Teaching with WMT

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Agenda

- Why Teaching of Modeling of Earth Surface Processes?

What possibilities does CSDMS WMT offer?

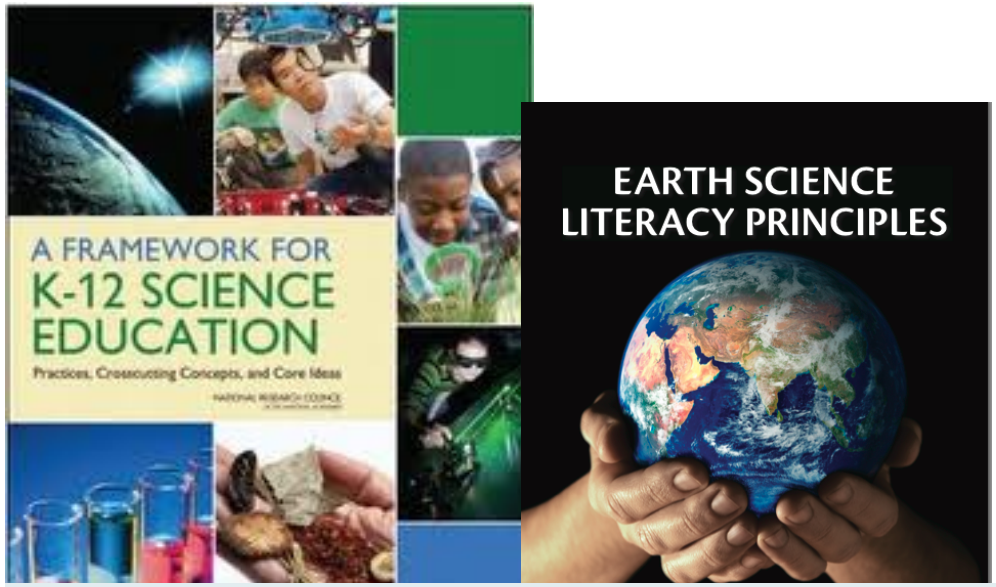
- Integrated Help System between WMT and CSDMS wiki
- Model-Labs in EKT Repository

- Hand-on Modeling Lab with CEM

Vision

- CSDMS motto: “Explore Earth’s Surface with Community Software”
- Develop a modular modeling environment capable of significantly advancing fundamental earth-system science; and
- Develop fully functional and useful repositories for models, supporting data and tools, and other products for education in quantitative modeling.

Why teach modeling?

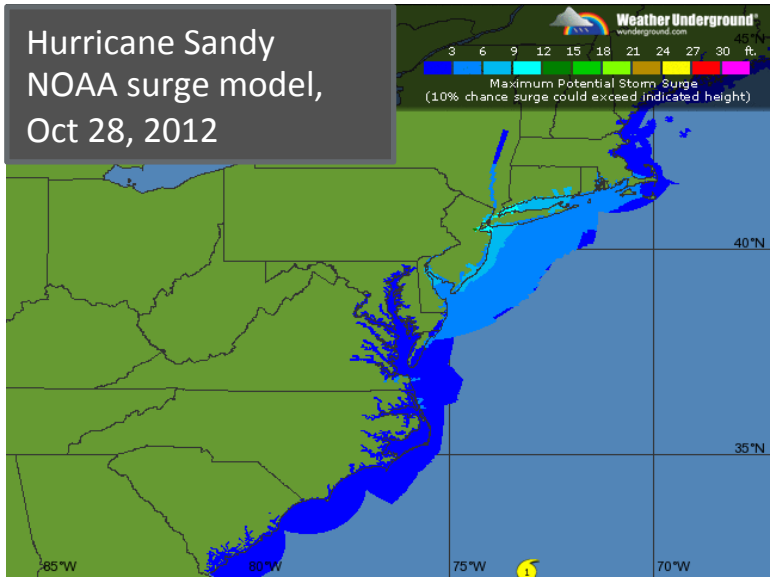


Essential elements of the K-12 science and engineering curriculum relate to modeling:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology and computational thinking
6. Constructing explanations and designing solutions

Why teach modeling?

Hurricane Sandy
NOAA surge model,
Oct 28, 2012



Modeling is imperative to forecasting the behavior of a complex and evolving Earth System

Geoscience research nowadays heavily uses models:

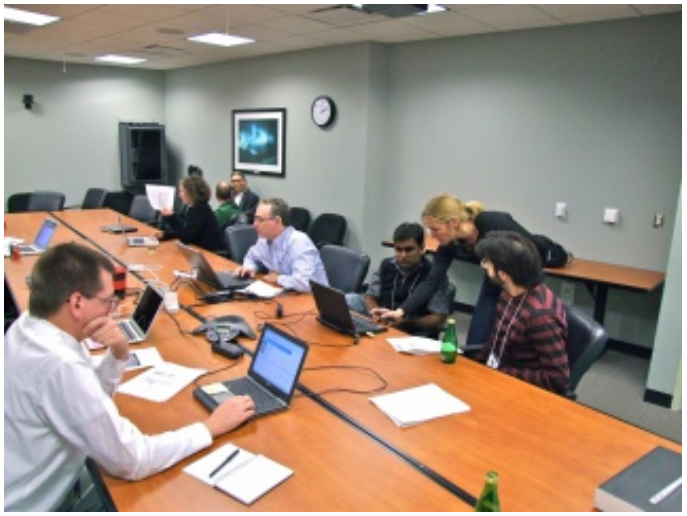
1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology and computational thinking
6. Constructing explanations and designing solutions

Learning outcomes of modeling labs

- Awareness of models versus instrumental data
- Awareness of simplification, assumptions and uncertainty in models

- Explore possible outcomes of a system under different parameters
- Create and analyze model output
- Predict attributes of complex system behavior
- Describe feedbacks in coupled systems
- Computing skills – familiarity with HPCC procedures

