



HIRDLS Ozone Validation

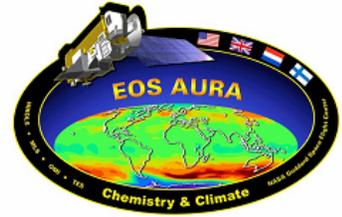
Bruno Nardi ¹, Cora Randall ², Lynn Harvey ², Mike Coffey ¹, Alison Waterfall ⁴, Doug Kinnison ¹, Thierry Leblanc ⁷, John Gille ⁵, John Barnett ⁶ and the HIRDLS Team¹⁻⁶

Aura Science Team Meeting, Den Haag, Netherlands, 2005-Nov-8-11

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Overview



OZONE Correlative Measurements

1. Space-borne Measurements

- Aura-MLS
- Solar Occultation: HALOE; POAM3; SAGE 2; SAGE 3

2. Ozonesondes

- Low Latitude: Ascension Island, Cotonou, Irene, Kuala Lumpur, La Reunion, Malindi, Nairobi, Natal, Pago Pago, Paramaribo
- Mid/high Latitude

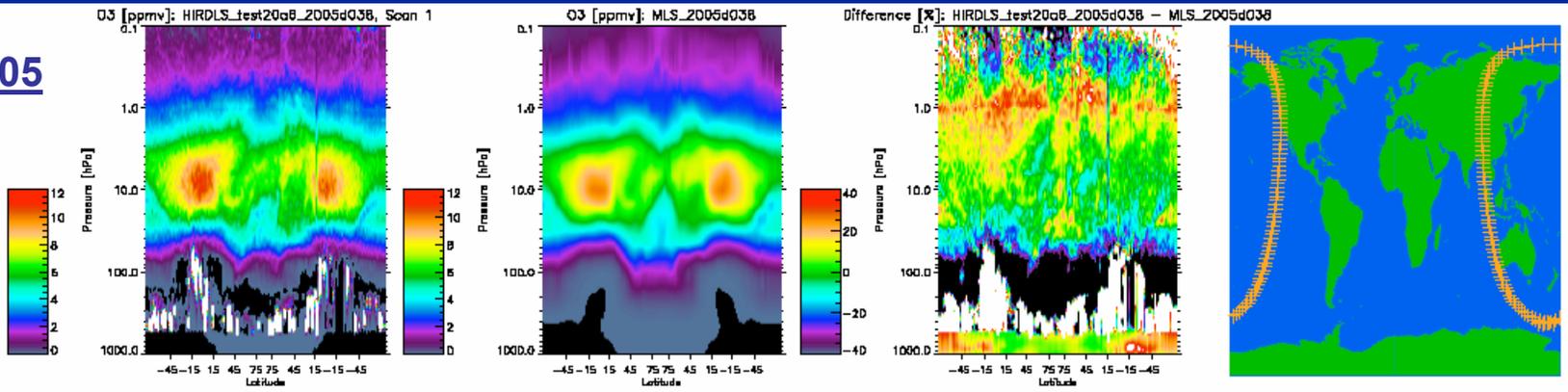
3. Ground-based Lidar

- Mauna Loa Observatory (JPL)
- Table Mountain (JPL)

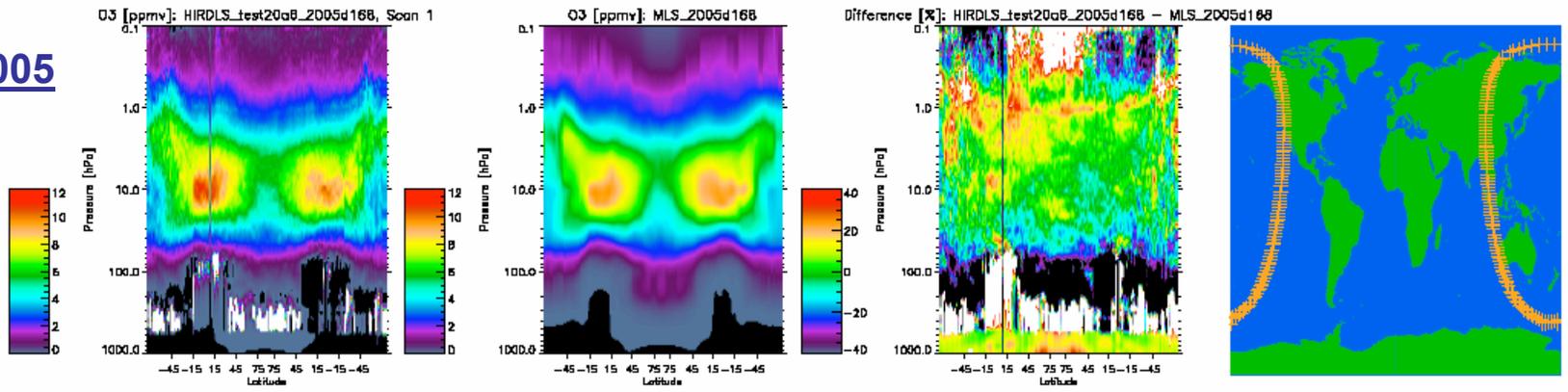
4. Airborne: PAVE (DIAL, AROTAL)

Comparison to Aura MLS

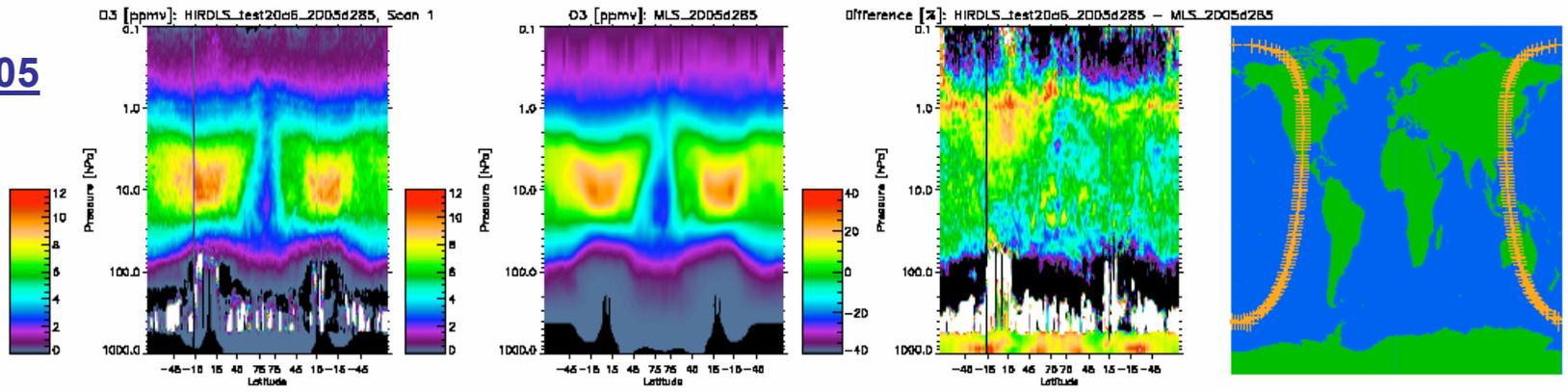
Feb. 2005



June 2005

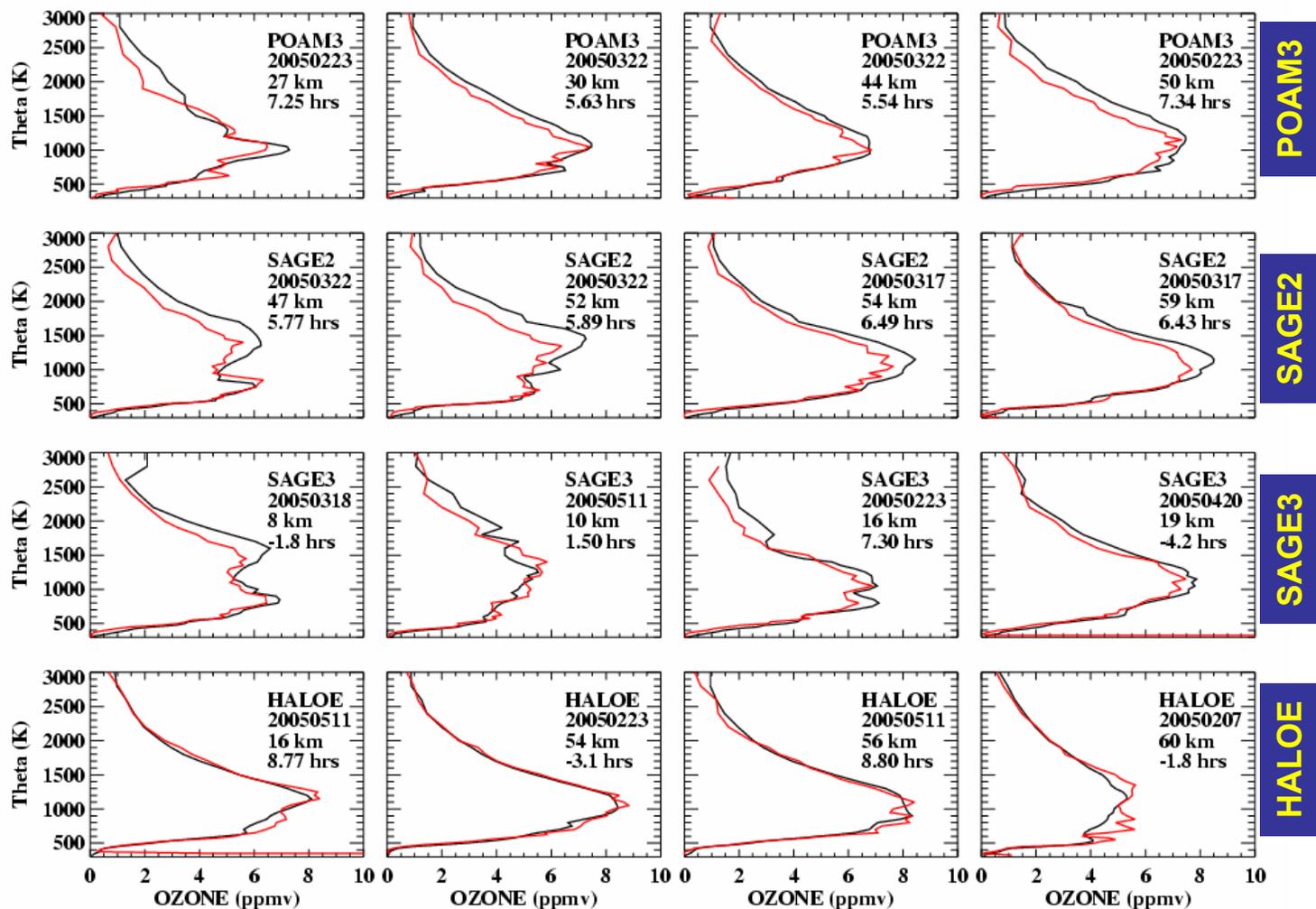


Oct. 2005



Individual Comparisons: 4 Closest Coincident Ozone Profiles to Occultation Measurements

OZONE Closest Coincidences: HIRDLS (red), Occultation (black)

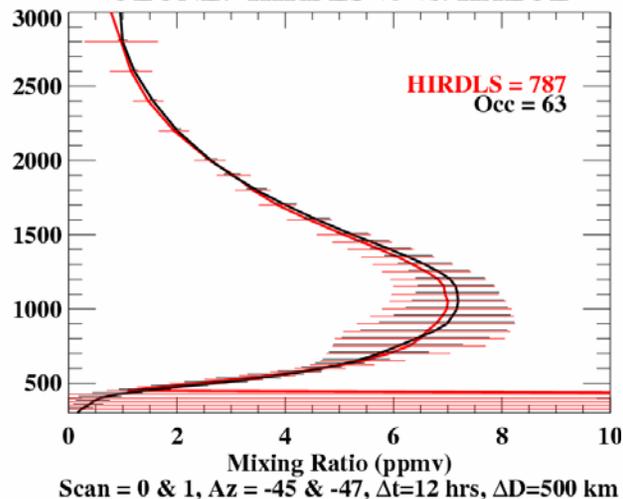


Each panel denotes the occ. instrument, date, distance, and Δ time for the four closest HIRDLS coincidences with each instrument.

