Atmospheric Remote Sensing with SCIAMACHY Limb Observations

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SCIAMACHY

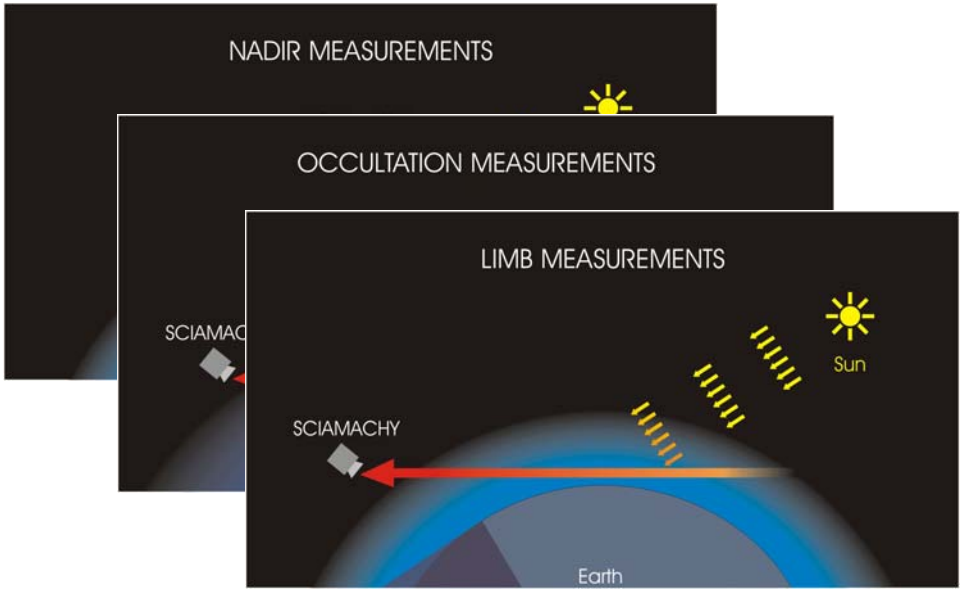
Outline

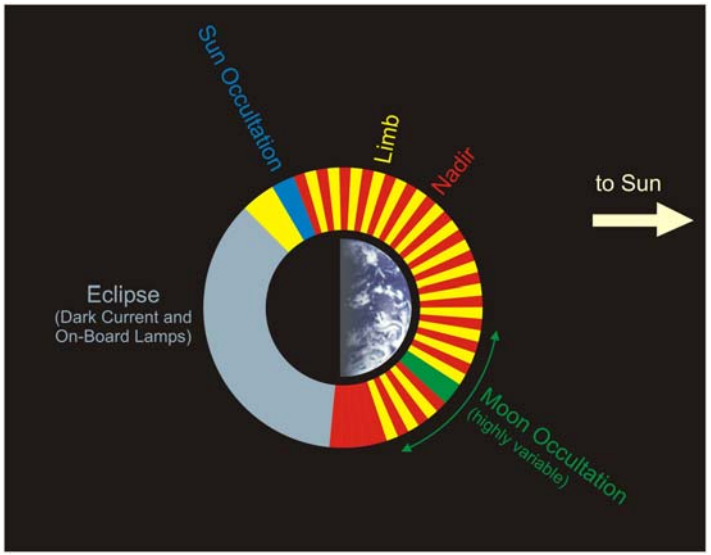
- Introduction
- Stratospheric applications (O3, OClO, BrO, NO2, PSC)
- Mesospheric applications (OH, O3, NLC)

SCIAMACHY on Envisat

SCIAMACHY = Scanning Imaging Absorption Spectrometer for Atmospheric CartograpHY

- Grating spectrometers: 220 - 2380 nm
- Spectral resolution: 0.2 – 1.5 nm
- Measurement Geometries:





- Polar, sun-synchronous orbit
- Descending node: 10:00 LST
- Global coverage within 6 days
- During eclipse calibration and limb measurements

SCIAMACHY Limb scattering / emission observations

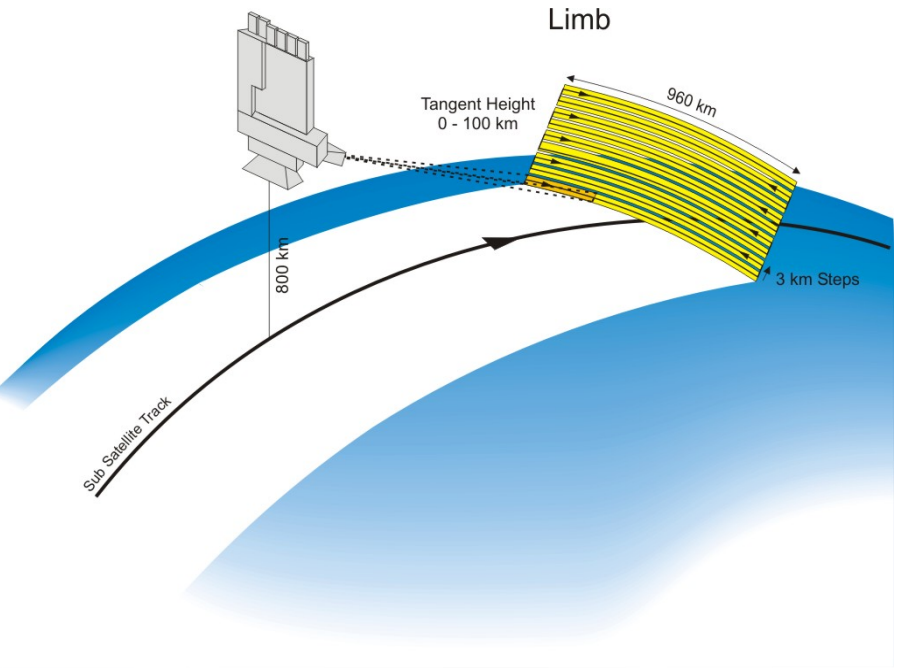
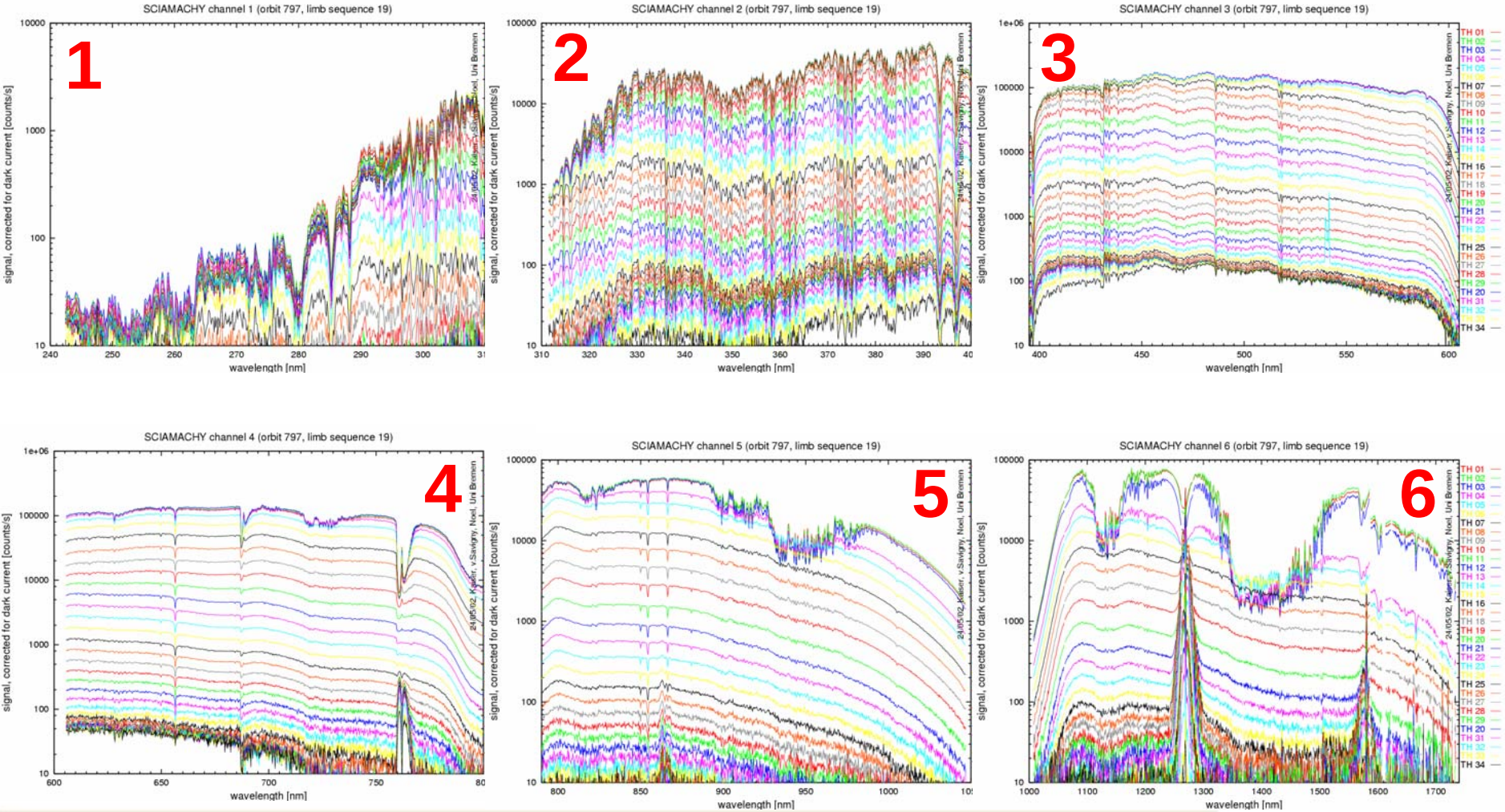


