

# Operational Prediction of the Mid Atlantic Bight Ocean Circulation

*J Zavala-Garay*

*John Wilkin, and Julia Levin*

IMCS, Rutgers, The State University of New Jersey, USA

*Reprocessed altimeter data:*

*D. Vandemark, R. Scharoo*



[jzavala@marine.rutgers.edu](mailto:jzavala@marine.rutgers.edu)

<http://marine.rutgers.edu>

RUTGERS

OSTST meeting, Lisbon, Portugal

Oct 19 2010

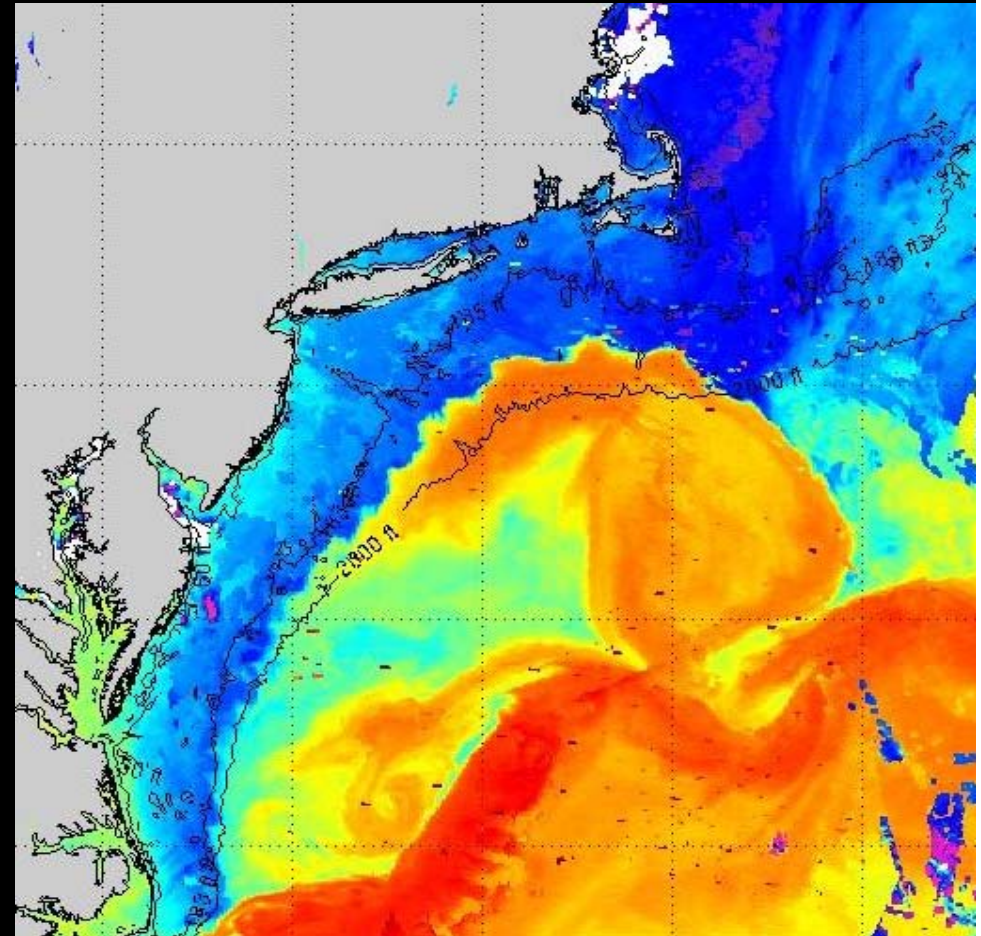
# Outline

- The Mid Atlantic Bight (MAB)
- Model (ROMS)
- Variational Data Assimilation
- Observations (along-track SSHA, SST, CODAR surface currents)
- Real time system details/example
- Final remarks

# The Mid Atlantic Bight (MAB)

## The Mid Atlantic Bight (MAB)

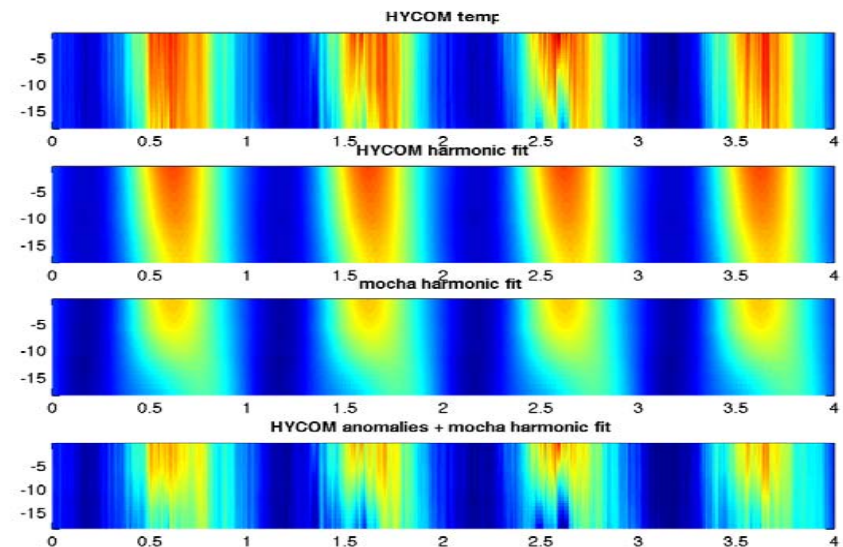
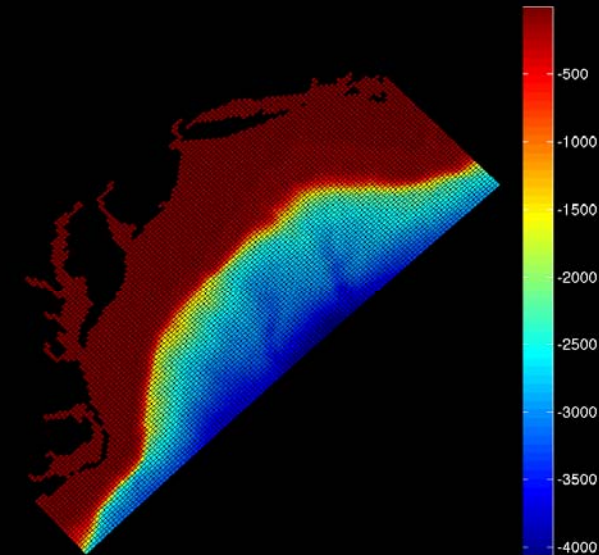
- wide shallow shelf separated from Gulf Stream by the Slope Sea
- Shelf/Slope Front (approx 0.3 m/s) at shelf edge
- Gulf Stream rings frequently enter Slope Sea and impact shelf
- Strong tides
- Shelf variability highly affected by atmospheric forcing



# The Numerical Model

# We use the Regional Ocean Modeling System (ROMS; [www.myroms.org](http://www.myroms.org))

- Resolution approx 5 km resolution
- 36 sigma levels
- Forced at the boundaries by HYCOM-NCODA operational product obtained from a dedicated ftp site at NRL Stennis-> **seasonal bias correction!**
- Surface Forcing by North American Mesoscale Model (NAM) forecast system from NCEP via NOMADS opendap server (3 hrs and ~15 km resolution)
- Rivers from USGS
- Tides from ADCIRC tidal model

