

3rd German SCIAMACHY Validation Team Meeting, July 7-8, 2003, Bremen

First scientific products from SCIAMACHY limb and occultation measurements

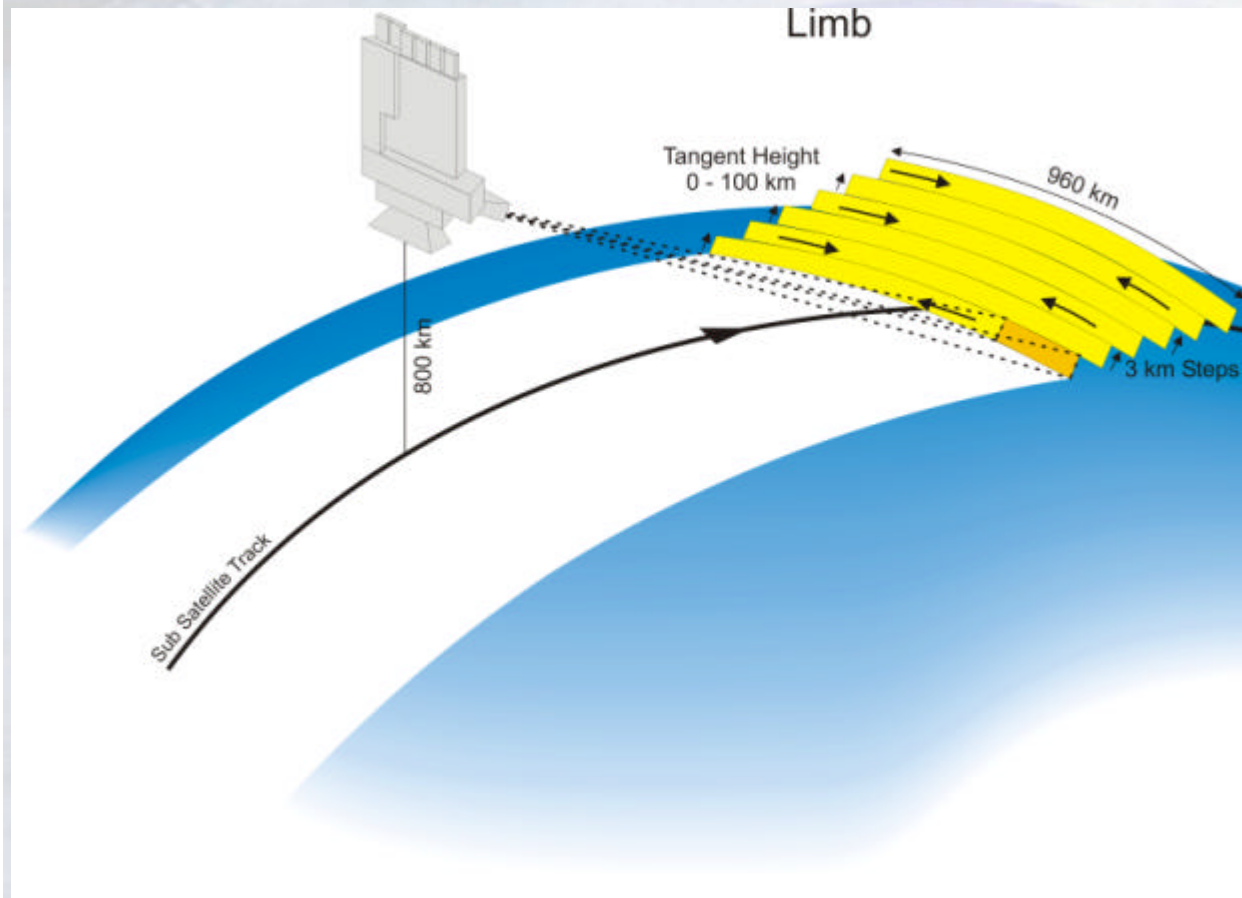
C. von Savigny, A. V. Rozanov, K.-U. Eichmann, J. Meyer, G. Rohen,
A. Schlesier and J. P. Burrows

*Institute of Environmental Physics and Remote Sensing, University of Bremen,
Otto-Hahn-Alle 1, 28334 Bremen, Germany*

Outline:

- Limb results
- Occultation results
- Conclusions

SCIAMACHY Limb Geometry



- Vertical resolution: 2.6 km
- Horizontal resolution in azimuth direction: 240 km (120 km min.), 960 km swath
- Horizontal resolution in flight direction: approx. 400 km
- Observation optimised to match limb with nadir measurements
- Duration of Limb sequence: 60 sec.
- Global coverage: 6 days at the equator

Approaches for retrieving minor constituent profiles

Two different types of algorithms are applied:

DOAS-type algorithms:

(Differential Optical Absorption Spectroscopy)

- Continuous wavelength range used
- Removal of broad-band spectral component
- Exploit high frequency differential structure
- Applicable to O₃, NO₂, BrO, OCIO

Limb radiance profile methods:

- Discrete wavelengths used
- Computationally very efficient
- So far only applied to O₃

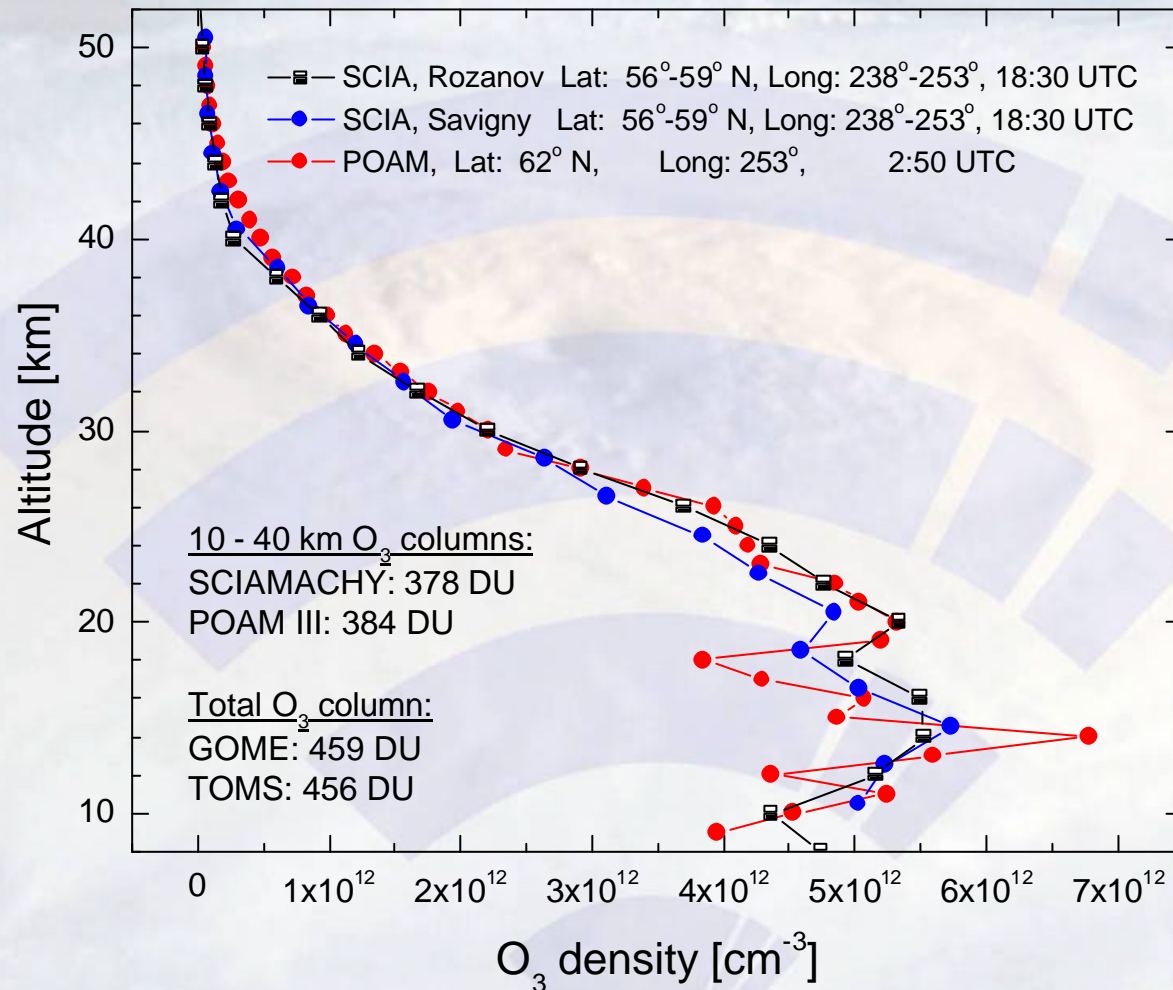
All methods require forward modelling with radiative transfer models taking all relevant physical processes into account

Retrieval speed improvements possible with:

- analytically calculated weighting functions [*Rozanov et al.*, 1997]
- SS weighting functions [*Kaiser and Burrows*, 2003]

