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Impact of varying optical depths and locations of persistent contrails on their radiative forcing

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The radiative forcing due to persistent contrails is one with the largest uncertainties in assessing the impact of aviation on climate. We present an analysis which builds on a previous study (Rädel and Shine, 2008) that estimated the radiative forcing by persistent contrails and its dependence on the cruising altitude. This new analysis improves the previous one in two ways. Firstly, the contrail optical depth is made dependent on the ambient temperature, which allows the optical depth to vary with location and vertically. Secondly, a regional study has been performed, investigating whether the dependence of contrail forcing on cruise altitude depends on where the air traffic is taking place. Four regions, representing North America, Europe and two areas in South East Asia, were chosen. Since a global constraint on contrail optical depth is not available, the calculations are constrained to have a global-mean optical depth of 0.15, which yields a global mean forcing of 6 Wm-2.
Compared to a case with fixed optical depth, everywhere, a larger regional dependence of the radiative forcing was found, with smaller values at tropical and subtropical latitudes compared to midlatitudes.
The impact of the cruise altitude on the radiative forcing shows a strong regional dependence.
In general the forcing per distance flown peaks at higher altitudes for low latitude flights (around 12 km) than it does for midlatitude flights (about 10 km).
The results have implications for any discussions on the climate impact of changes in aircraft cruise altitude, which we demonstrate by showing the dependence of the global warming potential (GWP) on the cruise altitude for the different regions.

References:
Rädel G. and K.P. Shine, 2008: Radiative forcing by persistent contrails and its dependence on cruise altitudes, J. Geophys. Res. 113, 10.1029/2007JD009, 117, 2008.