

# CSDMS 2011 ANNUAL Meeting

## Impact of time and process scales

*October 28-30th, Boulder Colorado, USA*

- Day 1-3: Mornings: keynote addresses on concepts and models
- Day 1-3: Hour lunch
- Day 1-3: Early Afternoons: Clinics (models, generic)
- Day 1-2: Later Afternoons: Posters with Refreshments
- Day 3: Later Afternoon: Working Group or FRG meetings
- Day 2: Banquet: Poster Award; Lifetime Achievement Award
- Day 4: Morning: ExCom Meeting & Steering Committee Meeting



**CSDMS**  
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



**BOEM**  
BUREAU OF OCEAN ENERGY MANAGEMENT



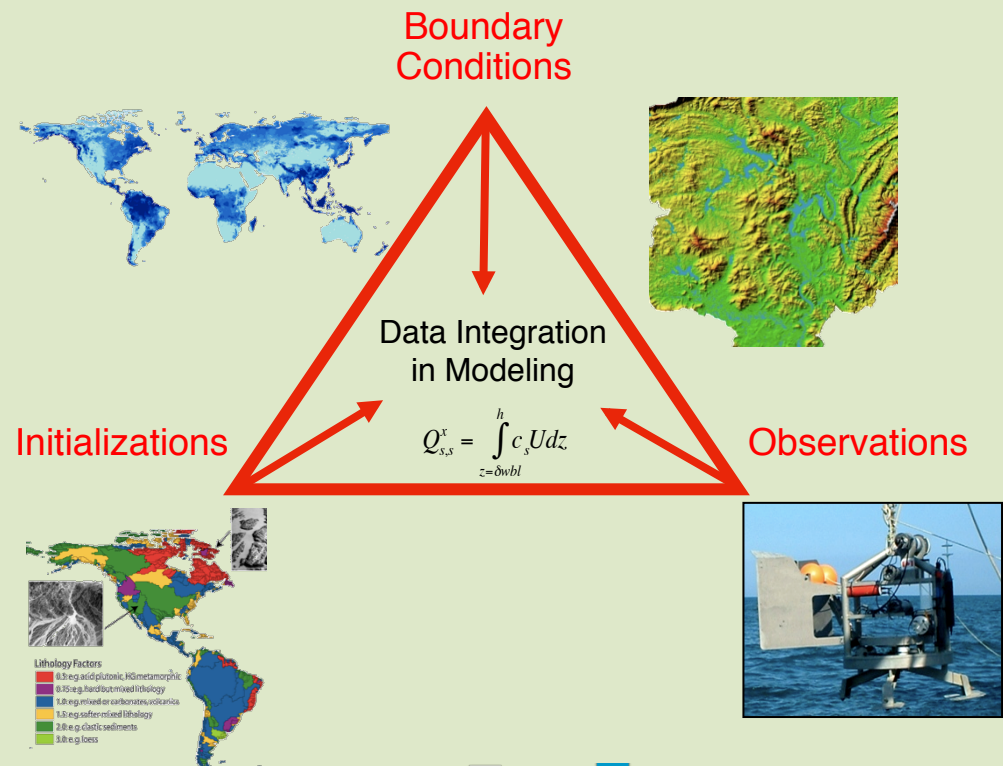


## CSDMS Model Domain:

Glacier, Iceberg Models,  
 Transport or Flux Models,  
 Ocean & Weather Circulation Models,  
 Morphodynamics Models,  
 Landscape or SeascapE Evolution Models,  
 Stratigraphic Models

## CSDMS offers

1. Development & Support of an International ESD Community
2. A Model Repository
3. Model Coupling & Model Reuse Middleware
4. High Performance Computing Support
5. Education & Knowledge Products
6. Model Support Services
  - Data Repository
  - Modeling Tools
  - Model Metadata & Info

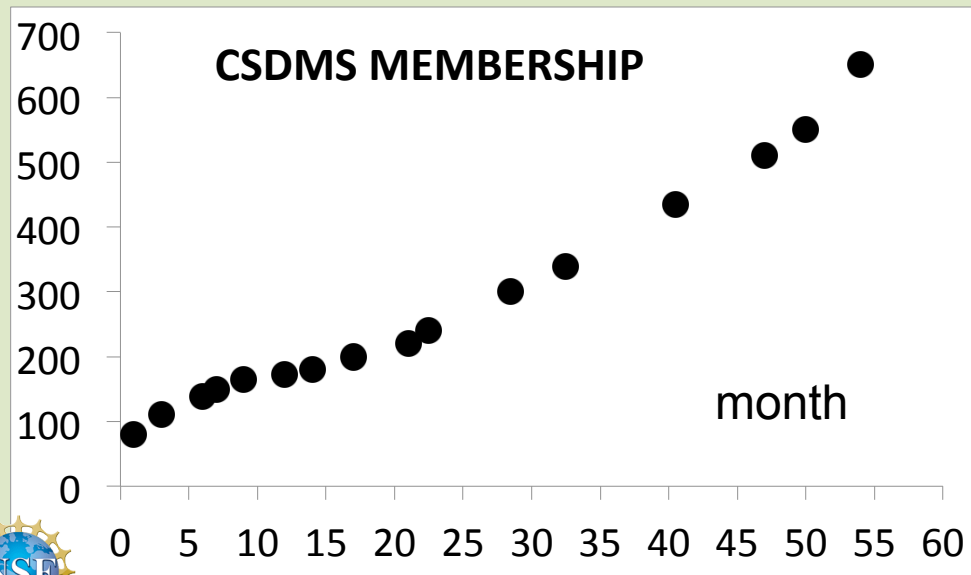


**CSDMS**  
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# CSDMS offers a community of communities to promote the modeling of earth-surface processes

650 Members contribute to 8 Working or Focus Research Groups

Terrestrial	303
Coastal	240
Hydrology	215
Marine	173
Cyber	113
EKT	83
Carbonate	52
Chesapeake	39



## CSDMS partners with:

- **>125 U.S. institutions (>95 universities, 12 private corp., 19 gov't. labs or agencies)**
- **>125 non-US institutions from 40 countries (>85 universities, 3 private, 27 gov't agencies)**
- *Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Canada, Chile, China, Cuba, Denmark, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Myanmar, New Zealand, Nigeria, Norway, Peru, Poland, Portugal, Scotland, Singapore, Spain, Sweden, Switzerland, The Netherlands, UK, Uruguay, USA, Venezuela)*



