

# Aura Validation Program Status

Aura instruments produce 63 data products that need validation.

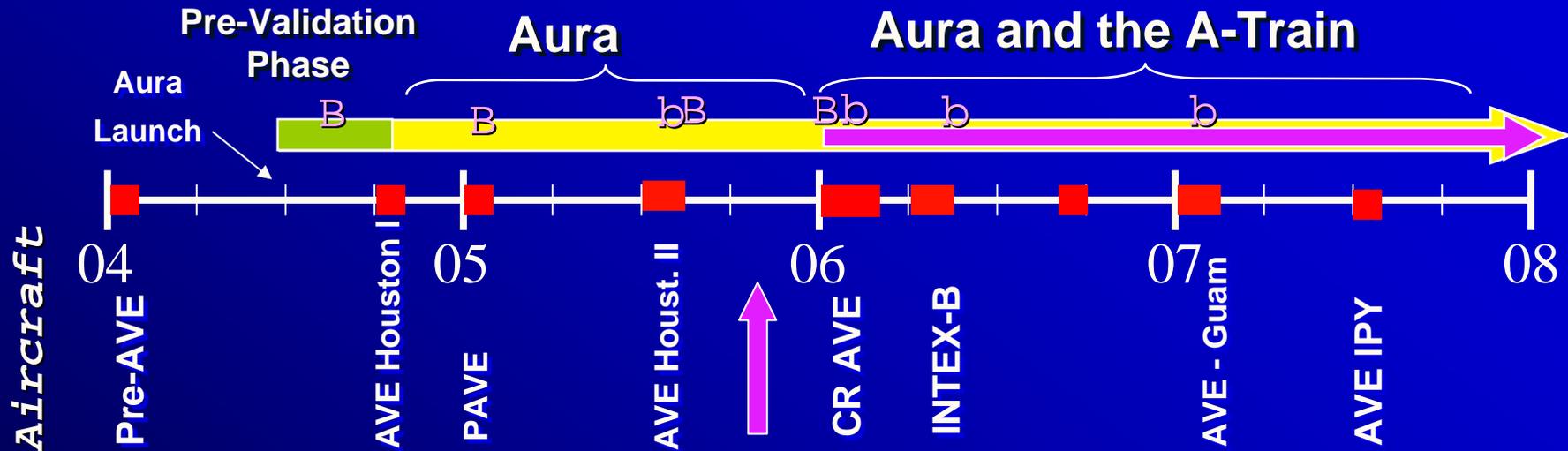
Validation activities up to 09/05 ~ 1 year after Aura activation:

- AVDC is up and running
- Validation workshop Sept. 05.
- Aircraft Field Campaigns
  - Two Houston WB-57 mini-campaigns
  - One polar DC-8 mini-campaign
  - UAV payload and plans moving forward
- Two high altitude instrumented balloon flights from Palestine, TX
- Two intensive H<sub>2</sub>O and O<sub>3</sub> sonde campaigns in Costa Rica
- Additional sondes launched from traditional sites
- Numerous satellite intercomparisons
  - UARS HALOE
  - ACE
  - Envisat
  - Odin, SBUV, etc.



# Aura Validation Campaign Timeline

B = high altitude balloonsonde campaign



Jan. 04	- pre-AVE- (Costa Rica)
Aug. 04	-- Ticosonde I (Costa Rica)
Oct. 04	-- Houston AVE I
Jan. 05	- PAVE
Jan. 05	-- Polar high altitude balloon launch (failed)
June 05	- Houston AVE II
July-Aug. 05	-- Ticosonde II campaign - Costa Rica
Sept. 05	-- Validation Workshop I
Sept. 05	-- High altitude balloon launch
Jan.-Feb. 06	- Costa Rica AVE (CR-AVE) (payload increased)
Jan. 06	-- Polar high altitude balloons (replaced failed launch)
Jan.-Feb. 06	--Ticosonde campaign - Costa Rica (added)
Mar.- Apr. 06	- INTEX-B (Houston, Anchorage, Hawaii) (lidars added)
April 06	-- Sodankyla High latitude ozone column intercomparison campaign
Jan. 07	- AVE/TC4 winter (Guam) + sonde campaign
Aug. 07	-- AVE (IPY) - still under discussion

Completed activities  
Planned activities  
Augmentations



# Summary of Validation Workshop

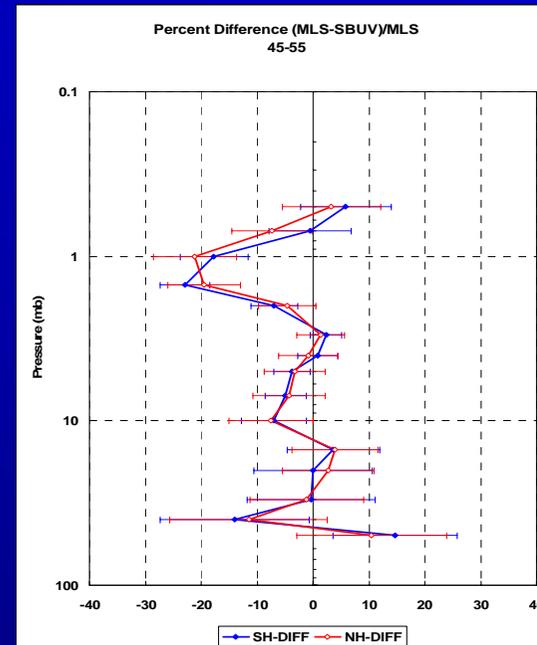
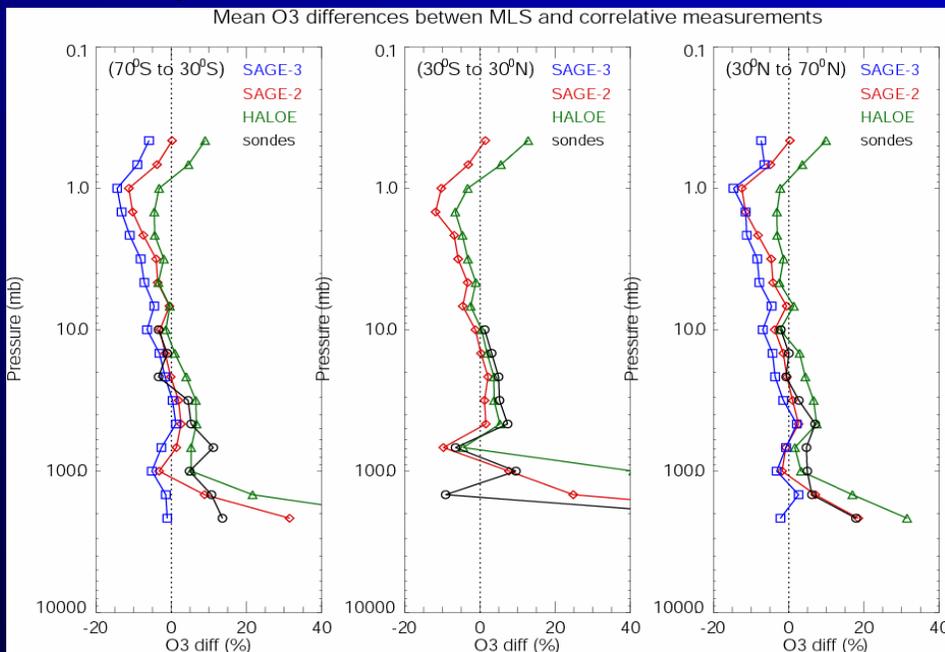
## - where we are now

- Stratospheric ozone profiles
- Tropospheric ozone profiles
- Stratospheric Temperature
- Ozone column
- N<sub>2</sub>O
- Water
- Chlorine (HCl, ClO and HOCl)
- Radicals
- CO
- Aerosols, Clouds and SO<sub>2</sub>



# Stratospheric Ozone Profiles

- Most validation is associated with MLS
- HIRDLS coincidences will be the focus of sondes and stratospheric lidar profiles in '06