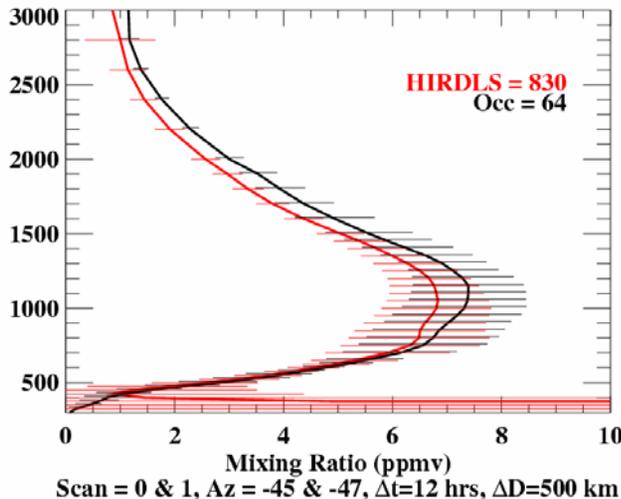
HIRDLS agrees well with, and captures much of the same high-resolution vertical structure as, the occultation instruments.

Average Ozone Profiles from HIRDLS and Coincident Occultation Measurements

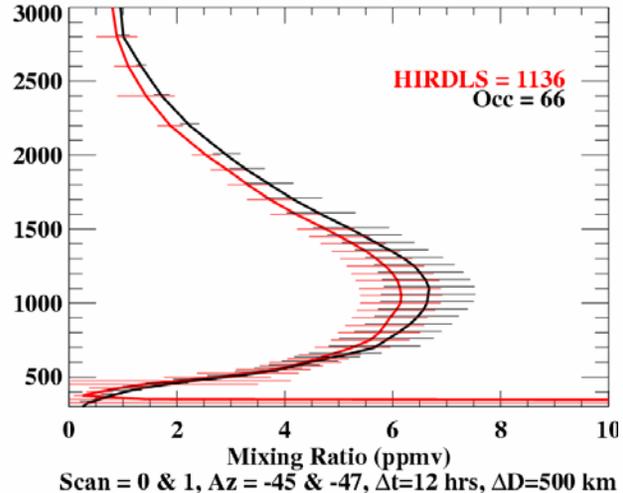
OZONE: HIRDLS v5 vs. HALOE



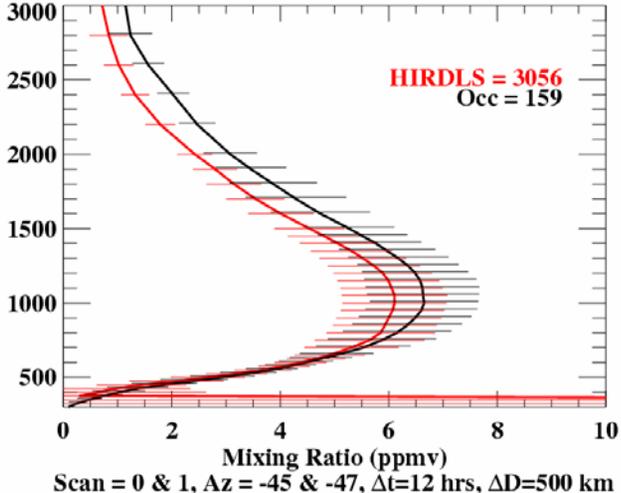
OZONE: HIRDLS v5 vs. SAGE2



OZONE: HIRDLS v5 vs. POAM3



OZONE: HIRDLS v5 vs. SAGE3



Average O₃ profiles for all coincidences on ten dates.

Coincidence criteria:
500 km, $\Delta t = 12$ hrs

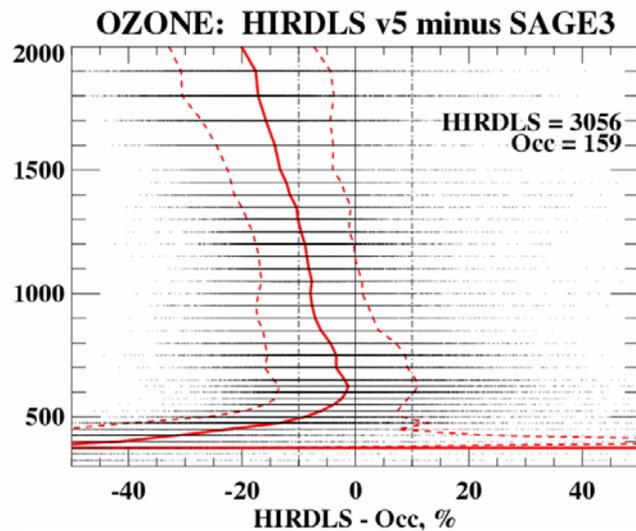
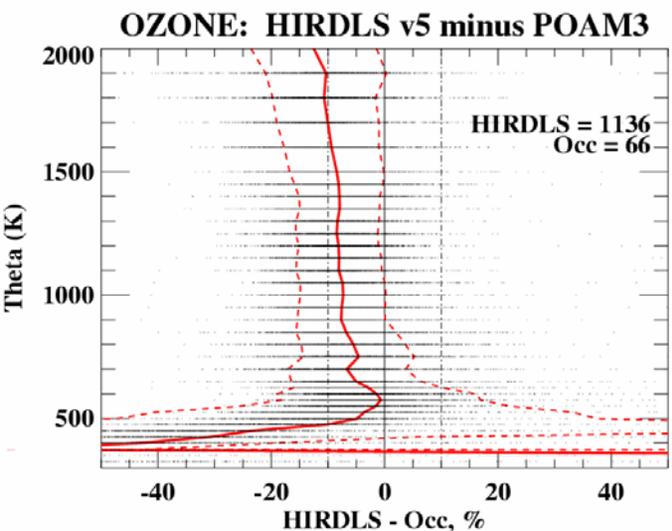
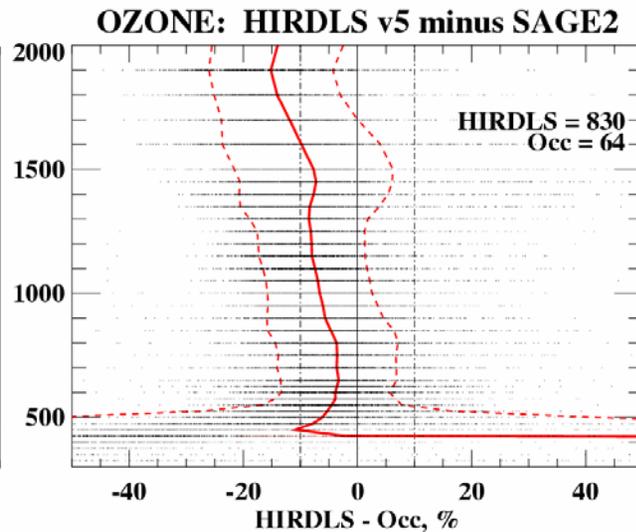
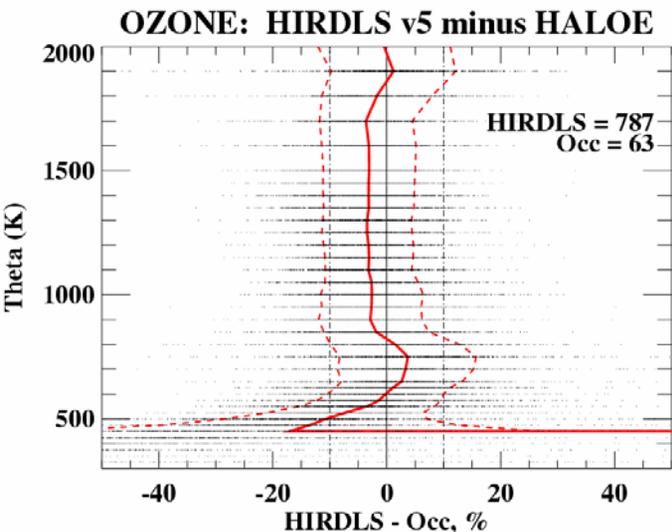
Include up & down scans, azimuth -45 & -47.

HIRDLS=red, Occ=black

“Error” bars are 1- σ standard deviation of the distributions.

Each occultation profile coincident with multiple HIRDLS profiles: #’s denoted in each panel.

Solar Occultation Ozone Comparisons with HIRDLS Statistical Summary: Average Differences



Statistical differences between HIRDLS & occultation data for all coincidences within 500 km & 12 hrs.

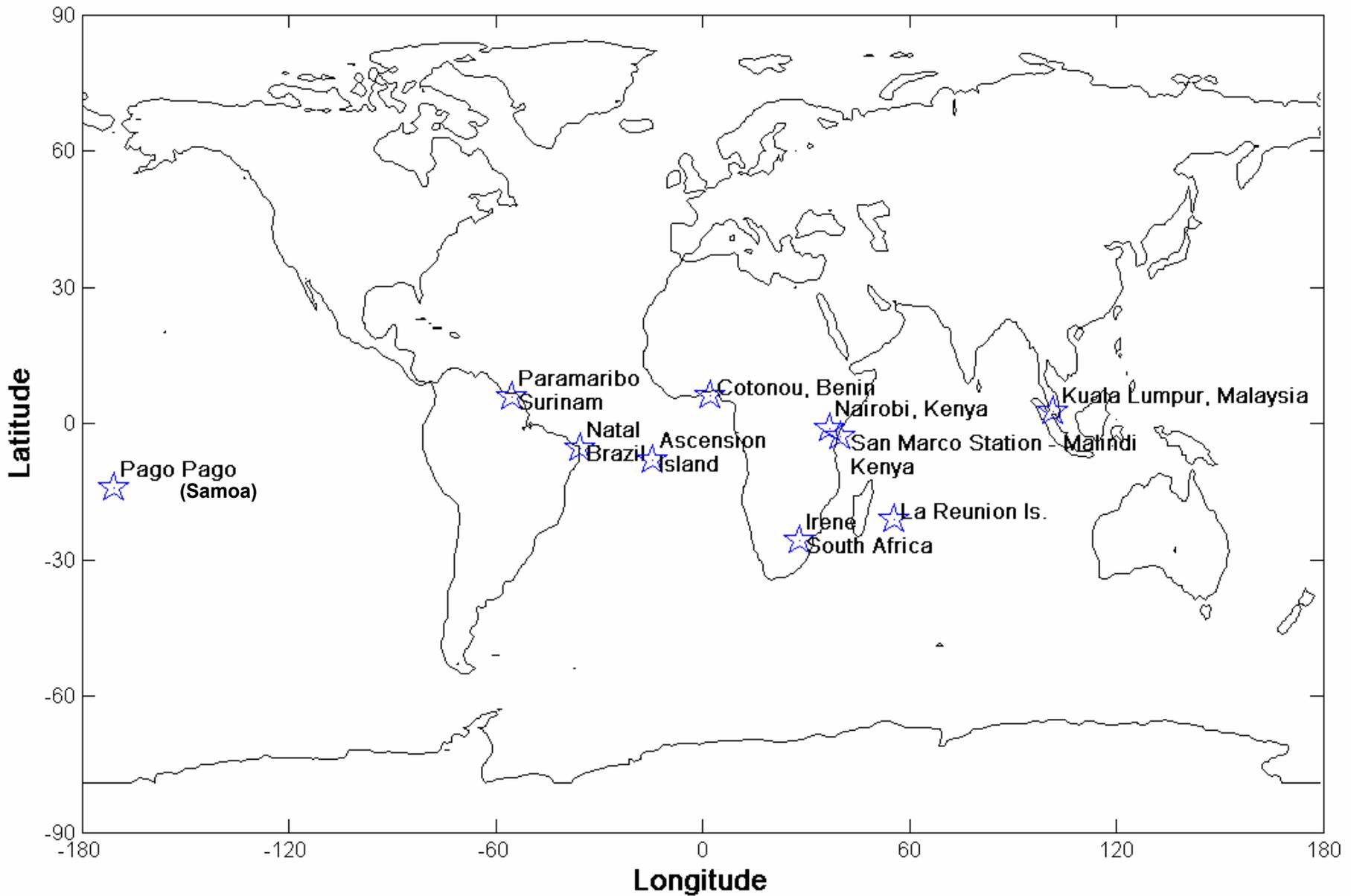
Solid red: Average diff(%).
Dashed red: 1- σ standard deviation.

