



# DSM2 Sediment Transport Module

DSM2 User Group Update  
January 27, 2010

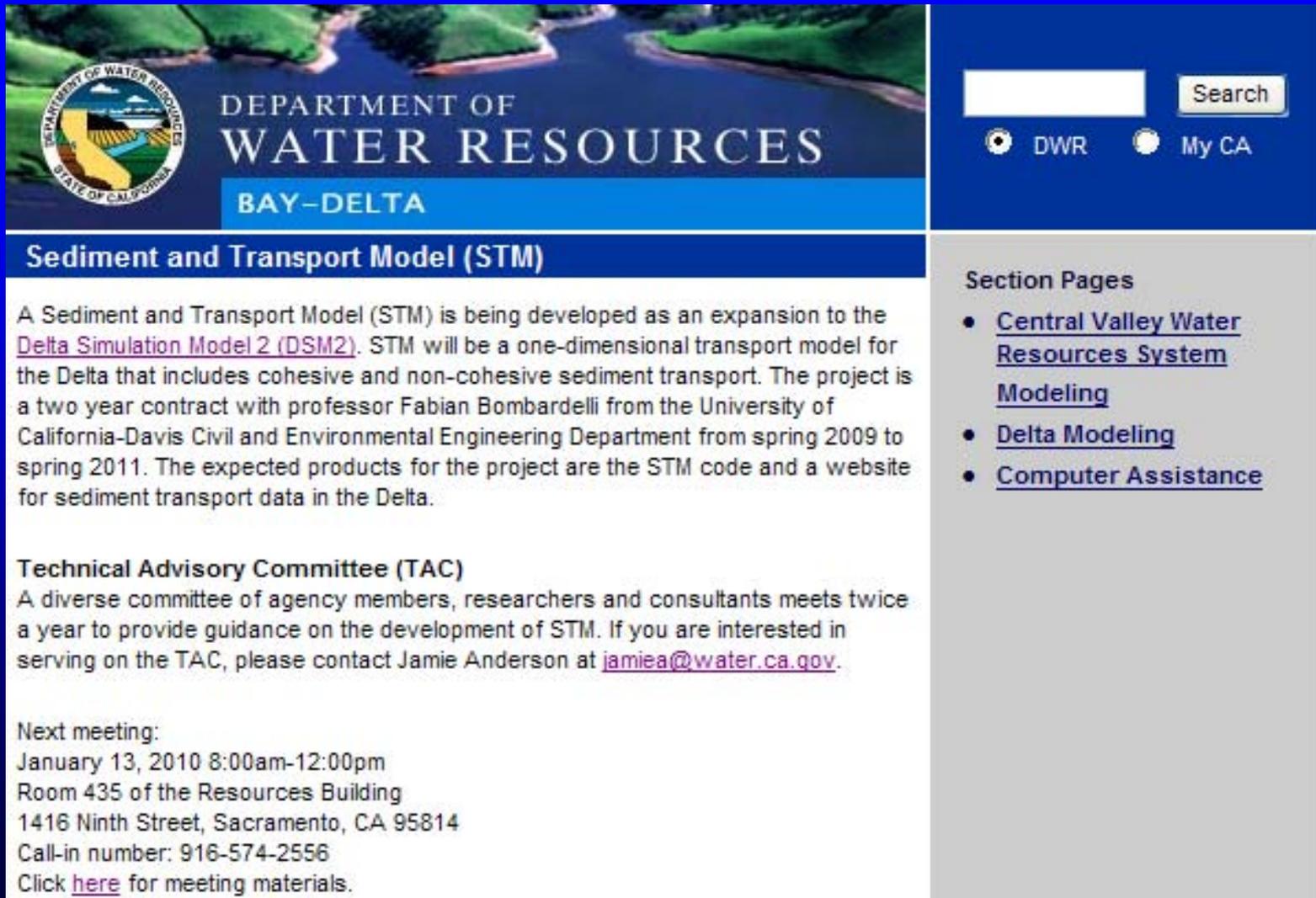
Jamie Anderson, Ph.D., P.E.



