CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

SEMI-ANNUAL REPORT

AUG 2012

NSF COOPERATIVE AGREEMENT 0621695

CSDMS
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

Executive Summary

The Community Surface Dynamic Modeling System (CSDMS) is an NSF-supported, international and community-driven program that seeks to transform the science and practice of earth-surface dynamics modeling. CSDMS integrates a diverse community of more than 850 geoscientists representing 380+ international institutions (academic, government, industry) from 60 countries. The effort is supported by a CSDMS Interagency Committee (22 Federal agencies), and by industry (20+ companies). CSDMS distributes more 200 Open Source models and modeling tools, provides access to high performance computing clusters in support of developing and running models, and offers a suite of products for education and knowledge transfer. The CSDMS architecture employs frameworks and services that convert stand-alone models into flexible "plug-and-play" components to be assembled into larger applications. The first five years of CSDMS have come to a close and CSDMS activities have continued with a supplemental to the original NSF cooperative agreement. This Semi-Annual Report covers this supplemental period from March 2012 to July 2012, and provides an update since the last (2011) Annual Report to NSF. The Report also provides a look ahead to CSDMS2.0 as NSF funding has been recommended for the next five years.

CSDMS 2011 Annual Report

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CSDMS 2012 Semi-Annual Report

1.0 CSDMS Mission: The Community Surface Dynamics Modeling System (CSDMS) catalyzes new paradigms and practices in developing and employing software to understand the earth's surface — the ever-changing dynamic interface between lithosphere, hydrosphere, cryosphere and atmosphere. CSDMS focuses on the movement of fluids and the sediment and solutes they transport through landscapes, seascapes and sedimentary basins. CSDMS supports the development, integration, dissemination and archiving of community open-source software, that reflects and predicts earth-surface processes over a broad range of temporal and spatial scales.

This Semi-Annual Report covers this supplemental period from March 2012 to July 2012, and provides an update since the last (2011) Annual Report to NSF..

2.0 CSDMS Management and Oversight.

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

- Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State Univ.
- Brad Murray (April, 2007), Chair, Coastal Working Group, Duke Univ.
- Pat Wiberg (April, 2007), Chair, Marine Working Group, Univ. of Virginia
- Greg Tucker (April, 2007), Chair, Terrestrial Working Group, CIRES, U. Colorado – Boulder
- Eckart Meiburg (Jan, 2009), Chair, Cyberinformatics & Numerics WG, U. California-Santa Barbara
- Irina Overeem (Oct, 2011), Chair, Education & Knowledge Transfer WG, U. Colorado – Boulder
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, University of Colorado - Boulder
- Scott Peckham *(ex-officio)* Chief Software Architect, CSDMS Integration Facility, U. Colorado – Boulder

The Executive Committee is the primary decision-making body of CSDMS, and ensures that the NSF Cooperative Agreement is met, oversees the Bylaws & Operational Procedures, and sets up the annual science plan. ExCom approves the business reports, management plan, budget, partner memberships, and other issues that arise in the running of CSDMS.

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

- Rudy Slingerland (April, 2007), Chair, CSDMS Steering Committee, Penn State Univ., University Park, PA
- Tom Drake (April, 2007), U.S. Office of Naval Research, Arlington, VA
- Bert Jagers (April, 2007), Deltares and OpenMI, Delft, The Netherlands
- Rick Sarg (April, 2007), Colorado School of Mines, Golden, CO
- Gary Parker (April, 2007), Univ. Illinois Urbana-Champaign, IL
- Dan Tetzlaff (April, 2007), Schlumberger Ltd, Cambridge, MA
- Dave Furbish (April, 2007), Vanderbilt University, Nashville, TN
- Chris Paola (Sept, 2009), NCED, U. Minnesota, Minneapolis, MN
- Cecilia DeLuca (Sept, 2009), ESMF, NOAA/CIRES, Boulder, CO
- Boyana Norris (Sept, 2009), Argonne National Lab, Argonne, IL
- James Syvitski *(ex-officio),* CSDMS Executive Director, INSTAAR, CU-B, Boulder, CO
- Bilal Haq *(ex-officio),* National Science Foundation
- Paul Cutler *(ex-officio),* National Science Foundation — joined fall 2010.

The CSDMS SC assesses the competing objectives and needs of the CSDMS; assesses progress in terms of science, outreach and education; advises on revisions to the 5-year strategic plan; and approves the Bylaws and its revisions.

2.3 CSDMS Working and Focus Research Groups

The almost 840 members represent 156 U.S. institutions (116 academic, 18 private, 22 federal) and 225 non-U.S. institutions from 59 countries (133 academic, 32 private, 60 government). There are now ~**380+** affiliated institutions. Members are organized within 5 working groups (Terrestrial, Coastal, Marine, Education, Cyberinformatics) and 3 focus research groups (Hydrology, Carbonate, Chesapeake) as of 07/31/2012:

Terrestrial	**383**
Coastal	**302**
Hydrology	**297**
Marine	**216**
Cyber	**131**
EKT	**121**
Carbonate	**58**
Chesapeake	**42**

2.4 The CSDMS Integration Facility (IF)

The CSDMS Integration Facility (IF) maintains the CSDMS Repositories, facilitates community communication and coordination, public relations, and product penetration. IF develops the CSDMS cyber-infrastructure and provides software guidance to the CSDMS community. The IF maintains the CSDMS vision and supports cooperation between observational and modeling communities. CSDMS' IF is located at INSTAAR, University of Colorado-Boulder, csdms.colorado.edu/wiki/Contact_us. As of July 2012, CSDMS IF staff included csdms.colorado.edu/wiki/Staff

- Executive Director, Prof. James Syvitski (April, 2007) — CSDMS & CU support
- Executive Assistant, Ms. Marlene Lofton (Aug. 2008) — CSDMS support
- Chief Software Engineer, Dr. Scott Peckham (April, 2007) — CSDMS & other NSF/NOAA support
- Software Engineer, Dr. Eric Hutton (April, 2007) — CSDMS & other NSF support
- Cyber Scientist Dr. Albert Kettner (July, 2007) — CSDMS, ConocoPhillips & other NSF/NASA support
- EKT Scientist Dr. Irina Overeem (Sept, 2007) — CSDMS, ConocoPhillips & other NSF support
- Ph.D. GRA Stephanie Higgins (Sept, 2010) — Other NSF & NASA support
- Ph.D. GRA Fei Xing (July, 2010) — Other NSF support
- Ph.D. GRA Ben Hudson (May, 2010) — Other NSF support
- Accounting Technician Mary Fentress (April, 2007) — multiple grant support
- Systems Administrator Chad Stoffel (April, 2007) — multiple grant support
- Director Dartmouth Flood Observatory, G Robert Brakenridge (Jan, 2010) — NASA support
- Senior Research Scientist Christopher Jenkins (Jan 2009) — NSF & other support

Departures

- PDF Dr. Sagy Cohen (2010-2012) — NASA support
- Computer Scientist, Jisamma Kallumadikal (2009-2012) — Industry, CSDMS support

CSDMS VISITING SCIENTISTS AND STUDENTS since January 2012:

•	Robert Busey	Research Engineer	International Arctic Research Center	2012 January
•	Robert Bolton	Assistant Professor	International Arctic Research Center	2012 January
•	Andreas Mikkelsen	Ph.D. Student	University of Copenhagen, Denmark	2012 Feb-April
•	Ron Boyd	Executive	ConocoPhillips, Houston	2012 March

3.0 Just the Facts

3.1 CSDMS Model Repository

The CSDMS Model Repository hosts open-source models, modeling tools, and plug-and-play components, including: i) Cryospheric (e.g. glaciers, permafrost, icebergs), ii) Hydrologic, from reach to global scale, iii) Marine (e.g. ocean circulation), iv) River, coastal and estuarine morphodynamics, v) Landscape or seascape evolution, vi) Stratigraphic, and vii) Affiliated domains (e.g. weather & climate models). Of the ~5.7 million lines-of-code held in the Repository, 61 projects are in Fortran, 98 in C or C++, 30 in Python, 18 in Matlab, with the remaining in C#, IDL, SAS, Java, or VB. About 70% are distributed through a central Repository; others are distributed through linkages to existing community efforts. Centralized downloads exceed 9000 and redirected download traffic to other sites is similarly high. The 217 projects noted below may involve more than one model.

Repository lines of code statistics as of June 2012: csdms.colorado.edu/wiki/Model_SLOC_Page

Language	Projects	Comment	Source
Fortran 77/90/95+	61	1067175	2457622
c/c++	98	348040	1131334
Python	30	98713	148740
C#	1	29344	160373
MATLAB	18	39594	58999
IDL	5	38834	36954
Statistical Analysis Software	1	2390	5796
Java	2	2214	12851
Visual Basic	1	537	8581
Total	217	1626841	4021250

Models, Tools & Components by Environmental Domain http://csdms.colorado.edu/wiki/Main_Page

Domain	Models	Tools	Components
Terrestrial	78	45	33
Coastal	53	3	5
Marine	45	5	8
Hydrology	51	38	43
Carbonate	1	1	0
Climate	10	2	0

Models run on the CSDMS supercomputer without download are not included in these statistics. Community models downloaded from other sites (e.g. ROMS, NearCOM) are also not counted. The top ten most downloaded models by version (July 2012): (http://csdms.colorado.edu/wiki/Model_download_Page)

	Model	No. Times	Topic
1.	**topotoolbox**	1253	A set of Matlab functions for topographic analysis
2.	**child**	875	Landscape evolution model
3.	**topoflow**	727	Spatially-distributed, D8-based hydrologic model
4.	**sedflux**	326	Basin filling stratigraphic model
5.	**hydrotrend**	245	Climate driven hydrological transport model
6.	**2dflowvel**	231	Tidal & wind-driven coastal circulation routine
7.	**adi-2d**	211	Advection Diffusion Implicit method for 2D diffusion
8.	**bing**	205	Submarine debris flows
9.	**midas**	172	Coupled flow- heterogeneous sediment routing model
10.	**cem**	171	coastal evolution model

3.2 CSDMS DATA REPOSITORY csdms.colorado.edu/wiki/Data_download

Data Repository as of June 2012

Data Type	Databases
Topography/bathy	15
Climate	6
Hydrography	5
River discharge	8
Cryosphere	5
Surface Properties	5
Land cover	4
Substrates	3
Human Dimensions	2
Sea level	2
Oceanography	9
GIS Tools	12
Network Extraction	7

3.3 CSDMS Education & Knowledge Transfer (EKT) Repository

The **Education Repository** offers undergraduate and graduate modeling courses, educational modules, modeling labs, and process and simulation movies.

Animations library csdms.colorado.edu/wiki/Movies_portal.

