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Unexpected long-range transport of glyoxal and formaldehyde observed from the Copernicus Sentinel-5 Precursor satellite during the 2018 Canadian wildfires

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Glyoxal (CHO.CHO) and formaldehyde (HCHO) are intermediate products in the tropospheric oxidation of the majority of Volatile Organic Compounds (VOC). CHO.CHO is also a precursor of secondary organic aerosol (SOA) in the atmosphere. CHO.CHO and HCHO are released from biogenic, anthropogenic, and pyrogenic sources. CHO.CHO and HCHO tropospheric lifetimes are typically considered to be short during the daytime at mid-latitudes (e.g. several hours), as they are rapidly removed from the atmosphere by their photolysis, oxidation by OH, and uptake on particles or deposition. At night and at high latitudes, tropospheric lifetimes increase to many hours or even days. Previous studies demonstrated that CHO.CHO and HCHO vertical column densities, VCDs, are well retrieved from space-borne observations using the differential optical absorption spectroscopy, DOAS.

In this study, we present CHO.CHO and HCHO VCDs retrieved from measurements of the TROPOMI instrument, launched on the Sentinel-5 Precursor (S5P) platform in October 2017. We observe strongly elevated amounts of CHO.CHO and HCHO during the 2018 fire season in British Columbia, Canada, where a large number of fires occurred in August. CHO.CHO and HCHO plumes from individual fire hot-spots are observed in air masses travelling over distances of up to 1500 km, i.e. much longer than expected for the relatively short tropospheric lifetime expected for CHO.CHO and HCHO. Comparison with simulations by the particle dispersion model FLEXPART indicates that effective lifetimes of 20 hours and more are needed to explain the observations of CHO.CHO and HCHO if they decay in an effective first order process.

FLEXPART used in the study calculates accurately the transport. In addition an exponential decay, in our case assumed to be photochemical, of a species along the trajectory is added. We have used this simple approach to test our assumption that the CHO.CHO and HCHO are created in the fires and then decay at a constant rate in the plume, as it is transported. This is clearly not the case and we infer that CHOCHO and HCHO are either efficiently recycled during transport, or continuously formed from the oxidation of longer-lived precursors present in the plume, or possibly a mixture of both. We consider the best explanation of the observed CHO.CHO and HCHO VCD in the plumes of the fire is that they are produced by oxidation of longer-lived precursors, also released by the fire and present in the plume.

The content of this seminar was published in ACP. Please, see the paper for the full list of co-authors. Link to ACP paper: https://acp.copernicus.org/articles/20/2057/2020/acp-20-2057-2020.pdf