



Data Intercomparison/Validation

MIPAS Examples

Bruno Carli



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- Temperature validation
- Ozone validation
- Other target species: synthesis of results
- Verification of continuity
- Validation of RR measurements

Temperature validation

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Geophysical validation of temperature retrieved by the ESA processor from MIPAS/ENVISAT atmospheric limb-emission measurements

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C. De Clercq⁶, K. H. Fricke⁷, F. Friedl-Vallon¹³, M. Iarlori⁸, P. Keckhut⁹,
B. Kerridge¹⁰, J.-C. Lambert⁶, Y. J. Meijer¹¹, L. Mona¹², H. Oelhaf¹³,
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MIPAS temperature
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M. Ridolfi et al.

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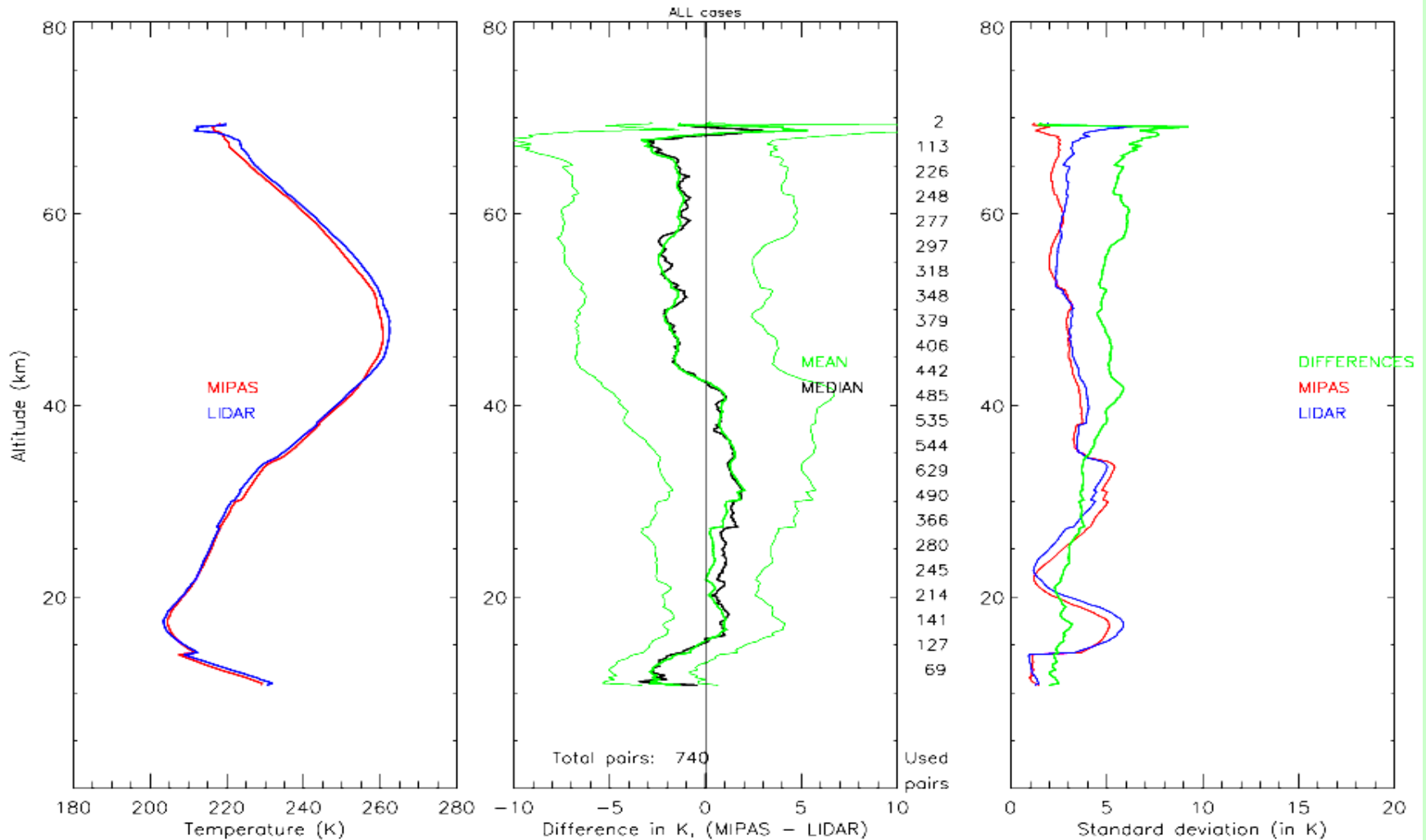
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Interactive Discussion

EGU

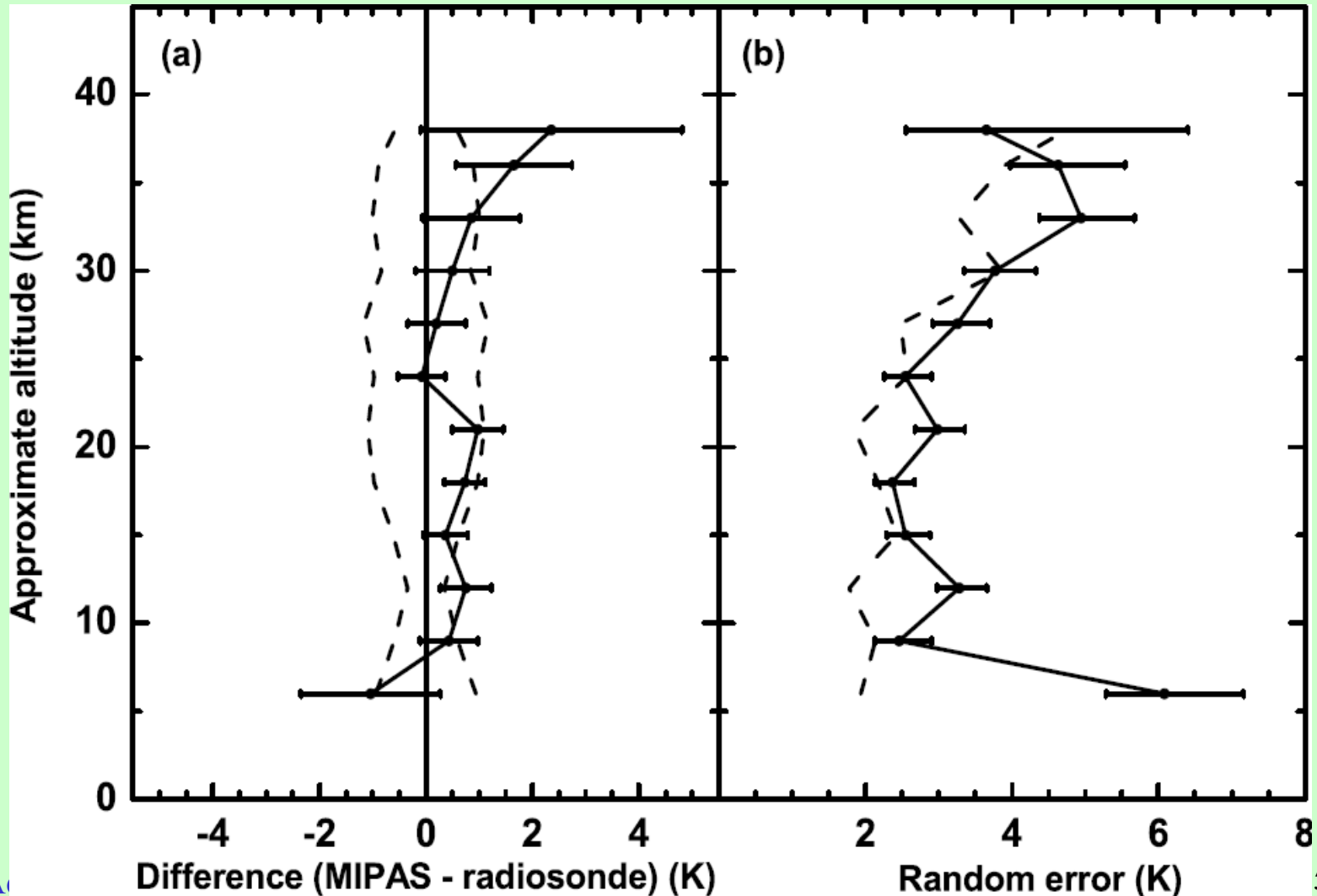
Temperature validation

Comparison with ground based lidar measurements



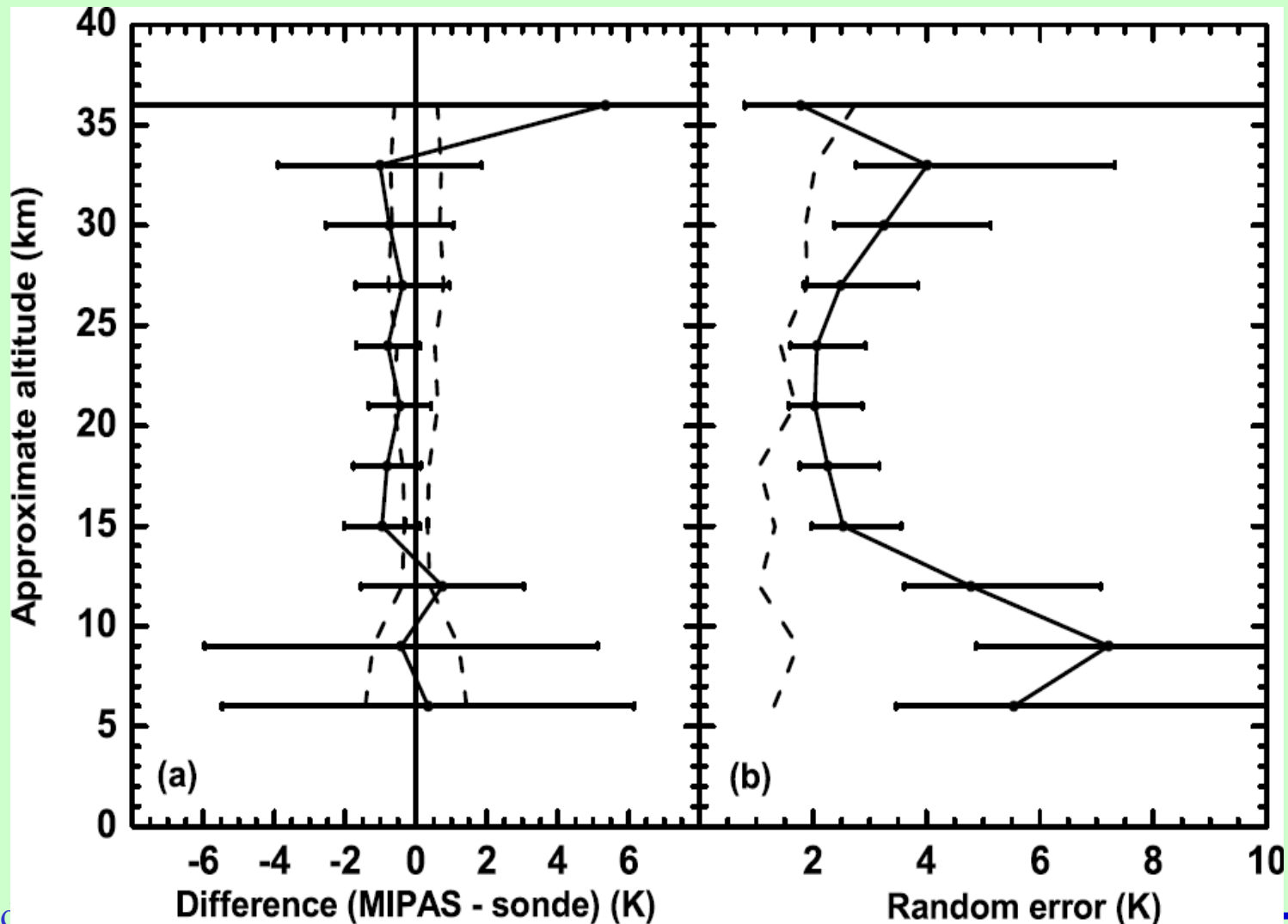
Temperature validation

MIPAS vs radiosondes @ Esrange



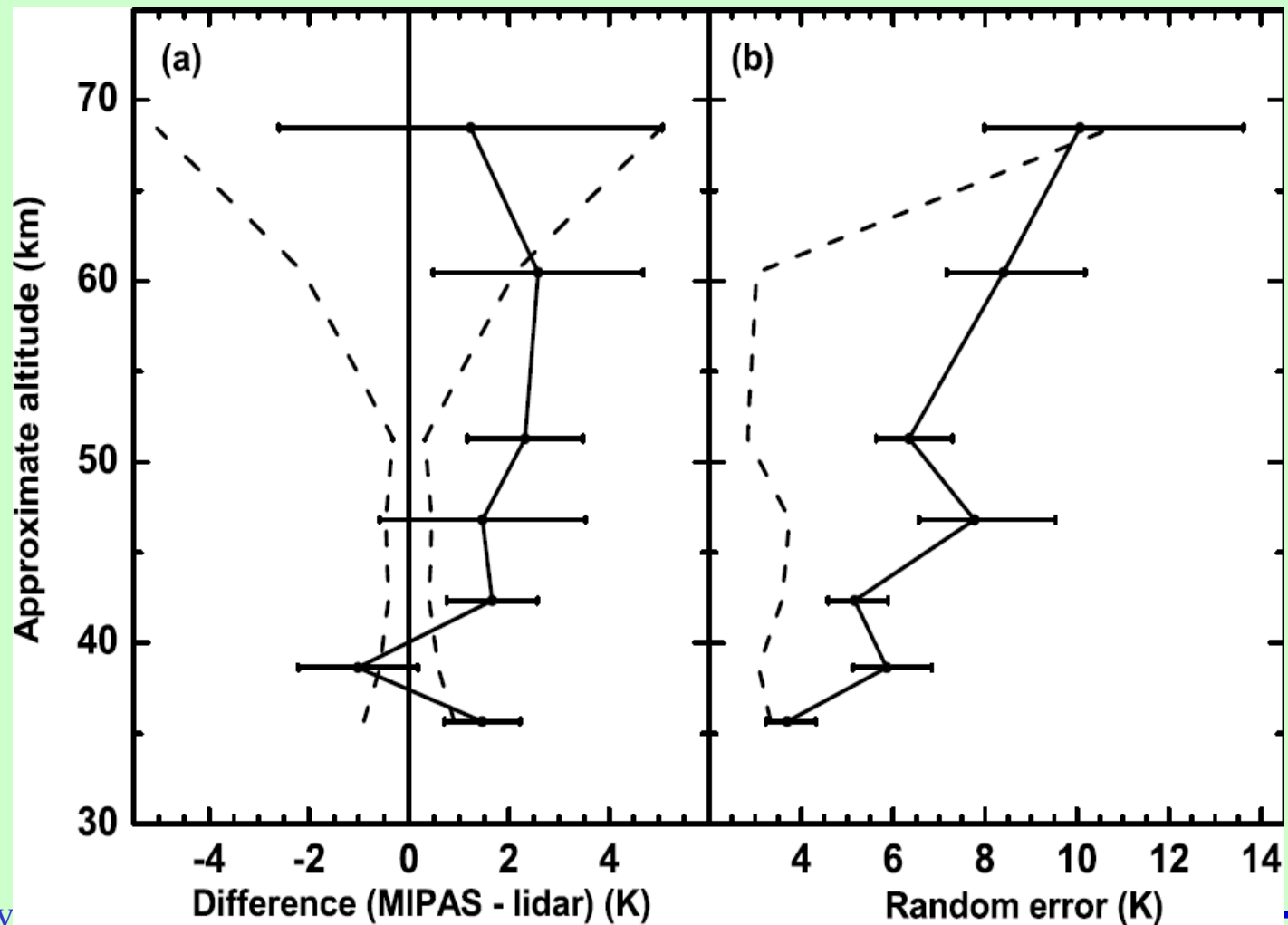
Temperature validation

MIPAS vs radiosondes @ Potenza and L'Aquila (Italy)