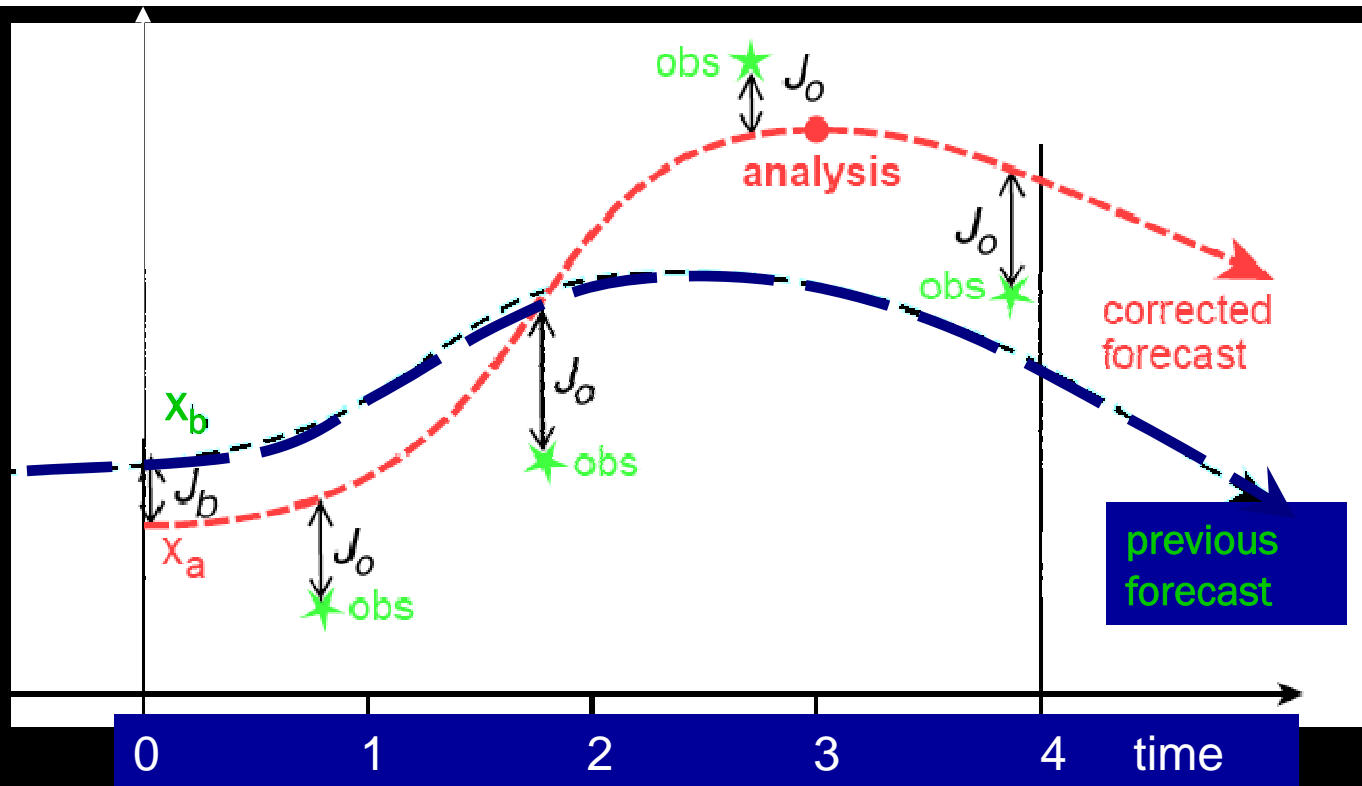


# The variational data assimilation system

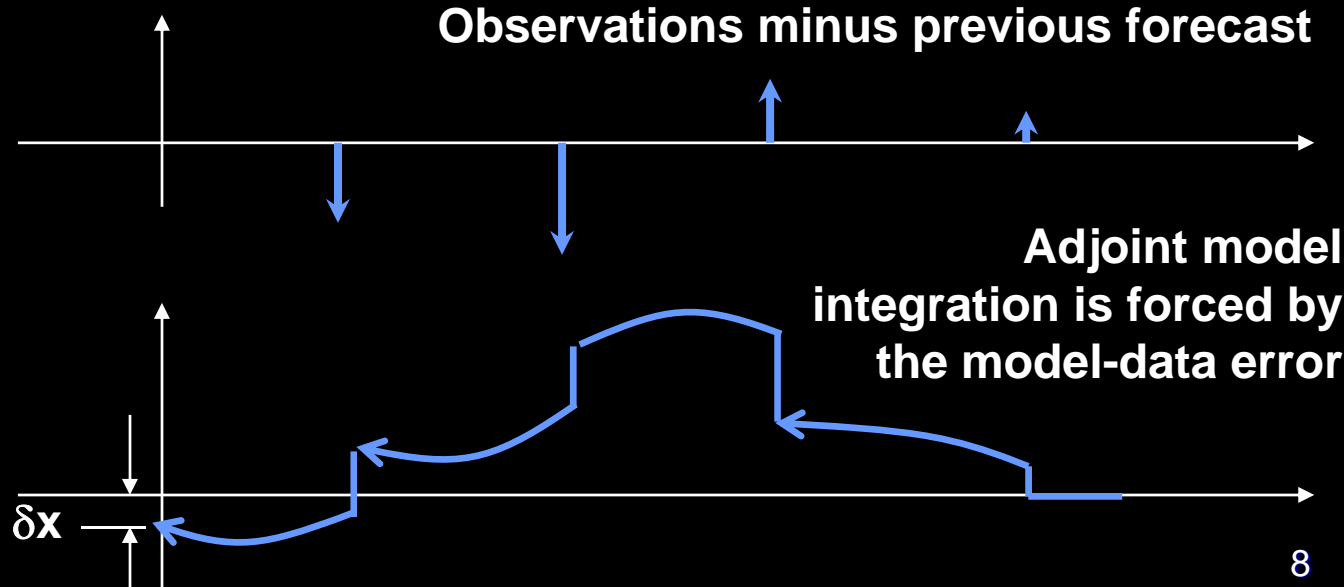
$x_b$  = model state (background) at end of previous cycle, and 1<sup>st</sup> guess for the next forecast

In 4DVAR assimilation the adjoint gives the sensitivity of the initial conditions to mis-match between model and data

A descent algorithm uses this sensitivity to iteratively update the initial conditions,  $x_a$ , (analysis) to minimize  $J_b + J_o$



Observations minus previous forecast



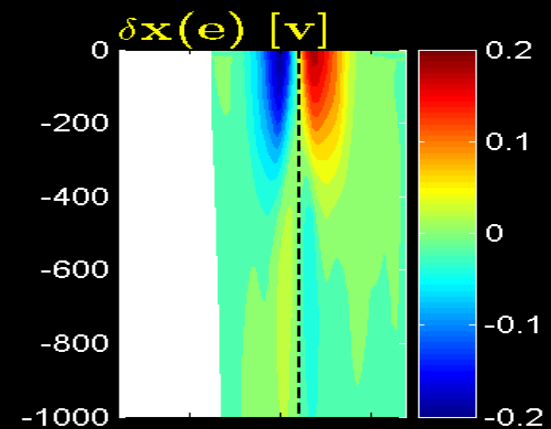
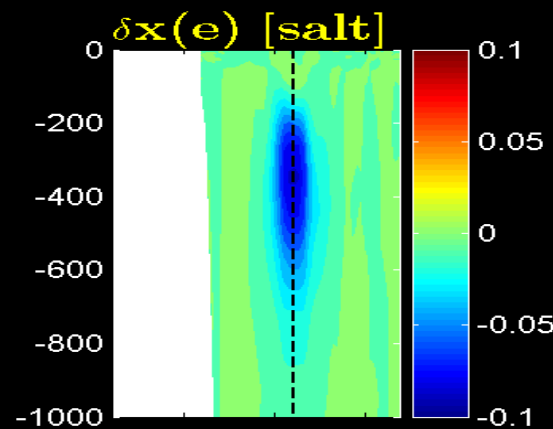
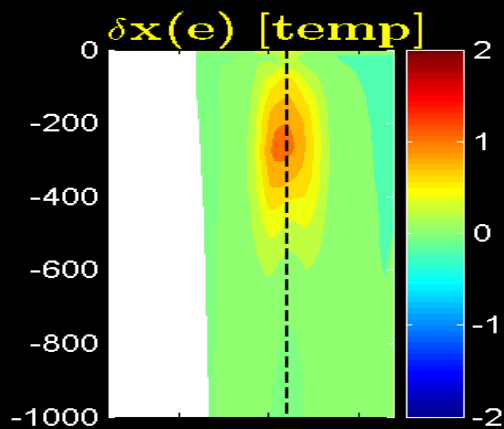
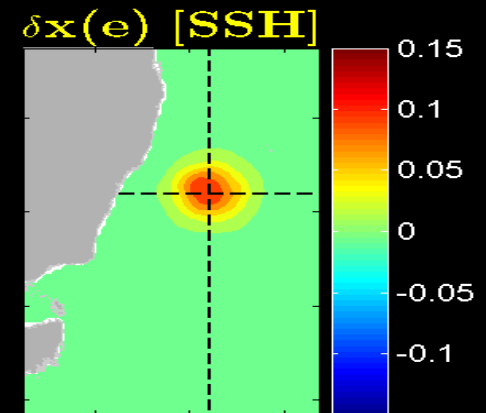


