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Efficacies of various forcing components contributing to aircraft climate impact

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The net impact of aviation on global climate results from a combination of individual contributions (e.g. from CO_2, ozone, and methane changes, contrails). The various components are usually compared in terms of their respective radiative forcing, or in terms of advanced metrics (like the global warming potential) for which radiative forcing forms the key input. However, this only leads to sensible assessments if the efficacy of the contributing forcings is similar or equal, i.e. if each effect causes the same global temperature change per unit radiative forcing. A systematic comparison of efficacies is presented for the most important component forcings (as far as their effect has established in the framework of global climate models).
The results are compiled from simulations with the ECHAM4/ATTILA climate model, which has been especially prepared for investigating aviation climate impact. The climate sensitivity of CO_2 is rather well defined, i.e. its value is only moderately dependent on the CO_2 radiative forcing amount over a wide range of concentration changes. The efficacy of contrails is significantly lower than that of CO_2, a result which appears to be robust and confirms a similar conclusion drawn from simulations with other models. For other aviation forcings (ozone, methane, stratospheric water vapour) it is less easy to establish unique efficacy values. The difficulties are caused by non-linearities in the feedbacks that make the efficacy dependent on the extent of scaling of the original forcing. Moreover, methodical and model dependencies allow only preliminary conclusions at the present stage. Deeper understanding of the feedbacks caused by non-CO_2 forcings within the model framework is necessary. Independent research with other models is also highly recommended.