

The Community Surface Dynamics Modeling System: Infrastructure Updates and EKT

Irina Overeem, Erik Hutton, Albert Kettner, Mark Piper, James Syvitski,
Scott Peckham

CSDMS Integration Facility, University of Colorado, Boulder, CO, USA



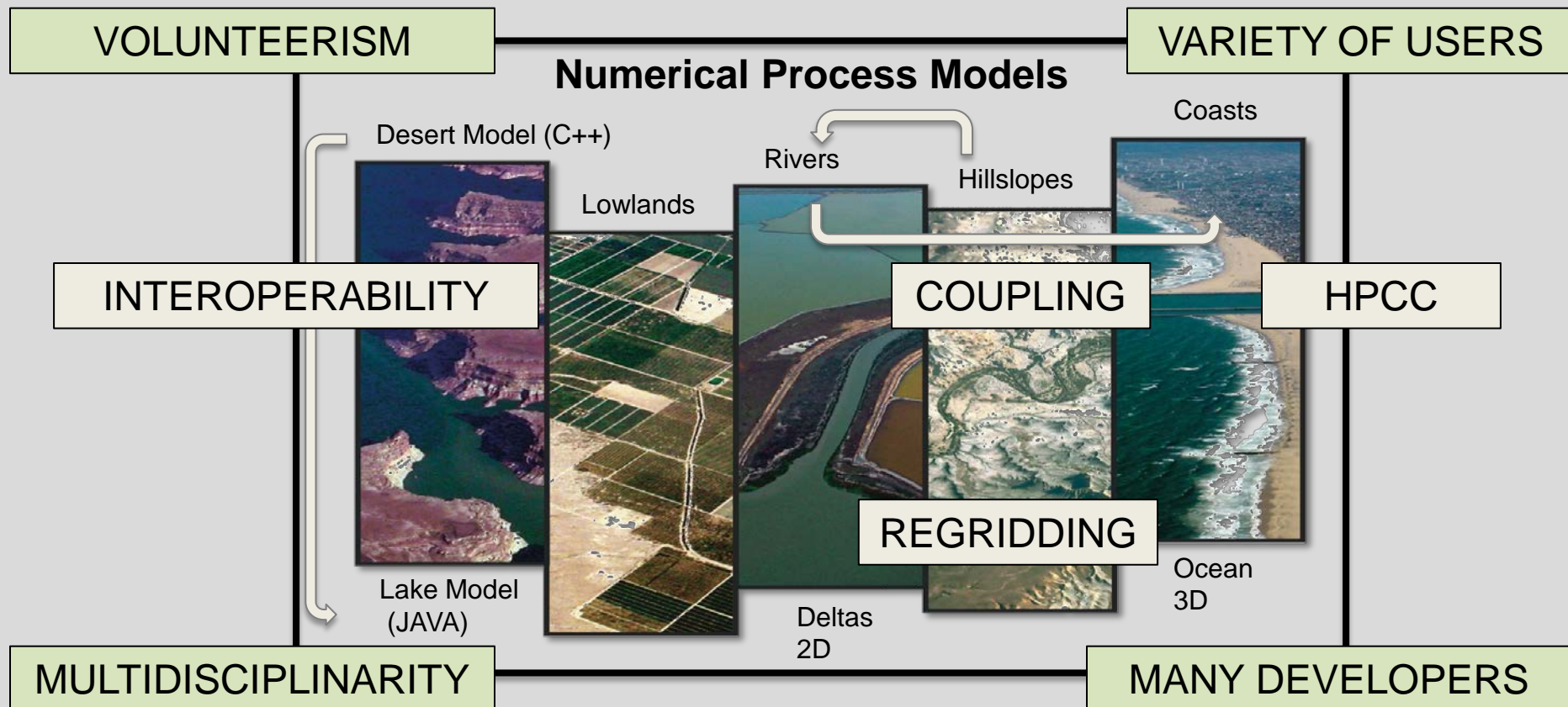
Outline

- What is CSDMS?
- Tools for Collaboration
 - 1) CSDMS Wiki
 - 2) CSDMS Modeling Tool
- Education with Models
- Data Analysis Novice User Engagement
- Call for contributions and volunteers with geodynamics expertise!

