[V004] HIRDLS Ozone Validation Update

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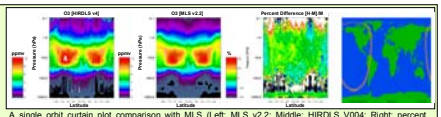
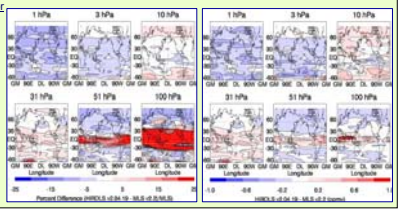
Aura MLS



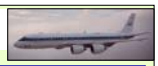
A single orbit curtain plot comparison with MLS (Left: MLS v2.2; Middle: HIRDLS V004; Right: percent difference). The abscissa indicates the latitude along the track of one orbit. The ascending node of the orbit (day-time) is the left half of each panel while the descending node (night-time) is on the right half.

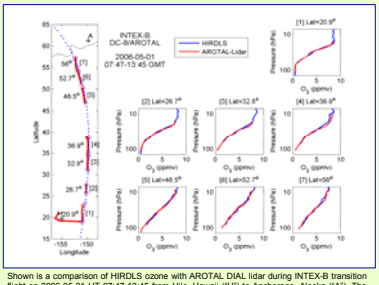
Pressure Surface on Mercator

Shown are Mercator representations of the ozone difference between HIRDLS (v004) and collocated MLS (v2.2) for 2006-July-15. Plots in the left block are in percent difference, on the right are units of Volume Mixing Ration (ppmv). Each plot in a block corresponds to a pressure level, between 1 - 100 hPa, as indicated on the upper edge. The ozone fields from which these differences are calculated are relatively quiescent. Agreements is generally to better than 5-10%, with the notable exception of the tropical UTLS, where agreements deteriorates to 20-100%.

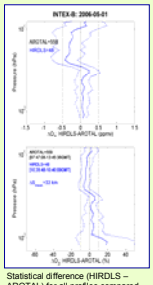


Intercontinental Chemical Transport Experiment (INTEX-B)





Shown is a comparison of HIRDLS ozone with AROTAL DIAL lidar during INTEX-B transition flight on 2006-05-01 UT 07:47-13:45 from Hilo, Hawaii ("H") to Anchorage, Alaska ("A"). The leftmost plot shows the AROTAL (red) and HIRDLS (blue) measurement locations. The segment endpoints are denoted by circles and segments are numbered in the square brackets. The averaged profiles for each of the 7 segments are compared in separate plots at right (HIRDLS, blue; AROTAL, red), with titles indicating segment number and average segment latitude.

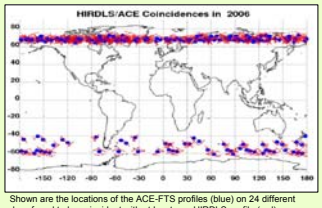


Statistical difference (HIRDLS – AROTAL) for all profiles compared. Each AROTAL profile is compared to the nearest HIRDLS profile. The mean coincidence distance between all profile pairs is 33 km.

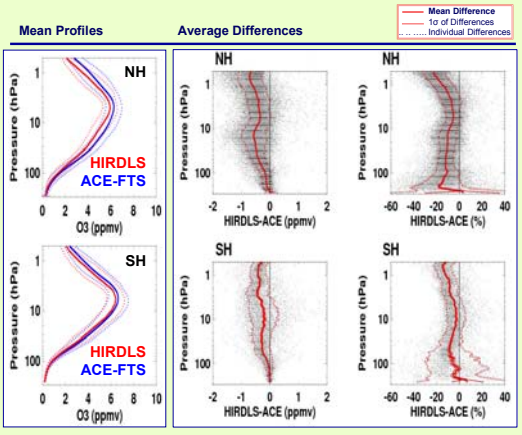
ABSTRACT

Updated comparisons of the recently released HIRDLS ozone data (v004) are made with satellite observations, ozonesondes, ground-based lidars, and air-borne lidar measurements made during INTEX-B. Overall the quality of v004 ozone is significantly improved over V003 in both vertical range and accuracy. The vertical range of useful measurements is extended earthward from 100hPa to about 250 hPa. The low bias in the extra-tropical upper troposphere / lower stratosphere UTLS is diminished. The much improved cloud detection capability results in far fewer ozone spikes especially in the tropical UTLS, which in turn results in a diminished high bias in the tropical UTLS region. The low bias near 1-5 hPa is also diminished. Comparisons with ozonesondes and lidars give a clear indication that HIRDLS is capable of resolving fine vertical ozone features (1 - 2 km) in the UTLS region. Development continues on the radiance correction algorithms necessitated by the large visual obstruction in the HIRDLS FOV incurred during launch, and further improvements, such as in the tropical UTLS high bias, are anticipated.

