NOAA/NESDIS Plan for AIRS, CrIS and IASI: Program and Science

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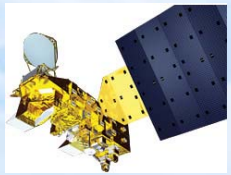
AIRS & MODIS PRODUCTS ARE DISTRIBUTED THROUGH THREE MAIN CHANNELS



NOAA NESDIS

NWP Centers
- NCEP
- Navy
- ECMWF
- UK Met Office
- more

GSFC DAAC

- Science Community
- Public

DIRECT BROADCAST

- Universities
- Local Weather Stations
- Brazil (INPE)
- China
- DoD
- Other International

Risk Reduction Benefits

- Early demonstration of operational processing of high spectral resolution infrared sounder data prior to CrIS, IASI and GOES-R

- Early opportunity for forecast centers to learn how to assimilate advanced IR data

AIRS Update

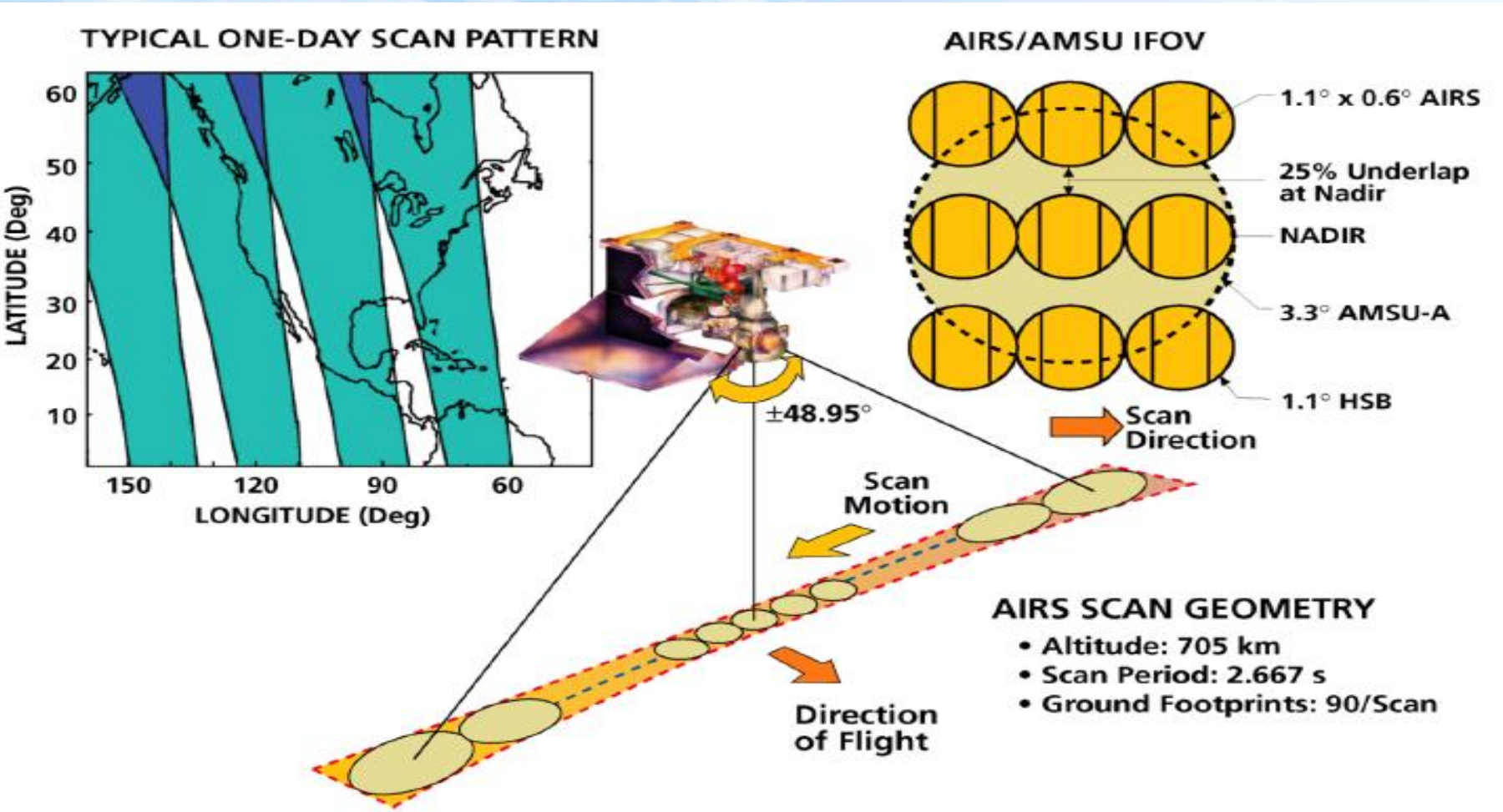
- ORA has implemented the AIRS/AMSU processing system – quasi-operational
- Processing system is based on the retrieval methodologies developed by the AIRS Science Team
- Science Algorithms developed by NASA, NOAA, UW, MIT, UMBC - truly a collaborative effort
- Science improvements are continuing

Science Improvements

- Adding MODIS to improve cloud clearing
- Adding trace gas retrieval algorithms to derive CO2, CO, and CH4
- Improving surface emissivity/bidirectional reflectance (non-ocean)
- Improving data compression algorithms

AMSU is a critical component of AIRS

- provides retrievals in overcast conditions
- drives cloud clearing



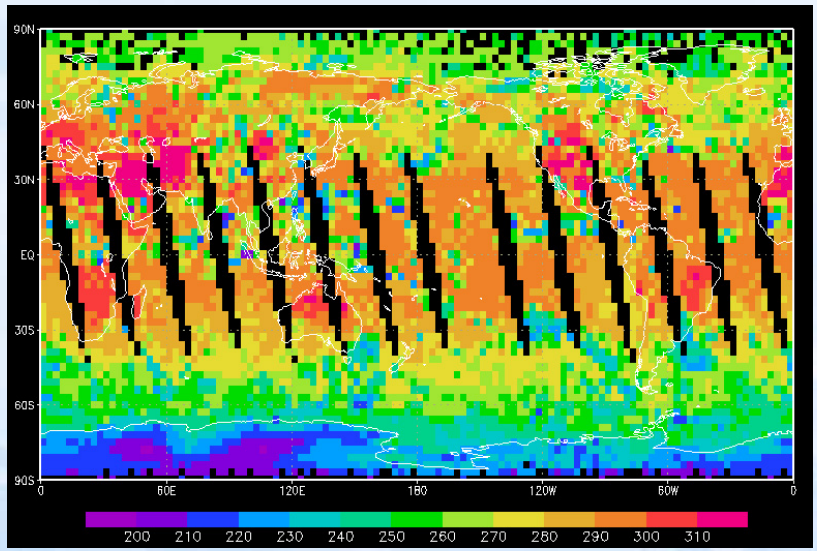
AIRS acquires 2,916,000 spectra = 35 GByte/day

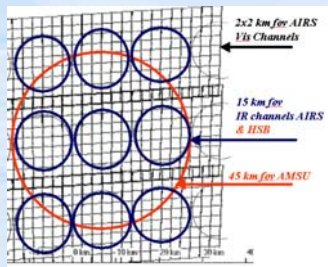
AIRS/AMSU Products for a ≈50 km footprint (varies w/ view angle), 324,000 footprints/day

- Cloud Cleared Radiance
- Temperature
- Moisture
- Ozone
- Land/Sea Surface Temperature
- Surface Spectral Emissivity
- Surface Reflectivity
- Cloud Top Pressure
- Cloud Liquid Water (AMSU product)
- Cloud Fraction (per 15 km footprint).
- Carbon Monoxide
- Carbon Dioxide
- Methane
- Cirrus Cloud Optical Depth and Particle Size, Aerosols

NOAA-Unique AIRS Products

- Tailored radiance datasets for NWP data assimilation, including PC scores
- Products into BUFR format
- Use of MODIS to improve AIRS cloud-cleared radiances.
- Noise-filtered radiances based on eigenvector decomposition (reconstructed radiances)
- Thinned datasets for scientific studies, including reprocessing for climate.





AIRS Radiance Products from NOAA

a) center/warmest of 3 x 3 from every AMSU fov, ~300 channels. + AMSU (16 mbytes per orbit)

b) 200 principal component scores using same thinning as a)

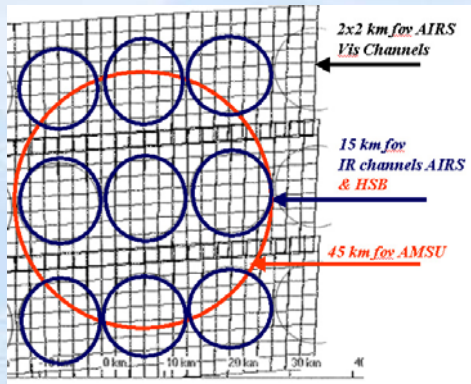
c) Every 2nd 3 x 3 AIRS fovs (~300 channels) plus all AMSU

d) cloud cleared a) and b)

e) Reconstructed Radiances

f) Full resolution AMSU

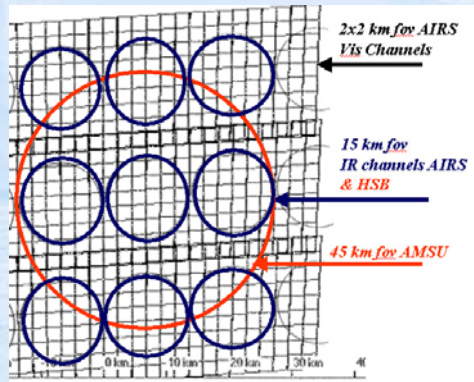
g) MODIS at AIRS resolution



AIRS Level 2 Products from NOAA

a) Full resolution level 2 products – temperature, moisture and ozone, cloud amount, cloud height, surface emissivity, surface temperature, including carbon products

b) MODIS cloud products @ AIRS resolution



NOAA Operational Processing

- AIRS/AMSU/MODIS integrated processing system is currently being modified to generate the same family of products from EUMETSAT IASI/AMSU/AVHRR and from NPOESS CrIS/ATMS/VIIRS

