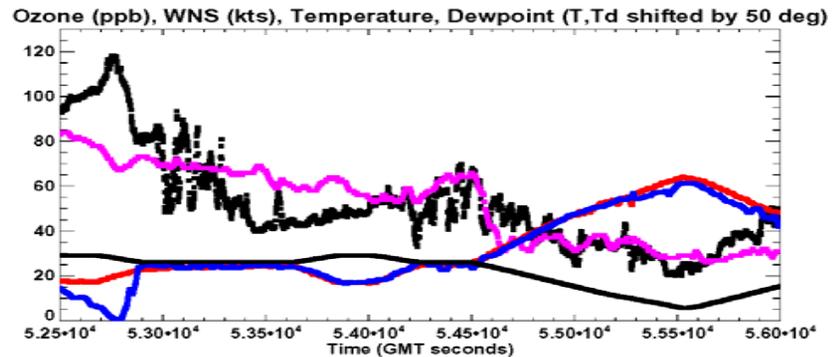


# Langley In Situ Fast-Response Ozone Measurements (FASTOZ)



Melody Avery, James Plant, Charles Hudgins

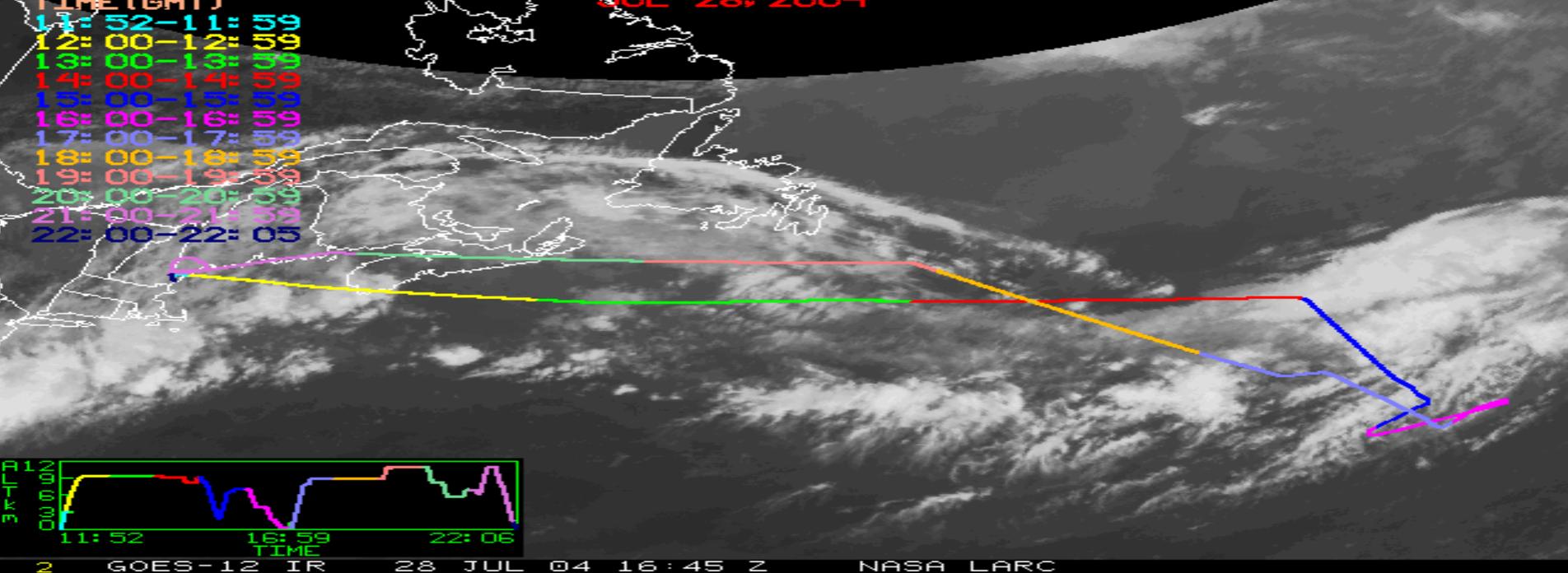
# Ozone Instrument Specifications (INTEX Phase A – DC-8)

- Technique: Chemluminescent reaction of ozone with nitric oxide
- Dynamic Range: 0.6 - 1600 ppb
- Accuracy: 5% or 2 ppb
- Precision: 2% or 0.6 ppb
- Response: 2-3 Hz; recorded at 6 Hz, reported at 1 Hz, faster data on request
- Spatial Resolution: <10 m vertical (aircraft spiral), 200 m horizontal (at 400 kts)

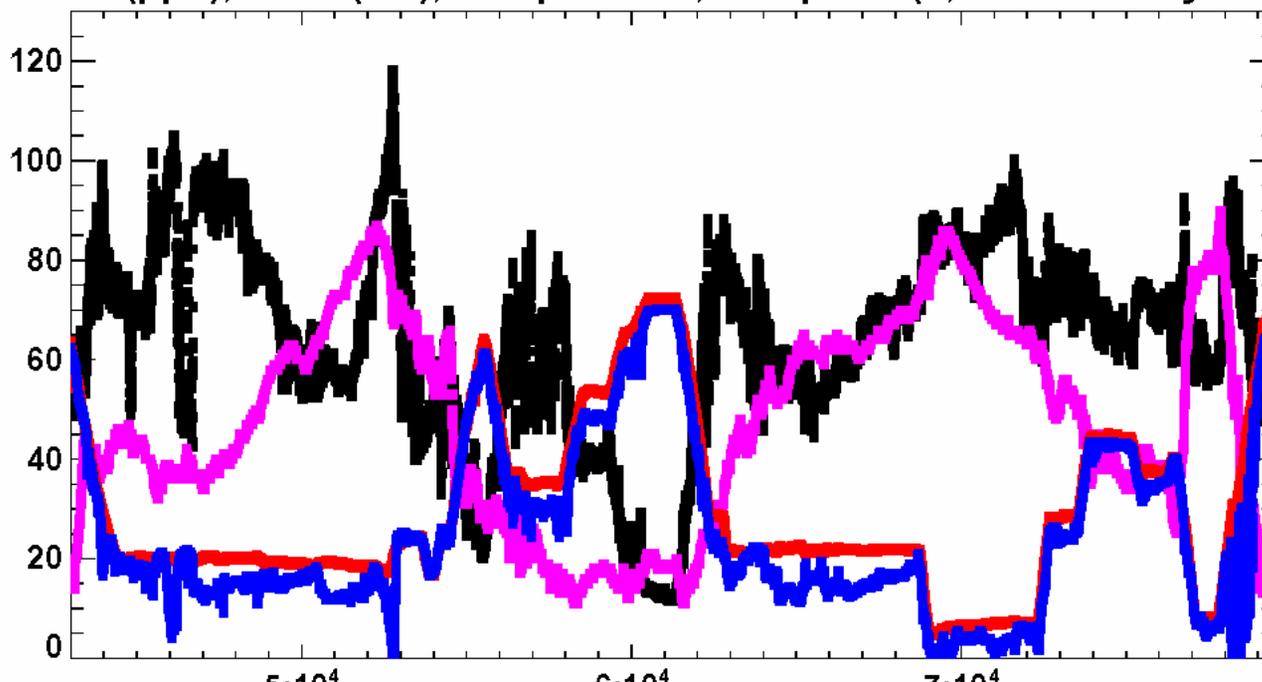
# In situ Ozone INTEX Calibration Statistics



- Slope = 46.187 ppb/volt; offset = 178 ppt; (disregard the offset – smaller than the LOD).
- 1 sigma “noise” is 0.33% measured value at top of range; 1 sigma slope = 0.66%
- Largest residual error = 1.3% at ~400 ppb
- Water vapor correction multiplier  
 $1 + 0.000007965 * wvmr(j)$  ( $wvmr(j)$  = Glenn Diskin’s DLH water vapor mixing ratio).



