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Investigation of the 3D distribution of tropospheric formaldehyde (HCHO) at the city of Mainz (Germany) using measurements of a 4 azimuth MAX-DOAS instrument

Sebastian Donner, Myojeong Gu, Julia Remmers, Yang Wang, and Thomas Wagner
Max Planck Institute for Chemistry, Mainz, Germany

The Differential Optical Absorption Spectroscopy (DOAS)-method allows to investigate the distribution of different atmospheric trace gases (e.g. NO_2, SO_2, HCHO...) simultaneously. This is done by analysing the absorptions of these species in spectra of scattered sunlight. Multi-AXis (MAX)-DOAS measurements observe scattered sun light under different elevation angles. From such measurements tropospheric vertical column densities (VCDs) and vertical profiles of the measured trace gases and aerosols can be determined. We performed measurements using a 4 azimuth MAX-DOAS system on the roof of the Max Planck Institute for Chemistry in Mainz/Germany since 2013. This instrument observes scattered sunlight in 4 separate orthogonal azimuth directions. We derive vertical profiles of trace gases in these 4 different azimuth directions. From these results we can investigate the 3D distribution of the trace gases. Mainz is located at the edge of the Rhine-Main area which is one of the densest populated areas in Germany. Therefore it experiences episodes of high and low pollution depending on the meteorological conditions. In this study we focus on formaldehyde (HCHO). It is either emitted directly by industries and other anthropogenic and biogenic activities. Usually higher amounts are produced by photochemical reactions from precursor substances (secondary production), where it plays an important role in photochemical smog chemistry and O_3 chemistry. As it is an intermediate product of basic oxidation cycles of other hydrocarbons (also referred to as volatile organic compounds (VOCs)) especially in summer its concentrations are determined by the abundances of VOCs. Therefore HCHO observations can be used as an indicator for VOCs.

Up to now we have nearly 4 years (starting from May 2013) of almost continuous data which provides already a quite large dataset. In this work we present a first overview of our HCHO results including time series of HCHO columns, a first comparison of the results for different azimuth directions, a first characterisation of the corresponding spatial gradients and a comparison to mobile MAX-DOAS measurements which were performed in Winter 2015/2016.