



CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

FIVE-YEAR STRATEGIC PLAN
APRIL 1, 2008 TO MARCH 31, 2013

NSF COOPERATIVE AGREEMENT 0621695
NSF AWARD NUMBER EAR-1543444;
NSF EAR-1543556

Table of Contents

0. Community Oversight	2
1. An Overview of CSDMS	3
2. CSDMS Long Range Goals and the Development of the CSDMS Cyber-Infrastructure	4
3. CSDMS Proof-of-Concept Challenges and Fundamental Science Questions	9
4. Details of Working Group Short-, Intermediate-, and Long-Term Goals	11
4.1 Numerics and Cyber Infrastructure	11
4.2 Terrestrial Dynamics	14
4.3 Coastal Dynamics	17
4.4 Marine Dynamics	19
4.5 Education and Knowledge Transfer	21
5. Achieving Our Long-Range Goals	23
6. Community Computational Resources	24
7. Organizing Community Participation	25
8. User Training	28
9. CSDMS Membership	29
9.1 US Academic Institutions	29
9.2 US Federal Labs and Agencies	29
9.3 Foreign Membership	29
9.4 Industrial Membership and Consortium	30
9.5 Communication Strategy	30
10. Five Year Management Plan	31
10.1 CSDMS Membership (Working Groups)	31
10.2 The CSDMS Executive Committee (ExCom)	31
10.3 The CSDMS Steering Committee (SC)	32
10.4 The CSDMS Integration Facility (IF)	32
10.5 Partners	33
10.6 Formulating CSDMS Priorities and Management of Its Resources	35
10.7 Annual Science and Management Plan, Year 2	36
11. NSF Revenue & Expenditure	37
Appendix 1: By-Laws of the Community Surface Dynamics Modeling System (Feb. 15, 2008)	38
Appendix 2: CSDMS Working Group participants (Feb. 1, 2008)	42
Appendix 3: CSDMS Industrial Consortium (Feb. 1, 2008)	47

CSDMS Community Oversight

Executive Committee (ExCom)

Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State University

Brad Murray (April, 2007), Chair, Coastal Working Group, Duke University

Pat Wiberg (April, 2007), Chair, Marine Working Group, University of Virginia

Greg Tucker (April, 2007), Chair, Terrestrial Working Group, CIRES,

University of Colorado - Boulder

Tao Sun (April, 2007), Chair, Cyberinformatics & Numerics Working Group,

ExxonMobil Upstream Research Company

Lincoln Pratson (April, 2007), Chair, Education and Knowledge Transfer WG, Duke University

James Syvitski (*ex-officio*), CSDMS Executive Director, INSTAAR, University of Colorado - Boulder

Scott Peckham (*ex-officio*) Chief Software Architect, CSDMS Integration Facility,

University of Colorado - Boulder

Steering Committee (SC)

Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State University

Tom Drake (April, 2007), U.S. Office of Naval Research

Bert Jagers (April, 2007), Delft Hydraulics | Deltares

Rick Sarg (April, 2007), Colorado School of Mines

Gary Parker (April, 2007), University of Illinois - Urbana-Champaign

Dan Tetzlaff (April, 2007), Schlumberger

Dave Furbish (April, 2007), Vanderbilt University

Tom Dunne (April, 2007), University of California - Santa Barbara

James Syvitski (*ex-officio*), CSDMS Executive Director, INSTAAR, University of Colorado - Boulder

Mike Ellis (*ex-officio*), National Science Foundation

1. Overview of CSDMS

The Community Surface Dynamics Modeling System (CSDMS) is the cyber-infrastructure for the development, distribution, archiving, and importantly the integration of the suite of numerical models that define the Earth's surface - the ever-changing, dynamic interface between lithosphere, hydrosphere, cryosphere, and atmosphere. CSDMS is also the virtual home for a diverse community of experts who foster and promote the modeling of earth surface processes, with emphasis on the transport and sequestration of water, sediment and solutes, across landscapes and sedimentary basins.

CSDMS

- Produces protocols for community-generated, continuously evolving, open software
- Distributes software tools and models
- Provides cyber-infrastructure to promote the quantitative modeling of earth surface processes
- Addresses the challenging problems of surface-dynamic systems: self-organization, localization, thresholds, strong linkages, scale invariance, and interwoven biology and geochemistry
- Enables the rapid development and application of linked dynamic models tailored to specific landscape to basin-evolution problems, at specific temporal and spatial scales
- Partners with related computational and scientific programs to eliminate duplication of effort and to provide an intellectually stimulating environment
- Supports a strong linkage between what is predicted by CSDMS codes and what is observed, both in nature and in physical experiments
- Supports the imperatives in Earth Science research: 1) discovery, use, and conservation of natural resources; 2) characterization and mitigation of natural hazards; 3) geotechnical support of commercial and infrastructure development; 4) stewardship of the environment; and 5) terrestrial surveillance for global security.

The CSDMS Executive Committee, with contributions from the CSDMS Steering Committee, CSDMS Working Group members, and the CSDMS staff, has collaboratively developed this 2008 CSDMS Strategic Plan.

2. CSDMS Long Range Goals and the CSDMS Cyber-Infrastructure

CSDMS has two overriding long range goals. The first long-range goal is to

- *Develop a modular modeling environment capable of significantly advancing fundamental earth-system science* (see section 3).

The concept of a module is central to community modeling, where individuals and small teams work to develop individual modules that are combinable in unique combinations depending on the nature of the scientific problem being addressed. A module can be a standalone model, or a data set, or a wrapper that provides interoperability between other modules, functions or models. For true modularity, model components are formulated in such a way that they can be added to the computational framework with little effort, by following a set of protocols that ease this transition. The CSDMS modeling architecture can, in turn, access a repository of compliant modules (see below).

To address this first long-range goal, CSDMS is working with the **Common Component Architecture** (CCA) as its framework for linking landscape-basin evolution models. CCA includes a compiler called *Babel* that allows individual components to be written in any of several programming languages, including FORTRAN 77/90/95/03, C, C++, python, and java, using SIDL / XML metadata. This language interoperability is achieved without a significant reduction in performance, and therefore allows legacy code to be considered for adoption into the **CSDMS Compliant Repository**. CCA is interoperable with other modeling frameworks such as ESMF, PRISM and MCT. CCA supports single and multi-processor systems, distributed or parallel computing (via MPI), and high-performance computing (HPC), and is compatible with most major operating systems (Windows, OSX, Linux and other Unix). CCA is used commercially, by academics and by government agencies. CCA supports structured, unstructured & adaptive grids. CCA has stable DOE / SciDAC funding.

A key task for the CSDMS community is to define the *interfaces* for CSDMS modules in order to maximize their interoperability with each other and with components (e.g. PDE solvers, mesh routines, visualization tools) written by software engineers outside of the CSDMS community. Thus the first long-range goal is to create the richest possible collection of shared “plug-and-play” CSDMS components and to ensure that they can be used in a HPC context. In an object-oriented context, this includes defining robust object classes and methods (e.g. string class and grid class).

The second long-term goal of CSDMS is to:

- *Develop fully functional and useful repositories for CSDMS data, for CSDMS models and numerical tools, and for educational use.*

The **CSDMS Data Repository** supports the archiving and distribution of useful data for model initializations and boundary conditions, for benchmarking of individual models/modules, and for CSDMS framework-integrated validation experiments. The CSDMS site presently supplies the community with the following gridded and geo-referenced data types:

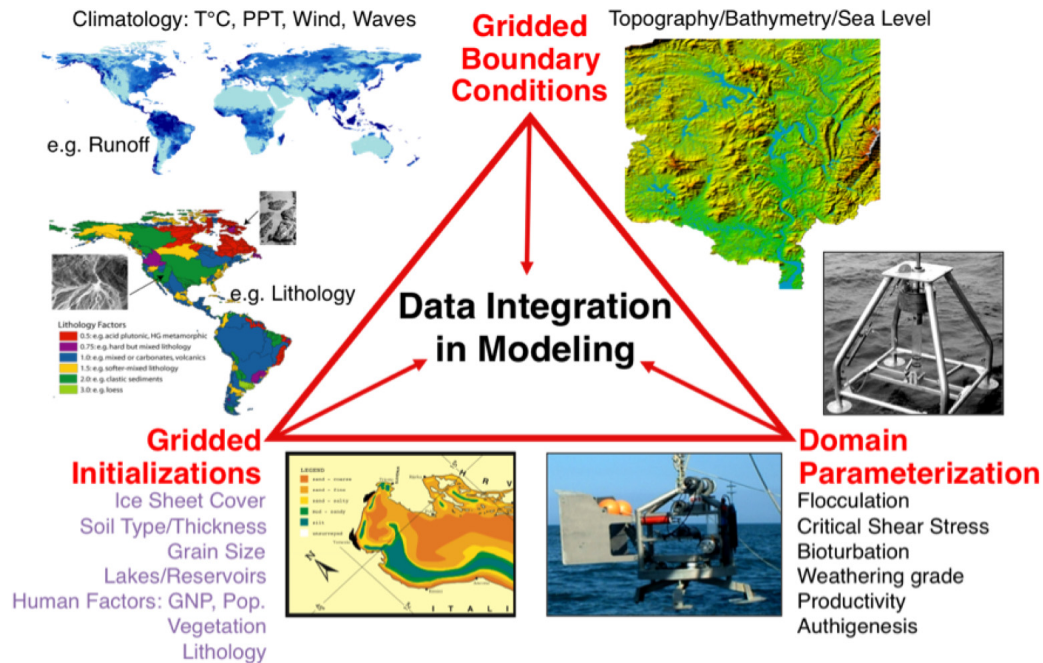
- Bathymetric data;
- Climate data;
- Hydrographic data; and
- Topographic data.

A number of other datasets are in progress for community sharing, and include:

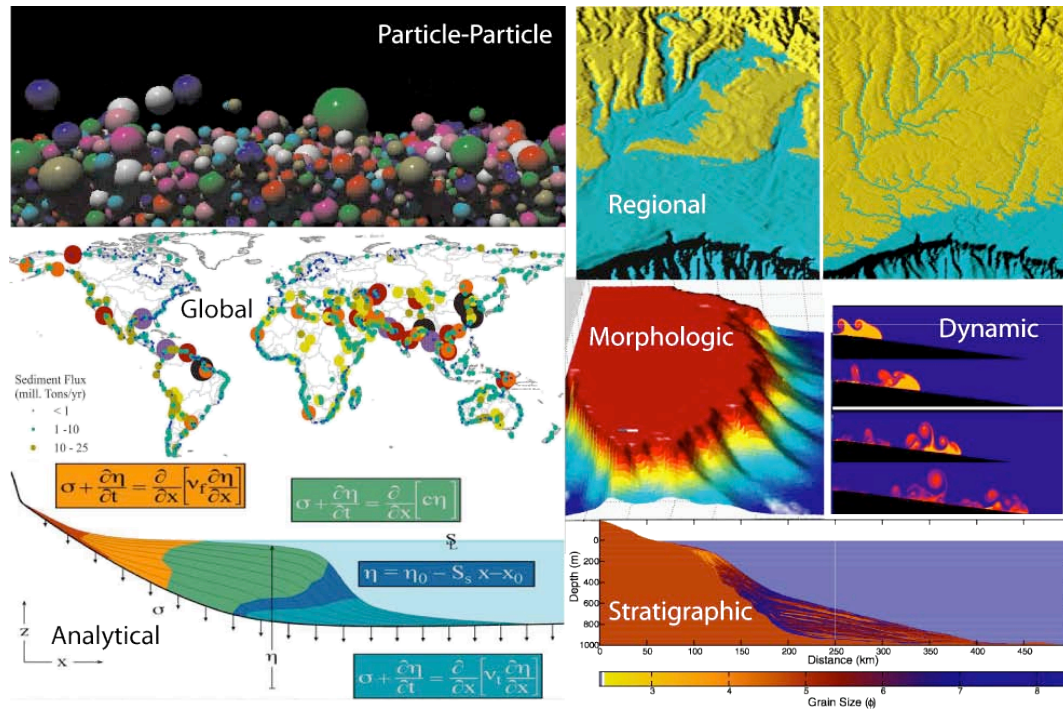
- Global delta data,

- Global tidal data developed from the UNIX *Xtide* program,
- Global wave data of 10 years of 3 hourly wave characteristics (height, period, winds) at 1° spatial scale, developed from WaveWatch III model output, and
- 100 years of monthly sediment discharge (BQART/WBM model) for the global rivers of the world.

Each year the data repository will grow through contributions by CSDMS members and affiliated partners. CSDMS expects to host benchmarking data from flume experiments, such as lock burst experiments used to ascertain how a particular turbidity current model is able to capture shock front dynamics.



The **CSDMS Model/Tools Repository** hosts stand-alone models and tools relevant to surface dynamics, including novel computational strategies, moving boundary methods, distributed source terms, and nested modules. CSDMS currently points to, or distributes, 61-legacy models/codes dealing with terrestrial, coastal and marine processes and environments. CSDMS is presently gathering the metadata behind each of these models, reviewing the source code, if available, and the model documentation. The repository also provides access to important GIS and network extraction tools through the CSDMS website <http://csdms.colorado.edu/>. Almost each month the repository receives contributions from CSDMS members and affiliated partners. CSDMS has investigated and tested a number of methods to distribute software to users: *RPM*, *Debian*, and *PackageMaker*. Both *Debian* and *RPM* are typical on many Linux operating systems, while *PackageMaker* produces an installer for OSX. Each distribution contains binaries that have been precompiled for a specific operating system. This is the preferred method of distributing software since a user need not compile anything. A Python-based program called *Contractor* is being investigated to help simplify the build process when it is necessary to install a large number of separate packages with complex (e.g. package version) dependencies.



The **CSDMS Education Repository** distributes model simulations, CSDMS-related educational presentations, reports and publications, CSDMS-related short course materials, CSDMS images, and CSDMS-hosted or sponsored workshop and meeting presentations. Educational tutorials hosted on the CSDMS web site presently include:

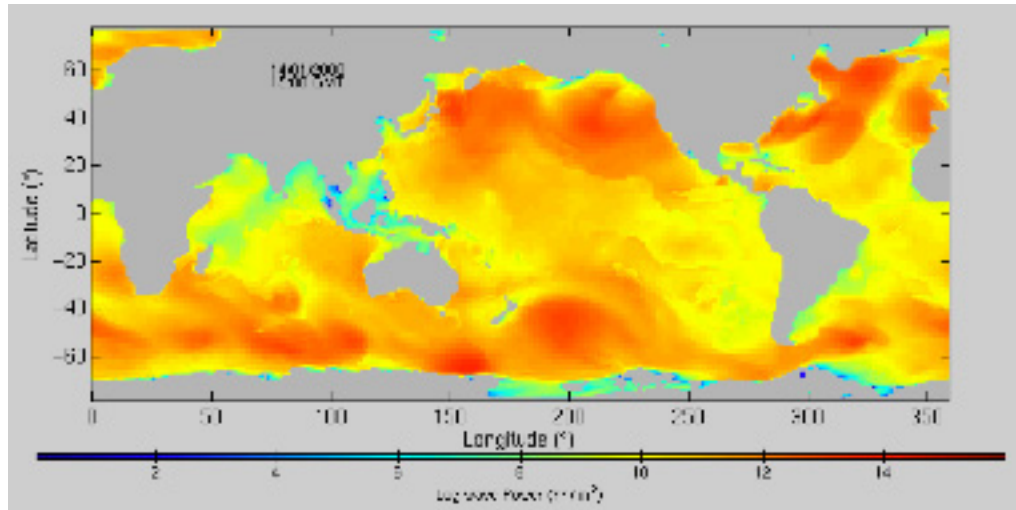
- Charge to the CSDMS Working Groups;
- Advantages of the Common Component Architecture (CCA) for CSDMS;
- Comparing Model Coupling Systems: An Example;
- CCA Recommended Reading List; and
- Mini-tutorial on *Subversion*.

