HALO - (AC)³

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

Quotations Manfred Wendisch (University of Leipzig)

What does the campaign HALO-(AC)³ aim at?

The climate in the Arctic is changing with unprecedented speed and intensity. For several decades, scientists here have observed a worrying rise in temperatures that exceeds the average global warming by more than a factor of two. This phenomenon is named Artic Amplification. Predicting the future of the Arctic climate remains difficult. The results of the HALO-(AC)³ campaign will help to improve the corresponding forecasts of weather and climate models.

Climate research gains strongly in significance, due to the progressing climate crisis. How does HALO-(AC)³ contribute to this research field?

The data obtained during the HALO-(AC)³ campaign will help to check the ability of weather and climate models to reproduce the processes that drive the transformation of air masses on their way into and out of the Arctic. In particular, the formation and decay of clouds during the transport into and out of the Arctic will be observed. Current models specifically struggle with these processes. The model results will be compared to the measurements in detailed case studies. If there is disagreement, then models will be improved such that they optimally fit the measured data. Appropriate parameterizations will be developed on the basis of the data, and implemented into the models, to represent sub-grid processes that cannot be resolved explicitly in the models.

Are there atmospheric events of particular interest for the research flights during HALO-(AC)³ ?

We target two typical phenomena that are important drivers of the Arctic Amplification. Warm Air Intrusions (WAIs) and Cold Air Outbreaks (CAOs), where warm and cold air, respectively, are transported over distances of up to 1000 km.

Warm air intrusions transport warm air and water vapor into the Arctic, which causes the formation of clouds that are usually long-lived and persist for several days. The transported water vapor warms the Arctic by reducing heat loss to space.

Cold air outbreaks (CAOs) can trigger polar low-pressure systems (polar lows) over the Arctic Ocean and cool mid-latitude continents and subpolar oceans, leading to extreme mid-latitude weather. Arctic CAOs occur most frequently in winter.

These processes are often poorly represented in models; improving their representation is important for enhancing the predictive performance of weather and climate models in the Arctic and mid-latitudes.

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What makes the deployed research aircrafts so well suited for the campaign?

HALO is the only German research aircraft with a flight duration of up to 9 hours, which is required for the planned quasi-Lagrangian observations (observations along air mass paths). Furthermore, it can also carry a scientific payload of up to 3 tons with state-of-the-art measuring instruments. The maximum flight altitude of up to 15 km enables observations of the entire air mass column in the troposphere, including meteorological variables, turbulence and radiation parameters, water vapor, aerosol particles and clouds. For the HALO-(AC)³, HALO will be equipped with a payload of remote sensing instruments that has been steadily improved over several campaigns during the past decade. The instrumentation includes a 26-channel microwave radiometer, a Ka-band Doppler radar, and aerosol and differential absorption lidar instruments for measuring water vapor. HALO also has spectral and broadband solar and thermal infrared radiation sensors (up and down) and imaging camera spectrometers that detect in the sunlight and thermal infrared spectral regions, as well as numerous dropsondes (sondes that are dropped from the aircraft and glide to Earth by parachute, collecting data as they go).
The lower-flying Polar 5 and Polar 6 research aircraft, which are part of AWI, will work in tandem with HALO. Polar 5 will make active and passive remote sensing measurements, and Polar 6 will make in situ measurements of clouds, aerosol particles, and radiation. The AWI aircraft will enable us to probe radiative and turbulent energy fluxes and smaller-scale processes in the lower troposphere (below 3–5 kilometers altitude) and to observe surface properties.

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