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,

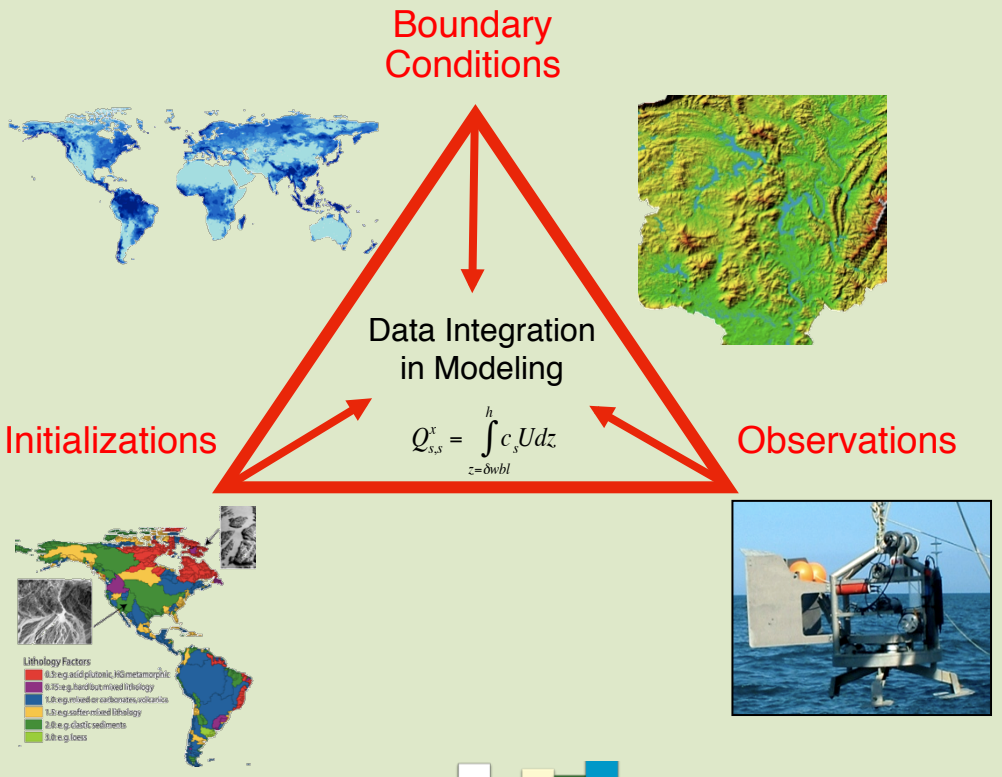
Morphodynamics Models,

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



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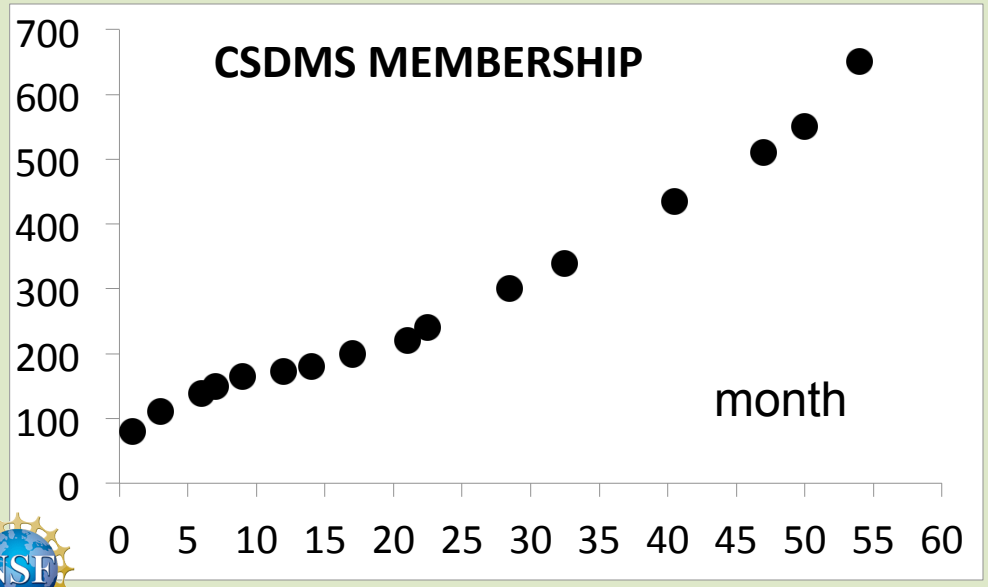
CSDMS offers a community of communities to promote the modeling of earth-surface processes

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)*

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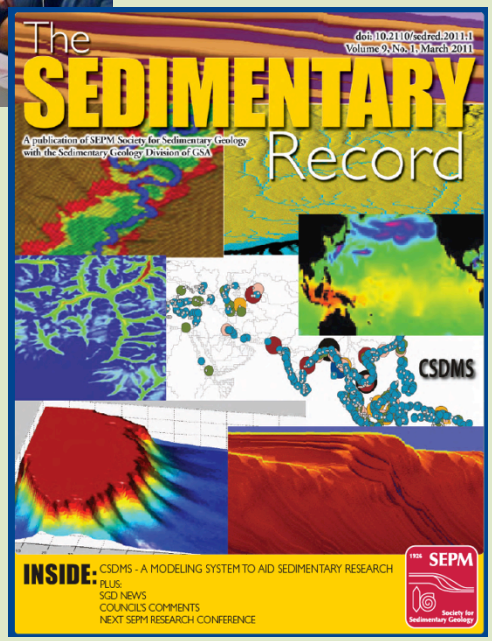
CSDMS Community and Activities (2007-11)

