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Determination of the geographic and seasonal variation of tropospheric HCHO derived from MAX-DOAS measurements

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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 different atmospheric trace gases and aerosols can be determined for the lower troposphere. A further advantage of these measurements is the fact that multiple trace gases (e.g. HCHO, CHOCHO, NO_2, etc.) can be observed with the same measurement setup simultaneously. Together with international partners, we operate five stationary MAX-DOAS instruments located in Mainz/Germany, Bayfordbury/United Kingdom, Greater Noida/India, at the Amazonian Tall Tower Observatory (ATTO) measurement site/Brasil and in Guangzhou/China. Further, campaign based data is available from intensive measurement campaigns which took place at various locations all around the world. These campaign datasets include both stationary and mobile (car and ship MAX-DOAS) measurements. All these measurements were taken with different underlying meteorological and environmental conditions. In this study, we focus on measurements of tropospheric formaldehyde (HCHO). HCHO can be emitted directly by industrial and other anthropogenic and biogenic activities, but it is mainly produced by photochemical reactions from precursor substances (secondary production). Further, 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. Our large data set allows to gain insights into the contributions from different sources and chemical processes covering various geographic and environmental conditions. Here, it is important to note that compared to satellite instruments, MAX-DOAS instruments have a much higher sensitivity to boundary layer HCHO (by a factor of 10 or more).

In this study we first retrieve differential slant column densities (dSCDs) of HCHO for our stationary measurements in a consistent way. Further, HCHO profiles are retrieved using the the MAinz Profile Algorithm MAPA (Beirle et al., 2018). Additionally, the HCHO results are combined with the results of other trace gases such as NO_2 and CHOCHO.