

Data assimilation in a regional ocean model of the Labrador Sea

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OUTLINE

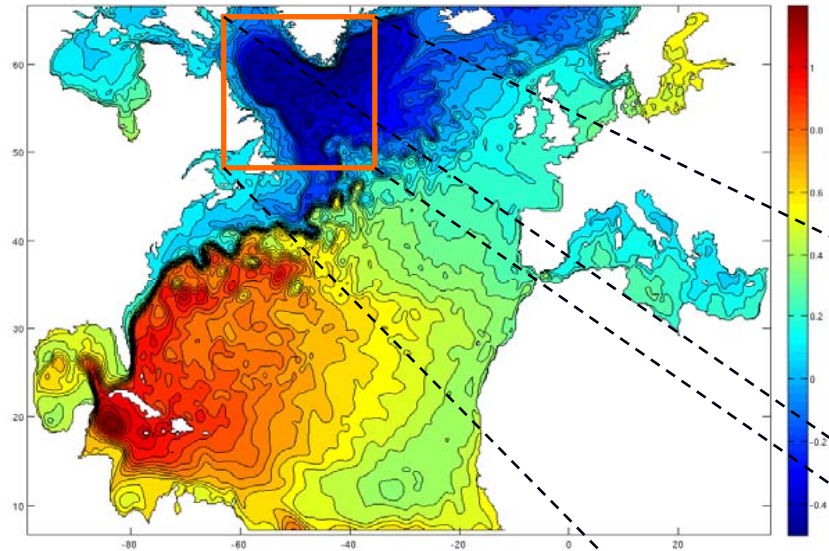
- Overview of the regional model for the Labrador Sea
- Implementation of the Data Assimilation Scheme
- Preliminary results and future work

Regional modeling in data assimilation in the Labrador Sea

Major Objectives:

- Develop a regional model nested into the GOAPP global model.
- Implement an efficient data assimilation scheme to improve the solution in the shallow regions and weakly stratified basins.
- Conduct model hindcast studies of the Labrador Sea.

The regional model of the Labrador Sea

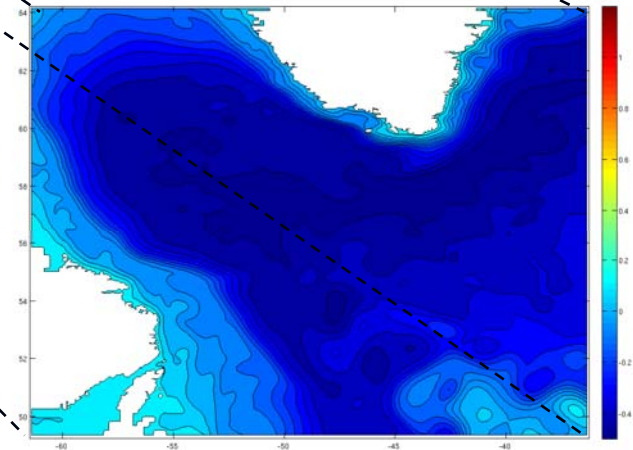


- BIO-NEMO ocean model coupled with a se-ice model

- $1/4^\circ$ horizontal resolution

- Spectral nudging in the surface layer

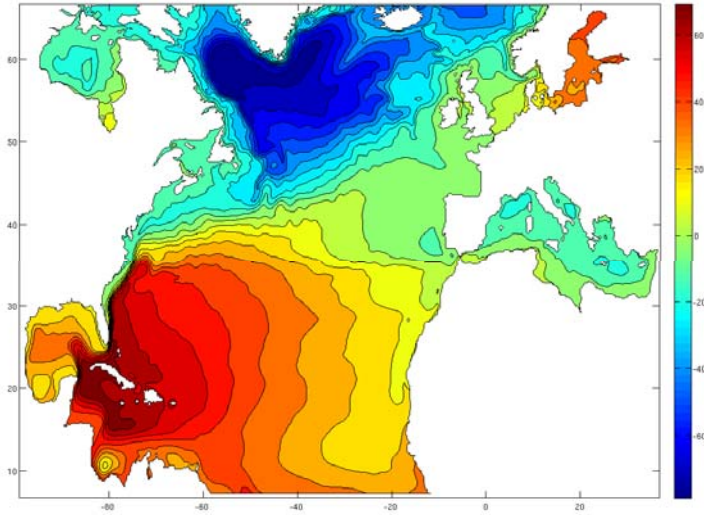
- Nested Labrador Sea model with $1/12^\circ$ horizontal resolution



