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On the effect of emissions from aircraft engines on the state of the atmosphere

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Abstract. Emissions from aircraft engines include carbon dioxide, water vapour, nitrogen oxides, sulphur components and various other gases and particles. Such emissions from high-flying global civil subsonic air traffic may cause anthropogenic climate changes by an increase of ozone and cloudiness in the upper troposphere, and by an enhanced greenhouse effect. The absolute emissions by air traffic are small (a few percent of the total) compared to surface emissions. However, the greenhouse effect of emitted water and of nitrogen oxides at cruise altitude is potentially large compared to that of the same emissions near the earth's surface because of relatively large residence times at flight altitudes, low background concentrations, low temperature, and large radiative efficiency. Model computations indicate that emission of nitrogen oxides has doubled the background concentration in the upper troposphere between 40°N and 60°N. Models also indicate that this causes an increase of ozone by about 5-20%. Regionally, the observed annual mean change in cloudiness is 0.4%. It is estimated that the resultant greenhouse effect of changes in ozone and thin cirrus cloud cover causes a climatic surface temperature change of 0.01-0.1 K. These temperature changes are small compared to the natural variability. Recent research indicates that the emissions at cruise altitude may increase the amount of stratospheric aerosols and polar stratospheric clouds and thereby have an impact on the atmospheric environment. Air traffic is increasing about 5-6% per year, fuel consumption by about 3%, hence the effects of the related emissions are expected to grow. This paper surveys the state of knowledge and describes several results from recent and ongoing research.