Development of a regional model and data assimilation scheme for the Labrador Sea

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GOAPP
Global Ocean-Atmosphere Prediction and Predictability

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

OUTLINE

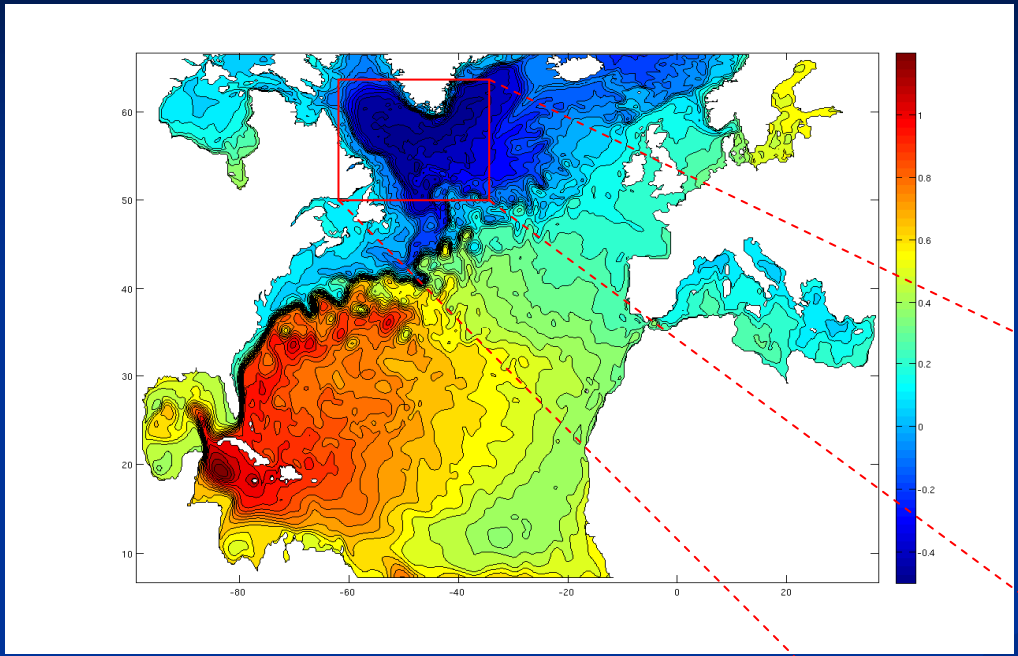
- Overview of the regional system for modeling and data assimilation
- Bias error in the ¼ degree model
- Hindcast model experiments
- Data Assimilation in the ¼ degree model
- Development of a regional atmospheric model

Regional modeling and data assimilation in the North Atlantic

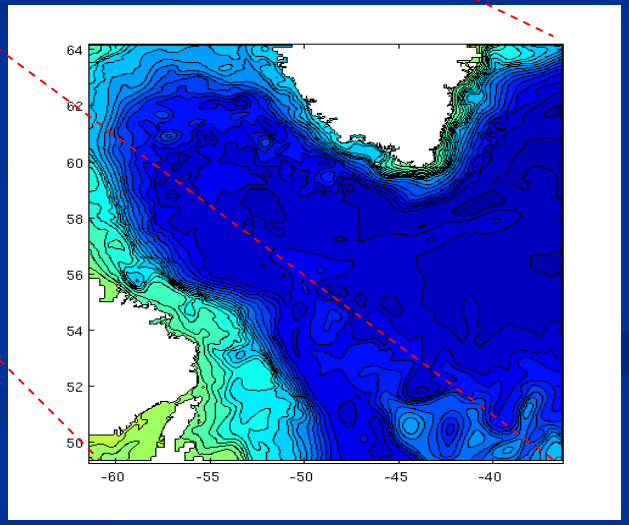
Major Objectives:

- Develop a regional model nested into the GOAPP global model.
- To assess the model error and uncertainty in prognostic simulations of interannual and interdecal ocean variability.
- 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



- NEMO ocean model coupled with LIM sea-ice model
- ¼° horizontal resolution



- Nested Labrador Sea model with 1/16° horizontal resolution

Model set up

- 30 years spin up with climatological forcing.
- NCEP/NCAR 6-hours surface forcing.
- Open boundary conditions (Tréguier et al. 2001) defined from the SODA data.

Study of the model bias

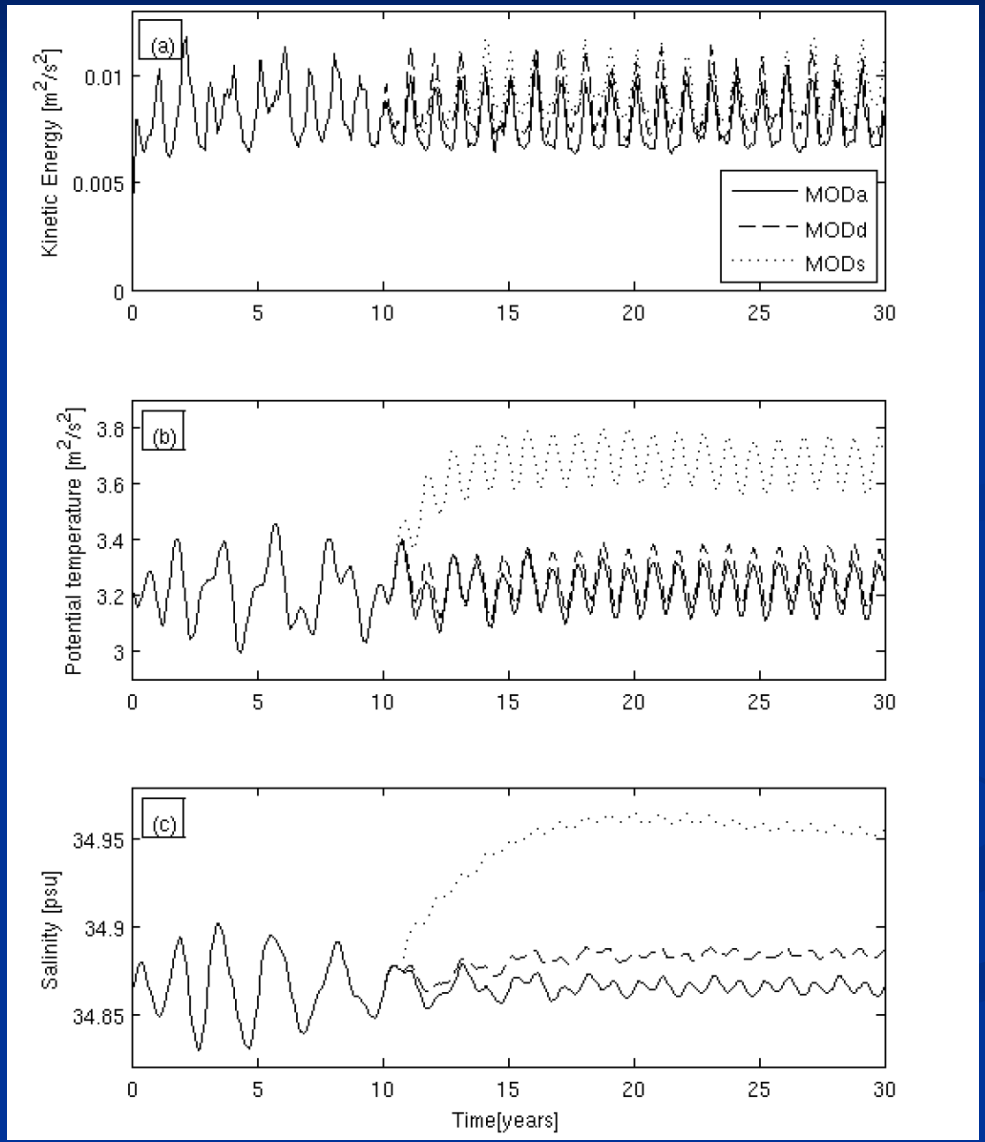
- Impact of model bias on the water mass characteristics in the Labrador Sea
- Impact of model bias on deep convection deep convection.
- Impact of model bias on water transport

