On the effects of dust on AIRS and IASI Operational Level 2 Products

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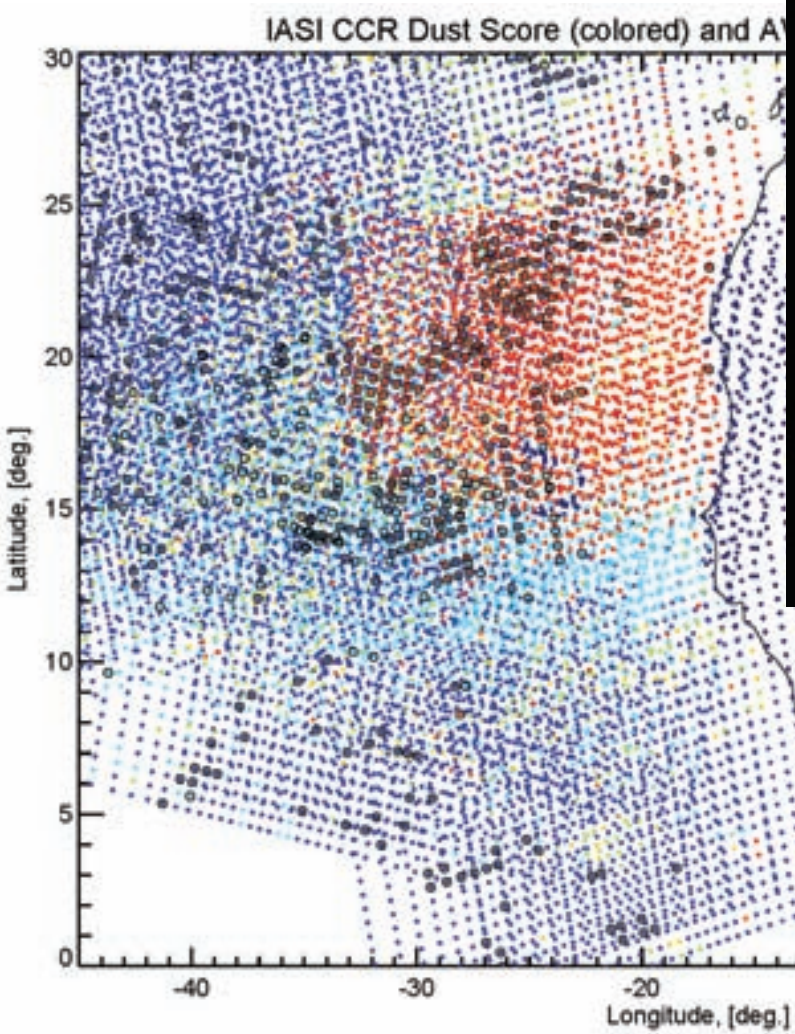
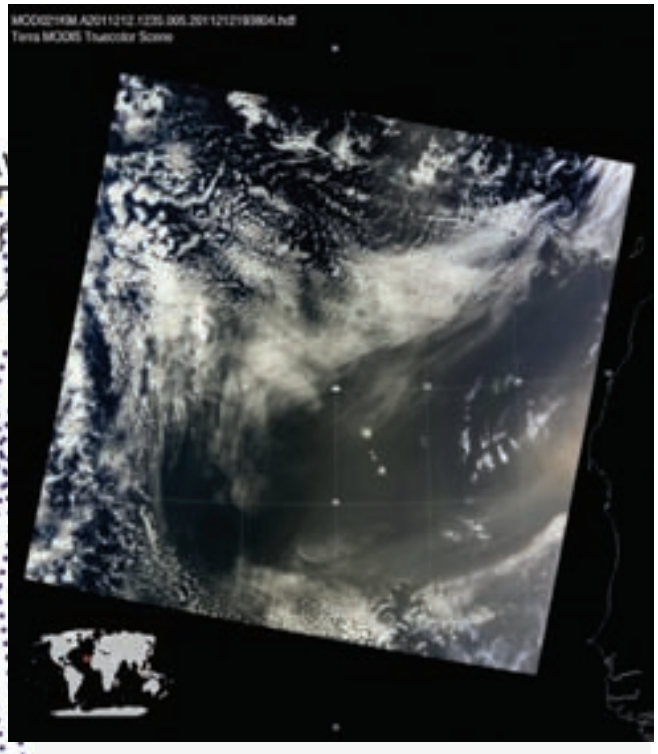
Background and Motivation

- Sergio De-Souza Machado has shown that the AIRS V5 temperature and moisture profile products and surface temperature products have spurious biases relative to ECMWF when his dust score is large (qualitative assesment of the dust amount).
- We are funded through the 2009 ROSES to understand the error characteristics of the AIRS L2 products in dust laden and cloudy-sky scenes.
    - Since 2004, as part of AEROSE field campaigns, Nick Nalli et al. has been collecting correlative dedicated radiosonde profiles of temperature, humidity and ozone in addition to Microtops aerosol optical depth measurements over a large portion of the Atlantic Ocean.
    - Since 2008 dedicated sondes have been launched at both IASI and AIRS overpass times.
- The SAL is an active area of research (hurricane suppression, OLR, ...) and there have been recent studies (e.g., Davidi, et al., JGR, 2011) that have used the AIRS profiles in the presence of dust to infer thermodynamic properties of Saharan outflow.
- Our goal is to validate and extend Sergio's findings (use our AIRS experience) using these high quality radiosondes and AOD measurements from the AEROSE campaigns so that we can make users aware of appropriate caveats for both AIRS and IASI L2 products.