Using WMT for teaching

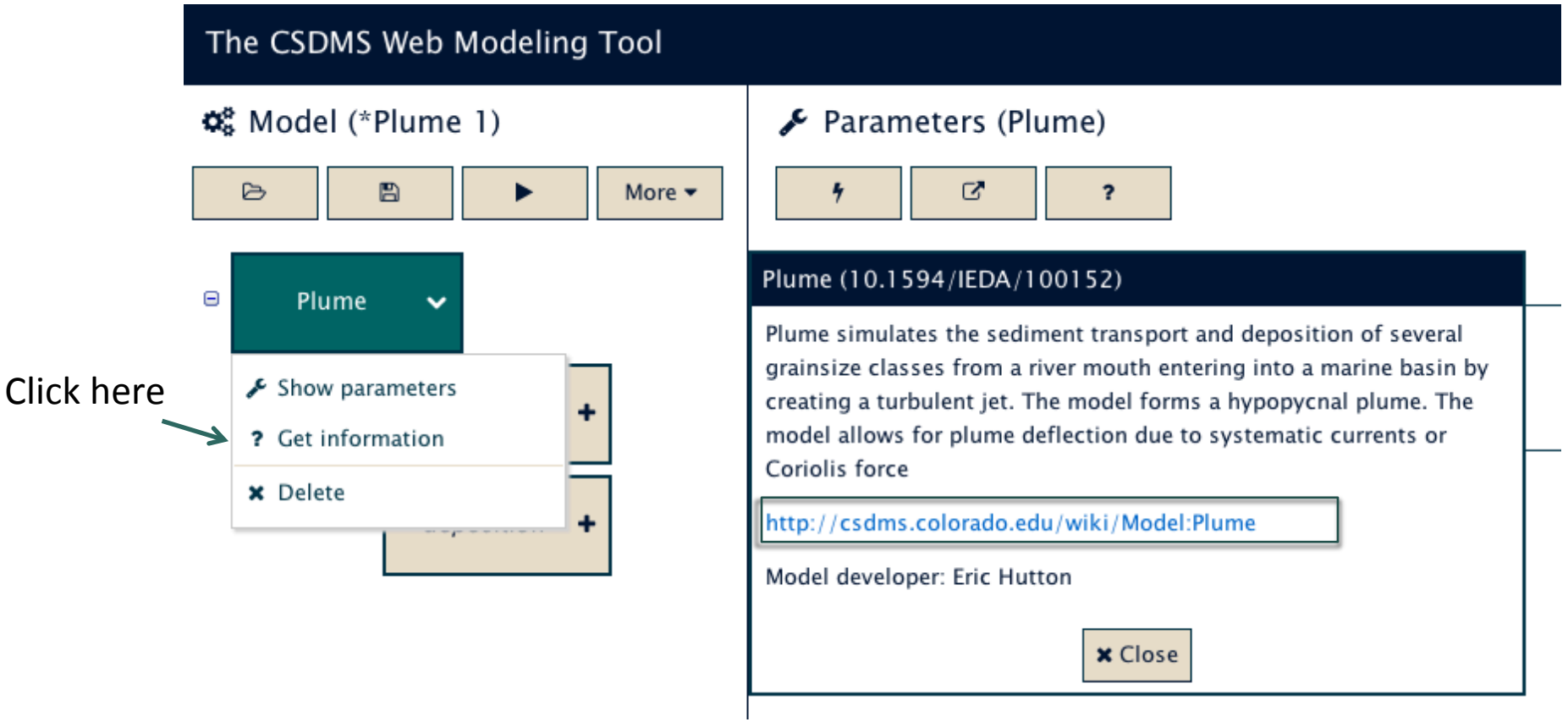


CSDMS members and > 100 graduate students have been exposed to CSDMS Modeling Tool

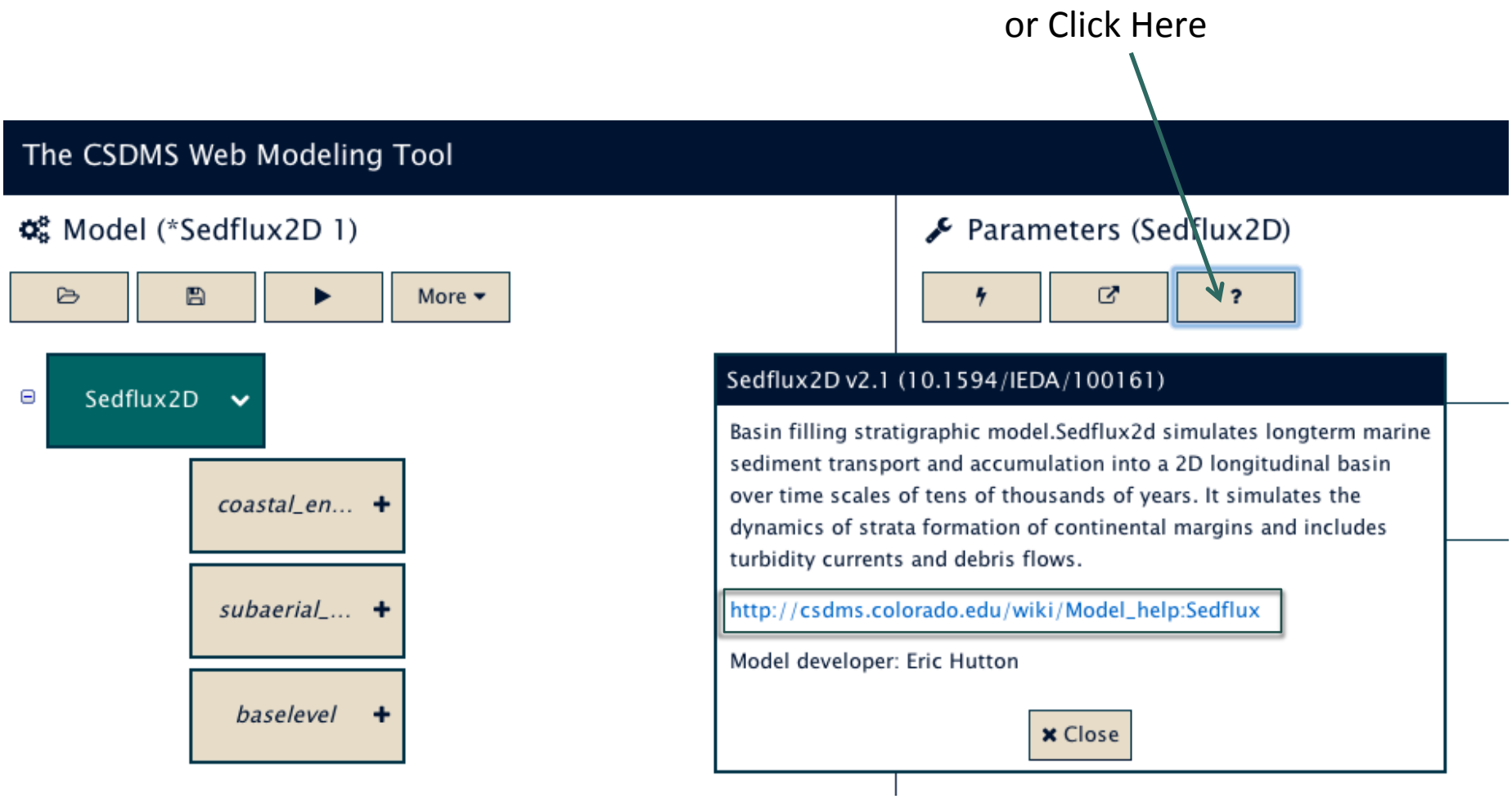
- CSDMS clinics in 2010, 2011, 2012 and 2013
- CU graduate courses on Earth Surface Process modeling
- NCED SIESD 2-day clinics in 2011, 2012, 2013

