CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

Annual Report, Dec. 31, 2009

NSF Cooperative Agreement 0621695

Community Surface Dynamics Modeling System
Annual Report, Dec. 31, 2009

Executive Summary

CSDMS continues to gather momentum, with over a hundred new members joining the effort. CSDMS is fast becoming the international coordinator of earth-surface dynamics models and modeling efforts, being well regarded both nationally and internationally. In the last 9 months CSDMS has registered 1500 downloads of its various models in the CSDMS Model Repository, directly addressing the historical lack of readily available models for research and application. This penetration of computational tools into the earth-science community should provide valuable future dividends. The CSDMS Model Repository presently offers ≈100 open-source models comprising 2.1 million lines of open-source code. Another 55 models are made available through web links to other established modeling sites and software teams. CSDMS protocols for contributing earth-surface models are being adopted by the journal Computers & Geosciences (International Association of Mathematical Geosciences). The protocols allow models to be employed quickly within the CSDMS Framework, to better penetrate the research community.

Year 1 focused on organization. Year 2 focused on developing the architecture for model coupling. Year 3 has been dedicated to advanced simulations through proof-of-concept projects. The CSDMS Integration Facility has completed three highly varied proof-of-concept exercises in linking six models (SedFlux, GC2D, CHILD, TopoFlow, CEM, HydroTrend) written by six authors, in four computer languages (c, c++, IDL, Matlab), three different grids (raster, non-uniform mesh, spatially-averaged), and two levels of granularity (process and modular). With the success of these coupling exercises, the conversion of contributed code into 'components' within the CSDMS Model Repository has begun. A CSDMS GUI prototype is now available, able to operate on multiple platforms (PC, OX, Linux) with direct connection to the CSDMS supercomputer. The GUI offers ease of use for professionals and non-modelers alike, and serves as an excellent educational platform through its help system. CSDMS courses and workshops have provided graduate students and younger professionals an opportunity to learn the science and engineering of model development and model coupling. CSDMS software engineers have begun to support the CSDMS community in the transition of their software from limited processor venues to modern HPC clusters.

This report outlines Year-3 progress, provides Year-4 goals and resource requirements needed to advance the CSDMS effort. The Annual Report documents community activity, management structure and plans, publications and presentations, meetings, models, membership, and provides budgetary details on income and expenditures. The report builds upon the Year-3 Semiannual Report and other CSDMS documents.

CSDMS Annual Report, Dec. 31, 2009

Table of Contents

CSDMS Annual Report, Dec 31, 2009

1.0 CSDMS Mission:
The Community Surface Dynamics Modeling System (CSDMS) develops, supports, and disseminates integrated software modules that predict the movement of fluids (wind, water, and ice) and the flux (production, erosion, transport, and deposition) of sediment and solutes in landscapes, seascapes 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, 2009 to December 31, 2009, and provides anticipated progress through March 31, 2010.

2.0 CSDMS Management and Oversight.

2.1 The CSDMS Executive Committee (ExCom) is comprised of organizational chairpersons:

- 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
- Eckart Meiberg (Jan, 2009-present), Chair, Cyberinformatics & Numerics WG, UC-Santa Barbara
- Karen Campbell (Oct, 2008-present), Chair, Education & Knowledge Transfer WG, NCED, U. Minnesota
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, University of Colorado - Boulder
- Scott Peckham *(ex-officio)* Chief Software Architect, CSDMS Integration Facility, U. Colorado – Boulder

The Executive Committee is the primary decision-making body of CSDMS, and ensures that the NSF Cooperative Agreement is met, oversees the 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. Professor Eckart Meiberg of the Department of Mechanical Engineering, University of California at Santa Barbara, was elected as Chair of the Cyberinformatics & Numerics Working Group, and brings valuable experience in High Performance Computer Modeling. ExCom met twice in 2009 (03/02/09; 09/04/09).

2.2 The CSDMS Steering Committee (SC) includes representatives of U.S. Federal Agencies, Industry, and Academia:

- Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State Univ., University Park, PA
- Tom Drake (April, 2007), U.S. Office of Naval Research, Arlington, VA
- Bert Jagers (April, 2007), Delft Hydraulics, The Netherlands
- Rick Sarg (April, 2007), Colorado School of Mines, Golden, CO
- Gary Parker (April, 2007), Univ. Illinois Urbana-Champaign, IL
- Dan Tetzlaff (April, 2007), Schlumberger, Cambridge, MA
- Dave Furbish (April, 2007), Vanderbilt, Nashville, TN
- Chris Paola (Sept, 2009), U. Minnesota, Minneapolis, MN
- Cecilia DeLuca (Sept, 2009), NCAR, Boulder, CO
- Boyana Norris (Sept, 2009), Argonne Natl. Lab, Argonne, IL
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, CU-B, Boulder, CO
- Bilal Haq *(ex-officio),* National Science Foundation
- Richard Yuritech *(ex-officio)*, National Science Foundation

The CSDMS SC assesses the competing objectives and needs of the CSDMS; assesses progress in terms of science, outreach, and education; advises on revisions to the 5-year strategic plan; and approves the Bylaws and its revisions. The Steering Committee was expanded (see Bylaw change below), with the following subsequent appointments:

Cecelia DeLuca, Head, Earth System Modeling Infrastructure Section, National Center for Atmospheric Research;

Boyana Norris, Mathematics and Computer Science Division, Argonne National Laboratory.

Chris Paola, Professor of Geology, University of Minnesota, replaced Tom Dunne who stepped off the SC in 2009. The SC met on 12/11/09.

2.3 The CSDMS Bylaws Upon the recommendation of the Steering Committee, the Executive Committee approved the expansion of the Steering Committee membership. Article V Section 1 is in part revised as:

> "The Steering Committee be comprised of a minimum of ten (10) members selected by the ExCom to represent the spectrum of relevant Earth science and computational disciplines, and each of the two Partner Sub-Committees."

2.4 CSDMS Working and Focus Research Groups

The CSDMS community continues to grow with a total membership of 348 (as 01/05/10). A member may join more than one CSDMS group. The growth is faster and more consistent than anticipated. Ideas brought forth by this growing community are serving to invigorate CSDMS. Membership in Groups as of 12/26/09 was as follows:

Terrestrial	164	Cyber	64
Coastal	110	EKT	36
Marine	87	Carbonate	27
Hydrology	70	Chesapeake	23

Since the Year 2 Annual Report, the Integration Facility has organized the following WG meetings:

- Hydrology Focus Group Meeting, Jan. 20-21, 2009, CSDMS, Boulder, CO http://csdms.colorado.edu/wiki/Hydrology_FRG_2009. Attendance: 13 members plus 4 IF staff.
- Carbonate Focus Research Group Meeting, Jan. 26-27, 2009, CSDMS, Boulder, CO: http://csdms.colorado.edu/wiki/Carbonate_FRG_2009. 15 members plus 3 IF staff.
- Terrestrial Working Group Meeting, Feb. 2-3, 2009, CSDMS, Boulder, CO: http://csdms.colorado.edu/wiki/Terrestrial_WG_2009. Attendance: 20 members plus 6 IF staff.
- Joint Coastal and Marine Working Groups Meeting, Feb. 25-26, Charlottesville, VA. http://csdms.colorado.edu/wiki/Marine_WG_2009, http://csdms.colorado.edu/wiki/Coastal_WG_2009. Attendance: 17 members plus 2 IF staff.
- Cyberinformatics and Numerics Working Group Meeting, March 3, 2009, U. California, Santa Barbara, CA. http://csdms.colorado.edu/wiki/Cyberinformatics_Meeting_2009_March. Attendance: 12 members plus 3 IF staff.
- Chesapeake Focus Research Group meeting, Apr. 3, 2009, Johns-Hopkins U, Baltimore, MD: http://csdms.colorado.edu/wiki/Chesapeake_FRG_meeting_2009. 12 members plus 1 IF staff.
- Joint Marine WG and Carbonate FRG Meeting, Oct. 19-20, CSDMS, Boulder, CO: http://csdms.colorado.edu/wiki/Joint_workshop_Marine_WG_Carbonate_FRG. Attendance: 11 members plus 4 IF staff.
- Joint Terrestrial WG and Coastal WG Meeting, Oct. 26-27, CSDMS, Boulder, CO: http://csdms.colorado.edu/wiki/Joint_workshop_Terrestrial_Coastal_WG_Oct2009. Attendance: 21 members plus 6 IF staff.
- Chesapeake Focus Research Group meeting, Nov 10, 2009, CSDMS, Boulder, CO:

http://csdms.colorado.edu/wiki/Chesapeake_FRG_meeting_NOV2009. 12 members plus 1 IF staff.

- Joint EKT WG, Cyber WG and Hydrology FRG Meeting, Nov. 16-17, CSDMS, Boulder, CO: http://csdms.colorado.edu/wiki/Joint_workshop_Hydrology_EKT_and_Cyberinformatics_Nov2009. Attendance: 24 members plus 6 IF staff.

165 participants (≈50% of the CSDMS membership) attended one of these meetings. Joint meetings in the autumn were designed to get working groups to reach out in their model development to those working in other environmental domains, an overall goal of CSDMS. The groups met twice last year; the second meeting was scheduled to provide more timely deliberation for this annual report.

2.5 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. A primary goal of the CSDMS Consortium is to engage industry stakeholders in CSDMS research. Consortium members 1) demonstrate corporate responsibility and community relations; 2) contribute to the direction of CSDMS research and products; 3) access the latest CSDMS products and information; and 4) join an association of diverse scientists, universities, agencies, and industries. In 2009, Statoil (Norway) and ConocoPhillips (USA) joined the consortia.

2.6 The CSDMS Integration Facility (IF)

The CSDMS IF is established at INSTAAR, University of Colorado-Boulder, http://csdms.colorado.edu/wiki/Contact_us. As of Dec 31, 2009, CSDMS IF staff includes http://csdms.colorado.edu/wiki/Staff

- Executive Director, Prof. James Syvitski (April, 2007) — CSDMS and CU support
- Executive Assistant, Ms. Marlene Lofton (Aug. 2008) — CSDMS support
- Chief Software Engineer, Dr. Scott Peckham (April, 2007) — CSDMS and other NSF support
- Software Engineer, Dr. Eric Hutton (April, 2007) — CSDMS support
- Software Engineer, Dr. Beichuan Yan (April, 2009) — CSDMS support
- Computer Scientist, Jisamma Kallumadikal (Aug, 2009) — Industry & CSDMS support
- Cyber Scientist Dr. Albert Kettner (July, 2007) — CSDMS and NASA support
- EKT Scientist Dr. Irina Overeem (Sept, 2007) — CSDMS, NOPP and ConocoPhilip support
- PDF Dr. Maureen Berlin (Oct, 2009) —NSF/OPP support
- Ph.D. GRA Mark Hannon (July, 2007) — ONR & ConocoPhilips support
- Accounting Technician Mary Fentress (April, 2007) — CSDMS and other support
- Systems Administrator Chad Stoffel (April, 2007) — CSDMS and other support

The CSDMS Integration Facility has one geophysical *post-doctoral fellow* position open for someone with experience in software development, GIS systems, and able to work in a team with other scientists in the development of an integrated framework for the modular modeling of global hydrology — http://csdms.colorado.edu/wiki/Jobs.

The CSDMS Integration Facility (IF) maintains the CSDMS Repositories; facilitates CSDMS communication, community coordination, public relations, and product penetration. The IF develops the CSDMS cyber-infrastructure (e.g. coupling frameworks, protocols), and provides software guidance to the CSDMS community. The IF maintains the CSDMS vision and supports cooperation between field and modeling communities.

3.0 Advances and Progress on Goals

3.1 Goal 1) Model Protocols, Contributions, and CSDMS Components.

The International Association of Mathematical Geosciences is supporting the acceptance of CSDMS protocols for compliant earth-surface code, and is working with the CSDMS Executive Director to publish the CSDMS protocols in their journal Computers & Geosciences. The protocols are:

1) Contributed software should hold an open-source license [e.g. GPL2 compatible; OSI approved].

2) Contributed software should be widely available to the community of scientists [e.g. CSDMS Model Repository; Computers & Geosciences Repository].

3) Contributed software should receive some level of vetting [e.g. by a colleague; manuscript reviewer; CSDMS Working Group]. At the minimum level, software should be determined to do what it says it does.

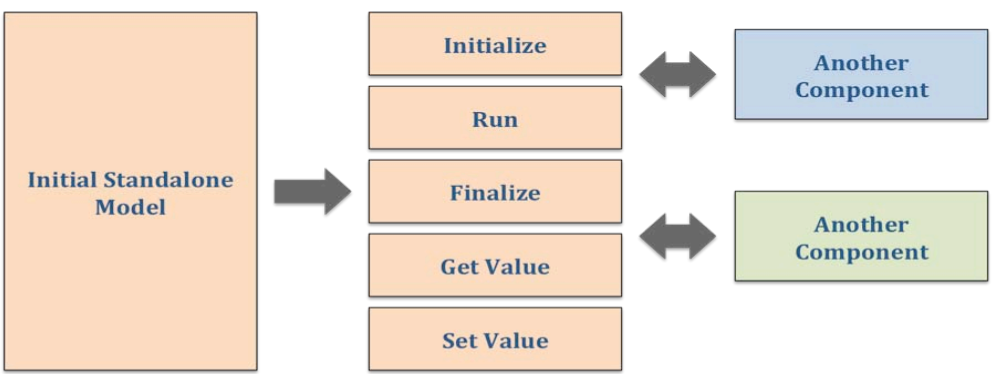
4) Contributed software should be written in an open-source language (C, C++, any Fortran, Java, Python), or have a pathway for use in an open-source environment [e.g. IDL & Matlab code can be made compatible].

5) Code should be written or refactored to become componentized with an interface (initialize, run, finalize), with specific I/O exchange items (getters, setters, grid information) documented.

6) Code should be accompanied with a metadata description file, e.g. http://csdms.colorado.edu/wiki/Form:Module_questionnaire, and test files (input files to run the model; output files to verify the initial model run).

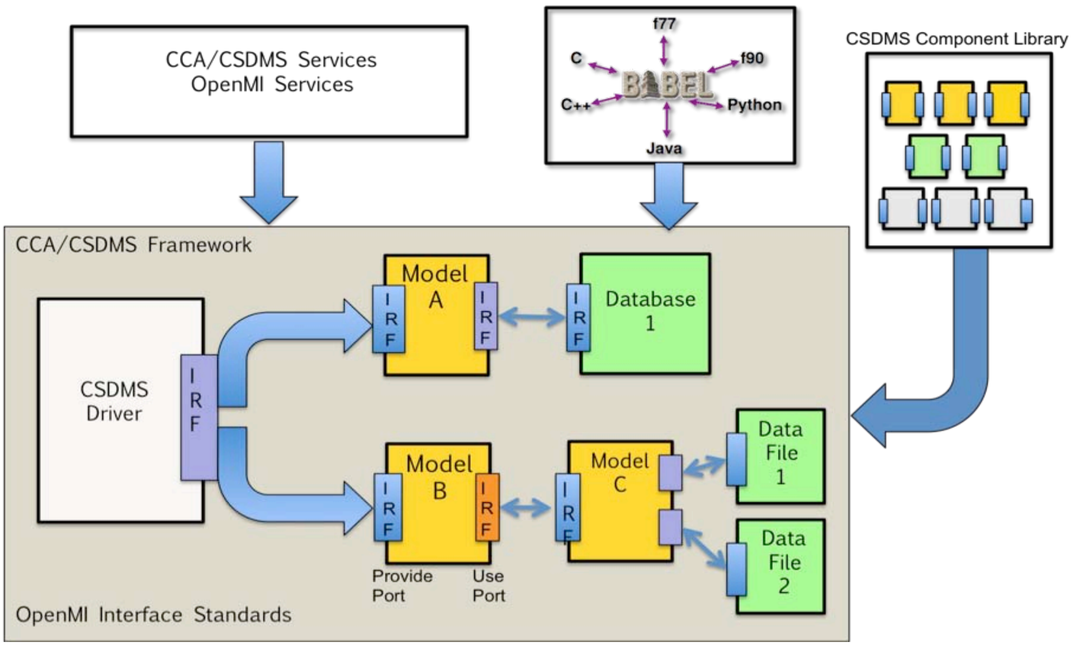
7) Code should be clean and documented. Source code annotated using keywords within comment blocks to provide basic metadata for the model and its variables.

Since 01/01/08, the CSDMS Model Repository has increased its holding from 41 models to 97 models (as of 12/27/09). During that time the associated lines of source code has increased from <200,000 to >2.1 million lines of source code (see Goal 6). Standalone models are starting to be made into CSDMS component models by dividing them into tasks that other component models could use (Fig. 1).



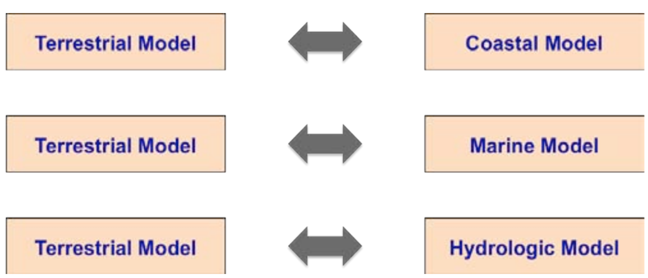
- Figure 1. Refactoring a stand-alone model for linkage to other model components.

Once a contributed model has been refactored into a component model, it becomes available to be linked to other appropriate models within the CSDMS component library to provide value added products beyond the intention or domain of the original model (Fig. 2). The language neutral compiler BABEL allows for models to communicate across various languages (Fig. 2). Access to CCA/CSDMS and OpenMI Services, such as grid remapping tools, is then made available. Databases and files can also be componentized and coupled within the CSDMS framework.



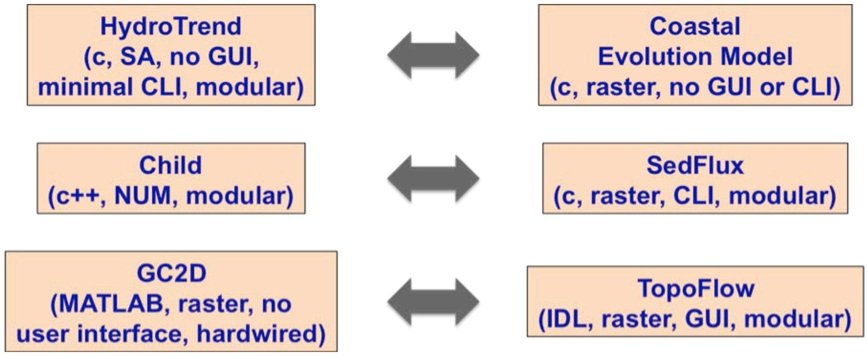
- Figure 2. The CSDMS model coupling domain.

While Year 2 developed the workflow to create CSDMS model components, Year 3 saw the completion of proof-of-concept projects, designed to couple models across environmental domains (Fig. 3).



