SCIAMACHY limb water vapor retrieval V3.01, 2002-2012

K. Weigel[1], A. Rozanov[1], F. Azam[1], K. Bramstedt[1], K.-U. Eichmann[1], M. Weber[1], H. Bovensmann[1], G. P. Stiller[2], and J.P. Burrows[1]

1 University of Bremen, Institute of Environmental Physics (weigel@iup.physik.uni-bremen.de, phone: +49-421-21862083),

2 Karlsruhe Institute of Technology.

1. Introduction

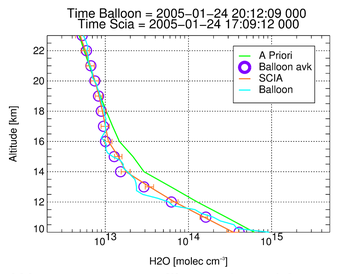
- The upper troposphere, lower stratosphere (UTLS) is important for transport processes into the stratosphere and the water cycle
- Model studies have shown that stratospheric water vapor is important for surface climate
- Not many dense, long term measurements of water vapor available in the UTLS

2. SCIAMACHY

- Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY, on Envisat
- Measurements: 08/2002–04/2012
- Sun-synchronous (10:00 AM local equator crossing time)
- Limb spectra at about 12.0, 15.3, 18.6, 21.9, 25.2 km used for water vapor retrieval
- Vertical resolution / sampling: 2.5 / 3.3 km

3. H_2O retrieval V3.01

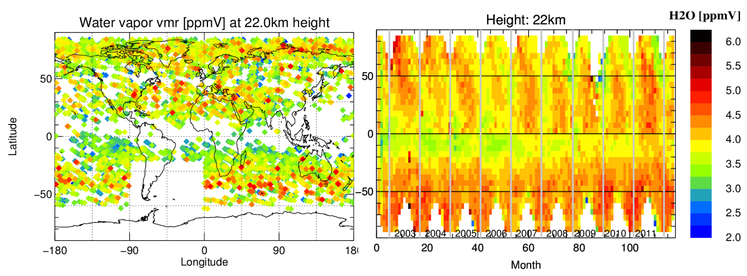
- SCIAMACHY channel 6, near infrared, 1353-1410 nm
- Scattered solar radiation
- Retrieval with SCIATRAN using optimal estimation, correlated-k, multiple scattering, and Tikhonov regularization [2]
- Includes retrieval of CH_4, scaling of the tropospheric column and albedo



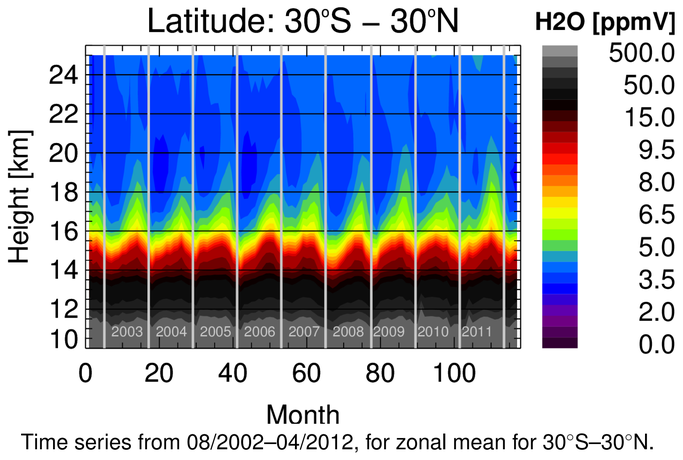
Water vapor profile retrieved from SCIAMACHY and balloon measurement.

4. Clouds, coverage, and time series

- Data filtered for clouds at or above 12 km (SCODA V1.9), South Atlantic Anomaly (SAA), and retrieval convergence.
- Very time-consuming retrieval: data set contains every 2nd day, 45°S–45°N, every 8th day globally.



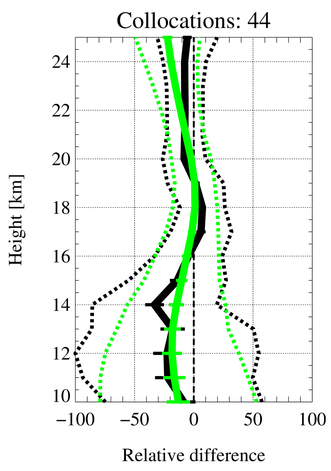
Coverage in May 2006 and latitudinal coverage for the time series from 08/2002–04/2012.