Posted **CSDMS Documents and Reports** include:

- CSDMS Bylaws (2008);
- CSDMS Science Plan (2004),
- CSDMS Implementation Plan (2004),
- CSDMS Rationale and Strategy (2004), and
- CSDMS 2007 Annual Report (2008).

The **CSDMS educational and meeting presentations** presently include those from the:

- GWSP/LOICZ/CSDMS sponsored *Workshop on Dynamics and Vulnerability of River Delta*,
- SCOR/LOICZ/CSDMS sponsored *Workshop on Mechanisms of Sediment Retention in Estuaries*,
- NSF sponsored, CSDMS hosted, *Workshop on Community Carbonate Modeling*,
- CSDMS *Implementation Workshop*,
- CSDMS 2003 *Federal Agencies Workshop*, and
- 2002 *CSDMS Planning Workshop*.



Simulation clip from a wave power movie produced at the CSDMS Integration Facility using WaveWatch III as the driver (courtesy of Albert Kettner).

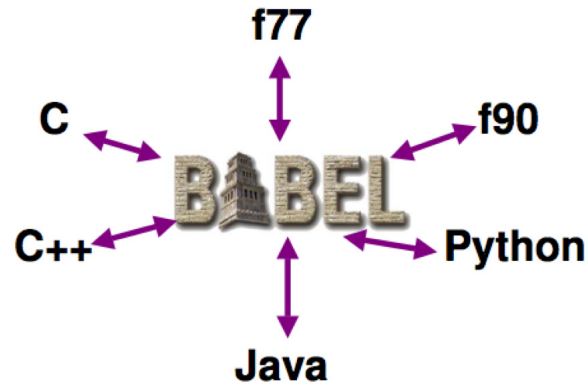
The **CSDMS Image Gallery** <http://csdms.colorado.edu/> hosts a variety of downloadable images designed to illustrate aspects of environments that the CSDMS Project tries to capture by its suite of models. Participants generously contribute to these freely downloadable images.

The CSDMS Compliant Repository contains contributed compliant code able to function within the CSDMS integrated modeling framework. The CSDMS Framework is designed to support multiple operating systems (*Linux, Mac-OSX & Windows*), parallel computation (*via MPI standard*), modules interoperable even if written in a variety of languages (*C, Fortran, Java, C++, Python*), with code both procedural and object-oriented, supporting both structured and unstructured grids, with a platform-independent GUI (*e.g. via wxPython*), offering open-source tools, in a manner friendly to industry yet with the proper protection for authors that tracks modifications.

CSDMS has developed a wiki-based website that is home to the CSDMS-CCA development project (<http://csdms-cca.googlecode.com>) to present CSDMS latest developments on model protocols, model components, and instructive information about how scientists can use CCA in this environment. The website allows CSDMS members to easily add information to the website, allowing them to stay current and to further foster community around the project. The website contains a description on how to install the CCA development tools on various platforms (platforms include *fedora, ubuntu, OSX10.5*, and *Solaris 8*). Installation scripts for the various platforms are available. The community is able to submit issues under the issue tracker section, providing users the ability to see what current issues, and what issues have been solved with respect to the CSDMS CCA project.

Interface definition is a large part of the CSDMS effort. The CSDMS has begun to explore the interfaces that models will present to other component models. Initial interfaces have been developed to define the previously discussed components. These interfaces are not final but will be further developed by the CSDMS-IF with advice from the five working groups. The *SedFlux* component presents an interface that is a handle to the *SedFlux* environment as well as a series of functions that query that environment (wave height, water depth, for example). The single-process components use more general interfaces. For instance, the river component provides an interface that allows another component to query

current river conditions, or to get the next river event. The final set of interfaces will be some combination of the two approaches and will contain converters that allow non-like ports to communicate.



Babel is a CCA compiler used for language interoperability: Components written in different languages can be rapidly linked with little performance cost, allowing for open-source solutions (e.g. libraries), and access to both procedural and object-oriented strategies (legacy and modern code), with graphics & GUIs.

3. Proof-of-Concept Challenges & Fundamental Science Questions

The first couple of years of the CSDMS initiative are devoted to establishing the Cyber-infrastructure, the administrative structure (Integration Facility, Steering Committee, Executive Committee, Working Groups and Partner Consortium), the requirements of the digital library, module protocols, the CSDMS modeling framework, and the web-based communication with the community. Concurrent with the development of this CSDMS cyber-infrastructure, Working Groups are coalescing around demonstration challenges and over-arching science questions. The Challenges are:

Challenge1: Predicting the Transport and Fate of Fine Sediments & Carbon from Source to Sink

Carbon dynamics as addressed by CSDMS will focus on those processes involving fine sediment: fluvial and marine transport, reservoir impoundment, and environmental sequestering (floodplains, wetlands, continental shelves). Focusing on carbon ensures that CSDMS will incorporate key geochemical linkages in its design and allow the System to contribute to an immediate scientific debate having societal relevance. NSF, NASA, DOE, and NOAA presently fund core programs that address this topic.

Challenge2: Sediment Dynamics in the Anthropocene

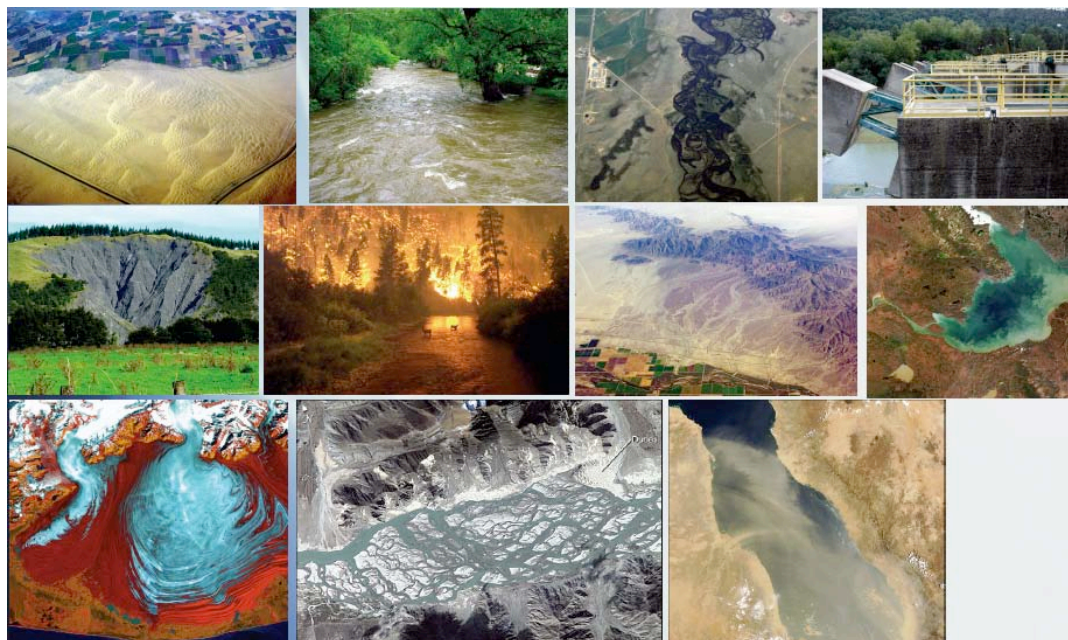
The “Anthropocene” refers to that part of the Earth’s recent history in which humans have become a major force for change in Earth systems. By combining CSDMS transport models with data sets addressing human-influenced as well as pre-human conditions, the CSDMS effort aims to quantify human influence on landscape evolution and sediment dynamics. Large integrated field studies funded by NSF (MARGINS) and ONR (EuroSTRATAFORM, Tidal Flat DRI) are providing valuable data documenting Anthropogenic modification of landscapes, in basins such as the Eel, Waipaoa, Po, Rhone, and Skagit. Focusing on the human time scale allows for CSDMS models to investigate the cumulative effects of human activities on the environment, including: 1) perturbations on sediment generation, 2) interruptions to sediment routing and storage (i.e. reservoirs), and 3) impacts on coastal ecosystems (e.g. elimination of flooding on delta surfaces). This challenge allows for CSDMS to evolve with access to modern global databases and large integrated data sets (e.g. Shuttle Radar, satellite imagery, DEMs, meteorological and ocean data), and to reach out to the global change research community.

Challenge3: Tracking surface dynamics through glacial cycles

The sequence of high-frequency sea level and climatic cycles that characterize the Pleistocene poses an exciting challenge to CSDMS. Modeling the earth-surface response to glacial cycles involves coupled drivers such as ice cover, geophysical response to both ice and ocean loads, water and sediment delivery, base level, and wave/current climate, plus associated changes in ecosystems. The results — fluvial valley development and filling, major shoreline migration, and glacial advance and retreat — are sufficiently well documented to provide relatively strong constraints on CSDMS simulations. The glacial-cycle problem will test the ability of CSDMS to handle critical features such as dynamic moving boundaries (e.g. the shoreline) between transport domains, abrupt climate changes, ice-river interactions, and ice-ocean-sediment interactions. The challenge will allow CSDMS to evolve with access to global paleo-databases (e.g. paleoclimate proxy data, vegetation history data) and simulations (e.g. climate model predictions, glacial simulations, paleo-ocean predictions). This challenge also reaches out to the Quaternary and glaciological communities, including the International Ocean Drilling Project.

Seven fundamental scientific questions form the foundation and motivation for the CSDMS effort:

1. What are the fluxes, reservoirs, and flow paths associated with the physical, biological, and chemical transport processes in the Critical Zone? How do these depend on substrate properties like morphology, geology, and ecology, and on human activities?
2. What processes lead to self-organization and pattern formation in surface systems? How do self-organized patterns mediate surface fluxes and evolution?
3. How do material fluxes and surface evolution vary across time and space scales?
4. How are physical and biological processes coupled in surface systems?
5. How is the history of surface evolution recorded in surface morphology and physical, chemical, and biological stratigraphic records?
6. How do linked surface environments communicate with each other across their dynamic boundaries? How do changes in one part of the global surface system affect other parts?
7. How does the Critical Zone couple to the tectosphere, atmosphere, hydrosphere, cryosphere, and biosphere and serve as the dynamic interface among them?



The domain of the CSDMS Terrestrial Working Group, from top to bottom and left to right: Irrigation fields and canal through desert dunes, Arizona; Boulder Creek during flood; Riparian floodplain, N. Platte, CO; flood control and power plant on the Pesaro R, Italy; hillslope gully in the Waipaoa R catchment, NZ; wildfire Colorado (unknown web photo); alluvial fan off a range in the Mohave Desert, Arizona; sedimentation in Great Slave Lake, Canada (NASA MODIS data); Malaspina Glacier system (USGS LANDSAT image); Brahmaputra R, Tibet (Space Shuttle photograph, NASA); dust storm over the Red Sea (NASA MODIS data). All photos are courtesy of J.P.M. Syvitski, except for those indicated.

4. Details of Working Group Goals

4.1 Numerics and Cyber Infrastructure

Year 2+ (2008/09+) goals for the CSDMS Architecture:

1. Establish interface standards that define precisely the manner in which components can be connected, with the goal of creating the richest possible collection of plug-and-play components. This nontrivial task will require considerable discussion within from the entire CSDMS community. There are many different ways in which to subdivide and encapsulate useful functionality into components. The challenge is to find a way to do this (within the technological context of the CCA and object-oriented design) that leads to an intuitive, easy-to-use and yet powerful system that can be used for the rapid development of new applications. Users and developers/contributors will each see different views of component interfaces that are intuitive and flexible at both levels.
2. Link refactored code contributions from the community as CSDMS components within the CSDMS framework. This relatively straightforward yet time-consuming goal will take place once standard interfaces have been established. However, the expectation is that systems architects will need to be intimately involved during the initial phase of the project.
3. Begin to assemble a set of standard components (e.g. application drivers, clocks, solvers, meshing tools) that essentially transcend any particular model but that facilitate the linkage of components into working applications. Some of these standard components for specific problem areas (e.g. landscape evolution models or distributed hydrologic models) will be derived from the CSDMS community. Others, such as solvers and meshing tools, will be derived from elsewhere (e.g. large DOE-funded projects that use CCA components) and adapt to CSDMS needs.
4. Create or compile educational materials, conduct training workshops and otherwise assist the CSDMS community in preparing code and model contributions that comply with the CSDMS standards and interfaces.
5. Implement a particular type of model (e.g. landscape evolution, distributed hydrologic model, stratigraphic model) as an application built from CCA-compliant components. Some key goals would be to show (1) that this can be done without translating or significantly altering the original code, (2) how component interfaces should be written to maximize flexibility and (3) that there is little or no loss of performance.

Year 3+ (2009/10+) goals for the CSDMS Architecture:

6. Show how two different componentized models from different problem areas (e.g. ocean and terrestrial) can be linked together to provide new functionality. A key goal would be to demonstrate that this could be done in a straightforward manner by following a simple and flexible procedure.
7. Perform experiments, using the CSDMS “Experimental Supercomputer” in order to explore different strategies for taking advantage of multiple processors. The CCA architecture supports parallel computing via the MPI standard and we are already collaborating with HPC experts at CU. However, there are many different ways in which to “parallelize code”. Some examples include: (1) tiling the geographic domain and using a separate processor for each tile (used by ESMF), (2) using existing components (e.g. solvers) that have already been parallelized efficiently whenever possible (e.g. from the CCA community), (3) writing parallelized versions of array-based operators (relatively easy to do for many operators and

has been done in languages like IDL and Matlab) and (4) analyzing a particular problem in detail in order to determine how it can best employ multiple processors while keeping the load balanced (so that each processor is working continuously).

8. Build a CCA-compliant “CSDMS framework” by extending the existing *Ccaffeine* framework with classes and services available to all CSDMS components. One example will be a “grid class” embedded in the CSDMS framework, to provide methods for performing a wide variety of operations on grids (e.g. histograms, regridding, smoothing). Utilities for run-time graphics or progress dialogs would also be included here.
9. Develop a mechanism, most likely a standardized GUI dialog or input file template, that can be used to provide/set all of the input variables that are required by a component. We envision a standardized dialog template for consistent look and feel, with a Help button that launches HTML-based help. Each component would then have its own GUI and HTML help pages that conform to this template.
10. Perform extensive testing of the CSDMS framework services and all of the “standard components”.
11. Offer training workshops (coding camps) and/or tutorials to enable contributors to link refactor code contributions.
12. Adapt/rewrite the visual programming tool called *Ccafe* GUI that is currently available for creating applications from CCA components. The *Ccafe* GUI is currently too limited to serve the needs of the CSDMS community, but does lay some of the groundwork. The *Ccafe* GUI is written in Java and has not been componentized. Based on discussions with the CCA developers, it would probably be best to write our new tool in Python using *wxPython* or *PyQT*.

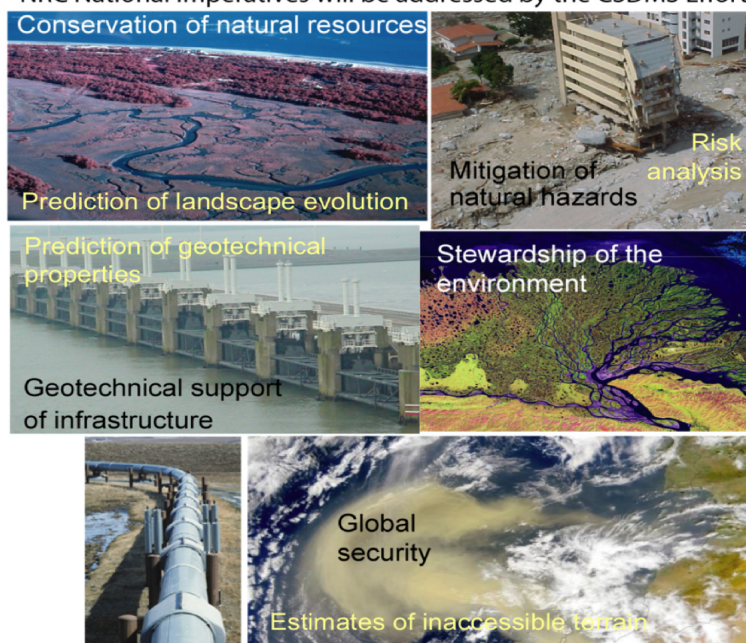
The CSDMS Integration Facility will initially be responsible for refactoring code contributions from the community into “CSDMS components”. Based on work conducted during year 1, we anticipate that the following “rules of thumb” will apply to this effort.

