



HALO - (AC)³

Arctic Air Mass Transformations During Warm Air Intrusions and Marine Cold Air Outbreaks

Measurement campaign

In March and April 2022, the large-scale, international research campaign HALO-(AC)³ to study the change of air masses in the Arctic took place. Through the measurements, more than 100 researchers from 12 countries are investigating the processes that contribute to Arctic amplification, the temperature increase in the Arctic in recent decades that is far above the global mean. The state-of-the-art High Altitude and Long Range research aircraft (HALO), operated by the German Aerospace Center (DLR), operated from Kiruna, Sweden. The polar research aircraft Polar 5 and Polar 6 of the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), which have been used in the Arctic for more than ten years, were stationed in Longyearbyen (Spitsbergen, Norway). In parallel, measurements were carried out with a tethered balloon of the Leibniz Institute for Tropospheric Research (TROPOS) in Ny-Ålesund on Spitsbergen. The measurements are completed by ground-based remote sensing of the atmosphere at the AWI-PEV research station in Ny-Ålesund.

What has been measured?

The aircraft are equipped with state-of-the-art instruments that can be used to characterize the entire atmosphere from the ground up to an altitude of twelve kilometers. The most important measurement parameters include cloud properties, meteorological parameters such as temperature and relative humidity, energy fluxes and properties of aerosol particles. The three German research aircraft completed a total of more than 40 measurement flights, covering an impressive distance of nearly 150,000 km. In addition, nearly 500 dropsondes were dropped from the aircraft, which glide to the ground on small parachutes to measure meteorological parameters. During the campaign, several cold air outbreaks, in which cold air is transported southward from the central Arctic, and their counterpart, warm air intrusions into the Arctic, could be studied in detail. Warm air intrusions can not only amplify the warming of the Arctic through feedback mechanisms, but also influence our weather in the mid-latitudes. Prof. Dr. Manfred Wendisch (University of Leipzig), scientific director of HALO-(AC)³, describes the first impressions of the measurements: „During the measurement campaign we could observe how warm, humid sub-polar air masses were pushed northward into the central Arctic. Surface temperatures were 20°C higher than expected from long-term climate records. This resulted in the formation of high reaching convective clouds, previously more familiar from the tropics. These caused heavy rain over the Arctic sea ice, leading to further melting.“ Not only the intensity of this warm air intrusion, but also its duration appeared unusual. Weather conditions have a strong influence on measurement campaigns and have a decisive impact on their success. In HALO-(AC)³, weather conditions were so favorable that not only warm air intrusions and cold air outbreaks could be sampled as the main targets of the campaign, but also phenomena associated with secondary targets such as a polar low or cirrus clouds over sea ice.



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First results

The observations from HALO-(AC)³ will be used to verify the accuracy of numerical atmospheric models. Based on this, these models, which are essential for understanding climate warming and Arctic amplification, will be further developed. Initial comparisons showed that the models tend to predict too many low clouds over Arctic sea ice. In addition, several aircraft measurements of clouds were compared with satellite observations that suffer from reduced spatial resolution in the Arctic. Here, again, it was shown that some deep clouds remained undetected by satellites, once again reinforcing the great need for measurement campaigns such as HALO-(AC)³.

Weather conditions were extremely favorable during the 6-week campaign, allowing it to be completed very successfully. The resulting data and measurements will provide exciting data analysis in the coming years and, most importantly, provide many PhD students who participated in HALO-(AC)³ with a wealth of data for their dissertations.

Who?

HALO-(AC)³ is a research campaign jointly performed by the University of Leipzig, the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, the German Aerospace Center, the Leibniz Institute for Tropospheric Research, the Max Planck Institutes for Meteorology and Chemistry, as well as the Universities of Bremen, Cologne, Hamburg, Mainz and the Ludwig Maximilian University of Munich and international partners. More than 100 researchers from 12 countries will participate in the research project. The campaign name HALO-(AC)³ embraces the lead research projects HALO-SPP (High Altitude and Long Range Research Aircraft - Priority Program) and the Collaborative Research Center/Transregio Arctic Amplification (AC)³ (Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms).