



Atmospheric Soundings of Temperature, Moisture and Ozone from AIRS

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NOAA/NESDIS/ORA

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Risk Reduction Benefits

- Early demonstration of operational processing of high spectral resolution infrared sounder data prior to CrIS, IASI and GOES-R
- Validation of retrieval performance
- Early opportunity for forecast centers to learn how to assimilate advanced IR data
- Demonstration of positive impact for NWP
- WE HAVE A LOT MORE TO LEARN!!!



AIRS Retrievals

- Microwave-only retrieval of sfc emissivity, sfc temperature, sfc type and profiles of temperature, water vapor and cloud liquid water.
- AIRS retrieval of cloud amount and height, cloud cleared radiances, sfc emissivity, sfc temperature, and profiles of temperature, water vapor and ozone.
- AIRS has two retrieval steps – very fast eigenvector regression followed by a physical retrieval algorithm.



AIRS Radiance Products

- Spectrally and Spatially Thinned Radiances
- Principal Component Scores (Spatially Thinned)
- Reconstructed radiances (Spatially/Spectrally Thinned)
- Cloud-Cleared radiances (Spatially/Spectrally Thinned)
- Cloud-Cleared PCS (Spatially Thinned)
- Super channel radiances



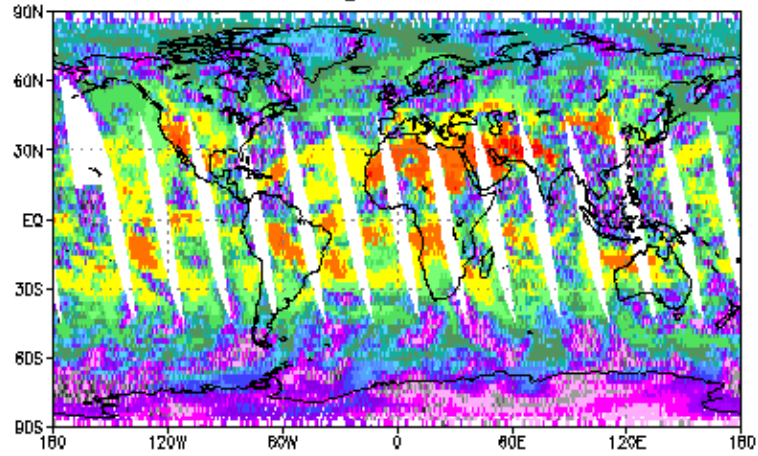
What have we learned?

- AIRS instrument is extremely stable and accurate
- Only 5% of the globe is clear at a 14 km fov
- Impact on NWP is currently small (remember 5%)
- Cloud-clearing increases yield to 60%
- Retrievals from cloud-cleared radiances are significantly more accurate than AMSU-only.
- Retrievals from cloud-contaminated radiances are also significantly more accurate than AMSU-only

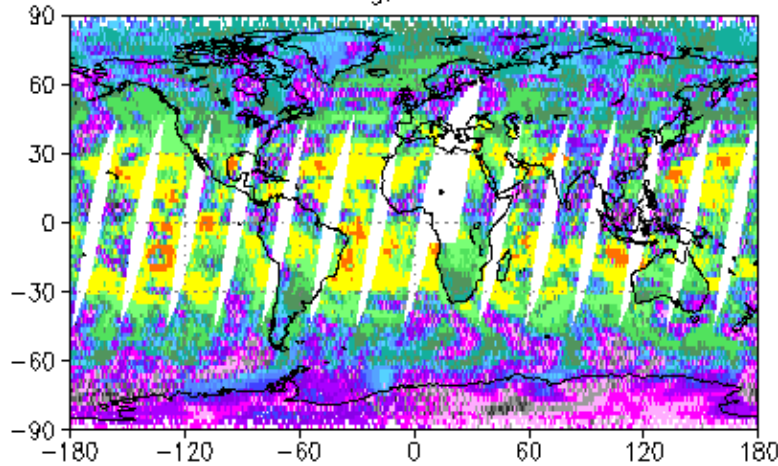
Simulated AIRS

Real AIRS

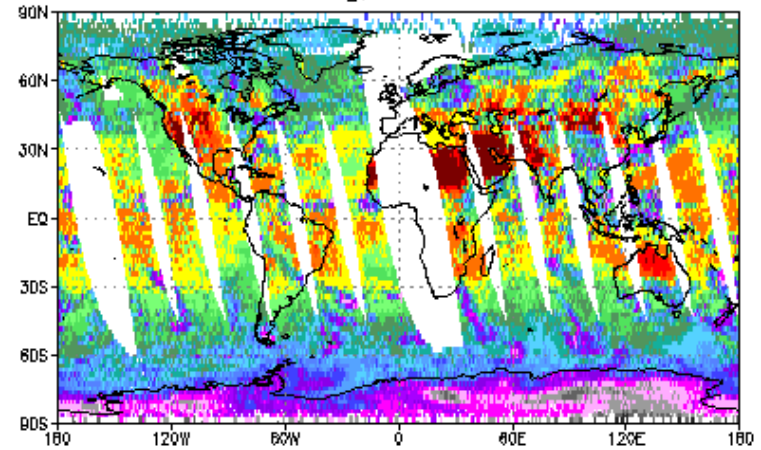
airs [965.323cm⁻¹]
ascending, 2002 Jun 14



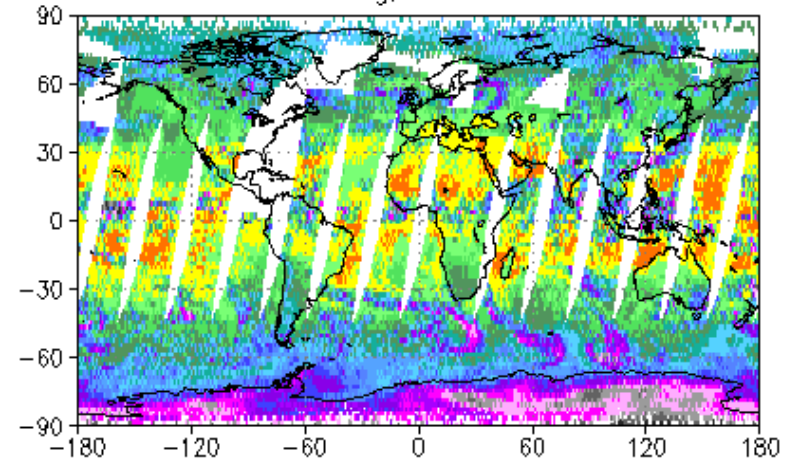
descending, 2002 Jun 14



airs [965.323cm⁻¹]
ascending, 2002 Jun 14



descending, 2002 Jun 14



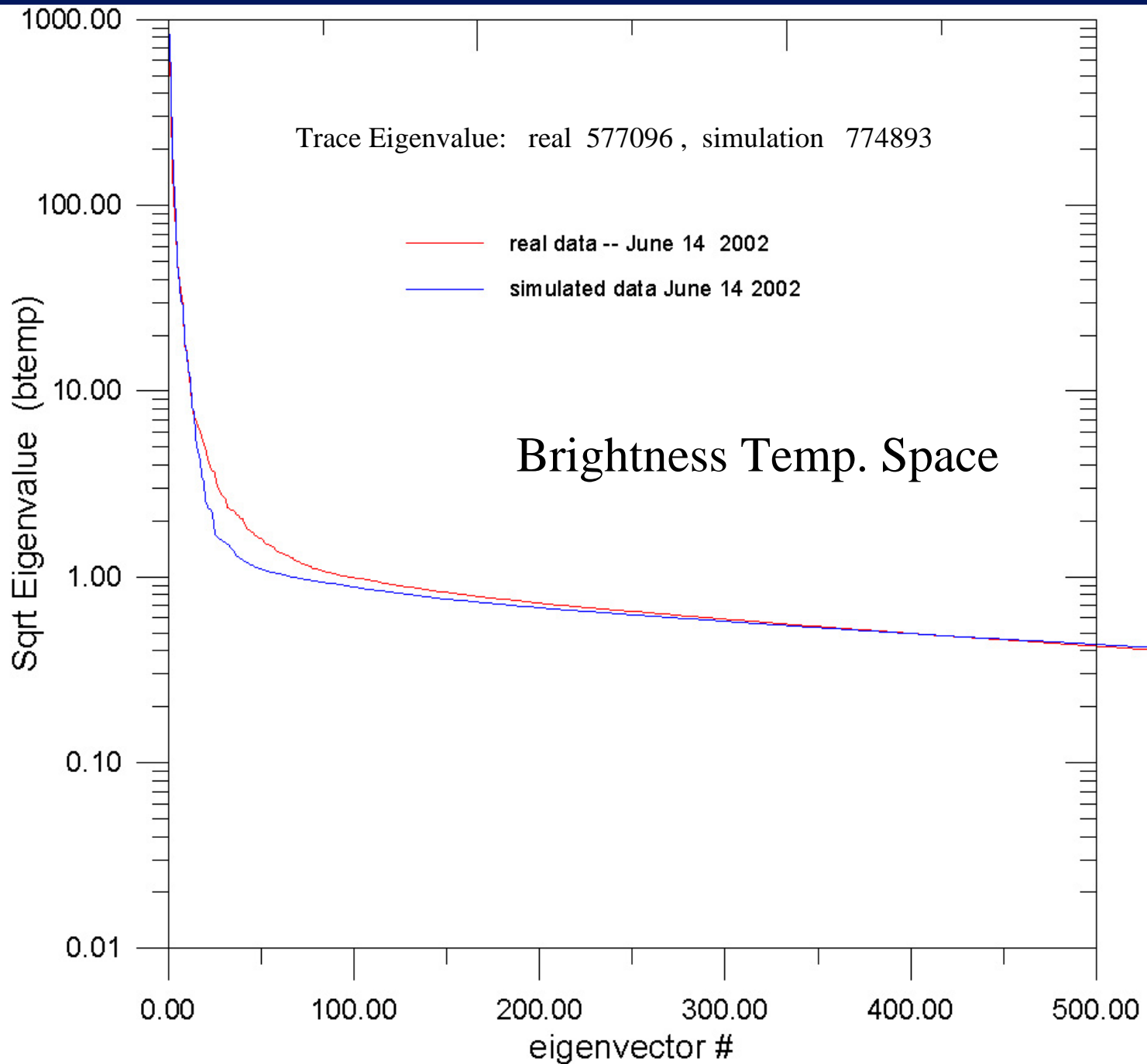


Trace Eigenvalue: real 577096 , simulation 774893

— real data -- June 14 2002
— simulated data June 14 2002

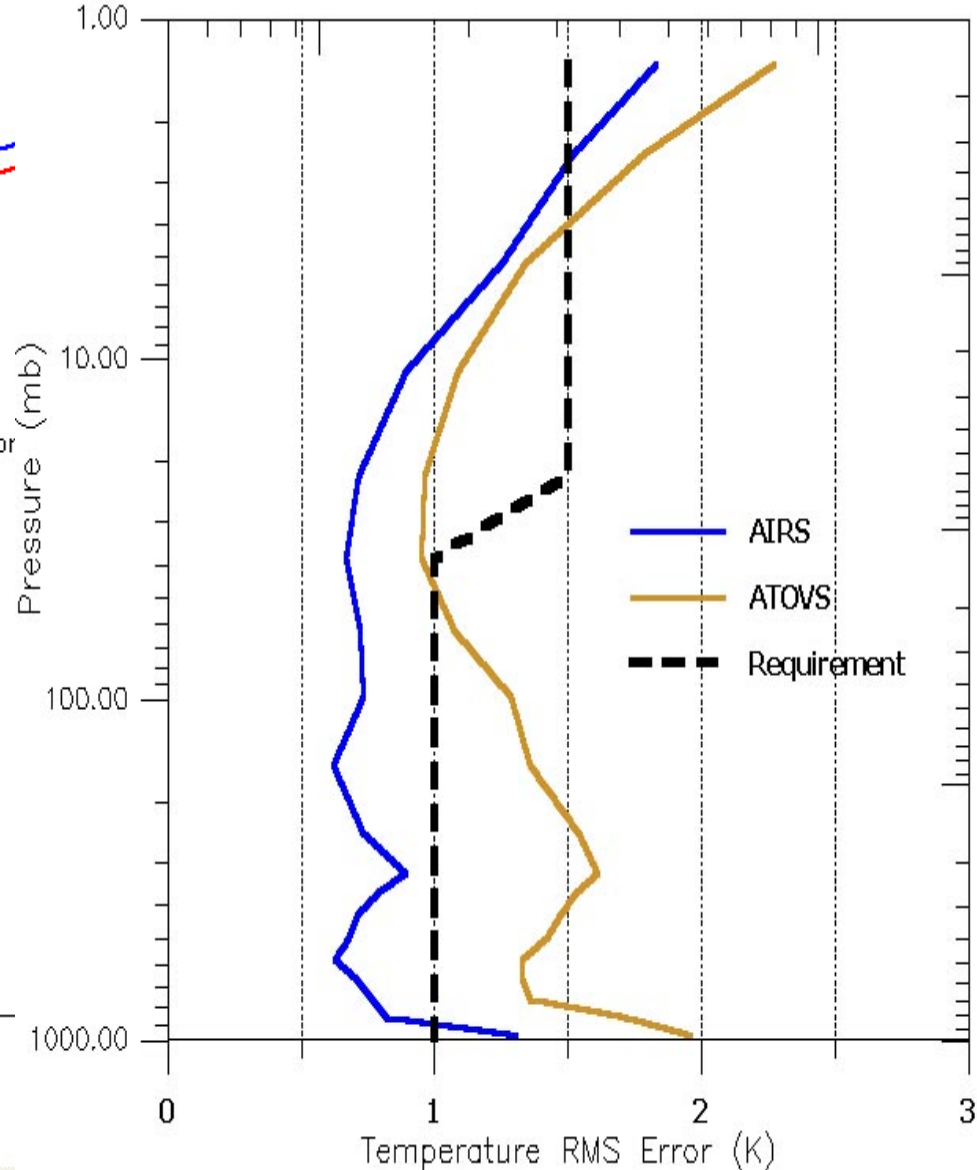
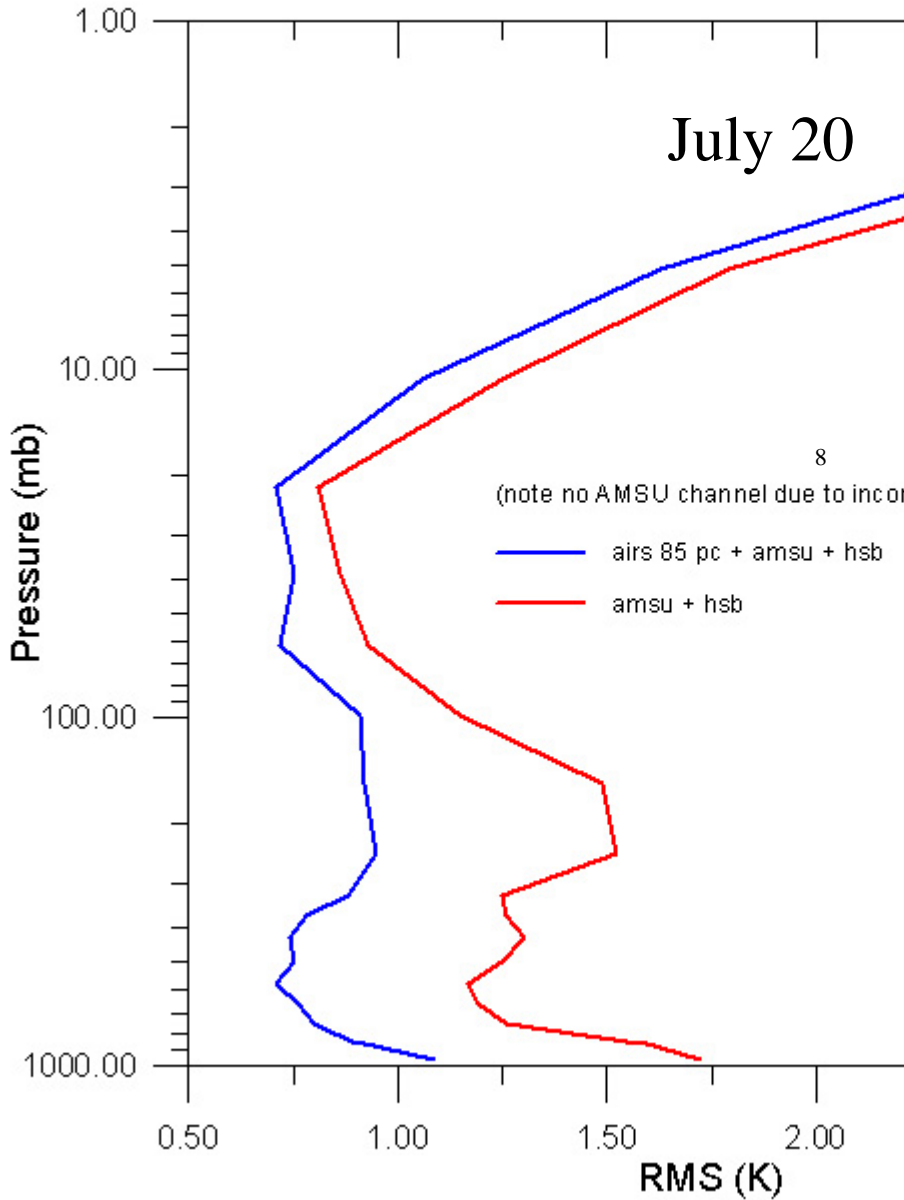
Brightness Temp. Space

