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Convection in the Greenland Sea in winter 2010–2011: Comparison between model and observations

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Dense water formation and the associated deep convection feeding the meridional overturning circulation is one crucial component in the earth's climate system. Furthermore, since convection is a sub-grid scale process in ocean and climate models, it needs to be parametrized. Although a number of different turbulence parametrization have been introduced trough the years these are rarely developed for deep convection. Traditionally convection in the Greenland Sea has been considered to be an important contributor to the Greenland-Scotland Ridge overflow waters, which form the main part of the abyssal limb of the Atlantic Meridional Overturning Circulation. However, this view has changed and presently there are indications that it is of minor importance.

Two possible forms of convection have been identified in the Greenland Sea, plume convection and mixed layer deepening. Plume convection occurs if the initial stratification, cold upper layer, allows the thermobaric effect to become important. The convection is, however, driven by extensive buoyancy loss and all the other forcing mechanisms are secondary.

This study uses observations from three Argo buoys and results from 1-D turbulence model (GOTM) runs to examine the convection in the Greenland Sea during the winter 2010-2011. Two different modelling approaches are tested. The first approach follows the float paths (Lagrangian approach) while the second stays at one (median) position (Eulerian approach). The model is forced with NCEP/NCAR and ERA-Interim surface fluxes. The resulting convection is in agreement with the mixed layer deepening scenario. Furthermore, all the traditional second order turbulence closures are found to perform relatively well in these conditions, most likely because non-local fluxes and thermobaric effects were insignificant. The different atmospheric forcings introduce most of the uncertainties, while the Lagrangian and Eulerian approaches are found to produce rather similar results.