TES-ozonesonde comparisons: Case studies from Costa Rica AVE, ARM-SGP and IONS, 2006

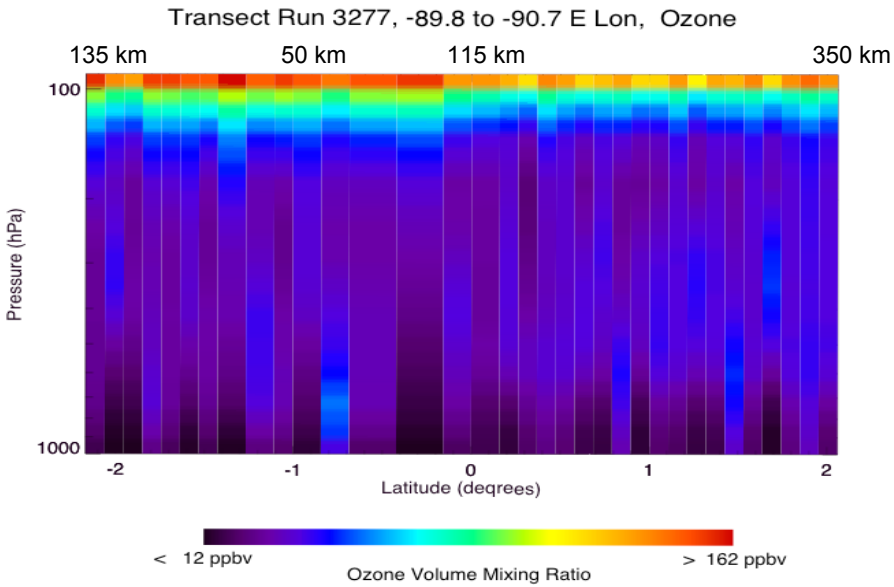
1. Use of ozonesondes in diagnosing TES calibration/retrieval errors.

2. How do we develop coincidence criteria for statistically-challenged sonde comparisons that let us determine TES-sonde biases for O3 as a function of pressure and latitude?

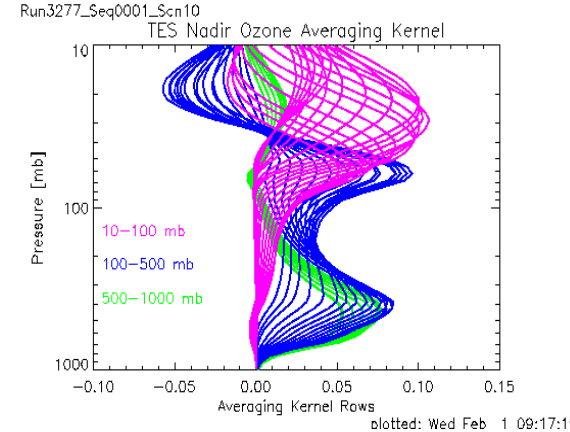
H. Worden, G. Osterman, R. Herman, JPL

Mexico City from the NASA DC8 aircraft , February 2006
Cameron McNaughton, University of Hawai`i

Galapagos (San Cristobal) comparisons

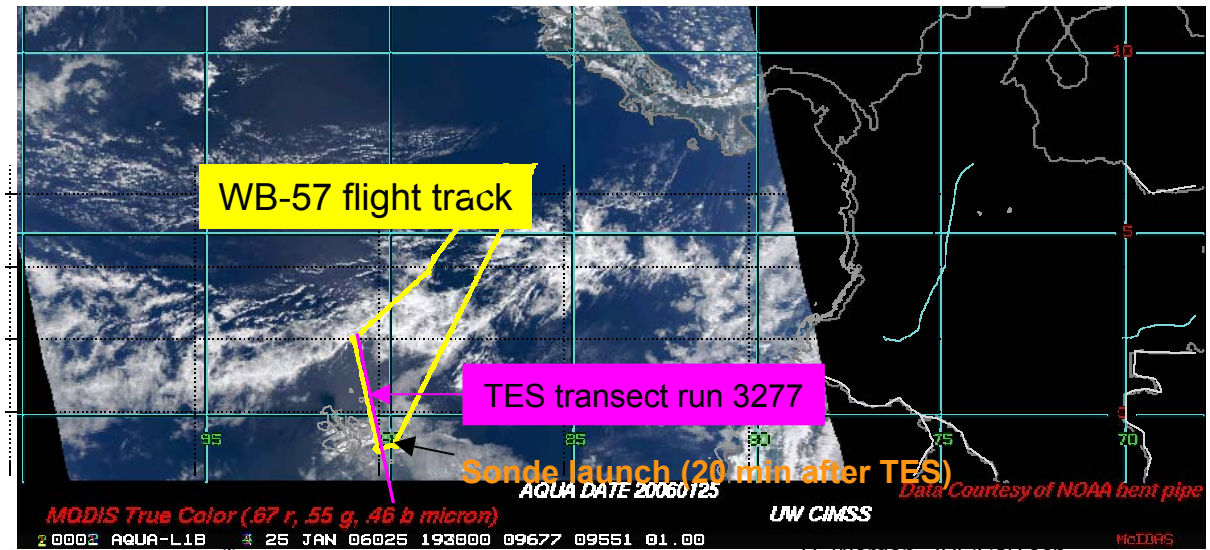


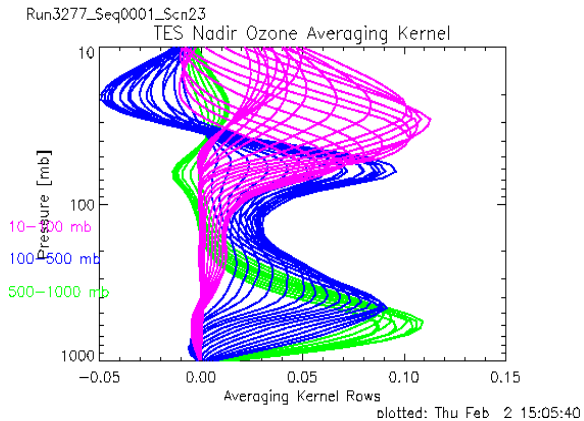
TES O3 Retrievals
DOFs = 2.7 to 3.5



AK for scan with cloud at 833 mb

25 Jan 2006. Aqua MODIS Visible RGB image

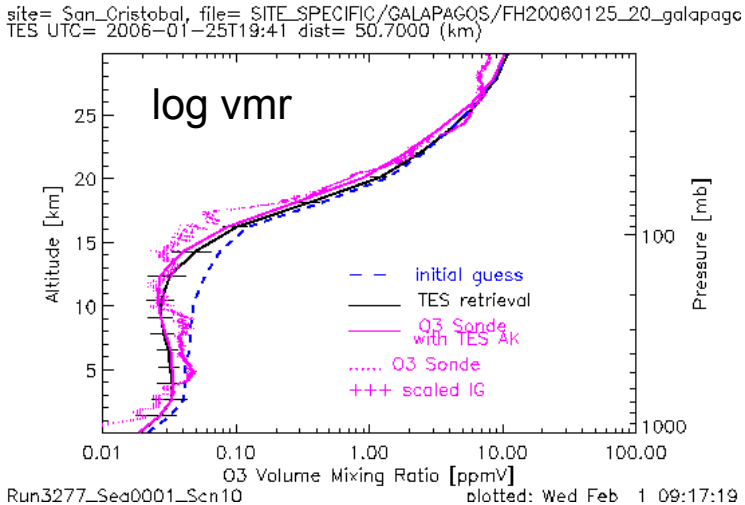




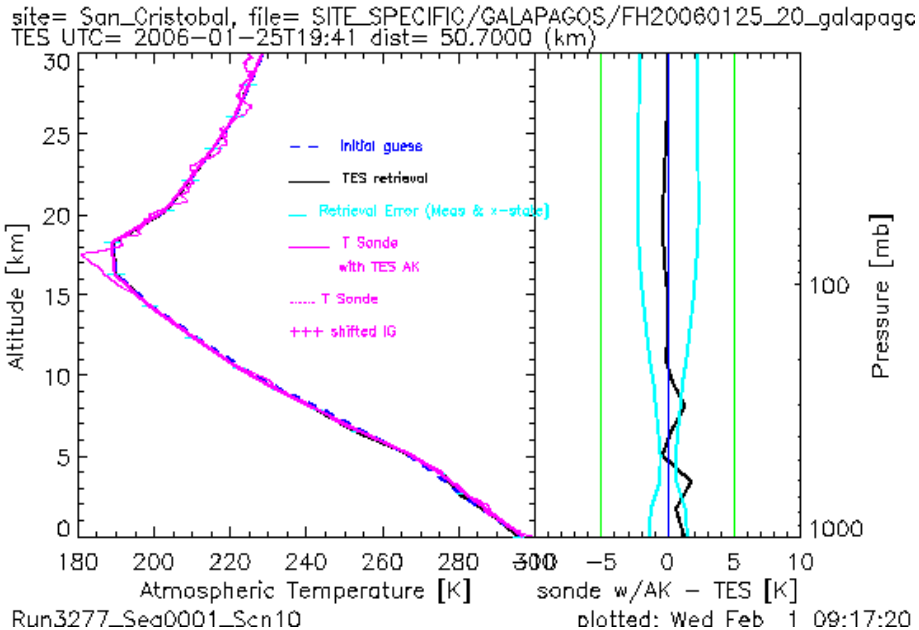
AK for no-cloud case

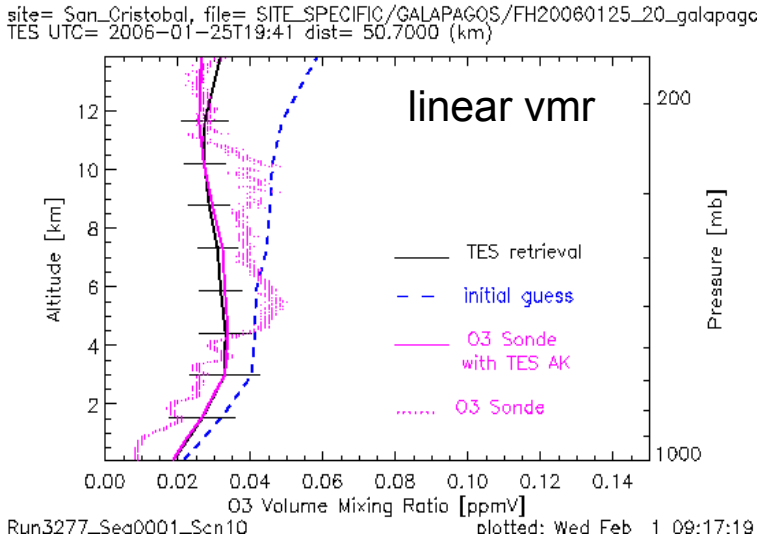
Galapagos (San Cristobal) Ozonesonde data from H. Voemel, CIRES, U. Colo.

