Dust contamination in AIRS v5 and v6 T(p) retrievals? Retrievals of Volcanic Ash - A work in progress

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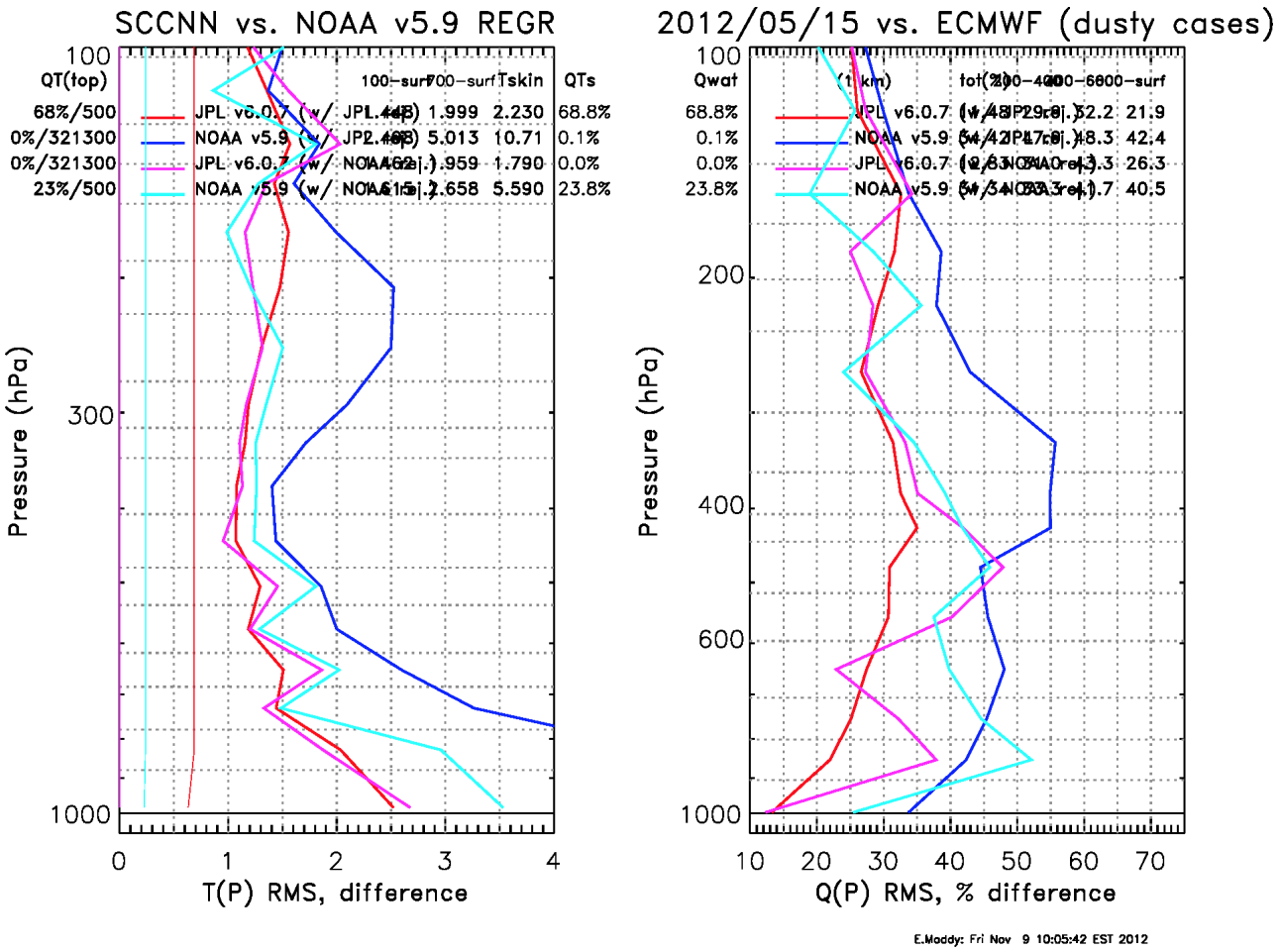
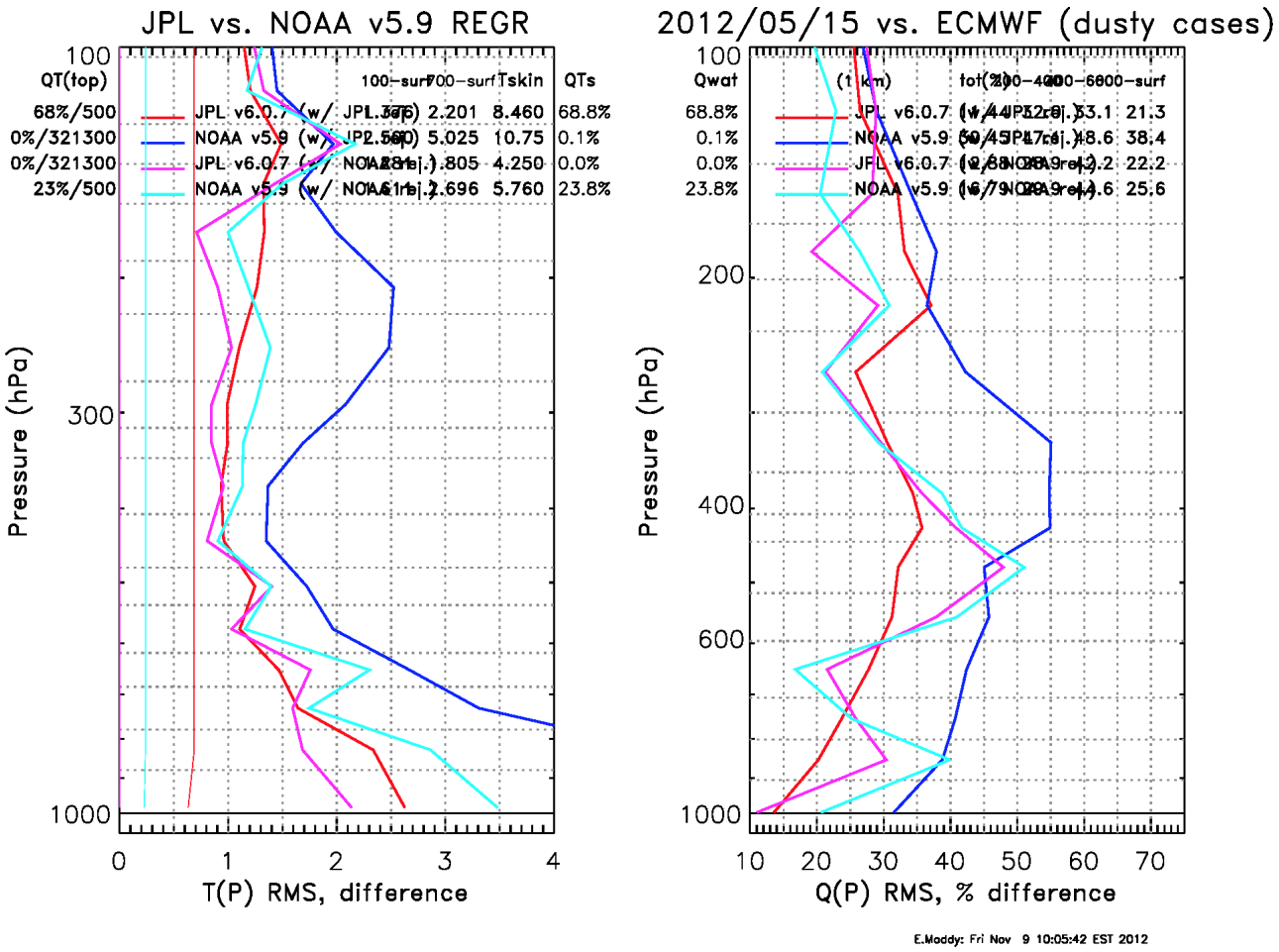
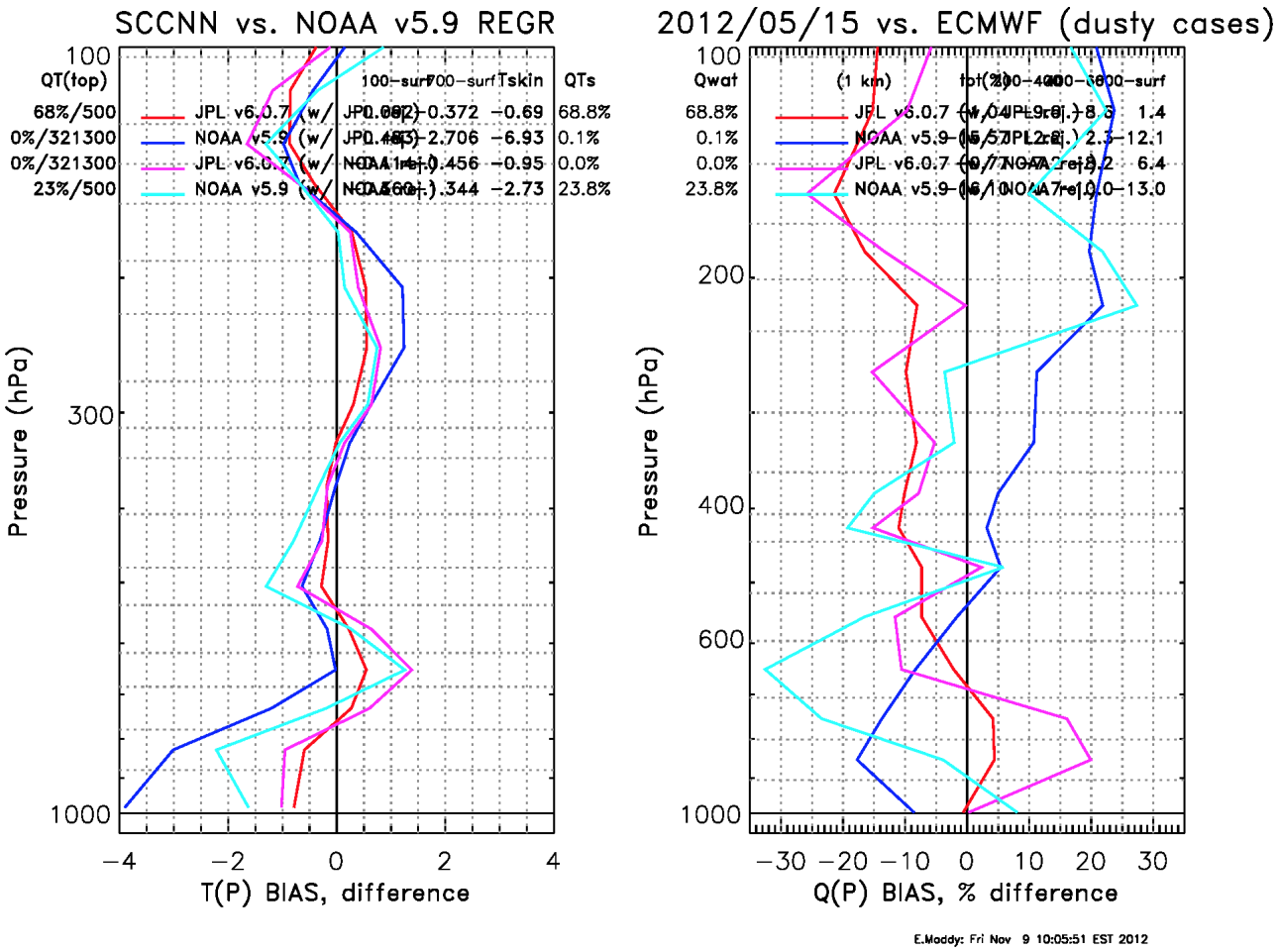
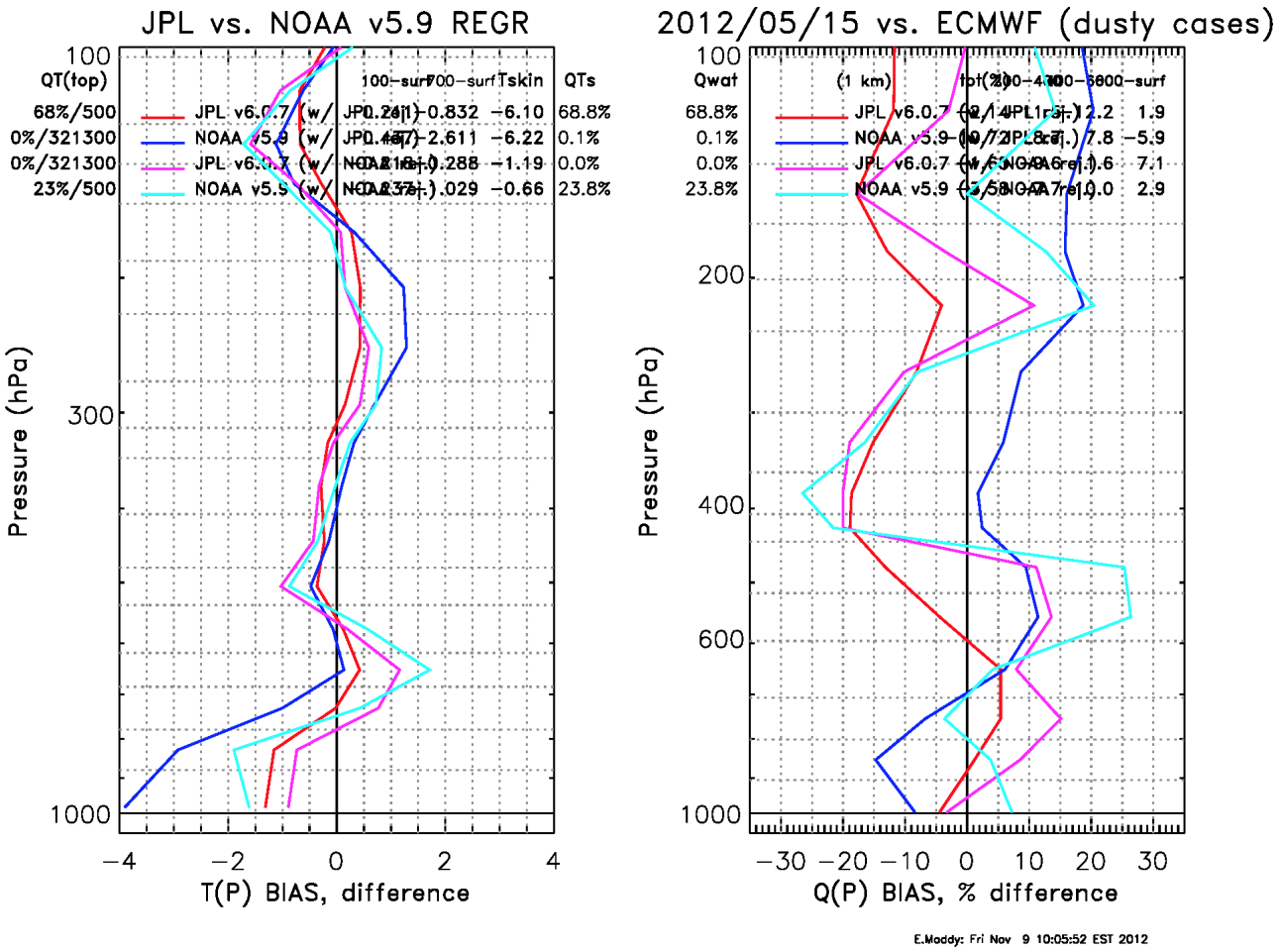
Background and Motivation

