C-45: Variability in Circulation and Hydrographic Structures in the Denmark Strait

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Abstract

Freshwater exchange across the east Greenland shelfbreak is influenced by local atmospheric forcing, adjacent circulation, bathymetry, and upstream inflow. Therefore, we have set up a high-resolution realistic model centered on the east Greenland shelf, the Iceland and Irminger Seas to interpret the sparse observations available for this area. Our results are compared to several shipboard hydrographic sections across Denmark Strait occupied between 1990 and 2012 using the same interpolation technique performed by Mastropole et al. [submitted]. The characterization of weakly stratified "boluses" of dense water that we present is only the first of many other analyses that will be performed on this new dataset. The main goal is to improve the understanding of the mechanisms that control the dynamics in this area, especially where environmental conditions inhibit measurements.

Model Configuration

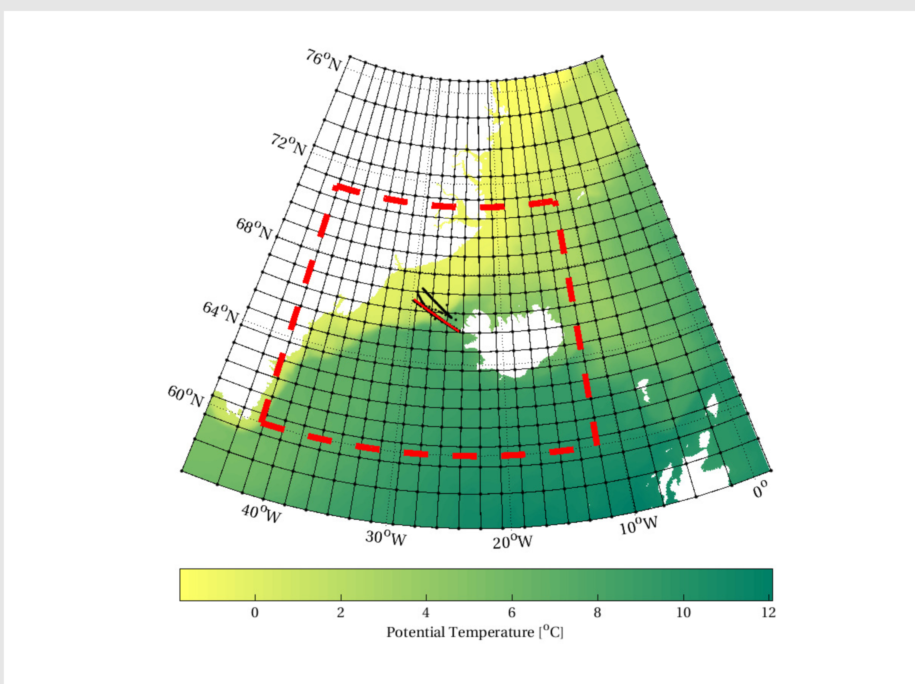


Figure 1 :
Model domain and 2007/2008 mean SST.
(i) red dashed line: high resolution area; (ii) black: shipboard hydrographic sections; (iii) red solid line: Látrabjarg hydrographic section across the Denmark Strait.

- DOMAIN: 47°W-1°E ; 57°N-77°N
- TIME PERIOD: Sep. 2007 - Sep. 2008
- HORIZONTAL RESOLUTION: 2-4 km
- VERTICAL RESOLUTION: 216 z-levels

What's new?

The model **domain** (Fig. 1) has been **extended** with respect to previous versions of this model (e.g. Magaldi et al. [2011]) to include the whole Iceland Sea in the north as well as Cape Farewell in the southwest. Moreover, (i) **surface runoff** estimated from a dataset of daily, 1 km resolution **Greenland Ice Sheet** surface mass balance [Noël et al., 2016], and (ii) **solid ice discharge** estimated from combination of climate modeling, and satellite and terrestrial data [Bamber et al., 2012] are now **included in the model forcing**.