Annual Student award

Annual Lifetime Achievement award



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

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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)

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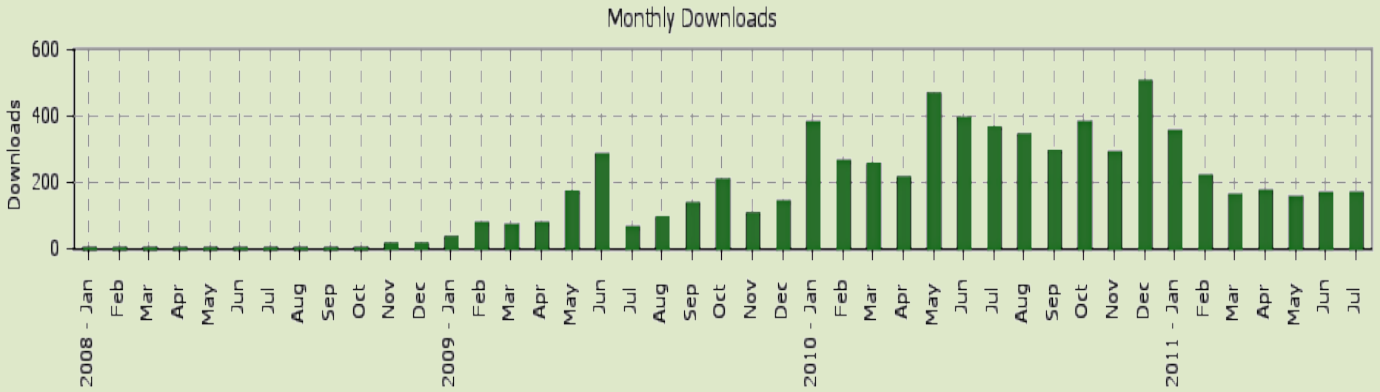
CSDMS Model Repository:

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.



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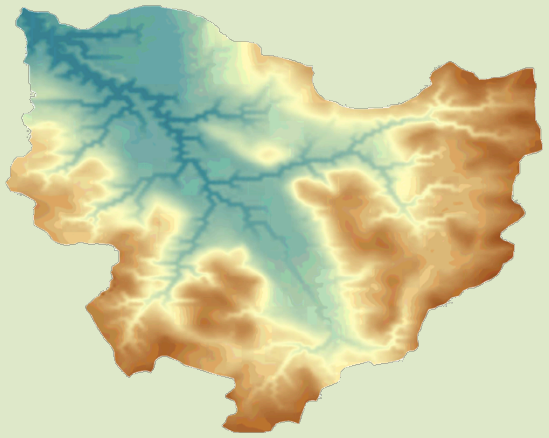
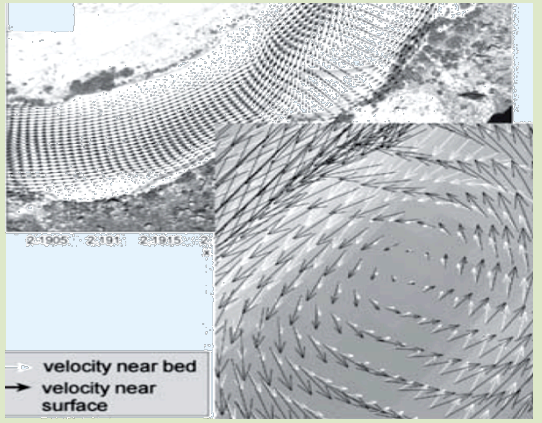
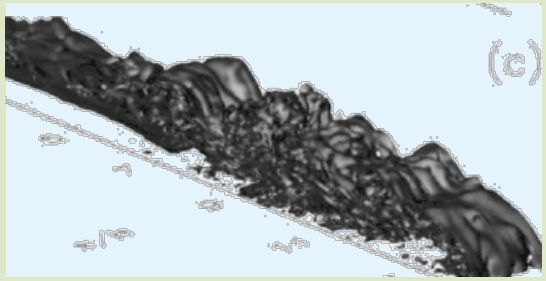
Types of CSDMS models



1) Landscape / Seascape 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

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CSDMS MODEL EXAMPLES

Model Category	Domain	Example models in the CSDMS Repository
Terrestrial	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
Hydrology	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
Coastal	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
Marine	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
Climate, Weather		WRF, WACCM+, and MITgcm
Tools		ADI2D, LOGDIST, TopoToolbox, TauDEM, Zscape, TURB, TOPOG, Parker Ebook, SVELA, SETTLE, PsHIC, FTCS, Compact