1. Not all units of functionality (e.g. classes) will be encapsulated as CCA components. For example, a grid class with a large number of standard methods for working with gridded data would be very useful to have in the CSDMS infrastructure or toolkit, but this class and its methods should be available to every CSDMS component without requiring an explicit linkage with a “grid class component”. Within the CCA **Architecture**, a CSDMS/CCA **Framework** is the mechanism by which functionality (e.g. services and classes) can be made automatically available to all components. Therefore we plan to create our own CSDMS framework (in the CCA sense) as an extension of the existing *Ccaffeine* framework.
2. Models that require time stepping should be broken into Initialize, Run (one time step) and Finalize parts. This exposes the Run module in a way that makes it more flexible in a plug-and-play setting. These parts could be wrapped as separate CCA components or they could be port methods associated with a single CCA component. The latter approach is probably better in the sense that it is cleaner and hides more details from users who are assembling applications with a visual-programming GUI. We also plan to incorporate solvers that use evaluations of the “function” at multiple time steps (e.g. predictor-corrector methods).
3. Components should not be too fine-grained. Very small units of functionality, such as a function like “min” that returns the minimum value in an array, do not lend themselves to

the efficient assembly of model applications from components. Moreover, this type of fine-grained functionality is already available in many programming languages (or their associated libraries) and does not need to be duplicated. It would be more natural for the min function to be included as one of many methods in a “grid class”. Similarly, there should not be a component for every physical variable that is computed; it is preferable to implement these as methods for a given “process component”. For example, for the physical process or phenomenon of water waves there could be Airy Wave, Stokes Wave, SWAN, REF-DIF and Boussinesq components that each have a CCA “provides port” called “wave”. Physical variables like wave height and wavelength (as grids) would then be returned from these components as standard methods of their wave port.

4. Components should generally be associated with a particular method of modeling a particular physical process. Examples might include Degree-Day method for Snowmelt, Green-Ampt method for Infiltration, Airy Wave method for Waves, and Bagnold method for Sediment Transport. There will typically be multiple, interchangeable or swappable components for modeling any given physical process or phenomenon. Methods (or method functions) associated with the component should then focus on returning all of the physical variables that are of interest (and can be computed) for that physical process, or that are necessary to couple with components for other physical processes.
5. Show how many different (process or model) components can be rapidly assembled into a relatively complex application with the smallest possible amount of time and effort.
6. Assuming that each of these milestones has been reached, it then makes sense to tackle one or more “grand challenge” projects in the final year of the project. It is clear that grand challenge problems cannot be addressed until a sufficiently rich collection of components has been made available.

NRC National Imperatives will be addressed by the CSDMS Effort



The Community Surface Dynamics Modeling System (CSDMS) assumes responsibilities to develop, support, and disseminate to the earth-science research and teaching community integrated software modules that are aimed at predicting the erosion, transport, and deposition of sediment and solutes in landscapes and their repository sedimentary basins.

4.2 Terrestrial Dynamics

Year 2+ (2008/09+) goals

- Evaluate the state-of the-art in understanding sediment-transport processes that fall within the terrestrial domain (e.g., hillslopes, river networks, glaciers, etc.). This includes identifying existing models, research needs, and areas where models (and perhaps also data and process understanding) are missing. This inventory provides the community with a basic map of the current state-of-the-art regarding both process knowledge and modeling capability.
- Develop a set of criteria for proof-of-concept applications. Among these criteria are the integration between at least two different components of the surface dynamics system, and well constrained boundary conditions. To the extent that such coupling is not seen as feasible in the short to medium term, then these criteria should address the barriers to that feasibility.
- Identify potential proof-of-concept applications and data sets.
- Stimulate proposals from the community for projects that will address important science questions while completing steps necessary for realizing the overall goals of CSDMS, for example by (1) developing / improving software for CSDMS, (2) developing proof-of-concept modeling applications, (3) developing data sets for potential proof-of-concept applications, and/or (4) developing strategies to test model predictions. In particular, encourage proposals for integration of at least two different landscape-scale models within the CSDMS framework. These models need not necessarily link across domains; at this stage it is most important that a comparison of models within a unified framework should analyze and explicate different model predictions in the context of existing data sets.
- Create a prioritized list of computational infrastructure needs as relates to terrestrial process modeling and interface with coastal and marine environments. This will include working closely with the Cyberinfrastructure and Numerics Working Group to develop interfaces and basic components.
- Stimulate the beginnings of self-organizing collaborative teams, many of which include partners in the marine, coastal, cyberinfrastructure, and/or EKT realms.
- Define and prioritize educational needs training in the use of the CSDMS framework.

Year 3+ (2009/10+) Intermediate-Term Goals (2-4 years)

- Enhance the CSDMS library to include a healthy inventory of computer models and related tools that encapsulate our best present knowledge and ideas about terrestrial weathering, erosion, transport, and deposition, as well as related hydrologic and ecologic processes. The collection should include different sub-systems (large alluvial rivers, drainage basins, sand dunes, glaciers, etc.), different landform scales (e.g., single soil profiles, hillslope profiles, small catchments, sub-continental regions), different time scales (e.g., agricultural soil erosion, mountain growth and erosion), different domains (e.g., surface-water hydrology, landform evolution, chemical weathering, vegetation dynamics), and different ideas (e.g., three fundamentally different approaches to soil development). Initially, the library is to be mostly populated by legacy code. Over time, as interfaces are designed and new basic components become available, the number of CSDMS-compliant modules is expected to grow.
- Describe and evaluate models according to scale, applicability, and validation.

- Break-up one or two of the larger existing terrestrial models into individual components that can be combined in various ways using the CSDMS Architecture.
- Develop a first-generation set of standard interfaces between component modules, in close collaboration with other Working Groups.
- Design prototypes for ways to represent a landscape that are generic enough to swap in and out various transport laws on a surface (terrestrial or submarine) and its subjacent stratigraphy, with the ability incorporate a dynamic shoreline.
- Make progress in implementing proof-of-concept applications. We expect that these will gradually progress from fairly simple tests of CSDMS technology to increasingly rich science applications that couple subsystems (e.g., glacial, fluvial, coastal) and can be compared with observations from well chosen case studies (e.g., growth and change of Ebro Delta in response to anthropogenic landscape change).
- Make modeling tools available for educational use.

Long-Term Goals (4-6 years and beyond)

- Develop and test a prototype “landscape framework.” A landscape framework is a software module that includes all that is necessary to set up a grid (regular or irregular) to represent a topographic surface in two (or even three) dimensions, store information about stratigraphy, and compute changes in topography and stratigraphic properties. Different frameworks may use different representations. For example, one may be based on cellular automata while another is a numerical solutions to PDEs; one may view a landscape as a 2D surface underlain by a vertically homogeneous regolith of varying thickness, while another may entail a smooth gradation from unweathered to fully weathered rock. These frameworks should be generic enough to avoid stifling creativity while being concrete enough to be practical.
- Further develop and implement a first set of proof-of-concept applications. These should generate feedback that will shape both the community computing toolkit and the design of experiments and data-collection projects. At this stage, we expect that new applications will be coming on line, while earlier ones will be fleshed out and extended. One result is identification of needs for basic process-based research to improve the accuracy of model predictions, for example by understanding nonlinearity in transport laws, and the impact of biotic processes. Results from proof-of-concept applications should also stimulate the collection of new data designed to test hypotheses arising from computational experiments and preliminary field tests.
- Develop the terrestrial components of the modeling system so that it has the capability to explore impacts of climate and land-use change on a wide range of surface processes, as well as interactions and feedbacks among processes. For example, the system might accommodate natural changes in runoff generation mechanism arising from centennial-scale climate excursions such as the Medieval Warm Period.
- Contribute to the Education and Knowledge Transfer program with the aim of seeing a new generation of computationally literate graduate students, versed in how to take maximum advantage of CSDMS tools and capabilities, begin to join the research community. Their training should allow them to make rapid progress in using numerical models to interpret data and introduce new hypotheses.

- Demonstrate in an application the ability to apply CSDMS knowledge and technology to a test problem with direct societal relevance.
- By stimulating applications and data collection efforts, support the iterative improvement of methods for robust statistical evaluation of surface-process models.



The domain of the CSDMS Coastal Working Group, from top to bottom and left to right: rapidly eroding permafrost coast of the North Slope of Alaska (courtesy Cameron Wobus); Chesapeake Bay estuary under river flood (MODIS image, NASA); Los Angeles R and coast; Atlantic coast of Portugal; tidal flats of San Francisco Bay; Honolulu harbor; Eel River plume during flood (courtesy of Rob Wheatcroft); Lena delta (NASA MODIS data); Mississippi delta (NASA, Space Shuttle SRTM data); coastal dunes of Brazil (Google Earth Digitalglobe image); the Great Spit of Denmark. All photos are courtesy of J.P.M. Syvitski, except for those indicated.

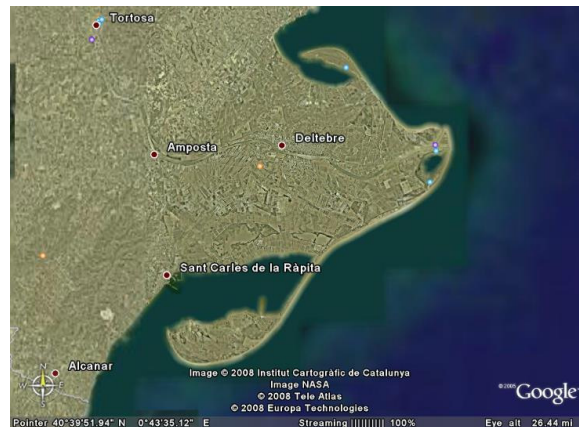
4.3 Coastal Dynamics

Year 2+ (2008/09+) goals

- Evaluate present knowledge of processes in coastal environments (nearshore, inner shelf, barrier islands, sandy coastlines, rocky coastlines, estuaries, lagoons and marshes, eolian, deltas)—including the human component of those systems (i.e. direct couplings between human manipulations and landscape evolution in deltas and coastlines)—and identify the numerical models presently in use.
- Identify gaps in knowledge and areas where model development is needed—both poorly understood phenomena requiring basic research and exploratory modeling, and better understood systems for which model reliability should be improved.
- Define proof-of-concept questions—questions that require linking together models of different environments, preferably spanning between coastal and terrestrial or marine environments. These should be examples of types of interesting and relevant scientific questions, but should have known answers, to allow evaluation of the pilot-modeling endeavor.

For example, how do land-use changes in hillslope/mountain environments affect coastline evolution, via altered fluvial sediment loads? The evolution of the Ebro Delta, Spain provides one known instance that we could try to reproduce, in which progressive deforestation in the mountainous watershed lead to the emergence of the delta, where an estuary previously indented the rocky coastline (Montsia Museum, Ebro Delta, Spain). Subsequently, reforestation and development in the watershed have reduced sediment loads, apparently causing the balance between wave driven sediment transport and fluvial delivery to shift and leading to a shift in the morphological evolution of the delta (Ashton and Murray, Coastal Dynamics '05), producing the current distinctive shape (Figure below).

A proof-of-concept project should involve modeling challenges, and yet should be achievable within 5 years; models of the component environments should already exist. For the Ebro Delta example, candidate models would include the CHILD and Ashton-Murray models of terrestrial and coastal landscape evolution, respectively, and the moving-boundary nature of the coupling would provide a significant challenge.



Year 3+ (2009/10+) Intermediate-Term Goals

- Gather together the available models; reach out to researchers with expertise and models to contribute to the CSDMS, making them available to other scientists and the broader community.
- Evaluate and describe the uses, intended goals, and limitations of the available models; which of them are designed to address abstract, basic science questions; which are designed to provide detailed and accurate simulations of processes and evolution in either specific locations or generic environment types; which fall between these end members; and how

well do the models accomplish their goals (e.g. numerical fidelity and stability)? This large task will require significant community input, via the interactive (wiki) CSDMS website.

- Identify which of the available models are best suited to be linked to models of other coastal as well as terrestrial and marine environments. In this effort we will continue to affirm the need for and value of stand-alone and exploratory models essential for scientific progress (and therefore in the long term for the ability to more comprehensively model linkages between environments).
- Identify what development tools would be most valuable to researchers developing new models; what model building blocks (e.g. equation solvers, gridding modules) are needed commonly enough that inclusion in the CSDMS toolbox would facilitate efficient model development (decreasing the need for wheel reinvention)?
- Encourage the coastal science community to propose to funding agencies scientific projects that will help fill gaps in knowledge and gaps in modeling capabilities.
- Persuade the modeling community to begin adopting the Cyber Infrastructure Working Group's recommendations as new models and model components are developed, so that models can be more readily shared and in some cases linked to other models and components.
- Encourage some in the community to undertake the linking of specific models of different environments (within and beyond coastal environments); to broaden our thinking to include scientific questions we don't currently entertain, and to write proposals to address such questions involving multiple environments. The proof-of-concept project(s) we identify will provide the initial example(s).

Long-Term Goals

- Complete and evaluate a proof of concept project.
- Provide open access to a toolbox of stand-alone and linkable models and modules that represent the scientific state of the art—while continually adding to it as knowledge and modeling capabilities improve.
- Through this access, to grease the wheels of science; individual scientists and research groups use the available models, both stand-alone and linked, to address new intra- and inter-environment questions (with minimal need for new model development).
- Through this access to also allow the broader community—including educators and environmental managers—to use state-of-the-art science and modeling capabilities (and animations) when addressing landscape and ecosystem evolution, global change (including direct human manipulations of landscapes as well as climate change) and exposure to natural hazards.

4.4 Marine Dynamics

Year 2+ (2008/09+) goals

Our goals for the short term are to develop a framework for marine modeling within CSDMS and to identify the necessary marine components of the modeling system. Accomplishing this requires us to:

- Identify the dominant marine processes that must be included the CSDMS
- Identify the gaps in knowledge of important marine processes, e.g., dynamics of mixed-grain size beds
- Survey the existing models, including the form they take, input and output requirements
- Identify processes for which model development is required
- Develop criteria and procedures for model evaluation
- Prioritize modeling effort and resource allocation

In addition, we will take initial steps toward the longer-term goals by identifying the important marine science questions that CSDMS could address and proposing one or two proof-of-concept challenges that utilize the unique capabilities of CSDMS to make progress on these questions.

Members attending the first Marine Working Group Meeting (March 8, 2008) identified the following processes as essential marine components in CSDMS: particle aggregation/disaggregation; dynamics of muddy seabeds (including biological mixing and irrigation, diagenesis); dynamics of sandy seabeds (including bed form dynamics); dynamics of carbonate sediments (including effects on porewater chemistry); dynamics of mixed-sediment-size/composition beds; gravity-driven flows; bedload and suspended load transport (including nepheloid layers); seabed scour (from icebergs, trawls); sediment-related ice dynamics; isostasy; diagenesis; subsidence and tectonics. Models for many of these processes exist and will be identified this year. Short-term marine transport modeling depends on hydrodynamic forcing which can be provided by data or, increasingly commonly, by 3D hydrodynamic models. The NOPP/USGS Community Coastal Sediment Transport Modeling System has adopted ROMS for this purpose. The Working Group was enthusiastic about incorporating ROMS into CSDMS, but also believes that it is important to have another choice, such as Delft-3D or an unstructured or adjustable grid model. Longer-term marine modeling depends on new ideas about scaling up processes, forcing, and boundary conditions from shorter to longer time scales.

