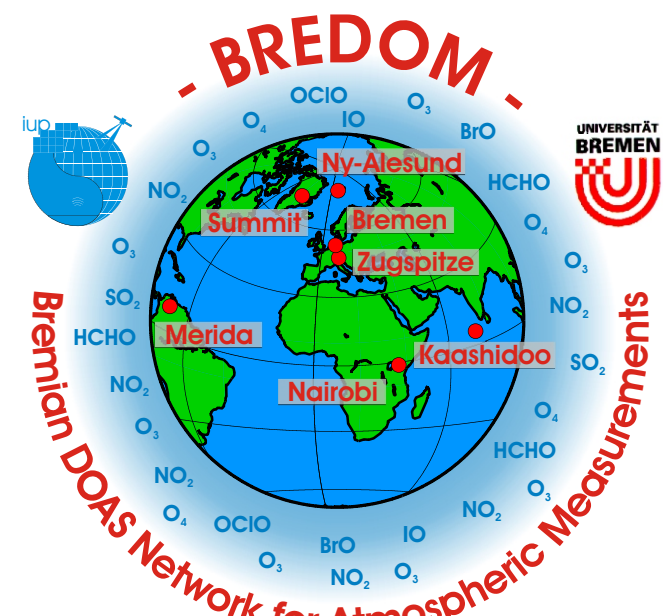


Observations of Atmospheric Trace Gases from 1994 to 2003



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Introduction

This study presents ground-based measurements of atmospheric trace gases (ozone, NO₂ and BrO) by means of UV/ visible spectroscopy from 1994 to 2003. The measurement sites range from northern high latitudes (Ny-Ålesund, 79° N, 12°E) over mid-latitudes (Bremen, 53°N, 9°E) to equatorial regions (Nairobi, 1°S, 36° E). They are part of the Bremian DOAS network for atmospheric measurements (BREDOM). In 2002 all instruments have been substantially enhanced to use different line of sights 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 enables us to further investigate the consistency of trace column amounts derived from different platforms and/ or from model calculations.

Experimental Setup

- Czerny-Turner Spectrograph(s), UV (320-410 nm), visible (395-565 nm)
- CCD (2048 x 512 Pixel) and/or (1024 x 256 Pixel)
- spectral resolution: ~0.5 nm
- Targeted trace gases: O₃, NO₂, BrO, HCHO, IO, OClO, HONO
- five viewing directions (4 off-axis between 0 and 30° above horizon, 1 zenith) with new telescope unit (see Figure 1)
- temporal resolution: 5 min for all directions
- daily calibration measurements

