Two Years of MAX-DOAS Data from Remote Tropical Marine Mountaintops

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The remote tropical troposphere is responsible for about 75% of the chemical removal of ozone (O_3) and methane (CH_4), two important greenhouse gases. Yet the atmospheric chemistry over remote oceans is largely unconstrained in the free troposphere (FT). Mountaintops on isolated oceanic islands provide access to FT with minimal continental and boundary layer influence. Since February 2017 we have deployed Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) instruments at two sites: 1) Mauna Loa Atmospheric Baseline Observatory (MLO) at 19.5°N, 155.6°W, at 3.4-km altitude in the northern hemisphere tropics; and 2) Maïdo Observatory (Maïdo) at 21.1°S, 55.4°E, at 2.2-km altitude in the southern hemisphere tropics. We consistently measure the halogen oxide radicals bromine oxide (BrO) and iodine oxide (IO), small oxygenated volatile organic compounds [OVOC; e.g. formaldehyde (HCHO) and glyoxal (CHOCHO)]; which impact oxidative capacity and inform carbon cycling. We also measure total columns of O_3, and nitrogen dioxide (NO_2) using NDACC retrievals, and aerosol optical depth, which can be used for satellite validation.

We present an overview of the two-year time series of these measurements at both sites, highlighting chemical and dynamic changes at and above the observatories occuring on diurnal to seasonal scales. These include: 1) diurnal variations driven by orographic meteorology; 2) large-scale tropospheric systems on time scales of days to weeks; and 3) an annual cycle of the upper atmosphere between tropical conditions in hemispheric summer, and midlatitude conditions in hemispheric winter. Progress toward an efficient cloud-screening procedure for the MAX-DOAS data is demonstrated. A high degree of freedom profile retreival for BrO, leveraging O_3 and NO_2 columns, coupling photochemical change into radiative transfer, and iteratively determining reference contibutions is highlighted in case studies.

Figure 1. A view over the MLO MAX-DOAS telescope (pictured here without it's protective cover) in the primary scanning direction. Light is collected through viewing port (faceon here) and sent to two spectrometers for analysis via optical fibers. By rotating in the veritcal plane, spectra can be collected along lines of sight pointing below, at, and above instrument altitude. The instrument has collected data on a vareity of tropospheric and stratospheric trace gases since February 2017.