The first two years of the MIPAS/ENVISAT mission: Scientific results related to the upper troposphere and lower stratosphere (UTLS)

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Acknowledgments

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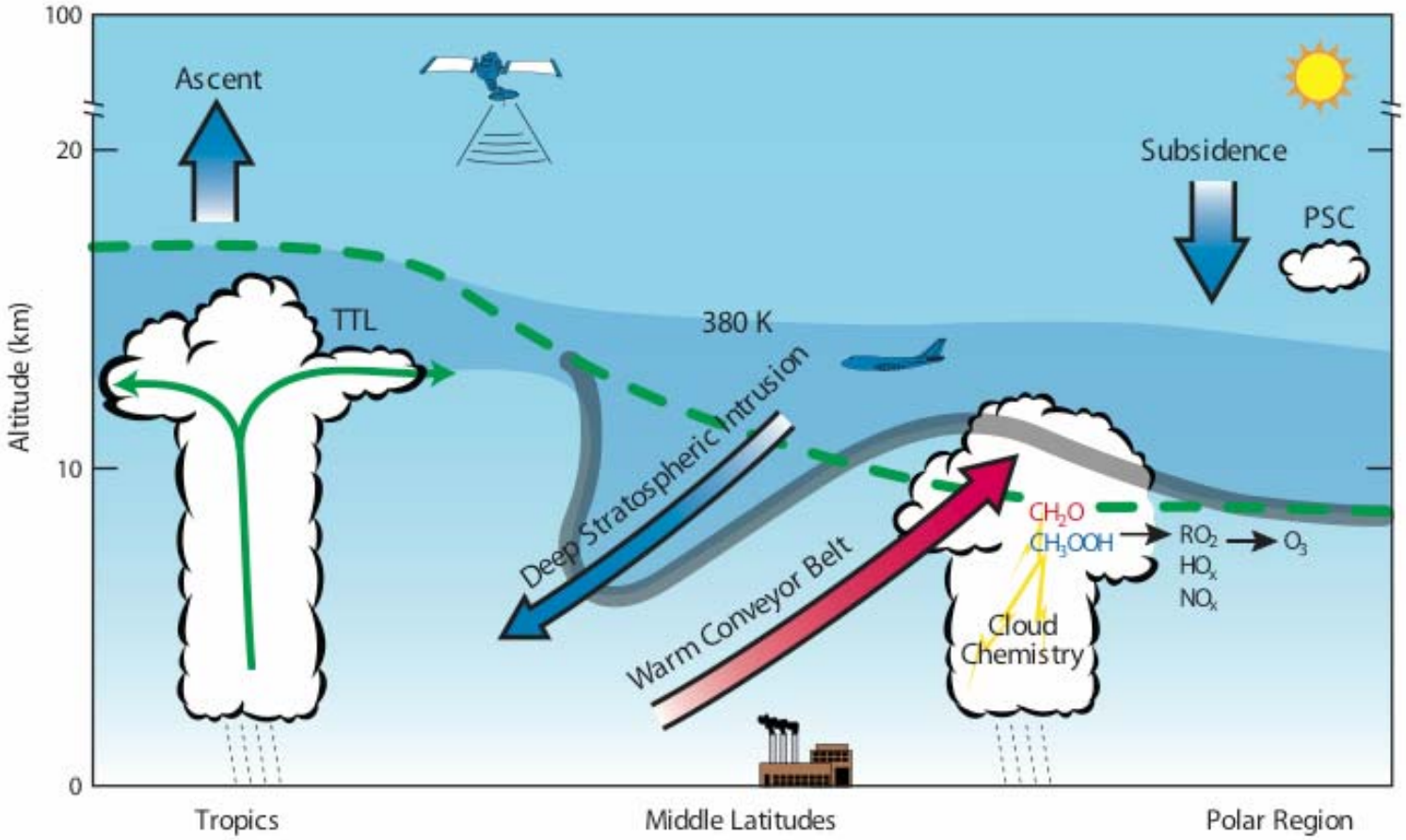
Outline

- Scientific questions at UTLS
- Introduction to the MIPAS experiment and data analysis
- Results
  - Tropical tracers
  - Tropical water vapor
  - Biomass burning
  - Identification of deep intrusion by MIPAS S6 mode
- Conclusions

Scientific questions at UTLS

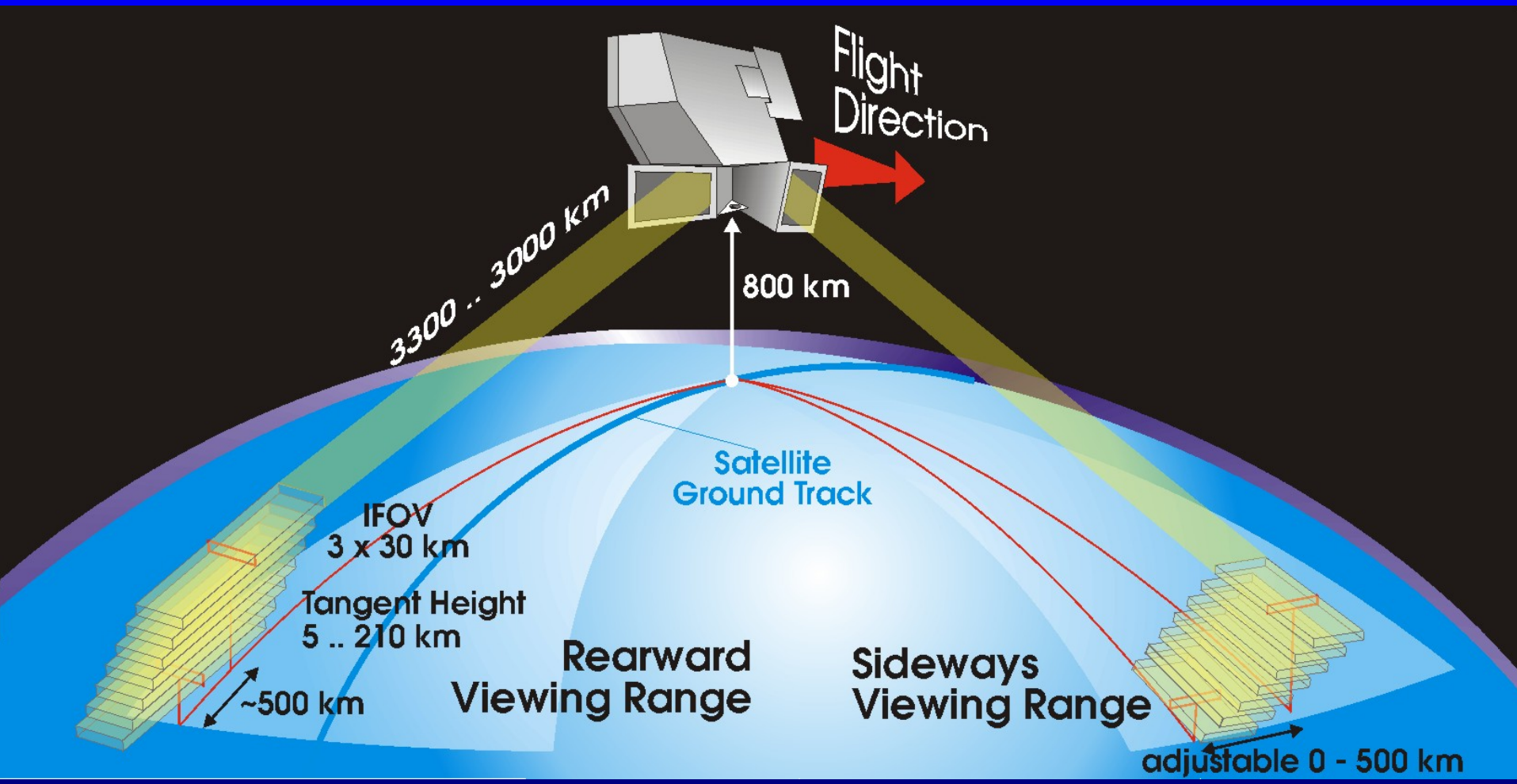


From G. Brasseur, SPARC mtg 2004

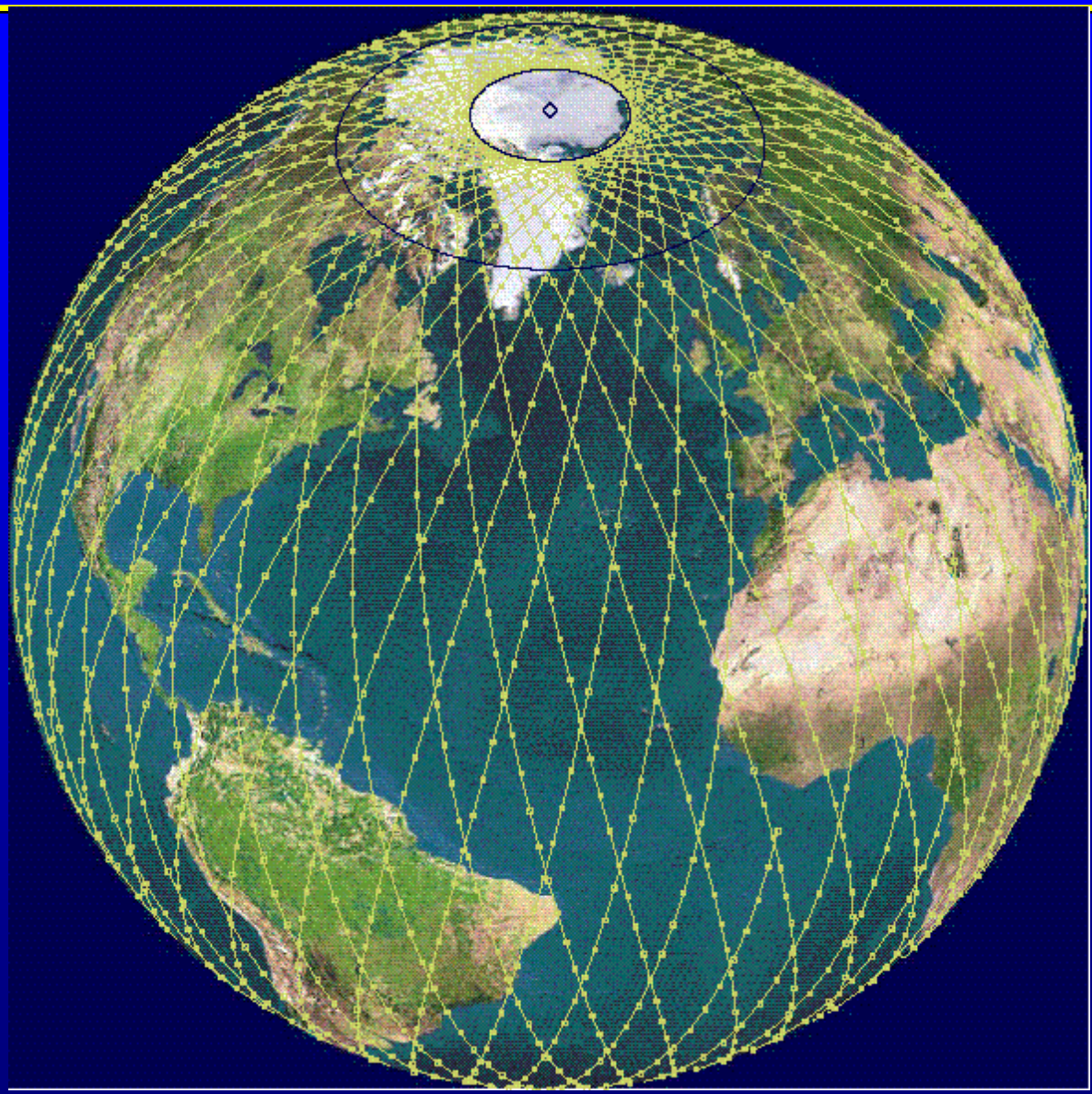
Introduction to the MIPAS experiment

- Michelson Type mid-IR Fourier Transform limb emission Spectrometer
- Spectral range: 4.15 to 14.6 μm (685 to 2410 cm^{-1})
- Spectral resolution: 0.035 cm^{-1} (unapodized)
- NESR: 50 (685 cm^{-1}) to 4.2 (2410 cm^{-1}) nW/cm^2srcm^{-1}
- Radiance calibration via deep space and BB meas.
- Scans across the limb during 17 interferometer sweeps
- Altitude range (standard): 6 - 68 km, 3 km step width
- Since January 2005 MIPAS measures in a reduced spectral resolution mode (0.0625 cm^{-1}) due to mechanical problems

