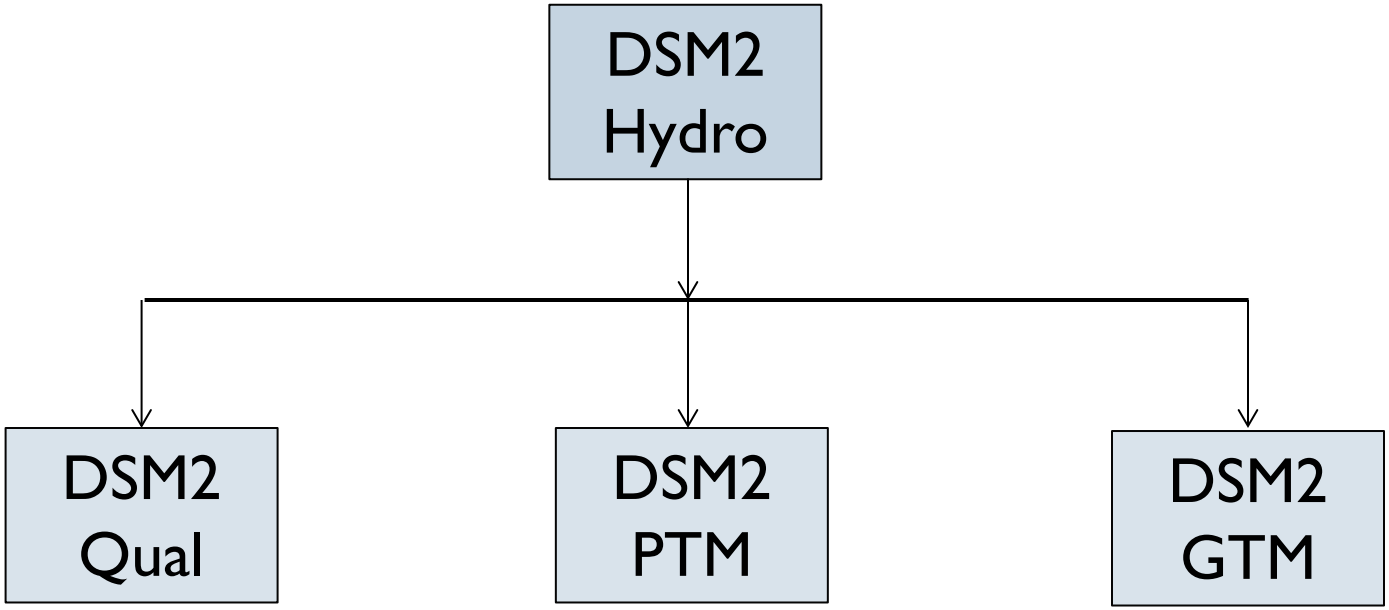
DSM2 General Transport Model (DSM2-GTM) Development Status Update

En-Ching Hsu
Nicky Sandhu
Eli Ateljevich

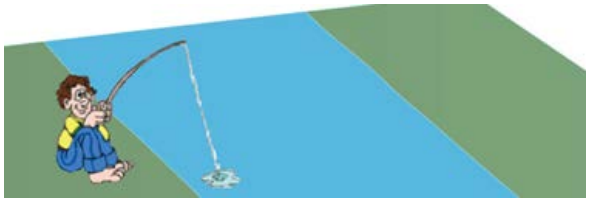
November 12, 2015

What is GTM?



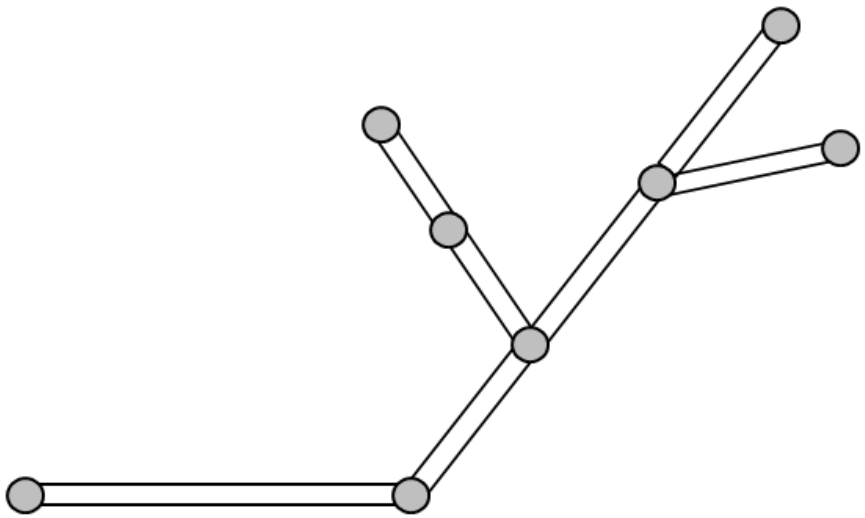
Lagrangian Reference

Eulerian Fixed-frame Reference



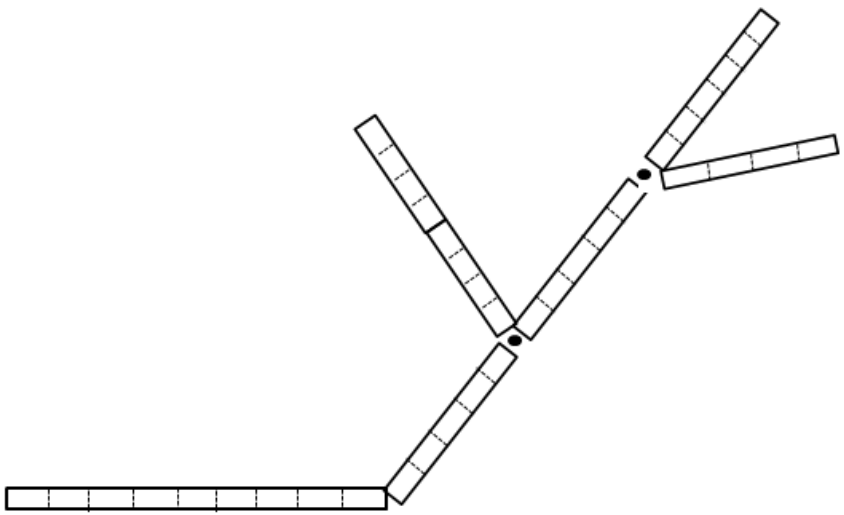
DSM2-GTM Grid

DSM2-Qual Grid



Lagrangian Reference

DSM2-GTM Grid



Eulerian Fixed-frame Reference

Why GTM?

- Generalized Eulerian transport coding is adaptable to other constituents, such as sediment, non-conservative constituents, and mercury.

- Modular design for further implementations, such as running inline with DSM2-Hydro, taking concentrations not limited by node, and more.

Eulerian ADR Transport Module

- The Eulerian Advection-Diffusion-Reaction Transport Module for a single channel network as well as its unit-test has been completed in 2012 by:

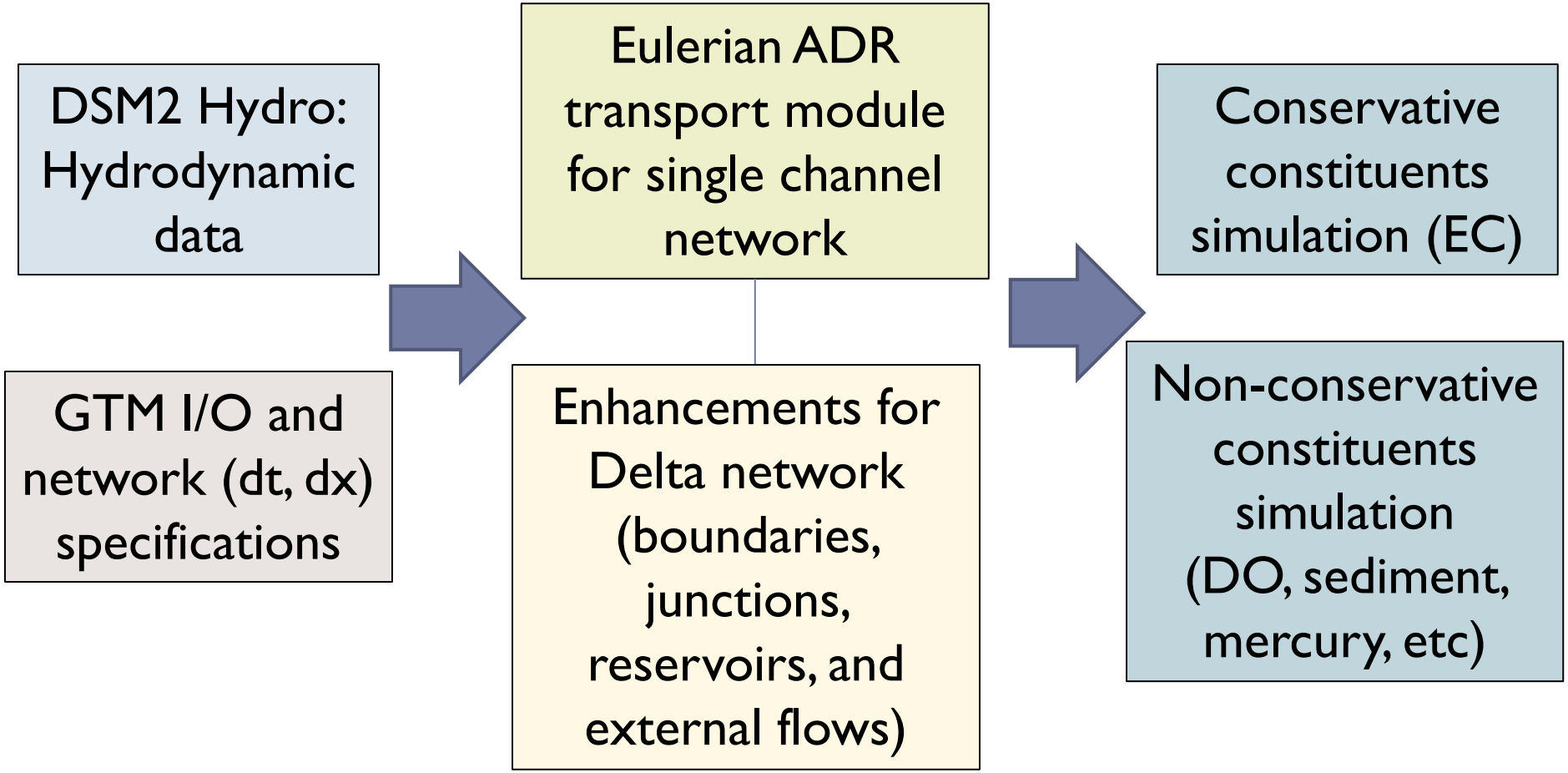
  Eli Ateljevich (DWR)

  Jamie Anderson (DWR)

  Fabian A. Bombardelli (UC Davis)

  Kaveh Zamani (UC Davis)

Linkage to DSM2-Hydro and beyond



1. DSM2-Hydro: Hydrodynamic Data

- Implementations on DSM2-Hydro HDF5 outputs (new Hydro Tidefile)
  - Spatial resolution from node to **computational points**
  - Temporally output **instantaneous values** instead of theta average quantities
  - Delete redundant information (keep **water surface** and remove area)
  - Output reusable information (**virtual cross section**)

2. GTM Development – I/O system design

- Modular design for all components
- Used similar input system as DSM2-Hydro and DSM2-Qual
- Read time series input from HEC-DSS and HDF5
- Parsed network information

  (boundaries, channels, junctions, reservoirs, etc.)
- Assigned time varying data to network

  (Boundary flows, DICU flows and node concentrations)

3. GTM Development – Delta Network

- Generate GTM grid by given dx
- Find boundaries, junctions, and gates
- Add reservoirs and external flows to the network
- Add sub time stepping if needed

4. GTM Transport Scheme – ADR

- The general transport equation with operator splitting:

$$\frac{\partial(AC)}{\partial t} = \frac{\partial}{\partial x}\left(AK\frac{\partial C}{\partial x}\right) \boxed{- \frac{\partial(QC)}{\partial x} + S}$$

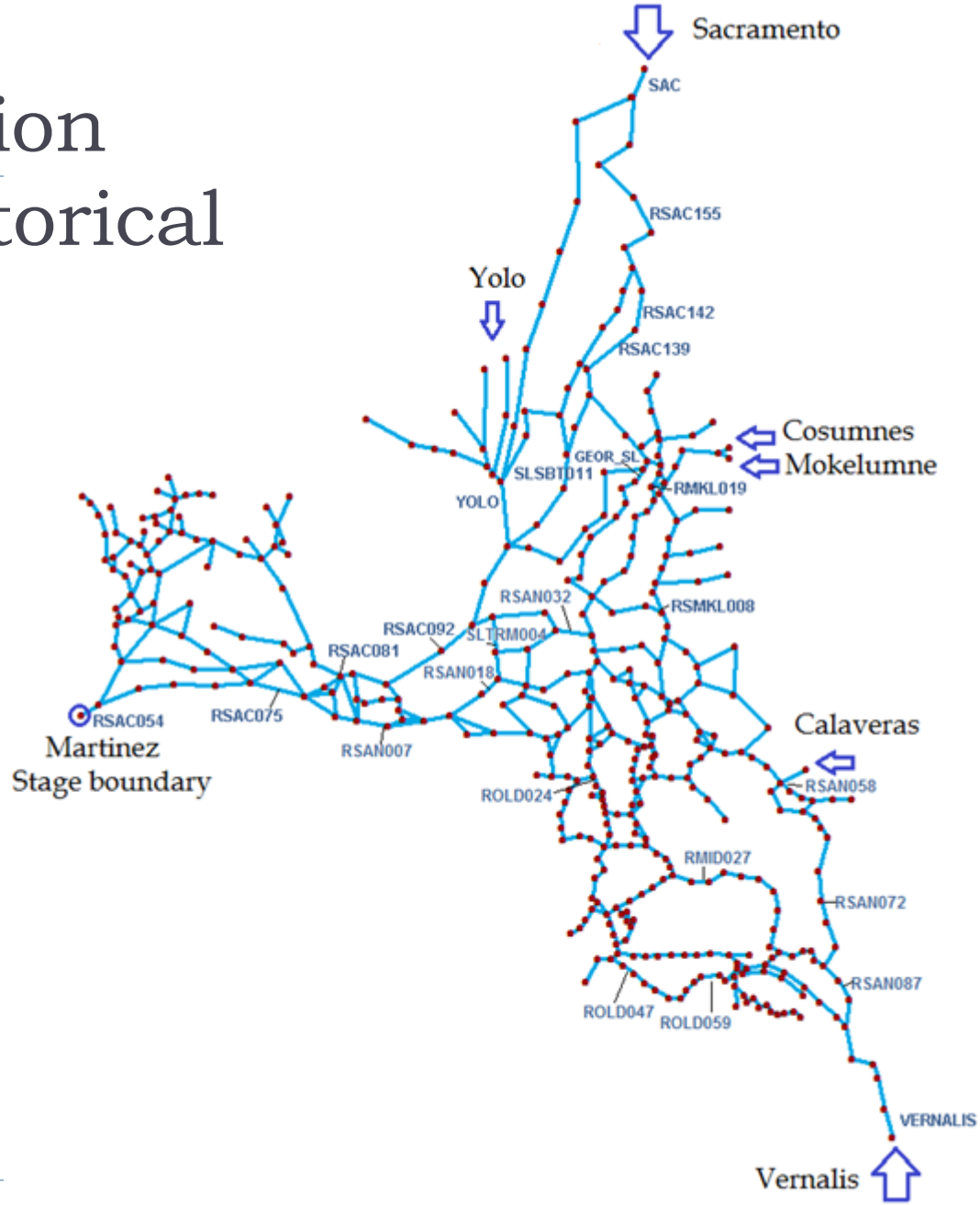
$$Advection\ \&\ Reaction$$

$$\frac{\partial(AC)}{\partial t} = \boxed{\frac{\partial}{\partial x}\left(AK\frac{\partial C}{\partial x}\right)} + f$$

$$Diffusion$$

5. EC Simulation with Delta historical setup

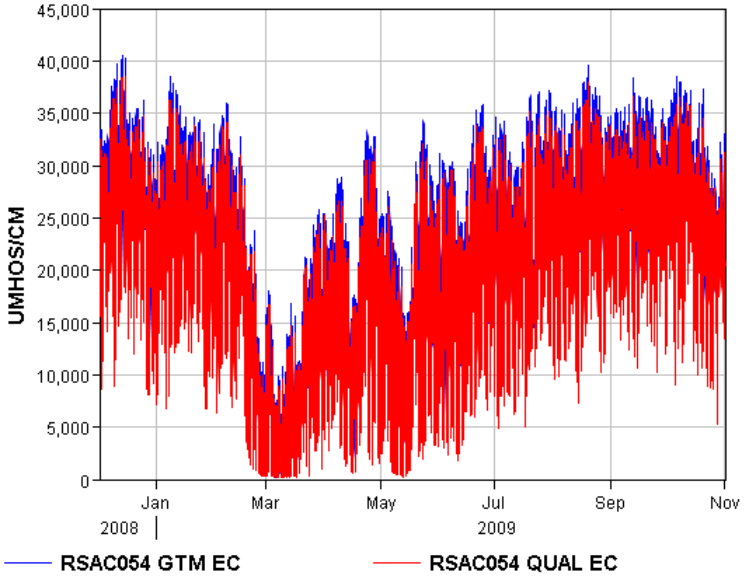
- With all the boundary flows, DICU flows, reservoir flows, and gates
- Running period from Oct 2008 to Oct 2009 as an example