First comparison of SCIAMACHY and POAM III ozone profiles

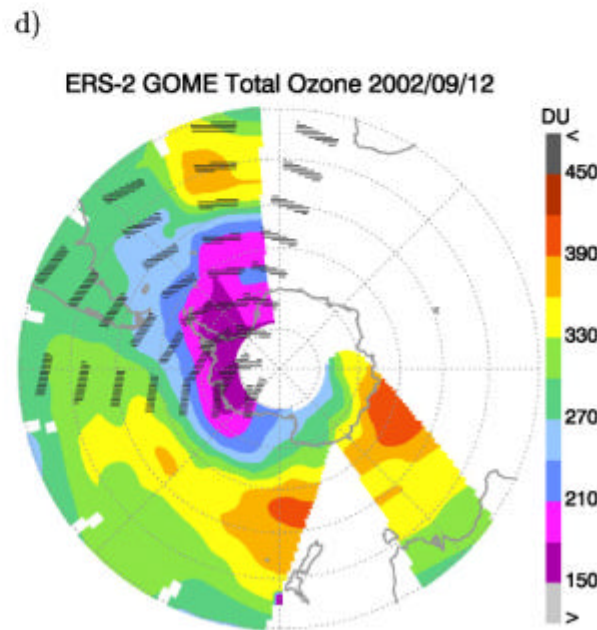
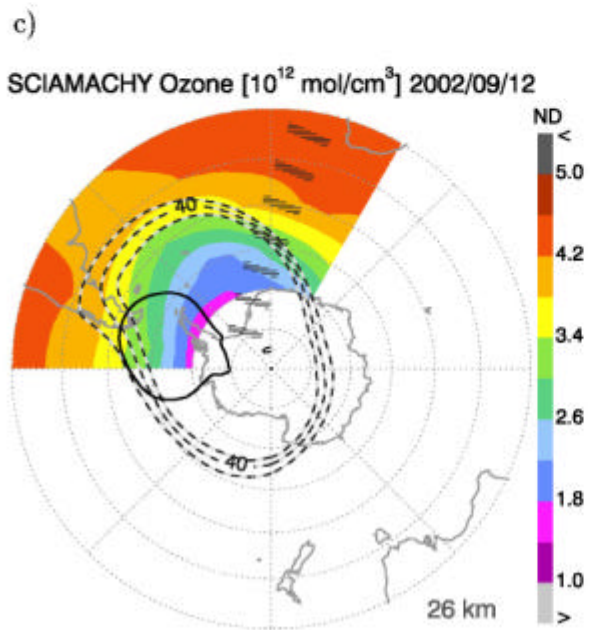
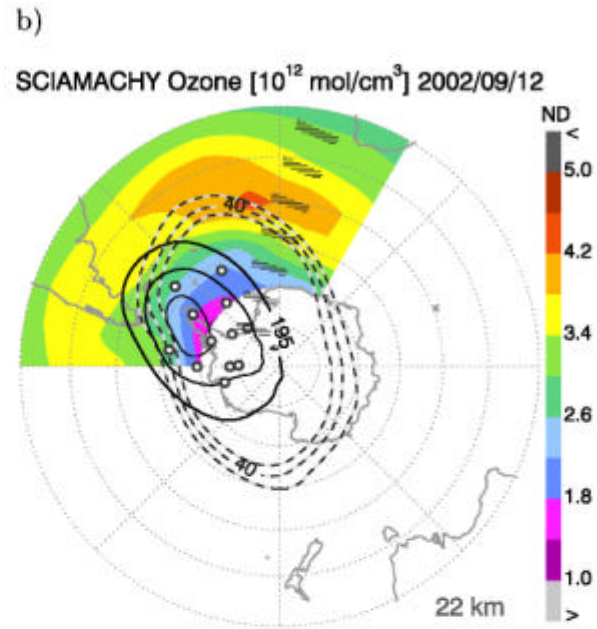
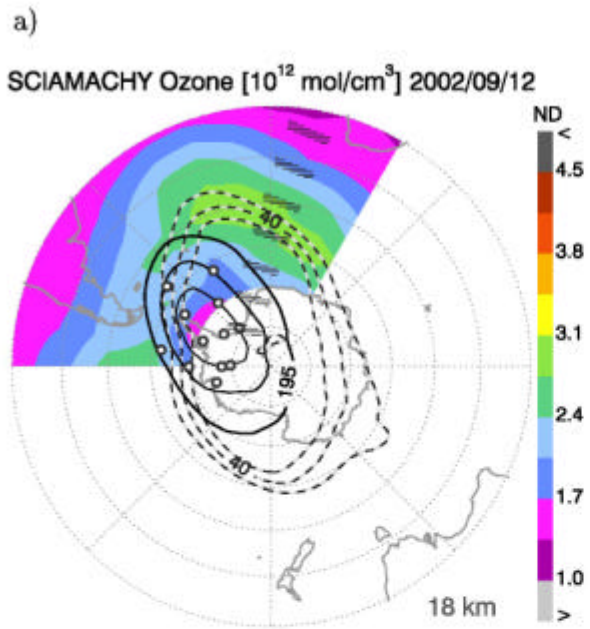
SCIAMACHY - POAM III coincidence on April 25, 2002



Rozanov: Differential retrieval employing O₃ Huggins and Chappuis bands

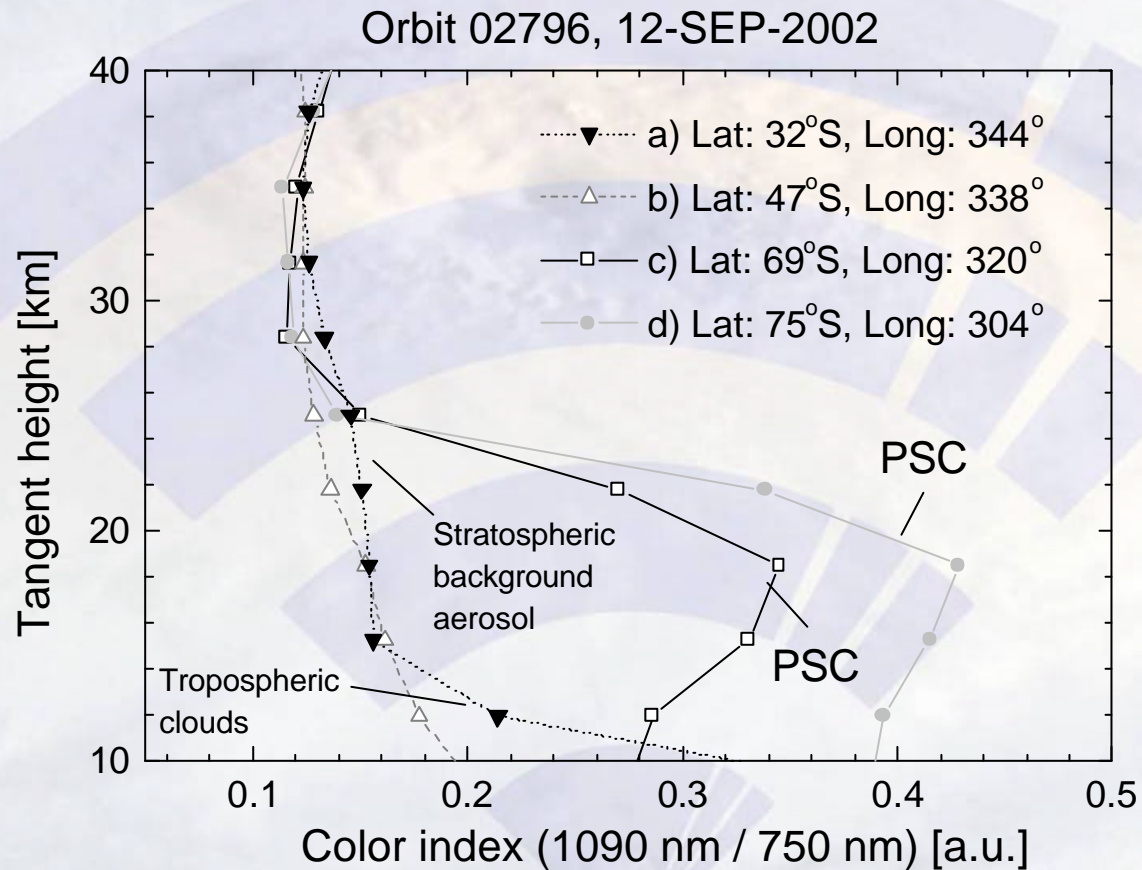
Savigny: 3 wavelength retrieval employing O₃ Chappuis bands

One week before the major stratospheric warming: September 12, 2002



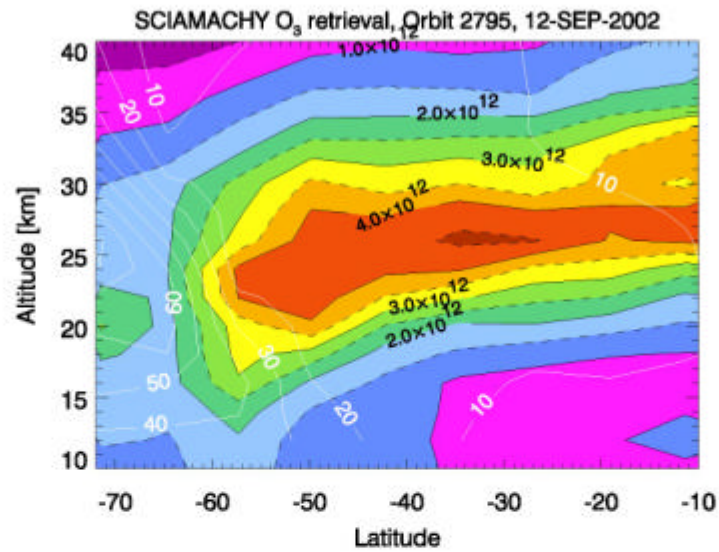
Detection of Polar Stratospheric Clouds (PSCs)