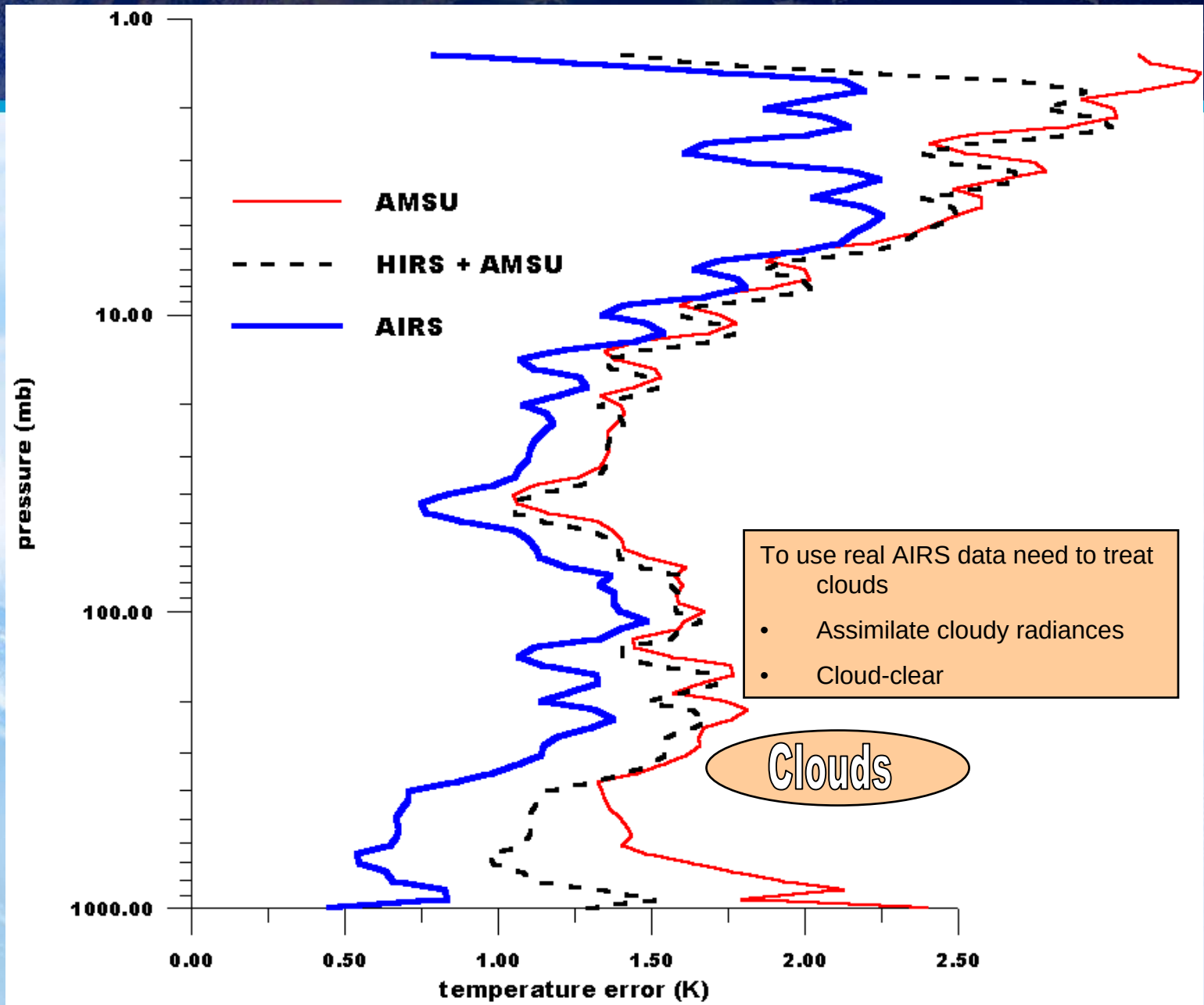
- Same Science (e.g. same transmittance model, same cloud detection/clearing, etc) and Software will process AIRS, IASI and CrIS

- Prelaunch Simulated Products -- repeating AIRS approach

Science and Applications

- Cloud Clearing using MODIS
- Carbon Products
- Validating NWP Products

Temperature errors as a function of sounder instrumentation

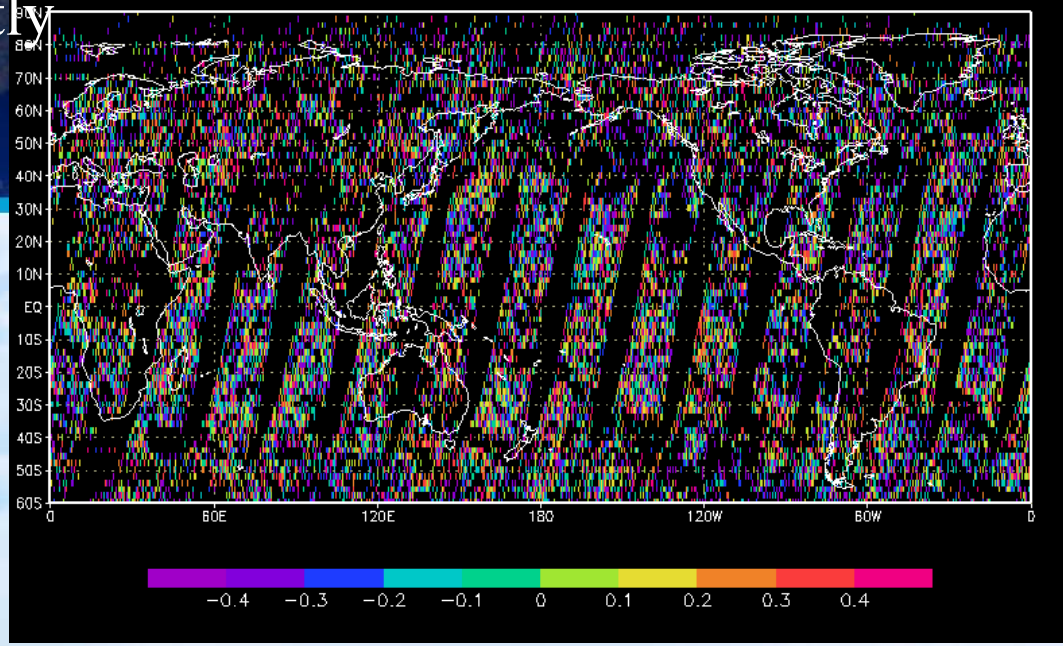


Cloud clearing significantly improves data coverage

735.69 cm-1 (peak ~ 700 mb)

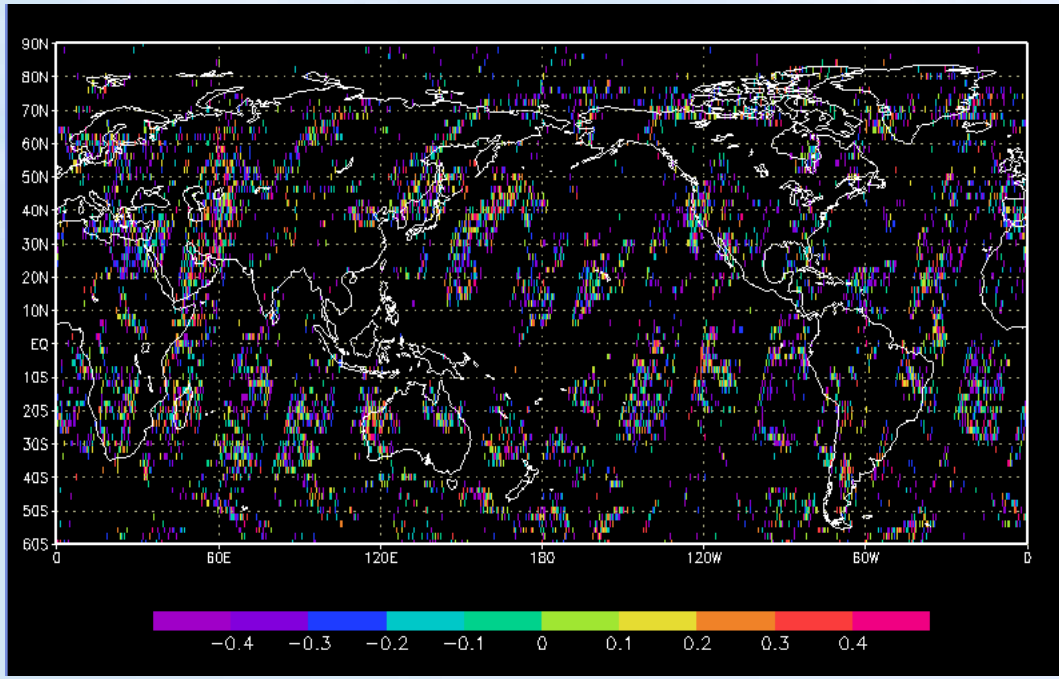
ALL diff < +- 0.5 K

Cloud-cleared minus clear simulated brightness temperatures (ECMWF)



700 MB – Lower to Mid Troposphere

Observed minus clear simulated brightness temperatures (ECMWF)



965 cm-1 (window)

