Institute of Environmental Physics

Department 01
Physics and Electrical Engineering

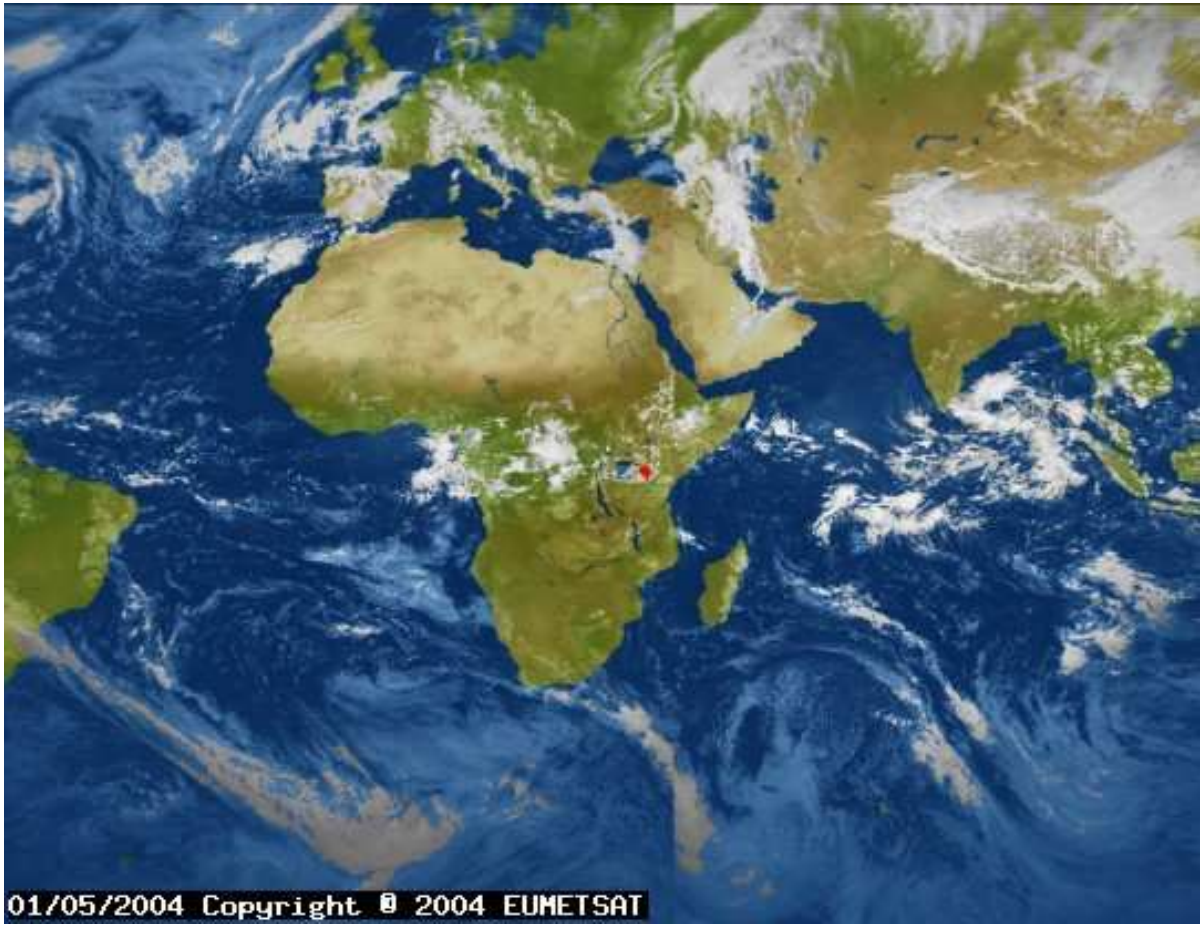
Measurements of atmospheric trace gases with a ground based DOAS instrument in Nairobi (1°S, 37°E)