Mean Fields

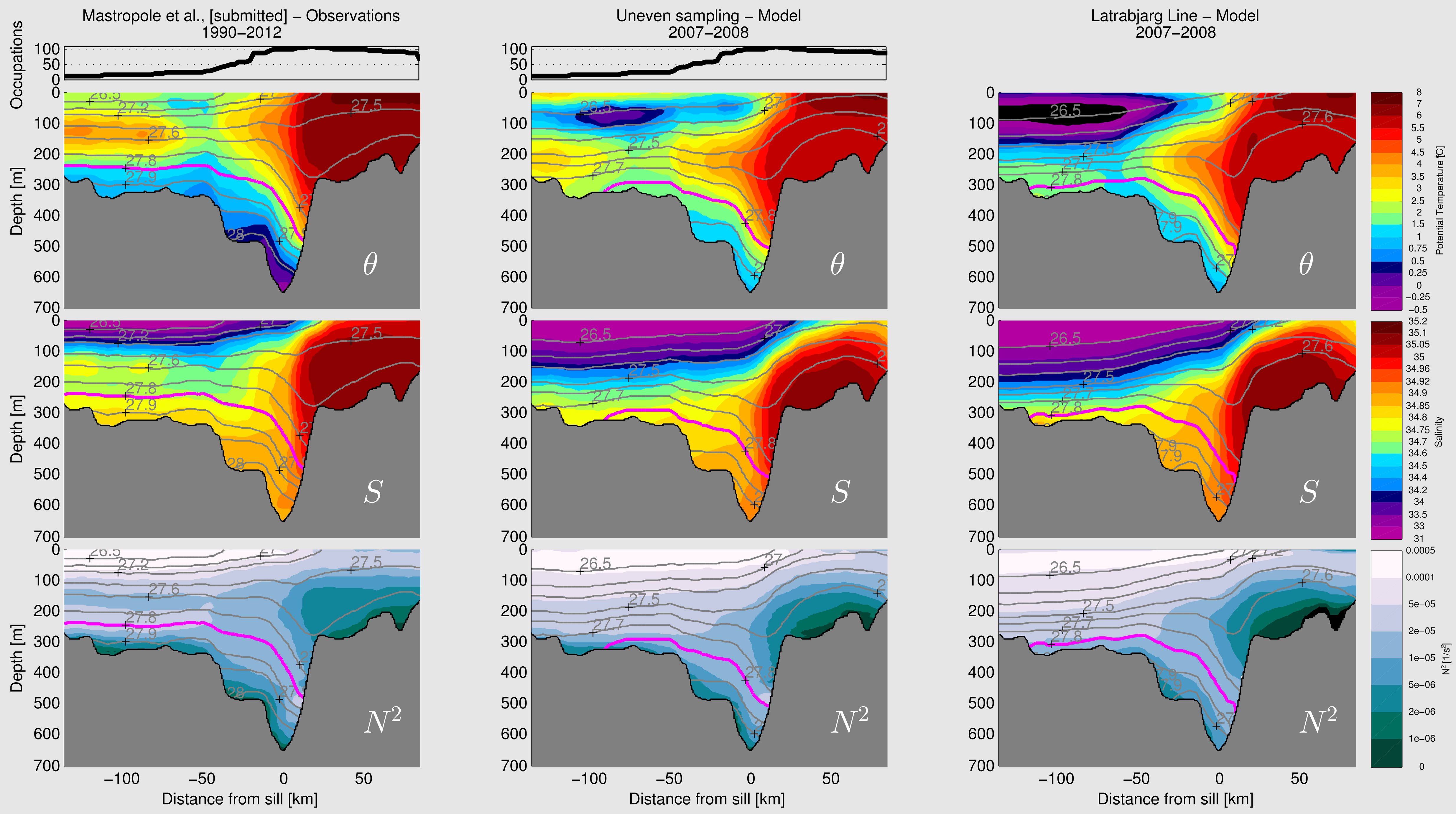


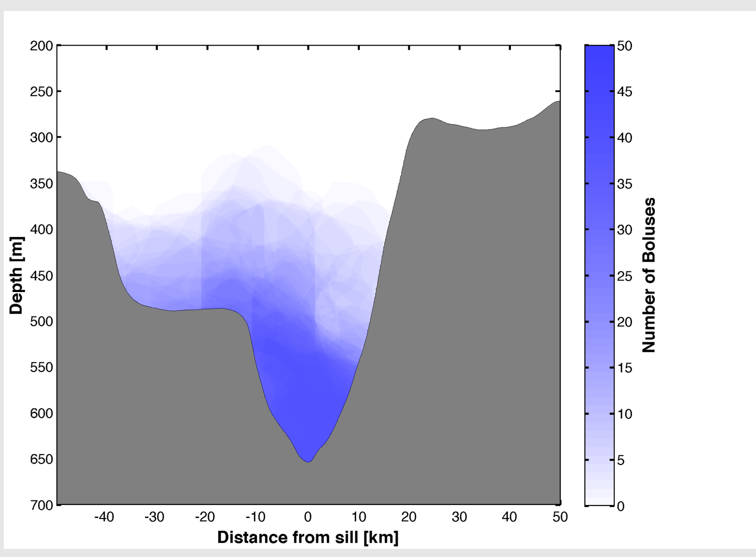
Figure 2 : Comparison between observed (left) and modeled (middle-right) mean fields.

