SCHISM Performance in Chester River

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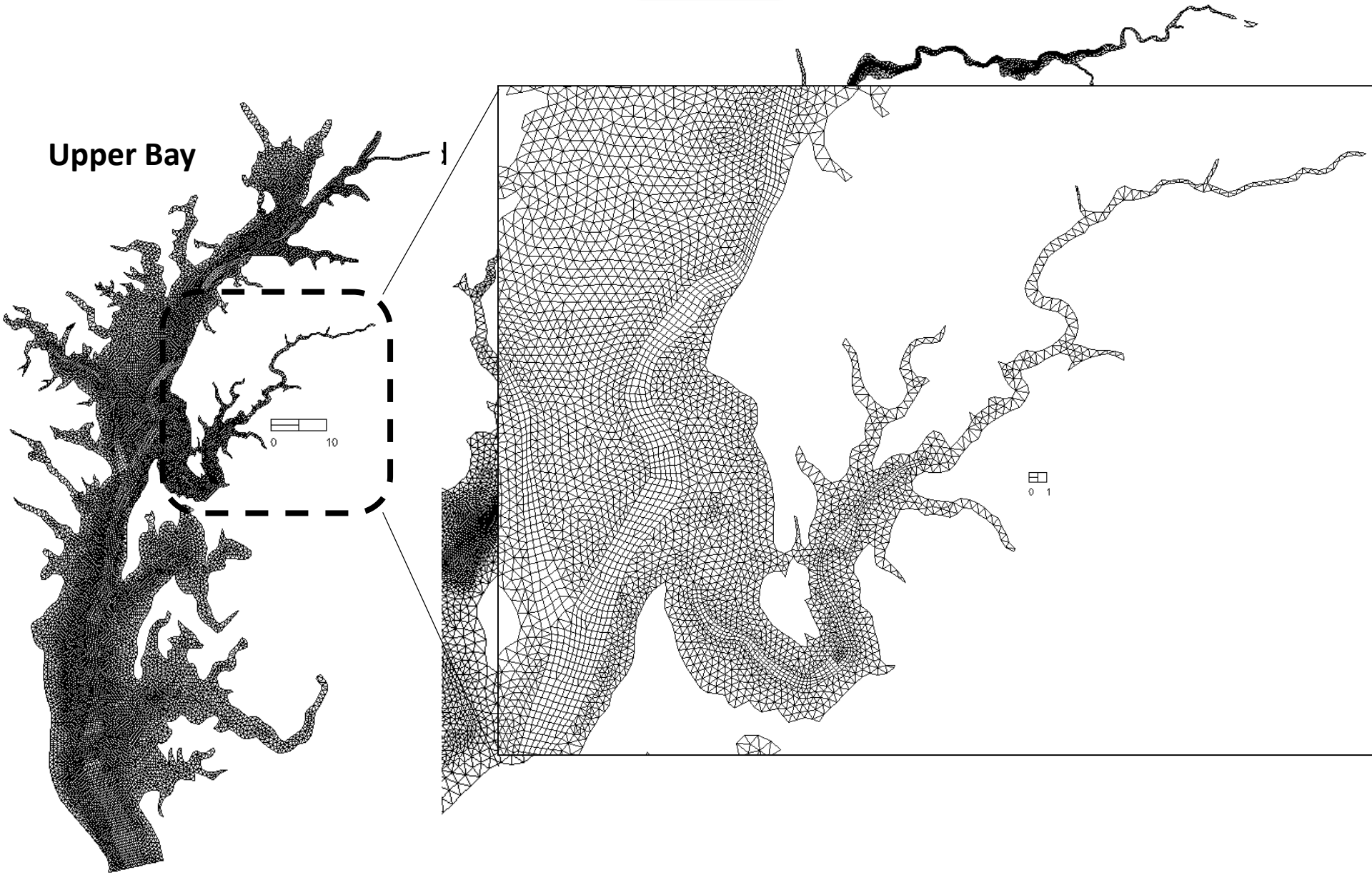
Outline of talk

- Hydrodynamic model set-up
- Comparison of salinity and temperature
  - Vertical profiles
- Discussions on initial assessment of model performance
  - Strengths
  - Weaknesses and fixes
- Wave model set-up (whole Bay)
  - Comparison of wave characteristics
- Future work plan

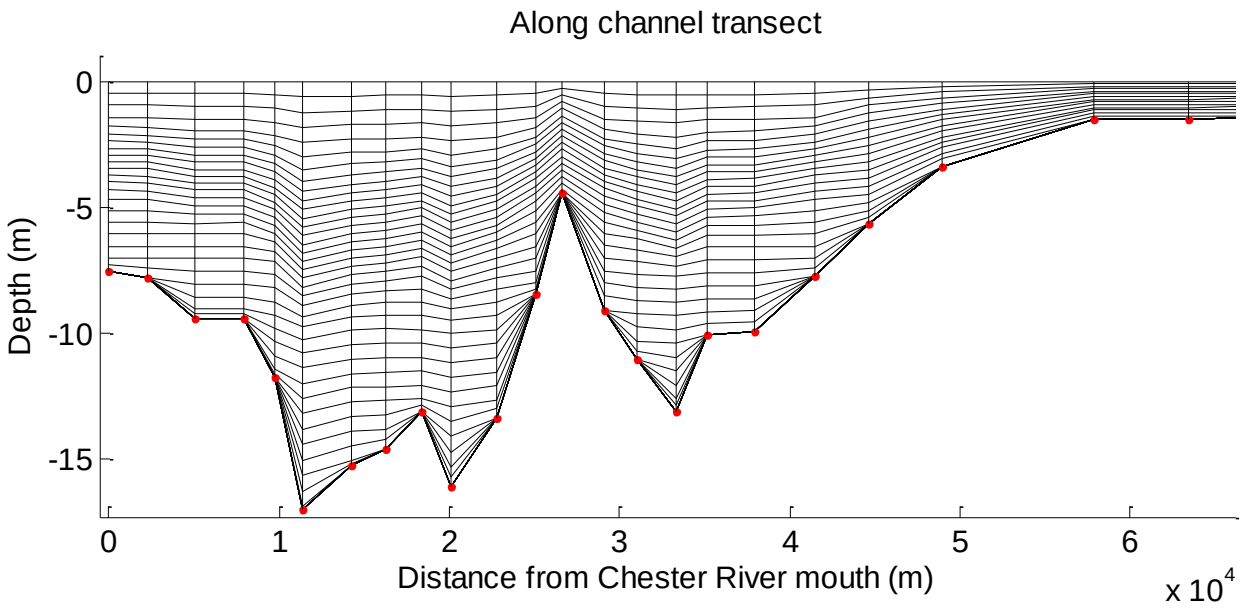
Chester River model setup

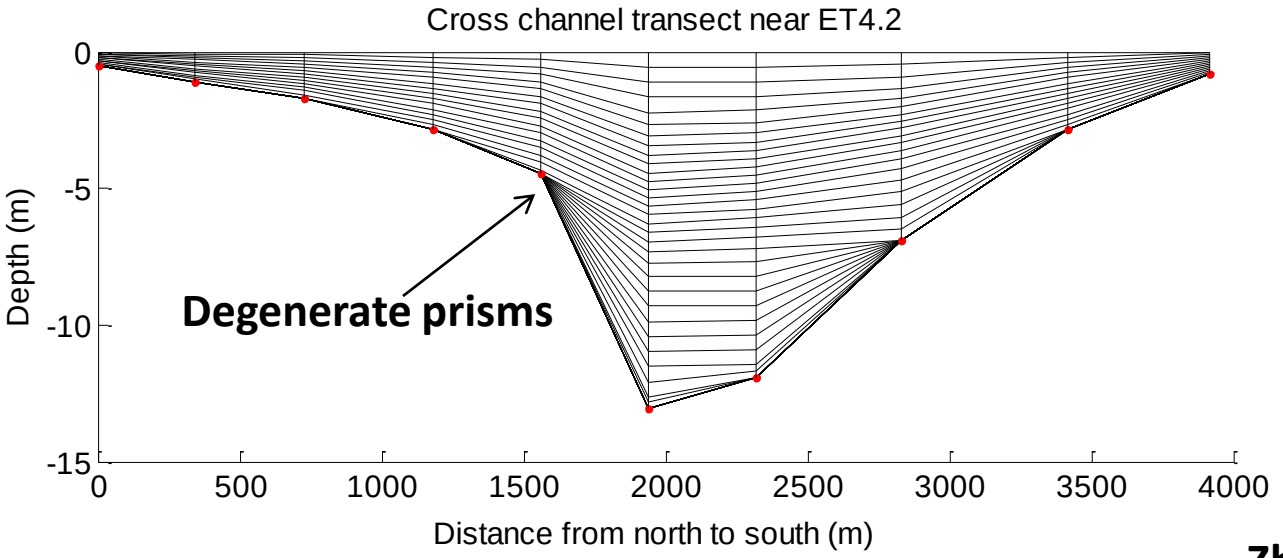
- Horizontal grids
  - Upper-Bay grid: 13K nodes, 22K elements (mixed triangles/quads)
  - 1st version: 1900 nodes, 3000 elements, cut from Upper-Bay grid
  - Finer grid*: refined from 1st version; 8800 nodes
- Initial condition:
  - Interpolated from observation in 2003
- Boundary condition:
  - CH3D: elevation, salinity, temperature
  - Schism Upper Bay model: elevation, salinity, temperature, velocity
- Fresh water inputs:
  - Point and non-point sources provided by the HSPF watershed model results
  - Susquehanna & Choptank River fall-line flows for the upper bay model
- Wind:
  - Thomas Point station, spatially homogeneous throughout the domain
- Heat fluxes and precipitation:
  - North American Regional Reanalysis (NARR)
  - Our own air-sea exchange module will calculate various fluxes
- Time step: 120 sec
- Transport: TVD^2
- Performance: 851xRT on 48 cores (finer grid)

Grids



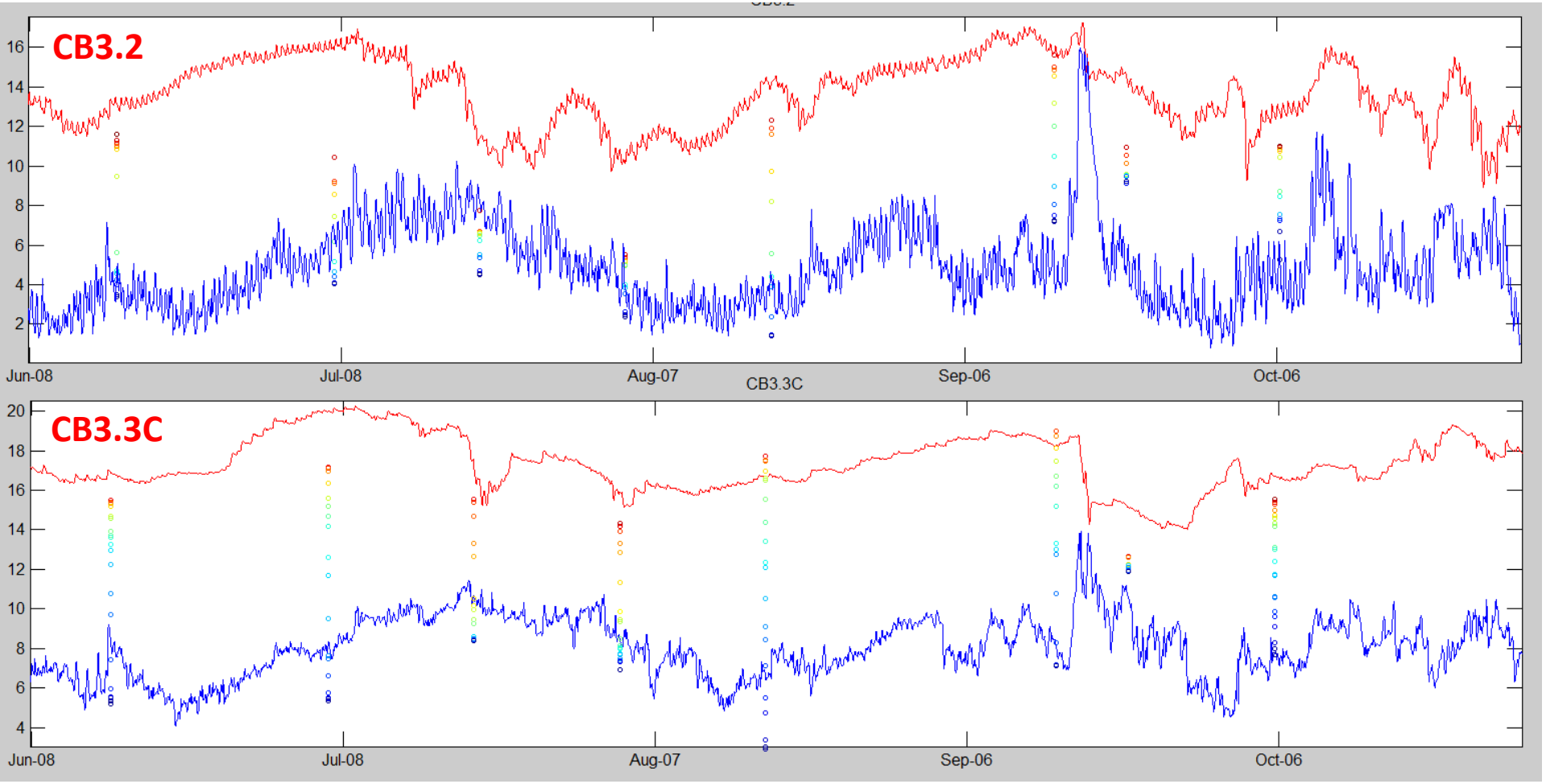
Vertical discretization in the Chester River





Zhang et al. (2015)

CH3D b.c.