TES O3 profile compared to sonde

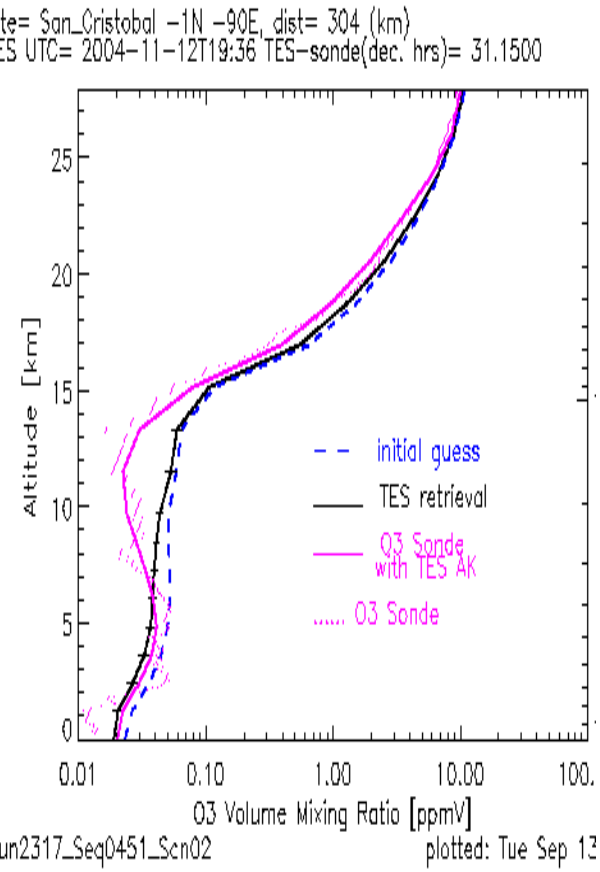


TES Temperature profile compared to O3 sonde temperature

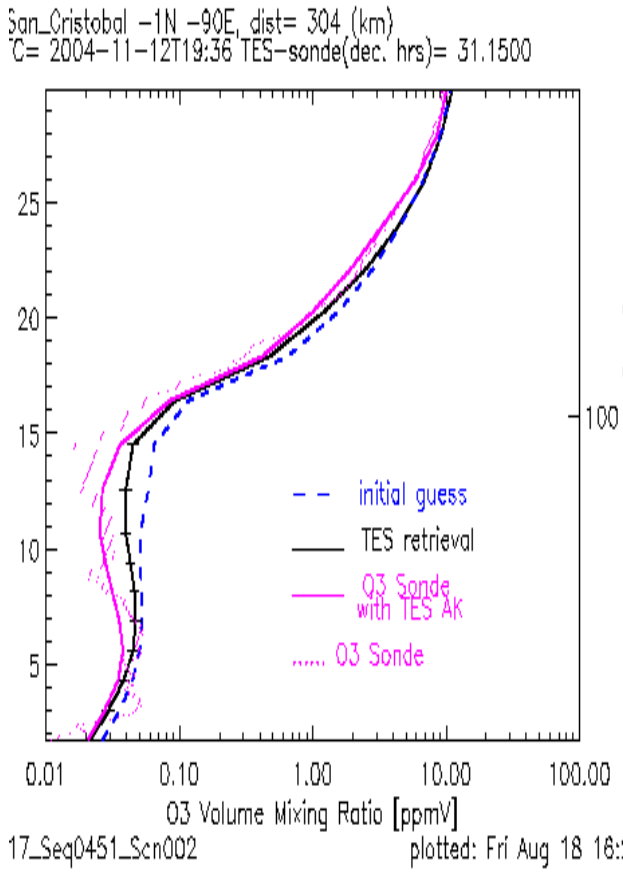




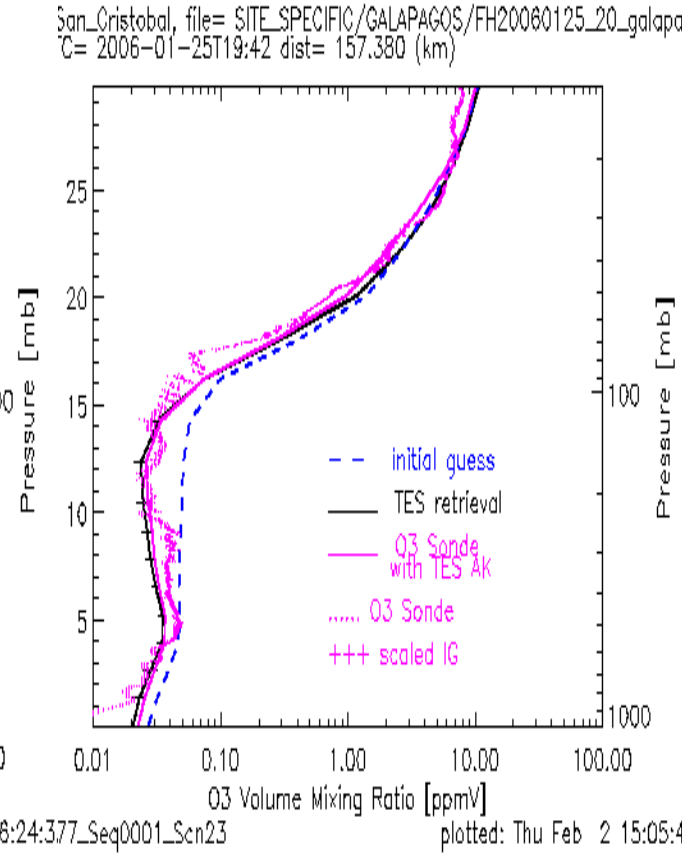
Old vs. new Galapagos compari



V001 Fall 2004 data



V002 Fall 2004 data



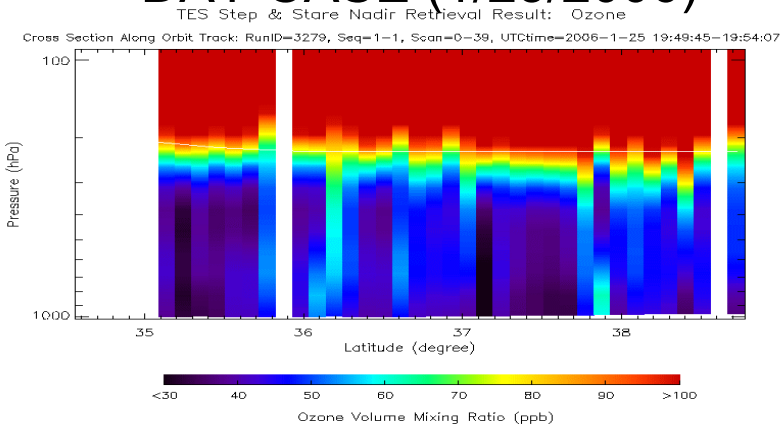
V002 data, Jan 25 2006

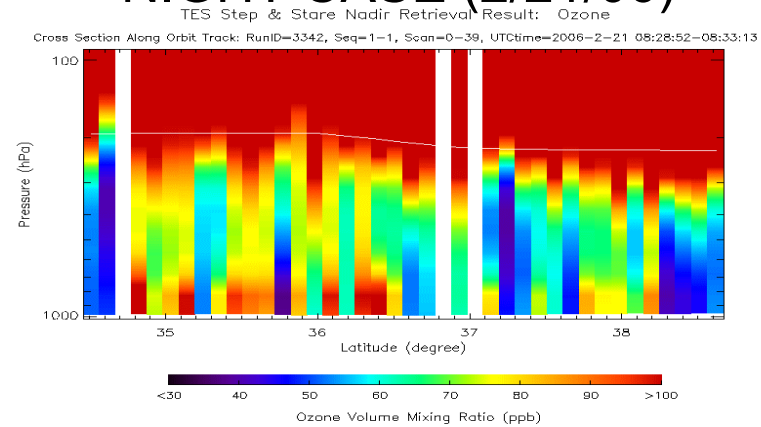
ARM-SGP comparisons (ozonesonde data from F. Schmidlin, NASA Wallops)

DAY CASE (1/25/2006)

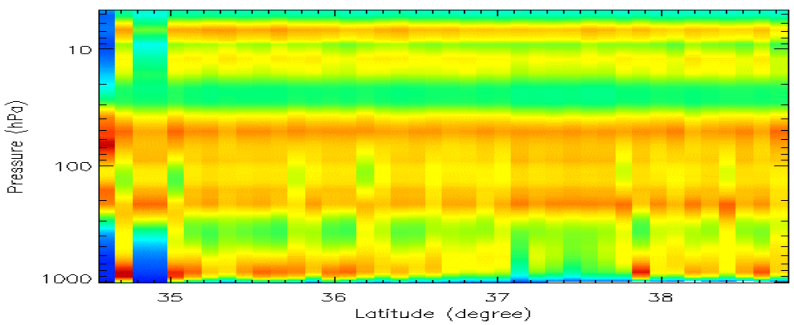
NIGHT CASE (2/21/06)