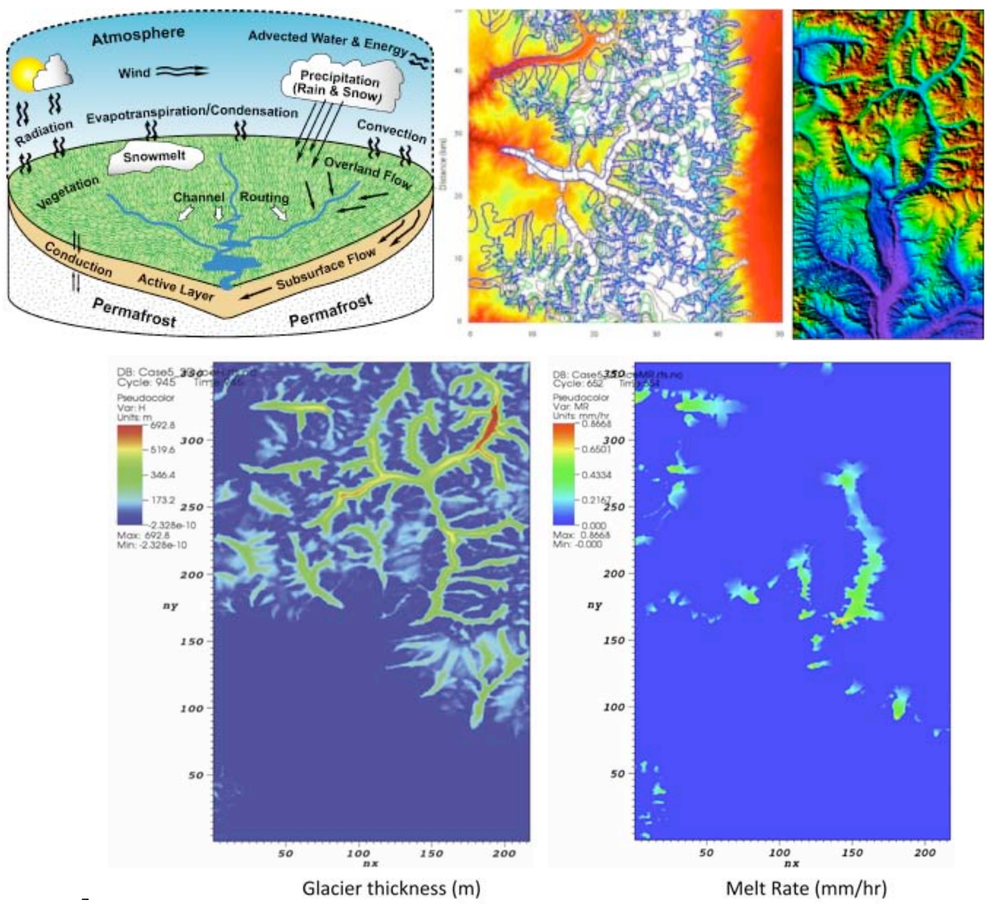
- Figure 3. Coupling across environmental domains.

Three proof-of-concept projects were chosen to test the flexibility of the model-coupling framework (Fig. 4). The six models represent "type" models in the CSDMS repository, written by six different authors or teams of authors, offering six unique programming styles. The models employed four computer languages (c, c++, IDL, Matlab), three different grids (raster, non-uniform mesh or NUM, spatially-averaged or SA), and two levels of granularity (process and modular) (Fig. 4). Some models contributed to the CSDMS Model Repository do not offer a graphical user interface (GUI) or a command language interface (CLI). Some models need to be translated: TopoFlow was translated from IDL to Python using the CSDMS-enhanced I2Py Translator, and CG2D was translated from MATLAB to Python.



- Figure 4. Three proof-of-concept projects (see text for acronym details).

Proof-of-concept Project 1: TopoFlow a fully spatial hydrologic model with multiple methods for multiple processes was successfully coupled to GC2D, a 2D valley glacier and ice sheet model, to build glaciers and route meltwater (Fig. 5).



-

- Figure 5. (UL) TopoFlow hydrological domain and processes; (UC) GC2D glacier domain; (UR) Digital Elevation Model of the Animas basin (Colorado) used in the Proof of Concept project; (LL) Glacier Thickness from coupled model run; (LR) Melt rate routing through basin.

TopoFlow was a fully spatial hydrologic model with multiple methods for modeling a variety of physical processes in watersheds, written in IDL (Interactive Data Language) with the following properties:

- A complete, point-and-click GUI with HTML Help System.
- Any input variable can be: Scalar, Time Series, Grid or Grid Sequence.
- Any computed variable can be saved as Time Series or Grid.
- Not object-oriented (but almost)
- Components were designed to use TopoFlow's own internal coupling mechanisms.

After CSDMS refactoring, TopoFlow offered up 17 separate components. Each component has:

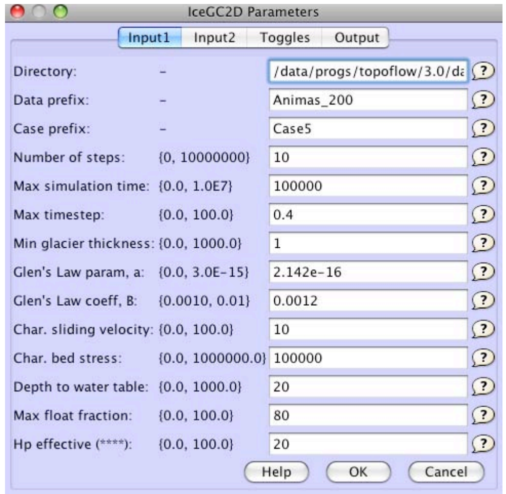
(1) Ability to be used as a model (driver), or as a component.
(2) An OpenMI-style interface (incl. IRF, getter, setters, etc.)
(3) A wrapper to make it a CCA component (CCA "impl" file)
(4) Its own, separate input file (*.cfg)
(5) A GUI dialog to change its parameters, with HTML help.
(6) Its own output options.

TopoFlow was converted from 37,434 lines of IDL code to 33,058 lines of Python using I2PY 2.0, and now uses Numerical Python. The new model is completely object-oriented. Computed variables can be saved as before, and additionally as BOV (Brick of Values) or netCDF. Precipitation component is now merged into a Meteorology component.

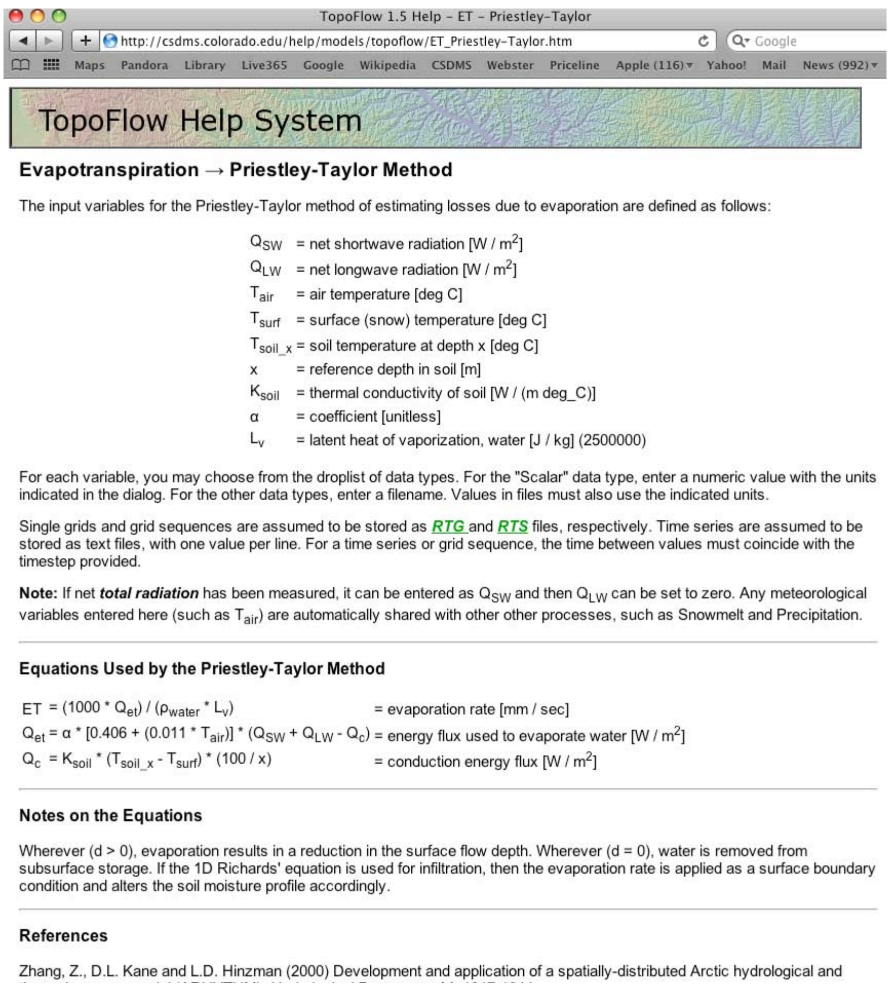
GC2D is a valley glacier and ice sheet model with the following properties.

- Finite-difference, explicit time-stepping
- Ice flow is via Glen's Law (nonlinear stress-strain) with basal sliding velocity derived from basal shear stress.
- Input consists of a DEM and prescribed ELA (as scalar or time series).
- Precipitation and ice melt processes employ a "net mass balance" method.

GC2D had 1495 lines (30 pages) of MatLab code that did not offer an OpenMI-style interface. All input parameters were hard-wired into the code. There was limited ability to save computed variables to output files. After conversion to 1966 lines of Python, GC2D is able to use Numerical Python, and can be used as either a component that provides meltwater runoff to a spatial hydrologic model such as TopoFlow, or as a stand-alone Model/Driver. As a Driver, GC2D can optionally be driven by TopoFlow's physically based process components. For example, the Meteorology/Precip and Snow components can be used to provide snowfall and ice melt rates directly to GC2D. With refactoring, GC2D was wrapped as an "ice_base" class to provide OpenMI-style interface with additional capabilities (880 additional lines, Python), and wrapped again (IceGC2D_Impl.py) to be a CCA component. GC2D now reads all input parameters from a "configuration file" (*.cfg) (Fig. 6). Computed variables can now be saved as BOV or netCDF, and can now output a grid of "melt rates" for use by other models.



- Figure 6. New input dialog box for the refactored GC2D model, showing typical ranges of values and model-run values with help dialog toggles to the right.



- Figure 7. A CSDMS help box for the refactored TopoFlow model.

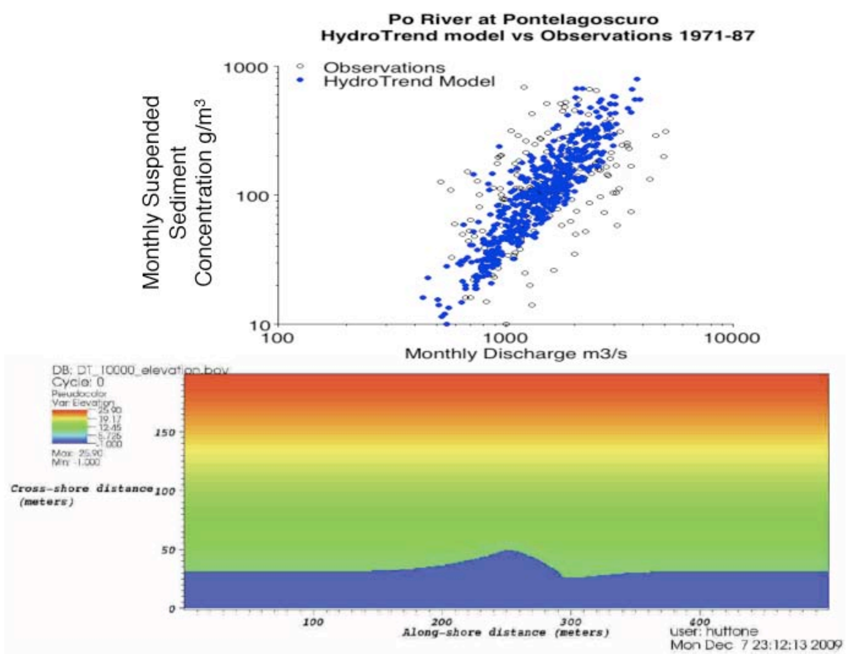
Each CSDMS model component can now have its own HTML help page (e.g. Fig. 7). This can be used to provide various types of info, such as:

- Brief tutorial (or link)
- List of equations
- List of assumptions
- List of references
- Model output images
- Model output movies
- Credit to author
- License type
- Warnings
- Known problems
- Links to elsewhere

The added value for the newly refactored TopoFlow and GC2D is that they can:

(1) Each be used as a Component or stand-alone Model/Driver.
(2) Be run by any CSDMS member, remotely, on the CSDMS HPCC.
(3) Use VisIt that is integrated into CCAFFE-GUI, to visualize output.
(4) Be linked to components written in other languages.
(5) Offer new outputs (e.g. melt rate) or reflect new inputs (e.g. Meteorology & Snow).
(6) Use the CSDMS GUI dialog and input files for changing model parameters.
(7) Offer improved output options (time Series and/or grid sequence).

Proof-of-concept Project 2: HydroTrend is a spatially averaged hydrologic model driven by temperature and precipitation that simulates a time series of single river channel or distributary-channel delta hydraulics and sediment load (bedload and suspended load) (Fig 8). The Coastal Evolution Model (CEM) predicts the distribution of the bedload fraction entering a coastal zone and subjected to wave energy. The two models were successfully coupled to simulate the growth of the Po River delta (Adriatic Sea) (Fig 8).

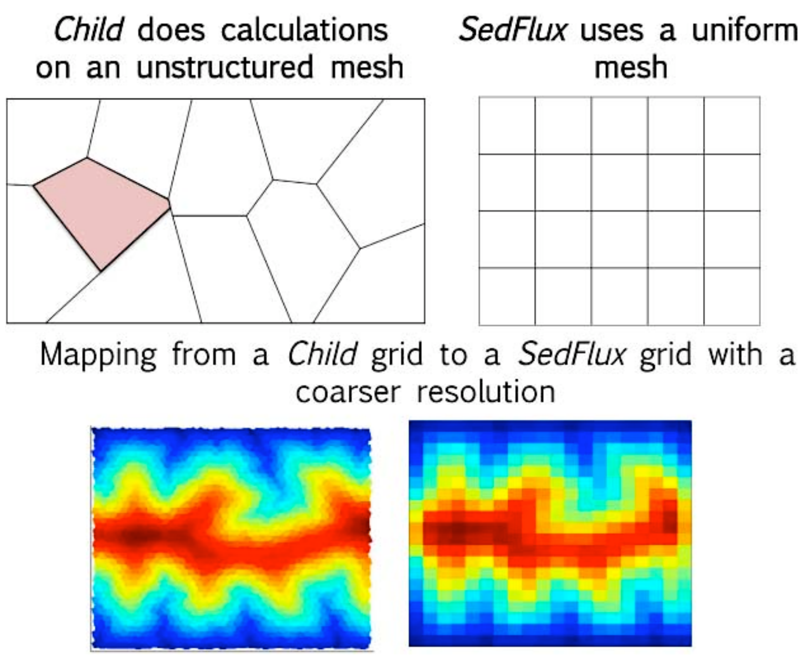


-Figure 8. (U) HydroTrend output for the Po River (1971-87) for suspended sediment concentration. (L) Growth of the Po delta after 30 CEM years with wave attack.

HydroTrend before refactoring was 10,500 lines of C code, offering minimal command line interface (CLI) to describe the model drainage and climate conditions. The output was a binary Hydrotrend file. After refactoring, HydroTrend was made into a CCA component with 11,300 lines of C code (8% increase), offering an expanded CLI, a GUI within CCA, and an API that provides IRF functions, a getter for elevation, and a setter for sediment discharge,with additional output formats (.curve, netcdf). CEM before refactoring was 4,300 lines of C code offering no command line interface, no input files (hardcoded variables), operating with constant sediment supply and wave angle characteristics. Output was as bathymetric changes as a text file. After refactoring CEM is 4,500 lines of C code (8% increase), is available as C and Python CCA components, offers a library, a CLI, a GUI within CCA, an API that provides IRF functions, a getter for elevation, and a setter for sediment discharge, and various output formats (CSV, BOV, netCDF).

Proof-of-concept Project 3: CHILD is a large modular landscape evolution model that given climate and tectonic dynamics, erodes and delivers a flux of sediment. As the land rises, water erodes the landscape and carries sediment to the ocean where it is dumped at the shoreline. SedFlux provides a framework that keeps track of 3D stratigraphy generated by 15 coastal and marine (component) models. The proof-of-concept exercise was designed to link large, established models that offered little overlap. The challenge was also in the linking of different numerical grids and I/O overlap (Fig. 9).

Before refactoring Child was 39,000 lines of **C++** code, was a component model with its own driver, offered a user interface through an input file, offered lots of output variables as ASCII files, and did its calculations on a non-uniform mesh. Before refactoring SedFlux was 70,000 lines of C code, was a component model with its own driver, offered a user interface through input file, and command line, had lots of output variables as confusing binary data, and its calculations were done on a uniform mesh. Using the OpenMI toolkit mapping between the two meshes with 100 x 100 grid points (Fig. 9) took between 18 and 20 hours on a fast single processor. By redistribution within a HPC node, run time was reduced to 2 hours. Work continues to find an even faster solution, such as employing the Model Coupling Toolkit (MCT). Another challenge is that Child provides a sediment flux to every grid cell. SedFlux requires deliver to the ocean through fewer river channels.



-Figure 9. Two different meshes make linking Child and SedFlux a challenge using OpenMI.

With refactoring there is an expanded IRF application programming interface (API) for both CHILD and SedFlux to include the necessary getters and setters for their coupling. The CHILD interface now includes getter functions that retrieve the model grid's elevation, discharge, and erosion (and deposition). In addition, the interface now provides a setter method that is able to change elevation values of the CHILD grid. The SedFlux interface now presents methods that retrieve elevation values and sets erosion (and deposition) values of its grid. These new interface functions allow CHILD to determine the amount of erosion or deposition over the delta plain, and then pass this information along to SedFlux to keep track of the evolving stratigraphy. Calculated discharge (both water and sediment) from CHILD at the shoreline can now be read by SedFlux, which it will then distribute into the ocean.

Tasks to accomplish with remaining 3 months of year 3:

1. Extract river mouths from the CHILD grid. The current version of CHILD does not define river mouths; instead it calculates discharge at all of the land cells on its grid. Shoreline cells that have large discharge values will be determined to be river mouths. These river mouth locations (and their discharges) will be exchanged with SedFlux.
2. New functionality will be added to SedFlux that will allow it to add and remove river mouths to its domain. Their locations and conditions (sediment and water discharge, river velocity, etc.) will be able to be varied through time.

3.2 Goal 2) HPC-targeted software tools, and Goal 4) HPCC Simulations.

The CSDMS website has added instructional pages to assist CSDMS members with high performance computing (HPC) issues. Under the "Help" tab is a section that deals with HPC and how to use some of the resources on the CSDMS high-performance computing cluster. Information on how to submit jobs to run on the CSDMS HPCC can be found at: http://csdms.colorado.edu/wiki/Help:HPCC_Torque and describes our batch job scheduling software, Torque. Sample submission scripts are provided for both serial and parallel programs as well as examples that use the MPI implementations installed on the CSDMS HPCC.

