The assimilation of AMSU-B radiances in the CMC global data assimilation system; their difficulties relative to AMSU-A radiances and their impact

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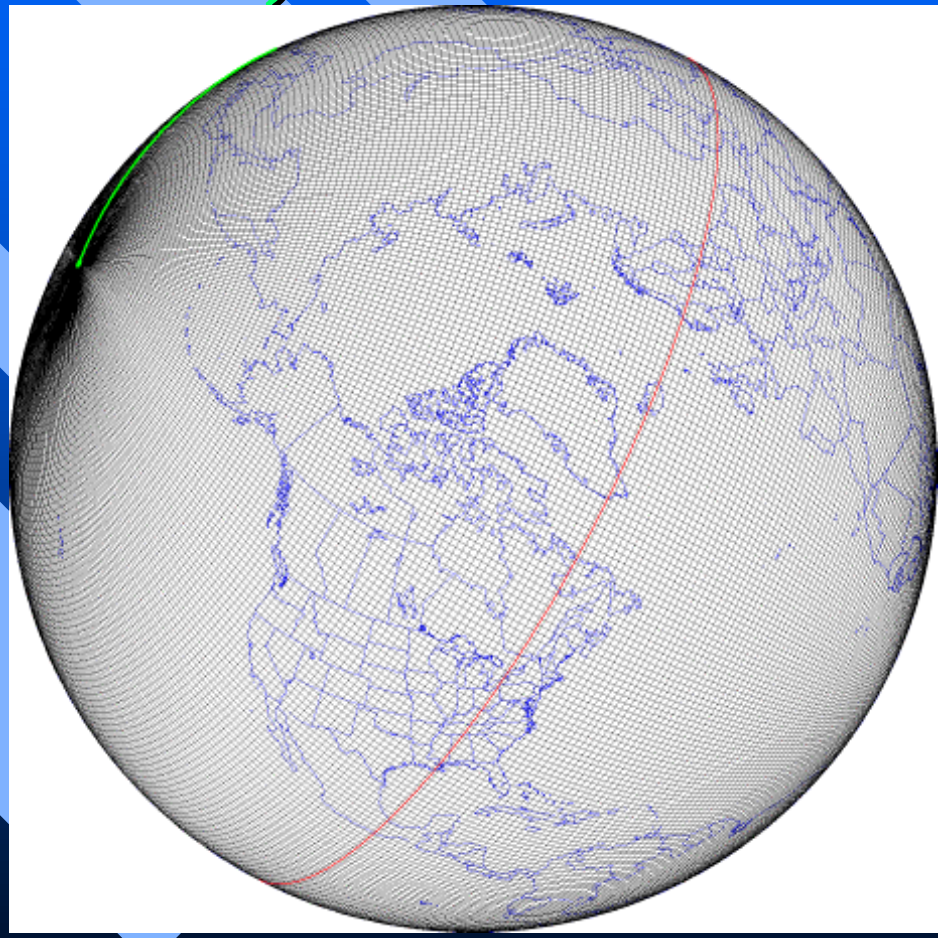
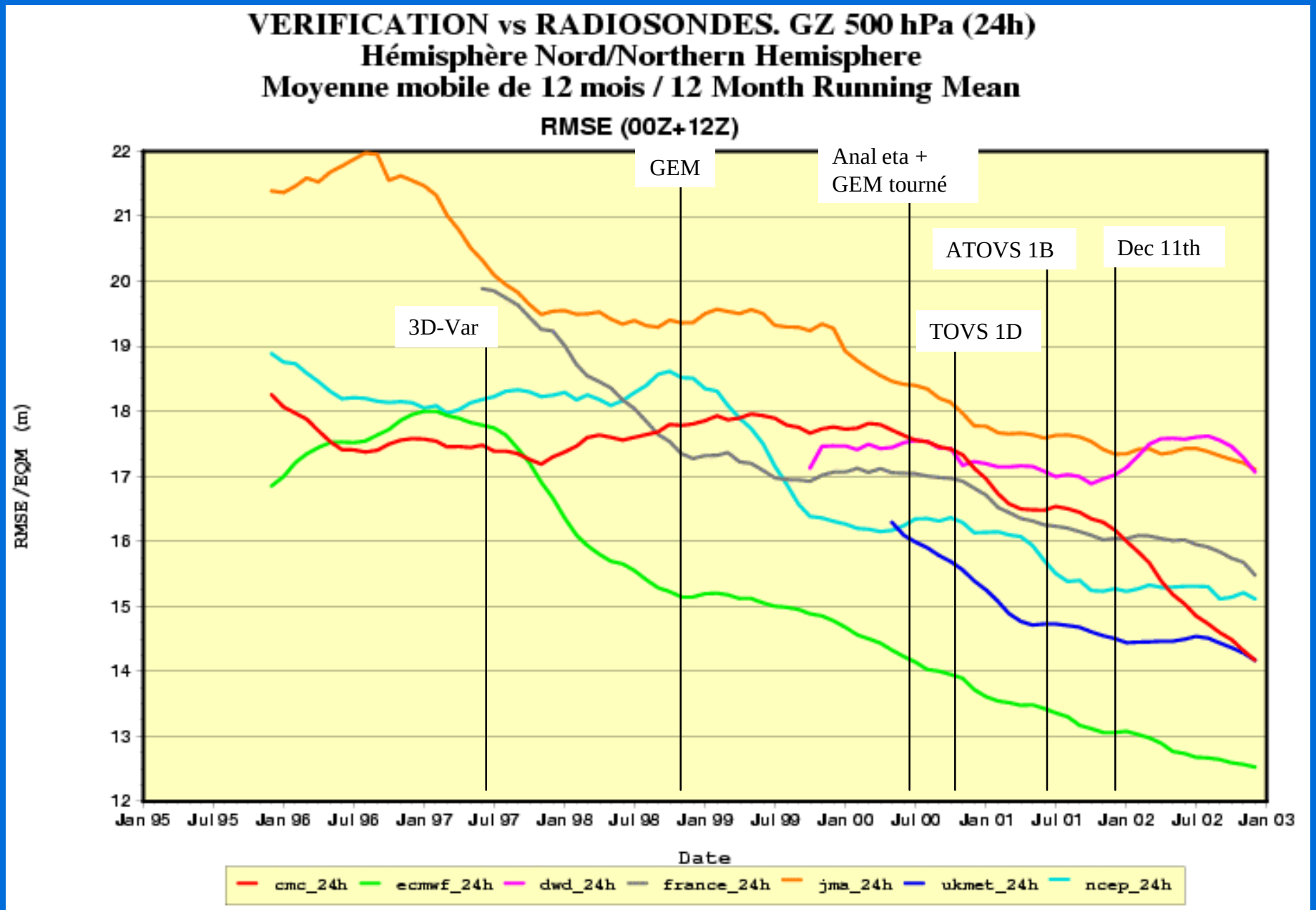
Medium- and long-range forecasts by the global version of the GEM (Global Environmental Multiscale) model

- uniform 0.9 degree lat-lon grid
- 28 *h* levels in vertical
- forecast to 144 h (12 UTC)
- forecast to 240 h (00 UTC),
- forecast to 360 h (Saturdays only)
- Operational since Oct. 14 1998



Comparison of the CMC 24h 500 hPa GZ to other NWP Centres Northern Hemisphere



3D-Var moisture analysis (Pre-AMSU-B)

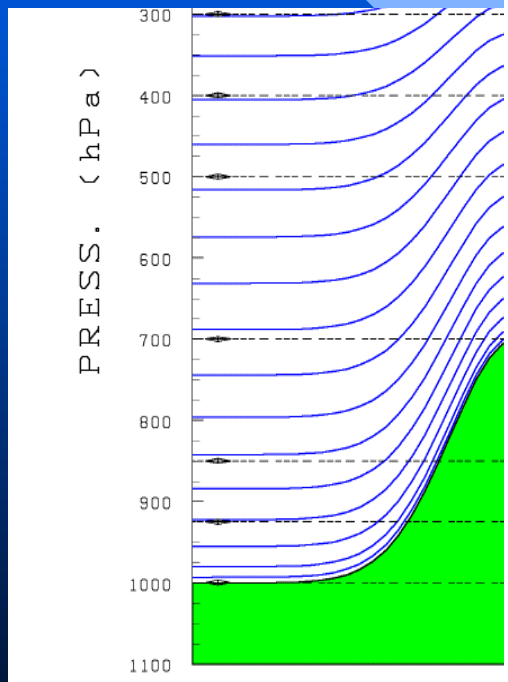
- direct assimilation of surface T, T-Td and ps
- RAOB T, T-Td, and winds at 27 levels
- added 3 ATOVS/AMSU-A (channels 3-5)
  - assimilated HUMSAT derived profiles of T-Td