Model Drift

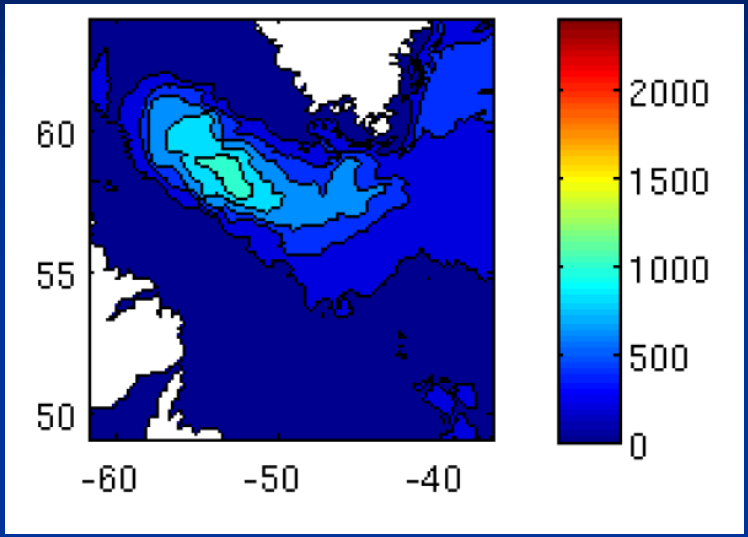
KE

θ

S

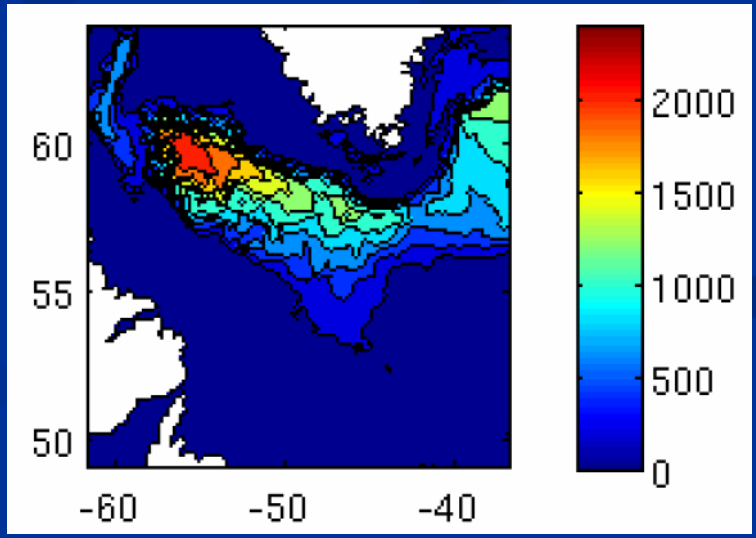


Mixed layer depth

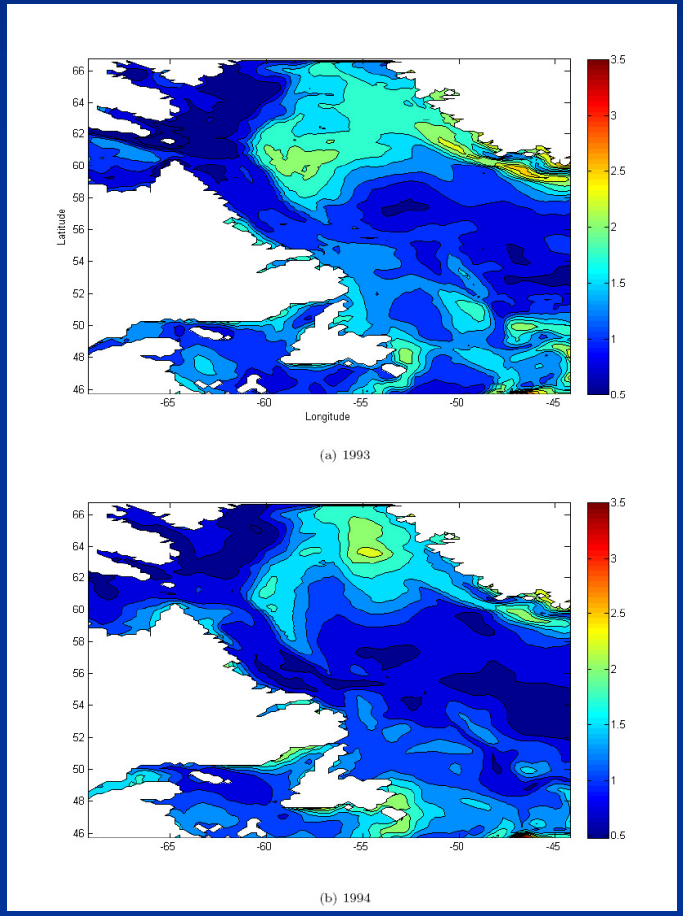


Model run with spectral nudging

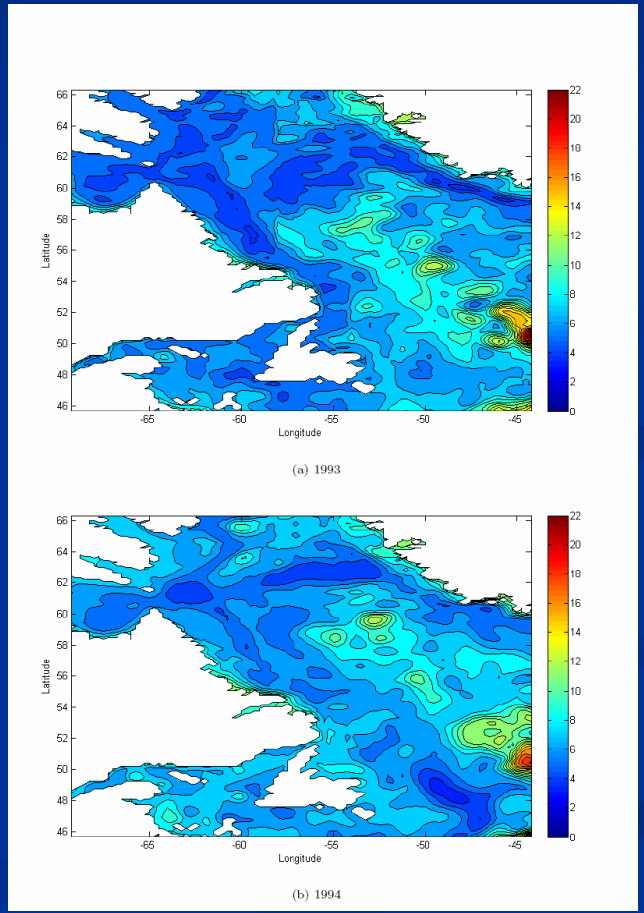
Run without spectral nudging



Uncertainty related to unresolved mesoscale processes

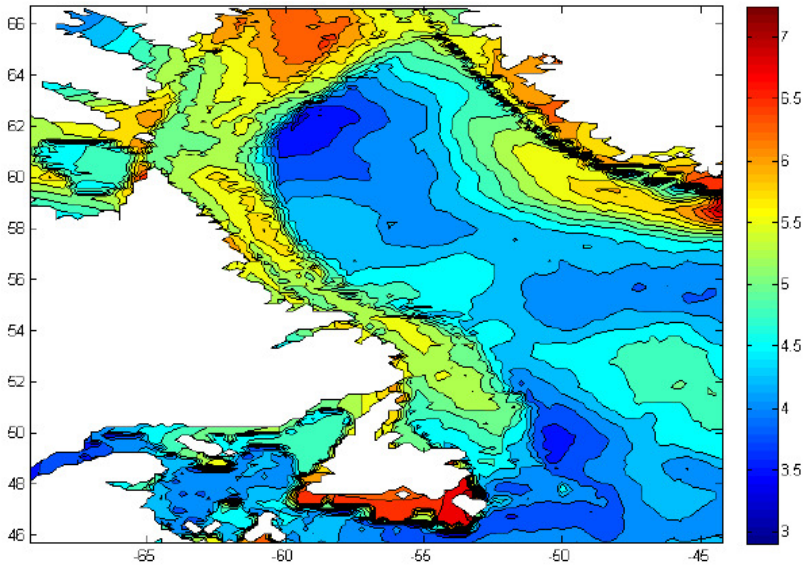


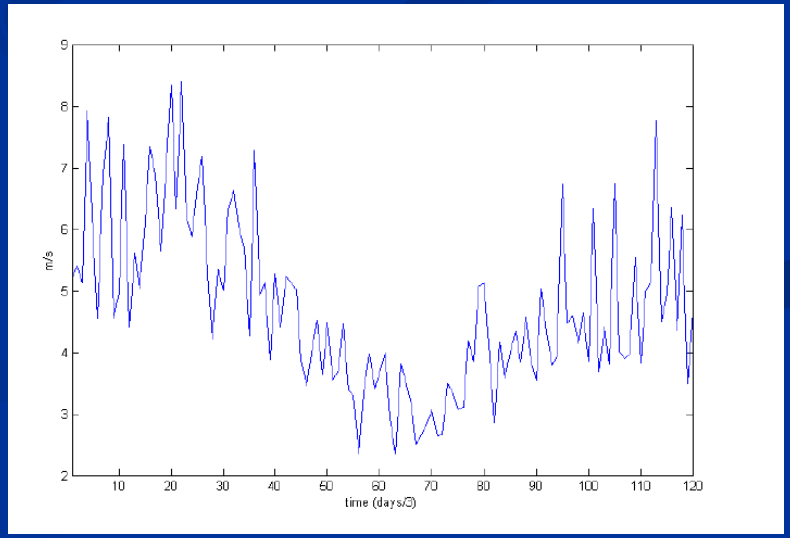