The Marine Working Group Meeting attendees also discussed proof-of-concept challenges for CSDMS. The proposals included modeling challenges within the marine domain, e.g., a generic wind-current-wave-driven resuspension model that could be applied to any shelf (away from large buoyancy sources) and combining a turbidity model with a deeper ocean circulation model. A challenge of particular interest is one that spans time scales, e.g., a plume model coupled with stochastic forcing to develop a climatology for flood deposition that could be used in longer-term models. The group also proposed challenges that extend into the coastal and/or terrestrial realm. Among these are: changes in river mouth

morphology through time and its effect on river plume discharge and flood deposition; rapid tectonic uplift (perhaps earthquake induced) and consequent effects sediment production, routing through the terrestrial and coastal systems, and offshore transport and deposition; and tropical muddy deltas where physical setting forces unusual biogeochemistry.

The ideas developed by those attending the working group meeting are now being sent to the rest of the working group membership for additional suggestions and modifications.

Year 3+ (2009/10+) Intermediate-Term Goals

Our intermediate-term goals are to populate the marine component of CSDMS with a core set of high-priority models of marine processes that have been documented and evaluated following our criteria and procedures, and to test the coupling of 2-3 models for functionality and utility. Accomplishing this requires us to:

- Enlist support of community to provide high-priority model code,
- Do necessary up-front work on high priority model codes to make them compatible with CSDMS architecture,
- Evaluate these models using our established criteria and procedures,
- Create guidelines for documentation and implement these for the initial marine model codes submitted to CSDMS.

As part of this effort, we will identify datasets available for modeling testing and the development tools most useful for researchers (modelers and model users) interested in using CSDMS. In addition, we will encourage development of models in areas of knowledge/model gaps and interface with other working groups to assure necessary "upstream" input and to discuss areas of overlap.

Long-Term Goals

Our long-term goals are to participate in a proof-of-concept challenge that extends beyond the marine realm and to assure that CSDMS has a toolbox of marine models that will serve the needs of research, education and management users. Accomplishing this requires us to:

- Have the necessary marine modeling components in place for the proof-of-concept challenge,
- Develop one or more coupled sets of models that can serve as a proof-of-concept for the utility of CSDMS to educators and managers interested marine processes,
- Enlist trial users in the community,
- Continue to enlist support of community to provide model code.

4.5 Education and Knowledge Transfer

CSDMS plans on strong and fully integrated Education and Knowledge Transfer components. CSDMS will focus its knowledge transfer efforts on three CSDMS end-user groups: researchers, planners, and educators. CSDMS will target:

- **Researchers** with model and visualization tools for the testing of hypotheses in support of data interpretation, and development of field programs. The archiving of benchmark data sets, documented source code, and the ability to download models with user-friendly graphical interfaces are key components of the Center's knowledge transfer objective.
- **Planners** with decision-making tools to run scenarios, and relate GIS output to environmental factors and land use while quantifying uncertainties.
- **Educators** with pre-packaged models to help illustrate surface processes, tools to build intuition with “what-if”-type model runs, case studies that integrate field data and model simulations, and prepare exploratory exercises for students. The Web-Data Specialist and EKT Specialist will be expected to work closely together and will be carefully selected to have good popular-science writing skills.

Our principal Education audiences are university students, professionals, teachers at the secondary school and college levels, and the general public. Resources to support this effort will not become available until the third year of the CSDMS effort, due to NSF budget reductions. CSDMS will jump-start our Education and KT activities by coordinating them closely with the EKT programs at the National Center for Earth-surface Dynamics (NCED), a funded NSF Science and Technology Center devoted to developing a predictive, quantitative understanding of the processes that shape the Earth's Surface.

Year 2+ (2008/09+)

- 1) Provide professional training in the use of CSDMS and its components. This first goal will be accomplished by hosting weeklong short courses for U.S. graduate students, post-docs, and professionals. These short courses will be taught by CSDMS working group members and other volunteers, and will cover topics such as: CSDMS modules, developing process algorithms, modeling multiple-process environments (e.g., longshore transport), coupling models (e.g. hillslope-fluvial, or estuarine-shelf), and complete source-to-sink modeling. These courses will be closely coordinated with the short course program already in place at NCED.

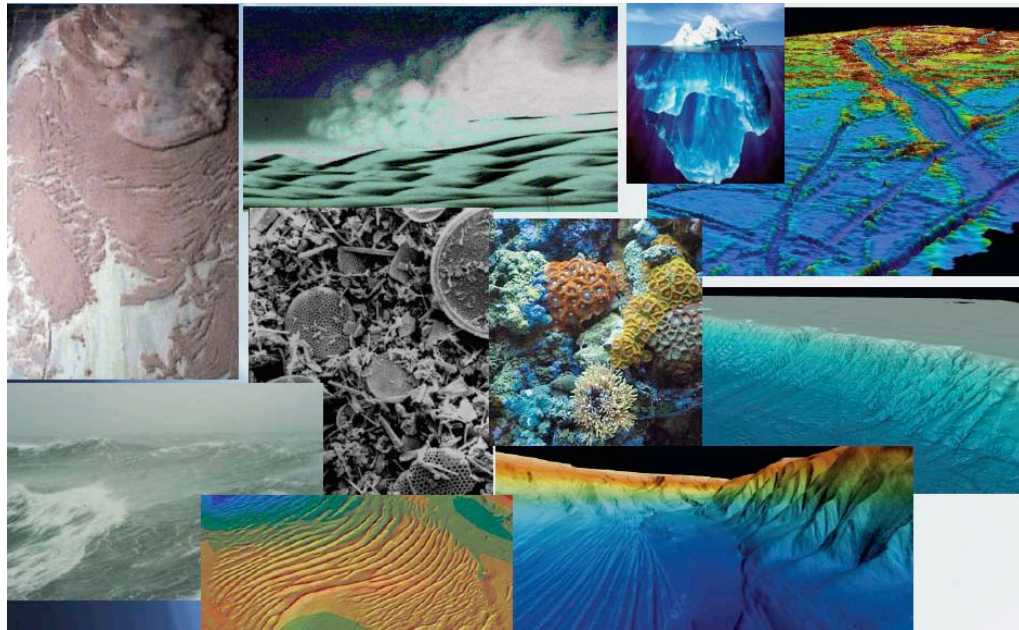
Year 3+ (2009/10+)

- 2) Use CSDMS technology to enhance undergraduate earth science education. This second goal will be addressed through its contributions to undergraduate and graduate earth-science education, by developing, deploying, and formally assessing a set of instructional modules centered on interactive, animated simulations of earth-surface processes. Here the goal is to further authentic inquiry, by engaging students in real problems. CU courses have been identified to test out these course materials and laboratory exercises once the education modules are developed. The effectiveness of the materials will be assessed using before-and-after survey methods and, in the case of a large introductory course for non-majors, interactive (“clicker”) feedback technology.
- 3) Provide CSDMS-based tools for enhancing secondary-school teaching in earth-surface science. This education goal will build on the teacher-training program already in place at NCED. This has two components: the ESTREAMS teachers in research program, in which 4-12 level teachers participate in research at NCED facilities and then develop activities

based on their experience, which are then made available via the NCED website. The second component is a series of summer Teacher Institutes and school residencies run in collaboration with the Science Museum of Minnesota in St Paul. 35 teachers have participated in these programs over three years. CSDMS will work with these programs by providing research opportunities and products to the teacher-participants using CSDMS technology, including hosting teachers at the National CSDMS facility.

- 4) Contribute to the public understanding of Earth-surface dynamics by working with informal education institutions such as science museums. CSDMS will contribute to public understanding of science by working with NCED to develop, using CSDMS technology, a three-dimensional movie that will convey the excitement of earth-surface science, while emphasizing the space-time complexity. The movie will be produced at the Science Museum of Minnesota, a national leader in this exciting new visualization technology, and will travel nationally to reach audiences in the millions of people. Funding for the movie will be provided by NCED, and is an opportunity ideally suited to showcasing CSDMS technology as well.

CSDMS will support diversity efforts by engaging the CU SMART program that nationally targets historically underserved undergraduates in science and engineering through ten-week research internships each summer <http://www.colorado.edu/graduateschool/SMART/SMARTWebsite>. The internships provide hands-on experience in research and an introduction to graduate education at a major research institution. Under the guidance of a CSDMS faculty mentor, interns would design, carry out, and formally present research projects. Interns will earn 3 hours of upper division credit, and receive all expenses and stipend. Application deadline is mid-February.



The domain of the CSDMS Marine Working Group, from top to bottom and left to right: Experimental debris flow (NCED film); Experimental turbidity current (NCED film); artist rendition of an iceberg; iceberg scoured seafloor (Norwegian Geological Survey); diatomaceous ooze SEM image; coral reef image; New Jersey margin bathymetry; Gale-generated waves, North Atlantic; Sediment Waves seaward of San Francisco Bay (USGS swath imagery); Cap de Creus Canyon, Gulf of Lions, Mediterranean (Fugro EM300 data).

5. Achieving Our Long-Range Goals

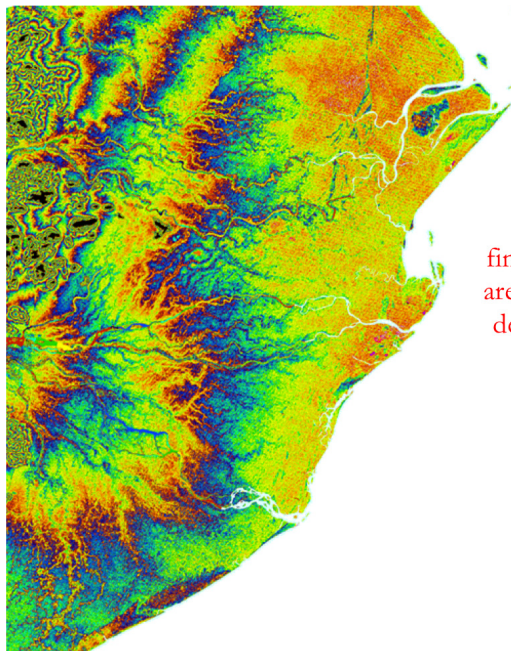
The long-term goals of CSDMS described generally in Section 2 and then in detail in Section 4, essentially involve two high level tasks:

- *Develop a modular modeling environment capable of significantly advancing fundamental earth-system science.*
- *Develop fully functional and useful repositories for CSDMS data, models, tools, and education.*

To achieve this first long-range goal, CSDMS must demonstrate that the **Common Component Architecture** (CCA) is an appropriate and sufficient approach to allow language interoperability without a significant reduction in performance. Secondly, CSDMS must develop amongst the community enough understanding of CCA to allow efficient creation and use of CSDMS diverse codes. Thirdly, CSDMS must help the community define acceptable **interfaces** for CSDMS modules. Fourthly, CSDMS must promote advanced numerical methods such as adaptive mesh refinement, thereby fulfilling its promise of providing software and ideas developed at the forefront of computational science.

Implicit within the first long-term goal is the need to define and promote a proof-of-concept challenge. The challenges have already been defined (see Section 3). Now CSDMS must organize scientists who can develop one or more coupled sets of models, enlist trial users in the community, and provide datasets with which to test the multi-scale, multi-physics model set.

To achieve the second long-range goal requires archiving and distributing useful data for model initializations and boundary conditions, for benchmarking of individual models/modules, and for CSDMS framework-integrated validation experiments. The Model/Tools Repository must be populated with stand-alone models and tools relevant to surface dynamics, including novel computational strategies. The models must be distributed to users as both source code and binaries that have been precompiled for common operating systems. Finally, the Education Repository must distribute CSDMS model simulations, educational presentations, reports and publications, short course materials, and CSDMS-hosted or sponsored workshops.



Topography of Mahanadi and Brahmani delta region sensed by the Space Shuttle Radar (SRTM) altimetry, binned at 1 m intervals, starting at sea level (white), then 1 color per 1 m interval, with colors cycled every 10 m, to a height of 100 m, then black. The crevasse splay fingers are from former distributary channels, and are seen to flare out across the very flat delta plain deposits. Image is courtesy of Albert Kettner and Mark Hannon, CSDMS Integration Facility.

6. Community Computational Resources

High-performance computing (HPC) has provided numerous advances to ocean and atmospheric science, but these advantages are not well exploited by land-surface dynamics (LSD), basin evolution (BE), and distributed transport (DT) models. LSD-BE-DT models (e.g. spatially-distributed hydrologic and fluvial landscape evolution models, ice-sheet dynamic models, coastal dynamic models) are similar to atmosphere and ocean models in that the time evolution of several spatial grids is modeled for one or more vertical layers by solving a set of coupled PDEs. However, the physically important spatial scales are much smaller than those of coupled ocean-atmosphere models, where 5m to 100m grid cells (vs. 1km to 100km cells) are required to resolve surface dynamic processes. In addition, coupled land-surface and subsurface processes are often integrated at different time scales, from seconds - minutes for channelized surface flow, to hours - days for overland and subsurface flows.

The hydrology/sedimentology, and paleoclimate communities identified six HPC applications at the 2006 NSF-sponsored workshop on HPC in Geosciences: 1) Fast turn around on end-to-end prediction in aid of natural disaster mitigation (e.g., flash flood forecasting that combines ensemble weather/hydrologic forecasting at high resolution); 2) Global simulations for water budgets and sediment/carbon delivery; 3) High resolution land surface processes in global cloud resolving models in support of sub-grid parameterizations; 4) Complex interactions in water, carbon, and nutrients within major river basins, where Earth system components (atmosphere, dynamic vegetation, biogeochemistry) are better coupled to predict at seasonal to decadal time scales, 5) Data assimilation of remote sensing data and other heterogeneous datasets to better assess land surface states at high spatial resolution, and 6) Longer geological simulations (10^3 - 10^4 yrs) of key Earth history events.

The CSDMS Integration Facility has recently secured funding, largely through the University of Colorado but with additional support from the USGS and possibly NOAA, to acquire a CSDMS-operated and dedicated Experimental Supercomputer (ES). The ES will support the CSDMS community to migrate their surface-dynamic models into the HPC world, accessing the benefits of component-based software engineering. CSDMS choice of the DoE's Common Component Architecture (CCA) with its supporting tools (e.g. Babel, Bocca, Caffeine) provides a mature HPC framework. Vendor details of the CSDMS ES are still in flux, but initial estimates suggest it will comprise between 256 - 400 cores offering 3 to 5 teraflops of computing power, and configured with two HPC approaches — 1) massive shared memory among fewer processors, and 2) the more typical parallel configuration — each running Linux with Fortran, C and C++ compilers. The CSDMS ES will be linkable to an NSF-proposed Front Range HPC with 7000 core, >100 teraflops, which in turn will be linked to the US TerraGrid, and to the proposed Cheyenne NCAR/UCAR Petascale HPC dedicated to support the NSF Geoscience Collaboratory.

7. Organizing Community Participation

Centrally important for CSDMS, is the guidance from the scientific community on how the infrastructure is designed and what this infrastructure should accomplish for their evolving research needs. All CSDMS reviews, meeting minutes, and other documents are openly available to the community in a timely fashion, for review and public discussion. Openness minimizes the risk of actual or perceived bias or conflicts of interest within CSDMS. CSDMS committees and workshops have an open and balanced representation of both the scientific and software communities.

Most of the organization of the CSDMS community is now in place. The membership has more than doubled during the first year from 80 to 170 participants. This growth is similar to the growth of the atmospheric community's Community Climate System Model (CCSM), which now exceeds over 400 participants. CSDMS membership will exceed 200 at the completion of year two and in all likelihood exceed 300 by the end of year three. Growth is unavoidable given the openness of the initiative. The new ideas brought forth by this growing community will serve to invigorate the CSDMS effort. Consequences of the growth are many (as it was for the CCSM community). Firstly, the CSDMS budget is 25% of the CCSM budget and thus providing travel support for CSDMS members to attend working group meetings will be a challenge, unless revenue supplements through NSF or other sponsors is realized. Secondly, the workload will increase on the CSDMS Integration Facility, particularly the Admin Staff. We hope that workload savings can be found in more automated systems, including web-based forums and communication. Thirdly, the Chairs of the Working Groups will need to gear up to running larger community workshops and the inherent increased technical and social difficulties that this entails.