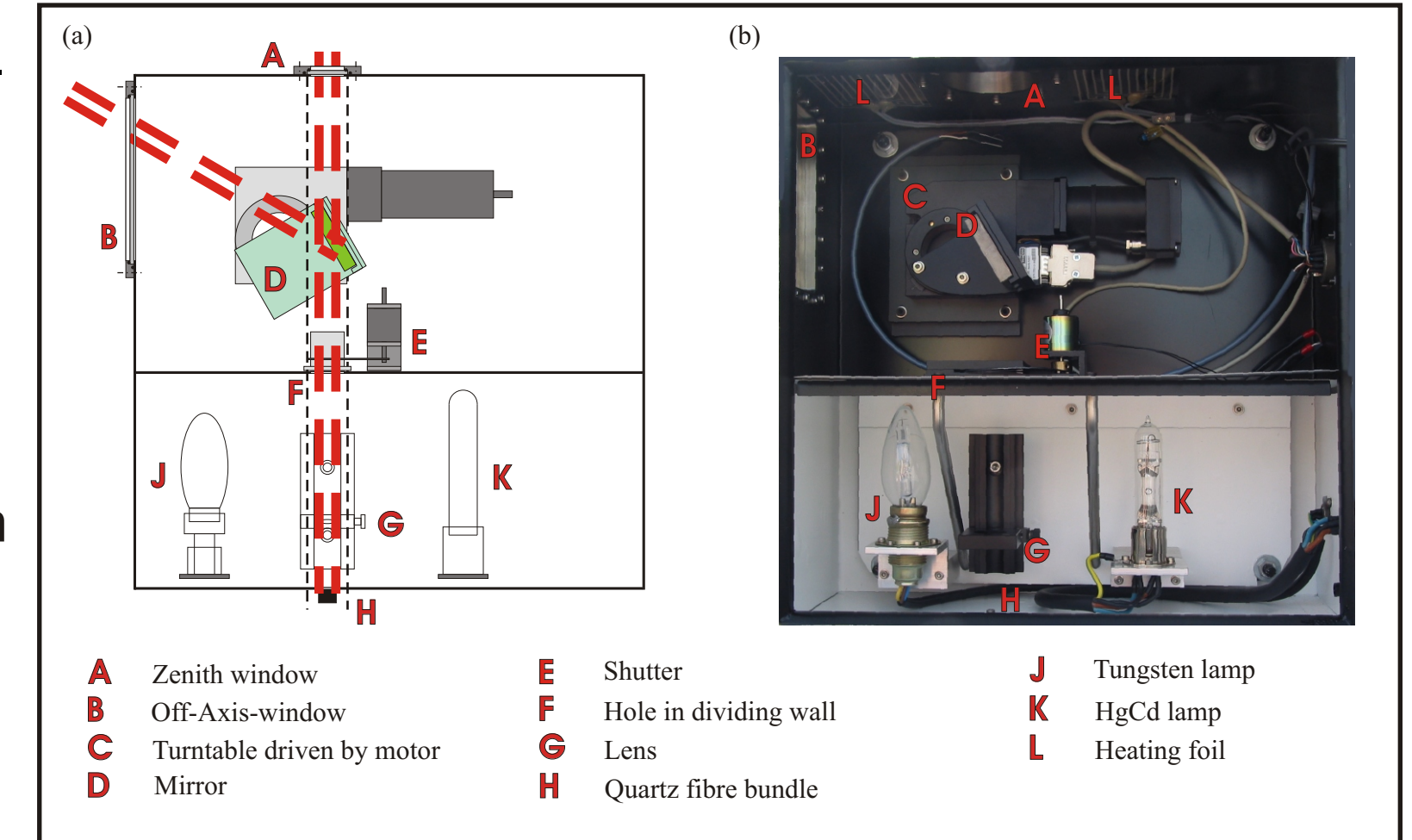


Figure 1: Scheme of the new MAX-DOAS telescope.

