Geophysical Research Abstracts
Vol. 21, EGU2019-9015, 2019
EGU General Assembly 2019

First mapping of nitrous acid (HONO) pyrogenic emissions using S5-P/TROPOMI

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With a spatial resolution of 7x3.5 km^2 and comparable (or even better) spectral performance in terms of signal to noise ratio, the TROPOspheric Monitoring Instrument (TROPOMI) onboard Sentinel-5 Precursor largely surpasses its predecessor OMI. This is particularly true for narrow plumes near emission sources where signal dilution often hampers the detection of several trace gases by OMI. In this paper, we demonstrate that TROPOMI largely resolves this problem for the detection of nitrous acid (HONO). HONO is a short-lived reactive gas and plays a key role in the atmosphere through its influence on the OH budget. Nitrous acid can be produced in cases of high NO_x and high aerosols, typical conditions occurring during large wildfires.
Using Differential Optical Absorption Spectroscopy (DOAS) applied in the UV wavelength range 337-375 nm, we analyzed several months of TROPOMI data and found that HONO is unambiguously detected in many of the big fires of 2018 (US, Canada, Australia, Russia, Africa). HONO slant column densities (SCDs) in regions collocated with large VIIRS fire counts are often > 1 x 1016 molec/cm^2, which scales to volume mixing ratios of several ppbvs of HONO in the fire plumes.
During July-September 2018, the University of Colorado participated to a field campaign (Biomass Burning Fluxes of Trace Gases and Aerosols (BB-Flux)), performed research flights near fire plumes in the US and successfully detected HONO for several of them using the CU-DOAS aircraft instrument. For some cases, flights were planned around the TROPOMI overpass. We exploit this unique opportunity to validate our satellite HONO retrievals. We discuss the comparison results and reasons for discrepancies. In particular, viewing observations are very different and can lead to air mass sampling differences in the presence of elevated aerosols.
Finally, a common feature of both satellite and aircraft datasets is the very high ratio HONO SCD/NO_2 SCD observed in many plumes (in the 0.5-1 range). We investigate and discuss the possible photochemical pathways that can lead to such high ratios.