Satellite Validation and Related Activities at the Howard University Beltsville Campus

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14 Science Systems Applications, Inc., Lanham, MD

Outline

- Howard University Beltsville Campus
- NASA University Research Center
  - "Howard University Beltsville Center for Climate System Observation"
  - Weather and Atmospheric Composition thrusts
- WAVES 2006 – 2008
- GRUAN
  - GCOS Reference Upper Air Network site


Aerial View of Site
Latitude: +39º 03' 15.117''
Longitude: -76º 52' 39.448''
Elevation: 53.2 m
Office/Shops/Labs
C-Band Radar
MDE
Profiler
Full Air Quality
Radiation Bldg
GPS (X2)
Ceilometer
MWR
All Sky
31 Met Tower
8-levels T/RH
Flux, Net rad
Soil Moisture
Chemistry
PDB
RSOS
CORS
Raman
ALVIS/AT
STROZ
GLOW
Lidar Laboratory
50 yds


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Office/Shops/Labs
C-Band Radar
MDE
Profiler
Full Air Quality
A semi-urban field site
mid-Atlantic, urban experiences a wide range of meteorological conditions
A major pollution corridor
High population pressure.
Very different than ARM sites
Comprehensive set of Observation Systems
Inter-agency and university collaboration
Student involvement in all instruments and areas of research
Radiation Bldg
GPS (X2)
Ceilometer
MWR
All Sky
31 Met Tower
8-levels T/RH
Flux, Net rad
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50 yds

"Howard University Beltsville Center for Climate System Observations"

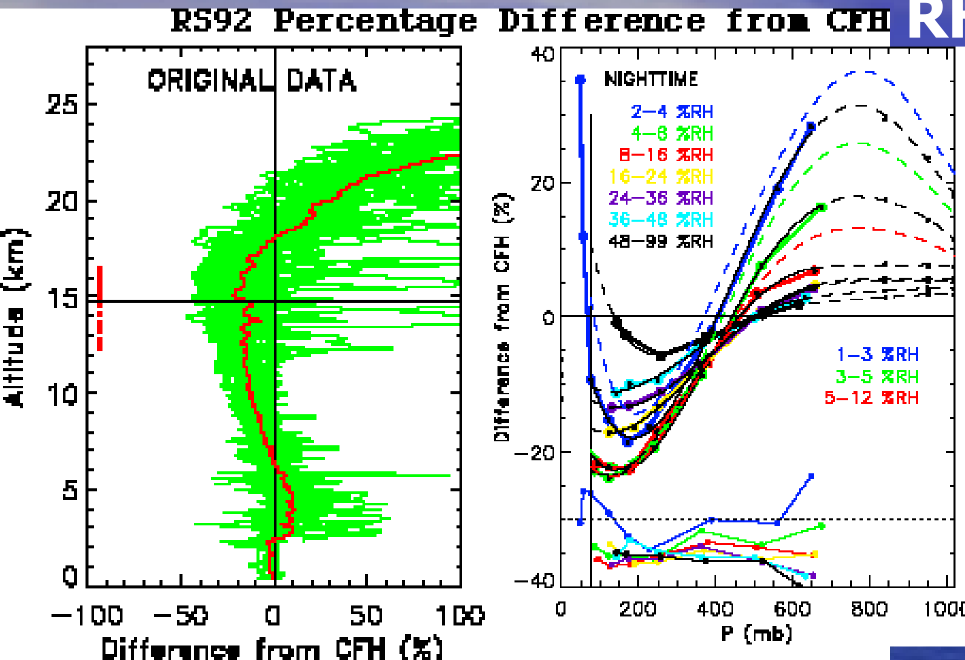
- Recently awarded 5-yr NASA University Research Center
  - Weather Thrust
    - GPM validation efforts
      - Quantify rain drop size distribution
    - Wind Lidar studies
      - Rayleigh and Aerosol doppler lidar intercomparison statistics
  - Atmospheric Composition Thrust
    - Aerosol
      - Aerosol and cloud studies in the mixed rural/urban environment
    - Tropospheric Ozone
      - Satellite validation and air quality
    - Water Vapor Variability and Temperature
      - Satellite validation, reference sounding and GRUAN

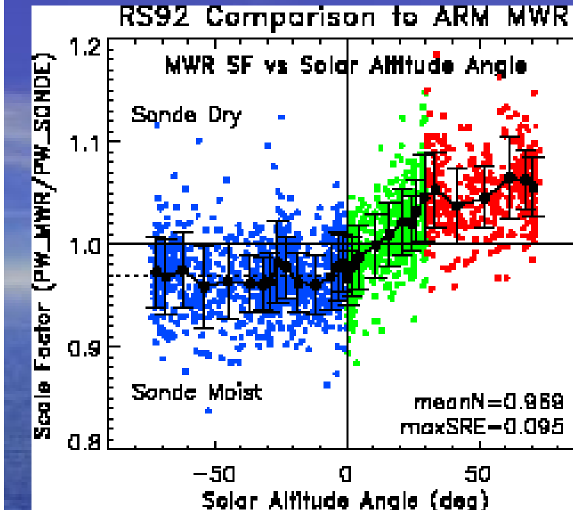
WAVES

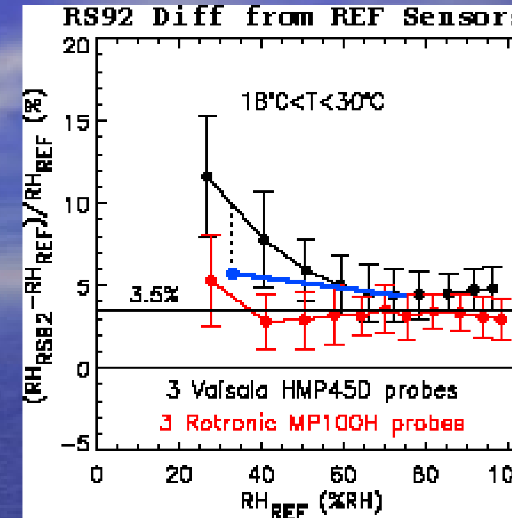
Water Vapor Variability Experiment – Satellite/Sondes

- Upgraded Beltsville infrastructure to support field campaign activities
- >75 A-train overpasses covered under differing seasons
  - More than 300 sonde packages including more than 100 RS-92s, 30 CFHs, 60 ECCs, and 6 additional PTU sensor technologies
    - NWS operational sonde testing
  - Multiple lidar measurements
- Vaisala RS-92 empirical correction
- NDACC Raman lidar characterization
- Aura Validation Papers
  - TES : water vapor (Shepherd), ozone (Nassar), temperature (Herman)
  - MLS : water vapor (Vömel)
  - HIRDLS : ozone (Nardi)

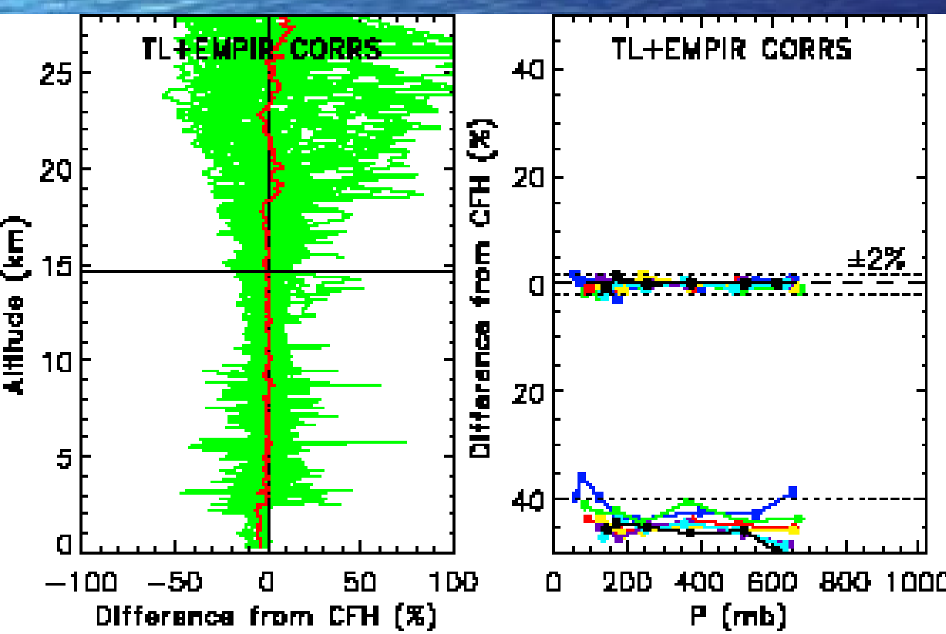
Correction of RS92 Mean Bias Error Relative to CFH, MWR, and ARM RH Probes

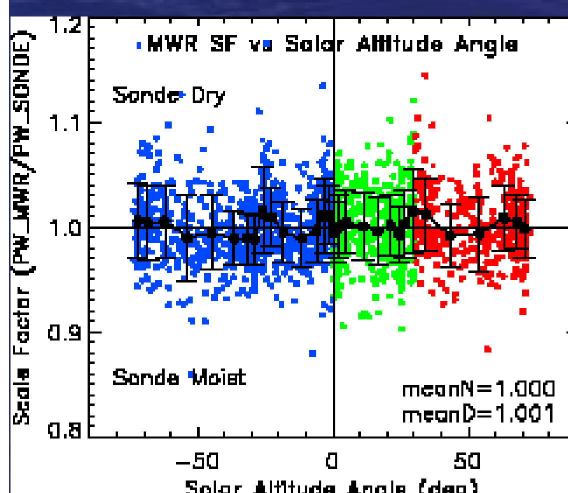


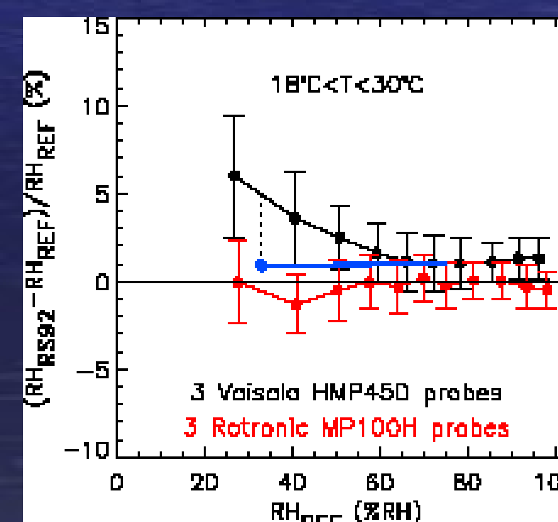




Above: Uncorrected RS92 difference from 3 reference sensors: CFH (altitude profiles, and P-dependence in 10 RH intervals); ARM MWR (ratio of PW); and certified ARM RH probes.
Below: Corrected RS92 mean accuracy is ±2% for all RH conditions from the surface to several km above the tropopause based on comparisons with same sensors as above.







Miloshevich et. al., to be submitted to JGR

TES Retrieval and Radiance Studies from WAVES_2006
(Shepherd et. al.)