Environmental Animations	8
Terrestrial Animations	20
Coastal Animations	22
Marine Animations	10
Laboratory Movies	14
Real Event Movies	32

Image Library csdms.colorado.edu/wiki/Images_portal

Terrestrial Images	90
Coastal and Marine Images	49

Modeling Labs csdms.colorado.edu/wiki/Labs_portal

Modeling Labs are being designed to have a tiered approach. There are spreadsheet labs that emphasize quantitative skills, but address earth surface process questions/problems with reduced parameter space. These labs are focused on undergraduate education and include lesson plans and teacher material. Whereas CMT-based modeling labs offer additional complexity and simulations can be run with more freedom in complexity level. The EKT web pages point to members who have active online teaching resources.

Current available labs:

1. Glacio-Hydrological Modeling
2. River-Delta Interactions
3. Sediment Supply to the Global Ocean
4. Landscape Evolution Numerical Experiments
5. Earth Science Models for K6-12
6. Coastal Engineering Experiments
7. Hydrological Processes Exercises
8. Sinking Deltas
9. Stratigraphic Modeling with Sedflux
10. Coastal Stratigraphy Numerical Experiments

Modeling Lectures and Courses csdms.colorado.edu/wiki/Lectures_portal

1. Surface Dynamics Modeling with CMT — I Overeem & SD Peckham
2. Quantitative Earth-surface Dynamics Modeling — JPM Syvitski
3. 1D Sediment Transport — G Parker
4. Morphodynamics of Rivers — G Parker
5. Source to Sink Systems around the World — Keynote Chapman Lectures
6. Plug and Play Component Technology — JPM Syvitski and I Overeem
7. Geological Modeling — I Overeem

Modeling Textbooks csdms.colorado.edu/wiki/Modeling_Textbooks

1. Mathematical Modeling of Earth's Dynamical Systems *By: Slingerland, R., Kump, L.*
2. Geomorphology; the Mechanics and Chemistry of Landscapes *By: Anderson, R., Anderson, S.*
3. Quantitative Modeling of Earth Surface Processes *By: Pelletier, J.D.*
4. Simulating Clastic Sedimentary Basins: Physical Fundamentals and Computing Procedures *By: R.L. Slingerland, K. Furlong and J. Harbaugh*
5. 1D Sediment Transport Morphodynamics with applications to Rivers and Turbidity Currents *By: G Parker*

3.4 CSDMS Experimental Supercomputer csdms.colorado.edu/wiki/HPCC_information

Over 180 CSDMS members now have accounts on the system and have met the use criteria:

- Running a CSDMS model(s) to advance science
- Developing a model that will ultimately become part of the CSDMS model repository.
- Developing a new data systems or visualizations in support of CSDMS models.

CSDMS High Performance Computing Cluster (HPCC) System *Beach* is an SGI Altix XE 1300 with 88 compute nodes (704 cores, 3.0 GHz Harpertown processors) (≈8 Tflops). 64 nodes have 2 GB of memory per core, 16 nodes have 4 GB of memory per core. Internode communication is accomplished through a non-blocking InfiniBand fabric. Each compute node has 250 GB of local temporary storage and can access 72TB (raw) of RAID storage through NFS. *Beach* provides GNU and Intel compilers as well as their MPI counterparts (mvapich2, mpich2, and openmpi). *Beach* is supported by the CU ITS Managed Services (UnixOps) under contract to CSDMS.

The *Janus* supercomputing cluster (NSF CNS-0821794) is also available for use by CSDMS members that have accounts on beach. This provides CSDMS members with 16,416 computational cores and 32TB of memory. Users are allowed 50,000 core-hours by default and must submit an allocation request for more computational time. The CSDMS high-performace computing cluster, *Beach* is connected to the *Janus* cluster through a private 10 Gb/s network. This enables *Beach* users to quickly and easily share large data sets between the two clusters and use *Janus* 1PB lustre file system. The Janus system consists of 1368 nodes, each containing two 2.8 GHz Intel Westmere processors with six cores each (16,416 cores total) and 24 GB of memory (2 GB/core) per node. Nodes are connected using a fully non-blocking quad-data rate InfiniBand interconnect, and the system's initial deployment will provide about 1 PB of parallel temporary disk storage..

3.5 CSDMS WEB PORTAL STATISTICS csdms.colorado.edu/wiki/Special:Statistics

Content Pages	1,066
Total Pages	5,223
Upload Files	2,372
Page Edits	88,307
Registered Users	894
View Statistics	10,275,329

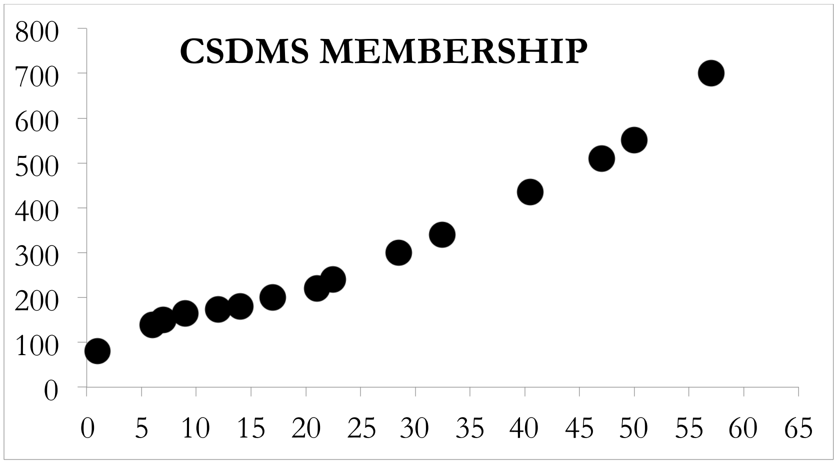

Fig. 1 Growth in Active membership (y-axis) in months since April 2007 (x-axis)

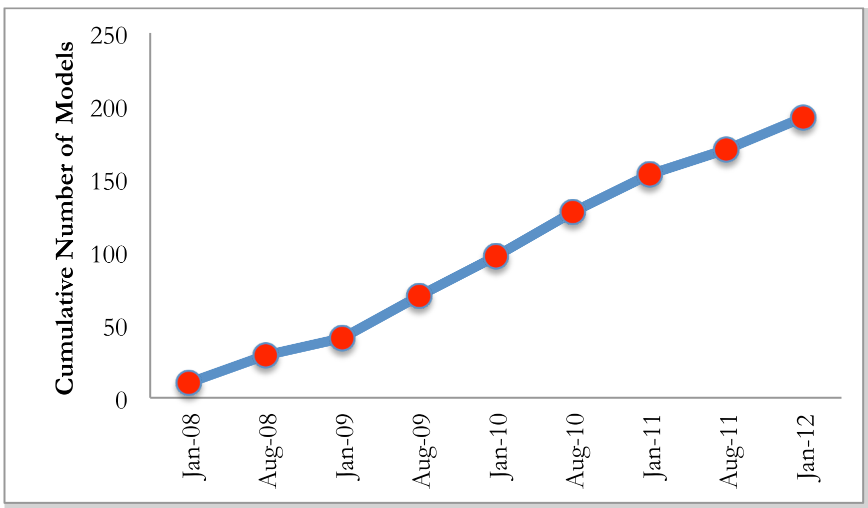

Fig. 2 Model contributions contributed by the community to the CSDMS Model Repository

4.0 Transition Period Supplemental Activities

4.1 Component Modeling Tool (CMT) on other platforms

The CSDMS IF has built the CSDMS tool chain, which consists of upward of 20 separate software packages, on a variety of platforms. The target platforms range from single-user machines to large high performance computing clusters that contain tens of thousands of computing cores (the NSF/CU High Performance Computing Center, Janus). Target operating systems are Linux-based and include several versions of RedHat (5.6, 5.2), Fedora (17), and Darwin (11.3). Compilers used include the GNU compiler set and the intel compilers.

Building this many packages on such a wide range on platforms is time consuming and error prone. To address this, we have developed a plugin-based program, developed in Python, that automates the build process of the CSDMS software stack, and it's dependencies. Although not yet fully automated, our software stack builds with little human intervention. The CSDMS package builder, bob, is available as either a Python egg, or as source code. Both can be downloaded from the CSDMS website.

The bob package builder,

- SVN repository: https://csdms.colorado.edu/svn/bob/trunk
- Source-code: https://csdms.colorado.edu/tools/bob/bob-0.1.tar.gz
- Python egg: https://csdms.colorado.edu/tools/bob/bob-0.1-py2.7.egg

4.2 Framework Service Components

File Writer: *This service component will retrieve data from a model component at specified times and write it to a netCDF file that follows the CF conventions and is compatible with visualization software VisIt.*

The CSDMS IF has created a file writing tools usable within the CSDMS framework. The new writer class receives data from a component model and outputs the data to either a VTK file or a NetCDF file. VTK files are written in binary format using the "new-style" XML format for VTKs. For structured grids, NetCDF files follow the CF conventions. However, since there are currently no CF standards for storing unstructured meshes in NetCDF format, we propose a new format for consideration by he community. The new NetCDF format defines an unstructured mesh with the following variables,

- x: Values of the x-coordinate for each node.
- y: Values of the y-coordinate for each node.
- connectivity: An array of integers that provide indices into data arrays for each element of the mesh.
- type: An array of integers that indicate the shape of each element (triangle, polygon, cube, etc.). Element types are defined in the same way as the VTK standard.

Variable values (at either nodes or elements) are then listed with the same ordering as the x and y, or connectivity arrays.

Spatial Regridding: *This service component will allow different contributed models to share data across different types of computational grid (structured meshes e.g. rectilinear and orthogonal curvilinear; and unstructured meshes e.g. Voronoi cells and triangles) using a multi-processor regridding tool.*

CSDMS IF has incorporated the ESMF regridding tools into our infrastructure. We currently use two versions of the tools, along with the CSDMS regridding tools. The first version is a serial version to be used on single-processor platforms, while the second makes use of the Message Passing Interface (MPI) to use multiple processors for the mapping. Although not yet completely integrated into the CSDMS framework, the parallel version of the mapper has been tested on the CSDMS High Performance Computing cluster and shown to scale nearly linearly up to several dozen processors.

The mappers are capable of mapping elements from one unstructured grid to another. Although grid elements must be either three or four sided, the ESMF team is developing a more general tool that can deal with a larger variety of element types. Once completed, the newer version will be incorporated into the current Grid Mapper class.

4.3 Time Interpolation Service Component

Earth surface process models may use fixed or adaptive timestepping schemes, and two models to be coupled may use timesteps that are significantly different in size. A fairly typical example would be a snowmelt model, with timesteps on the order of an hour coupled to a channelized flow model, with timesteps on the order of several seconds. It would clearly be inefficient to run the snowmelt model with timesteps appropriate to a channel model and the state variables of the snowmelt model vary much more slowly. However, it can be somewhat jarring to the channel model when a state variable it uses from the snowmelt model suddenly steps up to a new value that is then maintained without change for many channel timesteps. This issue is sometimes referred to as "temporal misalignment." In such cases it makes sense to fit a smooth interpolation function to each of the state variables in the model with the larger timestep. The model with the smaller timestep can then retrieve and use interpolated values that vary more smoothly and which can be updated (with every timestep) with very low computational cost.

