

Application of Satellite and Ozone sonde Data to the Study of Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality

Greg Osterman – Jet Propulsion Laboratory

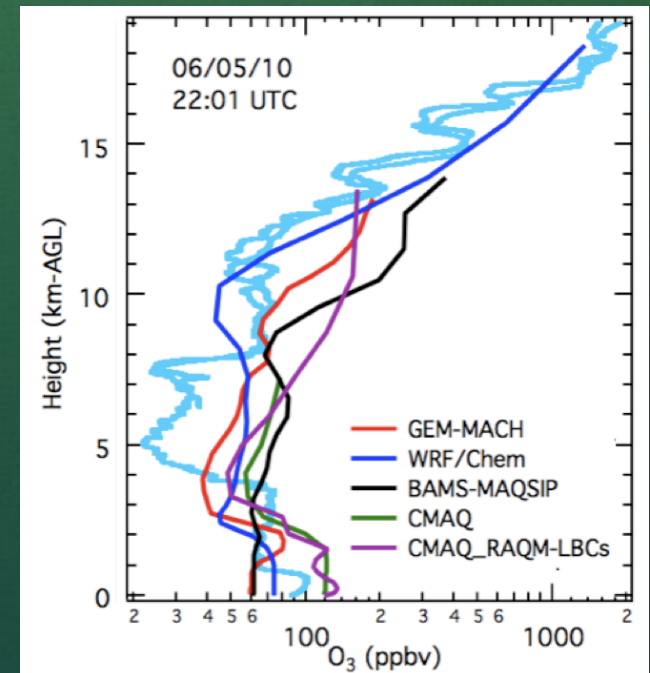
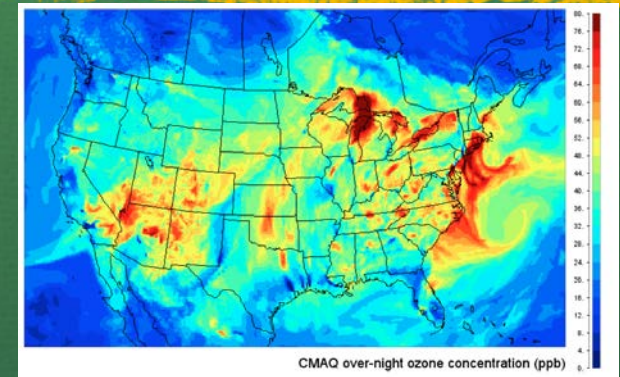
CMAS Meeting - October 25, 2011

Investigators

- AURA 2010 Proposal
- Annmarie Eldering (PI, JPL), Jessica Neu (JPL)
- Jeff McQueen, Youhua Tang (NOAA/NWS)
- Rob Pinder (EPA)

Project Objectives

- Characterize nighttime ozone aloft using satellite data and ozonesondes
- Evaluate the ability of the EPA CMAQ and NOAA National Air Quality Forecast Capability (NAQFC) to capture nighttime ozone aloft and possible relationship to air quality events
 - Evaluation of ozone, carbon monoxide and other key fields in air quality models in the middle/lower troposphere using satellite data
- Case Studies: Analyze a set of air quality events and determine if there is a relationship to nighttime ozone aloft



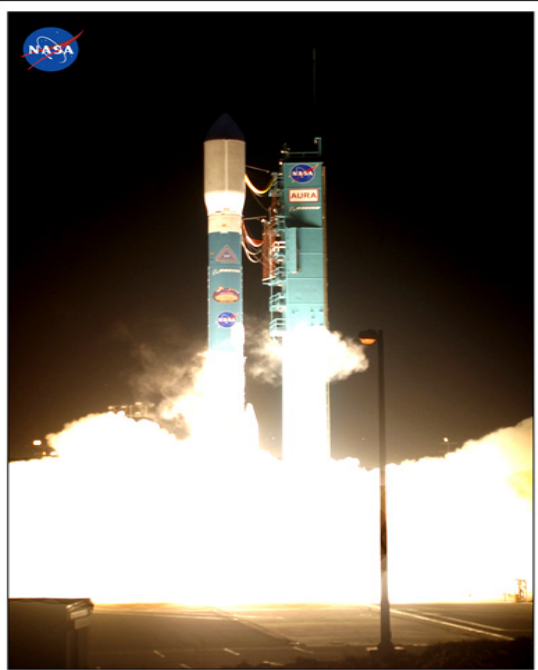
Data and Models

- Models:
 - NAQFC Forecast
 - EPA CMAQ 4.7.1
 - Time Periods – July/ August 2006, 2008, 2009
- Evaluation Data Sets:
 - Satellite data from TES (O₃, CO, TATM, H₂O), and OMI (O₃, NO₂)
 - Ozonesondes
 - Surface monitors

The background features a series of overlapping green triangles of varying shades, creating a mountain-like silhouette. A wide, horizontal band of bright yellow with a fine, grainy texture runs across the middle of the image. The word "TES" is centered within this yellow band.

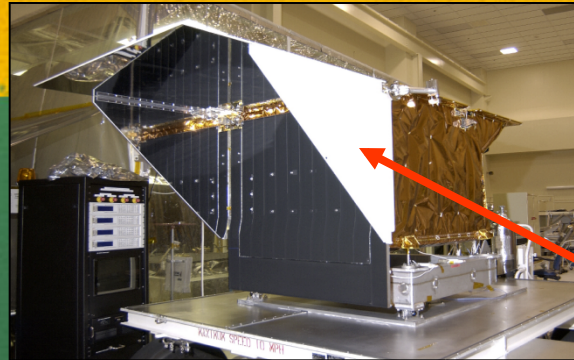
TES

TES on EOS-Aura

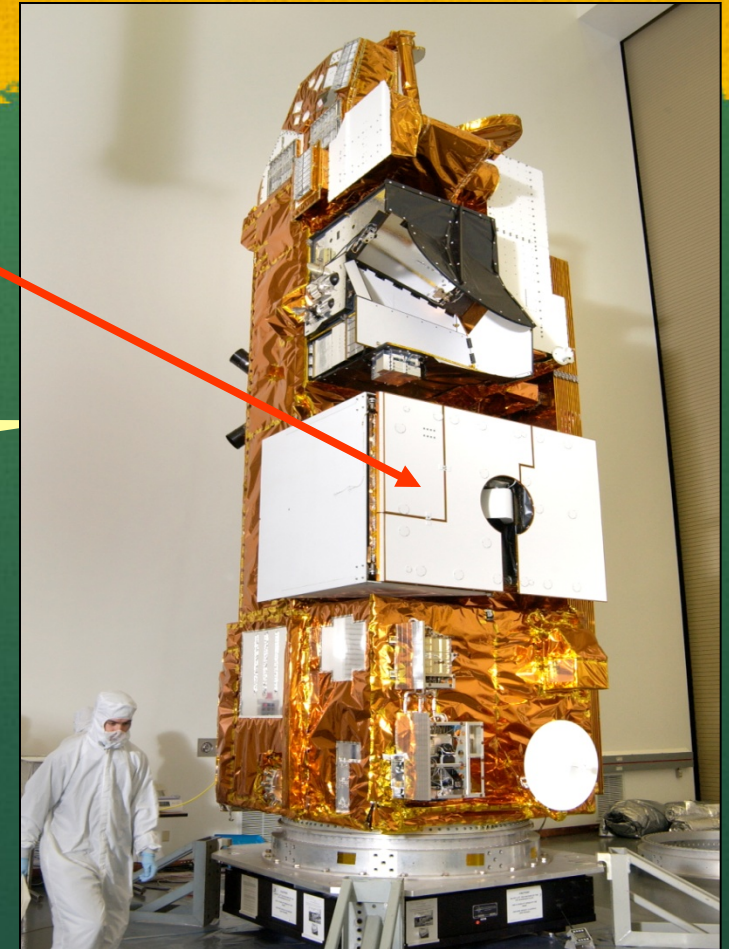


Aura Launch : July 15, 2004
Vandenberg Air Force Base, CA

EOS

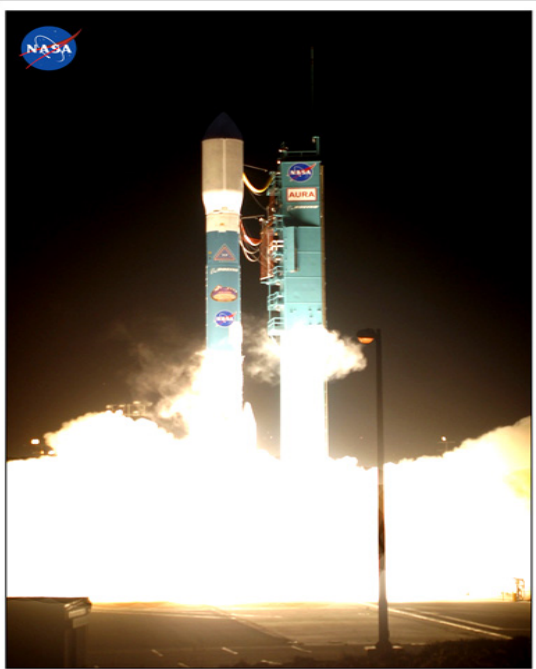


Launched 2004.07.15



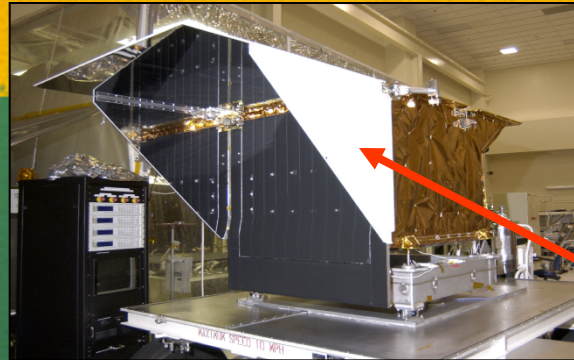
Goleta Air & Space Museum
www.Air-and-Space.com
©2004, Brian Lockett