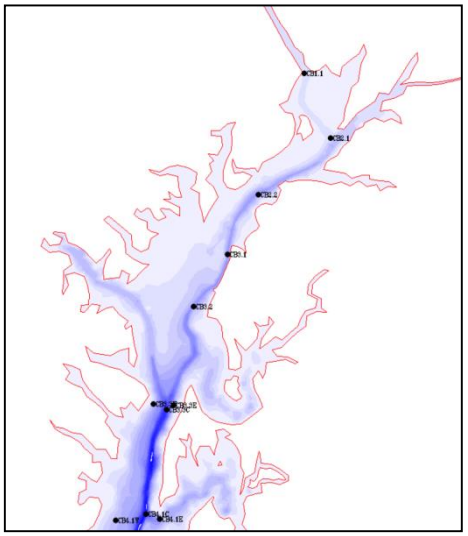


Days in 2003

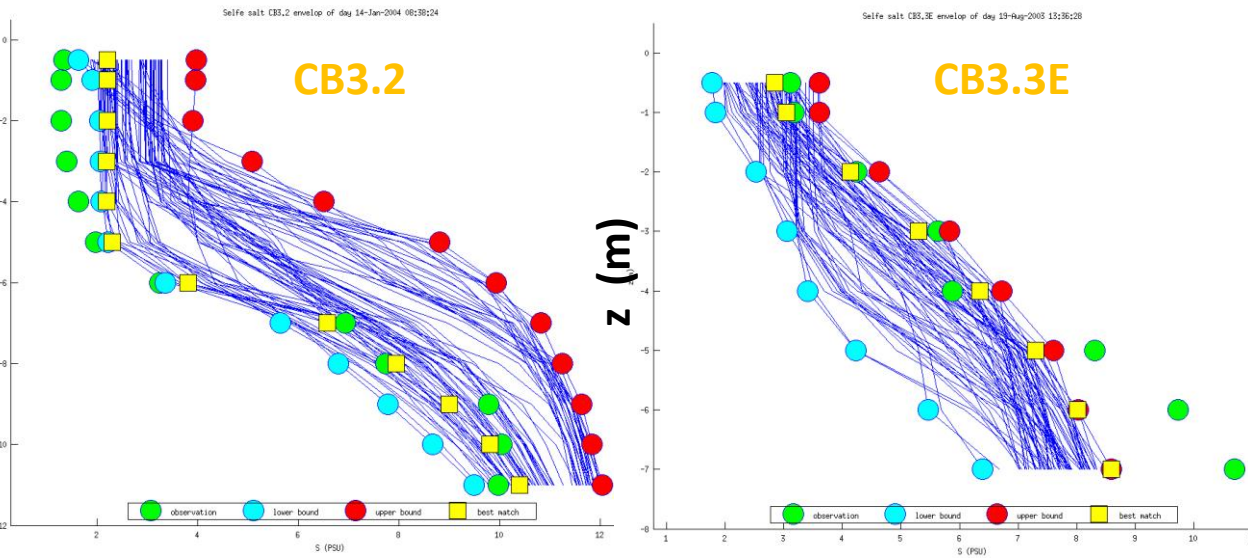
Salinity Profiles

We are doing well in the main stem of Upper Bay

Stations	Correlation
CB2.1	0.78
CB2.2	0.88
CB3.1	0.9
CB3.2	0.94
CB3.3C	0.96
CB4.1C	0.95
CB4.2C	0.96
CB4.3C	0.96



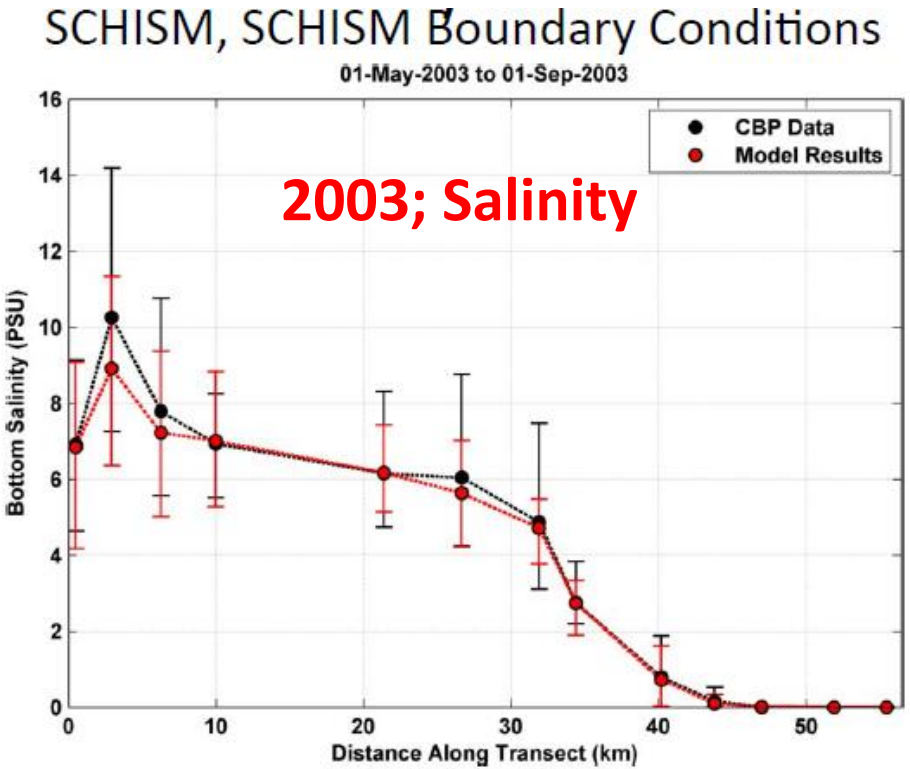
3 stations closest to Chester River

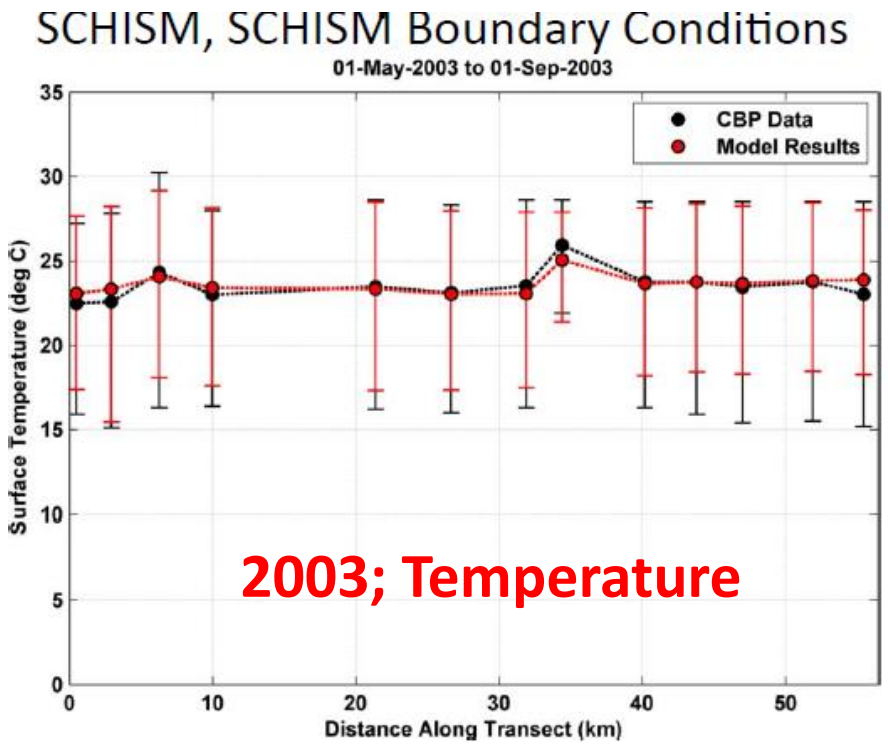


Salinity (PSU)

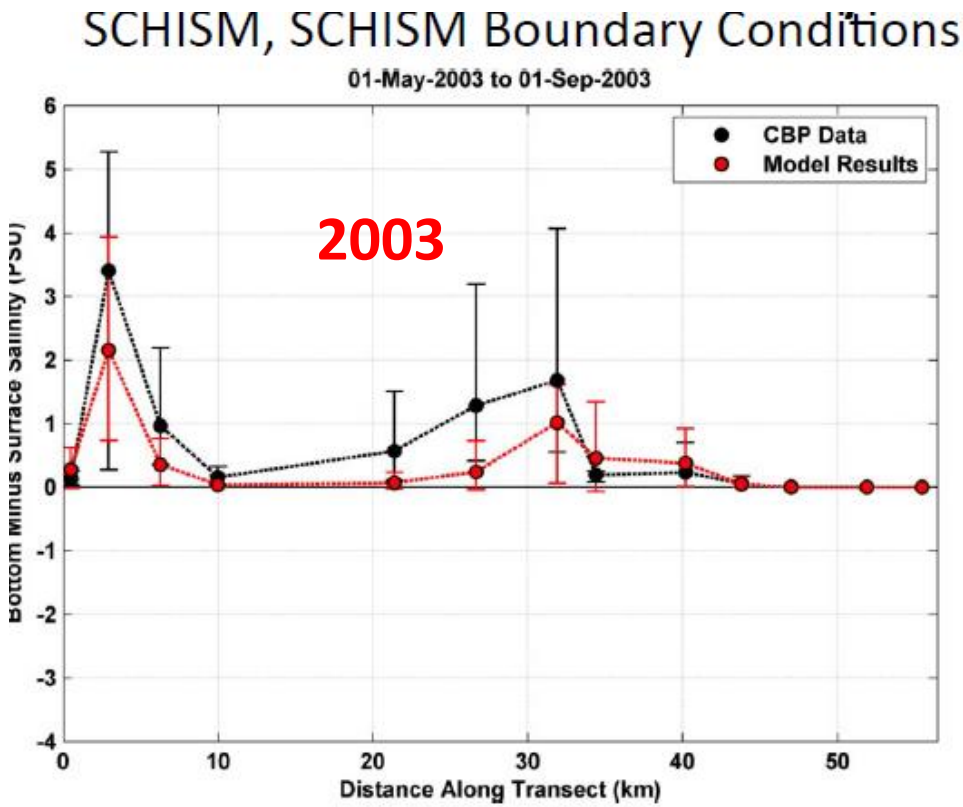
Model strengths

- The accuracy of the boundary condition is very important and is the source of *greatest* sensitivity for the model
  - With CH3D b.c., the over-estimation of S at boundary led to over-estimation upstream
- Overall structure and variability for T,S seem correct with SCHISM b.c.
- Variability and trend of stratification are reasonably captured

