HIRDLS Observations of an Ozone Intrusion from the Upper Troposphere into the Lower Stratosphere (and Vice Versa)

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Introduction to HIRDLS V4 Data

http://www.eos.ucar.edu/hirdls/

Being placed on Goddard DISC and BADC this week

New: CFC 11 & 12, aerosol extinction

Improved: Temperature, Ozone, & HNO_3

Vertical Range: 8-50+ km alt.

Vertical Resolution: 1 km

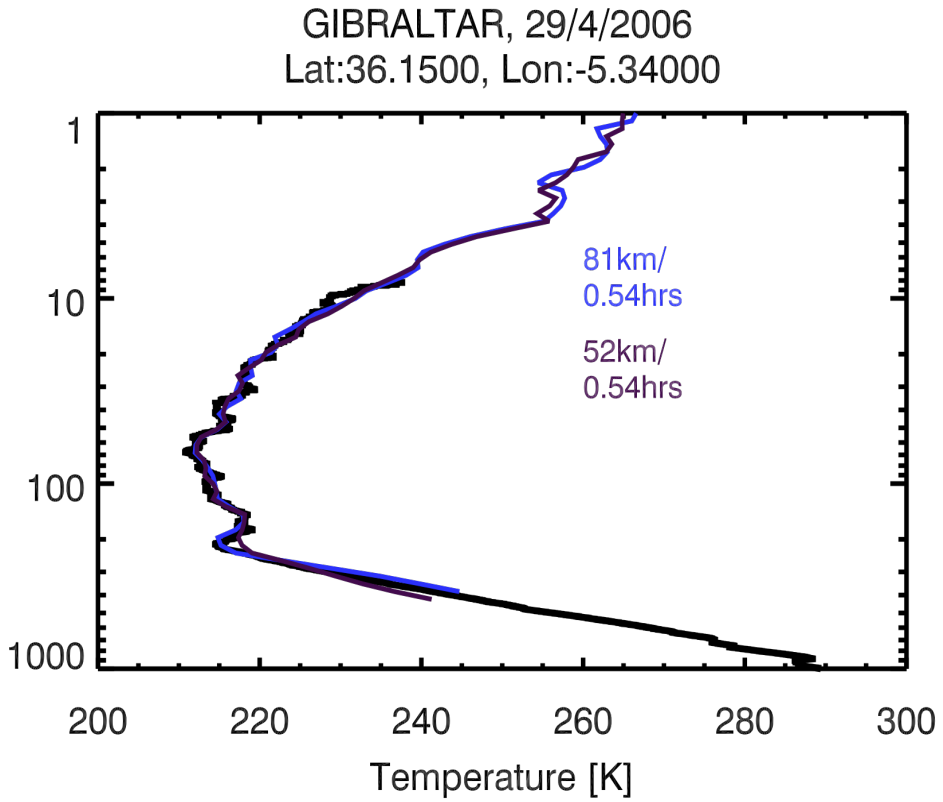
Horizontal Resolution: 100 km
(close to optimal sampling)

$$\frac{\Delta z}{\Delta x} = 10^{-2} \sim f/N$$

Coverage 65°S – 82°N
Nearly N-S from 10°-60°N

Temperature

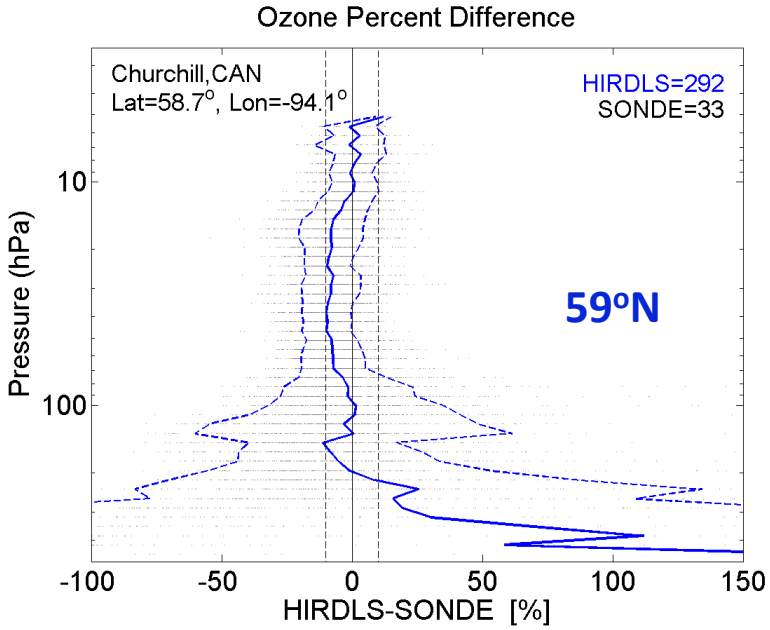
Agrees with ECMWF ± <1K, 400-1 hPa.
Comparison to radiosondes shows ability to capture features with small vertical scales.