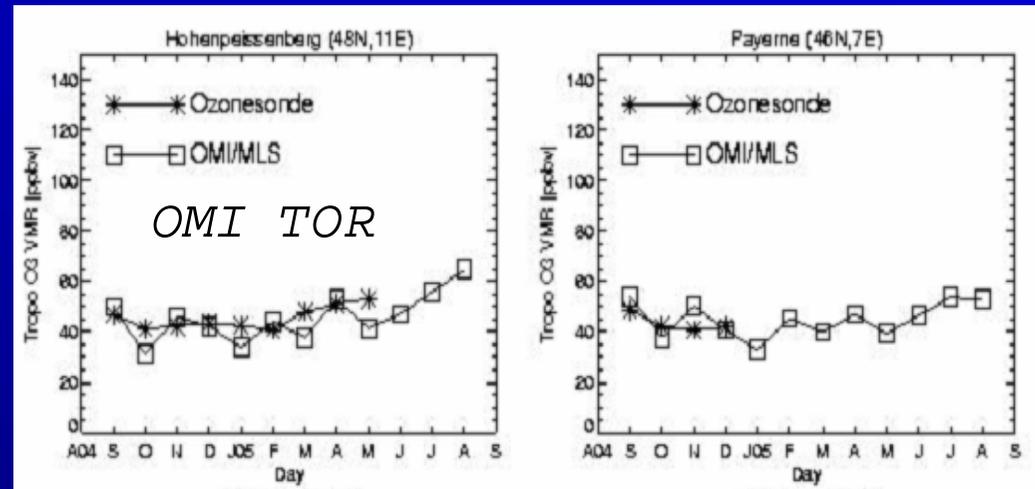
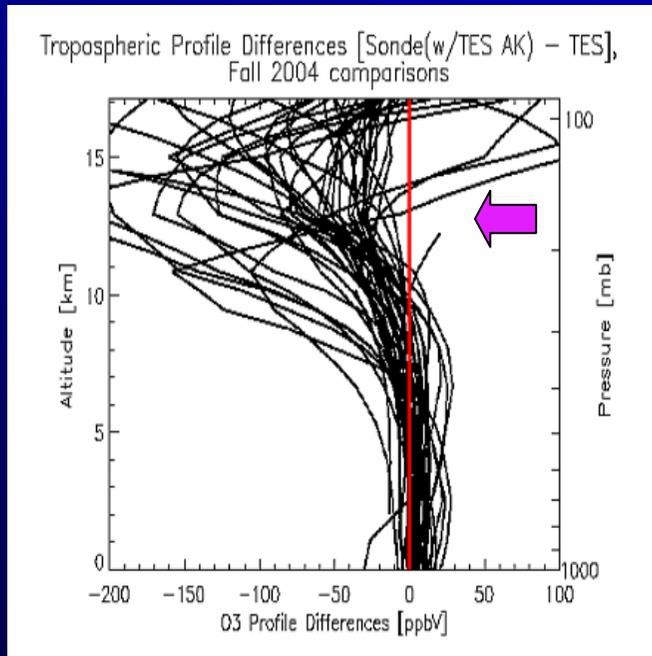
## MLS Stratospheric Ozone

- A small slope in differences vs height exists but varies bet
- MLS lower limit is 215 mb with upper limit of 0.46 mb for no
- Need to investigate bias - could be spectroscopy; for slope
- Larger issues in the UT/LS ozone - has team priority



# Tropospheric Ozone Profiles

- Most validation is associated with TES (profiles) and OMI TOR



TOR = Total ozone residual

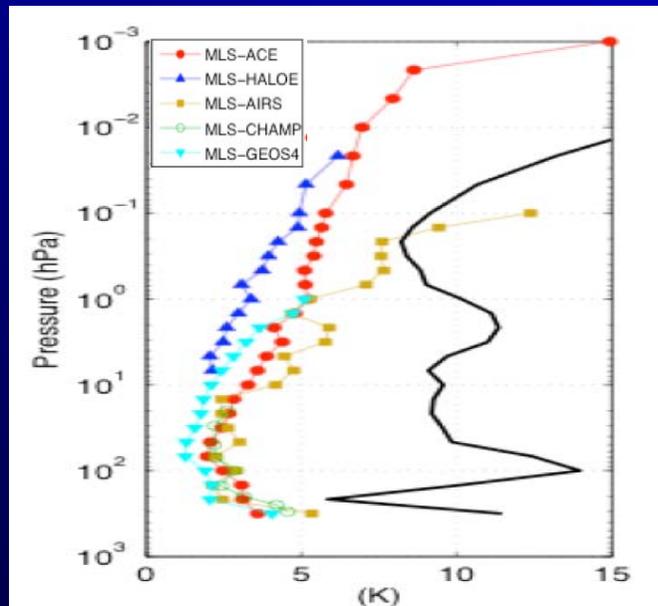
## Ozone Profiles

- High spatial correlation between TES retrieved and GEOS-Chem simulated tropospheric ozone.
- Largest difference in the upper troposphere: systematic high bias in TES
- New TES calibration scheme will improve the comparison in the upper troposphere with no significant impact in the lower troposphere.