Black Dots: Individual differences at each theta level.

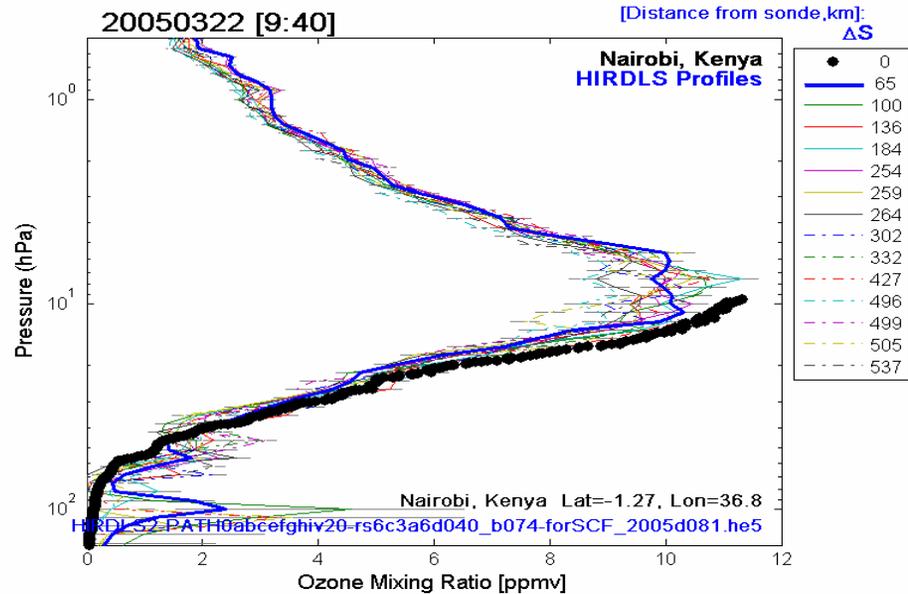
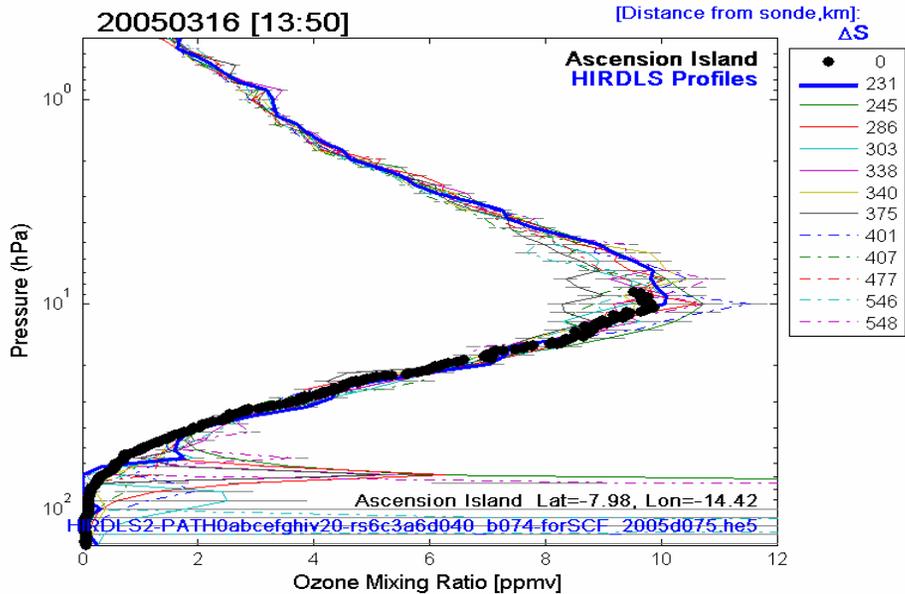
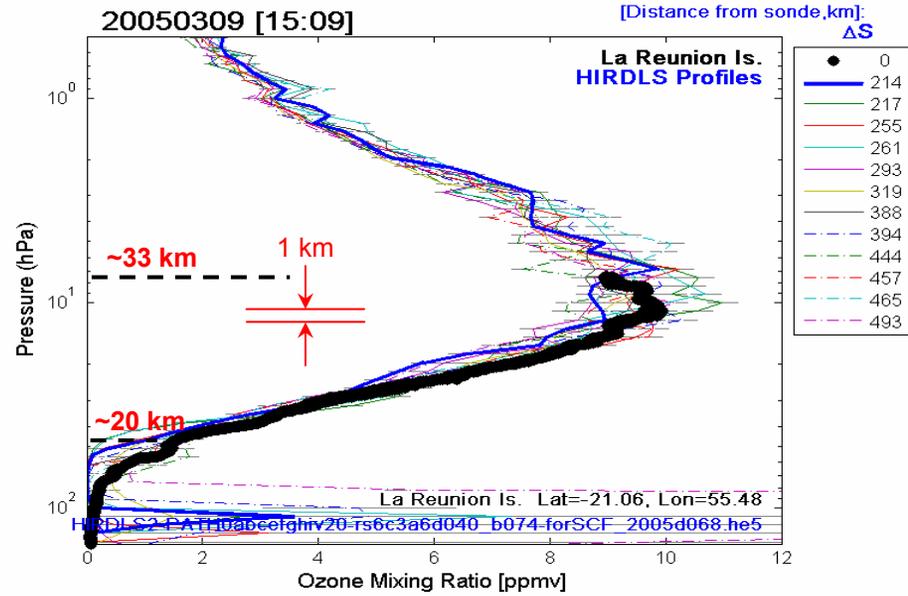
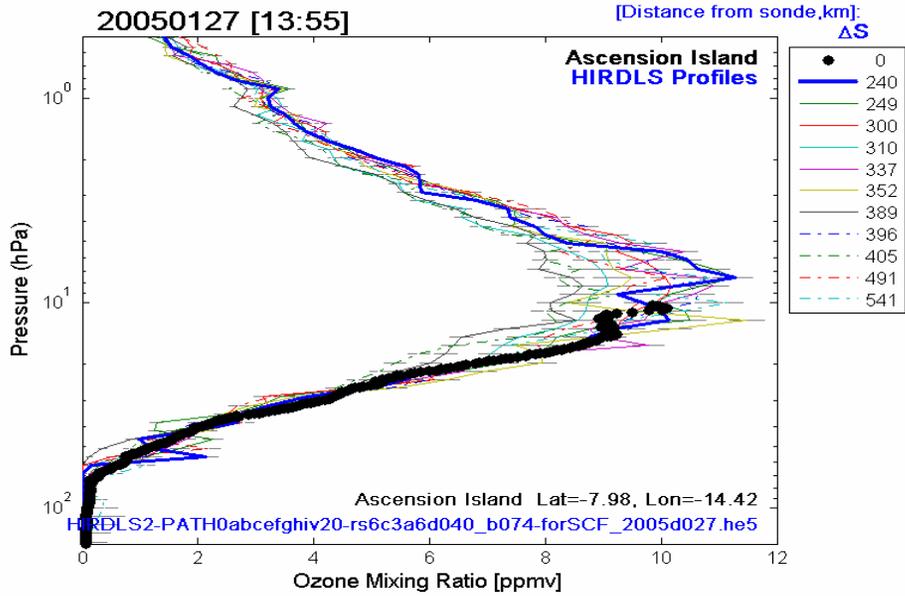
* HIRDLS appears to have 0-10% low bias from ~20-40 km (500-1500 K).

* Lower limit of valid v5 data appears to be ~400-450 K (12-18 km)