The CSDMS IF has installed a set of tools on its new HPCC that target high performance computing. In particular, the PETSc and hypre libraries are optimized for the particular configuration of the CSDMS HPCC. Other installed HPC tools include various MPI implementations — mpich2, mvapich2, and openmpi. These packages are customized to use high speed InfiniBand for inter-node communication. Alongside the set of GNU compilers, the CSDMS HPCC now contains the complete set of the fortran and c/c++ intel compilers optimized for the Intel Harpertown processors. The element mapper of the OpenMI SDK proved to be too slow for mapping to or from unstructured grids. The CSDMS IF refactored a portion of the SDK so that the implementation of the mapping function now is able to use multiple threads in its calculations. This improvement resulted in nearly linear speedup but is limited to shared memory architectures. Run on a single node of the CSDMS cluster, speedup is nearly eight-fold.

The CSDMS Service Desk has helped members upload, compile, and successfully run models on the HPCC in a parallel environment. In particular,

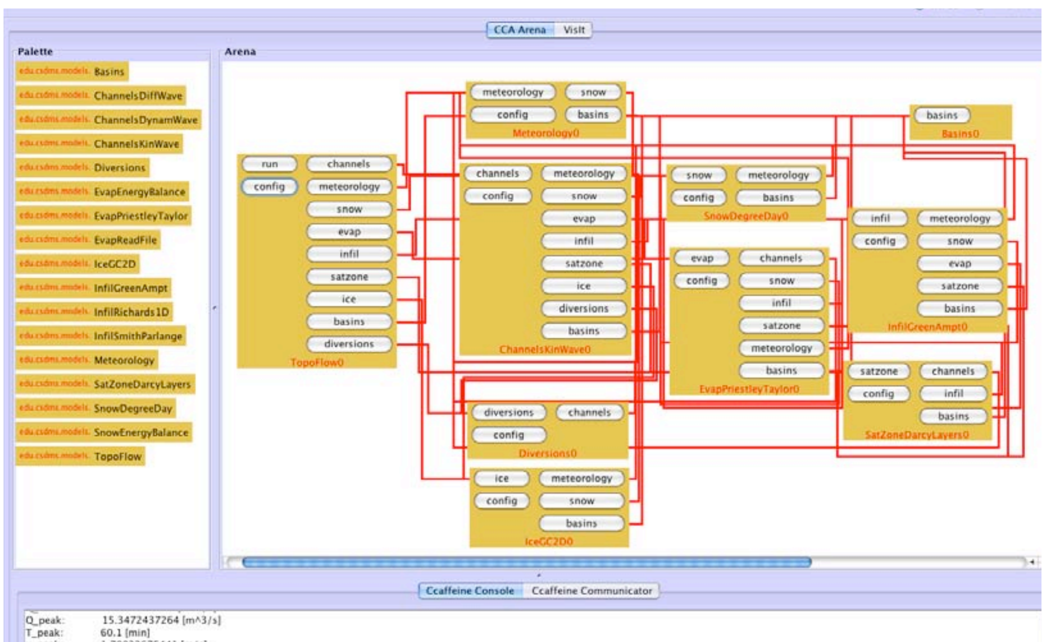
- Greg Tucker and Nate Bradley (Univ. Colorado) have conducted Monte Carlo CHILD simulations, each run on a separate processor.
- Mohamad Nasr-Azadani and Michael Zoellner (UC Santa Barbara) have begun testing the turbidity current model gvg3D and begun test runs. This model is parallelized using MPI and compiled with mpich2, and makes use of both PETSc and hypre.
- Scott Bachman (Univ. Colorado) installed and ran the flow routing model TopoFlow on large data sets (on the order of one million cells) for more than 700,000 time steps.
- Aaron Bever and Courtney Harris (VIMS) compiled and run a ROMS test case on the CSDMS HPCC. ROMS is a free-surface, terrain-following, orthogonal curvilinear, primitive equations ocean model. The code uses a coarse-grained parallelization with both shared-memory (OpenMP) and distributed-memory (MPI) paradigms coexisting together and activated via C-preprocessing.
- Gary Clow (USGS) is using WRF, the Weather Research and Forecasting Model to study the wind structure in the Arctic Ocean off of the North Slope of Alaska, as an aid to wave modeling coastal erosion. WRF is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs, and features multiple dynamical cores, a 3-dimensional

variational (3DVAR) data assimilation system, and a software architecture allowing for computational parallelism and system extensibility.

- Ian Ferguson (CSM) is setting up ParFlow on the CSDMS HPCC. Parflow is an open-source, object-oriented, parallel watershed flow model, that includes fully-integrated overland flow, the ability to simulate complex topography, geology and heterogeneity and coupled land-surface processes including the land-energy budget, biogeochemistry and snow (via CLM). ParFlow has been coupled to the mesoscale, meteorological code ARPS and the NCAR code WRF.
- Nikki Lovenduski has installed and run the open source MIT General Circulation Model.

3.3 Goal 3) CSDMS Ccaffeine GUI

The "Ccaffeine GUI" program is a portable Java application that allows users to graphically connect CCA components to create new applications. The program creates a Ccaffeine script that can either be run on the same computer or sent to a remote computer (e.g. the CSDMS HPCC). Ccaffeine is a CCA-compliant framework that supports parallel computation. While Ccaffeine is a large and complex program (without native support for Windows), and difficult for a user to install on their PC, the Ccaffeine GUI is a small, easy-to-install Java application, which can be used on any computer that supports Java. The CSDMS GUI is a modified version of the Ccaffeine GUI allowing CSDMS users to build applications from CSDMS components on their own PCs and then run them on our HPCC server called "beach" *csdms.colorado.edu/wiki/Help:Ccaffeine_GUI* (Fig. 10). Messages and files are passed between the user's PC and our HPCC server via SSH tunneling, while data generated by model runs resides on our server.



- Figure 10. The new CSDMS GUI for linking and running CSDMS code on the CSDMS high performance-computing cluster (HPCC).

The GUI now includes:

- Client-side Java application that can be easily installed by CSDMS members on their desktop or laptop computers: Windows, Mac OS X and Linux versions.

- A login dialog (and button) that allows users to choose between working with a CCA project on their own computer or connecting to a remote computer that is running Ccaffeine, such as the CSDMS HPCC.
- Ability to select from a droplist of CSDMS "component palettes" that are available on the CSDMS HPCC named 'Beach'
- Ability to save a CCA component "wiring diagram" that a user has created and to then "import" or "open" a previously saved diagram as the starting point for additional model runs.
- A console or "output log" window to display messages generated by simulations running on a remote computer (e.g. Beach).
- Improved appearance of the GUI, with "branding" such as a Help menu with information on how to use the GUI, links to CSDMS and CCA websites, and new menus, buttons and colors.

The new GUI also offers VisIt, a multi-dimensional graphic package designed for terrascale, multi-processor rendering for HPC models in a client-server configuration. VisIt supports a wide variety of data formats including netCDF, VTK, image formats such as PNG and TIFF, all of the GIS formats in the well-known GDAL package (e.g. shapefiles) and the SILO format (e.g. used by ParFlow). VisIt is split into client-side and server-side components. It can be launched from the CSDMS GUI to generate graphics from model output files that reside on our server and display them on the user's PC.

3.4 Goal 5) Feasibility of ROMS becoming CSDMS compliant

We have determined that ROMS can be coupled within the CSDMS Framework. ROMS is already in IRF form. ROMS has multiple model coupling (ESMF, MCT) and multiple grid nesting (composed, mosaics, refinement) capabilities. The extension to CSDMS coupling is logical. ROMS is already running on the CSDMS HPCC. We are presently working to get ROMS to be CSDMS compliant.

3.5 Goal 6) Data and Model Repositories

Data repository

The CSDMS Data Repository describes important data fields useful in CSDMS models and provides links to data centers for download: (csdms.colorado.edu/wiki/index.php/Data). CSDMS distinguishes between at least 3 data types relevant for modeling: 1) boundary or initialization data, 2) model algorithm test or benchmark data, and 3) integrated datasets for model validation of coupled systems. Model test files and validation files are explicitly solicited within the model submission process. The data repository has grown by 61% in 2009, and now includes:

- ICE-5G Model Data (Global Grids of Ice Sheet Thickness and Paleotopography for 21,000 - present day), the ICE-5G (VM2) model mathematically analyses glacio-isostatic adjustment processes and provides model data on global ice sheet coverage, ice thickness and paleotopography at 10 min spatial resolution for 21ka and 0ka, and at 1degree spatial resolution for intervals in between these snapshots. These are NETCDF files. CSDMS makes available scripts for data processing.
- Sea Ice data (Global grids of daily/2-daily sea ice concentration 1979-2008). This data is actively generated by NSIDC/NASA from brightness temperature data derived from Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) and Defense Meteorological Satellite Program (DMSP) -F8, -F11 and -F13 Special Sensor Microwave/Imager (SSM/I) radiances at a grid cell size of 25 x 25 km. The data are in the polar stereographic projection. CSDMS makes available scripts for data processing.
- HWSD Database (Harmonized World Soil Database).
- Sea Level Data: 1) PSMSL is the global data bank for longterm sea-level change information from tide gauges. The PSMSL collect data from several hundred gauges situated all over the globe. 2) Predictions of the rates of relative sealevel rise for ICE-5G (VM2 L90) model version 1.2 for PSMSL tidegauge sites. This data set contains values of the rates of relative sealevel rise and of vertical motion of the solid earth in mm/yr for times 100 years ago, present-day and 100 years into the future.

- Human dimensions data 1) World Population Prospects United Nations Population Database, incorporating total population, and population density for all UN countries. The data covers 1950-2005 and projects to 2050 with 5-year intervals. 2) World Urbanization Prospects United Nations Population (2007 revision) Database. This data shows total population, rural population and urban population as well as annual growth rates for all UN countries. The data covers 1950-2005 and projects to 2050 with 5-year intervals.
- ASTER Global Digital Elevation Model (GDEM v001) data which covers the Earth's land surface between 83N and 83S latitudes. Distribution contains ~22,895 tiles of 1º x 1º.

Repository Databases	Listed	Downloadable
Topography	11	9
Bathymetry	3	3
Climate	6	6
Hydrography	5	5
River discharge	3	3
Cryosphere	3	3
Geology	2	2
Soils	2	2
Sealevel	2	2
Land Cover	2	2
Human Dimensions	3	3
GIS Data Tools	12	12
Network Data Tools	7	7

Model repository

The CSDMS Model Repository presently offers 97 open-source models comprising 2.1 million lines of open-source code.

Language	Projects	Comment	Source	Total
Fortran 77/90	28	465,019	1,160,867	**1,625,886**
c/c++	57	258,259	892,239	**1,150,498**
Python	3	17,579	18,086	**35,665**
IDL	1	16,730	18,426	**35,156**
MATLAB	6	9,397	25,549	**34,946**
Statistical Analysis Software	1	2,390	5,796	**8,186**
Visual Basic	1	537	5,735	**6,272**
Total	**97**	**769,911**	**2,126,698**	**2,896,609**

For complete list of models see Appendix 2. The CSDMS Repository offers metadata descriptions on another 55 models. In the next few months we will sort through this second grouping of models to ensure their open availability to CSDMS members.

The Model Repository is now set up as a database, providing sort ability and search ability of model metadata. The model questionnaire and submission process have undergone a major change and are streamlined. In the last 9 months, CSDMS has registered 1500 downloads of its various models in the CSDMS Model Repository, directly addressing the historical lack of readily available models for research and application. This penetration of computational tools into the earth-science community should provide valuable future dividends.

CSDMS continues to enhance descriptions of its models. SedFlux, HydroTrend and Plume, TopoFlow, Erode, Child, and CEM have all received enhanced documentation to incorporate examples, description of visualization methodology, and references to both model papers and theoretical papers. Associated test files for test runs have been posted.

3.6 Goal 7) EKT Repository

The Educational Repository aims to distribute model simulations, educational presentations, reports, publications and short course material to the CSDMS community as a whole. The EKT Working Group identifies undergraduate students as the priority target audience. The EKT Repository now has:

- 4 modeling courses, ranging from detailed sediment transport processes courses to overview of earth surface dynamics modeling efforts. All lectures are made available as PowerPoint for immediate download csdms.colorado.edu/wiki/Products#Modeling_Lectures
- All educational codes (~ 60 modules) associated with 3 major modeling textbooks for geomorphologists and stratigraphers are available through the Repository.
- 20 modeling labs that can be used as classroom exercises in both undergraduate (Fig. 11) as well as graduate level courses csdms.colorado.edu/wiki/Products#Modeling_Labs
- >40 educational real-world movies of earth surface processes in action (e.g. Fig. 12). Fact sheets providing background information on the location and process observed help the knowledge transfer.
- 25 model animations that explain surface-dynamics processes (Fig. 13). Sequences of model animations with slight changes in certain parameters illustrate model processes and sensitivity. csdms.colorado.edu/wiki/Products#Model_Animations

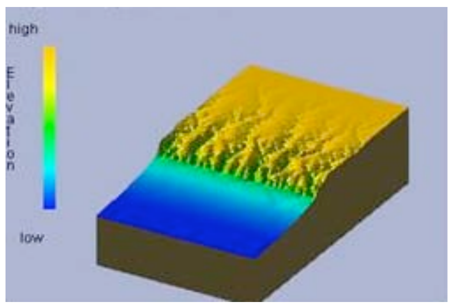


Figure 11: *The WILSIM model serves as an example of a web-based interface www.niu.edu/landform/*

-Figure 12. Frame from the tidal bore movie csdms.colorado.edu/wiki/Movie_GL. Associated fact sheet distinguishes a tidal bore from a tsunamis wave.

Figure 13. Frame from the CEM movie example of spit evolution csdms.colorado.edu/wiki/Animation_Coastal

The EKT repository will soon have a searchable database on the Wiki, for both ease-of-use as well as ease of submission. The EKT repository will soon add a section on experimental movies for educational purposes from NCED and University of Illinois data.

An extensive how-to guideline has been developed and made available to users on 1) employing the CSDMS GUI csdms.colorado.edu/wiki/Help:Ccaffeine_GUI, and on 2) how to develop a CSDMS model component csdms.colorado.edu/wiki/Help:IRF_Interface.

CSDMS asked its membership to nominate undergraduate or graduate students from earth or computer sciences to compete for the "Annual CSDMS Student Modeler Award" judged on the basis of ingenuity, applicability, and contribution towards the advancement of geoscience modeling. The 2009 winners (tie) are: (1) Adam Campbell for his MSc work on 'Numerical Model investigation of Crane Glacier in response to collapse of the Larsen B ice shelf, Antarctic Peninsula' — ice sheet dynamics from a physics-based perspective. Adam up the ice dynamical model from scratch, uses finite-element techniques to solve a complicated mesh, validates the model against field observations, then makes (theoretical) predictions on stability of outlet ice streams of varying dimensions. (2) Elchin Jafarov for his 'Numerical Modeling of Permafrost Dynamics in Alaska Using a High Spatial Resolution Dataset' involving coupling of GCM's to thermal dynamics. CSDMS will fund these winners to visit Boulder, CO and work with staff scientists to develop their model into a CSDMS component.

3.7 Goal 8) Really Simple Syndication feeds & Goal 9) Web structure and backups

The CSDMS web site incorporates a tool to monitor any changes on pages that are of interest to a certain user, as well as feeds. Users can either subscribe to single pages, to every edit on the CSDMS website, or subscribe to receive email updates of edits that are made on pages selected by the user. These are described at csdms.colorado.edu/wiki/Help:Watchlist. The CSDMS website also offers the community the possibility to stay up to date automatically of any newly added information in three ways:

1. *Subscribing to RSS (or ATOM) feeds per single page of interest.* The web browser will display on each page a RSS icon (see example figure on the right). Depending on the web browser this icon will appear in the URL text box (Firefox, Safari) or on in the menu bar (Explorer).
2. *Subscribing to the "Recent Changes" page with RSS (or ATOM) feeds.* The "Recent Changes" page (csdms.colorado.edu/wiki/Special:RecentChanges) displays changes that are done on the website at a given day and time, who made the changes and a short description of the newly added information. The "Toolbox" on the left side of the web site contains the RSS or ATOM feed subscribing option. By subscribing the CSDMS web site user can stay up to date of all the added changes through for example Google Reader.
3. *Receiving emails of the "Watch" pages that the CSDMS member is subscribed to.* This option is only available for CSDMS members. Every CSDMS member has a CSDMS website account, this is automatically set up when a person applies to become a CSDMS member. As soon as a member logs into the CSDMS website a "watch" option appears for every page in the "Page edit toolkit" on the left side of the website. By pressing "Watch", the page is added to a list: (csdms.colorado.edu/wiki/Special:Preferences).

New automation has been added to the website: a) the model repository list, b) new member subscription, c) model questionnaire database, d) model source code downloads csdms.colorado.edu/wiki/Model_download_Page, and e) Source Lines of Code (SLOC) csdms.colorado.edu/wiki/Model_SLOC_Page. Daily backups are automatically generated for the website and transferred to a 2nd server to guarantee a 'live' website during a primary server failure. Website functionality is significantly expended by adding "parser" functionality. Parser functionality in combination with database storage of form field contents makes it possible to generate and display lists and statistics of information on any desired web page, e.g. model metadata lists and new member registration. Model statistics are automatically generated to inform model developer and user.

3.8 Goal 10) Workshops, Meetings, Conferences and Courses.

2009 CSDMS organized and sponsored Workshops

1. CSDMS Hydrology FRG meeting, Boulder, CO, Jan 20-21
2. CSDMS Carbonate FRG meeting, Boulder, CO, Jan 26-27
3. CSDMS Terrestrial WG meeting, Boulder, CO, Feb 2-3
4. CSDMS Coastal WG & Marine WG, Charlottesville, VA, Feb 25-26
5. CSDMS Cyberinformatics & Numerics WG, Santa Barbara, Mar 3-4
6. CSDMS Chesapeake FRG Meeting, Annapolis, Mar 22-25
7. CSDMS Carbonate & Marine Group meeting, Boulder, CO, Oct 19-20
8. CSDMS Terrestrial & Coastal Group meeting, Boulder, CO, Oct 26-27
9. CSDMS Chesapeake FRG Meeting, VIMS, VA, Nov 10
10. CSDMS EKT, Cyber & Hydrology Group meeting, Boulder, CO, Nov 16-17

2009 CSDMS organized and sponsored Business Meetings or Addresses

11. CSDMS Steering Committee Meeting, Boulder, CO, Feb 4
12. CSDMS Executive Committee Meeting, Santa Barbara, CA Mar 2
13. Industrial Consortium Rep Meeting, June 2009
14. CSDMS Executive Committee Meeting, Boulder, CO, Sept 4
15. CSDMS Steering Committee Meeting, Boulder, CO, Dec 11
16. Gilbert Club: Town Hall Update, San Francisco, CA, Dec 19

2009 CSDMS organized and/or co-sponsored Conferences

17. MARGINS: Linking S2S & CSDMS, Gisborne NZ Apr 6-9
18. Modeling Turbidity Currents, U.C. Santa Barbara, CA, Jun 1-3
19. AAPG/SEPM: Deepwater Architecture & Models, Denver, CO, Jun 7-10
20. IAMG: Multiscale Modeling, Stanford U., CA, Aug 23-28
21. River Coastal Estuarine Morphodynamics, Santa Fe, Argentina Sep 20-25
22. SEDIBUD, Kingston, Canada, Oct 13-16
23. AGU: 4 Sessions, San Francisco, CA, Dec 14-18

2009 CSDMS Short Courses

24. NCED Summer Inst: Earth-surface dynamics Modeling, Minneapolis, Aug 18
25. RCEM Short Course: Earth-surface Modeling, Santa Fe, Argentina Sep 18-19

4.0 Year 4 (2010/11) Integration Facility Goals and Resources

Goal 1) CSDMS Website 'A Gateway into the CSDMS World'

Education and Knowledge Transfer through the CSDMS Website will focus on implementing a simpler interface that promptly informs members and new users what the Community Surface Dynamics Modeling System is all about, how to use CSDMS services, and how to become involved in the CSDMS community. The CSDMS website will be redesigned to be an efficient gateway into the three core Repositories that CSDMS maintains and develops. **Milestones:** Each Repository will be set up in a database structure to allow for efficient searching, and retrieval of information and downloads. A fast portal will make it possible for members to download the 'CSDMS Modeling Framework', and within a few steps allow for the secure* use of the CSDMS compliant models through the Ccaffeine Graphical User Interface for running models on the CSDMS HPCC. **Resources:** 0.6 FTE Web Specialist, 0.2 FTE EKT Specialist, 0.2 FTE Executive Assistant.

