Project:	**ba941**
Project title:	**Investigation of Labrador Sea Dynamics with the High-Resolution Finite Element Sea Ice – Ocean Model FESOM**
Principal investigator:	**Gerrit Lohmann**
Report period:	**2020-01-01 to 2020-12-31**

1 Project report

In a second paper based on the conducted high-resolution FESOM (Finite Element Sea Ice Ocean Model; Danilov et al. 2004, Wang et al. 2014) experiments we analyze small-scale eddy temperature flux dynamics in the Labrador Sea.

Oceanic mesoscale eddies play an important role in preconditioning and restratifying the water column before and after mixing events and thereby affect deep water formation variability. In the Labrador Sea, where deep convection occurs regularly, observations and models show that different eddy dynamics act in concert. Results from a realistic eddy-resolving ocean model in quasi-equilibrium (~5 km local horizontal resolution) suggest that the conversion of turbulent potential energy through baroclinic instabilities accompanied by large vertical velocities is the main driver of eddy generation during deep convection not only within the mixed layer patch, but also in the West Greenland Current. Barotropic instabilities play only a secondary role. In a low-resolution control simulation (~25 km) the modeled turbulence is strongly reduced and the associated heat fluxes too weak to increase stratification (Fig. 1). In addition, the mean circulation is crucial to provide buoyant water masses for eddies to act against steep isopycnals. Only together turbulence and mean flow balance the destabilizing forcing.

The paper is currently in the submission process at GRL. Previously, the effects of a high horizontal resolution and model spinup time were analyzed in a systematic comparison of two FESOM mesh configurations (Danek et al. 2019).

2 References

Danek, C., Scholz, P., and Lohmann, G. (2019): Effects of high resolution and spinup time on modeled North Atlantic circulation. ***J. Phys. Oceanography.***, 49 (5), 1159-1181. https://doi.org/10.1175/JPO-D-18-0141.1

Danilov, S., Kivman, G., and Schröter, J. (2004): A finite element ocean model: principles and evaluation. ***Ocean Modell.***, 6, 125-150. doi:https://doi.org/10.1016/S1463-5003(02)00063-X

Wang, Q., S. Danilov, D. Sidorenko, R. Timmermann, C. Wekerle, X. Wang, T. Jung, J. Schröter (2014): The Finite Element Sea Ice-Ocean Model (FESOM) v.1.4: formulation of an ocean general circulation model. ***Geosci. Model Dev.*** 7, 663-693. doi:10.5194/gmd-7-663-2014.

3 Figures

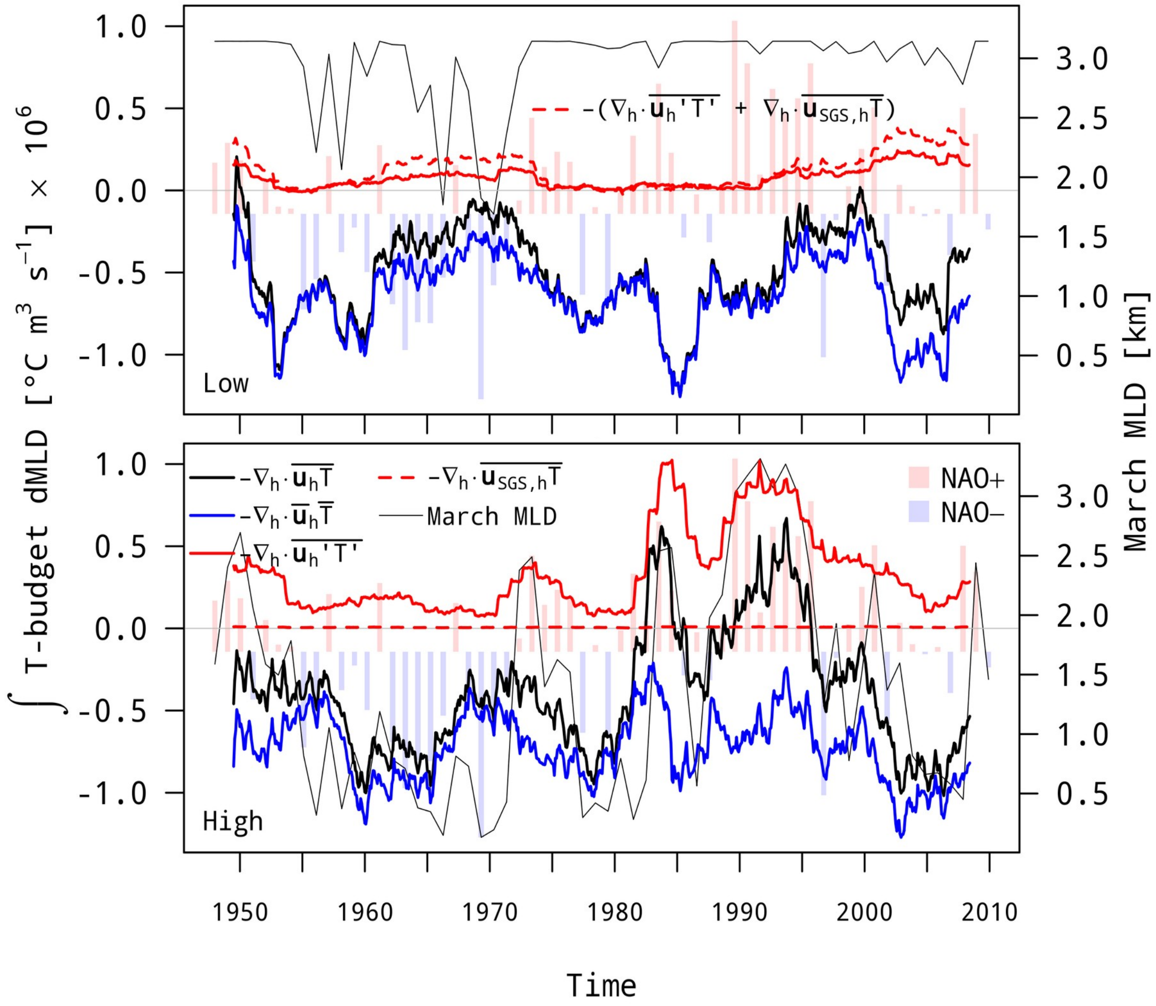

Fig. 1: Temporal evolution of mean (blue), eddy (red) and total (black solid lines) horizontal temperature advection divergence integrated over the Labrador Sea interior mixed layer depth as modeled by the low- (top) and high-resolution (bottom) FESOM configurations (in 10^6 °C m^3 s^{-1}; left axes; positive values indicate a temperature gain). Red dashed lines show the sub-grid scale (SGS) component (bottom) or the eddy and SGS sum (top; here, the SGS component is also included in the total advection). Thin black lines show the March mixed layer depth (in km; defined as the depth at which the potential density σ_Θ deviates from its 10 m depth value by 0.125 kg m^{-3}; right axes). A 3-year running mean is applied to all advection time series. Red (blue) bars in background indicate years with a positive (negative) NAO index on an arbitrary scale.