Overview of HIRDLS V7 Products: O_3, HNO_3, CFC11, CFC12, H_2O and N_2O

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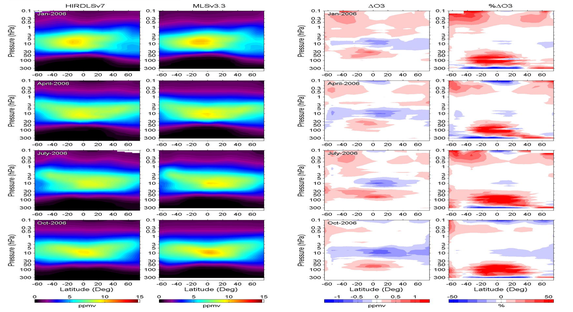
Acknowledgements: K. Walker (ACE-FTS data), L. Froidevaux (Aura-MLS data), T. Leblanc (TMO & MLO lidar data), R. Stubi (Payerne ozonesonde data), G. Stiller & T. v. Clarmann [KIT] & C. Hepplewhite (MIPAS data)

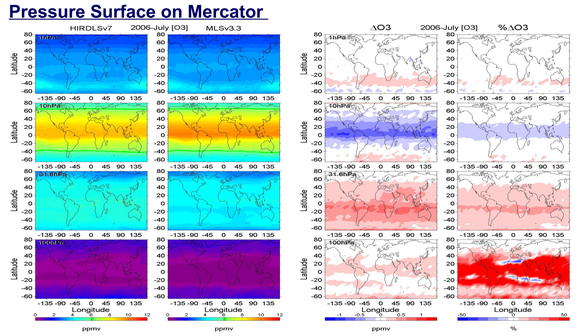
O_3 - MLS Comparisons

Monthly Zonal Mean

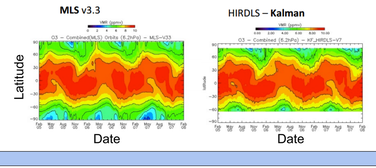


Shown above are monthly O_3 zonal mean VMR (ppmv) cross-sections for HIRDLS (1st col) and MLS v3.3 (2nd col), their difference (3rd col) and the %-difference (H-M/M) (4th col). The rows correspond to 2006, January (row 1), April (row 2), July (row 3) & October (row 4). The white areas in %-difference plots correspond to ±5%. VMR color increments are 10%. These are incrementally better than V6.

Pressure Surface on Mercator



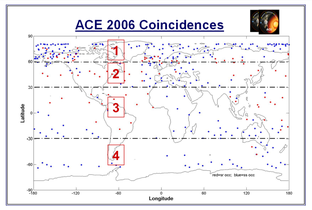
Shown are Mercator representations of the ozone percent difference between HIRDLS v7 and collocated MLS (v3.3) averaged over 2006-July. Each row of plots corresponds to a pressure level: 1 hPa, 10 hPa, 51 hPa and 100 hPa, as indicated on the upper left corner of each plot in columns 1 & 3.



Shown is mean ozone volume mixing ratio at the 6.2 hPa pressure level for MLS v3.3 (left) and HIRDLS v7 (right), as a function of time (2005-2007) for all latitudes.

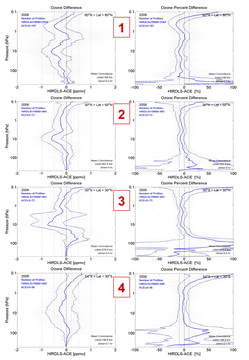
O_3 - ACE-FTS Comparisons

ACE 2006 Coincidences



All coincident ACE-FTS occultation measurements during 2006 (within 400km and 6 hours) are shown on the Mercator plot above for four latitude regions labeled [1], [2], [3] & [4].