TES on EOS-Aura

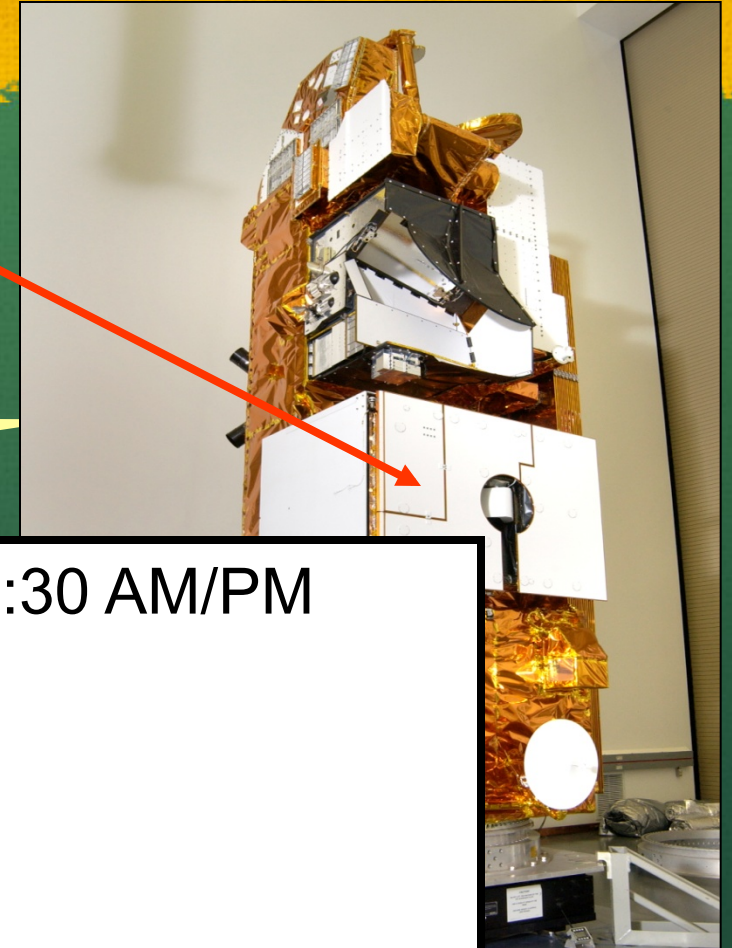


Aura Launch : July 15, 2004
Vandenberg Air Force Base, CA

EOS



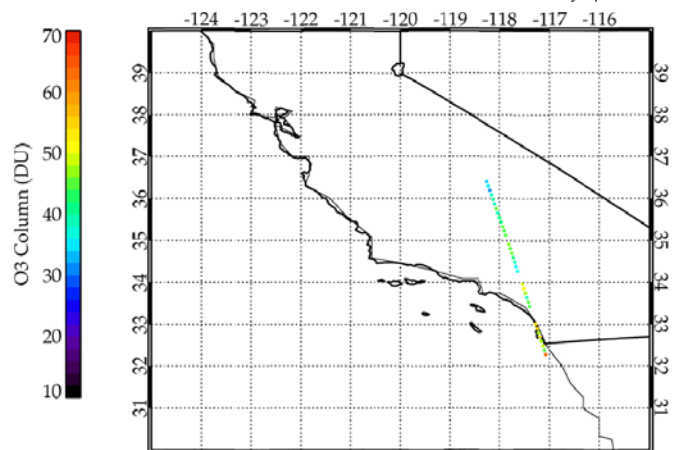
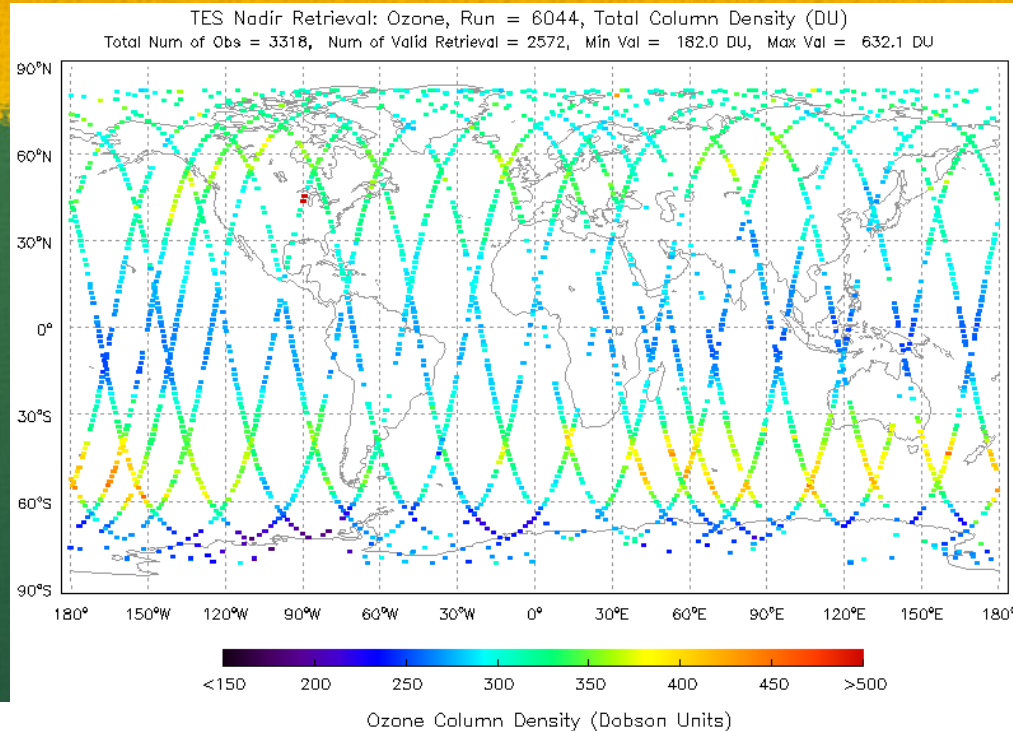
Launched 2004.07.15



TES Measures in Nadir Mode (~01:30 AM/PM Local Time):

- Ozone
- Carbon Monoxide
- Water Vapor and HDO
- Ammonia
- Methane and Carbon Dioxide
- Surface Temperature (Sea Surface Temperature)

TES Nadir Coverage

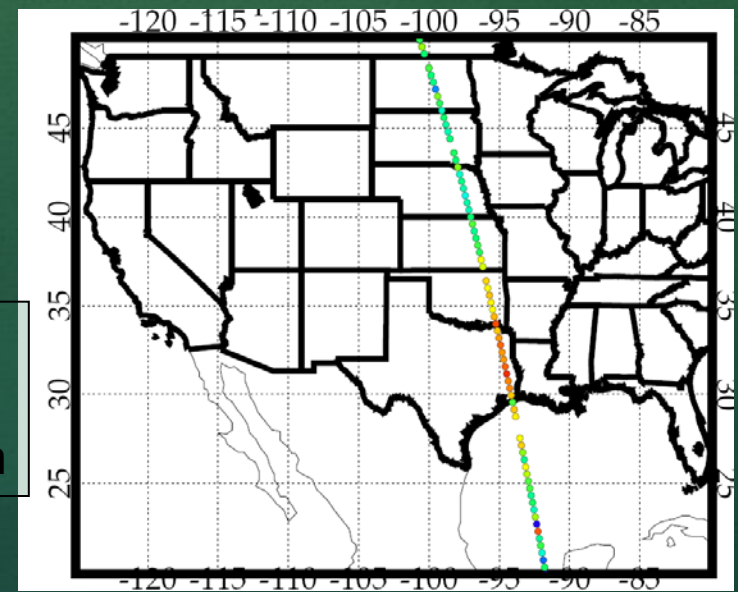


Transect footprints
12 km apart
Special observation

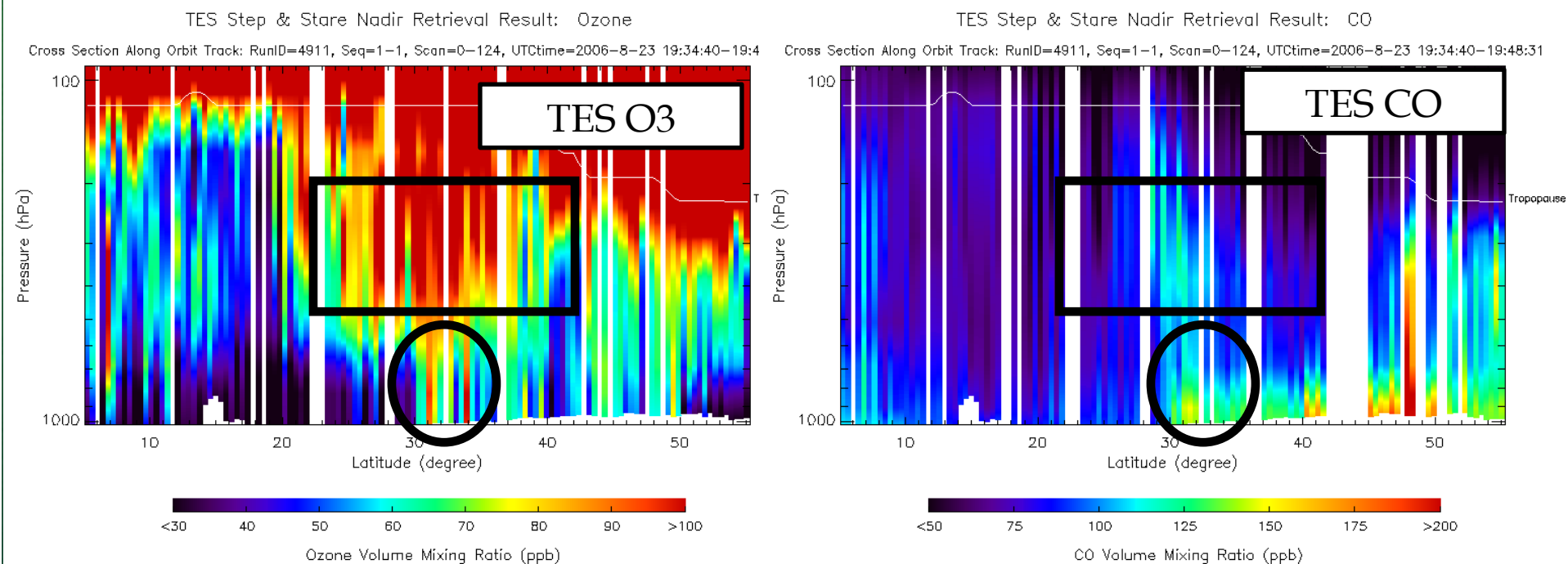
TES Footprint 5 x 8 km

Global Survey footprints
180 km apart
Every 2 days... ~767 and counting

Step & Stare footprints
45 km apart
Special observation



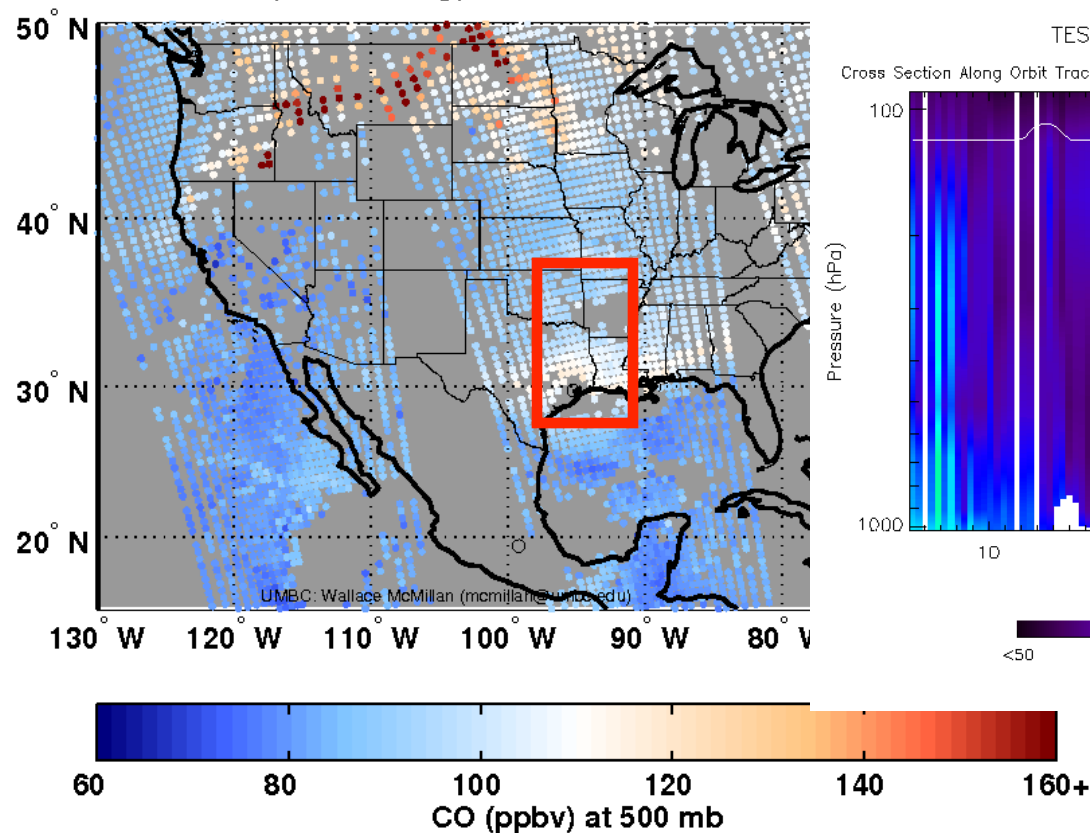
Elevated CO and O3 over SE Texas observed from TES on Aug 23, 2006



- TES resolves peaks in middle and lower tropospheric O3 and CO over East Texas
- Used to identify high ozone in middle troposphere
- Assimilated (along with OMI and MLS data) into RAQMS

