Uncertainty and predictive skills in model simulations of the Labrador Sea with an eddy permitting circulation model.

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Outline

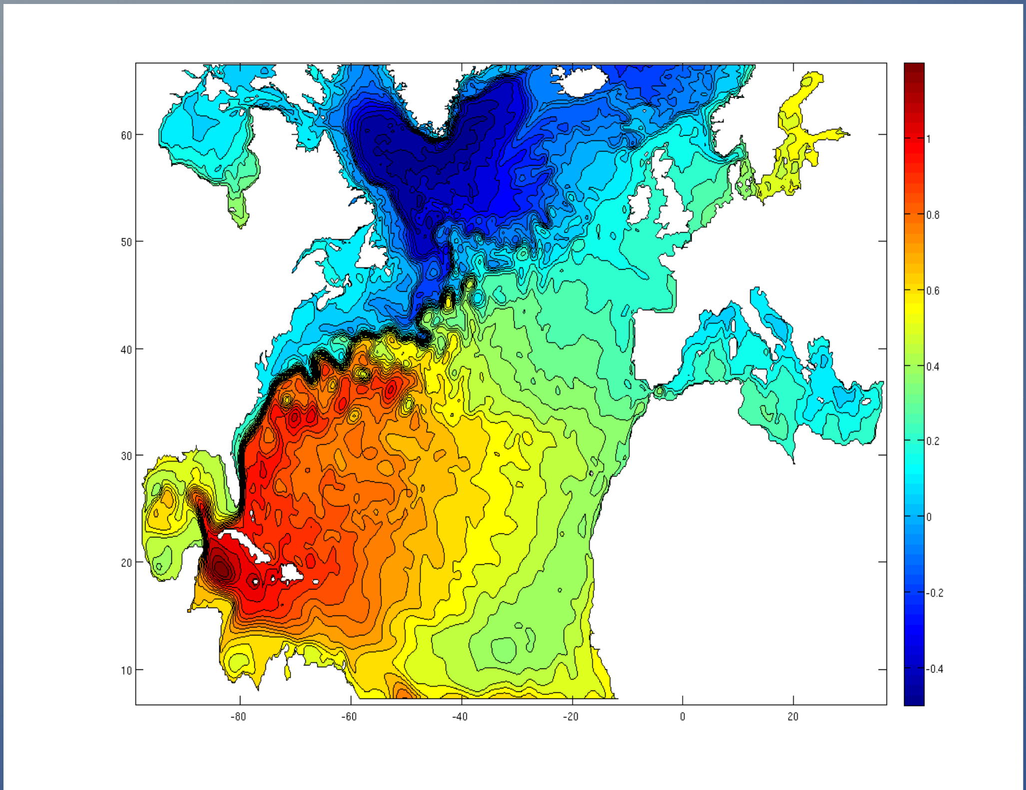
- Labrador Sea regional ocean model
- Assessment of the model bias
- Assessment of impact of unresolved mesoscale processes on the model solution for SSH and SST
- Conclusions and future work

Regional model of the North Atlantic

<u>Major Objectives:</u>

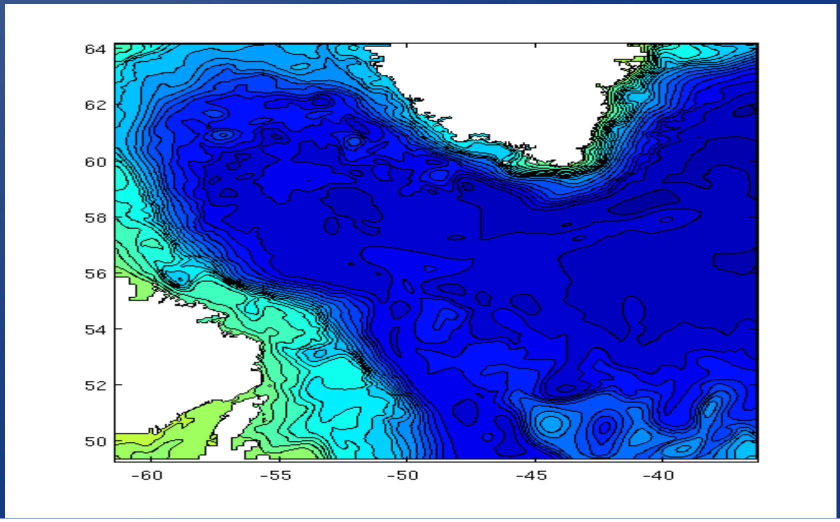
- To develop a regional model nested into the GOAPP global model.
- To assess the model error and uncertainty in prognostic simulations of inter-annual ocean variability.
- Implement an efficient data assimilation scheme to improve the solution in the shallow regions and weakly stratified basins.
- Conduct model hindcast studies of the Labrador Sea