# CSDMS Community and Activities (2007-11)

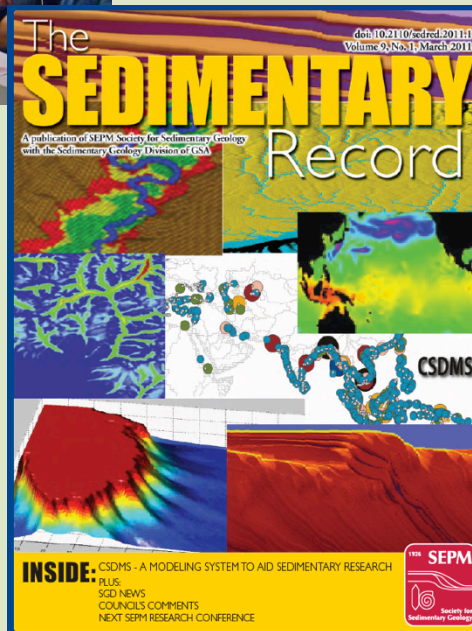


**120 workshops,  
symposia & meetings**

**11 CSDMS Short  
Courses (U.S.A.,  
Germany, Korea, New  
Zealand)**

**190 IF staff  
presentations**

**123 IF staff peer-  
reviewed journal  
papers, books and  
book chapters**



**Annual  
Student  
award**

**Annual  
Lifetime  
Achievement  
award**



# CSDMS Integration Facility (IF) Staff



## 1. NSF-supported CSDMS Staff 5.6 FTE (2011)

• Exec. Director	2007	0.25 FTE
• Software Architect	2007	0.71 FTE
• Software Engineer	2007	0.92 FTE
• Cyber IF Scientist	2007	0.60 FTE
• EKT Scientist	2009	0.62 FTE
• Computer Scientist	2009	0.90 FTE
• Exec Assist	2007	1.00 FTE
• Accounting Tech	2007	0.36 FTE
• Systems Admin	2007	0.28 FTE

## 2. Staff support from other sources 2.4 FTE (2011)

## 3. CSDMS-related support from other sources (2007-2011)

9 grad students

2 undergrad students

3 postdocs

2 senior research scientists

34 CSDMS Visiting Scientists & Students (USA, Canada, Germany, Norway, Australia, Italy, Columbia, China, Netherlands, Belgium)



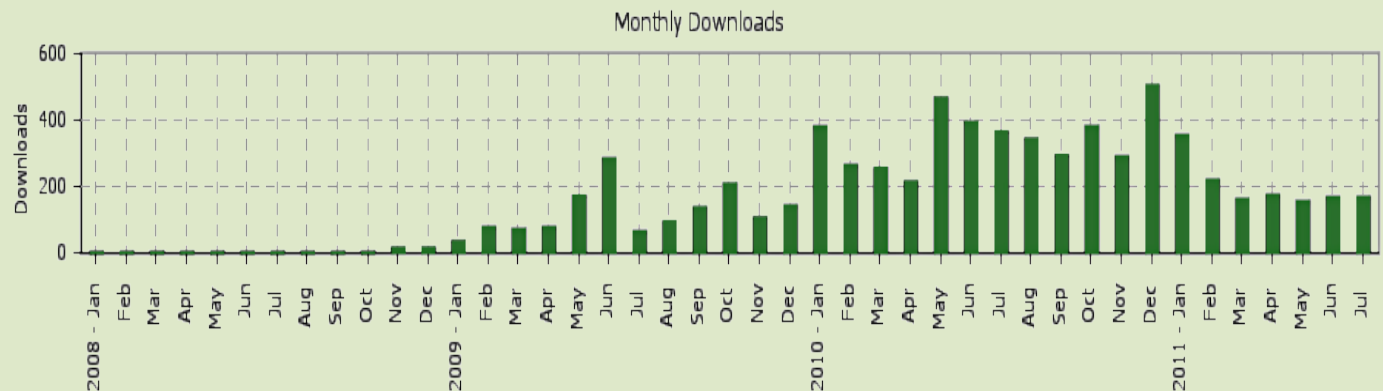
# CSDMS Model Repository:

Domain	Models	Tools	Components
All domains	140	47	53
Terrestrial	74	44	33
Coastal	42	1	3
Marine	28	2	6
Hydrology	47	34	43
Carbonate	1	1	0
Climate	5	2	0

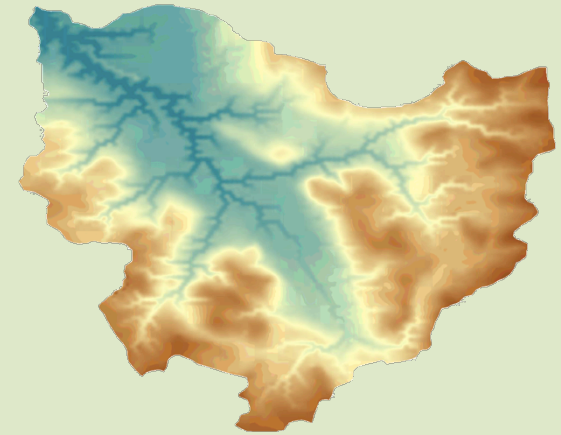
Repository consists of more than 4 million lines of code, valuable metadata for each model with up-to-date references behind the model and its application.

No. of models	No. of downloads
14	>100
29	50-100
29	20-49
45	<20

**CSDMS** provides the cyber-infrastructure to distribute software tools, models & model data in aid of application and education.



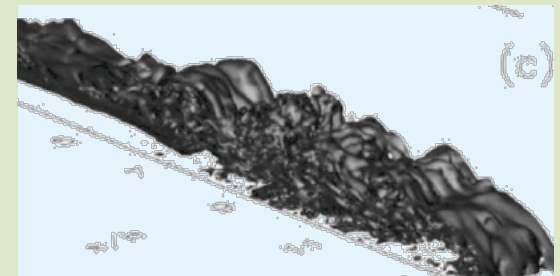
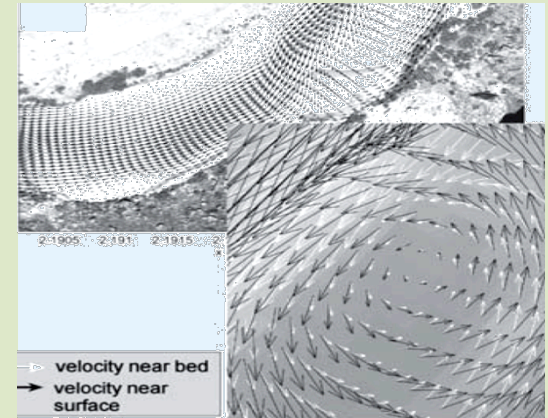
# Types of CSDMS models



**1) Landscape / Seascapes Evolution Models:**  
Geomorphic & stratigraphic models to simulate across geological time and space by incorporating geophysical & geochemical feedbacks including isostasy, eustasy, tectonics, climate change, sea level, post-depositional processes and biology.