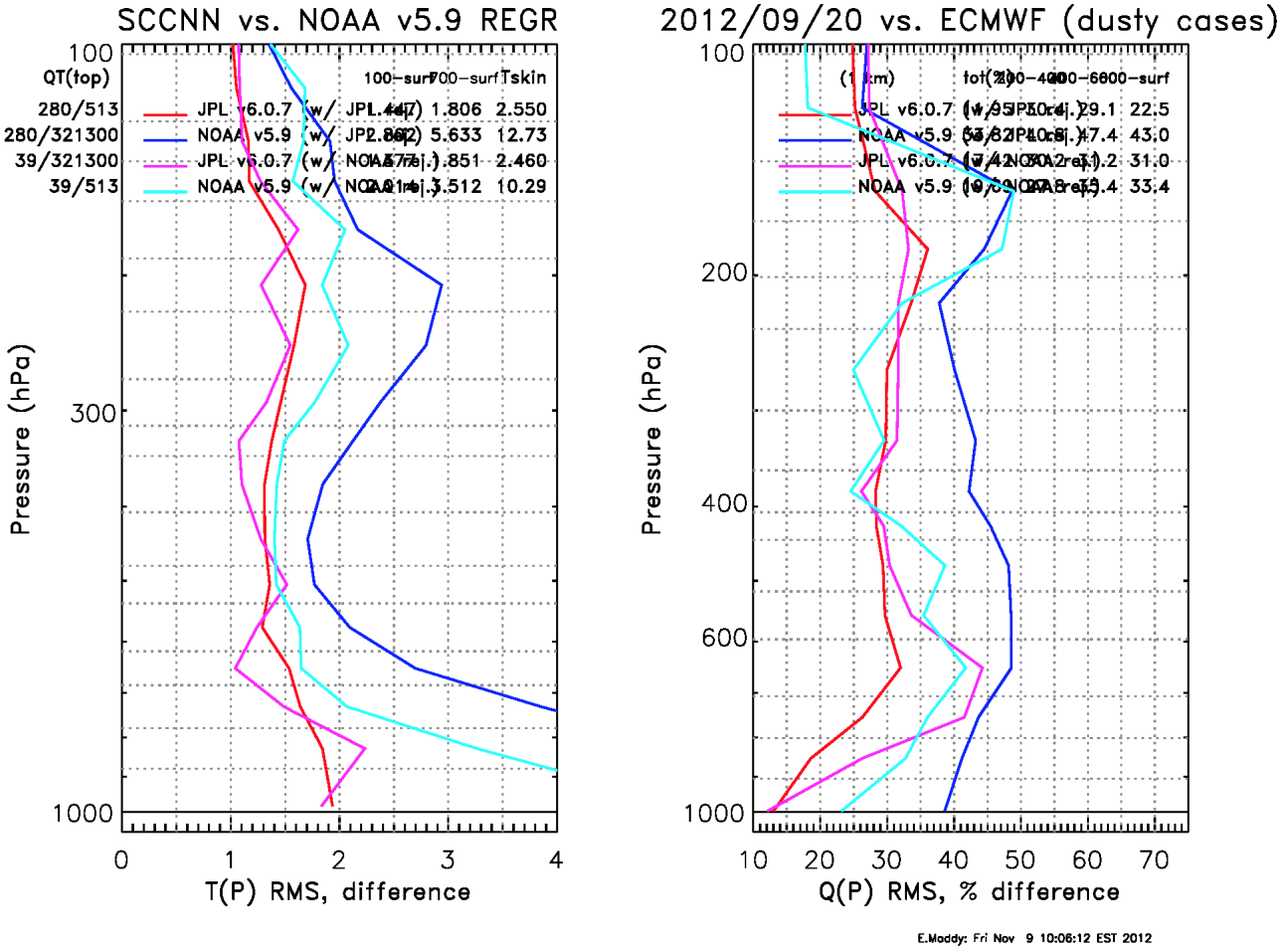
- Sergio De-Souza Machado has shown that the AIRS V5 temperature and moisture profile products and surface temperature products have spurious biases relative to ECMWF when his dust score is large (qualitative assesment of the dust amount).
- We've extended results using N. Nalli's AEROSE radiosondes (Maddy, GRL, 2012) and have shown at previous meetings that the AIRS V5 temperature product is affected by dust. How does v6 behave in dusty situations? - Limited data, but I'll show results.
- Volcanic ash and Saharan dust spectral signatures are similar, so we would expect similar negative effects in the presence of volcanic ash.
- Can we simultaneously retrieval dust (or volcanic ash) and cloud using SARTAs scattering model? ... a work in progress.