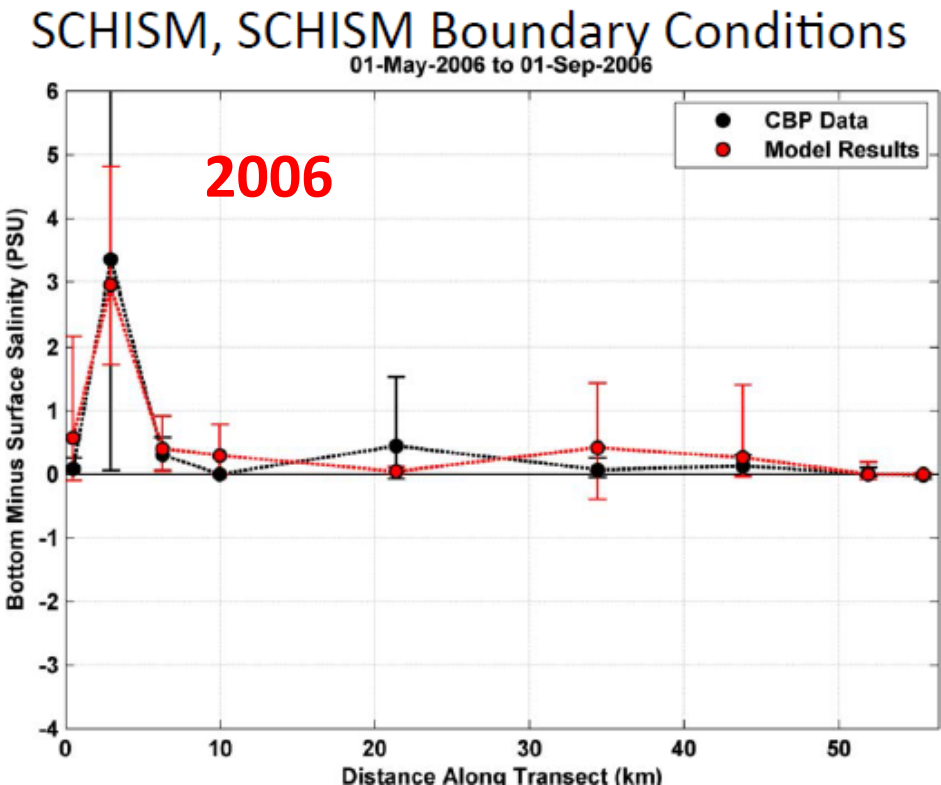




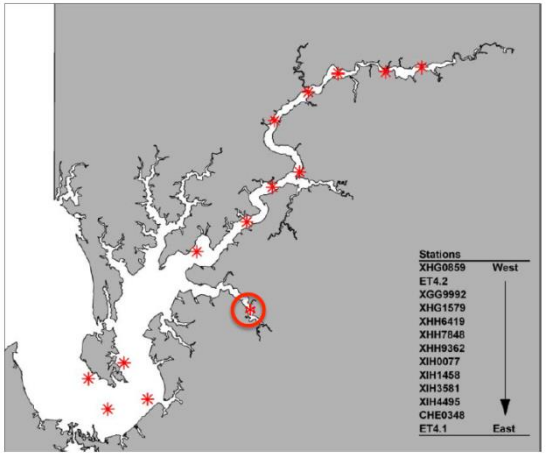
Model strengths



Stratification @ ET4.2 seems correct

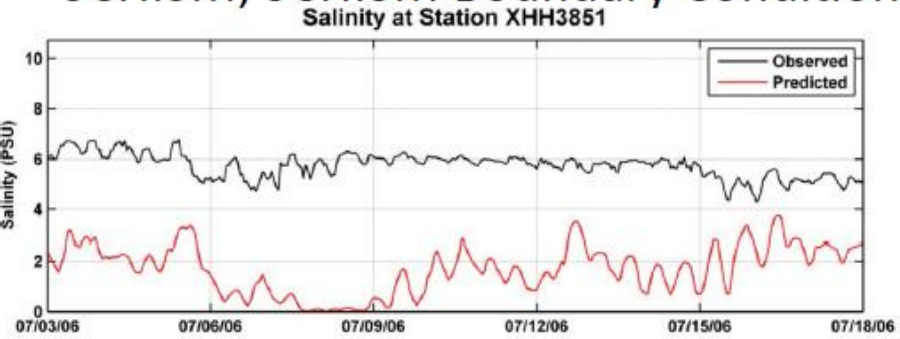


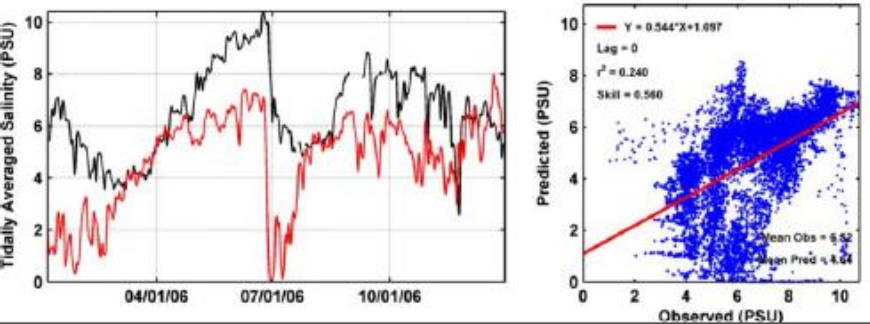
Model weakness I



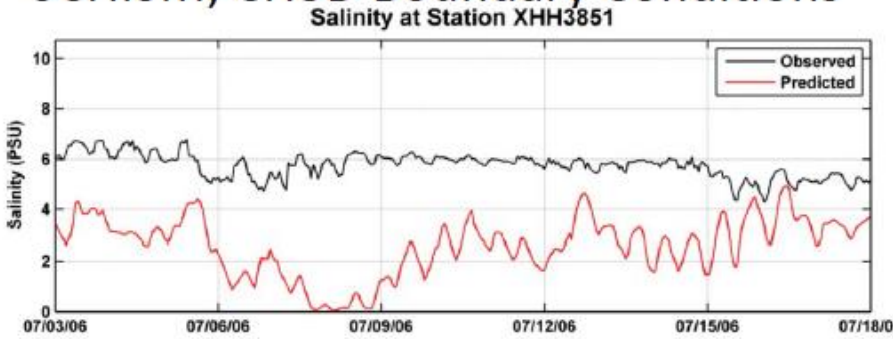
- Salinity near intrusion limit needs improvement, especially for 2006
- Fixes
  - Check model set-up for 2006
  - Further work on horizontal and vertical grids
  - Distribution of point sources

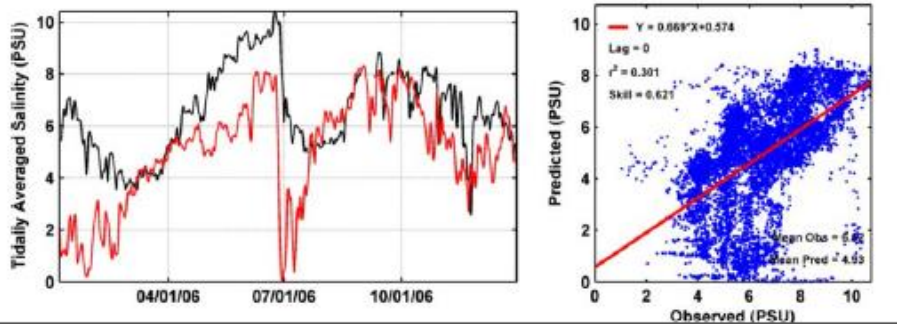
SCHISM, SCHISM Boundary Conditions



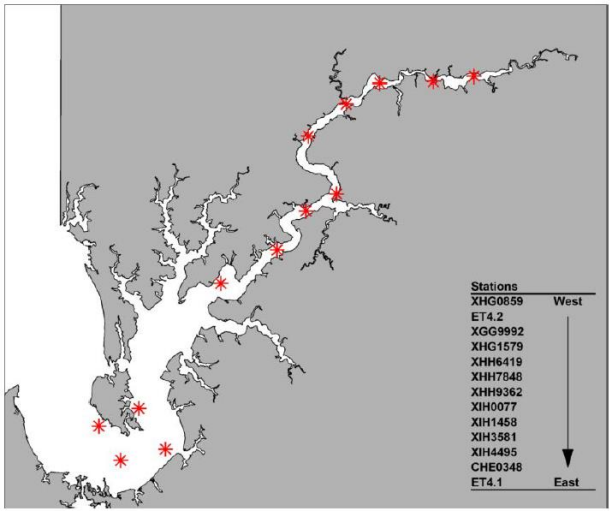


SCHISM, CH3D Boundary Conditions

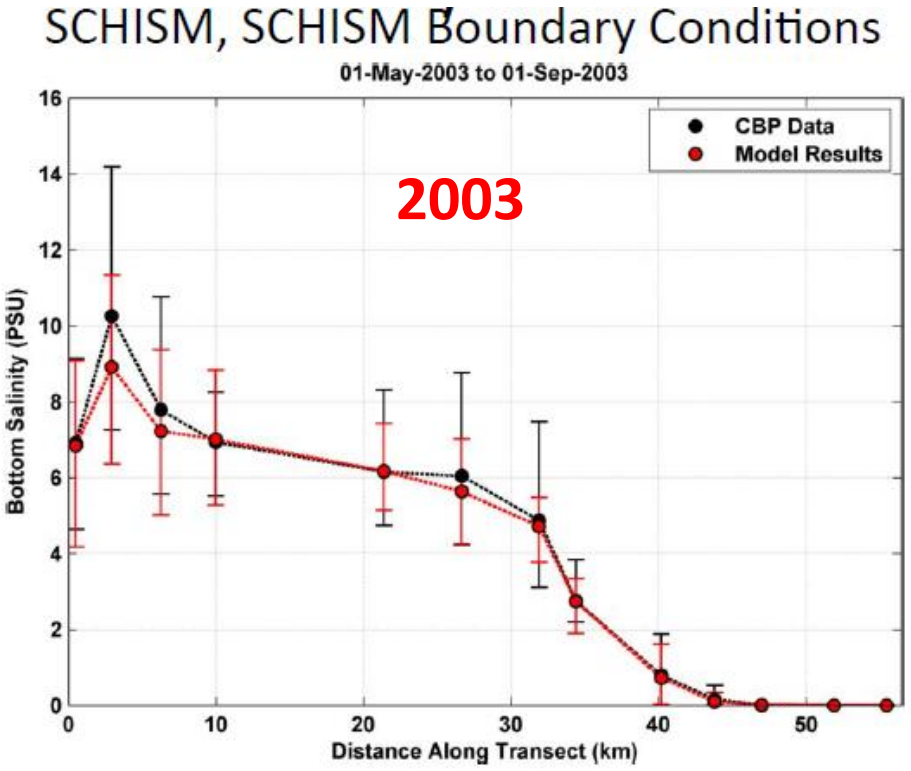


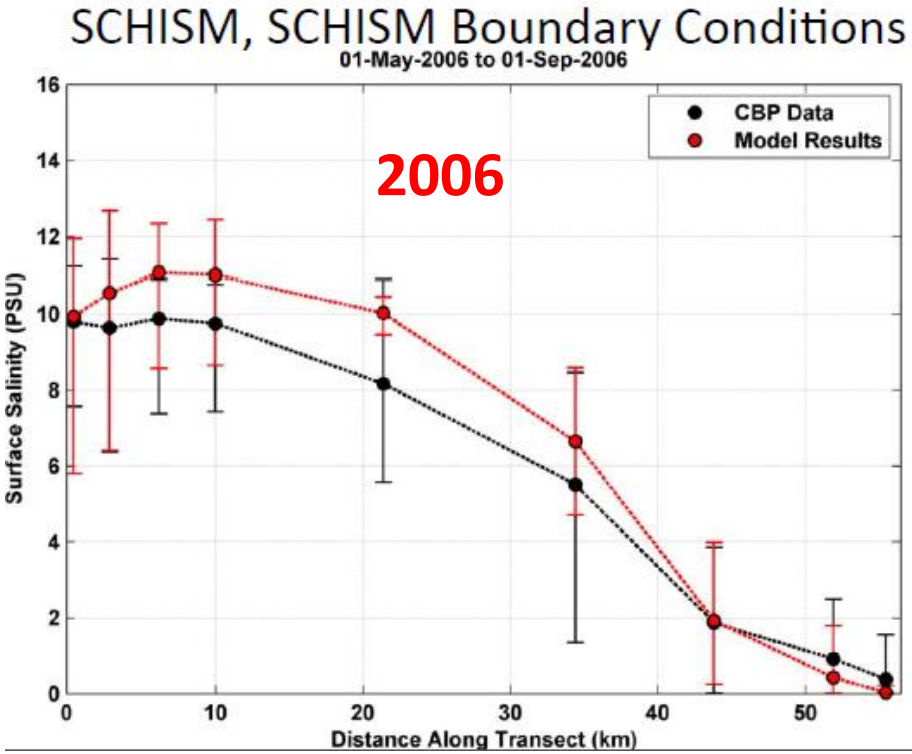


Model weakness II

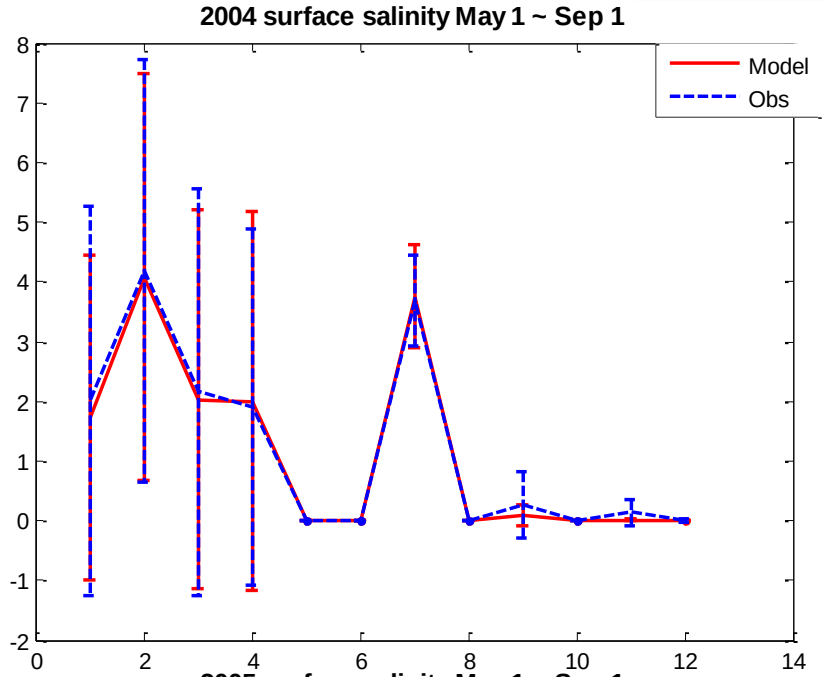


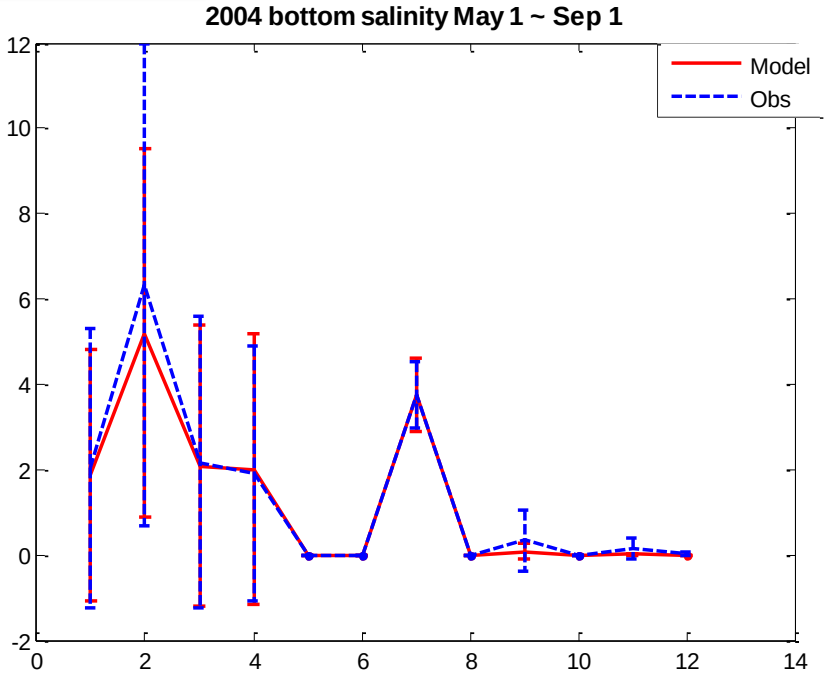
- The overall salinity structure for year 2006 is worse than 2003, and needs improvement
- Fixes
  - Check model set-up for 2006, especially point sources and sensitivity to evaporation/precipitation

