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## Arctic Cloud Development during Airmass Transformation: First results from HALO-AC3

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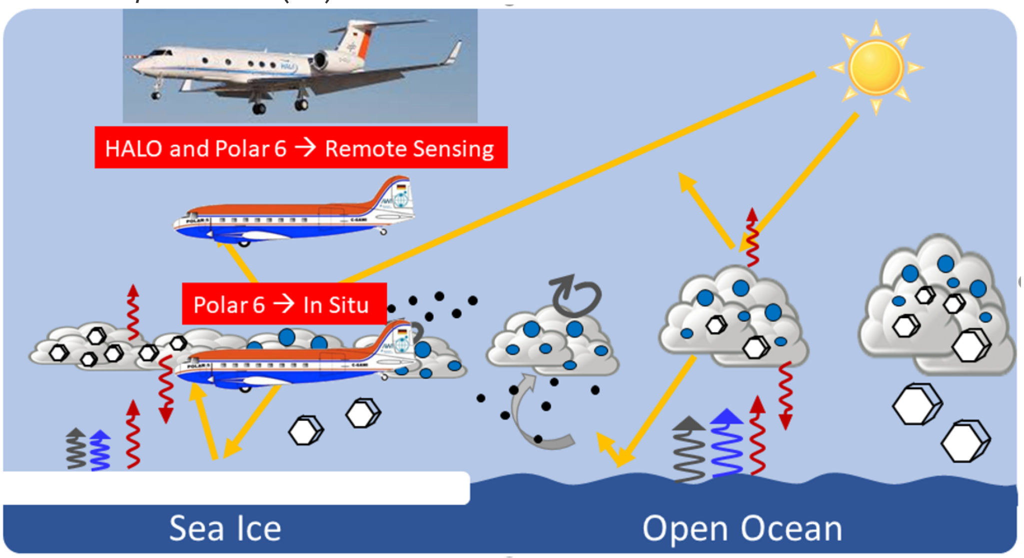
**Abstract Text:**

Arctic Amplification is most evident in the rise of the near-surface air temperature in the Arctic being at least twice as strong as the global average. The excessive warming is both a consequence and a driver of feedback processes specific to the Arctic. Herein many processes and especially the role of clouds are still poorly understood. Airmass transport into and out of the Arctic, their modification and transformation is under debate as an important contributor to Arctic Amplification. Transformation processes are particularly associated with warm air intrusions into the Arctic and marine cold air outbreaks. For that cloud and precipitation processes are crucial, however, a strong lack of direct observations of airmass transformation exists. To overcome this gap the HALO-(AC)$^3$ field study aimed at quasi-Lagrangian observations of air-mass transformation processes during meridional transports. Furthermore, we assess the ability of numerical atmospheric models to reproduce the measurements.

HALO-(AC)$^3$ was conducted in March/April 2022 combining three research aircraft with state-of-the art remote sensing and in-situ instruments. The German High Altitude and Long Range Research Aircraft (HALO), was operated from Kiruna, Sweden, covering long distances up to the North Pole with flight patterns tackling to probe airmasses multiple times on their way into and out of the Arctic. The POLAR 5 and POLAR 6 aircraft from the Alfred-Wegner-Institute (AWI) operated in a narrower region including the marginal sea ice zone in the vicinity from Longyearbyen, Svalbard. HALO was flown in a remote sensing configuration including a Ka-band Doppler radar, a 25-channel microwave radiometer, and aerosol and DIAL water vapour lidar, spectral and broadband solar and thermal-infrared radiation sensors (upward and downward-looking), imaging camera spectrometers in the solar and thermal-infrared spectral ranges, and dropsondes. Several coordinated flights with the three aircraft were performed in which the POLAR 6 sampled in-situ aerosol, cloud, and precipitation particles within the boundary layer while the POLAR 5 flew roughly at 3 km altitude observing clouds with radar, lidar and radiation sensors to gain better understanding of cloud microphysics and radiative fluxes (see figure below).

Weather conditions were favorable allowing us to observe multiple cold air outbreaks and a major warm air intrusion in the mid of march which included also a strong atmospheric river event. During the warm air intrusion, a strong southerly flow transported heat and moisture into the high Arctic leading to extended rain on the sea ice and ice clouds reaching more than 12 km altitude. An observational highlight were targeted observations of a polar low on April 8 for which we were able to derive divergence and vorticity profiles from multiple dropsondes. In total 17 research flights covering more than 100.000 km were conducted with HALO on which more than 300 dropsondes were launched – several of them above 80 N. In addition, the POLAR aircraft flew more than 36.000 km west of Svalbard and launched 142 dropsondes over the Arctic ice and the open ocean. The presentation will give an overview on the overall campaign setup, the data set gathered and first results such as distinct difference of clouds over sea ice and open water.

*This work is supported by the DFG funded Transregio-project TR 172 "Arctic Amplification* (AC)$^3$ *".*




**Abstract ID:**
404932

**Abstract Password:**
717397

**Program Selection:**
17th Conference on Polar Meteorology and Oceanography

**Submitter's E-mail Address:**
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**Preferred Presentation Format:**
Oral

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