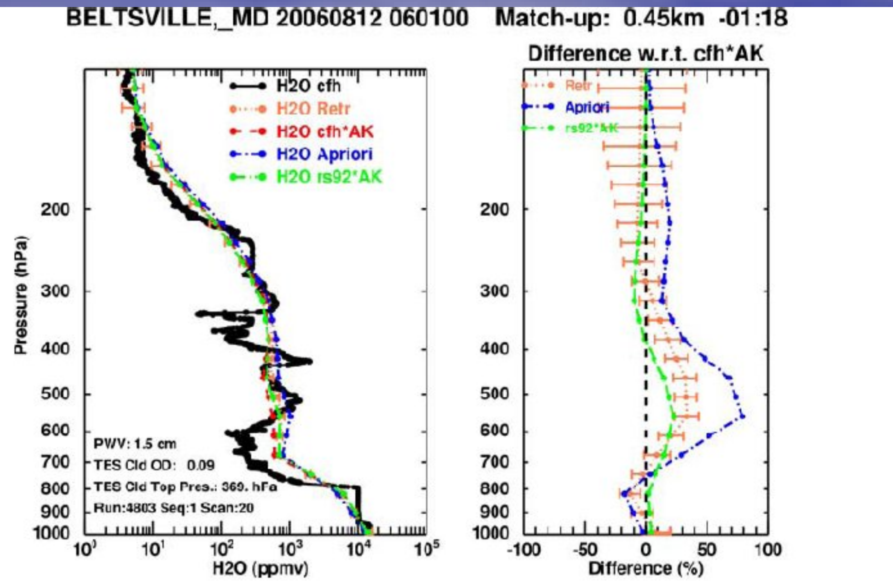


Figure 8. This is a CFH comparison plot on 12 August 2006 that corresponds to TES scan 20. The CFH launch was launched 12.5 km away and 1 h and 17 min before this TES scan. (left) The observed CFH profile (black), the a priori profile (GMAO) (blue), the TES retrieved profile (salmon), and the CFH (red) and RS92 (green) profiles with the TES a priori and averaging kernels (AK) applied. (right) The relative percent differences (Profile − CFH/CFH) × 100 of the different profiles with respect to the CFH with the TES a priori and averaging kernel applied (dotted line at zero).

This shows that even for coincidences that are within 12 km and 1 h there can be large differences in water vapor observations, and that the sampling differences between the sondes and the instantaneous TES profiles account for most of the profile comparison differences.

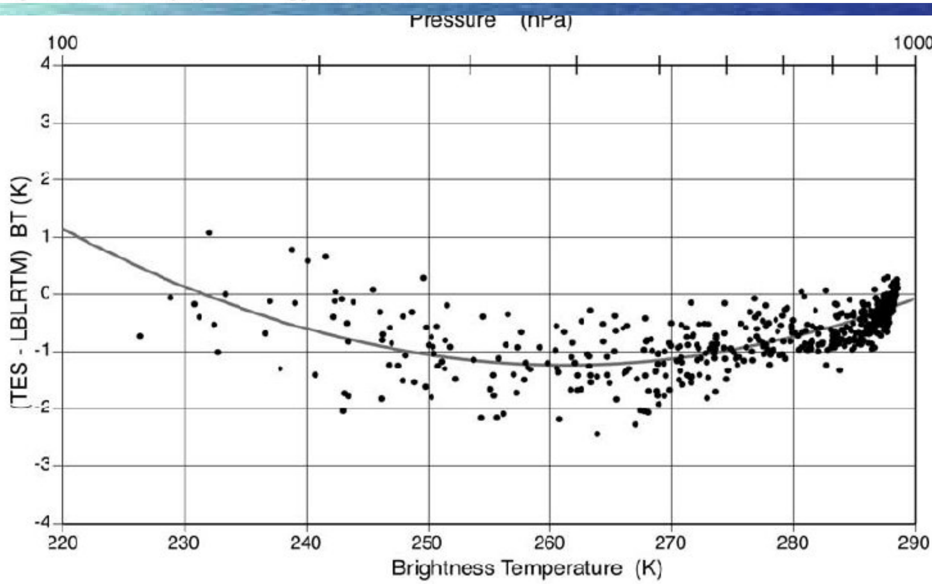
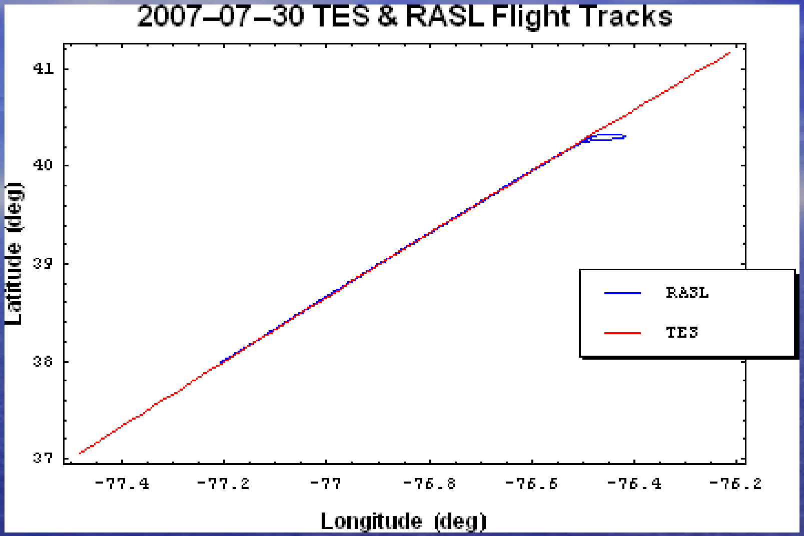


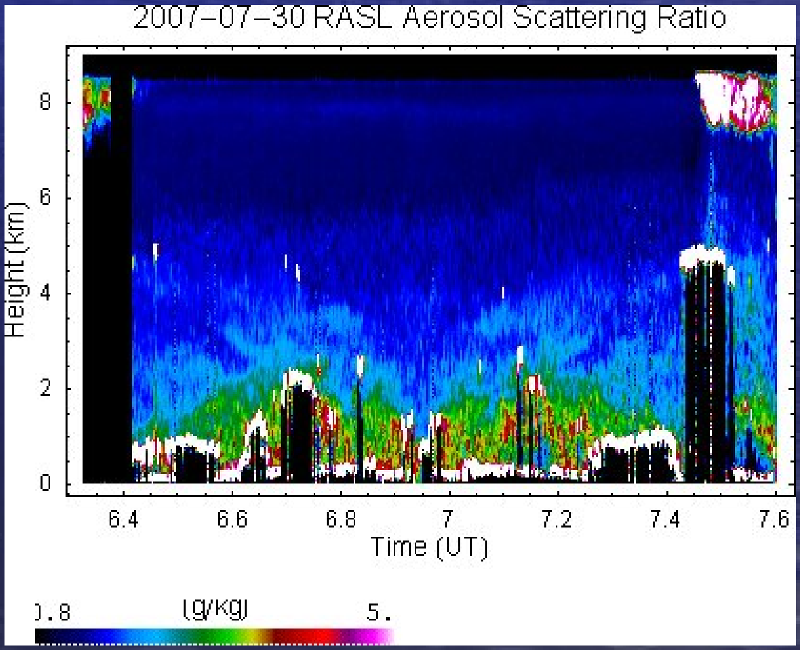
Figure 15. Scatterplot of TES − LBLRTM residuals versus the observed TES brightness temperatures for TES scan 20. The LBLRTM calculations were computed using the CFH profile. The pressure axis is only an approximate as it was generated assuming the observed brightness temperature represents closely the region in the CFH profile with the same temperature.