We are moving this course material to WMT web-based tool

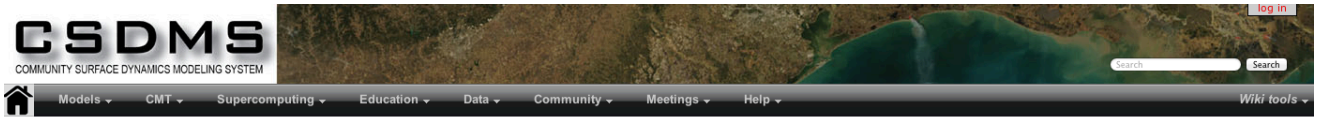
Integration between WMT and wiki



Model Help?


or Click Here
The CSDMS Web Modeling Tool
Model (*Sedflux2D 1)
More
Sedflux2D
coastal_en...
subaerial_...
baselevel
Parameters (Sedflux2D)
?
Sedflux2D v2.1 (10.1594/IEDA/100161)
Basin filling stratigraphic model.Sedflux2d simulates longterm marine sediment transport and accumulation into a 2D longitudinal basin over time scales of tens of thousands of years. It simulates the dynamics of strata formation of continental margins and includes turbidity currents and debris flows.
http://csdms.colorado.edu/wiki/Model_help:Sedflux
Model developer: Eric Hutton
Close

Model Help?



Sedflux

SEDFLUX is a basin-fill model, written in ANSI-standard C, able to simulate the delivery of sediment and their accumulation over time scales of tens of thousands of years. It simulates the dynamics of strata formation of continental margins fuse information from the atmosphere, ocean and regional geology, and it can provide information for areas and times for which actual measurements are not available, or for when purely statistical estimates are not adequate by themselves.

Model introduction

Sedflux combines individual process-response models into one fully interactive model, delivering a multi-sized sediment load onto and across a continental margin. The model allows for the deposit to compact, to undergo tectonic processes and isostatic subsidence from the sediment load. The new version, Sedflux 2.0 introduces a series of new process models, and is able to operate in one of two models to track the evolution of stratigraphy in either 2D or 3D. Additions to the 2D mode include the addition of models that simulate (1) erosion and deposition of sediment along a riverbed, (2) cross-shore transport due to ocean waves, and (3) turbidity currents and hyperpycnal flows. New processes in the 3D mode include (1) river channel avulsion, (2) two-dimensional diffusion due to ocean storms, and (3) two-dimensional flexure due to sediment loading. The spatial resolution of the architecture is typically 1–25 cm in the vertical and 10–100 m in the horizontal when operating in 2D mode. In 3D mode, the horizontal resolution usually extends to kilometers. In addition to fixed time steps (from days to hundreds of years), Sedflux 2.0 offers event-based time stepping as a way to conduct long-term simulations while still modeling low-frequency but high-energy events.

Model parameters

Input Files and Directories | Ports | Run Parameters | Processes | Output Grids | Output Gubes | About

Parameter	Description	Unit
Input directory	path to input files	-
Site prefix	site prefix for Input/Output files	-
Case prefix	case prefix for Input/Output files	-

Uses ports

This will be something that the CSDMS facility will add

Provides ports

This will be something that the CSDMS facility will add

Main equations

- River dynamics (using HydroTrend model)

1) Water discharge

$$Q_0 = u_0 b_0 h_0$$

3) Plume's centerline

$$\frac{x}{b_0} = 1.53 + 0.90\left(\frac{u_0}{v_0}\right)\left(\frac{y}{b_0}\right)^{(0.37)} \quad (8)$$

4) Non-conservative concentration along and surrounding the centerline position

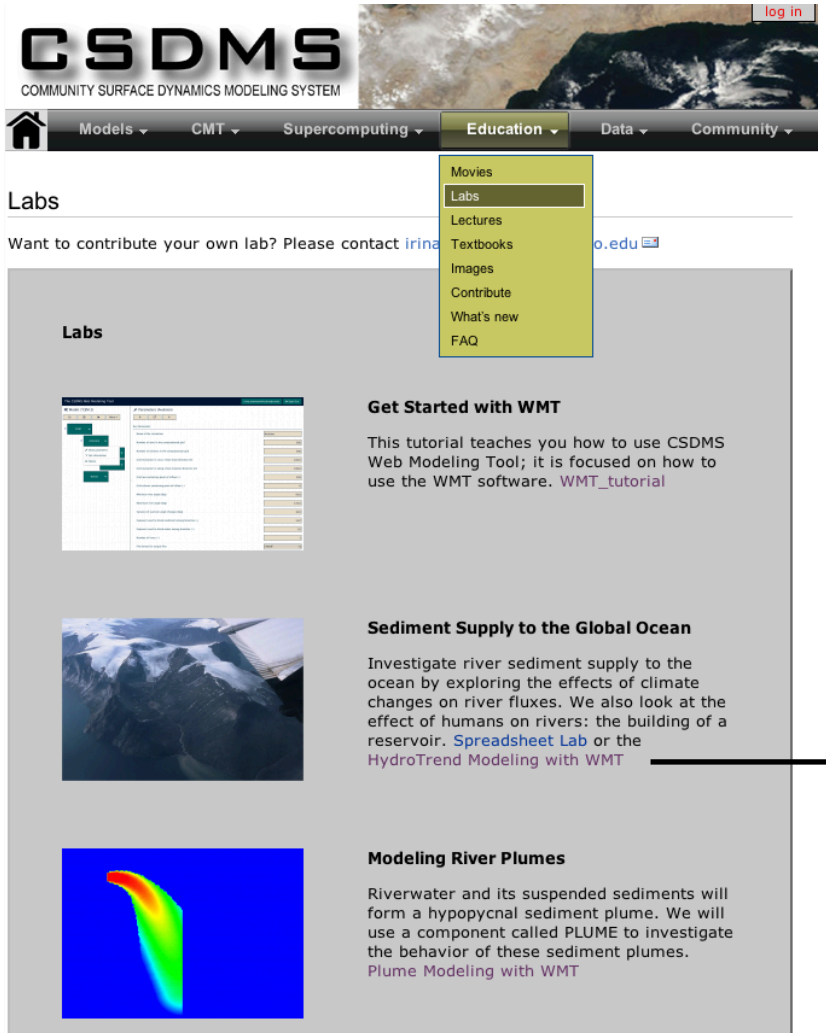
$$C(x,y) = C_0 exp(-\lambda t)\sqrt{\frac{b_0}{\sqrt{\pi}C_1 x}} exp[-\left(\frac{y}{\sqrt{2}C_1 x}\right)^2] \quad (9)$$

$$t(x,y) = \frac{u_0 + u_c(x) + 7u(x,y)}{9} \quad (10)$$

$$u_c(x) = u_0\sqrt{\frac{b_0}{\sqrt{\pi}C_1 x}} \quad (11)$$

$$u(x,y) = u_0\sqrt{\frac{b_0}{\sqrt{\pi}C_1 x}} exp[-\left(\frac{y}{\sqrt{2}C_1 x}\right)^2] \quad (12)$$

Model Labs



Overview of Labs for Teaching:
http://csdms.colorado.edu/wiki/Labs_portal

Example:
http://csdms.colorado.edu/wiki/Labs_WMT_River_Sediment_Supply

Model Labs

- Labs are intended for advanced undergraduate and graduate classes (3-4 hrs, with homework). Labs include:

1) Tutorial on use of WMT
2) Presentations on the specific model and processes.
3) Instructions to run simulations. These runs have been tested.
4) Questions to meet topical learning objectives.
5) Key references to learn more on relevant processes and models.

