

# Implementation of the **Reduced Order Information Filter** **ROIF**

## Data Assimilation Scheme in HYCOM

An Update on Tuning Experiments in Progress  
&  
Computational Performance

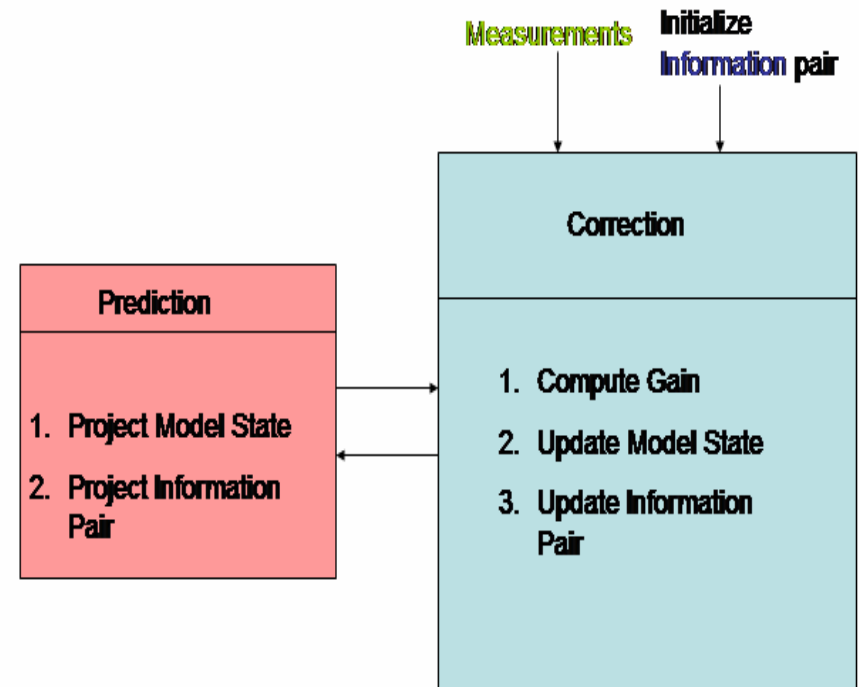
Ashwanth Srinivasan, Mike Chin, Eric Chassignet  
and  
Arthur Mariano

# Reduced Order Information Filter

## Information Filter:

- Algebraically same as the **Kalman Filter**
- Propagates the **Information Matrix** which is the **inverse** of the Covariance matrix
- Often a convenient form to circumvent computational and numerical difficulties associated with Kalman Filter recursion

Reference: Chin, Mariano & Chassignet 1999.

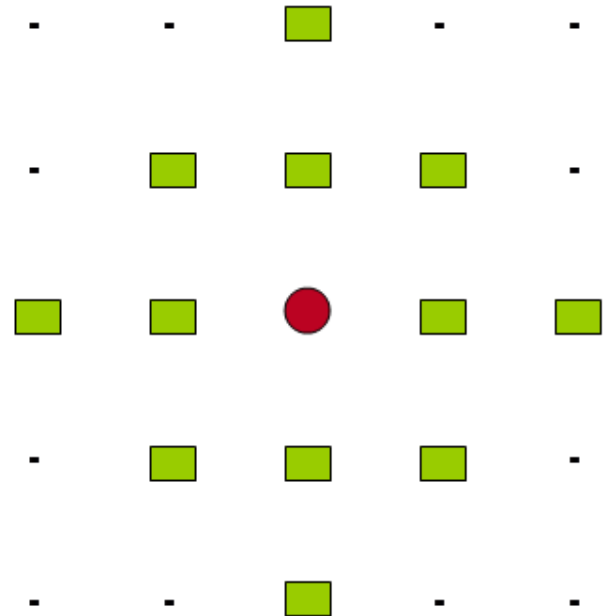


Schematic of the Kalman Filter Recursion

# Reduced Order Information Filter

- Gaussian Markov Random Field (GMRF) is used to parameterize the Information Matrix
- A regression operator encodes the correlation in the error process

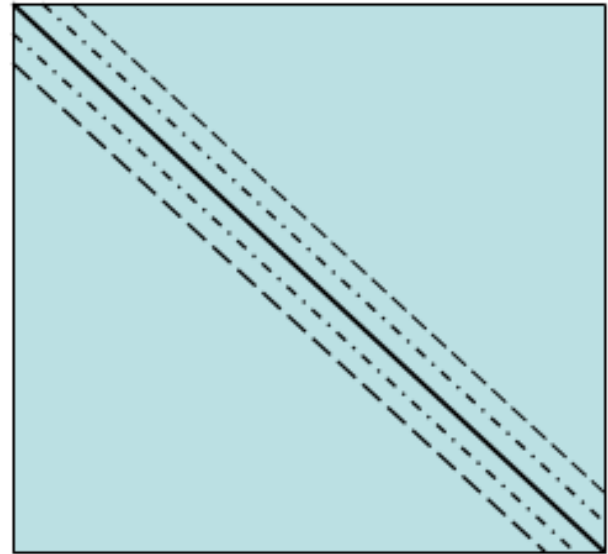
$$e_j = \sum_{i \in \mathcal{Z}} \alpha_{ij} e_{j-i} + v_j$$