[40] In order to rigorously validate the TES water vapor retrievals, further detailed comparison studies are needed in which accurate coincident profile observations are identified from radiance closure studies and accompanied by a suite of other water vapor measurements that capture the water vapor variability and the clouds. The next step in the TES water vapor "validation" will be to perform water vapor comparisons with the purely vertical, remotely sensed profiles from the ground-based Raman lidar during WAVES_2006 and the proposed airborne Raman lidar measurements for WAVES_2007 [*Whiteman et al.*, 2006]. In addition, any coincident and colocated retrievals from interferometer instruments will be used for validations.

TES Special Ops July 30, 2007

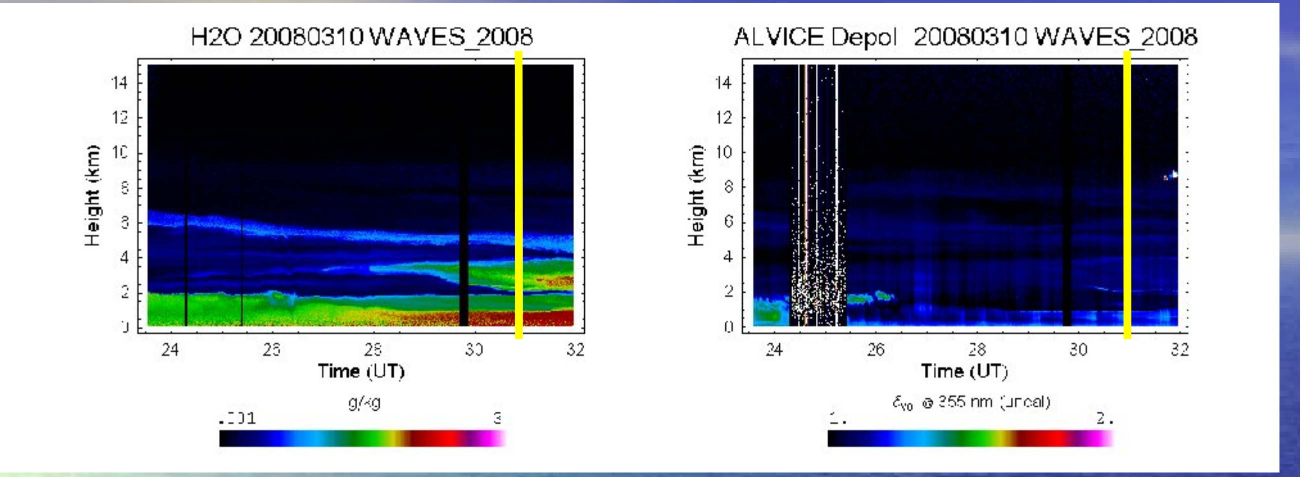
- Raman Airborne Spectroscopic Lidar (RASL) flown in support of WAVES_2007
  - IIP and ESTO supported
- Cloudy conditions but fov by fov comparison in process
  - Bob Herman/JPL, Mark Shepherd/AER