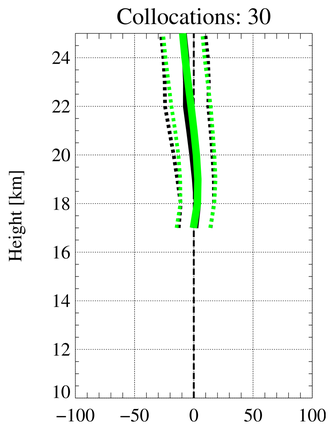
Time series from 08/2002–04/2012, for zonal mean for 30°S–30°N.

5. Comparisons

5.1 Methods and collocation criteria



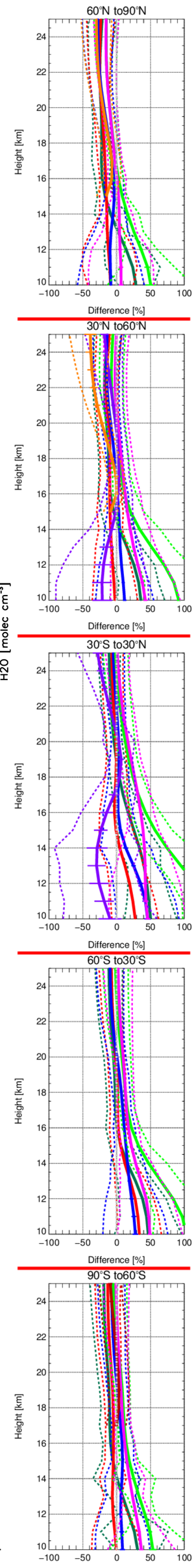
Mean percentage difference to Cryogenic frost point (CFH) data: same data set as [2], different sub-sample.



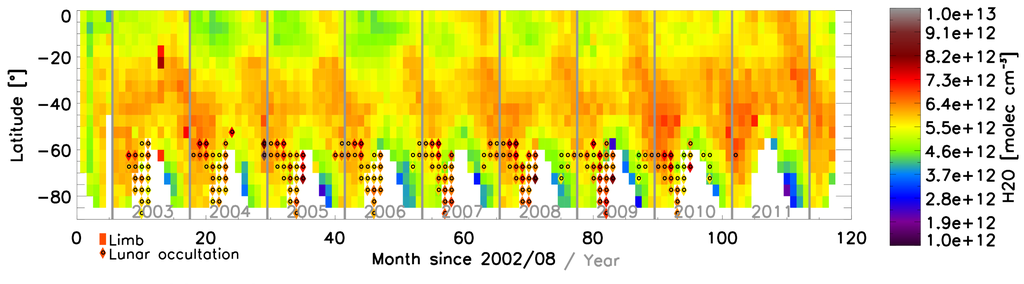
Mean percentage difference to SCIAMACHY Lunar Occultation data [1].

Instrument	Distance	Time difference	Time period with collocations	Number of collocations
MLS V3.3	100 km	6 h	2004–2012	13680
MIPAS V5R	200 km	6 h	2005–2012	26082
ACE-FTS V3.0	500 km	6 h	2004–2010	1850
HALOE V19	500 km	6 h	2002–2005	1348
SAGE II V6.2	500 km	6 h	2005–2005	1297
Balloon CFH	1000 km	5 h	2005–2008	44
SCIA Solar Occultation	500 km	6 h	2002–2012	2009
SCIA Lunar Occultation	500 km	6 h	2004–2008	30

- Mean percentage difference: SCIAMACHY-other/((SCIAMACHY+other)*0.5) * 100 (solid), debiased standard deviation (dotted) and standard error of the mean (error bars) of SCIAMACHY data and other measurements
- Interpolated on SCIAMACHY retrieval grid (black) or smoothed with SCIAMACHY Averaging Kernel (green or colored)
- AVK effects the comparisons both for vertically high resolved data and satellite data with a similar resolution as SCIAMACHY.