Logistics

- Students need accounts on the CSDMS super-computer. This takes time; count on 5 work days.
- Student need to familiarize with WMT
- Students learn to visualize NetCDF time-series and grids. All CSDMS compliant models output NetCDF files. NetCDF can be visualized in VisIT or ParaView (open-source visualization tools) or Matlab. Some models have their own ASCII files.

Example of a Model Lab

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

Sediment Settling Rates

PLUME is one of the key components of the marine sedimentation model SedFlux; river plumes are just one of the marine processes that control marine sedimentation. Other processes include waves and tides and turbidity currents and biological production. The stand-alone plume component runs for a single flood event, and it runs for a single suspended sediment load class only. You can imagine that in a more comprehensive framework the plume model runs for several grain-size classes and for a sequence of many different discharge events over time. We will look at the effect of changing the suspended grain-size in the river.
Empirically, sediment removal rates, λ, [1/T] for fine sediment in the plume model are defined as a function of grain-size, D:

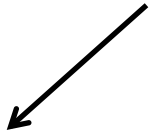
$\lambda(D) = 0.222D + 1.573$

This relationship was derived from time-lapse image analysis of underwater particle settling for grains between 2 micron and 42 micron.

Sediment	
Saturated bulk density of bottom sediments (kg/m^3)	1,800.0
Removal rate of susmpended sediment (day^-1)	16.8

>> Run 3 simulations of PLUME. Vary the removal rates systematically.
>> List your parameters for grainsize and removal rate, discharge scenario and basin shape.