SST



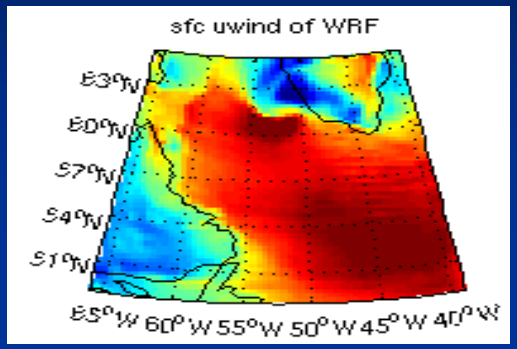
SLA

Surface wind speed rms error



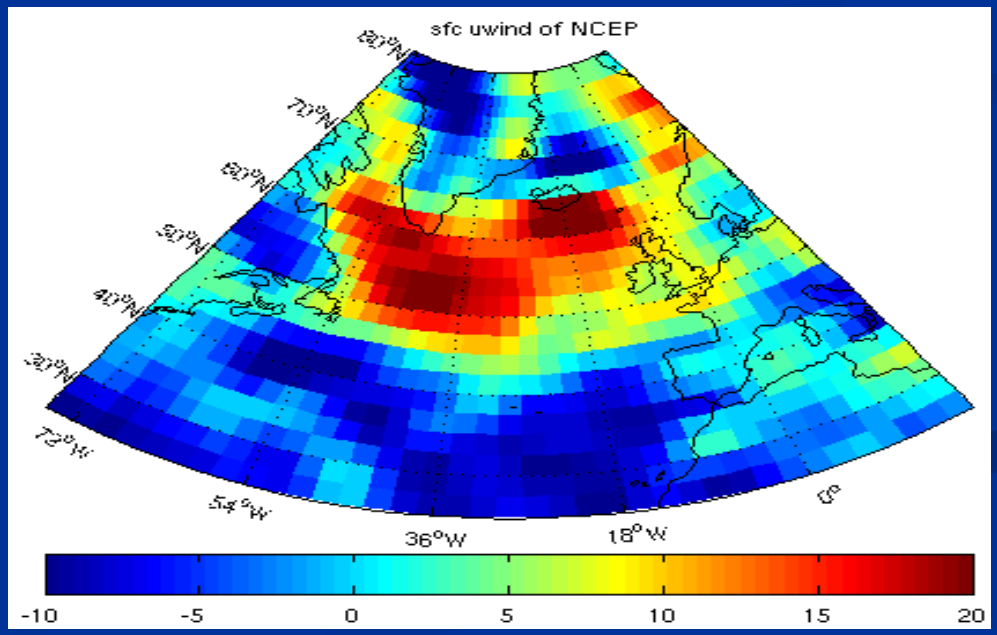


Development of regional atmospheric model



- WRF: Weather Research and Forecasting Model
- 30 km horizontal resolution

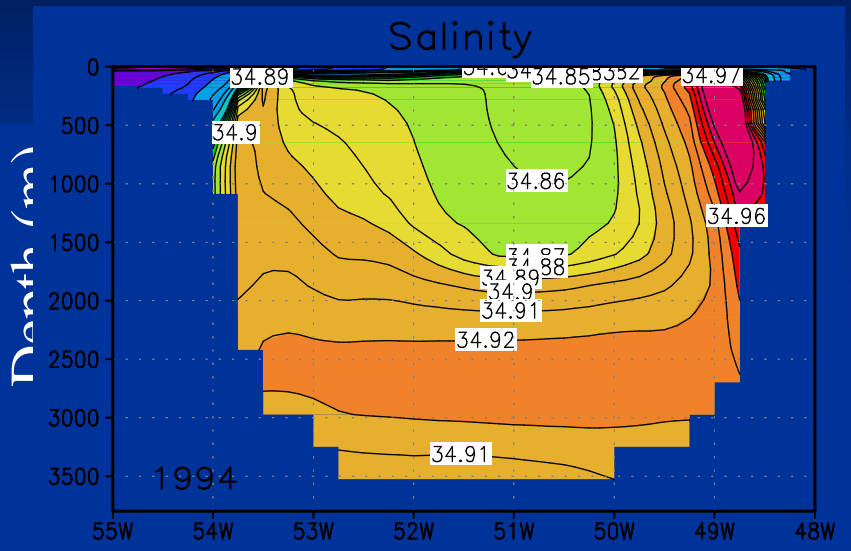
- One way nesting within a global atmospheric model
- The boundary conditions are defined every 6 hours