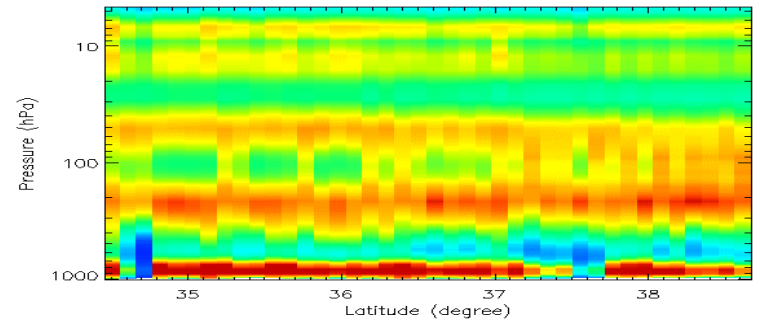
TES O3 Retrievals



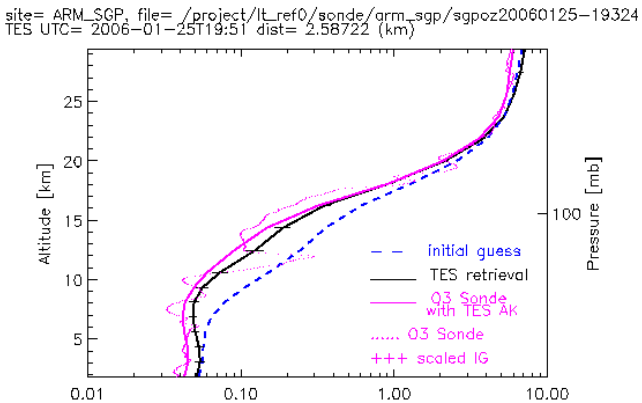


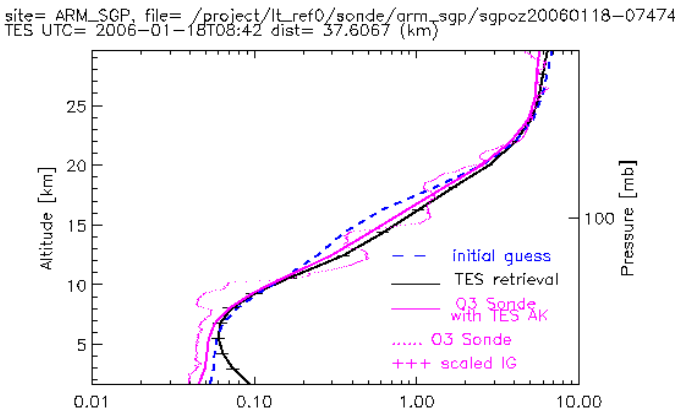
TES O3 AK Diagonals





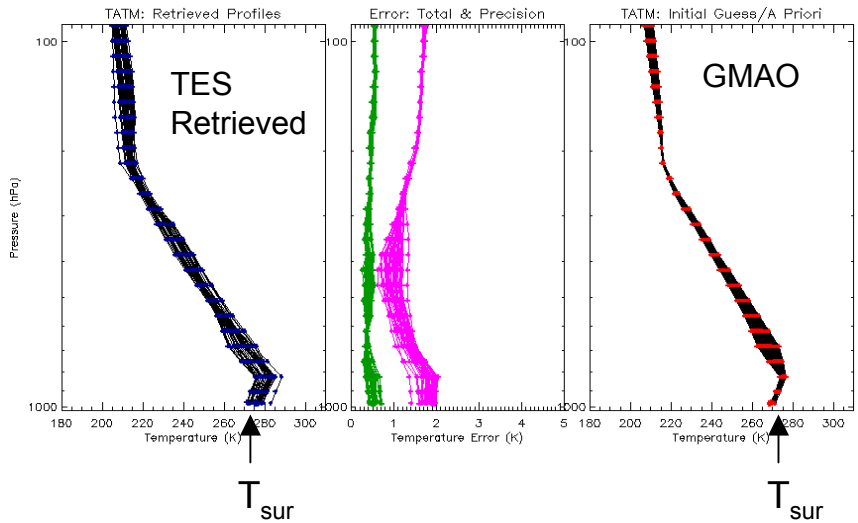
TES-O3sonde Comparisons





H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

ARM-SGP comparisons (cont.)



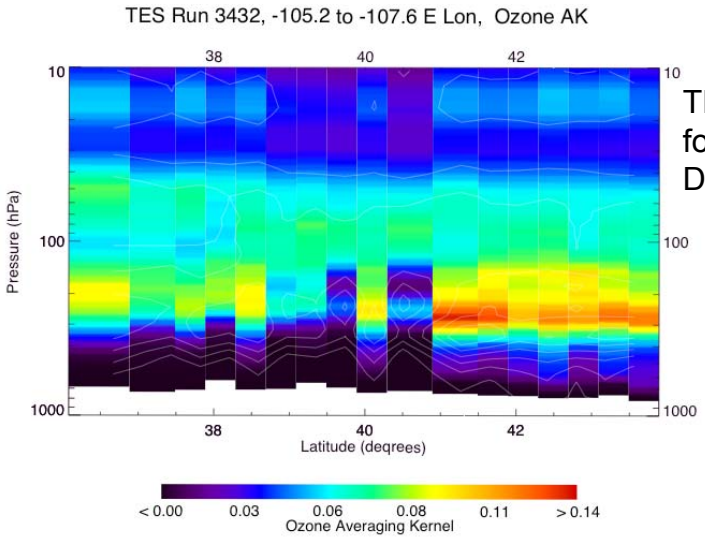
Atmos. temperature retrievals for nighttime case (2/21/2006). Surface temperature (T_{sur}): 268 - 273K

- ARM-SGP ozonesondes have helped us diagnose erroneous TES retrievals now identified by the "Emission layer flag".
- These cases have the layers nearest to the surface in emission ($T_{atm} > T_{sur}$).
- Current O3 constraints do not prevent retrievals with large O3 in emission layers which radiatively cancel with the above layers in absorption.
- Retrieval can find a false minimum as erroneous O3 in emission layer suggests higher sensitivity - e.g. Averaging Kernel plot for night case.

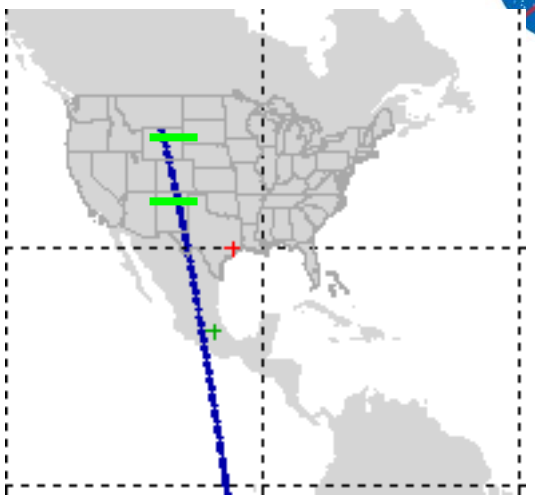
IONS 2006
TES-Ozonesonde Comparisons

H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

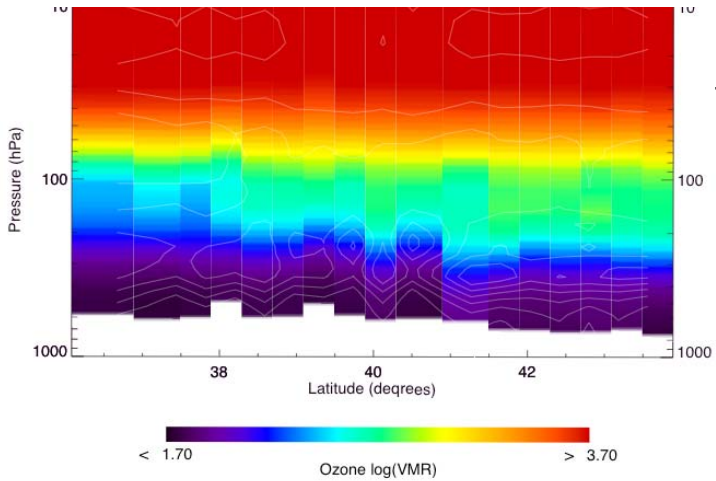
Sonde launched 2006.03.10 at 20:19 UTC, 40.3°N, -105.2°E (Boulder, CO. S. Oltmans, NOAA/CMDL)



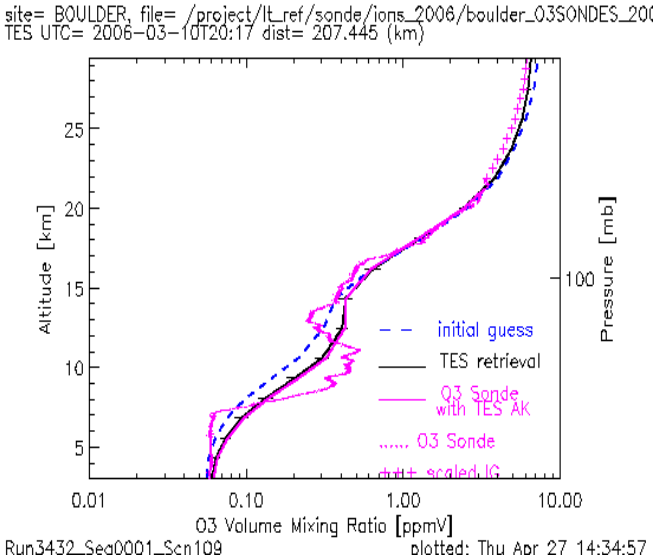
TES Averaging Kernel (AK) for run 3432 closest scans
DOFs = 1.7 to 3.1