Workshops and committee meetings will continue to be the mechanism by which we layout a software system that delivers the core functionality of earth-surface dynamics in an open and extensible fashion. As described already, CSDMS sponsors or co-sponsors topical workshops with the principal goal of increasing community participation. The Web site is an important tool for community participation. It is not just used as a means to distribute software and documentation, as described above, but it is also used for members to communicate. CSDMS website is now a *Wiki* using *MediaWiki* software — the same software used by the famous *Wikipedia*. Members can comment on the ongoing discussion that goes with their particular working group, and add comments and content to discussions taking place in other CSDMS Working Groups. CSDMS maintains email lists for each of the ten plus working groups and committees, and the web site points to individuals web pages that contain highly relevant CSDMS-related information.

Many participants provide valuable time to the CSDMS effort, often with their effort underwritten by their host organization, or through the support of funds secured from participating funding agencies and partners (NSF, NOAA, USGS, NASA, ONR, ARO, ACE, NCAR, NCED, industry).

Below are CSDMS workshop participant findings:

Arctic Coastal Zone at Risk: Prognosis and Modeling

Significant, directed research effort is required to attain a level of sophistication and computational efficiency necessary to address complex anthro-bio-geo-physical interactions inherent in modern Arctic Coast Zone (ACZ) models. Because of high socio-economic impacts associated with projected Arctic climate change, particular importance should be placed on understanding model uncertainty, limitations, and quantifying outcomes. In

addition to known processes (such as those associated with permafrost, sea ice, and surface waves), such error propagation considerations should become part of the CSDMS model framework development. The ACZ provides an opportunity given the comparatively trophic-level simplification and minimum level of direct human impact, yet the simplification points to the limited level of data to adequately validate ecosystem models. No long-term coastal morphodynamic model is identified suitable to the ACZ, e.g. one that takes into account permafrost or other ice-sediment interactions. Model integration is thus at the earliest stages for the ACZ. The present limited observation stations are not adequate for data assimilation schemes.

Mechanisms of Sediment Retention in Estuaries

Present numerical models are not capable of predicting estuarine evolution over long periods (hundreds to thousands of years), as there remain many problems in defining and quantifying the conditions at the open boundaries. Future progress should advance toward coupling models operating across different spatial and temporal scales. Behind each model lies commonly used concepts like tidal pumping and scour and settling lags that require further improvements. A hybrid model may facilitate a better solution to the sediment transport problem. Boundary conditions are the biggest problem in modeling, whereas calibration and verification require detailed synoptic-scale data. Bedform predictions are very difficult or but cannot be up-scaled. CSDMS Architecture is an important solution to advancing our understanding on how estuaries, for example, can change from exporter to importer of sediment.

Dynamics and Vulnerability of River Delta Systems

As a result of human development and global changes, deltas are now perilously out of dynamic equilibrium, being maintained at lower elevations and farther offshore than in natural conditions. Human stabilization of naturally dynamic deltaic systems is likely to result in less frequent, but catastrophic failures of delta system components following extreme events. Compounding chronic problems of deltas, extreme events may contribute to the collapse of entire deltaic systems. Although delta ecosystems are among the most productive and provide environmental goods and services of regional and global importance, human development within deltas and further upstream in the drainage basin may push deltas over ecological collapse thresholds. Research must address the full range of responses of this complex dispersal system to external forcing, and to assess its internal controls. Future programs should focus on (1) developing modeling methods for coupling biological, geochemical, physical, and human dynamics, and (2) acquisition of detailed information on forcing factors such as paleo-discharge, high resolution sea level and subsidence histories, and past records of energy regimes in the receiving basin.

Community Carbonate Modeling

The community hopes to address the following knowledge gaps: 1) How carbonate processes scale in time and space? 2) How best to include non-linear dynamics? 3) What are the feedbacks between processes, extent and importance, 4) How best to reproduce heterogeneity controls at different scales, and biogenic non-stationarity? The community supports a numerical work-bench for carbonate knowledge generation should: i) include a suite of process modules, ii) accept input from ocean, climate and hydrological fields, iii) accept observations from different sources and databases, iv) include multiple inversion/verification schemes, v) employ multiple sensitivity/response surfaces within its experimental design and include uncertainty quantification, vi) include multiple scales (up-downscaling), vii) provide multiple outputs with tie-in to Global Ocean Observatory, and viii) use CSDMS Architecture for transfer and coupling.

Organizing Community Participation – Year 1

- CSDMS Executive Committee meeting, June 13-14, 2007, INSTAAR, Boulder, CO.
- SCOR/LOICZ/CSDMS workshop on Mechanisms of Sediment Retention in Estuaries, Sept. 23-25, 2007, INSTAAR, Boulder, CO.
- GWSP/LOICZ/CSDMS Dynamics and Vulnerability of River Delta Systems - A Scoping Workshop, Sept. 26-28, 2007, INSTAAR, Boulder, CO.
- IASC/AMAP/LOICZ/CSDMS Arctic Coasts at Risk, Oct. 1-3, 2007, Tromso, Norway.
- CSDMS Terrestrial Working Group startup meeting, Dec. 2007, UC Berkeley, CA
- CSDMS Steering Committee Meeting, Dec. 17, 2007, Boulder, CO.
- Cyberinformatics and Numerics Working Group startup meeting, Feb. 4-5, 2008, INSTAAR, Boulder, CO.
- CSDMS Executive Committee meeting, Jan. 16, 2008, teleconference.
- CSDMS Community Sediment Model for Carbonate Systems, Feb. 27-29, 2008, Colorado School of Mines, Golden, CO
- Coastal Working Group startup meeting, March 8, 2008, Orlando, FL
- Marine Working Group startup meeting, March 8, 2008, Orlando, FL

Already scheduled for Year 2

- SEPM - CSDMS Research Conference on Clinoform sedimentary deposits: Aug. 15-18, 2008, Rock Springs, WY.
- I.A.G./A.I.G./ CSDMS SEDIBUD workshop on Sediment Budgets in Changing High-Latitude and High-Altitude Cold Environments, Boulder, CO, Sep. 9-13, 2008,

DOCTOR FUN



| Oct 7

Copyright © 2002 David Farley, d-farley@ibiblio.org
http://ibiblio.org/Dave/drfun.html

The daydreams of cat herders

Image courtesy of David Farley, syndicated cartoonist.

8. User Training

A key objective of CSDMS is the widespread adoption of CSDMS-developed software by the general Earth science community and, in particular, by geophysicists, engineers, environmental scientists, geomorphologists, hydrologists, sedimentologists, glaciologists and oceanographers. Significant training and comprehensive documentation are required. The CSDMS website offers its members recommended reading lists, mini-tutorials, and wiki-based web sites that offer easy communication with the CSDMS software engineers.

A series of coding camps are presently being designed to allow, for example, participants to learn the use of the CCA family of tools (*Babel*, *Ccaffine*, *Bocca*, etc). As the working groups gather momentum through their communities, they will help develop a series of best practice guidelines and training sessions for using CSDMS-coordinated software, both for gaining an understanding of the underlying algorithms and for implementation details. The CSDMS approach is to provide values to 1) the sophisticated users who require a deeper understanding of the workings of the software and will likely use several different computational components to create working codes that incorporate algorithmic innovations, 2) *Avant garde* scientists who will push the CSDMS architecture and string together several components of CSDMS software in new untried ways, and 3) the less-technically-demanding users who will want to use CSDMS codes in a standard manner (e.g., for pedagogical purposes or using standard codes as an aid in their field investigations).

The members of the Common Component Architecture (CCA) forum meet quarterly at different locations throughout the U.S.. Some of these meetings offer “coding camps” where CCA users can work side-by-side with developers on their own problems and get answers to technical questions. The CSDMS architects attended one of these meetings and found it to be extremely productive. Many of the CCA forum members are also willing and available to visit and give seminars/workshops for individual groups. We anticipate providing similar “coding camps” for CSDMS contributors, perhaps twice a year, at the Integration Office. This is one of the most effective ways of transferring technical expertise to the CSDMS community, and is in addition to numerous tutorials, documentation and other educational resources that will be provided on the CSDMS website.

9. CSDMS Membership

9.1 U.S. Academic Institutions

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

9.2 U.S. Federal Labs and Agencies

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

9.3 Foreign Membership

- | | |
|--|---|
| 1. The University of Sydney Institute of Marine Science, Australia | 5. University of Calgary, Canada |
| 2. Federal University of Itajuba, Brazil | 6. University of Copenhagen, Denmark |
| 3. Bedford Institute of Oceanography, Canada | 7. CNRS / University of Rennes I, France |
| 4. Geological Survey of Canada, Pacific | 8. IFREMER, France |
| | 9. Institut Francais du Petrole (IFP), France |
| | 10. Universite Bordeaux 1, France |

- | | |
|--|---|
| 11. Darmstadt University of Technology,
Germany | 19. Wageningen University, Netherlands |
| 12. University of West Hungary - Savaria
Campus | 20. WL Delft Hydraulics Lab, Netherlands |
| 13. University of Padova , Italy | 21. ASR Ltd., New Zealand |
| 14. University of Rome "LaSapienza", Italy | 22. GNS Science, New Zealand |
| 15. Geological Survey of Japan, | 23. National Institute of Water and
Atmosphere (NIWA), New Zealand |
| 16. JAMSTEC, Japan | 24. University of Bergen, Norway |
| 17. Delft University of Technology,
Netherlands | 25. Imperial College London, UK |
| 18. Utrecht University, Netherlands | 26. King's College London, UK |
| | 27. University of Cambridge, UK |
| | 28. University of Edinburgh, UK |

9.4 Industrial Membership and Consortium

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

9.5 Communication Strategy

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

- Through e-mail. CSDMS maintains several list servers through the CSDMS website including several for the main committees (e.g. Executive Committee, Steering Committee, Industrial Consortium) as well as for working groups and general information. A CSDMS Newsletter highlighting new developments and capabilities with appropriate links to the CSDMS website will be distributed by email on a regular quarterly basis.
- Through the <http://csdms.colorado.edu> web site. The upcoming CSDMS calendar of events is posted and continuously revised. Nearly all CSDMS documents including the annual revision of the CSDMS Strategic Plan, By-Laws, etc., are posted on this site. The Web site is the principal means for standard software downloads, sharing of community benchmarks, specifications of standards, and distribution of user & training manuals. Documents and presentations from various CSDMS-sponsored workshops and meetings are also posted to the site for the benefit of the entire community.
- The annual CSDMS Townhall meeting. This meeting will be open to all and will be a forum for open discussions of the working of CSDMS, including past and upcoming activities & the Strategic Plan. In year two, this meeting will be held in conjunction with the Fall AGU meeting in San Francisco. Depending on the success of this meeting, this may be the venue for subsequent years.
- CSDMS sponsored and co-sponsored workshops and training sessions. The current status of CSDMS will be presented at these workshops and we expect that CSDMS members will attend such workshops.

10. Five Year Management Plan

The **CSDMS Bylaws** were adopted June 14, 2007, reviewed by the CSDMS Steering Committee on Dec. 17, 2007, and revised on Jan 1, 2008, approved by the ExCom on Jan. 16, 2008 and approved by the CSDMS Steering Committee on Feb. 15, 2008 --- see Appendix 1.

10.1 CSDMS Membership (Working Groups)

Membership is principally through five CSDMS Working Group: 1) Terrestrial WG, 2) Coastal WG, 3) Marine WG, 4) Cyber-informatics and Numerics WG, and 5) Education and Knowledge Transfer WG. As of Feb 2008, 163 participants from more than 80 institutions have joined the program (see Appendix 2).

The following charge was developed and accepted by the Environmental Working Groups: 1) identify: processes that should be in their disciplinary toolkit, gaps in knowledge, and areas for numerical tool development; 2) develop both short and long term goals; 3) set scientific modeling priorities for their discipline; 3) recommend resource prioritization to the Executive Committee; 4) create and manage the environmental process modules related to their discipline; 5) ensure: quality control for the algorithms and modules for their area of expertise (benchmark validation datasets); 6) coordinate the evaluation of numerical codes according to interoperability, scientific contribution, protocol compliance, and technical documentation; 7) ensure adequacy of supporting boundary conditions and boundary initializations; 8) address the CSDMS proof-of-concept challenges; 9) provide community continuity to meet long-term CSDMS objectives; 10) stimulate proposals and input from the community.

The Cyber and Numerics Working Group develops and prioritizes the CSDMS 5-year Cyber-Infrastructure including: 1) protocols for linking modules; 2) common data structures and interfaces to link transport processes; 3) incorporation of "legacy code" from the modeling community, 4) toolkits for pre- and post-processing, and model visualization; 5) standards for benchmarking and testing modules with the setup of standardized data sets; 6) standard computational tools, including low-level routines (I/O error handling and data exchange); as well as grid generators and PDE/flux solvers; 7) infrastructure to facilitate the proof-of-concept challenges undertaken by WG; and 8) graphical user interface (GUI).

The Education and Knowledge Transfer Working Group will focus its knowledge transfer efforts on three CSDMS end-user groups: researchers, planners, and educators. CSDMS educational goals are to: 1) Provide professional training in the use of CSDMS and its components. 2) Use CSDMS technology to enhance undergraduate earth science education. 3) Provide CSDMS-based tools for enhancing secondary-school teaching in earth-surface science. 4) Contribute to the public understanding of Earth-surface dynamics by working with informal education institutions such as science museums.

10.2 The CSDMS Executive Committee (ExCom)

ExCom is comprised of organizational chairs and is the primary decision-making body of CSDMS. ExCom ensures that the NSF Cooperative Agreement is met, develops Bylaws & Operational Procedures, and sets up the annual science plan. ExCom approves the business reports, management plan, budget, partner memberships, and other issues that arise in the running of the CSDMS. Details of the governance are found in the Bylaws (Appendix 1).

10.3 The CSDMS Steering Committee (SC)

The SC includes representatives of the U.S. Federal agencies, industry, the U.S. National Academy of Science, and other learned scholars. The CSDMS SC assesses the competing objectives and needs of the CSDMS; progress of CSDMS in terms of science, management, outreach, and education; advises on revisions to the 5-year strategic plan; and approves the Bylaws and its revisions. Details of the governance are found in the Bylaws (Appendix 1).

10.4 The CSDMS Integration Facility (IF)

The IF is established at INSTAAR, University of Colorado-Boulder, at 3100 Marine Street, Boulder, with its own Campus Box and zip code. As of Feb. 1, 2008, CSDMS IF staff includes:

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

The CSDMS Integration Facility also hosts visiting scientist and to date has hosted 1) Prof. Bjarte Hannisdal (U. Bergen) to work on protocols for adding animal-sediment interactions into a CSDMS framework, 2) Dr. Gwyn Lintern (Geological Survey of Canada-Pacific) to work on flocculation dynamics, 3) Dr. Bert Jagers (Delft Hydraulics), senior Delft3D software architect, to discuss his company's philosophy and interactions with CSDMS, 4) Drs. Belasz Fekete (UNH) and John Harrison (OU) to work out a modeling framework for Global hydrological and biogeochemical modeling, and 5) BHP Billiton participants Drs. Gil Hansen, Chris Lerche and Mike Glinsky, to work on the incorporation of the QIWorkBench into the CSDMS framework.

The CSDMS Integration Facility maintains the CSDMS Repositories: 1) Data Repository; 2) Model/Tools Repository; 3) Education Repository; 4) Compliant Repository; 5) Membership Repository; 6) CSDMS Communication Repository & 7) CSDMS Governance. The CSDMS IF also facilitates CSDMS Communication: 1) Business Meetings (SC, ExCom, Partners, Directorate); 2) Working Group Meetings; 3) Workshops, 4) Short Courses; 5) Web Pages, 6) Teleconference, 7) Videoconferences, and 8) Email Communication. The IF also facilitates Community coordination, public relations, and product penetration. The IF conducts Tool/Model Protocol testing and evaluation on varied platforms, and evaluates hardware & software configurations with CSDMS products. The CSDMS IF develops the CSDMS cyber-infrastructure (e.g. coupling frameworks; licenses; protocols), and provides CSDMS software modeling guidance (expertise) to the community. The IF maintains the CSDMS vision and cooperation between disparate communities, & between field and modeling communities.