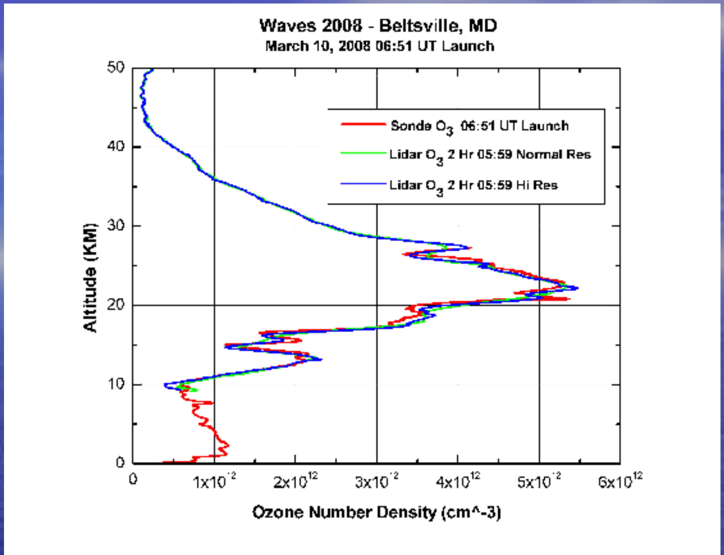




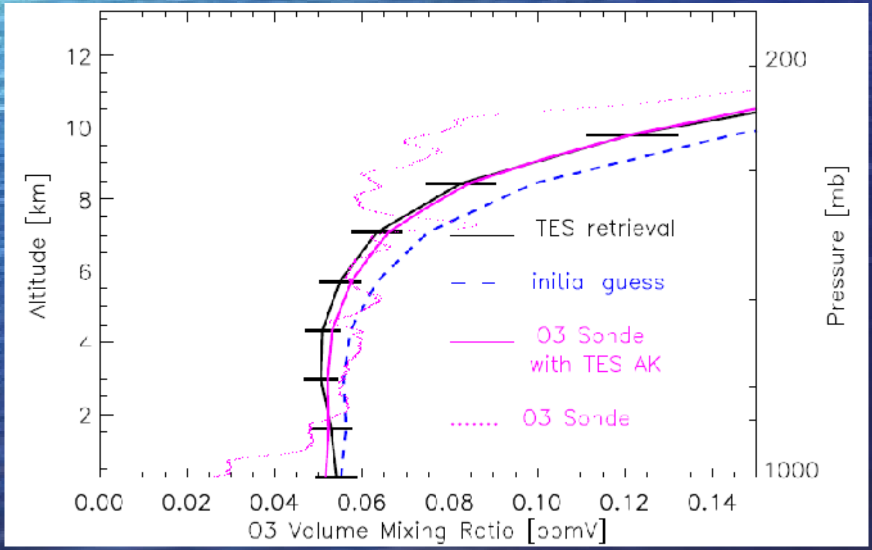
RASL flew on King Air B200

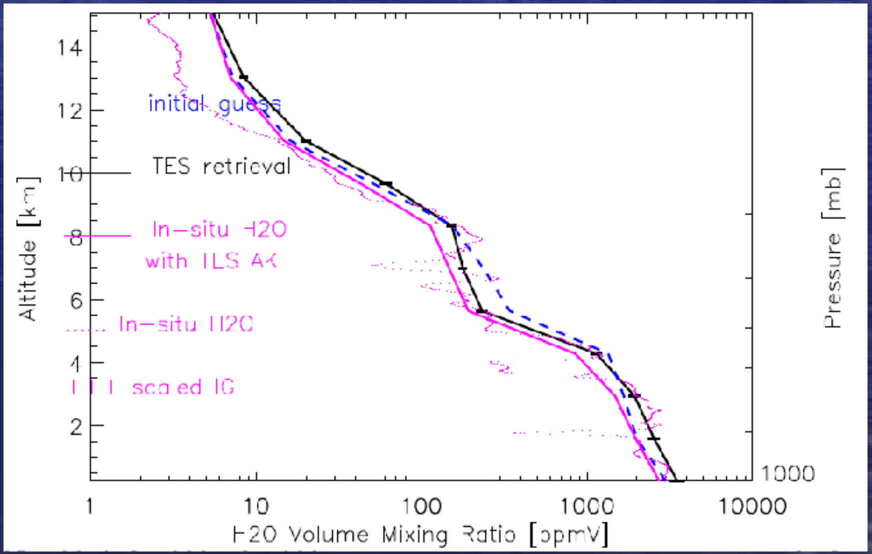
TES Special Ops March 10, 2008





Water vapor, aerosol and ozone lidars ran continuously during overpass. RS92 + ECC launched prior to overpass