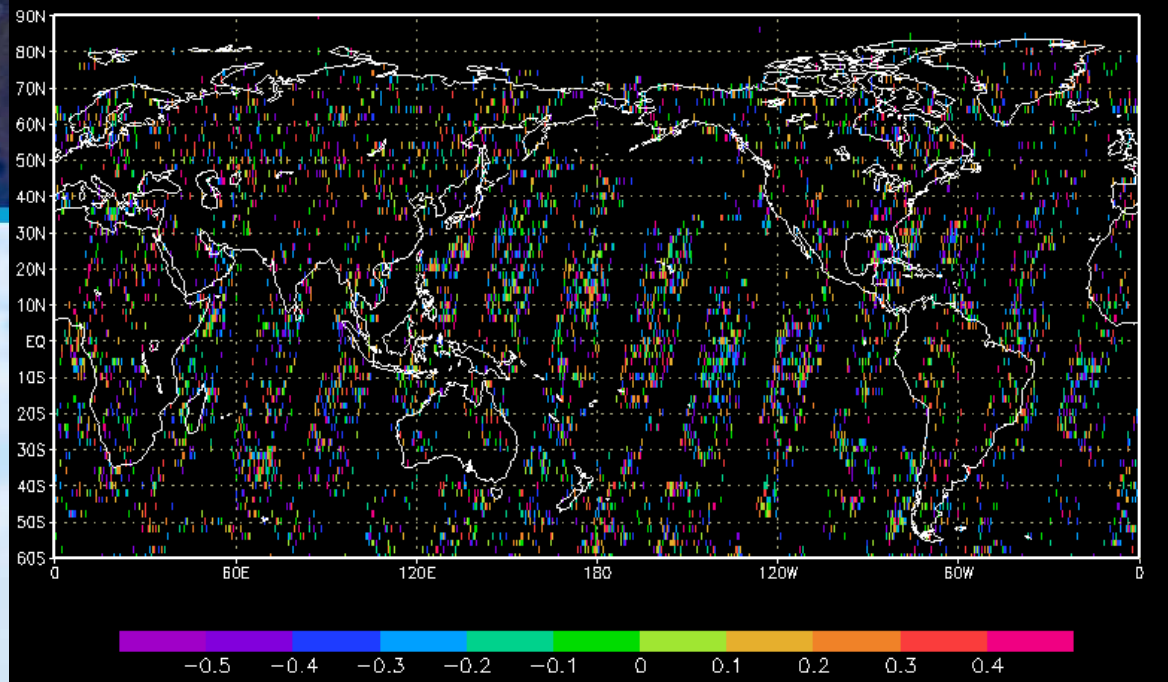
ALL diff < +- 0.5 K

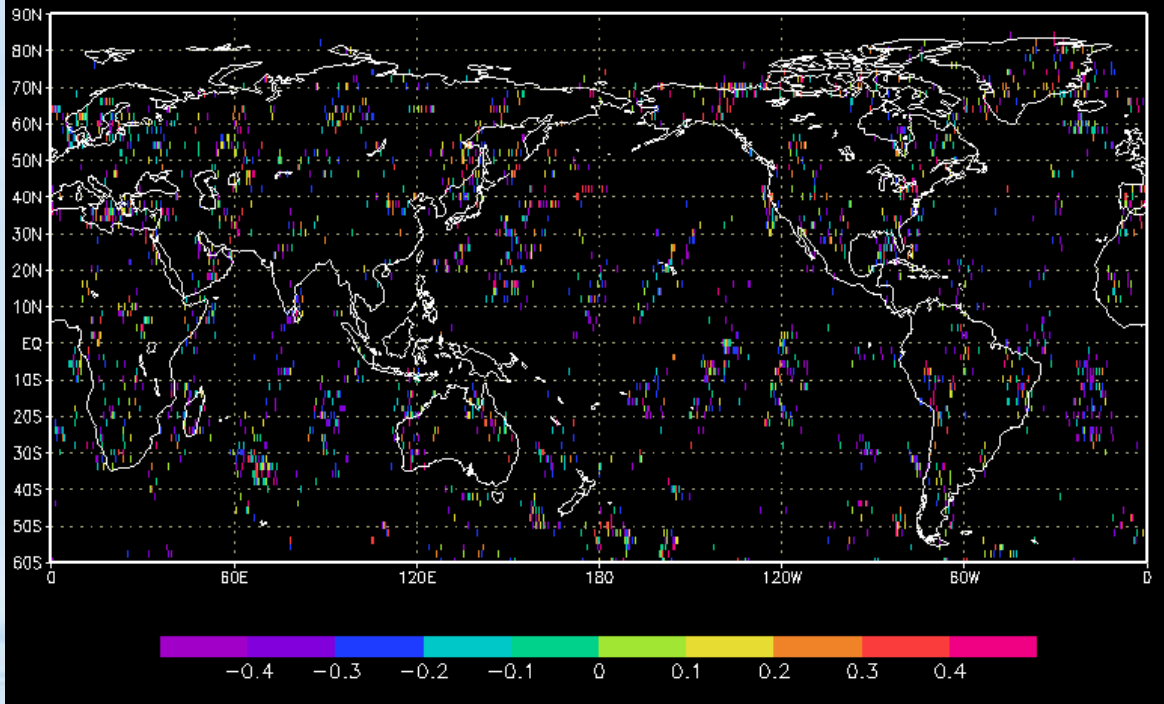
Cloud-cleared minus ECMWF

NEAR SURFACE

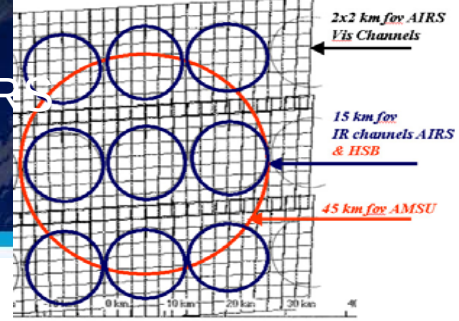
Relatively few observation with no cloud clearing

Raw minus ECMWF

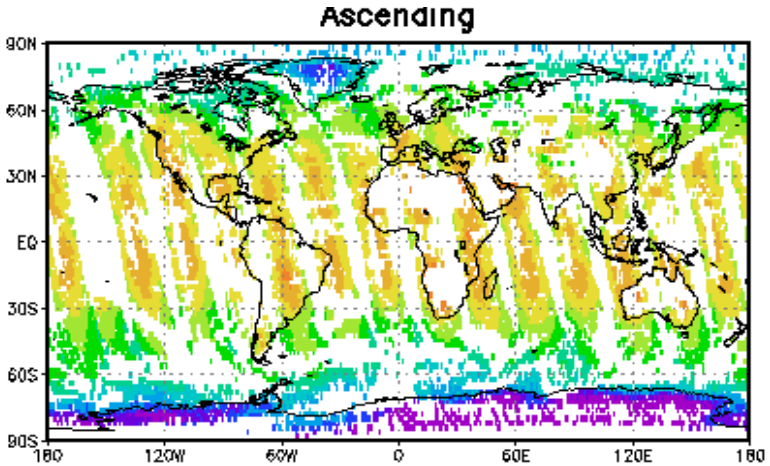


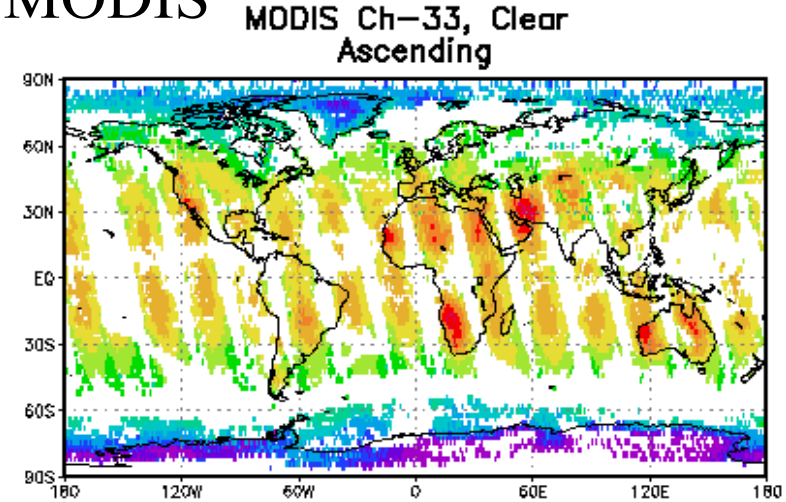


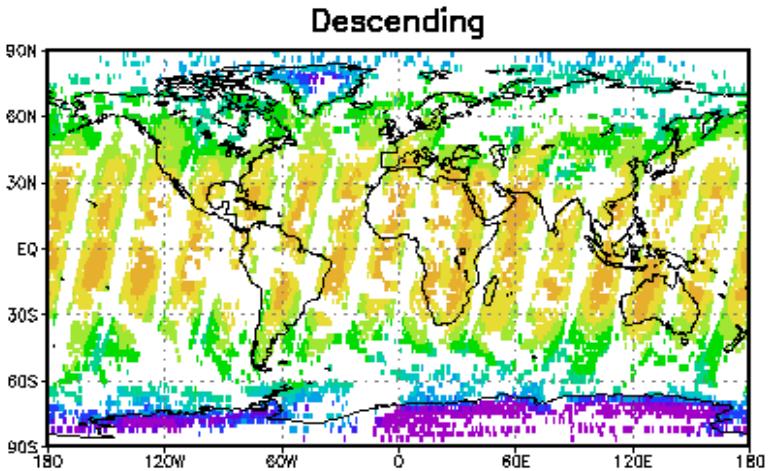
WE have tools to integrate MODIS with AIRS for improved cloud clearing , left figure is cloud-cleared AIRS convolved to MODIS, and right figure is MODIS clear averaged to AIRS fov