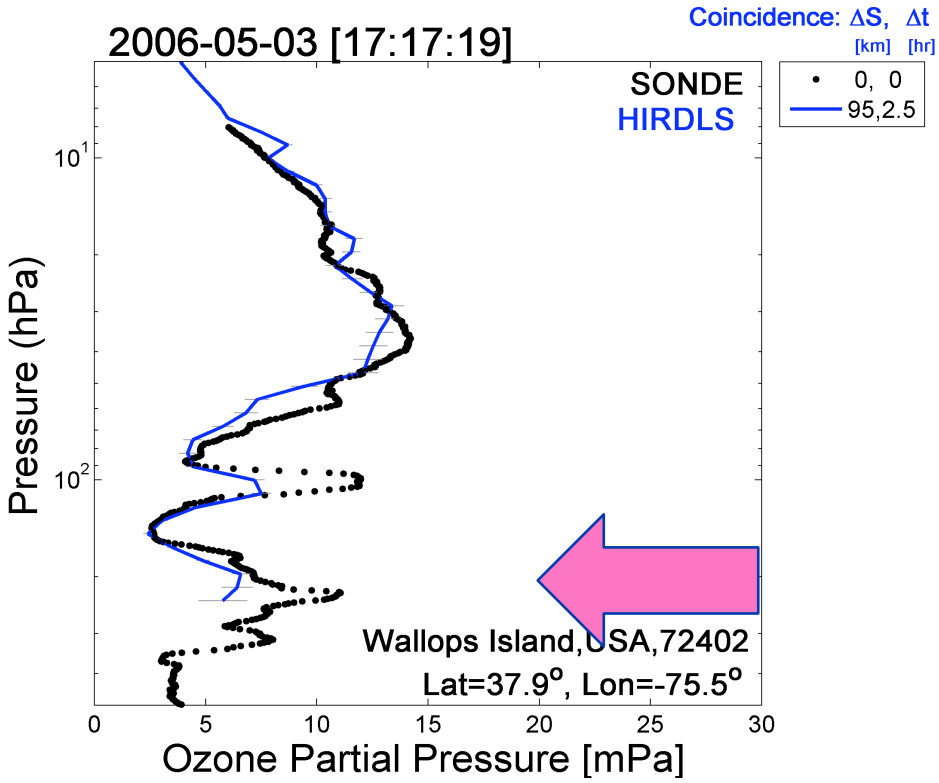


HIRDLS V4 Ozone

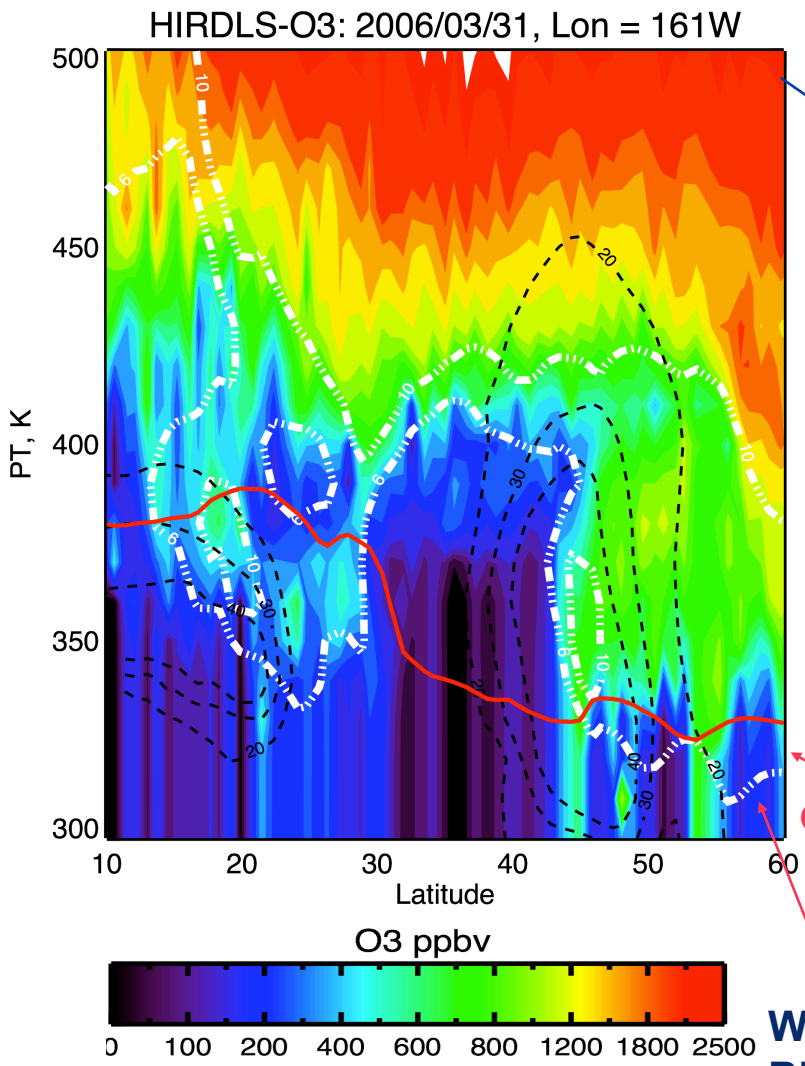
Ozone values agree with sondes to + 10% from 1-100 hPa (less far down in tropics), with a precision of 2-5% (0.2-0.4 ppmv, depending on altitude).

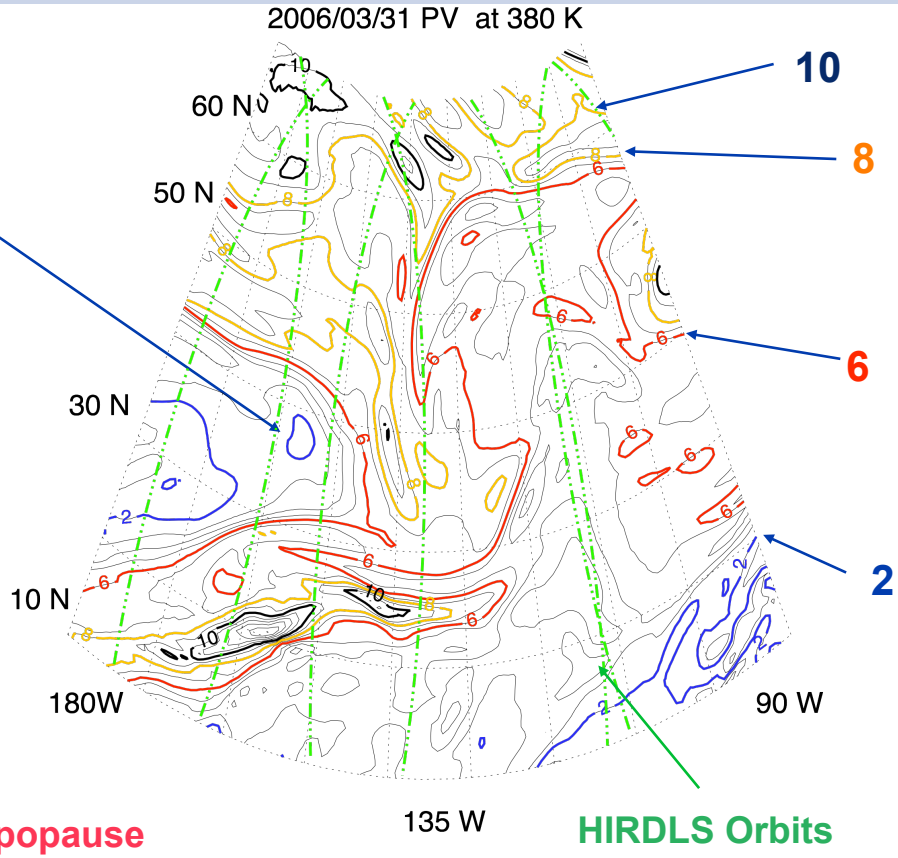
Comparisons with ozone sondes and lidar shows that HIRDLS resolves small-scale features 1.2 – 2 km in vertical extent.