TES Step/Stare track, run 3432

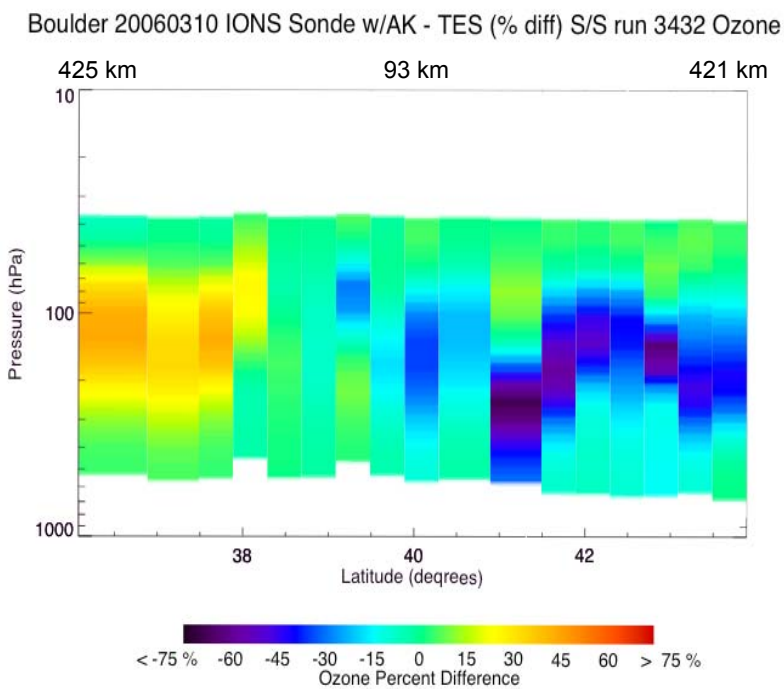


TES O3 Retrievals for run 3432 closest scans

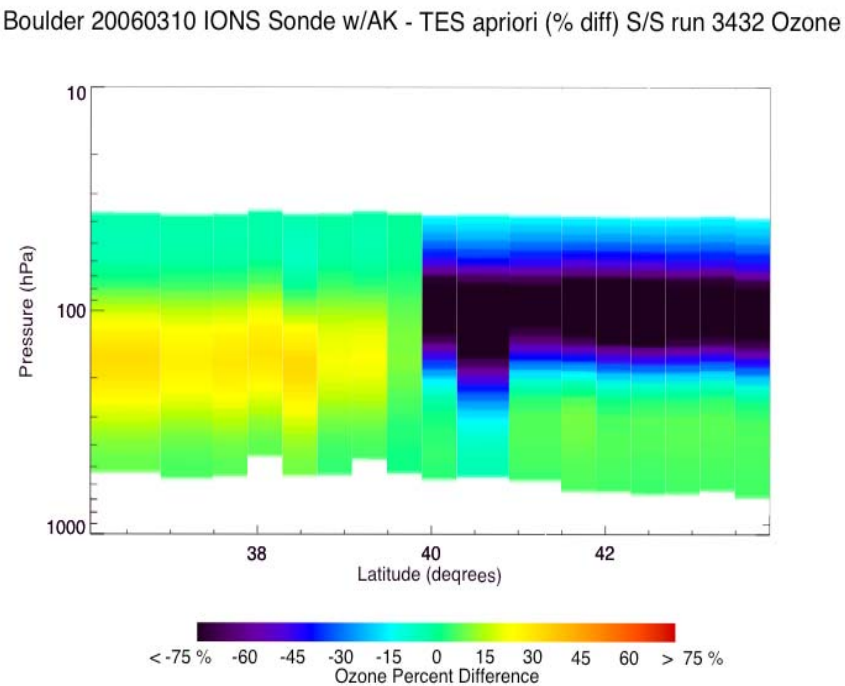


Relative (%) Sonde (w/AK and apriori) - TES differences

% Difference with TES Retrievals



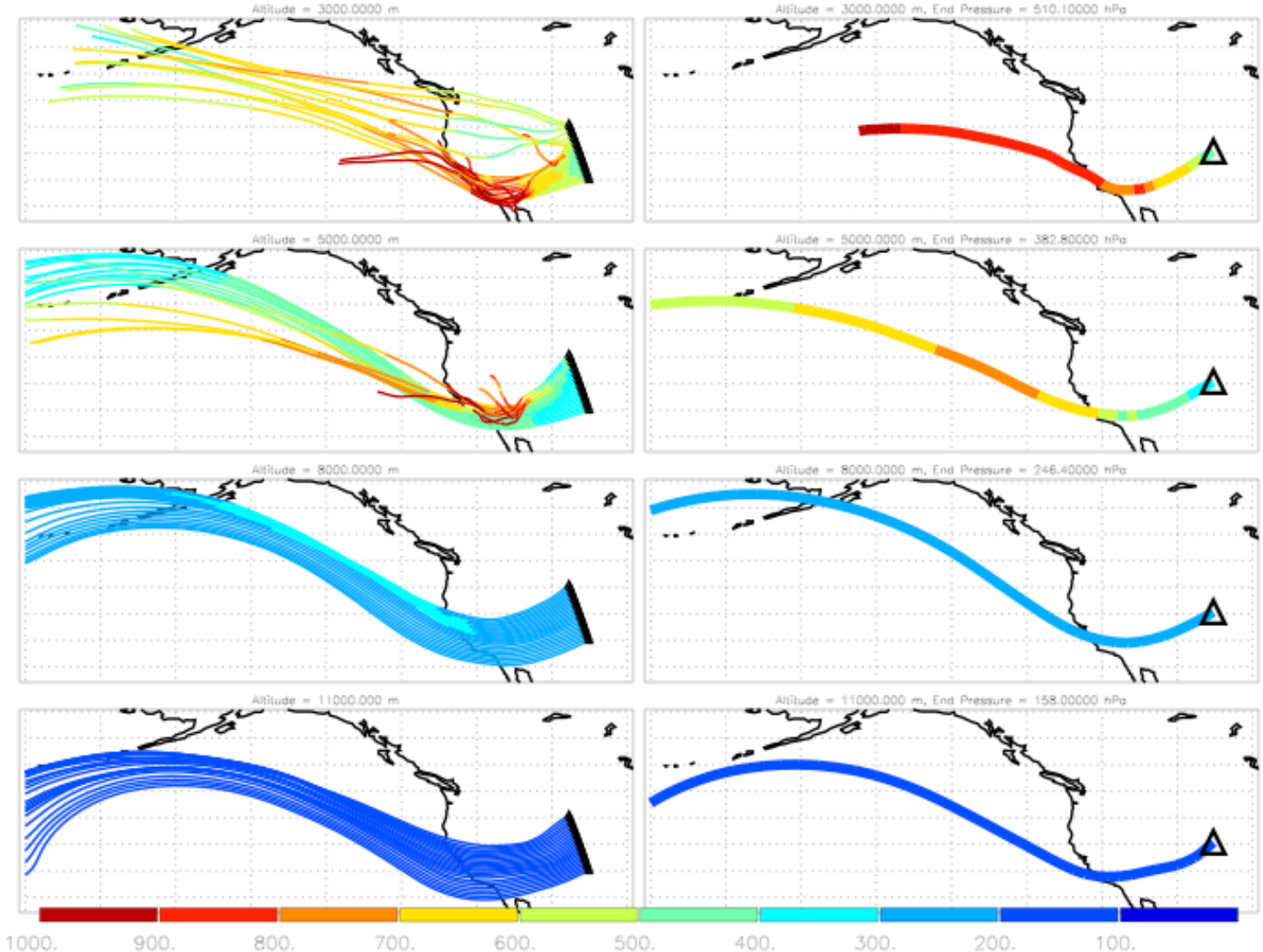
% Difference with Initial Guess



Trajectories from NOAA HYSPLIT model

Back trajectories to TES measurements

Back trajectories to Boulder sonde site



3 km
510 hPa

5 km
383 hPa

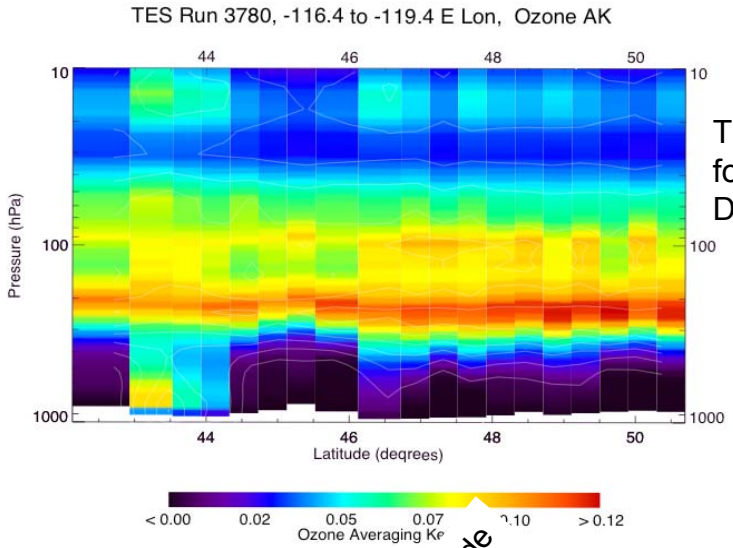
8 km
246 hPa

11 km
158 hPa

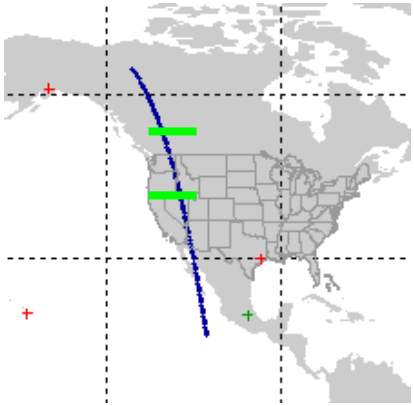
Pressure (hPa)

H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

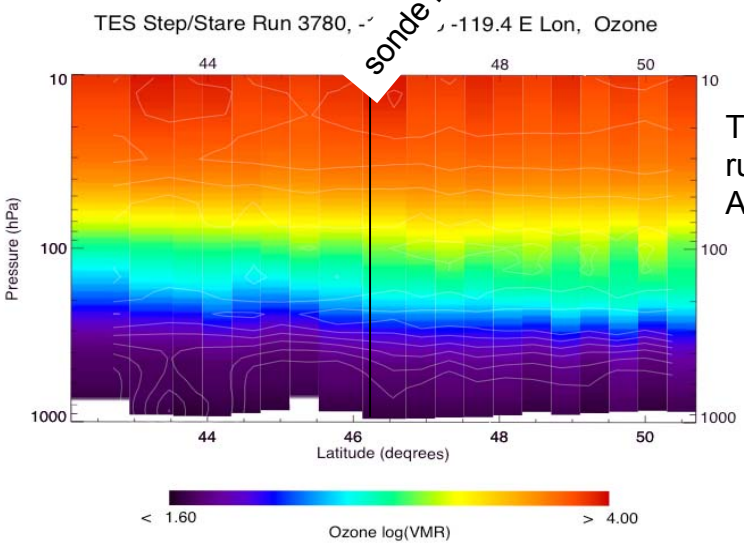
Sonde launched 2006.04.21 at 21:35 UTC, 46.2°N, -119.16°E (PNNL, Richland, WA, Native platform - A. Thompson, Penn State)



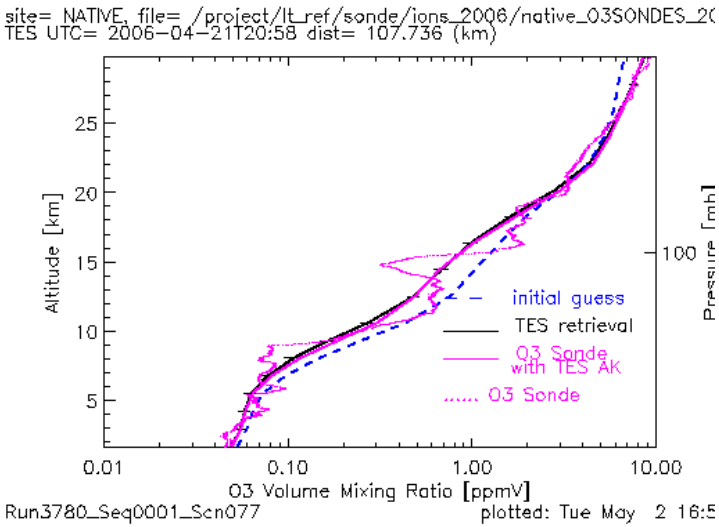
TES Averaging Kernel (AK) for run 3780 closest scans DOFs = 2.5 to 3.7