LOG

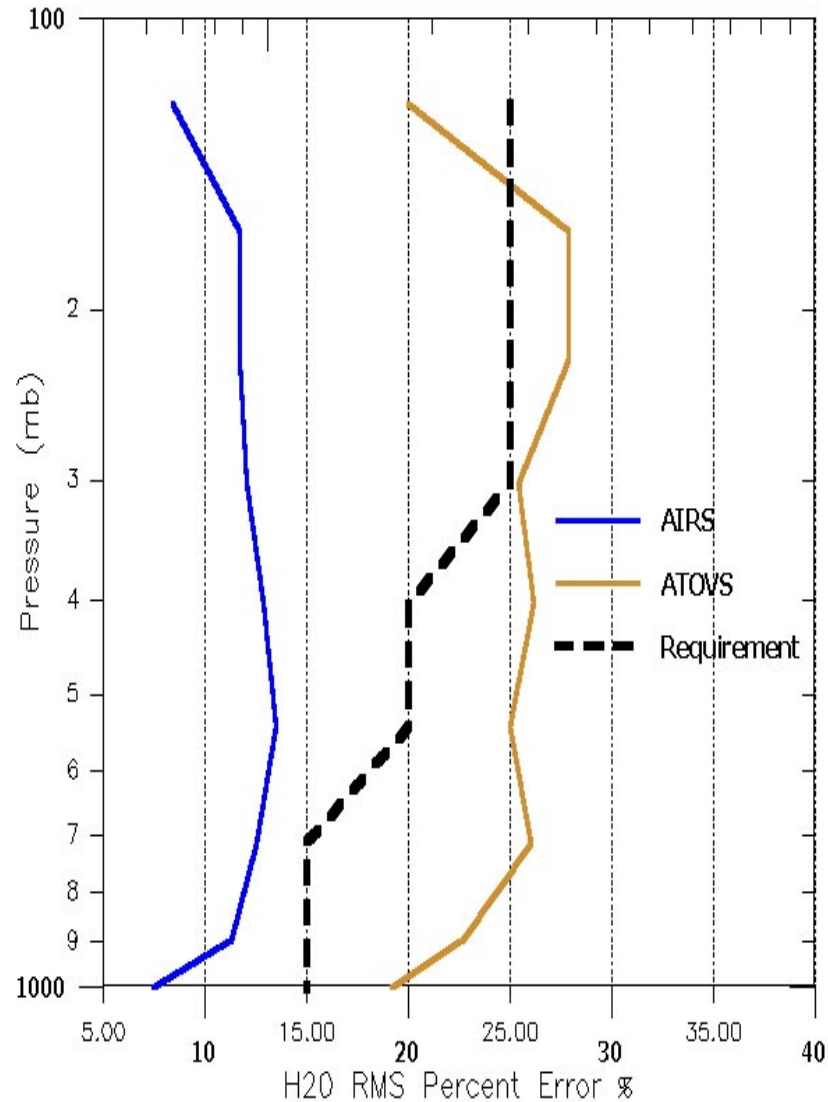
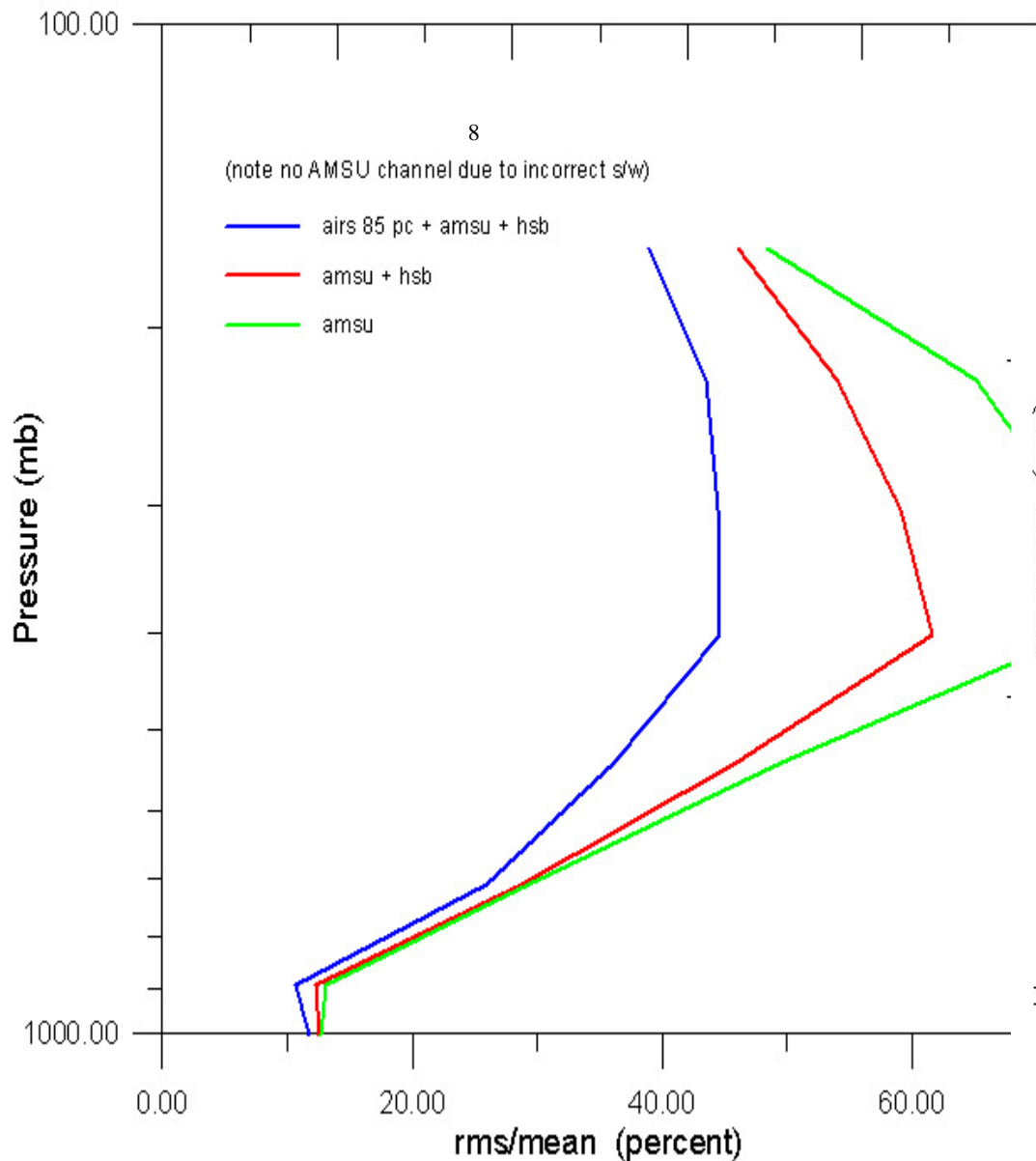




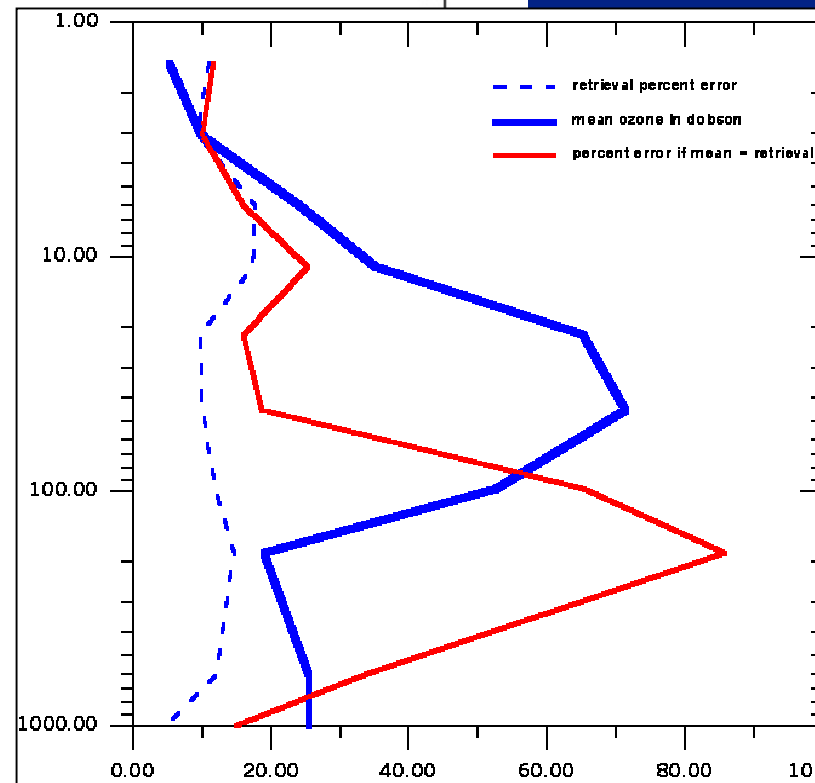
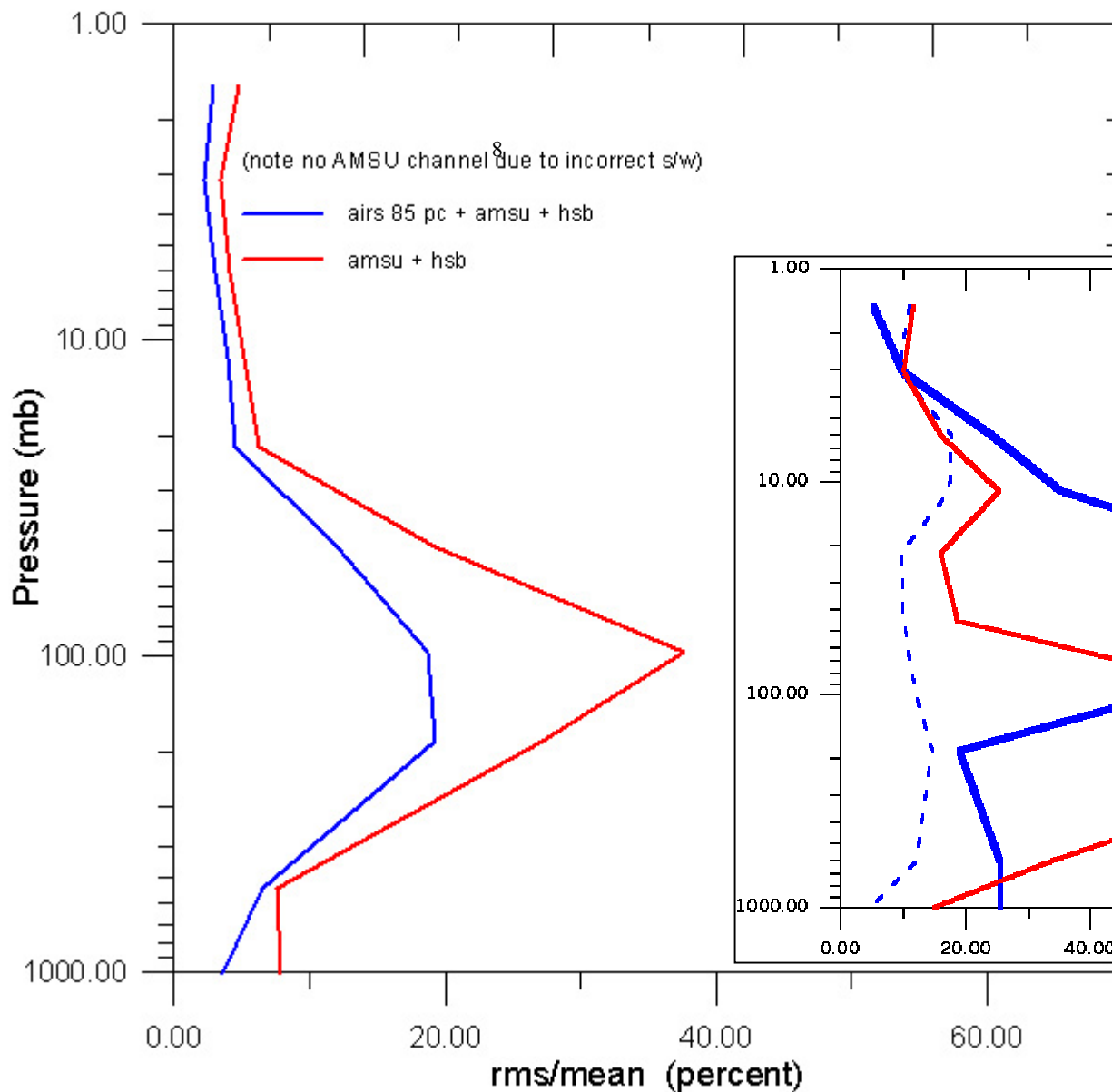
Regression prediction of ECMWF Temperature



Regression prediction of ECWWMF moisture



Regression prediction of ECWMMF ozone

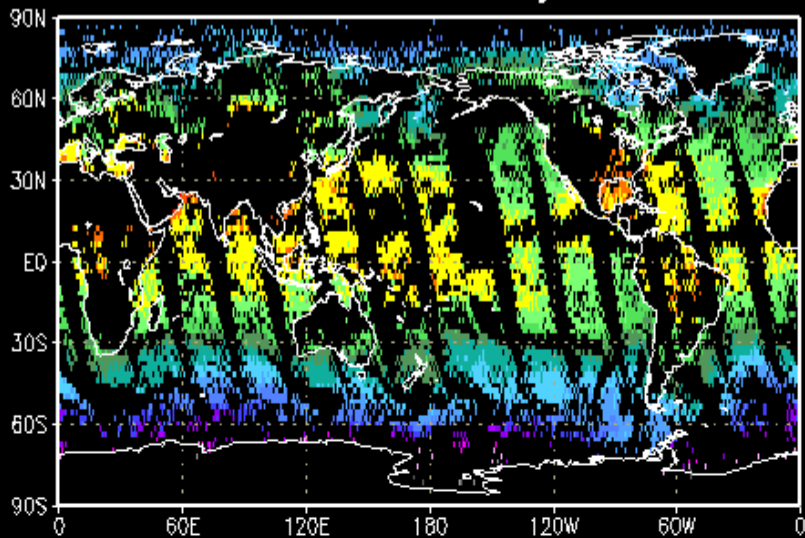


How sensitive is the regression solution to clouds?



