CSDMS
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

Annual Report, Dec. 31, 2008
NSF Cooperative Agreement 0621695

Community Surface Dynamics Modeling System
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Executive Summary

CSDMS continues to gather momentum, with a 66% increase in new community participants (soon to be 250 members). New Focus Research Groups, government agencies and industry continue to join the CSDMS effort, supporting the long term vision and goals as laid out in a companion document — the CSMDS 5-year Strategic Plan. Year-2 has seen CSDMS become better recognized and well regarded, both nationally and internationally. Historical problems, such as duplication of efforts, or the lack of readily available models for research and application, are starting to disappear. The number of models and associated databases distributed by CSDMS has quadrupled, with over 100 models and subroutines now part of its Repository.

As the awareness of the CSDMS program penetrates academic institutions and federal labs, scientists are incorporating new practices in how to better formulate and present their numerical models and associated tools. The CSDMS community continues to define these best practices, to provide useful and clean software, better able to be coupled to models developed by others. By adopting the Common Component Architecture (CCA) and its associated tools and compilers (Ccaffine, Bocca, SIDL, and Babel), the diversity of model languages using varied operating systems becomes less of a problem. By adopting the OpenMI Interface Standard, numerical information can be efficiently transferred, allowing models and databases to better communicate. The Software Development Kit of OpenMI as well as those from other efforts should ease the community's Earth science modeling efforts. Finally a CSDMS-dedicated high performance computer is now operational. The Facility will support the CSDMS community to transition their software from limited processor venues to modern HPC servers and grids.

Year 1 focused on organization. Year 2 focused on model coupling, and most of the Year-2 goals have been or should be met by the end of the fiscal year. This report outlines the CSDMS progress, and provides Year-3 goals and resources needed to advance the CSDMS program. Year 3 is being dedicated to advanced simulations. This Annual Report documents community activity, management structure and plans, publications and presentations, meetings, models, membership, and provides budgetary details on income and expenditures. Scientific discourse from 5 selected CSDMS-sponsored workshops is provided as separate Appendices. The companion CSDMS 5-year Strategic Plan provides details on the Annual Science plan.

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1.0 CSDMS Mission: The Community Surface Dynamics Modeling System (CSDMS) develops, supports, and disseminates integrated software modules that predict the movement of fluids, and the flux (production, erosion, transport, and deposition) of sediment and solutes in landscapes and their sedimentary basins. CSDMS involves the Earth surface — the dynamic interface between lithosphere, atmosphere, cryosphere, and hydrosphere.

This Annual Report covers the period from January 1, 2008 to December 31, 2008, and provides anticipated progress through March 31, 2008.

2.0 CSDMS Management and Oversight.

2.1 The CSDMS Executive Committee (ExCom) is comprised of Organizational Chairs:

- Rudy Slingerland (April, 2007-present), Chair, CSDMS Steering Committee, Penn State Univ.
- Brad Murray (April, 2007-present), Chair, Coastal Working Group, Duke Univ.
- Pat Wiberg (April, 2007-present), Chair, Marine Working Group, Univ. of Virginia
- Greg Tucker (April, 2007-present), Chair, Terrestrial Working Group, CIRES, CU-B
- Tao Sun (April, 2007-present), Chair, Cyberinformatics & Numerics Working Group, ExxonMobil Upstream Research Company
- Karen Campbell (October, 2008-present), Chair, Education and Knowledge Transfer WG, NCED, University of Minnesota
- [Lincoln Pratson (April, 2007-October, 2008), former Chair, Education and Knowledge Transfer WG, Duke Univ.]
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, University of Colorado - Boulder
- Scott Peckham *(ex-officio)* Chief Software Architect, CSDMS Integration Facility, University of Colorado – Boulder

The Executive Committee is the primary decision-making body of CSDMS**.** ExCom ensures that the NSF Cooperative Agreement is met, develops Bylaws & Operational Procedures, and sets up the annual science plan. ExCom approves the business reports, management plan, budget, partner memberships, and other issues that arise in the running of CSDMS. Details of the governance are found in the Bylaws. The CSDMS Executive Committee last met on July 17-18, 2008, Boulder CO (all present except EKT Chair). The next meeting is scheduled for March 2 in UC Santa Barbara.

2.2 The CSDMS Steering Committee (SC) includes representatives of the U.S. Federal agencies, industry, the U.S. National Academy of Science, and other learned scholars:

- Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State Univ.
- Tom Drake (April, 2007), U.S. Office of Naval Research
- Bert Jagers (April, 2007), Delft Hydraulics,
- Rick Sarg (April, 2007), Colorado School of Mines,
- Gary Parker (April, 2007), Univ. Illinois Urbana-Champaign,
- Dan Tetzlaff (April, 2007), Schlumberger,
- Dave Furbish (April, 2007), Vanderbilt,
- Tom Dunne (April, 2007), UC-Santa Barbara.
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, CU-B
- Richard Yuritech *(ex-officio)*, National Science Foundation [Mike Ellis (*former ex-officio),* National Science

Foundation]

The CSDMS SC assesses the competing objectives and needs of the CSDMS; assesses progress in terms of science, management, outreach, and education; advises on revisions to the 5-year strategic plan; and approves the Bylaws and its revisions. Details of the governance are found in the Bylaws. The CSDMS Steering Committee is next scheduled to meet on Feb. 4, 2009, in Boulder CO.

2.3 The CSDMS Bylaws were adopted June 14, 2007, reviewed by the CSDMS Steering Committee on Dec. 17, 2007, and revised on Jan 1, 2008, approved by the ExCom on Jan. 16, 2008 and approved by the CSDMS Steering Committee (Feb 15, 2008) – see 5 yr Strategic Plan http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf

2.4 CSDMS Working Groups

The CSDMS community continues to grow with membership exceeding 230 members, with ≈ 7 new members joining per month. Growth will likely exceed predictions by 50, before the end of the fiscal year. Growth is unavoidable given the openness of the initiative. The new ideas brought forth by this growing community serve to invigorate the CSDMS effort. NSF has acknowledged and supported CSDMS growth with new resources directed towards the travel cost of this growing membership to attend group meetings. Growth has increased the workload of the CSDMS Admin Staff and Working Group Chairs.

Since the last (Year 1) CSDMS Annual Report, the Integration Facility has organized the following WG meetings:

- Cyberinformatics and Numerics Working Group startup meeting, Feb. 4-5, 2008, INSTAAR, Boulder, CO (see Chapter 4, Section 1 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 9 working group members plus 4 CSDMS staff members

- Coastal Working Group startup meeting, March 8, 2008, Orlando, FL (see Chapter 4, Section 3 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 29 working group members plus 4 CSDMS staff members

- Marine Working Group startup meeting, March 8, 2008, Orlando, FL (see Chapter 4, Section 4 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 29 working group members plus 4 CSDMS staff members

- CSDMS Education and Knowledge Transfer (EKT) Working Group Meeting: October 10, 2008, INSTAAR- CSDMS Integration Facility, Boulder, CO. 14 participants. http://csdms.colorado.edu/wiki/index.php/EKT_2008

- CSDMS Town Hall, American Geological Union (AGU), Annual Meeting, San Francisco, CA: December 18, 2008. 32 Participants. Included updates and demonstrations of modeling efforts.

Within the next three months of Fiscal Year 2, CSDMS Office will organize the following Working Group meetings:

- **Feb. 2-3** Terrestrial Working Group meeting Boulder, CO, USA

- **Feb. 25-26** Coastal Working Group meeting Charlottesville, VA, USA

- **Feb. 25-26** Marine Working Group meeting Charlottesville, VA, USA

- **Mar. 3-4** CSDMS Cyberinformatics and Numerics Working Group Meeting Santa Barbara, CA, USA

CSDMS asked it membership to nominate undergraduate or graduate students from earth or computer sciences to compete for the "Annual CSDMS Student Modeler Award 2008". Students will have completed an outstanding research project in 2008, which involved developing an earth science model (terrestrial, coastal, marine or biogeochemistry), a modeling tool, or module linking technology. Entries are judged on the basis of ingenuity, applicability, and contribution towards the advancement of geoscience modeling by a panel of experts in the field. At the 2008 AGU Town Hall meeting, the winner of the first annual 'CSDMS Student Modeler Award" was Brendon Hall, University of California, Santa Barbara. Brendon is a mechanical engineer working with Eckart Meiburg studying the analysis of large eddy simulation for 2D gravity currents. CSDMS will fund his visit to Boulder, Colorado to learn about CSDMS and work with staff scientists to develop his model into a CSDMS component.

2.5 CSDMS Focus Research Groups

In 2008, the CSDMS Executive Committee authorized the establishment of Focus Research Groups (FRGs) that cut across our Environmental Working Group structure. CSDMS currently has three FRGs. Focus Research Groups differ from Working Groups in that they serve a unique subset of our surface dynamics community, and usually represent a well-developed community. FRGs are often co-sponsored by another organization, but are similarly supported by the CSDMS Integration Facility as Working Groups. Focus Research Groups meet once per year, coordinating much of their activity via remote communication systems. FRG Chairs report directly to the CSDMS Executive Director, and often to the Director of the co-sponsoring organization. Each FRG:

- Operate a CSDMS wiki discussion page, through the CSDMS web site;
- Store models and data as part of our CSDMS computational resources and repositories;
- Receive access to the CSDMS High Performance Computing Clusters;
- Receive updates and advice from our Computational Team;
- Access CSDMS Integration Facility products; and
- Receive CSDMS Integration Facility support of annual meetings/workshops.

Hydrology Focus Research Group represents the hydrological modeling community, and is being co-sponsored by CUAHSI, the Consortium of Universities for the Advancement of Hydrologic Science, Inc. This FRG deals with aspects of the hydrological system that impact earth-surface dynamics. (Chair, Jay Famiglietti). The goal is to provide input to the CSDMS Working Groups and to the Executive Committee on how to best represent hydrological processes in CSDMS. The Hydrology FRG will facilitate links to other community hydrologic modeling activities, including those led by CUAHSI. This FRG will meet for the first time on Jan. 20-21, Boulder, CO:
http://csdms.colorado.edu/wiki/index.php/Hydrology_FRG_2009

Carbonate Focus Research Group is the outgrowth of the recent NSF effort to coordinate the carbonate modeling community and their development of a numerical carbonate workbench (Chair, Peter Burgess). The Carbonate Focus Research Group will identify and address the grand challenges for fundamental research on ancient and recent carbonate systems, through creation of the next generation of numerical carbonate process models under the umbrella of CSDMS. The initiative is driven by the idea that open-source numerical models and associated quantitative datasets can be state-of-the-art repositories for our knowledge of how carbonate systems work, and provide experimental tools to apply to develop and enhance that knowledge.

- CSDMS Community Sediment Model for Carbonate Systems, Feb. 27-29, 2008, Colorado School of Mines, Golden, CO; http://csdms.colorado.edu/wiki/index.php/Carbonates_2008 (see Appendix 2 for a summary of the Workshop). Attendance: 32 international attendees (20 from

universities and research institutes, 8 from the petroleum industry, plus 4 CSDMS staff members)

- The FRG plans to meet next on Jan. 26-27, Boulder, CO:
  http://csdms.colorado.edu/wiki/index.php/Carbonate_FRG_2009

Chesapeake Focus Research Group is CSDMS's first 'geographically-focussed' effort representing and co-sponsored by the Chesapeake Community Modeling Program, with their unique collection of models and field data set (Chair, Alexey Voinov). The Chesapeake Bay research community has been building an open source system of watershed and estuary models. Through support from Chesapeake Research Community member institutions and the NOAA Chesapeake Bay Office, CCMP modelers have committed to developing a modeling framework that will enable free and open access to code specific to the Chesapeake Bay region. As a complementary activity to the CBP modeling program, the Chesapeake Community Model Program strives to develop a comprehensive model consisting of interchangeable individual modules covering all aspects of hydrodynamics, ecosystem dynamics, trophic exchanges, and watershed interactions towards a future linked watershed-estuary model. The Chesapeake FRG plans to meet around the Ecosystem Based Management: Chesapeake and Other Systems meeting, scheduled for March 22-25, 2009. (http://www.chesapeakemeetings.com/EBM)

2.6 Industrial Consortium

Industry partners play an important role in contributing to the success of CSDMS through their financial or in-kind contributions. Their sponsorship supports the CSDMS effort and thus the next generation of researchers and modelers working to develop innovative approaches towards modeling complex earth-surface systems. The primary goal of the CSDMS Consortium is to engage industry stakeholders in CSDMS research. Consortium members join with the CSDMS community to address key issues in the development and use of the models and tools produced by the CSDMS initiative. Consortium members 1) demonstrate corporate responsibility and community relations; 2) contribute to the direction of CSDMS research and products; 3) access CSDMS research activities and product development; and 4) join an association of diverse scientists, universities, agencies, and industries. The CSDMS Industry Consortium met in Apr. 2008, at a CSDMS-sponsored Meeting and Reception in San Antonio, Texas as part of AAPG.

2.7 The CSDMS Integration Facility (IF)

The CSDMS IF is established at INSTAAR, University of Colorado-Boulder, http://csdms.colorado.edu/about/contact_us.html. As of Dec 31, 2008, CSDMS IF staff includes http://csdms.colorado.edu/organization/personnel.html:

- Executive Director, Prof. James Syvitski (April, 2007) — CSDMS and CU support
- Chief Software Engineer, Dr. Scott Peckham (April, 2007) — CSDMS and other NSF support
- Software Engineer, Dr. Eric Hutton (April, 2007) — CSDMS support
- Executive Assistant, Ms. Marlene Lofton (Aug, 2008) [formerly Mr. Andrew Svec (Oct-Jun, 2007)
- Accounting Technician Mary Fentress (April, 2007) — CSDMS and much other support
- Systems Administrator Mr. Chad Stoffel (April, 2007) — CSDMS and much other support
- Research Scientist & EKT expert Dr. Irina Overeem (Sept, 2007) — CSDMS, NOPP and ConocoPhilip support
- Research Scientist & Web Master, Dr. Albert Kettner (July, 2007) — CSDMS and NASA funds
- Ph.D. GRA Scott Bachman (April, 2007) — other NSF Funds
- Ph.D. GRA Mark Hannon (July, 2007) — ONR & ConocoPhilips funds

The CSDMS Integration Facility is posting two computational and/or geophysical *post-doctoral fellow* positions with experience in software development, to work in a team as a software engineer in the

development of an integrated framework for the modular modeling of Earth-surface dynamics —
http://csdms.colorado.edu/wiki/index.php/Jobs.

The CSDMS Integration Facility (IF) maintains the CSDMS Repositories; facilitates CSDMS communication, community coordination, public relations, and product penetration. The IF conducts Tool/Model protocol testing and evaluation on varied platforms, and evaluates hardware & software configurations with CSDMS products. The CSDMS IF develops the CSDMS cyber-infrastructure (e.g. coupling frameworks; licenses; protocols), and provides CSDMS software modeling guidance to the community. The IF maintains the CSDMS vision and supports cooperation between field and modeling communities.

3.0 Cyber-Infrastructure Definitions

Computer jargon can be intimidating. Below we define some of the core acronyms and jargon used in the semi-annual report, in aid of understanding the report.

Babel: A language interoperability tool (and compiler) that automatically generates the "glue code" that is necessary in order for components written in different computer languages to communicate. It currently supports C, C++, Fortran (all years), Java and Python. Babel enables passing of variables with data types (e.g. objects, complex numbers) that may not normally be supported by the target language. Babel uses SIDL (see below). Babel was designed to support high-performance computing and is one of the key tools in the CCA tool chain.

Bocca: A development environment tool to enable application developers to perform rapid component prototyping while maintaining robust software- engineering practices suitable to HPC environments. Bocca provides project management and a comprehensive build environment for creating and managing applications composed of Common Component Architecture components Bocca operates in a language-agnostic way by automatically invoking the Babel tool. Bocca frees users from mundane, low-level tasks so they can focus on the scientific aspects of their applications.

CCA: Common Component Architecture (http://www.cca-forum.org/) is a software architecture adopted by federal agencies (e.g. Department of Energy and its national labs) and academics to allow components to be combined and integrated for enhanced functionality on high-performance computing systems. CCA defines standards necessary for the interoperation of components developed in the context of different frameworks. Software components that adhere to these standards can be ported with relative ease to another CCA-compliant framework.

Component: A software object, meant to interact with other components, encapsulating certain functionality or a set of functionalities. A component has a clearly defined interface and conforms to a prescribed behavior common to all components within an Architecture. Multiple components may be composed to build other applications. In object-oriented terminology, components are usually implemented as classes.

ESMF: Earth Surface Modeling Framework (ESMF) is software for building and coupling weather, climate, and related models. ESMF (http://www.esmf.ucar.edu/) helps to support operational models principally for NOAA and DoD. ESMF also includes toolkits for building components and applications, such as regridding software, calendar management, logging and error handling, and parallel communications.

Framework: The software environment or infrastructure in which components are linked together to create applications. A framework typically provides a set of services that all components can access directly. A CCA framework is a specific implementation of the CCA architecture standard, typically associated with a particular computing environment. For example, the Ccaffeine Framework is used for

parallel computing; the XCAT Framework is used for distributed computing.

HPC: High-performance computing (HPC) uses supercomputers and computer clusters to solve advanced computing problems. Computer systems approaching the teraflops-region are counted as HPC-clusters.

Interface Standard: A standardized set of rules (and supporting infrastructure) for how a component must be written or refactored in order for it to more easily exchange data with other components that adhere to the same standard. A set of components that conform to this standard can then be linked together to build new applications. Such a standard promotes interoperability between components developed by different teams across different institutions.

OpenMI: Open Modeling Interface (OpenMI) is an open source software-component Interface Standard for the computational core of numerical models. Model components that comply with this standard can, without any programming, be configured to exchange data during computation (at run-time). This means that combined systems can be created, based on OpenMI-compliant models from different providers, thus enabling the modeler to use those models that are best suited to a particular project. The OpenMI standard supports two-way links where the involved models mutually depend on calculation results from each other. Linked models may run asynchronously with respect to time steps, and data represented on different geometries (grids) can be exchanged using built-in tools for interpolating in space and time.

Refactoring: Code refactoring is the process of changing a computer program's code, to make it amenable to change, improve its readability, or simplify its structure, while preserving its existing functionality.

SIDL: Scientific Interface Definition Language (SIDL) is a language developed for the Babel project whose sole purpose is to describe the interfaces (as opposed to implementations) of scientific model components. The Babel tool uses a "language-neutral" SIDL or XML description of an interface (e.g. function arguments, return values and their data types) to create the glue code that is necessary for components written in different languages to communicate. SIDL has a complete set of fundamental data types, from Booleans to double precision complex numbers. It also supports more sophisticated types such as enumerations, strings, objects, and dynamic multi-dimensional arrays.

Standard interfaces: Allows disparate software components to be composed together to build a running application. Such a standard will promote interoperability between components developed by different teams across different institutions.

SDK: Software Development Kit (also known as a native developer kit or NDK) is typically a set of development tools that allows a software engineer to create applications for a certain software package, software framework, hardware platform, computer system, video game console, operating system, or similar platform.

Subversion: SVN is a version control program that can be used to track changes in a directory tree, either to individual files, or to the tree itself. The latter would include addition, deletion or renaming of files or subdirectories. Subversion can track changes for any collection of files, but is best suited to tracking changes in text files, such as program source code or documentation.