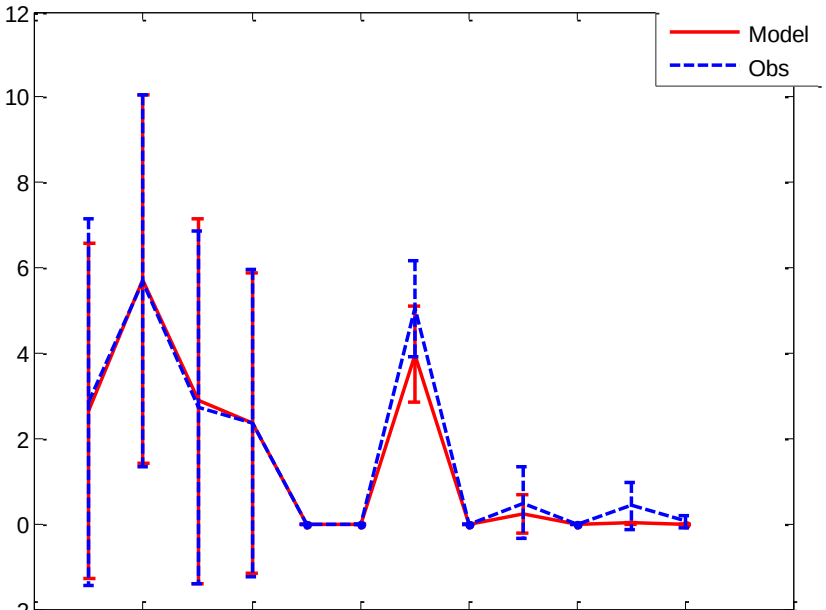


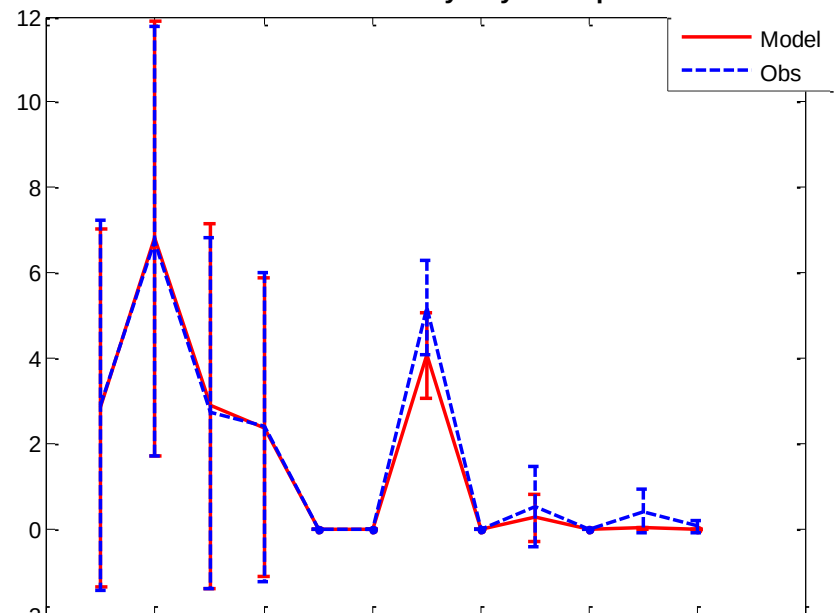


Model weakness



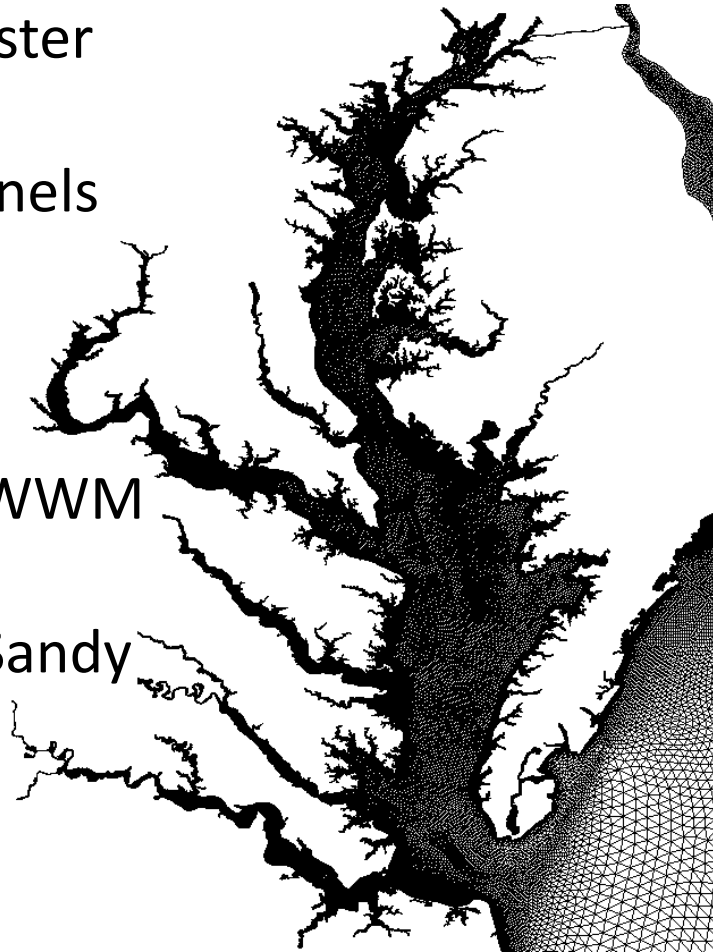






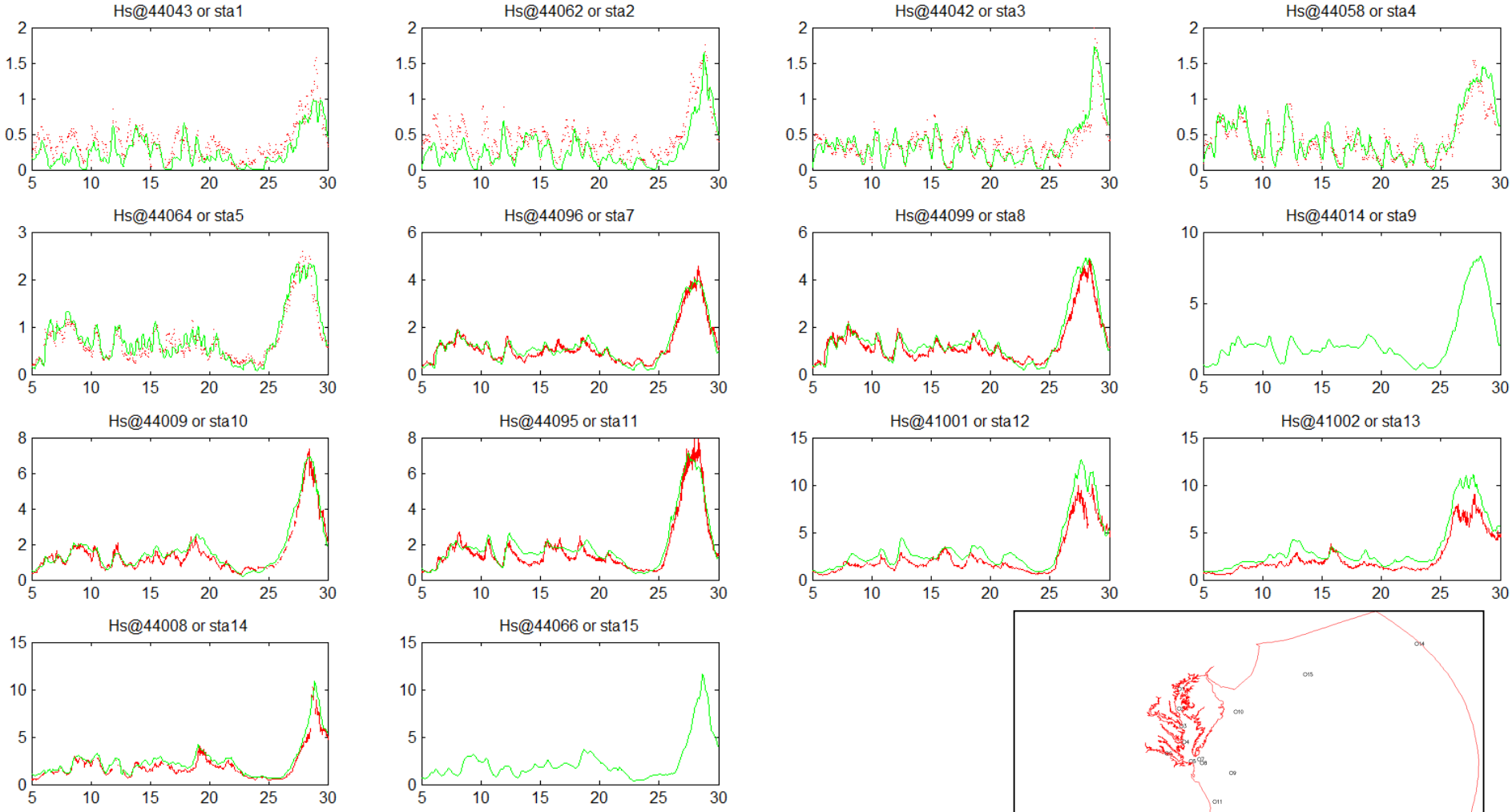
Wave model set-up

- Wind Wave Model III (Roland et al. 2012, JGR)
  - Fully integrated into SCHISM modeling system
- Set up for whole Bay + shelf
  - To eventually provide wave b.c. for Chester River model or other sub-domains
  - 308K nodes, 559K elements; both channels and shallows are resolved (~50-100m)
  - B.c. from Wave Watch III
  - 30 directional bins, 24 frequency bins
  - Time steps: 150s for SCHISM, 450s for WWM
  - 90x faster than RT on 160 cores
- Validation: NDBC buoys, during Hurricane Sandy (2012)



Wave model validation (Sandy)

Significant Wave Height (m)



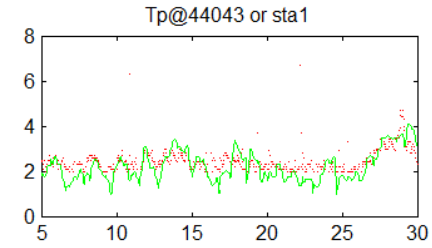
Days from 10/1/2012

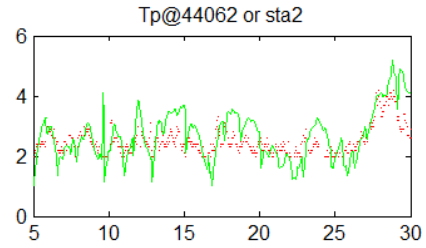
DATA

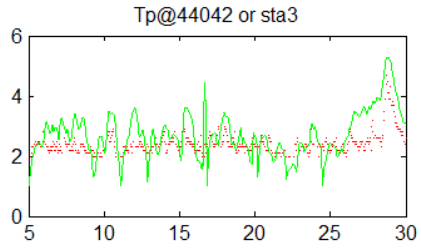
SCHISM-WWM

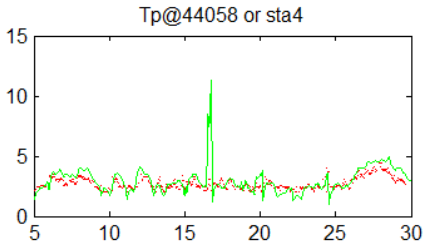
Wave model validation (Sandy)

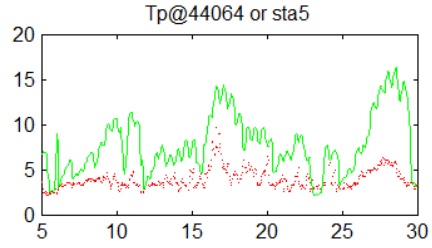
Peak period (sec)