The Labrador Sea regional model



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

- Two way nested Labrador Sea model
  1/16 horizontal resolution



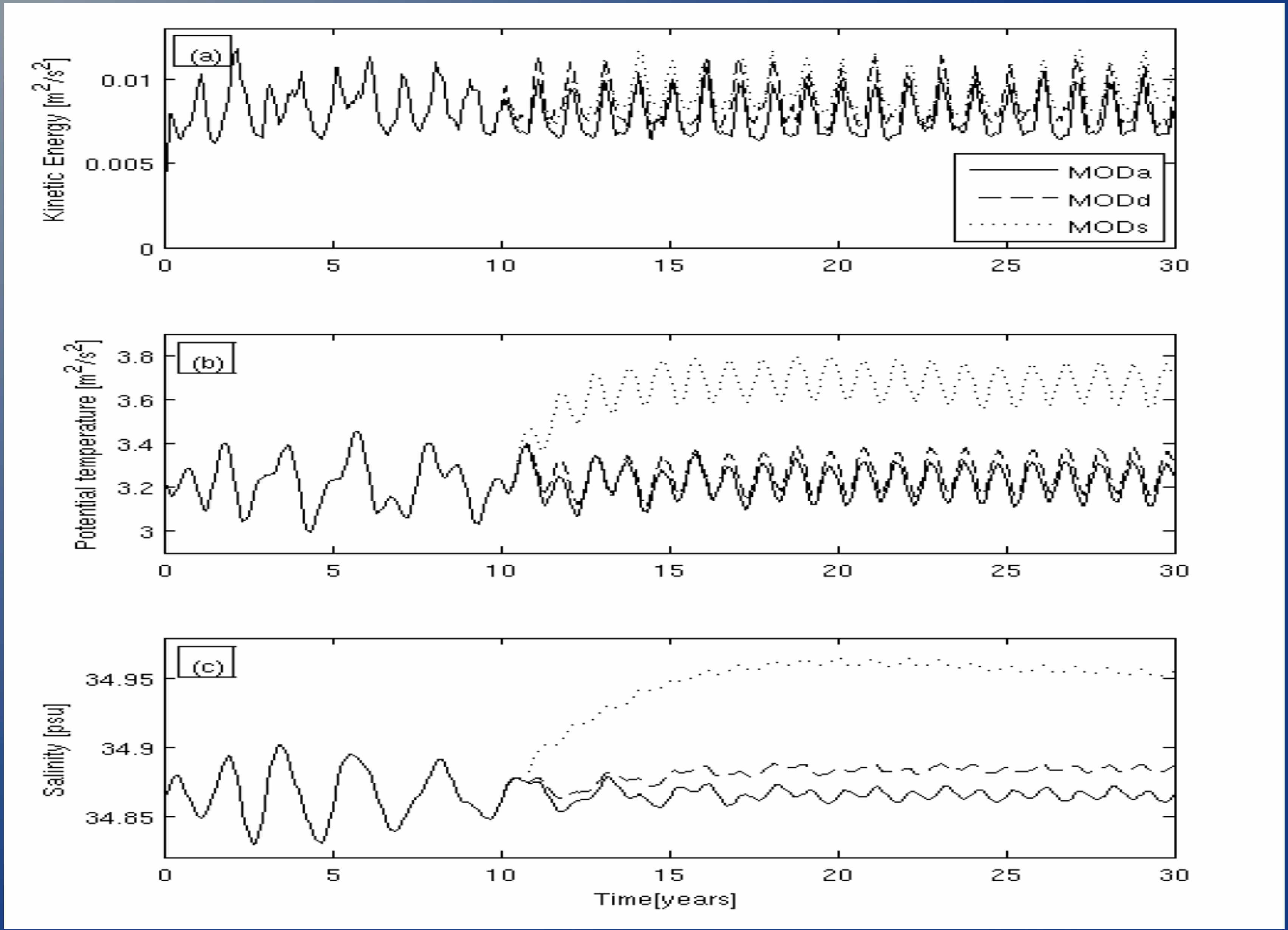
Model Set-up

- 30 years spin up with climatological forcing
- NCEP 6-hour surface forcing
- Open boundary conditions (**Tréguier et al. 2001**) defined from the SODA data
- Hindcast: January 1^{st}, 1948 - January 1^{st}, 2005
- Spectral nudging

Data

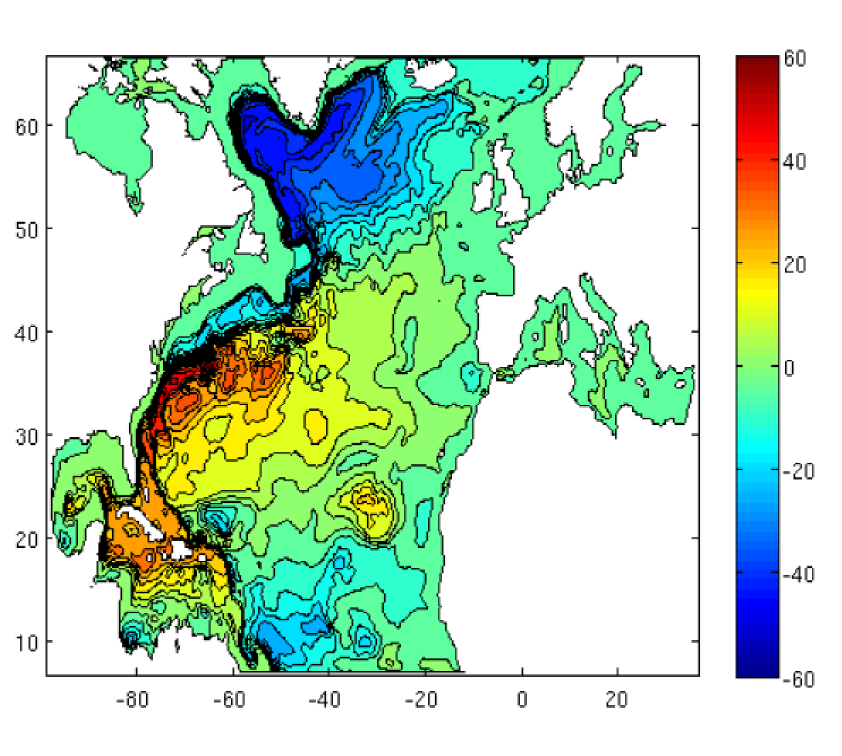
- Reynolds SST reanalysis (link)
- AVISO sea level anomaly (link)
- Scaterometer data for surface wind (link)