Teraflop: A teraflop is a measure of a computer's speed and can be expressed as 10 to the 12th power floating-point operations per second.

4.0 Progress on Year 2 Goals

4.1 Goal 1) Establish interface standards that define precisely the manner in which components can be connected. **Milestone:** Evaluation of existing interface standards.

Various model-interface standards were examined for their suitability for adoption within the CSDMS Architecture and Framework, which is based around CCA. Of the two main community standards (ESMF and OpenMI), CSDMS has adopted OpenMI. OpenMI transcends any particular programming language, operating system or framework. However, up until now it has only been implemented and tested in Microsoft's .NET framework, with C# as the language and Windows as the operating system. In order to demonstrate the utility of OpenMI, its developers wrote an SDK (software developer kit), which is a large set of supporting tools that form the backbone of OpenMI. These tools perform a variety of low-level tasks, but their main purpose is to accommodate differences between models such as time steps, units, dimensionality (1D, 2D or 3D) and the manner in which space is discretized (e.g. squares or triangles). In addition to the C#/.NET/Windows version, a Java/JDK version is nearly complete that allows use on non-Windows computers.   CSDMS is currently combining the best features of OpenMI and CCA by implementing the Java version of OpenMI within a CCA framework. To this end, CSDMS software engineers have converted the Java version of the standard itself (not the SDK) to SIDL and then used Bocca to create an "OpenMI port". Since CCA's Babel supports Java, OpenMI's Java SDK can be used in a CCA framework without major changes.

The CSDMS team has begun wrapping this Java implementation of the OpenMI interface as a CCA class. A subset of the complete SDK has been successfully wrapped; a technical problem with Bocca prevents wrapping of the complete SDK. However, Bocca developers are working to fix this problem and estimate that it will be fixed early January 2009. Once fixed, the remaining pieces of the SDK will be wrapped to provide a standardized means by which components will communicate, as well as provide its complete functionality to the CCA supported languages.

CSDMS is currently working on a tool that will add an OpenMI interface to any "properly refactored" model component. The goal is to make it as easy as possible to add an OpenMI interface (as a CCA port) to an existing model component, because by design, any two components with this interface can be linked together (if it makes sense to do so). Documentation on the details of this procedure will be part of the "CSDMS Handbook" that has been developed. Users will learn how to write "get values" routines for their models so that they are ready to be wrapped with an OpenMI interface. Documentation on the details of this procedure are part of the 60-page "CSDMS Handbook of Concepts and Protocols: a Guide for Code Contributors" made available to the scientific community on the CSDMS wiki website: (http://csdms.colorado.edu/wiki/index.php/Tools_CSDMS-Handbook). This document discusses technical concepts at an introductory level and offers examples that enable a code contributor to access and effectively use the codes. The Handbook has a section called "Requirements for Code Contributors" that explains the CSDMS requirements and the rationale behind them. In addition, the document contains a fairly complete list of references, most of which are directly linked to online versions. The Handbook addresses our Goal 1 by establishing the CSDMS interface standard. It can be used for a training module and therefore also addresses our second year Goal 7.

4.2 Goal 2) Link refactored code contributions from the community as CSDMS components within the CSDMS framework. **Milestone:** Link SedFlux model to CHILD model using CCA.

SedFlux 3D a coastal marine model (originally 100,000 lines of code) has been refactored (now 70,000 lines of code) and results are documented on http://code.google.com/p/sedflux/. Individual component models that were within SedFlux are now available to the CSDMS community as stand-alone models (or components) (http://csdms.colorado.edu/wiki/index.php/Models_page). SedFlux is now CCA compliant

and ready to be wrapped with an OpenMI interface. SedFlux 3D users have been communicating using the code.google site with queries and to receive code updates, or to request help in their modeling activities. The SedFlux 3D source code is contained in the CSDMS subversion repository: https://mp.colorado.edu/svn/Main/sedflux/. The latest stable version can be obtained from: http://instaar.colorado.edu/pub/csdms/models/marine/sedflux/.

CHILD is a 2D landscape evolution model, "Channel-Hillslope Integrated Landscape Development" (http://csdms.colorado.edu/wiki/index.php/CHILD). CSDMS software engineers have worked with CHILD's developer to refactor CHILD so that it is ready to be wrapped with an OpenMI interface. A new 40-page User's Guide is now available as well. CSDMS software engineers are working on adding an OpenMI interface to CHILD, and expect to be finished with this task before the end of Year 2, in March. Once the OpenMI interface for CHILD is complete, linking CHILD together with other models that have an OpenMI interface (such as SedFlux) will be straightforward.

The CSDMS website now hosts the development page for the CHILD model. Users that wish to download and use the model can do so at: http://csdms.colorado.edu/wiki/index.php/CHILD_Download. This is the most recent stable release of the model. Developers that wish to contribute code to the CHILD project can access the source code at: http://csdms.colorado.edu/wiki/index.php/CHILD_Source. For this project, only members of the development team are allowed to view and commit changes to the code. Community members that wish to join the development team are asked to contact CSDMS.

As an initial step before linking SedFlux to CHILD, the CSDMS IF has linked SedFlux with two different subsidence models. The first simulates subsidence using the Airy method, while the second solves to more complicated flexure equations. Simulations were run that demonstrate the change in delta progradation when using one subsidence model over another. The results of this coupling will be added to the CSDMS wiki under the Education tab.

4.3 Goal 3) Implement a glacier erosion model (e.g. GC2D) with a distributed hydrologic model (e.g. TopoFlow) as an application built from CCA-compliant components.

TopoFlow http://csdms.colorado.edu/wiki/index.php/TopoFlow and http://instaar.colorado.edu/topoflow/ is a spatially distributed hydrological model. It has been converted from IDL to the open source Python language using an advanced version of open source i2py. This required CSDMS software engineers to add significant extensions to i2py. Lessons learned from this conversion exercise are described in the "CSDMS Handbook", particularly the technical issues dealing with the conversion of pointers and structures.

The glacier erosion model GC2D has been converted from MATLAB to Python. The CSDMS IF wrapped the new Python version of GC2D to comply with the preliminary CSDMS interface standards based on OpenMI. Testing of the translation of the GC2D model from MATLAB to Python continues. GC2D is wrapped as a component class that has member functions, *init*, *finalize*, and *get_values*. *init* reads input files and initializes the model grid, *finalize* frees resources at the end of the simulation, and *get_values* retrieves a set of variables at a specified time and location from the model. This allows a set of variables to be transferred between models. The source code is contained in the CSDMS subversion repository at: https://csdms.colorado.edu/svn/gc2d/ and a distribution of the latest stable version can be obtained at: http://csdms.colorado.edu/wiki/index.php/gc2d_Download.

Translation of Matlab code to Python presents several problems: it is time consuming, error prone, and must be repeated as updates to the original Matlab code are made (unless the model developer elects to continue to develop the model in Python). As such, the CSDMS IF has begun testing another method.

With this method, Matlab is used to create shared libraries from Matlab code that can be called from the c/c++ code within the CCA framework. Thus the contributed Matlab code need only be refactored to have a standard IRF interface to be able to communicate with the CCA framework. This should allow model developers to continue to write their model in Matlab, without worrying about updating the converted Python version, and carrying out time-consuming error checks.

The two models GC2D and TopoFlow cannot be presently linked using CCA/OpenMI, as the GC2D model has not been designed to provide a time-dependent surface/subsurface runoff (from glacier melt), as an output variable. Once this new hydrological process component is added to GC2D, the two models should be able to be linked.

As TopoFlow is not quite ready to be coupled, gc2d was coupled using the CCA framework with two subsidence components. This coupling demonstrated the coupling of two models, written in different languages for different purposes. In addition it demonstrates a mechanism for feedback between two components. In this case, the amount of ice that gc2d predicts at any location depends on ice surface elevation. The ice thickness at these locations gives rise to a load that the subsidence model then uses to predict crustal deflections. In turn, these vertical deflections cause changes in ice elevation that then feed back into the ice model.

The CSDMS IF has obtained a 1D version of gc2d that will also be added to the CSDMS model repository and wrapped as a CSDMS component. This model is able to calculate runoff. This functionality will be added to gc2d so that when TopoFlow is ready, the two can be linked in a non-trivial way.

4.4 Goal 4) Implement a landscape evolution model and a coastal evolution model built as CCA compliant components.

The CSDMS IF has wrapped the coastal evolution model SedFlux 3D to be compliant with initial CSDMS interface standards. This includes functions that initialize, run, and finalize SedFlux 3D. The initialize function is called once to setup the model simulation, and the finalize function is called once at the end of the simulation to free computational resources. The run function advances the model to a specified simulation time and calculates a set of specified variables. The calculated variables can now be passed along to a landscape evolution model, for example, the CHILD model.

The CSDMS IF has wrapped the coastal model, sedflux, as a CCA class and given it OpenMI-like ports so that it is able to communicate with compatible components. Once the Java implementation of the OpenMI interface is complete (Goal 1), the port will be easily converted to a true OpenMI port. The CSDMS team successfully linked the SedFlux component with two subsidence components to demonstrate its ability to be linked to other components.

4.5 Goal 5) Explore the coupling of a 3D hydrodynamic ocean model within CSDMS/CCA.

The CSDMS Integration Facility has not been able to obtain the source code for Delft3D (http://csdms.colorado.edu/wiki/index.php/Delft3D_Information) due to contractual problems involving the State of Colorado and the company Deltares. Delft3D is a product of Delft Hydraulics (now Deltares), one of the companies that helped to develop the OpenMI standard.

CSDMS software engineers have begun communication with the developers of ROMS regarding their experiences with ESMF and model coupling issues.

4.6 Goal 6) Begin to assemble a set of standard components that transcend model components and facilitate their linkage of components into working applications. **Milestone:** Evaluate solvers such as PETSc & format converters

As discussed in Goal 1, the Java SDK for OpenMI contains a variety of low-level tools that help to accommodate differences between models, such as basic regridding and interpolation tools. CSDMS has acquired this set of tools and will be repackaging much of it in the form of CCA framework services. In addition, CSDMS software engineers have identified various open-source "toolkits" such as a suite of tools for reading and writing many standard data formats that has been made available by the OGC (Open Geospatial Consortium). The USDA's OMS (Open Modeling System) project also has a number of hydrologic process components and low-level tools that are all written in Java. The GEOTOP project, based in Italy, has also developed a large number of tools in Java in support of their modeling efforts and we are working with them to share components and expertise. There is also a large and growing set of tools available as extension modules for Python, including things like XML and HTML parsers, file-format converters, GUI development tools and plotting/visualization tools. Python is rapidly gaining popularity in the modeling community, as evidenced by special sessions at AGU and recent work by many of our colleagues. As mentioned previously, both Java and Python are CCA-supported, object-oriented and highly portable languages.

The CSDMS IF has obtained a Java implementation of the OpenMI interface. A subset of the implementation has been wrapped as a set of CCA classes. This allows the functionality of the SDK to be used within the CCA framework. It also gives the SDK bindings to the CCA-supported languages so that a developer can use its functionality directly within their own program. As mentioned in Goal 1, the SDK has not been completely wrapped due to a technical problem in Bocca. The Bocca developers are working to resolve the problem and expect it to be fixed early January 2009. Once wrapped, the full functionality of the SDK will be available through the CCA framework.

4.7 Goal 7) Create two educational modules, conduct a training workshop and assist the CSDMS community in preparing code and model contributions that comply with the CSDMS standards and interfaces.

As outlined in Goal 1, the 60-page "CSDMS Handbook of Concepts and Protocols: A Guide for Code Contributors" was developed and made available to the scientific community online at the CSDMS wiki website: (http://csdms.colorado.edu/wiki/index.php/Tools_CSDMS-Handbook). The Handbook can be used for a training module to addresses our second year Goal 7. In addition to its online accessibility, the Handbook will be distributed to code contributors, new hires and technical contacts to help them understand what we require from them and how CSDMS is combining several new technologies to achieve project goals. The Handbook outline is:

1 Introduction
2 Why is it Often Difficult to Link Models?
3 Requirements for Code Contributors
        3.1 1. Code must be in a Babel-supported language
        3.2 2. Code must compile with a CSDMS-supported, open-source compiler
        3.3 3. Refactor source code to have an "IRF interface"
        3.4 4. Provide complete descriptions of input and output "exchange items"
        3.5 5. Include suitable testing procedures and data
        3.6 6. Include a user's guide or at least basic documentation
        3.7 7. Specify what type of open-source license applies to your source code.

A policy paper entitled "A Community Approach to Modeling Earth Surface Dynamics" is completed with coauthors from the CSDMS, ESMF, CSTMS, and CCMP, the main representative community programs in earth-surface dynamics (Appendix 1).

Having wrapped the SedFlux3D and GC2D models to comply with the initial interface standards, the CSDMS IF now has examples that demonstrate how to wrap a model written in either Python or C, and thus how to make a model CSDMS compliant.

4.8 Goal 8) Develop the three CSDMS repositories (Data, Model, & Education), with community contributions. **Target:** A doubling of the number of data sets, contributed models and educational presentations hosted on the CSDMS site; track community interest and use of this material.

The CSDMS Model Repository
An FTP site gives access to all stable models that are hosted by CSDMS. A link to the FTP site is provided on each model page. Thirty-seven new models were added to the model repository. Source code snapshots of these models are available for download at:
http://csdms.colorado.edu/wiki/index.php/Model_SLOC_Page. Each model has been verified to compile with standard GNU development tools (gcc, gfortran, make, etc.) and to run under a UNIX environment. Subversion (SVN) source code version control has been made operational for all members who want to upload and share source code of any model http://csdms.colorado.edu/svn/. Six model pages are created for each model, once a model questionnaire has been filled out. Model owners are encouraged to use those pages to provide the source code, stable model versions, detailed information about the model and its input and output information, known issues if applicable, and other information that is useful for potential model users. Software licensing is important to ensure that models are only used under the terms set by the model owner. CSDMS provides information about what license to use. Model owners are encouraged to use the standard license GPL v2 if owners have no preference. The CSDMS IF now hosts over 260,000 lines of code. To see the full CSDMS source line statistics, readers are referred to the http://csdms.colorado.edu/wiki/index.php/Model_SLOC_Page.

CSDMS model & subroutine repository statistics as of 12/22/08:

Domain	Listed	Descriptions	Source code
Terrestrial	51	40	21
Coastal	66	36	11
Marine	27	20	9

To help with the testing of models, the CSDMS IF has begun development on a testing framework called Damian. Users specify input files, output files, and a test to perform. Damian automatically sets up, runs, grades, and cleans up the test. The user is provided with a report card of the series of tests. A distribution of latest stable version can be obtained at: http://csdms.colorado.edu/pub/csdms/tools/damian/. The project web page is at: http://damian-csdms.googlecode.com/.

 The CSDMS Education Repository distributes model simulations, CSDMS-related educational presentations, reports and publications, CSDMS-related short course materials, CSDMS images, and CSDMS-hosted or sponsored workshop and meeting presentations. Educational tutorials hosted on the CSDMS web site presently include: 1) Charge to the CSDMS Working Groups; 2) Advantages of the Common Component Architecture (CCA) for CSDMS; 3) Comparing Model Coupling Systems: An Example; 4) CCA Recommended Reading List; 5) Mini-tutorial on *Subversion*; 6) Evaluation of model coupling frameworks for use by CSDMS, and 7) Powerpoints on Graduate Level course 'Geological Modeling'.

   The educational repository also contains lecture modules, modeling labs with exercises and notes, photo galleries for each of the 3 domains (terrestrial, coastal and ocean) and a publication section. We have posted a series of 6 linked powerpoint presentations intended for teaching 'Geological Modeling at a graduate student level http://csdms.colorado.edu/wiki/index.php/Products. An associated 3hr-modeling lab with a user-friendly stratigraphic model features as an example of teaching material. The module includes the executable of the model as well as notes for lab exercises focused on studying geological processes and modeling strategy. We have also posted a movie of model output, i.e. wave power and wave height, to serve as an example of educational products for undergraduates or undergraduate education. CSDMS hosts all the presentations that are given at each of the CSDMS meetings. All presentations and data from the educational repository are freely downloadable through the CSDMS web site.

The 'Geological Modeling' graduate level course aims at exploring Geological Modeling techniques:
- Learning tools to study complex interactions of sedimentary depositional systems and time varying boundary conditions.
- Quantitative tools to create geological models of the subsurface, including realizations of subsurface properties like grain-size distribution, porosity and permeability.
- Means to quantify uncertainties in the subsurface models by running sensitivity tests.
- Ten presentations and 5 classroom exercises can be downloaded for teaching purposes.

Coastal erosion and permafrost photos are now featured on the CSDMS website under the 'Coastal photo gallery', available to the community for teaching purposes http://csdms.colorado.edu/wiki/index.php/Coastal_GL4.

CSDMS Data Repository site points the community to the following gridded and geo-referenced data types:

- Bathymetric data: 1) GEBCO (General Bathymetric Chart of the Oceans); 2) Smith & Sandwell (1 minute Global seafloor topography); IBCAO (International Bathymetric Chart of the Arctic

Ocean)

- o Climate data: 1) GCRP (Global Climate Resource Pages); 2) GHCN (NOAA Global Historical Climate Network); 3) GOBALSOD (NOAA Daily Global Summary of Day Station Data); and 4) PSD (Climate and Weather data)

- o Topographic data: 1) LiDAR / ALSM (Airborne Laser Swath Mapping); 2) TOPO2 (Global 2-minute gridded elevation data); 3) ETOPO5 (Global 5-minute gridded elevation data).

Since the last Annual Report the following data or data links have been added to the CSDMS website (http://csdms.colorado.edu/wiki/index.php/Data)

- • Discharge data: 1) USGS national water information system (Daily and monthly discharge and water quality maintained by the USGS), 2) HYDAT (A data-base of daily and monthly river discharge of Canadian Rivers maintained by Water Survey of Canada), and 3) R-Arctic Net (A data-base of Arctic-wide monthly river discharge)

- • World Glacier Inventory (NISDIC Information on glaciers for over 100,000 glaciers through out the world)

- • New climate data: 1) TRMM (Tropical Rainfall Measuring Mission) precipitation data; and 2) Unisys Weather (hurricane/Tropical data)

- • New Topographic data: 1) GLOBE (Global Land One-km Base Elevation), 2) GTOPO30 (Global 30 Arc-Second Elevation Data Set), 3) NED (National Elevation Dataset; USA), 4) SLA-02 (Shuttle Laser Altimeter III), and 5) SRTM (Shuttle Radar Topography Mission)

- • Developed new algorithms for processing TRMM 3B42 data (0.25 x 0.25 degrees on a 3 hourly basis), so as to determine for a defined area the intra-daily, monthly, and yearly precipitation statistics and the inter-monthly and yearly precipitation statistics

Data Repository statistics as of 12/22/08

Data	Listed	Descriptions	Downloadable
Topography	8	5	8
Bathymetry	3	-	3
Climate	6	-	6
Hydrography	5	-	5
River discharge	3	-	3
Glaciers	1	-	1

4.9 Goal 9) Purchase and setup the CSDMS Experimental Supercomputer, test compilers with SedFlux, develop and open up to the CSDMS community for job sharing.