The mean differences of HIRDLS V7 O_3 and ACE-FTS V3 O_3 are shown at right for each of these labeled regions. →

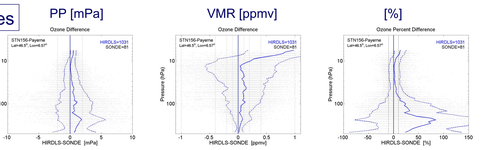


Ozonesonde Comparisons

Differences

47°N Payerne

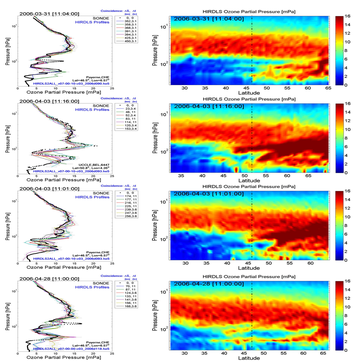
PP [mPa] VMR [ppmv] [%]



Shown above are mean differences of HIRDLS V7 O_3 mixing ratios with all coincident ozone-sondes in 2006 (12 hours and 400 km) from the Payerne, Switzerland WOUDC site. The observed bias, does not degrade when comparing only highly structured profiles with lamina features, indicating a lack of difficulty resolving them. The WOUDC-site ozonesonde data have been extremely useful in validating HIRDLS ability to resolve the fine structure in ozone, such as the laminae shown below.

To the right are specific → cases of lamina events. On the right hand side are curtain plots of ozone as measured by HIRDLS about a coincident ozonesonde, showing 20° latitude in both directions about the sonde location (marked by dashed line).

The ozonesonde profile is plotted to the left of the HIRDLS contour in each case (black dots), and is compared with adjacent HIRDLS profiles (colored lines). Comparisons show excellent agreement well below 200 hPa in many cases.



O_3 Precision

Shown are the predicted (red) and observed (blue) ozone precision, in units of volume mixing ratio (left column) and percent (right column).

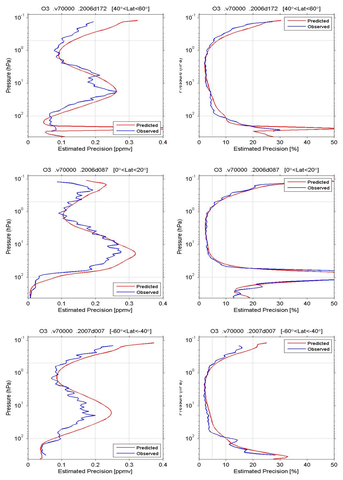
Predicted precision is computed by the retrieval algorithm, and averaged over the indicated latitude band.

Observed precision is estimated at each pressure level as the standard deviation about the mean O_3 value of 12 adjacent profiles along the track. Contributions from geophysical variability are minimized by fitting straight line (ax+b) to the set of profiles at each pressure level to remove any trend that may be present. The average STDs from ten sets of profiles is used for each latitude region.

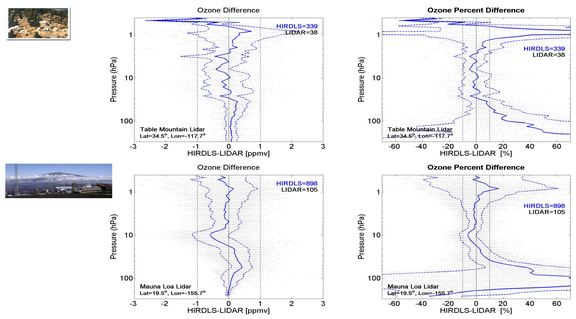
Three representative latitude bands are shown for undisturbed periods (i.e., summer at high latitudes): 40-60°N (top), 0-20°N (middle), 40-60°S (bottom).

HIRDLS v7 ozone precision is 2% between 1-10 hPa, and 2-20% between 10-200 hPa, except in the tropic where precision can be greater than 20-~100% between 50-200 hPa.

Precision estimates for HNO3, CFCs, H2O & N2O (right) are computed similarly.



O_3 – Lidar Comparisons



The mean ozone difference (solid blue lines) from comparisons with lidars is shown for the mid-latitude station at Table Mountain Facility (39°N, left) and for the low latitude Mauna Loa Observatory (20°N, right). Top plots are in units of ozone volume mixing ratio (ppmv); bottom plots are percentage difference. The dashed blue lines are the standard deviation of differences.