What is CSDMS: the Community Surface Dynamics Modeling System

Develops, integrates and disseminates software to define the earth's surface dynamics by simulating the movement of water, sediment and nutrients through landscapes and seascapes.

Grand Challenge: Building a Toolbox of Component Models with guidance and input of a large community of scientists



CSDMS Community



Workshops, symposia & Working Group meetings



*CSDMS
Short
Courses*

CSDMS meets face-to-face, but is mostly virtual

- Annual All-Hands Member Meeting

Beyond meetings we are a virtual community:
CSDMS Wiki, Reports and Email Lists


<http://csdms.colorado.edu>

Sign up to be a Member!

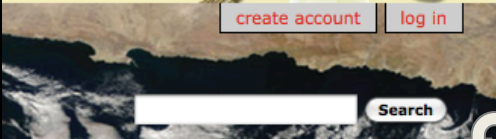



*Annual all-hands meeting
In Boulder CO*

CSDMS Wiki: a Platform for our Virtual Community



Upfront Access to CSDMS Resources and Services





Models ▾ CMT ▾ Supercomputing ▾ Education ▾ Data ▾ Community ▾ Meetings ▾ Help ▾ Wiki tools ▾

Explore Earth's surface with community software

Welcome your chairs for the next years

Members Share in Governance

Working Group Chairs
Meet the new and continuing chairs of your Working Group

CSDMS for you
Join, What is CSDMS, Groups, ...

Get started with CMT
All about Component Modeling Tool (CMT), ...

Contribute
Submit source code/data/education material, ...

Download
Models, Data, CMT, Education material, ...

Announcements
Jobs, In the news, Missives, ...

Help
Search, FAQ, Instructional videos, Contact, ...

Model highlight

1901 Lido basin 2000 Malamorco basin Wave

Modeling Transition from Tidal Flat to Salt Marsh
Point Tidal Flat, a m...

Science in the spotlight

Extensive Sands Deposited By Mississippi Floodwaters
The 2011 flood in the Mississippi River

Wiki functionality allows member input

Low threshold for users and contributors

Keep Members Engaged in Science

Web-Forms for Model Metadata, Educational Material, Data

SummaryContactTechnical specsIn/OutputProcessTestingOtherComp

Module type

Module name:Test

Also known as:

Module type:

Module identity

Module domain:

Spatial dimensions:
(More options possible)

For example:

Technical information

Supported platforms:
(More options possible)

Other platform:

Programming language:

Make sure that after you complete the questionnaire you submit for your module will be created instantly on submission.

SummaryContactTechnical specsIn/OutputPro

Technical information

Supported platforms:
(More options possible)

Other platform:

Programming language:

Make sure that after you complete the questionnaire you submit for your module will be created instantly on submission.

- [-] ☐ Model domain
- [x] ☐ Carbonate
- [x] ☐ Climate
- [x] ☐ Coastal
- [x] ☐ Hydrology
- [x] ☐ Marine
- [x] ☐ Terrestrial

- ☐ 1D
- ☐ 1.5D
- ☐ 2D
- 1D: profiles
- 1.5D: 2D projections extracted from 1

- ☐ Unix
- ☐ Linux
- ☐ Mac OS
- ☐ Windows

- ☐ Fortran77
- ☐ Fortran90
- ☐ C
- ☐ C++
- ☐ Python
- ☐ Java
- ☐ IDL
- ☐ Matlab

CSDMS requires metadata and source code, developer can submit through a web-based database.

http://csdms.colorado.edu/wiki/Contribute_model

CSDMS test whether code compiles. Metadata becomes accessible for everyone, code is archived in Subversion and downloadable.