Time Series and Off-Axis Applications

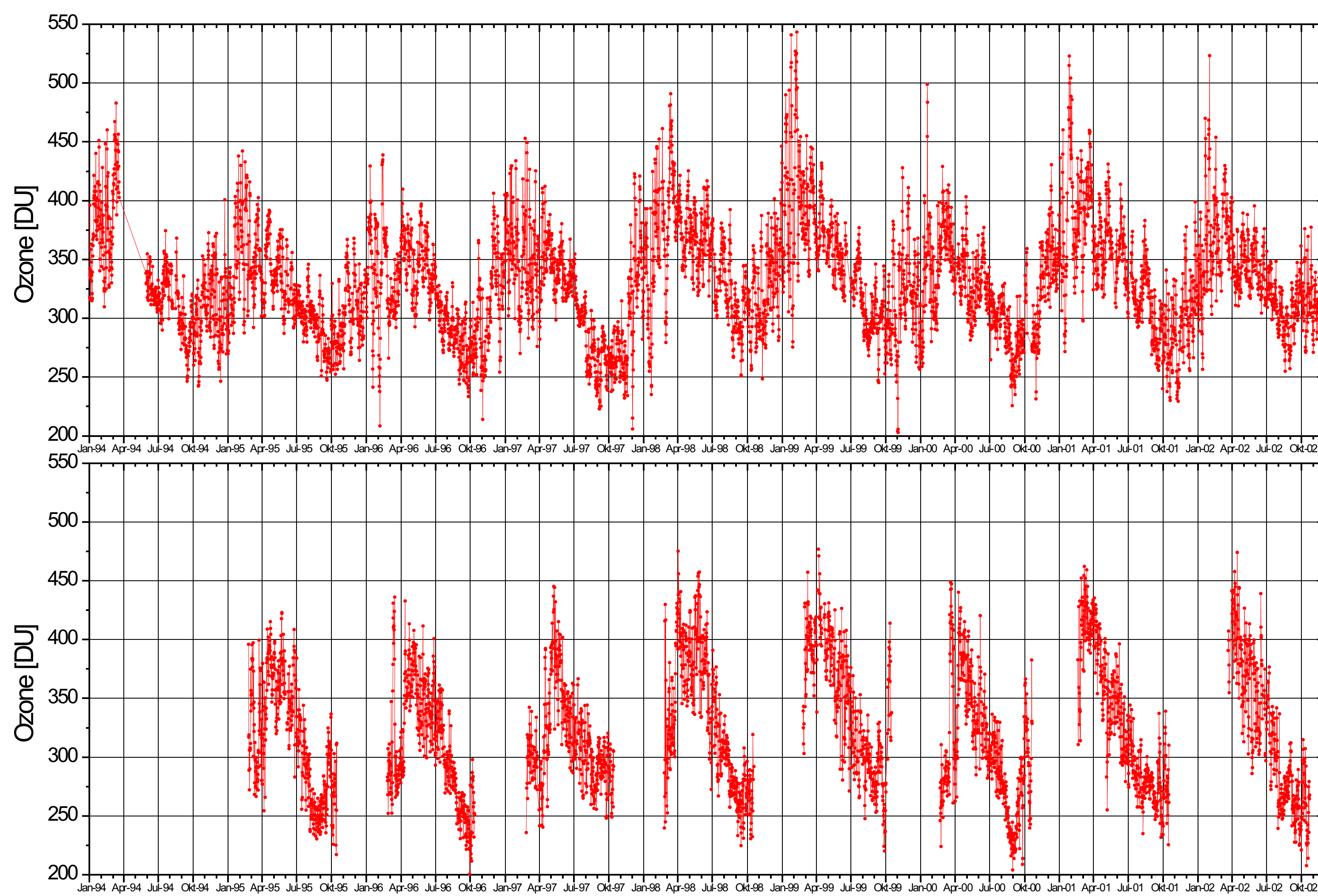


Figure 2: Ozone time series for Bremen (top) and Ny-Ålesund (bottom).