SUMMARY

1. HIRDLS ozone is scientifically useful between 0.5 – 400 hPa at mid- and high latitudes and between 0.1 – 100 hPa at low latitudes.
2. HIRDLS V7 ozone is comparable to v6, with a precision as good as 2%, and accuracy as good as <5%. These values become significantly larger at tropical lower stratosphere.
3. HIRDLS ozone continues to resolve vertical ozone features on the scale of 1 km, even in the lower stratosphere.
4. V7 CFC11 and CFC12 and HNO3 are significantly improved over the V6 products. More detailed validation studies are necessary.
5. Newly released products H_2O and N_2O show very reasonable agreement with all datasets compared, including MLS, MIPAS, ACE-FTS and the WACCM93 model.
6. H_2O precision is 7%-20% between 150 hPa – 2 hPa, and accuracy is roughly 5%-20% depending on region, but can be larger in isolated regions (>50% in SH, high latitude stratosphere).
7. N_2O precision is 5-20% between 10-100 hPa and accuracy is typically <10% below 10 hPa (except SH winter where it's biased high ~50%). Above ~10 hPa where N2O concentration drop off rapidly HIRDLS has a strong low bias.

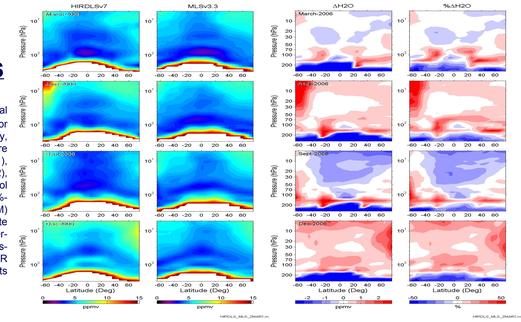
ABSTRACT

HIRDLS V7 data products: O3, HNO3, CFC11, CFC12, H2O and N2O are summarized here. Significant modifications have been made in the radiance correction and retrieval algorithms for V7, resulting in significant improvements to data quality, both in terms of systematic and random errors. Estimates of the accuracy and precision are shown, using comparisons with other satellite data sets, including Aura-MLS (Microwave Limb Sounder), ACE-FTS (Atmospheric Chemistry Experiment / Fourier Transform Spectrometer), MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), ground-based lidars, and balloon-sonde measurements. Of the previously released products, HNO3, CFC11, CFC12, have improved significantly over V6, while O3 continues to have the ability to detect thin ozone laminae (on the order of 1km) at mid-latitudes but with a smaller low bias. Newly released V7 products N2O and water vapor have precision of roughly 10%-20%, and accuracy of about 5-10% (with notable exceptions in the high latitude southern hemisphere stratosphere, where the bias is higher).

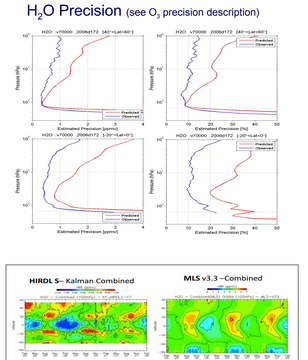
H_2O

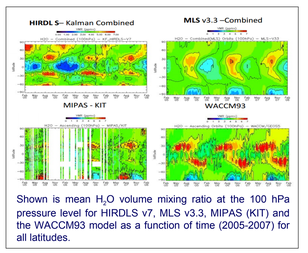
MLS

H_2O Monthly zonal mean VMR for 2006 Jan, Apr, July, & Oct. Shown are HIRDLS V7 (col 1), MLS v3.3 (col 2), their difference (col 3) and the %-difference (H-M/M) (col 4). The white areas in % difference plots correspond to ±5%; VMR color increments are 10%.



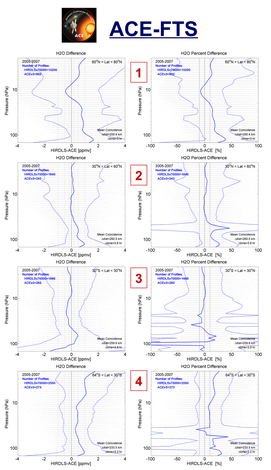
H_2O Precision (see O_3 precision description)





Shown is mean H_2O volume mixing ratio at the 100 hPa pressure level for HIRDLS v7, MLS v3.3, MIPAS (KIT) and the WACCM93 model as a function of time (2005-2007) for all latitudes.