Employ color-index: $CI = LR(1090 \text{ nm}) / LR(750 \text{ nm})$



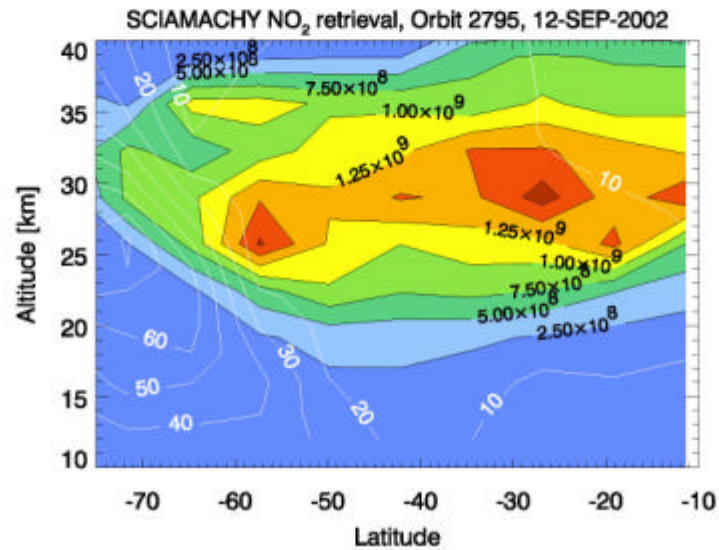
Cross sections along orbit 2795

O₃ b)



Unit: molec cm³

NO₂ c)

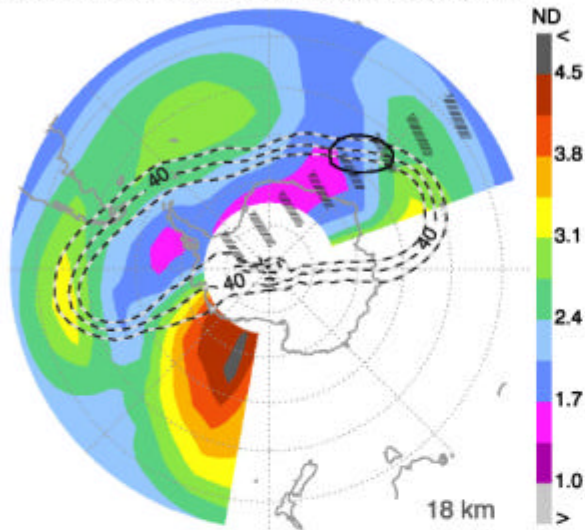


Unit: molec cm³

The ozone hole split: September 27, 2002

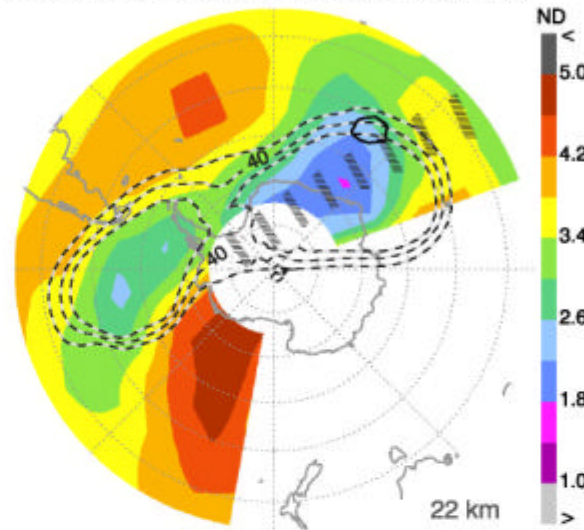
a)

SCIAMACHY Ozone [10^{12} mol/cm³] 2002/09/27



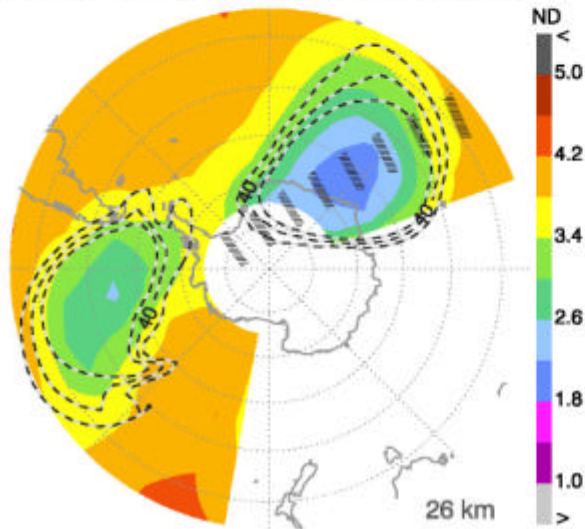
b)

SCIAMACHY Ozone [10^{12} mol/cm³] 2002/09/27



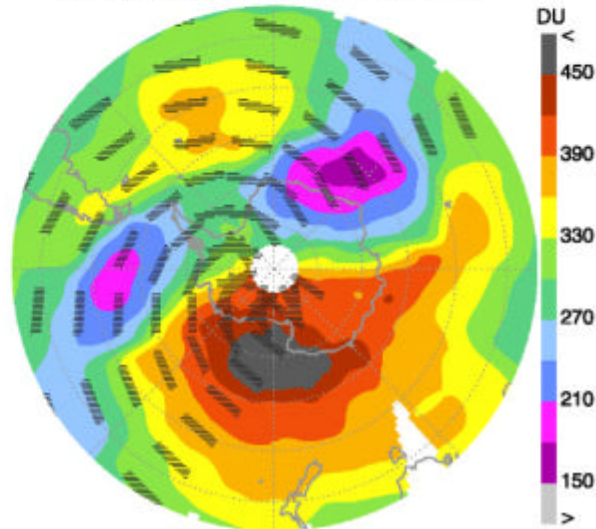
c)

SCIAMACHY Ozone [10^{12} mol/cm³] 2002/09/27

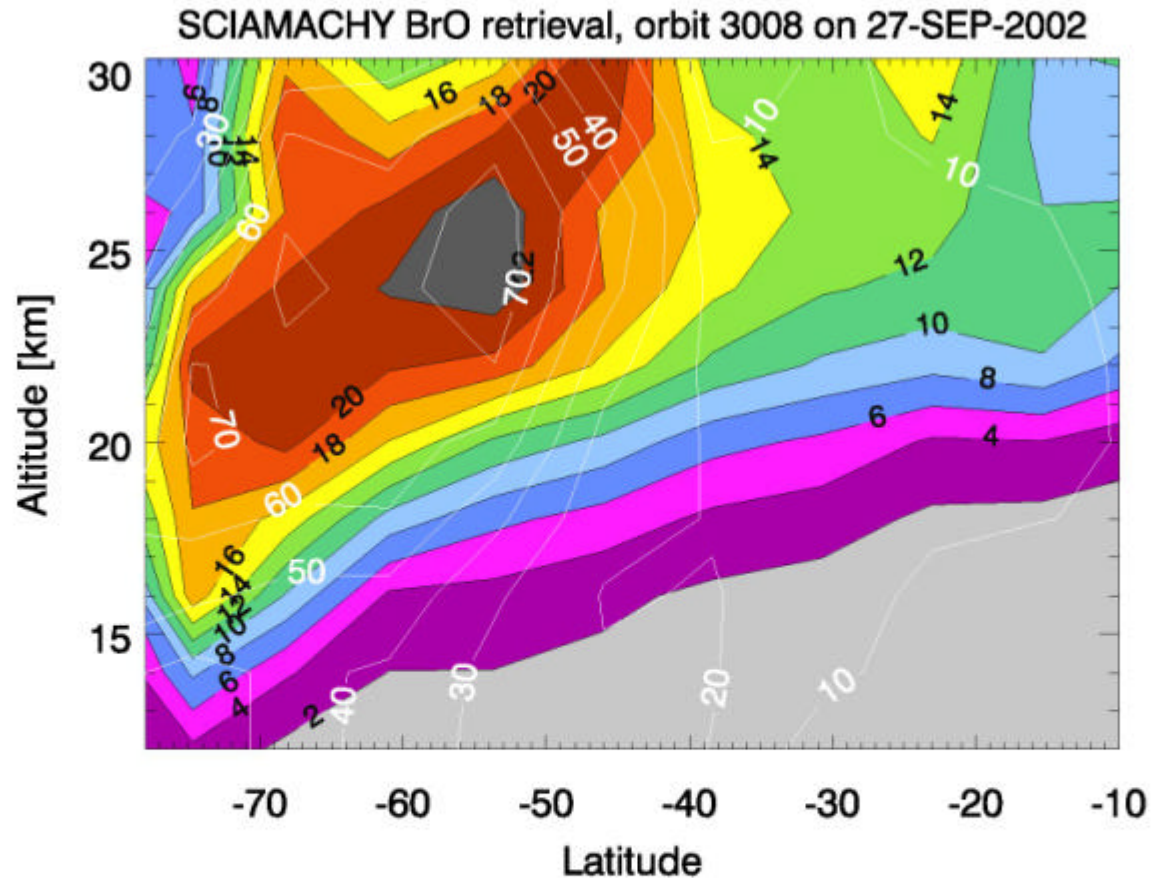


d)