Instructions on Parameter Settings



Questions to guide more in-depth analysis of parameters

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Question 4
Compare the empirically derived removal rates with Stokes settling velocities for these grain diameters?
What would be the removal rates if you assume turbulent conditions during settling?
Can you explain the difference?
```

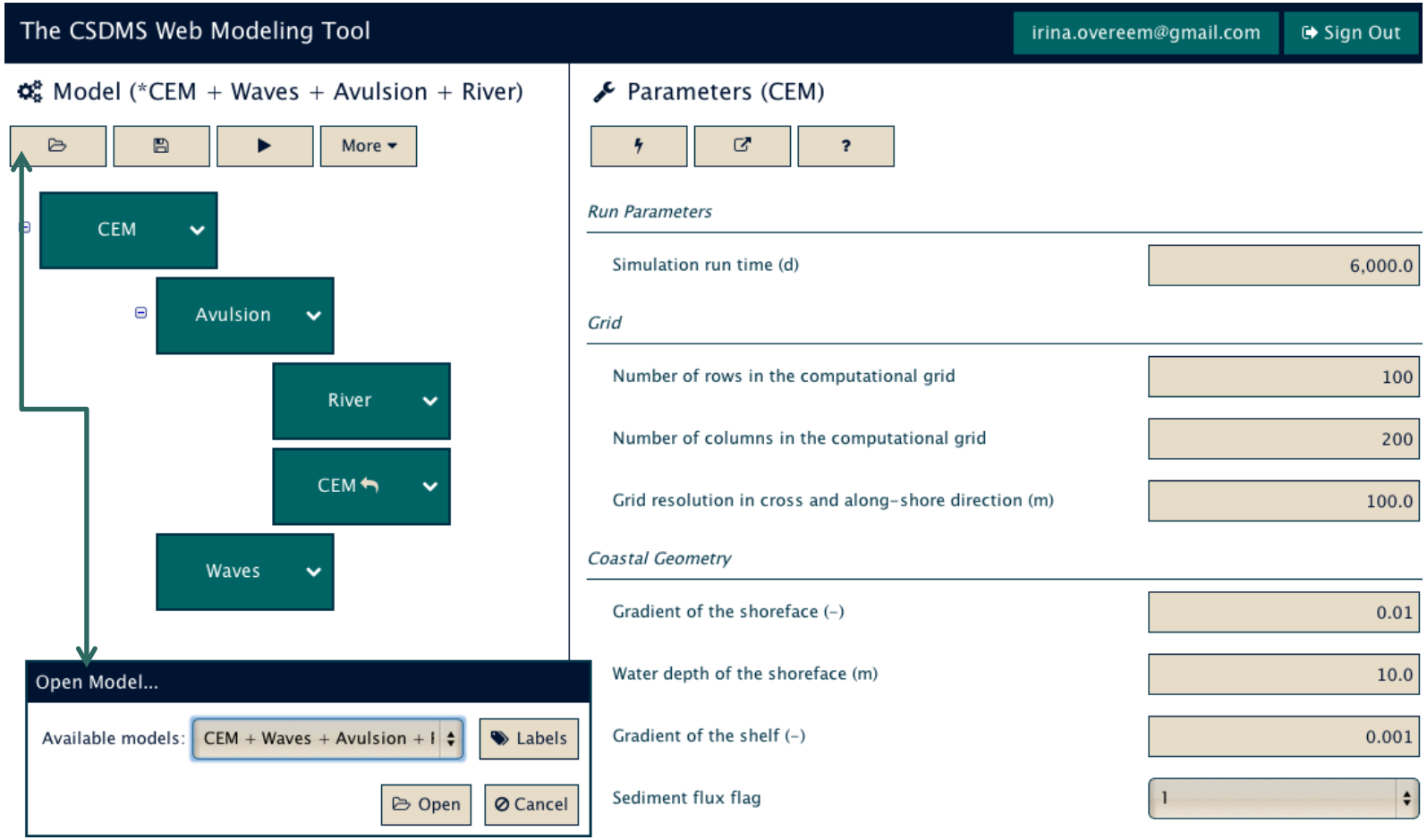
Hands-on Model Lab

Explore a model lab on coastal evolution modeling (20 min)
CEM Model (Murray, Ashton, Nienhuis), HydroTrend Model (Kettner), Avulsion Model (Hutton)

Team up with people who have their Beach account information available: you will need your user name and password.

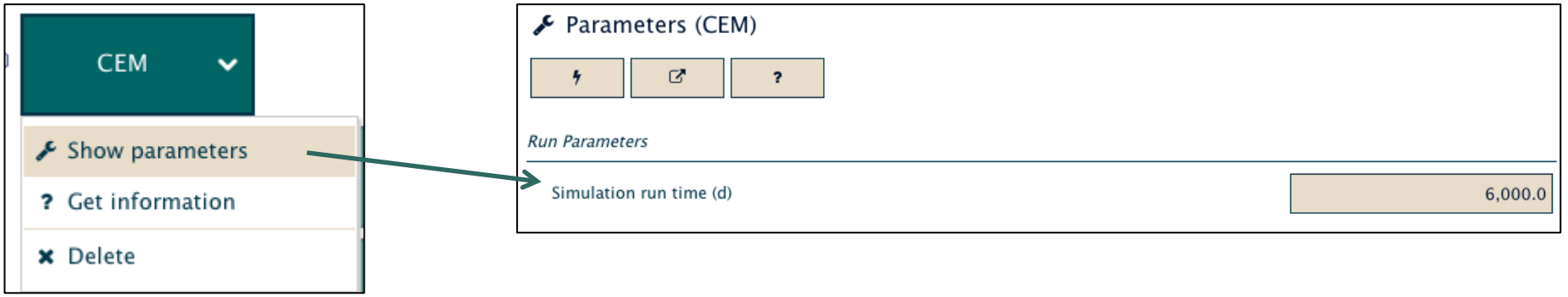
Directions are on CSDMS wiki:
http://csdms.colorado.edu/wiki/Labs_WMT_CEM

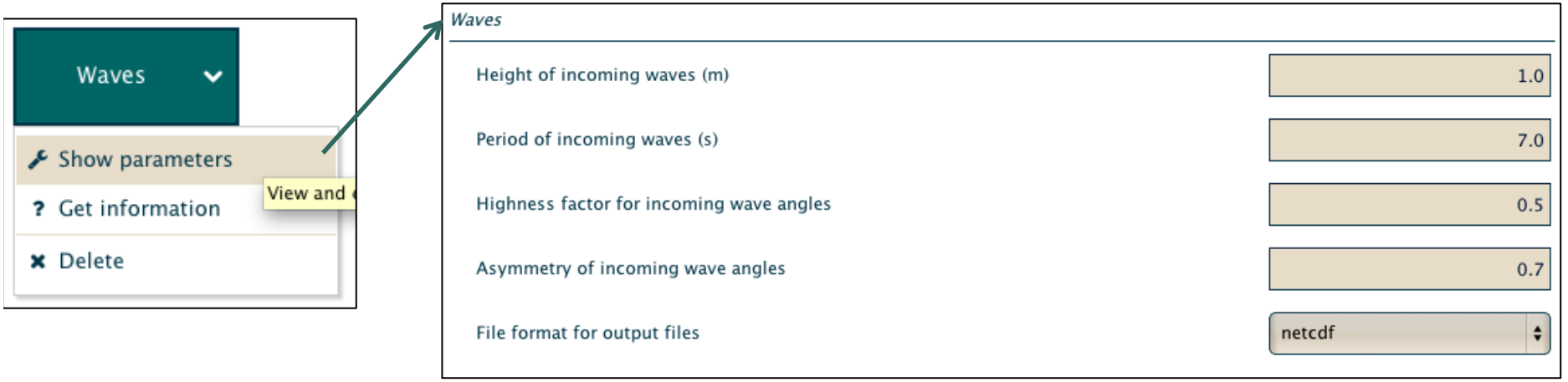
Simulation Setup



Option: use the pre-wired example; and start changing parameters from there.

Parameter Setup