ACE-FTS

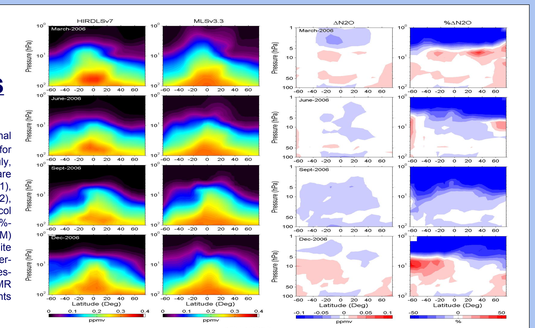


Shown above are mean H_2O differences (solid blue lines) from comparisons with ACE-FTS v3 for all 2005-2007 coincidence profiles (within 400km and 6 hours) in latitude regions labeled [1], [2], [3] & [4] (see O_3).

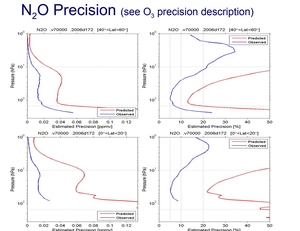
N_2O

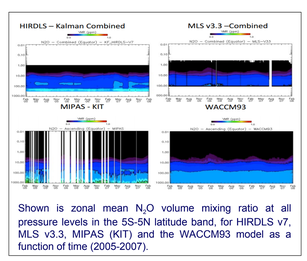
MLS

N_2O Monthly zonal mean VMR for 2006 Jan, Apr, July, & Oct. Shown are HIRDLS V7 (col 1), MLS v3.3 (col 2), their difference (col 3) and the %-difference (H-M/M) (col 4). The white areas in % difference plots correspond to ±5%; VMR color increments are 10%.



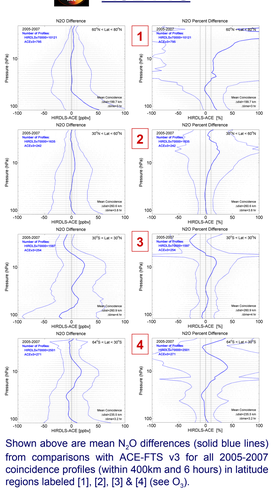
N_2O Precision (see O_3 precision description)





Shown is zonal mean N_2O volume mixing ratio at all pressure levels in the 5S-5N latitude band, for HIRDLS v7, MLS v3.3, MIPAS (KIT) and the WACCM93 model as a function of time (2005-2007).

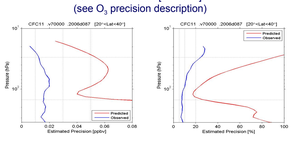
ACE-FTS



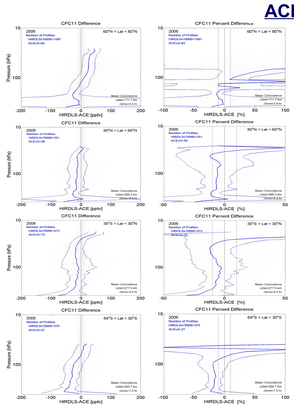
Shown above are mean N_2O differences (solid blue lines) from comparisons with ACE-FTS v3 for all 2005-2007 coincidence profiles (within 400km and 6 hours) in latitude regions labeled [1], [2], [3] & [4] (see O_3).

CFC11

CFC11 Precision [20-40°N] (see O_3 precision description)



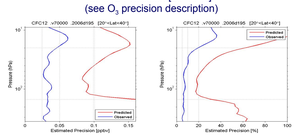
ACE-FTS



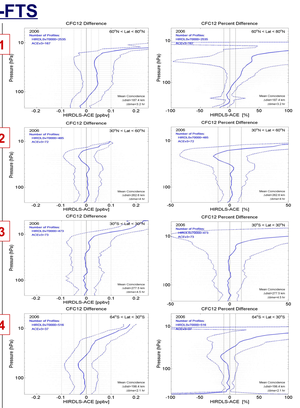
In tropics and N-mid-latitude CFCF-11 is biased 5-10% low below ~30 hPa, and CFC-12 is typically biased within <5% below 20 hPa, with respect to ACE. Southward of -30degS and at high latitudes bias tend to be higher and increasingly positive. These are significantly improved over HIRDLS V6, but require additional validation. Coincidence locations for each region are shown in the Mercator plot in the O3 section (left on poster) for each of four latitude regions.