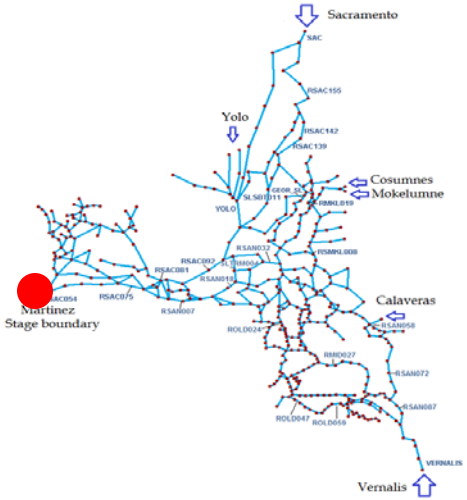


Results from Pure Advection

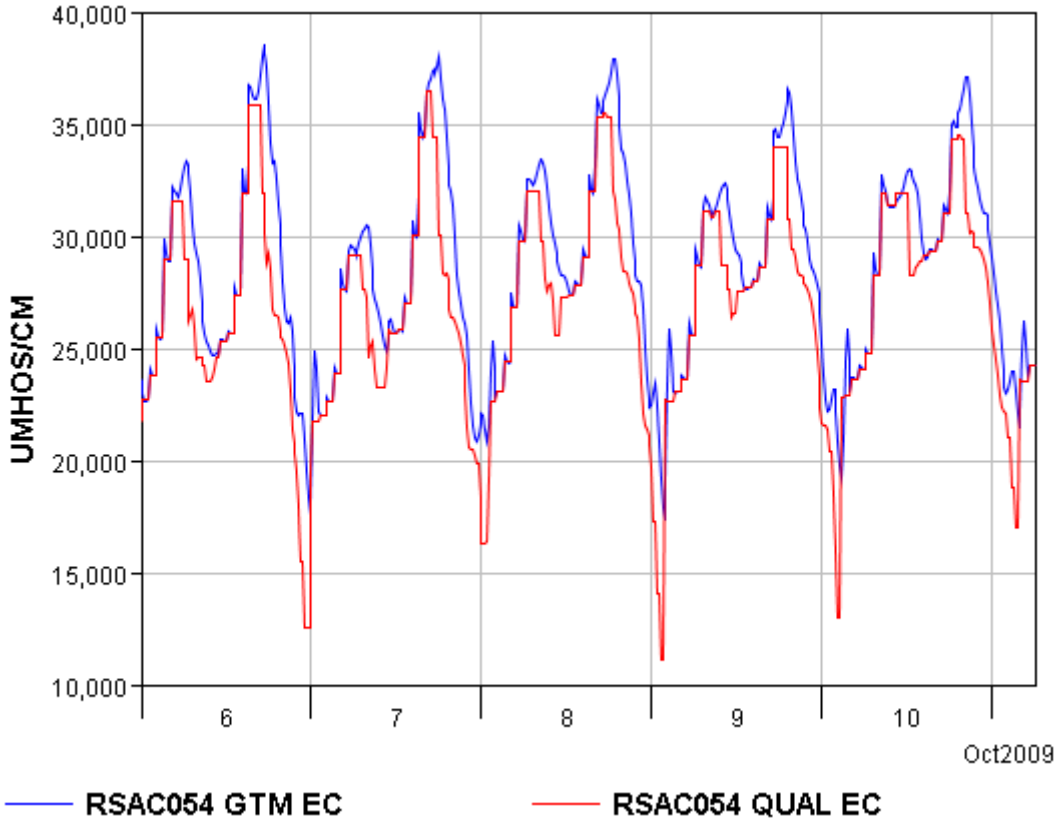
(K=0 for all channels)

Comparison with advection only





- RSAC054 (Martinez)



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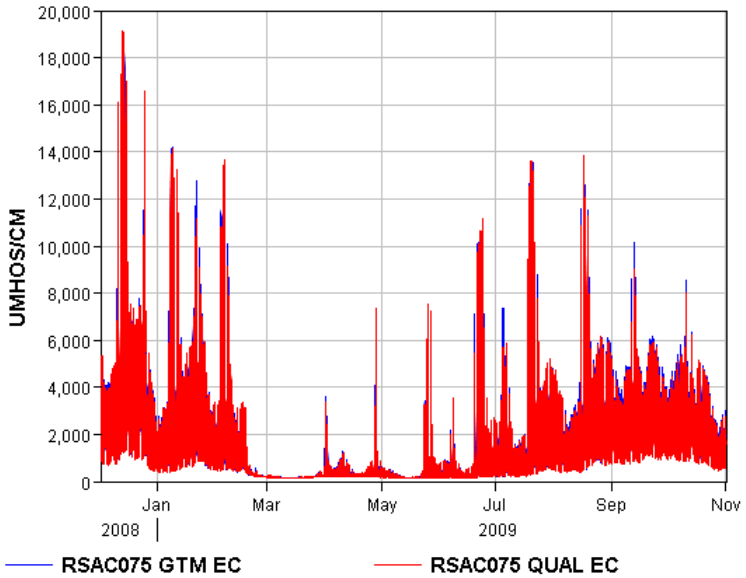
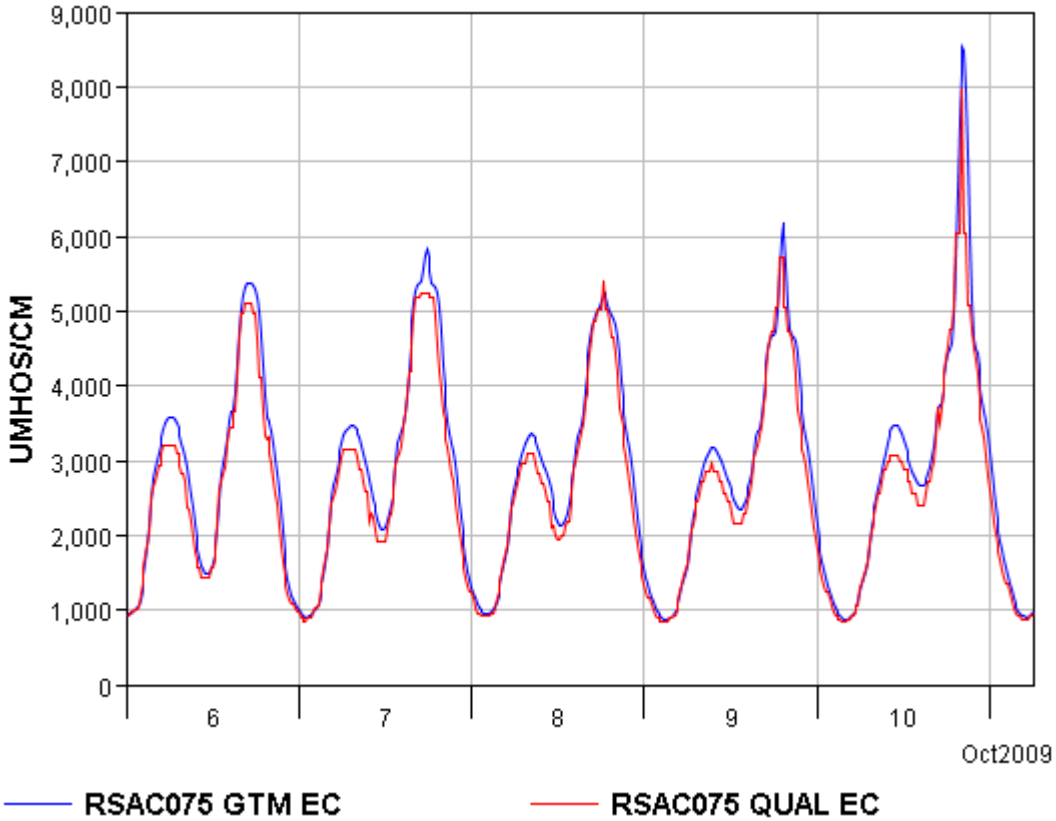


- RSAC075 (Mallard)



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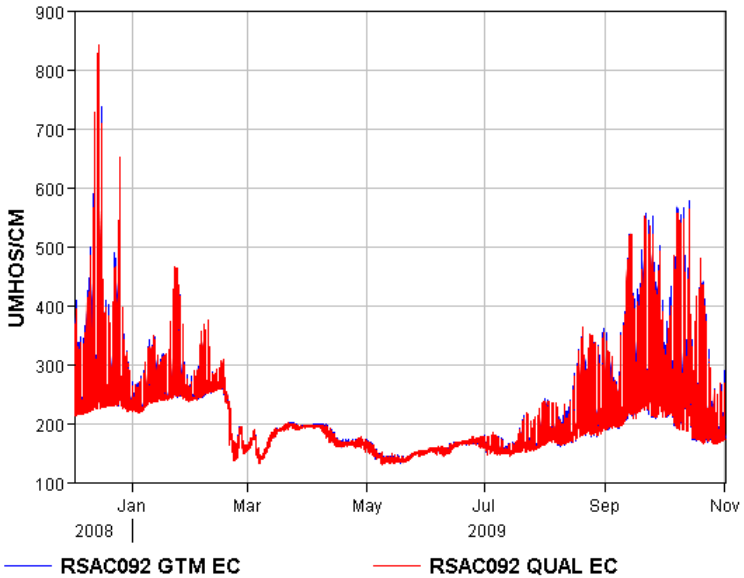
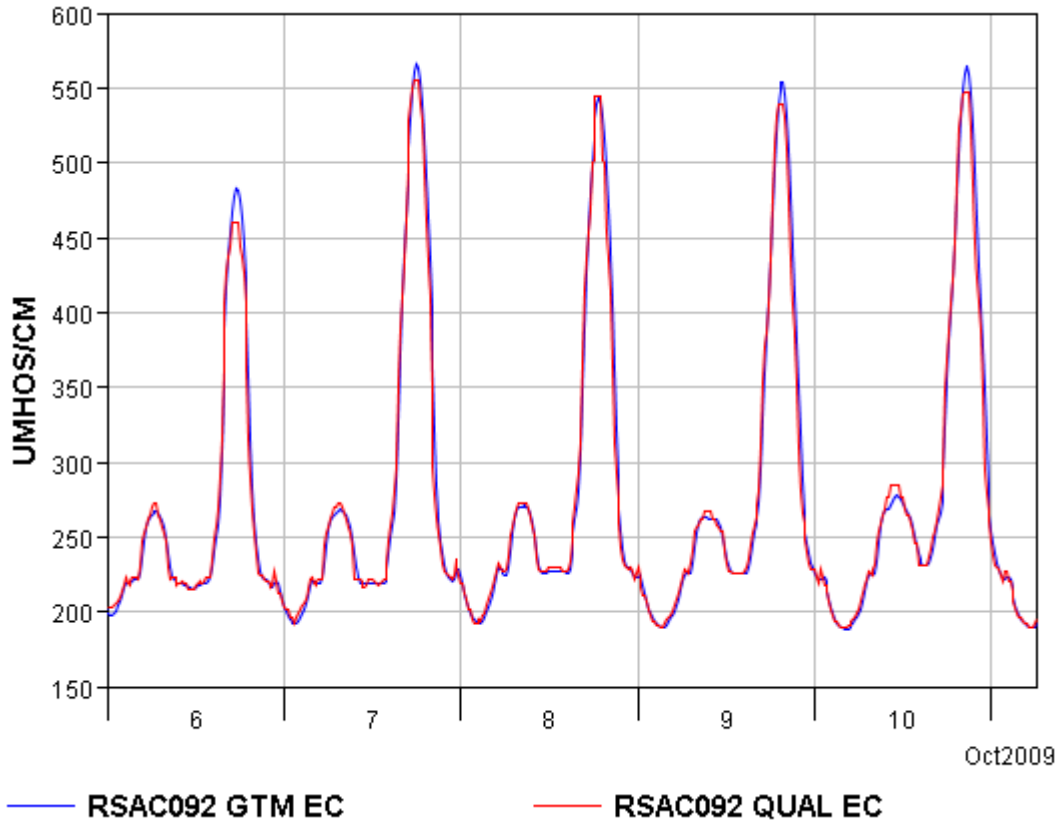
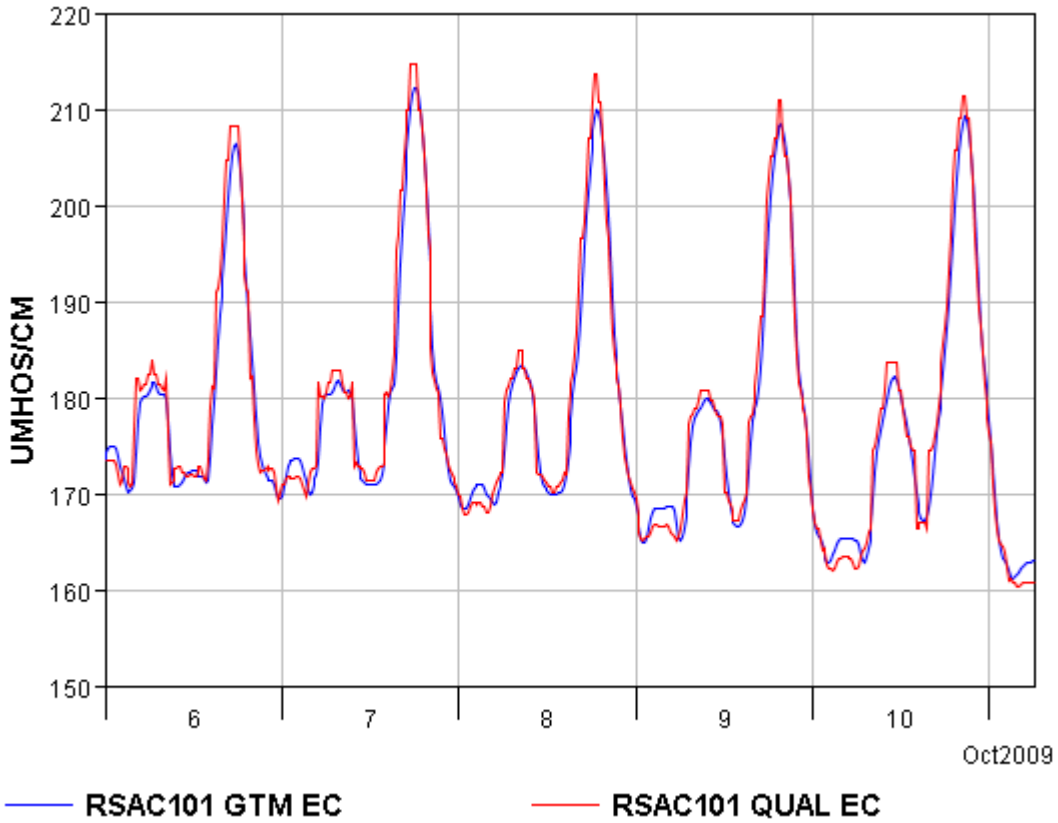


- RSAC092 (Emmaton)



Comparison with advection only

- RSAC101 (Rio Vista)