CSDMS CMT - component modeling tool

CSDMS CMT Framework & Services:

- (1) Platform-independent Modeling Tool (Linux, Mac OS X, Windows)
- (2) Language interoperability (C, C++, Java, Python, Fortran) with *Babel*;
- (3) Component preparation & project management using *Bocca*;
- (4) Low-level model coupling within a HPC environment using *Ccaffeine*;
- (5) Single-processor spatial regridding (OpenMI *Regrid*) or multi-processor spatial regridding (ESMF *Regrid*) – all grid types;
- (6) Component interface standards BMI & CMI;
- (7) Open-source standards (e.g. CCA, SIDL, OGC, MPI, NetCDF, OpenDAP).
- (8) Visualization of large datasets in a multiple processor environment (*VisIt*)
- (9) Message passing within the HPC environment using *MPI (MPICH)* & *OpenMP with PETSc* - Portable Extensible Toolkit for Scientific Computation

Developed Tool for running CSDMS-component models

The image displays the CSDMS Modeling Tool interface. The main window shows the 'Driver' section with 'TopoFlow' selected. The 'Hydro Model: TopoFlow Parameters' dialog box is open, showing input parameters such as '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' (0.05), 'Model stop time' (20), and 'Number of steps' (100). The 'Help' button in the dialog is circled in red. The background shows the 'CSDMS Help System' tutorial for 'Getting Started with TopoFlow 1.5 - A Short Tutorial'. The tutorial text describes TopoFlow as a free, spatially-distributed hydrologic model and provides information on how to set up a model run.

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
... (corresponding to the timestep for that process).

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

... 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 ... (comment 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

... work with TopoFlow, you may find it helpful to review the concepts behind spatially-distributed ... One paper that you might find helpful is a draft book chapter on spatial hydrologic modeling written ... al., 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/>.