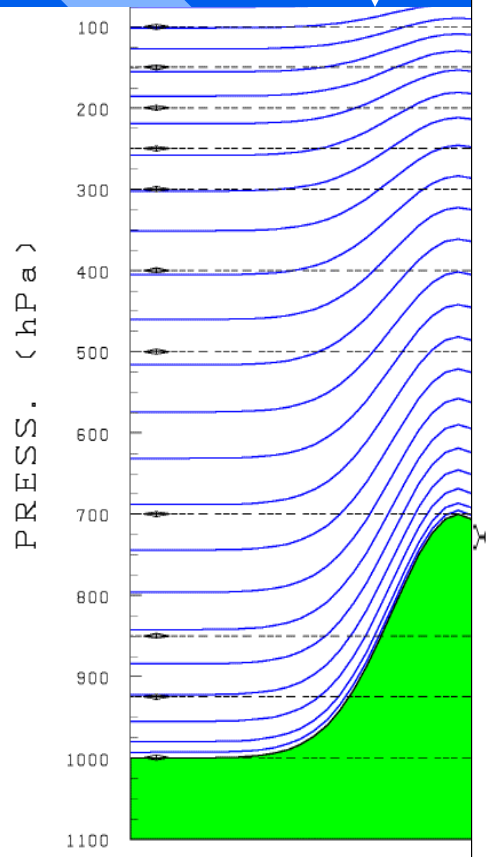
Preparation of 3D-Var; raising the humidity analysis top