*extra steps are needed however, to access the CSDMS supercomputer given University security protocols

Goal 2) Usability of the 'CSDMS Modeling Framework'

The CSDMS audience is comprised of computer scientists, academics, post-graduates and graduate students – both members and non-members. To facilitate their use of the CSDMS Modeling Framework, the Framework will undergo further development to make it as user-friendly as possible. The CSDMS Modeling Framework is a key product of the overall project, as it allows earth scientists with relatively modest computer coding experience to use the CSDMS modules for earth surface dynamics research and education. **Milestones:** Facilitate non-expert users by developing clear and concise tutorials on the installation and use of the CSDMS Modeling Framework served on the CSDMS website and integrated within the 'Help' system of the downloadable applications. Compliant CSDMS modules will be given associated 'HTML Help Pages', listing vital information on the model processes and parameters. This information will be stored within the Model Repository for download with the code. The CSDMS Modeling Framework will undergo testing by a number of non-experts, who are not part of the Integrations Facility team. A number of 'case-studies' will be evaluated by surveying the testers for ease-of-use of the CSDMS Modeling Framework. **Resources:** 0.5 FTE Computer Scientist, 0.2 FT EKT Specialist, 0.3 Software Engineer.

Goal 3) Componentizing the CSDMS Model Repository

With the success of the model coupling proof-of-concept projects (see section 3.1), CSDMS engineers will convert as time permits user-contributed code into CSDMS plug-and-play components according to project needs and feedback from the working groups. For example, of particular importance is to bring into CSDMS-compliance a circulation and wave model (e.g. ROMS and SWAN/WaveWatch III). **Milestone:** Diagram potential linkages between contributed models to aid in planning and usability. Wrap contributed models with an IRF interface, with priority given to models identified as important by the working groups. Run test cases of the circulation model, with a one-way linkage through input/output files from a river discharge model (HydroTrend, for example). If time permits, provide ROMS with a tabbed-dialog GUI and HTML help pages. **Resources:** 1.0 FTE Software Engineer; 0.1 FTE Executive Director.

Goal 4) Advancing Selected Goals of the Working Groups and Focus Research Groups

This goal will work in conjunction of goals 3 & 7, and support the high priority Working Group and Focus Research Group directions outlined in Appendix 3.

- **All Groups:** Develop a programming Framework to provide classes and functions that describe and evolve stratigraphy within the CSDMS modeling domain. The Framework would ideally provide language bindings for both C and Python.
- **Carbonate & Marine:** Deconstruct the component model, SedFlux into process components that can be used within the CSDMS Modeling Framework and run as standalone models with standardized input/output files and user interfaces

- **Carbonate:** Outline a modified framework to account for new domains
- **Coastal & Terrestrial:** Create an avulsion model (e.g. Jerolmack-Paola). Link the delta model and coastal evolution model. Complete a delta-related Proof of concept project that links an avulsion model, delta model (e.g. SedFlux3D), and a coastline evolution model (e.g. CEM).
- **Hydrology:** Demonstrate ability to ingest measured time series data (e.g. temperature, precipitation, discharge) from a CUAHSI-HIS web-service into a CSDMS model**.**

Resources: 1.0 FTE Software Engineer.

Goal 5) Conferences, Meetings, Planning, and a CSDMS Special Issue

To address a directive of the Working Groups and Focus Research Groups as well as to further CSDMS project goals, an all-hands meeting or CSDMS members conference will be held to highlight CSDMS open-source models, their application, and particularly their coupling. Keynote lectures on componentized models by community leaders will be an important feature. Working Groups will be given independent time for their community coordination as well as time to interact with other WG/FRG disciplines. Steering Committee, Executive Committee and Industrial Consortia meetings could be scheduled around the all-hands meeting. CSDMS staff will provide a half-day clinic on using the CSDMS Modeling Framework. In addition, the all-hands meeting would motivate a special issue of Computers & Geoscience illustrating use of the CSDMS Modeling Framework, and documenting selected componentized models. It is anticipated that the all-hands meeting would also provide important input for the Phase 2 extension of the cooperative agreement with the National Science Foundation. The meeting venue, location and time remain TBD, but a late summer or fall meeting, possibly in San Antonio, Texas is a possibility. The Executive Director will further represent CSDMS at other national and international meetings, and appropriate conference sessions. CSDMS is supporting or co-sponsoring the following 2010 CSDMS-related conferences

1. MARGINS Successor Planning Meeting, Feb 15-18, San Antonio Texas
2. AAPG/SEPM: Numerical & Physical Models, New Orleans, LA, Apr 11-14
3. LOICZ: Storm Surges Congress, Hamburg, Ger, Sep 13-17
4. Geol Soc: Landscapes into Rock, London, UK, Sep 21-23
5. ISC: Numerical models for morphodynamics & stratigraphy, Mendoza, Arg, Sep 27-Oct 1

Resources: 0.5 FTE CSDMS Executive Assistant, 0.2 FTE Cyber Scientist, 0.2 FTE Executive Director.

2010 Communication Strategy:

- Email communication is supported by several list servers through the CSDMS website.
- A CSDMS Newsletter highlights new developments and capabilities with appropriate links to the CSDMS website, and is distributed by email.
- The Web site (csdms.colorado.edu/wiki/Main_Page) is the principal means for standard software downloads, sharing of community benchmarks, specifications of standards, and distribution of training manuals. Documents and presentations from CSDMS-sponsored workshops and meetings are posted to the site for the benefit of the entire community. The web site is a wiki allowing for discussions about working group activities. The CSDMS calendar of events and documents are continuously updated on the Web site.

Goal 6) Technical Advances in the CSDMS Cyber-Infrastructure

CSDMS staff will work on a suite of cyber issues to aid the future direction of the CSDMS modeling environment, including issues related to semantics and ontologies. **Milestones:**

- Adopt elements of the new OpenMI 2.0 interface that offer support for multiple processors and how models handle time (i.e. fixed or adaptive timesteps).
- Demonstrate interoperability with CUAHSI-HIS approach to accessing time series data via web-services and WaterML.
- Develop low-level tools to simplify various tasks such as: (1) creating or changing a component interface (e.g. wrapping tools and base classes), (2) providing components with tabbed-dialog GUIs, and (3) allowing components to read input or write output in standard formats (e.g. netCDF, OGC, GDAL formats).

- Improve performance of grid mapping operations for improved functionality (e.g. MCT, ESMF).
- Work with experts at the Marine Metadata Interoperability Project (marinemetadata.org, mmisw.org) and the University of Texas at El Pase Cybershare Center of Excellence (cybershare.utep.edu).
- Consider adoption of the "CF conventions" (cf-pcmdi.llnl.gov) used in netCDF files to provide standardized names for variables that occur in earth system models.

Resources: 0.5 FTE Software Engineer, 0.5 FTE Computer Scientist.

Goal 7) Educational and Knowledge Transfer

Develop a suite of educational modules in the CSDMS Modeling Framework that target undergraduate and graduate students, e.g.:

- Event-driven Precipitation influencing Landscape Evolution
- Valley Glacier Dynamics affecting Basin Hydrology
- Stratigraphic Architecture Storage Component
- Delta Dynamics affected by Human Pertubations
- River Sediment Fluxes into a Wave-Dominated Coastal Environment
- Ice Sheet Melt feeding Coastal Plumes
- Global Wind-Driven Waves affecting Coastal Zones

All case studies will undergo simplification with enhanced documentation to become educational modules targeted towards undergraduate and graduate students. **Milestones:**

- Sequentially post modules and model animations on the educational repository.
- Inventory Earth Surface Dynamics Modeling courses that CSDMS members now teach and have instructional material to share.
- Identify common elements of these courses and experiences of instructors and students to inform the development of CSDMS educational modules.
- CSDMS is providing a short course on models and model coupling at a conference of Future Oceans, Kiel, Germany Sept 11.
- Solicit feedback from CSDMS members through the website on their experiences with using the CSDMS Modeling Framework.

Resources: 0.25 FTE CDI PDF, 0.2 FTE EKT Specialist

5.0 2009 Integration Facility Presentations, Publications & Training

2009 CSDMS IF Journal & Book Publications, Reports

1. Abers, G. et al., 2008, Margins 2009 Review. Margins Office, LDEO, NY, 184 pp.
2. Gomez, B., Cui, Y., Kettner, A.J., Peacock, D.H., Syvitski, J.P.M., Simulating changes to the sediment transport regime of the Waipaoa River driven by climate change in the twenty-first century, *Global and Planetary Change,* 67: 153-166.
3. Hutton, E.W.H., J.P.M. Syvitski & S.D. Peckham, 2010, Producing CSDMS-compliant Morphodynamic Code to Share with the RCEM Community. In: Vionnet et al. (eds) River, Coastal and Estuarine Morphodynamics RCEM 2009, *Taylor & Francis Group, London, ISBN 978-0-415-55426-CRC* Press, p. 959-962.
4. Kettner A.J., Syvitski, J.P.M., 2009, Fluvial responses to environmental perturbations in the Northern Mediterranean since the Last Glacial Maximum. *Quaternary Science Reviews,* 28: 2386-2397.
5. Kettner, A.J., Restrepo, J.D., Syvitski, J.P.M., in press, Spatial Simulation of Fluvial Sediment Fluxes within an Andean Drainage Basin, the Magdalena River, Colombia. *J Geology.*
6. Kettner, A.J., Gomez, B., Hutton, E.W.H., and Syvitski, J.P.M., 2009. Late Holocene dispersal and accumulation of terrigenous sediment on Poverty Shelf, New Zealand. Basin Research, 21, doi:10.1111/j.1365-2117.2008.00376.x
7. McCarney-Castle, K., Voulgaris, G., and Kettner, A.J., in review. Analysis of fluvial suspended sediment load contribution through Anthropocene history to the South Atlantic Bight coastal zone, U.S.A. *J Geolog*
8. Overeem, I. and Syvitski, J.P.M., 2009, Dynamics and Vulnerability of Delta Systems, LOICZ Reports and Studies, No. 35, GKSS Research Center, Geesthacht, 54 pp.
9. Overeem, I., Syvitski, J.P.M., 2010, Experimental exploration of the stratigraphy of fjords fed by glacio-fluvial systems, In: Fjords: Depositional Systems and Archives, J. Howe (Editor), Geological Society, London
10. Overeem, I., Syvitski, J.P.M., in press, Shifting Discharge Peaks in Arctic Rivers, 1977-2007, *Geografiska Annaler*
11. Syvitski, J.P.M. and Slingerland, R.L., 2009, CSDMS and What it Means in the MARGINS context. MARGINS Newsletter No. 22, pg. 16-17.
12. Syvitski, J.P.M., AJ. Kettner, MT. Hannon, EW.H. Hutton, I Overeem, G. R Brakenridge, J Day, C Vörösmarty, Y Saito, L Giosan, R J. Nicholls, 2009, Sinking Deltas, *Nature Geoscience 2: 681-689*.
13. Syvitski, J.P.M., R.L. Slingerland, P. Burgess, E. Meiburg, A. B. Murray, P. Wiberg, G. Tucker, A.A. Voinov, 2010, Morphodynamic Models: An Overview. In: Vionnet et al. (eds) River, Coastal and Estuarine Morphodynamics: RCEM 2009, *Taylor & Francis Group, London, ISBN 978-0-415-55426-8* CRC Press, p. 3-20.
14. Voinov, C. DeLuca, R. Hood, S. Peckham, C. Sherwood, J.P.M. Syvitski, in press, Community Modeling in Earth Sciences. *EOS Transactions of the AGU.*
15. Vorosmarty, C. Syvitski, J.P.M., J Day, Paola, C., Serebin, A, 2009, Battling to save the world's river deltas, Bulletin of the Atomic Scientists, 65(2): 31-43.

2009 Training and Development:

1. NCED Summer Inst: Earth-surface dynamics Modeling & Model Coupling, Minneapolis, Aug 18. Instructor J. Syvitski, 35 students; http://www.nced.umn.edu/content/2009-summer-institute-earth-surface-dynamics-participants?page=0%2C0%2C0; content: http://www.nced.umn.edu/content/siesd-2009-materials
2. RCEM Short Course: Earth-surface Modeling & Model Coupling, Santa Fe, Argentina Sep 18-19. Instructor J. Syvitski, E. Hutton, R. Slingerland, 12 students; http://www.unl.edu.ar/rcem2009/pc_activities.php, lectures: http://csdms.colorado.edu/wiki/Products#Modeling_Lectures

2009 CSDMS IF Presentations and Posters:

1. Donselaar, ME, Overeem, I. 2009. Gradual avulsion in the rock record: Outcrop example of the Huesca Fluvial Fan, Abstract for Fluvial Sedimentology meeting, Aberdeen 26-28th January 2009.
2. Donselaar, ME, Overeem, I. 2009. Reservoir Architecture modeling of the Ten Boer Claystone Member, Final Research Report for NAM-Shell, The Netherlands, February 2009.
3. Hannon, MT, Syvitski, JPM, Kettner, AJ, 2009. Analyzing River Longitudinal Profiles Around the World. Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract H11E-0866
4. Hutton, E.W.H., J.P.M. Syvitski & S.D. Peckham, 2009, Producing CSDMS-compliant Morphodynamic Code to Share with the RCEM Community. Rivers, Coastal Estuarine Morphodynamics, Santa Fe, Argentina.
5. Kettner, AJ, B Gomez, Y Cui, Syvitski, JPM. 2009. Sensitivity of fluvial sediment flux to climate change in the 21st Century: Waipaoa River, New Zealand, Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract U34B-07
6. Kettner, A.J., Syvitski, J.P.M., and Gomez, B., 2009. Coupling models to investigate the dispersal and accumulation of fluvial sediment delivered by the Waipaoa River, to Poverty Shelf, New Zealand over a 3000year period. Source S2S Integration and Synthesis Workshop Gisborne, New Zealand.
7. McGrath, D., K. Steffen and I. Overeem. 2009. "Sediment Plumes in Sondre Stromfjord, Greenland as a proxy for runoff from the Greenland Ice Sheet". Abstract for Copenhagen Climate Conference 'Climate Change: Global Risks, Challenges and Decisions'. 10-12 March 2009, Copenhagen, Denmark.
8. Milliman, J.D., and Kettner, A.J., 2009. Recent Trends in Fluvial Discharge of Water and Sediment to the Black Sea CIESM International Workshop, Trabzon, Turkey.
9. Overeem, I. and Donselaar, M.E., 2009. Outcrop Characteristics of a Gradual Avulsion, abstract for Annual Meeting American Association of Petroleum Geologists, Denver June 7th-10th, 2009.
10. Overeem, I. Wobus, C.W., Anderson, R.S., Clow, G.D., Urban, F.E., Stanton, T.P. EP43B-0658. Quantifying Sea-Ice Loss as a Driver of Arctic Coastal Erosion . AGU, 90(52), Fall Meet. Suppl., Abstract EP43B-0658.
11. Overeem, I., McGrath, D., Steffen, K., 2009. Sediment Plumes as Indicators for Greenland Ice Sheet Melt. SEDIBUD October, 2009, Annual Meeting, Kingston, Canada.
12. Overeem, I., and co-authors, 2009. Sinking Deltas due to Human Activities. US Wetland Foundation, Washington DC, 4th November 2009.
13. Peckham, S.D. and Hutton, E.H., 2009, Componentizing, standardizing and visualizing: How CSDMS is building a new system for integrated modeling from open-source tools and standards, Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract IN11A-1045.
14. Peckham, S.D., 2009, A new algorithm for creating DEMs with smooth elevation profiles, extended abstract, Proceedings of Geomorphometry 2009, Zurich, Switzerland, p. 34-37, R. Purves, S. Gruber, T. Hengl, R. Straumann (Eds).
15. Peckham, S.D., 2009, A relationship between plan and profile curvature in a fluvial landscape model, presentation, Morphometry, Glaciers and Landscapes: A Workshop in Honour of Dr. Ian S. Evans, Durham University, UK, September 6.
16. Peckham, S.D., 2009, Analytic, steady-state solutions for fluvial landscape evolution models, presentation, Geomorphology 2009, 7th International Conference on Geomorphology (ANZIAG): Ancient Landscapes - Modern Perspectives, Melbourne, Australia, July 6-11.
17. Peckham, S.D., 2009, A brief overview of CSDMS, the Community Surface Dynamics Modeling System, presentation, University of Newcastle, July 6.
18. Peckham, S.D., 2009, A brief overview of CSDMS, the Community Surface Dynamics Modeling System, presentation, NCED Cyberseminar Series, Minneapolis, MN, April 8.
19. Peckham, S.D., 2009, A brief overview of CSDMS, the Community Surface Dynamics Modeling System, presentation, Tropical Hydrology Symposium, Smithsonian Tropical Research Institute (SRTI), Panama City, Panama, March 18.
20. Peckham, S.D., 2009, A very brief discussion of the "Mass Flux Method", presentation, Tropical Hydrology Symposium, Smithsonian Tropical Research Institute (SRTI), Panama City, Panama, March 18.

21. Peckham, S.D. Hutton, E.W.H. and Syvitski, J.P.M. 2009. The CSDMS project and submission standards for model source code. Abstracts of the IAMG 2009 Meeting, August 23-29, 2009 Stanford, CA
22. Pyles, DR, Syvitski, JPM, Slatt, R., 2009, Applying the Concept of Grade to Basin-scale Stacking Patterns and Reservoir Architecture: An Outcrop Perspective. SEPM Workshop on Stratigraphic Evolution on Deep-Water Architecture, Mariarmen Alicon, Chile, Feb 22-29, 2009.
23. Syvitski, JPM, E.W.H. Hutton, A.J. Kettner, Milliman, J.D., 2009. Hyperpycnal flows and the generation of continental shelf-traversing turbidity currents. Modeling Turbidity Currents and Related Gravity Flows Workshop, Santa Barbara, Jun 1-3, 2009, Univ. California, Santa Barbara.
24. Syvitski, JPM, E.W.H. Hutton, I. Overeem, A. Kettner, and S. Peckham, 2009, An Overview of Source to Sink Numerical Modeling Approaches & Applications, AAPG Denver, June 7-10
25. Syvitski, JPM, Hannon, M.T., Kettner, AJ, Bachman, S. 2009. Concepts on tracking the impact of tropical cyclones through the coastal zone, Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract H11E-0866,
26. Syvitski, J.P.M., R.L. Slingerland, P. Burgess, E. Meiburg, A. B. Murray, P. Wiberg, G. Tucker, A.A. Voinov, 2009, Morphodynamic Models: An Overview. Rivers, Coastal Estuarine Morphodynamics, Santa Fe, Argentina 2009. Keynote Address.
27. Upton, P., Kettner, A.J., Litchfield, N., Orpin, A.R., December 2009. Analyzing River Longitudinal Profiles Around the World. Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract EP42A-05.

