An airflow model to reduce time on the tarmac

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Plans for summer holidays are already taking shape. But before jetting off for some fun in the sun, many travellers will have to cope with long delays on the airport runway.

Thanks to new research from Concordia University, however, that time spent twiddling your thumbs on the tarmac could be significantly reduced.

In a new study, forthcoming in the American Institute of Aeronautics and Astronautics' *Journal of Aircraft*, Concordia mechanical engineering professor Georgios Vatistas describes a new mathematical tool he developed to calculate the flow of turbulent air produced by a plane's wing tips—known scientifically as wing-tip vortices—when an airplane takes off.

"Every aircraft leaves in its wake a turbulent flow of air that can be dangerous to the airplane immediately behind it. That's why there are often large separation distances between planes as they line up for takeoff. It's a major cause of delays on the runway," says Vatistas, who is no stranger to vortex research. In 2008, he and his team became the first to physically validate Nobel Prize winner J.J. Thomson's then 125-year-old theory on the stability of vortex rings.

The study will assist in improving the present standards for the separation distance between planes, while maintaining safety.

Mathematically calculating the amount of turbulence created by the wing tips of aircraft, particularly during takeoff, gives air traffic controllers a better method of determining how far each aircraft should be from the next.

"This research will place the required separation distance on a better ground, particularly for the huge Airbus 380," says Vatistas.

"Our model takes the airplane's specifications into account to develop a more precise picture of exactly how strong the wing tip vortices are. From that, you can accurately calculate how far away the following aircraft needs to be for safety," says Vatistas, who partnered with Concordia Master of Applied Science (MASc) students Fani Maniki and Georgios Panagiotakakos, for the study.

Extending the "Vatistas Vortex Model" to account for turbulence, the research team carefully recreated the swirling vortices of air produced by the wing tips of aircraft during takeoff. This turbulent air is particularly dangerous when it comes to the wake created by heavy, wide-body aircrafts.

"To make takeoff procedures more efficient, we need to establish strict separation standards for new aircraft like the super-heavy Airbus 380, which are becoming more and more common on runways around the world. At the same time, we need to develop more precise standards for smaller aircraft. This mathematical model could guide us to do both—in effect, tailoring separation distances based on aircraft size to allow better variability in spacing."

Vatistas expects that future studies using his research team's new methodology will improve on aviation safety by determining more precise safe-separation distances among different types of aircraft.