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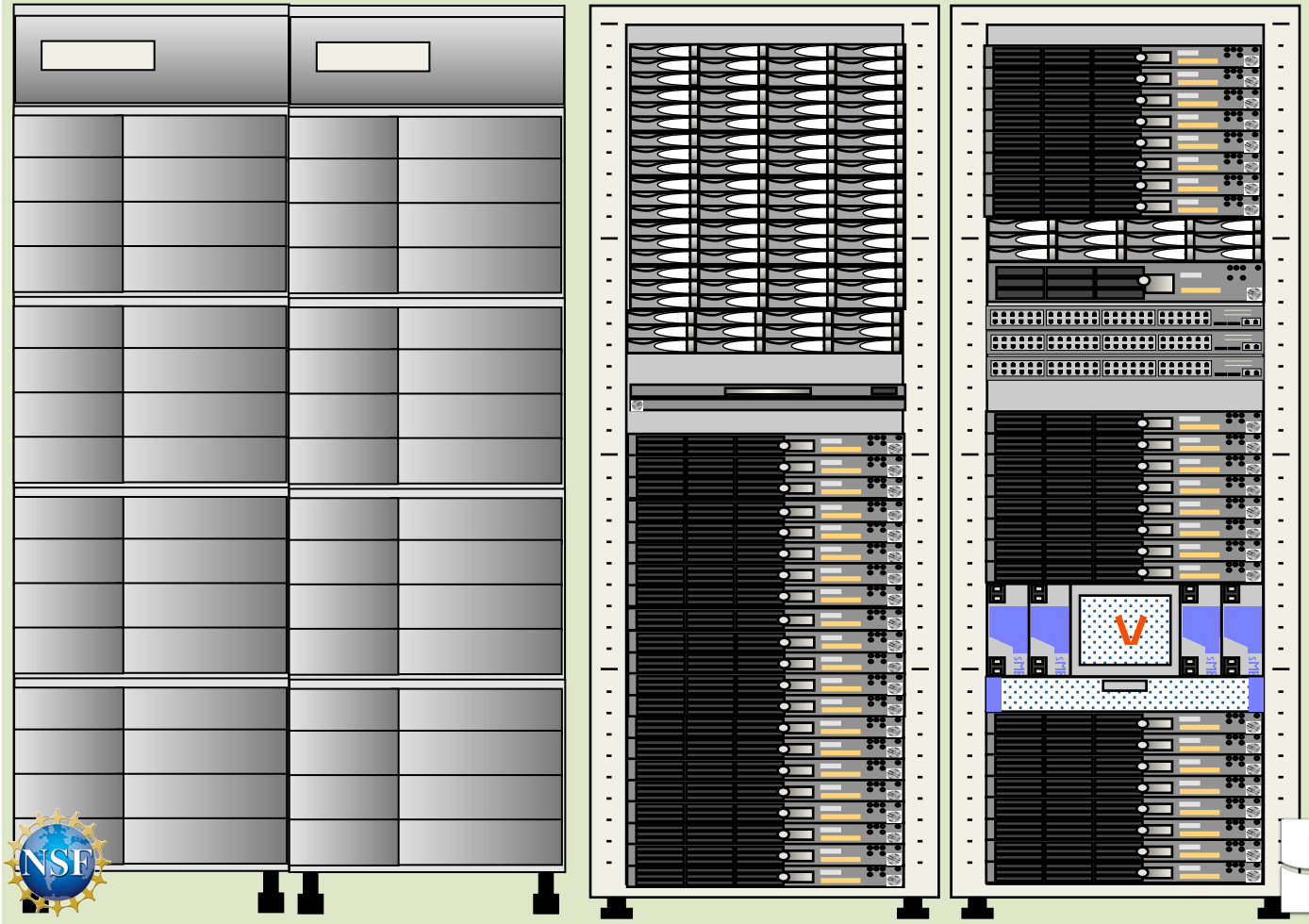
CSDMS members may gain access to the CU/USGS experimental supercomputer *Beach* supporting >150 CSDMS members who have met a use criteria

- 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.

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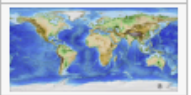
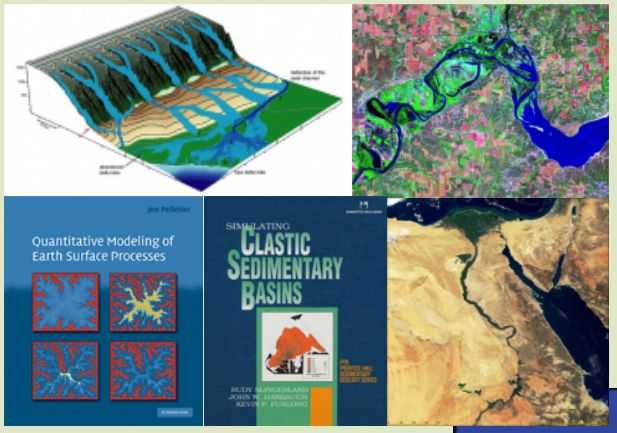
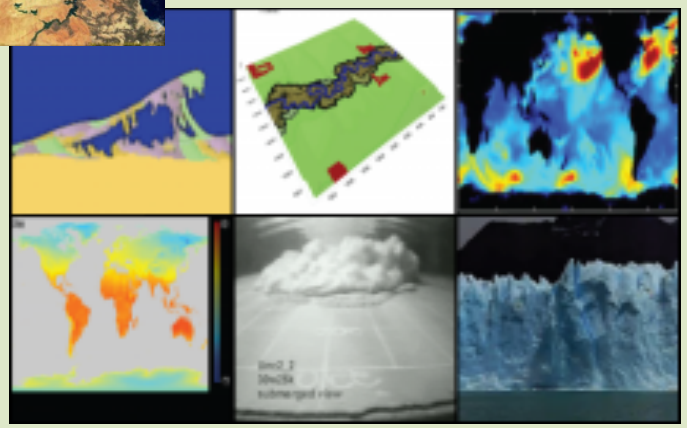
Dataset info	Type	Origin	Description	Data example
ASTER	Topography	Measured	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)	
DDM30	Hydrography	Modeled	Global drainage direction map	
ETOPO1	Topography	Modeled	ETOPO1 is a 1 arc-minute global relief model	
GEBCO	Topography	Modeled	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