**2) Morphodynamic Models:**  
Engineering & sedimentology models to simulate the evolving transport pathway and mobile bed with dynamical feedback to fluid transport processes — may include ecodynamics.

**3) Transport / Circulation Models:**  
Oceanographic, hydrologic & sedimentologic models to simulate the material flux along pathways at the even scale (e.g. river floods, ocean storms) using advanced computational fluid dynamics



# CSDMS MODEL EXAMPLES

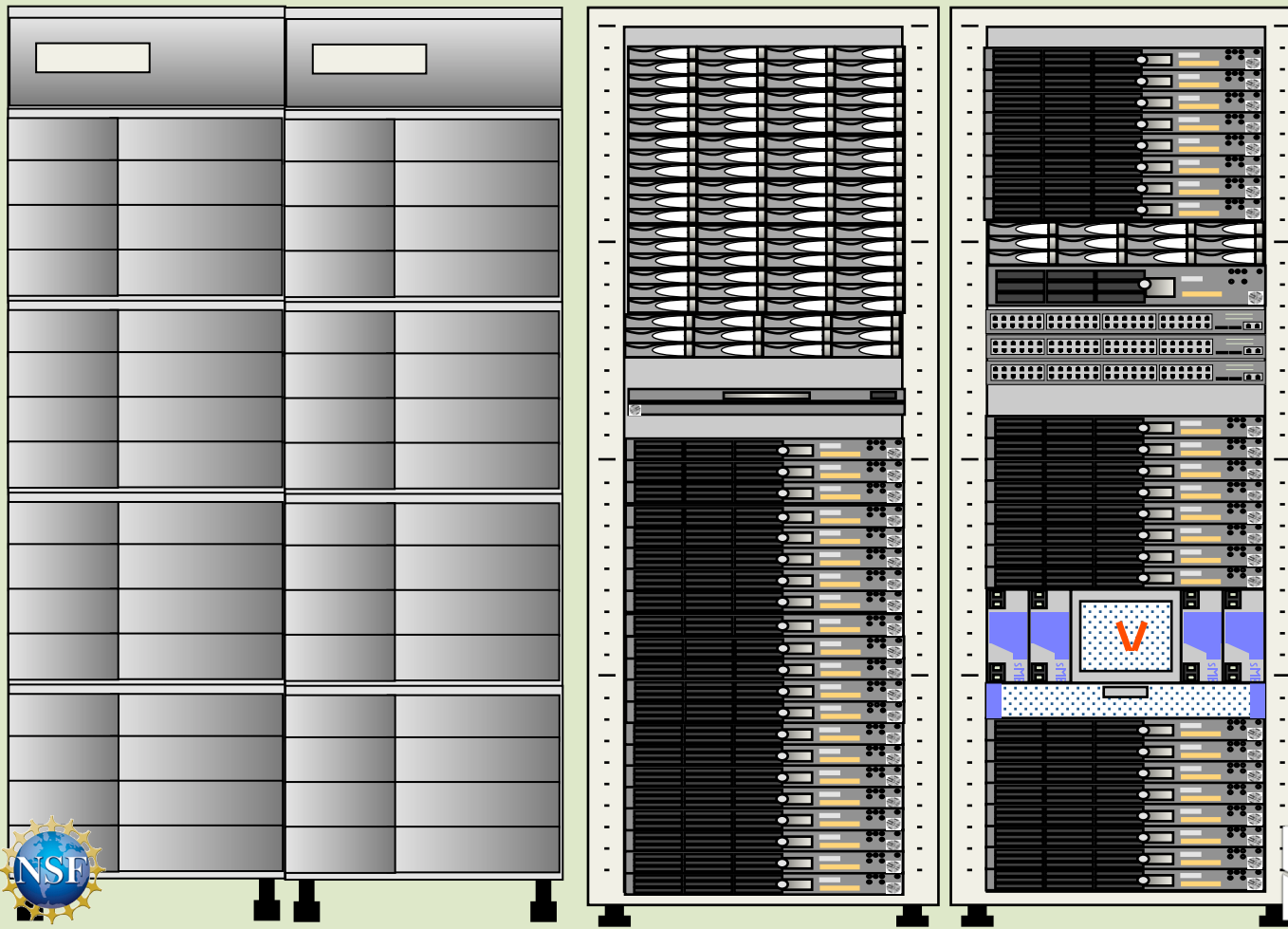
Model Category	Domain	Example models in the CSDMS Repository
<b>Terrestrial</b>	landscape evolution	CHILD, SIBERIA, Caesar, Erode, GOLEM, MARSSIM, WILSIM
	fluvial morphodynamics	LOGPRO, BEDLOAD, MIDAS, TISC, SUSP, YANGs
	eolian transport	Eolian Dune Model
	cryosphere	GC2D, ISGR, Ice ages
	geodynamics	TAo, TISC, LavaFlow2D
<b>Hydrology</b>	reaches	STVENANT, SWMM, FLDTA
	basins	DR3M, TopoFlow, GEOtop, HydroTrend, PIHM, ParFlow, MFDrouting, MODFLOW
	continental	ANUGA, CREST, DHSVM, PIHM
	global	WBM-WTM, VIC
	biogeochemistry & water quality	QUAL2K, OTEQ, OTIS, SPARROW, GNE, HSPF, LOADEST, RHESSys, SWAT
<b>Coastal</b>	flow dynamics	2DFLOWVEL, ADCIRC, NearCoM, ROMS
	wave dynamics	REF-DIF, STORM, STWAVES, SWAN, WAVEREF, WINDSEA, FUNWAVE, ROMS
	coastal evolution	CEM, Delta, XBeach, CrevasseFlow, Avulsion, AquaTellUs
<b>Marine</b>	physical oceanography	FVCOM, ROMS, POM, Symphonie, WAVEWATCH-III
	sediment transport	Diffusion, Plume, SedPlume, SedBerg, Sedtrans5, WSGFAM, SedFlux, Sakura, Hyper, Bing, Bio
	geodynamics	Subside, SedFlux
	stratigraphy	cyclopath, SedFlux
<b>Climate, Weather</b>		WRF, WACCM+, and MITgcm
<b>Tools</b>		ADI2D, LOGDIST, TopoToolbox, TauDEM, Zscape, TURB, TOPOG, Parker Ebook, SVELA, SETTLE, PsHIC, FTCS, Compact





**CSDMS** members may gain access to the CU/USGS experimental supercomputer *Beach* supporting >150 CSDMS members who have met a use criteria

- Running CSDMS models to advance science
- Developing a model for the CSDMS model repository.
- Developing a data or visualizations systems in support of CSDMS models.



*Beach* a 8Tflop/s  
HPCC employs:

- 88 compute nodes
- 704 x 3-GHz cores
- 2-4 GB/core
- non-blocking infiniband
- ~100TB RAID storage.