Temperature validation

MIPAS vs UBONN lidar @ Esrange



Temperature validation

Comparisons with ECMWF in different latitude bands

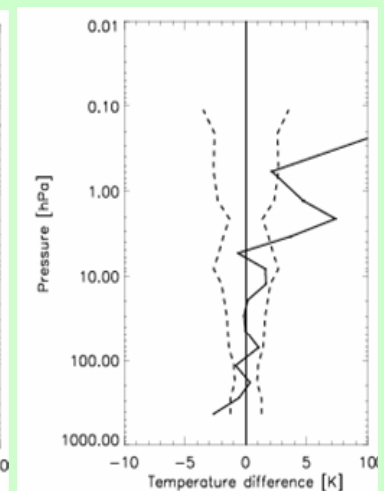
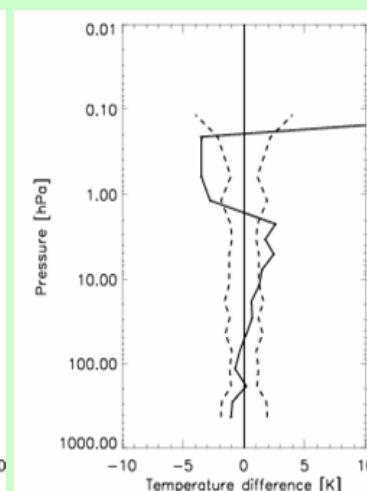
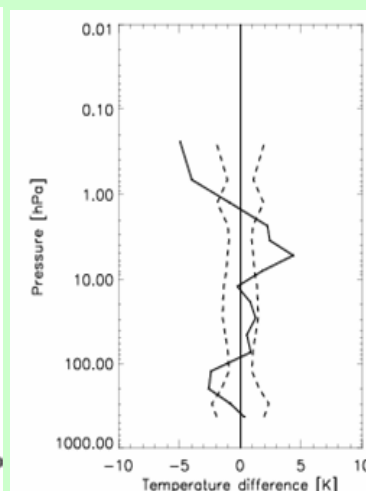
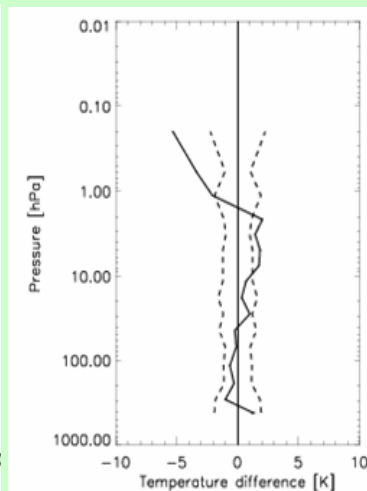
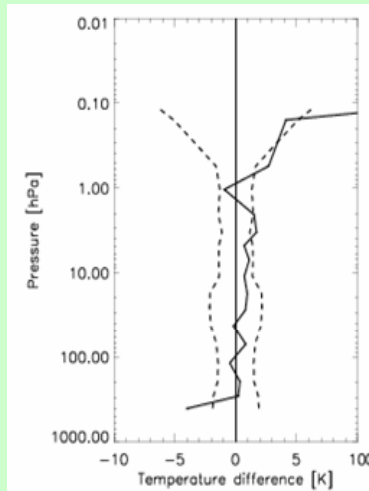
-90 -65

-65 -20

-20 +20

+20 +65

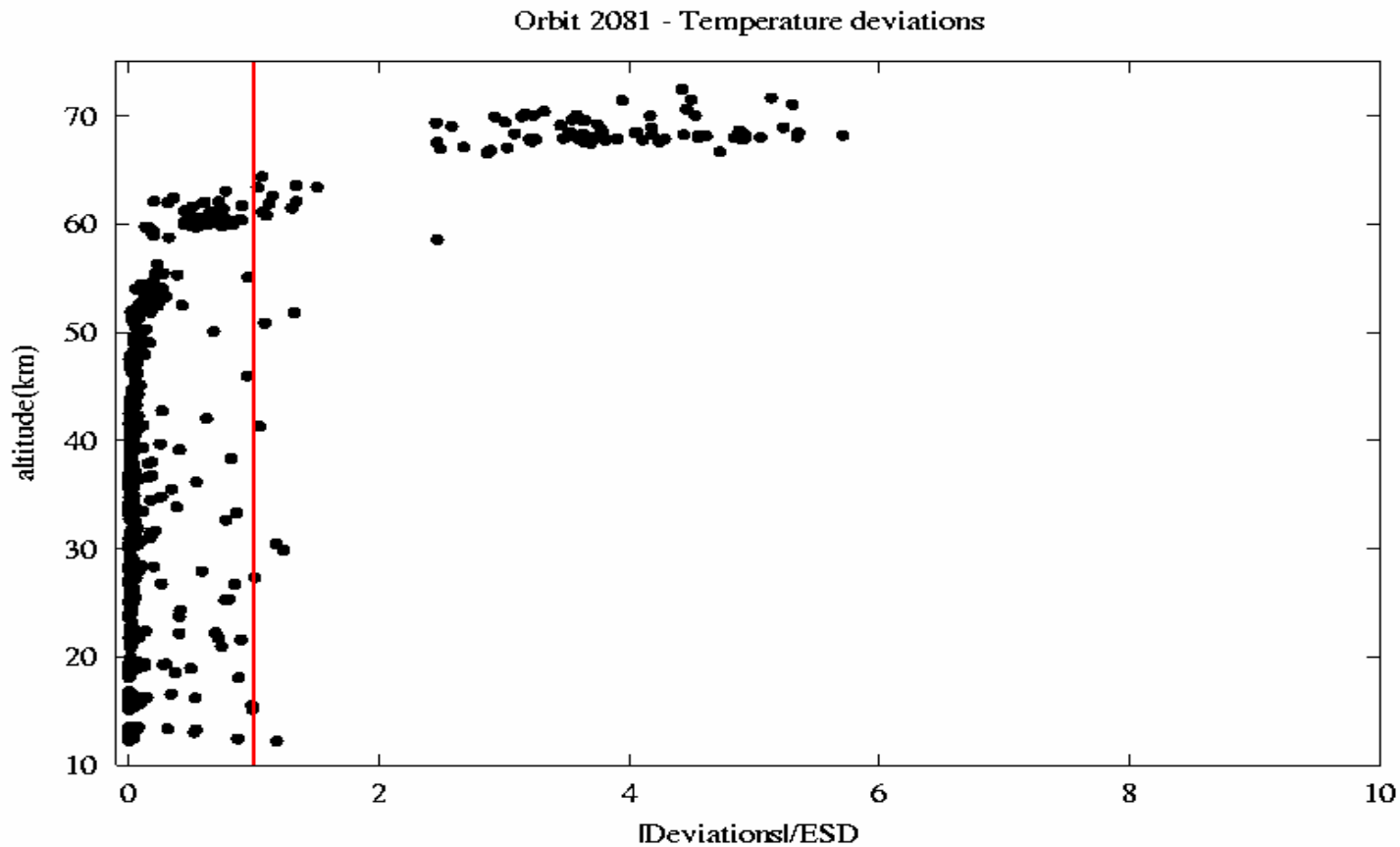
+65 +90



Standard deviation

- The standard deviation of the differences is usually larger than the predicted random errors
- Possible causes are:
 - Errors due to profile shape assumptions outside the vertical retrieval range of MIPAS.
 - Error due to insufficient cloud flagging at low altitudes.
 - Spatial smoothing:
 - one validation team (BIRA) found that this usually dominates the error budget of the profile differences (up to 7 K in some cases).

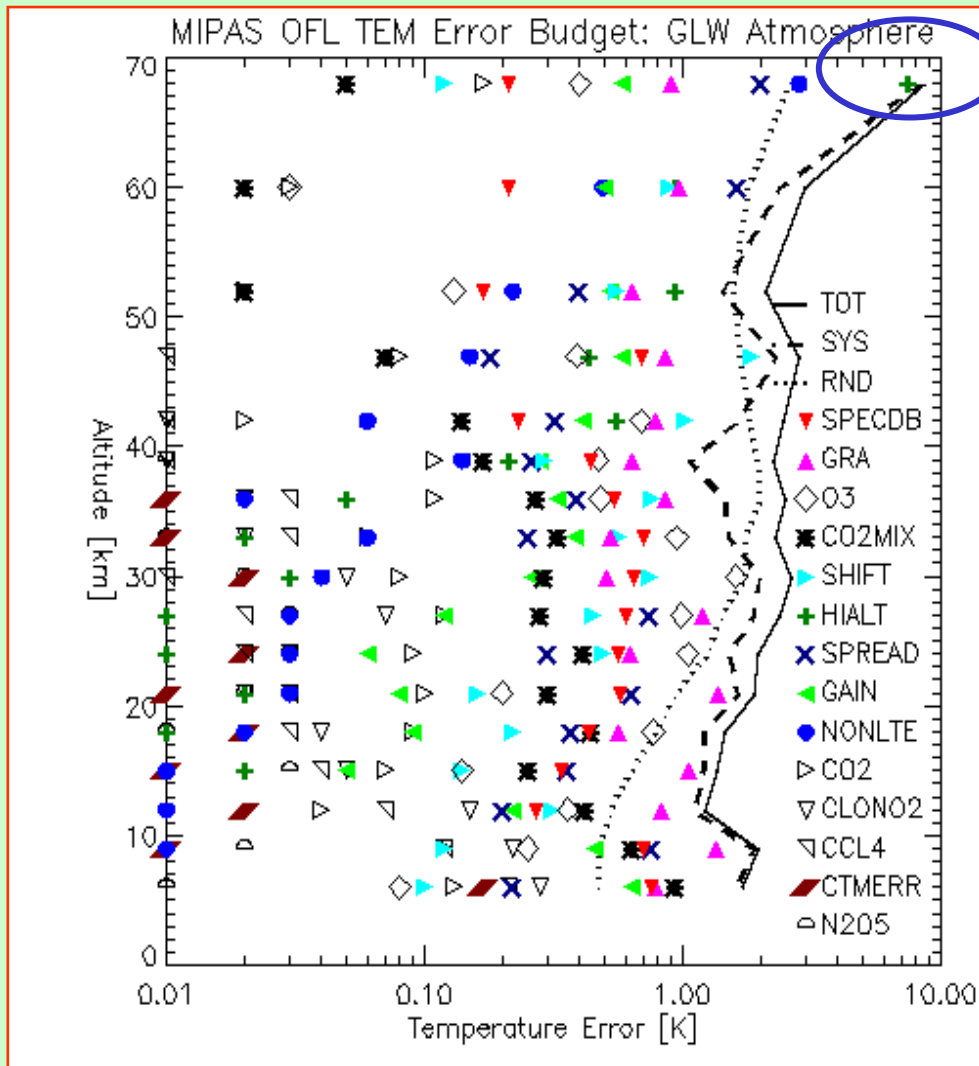
Tests on ORM extrapolation rules – errors on T



Test done by B.M.Dinelli, MIPAS commissioning phase, November 2002



Temperature validation



Error due to profile shape assumption above the topmost retrieved T profile point.

Bias

- In most cases the average difference (bias) is found to be statistically consistent with zero.
- In any case the bias is always within the systematic (i.e. constant part) error prediction (bias ≤ 2 K).
- Whenever different from zero, the bias detected in the intercomparisons depends not only on altitude, but also on geographic area, season, etc.

Ozone validation

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Geophysical validation of MIPAS-ENVISAT operational ozone data

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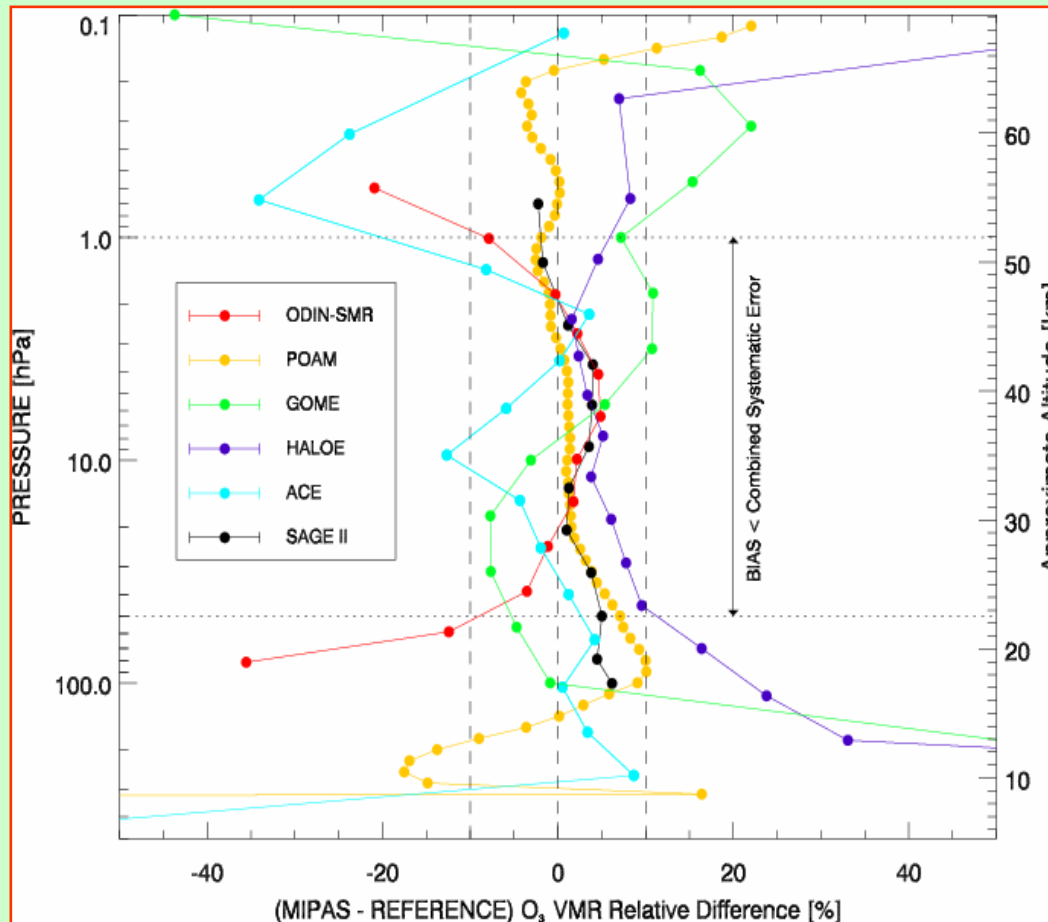
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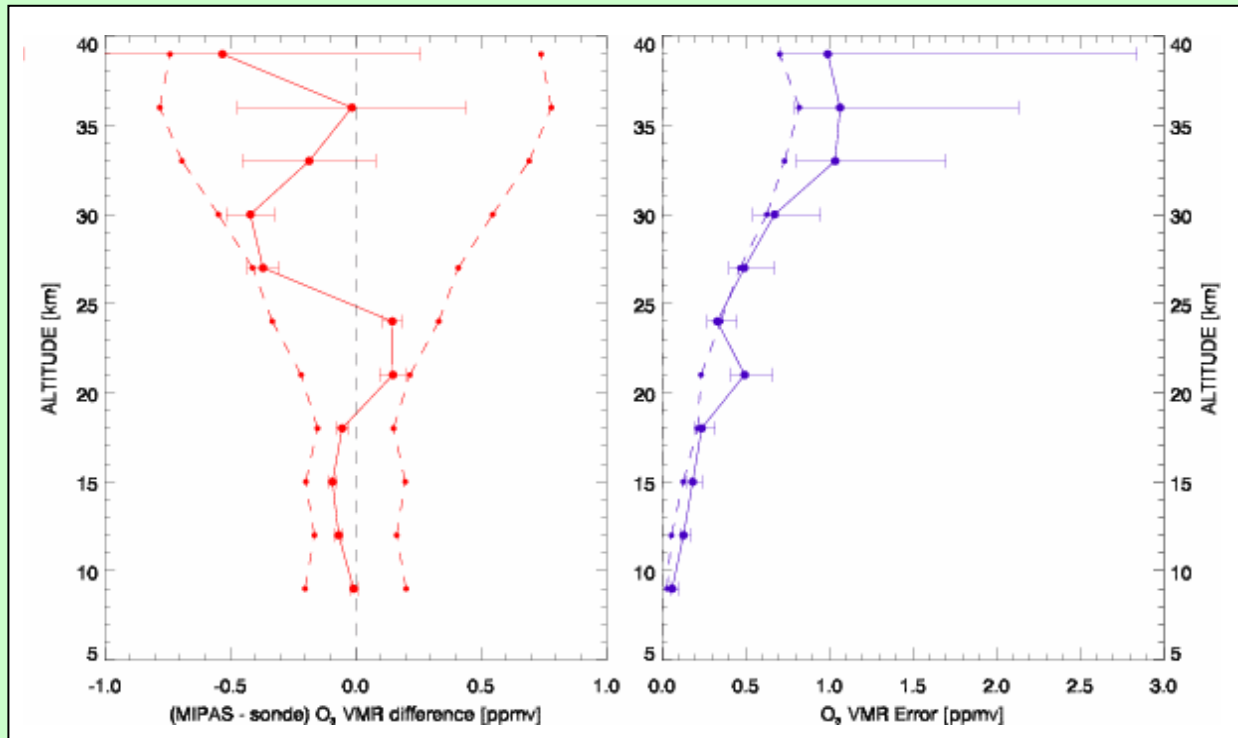
Ozone validation