S. Fietkau, D. Adukpo, T. Medeke, H. Oetjen, A. Richter,
F. Wittrock., and J.P. Burrows

Overview

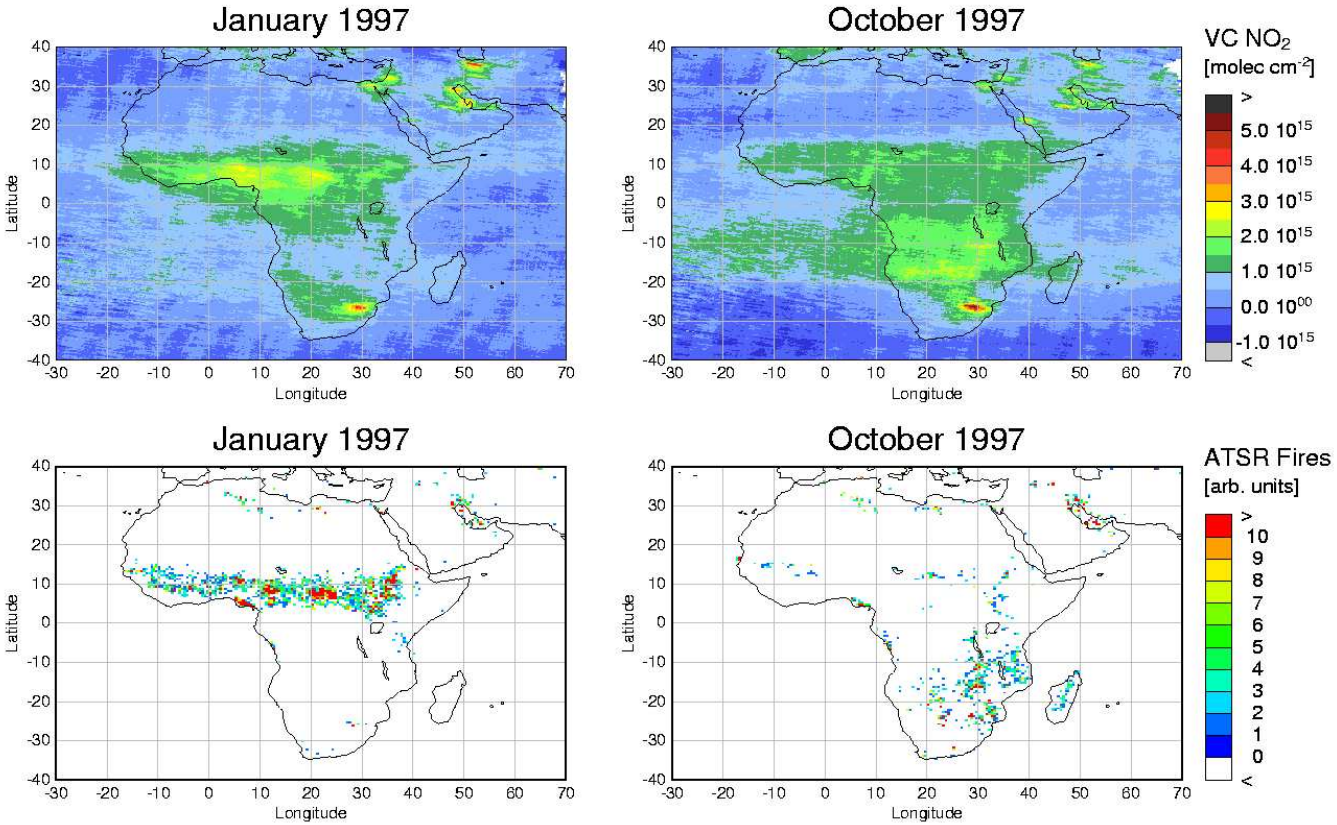
- Measurement Site
- MAX-DOAS instrument
- Data Analysis
- Results
- Summary and Outlook

Measurement Site (I)



Measurement Site (II)

GOME NO_2 and ATSR/ESA fires in Africa 1997



Measurement Site (III)

- Nairobi (1.2°S, 36.8°E)
- 1624 m above sea level
- installed in the headquarter of the United Nations Environmental Programme (UNEP), 15 km away from downtown Nairobi
- viewing direction: South to Downtown

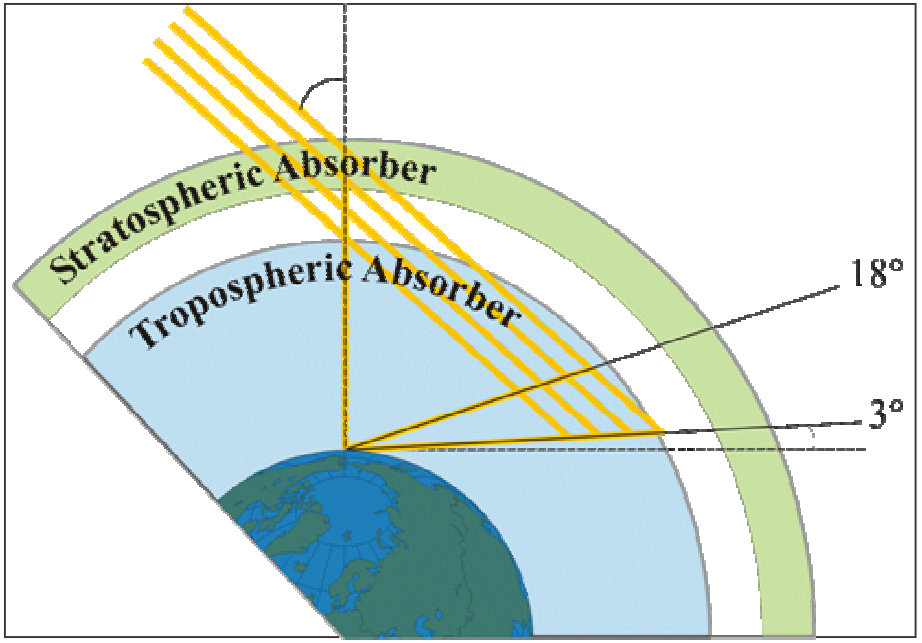
Instrument (I)

