Reducing turbulence near airports - DLR tests new procedures to mitigate wake vortices

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Currently, safety considerations related to wake vortices force pilots of small and medium-sized aircraft to maintain a separation of about 10 kilometres from heavier planes flying ahead of them. Soon, up to twice as many commercial aircraft could land on runways in good weather without endangering one another. For the first time, on 29 and 30 April, researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) tested - under real flight conditions - a process that can break down potentially dangerous wake vortices over a runway significantly faster. To do this, they used a patented configuration of parallel ground plates as well as a laser-based wake vortex measurement system.

"The construction of new runways at existing airports is intrinsically linked with immense effort, even in the planning and decision-making phases. Space is often scarce, and residential areas are affected by such an expansion," says Johann-Dietrich Wörner, Chairman of the DLR Executive Board. "If it becomes possible to land aircraft with reduced separation between them while maintaining current levels of safety - thereby avoiding construction of additional runways through making more effective use of the existing facilities - then it is an advantage for both airports and the nearby communities. Research flights recently performed by DLR are an important step in this direction."

Wing-tip vortices

Wake vortices are long-lasting turbulence generated behind an aircraft; they develop at the wing tips, where the higher-pressure air on the underside of the wing moves to the lower pressure region on the wing's upper surface. These powerful vortices can disrupt sensitive equipment close to the aircraft's path along a runway and also damage buildings. Smaller aircraft are especially sensitive to the wake vortices created by larger 'jumbo' jets, so they must maintain a greater safety separation.

A trick with plates

While vortices that are formed in higher air layers usually sink, drift away and then dissipate, they occasionally persist for some time in front of the runway threshold, just above the ground - exactly where following aircraft are preparing to land. Project manager Frank Holzäpfel from the DLR Institute of Atmospheric Physics explains the advantage of the new technique: "To dissipate vortices in front of the runway more quickly, we have developed 'Plate Line', a system of parallel plates arranged one after another. Secondary vortices form on the approximately four-metre-long plates, which causes the primary wake turbulence to dissipate significantly faster."

The DLR HALO research aircraft, a modified Gulfstream G550, flew just 22 metres above the row of plates during the measurement campaign. Using smoke, the researchers could demonstrate how the otherwise invisible wake vortices weakened faster over the plates in the test area. They recorded the behaviour of the wake vortices with laser instruments (lidar) for subsequent analyses. "The patented procedure already performed excellently in the laboratory and in numerical simulations," says Holzäpfel, now pleased with the successful demonstration.

Wake vortex warning system

Heavy winds, convection or stable temperature stratification can cause ascending wake vortices to occur along the final approach path to an airport. "In order to counter this additional danger for closely-spaced approaches, we have developed a wake vortex prediction and observation system that has already been tested at Munich and Frankfurt/Main airports," adds Holzäpfel. The Plate Line and the warning system complement each other as parts of a comprehensive approach to increasing wake vortex safety.

After this first demonstration, the Plate Line will be tested at a commercial airport. The size of the plates must then be adjusted to cope with the stronger wake vortices of heavier commercial aircraft. The goal is to develop a system approved by the aviation authorities, which can then be gradually installed at airports.

About HALO

The HALO research aircraft is a joint initiative involving German environmental and climate research institutions. HALO is supported by grants from the Federal Ministry for Education and Research (BMBF), the German Science Foundation (DFG), the Helmholtz Association (HGF), the Max Planck Society (MPG), the Leibniz Association, the Free State of Bavaria, the Karlsruhe Institute of Technology (KIT), the German Research Centre for Geosciences in Potsdam (GFZ), the Jülich Research Centre and the German Aerospace Center (DLR).

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HALO fly-over

HALO fly-over: At 22 metres high, HALO flies over the experiment. In the smoke, the two wake vortices are visible.

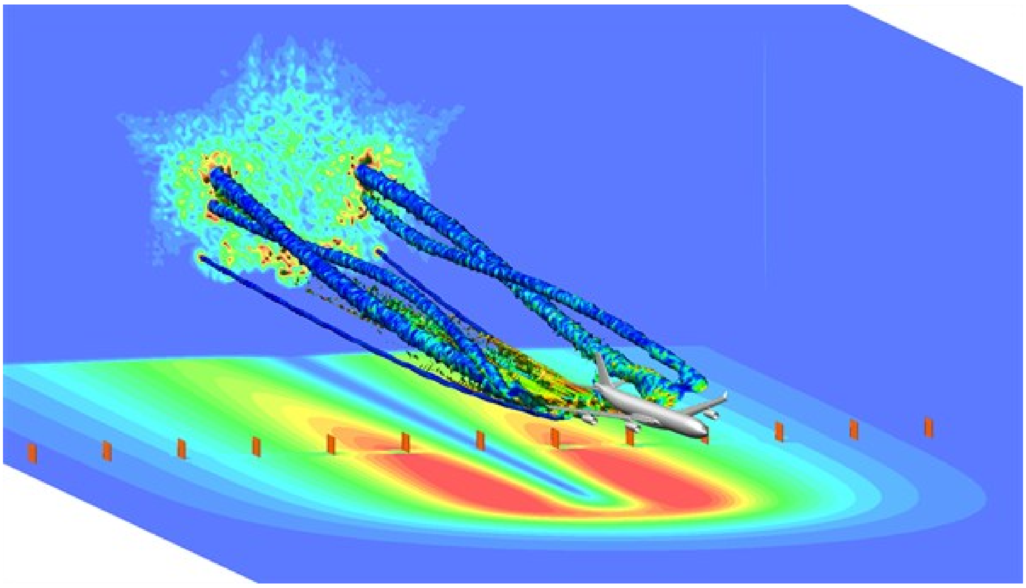
Vortex pattern

These powerful vortices can disrupt sensitive equipment close to the aircraft's path along a runway and also damage buildings. Smaller aircraft are especially sensitive to the wake vortices created by larger 'jumbo' jets, so they must maintain a greater safety separation.

DLR Patent - 'Plate Line'

Secondary vortices form on the approximately four-metre-long plates, which causes the primary wake turbulence to dissipate significantly faster.

Wake vortices in a simulation



Wake turbulence simulation for an Airbus A340 on final approach, just before touchdown. Below the aircraft, a 'Plate Line' can be seen. DLR has developed a globally unique method to simulate the flow around the aircraft with the creation of vortices, their further development and eventual dissipation. Here, the vortices are shown during their formation – prior to decay.

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