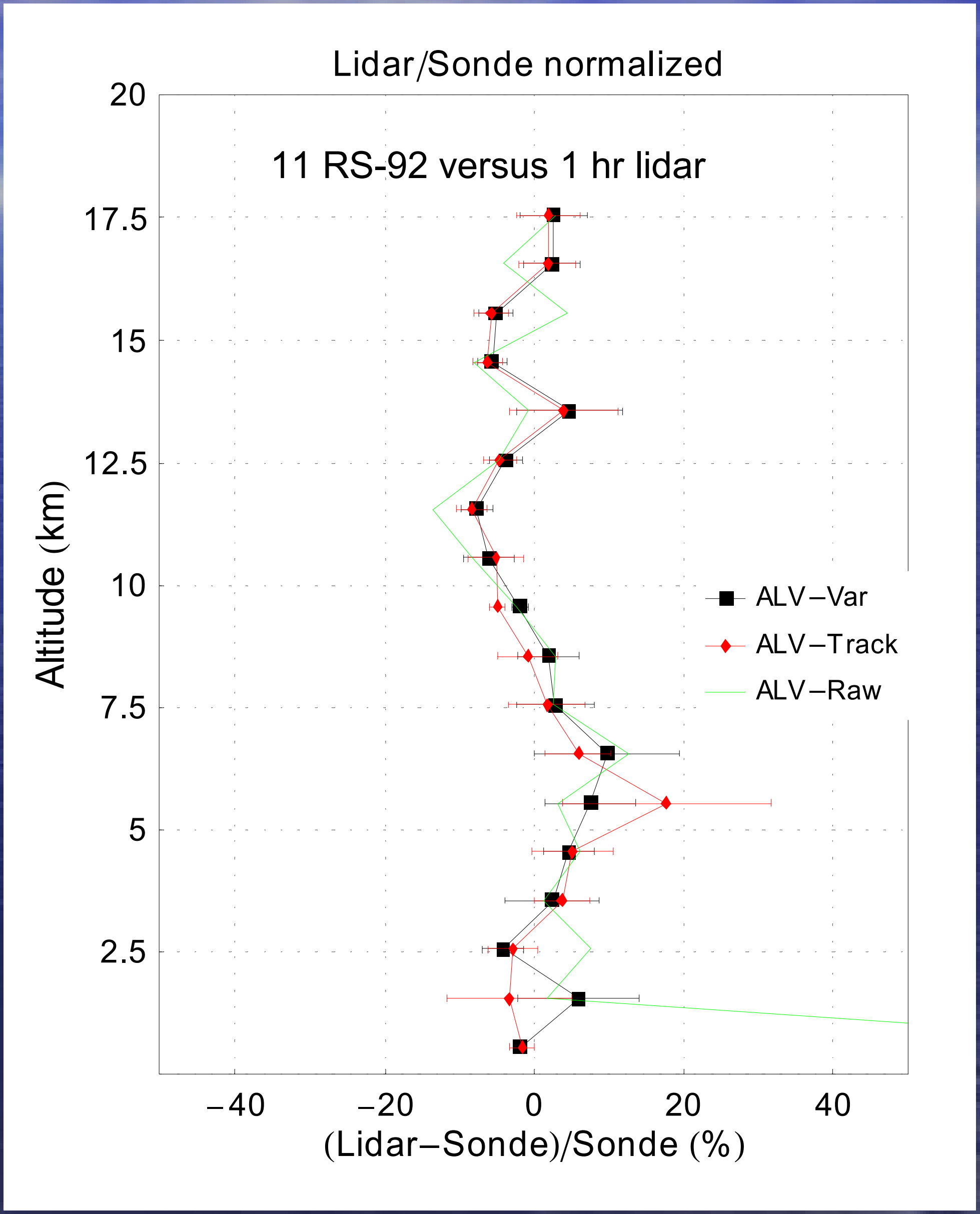




Preliminary retrievals show better agreement for ozone than water vapor

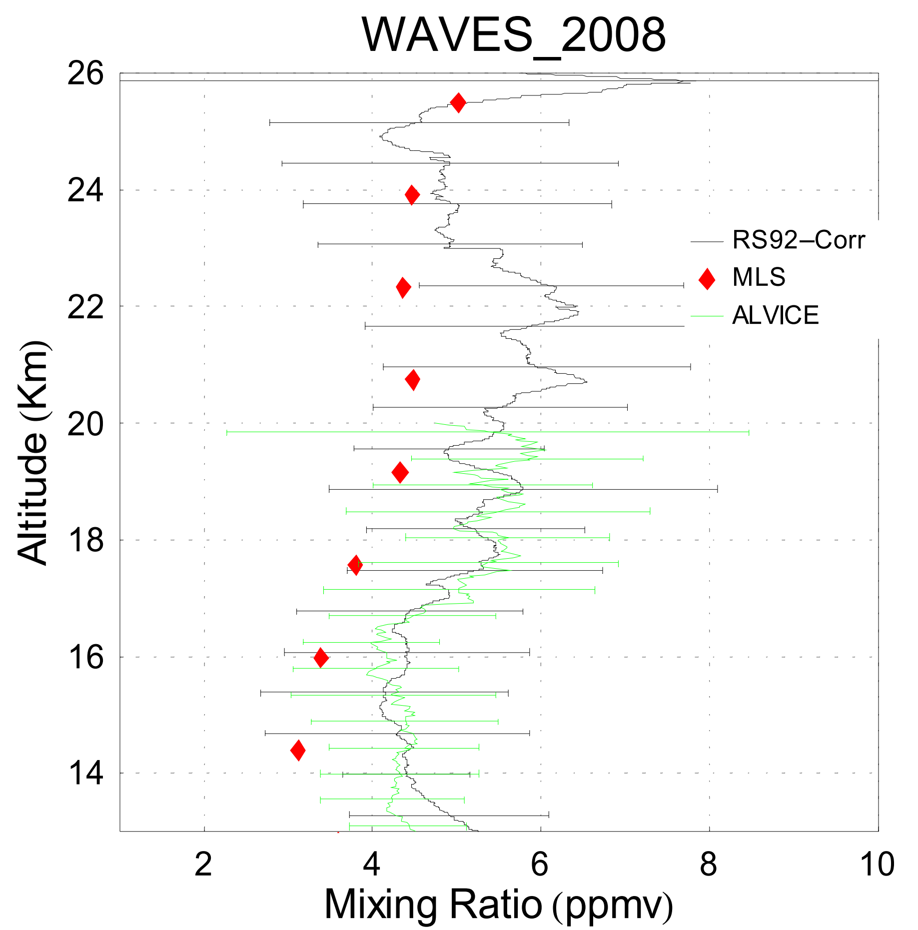
NDACC Raman Lidar Instrument Studies during WAVES_2008

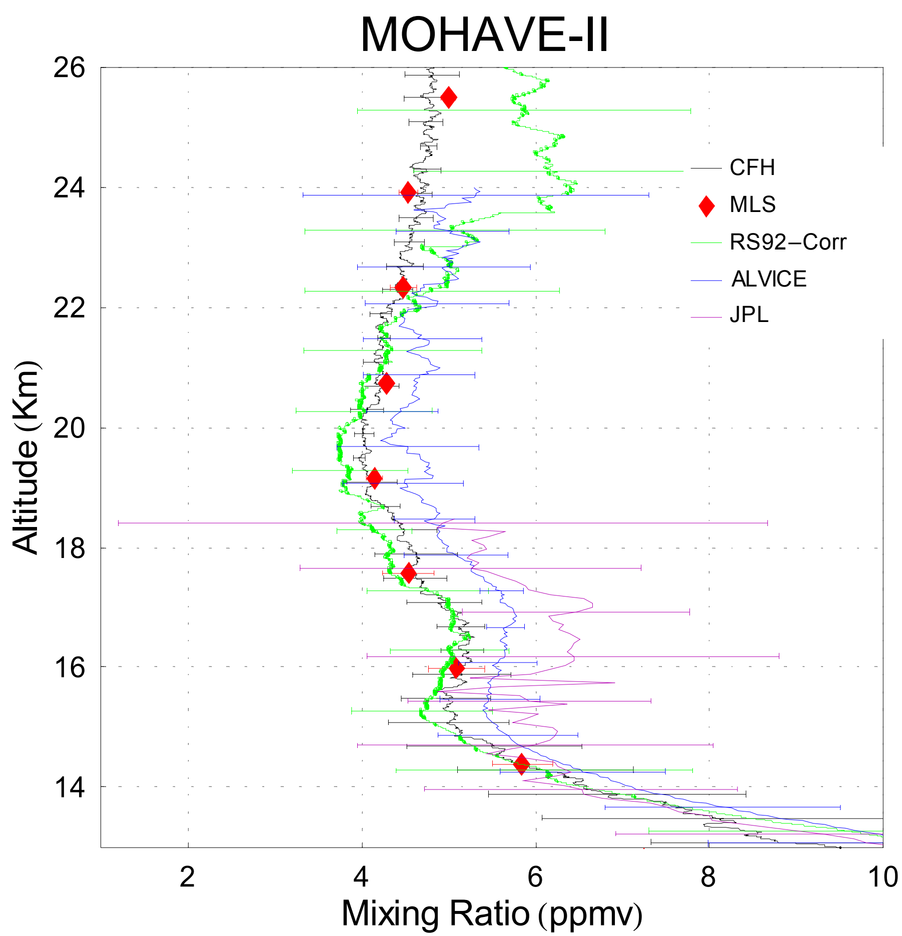
- ALVICE
  - Recently admitted to NDACC as a mobile complementary lidar system
  - CFH, Vaisala RS-92, SuomiNet GPS
- Ensemble comparison with corrected RS-92
  - Same correction as used in MOHAVE-II data reduction
  - Agreement within +/- 10%
    - No evidence of increasing moist bias with altitude.