CSDMS has addressed this need through a new time interpolation service component and associated changes to the CSDMS Component Model Interface (CMI). The new component supports the following interpolation options:

(1) no interpolation (or "stair step"), (2) linear interpolation, (3) a weighted average of "stair step" and linear and (4) cubic spline interpolation with several different closure options. The CMI interface was modified so that when it receives a get_values( ) request from another component it calls the BMI-enabled model below whenever it needs new values for interpolation and otherwise returns interpolated values stored in its own state to the caller. The BMI-enabled model therefore remains unchanged. This new time interpolation component is nearly finished but more work is required in support of the cubic spline option as explained below.

The use of cubic splines for "dynamic interpolation" or interpolation in time is nontrivial. Cubic splines do not simply fit a cubic polynomial using values of a state variable from four different times (i.e. using values at four "nodes" or "knots") over three adjacent time intervals. Though often misapplied in this manner, this defeats the purpose of using them, which is to ensure continuous first and second derivatives at each node. Typical applications of cubic splines require solving a tridiagonal matrix problem that requires knowing data values at all nodes at the outset. In our application, this would mean that model values at all times would be needed in order to compute the interpolation function for any of the intervals. What is desired for our problem is an interpolation method that can be applied dynamically using only some subset of the node values that have been seen up to the current time or a few timesteps into the future. It appears that this is indeed possible, but only by delving deeper into the less well-known theory of cubic splines. The fundamental nature of the cubic spline problem is a set of three coupled recurrence relations that can only be iterated forward in time if two additional constraints are imposed. Typical cubic spline applications get these two extra constraints by applying the so-called "natural spline" condition to the first and last node. For dynamic interpolation, however, the value at the last node would usually not be known in advance. While it is easy to generate other reasonable-sounding ways of supplying the two additional constraints needed for iteration, uninformed choices activate an exponential growth mode in the recurrence that causes the cubic spline to pass smoothly through the nodes but to experience an "exponential overshoot" problem where the spline oscillates with an exponentially increasing amplitude. It turns out that there is one particular constraint on the starting values for the recurrence that can "deactivate" this exponential growth mode. While this constraint, in principle, still requires knowing values at all nodes, it turns out that the dependence on values beyond those at the first node falls off exponentially fast. For the second required constraint, various choices can then be applied, such as specifying the slope at the first node. CSDMS has implemented this approach and is currently testing it for a variety of model coupling problems.

4.4 CSDMS Standard Names and Model Metadata

CSDMS needs unique identifiers or "standard names" for labeling the input and output variables that are used in models. These names are used in the BMI (Basic Model Interface) developed by CSDMS for automated matching (users to providers) and as a "lingua franca" for "semantic mediation" between models. CSDMS originally planned to use and extend the CF Convention Standard Names, developed primarily as unique identifiers for ocean and atmosphere model variables by LLNL. The CF Standard Names are also used in NetCDF files so that output from one model may be recognized as valid input to another model. However, the CF Standard Names are fairly domain-specific to ocean and atmosphere models and more importantly, the rules for constructing names are not very prescriptive and have internal inconsistencies. In addition, CF Standard Names may also contain model assumptions and other information besides just the name of the quantity. Once these issues were recognized, CSDMS began working on a detailed and general (cross-domain) set of naming rules that produce standardized variable names with an object part and a quantity part. These naming rules consist of an extensive set of patterns that cover a wide variety of cases gleaned from models in the CSDMS repository as well as from the CF Standard Names. Additional metadata to support the names, including assumptions, units, how measured, object name source, georeferencing (e.g. standard ellipsoid, datum and projection names), etc. are kept out of the name string itself and are instead stored in an associated XML file of "model metadata" that fully describes the model and its associated input and output variables. CSDMS staff is soliciting feedback from ontology/semantic experts and from the developers of other modeling frameworks such as ESMF to build consensus and to ensure that the CSDMS Standard Names will have broad applicability. Details on the patterns and rules that underpin the CSDMS Standard Names will soon be published on the CSDMS wiki for use by model developers who are implementing the BMI interface. Note that model developers use whatever variable names they want to in their code, but then "map" each of their variables to the appropriate CSDMS standard name.

4.5 Development of CSDMS Earth Surface Modeling Course Material

When a researcher or a student downloads a CSDMS model and the CSDMS Component Modeling Tool (CMT), they use a suite of associated interactive modules to allow an efficient and informed startup of their surface processes modeling projects. To learn this modeling software or use the software for teaching, documented examples are of key importance. Lectures and a published paper on plug & play technology, the basics of the CSDMS modeling framework and an associated paper have been accessed >4,070 times (as of June 2012) on our CSDMS wiki.

Several hands-on modeling labs are now fully documented and available from the educational repository:

- Glacio-Hydrological Processes
- River-Delta Interactions
- Sediment Supply
- Stratigraphic Processes

The modeling laboratories are designed to address environments of interest to the different working groups: i.e. terrestrial, hydrology, coastal, and marine. In addition, examples are designed to have societal and scientific relevance. As an example, one simulation lab discusses delta avulsion and coastline development providing theoretical insight on river distributary channel management and resulting delta vulnerability.

Any of these labs work under the assumption that users are CSDMS members and will run simulations on the CSDMS HPCC system to encourage exposure of new graduate students to high-performance computing.

The landing page of these labs in the educational repository has been visited >8000 times (as of June 2012).

Recently, we have designed a new laboratory that combines two different expert models (Sedflux and CHILD) as well as demonstrations of coupled model simulations. Clinics on these two models were initially taught entirely separately at the CSDMS annual meeting 2011 in ~3 hours hands-on experiments, whereas now the material will be presented in a 2-full days for >30 national and international graduate students at the NCED Summer Institute August 2012. The theme of the NCED summer institute is ' Future Earth: Interaction of Climate and Earth Surface Processes'.

Learning objectives and skills include (amongst topical learning objectives on landscape evolution and stratigraphy):

1) Modeling as a Scientific Method in the Earth Sciences
2) Uncertainty in Models and How to deal with results
3) Familiarization with coupled modeling tool and high-performance computing

Especially skills on HPCC use have consistently been positively evaluated by participants in courses and clinics in 2010 & 2011.

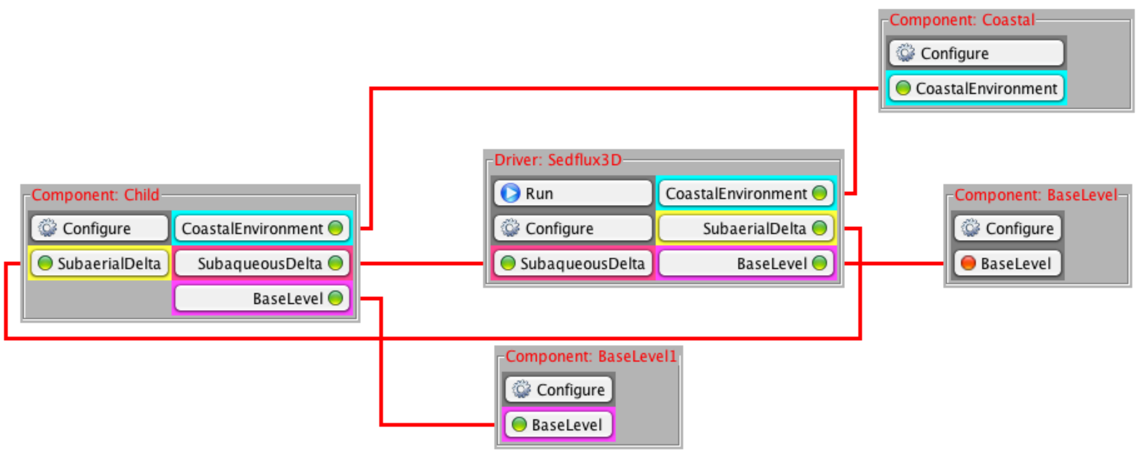

Figure 3 Wiring Diagram of Coupled Child-Sedflux simulation to be used in NCED Summer Institute, August 2012

We will use these new course materials and interactions with the graduate students and young faculty to populate Q&A sections on the wiki and provide treaded discussion, which will be maintained by the EKT specialist.

The interest in the educational repository and course materials is growing with two independent NSF IGERT proposals incorporating this CSDM curriculum material into their core teaching and preparation programs, one NASA Student Fellowship Award pledging to contribute modeling tools to the CSDMS model and educational repository, and a NSF Hydrology proposal proposing to use the EKT repository as a main outlet for material for K12 teachers.

4.6 Knowledge Transfer to Industry Partners

CSDMS reached out to interested industry partners in Houston, January 2012. Company-wide technical talks were presented on the CSDMS community and modeling tools, and followed by more detailed technical talks for specialist reservoir modeling and basin modeling groups. A dedicated 2-day meeting and discussions for future model improvements on floodplain sedimentation was provided to Conoco-Phillips representatives in March 2012.

CSDMS director and EKT specialist attended and presented at the Annual Meeting of AAPG (American Association of Petroleum Geologists) in Long Beach, CA in April 2012. Discussion with several company representatives resulted in requests for additional overview technical talks as well as short courses on 'source to sink modeling' for Fall 2012 for consortium members.

To target new industry members and policy makers more efficiently, CSDMS EKT with help of Research Media Ltd designed a new brochure highlighting the 5 year accomplishments of CSDMS presented in the June 2012 Issue of International Innovation. The 3 page article is titled "Encouraging Development of Coupled Earth Models' and was send out to over 300 industry partner members and governmental agency partners.

4.7 Digital Object Identifiers for models

DOI, or Digital Object Identifier is a unique string to identify an object in a digital environment. The object could be a paper published in a scientific journal or a specific dataset. A DOI guaranties that an object can always be traced by simply resolving a web address that is constructed by a DOI search engine URL "http://dx.doi.org/", combined by the unique identifier. The DOI contains metadata, including a URL that points to the specific object. Objects with a DOI are 5 times more likely to deliver active links to the digital content than objects without. To guaranty access to source code of numerical models CSDMS in close cooperation with Dr. K. Lehnert (Director of Integrated Earth Data Applications Research Group (IEDA)) and Dr. L. Hsu, both from Lemont-Doherty Earth Observatory, requested a DOI for each Model in the CSDMS repository. Despite over 50 million DOI strings, CSDMS is the first in history to request DOIs for numerical models. A list of all the numerical models of the CSDMS model database together with limited metadata for each model is provided to IEDA. Currently the provided material for the DOI requests is reviewed and we expect to receive DOIs for each model in the CSDMS repository by the latest in the coming months.