MRF order 2 Neighborhood

# Reduced Order Information Filter

- Regression operator implies a sparse Information matrix
- Degree of sparseness is the order of the spatial/diagnostic model
- MRF order =2 => Penta diagonal Information Matrix
- $O(N^2)$  Information Matrix approximated with  $O(n \times N)$  elements Reduced Order Information Matrix



---

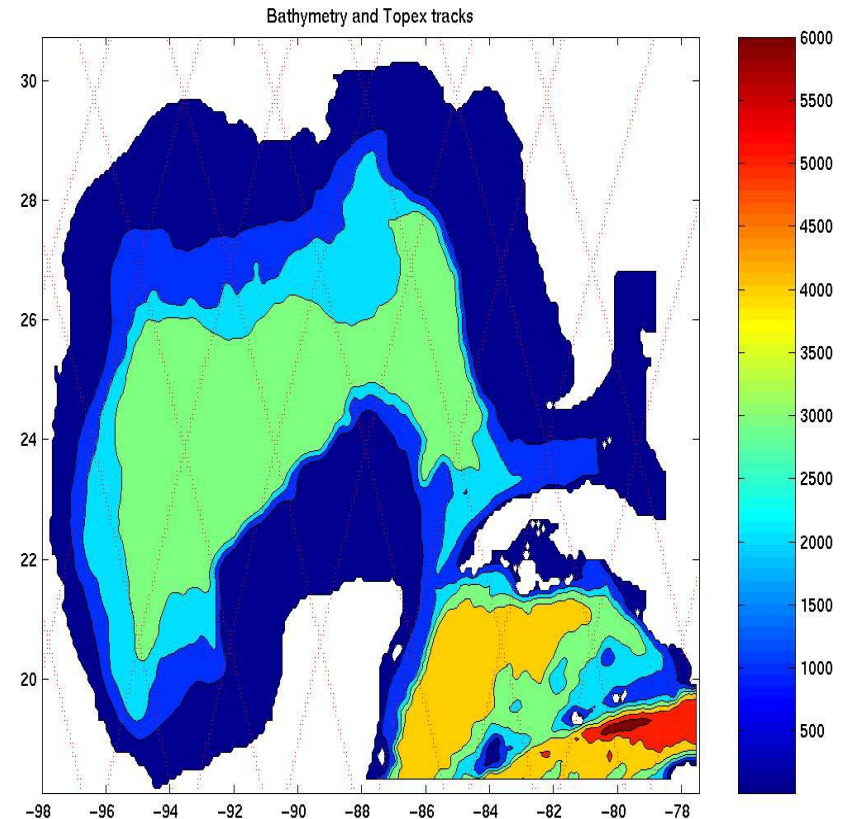
# Twin Experiments with $1/12^\circ$ HYCOM configured for Gulf of Mexico

---

# GOMd0.08 Configuration:

## Configuration:

- 1/12° horizontal grid  
(258x175 pts; 6.5km average spacing)
- 89 to 98 W Longitude and 8 to 31 N Latitude
- 20 vertical layers
- Forcing from NOGAPS/FNMOC
- Monthly River Runoff
- Relaxation of U,V,T,S to 1/12 N. Atlantic Model