TES Step/Stare track, run 3780



TES O3 Retrievals for run 3780 closest scans AK contours overplotted

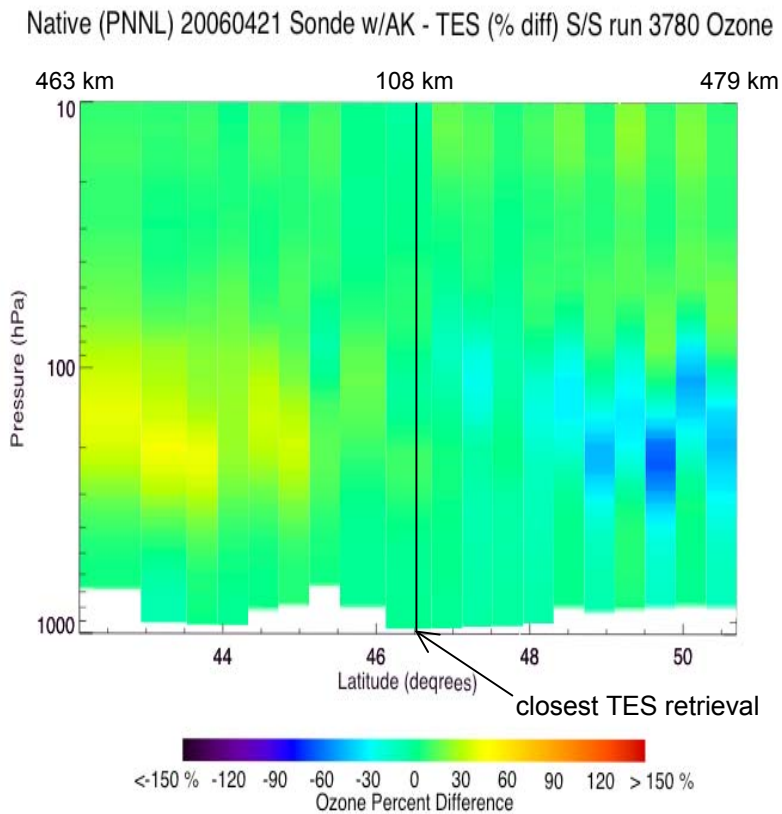


Comparison with closest TES measurement - 108 km away

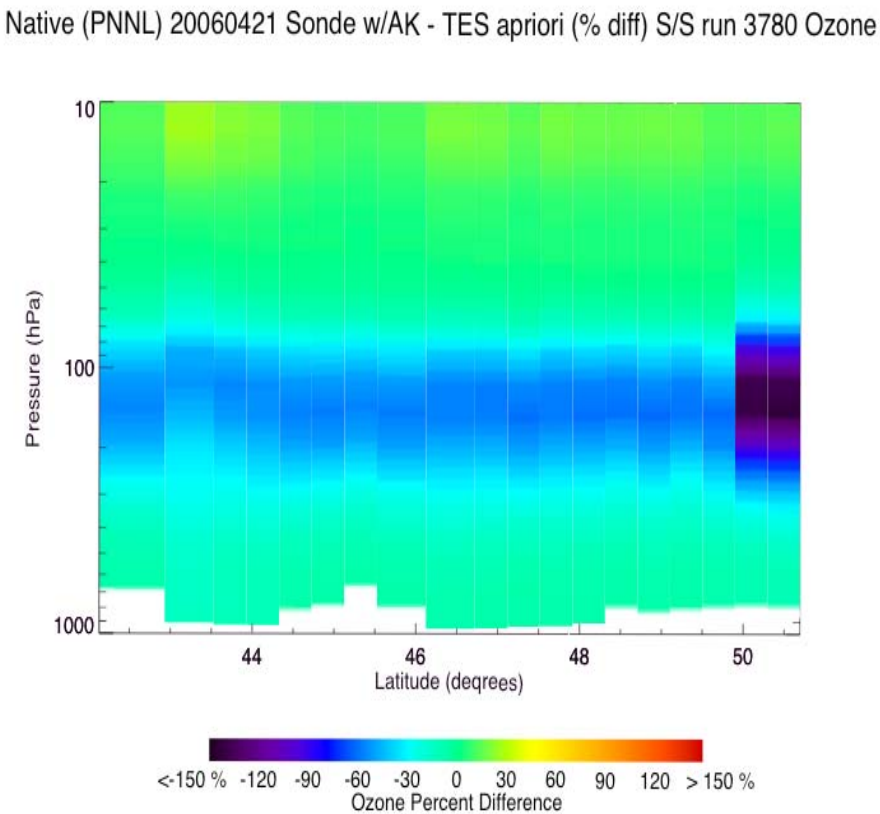
H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

Relative (%) Sonde (w/AK and apriori) - TES differences

% Difference with TES Retrievals



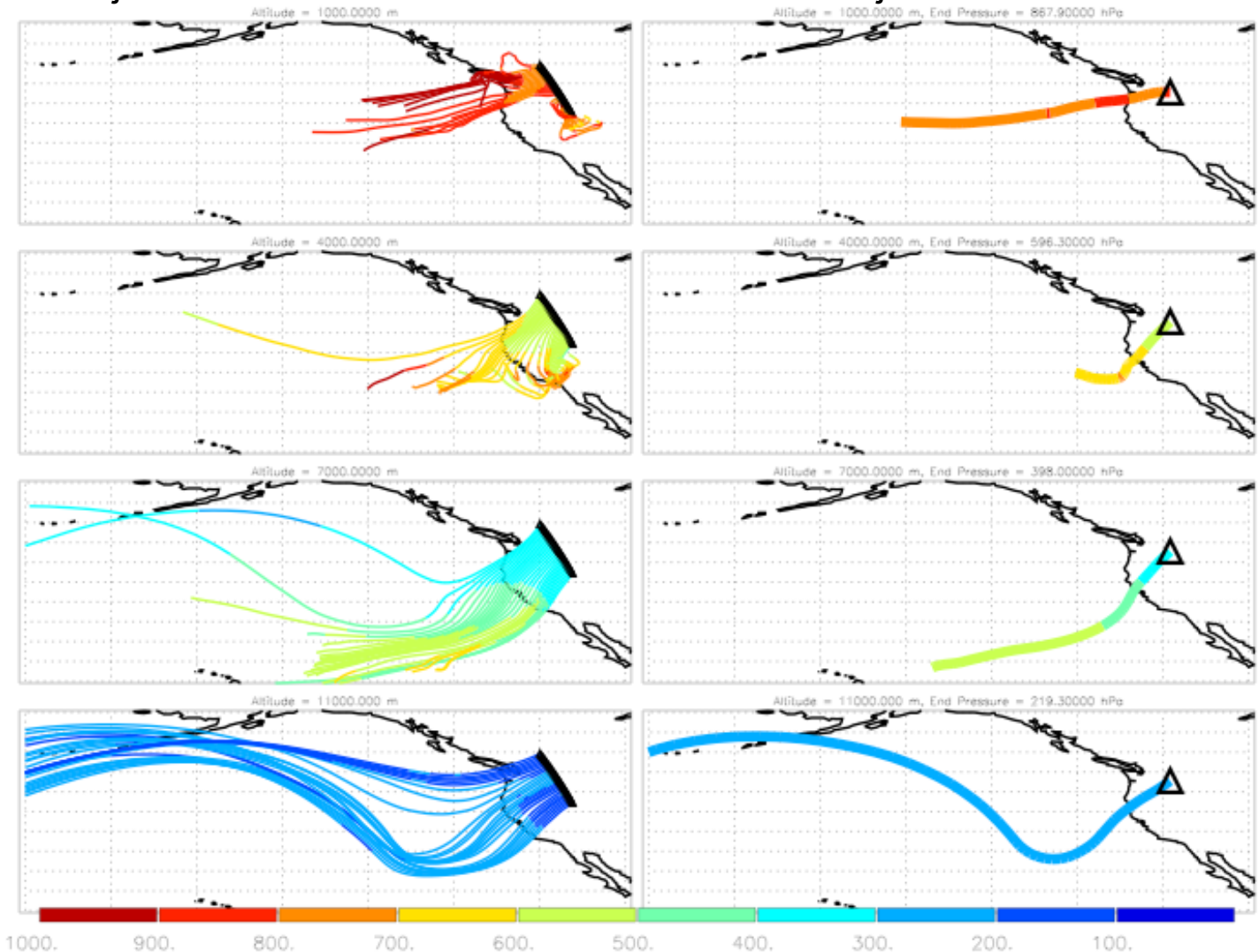
% Difference with Initial Guess



Trajectories from NOAA HYSPLIT model

Back trajectories to TES measurements

Back trajectories to PNNL sonde site



3 km
868 hPa

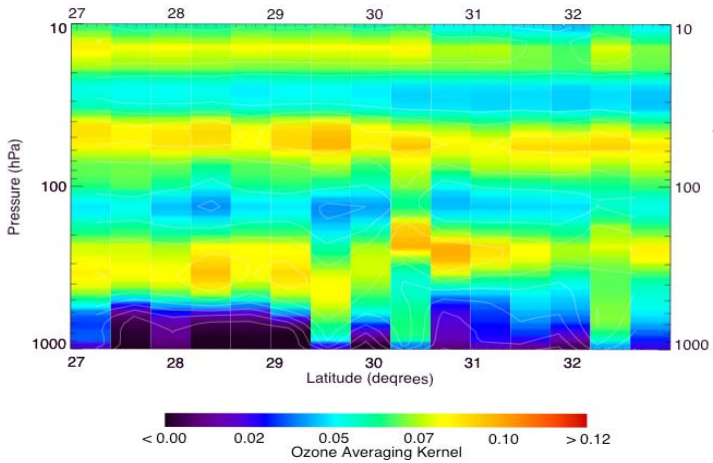
5 km
596 hPa

8 km
396 hPa

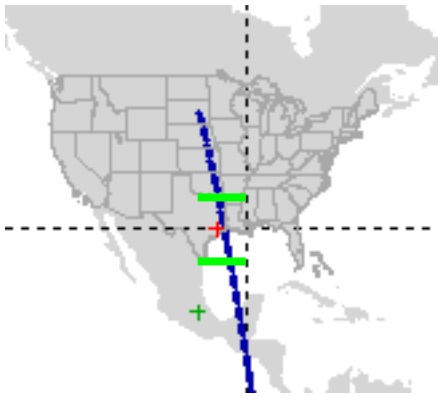
11 km
219 hPa

Pressure (hPa)

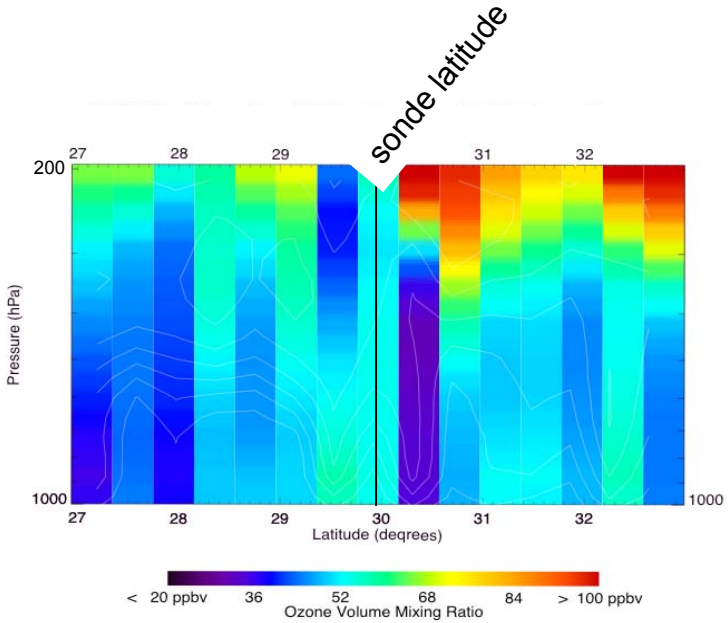
Sonde launched 2006.03.16 at 18:49 UTC, 29.97°N, -95.33°E (Houston, TX - G. Morris, Valparaiso U.)