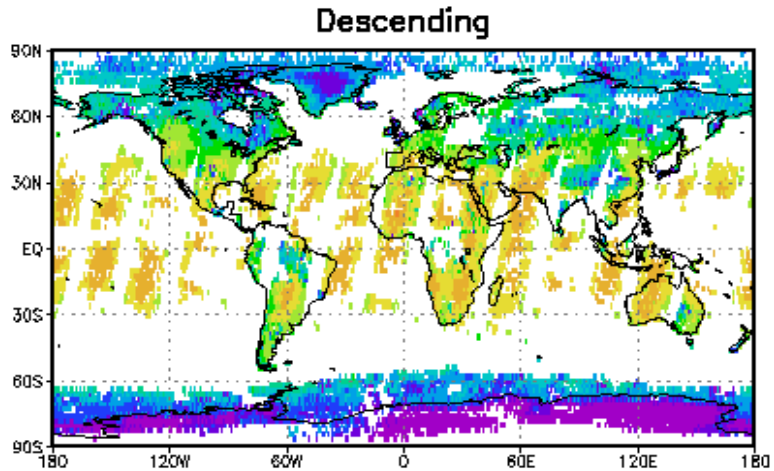


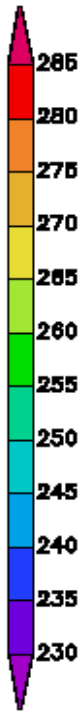
Cloud-Cleared AIRS convolved to MODIS



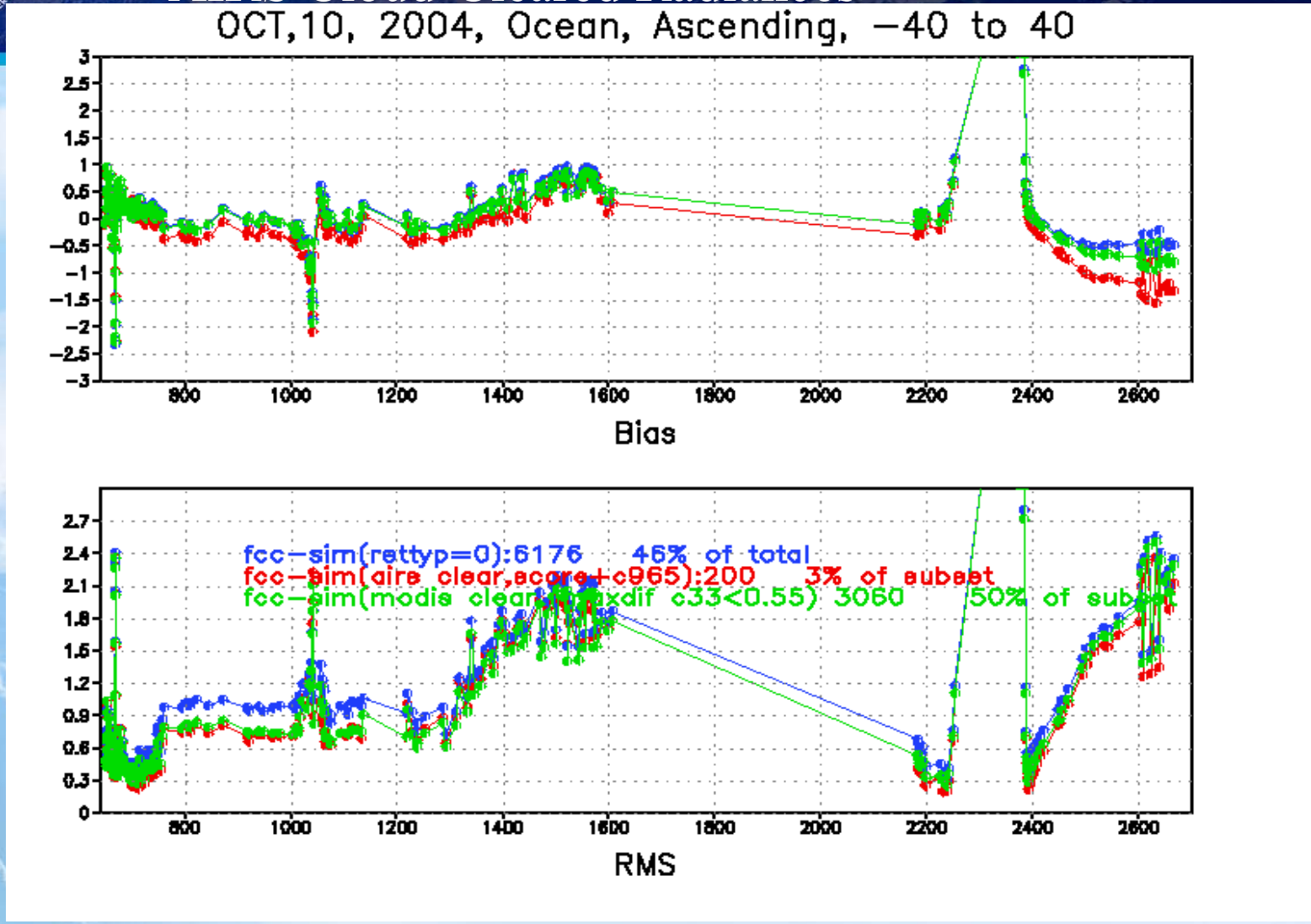






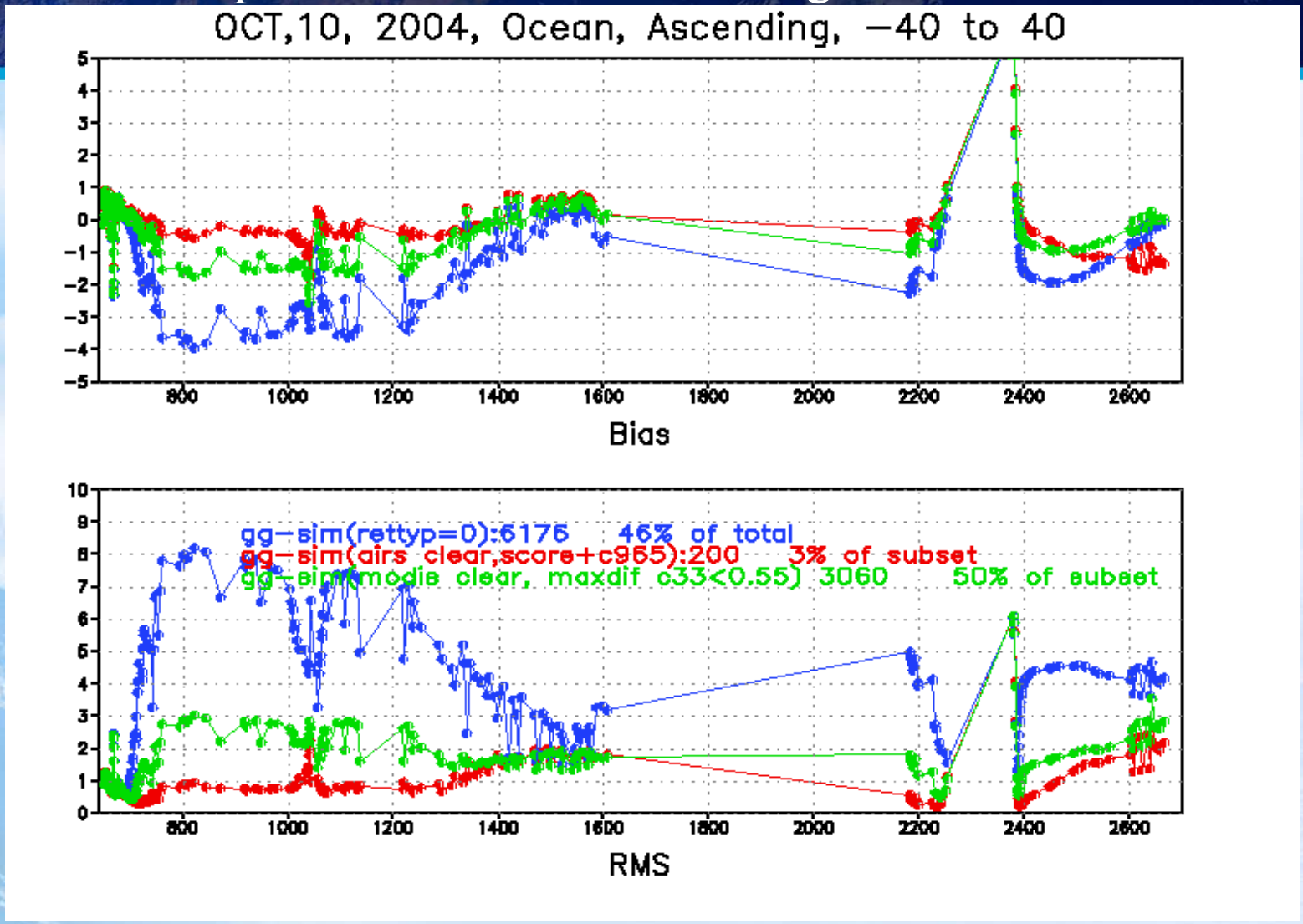


Currently using MODIS to quality control AIRS Cloud-Cleared Radiances



Cloud-clear minus clear simulated (ECMWF)

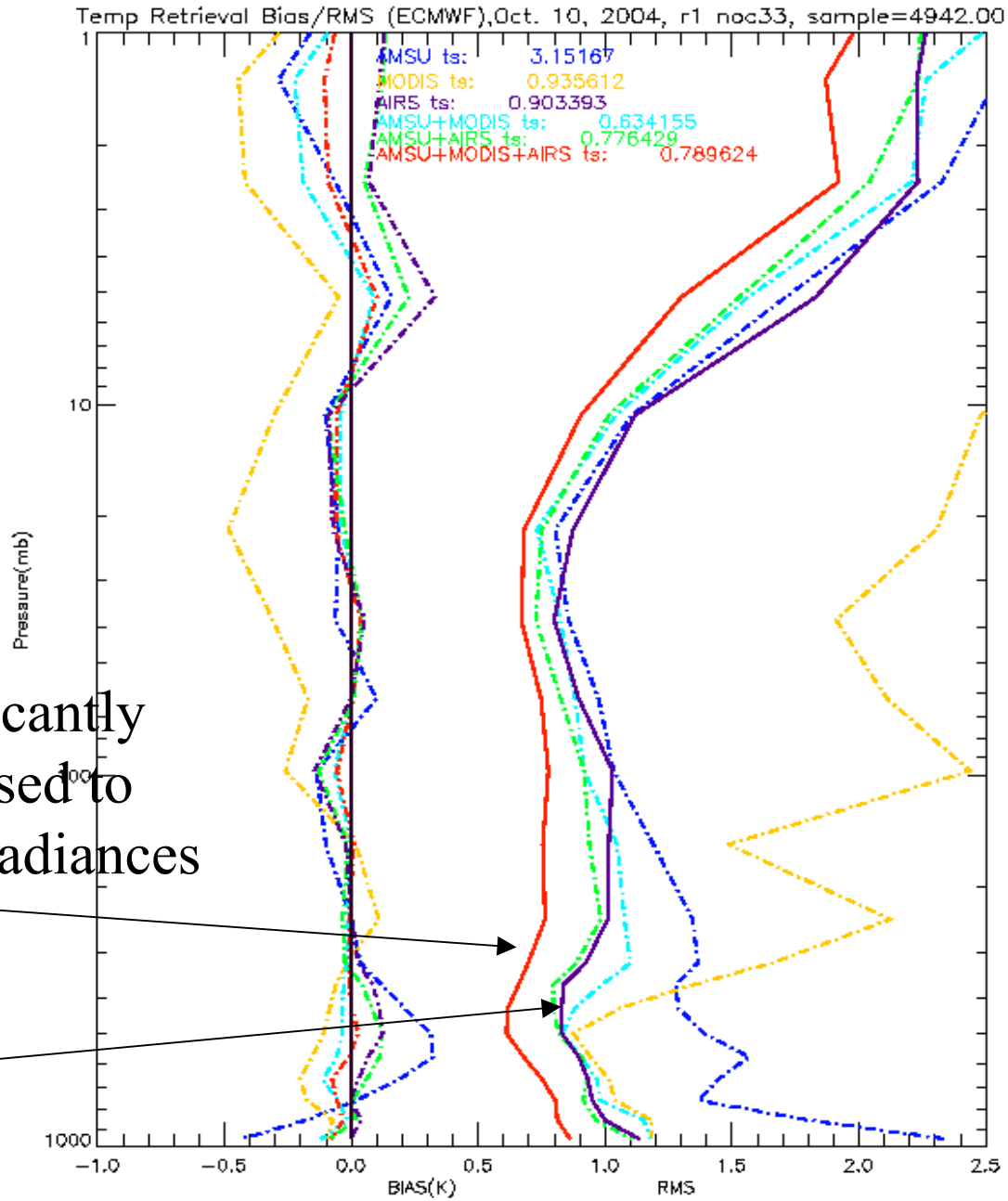
Consequence of not cloud-clearing



All-sky minus clear simulated (ECMWF)