10.5 Partners

Industry partners, NGOs, and government agencies play an important role in contributing to the success of CSDMS through their financial or in-kind contributions. This 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.

Industrial Consortium Framework is established (see Appendix 3). The primary goal of the CSDMS Consortium is to engage industry stakeholders in CSDMS research. Consortium members join with the CSDMS community to address key issues in the development and use of the models and tools produced by the CSDMS initiative. Consortium members 1) demonstrate corporate responsibility and community relations; 2) are provided opportunities to contribute to the direction of CSDMS research and products; 3) have access to research activities and product development; and 4) join an association of a diverse group of scientists, universities, agencies, and industries. The industrial consortium remains in its early phase but support from ExxonMobil Research and Engineering Company and ConocoPhillips is already in place. Other companies have indicated their interest in joining a CSDMS industrial consortium, including Chevron Energy Technology Company, Shell International Exploration, Delft Hydraulics, and BHP Billiton.

Other Program Partners include funding by the federal agencies of individual efforts, or teams, whose model development research provides a contribution to the CSDMS program. These agencies include the National Science Foundation (NSF), the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), U.S. Army Corps of Engineers (ACE), and the U.S. Army Research Office (ARO).

Additionally CSDMS works closely with U.S. Federal agencies in their ongoing large project efforts: 1) NSF MARGINS Source to Sink initiative; 2) ONR model developments related to the simulation of muddy environments in the coastal zone with an emphasis on tidal flat environments; 3) USGS staff contributions (\approx \$2M in staff support) of related numerical modeling efforts, for example WRF model applications to Arctic Coastal Dynamics; 4) National Oceanographic Partnership Program (NOPP) development of the Community Sediment Transport Model with applications to coastal zone dynamics; 5) the Consortium of Universities for the Advancement of Hydrologic Sciences (CUAHSI) Humans Transforming the Water Cycle: Community-Based Activities in Hydrologic Synthesis; 6) NSF National Geoinformatics System for the United States; 7) Science Museum of Minnesota (SMM) WATER PLANET, a 5,000 square-foot traveling exhibition, web site, and associated programs focusing on the new and evolving field of Earth-system science; 8) NSF Boulder Creek Critical Zone Observatory: Weathered profile development in a rocky environment and its influence on watershed hydrology and biogeochemistry and 9) the CUASHI Hydrological Information System.

The National Oceanic and Atmospheric Administration (NOAA) and the USGS are both likely to contribute funds towards the CSDMS Experimental Supercomputer dedicated to surface dynamic simulations. The National Center for Atmospheric Research (NCAR) has offered a match on a NSF MRI proposal for a community High Performance Computer to address HPC needs of the CSDMS community.

NOAA is also providing data sets to support the success of the ‘proof of concept’ challenges. All three challenges (carbon cycle, the Anthropocene, glacial-interglacial cycles) address aspects of the Earth system that change too slowly to be fully resolved in the short instrumental record, and paleoclimate data can be used by CSDMS participants to

understand and model the changes that occur on these longer multi-decade to century to millennial time scales. NOAA operates the World Data Center for Paleoclimatology in Boulder to provide time series, and time-slice reconstructions of glacial-interglacial change and aspects of the carbon cycle. NOAA also distributes many of the data sets that bear on the Anthropocene hypothesis, and also distribute the boundary condition data sets needed by atmospheric general circulation model experiments. Finally, NOAA provides data sets that can be used for data model intercomparisons. The Global Water System Project (GWSP) has made available its global digital HydroSheds database, and its GWSP Dams and Reservoirs Database. CSDMS is also working with the Data Management System for NSF-MARGINS Sedimentological Datasets. CSDMS supports the NSF/GEON v.2.0: Geoinformatics Facility to Develop An Open Multidimensional Framework for Integration of Earth Sciences Data.

Other National Centers and agencies are providing software: 1) U.S. Army Corps of Engineers (ACE) is providing in-kind support through its contribution of the GSSHA model; 2) NCAR Community Climate System Model; 3) Delft Hydraulics (Deltares) is making available to NSF & ONR supported CSDMS participants the source code to its DELFT-3D numerical model; 4) the URS Corporation has made available its SLICE shelf transport and stratigraphy model; 5) Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has made available its Sakura turbidity current model; 6) the NOPP Coastal Sediment-Transport Model CSTM; and 6) BHP Billiton Petroleum (Americas) will contribute its QI WorkBench software for dealing with core and seismic data.

Partners have supported the CSDMS effort through the co-sponsorship and funding of CSDMS workshops, for example: 1) the Global Water System Project (GWSP) and the Land-Ocean Interactions in the Coastal Zone (LOICZ) support for the Dynamics and Vulnerability of River Deltas Workshop; 2) the Scientific Committee on Oceanic Research (SCOR) and LOICZ support for the Mechanisms of Sediment Retention in Estuaries Workshop; 3) the International Arctic Science Committee (IASC) and LOICZ support for the Arctic Coasts at Risks Workshop; 4) NSF Community Sediment Model for Carbonate Systems Workshop; and 5) SEPM research conference Clinoform sedimentary deposits: The processes producing them and the stratigraphy defining them.

The National Center for Earth-surface Dynamics (NCED) has committed financial support of 2 liaison postdocs to work jointly between NCED and CSDMS in adapting existing codes and methods for CSDMS and to insure that new results are transferred efficiently between NCED and CSDMS. NCED will develop 1-3 shared short courses with CSDMS, including full or partial support for development and participant costs from NCED funds. NCED will include CSDMS people and research themes in our existing teacher-training programs (NCED ESTREAMS and Science Museum of Minnesota Teacher Institutes). NCED will work closely with CSDMS to develop jointly a 3D movie on surface dynamics with the Science Museum of Minnesota, and will investigate possibilities for incorporating CSDMS products into our existing and highly successful EarthScapes hands-on exhibits at the Museum.

10.6 Formulating CSDMS Priorities and Management of Its Resources

Year One is the start up year for CSDMS, wherein the CSDMS governance is established (Appendix 1 and 3), Committees and Working Groups are populated with world experts (Appendix 2), the Integration Facility is set-up in Boulder at INSTAAR, with all initial staff hired (section 10.4), communication systems with the community are developed (section 9.5), outreach and coordination with US Federal Labs and Agencies is progressed (section 9.2), outreach to industry is begun (section 9.4), outreach to the broader surface dynamic community is ongoing with a variety of scientific Workshops (section 7), funding for CSDMS high-performance computing procured (section 6), and the scientific goals and cyber-infrastructure is established and developed to meet those goals and challenges (sections 1, 2, 3, 4, and 5). Expenditures (section 11) related to the Integration Facility staff are largely as was proposed. Travel expenses (section 11) related to IF staff travel has turned out to substantively under budgeted as staff has worked with the CUASHI community, the ESMF community, the CCA community, the Arctic coastal community, the MARGINS community, the NOPP modeling community, and the Community Carbonate Modeling community. Travel savings partly underwrote these unanticipated expenditures, with savings from Steering Committee travel, and with the Executive holding its meeting via teleconference. Workshop participation costs and other direct costs are within a small fraction of the original proposal. The carry over 8% shown below is section 11, is likely to be even smaller when the yearend totals are finalized by the middle of May of 2008.

Year two will see expenditures related to further refinements in the CSDMS communication systems with greater community activity (section 9.5), further coordination with US Federal Labs with a CSDMS Interagency forum established (section 9.2), the Industry Consortium finalized (section 9.4), outreach to the broader surface dynamic community continued through scientific Workshops (e.g. Sedibud, Clinoform), the CSDMS high-performance computing installed and launched as a community open system (section 6), and further advances in the CSDMS cyber-infrastructure achieved (sections 1, 2, 3, 4, and 5). Expenditures (section 11) related to the increased IF staff travel will hopefully be covered via year-one carryover funds, if available. Workshop participation costs will increase as the CSDMS community grows. The Computer Services costs will spike in year two as the new CSDMS HPC comes on line. During the middle of Year-two, a software engineer will be hired through a nationally advertised search, and begin to support the Environmental Working Groups, and help them identify and convert targeted open-source surface-dynamic models to be compliant with the CSDMS Architecture.

Year three and beyond will see greater allocation of resources to meet the grand challenges of CSDMS (for details see sections 1, 2, 3, 4, and 5) within the broader surface dynamic community, employing a fully functioning CSDMS-dedicated high-performance computer tied into NCAR and TerraGrid systems (section 6), running a multitude of CSDMS compliant and interlinked surface dynamic modules. The Computer Services costs will continue to grow as the community grows in their use of the CSDMS HPC. Workshop participation costs will likely need supplementation from extra-source funds, as the CSDMS community grows. By year-three a scientist dedicated to the Education and Knowledge Transfer activities will be hired to support the EKT Working Group activities, such as developing a suite of educational modules (section 4.5).

10.7 Annual Science and Management Plan, Year 2

Goal 1) Establish interface standards that define precisely the manner in which components can be connected (see section 4.1 for details). **Milestone:** Evaluation of existing interface standards (e.g. OpenMI, ESMF). **Resource Allocation:** Software engineer (SE) 0.25 FTE

Goal 2) Link refactored code contributions from the community as CSDMS components within the CSDMS framework (see section 4.1, 4.2, 4.3). **Milestone:** link SedFlux model to CHILd model using CCA. **Resource Allocation:** SE 0.25 FTE

Goal 3) Implement a glacier erosion model (e.g. by R. Anderson) and with a distributed hydrologic model (e.g. TopoFlow) as an application built from CCA-compliant components (see section 4.1, 4.2). **Resource Allocation:** SE 0.5 FTE

Goal 4) Implement a landscape evolution model (e.g. CHILd) and a coastal evolution (e.g. Ashton-Murray Model) built as CCA compliant components (see section 4.1, 4.3). **Resource Allocation:** 0.5 FTE of an SE

Goal 5) Explore the coupling of a 3D hydodynamic ocean model within CSDMS/CCA (e.g. ROMS or Delft3D-Flow) (see section 4.1, 4.4). **Resource Allocation:** SE 0.25 FTE

Goal 6) Begin to assemble a set of standard components that transcend model components and facilitate their linkage of components into working applications (see section 4.1). **Milestone:** Evaluate solvers such as PETSc & format converters. **Resource Allocation:** SE 0.125 FTE

Goal 7) Create two educational modules, conduct a training workshop and assist the CSDMS community in preparing code and model contributions that comply with the CSDMS standards and interfaces (see section 4.1, 4.5). **Resource Allocation:** SE 0.25 FTE

Goal 8) Develop the three CSDMS repositories (Data, Model, & Education), with community contributions as outlined in Section 2. **Target:** A doubling of the number of data sets, contributed models and educational presentations hosted on the CSDMS site; track community interest and use of this material. **Resource Allocation:** Executive Assistant (EA) 0.25 FTE, Web Master (WM) 0.25 FTE

Goal 9) Purchase and setup the CSDMS Experimental Supercomputer, test compilers with SedFlux, develop and open up to the CSDMS community for job sharing (see Section 6). **Resource Allocation:** SE 0.125 FTE, Executive Director (ED) 0.25 FTE, EA 0.125 FTE, \$450K

Goal 10) Further develop the CSDMS Wiki website in aid of community integration and participation, as outlined in Section 7. **Target:** Active use in the website by CSDMS management and members of the five Working Groups, in support of the 2008/09 goals (see Section 4). **Resource Allocation:** EA 0.125 FTE, WM 0.25 FTE

Goal 11) Organize and/or sponsor and/or host 3 workshops (Clinoform, Sedibud, CUAHSI Natl. Meeting) meeting, 5 working group meetings, 4 management meetings, 1 Open Town-hall meeting and 1 short course (coding camp). **Target:** Discussed in detail in sections 4.1, 4.2, 4.3, 4.4, 4.5 under Year 2 (2008/09) Goals, and sections 7 & 8. **Resource Allocation:** ED 0.25 FTE, EA 0.25 FTE, \$60K in workshop travel, \$12K in other travel support.

Goal 12) Host the Industry Consortium first meeting, the U.S. interagency partners, further develop the EKT Working Group, represent CSDMS within the U.S. and abroad, run the day to day CSDMS operations in an efficient and smooth manner. **Resource Allocation:** EA 0.25 FTE, ED 0.25 FTE, \$18K travel.

11. NSF Revenue & Expenditure

	Proposal, Expenditures, Year 1	04/1/07-03/31/08	Proposal Year 2	Proposal Year 3	Proposal Year 4	Proposal Year 5
A. Salaries and Wages						
Executive Director:	\$48,986	\$47,895	99,382	103,109	89,143	73,918
Software Engineers*:	\$102,750	\$97,273	163,638	204,531	212,201	220,159
Communication Staff**	\$20,000	\$17,054	21,500	69,613	72,224	74,933
Administrative Staff**	\$50,891	\$47,964	73,159	80,484	83,494	86,616
Total Salaries and Wages	\$223,120	\$194,346	\$336,179	\$457,737	\$457,062	\$455,626
*Software engineers						
**Includes Web Master + EKT staff						
***Executive Assistant, System Administrator, Accounting Tech						
B. Fringe benefits	\$53,057	\$48,644	71,152	97,311	97,178	96,886
D. Travel						
Center Staff:	\$12,000	\$23,331	14,000	15,000	15,000	15,000
Steering Committee	\$3,000	\$1,580	6,000	6,000	7,000	7,000
Executive Committee	\$6,000	\$3,560	6,000	7,000	7,000	7,000
Total Travel Costs	\$21,000	\$28,471	\$26,000	\$28,000	\$29,000	\$29,000
E. Conference Meeting Workshop Participation						
Workshop Participants	\$40,000	\$37,000est.	60,000	60,000	60,000	60,000
F. Other Direct Costs						
Materials & Supplies	\$3,000	\$1,313	2,000	3,000	3,000	3,000
Publication Costs	\$1,000	\$6,163	3,000	4,000	4,000	4,000
Computer Services:	\$10,000	\$6,420	8,000	28,000	32,000	32,000
Communications	\$2,000	\$798	3,000	3,000	3,000	3,000
Total Other Direct Costs	\$16,000	\$14,694	38,000	51,000	56,000	56,000
G. Total Direct Costs	\$352,684	\$322,155	519,331	681,048	685,240	683,512
H. Total Indirect Costs						
On Campus: 49.0%	\$153,215	\$140,235	230,952	304,314	306,368	305,521
I. Total Costs	\$500,932	\$463,390	744,403	985,362	991,608	989,033
J. Carry Forward		estimate \$37,541 (as of 03/08)				

Additional Year 1 Funds Received by CSDMS Personnel:

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

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

ConocoPhillips: Cold-climate, higher latitude sedimentary environments: Sedimentary architecture and reservoir properties, 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: \$220K

ExxonMobil: Sedimentary Response to Syndepositional Faulting GIFT \$30K

Appendix 1: By-Laws of the Community Surface Dynamics Modeling System (Feb. 15, 2008)

PREAMBLE

The Community Surface Dynamics Modeling System (CSDMS) assumes responsibilities to develop, support, and disseminate to the earth-science research and teaching community integrated software modules that are aimed at predicting the erosion, transport, and deposition of sediment and solutes in landscapes and their repository sedimentary basins. The goal of CSDMS is to enable the rapid development and application of linked dynamical models tailored to specific landscape-basin evolution (LBE) problems at time scales that range from years to thousands of years or longer, and spatial scales that include global, regional and local aspects of the earth's surface — from the mountain tops covered in glaciers to the deep seafloor and their sediments. To foster longer-term progress in surface modeling, CSDMS gathers and makes available models designed to elucidate poorly understood aspects of landscape and seascape dynamics. CSDMS develops and maintains a high-level of community participation to ensure:

- a) Well-documented and user-friendly LBE software that keeps pace with both hardware and scientific developments;
- b) Partnerships with related computational and scientific programs in order to eliminate duplication of effort, leverage mutual progress, and provide and benefit from an intellectually stimulating environment;
- c) Appropriate training for both the users and teaching communities;
- d) Hardware and personnel resources to support and facilitate software development and its use by the community;
- e) Strong linkage between what is predicted by CSDMS codes and what is observed both in nature and in physical experiments.

