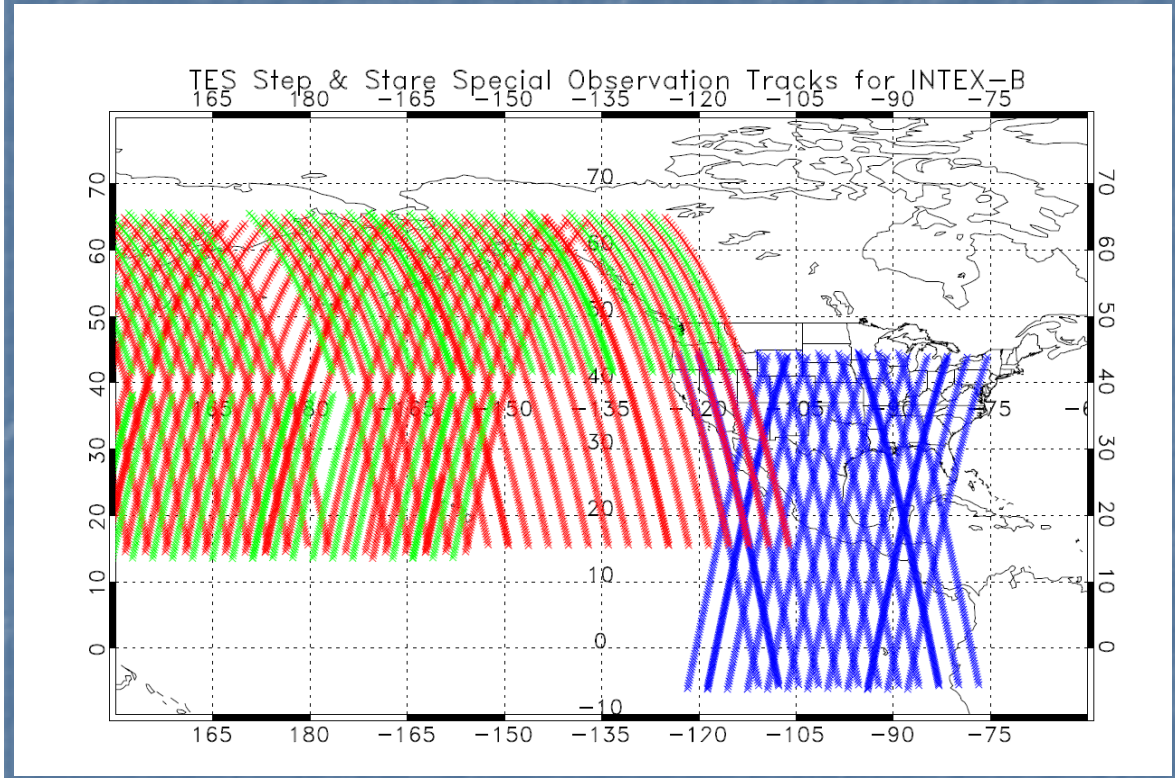
TES Observations in Support of INTEX-B

Annmarie Eldering, Greg Osterman, Susan Kulawik, Line Jourdain, Changsub Shim, Kevin Bowman and the TES Science Team

INTEX-B Meeting
March 6, 2007

Jet Propulsion Laboratory
California Institute of Technology

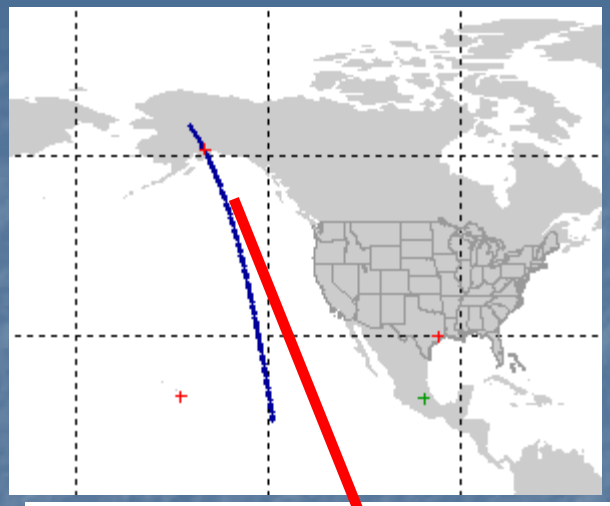
TES Participation in INTEX-B

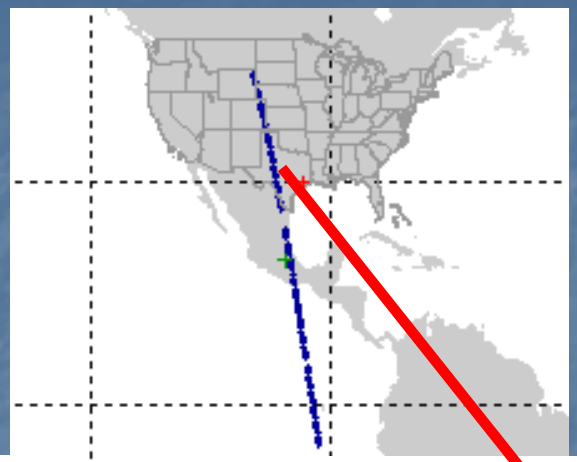


- INTEX-B is an extremely important mission for TES both scientifically and for data validation
- TES performed 243 Step & Stare (nadir) and 193 Limb special observations during INTEX-B
- TES provided overpass information about special observations to IONS-06 science team

