GROUND-BASED UV/VIS OBSERVATIONS OF ATMOSPHERIC TRACE GASES ABOVE DIFFERENT LATITUDES

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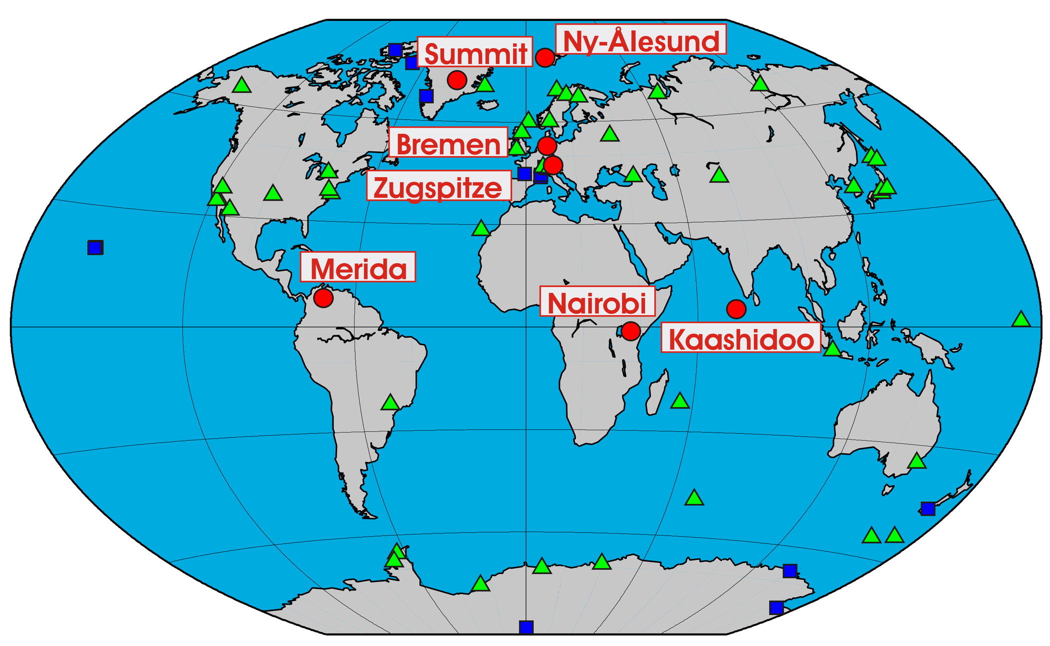
Introduction



● BREDOM sites ■ Primary NDSC sites ▲ Complementary NDSC sites

Figure 1: Map of the BREDOM and NDSC sites

Global pollution and climate change require worldwide measurements of the atmospheric constitution to study the impact of anthropogenic activities. The Differential Optical Absorption Spectroscopy (**DOAS**) enables us to detect simultaneously atmospheric trace gases as ozone, halogen oxides, nitrogen dioxide, formaldehyde and sulphur dioxide which are relevant to stratospheric and tropospheric processes. This study presents ground-based measurements by means of UV/visible spectroscopy. The measurement sites within the Bremian DOAS Network for Atmospheric Measurements (**BREDOM**) range from northern high latitudes (Ny-Aalesund, 79° N, 12°E) over mid-latitudes (Bremen, 53°N, 9°E) to equatorial regions (Nairobi, 1°S, 36° E). In 2002 all instruments have been substantially enhanced to use different lines of sight close to the horizon as additional viewing geometries. With this MAX-DOAS (multi-axis Differential Optical Absorption Spectroscopy) technique it is possible to derive profile information for the retrieved absorbers, which allows us to further investigate the consistency of trace column amounts derived from different platforms and/or from model calculations.

The ground based measurements yield high temporal and spatial resolution at selected locations whereas the satellite currently provide global coverage at selected times. Combining the different data sets permits validationof those measurements and in addition yields synergistic advantages and tests our theoretical understanding of the physical and chemical processes, which determine the behaviour and nature of the atmosphere.