ERS-2 GOME Total Ozone 2002/09/27



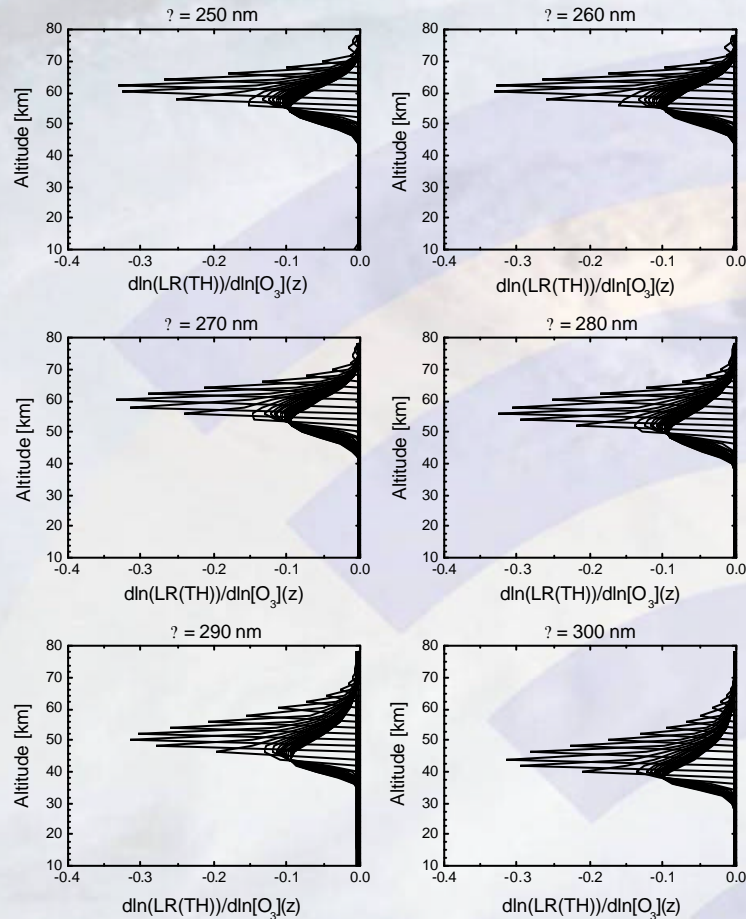
BrO cross-section along orbit 3008



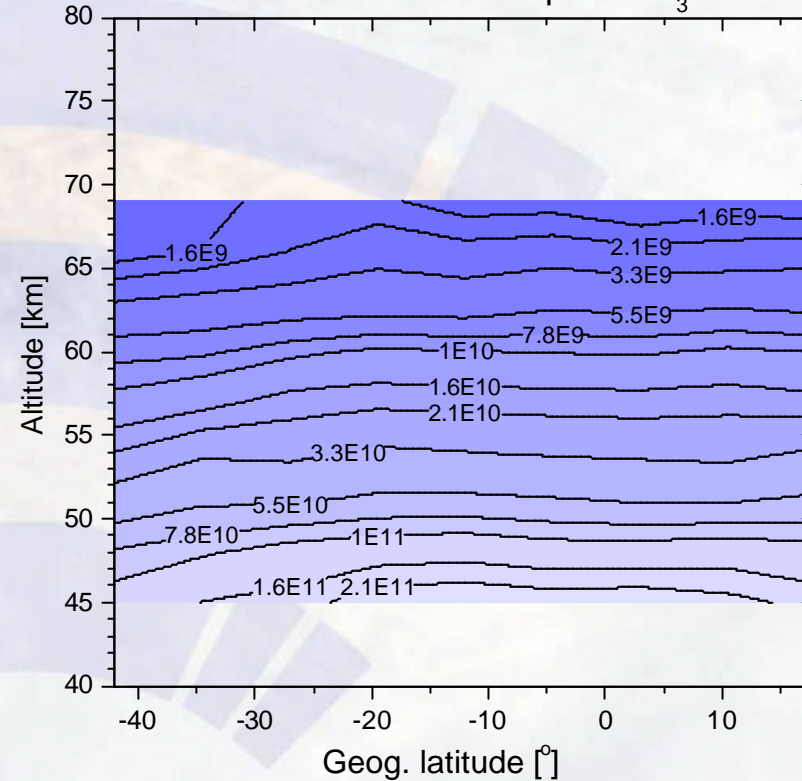
- At mid-latitudes typical BrO mixing ratios are about 10 pptv, corresponding to about 50 % of the available inorganic bromine (20 pptv). The rest is almost exclusively BrONO₂. [e.g., Sinnhuber et al., 2002]
- Within the vortex BrO mixing ratios are most likely enhanced due to the reduced NO₂, therefore reduced formation of BrONO₂.

Mesospheric O₃ retrieval in the Hartley bands

Radiance/[O₃] weighting functions



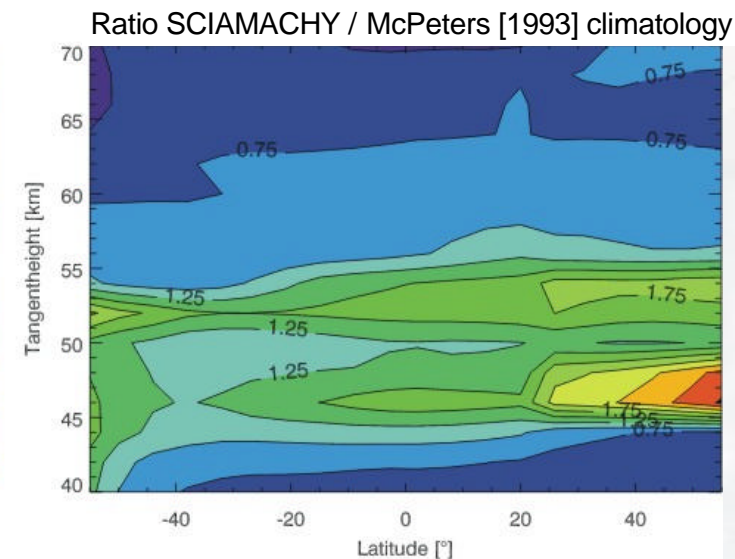
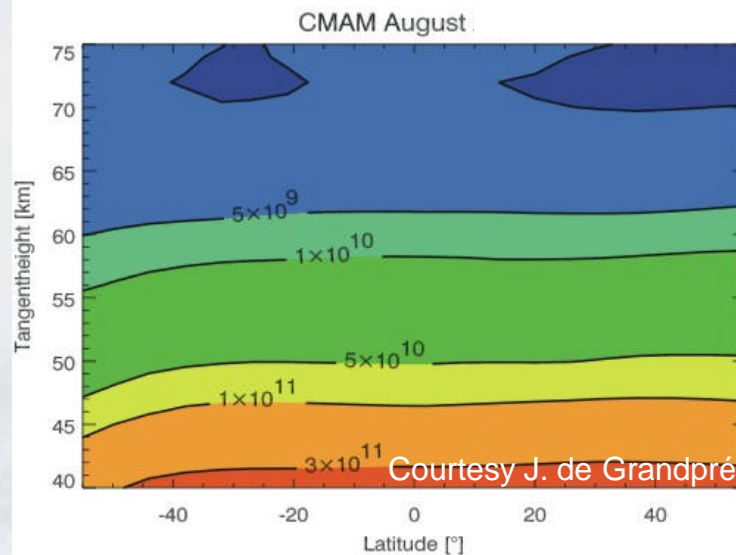
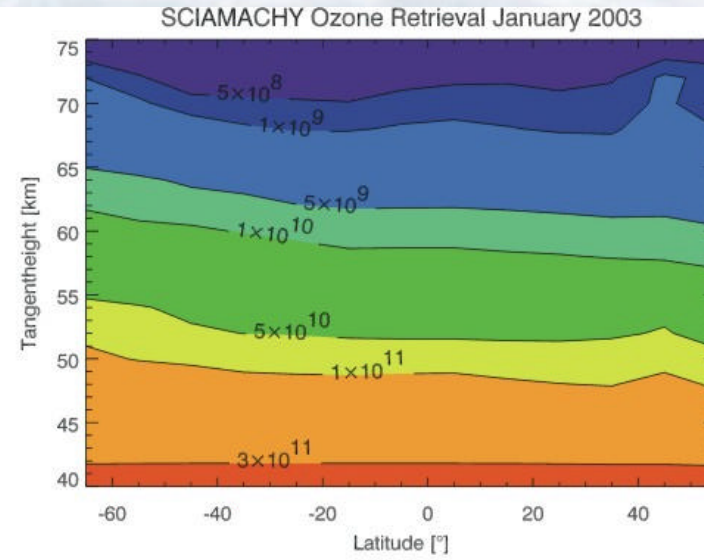
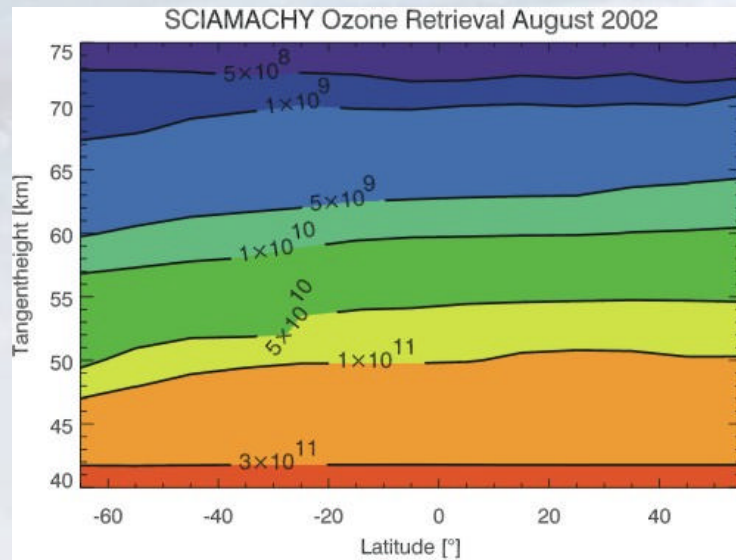
SCIAMACHY mesospheric O₃