The CSDMS Integration Facility has secured funding, largely through the University of Colorado but with additional support from the U.S.G.S., and acquired a CSDMS-operated and dedicated experimental High Performance Computing Cluster (HPCC). The CSDMS-HPC will support the CSDMS community to migrate their surface-dynamic models into the HPC world, accessing the benefits of component-based software engineering. The System is an SGI Altix XE 1300 with integrated 512 x 3.0GHz/12M/1600MHz/80W E5472 processor, using non-blocking Infiniband Interconnect with 1.152TB of memory, with one head node, 28 compute nodes, 4 compute nodes with heavy memory, associated infrastructure, 72TB/7200RPM/SATA Raid storage, web server 4 x 2.33GHz/8GB RAM E5420 processor. The CSDMS-HPCC (≈ 6Tflops) is configured with two HPC approaches: 1) massive shared memory among fewer processors, and 2) the more typical parallel configuration each running Linux Red Hat with Fortran, C and C++ compilers. The CSDMS HPC is now being test and is expected

to be fully operational by early January 2009. In preparation, the CCA tools and some existing models have been installed and tested on similar operating systems (Fedora 7,8,9 & 10, in particular) with success.

CSDMS Executive Director, James Syvitski is a Co-Investigator on the new NSF award entitled **MRI-Consortium: Acquisition of a Supercomputer by the Front Range Computing Consortium.** The FRCC offers to potential CSDMS researchers a state of the art HPC, once their code can be scaled up to take advantage of a Tier 3 HPC. This supercomputer will consist of 10 Sun Blade 6048 Modular System racks, nine deployed to form a tightly integrated computational plant, and the remaining rack to serve as a GPU-based accelerated computing system. Each computational rack is composed of four integrated Sun Blade 6000 series chassis units, containing 12 blades connected by an internal quad-data-rate InfiniBand fabric; a 24-port Network Expansion Module (NEM) provides external connectivity. Each blade is composed of two dual-socket boards with each socket containing a quad-core Intel Nehalem-EP processor clocked at an expected frequency of ≈ 3.3 GHz. Each dual-socket board has eight 2 GB DDR-3 DIMMS for a total of 16 GB of RAM (2 GB per core). Each rack contains 192 processors (768 cores), for a total of 7680 cores (including the accelerated computing rack), with a peak performance exceeding 10 Teraflops/s for aggregate system peak performance of 101.4 Teraflop/s. The storage solution will consist of a high-performance Lustre file system built on 12 to 16 Sun Thumper- 2 storage server chassis. Each of the Thumper-2 units has 48 internal disks, an 8x PCI-Express IB Host Bus Adapter (HBA), and utilizes the Sun ZFS block allocation layer to provide in excess of 800 Megabytes per second per Thumper. Using 1 Terabyte disks, the total raw capacity is between 576 and 768 Terabytes. The remaining computational rack provides the accelerated computing component using NVIDIA Tesla 870 GPU technology. The Tesla 870 GPU system is a 1U chassis containing four 128-simultaneous thread GPUs and 6 Gigabytes of RAM accessible at 76.8 Gigabytes per second. The entire system will utilize a standard Linux-based software stack, vendor-supplied IB-based MPI, and the Coordinated TerraGrid Software and Services. In addition, the Grid environment will provide access to NCAR's mass storage system.

4.10 Goal 10) Further develop the CSDMS Wiki website in aid of community integration and participation. **Target:** Active use in the website by CSDMS management and members of the five Working Groups, in support of the 2008-09 goals.

The CSDMS Wiki is successfully being used to communicate CSDMS-sponsored meeting information. Since the website was converted to a wiki, on March 27, 2008, the web pages total 1,220. Every wiki page has an associated 'talk' page which can be used for discussion and communicating with other users pages about Community Surface Dynamics Modeling System 'CSDMS'. There are 187 content pages. 501 files have been uploaded since the start of the CSDMS website.

CSDMS website uses MediaWiki version 12.3, which is presently the most secure and stable MediaWiki version. The website incorporates 27 plugins for advanced functionality. The CSDMS website is not upgraded yet to the latest media wiki version (13.3) as not all plugins that are critical for the functioning of the site are compatible with this latest version.

- A login is now required to make contributions to the CSDMS web site.
- Incorporated encrypted password functionality is added to ensure that password protocols to login to the website are protected.
- A Captcha tool is added to prevent automated login scripts to be able to create a CSDMS wiki account.
- A plugin is installed to be able to block 'undesirable' IP addresses that are known to harm wikis.

To improve administration, the CSDMS Website has:
    i.   Incorporated a script to reset passwords (for users who forget their password), using Sysops privileges.

ii.   Added a script to retrieve user information upon sign up for the WIKI.
iii.   Added the CSDMS WIKI to Google Analytics (a free Google web tool). Google Analytics is a tool to analyze where web site visitors (who are logged in) are coming from and how they browse on the CSDMS site.
iv.   Added an information page about how model developers should license their model contributions to CSDMS

The CSDMS Website has added functionality:
1.   Uploading documents was limited to a few file formats (pdf, jpg, tar, rar). This has been extended to ppt, doc, docx, zip.
2.   Incorporated a "Job" page to post CSDMS related job offers.
3.   Possibility to upload movies e.g. to display model simulations or to support educational modules
4.   Automated sign up & change information form for new working group & focus research group members that want to join or change contact information and interest in working group or FRG is incorporated.
5.   Automated online model questionnaire form.
6.   Added a program language source code highlight tool. Source code provided within the website can now be presented in color codes.
7.   A 'Print PDF' option is now included within the website. This plugin provides the possibility to create a PDF file from any CSDMS web page.

The CSDMS Website lay out has been improved, e.g.
a.   Selecting a main tab will now automatically change the color of the 'sub tab' bar.
b.   The web pages are presented over the whole width of the browser window.
c.   The static front page of CSDMS now offers a more dynamic page where people can directly choose a link to the page they want to go to.
d.   Added a favicon for a more professional look.

The CSDMS Website provides CSDMS member support:
•   A virtual meeting place for each of the working groups & focus research groups is created so members are able to start web discussions, have access to current members lists, meeting information
•   Easy access to the Wiki help section, that provides information on how to: 'log in', 'edit', 'create tables', 'incorporate pictures, movies', etc.
•   Presentation about 'how to contribute to' the CSDMS wiki and explain the available functionality has been given at EKT working group meeting.

Fifty-Six CSDMS members created a login to contribute to the CSDMS website. The total number of hits (people that visited the webpage since March 2008) was 254,543 page views, and 4,724 page edits since the Wiki was set up.

Top 10 most visited web pages:

Names web page		# of hits
Front page	http://csdms.colorado.edu/wiki/index.php/Main_Page	16916
Marine models	http://csdms.colorado.edu/wiki/index.php/Marine_Mo	10129
Marine members	http://csdms.colorado.edu/wiki/index.php/Marine_Members	9913
Terrestrial models	http://csdms.colorado.edu/wiki/index.php/Terrestrial_Mo	8979
Coastal members	http://csdms.colorado.edu/wiki/index.php/Coastal_Members	8836
Terrestrial members	http://csdms.colorado.edu/wiki/index.php/Terrestrial_Members	6910
CSDMS jobs	http://csdms.colorado.edu/wiki/index.php/Jobs	5287

Cyberinformatics members	http://csdms.colorado.edu/wiki/index.php/Cyberinformatics_Members	5011
Carbonate workshop	http://csdms.colorado.edu/wiki/index.php/Carbonates_2008	4671
CSDMS introduction	http://csdms.colorado.edu/wiki/index.php/Introduction	4611

4.11 Goal 11) Organize and/or sponsor and/or host 3 workshops (Clinoform, Sedibud, CUAHSI Natl. Meeting), 5 working group meetings, 4 management meetings, 1 Open Town-hall meeting and 1 short course (coding camp).

Since the last Annual Report of CSDMS, the Integration Facility has sponsored, &/or hosted, &/or organized the following meetings:

- Cyberinformatics and Numerics Working Group startup meeting, Feb. 4-5, 2008, INSTAAR, Boulder, CO (see Chapter 4, Section 1 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 9 working group members plus 4 CSDMS staff members

- CSDMS Community Sediment Model for Carbonate Systems, Feb. 27-29, 2008, Colorado School of Mines, Golden, CO; http://csdms.colorado.edu/wiki/index.php/Carbonates_2008 (see Appendix 2 for a summary of the Workshop). Attendance: 32 international attendees (20 from universities and research institutes, 8 from the petroleum industry, plus 4 CSDMS staff members)

- Coastal Working Group startup meeting, March 8, 2008, Orlando, FL (see Chapter 4, Section 3 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 29 working group members plus 4 CSDMS staff members

- Marine Working Group startup meeting, March 8, 2008, Orlando, FL (see Chapter 4, Section 4 of the CSDMS Strategic Plan for its findings: http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf). Attendance: 29 working group members plus 4 CSDMS staff members

- CSDMS Executive Committee Meeting, July 17-18, 2008, Boulder CO (all present except EKT Chair)

- SEPM - CSDMS Research Conference on Clinoform Sedimentary Deposits: Aug. 15-18, 2008, Rock Springs, WY. http://csdms.colorado.edu/wiki/index.php/Clinoform_2008 (also see Appendix 3). Attendance: 71 participants.

- I.A.G./A.I.G./ CSDMS SEDIBUD workshop on Sediment Budgets in Changing High-Latitude and High-Altitude Cold Environments, Boulder, CO, Sep. 9-13, 2008, attendance: 32 http://csdms.colorado.edu/wiki/index.php/SEDIBUD_2008

- CSDMS Education and Knowledge Transfer (EKT) Working Group Meeting: October 10, 2008, INSTAAR- CSDMS Integration Facility, Boulder, CO. 14 participants. http://csdms.colorado.edu/wiki/index.php/EKT_2008

- CSDMS Town Hall, American Geological Union (AGU), Annual Meeting, San Francisco, CA: December 18, 2008. Included updates and demonstrations of modeling efforts plus presentation of the winner of the first annual 'CSDMS Student Modeler Award" given to Grendon Hall, University of California.

Ten more CSDMS meetings are scheduled before the end of the year 2 Fiscal Year.

4.12 Goal 12) Host the Industry Consortium first meeting, the U.S. interagency partners, further

develop the EKT Working Group, represent CSDMS within the U.S. and abroad, run the day to day CSDMS operations in an efficient and smooth manner.

CSDMS Inter-Agency Meeting: The first CSDMS Inter-Agency Committee Meeting was held at NSF Headquarters in Washington, D.C. October 23, 2008. Discussed were the congressional mandate requirement for all Federally funded PIs to make their software code publicly available, along with supporting metadata and documentation. Exceptions to the rule were discussed. Discussion centered on minimum standards to be met by individual PIs, and the role the CSDMS Integration Facility (IF) and its 230+ member community in supporting this effort. The CSDMS IF will work with the Agencies in supporting this mandate.

CUAHSI:

- CSDMS SSE attended the WebEx meeting and presentation to CUAHSI members about CCA and CSDMS, Wed., Feb. 6, 2008.

- CSDMS SSE co-chaired the Community Models for Hydrologic and Environmental Research session (with Larry Murdoch, Clemson); CSDMS ED co-chaired the Surface Processes, Sediments and Landscape session (with Ben Hodges, Efi Foufoula-Georgiou) July 14-16. CUAHSI Biennial Colloquium on Hydrologic Science and Engineering, NCAR Conference Center, Boulder, CO (http://www.cuahsi.org/biennial/)

- CSDMS SSE represented CSDMS at CUAHSI Scoping Workshop for the proposed Community Hydrologic Modeling Platform (CHyMP), March 25-28, 2008, National Academy of Sciences, Washington, D.C. and presented a talk about CSDMS and its work with CCA.

- CSDMS SSE represented CSDMS at EU-NSF OpenMI Workshop April 5-11, hosted by the Centre for Ecology and Hydrology and Wallingford Software Ltd., Wallingford, UK and presented talk. Participated in technical breakout group meeting to work through the details of the OpenMI interface standard with its developers. Leaders of CUAHSI's proposed CHyMP project formally agreed to coordinate their efforts with those of CSDMS and felt that a possible Hydrology working group would be a logical next step.

- CSDMS SSE offered a presentation titled: "Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS), Apr. 19-21, IGWMC "ModFlow and More" meeting, Colorado School of Mines, Golden, CO.

- CSDMS SSE represented CSDMS at the Computational Methods in Water Resources, XVII International Conference, San Francisco, CA, July 8-12, with talk entitled: "Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS)".

Industry: CSDMS ED gave a CSDMS presentation at a Research Collaboration Partnership Meeting with petroleum companies at Colorado School of Mines, Golden, CO, Tue., Feb. 26, 2008. CSDMS Industry Consortium Meeting was held Tues., April 22; San Antonio, TX: 17 representatives from 5 oil companies (Chevron, ConocoPhillips, ExxonMobil, Shell, StatoilHydro) were invited to learn more about the CSDMS Industry Consortium.

ESMF: CSDMS Delta Force staff met with Cecelia DeLuca of Community Climate System Model (CCSM), National Center for Atmospheric Research (NCAR) to discuss how that community has worked to link code, models and modules using Earth System Modeling Framework (ESMF)), March 19, 2008.

OpenMI: OpenMI and Jupiter API Short Course, Colorado School of Mines, Golden, CO. See: http://typhoon.mines.edu/short-course/JUPITER_08.htm

DoE/INL: CSDMS ED represented CSDMS during CU site visit of Idaho National Lab (INL) March 31, 2008; formed a partnership between CSDMS by INL.

MARGINS: CSDMS ED represented CSDMS during a "Futures" source-to-sink NSF meeting, held in Orlando, FL, March 2, 2008.

Chesapeake Community Modeling Program: CSDMS ED represented CSDMS at a CCMP Workshop on Communicating Models and Data, Annapolis, May12-14, 2008

NSF: CSDMS ED provided a reverse site visit with EAR and OCE program directors, at the National Science Foundation, May 15, 2008

NCALM: CSDMS ED represented CSDMS at the NSF-sponsored workshop on Studying Earth Surface Processes with HR Topographic Data, UCAR, Boulder, June 16-18, 2008

Cyber-Infrastructure: CSDMS ED represented CSDMS at the NSF-sponsored at the Cyber-Infrastructure Forum on Environmental Observatories, UCAR, Boulder, May 5-7, 2008

NEON: CSDMS ED met with the NEON Chief Scientist Michael Keller to examine relationships between CSDMS and NEON, Aug. 20, 2008

4.13 Year 3 Goals and Resources

Goal 1) Work with the CSDMS Working Groups and Focus Research Groups to add additional models and subroutines as linkable components, using the procedures and interfaces developed during Year 2. **Milestone:** Encourage model developers whose models are listed as freely available to make their code downloadable. **Resource Allocation:** Software Engineer (SE): 0.5 FTE, Post-doctoral Fellow (PDF): 0.5 FTE.

CSDMS will rely on the working groups to select and prioritize models to be converted to components, but plans to create as many components as possible given resources. This will include both models themselves and numerous supporting tools and utilities. We also expect to be able to incorporate existing components from other open-source projects such as the Open Modeling System (OMS) and GEOTOP project, both of which have numerous, hydrologic, Java-based components. The OMS components already conform to the basic IRF interface.

Goal 2) Explore the use of HPC-targeted component libraries such as PETSc and hypre, and existing CCA-compliant solver and mesh-generation components developed at DOE labs. **Milestone:** Pursue at least one modeling project that incorporates the use of these HPC libraries as a means for existing models to be refitted to take advantage of multiple processors. **Resource Allocation:** SE: 0.25 FTE, PDF: 0.5 FTE.

Goal 3) Adapt a client-based version of the Ccaffeine GUI, with a simple installation process, that CSDMS members can use on their own computers to link components into new applications that will run on the CSDMS supercomputer. **Milestone:** Conduct a training workshop to assist the CSDMS community with preparing contributed code for conversion to a CSDMS component and how to link CSDMS components to create new applications with the Ccaffeine tool. **Resource Allocation:** SE: 0.25 FTE

Goal 4) Assist CSDMS members who have HPC experience with installing and running their models on our new supercomputer, and encourage them to share their knowledge with other CSDMS members via our wiki, workshops and recommended reading. Prepare educational materials related to high-performance computing (HPC) (e.g. how to use MPI and OpenMP) and add this material to the CSDMS wiki. **Resource Allocation:** SE: 0.5 FTE, PDF: 0.5 FTE, EKT: 0.25 FTE

Goal 5) Work with the Community Sediment Transport Modeling System (CSTMS) group to determine feasibility of getting the ROMS based sediment model to be compliant with the CSDMS CCA OpenMI framework and interface standards. **Resource Allocation:** SE: 0.5 FTE, PDF: 0.5 FTE.

Goal 6) Define the needs of datasets and put them in the repository. **Milestones:** Describe all new and listed datasets. Organize the 3 model domains (Terrestrial, Coastal, Marine) into sub categories. **Resource Allocation:** Web Master (WM): 0.25 FTE, EKT: 0.25 FTE

Goal 7) Put an EKT module on coupling models & examples on CSDMS web. **Milestone:** Extend education repository with a movie gallery of model simulations that can be used for educational purposes. Numerical movies should include some description before they are uploaded. **Resource Allocation:** WM: 0.25 FTE, EKT: 0.5 FTE

Goal 8) Offer RSS (Really Simple Syndication) feeds to the CSDMS community so that they can subscribe to CSDMS RSS feeds to stay up to date with newly added material. **Resource Allocation:** WM: 0.25 FTE

Goal 9) Develop an automated web structure such that the content of certain CSDMS web forms are automatically incorporated in CSDMS web pages. Develop a web structure that's able to, for example, automatically incorporate newly produced statistical data of model information into the CSDMS wiki. Automate website database backups to ensure that data won't get lost. Offer possibility for CSDMS community members to list their model papers. **Resource Allocation:** WM: 0.25 FTE

Goal 10) Organize and/or sponsor and/or host 2+ workshops (e.g. River Coastal and Estuarine Morphodynamics; Turbidity Current Modeling), 8 Working Group and Focus Research Group meetings, 5 management meetings, 1 Open Town-hall meeting and 1 short course or coding camp. Represent CSDMS within the U.S. and abroad. Run the day-to -ay CSDMS operations in an efficient and smooth manner. **Resource Allocation:** Executive Director: 0.5 FTE, Executive Assistant: 1.0 FTE

The Working Groups have each established their short, medium and long-term research goals which are published as part of the CSDMS 5 year Strategic Plan http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf . Most of the Working Groups will next meet in the last quarter of the fiscal year, where they will have a chance to review and revise, if necessary.

