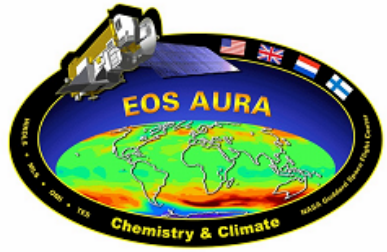


HIRDLS Ozone Validation
Solar Occultation, Ozone-sondes, Lidar

HIRDLS Team:
John Gille [1], John Barnett [2], Joan Alexander [3], Charles Cavanaugh [4], Mike Coffey [4], Jim Craft [5], Cheryl Craig [4], Vince Dean [5], Anu Dudhia [2], Tom Eden [4], Gene Francis [4], Chris Halvorson [4], Jim Hannigan [4], Lynn Harvey [6], Chris Hepplewhite [2], Brian Kerridge [7], Doug Kinnison [4], Rashid Khosravi [4], Charlie Krinsky [5], Alyn Lambert [4,8], Hyunah Lee [4], Joanne Loh [5], Steve Massie [4], Joe McInerney [5], Bruno Nardi [4], Brent Petersen [5], Cora Randall [6], Bill Randel [4], Jolyon Reburn [7], Brendan Torpy [5], Laurie Rokke [2], Alison Waterfall [7], Claire Waymark [7], Greg Young [5]

Thierry Leblanc [8]

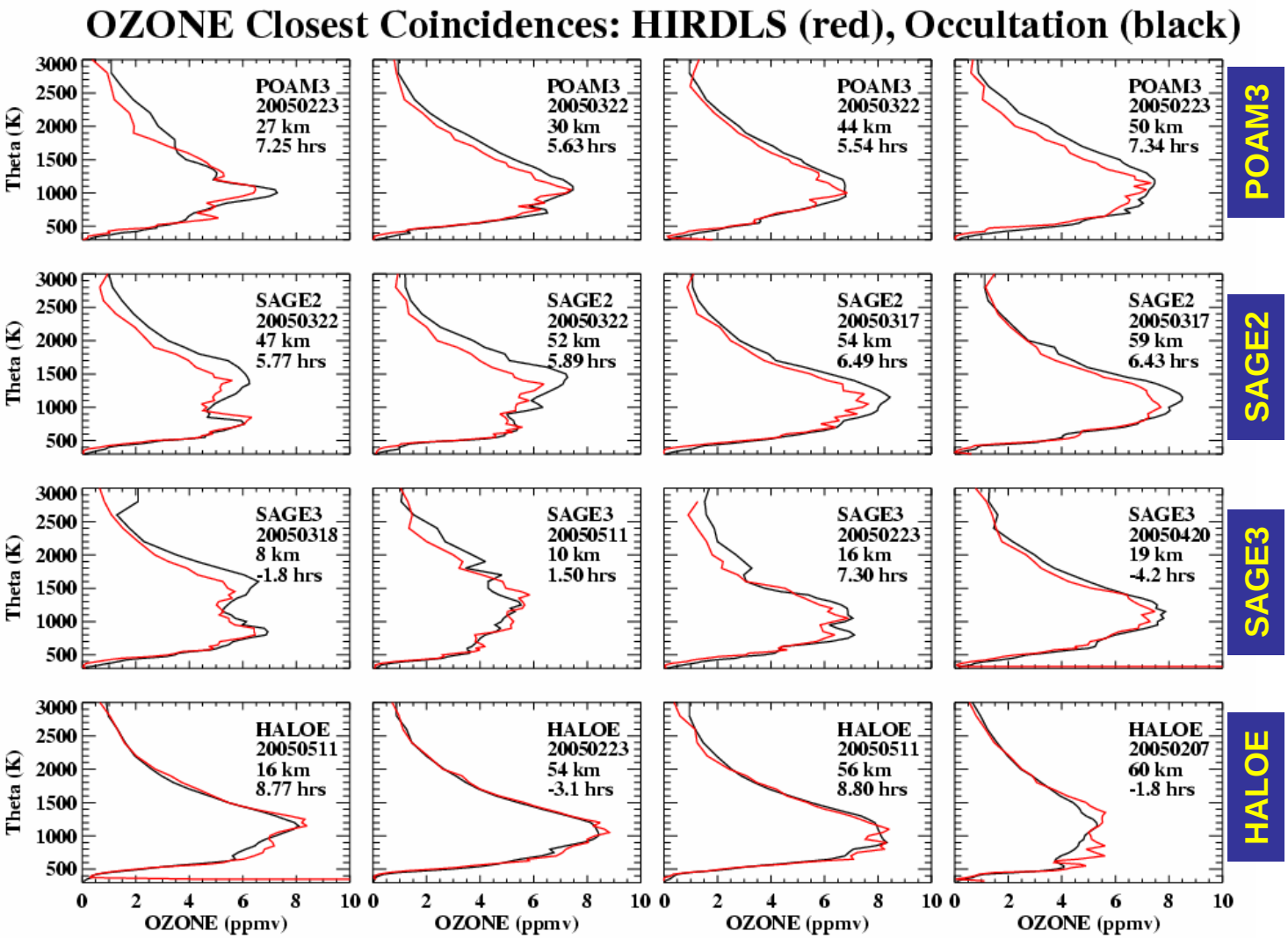
[1] CU/NCAR, [2] Oxford, [3] CORA/NWRA, [4] NCAR, [5] CU/CLAS, [6] CU/LASP, [7] RAL, [8] JPL

Overview

OZONE Comparisons with:

1. Space-borne Solar Occultation Measurements
   - HALOE
   - POAM3
   - SAGE 2
   - SAGE 3
2. Airborne: PAVE
3. Ozonesondes
   - Low Latitude: Nairobi, Marindi, La Reunion, Ascension Island, Natal
   - Mid/high Latitude
4. Ground-based Lidar: Mauna Loa Observatory (JPL)

Individual Comparisons: 4 Closest Coincident Ozone Profiles to Occultation Measurements