In this poster a short overview explaining the BREDOM network and comparisons of data from the different measurement sites with SCIAMACHY data are presented.

Experimental Setup

Figure 2: View of the DOAS telescope (Summit, Greenland)

Sunlight scattered from the sky is collected by a telescope (Fig 2) and transmitted to a Czerny-Turner spectrograph via a depolarizing quartz-fibre bundle. A charge coupled device (CCD) is used as a detector. The pointing of the telescope alternates between zenith and four off-axis directions (3 to 30° above horizon), which provides profile information of the absorbers. The observation in different lines of sight is realized by a mirror fixed on a revolving table driven by a computer controlled motor. The whole system works automatically and the measurement parameters can be set from Bremen via an internet connection. The time resolution is usual 5 minutes for each elevation angle.

Ny Ålesund (79°N, 12°E))

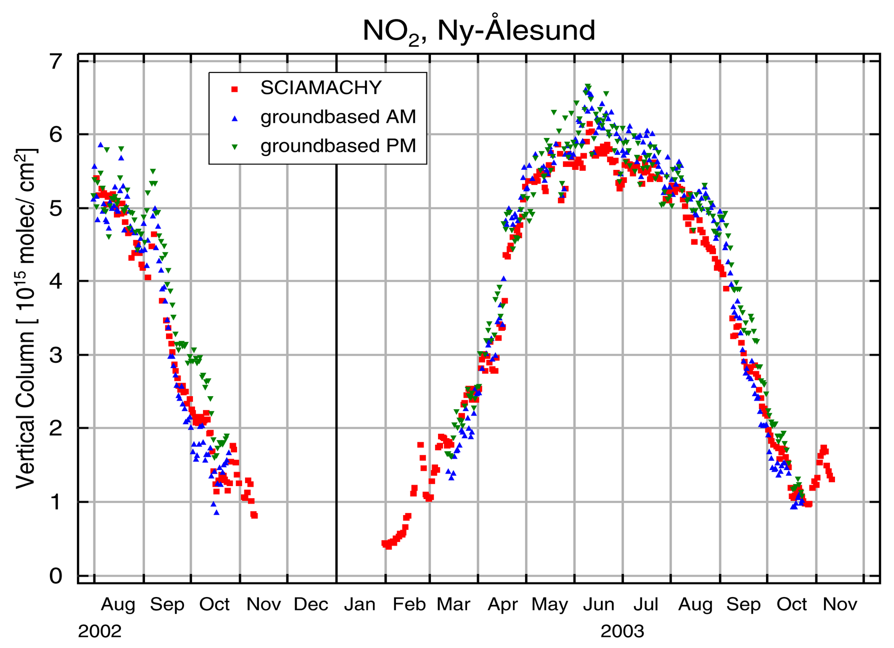


Fig 3: Vertical Columns of NO_2 compared with the IUP Bremen SCIAMACHY NO_2 product above Ny-Ålesund.

In Figures 3 to 6 and 8 ground-based DOAS measurements of NO2 from the BREDOM network are shown and compared to results from the SCIAMACHY satellite instrument onboard ENVISAT. Due to the limited number of available operational products for SCIAMACHY, the SCIAMACHY NO_2 columns have been retrieved from level0-data (uncalibrated radiances) using the IUP Bremen DOAS algorithm.

The Ny-Ålesund station is part of the primary Arctic site in the Network for Detection of Stratospheric Change (NDSC) with polar night from October to February, rapidly changing solar zenith angles in spring and fall as well as polar day in summer.

In Ny-Ålesund the SCIAMACHY NO_2 columns and ground based DOAS measurements (Figure 3) show an excellent agreement. Like Summit and Nairobi the SCIAMACHY values are closer to the AM measurements. The seasonal variation is well represented.

