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IMPACT OF AVIATION ON ATMOSPHERIC CHEMISTRY AND CLIMATE

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Résumé :

Global aviation represents a considerable environmental issue due to emissions of emission of green-house-gases, and other pollutant perturbing the atmospheric chemistry and the Earth's radiative balance. The global emissions from aircraft are increasing, therefore their impact is expected to be even higher in the future. This study is the first attempt to evaluate this impact using a global generation circulation climate model with *online stratospheric chemistry*, coupled with an ocean and sea ice model. We apply the model CNRM-AOCCM, which is an extension of CRNM-CM5 by online chemistry limited to the upper troposphere and stratosphere, i.e. the altitudes where the majority of aviation emissions occur. We examine the impact of aviation on atmospheric chemistry and climate for the period of 1940-2100 (1940 as the beginning of considerable aircraft emissions) under the A1B scenario. The emissions from air traffic follow the corresponding A1i scenario: "A1 GDP driven moderate to good fuel efficiency, without NOx improvements". To obtain consistent initial conditions (for the atmosphere incl. chemical concentrations, ocean, seaice), we ran the model for a 100 year long spinup for the year 1860 conditions and the period 1860-1920 without online chemistry, and 1920-1940 with activated online chemistry assuming fast chemical adjustment.

In our simulations we considered emissions of CO_2, NOx, CO, H_2O, a plume chemistry parameterization for NOx-chemistry and a empirical contrail cirrus (CIC) treatment. For the period 1940-2100 we ran the model with all the effects, and with one of the effects excluded. Finally we performed run with no aviation effects at all.
The results suggest a considerable signal of the aviation emissions on the chemistry for both the present day and future conditions, but the signal on the climate is non-detectable for the present-day conditions. The strongest signal is modelled towards the end of the 21st century. For CO_2, this represents a statistically significant warming by 0.1-0.2ºC over many regions of the globe, but still not uniformly covering the surface. For the stratosphere, due to CO_2, cooling occurs up to -0.4ºC as zonal mean. The NOx effect is very weak throughout the whole period, however the combined effect of CO_2 and NOx is stronger than that of CO_2 alone. The impact on precipitation is negligible even towards the end of the century. The global averaged SST is due to rise by 0.2ºC due to aviation CO_2 but NOx emissions cause a change of negligible magnitude. The evaluation of CIC impact is delayed, but the results for the 2000-2049 period suggest statistically significant heating due to additional cloudiness and this effect is expected to increase by the end of the 21st century, causing potential SST increase as well.

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