Web maintenance

CSDMS cyber infrastructure builds upon the open software package Mediawiki (http://www.mediawiki.org) and numerous third-party extensions (over 30 extension as of now) to extend cyber infrastructure capability and to provide the latest cyber tools to CSDMS web visitors to guaranty the easiest experience to interact through the web. About every 1 – 1.5 years the core software (mediawiki) is significantly upgraded and with it most third party software extensions, to guaranty performance, security, and to incorporate new features. It is required by the University of Colorado (CU) to upgrade cyber infrastructure to a newer version when a security upgrade becomes available, to reduce possible cyber attacks directed to CU. CSDMS executed latest major cyber infrastructure upgrade (upgraded to mediawiki version 1.19.1, see also http://csdms.colorado.edu/wiki/Special:Version) conform CU standards. Additional effort were made to adapt the CSDMS website appearance (skin) to the latest version as well as making all extensions operable under the new core software. Were needed outdated extensions were replaced to guaranty functionality.

Web innovation

Figure 1. QR-code example image for a numerical model. Scan to find out where this links to.

QR-code

CSDMS implemented an automatic process by developing a python script to generate QR-code images on the fly for its entire numerical model database and placed the images on the represented web addresses. QR-codes (Quick Response Code), are two-dimensional barcodes became more popular after the introduction of the smartphone in 2007. Unlike the barcode, these images can be scanned or captured by a phone or tablet that has a camera. People with a smartphone or tablet can scan the QR-code and will be automatically directed to the encrypted website URL, without typing in a long web address. So e.g., a QR-code can now be used in oral or poster presentations to easily direct a person to their specific CSDMS model questionnaire page.

Model info box

Figure 2. An example of the Model info box (See http://csdms.colorado.edu/wiki/Model:CMFT)

A fully automated dynamic "Model info" box is created for each model questionnaire page to serve model developers and users with summary information regarding the author of the numerical model (name, other models made by the author) as well as give a direct link to the download location for the source code. The model authors name is linked to his user profile page (when the author is a CSDMS member), which contains at the minimum contact information. A QR-code image, automatically generated once a person fills out a model questionnaire, is displayed in the Model info box as well. Additionally, a placeholder is set up to display in the near future model DOI information (This is only provided to models that are submitted to the CSDMS model repository). This is not shown yet as CSDMS is in the process of applying DOIs for each of its models (See this report for more information regarding DOI for models).

Presentation query capabilities

Over the last 5 years CSDMS members have given several hundred presentations. In agreement with the presenters, those presentations have always been made available to the public during or shortly after each meeting, by placing them on each specific CSDMS meeting website. However, with the growing number of presentations stored in the CSDMS meeting repository, the need for a database query tool became more urgent. Therefore metadata (Presenters name, title presentation, conference name and location) was added to each presentation file and a query environment was developed to serve the need to provide easy access to CSDMS presentations. This query tool is now available on the CSDMS website (http://csdms.colorado.edu/wiki/Special:RunQuery/Files_query).

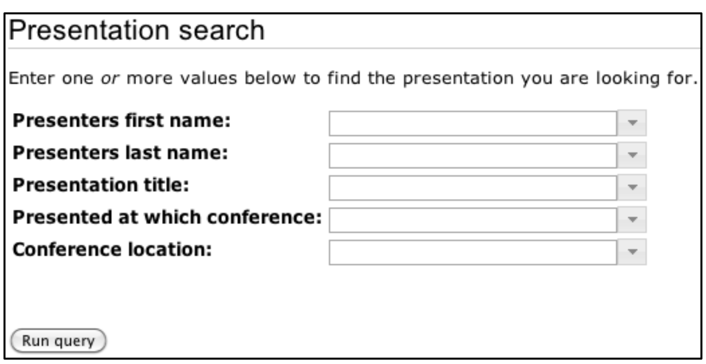

Figure 2. Query website page to search for any given presentation (powerpoint or poster)given a CSDMS meeting(http://csdms.colorado.edu/wiki/Special:RunQuery/Files_query)

Update Model metadata, adding key-papers

Metadata of models is of utmost importance to provide potential model users information such that they can decide if a certain model might fulfill their needs. Therefore CSDMS implemented a few years ago a model questionnaire that model developers have to fill out, describing their model, if they want to add their model to the CSDMS model repository. Each model questionnaire contains a field where people can describe the key papers that describe their model. However, not everybody has taken the effort to provide this information. CSDMS took the effort to search journal databases to identify the top 3 to 5 scientific papers that describe each model that is provided on the CSDMS web, and incorporated this into the existing metadata for each model.

Reach out to the model developer's community

CSDMS tracks for each numerical model that is available in the CSDMS repository how often it is downloaded and publishes these statistics on a daily basis on the CSDMS web (http://csdms.colorado.edu/wiki/Model_download_Page). Besides these statistics a person who downloads a model is asked to provide name & email address. For 2011, this information was generated and provided for the first time by email to each of the main model developer (34) of one or multiple numerical models. This is initiated on requests from the model developers community as an ability to contact their user group to provide information regarding bugs / upgrades or to identify if there are any requests for model upgrades or to discuss possible collaborations.

4.8 Staff Participation In 2012 Conferences & Meetings (to July)

** CSDMS co-sponsored meeting*

01/2012	Chevron: *Integrated Modeling of Earth Surface Dynamics.*	Houston, TX	(Overeem)
01/2012	ConocoPhillips: *Integrated Modeling of Earth Surface Dynamics.*	Houston, TX	(Overeem)
02/2012	AGU Chapman: *Remote Sensing of the Terrestrial Water Cycle*	Kona, HI	(Brakenridge, Cohen)
02/2012	AGU Ocean Sciences Meeting	Salt Lake City, UT	(Syvitski, Overeem)
02/2012	Deltares Audit Committee	Delft, Netherlands	(Syvitski)
03/2012	Second International Workshop on Global Flood	Delft, Netherlands	(Brakenridge)
03/2012	Planet Under Pressure Conference	London, UK	(Syvitski)
03/2012	International Year of Deltas Strategic Mtg	London, UK	(Syvitski)
03/2012	Shell London Lecture Series: *Life at the edge: sinking deltas*	London, UK	(Syvitski)
03/2012	Integrated Environ Modeling: Lowering the Barriers,	EPA Washington	(Peckham)
04/2012	IWRSS (Integrated Water Resources Sciences and Services) National Water Model Scoping Workshop.	Chapel Hill, NC	(Peckham)
04/2012	Modeling Framework Overview meeting with ESMF	Boulder, CO	(Peckham)
04/2012	SOT/EPA Meeting, Theme E Telecon (weekly)	Boulder, CO	(Peckham)
04/2012	AAPG Annual Meeting	Long Beach, CA	(Syvitski, Overeem)
04/2012	Delta Collaboration / FESD Meeting	Houston, TX	(Syvitski, Xing)
04/2012	CSDMS Seminars: Korean (KORDI)	Seoul-Ansan, Korea	(Syvitski)
05/2012	BOEM Project Telecon	Boulder, CO	(Peckham)
05/2012	NSF EarthCube EAGER PI ESM Telecon	Boulder, CO	(Peckham)
05/2012	NSF EarthCube EAGER PI Telecon Layered Arch.	Boulder, CO	(Peckham)
05/2012	Multi-Scale Integration Human Health & Environ Data	EPA Durham, NC	(Peckham)
05/2012	RGS: Harnessing Emerging Technologies for 2020	London, UK	(Syvitski)
05/2012	Euro CSDMS Strategic Meeting	Egham, UK	(Syvitski)
05/2012	NSF EarthCube Workflow Workshop, UCAR.	Boulder, CO	(Peckham)
05/2012	Earth System Modeling Workshop, NSF EarthCube	Boulder, CO	(Peckham)
05/2012	SDS (Spatial Decision Support) project	Redlands, CA.	(Peckham)

05/2012	CUAHSI Informatics Standing Committee meeting	Boulder, CO	(Peckham)
06/2012	NSF EarthCube 2nd Charrette meeting.	Washington, DC	(Kettner, Peckham)
07/2012	World Climate Research Program JSC	Beijing, China	(Syvitski)
07/2012	IEEE Intl Geoscience $ Remote Sensing Symposium	Munich, Germany	(Higgins)

4.9 Integration Facility 2012 Publications & Abstracts:

Book Chapters, Journal papers and Newsletters:

Submitted/in review since Jan 1, 2012:

Hirpa, F.A., Hopson, T., De Groeve, T., **Brakenridge, G. R.,** and Restrepo. P.J., 2012, in review. Upstream satellite-derived flow signals for river discharge prediction downstream: application to major rivers in South Asia. *Remote Sensing of the Environment.*

Syvitski, J.P.M. and **Brakenridge, G.R.,** 2012, in review. Causation and avoidance of catastrophic flooding along the Indus River, Pakistan.

Vanmaercke, M., **Kettner, A.J.,** van den Eeckhaut, M., Poesen, J., Govers, G., Mamaliga, A., Verstraeten, G., Radoane, M., and **Syvitski, J.P.M.** submitted. The neglected importance of tectonic activity in explaining catchment sediment yield. *Geology*.

Westerhoff, R. S., Kleuskens, M.P.H.,Winsemius, H.C., Huizinga, J.H., and **Brakenridge, G. R.,** 2012, Automated and Systematic Water mapping in a Near-real-time Global Flood Observatory based on SAR data. in review. *Hydrology and Earth System Sciences*.

Zhang, Y, Hong, Y., Gourley, J.J., Khan, S., Wang, X., Gao, J., **Brakenridge, G. R.,** De Groeve, T., Vergara, H., 2012, in review. Impact of assimilating spaceborne microwave signals for improving flood prediction in Cubango river basin, Africa. *Geophysical Research Letters*.

Accepted/in press since Jan 1, 2012:

Ashton, A.D., **Hutton, E.W.H., Kettner, A.J., Xing, F., Kallumadikal, J.**, Neinhuis, J., Giosan, L. (2012). Progress in Coupling Coastline and Fluvial Dynamics. *Computers & Geosciences*. http://dx.doi.org/10.1016/j.cageo.2012.04.004

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Chorynski, A., Pinskwar, I., Kron, W., **Brakenridge, G.R.,** Kundzewicz, Z. W., 2012, in press. Catalogue of large floods in Europe in the 20th century. In: Kundzewicz, Z. W. (ed.) Changes in Flood Risk in Europe, Special Publication No. 10, IAHS Press, Wallingford, Oxfordshire, UK.

Cohen, S., Kettner AJ, Syvitski, JPM and Fekete BM, 2012 WBMsed: a distributed global-scale daily riverine sediment flux model - model description and validation. Computers & Geosciences, doi:10.1016/j.cageo.2011.08.011

De Winter, I., Storms, J., **Overeem, I.**, (in press 2012). Numerical modeling of glacial sediment production and transport during deglaciation. *Geomorphology*.