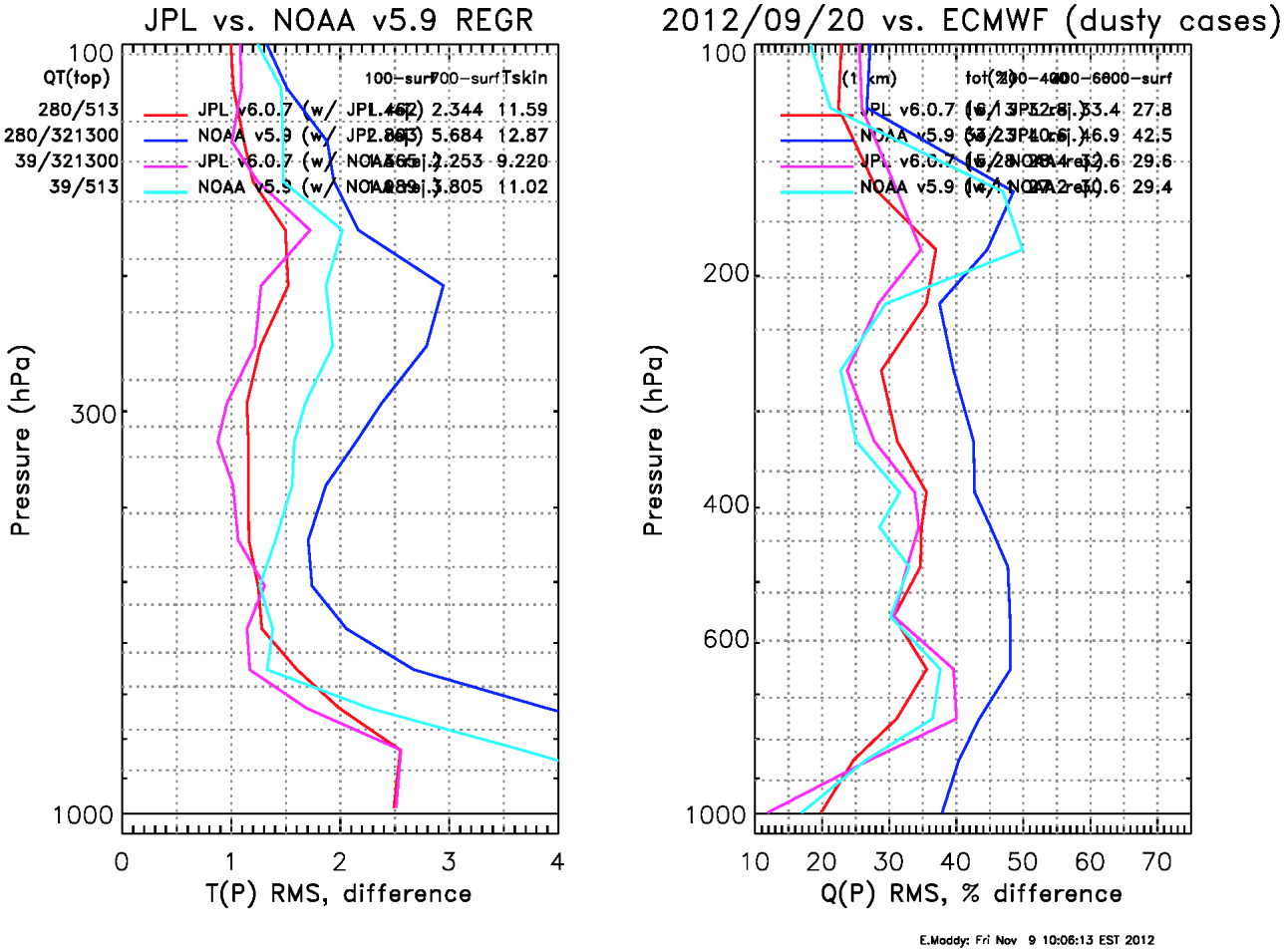

SCCNN vs. NOAA v5.9 REGR
2012/05/15 vs. ECMWF (dusty cases)
QT(top)
100-surf
700-surf
Tskin
QTs
68%/500
0%/321300
0%/321300
23%/500
JPL v6.0.7 (w/ JPL 44B) 1.999 2.230 68.8%
NOAA v5.9 (w/ JPL 46B) 5.013 10.71 0.1%
JPL v6.0.7 (w/ NOAA62) .959 1.790 0.0%
NOAA v5.9 (w/ NOAA15) 2.658 5.590 23.8%
Pressure (hPa)
T(P) RMS, difference
Qwat
(1 km)
tot(%)
0-4000
4000-6000
6000-surf
68.8%
0.1%
0.0%
23.8%
JPL v6.0.7 (w/ JPL29B) 52.2 21.9
NOAA v5.9 (w/ JPL17B) 18.3 42.4
JPL v6.0.7 (w/ NOAA0) 13.3 26.3
NOAA v5.9 (w/ NOAA3) 11.7 40.5
Q(P) RMS, % difference
E.Maddy: Fri Nov 9 10:05:42 EST 2012