Jet Propulsion Laboratory
California Institute of Technology

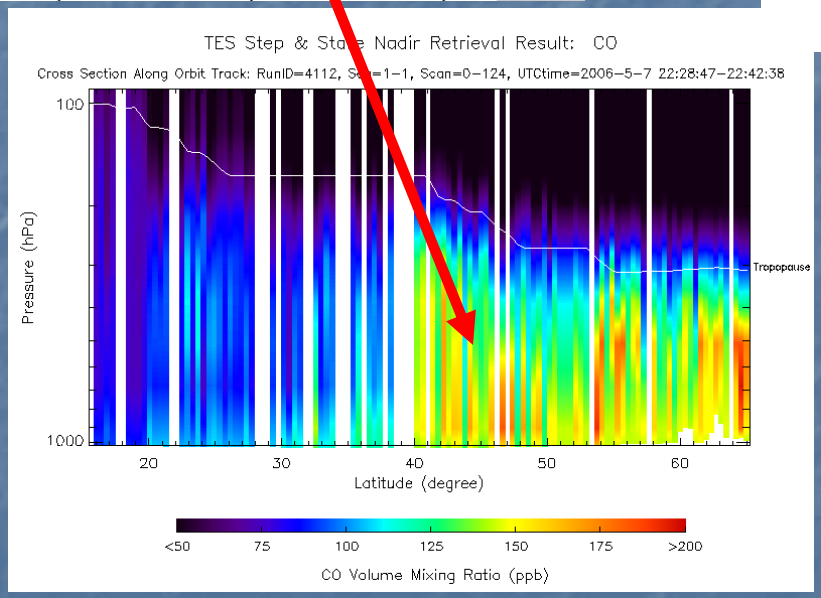
TES Special Observations, Summer 2006

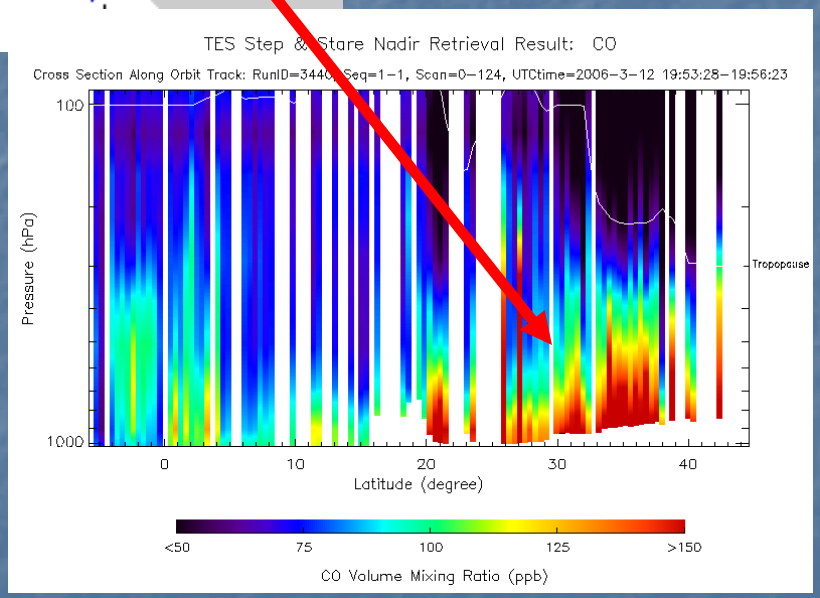




Step/Stare footprints:
~0.4 deg = 45 km apart

Global Survey footprints:
~1.6 deg = 180 km apart





May 7, 2006 – CO over the Pacific

March 12, 2006 – High CO over Texas and Midwestern USA

Jet Propulsion Laboratory
California Institute of Technology

TES Run IDs – DC-8 Flights

Date	DC-8 Flight #	TES Run ID	TES Observation
March 4	3	3399	Step & Stare
March 9	4	3429	Global Survey
March 12	6	3440	Step & Stare
March 16	7	3459	Step & Stare
March 21	9	3498	Global Survey
April 17	10	3700	Step & Stare
April 23	11	3830	Step & Stare
April 25	12	3868, 3869	Step & Stare, Limb
April 28	13	3921	Global Survey
May 1	14	3961	Step & Stare
May 7	16	4112, 4113	Step & Stare, Limb
May 9	17	4154, 4155	Step & Stare, Limb

TES L2 Data Products Update – Version 2 (V002)

- TES Version 2 data has processed for all TES runs since launch
- Significant improvements over previous version
  - L1B calibration improvement
  - L2 algorithm improvements
  - More extensive quality control information
- Version 2 includes HDO as a standard product
- Version 2 includes the first limb retrievals
  - Stratosphere only for this version
- Data available at the Langley Atmospheric Sciences Data Center (http://eosweb.larc.nasa.gov/) or the Aura Validation Data Center (http://avdc.gsfc.nasa.gov)
- Information on using TES data in the *TES L2 Data User's Guide* available at the Langley ASDC or the TES website