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Syvitski, J.P.M., Peckham, S.P., David, O., Goodall, J.L., Delucca, C., Theurich, G. 2013. Cyberinfrastructure and Community Environmental Modeling. In: Handbook in Environmental Fluid Dynamics, Editor: H.J.S. Fernando, CRC Press/Taylor & Francis Group, LLC. ISBN: 978-1-4665-5601-0. Chapter 28: 399-410.

Upton, P., **Kettner, A.J.,** Gomez, B., Orpin, A.R., Litchfield, N., and Page, M.J. 2012. Simulating post-LGM riverine fluxes to the coastal zone: The Waipaoa catchment, New Zealand. *Computers and Geosciences*, doi: 10.1016/j.cageo.2012.02.001.

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DeFries, R, E Ellis, F Stuart Chapin III, P Matson, BL Turner II, A Agrawal, P Crutzen, C Field, P Gleick, P Kareiva, E Lambin, D Liverman, E Ostrom, P Sanchez, **JP Syvitski**, 2012, Planetary Opportunities: A Social Contract for Global Change Science to Contribute to a Sustainable Future. BioScience 62(6): 603-606.

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Wobus, C., R.S. Anderson, **I. Overeem**, N. Matell, G. Clow, F. Urban, 2011. Thermal Erosion of a Permafrost Coastline: Improving Process-Based Models Using Time-Lapse Photography. Arctic, Antarctic and Alpine Research 43: 474–484.

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Cohen, S., **G.R. Brakenridge, A.J.Kettner, J.P.M. Syvitski**, B.M. Fekete and T., De Groeve 2012, Calibration of Orbital Microwave Measurements of River Discharge Using a Global Hydrology Model. *Proceedings of AGU Chapman Conference on Remote Sensing of the Terrestrial Water Cycle, February 2012- Kona, Hawaii, USA.*

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Hoke, M. R. T., Hynek, B. M., di Achille, G., and **Hutton, E. W. H.,** 2012. Process-Response Sedimentary Modeling of Ancient Martian Deltas 2: Offshore Sedimentation and Formation Timescales. *43rd Lunar and Planetary Institute Science Conference, LPSC, Abstracts, v. 43, p. 2254, The Woodlands, Texas, March, 2012*

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Syvitski, JPM, 2012, Life at the Edge: Sinking Deltas, Geological Society of London, Shell London Lecture Series 2012.

Syvitski, JPM, 2012, Harnessing Emerging Technologies for Environmental Science — A Survey of Representative Major NSF-funded Efforts. Harnessing Emerging Technologies for Environmental Science: a 2020 vision, Royal Geographical Society, May 2012.

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Syvitski, JPM, 2012, Planet under pressure. World Climate Research Program, Beijing JSC meeting, July, 2012.

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Vanmaercke, M., **Kettner, A.,** Van Den Eeckhaut, M., Poesen, J., Govers, G., Mamaliga, A., Verstraeten, G., Radoane, M., and **Syvitski, J.**, April 22-27, 2012. Predicting sediment yield for catchments under pristine conditions: the role of tectonic activity. *EGU, Vienna, Austria.*

Vanmaercke, M., Poesen, J., Govers, G., Verstraeten, G., **Kettner, A.,** and Van Den Eeckhaut, M., April, 22-27, 2012. Quantifying the effects of human impact on sediment yield for European catchments. *EGU, Vienna, Austria.*

Winsemius, H.C., **Brakenridge, G. R.,** Westerhoff, R. Huizinga, J., Villars, N. and Bishop, C., 2012. Flood mapping by combining the strengths of optical and active radar remote sensing, *European Geophysical Union Annual Meeting 2012, Vienna.*

5.0 CSDMS2.0

It has been recommended that NSF continue funding the CSDMS effort through the existing NSF cooperative agreement, with 50% of the funding from NSF Ocean Sciences Division(GEO/OCE Margine Geology and Geophysics) and the remaining 50% of the funding from a consortium of NSF Earth Sciences Division (GEO/EAR Geoinformatics; Geomorphology and Land-use Dynamics; Sedimentary Geology and Paleontology; Education and Human Resources; Hydrological Sciences) and NSF Biological Sciences Directorate (BIO/DEB Macrosystems Biology; Ecosystem Studies). The current CSDMS Modeling Framework will be extended for use within a web browser, on a wider variety of computational platforms, and on other high performance computing clusters to ensure robustness and sustainability of the framework. Ever-increasing numbers of community-generated models will be converted into "plug-and-play" components through the development of automated wrapping tools. Methods for quantifying model uncertainty will be adapted. Benchmarking data will be incorporated into the CSDMS modeling framework to support model inter-comparison. Finally, a robust mechanism for ingesting and utilizing semantic mediation databases will also be developed within the Modeling Framework.

Six new community initiatives will be pursued: 1) an *earth - ecosystem modeling initiative* to capture ecosystem dynamics and ensuing interactions with landscapes, 2) a *geodynamics initiative* to investigate the interplay among climate, geomorphology, and tectonic processes, 3) an *Anthropocene modeling initiative*, to incorporate mechanistic models of human influences, 4) a *coastal vulnerability modeling initiative*, with emphasis on deltas and their multiple threats and stressors, 5) a *continental margin modeling initiative*, to capture extreme oceanic and atmospheric events generating turbidity currents in the Gulf of Mexico, and 6) a *CZO Focus Research Group*, to develop compatibility between CSDMS architecture and protocols and Critical Zone Observatory-developed models and data.

5.1 CSDMS2.0 Work packages.

Work Package 1 — Modeling Framework will focus on accessibility and scope of CSDMS models and computational tools both to model developers and to users who work on single user desktop computers as well as high performance computing clusters. A web-based Component Modeling Tool (CMTweb) when developed would allow users to run CMT directly through a web browser, offering increased maintainability, sustainability, and accessibility of computational resources. The CSDMS software stack will also be deployed on other HPC clusters to avoid downtime for users through use-distributed resources. The range of supported platforms will depend on community demand. Plans also include the distribution of pre-built executables of models and tools able to run on a wide range of platforms as a means to increase access to these models. Community members will be able to select a model through a web interface, identify their computing platform, and download a version of the model built specifically for their platform and immediately run the model. Models will come with meta-data, help documents, and model synopses. Once downloaded, users will be able to run models either with a model interface created by the developer, or with the CSDMS GUI provided for each model, to present a uniform interface for all CSDMS models and similar in style to the CMT interface. CSDMS also plans to automate the component wrapping process to allow evermore legacy code in the Repository to become plug-and-play components.

Work Package 2 — Analysis of Model Uncertainty CSDMS plans to incorporate DAKOTA tools into the CMT. The DAKOTA Project has developed an extensive set of open-source, component-based tools for analyzing models in an HPC environment that appear to be well-suited for use within the CSDMS modeling framework. These analysis tools address issues such as: uncertainty, sensitivity, optimization and calibration (parameter estimation) by running a given model numerous times with different inputs. CSDMS also plans to explore other strategies for quantifying various types of model uncertainty, including benchmark or unit tests made available through the CMT. Four main uncertainties affecting model simulations will be explored: i) uncertainties associated with input data and how the data captures natural variability; ii) internal model uncertainty resulting from both model simplification which generates uncertainty at all levels, and modeling schemas which have their own unique numerical solution and resolution limitations; iii) error propagation between coupled models — some exchange variables may have their uncertainties dampened in contrast to others where they are amplified; and iv) test/verification data used to judge model skill, either field or lab, all come with their own uncertainties.

Work Package 3 — Model Benchmarking & Model Inter-comparison To help guide a users choice of what models to run when addressing a specific problem, it is important to have clear insights into the strengths and weaknesses of apparently similar models. Plans include incorporating benchmark data into the CSDMS modeling framework. After an evaluation of the CF Convention Standard Names, CSDMS recognized the need to develop a new and more robust naming standard for the quantities that are shared between models called the CSDMS Standard Names, as described in a previous section. This new standard will be used to provide standardized metadata descriptions of models, model quantities and data quantities. They will also be used in NetCDF model output files created with CSDMS tools.

Work Package 4 Semantic Mediation and Ontologies CSDMS plans to develop a robust mechanism for ingesting and utilizing semantic mediation databases within its modeling framework. When automated systems share data, it is essential to have a robust method for semantic mediation, such as a controlled vocabulary or well-defined ontology. CSDMS has started to use standards from the CF conventions, to provide well-defined standard names for different physical quantities, and for inclusion as metadata within NetCDF files to facilitate sharing of data.

Work Package 5 CSDMS Portal CSDMS plans to expand the use of Semantic MediaWiki SMW information fields to support complex query algorithms to further integrate different classes of model and data information. Query algorithms allow: i) side-by-side comparison of models; ii) access by drilling down to input, benchmark & test datasets, key simulations, and metadata and educational material available for a particular model; and iii) search for all papers written for a specific model or by a specific author. CSDMS plans to enhance model metadata and transparency through new capabilities such as the visualization of functions applied in models. CSDMS also plans to advance community plazas as convenient forums for discussion amongst like-minded modelers. CSDMS plans to make web-based tools available (e.g., threads, forums) where questions can be posted and answered allowing for the legacy of these questions to remain on the CSDMS content management system. Participants can elect to sign up to a distinct model community when downloading that specific model, to receive content updates, or to participate in webinars.

Work Package 6 Developing a Quantitative Surface Dynamics Educational Toolbox The envisioned toolbox will consist of modules hosted on the CSDMS content management system, designed to allow a progressive topical track through the curriculum:

1) **Simple model animations** to function as visualization in lectures; hosted on the CSDMS YouTube channel and documented in the CSDMS Repository (e.g. http://csdms.colorado.edu/wiki/Movie:Levee_breach).

2) A**dvanced CSDMS model animations** for NOAA's 'Science on a Sphere' displays (34 locations worldwide, including major science museums in the US, SOS: http://sos.noaa.gov/). A more economical way of projecting simulations on a sphere is the Magic Planet: it allows development of animations by users themselves (http://www.globalimagination.com/).
3) '**Concept to Model' exercises** function to encourage students to formulate a concept model and translate this model into a set of equations. These exercises address the notion that students need to be empowered to formulate quantitative models from scratch and be at ease with their shortcomings to address complex behavior.
4) **Simplified models that students can 'play' with**. These models will provide core disciplinary ideas and address common misconceptions. The models/modules will be based on current CSDMS CMT technology and CMT-web, but exercises will be entirely pre-wired and with greatly simplified tabbed dialogues of input parameters and generated output. Quantitative data generated by these model simulations have the potential to engage students in sophisticated analyses of time-series and statistics.
5) **Advanced models where learners can run complex scenarios**, can swap in and out different equations for a certain process, and can handle input and output data themselves. These models/modules will similarly be based on current CSDMS CMT technology and CMT-web, but allow for more user flexibility.