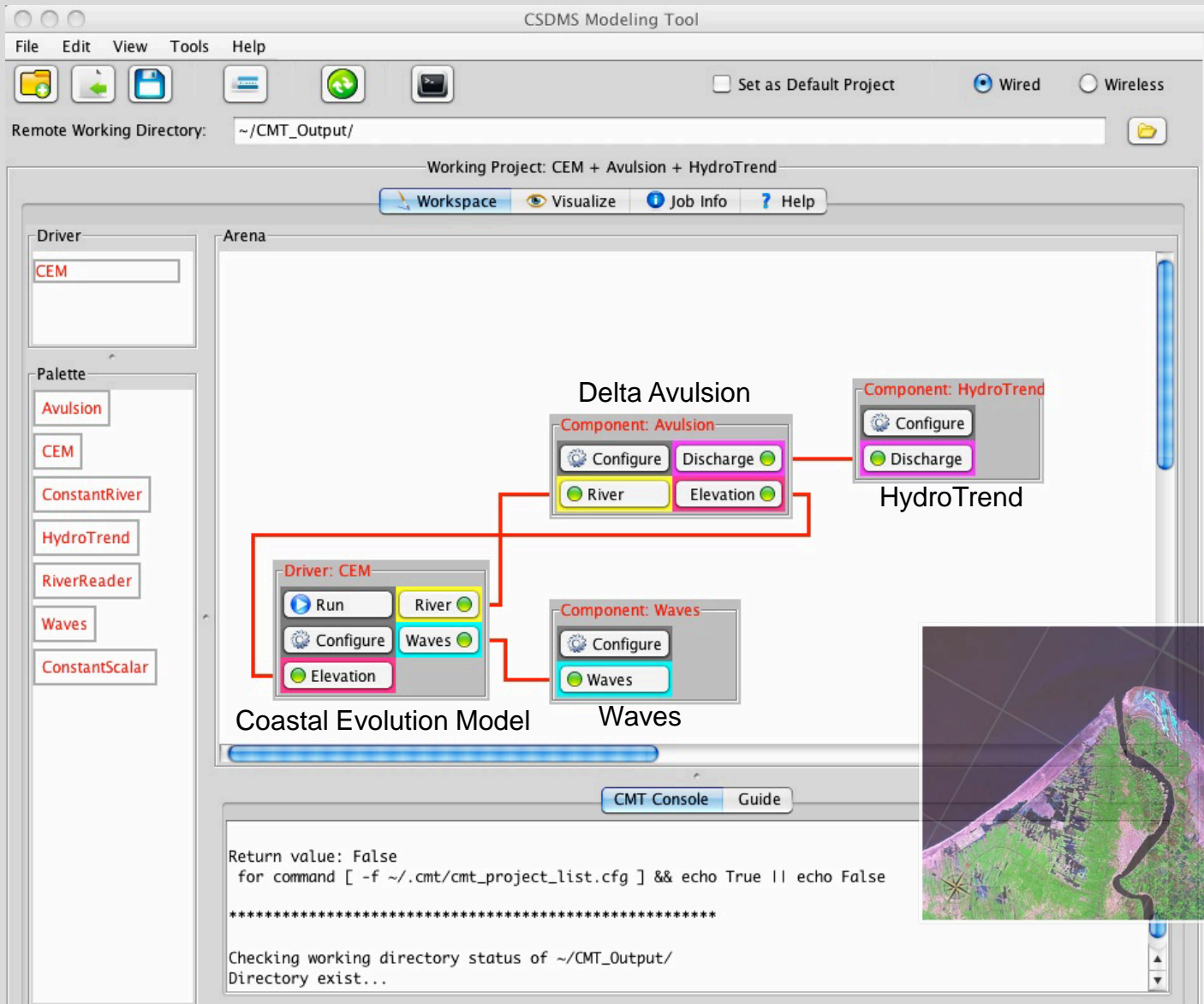
How to Set Up a Model Run

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 generated, if necessary, to have the RiverTools flow codes (the standard

Online Wiki-Based CMT 'help system' avoids black-box syndrome
Designed to become an interactive user platform, tightly linked to CSDMS wiki.

Model Coupling Example



Running CMT allows a user's computer to become a client that connects remotely to a server on the CSDMS HPC cluster, where the model computation takes place



Coupled code has 3 legacy models and 1 new model of > 7 developers linked.

Teaching with CSDMS tools



CU graduate student course
2010 and 2013

NCED SIESD summer institute
2011-onwards

Plans for 2014, 'Early Adopters'
Faculty:

- Louisiana State University with Coastal
processes focus

- University of Utah, Logan, with river processes
focus

- George Mason University with Marine focus

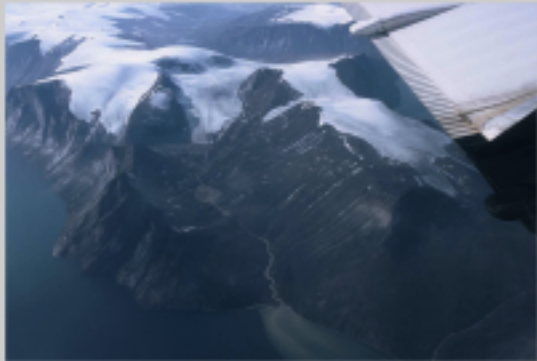
- VIMS Virginia, with coastal-marine focus