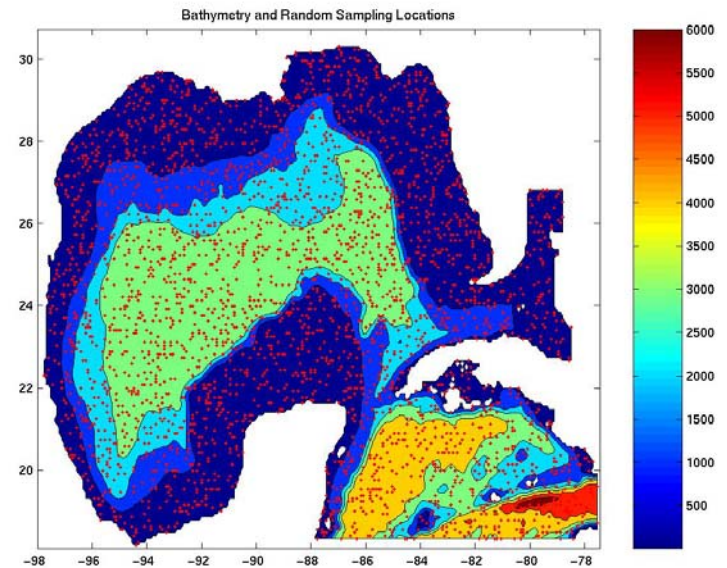
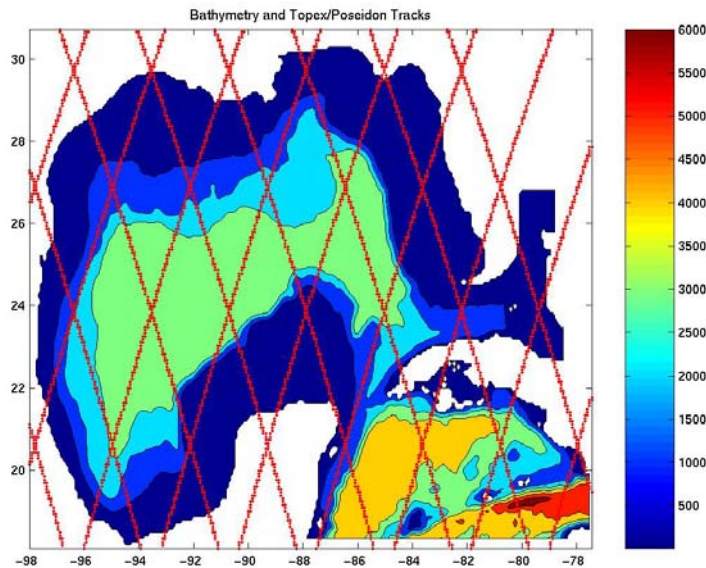


---

# Twin Experiments Configuration

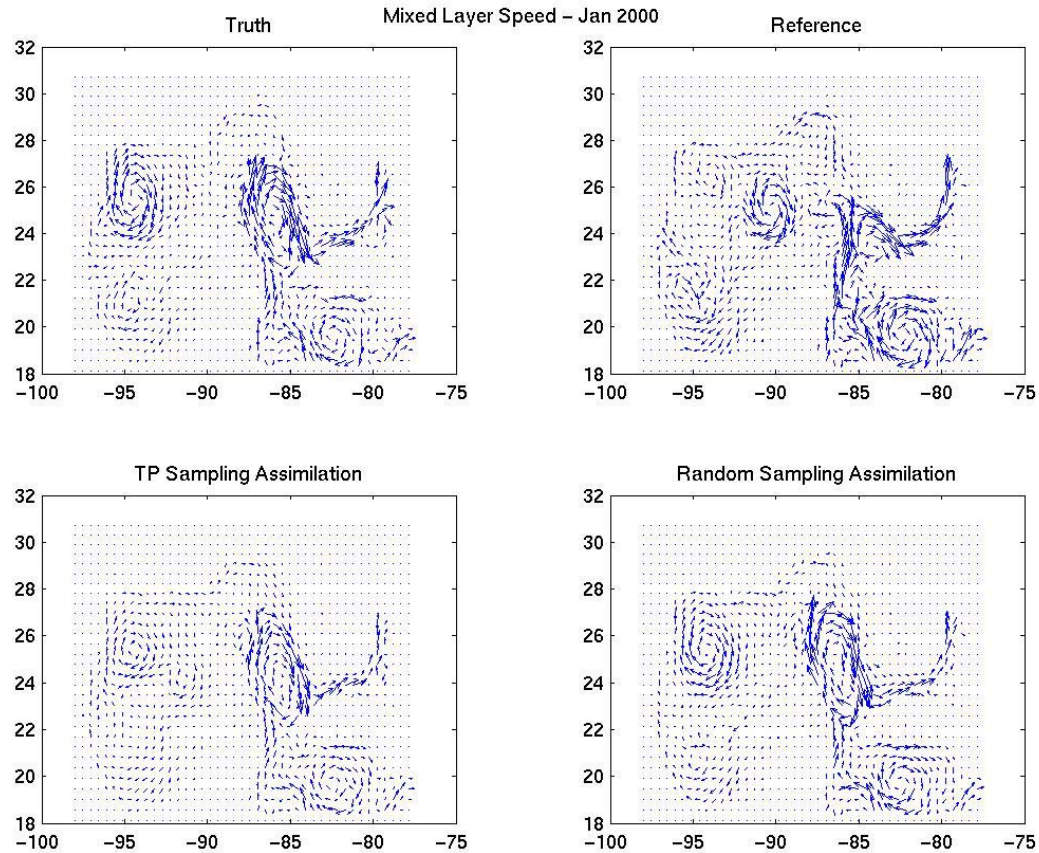
- Used **GOMd0.08 package** from the HYCOM FTP site
  - **Truth** – Output from running the GOMd0.08 package as configured – Aug 1999 – Dec 2000
  - **Reference** – Run the GOMd0.08 configuration, no assimilation without the restart file
  - **ROIF – TP Assimilation** – Run the GOMd0.08 model with assimilation of SSH sampled under TP tracks from the Truth run without a restart file
  - **ROIF – Random Assimilation** - Run the GOMd0.08 model with assimilation of SSH sampled randomly from the Truth run without a restart file (same no of data pts as the TP run)
-