5. 2 CSDMS2.0 Metrics for Success

- Couple and launch models on a HPCC through a web browser
- Make CSDMS software stack operational on other HPCC platforms
- Numbers of new CSDMS components
- New functionality to clone, edit and redeploy CSDMS components
- Ability to track uncertainty from data input through model output
- Service component to ingest benchmark data into CSDMS components
- Ability to couple models with different semantics
- Web portal visits and use
- Research proposals that draw on or use CSDMS
- Numbers of incoming models to the center
- Getting diverse communities to work together and solve problems through new focus research working groups, task forces and initiatives
- Linking the CSDMS effort with community data centers: CZO, Delta Collaboratory, NCED
- Use of the educational tool kits and products
- Number of workshop participants
- Number and quality of publications
- Special sessions at national / international society meetings and subsequent publications
- Improved predictions of earth system phenomena
- Improved time to solution --- getting models and tools into the hands of researchers
- Increased diversity of users within CSDMS community activities

Appendix 1: Institutional Membership — those in marked in blue have joined CSDMS in 2012. There are now more than 380+ affiliated institutions.

U.S. Academic Institutions: Current total of 116 with 13 new members from January -31 June 2012

1. Arizona State University
2. Auburn University, Alabama
3. Binghamton University, New York
4. Boston College
5. Boston University
6. Brigham Young University, Utah
7. California Institute of Technology, Pasadena
8. California State University - Fresno
9. California State University - Long Beach
10. California State University – Los Angeles
11. Carleton College, Minneapolis
12. Center for Applied Coastal Research, Delaware
13. Chapman University, California
14. City College of New York, City University of New York
15. Coastal Carolina University, South Carolina
16. Colorado School of Mines, Colorado
17. Colorado State University
18. Columbia/LDEO, New York
19. Conservation Biology Institute, Oregon
20. CUAHSI, District of Columbia
21. Desert Research Institute, Nevada
22. Duke University, North Carolina
23. Florida Gulf Coast University
24. Florida International University
25. Franklin & Marshall College, Pennsylvania
26. George Mason University, VA
27. Georgia Institute of Technology, Atlanta
28. Harvard University
29. Idaho State University
30. Indiana State University
31. Iowa State University
32. Jackson State University, Mississippi
33. John Hopkins University, Maryland
34. Louisiana State University
35. Massachusetts Institute of Technology
36. Michigan Technological University
37. Monterey Bay Aquarium Research Inst.
38. North Carolina State University
39. Northern Arizona University
40. Northern Illinois University
41. Nova Southeastern University, Florida
42. Oberlin College
43. Ohio State University
44. Old Dominion University, Virginia
45. Oregon State University
46. Penn State University
47. Purdue University, Indiana
48. Rutgers University, New Jersey
49. Scripps Institution of Oceanography, CA
50. South Dakota School of Mines, South Dakota
51. Stanford, CA
52. State University (Virginia Tech), VA
53. Syracuse University, New York
54. Texas A&M, College Station, TX
55. Tulane University, New Orleans
56. United States Naval Academy, Annapolis
57. University of Alabama - Huntsville
58. University of Alaska – Fairbanks
59. University of Arkansas
60. University of Arizona
61. University of California – Berkeley
62. University of California - Davis
63. University of California - Irvine
64. University of California - San Diego
65. University of California -Santa Barbara
66. University of California – Santa Cruz
67. University of Colorado – Boulder
68. University of Connecticut
69. University of Delaware
70. University of Florida
71. University of Houston
72. University of Idaho
73. University of Illinois-Urbana-Champaign
74. University of Iowa
75. University of Kansas
76. University of Louisiana – Lafayette
77. University of Maine
78. University of Maryland, Baltimore County
79. University of Memphis
80. University of Miami
81. University of Michigan
82. University of Minnesota – Minneapolis
83. University of Minnesota – Duluth
84. University of Nebraska – Lincoln
85. University of Nevada – Reno
86. University of New Hampshire
87. University of New Mexico
88. University of New Orleans
89. University of North Carolina – Chapel Hill
90. University of North Carolina - Wilmington
91. University of Oklahoma
92. University of Oregon
93. University of Pennsylvania – Pittsburgh
94. University of Pittsburgh
95. University of Rhode Island
96. University of South Carolina
97. University of South Florida
98. University of Southern California

99. University of Texas – Arlington
100. University of Texas – Austin
101. University of Texas – El Paso
102. University of Texas – San Antonio
103. University of Virginia
104. University of Washington
105. University of Wyoming
106. Utah State University
107. Vanderbilt University
108. Villanova University, Pennsylvania
109. Virginia Institute of Marine Science (VIMS)
110. Virginia Polytechnic Institute, VA
111. Washington State University
112. West Virginia University
113. Western Carolina University
114. Wichita State University
115. William & Mary College, VA
116. Woods Hole Oceanographic Inst.

U.S. Federal Labs and Agencies: Current total of 22 with 1 new member from January -31 June 2012

1. Argonne National Laboratory (ANL)
2. Bureau of Ocean Energy Management (BOEM)
3. Idaho National Laboratory (IDL)
4. National Aeronautics & Space Administration (NASA)
5. National Center for Atmospheric Research (NCAR)
6. National Forest Service (NFS)
7. National Oceanic & Atmospheric Administration (NOAA)
8. National Oceanographic Partnership Program (NOPP)
9. National Park Service (NPS)
10. National Weather Service (NWRFC)
11. Naval Research Laboratory (NRL)
12. Oak Ridge National Laboratory (ORNL)
13. Sandia National Laboratories (SNL)
14. The National Science Foundation (NSF)
15. U.S. Army Corps of Engineers (ACE)
16. U.S. Army Research Office (ARO)
17. U.S. Department of the Interior – Bureau of Reclamation
18. U.S. Department of the Interior – Bureau of Ocean Energy Management (BOEM)
19. U.S. Dept. of Agriculture (USDA)
20. U.S. Geological Survey (USGS)
21. U.S. Nuclear Regulatory Commission (NRC)
22. U.S. Office of Naval Research (ONR)

U.S. Private Companies: Current total of 18 with 1 new member from January -31 June 2012

1. Airlink Communications, Hayward CA
2. Aquaveo LLC, Provo, Utah
3. Chevron Energy Technology, Houston, TX
4. ConocoPhillips, Houston, TX
5. Deltares, USA
6. Dewberry, Virginia
7. Everglades Partners Joint Venture (EPJV), Florida
8. ExxonMobil Research and Engineering, Houston, TX
9. Idaho Power, Boise
10. PdM Calibrations, LLC, Florida
11. Philip Williams and Associates, Ltd., California
12. Schlumberger Information Solutions, Houston, TX
13. Science Museum of Minnesota, St. Paul, MN
14. Shell USA, Houston, TX
15. URS–Grenier Corporation, Colorado
16. Warren Pinnacle Consulting, Inc., Warren, VT
17. The Von Braun Center for Science & Innovation, Inc.
18. UAN Company

Foreign Membership: Current total of 224 with 42 new members from January – 13 June 2012 (**59** countries outside of the U.S.A.: Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Bulgaria, Cambodia, Canada, Chile, China, Colombia, Cuba, Denmark, Egypt, El Salvador, France, Germany, Ghana, Greece, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Kenya, Malaysia, Mexico, Myanmar, Nepal, New Zealand, Nigeria, Norway, Pakistan, Peru, Poland, Portugal, Romania, Scotland, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Netherlands, Turkey, UK, United Arab Emirates, Uruguay, Venezuela, Việt Nam).

1. Aberystwyth University, Wales, UK
2. Adam Mickiewicz University (AMU) Poznan, Poland
3. Aerospace Company, Taiwan
4. Agency for Assessment and Application of Technology, Indonesia
5. AgroCampus Ouest, France
6. Aix-Marseille University, France
7. Anna University, India
8. ANU College, Argentina
9. Aristotle University of Thessaloniki, Greece
10. ASR Ltd., New Zealand
11. Bakosurtanal, Indonesia
12. Bedford Institute of Oceanography, Canada
13. BG Energy Holdings Ltd., UK
14. BG Group, UK

15. Birbal Sahni Institute of Palaeobotany, India
16. Bonn University, Germany
17. Blaise Pascal University, Clermont, France
18. British Columbia Institute of Technology (BCIT), Canada
19. British Geological Survey, UK
20. Bundesanstalt fur Gewasserkunde, Germany
21. Cambodia National Mekong Committee (CNMC), Cambodia
22. Cambridge Carbonates, Ltd., France
23. Cardiff University, UK
24. Carleton University, Canada
25. CETMEF/LGCE, France
26. China University of Geosciences- Beijing, China
27. Chinese Academy of Sciences – Cold and Arid Regions Environmental and Engineering Research Institute
28. Chinese Academy of Sciences – Institute of Mountain Hazards and Environment, China
29. Chinese Academy of Sciences – Institute of Tibetan Plateau Research (ITPCAS), China
30. Christian-Albrechts-Universitat (CAU) zu Kie, Germany
31. CNRS / University of Rennes I, France
32. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
33. Consiglio Nazionale delle Ricerche (CNR), Italy
34. Cracow University of Technology, Poland
35. Darmstadt University of Technology, Germany
36. Delft University of Technology, Netherlands
37. Deltares, Netherlands
38. Digital Mapping Company, Bangladesh
39. Dongguk University, South Korea
40. Durham University, UK
41. Ecole Nationale Superieure des Mines de Paris, France
42. Ecole Polytechnique, France
43. Energy & Environment Modeling, ENEA/UTMEA, Italy
44. Environnement Illimite, Inc., Canada
45. Eidgenossische Technische Hochschule (ETH) Zurich, Switzerland
46. Excurra & Schmidt: Ocean, Hydraulic, Coastal and Environmental Engineering Firm, Argentina
47. FCEFN-UNSJ-Catedra Geologia Aplicada II, Argentina
48. Federal Ministry of Environment, Nigeria
49. Federal University of Itajuba, Brazil
50. Federal University of Petroleum Resources, Nigeria
51. First Institute of Oceanography, SOA, China
52. Free University of Brussels, Belgium
53. French Agricultural and Environmental Research Institute (CEMAGREF)
54. French Research Institute for Exploration of the Sea (IFREMER), France
55. Fugro-GEOS, UK
56. Geo Consulting, Inc., Italy
57. Geological Survey of Canada (Atlantic), Nova Scotia
58. Geological Survey of Canada, Atlantic
59. Geological Survey of Canada, Pacific
60. Geological Survey of Japan (AIST), Japan
61. Geosciences, Rennes France
62. GNS Science, New Zealand
63. Group-T, Myanmar
64. Grupo DIAO, C.A., Venezuela
65. Haycock Associates, UK
66. Helmholtz Centre for Environmental Research (UFZ), Germany
67. Hong Kong University, Hong Kong
68. H.R. Wallingford, UK
69. IANIGLA, Unidad de Geocriologia, Argentina
70. Imperial College of London, UK
71. India Institute of Technology – Delhi, India
72. India Institute of Technology – Kanpur, India
73. India Institute of Technology – Mumbai, India
74. Indian Institute of Science – Bangalore, India
75. Indian National Centre for Ocean Information Services (INCOIS), India
76. InnovationONE, Nigeria
77. Institut de Physique de Globe de Paris, France
78. Institut des Sciences de la Terre, France
79. Institut Francais du Petrole (IFP), France
80. Institut National Agronomique (INAS), Algeria
81. Institut Teknologi Bandung (ITB), Indonesia
82. Institute for Computational Science and Technology (ICST), Viet Nam
83. Institute for the Conservation of Lake Maracaibo (ICLAM), Venezuela
84. Institute of Earth Sciences (ICTJA-CSIC), Spain
85. Institute of Engineering (IOE), Nepal
86. Instituto Hidrografico, Lisboa, Lisbon, Portugal
87. Instituto Nacional de Hidraulica (INH), Chile
88. Instituto Nazionale di Astrofisica, Italy
89. International Geosphere Biosphere Programme (IGBP), Sweden
90. Italy National Research Council (CNR), Italy
91. IUEM: Institut Univ. Europeen de la Mer, France
92. Japan Agency for Marine-Earth Science Technology (JAMSTEC), Japan
93. Karlsruhe Institute of Technology (KIT), Germany