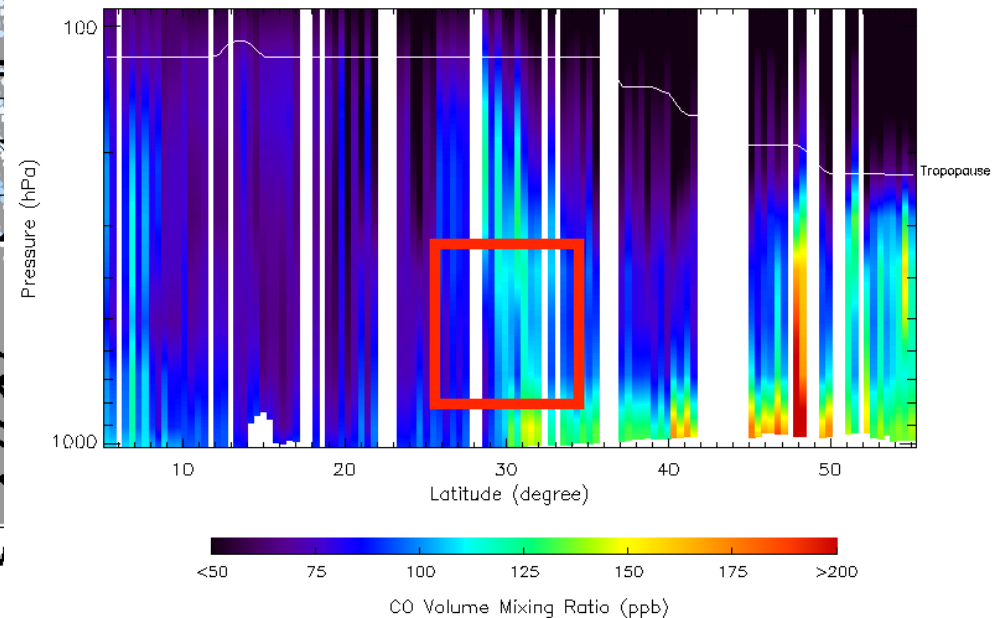
AIRS & TES CO – August 23, 2006

Local PM (ascending) AIRS CO at 500 mb on 20060823

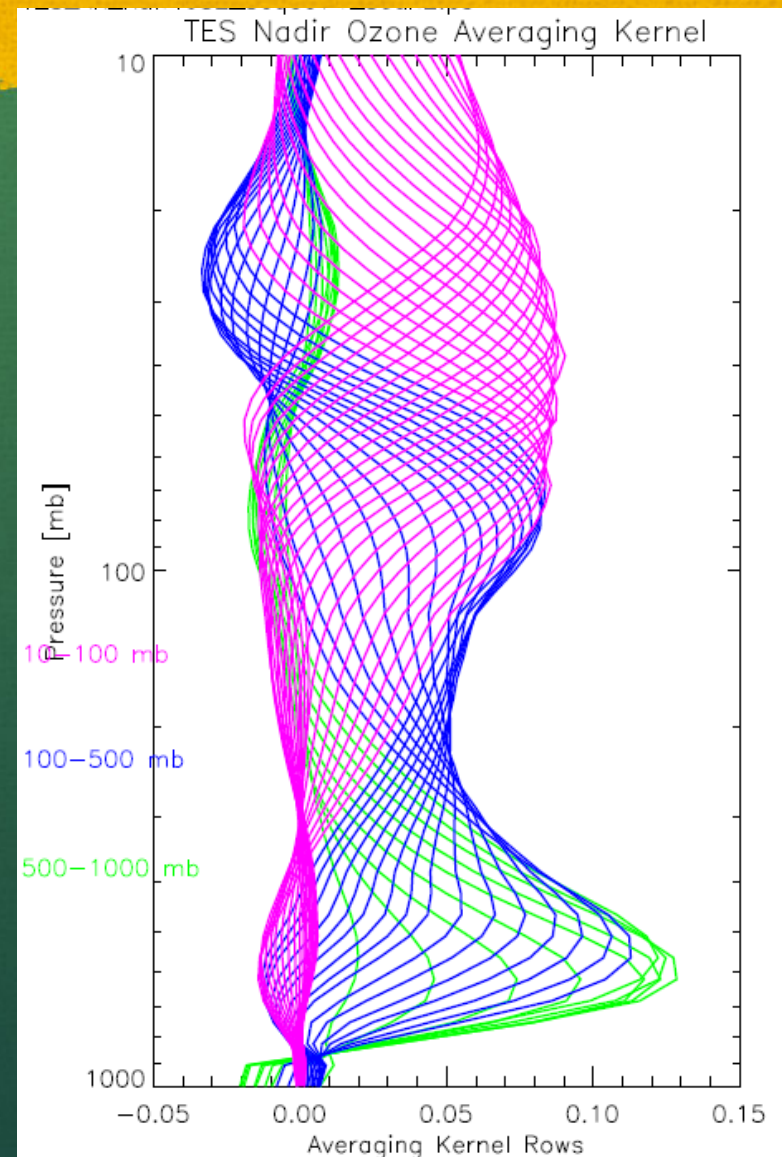
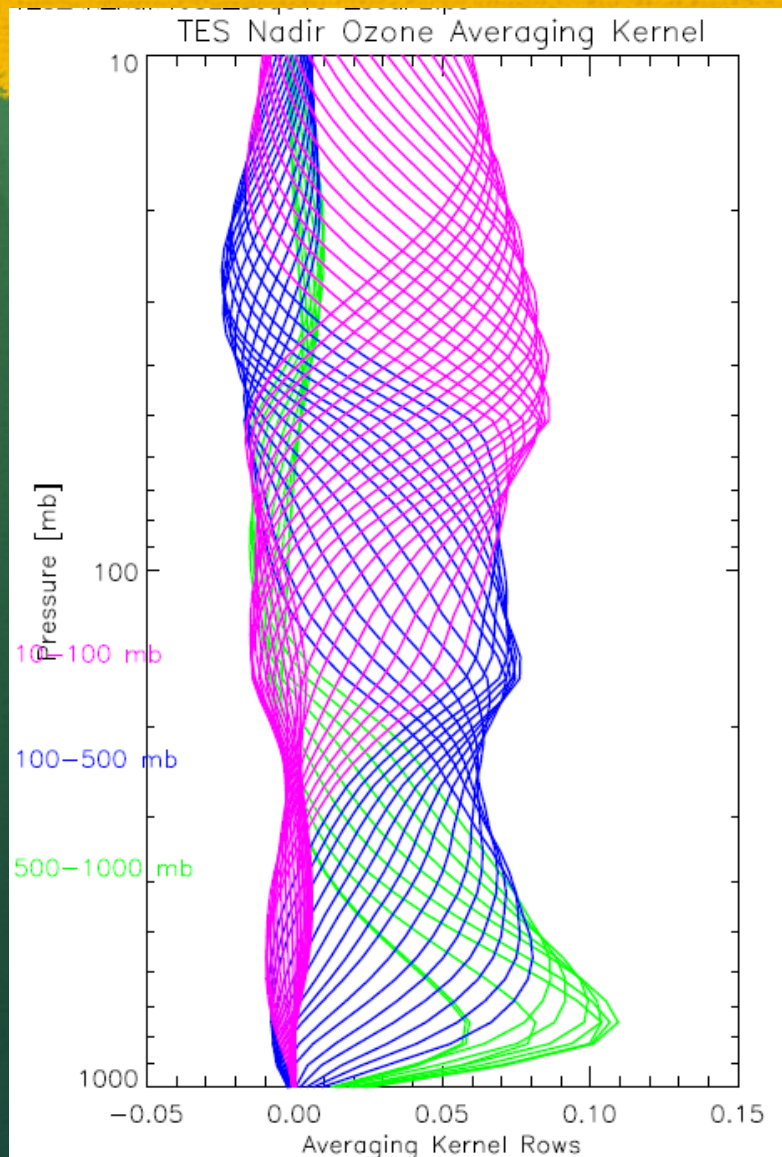


TES Step & Stare Nadir Retrieval Result: CO

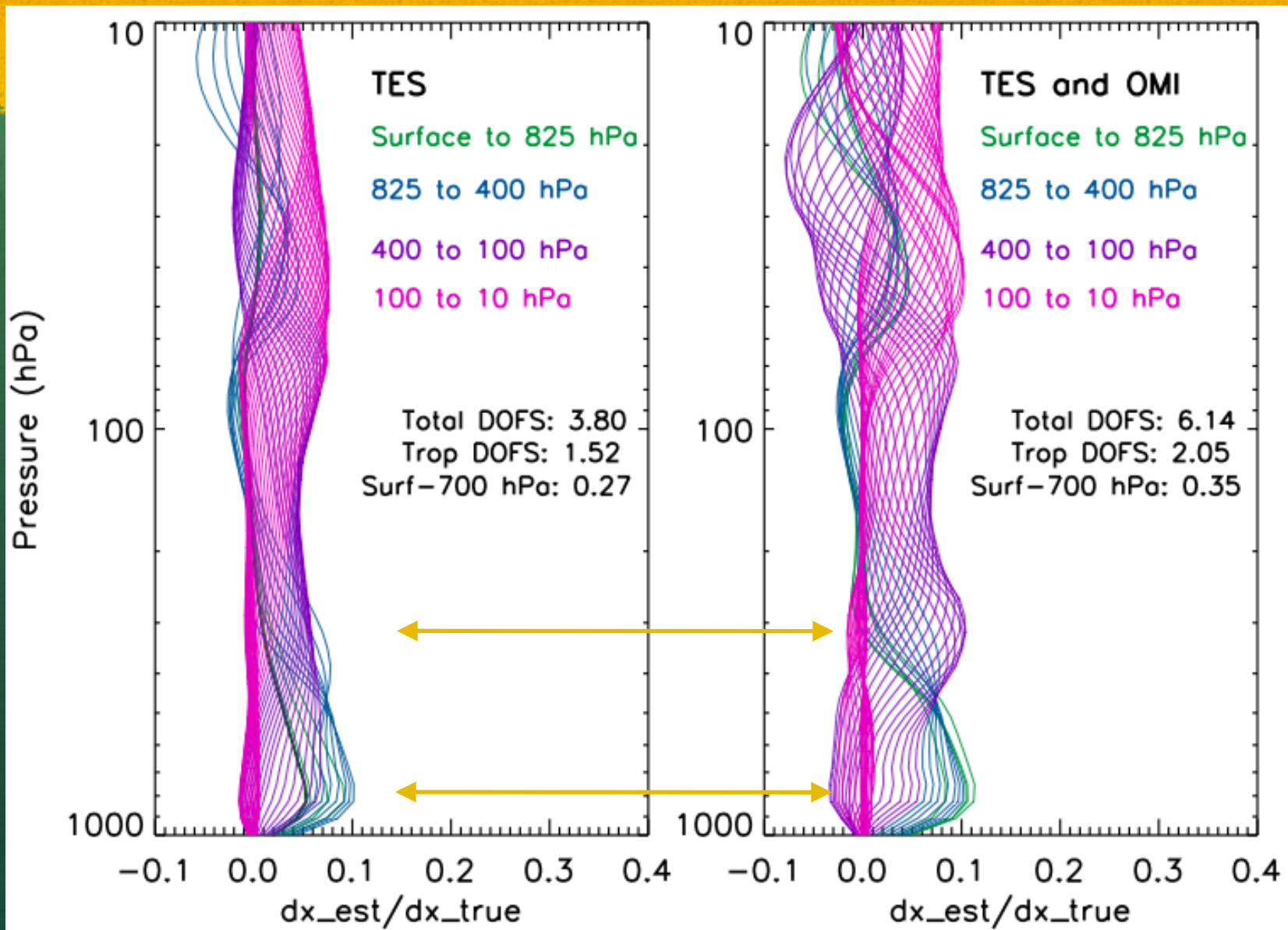
Cross Section Along Orbit Track: RunID=4911, Seq=1-1, Scan=0-124, UTtime=2006-8-23 19:34:40-19:48:31