Satellite intercomparison



Ozone validation

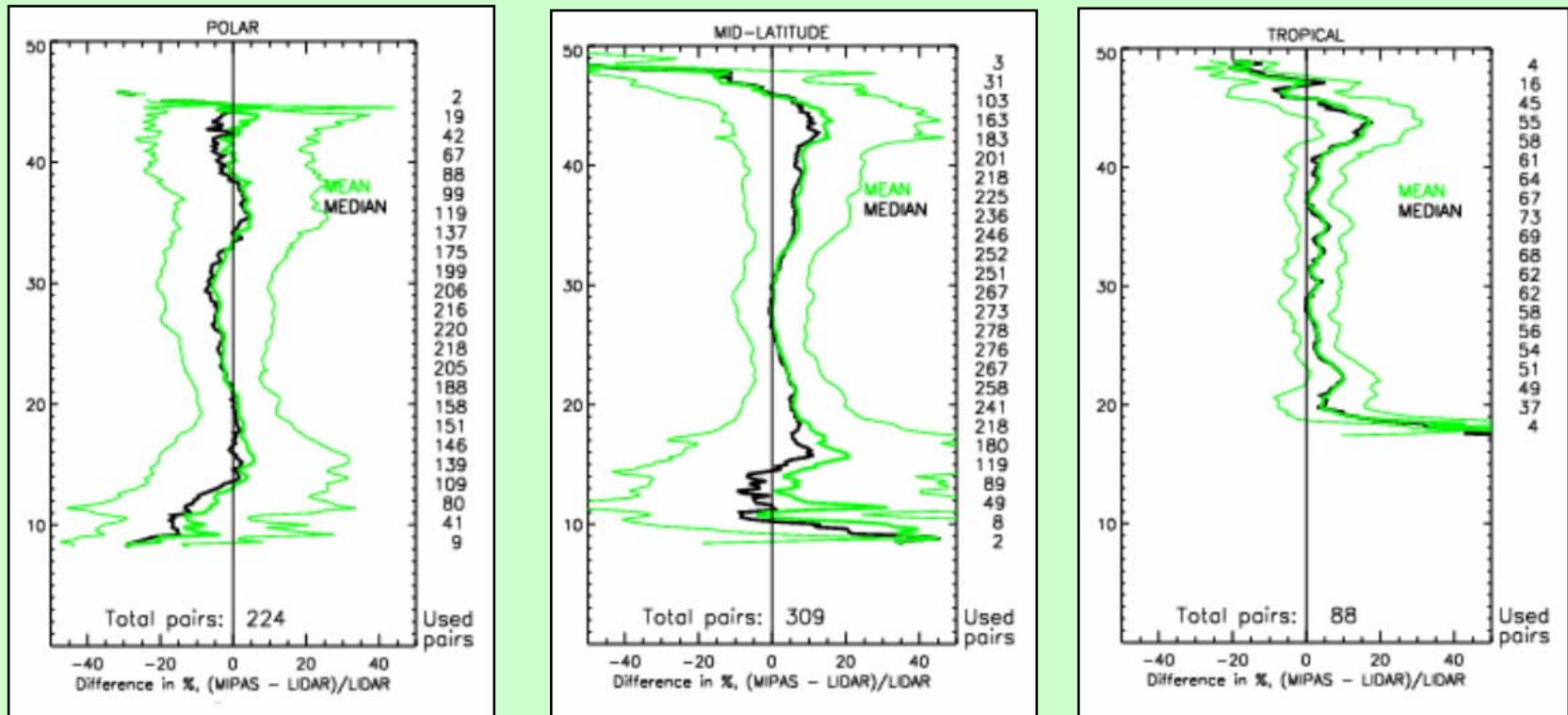
Comparison with ozone sondes (mid-latitude)



- Bias always within the systematic error of the comparison
- The standard deviation of the differences is larger than the random error of the measurements at lower altitudes (by a factor that is always less than 2).

Ozone validation

Comparison with lidar measurements



- O₃ VMR Mean Relative Difference within $\pm 5\%$ between 15 km and 40 km.
- Difference higher than 50% observed in the Tropics at $z < 20$ km could be explained by the presence of clouds along MIPAS line of sight.

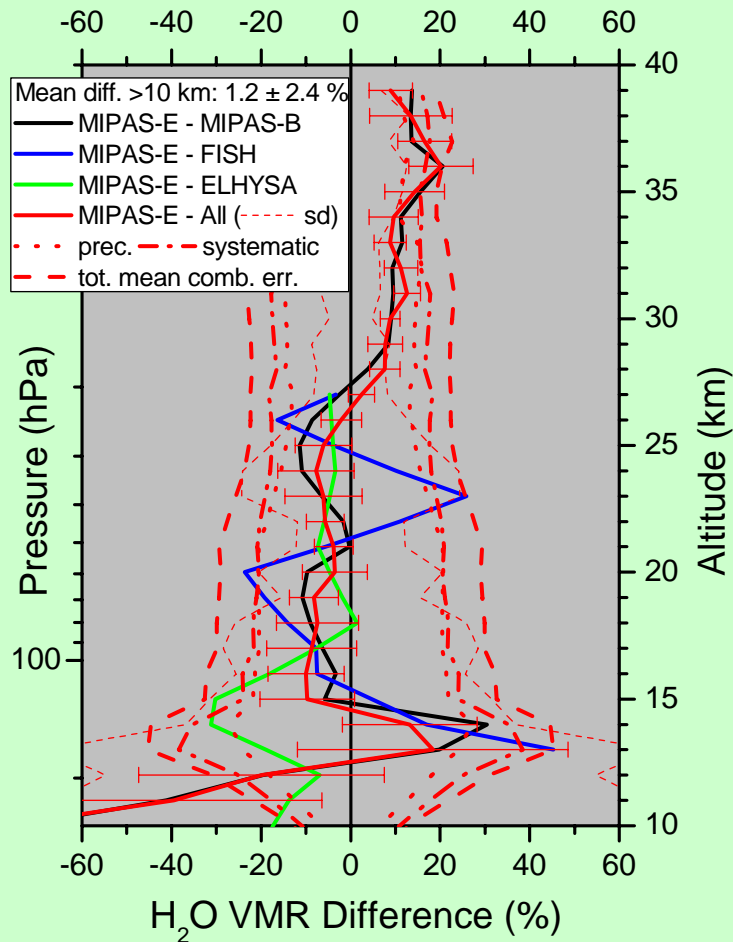
Ozone validation



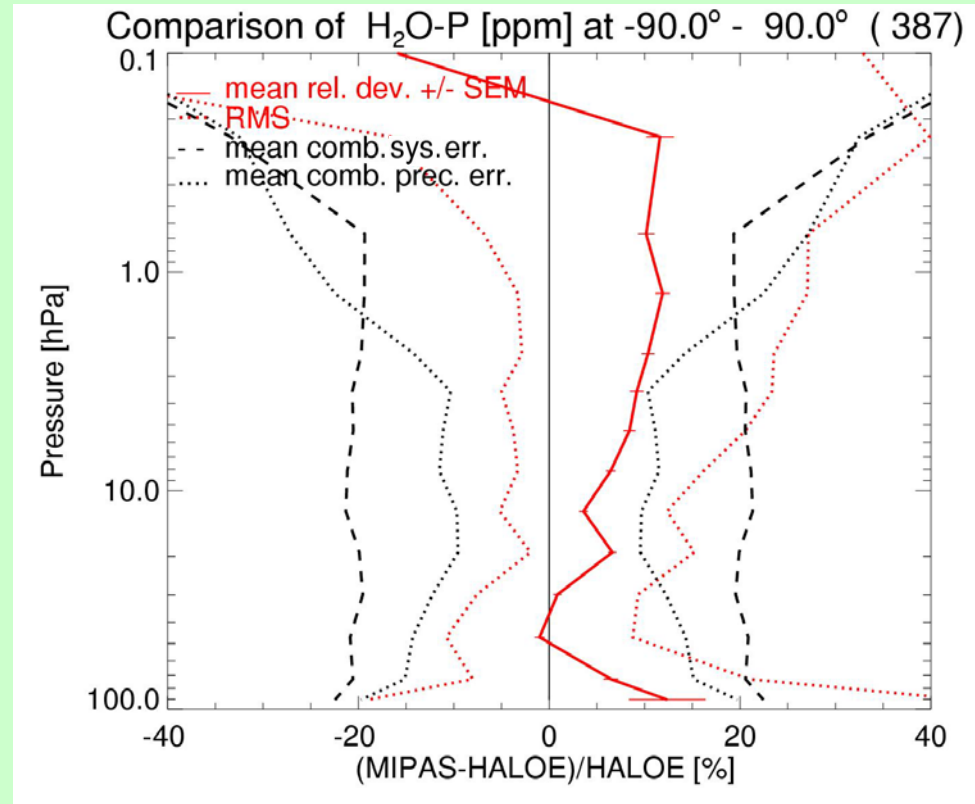
- Bias ($<\pm 10\%$) within the combined systematic error in the range 1 to 50 hPa (~ 52 to 23 km)
- Precision within the combined random error in the range 1 to 30-40 hPa (~ 52 to 25 km)
- Larger differences observed below 20-25 km could be explained by :
 - presence of clouds along MIPAS line of sight that are not adequately filtered.
 - underestimation of the pT propagation error at lower altitudes

H₂O: Synthesis of results

Balloon comparison

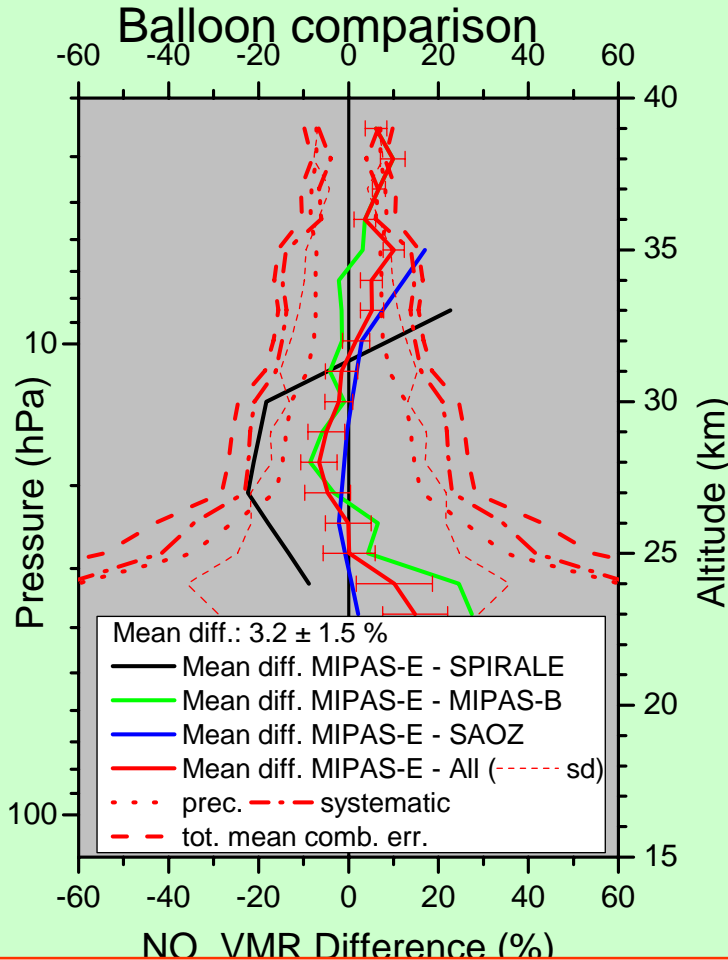


HALOE comparison

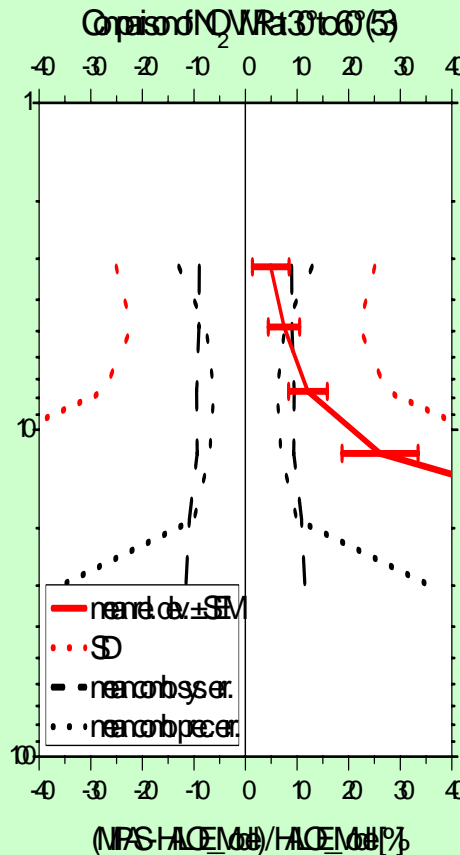


- Mean difference is well within combined total error .
- Tendency to positive bias at high altitudes.
- Standard deviation mostly similar to combined precision error.