Illustration of the limb geometry

- Tangent height range: 0 to 100 km
- Tangent height step size: 3.3 km
- Vertical FOV: 2.6 km
- Duration of Limb sequence: 60 s
- Observed is the limb scattered solar radiation and the terrestrial airglow emissions
- **On the Earth's night side limb emissions are observed in a dedicated mesosphere/ thermo-sphere observation mode with tangent heights between 75 and 150 km.**

SCIAMACHY limb spectra – Channels 1 - 6

Uncalibrated Level 0 limb spectra



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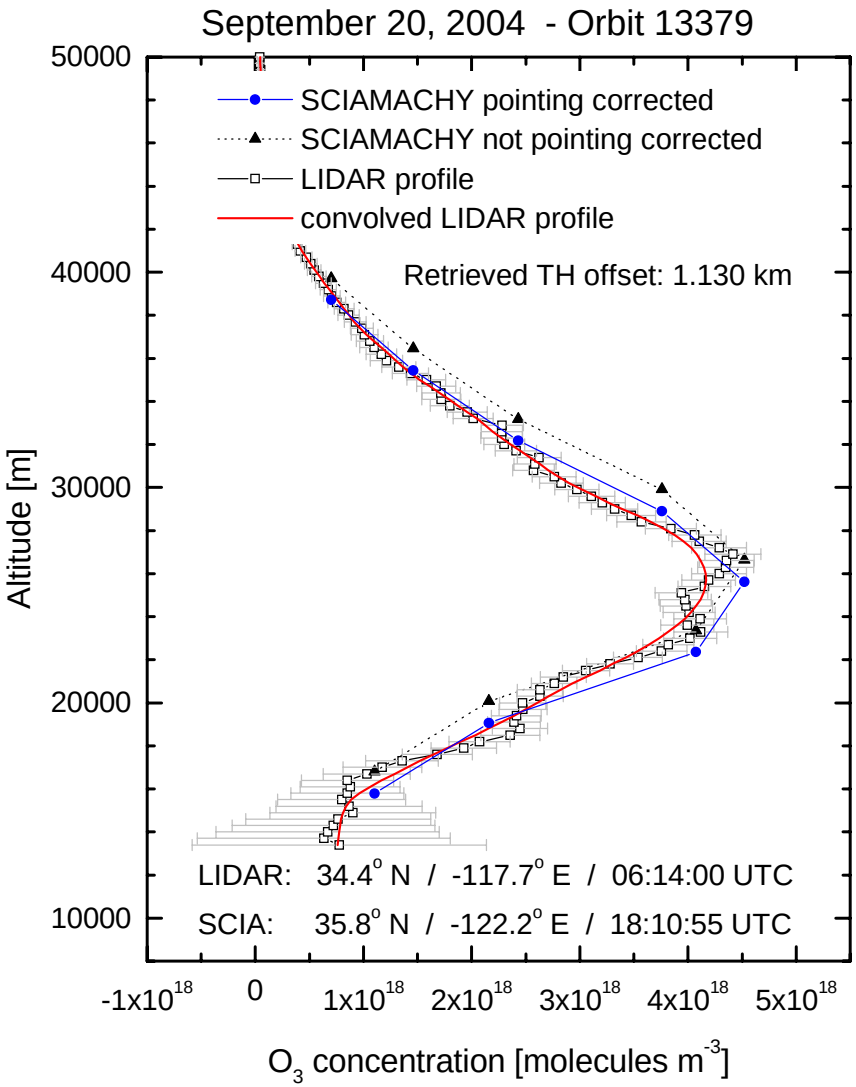
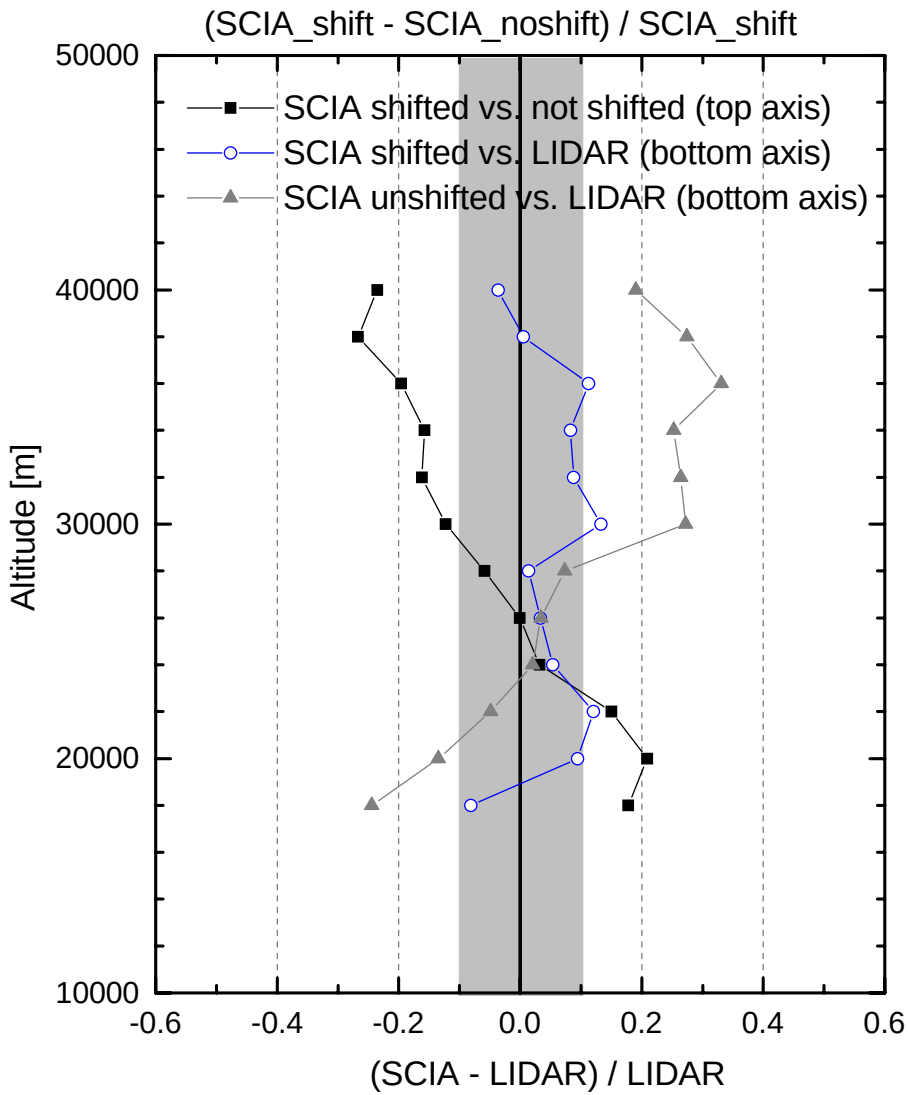
Evidence of pointing error after December 2003 from validation of minor constituent profiles





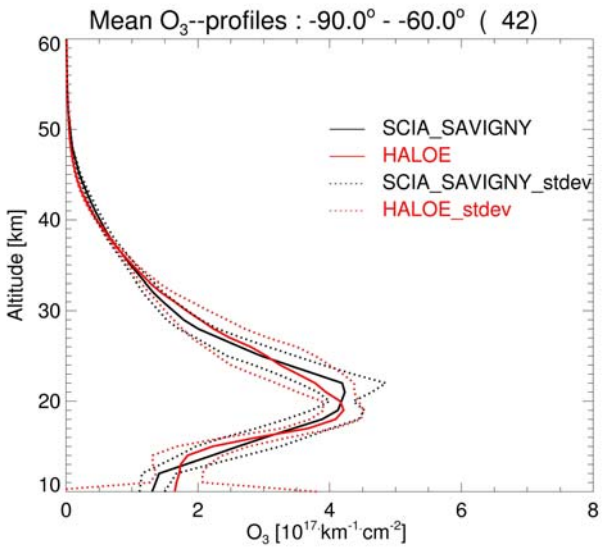
A pointing error of only 500 m leads to retrieval errors of up to 10 % for ozone in stratosphere and up to 20 % in the mesosphere !! A tangent height correction is implemented in the retrieval code (TRUE).

