Activity report Ny Ålesund

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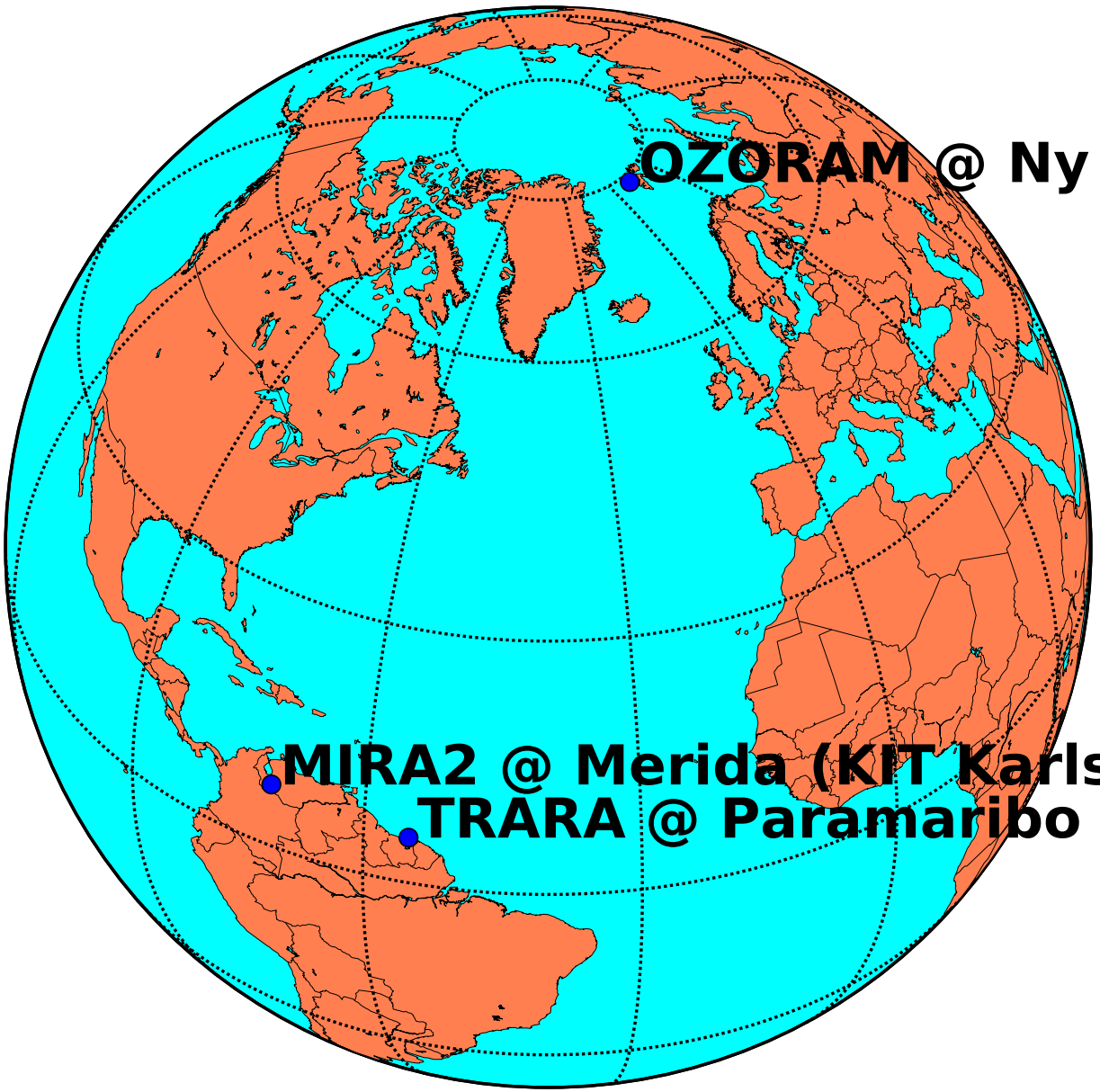
OZORAM @ Ny Alesund
MIRA2 @ Merida (KIT Karlsruhe)
TRARA @ Paramaribo

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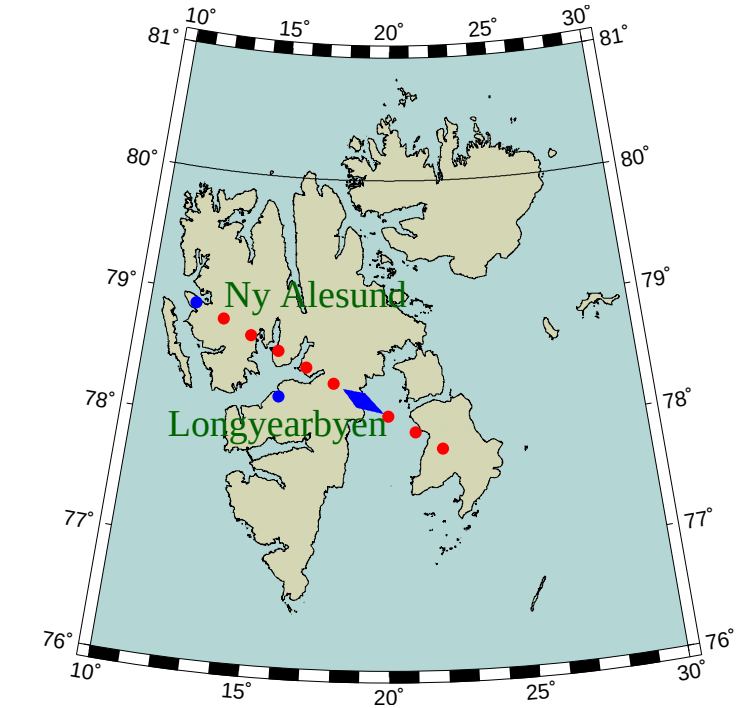
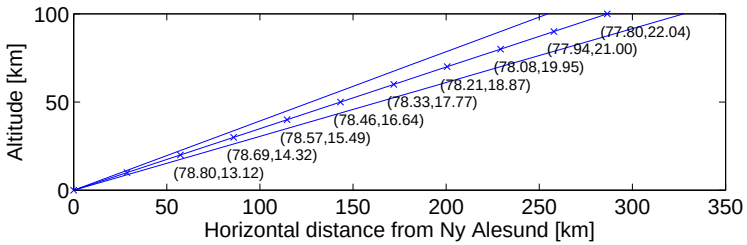
Measurement geometry





- Located on the Spitsbergen archipelago
- Geoposition 78.9N, 11.9E, Altitude 10m
- Elev. 20°, Azi. 113°
- Polar night 30/11 till 27/2
- Polar day 22/4 till 22/8
- Instrument at the AWIPEV research base
- On-site support available (engineer)
- Accessible throughout the year