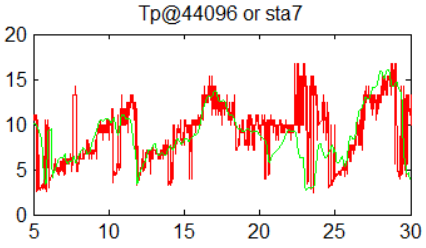


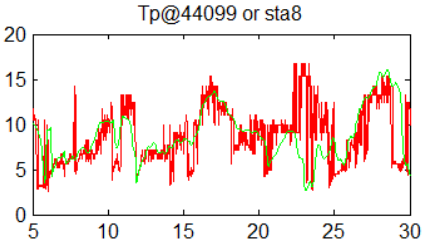


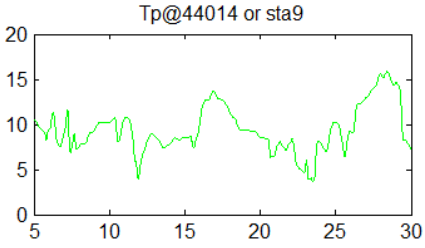


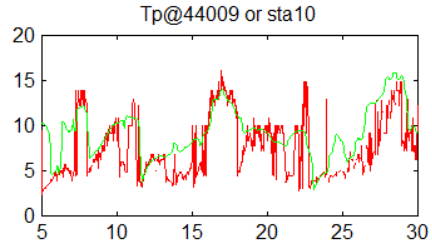


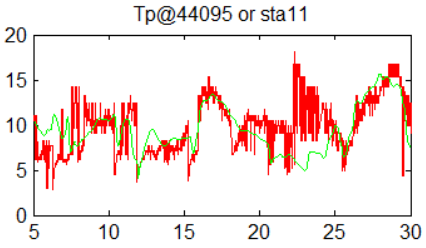


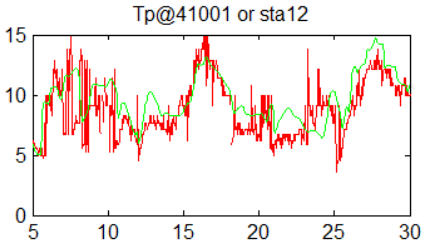


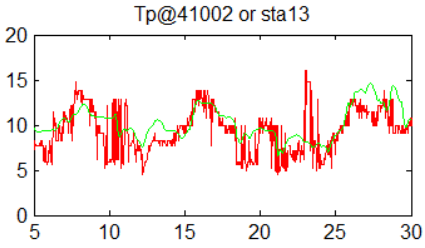


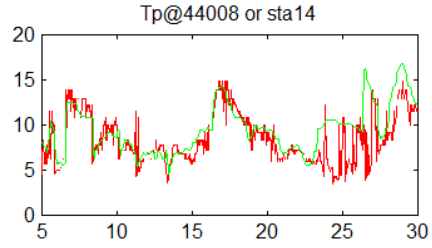


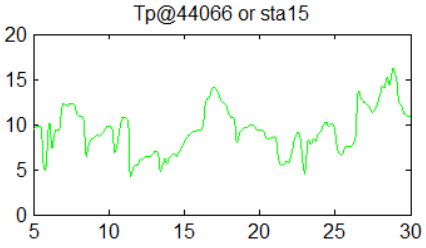












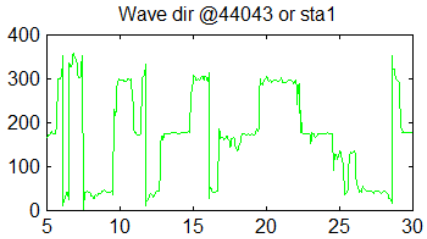
DATA

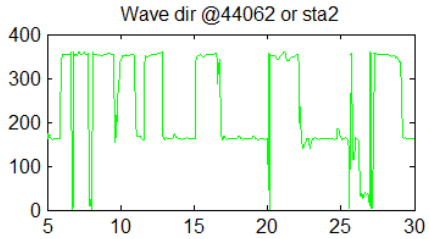
SCHISM-WWM

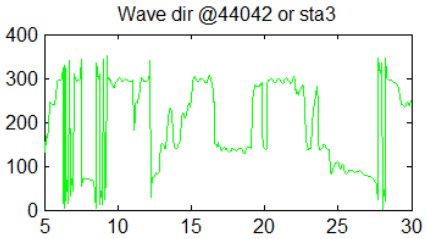
Days from 10/1/2012

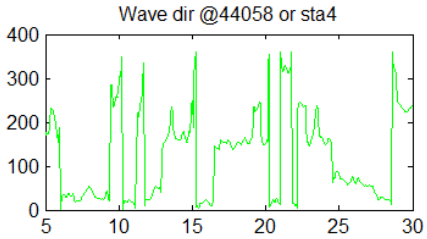
Wave model validation (Sandy)

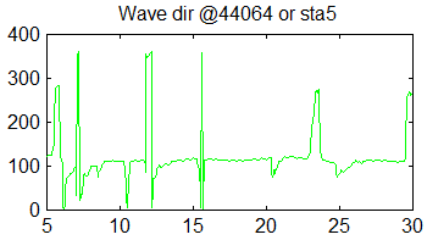
Mean Wave Direction (degrees)

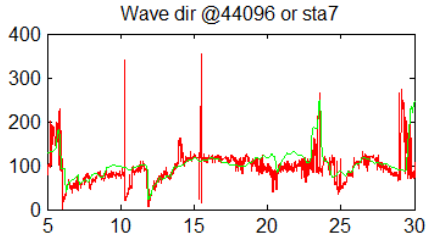


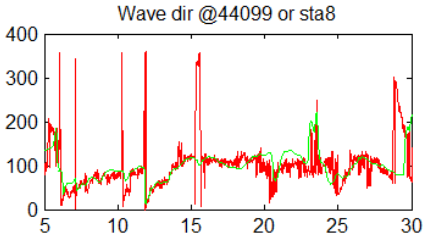


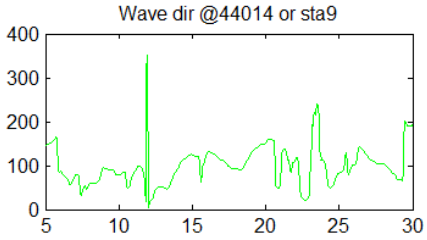


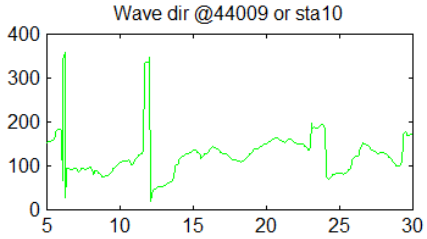


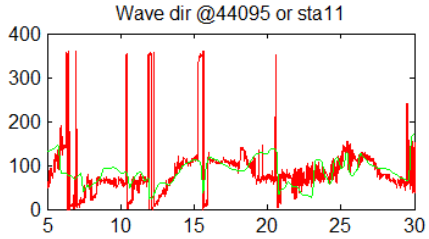


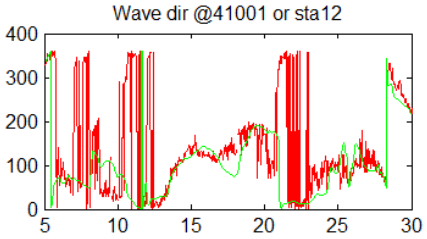


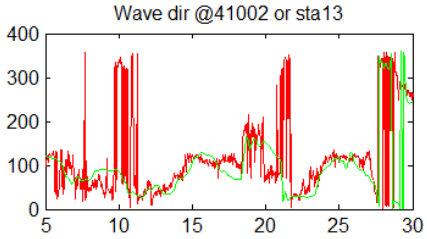


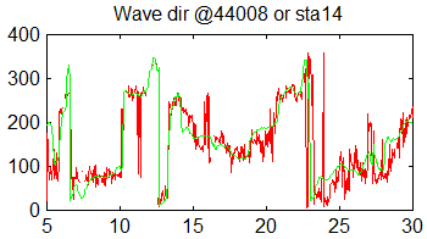


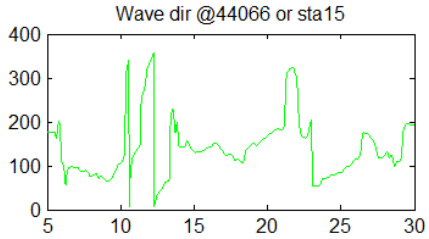










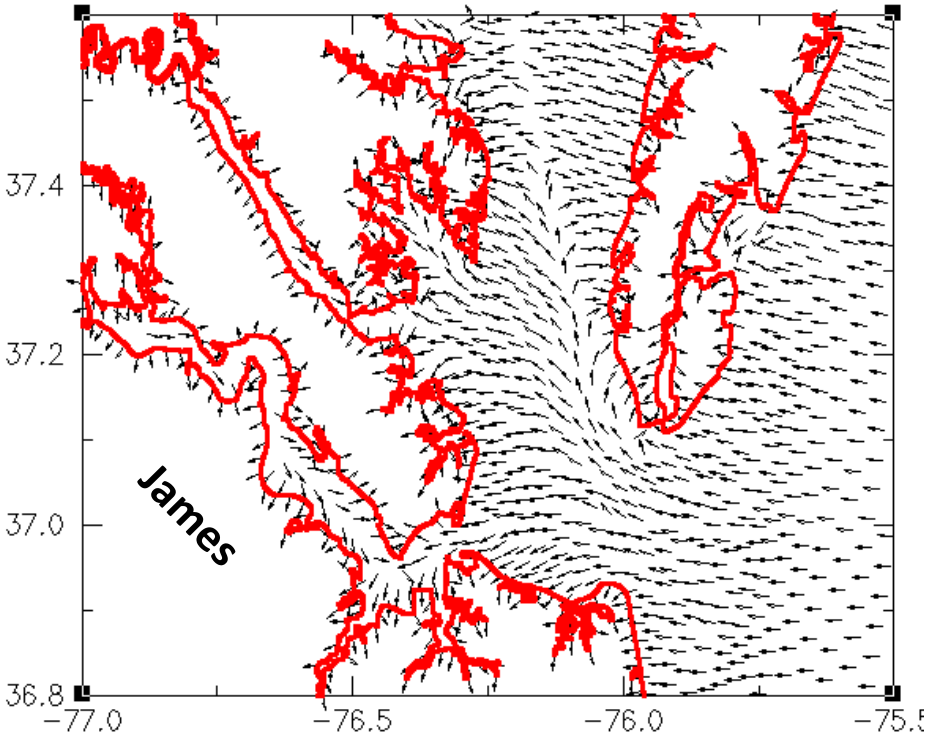


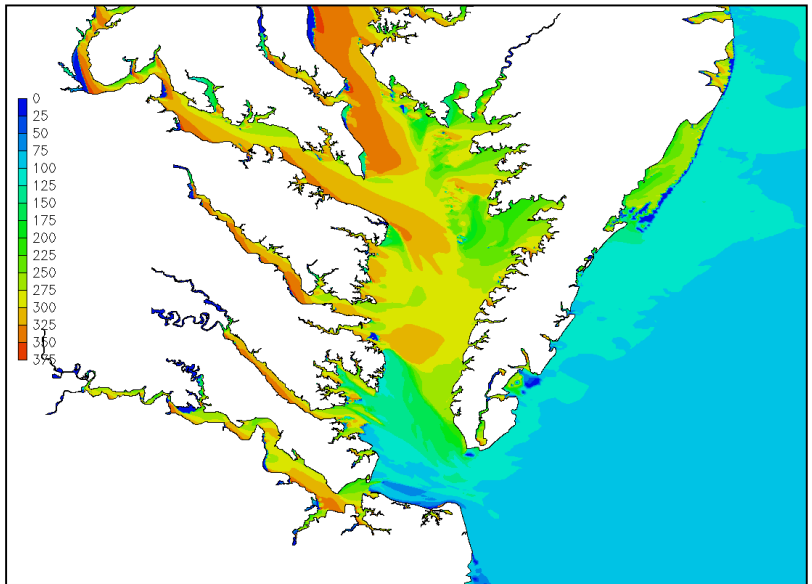
DATA

SCHISM-WWM

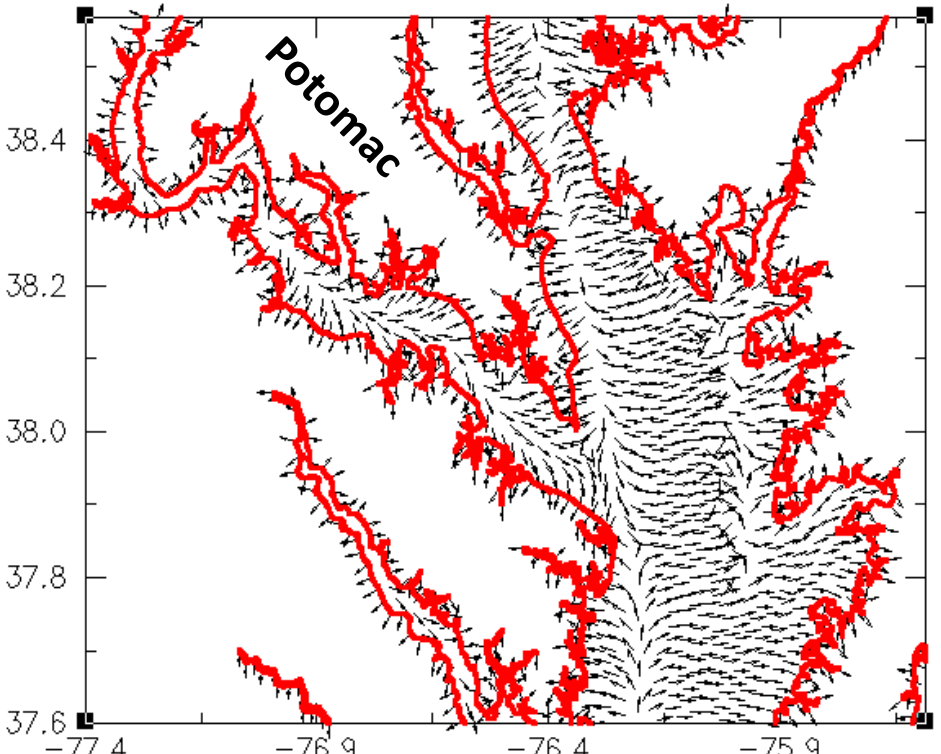
Days from 10/1/2012

Average wave direction





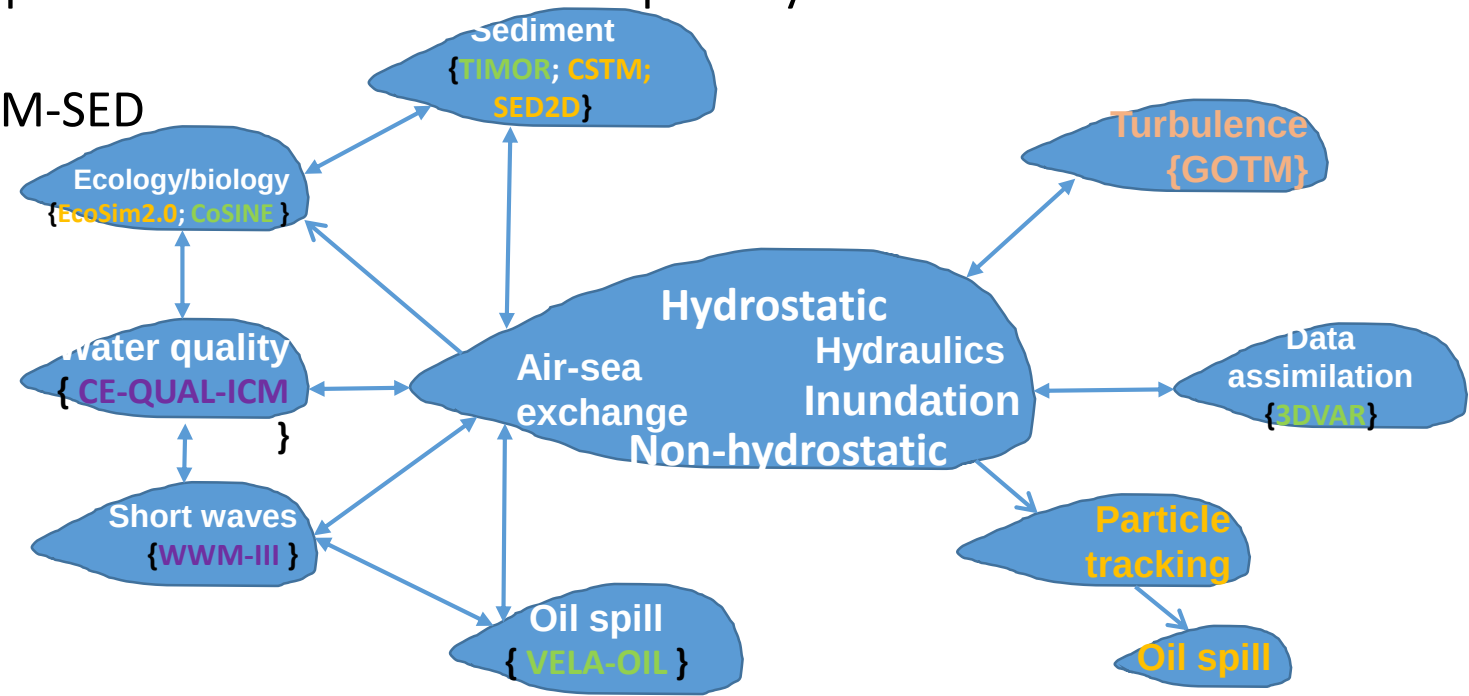
- **Averaged over Oct. 10 to 22, 2012**
- **Only direction is shown**