5.0 CSDMS Model Repository

5.1 Terrestrial

AquaTellUs, *Model*: Fluvial-dominated delta sedimentation model, **Overeem**, Irina

Avulsion, *Model*: Stream avulsion model, **Hutton**, Eric

BEDLOAD, *Subroutine*: Bedload transport model, **Slingerland**, Rudy

Caesar, *Model*: Cellular landscape evolution model, **Coulthard**, Tom

Cascade, *Model*: Landscape evolution model, **Braun**, Jean

CHILD, *Model*: Landscape Evolution Model, **Tucker**, Greg

DECAL, *Model*: Aeolian dune landscape model, **Baas**, Andreas

Delft3D, *Model*: 3D hydrodynamic and sediment transport model, **Delft3D support**

Dionisos, *Model*: 3D basin-scale stratigraphic model, **Granjeon**, Didier

DRAINAL, *Model*: Surface process model, **Beaumont**, Chris

DR3M, *Model*: Distributed Routing Rainfall-Runoff Model, **U.S. Geological Survey**

ENTRAIN, *Subroutine*: Simulates critical shear stress of median grain sizes, **Slingerland**, Rudy

ENTRAINH, *Subroutine*: Simulates critical shields theta for median grain sizes, **Slingerland**, Rudy

Erode, *Model*: Fluvial landscape evolution model, **Peckham**, Scott

FLDTA, *Subroutine*: Simulates flow characteristics on varied flow equation, **Slingerland**, Rudy

gc2d, *Model*: Glacier / ice sheet evolution model, **Kessler**, Mark

GNE, *Model*: Set of biogeochemical sub-models that predicts river export, **Seitzinger**, Sybil

GOLEM, *Model*: Landscape evolution model, **Tucker**, Greg

GPM, *Model*: Sedimentary process modeling software, **Tetzlaff**, Daniel

GSSHA, *Model*: Gridded Surface Subsurface Hydrologic Analysis model, **Ogden**, Fred

HEBEM, *Model*: Hydrologically Enhanced Basin Evolution Model, **Niemann**, Jeffrey

HydroTrend, *Model*: Climate driven hydrological transport model, **Kettner**, Albert

LITHFLEX1, *Subroutine*: Lithospheric flexure solution, **Furlong**, Kevin

LITHFLEX2, *Subroutine*: Lithospheric flexure solution for a broken plate, **Furlong**, Kevin

LOADEST, *Model*: A fluvial seven-parameter linear regression load model, **Runkel**, Robert

LOGDIST, *Subroutine*: Logrithmic velocity distribution solution, **Slingerland**, Rudy

LONGPRO, *Subroutine*: Dynamic evolution of longitudinal profiles, **Slingerland**, Rudy

MARSSIM, *Model*: Landform evolution model, **Howard**, Alan

MIDAS, *Model*: Coupled flow- heterogeneous sediment routing model, **Slingerland**, Rudy

MIKE SHE, *Model*: Advanced integrated hydrological modeling system, **DHI**

PIHM, *Model*: Penn State Integrated Hydrologic Model, **Duffy**, Christopher

PIHM GIS, *Model*: Penn State Integrated Hydrologic Model in GIS package, **Duffy**, Christopher

SETTLE, *Subroutine*: Practical settling velocity solution, **Slingerland**, Rudy

SimClast, *Model*: basin-scale 3D stratigraphic model, **Dalman**, Rory

SOBEK, *Model*: 1D hydraulic numerical model, **SOBEK support**

Subside, *Model*: Flexure model, **Hutton**, Eric

SVELA, *Subroutine*: Shear velocity solution associated with grain roughness, **Slingerland**, Rudy

SIBERIA, *Model*: Landscape evolution model, **Willgoose**, Garry

SUSP, *Subroutine*: Suspended load transport subroutine, **Slingerland**, Rudy

TOPOG, *Model*: Terrain analysis-based hydrologic modelling package, **Butt**, Tony

TopoFlow, *Model*: Hydrological model, **Peckham**, Scott

Tremp, *Model*: Eocene Tremp foreland basin model, **Clevis**, Quintijn

TUGS, *Model*: Fluvial gravel and sand transport model, **Cui**, Yantao

TURB, *Subroutine*: Gaussian distribution calculator of instantaneous shear stresses on a fluvial bed, **Slingerland**,

Rudy

WILSIM, *Model*: Landscape evolution model, **Luo**, Wei

YANG's routine, *Subroutine*: Fluvial sediment transport model, **Slingerland**, Rudy

ZScape, *Model*: Landscape evolution model, **Densmore**, A. & **Connor**, C.

5.2 Coastal

2DFLOWVEL, *Subroutine*: Tidal & wind-driven coastal circulation routine, **Slingerland**, Rudy

AquaTellUs, *Model*: Fluvial-dominated delta sedimentation model, **Overeem**, Irina

BarSim, *Model*: Barrier island simulation model, **Storms**, Joep

BITM, *Model*: Barrier Island Translation model, **Masetti**, Riccardo

BSM, *Model*: Moving boundaries shoreline model, **Swenson**, John

BTELSS, *Model*: Barataria-Terrebonne Ecological Landscape Spatial Simulation model, **Reyes**, Enrique

CARB3D+, *Model*: Forward Simulation Model for Sedimentary Architecture and Near-Surface Diagenesis in Isolated Carbonate Platforms, **Smart**, Peter

CELLS, *Model*: Landscape simulation model, **Reyes**, Enrique

CEM, *Model*: Coastal evolution model, **Murray**, Brad

CST, *Model*: Coastal System Tract model, **Niedoroda**, Alan

D'Alpaos model, *Model*: Marsh evolution model, **D'Alpaos,** Andrea

DECAL, *Model*: Aeolian dune landscape model, **Baas**, Andreas

Delft3D, *Model*: 3D hydrodynamic and sediment transport model, **Delft3D support**

Delft3D for marshes, *Subroutine*: 3D plant-flow interaction model to a tidal marsh landscape, **Temmerman**, Stijn

DELTA, *Subroutine*: Simulates circulation and sedimentation in a 2D turbulent plane jet and resulting delta growth, **Slingerland**, Rudy

Fluidmud, *Model*: Wave-phase resolving numerical model for fluid mud transport, **Hsu**, Tian-Jian

DeltaSIM, *Model*: Process-response model simulating the evolution and stratigraphy of fluvial dominated deltaic systems, **Hoogendoorn**, Bob & **Overeem**, Irina

Dionisos, *Model*: 3D basin-scale stratigraphic model, **Granjeon**, Didier

FunWave, *Model*: Phase-resolving, time-stepping Boussinesq model for ocean surface wave propagation in the nearshore., **Kirby**, James

GENESIS, *Model*: Global ENvironmental and Ecological Simulation of Interactive Systems., **Cialone**, Alan

Geombest, *Model*: A model that simulates the evolution of coastal morphology and stratigraphy resulting from changes in sea level and sediment supply., **Moore**, Laura

GNE, *Model*: Set of biogeochemical sub-models that predicts river export, **Seitzinger**, Sybil

GPM, *Model*: Sedimentary process modeling software, **Tetzlaff**, Daniel

HBIM, *Model*: Human/Barrier Island Model, **McNamara**, Dylan

Hyper, *Model*: 2D depth-averaged hyperpycnal flow model, **Imran**, Jasim

LITHFLEX1, *Subroutine*: Lithospheric flexure solution, **Furlong**, Kevin

LITHFLEX2, *Subroutine*: Lithospheric flexure solution for a broken plate, **Furlong**, Kevin

Marsh model, *Model*: A coupled geomorphic - ecological model of tidal marsh evolution., **Kirwan**, Matthew

Marsh elevation model, *Model*: Simulates deposition rates as a function of horizontal distance from a channel and vegetation density in a marsh, **Mudd**, Simon

MARSSIM, *Model*: Landform evolution model, **Howard**, Alan

Physprop, *Model*: Physical and acoustic property simulator for either computer-generated or experimental strata, **Pratson**, Lincoln

QDSSM, *Model*: Quantitative Dynamic Sequence Stratigraphic Model is a 3D cellular, forward numerical model that simulates landscape evolution and stratigraphy, **Postma**, George

RCPWAVE, *Model*: Regional Coastal Processes Monochromatic WAVE Model, **Cialone**, Alan

REF/DIF, *Model*: Phase-resolving parabolic refraction-diffraction model for ocean surface wave propagation, **Kirby**,

James

SBEACH, *Model*: Numerical Model for Simulating Storm-Induced Beach Change, **US Army Corps of Engineers**

SDM, *Model*: Shelf Deposition Model, **Wolinski**, Matt

Sedflux, *Model*: Basin-filling stratigraphy model, **Hutton**, Eric

Sedsim, *Model*: Sedimentary process modeling software, **Griffiths**, Cedric

SeisimID, *Model*: Simulates post-stack, time-migrated seismic data of stratigraphic simulations, **Pratson**, Lincoln

Sequence4, *Model*: Stratigraphic model, focused on the long-term development of stratigraphic sequences, **Steckler**, Michael

Shoreline, *Model*: Coastal evolution model, **Peckham**, Scott

SiAM3D, *Model*: 3D hydrodynamic model based on the hydrostatic and Boussinesq approximations, **Cayocca**, Florence

SimClast, *Model*: basin-scale 3D stratigraphic model, **Dalman**, Rory

SIMSAFADIM, *Model*: Finite element model for fluid flow, clastic, carbonate and evaporate sedimentation, **Bitzer**, Klaus

SLAMM model, *Model*: Sea Level Affecting Marshes model, **Park**, Richard & **Clough**, Jonathan

SLOSH, *Model*: Sea, Lake and Overland Surges from Hurricanes, **National Hurricane Center**

SPEM, *Model*: Shoreface profile evolution model, **Stive**, Marchel

SRSM, *Model*: Soft-Rock Shoreline Model, **Walkden**, Mike

STM, *Model*: Shoreline Translation Model, **Cowell**, Peter

STORM, *Subroutine*: Windfield simulator for a cyclone, **Slingerland**, Rudy

STVENANT, *Subroutine*: 1D gradually varied flow routine, **Slingerland**, Rudy

STWAVE, *Model*: Steady-State Spectral Wave Model, **Smith**, Jane

SWAN, *Model*: Third-generation wave model that computes random, short-crested wind-generated waves in coastal regions and inland waters., **The SWAN team**

WAM, *Model*: Global ocean WAve prediction Model, **Jensen**, Robert

WAVE REF, *Subroutine*: Wave refraction routine, **Slingerland**, Rudy

WINDSEA, *Subroutine*: Deep water significant wave height and period simulator during a hurricane routine, **Slingerland**, Rudy

Wolinsky Delta Model, *Model*: Physically-based deterministic cellular delta model, **Wolinsky**, Matt

WSGFAM, *Model*: Wave and current supported sediment gravity flow model, **Friedrichs**, Carl

WaveWatch3, *Model*: Wave model, **Tolman**, Hendrik

XBeach, *Model*: Wave propagation sediment transport model, **Roelvink**, Dano

SedBerg, *Model*: Iceberg sediment transport model, **Mugford**, Ruth

SedPlume, *Model*: meltwater plume model, **Mugford**, Ruth

Inflow, *Model*: Steady-state hyperpycnal flow model, **Hutton**, Eric

Sakura, *Model*: 3 Equation hyperpycnal flow model, **Hutton**, Eric

5.3 Marine

ADCIRC, *Model*: Coastal Circulation and Storm Surge Model, **Luettich**, Rick

Carbonate GPM, *Model*: 3D forward model of carbonate production and deposition, **Hill**, Jon

Coaster, *Model*: Long shore wave driven sediment transport model, **Peckham**, Scott

Compact, *Model*: Sediment compaction, **Hutton**, Eric

Delft3D, *Model*: 3D hydrodynamic and sediment transport model, **Delft3D Support**

Dionisos, *Model*: 3D basin-scale stratigraphic model, **Granjeon**, Didier

FanBuilder, *Model*: Process-based stratigraphic evolution of turbidite fans model, **Groenenberg**, Remco

GPM, *Model*: Sedimentary process modeling software, **Tetzlaff**, Daniel

Inflow, *Model*: Steady-state hyperpycnal flow model, **Hutton**, Eric

LITHFLEX1, *Subroutine*: Lithospheric flexure solution, **Furlong**, Kevin

LITHFLEX2, *Subroutine*: Lithospheric flexure solution for a broken plate, **Furlong**, Kevin

NCOM, *Model*: Navy Coastal Ocean Model, **Keen**, Tim

NearCoM, *Model*: Nearshore Community Model, **Kirby**, Jim

NearshorePOM, *Model*: Nearshore version of POM (Princeton Ocean Moel), **Kirby**, Jim

POM, *Model*: Princeton Ocean Model, **Ezer**, Tal

Sakura, *Model*: 3 Equation hyperpycnal flow model, **Hutton**, Eric

sedflux, *Model*: Basin-filling stratigraphy model, **Hutton**, Eric

Sedpak, *Model*: Simulation 2D empirical sedimentary fill model, **Kendall**, Chris

Sedsim, *Model*: Sedimentary process modeling software, **Griffiths**, Cedric

SEOMS, *Model*: Spectral Element Ocean Model, **Arango**, Herman

SimClast, *Model*: basin-scale 3D stratigraphic model, **Dalman**, Rory

SIMSAFADIM, *Model*: Finite element model for fluid flow, clastic, carbonate & evaporate sedimentation, **Bitzer**, K

Symphonie, *Model*: 3D primitive equation ocean model, **Marsaleix**, Patrick

ROMS/TOMS, *Model*: Regional Ocean Modeling System/Terrain-following Ocean Modeling System, **Arango**, H.

SHORECIRC, *Model*: Quasi-3D nearshore circulation model, **Svendsen**, Ib

6.0 2008 Integration Facility authored or co-authored Reports, Presentations, Publications and Abstracts:

6.1 2008 CSDMS IF Journal and Book Publications

Abers, G. et al., 2008, Margins Review. Margins Office, LDEO, NY, 184pp. Published

Berne, S., Syvitski, J.P.M., Trincardi, F. (Editors) 2008, Interactions Between High-Frequency Climate Changes and Deltaic Margin Architecture. *Geochem. Geophys. Geosyst.,* 9, Q09R04 Published

Goodall, J., D.G. Tarboton, S.D. Peckham, R. Hooper (2008) New software architecture for integrated water modeling, *EOS*, *Transactions*, 89(43), p. 420, American Geophysical Union.

Gruber, S. and S.D. Peckham (2008) Land-surface parameters and objects specific to hydrology, In: Hengl, T. and Reuter, H.I. (Eds), *Geomorphometry: Concepts, Software and Applications*. Developments in Soil Science, vol. 33, Elsevier, 127-142 pp.

Hutton E.W.H., and Syvitski, J.P.M., 2008, *SedFlux2.0*: An advanced process-response model that generates three-dimensional stratigraphy. Computers & Geosciences, 34: 1319-1337. (includes computer code) Published

Jouet, G, Hutton, E.W.H., Syvitski, J.P.M., Rabineau, M., Berné, S. 2008, Modeling the isostatic effects of sealevel fluctuations on the Gulf of Lions. Computers & Geosciences, 34: 1338-1357. (includes computer code) Published

Kettner, A.J., 2008. Oceaanstromingen: Bewegende Zeeen matigen het weer, in De Betacanon: Wat iedereen moet weten van de natuurwetenschappen. ISBN 978 90 290 8055 2 / NUR 910. Chapter 36 (160-163). Published

Kettner A.J., B. Gomez, E.W.H. Hutton and J.P.M. Syvitski, 2008, Late Holocene dispersal and accumulation of terrigenous sediment on Poverty Shelf, New Zealand, Basin Research doi: 10.1111/j.1365-2117.2008.00376.x Published

Kettner A.J., Syvitski, J.P.M. 2008. HydroTrend v3.0: a Climate-Driven Hydrological Transport Model that Simulates Discharge and Sediment Load leaving a River System. Computers & Geosciences 34: 1170-1183. (includes computer code) Published

Kettner, A.J., B. Gomez, J.P.M. Syvitski, 2008, Will human catalysts or climate change have a greater impact on the sediment load of the Waipaoa River in the 21st century? In: J. Schmidt, T. Cochrane, C. Phillips, S. Elliot, T. Davies and L. Basher, Editors, *Sediment Dynamics in Changing Environments*. IAHS Publ. 325, 425-431. Published

Kettner, A.J., Syvitski, J.P.M., 2008, Predicting Discharge and Sediment Flux of the Po River, Italy since the Late Glacial Maximum. In: P.L. de Boer, G. Postma, C.J. van der Zwan, P.M. Burgess and P. Kukla (Eds.) Analogue and Numerical Forward Modelling of Sedimentary Systems: from Understanding to Prediction. *Spec. Publ. Int. Assoc. Sedimentol.* 40, 171–189. Published

Mixon, D.M., Kinner, D.A., Stallard, R.F., and Syvitski, J.P.M. 2008, Geolocation of man-made reservoirs across terrains of varying complexity using GIS. Computers & Geosciences, 34: 1184-1197. (includes computer code) Published

Overeem, I., J.P.M. Syvitski, 2008, Changing Sediment Supply in Arctic Rivers, In: J. Schmidt, T. Cochrane, C. Phillips, S. Elliot, T. Davies and L. Basher, Editors, *Sediment Dynamics in Changing Environments*. IAHS Publ. 325, 391-397. Published

Peckham, S.D. (2008) Geomorphometry and spatial hydrologic modeling, In: Hengl, T. and Reuter, H.I. (Eds), *Geomorphometry: Concepts, Software and Applications*. Developments in Soil Science, vol. 33, Elsevier, 377-393 pp.

Peckham, S.D. (2008) On the form and stability of seafloor stratigraphy and shelf profiles: A mathematical model and solution method, *Computers & Geosciences*, 34, 1358-1369. (includes computer code) Published

Peckham, S.D. (2008) A new method for estimating suspended sediment concentrations and deposition rates from satellite imagery based on the physics of plumes, *Computers & Geosciences*, 34, 1198-1222. (includes computer code) Published

Peckham, S.D. (2008) Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS), In: *Proceedings of MODFLOW and More 2008: Ground Water and Public Policy Conference*, May 18-21, 2008, Golden, CO, 535p. Published

Syvitski, J.P.M. and A.J. Kettner, 2008, Scaling sediment flux across landscapes. In: J. Schmidt, T. Cochrane, C. Phillips, S. Elliot, T. Davies and L. Basher, Editors, *Sediment Dynamics in Changing Environments*. IAHS Publ. 325, 149-156.

Syvitski, J.P.M., 2008, Deltas at Risk. Sustainability Science 3: 23-32. Published

Syvitski, J.P.M., 2008, Predictive modeling in sediment transport and stratigraphy. Computers & Geosciences 34: 1167-1169. Published

Syvitski, J.P.M., et al., 2008, CSDMS: Community Surface Dynamics Modeling System, Five-Year Strategic Plan. CSDMS Office, University of Colorado Press, Boulder CO, 48 pp. Published

Wollheim, W. M., C. J. Vorosmarty, B. J. Peterson, P. A. Green, S. Seitzinger, J. Harrison, A. F. Bouwman, and J. P. M. Syvitski. 2008. Global N removal by freshwater aquatic systems: a spatially distributed within basin approach. Global Biogeochem. Cycles, 22, GB2026, doi:10.1029/2007GB002963. Published

6.2 2008 CSDMS IF Tutorials:

Peckham, S.D. (2008) Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS), Proceedings of MODFLOW and More 2008: Ground Water and Public Policy Conference, May 18-21, 2008, Golden, CO, 535p.

Peckham, S.D. (2008) CSDMS Handbook of Concepts and Protocols: A Guide for Code Contributors, http://csdms.colorado.edu/wiki/index.php/Tools_CSDMS_Handbook#Introduction

6.3 2008 Training and Development:

Syvitski, J.P.M., 02/04/08: 'The Charge of the CSDMS Working Groups', CSDMS Cyberinformatics and Numerics Working Group meeting, Boulder, Colorado; Abstract: The presentation provides an overview of the CSDMS project, its scope and promise, and the role and charge of the various working groups.

