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Controlled meteorological (CMET) balloon profiling of the Arctic atmospheric boundary layer

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We demonstrate profiling of the atmospheric boundary layer over Arctic ice-free and sea-ice covered regions by free-floating controllable CMET balloons. The CMET observations (temperature, humidity, wind-speed, pressure) provide in-situ meteorological datasets in very remote regions for comparison to atmospheric models.

Controlled Meteorological (CMET) balloons are small airborne platforms that use reversible lift-gas compression to regulate altitude. These balloons have approximately the same payload mass as standard weather balloons but can float for many days, change altitude on command, and transmit meteorological and system data in near-real time via satellite.

Five Controlled Meteorological (CMET) balloons were launched from Ny-Ålesund in Svalbard (Spitsbergen) over 5–12 May 2011 and measured vertical atmospheric profiles (temperature, humidity, wind) over coastal and remote areas to both the east and west. One notable CMET flight achieved a suite of 18 continuous soundings that probed the Arctic atmospheric boundary layer (ABL) over a period of more than 10 h. Profiles from two CMET flights are compared to model output from ECMWF Era-Interim reanalysis (ERA-I) and to a high-resolution (15 km) Arctic System Reanalysis (ASR) product. To the east of Svalbard over sea-ice, the CMET observed a stable ABL profile with a temperature inversion that was reproduced by ASR but not captured by ERA-I. In a coastal ice-free region to the west of Svalbard, the CMET observed a stable ABL with strong wind-shear. The CMET profiles document increases in ABL temperature and humidity that are broadly reproduced by both ASR and ERA-I. The ASR finds a more stably stratified ABL than observed but captured the wind shear in contrast to ERA-I. Detailed analysis of the coastal CMET-automated soundings identifies small-scale temperature and humidity variations with a low-level flow and provides an estimate of local wind fields.

We show that CMET balloons are a valuable approach for profiling the free atmosphere and atmospheric boundary layer in remote regions such as the Arctic, where few other in-situ observations are available to trace processes and for model evaluation.

References:

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