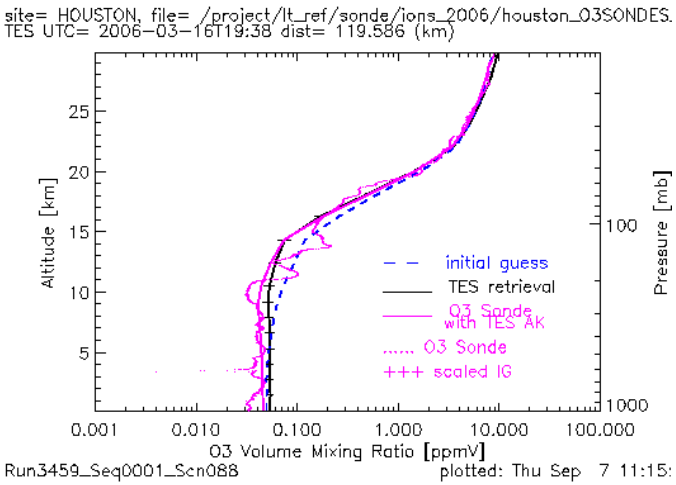
TES Averaging Kernel (AK) for run 3549 closest scans
DOFs = 2.9 to 3.6



TES Step/Stare track, run 3549



TES O3 Retrievals for run 3459 closest scans
AK contours overplotted



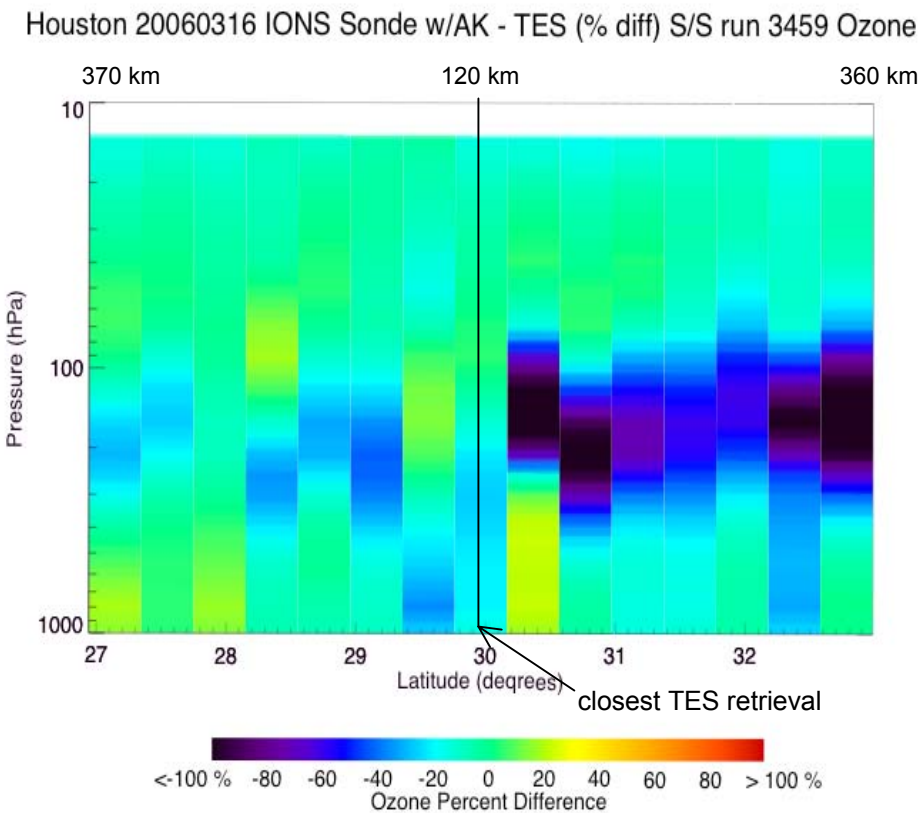
Comparison with closest TES measurement - 120 km away

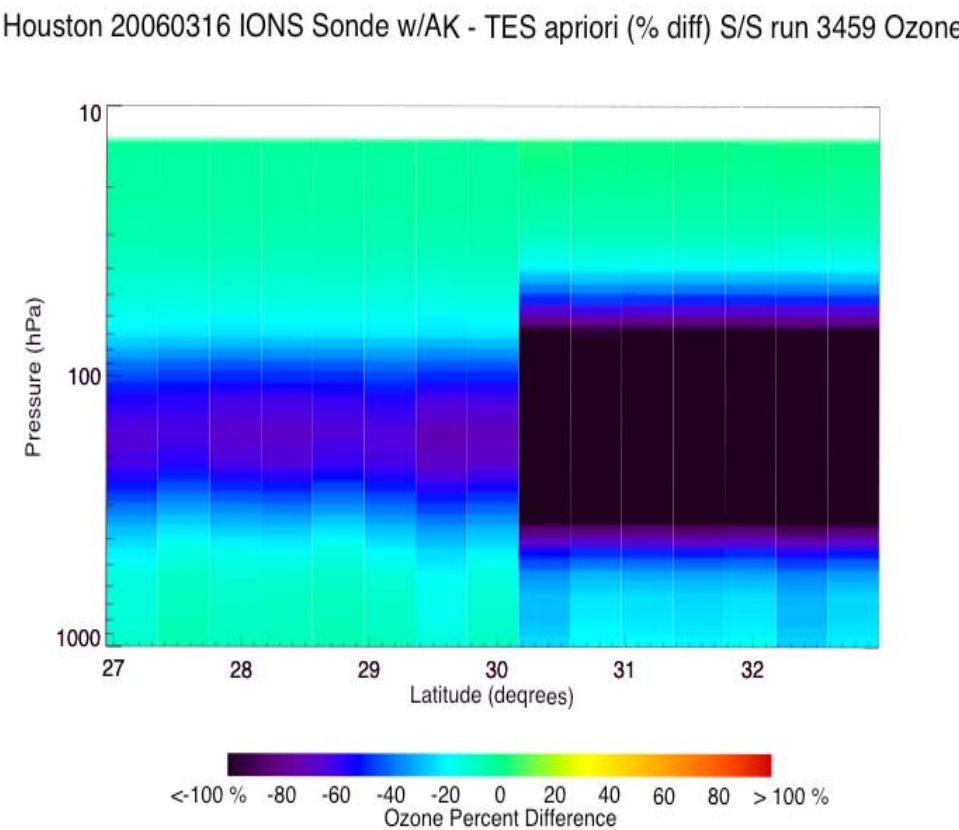
H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

Relative (%) Sonde (w/AK and apriori) - TES differences

% Difference with TES Retrievals

% Difference with Initial Guess

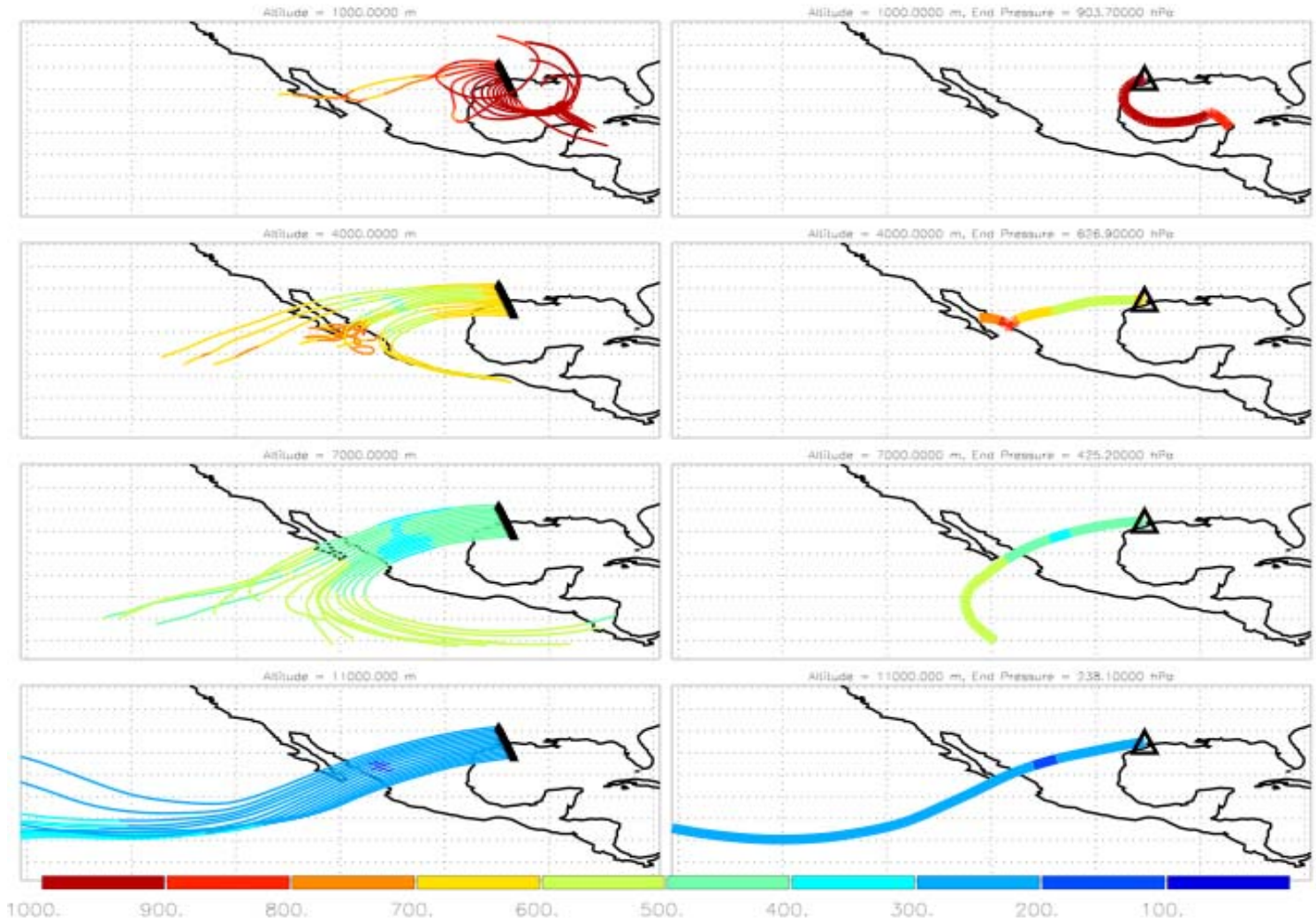




Trajectories from NOAA HYSPLIT model

Back trajectories to TES measurements

Back trajectories to Houston sonde site



1 km
904 hPa

4 km
630 hPa

7 km
425 hPa

11 km
238 hPa

Pressure (hPa)