Tropospheric Intrusion Event
31 March 2006





GMAO Tropopause

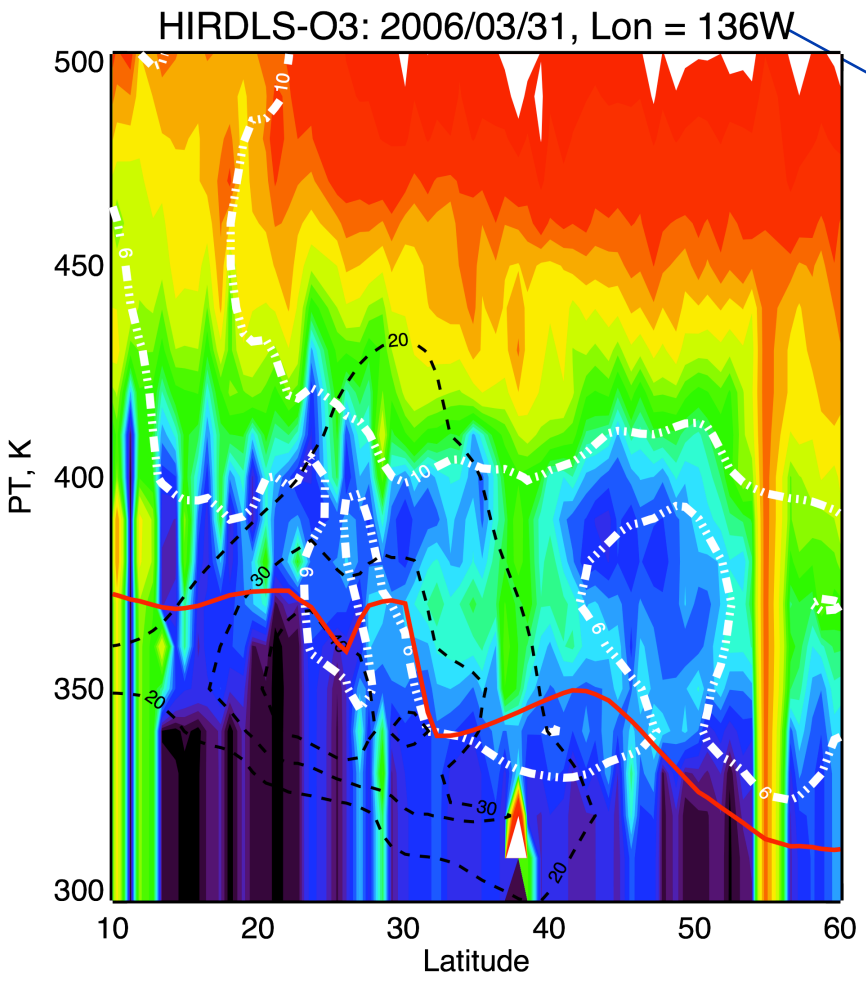
HIRDLS Orbits

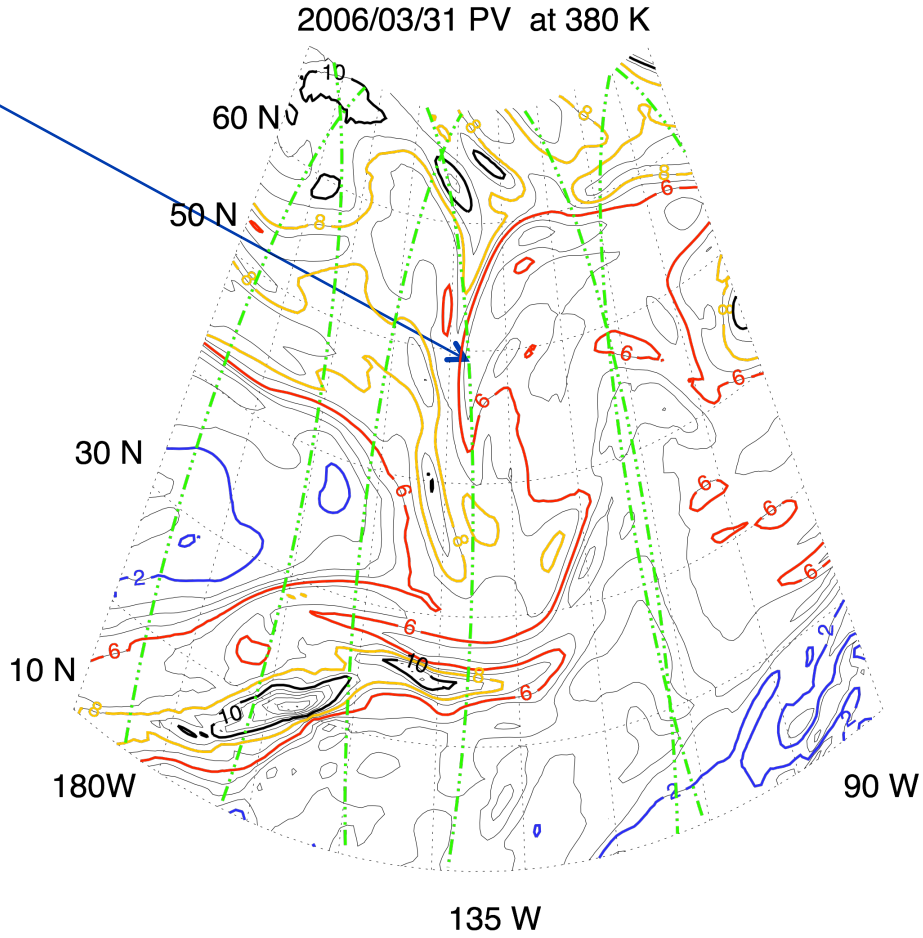
Ertel PV from GEOS 5 12Z

$$\left(10^{-6}\ m^2/s\ K/kg\right)$$

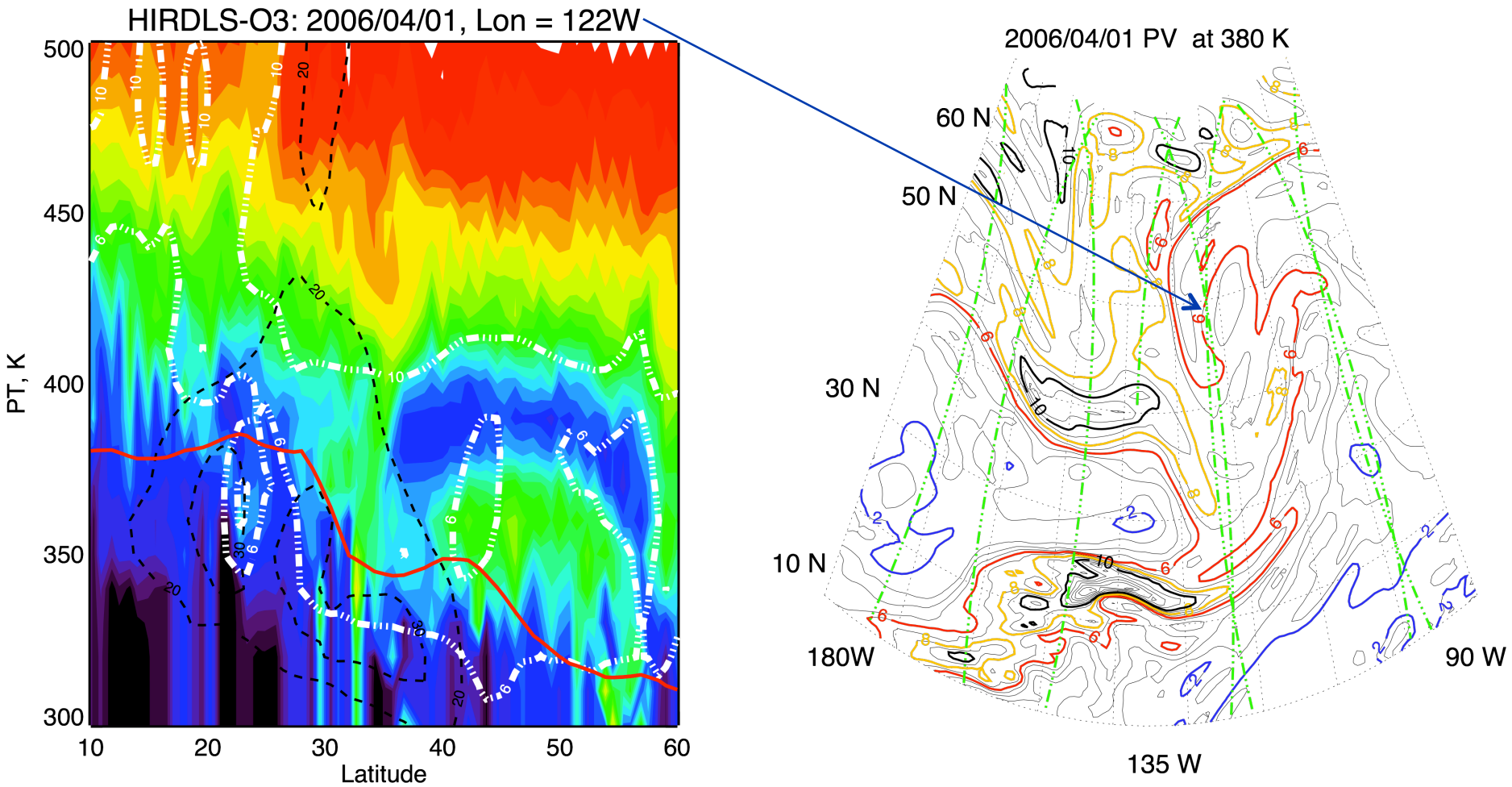
White-PV (6, 10 PVU)
Black- u (20, 30, 40m/s)