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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.**

NSF

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Instructional videos

Description	Link
How to connect to the supercomputer 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).	
How to contribute to the CSDMS repositories A step by step video of how to contribute a model to the CSDMS model repository and show how to edit your entries.	
How to use the model repository A brief video of how to use the model repository	
How to become a member A short description of how to become a member and what are the benefits of a CSDMS member.	

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

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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.

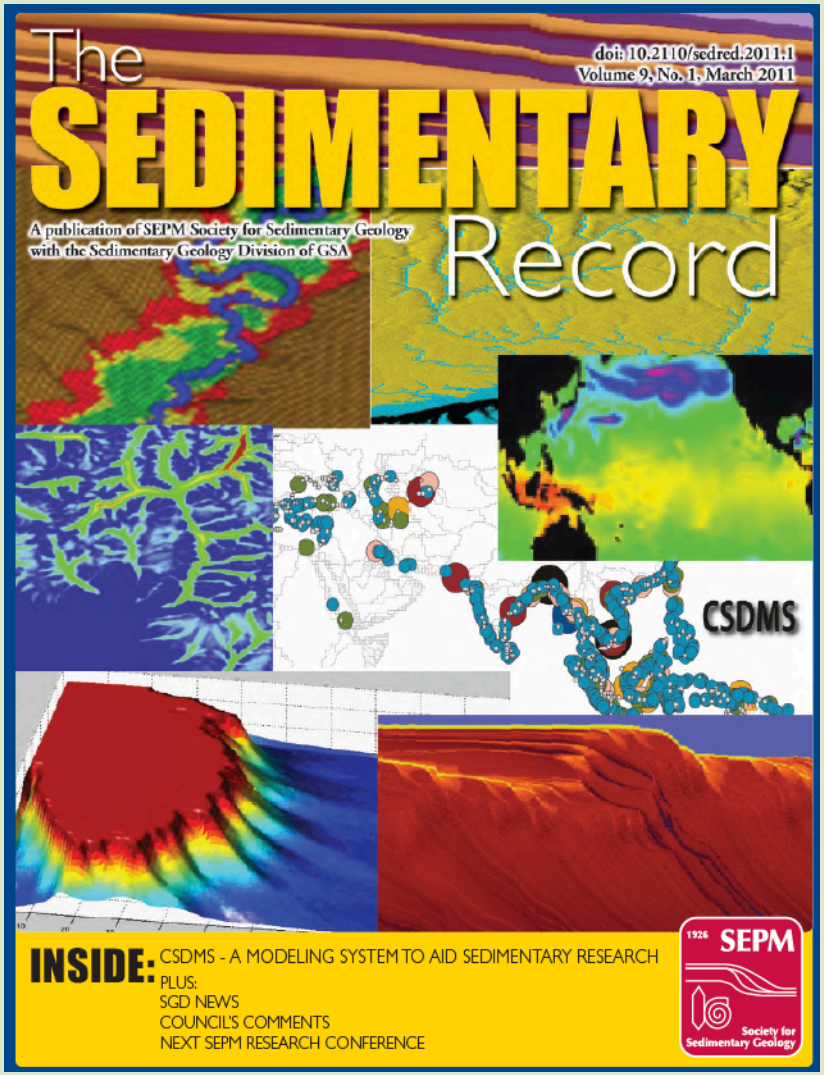
5) **Refactored with an IRF interface** [& getter and setter functions].

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.