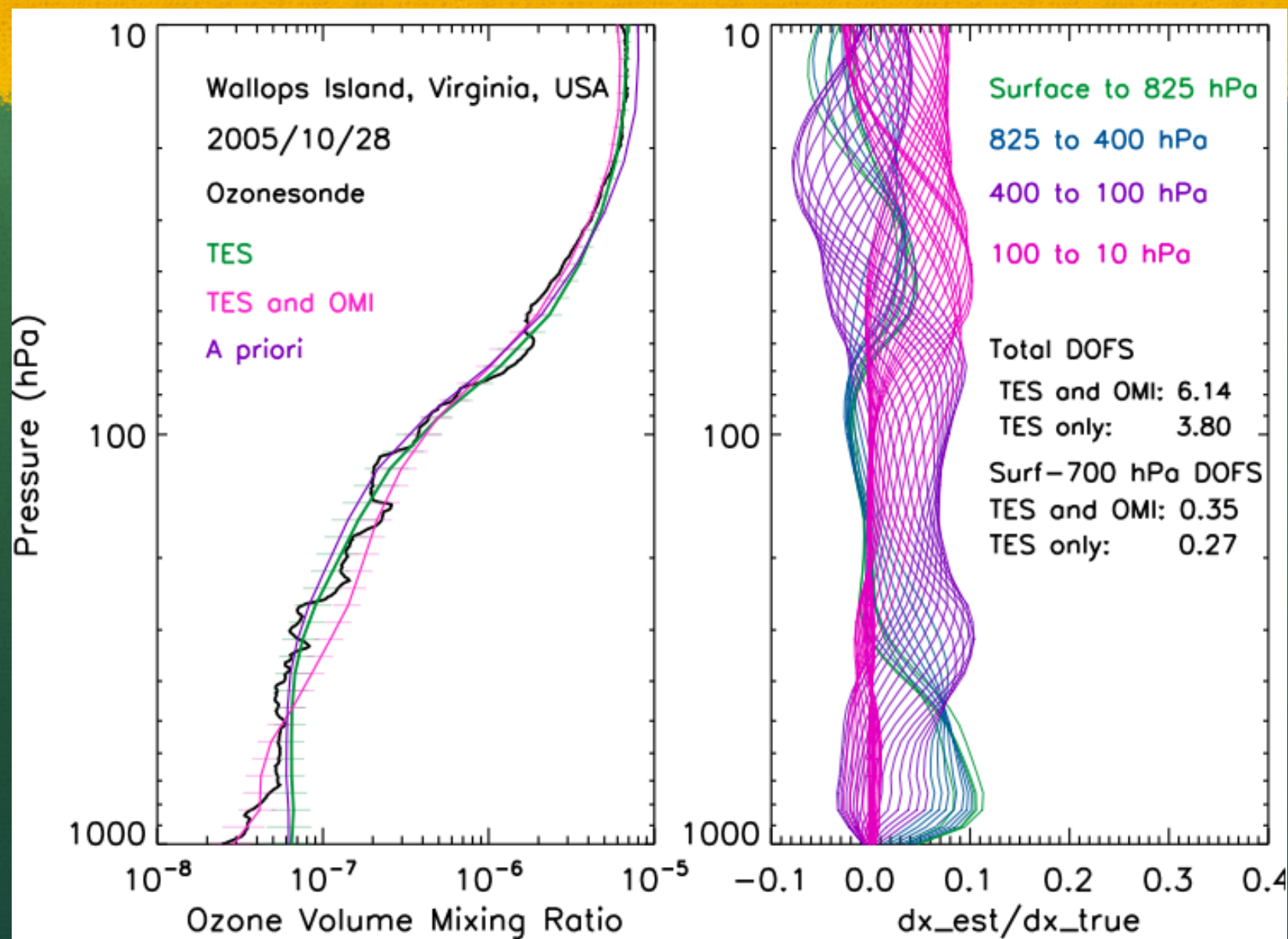
Measurement Sensitivity



New: TES + OMI



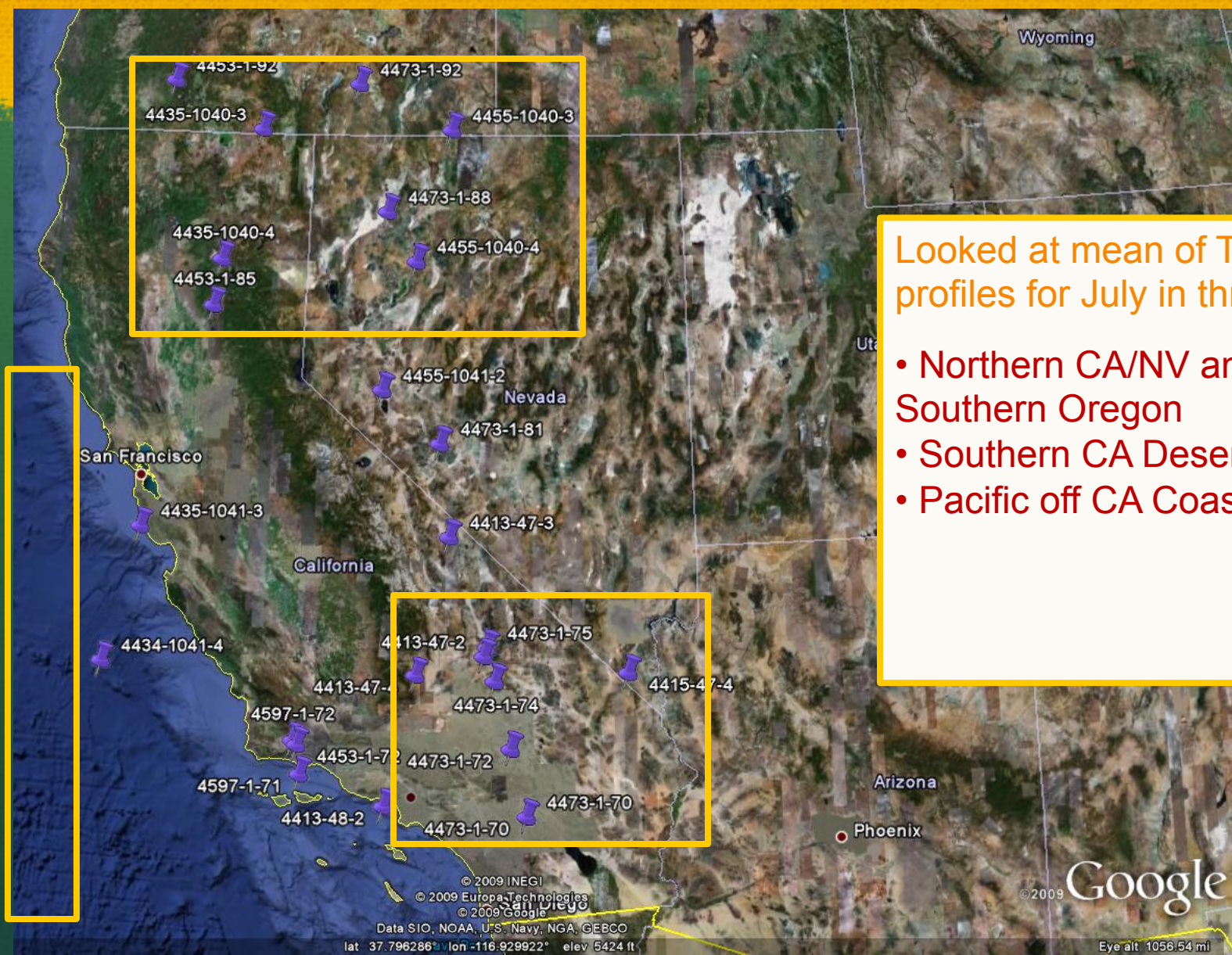
Measurement Sensitivity





Air Quality Model Evaluation using TES

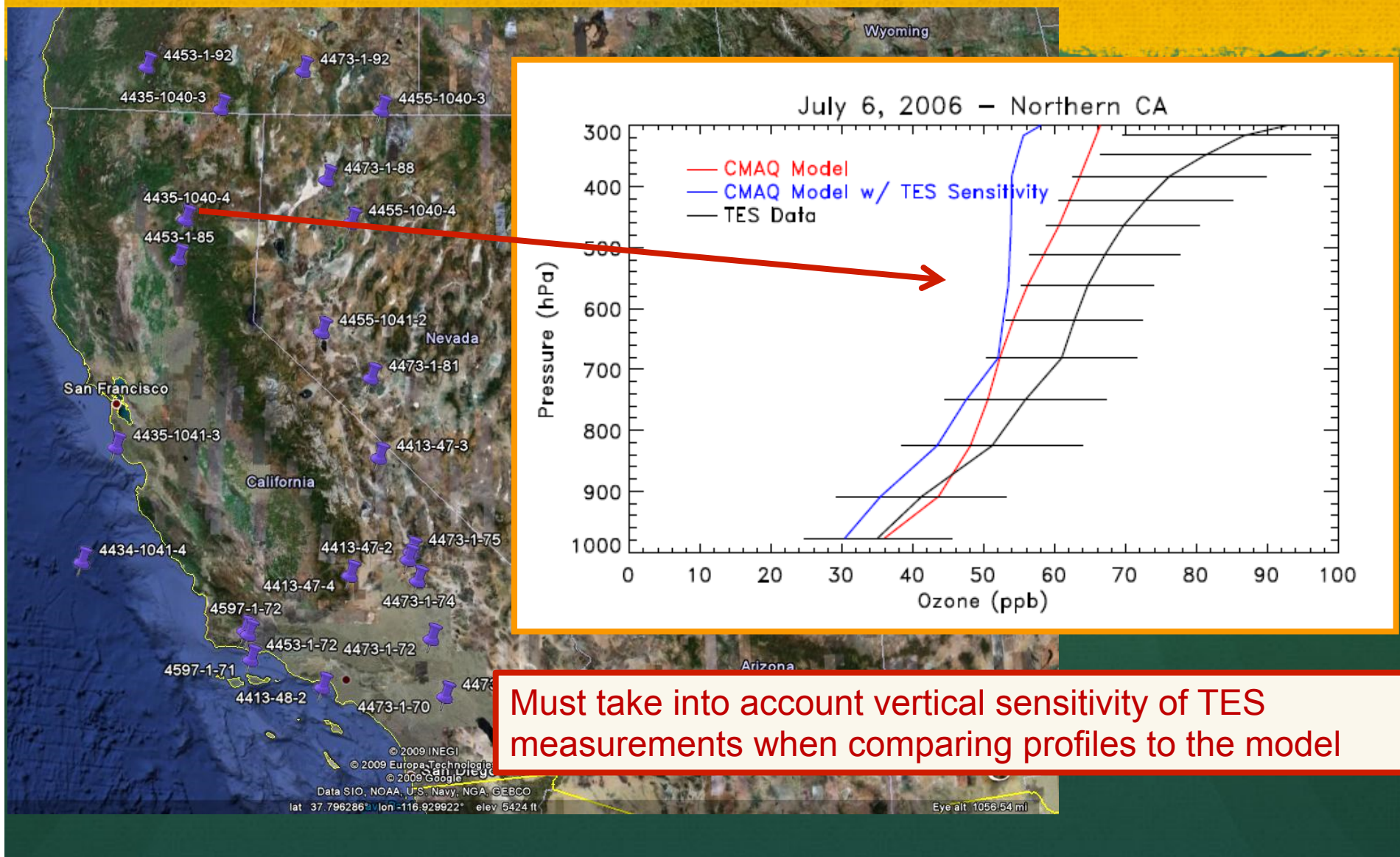
Model Evaluation using TES Tropospheric O₃