IASI dust scores (Sergio's prescription) 07/23-08/01/2011



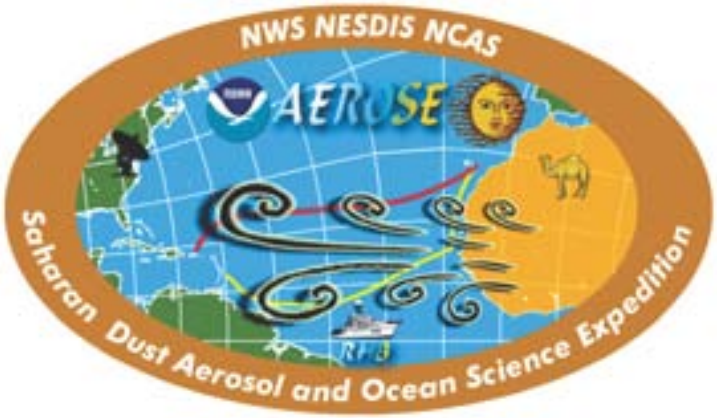


MODIS (Terra) Truecolor granule on July 31, 2011 showing dust outflow.

There is a small time difference between the two satellite overpasses.

PNE/AEROSE Participating Institutions

- Howard University NOAA Center for Atmospheric Sciences (HU/NCAS)
- NOAA/NESDIS/STAR
- University of Miami/RSMAS
- NOAA/ESRL/PSD (formerly NOAA/ETL)
- NOAA/OAR Atlantic Oceanographic and Meteorological Laboratory (AOML)
- NOAA Pacific Marine Environmental Laboratory (PMEL)



Correlative Data of Interest

Dedicated RAOBs

- Typically 4/day at 01:30, 09:30, 13:30, 21:30
- Over 250 PTU soundings in 2009, 2010, 2011
- not assimilated, decoupled from land-based RAOBs - thus truly independent