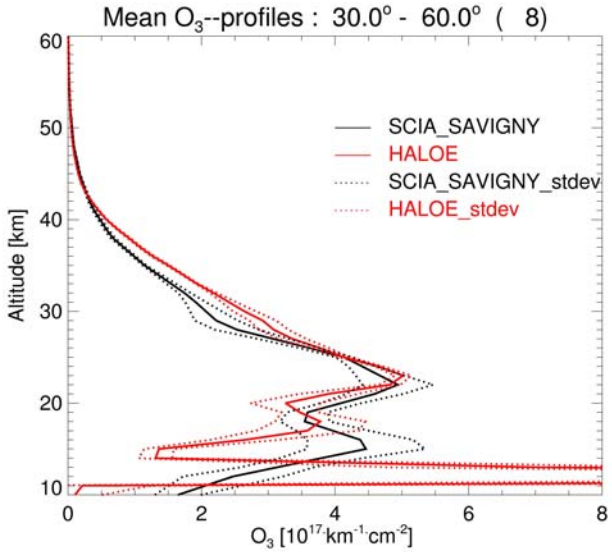
Stratospheric applications

- Retrieval of vertical profiles of O_3, OClO, BrO, NO_2
- Gridded maps of O_3 at different heights
- Detection of polar stratospheric clouds (PSCs) and descent rates

O3: Comparison with HALOE observations (March 2003)