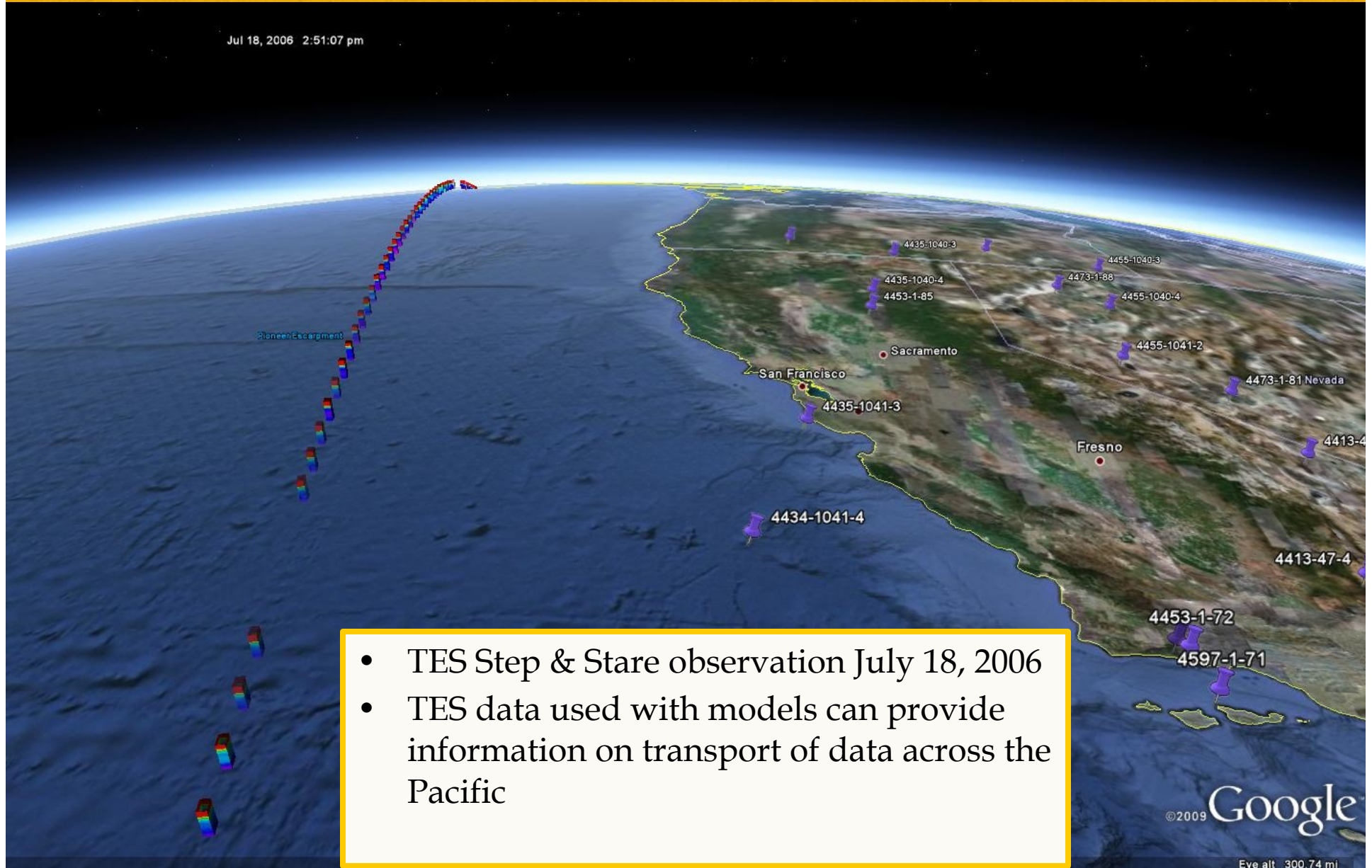
Looked at mean of TES profiles for July in three areas:

- Northern CA/NV and Southern Oregon
- Southern CA Desert
- Pacific off CA Coast

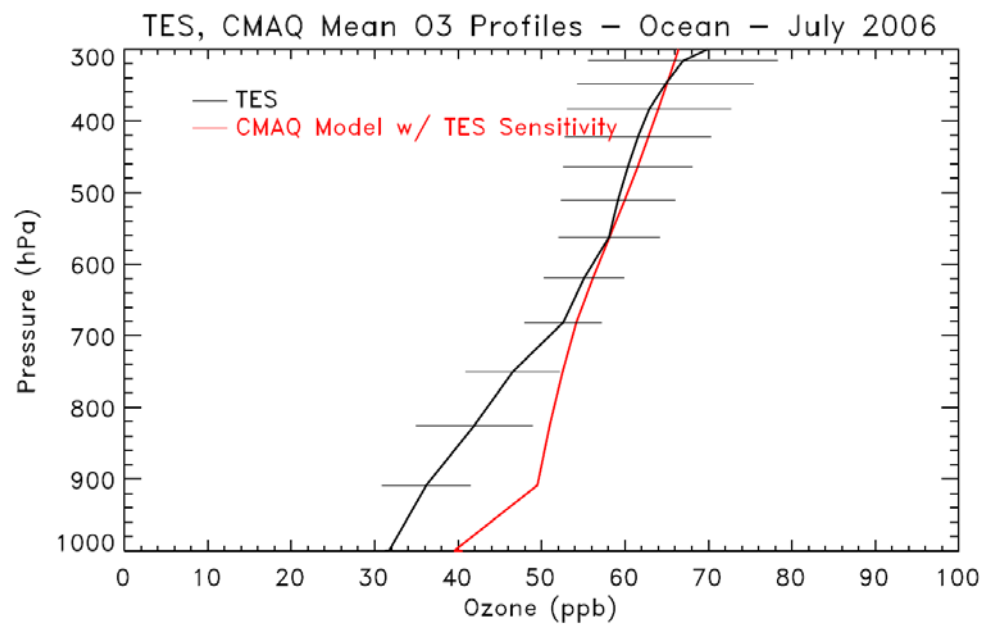
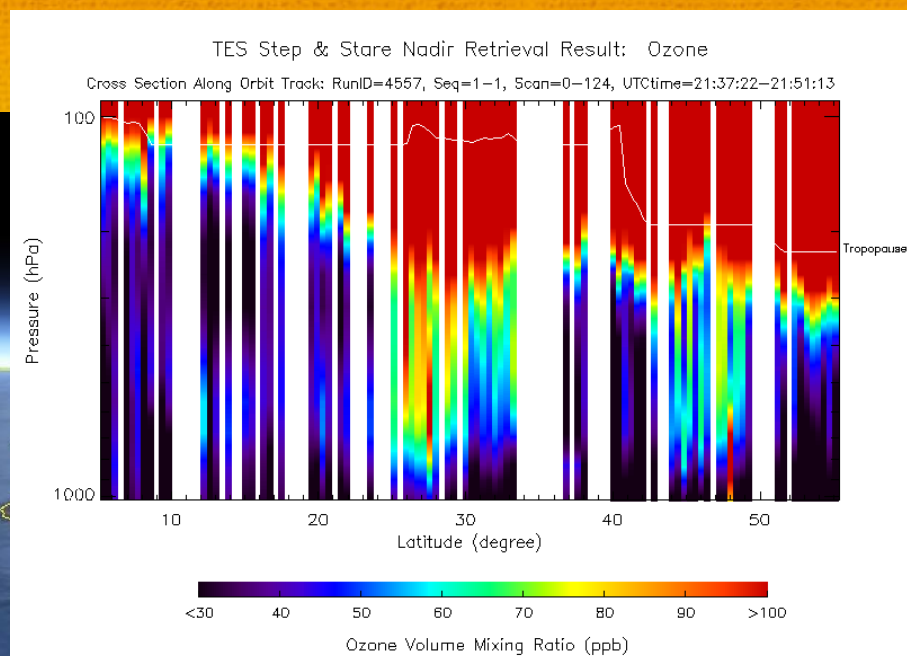
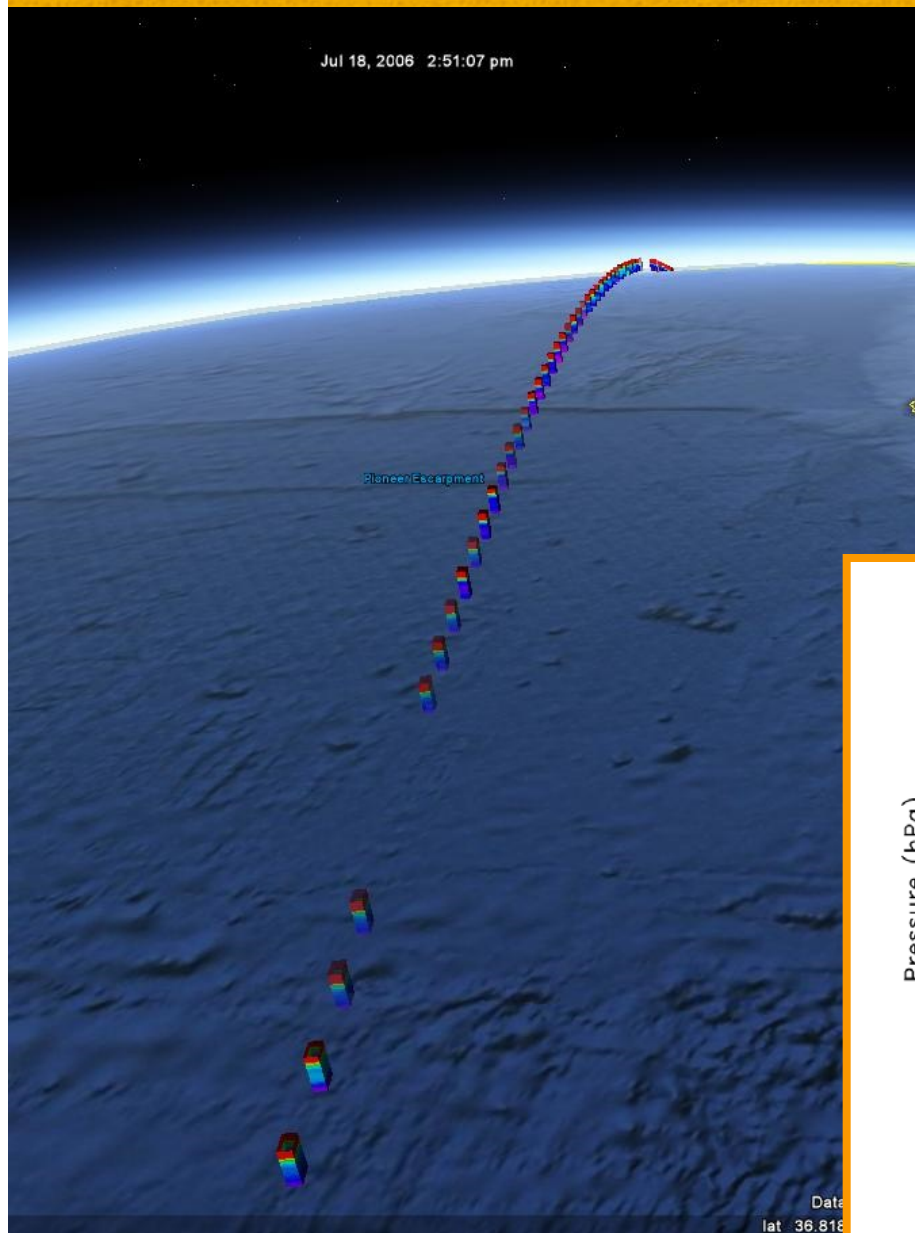
Model Evaluation using TES Tropospheric O3