- Regression should be able to reduce the impact of partial clouds in AIRS fov because of the high spectral resolution of AIRS.
- Each channel has a different sensitivity due to clouds.
- Generated coefficients for all cases where the predicted AIRS from AMSU difference test is less than 2 K (~50%)

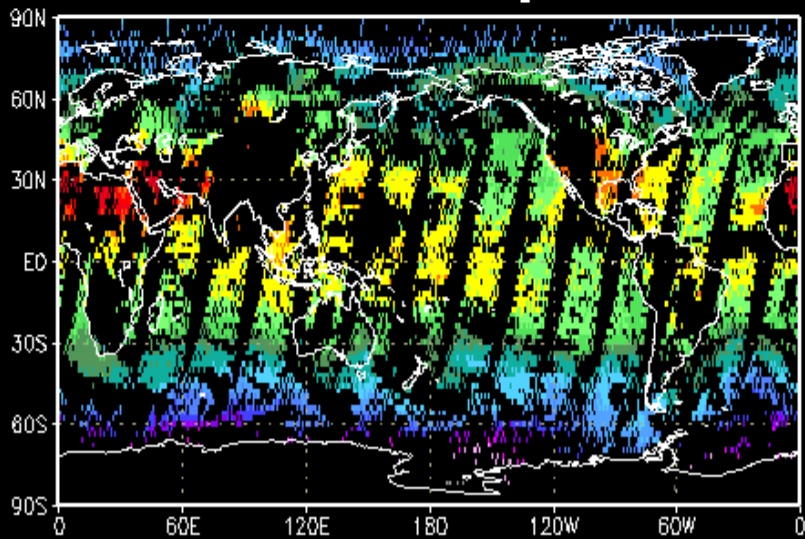
airs retrievals at layers



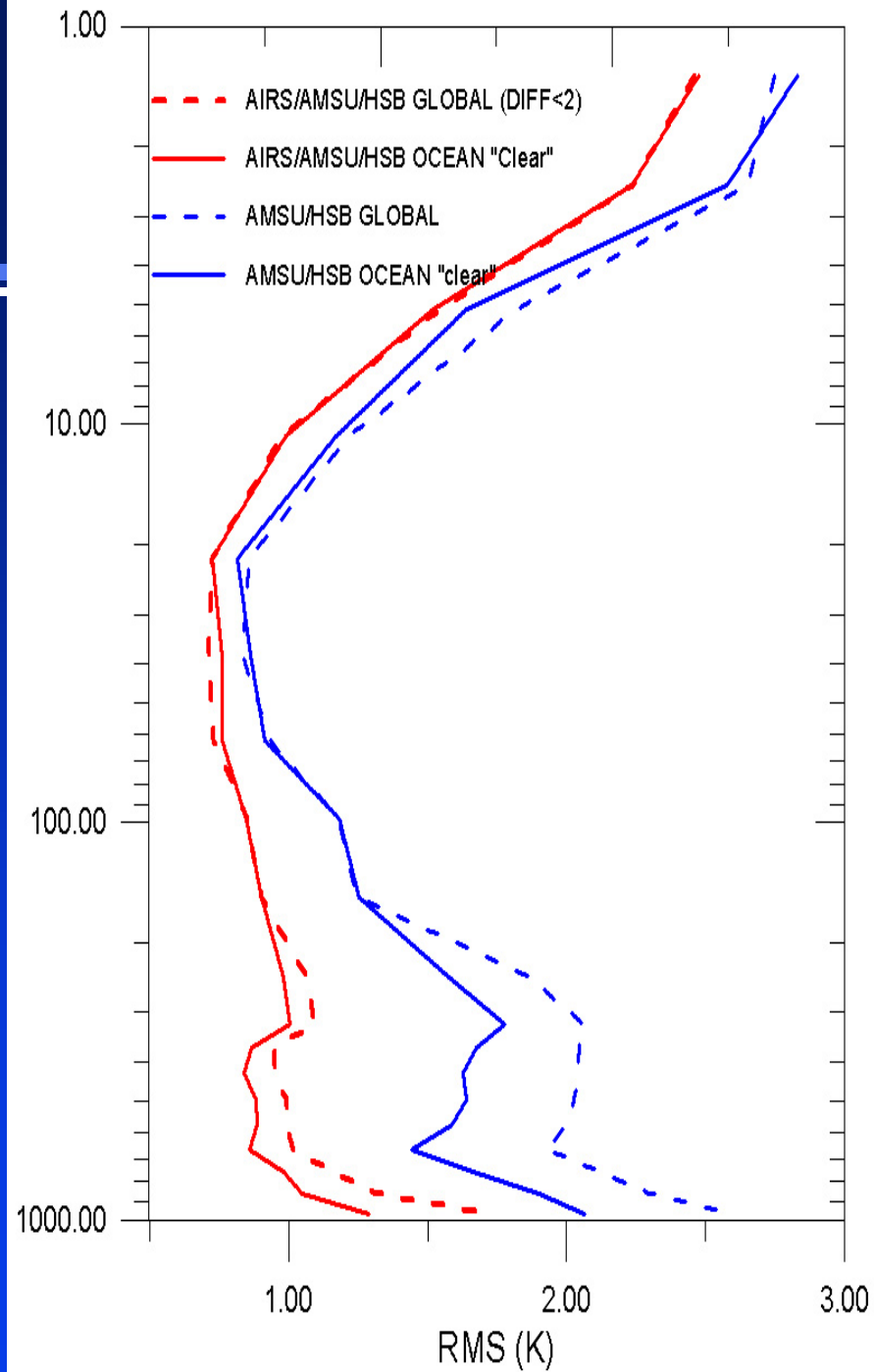
904.8660 to 1013.948 mb

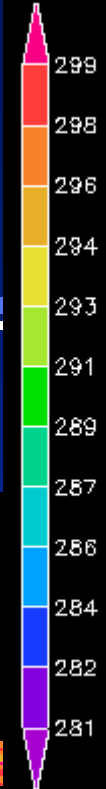
min=240.826, max=305.725, sample=18093 (49.18%)

Descending

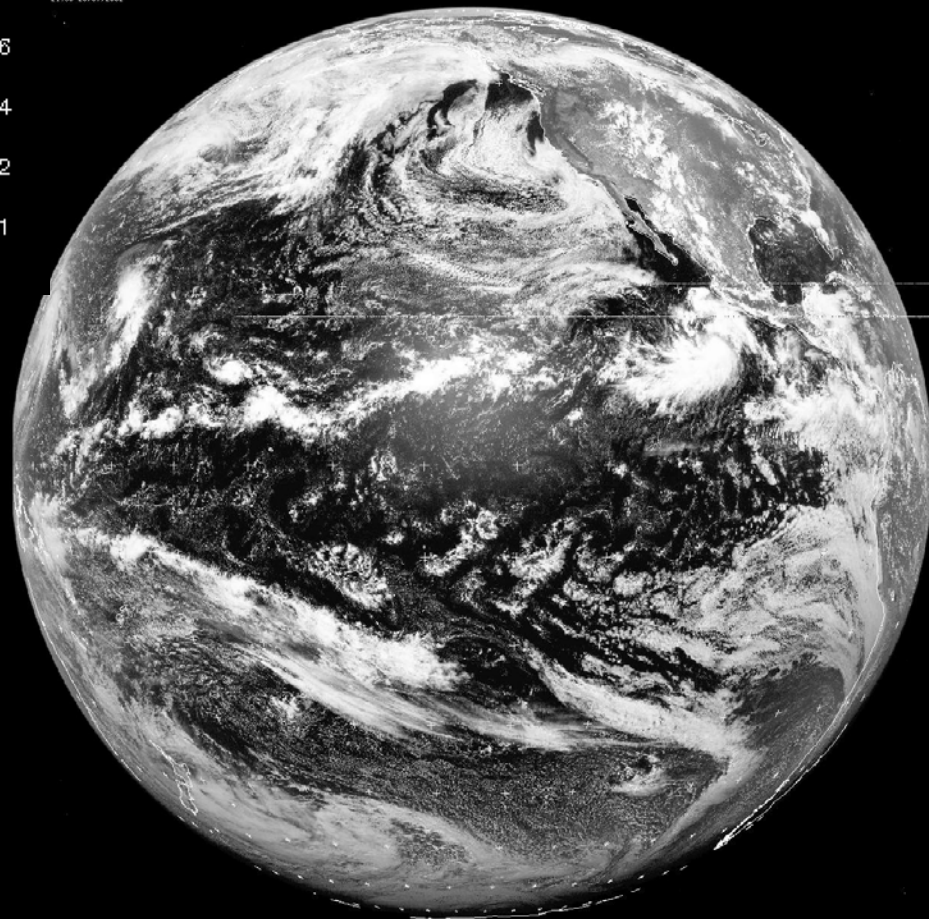
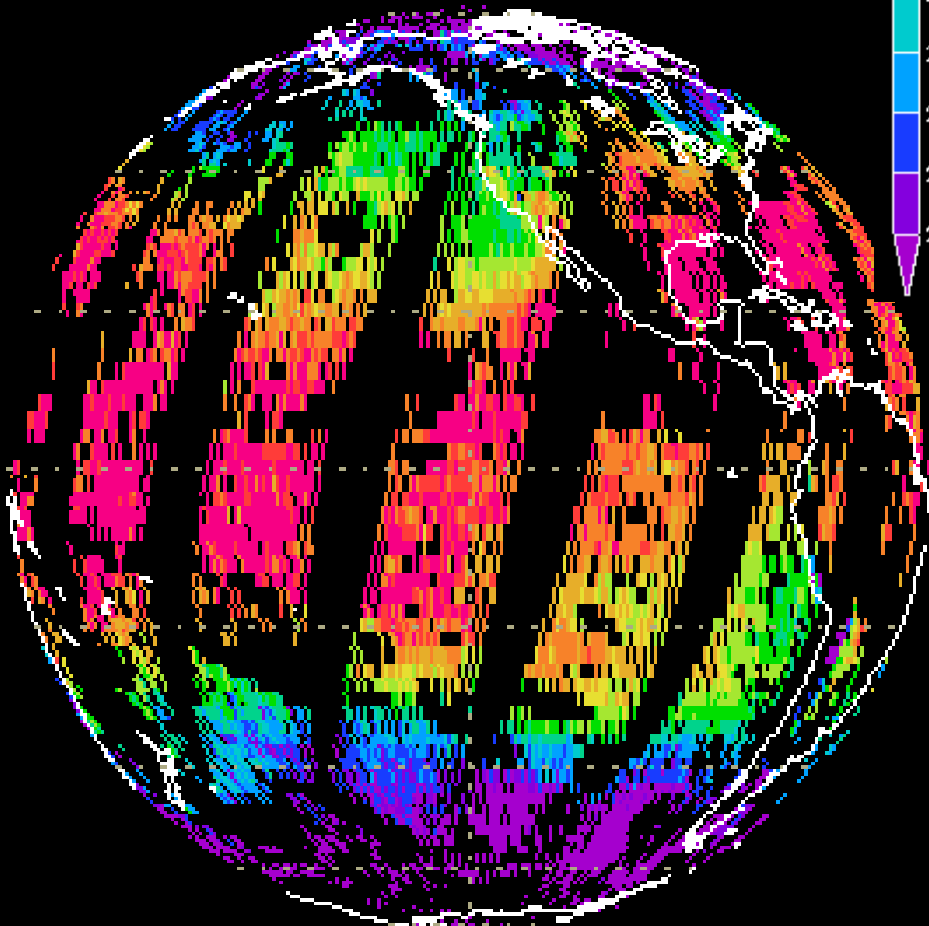


min=240.121, max=323.432, sample=18726 (50.09%)





01108 20/07/2002





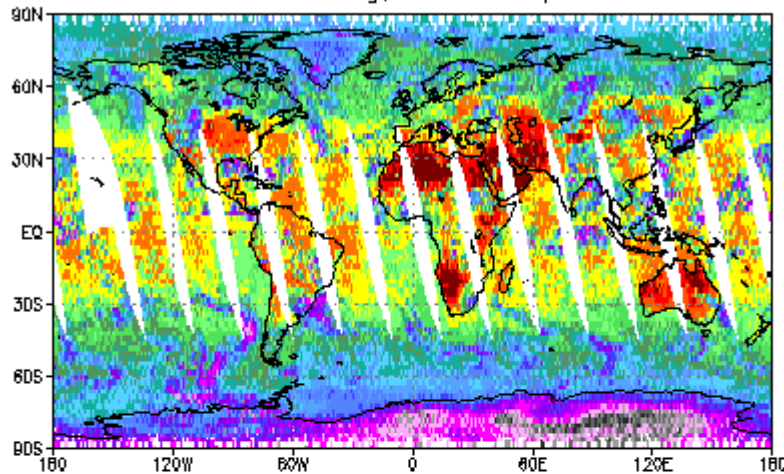
Cloud-Cleared Radiances

Are there benefits to use cloud-cleared data???



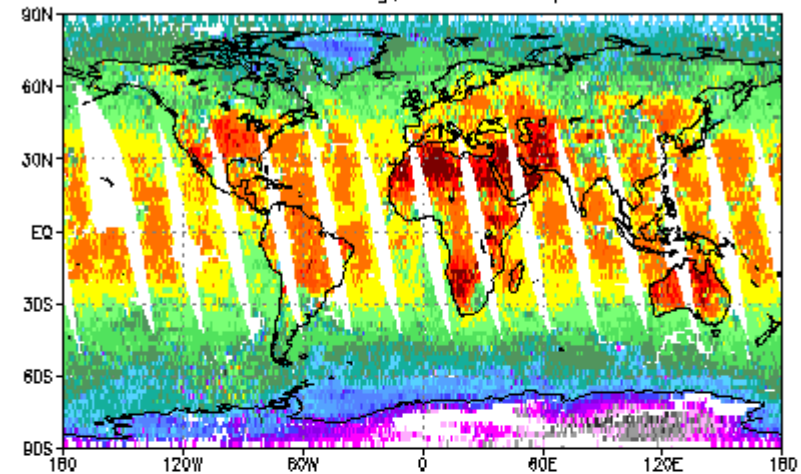
Cloud-contaminated

airs [965.83cm⁻¹]
ascending, 2002 Sep 6

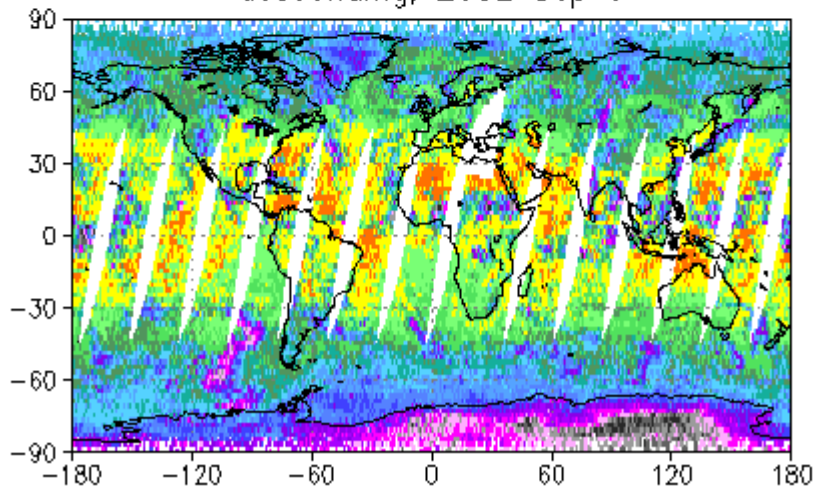


Cloud-Cleared

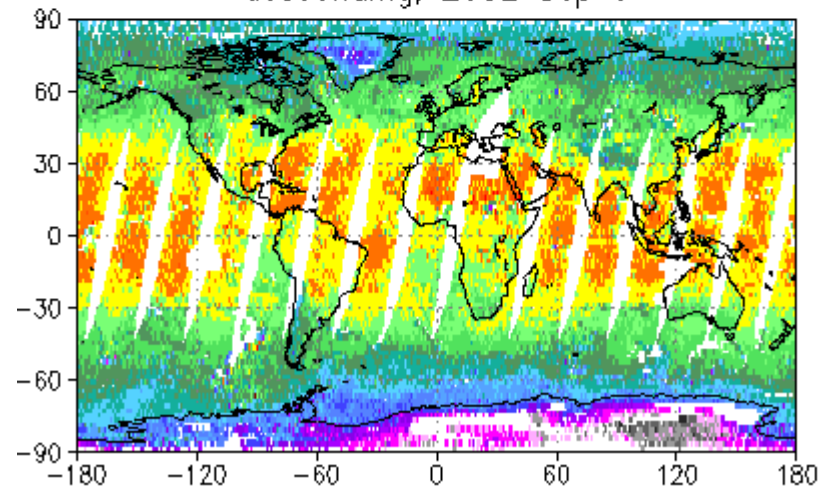
Cloud Cleared [965.83cm⁻¹]
ascending, 2002 Sep 6