Modeled temperature and salinity structures are similar to the structures identified from observations. However, modeled densities are slightly lower, and modeled temperatures are slightly warmer in the trough and colder on the western side of the strait. These biases can be due to:

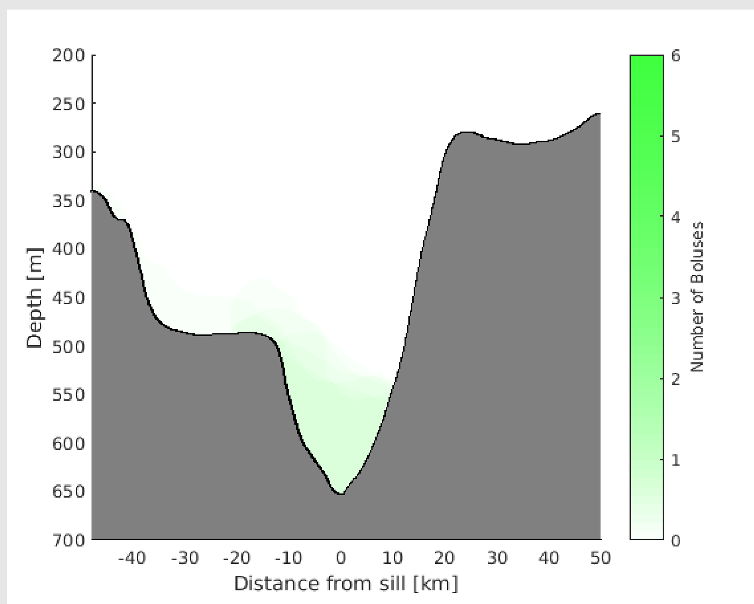
- **Inter-annual variability**: Macrander et al. [2005] found a significant decrease in the transport of the Denmark strait overflow, and a warming of the near bottom layer during the early 2000s. Jochumsen et al. [2012] found that the beginning of the recovery of the overflow transport coincides with the modeled years (2007-2008).
- **Lack of observations on the Greenland side** (top panels in Fig. 2): temperatures on the western side of the strait show that the interpolation technique performed by Mastropole et al. gives biased results in this area.
- **Model errors**, due for example to bias in the mixing parametrizations or in the initial conditions.

Differences in Brunt-Väisälä frequency fields are minor, allowing us to conduct accurate analysis on weakly stratified "boluses" of dense water.

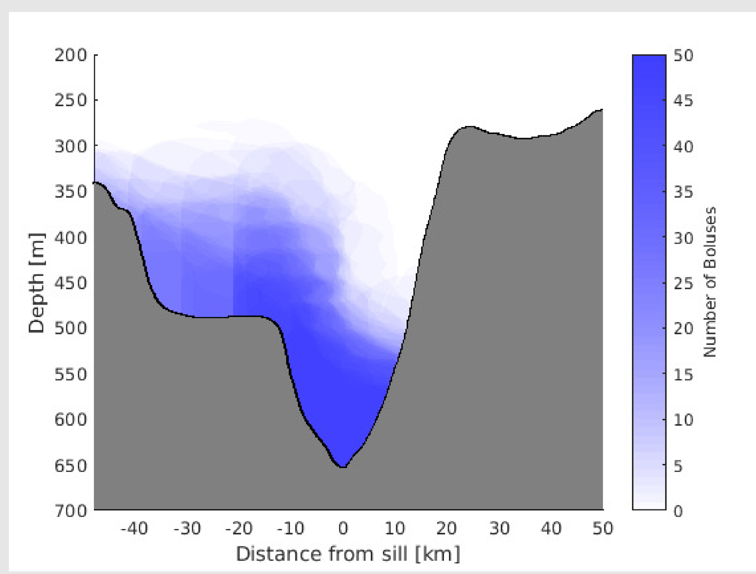
Boluses and DSOW transport



(a) $N^2 = 2 \times 10^{-6}$ s^{-2} - Observations Mastropole et al. [submitted]



(b) $N^2 = 2 \times 10^{-6}$ s^{-2} - Model



(c) $N^2 = 1.2 \times 10^{-5}$ s^{-2} - Model

Figure 3 : Number of boluses using different Brunt-Väisälä frequency limits.

Boluses are defined by Mastropole et al. [submitted] as weakly stratified water with Brunt-Väisälä frequencies less than or equal to 2.0×10^{-6} s^{-2}. We increased the Brunt-Väisälä frequency threshold by one order of magnitude in order to obtain the same number of boluses observed by Mastropole et al. [submitted]. We are currently exploring time-series of the Denmark Strait Overflow Water (DSOW) transport in order to properly adjust the Brunt-Väisälä freq. limit.

Conclusions

- **Temperature, salinity, and density structures are similar to observed structures.**
- **Biases with respect to observations can be due to inter-annual variability.**
- **Model's outputs are necessary to interpret the few observations on the western side of the Denmark Strait.**

References

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