Geophysical Research Abstracts
Vol. 21, EGU2019-15512, 2019
EGU General Assembly 2019

Tropospheric OH and stratospheric OH and Cl concentrations determined from CH_4, CH_3Cl, and SF_6 measurements

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The hydroxyl (OH) radical is the key oxidant in the global atmosphere as it controls the concentrations of toxic gases like carbon monoxide and climate relevant gases like methane. In some regions, oxidation by chlorine (Cl) radical is also important, and in the stratosphere both OH and Cl radicals impact ozone. An empirical method is presented to determine effective OH concentrations in the troposphere and lower stratosphere, based on CH_4, CH_3Cl, and SF_6 data from aircraft measurements (IAGOS-CARIBIC) and a ground-based station (NOAA). Tropospheric OH average values of 10.9×10^5 (σ=9.6×10^5) molecules/cm^3 and stratospheric OH average values of 1.1×10^5 (σ=0.8×10^5) molecules/cm^3 were derived over mean ages derived from SF_6. Using CH_4 led to higher OH estimates due to the temperature dependence of the CH_4+OH reaction in the troposphere and due to the presence of Cl in the stratosphere. Exploiting the difference in effective OH calculated from CH_3Cl and CH_4 we determine the main altitude for tropospheric CH_4 oxidation to be 4.5$\sim$10.5km and the average Cl radical concentration in the lower stratosphere to be 1.1×10^4 (σ=0.6×10^4) molecules/cm^3 (with a 35% measurement uncertainty). Furthermore, the data are used to examine the temporal trend in annual average stratospheric OH and Cl radical concentrations between 2010 and 2015. The year 2013 showed highest stratospheric OH and lowest Cl but no clear temporal trend was observed in the data in this period. These data serve as a baseline for future studies of stratospheric circulation changes.