Model bias

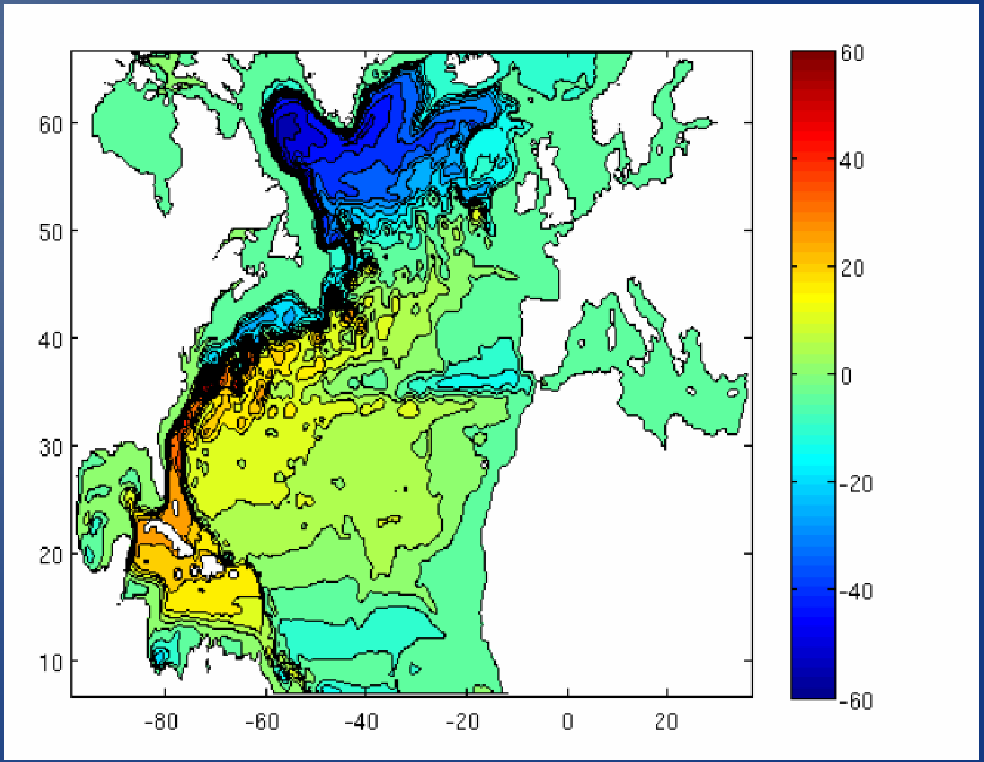


(a)
Kinetic Energy [m^2/s^2]
0.01
0.005
0
MODa
MODd
MODs
0
5
10
15
20
25
30
(b)
Potential temperature [m^2/s^2]
3.8
3.6
3.4
3.2
3
(c)
Salinity [psu]
34.95
34.9
34.85
Time[years]

