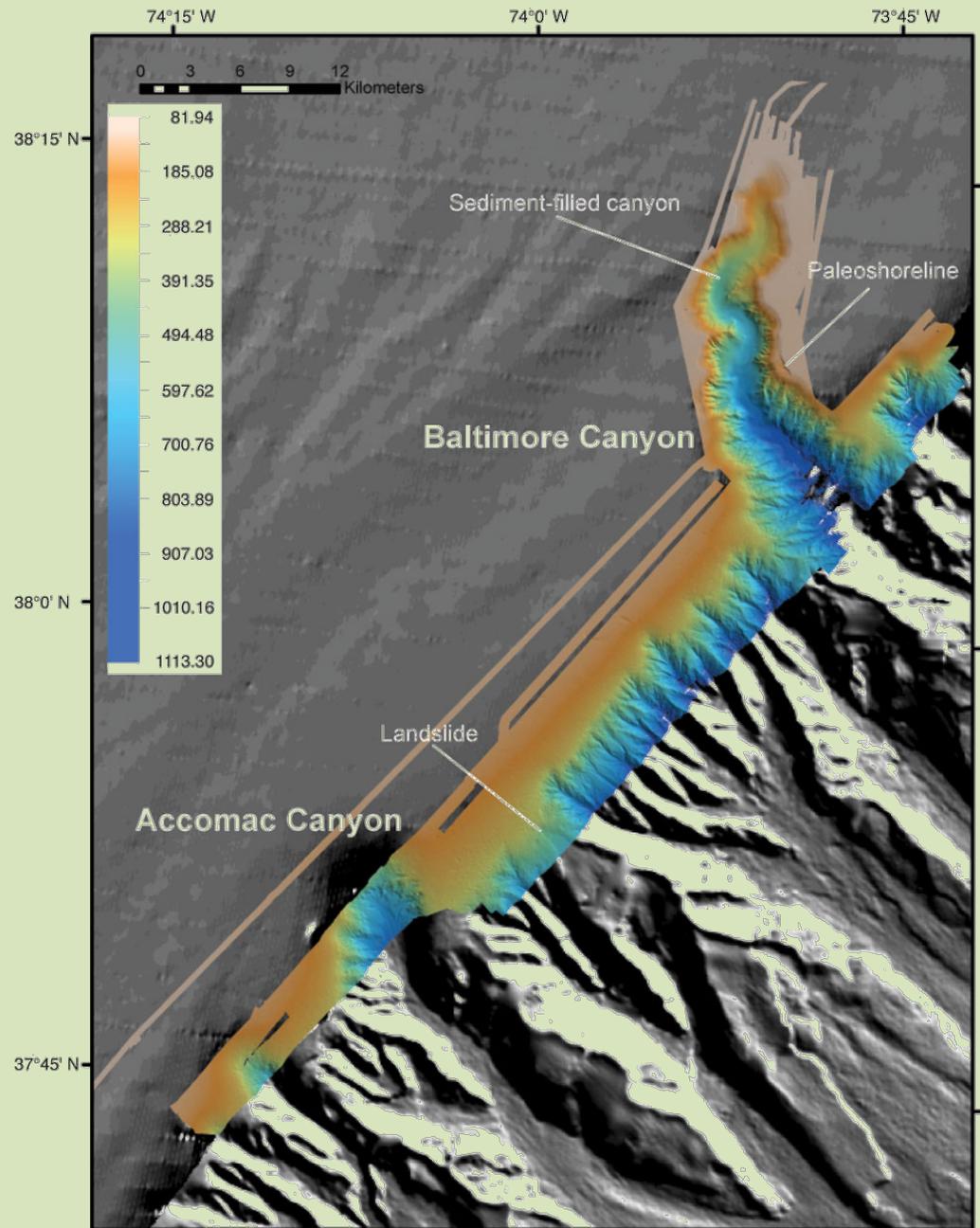


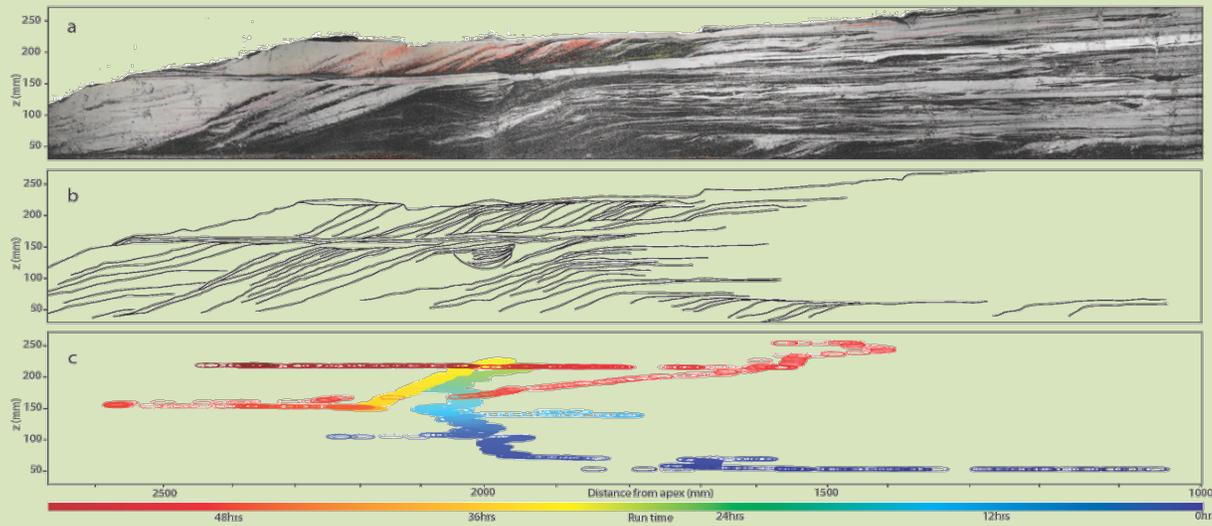
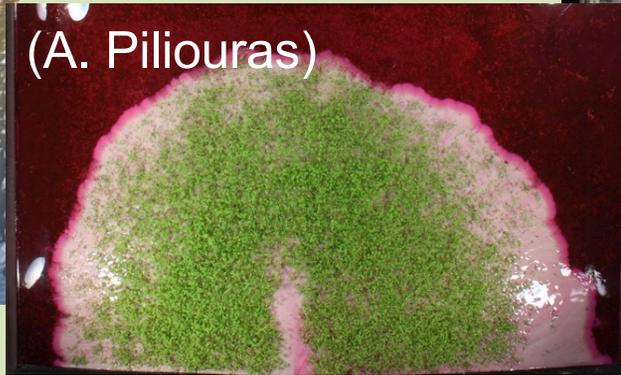
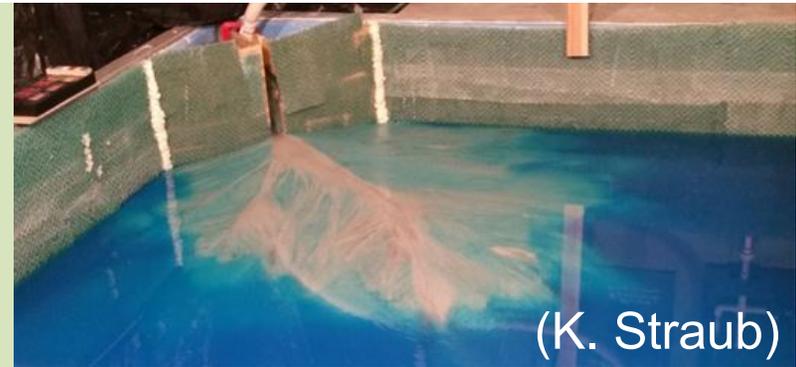
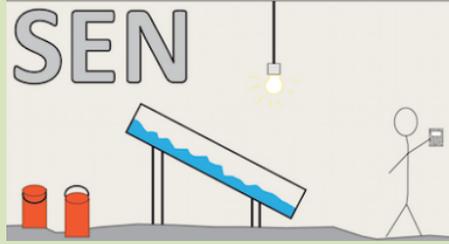
High-Resolution Multibeam Mapping of Mid-Atlantic Canyons to Assess Tsunami Hazards