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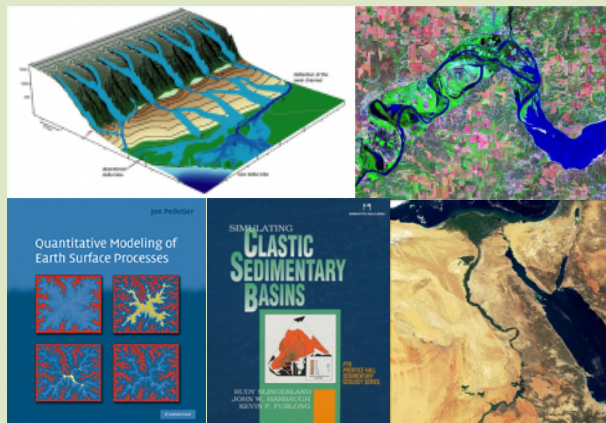
## ***Janus*** (NSF & CU)

*Beach* is linked to NSF/CU *Janus* offering 16,416-cores (>150 Tflop/s) --- 1368 nodes: 6 cores/processor x 2 - 2.8 GHz processors; 2 GB/core; non-blocking Infiniband; ~1PB of RAID storage.

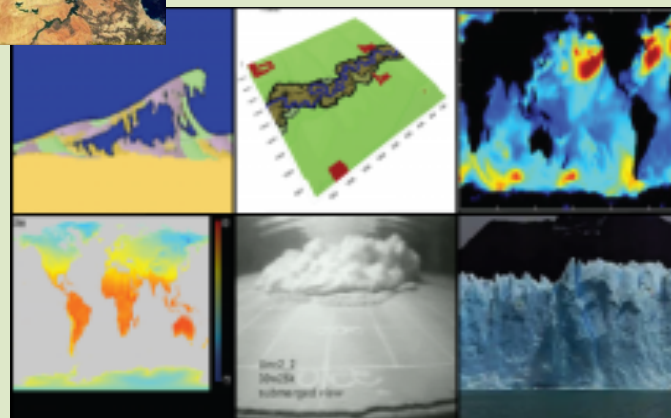


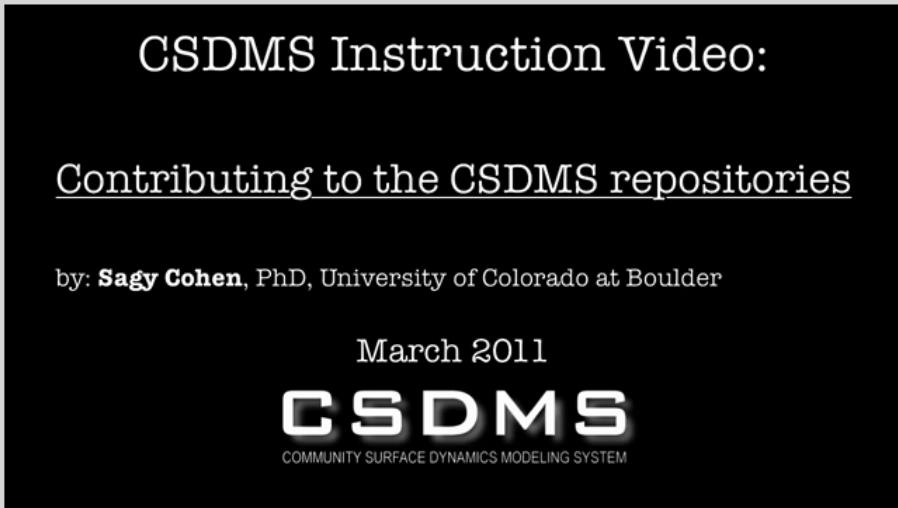
Dataset info	Type	Origin	Description	Data example
ASTER	Topography	Measured	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)	
DDM30	Hydrography	Modeled	Global drainage direction map	
ETOPO1	Topography	Modeled	ETOPO1 is a 1 arc-minute global relief model	
GEBCO	Topography	Modeled	The General Bathymetric Chart of the Oceans	
GLOBE	Topography	Modeled	GLOBE is a project to develop the best available 30-arc-second (nominally 1 kilometer) global digital	

**CSDMS Data Repository:** includes initialization databases; data tools; test & validation data; benchmarking data



**CSDMS Education Repository:** Real event & laboratory movies, model animation movies; student labs; modeling short courses, lectures, textbooks, imagery



**CSDMS**  
CSDMSmovie's Channel[Subscribe](#)[All](#)[Uploads](#)[Playlists](#)

# CSDMS Instruction Video: Contributing to the CSDMS repositories

by: **Sagy Cohen**, PhD, University of Colorado at Boulder

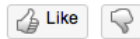
March 2011

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### Instruction Video- Contributing to the CSDMS repositories

From: CSDMSmovie | Apr 25, 2011 | 29 views

Follow the steps of contributing a model to the CSDMS model repository and show how to edit your entries.

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A short introduction to the CSDMS model repository
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Follow the steps of contributing a model to the CSDMS model repository and show how to edit your entries.
- CSDMSmovie uploaded a new video** (1 week ago)  
[Instruction Video- Connecting to CSDMS HPC and CMT](#)  
Follow the steps for connecting to the CSDMS High Performance Computer Cluster

**CSDMS**  
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CSDMS offers instructional material on its YouTube channel — highlighted several times for being in the “Top 50 most viewed channel” in the “non profit” category.

# Instructional videos

Description 	Link
<p><a href="#">How to connect to the supercomputer</a></p> <p>An instructional video that shows how to connect to the CSDMS High Performance Computer Cluster (HPCC; beach) and the CSDMS Modeling Tool (CMT; model coupling GUI).</p>	
<p><a href="#">How to contribute to the CSDMS repositories</a></p> <p>A step by step video of how to contribute a model to the CSDMS model repository and show how to edit your entries.</p>	
<p><a href="#">How to use the model repository</a></p> <p>A brief video of how to use the model repository</p>	
<p><a href="#">How to become a member</a></p> <p>A short description of how to become a member and what are the benefits of a CSDMS member.</p>	