TES L2 Data Products Update – Version 3 (V003)

- TES Version 3 data has just begun processing
- Improvements over previous version
  - L2 atmospheric temperature profile improvements
  - L2 nadir ozone improved in the upper troposphere
  - Species dependent quality control information
- Version 3 includes improved limb retrievals in the troposphere
- Updated *TES L2 Data User's Guide* for Version 3 data coming soon
- Estimated that processing of all TES data with V003 will be complete in Fall 2007

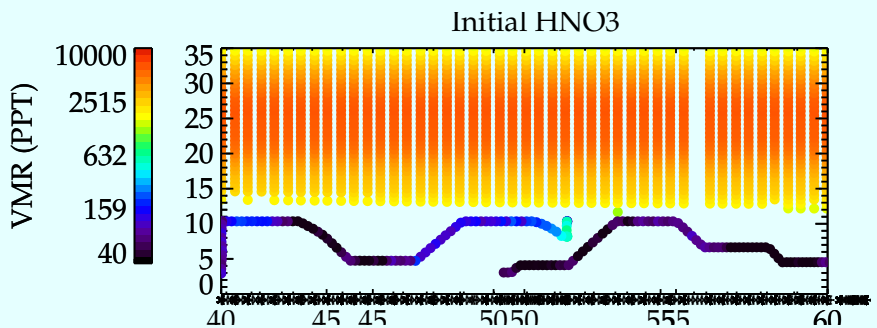
TES L2 Product Validation Update

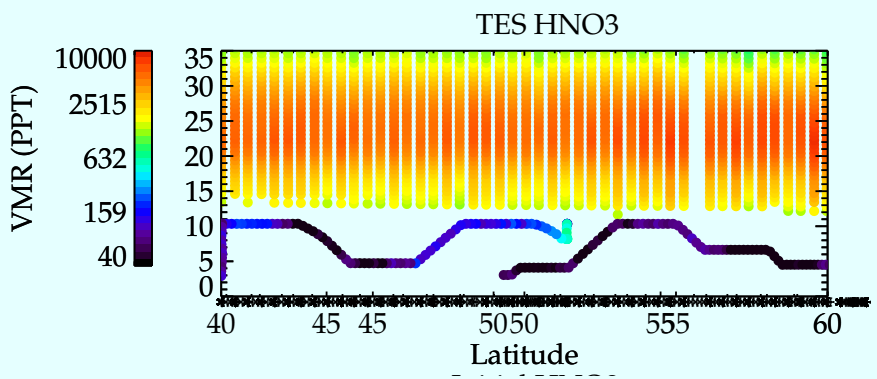
- Primary TES Level 2 nadir data products are validated and usable in scientific analyses
  - Version 2 is being used for validation papers that are in preparation
- Analyses using INTEX-B aircraft and IONS-06 data played a key role in
  - Validation of TES data products
  - Evaluation of data product updates
- Limb products HNO3 and O3 have undergone preliminary validation analysis
- *TES L2 Validation Report* (V002 Data) available at the Langley ASDC

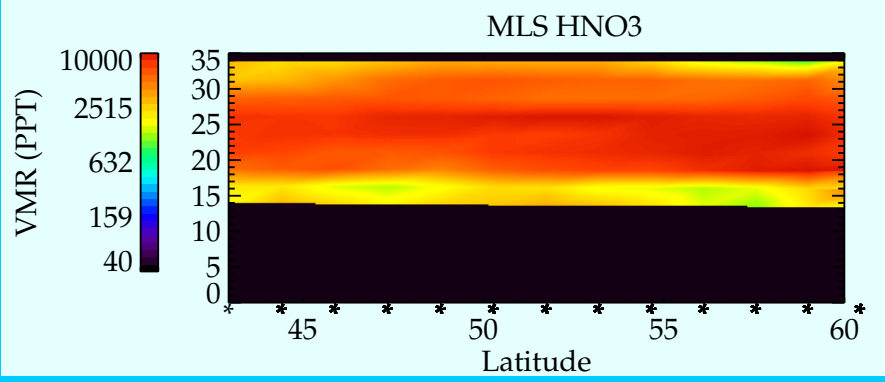
TES L2 Product Validation Status
(as of Feb 2007)