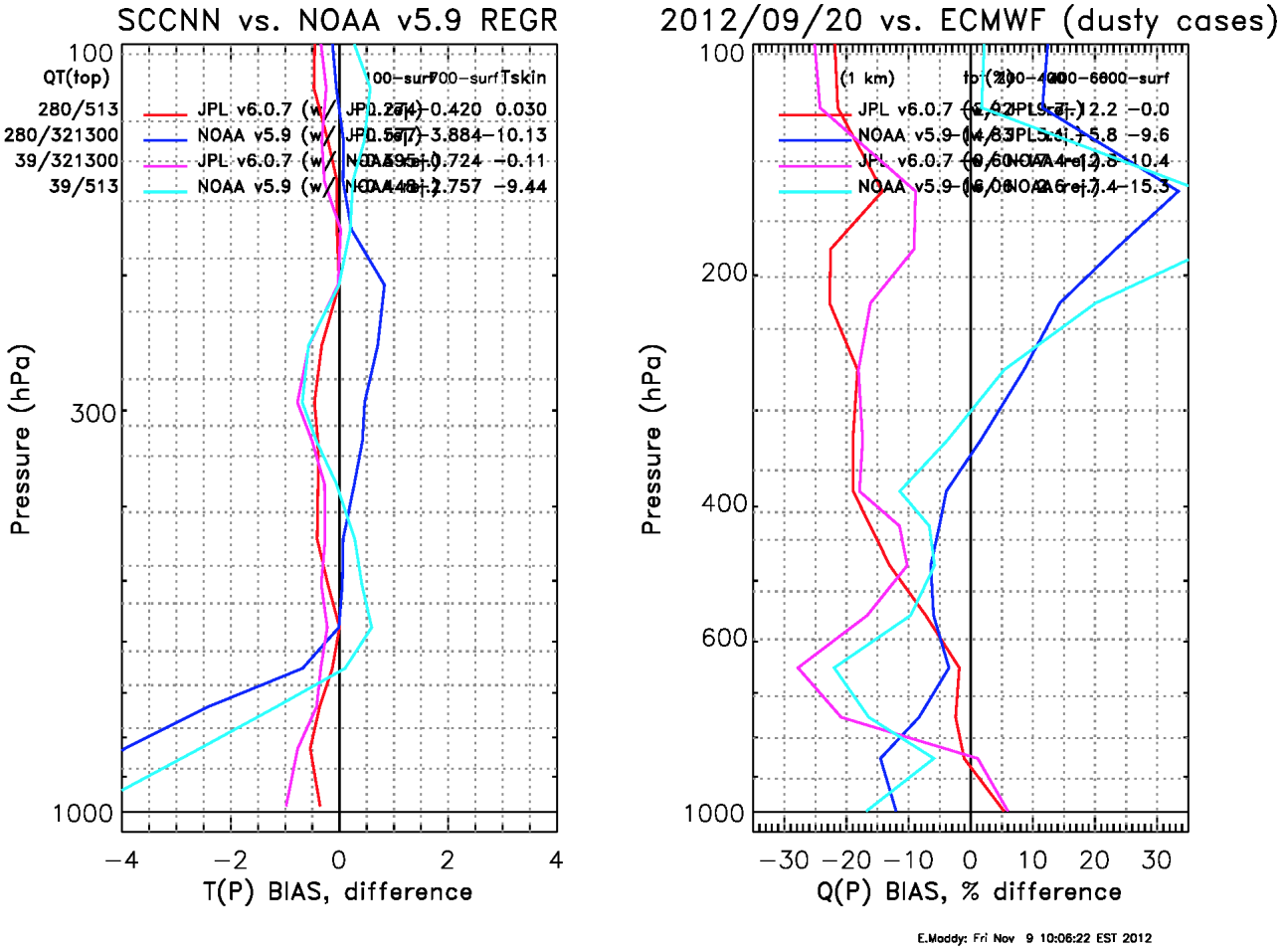

JPL vs. NOAA v5.9 REGR
2012/05/15 vs. ECMWF (dusty cases)
QT(top)
100-surf
700-surf
Tskin
QTs
68%/500
0%/321300
0%/321300
23%/500
JPL v6.0.7 (w/ JPL.376) 2.201 8.460 68.8%
NOAA v5.9 (w/ JPL.560) 5.025 10.75 0.1%
JPL v6.0.7 (w/ NOAA.81) .805 4.250 0.0%
NOAA v5.9 (w/ NOAA.1) 2.696 5.760 23.8%
Pressure (hPa)
T(P) RMS, difference
Qwat
(1 km)
tot(%)
0-4000
4000-6000
6000-surf
68.8%
0.1%
0.0%
23.8%
JPL v6.0.7 (w/ JPL.376) 33.1 21.3
NOAA v5.9 (w/ JPL.560) 18.6 38.4
JPL v6.0.7 (w/ NOAA.81) 22.2 22.2
NOAA v5.9 (w/ NOAA.1) 25.6
Q(P) RMS, % difference
E.Maddy: Fri Nov 9 10:05:42 EST 2012

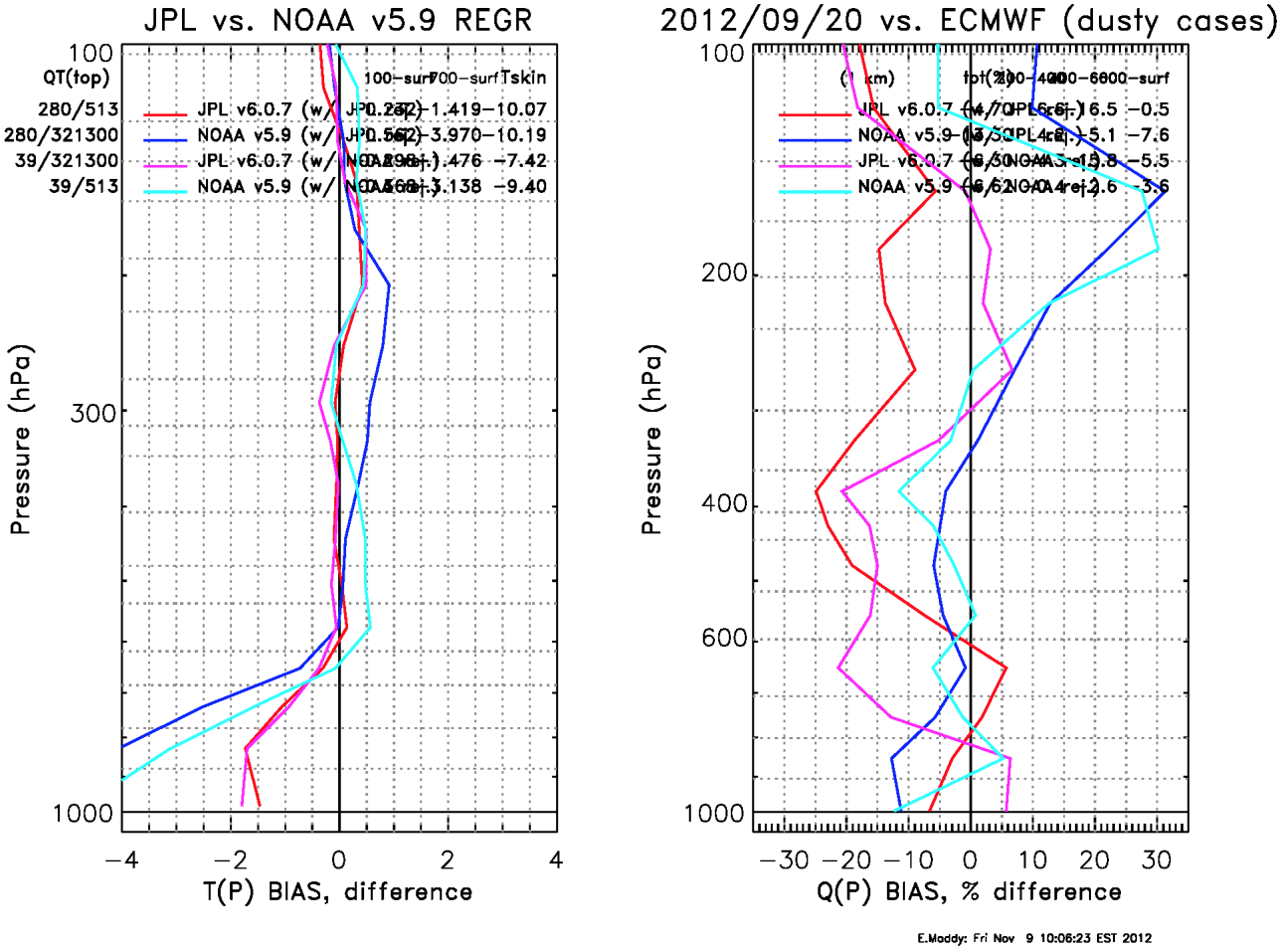

SCCNN vs. NOAA v5.9 REGR
2012/05/15 vs. ECMWF (dusty cases)
Pressure (hPa)
T(P) BIAS, difference
Q(P) BIAS, % difference
QT(top)
68%/500
0%/321300
0%/321300
23%/500
100-surf
700-surf
Tskin
QTs
68.8%
0.1%
0.0%
23.8%
Qwat
(1 km)
E.Maddy: Fri Nov 9 10:05:51 EST 2012


JPL vs. NOAA v5.9 REGR
2012/05/15 vs. ECMWF (dusty cases)
Pressure (hPa)
T(P) BIAS, difference
Q(P) BIAS, % difference
QT(top)
100-surf
700-surf
Tskin
QTs
68%/500
0%/321300
0%/321300
23%/500
Qwat
(1 km)
tot(%)
68.8%
0.1%
0.0%
23.8%
E.Maddy: Fri Nov 9 10:05:52 EST 2012


SCCNN vs. NOAA v5.9 REGR
QT(top)
100-surf
700-surf
Tskin
280/513
280/321300
39/321300
39/513
JPL v6.0.7 (w/ JPL 447) 1.806 2.550
NOAA v5.9 (w/ JPL 862) 5.633 12.73
JPL v6.0.7 (w/ NOAA 775) .851 2.460
NOAA v5.9 (w/ NOAA 214) 3.512 10.29
Pressure (hPa)
T(P) RMS, difference
2012/09/20 vs. ECMWF (dusty cases)
tot(%)
200-4000
4000-6600
-surf
JPL v6.0.7 (w/ JPL 10c4) 29.1 22.5
NOAA v5.9 (w/ JPL 10c6) 7.4 43.0
JPL v6.0.7 (w/ NOAA 2ret) 1.2 31.0
NOAA v5.9 (w/ NOAA 8ret) 4 33.4
Pressure (hPa)
Q(P) RMS, % difference
E.Maddy: Fri Nov 9 10:06:12 EST 2012


JPL vs. NOAA v5.9 REGR
QT(top)
100-surf
700-surf
Tskin
280/513
280/321300
39/321300
39/513
JPL v6.0.7 (w/ JPL 462) 2.344 11.59
NOAA v5.9 (w/ JPL 863) 5.684 12.87
JPL v6.0.7 (w/ NOAA 565) 2.253 9.220
NOAA v5.9 (w/ NOAA 889) 3.805 11.02
Pressure (hPa)
T(P) RMS, difference
2012/09/20 vs. ECMWF (dusty cases)
(1 km)
tot(%)
100-4000
4000-6000
6000-surf
JPL v6.0.7 (w/ JPL 2 8) 33.4 27.8
NOAA v5.9 (w/ JPL 10 6) 46.9 42.5
JPL v6.0.7 (w/ NOAA 4 ret) 32.6 29.6
NOAA v5.9 (w/ NOAA 2 ret) 30.6 29.4
Pressure (hPa)
Q(P) RMS, % difference
E.Maddy: Fri Nov 9 10:06:13 EST 2012