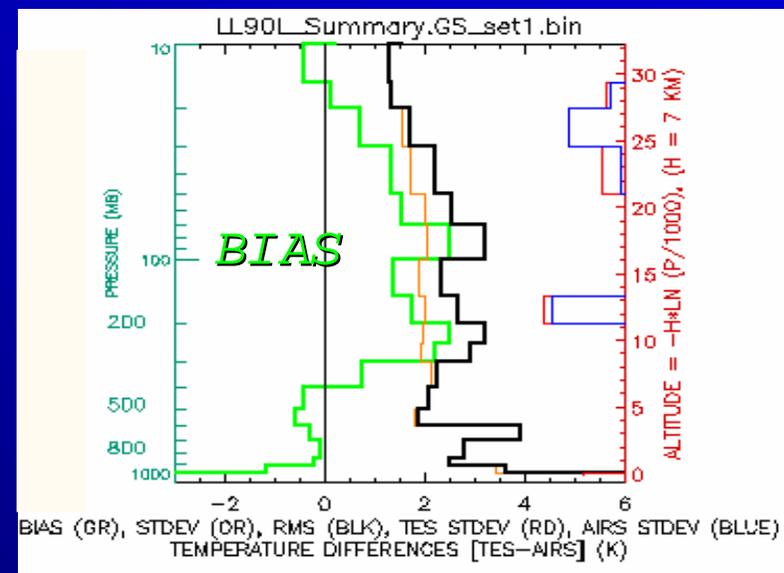
# Temperature

- MLS and TES comparisons
- Good leverage off AIRS validation

MLS



TES

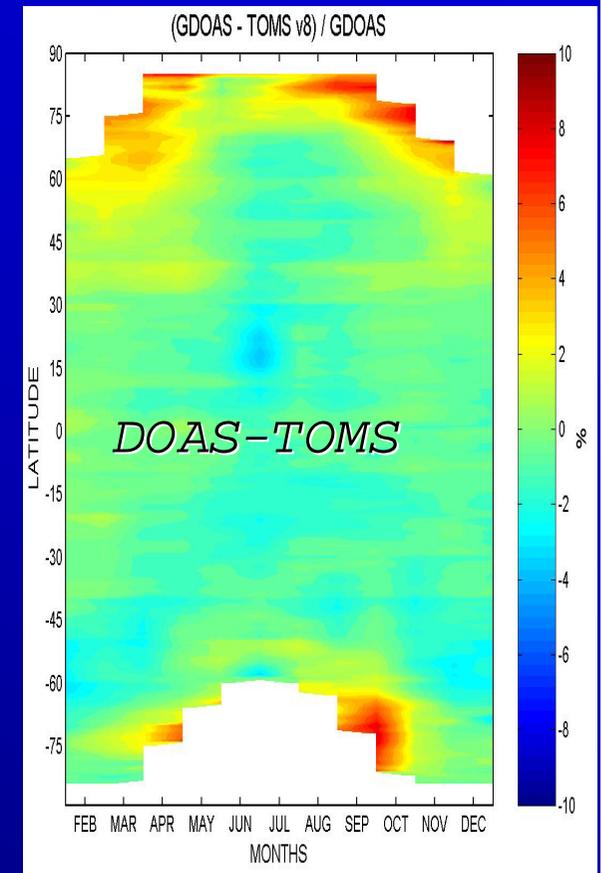
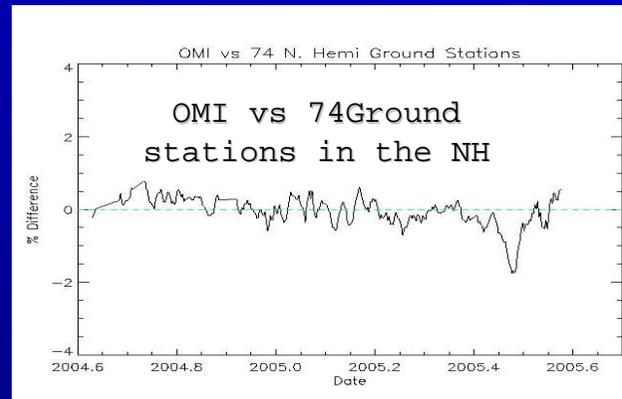
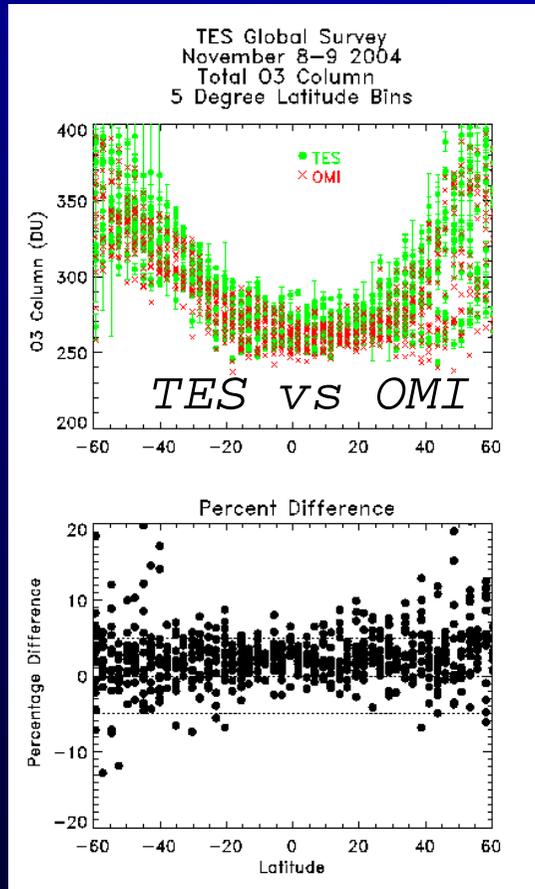


- TES UT warm bias and LT cold bias are due to known calibration problems which will be fixed in next version (Version 9).
- MLS biases at upper and lower range - needs to look at additional lines beside "core" for UT/LS and mesosphere



# Ozone Column

- OMI TOMS and DOAS algorithms, TES column

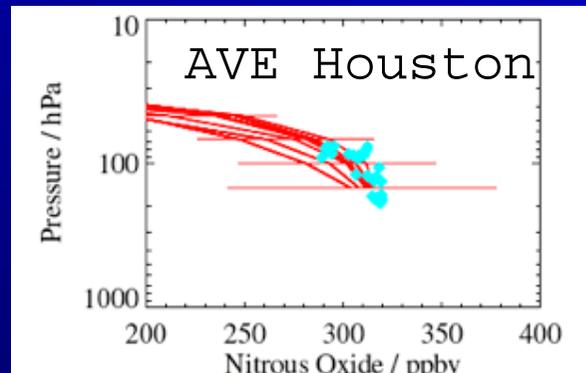
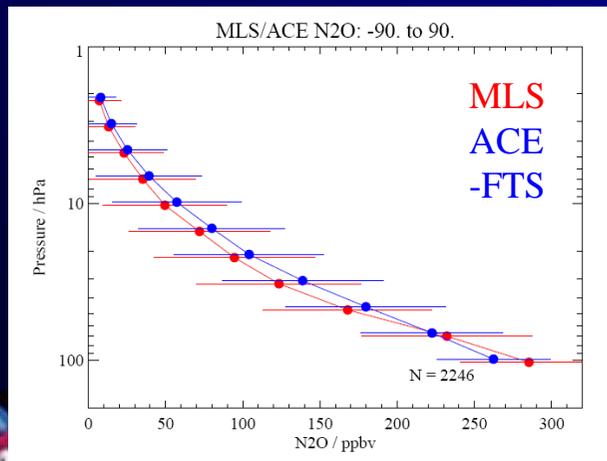
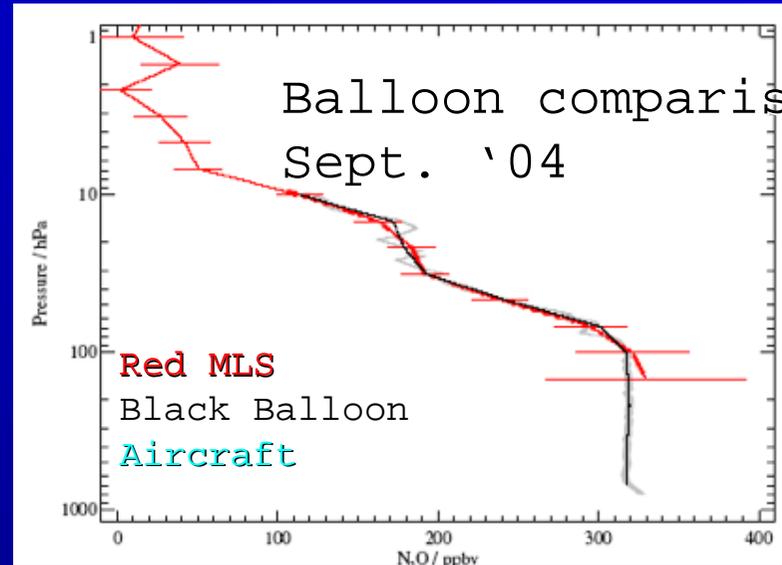
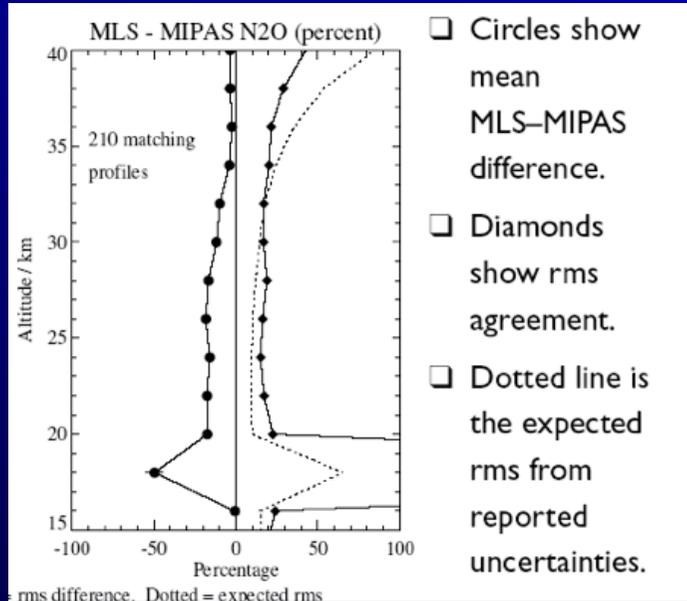


- No time drift in OMI, but DOAS vs TOMS bias show up at high latitudes.
- Good overall agreement between TES and OMI but some



