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Revisiting the Glyoxal-to-Formaldehyde Ratio (R_{GF}) as a Proxy for VOC Source Identification

Simon Bittner[1], Andreas Richter[1], Bianca Zilker[1], Sebastian Donner[2], Thomas Wagner[2], Mihalis Vrekoussis[1]

1 *Institute of Environmental Physics, University Bremen, Germany*
2 Max Planck Institute for Chemistry, Mainz, Germany

A multitude of processes of different origin (e.g. biogenic, anthropogenic, pyrogenic) couple the Earth’s surface and the atmosphere by releasing a large variety of species. These emissions can contribute to air quality degradation and climate forcing, among other impacts. As the full atmospheric state is hard to capture because of the large number of different species, proxies are of particular interest in atmospheric science.

Two important species in atmospheric chemistry are formaldehyde (HCHO) and glyoxal (CHOCHO), both belonging to the family of volatile organic compounds (VOC). Their sources (direct emissions, secondary production from oxidation of other VOC) and their sinks (photolysis, oxidation by the hydroxyl radical) are similar but differ in importance. These marginally different yields of CHOCHO and HCHO in the individual emission processes can be utilized to discriminate between sources. It was proposed to use their ratio as a proxy for the origin of VOC emissions. Multiple publications investigated this hypothesis and resulted in disagreeing results under different environmental conditions.

To gain additional insights into the drivers and limitations of the R_{GF} ratio, MAX-DOAS data from four stations with systematically different conditions (Orleans France, Athens Greece, Incheon South-Korea, ATTO-Tower Brazil) is analyzed with the focus on the ratio and potential influencing factors. The two primarily biogenic environments (Orleans and ATTO) are compared against the primarily anthropogenically influenced stations (Incheon and Athens). We report systematically higher R_{GF} values for anthropogenic stations due to enhanced CHOCHO levels and, conversely, lower R_{GF} values for biogenic stations. In addition, we show strong diurnal and seasonal cycles for anthropogenic stations, different sensitivity of the ratio to NO2 levels, as well as a temperature dependence of the ratio.