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Mechanisms of flow and water mass variability in Denmark Strait

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The dense water export through Denmark Strait contributes significantly to the lower limb of the Atlantic Meridional Overturning Circulation. Overflow water is transported southwestward not only in the deep channel of the Strait, but also within a thin bottom layer on the Greenland shelf. The flow on the shelf is mainly weak and barotropic, exhibiting many recirculations, but may eventually contribute to the overflow layer in the Irminger Basin by spilling events in the northern Irminger Basin. Especially the circulation around Dohrn Bank and the Kangerdlussuaq Trough contribute to the shelf-basin exchange.

Moored observations show the overflow in Denmark Strait to be stable during the last 20 years (1996-2016). Nevertheless, flow variability was noticed on time scales of eddies and beyond, i.e. on weekly and interannual scales. Here, we use a combination of mooring data and shipboard hydrographic and current data to address the dominant modes of variability in the overflow, which are (i) eddies, (ii) barotropic pulsations of the plume, (iii) lateral shifts of the plume core position, and (iv) variations in vertical extension, i.e. varying overflow thickness. A principle component analysis is carried out and related to variations in sea surface height and wind stress, derived from satellite measurements. Furthermore, a test for topographic waves is performed.

Shelf contributions to the overflow core in the Irminger Basin are identified from measurements of temperature and salinity, as well as velocity, which were obtained during recent cruises in the region. The flow and water mass pattern obtained from the observational data is compared to simulations in a high resolution regional model (ROMS), where tracer release experiments and float deployments were carried out. The modelling results allow a separation between different atmospheric forcing modes (NAO+ vs NAO- situations), which impact the water mass distribution and alter the dense water pathways on the Greenland shelf. Finally, the results are discussed with respect to other regional model studies on the circulation in the northern Irminger Basin.