descending, 2002 Sep 6

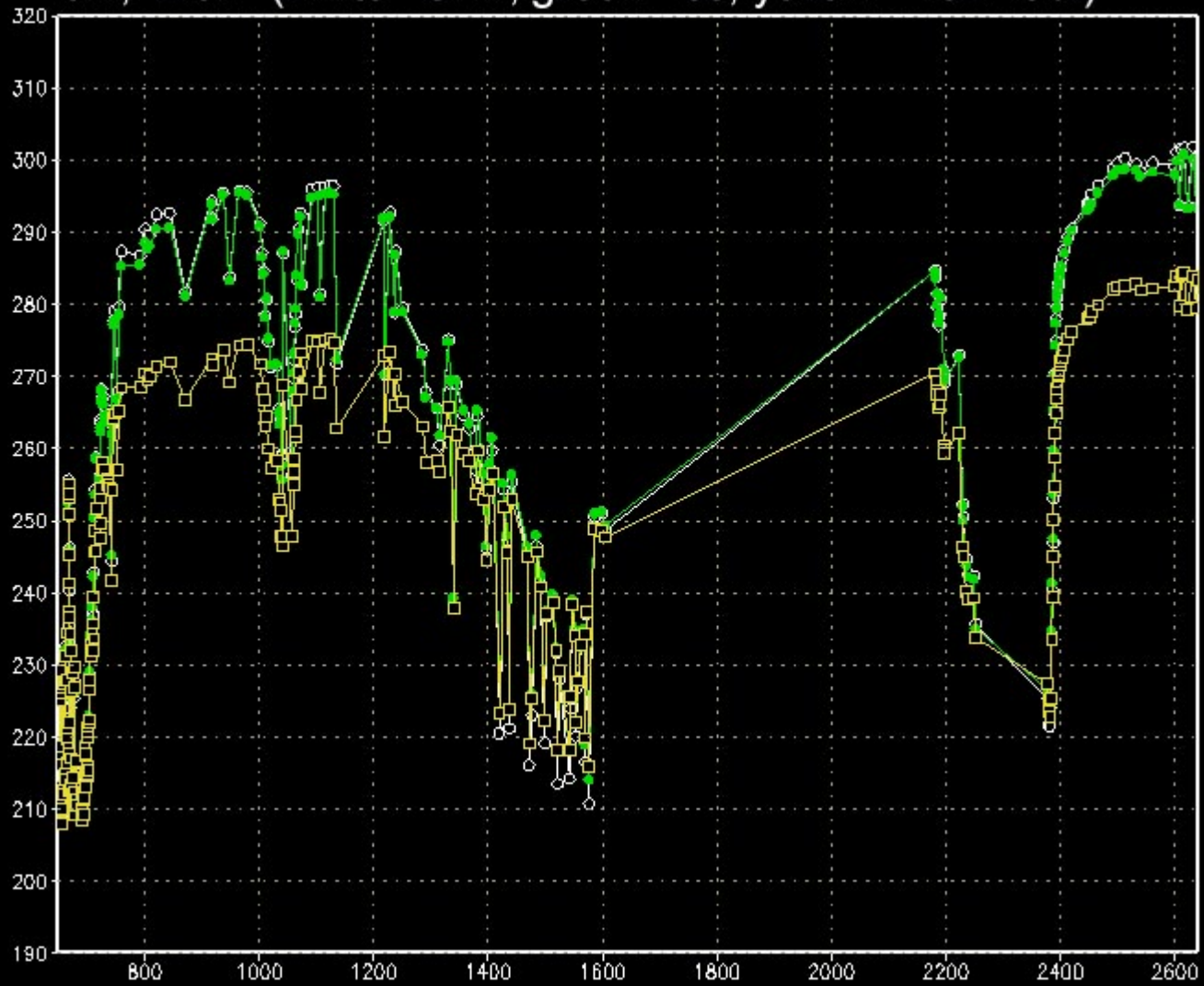


descending, 2002 Sep 6

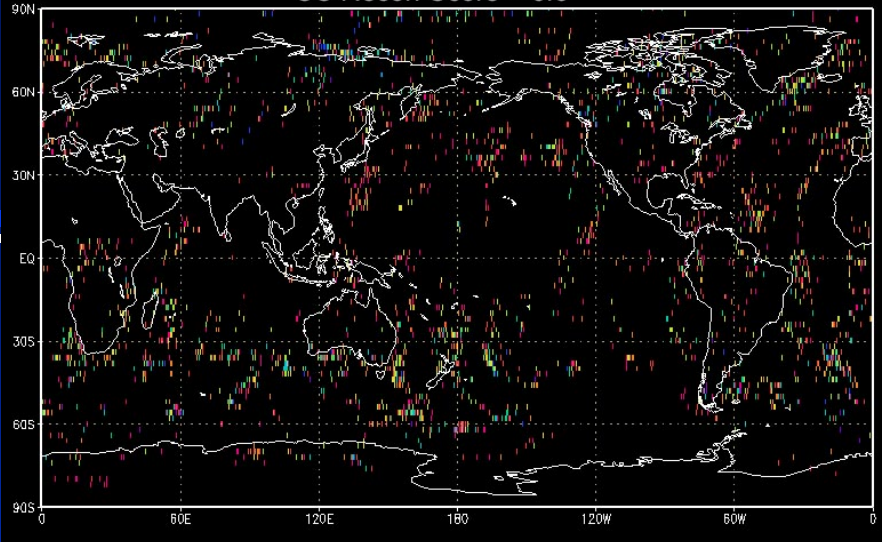




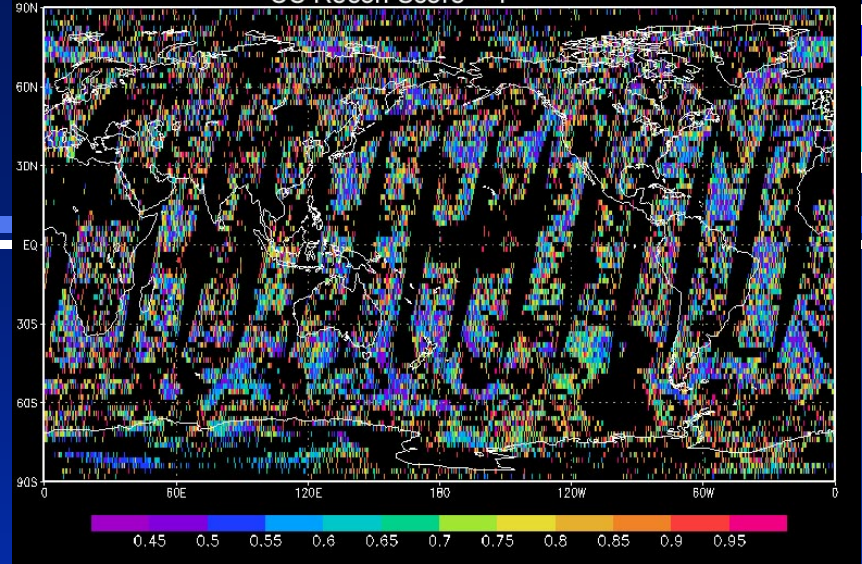
0N, 140E (white= sim., green= cc, yellow = raw rad.)



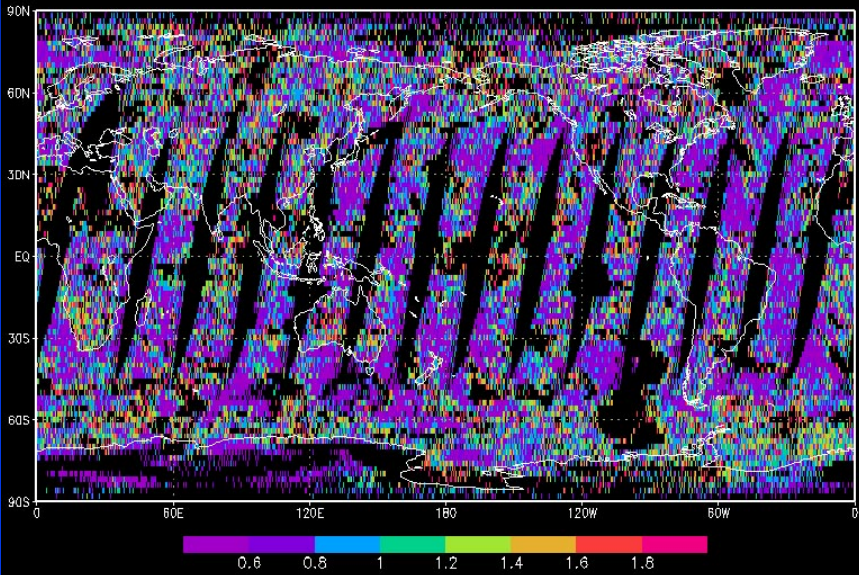
CC Recon Score < 0.5



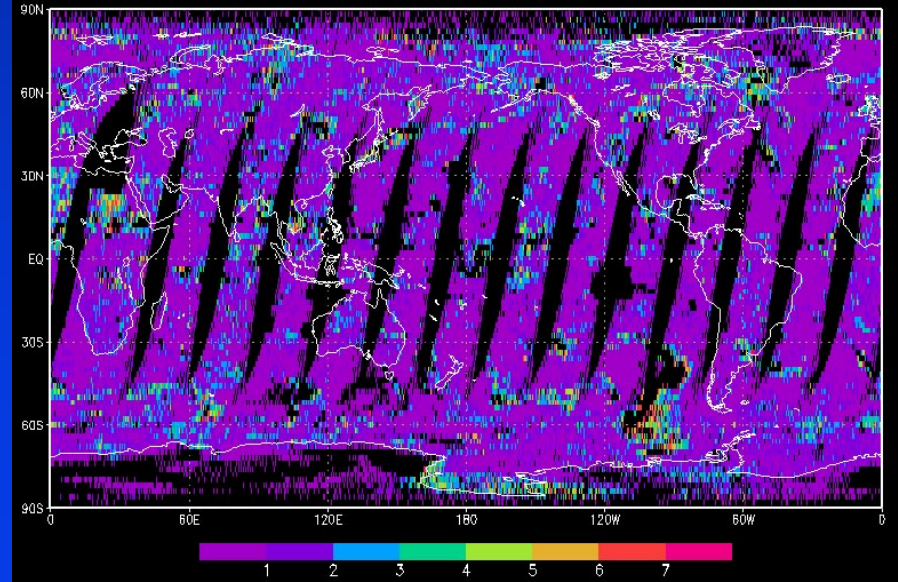
CC Recon Score < 1



CC Recon Score < 2.0



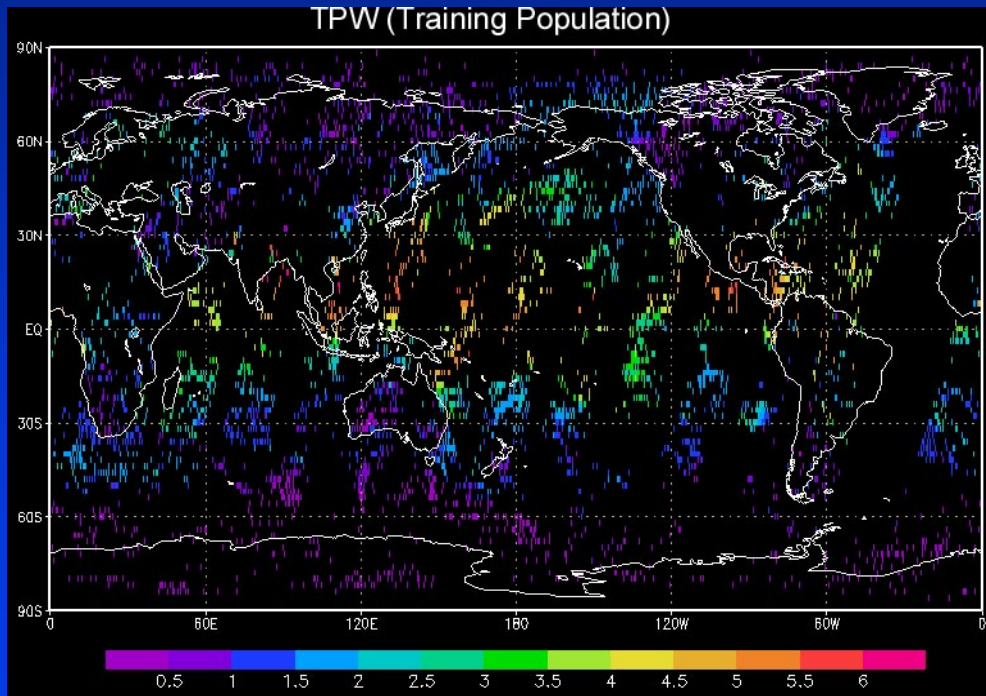
CC Recon Score < 8



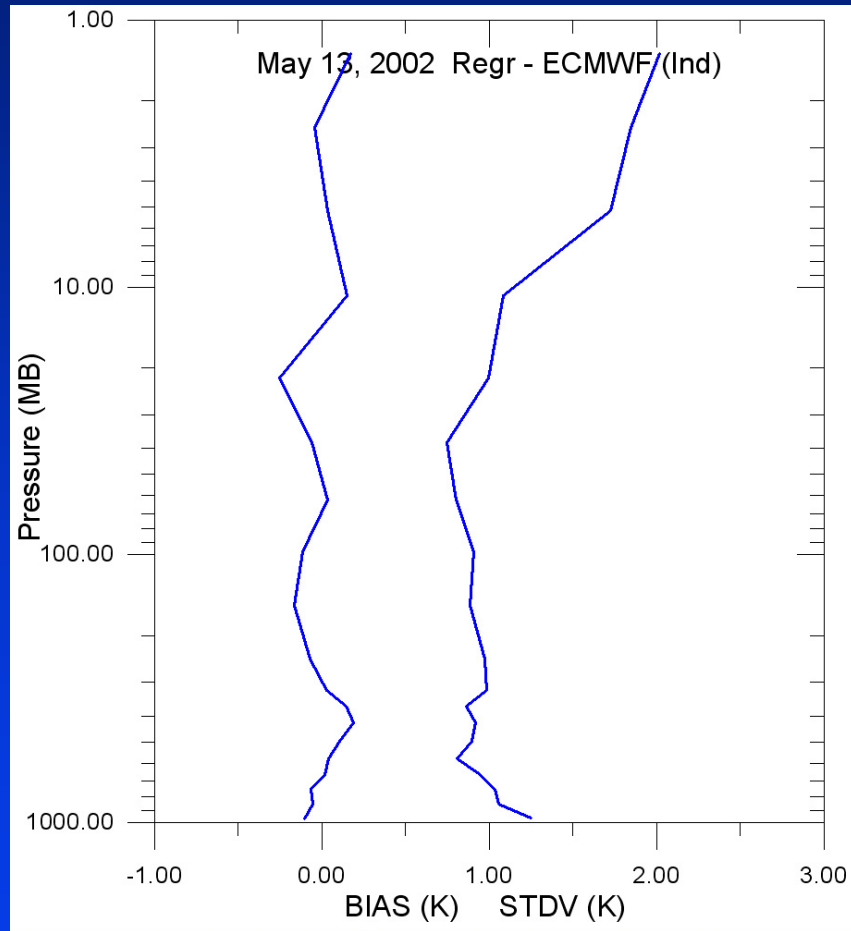


5 days of screened collocated ECMWF and CC PCS are used for generating the regression coefficients.