CSDMS develops and maintains the computational system to ensure the portability and interoperability of modules, the computational efficiency of system code, and the clarity and consistency of documentation. CSDMS offers pedagogically evaluated LBE technology to enhance and inform education in environments of high school, undergraduate programs, and science museums.

These By-Laws of the Community Surface Dynamics Modeling System (CSDMS) are adopted by its Members for the purpose of conducting CSDMS business in a collegial manner. They do not override the standard responsibilities and prerogatives of Principal Investigator and his/her institution.

Articles

ARTICLE I. NAME

Section 1. Name: The name of the Organization is *Community Surface Dynamics Modeling System (CSDMS)*.

ARTICLE II. WORKING GROUPS, MEMBERS AND THEIR INSTITUTIONS

Section 1. Working Groups: The five Working Groups to support the CSDMS program include three (3) Environmental Working Groups and two (2) Integrative Working Groups. The three key Environmental Working Groups are:

- i) Terrestrial WG: weathering, hillslope, fluvial, glacial, aeolian, lacustrial;
- ii) Coastal WG: delta, estuary, bays and lagoons, nearshore;
- iii) Marine WG: shelf, carbonate, slope, deep marine.

The two key Integrative Working Groups are:

- iv) Education and Knowledge Transfer (EKT) WG: includes marketing to gain end-users, workshops to provide training for end-users, web-based access to simple models (e.g. K-12 teaching), access to archives of simulations. This WG will interact closely with its Partner Committees (Industry, Agency), field programs, and cyberinformatic partners.
- v) Cyber-Infrastructure and Numerics WG: includes technical computational aspects of the CSDMS, ensures that the modeling system properly functions and is accessible to users; software protocols are maintained, along with model standardization and visualization.

Section 2. Membership: Working Group members shall be holders of an academic or research appointment, with major responsibilities for instruction and/or research in the earth, environmental and engineering sciences, in a department, program, or other organizational unit of their Institutions (academic institutions, not-for-profit organizations, state and federal labs, and consulting and industrial companies), and have demonstrated a major commitment to research in Earth System Science with a particular emphasis on computational earth-surface dynamics, and related fields (hydrology, fluvial processes, biogeochemistry, sedimentology, stratigraphy, geomorphology, glaciology, oceanography, marine geology, climate forcing, active tectonics, surface geophysics, remote sensing, geomathematics, computational fluid dynamics, computational science, and environmental engineering). Applicants may apply to the CSDMS Integration Facility to join one or more of the CSDMS Working Groups. The CSDMS Integration Facility shall maintain a list of Members and their Institutions. Working Group membership requires a two-thirds majority approval of the CSDMS Executive Committee. A membership fee may be levied on for-profit organizations. Working Group Chairs may appoint a Coordinating Committee.

Section 3. Responsibilities/Activities:

- iv) **Group Discussion:** Stay current in the processes and models associated their disciplinary toolkit, and identify gaps in knowledge and areas where numerical tools need to be developed. Set scientific modeling priorities for their discipline. Make recommendations for resource prioritization and facilitate the movement of these priorities up the hierarchy from technology group to steering committee.
- v) **Review Activities:** Ensure quality control for the algorithms and modules for their area of expertise (benchmarking and model testing). Coordinate the evaluation of numerical codes according to interoperability, scientific contribution, and technical documentation. Ensure adequacy of supporting boundary conditions and boundary initializations.
- iv) **Group Project:** Address a CSDMS proof-of-concept challenge, if appropriate.
- v) **Individually and collectively:** Stimulate proposals and input from the community. Create and/or manage the various environmental process modules related to their discipline. Provide community continuity to meet long-term CSDMS objectives.
- vi) **Meetings:** Working Groups will coordinate much of their activity via remote communication systems, but are encouraged to meet as resources and interests permit.
- vii) **Reporting:** Working Groups will report annually on their progress.

Section 4. Foreign Membership: Working Group members from foreign academic institutions, not-for-profit organizations, foreign government labs, and consulting and industrial companies, are offered all of the privilege of U.S. working group members, except for the privilege of voting for the Chairs of the Working Groups that reside on the governing body of CSDMS — the CSDMS Executive Committee.

Section 5. Resignation or Removal: Any Member may resign at any time by giving written notice to the Chairperson of the Steering Committee, or to the CSDMS Executive Director. Such resignation shall take effect at the time of receipt of the notice, or at any later time specified therein. Given sufficient cause, any

Member may be removed by the affirmative vote of two-thirds of the Members of the CSDMS Executive Committee.

Section 6. Quorum: Except as may be otherwise expressly required by these By-Laws, at all CSDMS Working Group meetings, attendance and/or a notification of intent to attend by thirty percent (30%) of the members then serving shall constitute a quorum. For the purpose of the election of their Executive Committee member (Working Group Chair), a quorum shall be determined by a simple majority.

Section 7. Voting: Each CSDMS WG member shall be entitled to one vote. Except as otherwise expressly required by law or these By-Laws, all matters shall be decided by the affirmative vote of a majority of the Working Group members present at the time of the vote, if a quorum is then present.

Section 8. Action without a Meeting: Any action required or permitted to be taken by the CSDMS members, or the Executive Committee, may be taken without a meeting if the CSDMS members, or the Executive Committee, consent in writing to the adoption of a resolution authorizing the action. The resolution and the written consents thereto shall be filed with the minutes of the proceedings of the CSDMS members or the Executive Committee.

ARTICLE III. CSDMS EXECUTIVE COMMITTEE

Section 1. Executive Committee of CSDMS: The Executive Committee (ExCom) will comprise a) Executive Director and PI of the award as Chair, (non-voting, except to break a tied vote), b) Chair of the Steering Committee (voting); c) Chief Software Architect (non-voting), d) Chairs of the defined working groups (voting): (i) Terrestrial, (ii) Coastal, (iii) Marine, (iv) Cyber-infrastructure and Numerics, and (v) Education and Knowledge Transfer. The elected members of ExCom shall have terms not to exceed three years or until his or her successor is chosen and qualified. Members of ExCom other than the chair of the Steering Committee may not simultaneously serve on the Steering Committee.

Section 2. Powers of the Executive Committee of CSDMS: The ExCom is the primary decision-making body of the CSDMS, and will meet twice a year to approve the annual science plan, the semi-annual reports, the management plan, budget, partner membership, and other day-to-day issues that arise in the running of the CSDMS. The Executive Committee will ensure that the objectives of the Cooperative Agreement are met. The ExCom will develop the By-Laws and Operational Procedures, to be co-approved by the Steering Committee. At all meetings of ExCom, the presence of a simple majority of its members then in office shall constitute a quorum for the transaction of business. So long as they do not conflict with the responsibilities of the Principal Investigator (the CSDMS Executive Director), power in the management of the affairs of the CSDMS Organization is vested in the CSDMS Executive Committee. To this end and without limitation of the foregoing or of its powers expressly conferred by these By-Laws, the CSDMS Executive Committee shall have power to authorize such action on behalf of the Organization, make such rules or regulations for its management, and create additional offices or special committees. The Executive Committee shall have the power to fill vacancies in, and change the membership of, such committees as are constituted by it. Appointments of Working Group membership shall rest with the Executive Committee.

The CSDMS Executive Committee will co-share authority with the CSDMS Steering committee to amend or repeal the By-Laws, or the adoption of new By-Laws.

Section 4. Executive Director: The Executive Director shall, when present, preside at all meetings of the Executive Committee and shall perform such other duties and exercise such other powers as shall from time to time be assigned by the Executive Committee. The Executive Director shall be an *ex officio* member of all CSDMS committees. The Director is the Chief Executive Officer of the Organization, and unless authority is given by the Executive Committee to other officers or agents to do so, he or she shall execute all contracts and agreements on behalf of the Organization. The Director shall be the Principal Investigator on proposals, which fund the core CSDMS Facility. It shall be his or her duty, insofar as the facilities and funds furnished to him or her by the Organization permit, to see that the purposes, orders and voting within the CSDMS Organization are carried out. The Director shall preside at CSDMS-wide town-hall meetings.

Section 5. Chairperson of the Steering Committee: The SC Chairperson when present shall preside at all meetings of the Steering Committee and perform such other duties and exercise such other powers as shall from time to time be assigned by the Executive Committee. The Chairperson of the Steering Committee shall be an *ex officio* member of all CSDMS committees. After the Chair's term is complete, they will be offered the honorary title of Past-Chair and provided with travel funds, when available, to attend CSDMS meeting as appropriate to their interest and CSDMS need.

Section 6. Chief Software Architect: The Chief Software Architect will act as the chief advisor to the CSDMS Director and Executive Committee on matters of software development and integration. The Chief Software Architect shall be a non-voting member of the Executive Committee.

Section 7. Chairs of Working Groups: Chairs of the defined working groups will be full voting members of the Executive Committee and will represent the following areas of surface dynamics expertise: (i) Terrestrial Systems, (ii) Coastal Systems, (iii) Marine Systems, (iv) Cyber-infrastructure & Numerics, and (v) Education and Knowledge Transfer. They will have the authority to call meetings of the working groups they are responsible for, and to meet the collective long-term CSDMS objectives.

Section 8. Election and Term of Office: Appointments of the Executive Committee, for the first start-up year only, shall rest with the Principal Investigator. All members of the Executive Committee must stand for election thereafter. The Chairperson of the Steering Committee shall be elected by a virtual vote of the CSDMS membership orchestrated and recorded by the CSDMS Executive Assistant, for a term not to exceed three years or until his or her successor is chosen and qualifies. Chairs of the Working Groups shall be elected by the members of the respective working groups, orchestrated and recorded by the CSDMS Executive Assistant, for terms not to exceed three years or until their successors are chosen and qualify, and they shall be eligible for re-election.

Section 9. Resignation: Any Officer may resign at any time by giving written notice to the Chairperson of the Steering Committee, or the CSDMS Executive Director. Such resignation shall take effect at the time of receipt of the notice, or at any later time specified therein.

Section 10. Vacancies: Any vacancy in any Office may be filled for the unexpired portion of the term of such office by the Executive Director.

Section 11. Removal: Any officer may be removed at any time with cause by a vote of the Executive Committee.

ARTICLE IV. OPEN MEETINGS

Section 1. Annual CSDMS Meeting: An annual open meeting of the CSDMS membership will be held to solicit comment and feedback from the community. Comments from the community will be recorded and forwarded to the CSDMS Executive Committee and the CSDMS Steering Committee.

Section 2. Special Meetings: Special meetings may be called by the Chairperson of the Steering Committee, or by the CSDMS Executive Director, upon written request of at least one-fifth (1/5) of the membership of the CSDMS Working Groups.

Section 3. Place of Meetings: The CSDMS Executive Director shall designate the place and forum (face-to-face or virtual) of the annual meeting or any special meeting and which shall be specified in the notice of meeting or waiver of notice thereof. The meeting venue will be chosen to maximize community participation, for example, to be in conjunction with a popular science meeting (AGU, Ocean Sciences, GSA, etc)

Section 4. Notice of Meetings: Notice of such meeting of the CSDMS members shall be given at least sixty (60) days before the date fixed for the meeting.

ARTICLE V. STEERING COMMITTEE AND OTHER COMMITTEES

Section 1. Steering Committee: In order to carry out and oversee CSDMS operations, a Steering Committee (SC) shall be established. The Steering Committee will comprise eight (8) members: six (6) selected by the ExCom to represent the spectrum of relevant Earth science and computational disciplines, and one (1) from each of the two Partner Sub-Committees. The serving NSF program officer or his/her designate, and the Executive Director or his/her designate, will serve as *ex officio* members of the SC. During SC meetings, there may be occasions when these *ex officio* members would exclude themselves from discussions.

The SC members will serve terms up to three years duration. The Steering Committee will meet once a year to assess the competing objectives and needs of the CSDMS; will comment/advise on the progress of CSDMS in terms of science (including the development of working groups and partner memberships), management, outreach, and education; and will comment on and advise on revisions to the 5-year strategic plan. The Steering Committee will provide a timely report to the Executive Director who is to respond within four weeks.

Section 2. Partner Committees: The Partner Committees (PCs) will comprise a U.S. Federal Agencies Committee, and separately, an Industrial Partners or consortium committee. The PCs will be provided with all relevant documents in order to provide meaningful feedback to the Executive Committee and to the NSF Program Director.

Section 3. Special or Standing Committees: The ExCom may create such special or standing committees as may be deemed desirable, the members of which shall be appointed by the Executive Director from among the Membership, with the Membership approved by the Executive Committee. Each such committee shall have only the lawful powers specifically delegated to it by the Executive Committee.

ARTICLE VI. ELECTIONS

Section 1. Executive Committee: After the first year, with the exception of the Executive Director and the Chief Software Architect, the Executive Committee members will be elected by the CSDMS Membership in accordance with the procedures established in this Article.

Section 2. Nominations for the Executive Committee: In consultation with the Steering Committee, the Executive Director will nominate candidates for each position to be filled. The Membership is encouraged to suggest nominees to the Executive Director.

Section 3. Election: Election shall be conducted electronically. Electronic or Paper votes must be received by the CSDMS Integration Facility by the deadline specified in the ballot. The outcome of the election will be decided by a simple majority of the votes cast.

Section 4. Counting of ballots: Ballots shall be counted by the Steering Committee Chair or his/her designated representative.

ARTICLE VI. COMPENSATION

Section 1. Compensation: No Member shall be paid any compensation for serving on the CSDMS Executive Committee, Steering Committee or other committees and Working Groups. Representatives may be reimbursed for the actual expenses incurred in performing duties assigned to them, within limitations of the host Institution's budget associated with the NSF Cooperative Agreement 0621695.

ARTICLE VII. AMENDMENTS TO THE BY-LAWS

Section 1. Amendments: All By-Laws of the Organization shall be subject to amendment or repeal and new By-Laws may be made by the affirmative vote of two-thirds of the Executive Committee and the Steering Committee.