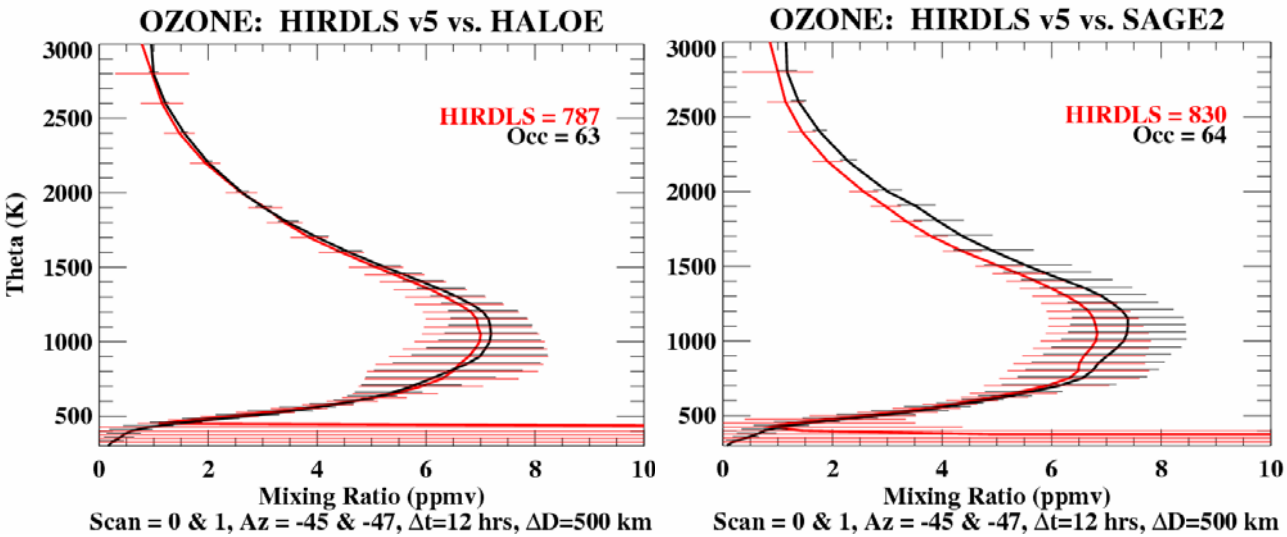


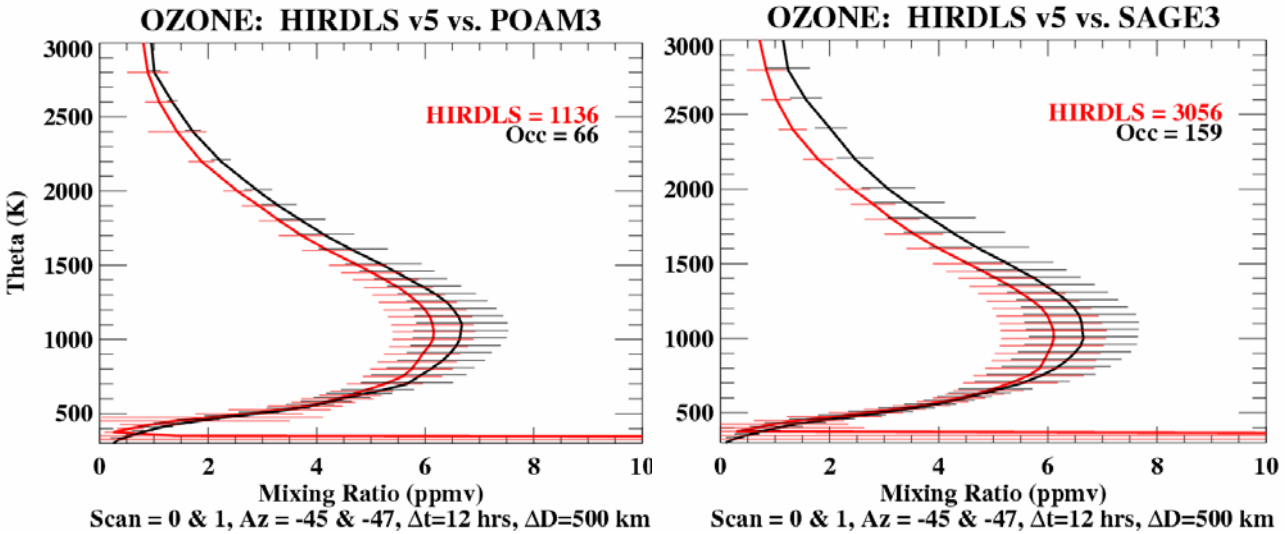
Each panel denotes the occ. instrument, date, distance, and Δ time for the four closest HIRDLS coincidences with each instrument.

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

Courtesy Cora Randall, Lynn Harvey

Average Ozone Profiles from HIRDLS and Coincident Occultation Measurements





Average O_3 profiles for all coincidences on ten dates.

Coincidence criteria:
500 km, Δt = 12 hrs

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

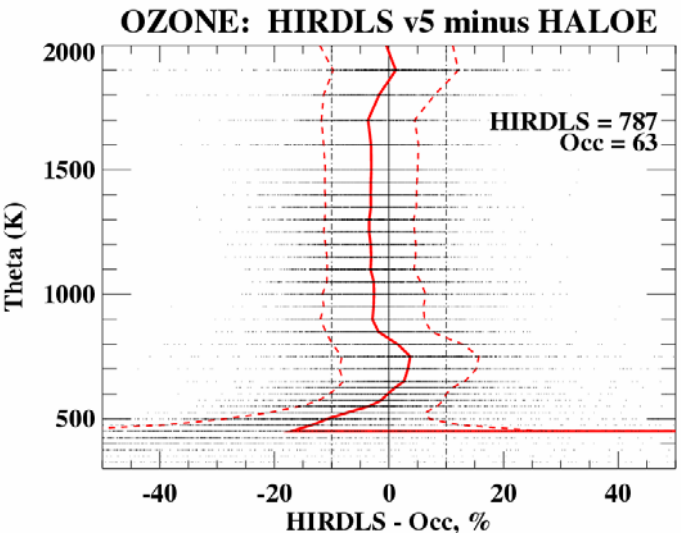
HIRDLS=red, Occ=black

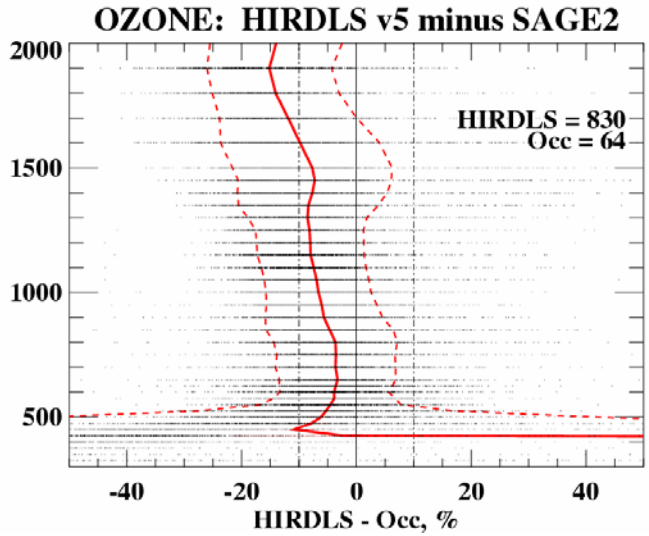
"Error" bars are 1-σ standard deviation of the distributions.

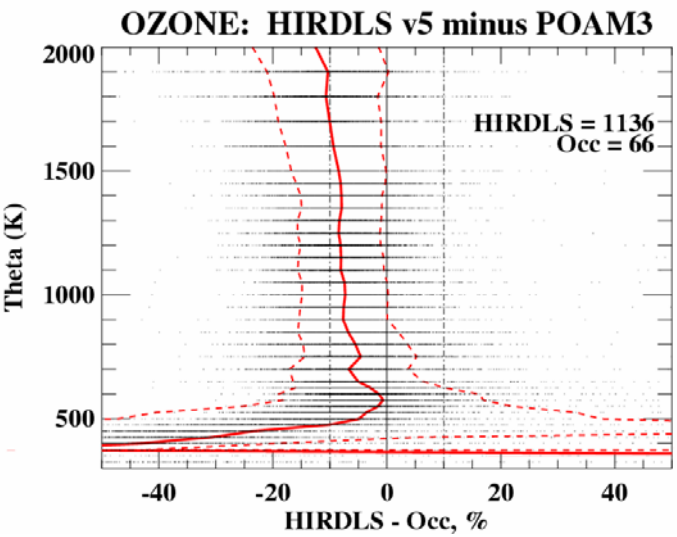
Each occultation profile coincident with multiple HIRDLS profiles: #'s denoted in each panel.

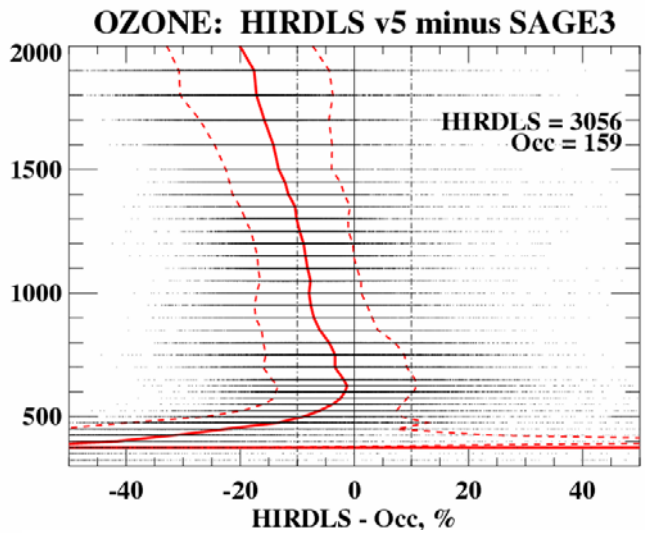
Courtesy Cora Randall, Lynn Harvey

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)