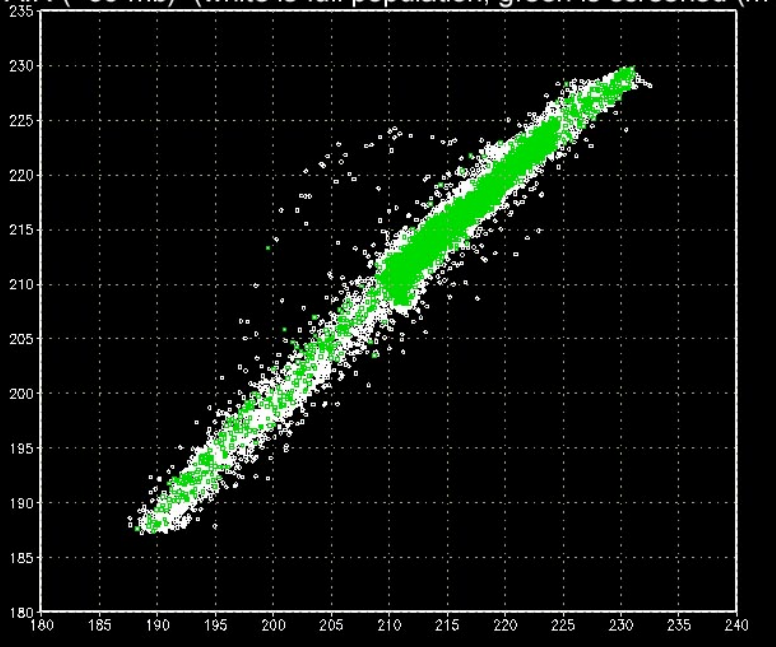
Example of Training Pop. for a given day



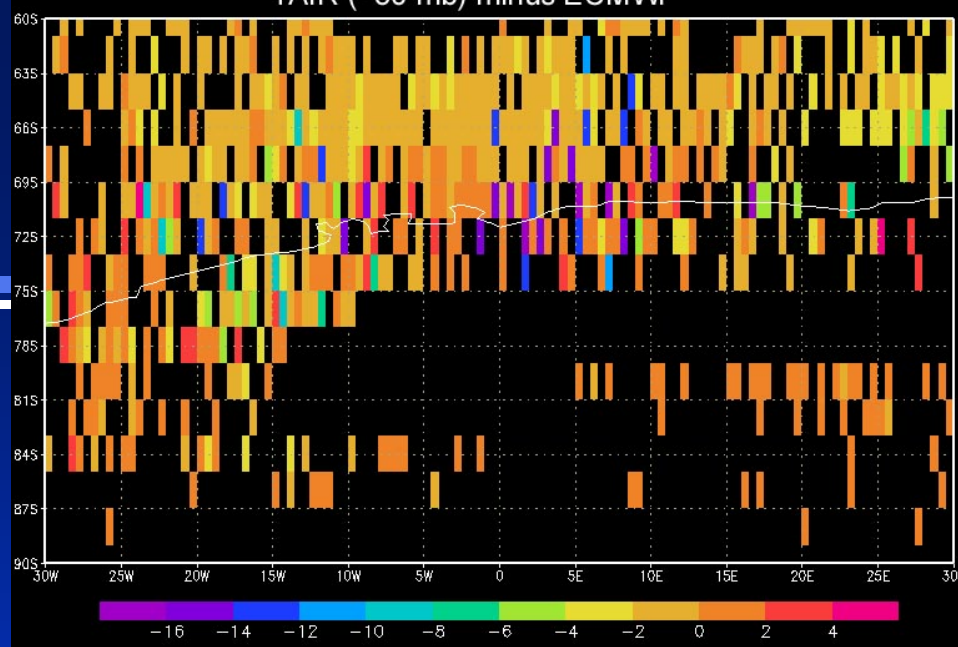
- Screen model data by requiring agreement between observed AIRS and model calculated AIRS
- Selected 12 channels
702.7 706.1 711 712.7 715.9 724.8
746.0 759.57 965.4
1468.83 1542.35 1547.88
- All channels < 2 K
- Coefficient generated used 5 days of data



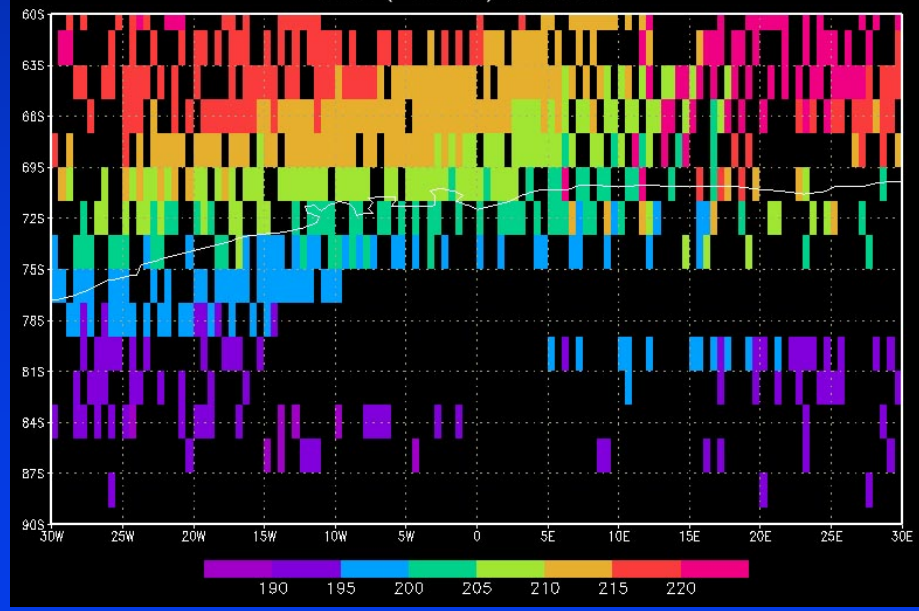
TAIR (~30 mb) (white is full population, green is screened (m-c))



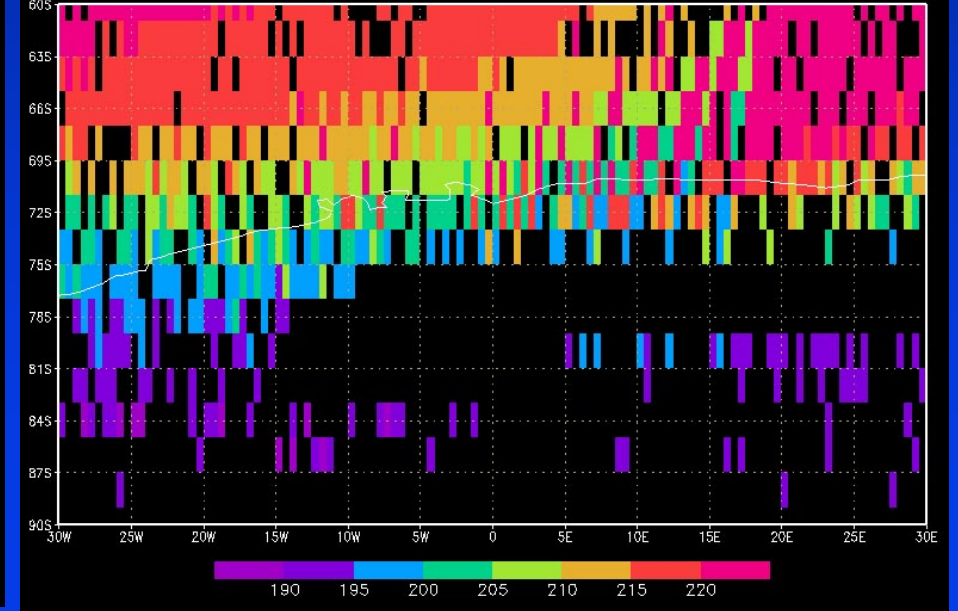
TAIR (~30 mb) minus ECMWF



TAIR (~30 mb) retrieval



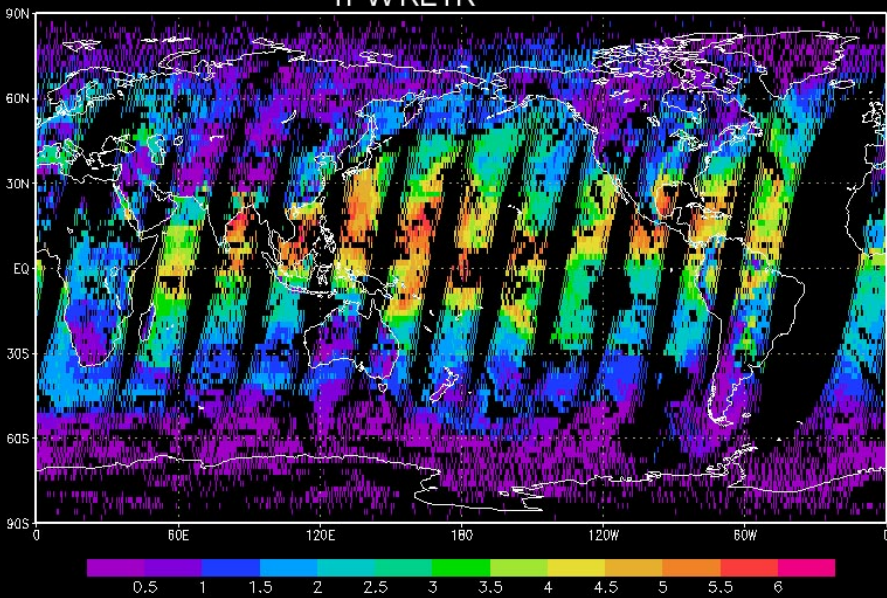
TAIR (~30 mb) ECMWF



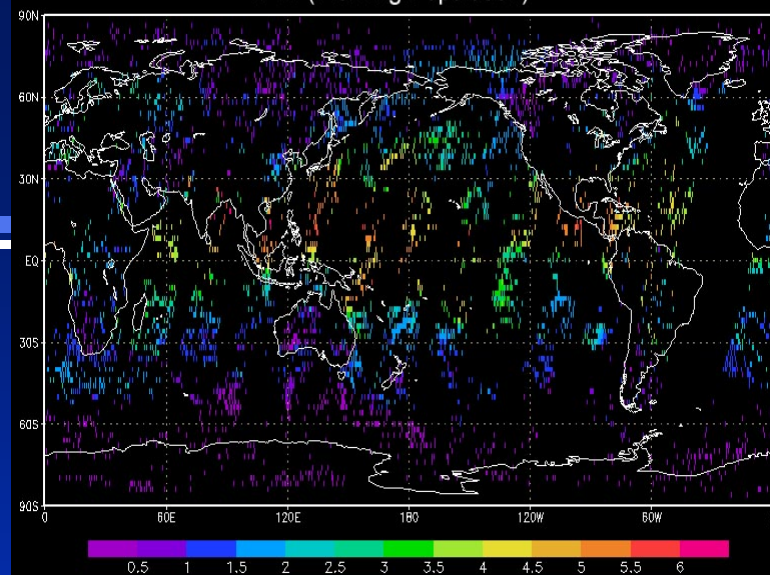
Ocean – screened (sdv 0.32 cm, mean 2.53 cm, 12.6%)

Ocean – all (sdv 0.42 cm, mean 2.63 cm, 16%)

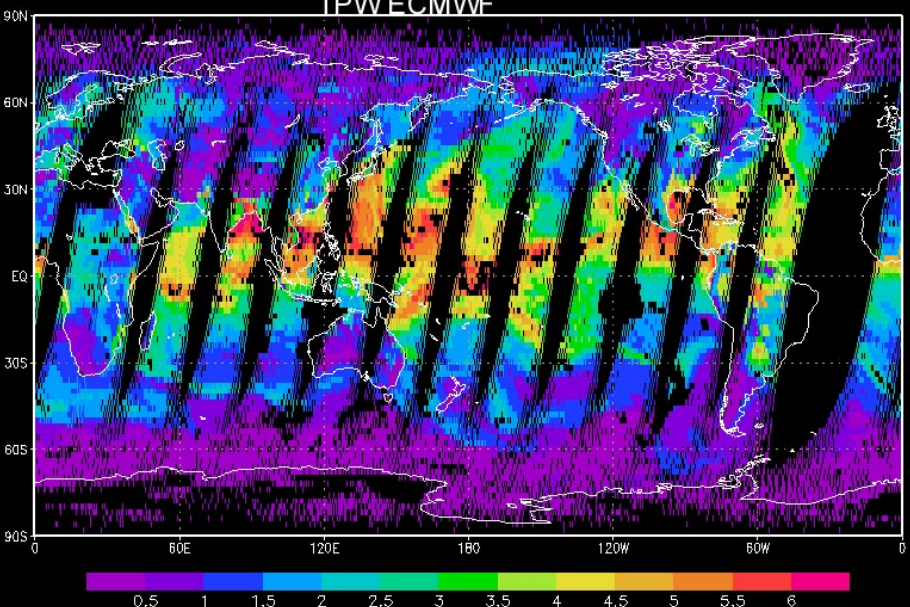
TPWRETR



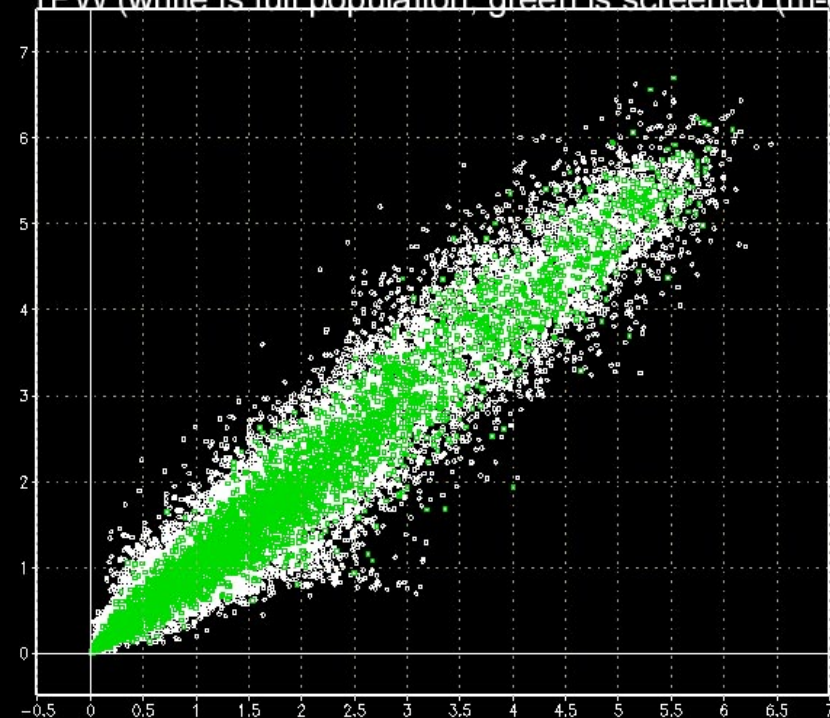
TPW (Training Population)



TPWECMWF

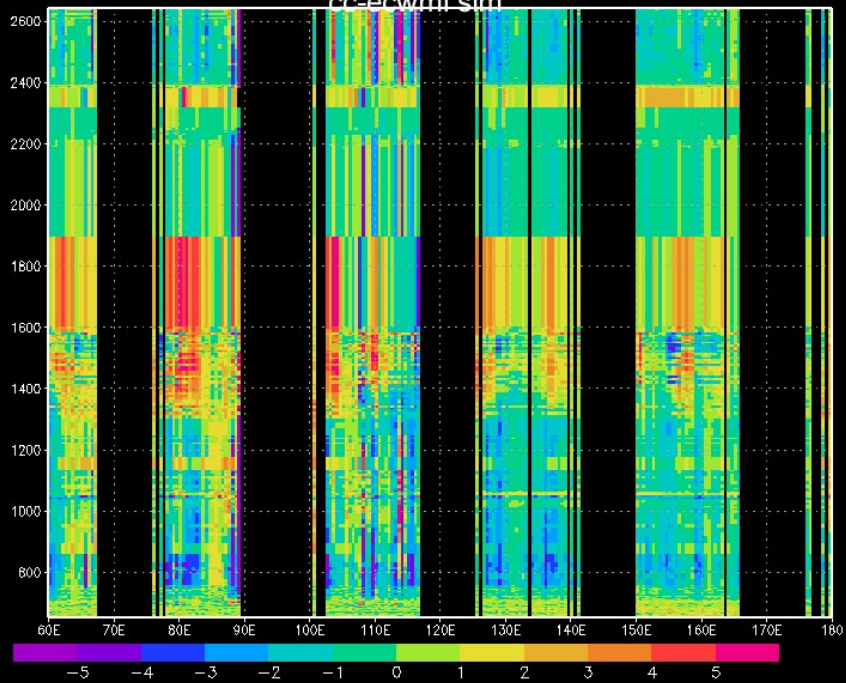


TPW (white is full population, green is screened (m-c))