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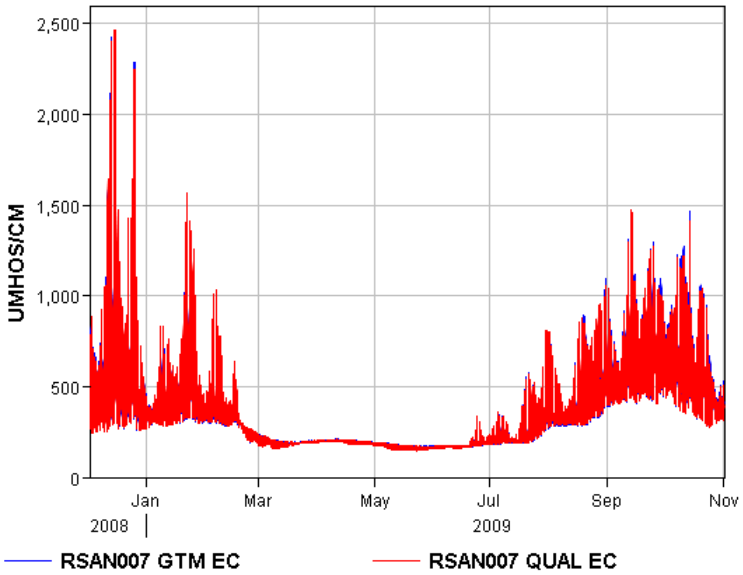
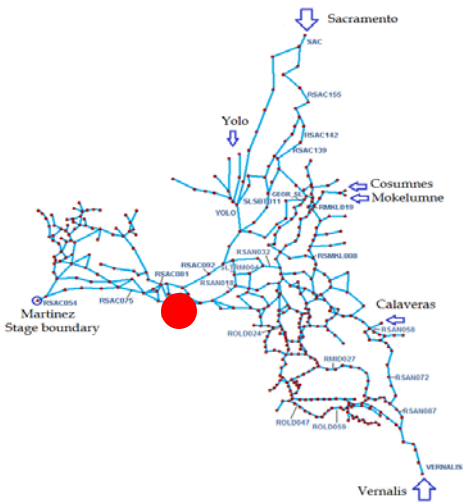
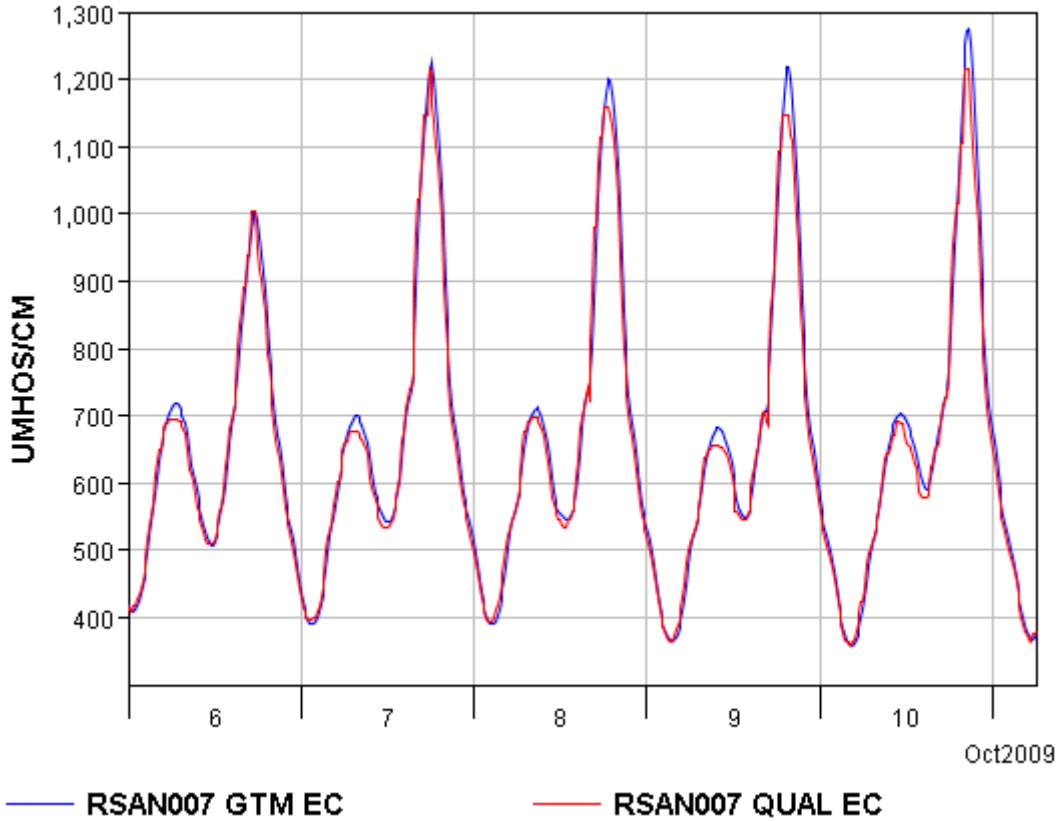




- RSAN007 (Antioch)



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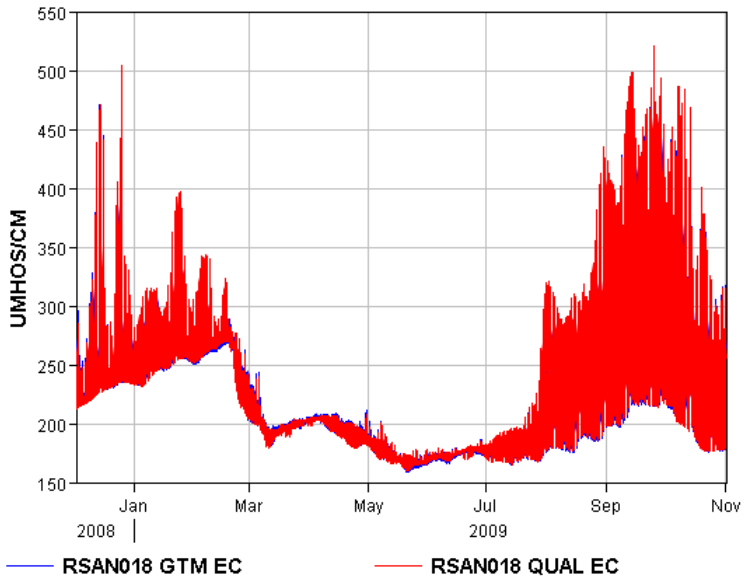
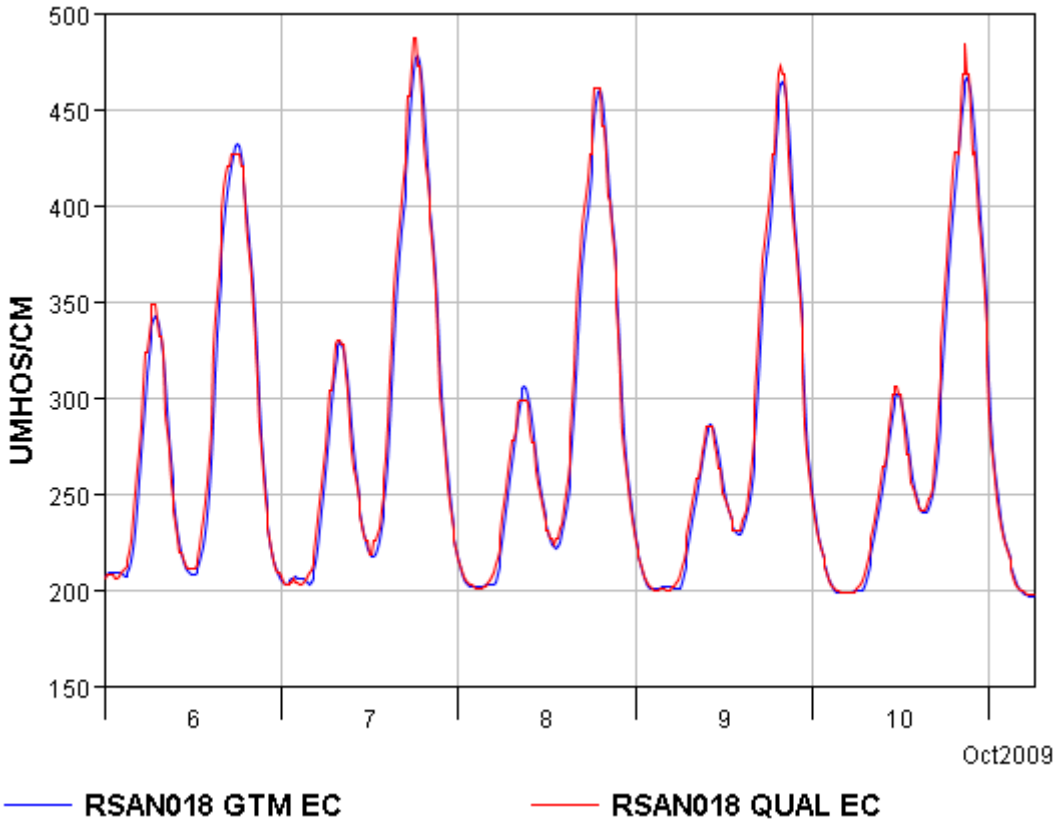


- RSAN018 (Jersey Point)



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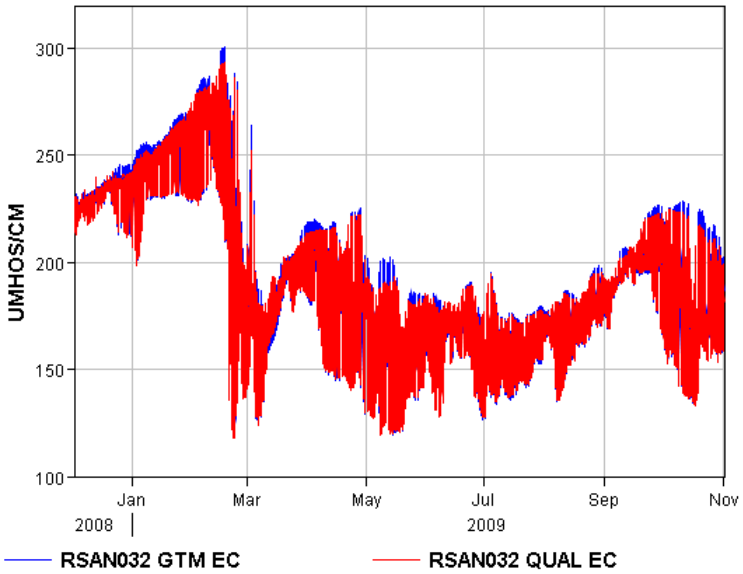
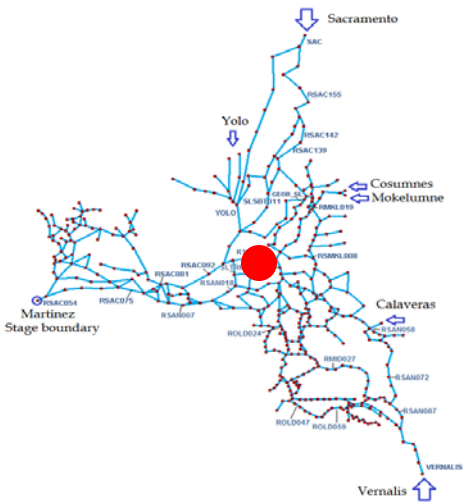
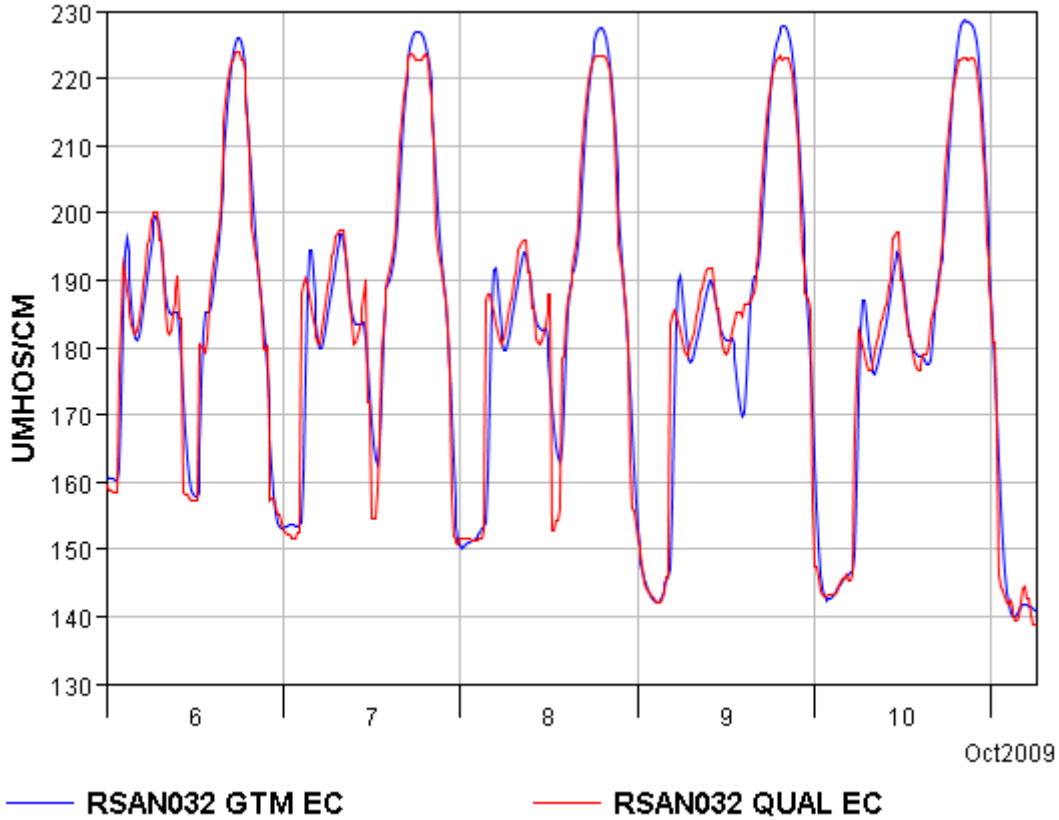




- RSAN032 (Andreas)



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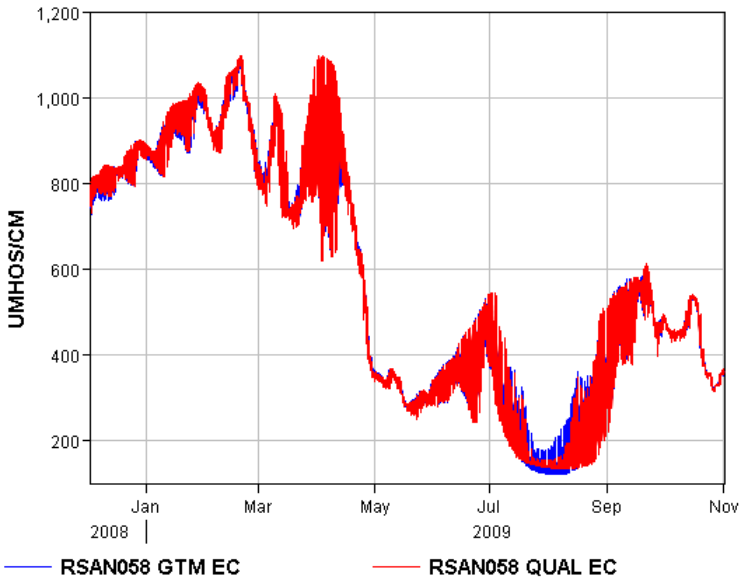
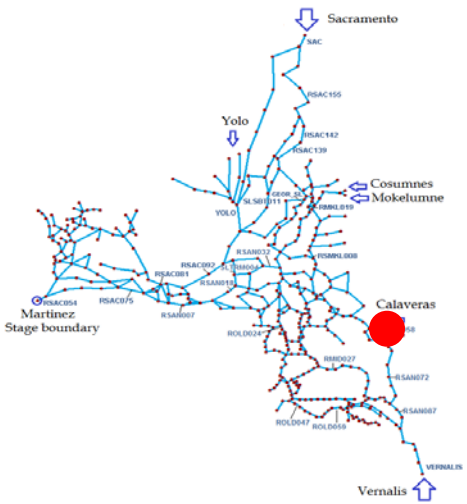
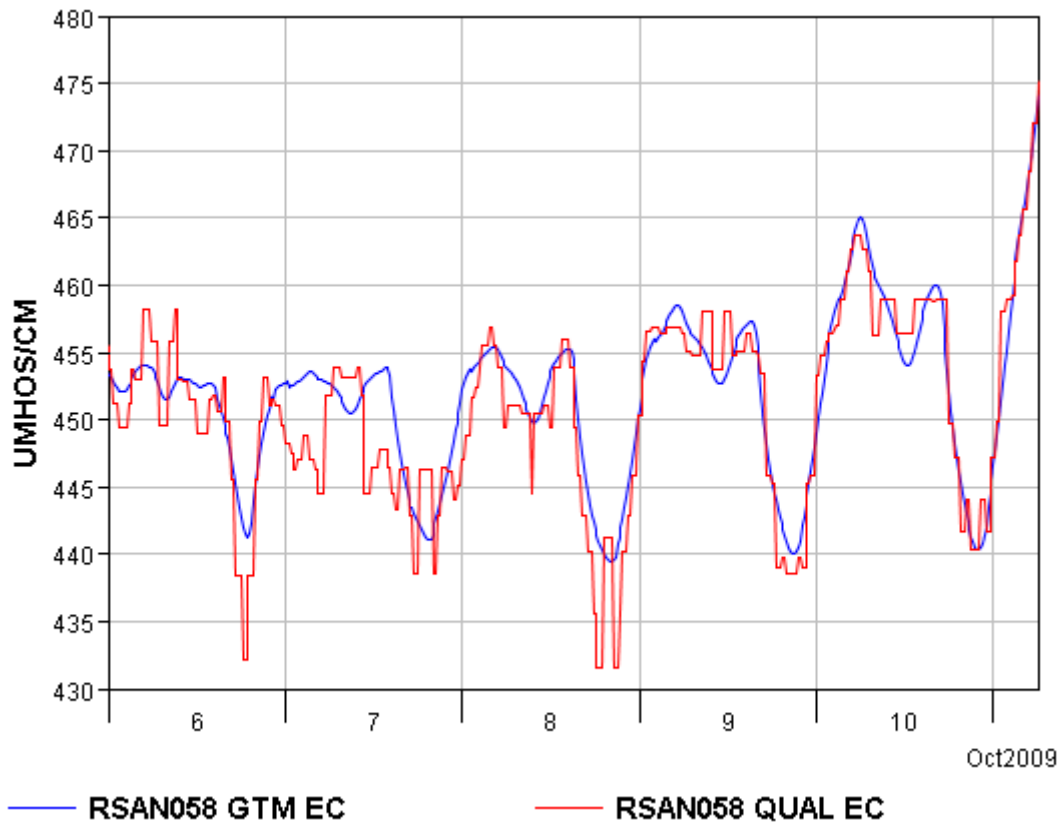