Courtesy Cora Randall, Lynn Harvey

HIRDLS Estimated Ozone Precision

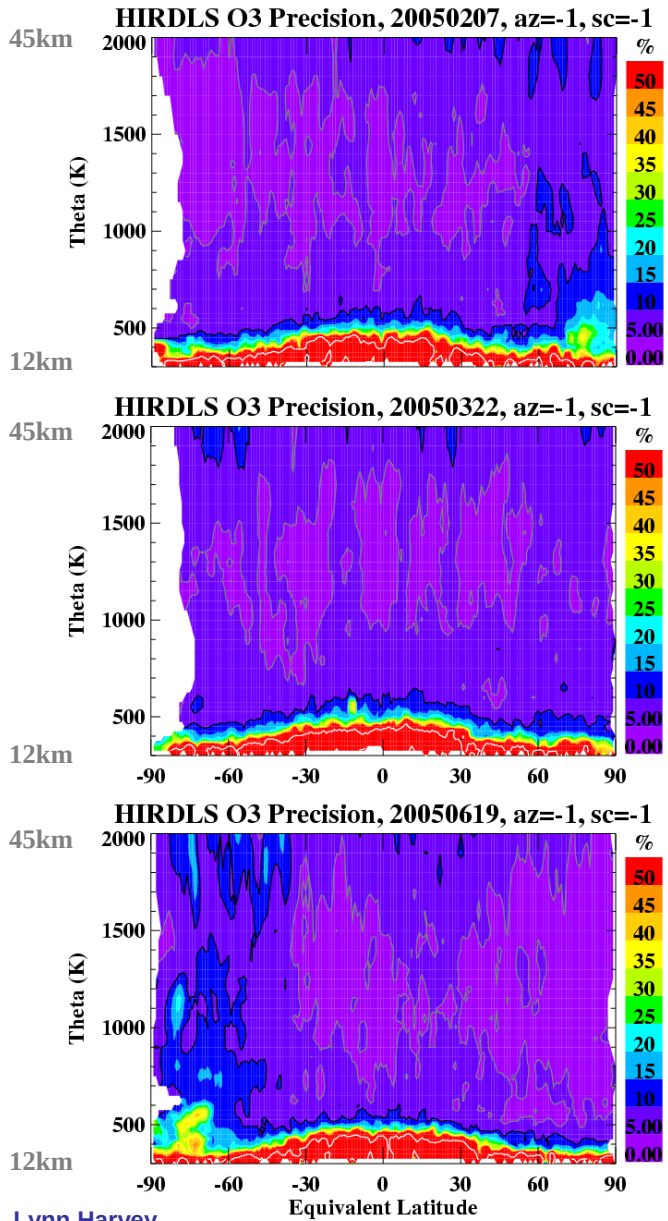
(1) Interpolate HIRDLS data to a theta grid with vertical resolution equivalent to ~1-km.

(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.

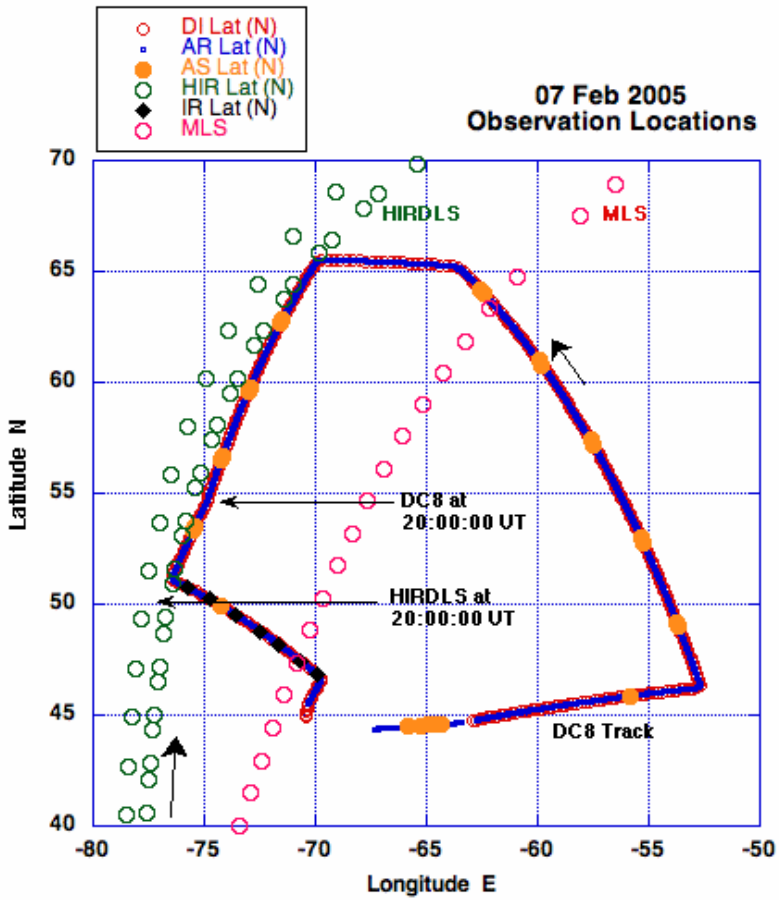
Result: Measured HIRDLS O_3 precision better than 10% except below ~450-500 K (18-20 km) and inside the vortex.

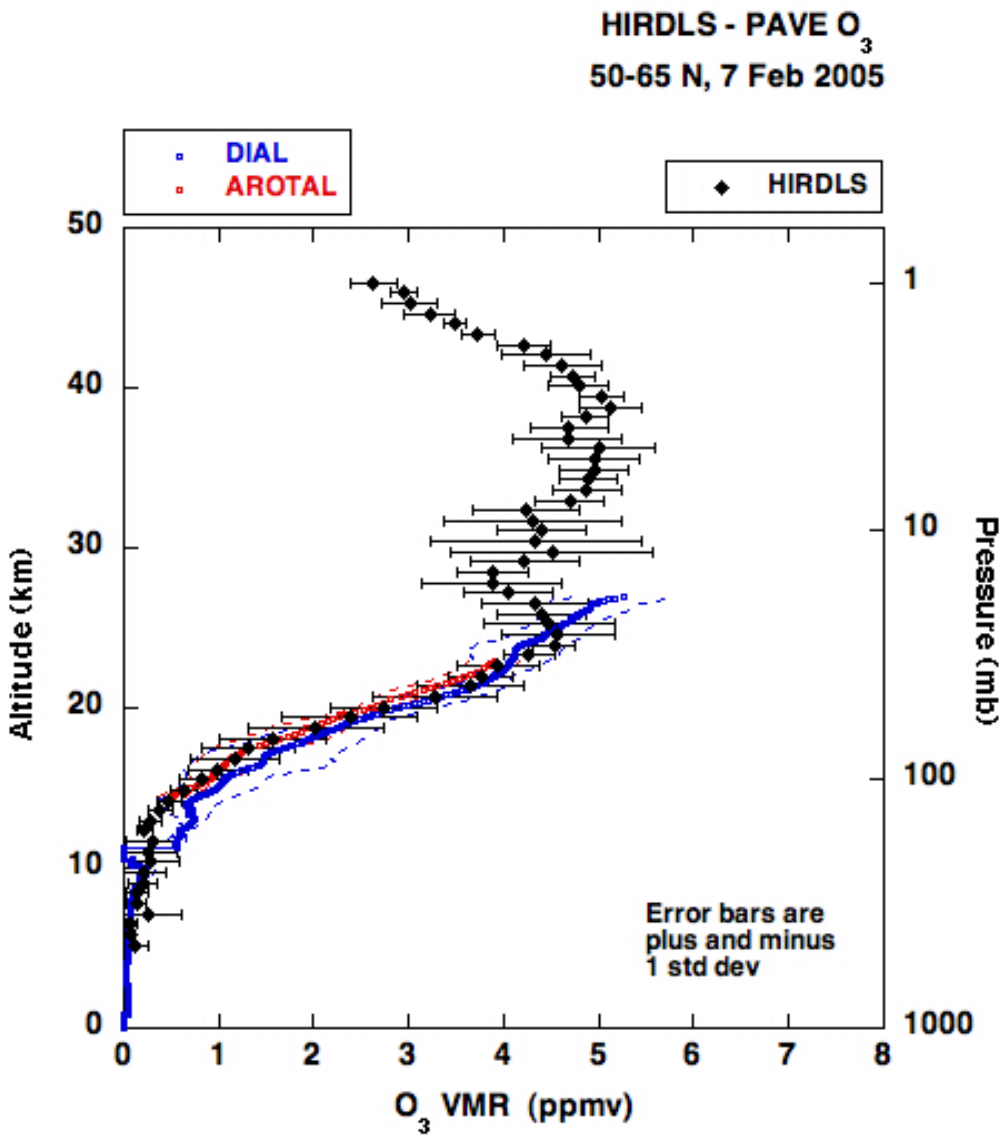


Courtesy Cora Randall, Lynn Harvey

Polar Aura Validation Experiment (PAVE)

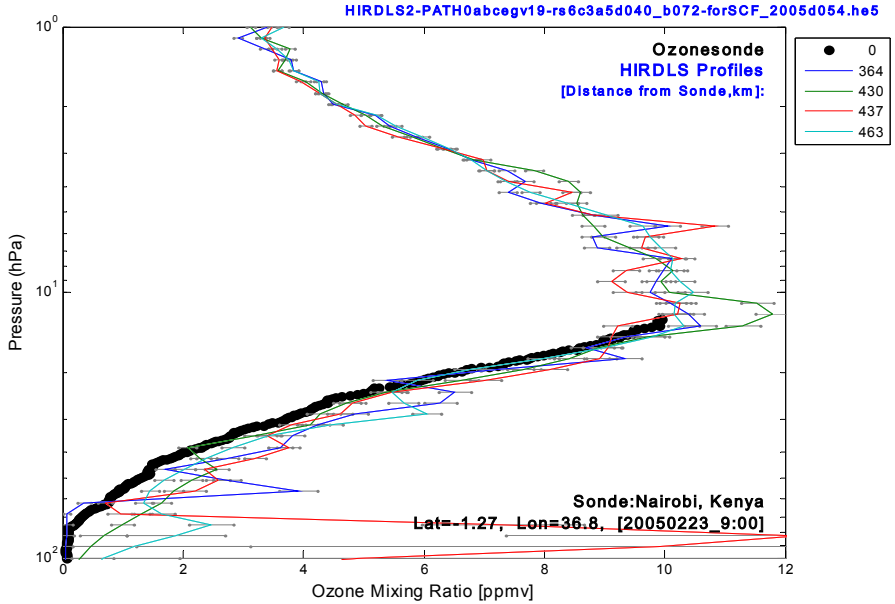
- **DI- NASA LaRC DIAL LIDAR**
- **AR-NASA GSFC AROTAL LIDAR**
- **AS-U. Bremen ASUR μwave spect.**
- **IR- NCAR FTIR**