Tropospheric Intrusion Event
2nd Feature
31 March 2006



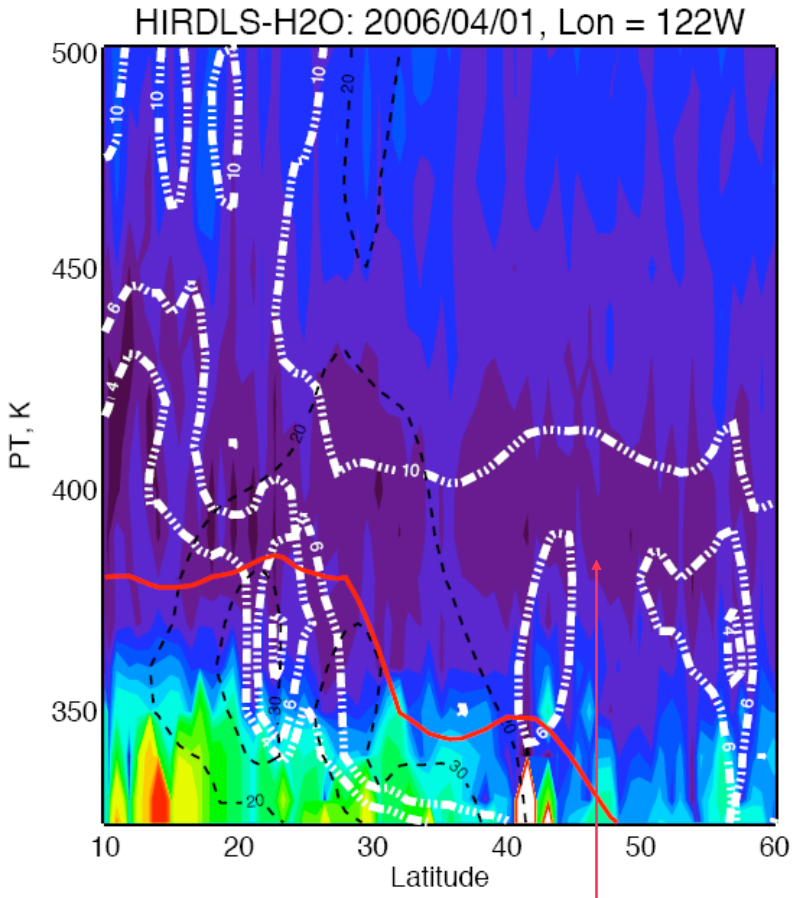


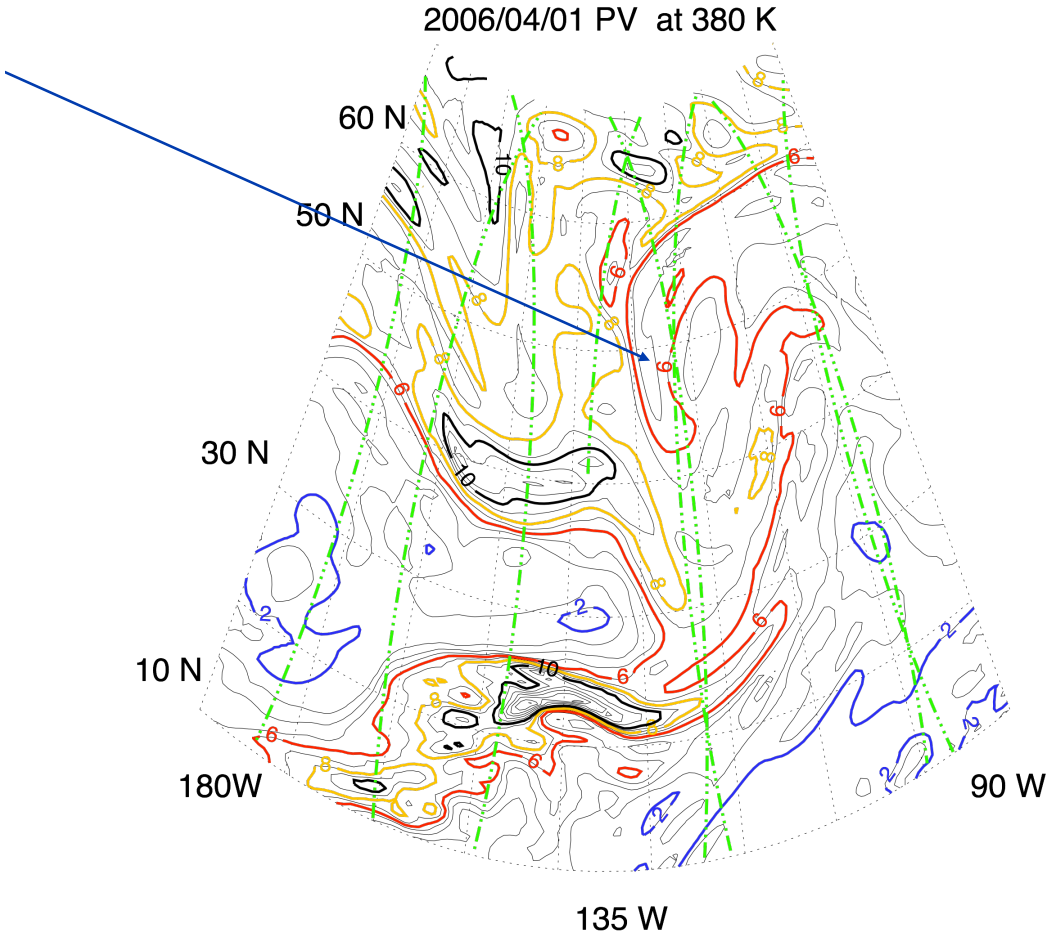
Tropospheric Intrusion Event
1 April 2006



Low Ozone Feature Separates From Troposphere

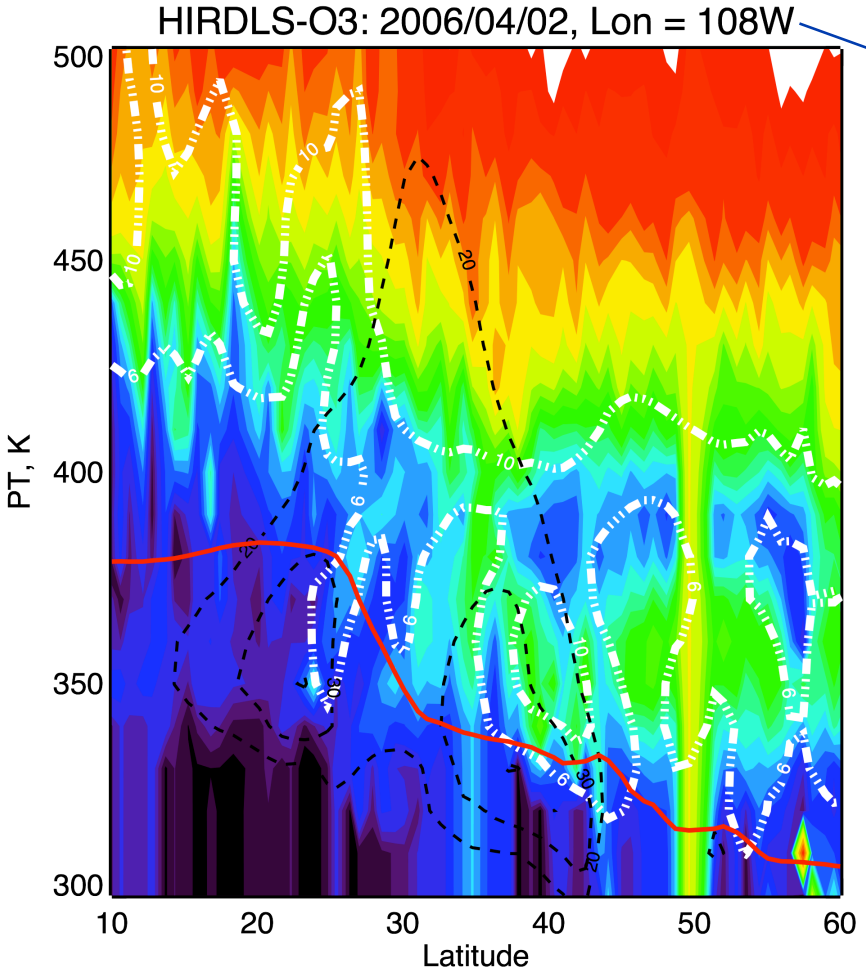
Prototype Water Vapor Cross-sections Agree with Ozone Feature 1 April 2006