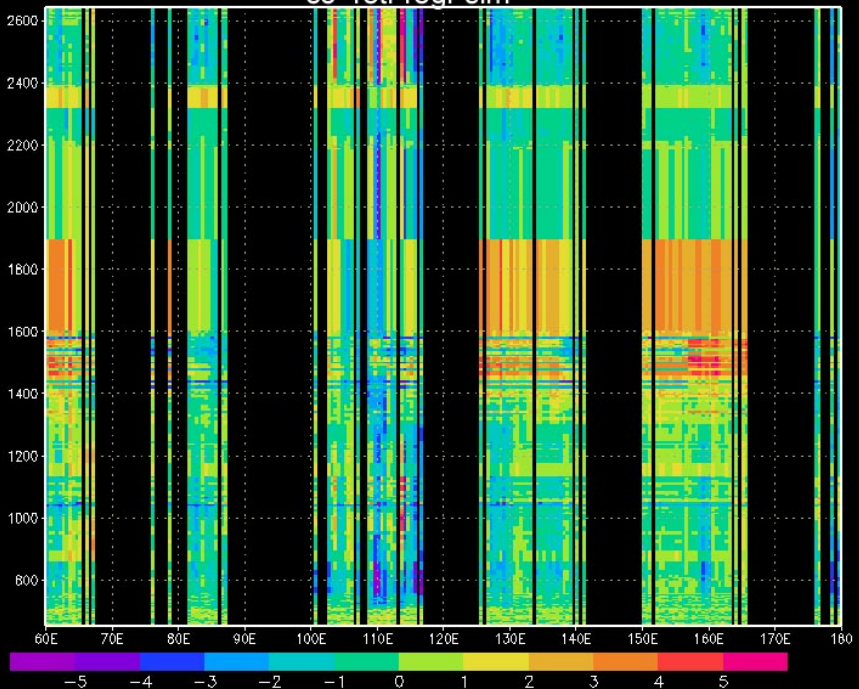




cc-ecwfmf sim



cc- retr regr sim



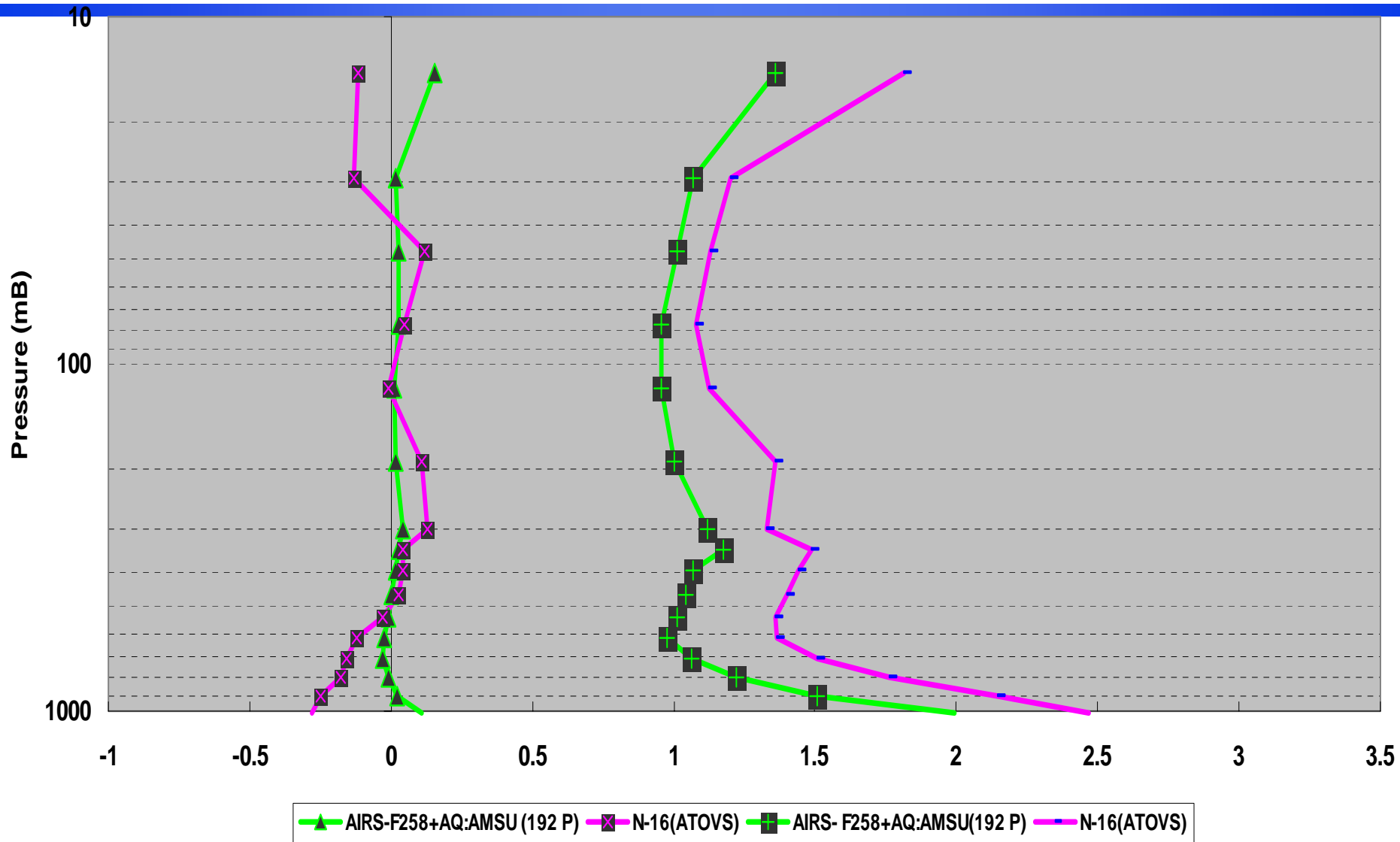
lat 0 , lon 102 white = cc-ecsim green = cc-retrgrsim



Temperature Bias and RMS (Land and Sea Samples) With Cloud Test



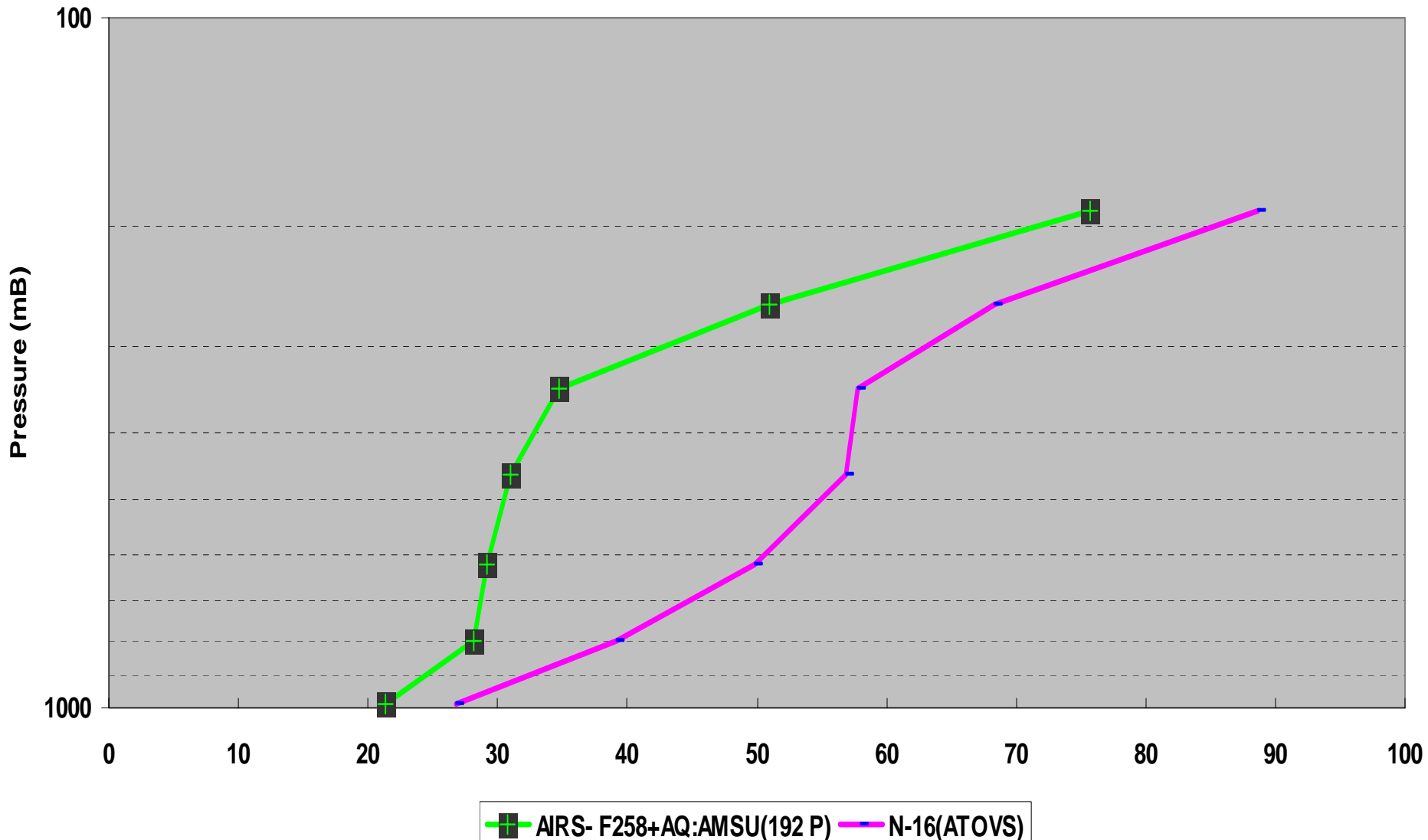
Bias and RMS (Deg. K), NSAMP=8238 COLLOCATED RADIOSONDES



Water Vapor Error (Land and Sea Samples) With Cloud Test

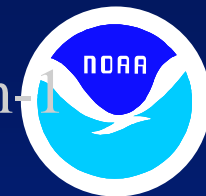


% Error , NSAMP = 8238 COLLOCATED RADIOSONDES

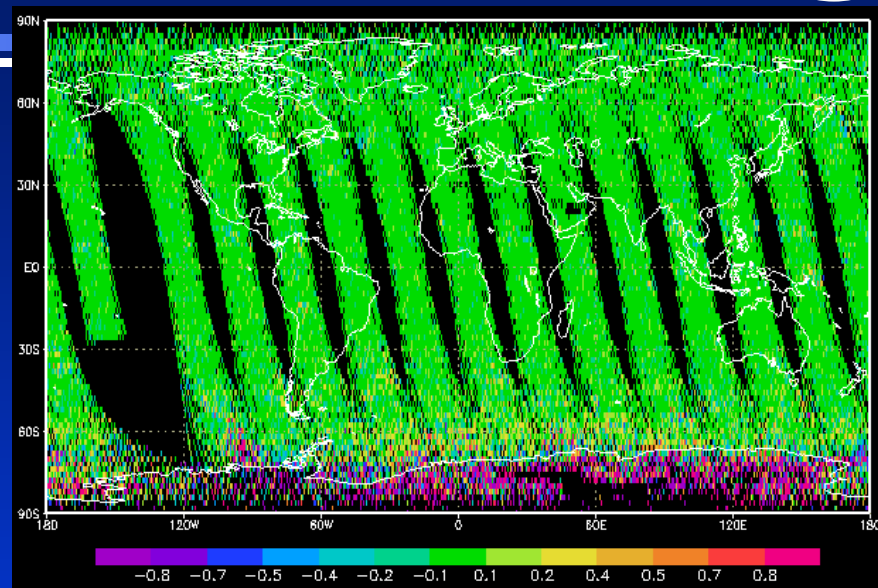
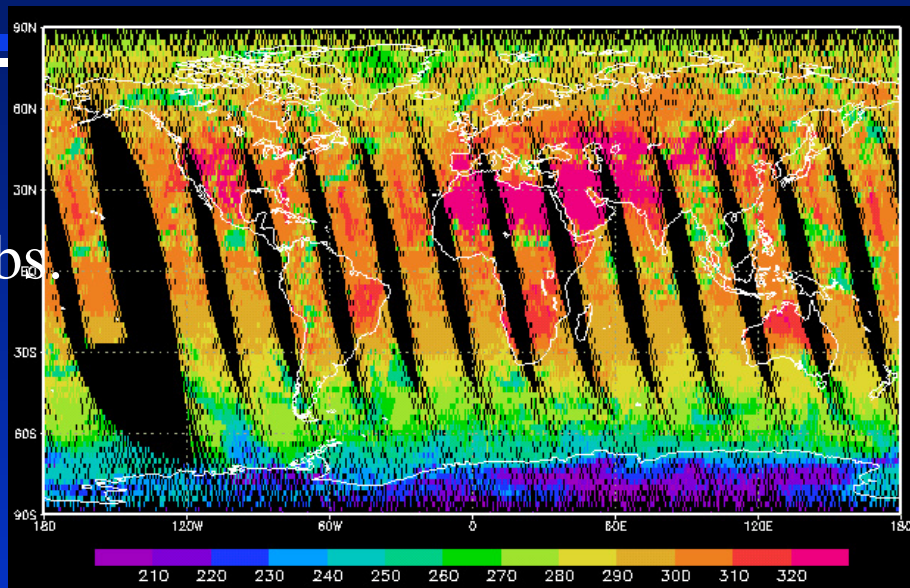


Are there benefits to use reconstructed data???

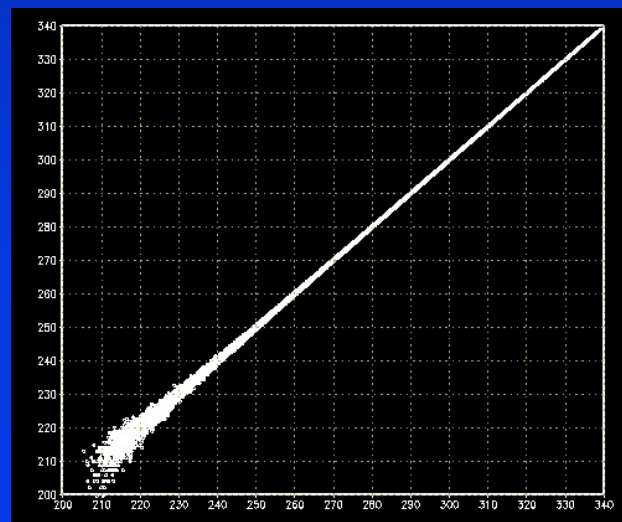
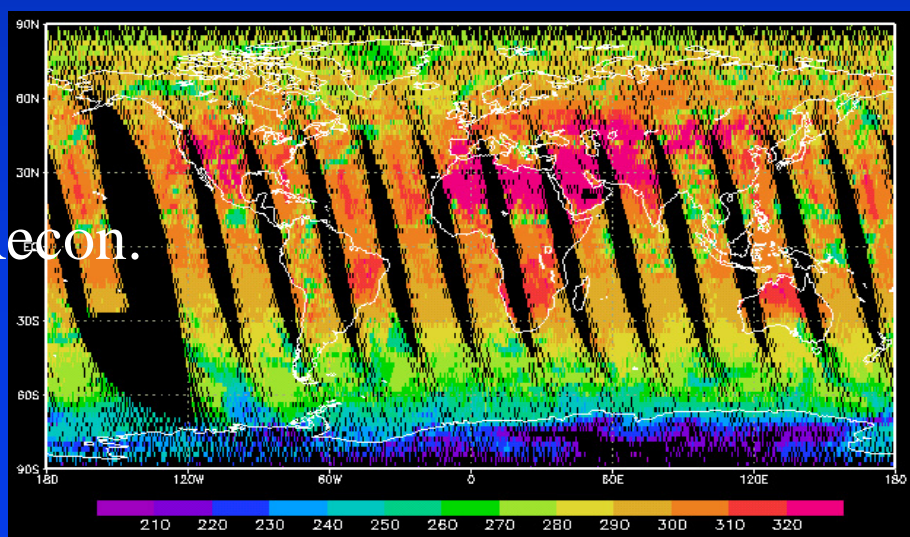
Example of reconstructed brightness temperatures for 2616 cm⁻¹