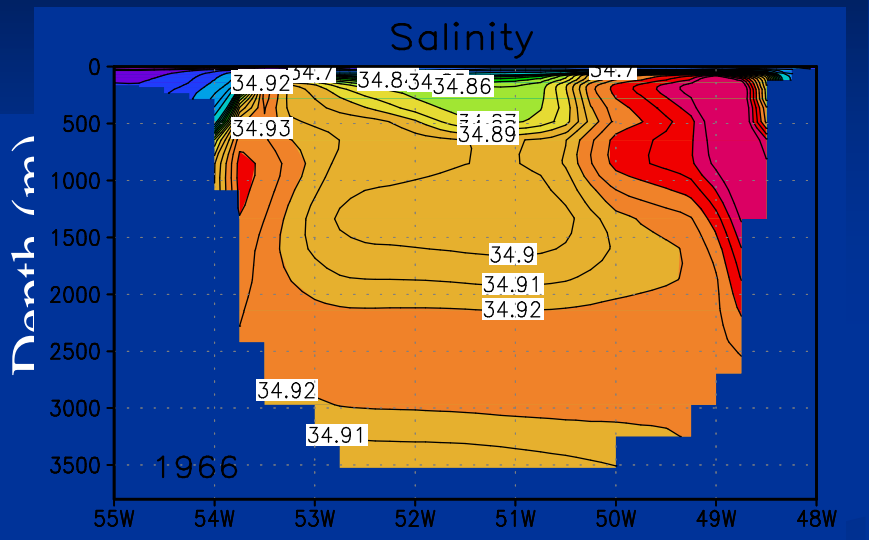


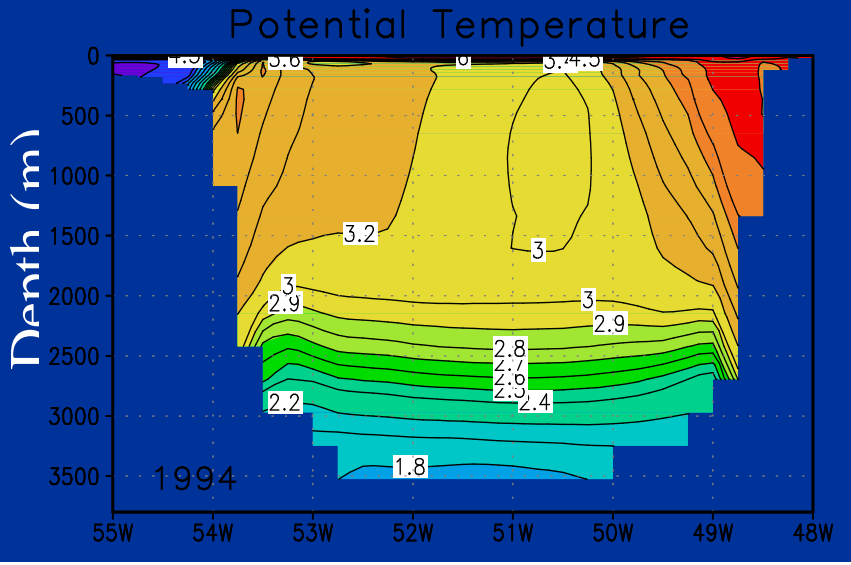
Model hindcast 1948 – 2005

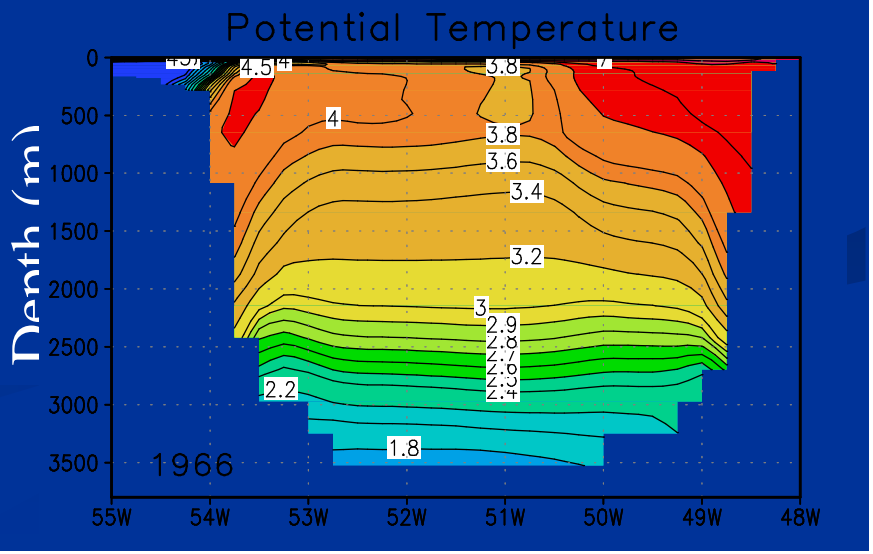
- Model simulations with ¼ Atlantic Ocean model.
- Model simulations 1980 – 2005 with 1/16 degrees two-way nested Labrador Sea regional model (ongoing model experiment).
- Model simulations with data assimilation 2003 – 2005. (ongoing model experiment).