Department of Water Resources  
Modeling Support Branch  
Bay-Delta Office

# STM Website

<http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/stm/stm.cfm>



The screenshot shows the top portion of a website. On the left is a banner with the Department of Water Resources logo and the text 'DEPARTMENT OF WATER RESOURCES BAY-DELTA'. On the right is a navigation bar with a search box, 'DWR', and 'My CA' links. Below the banner is a section titled 'Sediment and Transport Model (STM)' containing a paragraph of text, a 'Technical Advisory Committee (TAC)' section, and meeting information. On the far right is a 'Section Pages' sidebar with three links.

**DEPARTMENT OF WATER RESOURCES**  
**BAY-DELTA**

**Sediment and Transport Model (STM)**

A Sediment and Transport Model (STM) is being developed as an expansion to the [Delta Simulation Model 2 \(DSM2\)](#). STM will be a one-dimensional transport model for the Delta that includes cohesive and non-cohesive sediment transport. The project is a two year contract with professor Fabian Bombardelli from the University of California-Davis Civil and Environmental Engineering Department from spring 2009 to spring 2011. The expected products for the project are the STM code and a website for sediment transport data in the Delta.

**Technical Advisory Committee (TAC)**  
A diverse committee of agency members, researchers and consultants meets twice a year to provide guidance on the development of STM. If you are interested in serving on the TAC, please contact Jamie Anderson at [jamiea@water.ca.gov](mailto:jamiea@water.ca.gov).

Next meeting:  
January 13, 2010 8:00am-12:00pm  
Room 435 of the Resources Building  
1416 Ninth Street, Sacramento, CA 95814  
Call-in number: 916-574-2556  
Click [here](#) for meeting materials.

**Section Pages**

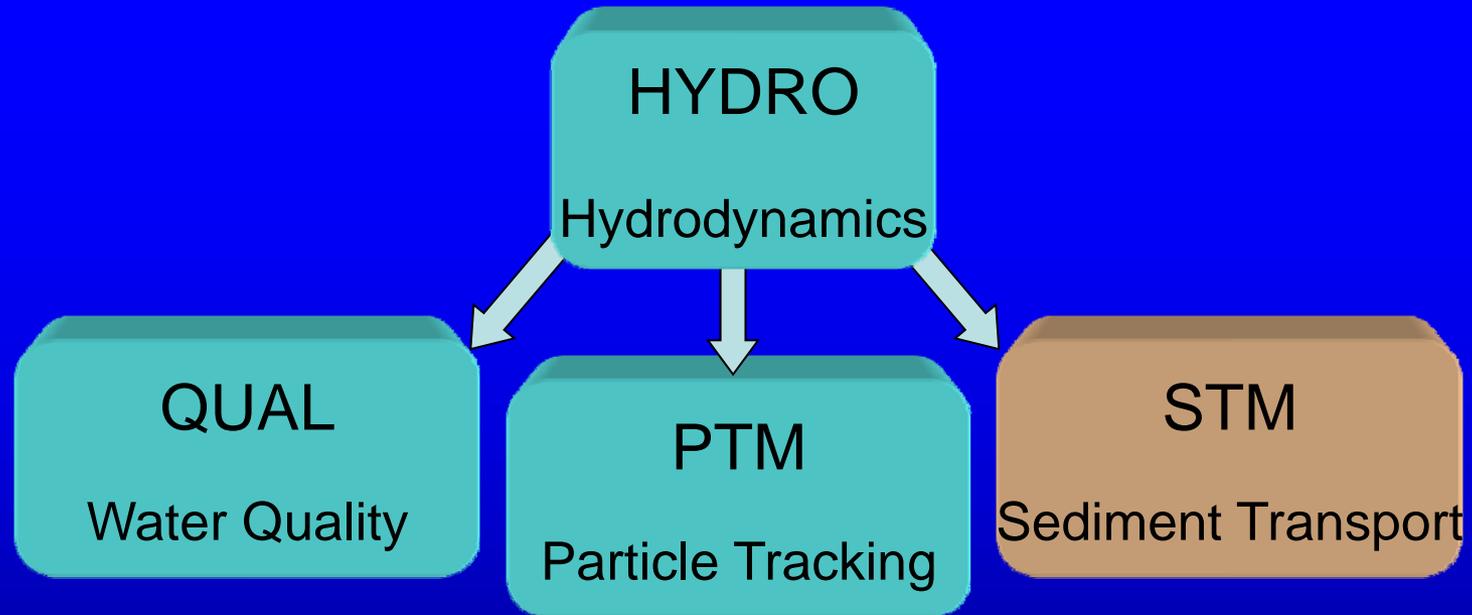
- [Central Valley Water Resources System Modeling](#)
- [Delta Modeling](#)
- [Computer Assistance](#)