July 3, 2002, Orbit 1779

→ Limb radiances in the Hartley bands are sensitive to O₃ up to altitudes > 80 km

Mesospheric Ozone Climatology



Courtesy J. de Grandpré

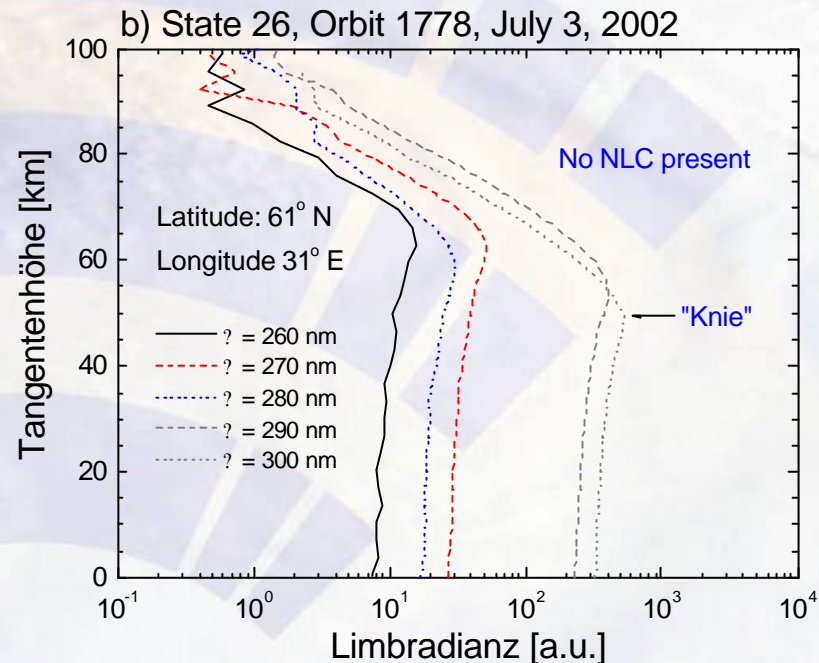
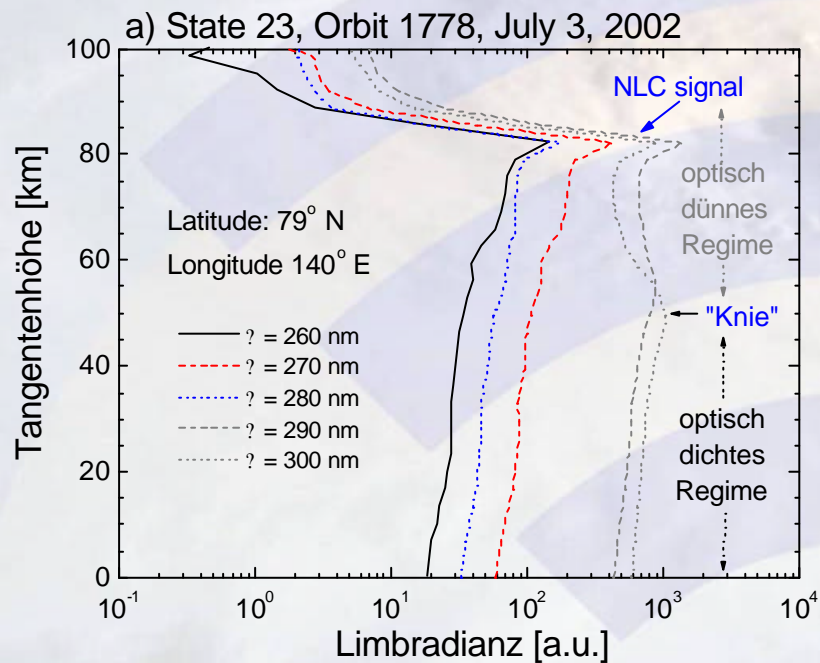
Detection of Polar Mesospheric Clouds

UV limb radiance profiles

with PMCs

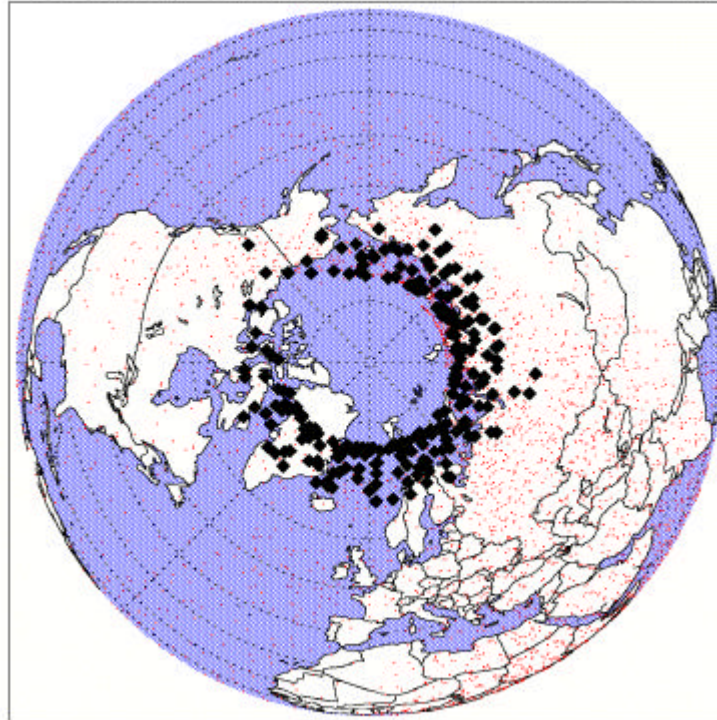
and

without PMCs



PMCs detected during the 2002 northern hemisphere season

NLCs detected by SCIAMACHY in the NH after 06/30/2002



Only small fraction of data taken by SCIAMACHY available for analysis!!

Problems

Two important problems all present limb scattering instruments have to deal with

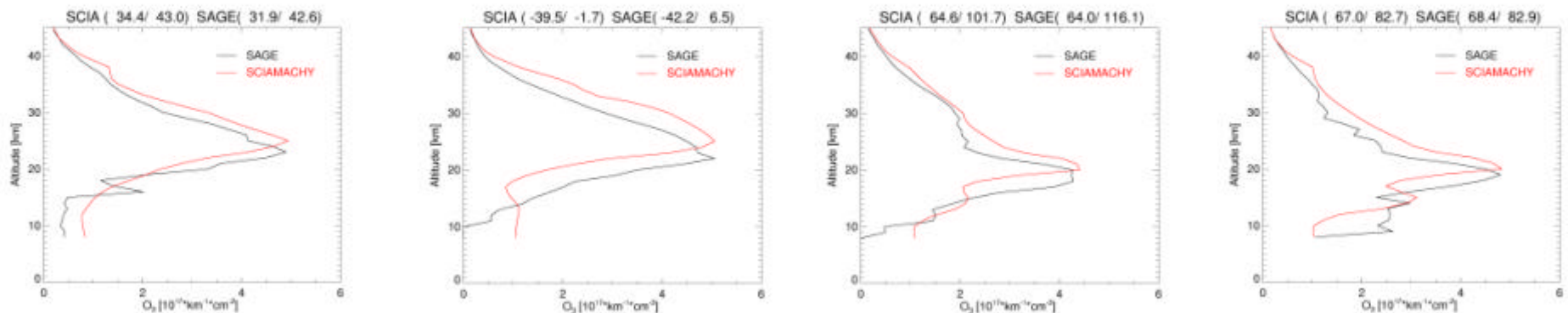
(a) **baffle scattered radiation**: radiation from outside the field of view entering the instrument

(b) **Inaccurate pointing**:

1 km tangent height error = 15×10^{-3} degrees pointing error

→ Satellite attitude control systems have to be very accurate!!