Future work

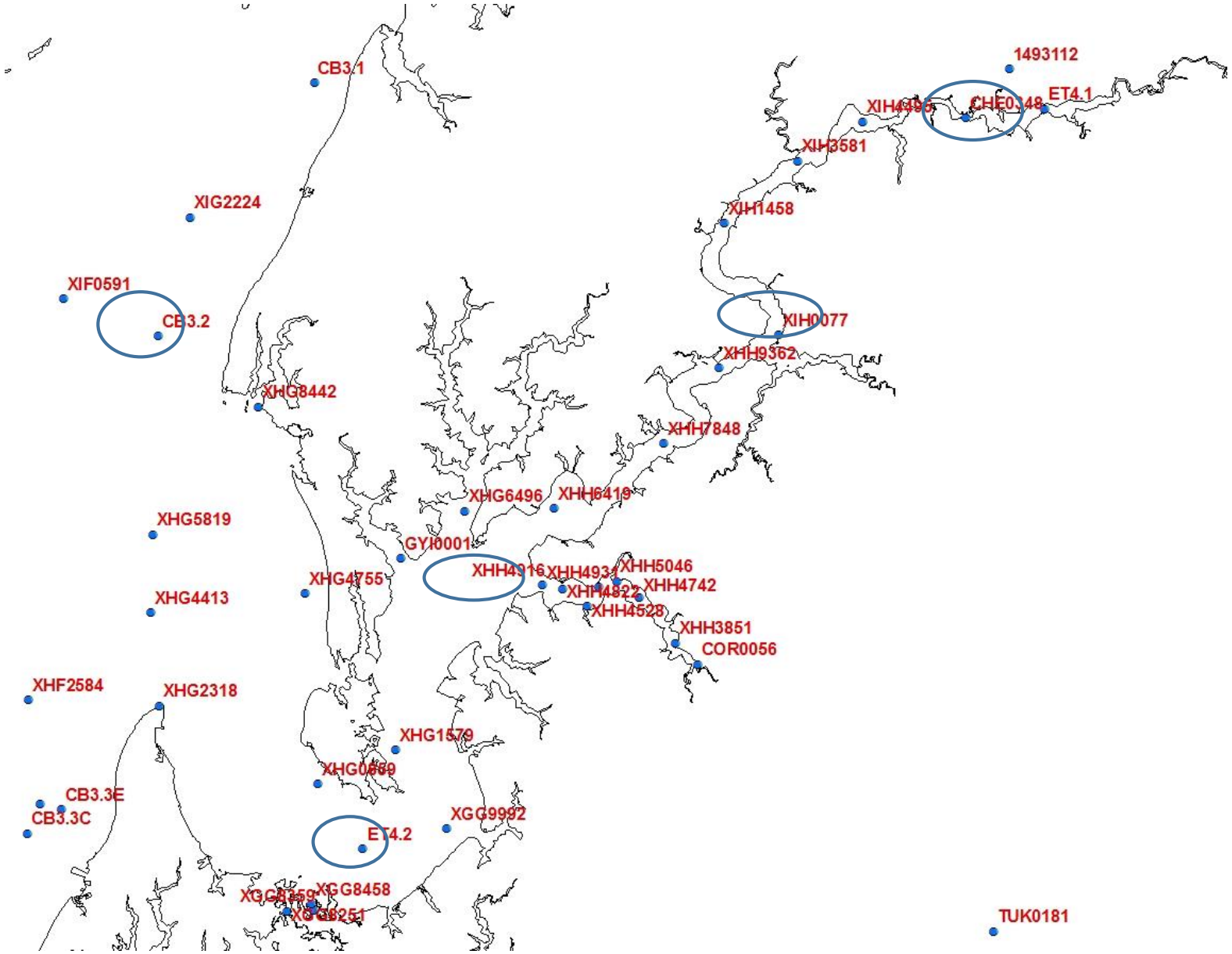
- Further work on hydrodynamics
- TSS
  - Conducting long-term wave simulation to provide b.c. for the Chester River model
  - Calibrating the sediment transport model for whole Bay as well as for the Chester River
- DO, Chl
  - Conducted 1st simulation on a coarser grid
  - Processing nutrient load inputs
  - Estimated performance: 4x slower than pure hydro code
- Fully coupled

SCHISM-ICM-WWM-SED

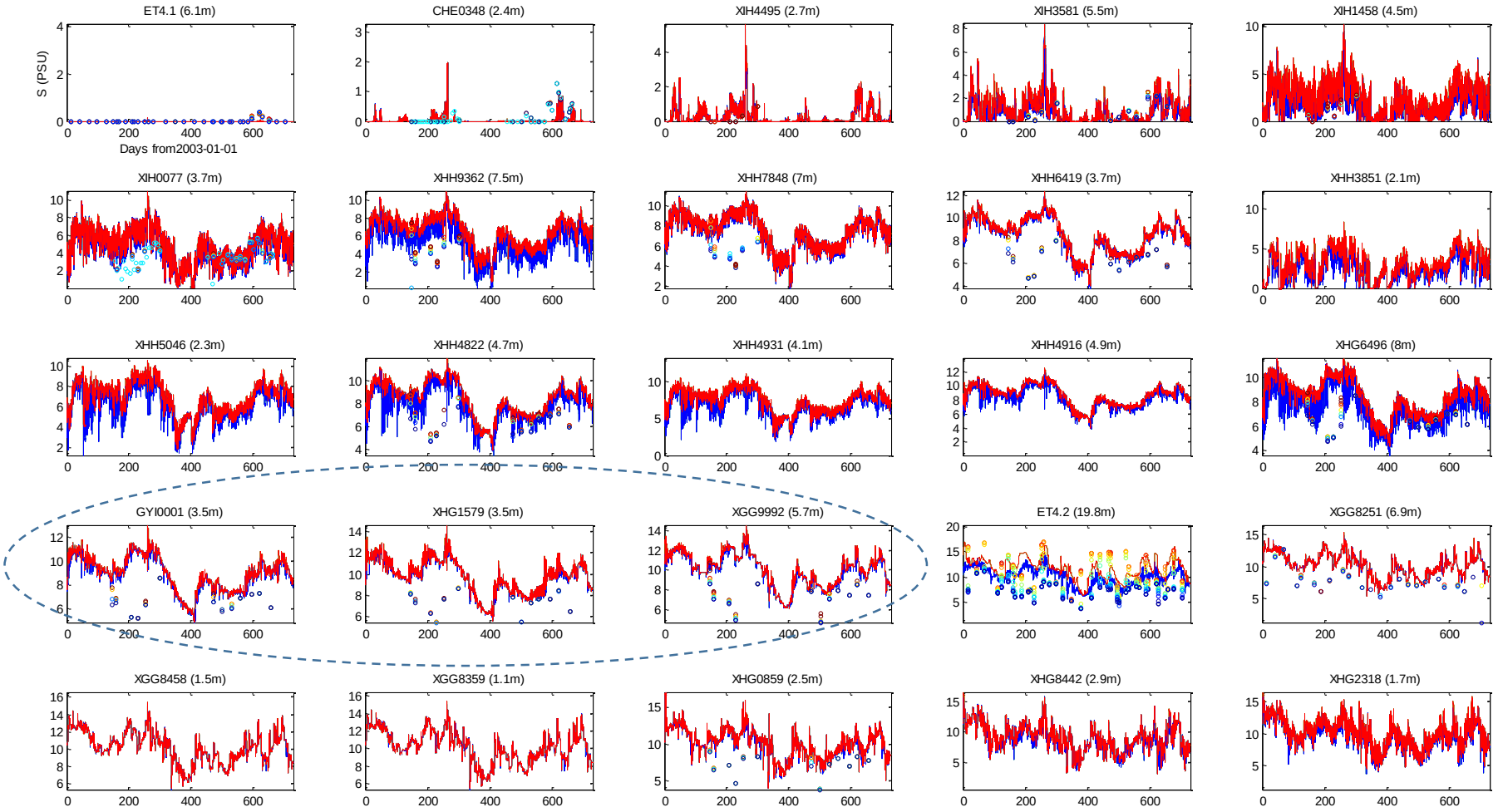


End

Chester River monitoring station



Comparison: salinity (with CH3D b.c., 2003~2004)



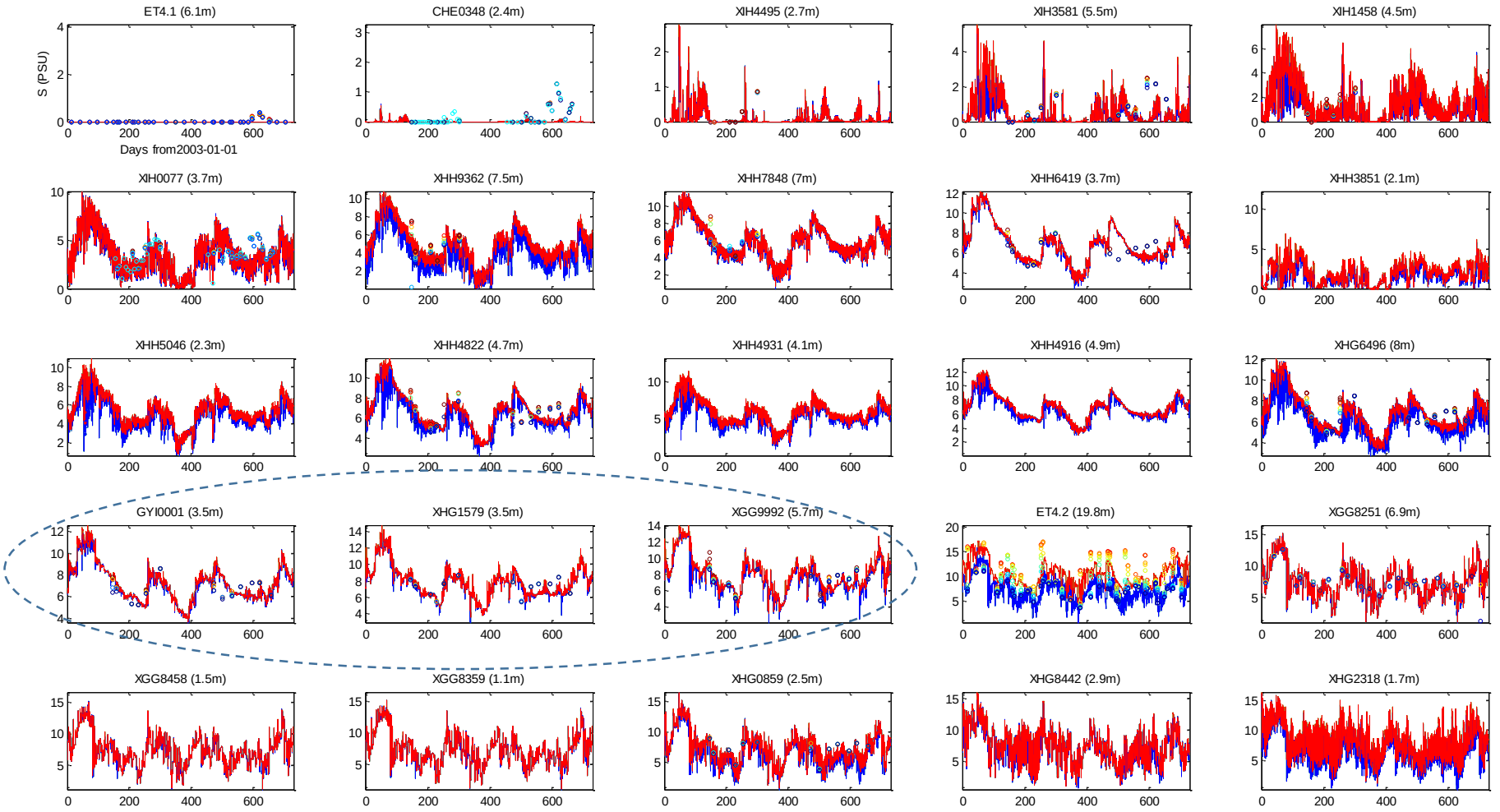
Days from 1/1/2003

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Salinity (**with upper bay b.c.**, 2003~2004)