By [Jason Chaytor](#) and [Daniel Brothers](#)

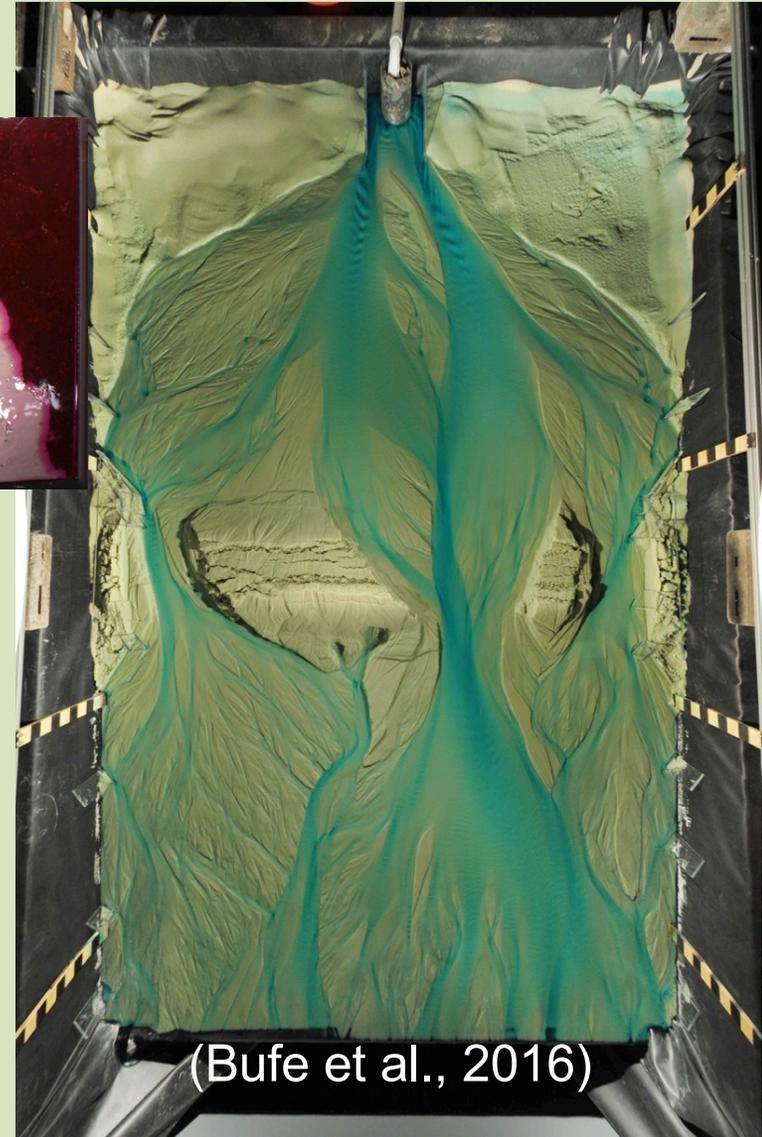
Sept. / Oct. 2011

Multibeam bathymetry
5—10 m horizontal resolution





(Mahon et al., 2015)



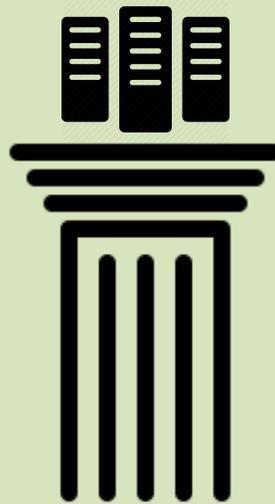
Meeting the challenge ... in three pillars