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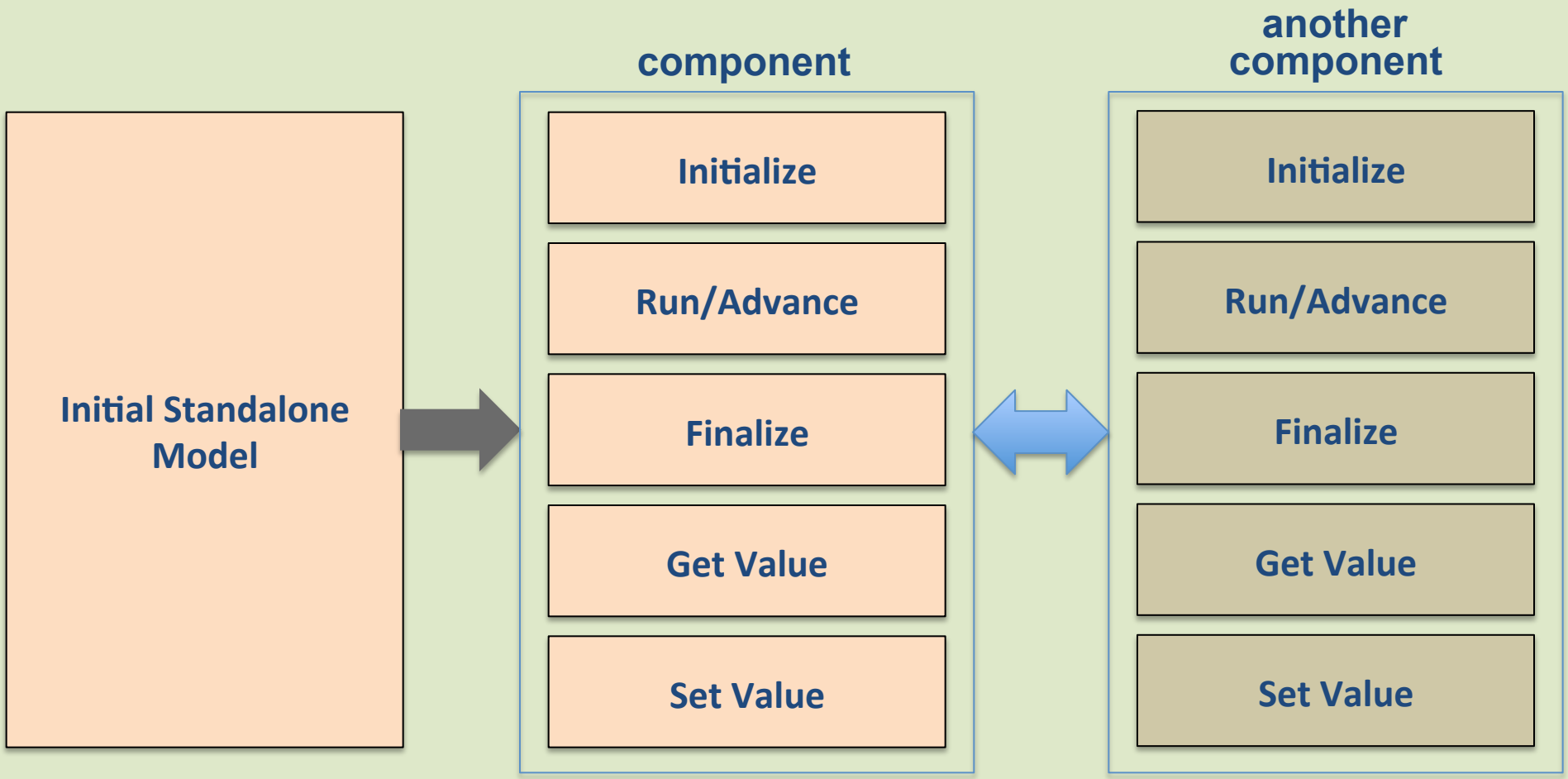
A standalone model is componentized by dividing it into tasks that other components can use



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.

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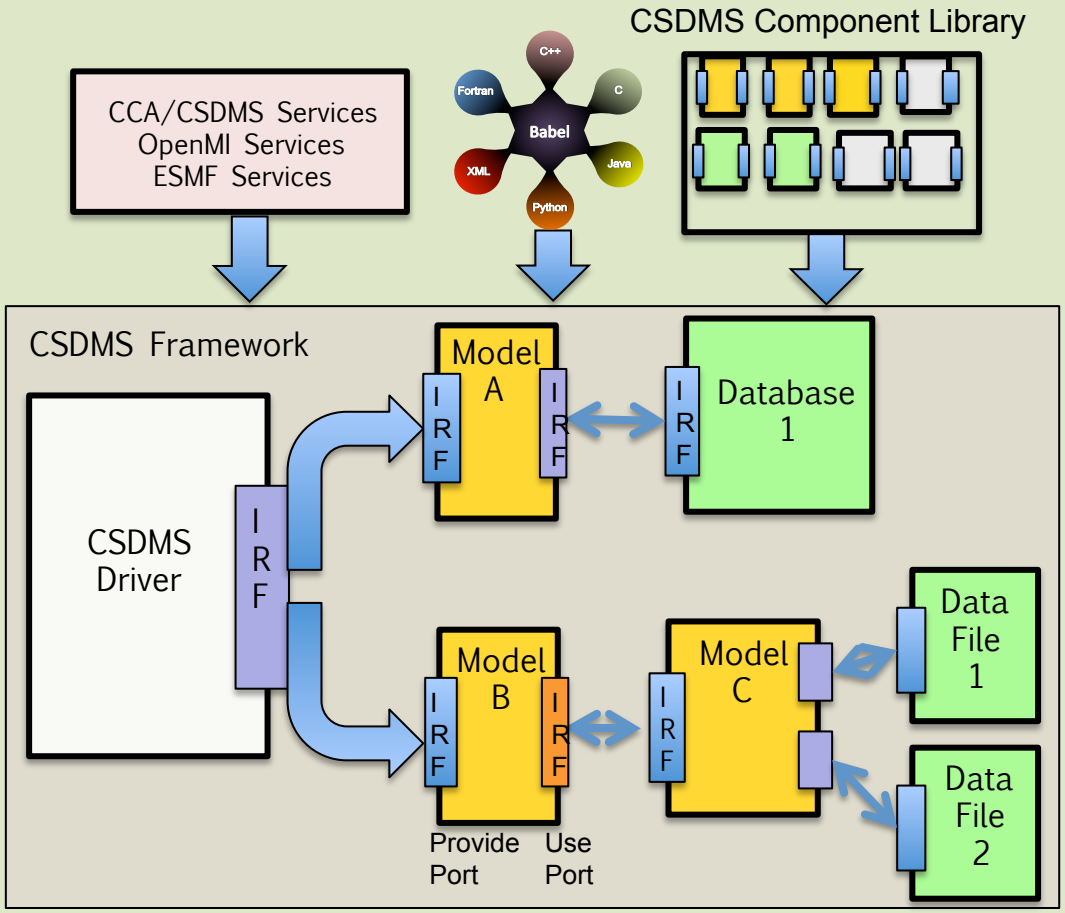