Peckham, S.D., 02/04/08: 'Selecting a Framework to Meet the Needs of CSDMS for Coupling Different Models', CSDMS Cyberinformatics and Numerics Working Group meeting, Boulder, Colorado; Abstract: The presentation provides a discussion of features that are considered desirable for the CSDMS 'component coupling framework' and examines the extent to which these features are provided by the ESMF, OpenMI and CCA frameworks.

Hutton, E.W.H. 02/04/08: 'Comparing Model Coupling Systems: an Example', CSDMS Cyberinformatics and Numerics Working Group meeting, Boulder, Colorado. Abstract: The presentation provides a case study comparing the use of OpenMI and CCA to couple two model components.

Kettner, A.J., 10/01/08: "Wave power and wave height movies". The model Wavewatch III simulates ocean waves every 3 hours since 1997 for different regions of the world at different resolutions. The model simulates the following parameters: Wind speed U and V components; Significant wave height; Peak wave period; Peak wave direction. Wave power can be derived from the parameters mentioned above. The zip movie files presented here are an example of the wave height (zipped as rar file) and wave power (zipped as rar file) changes during the year 2000, for the world. Grid resolution: 1 X 1.25 degrees.

Overeem, I., 09/17/08: "Geological Modeling Lab on Coastal Stratigraphy". The excercise is part of a course on Geological Modeling, intended for graduate level teaching. The zipped file contains an executable of a teaching model, BarSim, developed originally by Joep Storms. The archive contains notes for a 3-hour computer lab as well as the background literature. Feel free to download the material for use in your own courses and please provide feedback or expand the material! The excercise allows graduate students hands-on experience with a simple stratigraphic model to get insight in setting up stratigraphic simulation experiments. Focus is on exploration of the effects of external forcing factors, i.e. sediment supply and sea-level, on wave-dominated coasts and barrier islands.

Overeem, I., 09/02/08: "Geological Modeling Presentations". This zipped file contains presentations that are part of a course on Geological Modeling, intended for graduate level teaching. Feel free to download the material for use in your own courses.This course aims at exploring Geological Modeling techniques as: 1. Learning tools to study complex interactions of sedimentary depositional systems and time varying boundary conditions. 2. Quantitative tools to create geological models of the subsurface, including realizations of subsurface properties like grain-size distribution, porosity and permeability. 3. A means to quantify uncertainties in the subsurface models by running sensitivity tests.

Syvitski, J.P.M., 11/02/2008, Short Course on Source to Sink Numerical Modeling. Geological Nuclear Sciences, Lower Hutt (Wellington, NZ).

2008 CSDMS IF Presentations and Posters:

Bachman, S. and S.D. Peckham, 2008. Comparison of numerical approaches to a steady-state landscape equation, AGU Fall Meeting, San Francisco, CA.

Brommer, M.B., Weltje, G.J., Kettner, A.J., Trincardi, F., 2008. Source-to-sink analysis of the Northern Adriatic Basin over the past 19.000 years: data-model comparison using a mass balance approach. EGU meeting, Vienna, Austria, April 13-18.

Christoffersen, P, Heywood, K, Dowdeswell, J, Syvitski, JPM, Benham, TJ, Mugford, RI , Joughin, I, Luckman, A, 2008, Warm Atlantic water drives Greenland Ice Sheet discharge dynamics Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract: C31B-0501

De Winter, I.L., Overeem, I., Storms, J.E.A., 2008. Sedimentary Architecture of a glacio-fluvial valley fill; West-Greenland Case-Study. 38th Arctic Workshop, Boulder, Colorado, USA, 5-7th of March 2008. Extended Abstract.

Donselaar, M.E., Overeem, I., Reichwein, J.A., Visser, C.A., 2008. Reservoir potential of fluvial sheet sandstone, Ten Boer Claystone, Southern Permian Basin. AAPG Annual Convention and Exhibition, April 20-23 2008, San Antonio, TX, USA.

Goodall, J. and S.D. Peckham, 2008. Component-based architectures for building community models, CUAHSI Biennial Colloquium on Hydrologic Science and Engineering, July, Boulder, CO.

Hannon, M. Syvitski, J.P.M., Kettner, A.J., 2008, Hydrologic Modeling of a Tropical River Delta by Applying Remote Sensing Data: the Niger Delta and its Distributaries. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract: H53B-1050

Hutton, E.W.H. & J P M Syvitski, 2008, Modeling hydro-isostasy: Isostatic Flexure along the Global Coastlines Due to Sea-Level Rise and Fall, AAPG, San Antonio, April 20-23, 2008, http://www.searchanddiscovery.net/documents/2008/08039annual_abst/index.html#S

Kettner, A.J. 2008. What can the CSDMS website mean for Education and Knowledge Transfer. Education and Knowledge Transfer Working Group startup meeting, Oct 10, 2008, Boulder, CO.

Kettner, A.J., Hannon, M.T., Syvitski, J.P.M. 2008. Exploring ways to share CSDMS model input / output. Google workshop, May 5-6 2008, Boulder, CO. Kettner, A.J., B. Gomez, Syvitski, J P M, 2008, Human catalysts or climate change: will have a greater impact on the sediment load of the Waipaoa River in the 21st century? International Symposium on Sediment Dynamics in Changing Environments. Dec. 1-5, 2008, Christchurch, New Zealand.

Kettner, A.J., Syvitski, J.P.M., Restrepo, J.D. 2008, Simulating Spatial Variability of Fluvial Sediment Fluxes Within the Magdalena Drainage Basin, Colombia, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract: H53C-1065,

Overeem, I, Syvitski, J P M, 2008, Changing sediment supply in Arctic river systems. International Symposium on Sediment Dynamics in Changing Environments. Dec. 1-5, 2008, Christchurch, New Zealand.

Overeem, I, Syvitski, J P M, 2008, The sediment supply in Arctic river systems. SEDIBUD workshop, September 9 - 13, 2008, Boulder, Colorado, USA.

Overeem, I, Syvitski, J.P.M., Kettner, A.J. 2008. Are Arctic Rivers Unique and Are They Changing? Extended Abstract.38th Arctic Workshop, Boulder, Colorado, USA, 5-7th of March 2008.

Overeem, I. 2008. CSDMS introduction to International Arctic Research Center, Fairbanks for 'Arctic System Modeling' Workshop to be held May 19-21, 2008, Boulder.

Peckham, S., 2008, Update on CSDMS Adoption of CCA, CCA Winter Meeting, Boulder, CO.

Peckham, S., 2008, Advantages of using the Common Component Architecture (CCA) for the CSDMS project, CSDMS Cyberinformatics and Numerics Working Group Meeting, University of Colorado, Boulder, CO

Peckham, S., 2008, A brief overview of model coupling frameworks, CSDMS Marine and Coastal Working Group Meeting, Orlando, FL.

Peckham, S., 2008, Community hydrologic modeling: Advantages of using the Common Component Architecture (CCA), Scoping Workshop on a Community Hydrologic Modeling Platform (CHyMP), National Academy of Sciences, Washington, DC.

Peckham, S., 2008, Community Surface Dynamics Modeling System overview and working group charge, NSF/EU Workshop on CUAHSI and OpenMI, Wallingford, UK.

Peckham, S., 2008, "Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS), Apr. 19-21, IGWMC "ModFlow and More" meeting, Colorado School of Mines, Golden, CO.

Peckham, S., 2008, co-chaired the Community Models for Hydrologic and Environmental Research session (with Larry Murdoch, Clemson); CUAHSI Biennial Colloquium on Hydrologic Science and Engineering, NCAR Conference Center, Boulder, CO (http://www.cuahsi.org/biennial/)

Peckham, S., 2008, IGWMC (International Ground Water Modeling Center) meeting, Golden, Colorado, May 19-21, 2008. Evaluation of Model Coupling Frameworks for Use by the Community Surface Dynamics Modeling System (CSDMS).

Peckham, S., 2008, represented CSDMS at the Computational Methods in Water Resources, XVII International Conference, San Francisco, CA, July 8-12, with talk entitled: "Evaluation of model coupling frameworks for use by the Community Surface Dynamics Modeling System (CSDMS)".

Peckham, S., 2008, WebEx meeting and presentation to CUAHSI members about CCA and CSDMS, Wed., Feb. 6, 2008.

Peckham, S., 2008, TopoFlow hydrologic model: A community project, Third IAG/AIG SEDIBUD Workshop: Sediment Budgets in Cold Environments, Mountain Research Station, University of Colorado, Boulder.

Peckham, S., 2008, The technology behind the Community Surface Dynamics Modeling System (CSDMS), CSDMS Education and Knowledge Transfer (EKT) Working Group Meeting, Boulder, CO.

Peckham, S., 2008, Sediment transport in a changing Arctic: River plumes, longshore transport and coastal erosion, Arctic Change 2008 Meeting, Quebec City, Canada.

Peckham, S., 2008, Towards a system for high-performance, multi-language, component-based modeling, AGU Fall Meeting, San Francisco, CA.

Peckham, S., 2008, Overview and demonstration of the Community Surface Dynamics Modeling System, CSDMS Town Hall Meeting, AGU Fall Meeting, San Francisco, CA.

Syvitski, J P M, Overeem, I, 2008, Fjords: Development of the Ultimate Sedimentary Clinoform with a Falling Sea level. Clinoform sedimentary deposits: The processes producing them and the stratigraphy defining them, Aug. 15 - 18, 2008, Western Wyoming Community College, Rock Springs, WY, USA

Syvitski, J.P.M. CSDMS AGU Town Hall Meeting. San Francisco AGU, Dec. 18, 2008

Syvitski, J.P.M. CSDMS and Hydrology. NSF Hydrological Synthesis Meeting. UCAR, Boulder, Oct. 7, 2008.

Syvitski, J.P.M. CSDMS Overview and Update. Coastal Working Group startup meeting, March 8, 2008, Orlando, FL

Syvitski, J.P.M. CSDMS Overview and Update. CSDMS Community Sediment Model for Carbonate Systems, Feb. 27-29, 2008, Colorado School of Mines, Golden, CO

Syvitski, J.P.M. CSDMS Overview and Update. CSDMS Executive Committee Meeting, July 17-18, 2008, Boulder CO

Syvitski, J.P.M. CSDMS Overview and Update. Cyberinformatics and Numerics Working Group startup meeting, Feb. 4-5, 2008, Boulder, CO

Syvitski, J.P.M. CSDMS Overview and Update. Education and Knowledge Transfer Working Group startup meeting, Oct 10, 2008, Boulder, CO

Syvitski, J.P.M. CSDMS Overview and Update. Marine Working Group startup meeting, March 9, 2008, Orlando, FL

Syvitski, J.P.M. CSDMS. CCMP Workshop on Communicating Models and Data, Annapolis, May12-14, 2008.

Syvitski, J.P.M. CSDMS. Geological Nuclear Sciences, Lower Hutt (Wellington, NZ), 2008.

Syvitski, J.P.M. CSDMS. Industry Consortium Meeting held Tues., April 22; San Antonio, TX

Syvitski, J.P.M. CSDMS. Macquarie U, Sydney, Australia, 2008.

Syvitski, J.P.M. CSDMS. National Science Foundation, May 15, 2008

Syvitski, J.P.M. CSDMS. Research Collaboration Partnership Meeting, Colorado School of Mines, Golden, CO, Tues., Feb. 26, 2008.

Syvitski, J.P.M. CSDMS. SEDIBUD Workshop, Sept 9-13, 2008, Niwot, MRS, CO

Syvitski, J.P.M. Data and Modeling: two versions of the same reality? Geological Society of America Sedimentology and Stratigraphy Section, Houston TX, Oct. 4, 2008.

Syvitski, J.P.M. InSAR sensing (SRTM) of low-lying topography in river floodplains and deltas: An assessment at the Studying Earth Surface Processes with High Resolution Topographic Data, Boulder, June 16-18, 2008, UCAR

Syvitski, J.P.M. Sediment production and transport in the global setting. International Workshop on Sediment Transport in Taiwanese Rivers - Coastal Seas and Other Coastal Systems; November 3 - 5 2008 , National Central U Taipei http://www.ihs.ncu.edu.tw/~sediments/conference/

Syvitski, J.P.M. Sedimentation on Floodplains. NASA assessment, City College, CUNY, 2008.

Syvitski, J.P.M. Sinking Deltas, Geological Colloquium, CU-Boulder, 2008.

Syvitski, J.P.M. What is CSDMS. Margins S2S Futures Meeting, Orlando, 2008.

Syvitski, J.P.M., co-chaired the Surface Processes, Sediments and Landscape session (with Ben Hodges, Efi Foufoula-Georgiou) July 14-16. CUAHSI Biennial Colloquium on Hydrologic Science and Engineering, NCAR Conference Center, Boulder, CO (http://www.cuahsi.org/biennial/)

Syvitski, J.P.M., Hutton, E.W.H., 2008, Delivering Terrestrial Sediment to Continental Slopes: An Overview of Gravity Flow Mechanisms, AAPG, San Antonio, April 20-23, 2008, http://www.searchanddiscovery.net/documents/2008/08039annual_abst/index.html#S

Syvitski, J.P.M., Kettner, A.J., 2008, Scaling Sediment Flux across Landscapes. International Symposium on Sediment Dynamics in Changing Environments. Dec. 1-5, 2008, Christchurch, New Zealand.

7.0 CSDMS Membership

7.1 U.S. Academic Institutions

1. Arizona State University
2. Boston University
3. Colorado School of Mines
4. Colorado State University
5. Cooperative Institute for Research in Environmental Sciences (CIRES)
6. Duke University
7. Harvard University
8. Indiana State University
9. Lamont-Doherty Earth Observatory
10. Louisiana State University
11. Massachusetts Institute of Technology
12. Monterey Bay Aquarium Research Inst.
13. North Carolina State University
14. Northern Illinois University
15. Oberlin College
16. Ohio State University
17. Oregon State University
18. Penn State University
19. Rutgers University
20. Tulane University
21. University of Alaska Fairbanks
22. University of Arizona
23. University of California - San Diego
24. University of California - Berkeley
25. University of California - Irvine
26. University of California -Santa Barbara
27. University of Colorado - Boulder
28. University of Connecticut
29. University of Florida
30. University of IL-Urbana-Champaign
31. University of Iowa
32. University of Maryland
33. University of Miami
34. University of Minnesota
35. University of Minnesota-Duluth
36. University of Nebraska, Lincoln
37. University of New Hampshire
38. University of New Mexico
39. University of Oregon
40. University of Rhode Island
41. University of South Carolina
42. University of South Florida
43. University of Southern California
44. University of Texas-Austin
45. University of Texas at El Paso
46. University of Texas-Arlington
47. University of Virginia
48. University of Washington
49. University of Wyoming
50. Utah State University
51. Vanderbilt University
52. Virginia Institute of Marine Science (VIMS)
53. Washington State University
54. Western Carolina University
55. William & Mary
56. Woods Hole Oceanographic Inst.

7.2 U.S. Federal Labs and Agencies

The following government departments and agencies have filed official letters of support for the CSDMS initiative and its mission. In addition to their collaboration with and support of CSDMS efforts on various levels - from financial support to in-kind support to collaborative research - these departments and agencies also offer partnership via the participation of representatives in the various committees and working groups operating within CSDMS: U.S. Office of Naval Research (ONR), U.S. Army Corps of Engineers (ACE), U.S. Army Research Office (ARO), U.S. Geological Survey (USGS), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), National Oceanographic Partnership Program (NOPP).

7.3 Foreign Membership

1. The University of Sydney Institute of Marine Science, Australia
2. Federal University of Itajuba, Brazil
3. Bedford Institute of Oceanography, Canada
4. Geological Survey of Canada, Pacific
5. University of Calgary, Canada
6. University of Copenhagen, Denmark
7. CNRS / University of Rennes I, France
8. IFREMER, France
9. Institut Francais du Petrole (IFP), France
10. Universite Bordeaux 1, France
11. Darmstadt University of Technology, Germany
12. University of West Hungary - Savaria Campus
13. University of Padova , Italy
14. University of Rome "LaSapienza", Italy
15. Geological Survey of Japan,
16. JAMSTEC, Japan
17. Delft University of Technology, Netherlands
18. Utrecht University, Netherlands
19. Wageningen University, Netherlands

20. WL Delft Hydraulics Lab, Netherlands
21. ASR Ltd., New Zealand
22. GNS Science, New Zealand
23. National Institute of Water and Atmosphere (NIWA), New Zealand
24. University of Bergen, Norway
25. Imperial College London, UK
26. King's College London, UK
27. University of Cambridge, UK
28. University of Edinburgh, UK

7.4 Industrial Membership and Consortium

The following industrial partners have collaborated with and support CSDMS efforts on various levels - from financial support to in-kind support to collaborative research. These organizations also offer support via the participation of representatives in the various committees and working groups operating within CSDMS: BHP Billiton Petroleum (Americas), Chevron Energy Technology Company, ConocoPhillips, Delft Hydraulics (Deltares), ExxonMobil Research and Engineering Company, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Schlumberger Information Solutions, Shell International Exploration, Petrobras, Statoil-Hydro, and URS Corporation.

7.5 Communication Strategy

Member representatives and individuals within the larger CSDMS community (including those at member institutions) will be kept informed in several ways.

- Through e-mail. CSDMS maintains several list servers through the CSDMS website including several for the main committees (e.g. Executive Committee, Steering Committee, Industrial Consortium) as well as for working groups and general information. A CSDMS Newsletter highlighting new developments and capabilities with appropriate links to the CSDMS website will be distributed by email on a regular quarterly basis.

- Through the http://csdms.colorado.edu web site. The upcoming CSDMS calendar of events is posted and continuously revised. Nearly all CSDMS documents including the annual revision of the CSDMS Strategic Plan, By-Laws, etc., are posted on this site. The Web site is the principal means for standard software downloads, sharing of community benchmarks, specifications of standards, and distribution of user & training manuals. Documents and presentations from various CSDMS-sponsored workshops and meetings are also posted to the site for the benefit of the entire community.

- The annual CSDMS Town Hall meeting. This meeting will be open to all and will be a forum for open discussions of the working of CSDMS, including past and upcoming activities & the Strategic Plan. In year two, this meeting was held in conjunction with the Fall AGU meeting in San Francisco. Competition with other NSF Town Halls may not make this a wise choice, unless the event was held at a local SF Hotel and on a different day.

- CSDMS sponsored and co-sponsored workshops and training sessions. The current status of CSDMS will be presented at these workshops and we expect that CSDMS members will attend such workshops.

8.0 CSDMS Priorities and Management of Its Resources

The start up year 1 saw the CSDMS governance established; Committees and Working Groups populated; the Integration Facility set-up; communication systems for the community developed; outreach and coordination with US Federal Labs and Agencies, industry, and to the broader surface dynamic community; and the hosting of a variety of scientific Workshops. Year 1 saw the scientific goals and cyber-infrastructure established to meet those goals and challenges. Expenditures related to the Integration Facility staff; travel expenses related to CSDMS governance, operations and workshop participation costs.