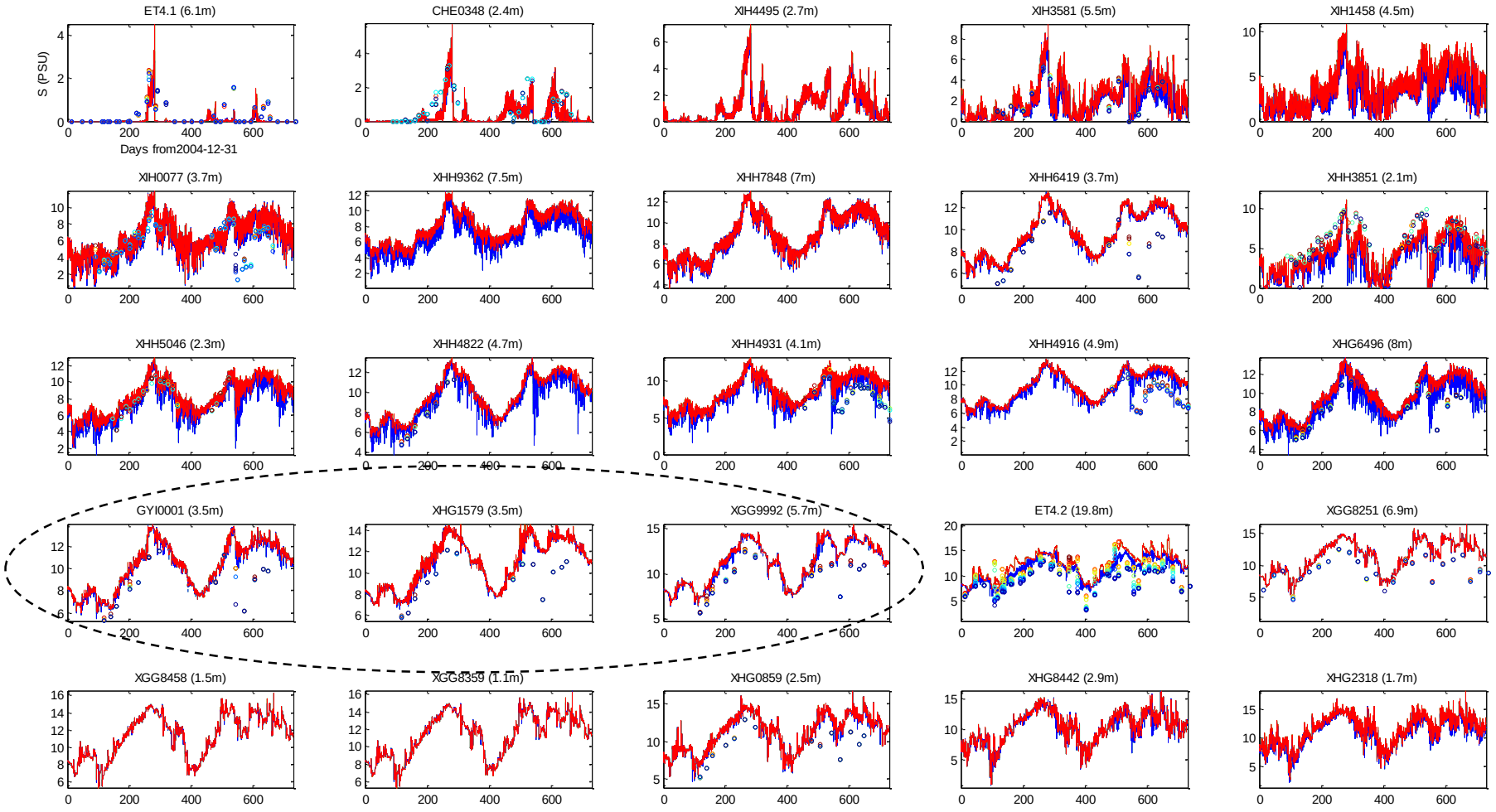
Days from 1/1/2003

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Salinity (with CH3D b.c., 2005~2006)



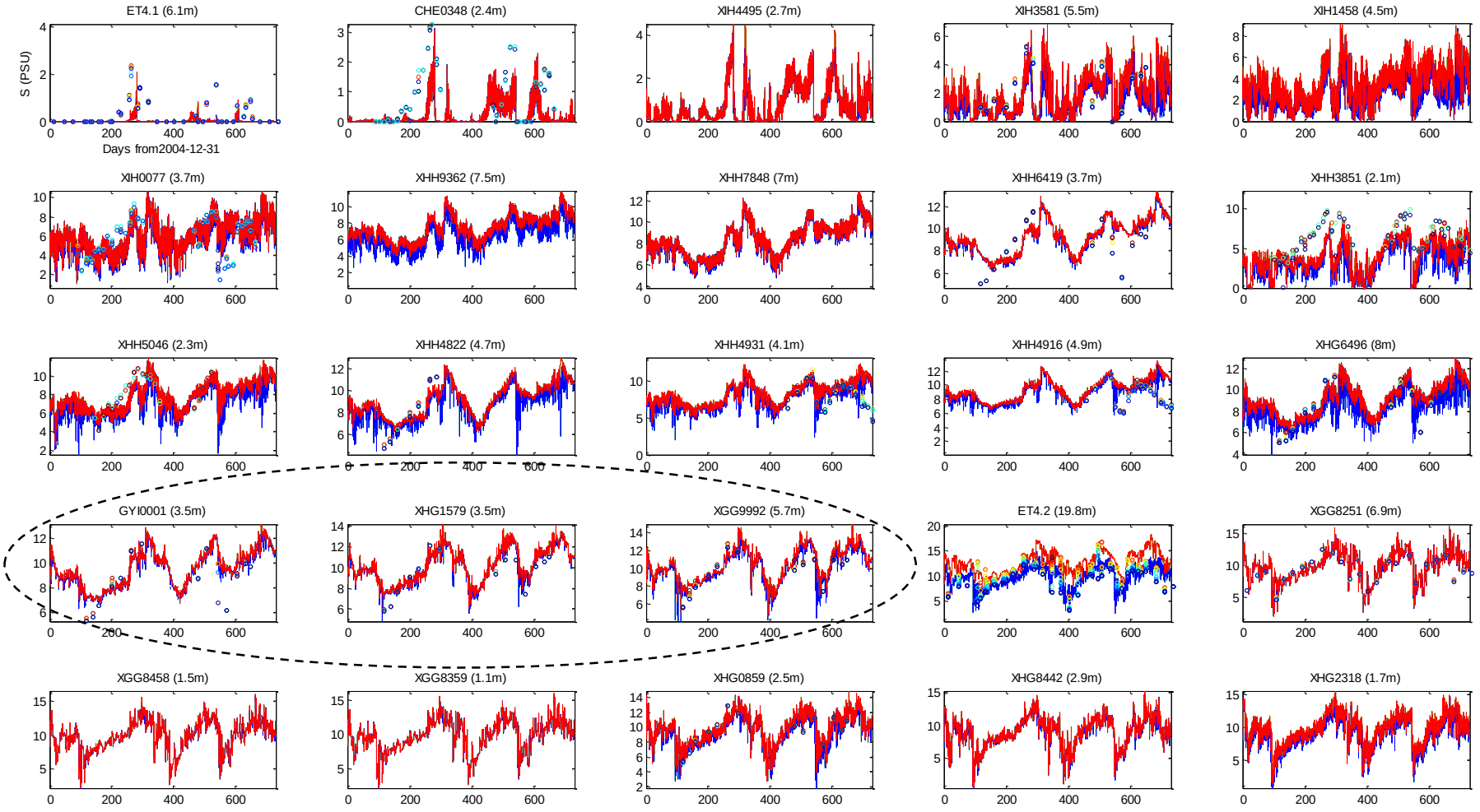
Days from 12/31/2004

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Salinity (with upper bay b.c., 2005~2006)



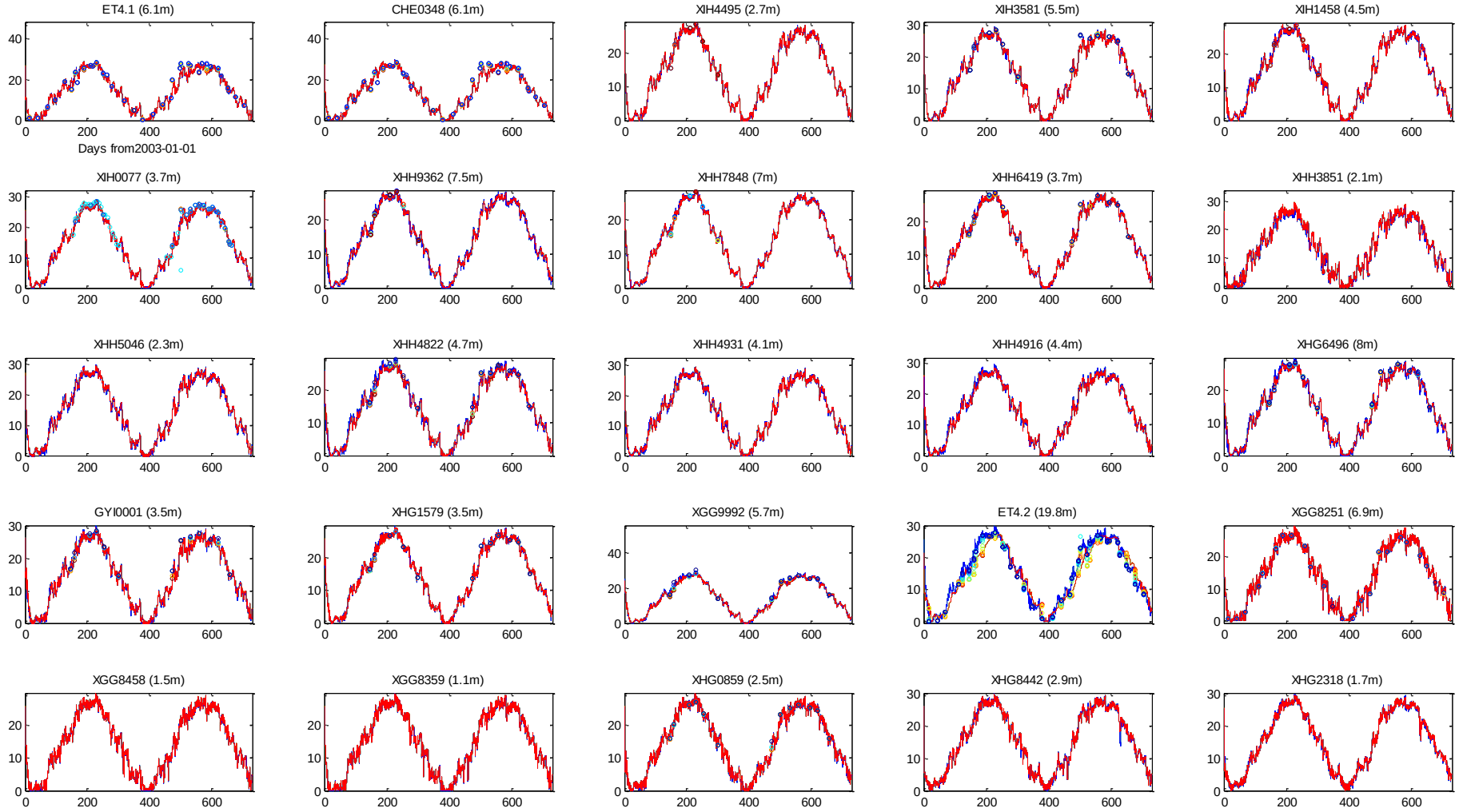
Days from 12/31/2004

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Temperature (with CH3D b.c., 2003~2004)



