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Aircraft pollution – a futuristic view

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Abstract. Impacts of NO_x, H_2O and aerosol emissions from a projected 2050 aircraft fleet are investigated using the Oslo CTM2, with emissions provided through the EU project SCENIC. The aircraft emission scenarios consist of emissions from subsonic and supersonic aircraft. In particular it is shown that aerosol emissions from such an aircraft fleet can have a relatively large impact on ozone, and possibly reduce the total atmospheric NO_x by more than what is emitted by aircraft. Without aerosol emissions this aircraft fleet leads to similar NO_x increases for subsonic (at 11–12 km) and supersonic (at 18–20 km) emissions, 1.35 ppbv and 0.83 ppbv as annual zonal means, respectively. H_2O increases are also comparable at these altitudes: 630 and 599 pptv, respectively. Tropospheric ozone increases are about 10 ppbv in the Northern Hemisphere due to emissions from subsonic aircraft. Increased ozone loss from supersonic aircraft at higher altitudes leads to ozone reductions of about 39 ppbv in the Northern Hemisphere and 22 ppbv in the Southern Hemisphere. The latter reduction is a result of transport of ozone depleted air from northern latitudes. When including aircraft aerosol emissions, NO_x is reduced due to heterogeneous chemistry. The reduced NO_x seems to counterweight the reduction of ozone from emissions of NO_x and H_2O above 20 km. At these altitudes the NO_x (and thus ozone loss) reduction is large enough to give an aircraft emissions induced increase in ozone. In the height range 11–20 km altitude, however, ozone production is reduced. Heterogeneous reactions and reduced NO_x enhances ClO, further enhancing ozone loss in the lower stratosphere. This results in a 14 ppbv additional reduction of ozone. Although supersonic aircraft have opposite effects on ozone in the upper and lower stratosphere, the change in ozone columns is clearly dominated by the upper stratospheric loss, thus supersonic aircraft aerosol emissions lead to enhanced ozone columns. The largest increase in the ozone column due to aerosol emissions is therefore seen in the Northern Hemispheric autumn and winter, giving a column increase of 4.5 DU. It is further found that at high northern latitudes during spring the heterogeneous chemistry on PSCs is particularly efficient, thereby increasing the ozone loss.

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