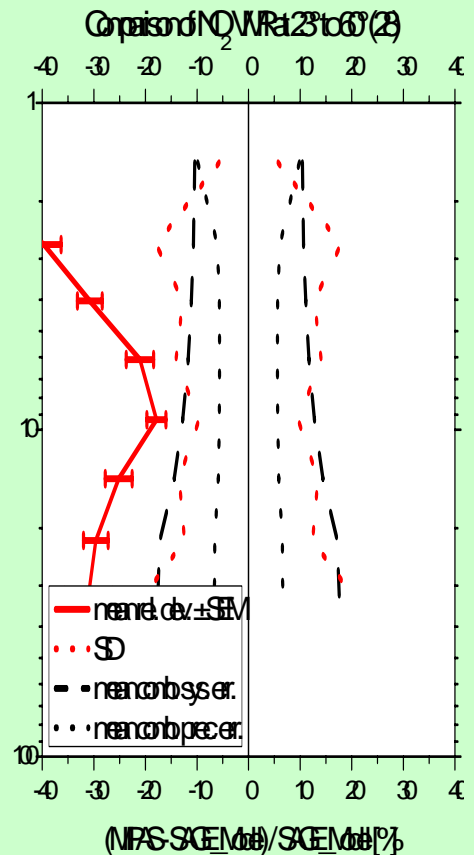
NO₂: Synthesis of results



HALOE comparison



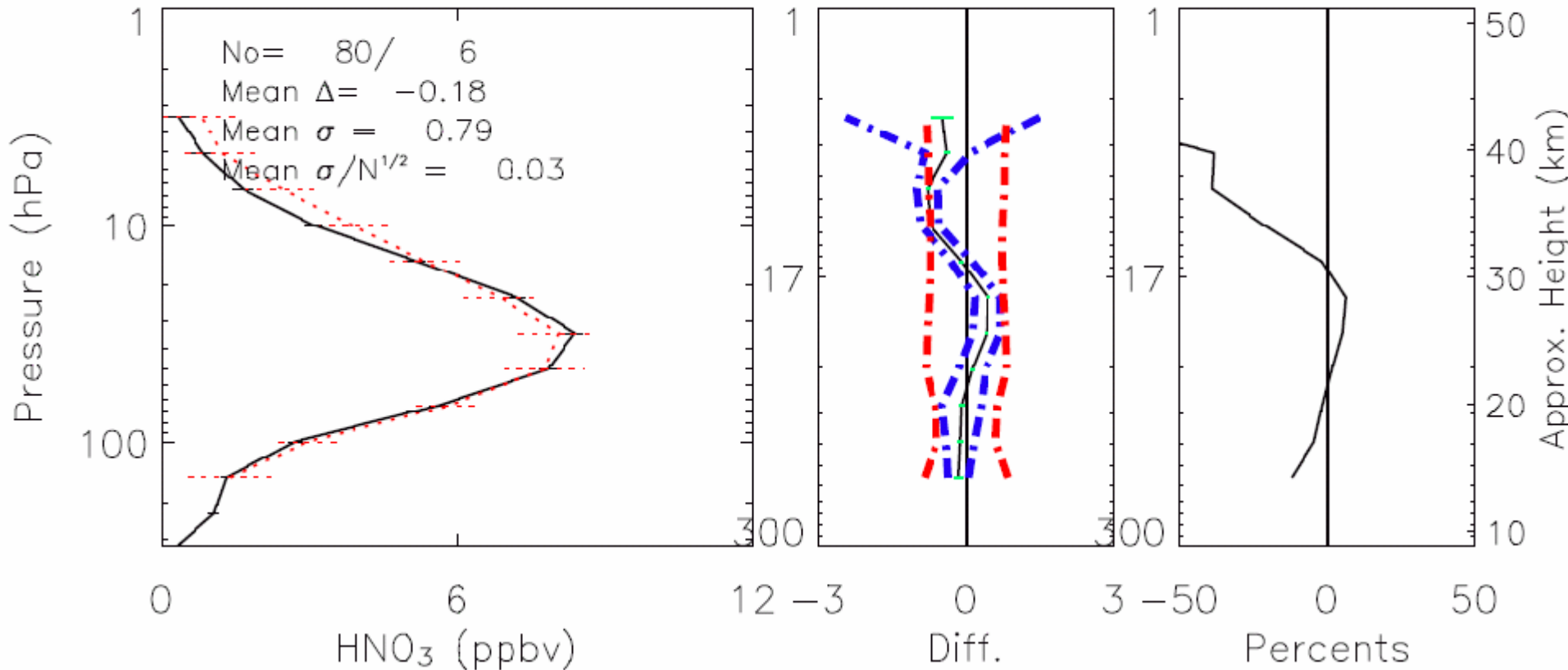
SAGE II comparison



- Mean difference and standard deviation mostly within the combined total errors.
- Satellite comparison show large biases that are season and latitude dependent.
- In polar winter the accuracy of stratospheric NO₂ profiles suffers from overburden at high altitudes (not enough information in NO₂ MWs at lower alt.).

ILAS-II (90N-60N)

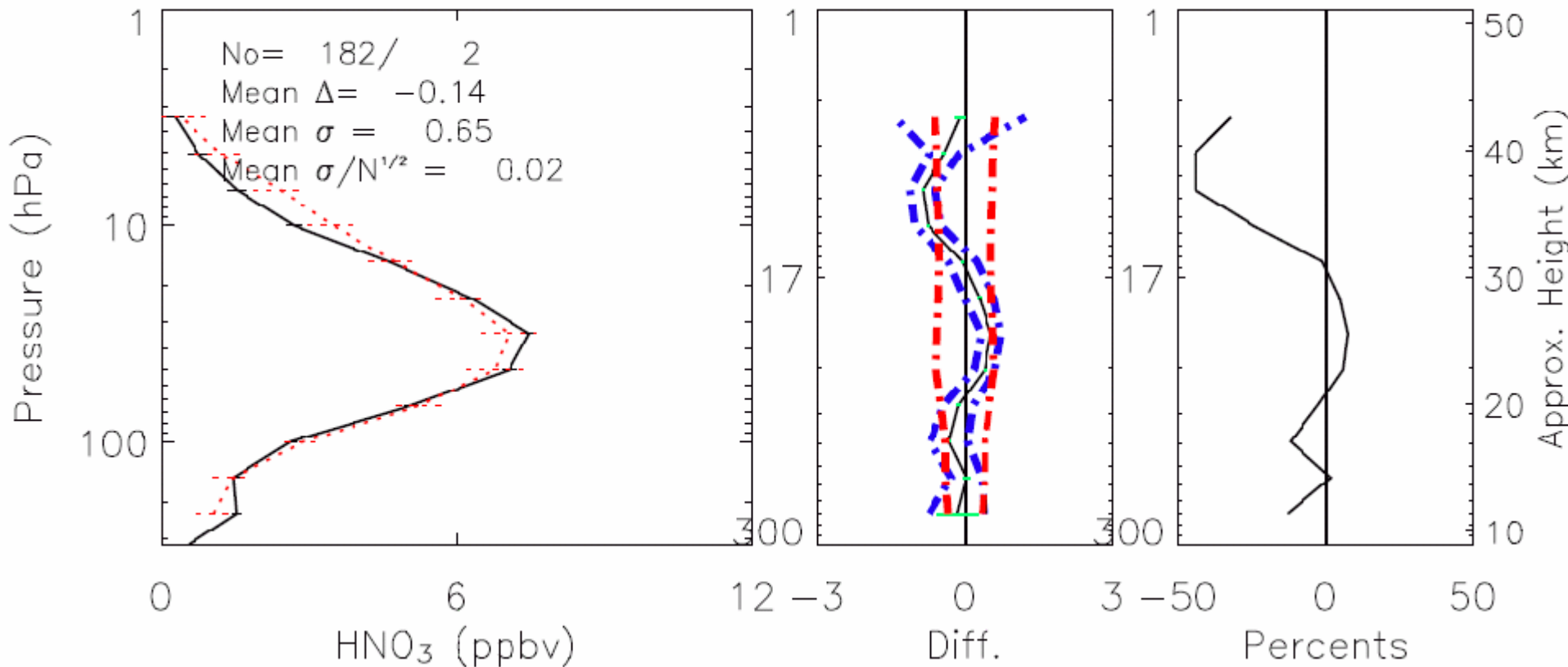
12-FEB-2003/24-OCT-2003
LAT Band: 90N-60N



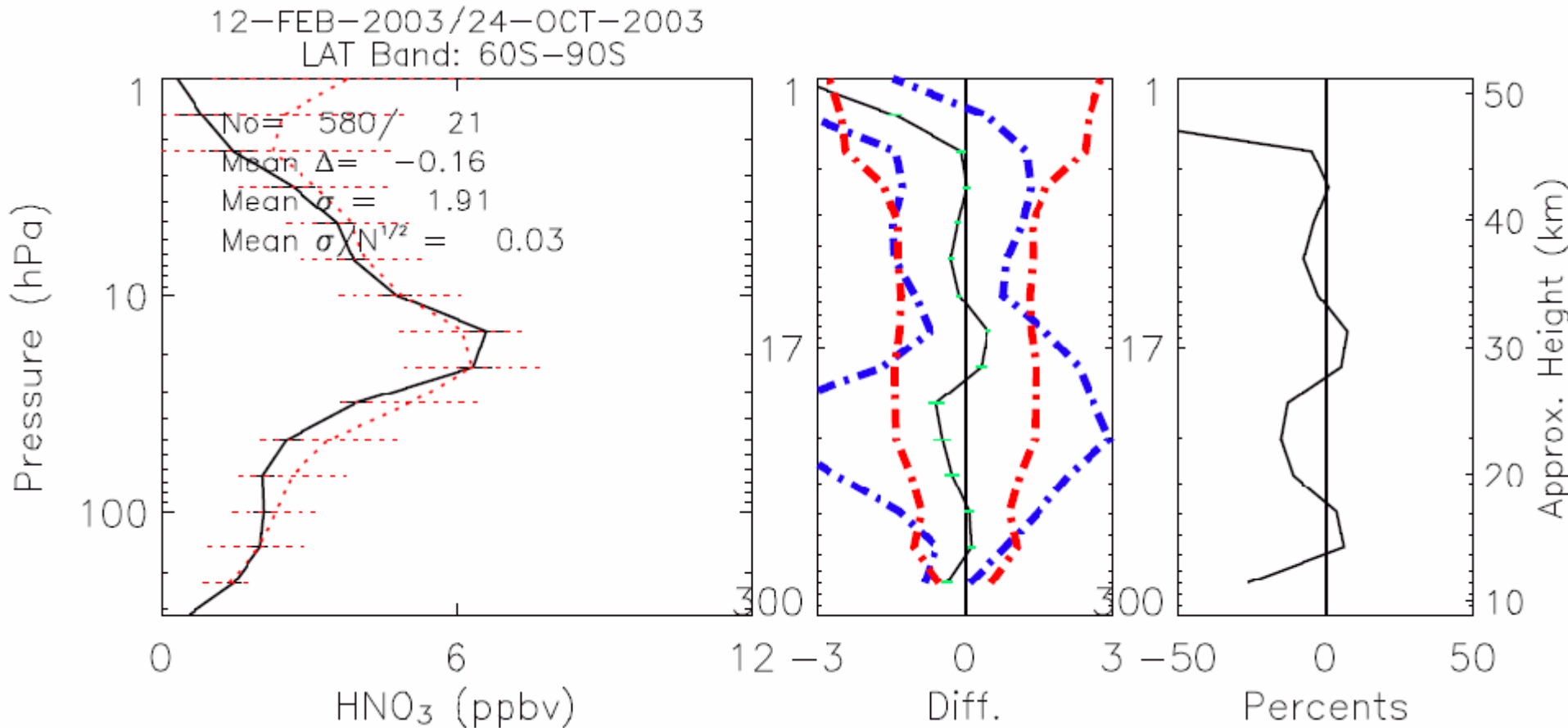
ILAS-II (60N - 30N)

12-FEB-2003/24-OCT-2003

LAT Band: 60N-30N

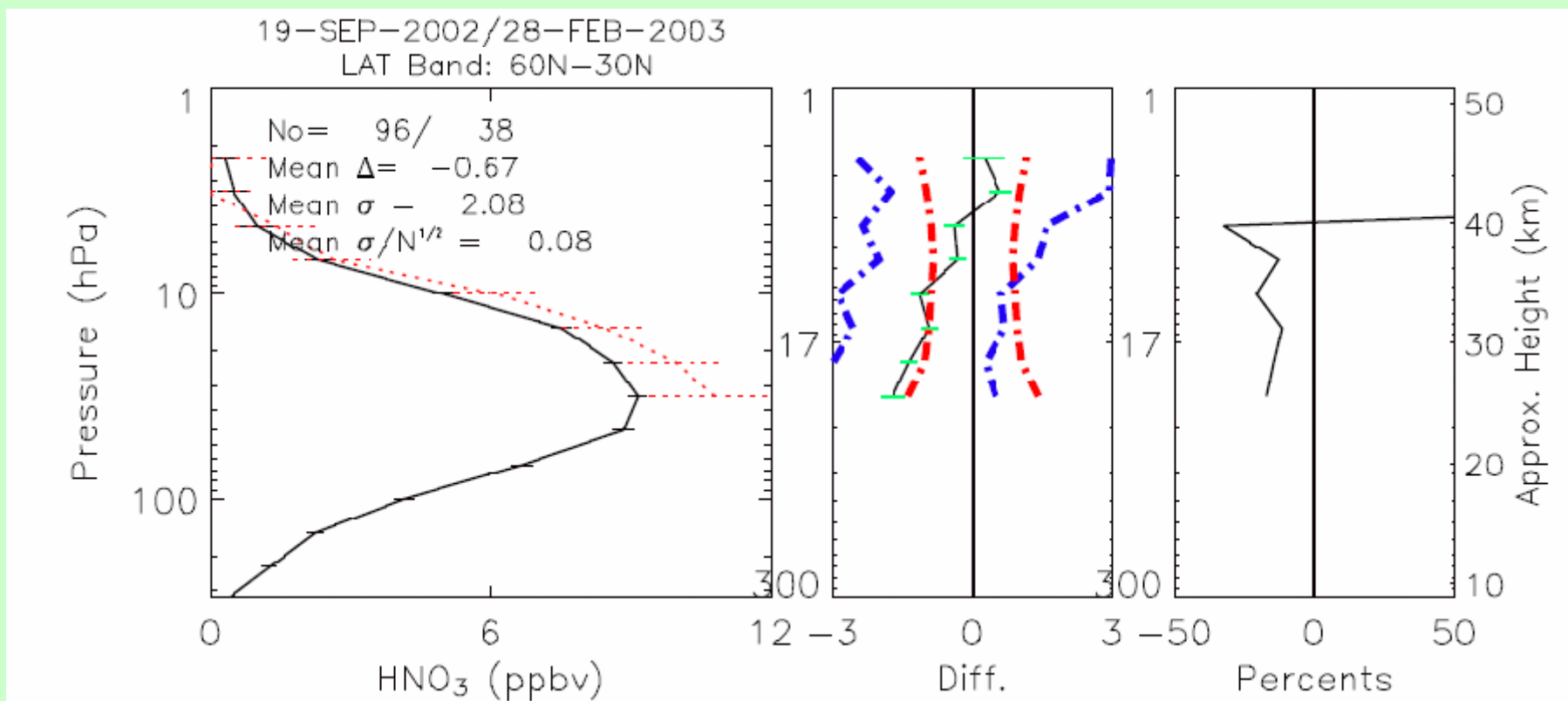


ILAS-II (60S - 90S)