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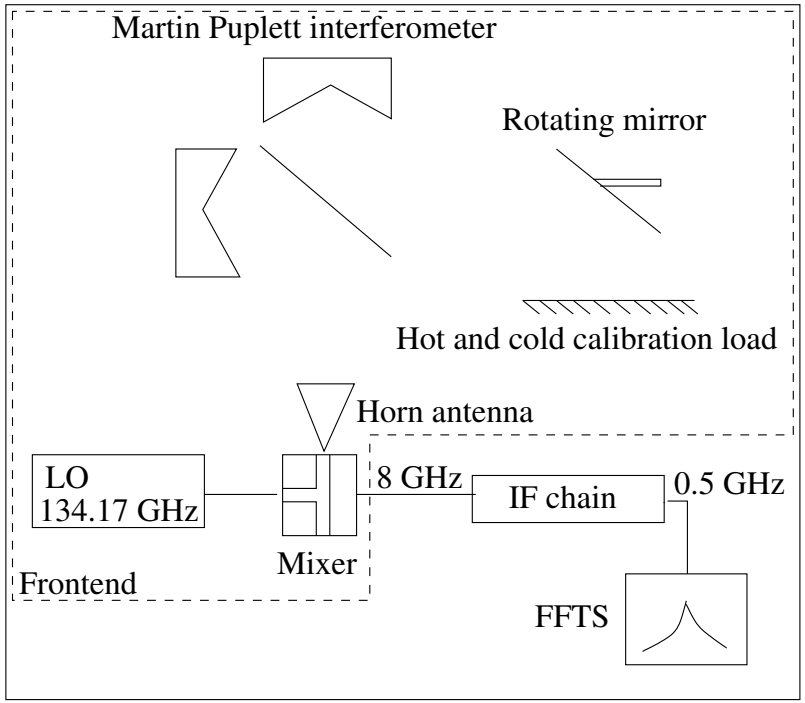
Technical details



- O_3 emission, 142.175 GHz
- Res. 60 kHz, Bandwith 900MHz
- Integration time, 1 hour
- Calibration method: Total power(C:A:H 44:50:6)
- $T_{\mathrm{REC}} \approx 1200K$

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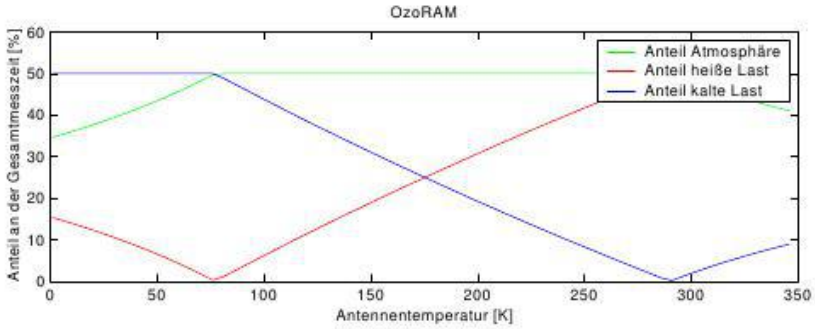
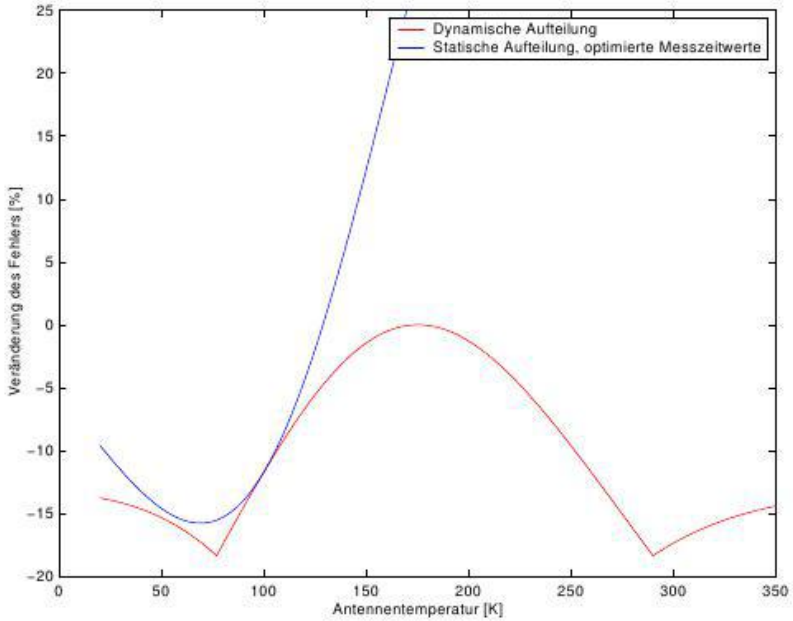
Optimization of measurement cycle (Hoffmann, 2008)



- Total power calibration

$$S = (B(T_H) - B(T_C)) \frac{P_A - P_C}{P_H - P_c} + B(T_C)$$

- Optimal distribution of measurement cycle by error propagation
- Static distribution chosen with optimum at 100 K



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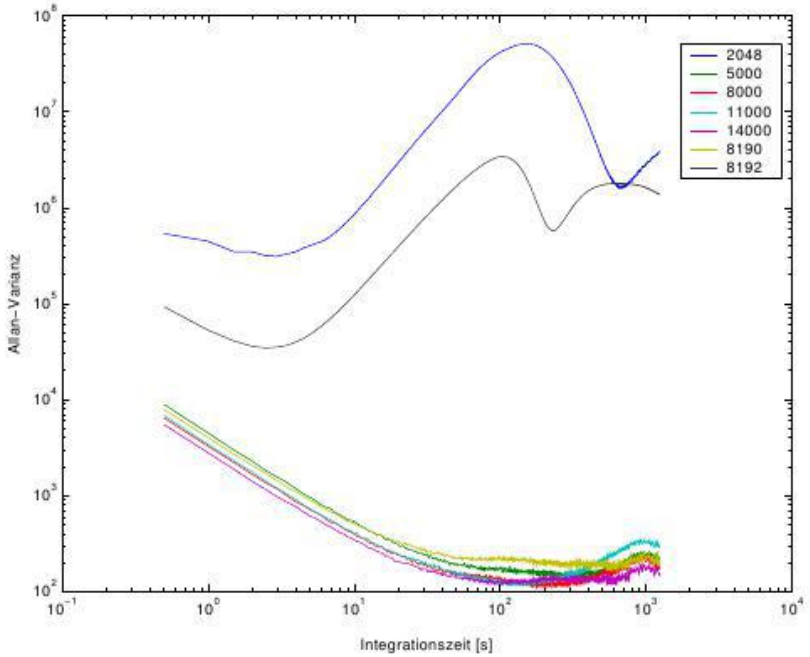
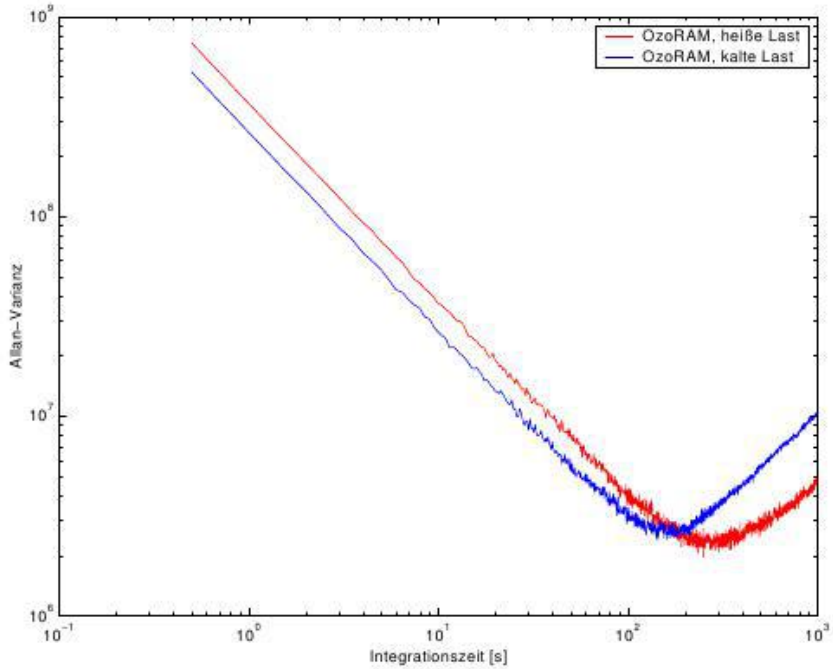
Performance of FFT (Hoffmann, 2008)



- Allan variance time of FFT about 200 s
- Some channels show deviant behavior
- Position of spikes constant