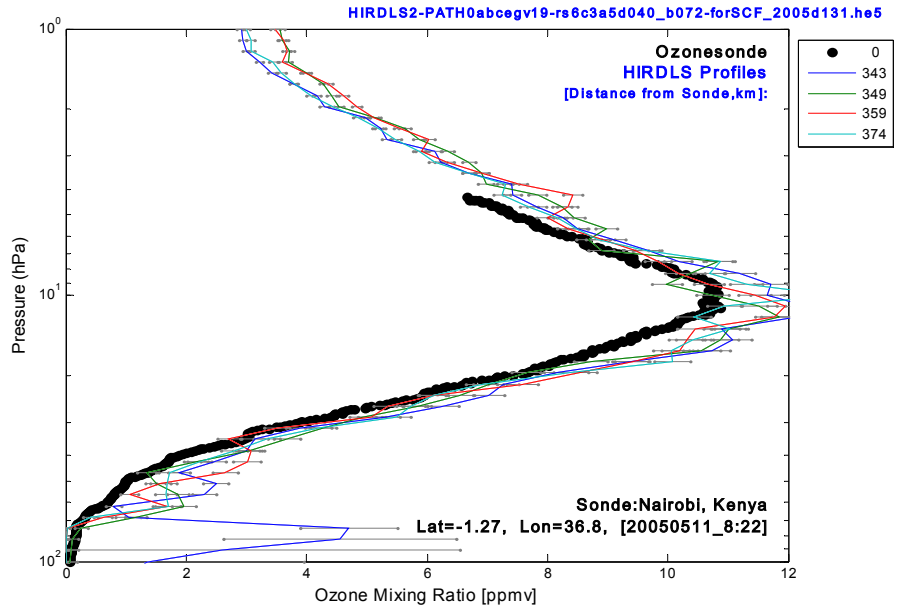


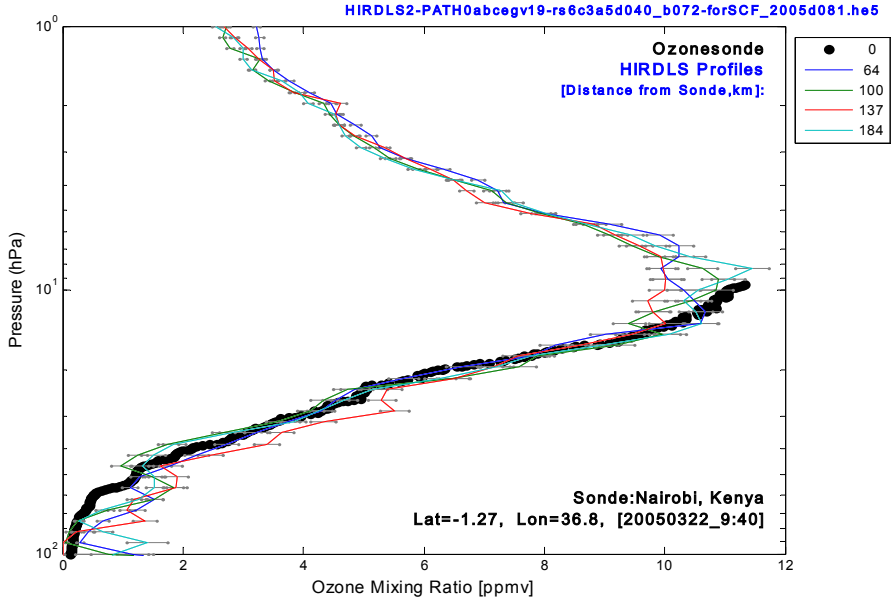


Courtesy Mike Coffey

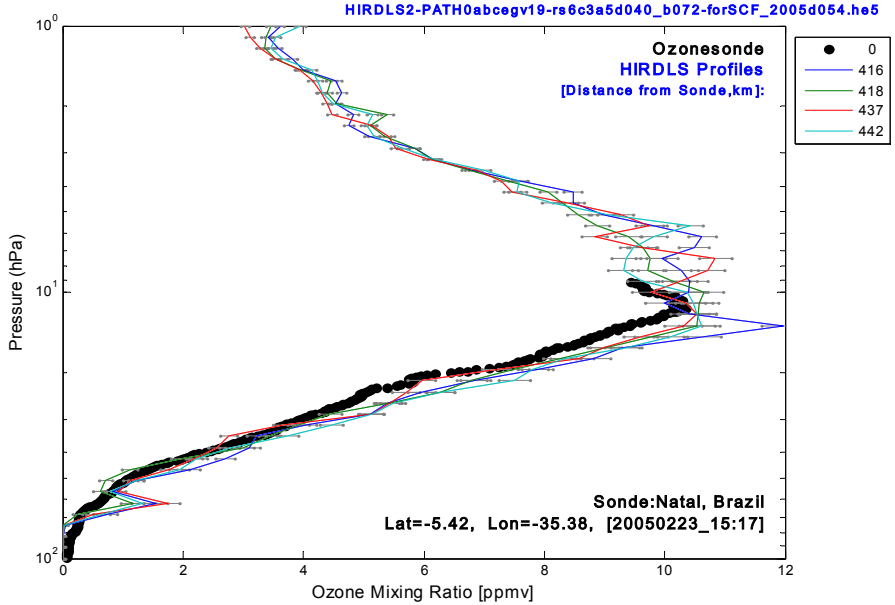
SHADOZ Ozone Sondes vs. HIRDLS

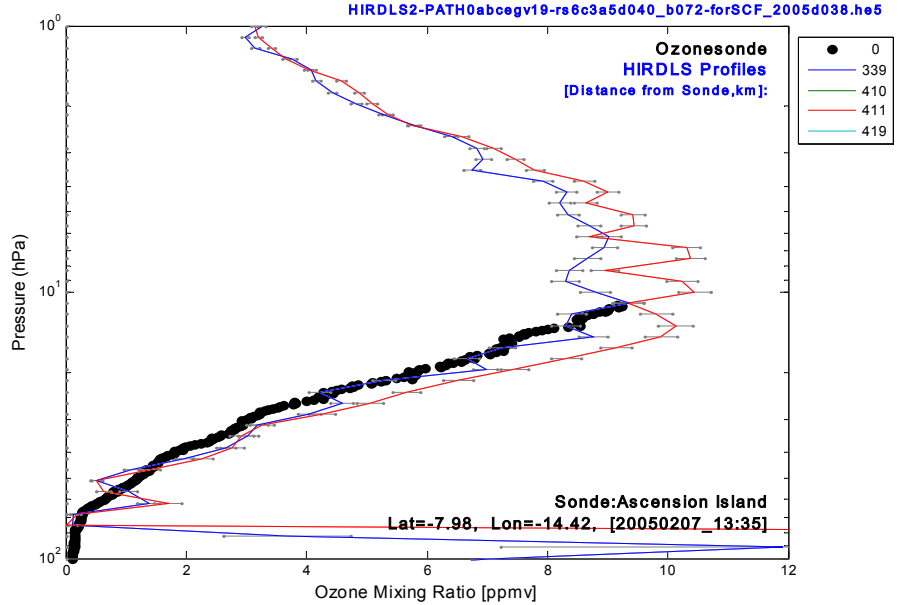


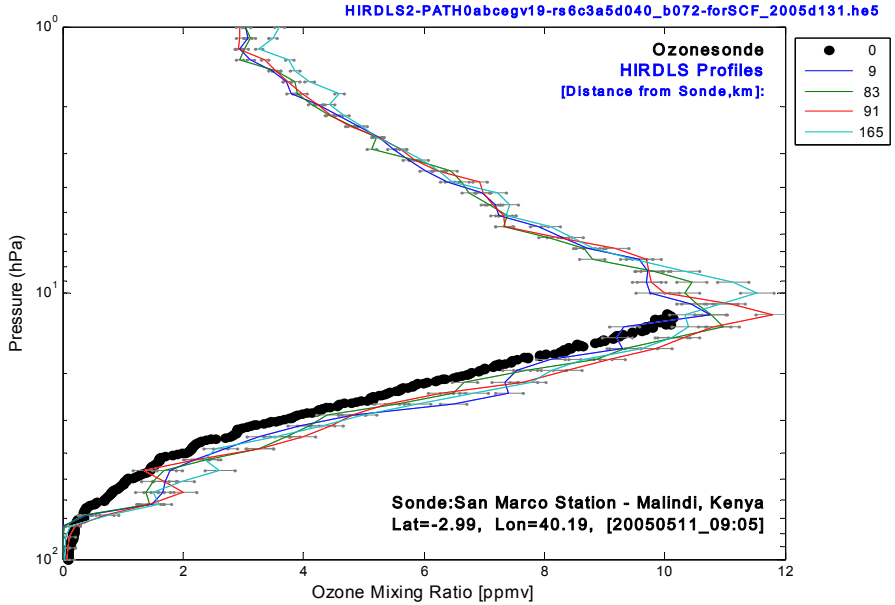