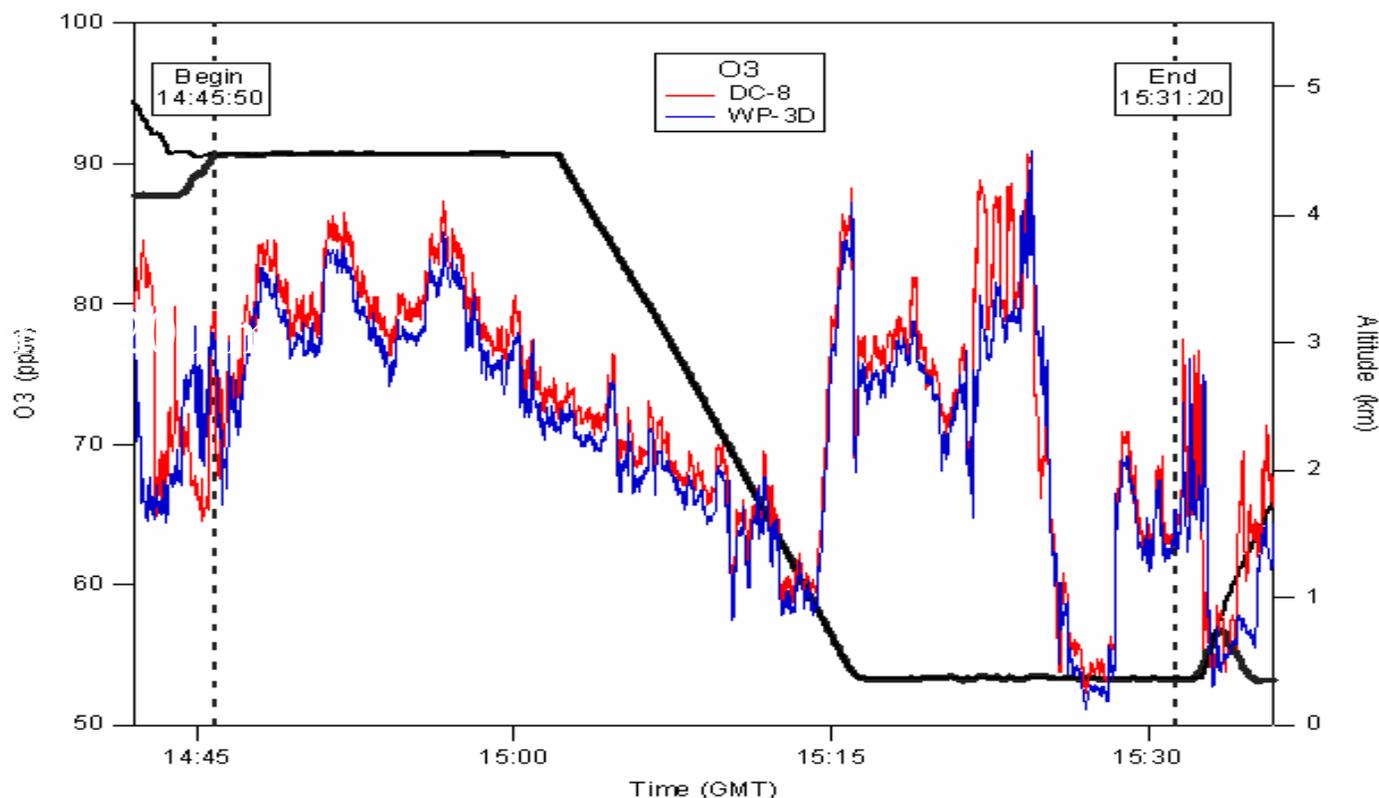
Ozone (ppb), WNS (kts), Temperature, Dewpoint (T,Td shifted by 50 deg)



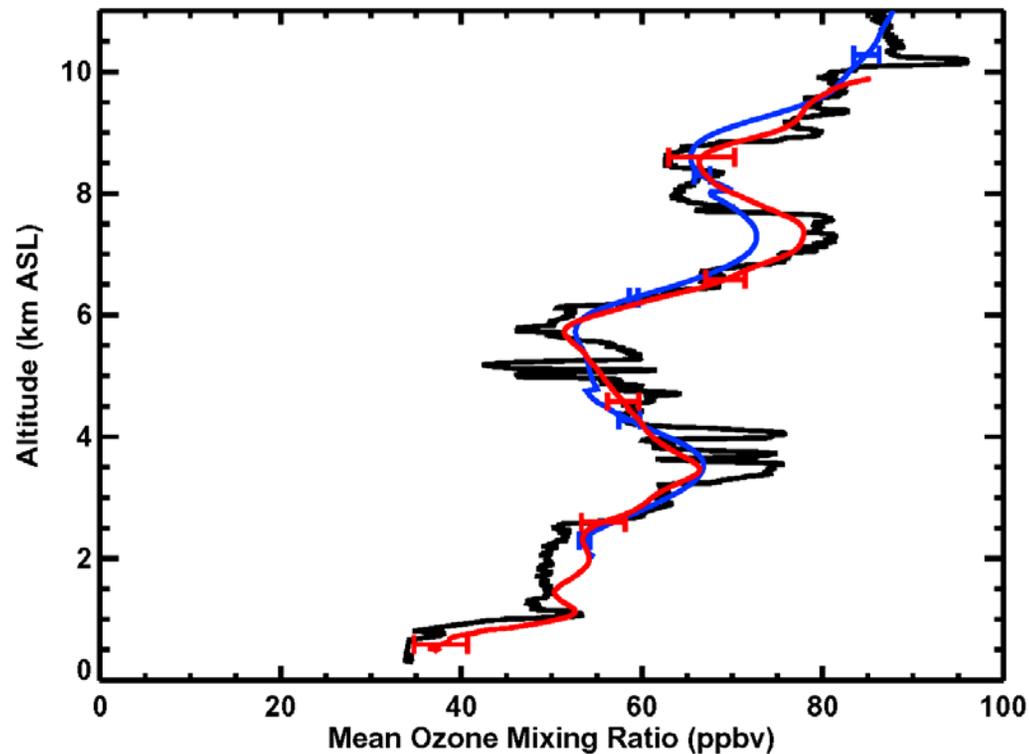
# AVE Science Question we hope to answer with FASTOZ data:

- What is the horizontal and vertical variability of ozone in the lower stratosphere, tropopause, and middle to upper troposphere?
- What is the impact of sub-model grid scale processes on inhomogeneity and on ozone profiles retrieved from AURA instruments?
- Can geophysical synoptic-scale markers be used to locate areas with relatively large inhomogeneity?

In situ ozone data from the **NASA DC-8 (red)** and the **NOAA P3-B (Tom Ryerson, NOAA Aeronomy Lab - blue)** at 1 second time resolution, measured while the two planes flew side-by-side on July 22, 2004 during INTEX-A. The excellent correlation of measurements from two different airplanes at this resolution suggests that both instruments have a true 1-Hz response time to atmospheric ozone fluctuations.



In situ ozone (black) and DIAL lidar ozone (Edward Browell, LaRC, blue – zenith, red – nadir) profile measurements during an INTEX-A TERRA under flight at 15 Z on August 11, 2004.