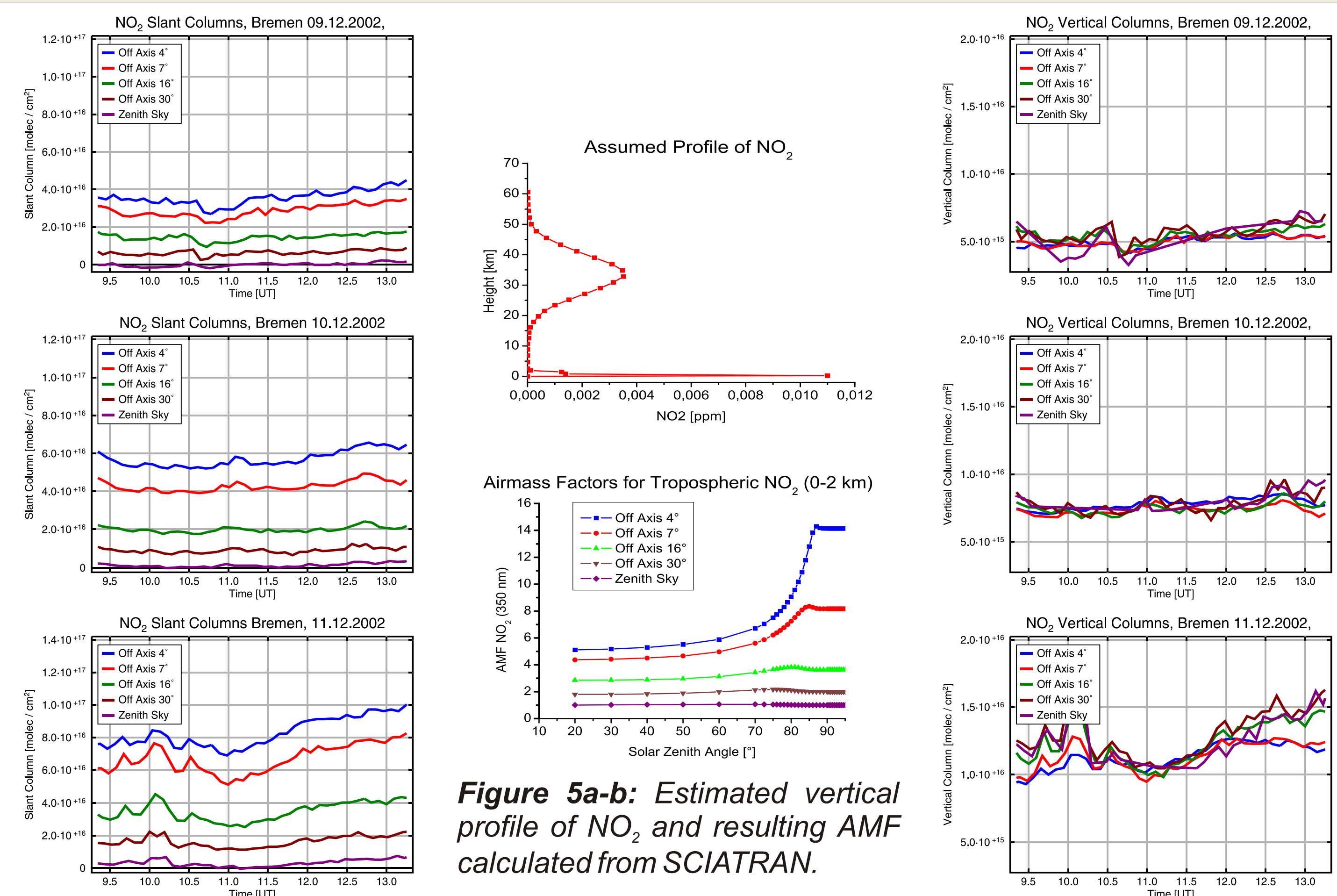


Figure 4a-c: Slant Columns of NO₂ for different viewing directions on Dec. 09-11, 2002 in Bremen.

Figure 6a-c: Vertical Columns of NO₂ for different viewing directions on Dec. 09-11, 2002 in Bremen.

Retrieval

- iup Bremen DOAS algorithm to derive slant columns of trace gases
- Radiative transport model SCIATRAN to combine results from different viewing directions - calculation of air mass factors (AMF) to convert slant columns (SC) to vertical columns (VC)
- CDIPI approach: combined differential-integral approach involving the Picard iterative approx.
- Full spherical, refraction included, full Multiple scattering
- interface to chemical model still under construction
- examples for Off-Axis applications are shown in Figures 4-7

