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Federal Department of Home Affairs FDHA
**Federal Office of Meteorology and Climatology MeteoSwiss**

# Analysis of the long-term profile ozone measurements of MeteoSwiss

E. Maillard Barras, R. Stübi, MeteoSwiss, Payerne

- Payerne ozone sounding series
- Arosa Umkehr series
- Microwave SOMORA ozone series

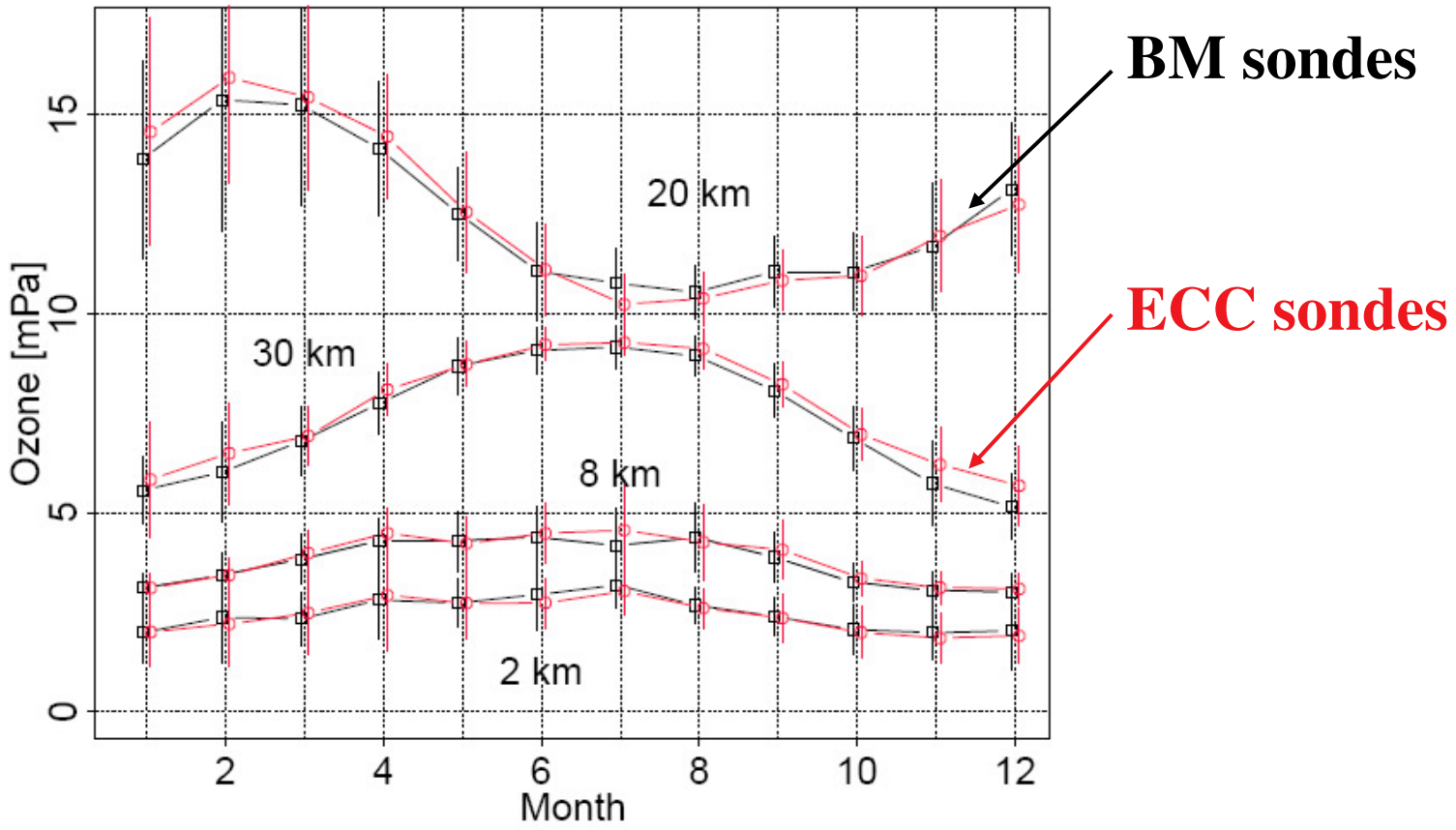
# Ozone sounding from Payerne

| | |
|---|---|
| continuously operated since 1968 (1966) | time resolution: 3 profiles/week |
| ozone profiles from 0 to ~32 km | vertical resolution: 100 m |
| 1 instrumental change | 2002: Brewer-Mast to ECC sonde |

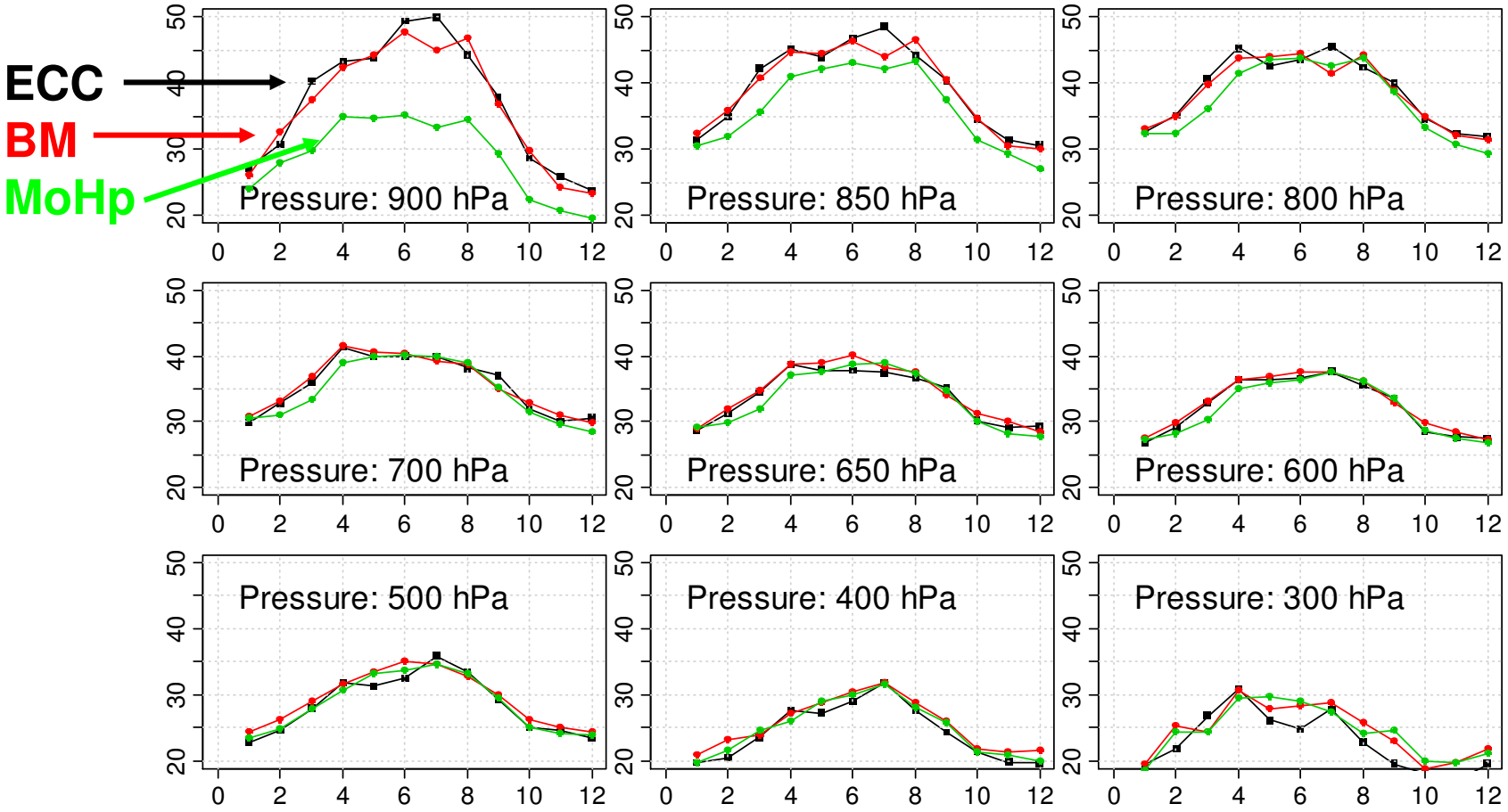
- The BM data series have been described in Jeannet et al. (2007),
  - Ozone balloon soundings at Payerne (Switzerland): Reevaluation of the time series 1967–2002 and trend analysis, J. Geophys. Res., 112, D11302, doi:10.1029/2005JD006862.
- The transition from BM to ECC has been described in Stübi et al. (2008),
  - In-flight comparison of Brewer-Mast and electrochemical concentration cell ozonesondes, J. Geophys. Res., 113, D13302, doi:10.1029/2007JD009091
- Comparison of the series with:
  - Hohenpeissenberg BM series
  - Jungfraujoch high alpine station data