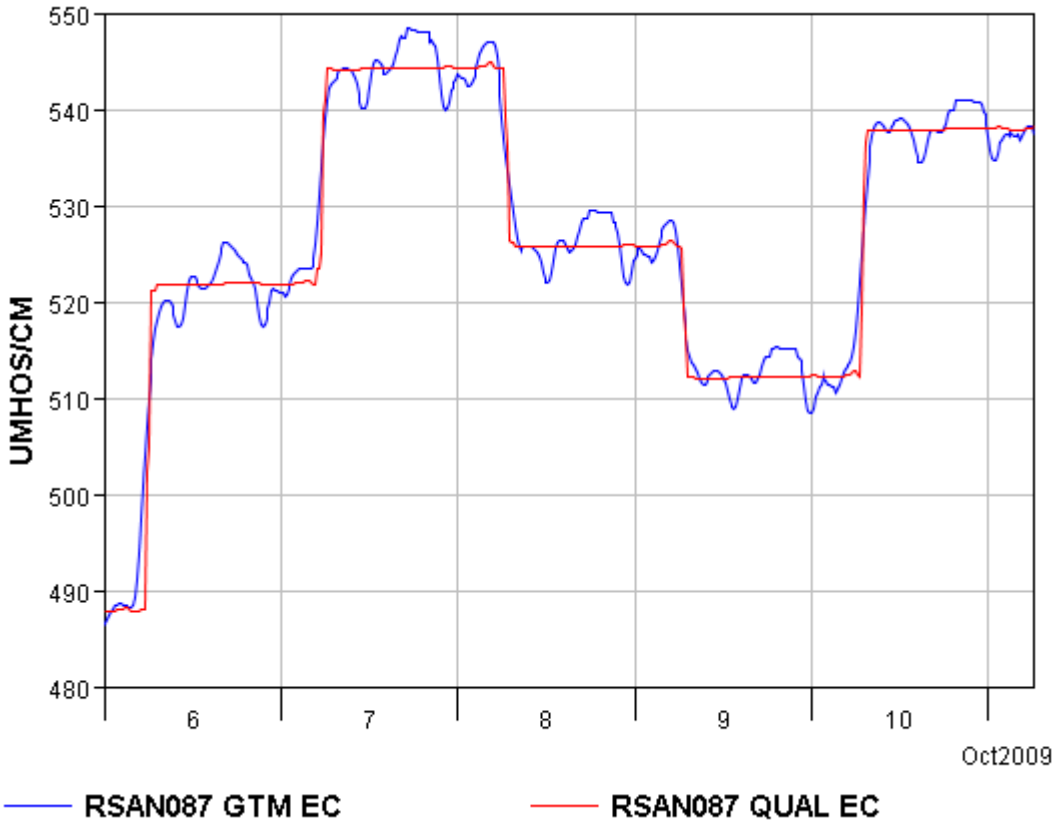


- RSAN058 (SJR @ Stockton Ship Channel)



Comparison with advection only

- RSAN087 (SJR @ Mossdale)



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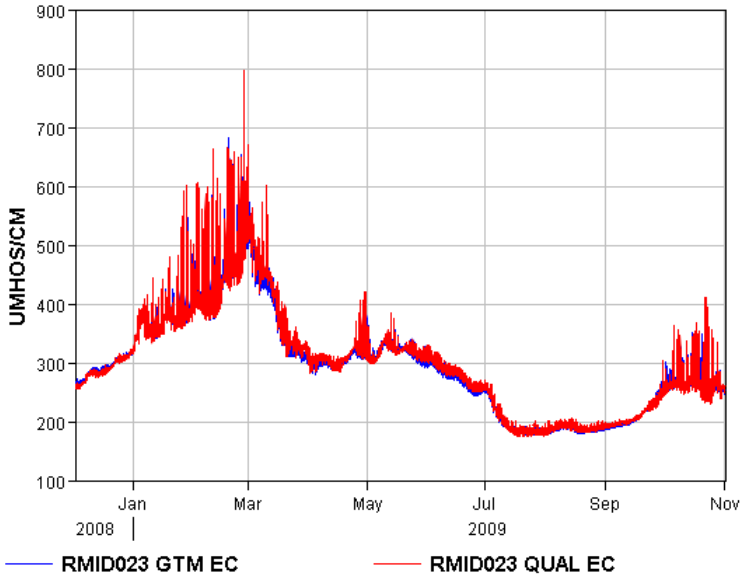
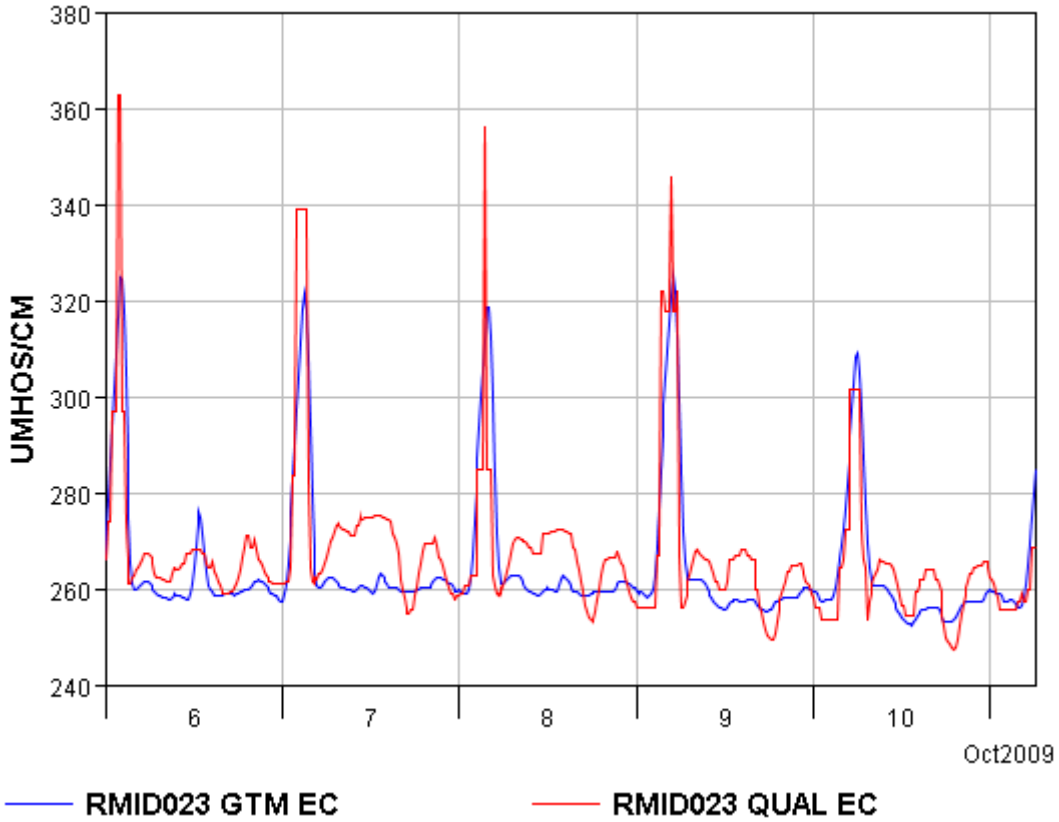


- RMID023 (Middle River at Borden Hwy)



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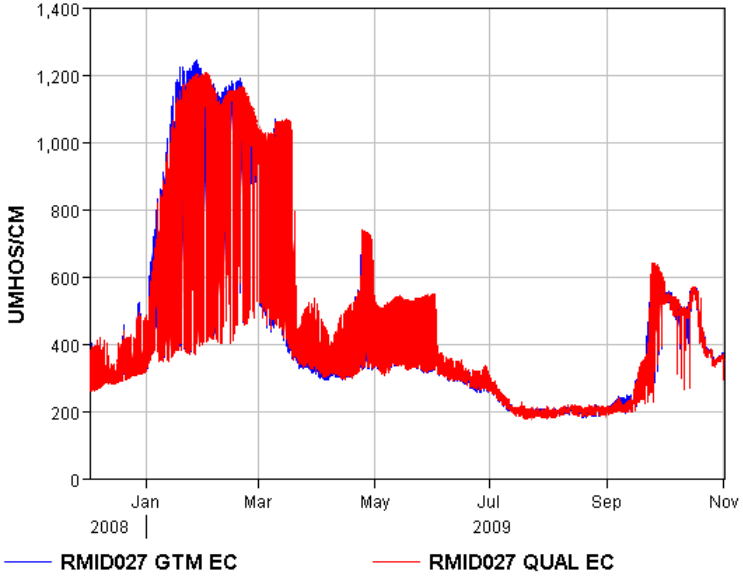
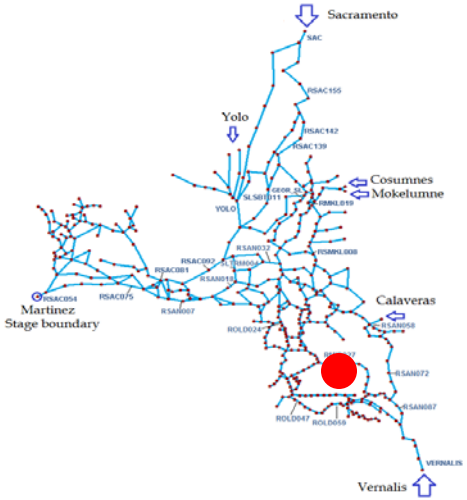
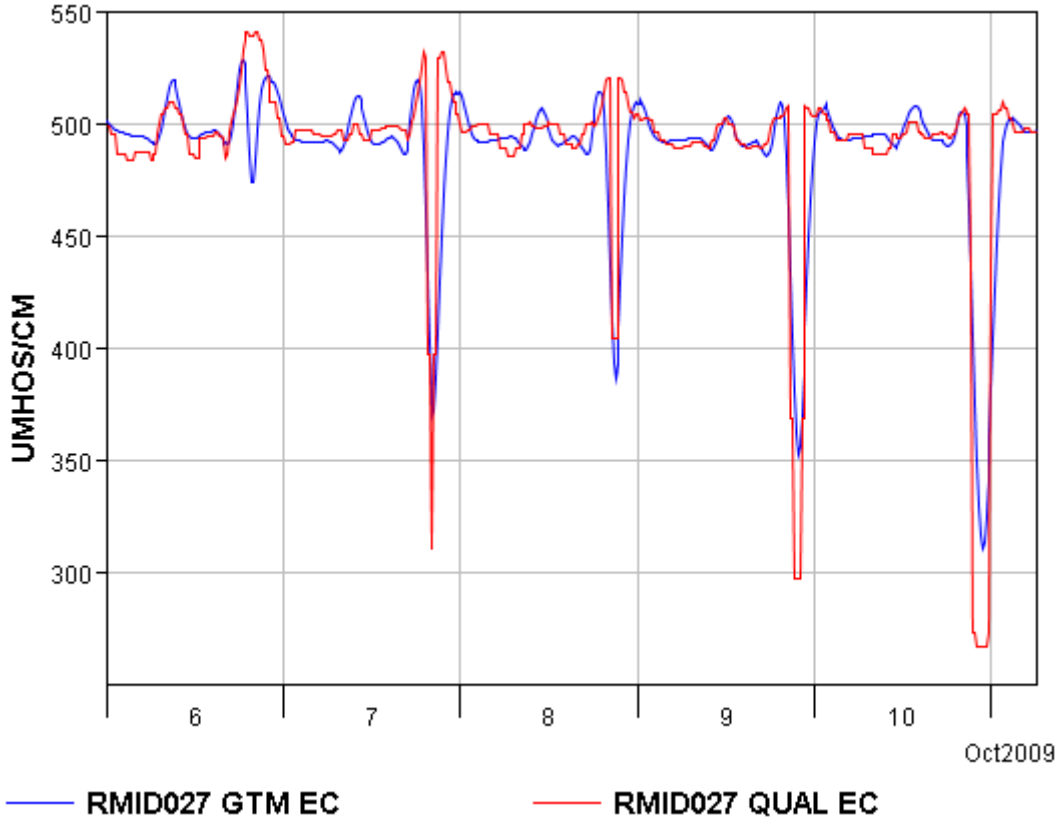




- RMID027 (Middle River at Tracy)



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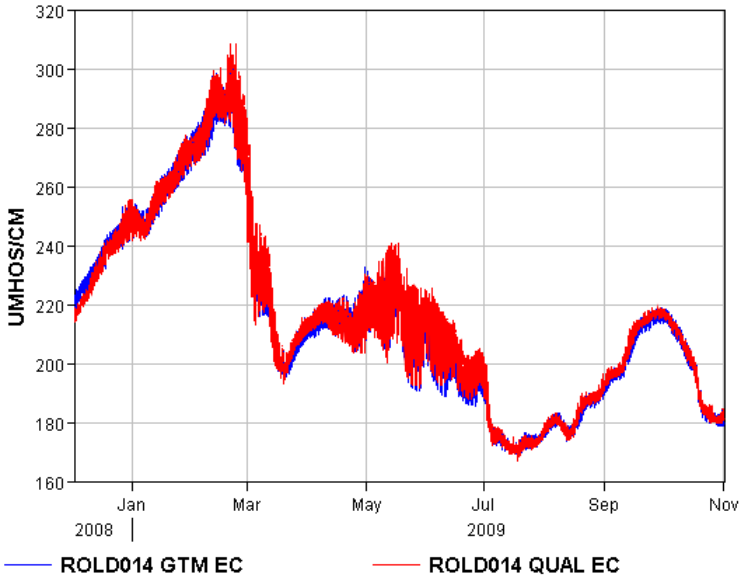
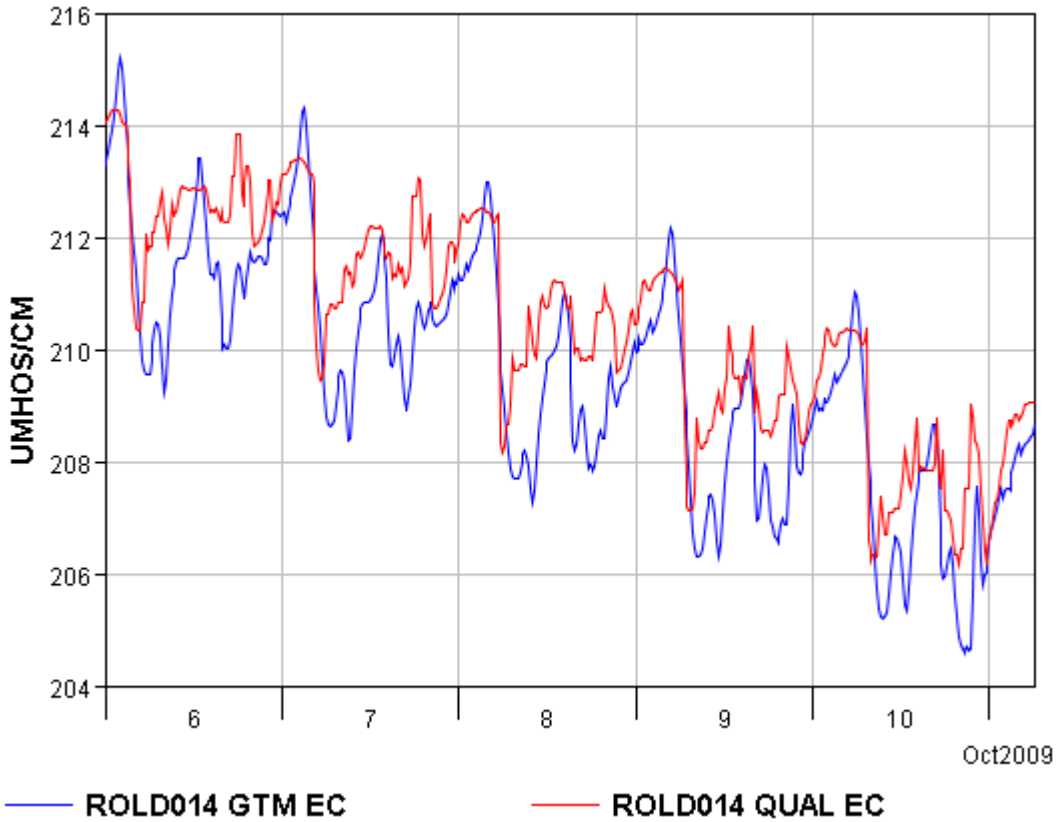