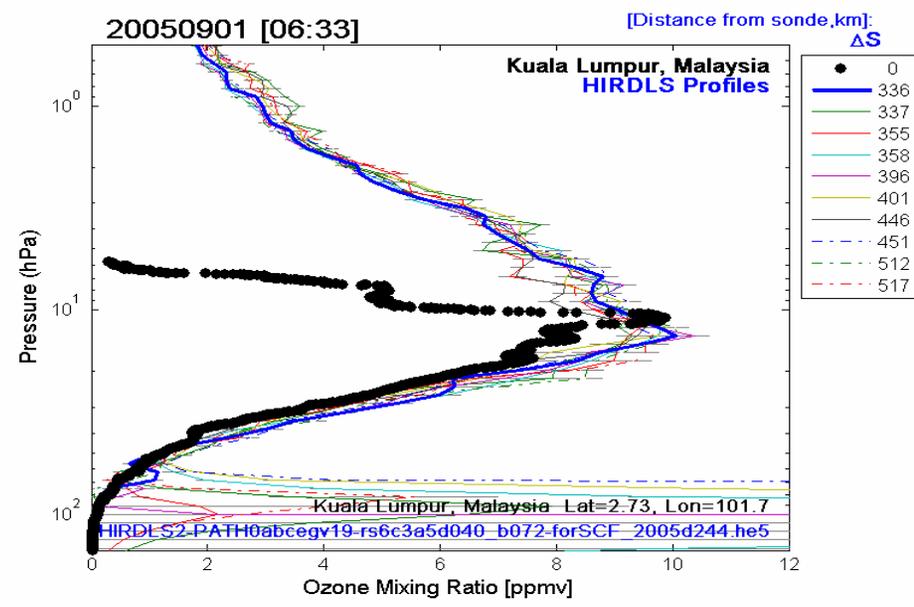
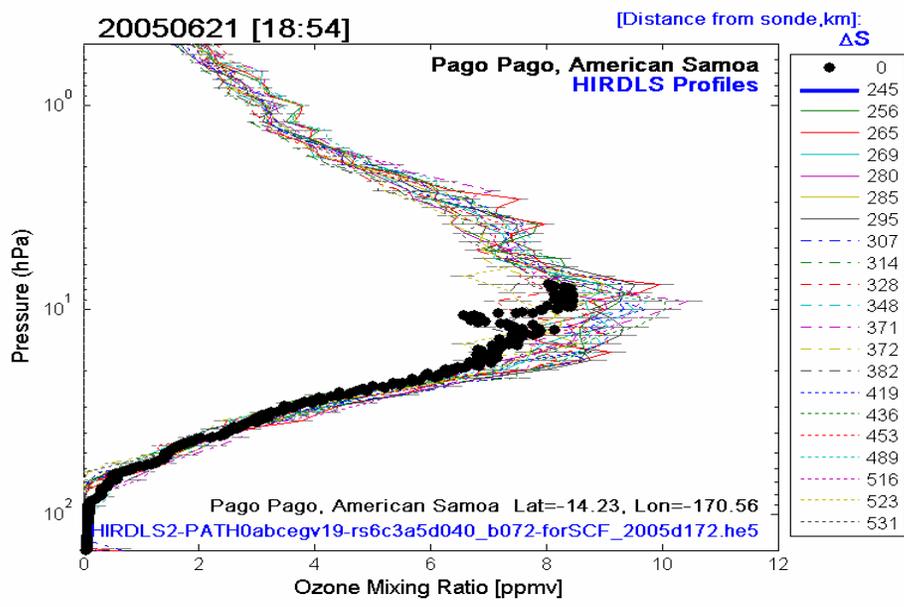
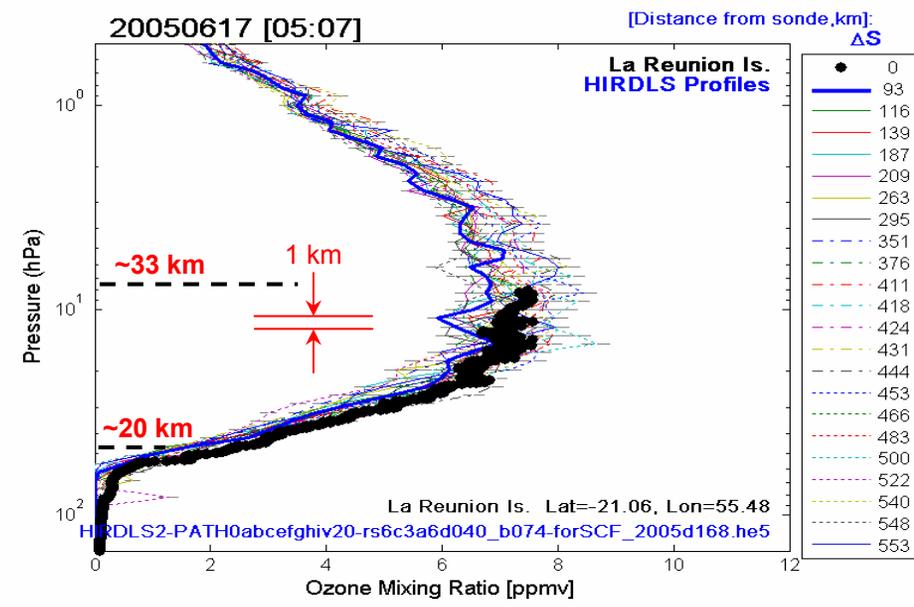
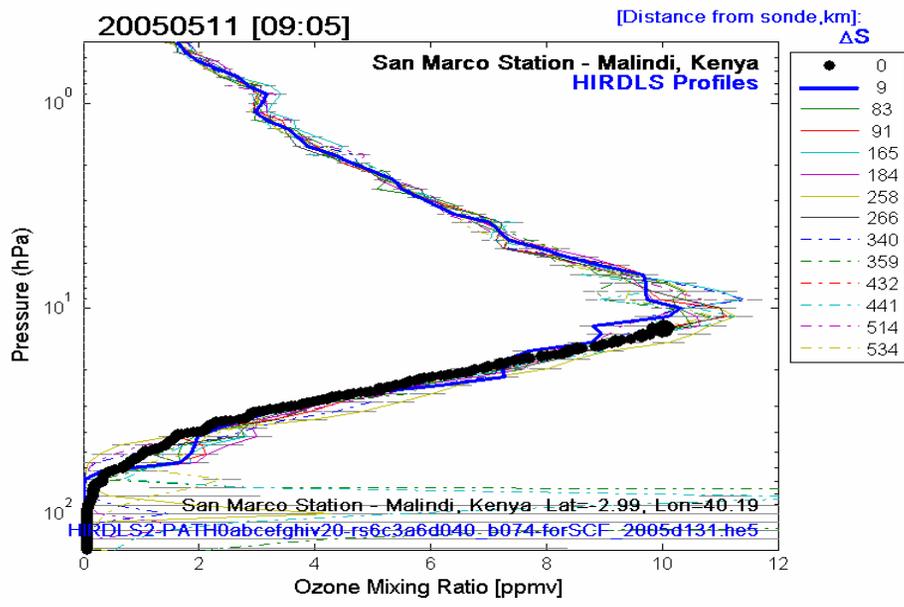
Selected SHADOZ Ozonesonde Stations