2009 Graduate & Undergraduate Student Support

1. Nora Matell, University of Colorado, Boulder. "Shoreline erosion and thermal impact of thaw lakes in a warming landscape, Arctic Coastal Plain, Alaska". MSc thesis.
2. Dan McGrath, University of Colorado, Boulder. April 2009. "Sediment Plumes in Sondre Stromfjord, Greenland as a proxy for runoff from the Greenland Ice Sheet". MSc thesis.
3. Cordelia Holmes, University of Colorado, Boulder. March 2009. "Focused Temporal and Spatial Study on Sea Ice Location in the Beaufort Sea, Alaska, and its Role in Coastal Erosion". Honors BSc thesis.
4. Hosted Phd student Ilja de Winter, Delft University of Technology, The Netherlands to work with CSDMS staff on coupling glaciological and sediment production and transport models, June 2009.
5. Hosted postgraduate scientist Dr. Bjorn Heise, Christian-Albrechts-University Kiel, Germany, August, 2009. Explore the linkage of CHILD and sedflux models for long time scale (100k year) simulations.
6. Mark Hannon, University of Colorado, Boulder. Ph.D Candidate
7. Scott Bachman, University of Colorado, Boulder. Ph.D Candidate

6.0 CSDMS Priorities and Management of Its Resources

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 2 saw 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 and Meetings. 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. A software engineer was hired to help with the Proof-of-concept Projects in Model Coupling.

Year 3 has been dedicated to advanced simulations through proof-of-concept projects. The CSDMS Integration Facility has completed three highly varied proof-of-concept exercises in linking six models (SedFlux, GC2D, CHILD, TopoFlow, CEM, HydroTrend) written by six authors, in four computer languages (c, c++, IDL, Matlab), three different grids (raster, non-uniform mesh, spatially-averaged), and two levels of granularity (process and modular). With the success of these coupling exercises, the conversion of contributed code into 'components' within the CSDMS Model Repository has begun. A CSDMS GUI prototype is now available, able to operate on multiple platforms (PC, OX, Linux) with direct connection to the CSDMS supercomputer. The GUI offers ease of use for professionals and non-modelers alike, and serves as an excellent educational platform through its help system. CSDMS courses and workshops have provided graduate students and younger professionals an opportunity to learn the science and engineering of model development and model coupling. CSDMS software engineers have begun to support the CSDMS community in the transition of their software from limited processor venues to modern HPC clusters. CSDMS now offers to its community of researchers a dedicated high-performance computing cluster (HPCC), running a multitude of CSDMS compliant and interlinked surface dynamic modules. Year 3 also saw the hiring of new staff: 1) a software engineer to help the overwork staff in the development of the model coupling framework; 2) a computer scientist funded by the industrial consortia to develop the CSDMS GUI for model coupling on the CSDMS HPCC; and 3) a dedicated Education and Knowledge Transfer specialist to start developing a suite of educational modules. CSDMS staff will continue their community interactions at both national and international venues. Expenditures related to the Integration Facility staff, travel expenses related to CSDMS governance, operations and workshop participation costs.

Year 4 will see the new staff integrated into the software team and rapid advances in community products, including 1) improvements to CSDMS web services, 2) CSDMS Model Coupling Framework, 3) Componentizing key models in the CSDMS Model Repository including ROMS, 4) CSDMS Domain Architecture (SedGrid development), 5) Data handling including the ability to link to the CUAHSI-HIS web-services, 6) All-hands Conference, among others, and 7) Development of robust Educational Modules. The CSDMS Integration Facility Staff will now need to juggle the competing demands of an actively engaged CSDMS Community.

7.0 NSF Revenue & Expenditure

	Actual Year 1	Actual Year 2	Proposed Year 3	Estimated Year 3*	Proposed Year 4
A. Salaries and Wages					
Executive Director:	$47,895.00	$51,860.01	$81,290.55	$51,860.01	**$55,000.00**
Software Engineers:	$97,273.00	$112,750.00	$187,353.00	$211,000.00	**$225,000.00**
Communication Staff**	$17,054.00	$73,000.00	$90,227.00	$90,227.00	**$92,000.00**
Admin Staff***	$47,964.00	$62,716.00	$81,355.00	$81,355.00	**$84,000.00**
Total Salaries	$209,886.00	$300,326.01	$440,225.55	$434,442.01	**$456,000.00**
B. Fringe	$48,644.00	$81,088.02	$121,211.00	$117,299.34	**$123,120.00**
D. Travel					
Center Staff:	$23,331.00	$27,900.00	$29,000.00	$28,000.00	**$29,000.00**
Steering Committee	$1,580.00	$7,368.00	$7,000.00	$8,400.00	**$7,000.00**
Executive Com.	$4,760.00	$11,500.00	$7,000.00	$5,000.00	**$7,000.00**
Total Travel	$29,671.00	$46,768.00	$43,000.00	$41,400.00	**$43,000.00**
E. Workshop Participation					
	$37,000.00	$76,303.25	$80,000.00	$50,000.00	**$80,000.00**
F. Other Direct Costs					
Materials & Suppl	$1,313.00	$6,200.00	$3,000.00	$3,800.00	**$3,000.00**
Publication Costs	$6,163.00	$6,500.00	$4,000.00	$5,500.00	**$4,000.00**
Computer Services:	$6,420.00	$12,900.00	$28,000.00	$14,100.00	**$25,000.00**
Non Capital Equipment	$0.00	$0.00	$6,000.00	$7,800.00	**$4,000.00**
Communications	$1,500.00	$3,100.00	$3,000.00	$3,000.00	**$3,000.00**
Total	$15,396.00	$28,700.00	$44,000.00	$34,200.00	**$39,000.00**
G. Total Direct Costs	$340,597.00	$533,185.28	$728,436.55	$677,341.35	**$741,120.00**
H. Indirect Cost	$140,235.00	$233,009.84	$317,734.00	$307,397.26	**$330,560.00**
I. Total Costs	$489,359.00	$766,195.12	$1,046,170.55	$984,738.62	**$1,071,680.00**

*Estimates for Year 3 includes salaries projected 3 months out to the end of the CSDMS fiscal year. The Executive Director AY salary is underwritten by the University of Colorado --- transfers to Software Engineers salaries are the result.
**Communication Staff includes Cyber Scientist + EKT Scientist.
*** Admin Staff includes Executive Assistant + System Administrator + Accounting Technician.
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.

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: $70K
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

Additional Year 3 Funds Received by CSDMS Personnel:
Office of Naval Research: Hydrologic and morphodynamic modeling of Deltas: $107K
NASA: Modeling framework to detect and analyze changes in land-to-coastal fluxes: $140K
ConocoPhillips: CSDMS, GIFT $30K
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
StatOil: CSDMS GIFT $50K
NSF: Greenland Ice Sheet Inverse Plume modeling and observations: $80K
USGS: UPS for the CSDMS HPCC: $40K

Appendix 1: CSDMS Membership

Focus Research and Working Group participants (12/31/09)

Hydrology Focus Research Group

First Name	Last Name	Institution	Country
Peter	Adams	University of Florida	USA
Daniel	Ames	Idaho State University	USA
Christoff	Andermann	Universite de Renness 1	France
David	Anderson	NOAA	USA
Bob	Anderson	University of Colorado	USA
Matthew	Becker	California State Univ Long Beach	USA
Patrick	Belmont	University of Minnesota	USA
Michael	Bruen	University College Dublin	Ireland
Bill	Capehart	South Dakota School of Mines	USA
Kuo-Hsien	Chang	U. of Guelph	Canada
Dong	Chen	Desert Research Institute	USA
Sagy	Cohen	The University of Newcastle	Australia
Olaf	David	Colorado State University	USA
Russell	Detwiler	University of California	USA
Gaetano	Di Achille	University of Colorado	USA
Jay	Famiglietti	University of California, Irvine	USA
Ian	Ferguson	Colorado School of Mines	United States
Peter	Gijsbers	Deltares	Netherlands
Wendy	Graham	University of Florida	USA
Jianwei	Han	Tulane University	USA
Xujun	Han	Shenzhen Inst of Advanced Technolgy	China
Nick	Haycock	Haycock	U Kingdom
Yang	Hong	University of Oklahoma	USA
Richard	Hooper	CUAHSI	USA
Susan Meredith	Howell	Vanderbilt University	USA
Jasmeet	Judge	University of Florida, Ctr Remote Sensing	USA
Stephanie	Kampf	Colorado State University	USA
Eric	Lajeunesse	Institut de Physique de Globe de Paris	France
Venkat	Lakshmi	University of South Carolina	USA
Laurel	Larsen	U.S. Geological Survey	USA
Xu	Liang	University of Pittsburgh	USA
Mingliang	Liu	Auburn University	USA
MinHui	Lo	University of California-Irvine	USA
Rafael	Manica	UFRGS, Necod/iph	Brazil
Reed	Maxwell	Colorado School of Mines	USA
Emilio	Mayorga	University of Washington	USA
Jim	McElwaine	University of Cambridge	UK
Thomas	Meixner	University of Arizona	USA
Steve	Meyerhoff	Colorado School of Mines	USA
Peter	Moore	Iowa State University	USA
Shadi	Moqbel	Colorado School of Mines	USA
Mark	Morehead	Idaho Power	USA
Karthik	Nagarajan	University of Florida	USA
M. Mehdi	Nasr Azadani	University of California, Santa Barbara	USA

Jeff	Niemann	Colorado State University	USA
Harold	Opitz	National Weather Service, NWRFC	USA
Murari	Paudel	Brigham Young University	USA
Scott	Peckham	University of Colorado, INSTAAR	USA
Mariela	Perignon	University of Colorado - Boulder	USA

Chesapeake Focus Research Group

First Name	Last Name	Institution	Country
Mark	Brush	Virginia Institute of Marine Science (VIMS)	USA
Victoria	Coles	ULP/UMCES	USA
Kevin	Dressler	Pennsylvania State University	USA
Christopher	Duffy	Pennsylvania State University	USA
David	Forrest	Virginia Institute of Marine Science, VIMS	USA
Marjorie	Friedrichs	Virginia Inst of Marine Science (VIMS)	USA
Carl	Friedrichs	Virginia Institute of Marine Science (VIMS)	USA
Courtney	Harris	Virginia Inst of Marine Science (VIMS)	USA
Raleigh	Hood	University of Maryland Ctr for Environmtl Science	USA
Ken	Kiger	University of Maryland	USA
John	Klinck	Old Dominion University	USA
Wen	Long	Univ of Maryland	USA
Andy	Miller	UMBC	USA
M. Mehdi	Nasr Azadani	University of California, Santa Barbara	USA
Scott	Peckham	University of Colorado, INSTAAR	USA
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Lawrence	Sanford	University of Maryland	USA
Malcolm	Scully	Old Dominion University	USA
Jian	Shen	Virginia Inst of Marine Science (VIMS)	USA
Gary	Shenk	Chesapeake Bay Program Office	USA
Alexey	Voinov	Chesapeake Community Modeling Program	USA
Claire	Welty	University of Maryland Baltimore County	USA
Peter	Wilcock	Johns Hopkins University	USA

Carbonate Focus Research Group

First Name	Last Name	Institution	Country
Andrew	Barnett	BG Group	UK
David	Budd	University of Colorado	USA
Govert	Buijs	ConocoPhillips	USA
Peter	Burgess	BG Energy Holdings Limited	UK
Comenico	Capolongo	University of Bari	Italy
Kuo-Hsien	Chang	U. of Guelph	Canada
Kristina	Clark	MUST	USA
Bob	Demicco	Binghamton University	USA
Carl	Drummond	Indiana Univ.-Purdue Univ. Fort Wayne	USA
Evan	Franseen	University of Kansas	USA
Ned	Frost	ConocoPhillips	USA
Xavier	Janson	University of Texas at Austin	USA
Chris	Jenkins	University of Colorado	USA
Gareth	Jones	Chevron Energy Technology Company	USA
Albert	Kettner	University of Colorado	USA
Richard	Lane	National Science Foundation	USA

Patrick	Lehmann	Exxonmobil Exploration company	USA
Mingliang	Liu	Auburn University	USA
William	Morgan	ConocoPhillips	USA
M. Mehdi	Nasr Azadani	University of California, Santa Barbara	USA
William	Parcell	Wichita State University	USA
Gene	Rankey	University of Kansas	USA
Bernhard	Riegl	Nova southeastern University	USA
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Rick	Sarg	Colorado School of Mines	USA
Fiona	Whitaker	University of Bristol	UK
Bruce	Wilkinson	Syracuse University	USA

Coastal Working Group

First Name	Last Name	Institution	Institution
Peter	Adams	University of Florida	USA
Pascal	Allemand	Laboratoire de sciences de la Terre	France
Matthew	Arsenault	U.S. Geological Survey (USGS)	USA
Andrew	Ashton	Woods Hole Oceanographic Institution	USA
Andreas	Baas	King's College London	UK
Scott	Bachman	University of Colorado	USA
Juan	Baztan	Marine Sciences For Society	France
Marcos	Bernardes	Federal University of Itajuba	Brazil
Aaron	Bever	Virginia Institute of Marine Science (VIMS)	USA
Christian	Bjerrum	University of Copenhagen	Denmark
Mike	Blum	Louisiana State University	USA
Pete	Bowyer	Independent	Ireland
Ron	Boyd	ConocoPhillips	USA
Michael	Bruen	University College Dublin	Ireland
Joseph	Calantoni	Naval Research Laboratory	USA
Alberto	Canestrelli	Padua University	Italy
Florence	Cayocca	IFREMER	France
Yunzhen	Chen	Nanjing University	China
Giovanni	Coco	National Institute of Water and Atmosphere (NIWA)	New Zealand
Nicole	Couture	McGill University	Canada
Peter	Cowell	The University of Sydney Institute of Marine Science	Australia
Andrea	D'Alpaos	University of Padova	Italy
Rory	Dalman	Delft University of Technology	Netherlands
Philippe	Davy	CNRS / University of Rennes I	France
Christopher	Delacourt	Lab Domaines Oceanique IUEM/UBO	France
Bob	Demicco	Binghamton University	USA
Tom	Drake	Office of Naval Research (ONR)	USA
Doug	Edmonds	Universit of Minnesota	USA
Sergio	Fagherazzi	Boston University	USA
David	Fugate	Florida Gulf Coast University	USA
Ioannis	Georgiou	University of New Orleans	USA
Rocky	Geyer	Woods Hole Oceanographic Inst.	USA
Liviu	Giosan	Woods Hole Oceanographic Inst.	USA
Vincent	Godard	Aix-Marseille Université	France
Nicolas	Guillou	CETMEF/LGCE	France
Jouet	Gwenael	IFREMER	France
Brendon	Hall	ExxonMobil	USA

Daniel	Hanes	USGS Pacific Science Center	USA
Mark	Hannon	University of Colorado, INSTAAR	USA
Jeff	Harris	University of Rhode Island	USA
Shawn	Harrison	ASR Ltd.	New Zealand
John	Harrison	Washington State University	USA
Susan	Hazlett	University of Alaska Fairbanks	USA
Bjoern	Heise	Christian-Albrechts-Universitat zu Kie	Germany
Piet	Hoekstra	Utrecht University	Netherlands
Alan	Howard	University of Virginia	USA
Susan	Howell	Vanderbilt University	USA
TianJian	Hsu	Center for Applied Coastal Research	USA
Eric	Hutton	University of Colorado, INSTAAR	USA
Jasim	Imran	University of South Carolina	USA
Bert	Jagers	Deltares	Netherlands
Dave	Jasinski	CRC/CCMP	USA
Chris	Jenkins	University of Colorado	USA
Gareth	Jones	Chevron Energy Technology Company	USA
Felix	Jose	Louisiana State University	USA
Camille	Kervazo	IUEM: Inst Universitaire Europeen de la Mer	France
Ken	Kiger	University of Maryland	United States
Matthew	Kirwan	USGS, University of Virginia	USA
Maarten	Kleinhans	Utrecht University	Netherlands
Yusuke	Kubo	Jap Agncy Mar-Earth Sci Tech, JAMSTEC	Japan
Eric	Lajeunesse	Institut de Physique de Globe de Paris	France
Richard	Lane	National Science Foundation	USA
Stefano	Lanzoni	University of Padova	Italy
Suzanne	LeClair	Environnement Illimite inc.	Canada
Michael	Li	Geological Survey of Canada (Atlantic)	Canada
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Tom	Lippman	University of New Hampshire	USA
Wen	Long	Univ of Maryland	USA
Rafael	Manica	UFRGS, Necod/iph	Brazil
Marco	Marani	University of Padova	Italy
Emilio	Mayorga	University of Washington	USA
Dylan	McNamara	UNC-Wilmington	USA
Laura	Moore	University of Virginia	USA
Simon	Mudd	University of Edinburgh	UK
Brad	Murray	Duke University	USA
M. Mehdi	Nasr Azadani	University of California, Santa Barbara	USA
Alan	Niedoroda	URS Corp	USA
Andrea	Ogston	University of Washington	USA
Scott	Peckham	University of Colorado, INSTAAR	USA
Will	Perrie	Bedford Institute of Oceanography	Canada
George	Postma	Utrecht University	Netherlands
Marina	Rabineau	University of Brest, France	France
Ad	Reniers	RSMAS, University of Miami	USA
Dano	Roelvink	UNESCO-IHE	Netherlands
Kimberly	Rogers	Vanderbilt University	USA
Brian	Romans	Chevron Energy Technology Company	USA
Gerben	Ruessink	Utrecht University	Netherlands
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Mihaela	Ryer	ConocoPhillips	USA

Yoshiki	Saito	Geological Survey of Japan / AIST	Japan
Lawrence	Sanford	University of Maryland	USA
Steve	Scott	U.S. Army Eng. Research & Development Center	USA
Malcolm	Scully	Old Dominion University	USA
Sybil	Seitzinger	Rutgers University	USA
Ben	Sheets	University of Washington	USA
Alex	Sheremet	University of Florida	USA
Ramesh	Singh	Chapman University, Physics Dept	USA
Minwoo	Son	University of Florida	USA
Joep	Storms	Delft University of Technology	Netherlands
John	Swenson	University of Minnesota-Duluth	USA
Daniel	Tetzlaff	Schlumberger Information Solutions	USA
Torbjörn	Törnqvist	Tulane University	USA
George	Voulgaris	University of South Carolina	USA
Ping	Wang	University of South Florida	USA
Gert Jan	Weltje	Delft University of Technology	Netherlands
Andrew	Wickert	University of Colorado - Boulder	USA
Jeffress	Williams	U.S. Geological Survey (USGS)	USA
Matthew	Wolinsky	Shell Intl Exploration & Production	USA
Francisco	Zucca	University of Pavia	Italy
Ilja	de Winter	Delft University of Technology	Netherlands

