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Modelling the impact of aircraft emissions on atmospheric composition

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Emissions of the trace gases CO_2, CO, H_2O, HC, NO_x, and SO_x that have the potential to perturb large scale atmospheric composition are accumulating in the atmosphere at an unprecedented rate as the demand for air traffic continues to grow. We investigate the global, regional and local effects of aircraft emissions on the atmosphere and climate using mathematical modelling, sensitivity simulations, and perturbation simulations. The approach is to gather results for the three main industrialised regions in the Northern Hemisphere, focusing on the $40\,^{\circ}\mathrm{N}$ - $60\,^{\circ}\mathrm{N}$ latitude belt where the majority of aircraft movements take place. A comprehensive aircraft movement database spanning years 2005 - 2012, covering 225 countries and over 223 million departures on approx. 41000 unique routes serves as a basis for our investigation. We combine air traffic data with output from an aircraft performance model including 80 distinct aircraft types, representing 216 of all the aircraft flown in the world in 2005 - 2012. This accounts for fuel burn and emissions for 99.5% of the total number of departures during that time. Simulations are being performed using a state of the art 3D Lagrangian global chemical transport model (CTM) CRI–STOCHEM for simulation of tropospheric chemistry. The model will be applied with two chemistry schemes, namely the Common Representative Intermediates (CRI) reduced chemistry scheme (220 chemical species, 609 reactions) and the near explicit Master Chemical Mechanism (MCM) chemistry scheme (5900 chemical species, 13500 reactions). This will allow us to study in detail the chemical cycles driven by NO_x, governing the rate of formation of O_3 which controls the production of OH and indirectly determines the lifetime of other greenhouse gases.