For a single observation (e.g. SSH at one grid point)  
the increment is given by:

$$\delta \mathbf{x} = \mathbf{c} \mathbf{B} \mathbf{M}^T \mathbf{e}$$

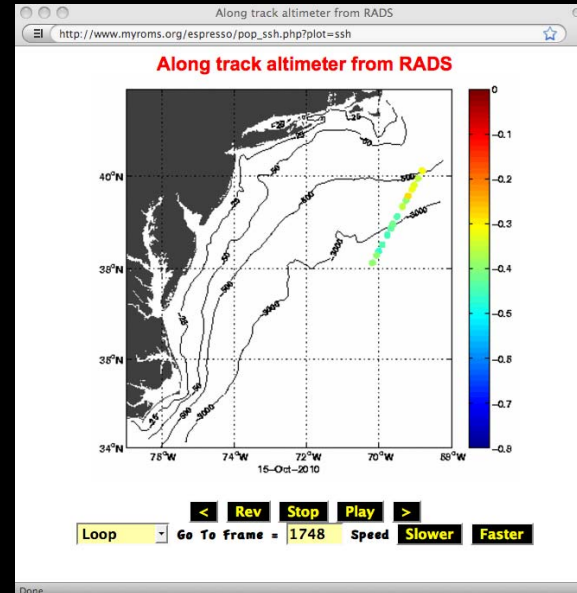
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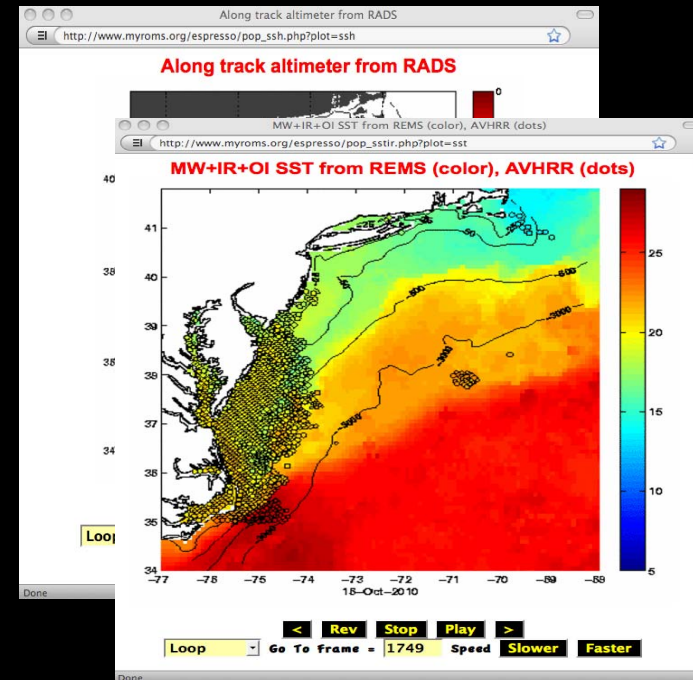


# The Observations

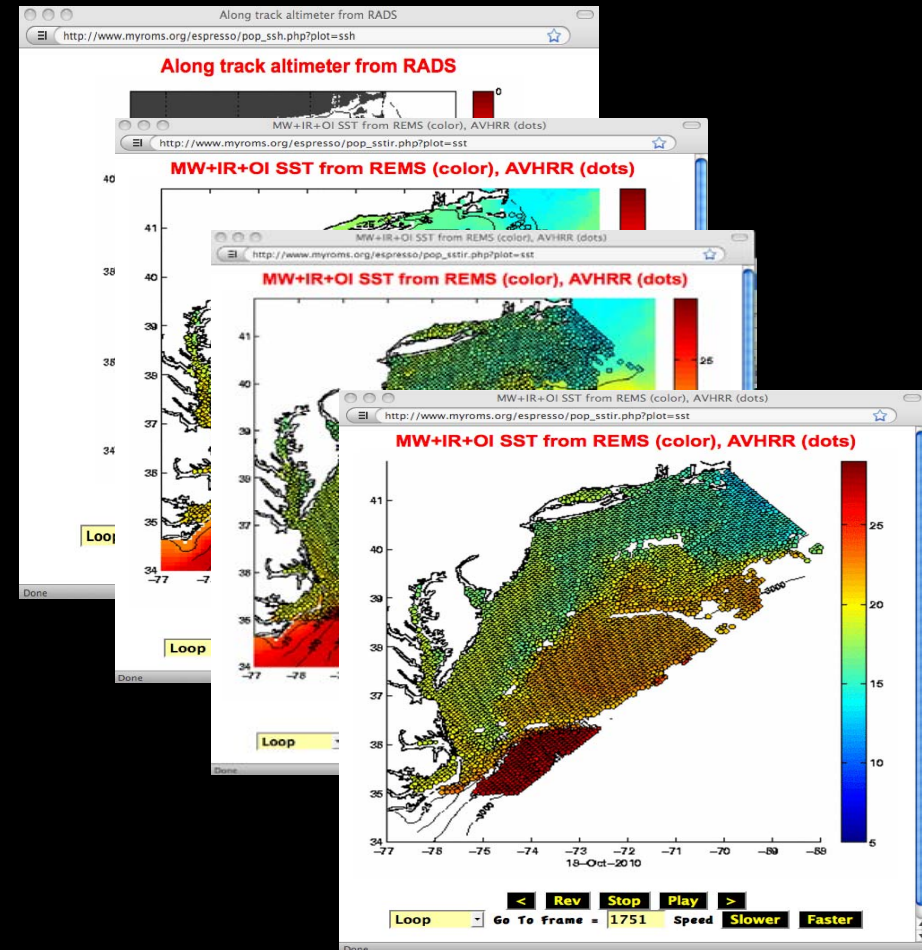
- Jason-2 SSH anomalies from RADS served via UNH



