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HALO-AC3: Airborne Observations of Arctic Clouds in Airmass Transformations

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Abstract Text:

The phenomenon of Arctic Amplification is most evident in the rise of the near-surface air temperature observed in the last decades and being at least twice as strong as the global average. The mechanisms behind that are widely discussed. Many processes and their feedback mechanisms are still poorly understood. Especially the role of clouds and of airmass transport in and out of the Arctic associated with transformation processes have unanswered questions. To increase the understanding of such processes, direct observations are needed, but are barely available. The HALO-(AC)3 campaign aimed to provide such observations in a quasi-Langrangian sense by following airmasses during meridional transports and by observing clouds and precipitation by remote sensing from above and in-situ measurements.

Within HALO-(AC)3, three research aircraft equipped with state-of-the-art instrumentation performed measurements in March/April 2022 over the Arctic ocean and sea ice. The German High Altitude and Long Range Research Aircraft (HALO), equipped with remote sensing instrumentation and dropsondes, was operated from Kiruna, Sweden. The flight pattern covered long distances up to the North Pole tackling to probe airmasses multiple times on their way into and out of the Arctic. The Polar 5 (remote sensing) and Polar 6 (in-situ) aircraft from the Alfred Wegener Institute operated in the lower troposphere out of Longyearbyen in the lower troposphere over Fram Strait West of Svalbard. Several coordinated flights between the three aircraft were performed with Polar 6 sampling in-situ aerosol, cloud, and precipitation particles within the boundary layer, Polar 5 observing clouds and precipitation from above roughly at 3 km altitude, and HALO providing the large scale view on the scene following air masses.

In total, HALO performed 17 research flights covering more than 100.000 km and launched over 300 dropsondes. The Polar aircraft together covered more than 36.000 km with 142 dropsondes launched from Polar 5. During the flights, multiple cold air outbreak events and a major warm air intrusion with atmospheric river embedded bringing warm and moist air far into the Arctic could be observed. The presentation will give an overview of the overall campaign setup, the data set gathered and first results derived from the measurements.

Plain-Language Summary:
Climate change is seen all over the world and especially strong in the Arctic. To better understand what causes this enhanced warming, measurements within the Arctic atmosphere are necessary. Within the HALO-(AC)3 campaign, three research aircraft have been equipped with modern remote sensing and in-situ instruments to perform measurements over the Arctic ocean and the

sea ice in March/April 2022. Thereby, the aircraft were flying together to investigate airmasses and clouds from within and above. While performing around 40 research flight more than 140.000 km have been covered and more 400 dropsondes have been launched. During these flight the dominant weather phenomenon were cold air outbreaks, where cold air masses travel from the sea ice to the open ocean. In addition, warm air intrusions in the Arctic from mid-latitudes have been observed. We will present here the campaign setup and ideas behind, as well as first results from the successful measurements.

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