Commitments needed to solve aviation's impact on our climate, says new research

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Concerted efforts and commitments are needed to solve the complex trade-offs involved in reducing the impact of aviation on the climate, according to new research.

Non-CO_2 emissions from aircraft—largely of nitrogen oxides, soot and water vapor—are known to add to global warming effects alongside the aviation sector's other CO_2 emissions.

Soot triggers the formation of contrails and "contrail cirrus," which are line-shaped clouds produced by aircraft engine exhaust. This causes an increase in high clouds that can warm the Earth's atmosphere.

In a comprehensive assessment of the potential solutions to limit the non-CO_2 emissions produced by aircraft, scientists warn there is "no silver bullet" and a committed and coordinated effort from a range of stakeholders is urgently required.

The research, published in *Environmental Science: Atmospheres*, outlines aviation's non-CO_2 effects on the atmosphere, both in terms of climate and air quality, and how these may change in the future, as well as the effects of future technologies and fuels.

The findings are the result of a two-year study by Manchester Metropolitan University, the University of Oxford, the University of Reading and Imperial College London.

David Lee, Professor in Atmospheric Science at Manchester Metropolitan, said, "What we highlight is the inherent uncertainties that remain in some of these very complex effects on climate from non-CO_2 emissions.

"More importantly, reducing the impact of emissions on the climate is not straightforward as practically all routes forward with conventional liquid hydrocarbon fuels involve 'trade-offs,' mostly at the expense of emitting more CO_2, whether it be technological or operational efforts.

"These trade-offs and uncertainties mean that there are no simple silver

bullets or low-hanging fruit to solve the problem. What is often forgotten is, that while the non-CO_2 climate impacts of, for example, an individual flight are short-lived, a substantial proportion of the emitted CO_2 persists for a very long time, literally tens of millennia. This means it is a difficult balancing act if reducing non-CO_2 emissions leads to an increase in CO_2 emissions."

Professor Keith Shine, Regius Professor of Meteorology and Climate Science at the University of Reading, is an author of the new paper. He said, "Given the many uncertainties in the size of aviation non-CO_2 climate effects, it is premature to adopt any strategy that aims to decrease non-CO_2 climate effects but, at the same time, risks increasing CO_2 emissions. We must be mindful that aviation affects local air quality as well as climate. Sometimes measures that improve one will be to the detriment of the other."

Aviation is responsible for around 2.5% of the global CO_2 emissions caused by human activity. However, due to the amount non-CO_2 emissions it produces, it is responsible for around 3.5% of change in the energy balance of the atmosphere—known as radiative forcing—or around 4% of the increase in global mean temperatures.

The sector is difficult to decarbonize because of its strong dependence on fossil kerosene—jet fuel—and the long timescales involved in developing new aircraft and replacing older fleets.

Given the aviation sector's strong growth after the COVID-19 pandemic, this contribution to climate change is set to increase, when other sectors are battling to reduce emissions.

In the latest assessment, researchers argue for more work to be performed on the complex trade-offs in order to urgently search for solutions.

This difficulty has recently been recognized by the UK government which, through the Natural Environment Research Council (NERC), has announced a £10 million research program to help inform policy decisions in this area.

Professor Lee said, "This is a very welcome and much needed development by the government. Some of our previous research that was used by the Intergovernmental Panel on Climate Change (IPCC) has vitally informed the government on the scale of the problem. We have endeavored to keep the Department for Transport informed of our work while we prepared this assessment, to inform the shape of future research needed."

More information: David S. Lee et al, Uncertainties in mitigating aviation non-CO2 emissions for climate and air quality using hydrocarbon fuels, *Environmental Science: Atmospheres* (2023). DOI: 10.1039/D3EA00091E

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