# Stratospheric N<sub>2</sub>O

- MLS N<sub>2</sub>O



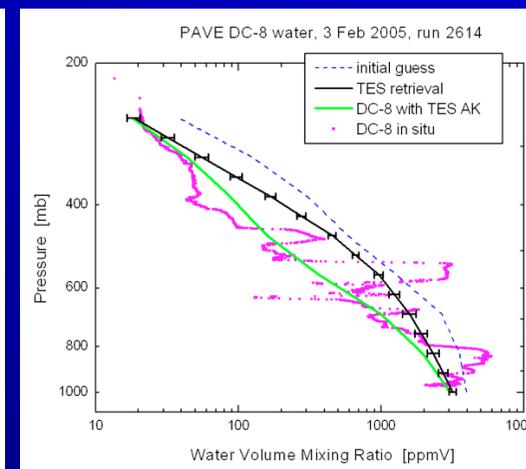
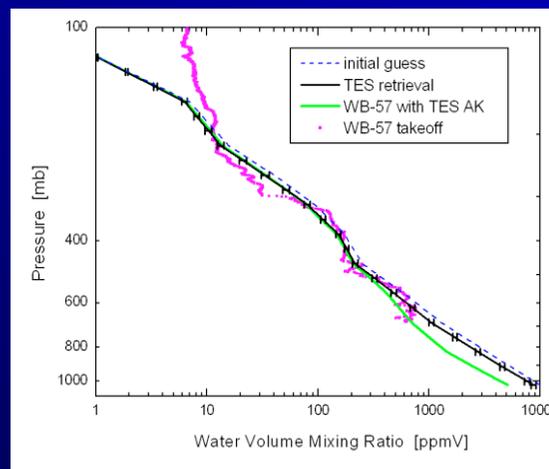
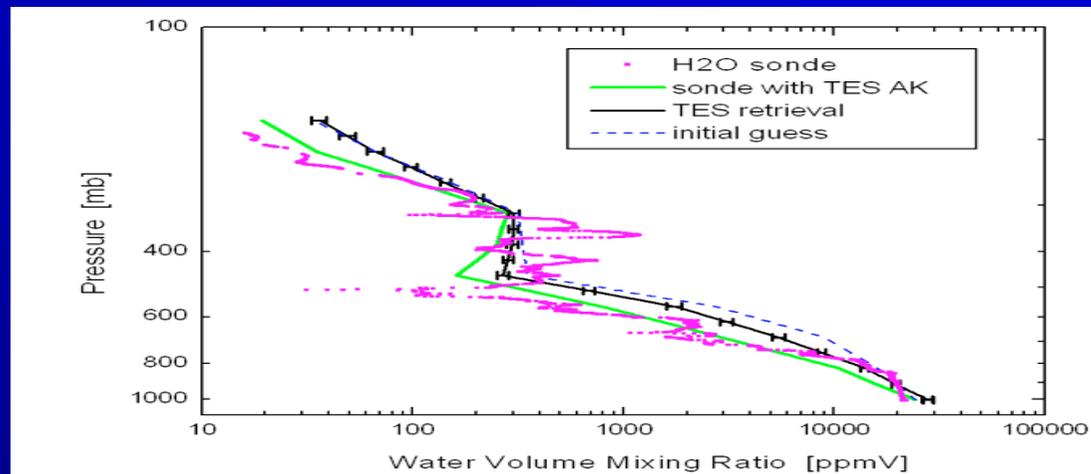
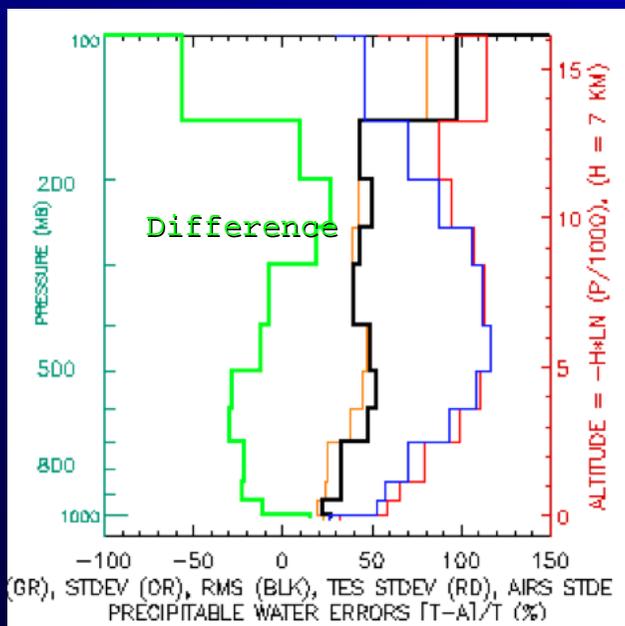
- N<sub>2</sub>O compares to within 20% of other measurements
- Improvements can probably be made with refined spectroscopy



# TES Water

Good leverage off AIRS validation vs Sonde and Aircraft

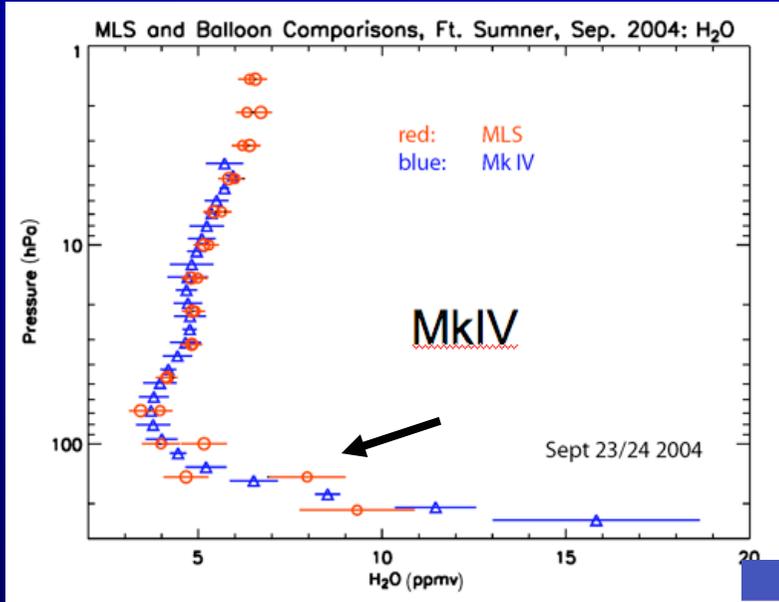
TES vs AIRS



- TES H<sub>2</sub>O compares to within 20% of AIRS & sondes
- Improvements will occur with change in calibration (Version 9)



# MLS Water



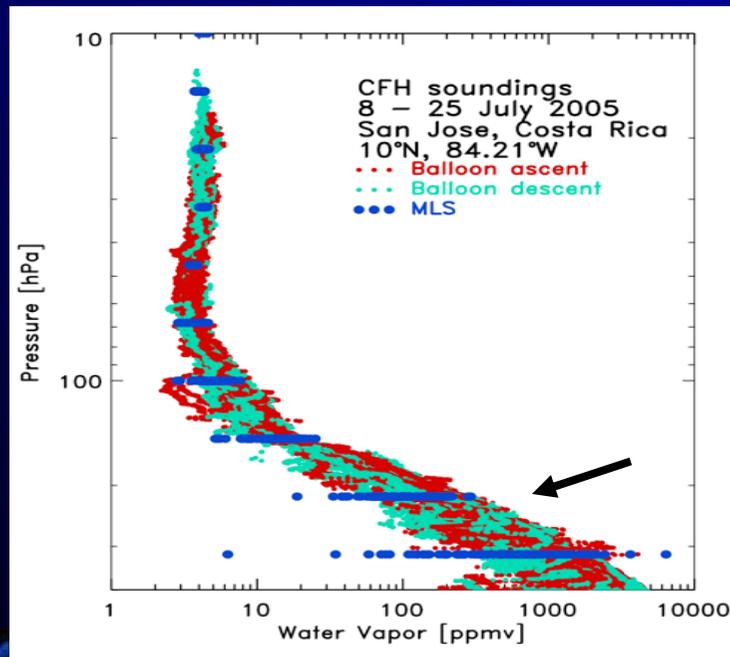
← MLS vs Balloon

MLS vs Satellite



Summary of Satellite Intercomparisons

Pressure, hPa	Vertical Resolution, km	"True" Precision, ppmv	Estimated Precision ppmv	Estimated Accuracy Difference		
				HALOE	SAGEII	ACE
0.1	7	0.3	0.8	+10%		-10%
1	5	0.1	0.3	+5%	-15%	-3%
10	4	0.1	0.3	+5%	+10%	-1%
100	3	0.8	0.5	+15%	+5%	-5%