- ROLD014 (Old River at Holland Cut)



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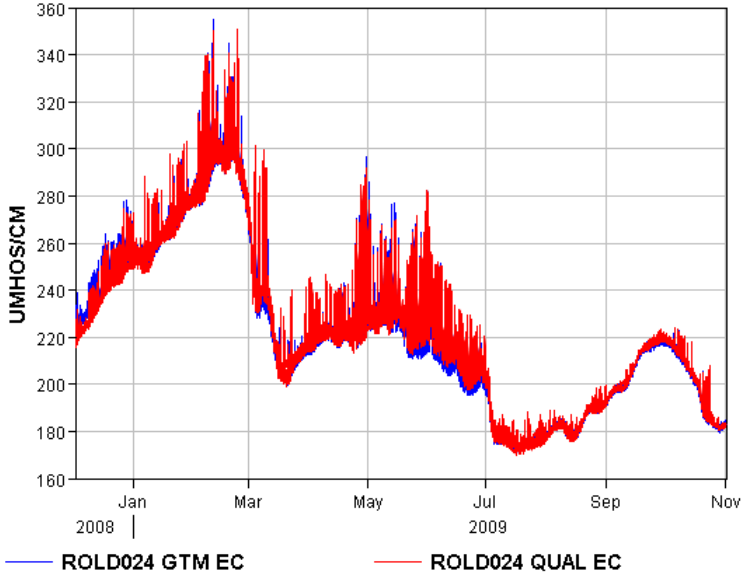
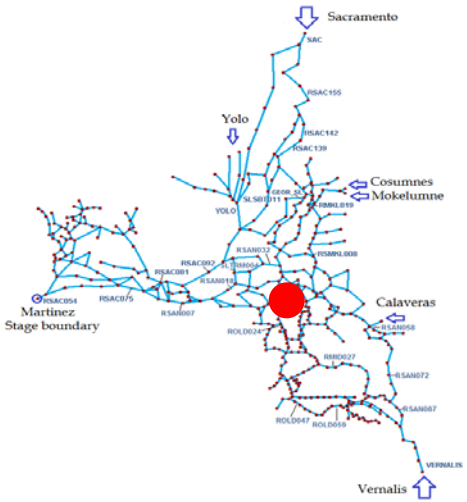
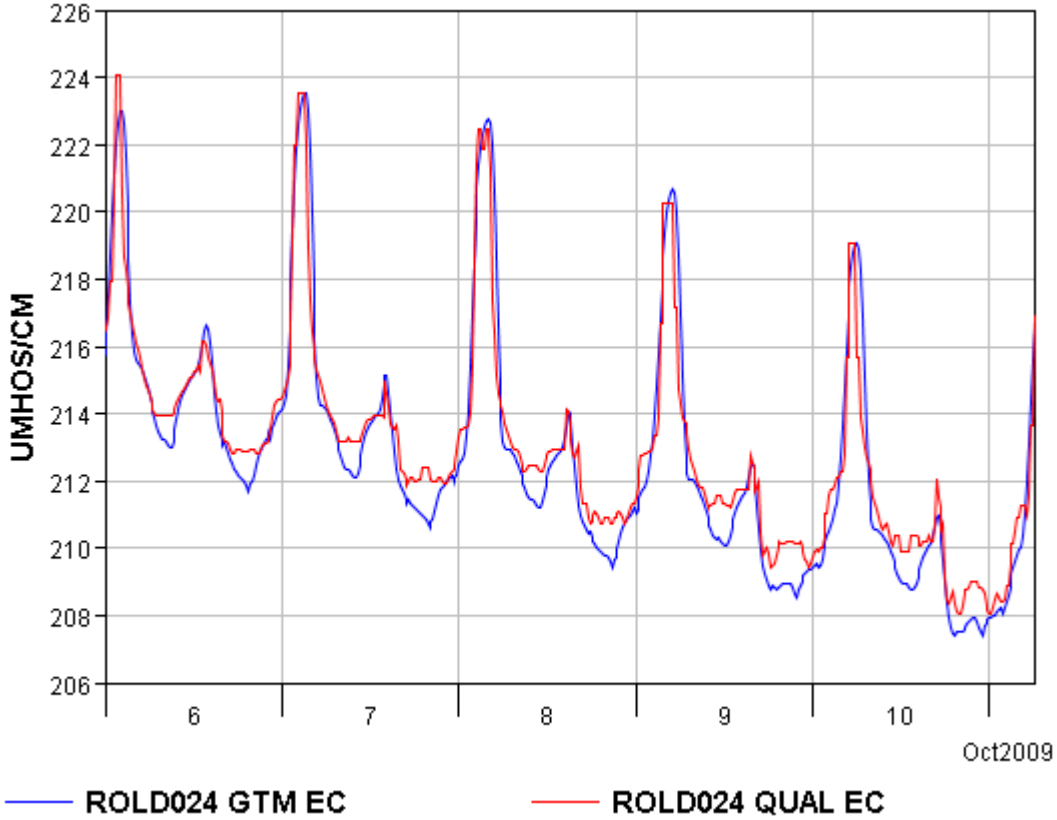




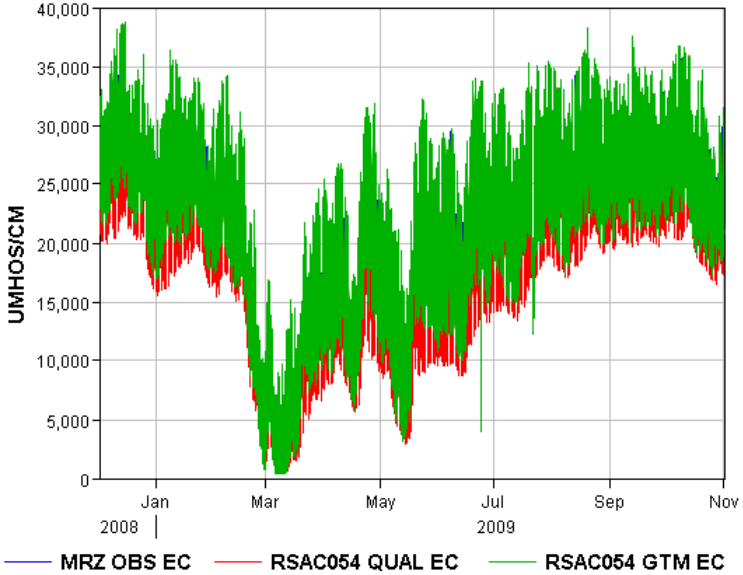
- ROLD024 (Old River at Bacon Island)

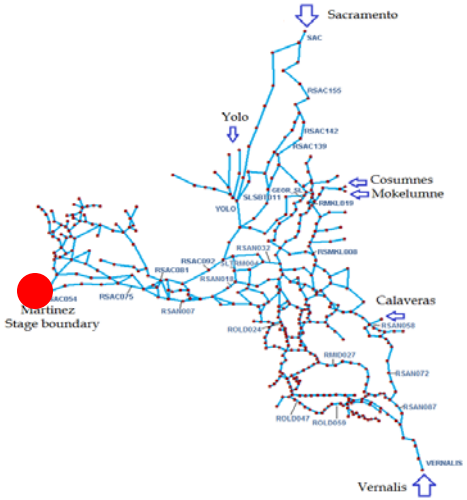


Results with Advection+Diffusion

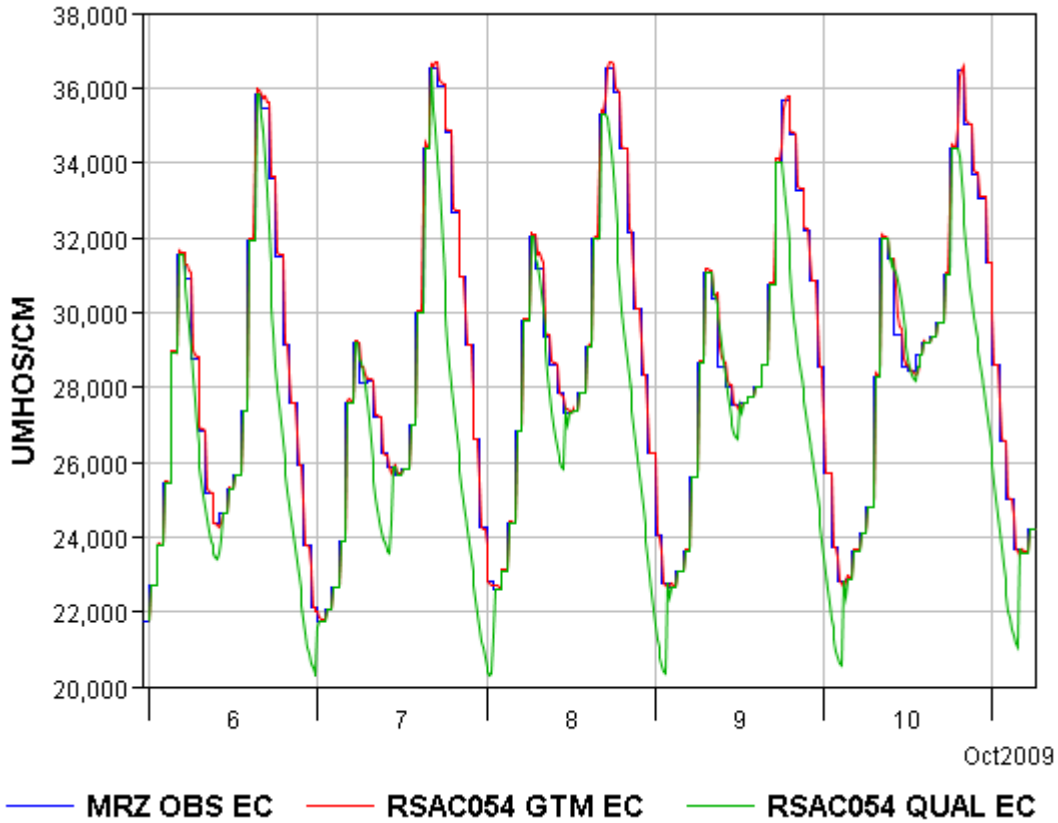
(Use current K from DSM2-Qual)

Comparison when advection+diffusion





- RSAC054 (Martinez)



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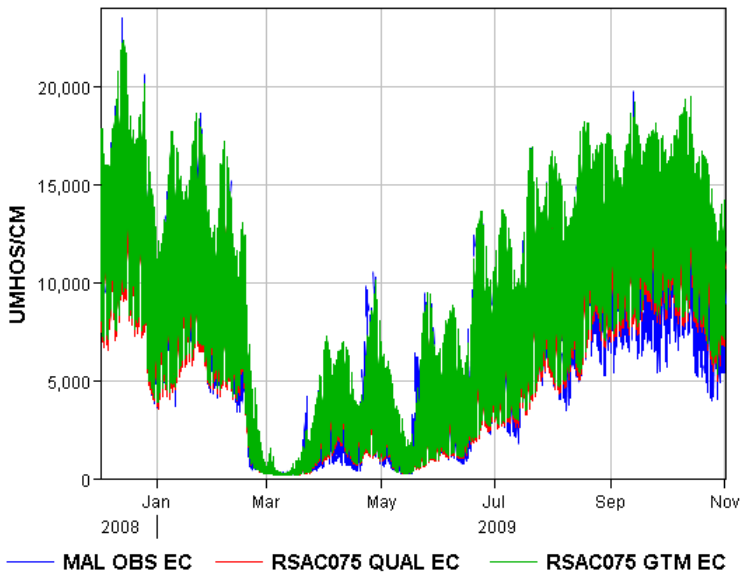
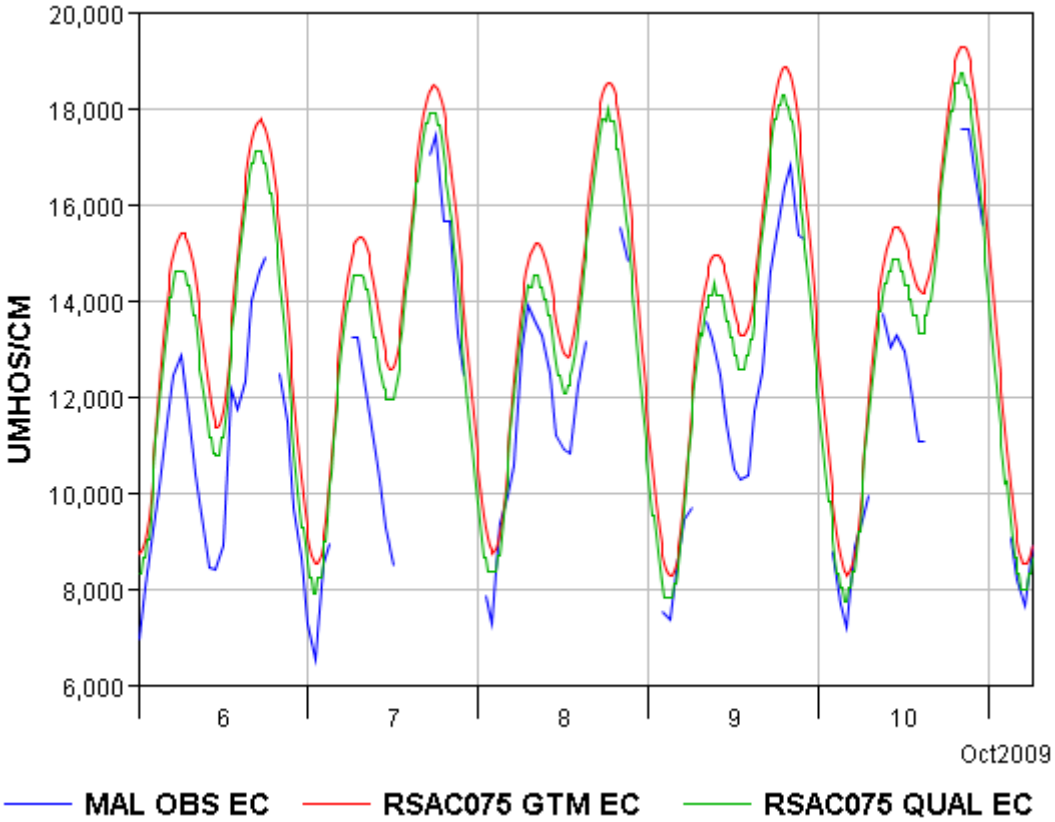


- RSAC075 (Mallard)