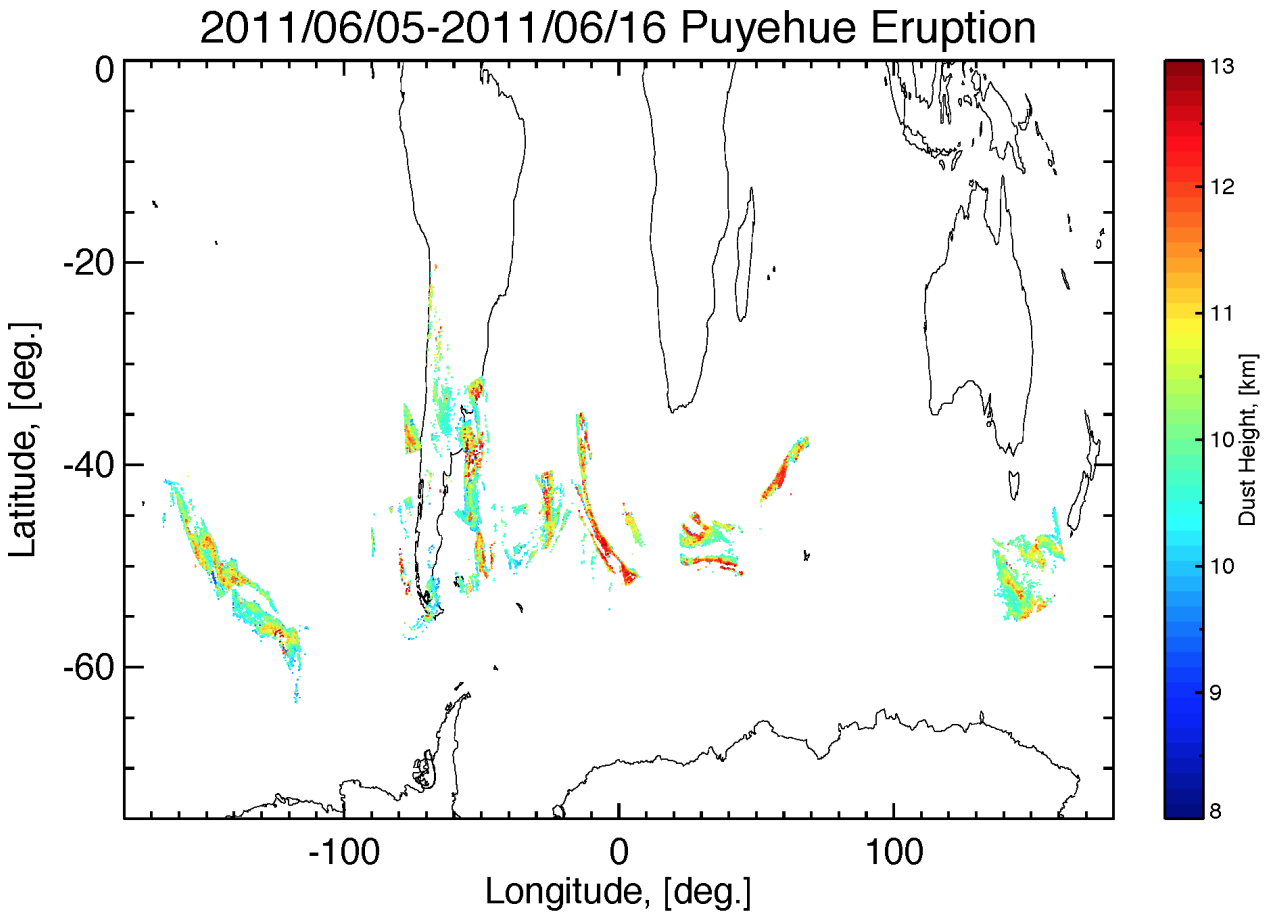

SCCNN vs. NOAA v5.9 REGR
QT(top)
280/513
280/321300
39/321300
39/513
100-surf
700-surf
Tskin
JPL v6.0.7 (w/ JP
NOAA v5.9 (w/ NO
JPL v6.0.7 (w/ NO
NOAA v5.9 (w/ NO
0.420 0.030
3.884 -10.13
0.724 -0.11
2.757 -9.44
Pressure (hPa)
T(P) BIAS, difference
2012/09/20 vs. ECMWF (dusty cases)
(1 km)
JPL v6.0.7
NOAA v5.9
JPL v6.0.7
NOAA v5.9
2.2 -0.0
5.8 -9.6
10.4
15.3
Pressure (hPa)
Q(P) BIAS, % difference
E.Maddy: Fri Nov 9 10:06:22 EST 2012


JPL vs. NOAA v5.9 REGR
QT(top)
280/513
280/321300
39/321300
39/513
100-surf
700-surf
Tskin
JPL v6.0.7 (w/ JPL2012) -1.419 -10.07
NOAA v5.9 (w/ JPL2012) -3.970 -10.19
JPL v6.0.7 (w/ NOAA2012) -1.476 -7.42
NOAA v5.9 (w/ NOAA2012) -3.138 -9.40
Pressure (hPa)
T(P) BIAS, difference
2012/09/20 vs. ECMWF (dusty cases)
(1 km)
tot(%)
200-4000
4000-6600
6600-surf
JPL v6.0.7 (4,7) JPL6.6 -6.5 -0.5
NOAA v5.9 (3,5) JPL4.6 -5.1 -7.6
JPL v6.0.7 (6,5) NOAA3 -15.8 -5.5
NOAA v5.9 (6,6) NOAA4 -2.6 -3.6
Q(P) BIAS, % difference
E.Maddy: Fri Nov 9 10:06:23 EST 2012

Retrieval of dust/ash from AIRS

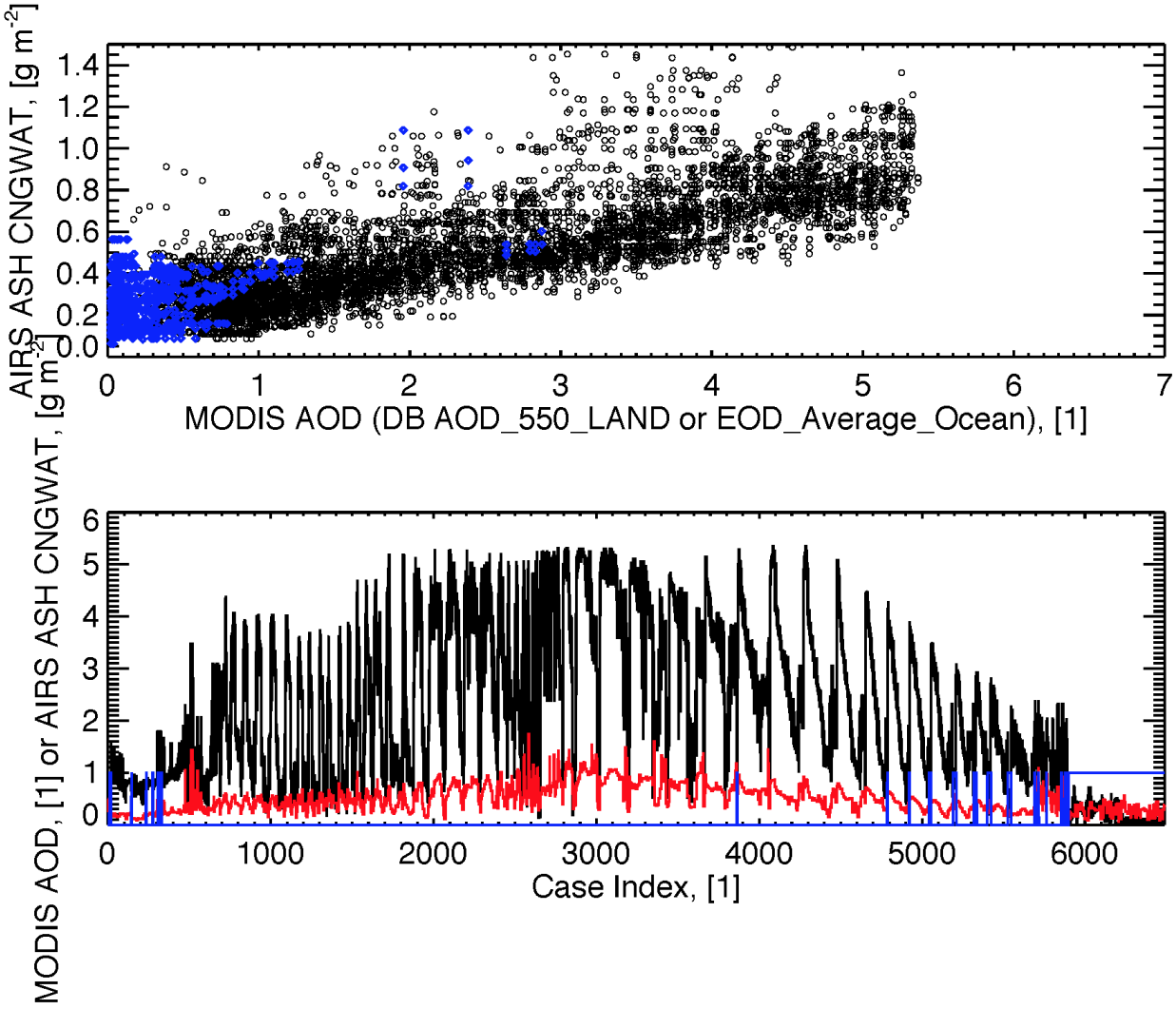
- Use an unconstrained (or loosely constrained) optimal estimation algorithm to retrieval dust (ash) particle size, loading and height.
- SARTA's scattering algorithm currently in use.
- Also can estimate ice/cirrus in addition to dust - now using some brute-force type retrievals from UMBC (Sergio).