- Allan variance time of OZORAM about 200 s

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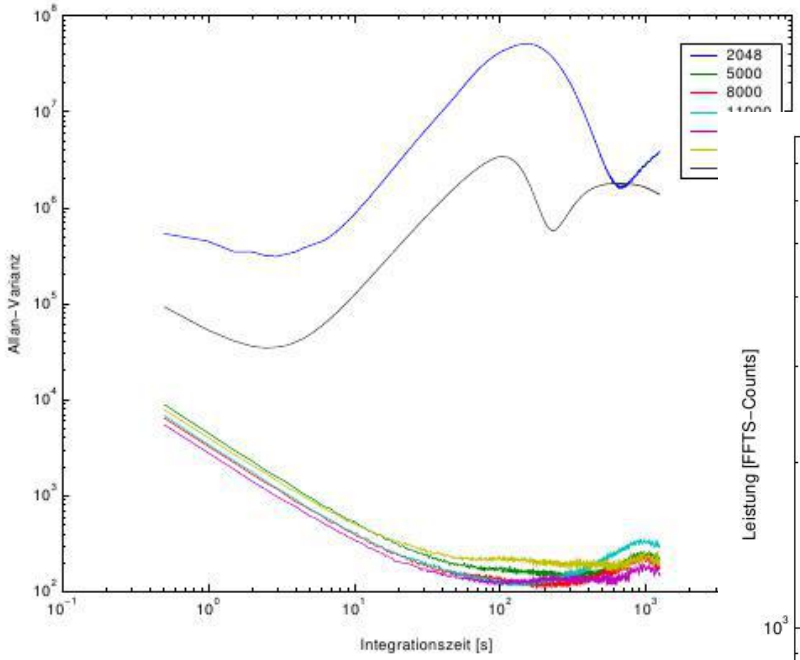
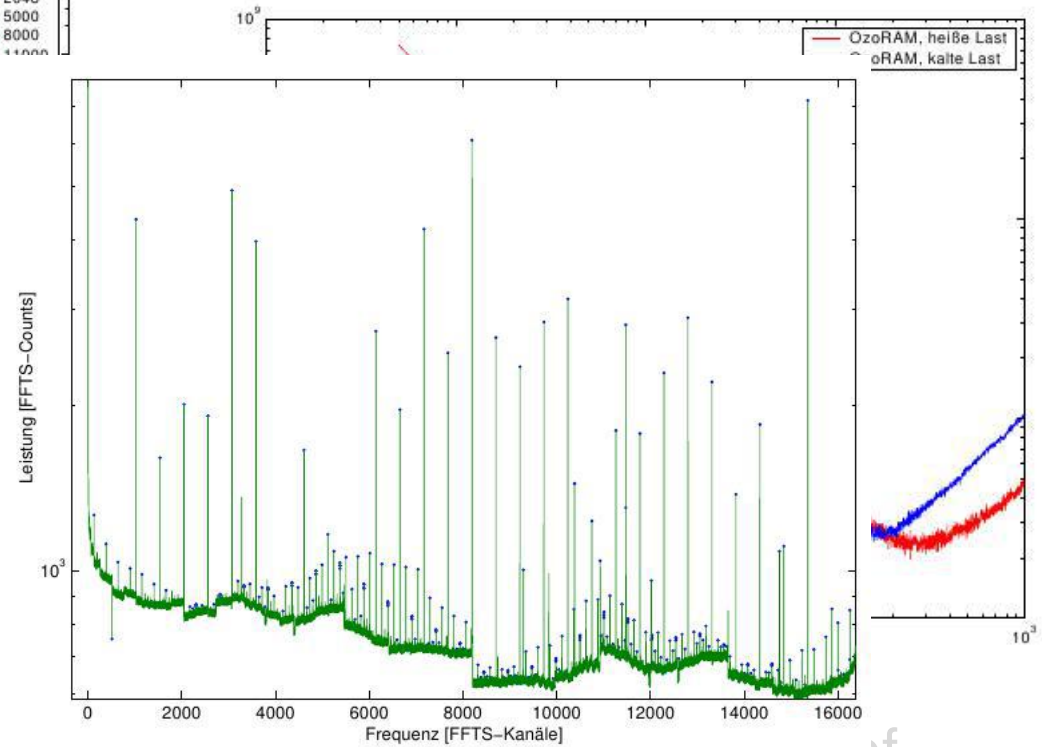
Performance of FFT (Hoffmann, 2008)





- Allan variance time of F about 200 s
- Some channels show deviant behavior
- Position of spikes constant

- Allan variance time of OZORAM about 200 s
- Channels with spikes are masked

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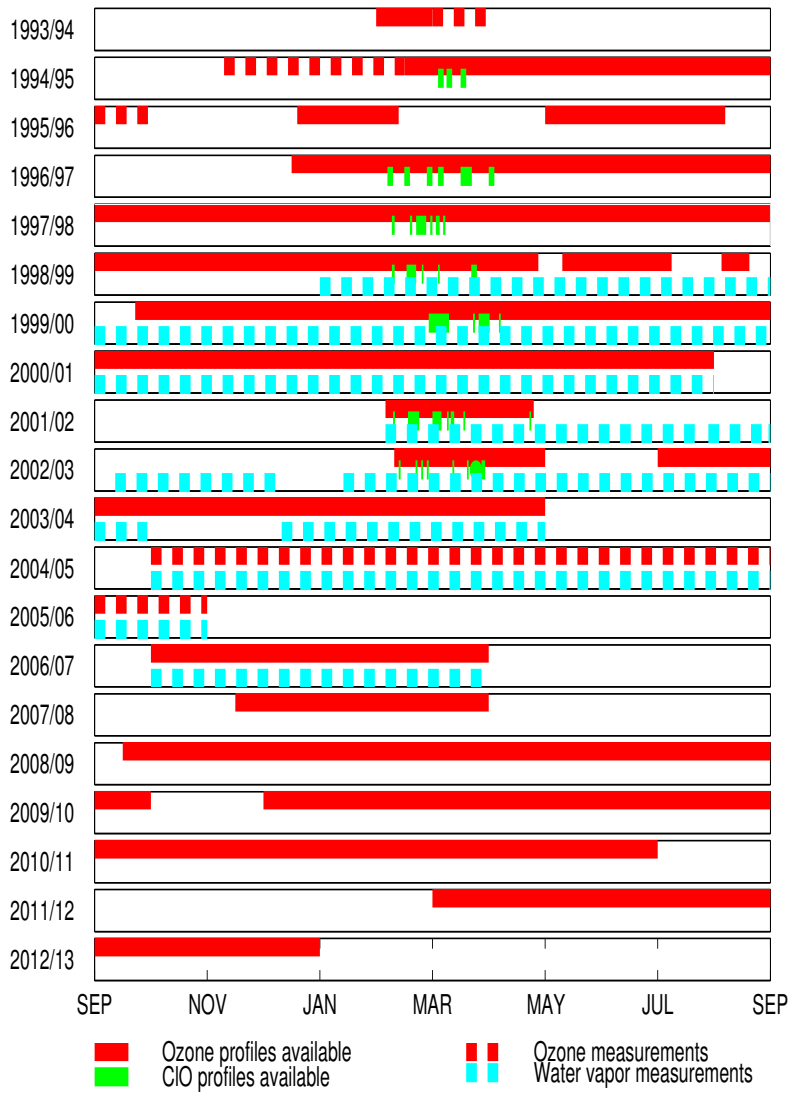

General operation

- Water vapour and ClO radiometer taken out of operation
- AOS spectrometer backend 1994 till 2004
- AOS and CTS spectrometer in parallel in 2006/2007
- O3 measurements using an Acqiris FFTS since end of 2007

Submission to NDACC database

- Regular data once a year (actual up to August 2012).

