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The Irminger Sea – air-ice-ocean interactions in a 5 km coupled simulation with ICON-ESM

Oliver Gutjahr[1,2], Johann H. Jungclaus[2], Nils Brüggemann[1,2], Helmuth Haak[2], and Jochem Marotzke[2]

[1]Universität Hamburg, Institut für Meereskunde, Hamburg, Germany (oliver.gutjahr@uni-hamburg.de)

[2]Max Planck Institute for Meteorology, Ocean in the Earth System

Recent observations suggest that deep convection and water mass transformation in the Irminger Sea southeast of Greenland, together with overflows from the Nordic Seas, may be more important for the variability of the Atlantic meridional overturning circulation (AMOC) than the Labrador Sea. The preconditioning for and triggering of deep convection in the Irminger Sea is strongly associated with topography-induced mesoscale wind phenomena, such as Greenland tip jets, katabatic winds and marine cold air outbreaks. However, the resolution of current coupled climate models is too coarse to capture all the properties of these wind systems or to capture them at all. Here we explore the air-ice-ocean interactions induced by mesoscale wind phenomena in the Irminger Sea in a 1-year global coupled 5km simulation with ICON-ESM. The model is able to capture the complex interactions of the wind field and the ocean. We find that strong downward katabatic winds cause substantial heat loss from the Irminger Sea in addition to Greenland tip jets. The outflowing katabatic winds form narrow streaks of cold air that extend across the entire Irminger basin from southeast Greenland to Iceland. In addition, cold air outbreaks from the sea ice lead to the genesis of mesoscale cyclones, which in turn can cause Greenland tip jets before moving off to the east. All these wind phenomena cause substantial heat loss that preconditions the ocean for deep convection. If these wind systems are not resolved, the water mass transformation in the Irminger Sea could be too weak, contributing to why the Labrador Sea dominates AMOC variability in models. We conclude that resolving these mesoscale wind systems in an Earth system model could have significant implications for deep convection and water mass transformation in the Irminger Sea, and thus for AMOC variability.