Marine Working Group

First Name	Last Name	Institution	Institution
David	Anderson	NOAA	USA
John	Andrews	University of Colorado	USA
Matthew	Arsenault	U.S. Geological Survey (USGS)	USA
Andrew	Ashton	Woods Hole Oceanographic Institution	USA
Andrew	Barnett	BG Group	UK
Juan	Baztan	Marine Sciences For society	France
Steve	Bergman	Shell International Exploration	USA
Aaron	Bever	Virginia Institute of Marine Science (VIMS)	USA
Christian	Bjerrum	University of Copenhagen	Denmark
Pete	Bowyer	independent	Ireland
Ron	Boyd	ConocoPhillips	USA
Peter	Burgess	BG Energy Holdings Limited	UK
James	Buttles	University of Texas at Austin	USA
Florence	Cayocca	IFREMER	France
Rory	Dalman	Delft University of Technology	Netherlands
Bob	Demicco	Binghamton University	USA
Tom	Drake	Office of Naval Research (ONR)	USA
Carl	Drummond	Indiana Univ.-Purdue Univ. Fort Wayne	USA
Doug	Edmonds	Universit of Minnesota	USA
Federico	Falcini	University of Rome ""LaSapienza""	Italy
Andrea	Fildani	Chevron Energy & Technology Company	USA
Carl	Friedrichs	Virginia Institute of Marine Science (VIMS)	USA
David	Fugate	Florida Gulf Coast University	USA
Marcelo	Garcia	University of IL-Urbana-Champaign	USA
Ioannis	Georgiou	University of New Orleans	USA
Jouet	Gwenael	IFREMER	France
Bjarte	Hannisdal	University of Bergen	Norway
Courtney	Harris	Virginia Inst of Marine Science (VIMS)	USA

William	Hay	University of Colorado at Boulder	USA
Susan	Hazlett	University of Alaska Fairbanks	USA
Linda	Hinnov	Johns Hopkins University	USA
Gary	Hoffmann	University of California at Santa Cruz	USA
Eric	Hutton	University of Colorado, INSTAAR	USA
Jasim	Imran	University of South Carolina	USA
John	Jaeger	University of Florida	USA
Bert	Jagers	Deltares	Netherlands
Xavier	Janson	University of Texas at Austin	USA
Chris	Jenkins	University of Colorado	USA
Gareth	Jones	Chevron Energy Technology Company	USA
Philippe	Joseph	Institut Francais du Petrole	France
Chris	Kendall	University of South Carolina	USA
Yusuke	Kubo	Jap Agncy Mar-Earth Sci Tech, JAMSTEC	Japan
Steven	Kuehl	William & Mary	USA
Eric	Lajeunesse	Institut de Physique de Globe de Paris	France
Michael	Li	Geological Survey of Canada (Atlantic)	Canada
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Nikki	Lovenduski	Colorado State University	USA
Rafael	Manica	UFRGS, Necod/iph	Brazil
Dylan	McNamara	UNC-Wilmington	USA
Eckart	Meiburg	University of California, Santa Barbara	USA
Paul	Meijer	Utrecht University	Netherlands
David	Mohrig	University of Texas	USA
Ruth	Mugford	University of Cambridge	UK
Thierry	Mulder	Universite Bordeaux 1	France
Chuck	Nittrouer	University of Washington	USA
James	O'Donnell	University of Connecticut	USA
Andrea	Ogston	University of Washington	USA
Thanos	Papanicolaou	University of Iowa	USA
William	Parcell	Wichita State University	USA
George	Postma	Utrecht University	Netherlands
Ross	Powell	Northern Illinois University	USA
David	Pyles	Colorado School of Mines	USA
Marina	Rabineau	University of Brest, France	France
Gene	Rankey	University of Kansas	USA
Chris	Reed	URS Greiner Corporation	USA
Bernhard	Riegl	Nova southeastern University	USA
Brian	Romans	Chevron Energy Technology Company	USA
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Mihaela	Ryer	ConocoPhillips	USA
Lawrence	Sanford	University of Maryland	USA
Rick	Sarg	Colorado School of Mines	USA
Malcolm	Scully	Old Dominion University	USA
Ben	Sheets	University of Washington	USA
Christopher	Sherwood	U.S. Geological Survey (USGS)	USA
Ramesh	Singh	Chapman University, Physics Dept	USA
Rudy	Slingerland	Penn State University	USA
Michael	Steckler	Lamont-Doherty Earth Observatory	USA
John	Suter	Conoco Phillips	USA
Bill	Ussler	Monterey Bay Aquarium Research Inst.	USA
Benoit	Vincent	Cambridge Carbonates Ltd.	France

Pat	Wiberg	University of Virginia	USA
Bruce	Wilkinson	Syracuse University	USA
Jeffress	Williams	U.S. Geological Survey (USGS)	USA
Matthew	Wolinsky	Shell Intnl Exploration & Production	USA
Kehui (Kevin)	Xu	Coastal Carolina University	USA
Michael	Zoellner	UCSB, Dept Mechanical Engineering	USA
Francisco	Zucca	University of Pavia	Italy

Terrestrial Working Group

First Name	Last Name	Institution	Institution
Rolf	Aalto	University of Exeter	UK
Pascal	Allemand	Laboratoire de sciences de la Terre	France
Philip	Allen	Imperial College London	UK
Daniel	Ames	Idaho State University	USA
Christoff	Andermann	Universite de Renness 1	France
Susan	Anderson	University of Colorado	USA
Bob	Anderson	University of Colorado	USA
Andrew	Ashton	Woods Hole Oceanographic Institution	USA
Mikael	Attal	University of Edinburgh	UK
Andreas	Baas	King's College London	UK
Matthew	Becker	California State Univ Long Beach	USA
Patrick	Belmont	University of Minnesota	USA
Maureen	Berlin	University of Colorado, INSTAAR	USA
Mike	Blum	Louisiana State University	USA
Collin	Bode	Ntl Ctr Earth-Surface Dynamics NCED	USA
Ron	Boyd	ConocoPhillips	USA
Nathan	Bradley	University of Colorado	USA
Susan	Brantley	Penn State University	USA
Michael	Bruen	University College Dublin	Ireland
Bill	Capehart	South Dakota School of Mines	USA
Comenico	Capolongo	University of Bari	Italy
Jack	Carlson	USDA Agricultural Research Service	USA
Kuo-Hsien	Chang	U. of Guelph	Canada
Dong	Chen	Desert Research Institute	USA
Yunzhen	Chen	Nanjing University	China
Gary	Clow	U.S. Geological Survey, Earth Surface Dyn	USA
Sagy	Cohen	The University of Newcastle	Australia
Rory	Dalman	Delft University of Technology	Netherlands
Philippe	Davy	CNRS / University of Rennes I	France
Christopher	Delacourt	Lab Domaines Oceanique IUEM/UBO	France
Gaetano	Di Achille	University of Colorado	USA
Bill	Dietrich	University of California - Berkeley	USA
Tom	Drake	Office of Naval Research (ONR)	USA
Jennifer	Duan	University of Arizona	USA
Michael	Ellis	British Geological Survey	UK
Jason	English	University of Colorado	USA
Tom	Farr	Jet Propulsion Lab	USA
David	Furbish	Vanderbilt University	USA
Joe	Galewsky	University of New Mexico	USA
Nicole	Gasparini	Tulane University	USA
Peter	Gijsbers	Deltares	Netherlands

Vincent	Godard	Aix-Marseille Université	France
Basil	Gomez	Indiana State University	USA
Antonio	Gonzalez Pena	INSTAAR, University of Colorado	USA
William	Goran	Army Corp of Engineers	USA
Wendy	Graham	University of Florida	USA
Laurel	Griggs Larsen	University of Colorado	USA
Jouet	Gwenael	IFREMER	France
Xujun	Han	Shenzhen Inst of Advanced Technolgy	China
Jianwei	Han	Tulane University	USA
Mark	Hannon	University of Colorado, INSTAAR	USA
John	Harrison	Washington State University	USA
Jens	Hartmann	Darmstadt University of Technology	Germany
Nick	Haycock	Haycock	U Kingdom
Rachel	Headley	University of Washington	USA
Bjoern	Heise	Christian-Albrechts-Universitat zu Kie	Germany
Michael	Hofmann	ConocoPhillips	USA
Michael	Hofmockel	Duke University/Penn State University	USA
John	Holbrook	University of Texas-Arlington	USA
Yang	Hong	University of Oklahoma	USA
Richard	Hooper	CUAHSI	USA
Alan	Howard	University of Virginia	USA
Audrey	Huerta	Penn State University	USA
Hope	Humphries	University of Colorado	USA
Eric	Hutton	University of Colorado, INSTAAR	USA
Erkan	Istanbulluoglu	University of Nebraska, Lincoln	USA
Bert	Jagers	Deltares	Netherlands
Edward	Johnson	University of Calgary	Canada
Jasmeet	Judge	University of Florida, Ctr Remote Sensing	USA
Albert	Kettner	University of Colorado	USA
David	Kinner	Western Carolina University	USA
Eric	Kirby	Penn State University	USA
Maarten	Kleinhans	Utrecht University	Netherlands
Ryan	Knox	Massachusetts inst Technology	USA
Jim	Kubicki	Penn State University	USA
Eric	Lajeunesse	Institut de Physique de Globe de Paris	France
Venkat	Lakshmi	University of South Carolina	USA
Stephen	Lancaster	Oregon State University	USA
Richard	Lane	National Science Foundation	USA
Laurel	Larsen	U.S. Geological Survey	USA
Erik	Larson	University of Colorado	USA
Suzanne	LeClair	Environnement Illimite inc.	Canada
Xu	Liang	University of Pittsburgh	USA
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Nicola	Litchfield	GNS Science	New Zealand
Mingliang	Liu	Auburn University	USA
Wei	Luo	Northern Illinois University	USA
Shawn	Marshall	University of Calgary	Canada
Yvonne	Martin	University of Calgary	Canada
Reed	Maxwell	Colorado School of Mines	USA
Emilio	Mayorga	University of Washington	USA
Scott	McCoy	University of Colorado	USA
Paul	Meijer	Utrecht University	Netherlands

Thomas	Meixner	University of Arizona	USA
Steve	Meyerhoff	Colorado School of Mines	USA
Peter	Moore	Iowa State University	USA
Mark	Morehead	Idaho Power	USA
Paul	Morin	University of Minnesota	USA
Simon	Mudd	University of Edinburgh	UK
Karthik	Nagarajan	University of Florida	USA
Diana	Nemergut	University of Colorado - Boulder	USA
Jeff	Niemann	Colorado State University	USA
Fred	Ogden	University of Wyoming	USA
Harold	Opitz	National Weather Service, NWRFC	USA
Irina	Overeem	University of Colorado, INSTAAR	USA
Chris	Paola	University of Minnesota	USA
Thanos	Papanicolaou	University of Iowa	USA
Gary	Parker	University of IL-Urbana-Champaign	USA
Murari	Paudel	Brigham Young University	USA
Scott	Peckham	University of Colorado, INSTAAR	USA
Jon	Pelletier	University of Arizona	USA
Mariela	Perignon	University of Colorado - Boulder	USA
Taylor	Perron	MIT	USA
Tad	Pfeffer	University of Colorado	USA
George	Postma	Utrecht University	Netherlands
Harihar	Rajaram	University of Colorado	United States
Jorge	Ramirez	Colorado State University	USA
Francis	Rengers	University of Colorado	USA
Pedro	Restrepo	NOAA Ntnl Weather Service	USA
Josh	Roering	University of Oregon	USA
Lucas	Ruiz	Ianigla, Unidad De Geocriologia	Argentina
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Mihaela	Ryer	ConocoPhillips	USA
James	Selegean	U.S. Army Corps of Engineers	USA
Ben	Sheets	University of Washington	USA
Rudy	Slingerland	Penn State University	USA
Kees	Sloff	Deltares and Delft University	Netherlands
PÇter	Solyom	University of West Hungary Savaria Campus	Hungary
Minwoo	Son	University of Florida	USA
John	Stamm	U.S. Geological Survey	USA
Philippe	Steer	Universite Montpellier 2	France
Rob	Stewart	University of New Hampshire	USA
Mark	Stone	Desert Research Institute	USA
David	Stonestrom	US Geological Survey	USA
Joep	Storms	Delft University of Technology	Netherlands
John	Swenson	University of Minnesota-Duluth	USA
Sean	Swenson	NCAR	USA
Christina	Tague	University of California, Santa Barbara	US
David	Tarboton	Utah State University	USA
Arnaud	Temme	Wageningen University	Netherlands
Greg	Tucker	Cooperative Ins for Res in Env Sciences	USA
Craig	Tweedie	University of Texas at El Paso	USA
Phaedra	Upton	GNS Science	New Zealand
Ronald	Van Balen	Vrije Universiteit	Netherlands
Enrica	Viparelli	University of Illinois at Urbana-Champaign	USA

Rachel	Walcott	The University of Edinburgh	Scotland
Jingfeng	Wang	University of California	USA
Carl	Watson	British Geological Survey	UK
Gert Jan	Weltje	Delft University of Technology	Netherlands
Claire	Welty	University of Maryland Baltimore County	USA
Joseph	Wheaton	Idaho State University	USA
Andrew	Wickert	University of Colorado - Boulder	USA
Peter	Wilcock	Johns Hopkins University	USA
Garry	Willgoose	The University of Newcastle	Australia
John	Williams	Colorado School of Mines	USA
Ellen	Wohl	Colorado State University	USA
Eric	Wolf	University of Colorado/LASP	USA
Wilfred	Wollheim	University of New Hampshire	USA
Theresa	Wynn	Virginia Tech	USA
Kehui	Xu	Coastal Carolina University	USA
Beichuan	Yan	University of Colorado, INSTAAR	USA
Brian	Yanites	University of Colorado - Boulder	USA
Francisco	Zucca	University of Pavia	Italy
Ilja	de Winter	Delft University of Technology	Netherlands

Education and Knowledge Transfer Working Group

First Name	Last Name	Institution	Institution
Matthew	Arsenault	U.S. Geological Survey (USGS)	USA
Juan	Baztan	Marine Sciences For Society	France
Maureen	Berlin	University of Colorado, INSTAAR	USA
Michael	Bruen	University College Dublin	Ireland
Karen	Campbell	University of Minnesota	USA
Bill	Capehart	South Dakota School of Mines	USA
Comenico	Capolongo	University of Bari	Italy
Jack	Carlson	USDA Agricultural Research Service	USA
Kuo-Hsien	Chang	U. of Guelph	Canada
Rory	Dalman	Delft University of Technology	Netherlands
Vincent	Godard	Aix-Marseille Université	France
Patrick	Hamilton	Science Museum of Minnesota	USA
Rachel	Headley	University of Washington	USA
Chris	Jenkins	University of Colorado	USA
Walker	Johnson	University of Texas at El Paso	USA
Yong	Liu	NCSA	USA
Wei	Luo	Northern Illinois University	USA
Cathy	Manduca	Carleton College	USA
Paul	Meijer	Utrecht University	Netherlands
Paul	Morin	University of Minnesota	USA
Damian	O'Grady	Exxon Mobil Company	USA
Irina	Overeem	University of Colorado, INSTAAR	USA
Chris	Paola	University of Minnesota	USA
Jon	Pelletier	University of Arizona	USA
Lincoln	Pratson	Duke University	USA
Ad	Reniers	RSMAS, University of Miami	USA
Dano	Roelvink	UNESCO-IHE	Netherlands
Kimberly	Rogers	Vanderbilt University	USA
Lucia	Ruzycki	FCEFN-UNSJ-Catedra Geologia Aplicada II	Argentina
Mihaela	Ryer	ConocoPhillips	USA

Mark	Stone	Desert Research Institute	USA
Alexey	Voinov	Chesapeake Community Modeling Program	USA
Charles	Vörösmarty	City College of NY, City Univ. of NY	USA
Carl	Watson	British Geological Survey	UK
John	Williams	Colorado School of Mines	USA
Ilja	de Winter	Delft University of Technology	Netherlands

Cyber-Infrastructure and Numerics Working Group

First Name	Last Name	Institution	Country
Philip	Allen	Imperial College London	UK
Daniel	Ames	Idaho State University	USA
Matthew	Arsenault	U.S. Geological Survey (USGS)	USA
Michael	Bruen	University College Dublin	Ireland
Bill	Capehart	South Dakota School of Mines	USA
Kristina	Clark	MUST	USA
George	Constantinescu	University of Iowa	USA
Olaf	David	Colorado State University	USA
Ewa	Deelman	University of Southern California	USA
Jay	Famiglietti	University of California, Irvine	USA
Balazs	Fekete	The City College of NY at City Univ NY	USA
Ian	Ferguson	Colorado School of Mines	USA
Efi	Foufoula-Georgiou	University of Minnesota	USA
David	Furbish	Vanderbilt University	USA
Peter	Gijsbers	Deltares	Netherlands
Antonio	Gonzalez Pena	INSTAAR, University of Colorado	USA
Jon	Goodall	University of South Carolina	USA
Didier	Granjeon	Institut Francais due Petrole	France
Brendon	Hall	ExxonMobil	USA
Gil	Hansen	BHP Billiton Petroleum	USA
Michael	Hofmockel	Duke University/Penn State University	USA
Alan	Howard	University of Virginia	USA
Eric	Hutton	University of Colorado, INSTAAR	USA
Matthias	Imhof	Exxon Mobil Company	USA
Bert	Jagers	Deltares	Netherlands
Chris	Jenkins	University of Colorado	USA
Walker	Johnson	University of Texas at El Paso	USA
Gareth	Jones	Chevron Energy Technology Company	USA
Camille	Kervazo	IUEM: Inst Universitaire Europeen de la Mer	France
Lutz	Lesshafft	Ecole Polytechnique	France
Xu	Liang	University of Pittsburgh	USA
Yong	Liu	NCSA	USA
Wei	Luo	Northern Illinois University	USA
David	Maidment	University of Texas	USA
Rafael	Manica	UFRGS, Necod/iph	Brazil
Emilio	Mayorga	University of Washington	USA
Jim	McElwaine	University of Cambridge	UK
Eckart	Meiburg	University of California, Santa Barbara	USA
Helena	Mitasova	North Carolina State University	USA
Shadi	Moqbel	Colorado School of Mines	USA
Mark	Morehead	Idaho Power	USA

Simon	Mudd	University of Edinburgh	UK
Boyana	Norris	Argonne National laboratory	USA
Damian	O'Grady	Exxon Mobil Company	USA
Rafael	Oliveira	Univ California-Santa Barbara	USA
Harold	Opitz	National Weather Service, NWRFC	USA
Scott	Peckham	University of Colorado, INSTAAR	USA
Michael	Pyrcz	Chevron Energy Technology Company	USA
Gene	Rankey	University of Kansas	USA

U.S. Academic Institutions

Twenty new U.S. Academic Institutions have joined CSDMS in 2009 (those in blue are new)

1. Arizona State University
2. Auburn University, Alabama
3. Binghamton University, New York
4. Boston University
5. Brigham Young University, Utah
6. California State University – Long Beach
7. Carleton College, Minneapolis
8. Center for Applied Coastal Research, Delaware
9. Chapman University, California
10. City College of New York, City University of New York
11. Coastal Carolina University, South Carolina
12. CRC/Chesapeake Community Modeling Program, Virginia
13. Colorado School of Mines,
14. Colorado State University
15. Columbia/LDEO, New York
16. CUAHSI, District of Columbia
17. Desert Research Institute, Nevada
18. Duke University, North Carolina
19. Florida Gulf Coast University
20. Harvard University
21. Idaho State University
22. Indiana State University
23. John Hopkins University, Maryland
24. Lamont-Doherty Earth Observatory
25. Louisiana State University
26. Massachusetts Institute of Technology
27. Monterey Bay Aquarium Research Inst.
28. North Carolina State University
29. Northern Illinois University
30. Nova Southeastern University, Florida
31. Old Dominion University, Virginia
32. Oberlin College
33. Ohio State University
34. Oregon State University
35. Penn State University
36. Rutgers University, New Jersey
37. Science Museum of Minnesota
38. Syracuse University, New York
39. Tulane University, New Orleans
40. University of Alaska Fairbanks
41. University of Arizona
42. University of California - San Diego
43. University of California - Berkeley
44. University of California - Irvine
45. University of California -Santa Barbara
46. University of Colorado - Boulder
47. University of Connecticut
48. University of Florida
49. University of IL-Urbana-Champaign
50. University of Iowa
51. University of Maryland
52. University of Miami
53. University of Minnesota
54. University of Minnesota-Duluth
55. University of Nebraska, Lincoln
56. University of New Hampshire
57. University of New Mexico
58. University of North Carolina
59. University of Oregon
60. University of Rhode Island
61. University of South Carolina
62. University of South Florida
63. University of Southern California
64. University of Texas-Austin
65. University of Texas at El Paso
66. University of Texas-Arlington
67. University of Virginia
68. University of Washington
69. University of Wyoming
70. Utah State University
71. Vanderbilt University
72. Virginia Institute of Marine Science (VIMS)
73. Washington State University
74. Western Carolina University
75. William & Mary
76. Woods Hole Oceanographic Inst.