- Czerny-Turner Spectrograph L.O.T. MS257 (focal length 257 mm, 1200 l/mm grating) and CCD Andor DV440-BU (2048 x 512 pixels) for the UV spectral range
- L.O.T. MS260i (focal length 260 mm, 600 l/mm grating) and CCD Andor DV420-BU (1024 x 256 pixels) for the visible range
- UV/vis wavelength regions: 320 – 410 nm, 395 - 565 nm
- spectral resolution: ~0.5 nm
- targeted trace gases: O_3, NO_2, BrO, HCHO, IO, OClO

Instrument (II)

- atmospheric viewing directions:
  - Zenith
  - 4 lines of sight to horizon (4°, 7°, 16°, 30°)
- daily calibration measurements

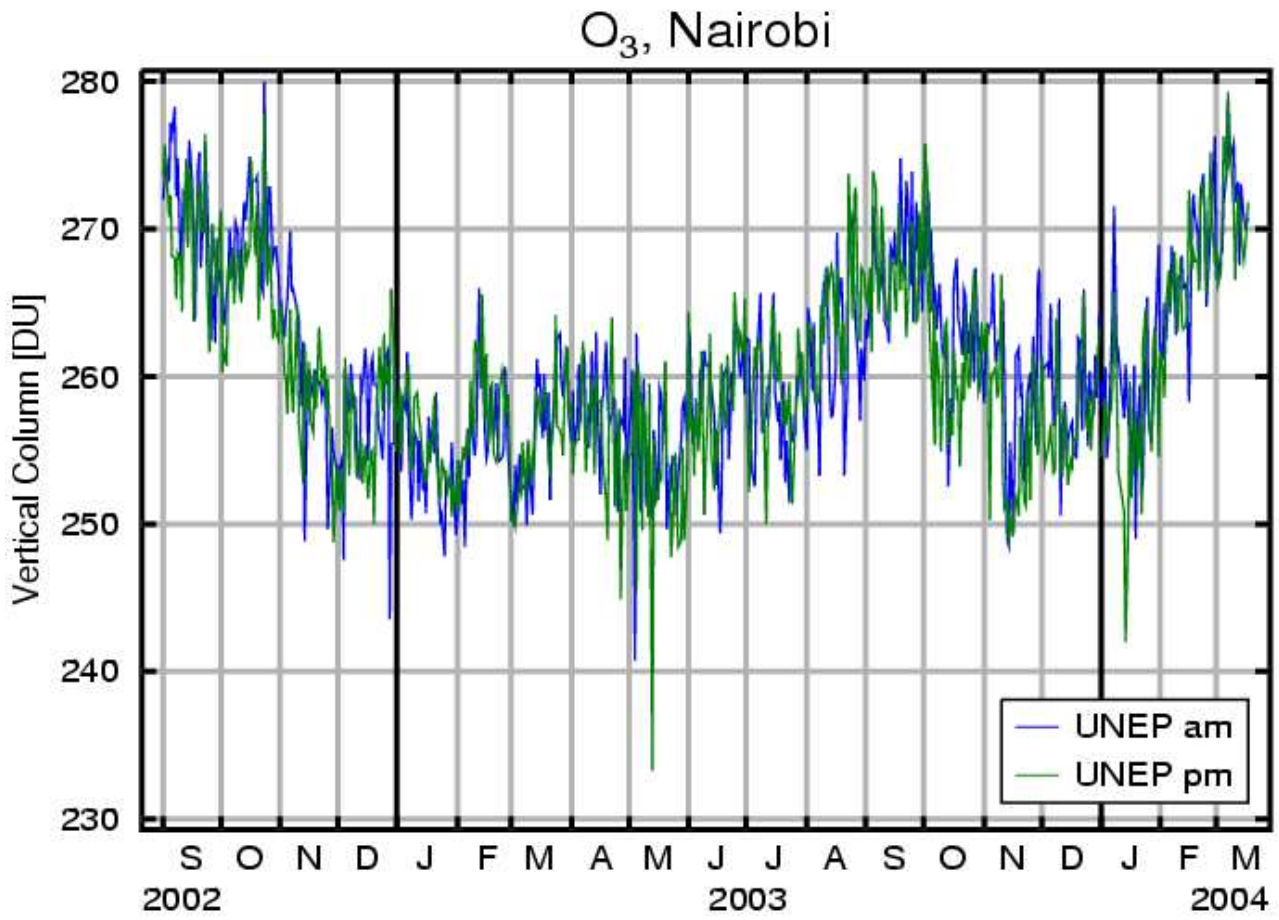
Data Analysis



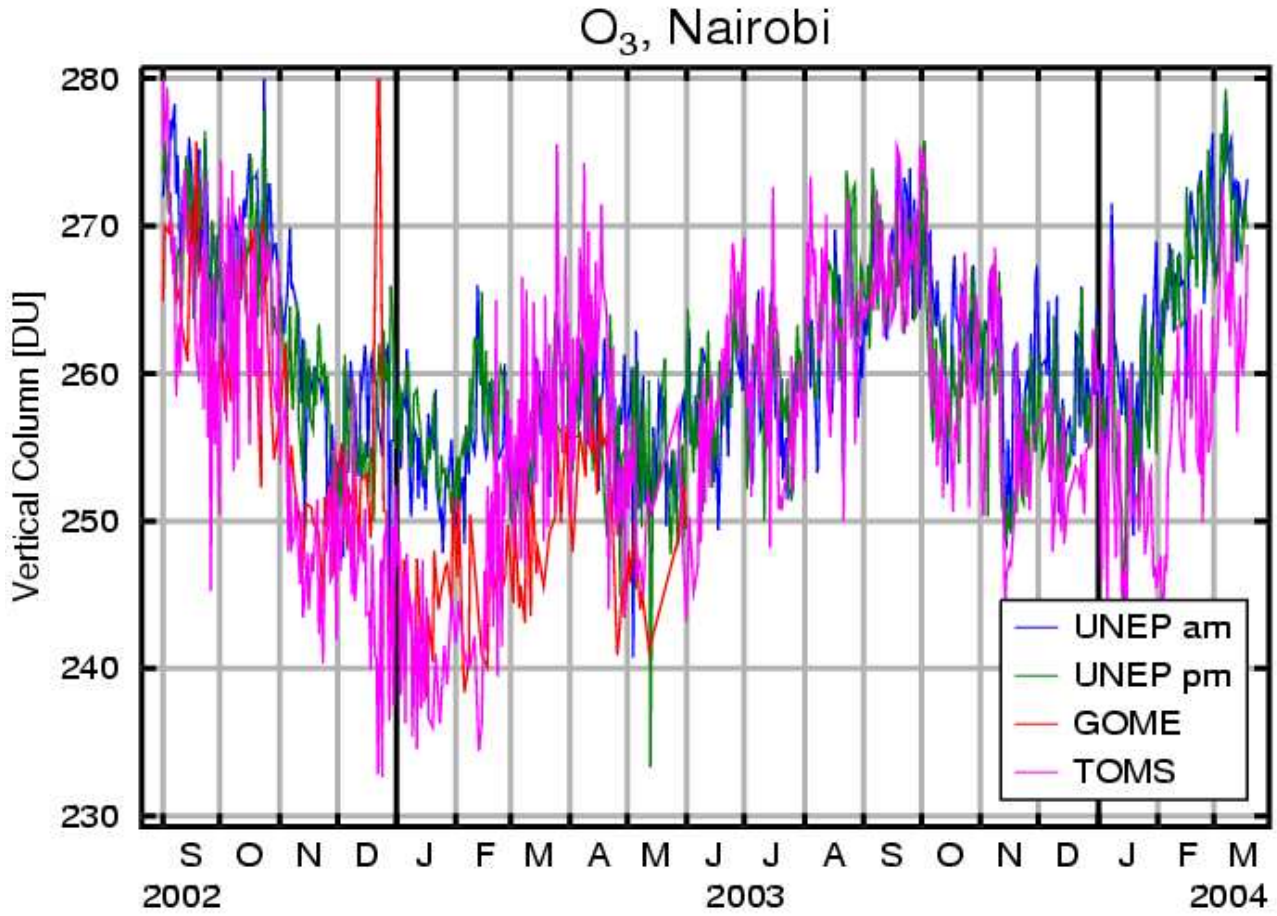
- to derive slant columns of trace gases the DOAS method is used
- to convert slant columns (SC) to vertical columns (VC) radiative transfer model SCIATRAN for calculation of air mass factors (AMF):