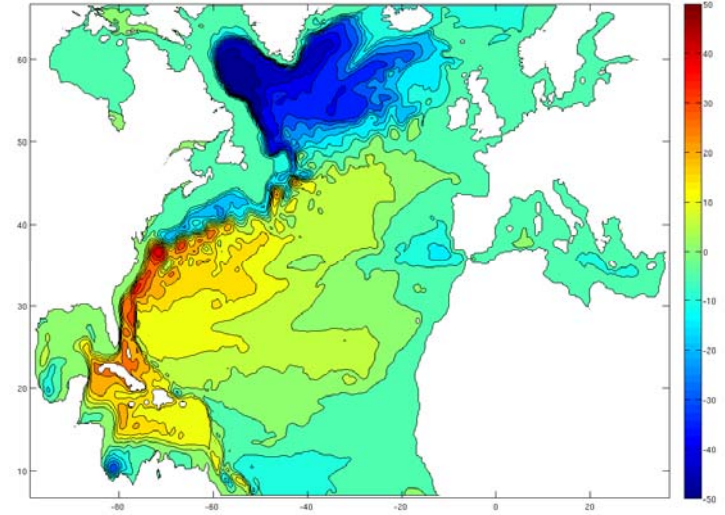
Model set up

- 30 years spin up with spectral nudging and climatological forcing.
- NCEP 6-hours surface forcing.
- Open boundary conditions defined from the SODA data.
- The model simulation 1991 – 1996 are with spectral nudging in the surface 20m layer only.

Model hindcast 1991-1995



Mean sea surface height



Mean barotropic stream function

Extended Kalman Filter

- EKF is recursive: assuming the estimate of the state vector \mathbf{x}_i^a and analysis error covariance \mathbf{P}_i^a are known at time t_i .

- Forecast:

$$\mathbf{x}_{i+1}^f = \mathbf{M}(\mathbf{x}_i^a)$$

$$\mathbf{P}_{i+1}^f = \mathbf{M} \mathbf{P}_i^a \mathbf{M}^T + \mathbf{Q}$$

- Analysis (update):

$$\mathbf{K}_{i+1} = \mathbf{P}_{i+1}^f \mathbf{H}^T (\mathbf{H} \mathbf{P}_{i+1}^f \mathbf{H}^T + \mathbf{R})^{-1}$$

$$\mathbf{x}_{i+1}^a = \mathbf{x}_{i+1}^f + \mathbf{K}_{i+1} (\mathbf{y}_{i+1} - \mathbf{H} \mathbf{x}_{i+1}^f)$$

$$\mathbf{P}_{i+1}^a = (\mathbf{I} - \mathbf{K}_{i+1} \mathbf{H}) \mathbf{P}_{i+1}^f$$

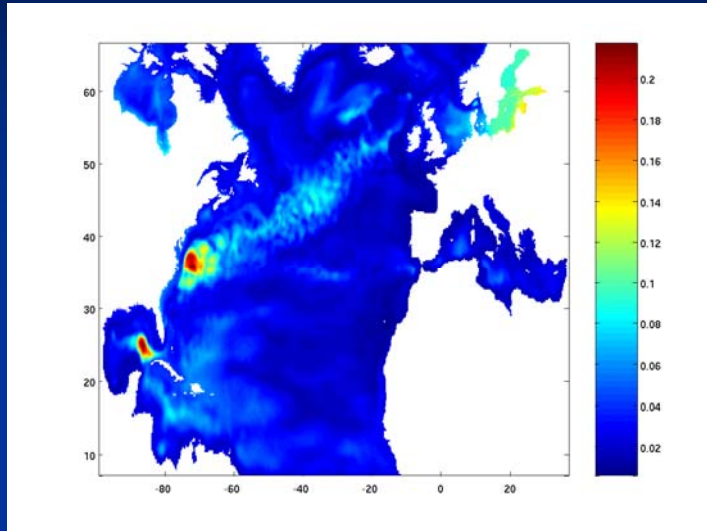
Limitations to extended Kalman filter

- Error covariances must be carefully estimated and monitored.
- Estimating Q and R may be particularly difficult.
- Computationally heavy