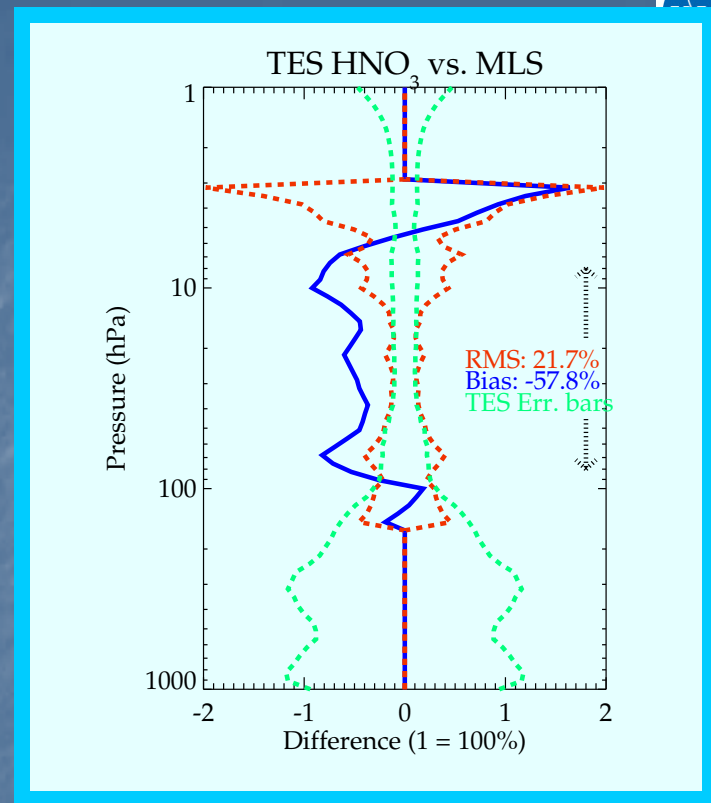
Species	Validation Status
Nadir Ozone	Validated Stage 2
Nadir Carbon Monoxide	Validated Stage 2
Nadir Water (Lower/Middle Troposphere	Validated Stage 2
Nadir Water (Upper Troposphere	Validated Stage 2
Nadir Temperature	Validated Stage 2
Sea Surface Temperature	Validated Stage 2
Land Surface Temperature/Emissivity	Beta (Provisional in 2007)
Nadir Methane	Beta (Provisional in 2007)
Nadir HDO	Validated Stage 1
Limb Nitric Acid	Beta (Provisional in 2007)
Limb Ozone	Beta (Provisional in 2007)
Limb Temperature	Beta (Provisional in 2007)

TES Nitric Acid









TES vs. SAGA

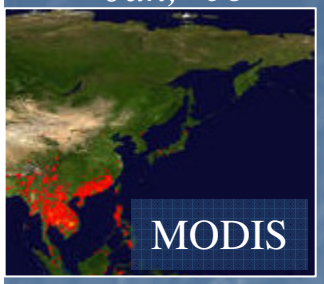
- Current processing IDs clouds below 12 km
- SAGA will be very useful when TES can process the lower detectors

TES vs.MLS

- Comparisons show similar pattern
- TES shows a -58% bias wrt MLS and the RMS is very similar to the TES reported error between 100 and 10 hPa