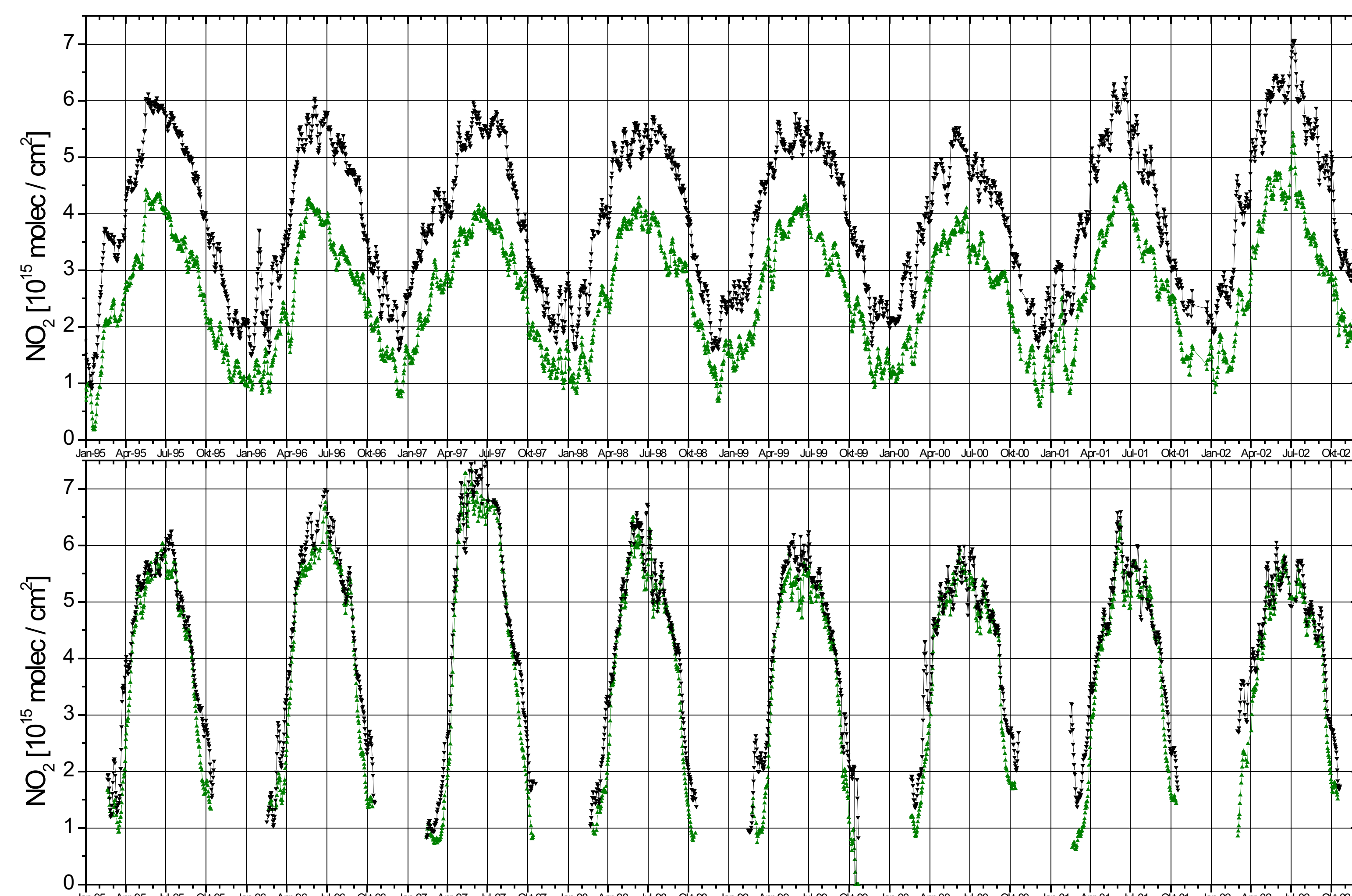


Figure 3: NO₂ time series for Bremen (top) and Ny-Ålesund (bottom), am green, pm values black.