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Retrieval (Palm et al., 2010a)

- Retrieval using optimal estimation (Rodgers) using ARTS/QPACK
- A priori profile and covariance kept constant
- Noise on measurement calculated for each spectrum
- Retrieval on constant altitude grid 0.5-100.5 km in 1km steps. Pressure grid is adjusted for each spectrum.
- Baseline and background absorption part of the forward model and retrieved together with profile. The background absorption may be used to derive a total water vapor column (Palm et al., 2008; Wohltmann, 2002)
- temperature and pressure up to 0.001 hPa (ca 70-80 km) taken from ECMWF operational
- line intensity from JPL 2009, other parameters empirically determined (taken from ARTS package)
- Error calculation for temperature profile, spectroscopy and calibration parameters.

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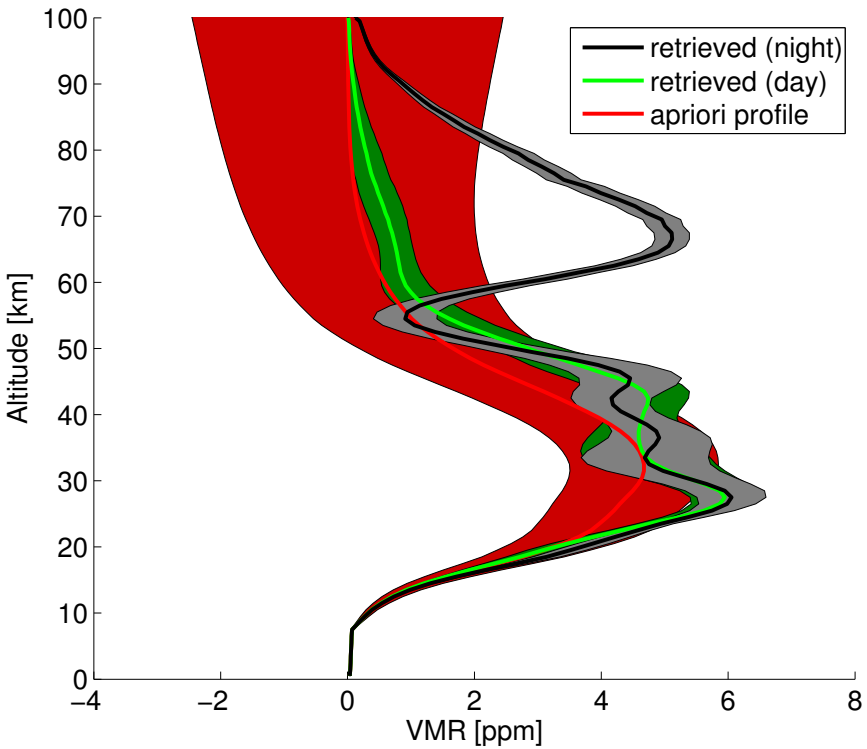
Example of OZORAM measurements (Palm et al., 2010a)



- 25th February 2009 at 0 UTC (black) and noon (green)
- a priori profile and covariance in red
- total error for profiles

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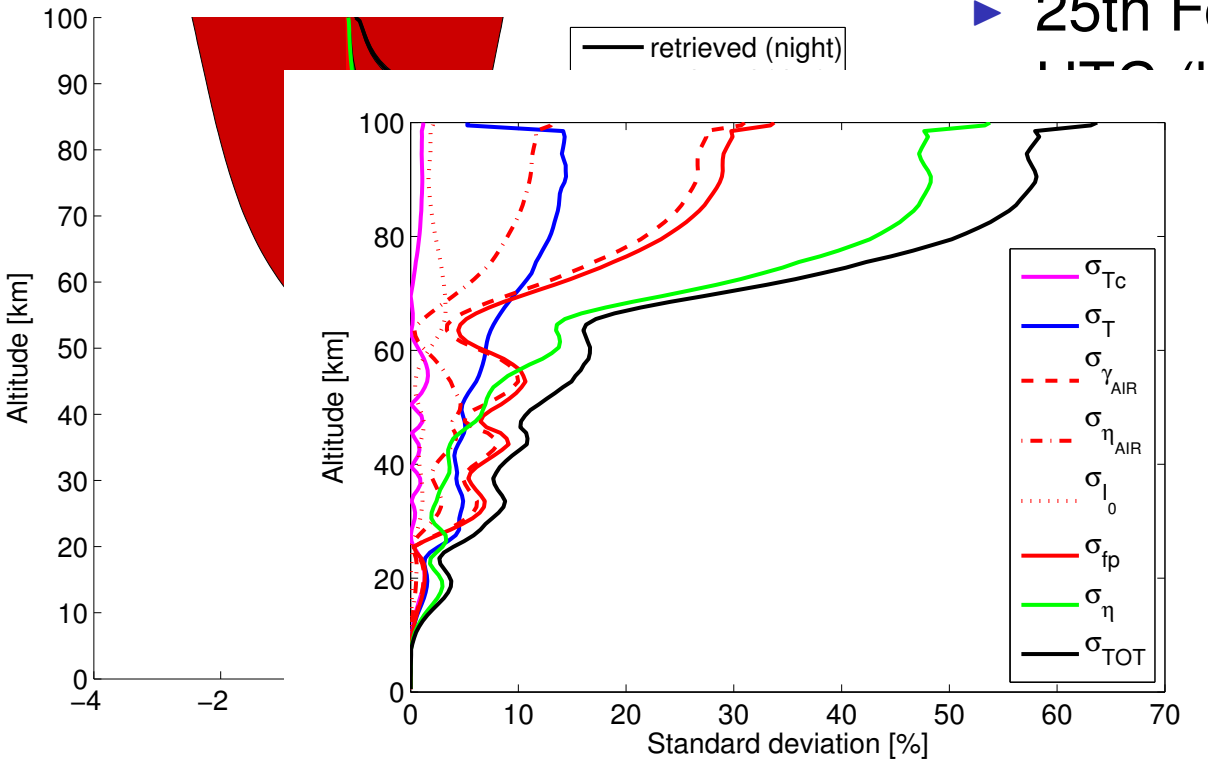
Example of OZORAM measurements (Palm et al., 2010a)