Year 2 saw further refinements in the CSDMS communication systems with greater community activity; establishment of a CSDMS Interagency Committee established; the Industry Consortium finalized; and outreach

to the broader surface dynamic community continued through scientific Workshops (e.g. Sedibud, Clinoform, Carbonates), five Working Group meetings, three Focus Research Group meetings. Workshop participation costs increased as the CSDMS community grows. The CSDMS high-performance computer was installed and launched as a community-open system, and further advances in the CSDMS cyber-infrastructure was achieved. The Computer Services costs spiked in year two with the new CSDMS HPC. During the final quarter of Y2, a software engineer will be hired through an internationally advertised search, and will work with the Environmental Working Groups to help them identify and convert targeted open-source surface-dynamic models to be compliant with the CSDMS Architecture.

Year 3 will see greater allocation of resources to meet the grand challenges of CSDMS (see Five Year Strategic Plan http://csdms.colorado.edu/wiki/images/CSDMS_Strategic_Planv3F-48-op.pdf) within the broader surface dynamic community, employing a fully functioning CSDMS-dedicated high-performance computer, running a multitude of CSDMS compliant and interlinked surface dynamic modules. The Computer Services costs will continue to grow as the community grows in their use of the CSDMS HPC. Workshop participation costs will also increase, as the CSDMS community grows through the support of 5 Working Groups and 3 Focus Research Groups. At the beginning of Y3 a scientist dedicated to the Education and Knowledge Transfer activities will be hired to directly support the EKT Working Group activities, such as developing a suite of educational modules. CSDMS staff will continue their community interactions at both national and international venues. At least two international workshops will be support (Rivers-Coastal-Estuarine Morphodynamics; Modeling Turbidity Currents and Related Gravity Flows).

9.0 NSF Revenue & Expenditure

		Proposal	Expenditure	Proposal	Expenditure #	Proposal
		Year 1	**Year 1** 03/31/08	**Year 2**	09/30/08	**Year 3**
A. Salaries and Wages						
	Executive Director:	$48,986	$47,895	$87,244	$52,200	$103,109
	Software Engs:	$102,750	$97,273	$147,600	$96,100	$204,531
	Commun Staff**	$20,000	$17,054	$20,760	$30,760	$69,613
	Admin Staff***	$50,891	$47,964	$70,249	$41,000	$80,484
Total Salaries		$223,120	$209,886	$325,853	$220,060	$457,737
B. Fringe		$53,057	$48,644	$88,458	$57,015	$115,311
D. Travel						
	Center Staff:	$12,000	$23,331	$30,000	$18,000	$32,000
	Steering Committee	$3,000	$1,580	4,000	0	6,000
	Executive Com.	$6,000	$4,760	6,000	3,500	7,000
Total Travel		$21,000	$29,671	$40,000*	$21,500	$45,000
E. Workshop Participation		$40,000	$37,000	80,000*	20,000^	80,000
F. Other Direct Costs						
	Materials & Suppl	$3,000	$1,313	2,000	1,500	3,000
	Publication Costs	$1,000	$6,163	3,000	3,000	4,000
	Computer Services:	$10,000	$6,420	18,000	12,000	28,000
	Communications	$2,000	$1,500	3,000	1,500	3,000
	Total	$16,000	$15,396	26,000	18,000	51,000
G. Total Direct Costs		$352,684	$340,597	566,311	336,575	749,048

H. Indirect Cost	$153,215	$140,235	$238,292	$161,453	$341,214
I. Total Costs	$500,932	$489,359	804,603	498,028	$1,090,262

J. Carry Forward FY1 to FY2   **$11,572**

**Communication Staff includes Web Master + EKT staff

*** Admin Staff includes Executive Assistant, System Administrator, Accounting Technician

#Preliminary: the CSDMS fiscal year is from April 1 to March 31; CU can complete a preliminary estimate of expenditures after 60 days of a time marker. CU provides a finalization typically within 120 days of a fiscal year.

*Total includes supplemental NSF funds not yet received

^Most working group meetings are scheduled for the last quarter of Fiscal Year 2

Additional Year 1 Funds Received by CSDMS Personnel:

Office of Naval Research: Hydrologic and morphodynamic modeling of Deltas: $150K

NASA: Modeling framework to detect and analyze changes in land-to-coastal fluxes: $150K

ConocoPhillips: Cold-climate sedimentary environments: Sedimentary architecture, GIFT $50K

NSF: Modeling river basin dynamics: Parallel computing and advanced numerical methods $220K

NOPP: Toward a predictive model of Arctic coastal retreat in a warming climate $32K

University of Colorado: Salary and Capital support for the CSDMS Integration Facility: $50K

ExxonMobil: CSDMS GIFT $30K

Additional Year 2 Funds Received by CSDMS Personnel:

Office of Naval Research: Hydrologic and morphodynamic modeling of Deltas: $110K

NASA: Modeling framework to detect and analyze changes in land-to-coastal fluxes: $90K

ConocoPhillips: Cold-climate sedimentary environments: Sedimentary architecture, GIFT $100K

NSF: Modeling river basin dynamics: Parallel computing and advanced numerical methods $220K

NOPP: Toward a predictive model of Arctic coastal retreat in a warming climate $32K

University of Colorado: Salary and Capital support for the CSDMS Integration Facility: $220K

ExxonMobil: CSDMS GIFT $40K

Appendix 1: A Community Approach to Modeling Earth Surface Dynamics

Alexey Voinov[1], Cecelia DeLuca[2], Raleigh Hood[3], Scott Peckham[5], Chris Sherwood[4], James P.M. Syvitski[5],

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[2]Earth System Modeling Framework, National Center for Atmospheric Research, Boulder, CO 80302, USA

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[4]USGS, Woods Hole, MA

[5]CSDMS Integration Facility, University of Colorado—Boulder, Boulder CO, 80309-0545, USA

Community models first emerged in the 1980's in the fields of air quality modeling, climate prediction, and weather forecasting. The first generation systems that were developed, including the EPA's Models-3 System, the NCAR Community Climate Model (CCM), and the Pennsylvania State/NCAR Mesoscale Model (MM5), demonstrated that freely available, portable, and the broader community would enthusiastically receive well-documented models as research tools.

The next generation of community modeling projects was more ambitious. The Community Climate System Model (CCSM), the successor to CCM, continues to assimilate new physical processes and now, human factors, at an accelerating rate. The CCSM project participated in the demanding Intergovernmental Panel on Climate Change assessments, while continuing to serve as a vehicle for research. The Weather Research and Forecast (WRF) Model, the successor to MM5, has attempted to serve both the research and operational communities. These models are widely used and have developed networks of contributors. They have also struggled to meet the demands placed on them: to satisfy diverse user bases, to keep up with the integration of new science, and to create governance bodies that can support scientific processes and scale to large numbers of participants.

Computer modeling is a widely used and practical tool for solving scientific and engineering problems in Earth sciences. Every day, Earth science models are used by government agencies, academic institutions, and private industry in ways that can save lives, protect the environment, and enhance economic productivity. In Earth science we are dealing with complex systems that span over many disciplines, and require scientists from many backgrounds to participate in designing and testing model algorithms. Most important, we need to provide timely and adequate information to drive the decision-making process, which is goal driven, and needs to be iterative, adaptive, and flexible. Complex systems require complex models to understand them, but simple models are more appropriate for management and effective decision-making. Therefore there is no "one size that fits all" model and there is no one model that can answer all questions. Therefore models must be modular and hierarchical, so there is a need for framework and integration software and standards for modules and interfaces. Complex models are difficult to use, require lots of data, and generate lots of output, so again, design of the user interface is important, as are standards for data, model output, and Internet data sharing. Complex models must be efficient to be useful, so they require contributions by software engineers to ensure efficient and accurate numerics and implementation on fast computers

While the modeling community is rightfully proud of its successes, we also see unmet challenges. Many of these can be attributed to demands to cross disciplines and scales, to address harder problems by creating alternative models that encompass more physical processes and human factors, to use computing systems that are growing in computational and visualization power and complexity, and to harness the expertise of increasingly large and distributed development teams. A sole developer or small group working with a model of limited scope can produce results without spending much time on software processes, standards, licensing, or issues of accessibility. Yet the absence of these elements in a large endeavor results in redundant activities, inefficient information transfer, poor coding practices, minimal quality assurance, and poor documentation. It is crucial to develop sound practices that support distributed multi-developer projects, to build model software that is flexible and enables component substitutions, and to provide continuity in model development.

Open-source, community approach is the best way to build these models

A community model or modeling system is an open source suite of modeling components within a framework that is constructed and/or improved through the organized efforts of a group of individuals working together to help develop, debug, calibrate, document, run and use it. It typically includes datasets for parameters, external, initial, and boundary conditions, as well as expected outputs for a suite of test cases to verify that the modeling system is working correctly. It may also contain a suite of model data comparisons to evaluate model skills, associated tools for helping to prepare input or evaluate output, and current documentation.

The community often includes both developers and users, and is distributed among different institutions and organizations. Community modeling is a process of building, supporting, linking and integrating data and components for a community model. At its best, it can lead to efficiencies in model development, the emergence and use of scientifically sound, validated scientific components, better linkages to data systems or networks, faster development cycles through pooled technical resources, more transparency in concepts, assumptions, and model source codes, and closer connection with the user community.

Some examples of community modeling projects in Earth science include the NSF-funded CSDMS (Community Surface Dynamic Modeling System - http://csdms.colorado.edu), the EPA-funded CMAS (Community Modeling and Analysis System - http://www.cmascenter.org/), the NOAA-funded CCMP (Chesapeake Community Model Program - http://ccmp.chesapeake.org), DoD-funded CSTM (Community Sediment Transport Model - http://woodshole.er.usgs.gov/ project-pages/sediment-transport/), CCSM (?) and others. Key to these efforts is a new culture of scientific research based on open sharing of information and skills.

There are several advantages of a community approach. It provides much needed integration of effort between multiple institutions, which is crucial because models are too multidisciplinary and complex for individual research groups. It allows scientists to work with software engineers, helping to bridge the cultural and, often, institutional gap between these teams. Moreover it provides the essential link to the user community, offering much needed transparency that promotes user participation and input at early stages of the project and during the testing phase. More users yields better testing, more robust models and more acceptance of the results. Generally, more applications yield more useful models.

All community-modeling efforts rely on the open source paradigm. Open source is used to refer both to the idealistic philosophy of software development that originated in computer programming, and to the legal status conferred by an open source software license. The license supports, but is only an element of, the larger paradigm.

The reliance on open source delivers the following important features:

- Complete information transfer; this transparency is important because code is ultimate statement of scientific hypotheses
- Allows peer review and replication of results
- Code can be reused, which reduces redundancy

Since much science is funded with public funds, it makes it natural to expect that products should be publicly available. Open source is one of the ways to deliver such results to the public.

The challenges are also there

We are still learning how to best to develop open-source scientific software using a community approach. On the technical side, required are fundamental algorithms to describe processes; software to implement these algorithms; software for manipulating, analyzing, and assimilating observations; standards for data and model interfaces; software to facilitate collaborations; and substantial improvements in hardware (e.g., network and computing infrastructure). Standard metadata and ontologies to describe models and data are also needed.

However, most of the most difficult challenges are social or institutional:

- Reward structure is skewed toward publications and away from technical contributions in many institutions

- Funding is discontinuous, and not reliably available for support and technical infrastructure

- Intellectual property policies of universities and private companies are not always compatible. Software is often viewed as a competitive advantage among competitors for funding and academic honors, including graduate students that develop software for theses

- There are instances of a "not made here" culture, when researchers prefer in-house products, rather than implementations of already existing products

- There is always an overhead that comes with "soft" organization with no clear internal hierarchy. Many community projects are using the so-called "bazaar" approach that is an open-ended process of simultaneous efforts of numerous players, with no clear subordination and ruling. This does not work well with deadlines and deliverables. Such efforts may lack realistic project assessment, and clear strategies to deal with conflicts and inefficiencies.

- It is sometimes difficult to work across great distances and time zones with a diverse group of people.

We believe it is paramount to reaffirm our commitment to the fundamental precepts of science and encourage the rebuilding of a culture of collaboration and information sharing.

What's needed?

There are a number of recommendations that we find useful to enhance and support the community modeling efforts. These may fall into two categories: organizational and technical. The organizational ones are about the cultural and social background that is important for community modeling, and the programmatic decisions that can make projects more successful. The technical recommendations are about the actual software and analytical tools that are required. It is also important to keep communication lines open between the "techies" and the program managers. It is crucial that these two groups develop some appropriate protocol regarding which information needs to be "passed upward" and how best to do this. Technical details are the foundation of community software projects and the number of concepts, languages, terms, tools, systems, etc. that are involved continue to grow exponentially. The communication and time-management challenges presented by this "information overload" should not be underestimated.

Recommendations for funding agents and program managers

- Program managers should insist that code be open source and meet a minimum level of standards or protocols as a requirement for receiving federal funds.

- Funders should provide stable (longer-term) funding of software architects and engineers within the research environment, on par with the technical staff support of large academic or medical labs.

- Funders should require that code and documentation be accessible as early and openly as possible during development, and should ensure that code from a completed project be archived and accessible, in the same way the field data and measurements are now.

- Support repositories of models and software and make sure they synchronize information and standards among themselves.

Recommendations for institutional leadership

- Recognize that producing well-documented, peer-reviewed code is worthy of merit.
- Develop effective ways of for peer-review, publication, and citation of code, standards, and documentation
- Embrace open-source while protecting intellectual property rights
- Recognize the value of both open-source sharing and community efforts.
- Support collaborative environments that minimize the need for temporal and spatial locality are crucial for the success of community efforts.

Recommendations for project leaders

- Criteria and metrics for success must be assessed carefully, with consideration of factors such as whether the core user base is satisfied; whether the software is accessible, technically adequate, uses community standards, and is well documented; whether contributions are evaluated and assimilated in a clear and timely way; whether the project scope is commensurate with resources; and whether the project is able to complete its central functions.
- Community efforts require project governance at different timescales (e.g. daily, weekly, quarterly, annually, funding cycles) and involving different staff levels (e.g. developer, project manager, program manager). In particular, structures and processes must enable the project teams to set priorities, schedules, and make decisions as a unified project working towards a common goal. Project governance must accommodate, but must also be able to supersede, the interests and priorities of working groups operating in specific disciplines.
- Support collaborative environments that minimize the need for temporal and spatial locality are crucial for the success of community efforts.

Technical recommendations for developers and the rest of us

- Adopt existing standards for data, model input and output, and interfaces
- Develop standards for model conceptualization, formalization and scaling
- Seek to use/adapt existing tools first before developing your own.
- Provide good documentation to facilitate reuse and code/model transparency
- Establish and use good modeling practice that code maintenance, reusability, portable, and follows object-oriented

Appendix 2: NSF/CSDMS Workshop: Community Sedimentary Model for Carbonate Systems

Convened at: Colorado School of Mines, Golden, CO

February 27-29, 2008

Rick Sarg, Colorado School of Mines, jsarg@mines.edu

Evan Franseen, KGS & Univ. of Kansas, evanf@kgs.ku.edu

Gene Rankey, Univ. of Miami, grankey@rsmas.miami.edu

INTRODUCTION, SOCIETAL RELEVANCE, AND WORKSHOP SUMMARY

Developing predictive models of carbonate systems has important implications for monitoring and managing global climate change affecting societies around the world. Carbonate sediments and rocks form an important part of the global carbon cycle. More than 80% of Earth's carbon is locked up in carbonate rocks. Almost all of the remainder is in the form of organic carbon in sediments. About 0.05% of Earth's carbon is present in the ocean in the form of the carbonate and bicarbonate ions and dissolved organic compounds, whereas 0.0008% is tied up in living organisms, and about 0.002% is in the form of CO_2 in the atmosphere. Carbonate rock is the primary ultimate sink for CO_2 introduced into the atmosphere.

Throughout most of Earth history, precipitation of mineral carbonate has been closely linked to the metabolism and activities of living organisms. An important but often neglected part of understanding the carbon cycle requires that we understand how mineral carbonate is produced, how it accumulates into sedimentary deposits, how it is altered after burial, and how it is recycled back into mobile chemical species.

Although we have learned a lot about carbonate fixation, deposition, and dissolution in open ocean deep-sea environments, our knowledge of the rates of formation of mineral carbonate in shallow waters remains rudimentary. Knowledge of the changes of rates of deposition and dissolution with rises and falls in sea level associated with climate change is largely speculative and becomes increasingly uncertain for the more distant geologic past. A better understanding of these processes is essential to progress in understanding the effects of alterations of the carbon cycle resulting from the introduction of fossil fuel CO_2 into the atmosphere.

Reefs and carbonate platforms, in general, are sensitive climatic indicators, are "global sinks of carbon", and contain important records of past climate change. They are reservoirs of biodiversity, and provide critical fisheries habitat. Changes in global climate dramatically affect carbonate systems, and the peoples that live amongst them. Rising sea level heightens erosion of islands, reduces shoreline stability, causes marine flooding of coastal freshwater aquifers, and displaces indigenous people (e.g., South Pacific). Increased global CO_2 causes ocean acidification, which in turn affects the ability of many modern carbonate-producing organisms and processes to function optimally.

Ancient carbonate platforms and systems play a significant role in the global economy.   They are the raw material for construction, both as building stone and as the parent material required for manufacture of cement. Through their high permeabilities and porosities, carbonate rocks serve as important aquifers and as petroleum reservoirs. They are major freshwater aquifers critical to the health of urban and rural areas (e.g., Edwards Aquifer, central Texas, USA), and in many island nations, the primary source of fresh water. Likewise, carbonate rock reservoirs host more than half of the world's petroleum. Finally, carbonate systems that fringe island nations across the planet form the basis of tourism and food for island peoples.

In response to the needs discussed above, an NSF-sponsored workshop on carbonate systems and numerical systems modeling was held in late February, 2008, at the Colorado School of Mines. The purposes of the workshop were to identify grand challenges for fundamental research on ancient and recent carbonate systems, and to identify promising

areas for advancing the next generation of numerical process models to enhance our ability to meaningfully and accurately model carbonate systems. Thirty-one attendees from academia and industry worked to initiate a carbonate community across a broad spectrum of disciplines, including sedimentology, stratigraphy, geobiology, oceanography, paleoclimatology, numerical process modeling, and carbonate diagenesis. Although attended by a small subset of the greater potential community, this workshop served to open dialog, and began to define the necessary inputs to improved modeling of carbonate systems. The results of this first carbonate systems workshop are posted on the Community Surface Dynamics Modeling System (CSDMS) website (http://csdms.colorado.edu/meetings/carbonates_2008.html). Workshop participants, through a series of presentations, break-out groups, and open dialog, evaluated recent findings and research directions on the influences of climate, ocean systems, ecology, and diagenesis on carbonate deposits, and then began to identify the "grand challenges" (e.g., modeling large facies heterogeneities; numerical simulation of diagenetic history) to the understanding and modeling of ancient and recent carbonate systems.

Through these efforts, participants recommended forming working groups to synthesize the current knowledge and research needs within each of five broad areas of carbonate research – physical processes, biological processes, diagenesis, analytical tools for studying carbonate systems, and modeling. Modeling in this context, includes all types of numerical models, such as dynamic process-based models, stochastic, and fuzzy-logic models. Although the emphasis was on addressing the needs for enhanced models, participants emphasized the need for robust data to be applied to modeling inputs (e.g., carbonate biological and physio-chemical production rates). These working group syntheses could entail collaboration between the carbonate sedimentary and modeling communities to identify gaps in documentation of parameters and/or development of algorithms.