$\Delta v = 600\text{m}$

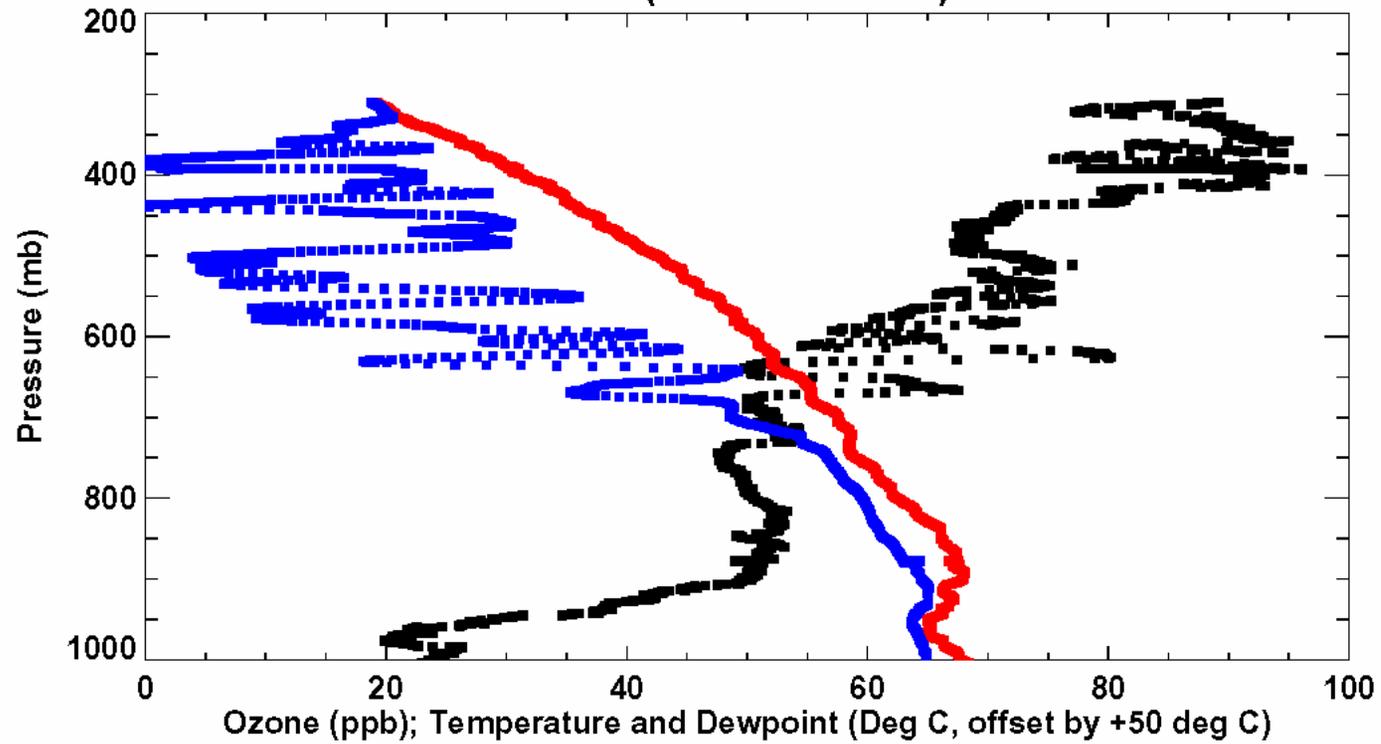
$\Delta v = 300\text{m}$ ,

$\Delta h = 36\text{ km}$

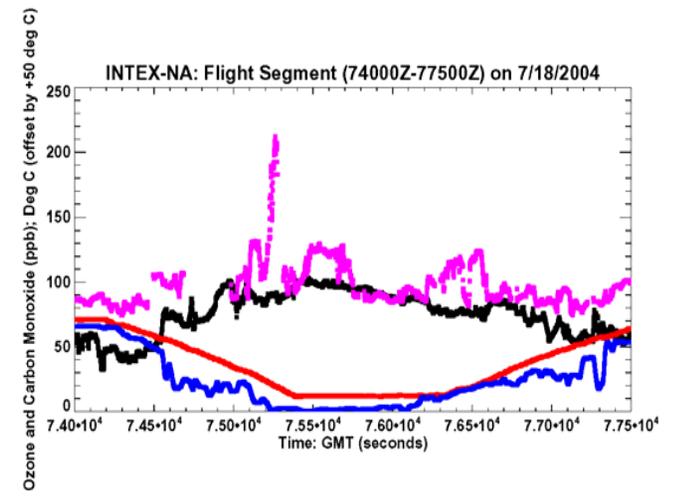
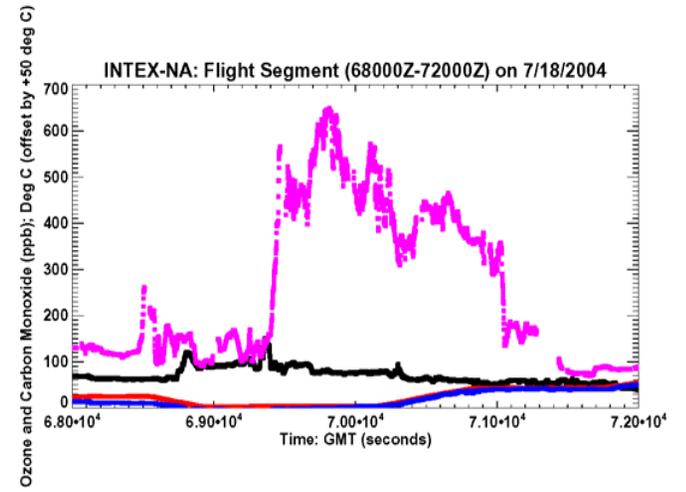
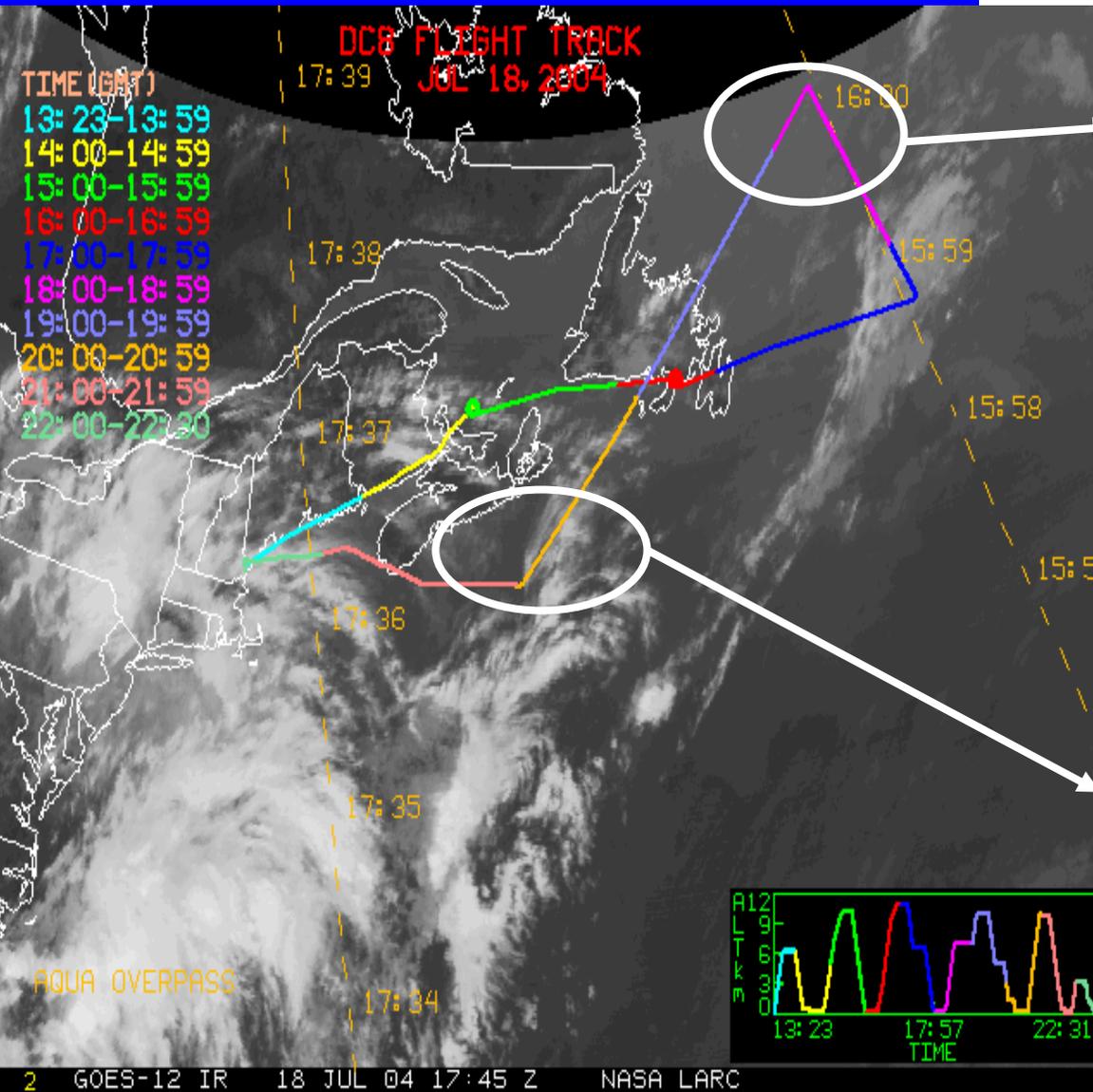
$\Delta v = 15\text{ m}$ ,