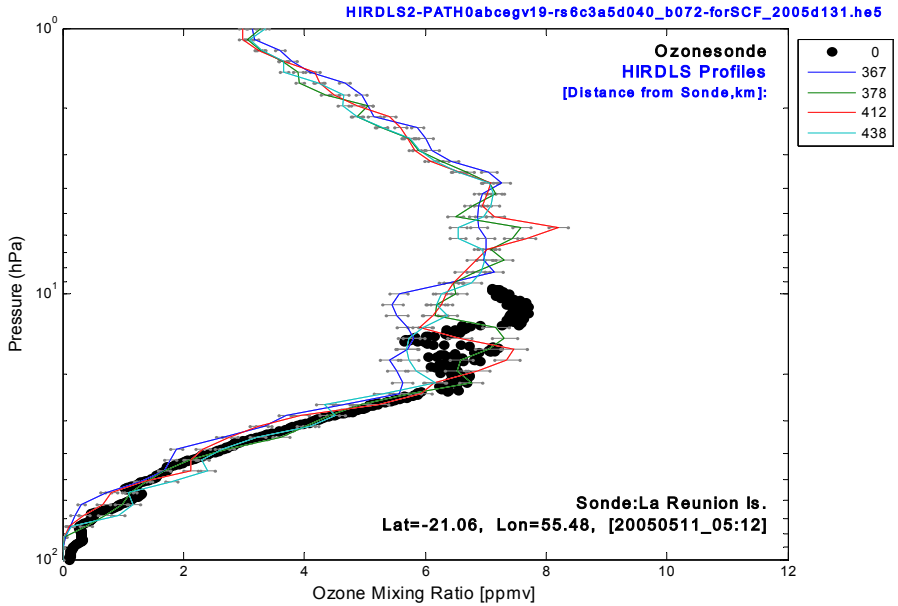


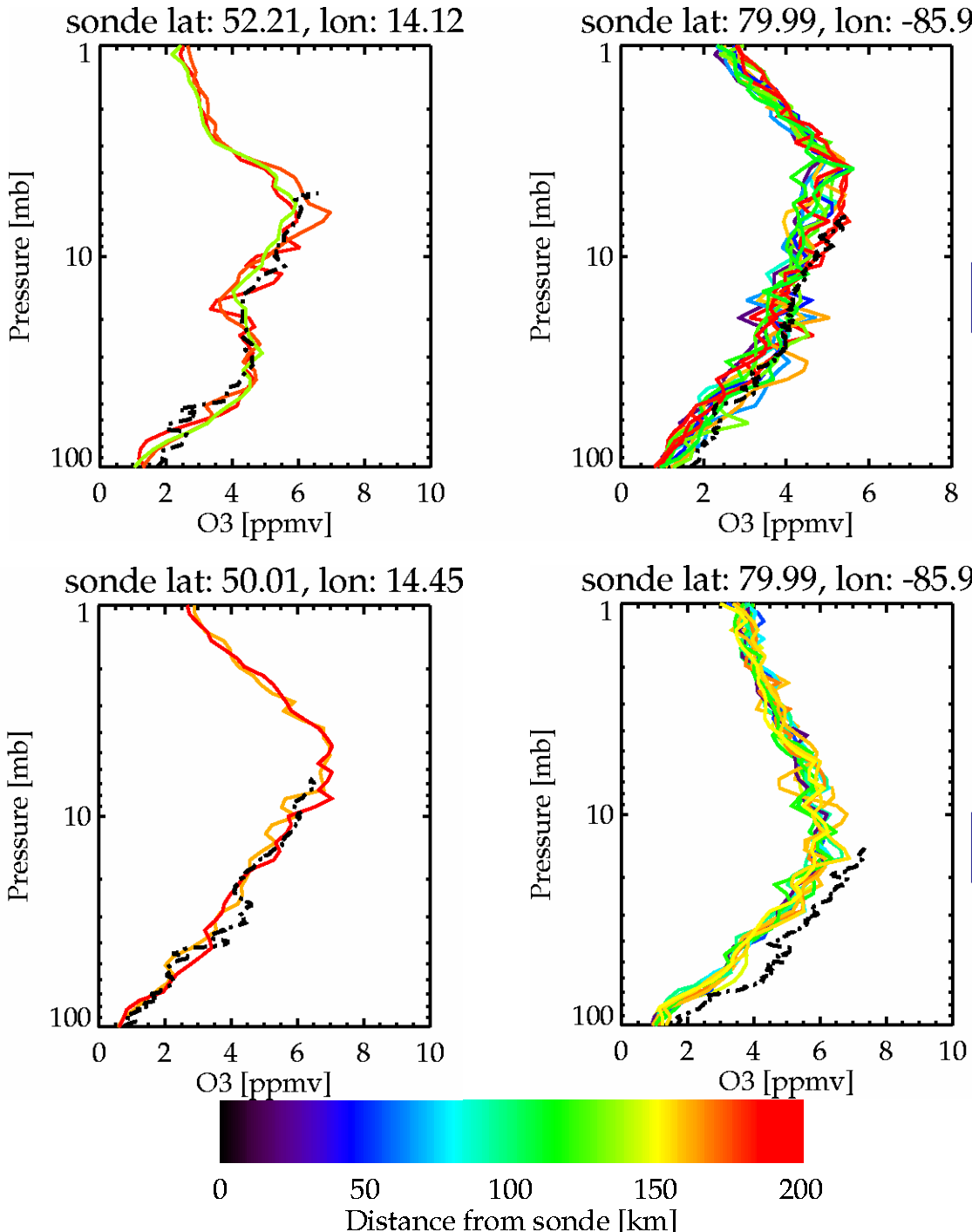
SHADOZ Ozone Sondes vs. HIRDLS











Ozonesondes vs. HIRDLS (Mid/High Latitude)

23 February 2005

Ozonesonde (World Ozone & Ultraviolet Data Centre), [black]