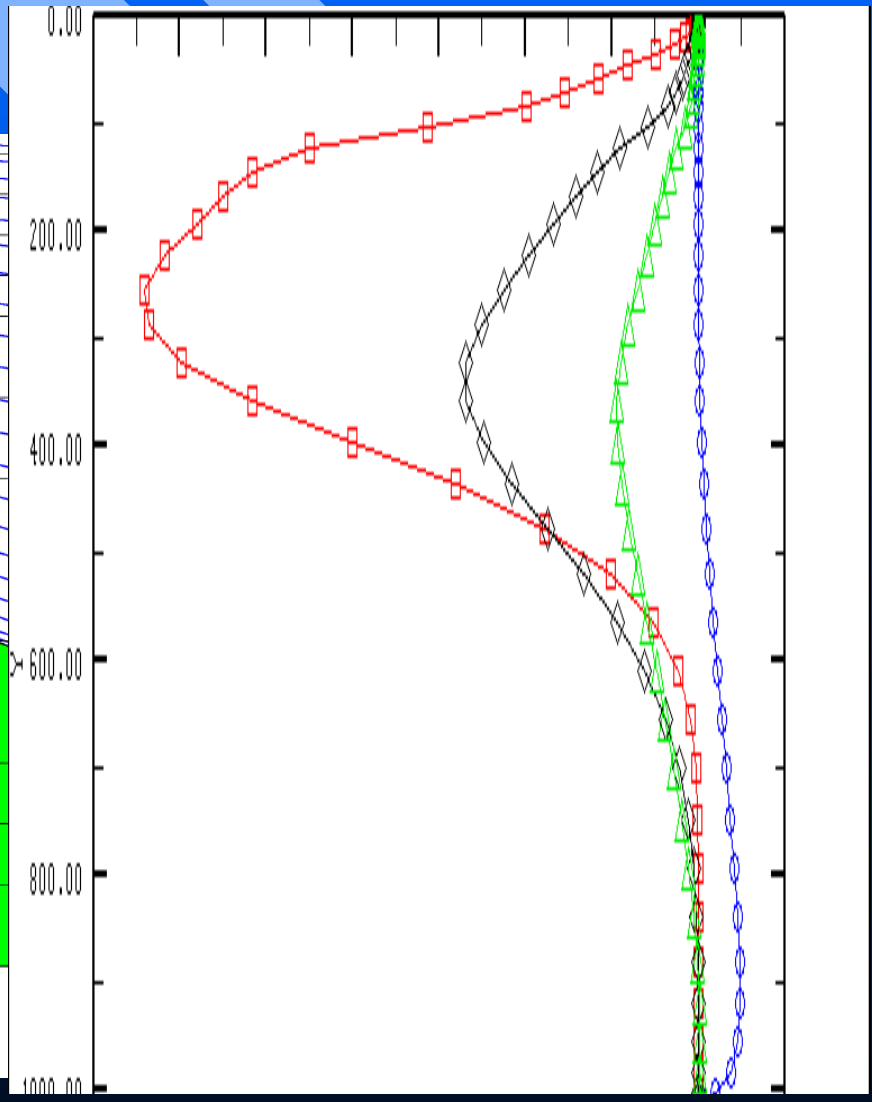
Operational

New

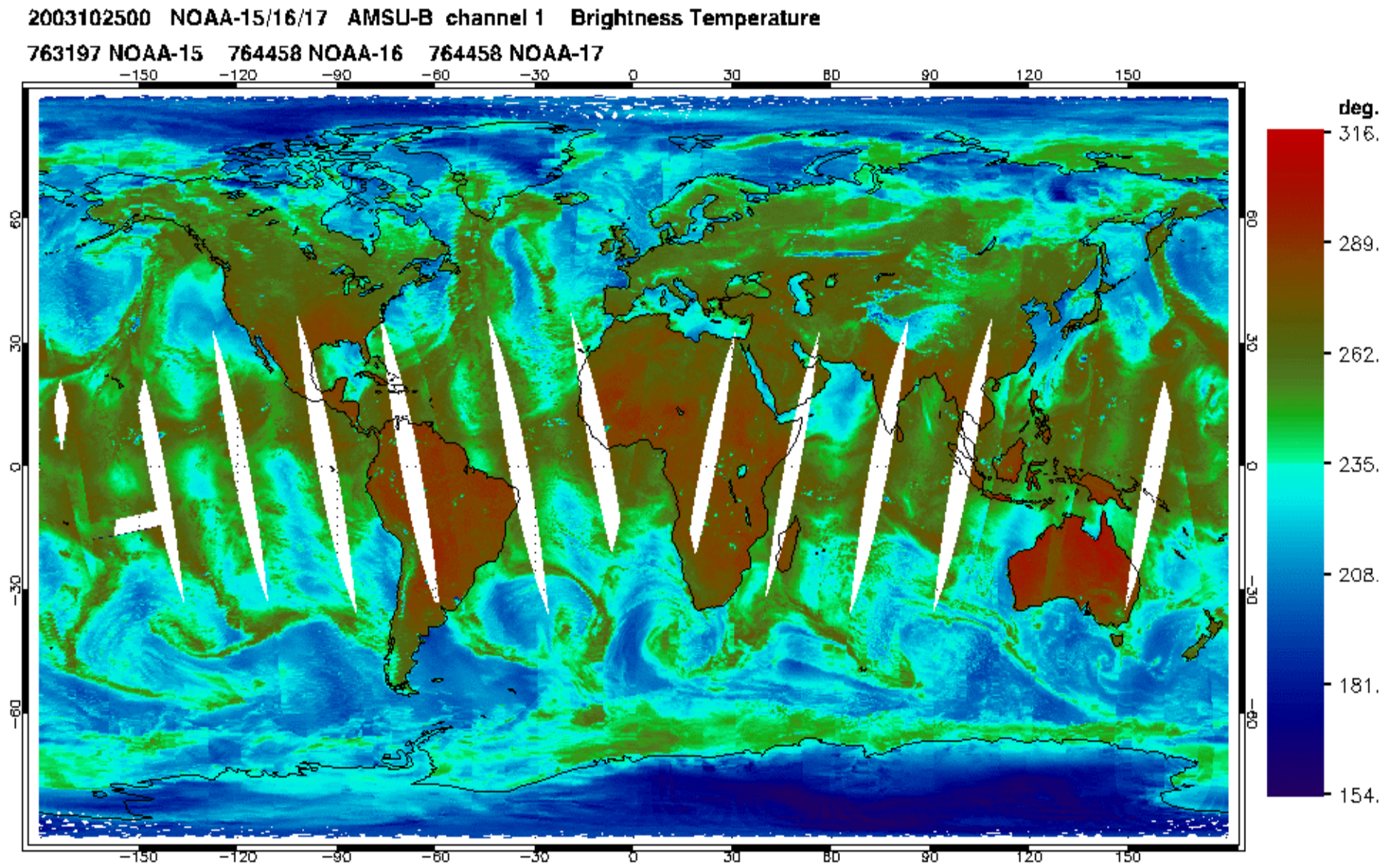
Sensitivity to lnq