An example of retrievals from Puyehue - dust heights



- Select all MODIS pixels falling within 15 kilometers of AIRS footprint FOV.
- Compare the individual MODIS pixels MYD04 product for Aerosol OD comparisons to our volcanic ash loading (Either Deep_Blue_Aerosol_Optical_Depth_550_Land or Effective_Optical_Depth_Average_Ocean).

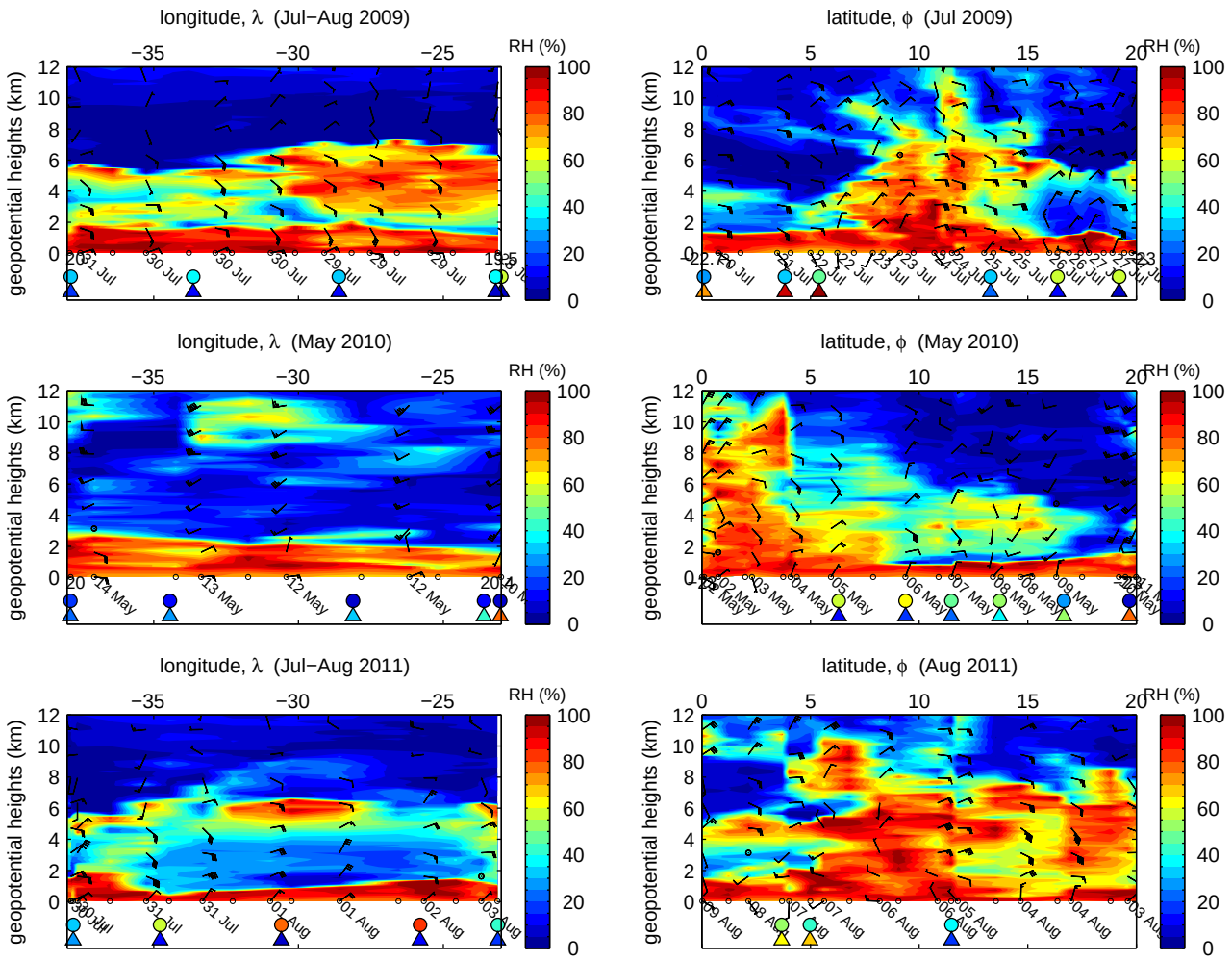
Ash loadings - Comparison to MODIS

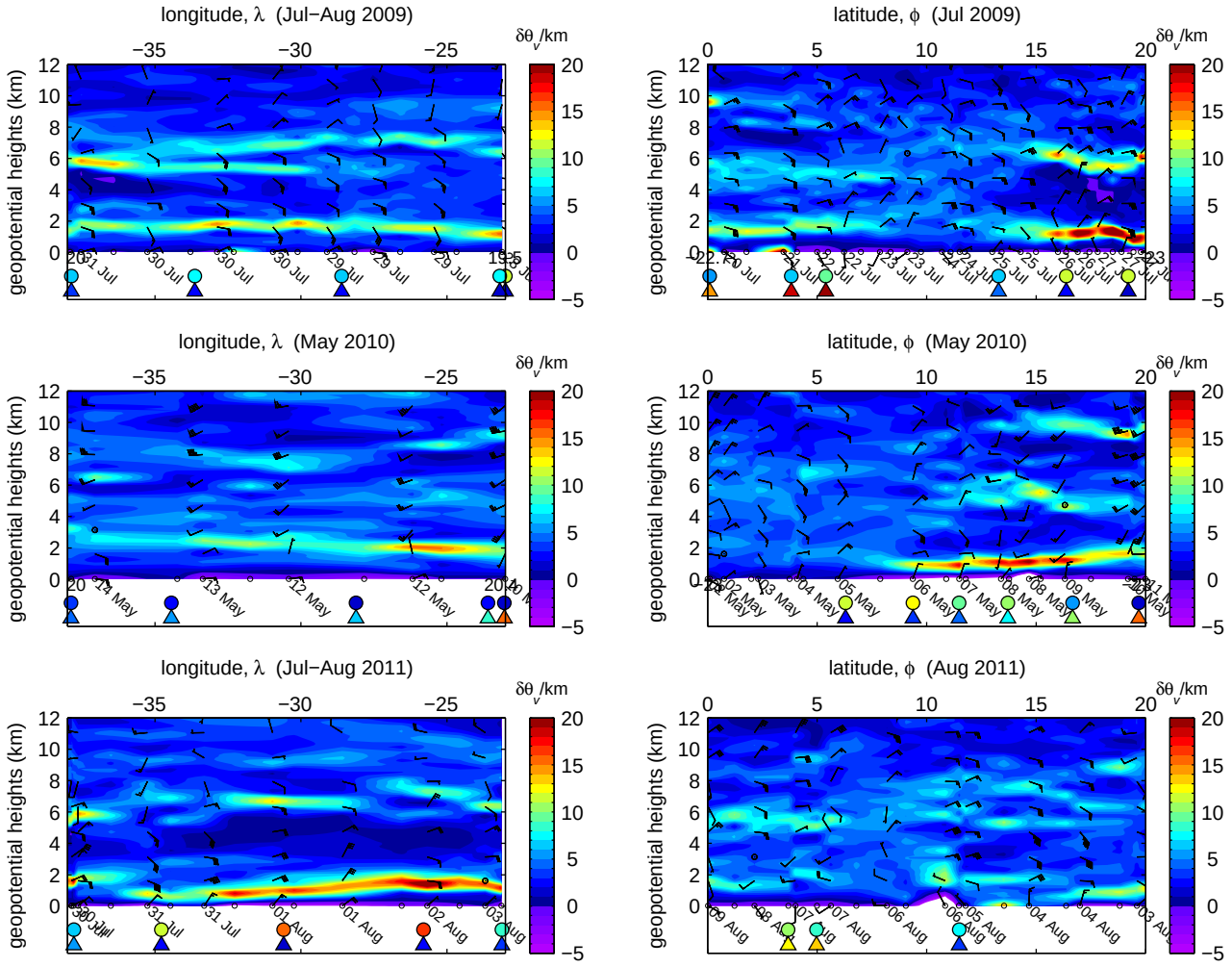


Discussion and Future Work

- AIRS v5 is severely affected by dust - most of the errors come from the first guess PC regression.
- AIRS v6 is moderately affected by dust. Appears that the SCCNN is somewhat immune to dust contamination - AIRS v6 physical retrieval has slightly larger RMS uncertainties as compared to the SCCNN.
- We suggest flagging dusty cases in AIRS L2.
- Work in progress, but we have shown AIRS can retrieve dush/ash loadings that are comparable to MODIS AOD.
- More work is needed to optimize the algorithm/constraints - but simultaneous dust + L2 retrievals should enable more accurate retrievals in the prescence of dust.

