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Impact of aircraft NO_x emissions on the atmosphere – tradeoffs to reduce the impact

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Abstract. Within the EU-project TRADEOFF, the impact of NO_x (=NO+NO_2) emissions from subsonic aviation upon the chemical composition of the atmosphere has been calculated with focus on changes in reactive nitrogen and ozone. We apply a 3-D chemical transport model that includes comprehensive chemistry for both the troposphere and the stratosphere and uses various aircraft emission scenarios developed during TRADEOFF for the year 2000. The environmental effects of enhanced air traffic along polar routes and of possible changes in cruising altitude are investigated, taking into account effects of flight route changes on fuel consumption and emissions.

In a reference case including both civil and military aircraft the model predicts aircraft-induced maximum increases of zonal-mean NO_y (=total reactive nitrogen) between 156 pptv (August) and 322 pptv (May) in the tropopause region of the Northern Hemisphere. Resulting maximum increases in zonal-mean ozone vary between 3.1 ppbv in September and 7.7 ppbv in June.

Enhanced use of polar routes implies substantially larger zonal-mean ozone increases in high Northern latitudes during summer, while the effect is negligible in winter.

Lowering the flight altitude leads to smaller ozone increases in the lower stratosphere and upper troposphere, and to larger ozone increases at altitudes below. Regarding total ozone change, the degree of cancellation between these two effects depends on latitude and season, but annually and globally averaged the contribution from higher altitudes dominates, mainly due to washout of NO_y in the troposphere, which weakens the tropospheric increase.

Raising flight altitudes increases the ozone burden both in the troposphere and the lower stratosphere, primarily due to a more efficient accumulation of pollutants in the stratosphere.

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