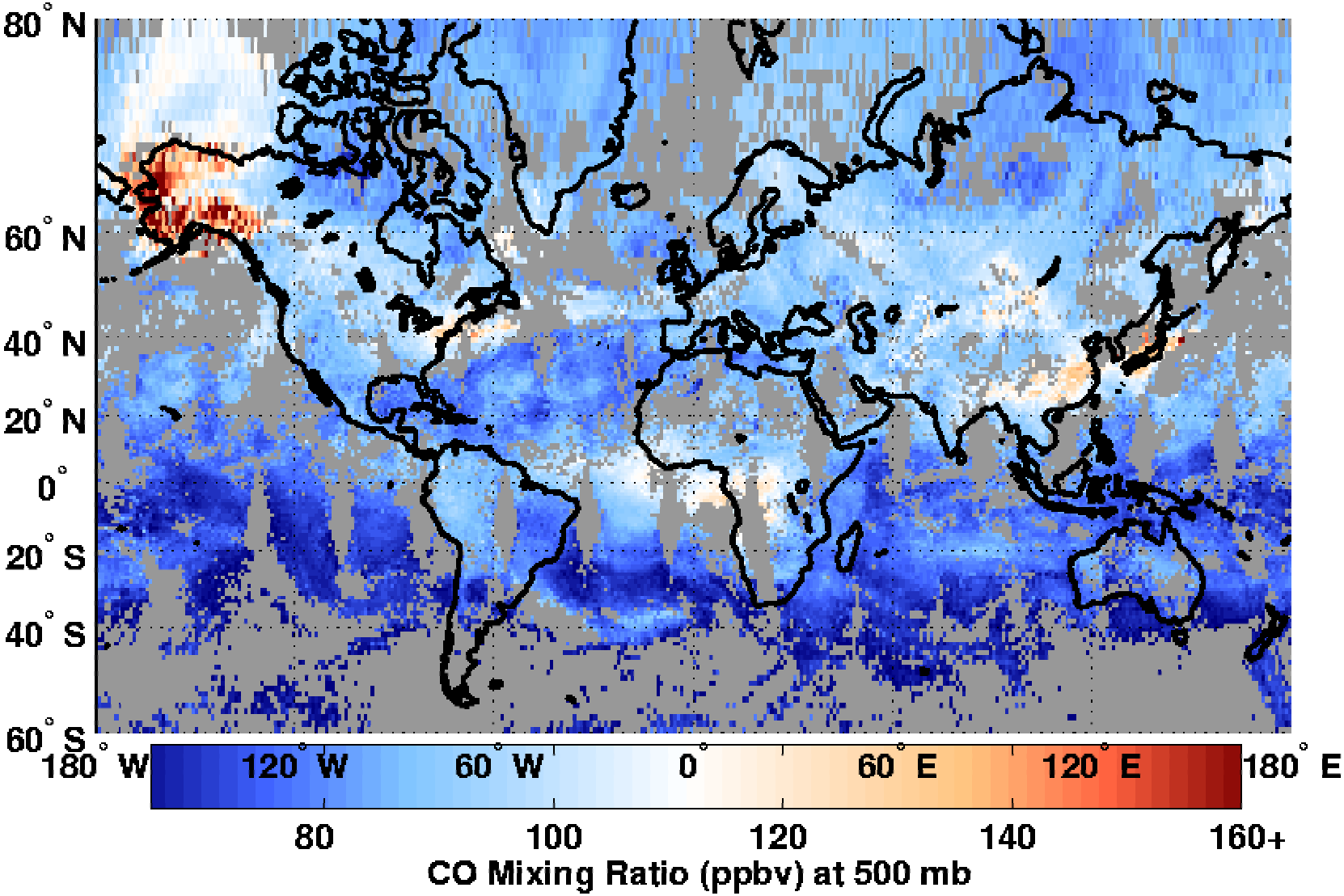
Retrieval errors are significantly reduced after MODIS is used to QC AIRS cloud-cleared radiances