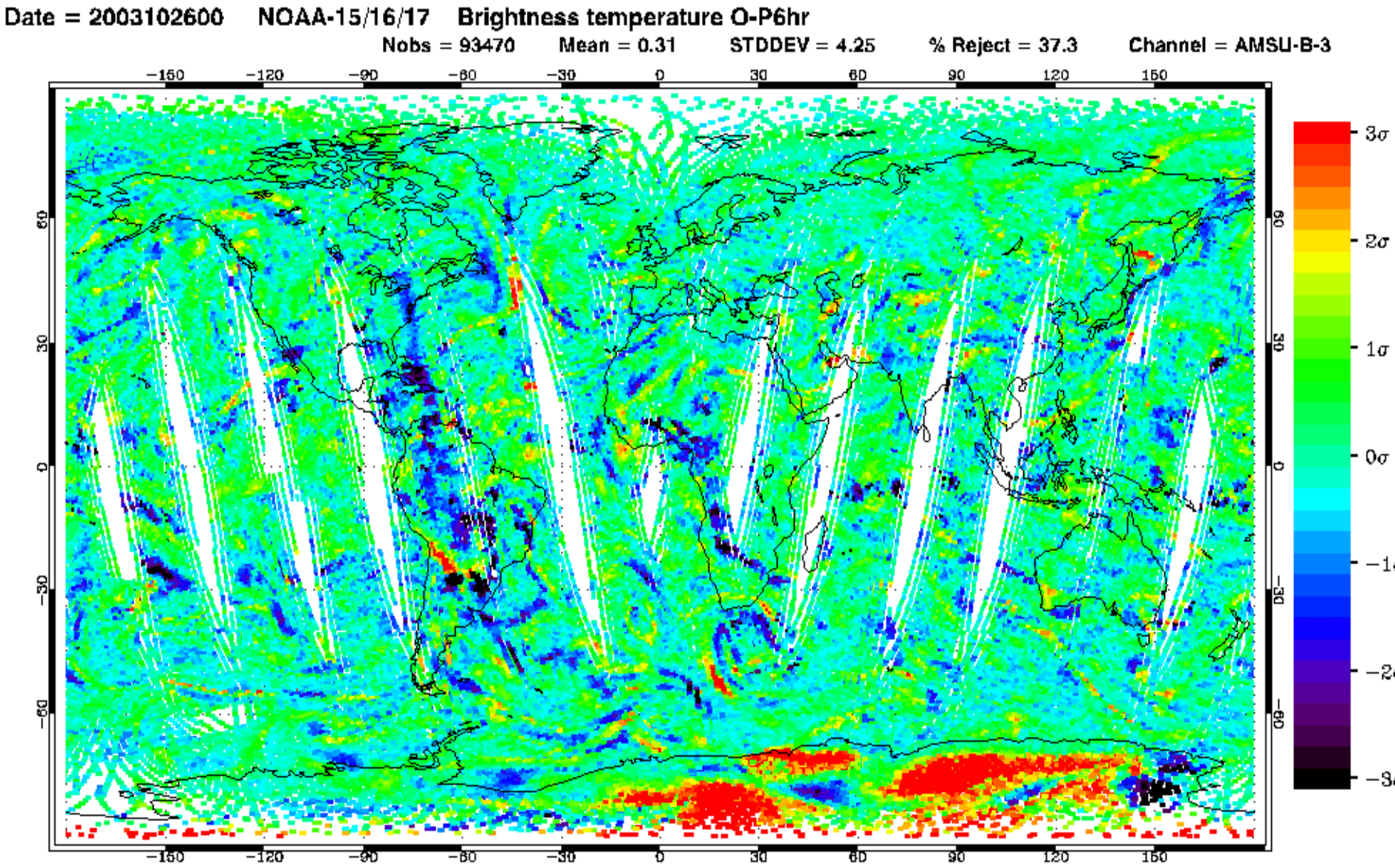




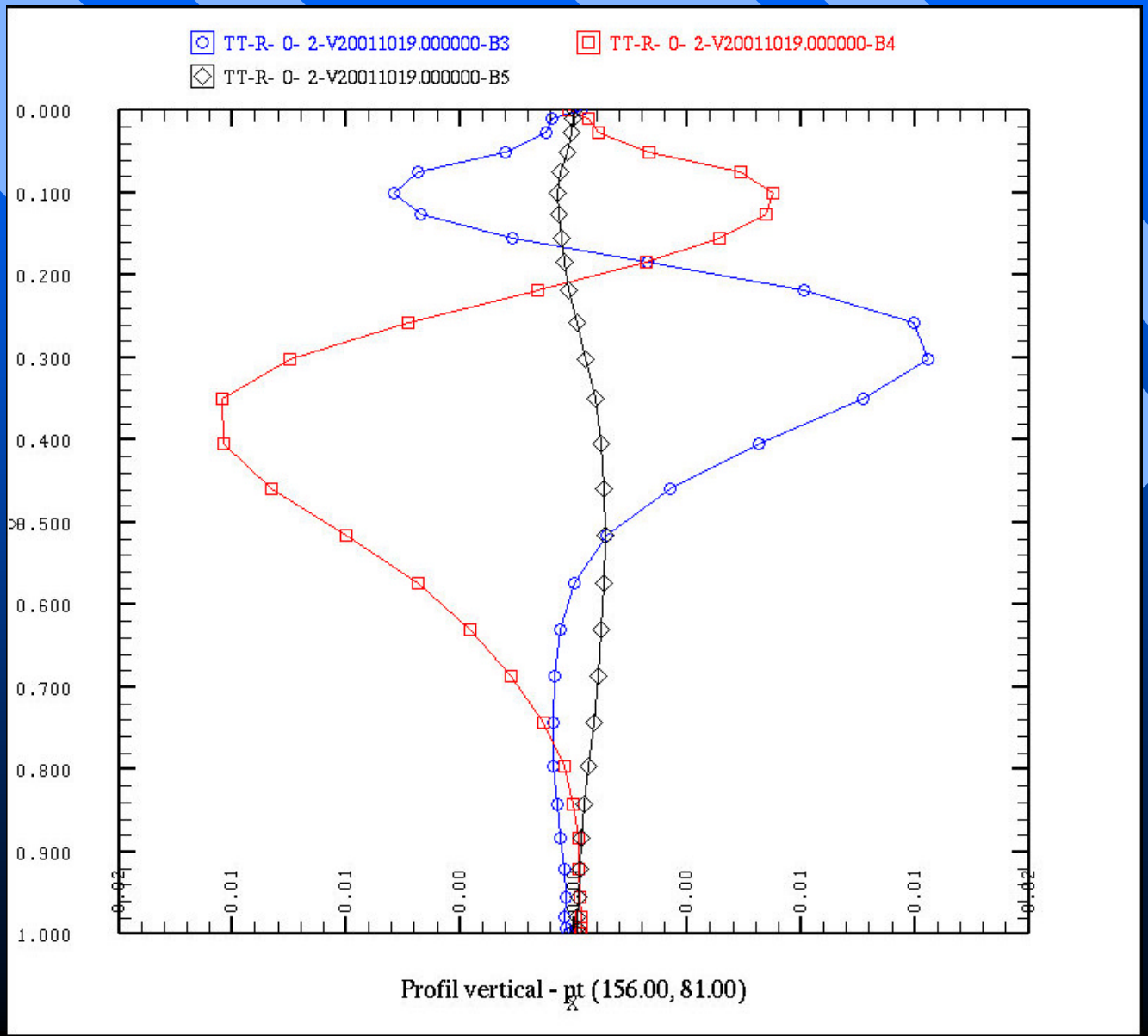
Coverage of AMSU-B radiances (16 km footprint)



