Research flights - DLR investigates the effect of contrails and volcanic emissions on the climate

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What influence do contrails and volcanic emissions have on the climate? Scientists from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) tackled this question by conducting 12 research flights with the Falcon research aircraft as part of the Concert (Contrail and Cirrus Experiment) project. These extensive measurements will allow the verification of existing simulations and calculations.

Aircraft emit sulphuric acid aerosols and soot particles. At temperatures below 42 degrees Celsius, ice can form on these particles and create visible vapour trails. These clouds of tiny ice crystals can survive for several hours under damp, cold conditions, with contrail cirrus clouds forming at heights of between 8000 and 12,000 metres. Climate researchers see these man-made cirrus clouds and their connection to aviation as highly significant. "There are signs that contrail cirrus clouds have just as great an impact on climate as the aircraft's carbon dioxide emissions," explains Project Leader Christiane Voigt from the DLR Institute of Atmospheric Physics in Oberpfaffenhofen. If this is true, in the future airlines could avoid areas with heightened cirrus presence or vary their altitude. "However, commercial jets changing their altitude would emit even more carbon dioxide – so we need to look at the overall picture," says Voigt.

'Young' and 'aged' contrails

Besides the 'old' contrail cirrus clouds, the researchers' investigations have also turned to studying vapour trails that are just a few minutes old: "We collected information about the quantity and size of the ice crystals in contrails because they hold the key to the climatic impact," explains Voigt. When measuring the 'young' contrails, DLR test pilots flew into the vapour trail of a Boeing 777 and closely followed the aircraft for up to 15 minutes - a manoeuvre that requires the utmost concentration and a very robust aircraft. "We cooperated closely with the German air traffic control service (Deutsche Flugsicherung GmbH; DFS), and the European Air Traffic Control Centre, EUROCONTROL," says Voigt. In an unprecedented experiment, the scientists also carried out measurements on aircraft cirrus clouds that were simultaneously imaged by a satellite. "For the first time, we can compare data collected from contrail cirrus clouds by a satellite with detailed measurements taken by the Falcon from within the cloud itself," explains Christiane Voigt.

Measuring volcanic emissions

The Concert project also involved conducting short measurement flights over the Italian volcano Mount Etna, which was mildly active shortly before the flight on 29 September 2011. The Falcon conducted flights through the volcanic plume - the emission cloud discharged by the volcano. "We examined the chemical evolution of particles after an eruption. Volcanoes discharge large quantities of halogens such as bromine and chlorine, which have a substantial impact on the ozone layer. Etna emits gas at very regular intervals - and, up to now, these emissions have been tested only a handful of times," says Voigt. This basic research is necessary; the aim is to gain a better understanding of how these particles react and to gather more information about volcanic emissions and their impact on the climate. The last research flight took place on 30 September 2011; now the team is analysing the data, which will take about six months.

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The DLR research aircraft Falcon during a test flight

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