CSDMS pioneering efforts in model coupling have led to a **"plug and play" programming** environment that increases the performance of contributed models, increases their ease of maintenance and use, their flexibility, stability, portability, and future proofing.

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

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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.

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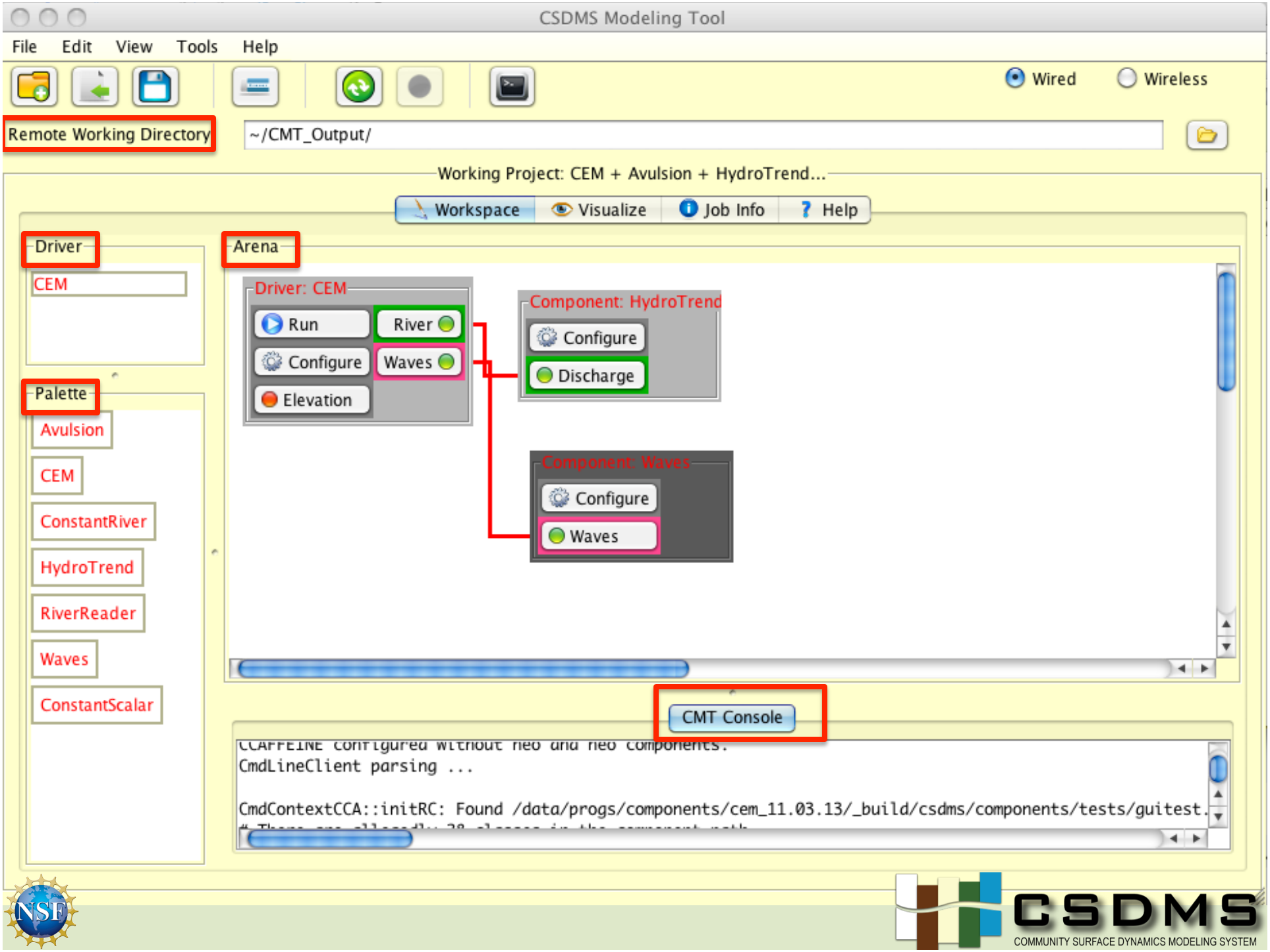
CSDMS Modeling Tool
File
Edit
View
Tools
Help
Wired
Wireless