Impact of model bias on the water transport

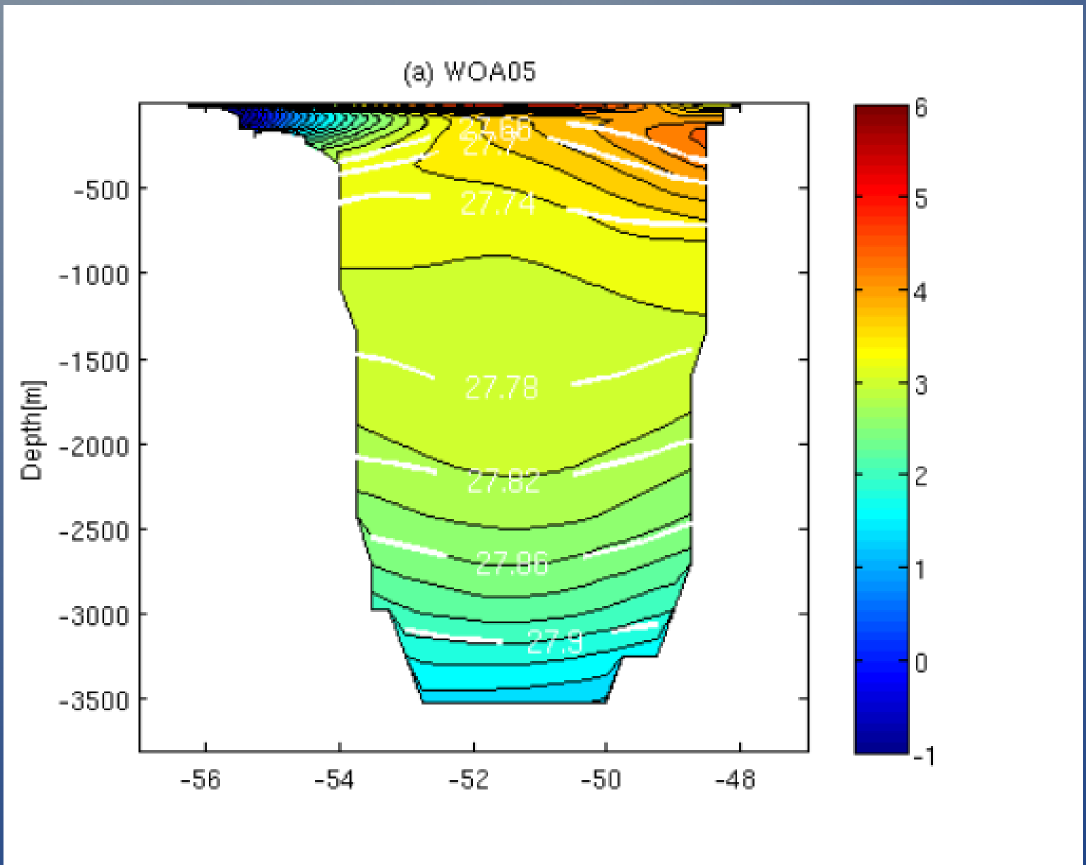


Run with spectral nudging

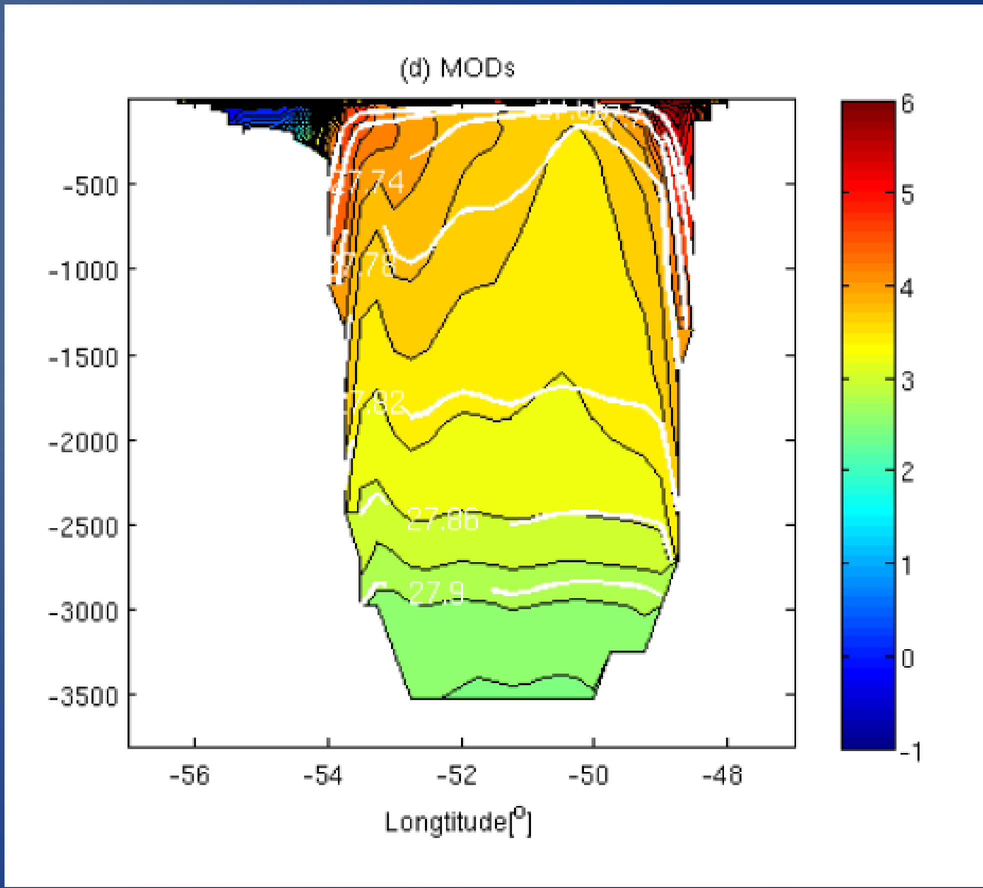


Free run

Impact of model bias on the water mass characteristics

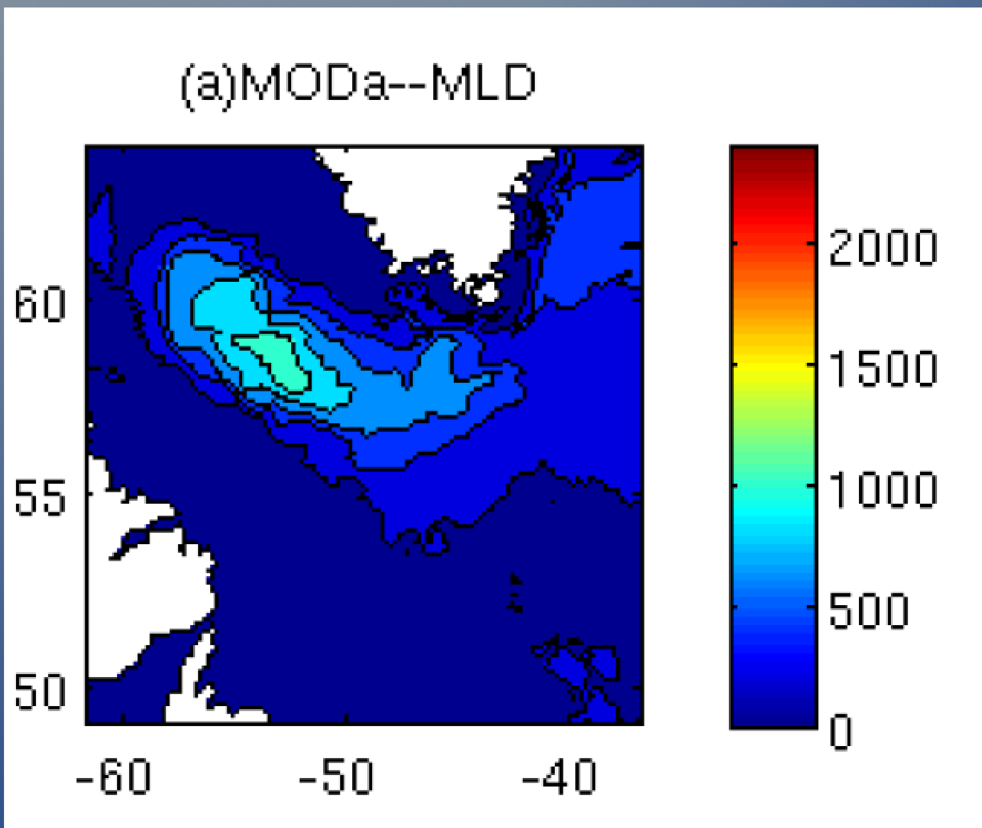


Levitus et al., 2005 annually mean climatology