# Transition BM to ECC sondes: annual cycles

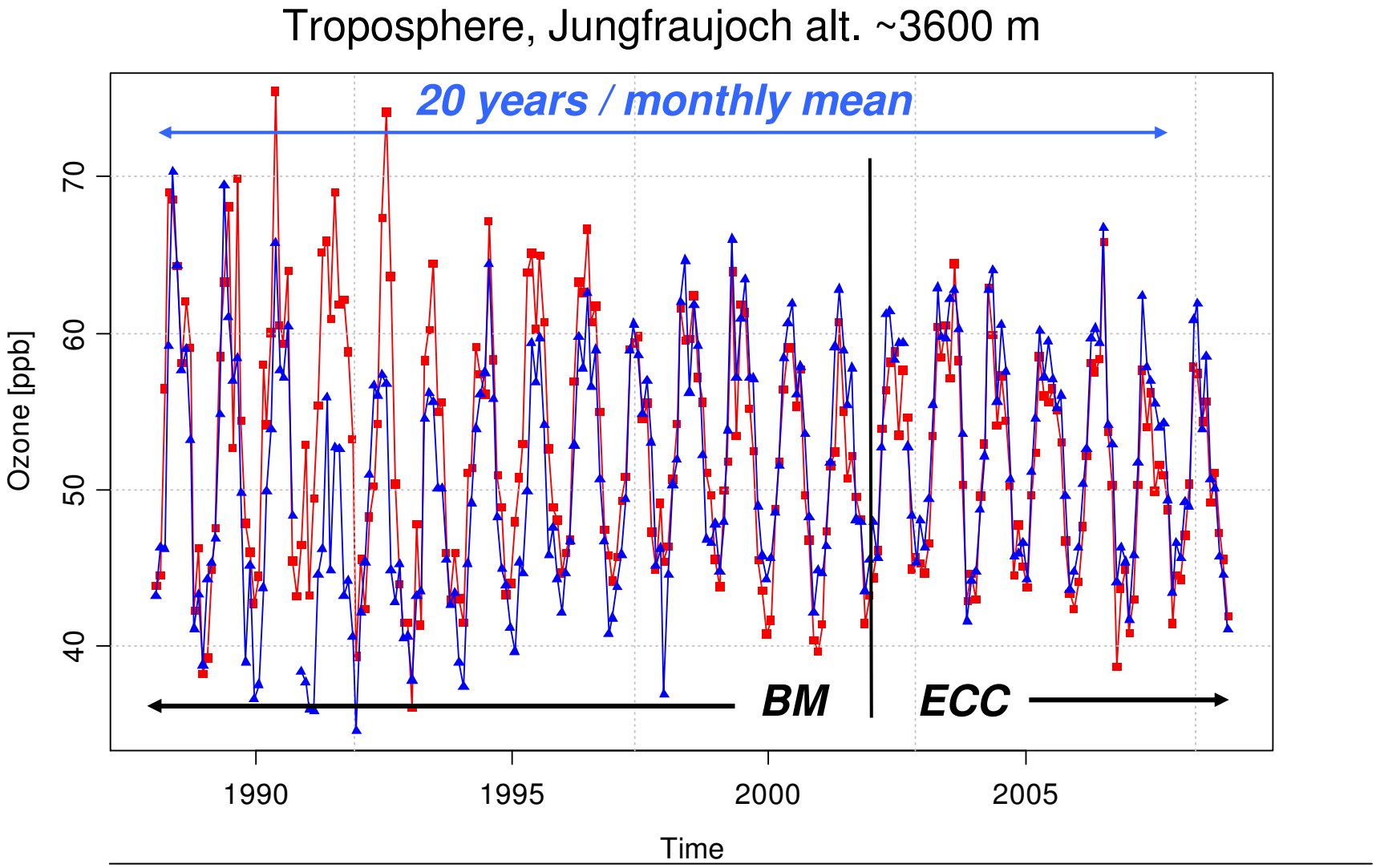
- Annual cycles over “last 7 years of BM ” and “first 7 years of ECC”
- No significant difference between BM and ECC periods



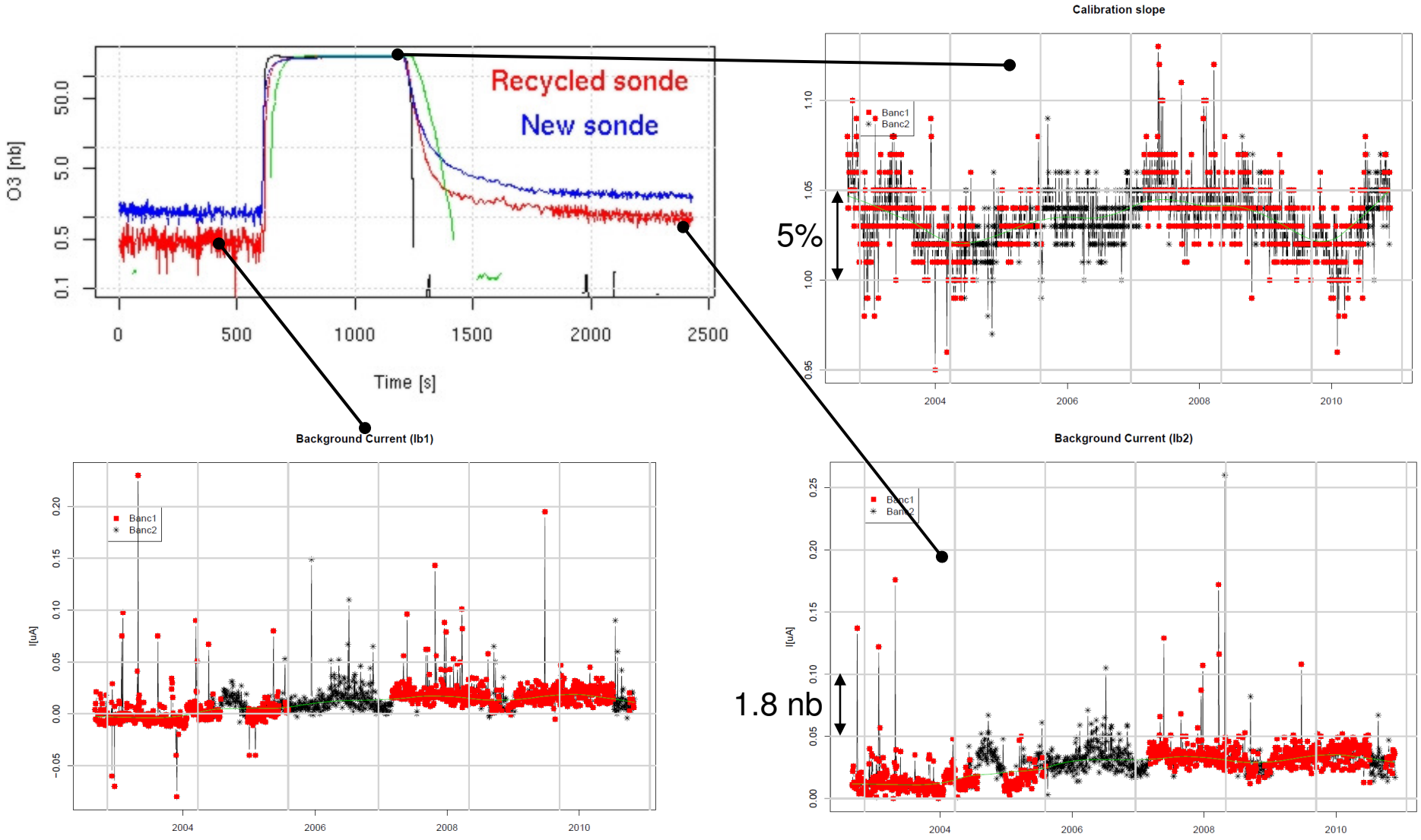
# Tropospheric annual cycles: Payerne vs. MOHp