$$AMF(SZA) = SC / VC$$

- full spherical, refraction and full multiple scattering included

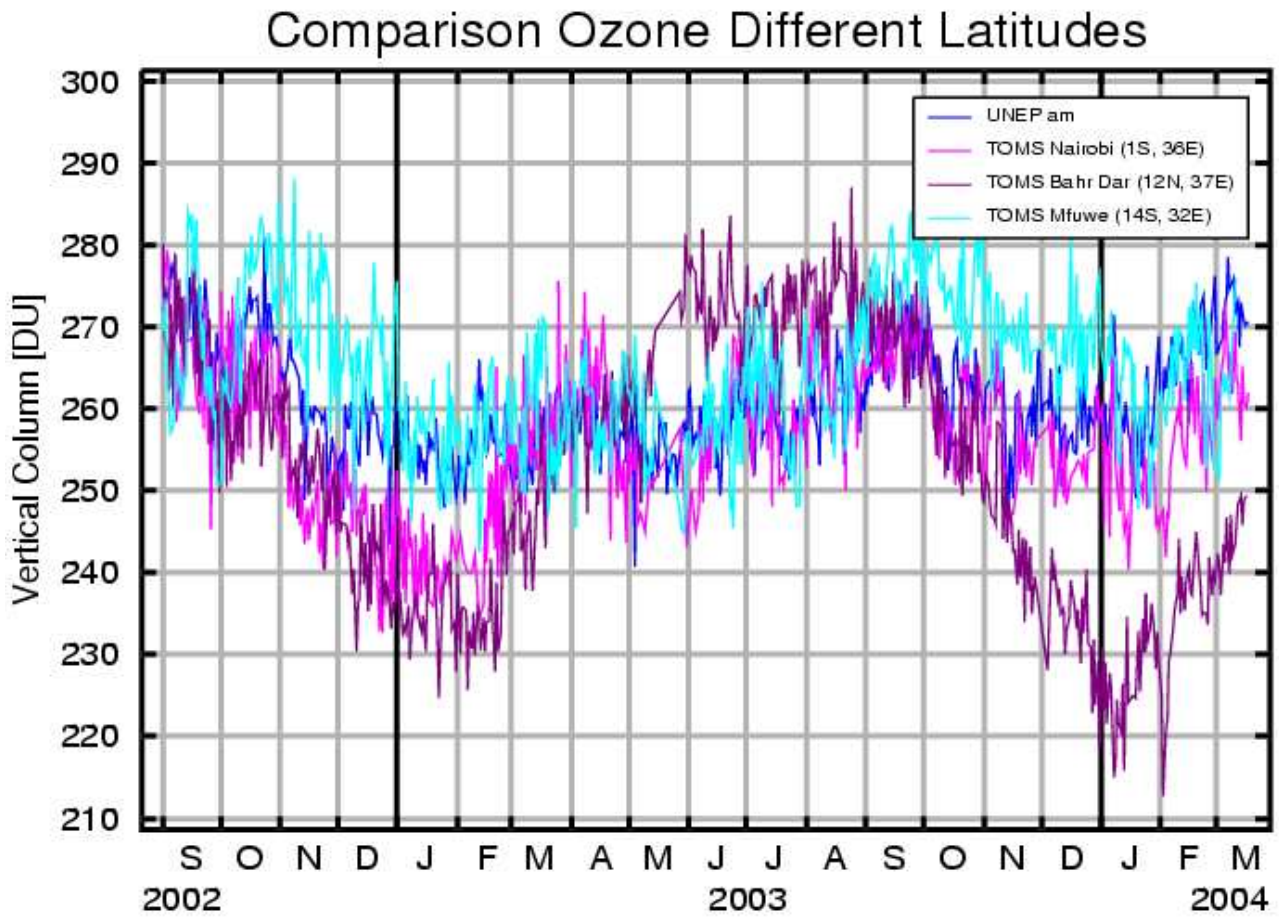


GOME, Andreas Richter IUP Bremen



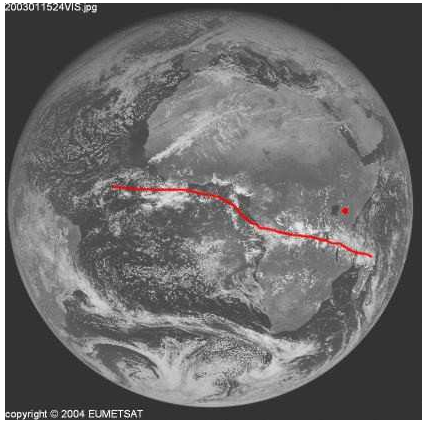
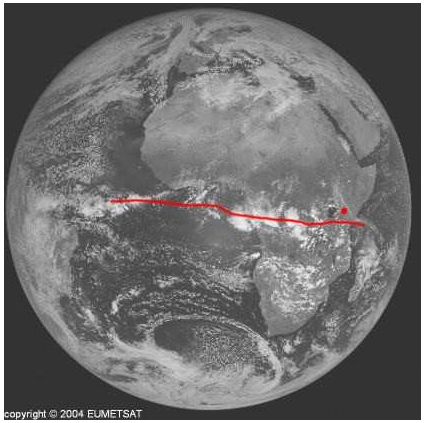
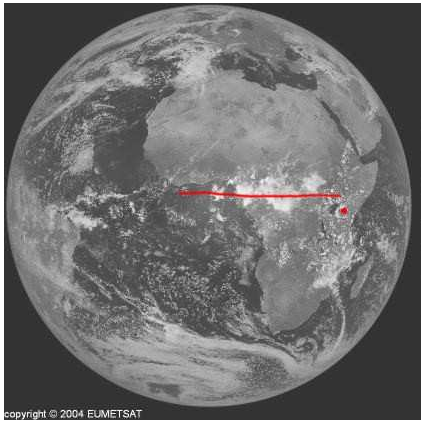
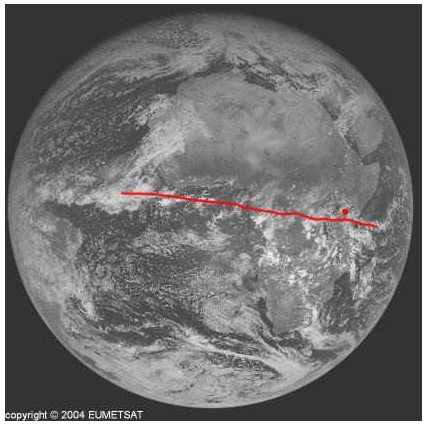