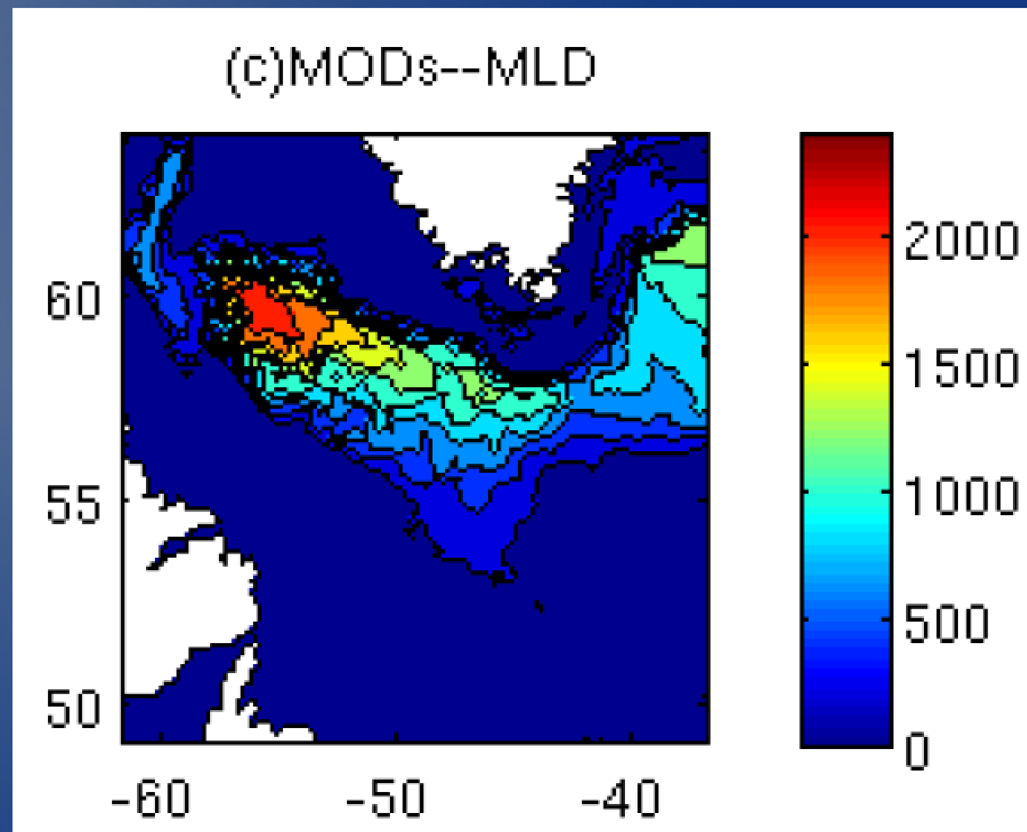


Annual mean temperature in free run

Impact of bias on the winter maximum mixed layer depth



Model run with spectral nudging



Free model run

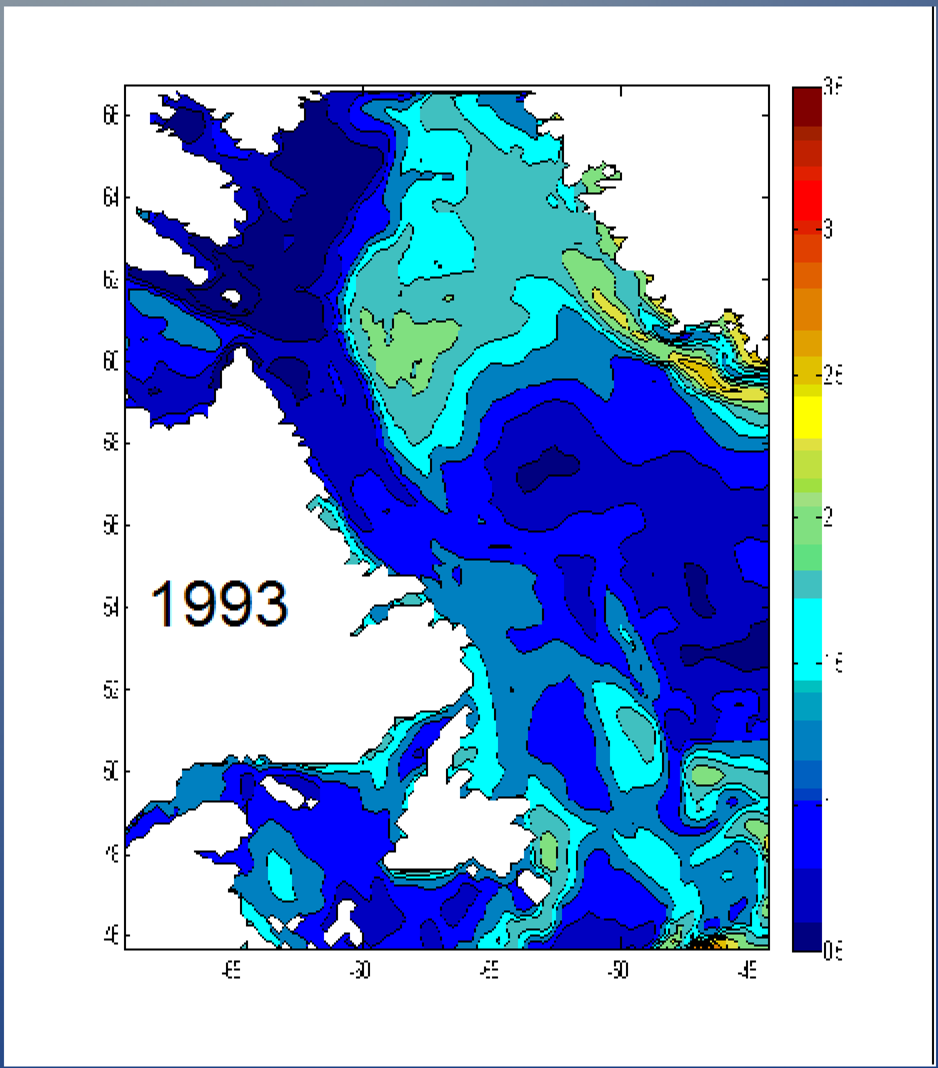
Impact of unresolved mesoscale process on the model error