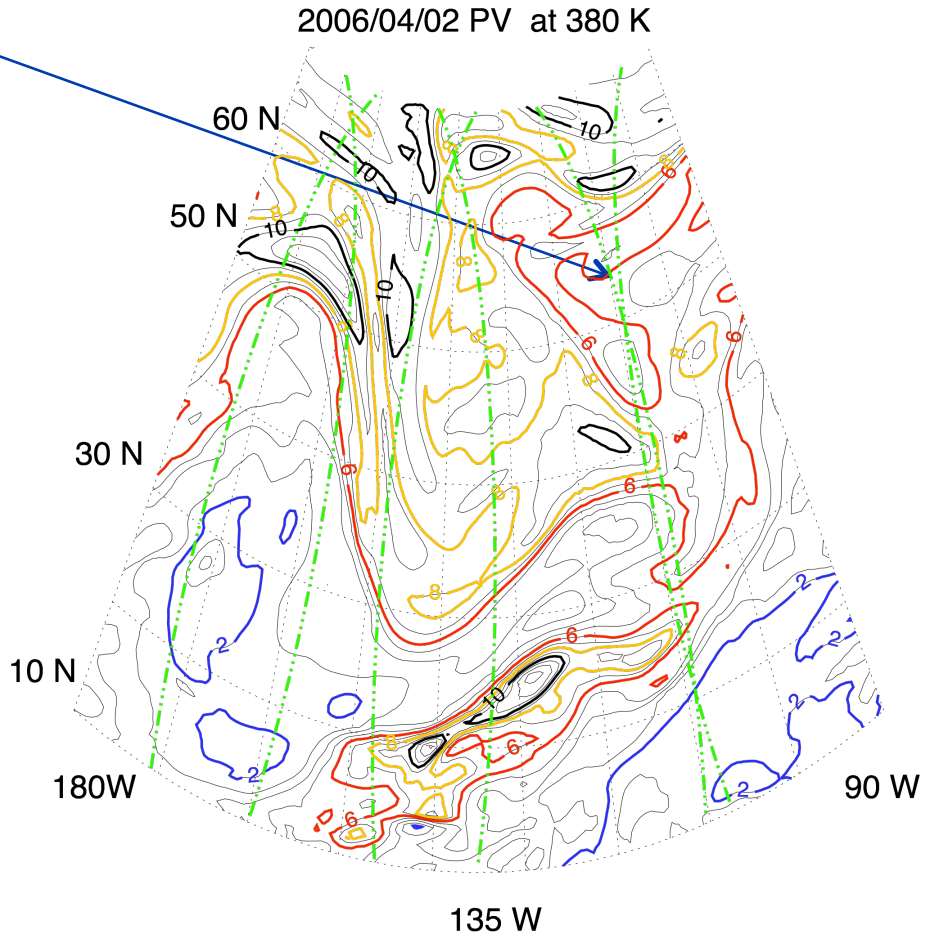




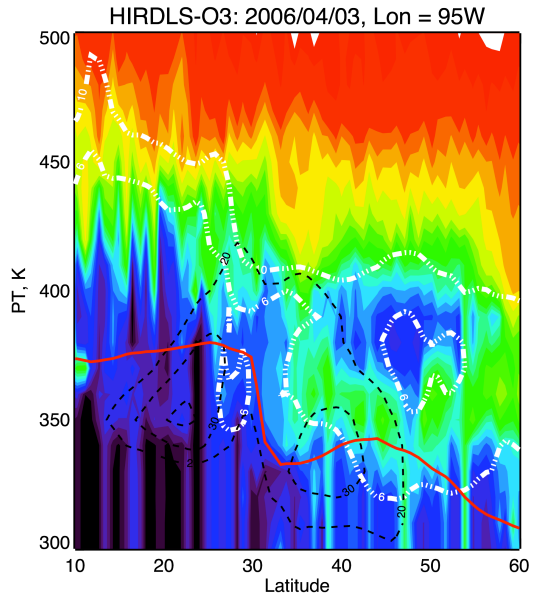
Lowest Water Vapor Mixing Ratios (in same location as Lowest Ozone)

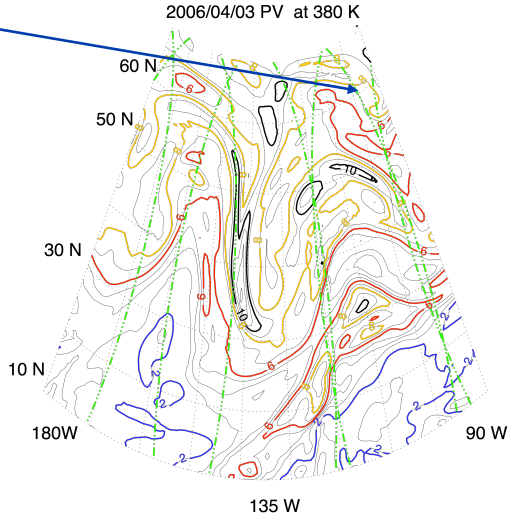
Tropospheric Intrusion Event
2 April 2006