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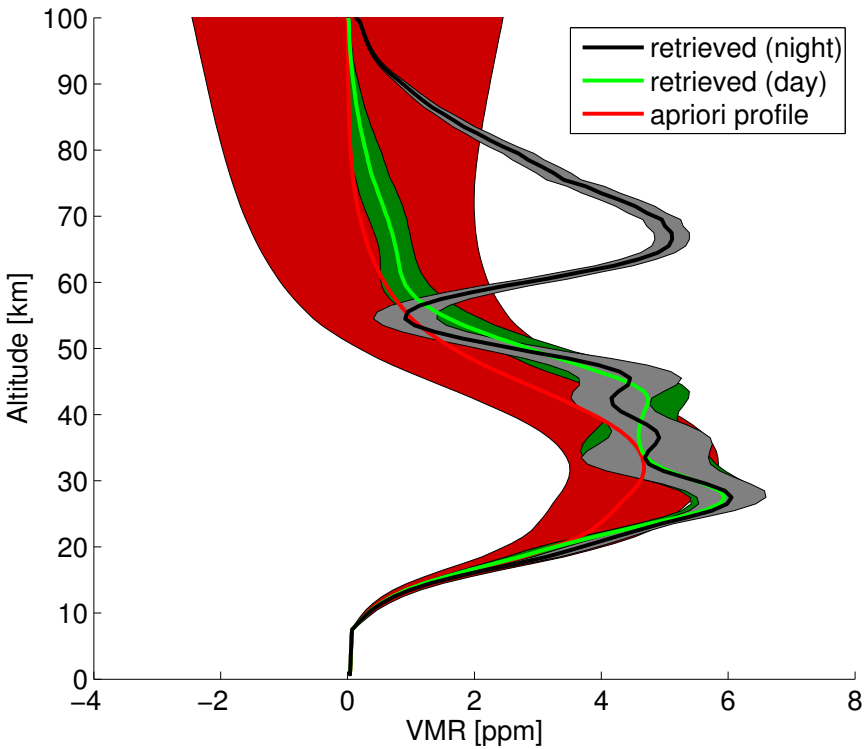
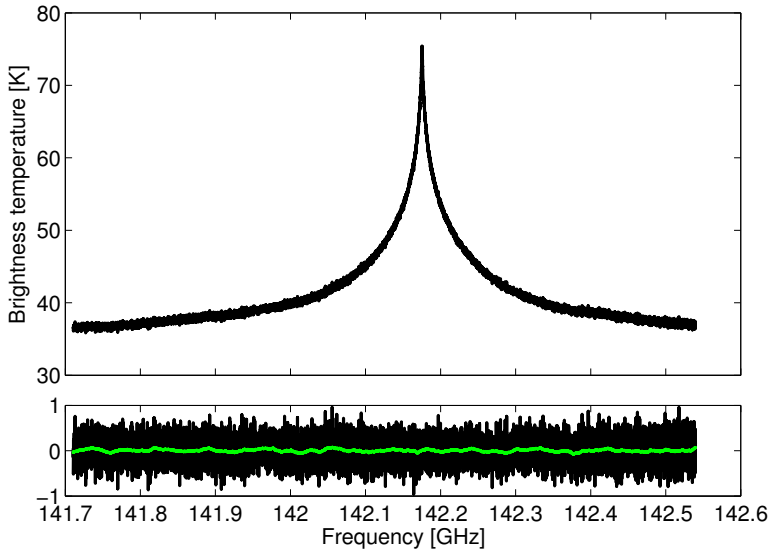
Example of OZORAM measurements (Palm et al., 2010a)



- spectrum during nighttime
- running mean in green (on residuum)

- 25th February 2009 at 0 UTC (black) and noon (green)
- a priori profile and covariance in red
- total error for profiles



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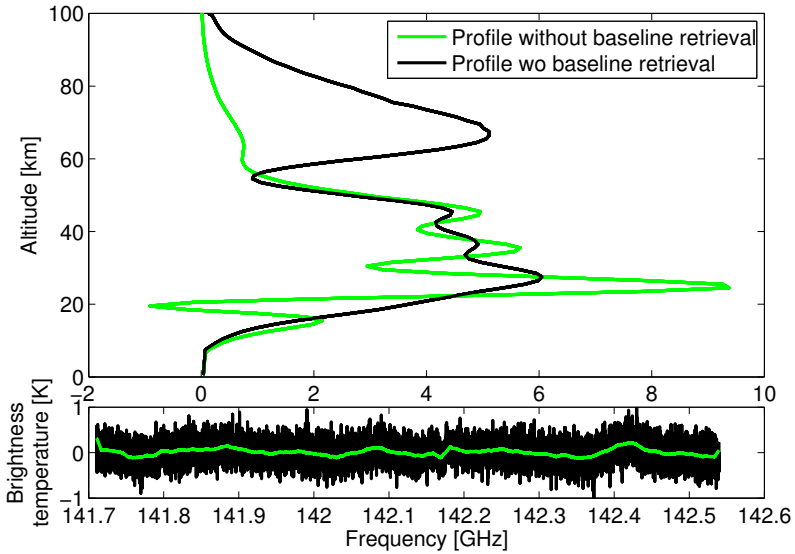
Baseline retrieval



- Spectrum from 12th Feb 2009, 0 UTC
- Retrieval of all baseline features switched off (green line)
- Justification of baseline retrieval by comparison with independent measurements.

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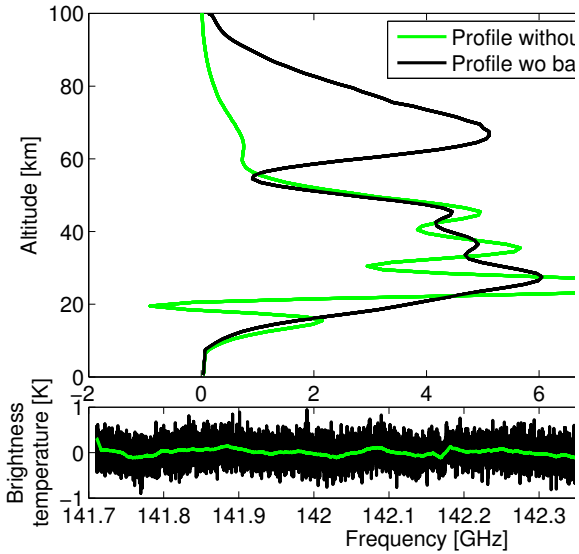
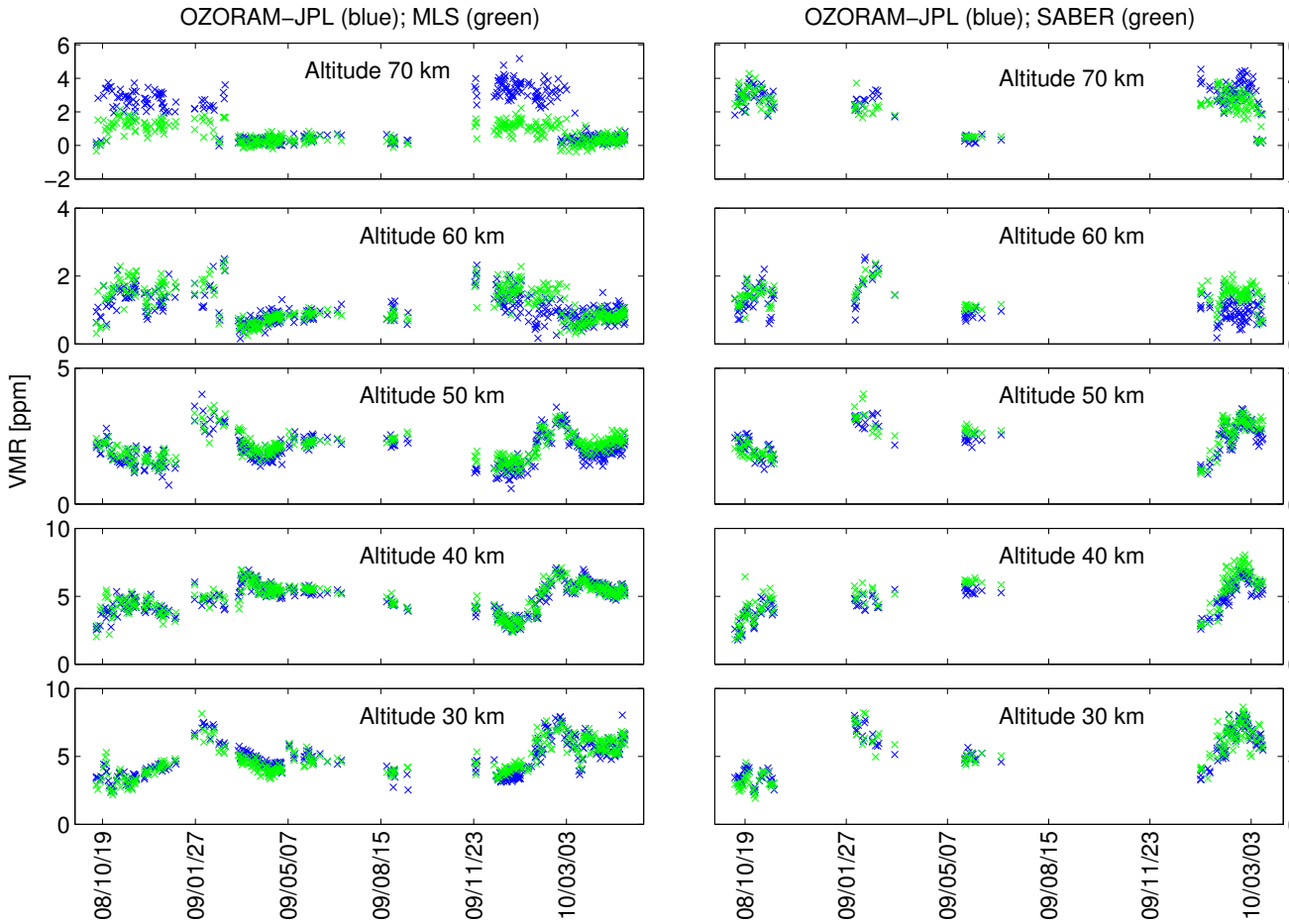
Baseline retrieval