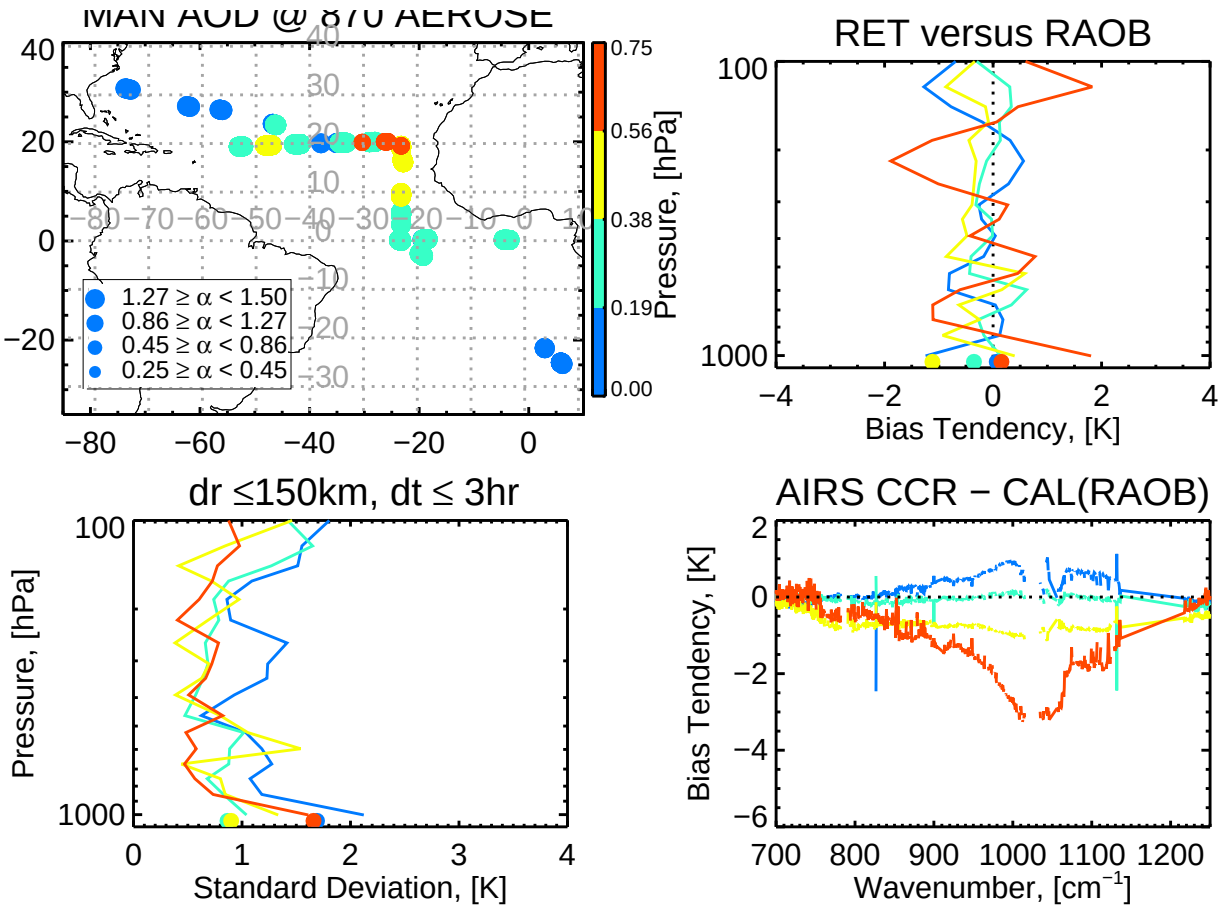
Discussion and Future Work

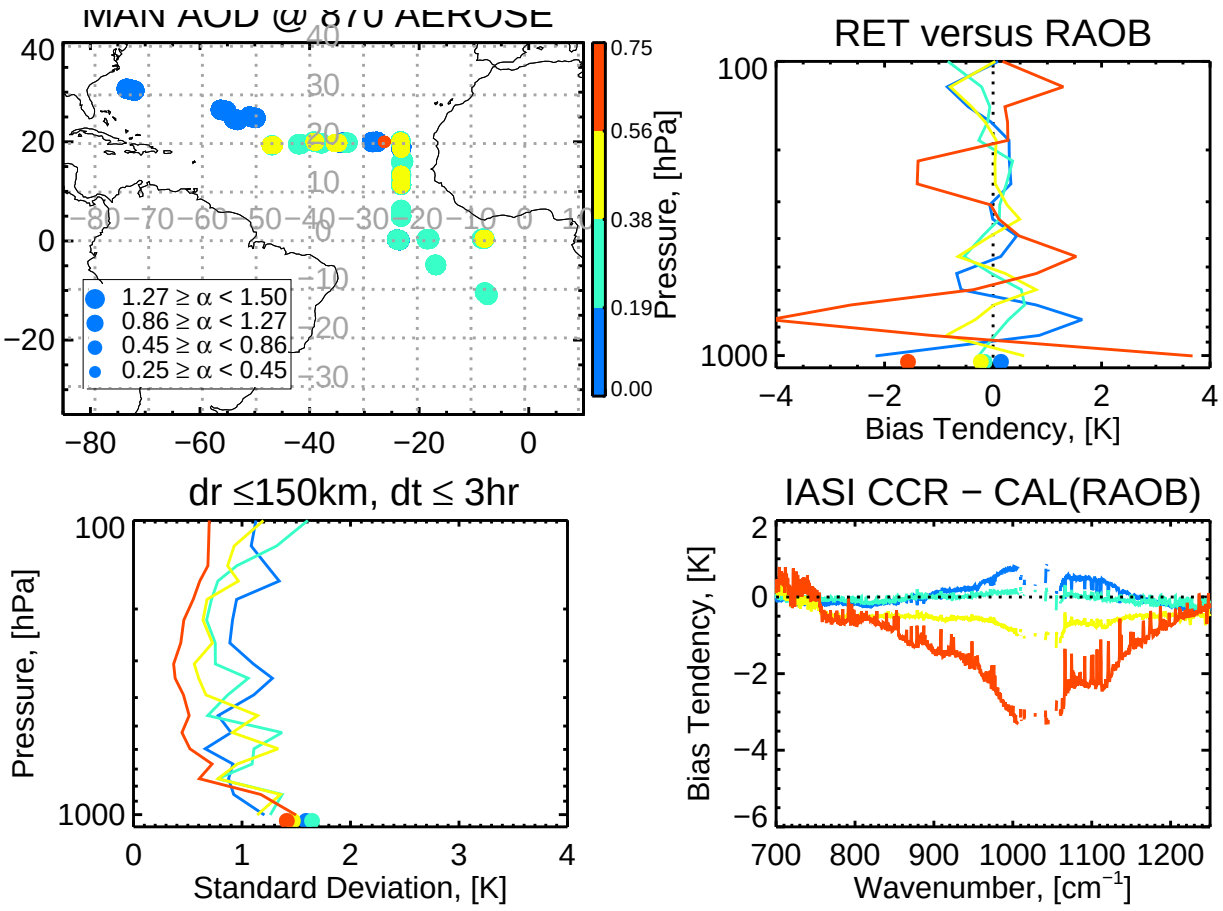

longitude, λ (Jul−Aug 2009)
latitude, ϕ (Jul 2009)
longitude, λ (May 2010)
latitude, ϕ (May 2010)
longitude, λ (Jul−Aug 2011)
latitude, ϕ (Aug 2011)
geopotential heights (km)
RH (%)


longitude, λ (Jul−Aug 2009)
latitude, ϕ (Jul 2009)
longitude, λ (May 2010)
latitude, ϕ (May 2010)
longitude, λ (Jul−Aug 2011)
latitude, ϕ (Aug 2011)
geopotential heights (km)
δθ_v/km