Long Averages from WAVES_2008 and MOHAVE-II

- "Ensemble" comparisons from M-II and WAVES

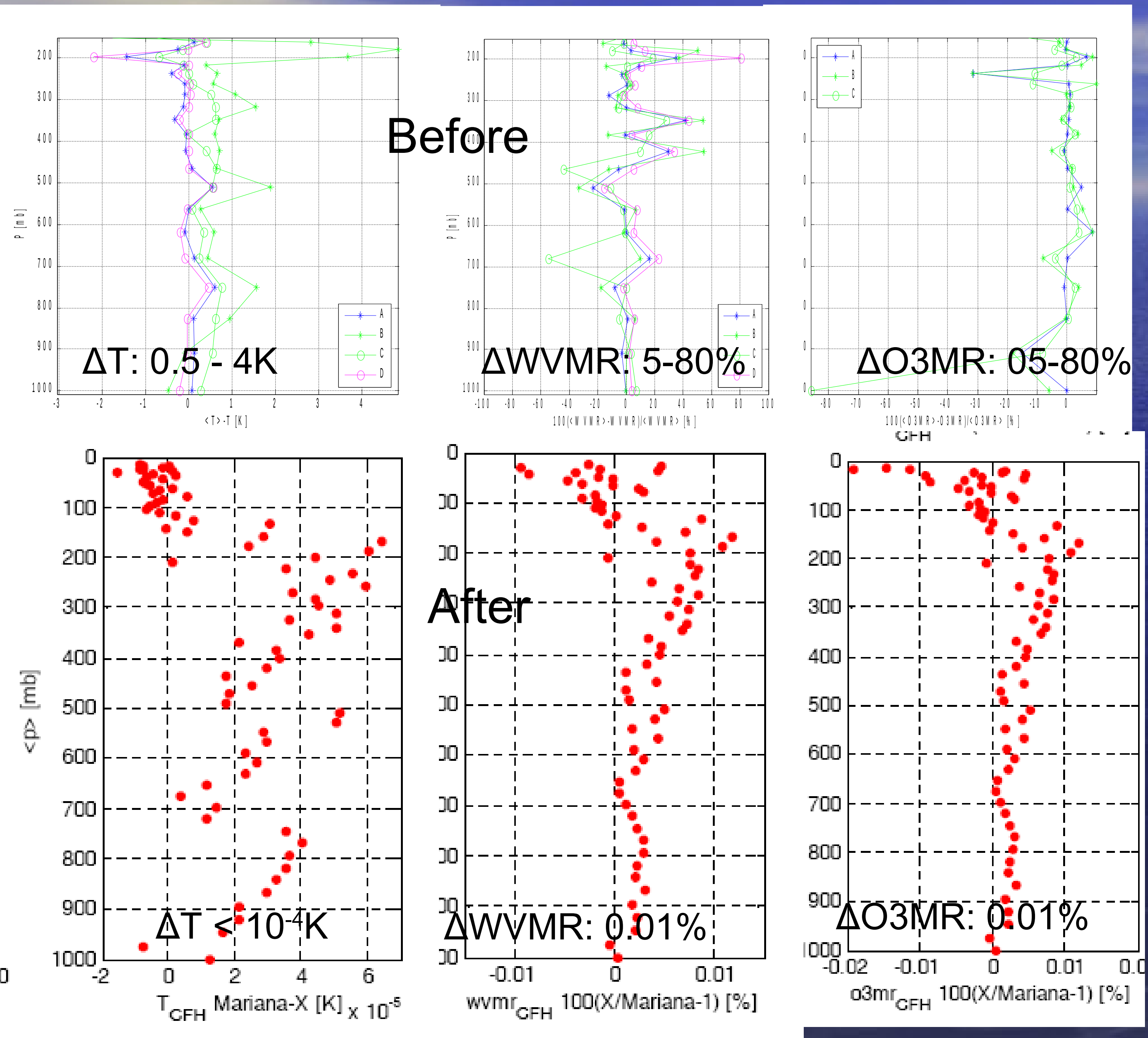




WAVES Intercomparison Study

- Initial comparison of WAVES water vapor and ozone sondes with AIRS and TES retrievals, performed by different people, did not necessarily lead to same conclusions
  - Sub-group formed to study methods of comparison with the goal of coming to common agreement on how to intercompare AIRS and TES with validation data (either sonde or lidar)
  - Group members from Howard University, NOAA (AIRS team), JPL, AER (TES team),NASA-GSFC
- Start by selecting a single case where CFH, RS92, TES, AIRS and lidar all operating.
- Focus on the first step of interpolating sonde data to either the 67 levels of TES or 100 layers of AIRS.