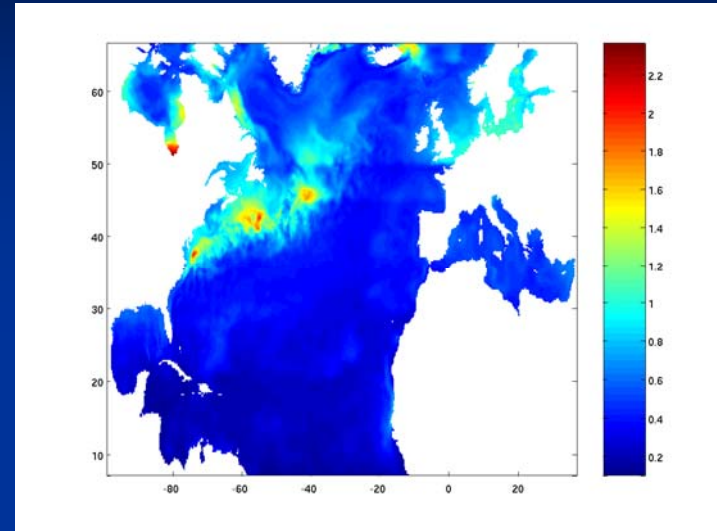
The SEEK filter

- Covariance matrix $P = L U L^T$
- The equation of analysis error covariance is projected onto singular modes.
- Error subspace $S_o \approx L (U)^{1/2}$, $P = S_o S_o^T$

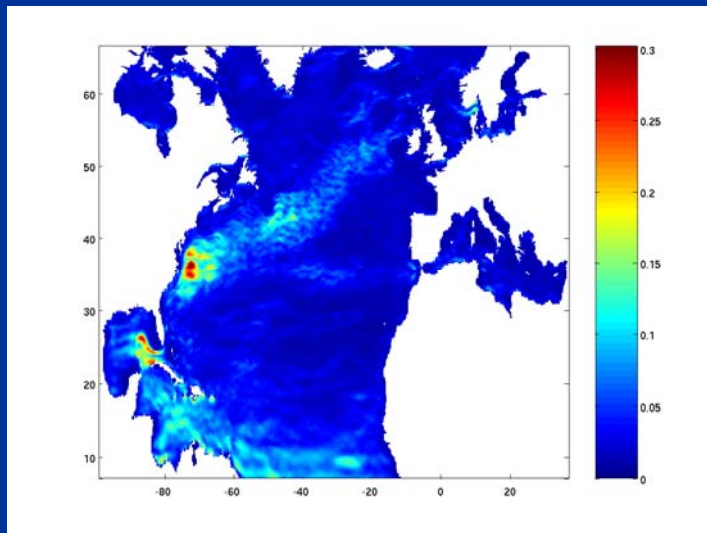
First singular vector of covariance matrix