Interannual variability of the LSW

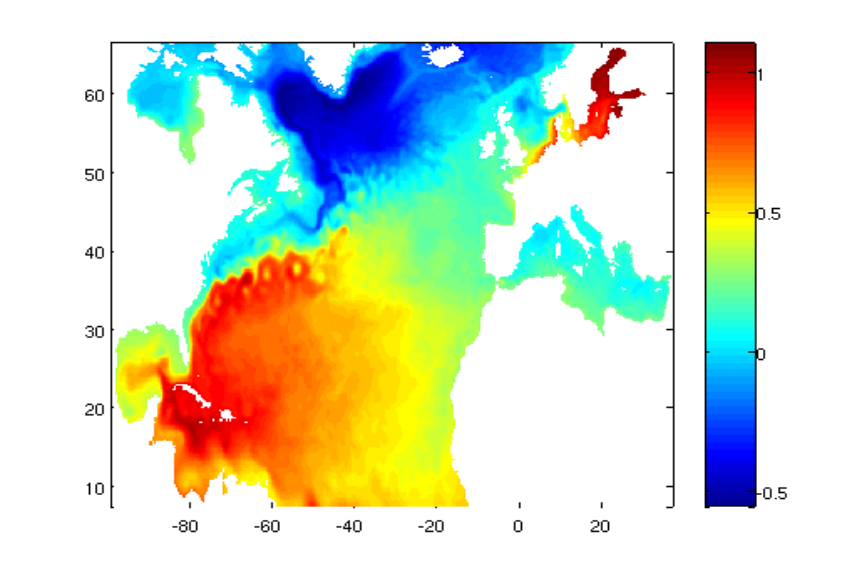




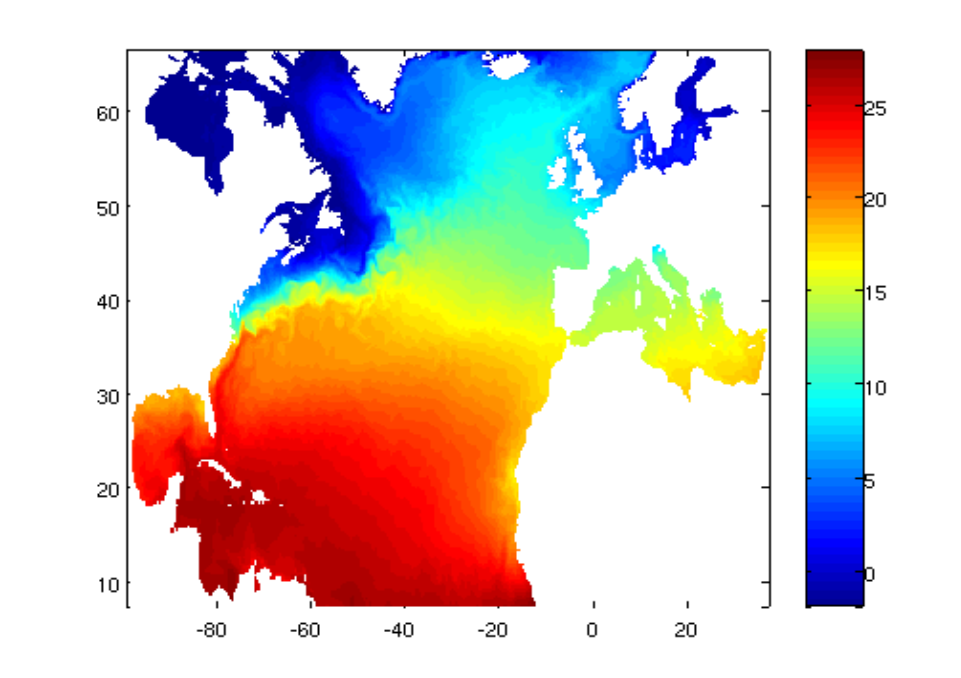




Model hindcast 1948-2005



Model SSH, January 1, 1996



Model SST, January 1, 1996

The SEEK filter

(Pham et al., 1998; Brankart et al., 2003)

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

Background error parameterization.

