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AirClim: an efficient tool for climate evaluation of aircraft technology

V. Grewe and A. Stenke
Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, 82230 Wessling, Germany

Abstract. Climate change is a challenge to society and to cope with requires assessment tools which are suitable to evaluate new technology options with respect to their impact on global climate. Here we present AirClim, a model which comprises a linearisation of atmospheric processes from the emission to radiative forcing, resulting in an estimate in near surface temperature change, which is presumed to be a reasonable indicator for climate change. The model is designed to be applicable to aircraft technology, i.e. the climate agents CO_2, H_2O, CH_4 and O_3 (latter two resulting from NO_x-emissions) and contrails are taken into account. AirClim combines a number of precalculated atmospheric data with aircraft emission data to obtain the temporal evolution of atmospheric concentration changes, radiative forcing and temperature changes. These precalculated data are derived from 25 steady-state simulations for the year 2050 with the climate-chemistry model E39/C, prescribing normalised emissions of nitrogen oxides and water vapour at various atmospheric regions. The results show that strongest climate impacts (year 2100) from ozone changes occur for emissions in the tropical upper troposphere (60 mW/m^2; 80 mK for 1 TgN/year emitted) and from methane changes from emissions in the middle tropical troposphere (−2.7% change in methane lifetime; −30 mK per TgN/year). For short-lived species (e.g. ozone, water vapour, methane) individual perturbation lifetimes are derived depending on the region of emission. A comparison of this linearisation approach with results from a comprehensive climate-chemistry model shows reasonable agreement with respect to concentration changes, radiative forcing, and temperature changes. For example, the total impact of a supersonic fleet on radiative forcing (mainly water vapour) is reproduced within 10%. A wide range of application is demonstrated.

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