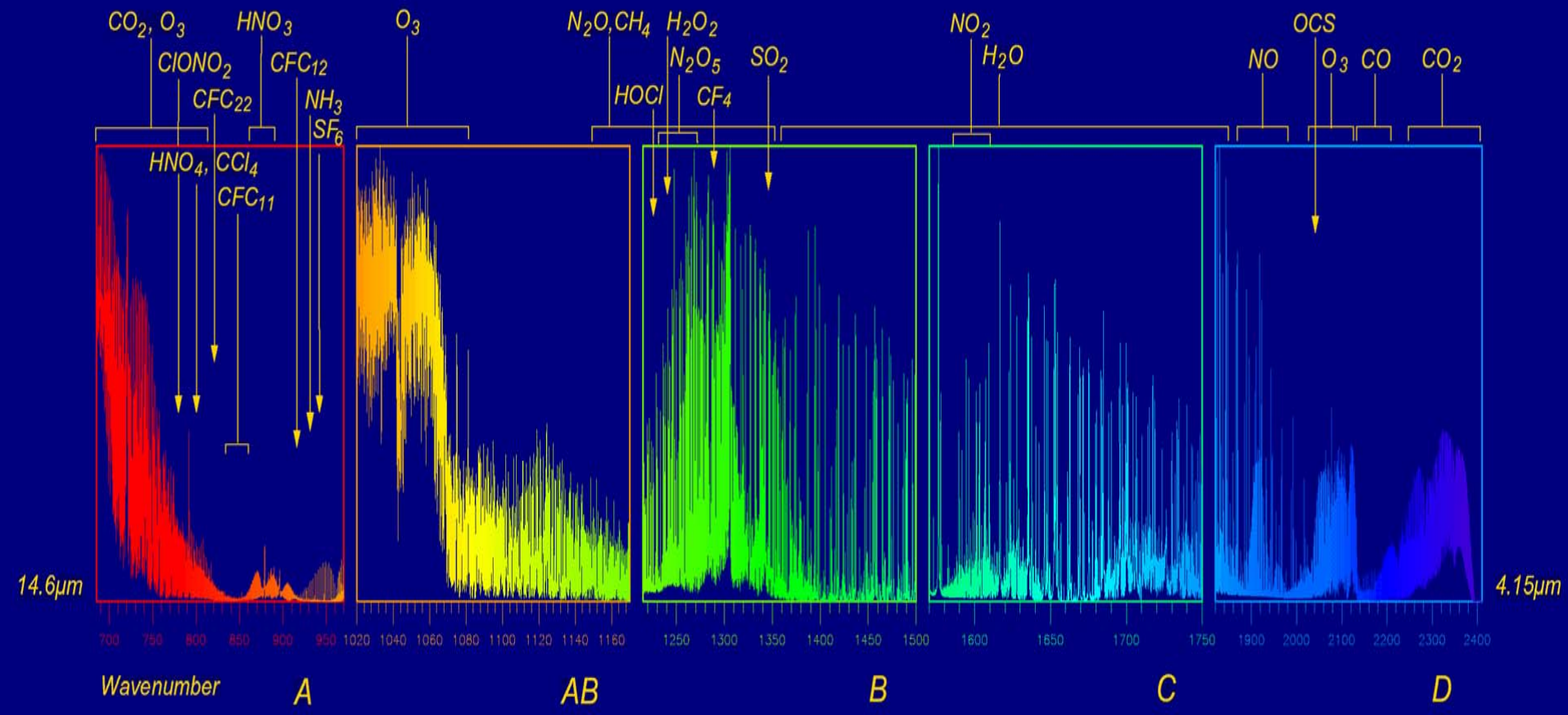
MIPAS Observation Geometry



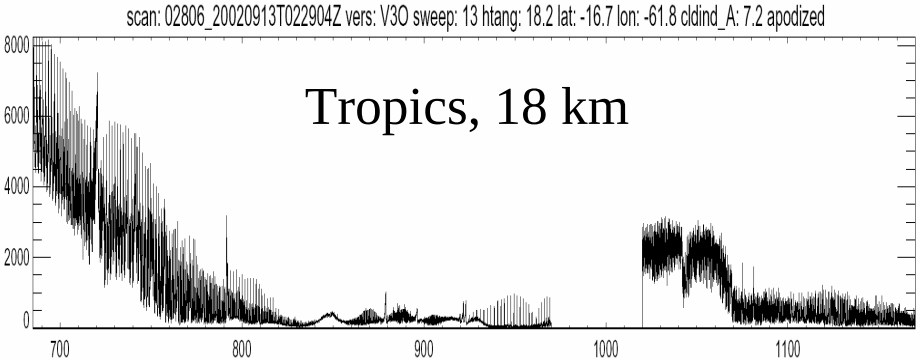
MIPAS Global Coverage

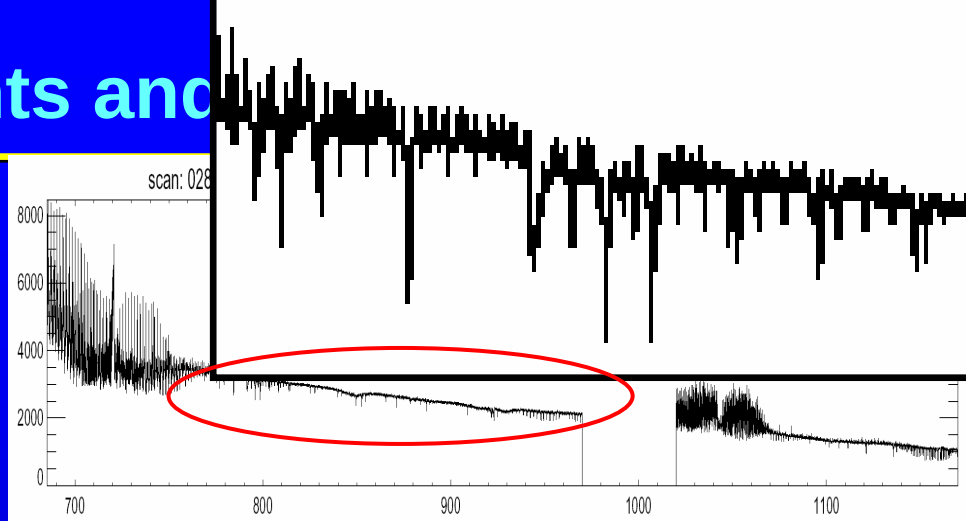


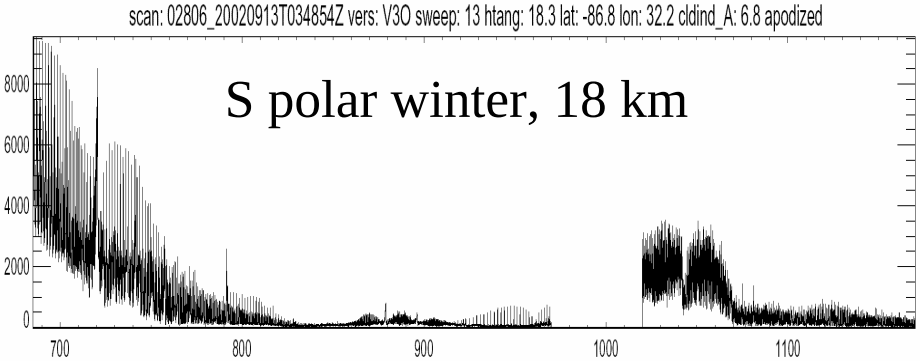
MIPAS Spectral Coverage

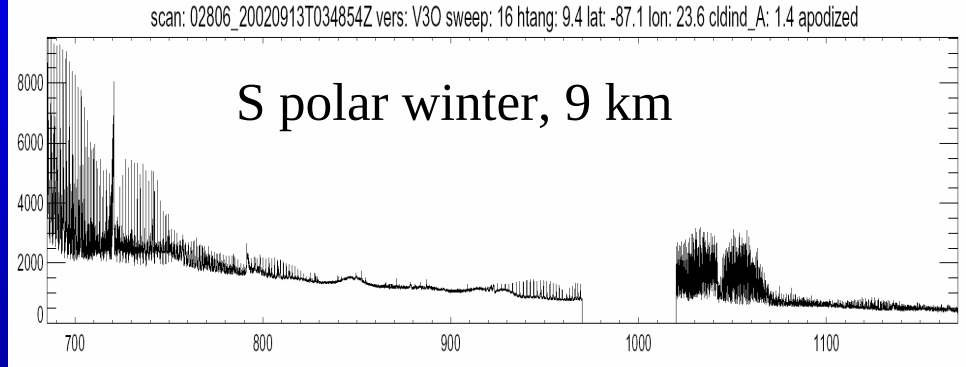


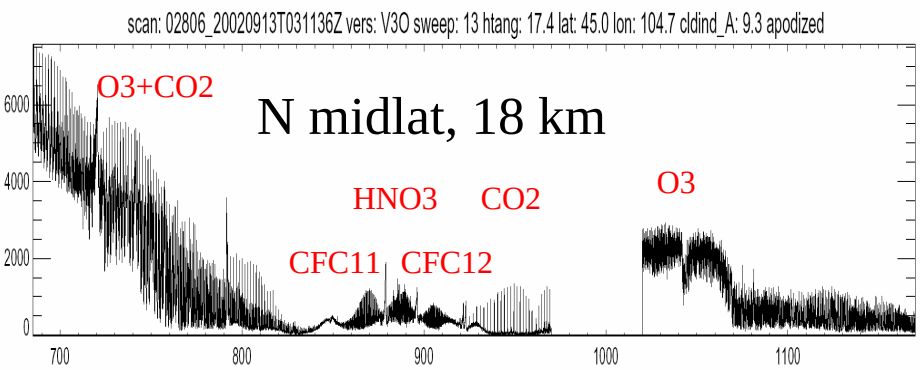
MIPAS measurements and

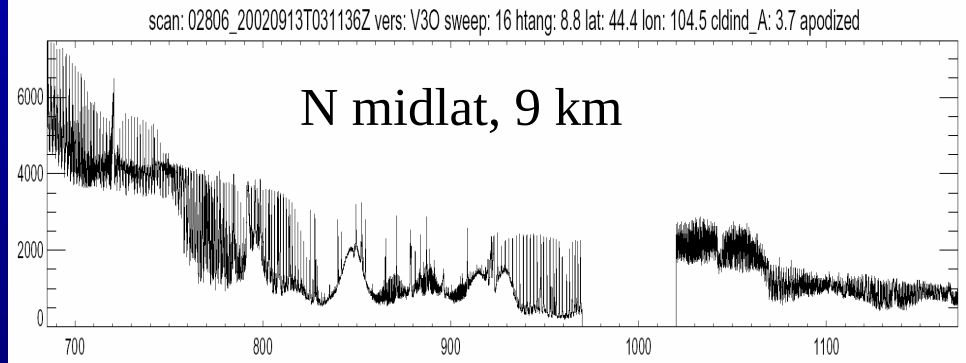












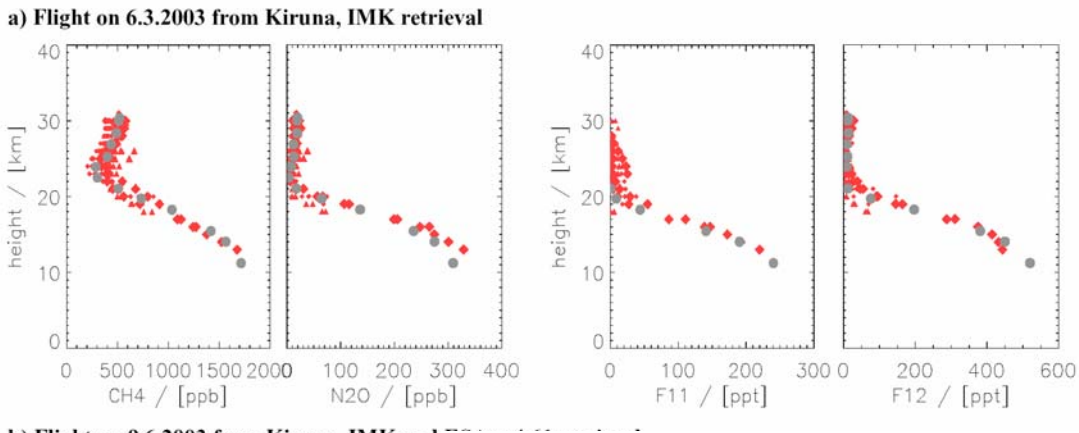
IMK Retrieval approach (RCP)

Non-linear constrained multi-parameter Levenberg-Marquardt least-squares fit

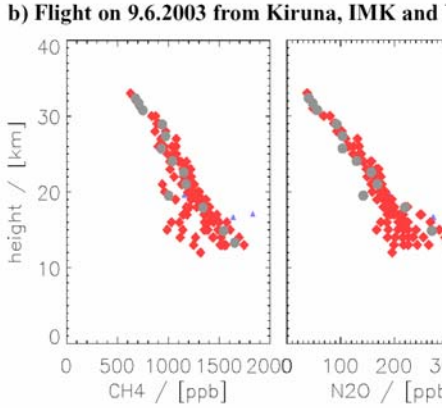
of spectral data of all tangent altitudes of one scan within one run (global fit)