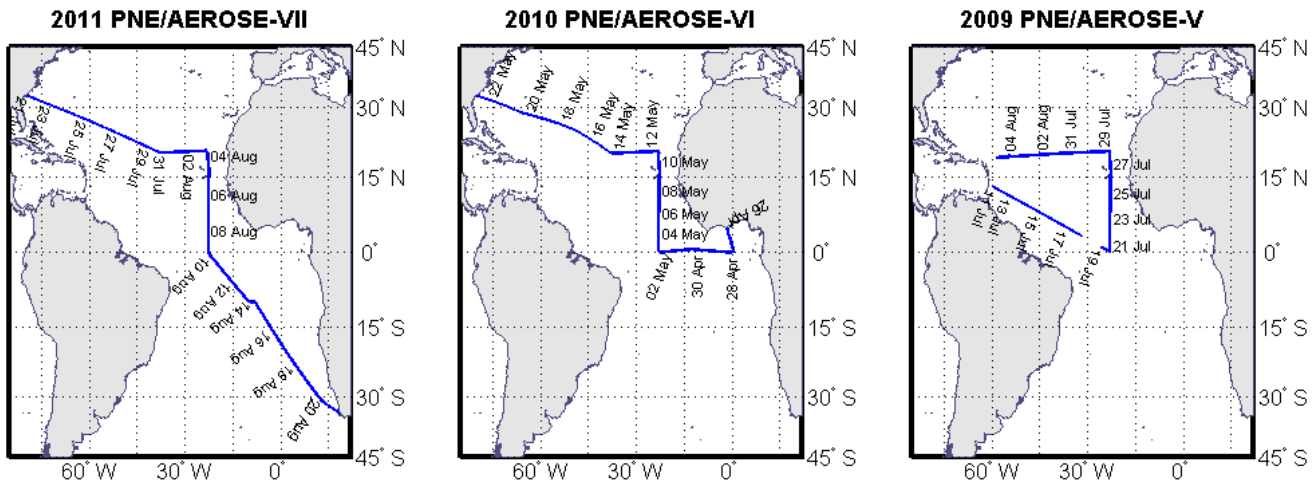
Ozone sondes

- Over 64 soundings in 2009, 2010, and 2011
- 113 O_3 soundings to date

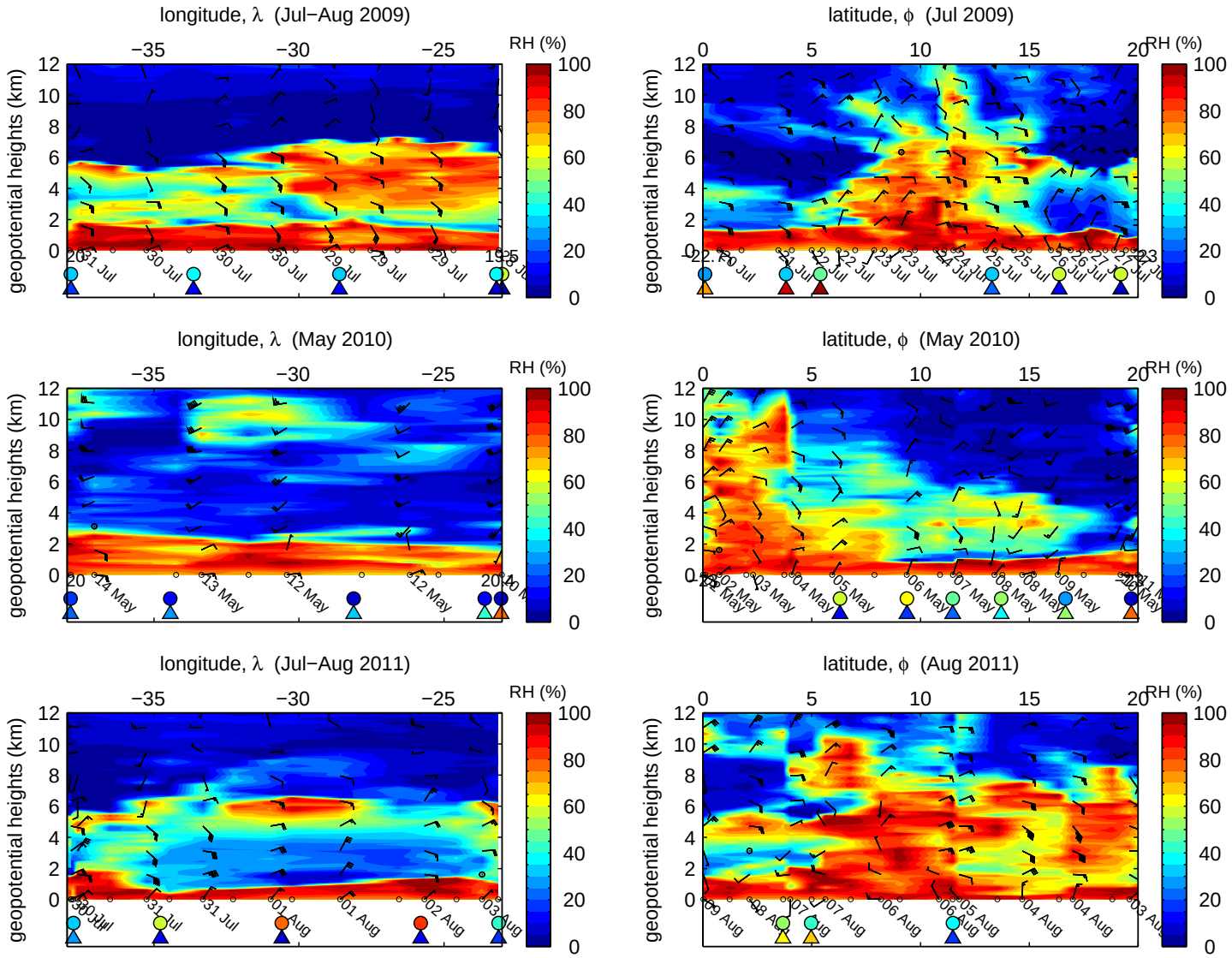
Microtops Sunphotometer

- Multi-channel aerosol optical depth (AOD)
- NASA/GSFC AERONET Maritime Aerosol Network (MAN) methodology and QC applied to retrieve a standardized AOD.