$\Delta h = 225\text{ m}$

### INTEX-NA: Profile (78000Z-79500Z) on 7/28/2004

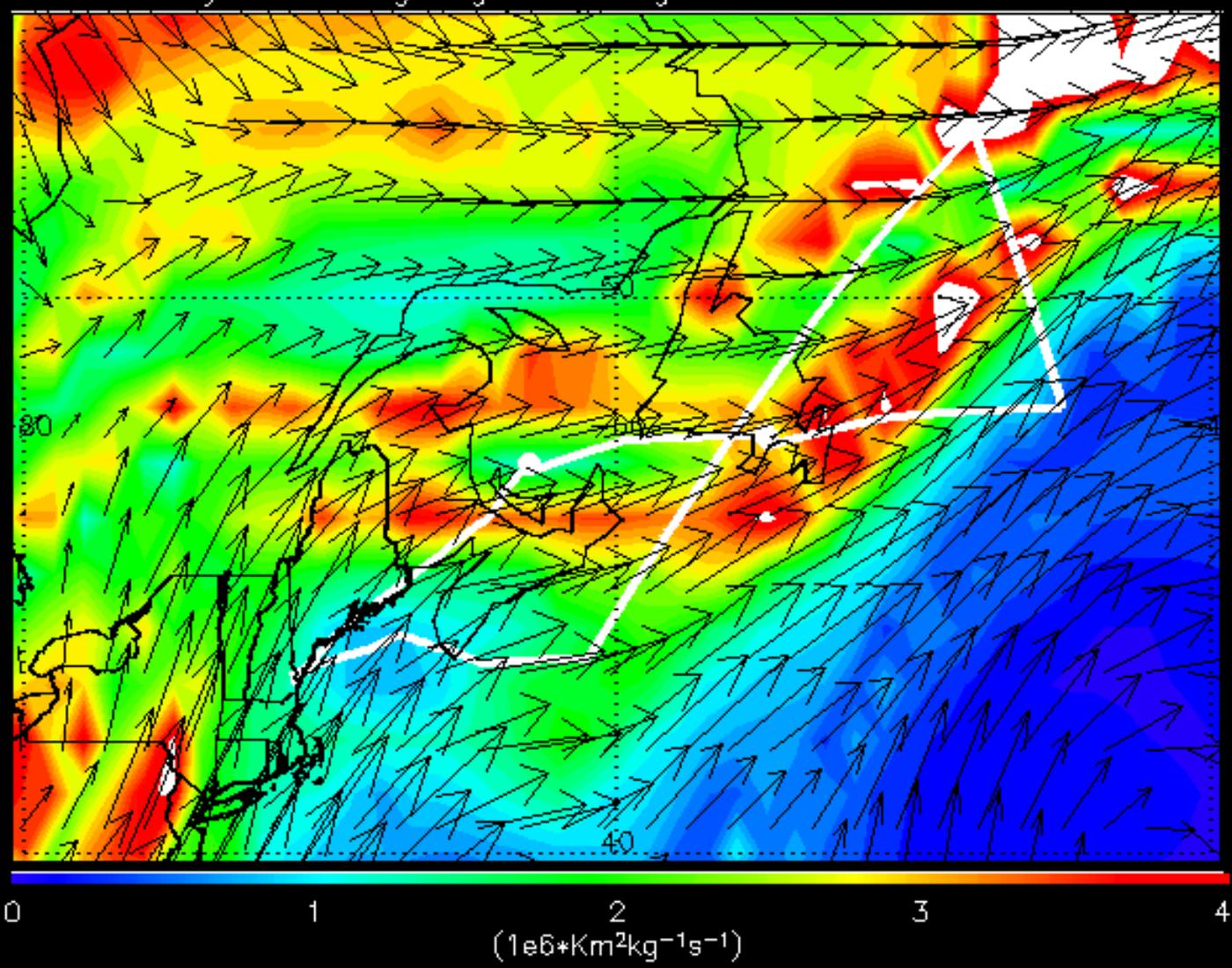


# Flight 9 on July 18, 2004: DC-8 In Situ Ozone, CO, Dewpoint and T data Sachse, Avery, Barrick



5-day 340K\_Lagrangian Averaged PV

18Z 20040718



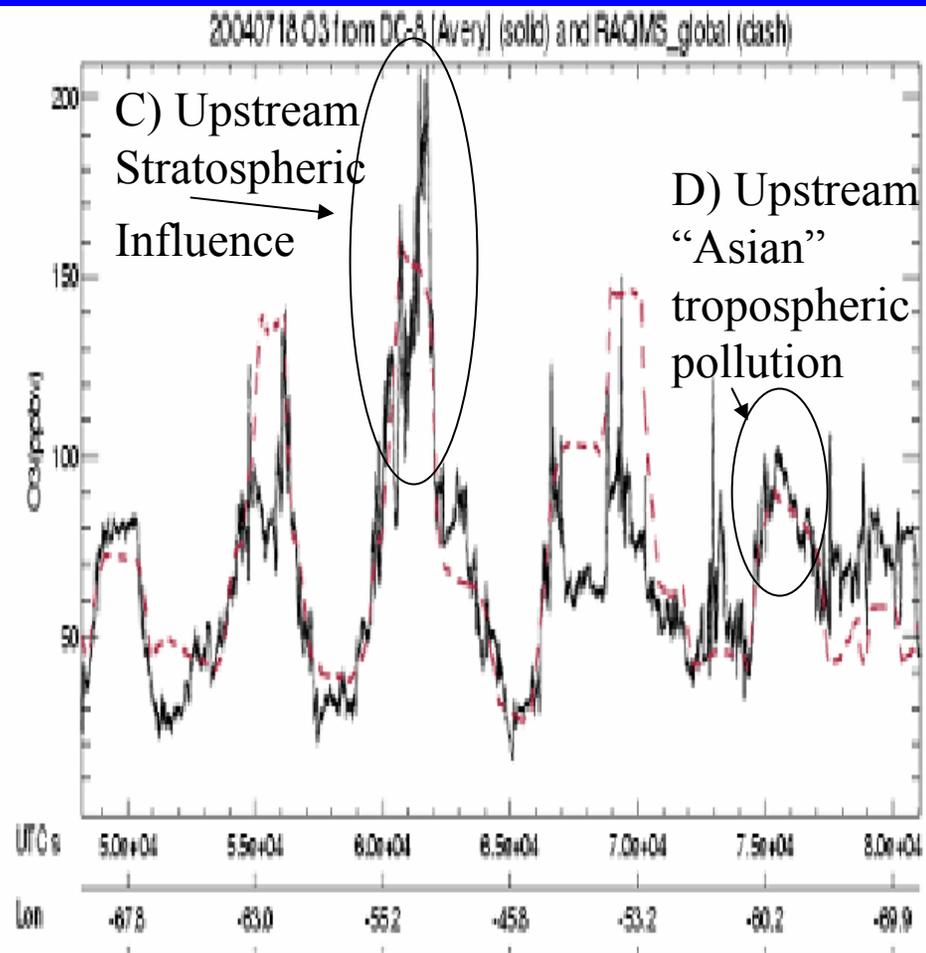
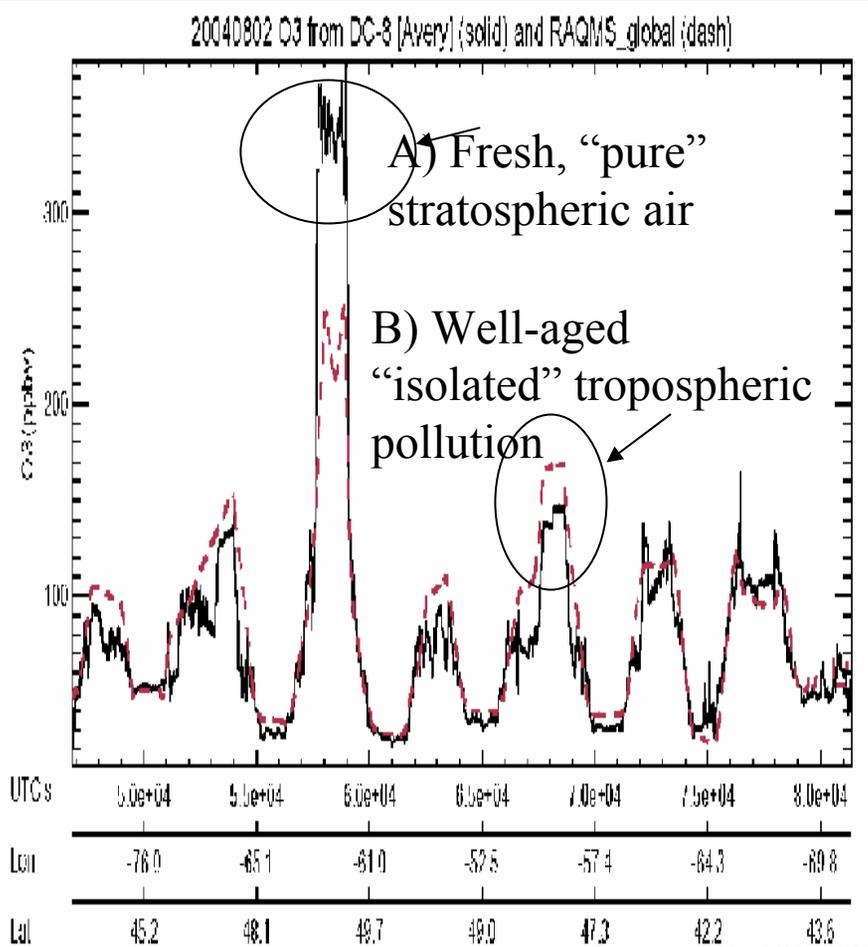
# The Upper Troposphere During INTEX-A: a Combination of Stratospheric and Tropospheric Influences

**Question: How much of the ozone we observe in the Upper Troposphere (above 500 hPa) is produced by photochemistry (anthropogenic) or from Strat.-Trop. exchange (natural) ?**

**What we need to know to answer the “big” question:**

- How do we tell the difference between Strat. and Trop. air?