# California Water and Environmental Modeling Forum Conference

- Feb 22-24, 2010
- Asilomar near Monterey
- STM update in DSM2 session
- <http://cwemf.org>



# DSM2 Sediment Transport Module (STM)



2 year MACHRO contract with UC Davis

PI Fabian Bombardelli Civil & Env. Engineering

- Kaveh Zamani (modeling)
- Jamie Kohne & Joseph Waltz (data)\*

Project products

- Web site with available sediment data in the Delta
- DSM2 Sediment Transport Module
  - Suspended sediment and bed load
  - Multiple sediment class sizes
  - One-dimensional model

\*supported by another funding source

# STM Code Development Plan

- Flexible, modular design
- Generalize Eulerian transport that could be adapted to other constituents
  - New fixed frame of reference transport model
  - Clean slate, develop testable code
  - Combine resources with data assimilation project
  - Future benefit: baroclinic term in HYDRO, salinity based op rules
- Self documenting with Doxygen



# Self-Documenting Code using Doxygen

```
!> Integrate advection plus sources for a time step.
!> The final argument to advect is a callback for computing the source term,
!> which should conform to the source_if interface
!> The algorithm looks like this:
!>   - Convert to primitive variables
!>   - Extrapolate to faces
!>     - difference()
!>     - limiter()
!>     - extrapolate()
!>   - upwind()
!>   - compute_flux()
!>   - replace_boundary_flux()   for boundary and special cases
!>   - Compute conservative divergence
!>   - Apply divergence in conservative_update along with Huen's method for sources
!> Note that all these steps are operations on entire arrays of values -- this ke
```

```
subroutine advect(mass,      &
                 mass_prev,&
                 flow,      &
                 flow_lo,  &
                 flow_hi,  &
                 area,      &
                 area_prev,&
                 area_lo,  &
                 area_hi,  &
                 ncell,    &
                 nvar,     &
                 time,     &
                 dt,       &
                 dx)
```

# Self-Documenting Code using Doxygen

Package advection

file:///D:/delta/trunk/stm/doc/html/a00024.html#\_details

Water Data Library : ... ESRI Training Matters FEMA: The National Fl... ISI Web of Knowledg... Dissertation Search ILLiad Main Menu Computational Fluid D...

Main Page Modules Packages Data Types List

Packages Package Functions

## Package advection [transport]

Module orchestrating the **advection** scheme. The main routine in the module is `advection()`. [More...](#)

### Functions/Subroutines

subroutine **advect** (mass, mass\_prev, flow, flow\_lo, flow\_hi, area, area\_prev, area\_lo, area\_hi, ncell, nvar, time, dt, dx)  
Integrate **advection** plus sources for a time step. The final argument to `advect` is a callback for computing the source term, which looks like this:

- Convert to primitive variables
- Extrapolate to faces
  - `difference()`
  - `limiter()`
  - **extrapolate()**
- `upwind()`
- **compute\_flux()**
- **replace\_boundary\_flux()** for boundary and special cases
- Compute conservative divergence
- Apply divergence in `conservative_update` along with Huen's method for sources Note that all these steps are operations on entire

subroutine **extrapolate** (conc\_lo, conc\_hi, conc, grad, source, flow, area, ncell, nvar, time, dt, dx)  
Extrapolate primitive data from cell center at the old time to cell edges at the half time. The extrapolation is done by a Taylor series in time and the PDE is used to represent the time part.

subroutine **compute\_flux** (flux\_lo, flux\_hi, conc\_lo, conc\_hi, flow\_lo, flow\_hi, ncell, nvar)  
Compute the upwinded fluxes The calculation here does not include tributaries, boundaries or special objects.

subroutine **compute\_divergence** (div\_flux, flux\_lo, flux\_hi, ncell, nvar)  
Compute the divergence of fluxes. At present, this is undivided...which may be not what we want.