# Domain and Topex/Poseidon Tracks and Random Sampling Locations

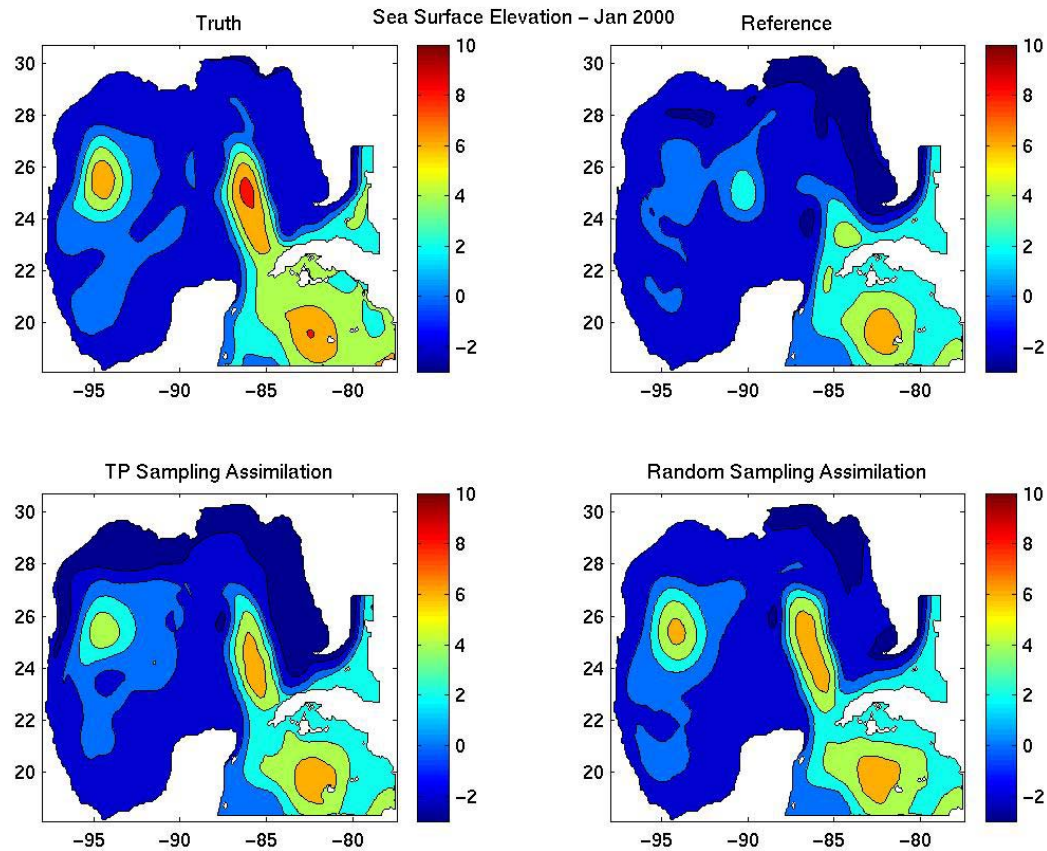




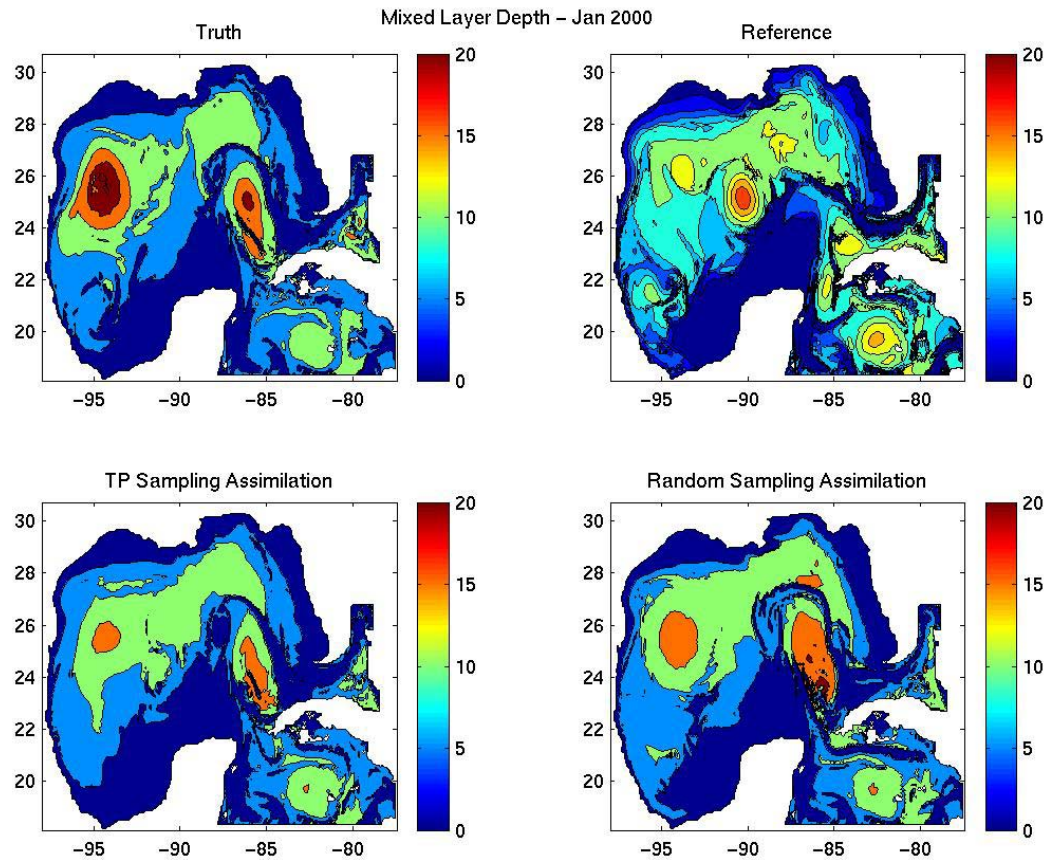
# Twin Experiments with ROIF



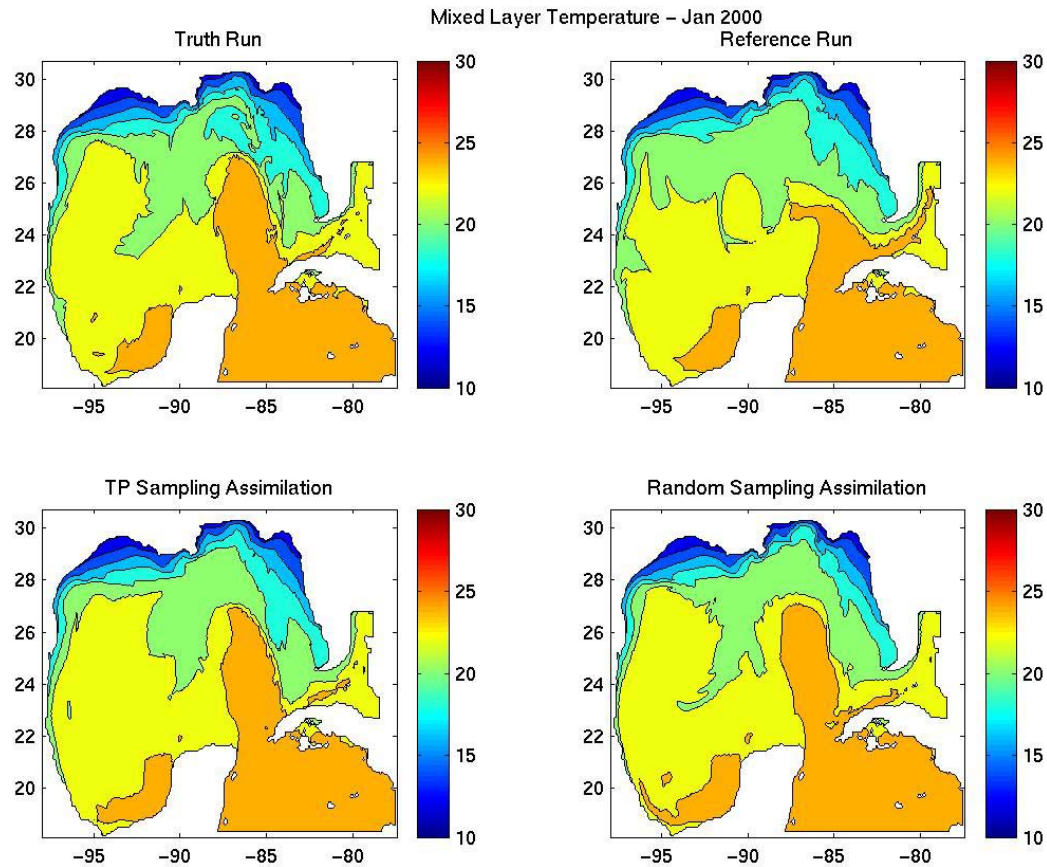