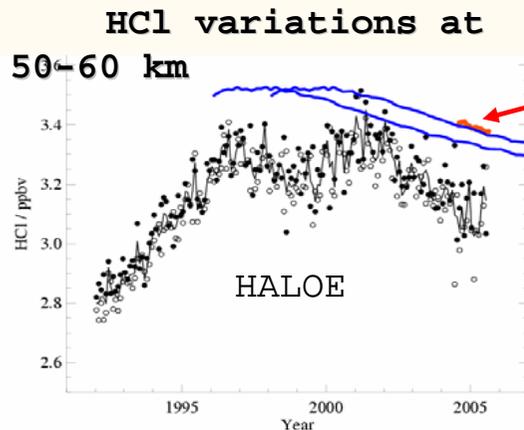
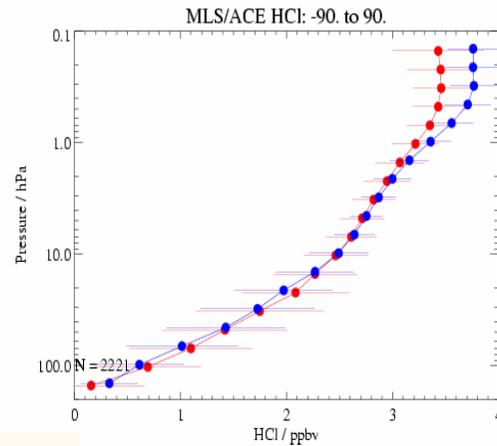
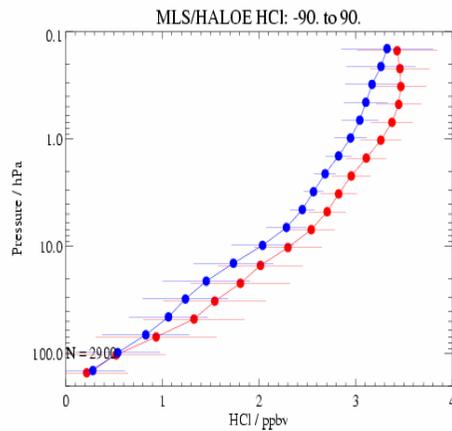


- More Lower Stratosphere validation is needed

- Known algorithm issues in the lower stratosphere

- Need to extend vertical range

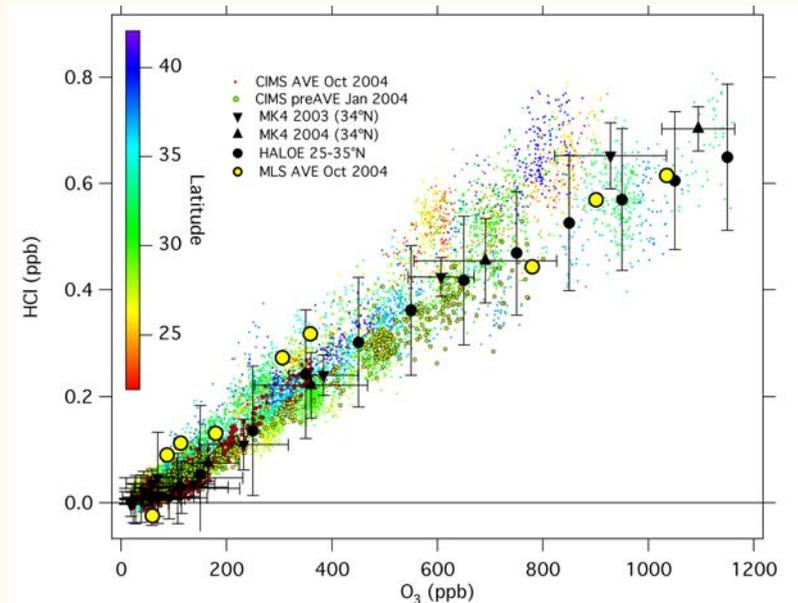
# Chlorine (MLS HCl, ClO and HOCl)



MLS data

From surface chlorine (4 or 6 yr lag)

## MLS HCl vs AVE / CIMS:



**HCl Status:** Looks good, some bias between HALOE that doesn't appear with ACE

**ClO Status:** Good except for persistent negative MLS bias (~0.3 ppbv), mainly for  $p > 45$  hPa

**HOCl Status:** Difficult to validate, but first-order 'reasonableness' is apparent for  $p < 22$  hPa.

**Future plans:** MLS team to address the low bias issue and continue

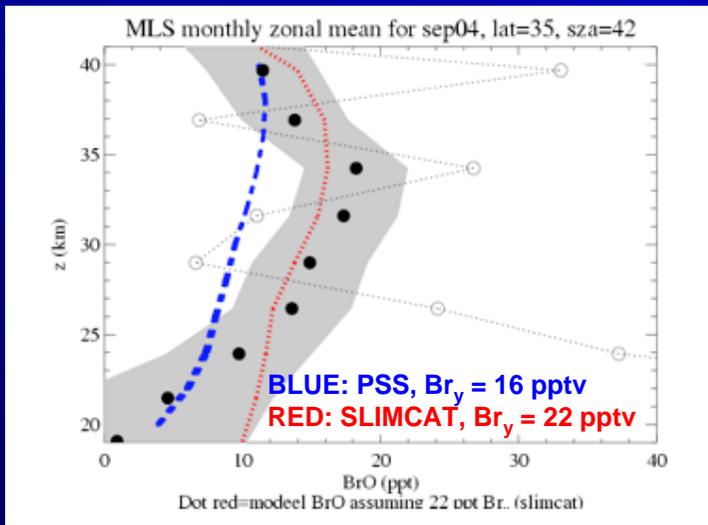
# Radicals

Species	Column	Profile	Validation	Status
NO <sub>2</sub>	OMI		Ground based column, Satellite	Good start, need lower trop. profiles
HCHO	OMI		Aircraft, Satellite	No validation
BrO	OMI	MLS	Balloon, aircraft	Models
OCIO	OMI		Balloon, aircraft	Product not available yet
OH		MLS	Balloon & ground based column	Balloon profiles and ground based comparisons
HO <sub>2</sub>		MLS	Balloon	No validation yet

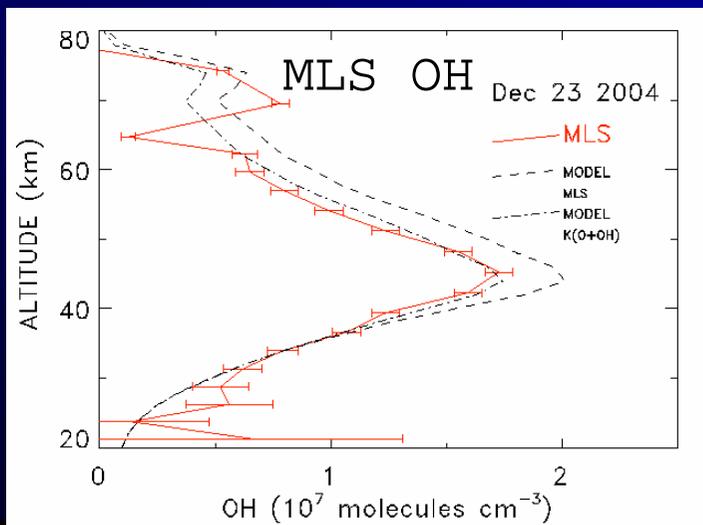
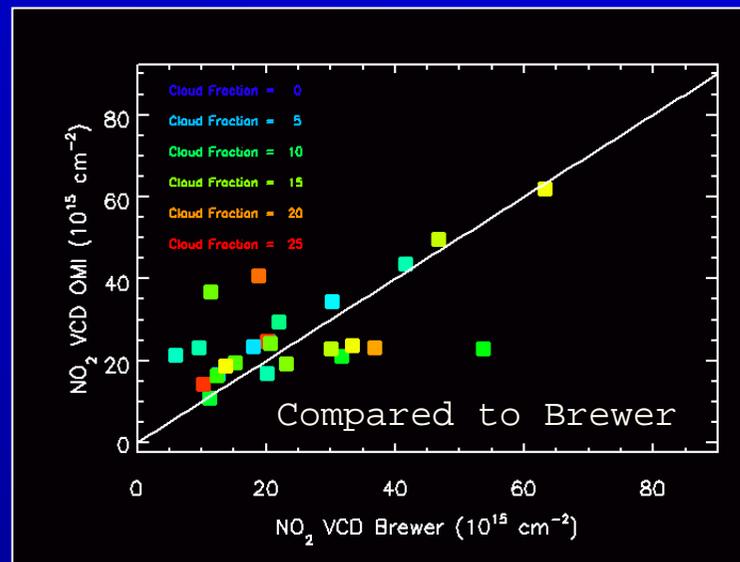