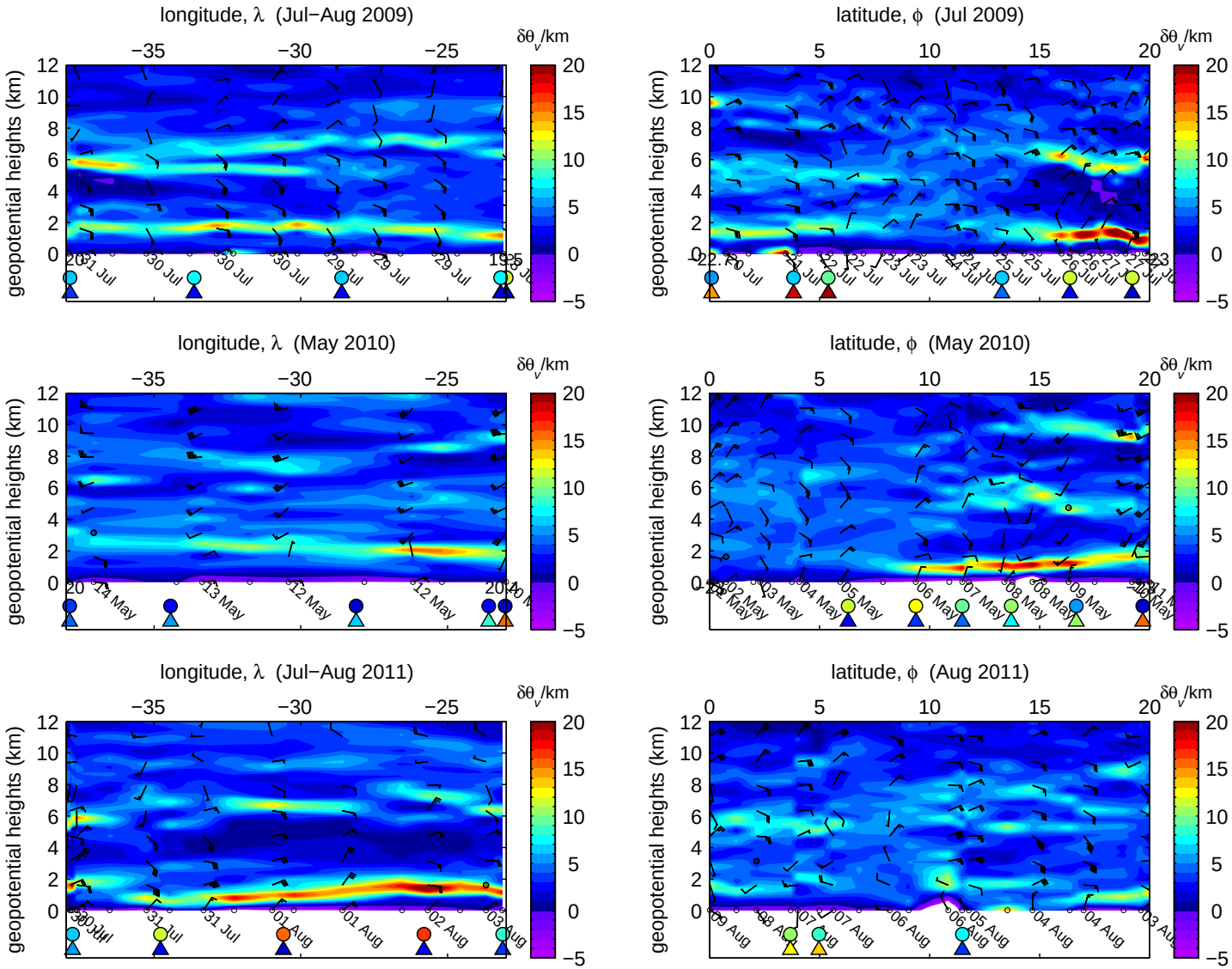
Ship Tracks


2011 PNE/AEROSE-VII
2010 PNE/AEROSE-VI
2009 PNE/AEROSE-V
45° N
30° N
15° N
0°
15° S
30° S
45° S
60° W
30° W
0°
04 Aug
06 Aug
08 Aug
10 May
08 May
06 May
04 May
27 Jul
25 Jul
23 Jul
21 Jul

Relative Humidity Cross Sections - 2009, 2010, 2011

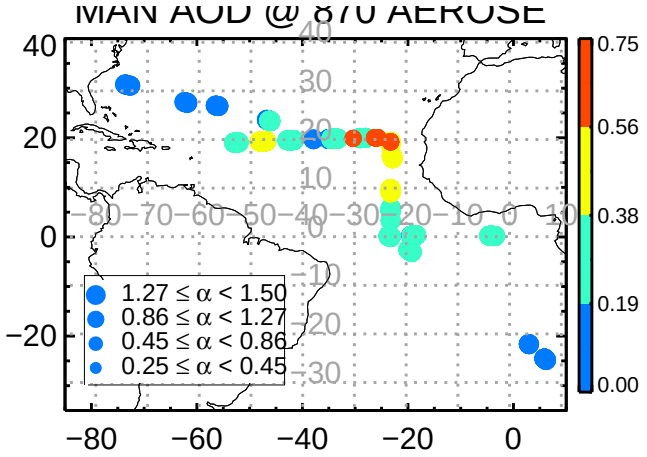


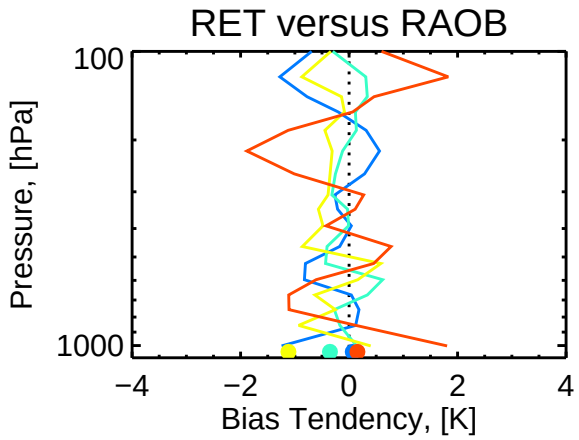
Virtual Potential Temperature Cross Sections - 2009, 2010, 2011