94. Katholieke Universiteit Leuven, KUT, Belgium
95. Kenya Meteorological Services, Kenya
96. King's College London, UK
97. Korea Ocean Research and Development Institute (KORDI), South Korea
98. Korea Water Resources Corporation, South Korea
99. Lab Domaines Oceanique IUEM/UBO France
100. Laboratoire de Sciences de la Terre, France
101. Lanzhou University, China
102. Leibniz-Institute fur Ostseeforschung Warnemunde (IOW)/Baltic Sea Research, Germany
103. Loughborough University, UK
104. Lund University, Sweden
105. Marine Sciences For Society, France
106. McGill University, Canada
107. Ministry of Earth Sciences, India
108. MUC Engineering, United Arab Emirates (UAE)
109. Mulawarman University, Indonesia
110. Nanjing Hydraulics Research Institute, China
111. Nanjing University of Information Science & Technology (NUIST), China
112. Nanjing University, China
113. National Research Institute of Science and Technology for Environment and Agriculture (CEMAGREF became IRSTEA), France
114. National Institute for Space Research (INPE), Brazil
115. National Institute of Oceanography (NIO), India
116. National Institute of Water and Atmosphere (NIWA), New Zealand
117. National Marine Environmental Forecasting Center (NMEFC), China
118. National Research Centre for Sorghum (NRCS), India
119. National Research Council (NRC), Italy
120. National Space Research & Development Agency, Nigeria
121. National University of Sciences & Technology, (NUST), Pakistan
122. Natural Resources, Canada
123. Northwest University of China, China
124. Norwegian University of Life Sciences, Norway
125. Ocean University of China, China
126. Padua University, Italy
127. Peking University, China
128. Petrobras, Brazil
129. Pondicherry University, India
130. Pukyong National University, Busan, South Korea
131. Riggs Engineering, Ltd., Canada
132. Royal Holloway University of London, UK
133. Sejong University, South Korea
134. Senckenberg Institute, Germany
135. SEO Company, Indonesia
136. Seoul National University, South Korea
137. Shell, Netherlands
138. Shenzhen Inst. of Advanced Technology, China
139. Shihezi University, China
140. Singapore-MIT Alliance for Research and Technology (SMART), Singapore
141. Southern Cross University, United Arab Emirates (UAE)
142. Sriwijaya University, Indonesia
143. SRM University, India
144. Statoil, Norway
145. Stockholm University, Sweden
146. Tarbiat Modares University, Iran
147. The European Institute for Marine Studies (IUEM), France
148. The Leibniz Institute for Baltic Sea Research, Germany
149. The Maharaja Sayajirao University of Baroda, India
150. Tianjin University, China
151. Tsinghua University, China
152. UNESCO-IHE, Netherlands
153. Universidad Agraria la Molina, Peru
154. Universidad Complutense de Madrid, Spain
155. Universidad de Granada, Spain
156. Universidad de Guadalajara, Mexico
157. Universidad de Oriente, Cuba
158. Universidad Nacional de San Juan, Argentina
159. Universidad Politecnica de Catalunya, Spain
160. Universidade de Lisboa, Lisbon, Portugal
161. Universidade de Madeira, Portugal
162. Universidade do Minho, Braga, Portugal
163. Universidade Federal do Rio Grande do Sul (FRGS), Brazil
164. Universit of Bulgaria (VUZF), Bulgaria
165. Universita "G. d'Annunzio" di Chieti-Pescara, Italy
166. Universitat Potsdam, Germany
167. Universitat Politecnica de Catalunya, Spain
168. Universitas Indonesia, Indonesia
169. Universite Bordeaux 1, France
170. Universite de Rennes (CNRS), France
171. Universite du Quebec a Chicoutimi (UQAC), Canada
172. Universite Montpellier 2, France
173. Universiteit Gent, Ghent, Belgium
174. Universiteit Stellenosch University, South Africa
175. Universiteit Utrecht, Netherlands
176. Universiteit Vrije (VU), Amsterdam, Netherlands
177. Universiti Teknologi Mara (UiTM), Mayalsia

178. Universiti Malaysia Pahang, Malaysia
179. University College Dublin, Ireland
180. University of Bari, Italy
181. University of Basel, Switzerland
182. University of Bergen, Norway
183. University of Bremen, Germany
184. University of Brest, France
185. University of Bristol, UK
186. University of British Columbia, Canada
187. University of Calgary, Canada
188. University of Cambridge, UK
189. University of Copenhagen, Denmark
190. University of Dundee, UK
191. University of Edinburgh, Scotland
192. University of Edinburgh, UK
193. University of Exeter, UK
194. University of Ghana, Ghana
195. University of Guelph, Canada
196. University of Haifa, Israel
197. University of Kashmir, India
198. University of Lethbridge, Canada
199. University of Milano-Bicocca, Italy
200. University of Natural Resources & Life Sciences, Vienna, Austria
201. University of New South Wales, Australia
202. University of Newcastle upon Tyne, UK
203. University of Newcastle, Australia
204. University of Nigeria, Nsukka, Nigeria
205. University of Palermo, Italy
206. University of Padova, Italy
207. University of Pavia, Italy
208. University of Queensland (UQ), Australia
209. University of Rome (INFN) "LaSapienza", Italy
210. University of Southampton, UK
211. University of St. Andrews, UK
212. University of Sydney, Australia
213. University of Tabriz, Iran
214. University of the Republic, Uruguay
215. University of Waikato, New Zealand
216. University of Warsaw, Poland
217. University of West Hungary - Savaria Campus, Hungary
218. University of Western Australia, Australia
219. Vision on Technology (VITO), Belgium
220. VUZF University, Bulgaria
221. Wageningen University, Netherlands
222. World Weather Information Service (WMO), Cuba
223. Xi-an University of Architecture & Technology, China
224. York University, Canada

Independent Researchers (both U.S. and Foreign): **25** members self-identify either as independent researchers or left their affiliation unknown.

Appendix 2: Summary of Euro-CSDMS Meeting, May 17th-18th 2012

Euro-CSDMS is a new initiative to enhance Earth surface modeling in Europe and to establish a sister organization to the existing CSDMS group in the USA. Euro-CSDMS will be an IT infrastructure and an associated group of researchers that marry and leverage the science, engineering, social & economic communities to develop and provide practical tools, applications and solutions for environmental security and industry innovation. Its main purpose will be to foster collaborative research in order to develop open-source technologies to evaluate and predict the global, regional and local response to environmental change. Collaborative research in the group should grow organically, from the bottom up.

Draft 3-year plan

The plan agreed at the meeting is to prepare for submission of a large Europe-wide research proposal in 2015 to support growth of Euro-CSDMS activities. Suggestions for how to achieve this are:

- Establish small-scale collaborative research efforts from 2012 onwards to demonstrate how the existing group can productively collaborate to generate relevant research output. This could include submission of funding requests, at national or international level.
- Establish some basic low-cost IT infrastructure, starting with a Euro-CSDMS Wiki site that will act as repository for member profiles, funding opportunities, draft funding proposals, and research discussion.
- Fund, organize and run a Europe-wide meeting, possibly in Q3 2013, to expand group membership and plan in detail the focus, content, structure, finances and funding body target for the 2015 research proposal. Conference would aim to develop breadth and depth in the EuroCSDMS buy-in and result in a meeting that was in some sense "quorate".

What is in the rest of this document

The rest of the material in this document records the discussion from the 2day meeting, mostly in note form.
Day 1 focussed on ideas to define and identify a focus for Euro-CSDMS.
Day 2 focused on ideas for funding, further discussion for defining research areas, and action items for all attendees of the meeting.

Meeting Attendees

Surname	Forename	Institution	Country
Alison	Peter	Imperial	UK
Kingdon	Andy	BGS	UK
Burgess	Peter	RHUL	UK
Ellis	Mike	BGS	UK
Harpham	Quillon	HR Wallingford	Uk
Hill	Jon	Imperial	UK
Issa	Reza	EDF	France
Jagers	Bert	Delft 3D	Netherlands

Mudd	Simon	Edinburgh	UK
Piggot	Matthew	Imperial	Uk
Pisacane	Giovanna	ENEA	Italy
Sutherland	James	HR Wallingford	UK
Syvitski	James	Colorado University	USA
Villaret	Catherine	EDF	France
Waltham	Dave	RHUL	UK

Day 1 Ideas for the identity of Euro-CSDMS

Meeting attendees split into four groups and discussed what Euro-CSDMS should be. A synthesis of those discussions was used in the first page of this document. Additional material is presented below, mostly related to research challenges and the infrastructure necessary to achieve them.

Group 2 notes

The multiple environmental problems that affect humans' interaction with the environment cannot currently be modelled with the available numerical modelling tools. But with increasing environmental stresses as populations expand and climate changes, technological societies require ever more robust predictions of environmental processes. In addition, for scientific predictions to be trusted by wider society and policymakers, model validation using well documented, publicly accessible data is required.