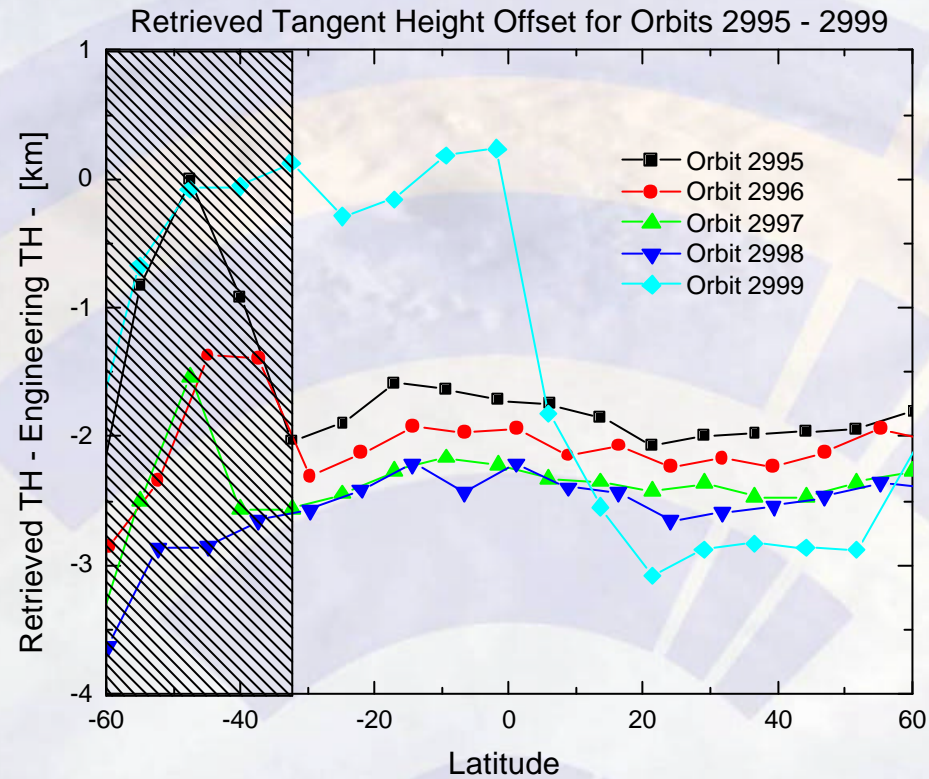
Examples of tangent height offsets: comparisons with SAGE II



Tangent height retrieval with „knee“ methods

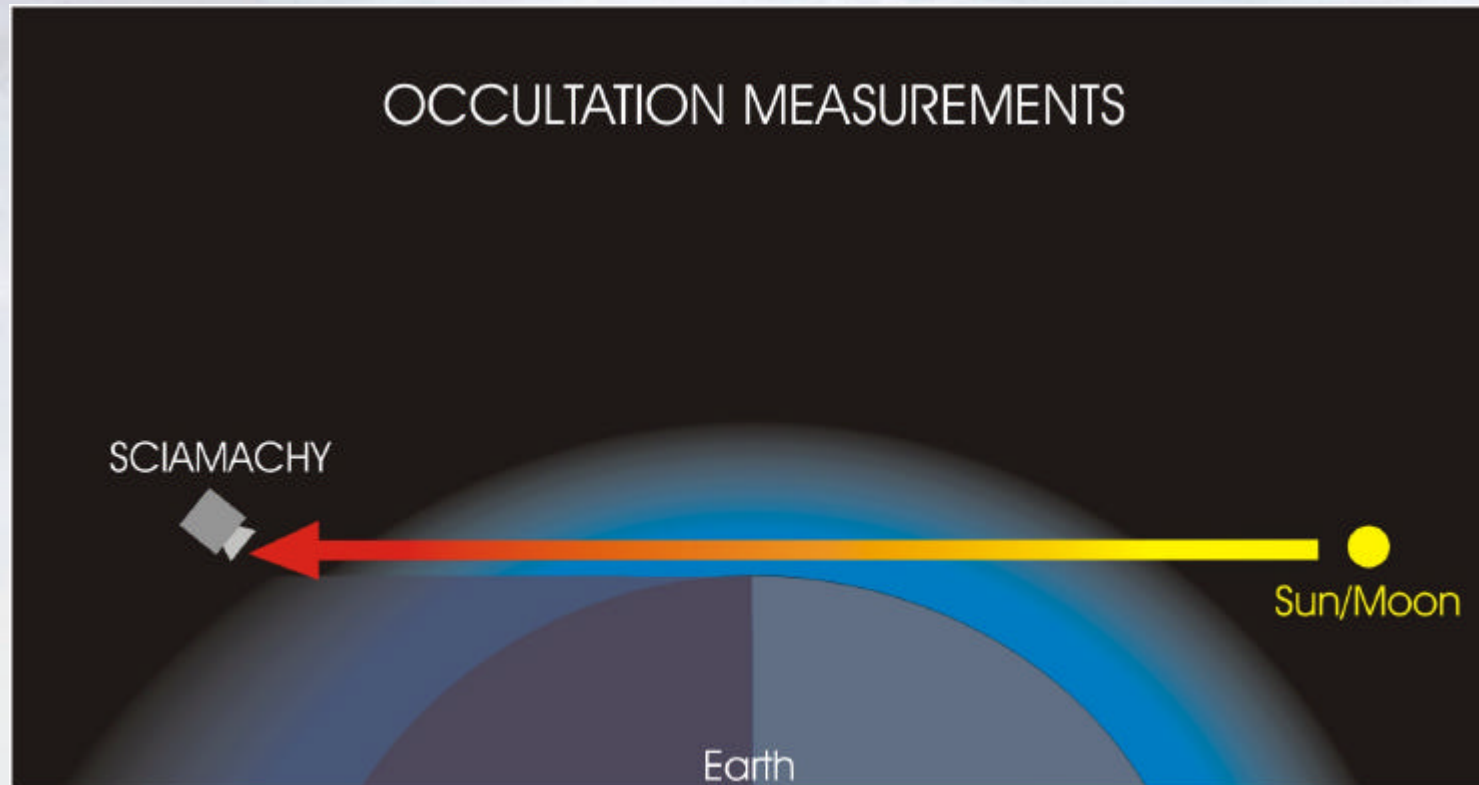
TRUE = Tangent height Retrieval by UV-B Exploitation

based on RTM SCIARAYS (two scattering orders)



- Indications for:
- (a) slow drift in pointing to lower THs
 - (b) TH discontinuities of up to 3 km associated with with on-board orbit model update