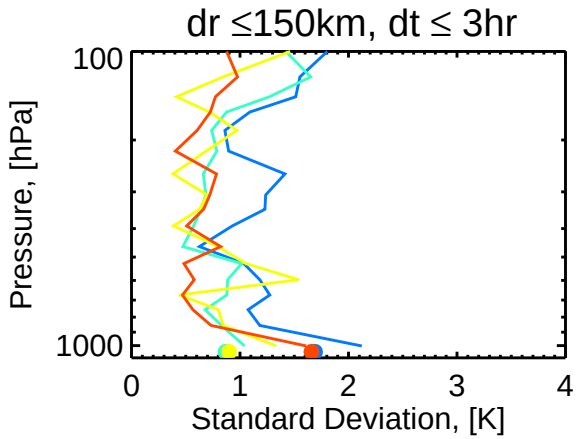


Collocation Strategy

- We select all retrievals within $\delta t = \pm 3$ hr, $\delta r =$150km of a Microtops Sunphotometer measurement and corresponding to a collocated RAOB - more than one retrieval per point shown.
- We calculate mean bias tendency and standard deviation statistics for data that fall within 4 AOD bins.
- We also use the RAOB profiles + ECMWF surface temperature and compare cloud-cleared radiances from AIRS and IASI to the forward calculations for each of the 4 AOD bins


MAN AOD @ 870 AEROSE
1.27 ≤ α < 1.50
0.86 ≤ α < 1.27
0.45 ≤ α < 0.86
0.25 ≤ α < 0.45
0.75
0.56
0.38
0.19
0.00


RET versus RAOB
Pressure, [hPa]
Bias Tendency, [K]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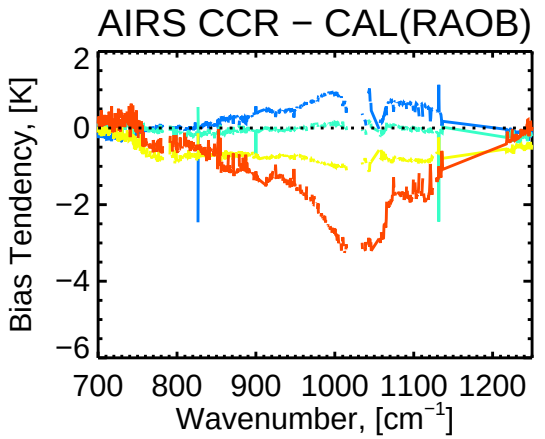
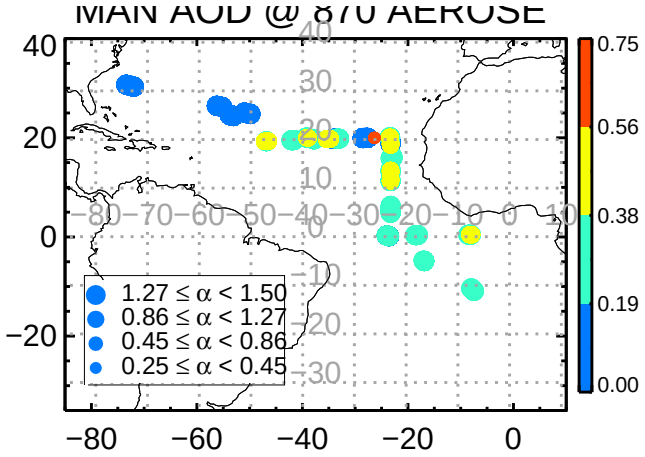