Appendix 2: CSDMS Working Group Participants (Feb. 1, 2008)

*denotes chair of working group

Education and Knowledge Transfer Working Group

First Name	Last Name	Institution	Country
Karen	Campbell	University of Minnesota	USA
Patrick	Hamilton	Science Museum of Minnesota	USA
G. Walker	Johnson	University of Texas at El Paso	USA
Wei	Luo	Northern Illinois University	USA
Paul	Morin	University of Minnesota	USA
Damian	O'Grady	Exxon Mobil Company	USA
Irina	Overeem	University of Colorado - Boulder	USA
Chris	Paola	University of Minnesota	USA
Jon	Pelletier	University of Arizona	USA
Lincoln	Pratson*	Duke University	USA
Alexey	Voinov	Chesapeake Community Modeling Program	USA
Charles	Vorosmarty	University of New Hampshire	USA

Cyber-Infrastructure and Numerics Working Group

First Name	Last Name	Institution	Country
Philip	Allen	Imperial College London	UK
Ewa	Deelman	University of Southern California	USA
Jay	Famiglietti	University of California, Irvine	USA
Balazs	Fekete	University of New Hampshire	USA
Efi	Foufoula-Georgiou	University of Minnesota	USA
David	Furbish	Vanderbilt University	USA
Jon	Goodall	University of South Carolina	USA
Didier	Granjeon	Institut Francais due Petrole	France
Gil	Hansen	BHP Billiton Petroleum	USA
Alan	Howard	University of Virginia	USA
Eric	Hutton	University of Colorado - Boulder	USA
Matthias	Imhof	Exxon Mobil Company	USA
G. Walker	Johnson	University of Texas at El Paso	USA
Wei	Luo	Northern Illinois University	USA
David	Maidment	University of Texas	USA
Eckart	Meiburg	University of California, Santa Barbara	USA
Helena	Mitasova	North Carolina State University	USA
Scott	Peckham	University of Colorado - Boulder	USA
Michael	Pyrz	Chevron Energy Technology Company	USA
Eugene	Rankey	University of Miami	USA
Ettore	Salusti	INFN, University of Rome "LaSapienza"	Italy
Mark	Schmeeckle	Arizona State University	USA
Dogan	Seber	University of California - San Diego	USA
Rich	Signell	USGS	USA
Kenneth	Skene	Exxon Mobil Upstream Research Company	USA
Jordan	Slott	Duke University	USA
Tao	Sun*	Exxon Mobil Upstream Research Company	USA
David	Tarboton	Utah State University	USA
Daniel	Tetzlaff	Schlumberger Information Solutions	USA
Alexey	Voinov	Chesapeake Community Modeling Program	USA

Terrestrial Working Group

First Name	Last Name	Institution	Country
Philip	Allen	Imperial College London	UK
Bob	Anderson	University of Colorado	USA
Suzanne	Anderson	University of Colorado	USA
Mikael	Attal	University of Edinburgh	UK
Andreas	Baas	King's College London	UK
Mike	Blum	Louisiana State University	USA
Susan	Brantley	Penn State University	USA
Philippe	Davy	CNRS / University of Rennes I	France
Bill	Dietrich	University of California - Berkeley	USA
Tom	Drake	Office of Naval Research (ONR)	USA
Jennifer	Duan	University of Arizona	USA
Michael	Ellis	National Science Foundation, EAR	USA
Tom	Farr	Jet Propulsion Lab	USA
David	Furbish	Vanderbilt University	USA

Joe	Galewsky	University of New Mexico	USA
Basil	Gomez	Indiana State University	USA
William	Goran	Army Corp of Engineers	USA
Laurel	Griggs Larsen	University of Colorado	USA
John	Harrison	Washington State University	USA
Jens	Hartmann	Darmstadt University of Technology	Germany
Audrey	Heurta	Penn State University	USA
Michael	Hofmockel	Duke University	USA
John	Holbrook	University of Texas-Arlington	USA
Alan	Howard	University of Virginia	USA
Erkan	Istanbulluoglu	University of Nebraska, Lincoln	USA
Bert	Jagers	WL Delft Hydraulics Lab	Netherlands
Edward	Johnson	University of Calgary	Canada
Albert	Kettner	University of Colorado - Boulder	USA
David	Kinner	Western Carolina University	USA
Eric	Kirby	Penn State University	USA
Maarten	Kleinhans	Utrecht University	Netherlands
Jim	Kubicki	Penn State University	USA
Venkat	Lakshmi	University of South Carolina	USA
Stephen	Lancaster	Oregon State University	USA
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Nicola	Litchfield	GNS Science	New Zealand
Wei	Luo	Northern Illinois University	USA
Shawn	Marshall	University of Calgary	Canada
Thomas	Meixner	University of Arizona	USA
Paul	Morin	University of Minnesota	USA
Simon	Mudd	University of Edinburgh	UK
Jeff	Niemann	Colorado State University	USA
Fred	Ogden	University of Wyoming	USA
Irina	Overeem	University of Colorado - Boulder	USA
Chris	Paola	University of Minnesota	USA
Thanos	Papanicolaou	University of Iowa	USA
Gary	Parker	University of IL-Urbana-Champaign	USA
Scott	Peckham	University of Colorado - Boulder	USA
Jon	Pelletier	University of Arizona	USA
Taylor	Perron	Harvard University	USA
Tad	Pfeffer	University of Colorado	USA
George	Postma	Utrecht University	Netherlands
Josh	Roering	University of Oregon	USA
James	Selegan	U.S. Army Corps of Engineers	USA
Rudy	Slingerland	Penn State University	USA
Péter	Sólyom	University of West Hungary - Savaria Campus	Hungary
John	Swenson	University of Minnesota-Duluth	USA
David	Tarboton	Utah State University	USA
Arnaud	Temme	Wageningen University	Netherlands
Greg	Tucker*	Cooperative Institute for Research in Environmental Sciences (CIRES)	USA
Craig	Tweedie	University of Texas at El Paso	USA
Gert Jan	Weltje	Delft University of Technology	Netherlands
Brian	Yanites	University of Colorado - Boulder	USA

Coastal Working Group

First Name	Last Name	Institution	Country
Andrew	Ashton	Woods Hole Oceanographic Institute	USA
Andreas	Baas	King's College London	UK
Marcos	Bernardes	Federal University of Itajuba	Brazil
Christian	Bjerrum	University of Copenhagen	Denmark
Mike	Blum	Louisiana State University	USA
Joseph	Calantoni	Naval Research Laboratory	USA
Florence	Cayocca	IFREMER	France
Giovanni	Coco	National Institute of Water & Atmosphere (NIWA)	New Zealand
Peter	Cowell	University of Sydney Institute of Marine Science	Australia
Andrea	D'Alpaos	University of Padova	Italy
Philippe	Davy	CNRS / University of Rennes I	France
Tom	Drake	Office of Naval Research (ONR)	USA
Sergio	Fagherazzi	Boston University	USA
Rocky	Geyer	Woods Hole Oceanographic Inst. (WHOI)	USA
Liviu	Giosan	Woods Hole Oceanographic Inst.	USA
Daniel	Hanes	USGS Pacific Science Center	USA
Jeff	Harris	University of Rhode Island	USA
John	Harrison	Washington State University	USA
Shawn	Harrison	ASR Ltd.	New Zealand
Susan	Hazlett	University of Alaska Fairbanks	USA
Piet	Hoestra	Utrecht University	Netherlands
Alan	Howard	University of Virginia	USA
Tom	Hsu	University of Florida	USA
Bert	Jagers	WL Delft Hydraulics Lab	Netherlands
Felix	Jose	Louisiana State University	USA
Maarten	Kleinhans	Utrecht University	Netherlands
Stefano	Lanzoni	University of Padova	Italy
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Tom	Lippman	Ohio State University	USA
Marco	Marani	University of Padova	Italy
Dylan	McNamara	Duke University	USA
Laura	Moore	Oberlin College	USA
Simon M.	Mudd	University of Edinburgh	UK
Brad	Murray*	Duke University	USA
Alan	Niedoroda	URS Corp	USA
Andrea	Ogston	University of Washington	USA
Scott	Peckham	University of Colorado - Boulder	USA
Will	Perrie	Bedford Institute of Oceanography	Canada
George	Postma	Utrecht University	Netherlands
Marina	Rabineau	University of Brest	France
Gerben	Ruessink	Utrecht University	Netherlands
Yoshiki	Saito	Geological Survey of Japan	Japan
Larry	Sanford	University of Maryland	USA
Steve	Scott	U.S. Army Eng. Research & Development Center	USA
Sybil	Seitzinger	Rutgers University	USA
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
Matthew	Wolinsky	University of Minnesota	USA

Marine Working Group

First Name	Last Name	Institution	Country
David	Anderson	NOAA	USA
John	Andrews	University of Colorado	USA
Steve	Bergman	Shell International Exploration	USA
Christian	Bjerrum	University of Copenhagen	Denmark
James	Buttles	Massachusetts Institute of Technology	USA
Florence	Cayocca	IFREMER	France
Tom	Drake	Office of Naval Research (ONR)	USA
Federico	Falcini	University of Rome "LaSapienza"	Italy
Andrea	Fildani	Chevron Energy & Technology Company	USA
Carl	Friedrichs	Virginia Institute of Marine Science (VIMS)	USA
Marcelo	Garcia	University of IL-Urbana-Champaign	USA
Bjarte	Hannisdal	University of Bergen	Norway
Courtney	Harris	William & Mary	USA
Susan	Hazlett	University of Alaska Fairbanks	USA
Jasim	Imran	University of South Carolina	USA
Bert	Jagers	WL Delft Hydraulics Lab	Netherlands
Chris	Jenkins	University of Colorado	USA
Philippe	Joseph	Institut Francais du Petrole	France
Chris	Kendall	University of South Carolina	USA
Yusuke	Kubo	JAMSTEC	Japan
Steven	Kuehl	William & Mary	USA
Gwyn	Lintern	Geological Survey of Canada, Pacific	Canada
Eckart	Meiburg	University of California, Santa Barbara	USA
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
Ross	Powell	Northern Illinois University	USA
David	Pyles	Colorado School of Mines	USA
Marina	Rabineau	University of Brest	France
Eugene	Rankey	University of Miami	USA
Chris	Reed	URS Greiner Corporation	USA
Rick	Sarg	Colorado School of Mines	USA
Christopher	Sherwood	USGS	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	Institut Francais du Petrole	France
Pat	Wiberg*	University of Virginia	USA
Matthew	Wolinsky	University of Minnesota	USA

Appendix 3: CSDMS Industry Consortium (Feb. 1, 2008)

CSDMS is an integrated community of experts that promotes the understanding of earth-surface processes through numerical simulation experiments. The experiments employ an open-source library of community-generated, continuously evolving software. CSDMS is partnered with related scientific programs in order to provide a strong linkage between predictions and observations. The CSDMS Integration Facility provides the cyber-infrastructure to help develop and distribute software tools and models of use to the academic communities, and to those engaged in industrial applications and environmental assessments. The CSDMS program operates under a cooperative agreement with the U.S. National Science Foundation (NSF), and a community-generated set of Bylaws (Appendix 1). Industry partners, NGOs, and government agencies play an important role in contributing to the success of CSDMS through their financial or in-kind contributions. This sponsorship supports the CSDMS effort and the next generation of researchers and modelers working to develop innovative approaches towards modeling complex earth-surface systems.

The CSDMS Consortium of Industry Partners

The primary goal of the CSDMS Consortium is to engage industry stakeholders in CSDMS research. Consortium members join with the CSDMS community to address key issues in the development and use of the models and tools produced by the CSDMS initiative.

Benefits of Membership in the CSDMS Industry Consortium

1) Corporate responsibility and community relations

In addition to hard products such as code, or gaining new insights into earth-surface dynamics, members of the CSDMS Consortium demonstrate their corporate commitment to improving quality of life and promoting optimal natural resource management through the more accurate modeling of earth surface processes. The CSDMS Industry Consortium supports the imperatives in Earth-science research: 1) discovery, use, and conservation of natural resources; 2) characterization and mitigation of natural hazards; 3) geotechnical support of commercial and infrastructure development; 4) stewardship of the environment; and 5) terrestrial surveillance for global security. Member companies are recognized for their commitment and support within various CSDMS publications, promotional materials, presentations, and on our website.

2) Opportunities to contribute to the direction of CSDMS research and products

The CSDMS Consortium provides an opportunity for its members to help guide CSDMS research and product development in directions relevant to their respective activities, thus directly benefiting their companies. By identifying needs for information and processes not available elsewhere, providing input on product development, and organizing activities around new research paths, members help focus CSDMS research in respect to their industries' short- and long-term needs, while avoiding some of the related costs of in-house research infrastructure, facilities and staff. Rigorous and objective Consortium feedback strengthens the CSDMS research and products, and provides a higher level of overall credibility.

3) Access to research activities and product development

CSDMS Consortium members are provided access to current advances in CSDMS research and products — data, tools, models, papers, presentations and status reports on progress. Members are encouraged to provide feedback on these models, tools, and other products. CSDMS uses MIT X11 as its software license. MIT X11 is OSI approved, GPL v. 2 compatible, and allows for the distribution of derivative works (with minimum requirements to shield the original author from liability). MIT X11 is user-friendly, compatible with most other open source licenses, and third party developers may keep derivative works proprietary.

Consortium members can request/suggest fee-based short courses, organized through the Integration Facility and instructors chosen from the CSDMS Working Groups, offering expertise in terrestrial dynamics (e.g. flood plain models), coastal dynamics (e.g. delta development), marine dynamics (e.g. turbidity currents), computation and cyber-infrastructure (e.g. coupling science behind the linking of models across time and space).

Consortium members are invited to attend CSDMS events, in addition to an annual site visit for insight into the latest research activities, experimental data and approaches, and demonstrations of products in development. Members receive a copy of the CSDMS annual report.

4) Association with a diverse group of scientists, universities, agencies, and industries

CSDMS actively works with international scientists, both from academic and research institutions, government agencies, and industry partners. As of February 2008, over 160 scientists and engineers from 80 institutions support the CSDMS effort. The CSDMS Consortium offers its members opportunities to develop connections and gain insight with this diverse group of participants. The result is an open exchange of state-of-the-art information in aid of problem solving, allowing companies to increase their effectiveness through application of CSDMS research and products. The CSDMS connection with NSF and other agencies — the U.S. Office of Naval Research, National Aeronautics and Space Administration, U.S. Geological Survey, U.S. Army Research Office, U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration, U.S. Dept of Energy, and U.S. Environmental Protection Agency — gives CSDMS products an immediate level of professional credibility, increasing their impact, acceptance and application in practice. Consortium members gain new knowledge with, for one example, direct application to subsurface stratigraphy, sedimentology, and reservoir characterization.

CSDMS Consortium Sponsorship

Consortium partners are asked to contribute to the success of CSDMS through either a financial contributions (larger companies), or as an in-kind contribution (smaller companies).

Large multinational (e.g. petroleum and mining) companies are asked for an annual tax-deductible gift contribution in the range of \$30,000 to \$100,000. The CSDMS Steering Committee, comprised of representatives of U.S. funding agencies (e.g. NSF and ONR), the U.S. National Academy of Science, academic leaders, and the petroleum and environmental industry itself, hope for Consortium contributions to grow to the million dollar level, wherein the Consortium could become a true strategic partner — rising closer to the level of NSF funding (>\$1M/yr) and multi-agency CSDMS-related funding of Working Group member research (>\$5M/yr). An overall longer-term goal is to obtain larger investments from corporate foundations. Gifts to the CSDMS initiative are to the CSDMS Integration Facility through the CU Foundation Corporation, due April 1, or by special arrangement to suit members' accounting cycles.

Smaller companies, typified by environmental or engineering firms, are asked for in-kind support, such as covering the cost of their employees and officers participating in the CSDMS effort (CSDMS meetings and events, Working Group activities, code development, code-sharing arrangements, and program advertising), and where possible gift support.

Professional staff supported with Consortium funds will be either post-doctoral research scientists or professional software engineers. These staff will work to contribute to the CSDMS efforts, while providing intimate liaison between the Consortium and the CSDMS Integration Office. The staff would support the development of models/modules/tools that meet the prioritized needs of the Consortium, and conduct numerical experiments suggested by the consortium members.

Consortium funds could also contribute to the developing of the cyber-infrastructure. The CSDMS IF is hoping to soon acquire a CSDMS-operated Experimental Supercomputer (ES) offering >256 cores for >3 teraflops of computing power, and configured with two HPC approaches — 1) massive shared memory among fewer processors, and 2) the more typical parallel configuration — running Linux with Fortran, C and C++ compilers. This CSDMS ES will be linked to the proposed Front Range High Performance Computer (HPC) with 7000 core, >100 teraflops, that in turn linked to the US TerraGrid and the proposed Cheyenne NCAR/UCAR Petascale HPC dedicated to the NSF Geoscience Collaboratory. The Professional staff supported with Consortium funds would have access to these High Performance Computers.

Request by a Consortium member, for directed and company-specific research, must be negotiated separately with the Environmental Computation and Imaging (ECI) Facility, at the University of Colorado — Boulder. If an ECI employee is associated with CSDMS and its Integration Facility, then: 1) the generalized topic must be transparent to other members of the Consortium, and 2) is not in conflict with CSDMS goals. Results and products could be proprietary for an agreed, predetermined time.

CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

website: csdms.colorado.edu
e-mail: csdms@colorado.edu