SHADOZ Ozonesondes vs. HIRDLS

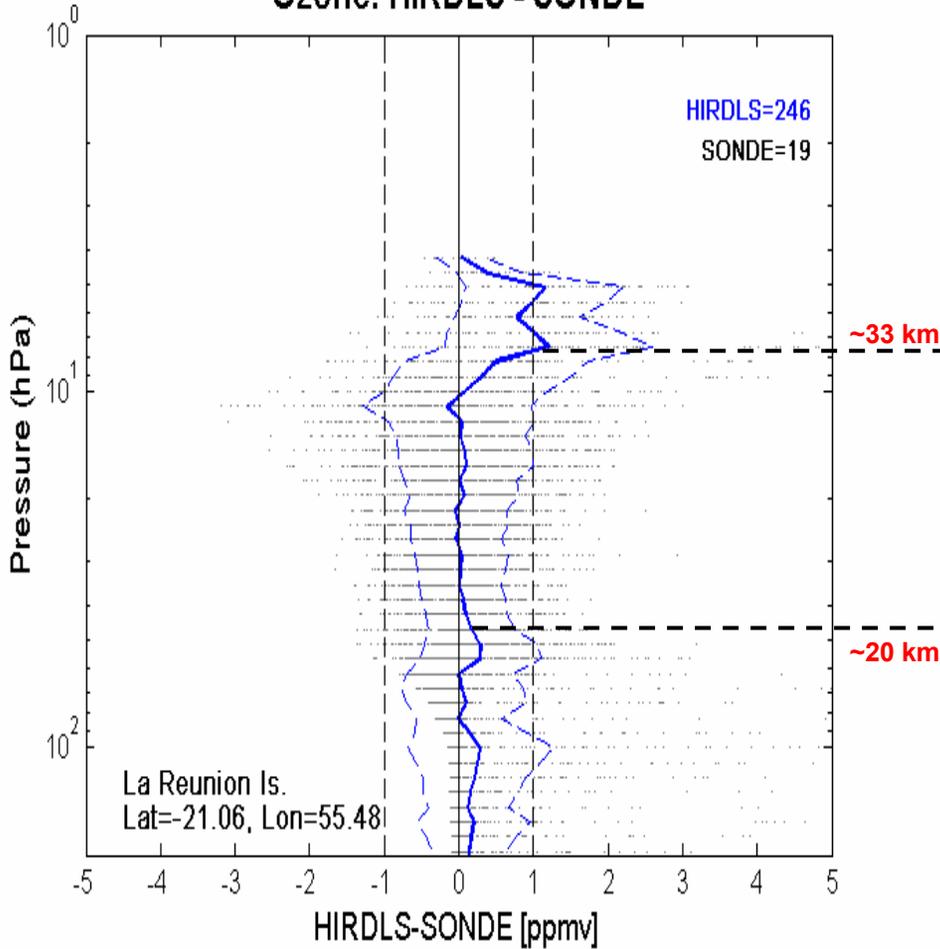


SHADOZ Ozonesondes vs. HIRDLS

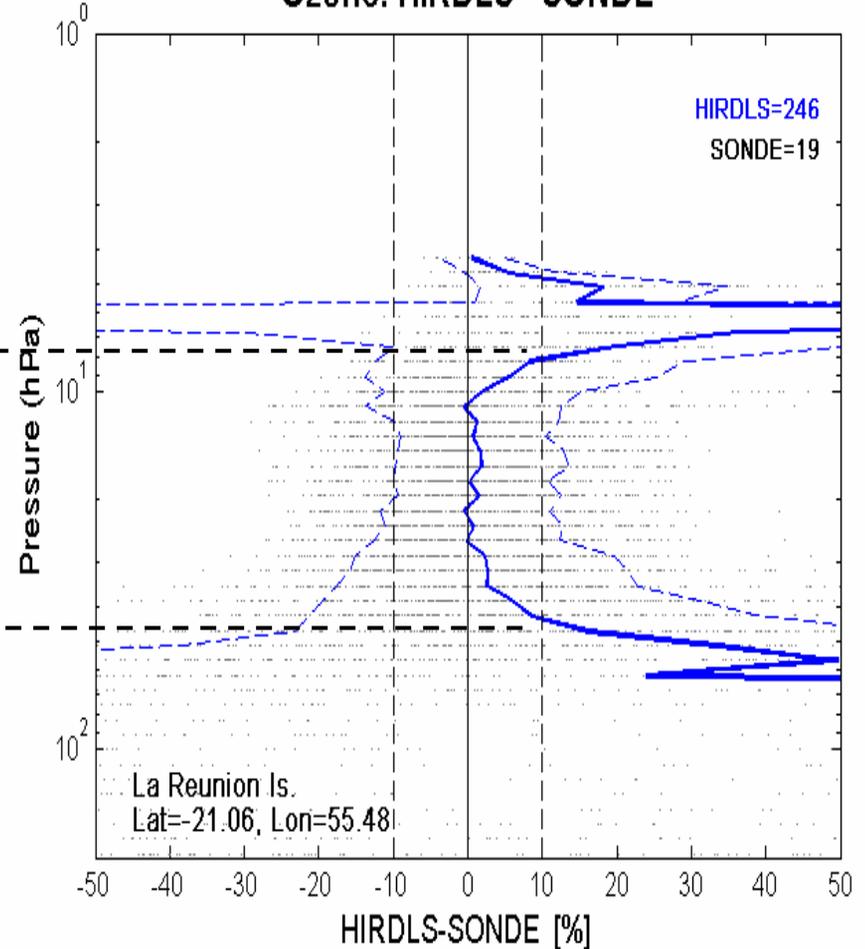


Ozonesonde Comparisons with HIRDLS Statistical Summary: Average Differences

Ozone: HIRDLS - SONDE



Ozone: HIRDLS - SONDE



— Mean Difference
 - - - 1 σ of Differences
 . . . Individual Differences

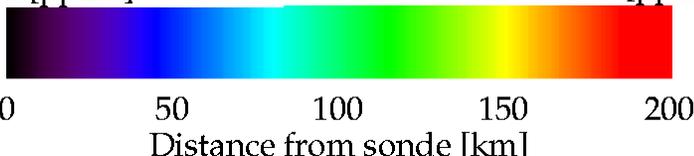
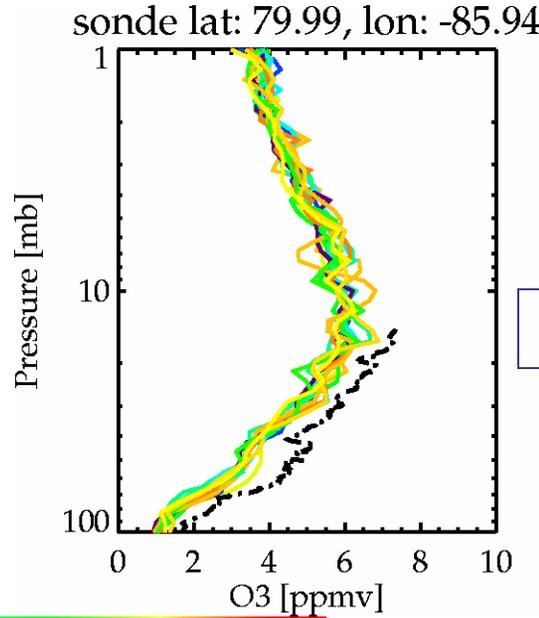
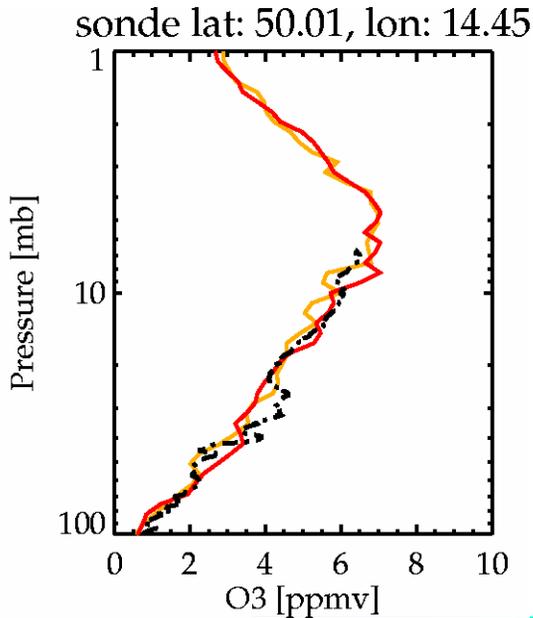
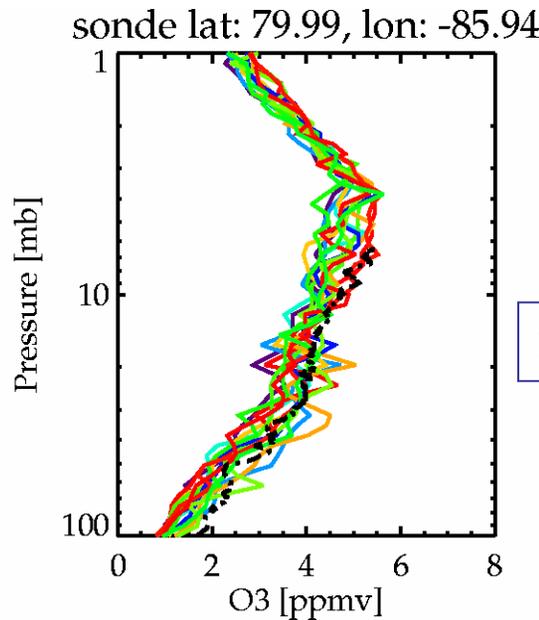
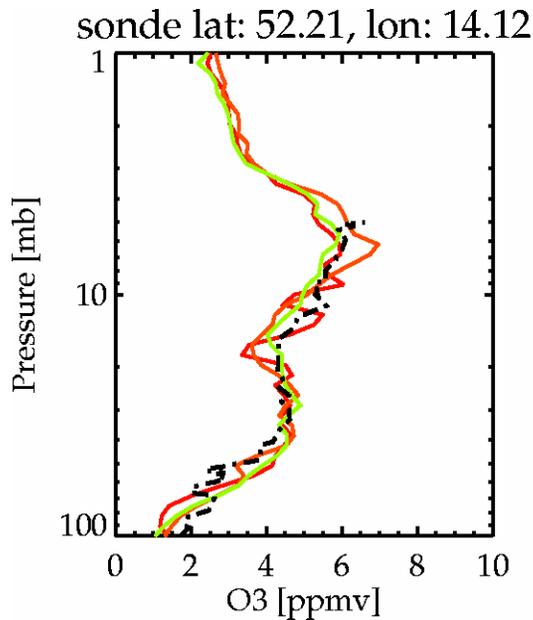
Ozonesondes vs. HIRDLS (Mid/High Latitude)

23 February 2005

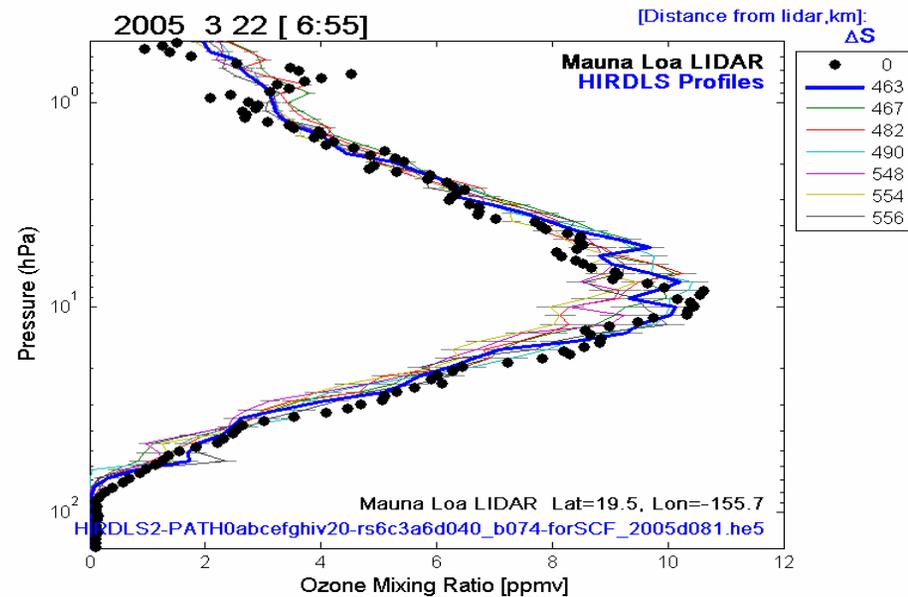
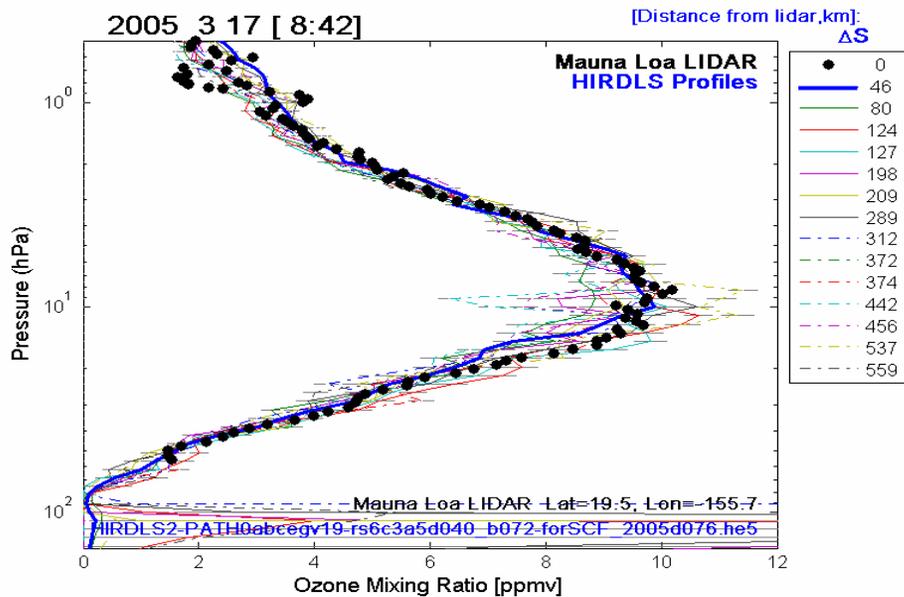
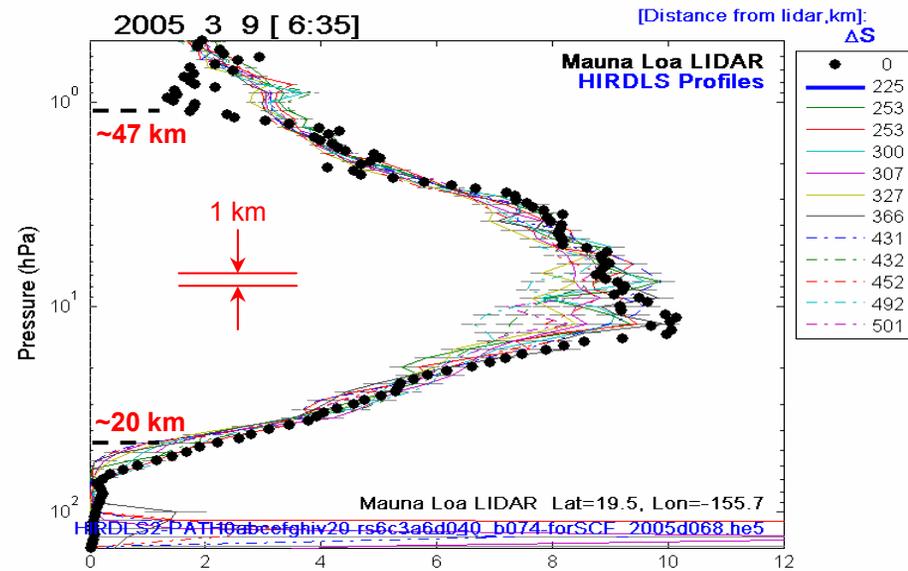
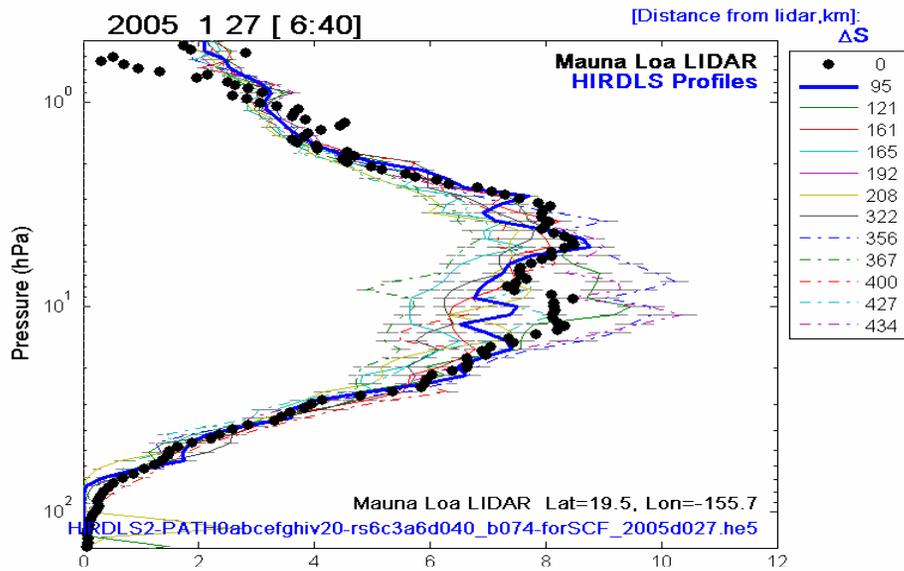
--- Ozone (World Ozone & Ultraviolet Data Centre), [black]
— HIRDLS [color → distance]