- **Radiative transfer model: KOPRA**
- **Constraint: Smoothness of the profile (Tikhonov-like regularization)**
- **Retrieval grid: user defined, standard approach: 1 km step width**
- **Retrieval parameters: temperature, trace species, line of sight, microphysical properties of clouds, non-LTE process parameters**
- **Simultaneous retrieval of several parameters supported**
- **Measurement vector: user defined ⇒ microwindows**

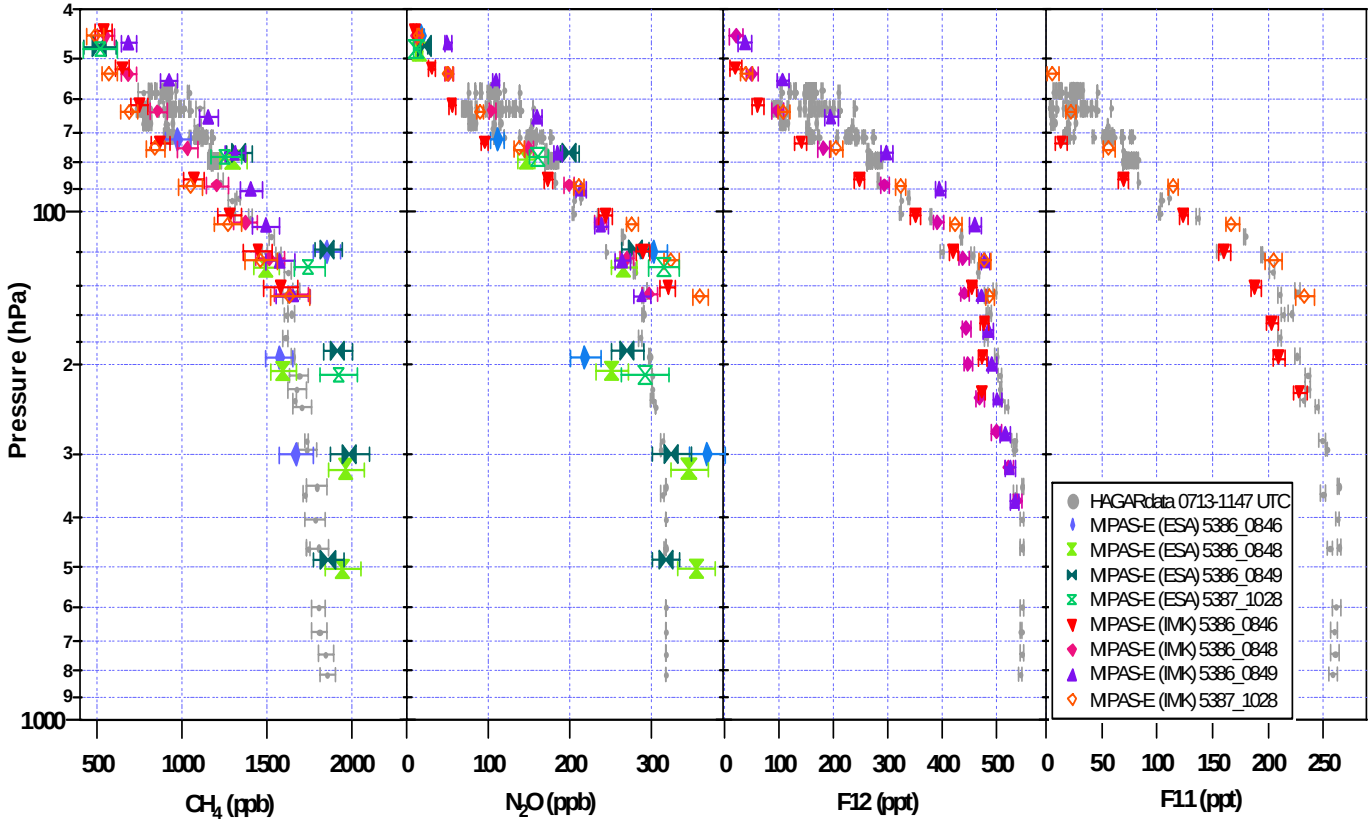
Validation of tracers



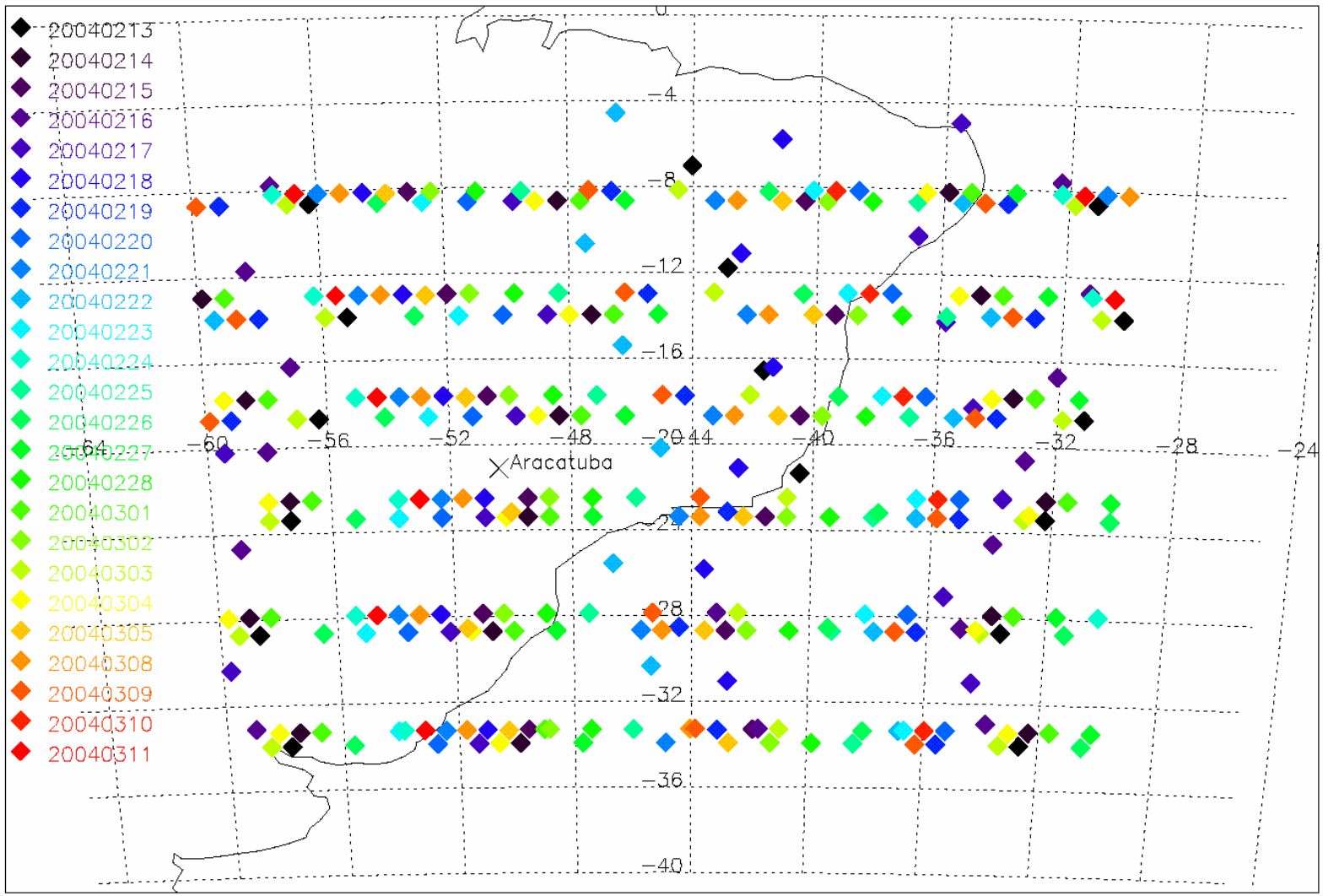
Comparison to BONBON, co-locations from forward/ backward trajectory calculations
J. Baehr et al., 2004