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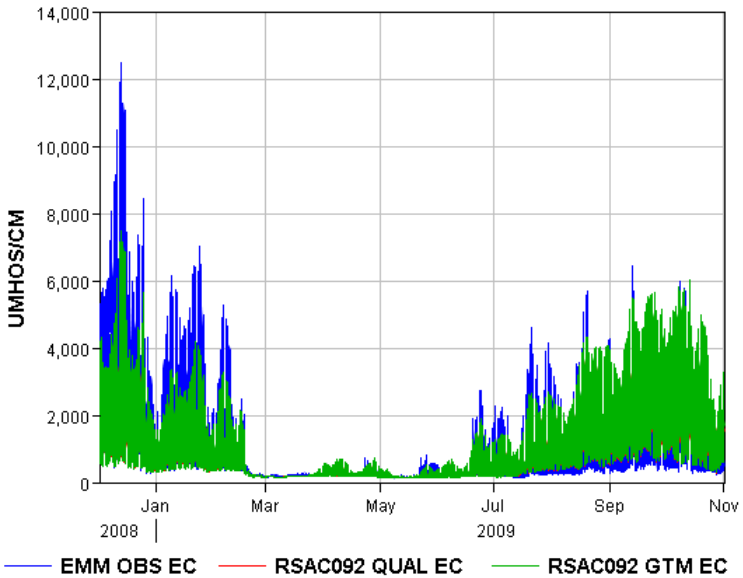
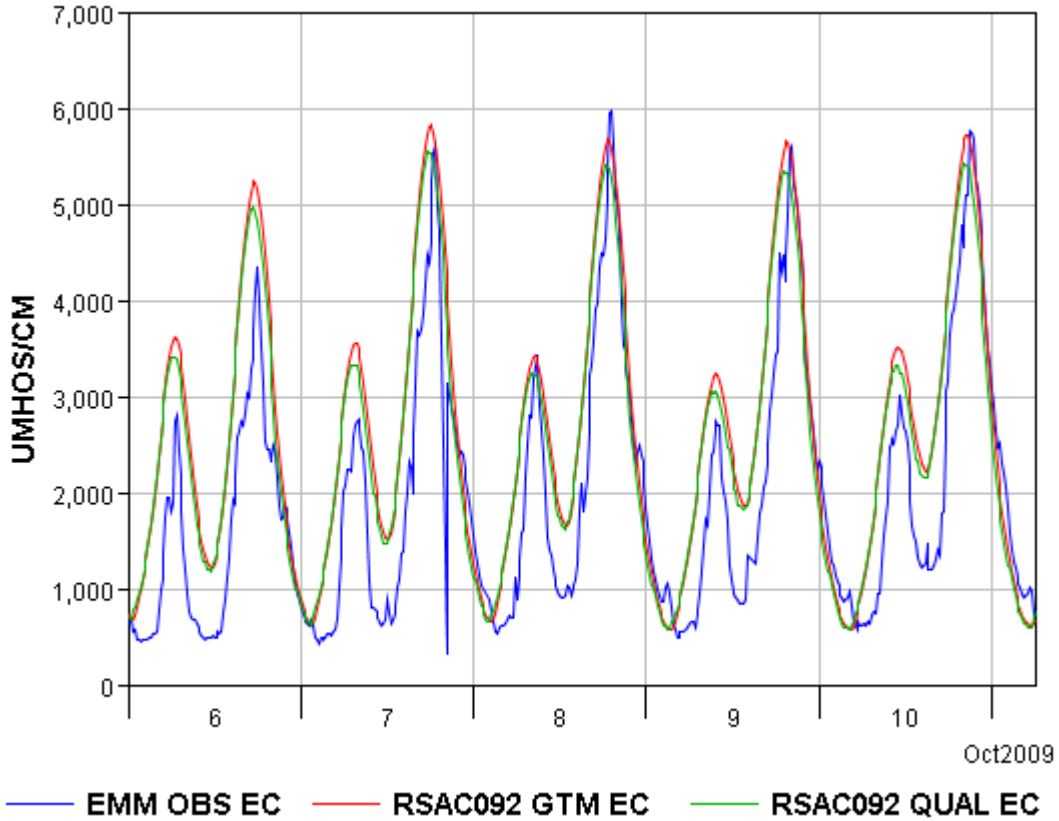


- RSAC092 (Emmaton)



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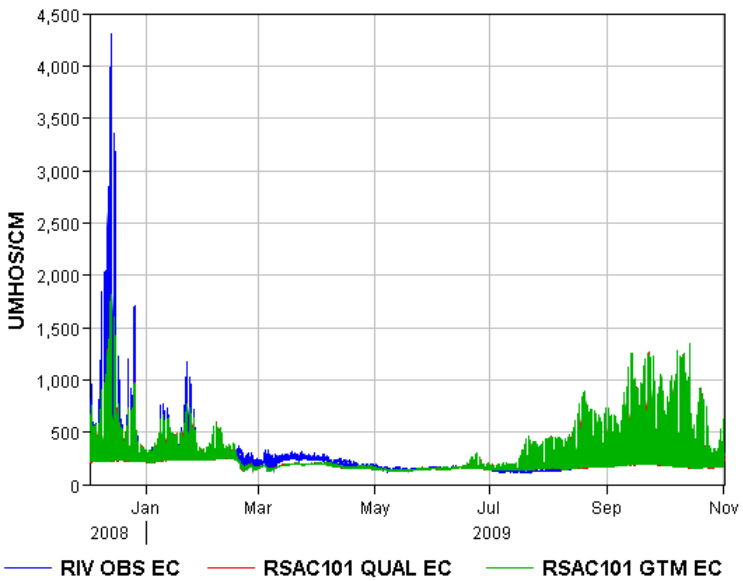
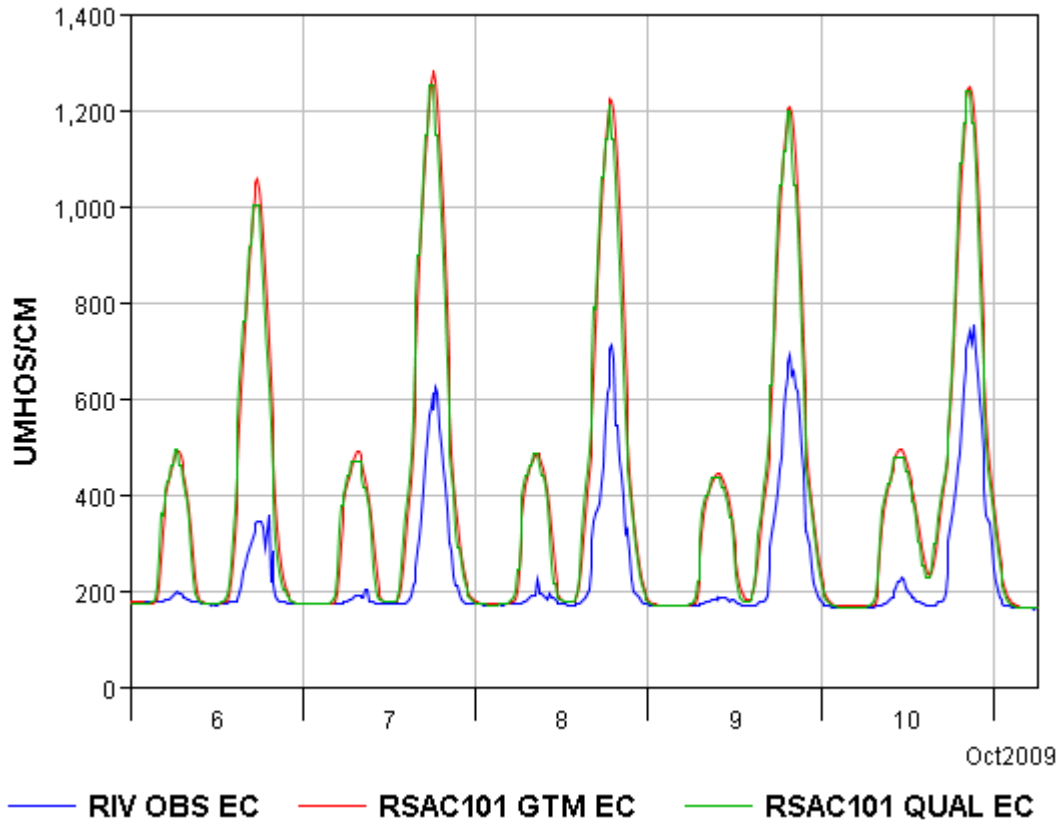


- RSAC101 (Rio Vista)



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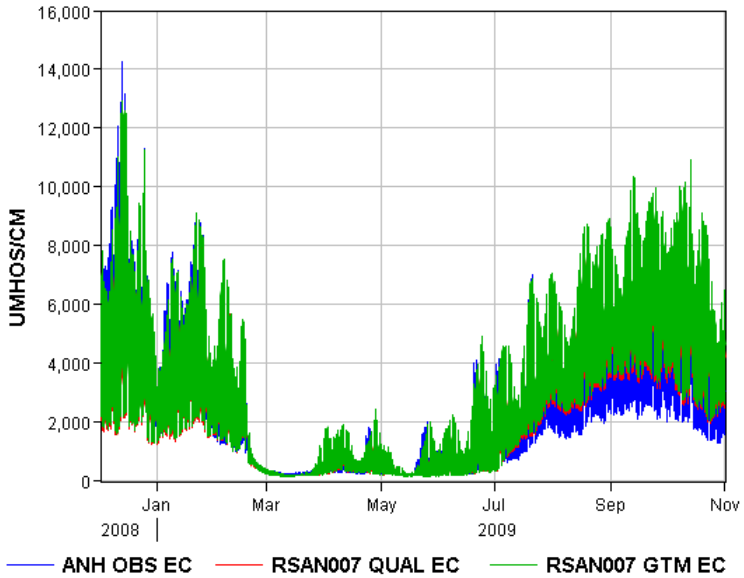
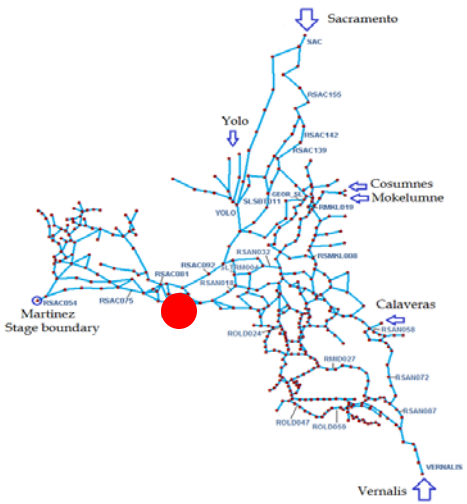
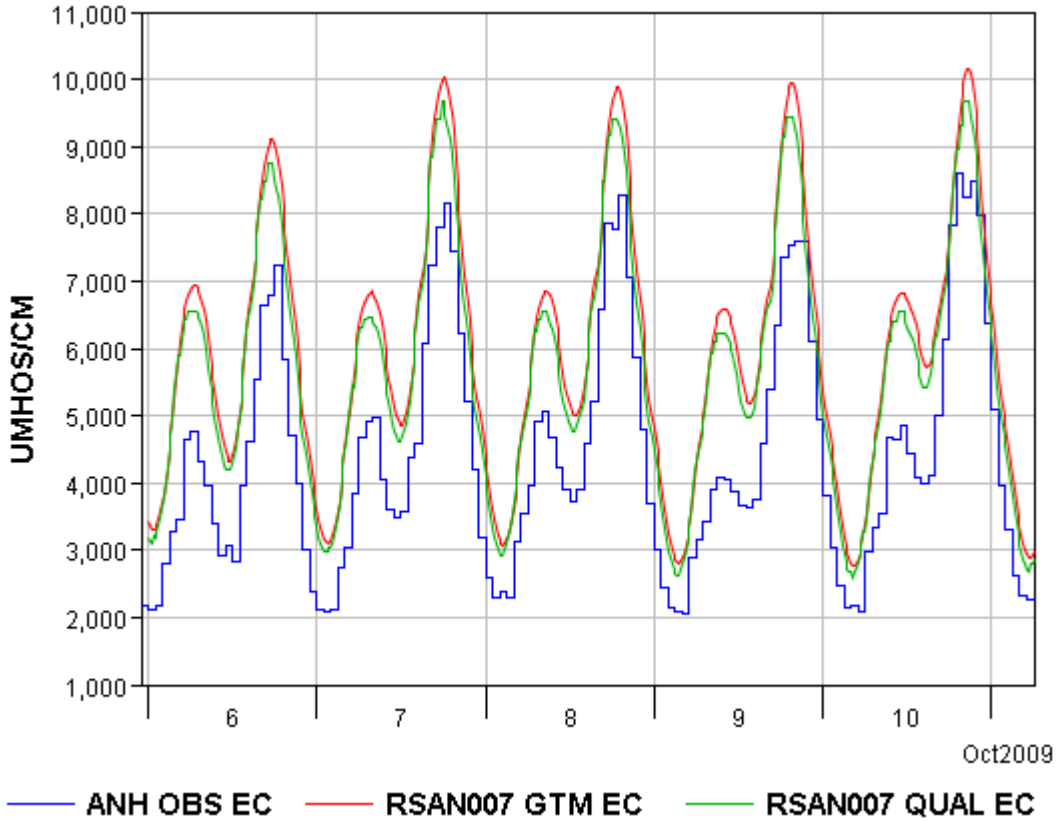




- RSAN007 (Antioch)



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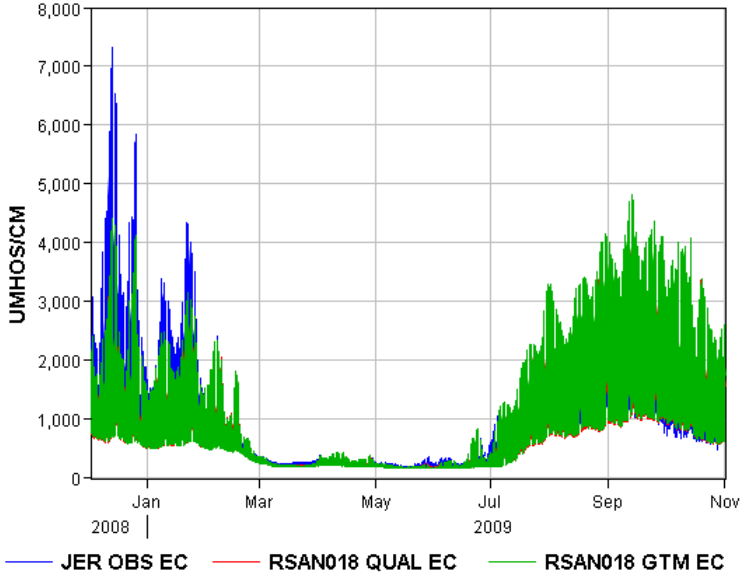
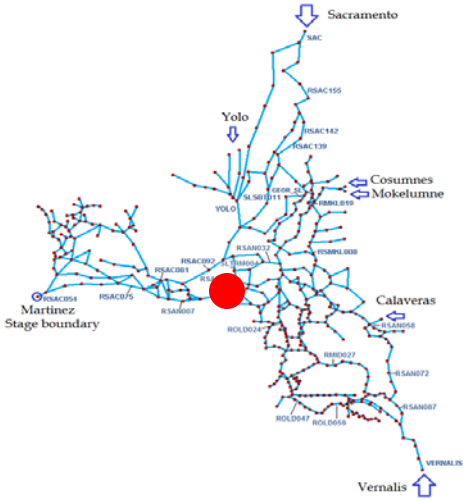
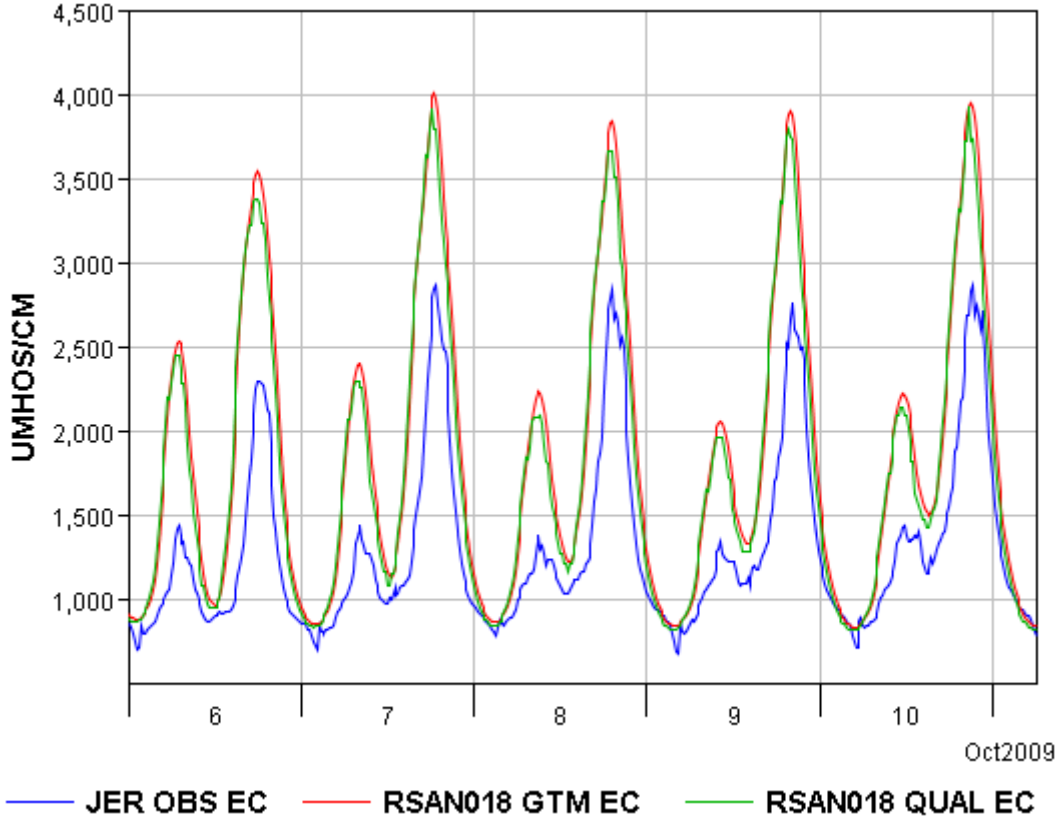




- RSAN018 (Jersey Point)