Collocation Strategy

- We select all retrievals within $\delta t = \pm 3$ hr, $\delta r =$150km of a Microtops Sunphotometer measurement and corresponding collocated RAOB.
- 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
Pressure, [hPa]
RET versus RAOB
Bias Tendency, [K]
dr ≤150km, dt ≤ 3hr
Standard Deviation, [K]
AIRS CCR − CAL(RAOB)
Bias Tendency, [K]
Wavenumber, [cm^{-1}]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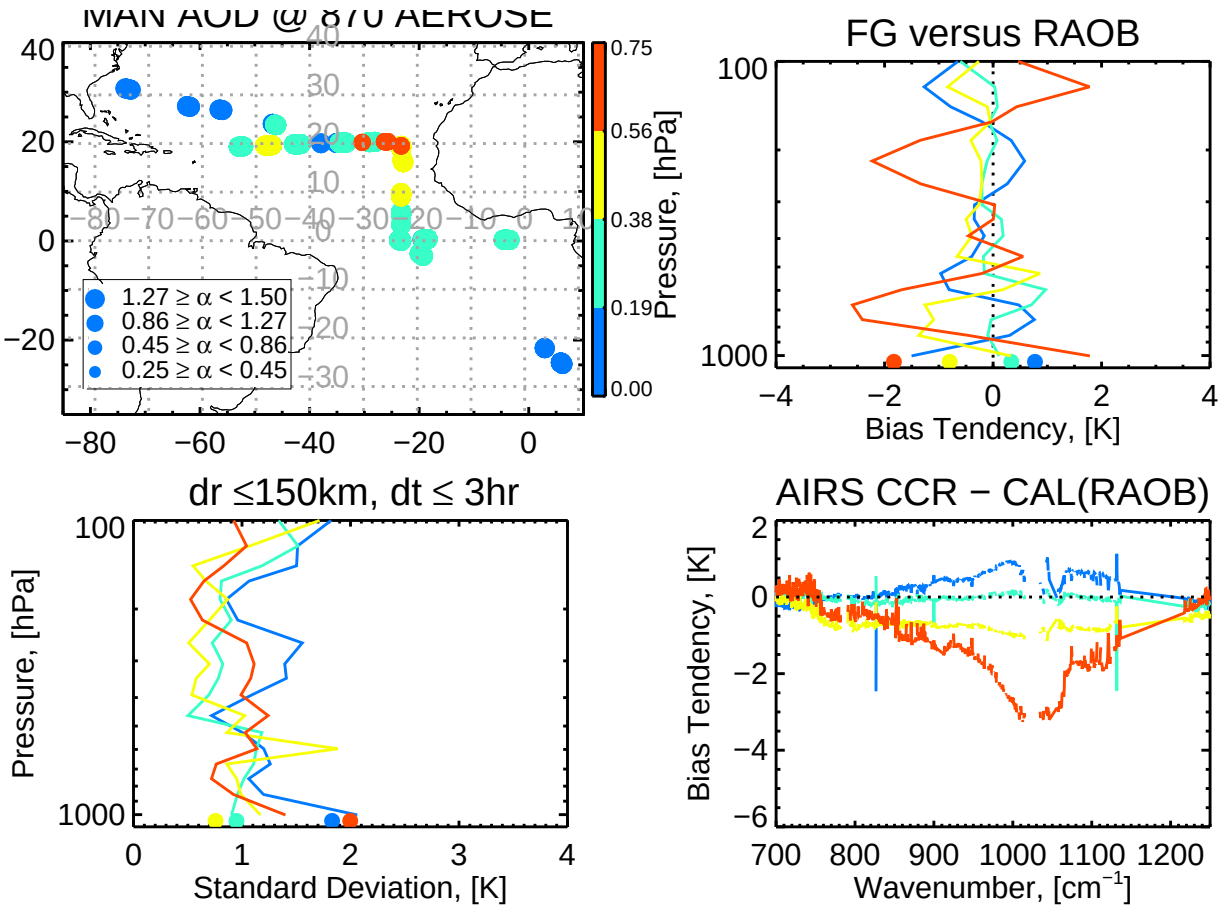
0.25 ≥ α < 0.45
Pressure, [hPa]
RET versus RAOB
Bias Tendency, [K]
dr ≤150km, dt ≤ 3hr
Standard Deviation, [K]
IASI CCR − CAL(RAOB)
Wavenumber, [cm^{-1}]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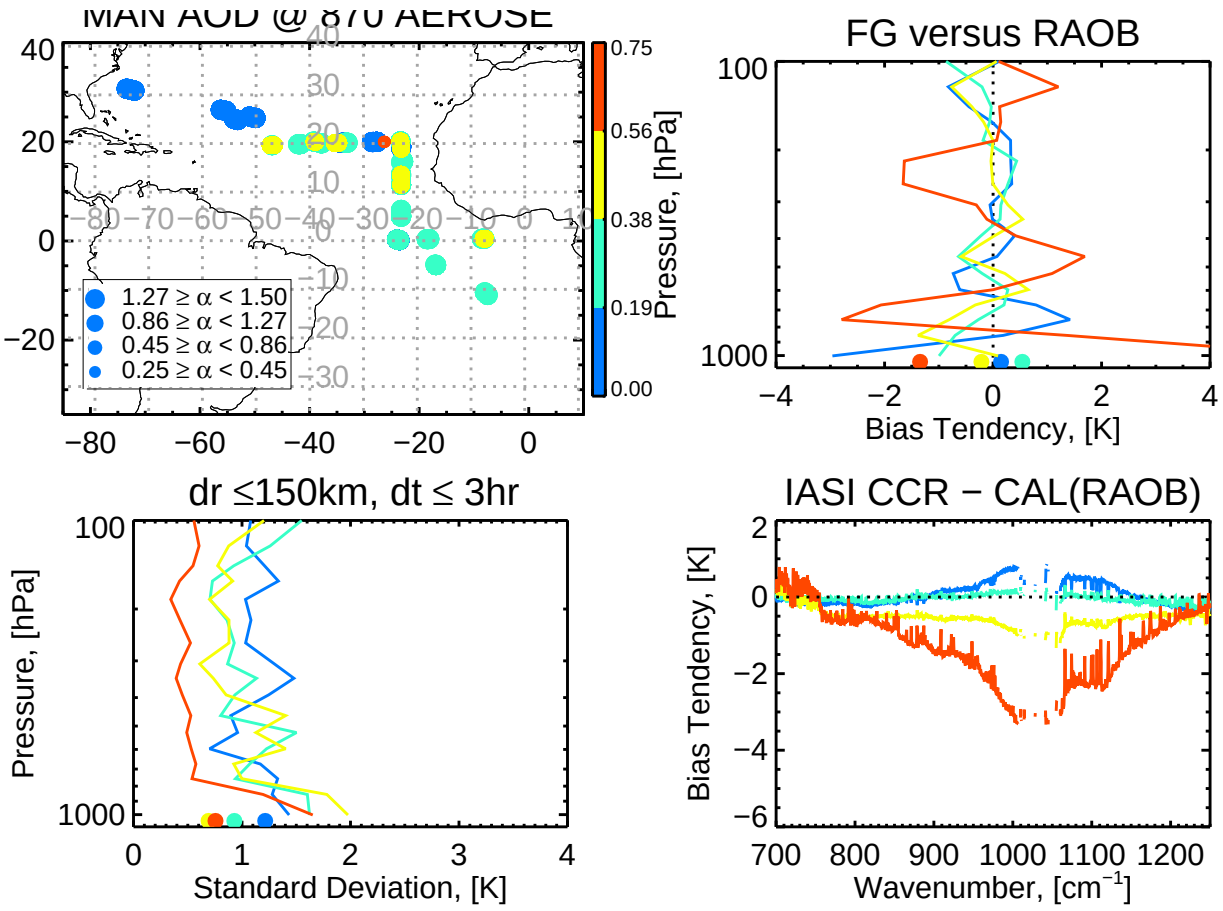
0.86 ≥ α < 1.27
0.45 ≥ α < 0.86
0.25 ≥ α < 0.45
Pressure, [hPa]
FG versus RAOB
Bias Tendency, [K]
dr ≤150km, dt ≤ 3hr
Standard Deviation, [K]
AIRS CCR − CAL(RAOB)
Bias Tendency, [K]
Wavenumber, [cm^{-1}]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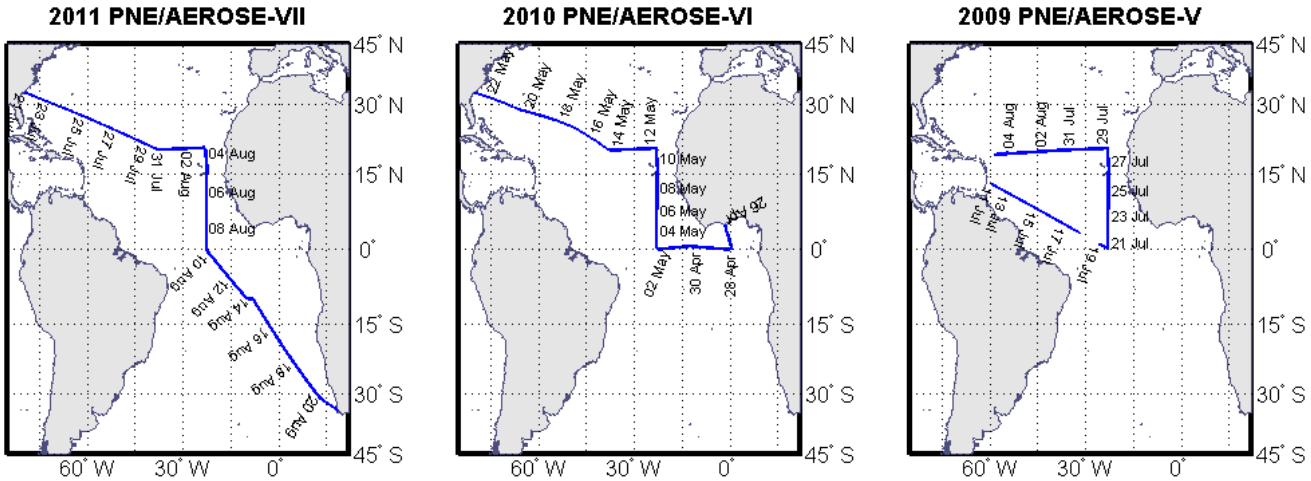
0.86 ≥ α < 1.27
0.45 ≥ α < 0.86
0.25 ≥ α < 0.45
Pressure, [hPa]
FG versus RAOB
Bias Tendency, [K]
dr ≤150km, dt ≤ 3hr
Standard Deviation, [K]
IASI CCR − CAL(RAOB)
Wavenumber, [cm^{-1}]

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

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.