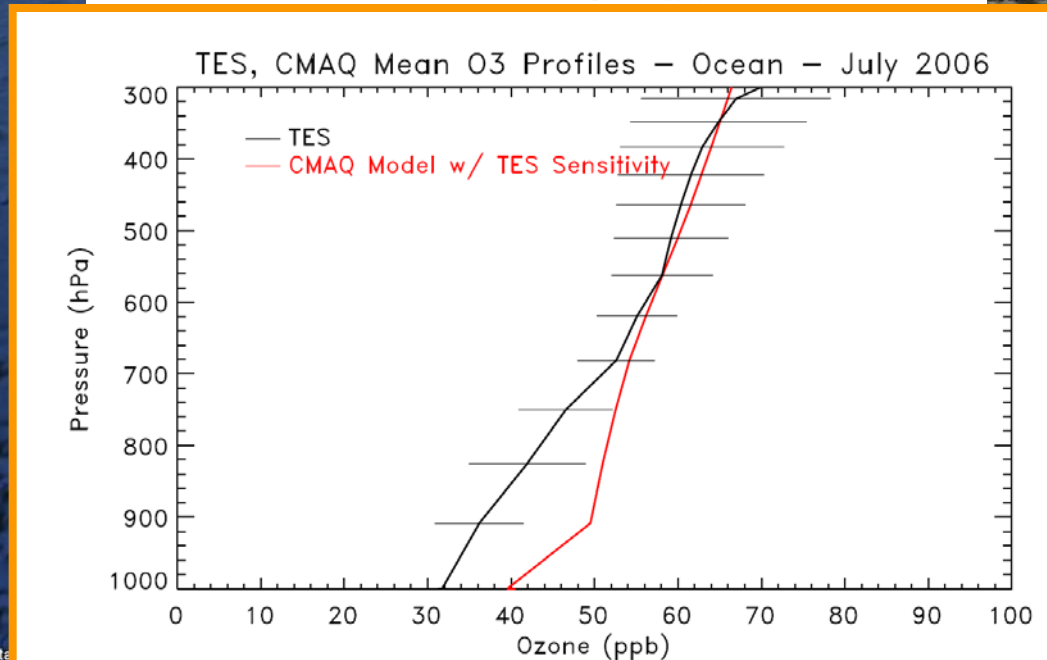
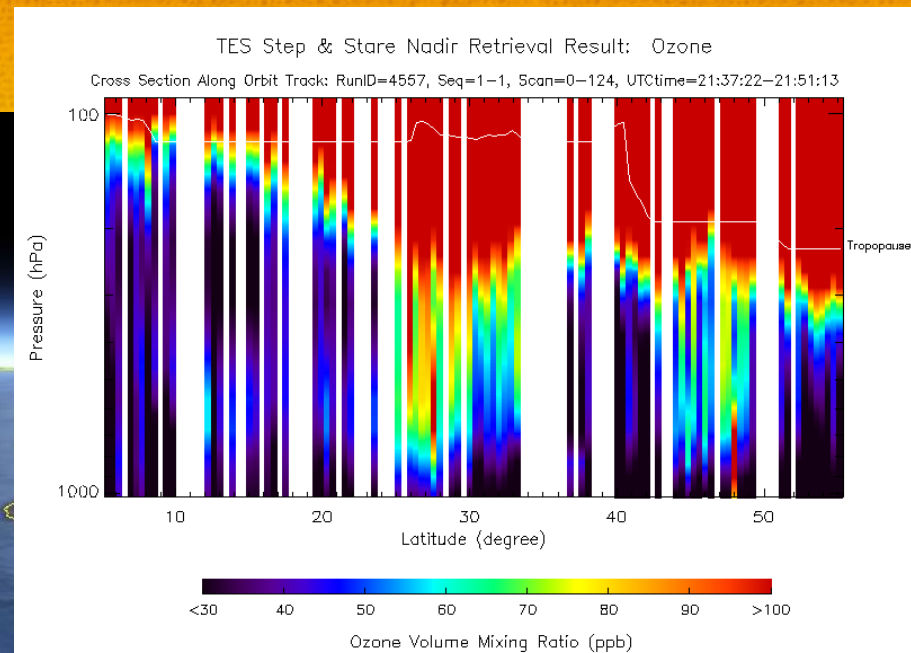
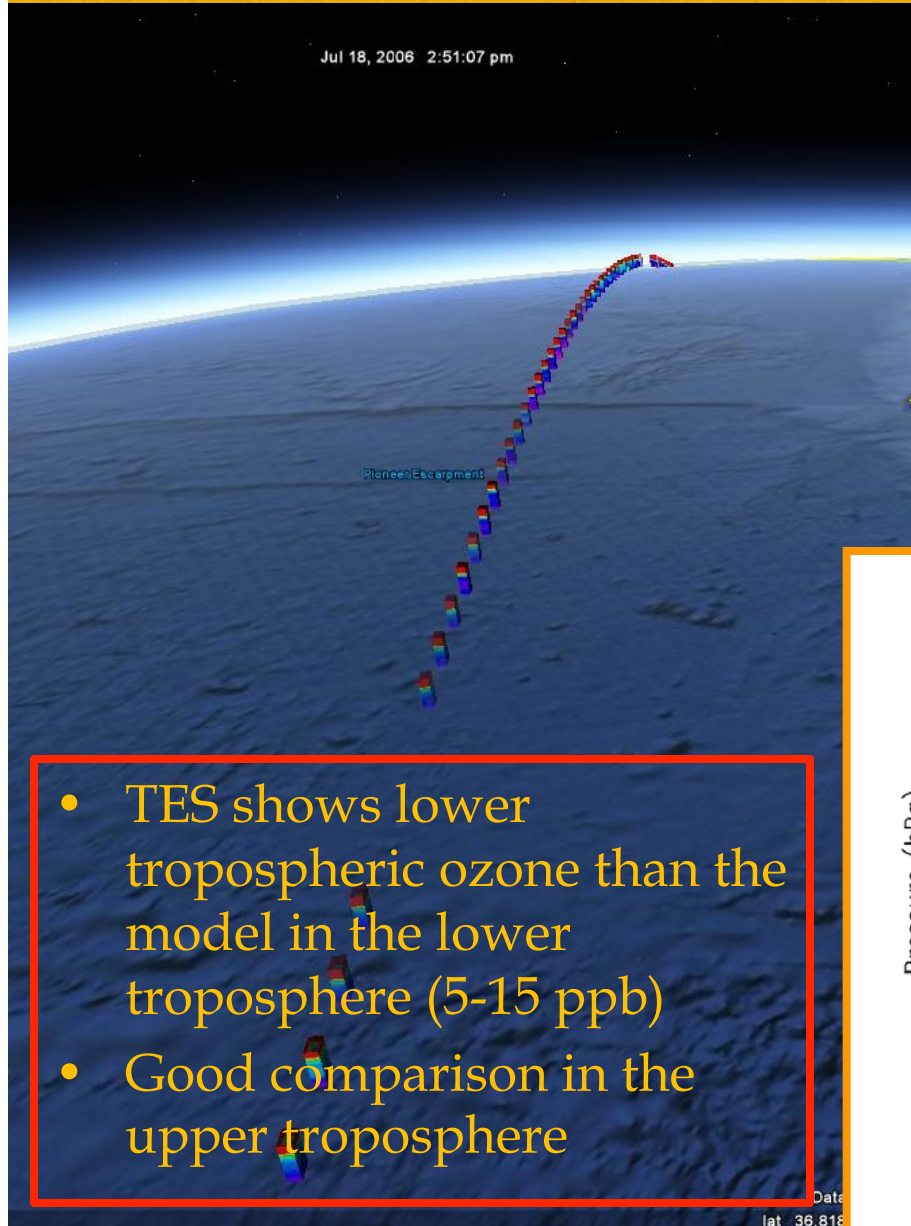
Evaluation: Ocean



Ocean

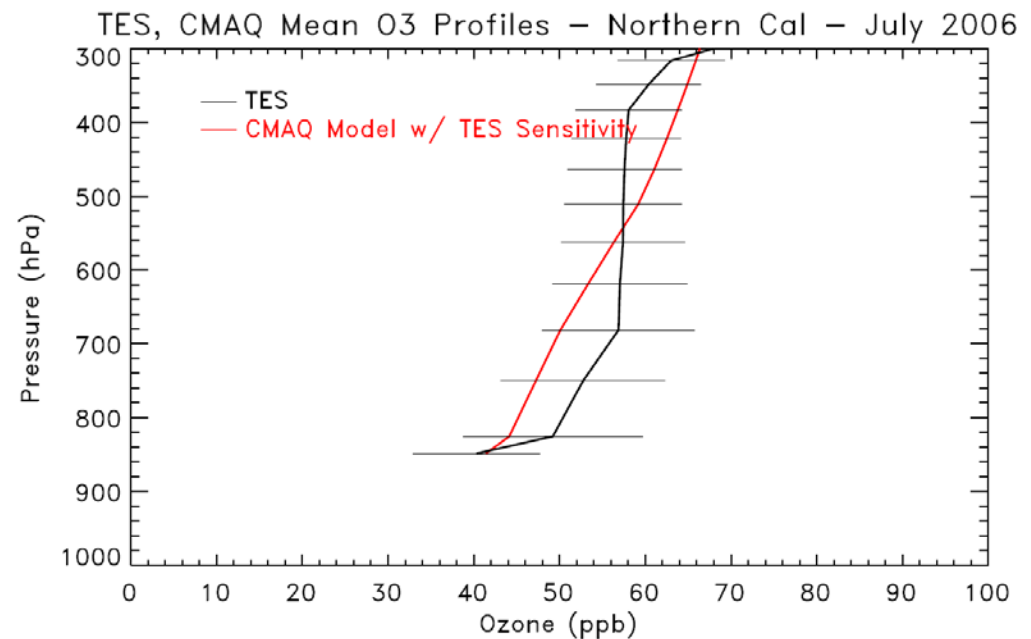
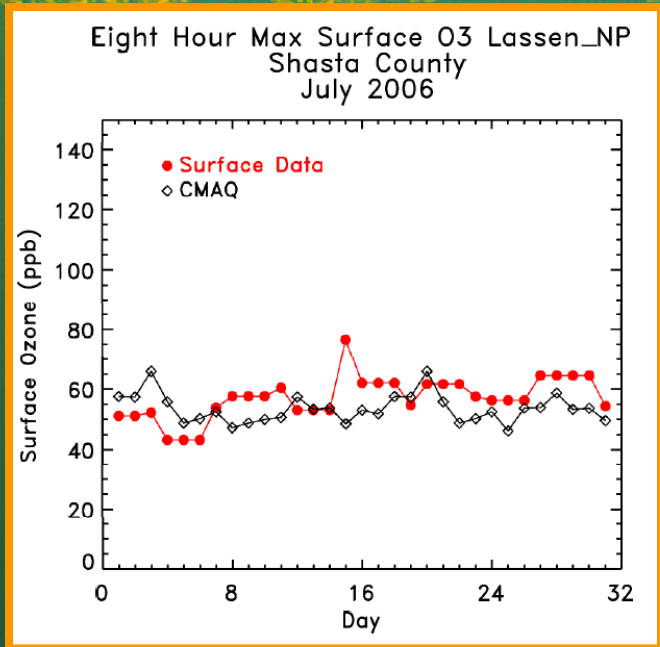


Ocean



- TES shows lower tropospheric ozone than the model in the lower troposphere (5-15 ppb)
- Good comparison in the upper troposphere

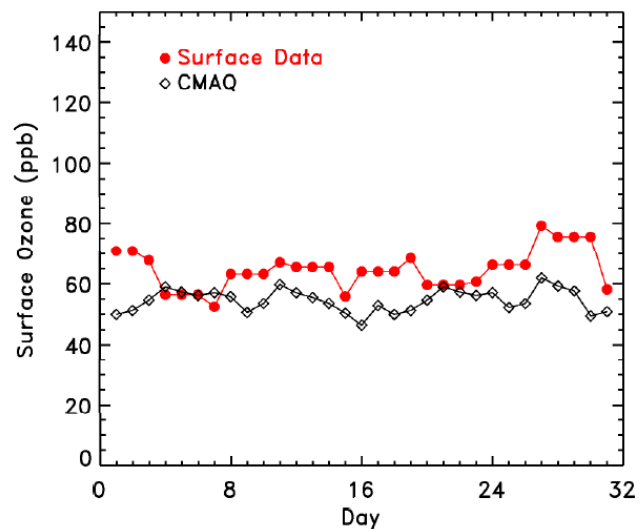
Evaluation: Northern California



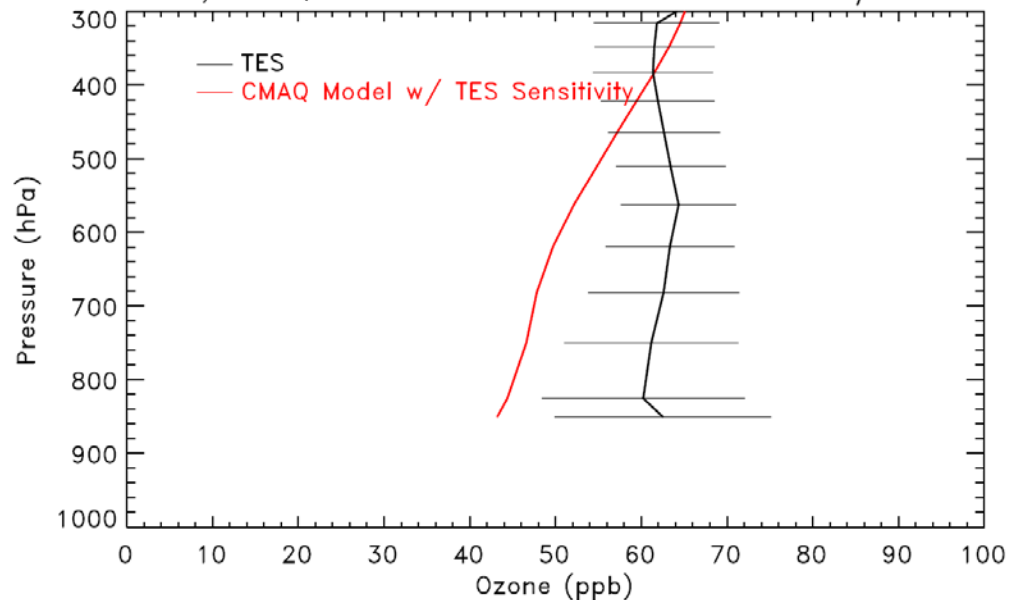
- TES shows reasonable comparison with model throughout the troposphere
- Surface monitor data higher than CMAQ for month at Lassen and Yreka