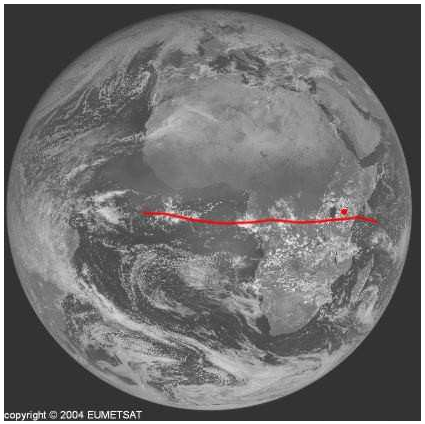
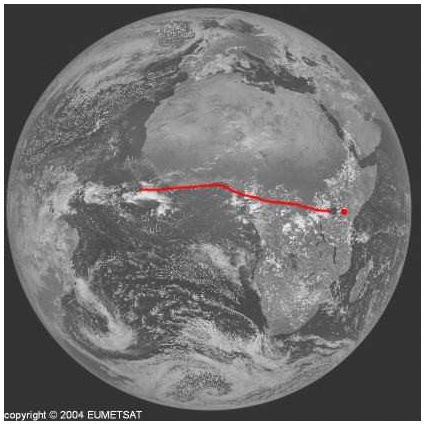
GOME, Andreas Richter IUP Bremen

TOMS, NASA


Comparison Ozone Different Latitudes
Vertical Column [DU]
300
290
280
270
260
250
240
230
220
210
S O N D J F M A M J J A S O N D J F M
2002
2003
2004
UNEP am
TOMS Nairobi (1S, 36E)
TOMS Bahr Dar (12N, 37E)
TOMS Mfuwe (14S, 32E)