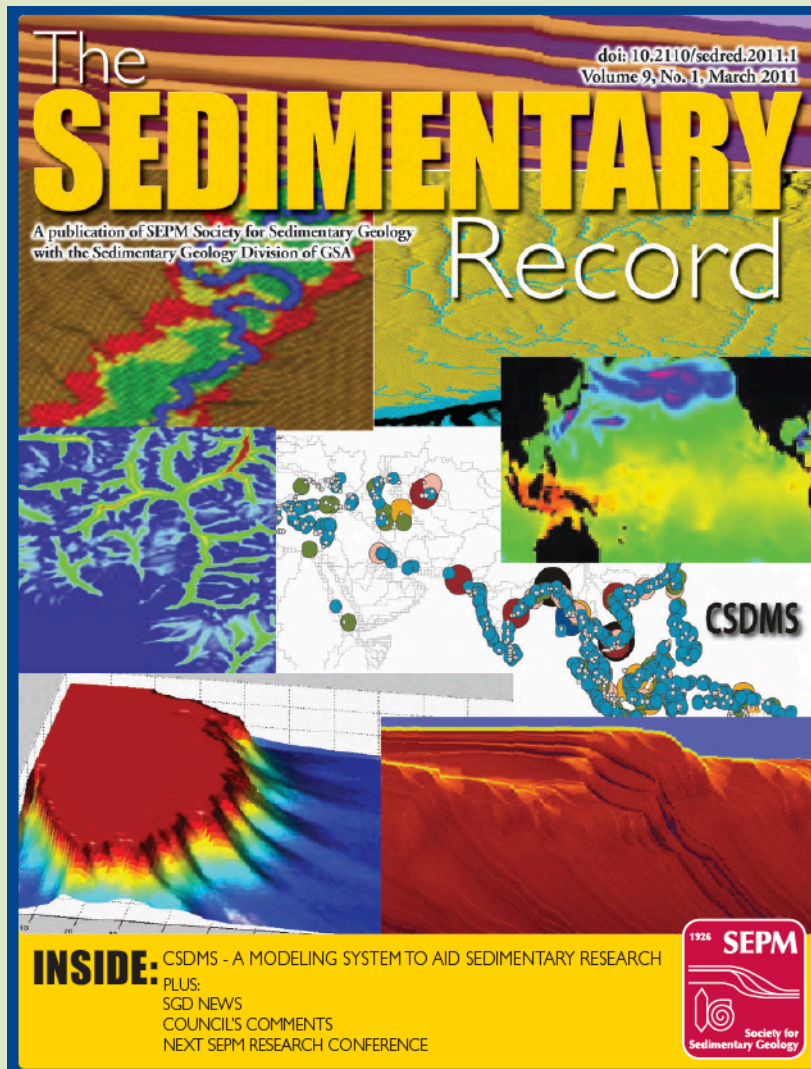
CSDMS instructional videos offer step by step instruction on how to use the various tools and facilities of CSDMS.



# CSDMS best-practices or protocols for contributed models

- 1) **Open-source license.**
- 2) Be **widely available.**
- 3) **Vetted** — the software should do what it says it does.
- 4) In a Babel-supported **open-source language** (C, C++, Fortran, Java, Python) or have a pathway for conversion.
- 5) **Refactored with an IRF interface** [& getter and setter functions].
- 6) **Separate out any user interface**
- 7) Include a **metadata file** and **test I/O files.**
- 8) Be **clean and documented** using keywords within comment blocks to provide basic metadata for the model and its variables.
- 9) Provide **descriptive state variables with identified units**



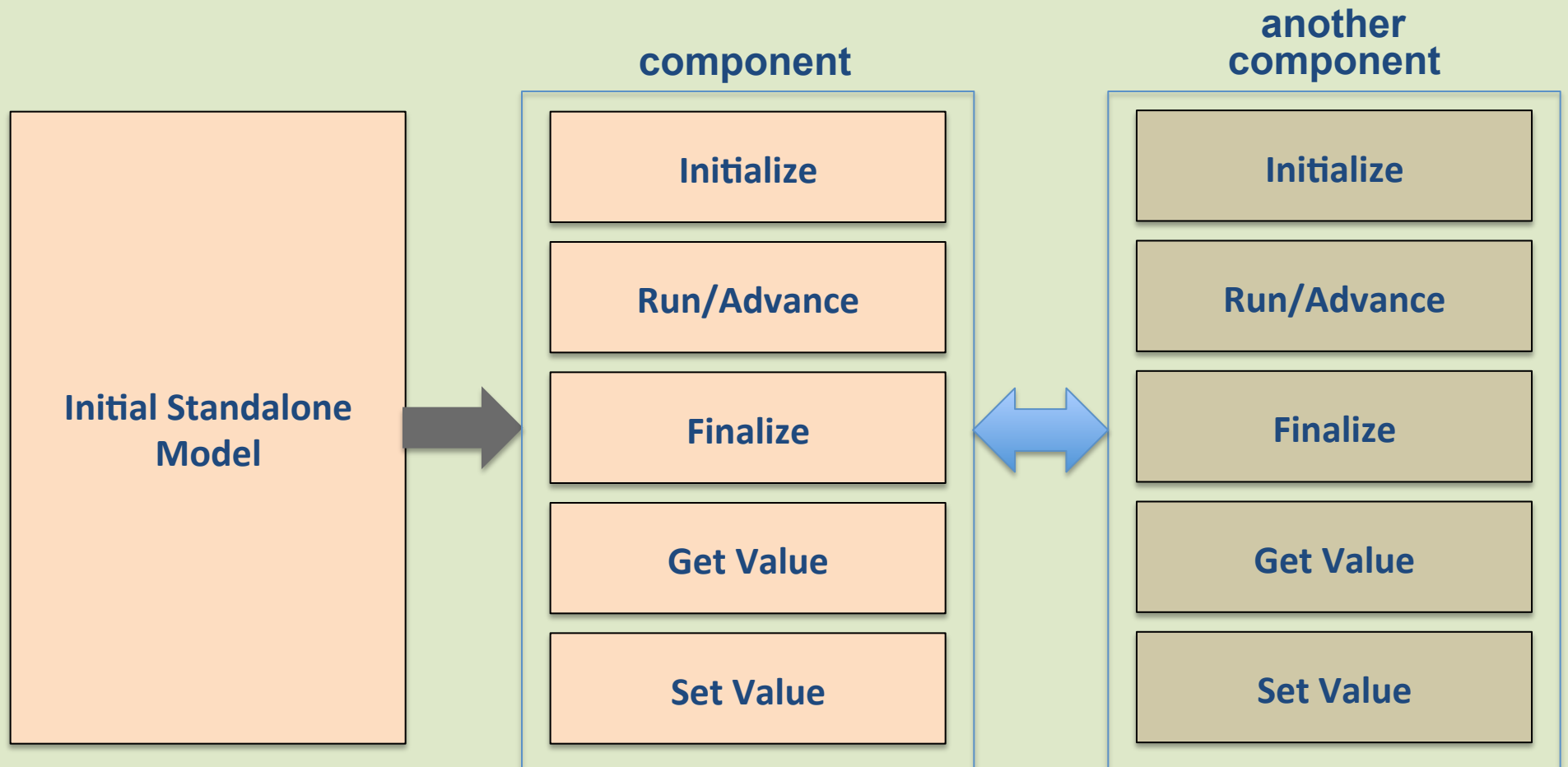


## Why Open Source?

- ❖ Revealing source code provides the scientific hypotheses embodied in a numerical model, and reveals their implementation.
- ❖ Details are important. A solution to a set of equations can take numerous forms, and each solution has its pyramid of assumptions and limitations.
- ❖ Code transparency allows for full peer review and replication of results — **the foundation of modern science.**
- ❖ Code transparency allows for reuse, often in new and clever ways, and reduces redundancy.