# Twin Experiments with ROIF



# Twin Experiments with ROIF



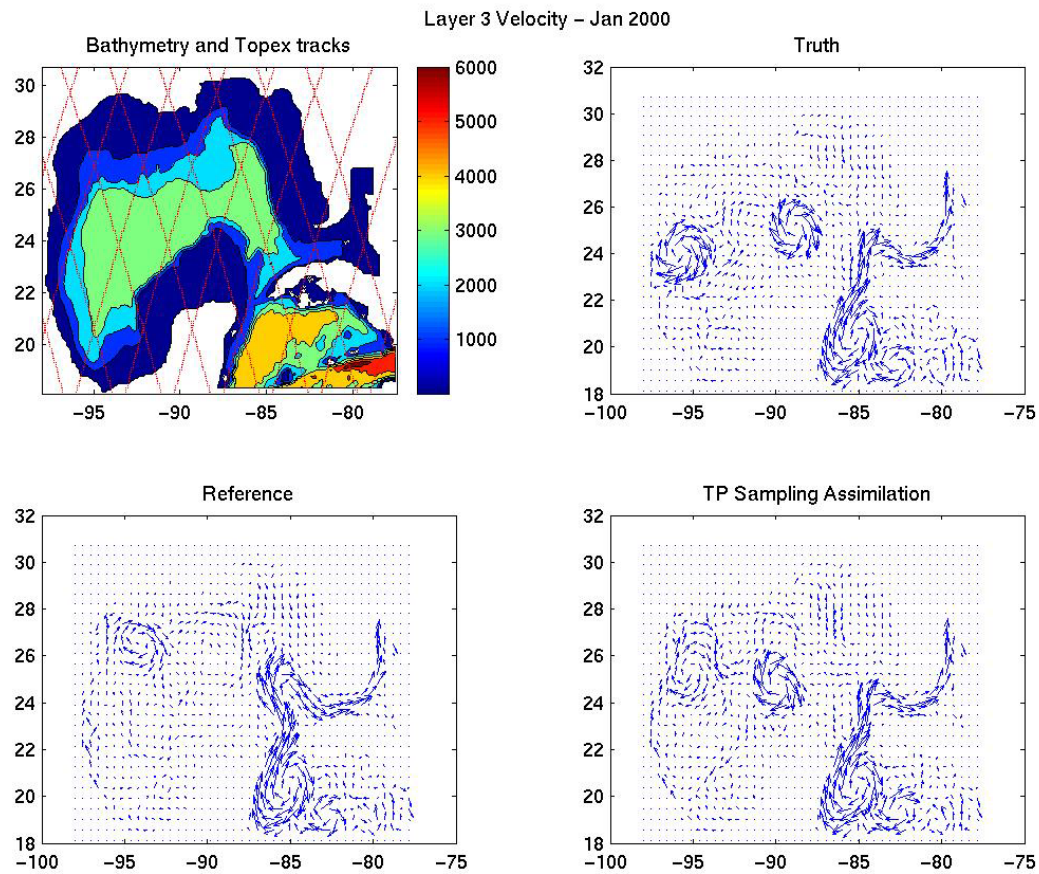
# Twin Experiments with ROIF

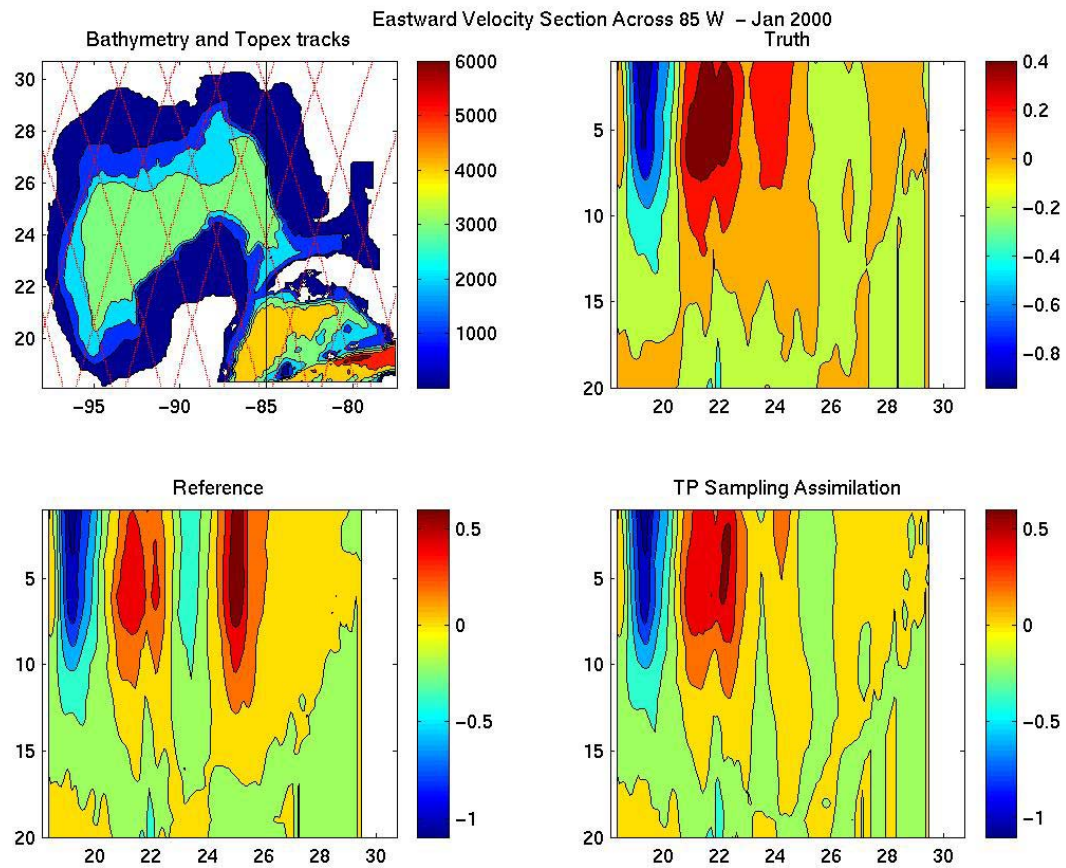


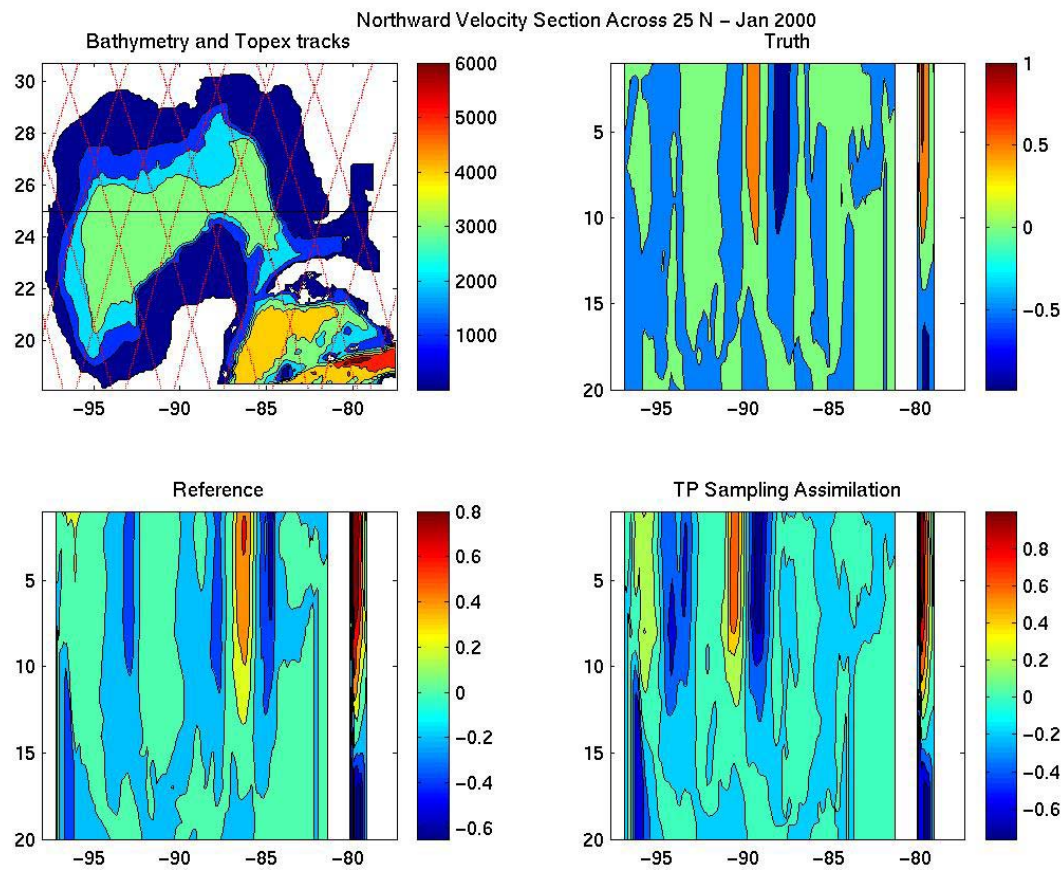
# Multi-Layer ROIF & ROIF-vd

- A full multi-layer version of ROIF will use a vector GMRF
- We use a simpler implementation called ROIF-vd, vertically decoupled
- A single layer ROIF runs in each layer
- This version does not update the vertical correlations dynamically. The vertical correlations **must be externally supplied.**
- We are currently using statistics extracted from a 2x2 degree North Atlantic Run to vertically distribute the SSH signal.
- Results are expected to be much better when we have the statistics from the 1/12° GOM truth run