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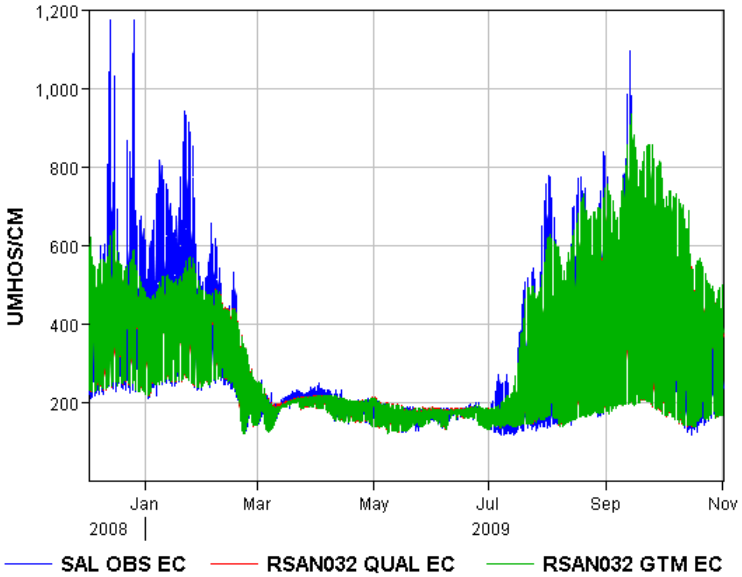
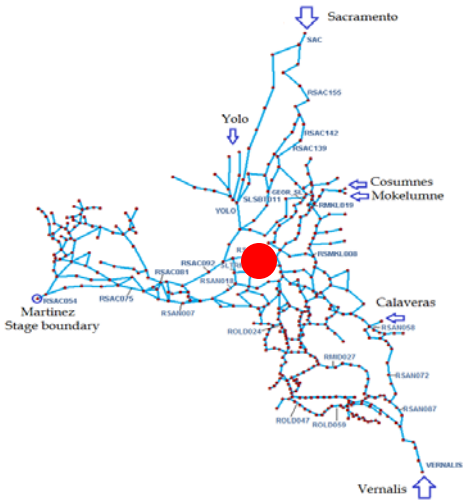
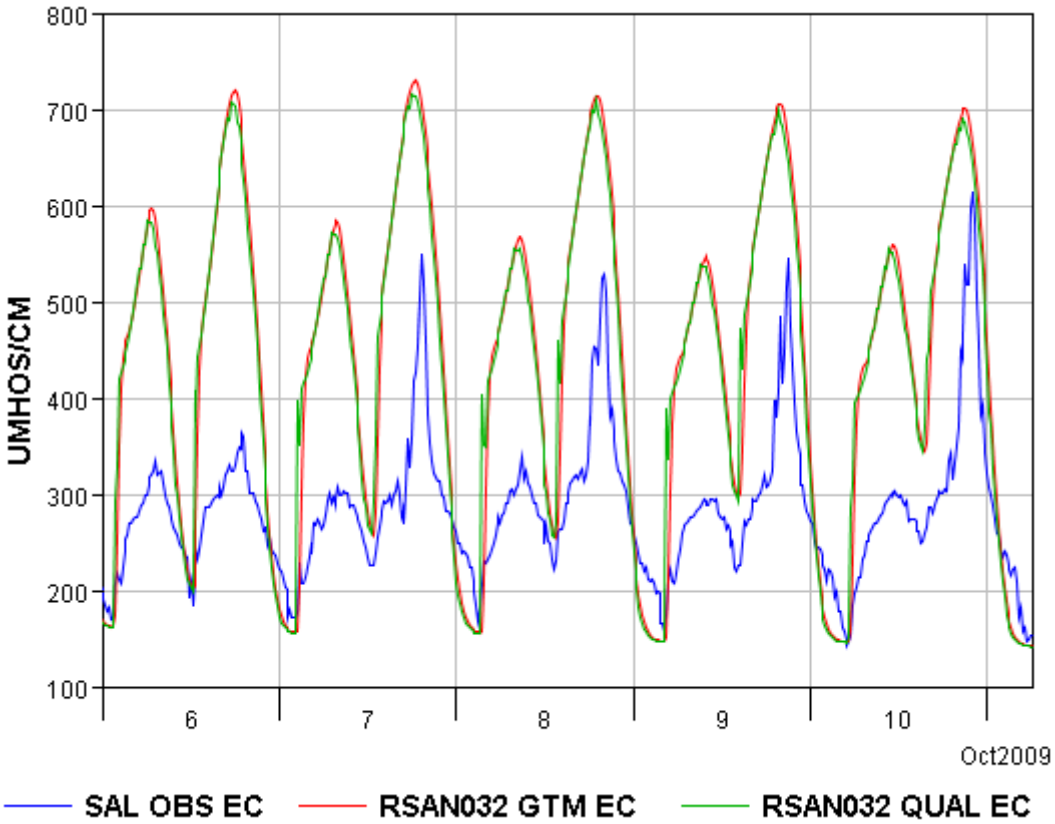
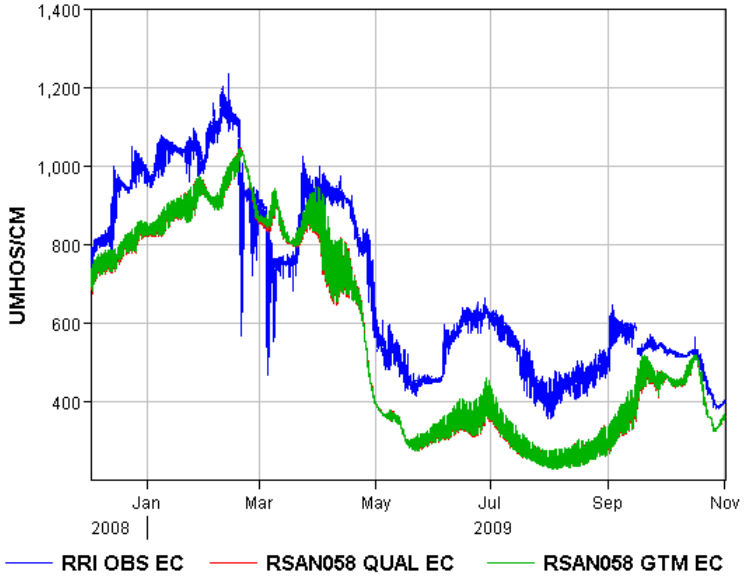


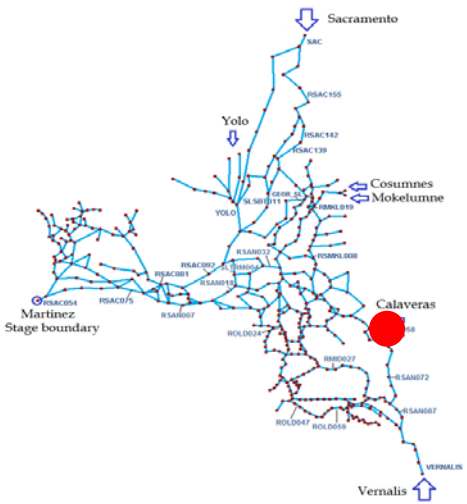


- RSAN032 (Andreas)

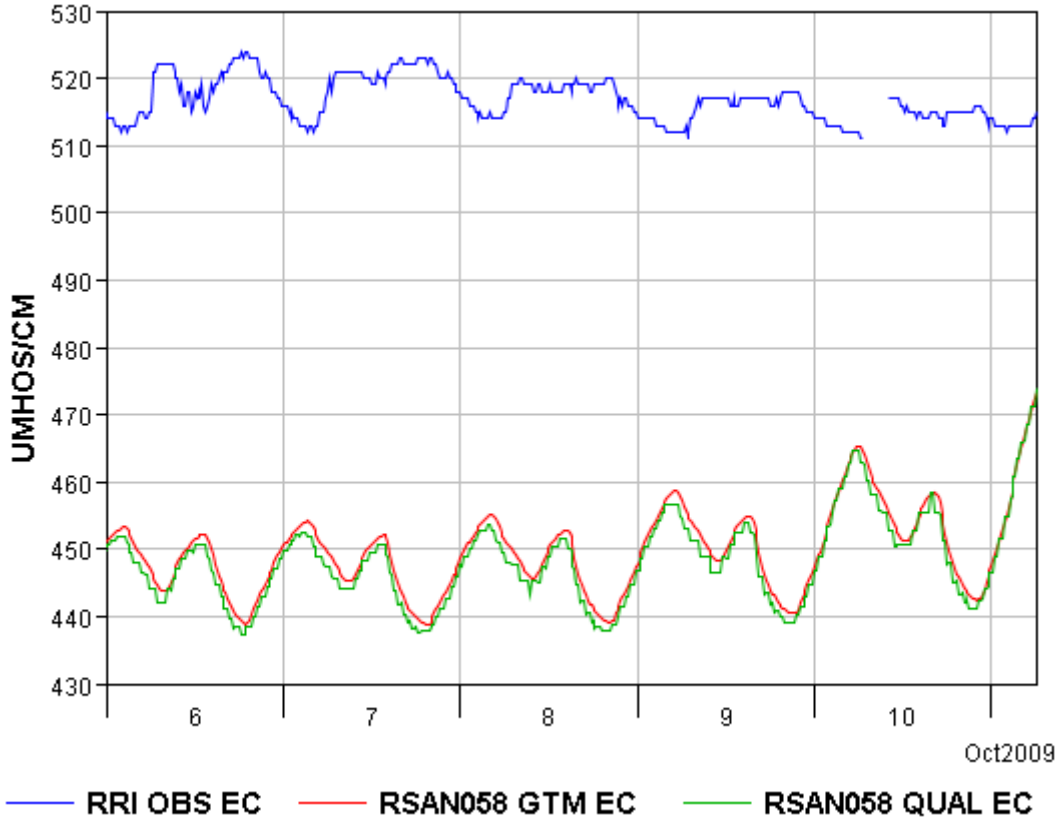


Comparison when advection+diffusion

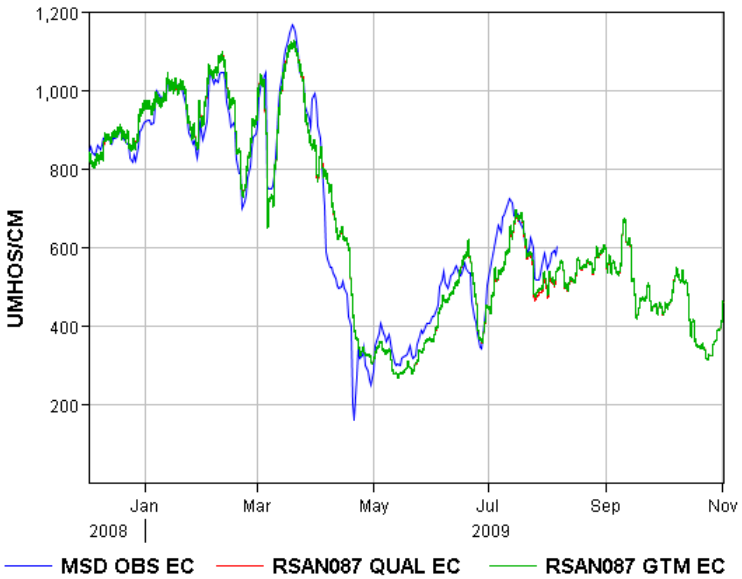




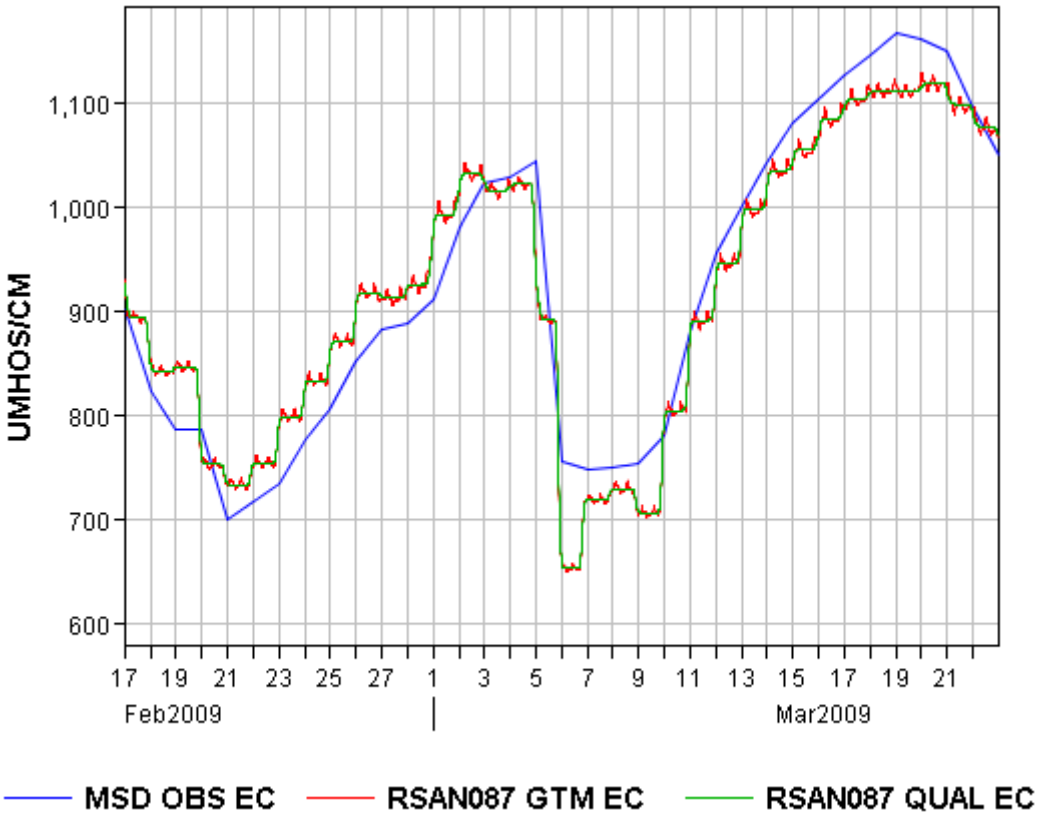
- RSAN058 (SJR @ Stockton Ship Channel)



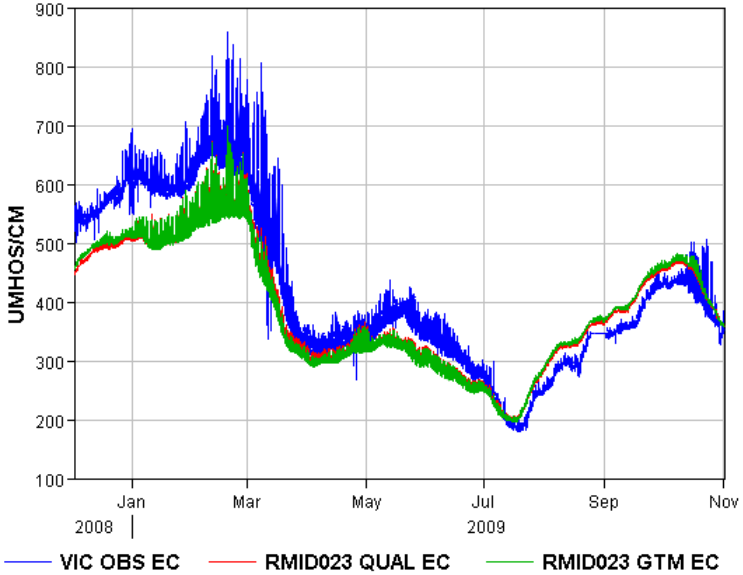
Comparison when advection+diffusion

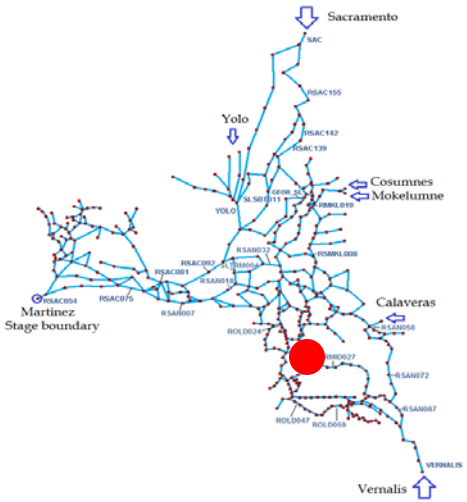


- RSAN087 (SJR @ Mossdale)

