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A study of a boundary layer front near Svalbard using aircraft measurements and numerical model simulations

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Boundary layer fronts (BLFs) associated with the sea ice front are associated with cold air outbreaks and the formation of meso-scale cyclones takes place at these low-level baroclinic zones in many cases. BLFs can also be regions of strong winds and low-level jets. During the aircraft-based experiment LEAST (Lead and ABL Study in the Transpolar System) around Svalbard in March 2014 boundary layer structures were studied in the marginal ice zone north of Svalbard. The research aircraft POLAR 5 of the Alfred Wegener Institute (AWI, Bremerhaven, Germany) was used.

Because of an unusual warm winter in the Svalbard region (temperatures 15K above normal conditions in February 2014) a huge zone of open water extended north of Svalbard. On 13 March 2014, a BLF near the MIZ north of Svalbard associated with a remarkable convergence zone was measured using dropsondes. On the northward side of the BLF, a shallow (300m) cold air outbreak with near-surface temperatures of about -20°C and a southward wind component of 8m/s is observed, while on its southern side a well-mixed layer with -10°C (pot. temperature) associated with a low-level jet of 14m/s and a strong northward wind component (10m/s) is present in the lowest 500m.

The regional climate model CCLM (nested in ERA5) is used in a forecast mode to simulate this event. CCLM is run for the whole Arctic with 15km resolution and for the Svalbard area with 5km resolution. The simulated BLF structures are compared with the in-situ measurements. CCLM profiles agree well with observations, but have time shift of 1h. CCLM shows exceptional high frontogenesis in the lowest 500m.