Geophysical Research Abstracts
Vol. 17, EGU2015-548, 2015
EGU General Assembly 2015


# Vertical Profiles of $SO_2$ and $NO_2$ in the Alberta Oil Sands: MAX-DOAS Measurements and Comparison to in-situ Instrumentation

Zoe Davis, Akshay Lobo, and Robert McLaren
Centre for Atmospheric Chemistry, York University, Toronto, Canada (zoeywd@yorku.ca)

Understanding the levels of industrially emitted gas pollutants in the Alberta oil sands is essential to making quality environmental management decisions but is currently limited due to scarcity of top-down quantification studies. Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) measurements of nitrogen dioxide ($NO_2$) and sulfur dioxide ($SO_2$) , important tropospheric trace gas pollutants, contributes to improved knowledge of these pollutants' levels, vertical distributions and chemical transformations.
A mini-MAX-DOAS instrument measured spectra at multiple viewing elevation angles in order to retrieve $NO_2$ and $SO_2$ differential slant column densities (dSCDs) at an Environment Canada research site north of Fort McMurray, Alberta in the fall of 2013. For the first time in the oil sands, tropospheric vertical profiles of $NO_2$ and $SO_2$ were retrieved by applying the optimal estimation technique to the MAX-DOAS measurements.
The DOAS fit retrievals of $SO_2$ dSCDs were validated by comparison with retrievals obtained with a quartz calibration cell with known $SO_2$ SCD placed in front of the MAX-DOAS telescope at multiple elevation angles on a clean day. Retrieved $SO_2$ dSCDs varied significantly from the true value depending on the chosen wavelength fitting interval. At the lowest wavelength intervals, interference by stray light and $O_3$ differential structures significantly reduced dSCDs and caused an elevation angle dependence. These results indicate that MAX-DOAS dSCD retrieval settings, particularly for weak absorbers with differential absorption structures in low-intensity spectral regions, must be chosen carefully in order to achieve the most accurate results.
Tropospheric vertical column densities (VCDs) and vertical profile retrievals of $NO_2$, $SO_2$ and aerosol extinction during significant pollution events will be illustrated. Trace gas vertical profiles exhibited significant variability between days and at different times of day and were often spatially complex (e.g. elevated layers). Retrieved trace gas vertical profiles were compared with aircraft composite profiles from flights over the site. Trace gas surface retrievals were compared with results from a co-located active-DOAS instrument. The degree of agreement between the DOAS instruments appear to be related to pollution levels and meteorological conditions. Significant observed pollution events were associated with particular meteorological conditions such as South-Westerly winds. Maximum observed $SO_2$ and $NO_2$ retrieved mixing ratios were 250ppb and 60ppb, respectively, at approximately 300m above the surface while maximum surface concentrations measured by the active-DOAS were 77ppb and 20 ppb, respectively. The observed spatial complexity in the trace gas profiles indicates that comprehensive air quality monitoring in the oil sands requires instruments with boundary layer spatial profiling capabilities.