- How “fresh” are the contributions from each source?
- How much mixing has taken place between them?
- Is there any unusual chemistry going on at the interfaces between stratospheric and tropospheric filaments?

# In Situ Ozone Time Series: Data From 4 DC-8 Flight Segments at 250 hPa

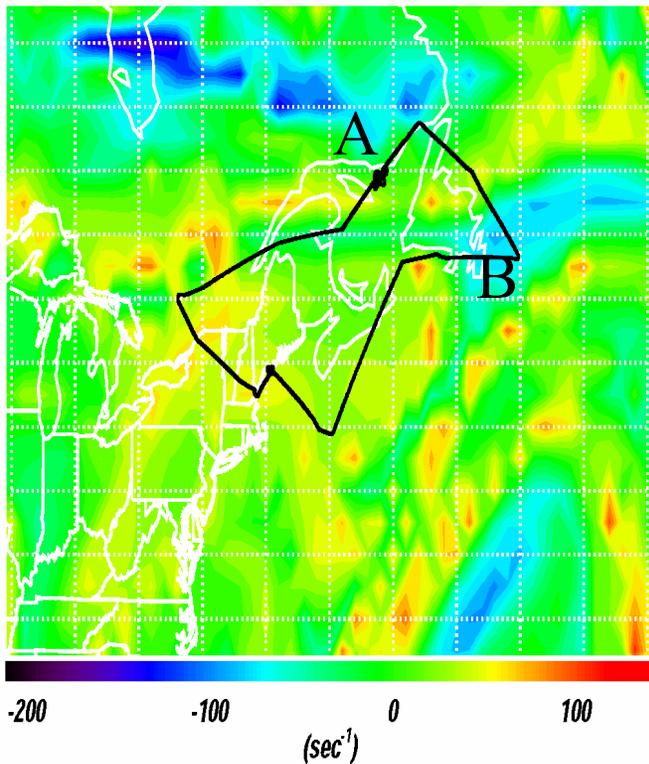


08/02/2004: More Distinct

07/18/2004: More Mixing

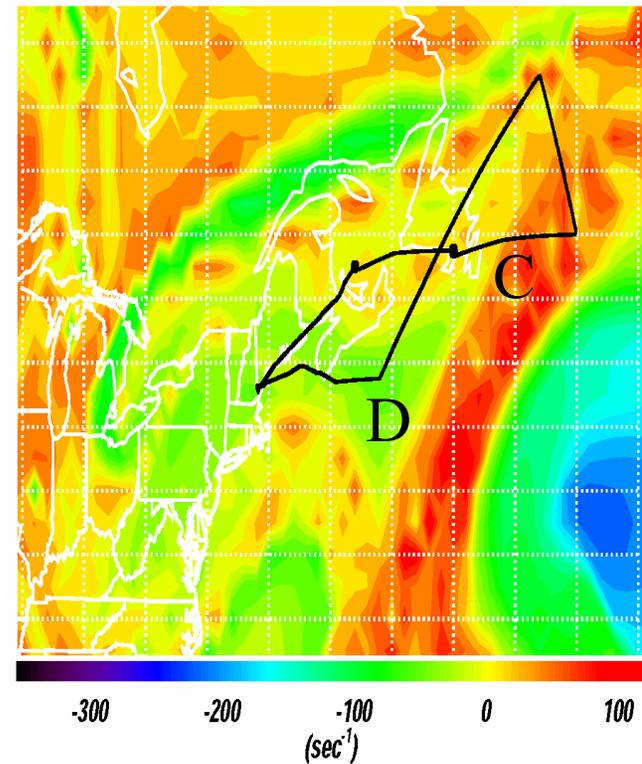
# Mixing Diagnostic from the Langley RAQMS, Averaged over Five-Day Back Trajectories

RAQMS<sub>c</sub> 350K Lagrangian Averaged Mixing 2004080218



More distinct (blue, mixing neg.)