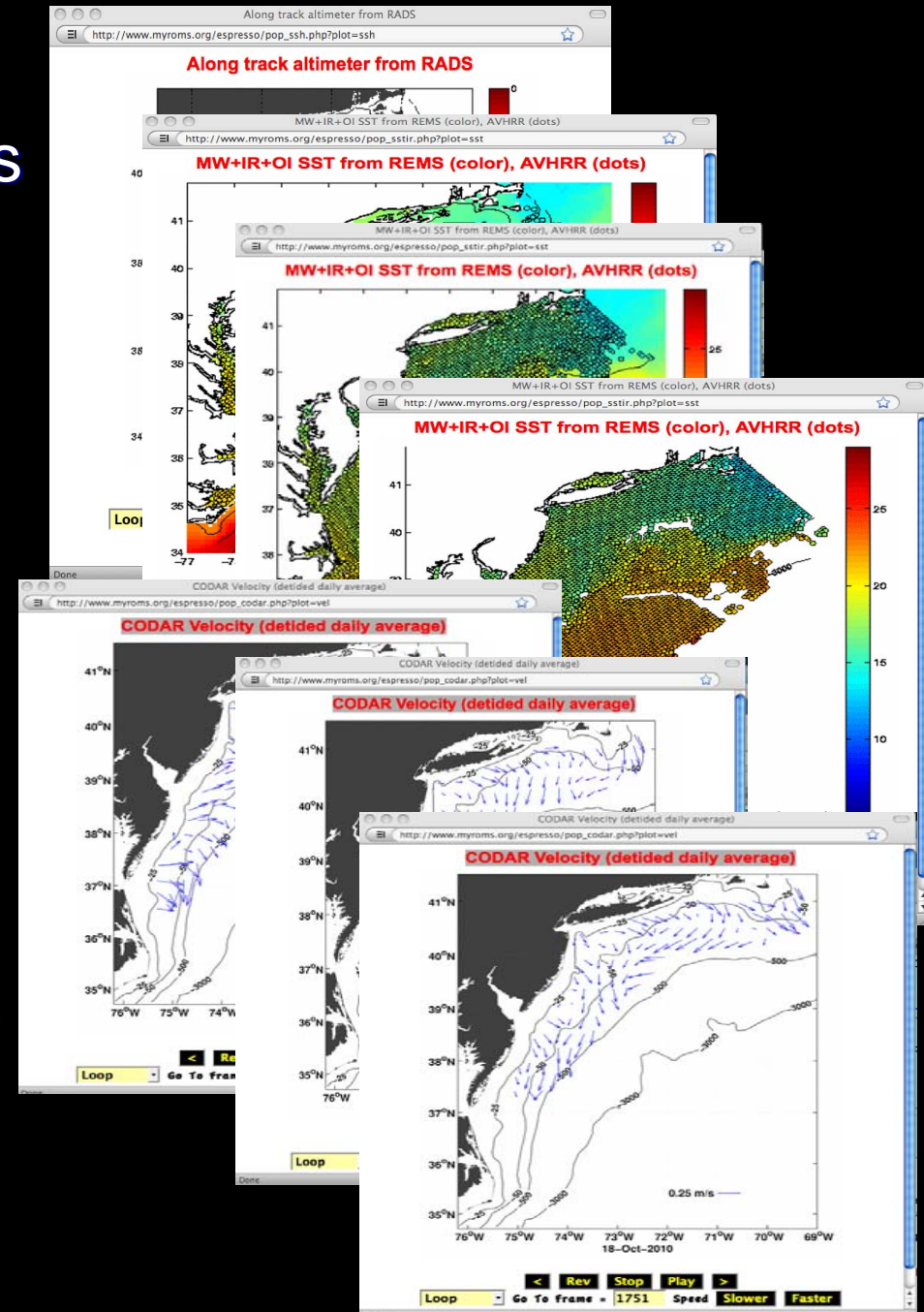
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- SST from Rutgers University Coastal Ocean Observation Laboratory (RU-COOL) NOAA/POES AVHRR instrument
- 1-day blended SST (MW+AVHRR+OI).



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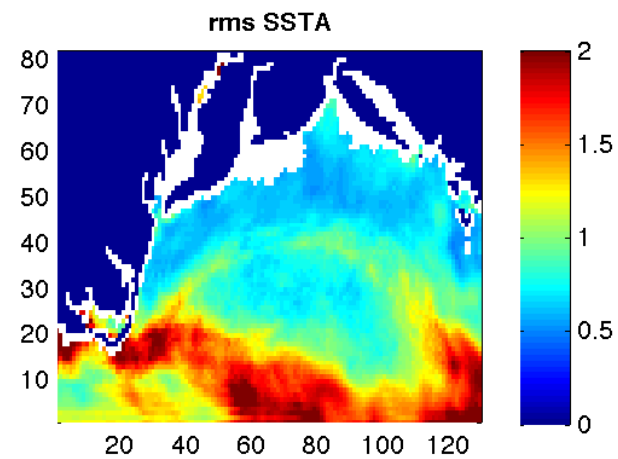
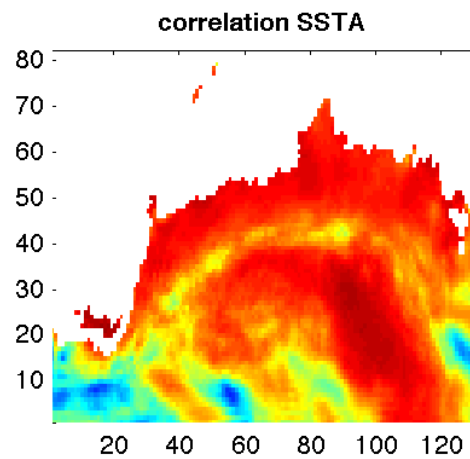
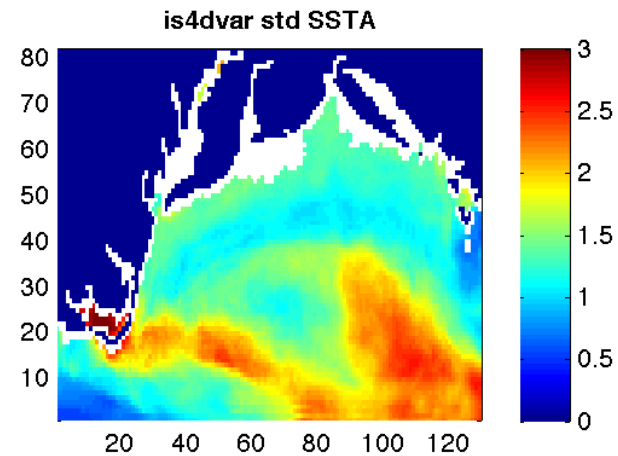
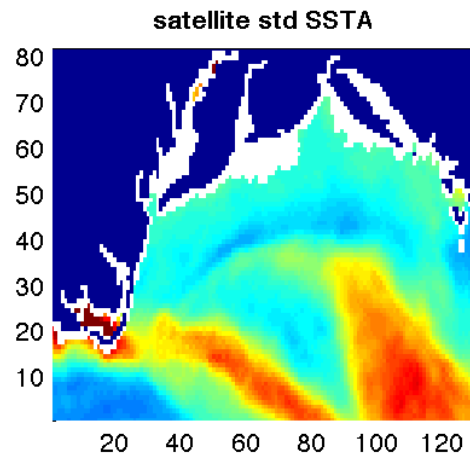
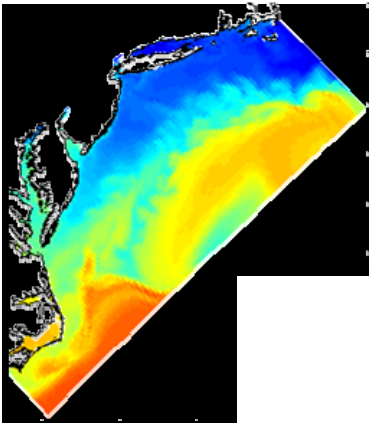
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- Hourly CODAR surface velocities from RU-COOL



