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Measurement instruments are prepared for use in the HALO research aircraft

TAKING TO THE SKIES IN TIMES OF A PANDEMIC

The BLUESKY project investigates the atmosphere during the Coronavirus lockdown

By Falk Dambowsky and Valerian Hahn

DLR's Falcon research aircraft has seen a lot in its time – it has been used for scientific purposes for over four decades. Ten years ago, it was deployed as a 'volcanic ash hunter' when air traffic over Europe largely came to a standstill following the eruption of the Icelandic volcano Eyjafjallajökull. In the aftermath, the Falcon conducted measurement flights through the ash cloud, acquiring data that would prove important in assessing the situation and determining the right moment for European air traffic to resume operations. In May 2020, it embarked on another very special mission – to examine the sky during the COVID-19 lockdown, while most aircraft remained on the ground.

The Falcon was not alone as it performed these remarkable flights. It was accompanied by the High Altitude and Long Range Research Aircraft (HALO), which is also stationed at DLR's site in Oberpfaffenhofen. The German research team, which included many scientists from the DLR Institute of Atmospheric Physics, aimed to study the atmosphere during the lockdown resulting from the Coronavirus pandemic – a time of less air traffic and, as such, reduced air pollution.

Overseeing the mission while working remotely

Before the two research aircraft could take off, they had to be prepared at the DLR Flight Experiments Facility in Oberpfaffenhofen. Numerous instruments were installed and adapted as the aircraft were prepared for the upcoming mission under challenging conditions. This task was made somewhat easier for the team because the measures to equip the aircraft for other, previously planned, flight campaigns were still in place. Preparatory work for these missions had been suddenly halted due to the introduction of COVID-19 precautionary measures, and their planned flights postponed indefinitely. This meant that many important instruments had already been installed on HALO and Falcon, and only a few had to be newly installed and prepared. The COVID-19 precautionary measures forced experts across DLR to find ground-breaking solutions. Campaign organisation and certification activities for the aircraft and their instruments now had to be conducted from the scientists' desks at home. In order to get the aircraft flying as quickly as possible despite the restrictions, while also protecting the people involved, the on-site staff worked in daily shifts with minimal personnel. Wherever possible, instruments were prepared to allow monitoring and control from the scientists' home offices during the preparations and the research flights themselves.

Despite its ramifications, the pandemic represents the opportunity of a century for scientists to measure trace gases and aerosols in the air above European cities and at cruising altitude on flight paths. What impact do emissions from industry and air transport have on the atmosphere, and how much have these emissions been reduced by the restrictions put in place in response to the pandemic? How does air traffic affect the upper troposphere? These are the central questions being addressed by the BLUESKY project, which was launched at short notice during spring 2020 under the leadership of DLR and the Max Planck Institute for Chemistry. Prior to the campaign, a decrease in concentrations of nitrogen dioxide in industrial hubs and a marked reduction in contrails over Europe had already been demonstrated by satellite measurements evaluated by DLR. This gave rise to the assumption that the emissions of other trace gases and aerosols – microscopic particles that form when fossil fuels are burned, among other causes, and which have a bearing on cloud formation – had also been reduced. Unlike satellite images, which are taken from a considerable distance, measurements made on board research aircraft can deliver data with much greater precision and higher resolution, thus providing a more complete picture of the situation.

A bright blue sky

Following the initial measurement flights over Germany – from Oberpfaffenhofen to the Ruhr region and over Berlin and Hamburg – the two research aircraft flew to Milan. This region in the Po Valley is an important industrial and business location in Northern Italy. Due to the far-reaching pandemic measures introduced by the Italian government, the chances of measuring a corona-induced reduction of air pollutants in the boundary layer were particularly good there, similar to those above the Ruhr area. After a temporary, significant drop in road traffic in the weeks of the lockdown, cars were already visible on the roads again with the loosening of the restrictions, and factories gradually increased their production. However, one could not yet speak of 'normality'.

The BLUESKY team was particularly interested in the emissions from urban agglomerations. On this day, the exhaust plume from Milan drifted westward, spreading across the surrounding area and accumulating in the foothills of the Alps. Directly above the city and in the surrounding region, the Falcon's instruments recorded high aerosol and particulate matter levels in the boundary layer at an altitude of one to two kilometres. In contrast to these boundary layer measurements, the two DLR research aircraft flew at cruising altitudes between 10 and 12 kilometres above the Atlantic off the Irish coast in two flights. There, the team carried out measurements on the few remaining emissions from the 80 percent reduction in air traffic.

The airspace over western Ireland is flown through by passenger and cargo aircraft at the beginning of their North Atlantic routes on their way to America. The influences of air traffic are particularly easy to measure in the clean air over the ocean. HALO and Falcon's measurements focused particularly on nitrogen oxides and aerosols from passenger flights. The first results of the Falcon showed a slight decrease of aerosols in the upper troposphere. Among other influences, such lower aerosol concentrations in the air make the sky appear bluer.

Situation is comprehensively documented

Falcon and HALO took off for BLUESKY a total of 20 times from their Bavarian home airport in May and June 2020. The data acquired during these missions will be evaluated by the end of the year. The analyses will include comparative data from previous HALO research flight campaigns on air traffic emissions and emissions from conurbations. The coming year will also be interesting. There will be further measurement flights that the researchers hope will document the situation after the pandemic.

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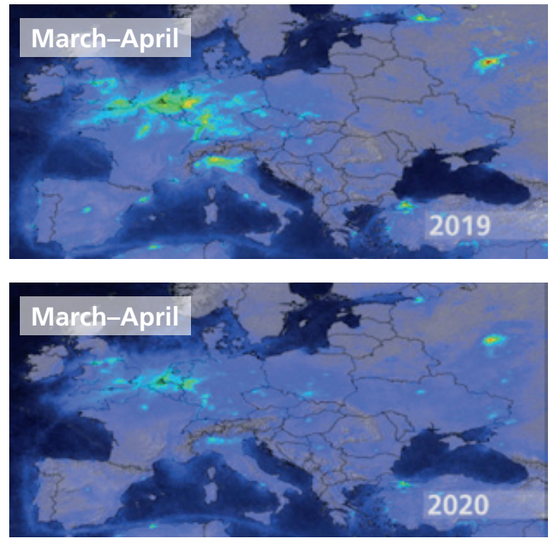
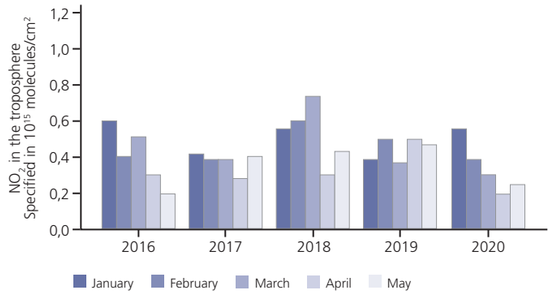


Even before the BLUESKY flights, DLR's Earth Observation Center (EOC) detected a sharp drop in nitrogen dioxide over Europe compared to the previous year. The data originate from the TROPOMI sensor on board the European Copernicus Sentinel-5P satellite. Nitrogen dioxide is an indicator of air pollution from industrial activities and road traffic.

CONCENTRATION OF NITROGEN DIOXIDE IN THE ITALIAN PO VALLEY



Development of tropospheric nitrogen dioxide over the Italian Po Valley from 2016 to 2020, measured with the GOME-2 sensor on board the European weather satellite MetOp. The values from March to April 2020 are significantly reduced compared to previous years, while the values in May 2020 increased again after the lifting of the lockdown measures.

Measurements in the clouds above the Po valley