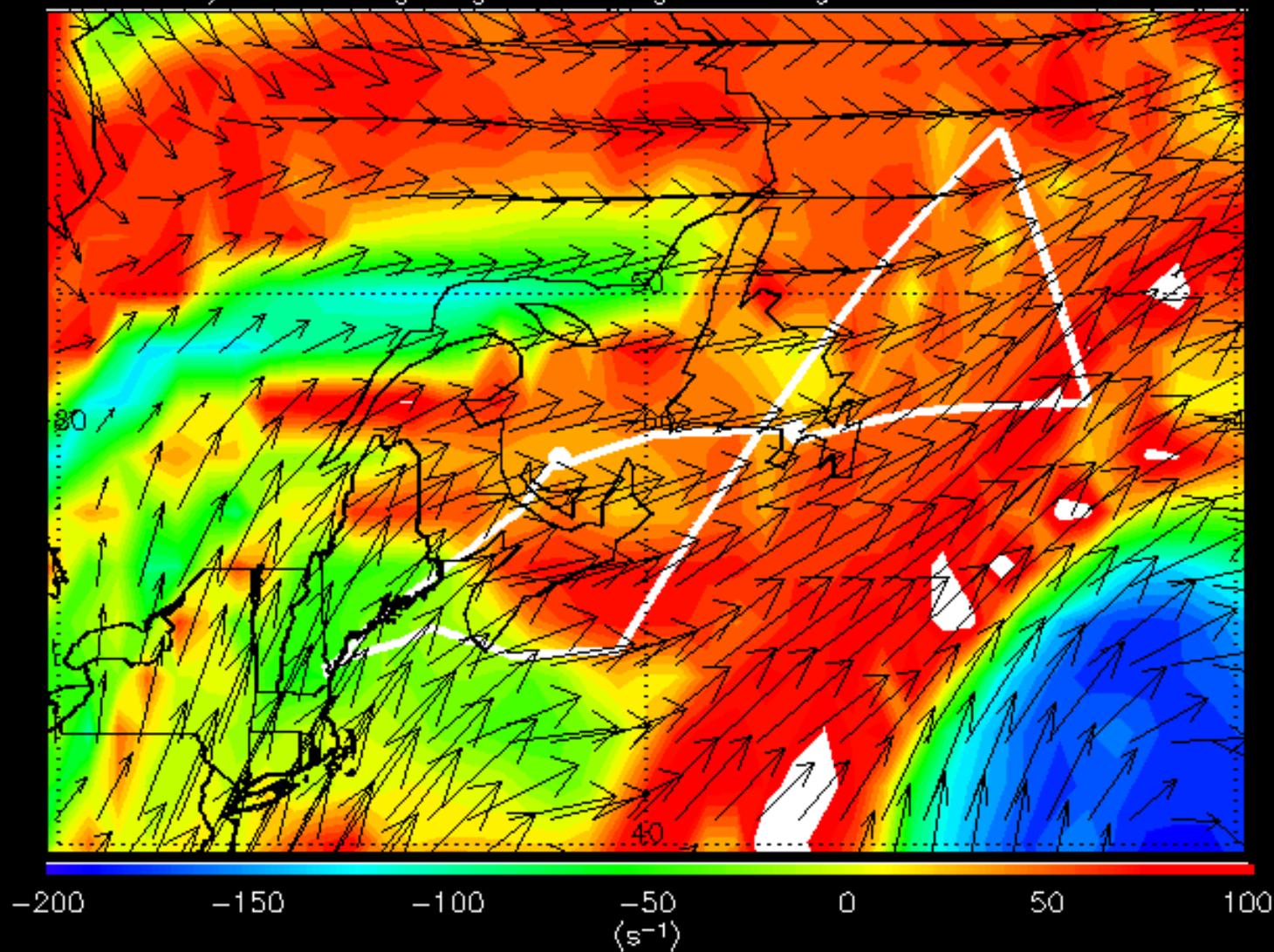
RAQMS<sub>c</sub> 350K Lagrangian Averaged Mixing 2004071818



More mixing (red, mixing pos.)