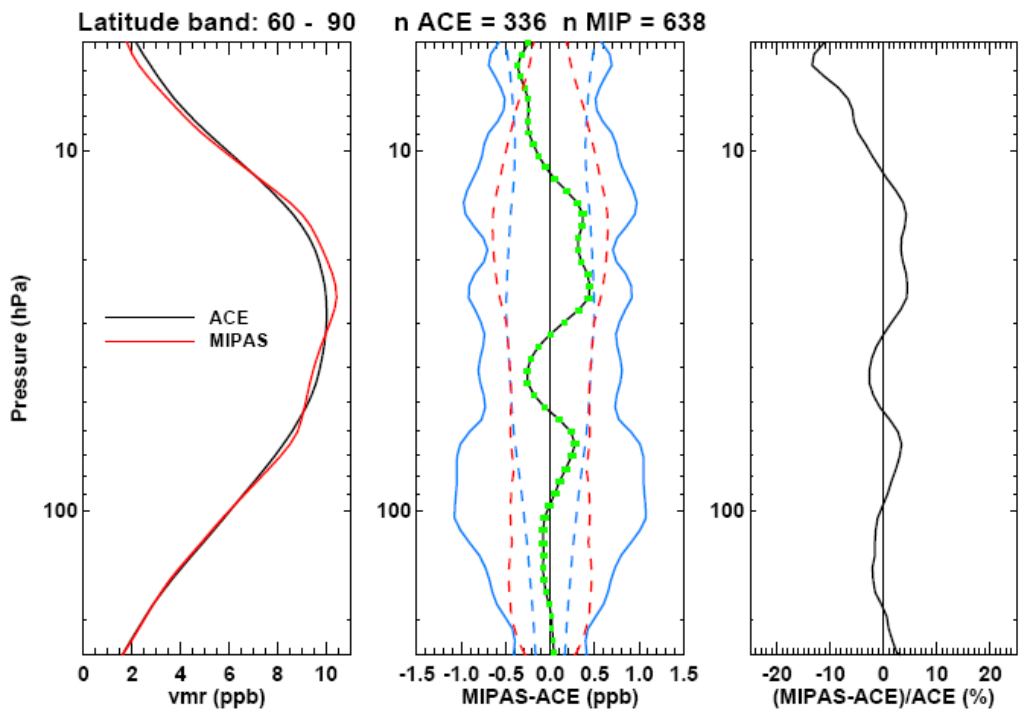
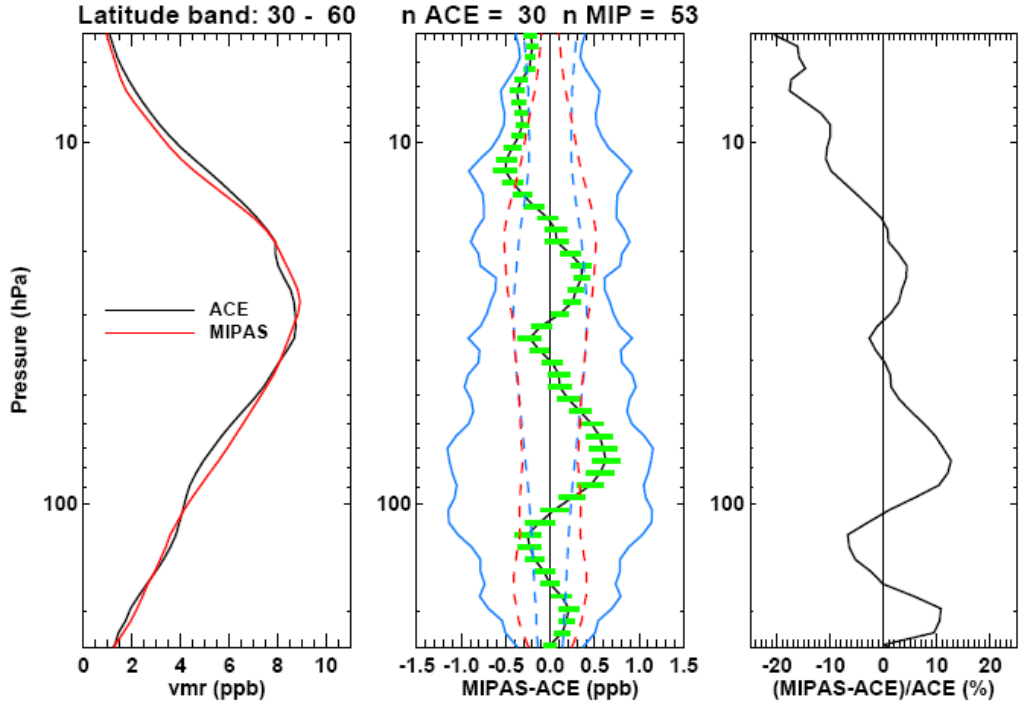
HNO₃: Synthesis of results

ODIN



HNO₃: Synthesis of results

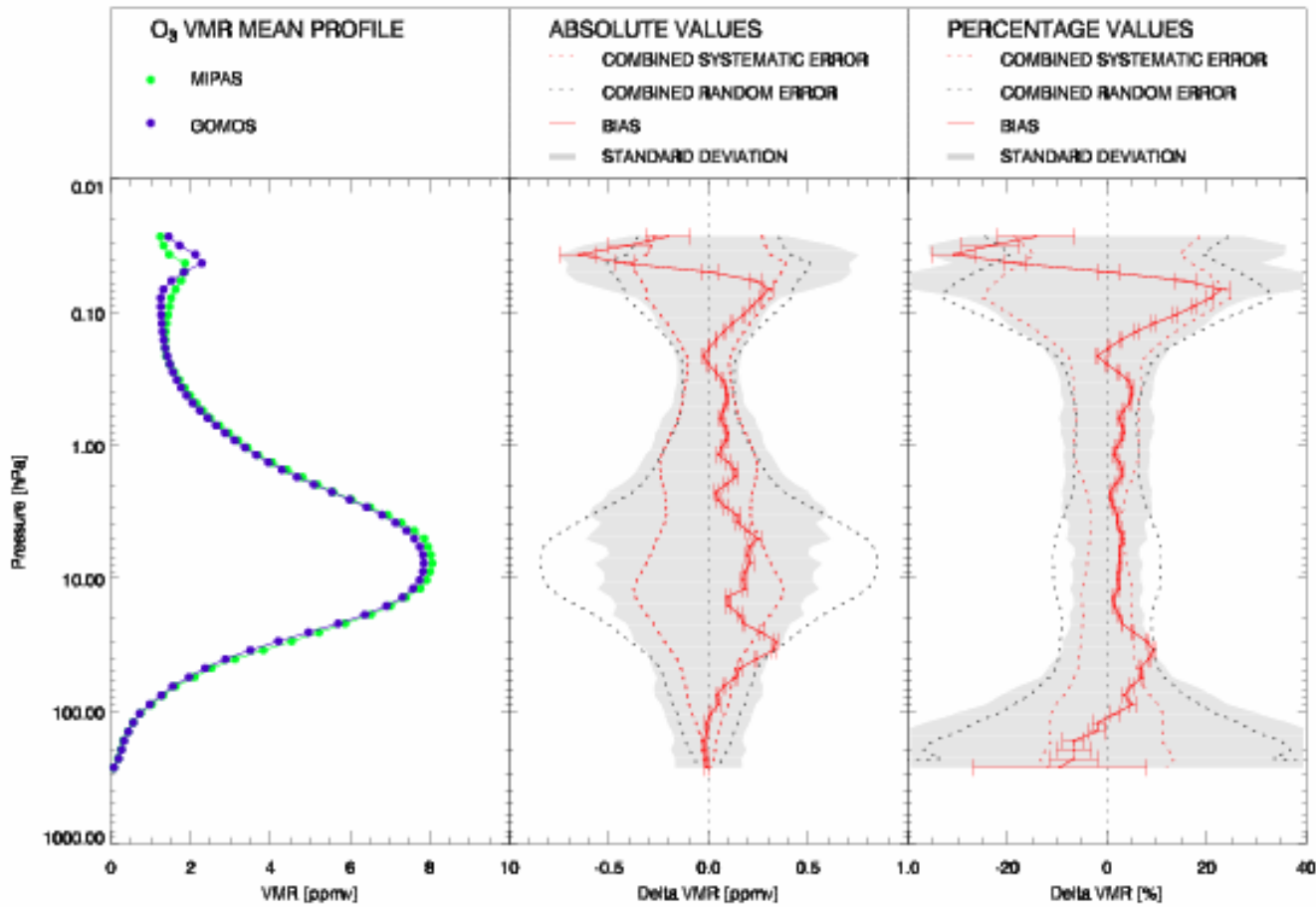
ACE-FTS



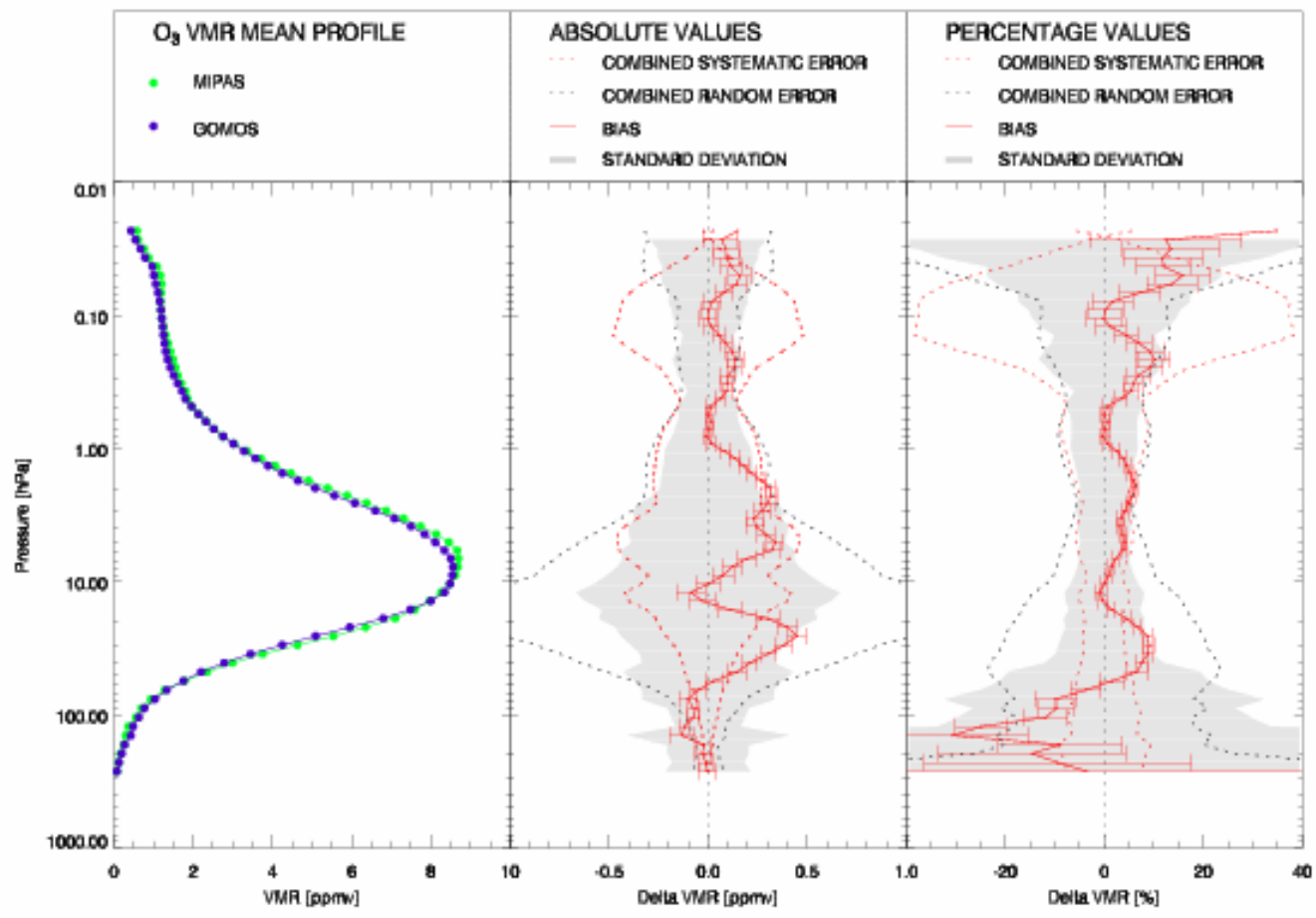
Continuity FR and RR



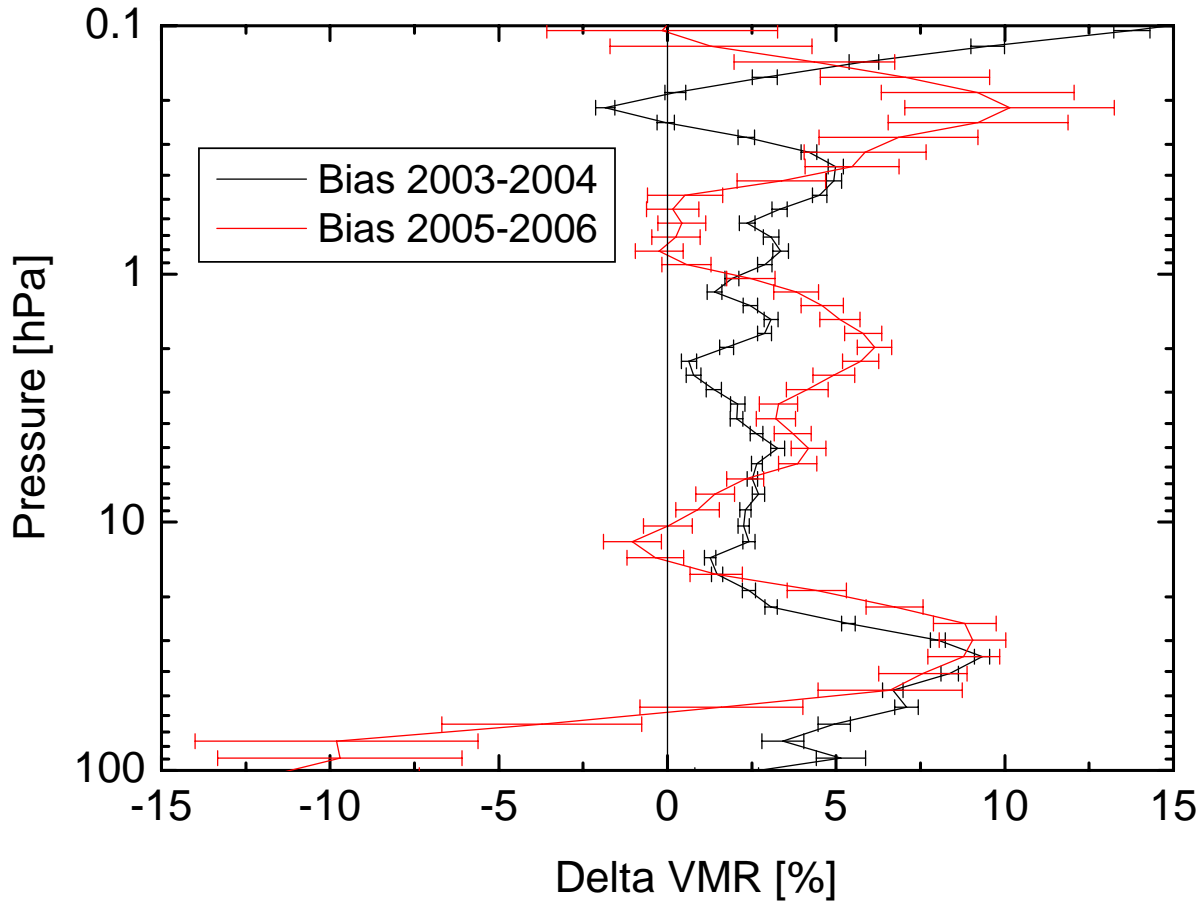
- The change of spectral resolution implies a change in the microwindows (MWs) used for the retrieval
- Different MWs have different systematic errors
- In order to quantify the bias introduced by this instrumental change a comparison was made for ozone with GOMOS.