(green: MLS)

- Justification of baseline retrieval by comparison with independent measurements.

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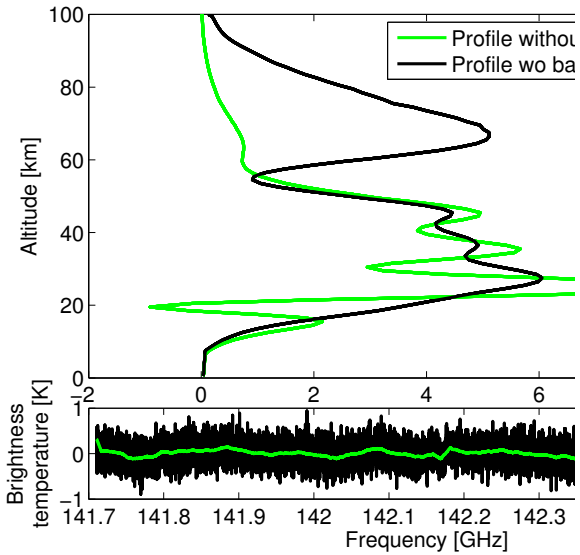
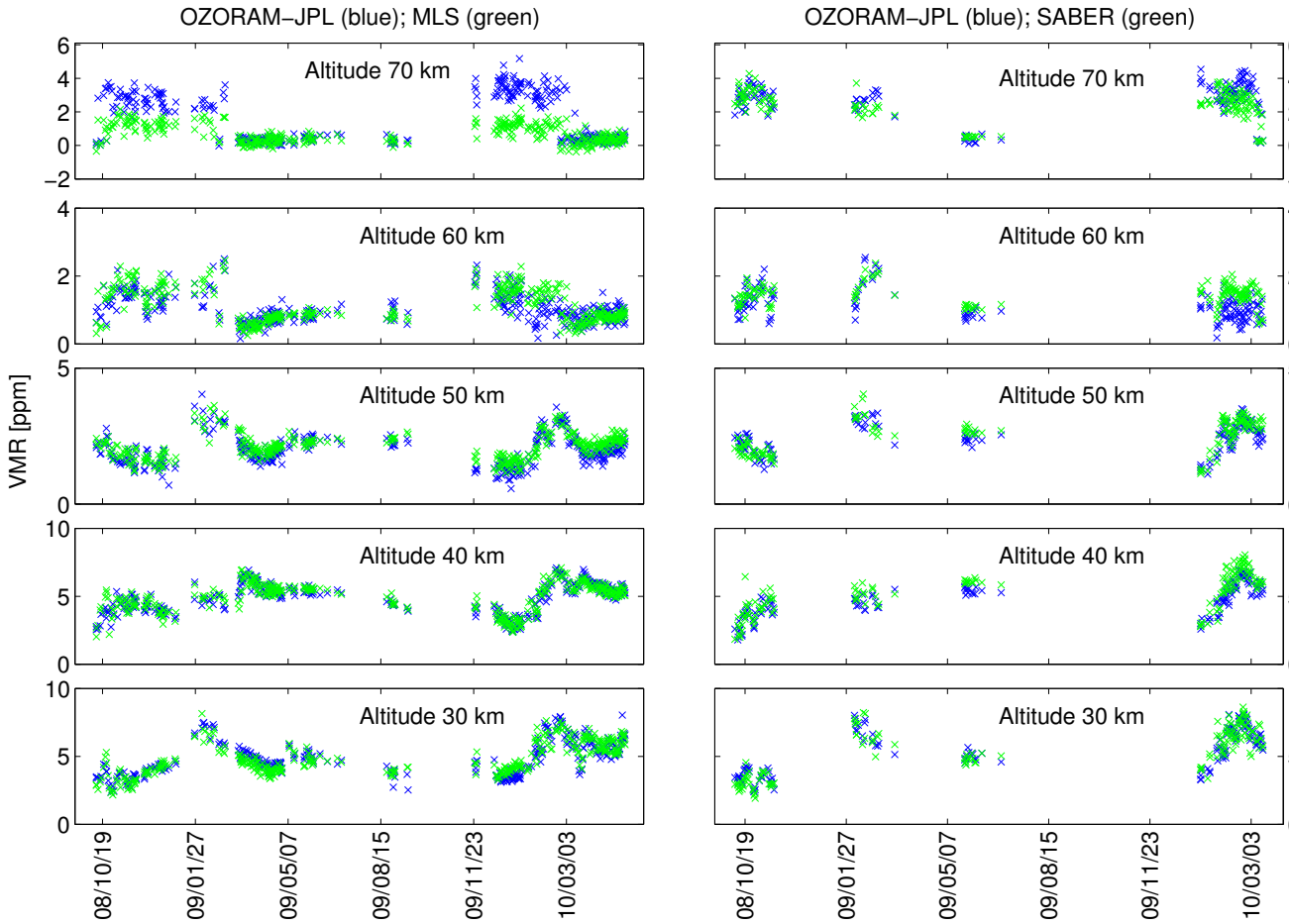
Baseline retrieval





The OZORAM Baseline consists of:

- 9 sine functions with fixed frequencies, amplitude (1K variance) and phase (free) retrieved

- Justification of baseline retrieval by comparison with independent measurements.