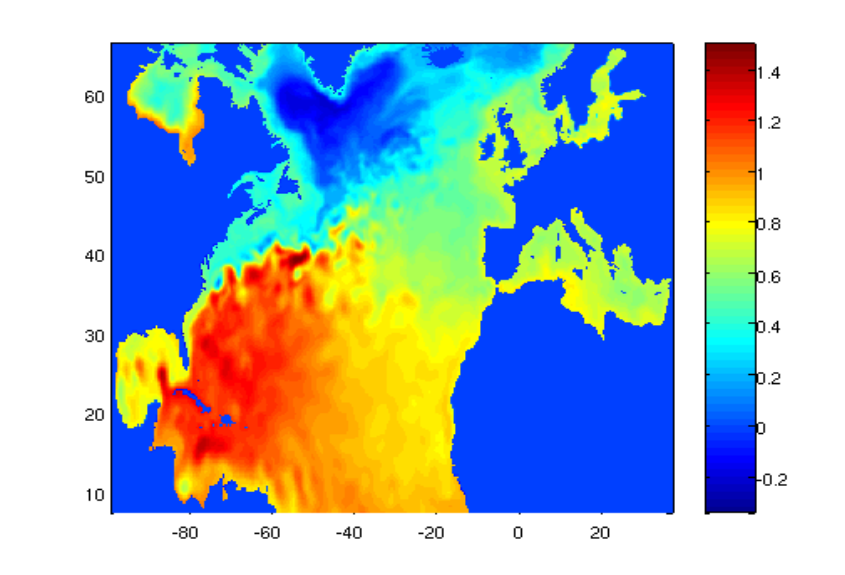
(Brankart et al, 2003)

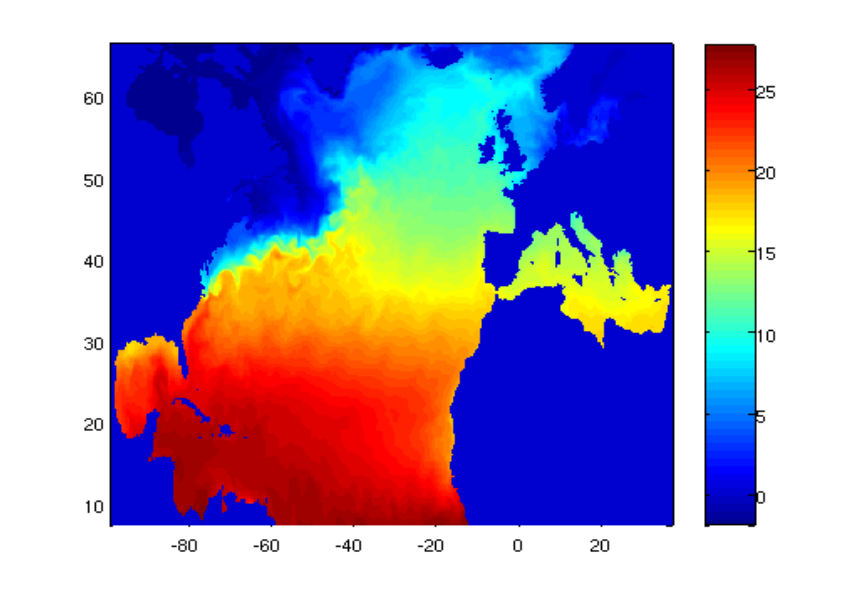
- Initial error covariance matrix is approximated with 10 EOFs computed from free run 1995-1996 (variance 95%)

- Local gain operator is used with influence bubble of 100km

- The model error variance is adapted to be coherent with the innovation variance.