subroutine **replace\_boundary\_flux** (flux\_lo, flux\_hi, conc\_lo, conc\_hi, flow\_lo, flow\_hi, ncell, nvar, time, dt, dx)  
Replace original calculated flux at boundary locations todo: figure out if the arguments are right and move this routine to the application - hydro\_data Also, eventually have to think out channel network.

subroutine **update\_conservative** (mass, mass\_prev, div\_flux, source\_prev, area, ncell, nvar, dt, dx)  
Update the conservative variables using divergence of fluxes and integrate the source term using Huen's method.

Detailed Description

# STM Code Development Plan

- Flexible, modular design
- Generalize Eulerian transport that could be adapted to other constituents
  - New fixed frame of reference transport model
  - Clean slate, develop testable code
  - Combine resources with data assimilation project
  - Future benefit: baroclinic term in HYDRO, salinity based op rules
- Self documenting with Doxygen
- Companion code testing routine



# STM Code Testing

STM Code

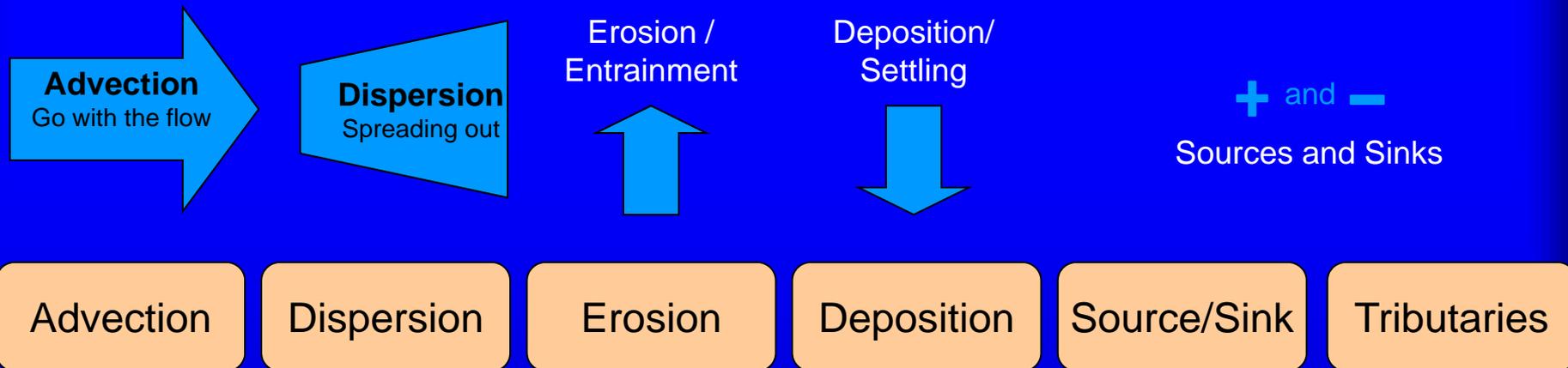
Testing Code  
Calls STM  
functions

Each function in STM has tests  
Code and analytical tests  
Test wide range of scenarios  
Produce report of pass/fail result  
Run tests regularly

Unit testing using FRUIT  
(Fortran Unit Test Framework)  
Test each “unit” of code



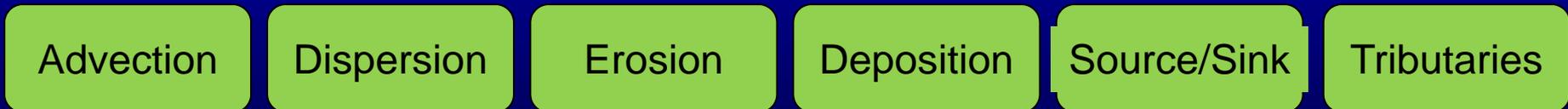
# Sediment Transport Processes



Progress to Date: Single Channel



Next step: Complete single channel model



Next step: Extend model to a channel network

# Thank You!

Jamie Anderson  
jamiea@water.ca.gov  
916-654-5455

Fabian Bombardelli  
fabianbombardelli2@gmail.com  
530-752-0949