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CARIBIC passenger aircraft measurements in the UT/LMS: Long-term analysis of the correlation between acetone and carbon monoxide

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Since May 2005 the CARIBIC flying laboratory is regularly deployed in the cargo bay of a Lufthansa passenger aircraft (Airbus A340-600) measuring ∼100 trace gases and aerosol components in the upper troposphere / lowermost stratosphere UT/LMS on four flights per month. Acetone is measured using a PTR-MS (proton-transfer-reaction mass spectrometer) and carbon monoxide (CO) is detected using a fast-response vacuum UV resonance fluorescence instrument. Over the years a comprehensive dataset of accurate and high-resolution acetone and carbon monoxide concentrations has been composed.
Acetone is directly emitted both from anthropogenic and biogenic sources or can be produced by the oxidation of hydrocarbons (e.g. propane). CO is produced by incomplete combustion of hydrocarbons (e.g. methane or petrol) and is considered to be a reliable tracer for anthropogenic air pollution and biomass burning. Furthermore it is often co-emitted with hydrocarbons that are important precursors of acetone (i.e. propane).
A strong linear correlation between acetone and CO was found during research aircraft campaigns (Reus et. al. 2003). However the available dataset from research aircraft is very limited.
We present a data analysis based on CARIBIC in-situ data of acetone and CO collected over ∼6 years. Ozone data were used to distinguish between tropospheric and stratospheric air masses. Due to possibly large differences between the sampled latitude and the origin of the sampled air masses 5-day back-trajectories from the ECMWF model were utilized for data interpretation.
Overall, the variability in the acetone-CO correlation slope is considerable, which indicates that a representative long-term dataset as collected during CARIBIC is required to obtain representative mean slopes. In winter substantially lower acetone-CO correlation slopes were observed as during summer times. Slopes grouped according to the 5-day back trajectories showed an increase with latitude from (summer / winter) ∼ 12/8 pptv acetone per ppbv CO at the equator to ∼34/17 at 60°N that might be related to stronger acetone photolysis at lower latitudes. The presented findings and correlation slopes are particularly useful for model calculations to assess the performance of the chemical module of the models.