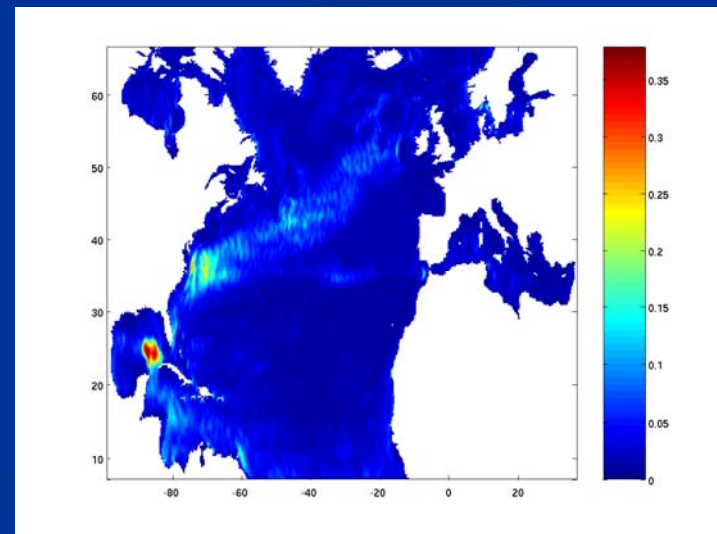
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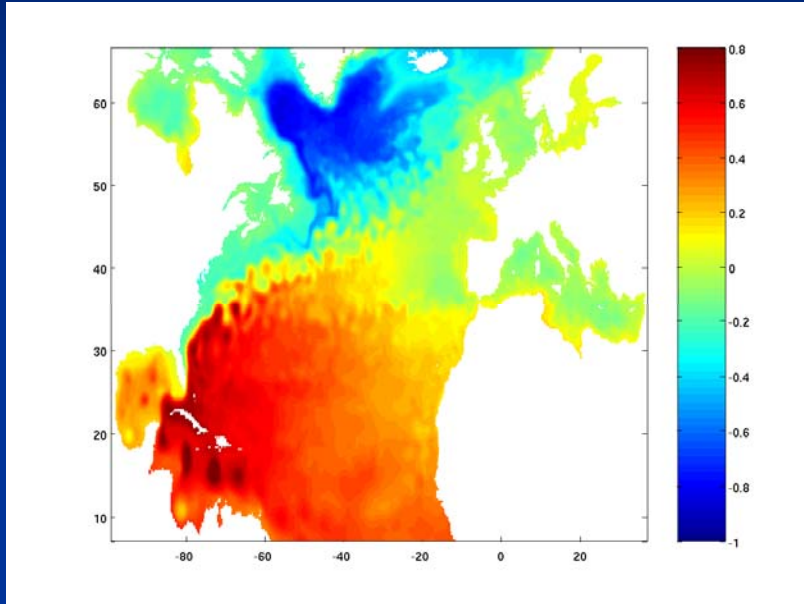


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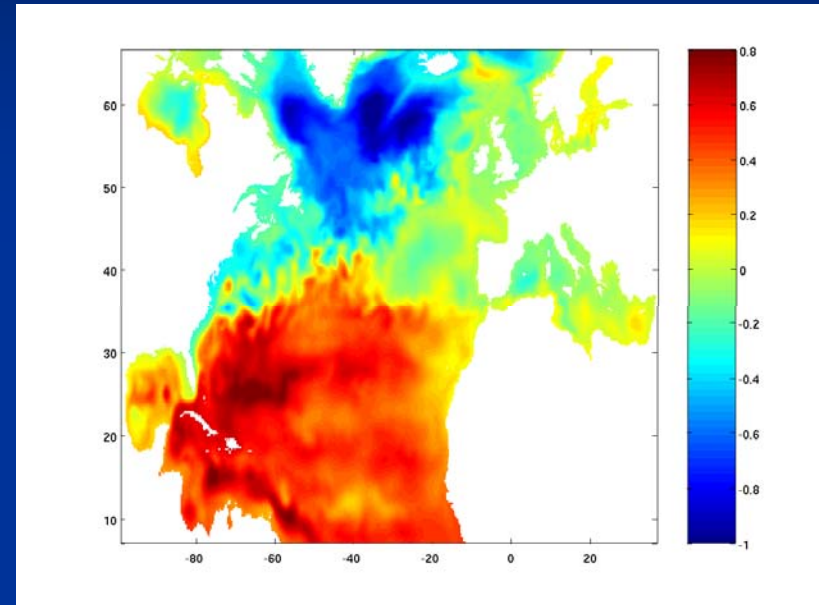