# Radicals cont.

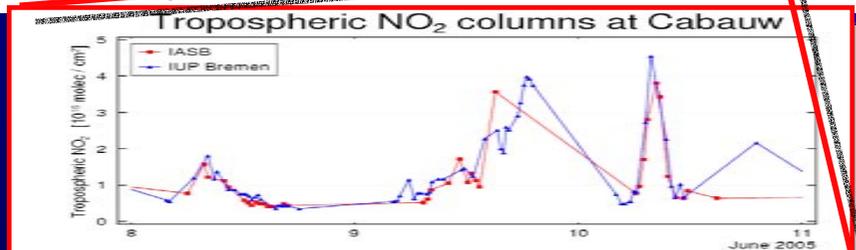
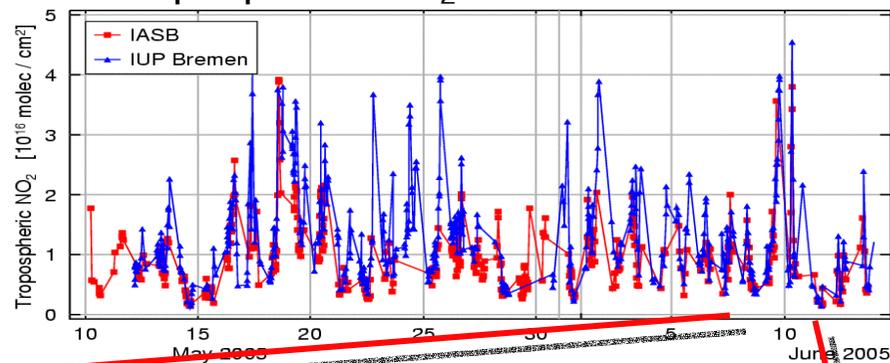
MLS BrO Profiles



OMI NO<sub>2</sub>



Tropospheric NO<sub>2</sub> columns at Cabauw



# Radicals Summary

More observations of radicals with sub-orbital data is needed

Problem is tricky due to the solar zenith angle changes for most radicals

NO<sub>2</sub>:

- compare OMI total and tropospheric column to existing ground based columns that are sensitive to both total and tropospheric NO<sub>2</sub>

HCHO:

- Intex-B (this spring) & GOME + SCIA columns

OClo:

- compare with available, ground based column data (European products)
- test consistency with MLS ClO, BrO, PV, T, etc.

BrO:

- test consistency between OMI column and MLS profiles
- compare with available DOAS, SAOZ balloon profiles (European data)
- compare with ground based column & MAX DOAS profiling (European; New Zealand;

future G. Mount & S. Sander systems)

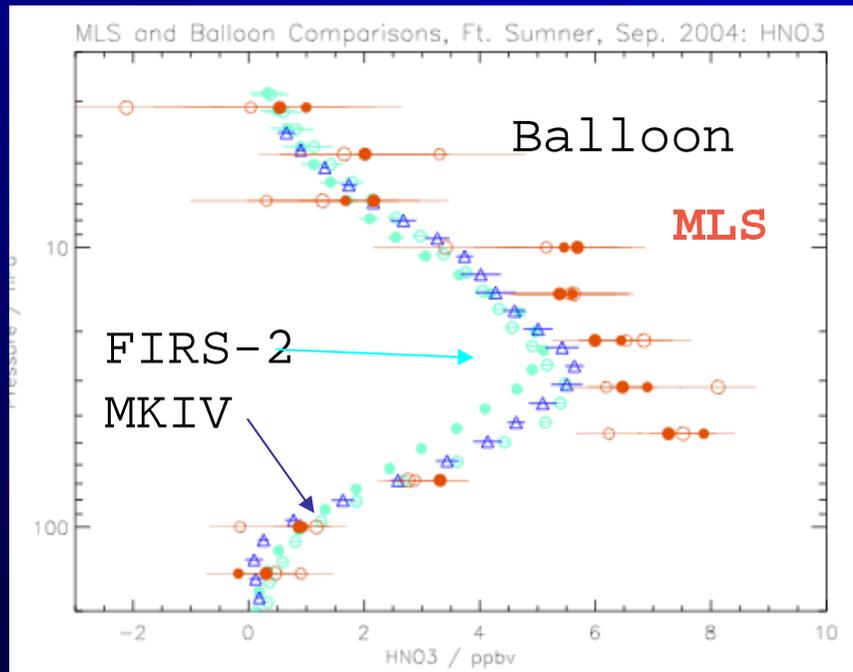
OH, HO<sub>2</sub> :

- compare MLS profiles to 20-21 Sept 2005 BOH, FIRS-2, SLS balloon



# HNO<sub>3</sub>

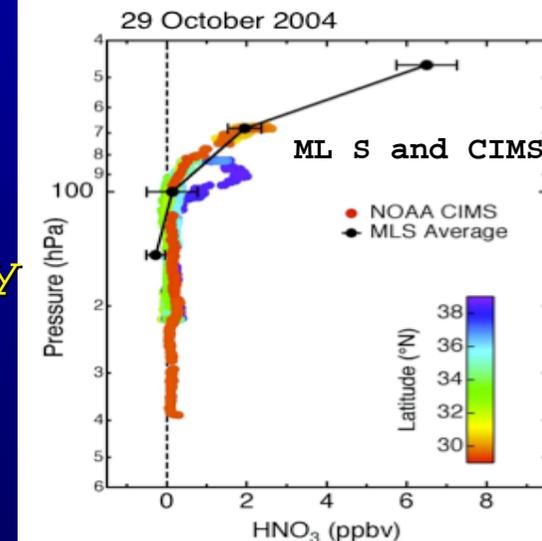
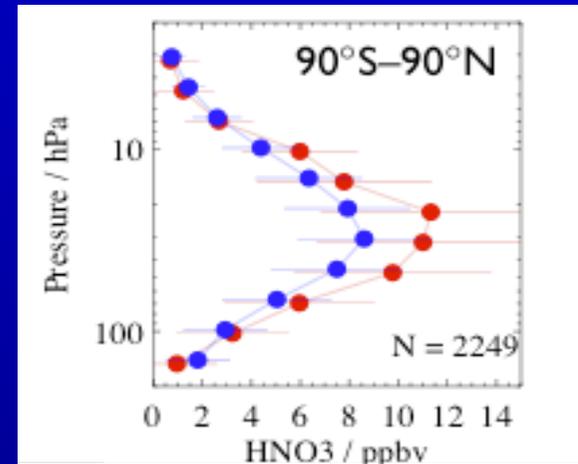
- MLS shows relatively high observations near peak



- Discrepancy at peak may be due to microwave (or IR) spectroscopy errors.