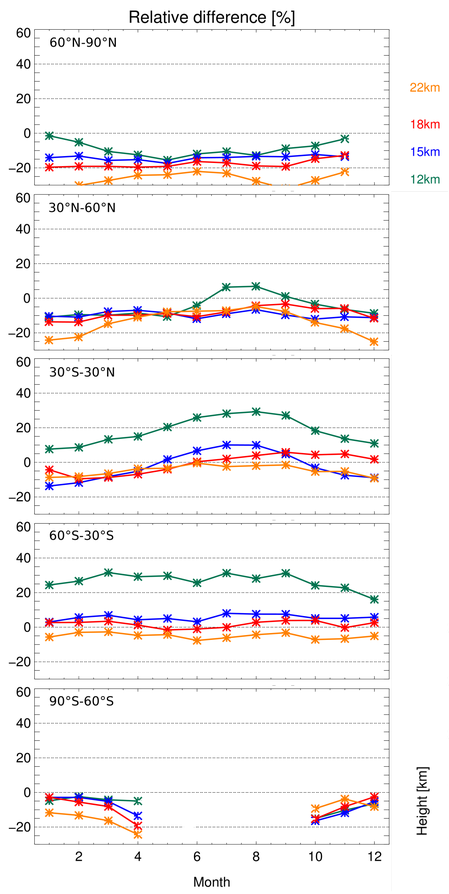


5.2 Lunar Occultation

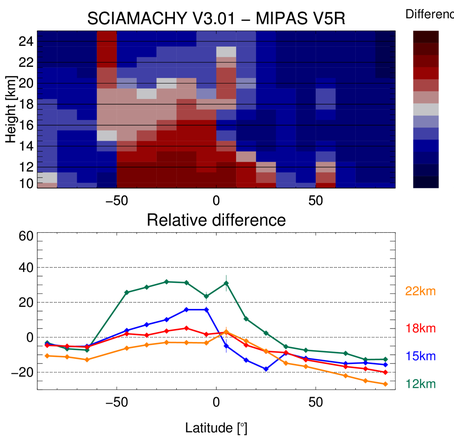


SCIAMACHY Limb and Lunar Occultation data, gridded, at 21 km altitude.

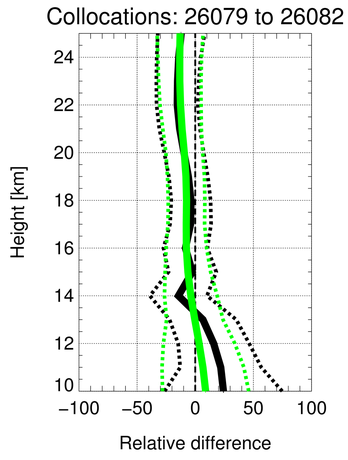
5.3 MIPAS KIT V5R



Difference in the annual cycle compared to MIPAS KIT V5R.

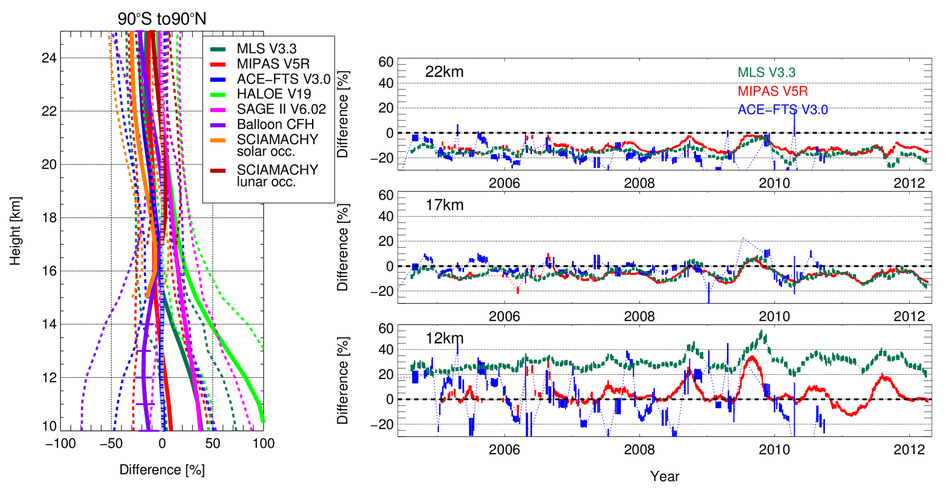


Difference on a 10° grid to MIPAS KIT V5R.