22 March 2005

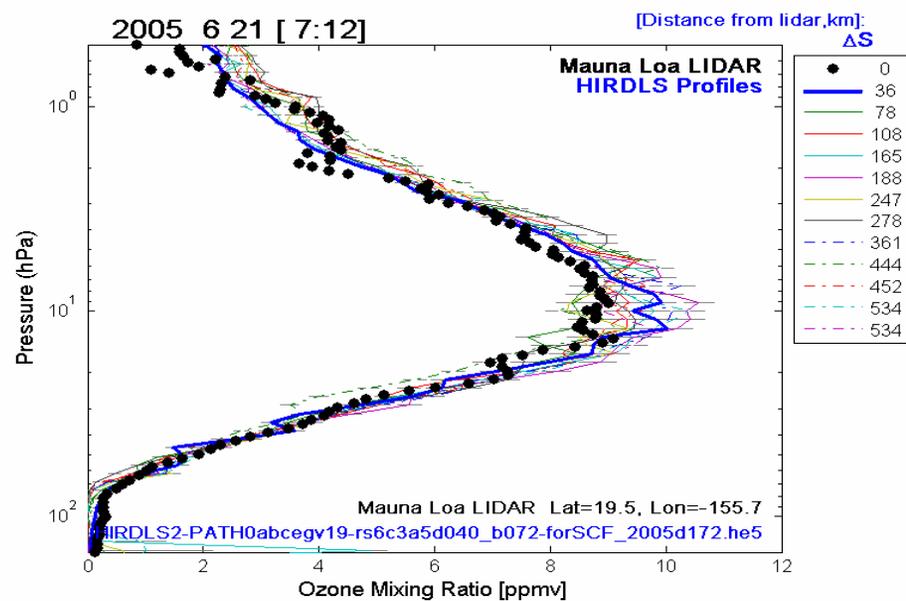
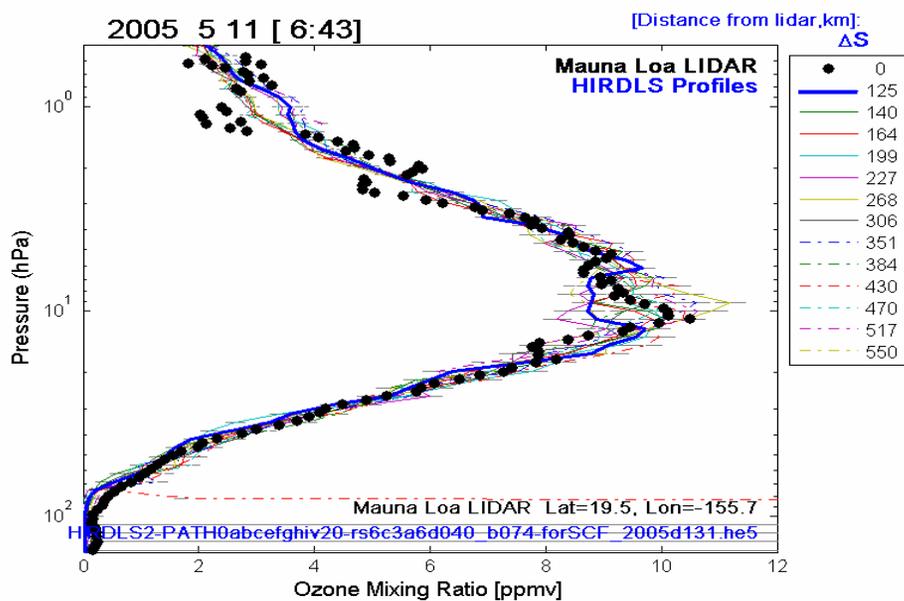
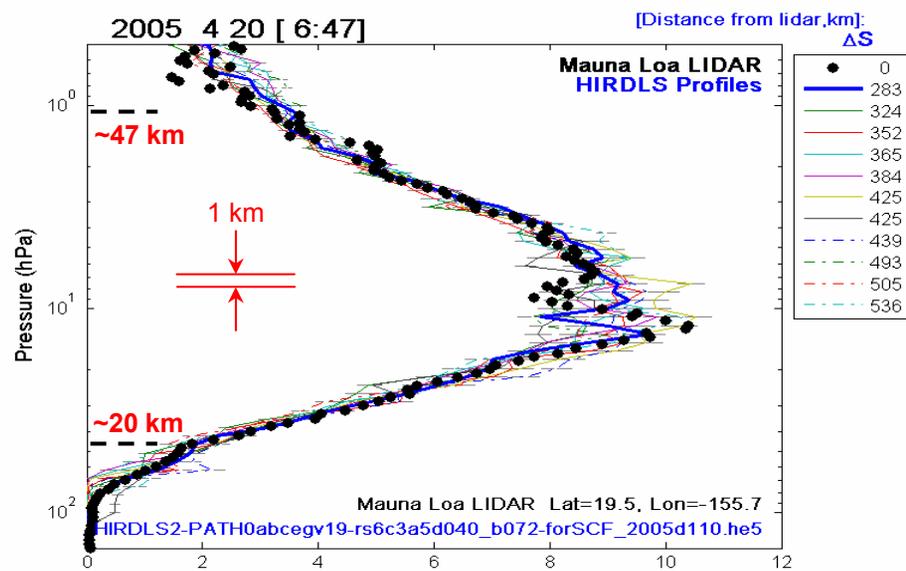
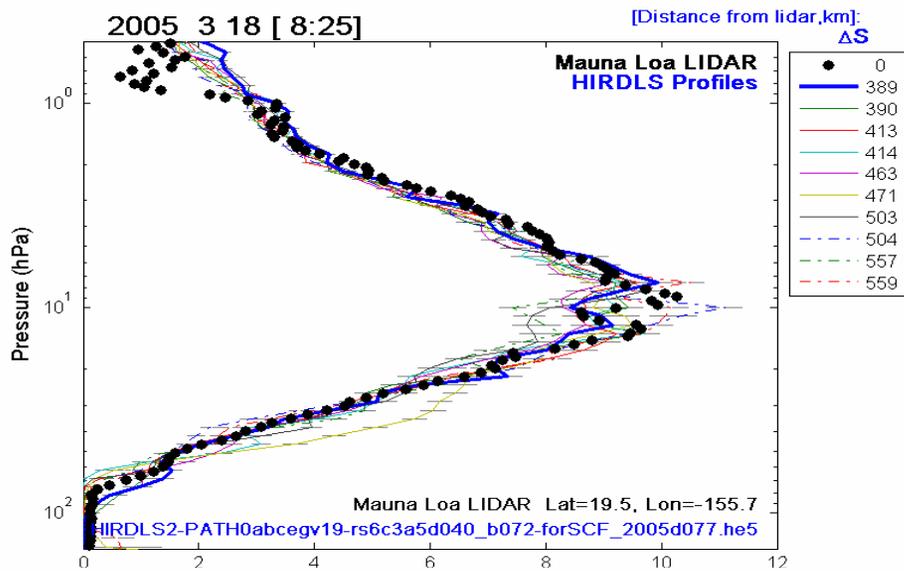
All HIRDLS data shown here is within 200km and 12 hours of the sonde data.



HIRDLS vs LIDAR (Mauna Loa)

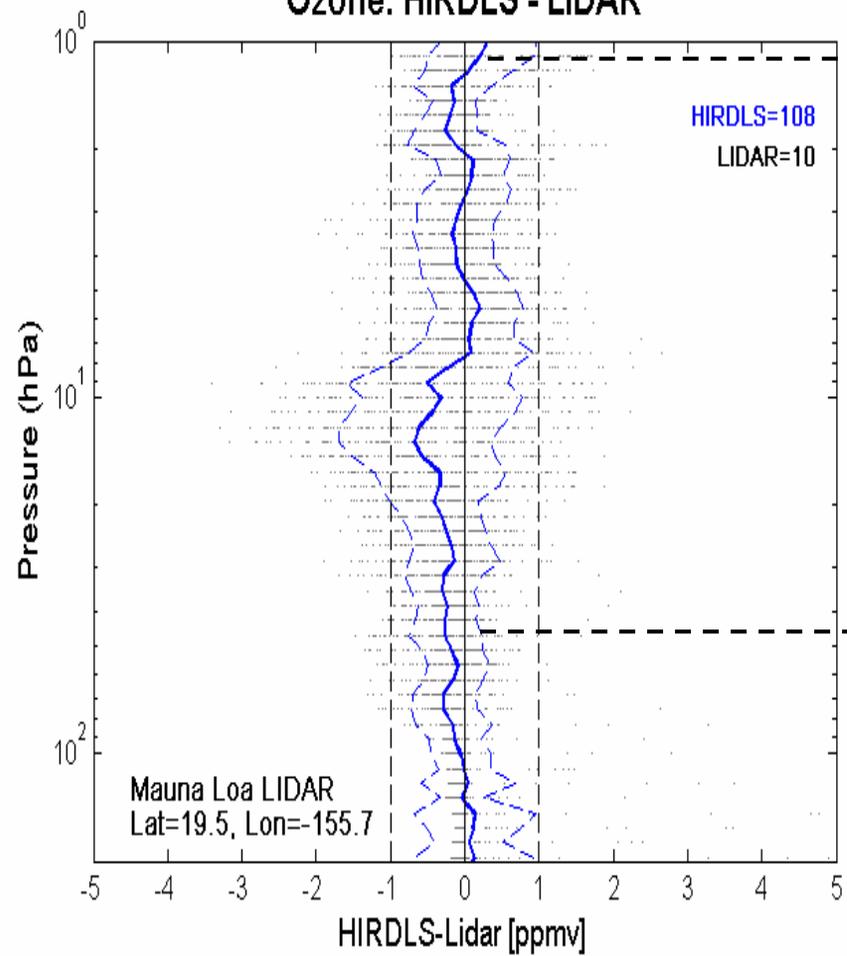


HIRDLS vs Lidar (Mauna Loa)

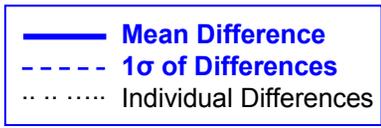
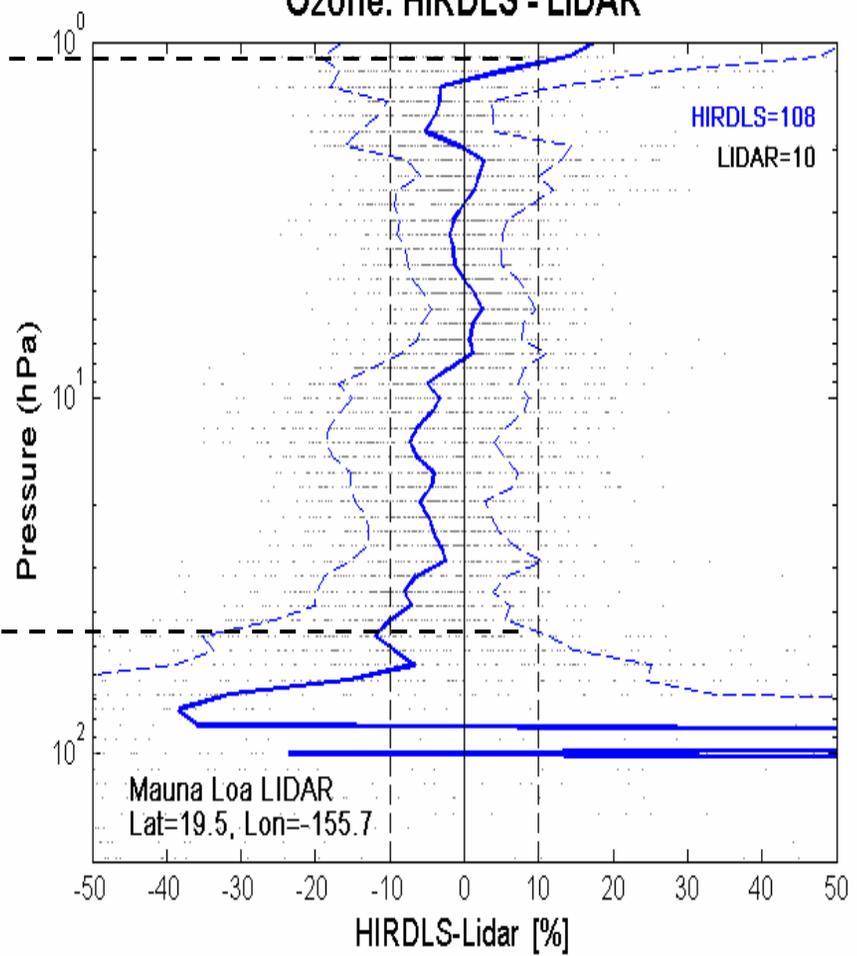