A standalone model is componentized by dividing it into tasks that other components can use

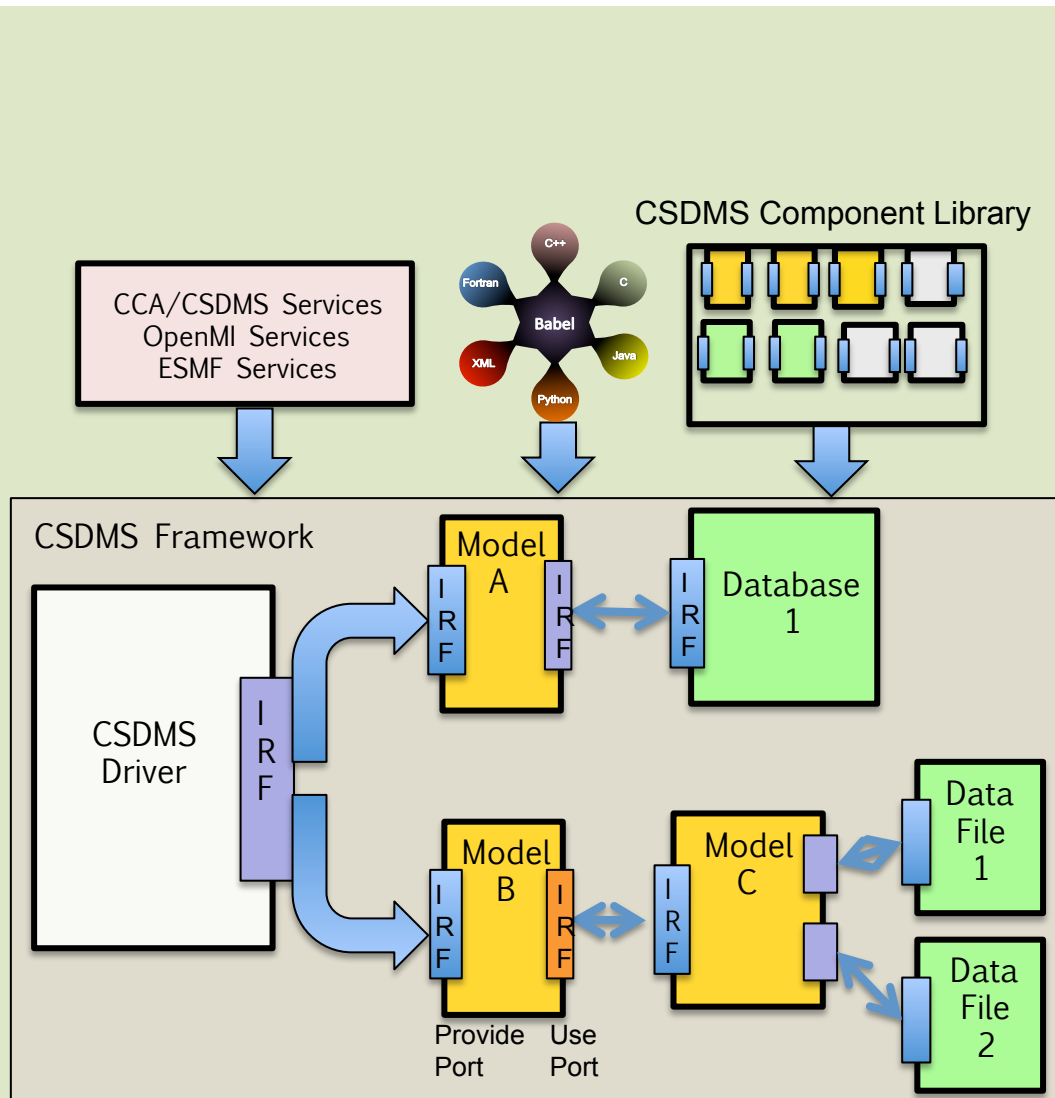




## CSDMS's component-based modeling Framework:

- ◆ Supports *multiple operating systems* (Linux, Mac OS X, Windows)
- ◆ *Language interoperability* for contributions in procedural languages (C or Fortran) & object-oriented languages (Java, C++, and Python).
- ◆ Supports *structured & unstructured grids* - spatial regridding tool
- ◆ Offers *platform-independent GUIs & graphics*.
- ◆ Uses *open-source standards* (e.g., CCA, SIDL, OGC, MPI, NetCDF, OpenDAP, XUL) & tools — avoids dependencies on proprietary software (Windows, C#, Matlab).
- ◆ Supports *parallel computation* (multiprocessor via MPI standard) and parallel tools (e.g., VisIt, PETSc, ESMF Regrid).
- ◆ *Interoperable or friendly with other coupling frameworks*.
- ◆ *Familiarity* — developers need not change how they work.





**CSDMS** pioneering efforts in model coupling have led to a “**plug and play**” programming environment that increases the performance of contributed models, increases their ease of maintenance and use, their flexibility, stability, portability, and future proofing.

The **CSDMS Component Modeling Tool (CMT)** offers an environment to link components, provide **services** accessible to all components, and avoids black box syndrome.



CSDMS has adopted, integrated and advanced open-source services into its modeling framework — largely invisible to users of the CSDMS **Component Modeling Tool (CMT)**.

### **CSDMS CMT Services:**

- (1) language interoperability (C, C++, Java, Python, Fortran) using ***Babel***;
- (2) component preparation & project management using ***Bocca***;
- (3) low level model coupling within a HPC environment using ***Ccaffeine***;
- (4) single-processor spatial regridding (***OpenMI Regrid***) or multi-processor spatial regridding (***ESMF Regrid***);
- (5) component interface standards advanced by ***OpenMI***;
- (6) self-describing scientific data format (***NetCDF***) & water markup language (***WML***);
- (7) visualization of large data sets within a multiple processor environment (e.g. ***VisIt***);
- (8) message passing within the HPC environment using ***MPI (MPICH)*** and ***OpenMP***, along with ***PETSc*** a Portable, Extensible Toolkit for Scientific Computation.





Remote Working Directory

~/CMT\_Output/

Working Project: CEM + Avulsion + HydroTrend...