H. Worden, JPL/CalTech
Aura Validation Working Group
September 2006

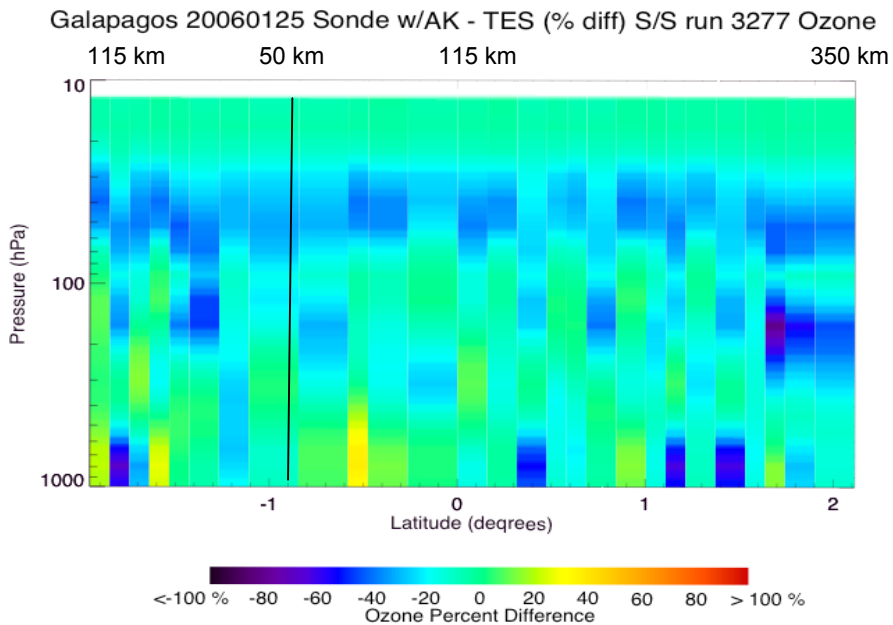
Summary & Future Work

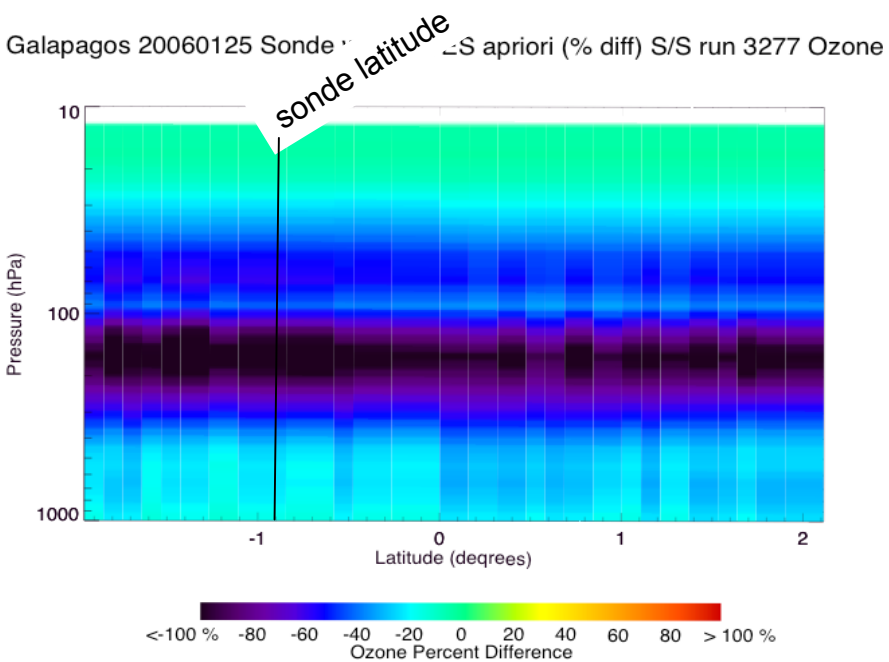
- **Sonde launches timed for Aura overpass have been extremely useful.**
- Substantial improvement over V001 data for clean Pacific cases.
- Day/Night differences for ARM-SGP comparisons led to "emission layer" diagnostic flag.
- Step/Stare and Transect runs allow detailed comparisons with sondes.
- Preliminary analysis of Step/Stare comparisons suggests coincidence criteria of 300 km for tropics and 200 km mid-latitudes for Global Survey data comparisons.
- Future work:
  - More IONS comparisons and statistical analysis.
  - Comparisons with sondes and regional model (e.g. RAQMS) as "transfer function”.

Relative (%) Sonde (w/AK and apriori) - TES differences

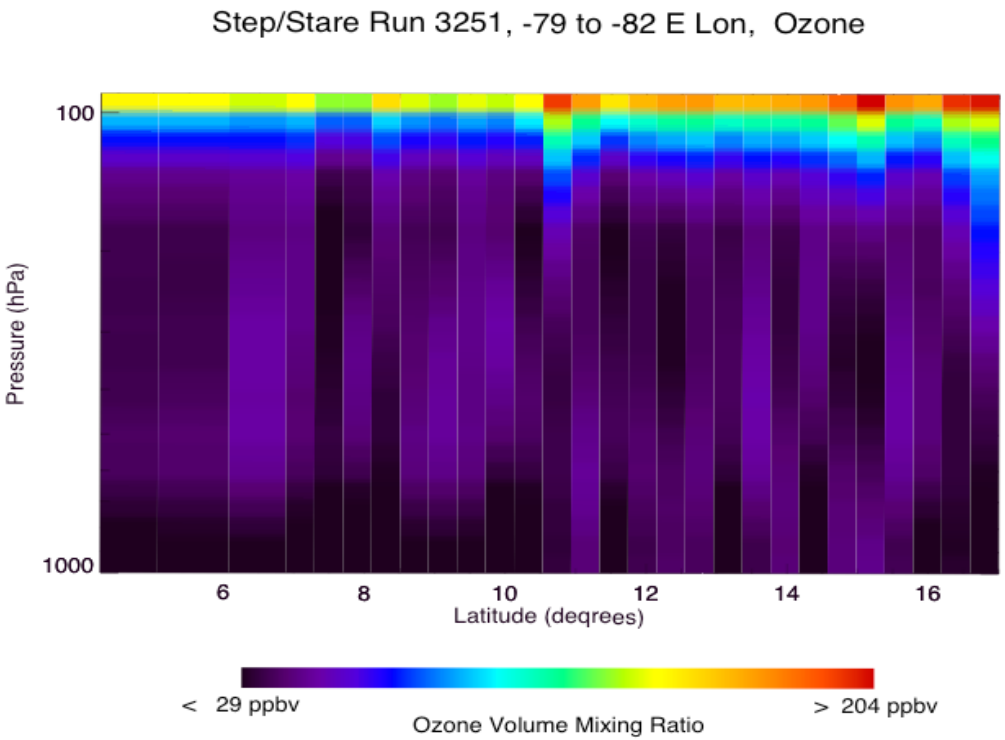
% Difference with TES Retrievals

% Difference with Initial Guess

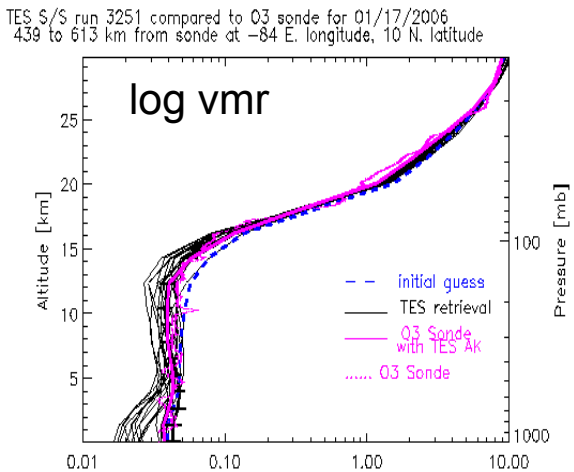


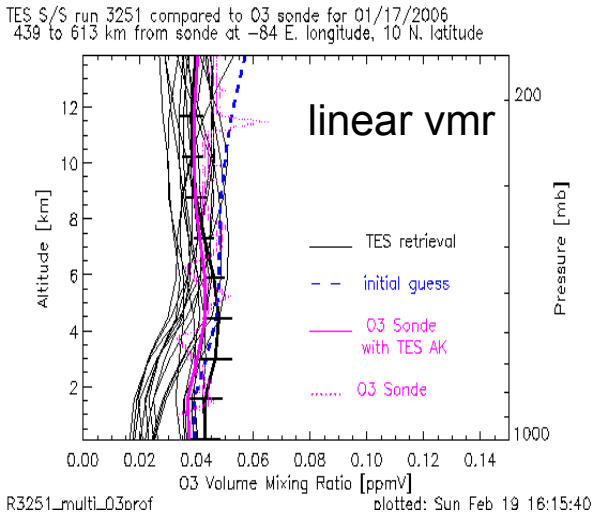


Step/Stare Run 3251 - 1/17/06
Closest scan 439 km away from Heredia, Costa Rica



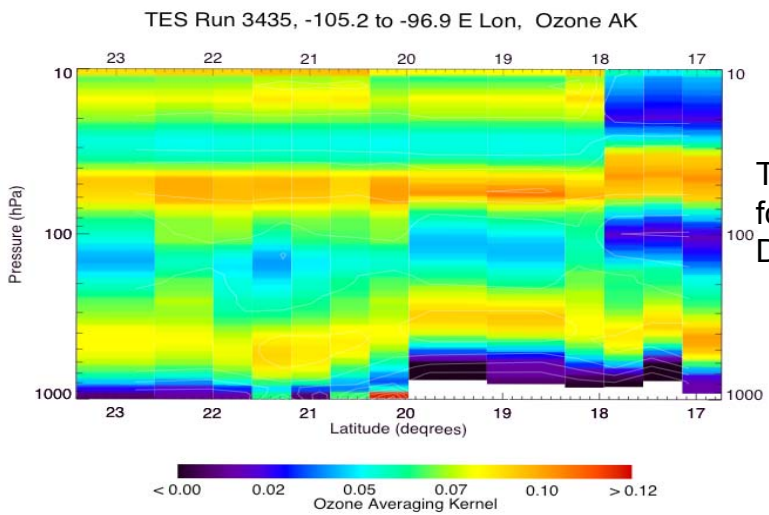
TES O3 retrievals



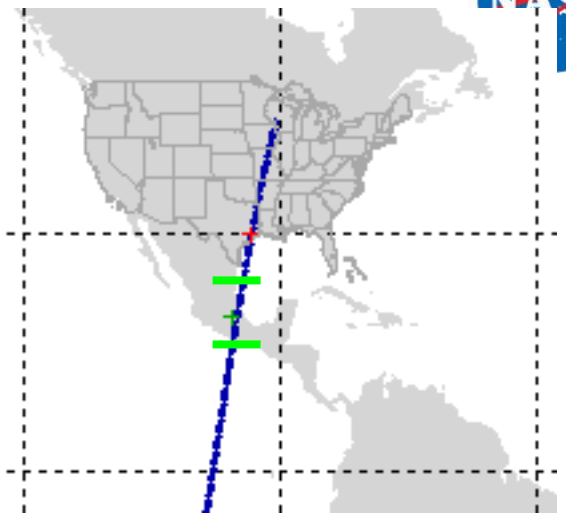


Ozonesonde data from
H. Voemel, CIRES, U. Colo.