Full resolution



Reduced resol.



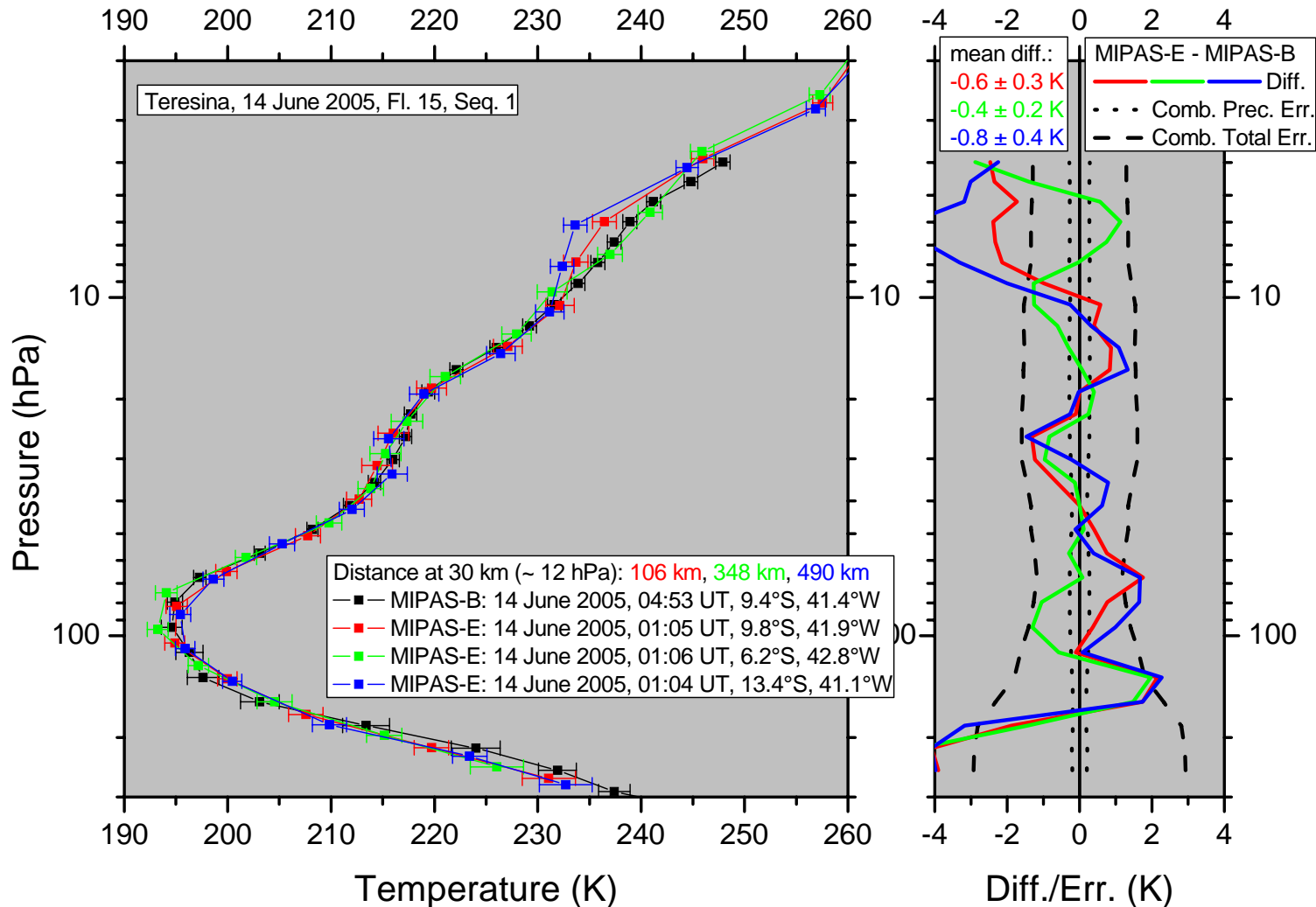
- For both datasets a bias of up to 10% is observed around 40 hPa.
- Around 2 hPa 2005-2006 dataset shows a larger bias than 2003-2004 dataset.
- This result was used to reconsider the MW selection.
- Large values are observed at the boundaries of the retrieval range.



Validation of RR measurements



Temperature





Temperature

- Differences are mostly within combined total errors. Good agreement in tropopause region (around 17 km). Larger deviations of up to -4 K in upper troposphere.
- Mean difference is only -0.27 K, but slightly higher than in 2002/2003 (Aire, Sep. 2002, 2 scans; Kiruna, March 2003, 2 scans; and Kiruna, July 2003, 1 scan) where the mean difference was even only -0.04 K.
- Standard deviation is higher than the combined precision (noise) error.

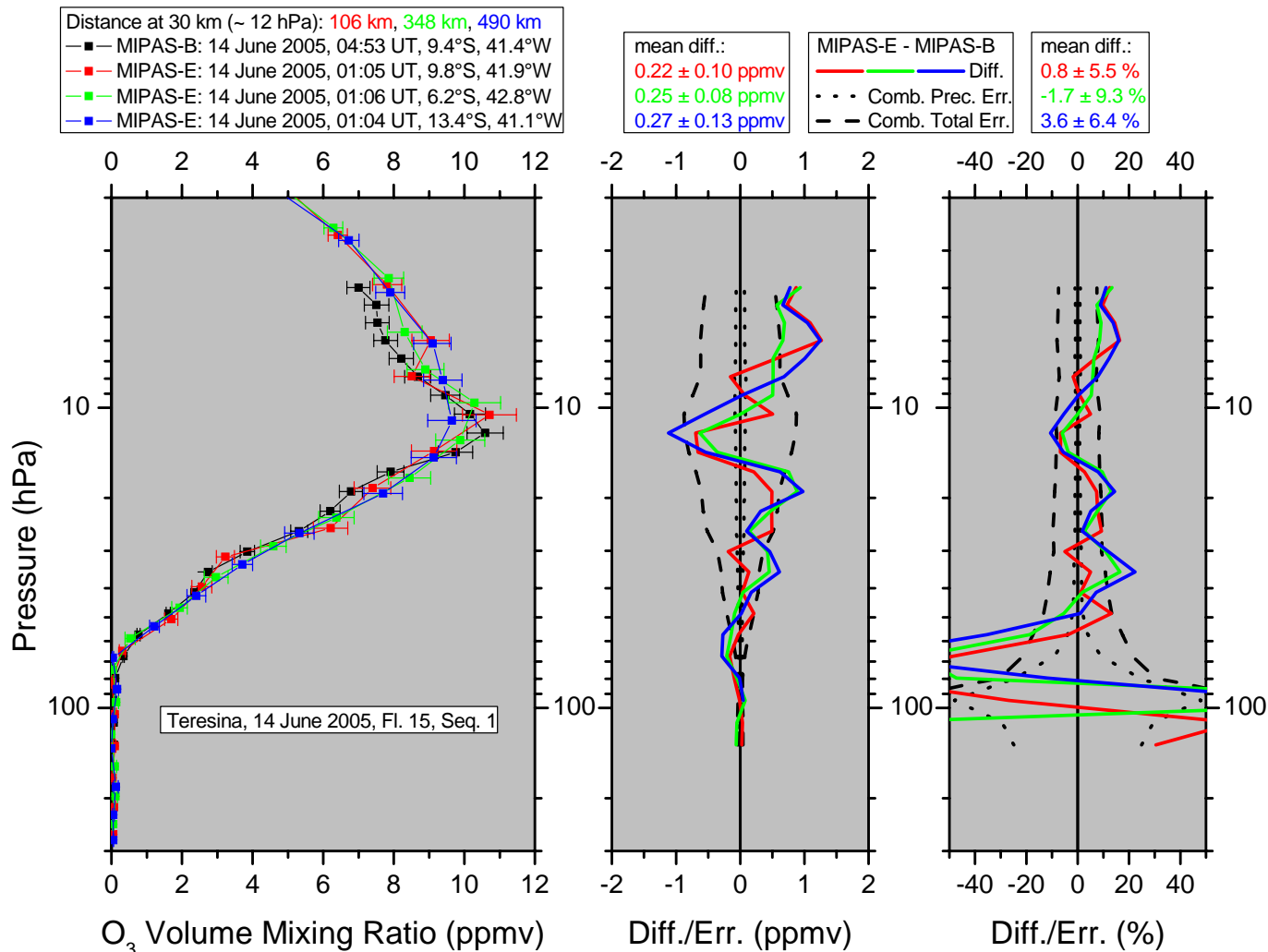


Validation of RR measurements



Ozone

Quite good agreement between all profiles (high bias at upper altitude levels).





Validation of RR measurements

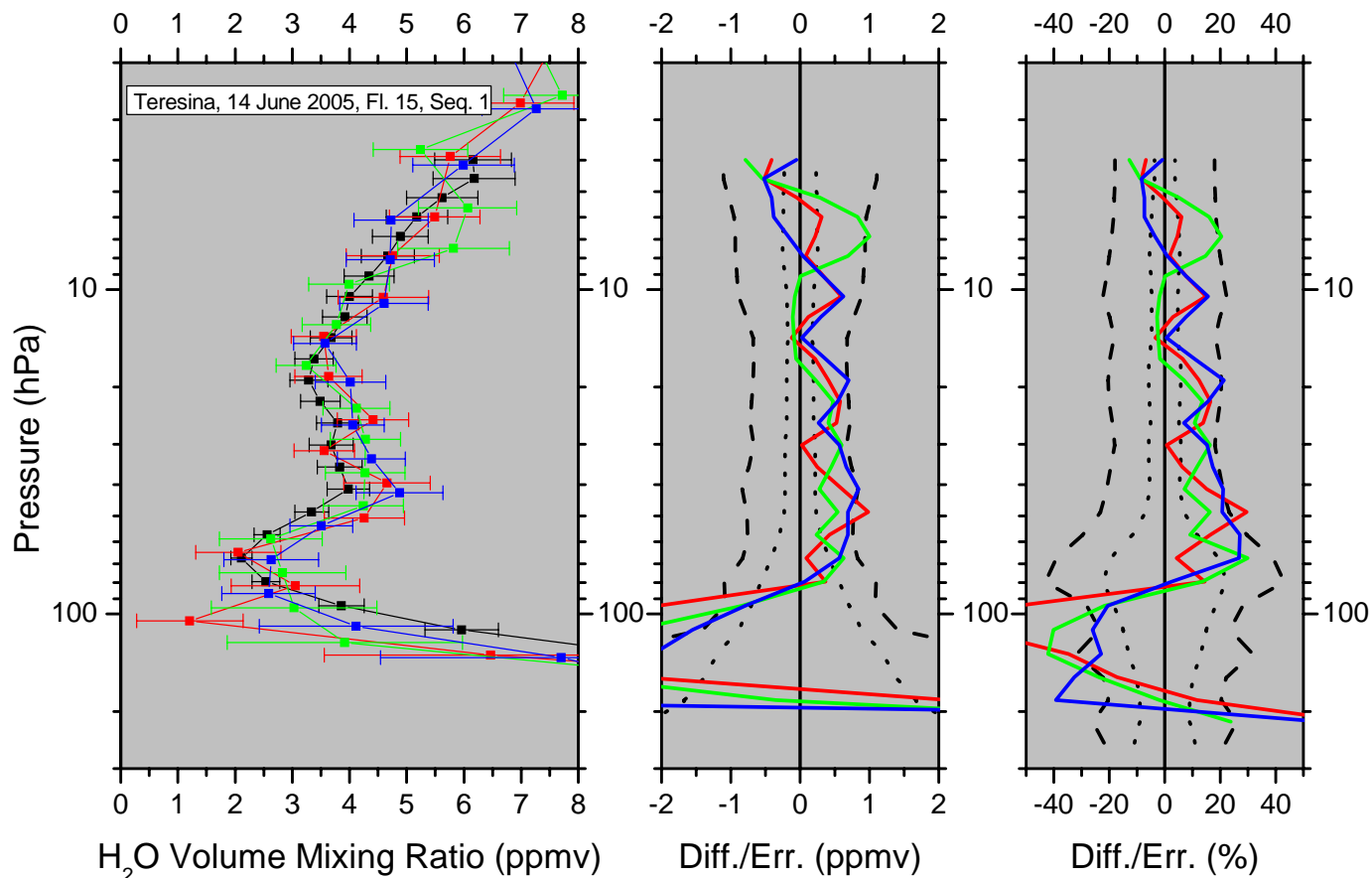


H₂O

Large deviations below hygropause level (about 70 hPa, 19 km).
Large variability of MIPAS-E profiles below this level.

