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Contrail ice particle formation in the wakes of airliners - insights from in-situ measurements and modelling.

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The role of soot and volatile aerosol in controlling ice particle formation in cirrus clouds is of global importance for climate. In particular, contrail studies may help to better understand the role of various aerosols in ice formation. Recent results suggest that contrails may contribute a large share to the climate impact of aviation. Hence, better knowledge on contrails is needed for developing a sustainable air transport system. So far, contrail models either specify the initial number of ice particles per flight distance or assume that the initial number of ice particles is determined by the number of soot particles emitted. Previous measurements were unable to decide conclusively whether the number of ice particles is directly related to the number of soot particles. Also information on the relative distribution of the mean ice particle concentration in the primary and secondary wakes is missing.

Here, we analyze particle concentrations and trace gas mixing ratios, their dilution and their correlations in 2 min old contrails from four airliners of types A319, A340, B737, and A380 under similar meteorological conditions. The measurements were performed with the research aircraft Falcon above northern Germany during the CONCERT campaign in November 2008. The instrumentation and observation methods were described before (Voigt et al., 2010).

The number of ice particles in contrails of the four airliners at cruise is determined from the measurements and a dilution model, and compared with estimated soot emissions. Dilution is derived from measured concentrations of NO, NO_y, SO_2 and HONO. The trace gas concentrations are largest in the primary wake and decrease with altitude in the secondary wake, consistent with emissions and aircraft-dependent dilution. In contrast, ice particle concentrations are slightly larger in the secondary wake than in the primary wake, and significantly larger than expected from dilution and emissions. The total particle concentration in the contrail is about twice and the particle concentration in the secondary wake about six times larger than expected from soot emissions.

The global importance of these findings is illustrated by a simulations with the CoCiP model (Schumann, 2012). The model results show a 70 % increase in global radiative forcing for a doubled ice particle concentration in young contrails because of simultaneous increases in optical depth, age and cover of contrail cirrus.

References

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