Full resolution Innovations (O-P)



Sensitivity of AMSU-B to temperature



Procedure for direct assimilation of (AMSU-A/B) radiances in 3D-Var

- choose radiances for which radiative transfer is appropriate
- correct systematic errors of the fast radiative transfer model
- carefully select radiances for land/sea/ice

  Example: land/ice; AMSU-A ch 6-10
  sea; AMSU-A ch 3-10
- QC and thin to equivalent NWP model resolution

Quality control - AMSU-A

-Gross check, i.e.. within physical limits.

-Grody cloud liquid water > 0.3 mm => AMSU-A 1-5, 15 rejected.

-Grody scattering index > 9 => AMSU-A 1-6, 15 rejected.

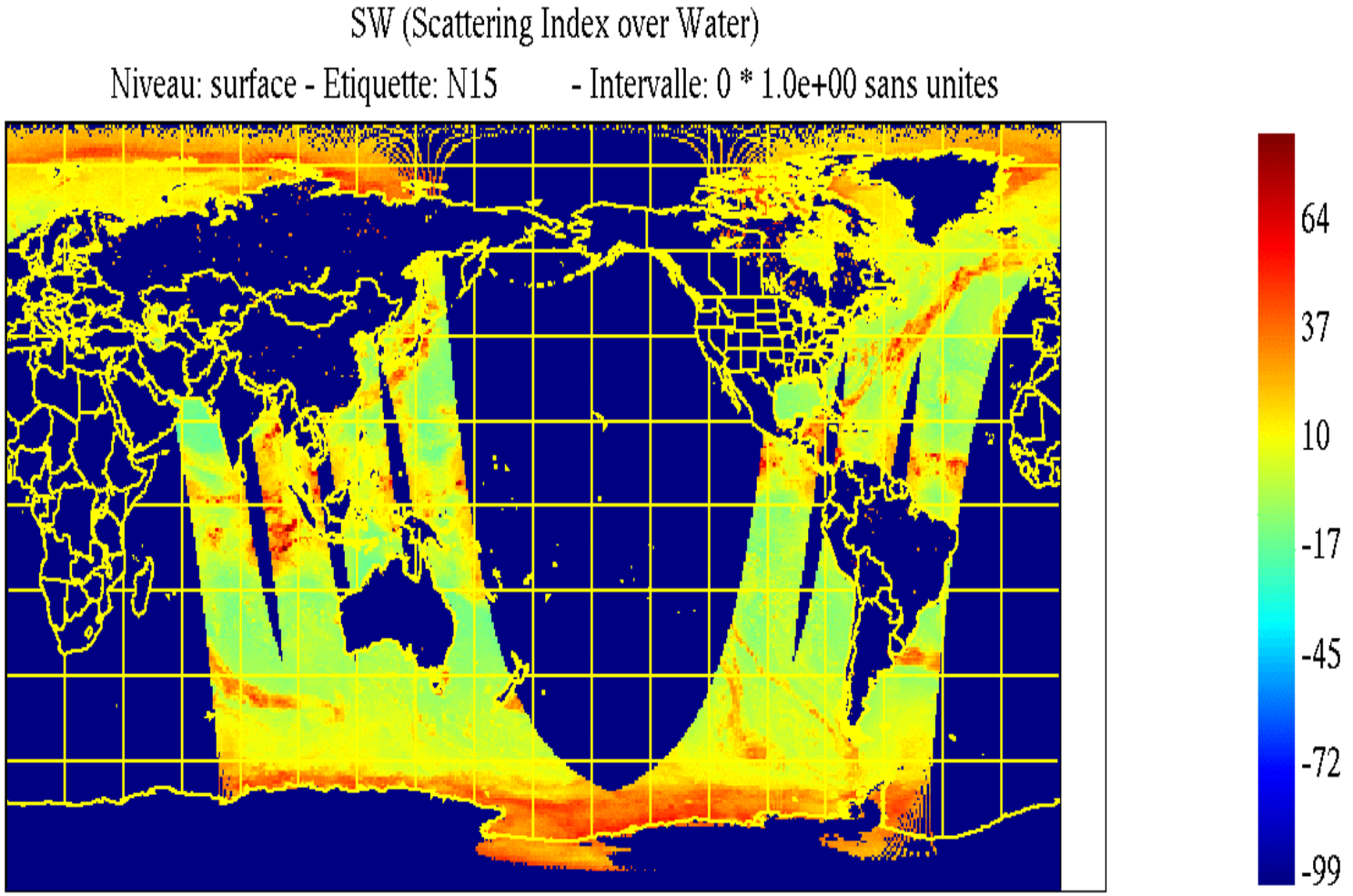
-Background check: (O-P) > $a\,s$, where s = error standard deviation
a = 4.0, except
= 3.0 for AMSU-A 3 and
= 2.0 for AMSU-A 1-2 and 15.

-Any background check reject of a surface channel eliminates AMSU-A 1-5, 15.

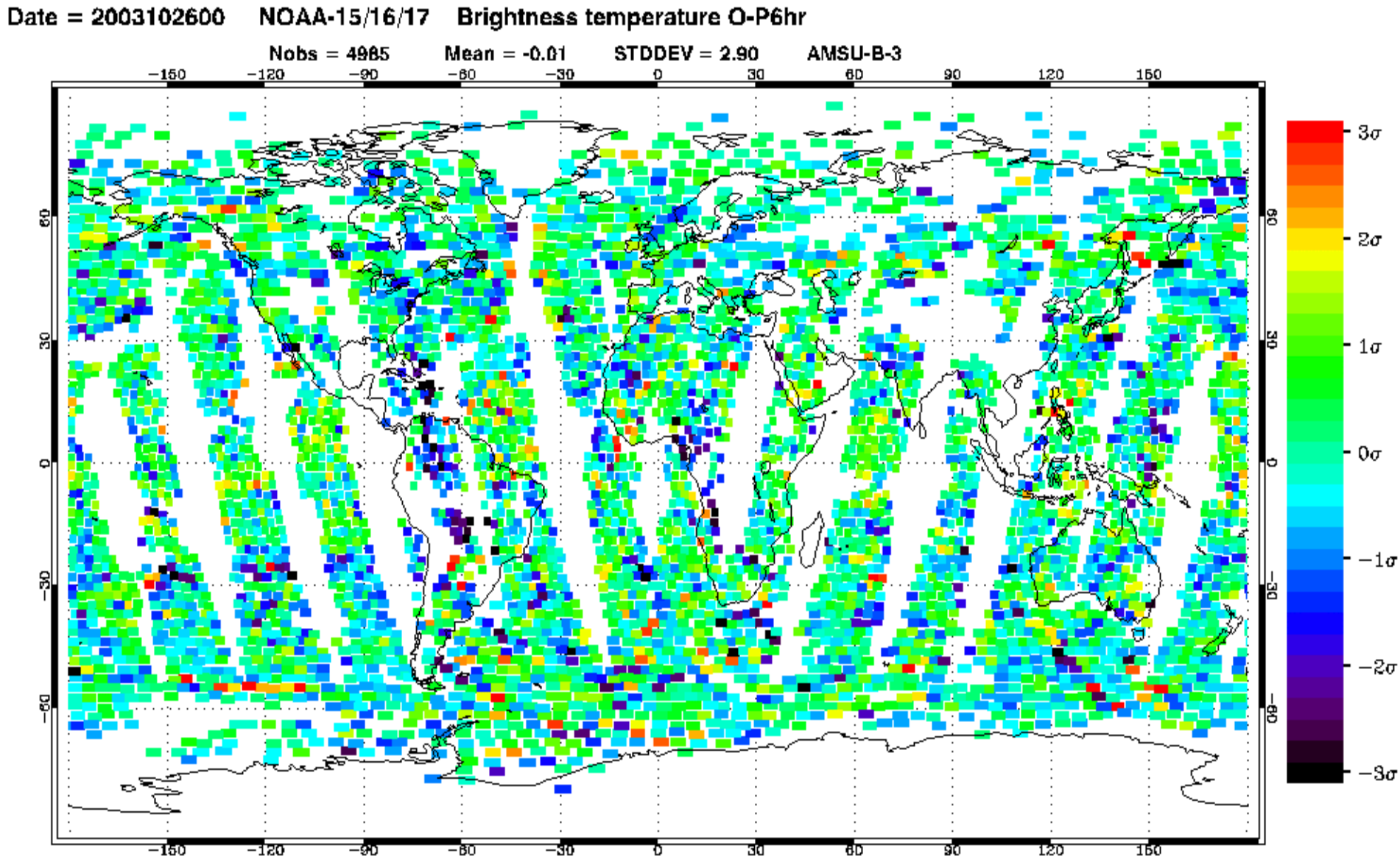
Quality control - AMSU-B (similar ones for AMSU-A)