AIRS CCR − CAL(RAOB)
Bias Tendency, [K]
Wavenumber, [cm^{-1}]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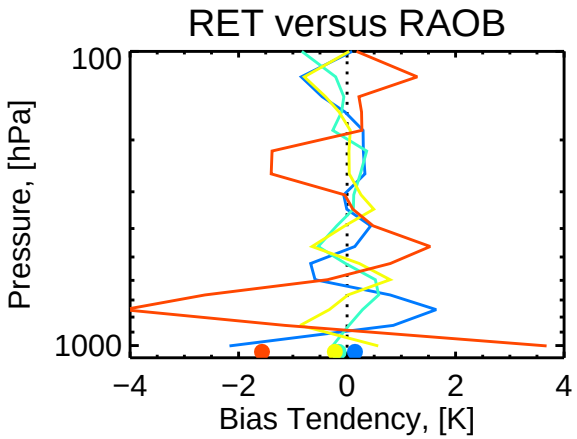
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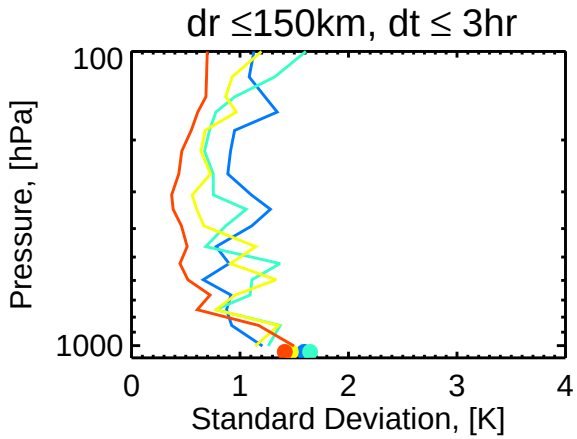
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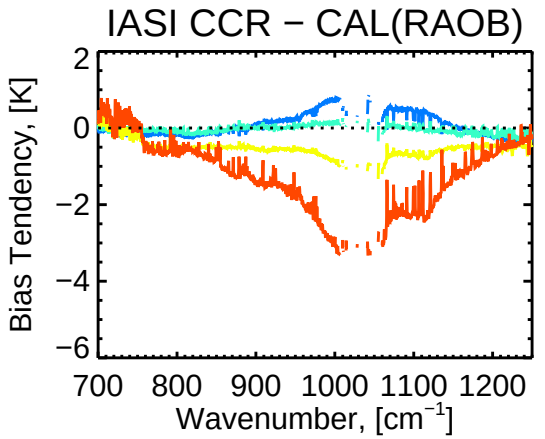
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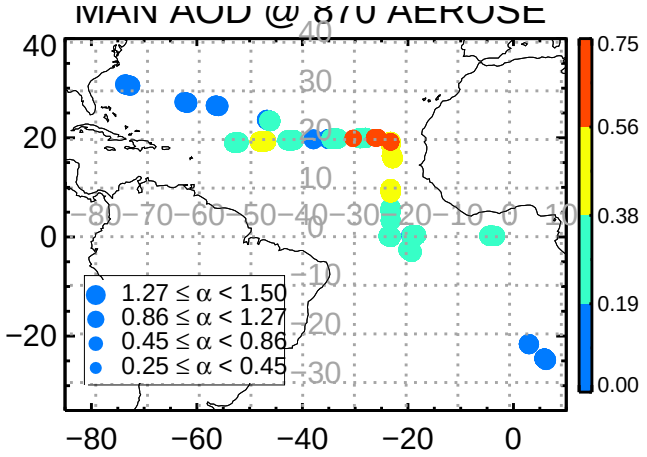
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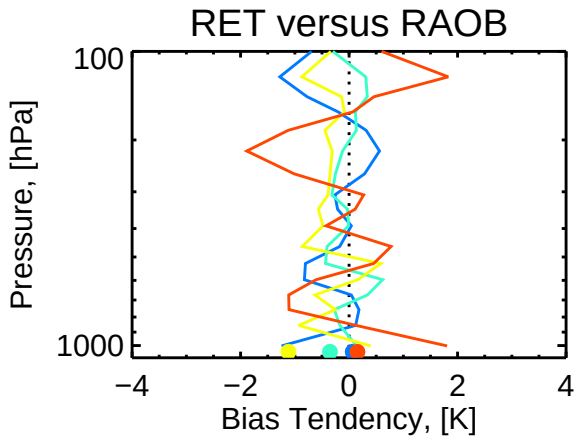
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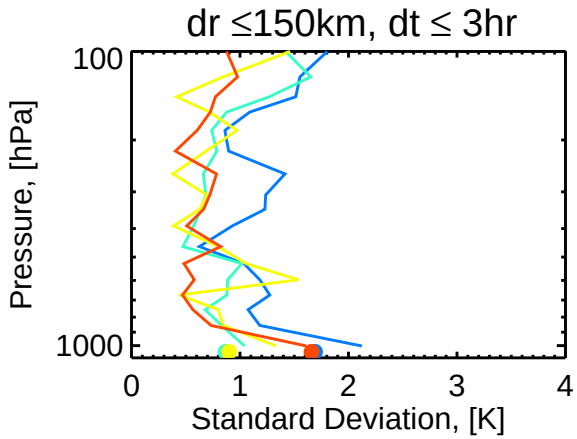
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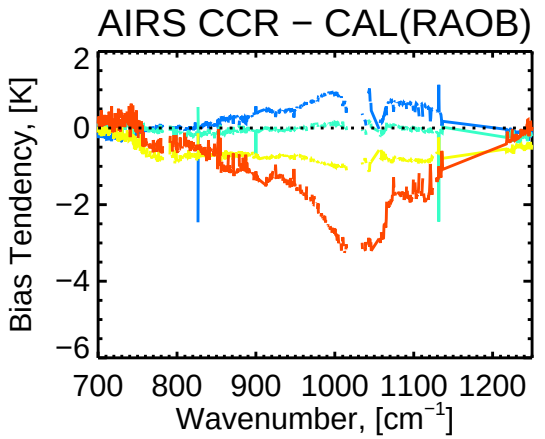
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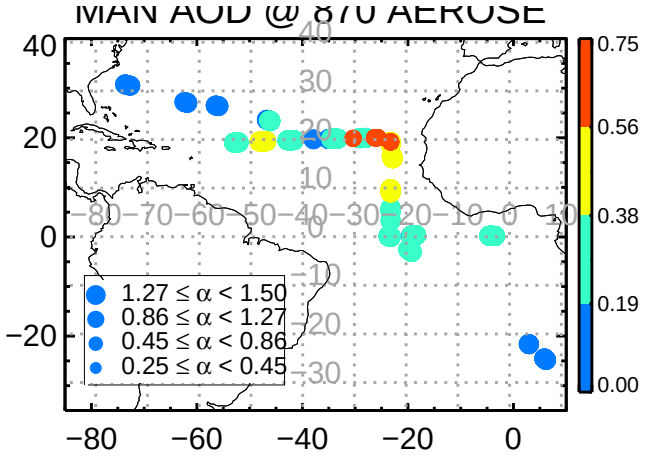
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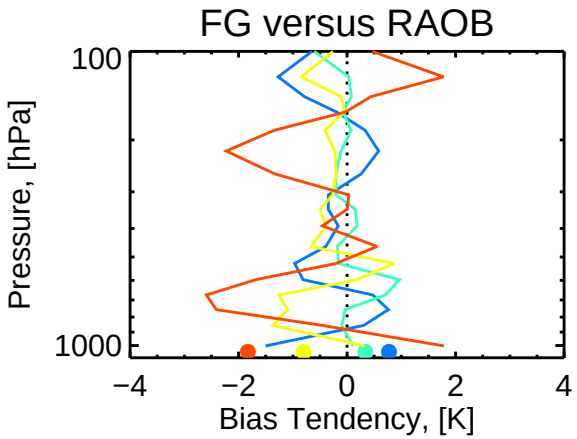
FG versus RAOB