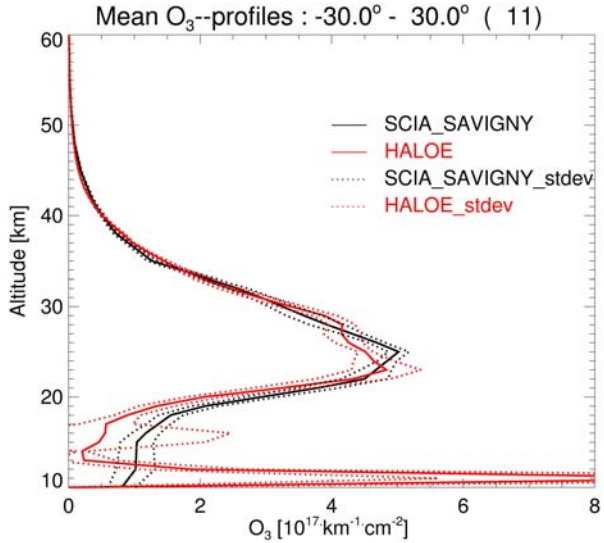
South Pole

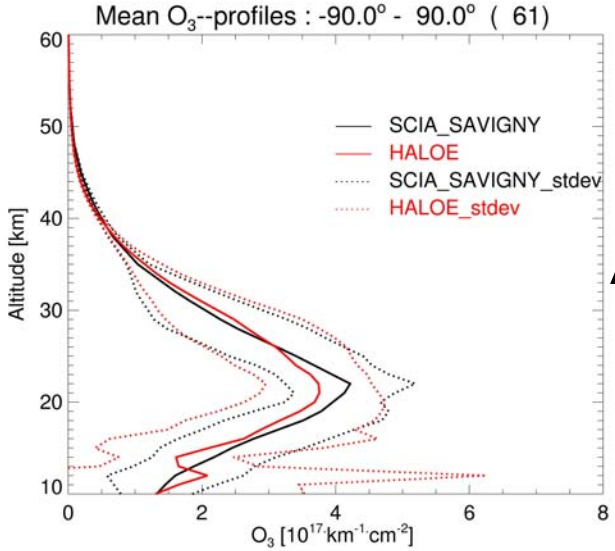




Northern hemisphere

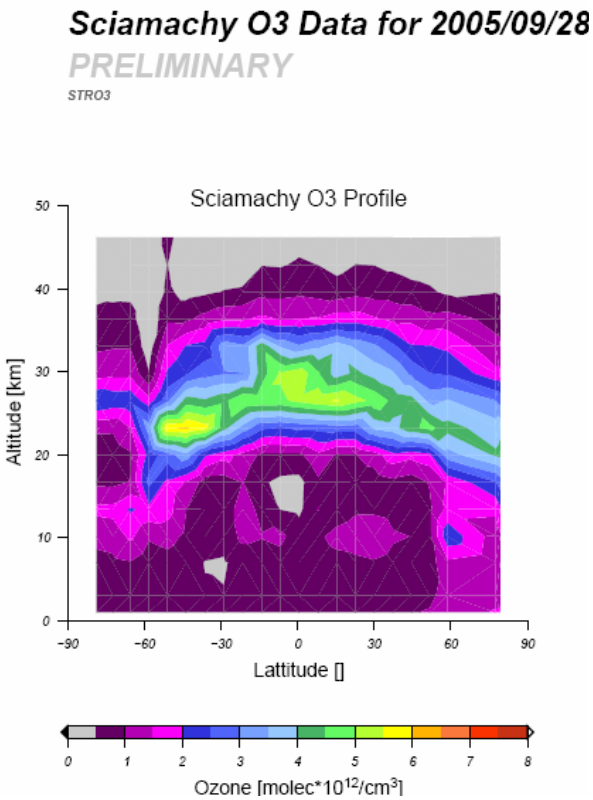
Tropics

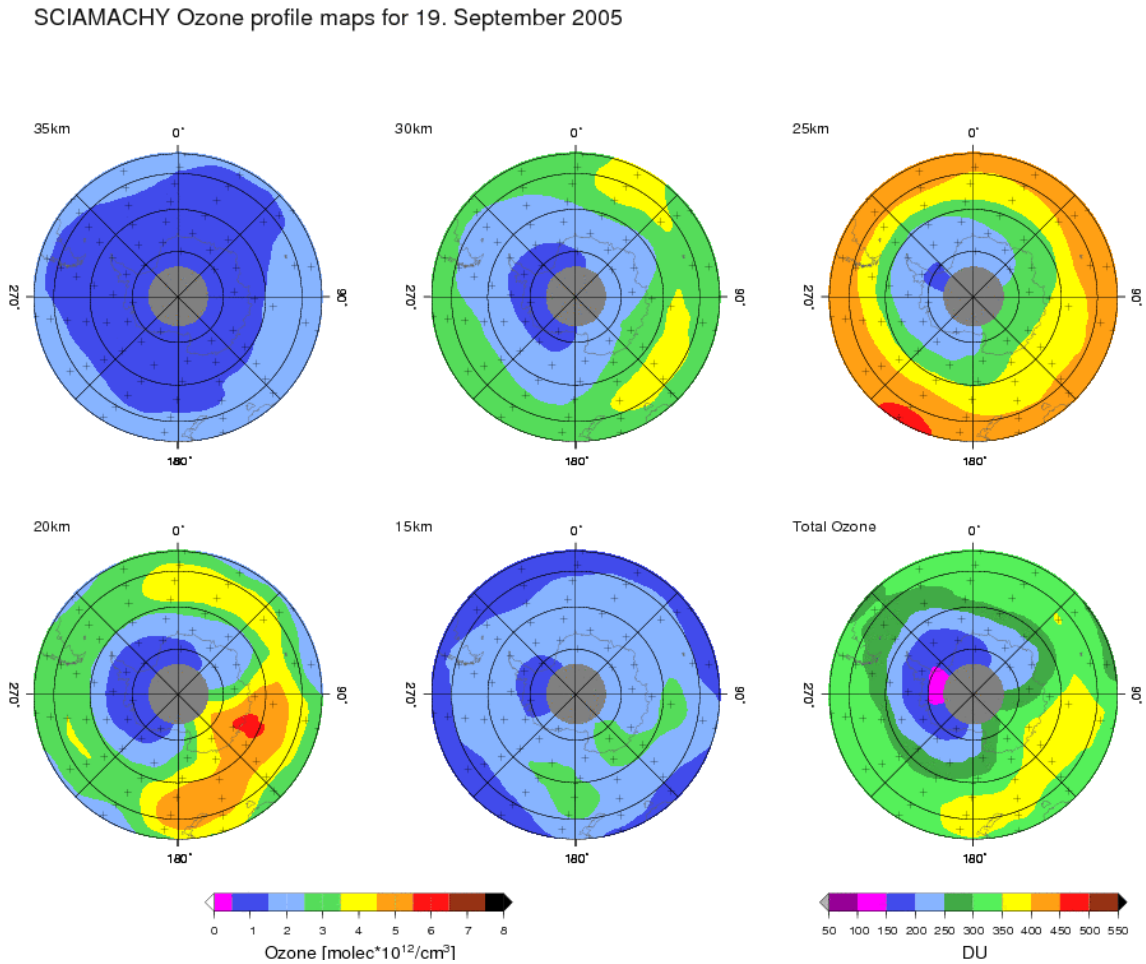




All data

Value-added operational retrievals on IUP website: O3





http://www.iup.physik.uni-bremen.de/scia-arc

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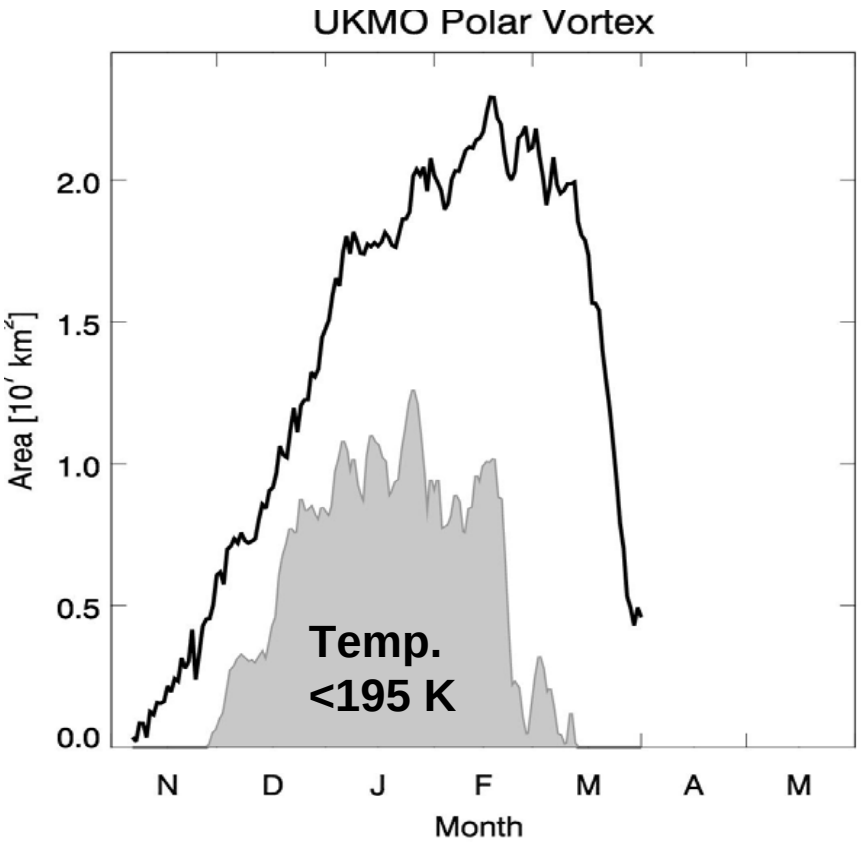
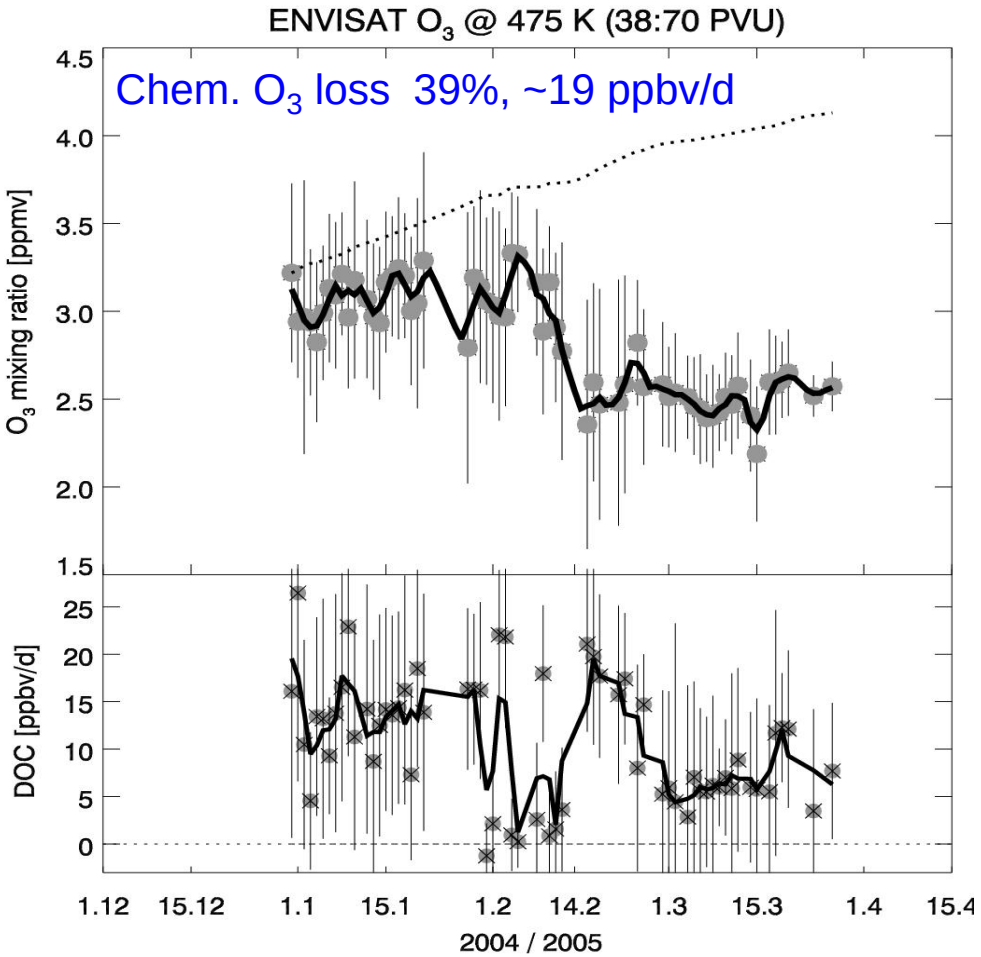
Polar ozone loss for polar vortex in winter/spring 2004/2005