WAVES Intercomparison Study - II



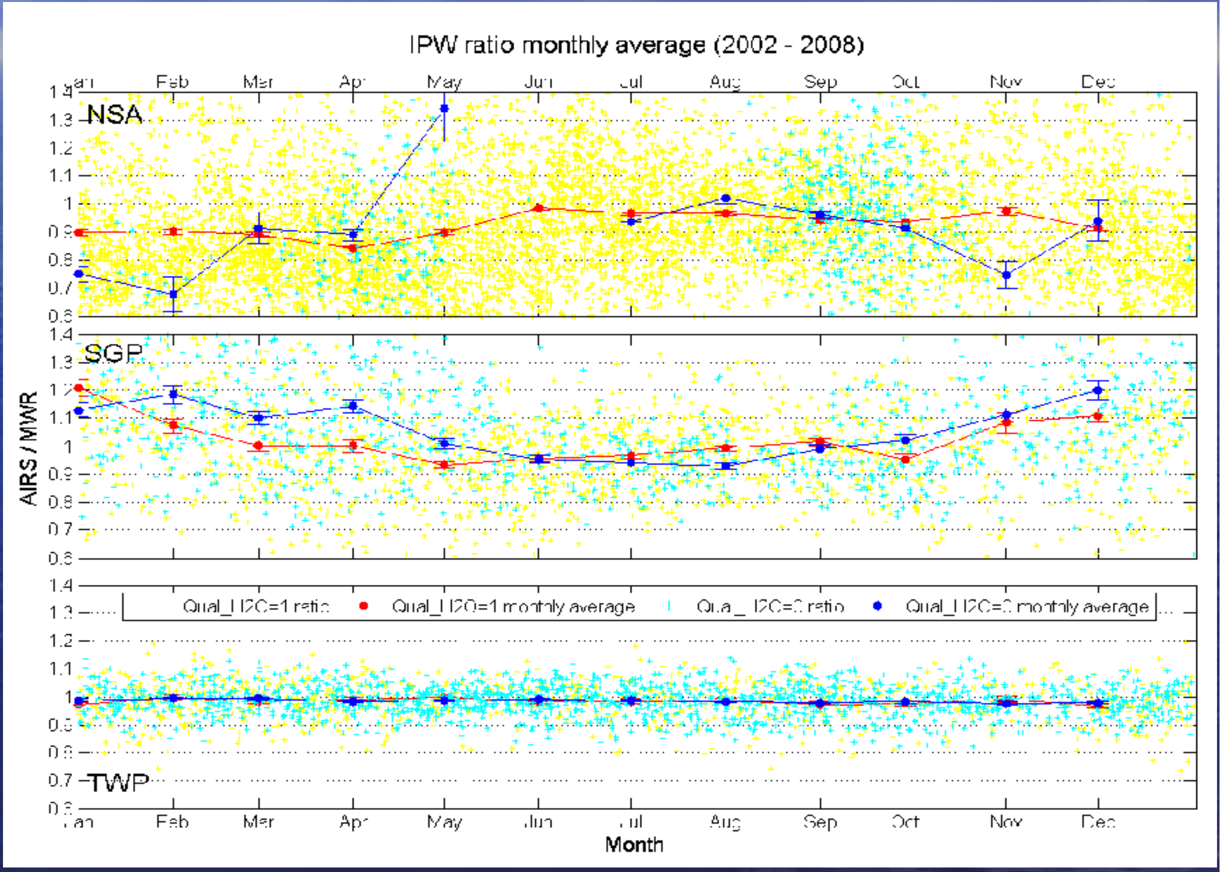
Differences due to definitions of mixing ratio, methods of integration, requirement that molecules and radiance be conserved through the interpolation step, methods of eliminating bad data

Student Research

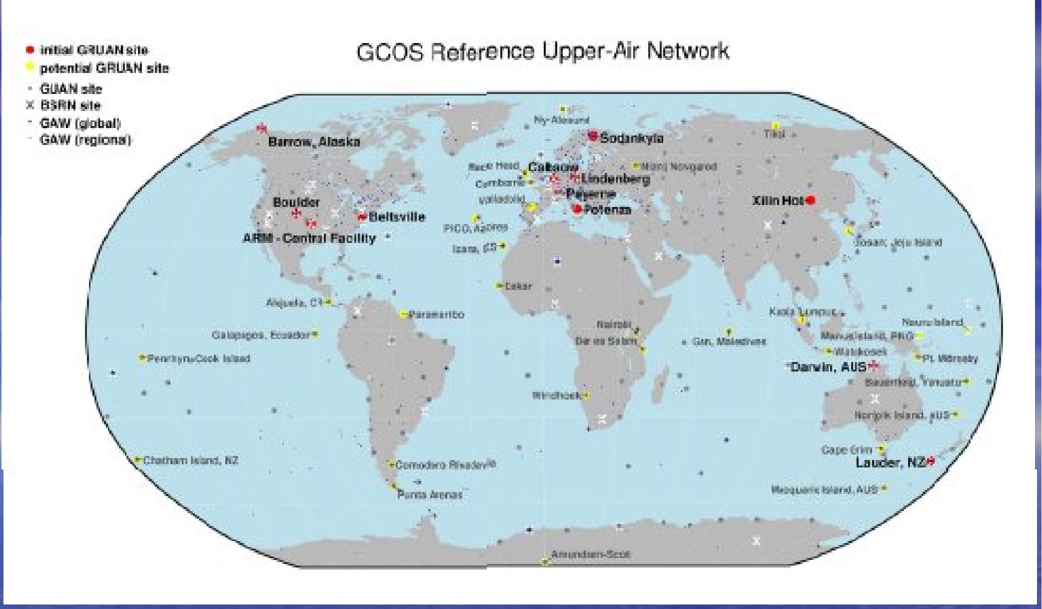
- Topics: aerosol/cloud interaction, aerosol humidification, mesoscale modeling, direct and diffuse radiation, surface/atmosphere exchange/fluxes, ozone monitoring, radiosonde studies
- Howard University (18) : S. Walford (PhD), R. Connell (PhD), M. Robjon (PhD), F. Nzeffe (PhD), C. Stearns (PhD), M. Hicks (PhD), P. Kurian (PhD), J. Brooks (UG), A. Crews (UG), M. Benitez (UG) T. Creekmore (PhD), K. Ogungbemi (PhD), N. George (UG), L. Sammuels (UG), V. Davis (MS), H. Coulibali (UG), H. Laryea (MS), A. Flores (PhD)
- UMBC (3): R. Rogers (PhD), M. Weldegaber (PhD), C. Wilson (PhD)
- UMCP (1) : S. Rabenhorst (PhD)
- Trinity University (2) : K. Roberts (UG), L. Kpetemey (UG)
- Penn State (2): J. Yorks (MS), S. Michaels (MS)
- Smith College (1) : C. Stearns (UG)
- The Citadel (1): M. Benitez (UG)
- Foreign (3): S. Wüst (Germany), A. Guinta (Italy), A. Torres (Brazil)

AIRS V5 PW vs ARM MWR

- Ratio of AIRS PW and ARM MWR PW (MWRLOS) at three NSA sites
  - Monthly means and standard errors
  - Significant biases seen at SGP
  - See Vermeesch poster for more



GCOS Reference Upper Air Network (GRUAN)



- WMO initiative (GCOS-112, GCOS-121)
- Establish an initial set of 12 stations globally (4 in U.S.)
  - "start small, but start"
  - 1x weekly production radiosonde with the best technology currently available at the site
  - monthly UT/LS sounding, multiple package launches, periodic intercomparisons of large range of sondes, regular daily 00 and 12 LST launches of best available technology
- Develop a reference radiosonde suitable for climate monitoring
- Regular GRUAN operations at Beltsville to begin in 2009

Questions?