LIDAR Ozone Comparisons with HIRDLS Statistical Summary: Average Differences

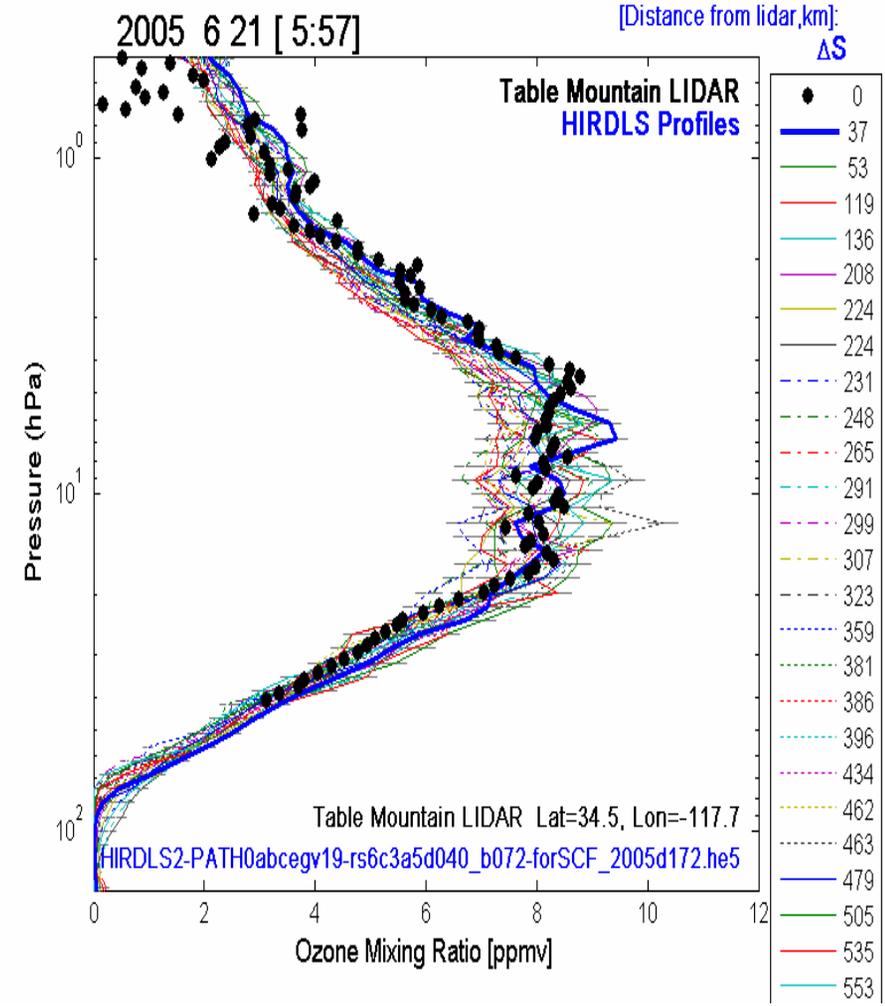
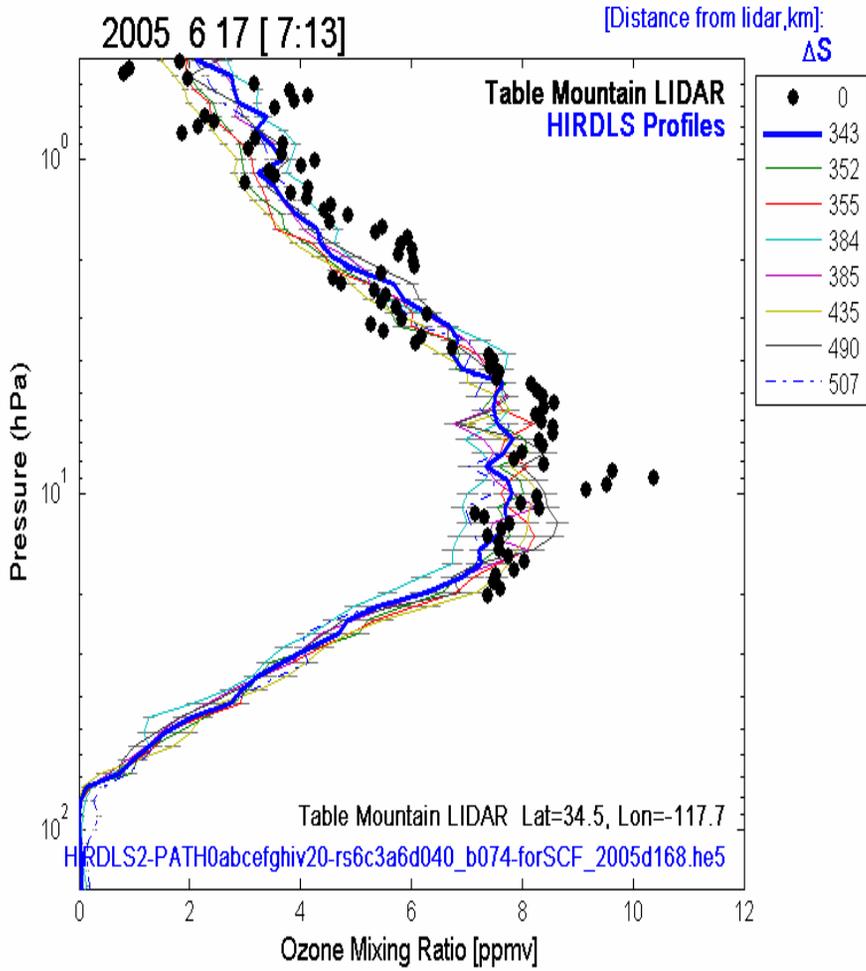
Ozone: HIRDLS - LIDAR



Ozone: HIRDLS - LIDAR

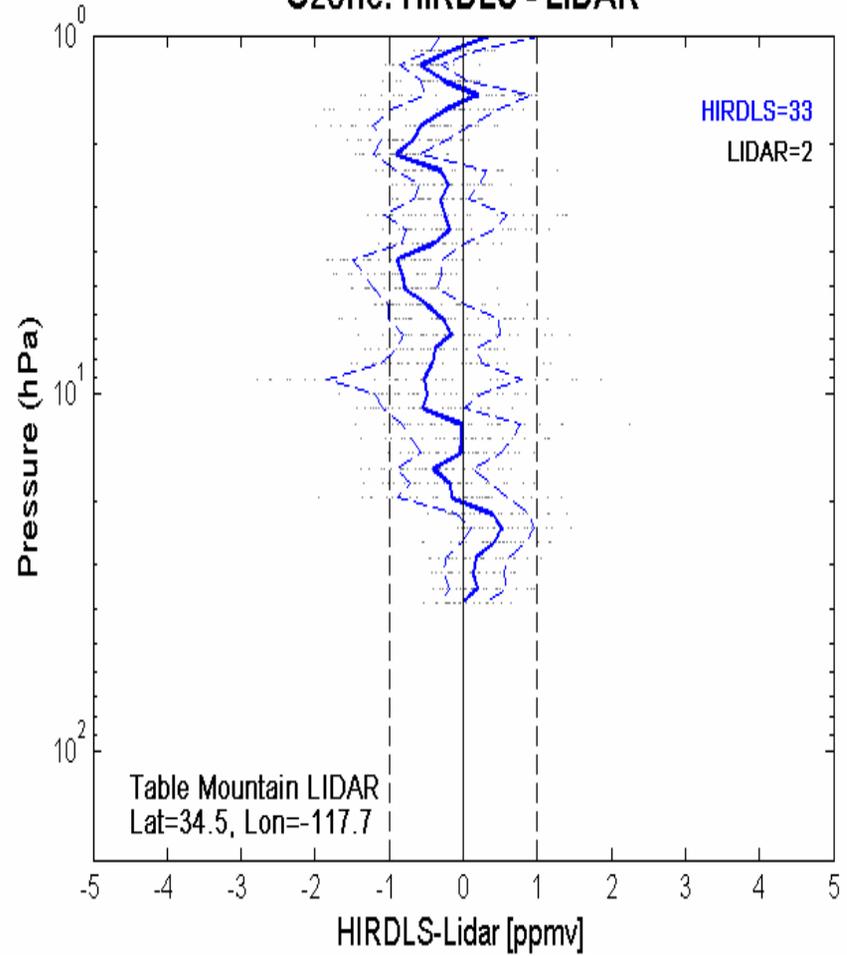


HIRDLS vs Lidar (Table Mountain)

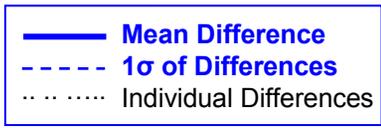
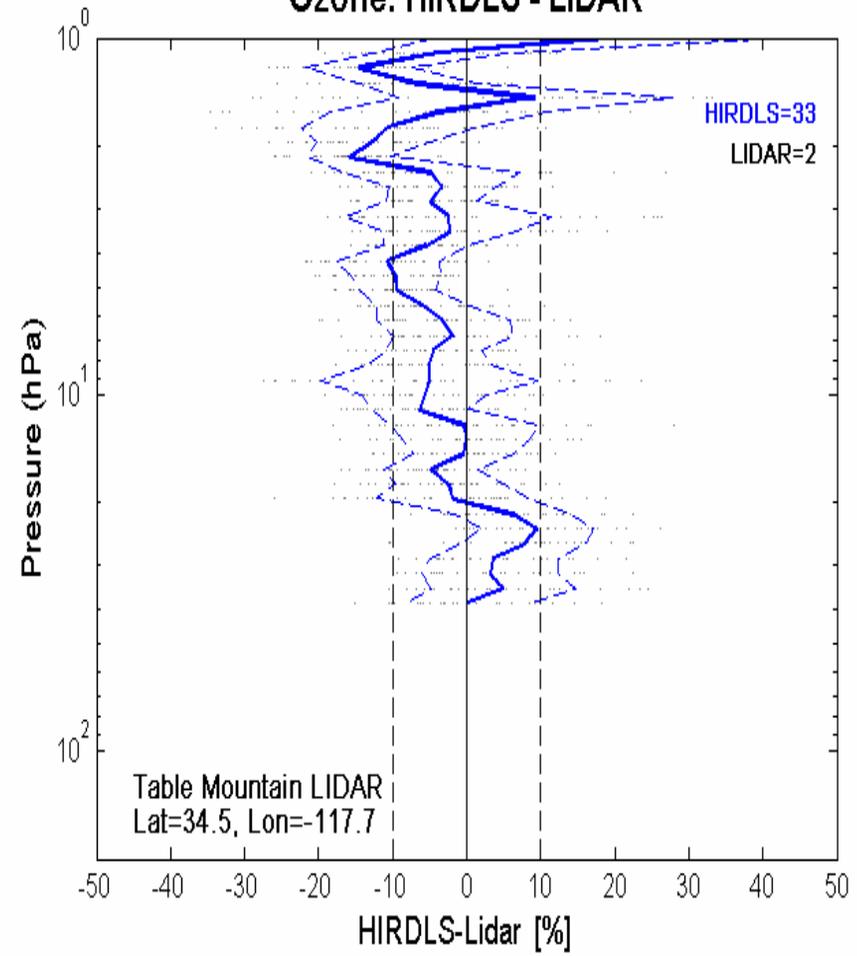