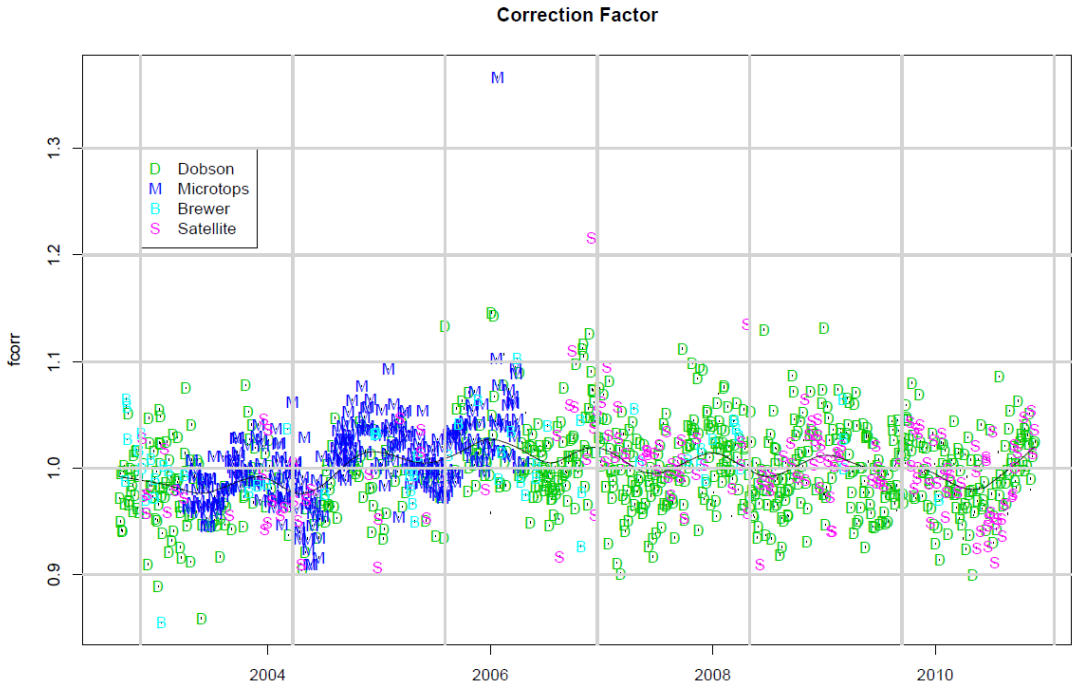
# Coincident data: Sondes vs. Alpine station JFJ