5-day 340K\_Lagrangian Averaged Mixing

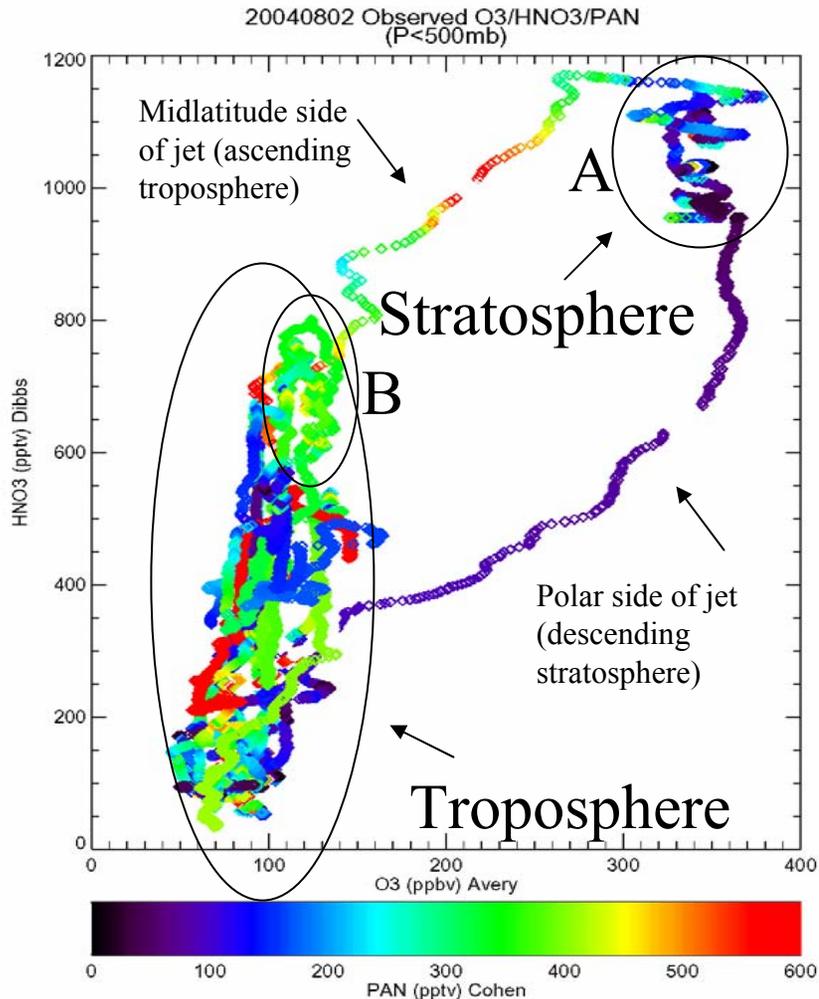
18Z 20040718



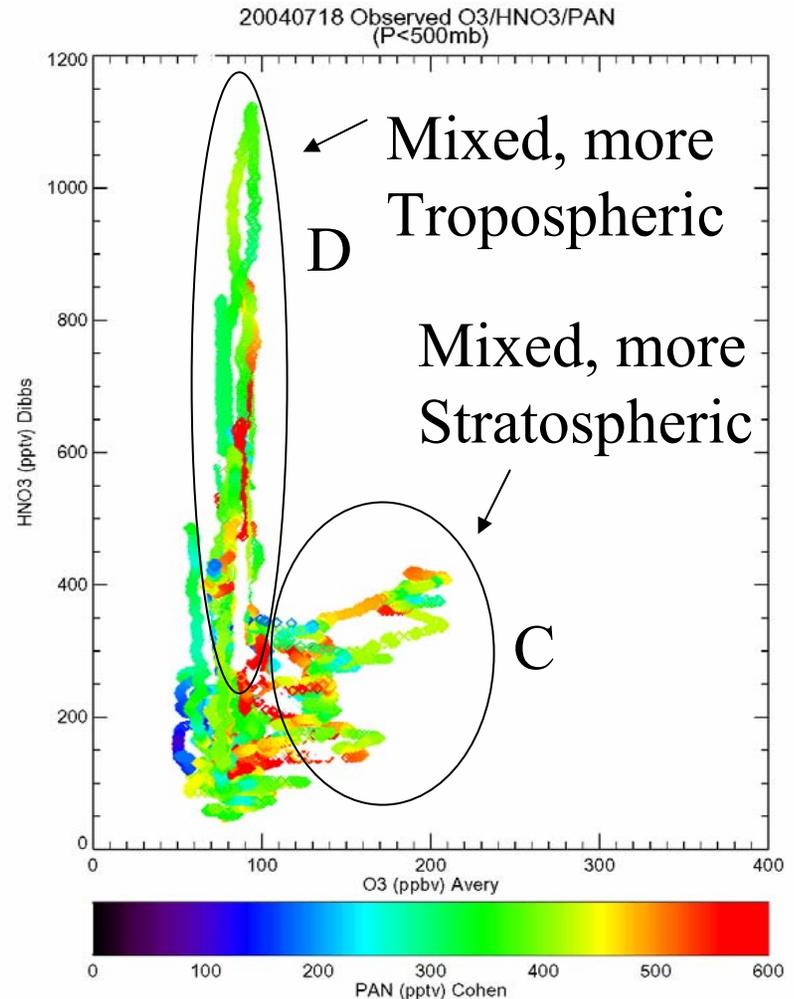
# Nitric Acid – Ozone Correlations, Colored by PAN:

- Large stratospheric source for Ozone, Nitric Acid (soluble)
- PAN is a long-lived Upper Tropospheric Pollutant

## Distinct :

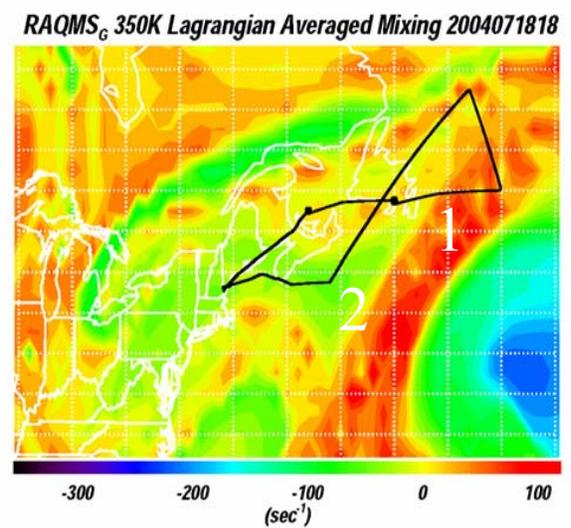
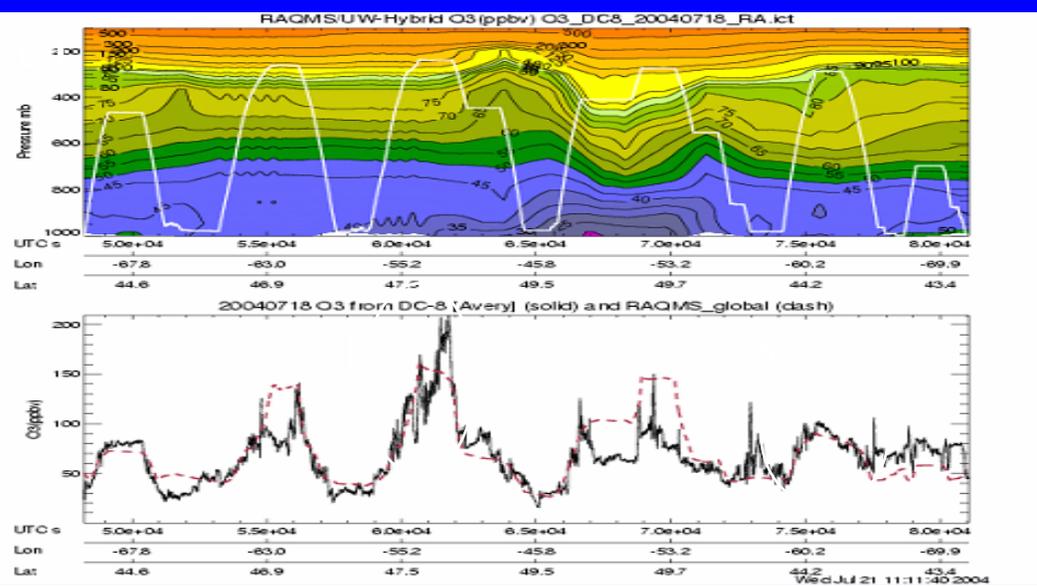
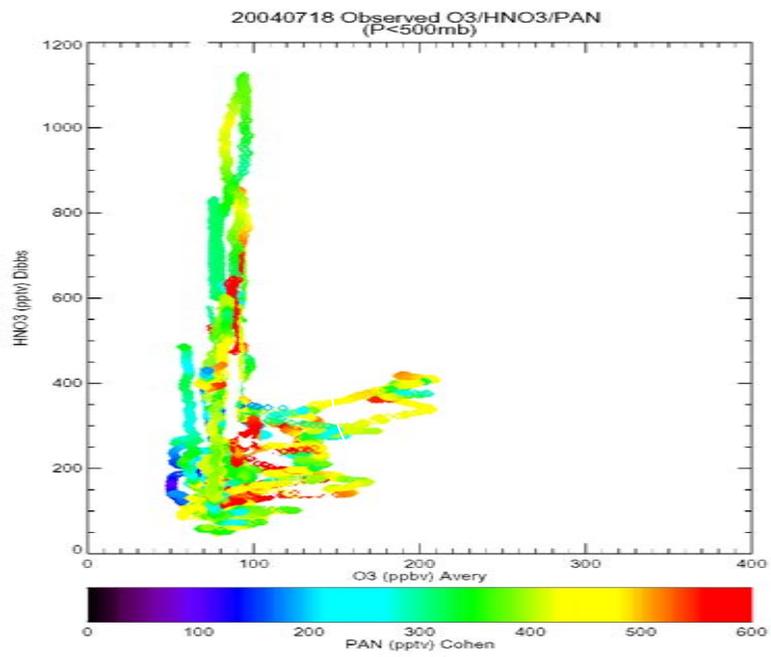
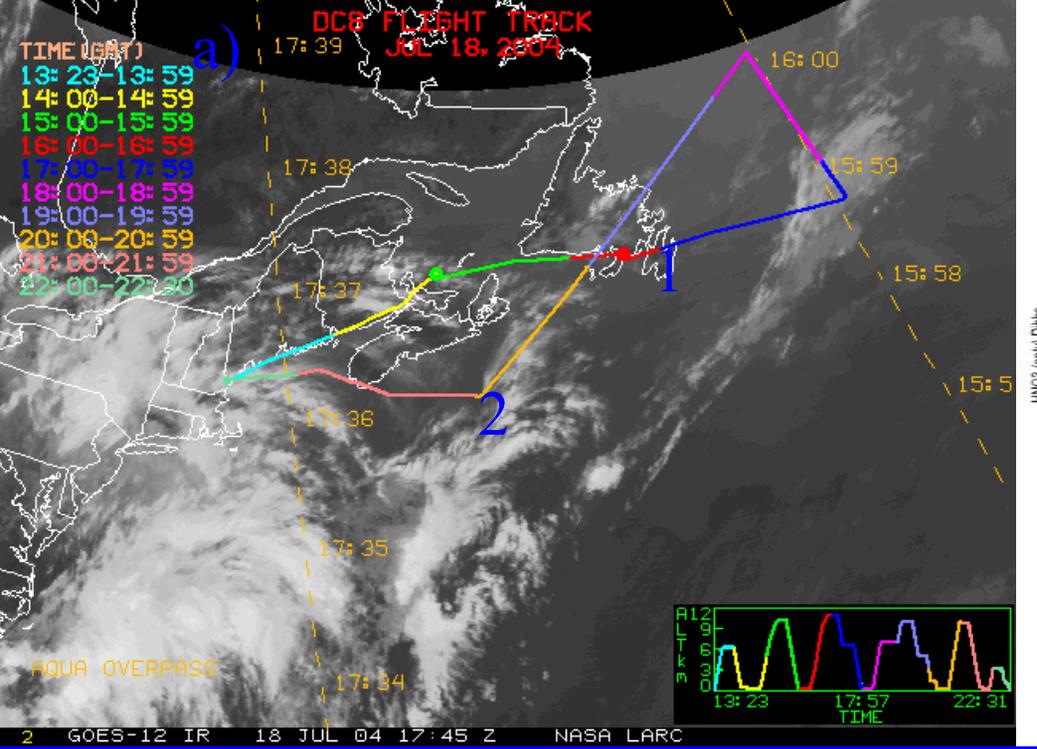