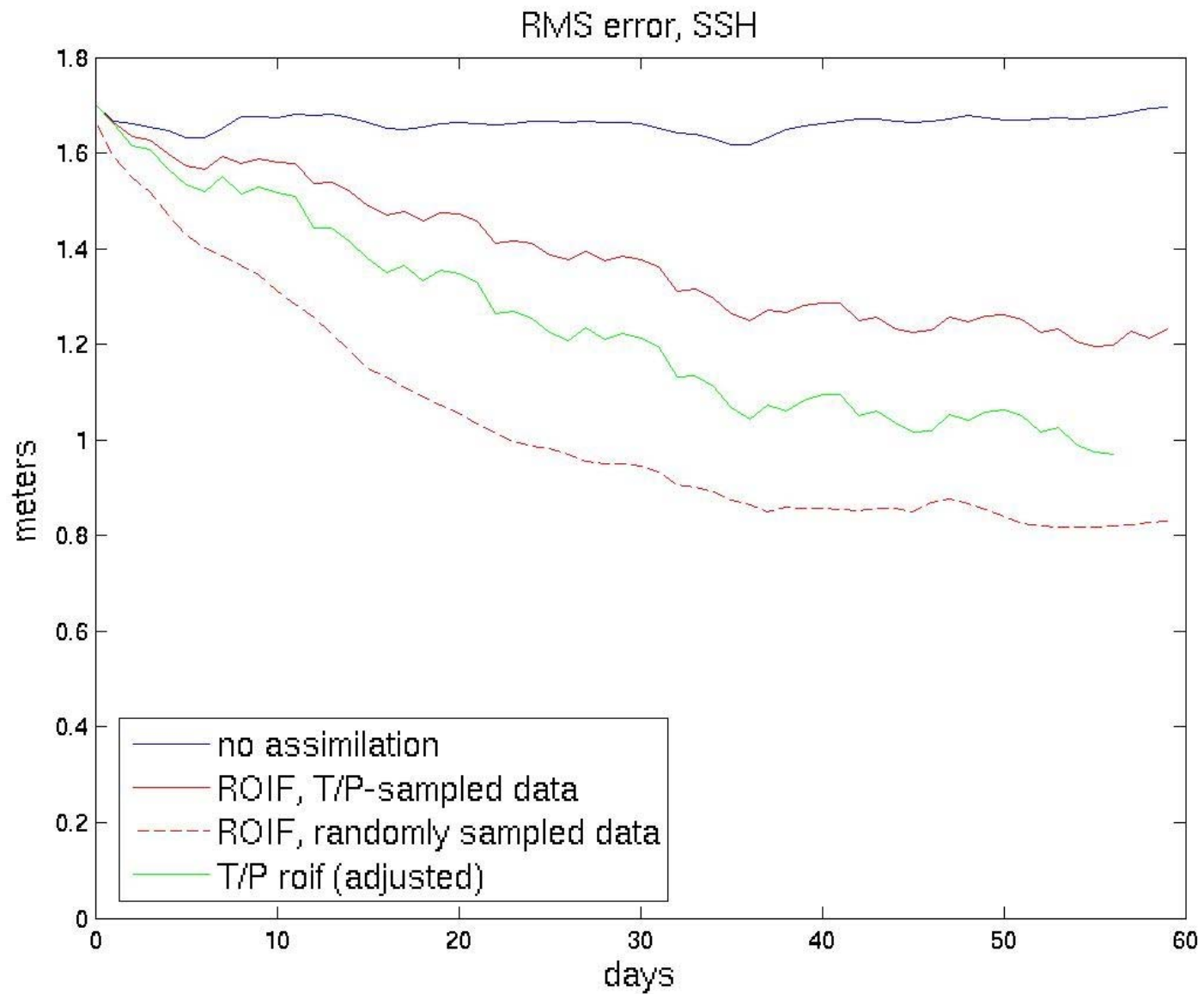












# ROIF Computational Performance

- CPU Time  
~ 3X as the  
free model

- Storage  
~6X as the  
free Model

## timer statistics

cnuity	calls =	7320	time =	1216.85890	time/call =	0.16623755
tsadv	calls =	7320	time =	7779.08540	time/call =	1.06271658
momtum	calls =	7320	time =	2990.61990	time/call =	0.40855463
barotp	calls =	7320	time =	221.92470	time/call =	0.03031758
thermf	calls =	7320	time =	97.68880	time/call =	0.01334546
ic****	calls =	7320	time =	0.01310	time/call =	0.00000179
mx****	calls =	7320	time =	1506.64760	time/call =	0.20582617
conv**	calls =	7320	time =	0.01070	time/call =	0.00000146
diapf*	calls =	7320	time =	0.01390	time/call =	0.00000190
hybgen	calls =	7320	time =	767.74540	time/call =	0.10488325
restrt	calls =	2	time =	0.73090	time/call =	0.36545000
overtn	calls =	2	time =	0.05580	time/call =	0.02790000
archiv	calls =	31	time =	3.33030	time/call =	0.10742903
roifin	calls =	1	time =	3.29560	time/call =	3.29560000
roifmn	calls =	7320	time =	29794.94520	time/call =	4.07034770
total	calls =	1	time =	44398.05010	time/call =	44398.05010000

\*\*\*\*\*

(normal)

\*\*\*\*\*

# Open Mp/MPI Implementation

