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A study of the stable boundary layer in strong gap flows in northwest Greenland using a research aircraft

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Gap flows and the stable boundary layer (SBL) were studied in northwest Greenland 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.

In the area of the Nares Strait 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 present in the lowest 100 m to 200 m. As a consequence of channeling effects a well-pronounced low-level jet (LLJ) system was documented. The channeling process is consistent with gap flow theory and can be shown to occur at the topographic gap between Greenland and Canada represented by the Smith Sound. While the flow through the gap and over the surrounding mountains leads to the lowering of isotropic surfaces and the acceleration of the flow, the strong turbulence associated with the LLJ leads to the development of an internal thermal SBL past the gap. Turbulence statistics in this fully turbulent SBL can be shown to follow the local scaling behaviour.