HydroTrend Example

Educational Material in CSDMS wiki

http://csdms.colorado.edu/wiki/Labs_portal



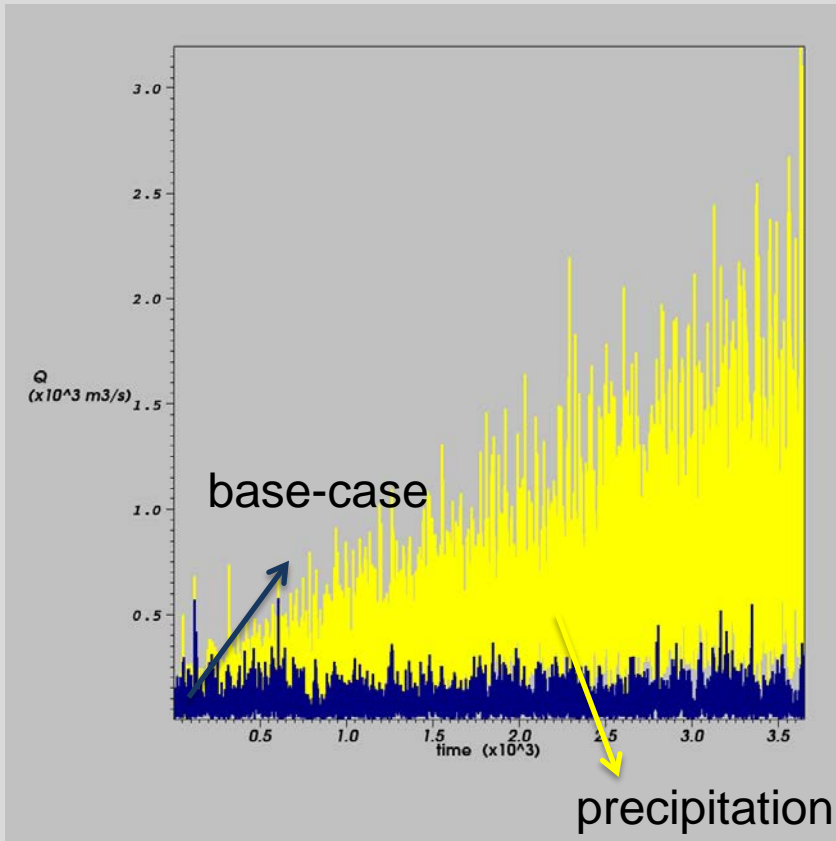
Sediment Supply to the Global Ocean

Investigate river sediment supply to the ocean by 1) a spreadsheet lab or 2) an advanced modeling lab using the HydroTrend Model to explore effects of climate changes on river fluxes. We also look at the effect of humans on rivers: the building of a reservoir.

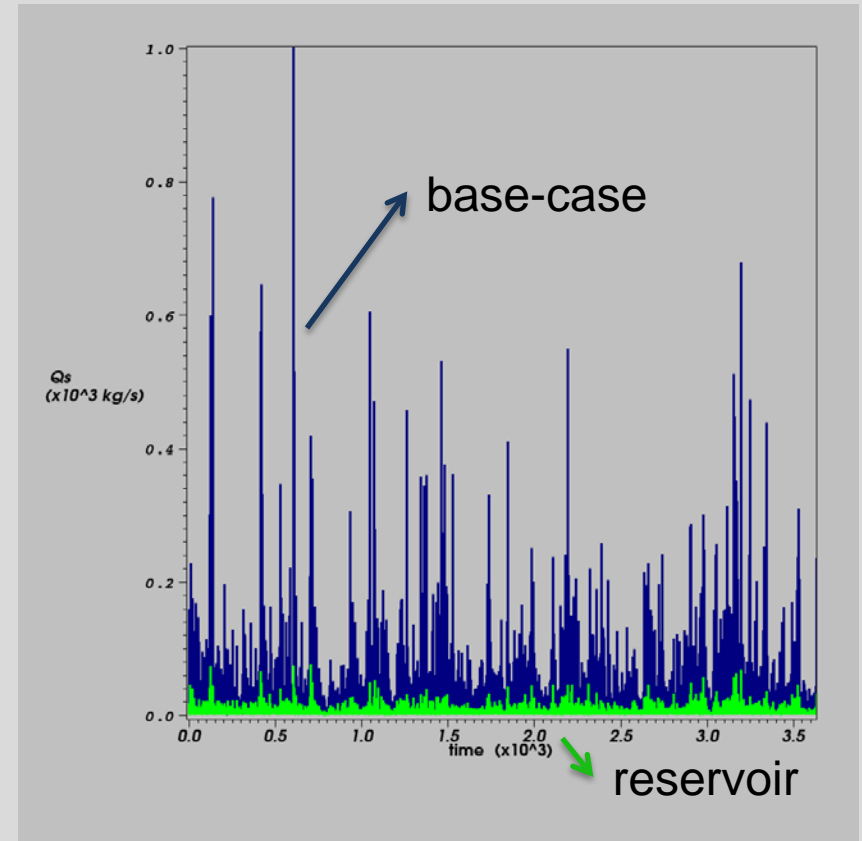
[Spreadsheet Lab](#) or the [River Sediment Supply Modeling with CMT](#)