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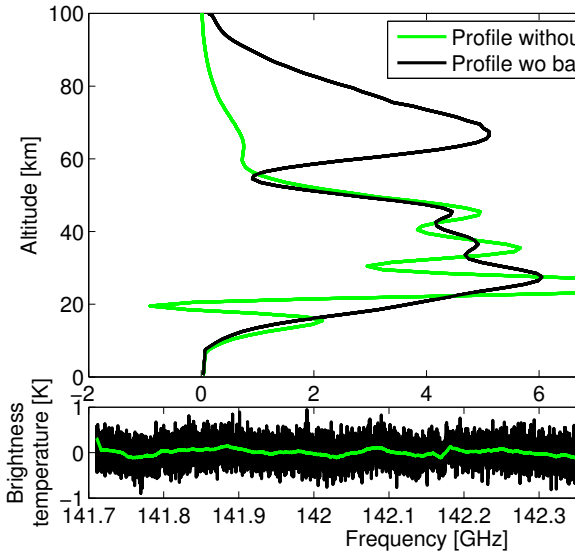
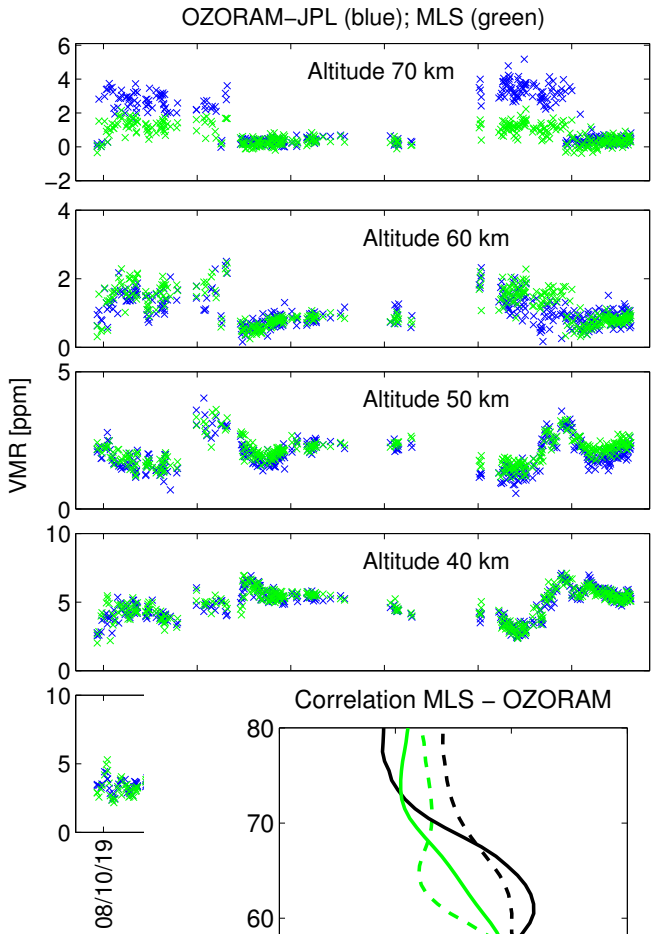
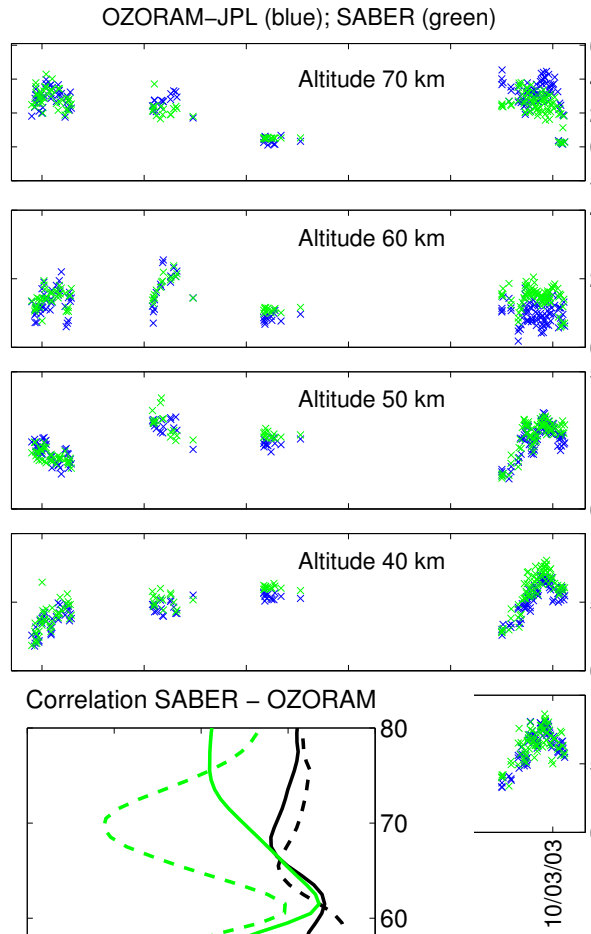
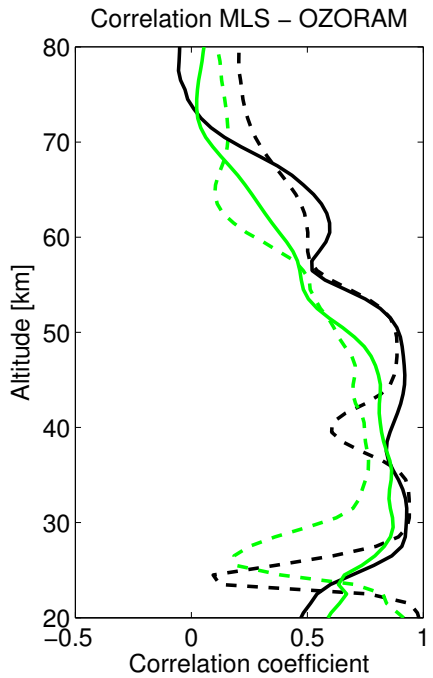
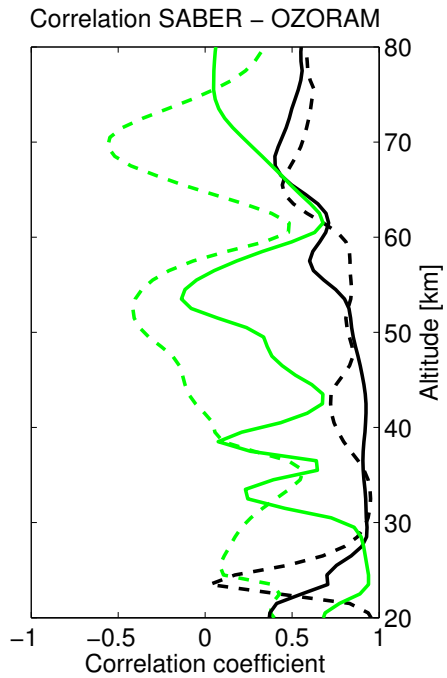
Baseline retrieval











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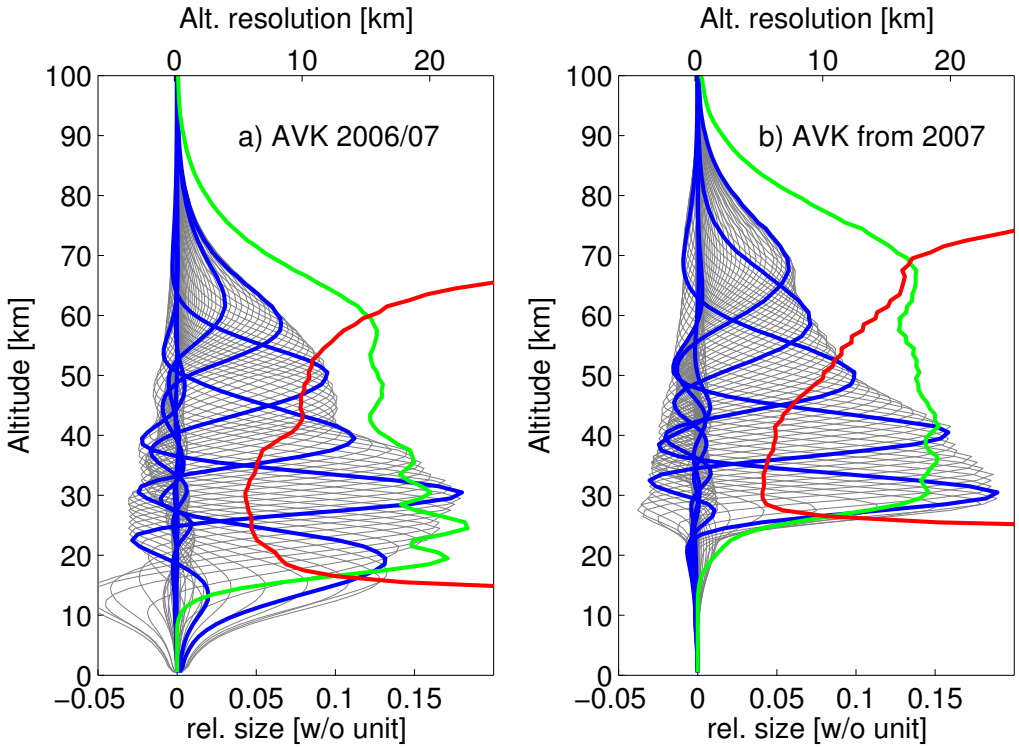
Averaging kernels



red: FWHM of Gaussian approximation of AVK.