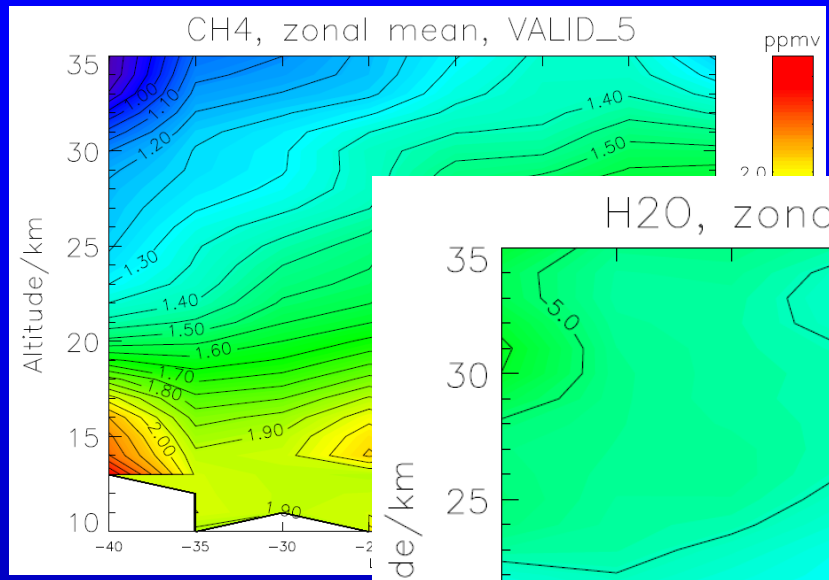
Comparison to HAGAR, Kiruna 12 March 2003