12	Dryness index reject	Dryness index = Tb(AMSUB3) – Tb(AMSUB5) Reject if (dryness index) > 0 for AMSU-B 3, -10 for AMSU-B 4, -20 for AMSU-B 5	partial (AMSU-B 3-5)
13	Bennartz scattering index reject	Bennartz scattering index> 40 over sea-ice, or 15 over sea, or 0 over land.	full
14	innovation rogue check failure	*(y-H(x))> a*(total error)*, where α=2 for AMSU-B 1, =3 for AMSU-B 2 =4 for AMSU-B 3-5	single

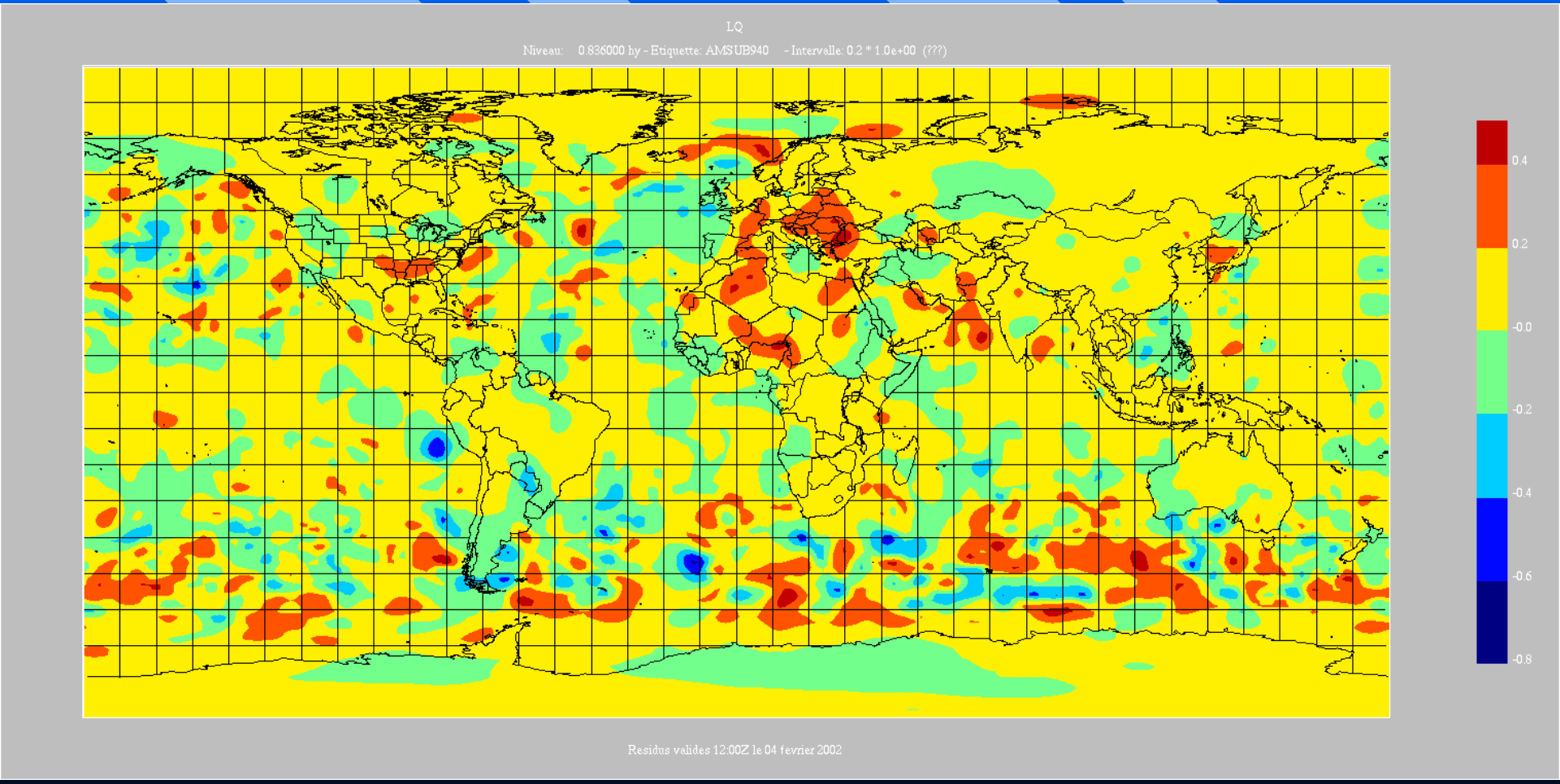
Scattering Index (Bennartz) to detect precipitation areas



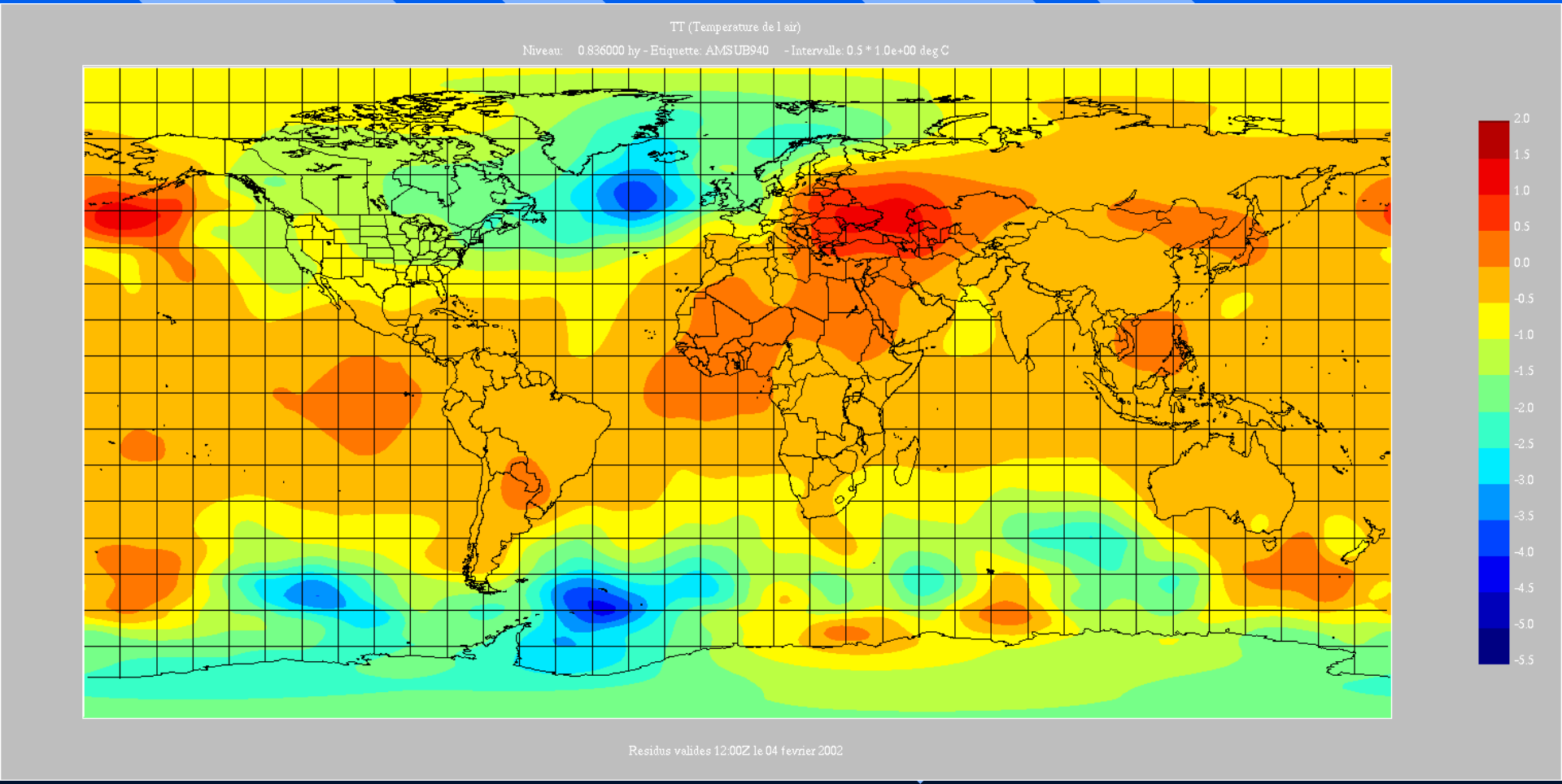
Final innovations (O-P) at analysis grid resolution



