Analysis and interpretation of DOAS measurements of tropospheric NO_2 at UNEP/Nairobi

Nitrogen Oxides (NO_x = NO + NO_2) are important species in atmospheric chemistry. In the stratosphere, reaction of N_2O with $O(^1D)$ provides a source for NO_x that forms a layer of seasonally, latitudinally and diurnally varying thickness at about 30 km altitude. NO_x is involved in stratospheric ozone chemistry through catalytic cycles destroying ozone, but also by forming halogen reservoir substances such as $ClONO_2$ and thereby preventing further ozone depletion. In the troposphere, sources of NO_x are both anthropogenic (mainly fossil fuel combustion and biomass burning) and natural (soil emissions, lightning). Nitrogen dioxide adversely affects the respiratory system and is a key substance in the formation of ozone in photochemical smog. In addition, it is also involved in acid rain formation and at least locally in radiative forcing.

Tropospheric NO_x is routinely measured at air quality stations using different in-situ measurement techniques. Nitrogen Dioxide can also be observed from space using nadir measurements from UV/visible spectrometers such as GOME, SCIAMACHY or OMI. The advantage of satellite measurements is their global coverage but the spatial and temporal resolution is still coarse compared to the size of typical sources. In addition, satellite data need continuous validation by independent measurements. One type of instrument that can be used to bridge the gap between local in-situ measurements and the integrating satellite data is the MAX-DOAS (Multi Axis Differential Optical Absorption Spectrometer) instrument. Such an instrument was installed at the UNEP in Nairobi by the University of Bremen in July 2002, and has been operational since that time.

As a semester project, a student could perform an analysis of tropospheric NO_2 columns and surface concentrations retrieved from measurements of the DOAS instrument operated at UNEP/Nairobi by the University of Bremen. These data could be compared with satellite measurements from GOME, SCIAMACHY, and OMI (once available) and in-situ measurements by the University of Nairobi.

The main steps in the project would be

- reading and learning on measurement techniques used for in-situ, optical ground-based, and space-borne measurements of NO_2
- reading on global behaviour of NO_2 with an emphasis on tropospheric NO_2 in polluted regions
- retrieval of tropospheric NO_2 columns and surface mixing ratios from the MAX-DOAS measurements using software and data provided by the University of Bremen
- collection of data from satellite instruments (GOME, SCIAMACHY, OMI...) for the location and time considered
- organisation and execution of a comparison “campaign” with in-situ measurements of the Nuclear Sciences department at the University of Nairobi
- comparison of the different data sets and analysis of systematic differences
- preparation of a summary report on the analysis and the results

The Institute of Environmental Physics at the University of Bremen will support this project by provision of spectra and NO_2 columns measured by the MAX-DOAS instrument in Nairobi as well as GOME, SCIAMACHY and potentially OMI and by provision of useful links to information and data sources. It can also provide limited support for questions related to data handling, analysis, and interpretation.