Monitoring Wake Vortices for More Efficient Airports

Originating Technology/ NASA Contribution

Wake vortices are generated by all aircraft during flight. The larger the aircraft, the stronger the wake, so the Federal Aviation Administration (FAA) separates aircraft to ensure wake turbulence has no effect on approaching aircraft. Currently, though, the time between planes is often larger than it needs to be for the wake to dissipate. This unnecessary gap translates into arrival and departure delays, but since the wakes are invisible, the delays are nearly inevitable.

If, however, the separation between aircraft can be reduced safely, then airport capacity can be increased without the high cost of additional runways. Scientists are currently studying these patterns to identify and introduce new procedures and technologies that safely increase airport capacity. NASA, always on the cutting edge of aerospace research, has been contributing knowledge and testing to these endeavors.

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Partnership

NASA's Langley Research Center, working with the FAA on a joint program known as the Wake Turbulence Research Program, conducted research on the wake vortices at the Denver International Airport.

Langley scientists collected acoustic signature data from the wakes of landing aircraft and then characterized these signatures for a variety of aircraft types in various conditions. Two large, precision microphone arrays were placed on the ground beneath the glide slope for a runway, one operated by NASA and the other by the German Aerospace Center, or Deutschen Zentrum für Luft- und Raumfahrt. Because there are numerous unknowns about the acoustic signatures of wakes, a truth sensor was needed to tell NASA the location of the wake, allowing the measurements to be properly characterized.

The research teams used WindTracer as a ground truth sensor for these wake vortex acoustic tests. WindTracer is manufactured by Coherent Technologies, Inc. (CTI), the recipient of a Langley **Small Business Innovation Research (SBIR)** grant to develop this integral piece of equipment. CTI is a privately held company based in Louisville, Colorado, and is the only company in the world that offers an infrared Doppler lidar as a commercial product.

Product Outcome

WindTracer uses an infrared, eye-safe laser, with precision pointing and scanning capabilities, to bounce off the natural particulates floating in air. The light reflected back to the system measures the wind and tracks the strength and location of the aircraft vortices. The technology has been developed over the past decade by CTI and

is applied to a variety of airport and airliner wind hazards, as well as measurement applications.

WindTracer detects wind hazards such as windshear, microbursts, gust fronts, turbulence, crosswinds, and wake vortices that can compromise the safety of an aircraft. It detects these hazards and transmits real-time data to air traffic control display monitors, providing immediate audio and visual alerts to the staff when dangerous conditions arise. This information can be quickly relayed to the pilots of arriving or departing aircraft who can then adjust their patterns to avoid the hazards.

A WindTracer unit is currently set up at the Hong Kong International Airport, which is located near Lantau Island, a large mountainous island that often experiences windshear and turbulence. Other wind hazards arise due to frontal passages and sea breezes. These wind conditions are potentially hazardous to landing and departing aircraft.

The device is operated by the Hong Kong Observatory (HKO), one of the world's leading meteorological organizations. It forecasts weather and issues warnings on weather-related hazards at the airport and within a designated airspace over the northern part of the South China Sea. To enhance the safety of aircraft landing at and taking off from the airport, the HKO issues alerts of low-level windshear and turbulence. A Terminal Doppler Weather Radar network of over 20 anemometers, 2 wind profilers, and WindTracer are used to assist in the detection and warning of windshear and turbulence.

It is also being employed successfully by the St. Louis International Airport, where it is used to observe wake vortices produced by aircraft landing on specific runways. It then provides data, which is used to validate the safety of new capacity-enhancing procedures being developed by the FAA.

WindTracer profiles winds and detects windshear, turbulence, and aircraft wake vortices at both airports and onboard commercial airliners.

Since its installation in 2003, the system has been running unattended, with system operational modes being automatically changed via an operator-defined schedule, and remote access to the system via an Ethernet connection enables mode and schedule changes to be affected without the need for onsite staff.

The WindTracer was also used for the U.S. Department of Defense's (DOD) atmospheric dispersion survey conducted in and around the Pentagon. The survey sought to improve knowledge about the weather conditions and movement of simulated airborne contaminants. Knowledge gained about the airflow around the Pentagon, and the associated transport of gases and their infiltration into the building, will lead the development for improved systems to protect other DOD facilities.

The product has been proving itself useful around the world, and it has the potential to revolutionize the entire airline industry. ❖

WindTracer uses an infrared, eye-safe laser, with precision pointing and scanning capabilities, to bounce off the air particulates. It poses no risks to pilots.