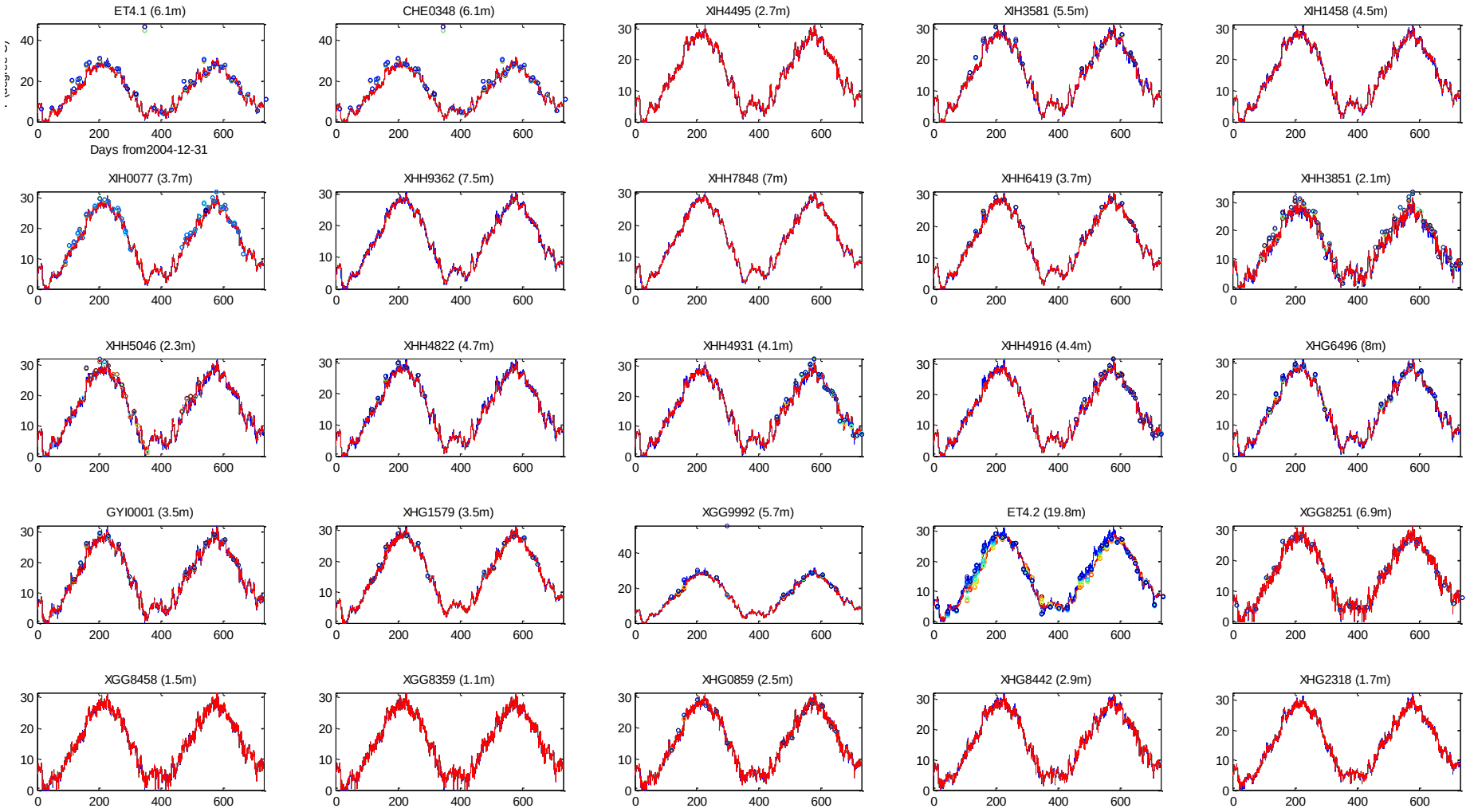
Days from 1/1/2003

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Temperature (with CH3D b.c., 2005~2006)



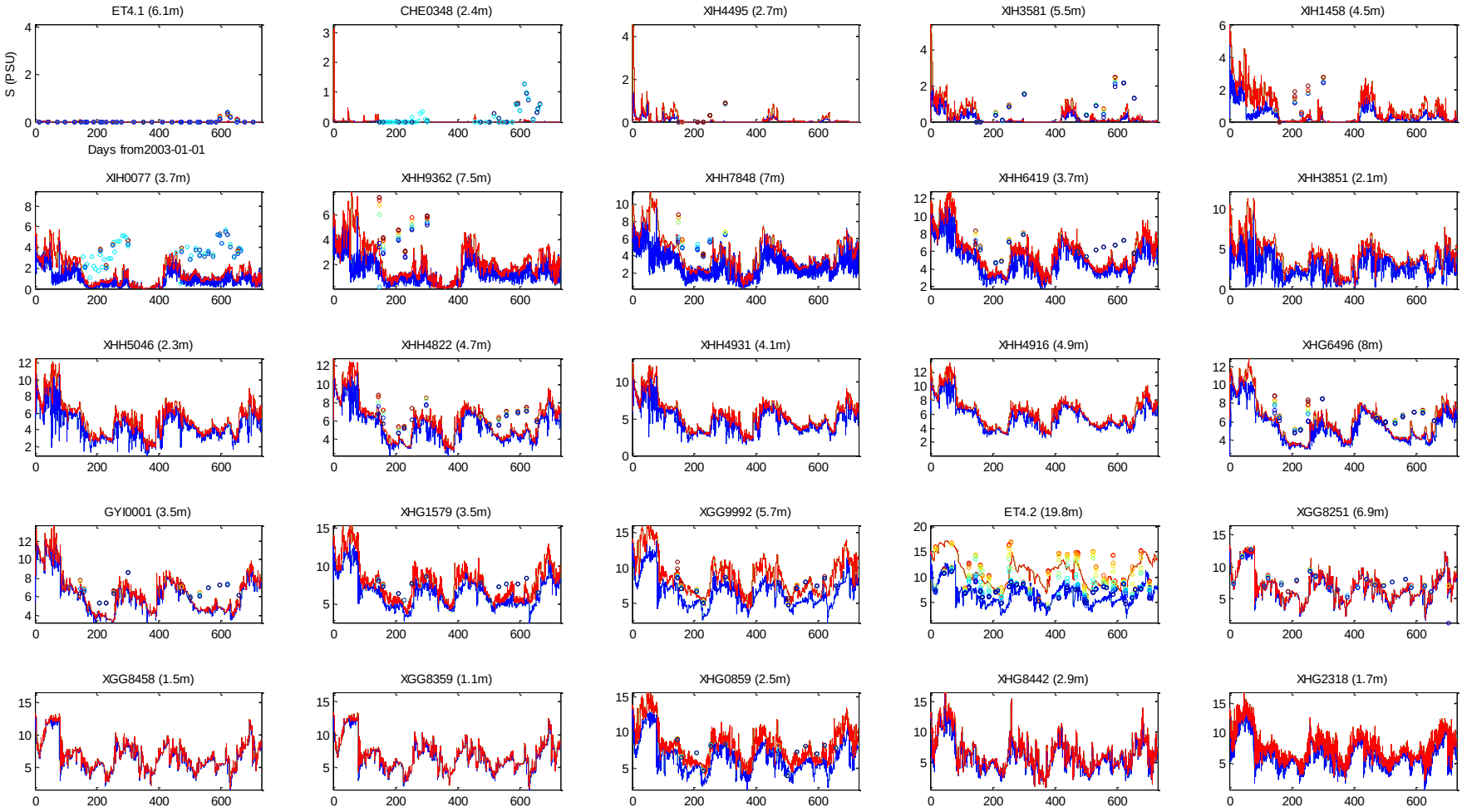
Days from 12/31/2004

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Salinity (**Upper bay model**, 2003~2004)



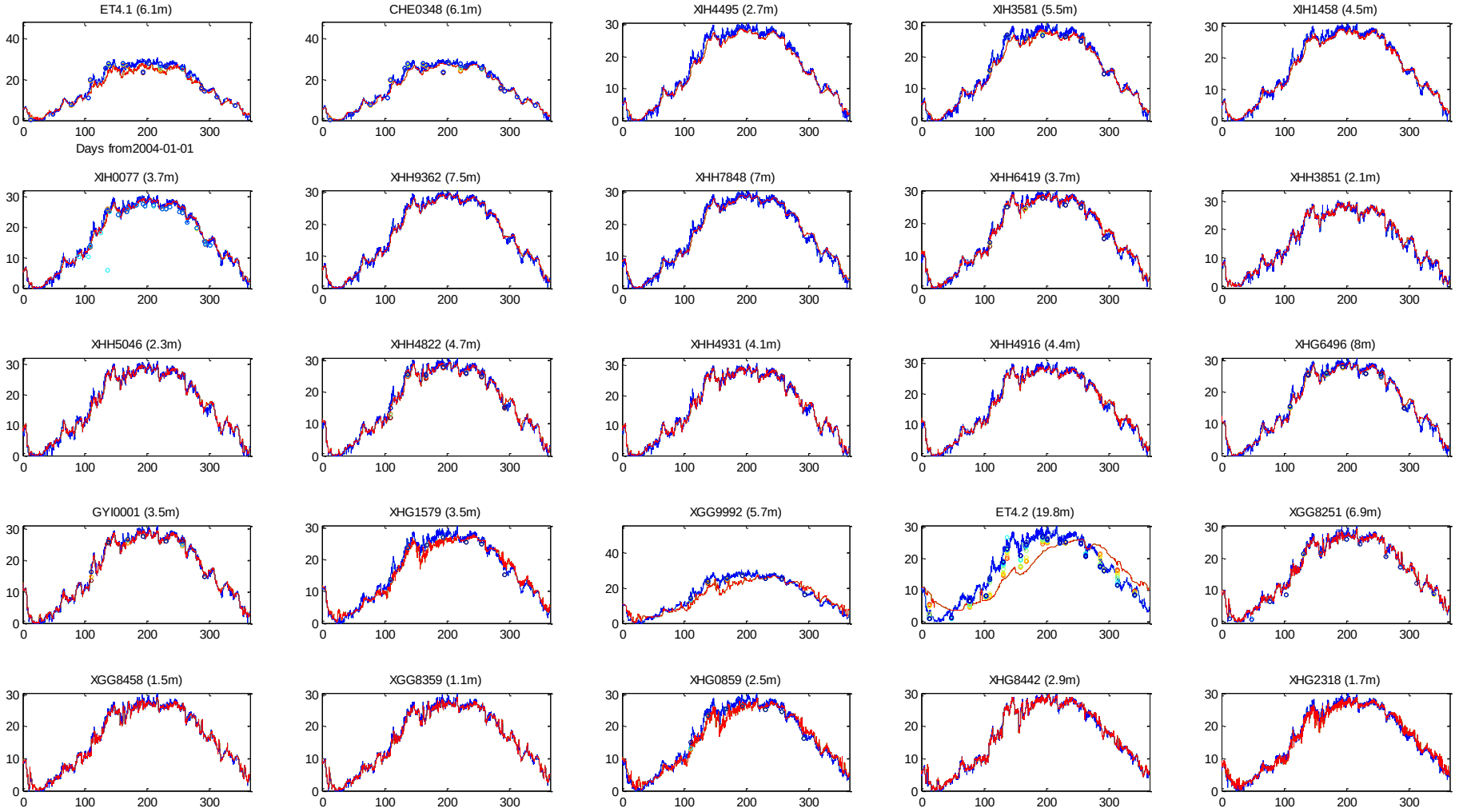
Days from 1/1/2003

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Temperature (Upper bay model, 2004)



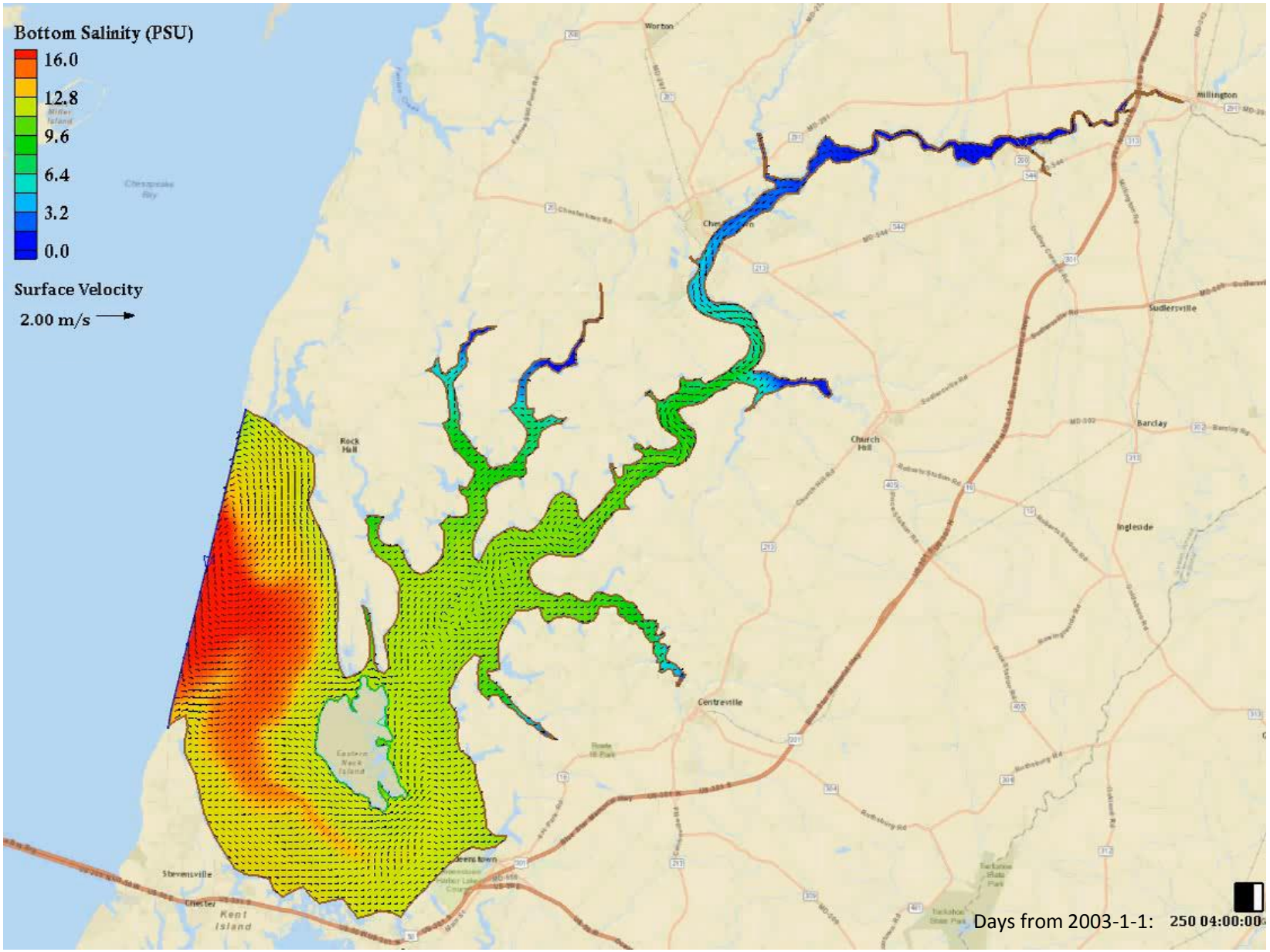
Days from 1/1/2004

Observation: Bottom Surface

Model: Bottom Surface

- The depth of each station is the maximum sampling depth

Response to Hurricane Isabel



Salinity Profiles

Sometimes the model over-stratifies inside Chester