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Model sea surface height



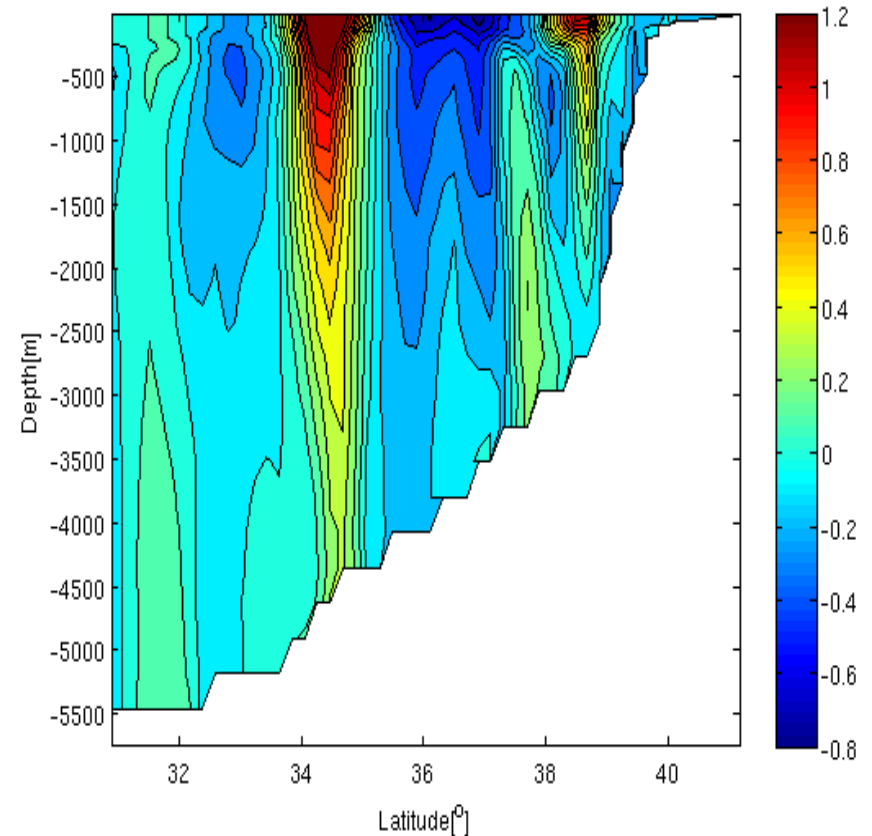
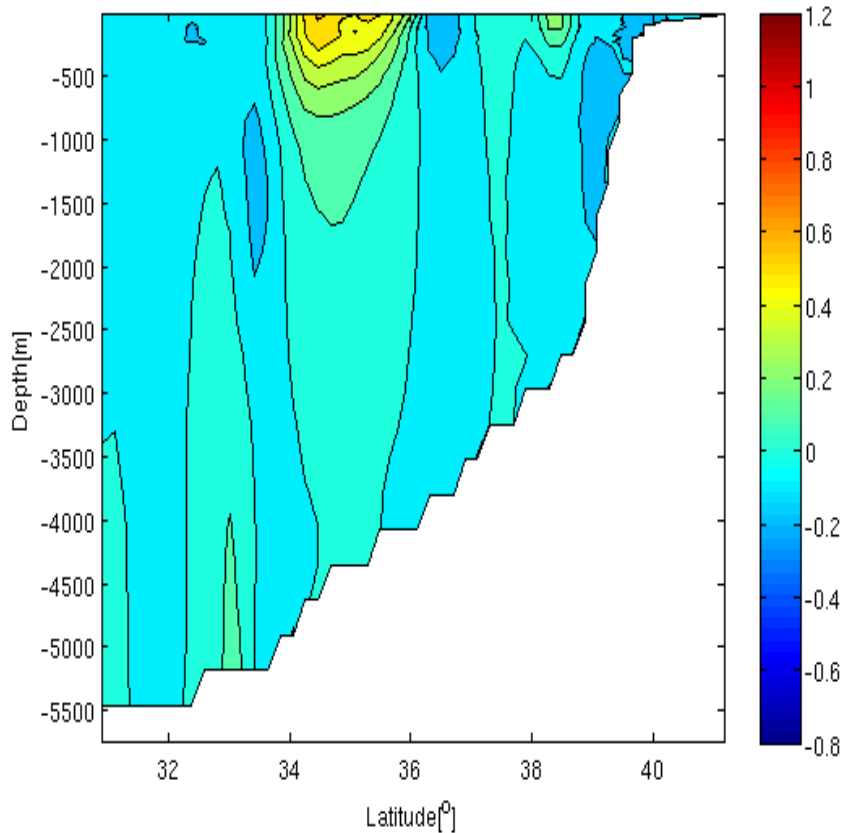
Model hindcast



Model with data assimilation

Assimilated data: (1) satellite altimetry, (2) weekly sst maps

Zonal velocity at 72°W



Future work

- Test and verification of data assimilation scheme.
- Assimilation of ARGO T&S profiles
- Data assimilation hindcast experiment
1991 - 2005

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