First analysis tests; AMSU-B data only
Moisture (lnq) corrections at 836 hPa

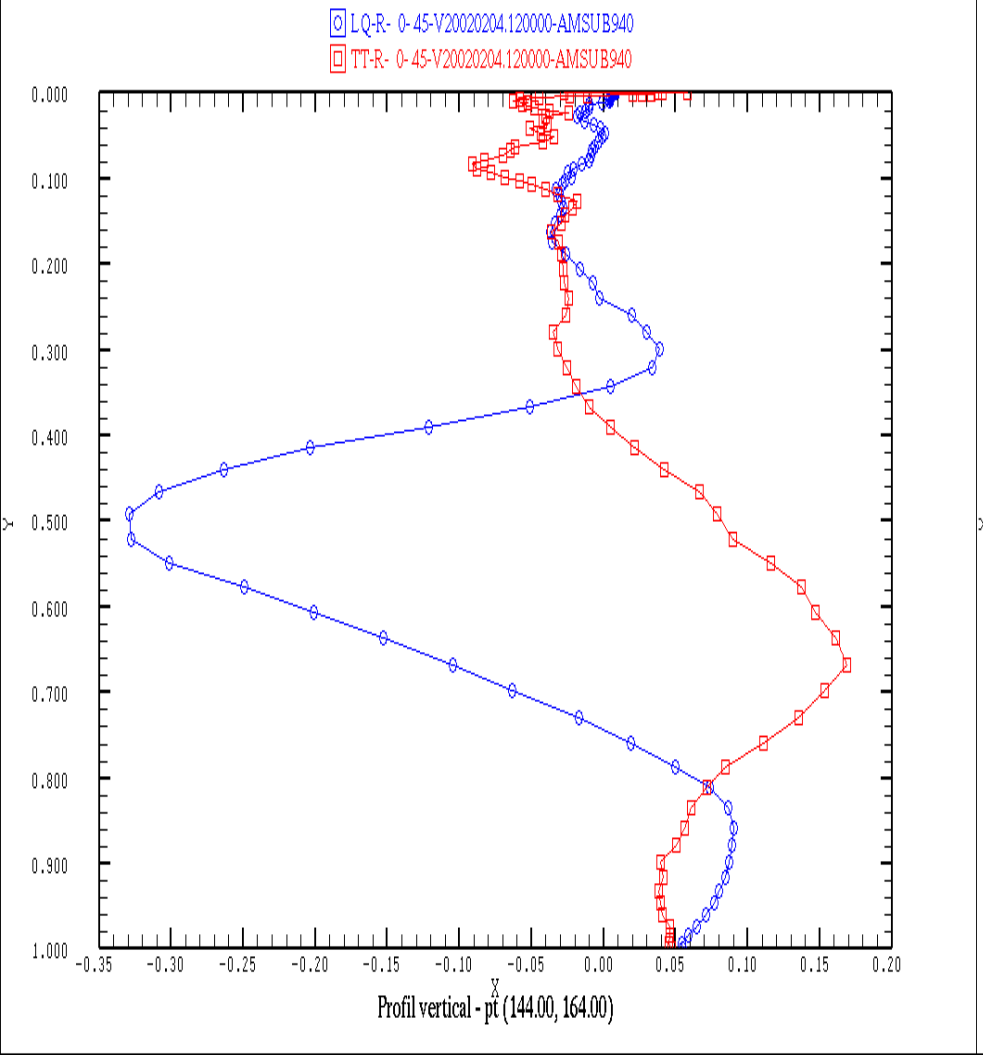


First analysis tests; AMSU-B data only
Temperature corrections at 836 hPa

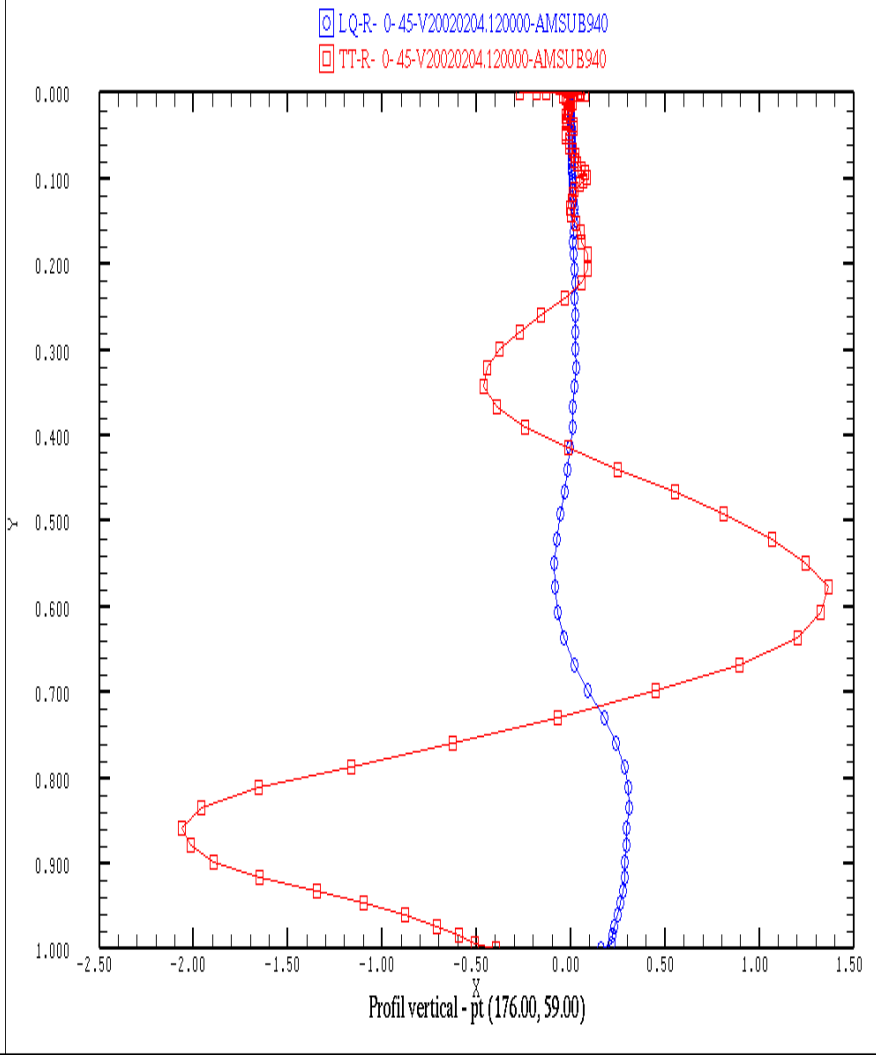


First analysis tests; AMSU-B data only
Temperature and lnq correction profiles