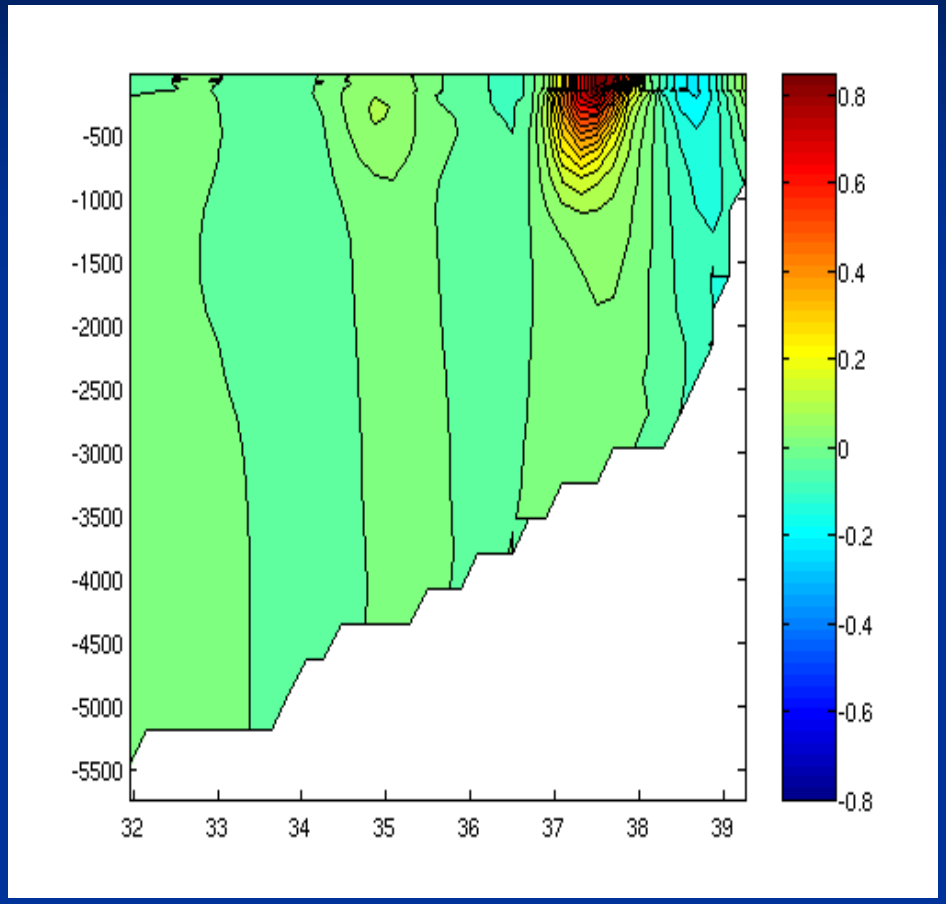
Assimilation run



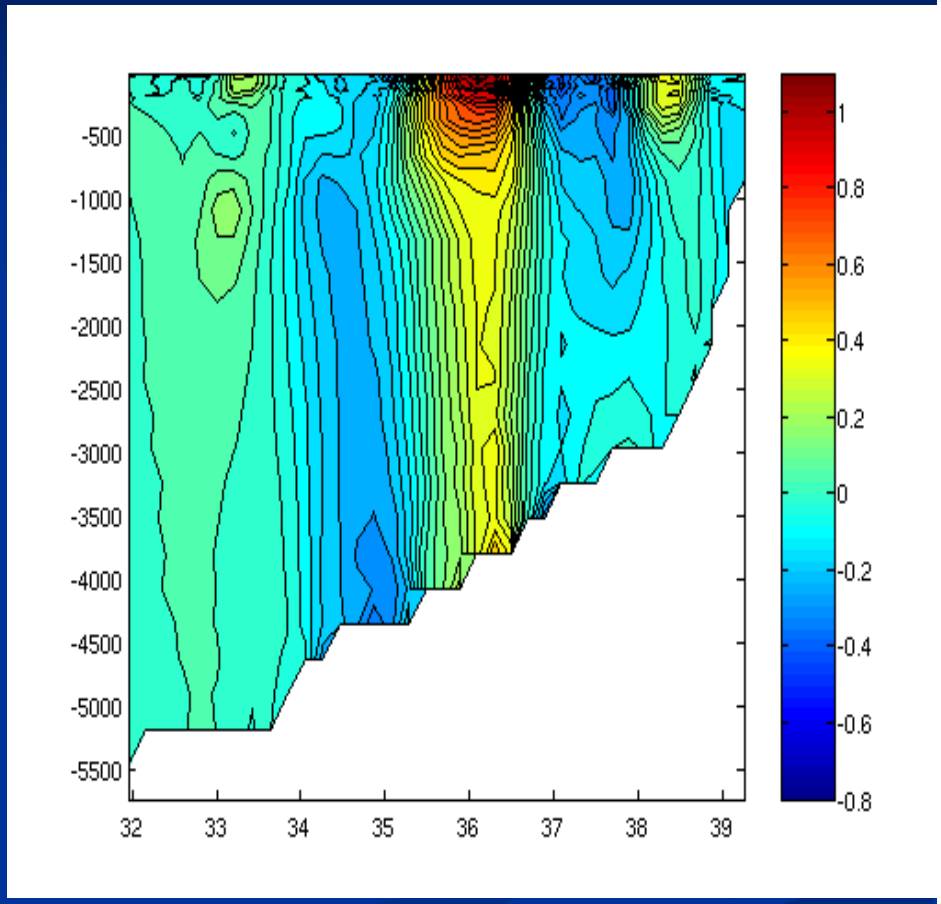


Assimilated data: (1) satellite altimetry, (2) weekly sst maps

Zonal velocity at 72ºW



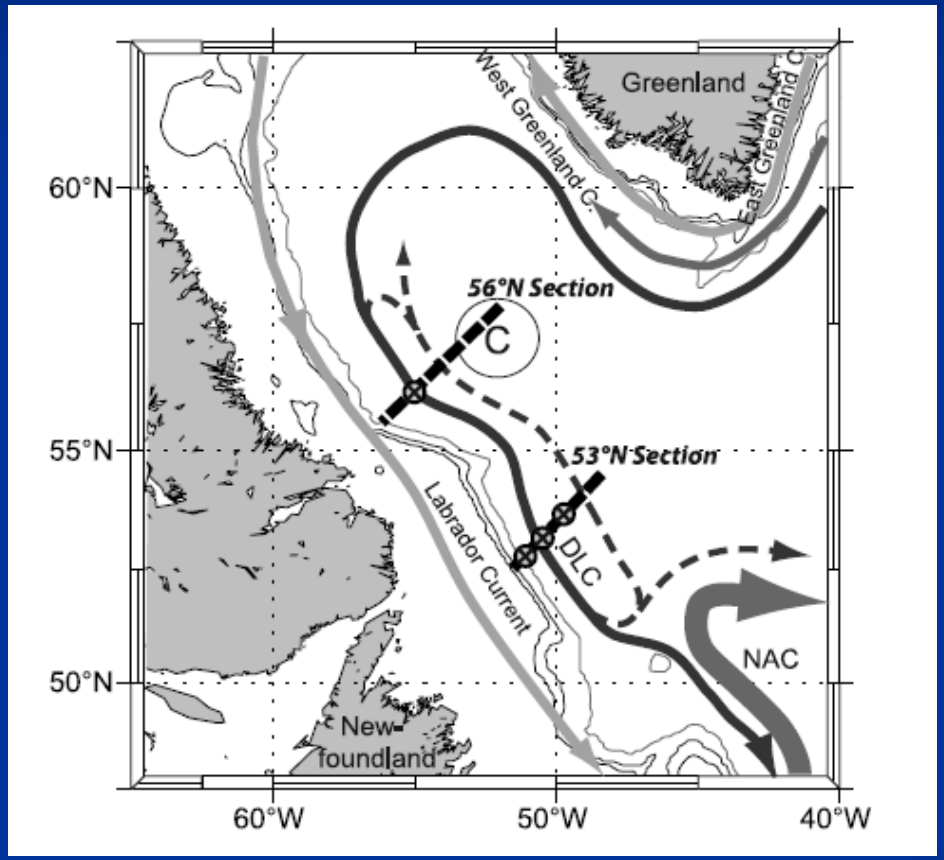
Prognostic run

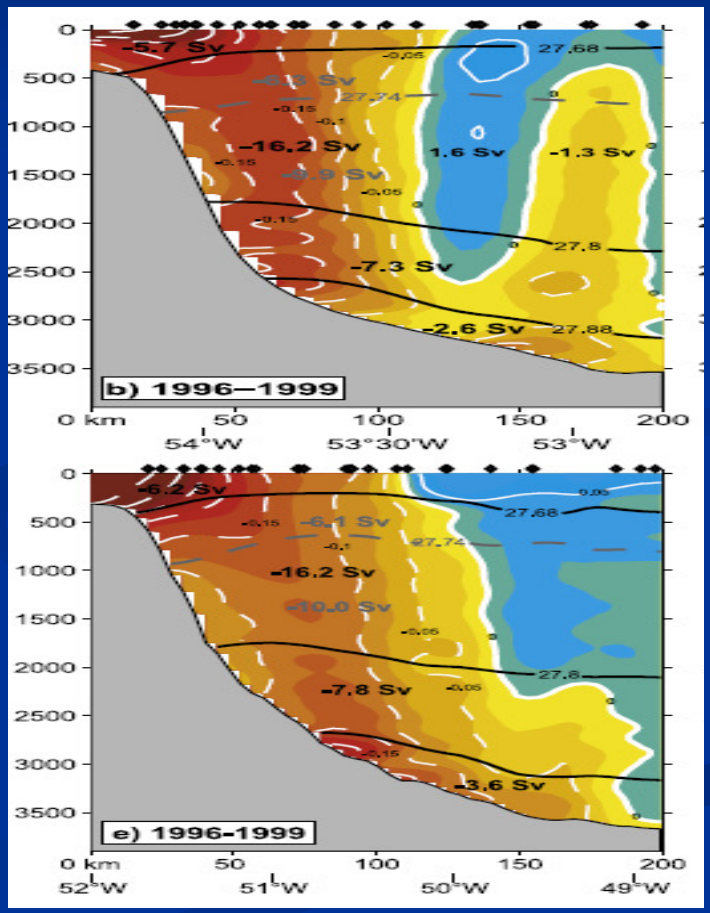


Data assimilation run

Schematic diagram of the Labrador Sea circulation

(Dengler et al, 2006)