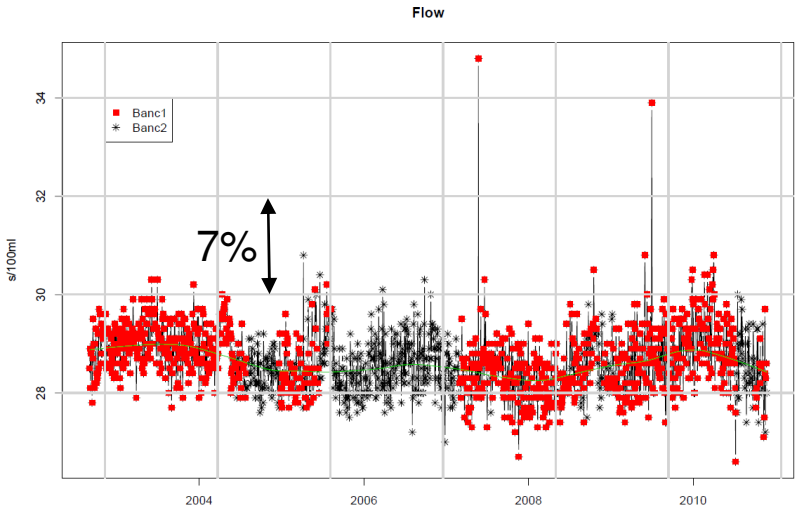


# Laboratory controlled parameters: bg, high O3, …



# QC parameters: pump flow rate, correction factor

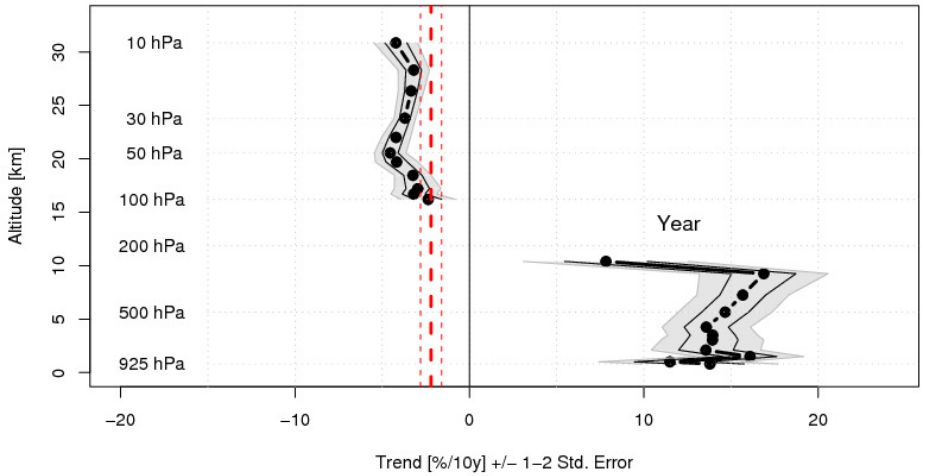


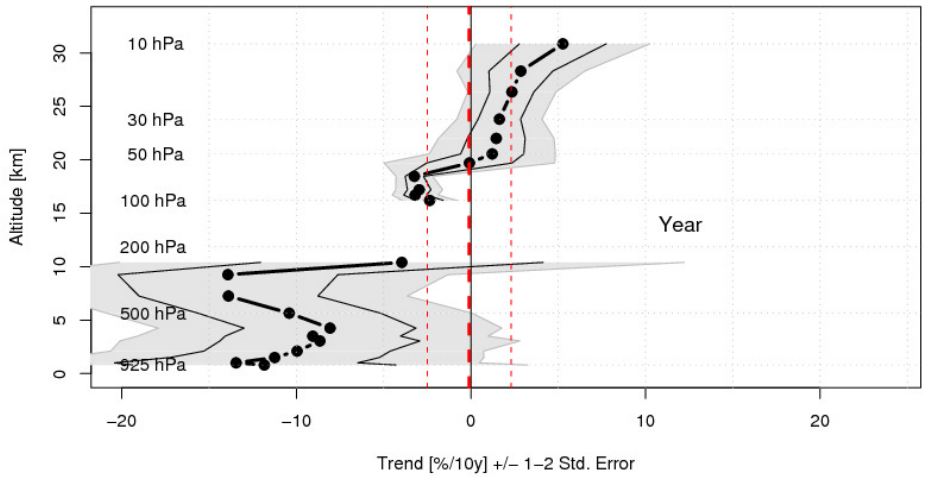



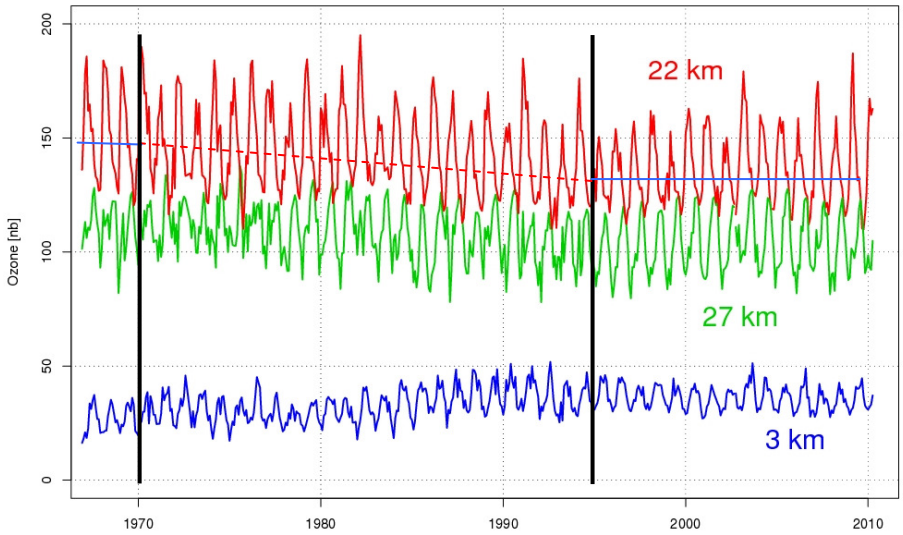

- Ozone is proportional to flow rate
- Stability of the production

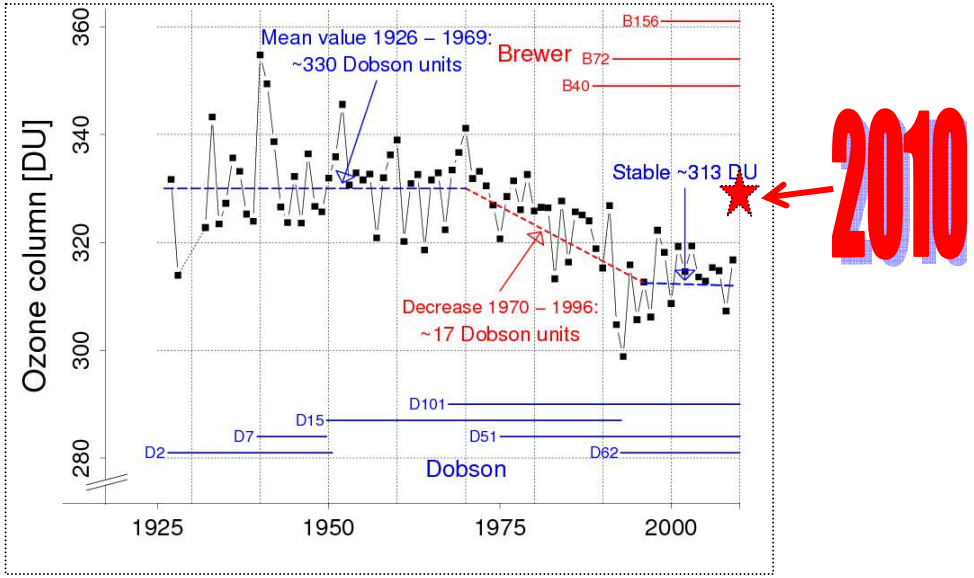
- Agreement with an independent ozone column measurement: 1.0 +/- 0.2

# Ozone trends 1970-1995 vs. 1996-2009




Jeannet et al.(2007), JGR,2005JD006862

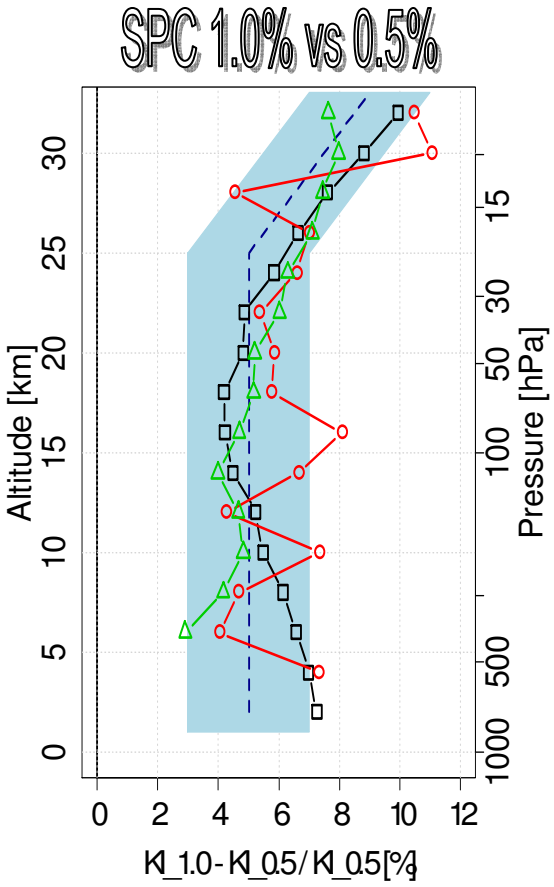
# Correction for change of solution conc.

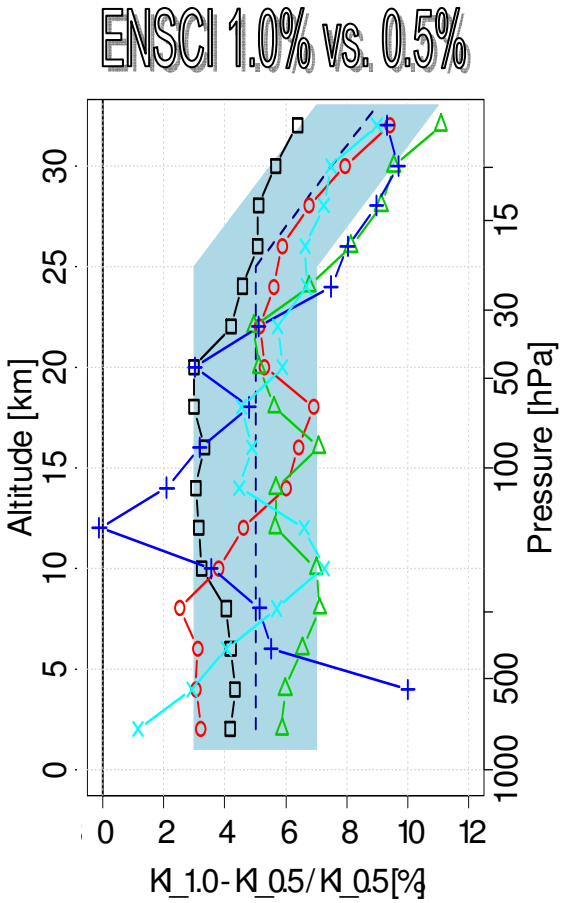
- **First order transfer functions for ECC sondes from field campaigns**

=> correcting the data (+/- 2%) for changes of provider / solution conc.

- Difference 0.5 % => 1.0 %: 5% up to 25 km + add 1% / 2km above
- Difference SPC-1% and ENSCI-0.5%: not significant (1%)
- Difference ENSCI => SPC with 1%: 3% till 25km + add 1.5% / 2 km above.

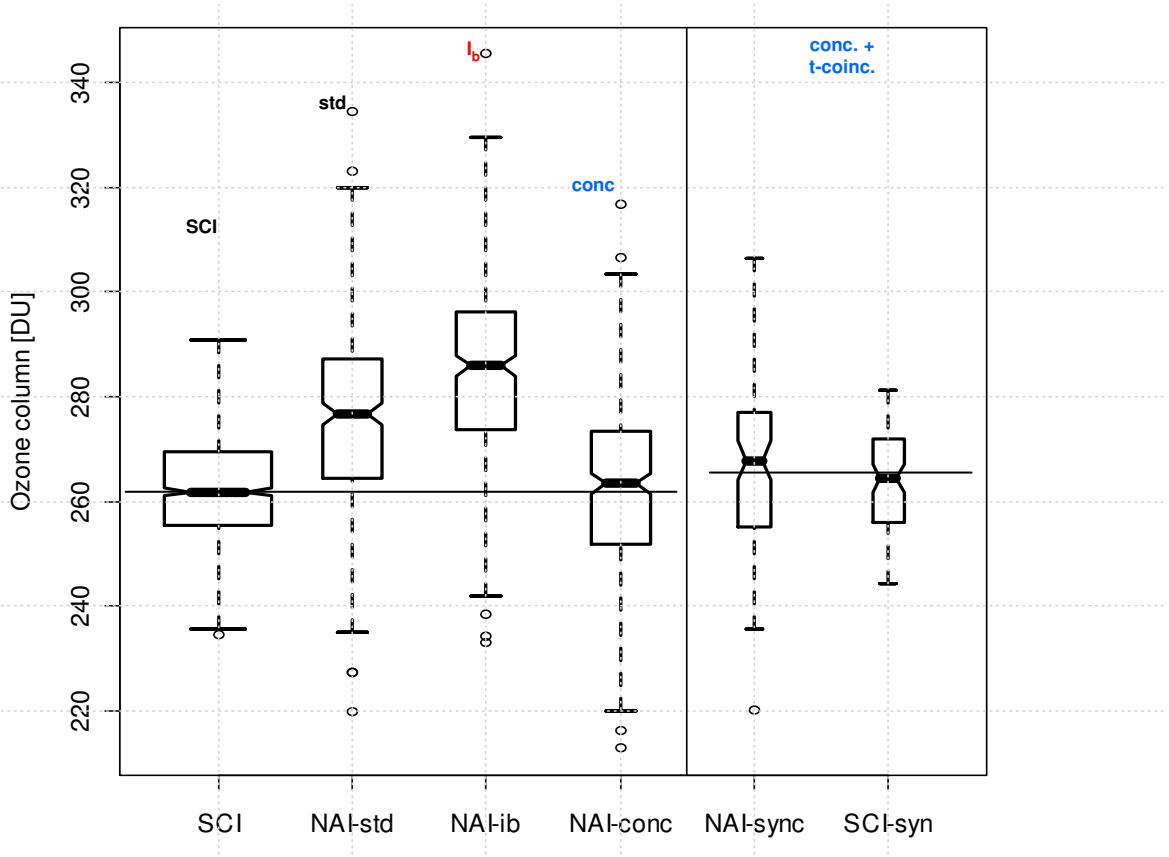
New JOSIE campaign 2009-2010 to check the recent ECC production.