Remote Working Directory
~/CMT_Output/
Working Project: CEM + Avulsion + HydroTrend...
Workspace
Visualize
Job Info
Help
Driver
CEM
Palette
Avulsion
CEM
ConstantRiver
HydroTrend
RiverReader
Waves
ConstantScalar
Arena
Driver: CEM
Run
River
Configure
Waves
Elevation
Component: HydroTrend
Configure
Discharge
Component: Waves
Configure
Waves
CMT Console
CmdLineClient parsing ...
CmdContextCCA::initRC: Found /data/progs/components/cem_11.03.13/_build/csdms/components/tests/guitest.
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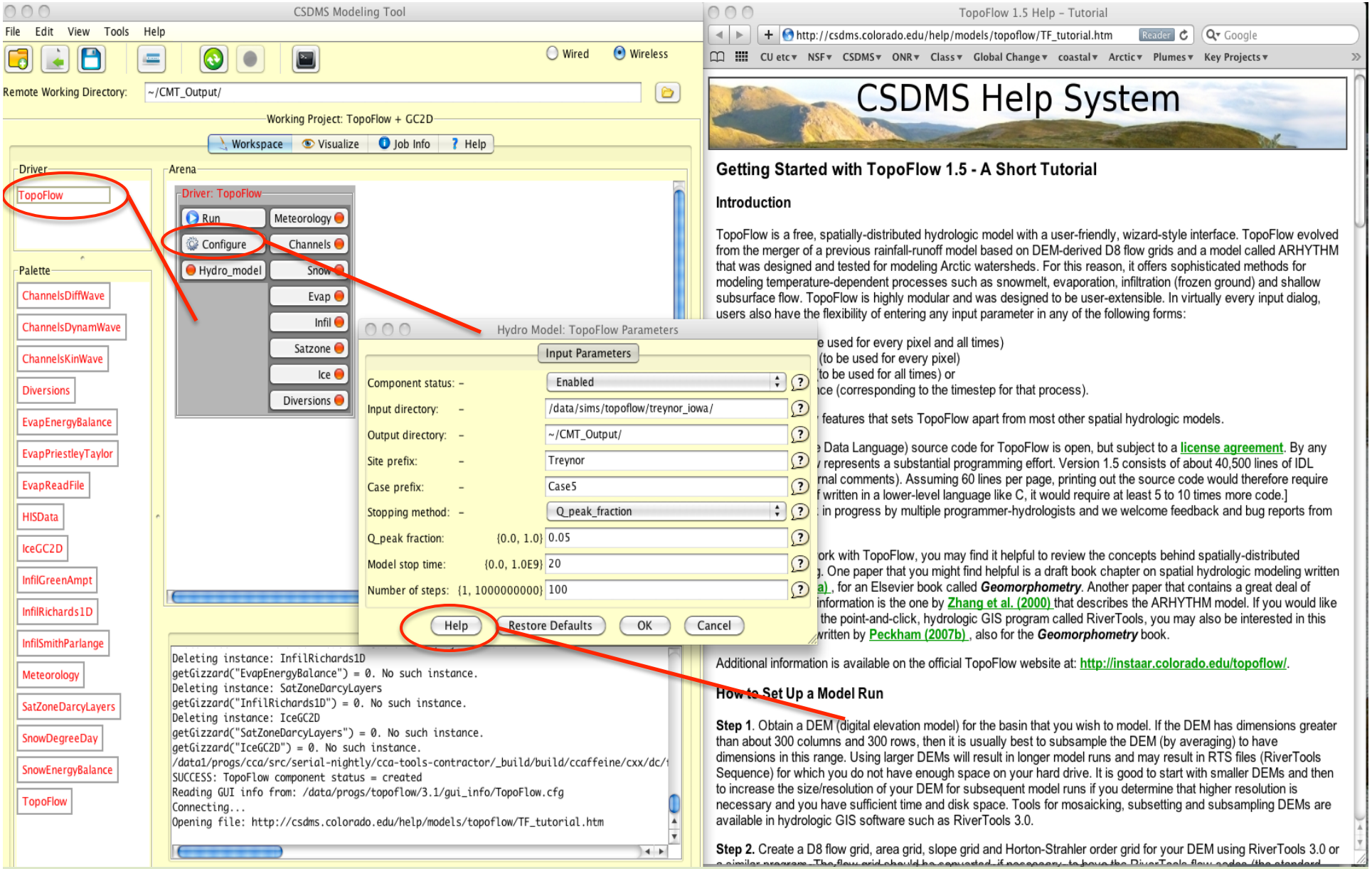