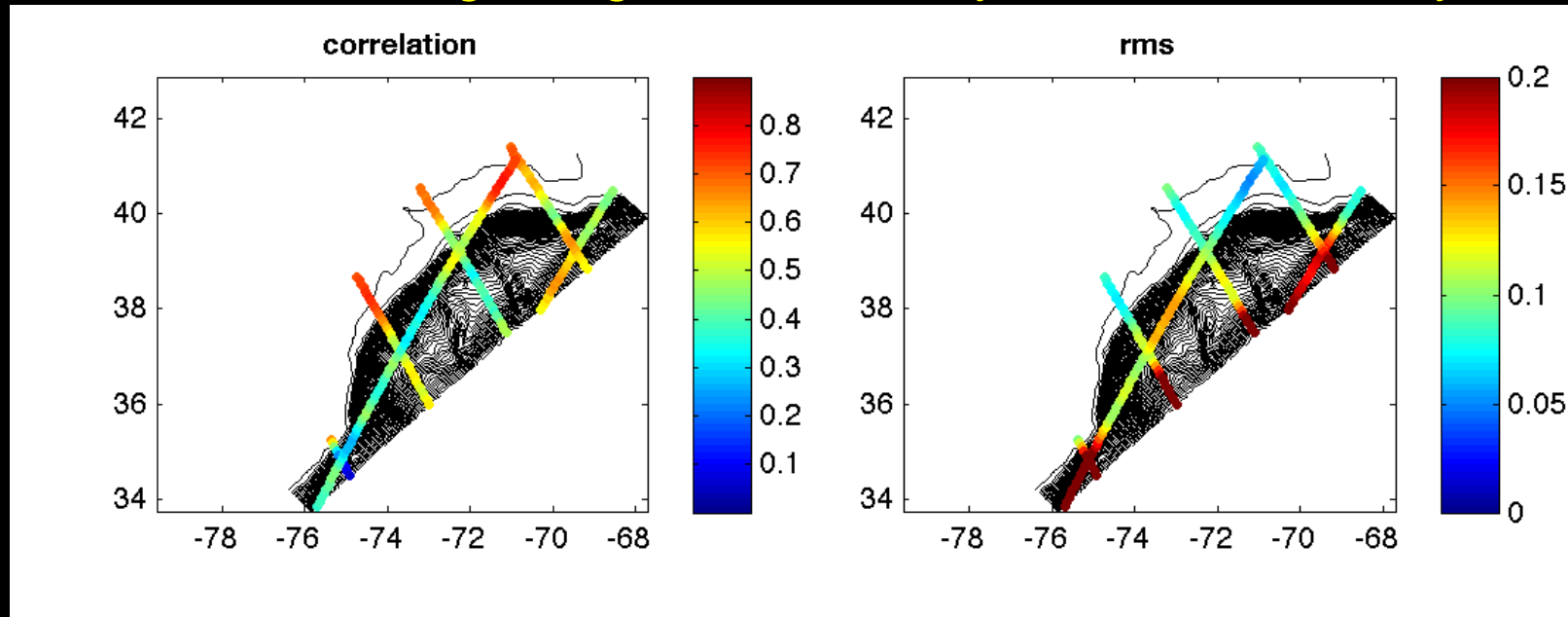
# Validation



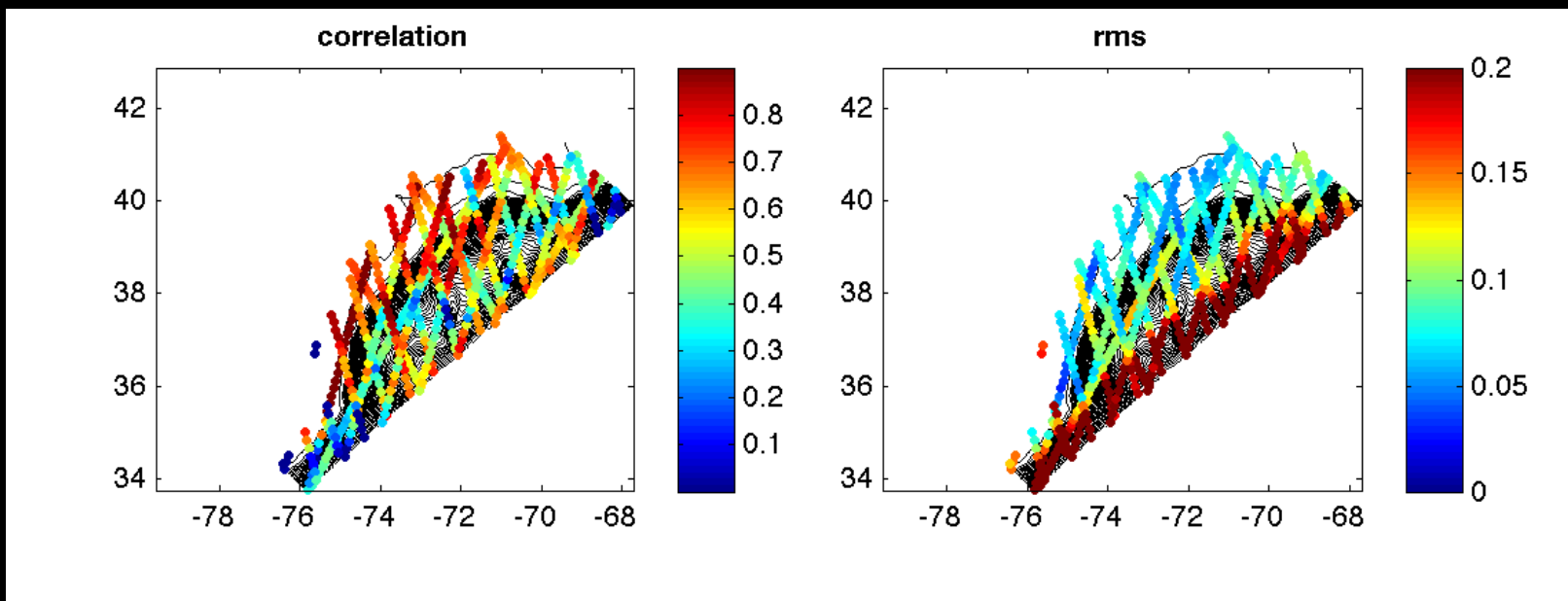
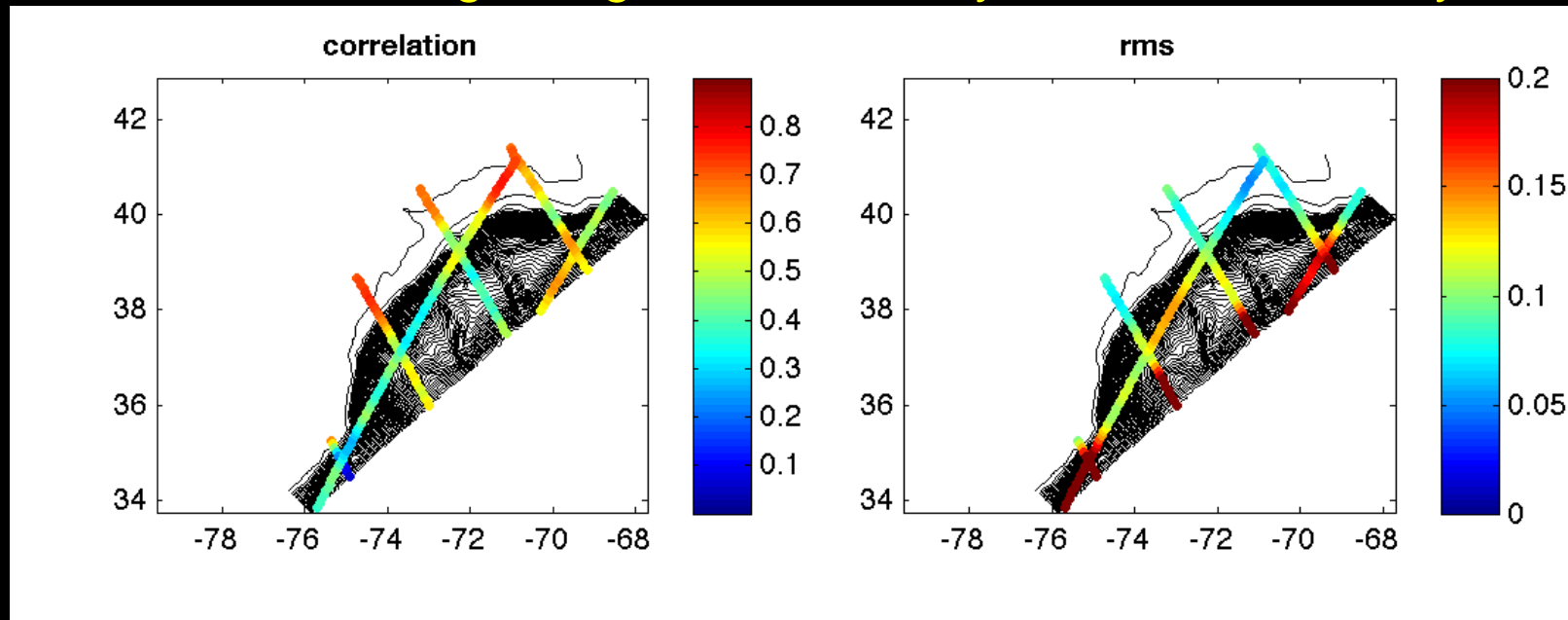
# Skill in hindcasting mesoscale SST by the assimilation system