Workspace Visualize Job Info Help

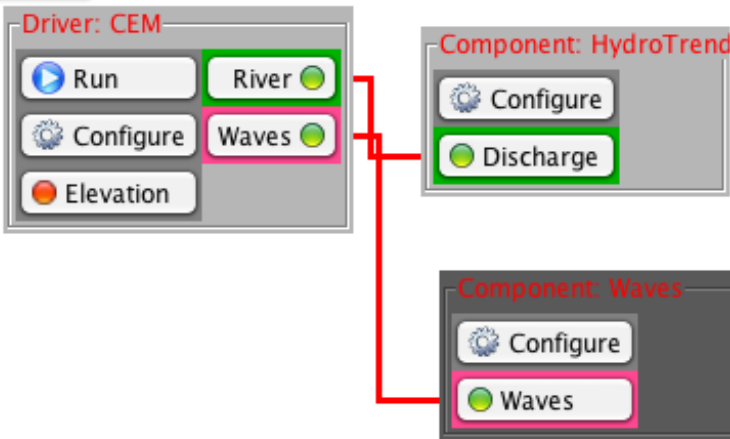
Driver

CEM

Palette

- Avulsion
- CEM
- ConstantRiver
- HydroTrend
- RiverReader
- Waves
- ConstantScalar

Arena



CMT Console

```
CCAFFEINE configured without neo and neo components.  
CmdLineClient parsing ...  
  
CmdContextCCA::initRC: Found /data/progs/components/cem_11.03.13/_build/csdms/components/tests/guitest.  
# There are already 28 classes in the component path
```



Remote Working Directory: ~/CMT\_Output/

Working Project: TopoFlow + GC2D

Driver: TopoFlow

Run Configure

Hydro Model: TopoFlow Parameters

Input Parameters

Component status: Enabled

Input directory: /data/sims/topoflow/treynor\_iowa/

Output directory: ~/CMT\_Output/

Site prefix: Treynor

Case prefix: Case5

Stopping method: Q\_peak\_fraction

Q\_peak fraction: {0.0, 1.0} 0.05

Model stop time: {0.0, 1.0E9} 20

Number of steps: {1, 1000000000} 100

Help Restore Defaults OK Cancel

Deleting instance: InfilRichards1D  
getGizzard("EvapEnergyBalance") = 0. No such instance.  
Deleting instance: SatZoneDarcyLayers  
getGizzard("InfilRichards1D") = 0. No such instance.  
Deleting instance: IceGC2D  
getGizzard("SatZoneDarcyLayers") = 0. No such instance.  
getGizzard("IceGC2D") = 0. No such instance.  
/data1/progs/cca/src/serial-nightly/cca-tools-contractor/\_build/build/ccaffeine/cxx/dc/  
SUCCESS: TopoFlow component status = created  
Reading GUI info from: /data/progs/topoflow/3.1/gui\_info/TopoFlow.cfg  
Connecting...  
Opening file: http://csdms.colorado.edu/help/models/topoflow/TF\_tutorial.htm

# CSDMS Help System

## Getting Started with TopoFlow 1.5 - A Short Tutorial

### Introduction

TopoFlow is a free, spatially-distributed hydrologic model with a user-friendly, wizard-style interface. TopoFlow evolved from the merger of a previous rainfall-runoff model based on DEM-derived D8 flow grids and a model called ARHYTHM that was designed and tested for modeling Arctic watersheds. For this reason, it offers sophisticated methods for modeling temperature-dependent processes such as snowmelt, evaporation, infiltration (frozen ground) and shallow subsurface flow. TopoFlow is highly modular and was designed to be user-extensible. In virtually every input dialog, users also have the flexibility of entering any input parameter in any of the following forms:

used for every pixel and all times)  
(to be used for every pixel)  
to be used for all times) or  
nce (corresponding to the timestep for that process).

features that sets TopoFlow apart from most other spatial hydrologic models.

the Data Language) source code for TopoFlow is open, but subject to a [license agreement](#). By any  
represents a substantial programming effort. Version 1.5 consists of about 40,500 lines of IDL  
normal comments). Assuming 60 lines per page, printing out the source code would therefore require  
written in a lower-level language like C, it would require at least 5 to 10 times more code.]  
in progress by multiple programmer-hydrologists and we welcome feedback and bug reports from

ork with TopoFlow, you may find it helpful to review the concepts behind spatially-distributed  
g. One paper that you might find helpful is a draft book chapter on spatial hydrologic modeling written  
a], for an Elsevier book called **Geomorphometry**. Another paper that contains a great deal of  
information is the one by [Zhang et al. \(2000\)](#), that describes the ARHYTHM model. If you would like  
the point-and-click, hydrologic GIS program called RiverTools, you may also be interested in this  
written by [Peckham \(2007b\)](#), also for the **Geomorphometry** book.

Additional information is available on the official TopoFlow website at: <http://instaar.colorado.edu/topoflow/>.

### How to Set Up a Model Run

**Step 1.** Obtain a DEM (digital elevation model) for the basin that you wish to model. If the DEM has dimensions greater than about 300 columns and 300 rows, then it is usually best to subsample the DEM (by averaging) to have dimensions in this range. Using larger DEMs will result in longer model runs and may result in RTS files (RiverTools Sequence) for which you do not have enough space on your hard drive. It is good to start with smaller DEMs and then to increase the size/resolution of your DEM for subsequent model runs if you determine that higher resolution is necessary and you have sufficient time and disk space. Tools for mosaicking, subsetting and subsampling DEMs are available in hydrologic GIS software such as RiverTools 3.0.

**Step 2.** Create a D8 flow grid, area grid, slope grid and Horton-Strahler order grid for your DEM using RiverTools 3.0 or a similar program. The flow grid should be converted, if necessary, to have the RiverTools flow codes (the standard

## CSDMS 'help system' avoids black-box syndrome




*CSDMS members* can express which model they want the Integration staff to make into a component --- each member only receives *one* vote per model

Program	Description	Developer	Voting results
SedBerg	An iceberg drift and melt model, developed to simulate sedimentation in high-latitude glaciated fjords.	Mugford, Ruth	<b>1.98</b> (2 voters)
WRF	Weather Research and Forecasting Model	Skamarock, Bill	<b>1.98</b> (2 voters)
Delft3D	3D hydrodynamic and sediment transport model	Delft3D, Support	<b>1.95</b> (3 voters)
XBeach	Wave propagation sediment transport model	Roelvink, Dano	<b>1.86</b> (2 voters)
GOLEM	Landscape evolution model	Tucker, Greg	<b>1.82</b> (2 voters)
MODFLOW	MODFLOW is a three-dimensional finite-difference ground-water model	Barlow, Paul	<b>1.74</b> (2 voters)
Caesar	Cellular landscape evolution model	Coulthard, Tom	<b>1.5</b> (2 voters)
Anuga	ANUGA is a hydrodynamic modelling tool that allows users to model realistic flow problems in complex 2D geometries.	Habili, Nariman	<b>1</b> (1 voter)
PIHM	PIHM is a multiprocess, multi-scale hydrologic model.	Duffy, Christopher	<b>1</b> (1 voter)