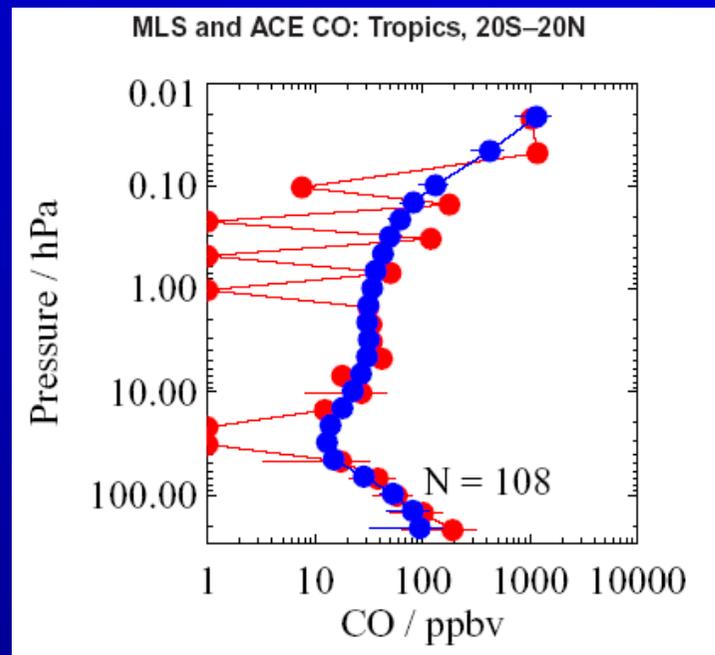
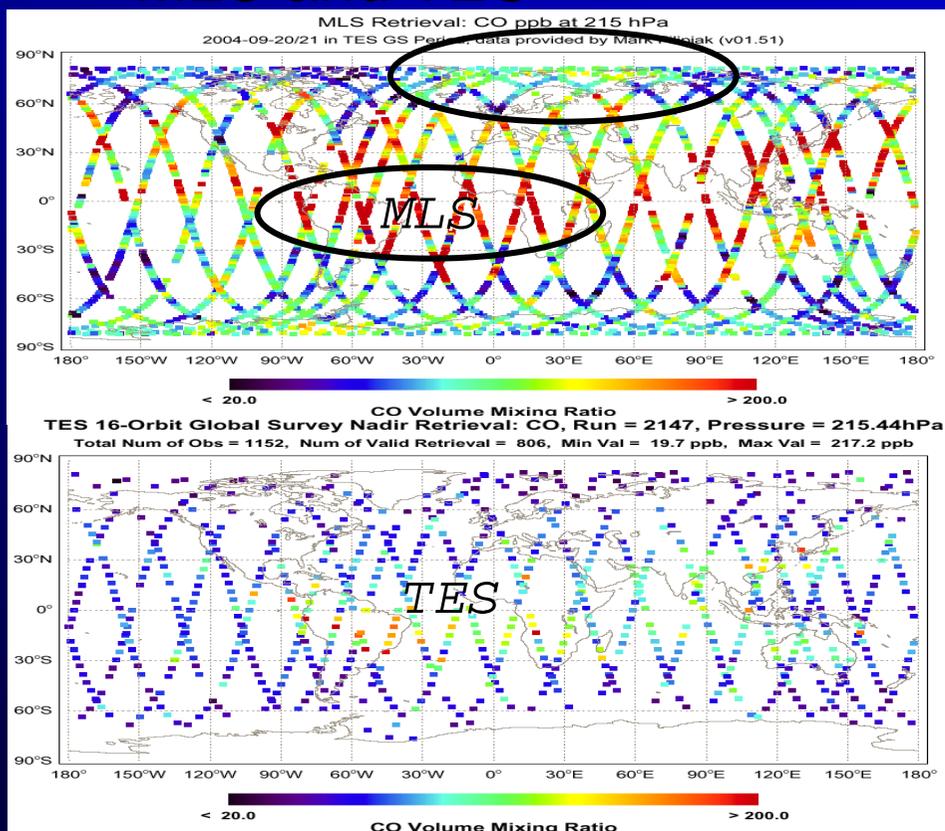
- TES will begin work on HNO<sub>3</sub> limb soon

MLS and ACE



# CO

- MLS and TES



Worst case, MLS

Major artifacts exist in MLS data (will be addressed in V2.0):

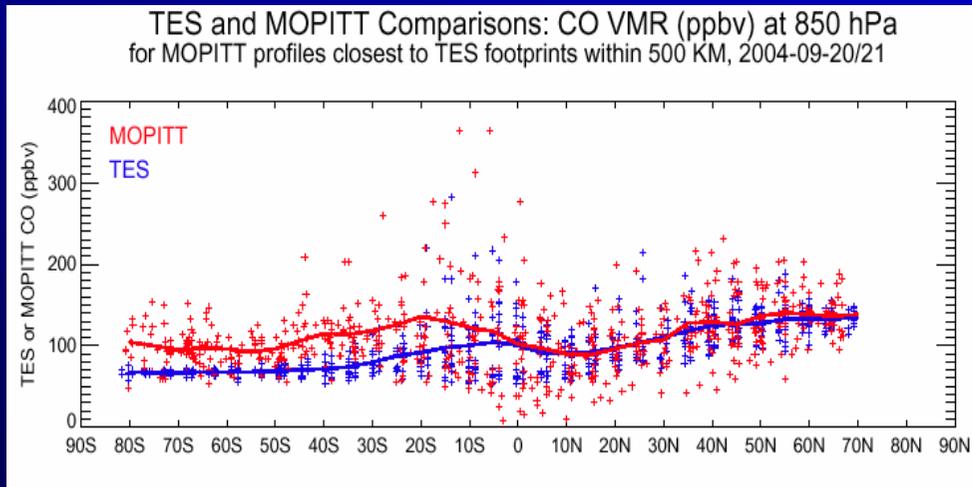
- Large oscillations
- Some negative CO volume mixing ratios
- Enhanced CO in winter polar lower stratosphere, due to not including  $\text{HNO}_3$  lines

TES vs MLS – MLS CO Upper trop. VMR are higher than TES at low latitudes and lower than TES at high latitudes.