Evaluation: Southern California Desert

Eight Hour Max Surface O₃ Death_Valley
Inyo County
July 2006

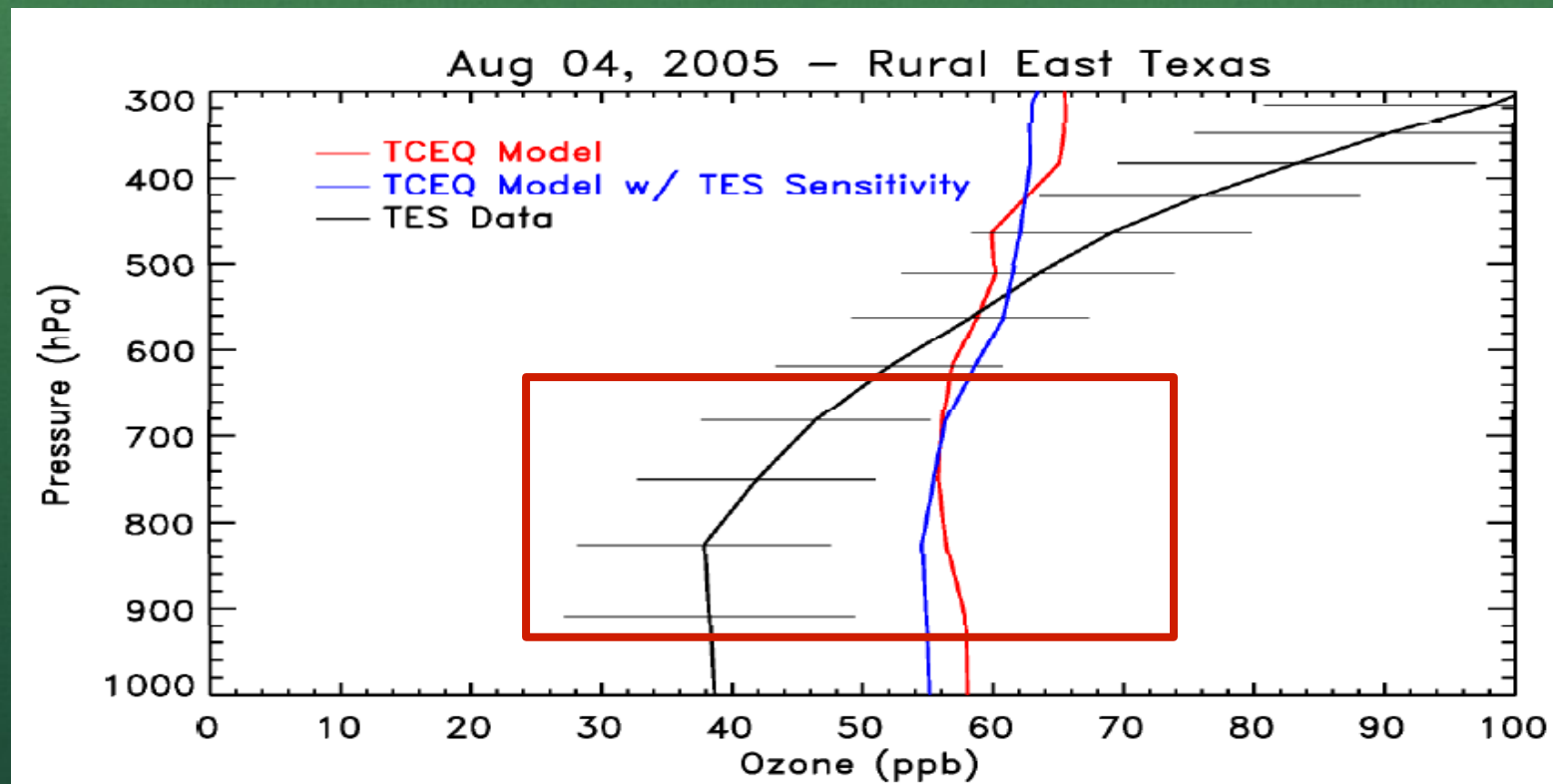


TES, CMAQ Mean O₃ Profiles – Desert – July 2006



- TES shows higher tropospheric ozone than the model in the lower troposphere (15-20 ppb)
- Good comparison in the upper troposphere
- Surface monitor data higher than CMAQ for month at Death Valley, Palm Springs and Joshua Tree

Evaluation of CAMx Ozone in Free Troposphere



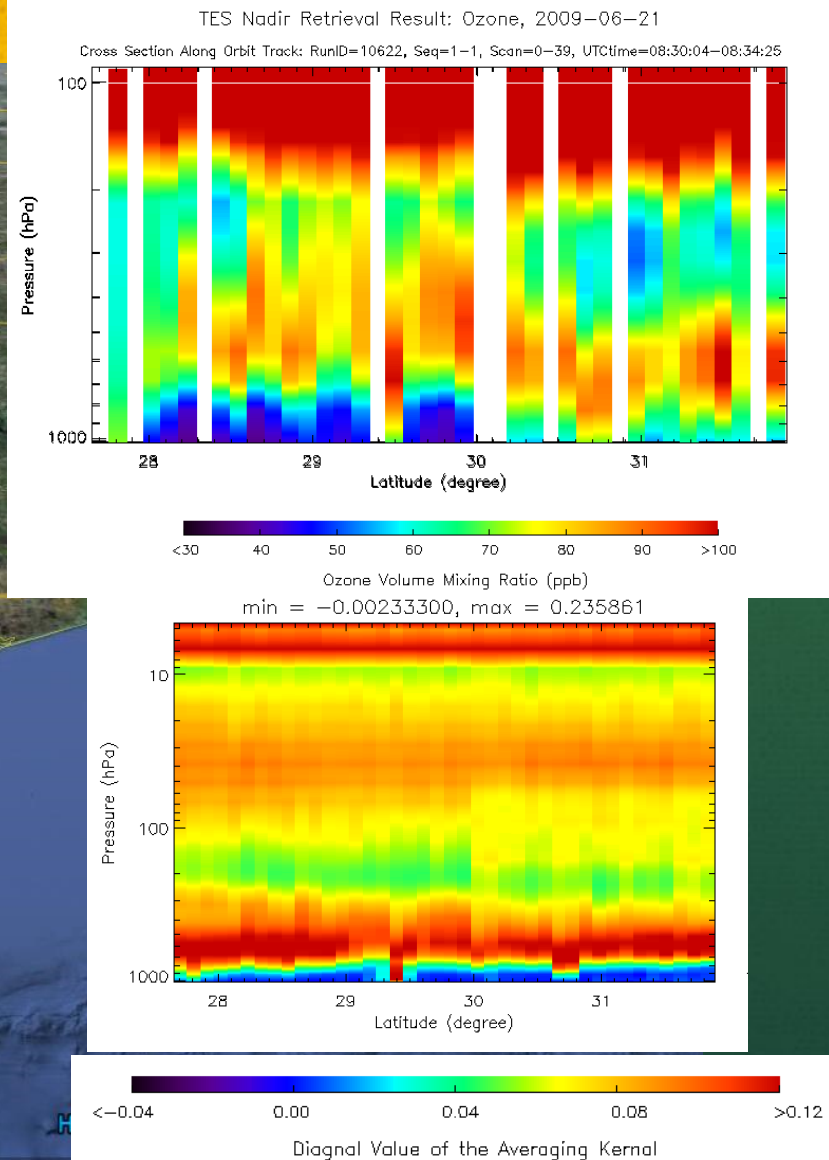
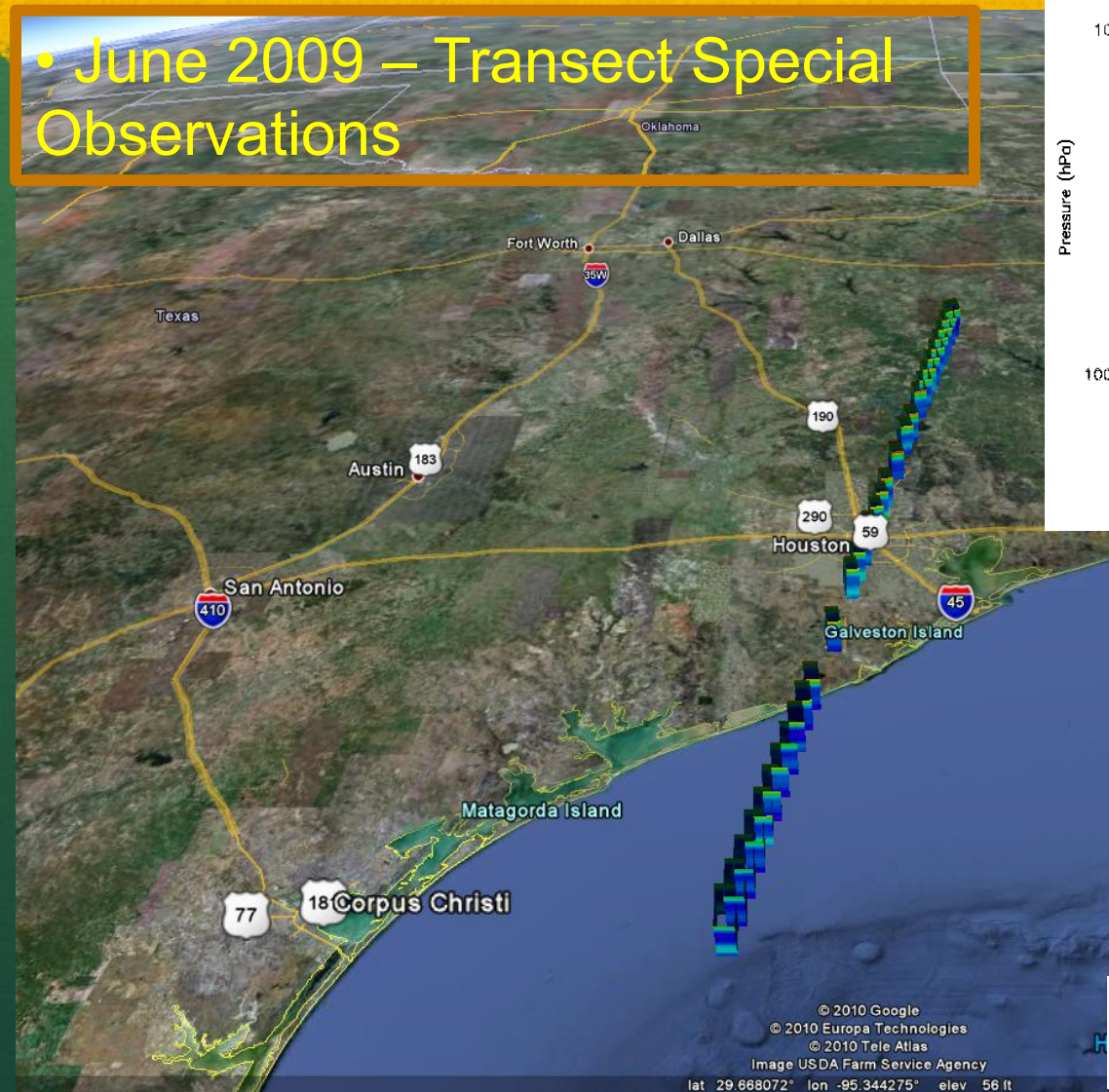
- **Preliminary Result** – CAMx model higher than TES in lower troposphere