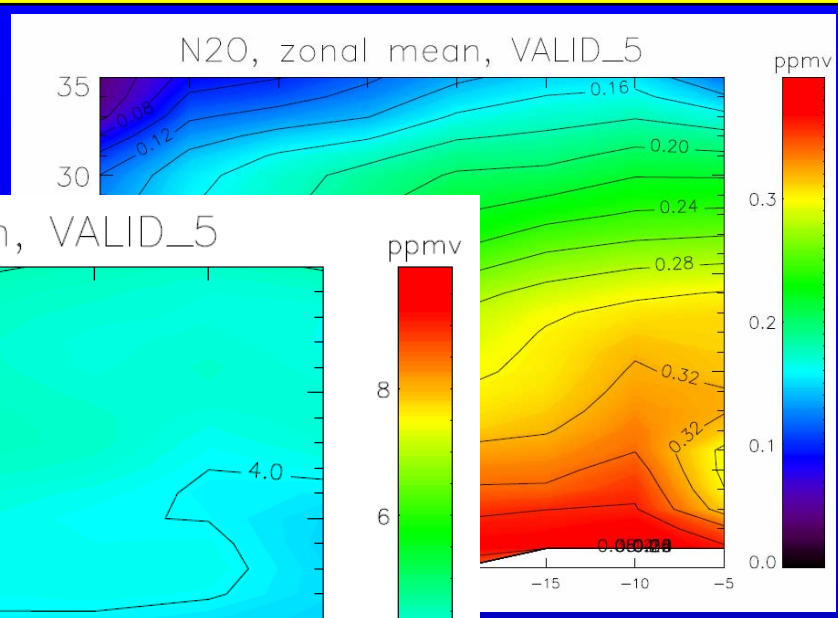


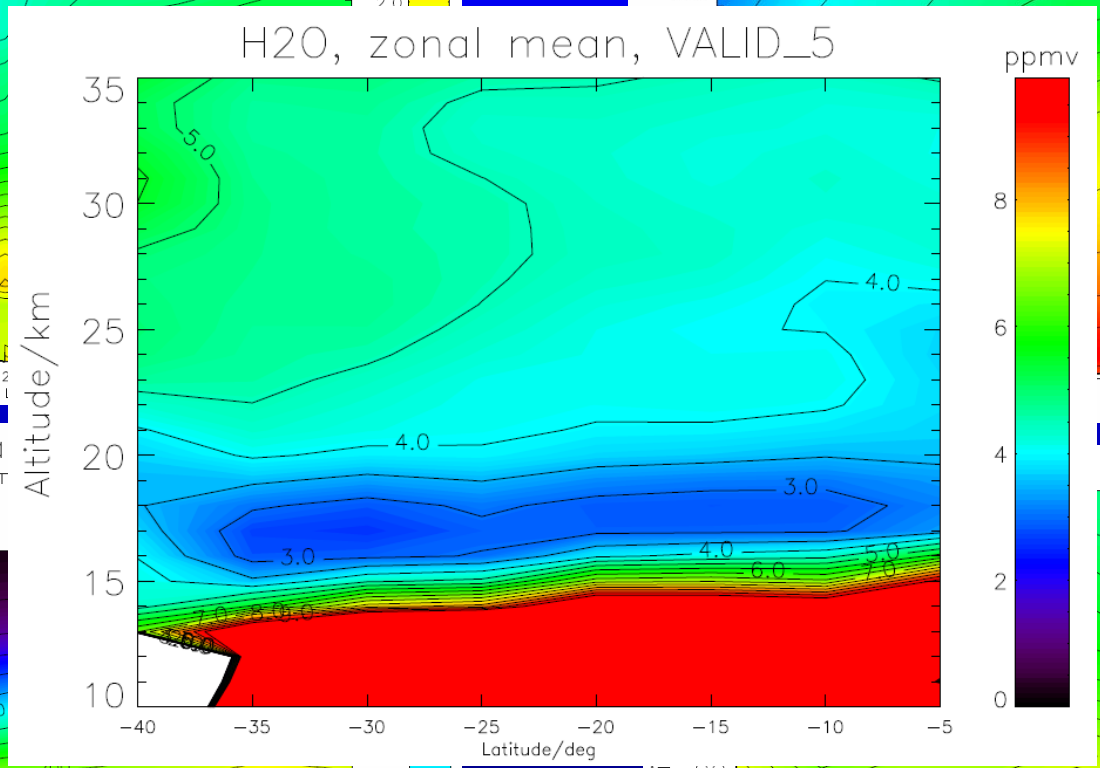
Tropical tracers: TROCCINOX

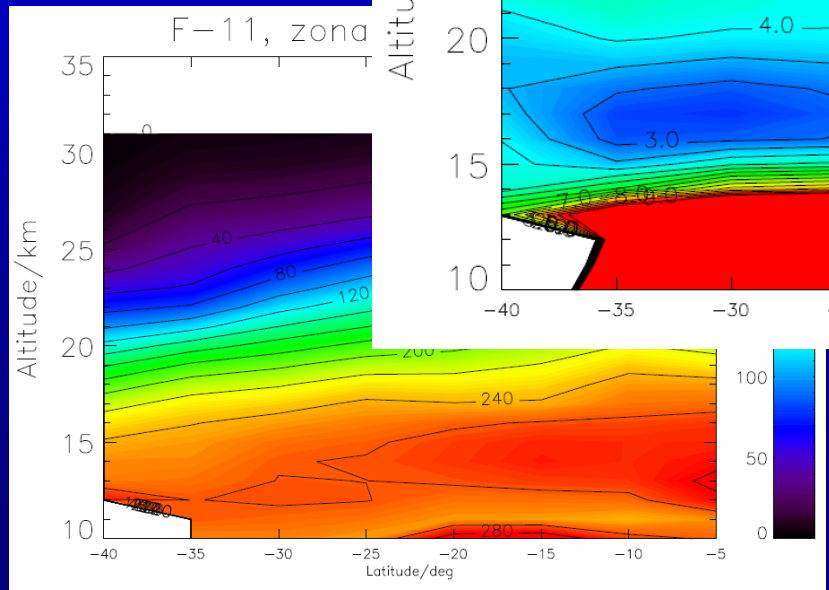


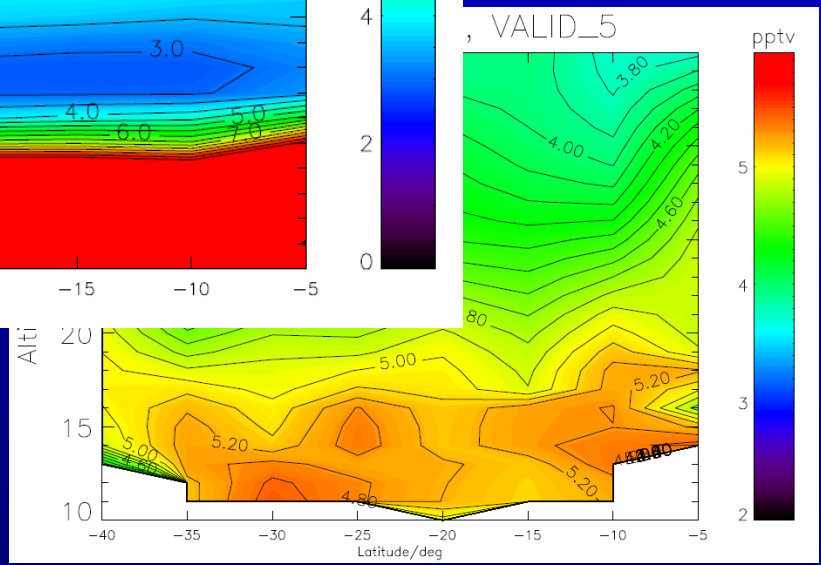
Tropical tracers: TROCCINOX



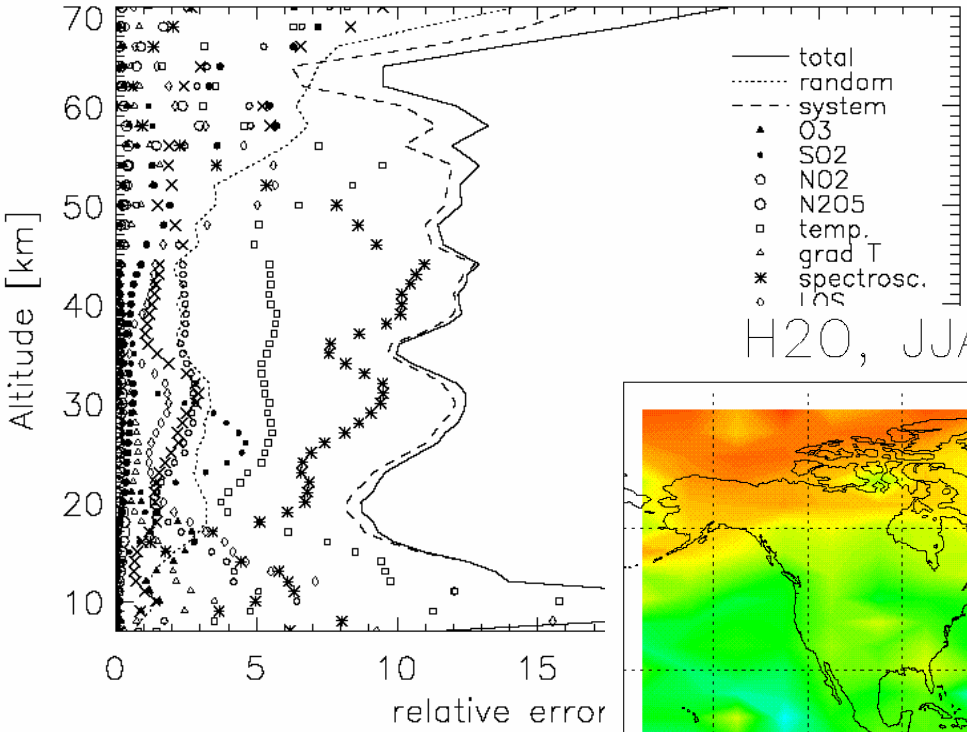


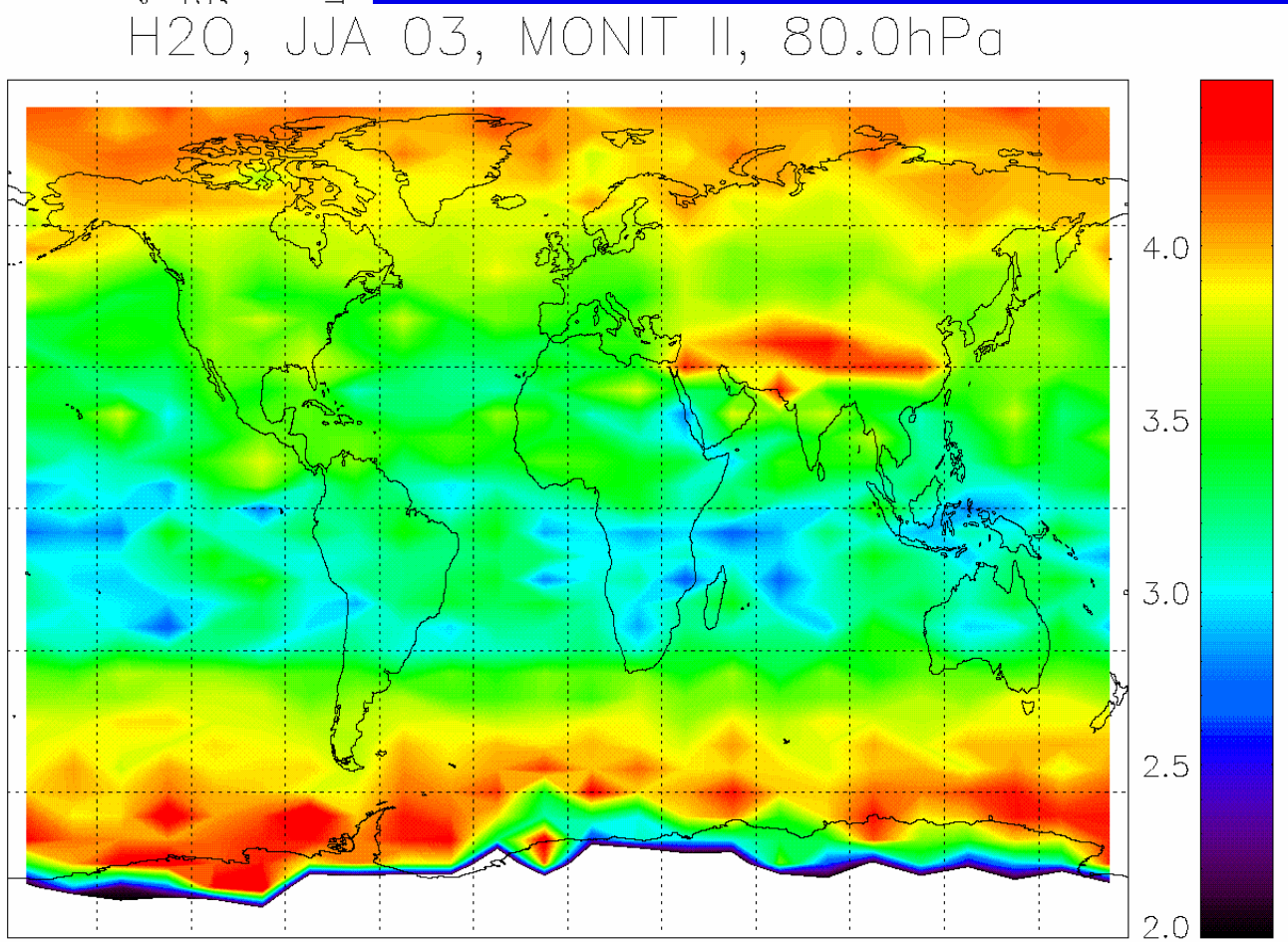






Tropical water vapor

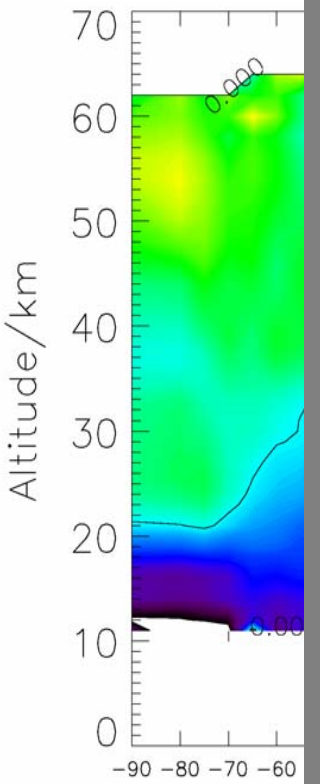




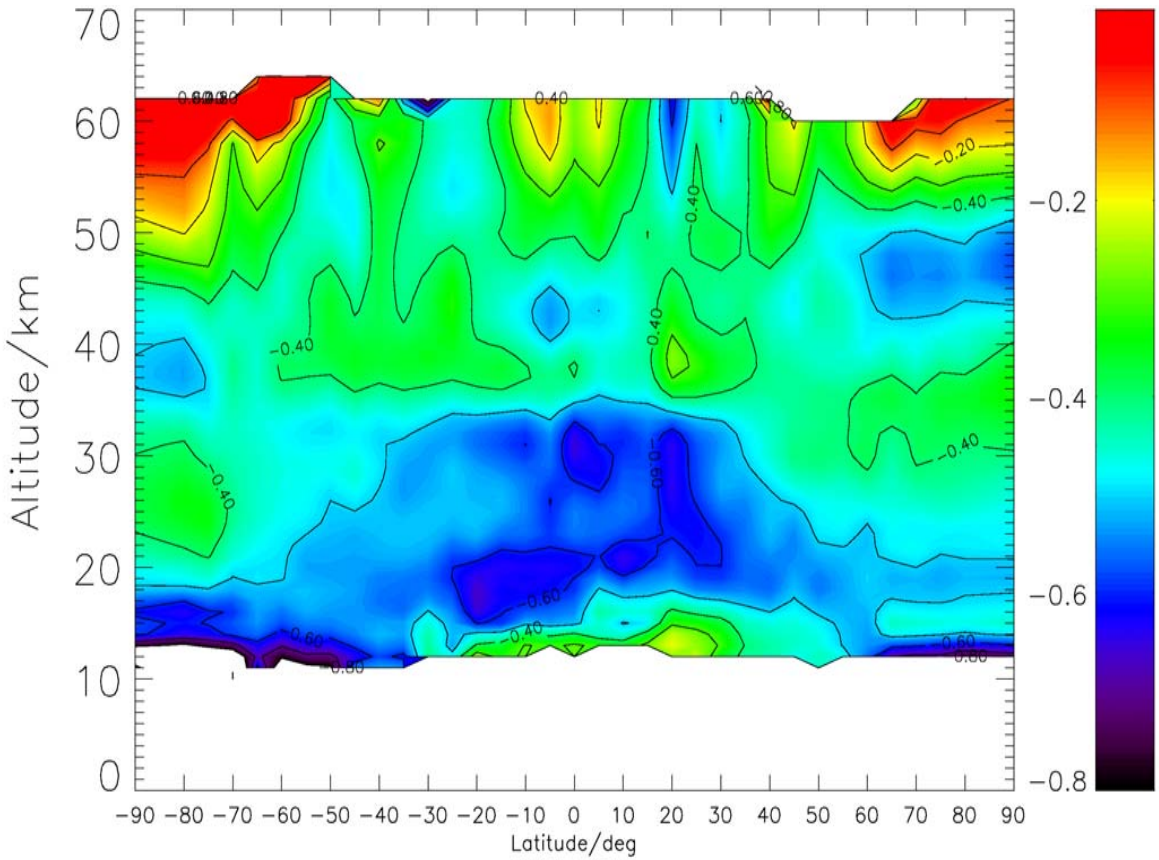
AU

HDO retrievals

Zonal Mean



