Introduction

Pollution and climate change are significant global environmental issues. To improve our understanding of the impact of pollution on the climate, Multi-Axis Differential Optical Absorption Spectroscopy (DOAS) is a remote sensing measurement technique, which enables many important trace gases to be detected e.g.: a) tropospheric ozone, nitrogen dioxide, formaldehyde during pollution episodes and smog, b) stratospheric ozone, nitrogen oxides and halogen compounds and c) water vapour.

In this poster a short overview explaining the BREDOM network and the measurement site Nairobi is provided. In particular the experimental arrangement of the ground based instrument in Nairobi is described and some first results of the Nairobi measurements presented.

BREDOM

The Bremen DOAS Network for Atmospheric Measurements[BREDOM] consists of seven ground based stations at different latitudes (see Fig. 1):

- Ny-Ålesund (79°N, 12°E), Bremen (53°N, 9°E), Zugspitze (47°N, 10°E) and Nairobi (1°, 37°E) in operation (UV range), second detector-spectrometer system for visible range planned for 2003

At BREDOM instruments will be operating with a similar setup and the new off-axis viewing geometry - a new application of the DOAS method to distinguish between stratospheric and tropospheric sources up to a determination of slightly resolved profiles.

Measurement Site Nairobi

Nairobi is one of our tropical stations and lies near the equator, 1°S and 37°E. With a high altitude of about 1800 m above sea level it is in a moderate climate (Figure 2). Temperatures rarely drop below 15°C or get warmer than 30°C year-round. January-March is usually warm, with temperatures rising to about 28-30°C. The cool time of year is April-July, when temperatures can dip below 10°C. Rainy seasons typically occur April through May and October-December, while August is known to be a wet month as well. Mean sunshine hours ranging from 130 hours in August to about 270 hours in January.

The ground based DOAS instrument is installed in the headquarters of the United Nations Environmental Programme (UNEP), at the outskirts of Nairobi. Its telescope (Figure 3) is mounted on the rooftop of a building with viewing direction of the axis measurements to the south, downtown Nairobi.

Experimental Setup

- Czerny-Turner Spectrograph L.O.T. MS257 (focal length 257 mm, 1200 l/mm grating)
- CCD Andor DV440-BU (2048 x 512)
- UVVIS wavelength range: 320 - 410 nm
- Spectral resolution: 0.5 nm
- Targeted trace gases: O3, NOx, BrO, HCHO, NO2, O3
- Atmospheric Viewing: continuous alternating observations between zenith and horizon (4 off axis viewing directions: 4°, 7°, 16°, 30°) by employing a miniaturized setup by a computer controlled servomotor as shown in Figure 4

References

[4] Urban Climatet Homepage at the Meteorological Institute of the University of Freiburg, www.stadtlima.de

First Results

In Figures 5a to 5c comparisons of the ozone measurements with GOME, TOMS and SHADOZ sondes from Nairobi are shown. There is a good agreement of the GOME, TOMS and SHADOZ data within the Nairobi measurements, the absolute values as well as the variation with time. From mid November there is a difference of 5-15% of the SHADOZ data in the ground based data. For the ground based measurements morning and afternoon values are given. There appears to be no significant diurnal variation of ozone except the time from mid October to mid November 2002. This appears to be stratospheric rather than tropospheric in origin. Up to now there is no well founded explanation for this phenomenon.

In Figures 6a, 6b and 6c results of measurements of NO2, HCHO and BrO are shown. The ground based measurements morning and afternoon values are given. The results demonstrate the reliability and accuracy of the instrument and it is already being used for validation work. The results of the comparison with SHADOZ for NO2 and ozone are shown in Figures 5a and 5c. In Figure 5a it can be seen that the absolute values and the variation with time is well captured by the SHADOZ data. The ground based measurements showing morning and evening columns show a pronounced diurnal variation. This is part due to photolysis of NO2 in stratosphere and the diurnal variation of NOx in the troposphere. This is being investigated. The time of the ENVIROSAT overpass is close to 10 AM, so that the SCIAMACHY data should be used to the morning measurements. Is it is the case?

Conclusions

At end of 2002 the Nairobi DOAS station started its measurements and since then has been measuring continuously in operation. The results demonstrate the reliability and accuracy of the instrument and it is already providing scientifically important and challenging observations of different trace constituents. Significantly it has also been demonstrated that the ground based DOAS station in Nairobi is well suited for validation of both GOME and SCIAMACHY column and profile measurements.

Acknowledgements

This project (SOEE0005) has been funded in parts by:
- the German Federal Ministry of Education and Research (BMBF)
- the German Aerospace Agency (DLR)
- the German Research Council (DFG) and
- the State of Bremen and the University of Bremen.

For more information about tropical ozone measurements see also talk UP 5.5 of A. Ladstätter-Weißenmayer.

www.doas-bremen.de