Seasonality of TES High Ozone Events

Jan, '06



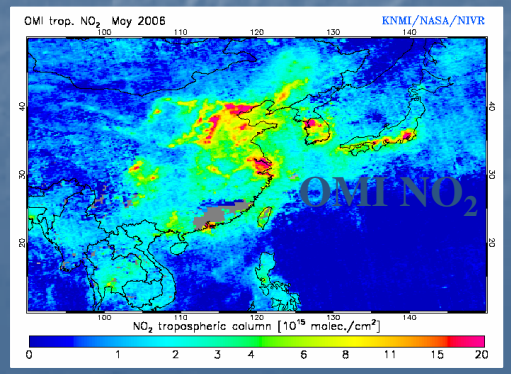
March, '06

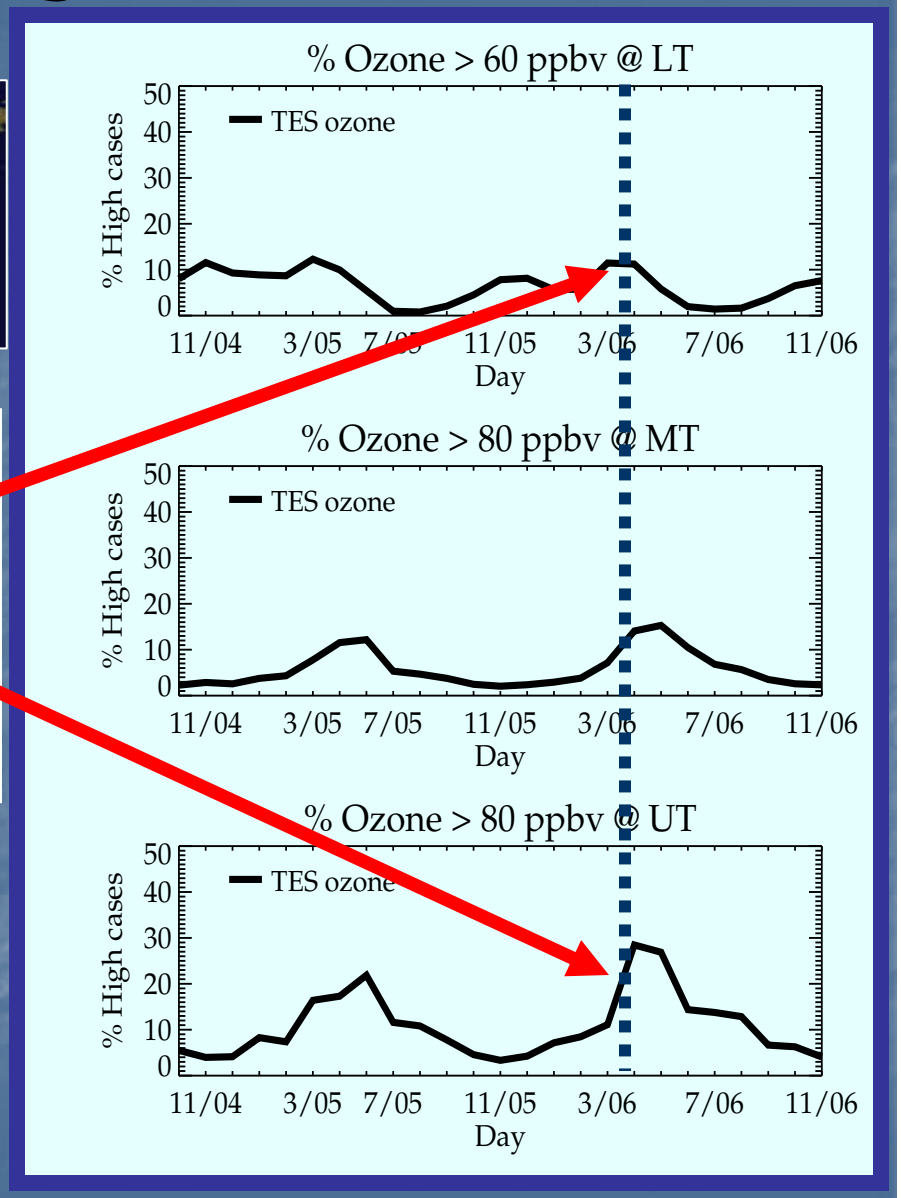
May, '06

The lower tropospheric ozone maximum results from Southeast Asia Biomass Burning. Oltmans et al., 2004

Upper tropospheric ozone has a maximum in May and a minimum in November. Thouret et al., 2006