## Well-Mixed and Aged :

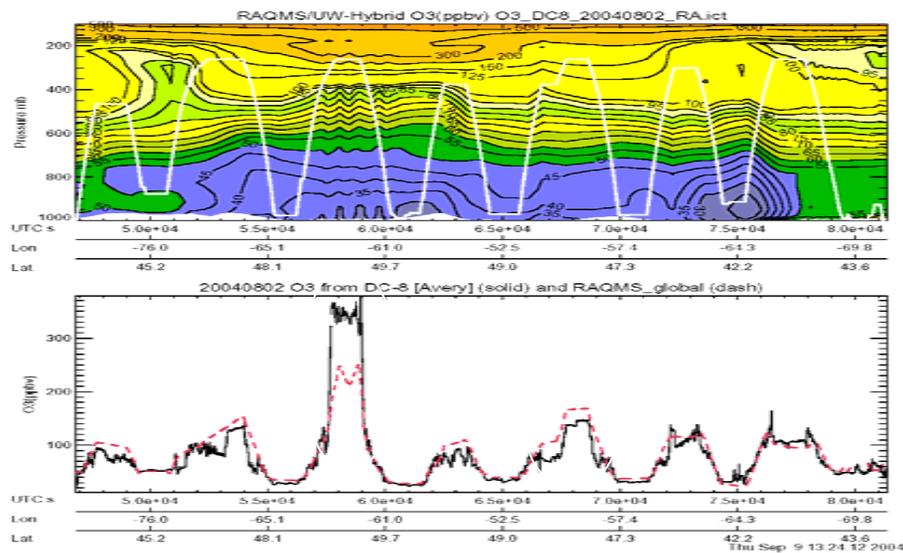
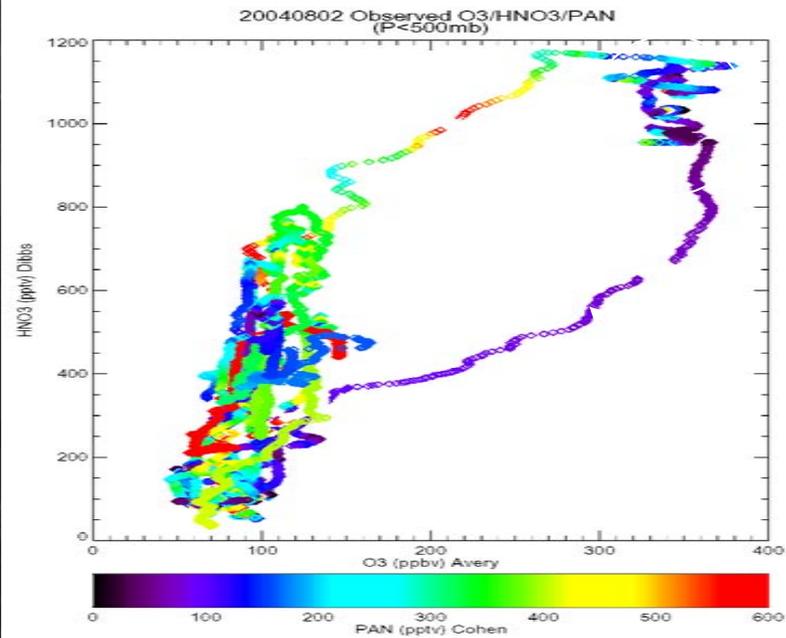
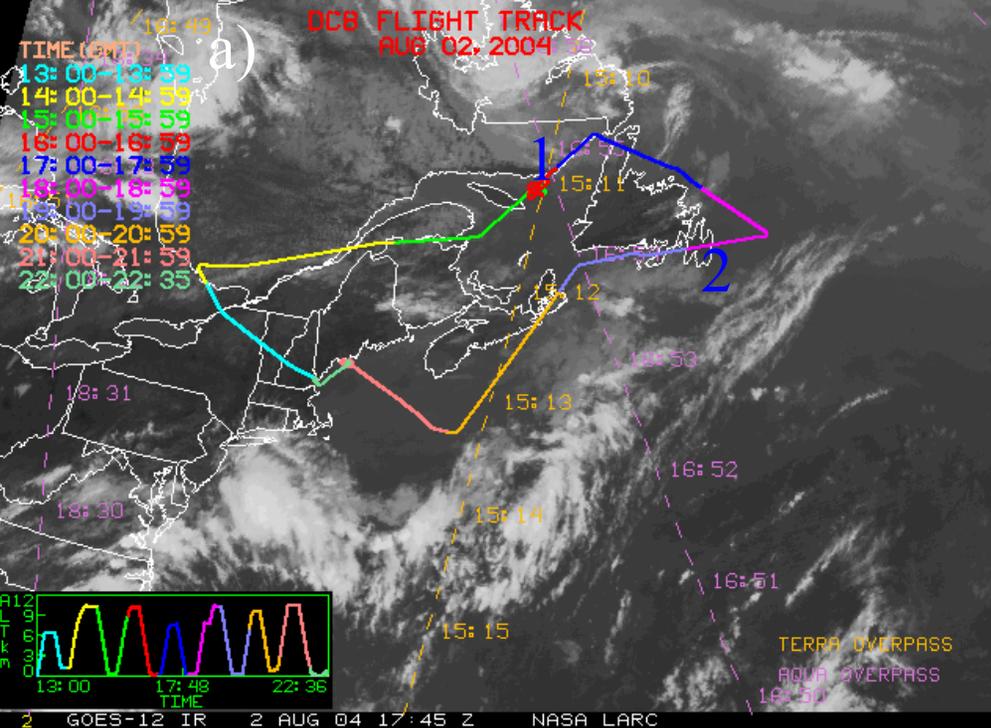


## Summary:

- Ozone instrument functioned well during INTEX-A
- Max ozone = 447 ppb (stratospheric),  
Min ozone ~ 11 ppb (cold marine boundary layer – fish ate it?)
- Upper troposphere appears to be a complex mixture of stratospheric and internationally polluted tropospheric air with fire signature (in ozone?)



**Figure 3: DC-8 Flight on July 18, 2004 during INT**



RAQMS<sub>c</sub> 350K Lagrangian Averaged Mixing 2004080218