U.S. Federal Labs and Agencies

Many government departments and agencies have filed official letters of commitment for the CSDMS initiative and its mission and CSDMS has established an Interagency Committee. Their collaboration for the CSDMS effort varies from financial support to in-kind support to collaborative research. These departments and agencies offer partnership via the participation of representatives in the various committees and working groups operating within CSDMS. Participating agencies includes:

1. The National Science Foundation (NSF)
2. U.S. Office of Naval Research (ONR),
3. U.S. Army Corps of Engineers (ACE),
4. U.S. Army Research Office (ARO),
5. U.S. Geological Survey (USGS),
6. National Aeronautics and Space Administration (NASA),
7. National Oceanic and Atmospheric Administration (NOAA),
8. National Oceanographic Partnership Program (NOPP),
9. Idaho National Laboratory (IDL).
10. National Park Service (NPS)
11. National Forest Service (NFS)
12. U.S. Dept of Agriculture (USDA)
13. Argonne National Laboratory (ANL),
14. National Weather Service (NWRFC),
15. Naval Research Laboratory (NRL),
16. National Center for Atmospheric Research (NCAR),
17. U.S. Nuclear Regulatory Commission (NRC)

Foreign Membership

This category has grown substantively to 63 in 2009 (from 28 in 2008 with new additions shown in blue).

1. FCEFN-UNSJ-Catedra Geologia Aplicada II, Argentina
2. IANIGLA, Unidad de Geocriologia, Argentina
3. The University of Sydney Institute of Marine Science, Australia
4. The University of Newcastle, Australia
5. Federal University of Itajuba, Brazil
6. UFRGS, Brazil
7. Bedford Institute of Oceanography, Canada
8. Geological Survey of Canada, Pacific
9. University of Calgary, Canada
10. Environnement Illimite Inc., Canada
11. McGill University, Canada
12. University of Calgary, Canada
13. University of Guelph, Canada
14. Nanjing University, China
15. Shenzhen Inst. of Advanced Technology, China
16. University of Copenhagen, Denmark
17. CNRS / University of Rennes I, France
18. IFREMER, France
19. Institut Francais du Petrole (IFP), France
20. Universite Bordeaux 1, France
21. Aix-Marseille University, France
22. Cambridge Carbonates, Ltd., France
23. CETMEF/LGCE, France
24. Ecole Polytechnique, France
25. Institut de Physique de Globe de Paris, France
26. IUEM: Institut Univ. Europeen de la Mer, France
27. Lab Domaines Oceanique IUEM/UBO France
28. Laboratoire de Sciences de la Terre, France
29. Marine Sciences For Society, France
30. Universite Bordeaux 1, France
31. Universite Montpellier 2, France
32. University of Brest, France
33. Darmstadt University of Technology, Germany
34. Christian-Albrechts-Universitat zu Kie, Germany
35. University of West Hungary - Savaria Campus, Hungary
36. University College Dublin, Ireland
37. University of Padova, Italy
38. Padua University, Italy
39. University of Bari, Italy
40. University of Rome "LaSapienza", Italy
41. Geological Survey of Japan
42. JAMSTEC, Japan
43. Delft University of Technology, Netherlands
44. Deltares, Netherlands
45. UNESCO-IHE, Netherlands
46. Utrecht University, Netherlands
47. Vrije Universiteit, Netherlands

48. Wageningen University, Netherlands
49. WL Delft Hydraulics Lab, Netherlands
50. ASR Ltd., New Zealand
51. GNS Science, New Zealand
52. National Institute of Water and Atmosphere (NIWA), New Zealand
53. University of Bergen, Norway
54. Geological Survey of Canada (Atlantic), Nova Scotia
55. University of Edinburgh, Scotland
56. BG Energy Holdings Ltd., UK
57. BG Group, UK
58. British Geological Survey, UK
59. Imperial College of London, UK
60. King's College London, UK
61. University of Bristol, UK
62. University of Cambridge, UK
63. University of Exeter, 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, 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.

Appendix 2. CSDMS Model Repository

5.1 Terrestrial

Program Description Developer

(1) ADI-2D, Advection Diffusion Implicit (ADI) method for solving 2D diffusion equation, Pelletier, Jon
(2) Alpine3D, 3D model of alpine surface processes, Bavay, Mathias
(3) AquaTellUs, Fluvial-dominated delta sedimentation model, Overeem, Irina
(4) Avulsion, Stream avulsion model, Hutton, Eric
(5) BEDLOAD, Bedload transport model, Slingerland, Rudy
(6) Bedrock Erosion Model, Knickpoint propagation in the 2D sediment-flux-driven bedrock erosion model, Pelletier, Jon
(7) CAM-CARMA, A GCM for Titan that incorporates aerosols, Larson, Eric
(8) CASCADE, Large scale SPM based on irregular spatial discretization, Braun, Jean
(9) CHILD, Landscape Evolution Model, Tucker, Greg
(10) Caesar, Cellular landscape evolution model, Coulthard, Tom
(11) CellularFanDelta, Coarse-grained delta dynamics and stratigraphy, Wolinsky, Matthew
(12) ChannelOscillation, Simulates Oscillations in arid alluvial channels, Pelletier, Jon
(13) CosmoLand, 2-D model tracking cosmogenic nuclides and mixing in landslide terrain, Yanites, Brian
(14) Coupled1D, Coupled 1D bedrock-alluvial channel evolution, Pelletier, Jon
(15) DECAL, Aeolian dune landscape model, Baas, Andreas
(16) DHSVM, DHSVM is a distributed hydrologic model that explicitly represents the effects of topography and vegetation on water fluxes through the landscape., DHSVM, Administrator
(17) DR3M, Distributed Routing Rainfall-Runoff Model--version II, U.S., Geological Survey
(18) Delft3D, 3D hydrodynamic and sediment transport model, Delft3D, Support
(19) ENTRAIN, Simulates critical shear stress of median grain sizes, Slingerland, Rudy
(20) ENTRAINH, Simulates critical shields theta for median grain sizes, Slingerland, Rudy
(21) Eolian Dune Model, Werner's model for eolian dune formation and evolution, Pelletier, Jon
(22) Erode, Fluvial landscape evolution model, Peckham, Scott
(23) FLDTA, Simulates flow characteristics based on gradually varied flow equation, Slingerland, Rudy
(24) FTCS1D-NonLinear, Forward Time Centered Space (FTCS) method for 1D nonlinear diffusion equation, Pelletier, Jon
(25) FTCS2D, Forward Time Centered Space (FTCS) method for 2D diffusion equation, Pelletier, Jon
(26) FTCS2D-TerraceDiffusion, Forward Time Centered Space (FTCS) method for 2D Terrace diffusion, Pelletier, Jon
(27) FillinPitsFlatsDEM, Filling in pits and flats in a DEM, Pelletier, Jon
(28) Flex1D, Fourier filtering in 1D while solving the flexure equation, Pelletier, Jon
(29) Flex2D, Fourier filtering in 2D while solving the flexure equation, Pelletier, Jon
(30) Flex2D-ADI, Solving the flexure equation applying Advection Diffusion Implicit (ADI) method, Pelletier, Jon
(31) Fourier-Bessel integration, Numerical integration of Fourier-Bessel terms, Pelletier, Jon
(32) FractionalNoises1D, 1D fractional-noise generation with Fourier-filtering method, Pelletier, Jon
(33) FractionalNoises2D, 2D Gaussian fractional-noise generation with Fourier-filtering method, Pelletier, Jon
(34) GEOtop, Distributed hydrological model, water and energy budgets, Rigon, Riccardo
(35) GNE, Set of biogeochemical sub-models that predicts river export, Seitzinger, Sybil
(36) GOLEM, Landscape evolution model, Tucker, Greg
(37) GSSHA, Coupled distributed engineering hydrology, sediment, contaminant fate/transport, Ogden, Fred
(38) Gc2d, Glacier / ice sheet evolution model, Kessler, Mark
(39) HSPF, a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants, Bicknell, Bob
(40) HydroTrend, Climate driven hydrological transport model, Kettner, Albert
(41) Ice-sheet / Glacier reconstruction, Sandpile method for ice-sheet and glacier reconstruction, Pelletier, Jon
(42) Iceages, Stochastic-resonance subroutine of Pleistocene ice ages, Pelletier, Jon
(43) LITHFLEX1, Lithospheric flexure solution, Furlong, Kevin
(44) LITHFLEX2, Lithospheric flexure solution for a broken plate, Furlong, Kevin
(45) LOADEST, Software for estimating constituent loads in streams and rivers, Runkel, Rob
(46) LOGDIST, Logrithmic velocity distribution solution, Slingerland, Rudy
(47) LONGPRO, Dynamic evolution of longitudinal profiles, Slingerland, Rudy
(48) Lake-Permafrost with Subsidence, 1-D lake-permafrost thermal model with subsidence., Matell, Nora

(49) LavaFlow2D, 2D radially symmetric lava flow model, Pelletier, Jon
(50) MARSSIM, Landform evolution model, Howard, Alan
(51) MFDrouting, Multiple Flow Direction (MFD) flow routing method, Pelletier, Jon
(52) MFDrouting-Successive, Successive flow routing with Multiple Flow Direction (MFD) method, Pelletier, Jon
(53) MIDAS, Coupled flow- heterogeneous sediment routing model, Slingerland, Rudy
(54) MODFLOW, MODFLOW is a three-dimensional finite-difference ground-water model, Barlow, Paul
(55) ParFlow, Parallel, high-performance, integrated watershed model, Maxwell, Reed
(56) Pllcart3d, 3D numerical simulation of confined miscible flows, Oliveira, Rafael
(57) QUAL2K, A Modeling Framework for Simulating River and Stream Water Quality, Chapra, Steve
(58) RHESSys, Regional Hydro-Ecologic Simulation System, Tague, christina
(59) SETTLE, Partical settling velocity solution, Slingerland, Rudy
(60) SIBERIA, SIBERIA simulates the evolution of landscapes under the action of runoff and erosion over long times scales., Willgoose, Garry
(61) SPARROW, The SPARROW Surface Water-Quality Model, Alexander, Richard
(62) SUSP, Suspended load transport subroutine, Slingerland, Rudy
(63) SVELA, Shear velocity solution associated with grain roughness, Slingerland, Rudy
(64) SWAT, SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds., Arnold, Jeff
(65) SWMM, Storm Water Management Model, Rossman, Lewis
(66) SimClast, basin-scale 3D stratigraphic model, Dalman, Rory
(67) Spirals1D, 1D model of spiral troughs on Mars, Pelletier, Jon
(68) StreamPower, Modeling the development of topographic steady state in the stream-power model, Pelletier, Jon
(69) Subside, Flexure model, Hutton, Eric
(70) TOPMODEL, Physically based, distributed watershed model that simulates hydrologic fluxes of water through a watershed, Beven, Keith
(71) TOPOG, TOPOG is a terrain analysis-based hydrologic modelling package, Silberstein, Richard
(72) TUGS, Fluvial gravel and sand transport model, Cui, Yantao
(73) TURB, Gausian distribution calculator of instantaneous shear stresses on the fluvial bed, Slingerland, Rudy
(74) TopoFlow, Hydrological model, Peckham, Scott
(75) TreeThrow, Sediment transport by tree throw on hillslopes, Kirwan, Matthew
(76) WACCM-CARMA, atmospheric/aerosol microphysical model, English, Jason
(77) WACCM-EE, GCM for deep paleoclimate studies, Wolf, Eric
(78) WASH123D, Watershed Model, River Hydraulics, Overland Flow, Subsurface Flow, Sediment Transport, Water Quality Transport, Yeh, Gour-Tsyh (George)
(79) WBM/WTM, Water Balance/Transport Model, Fekete, Balazs
(80) WEPP, Process-based soil erosion by water at field/farm scale, Flanagan, Dennis
(81) WILSIM, Landscape evolution model, Luo, Wei
(82) WRF, Weather Research and Forecasting Model, Skamarock, Bill
(83) YANG's routine, Fluvial sediment transport model, Slingerland, Rudy
(84) Zscape, A simple parallel code to demonstrate diffusion, Connor, Chuck

5.2 Coastal

Program Description Developer
(1) 2DFLOWVEL, Tidal & wind-driven coastal circulation routine, Slingerland, Rudy
(2) ADCIRC, Coastal Circulation and Storm Surge Model, Luettich, Rick
(3) AquaTellUs, Fluvial-dominated delta sedimentation model, Overeem, Irina
(4) BITM, Barrier Island Translation model, Masetti, Riccardo
(5) BTLESS, Regional Ecological Model for Coastal Wetlands, Reyes, Enrique
(6) BarSim, simulates cross shore coastal respons at millenium scale, Storms, Joep
(7) CBIRM, Coupled Barrier Island-Resort Model, McNamara, Dylan
(8) CELLS, Landscape simulation model, Sklar, Fred
(9) CEM, Coastal evolution model, Murray, A. Brad
(10) CMFT model, Coupled salt Marsh - tidal Flat Transect model, Mariotti, Giulio
(11) CSt ASMITA, Aggregate scale morphodynamic model of integrated coastal systems, Niedoroda, Alan
(12) Carbonate GPM, Carbonate deposition module for GPM, Hill, Jon

(13) CellularFanDelta, Coarse-grained delta dynamics and stratigraphy, Wolinsky, Matthew
(14) D'Alpaos model, Tidal network and marsh model, D'Alpaos, Andrea
(15) DECAL, Aeolian dune landscape model, Baas, Andreas
(16) DELTA, Simulates circulation and sedimentation in a 2D turbulent plane jet and resulting delta growth, Slingerland, Rudy
(17) Delft3D, 3D hydrodynamic and sediment transport model, Delft3D, Support
(18) DeltaSIM, Process-response model simulating the evolution and stratigraphy of fluvial dominated deltaic systems, Hoogendoorn, Bob
(19) FUNWAVE, Fully Nonlinear Boussinesq Wave Model, Kirby, Jim
(20) FVCOM, The Unstructured Grid Finite Volume Coastal Ocean Model, Chen, Changsheng
(21) FluidMud, Wave-phase resolving numerical model for fluid mud transport, Hsu, Tian-Jian
(22) GENESIS, GENEralized model for SImulating Shoreline change, Gravens, Mark
(23) GNE, Set of biogeochemical sub-models that predicts river export, Seitzinger, Sybil
(24) Hyper, 2D Turbidity Current model, Imran, Jasim
(25) Inflow, Steady-state hyperpycnal flow model, Hutton, Eric
(26) Kirwan marsh model, Ecomorphoydamic model of marsh elevation and channel evolution, Kirwan, Matthew
(27) LITHFLEX1, Lithospheric flexure solution, Furlong, Kevin
(28) LITHFLEX2, Lithospheric flexure solution for a broken plate, Furlong, Kevin
(29) LOADEST, Software for estimating constituent loads in streams and rivers, Runkel, Rob
(30) MARSSIM, Landform evolution model, Howard, Alan
(31) Marsh column model, Simulates sediment, roots and carbon accumulating in a 1D marsh profile., Mudd, Simon
(32) NearCoM, Nearshore Community Model, Kirby, James
(33) Physprop, Calculates the acoustic values based on physical properties, Pratson, Lincoln
(34) Plume, Hypopycnal sediment plume, Hutton, Eric
(35) Point-Tidal-flat, Point Model for Tidal Flat Evolution model, Fagherazzi, Sergio
(36) QDSSM, Quantitative Dynamic Sequence Stratigraphic Model, Postma, George
(37) RCPWAVE, Regional Coastal Processes Wave Model, Gravens, Mark
(38) REF-DIF, Phase-resolving parabolic refraction-diffraction model for ocean surface wave propagation., Kirby, James
(39) SBEACH, Numerical Model for Simulating Storm-Induce Beach Change, Gravens, Mark
(40) SEOM, Spectral Element Ocean Model, Haidvogel, Dale
(41) SIMSAFADIM, Finite element model for fluid flow, clastic, carbonate and evaporate sedimentation, Bitzer, Klaus
(42) STORM, Windfield simulator for a cyclone, Slingerland, Rudy
(43) STVENANT, 1D gradually varied flow routine, Slingerland, Rudy
(44) STWAVE, Steady-State Spectral Wave Model, Smith, Jane
(45) SWAN, SWAN is a third-generation wave model, SWAN, Team
(46) Sakura, 3 Equation hyperpycnal flow model, Kubo, Yusuke
(47) SedBerg, An iceberg drift and melt model, developed to simulate sedimentation in high-latitude glaciated fjords., Mugford, Ruth
(48) SedPlume, meltwater plume model, Mugford, Ruth
(49) Sedflux, Basin filling stratigraphic model, Hutton, Eric
(50) Sedsim, Sedimentary process modeling software, Griffiths, Cedric
(51) Shoreline, Coastal evolution model, Peckham, Scott
(52) SimClast, basin-scale 3D stratigraphic model, Dalman, Rory
(53) Subside, Flexure model, Hutton, Eric
(54) WAVE REF, Wave refraction routine, Slingerland, Rudy
(55) WAVEWATCH III ^TM, Spectral wind wave model, Tolman, Hendrik
(56) WINDSEA, Deep water significant wave height and period simulator during a hurricane routine, Slingerland, Rudy
(57) WSGFAM, Wave and current supported sediment gravity flow model, Friedrichs, Carl
(58) WWTM, The WWTD (Wind Wave Tidal Model) has been developed to describe hydrodynamic and wind-wave generation and propagation within shallow tidal environments, Carniello, Luca
(59) XBeach, Wave propagation sediment transport model, Roelvink, Dano

5.3 Marine

Program , Description , Developer

(1) BarSim, simulates cross shore coastal respons at millenium scale, Storms, Joep
(2) Bing, Submarine debris flows, Hutton, Eric