Summit (72°N, 38°W)

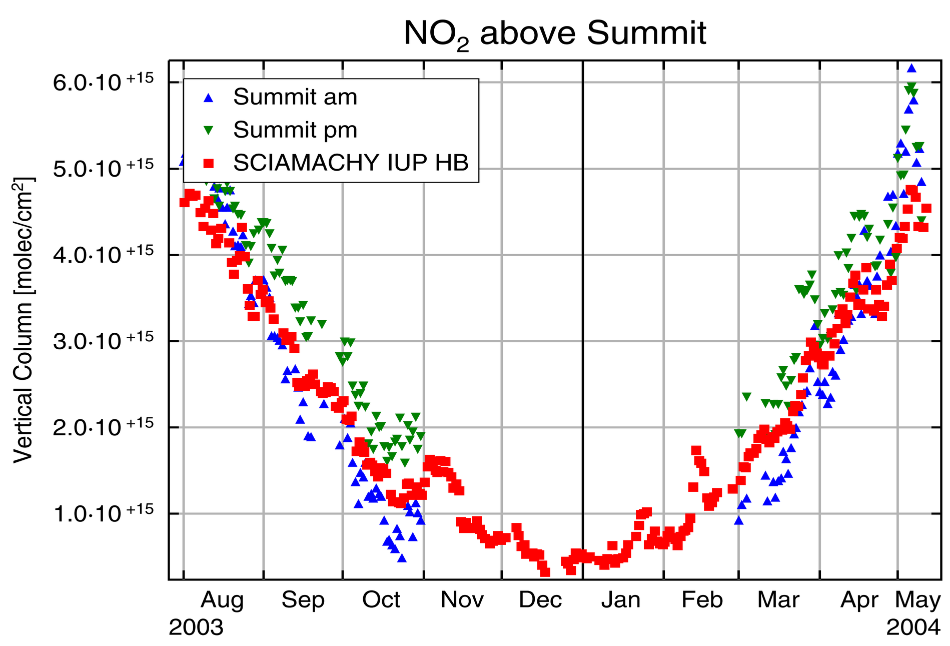


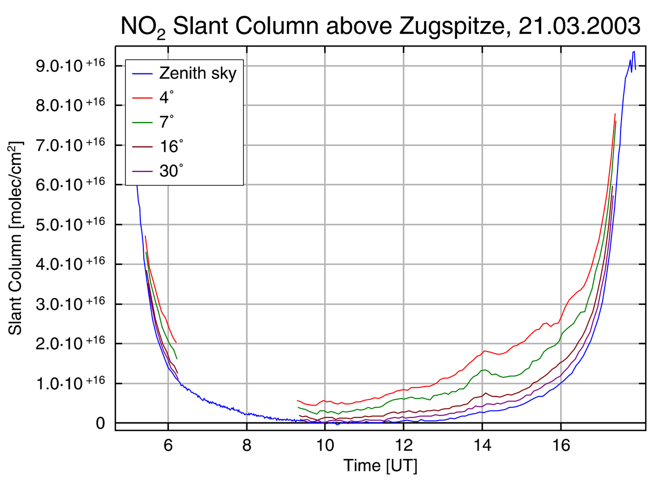
Fig 4: Vertical Columns of NO_2 compared with the IUP Bremen (HB) SCIAMACHY NO_2 product above Summit.

The Summit camp sponsored by the National Science Foundation (NSF) is a scientific research station located at the peak of the Greenland ice cap at 3200 m altitude. This high altitude Arctic site is characterized by:

- low temperatures,
- very low water vapour column and
- a clean troposphere.