green: Sum of AVK

thick blue: AVK for retrieved value every 5 km

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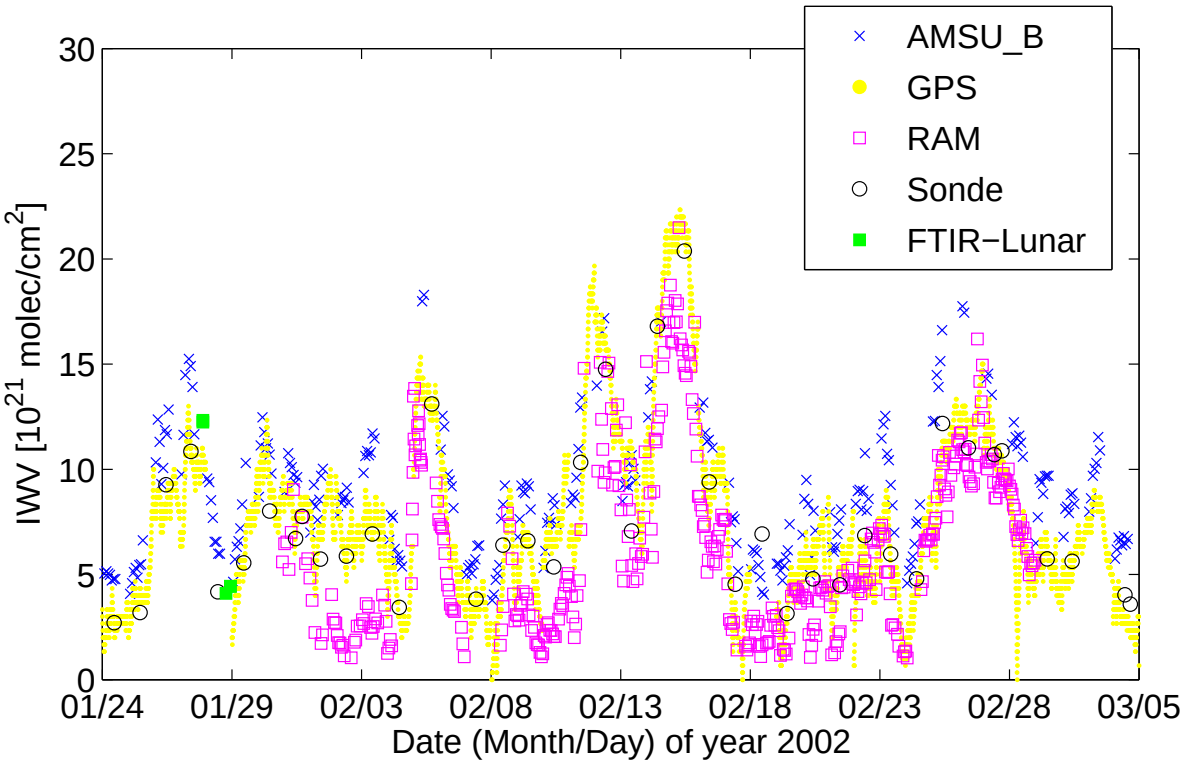
Total water vapor (Palm et al., 2008)

- Calculated from absorption coefficient τ using the empirical formula

$$c = \frac{\tau - \tau_{O_2}}{\alpha_{H_2O}}$$

- In case of saturation a correction is applied.



Mérida

- operational until 2009, Mountain top on Pico Espejo became inaccessible.
- Only O3 has been analyzed (Belova et al., 2008; Kopp et al., 2009, and others)
- H_2O suffer from baseline artifacts and are only in preliminary state
- Available are spectra of ClO, N_2O and HNO_3
- Spectra are planned to be retrieved using ARTS/QPACK and made public.

Summary and outlook

- OZORAM in Ny Ålesund in routine operation
- Spectra recorded in Mérida, Venezuela "inherited" from Gerd Hochschild (KIT Karlsruhe)

- Operation of OZORAM and TRARA will be continued
- New CO radiometer proposed, decision in Spring
- Mérida spectra will be analyzed and made available in Kooperation with KIT Karlsruhe,

Publications I

Belova, Alla et al. (2008). “Five-day planetary waves as seen by the Odin satellite and the ground-based Kiruna millimeter wave radiometer in January – March 2005”. In: *Can. J. Phys.* 86, pp. 459 –466. DOI: 10.1139/P07-172.

Hoffmann, Christoph (2008). “Optimierung der Mikrowellenradiometer OzoRAM und WaRAM”. MA thesis. Universität Bremen.

Klein, U. et al. (2002). “Ozone depletion and chlorine activation in the Arctic winter 1999/2000 observed in Ny-Ålesund”. In: *J. Geophys. Res.* 107.D20, p. 8288. DOI: 10.1029/2001JD000543.

Klein, Ulf et al. (2000). “Winter and Spring Observations of Stratospheric Chlorine Monoxide from Ny-Ålesund, Spitsbergen, in 1997/98 and 1998/99”. In: *Geophys. Res. Lett.* 27.24, pp. 4093 –4097.

Kopp, G et al. (2009). “Inner-tropical ozone measurements at the Mérida Atmospheric Research Station (MARS) using ground-based microwave radiometry”. In: *International Journal of Remote Sensing* 30.15–16, pp. 4019 –4032.

Palm, M. et al. (Aug. 2005). “Intercomparison of O_3 profiles observed by SCIAMACHY and ground based microwave instruments”. In: *Atmos. Chem. Phys.* 5, pp. 2091–2098.

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Publications II

Palm, Mathias et al. (2013). “Influence of Solar Radiation on the Diurnal and Seasonal Variability of O_3 and H_2O in the Stratosphere and Lower Mesosphere, Based on Continuous Observations in the Tropics and the High Arctic”. In: *Climate and Weather of the Sun-Earth System (CAWSES)*. Ed. by Franz-Josef Lb̈ken. Springer Atmospheric Sciences. 10.1007/978-94-007-4348-9_8. Springer Netherlands, pp. 125–147. ISBN: 978-94-007-4348-9. DOI: 10.1007/978-94-007-4348-9_8. URL: http://dx.doi.org/10.1007/978-94-007-4348-9_8.

Rohen, G. J. et al. (2007). “Ozone profile retrieval from limb scatter measurements in the HARTLEY bands: methodology, algorithm description, sensitivity studies, and validation”. In: *ACPD* 7.4, pp. 12097–12143. ISSN: 1680-7367. URL: http://www.atmos-chem-phys-discuss.net/7/12097/2007/.

Rohen, G. J. et al. (2008). “Ozone profile retrieval from limb scatter measurements in the HARTLEY bands: further retrieval details and profile comparisons”. In: *Atmos. Chem. Phys.* 8, pp. 2509 –2517. URL: www.atmos-chem-phys.net/8/2509/2008/.

Sinnhuber, Björn-Martin et al. (1998). “Ground based millimeter-wave observations of Arctic ozone depletion during winter and spring of 1996/97”. In: *Geophys. Res. Lett.* 25.17, pp. 3327–3330. DOI: 10.1029/98GL52488.

Wohltmann, Ingo (2002). “Ozone depletion, chlorine activation and water vapor observed in Spitsbergen”. PhD thesis. Universität Bremen.