May, '06

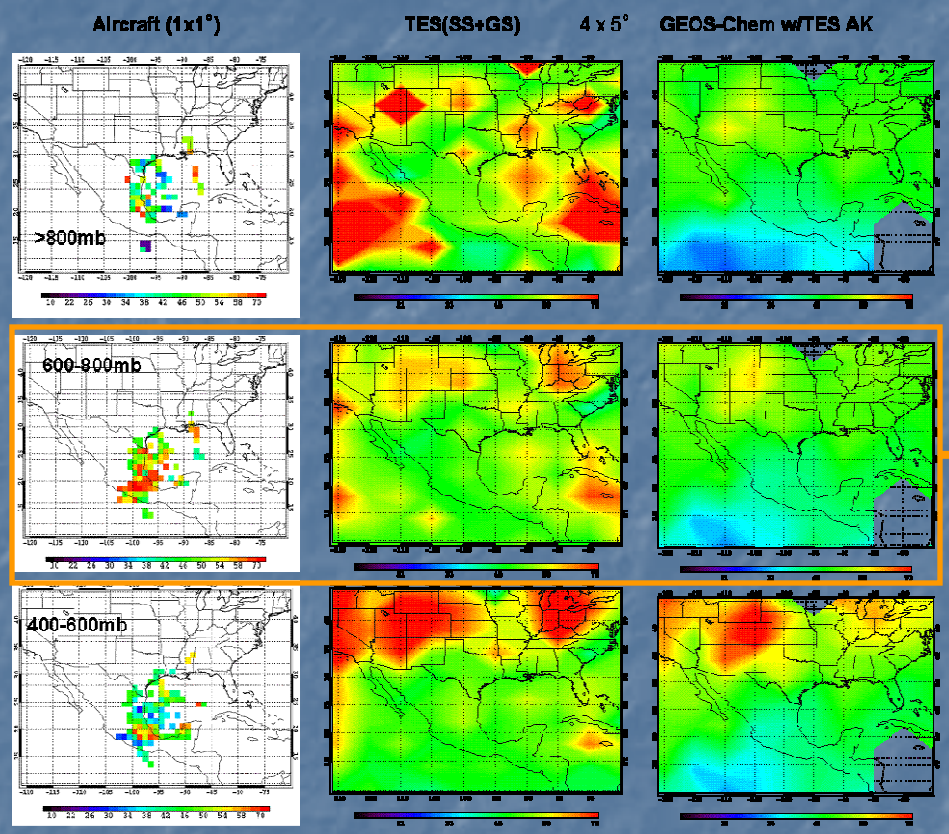




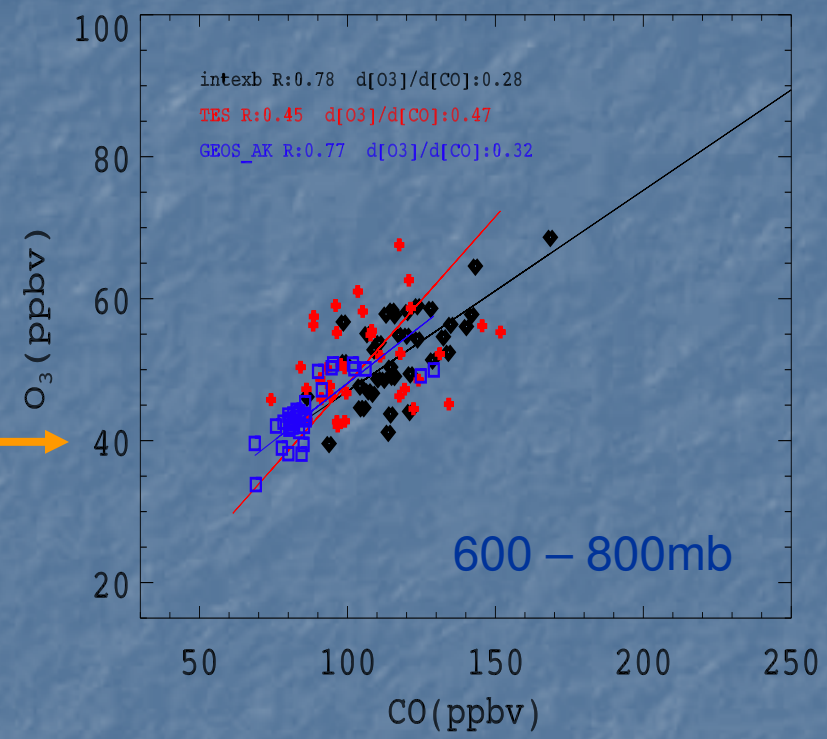
Jet Propulsion Laboratory
California Institute of Technology

Characterizing the Effect of Megacity (MCMA) Pollution on Regional Air Quality using TES measurements

