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Smart aircraft routing - a possibility for mitigation?

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Air traffic affects the energy balance of the earth in various ways. Emission of CO_2 with atmospheric residence times measured in decades contributes to the greenhouse effect as well as emission of nitrous oxides, with their impact on ozone and methane chemistry. Soot has a direct effect on the net radiation and, much more important, is involved the production of contrails and the triggering of contrail cirrus, which can be visible for several hours. These artificial clouds are initiated when flying in sufficiently cold and moist air. In total their net radiative forcing is of the same order of magnitude as the forcing by the emitted CO_2. The impact of contrail cirrus on net radiation results from the conversion of ambient moisture in ice super-saturated regions into ice crystals and depends strongly on the conditions of the ambient radiation field. It ranges from a warming at night or over bright low clouds to cooling during daytime over dark surfaces like the ocean. For the time being these effects are not at all taken into consideration in aircraft routing: the production of contrails and contrail cirrus happens by chance. in.

The dependency of the radiative forcing by contrail cirrus clouds on the weather conditions opens the possibility for a soft version of geo-engineering: Avoiding warming (and perhaps also producing cooling) contrails and contrail cirrus by small changes of the flight routes has the potential to reduce the man-made imbalance in radiative forcing by a few percent - not much compared to other geo-engineering strategies, but without any adverse consequences. With the exception of a small amount of additional fuel usage no other substances have to be brought into the atmosphere. As contrails are produced only in 10%-20% of the flown distances and only the warming contrails should be avoided, the impact on the traffic system is limited.

The basic idea of the project 'Environmentally compatible flight route optimisation', funded by the German Ministry for Research and Education is, to predict the time integrated radiative forcing of a potential contrail cirrus based on the information given by a weather forecast model and use this information in relation to total forcing of the additionally emitted CO_2 when avoiding to trigger these clouds by choosing other flight levels or routes within the usual flight route optimisation tools. Operational contraints, costs and effectivity of such a strategy will be evaluated in the next phase of the project.