Polar Vortex area @ 475 K



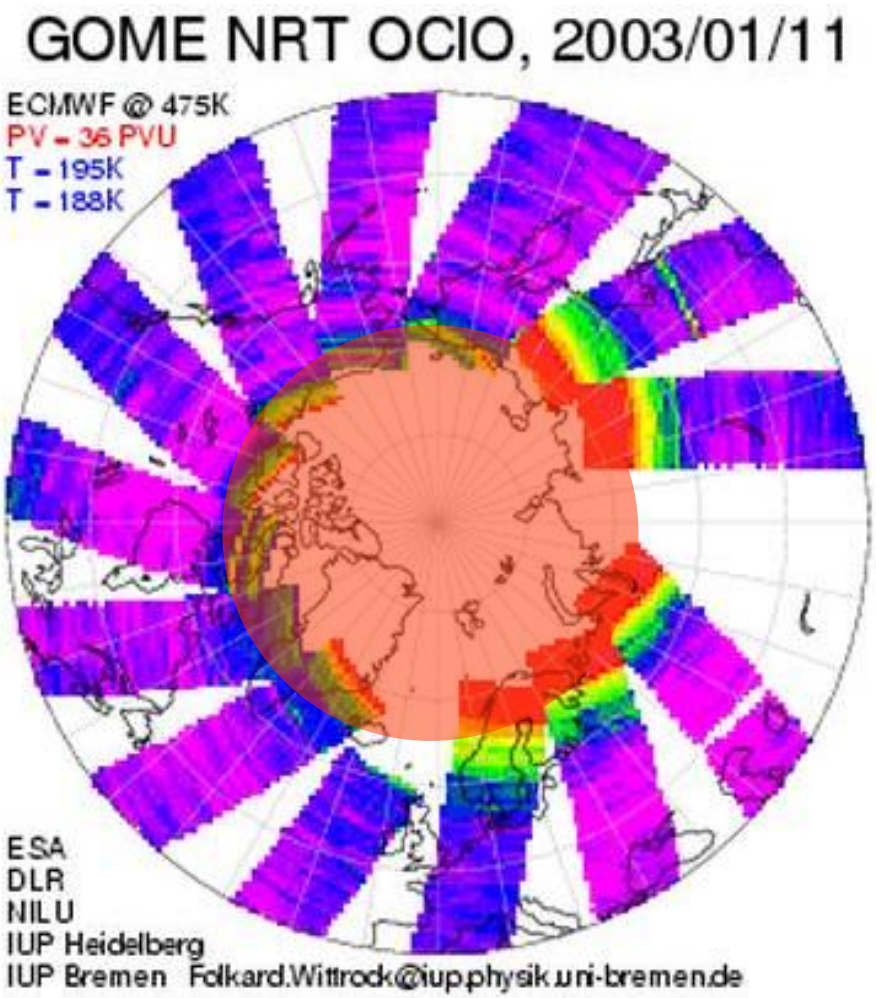
2004/05

SCIAMACHY & GOMOS ozone VMR @ 475 K



Bracher et al. [EGU, 2005]

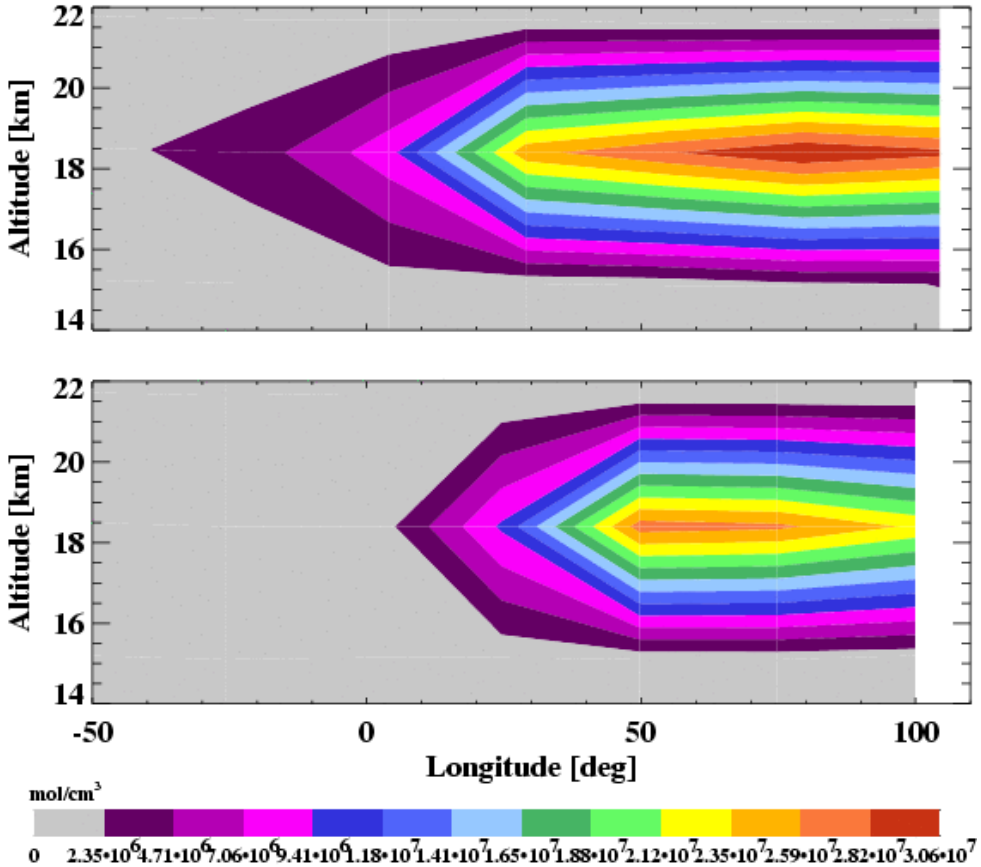
OClO: Increase in the polar vortex



Longitudinal cross section of OClO

65.5°N, SZA@TP = 89.5° (upper plot)

62.2°N, SZA@TP = 86.4° (lower plot)



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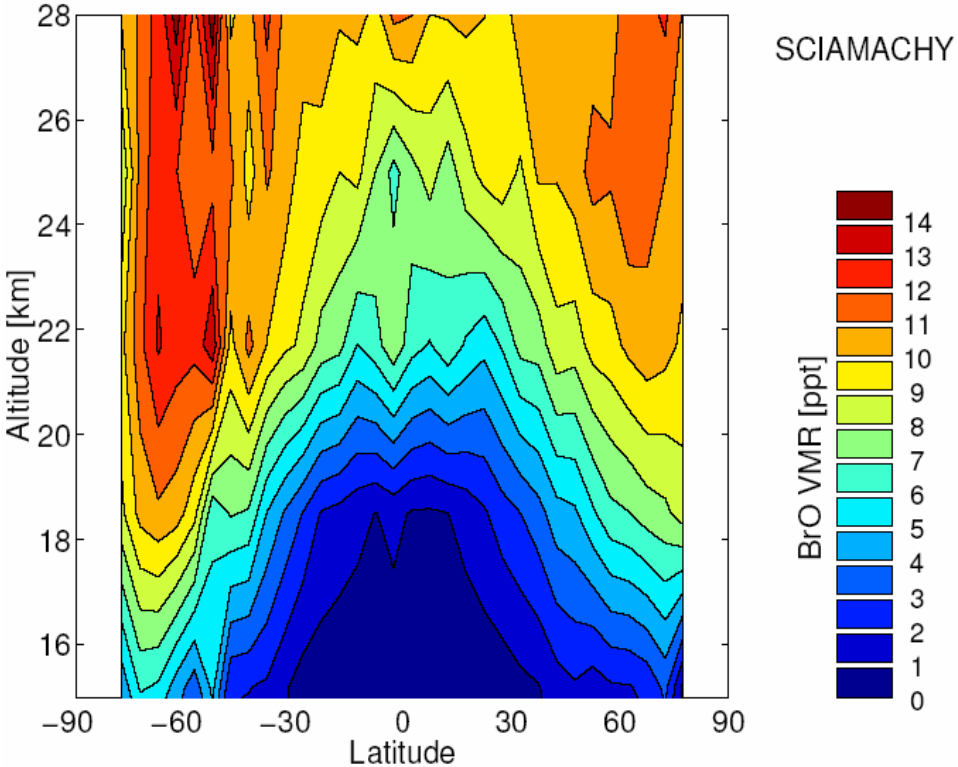
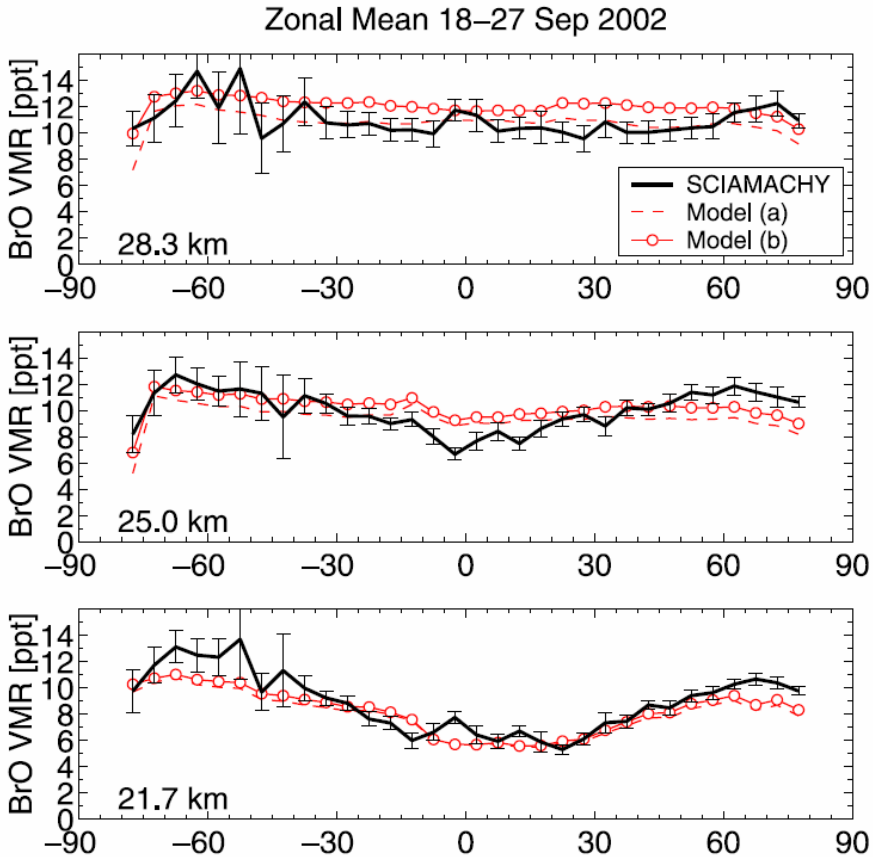
A. Rozanov

