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Investigating the impacts of aviation NOX, SO_2 and black carbon emissions on ozone, aerosol and climate.

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Aviation is currently responsible for 3% of global anthropogenic CO_2 emissions, but 2-14% of anthropogenic induced warming due to the co-emission of NOX, SO_2 and black carbon and formation of contrails.

The impact of aviation emissions on ozone and aerosol is uncertain with recent research demonstrating the need to include atmospheric nitrate chemistry. The inclusion of nitrate chemistry may lead to a 20% reduction in aviation induced ozone forcing estimates due to the competition for atmospheric oxidants such as OH . Compounding this, uncertainties relating to the effects of NO_x on ozone and methane illustrate the need for refining the understanding of aviation induced impacts. Furthermore the role of aerosol microphysics in controlling the climate impacts of aviation has not yet been explored.

Here we use the TOMCAT 3-D chemical transport model coupled to the GLOMAP-mode aerosol microphysics model to quantify the impacts of aviation NOX, SO_2 and BC emissions on ozone, aerosol and climate. GLOMAP-mode treats size resolved aerosol using a two-moment modal approach. We evaluate the effects of nitrate processing on the diagnosed impacts of aviation emissions on atmospheric composition including the first assessment of the impact on the global concentrations of cloud condensation nuclei. We investigate interactions between gas-phase oxidant photochemistry and aerosol microphysics in regions influenced by aircraft emissions, using fully-coupled tropospheric chemistry and multi-component aerosol treatment (BC, sulphate, nitrate). Finally, we use a 3-D radiative transfer model to quantify the ozone and aerosol direct and indirect radiative effects of aviation emissions.

The work presented here is part of a wider research project which will be the first study to combine aviation NOX, SO_2 and black carbon emission in a global size-resolved model which considers atmospheric nitrate chemistry, which will aim to add to the science surrounding present day aviation impacts by quantifying the impacts of aviation non-CO_2 emissions as baseline. Following on this project will project the future impacts of aviation emissions, and then finally the future impacts resultant from the use of alternative fuels through the development of various alternative fuels scenarios.