TES Observations of Nighttime Ozone

TES Observations of Nighttime Ozone

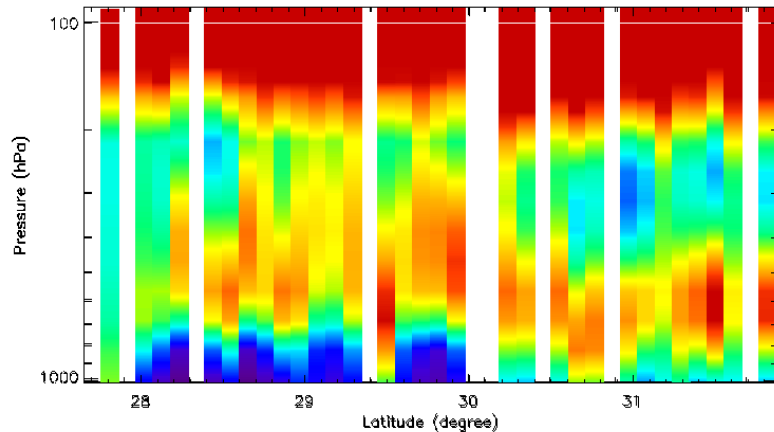
- June 2009 – Transect Special Observations



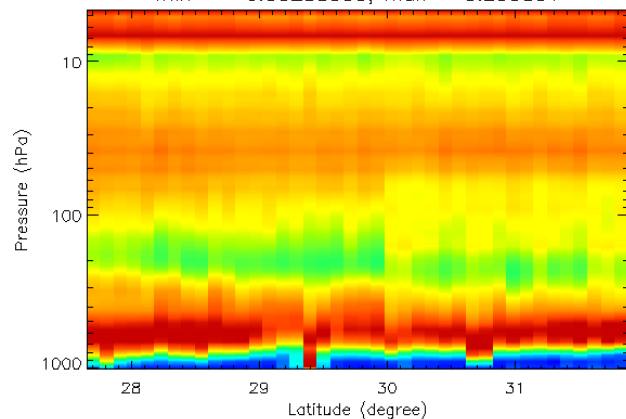
TES Observations of Nighttime Ozone

TES Nadir Retrieval Result: Ozone, 2009-06-21

Cross Section Along Orbit Track: RunID=10622, Seq=1-1, Scan=0-39, UTCtime=08:30:04-08:34:25



Ozone Volume Mixing Ratio (ppb)
min = -0.00233300, max = 0.235861

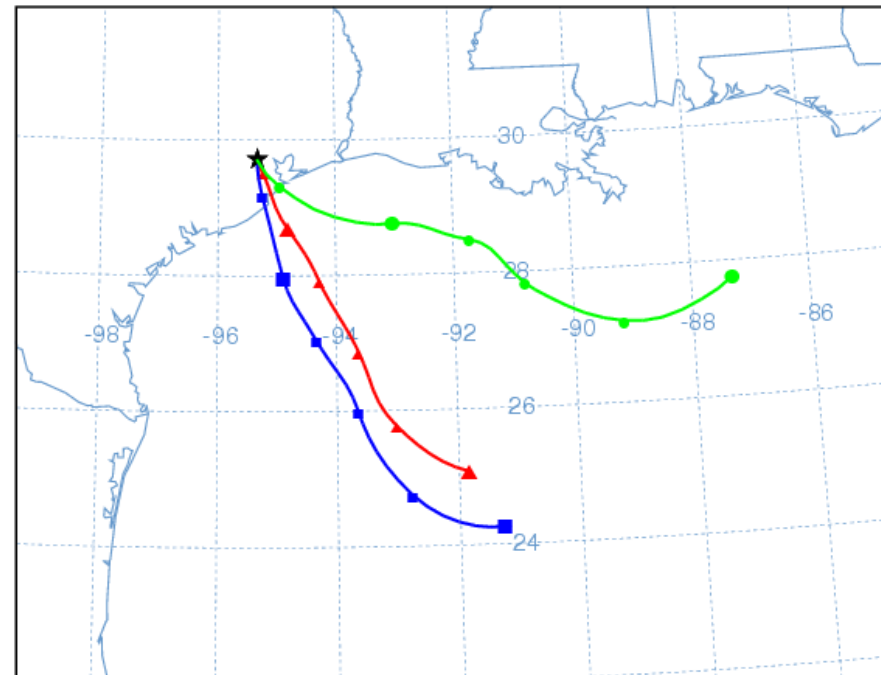


Diagonal Value of the Averaging Kernel
<-0.04 0.00 0.04 0.08 >0.12

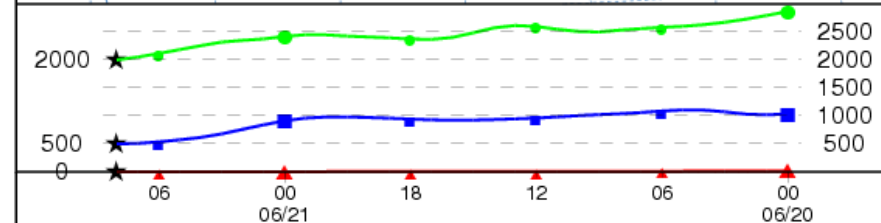
NOAA HYSPLIT MODEL

Backward trajectories ending at 0800 UTC 21 Jun 09
NAM Meteorological Data

Source ★ at 29.72 N 95.34 W



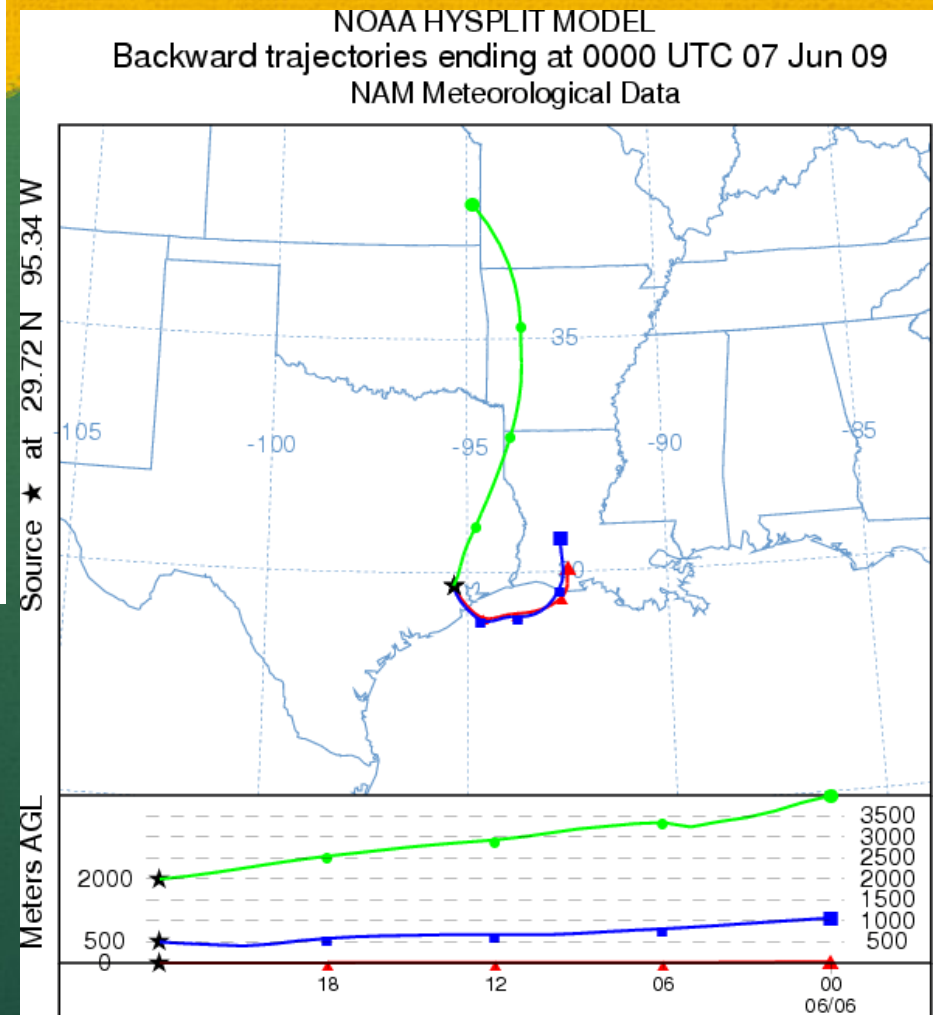
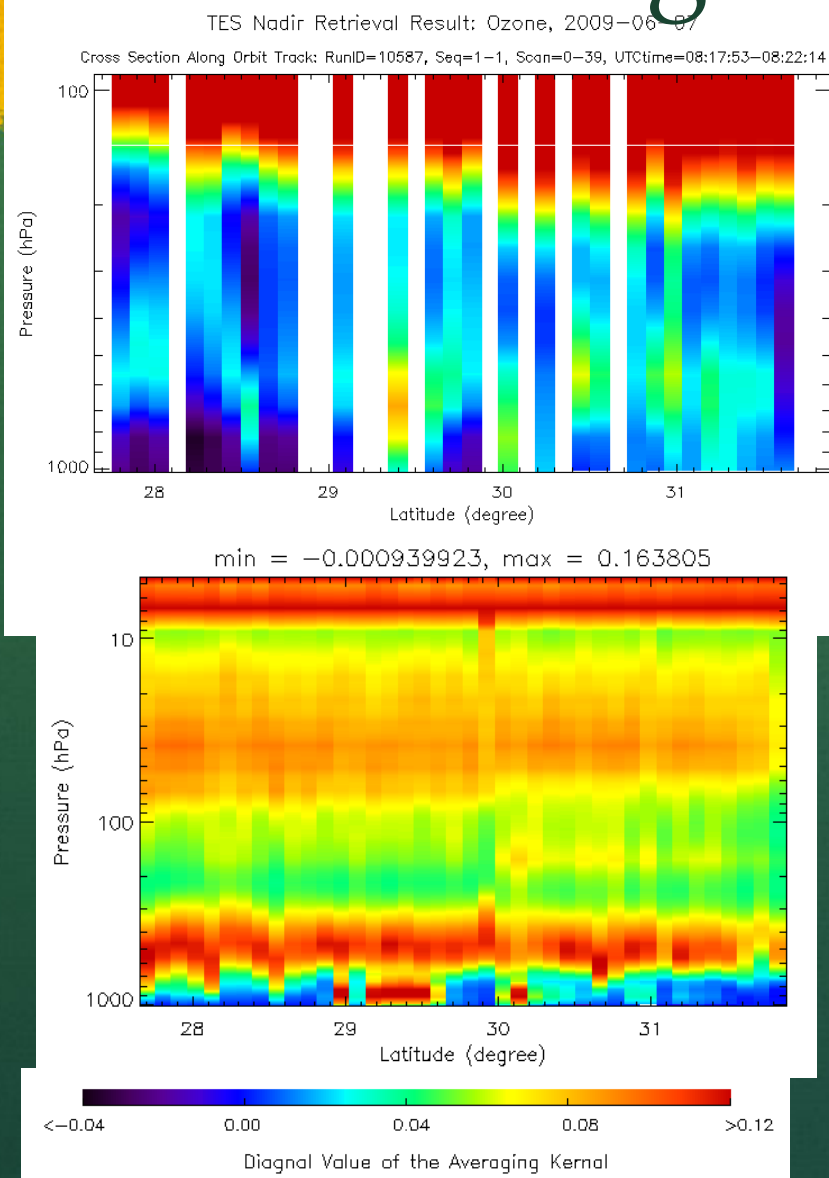
Meters AGL



Job ID: 31150 Job Start: Mon Feb 8 07:37:45 UTC 2010
Source 1 lat: 29.7176 lon: -95.3414 hghts: 000, 500, 2000 m AGL

Trajectory Direction: Backward Duration: 72 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 21 Jun 2009 - NAM12

TES Observations of Nighttime Ozone



O₃ in the Houston area on the morning of June 7 was in the range of 30-40.

Wrap Up

- Just getting started ...
 - Model outputs received – July and August 2006 from EPA and NOAA/NWS
 - Beginning day time comparisons with TES and ozonesondes
 - Systematic comparisons to models (daytime and nighttime)
- Acknowledgements
 - Aura 2010 Project Investigators
 - Dejian Fu and Entire TES team
- Thank you!