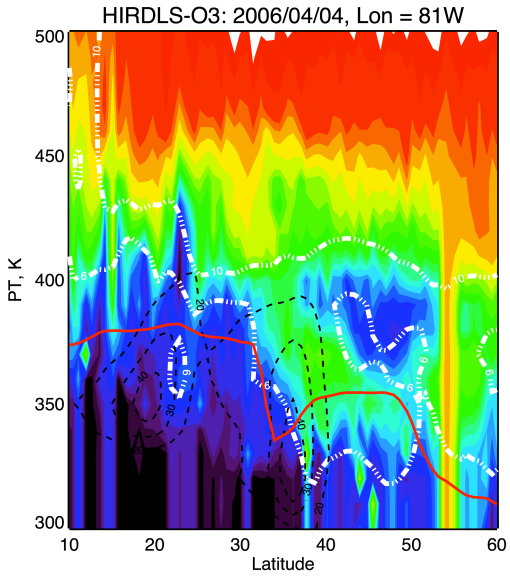


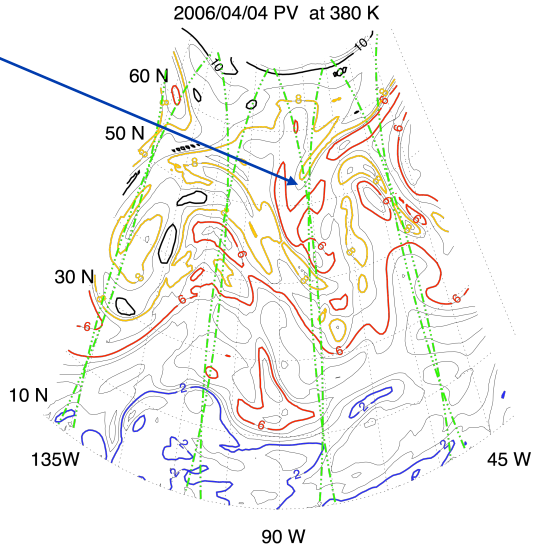


Tropospheric Intrusion Event 3, 4 April 2006



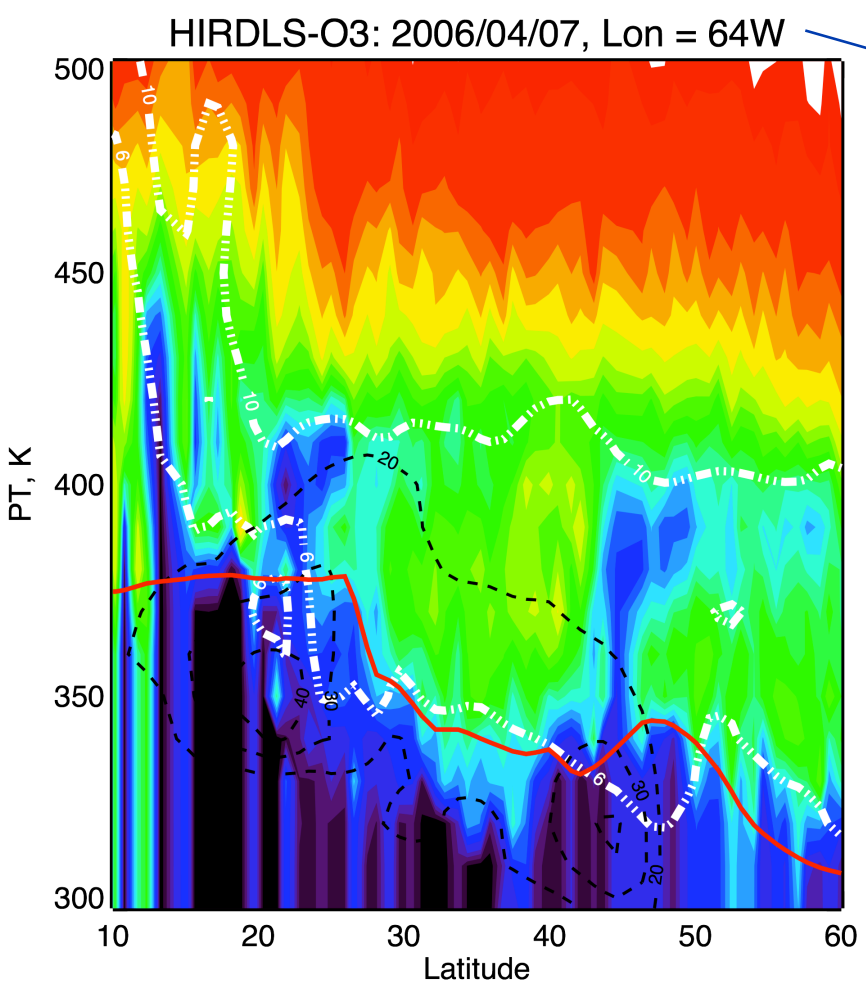


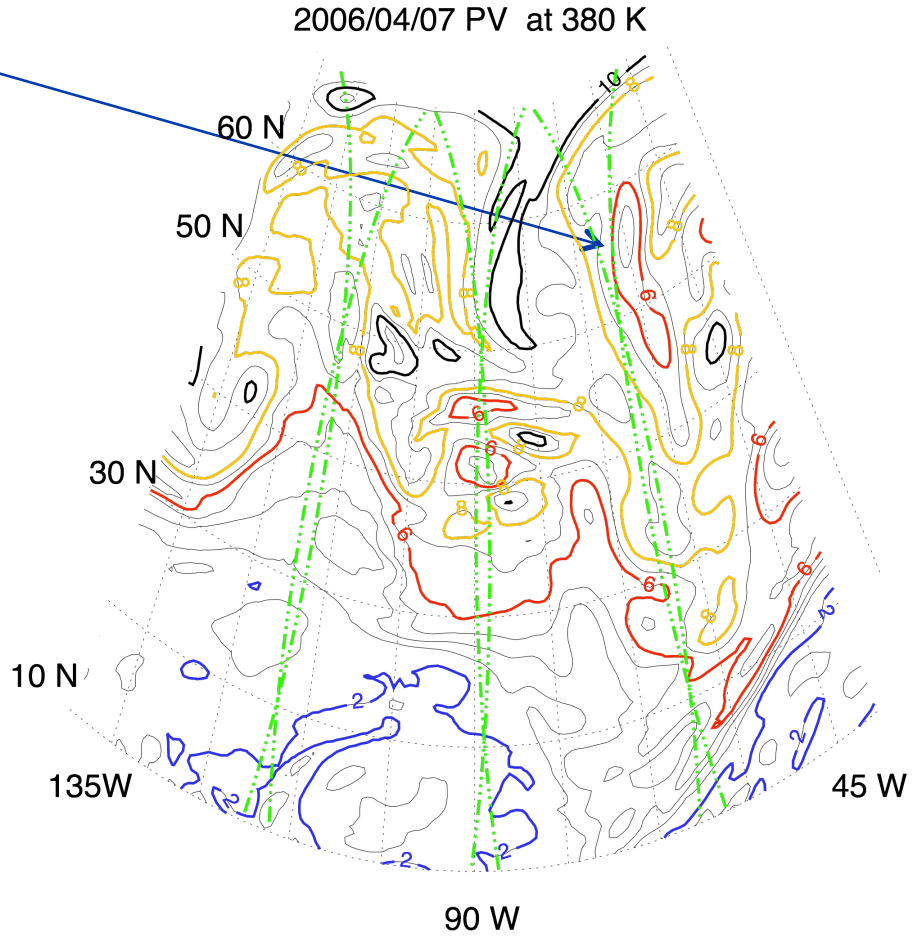




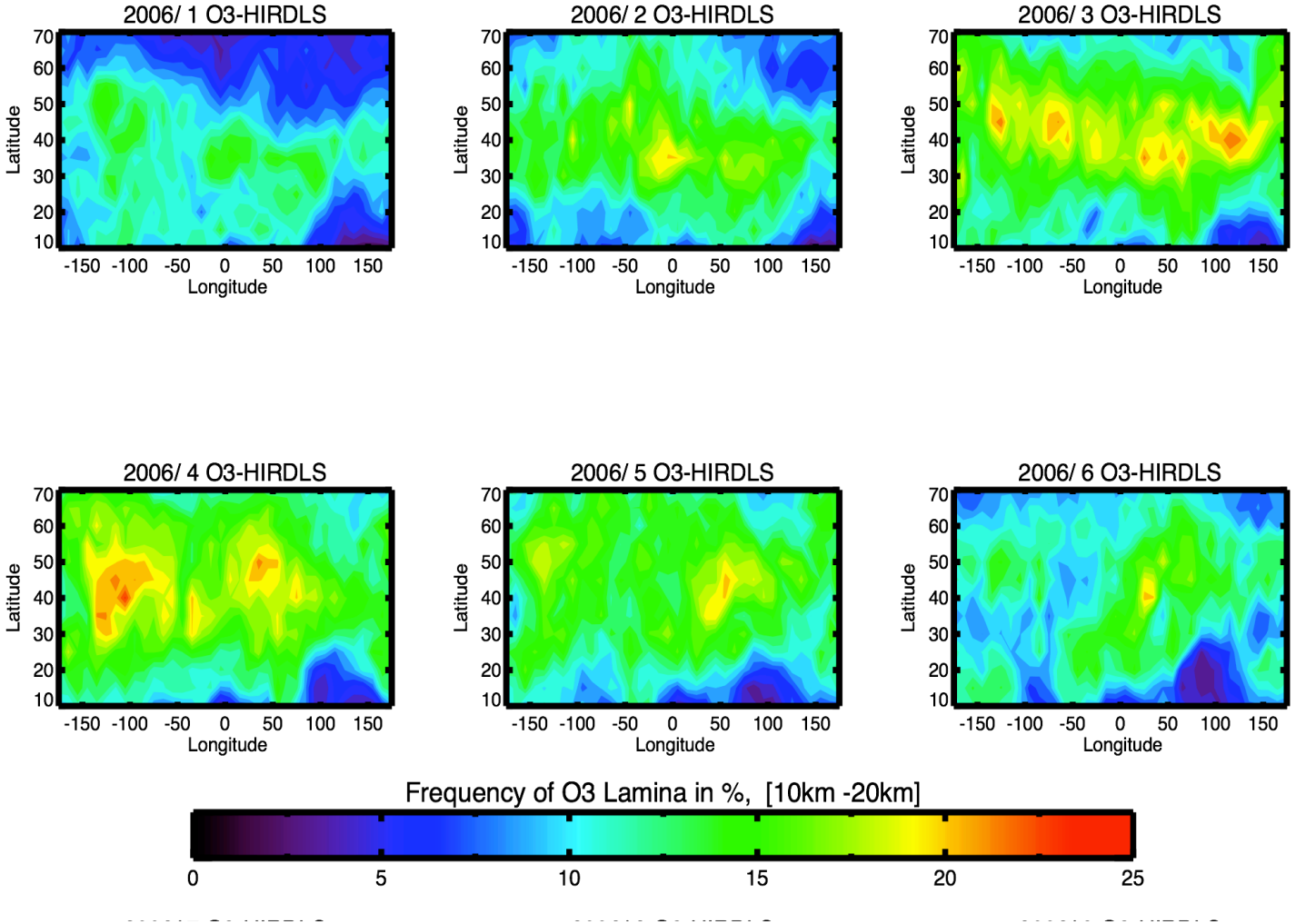
Note Shift of Longitudinal Range

Tropospheric Intrusion Event
7 April 2006

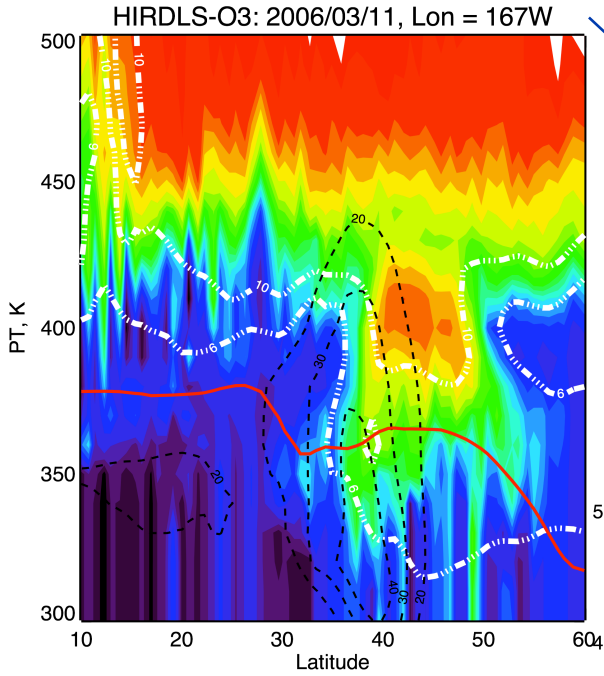


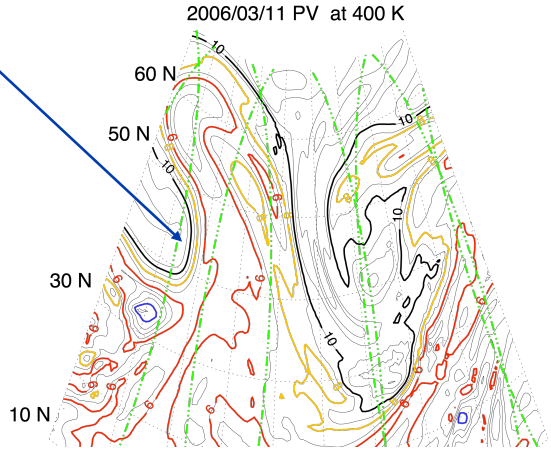


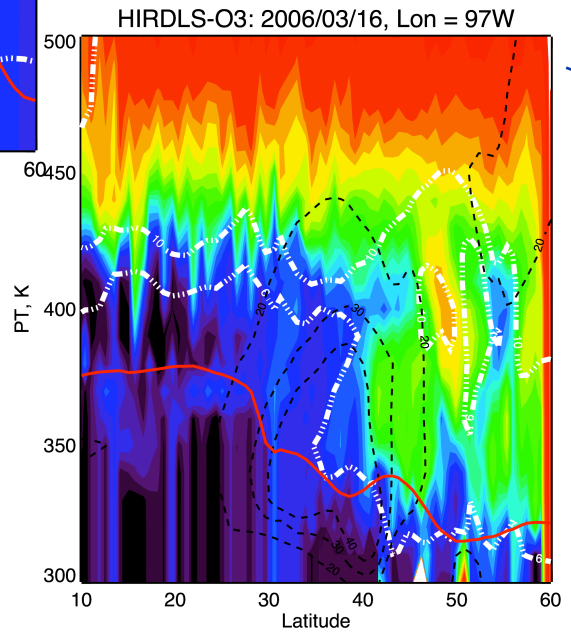