Output

VisIT: Daily Water Discharge Output



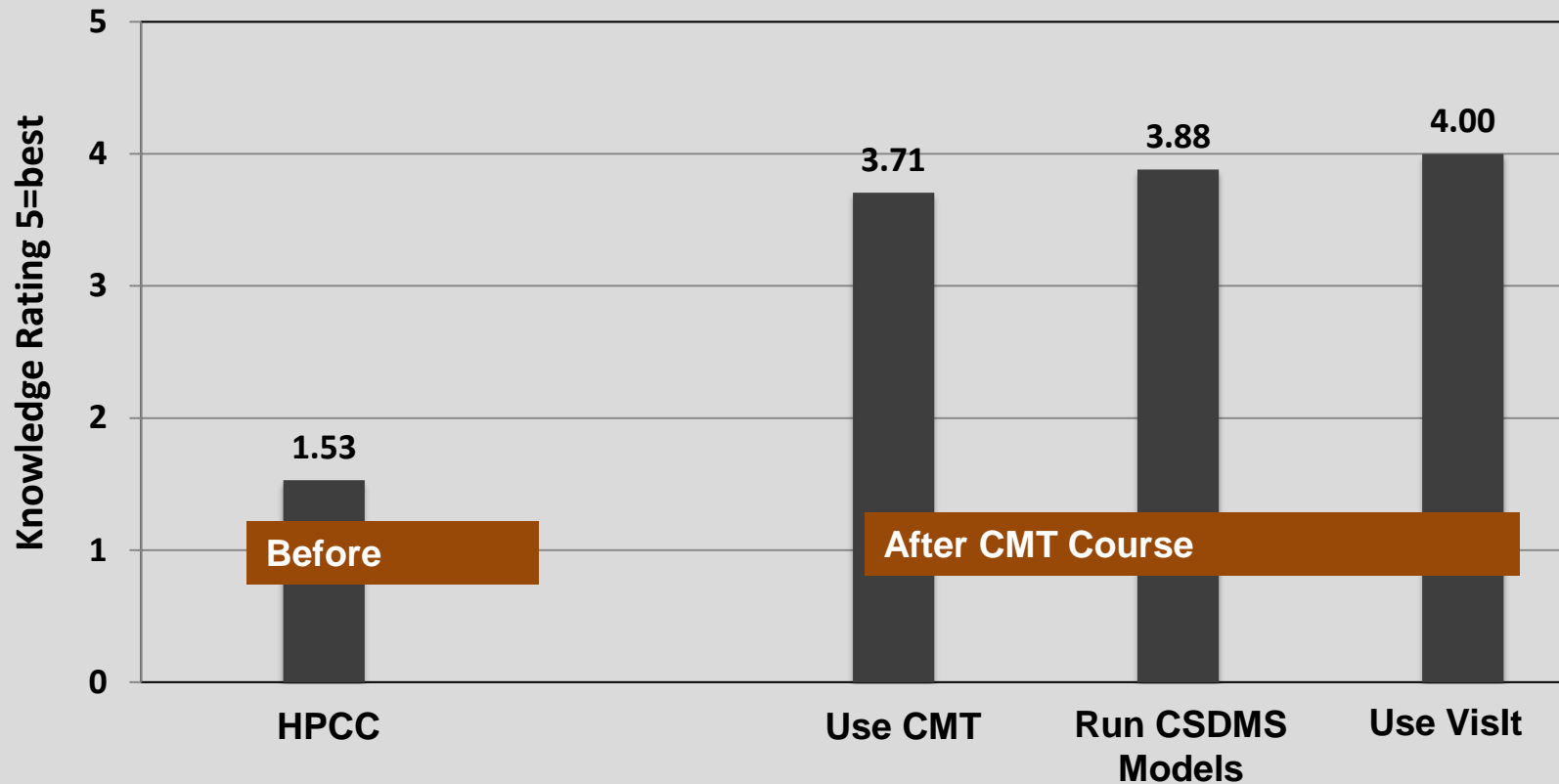
VisIT: Daily Sediment Load Output



Drastic changes in water flux result from increased precipitation regime,
Severe reduction in sediment flux results from damming.

Increasing Student Efficacy with models and HPCC

Graduate Student Learning of CMT and HPCC



Summary

- Teaching with models is an way of hands-on engagement of students in problem-solving and creating process understanding
- We need to teach with models, because models are an essential component of Earth Science now.
- CSDMS welcomes geodynamics modeling, task-team is an option?
- Modeling Teaching Resources are made available through CSDMS
- Feel free to contribute to these resources
- Questions/Contributions: irina.overeem@colorado.edu