W/O QC



Carbon Products

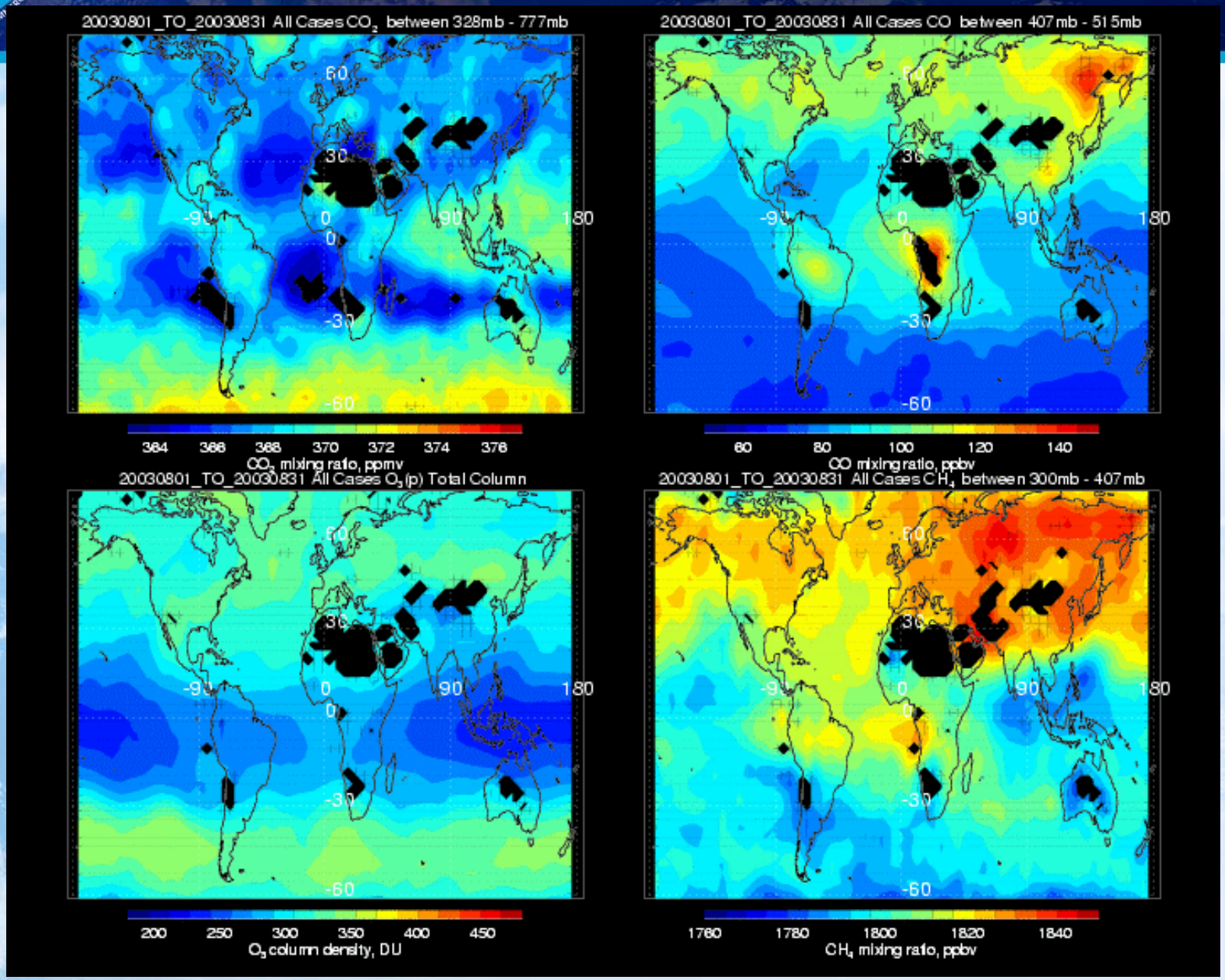
July 2004 AIRS Daily Global CO



UMBC

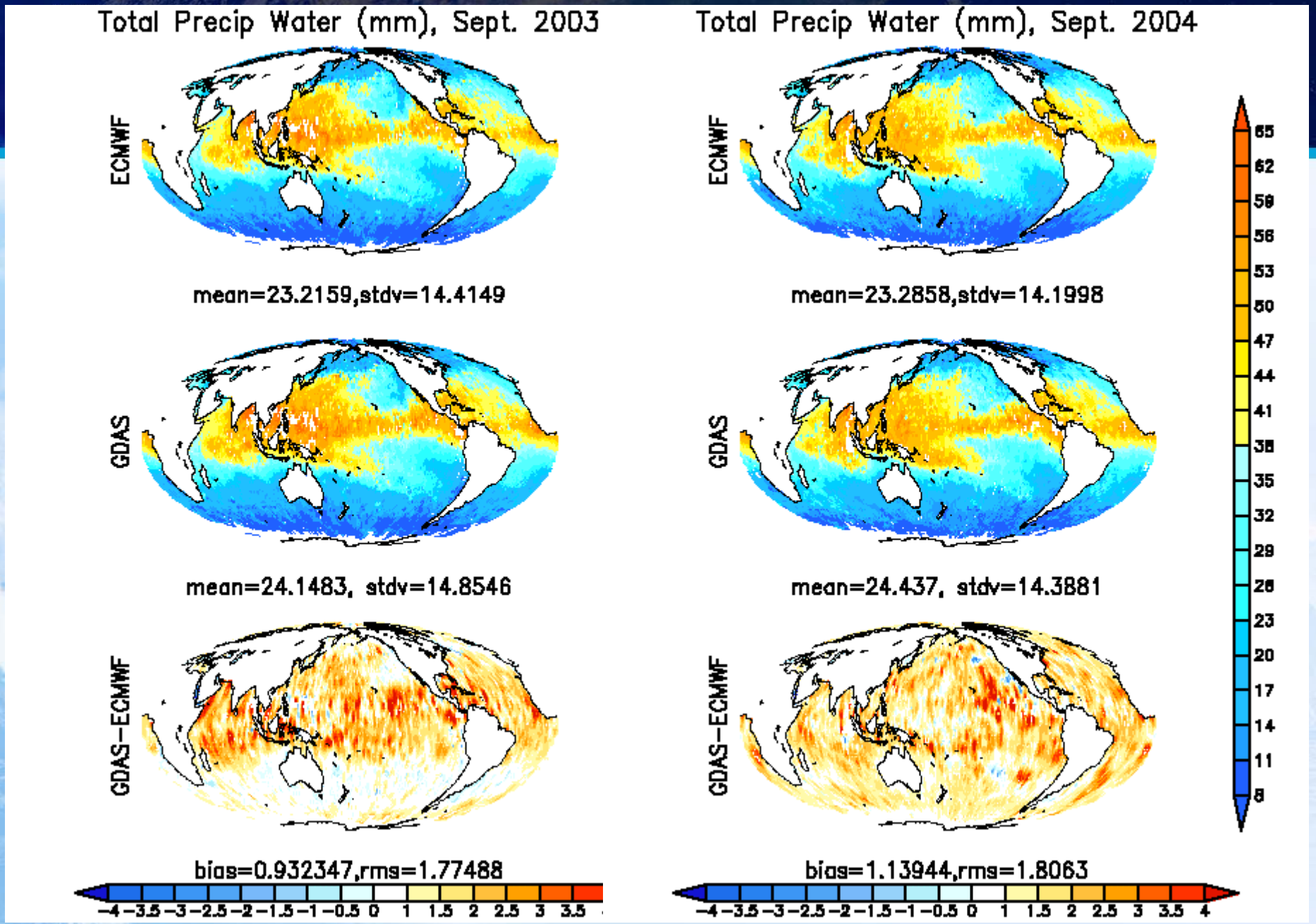
JCET

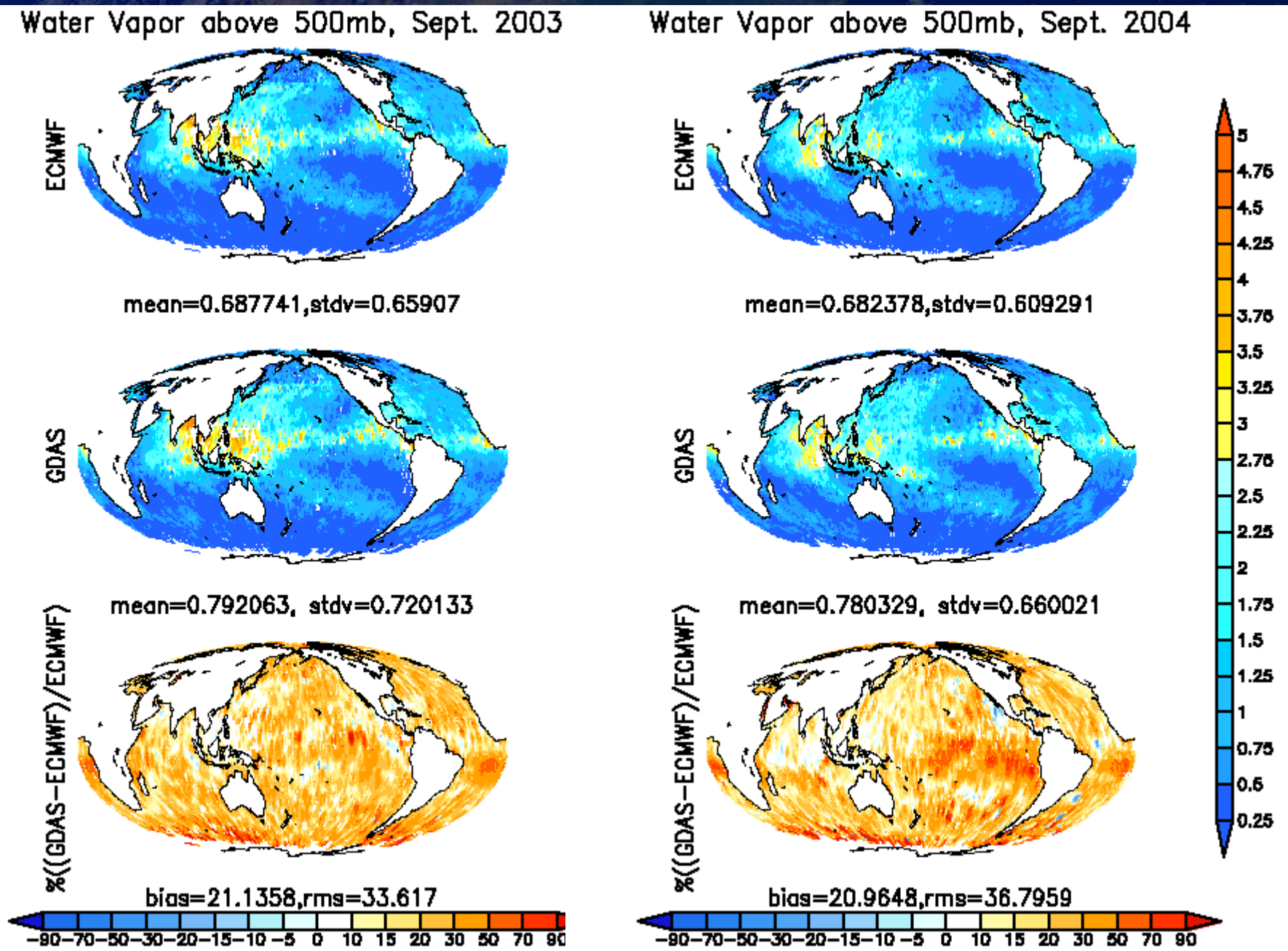
3°x3° grids trace gas movie – very preliminary



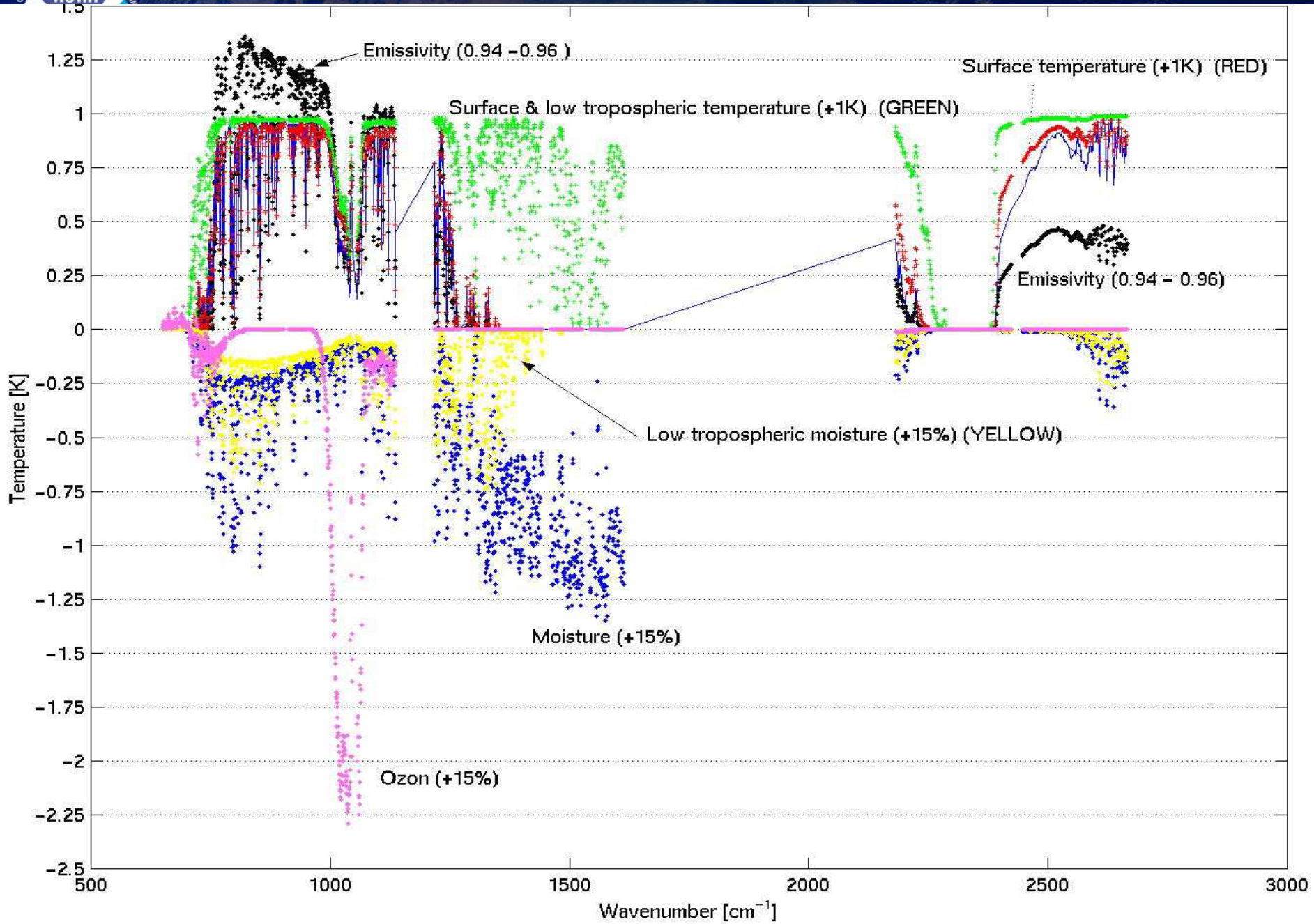
Validating Models

- Assumption is AIRS is very accurate.
- AIRS spectrally-resolved radiances can be used to validate model analyses.

