Geophysical Research Abstracts
Vol. 19, EGU2017-3035, 2017
EGU General Assembly 2017

Air-sea heat fluxes associated with episodic cold air outbreaks and their role for dense water formation in the Nordic Seas

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The formation of dense waters in the Nordic Seas is a key process for maintaining the Atlantic meridional overturning circulation. Where and when these dense waters are formed, is to a large extent controlled by sensible and latent heat fluxes, whose spatio-temporal variability is dictated by the occurrence of short-lived and intense events of strong upward heat fluxes. The vast majority of these events is the result of intermittent excursions of Arctic cold airmasses over the open ocean, so-called cold air outbreaks (CAOs).

First, we present a 35-year long climatology of wintertime CAO airmasses forming over the Nordic Seas to study (1) origin and pathways of the involved airmasses, (2) their thermodynamic evolution, and (3) the amount of heat extracted from the ocean along their pathways. Specifically, we show that CAOs in the Nordic Seas originate largely in the interior Arctic, entering the Nordic Seas via Fram Strait. These cold airmass outflows via Fram Strait are essentially controlled by the frequency of anti-cyclonic flow over Greenland and cyclone activity in the Nordic Seas. In addition, also flows across southern Greenland and katabatic drainage flow contribute. We discuss the role of the pathway over the underlying SST distribution for setting the total amount of heat extracted from the ocean by a certain CAO airmass. Our analysis indicates that CAO airmasses that are for the first time exposed to the open ocean in the Greenland and Iceland Seas are among those, which extract the most heat from the ocean.

Second, we analyse the impact of individual, intermittent CAOs on the ocean mixed layer in the western Iceland Sea, which is a region thought to play a fundamental role in the formation of the densest overflow waters produced in the Nordic Seas. This analysis is based on in-situ measurements from three Seagliders that were deployed during winter 2015/2016. The CAO activity and ocean mixed layer evolution during that particular winter are put into the context of the climatological findings on CAO formation and variability.