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Transport and chemical conversion of air pollutants under convective conditions - Results of the COPS-TRACKS campaign

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Embedded in the COPS project, the TRACKS campaign (Transport and Chemical Conversion in Convective Systems) was carried out in summer 2007 in order to study the transport of atmospheric trace gases and aerosols under convective conditions. One focus of this experiment was to investigate the dilution of air pollutants in the surroundings of a metropolitan area in complex terrain due to dynamical and chemical processes. Therefore, trace gas distributions in the lee of the city of Karlsruhe had been detected by coordinated measurements of different airborne platforms, including several aircraft and a zeppelin.
We study a summer day with convective boundary layer, characterized not by extreme but standard weather conditions with typical atmospheric pollution. The relevance of urban sources of atmospheric pollutants located in Karlsruhe is considered in relation to meteorological and transport conditions in the Upper Rhine Valley.
The observed ozone concentrations inside the TRACKS area are moderate during this day and reach maximum values around 60 ppb. However, the measurements reveal specific horizontal structures in several trace gas distributions lee-side of Karlsruhe. At a distance of 40 km away from the city, the ozone concentration increases by about 10 ppb, although NO_2 does not show a clear horizontal gradient.
The correlation of O_3 and CO provides an indicator for the origin of air masses. Near to Karlsruhe, the O_3/CO correlation is not significant. However, in the remote lee area a significant positive correlation with a coefficient of determination R2 = 0.71 was found which refers to additional insertion of air pollutants by longer distance transport or vertical transport processes.
A model simulation with COSMO-ART shows low NO_2 concentrations in the lee of Karlsruhe which vary around 5 ppb and indicate that Karlsruhe does not develop a distinctive city plume by the combination of local emissions and atmospheric conditions at this day. In the afternoon around 15 UTC, the modeled O_3/CO correlation is positive in different parts easterly of the Upper Rhine Valley (R2 $\approx$ 0.58). In the lee of Karlsruhe, horizontal transport of air masses which are originated in north-eastern parts of France and Southwestern Germany predominate the impact of local gas emission sources. This can be seen in the whole vertical extension of the boundary layer.