## Roadmap Flexure component status:

Project owner CSMDS-IF: [Eric Hutton](#)   
Start date project: 06/02/2011  
Estimated release date: **12/31/2012**  
Project status: 46%

### Milestone: Executable



Status	Task	Task owner	Information	Estimated completion date
<input checked="" type="checkbox"/>	Provide metadata	Andy Wickert	<a href="#">More...</a>	12/07/2010
<input checked="" type="checkbox"/>	Upload source	Andy Wickert	<a href="#">More...</a>	12/07/2010
<input checked="" type="checkbox"/>	Upload input and output data	Andy Wickert	<a href="#">More...</a> 	12/07/2010
<input checked="" type="checkbox"/>	Compile	Eric Hutton	<a href="#">More...</a> 	06/02/2011

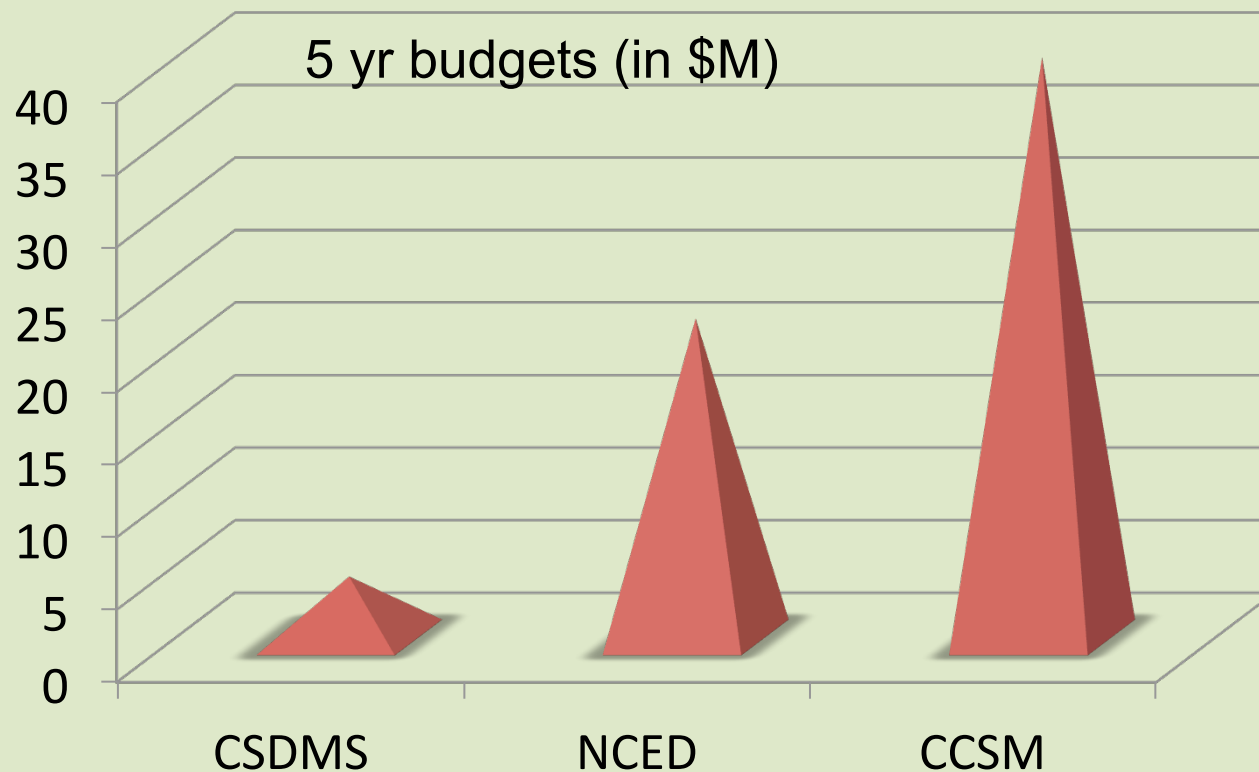
### Milestone: Standalone component



Status	Task	Task owner	Information	Estimated completion date
<input checked="" type="checkbox"/>	IRF interface	Greg Tucker, Andy Wickert, Beichuan Yan	<a href="#">More...</a> 	05/19/2011, 07/29/2011
<input checked="" type="checkbox"/>	Create CCA component	Andy Wickert		mm/dd/yyyy
<input type="checkbox"/>	Build GUI	TBD		mm/dd/yyyy
	Template input file	Andy Wickert, Beichuan Yan	<a href="#">More...</a> 	08/08/2011
	Documentation	TBD		mm/dd/yyyy

**CSDMS**  
componentizing  
activities are  
made transparent  
through web  
available road  
maps

**CSDMS** carries out its activities on a limited budget compared to other experimental or computational programs



*The latest World Economic Forum report ranks the U.S. 51<sup>st</sup> in science and math education; 6% of U.S. degrees are in engineering compared to 20% in Japan and 16% in Germany.*





## Future CSDMS Priorities:

1. **CSDMS 2.0: Expanding our Reach** — multiple platforms; better HPCC model capability, HPCC code training; advanced GIS support
2. **Coupling physical, biological & human processes:** FRGs in geodynamics & CIG? Ecosystems & GRASS? Biogeochemistry & CZO? Polar world? ESM & IAM?
3. **Landscape into Rock Initiative** — deep time and space support
4. **Global Environmental Change modeling:** for sustainability science support including an International Year of Deltas
5. **Modeling for operational needs:** 1) coupling NASA products with CSDMS models; 2) coupling CSDMS models for BOEM; 3) CCMP support
6. **CSDMS Model Benchmarking & Model Inter-comparison**
7. **More direct linkage of models to field work/programs** — e.g. NSF Delta FESD



# CSDMS 2011 ANNUAL Meeting

## Impact of time and process scales

*October 28-30th, Boulder Colorado, USA*

- Day 1-3: Mornings: keynote addresses on concepts and models
- Day 1-3: Hour lunch
- Day 1-3: Early Afternoons: Clinics (models, generic)
- Day 1-2: Later Afternoons: Posters with Refreshments
- Day 3: Later Afternoon: Working Group or FRG meetings
- Day 2: Banquet: Poster Award; Lifetime Achievement Award
- Day 4: Morning: ExCom Meeting & Steering Committee Meeting



**CSDMS**  
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



**BOEM**  
BUREAU OF OCEAN ENERGY MANAGEMENT