BrO: comparison with model

Zonal Average 18-27 September 2002





Talk, 16:45, N. Sheode

GEOPHYSICAL RESEARCH LETTERS, VOL. 32, L20810, doi:10.1029/2005GL023839, 2005

Global observations of stratospheric bromine monoxide from SCIAMACHY

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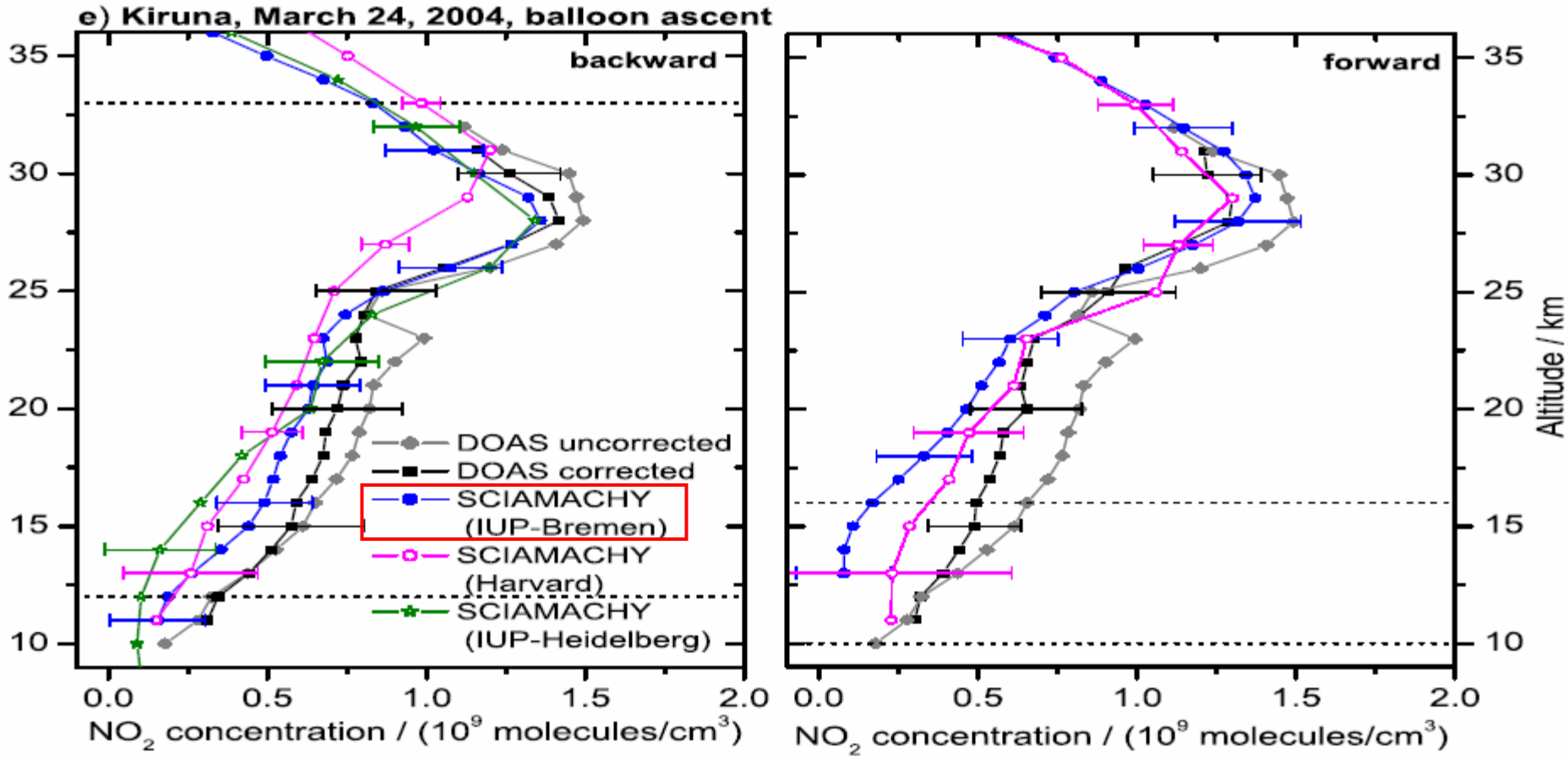
NO2: comparison with balloon



Atmos. Chem. Phys. Discuss., 5, 10747–10797, 2005
www.atmos-chem-phys.org/acpd/5/10747/
SRef-ID: 1680-7375/acpd/2005-5-10747
European Geosciences Union
Atmospheric Chemistry and Physics Discussions

Inter-comparison of stratospheric O_3 and NO_2 abundances retrieved from balloon borne direct sun observations and Envisat/SCIAMACHY limb measurements

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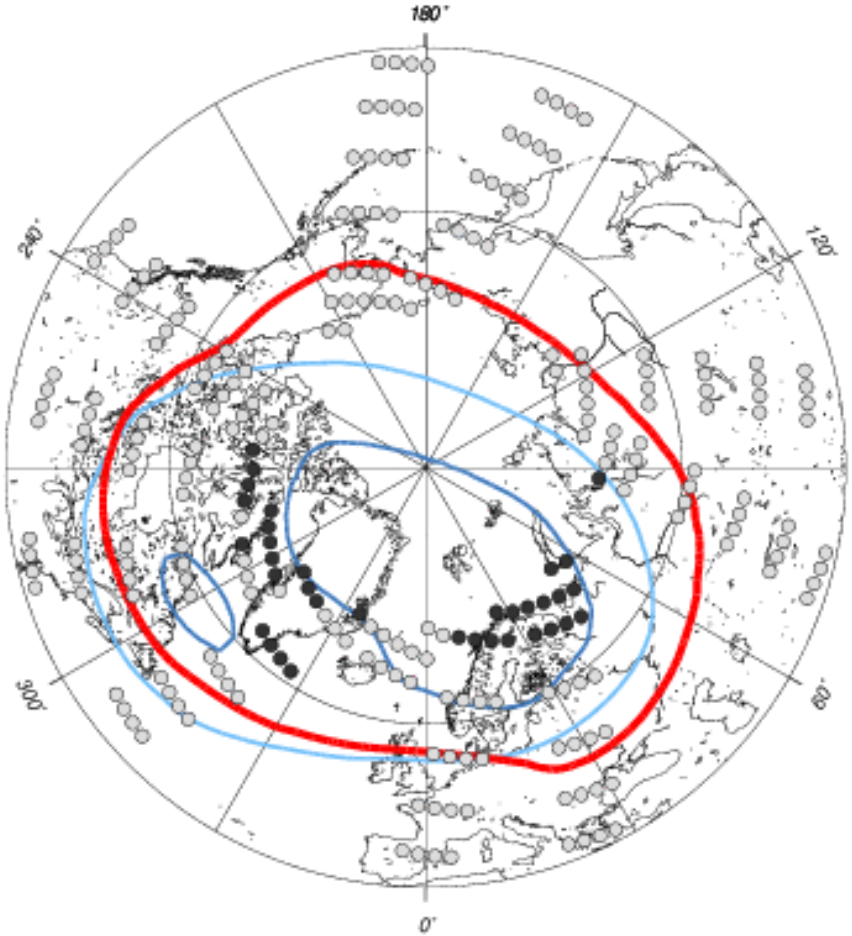
PSC maps on scia-arc (soon)