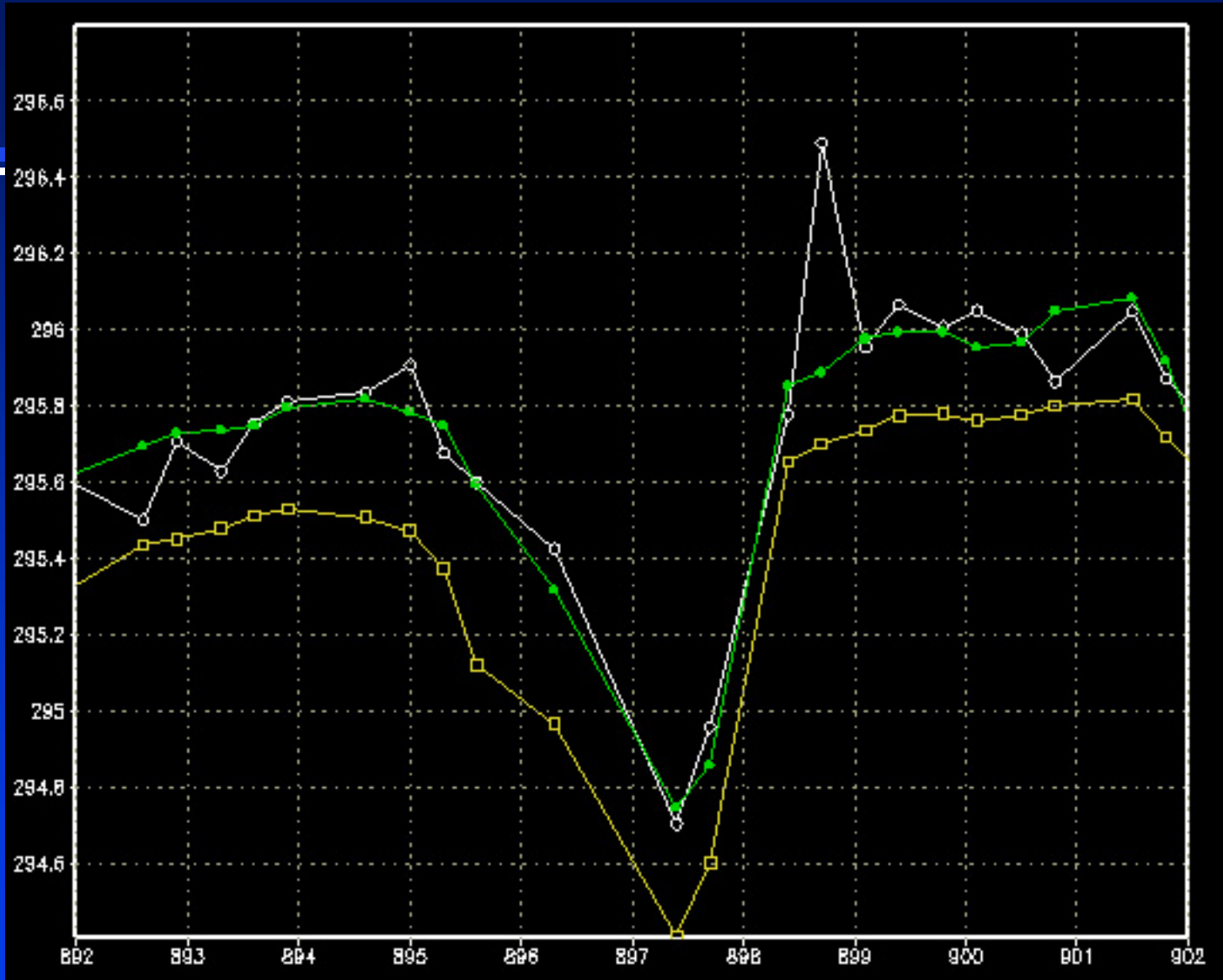
Obs.



Recon.



Spectrum from 892 to 902 wavenumber



Green is reconstructed, white is original, yellow is calculated from model



Summary – Encourage!!!

- Reconstructed radiances
- Cloud-cleared radiances
- Cloud-contaminated radiances
- Geophysical Retrievals



Plans for IASI and CrIS

- Our AIRS processing system will be adapted for IASI and CrIS.
- Similar geophysical and radiances products will be available.
- We are also actively conducting research to produce trace gas products (CO, CO₂, CH₄) from AIRS, IASI and CrIS



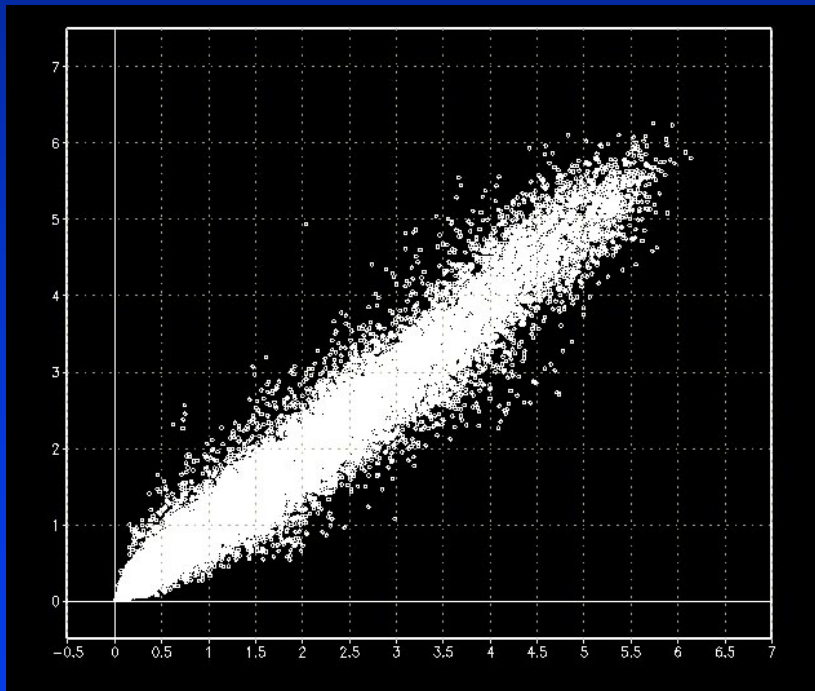
Backup

TPW Jan 20, 2003

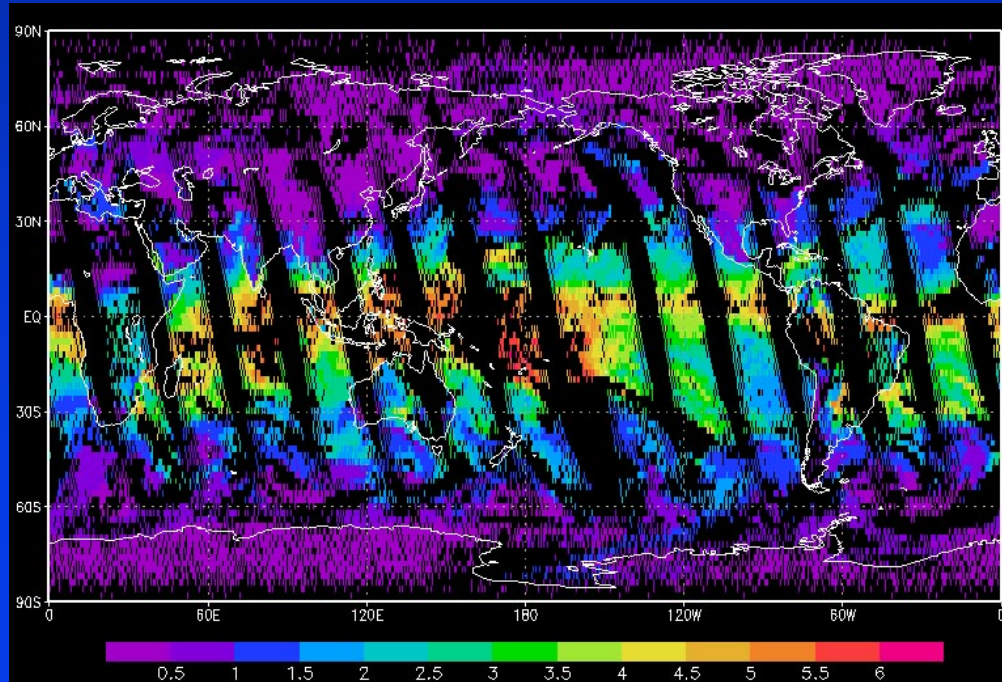
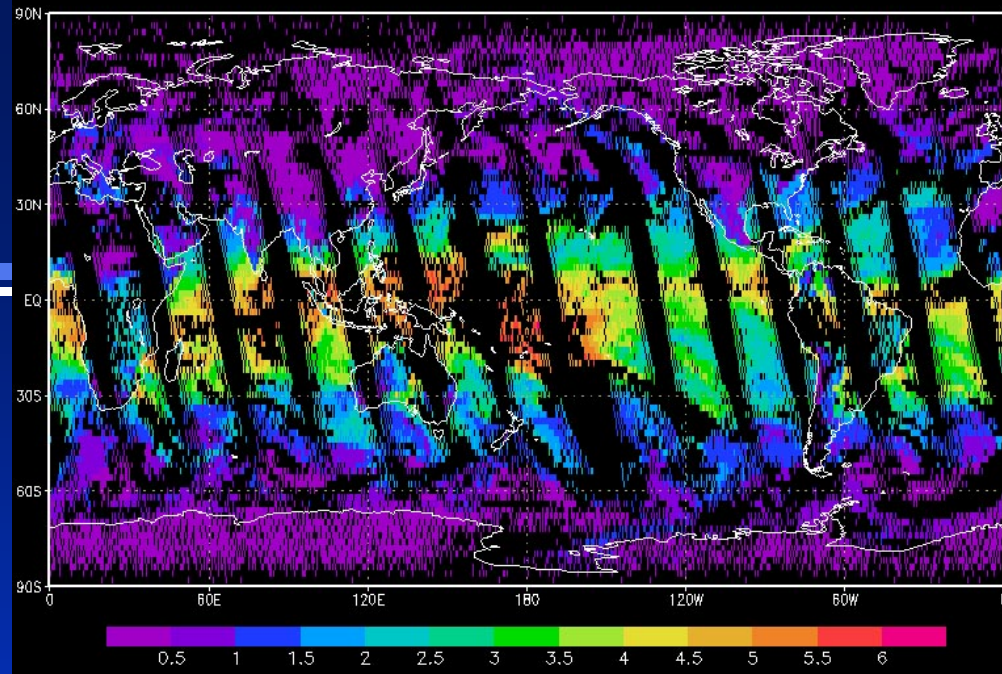
Retr >>>>

Mean diff $-.03$, std = $.29$

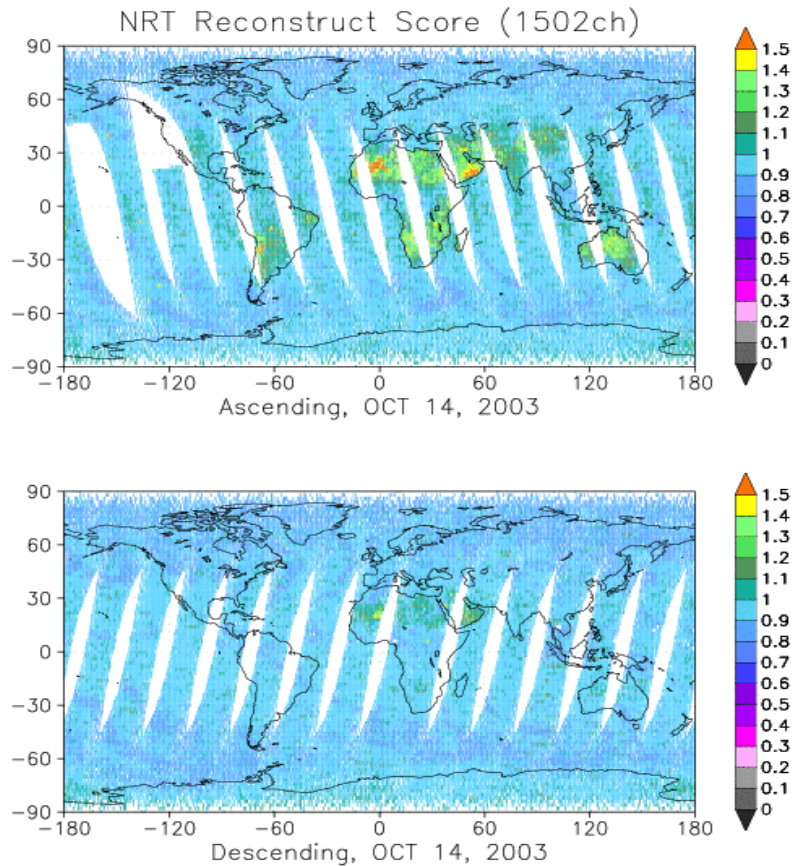
Mean totw = 1.44



retr

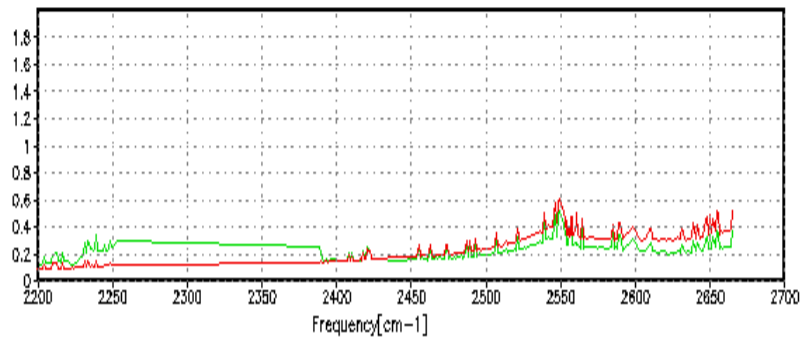
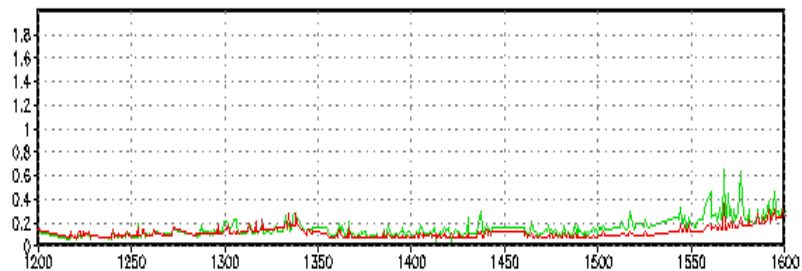
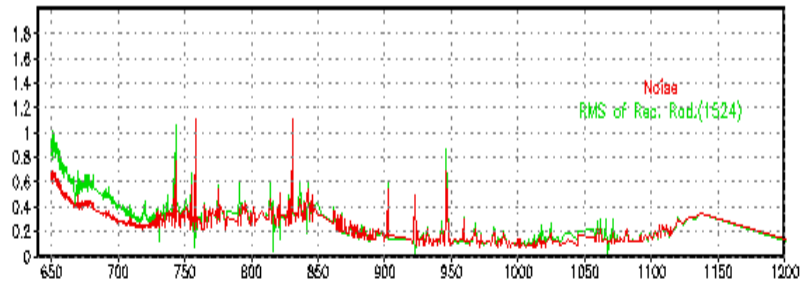


Radiance Reconstruction Scores Predominantly < 1

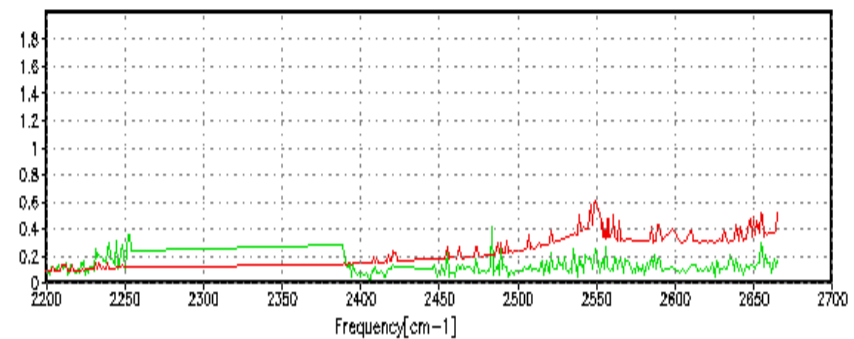
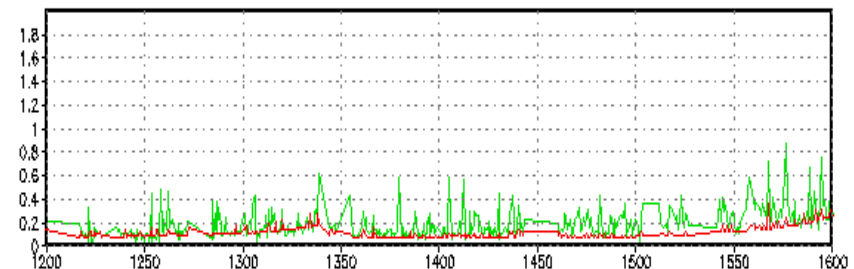
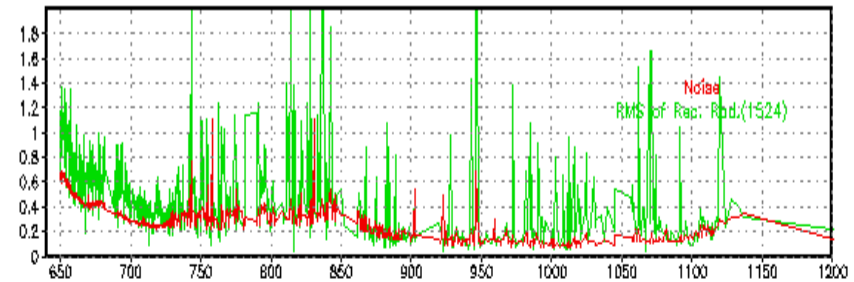


