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An aircraft-based investigation of the turbulent stable boundary layer over the North Water polynya (Greenland)

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Atmosphere/sea-ice/ocean exchange processes over the NOW (North Water) polynya in northwest Greenland were studied during the aircraft-based experiment IKAPOS (Investigation of Katabatic winds and Polynyas during Summer) in June 2010. The measurements were performed using the research aircraft POLAR 5 of Alfred Wegener Institute (AWI, Bremerhaven). Besides navigational and basic meteorological instrumentation, the aircraft was equipped with radiation and surface temperature sensors, two laser altimeters, and video and digital cameras. In order to determine turbulent heat and momentum fluxes, POLAR 5 was instrumented with a turbulence measurement system collecting data on a nose boom with a sampling rate of 100 Hz.

While a polynya is associated with a convective boundary layer during winter, the situation in early summer is quite different. With the surface temperature at the melting point of ocean water, warm air advection leads to the formation of a stable boundary layer. Over the NOW in June, a stable, but fully turbulent boundary layer with strong winds of 15 m s-1 to 20 m s-1 was found during conditions of relatively warm synoptically induced northerly winds through the Nares Strait. Strong surface inversions were found in the lowest 100 m to 200 m. As a consequence of channeling effects at Smith Sound a well-pronounced low-level jet system was documented. These channeling effects lead to an increased wind-induced sea-ice export from the Nares Strait through Smith Sound. Cross-sections of mean quantities over the polynya are presented. The multiresolution decomposition is used to identify the spectral gap for the computation of turbulent fluxes. For the NOW polynya flights gap scales are between 500 m – 1000 m. Sensible heat fluxes are around -30W/m^2 in the area of highest wind speed at Smith Sound. Accordingly, the momentum flux shows also a maximum caused by the channeling, which is an important factor for the process of NOW formation. The experimental data for the fully turbulent SBL are used to test parameterizations of exchange coefficients.

The results of IKAPOS are valuable for the validation of numerical models (including climate models) and will contribute to the understanding of the exchange processes over summertime Arctic polynyas and the formation of the NOW polynya.