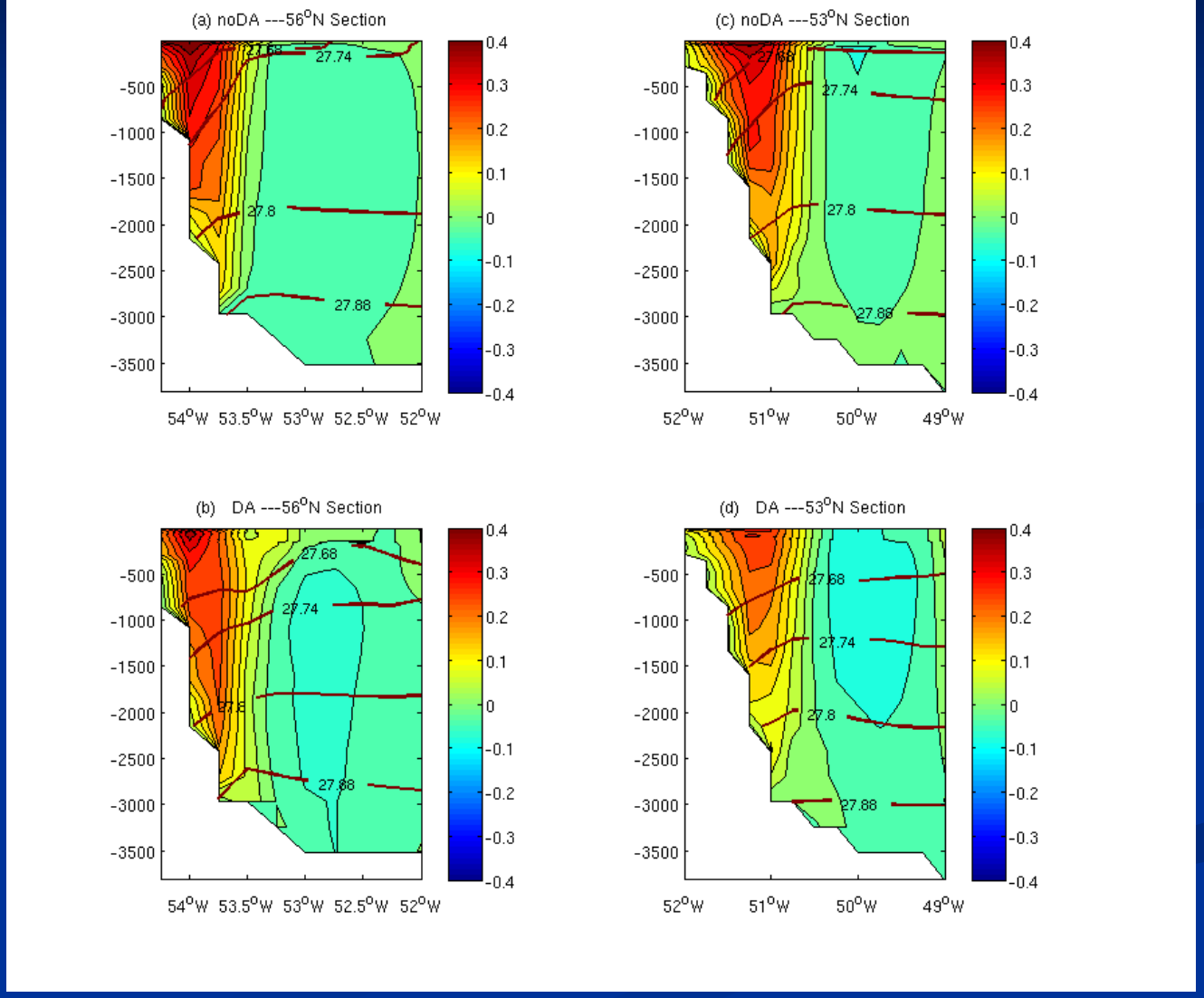




Model simulations of the Labrador

Prognostic run

Assimilation run



Future Work

- Sea-ice data assimilation.
- Coupling of regional atmospheric and ocean models.
- Data analysis, data management and data base.

Acknowledgments

- ***This work is part of GOAPP project.***

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