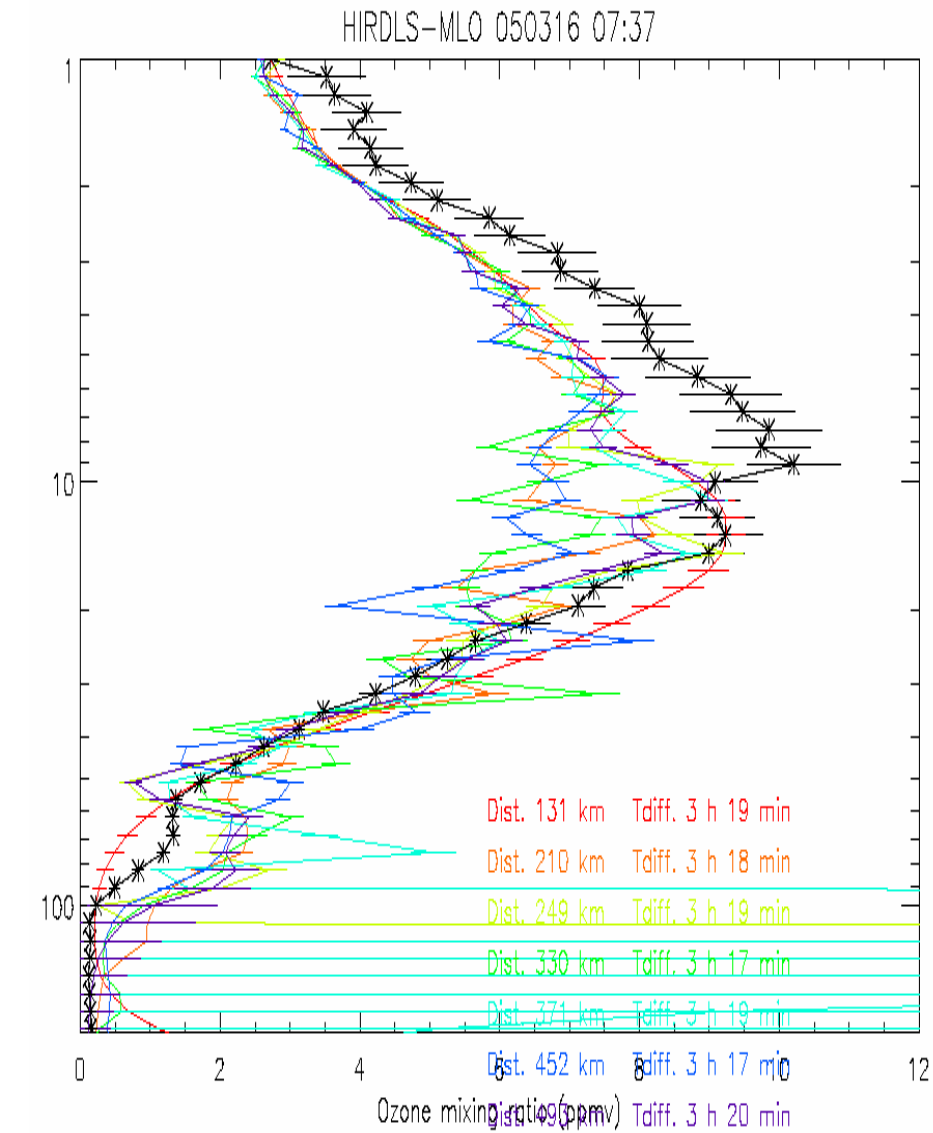
HIRDLS [colors]

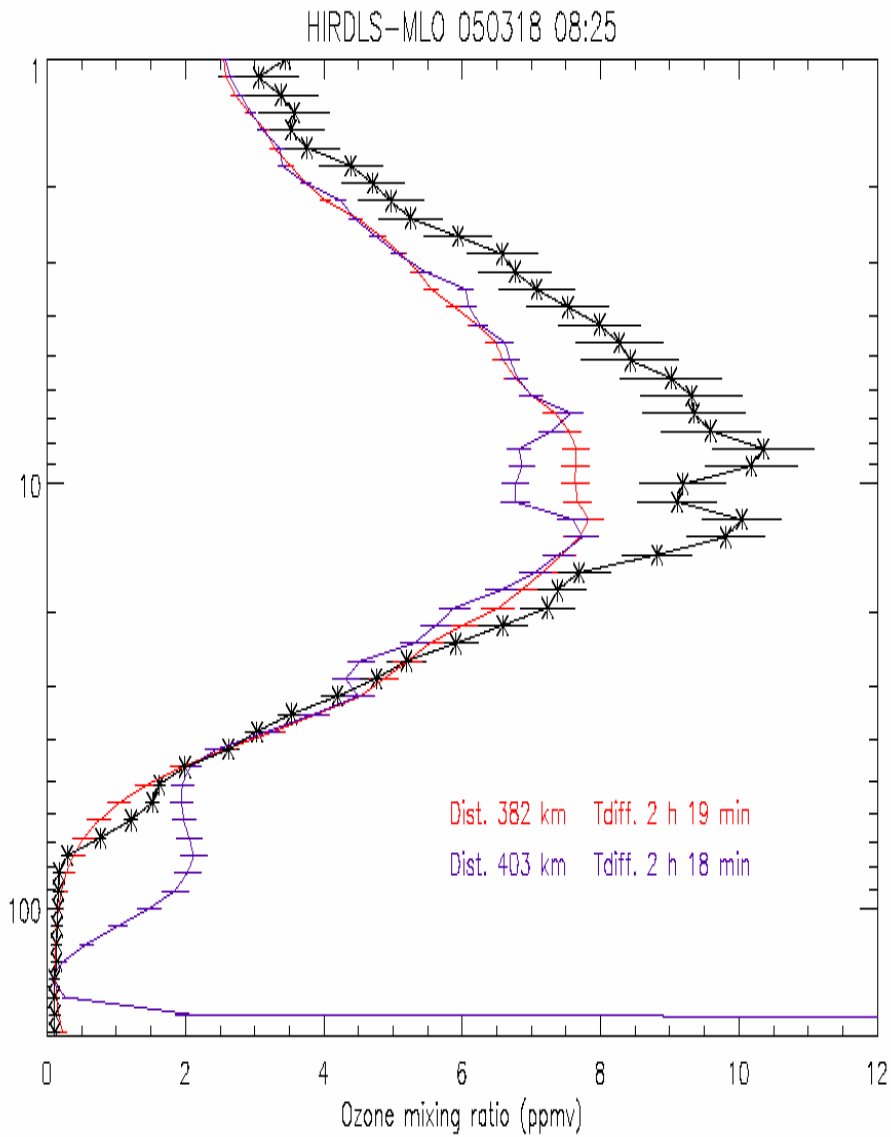
22 March 2005

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

Courtesy Alison Waterfall

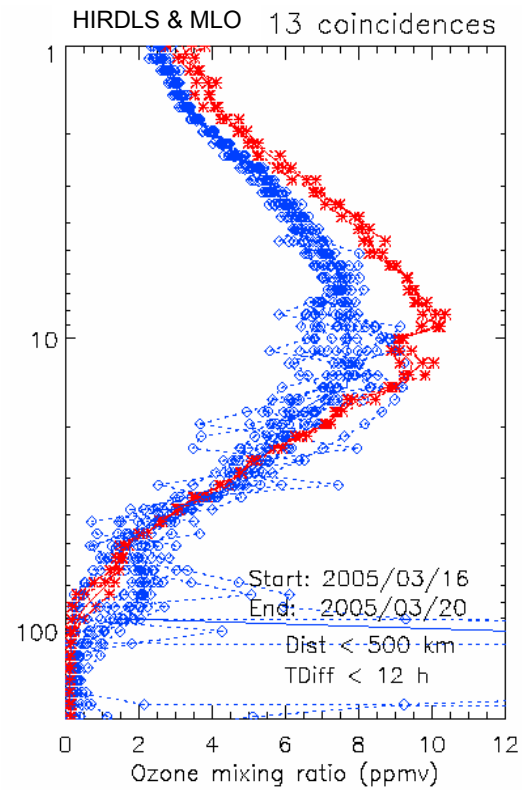
Lidar (Mauna Loa) vs HIRDLS

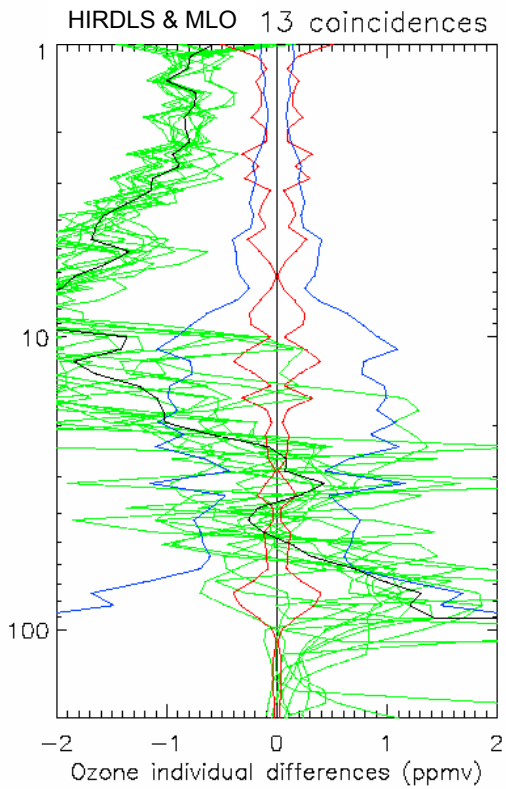


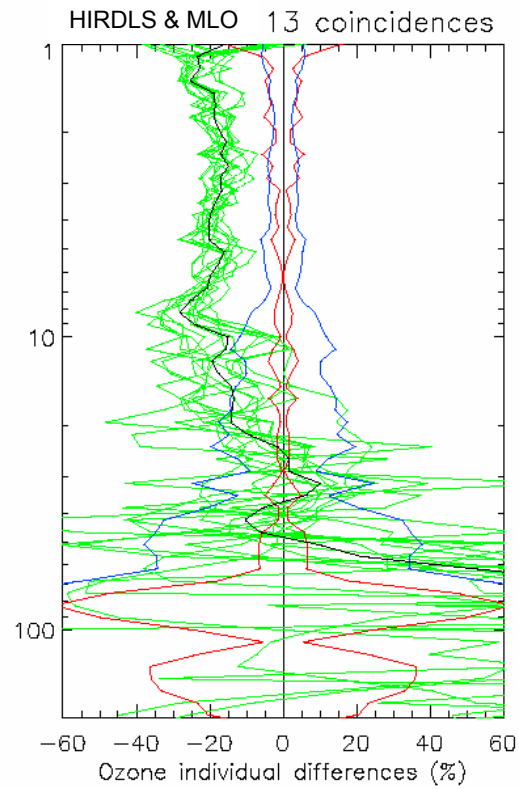


Courtesy Thierry Leblanc

LIDAR Ozone Profiles: Statistical Summary of Comparisons with HIRDLS







BLUE = HIRDLS Ozone (13) GREEN = Ozone Difference

RED = LIDAR Ozone (2) BLACK = Mean Diff [ppmv]