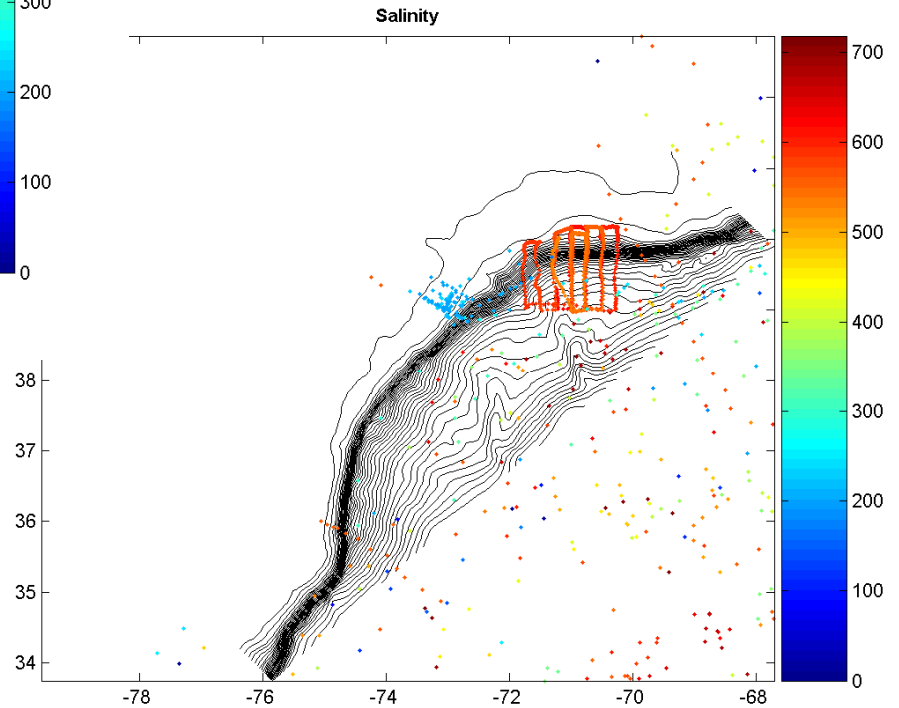
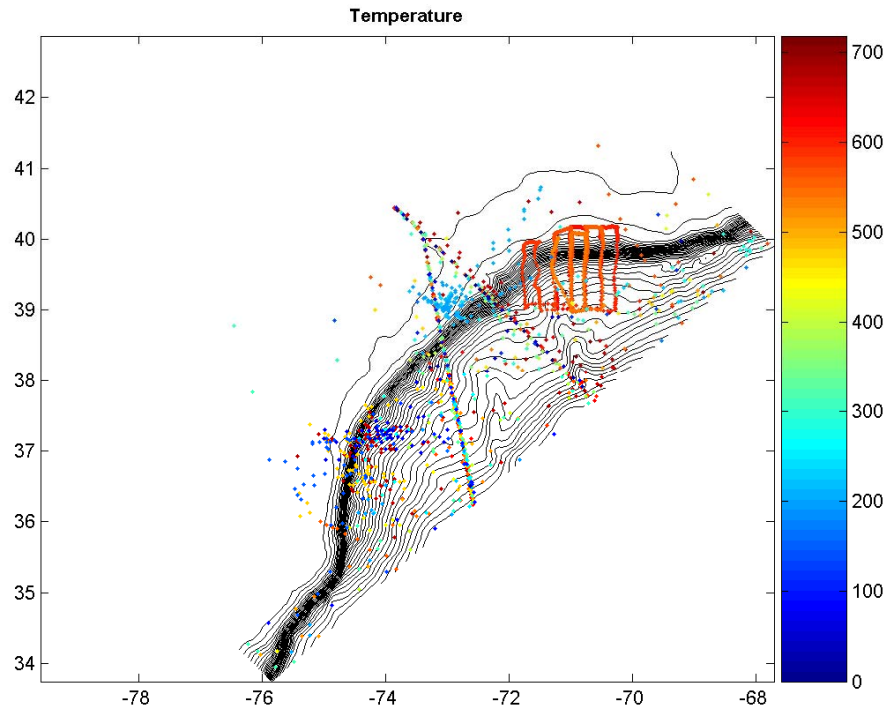
# Skill in hindcasting along-track SSHA by the assimilation system