ACE-FTS Solar Occultation

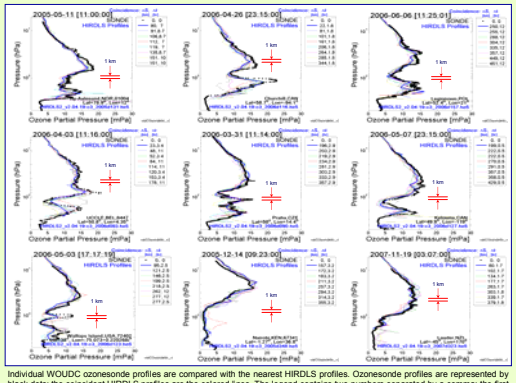


Shown are the locations of the ACE-FTS profiles (blue) on 24 different days found to be coincident with at least one HIRDLS profile (red).



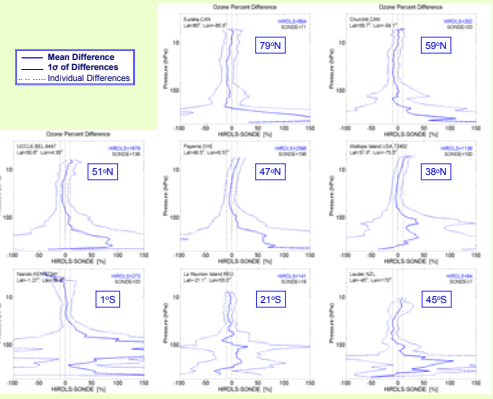
The LEFT panels show the average and standard deviation of all the HIRDLS (red) and ACE-FTS (blue) ozone profiles in the Northern hemisphere (top) and the Southern hemisphere (bottom). The mean (solid red) and standard deviation (dashed red) of the difference (HIRDLS minus ACE-FTS) for all coincidences are shown in terms of mixing ratio (MIDDLE COLUMN) and percentage (RIGHT COLUMN). Negative numbers indicate low HIRDLS values. The individual differences from which these are derived are the horizontally distributed layers of small black dots. The thin red lines bracketing the mean visible only in the SH, are the uncertainty in the mean (standard deviation divided by the square root of the number of points).

OZONE SONDES



Individual WOUDC ozonesonde profiles are compared with the nearest HIRDLS profiles. Ozonesonde profiles are represented by black dots; the coincident HIRDLS profiles are the colored lines. The legend contains two numbers separated by a comma: the first denotes the geophysical separation of the HIRDLS profile from the sonde in km, and the second denotes the separation in hours. The closest of the coincident HIRDLS profiles is the bold blue line in the plot. South latitudes and West longitudes are denoted as negative in the labels.

Ozonesonde Comparisons with HIRDLS Statistical Summary: Average Differences



Shown are ozone differences between HIRDLS and ozonesondes from the WOUDC Network. Ozone differences are shown in terms of percent of sonde values (BOTTOM). The mean differences are the solid blue lines, the standard deviation are the dashed blue lines bracketing the mean, and the individual differences from which these are derived are the horizontally distributed layers of black dots (visible as gray lines of varying intensity). All differences here are HIRDLS minus ozonesonde, so negative differences denote low HIRDLS values.

Estimated Precision

(1) HIRDLS data interpolated onto a potential temperature (Theta) grid with vertical resolution equivalent to ~1-km.

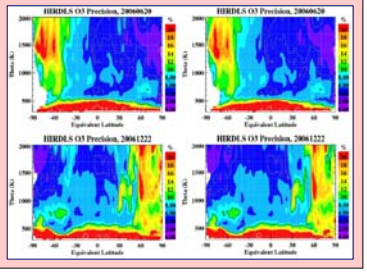
(2) HIRDLS geolocations at each theta level is interpolated to equivalent lat. (determined using Met Office PV).

(3) Standard deviation is calculated at each theta level in one- degree increments of Eqlat, from -90 deg to 90 deg.*

* Require locations to be: within (a) 2[o] of central Equiv.lat. & (b) 500 km of central location.