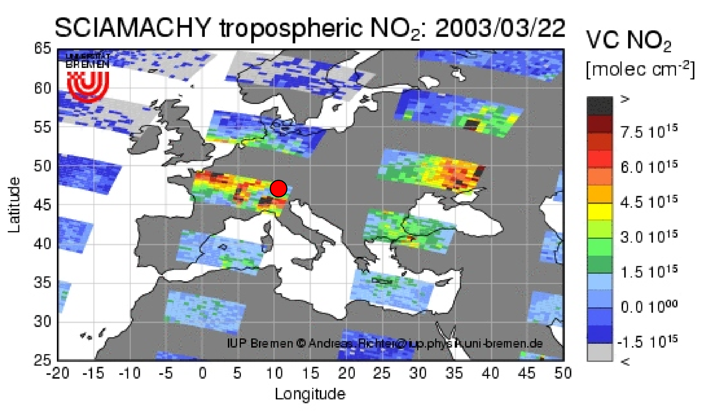
It can clearly be seen (Figure 4) that due to the increasing darkness in winter and the resulting less photolysis of N_2O_5 the amount of NO_2 is decreasing. There is a good agreement of the SCIAMACHY data with the Summit measurements, the absolute values as well as the variation with time. For the ground based measurements morning and afternoon values are given.

Zugspitze (47°N, 10°E)



The instrument was temporary installed at the Environmental Research Station Schneefernerhaus (UFS) which is located at Germany's highest mountain Zugspitze 2650m above sea level.

In contrast to the other stations where the NO_2 values of SCIAMACHY are more comparable with the morning data of the ground based measurements the SCIAMACHY data at Zugspitze are closer to the afternoon values of the ground based data. This might be due to the orography around the measurement site. The seasonal trend of both measurements is well represented.



After close-down of this instrument at Zugspitze it was reinstalled at Merida (Venezuela) in April 2004

Fig 5a-b: The diurnal variation of NO2 slant columns on 21 March, 2003 shows a clear tropospheric signal (a). This can also be seen from the satellite measurements (b).

Merida (8°N, 72°W)

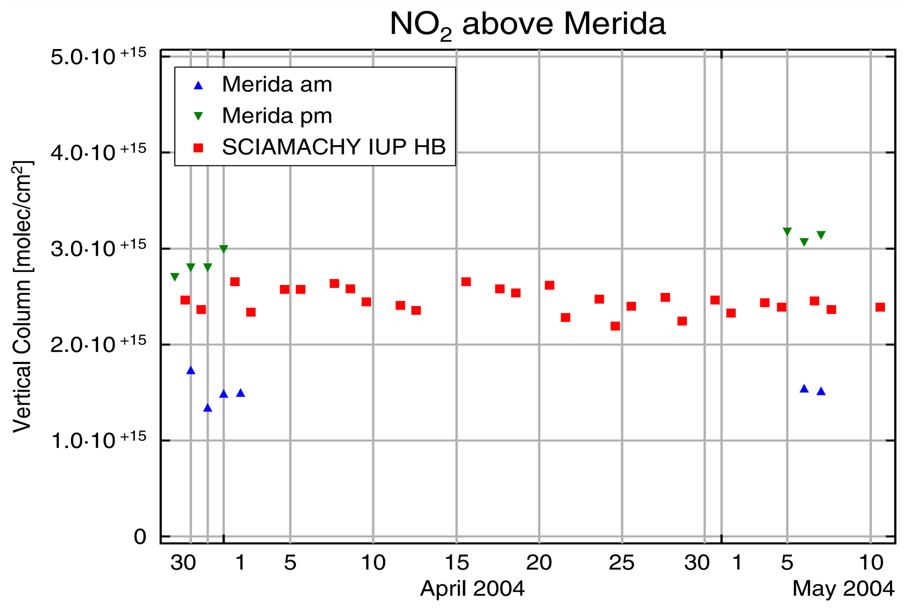


Fig 6: Vertical Columns of NO_2 compared with the IUP Bremen SCIAMACHY NO_2 product above Merida.

The Merida instrument has been installed inside the MARS (**M**erida **A**tmospheric **R**esearch **S**tation) building at Pico Espejo in April 2004. With 4765 m above sea level this station is the highest throughout the world.