Polar Stratospheric Cloud map for 2005 February 09

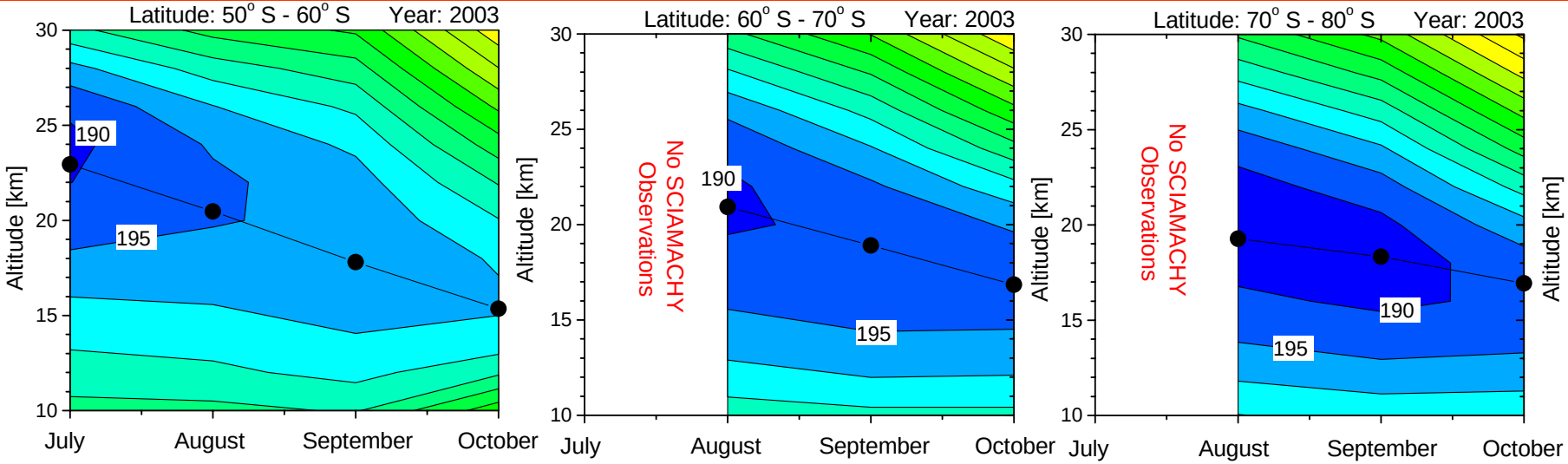
PRELIMINARY



|PV|=40 PVU
T=205 K
T=195 K
T=185 K
PV and T @ Θ=525 K

No PSC detected / PSC detected

Temporal variation of PSC altitudes: 2003



50-60°S 60-70°S 70-80°S

PSC descent rates for 2003:

50º S - 60º S	2.5 km / month
60º S - 70º S	2.0 km / month
70º S - 80º S	1.2 km / month

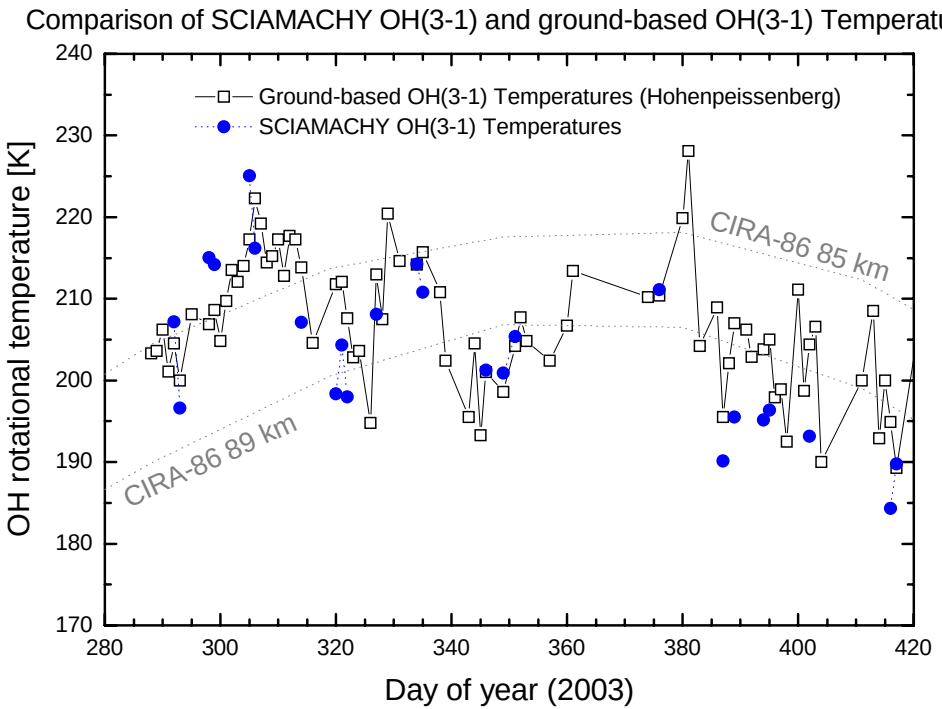
Santacesaria et al. [2001] : 2.5 km / month at 66º S / 140º E based on a 9-year Lidar climatology

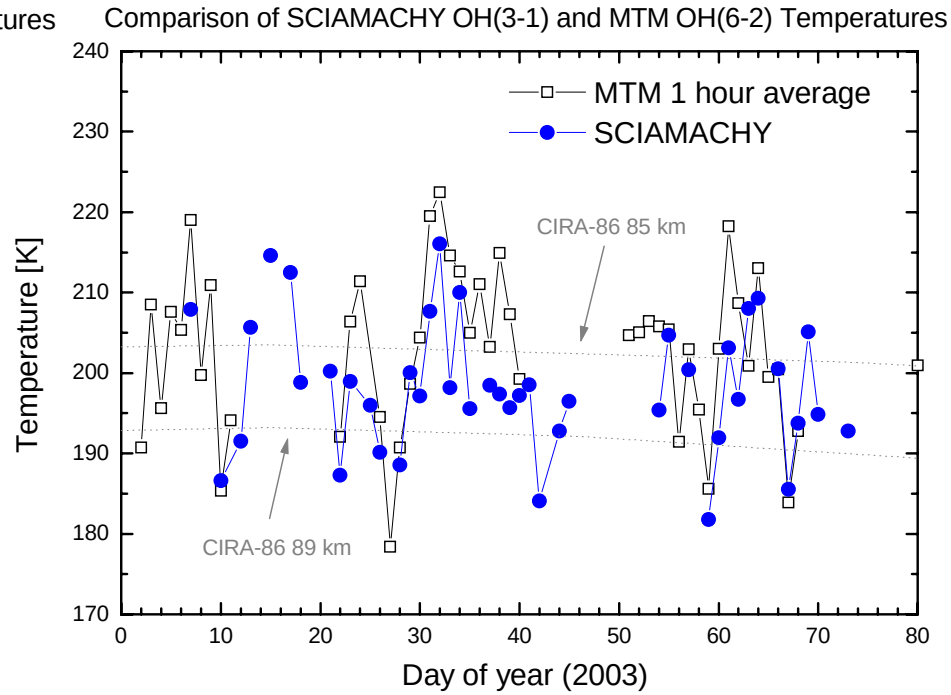
Fromm et al. [1997] : 2.0 km / month derived from POAM II

Mesospheric applications

- Determination of OH rotational temperatures
- Retrieval mesospheric O_3 profiles
- Detection of polar mesospheric clouds (PMC) (not shown here)
- Determination of PMC particle sizes (not shown here)

OH: First validation results





GRound-based Infrared P-branch Spectrometer (GRIPS) I at Hohenpeissenberg (47° N / 11° E).