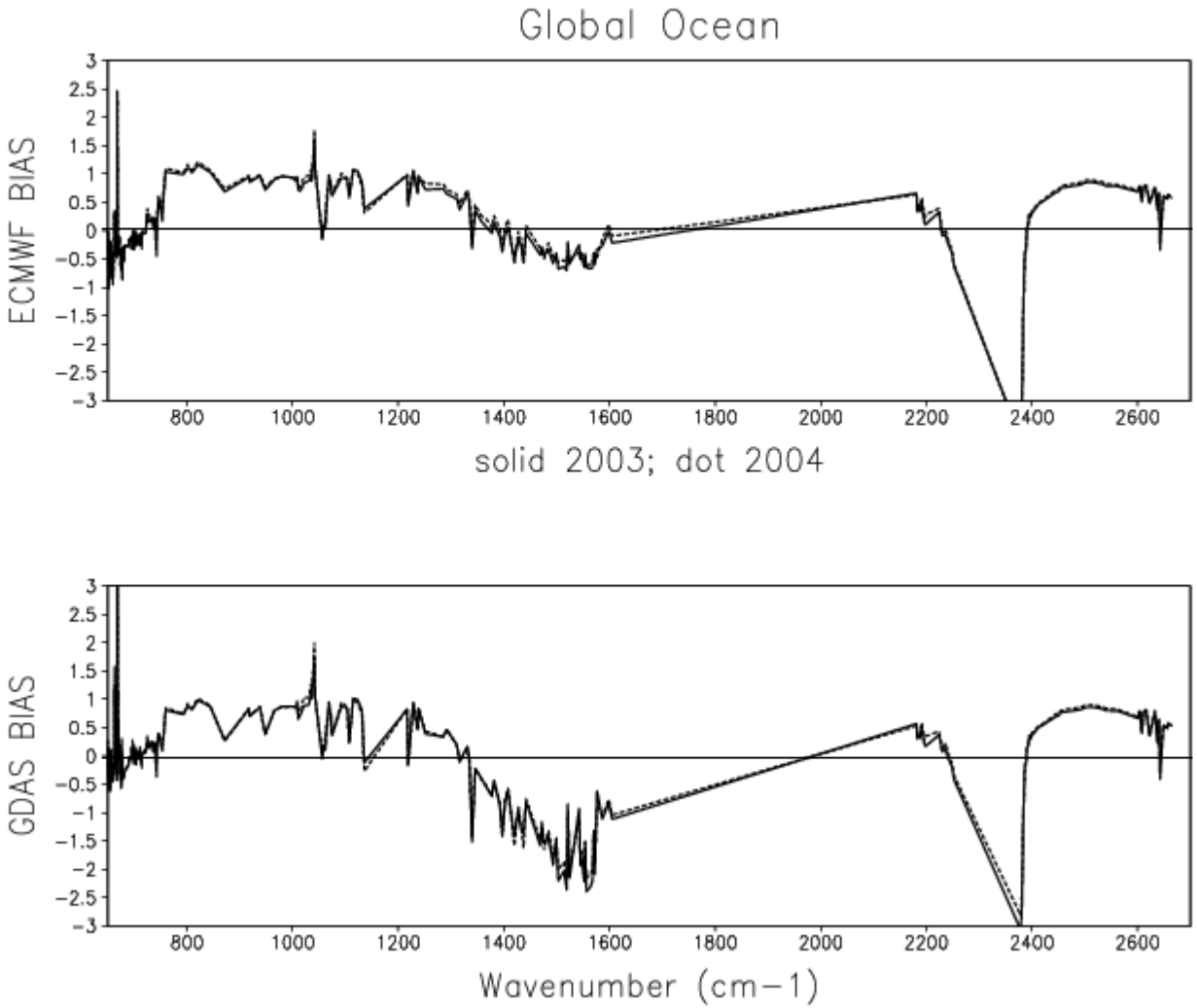

Total Precip Water (mm), Sept. 2003
Total Precip Water (mm), Sept. 2004
ECMWF
ECMWF
mean=23.2159,stdv=14.4149
mean=23.2858,stdv=14.1998
GDAS
GDAS
mean=24.1483, stdv=14.8546
mean=24.437, stdv=14.3881
GDAS-ECMWF
GDAS-ECMWF
bias=0.932347,rms=1.77488
bias=1.13944,rms=1.8063
65 62 59 56 53 50 47 44 41 38 35 32 29 26 23 20 17 14 11 8
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 1 1.5 2 2.5 3 3.5
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 1 1.5 2 2.5 3 3.5 4

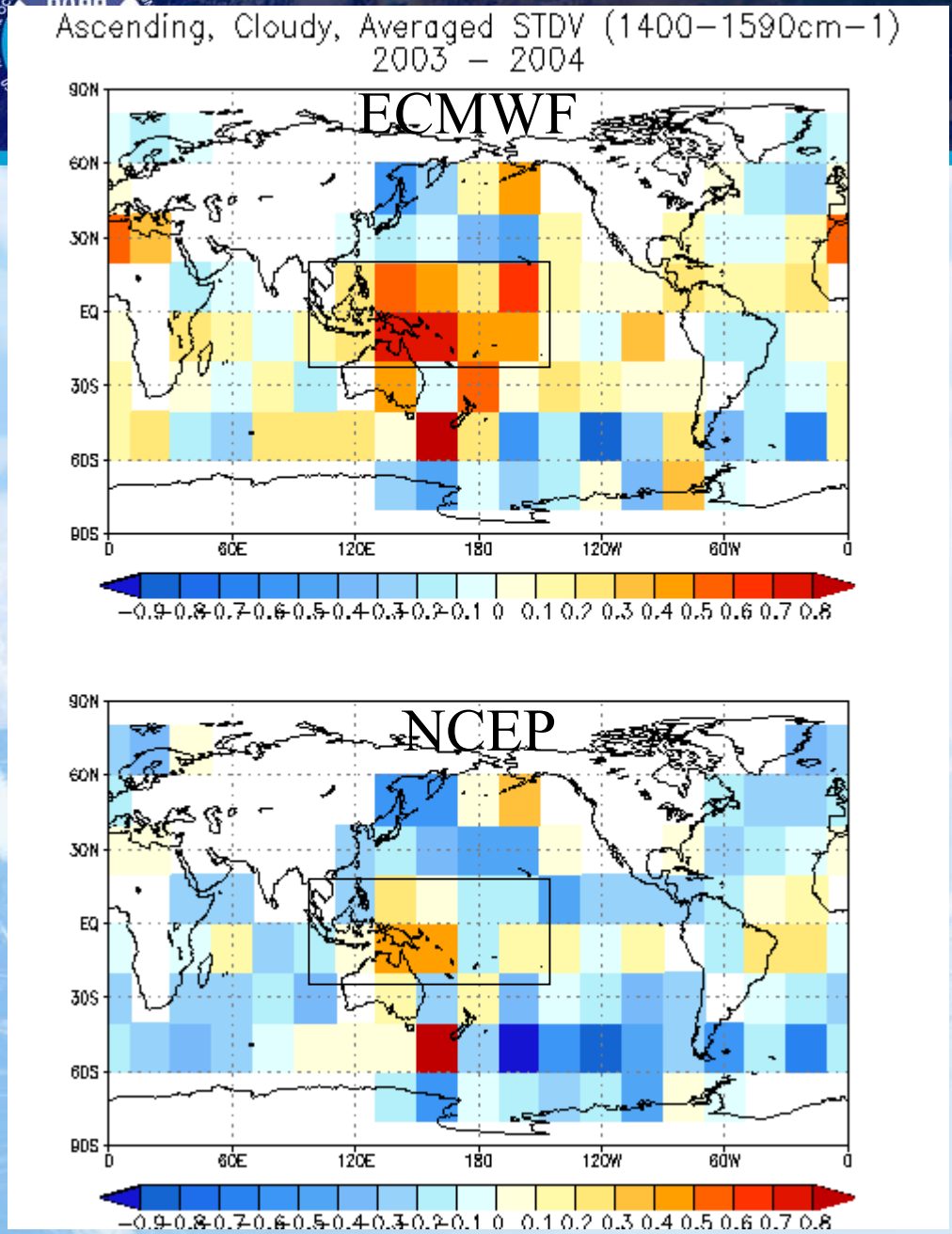

Water Vapor above 500mb, Sept. 2003
Water Vapor above 500mb, Sept. 2004
ECMWF
ECMWF
mean=0.687741,stdv=0.65907
mean=0.682378,stdv=0.609291
GDAS
GDAS
mean=0.792063, stdv=0.720133
mean=0.780329, stdv=0.660021
%((GDAS-ECMWF)/ECMWF)
%((GDAS-ECMWF)/ECMWF)
bias=21.1358,rms=33.617
bias=20.9648,rms=36.7959
5
4.75
4.5
4.25
4
3.75
3.5
3.25
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
-90 -70 -50 -30 -20 -15 -10 -5 0 10 15 20 30 50 70 90
-90 -70 -50 -30 -20 -15 -10 -5 0 10 15 20 30 50 70 90