Participants agreed that a more coordinated research effort in carbonates would be beneficial to advancing understanding, with the ultimate goal of advancing a set of quantitative predictive models for carbonate deposition and diagenesis. As a start to achieving some of the broad research objectives, workshop participants recommended interdisciplinary efforts focus on identifying a limited number of sites to conduct integrated research in selected key subsets of: (1) the modern and Pleistocene systems, to examine in quantitative and predictive detail, the effects of ocean conditions and climate change on carbonate accumulations, and the evolution of sediments into beds and strata; and (2) important analog field areas that combine outcrop, behind outcrop, and the subsurface, to build a new generation of 3-D carbonate analogs to test the validity of numerical models. A companion effort will be needed to build an archive system to capture and share data. From this standpoint, the CSDMS Integration Facility is in an ideal position to facilitate the development, and hosting of such an archive system.

Importantly, the workshop also attempted to identify promising areas for advancing the next generation of numerical models, to enhance our ability to meaningfully and accurately model carbonate systems, including both depositional processes and diagenesis (Figure 1). An important result of the workshop was the recognition of the need to integrate carbonate modeling efforts into other Earth-surface modeling efforts such as the Community Surface Dynamics Modeling System. The workshop resulted in the development of a plan for creation of a workbench platform for carbonate knowledge generation via a suite of integrative modules that is available to the carbonate community. As a result of the participants' efforts, this workshop has served to open the dialog, and to begin to define the necessary inputs to the modeling of carbonate systems from sedimentation through burial.

This workshop also aimed to establish a framework for future workshops to engage an expanded community interested in carbonate systems, and that can better define research goals and objectives. As part of this goal, a carbonate working group has been initiated within CSDMS, providing a hub and framework to facilitate future workshops. Subgroups, covering the five areas of physical processes, biological processes, diagenesis, tools, and modeling could be established within this broader working group.
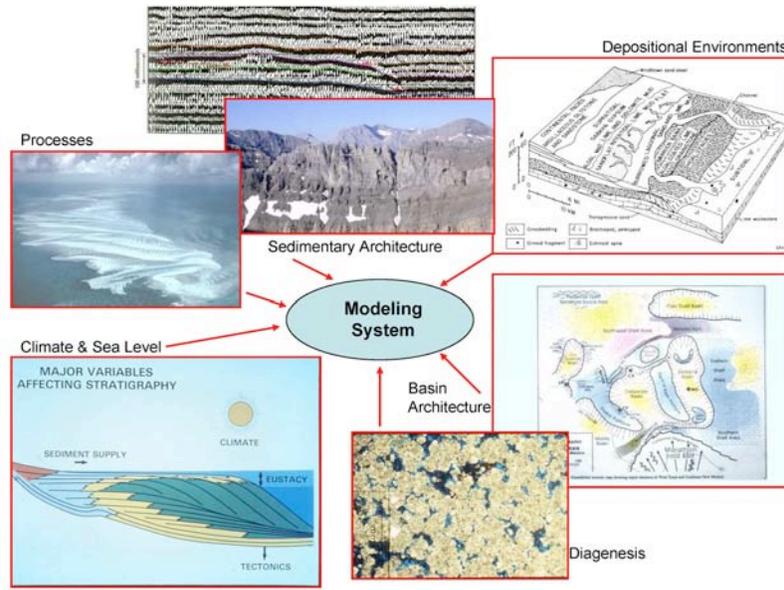
Figure 1. Components of Carbonate Community Model System.

RESULTS AND RECOMMENDATIONS

The following sections summarize workshop discussion and conclusions, and are divided into five topical areas: physical controls, biologic controls, diagenesis, numerical modeling, and tool development. They include some identified short- medium- and long-term goals for each of the topical workshop areas.

1) Physical Controls on Carbonate Deposition -

All carbonate community members face the grand challenge of quantitatively understanding and modeling facies heterogeneities, developed over various geologic timescales, as influenced by changing biotic, paleoceanographic, paleoclimatic, and sea level conditions. The first step is to understand the nature and origin of the patterns of sediment accumulation. Whereas we have a good qualitative understanding of patterns on carbonate platform tops, a rigorous quantitative understanding is lacking. Similarly, patterns and processes on platform slopes and deepwater reefs await better qualitative and quantitative exploration. Major knowledge gaps include a lack of a rigorous understanding of:

1) The effects of sea level fluctuations on sediments,

2) How to predict sedimentation patterns in a non-linear and complex system, as opposed to assessing sediments in a 1:1 linear relationship vs. depth;

3) The processes that lead to development and evolution of geomorphic and facies patterns, and the time scales of development;

4) The respective roles of quotidian and storm processes in sedimentologic and geomorphic evolution;

5) How to most accurately develop separate sector models for different environments (reefs, shoals, platform interior and tidal flats). This requires a clearer understanding of the different controls in these areas, and how sector models should be employed;

6) The interplay between physical processes and the occurrence of cemented areas (hardgrounds) and benthic mats that can influence accumulation; and

7) The effects of changes in sea water chemistry through the Phanerozoic on long-term facies development in carbonate systems.

Short-Term Goals: Participants noted a number of short-term goals that entail assembling existing data, including:

1) Assemble an inventory of modern platforms types and depositional systems and an associated inventory (database) of physical measurements and models from these systems. This could lead to a new classification of different platform types and depositional environments and would show where there are gaps in physical measurement data that are necessary for modeling;

2) Take existing carbonate numerical modeling packages and run sensitivity analyses on ranges of parameters in those models, to put bounds on certain physical parameters that need to be measured or better understood. For example, the "friction factor" in CARB3D$^+$ seems to be quite important although its physical meaning is vague.

3) Assemble a catalog of existing numerical siliciclastic models to assess parameters these models use as input, and explore for possible overlap.

Medium-Term Goals: Participants recommended the following:

1) Collecting oceanographic measurements (waves, tides, and currents) across one or two different platforms. Longer-term goals include a detailed coring program on one or more platforms to evaluate the platform depositional architecture, to provide information to test models.

2) Development of preliminary "sector models" of various specific environments to provide "modular" input to a larger community model. For example, we would envision a "reef model", one or more ooid shoal models; a tidal flat model, and a platform interior model. We do not have robust enough data to accurately model flow and sediment transport in these models.

Necessary partners for the short and medium term goals are physical oceanographers, especially to establish boundary conditions and measure the physical parameters on the platforms. This group should also partner with the biological working group for developing "sector models."

2) Biological Controls on Carbonate Deposition -

Modern tropical shallow-water coral reefs are comparatively well known, but many fundamental questions remain. Similarly, tropical meso/oligophotic reef systems, cool-water carbonate systems, and aphotic systems are poorly understood carbonate systems. Likewise, there is a broad base of paleontological knowledge of fossil biota. To better understand carbonate systems, however, a grand challenge centers on understanding how appropriate are Holocene tropical shallow-water reefs as analogues for ancient carbonate buildups, or, if they are not, how the ancient systems differ. Beyond this grand challenge, the fundamental questions of assessing how changes in biogeochemical boundary conditions (CO_2, alkalinity, salinity, and Mg/Ca ratios) have changed modes and rates of calcification remains.

Knowledge gaps identified by this group include lack of quantitative understanding of 1) the boundary conditions for hypercalcification; 2) rates of production and how they relate to rates of deposition/accumulation; 3) relative rates of bioerosion and physical erosion; and 4) the nature and origins of spatial heterogeneity. These unknowns center on aspects of rigorous understanding of the basic questions of 1) how carbonate producing communities function and how does the sediment produced accumulate; 2) the relative importance of different biota under different boundary conditions; 3) how does the seascape heterogeneity translate to stratigraphic heterogeneity; and 4) what are the origins of lime muds.

Participants suggested that experiments to understand how changes in geochemical parameters influence rates of biomineralization should be developed in collaboration with physiologists and geochemical modelers. Interaction with population ecologists will be key to interpret how changes in environment (chemical, physical, etc.) translate to population dynamics, and how that, in turn, translates to spatial heterogeneity within and between bottom types.

Improved collaboration with paleontologists and carbonate sedimentologists will allow better analogue comparison between modern and ancient systems. Modern test cases should be developed as possible analogues for ancient carbonate buildups, using the full breadth of carbonate depositional systems worldwide, including tropical meso/oligophotic carbonates, cool-water carbonate systems, and aphotic communities. Studies might cross a broad range of environments (e.g., latitudinal such as E/W Australia, E/W Florida, E Africa, Hawaii to NW Hawaiian islands; current-dominated systems like the Nicaraguan Rise; across depth gradients that have changing light, trophic resources, temperature, internal waves, etc. (i.e., most modern margins); and in mixed settings that contain terrigenous sediments). Hypotheses developed in modern systems can then be tested in appropriate ancient systems. The answers to these could provide insights into understanding how seascape heterogeneity translates to stratigraphic heterogeneity, and how to characterize seascapes and the inherent dynamics of biota across turn-on-turn-off gradients in a more realistic and effective manner.

These inherently interdisciplinary efforts require diverse partners such as ocean observing system engineers, "landscape" ecologists and modelers, microbiologists, geochemists, geochemical modelers, developers of experimental mesocosms and macrocosms that test changing geochemical and atmospheric boundary conditions, physiologists to help translate implications of geochemical models to predicting how specific biota might have responded, paleontologists and paleobiologists to translate understanding of modern biotas to interpreting fossil systems, taphonomists and sedimentary geochemists to assist in constraining syndepositional loss, and paleoceanographers to understand oceanographic changes that influence fossil carbonate producing communities.

Short-Term Goals: Workshop participants suggested that in the short-term, an updated literature search of biota- and habitat- specific rates of carbonate production, accumulation, and bioerosion, including microbial contributions and interactions should provide essential information for modeling. Identification of key experimental sites and gradients provides a necessary first step for quantifying carbonate biotic heterogeneity.

Medium-Term Goals: Contributors suggested a need for research to constrain controls on rates and nature of calcification by key biotic groups (e.g., corals, coralline algae, calcareous green algae, larger benthic foraminifera, microbes, including cyanobacteria). They also suggested the need to constrain seascape dynamics and patterns at targeted locations, both on the surface and stratigraphically, and across gradients.

Long-Term Goals: Participants suggested that successful outcomes would include a rigorous understanding of the geochemical and physical constraints on carbonate production, and its spatial heterogeneity, and its translation into numerical models.

3) Diagenesis -

Diagenesis in carbonate systems is particularly important due to the high reactivity of carbonate minerals from their initial deposition to their deepest burial and uplift. Diagenesis on the seafloor is part of the physical controls on sedimentation. Alterations through time determine the ultimate chemistry and mineralogy of the rock (e.g., Mg cycling and dolomitization) features that are increasingly used as proxies for paleoclimate and paleoceanographic conditions in the past. Facies, diagenesis, and brittle deformation also control the heterogeneity in carbonate rock properties, and that, in turn, affects the movement of fluids through carbonate rocks. As such, diagenetic heterogeneity can affect a variety of processes of societal interest, including CO_2 sequestration, aquifer storage and recovery, contaminant plume migration in carbonate aquifers, and the production of hydrocarbons.

The grand challenge in carbonate diagenesis is to construct predictive numerical simulations of diagenetic history (e.g., mass transfer and petrophysical transformation) from pore to platform scales. Ideally, models should incorporate the entire diagenetic system and all its coupled interactions - sedimentation, chemical and biological alterations on or near the seafloor, mechanical overprints, and chemical alterations resulting from fluid flow through pore and platform burial history. Once built, diagenetic numerical models would have multiple potential uses, including: (1) evaluating general diagenetic concepts, (2) testing specific diagenetic models of ancient carbonate systems, (3) predicting rock properties (e.g., porosity) and proxies (e.g., geochemical climate or ocean signals) through time and space, and (4) evaluating the effects of decreased seafloor lithification in times of increased ocean acidification (i.e., with rising global CO_2).

In general terms, diagenetic products and processes are known as a function of various diagenetic environments (i.e., hydrochemical regimes, Figure 2). We presently have a few limited empirical and rule-based modeling tools, but these include limited linkages between sedimentation processes and post-depositional diagenesis. Major gaps in understanding include:

> 1) The lack of benchmarks for the 3D distribution of processes and products in time and space – decades of research has focused on establishing processes and products using representative samples along one-dimensional vertical transects.

> 2) Significant uncertainty in many input parameters to diagenetic models – fluid chemistries, some thermodynamic and kinetic properties of carbonate minerals, and the nature of many mechanical processes.

> 3) The possible existence and influence of thresholds in diagenetic processes, and the nonlinear feedbacks of processes, products, and geochemical attributes is unexplored.

> 4) The role of biogeochemical reactions (i.e., catalysis, facilitators), empirical rules associated with some key processes (esp. cementation), and when to use transport- vs. reaction-controlled processes.

> 5) the nature of diagenetic outcomes at the full spectrum of scales, from thin section to platform-scale.

To explore these needs, participants suggested that access and information is required from the "right kinds of rocks" (closely spaced shallow drill cores and 3D quantitative data sets of well constrained outcrops). Large-scale monitoring sites are needed to examine seascape alterations (cementation, dissolution) and near surface post-deposition alteration (freshwater, mixing zones, refluxing brine settings). Potential partners include crystal surface geochemists, hydrologists/hydrodynamists, structural geologists, sedimentologists and stratigraphers.

Short-Term Goals: Identified goals included:

1) Dissemination of current numerical codes to grow the user community, and to develop community libraries of validation cases.

2) Develop consistent input parameters (e.g., depositional porosities), and improve most problematic of process rules.

3) Test existing tools at pore scale.

4) Establish examples of 3D diagenetic processes and products in select settings to have data sets to validate numerical codes.

5) Partner with larger community.

**Medium-Term Goals:** Couple second generation diagenetic models with improved sedimentary process models.
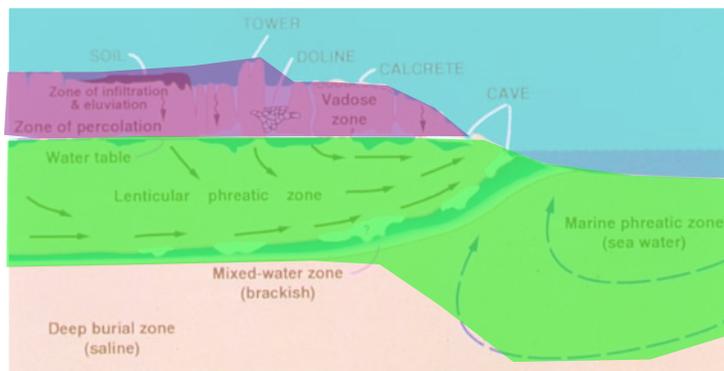
Figure 2. Diagenetic environments.

4) Numerical Modeling Strategies -

The grand challenge for numerical modeling is to make useful predictions/simulations of carbonate platform growth and diagenesis over varying time and space scales. Because it represents the numerical representation of our knowledge, this effort will require essential input and feedback from the other groups, and that the carbonate numerical community looks beyond itself, for numerical and conceptual inputs. The carbonate modeling community recognizes the need to integrate their modeling efforts into other Earth-surface modeling efforts, such as the Community Surface Dynamics Modeling System.

Knowledge gaps are wide and include 1) a lack of basic understanding of many processes, 2) uncertainties in scaling of processes temporally and spatially, 3) dearth of information on the influences of non-linearity and non-stationarity of biologic aspects of systems, 4) only qualitative insights on the feedbacks between different processes, and 5) absence of understanding of the controls on heterogeneity at different scales.

The goals for carbonate numerical process modeling are divided into four stages. The long-term goal is construction of a numerical work-bench (Figure 3) for carbonate knowledge generation that has a suite of process modules (physical, biologic, and chemical deposition, diagenesis, and structure/fractures).

Short-term goals (2 yr):

- Assign responsibilities for the cyber-infrastructure (i.e., GUI, protocols, coupling, and visualization).
- Build a module inventory and make modules available worldwide.
- Make available 5-9 modules that could include biogenic and inorganic production, biologic ecosystems and communities, physical and biologic syndepositional processes, dissolution-reprecipitation, cementation, hydrodynamics (e.g. Delft3D, ROMS), and sediment transport (CSDMS, e.g., SedFlux, SedFloCSTMS).
- Verify modules on appropriate time scales, and establish at least one database for testing.

Potential partners in this effort are global change community, reef health community, hydrology, industry, ecosystems, geochemistry, and ocean atmosphere communities. Start an online journal repository for modules and code documentation, possibly through the CSDMS organization, with benchmarks, and where editorial board and review involves the user community.

Medium-term goals:

- Involve students from geophysics, applied math, and computer science fields to address computational issues like grid conversion and interfaces.
- Have stage 1 modules tested and improved.
- Document results to enable informed choice of modules, and begin coupling with climate/ocean/siliciclastic models.
- Conduct initial sensitivity studies, and complete a comparative numerical scheme study, including an initial comparative verification/inverse objective cost function study.
- Conduct two international workshops in carbonate computational issues, and achieve "buy-in" with non-NSF funds for module development.
- Ensure high performance computing access, and activate partnerships.
- Have modules running efficiently on HPC, and have at least one useful prediction.
- Publish a series of peer reviewed papers using the workbench modules, and conduct a number of sedimentology courses in US using the carbonate workbench as a lab tool.

Long-term goals (10 yrs):

- Numerical work-bench for carbonate knowledge generation is available to the carbonate community. The workbench will: 1) have a suite of process modules (i.e., deposition, diagenesis, deformation/fracturing); 2) accept input from other models (e.g., ocean, climate, etc.); 3) accept observations from different sources, and databases; 4) have multiple inversion/verification schemes, and multiple sensitivity/response surfaces and uncertainty quantification; 5) have multiple scales/scalability, nestedness, and up- downscaling; and 6) have multiple outputs (Eclipse, Petrel, modflo etc.).

- Workbench prediction will be able to influence observatory systems like the Global Ocean Observatory.
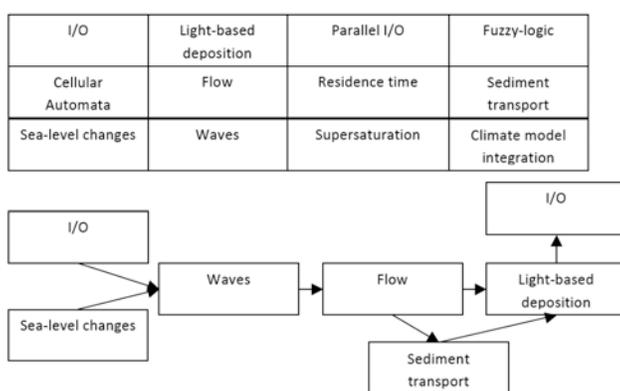
Figure 3. The carbonate "work bench" model is envisaged to contain a number of discrete modules (top), such as I/O interactions with other models, process-based factors, and stochastic process which can be linked together (bottom) to create a numerical model designed for the experiment in-hand. This frees the researcher from developing a model "from scratch" and maximizes the re-use of common functionality.