First analysis of the data indicates, that the measurements are well-suited for observations of the free troposphere in the tropics.

Fig 7: The MARS building on top of the Pico Espejo.

Conclusions

Comparisons of NO_2 from different ground-based measurements with the corresponding IUP Bremen SCIAMACHY products have been presented in this poster.

At all stations a good agreement between the SCIAMACHY and the ground-based measurements can be observed. Differences of the NO_2 values that can be observed in the figures are related to the time difference between the measurements. The ground-based data that shown here are usually calculated from spectra measured around 90° solar zenith angle (sunrise and sunset)when possible whereas the SCIAMACHY data are recorded around 10 am local time. Please note that from validation studies with data of the GOME instrument an offset of 1E15 molec/cm^2 is added to theslant column of SCIAMACHY.

The variation with time of the SCIAMACHY data fits very well with the measurements at all ground based stations. The decrease of NO_2 with increasing darkness for polar regions and also the variation of NO_2 over a long time period (see Nairobi) is very well captured.

The results illustrate the reliability and accuracy of the satellite instrument. It has also been demonstrated that the ground-based DOAS stations within BREDOM are well suited for validation of satellite measurements from all latitudes.

Nairobi (1°S, 36°E)

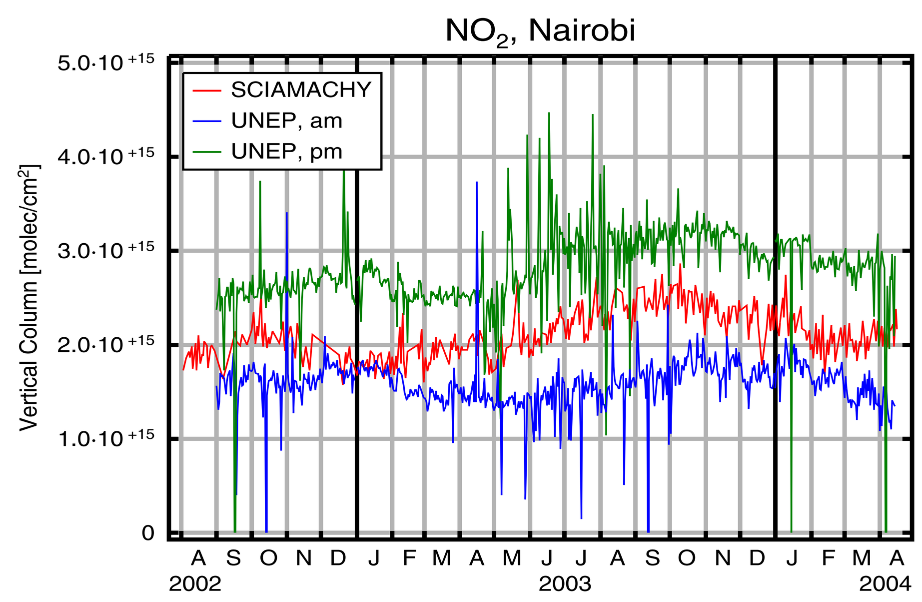


Fig 8: Comparison of NO_2 from groundbased measurements with the IUP Bremen SCIAMACHY NO_2 product above Nairobi.

Nairobi is one of our tropical stations and lies near the equator, 1.2°S and 36,8°E. The relatively high altitude of about 1620m above sea level results in a moderate climate.

The ground based measurements (Figure 8) showing morning and evening columns display a pronounced diurnal variation. This is partly due to photolysis of N_2O_5 in the stratosphere and the diurnal variation of NO_2 in the troposphere. The overall variation of the NO_2 values is small during the whole measurement period. As can be seen the SCIAMACHY results are in the same order of magnitude. Apart from the time period from December 2002 to January 2003 where the cooling of the SCIAMACHY detector had been switched of for decontamination the variation with time match quite well the afternoon values of the ground based measurements.

Selected References

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