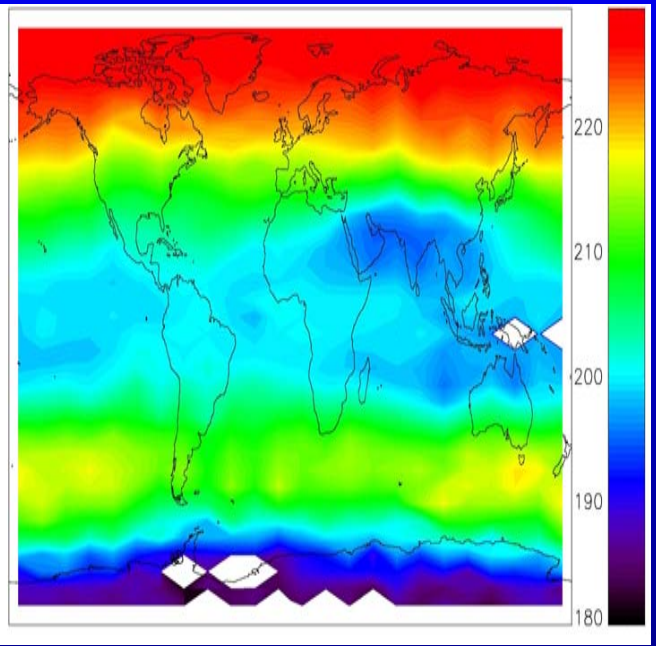
Zonal Mean δD, Sep 18th 2002, 14 orbits



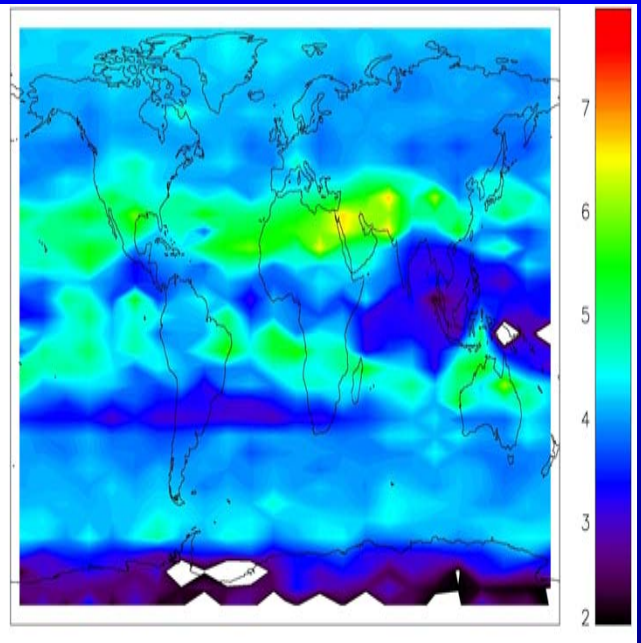
Steinwagner et al., ASA conf., 2005

MIPAS Climatology JJA 2003, 18 km

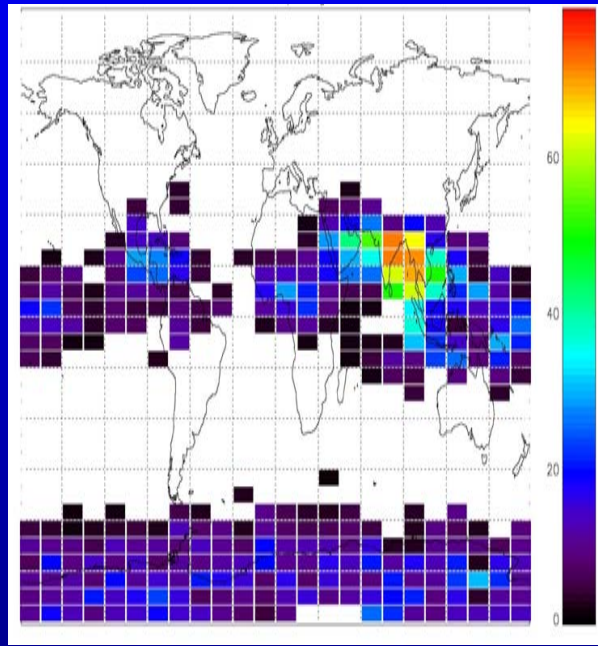
Temperature



Water vapor



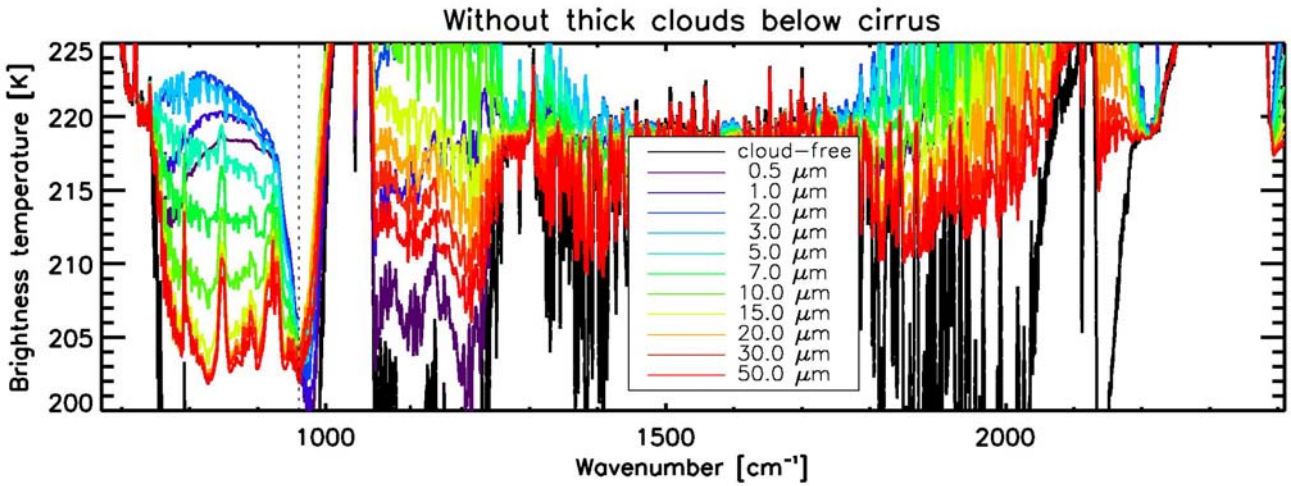
Cloud tops

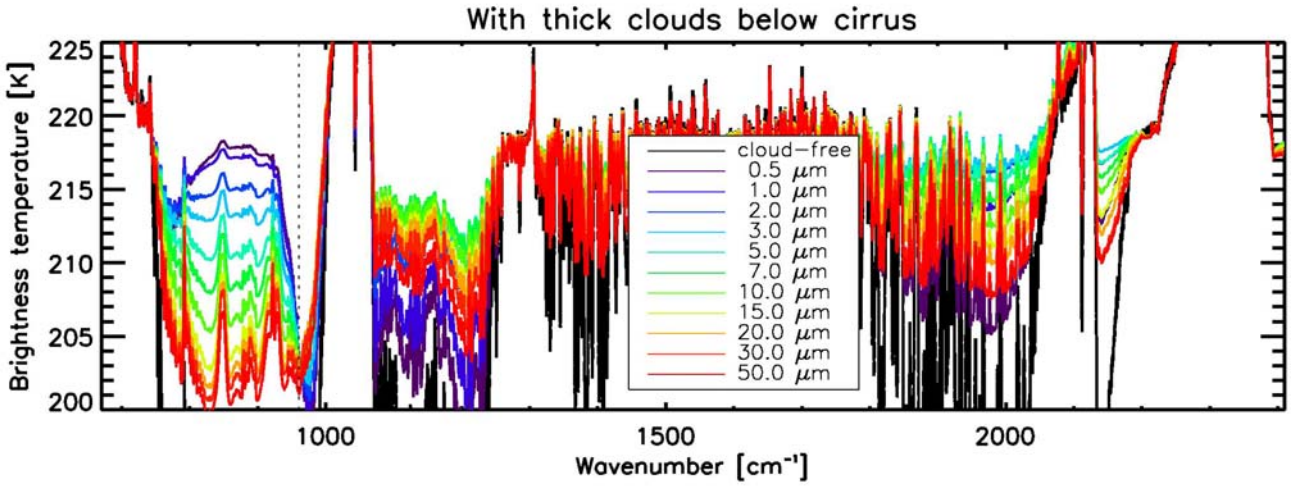


Milz et al., JGR, 2005

Cirrus clouds

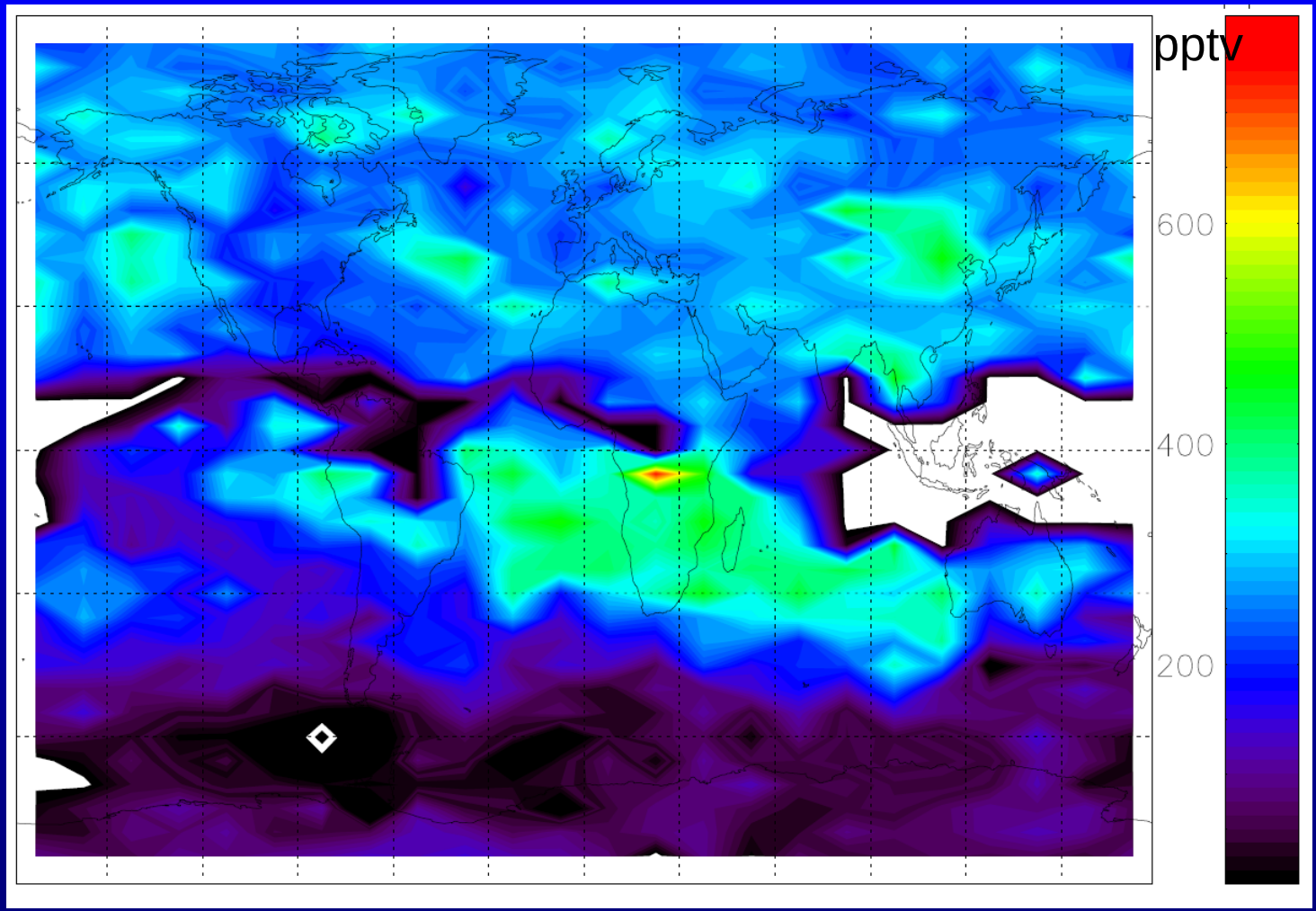
Simulation of different sizes of ice particles