5) Tools Needs and Development -

Recent advances in the remote sensing of earth systems are providing numerous opportunities for detailed digital numerical data collection. Current tools in use to gather data in modern and near-modern systems include optical remote sensing, Lidar (airborne/land), bathymetry and spectral response, sonar (bottom topography and bottom sensing (backscatter)), acoustic Doppler profiling (current velocity and direction), in-situ wave profilers, synthetic aperture radar, and shore-based radar (wave/current measurements), and turbidity, temperature, alkalinity sensors. Research needs include developing higher resolution versions of the tools mentioned above, and developing the software and computing power to process ever-larger quantities of data.

For ancient carbonate systems the advent and improvements of 3-D seismic data are beginning to provide the possibility of collecting extensive three-dimensional data on architecture and morphology of ancient carbonate platforms. Many of these 3-D datasets come from mature hydrocarbon fields that have extensive well log, core, biostratigraphic, and production data that can be used to calibrate the seismic data. The challenge is to provide these data to academic researchers. Building academic-industry partnerships to achieve this should be a priority. Surface and near-surface tools, such as Lidar and GPR, provide opportunities to collect quantitative and 3-D data, and link with other subsurface data sets. These tools ultimately can provide quantitative high-resolution data on geometry, facies, and diagenetic character (i.e., pore systems) of carbonate systems.

Enhanced understanding of ancient strata centers on the ability to gain accurate high-resolution chronostratigraphic, biostratigraphic and absolute time data, to better constrain correlations, dates, and rates. Most dating of carbonate systems involves a combination of biostratigraphic data and multiple other age determination techniques (e.g., Sr isotopes, magnetostratigraphy, high-precision radioisotope dating: U-Pb, U-Th and Ar/Ar dating recently improved to 0.1% error). Of notable concern is that in the area of biostratigraphy, many experts are of retirement age resulting in knowledge loss and very little of these data have been captured into publically available databases.

Future needs in studies of ancient carbonates require high resolution biostratigraphy resolving cyclostratigraphy to the 0.02-0.4 my level. This could involve partnering with Earthtime (NSF) and Earthtime Europe, CONOP (constrained optimization), and the high resolution event sequencing of assemblages of biostratigraphic sections that could provide resolving power better than 0.5 my time scale. Composite standards and coordination of data collection are needed to assure that all useful data are captured. Astronomically calibrated cyclostratigraphy offers resolving power at 0.02 to 0.4 my level for the Cenozoic-Mesozoic and modeling objectives should include testing for the astronomical signal in cyclic carbonate systems. Cyclostratigraphy validation tools include time series analysis tools that can potentially

quantify the time-frequency evolution of carbonate accumulation. However, the method incorporates assumptions of the stratigraphic record, and further research is needed on effects of depositional (stratigraphic) breaks, and accumulation (thickness) changes. Spectral analysis does provide one means to assess variability of carbonate sedimentation as a function of frequency. An understanding of the degree of randomness of sedimentation, and identification of external forcing mechanisms is necessary to validate apparent astronomical signals.

SUMMARY & CONCLUSIONS

The grand research challenges for advancing understanding of modern and ancient carbonate systems identified in this first integrated community workshop include:

1) Quantitatively understanding and modeling facies heterogeneities developed over various timescales, as influenced by changing biotic, paleoceanographic, paleoclimatic, and sea level conditions;
2) Understanding the appropriateness of using Holocene tropical shallow-water reefs as analogues for ancient carbonate buildups;
3) Developing predictive numerical simulations of diagenetic history from the scale of the pore to the scale of the platform by incorporating and coupling sedimentation, chemical and biological alterations on the seafloor, mechanical overprints, and chemical alterations resulting from fluid flow;
4) Resolving cyclostratigraphy to the 0.02-0.4 my level using high resolution biostratigraphy and absolute age dates;

A more coordinated research effort in carbonate systems would be beneficial to advancing these community challenges. The group recommended research that focuses on identifying a limited number of sites to conduct integrated research on selected key subsets of: (1) the modern to Pleistocene, to examine the effects of ocean conditions and climate change on carbonate sedimentation, and the evolution of sediments into beds and strata; and (2) important analog field areas that combine outcrop, behind outcrop, and the subsurface, to build a new generation of 3-D carbonate system models.

Acknowledgements: The co-conveners would like to thank all the attendees for their enthusiastic participation in the workshop, and their contributions to this summary document. Special thanks go to Bill Hay, Jon Hill, Dave Budd, Bill Morgan, and Gene Rankey, who made substantial improvements to this summary.

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Appendix 3: Workshop Notes: "Clinoform sedimentary deposits"

Ron Steel, Chuck Nittrouer and Bob Dalrymple

SEPM's Field Research Conference on **'Clinoform sedimentary deposits: The processes producing them and the stratigraphy defining them'** attracted 71 participants in the Western Wyoming Community College of Rock Springs Wyoming, August 15-18, 2008. The 4-day lecture, poster and fieldtrip conference on siliciclastic clinoforms at delta and shelf-margin scales succeeded in bringing together three research communities: marine geologists on modern deltas, sedimentologists on ancient deltas and shelf margins and sedimentary-process modelers. Their goal was to focus on clinoform landscapes and on the associated clinothem deposits and processes. During two initial days there were keynote and other short talks, as well as poster presentations. Poster presenters gave a brief overview of their posters in the plenum session. The 3rd and 4th days were field trips to areas with well-exposed clinothems.

The Fox Hills river-dominated delta clinothems with overlying fluvial channel deposits

Keynote talks included the clinoform systems of the modern Ganges-Brahmaputra Delta, Amazon Delta, and Po-Western Adriatic Sea shelf clinoform system. 'Ancient' keynotes reviewed delta-scale and shelf-margin scale clinoforms. Modelers gave keynotes on experimental studies of clinoform patterns and on the modeling of fine sediment transport on shelf clinoforms. There was enthusiastic discussion after all talks. Two entire afternoons were given to the presentation and discussion of some 37 posters, the centerpiece of the Conference. During the two field days, relationships between delta clinoform steepness, facies/processes and grain size were examined in the spectacular Campanian Chimney Rock clinoforms of Minnie's Gap, and in the Maastrichtian Fox Hills shelf-edge deltas of the Washakie-Great Divide Basin near Rawlins Wyoming. The challenge of taking 70 participants into the field went without a hitch.

The success of this Clinoform Conference came from the mixing of the three communities. From a brief 'what did you learn' poll of participants, those working ancient deltas were surprised by the amount of new knowledge on modern, muddy subaqueous deltas, and by recent breakthroughs in understanding wave-assisted sediment gravity flows on modern deltas. Modelers and those working in 'modern' environments gained insights on lowstand landscapes and deltas, and on the possible limitations of the highstand present to understanding the past.

Appendix 4: CSDMS Focus Research Group and Working Group participants (as of December 31, 2008)

Hydrology Focus Research Group

First Name	Last Name	Institution	Country
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Peter	Gijsbers	Deltares	Netherlands
Wendy	Graham	University of Florida	USA
Xujun	Hong	Shenzhen Institute of Advanced Technology	China
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Jasmeet	Judge	University of Florida	USA
Venkat	Lakshmi	University of South Carolina	USA
Xu	Liang	University of Pittsburgh	USA
Mingliang	Liu	Auburn University	USA
Emilio	Mayorga	Rutgers State University	USA
Thomas	Meixner	University of Arizona	USA
Jeff	Niemann	Colorado State University	USA
Murari	Paudel	Brigham Young University	USA
Mariela	Perignon	University of Colorado	USA
Jose	Ramirez	Colorado State University	USA
Mark	Stone	Desert Research Institute	USA
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Carbonate Focus Research Group

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Gareth	Jones	Chevron Energy Technology Company	Canada

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Eugene	Rankey	University of Miami	USA
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Bruce	Wilkinson	Syracuse University	USA

Coastal Working Group

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Mike	Blum	Louisiana State University	USA
Joseph	Calatoni	Naval Research Laboratory	USA
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Nicole	Couture	McGill University	Canada
Peter	Cowell	The University of Sydney Institute of Marine Science	Australia
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Sergio	Fagherazzi	Boston University	USA
Rocky	Geyer	Woods Hole Oceanographic Inst. (WHOI)	USA
Liviu	Giosan	Woods Hole Oceanographic Inst.	USA
Jouet	Gwenael	IFREMER	France
Daniel	Hanes	USGS Pacific Science Center	USA
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John	Harrison	Washington State University	USA
Alan	Howard	University of Virginia	USA
Tian-Jian	Hsu	University of Delaware	USA
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Marine Working Group

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Jasim	Imran	University of South Carolina	USA
John	Jaeger	University of Florida	USA
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Chris	Jenkins	University of Colorado	USA
Gareth	Jones	Chevron Energy Technology Company	Canada
Philippe	Joseph	Institut Francais du Petrole	France

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Steven	Kuehl	William & Mary	USA
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Eckart	Meiburg	University of California, Santa Barbara	USA
David	Mohrig	University of Texas	USA
Ruth	Mugford	University of Cambridge	UK
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Chuck	Nittrouer	University of Washington	USA
James	O'Donnell	University of Connecticut	USA
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Terrestrial Working Group

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Joe	Galewsky	University of New Mexico	USA
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Peter	Gijsbers	Deltares	Netherlands
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Education and Knowledge Transfer Working Group

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Paul	Morin	University of Minnesota	USA
Damian	O'Grady	Exxon Mobil Company	USA
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Charles	Vorosmarty	University of New Hampshire	USA

Cyber-Infrastructure and Numerics Working Group

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Efi	Foufoula-Georgiou	University of Minnesota	USA
David	Furbish	Vanderbilt University	USA
Peter	Gijsbers	Deltares	Netherlands
Jon	Goodall	University of South Carolina	USA
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Brendon	Hall	University of California-Santa Barbara	USA
Gil	Hansen	BHP Billiton Petroleum	USA
Alan	Howard	University of Virginia	USA
Eric	Hutton	University of Colorado - Boulder	USA
Matthias	Imhof	Exxon Mobil Company	USA
Chris	Jenkins	University of Colorado	USA
Gareth	Jones	Chevron Energy Technology Company	Canada
G. Walker	Johnson	University of Texas at El Paso	USA
Xu	Liang	University of Pittsburgh	USA
Yong	Liu	NCSA, University of Illinois	USA
Wei	Luo	Northern Illinois University	USA
David	Maidment	University of Texas	USA
Emilio	Mayorga	Rutgers State University	USA
Eckart	Meiburg	University of California, Santa Barbara	USA
Helena	Mitasova	North Carolina State University	USA
Mark	Morehead	Idaho Power	USA
Simon	Mudd	Vanderbilt University	USA
Scott	Peckham	University of Colorado - Boulder	USA
Michael	Pyrcz	Chevron Energy Technology Company	USA
Eugene	Rankey	University of Miami	USA
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Rich	Signell	USGS	USA
Kenneth	Skene	Exxon Mobil Upstream Research Company	USA
Jordan	Slott	Duke University	USA
Tao	Sun*	Exxon Mobil Upstream Research Company	USA
David	Tarboton	Utah State University	USA
Daniel	Tetzlaff	Schlumberger Information Solutions	USA
Alexey	Voinov	Chesapeake Community Modeling Program	USA

Appendix 5: Notes: I.A.G / CSDMS SEDIBUD Workshop (Sept 9-13, CO)

Location: Boulder, Colorado, USA

Armelle Decaulne, University Blaise Pascal, CNRS-UMR6042 Geolab, Clermont-Ferrand, France
Achim A. Beylich, Geological Survey of Norway, Trondheim, Norway
Scott F. Lamoureux, Department of Geography, Queen's University, Kingston, Canada
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Website: http://www.geomorph.org/wg/wgsb.html

The I.A.G./A.I.G. working group SEDIBUD (SEDIment BUDgets in Cold environments), founded in 2005, gathers over 350 researchers interested in high-latitude and high-altitude sedimentary fluxes and budgets, and Holocene environmental change. The aim of SEDIBUD is to better understand Earth surface systems modification in relation with climate change, through the observation and quantification of past and present-day erosion, transport and deposition of sediments and fluxes.

From September 9 to 13, 2008, 23 participants met during a workshop held at the Niwot Ridge Mountain Research Station of the University of Colorado at Boulder, USA. The workshop was hosted by INSTAAR and locally organised by Nel Caine and Irina Overeem. Additional sponsorship was provided by the Community Surface Dynamics Modeling System (CSDMS). The workshop was composed of paper and poster sessions covering a wide range of different cold climate environments as well as extended working group discussions and a field excursion. Nine countries were represented and 14 research institutes, both from the northern and southern hemisphere. The SEDIBUD working group addressed central issues during this workshop, concerning (i) an updated version of the published SEDIFLUX Manual (Eds. Beylich & Warburton) that establish common methods and standards for data collection in the field, enabling comparison from various cold environments; (ii) further to the presentation of the SEDIBUD Key Sites Fact Sheet Volume (Eds. Lamoureux, Decaulne & Beylich), that gathers characteristics from 23 SEDIBUD sites, a second edition has been decided with more key sites covering wider cold environments; the aim is to reach 45 well defined key sites. (iii) a clear protocol was defined during the workshop, addressing prerequisites for each SEDIBUD sites (data are requested with regard to the basin boundary conditions, the catchment and slopes), the collected data feeding the SEDIBUD metadata database; (iv) the extension of the existing SEDIBUD key test site database (Laute, Gintz & Beylich), including key annual data (see protocol) from each SEDIBUD key test site, (v) the potential link between CSDMS (http://csdms.colorado.edu/wiki/index.php/Main_Page) and SEDIBUD, that can offer interesting modelling possibilities for scientific issues and student training.

Talks: http://csdms.colorado.edu/wiki/index.php/SEDIBUD_2008
James Syvitski   CSDMS introduction
Armelle Decaulne   Debris Flows in Iceland pdf
Thorsteinn Saemundsson   2007 Morsarjokull Rockfall
Achim Beylich   Erdalen Sediment Budget
Irina Overeem   Arctic River Budget
Katja Laute   Erdalen braidplain budget
Jeff Warburton   Peaty Rivers and Carbon budgets
Richard Johnson Landslide budgets over time
Jukka Kayhko   Changing Catchments in Finland
Ted Lewis   Sediment transport and disturbances
Helgi Jonnson   Rockslides in Iceland
Colin Thorn   New dating techniques for Paleosols
John Dixon   Geochemical budgets in Cold Climates
Ole Saether   Natural Organic Matter in Subalpine Catchments

Appendix 6: Notes: "Education & Knowledge Transfer Working Group"

Notes taken by Scott Peckham and Irina Overeem

Discussion and Ideas on Modeler Education
- There is an important difference between model developers /contributors and model users.
- CSDMS software architects would need to be present at a coding workshop for model developers in order answer questions.
- Keep lessons at coding camps and examples simple.
- CSDMS Handbook should have a important role in the modelers education.
- Tutorials for different languages and linkage tools used in CSDMS, e.g. wxPython, are already available online. Do not duplicate those.
- Model users need special attention not to start misusing models. A grading system, for example with stars, may be put into place to grade the state of models. The topical working groups could be asked to submit grades within their expertise.
- We could look at the Delft3D warning for misuse?
- Metadata on models is of critical importance if CSDMS gets a wide variety of users. Modelers need to supply their assumptions.
- Could we avoid misuse by building 'warnings' into the linking framework?

Discussion and Ideas on Student Education
- We need to decide what we should put out: focus on undergraduate education and peers first, then policy makers and the general public?
- At the basic level there is a role for model animations and an animation gallery, they can be posted with documentation and associated questions about them.
- Examples of Animation Galleries: NASA E-Clips, Paul Heller's Sedimentary Movies.
- At the undergraduate level we have a larger audience and thus more impact.
- Animations of specific models can be posted in animation gallery as well as under the model sites themselves.
- Graduate student level seems to be right time to actively work with the models.
- Models should be relatively robust for this purpose; probably GUI's are a good idea. Students should not have to learn an entire new language to run simulations and scenarios.
- Models should not have too many parameters. Five 'knobs' was perceived a good level of complexity.

Discussion and Ideas on Website
- How do we get people to put things on the site, how do we advertise new additions?
- Looked at educational repository as it is now; power-points, model education per model, CSDMS Handbook, first examples of teaching tools (e.g. BARSIM).
- Use a quarterly newsletter to alert community to new features?
- We could let people choose how often they want an update on new additions on the CSDMS website. Maybe use RSS feeds.
- Try to add our educational repository as a link to websites, which point teachers and faculty to educational material. Example: Mars Camera.
- Digital Library for Earth System Education (DLESE) as a main leverage point.

Discussion and Ideas on Knowledge transfer to industry and federal agencies
- Will models get used for operational work? This raises questions about liability. (See discussion above on misuse of models).
- We can learn from some of the other modeling initiatives that started as research project but moved more and more to application. MODFLOW is an example, Delft3D as well. Both these modeling frameworks added GUI before making it available as a more applied tool.

- Should there be focused experiments or model connections, targeted to industry?
- First approach is a consortium-supported postdoc who can transfer information back, and as such provide a benefit to the funder.
- Consortium meeting is an opportunity for industry partners to learn about most recent results.
- Discussed implications of federal mandates on funding world; carrot and stick. Not just writing models, but higher standards and extra work. Expectation to make publicly available. Funding for ongoing maintenance and technical support. Want agencies to say that writing and publishing a model is at least equal to a paper.

Short-term Goals
- Models for students to run
- Provide teaching tool with assessment of how students do (i.e. does understanding improve after running the simulations?)
- Find really good examples that we all like, get volunteers to implement them. These can then serve as an example for the standards for submitting teaching tools.
- EKT group and community should find an example from each of the main process domains that has a Java GUI and assessment.

Examples:
1) Wei Luo's WILSIM work. What are the educational objectives of WILSIM?   Did some tests in a 100-level course, broad background, many people don't understand geologic timescales, erodibility concepts. Ask them questions both before and after for assessment. Uses blackboard. Wrote 2 papers on this. First time, improvement was not significant, so revised the questions to avoid negatives, etc. Second time around, assessment showed significant improvements.
2) Alexei 's predator-prey model with different levels of explanations. HTML help embedded in applications that have a GUI.
3) Xbeach looks at advancing this way.
4) Jon has modules that could be enhanced to Java applets with Wei's help
5) Find out about Stella, Simuli, Madonna
6) HydroTrend is web-based and run by students

Long-term Goals/ Big Ideas
- Working Group is supposed to help the community, so fundable ideas should be endorsed by EKT working group, people will write grants, then those ideas will have more weight since already went through one level of   vetting.
- Series of labs with added process complexity
- Make the EKT framework so that it can keep improving and growing. Tools for module use and student assessment by individual teachers.
- 'Google Earth' like application that set your model input conditions automatically or that can recommend model linkages depending on the domain that you select on the map.
- Testing of scaling across time and spatial scales within CSDMS; feed all experiments done by the community back into statistics. Educate on geomorphic effectiveness.
- Surface Process Animations for all US National Parks.
- GeoWalls as visualization tools.
- Publish findings of teaching tools and their assessment as a CSDMS product.
  (JP is editor of Geosphere, web-only GSA journal, with geoscience education focus and animations, very targeted case studies).

Organizational
- Karen Campbell is chair of the EKT Working Group
- Next year (April 2009 onwards) we'll have a full-time EKT person. (Now zero.)