To facilitate meeting these goals, we propose both infrastructure and activities that will address the following key challenges

i) Semantic interoperability: Creating interoperable models will increase collaboration between European computational geoscientists and efficient model interoperation is only possible if model parameters and variable names are standardized.

ii) Software engineering expertise is necessary to accelerate model interoperability. The vast majority of modelling results published in the scientific literature is not reproducible nor is it verifiable. This falls below the basic threshold for publication of laboratory-based work and cannot continue, yet it is unreasonable to retrain an entire generation of geoscientists in prevailing software engineering standards. Therefore expertise in computer science that bridges the gap between process expertise and software engineering is necessary.

iii) There are a growing number of standards for model linkage and data reporting, however there is limited uptake of these standards by the computational geoscience community; CSDMS Europe will attempt to address this problem by leading by example to demonstrate the utility and importance of selected standards.

iv) Data standards and methods to properly credit the originators of models and data.

Group 3 notes

What	Address environmental problems – Climate change – Renewable energy – Flooding – Geomorphic response altering vulnerability
Approach	Different disciplines / multi-disciplinary – Collaboration 1. computer science 2. oceanography 3. biology 4. geology 5. maths/physics 6. engineers – communication – 1. between the above and 2. with policy makers / stakeholders – knowledge exchange 1. choice of model: reduced complexity vs high complexity models
Requires code that is	Robust Inter-operable Defensible Transparent
How	Standards – run-time linking – core code standards – software tools [interpolators, wrappers etc] – uncertainty analysis –
Requires	User cases Model validation tools Inter-comparison exercises

Day 1 One sentence summaries of individuals vision for Euro-CSDMS

CSDMS should be:

- A platform for **crossing different science communities**, advancing **common knowledge**, and techniques for model scaling.
- **European infrastructure** for the **assessment of climate change impact on the regional to basin scale in the coupled human/earth dynamic system.**
- **Facilitate cross group and EU wide collaboration** and increase the success rate of funding applications; based on **science landscape into rock, anthropogenic climate change impact on sediment routing, and identification of inhabited areas most at risk.**
- **Community of earth system scientist sharing models, data and ideas within a common framework.**
- Will **provide infrastructure** and expertise to allow Europeans computational geoscientists to build **interoperable** robust defensible and transparent models which can be s**hared amongst members,** validated against recognized data sets **and ultimately used to solve environmental problems.**
- **Collaborative effort** to model threats to the natural environment. **Core infrastructure**, human geography of Europe – **climate change threats**, HPCC infrastructure, **uncertainty reduction across multiple scales.**
- **Define common standards** and use-cases for integrated modelling.
- To **address combined environmental problems** with multipurpose models.
- Should provide a community infrastructure that leverages **environmental science to solve environmental problems.**
- **Modelling uncertainty by comparison of different models.**
- Too difficult to aim at having a common platform but **knowledge must be shared** and models coupled across several areas like **physical processes, computational science, data handling and parameterization.**
- Sister organization of US CSDMS, building on what has been done using **same standards.**

Blue text indicates organizational and infrastructure elements.
Green text relates to research challenges

Day 2 Funding and Further Discussion of Research Direction

Initial Ideas for a funding Model

Summary of proposed funding strategy:

- Developing a focus/brand/alignment of EuroCSDMS members that can support individual grant applications.
- Encourage individuals and groups in EuroCSDMS to collaborate, fund visits, give invited talks, and take seats on grant steering committees.
- Develop activities that facilitate communication between the group members, leading to innovative funding proposals.

Notes on funding sources from discussion in the May meeting

- Leverhulme funded International Network (http://www.leverhulme.ac.uk/funding/IN/IN.cfm) . Perhaps at the Dervali Centre? To fund conference in 2013.
- EC Environment calls respond to needs of society. Any infrastructure must support the needs of the call. Funding will stop at the end of 3 to 4 years. Exemplar projects: DRIHM, iCOAST, PURE, WIDGET, FluidEarth. All use OpenMI.
- In preparation for a large-scale proposal in FP8 we can use other funding streams to build support and focus. Possible options include:
  - ENV.2013.6.5-4 - Knowledge platforms – North Atlantic
  - ClimateKIC – Deltare & Imperial College already involved, maybe possibilities for interoperability topics associated with CSDMS
  - ECRA – European Climate Research Alliance – get climate & hydrology (& oceanography?) communities together – may have funding opportunity or act as lobby platform in Brussels – ENEA link
  - TerenoMED initiative for some EC call – ENEA link
  - NERC calls … (see Mike)
  - ICT.2013.1.2 – Software engineering, services and computing?
- We may consider linking to FuturICT proposal for an EU flagship project with 100MEuro funding per year for 10 years. The FuturICT proposal includes a Living Earth Simulator component that matches our vision very well, see http://futurict.eu
- IEM funding from EU sources
  - New IEM funding applications from EC must reference OpenMI
  - FP7 ends after 2013 call (to be issued imminently)

- 2013 calls ICT-2013.1.2 Software Engineering, Services and Computing
- ENV.2013.WATER-1 Water efficiency and innovation demonstration projects.

- Horizon 2020("FP8")
  - Horizon 2020 ("FP8") will be smaller, different mechanisms, and likely to be a funding hiatus between the two
  - Poor prospect for large EU funding for IEM in the near future
  - http://ec.europa.eu/research/horizon2020/pdf/proposals/com(2011)_809_final.pdf#view=fit&pagemode=none

- Belmont Forum, Opportunities in Freshwater security call

CSDMS Research Gap Analysis

Things that CSDMS has an ambition to do but is not currently doing to a sufficient level:

- Validation of individual models/modules
- Validation of composite/coupled modelling systems
- Working on semantics and ontologies
- Leadership in biogeochemistry, toxins water quality
- Development/leadership in models for engineered systems e.g. dammed rivers, flow control systems, tidal barriers
- Rock record modelling/landscape into rock
- Connecting to agribusiness, forestry, fishery, policy
- CSDMS for renewable energy concepts

These are all possible opportunities for areas of research focus for Euro-CSDMS

Research Plans that might fall in the scope of Euro-CSDMS

Peter Alison & Jon Hill, Imperial College, UK

AMCG Modelling activities inline with possible EuroCDMS activities

1) Detailed validation of models and modules. PhD student and funded model development activities (thesis and papers available). The crucial thing is to define the limiting factors to model application, i.e. this model works best for this reasons, this model does not work in this circumstance because… Model improvement and development MUST be grounded in diagnostic evaluation.
2) AMCG collaborating with Jeff Peakall at Leeds to develop a series of validation experiments of increasing complexity for density current models.
3) Models for engineered systems. Multi-million pound urban flooding projects incorporating ICOM currently being assessed.
4) Rock record modeling. Use of ICOM and other models to understand ancient depositional systems. AMCG not involved in collaboration where we supply boundary conditions for forward strat models. Currently funded for £250k over 3-4 years (probably based on annual renewals plus additional £750k project on palaeotidal models. Note, latter is a very recent development.
5) Marine renewables. ICOM currently funded by 700k EPSRC grant and a couple of industry contracts for siting and design optimization of marine renewable installations.

Bert Jagers, Deltares, Delft, Netherlands

Use cases & standards	x	OpenMI, WaterML, netCDF, … - primary objective not on developing new standards, but adopting & adapting
Working with US on semantics/ontologies	>	DeltaModel & Digital Delta are ongoing related projects Deltares is involved - link to NSF EarthCube
Leadership in biogeochemistry, toxins, water quality	x	delwaq - common open source module together with EdF and HR Wallingford
Development/leadership in models for engineered	x	Urban water & water quality problems, human part of the water cycle

systems		
Rock record modeling (landscape into rock)	x	Joep Storms (TUD), Maarten Kleinhans (UU), Deltares-subsurface group, Delft3D long-term stratigraphy
Connecting to agribusiness, forestry, fishery, policy	x	Deltares policy group (a bit outside numerical modelling) - Alterra
CSDMS for renewable energy/concepts	x	modeling effect of tidal turbines on large scale environmental system, nesting of high resolution renewable energy detailed models in large scale models

Catherine Villaret, EDF R&D, Chatou, France

1. Standards for quality of open-source models
   - Definition of criteria for model robustness, best practice
   - Definition of bench-marking test cases from lab scale to larger scale
   - Definition of data base and use-cases (the Gironde esturary, comparison with other European estuarine systems)
   - Problem of boundary conditions (definition of fluxes at the interface between the terrestrial and the marine sphere)
   - Uncertainty analysis : interest of model intercomparison to assess model uncertainty
   - Comparison/advantage of complex models versus simplified models (ex 3D versus 1D models)
   - Comparison of platforms (CMT, Open MI, Salome, Pyxis…)
2. Engineering systems :
   - Built of reliable and robust, predictive flooding alert systems
   - Effect of dam breaking/land slides on inundation
   - …
3. Renewable energy
   - Use models to determine possible resources (wave power, tidal power, wind energy…)
   - Use models to assess the impact of new or existing structures on the environment (e.g. impact of Tidal power plant La Rance on the transport and eco-systems)

Giovanna Pisacane, ENEA, Rome, Italy

Use cases & standards for validation of individual models:

- Validation and improvement of existing land modules currently used in RCMs (upscaling and parameterization).
- Development of Montecarlo techniques in impact studies in order to explore the tails of statistical distributions of events.

Mike Ellis & Andy Kingdon, BGS, Keyworth, UK

BGS has world leading expertise in the study of urban geology and its relationship with the built-environment. A large scale integrated modelling project is required that
Issues for this research project include:

- Security of groundwater for potable water supplies
- Sustainable urban drainage / pollution prevention/ recharge in the urban environment
- Modelling of the interactions of groundwater, pluvial and fluvial flood risks

- The issues of water management and draining system management within cities
- parameterisation of the urban environment with geophysical and hydrogeological properties to facilitate higher resolution modelling.

Some specific research activities that could deliver and demonstrate the power of an integrated community, etc:

1. We need the ability to predict, at high resolution, the co-evolution of erosion, C-loss/gain, flood hazard, remobilization of legacy contaminants, etc. within a well-defined environment (see below for a specific example) in the face of environmental change.

For example: evolution or response of an urban area to changes in external forcings (specified at area boundaries and the urban-canopy surface in terms of hydrology, sediment, temperature, precipitation, etc. This could be a very high visibility project because it is aimed squarely at where people live.

2. Joining earth-surface processes to earth-system models via adaptive meshing technologies and by developing and/or applying high-resolution surface process "laws" within an earth-system land model. We have literally just begun to have this conversation and this could therefore be very timely.

Peter Burgess & Dave Waltham, Royal Holloway University of London, UK

Research questions:

- How does the complexity of modern landscapes and seascapes translate into ancient strata?
- What information on the heterogeneity of ancient strata is contained in modern land and seascapes?
- And vice versa, what information on landscape evolution, specifically response to environmental change, is coded in ancient strata?
- What should be included in model tools that we develop to investigate this?
- How can different models be coupled?
- How can sufficient process detail be included, while maintaining usefully fast run times? In other words, are there ways to upscale models?