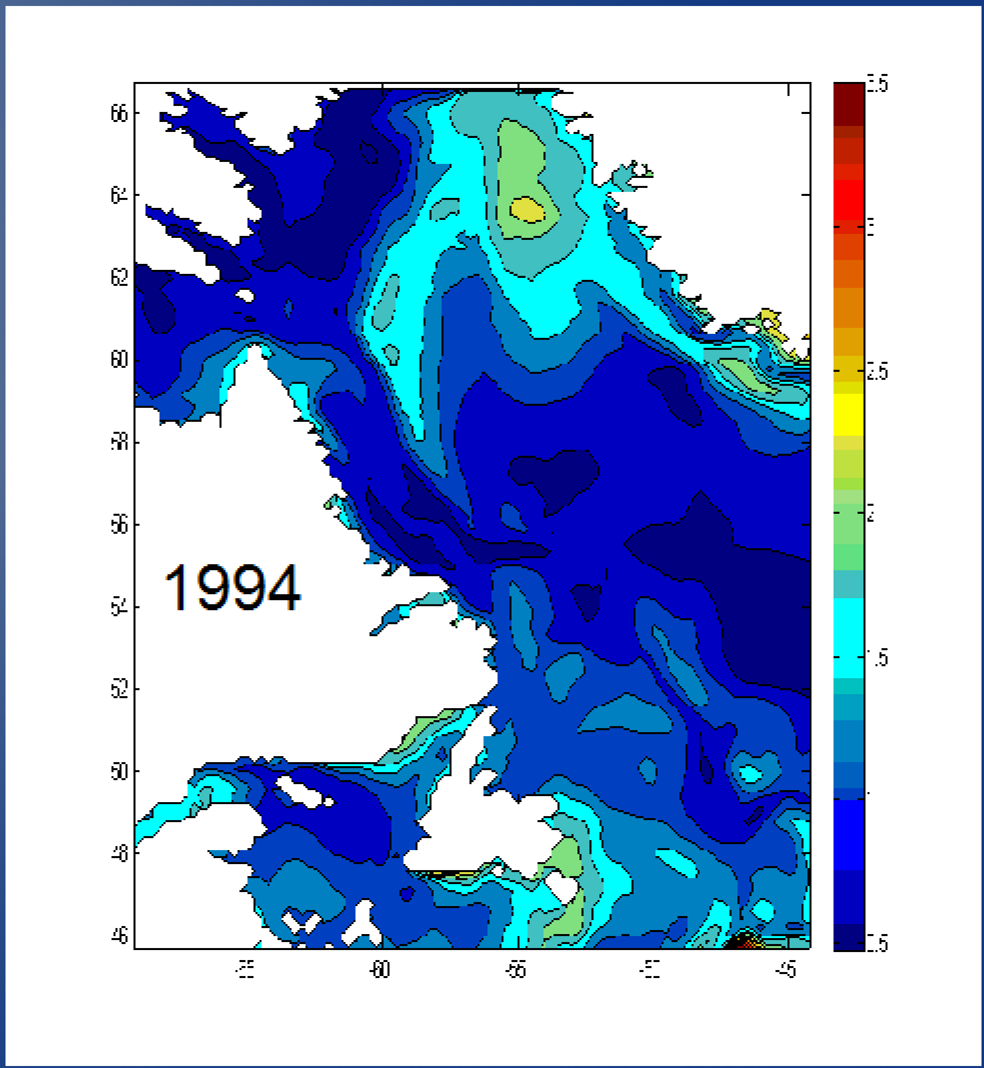
- The model used in this study is eddy permitting
- It does not resolve all the scales, which are important for the eddy dynamics
- This potentially may have importance in the regions of the northern branch of North Atlantic current, deep convection area and in representation of the transport of Irmenger Water in the Labrador Sea

Assessment of model error in surface temperature and sea level anomaly

- The effect of eddy processes have a strong signal in the surface temperature distribution and sea level anomaly
- Here we study the model error related to unresolved mesoscale processes through comparison of model solutions with SST and SLA observations