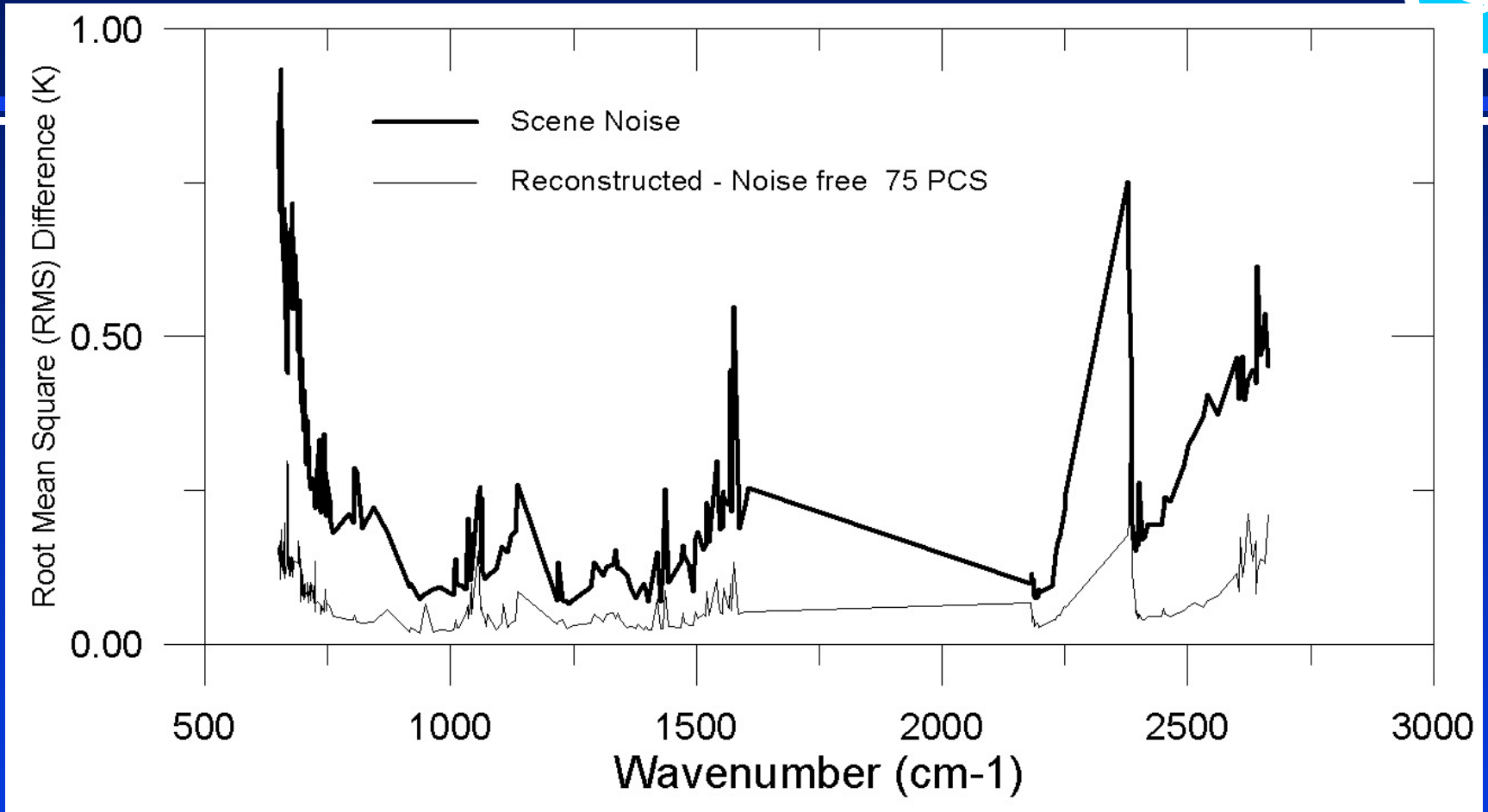
- Reconstruction scores > 1 are over hot ground, however because the nonlinearity of Planck function, these are region which has the best brightness temperature reconstructions.

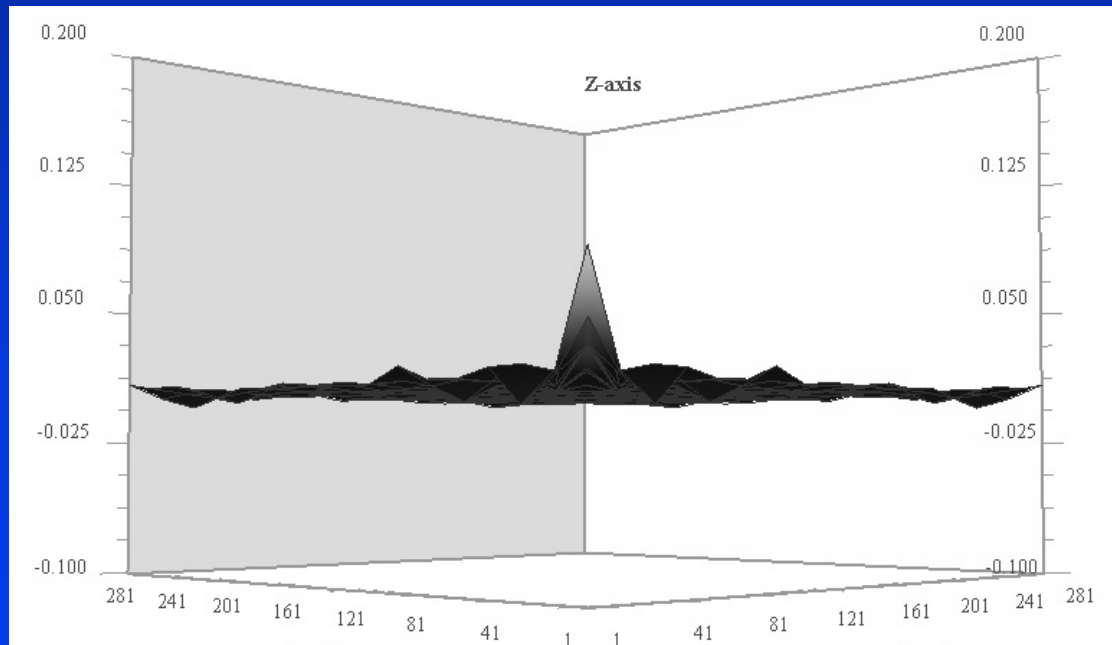
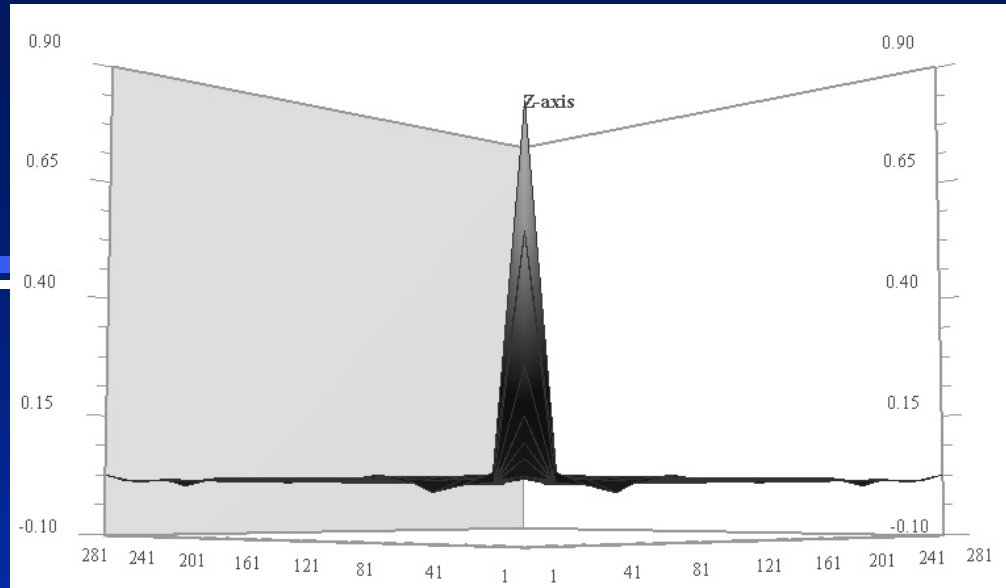
Ascending FEB 21, 2003, $0 < \text{score} < 1$, sample: 41323 (87.532%)



Descending FEB 21, 2003, $1.5 < \text{score} < 2.0$, sample: 8 (0.0170311%)

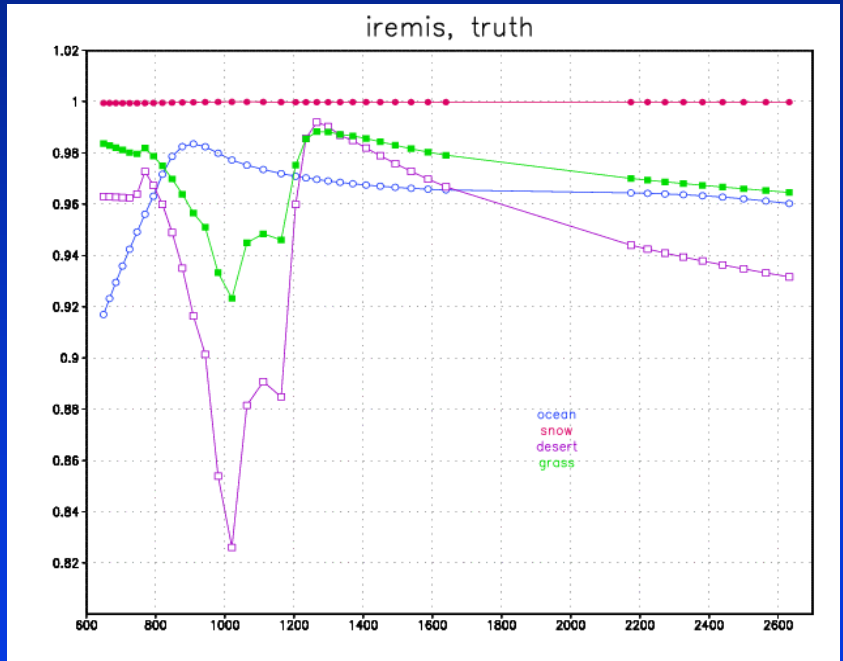
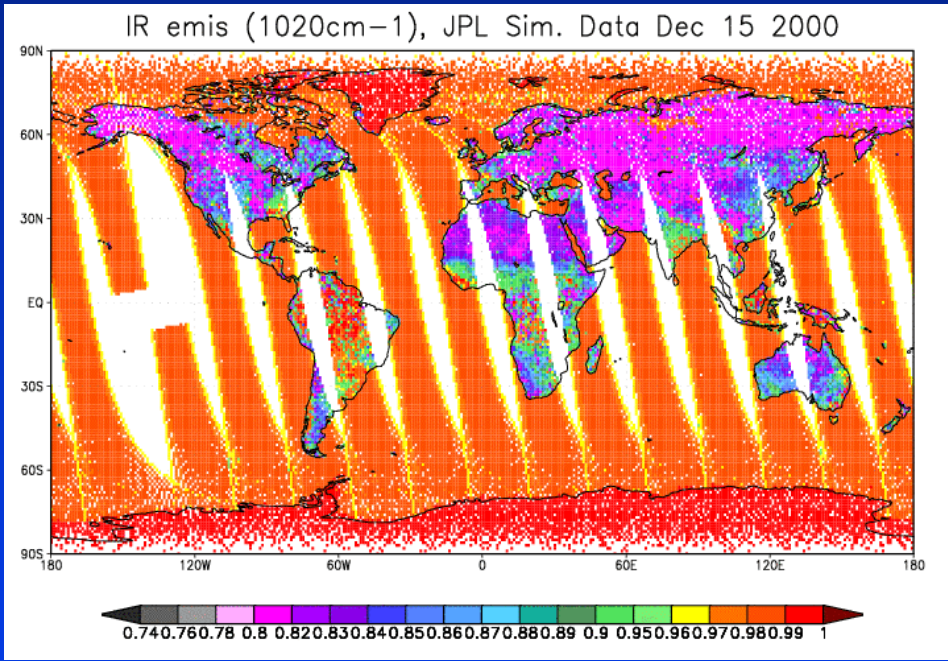








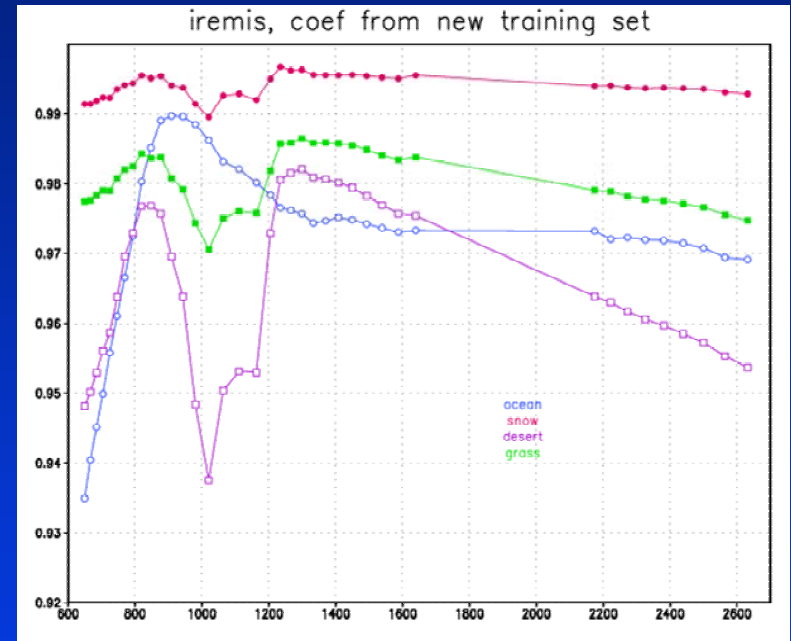
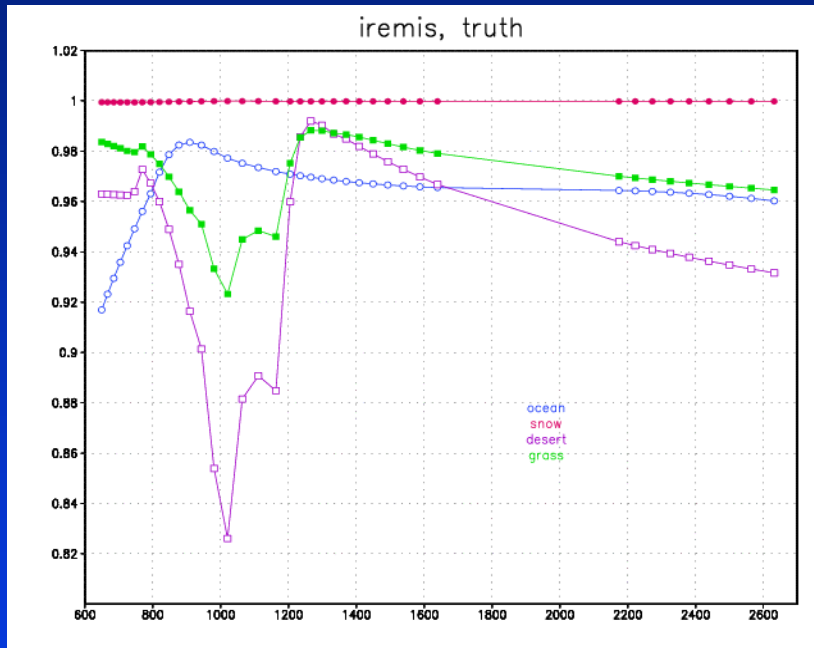
Emissivity from Simulation





IR Emissivity Results

Mean emissivity spectra as a function cloud cleared radiances for 4 different surface types



Ocean = average between 50 S- 50 N

Snow = 90S-80S

Desert = 0- 30E, 25-29N

Grass = 90W-80W, 30N-40N