AIRS radiance changes (in deg K) to atm & sfc changes

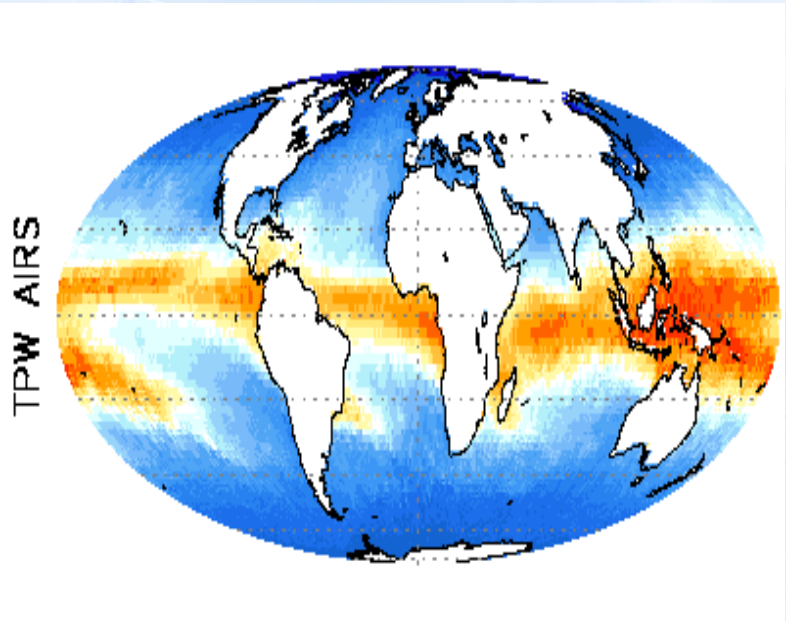


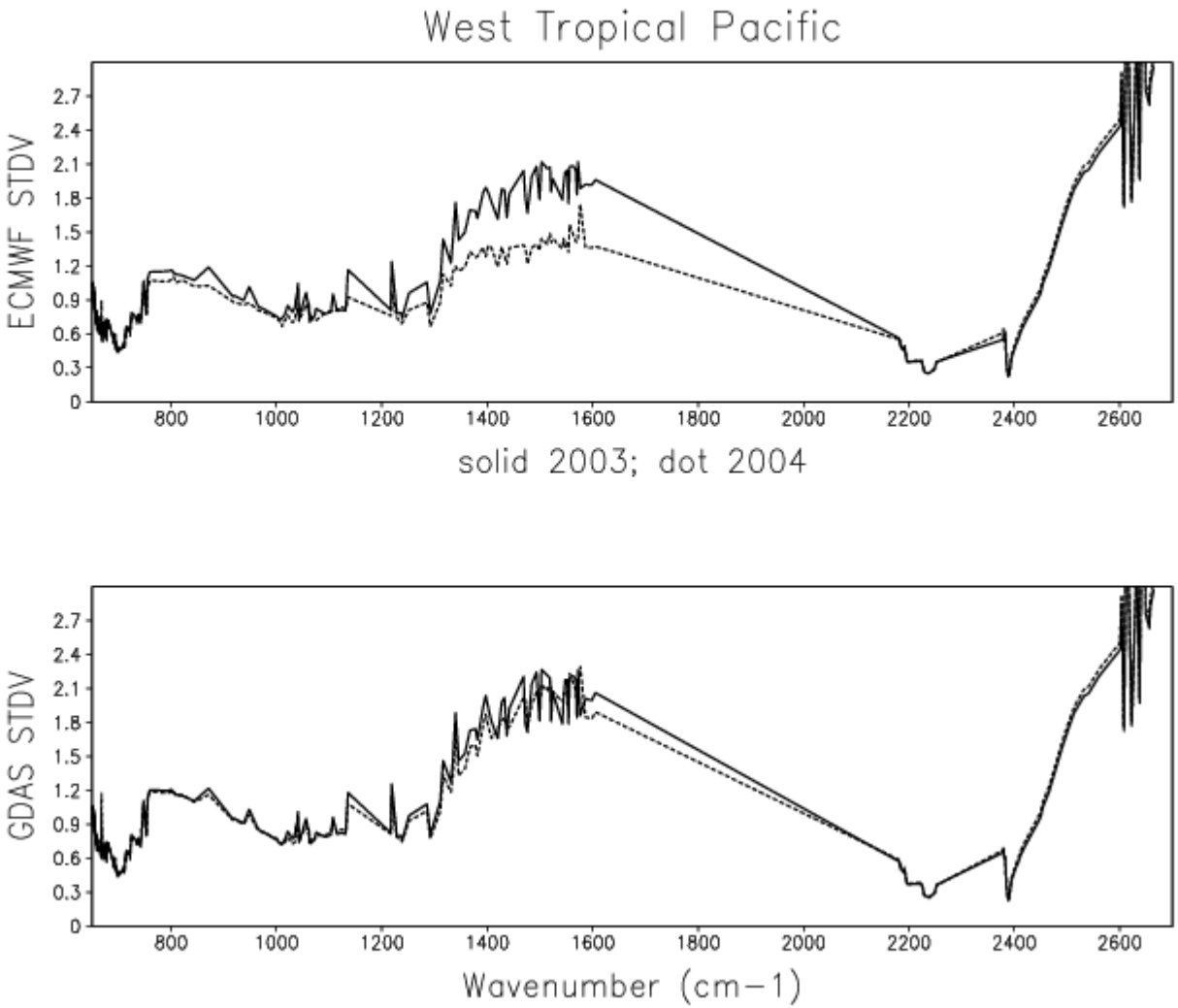
Global Ocean, Day and Night, BIAS



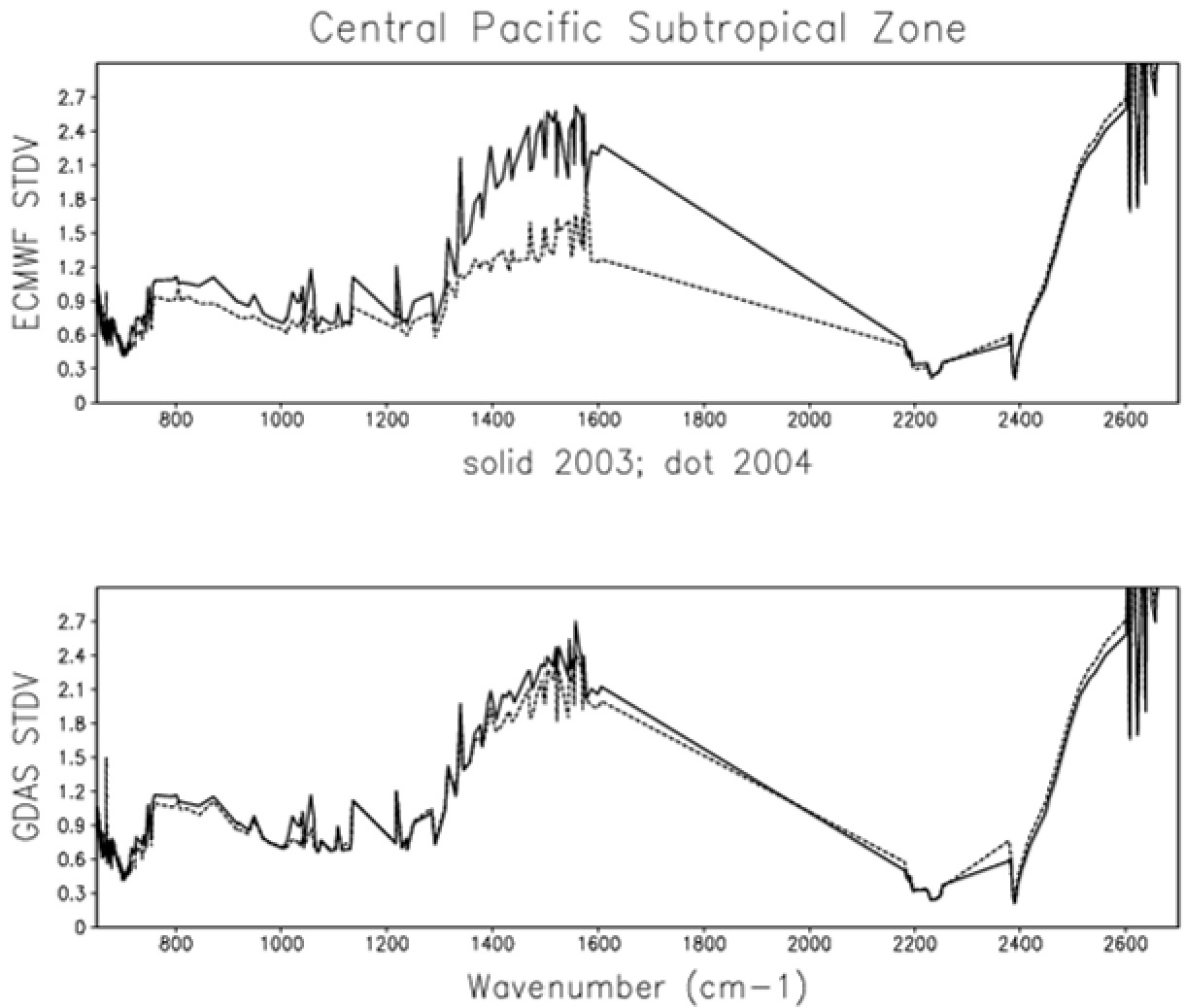


Significant Reduction In Measured – Computed Standard Deviation after \ AIRS is assimilated by ECMWF



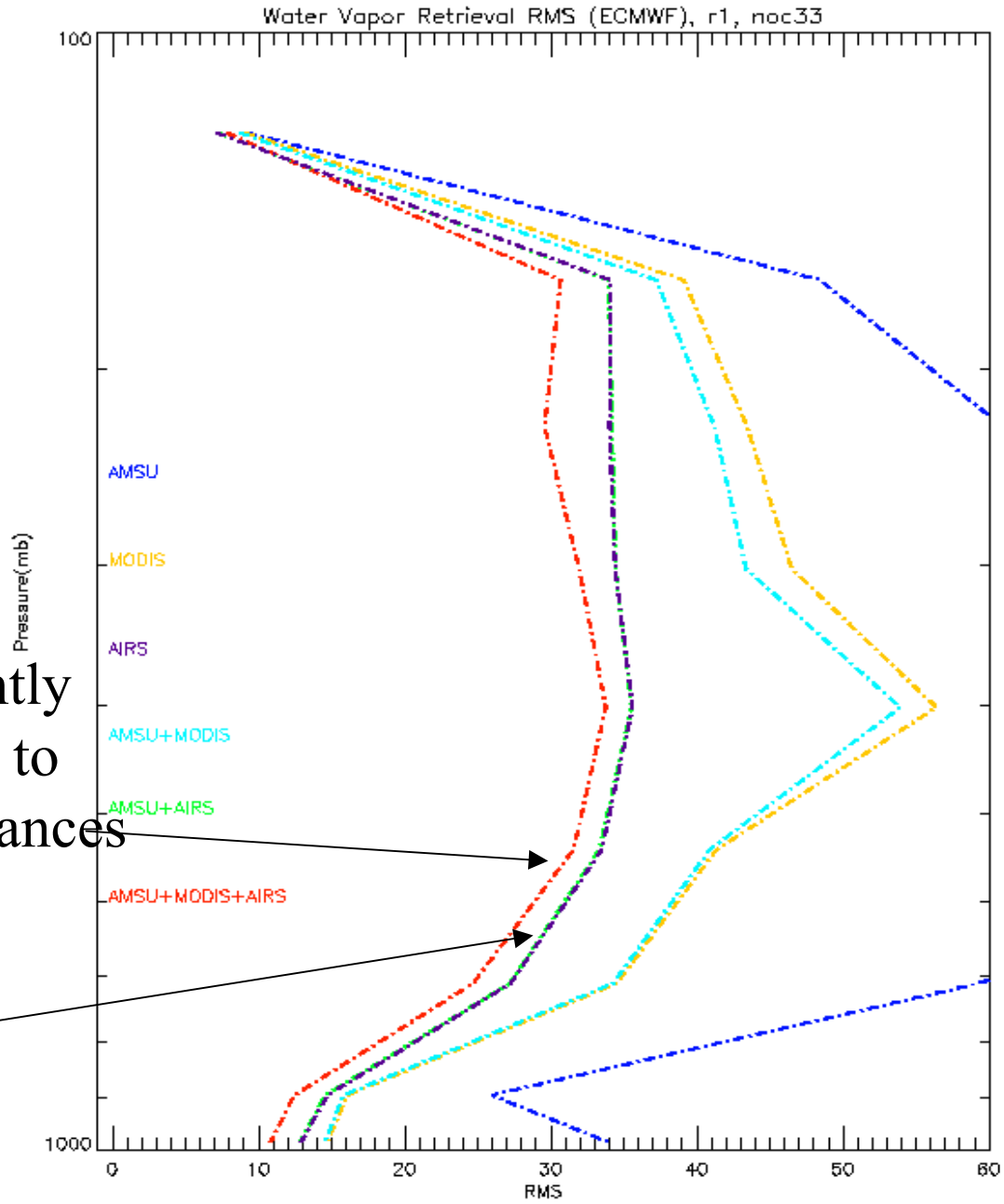

West Tropical Pacific
ECMWF STDV
GDAS STDV
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
solid 2003; dot 2004
Wavenumber (cm−1)

Central Pacific, Day



Summary

- NESDIS will provide operational radiance and level 2 and level 3 products for IASI and CrIS
- Need to integrate high spectral resolution infrared observations and high spatial imager data to provide the most accurate products.
- Research/application areas over the next few years should focus on the use of cloud cleared, the assimilation of cloudy radiances, and the development and validation of trace gases

Retrieval errors are significantly reduced after MODIS is used to QC AIRS cloud-cleared radiances

W/O QC