Model SST rms error



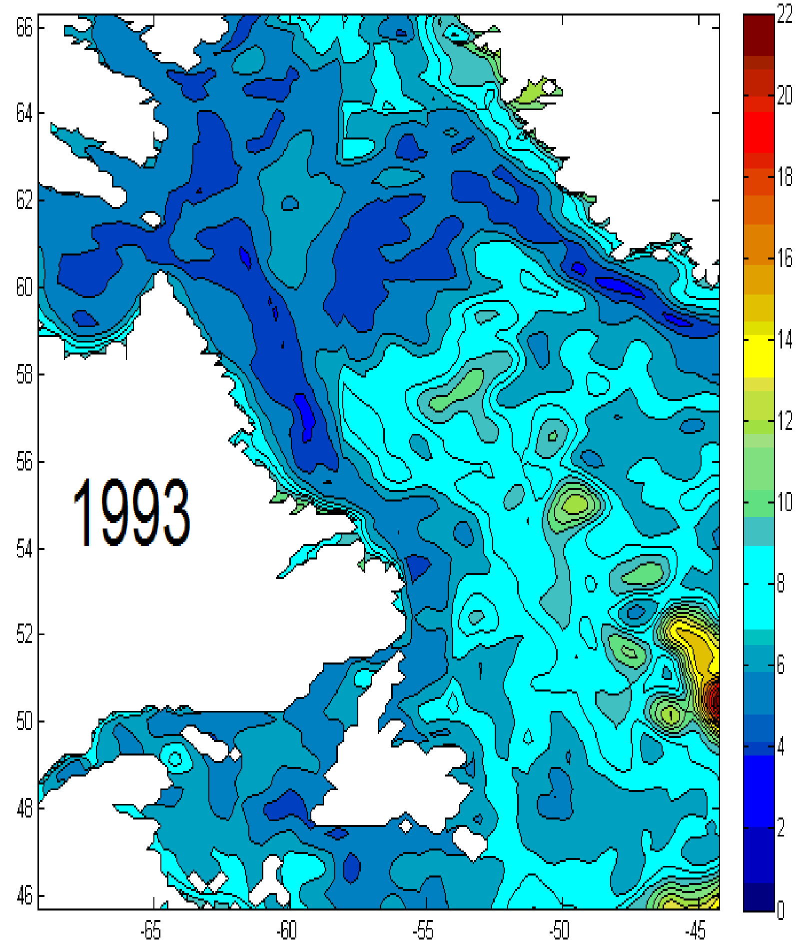


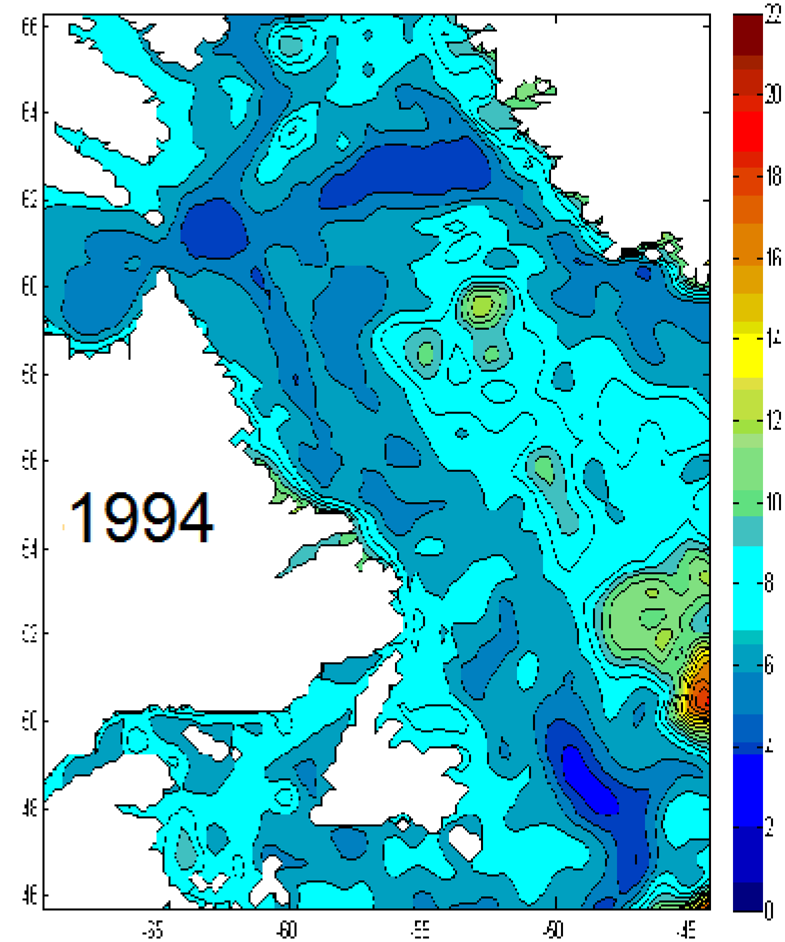
Model SST rms error

1993

1994

Model SLA rms error





Model SLA error

1993

1994

Surface wind speed rms error

- NCEP wind speed forcing data
- Comparison with Quikscat scatterometer data

Data assimilation and forecast error parameterization method
(Brankart et al, 2003)

- SEEK filter (Pham et al., 1998; Brankart et al., 2003)
- The state vector: **T, S, u, v,** ζ
- Covariance matrix $\mathbf{P} = \mathbf{L}\,\mathbf{U}\,\mathbf{L}^T$
- The initial error covariance matrix is approximated with 10 EOF's computed from the free run 1995-1996.
- Local gain operator is used with an influence bubble of 100km
- The model error variance is adapted to be coherent with the innovation variance