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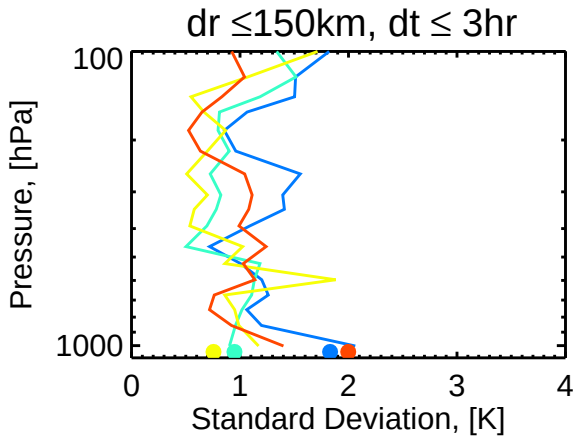
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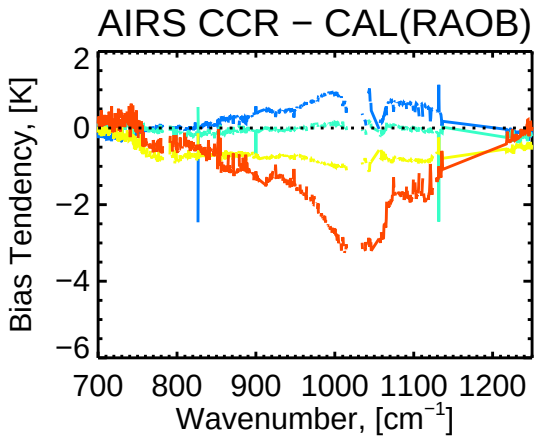
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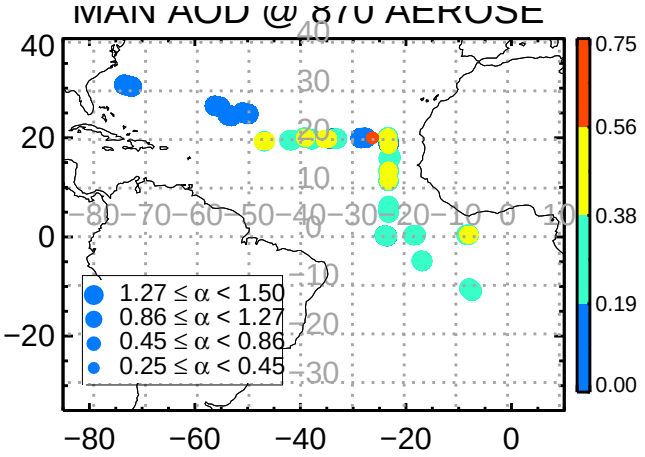
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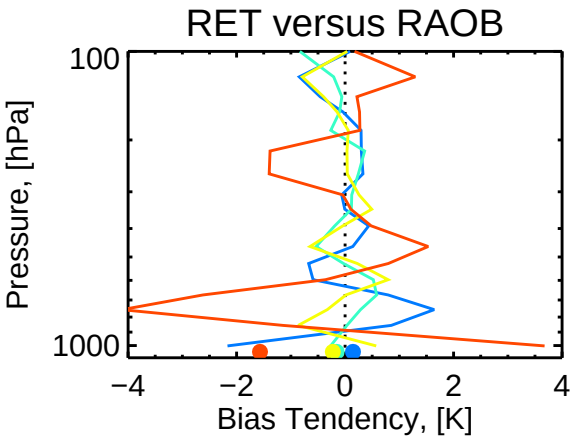
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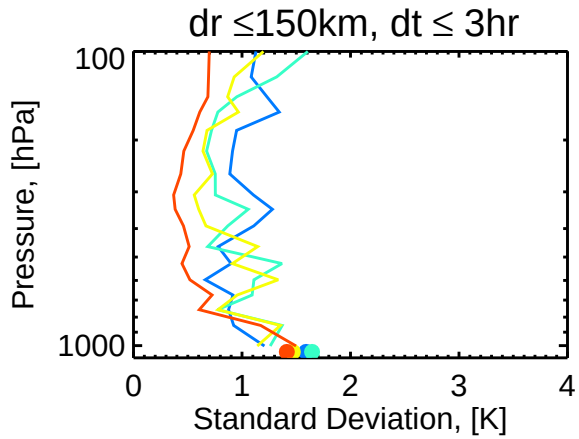
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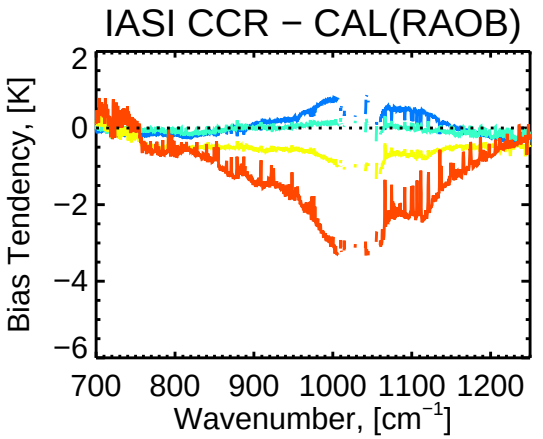
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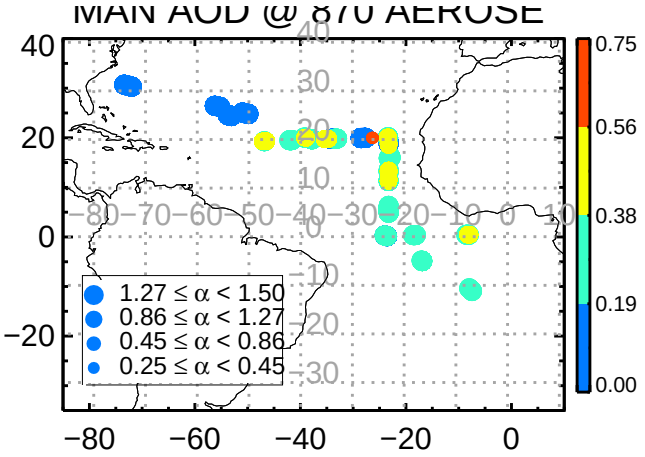
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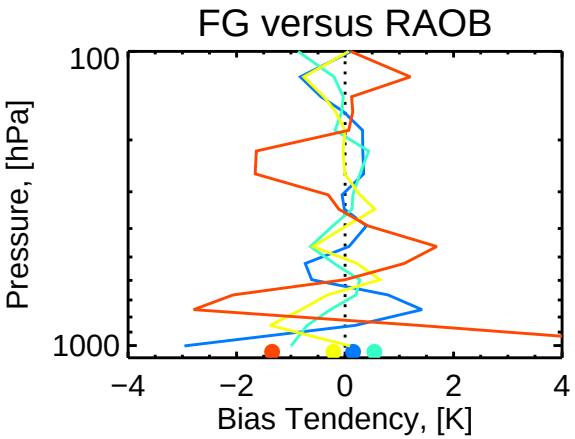
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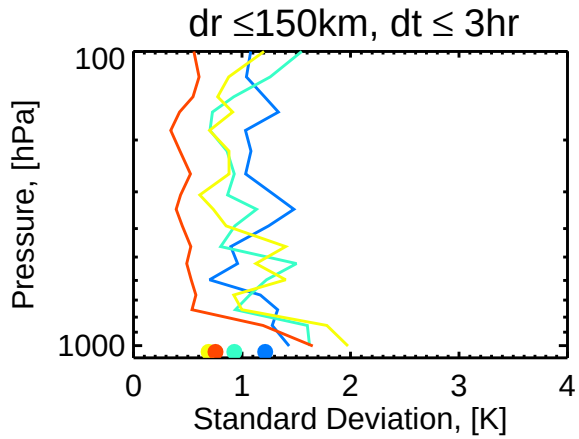
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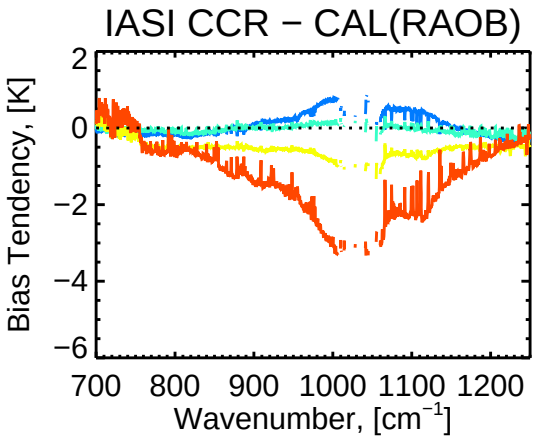
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Discussion and Future Work

- We have shown that AIRS v5 and IASI operational retrievals show spurious oscillatory biases in the presence of Saharan dust.
- In addition, cloud-cleared radiances show the spectral signature of dust ($\approx$4K) in the longwave window - likely due to the fact that dust outbreaks are spatially uniform
- Analysis of the first guess regression versus dedicated sondes shows that the some of the shape of the bias comes from the regression.
- We would recommend warning users of the potential for problems in the v5 and v6 retrievals in the presence of dust - we can provide granule numbers and dates if the AIRS project is interested in looking at v6.
- We plan on looking at H_2O and O_3 for similar granules and also publishing results of a simultaneous dust optical depth plus T(p), H_2O(p) retrieval.