*share resources,
collaborate*



**COMMUNITY
SUPPORT**

*create, run, test, and
apply models*



**COMPUTING
RESOURCES**

learn and teach



**EDUCATION
OPPORTUNITIES**

CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



CSDMS 3.0: education & training

- EKT Group and Repository
- Clinics
- Pre/post-meeting workshops
- **Webinars**
- **Hackathons**
- ***CSDMS Summer Schools***

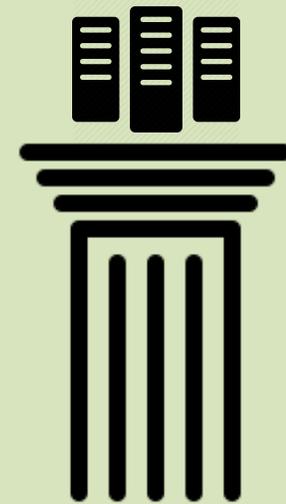


**EDUCATION
OPPORTUNITIES**



CSDMS 3.0: computing resources

- Basic Model Interface (BMI)
- Web Modeling Tool → *Python* ...
- *Uncertainty tools*
- **BMI for data & web API**
- **GIS / geospatial capability**
- **Landlab integration**
- **Upgrade to BEACH**
- ***Python Modeling Tool (PyMT)***

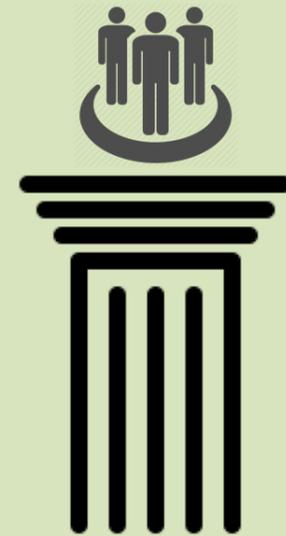


COMPUTING
RESOURCES



CSDMS 3.0: community support

- Annual meetings
- Hosted workshops
- **Enhanced** model repository
- **Cryosphere Focus Group**
- **Project and proposal support**
- ***Science Teams***
(*a.k.a. Science Steering Committees*)



COMMUNITY
SUPPORT



CSDMS 3.0

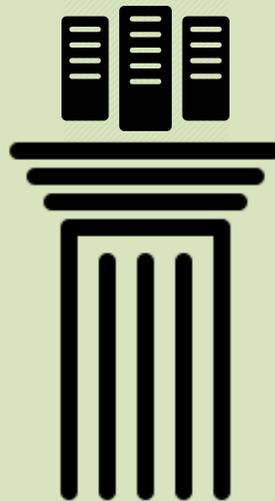
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

*share resources,
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SUPPORT**

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**COMPUTING
RESOURCES**

learn and teach



**EDUCATION
OPPORTUNITIES**



csdms@colorado.edu



2017 CSDMS Annual Meeting: Modeling Coupled Earth & Human Systems - The Dynamic Duo



csdms@colorado.edu





1) Linking Earth System Dynamics & Social System Modeling, May 23-25 2016 Boulder CO USA

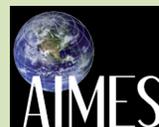


2) Modeling Challenges for Sustainability, Sept 27-30 2016, Kyoto, Japan



3) Integrated Modeling of Socio-Environmental Systems, Mar 13-15 2017, Potsdam, Germany

4) Modeling Coupled Earth & Human Systems - The Dynamic Duo, May 23-25 2017, Boulder CO USA