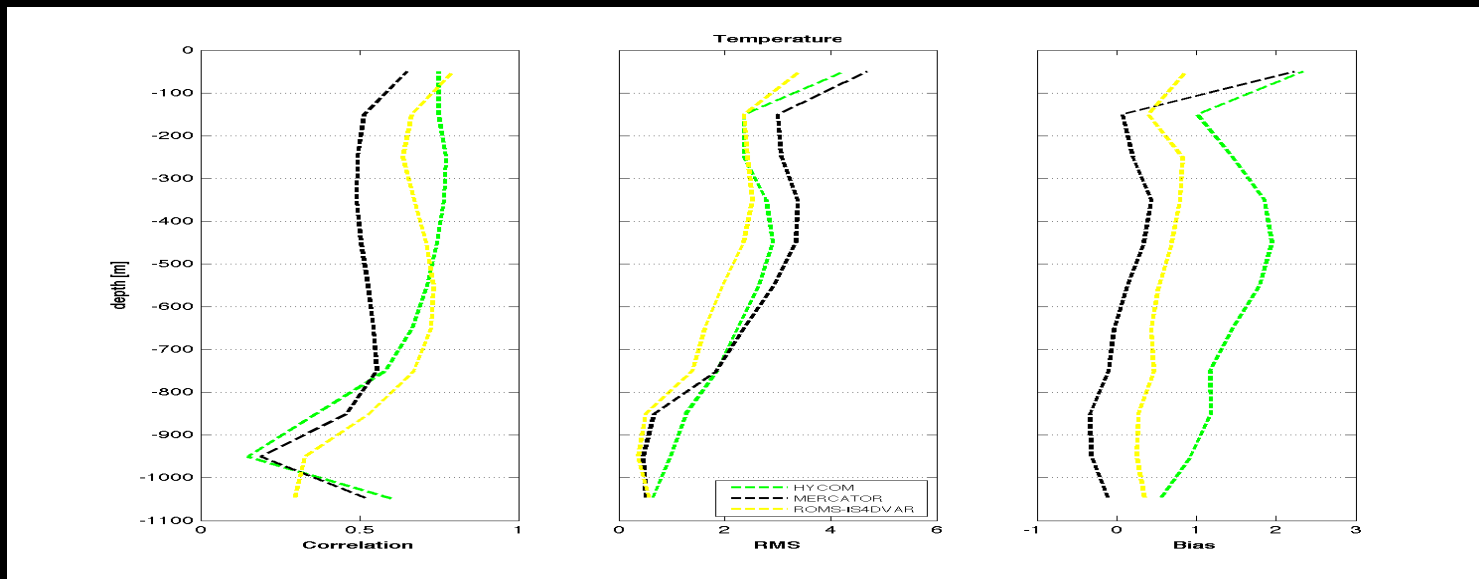
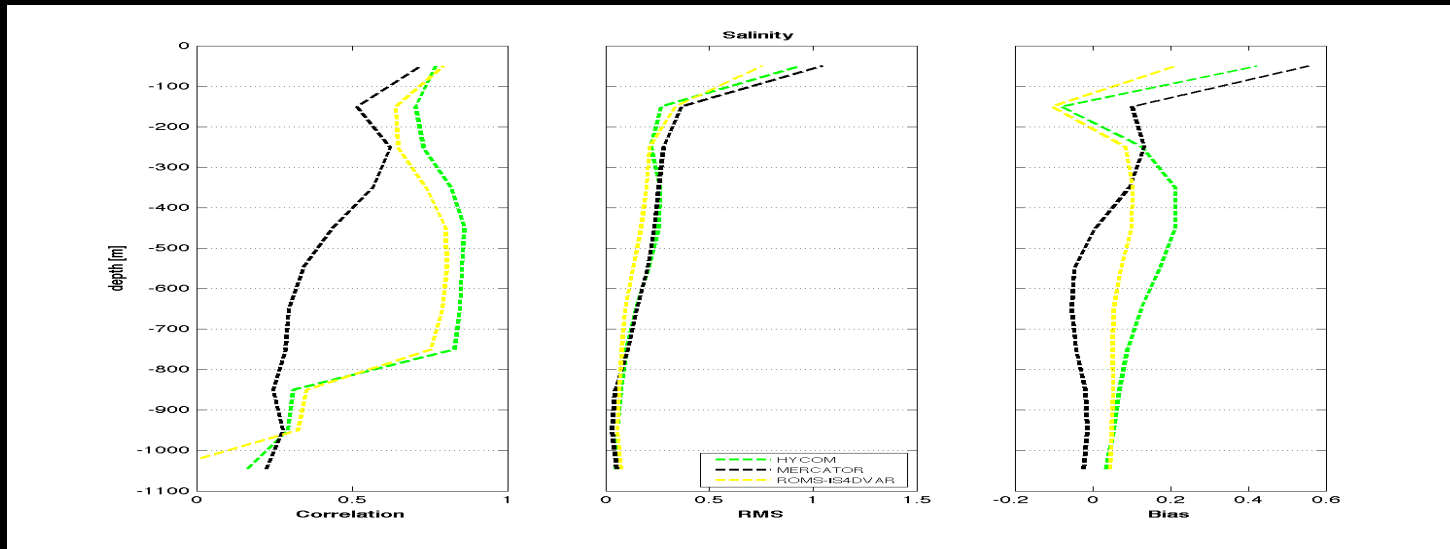
# Skill in hindcasting along-track SSHA by the assimilation system



# Large set of T and S observations from CTD, gliders, XBTs for 2006 and 2007



# Correlation, rms error, and bias in hindcasting the vertical structure of temperature and salinity.



# Real time system details and example

$t = -24$  hrs

$t = 0$

$t = +24$  hrs



@ 3:30am: Assimilation of last 3 days of observations (~4 hrs)

@ 7:30am: Forecast for the next 58 hrs

$t = -24$  hrs

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@ 3:00am get and process CODAR

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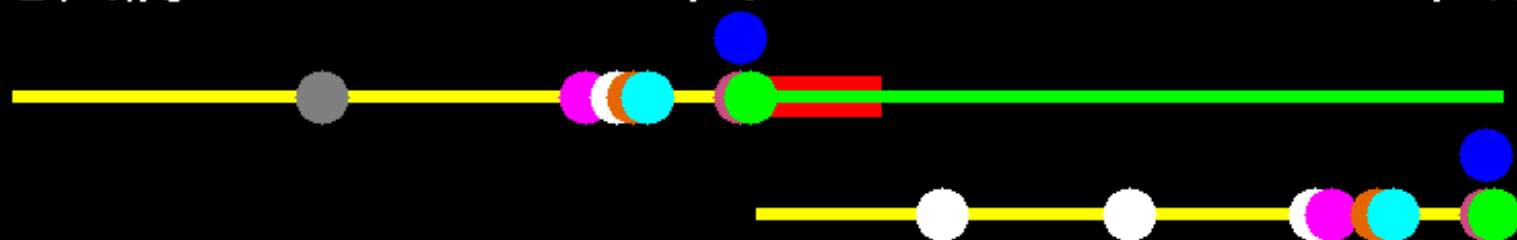
@ 3:00am get and process CODAR

@ 3:10am prepare the Jason-1 along track data

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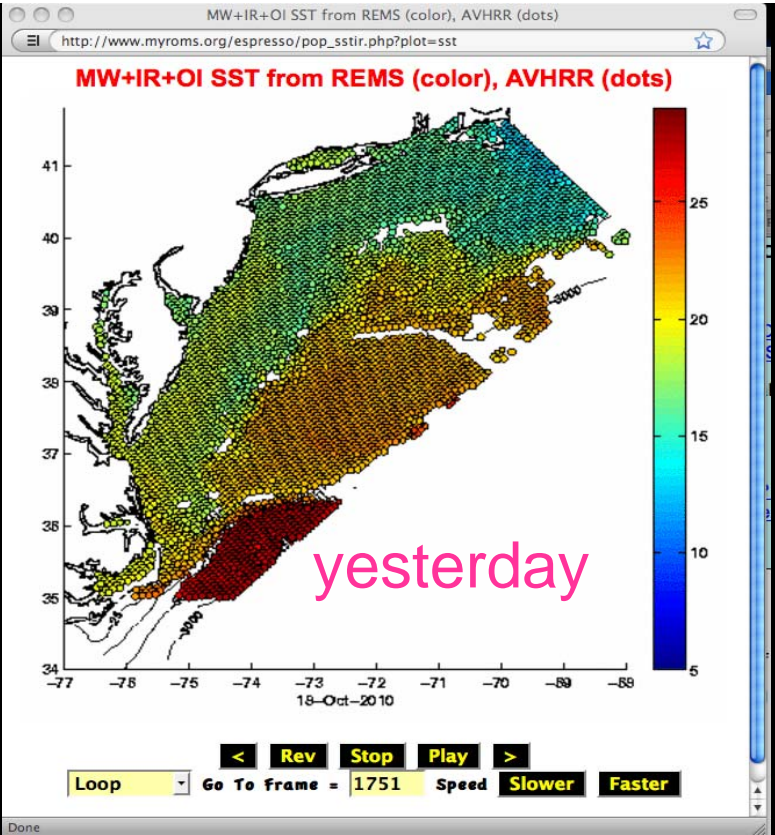
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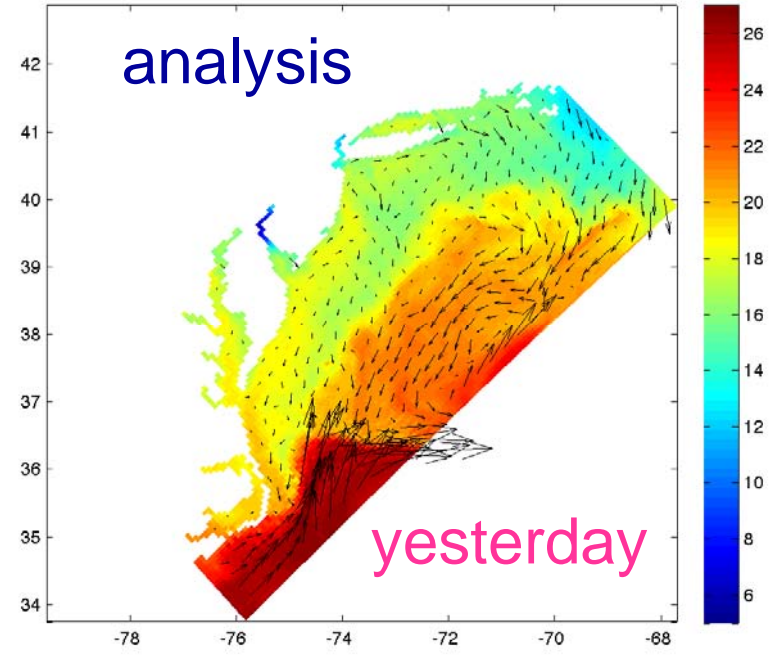
@ 3:00am get and process CODAR