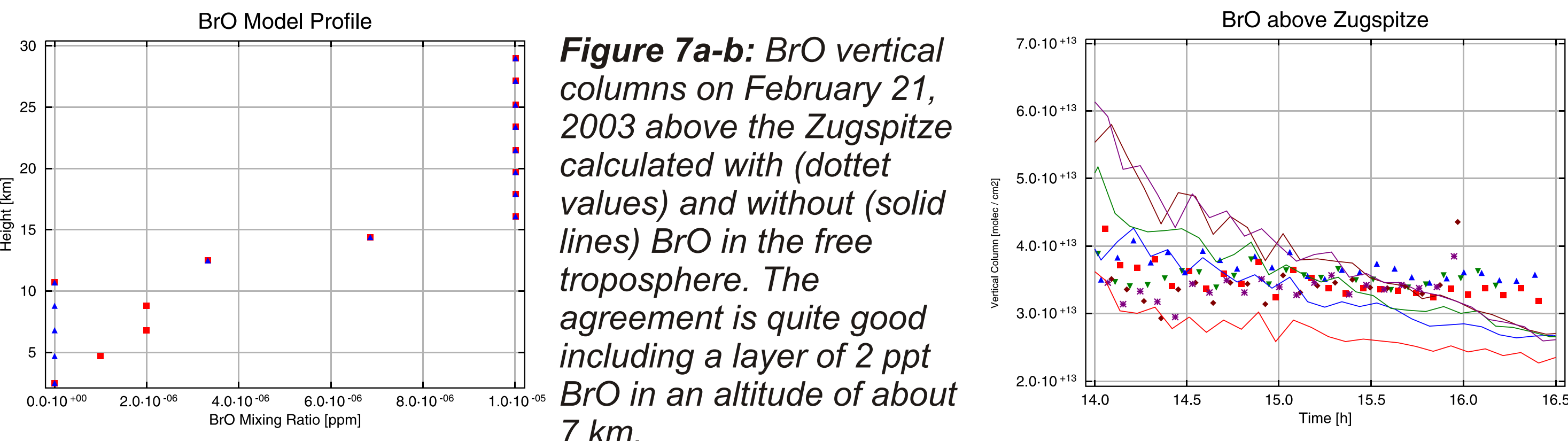


Figure 7a-b: BrO vertical columns on February 21, 2003 above the Zugspitze calculated with (dotted values) and without (solid lines) BrO in the free troposphere. The agreement is quite good including a layer of 2 ppt BrO in an altitude of about 7 km.

Figure 8: First results from the setup in Nairobi. The reason for the unexpected large discrepancies between am and pm ozone values is still under investigation.

Time series available from BREDOM

- Bremen: since summer 1993 zenith sky (ozone, NO₂, BrO), since autumn 2002 off-axis (trop. NO₂, BrO, HCHO)
- Ny-Ålesund: since February 1995 zenith sky (ozone, NO₂, BrO, OClO, IO), since April 2000 off-axis (trop. NO₂, BrO, HCHO, IO)
- Nairobi: since September 2002 zenith sky and off-axis (ozone, NO₂, BrO, HCHO)
- Zugspitze: since February 2003 zenith sky and off-axis (ozone, NO₂, BrO, HCHO)

