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Multi-year MAX-DOAS observations of the glyoxal-to-formaldehyde ratio (R_{GF}): drivers, variability, and limitations

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The Earth's surface and atmosphere are coupled through the release of a large variety of chemical species from biogenic, anthropogenic, and pyrogenic sources. These emissions influence atmospheric composition in ways that affect both air quality and climate. Given the complexity of the atmosphere and the large number of species involved, proxies that capture key aspects of this variability are of particular interest in atmospheric science.

Two important species in atmospheric chemistry are formaldehyde (HCHO) and glyoxal (CHOCHO) both members of the volatile organic compound (VOC) family. Both species share similar sources (direct emissions and secondary production through oxidation of other VOCs) and similar sinks (primarily photolysis and oxidation by the hydroxyl radical (OH)). However, the relative importance of these processes differs between the two species, resulting in characteristic differences in their production yields across origins. This has motivated the use of their ratio (R_{GF}) as a proxy for the origin of VOC emissions. Following investigations of this hypothesis have, however, produced inconsistent results across different environmental conditions.

To further investigate the drivers, variability and limitations of R_{GF} , MAX-DOAS observations from four stations representing systematically different environments (Orléans (France), Athens (Greece), Incheon (South Korea), and the ATTO Tower (Brazil)) are analysed with respect to R_{GF} and meteorological influence. The analysis reveals pronounced diurnal cycles at the anthropogenic sites, broadly consistent seasonal cycles across non-tropical sites, and a robust decrease of R_{GF} with temperature. Correcting for the temperature response eliminates the seasonal cycle at non-tropical sites, while the diurnal cycle at anthropogenic sites is largely retained.