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Stable Carbon Isotope Ratios of Toluene in the Boundary Layer and the Lower Troposphere

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Large amounts of Volatile Organic Compounds (VOC) are emitted into the atmosphere by various sources at the surface. Since these emissions permanently mix with each other and also are chemically processed in a large number of reactions, measurements of VOC concentrations in the troposphere are not easy to interpret. Additional measurements of stable carbon isotope ratios in VOC provide further useful information. They allow the determination of the photochemical age of the corresponding compound and, making use of the concept of the effective Kinetic Isotope Effect (KIE), to separate the effects of mixing and chemical processing.

Whole air samples were taken in the boundary layer and the lower troposphere onboard a zeppelin over the Lake Constance region in late autumn 2008 and analysed in the laboratory using a GC-C-IRMS (Gas Chromatograph – Combustion – Isotope Ratio Mass Spectrometer). The GC-C-IRMS was characterised carefully to estimate the precision as well as the effect of sample humidity on the measurement results. The major ion signal was used to derive VOC mixing ratios. We present stable isotope ratios (δ13C) and mixing ratios of toluene as an example compound and apply the aforementioned concepts of interpretation. The results show that the evolution of air masses in the boundary layer was characterised mainly by mixing, whereas the air masses in the free troposphere show significant influence of chemical processing.