In situ O_3 observations, TES retrieval, and GEOS-Chem/AK, Mar 2006



Relationship of O_3 - CO

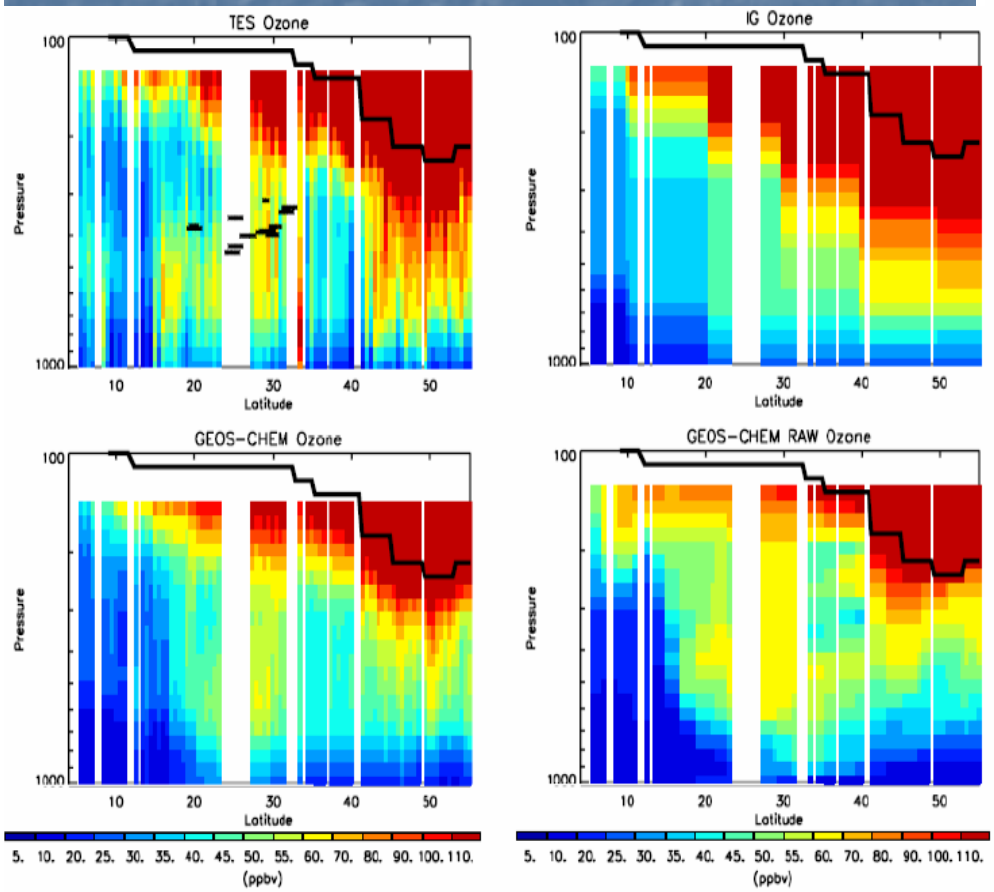


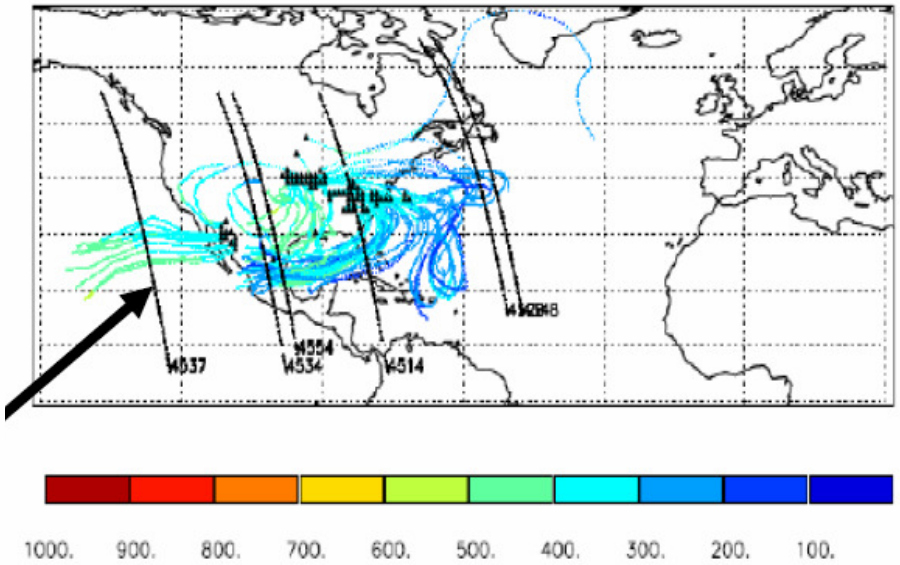
The Aircraft measurements show the significant enhancement of O_3, CO, and iso-Pentane at 800 – 600mb, reflecting pollution outflow from the MCMA. Those enhancement are not apparent in TES O_3 and CO retrievals. (CO and iso-Pentane observations are not shown.)

The relationship of O_3 and CO derived from TES data is in good agreement with those derived from the aircraft observations and GEOS-Chem simulations (*r*: 0.4 – 0.8; $\Delta O_3/\Delta CO$: 0.28 – 0.47), implying significant O_3 production and transport over the MCMA and surrounding region.

Ozone off the West Coast of North America (July 2006)

Forward trajectories initialized at lightning flash locations from the NLDN (triangles) intersect a TES transect at black dots (below)





TES observes enhanced ozone in the mid-troposphere west of Baja California (black square). This matches with the location of lightning forward trajectories

L. Jourdain

Jet Propulsion Laboratory
California Institute of Technology

Collaborations

- NASA Langley Research Center
  - RAQMS – TES data assimilation into RAQMS and study of long range transport
  - FASTOZ – Validation Studies
  - DIAL Group – Validation Studies
  - DACOM – Validation Studies
- University of New Hampshire – Validation Studies
- University of Iowa – Preliminary comparisons between TES and STEM
- IONS-06 Team – Validation studies, Analysis using sondes, TES and Flexpart
- Harvard University – Study of long range transport using TES and GEOS-Chem
- Florida State University – Convective transport of CO

Extra

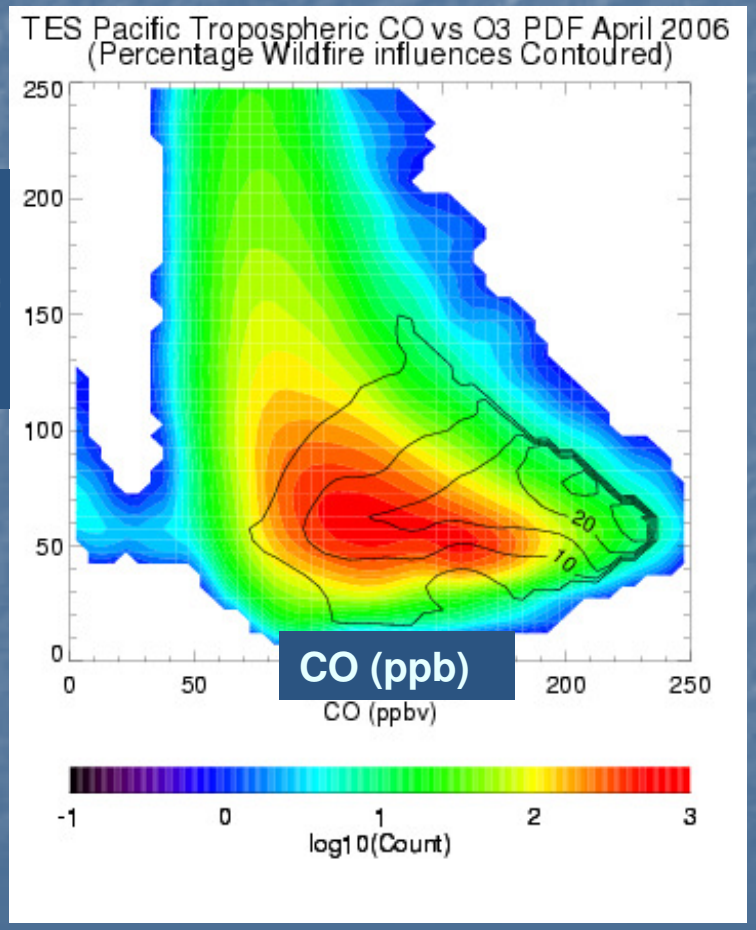
Validation Status Definitions

Term	Definition
Beta	Early release products for users to gain familiarity with data formats and parameters.
Provisional	Limited comparisons with independent sources have been made and obvious artifacts fixed.
Validated Stage 1	Uncertainties are estimated from independent measurements at selected locations and times.
Validated Stage 2	Uncertainties are estimated from more widely distributed independent measurements.
Validated Stage 3	Uncertainties are estimated from independent measurements representing global conditions.

Impact of Asian Fires

- Analysis of influence of wildfires on CO and O3 over the Pacific Ocean in spring 2006
- Wildfires have large CO emissions.
- Are they creating elevated ozone that is transported to US?
- This analysis shows little impact on ozone in the troposphere due to Asian wildfire emissions.