# Correction for change of sol. conc. at Nairobi

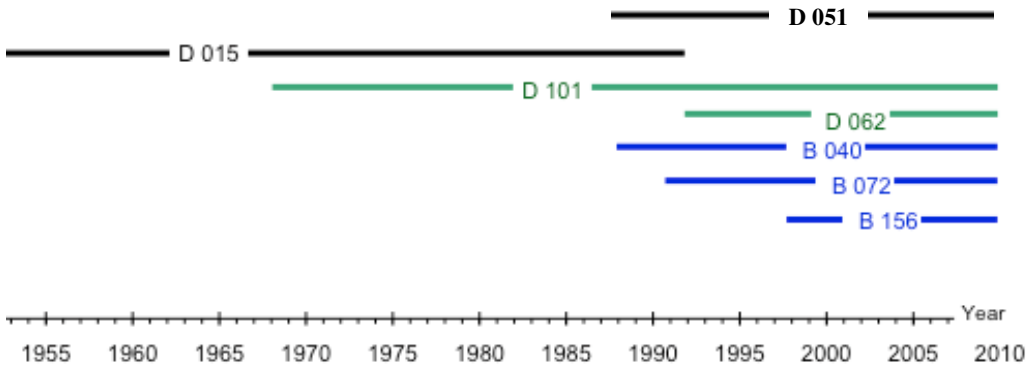
- Mean ozone column from SCIAMACHY overpasses
- Mean ozone column from last 7 years of O3-sonding (NAI-std) + conc. correction / back-ground correction

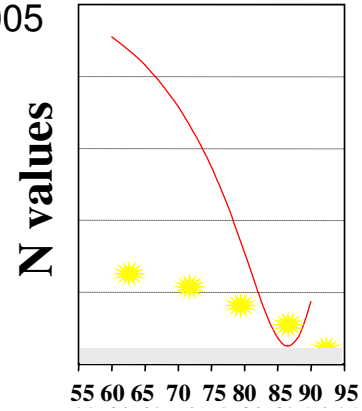


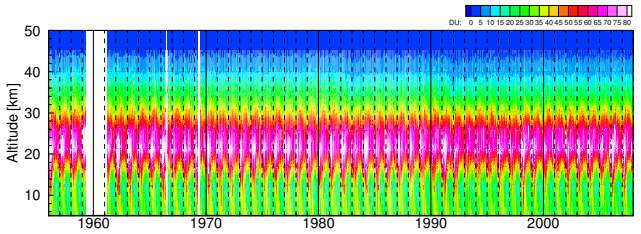
# Umkehr by Dobson sun spectrophotometer

| | |
|---|---|
| continuously operated since 1956 (1966) | time resolution: 2 prof./day (sr and ss) |
| ozone profiles from 10 to 50 km | vertical resolution: 10-15 km |
| 1 instrumental change | 1988: D15 to D51 |

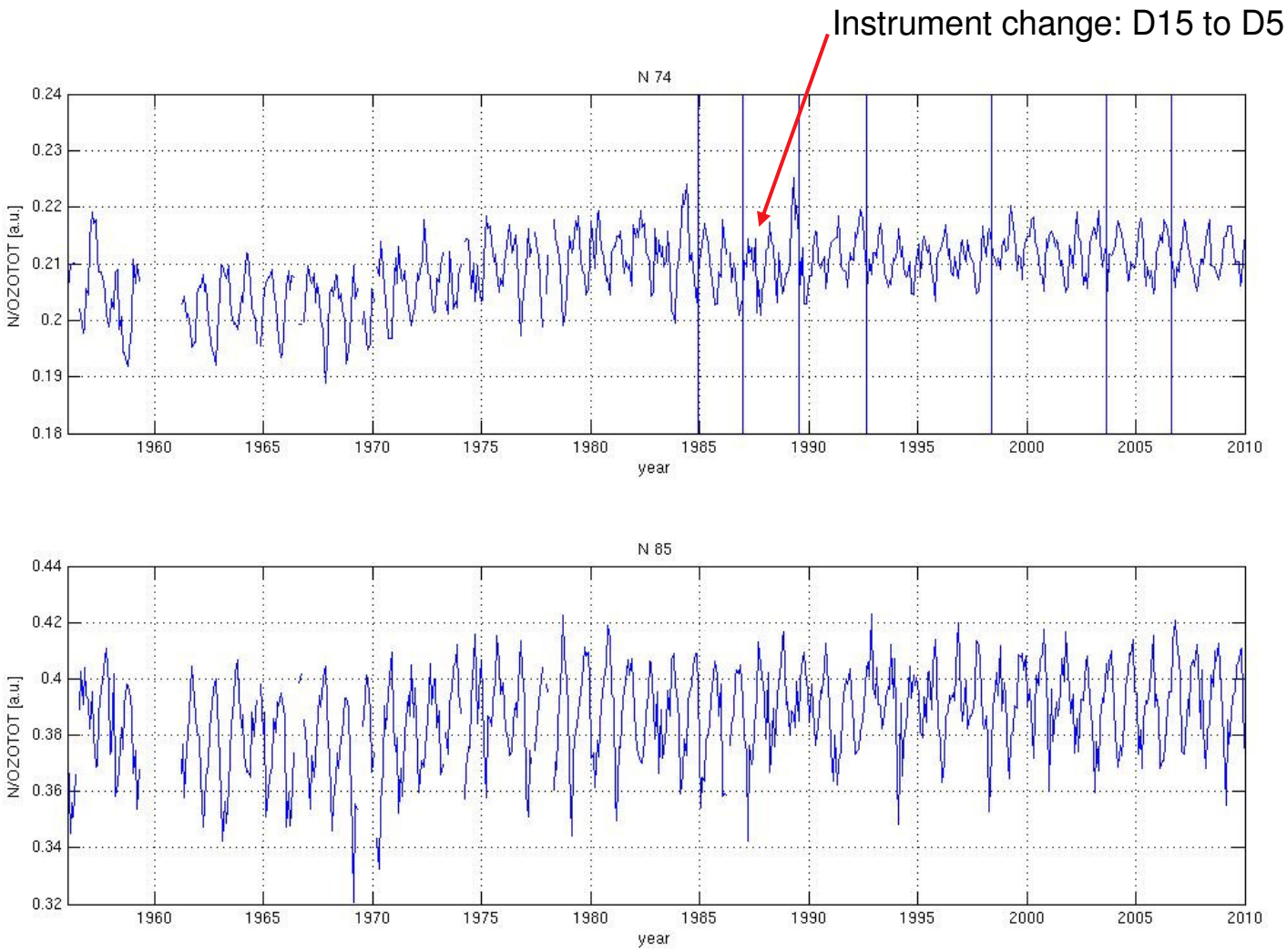
- Retrieval of ozone profiles: umkv8 of Irina Petropavlovskikh based on OEM by Rodgers
  described in GRL, VOL. 32, L16808, doi:10.1029/2005GL023323, 2005
- Quality control by redundant measurements