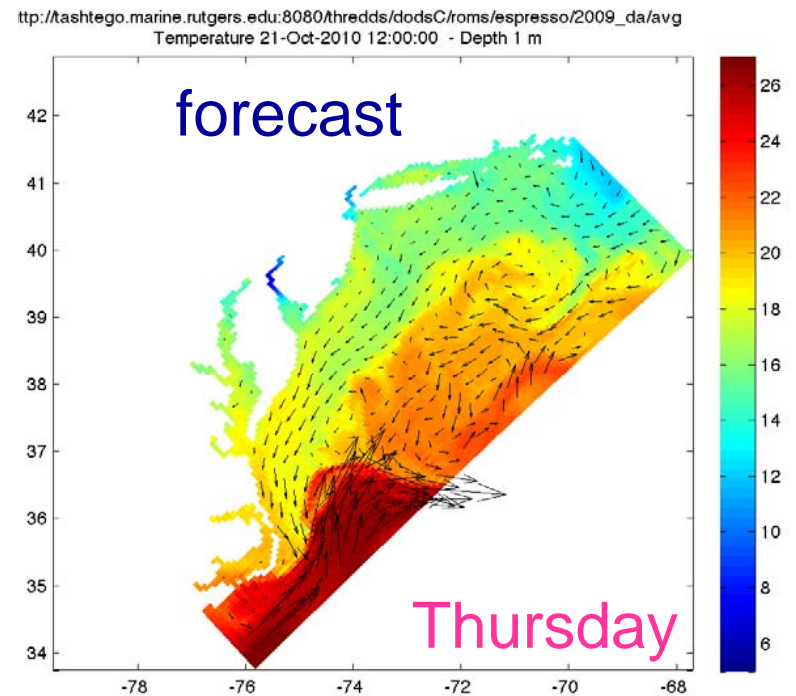
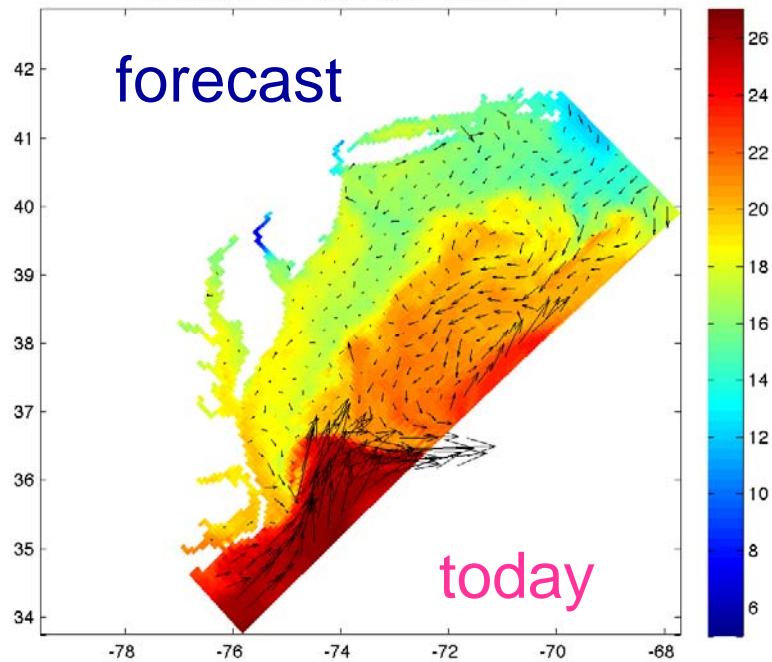
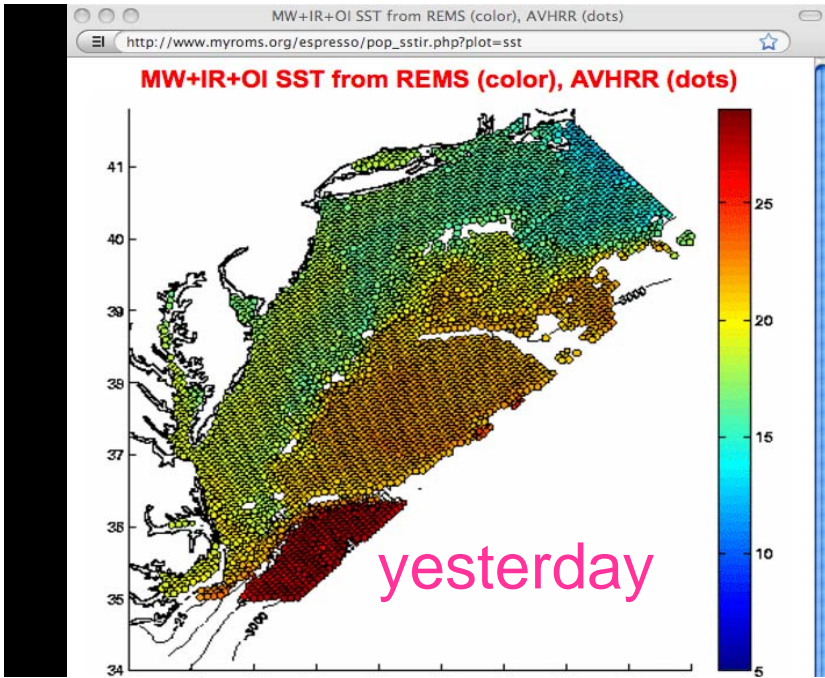
@ 3:10am prepare the Jason-1 along track data





file: [http://tashtego.marine.rutgers.edu:8080/thredds/dodsC/roms/espresso/2009\\_da/avg](http://tashtego.marine.rutgers.edu:8080/thredds/dodsC/roms/espresso/2009_da/avg)  
 Temperature 18-Oct-2010 12:00:00 - Depth 1 m





# Final Remarks

The operational version of ESPRESSO uses 4-dimensional variational (4DVAR) data assimilation techniques to integrate a 3-dimensional coastal model (ROMS) with near real-time along-track SSHA from Jason-2, SST from different satellite sensors, and CODAR surface currents.

Comparison with not-assimilated ENVISAT SSHA data, and insitu temperature and salinity observations suggest that the regional model has a good skill in regridding the SSH field and predicting the 3-dimensional circulation.

Need to validate the operational system and improve the boundary forcing used in the model

[www.myroms.org/espresso](http://www.myroms.org/espresso)