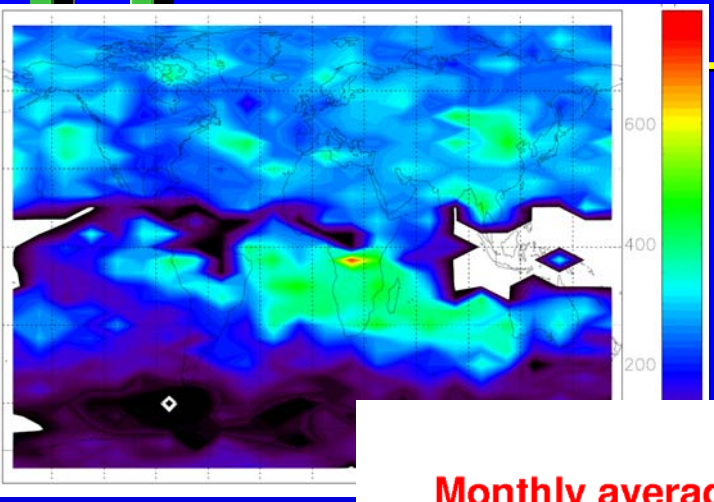


Biomass burning

MIPAS observations of C_2H_6 at 275 hPa, 21 Oct – 14 Nov 2003



Biomass burning



MATCH-MPIC model run, M. Lawrence et al., 2005

C_2H_6

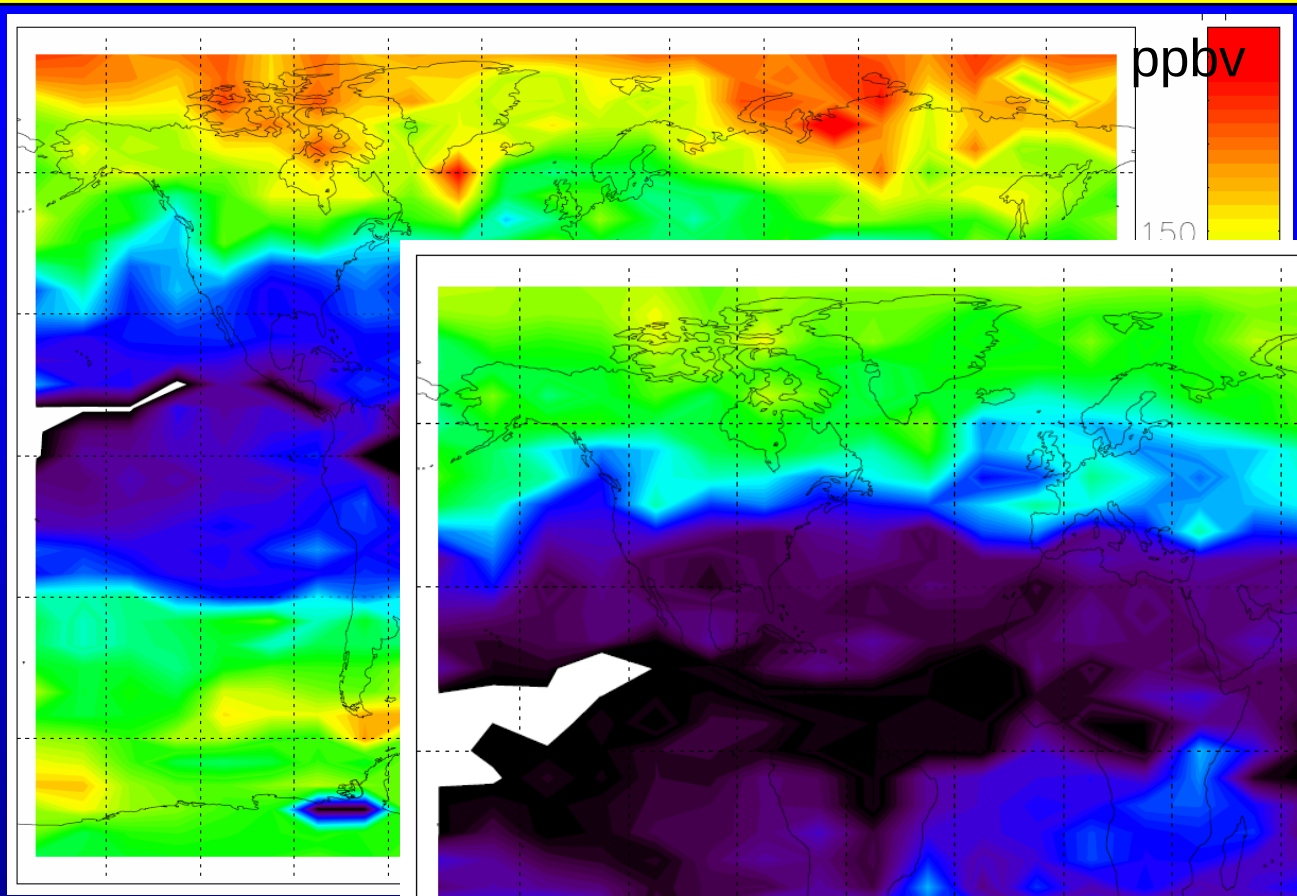
Monthly average: 200311 at 9 GMT (nmol/mol) 275 hPa

90
60
30
0
-30
-60
-90
180
-90
0
90
180
0.608
0.557
0.505
0.454
0.403
0.352
0.301

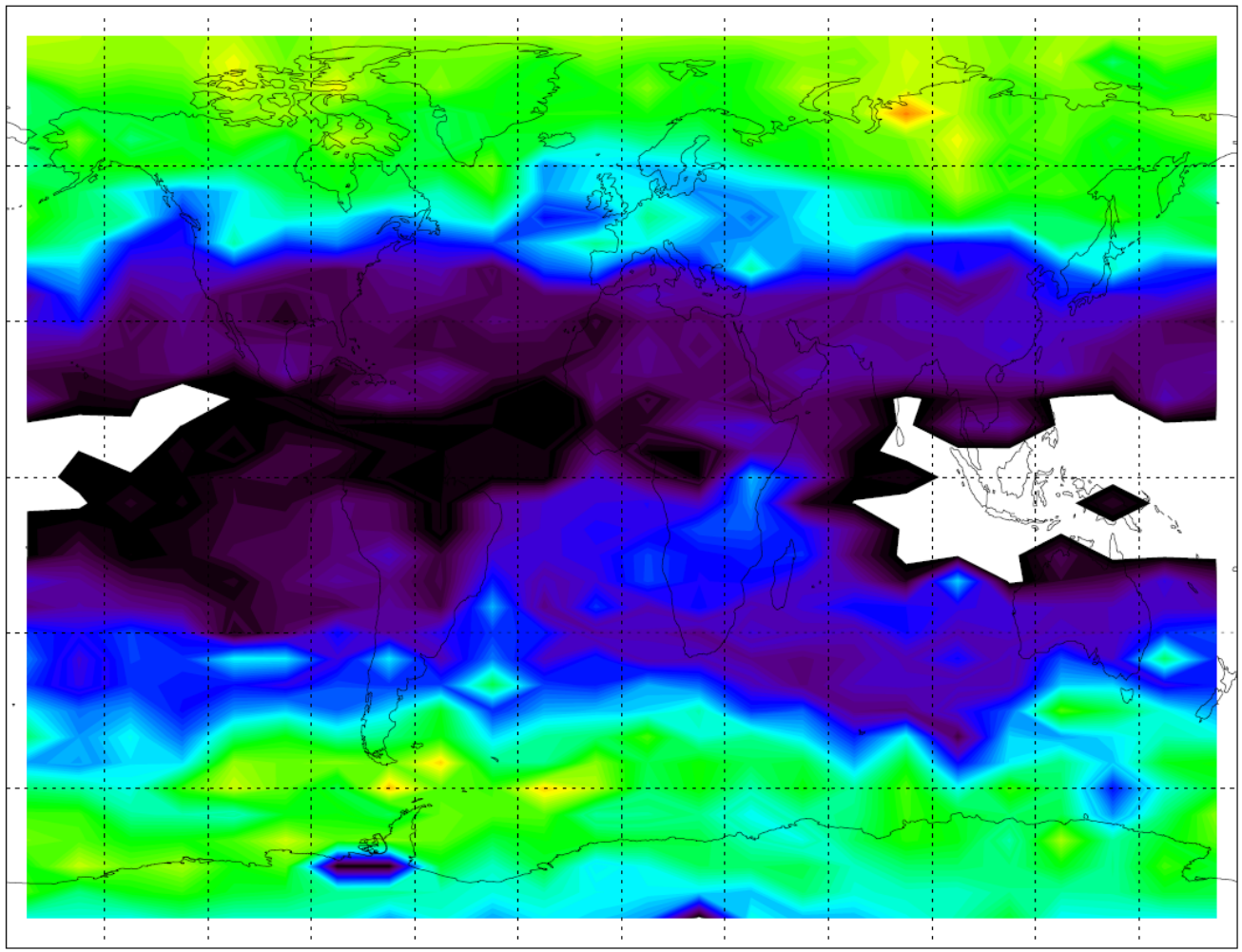
Based on Output from the MATCH-MPIC Chemical Weather Forecast and Analysis Run

