Ice clouds as a climate factor – research aircraft HALO examines cirrus clouds and vapour trails

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Unanswered questions about the formation of clouds and their impact on the climate are currently setting limitations on the validity of global climate forecasts. To make a detailed analysis of the climate effects of natural ice clouds and the vapour trails created by air traffic, the HALO (High Altitude and LOng Range) research aircraft embarked on the first of a total of 12 measurement flights on 24 March 2014. For four weeks, as part of the ML-CIRRUS (Mid-Latitude Cirrus) mission, ice clouds (also known as 'cirrus') will be measured at altitudes of between eight and 14 kilometres above Europe and the North Atlantic. Under the auspices of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), a team of around 100 scientists from various atmospheric research institutes will be studying the formation, lifecycle, and climate effect of both naturally occurring cirrus and vapour trail cirrus clouds.

The scientists will be paying particular attention to the long-lasting vapour trail cirrus created by air traffic. To date, the extent to which the properties of these anthropogenic clouds differ from natural cirrus remains unknown. "New findings indicate that the climate-warming effect of vapour trail cirrus may be greater than that of the carbon dioxide emissions from aircraft," explains campaign manager Christiane Voigt, a scientist at the DLR Institute of Atmospheric Physics and the University of Mainz. Locally, there are massive differences. "With HALO, we will collect a comprehensive set of measurement data, which will allow us to build better models and reduce the existing uncertainties," Voigt continues.

Three tons of state-of-the-art measurement technology on board

The atmospheric researchers on board HALO will be supported in their work by a set of innovative instrumentation. "To prepare for ML-CIRRUS, we have been developing new methods for several years to take very precise measurements of the properties of cirrus clouds and vapour trails," reports Andreas Minikin from the DLR Institute of Atmospheric Physics, who is co-directing the research campaign along with Christiane Voigt. "HALO will now be flying with one of the most modern sets of cloud research instrumentation in the world – altogether, the experimental payload weighs just under three tons." Besides the lidar (a laser experiment for remote cloud sensing), the equipment on board this research aircraft includes nine different cloud probes mounted under the wings and a complex set of aerosol, water vapour and trace gas instrumentation in the cabin.

Like a warming scarf

When the weather is clear, thin cirrus clouds and vapour trails can regularly be seen in the sky. They wrap around the Earth like a warming scarf. The actual strength of their warming effect is the subject of current research and depends on many parameters such as the size and number of ice crystals in the clouds, the altitude of these clouds, and their lifespan. The shape of the ice particles also influences their radiation effects: "There is a veritable menagerie of ice-crystal columns, platelets and complex branching structures waiting to be explored by our instruments," reveals Voigt. Under certain conditions, ice clouds can actually have a cooling effect. To gain a better understanding of the multiple effects of cirrus clouds and vapour trails, the scientists need accurate data about the number, shape and size of these ice crystals, which can vary from one thousandth of a millimetre to several millimetres in size. This is why HALO is equipped with a wide variety of complementary measuring instruments. At the end, the collected cloud information will be fitted together like a jigsaw puzzle to give a complete picture. After the measurements have been carried out with the HALO research aircraft, the scientists will

compare the results with sets of measurement data obtained from ground-based remote sensing stations, and assess global satellite data. The results will provide the basis for detailed process models, which will help improve global climate forecasts.

ML-CIRRUS – a collective mission involving many research institutes

The extensive cloud measurement campaign conducted by German atmosphere researchers is sponsored collectively by DLR, the Universities of Mainz, Leipzig, Frankfurt, and Heidelberg, the Ludwig-Maximilian University of Munich, as well as the Jülich Research Centre, the Karlsruhe Institute of Technology, the Leibniz Institute of Troposphere Research in Leipzig, the German national metrology institute (Physikalisch-Technische Bundesanstalt; PTB), the Max Planck Institute for Chemistry and the Federal Institute of Technology in Zürich. The DLR Flight Experiments Facility is responsible for operating the HALO research aircraft, which is a converted and heavily modified Gulfstream G550. "HALO is one of the world's most modern atmospheric research aircraft," says Oliver Brieger, Director of DLR the Flight Experiments Facility. "Between now and 2018, HALO is scheduled to take part in another eight major scientific missions."

About HALO

The HALO research aircraft is a collective initiative by German environment and climate research bodies. HALO is funded by contributions from the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung; BMBF), the German Research Foundation (Deutsche Forschungsgemeinschaft; DFG), the Helmholtz Association, the Max Planck Society, the Leibniz Association, the Free State of Bavaria, the Karlsruhe Institute of Technology, the German Research Centre for Geosciences (Deutsches GeoForschungsZentrum; GFZ), the Jülich Research Centre (Forschungszentrum Jülich) and the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR).

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HALO on final approach

As part of the ML-CIRRUS mission, HALO will complete a total of 12 measurement flights by the end of April 2014. Between now and 2018, a further eight major scientific missions are scheduled for HALO, and these will either be funded by the DLR or supported by them as a partner.

Credit: DLR (CC-BY 3.0).

Underwing stations

HALO carries one of the world's most modern sets of cloud research instrumentation. The 'underwing stations' carry the PMS probes – particle measurement instruments for sampling cloud droplets and ice crystals.

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Optical window of the lidar system

To precisely record the properties of cirrus cloud and vapour trails, the HALO research aircraft is equipped with a lidar system. This image shows the 'optical window', seen from outside the aircraft.

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