Mean percentage difference to MIPAS KIT V5R.

5.4 Overview



Comparisons between water vapor retrieval V3.01 from SCIAMACHY Limb measurements and other data sets. Above: all available data, right: different latitude bands. Mean percentage differences are shown for collocated profile and smoothed with the Averaging Kernel of SCIAMACHY.

Summary

- Retrieval of water vapor in the UTLS
- Result from SHARP / SPIN: Time series 08/2002 to 04/2012, every 2nd day, 45S–45N, every 8th day globally (V 3.01), available as profiles and gridded on 5x5 deg (NetCDF)
- Data filtered for clouds above 10 km, SAA, and retrieval convergence
- Differences to other data sets vary regionally and seasonally:
  - Hygropause broader
  - Possible wet bias below 20 km, small dry bias above, especially in northern hemisphere
- Possible reasons for differences: differences in sampling, aerosols correction?

References

[1] Azam, F., Bramstedt, K., Rozanov, A., Weigel, K., Bovensmann, H., Stiller, G. P., and Burrows, J. P.: SCIAMACHY lunar occultation water vapor measurements: retrieval and validation results, *http://www.atmos-meas-tech.net/5/2499/2012/amt-5-2499-2012.html, Atmos. Meas. Tech. 5, 2499–2513*, 2012.

[2] Rozanov, A., Weigel, K., Bovensmann, H., Dhomse, S., Eichmann, K.-U., Kivi, R., Rozanov, V., Vömel, H., Weber, M., and Burrows, J. P.: Retrieval of water vapor vertical distributions in the upper troposphere and the lower stratosphere from SCIAMACHY limb measurements, *http://www.atmos-meas-tech.net/4/933/2011/amt-4-933-2011.html, Atmos. Meas. Tech. 4, 933–954*, 2011.

Acknowledgments

ACE-FTS
The Atmospheric Chemistry Experiment (ACE), also known as SCISAT, is a Canadian-led mission mainly supported by the Canadian Space Agency and the Natural Sciences and Engineering Research Council of Canada.
Balloon
We thank Holger Vömel for collecting and providing the balloon data set. We thank Sam Oltmans and Dale F. Hurst (NOAA Earth System Research Laboratory, Global Monitoring Division) for providing NOAA FPH profile data. The CFH measurements from Beltsville, MD were made at the Howard University Beltsville Campus during the WAVES field campaigns supported by the NASA Atmospheric Chemistry Program and led by David Whiteman of NASA/GSFC, Everette Joseph and Belay Demoz of Howard University. The CFH measurements at Biak, Kototabang, and Ha Noi were made under the Soundings of Ozone and Water in the Equatorial Region (SOWER) project led by Fumio Hasebe (Hokkaido University), Masato Shiotani (Kyoto University), and Masatomo Fujiwara (Hokkaido University).
HALOE
Our gratitude also goes to the HALOE science and data processing teams for providing the profiles used in this study.
HLRN
Some data shown here were calculated on German HLRN (High-Performance Computer Center North).
ECMWF
We are thankful to ECMWF for providing pressure, temperature, and surface elevation information (ECMWF Special Project SPDECDIO).
Funding
This study has been funded by DLR Space Agency (Germany), grant 50EE0727, European Commission EC SCOUT-O3, by the University and State of Bremen, and by the SCIAMACHY Quality Working Group Project (ESA). Part of this work has been supported by the DFG Research Unit FOR 1095 "Stratospheric Change and its role for Climate Prediction (SHARP)" (Project: GZ WE 3647/3-1; www.fu-berlin.de/sharp/) and the ESA Project SPIN (ESA SPARC Initiative).
MIPAS
We thank the Karlsruhe Institute of Technology for providing MIPAS water vapor data based on the scientific IMK/IAA processor.
MLS
The MLS data used in this research were produced by the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautics and Space Administration.
SAGE II
Another thanks goes to the NASA Langley Research Center (NASA-LaRC) for providing the SAGE II data.