Contact: Mark Lawrence, Max Planck Institute for Chemistry, Mainz, Germany

Biomass burning

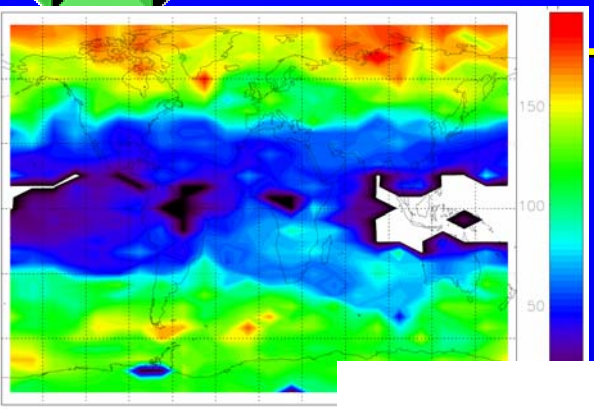


MIPAS O_3, 275 hPa



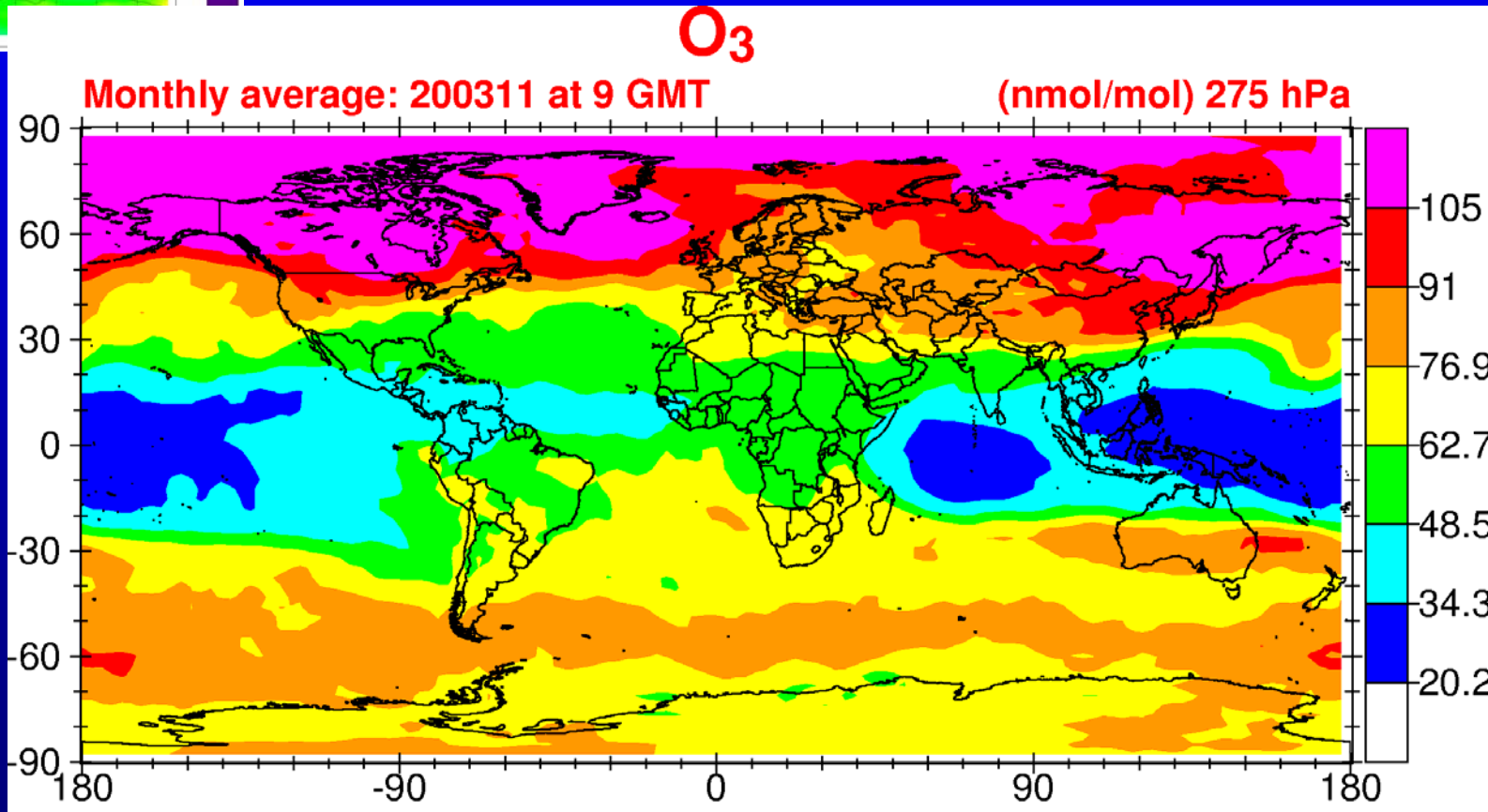
MIPAS HNO_3

Biomass burning



MIPAS O_3, 275 hPa

MATCH-MPIC O3, M. Lawrence et al., 2005



Based on Output from the MATCH-MPIC Chemical Weather Forecast and Analysis Run

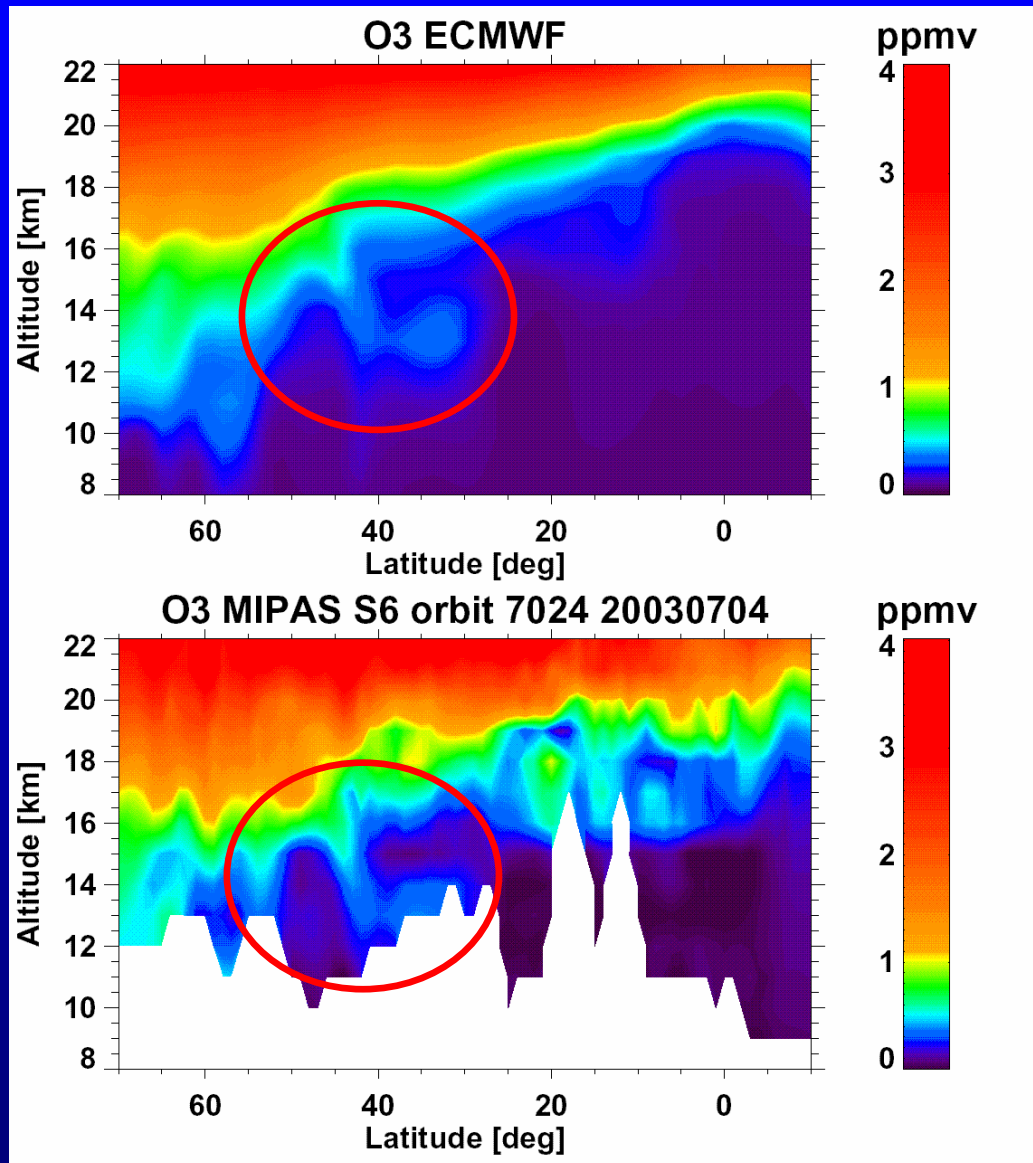
Contact: Mark Lawrence, Max Planck Institute for Chemistry, Mainz, Germany

Deep intrusion obs. by MIPAS S6 mode

S6 Mode:

Spectral resolution: 0.1 cm^{-1}
Horizontal distance between two scans : ca. 150 km
Vertical sampling (lat. dep.): 2(6) to 20 (24) km every 2 km, 24 (28) km, 31 (35) km
Attainable vertical resolution: 2 - 3 km
Attainable horizontal resolution: 110 - 140 km

2D tomographic retrieval approach, sequential estimation (Steck et al., 2005)

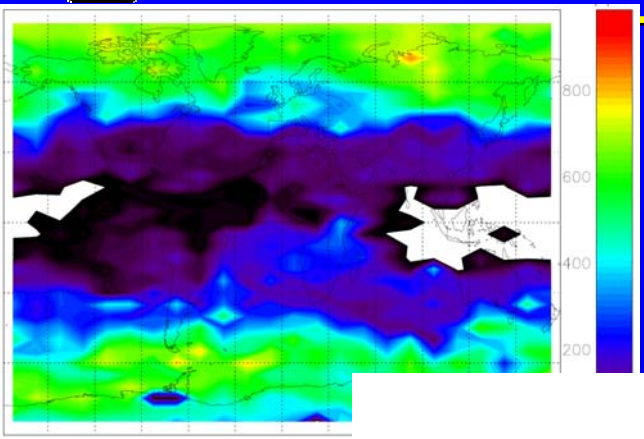


Conclusions

- Although the retrieval of trace species from UTLS spectra is not easy, careful modeling of radiative transfer and appropriate retrieval approaches allow to derive global fields of many species
- Vertical resolution is never better than 3 km due to sampling and MIPAS field of view , often much worse
- Tropical tracers allow to study TST
- H_2O, temperature, and cloud occurrence allow to study dehydration processes at the TTL
- Species involved in UT ozone chemistry (O_3, HNO_3, C_2H_6, …) allow to study pollution episodes and biomass burning and provide validation for UT chemical/transport models
- High spatial observation mode of MIPAS resolves small scale structures like deep stratospheric intrusions.

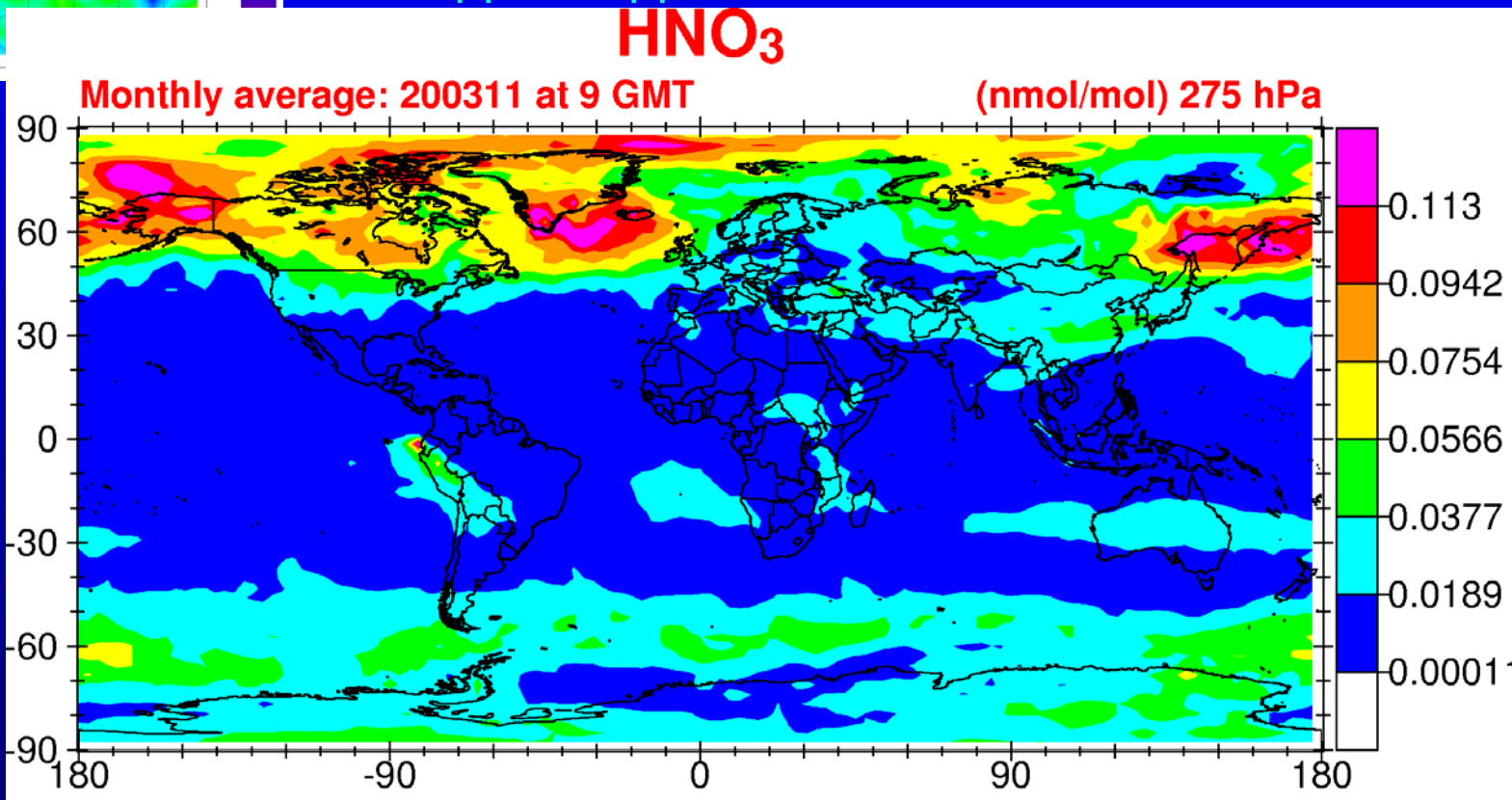
Additional material

Biomass burning



MIPAS HNO_3, 275 hPa
Appr. 300 pptv

MATCH-MPIC HNO_3, M. Lawrence et al., 2005
Appr. 30 pptv!



Based on Output from the MATCH-MPIC Chemical Weather Forecast and Analysis Run
Contact: Mark Lawrence, Max Planck Institute for Chemistry, Mainz, Germany