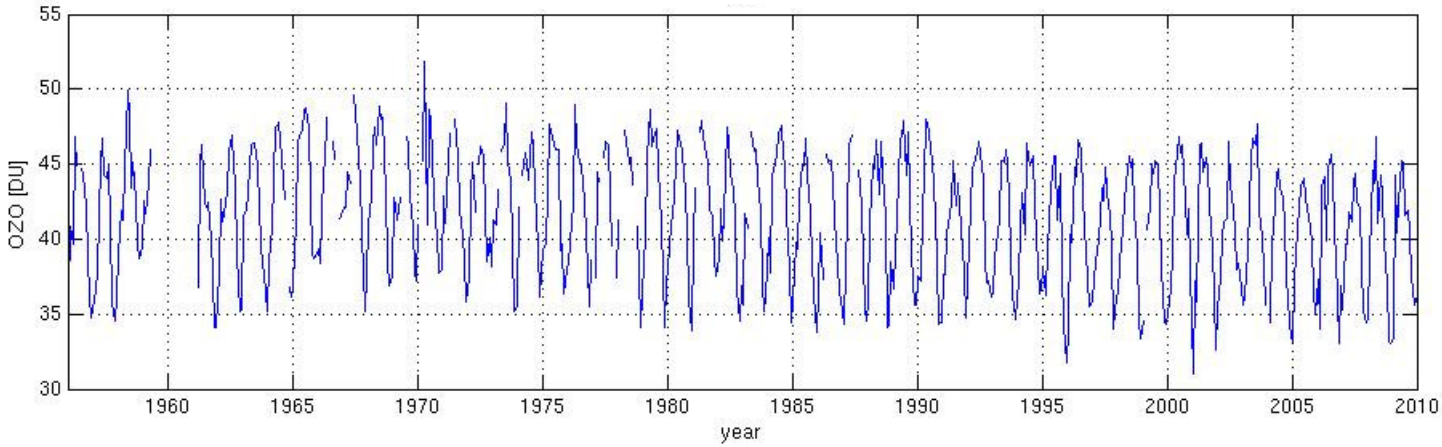



# Umkehr by Dobson: N-values QC ...

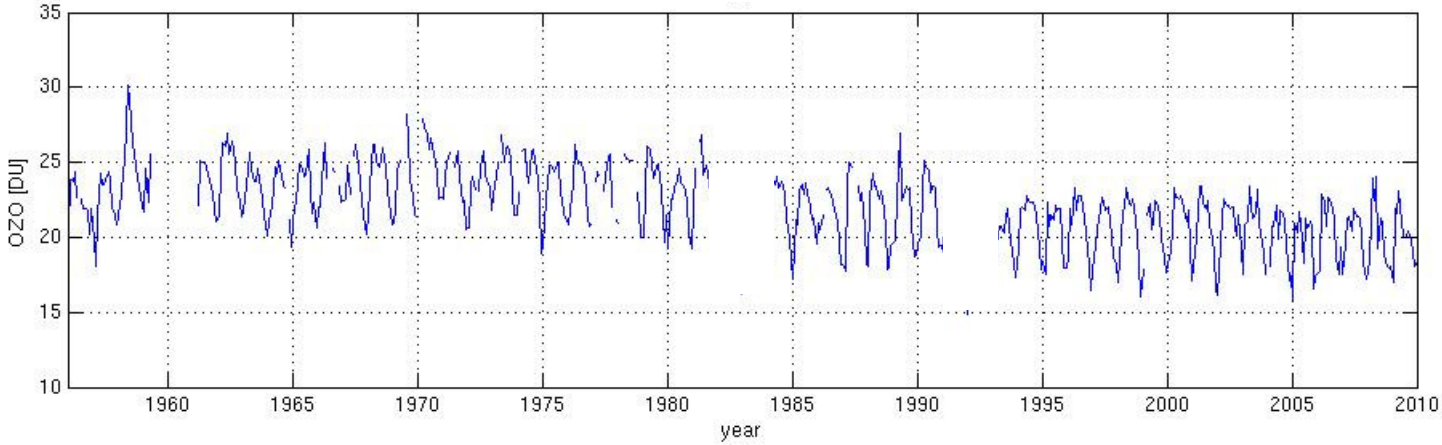


# Umkehr by Dobson: O3 time series ...

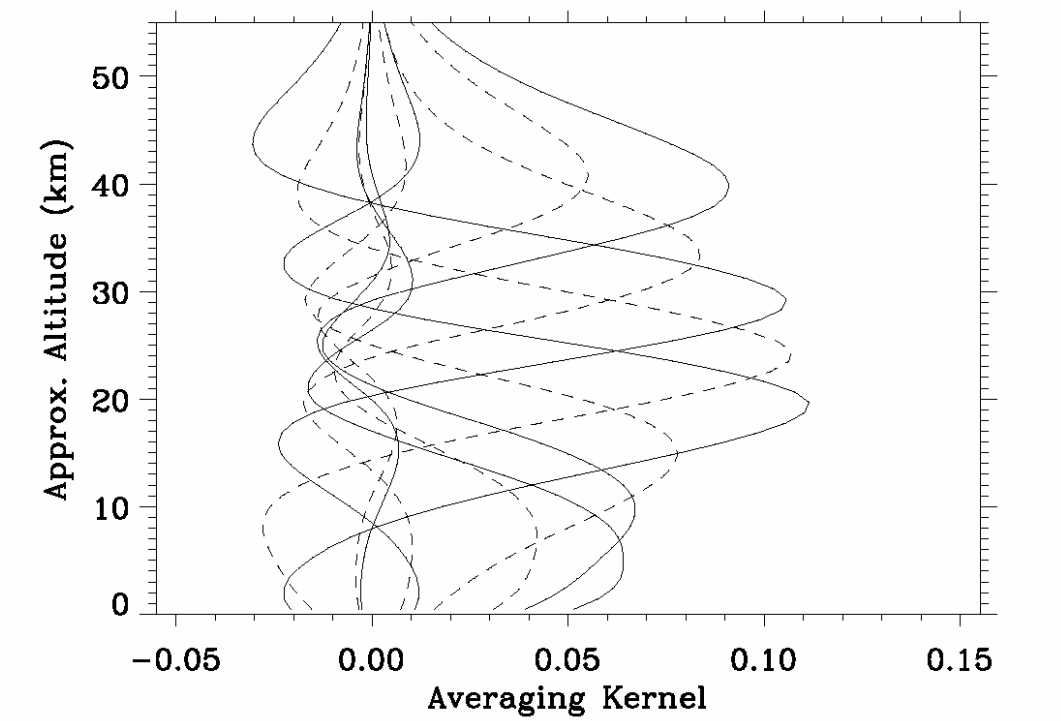
L6: 16hPa – 8 hPa




L7: 8hPa – 4 hPa



# Umkehr by Dobson: intercomparison results

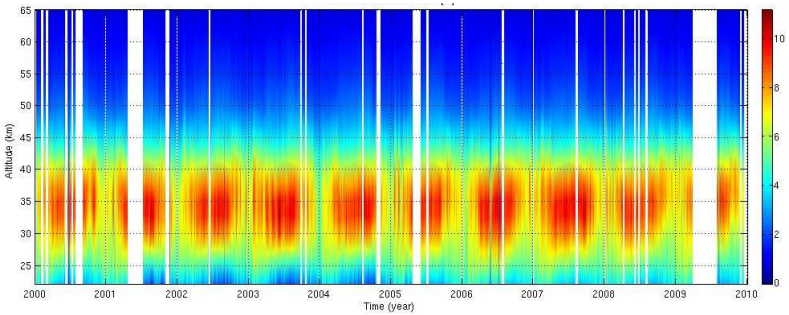


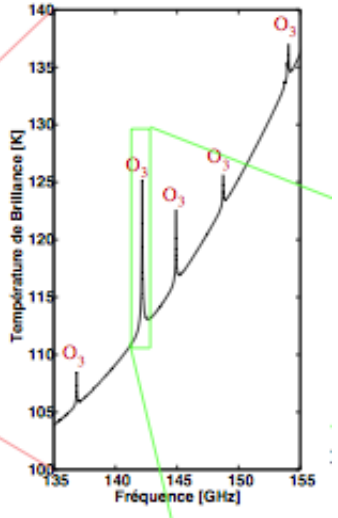

- ***GAW report No. 180***: Towards a Better Knowledge of Umkehr Measurements: A Detailed Study of Data from Thirteen Dobson Intercomparisons,
  I. Petropavlovskikh, R. D. Evans, G. L. Carbaugh, E. Maillard and R. Stubi

# Ozone microwave radiometer SOMORA

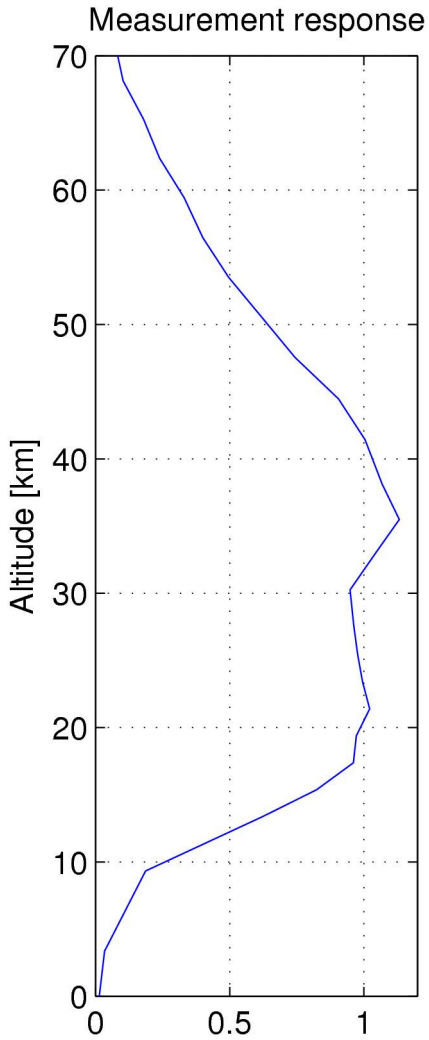
| | |
|---|---|
| continuously operated since 2000 | time resolution: 30 minutes |
| ozone profiles from 20 to 65 km | vertical resolution: 8 -15 km |
| 2 major instrumental changes | 2005 : front-end change<br>2009 : spectrometer change from AOS to FFT |