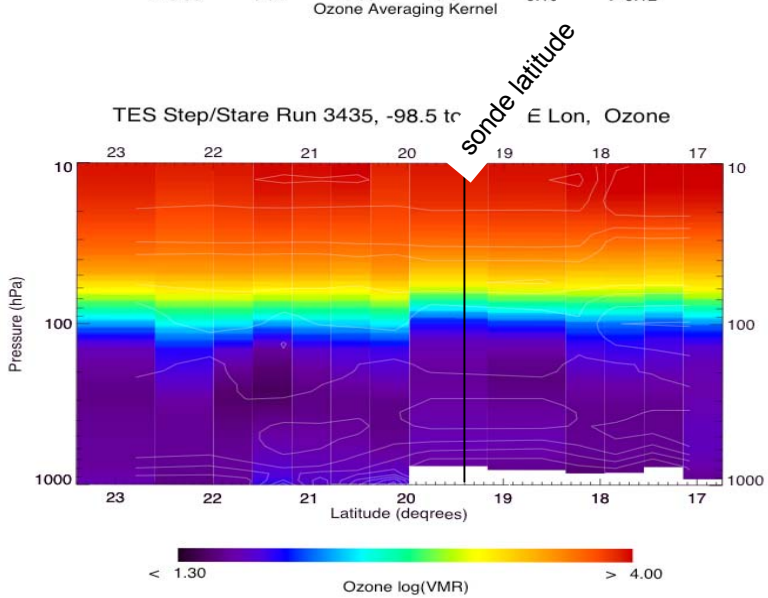
Sonde launched 2006.03.11 at 08:21 UTC, 19.42°N, -98.58°E (Mexico City - A. Thompson, Penn State)



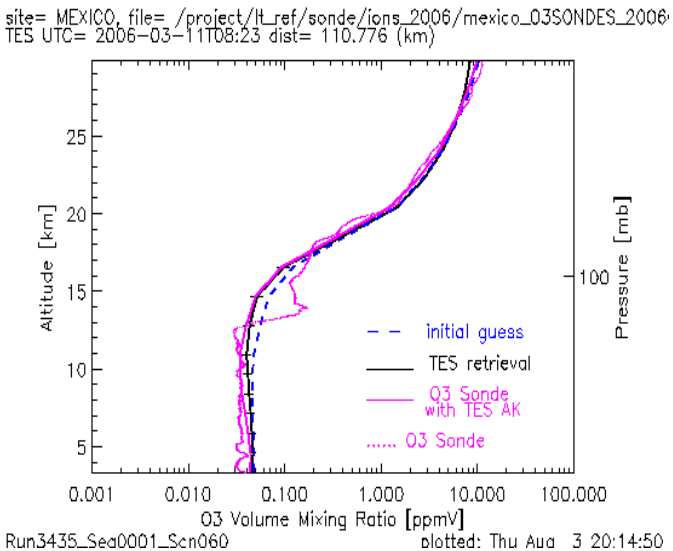
TES Averaging Kernel (AK) for run 3435 closest scans
DOFs = 2.7 to 3.8



TES Step/Stare track, run 3435

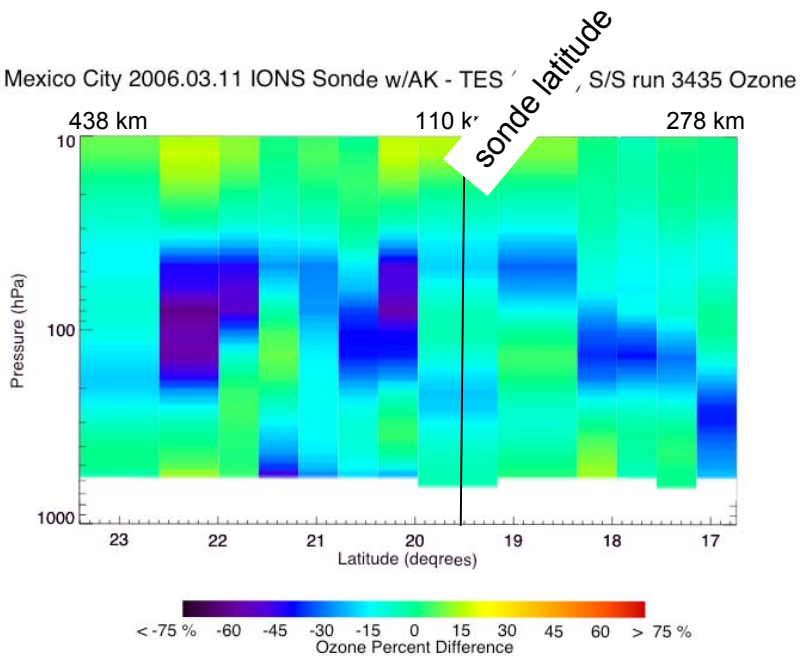


TES O3 Retrievals for run 3435 closest scans
AK contours overplotted

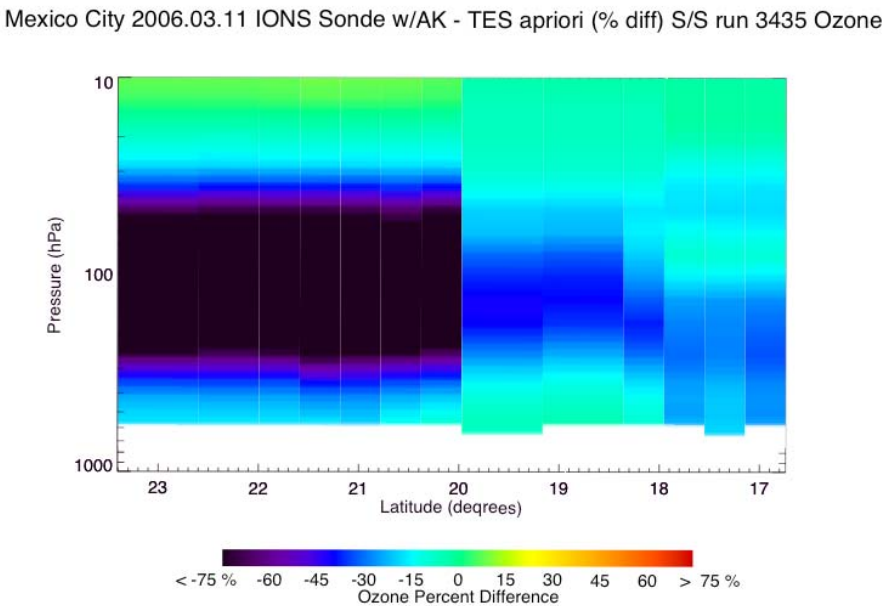


Relative (%) Sonde (w/AK and apriori) - TES differences

% Difference with TES Retrievals



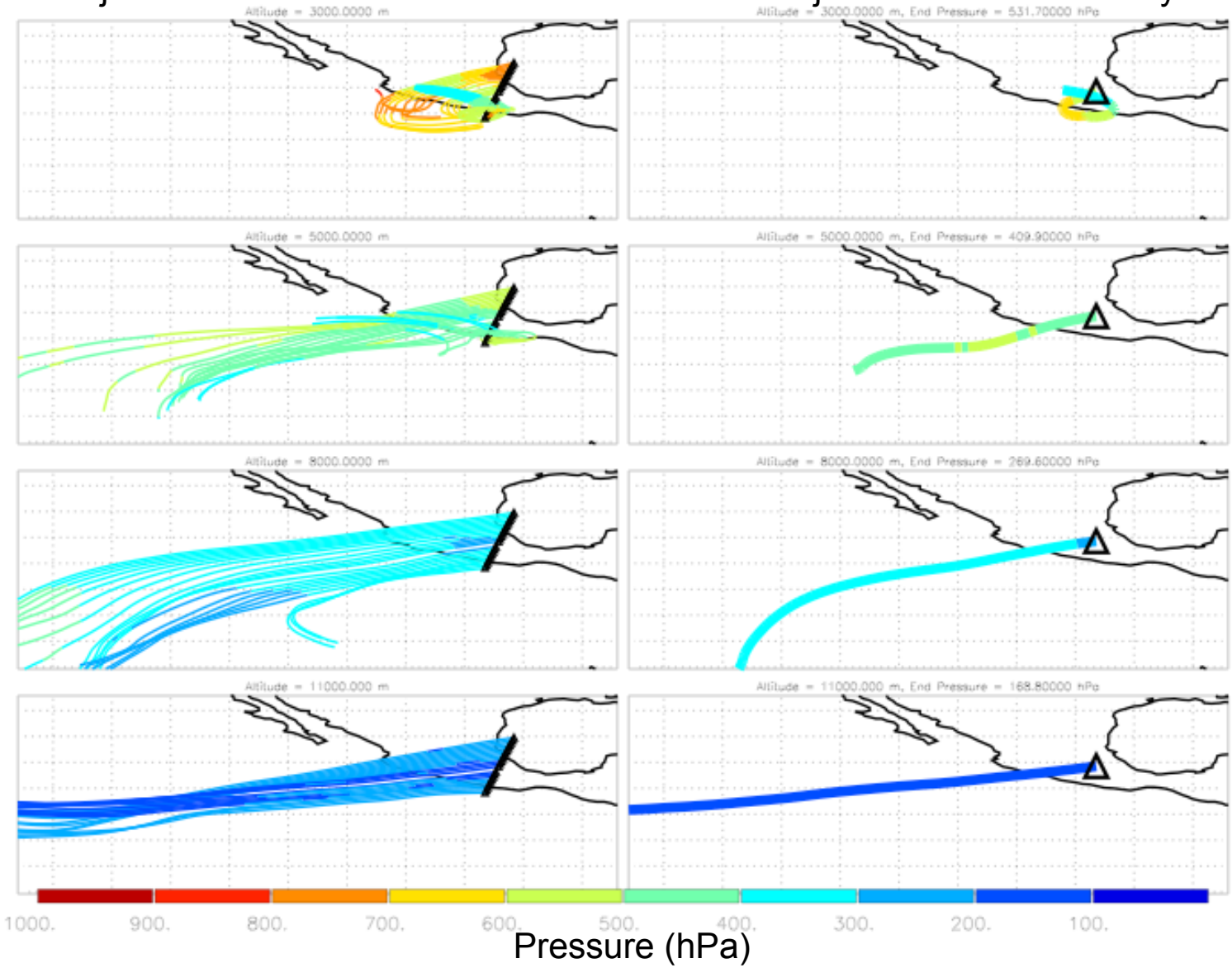
% Difference with Initial Guess



Trajectories from NOAA HYSPLIT model

Back trajectories to TES measurements

Back trajectories to Mexico City sonde site



3 km
532 hPa

5 km
410 hPa

8 km
270 hPa

11 km
169 hPa

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Aura Validation Working Group
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