CSDMS 'help system' avoids black-box syndrome

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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	**1.98** (*2 voters*)
WRF	Weather Research and Forecasting Model	**Skamarock**, Bill	**1.98** (*2 voters*)
Delft3D	3D hydrodynamic and sediment transport model	**Delft3D**, Support	**1.95** (*3 voters*)
XBeach	Wave propagation sediment transport model	**Roelvink**, Dano	**1.86** (*2 voters*)
GOLEM	Landscape evolution model	**Tucker**, Greg	**1.82** (*2 voters*)
MODFLOW	MODFLOW is a three-dimensional finite-difference ground-water model	**Barlow**, Paul	**1.74** (*2 voters*)
Caesar	Cellular landscape evolution model	**Coulthard**, Tom	**1.5** (*2 voters*)
Anuga	ANUGA is a hydrodynamic modelling tool that allows users to model realistic flow problems in complex 2D geometries.	**Habili**, Nariman	**1** (*1 voter*)
PIHM	PIHM is a multiprocess, multi-scale hydrologic model.	**Duffy**, Christopher	**1** (*1 voter*)

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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

100%

Status	Task	Task owner	Information	Estimated completion date
☑	Provide metadata	Andy Wickert	More...	12/07/2010
☑	Upload source	Andy Wickert	More...	12/07/2010
☑	Upload input and output data	Andy Wickert	More...	12/07/2010
☑	Compile	Eric Hutton	More...	06/02/2011

Milestone: Standalone component

42%

Status	Task	Task owner	Information	Estimated completion date
☑	IRF interface	Greg Tucker, Andy Wickert, Beichuan Yan	More...	05/19/2011, 07/29/2011
☑	Create CCA component	Andy Wickert		mm/dd/yyyy
☐	Build GUI	TBD		mm/dd/yyyy
☐	Template input file	Andy Wickert, Beichuan Yan	More...	08/08/2011
☐	Documentation	TBD		mm/dd/yyyy

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componentizing activities are made transparent through web available road maps

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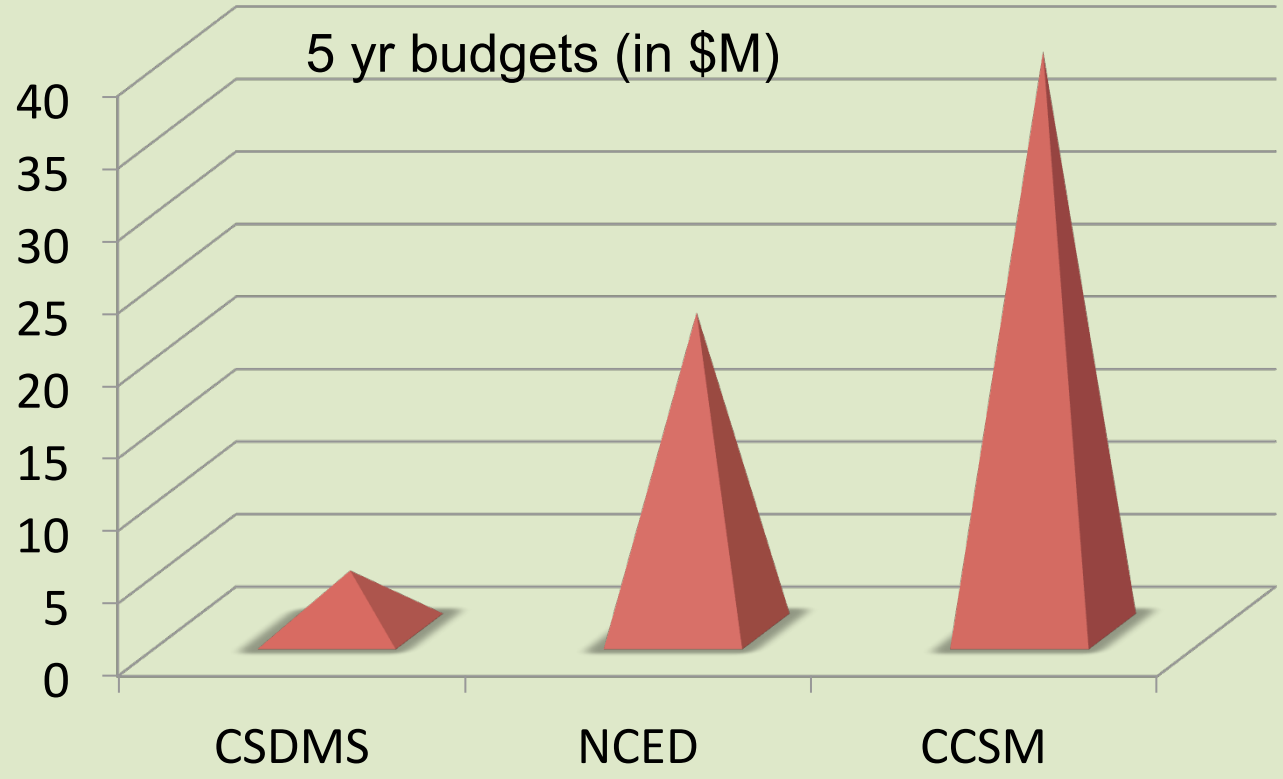
CSDMS carries out its activities on a limited budget compared to other experimental or computational programs



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

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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

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