GRIPS-I data provided by Michael Bittner and Kathrin Höppner (DLR)

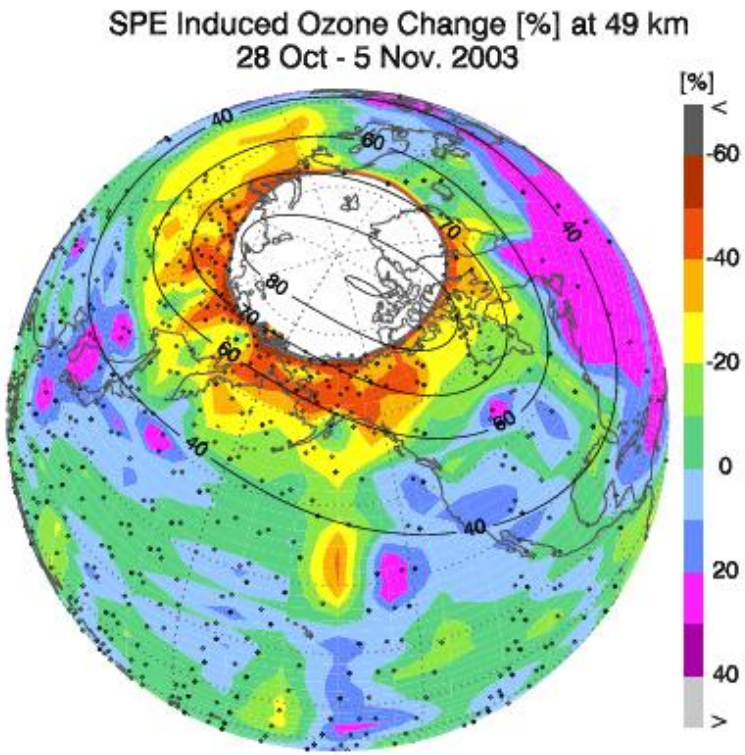
Mean difference: 2.6 K ± 11.1 K (19 nights)

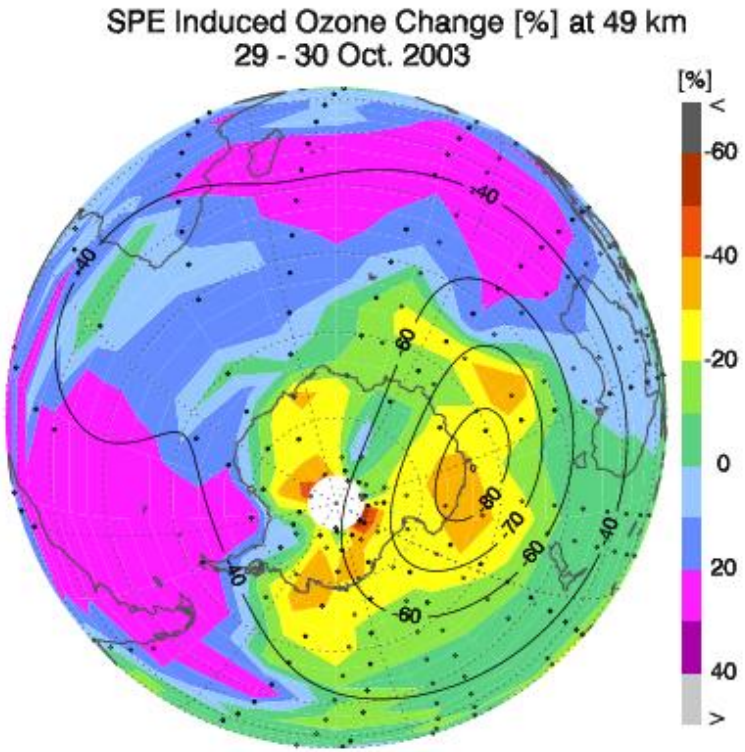
Mesospheric Temperature Mapper (MTM) at Hawaii (21° N / 204° E).

MTM data provided by Mike Taylor and Yucheng Zhao (Utah State U)

Mean difference: 7.1 K ± 11.4 K (36 nights)

Ozone Depletion during the Oct./Nov. 2003 SPE

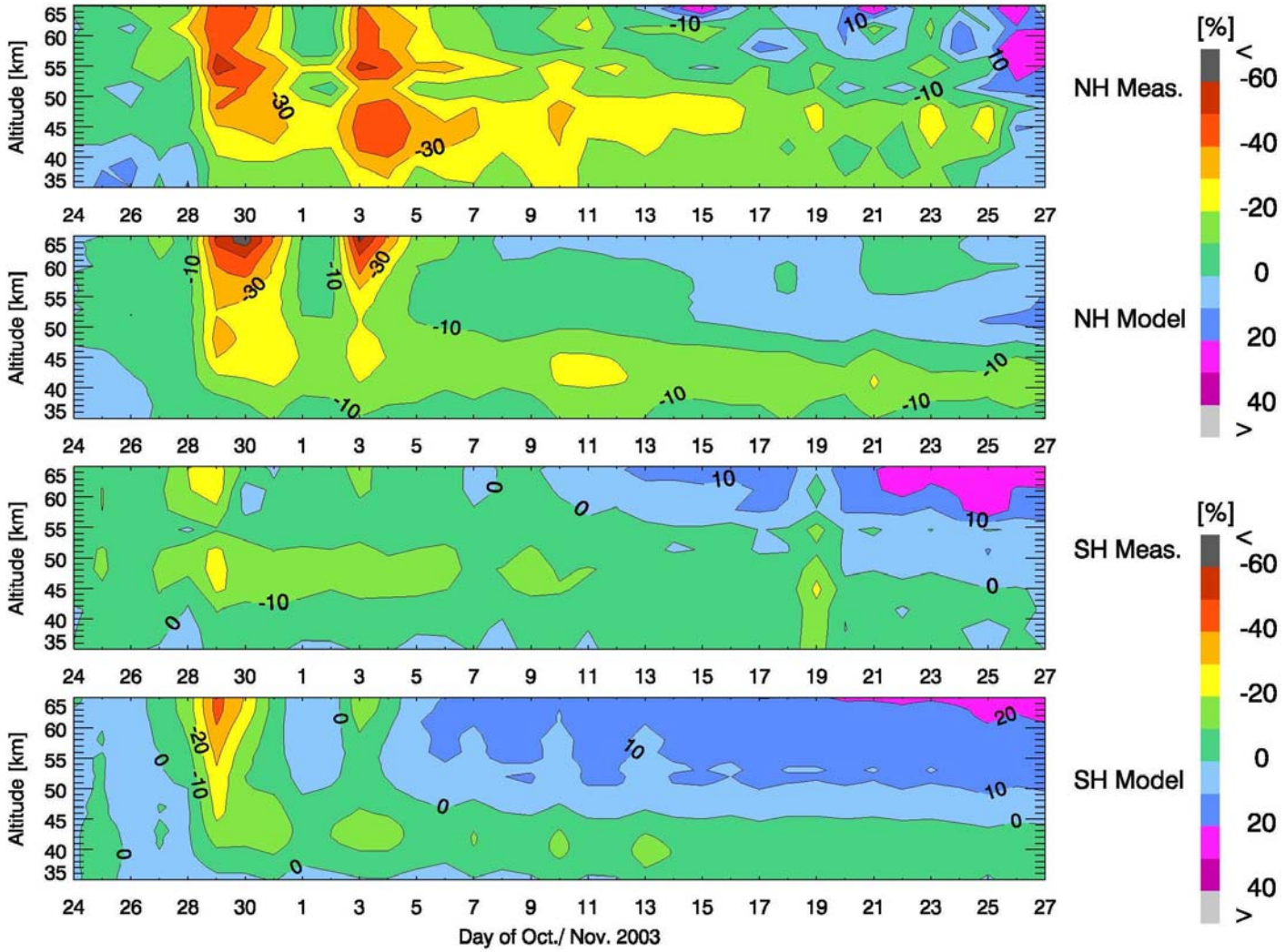




Interhemispheric differences due to different ambient H_2O levels

Rohen et al. [JGR, 2005]

Mesospheric O3: Measurements vs. Model



NH

SH

Ozone changes above 60° magnetic latitude

Rohen et al. [JGR, 2005]

Conclusions

- SCIAMACHY is a very versatile instrument
- Limb observations are very suited to study optically thin phenomena like PSCs (NLCs)
- Stratospheric profiles of O_3, NO_2, and BrO are retrieved on an operational basis at IUP Bremen and are made available to the public at

http://www.iup.physik.uni-bremen.de/scia-arc/

- Gridded maps of height dependent and total O_3 are now on the web
- Daily PSC maps will become available on the scia-arc site shortly
- OH rotational temperatures and NLC maps are available upon request

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