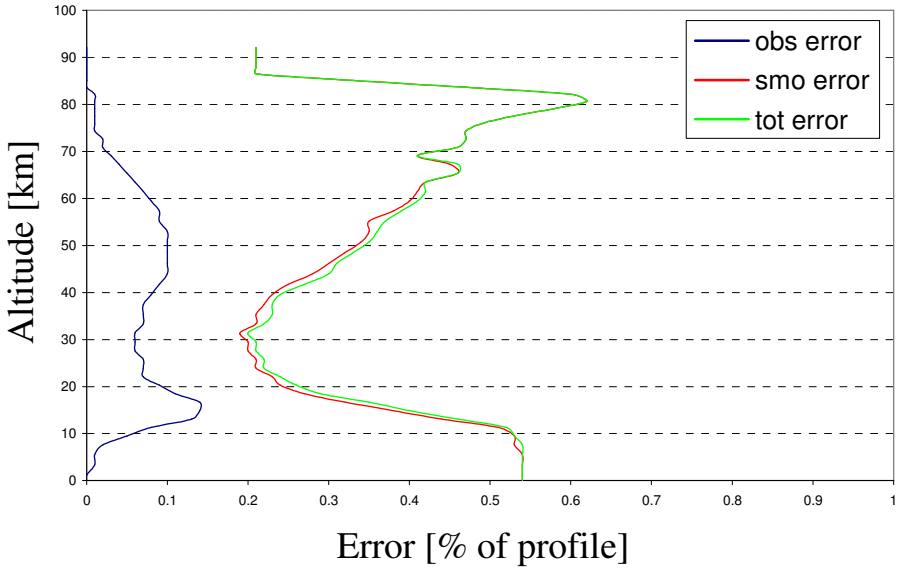
- Retrieval of ozone profiles: ARTS/Qpack based on OEM described in
  - ERIKSSON, P., et al, 2005, Journal of Quantitative Spectroscopy & Radiative Transfer, 91, 47–64
- Redundancy with GROMOS radiometer at University of Bern (1995 - now)



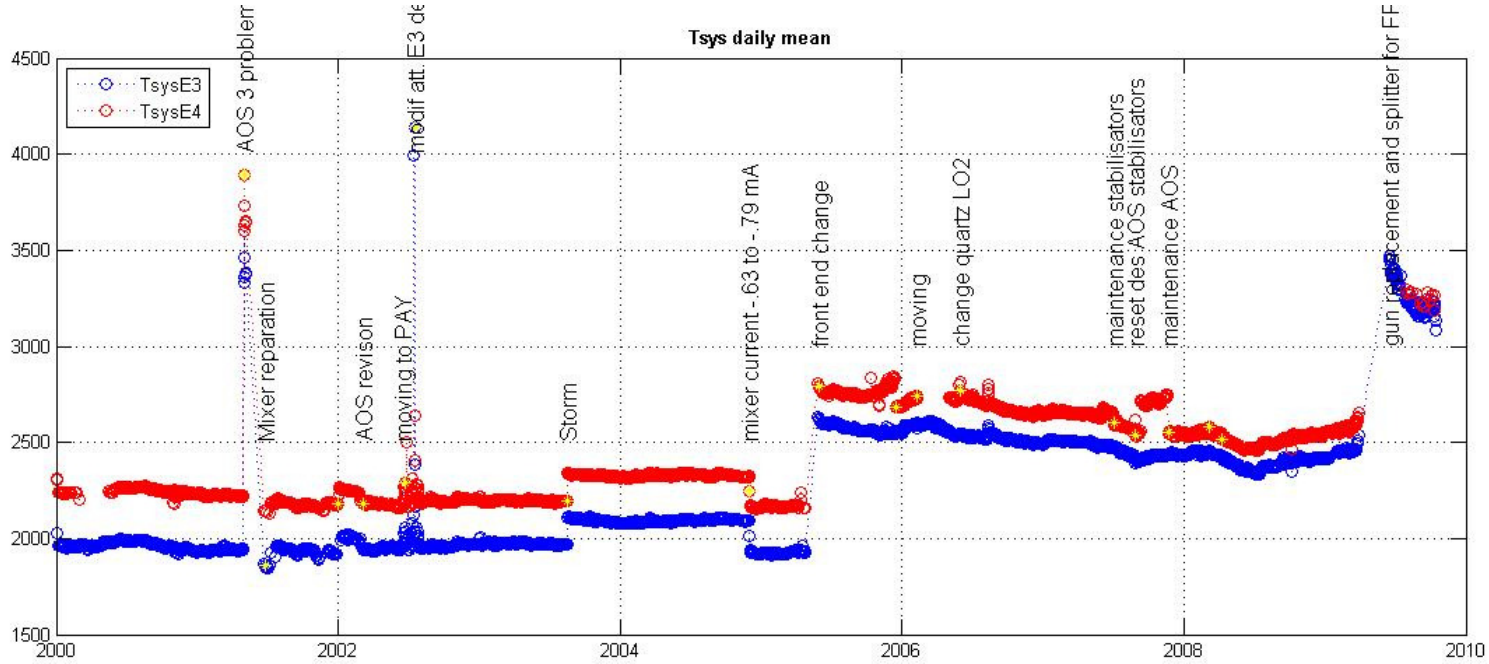



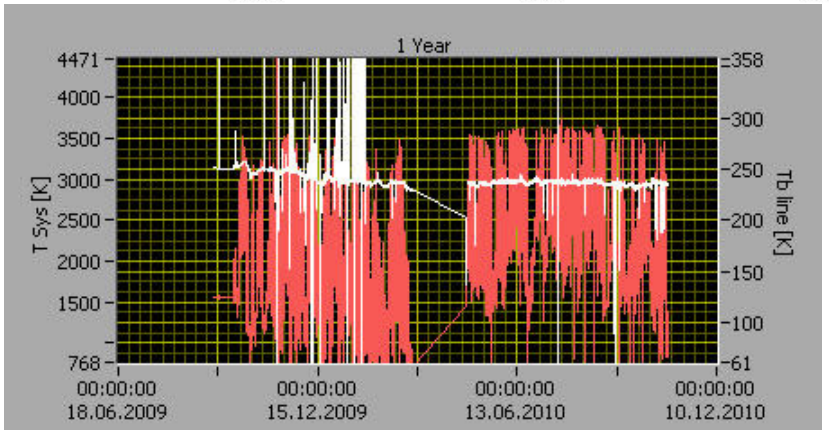
# SOMORA: contribution function and errors