Distance at 30 km (~ 12 hPa): 106 km, 348 km, 490 km
—■— MIPAS-B: 14 June 2005, 04:53 UT, 9.4°S, 41.4°W
—■— MIPAS-E: 14 June 2005, 01:05 UT, 9.8°S, 41.9°W
—■— MIPAS-E: 14 June 2005, 01:06 UT, 6.2°S, 42.8°W
—■— MIPAS-E: 14 June 2005, 01:04 UT, 13.4°S, 41.1°W

mean diff.:	MIPAS-E - MIPAS-B	mean diff.:
1.63 ± 1.35 ppmv	— Diff.	6.5 ± 6.3 %
0.01 ± 0.32 ppmv	· · · Comb. Prec. Err.	2.0 ± 3.4 %
1.75 ± 1.74 ppmv	— Comb. Total Err.	9.6 ± 6.9 %



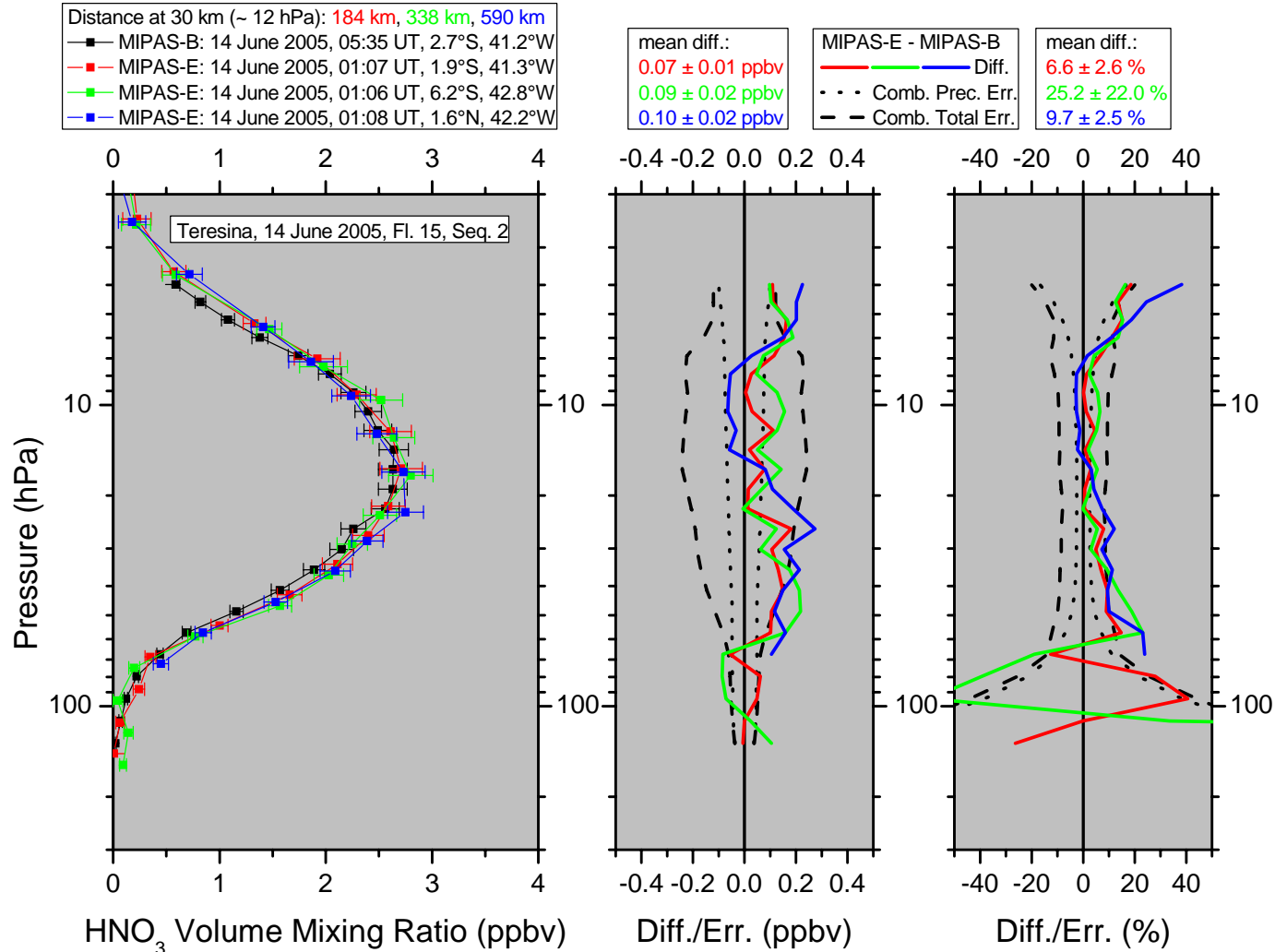


Validation of RR measurements



HNO₃

Slightly enhanced HNO₃ measured by MIPAS between 10 and 50 hPa.



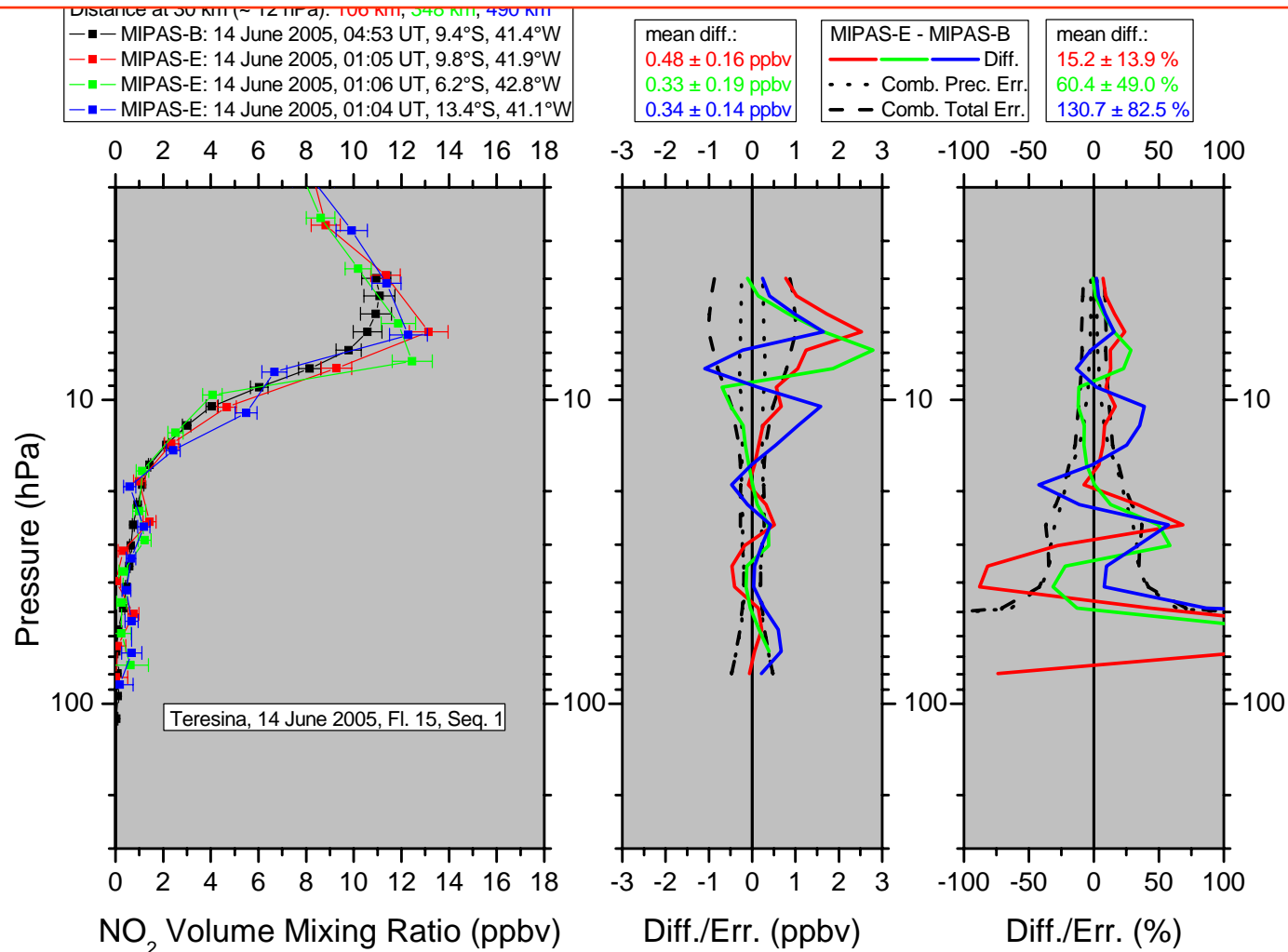


Validation of RR measurements



NO₂

Photochemical correction necessary due to a time difference of roughly 4 hours between MIPAS-E and MIPAS-B observations.





Validation of RR measurements



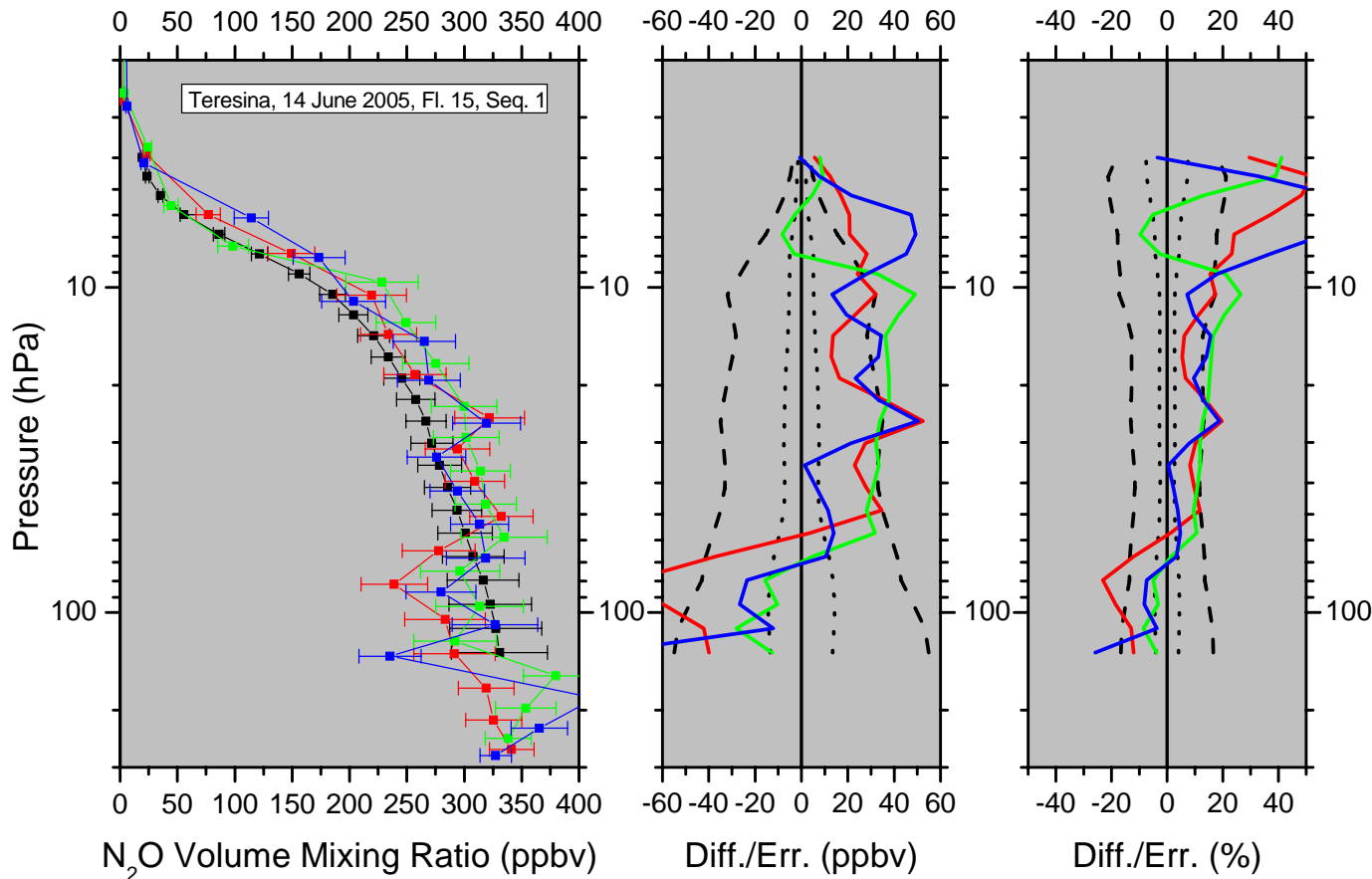
Some retrieval instabilities appear in the MIPAS profiles below about 50 hPa.

Distance at 30 km (~ 12 hPa): 106 km, 348 km, 490 km
—■— MIPAS-B: 14 June 2005, 04:53 UT, 9.4°S, 41.4°W
—■— MIPAS-E: 14 June 2005, 01:05 UT, 9.8°S, 41.9°W
—■— MIPAS-E: 14 June 2005, 01:06 UT, 6.2°S, 42.8°W
—■— MIPAS-E: 14 June 2005, 01:04 UT, 13.4°S, 41.1°W

mean diff.:
7.5 ± 6.6 ppbv
17.0 ± 4.6 ppbv
13.4 ± 6.1 ppbv

MIPAS-E - MIPAS-B
— Diff.
- - - Comb. Prec. Err.
- - - Comb. Total Err.