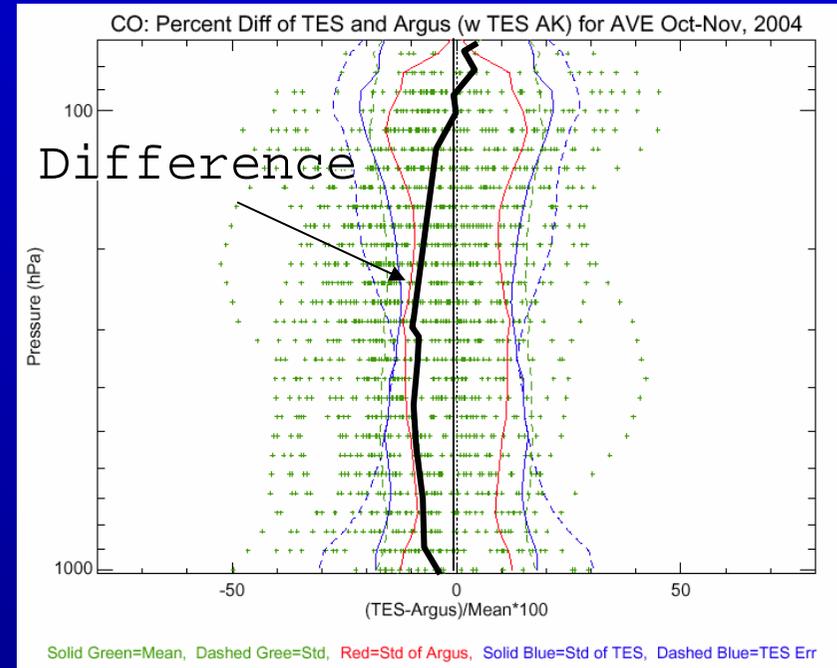
# CO

- TES

## TES and MOPITT



## Argus Comparisons



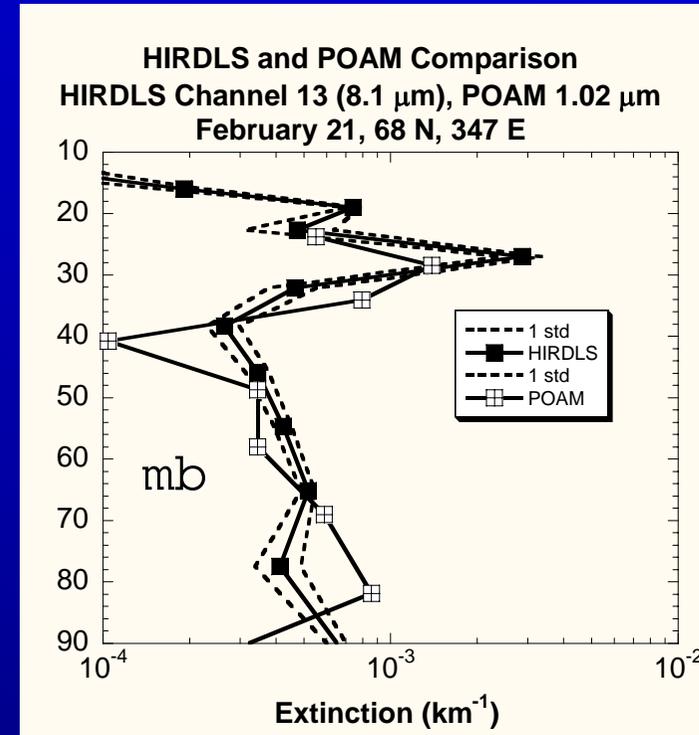
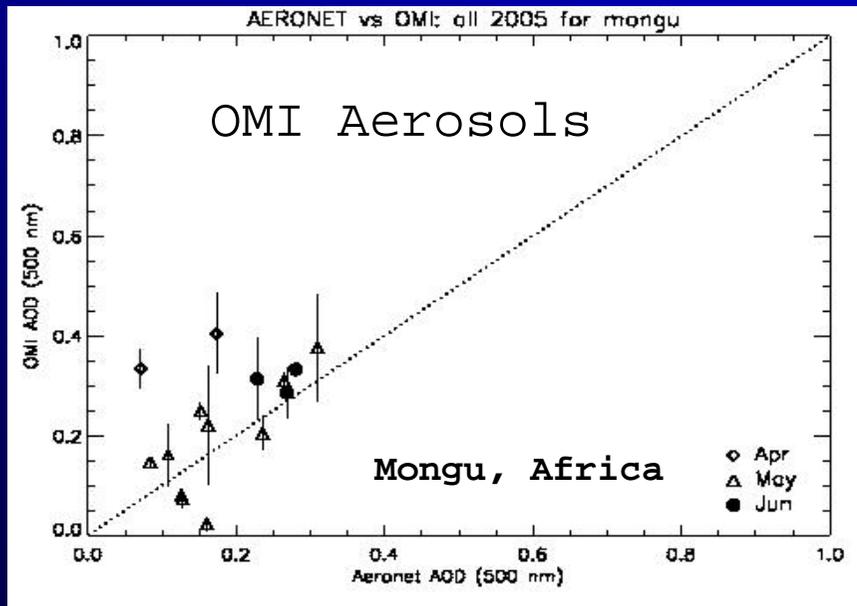
CO Comparison with MOPITT and Argus show some bias

- Generally the agreement is not too bad
- Improved CO should come from changing the optical bench temperature (improves the alignment) in TES



# Aerosols, Clouds and SO<sub>2</sub>

- TES, OMI and MLS (Cloud ice)



- MLS Cloud Ice has almost no validation
- OMI Aerosols are in good shape - comparisons to Aeronet
- HIRDLS aerosol product has had some preliminary comparisons
- TES vs MODIS cloud top pressure show some bias
- SO<sub>2</sub> needs more tropospheric (OMI) and stratospheric (MLS) validation



# What we have learned so far..

Validation activities have clearly shown where Aura data is useful for science, in addition:

- MLS
  - Spectroscopic issues need work (interfering gases)
  - Algorithm (S/N) issues have shown up
- TES
  - Calibration issues - will be significantly improved in V9
  - Comparisons with S-HIS show small translator velocity errors in TES
- OMI
  - Algorithm issues at high latitudes - mainly in DOAS products
  - Products which have low S/N are affected by stripping (i.e. OCIO)
  - Assumed trace gas profiles in the lower troposphere affect column calculations need better a priori's
- HIRDLS
  - Intensive validation will start in FY06



# What we additional things we need to do...

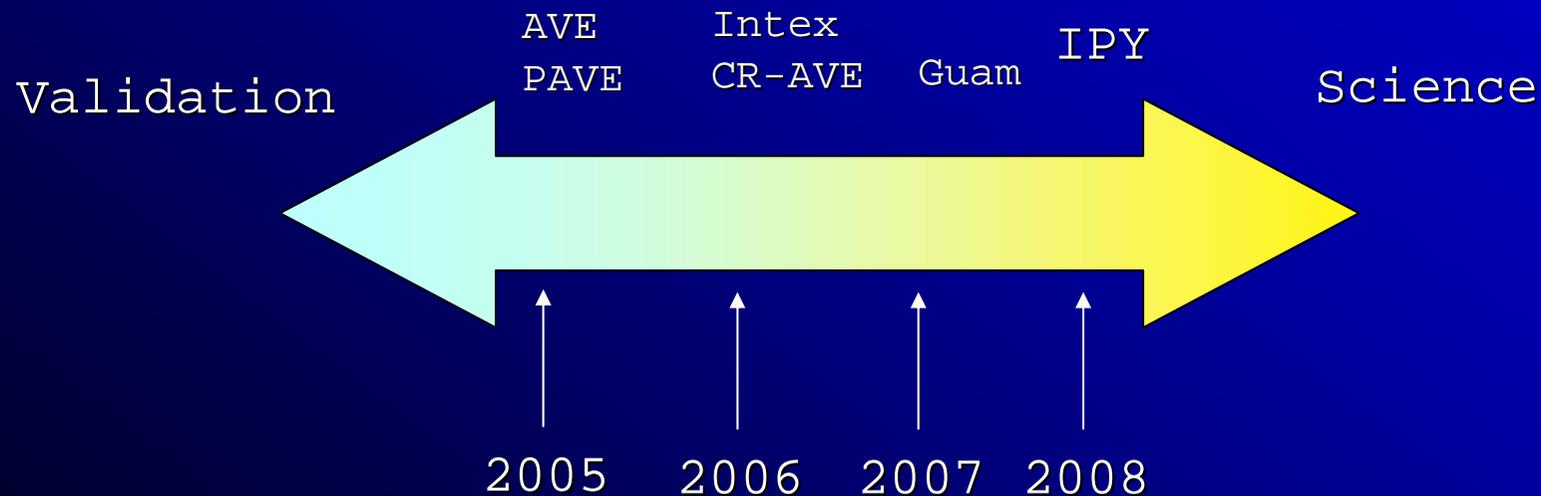
## New needs: Program Response

- Focus on HIRDLS ozone, temperature and trace gases
  - Stratosphere and UT/LS O<sub>3</sub> and T measurements added to Intex B via Lidars
    - INTEX flights include night measurements
  - Intensive O<sub>3</sub> and H<sub>2</sub>O sonde campaign added to CR-AVE
  - More in situ gases added to CR-AVE
- Focus on A-Train validation and cloud ice measurements
  - Cloud lidars included in CR-AVE
  - Additional T and H<sub>2</sub>O sondes for CR-AVE
  - Aerosol/ cloud package for Guam mission
- Additional tropospheric measurements needed for MLS, OMI & TES
  - Specific sub-satellite spirals added to Intex flight plans (CO, HNO<sub>3</sub>, O<sub>3</sub>, NO<sub>2</sub>)
  - TES “closure experiment” for CRAVE - S-HIS +Sondes
  - Improve sonde coincidences (AVDC web tool + more active management)
  - More upper tropospheric trace gases for MLS added to CR-AVE
- Additional stratospheric measurements needed for MLS HCl, CO, HNO<sub>3</sub>
  - Polar balloon flights in 2006
  - More CIMS HCl data needed in lower stratosphere for MLS (CRAVE)
- High latitude O<sub>3</sub> column measurement problems with OMI DOAS vs TOMS
  - Sodankyla campaign in spring 2006



# Aura Validation and Science

- Validation and data product development has been the primary Aura goal for the first year after launch.
- The validation program has been modified to address additional requirements and special needs (e.g. HIRDLS).
- In the future, validation will be more mixed with science and will include Cloudsat and Calipso validation (CR-AVE and Guam)
- The Guam mission will be a centerpiece of the Aerosol-Clouds-Climate initiative



# Aura Validation Data Center

- Goal to provide one stop shopping for validation work (both Aura instrument teams and validators)
- Provide tools for users (HDF converters, overpass data, etc.)

## Status

- AVDC opened to users February 10, 2005
  - 154 registered users
  - 1.4 TB total data, 100+ GB of validation data
  - 405,000 web hits (~1,500/day)
  - 50GB web transfers (~185MB/day)
- Support for all AVE, balloon and sonde campaigns
  - FOV predictions
  - Aura data subsetting (OMI, MLS and TES)
  - Correlative data collection and support including
- Validation data collection
  - Ground based (NDSC, GAW, national programs)
  - Satellite data collection (NOAA, Envisat, ACE, etc.)
  - Additional data sets coming on line when available (e.g. ACE 2.2)