2017 Annual Meeting Theme *The Dynamic Duo*

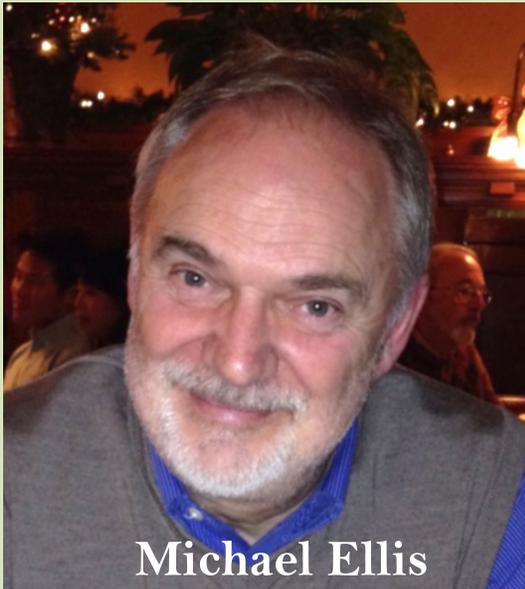
Tuesday	Wednesday	Thursday	Friday
Welcome talks (3)	Plenary Keynotes (2)	Plenary Keynotes (3)	ExCom Meeting
Plenary Keynotes (2)	Plenary PyMT Demo		
Discussion Breakout (6) <i>Nat & Social Modeling</i>	Group Business Meetings (5)	Clinics (4)	Steering Committee Meet
Lunch	Lunch	Lunch	Lunch
Clinics (4)	Clinics (4)	Plenary Keynotes (3)	
Plenary Keynotes (2)	Posters	Group Business Meetings (5)	
Posters	Banquet	Final Remarks Departures	2017 Best Poster Award

Modeling Clinics: *Landlab & Dakota, ANUGA, SiSteR, ABM, PERMAFrost, BMI: Live!, LANDLAB1.0, CSDMS EKT, Landlab Toolkit, Best Practices, SEN, ParFlow, EcoPath & EcoSim*

CSDMS Group Business Meetings: i) Goal updates, ii) CSDMS3.0



2017: Program Director's Award



Michael Ellis

*Oversaw CSDMS initiation at NSF.
First chair of Anthropocene FRG
(renamed Human Dimensions FRG).*

- BGS Director *Land, Soil & Coast*, and formerly —
- BGS Director, Climate & Landscape Change
- BGS Head, Climate Change Science
- Founder & first AGU Chair, *Earth & Planetary Surface Processes*
- NSF Director, Geomorphology & Land-use Dynamics

Student Modeler Award

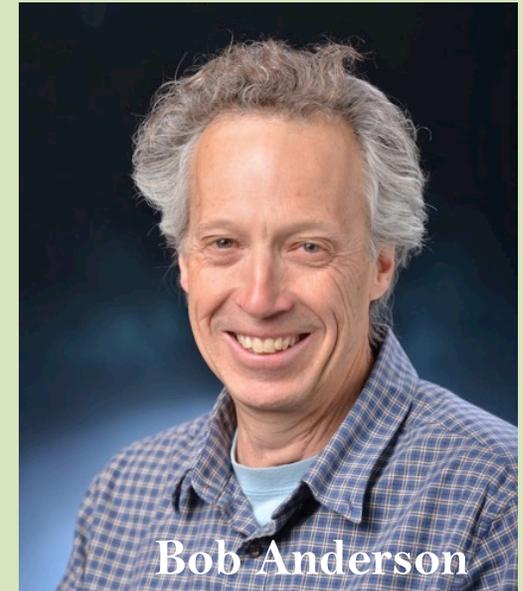


Julia Moriarty

*“Coupling Sediment Transport
& Biogeochemical Processes:
Role of Resuspension on O₂ &
Nutrient Dynamics”*

- Ph.D candidate @ VIMS
Physical & Geological
Oceanography
- NSF East Asia & Pacific
Summer Institute Fellow,
Academia Sinica, Taiwan
- George R. Healy Fellowship
Awardee, College of William
& Mary

Life-time achievement Award



Bob Anderson

*Outstanding CSDMS model developer
(aeolian transport, arctic coastal
erosion, glacier dynamics, fjords, etc.)*

- CU Distinguished Professor
- CU Hazel Barnes Prize
- NSF Presidential Young
Investigator
- GSA Gladys Cole Award
- Fellow, AGU
- Fellow, INSTAAR
- AGU's Gilbert award
- 157+ well-cited peer-reviewed
papers & books