- Show the gulf stream slice

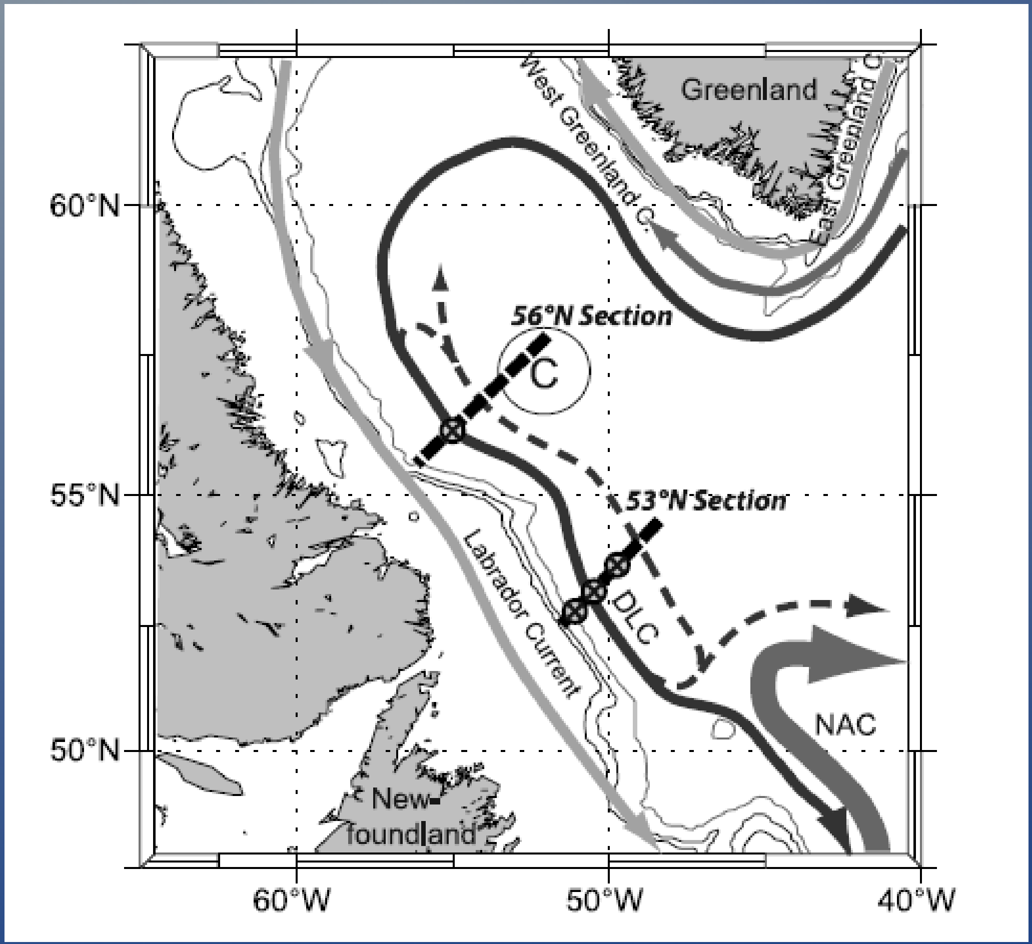
Zonal velocity at 72^{o}W

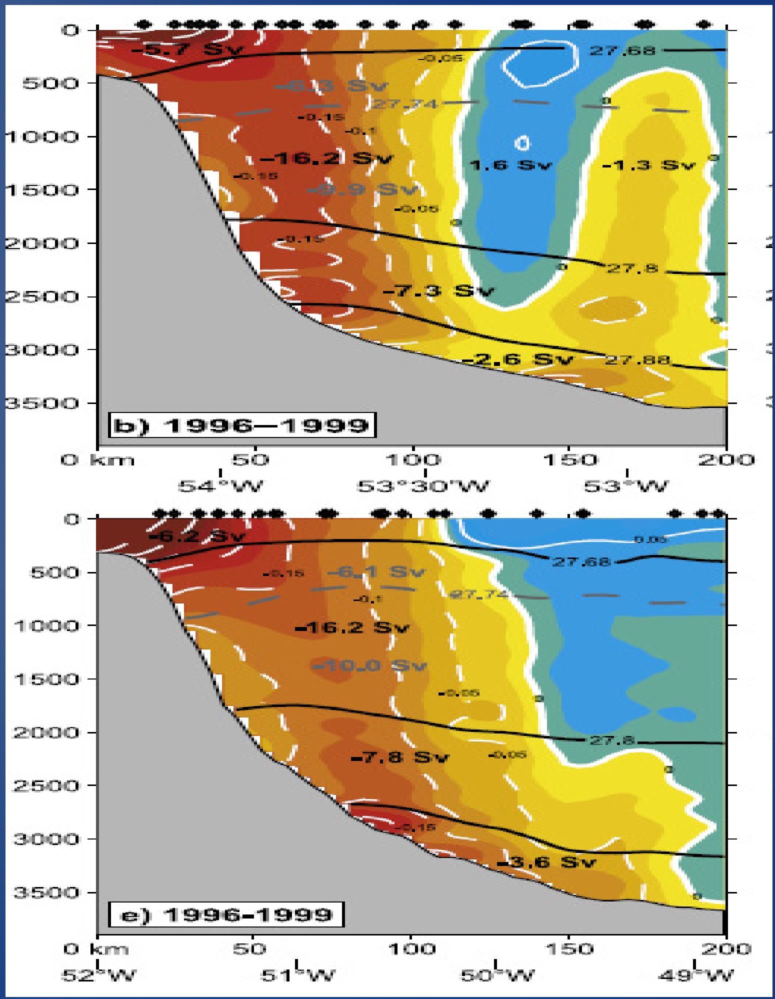
Prognostic run

Data assimilation run

Schematic diagram of the Labrador Sea circulation

(Dengler et al, 2006)





Model simulations of the Labrador Current

Prognostic run

Data assimilation run

53° N

56° N

Prognostic run SSH

Model

Observation

Assimilation run SSH

Model

Observation

Conclusions and future work

- The effect of model bias and unresolved mesoscale processes in model simulations of the Labrador Sea are studied.
- The uncertainty in the model solution for temperature and salinity is estimated
- The impact of these uncertainties on the model dynamics is discussed
- Future work: A data assimilation scheme is under development that aims to correct these errors.

Acknowledgments

- ***This work is part of GOAPP project, funded by Canadian Foundation for Climate and Atmospheric Sciences.***

- ***The altimeter data used in this study are provided by Ssalto/Ducas project.***

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)