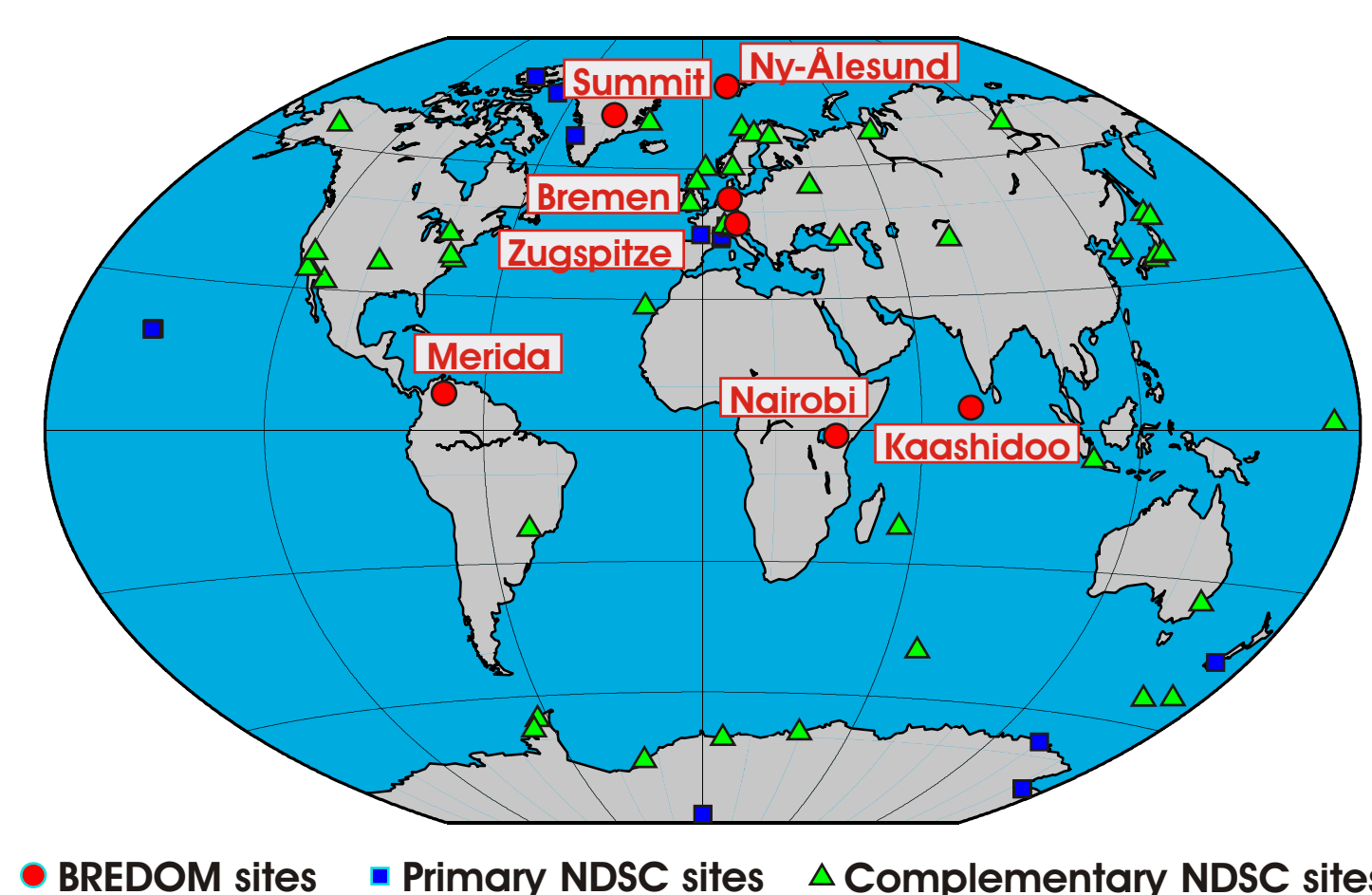
Standard data sets (total ozone and NO₂) are available on different data bases (e.g. NDSC and NILU), for additional data sets please contact Folkard Wittrock.
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Outlook

The Bremian DOAS Network for Atmospheric Measurements (BREDOM) consists of seven ground based stations at different latitudes:

- Ny-Ålesund (79°N, 12°E), Bremen (53°N, 9°E), Zugspitze (47°N, 10°E) and Nairobi (1°S, 37°E) in operation
- Setup of new sites: Summit (72°N, 38°W) June 2003, Merida (8°N, 71°W) fall 2003, Maldives not before fall 2003.

All 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 absorbers up to a determination of slightly resolved profiles.



• BREDOM sites • Primary NDSC sites • Complementary NDSC sites

References

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