LIDAR Ozone Comparisons with HIRDLS Statistical Summary: Average Differences

Ozone: HIRDLS - LIDAR

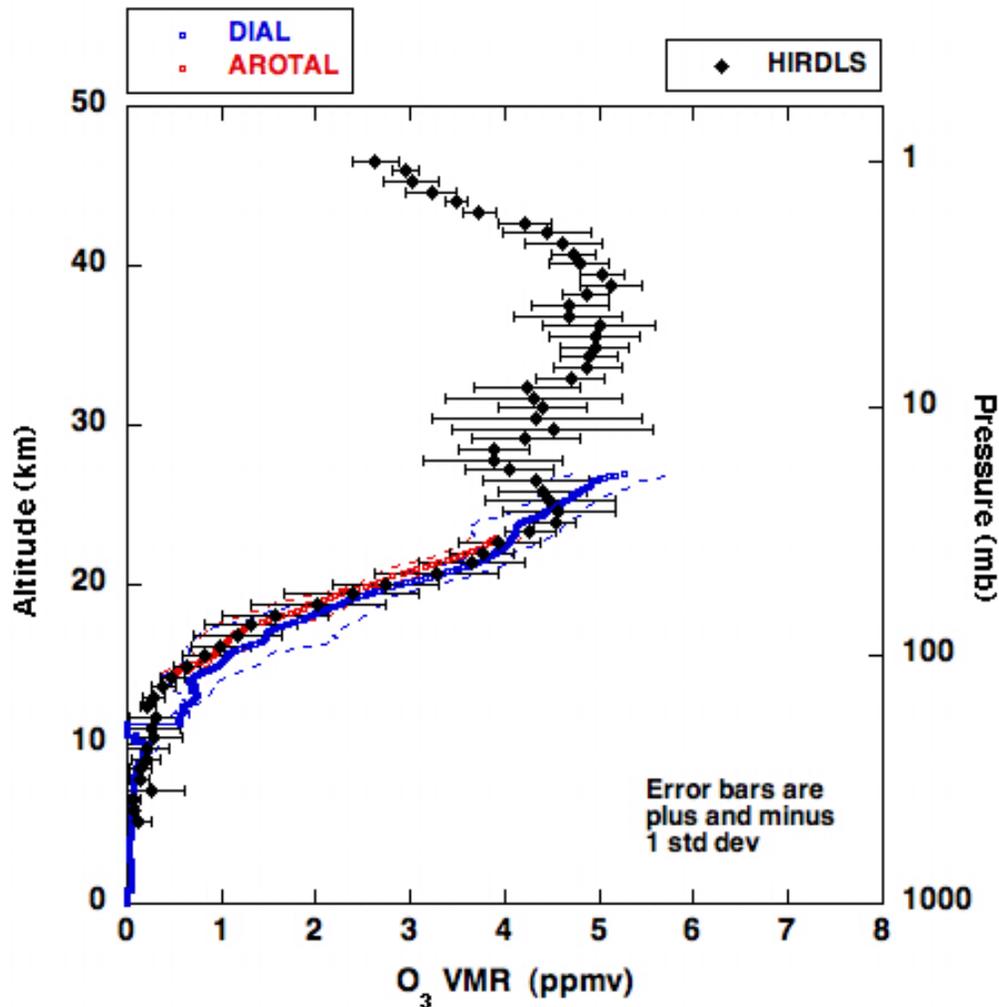
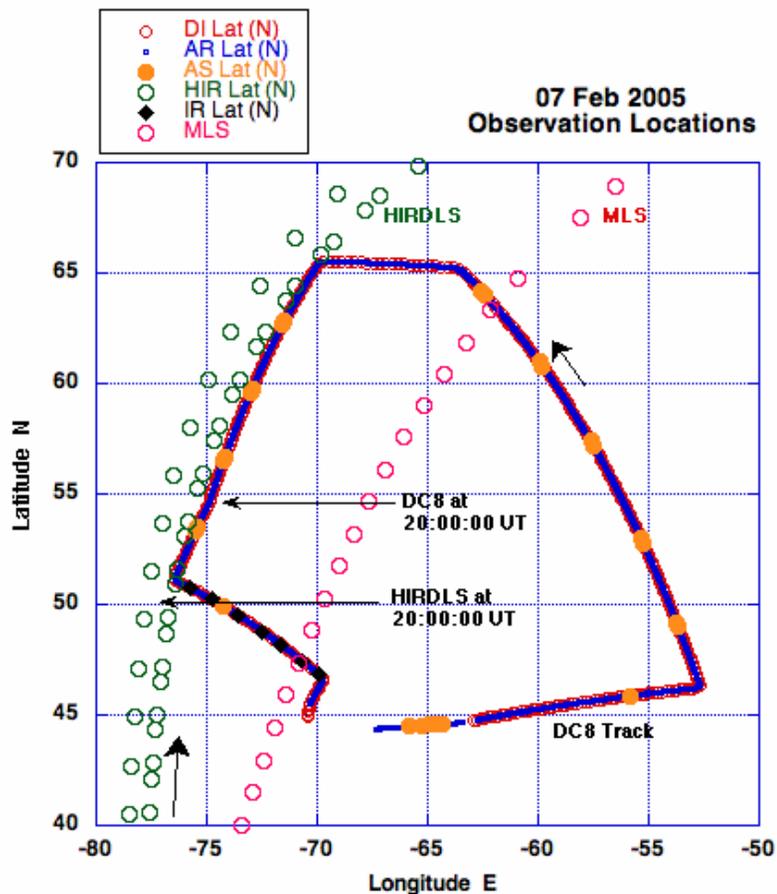


Ozone: HIRDLS - LIDAR



- **DI-NASA LaRC DIAL LIDAR**
- **AR-NASA GSFC AROTAL LIDAR**
- **AS-U. Bremen ASUR μ wave spect.**
- **IR-NCAR FTIR**

HIRDLS - PAVE O₃
50-65 N, 7 Feb 2005

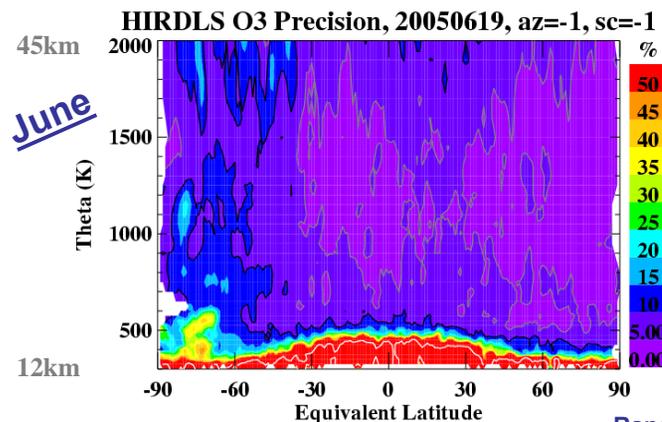
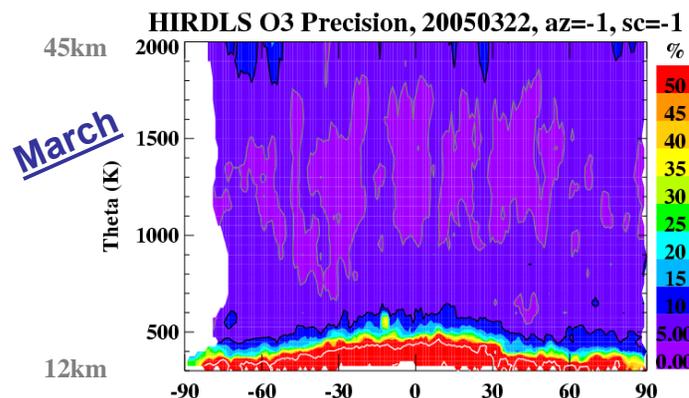
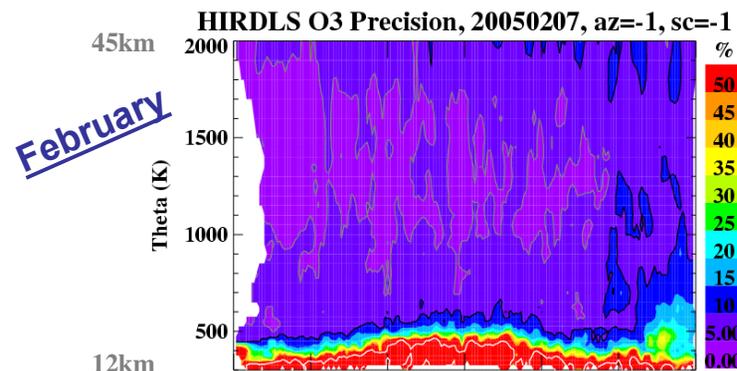


HIRDLS Estimated Ozone Precision

- (1) Interpolate HIRDLS data to a theta grid with vertical resolution equivalent to ~1-km.
- (2) Interpolate HIRDLS geolocations at all theta levels to equivalent latitude (Eqlat, determined using Met Office PV).
- (3) Calculate the standard deviation at each theta level in one-degree increments of Eqlat, from -90 deg to 90 deg.
 - * Require locations to be within 2 Eqlat degrees of central Eqlat.
 - * Require locations to be within 500 km of central location.

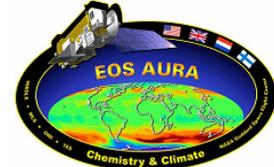
The result of step (3) is to remove, as far as possible, geophysical variations from the analysis. This is most effective in the summer hemisphere.

Result: Measured HIRDLS O₃ precision better than 10% except below ~450-500 K (18-20 km) and inside the vortex.





Summary



1. HIRDLS ozone currently has an estimated precision of largely better than 10% (often better than 5%) except below 18-20 km (~450-500 K) and inside the vortex;
2. Lower limit of valid ozone data appears to be 12-18 km (~400-450K; 200-80 hPa); above this to ~50 km agreement with correlative sources is 5%-10% range or better.
3. HIRDLS has high vertical resolution capability, this will be better quantified.

AVENUES TOWARD IMPROVED OZONE-PRODUCT / COMPARISONS

1. Continued improvements in characterization of Kapton-blockage:
 - Distinction between upward and downward profile corrections
2. Modified utilization of radiance of the third ozone channel (#12)
3. Identification/filtering of remaining low altitude cloud-related artifacts
4. Larger coincident data set → more stringent coincidence criteria
5. Note: Mid-latitude comparisons expected to yield better agreement at low altitude than low latitude comparisons shown here.

HIRDLS Team

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Bill Randel ², Jolyon Reburn ⁶, Brendan Torpy ¹, Laurie Rokke ²

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