The result of step (3) is to remove, as far as possible, geophysical variations from the analysis. This is most effective in the summer hemisphere.

Result:
Estimated HIRDLS O_3 precision better than 10%. Below ~450-500 K (18-20 km) and inside the winter vortex, standard deviation as estimate for precision breaks down, due to naturally high geophysical variability.



SUMMARY

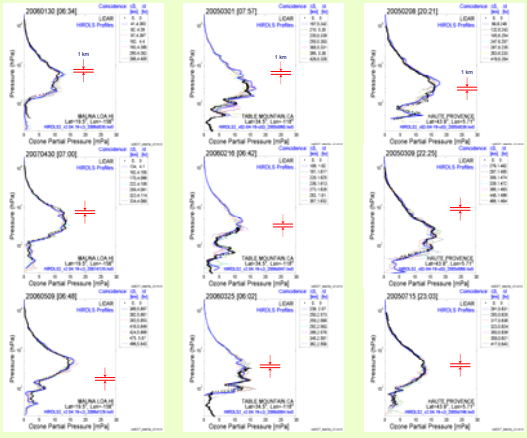
1. HIRDLS ozone is recoverable between 0.5 hPa – 260+ hPa at mid and high latitudes and between 0.5 – 100+ hPa at low latitudes;
2. HIRDLS has the ability to resolve vertical ozone features on the scale of 1 – 2 km;
3. HIRDLS ozone precision is estimated to be 5-10% (possibly better than 5%);
4. HIRDLS ozone accuracy is better than 10% between 1 - 100 hPa (HIRDLS biased generally low);
5. Some lidar & sonde comparisons indicate that HIRDLS ozone accuracy may by better than 5% between 2 - 50 hPa;
6. There is a widely observed slightly positive HIRDLS bias, <5%, in a limited pressure range within roughly 10-30 hPa, at nearly all latitudes;
7. In the extra-tropical UTLS (~100-260 hPa), HIRDLS ozone accuracy appears to be 10-20%. In the tropical UTLS (70-100 hPa) HIRDLS ozone accuracy is roughly 10-100%. The bias in the UTLS region is generally high and increases rapidly with increasing pressure;
8. The extra-tropical UTLS high bias does not appear to be caused by the previously problematic cloud-related ozone spikes, since the improved cloud detection algorithm and post processing filters eliminate these effectively. The bias may be linked to a variability of ozone in this region which sometimes exceeds the relatively low ozone concentrations;
9. Ongoing developments in the radiance correction algorithms suggest additional improvements are likely, such as in the tropical UTLS high bias.

OZONE DIAL lidar

Mauna Loa Observatory, Hawaii
19.54°N, 155.58°W, 3459m
Stuart McDermid, T. Leblanc, JPL

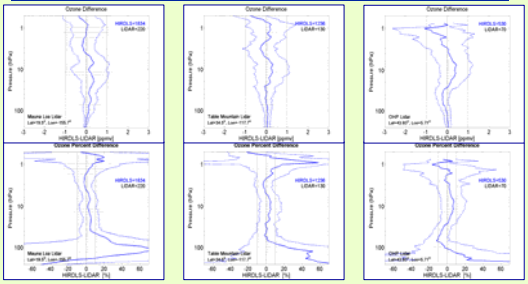
Table Mountain Facility, CA,
34.4°N, 117.7°W, 2300m
Stuart McDermid, T. Leblanc, JPL

Obs. Haute Provence, France,
43.9°N, 5.7°E, 650m
S. Godin-Beekman, CNRS



Comparisons of HIRDLS profiles with lidar profiles from: MLO (LEFT); TMF (MIDDLE); and OHP (RIGHT). Lidar profiles are represented by black dots; the coincident HIRDLS profiles are the colored lines, the closest being bold blue in the plot. The plot layout is the same as for ozonesonde figures. 1-2 km vertical features are clearly similarly observed by both lidar and HIRDLS in many instances.

Ozone LIDAR Comparisons with HIRDLS Statistical Summary: Average Differences



Shown are ozone differences between lidar profiles and coincident HIRDLS profiles [MLO (LEFT); TMF (MIDDLE); and OHP (RIGHT)], in terms of mixing ratio, top, and percent (of lidar values), bottom. The mean differences are the solid blue lines, the standard deviation are the dashed blue lines bracketing the mean, and the individual differences from which these are derived are the horizontally distributed layers of black dots (visible as gray lines of varying intensity).