# SOMORA QC: System temperature



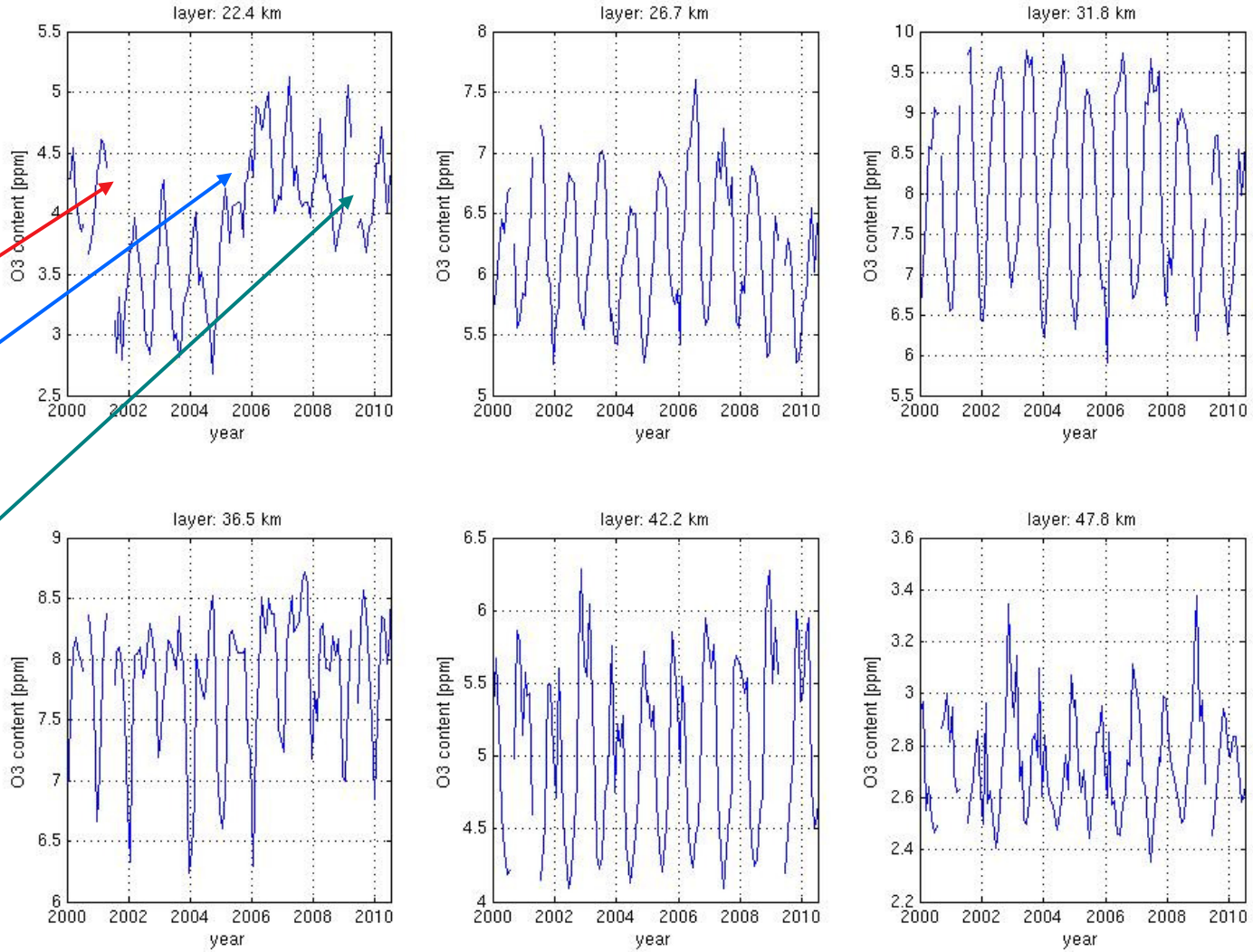

$$T_{sys} = \frac{(Th - Tc * y)}{y - 1} \quad \text{with} \quad y = \frac{Uh - Uoffset}{Uc - Uoffset}$$

# SOMORA: monthly mean ozone time series

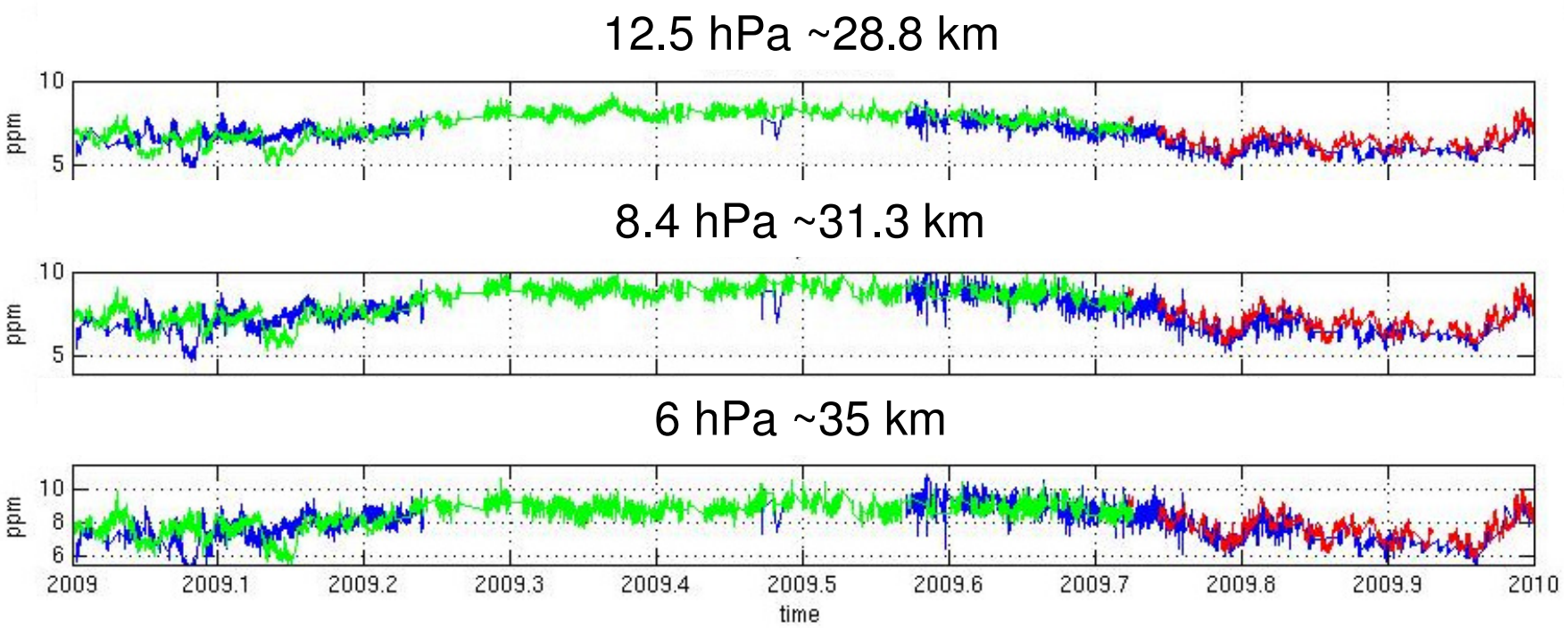
June 2001, mixer reparation

May 2005, front-end change

Sept 2009, spectrometer change



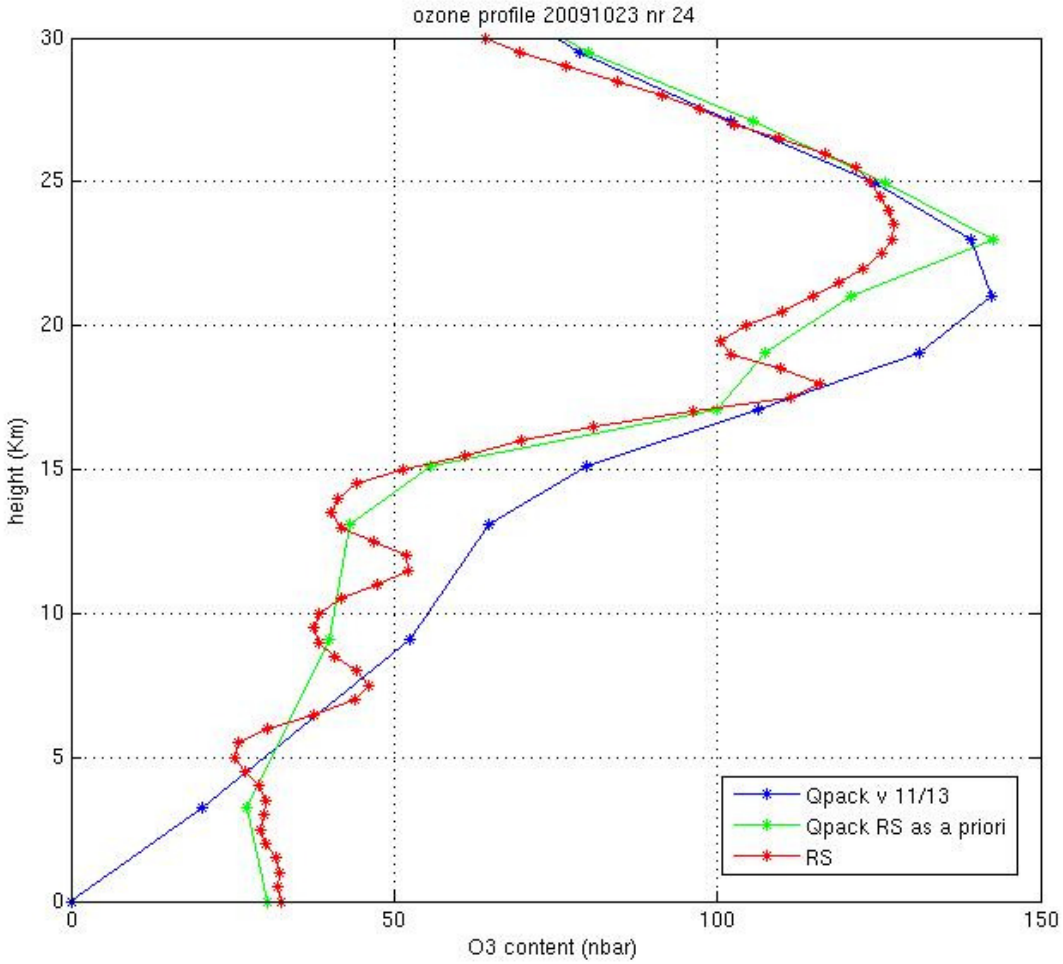
# SOMORA spectrometer change: AOS to FFT




Time [1year, 2008 / 2009]

AOS 2009 FFT 2009 AOS 2008

# Merging SOMORA and soundings: example




SOMORA measurement error below 20 km is important and the measurement contribution at the altitude range should be reduced to minimum.
At this altitude, radiosounding measures ozone with a superior precision.

By combining both profiles we get an **ozone profile with reliable values from ground to 60 km.**

Consider the **radiosounding as an a priori** and retrieve SOMORA ozone profile with an exclusive weight on radiosounding below 25 km