More information on Model

CEM [edit]

Metadata [edit]

Summary | Contact | Technical specs | In/Output | Process | Testing | Other | Component info

This part will be filled out by CSDMS staff

OpenMI compliant	No but planned
CCA component	Yes
IRF interface	Yes
CMT compontent	Yes

DOI model	10.1594/IEDA/100100
For model version	0.1.1
Year version submitted	2011

Can be coupled with:	Avulsion,

Model info

Authors [show]

Source code [show]

DOI [hide]

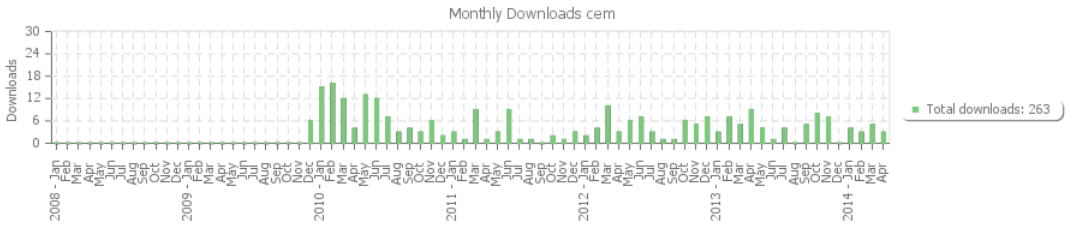
- CEM version: 0.1.1
  Doi: 10.1594/IEDA/100100

QR-code [hide]

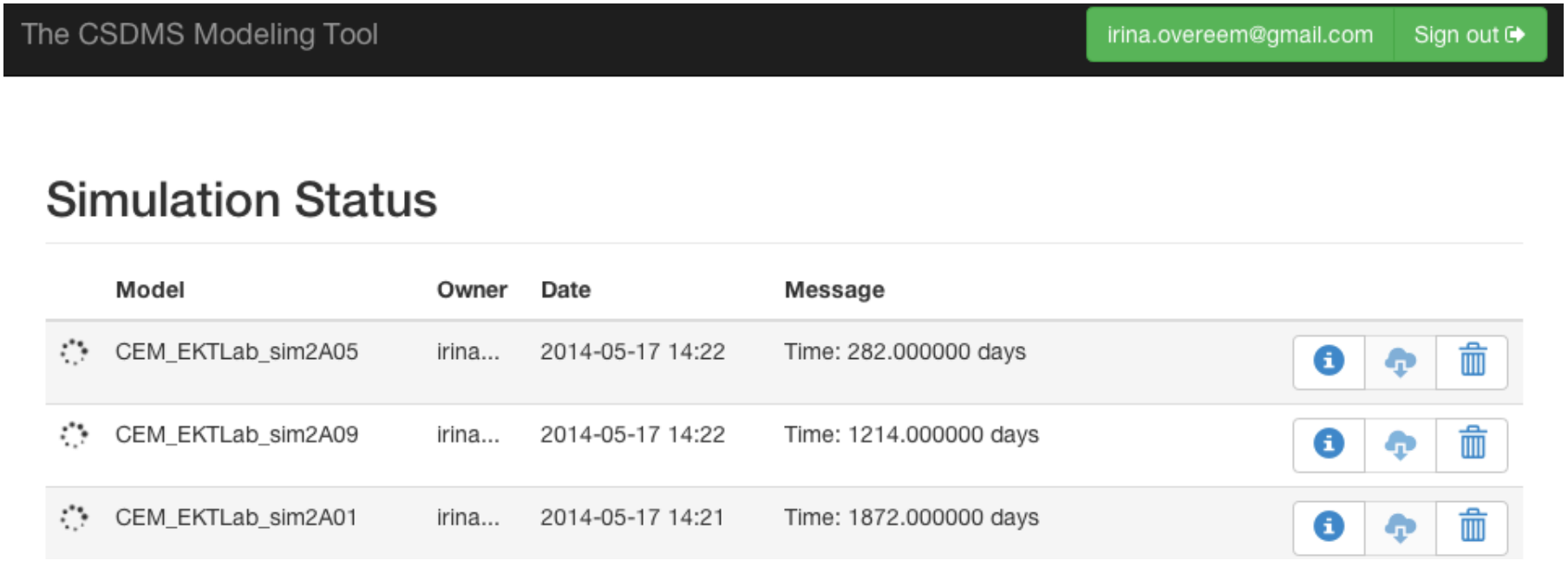
Link to this page

Other models by this author [show]

Download statistics



Simulation Status



Simulation takes about 5 minutes to complete, it reports progress in the 'Simulation Status' window

https://csdms.colorado.edu/wmt/api-dev/run/show

Visualize NetCDF files with VisIT

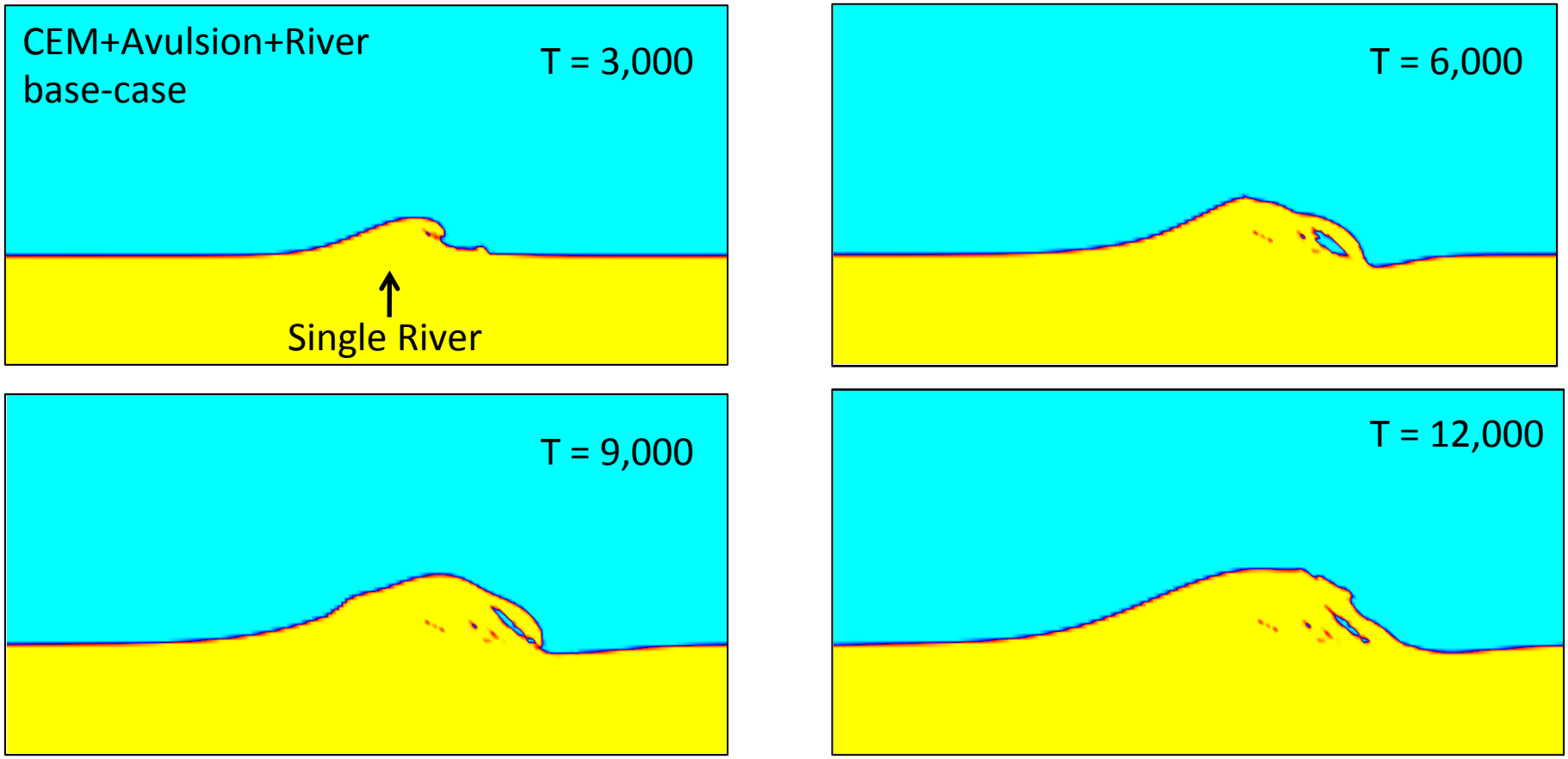
- Download VisIT software

https://wci.llnl.gov/codes/visit/