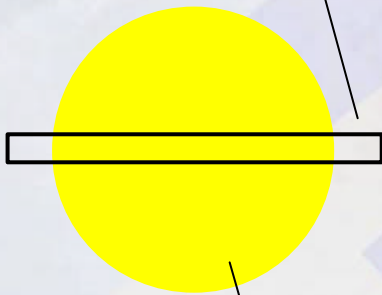
First occultation results



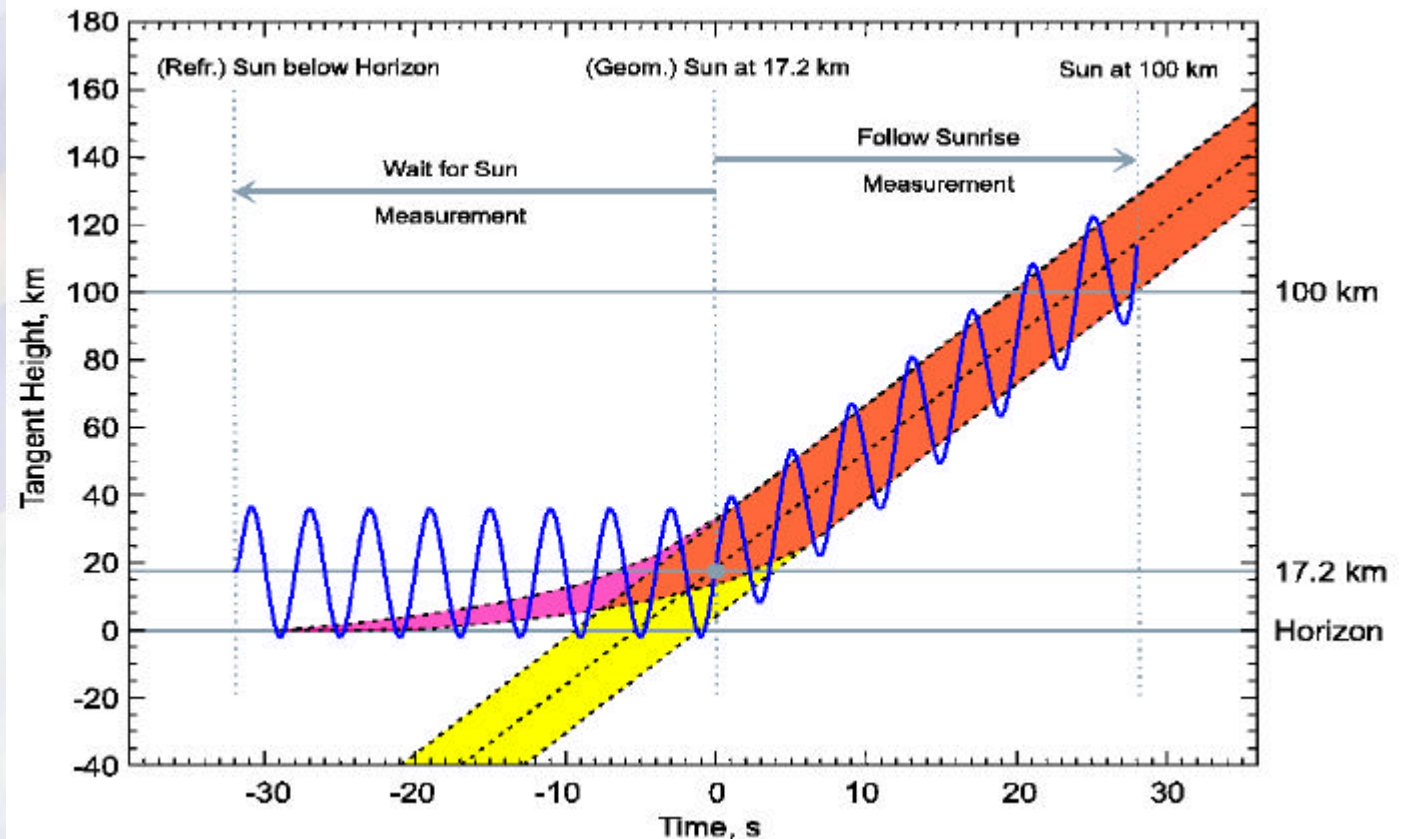
Jerome Meyer, Anke Schlesier

SCIAMACHY Scanning Sequence

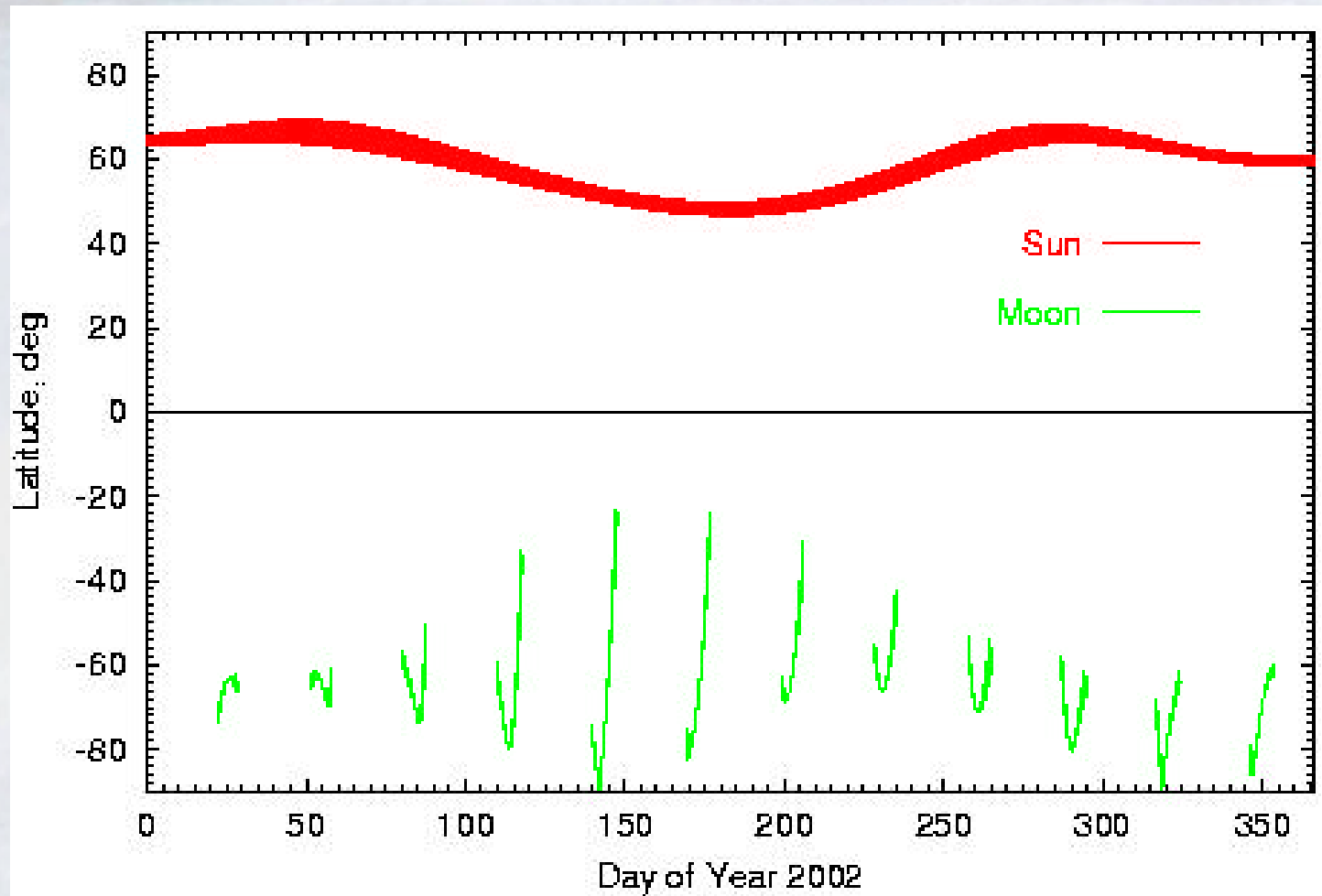
FOV: $0,7^\circ \times 0,045^\circ$

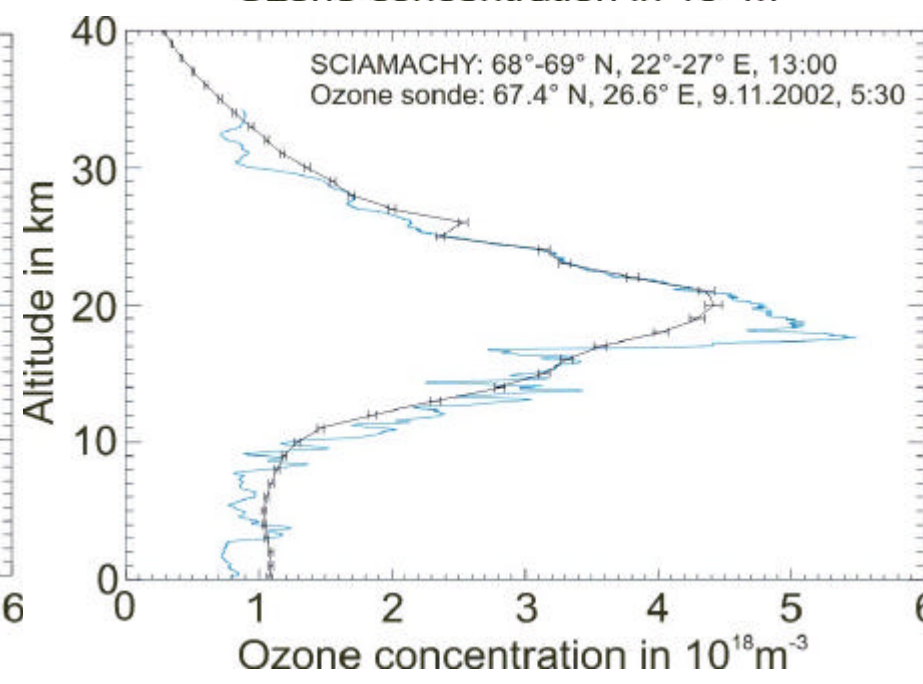
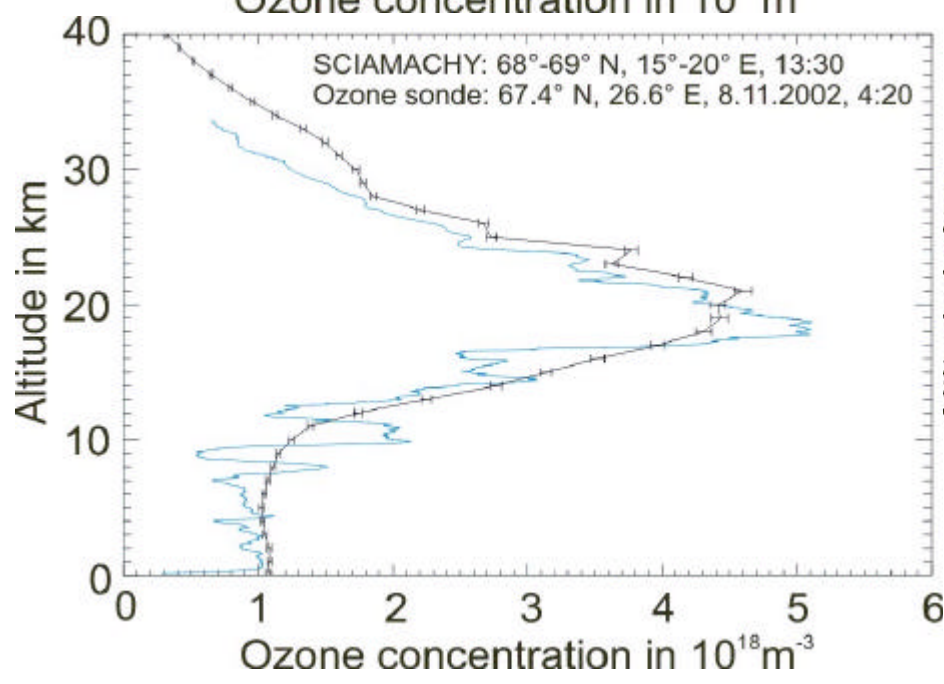
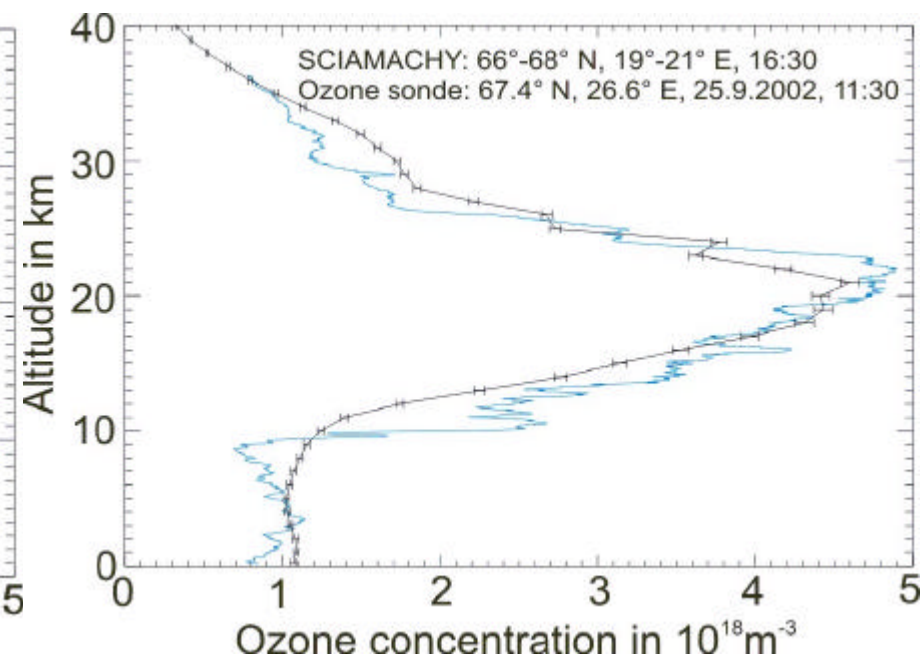
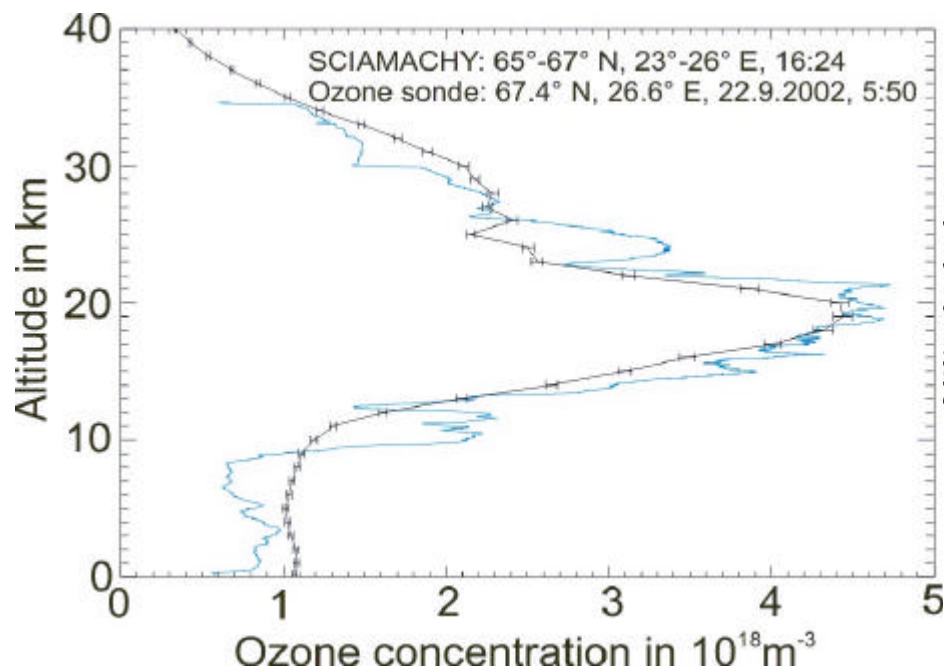


apparent solar
disk diameter: $0,53^\circ$

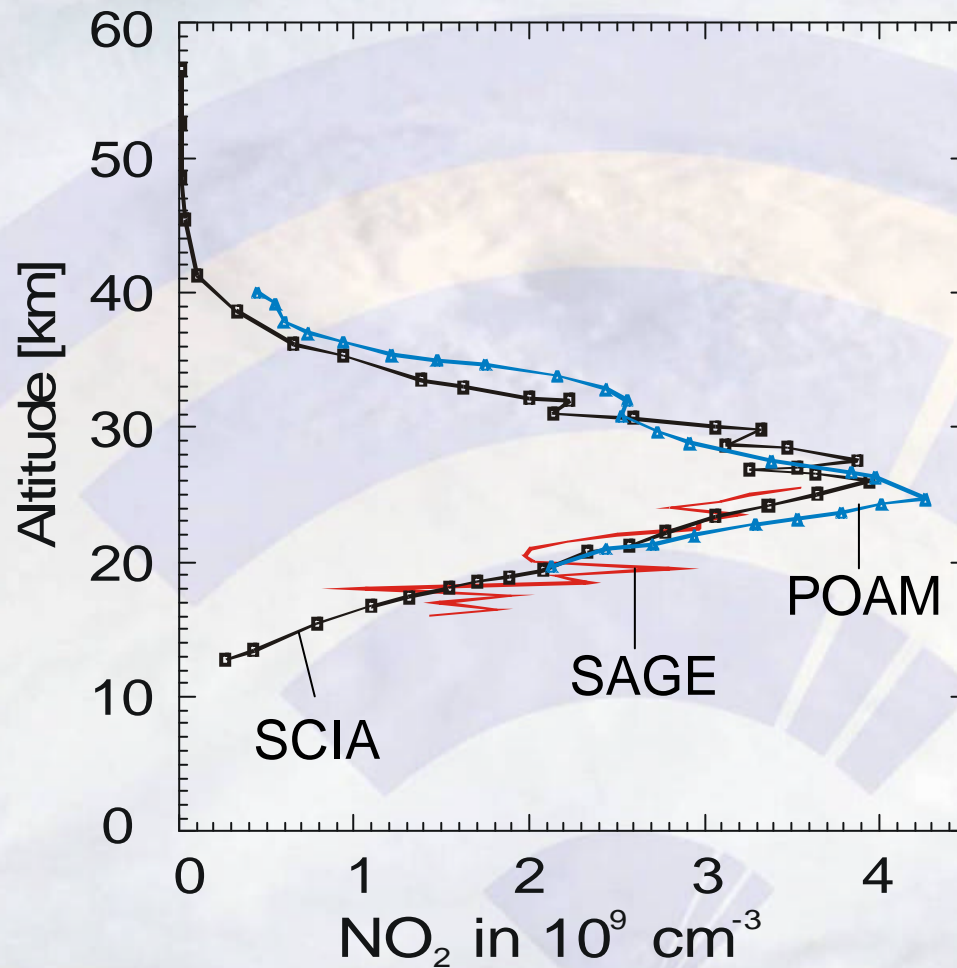


Geographical coverage of Occultation Measurements





NO₂ Profile in Comparison with POAM and SAGE



[G. Taha, University of Arizona]

Overview of SCIAMACHY scientific limb and occultation products available at IUP/IFE

Observation geometry	Data product	Altitude range	Algorithm exists ?	Processing capabilities
Limb	stratospheric O ₃	14 – 40 km	YES finetuning ongoing	most of available L0 and L1 data processed
Limb	stratospheric NO ₂	15 – 40 km	YES finetuning ongoing	few orbits processed orbits can be processed on demand
Limb	stratospheric BrO	18 – 30 km	YES finetuning ongoing	few orbits processed orbits can be processed on demand
Limb	stratospheric OCIO	18 – 30 km	YES finetuning ongoing	few orbits processed orbits can be processed on demand
Limb	PSC detection		YES finetuning ongoing	few orbits processed orbits can be processed on demand
Limb	UT/LS CH ₄	6 - 20 km	Under development	available within 2 months
Limb	UT/LS H ₂ O	6 - 20 km	Under development	available within 2 months
Limb	Mesospheric O ₃	40 - 70 km	YES finetuning ongoing	Many orbits processed operational processing of large amounts of data possible
Limb	NLC detection and particle size determination		YES finetuning ongoing	most of available L0 and L1 data processed
Occultation	stratospheric O ₃	13 - 50 km	YES finetuning ongoing	few orbits processed orbits can be processed on demand
Occultation	stratospheric NO ₂	13 - 50 km	YES finetuning ongoing	few orbits processed orbits can be processed on demand