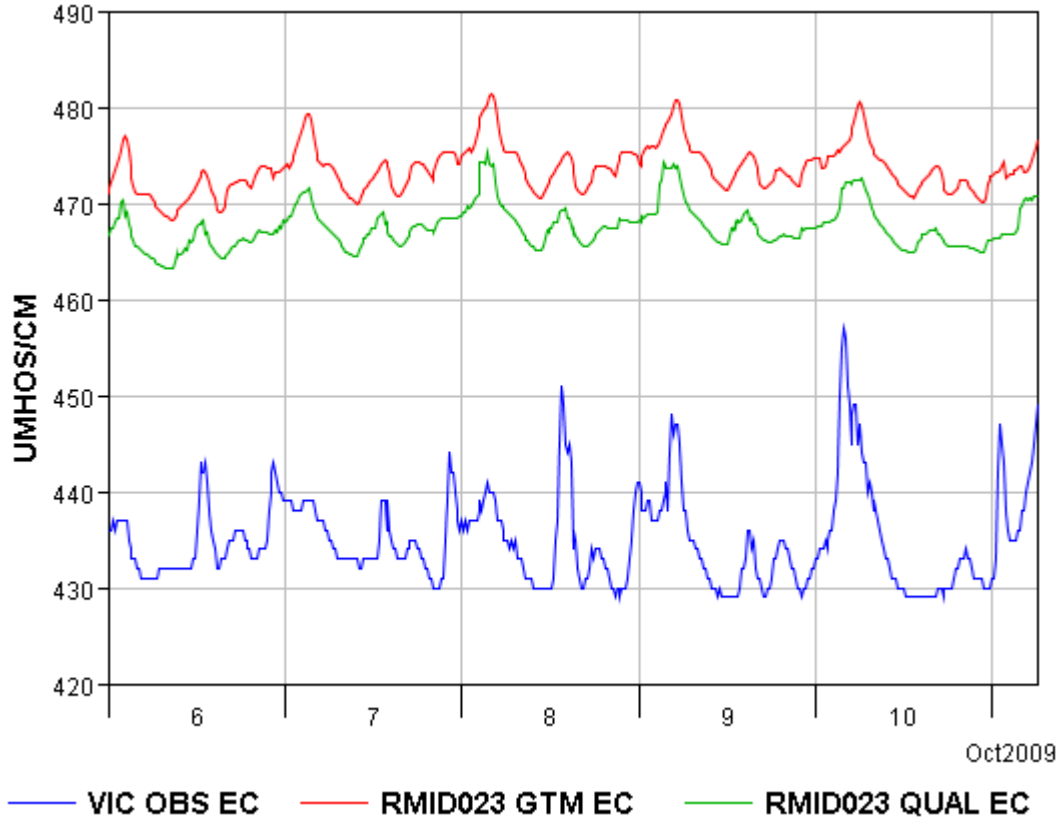


Comparison when advection+diffusion

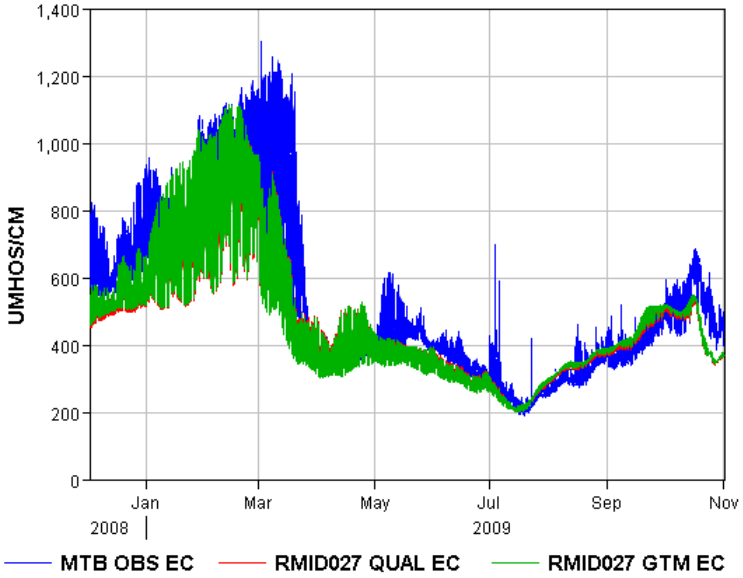


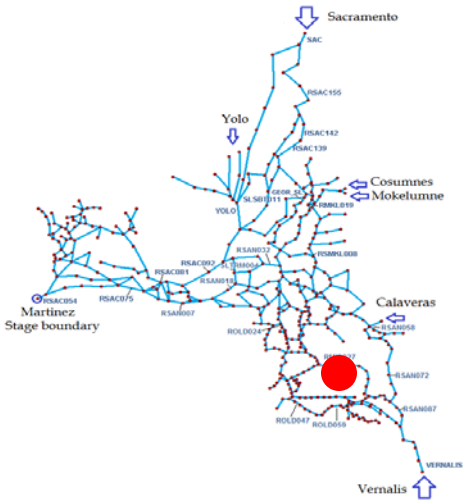


- RMID023 (Middle River at Borden Hwy)

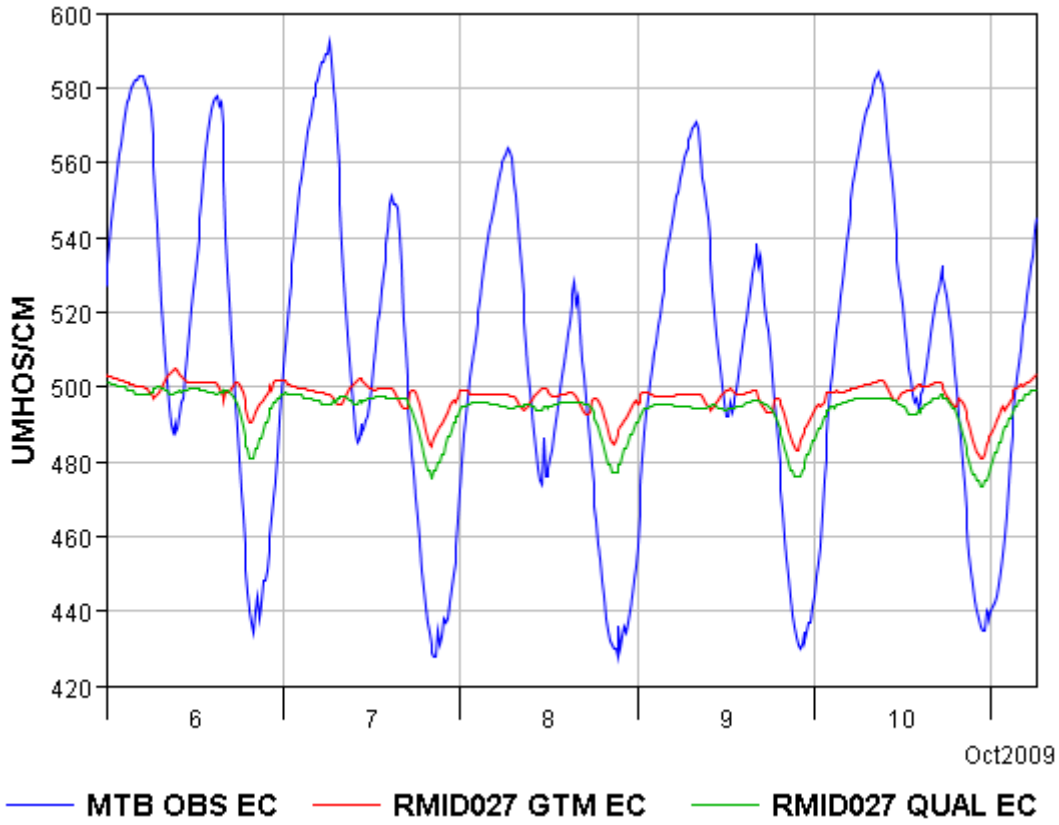


Comparison when advection+diffusion

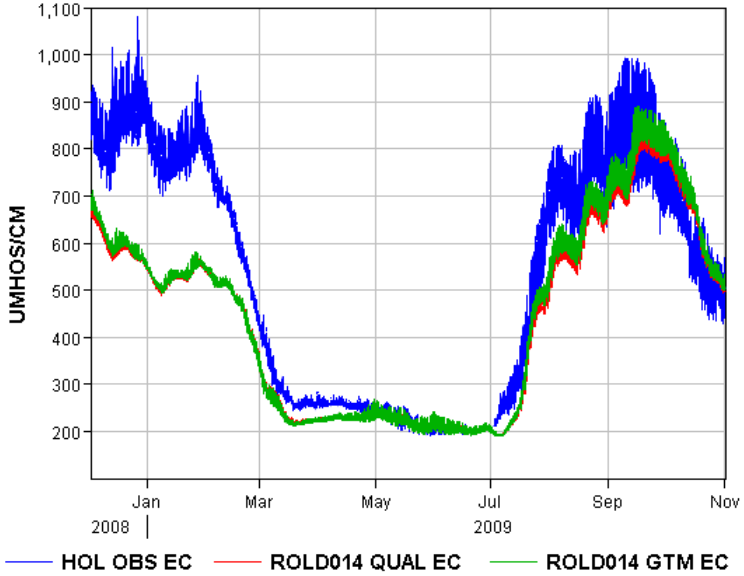




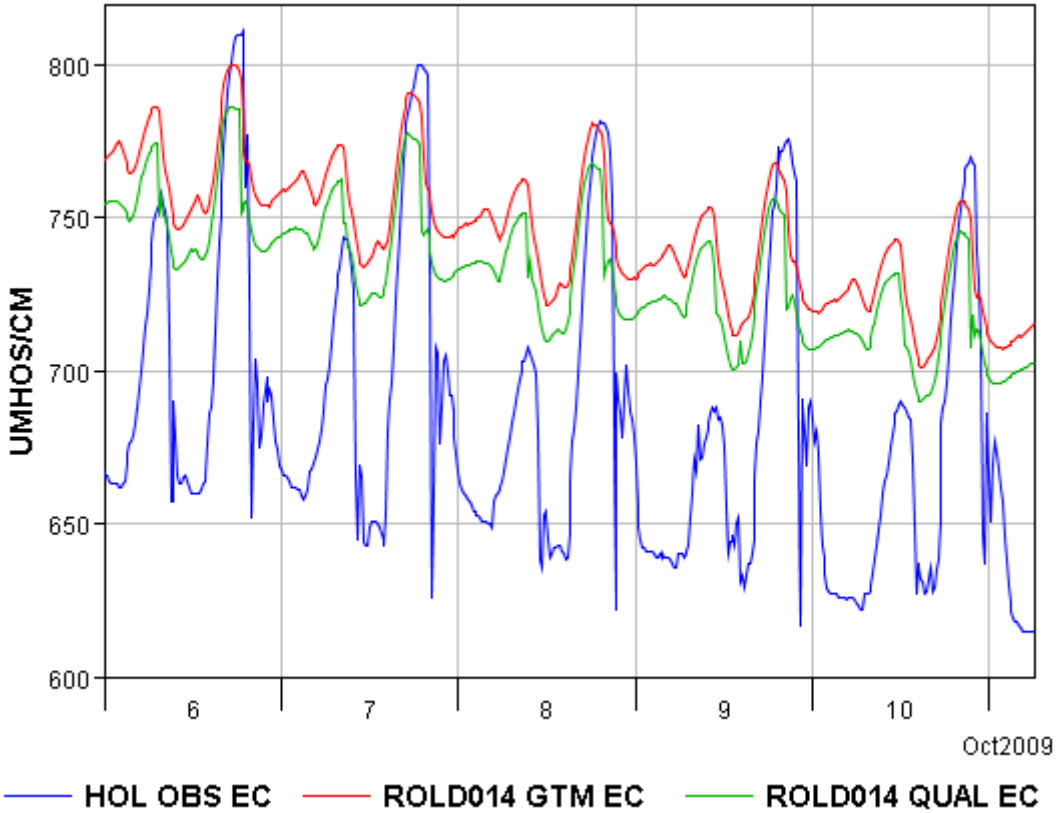
- RMID027 (Middle River at Tracy)



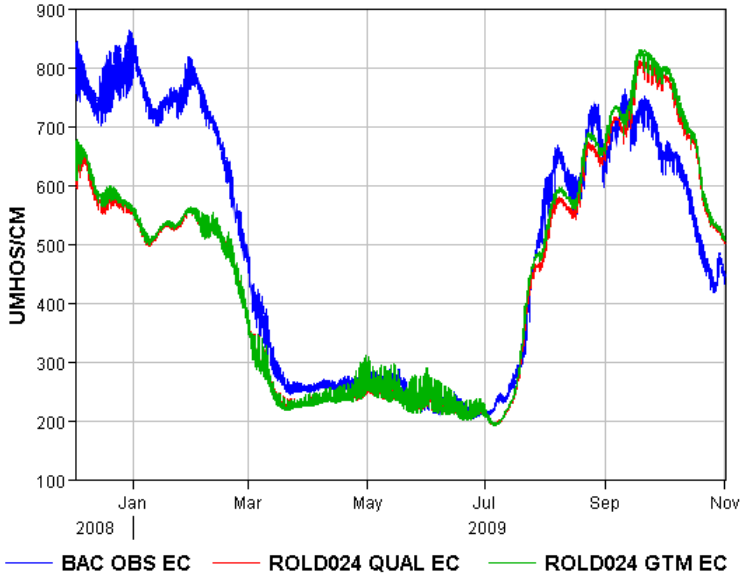
Comparison when advection+diffusion



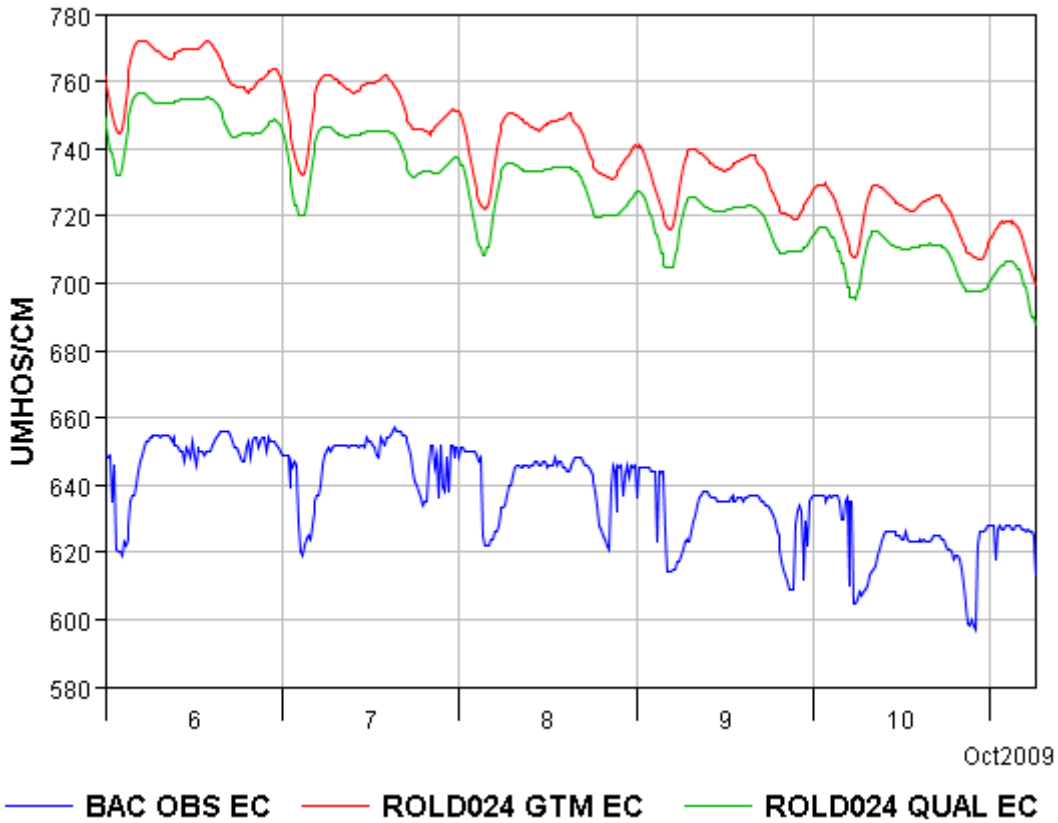
- ROLD014 (Old River at Holland Cut)



Comparison when advection+diffusion



- ROLD024 (Old River at Bacon Island)



Summary of the results

- The Eulerian transport scheme has been well tested on a single channel problem.
- GTM matches Qual fairly well in advection.
- GTM matches Qual fairly well in diffusion also by using current dispersion coefficients from Qual. GTM will still need to have its own calibration as two models take K differently.
- The results from EC simulation on entire delta for historical setup approved that GTM can perform as well as Qual but keep the grids information across delta. Further implementation may fine-tune GTM to make it even better.

To integrate with mercury modeling:

- Delta EC calibration
- Working on Suspended Sediment module
- Working on DO (dissolved oxygen) module
- Working on integration with mercury module

To integrate with DSM2:

- Performance
- Fingerprinting
- Running GTM inline with DSM2-Hydro
- Miscellaneous tools development to support the usage of GTM

Questions?