CFC12

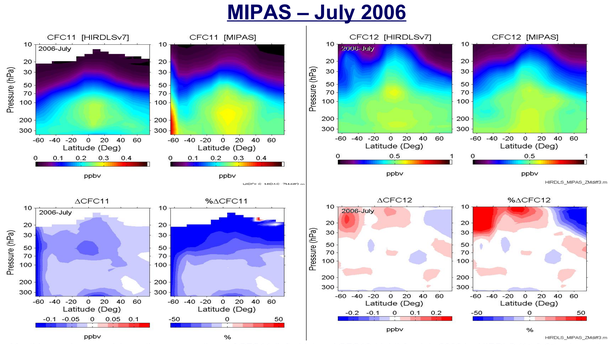
CFC12 Precision [20-40°N] (see O_3 precision description)



ACE-FTS



MIPAS – July 2006

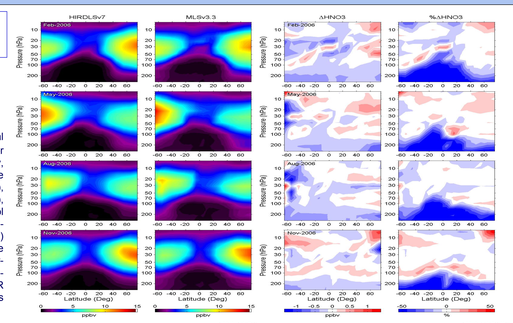


Monthly zonal mean mixing ratio cross-sections of CFC11 (left side) and CFC12 (right) for July 2006 by HIRDLS (1st & 3rd columns) and MIPAS (2nd & 4th columns). The difference & %-difference (H–M)/(M) are shown in the bottom row. VMR difference increments are 25 pptv for CFC11 and 50 pptv for CFC12; white areas in the %-difference plots correspond to ±5% and each color increment corresponds to 10%. The southern high latitude CFC11 feature in the MIPAS zonal mean is a non-geophysical artifact.

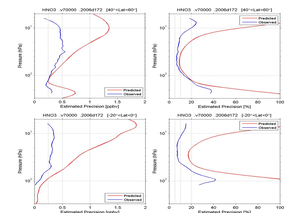
HNO_3

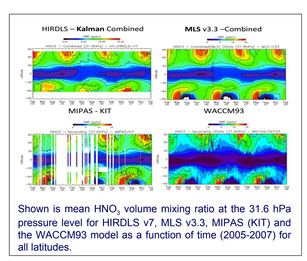
MLS

HNO_3 Monthly zonal mean VMR for 2006 Jan, Apr, July, & Oct. Shown are HIRDLS V7 (col 1), MLS v3.3 (col 2), their difference (col 3) and the %-difference (H-M/M) (col 4). The white areas in % difference plots correspond to ±5%; VMR color increments are 10%.



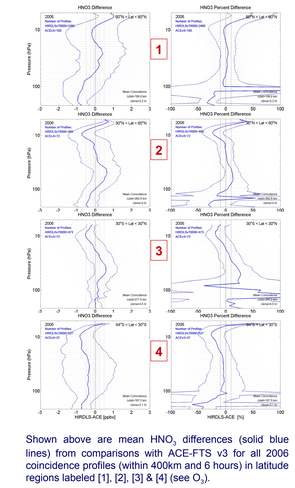
HNO_3 Precision (see O_3 precision description)





Shown is mean HNO_3 volume mixing ratio at the 31.6 hPa pressure level for HIRDLS v7, MLS v3.3, MIPAS (KIT) and the WACCM93 model as a function of time (2005-2007) for all latitudes.

ACE-FTS



Shown above are mean HNO_3 differences (solid blue lines) from comparisons with ACE-FTS v3 for all 2006 coincidence profiles (within 400km and 6 hours) in latitude regions labeled [1], [2], [3] & [4] (see O_3).