mean diff.:
11.4 ± 3.9 %
10.6 ± 2.8 %
14.7 ± 5.0 %



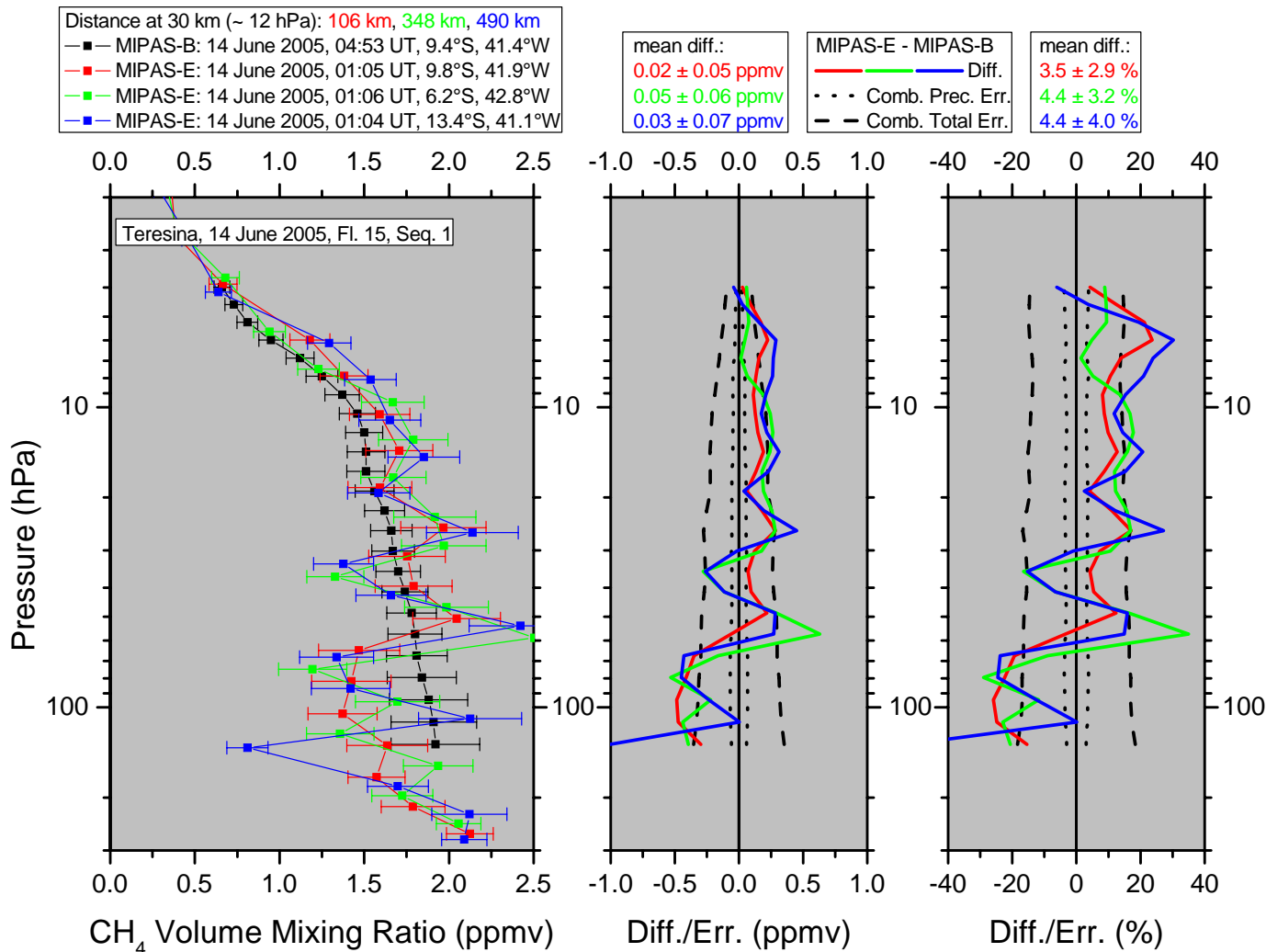


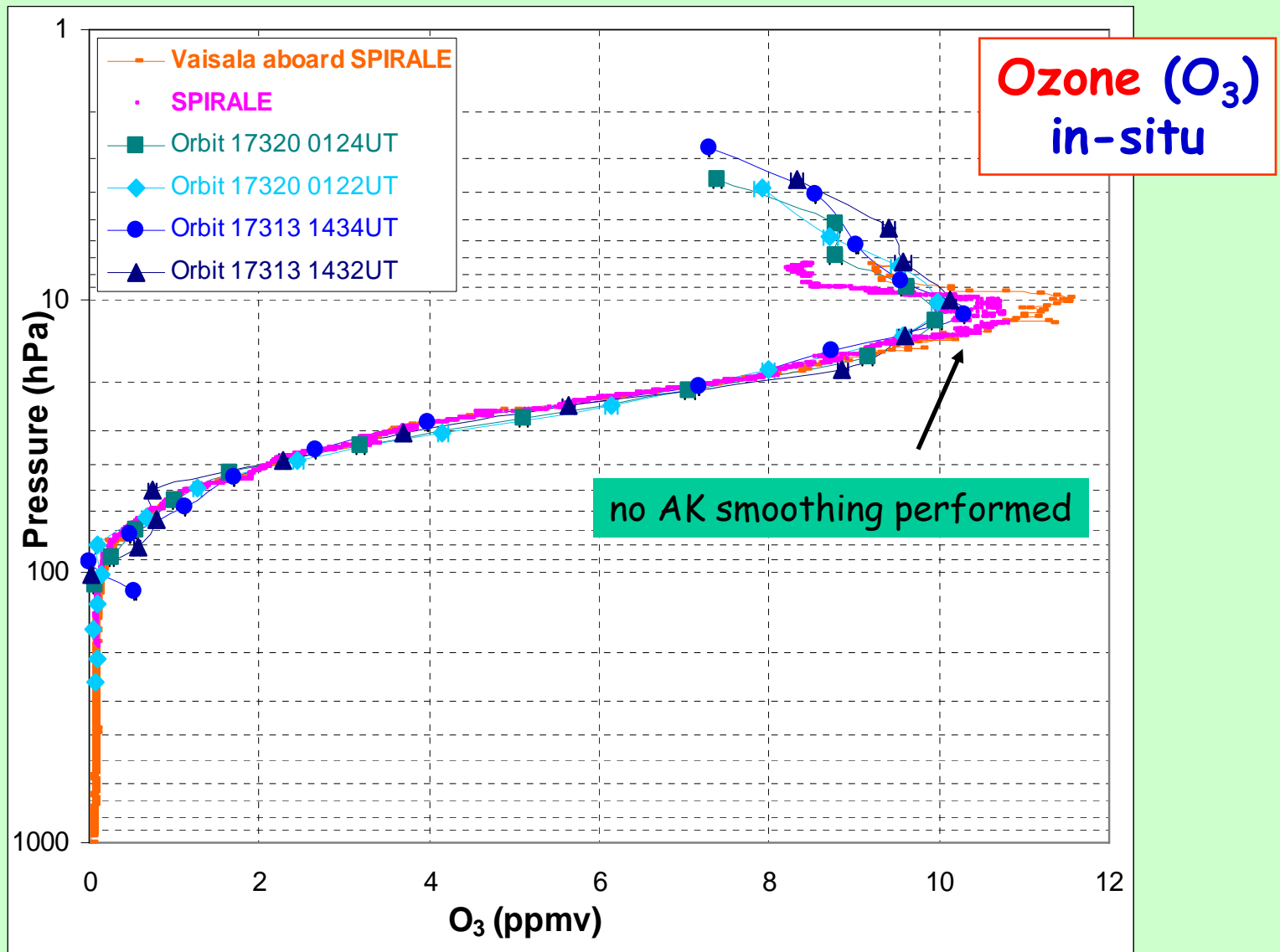
Validation of RR measurements



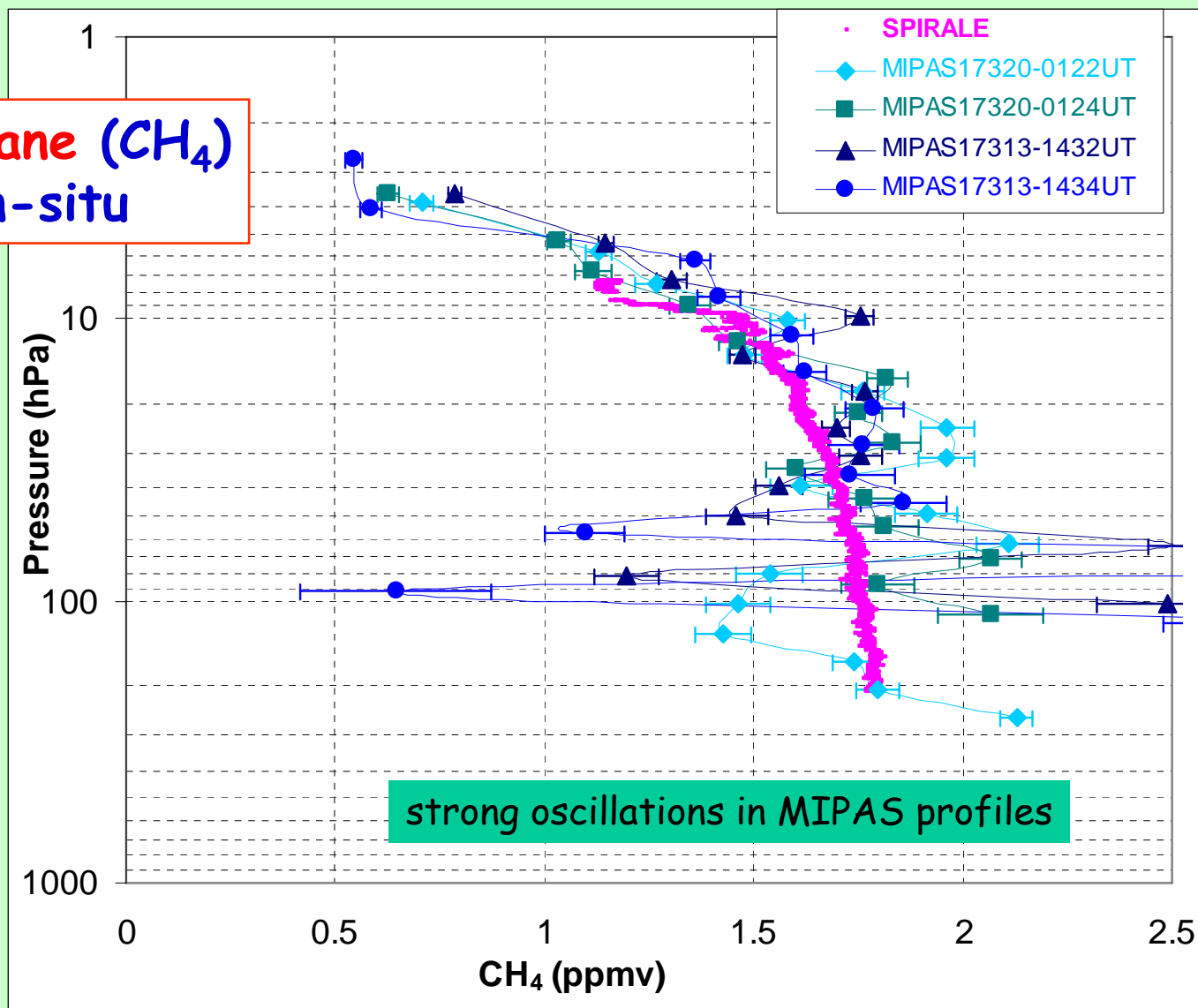
CH₄

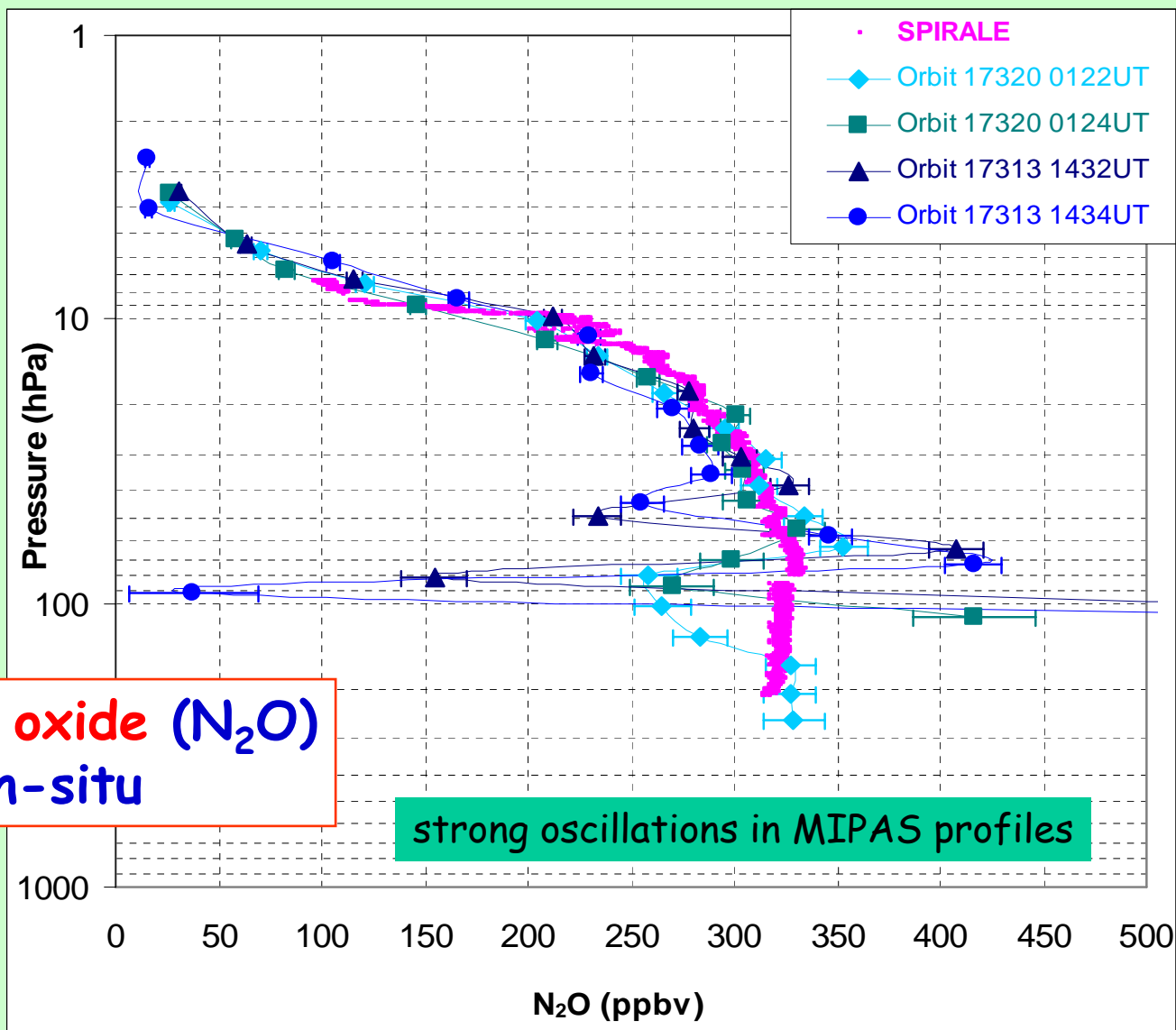
Strong retrieval instabilities are visible in MIPAS profiles below about 20 hPa.



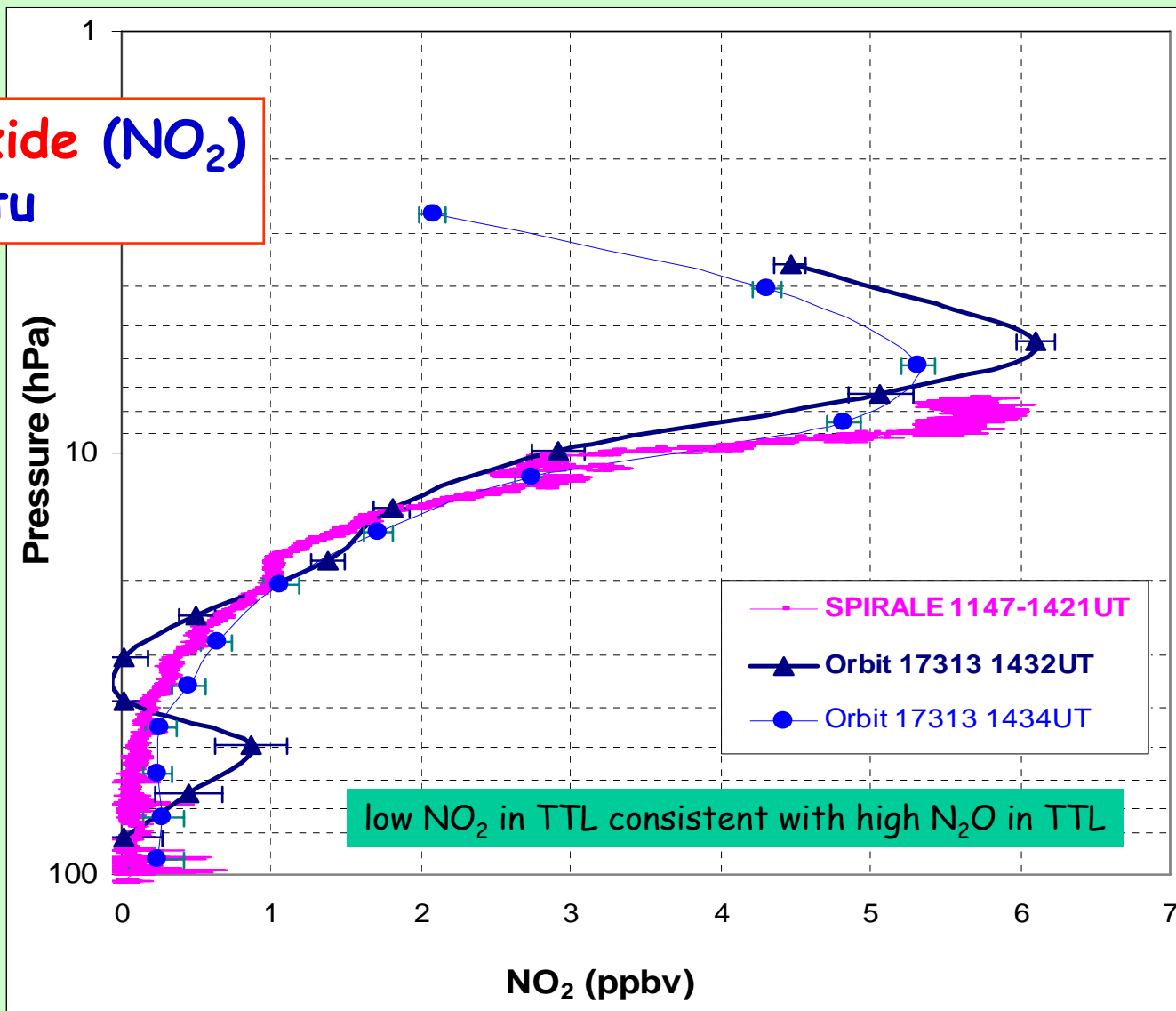


**Methane (CH₄)
in-situ**





**Nitrogen dioxide (NO₂)
in-situ**



Concluding remarks



- Comparisons with simultaneous measurements made by airborne and ground based instruments and other space instruments provides the verification of the assumed errors and of the long term consistency of the results, as well as, validation of the quality.
- The results of intercomparison activities are often used for improvements of the data analysis.