Frequency of Low Ozone Laminae 10-20 km, January-June 2006

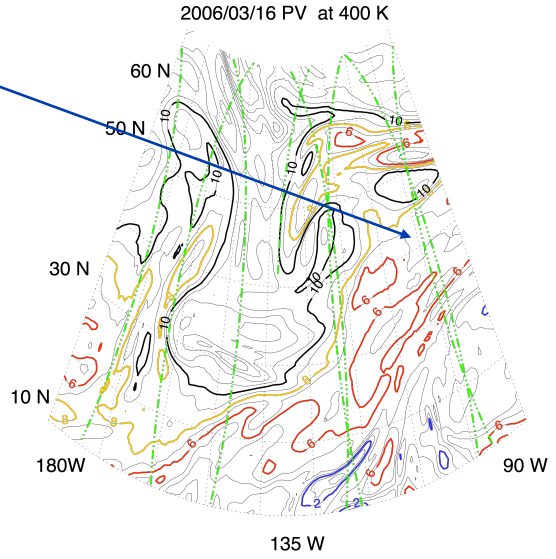


Intrusion of Stratospheric Ozone into Lower Stratosphere









Conclusions

- HIRDLS' vertical and horizontal resolution allows observation of thin layers (laminae) of trace gases in the UT/LS. Orbital spacing and timing gives reasonable sampling of dynamical events
- Maps of PV on θ surfaces show evidence of vigorous stirring and latitudinal transport, matching HIRDLS' observations of laminae with mixing ratios higher or lower than their surroundings.
- Regions of high/low ozone stay within PV contours for several days before PV may relax to the surroundings, while ozone does not.
- The frequency of these laminae increases through the winter, reaching a maximum in April, consistent with the frequency of baroclinic eddies. They are much less frequent in the summer and autumn.