Climate Change and the Future of Air Travel

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The investigation focuses on how aircraft can avoid creating vapor trails, also known as contrails. These spindly threads of condensation may not seem important but some persist for hours and behave in the same way as high altitude cirrus clouds, trapping warmth in the atmosphere and exacerbating global warming.

Air travel is currently growing at between 3 and 5% per year and cargo transportation by air is increasing by 7% per year. The researchers at Imperial College London are combining predictions from climate change models with air traffic simulations to predict contrail formation and identify ways of reducing it.

The Engineering and Physical Sciences Research Council (EPSRC) is funding the work, which is a joint effort between the Department of Civil & Environmental Engineering and the Department of Physics at Imperial College London.

As the climate changes, so will the general condition of the atmosphere and the new work aims to understand how this will affect contrail formation. They have already found that aircraft could generally minimize contrail formation by flying lower in the atmosphere. Their work suggests that in the summer, when the air is warmer, restricting jets to an altitude of 31,000 feet could be beneficial. In winter, when the air cools, and contrail formation becomes more likely, the ceiling should be no more then 24,000 feet.

Day to day variability in atmospheric conditions was also found to have a substantial effect on the ability of simple altitude restrictions to be an effective policy. Current work is aiming to examine more complex aircraft routing strategies aimed at avoiding air masses that lead to persistent contrail formation.

At present the production of contrails and their effect on the environment is not taken into account in government assessments of the environmental impact of air travel. Team leader, Dr Robert Noland, thinks it should be. He says, “We'd like this research to inform government policies, not just in the UK but throughout the EU and the rest of the world so that decision makers can take all the environmental issues into account and do the right thing.”

Dr Noland also believes that the work has direct relevance to aircraft manufacturers. He says, “There is little more that aircraft designers can do to increase engine fuel efficiency at high altitude, but designing new aircraft that can be as fuel efficient flying at 20,000 feet, as today's aircraft are at 35,000 feet, would help eliminate contrails.”

A key consideration in this study is the proliferation of short-haul flights. These are currently thought to be more environmentally disruptive than long-haul flights because of the high quantity of fuel needed for take-off and landing. In a short haul, this is not balanced by a long, fuel-efficient cruise. However, contrail effects are not taken into account in current environmental risk assessments of air travel. The team is investigating whether the picture would change if they were. The reason is that short-haul flights seldom reach the altitude where contrails form and this might make them overall more environmentally friendly than high-flying long-haul flights.

As well as the seasonal variation in atmospheric conditions, which the team estimated would require a general ceiling on flight altitudes (summer: 31,000 feet, winter: 24,000 feet), they also found significant day to day variations, so any contrail reduction strategy would work better if it were reactive on a daily basis. They also found days when the atmospheric conditions made it almost impossible to avoid contrail formation.

Aircraft already measure the exterior air conditions, so a simple piece of software, programmed with the details of the jet exhaust temperature and humidity could immediately alert a pilot to when his aircraft is creating a contrail. Although lower flying aircraft expend more fuel to push themselves through the thicker atmosphere, the team found this less damaging than the radiative forcing* effect of the contrails. Lower altitude flying does, however, slightly increase travel time.

*Radiative forcing is any change in the balance between radiation coming into the atmosphere and radiation going out. Positive radiative forcing tends to warm the surface of the Earth, and negative radiative forcing tends to cool it. This effort is being led by Dr. Robert Noland in Civil & Environmental Engineering. Dr Ralf Toumi in the Physics Dept is the co-investigator and Dr Victoria Williams in Civil & Environmental Engineering is an EPSRC-funded Research Fellow.

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