Downloads are available for Windows XP/Vista, Mac OS X,

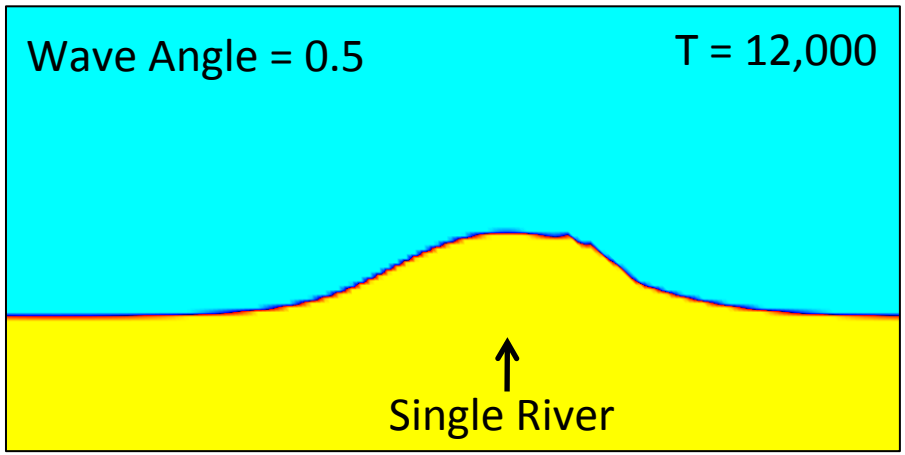
Linux RedHat and Ubuntu

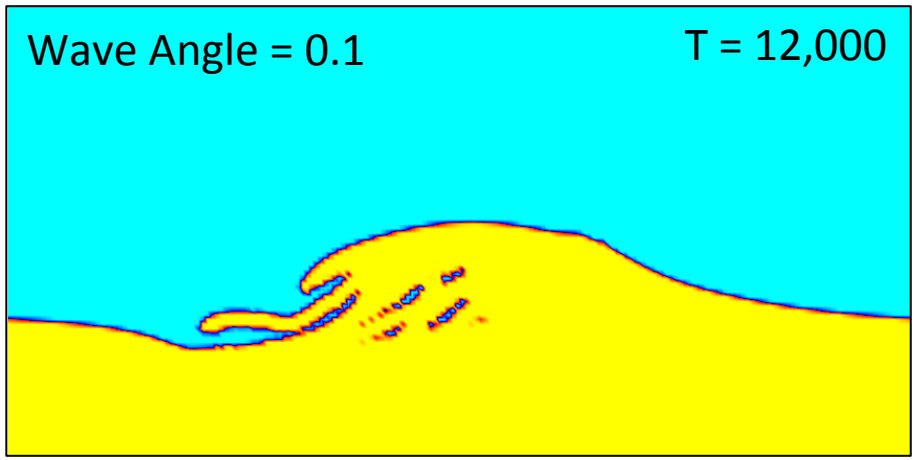
Hands-on Model Lab (1)

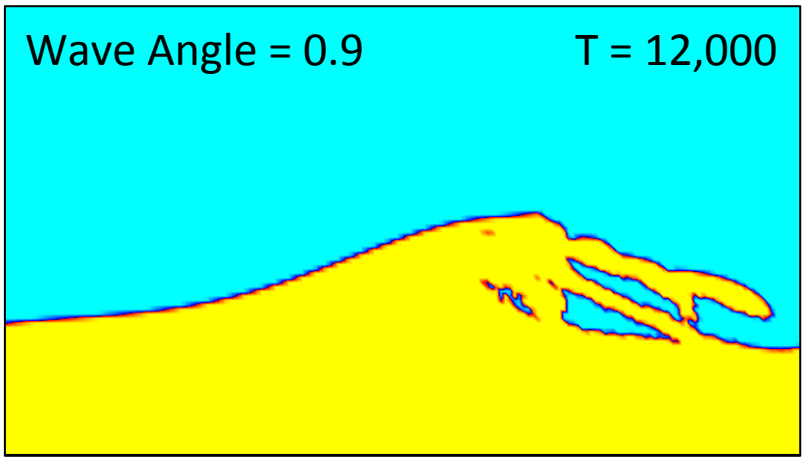


Simulation 1 allows simple exploration of coastal geomorphological evolution over time.
Learning Objective: Create-Describe-Interpret Model information

Hands-on Model Lab (2)



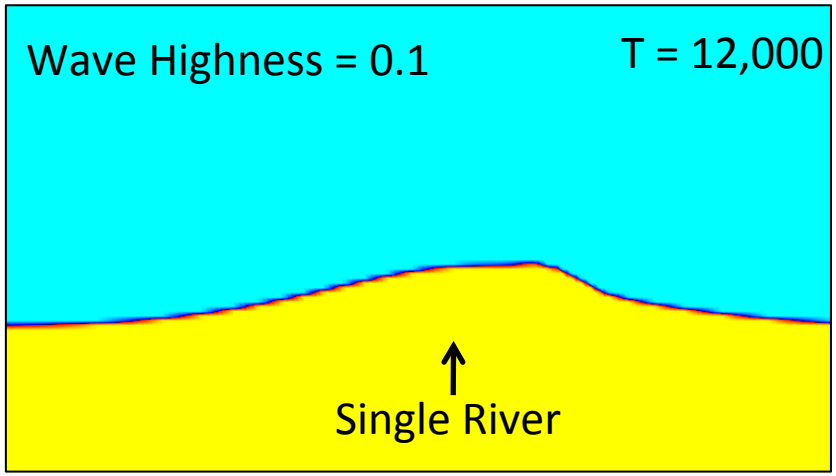


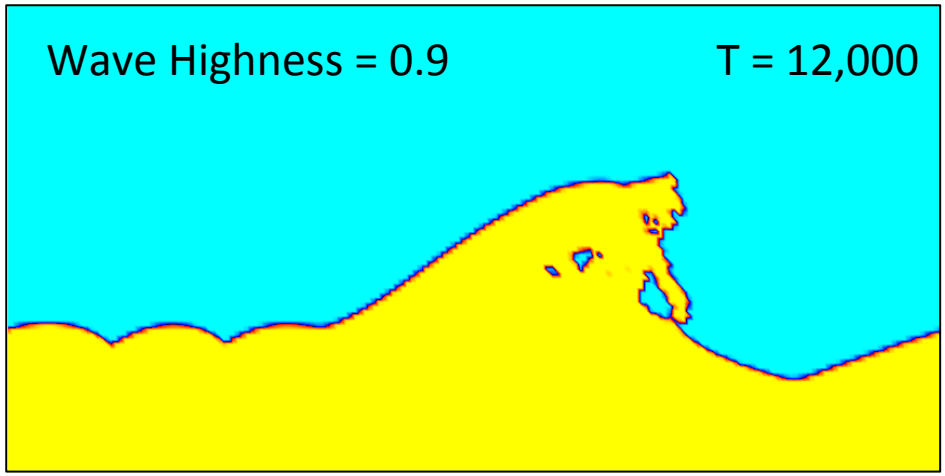


Simulation set 2 allows process-response relationships to be explored.

Learning Objective: Describe-Predict certain responses based on specific process parameters

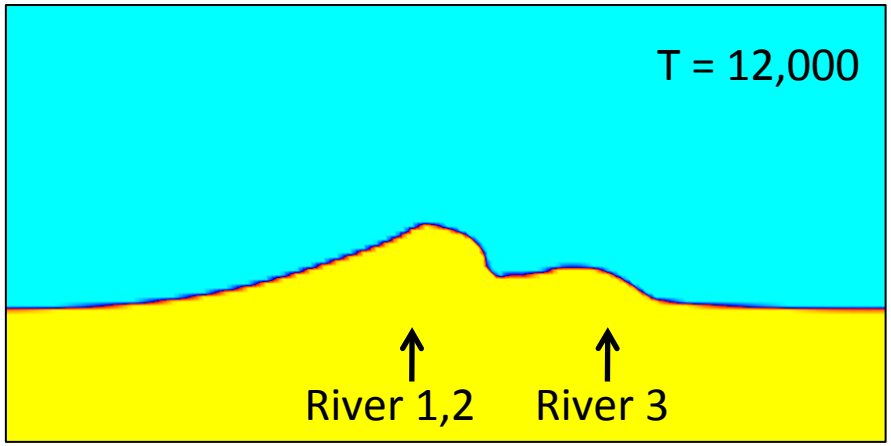
Hands-on Model Lab (2)

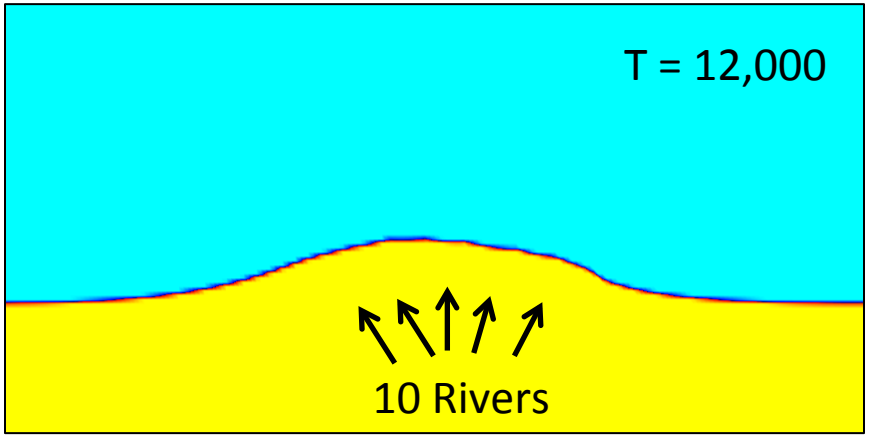




Simulation set 2 allows process-response relationships to be explored.
Learning Objective: Describe-Predict certain responses based on specific process parameters

Hands-on Model Lab (3)

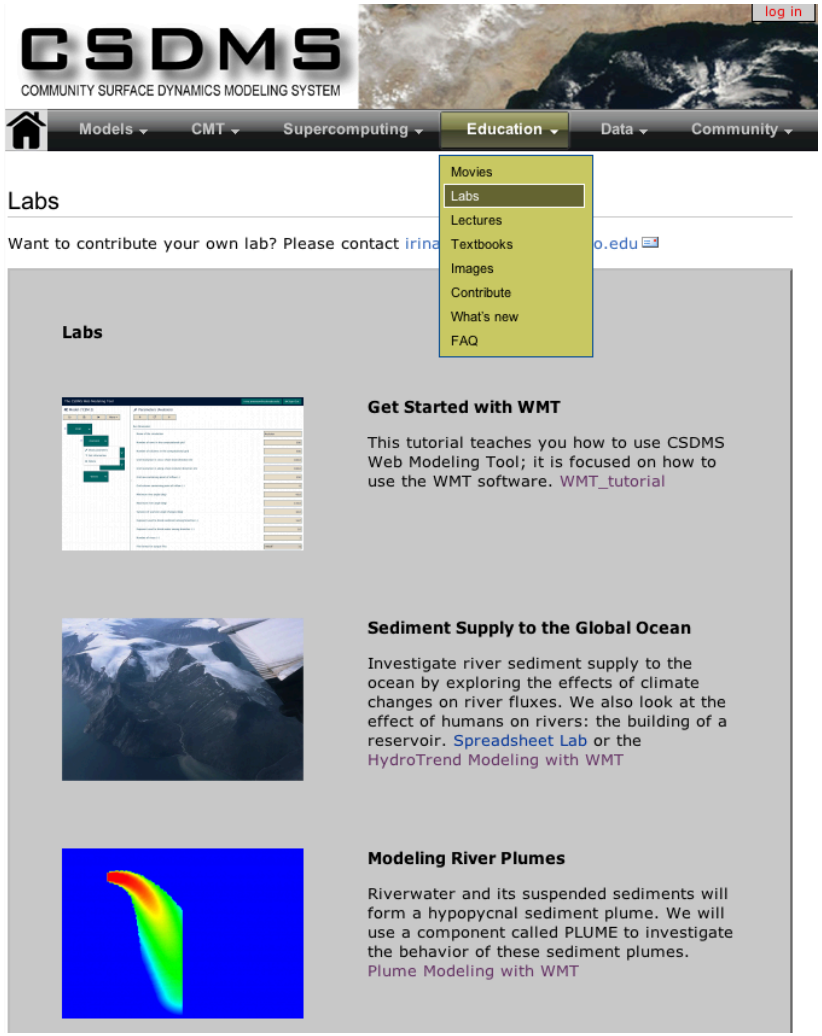