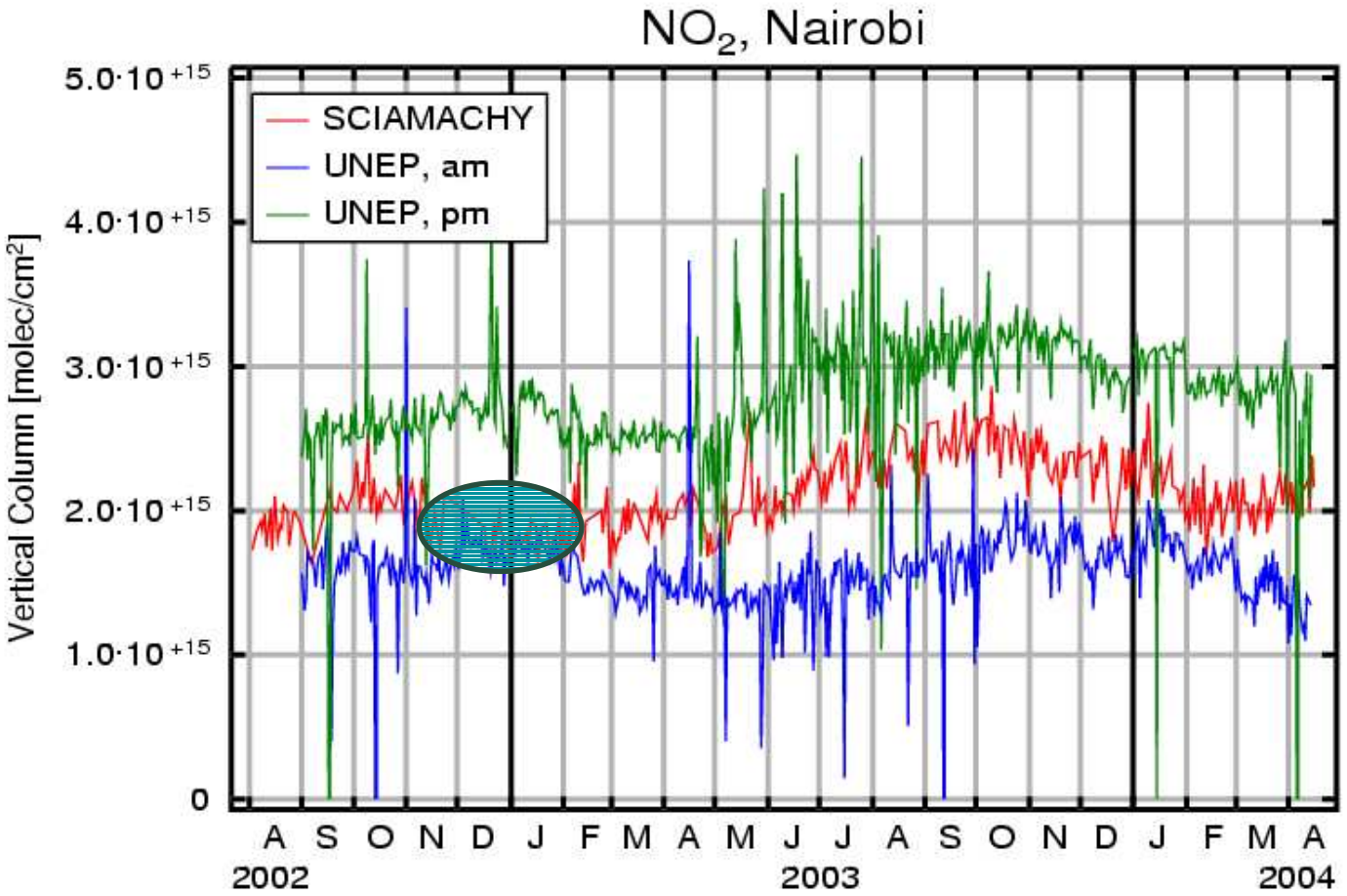
TOMS, NASA

ITCZ

	January	February	March
2003			
2004			

O_3 Summary

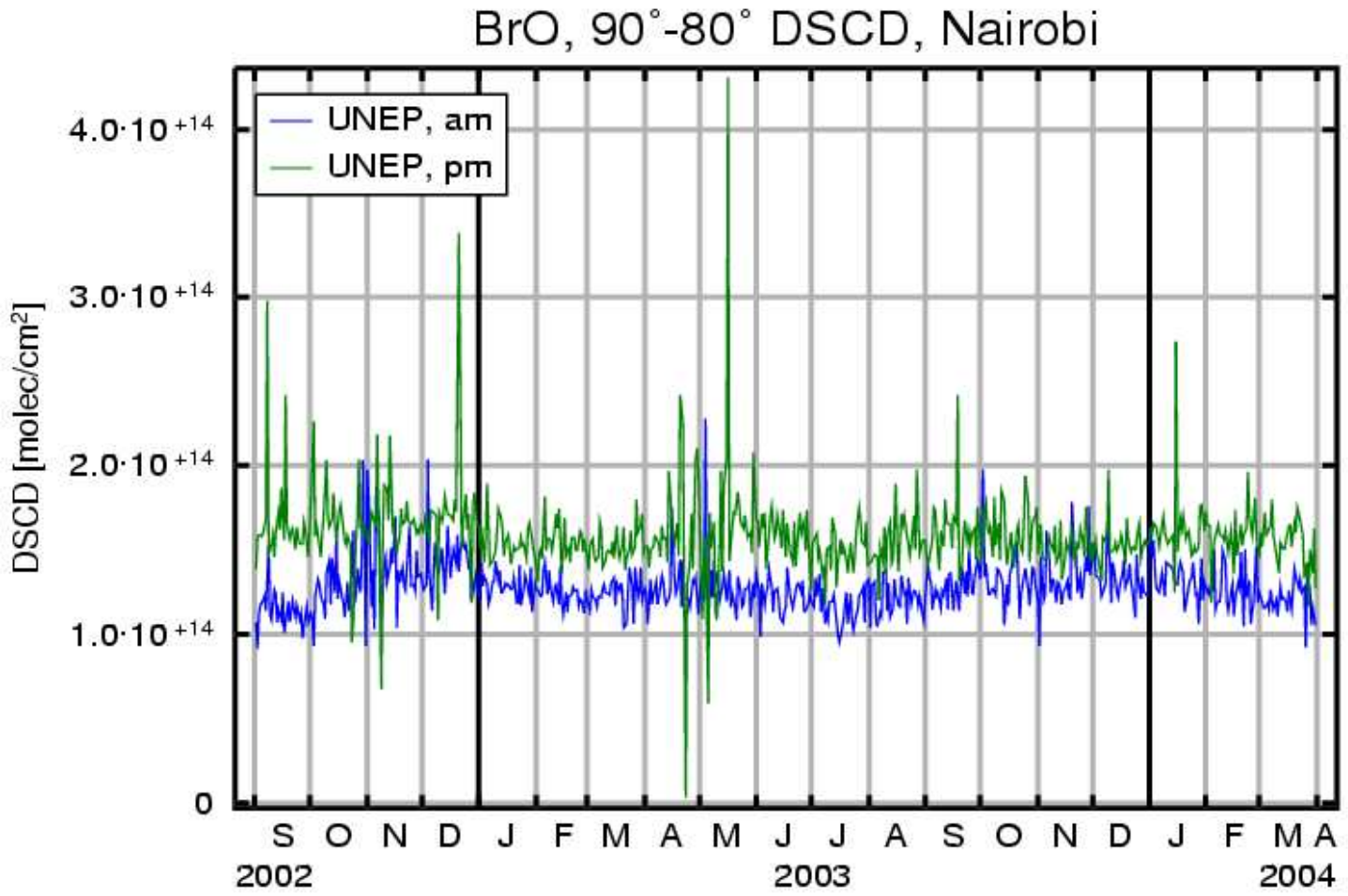
- variation of the vertical column: 255-275 DU
- in principle good agreement with TOMS and GOME measurements, except a period end 2002/ beginning 2003
- possible explanation: ITCZ position



SCIAMACHY: Andreas Richter, IUP Bremen

NO_2 Summary

- pronounced diurnal variation (photolysis of N_2O_5 in stratosphere, diurnal variation of NO_2 in troposphere)
- small variation of the NO_2 values during the whole measurement period
- SCIAMACHY results are in the same order of magnitude (an offset of 1E15 molec/cm^2 is added)
- SCIAMACHY variation with time match very well with the afternoon values of the ground based measurements


BrO, 90°-80° DSCD, Nairobi
UNEP, am
UNEP, pm
DSCD [molec/cm²]
4.0·10 +14
3.0·10 +14
2.0·10 +14
1.0·10 +14
0
S O N D J F M A M J J A S O N D J F M A
2002
2003
2004

BrO Summary

- total amount of the slant columns is around 1,5*10^{14} molec/cm^2
- compared to measurements at other latitudes e.g. *Fish* at Aberdeen, *Arpag* at Colorado ,*Kreher* at Arrival Heights and *Wittrock* at Ny Ålesund (1-3*10^{14} molec/cm^2) the values are in the same order of magnitude
- principle agreement with model results from other latitudes
- afternoon values are slightly higher than the morning values

Summary

- instrument installed in August 2002, second part in January 2004
- detection of O_3, NO_2, BrO, HCHO, O_4
- variation of ozone between 255 and 275 DU, but no strong seasonality
- no seasonal variation of NO_2, but increasing values in 2003, strong diurnal variation
- no significant seasonal variation of the BrO DSCD's
- long-term validation of SCIAMACHY products is possible

Outlook

- comparison of BrO with modelled data
- tropospheric columns
- validation of SCIAMACHY

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- State and University of Bremen and
- the UNEP, especially the staff from the Ozone Secretariat

The End