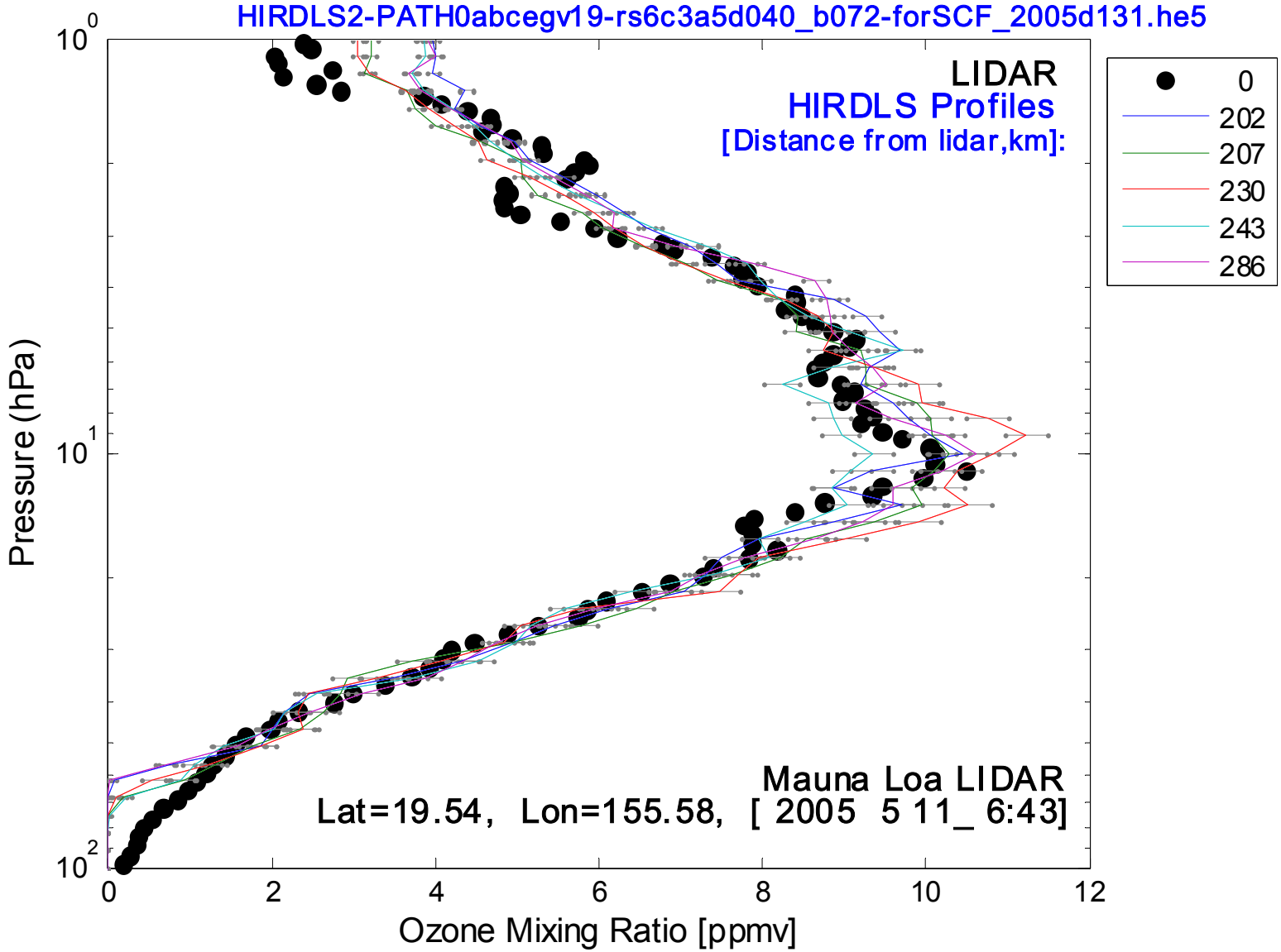
same as center

Mean Diff [%]