Simulation set 3 explores feedbacks between processes. Divide bedload based on channel length. Learning Objective: Describe-Predict feedbacks between specific process parameters

A. Ashton, E. Hutton, A. Kettner, F. Xing, J. Kallumadikal, J. Nienhuis, L. Giosan, Progress in coupling models of coastline and fluvial dynamics, Computers & Geosciences, 53, 2013, 21-29, http://dx.doi.org/10.1016/j.cageo.2012.04.004.

Available Model Labs

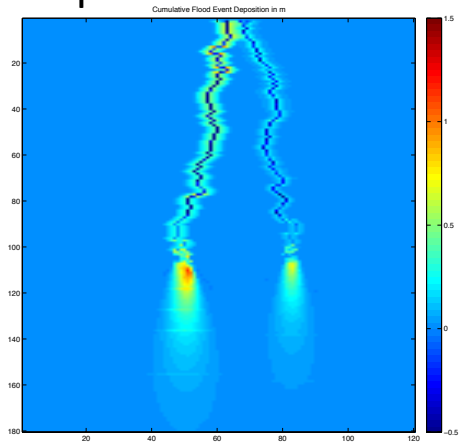


- WMT basics
- HydroTrend
- River Plumes
- Coastal Evolution – Avulsion - Waves
- Sedflux2D Stratigraphy

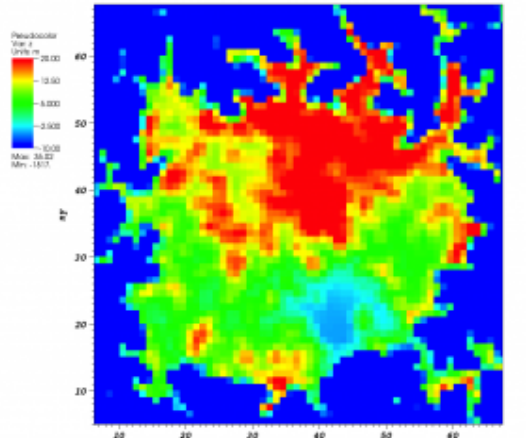
- *Soon to be updated from CMT lab*
- *TOPOFLOW*
- *CHILD*
- *ERODE*

Questions and Discussion

AquaTellUs



ERODE



Community input through EKT WG

- What models are next?
- Which topics are next?
- What about documenting output?

Community volunteering

- We are recruiting TA's and faculty to adopt and evaluate these teaching resources