Project:	**941**
Project title:	**Investigation of Labrador Sea Dynamics with the High-Resolution Finite Element Sea Ice – Ocean Model FESOM**
Principal investigator:	**Gerrit Lohmann**
Report period:	**2018-01-01 to 2018-12-31**

1 Project report

The effects of a high horizontal resolution and model spinup time were analyzed in a systematic comparison of two FESOM (Finite Element Sea Ice Ocean Model; Danilov et al. 2004, Wang et al. 2014) mesh configurations and summarized in a manuscript for the Journal of Physical Oceanography (JPO), currently under revision.

Using a high horizontal resolution of 5-15 km in the North Atlantic, we find a strong shift in the upper ocean circulation and water mass properties during a ~300 year long spinup (five consecutive CORE-II atmospheric forcing cycles from 1948-2009, Large and Yeager 2009). In the low-resolution (~1°) control run, in contrast, this spinup adjustment is much weaker. In the high-resolution model, the adjustment leads to a significant reduction of typical hydrographic biases such as a reduction of sub-polar gyre salinification, a reduction of too deep winter mixed layer depths in the Labrador Sea and an improved sea ice distribution and extent. These effects occur mainly due to a shifted position of the North Atlantic Current (NAC): the initially (1st spinup, 62 model years; Fig 1 b) correct current path is not maintained throughout five consecutive spinup cycles (310 model years; Fig 1 d) but shifted southeastward. Hence, in quasi-equilibrium, the upper ocean circulation resembles the low-resolution solution, where the NAC is in the wrong position as well. In addition, the low-resolution currents are too broad, slow and lack the vivid meanders seen in altimetry observations (AVISO; Fig 1 a) as well as in the high-resolution model (Fig 1 b and c). These effects were not stated before since most high-resolution ocean modeling studies exhibit rather short model integration times on the order of *O*(1-20 years) (e.g. Marzocchi et al. 2015).

2 References

AVISO. The altimeter products were produced by Ssalto/Duacs and distributed by Aviso, with support from Cnes, http://www.aviso.altimetry.fr/duacs/).

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Marzocchi, A., J. J.-M. Hirschi, N. P. Holliday, S. A. Cunningham, A. T. Blaker, and A. C. Coward, 2015: The North Atlantic subpolar circulation in an eddy-resolving global ocean model. ***J. Mar. Syst.***, 142, 126–143, doi:10.1016/j.jmarsys.2014.10.007.

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3 Figures

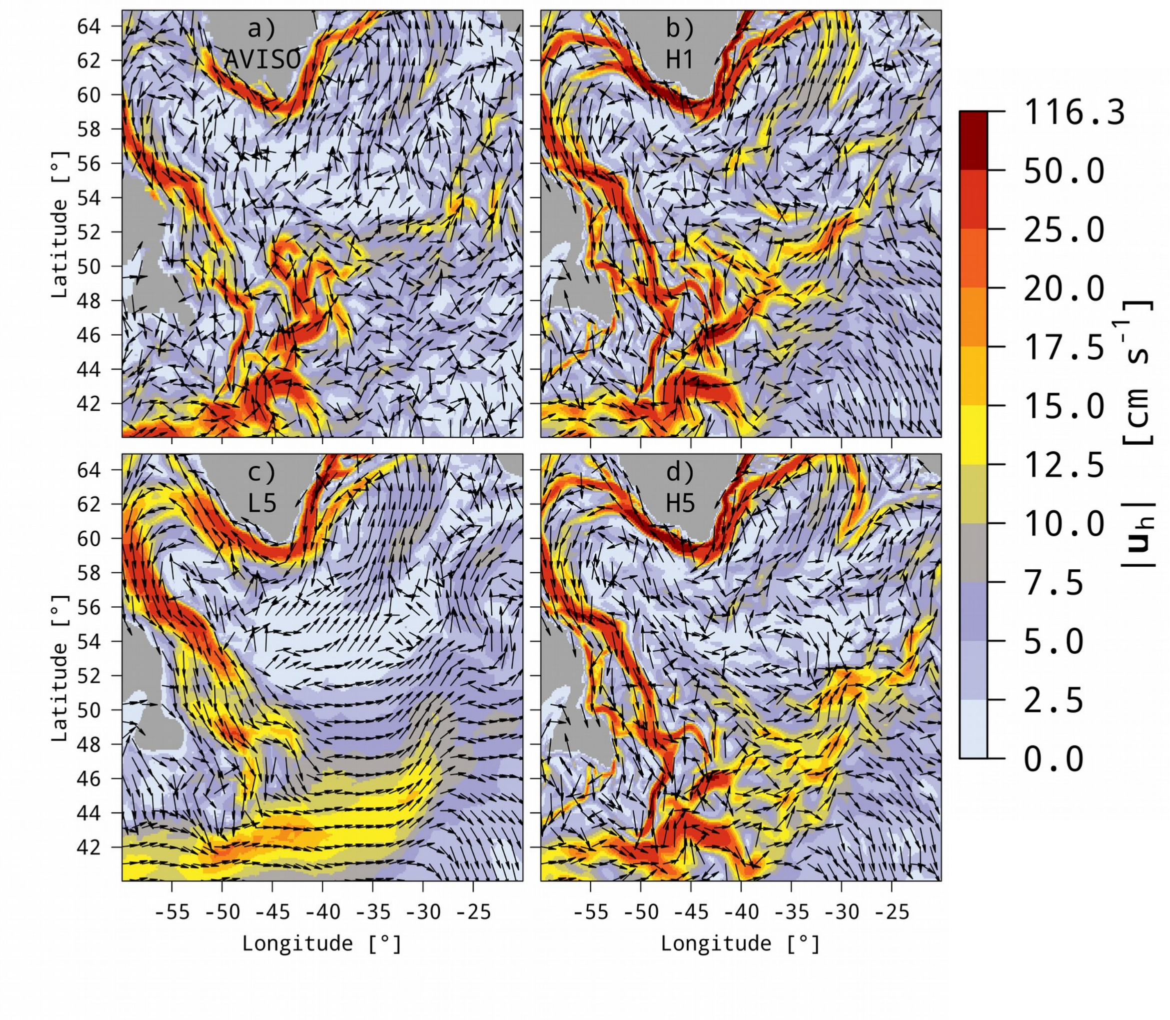

Fig. 1: Average (1993-2009) horizontal surface velocity norm (in cm s^{-1}, irregular levels) and direction (arrows of constant length, not all plotted). **a)** shows geostrophic velocities as derived by satellite altimetry (AVISO), **b)** the 1st spinup of the high-resolution model and **c-d)** the 5th spinups of low- and high-resolution models (differences between 1st and 5th low-resolution spinups are negligible). For the models the full (not geostrophic) velocities are shown.