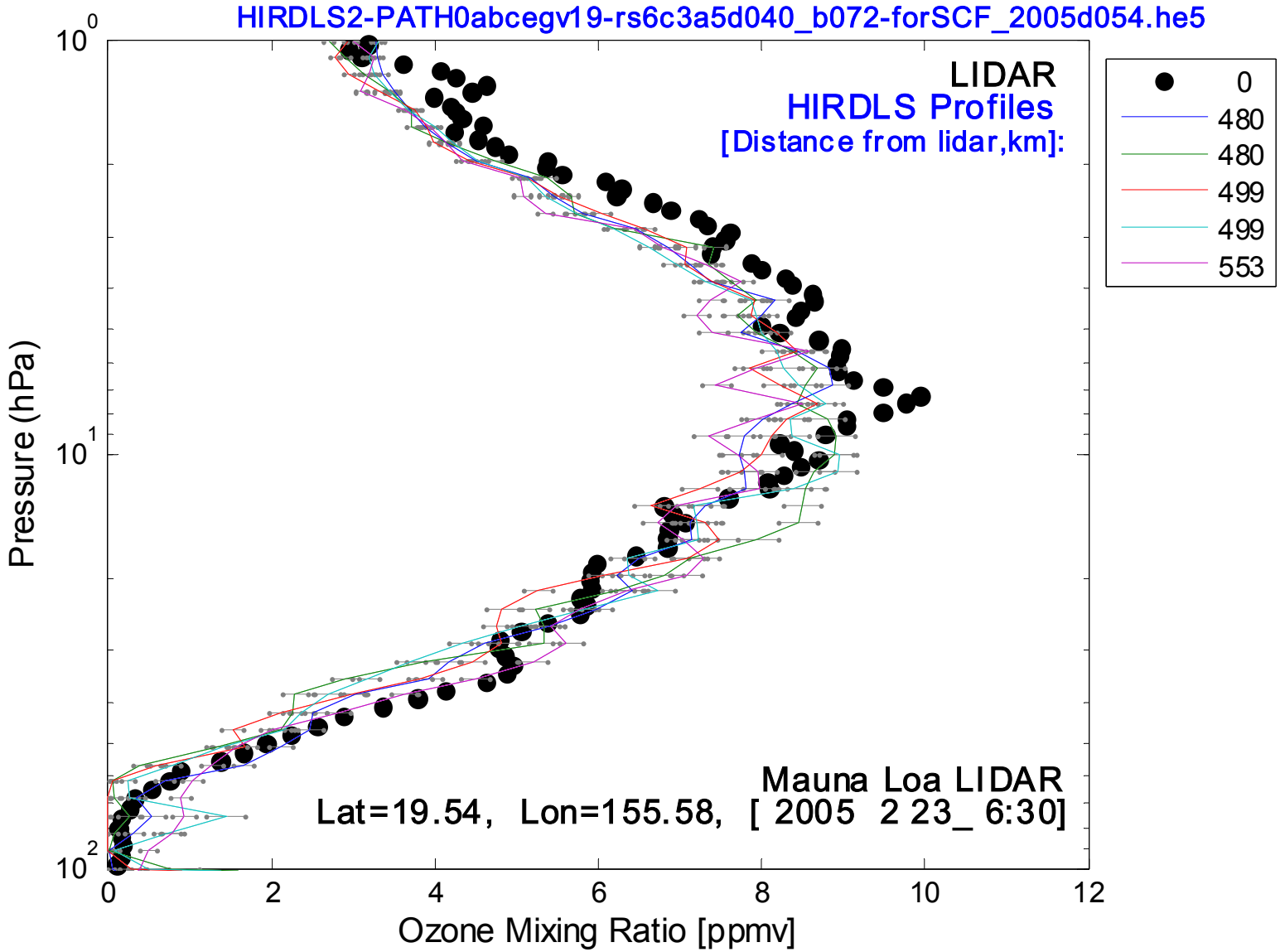
w/Lidar reference

Courtesy Thierry Leblanc

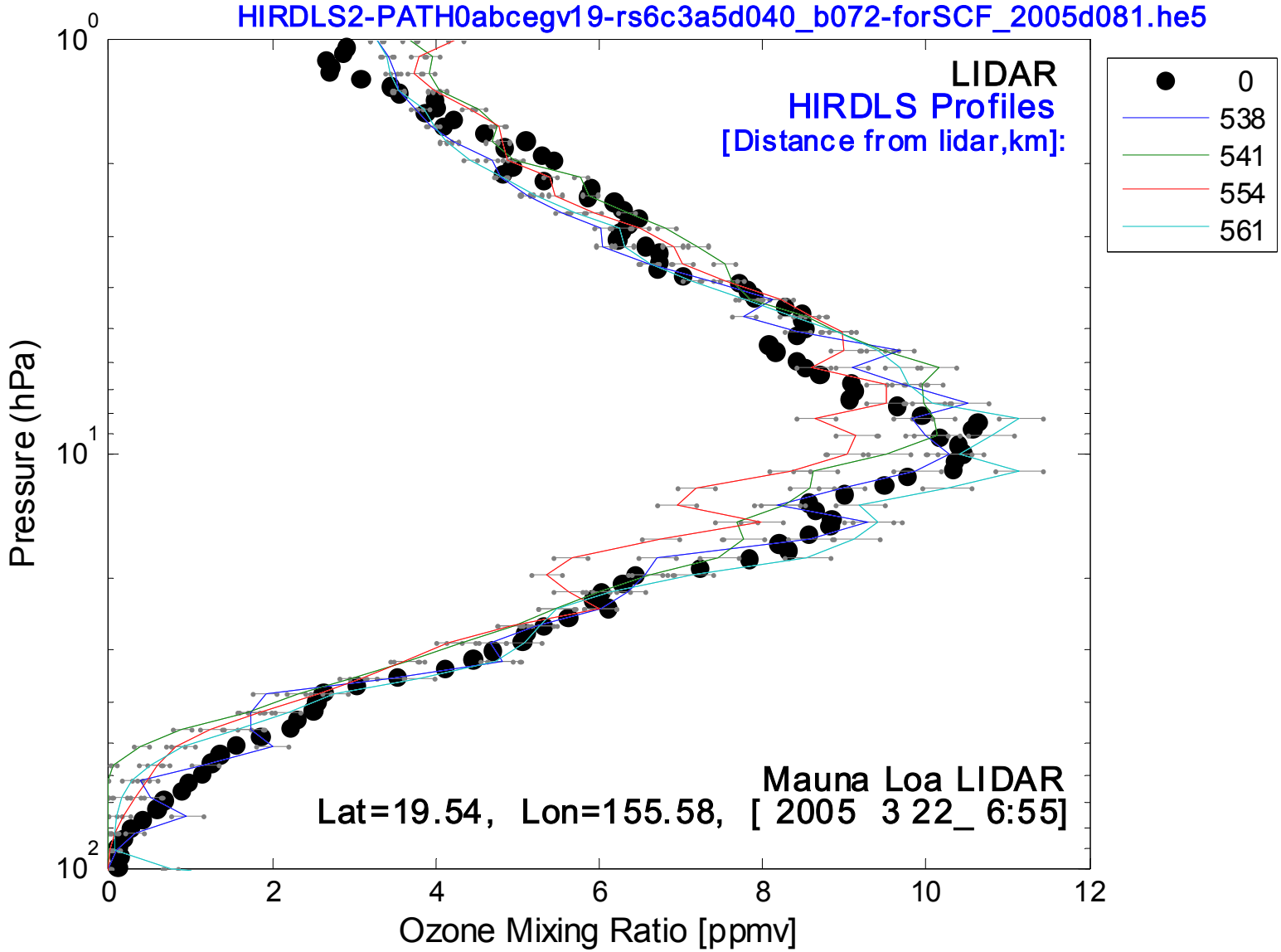
Lidar (Mauna Loa) vs HIRDLS



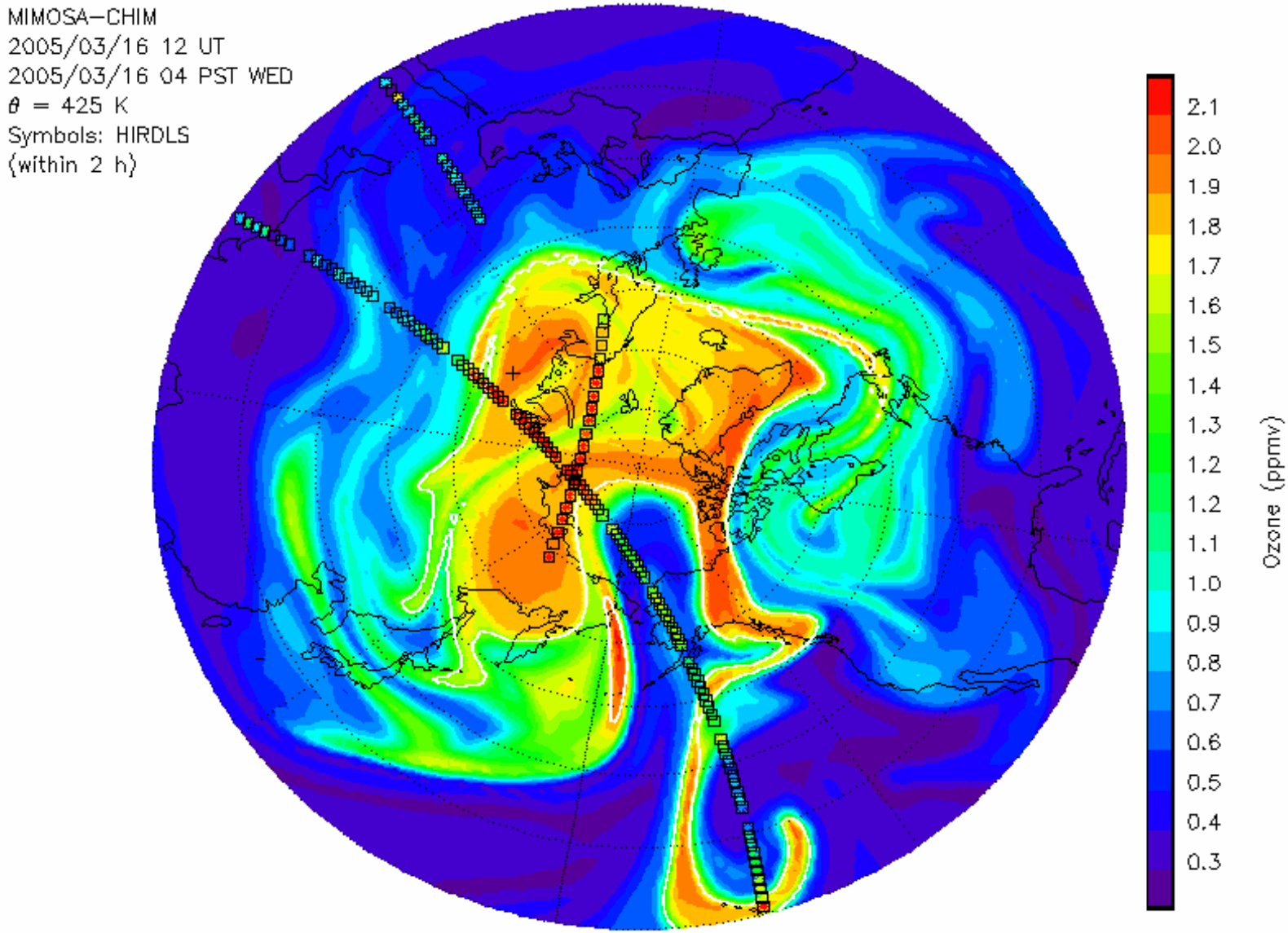
Lidar (Mauna Loa) vs HIRDLS



Lidar (Mauna Loa) vs HIRDLS



MIMOSA Chemical Model with HIRDLS track
Over polar vortex with filamentation



Courtesy Thierry Leblanc

Summary

1. HIRDLS ozone currently has an estimated precision of largely better than 10%, except below 18-20 km (~450-500 K) and inside the vortex;

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

3. Lower limit of valid ozone data appears to be 12-18 km (~400-450K);

4. HIRDLS clearly has high vertical resolution capability;

5. Continued correction-algorithm and retrieval development expected to yield additional improvement;

6. In parallel, additional validation analysis/ comparisons will be done → better statistics possible with lidar ozonesondes.