Frequency of observations in O3-CO coordinates

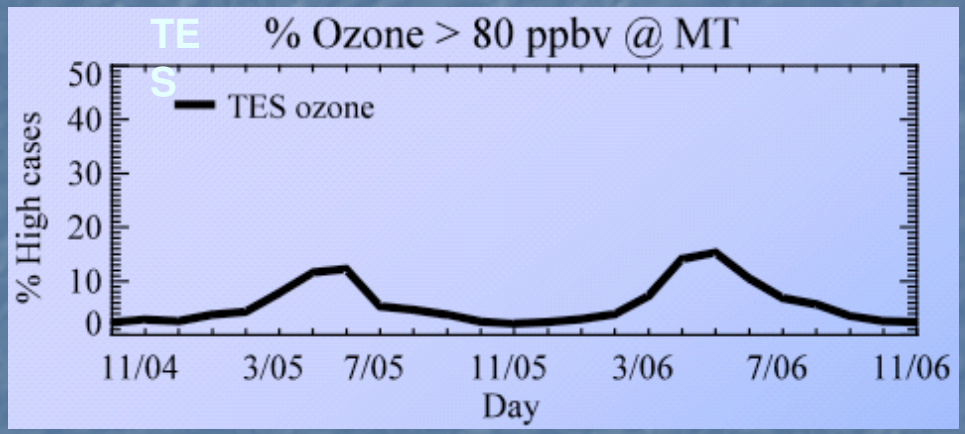


Black contours show fraction of observations influenced by wildfires, as calculated with RAQMS model.

Seasonality of Pacific O3 Events

- Study the seasonality of high ozone events in the upper and lower troposphere to characterize the transport across the Pacific Ocean.
- Wildfires have distinct seasonality.
- TES sees unexpected lower troposphere high ozone.
- Ongoing analysis investigating if this is stratospheric or in-situ formation

Jan, '06 *March, '06* *May, '06*



The lower tropospheric ozone maximum results from Southeast Asia Biomass Burning. Oltmans et al., 2004

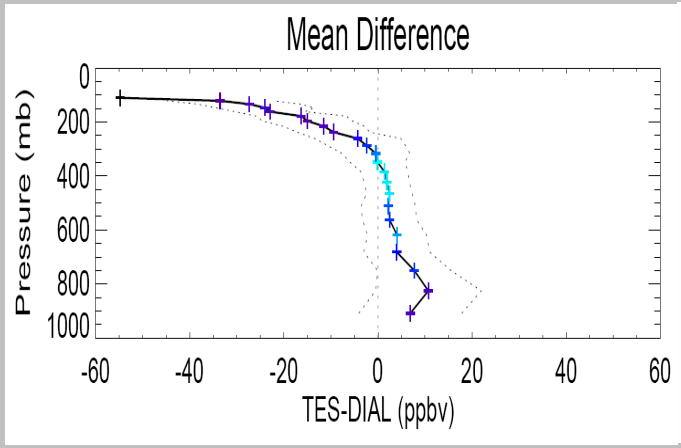
Upper tropospheric ozone has a maximum in May and a minimum in November. Thouret et al., 2006

Jet Propulsion Laboratory
California Institute of Technology

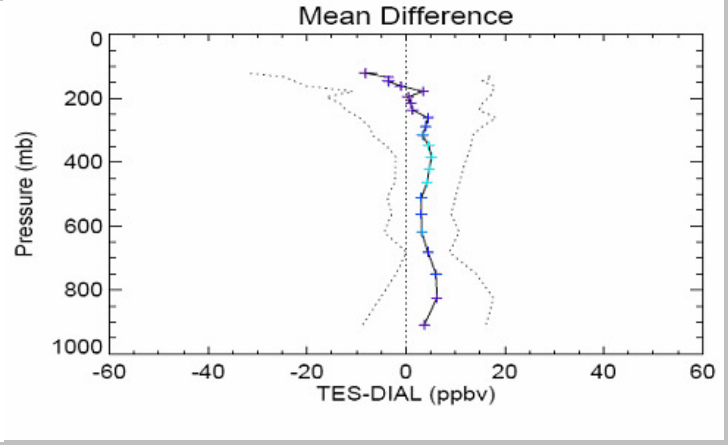
Version 3 Ozone

3459 (March 16th)

Version 2



Version 3



- The next version of TES data (Version 3) will include updates which will improve TES upper tropospheric temperature and Ozone retrievals
- The above example demonstrates this, where the large negative bias in the upper troposphere is significantly reduced.

TES Validation Papers in Preparation

- TES Ozone Validation with DIAL, FASTOZ – Richards et al
- TES CO Validation with DACOM – Luo et al
- TES Ozone Validation with Ozonesondes – Nassar et al
- TES Temperature Profile Validation – Shephard et al
- TES Water Profile Validation – Herman et al
- TES Total Column and Stratospheric Ozone Validation – Osterman et al
- TES Observations over Lake Tahoe – Tremblay et al
- Update on TES Cloud Parameter Retrievals – Eldering et al
- TES Sea Surface Temperature Validation – Lampel et al