(3) Bio, Biogenic mixing of marine sediments, Hutton, Eric
(4) CSt ASMITA, Aggregate scale morphodynamic model of integrated coastal systems, Niedoroda, Alan
(5) Carbonate GPM, Carbonate deposition module for GPM, Hill, Jon
(6) Compact, Sediment compaction, Hutton, Eric
(7) Delft3D, 3D hydrodynamic and sediment transport model, Delft3D, Support
(8) Diffusion, Diffusion of marine sediments due to waves, bioturbation, Hutton, Eric
(9) FVCOM, The Unstructured Grid Finite Volume Coastal Ocean Model, Chen, Changsheng
(10) FanBuilder, Process-based stratigraphic evolution of turbidite fans model, Groenenberg, Remco
(11) Gvg3Dp, 3D Numerical Simulation of Turbidity Currents, Nasr Azadani, Mohamad Mehdi
(12) Hyper, 2D Turbidity Current model, Imran, Jasim
(13) Inflow, Steady-state hyperpycnal flow model, Hutton, Eric
(14) LITHFLEX1, Lithospheric flexure solution, Furlong, Kevin
(15) LITHFLEX2, Lithospheric flexure solution for a broken plate, Furlong, Kevin
(16) MITgcm, The MITgcm (MIT General Circulation Model) is a numerical model designed for study of the atmosphere, ocean, and climate., Lovenduski, Nicole
(17) Physprop, Calculates the acoustic values based on physical properties, Pratson, Lincoln
(18) Plume, Hypopycnal sediment plume, Hutton, Eric
(19) Princeton Ocean Model (POM), POM: Sigma coordinate coastal & basin circulation model, Ezer, Tal
(20) ROMS, Regional Ocean Modeling System, Arango, Hernan G.
(21) SEDPAK, Models the sedimentary fill of basins, Kendall, Christopher
(22) SEOM, Spectral Element Ocean Model, Haidvogel, Dale
(23) SIMSAFADIM, Finite element model for fluid flow, clastic, carbonate and evaporate sedimentation, Bitzer, Klaus
(24) Sakura, 3 Equation hyperpycnal flow model, Kubo, Yusuke
(25) Sedflux, Basin filling stratigraphic model, Hutton, Eric
(26) Sedsim, Sedimentary process modeling software, Griffiths, Cedric
(27) Sedtrans05, Sediment transport model for continental shelf and estuaries, Neumeier, Urs
(28) SimClast, basin-scale 3D stratigraphic model, Dalman, Rory
(29) Subside, Flexure model, Hutton, Eric
(30) Symphonie, 3D primitive equation ocean model, Marsaleix, Patrick
(31) WAVEWATCH III ^TM, Spectral wind wave model, Tolman, Hendrik
(32) WSGFAM, Wave and current supported sediment gravity flow model, Friedrichs, Carl

5.4 Hydrology

Program , Description , Developer
(1) Avulsion, Stream avulsion model, Hutton, Eric
(2) ChannelOscillation, Simulates Oscillations in arid alluvial channels, Pelletier, Jon
(3) DHSVM, DHSVM is a distributed hydrologic model that explicitly represents the effects of topography and vegetation on water fluxes through the landscape., DHSVM, Administrator
(4) DR3M, Distributed Routing Rainfall-Runoff Model--version II, U.S., Geological Survey
(5) FLDTA, Simulates flow characteristics based on gradually varied flow equation, Slingerland, Rudy
(6) GEOtop, Distributed hydrological model, water and energy budgets, Rigon, Riccardo
(7) HSPF, a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants, Bicknell, Bob
(8) HydroTrend, Climate driven hydrological transport model, Kettner, Albert
(9) MFDrouting, Multiple Flow Direction (MFD) flow routing method, Pelletier, Jon
(10) MFDrouting-Successive, Successive flow routing with Multiple Flow Direction (MFD) method, Pelletier, Jon
(11) MODFLOW, MODFLOW is a three-dimensional finite-difference ground-water model, Barlow, Paul
(12) PIHM, PIHM is a multiprocess, multi-scale hydrologic model., Duffy, Christopher
(13) PIHMgis, Tightly coupled GIS interface for the Penn State Integrated Hydrologic Model, Duffy, Christopher
(14) ParFlow, Parallel, high-performance, integrated watershed model, Maxwell, Reed
(15) Pllcart3d, 3D numerical simulation of confined miscible flows, Oliveira, Rafael
(16) RHESSys, Regional Hydro-Ecologic Simulation System, Tague, christina
(17) SPARROW, The SPARROW Surface Water-Quality Model, Alexander, Richard
(18) SWAT, SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds., Arnold, Jeff

(19) SWMM, Storm Water Management Model, Rossman, Lewis
(20) TOPMODEL, Physically based, distributed watershed model that simulates hydrologic fluxes of water through a watershed, Beven, Keith
(21) TOPOG, TOPOG is a terrain analysis-based hydrologic modelling package, Silberstein, Richard
(22) TopoFlow, Hydrological model, Peckham, Scott
(23) VIC, VIC (Variable Infiltration Capacity) is a macroscale hydrologic model that solves full water and energy balances, originally developed by Xu Liang at the University of Washington., Lettenmaier, Dennis
(24) WASH123D, Watershed Model, River Hydraulics, Overland Flow, Subsurface Flow, Sediment Transport, Water Quality Transport, Yeh, Gour-Tsyh (George)
(25) WBM/WTM, Water Balance/Transport Model, Fekete, Balazs
(26) WEPP, Process-based soil erosion by water at field/farm scale, Flanagan, Dennis

Appendix 3. Working & Focus Research Group Goals Oct-Nov 2009

CARBONATE

Carbonate FRG Goals 2010:

- Continue to expand membership
- Develop Workbench…
- Create a CSDMS driver for carbonates - in progress
- Create a carbonates GUI in Caffeine – in progress
- Write pseudo code outlines for selected modules OR import some existing code – simple code imported
- Decide which SedFlux routines to adopt – in progress
- Make choices on suitable population models – in progress
- Begin to define database structure and content – in progress
- Working prototype with a few modules ready for meeting Oct 2010??

What carbonate properties should SedGrid store and how?

The hypothetical cell: [Aa 0.05; Ag 0.90; At 0.05]
The hypothetical cemented cell: [Aa 0.05; Ag 0.80; At 0.05; Bd 0.10]

Transport dictionary	Aa	…	Ag	…	At	…	Bd	…
Transportable	Yes		Yes		No		No	
Grain size (mm)	2mm		10mm		Null		Null	
Bulk density (gcm^{-3})	2.1		2.2		Null		Null	
Grain shape??	Messy		Spherical		Null		Null	

Production dictionary	Aa	…	Ag	…	At	…	Bd	…
Name	Coral X		Grainwithnoname		Seagrass		Cement	
Hardness	Skeletal		Skeletal		Soft		Null	
Feeding habit	Filter		Mobile carnivore		Photosynth		Null	
Trophic Type	Pred, sessile		Pred, mobile		Primary		Null	
Trophic level	5		7		1		Null	
Ingestion size	Large		Large		Small		Null	
Temp range	21-27		16-27		15-27		Null	
Salinity range							Null	
Mineralogy	Aragonite		Calcite		Aragonite		Aragonite	

Roughness dictionary	Aa	…	Ag	…	At	…	Bd	…
Roughness	Rough		Smooth		Rough		Smooth	
Form	Upstanding						Flat	
Bafflement	Some				Lots		None	
Form drag	2.1							

MARINE

Marine Working Group Short-term Goals/Priorities:

1. Development of SedGrid to support a range of marine and coastal/terrestrial modeling projects. [Basically stripping out the bookkeeping part of SedFlux that tracks sediment properties for each grid cell.]
2. Addition of a 2D, depth-averaged gravity flow models (turbidity currents and debris flows) to CSDMS. 2D failure criteria is also needed.
3. Create searchable model database.
4. IRF and link SedFlux components with SedGrid. [Essentially recreate SedFlux from a series of modules using the CSDMS framework.]

Marine Working Group Intermediate-term goals:

- Continue to populate the marine component of CSDMS with a core set of high-priority models that have been documented and evaluated.
- Implementation of one or more proof-of-concept projects linking marine modules (e.g. Friedrichs & Wiberg proposal to NSF for "Developing a Quantitative Understanding of Mud Dispersal Across and Along a Suite of Continental Shelves")
- Develop a method for generating gridded and/or time series input data needed to run the models in CSDMS (e.g., SST, wind speed & direction, tides, waves, river mouth discharge, sediment characteristics of seafloor)
- Bring into CSDMS compliance at least one circulation and wave model (e.g. ROMS and SWAN or WWIII)

Marine Working Group Long-term goals:

- Implementation of one or more proof-of-concept projects that extend beyond the marine realm and/or involve 2-way coupling.
- Assure that CSDMS has a toolbox of marine models that will serve the needs of research, education and management users.

COASTAL & TERRESTRIAL

Coastal and Terrestrial subgroup reports

1. Sed record: External (Milankovitch) forcing or internal dynamics?

- How is an external signal as it is filtered through transport systems that lead to the sedimentary record?
- What kinds of signals are generated by the system?
- Are there distinctive fingerprints that we can use to discern which of the two (autogenic, allogenic) alternatives is occuring?
- Model Components
    - Reservoirs for input of material
    - Bedrock (weathering law, f(climate input))
- Regolith (hillslope transport law: lin/nonlin diffusive creep)
    - Alluvial sediment transport (send material through system through transport laws, f(Q = discharge), channel geometry; Q = f(climate))
    - Deltaic processes (can deposit here, or bypass)
    - Final marine depositional record (final resting place, anything corresponds to climate signal?)
- Test case (Green River Formation/Basin)
    - Spans several cycles of orbital variations – 10-100 ka climate variability (deposited between 50 and 40 Ma, classic interpretation = Milankovitch forcing)
- Goals
    - See if autogenic processes can serve to filter signals in a way that produces a cyclic stratigraphy
    - Is an external climate forcing necessary for cyclic stratigraphy?
- CSDMS models
    - SEDFLUX could handle some parts of this problem already
    - Need new models to handle other components

2. Human influences on deltas

    1. Changes in water (Q) and sediment flux (Q_s)
    2. Avulsion dynamics and channel stabilization
        - Levee dynamics and avulsion: turn off avulsions and see how areas of the delta that are starved of Q, Q_S, respond
        - This response can be viewed with a marsh model
    3. Consider tidal channels as well
    4. Subsidence
    5. Storm surge (wave influence, etc.)

6. Human dynamics
    - Human influences on the system
    - Human response to the changing deltaic system (management strategies)

3. Orographic Asymmetry: Does it matter to stay true to the hydrograph?

- Merge orographic asymmetry with landscape evolution
- Questions about:
    - Magnitude and frequency of events
    - Spatial and temporal variability and precip: upscaling problem. Does it matter, or does it average out?
    - Where can we find natural experiments to figure out importance of meteorology and hydrology
- Simple hydrographic model to stay true to hydrograph pattern
- Hawaii provides a nice natural experiments (b/c of prevailing winds and high topography)
- Simple solution: see differences in landscape after multiple runs of CHILD with multiple meteorological inputs
    - Calculate an erosional field from 1000 storms and then use that for the next ka.
    - Distill complex storm code via a multiple regression analysis, and use as input

4. Proof-of-concept coupling. TopoFlow and GC2D coupling applied to science questions. SEDIBUD group has interest in applying this combination of models to their field hypothesis and data. Two groups are interested: Achim Beylich, Western Norway valley glaciers, John Orwin, Godfrey River and glacier, New Zealand. Both sites are relatively well-monitored for climatology, discharge and sediment fluxes.

5. Permafrost-modulated arctic landscape evolution [Doug Jerolmack, Andrew Ashton, Liviu Gosian, Scott Peckham, Andy Wickert]. The mechanics of hydrologic and geomorphic processes in the arctic are modulated by temperature-dependent permafrost dynamics. When groundwater is frozen, permafrost adds a large amount of cohesion to the landscape and stabilizes it. As permafrost melts, a loss of cohesion is mechanistically linked to an increase in water flux: as the resistor to landscape evolution weakens, a driver for landscape evolution emerges. Modeling such a system would be possible within CSDMS framework. In order to do this, we would need to understand heat inputs, heat distribution, the effect of that heat on the permafrost and melt/thaw processes, and the resulting hydrologic processes. Water flux and weakening of the substrate would lead to erosion and landscape evolution (though we ignore slumping for the simplest test case described here). Landscape change would then feed back into the melting processes by modifying the topography, which would direct groundwater flow paths and define the amount of solar radiation received per unit volume of material. Jerolmack and others are engaged in fieldwork at the Baldwin Peninsula near Kotzebue, Northwest Alaska, on the Arctic Circle. There, they are collecting repeat topographic surveys of channel head cuts, channel long profiles, and channel cross-sectional profiles. This data set includes both north- and south- facing channel systems, with channels on south face evolving more quickly. Their data on the evolution of the channels with time can be linked to observations of insolation to ground-truth the models. In list form, our modeling strategy is:

1. Topography (either prescribed starting topography or topography resulting from previous run of model)
2. Radiation model (from TopoFlow) ⇨ Heat flux to surface (as f(topography) due to aspect) ⇨ Thermal model via thermodynamics of water and sediment
3. Thermal model via thermodynamics of water and sediment ⇨ Temperature field and spatial distribution of ice and melt
4. Spatial distribution of ice and melt g groundwater flow model solution using specified hydraulic conductivity (or modeled, as a function of melt fraction)
5. Groundwater flow solution g Groundwater flow rate and direction at seepage face (TopoFlow) ⇨ Constitutive relation between water flux and erosion rate, calibrated to erosion survey data
6. Back to beginning and repeat

COASTAL

Link CEM to SedFlux3D, to explore the interesting 2-way couplings that are likely to emerge when dynamic avulsions are then linked in. This will not require Child or HydroTrend to give time-varying sediment input. Instead, this work will focus on the more basic (non-site-specific) questions about how fluvial processes (avulsion frequencies, locations, for example) are affected by coastal processes (i.e. alongshore transport). The CSDMS IF would focus on the linking of the three models (CEM, SedFlux, and the unnamed avulsion model) and the working group members on the science that is done as a result of the linking.

CHESAPEAKE

Short term:

- Recognize the Chesapeake FRG to be the academic research arm of the Chesapeake Community Modeling Program.
- Populate the Chesapeake FRG pages with existing open-source Chesapeake Bay region models.
- List publications which have used these models.
- Post links to freely available model forcing data, such as bathymetry, wind, runoff, etc.
- Pursue avenues for group proposals including funding for full-time of nearly full-time Chesapeake FRG oriented personnel, such as a dedicated post-doc.
- Give priority to Chesapeake FRG related projects which focus on models with management implications, such as land use, water quality, ecosystem function, storm surge, etc.

Intermediate term:

- Implement a version of ROMs for the Chesapeake Bay at CSDMS in IRF format. Promising candidates include CHIMP and/or ChesROMS.
- Implement the EPA/NOAA Chesapeake Bay models at CSDMS in IRF format.
- Post key common forcing data sets at CSDMS.

Long term:

- Implement additional distinct, swappable land use models, hydrodynamic models, water quality models, ecosystem models, etc., in IRF format at CSDMS.
- Utilize CSDMS to make side-by-side comparisons of model performance and differences in output by systematically swapping model components.
- Utilize CSDMS to perform ensemble modeling (i.e., using multiple distinct models) of future Chesapeake environmental conditions under various management scenarios.

EKT

- Stakeholder groups of EKT are: (1) potential model developers (grad students) and (2) undergraduates
- Identify how faculty members in CSDMS are already using modeling or model simulations in their courses, and offer best practices (like a template) for future integrating of their curriculum with CSDMS.
- Hari plans to set up a CU graduate level course on Earth System Modeling in Fall of 2010 that includes data mining, advanced hydrologic modeling, and coupled to ecological, geomorphological and stratigraphic modeling. CSDMS scientists, EKT specialist and faculty can contribute to the design of the curriculum and teach certain modules, advertize this within the CSDMS community and (perhaps later offering as a short CSDMS course, or an add-on to a professional meeting.
- Make an inventory of Earth Surface Dynamics Modeling courses that CSDMS members are teaching now, and how they use models within their courses at different levels (e.g. general natural sciences, or climate change courses, versus more advanced courses e.g. in numerical methods, fluid dynamics modeling, geomorphological modeling. What ca we learn from their courses; what are common elements, and would they share.

- To target general public or K12 education scenario modeling has been identified as an appropriate level of complexity: having a case study or applied problem will make modeling more attractive; use perhaps a GIS tool. Two concrete examples: scenarios that explore arctic coastal erosion (vary temperature, etc.), impacts of humans on delta evolution.
- Important to pair models with real-world data or movies of physical experiments; also, it's beneficial to make models interactive rather than flat.
- Promote web-based simulations like WILSIM, esp. for industry/student workshops.
- Special issue of Computers and Geoscience illustrating use of CSDMS. Coupling of models with the cyberinfrastructure that we've created.
- Provide 'Help' to componentized models. The newly developed CaffeineGUI allows pop-ups of detailed documentation. Each component needs explanation of basic underlying theory, input parameters and references to key papers.

CYBER

- Identify one or two prototype applications where we couple different computational models, in order to address a physical problem of interest that cannot be handled by one model alone. One potential candidate in this regard is to couple a RANS-type turbidity current model to a ROMS-type ocean model. This would allow us to study the coupled dynamics of turbidity currents influenced by internal waves, alongshore flows and other mechanisms. This coupling needs to be investigated in detail, in order to check what kind of errors can occur, how to avoid them, how to ensure convergence, how to couple phenonema effectively that cover a range of different temporal and spatial scales etc.
- Coupling more computational models to the Caffeine GUI interface. Here Reed Maxwell will work on coupling his ParFlow model to Caffeine.
- Finally, we hope to make progress towards ensuring the participation of a stable 'core group' of participants at our future group meetings. (Good progress in that regard during the last meeting.)
- Constantinescu submit a join proposal for gravity currents through vegetation, river and coastal ecology (so through a kelp forest). Couple this scientific proposal with substantial educational component. Educational component: show high school kids how science can provide answers; expose them to models. Also grad and undergrad education.
- Irina pointed out that EKT LHF would be to do a survey of how teaching faculty use models. Beneficial to gather that material and see how some of it could be an online course or a short course.

HYDROLOGY

- Technical priority: couple csdms to CUAHSI (with links to data calibration, inverse modeling)
- Natural hazards: couple topoflow to LEM. But, a faster time scale mass movement model might be more relevant.
- Go through model archive—are we comfortable with scope of models; are all bases covered? This should be achievable in the short term.
- Pursue groundwater ground motion model (Jay's animation)
- Educational use of TopoFlow—should be a GUI analogous to WILSIM.
- Proposal ideas: mountain to sea; water and sediment transport modeling suite
- Coupling of a distributed hydrologic model and an erosion model -no one wanted to take ownership at this time. This could have a time scale disparity though. Need models to operate on same time scales.
- Proposal: Continental scale sediment and nutrient transport modeling (relates to Jay's research)
- Componentize a dam-break model.
- Scott mentioned plant-specific model to track vegetation change in Panama.
- Mention of fire and hydrology modeling
- Active members: John Goodall, Larry Murdock. Involve an ecohydrologist.