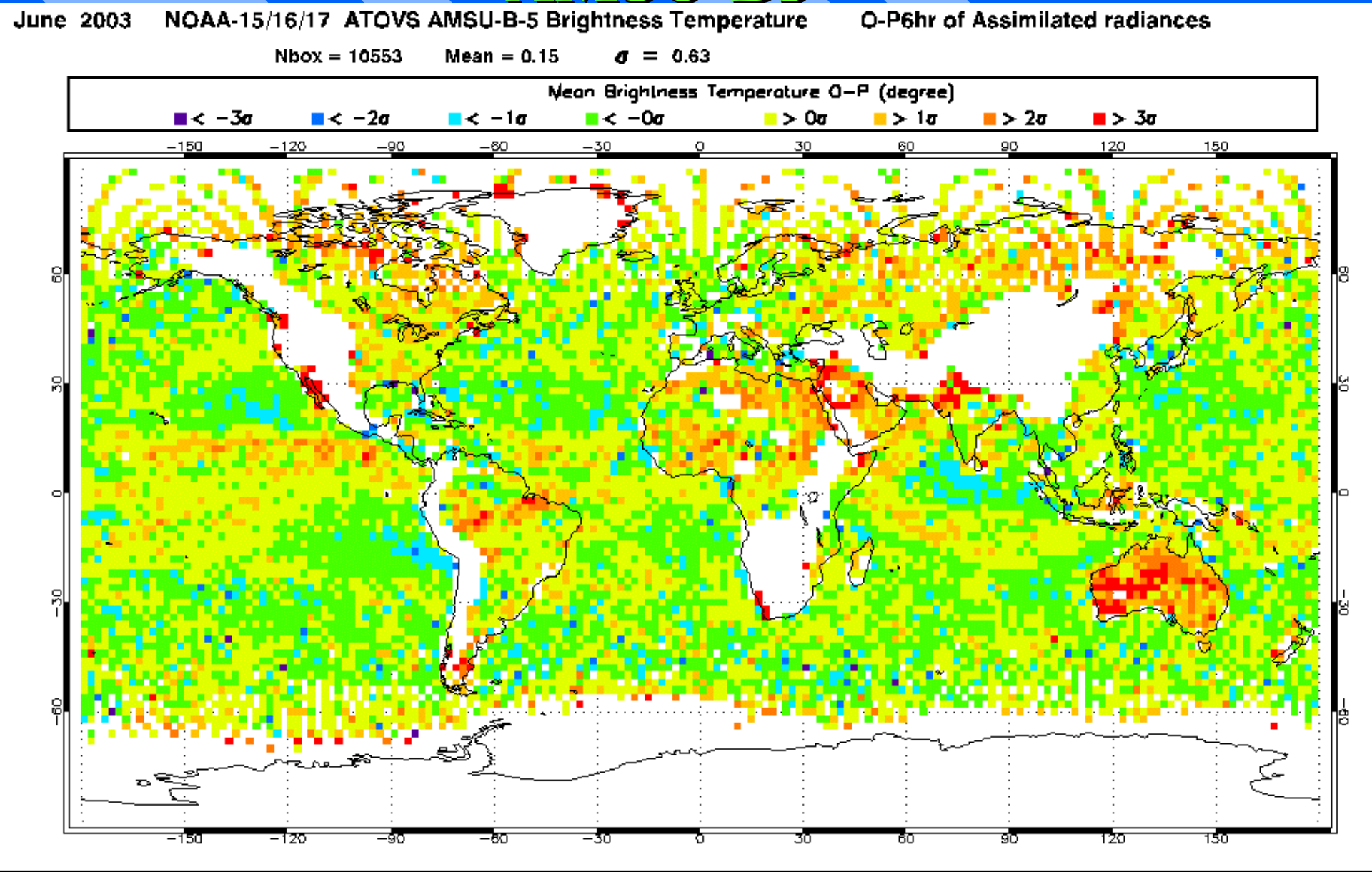
Tropics



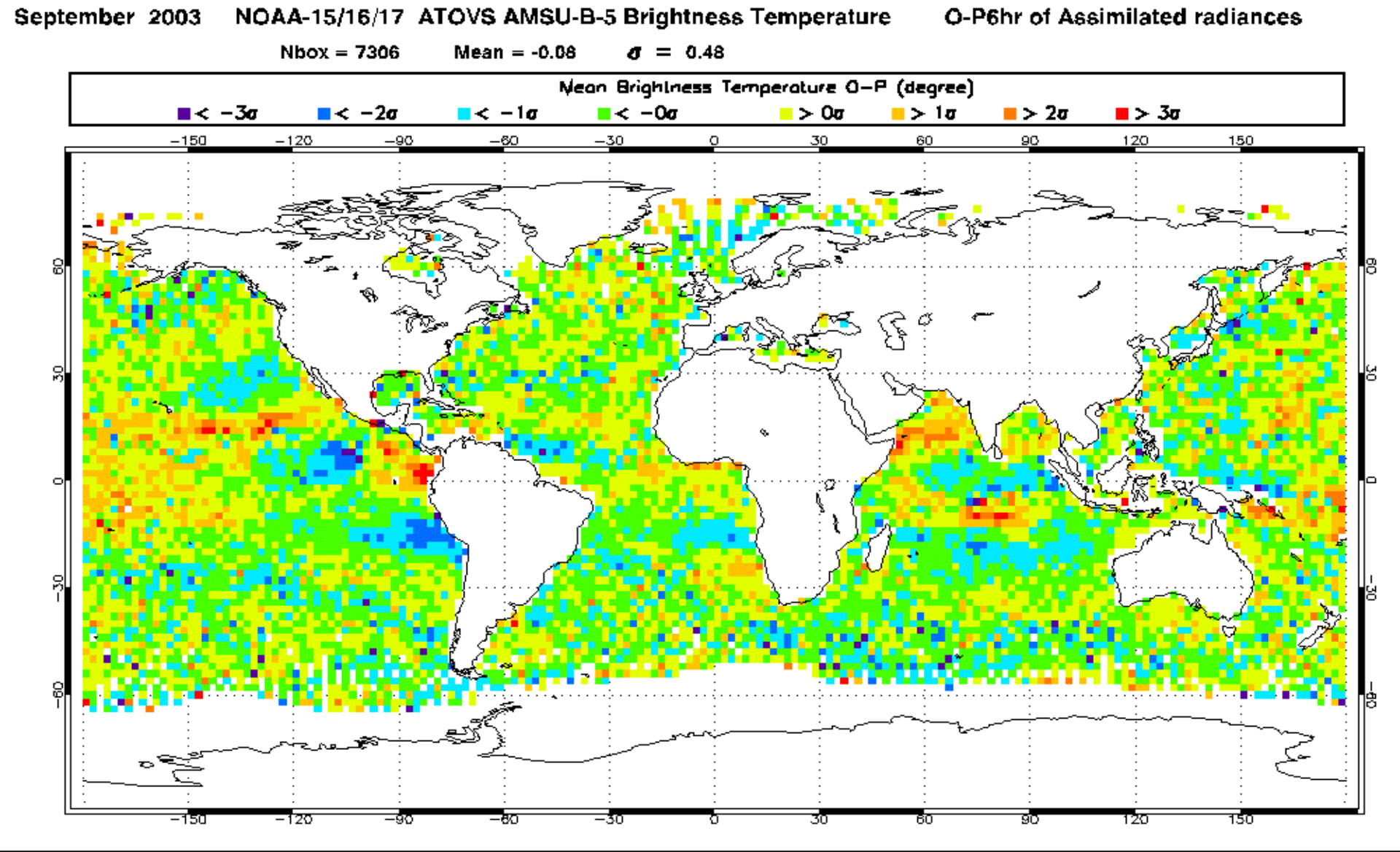
Extra-Tropics



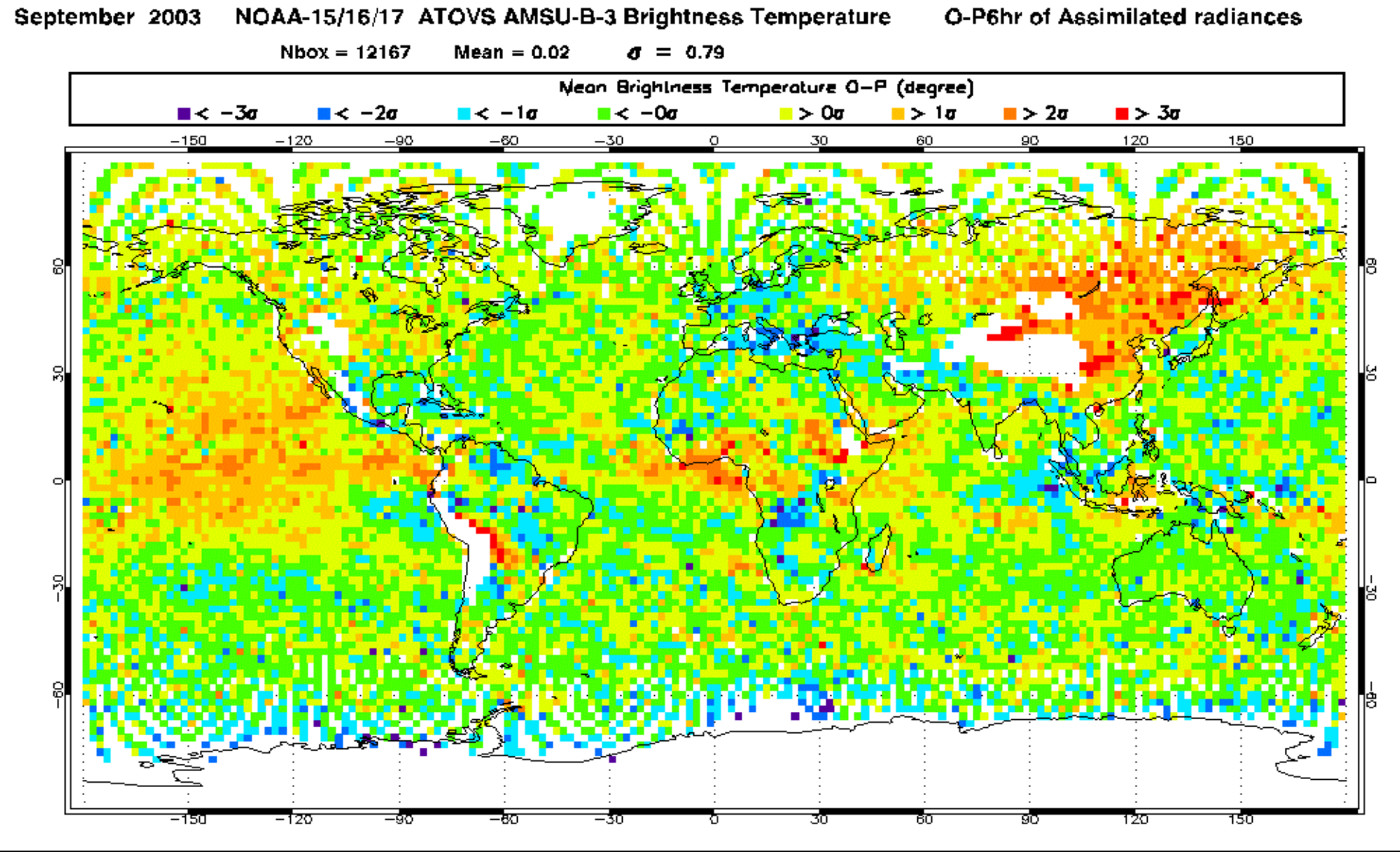
Full analysis tests highlighting problems AMSU-B5



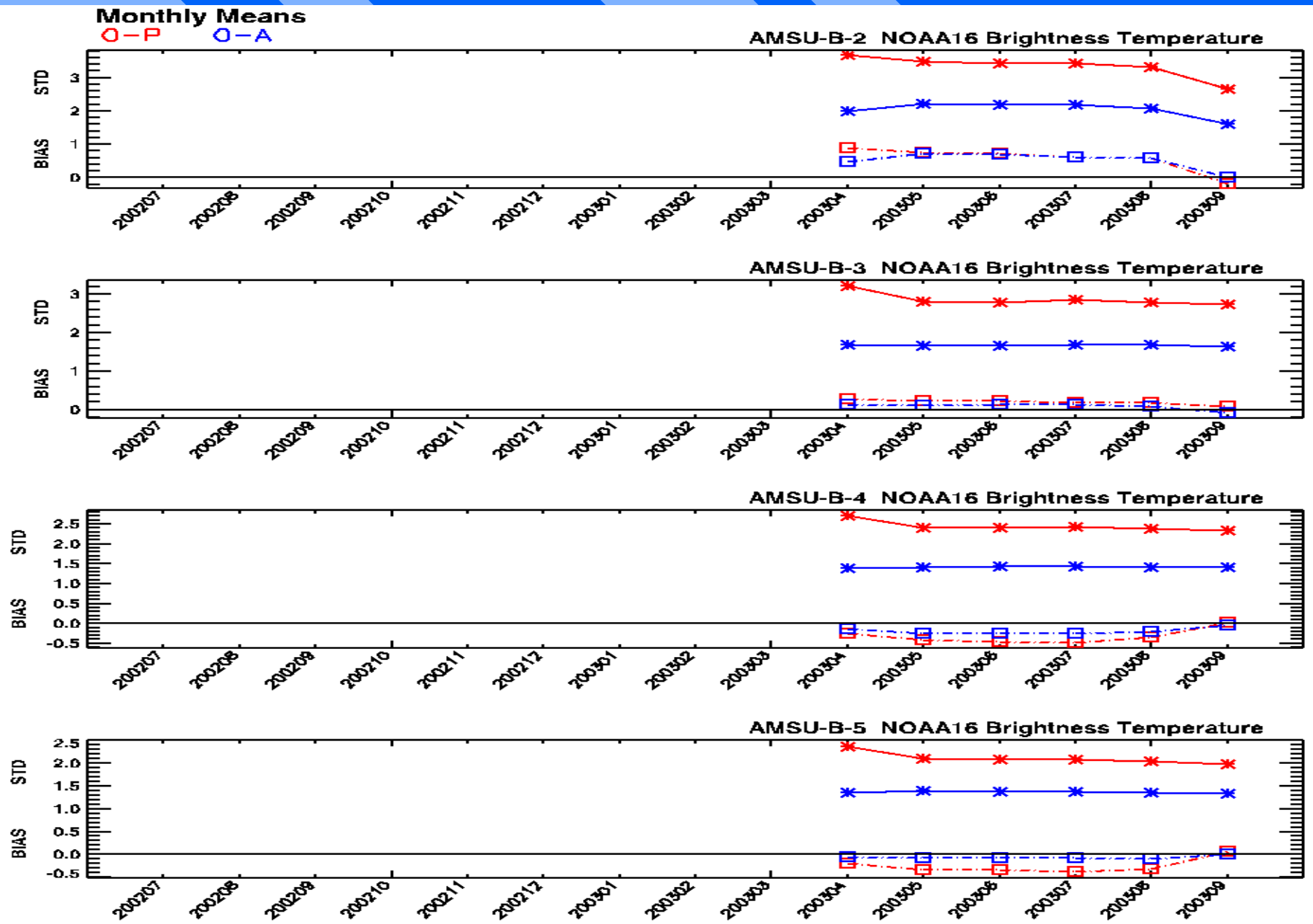
Corrections to problems with AMSU-B5



Biases over Eurasia in AMSU-B3

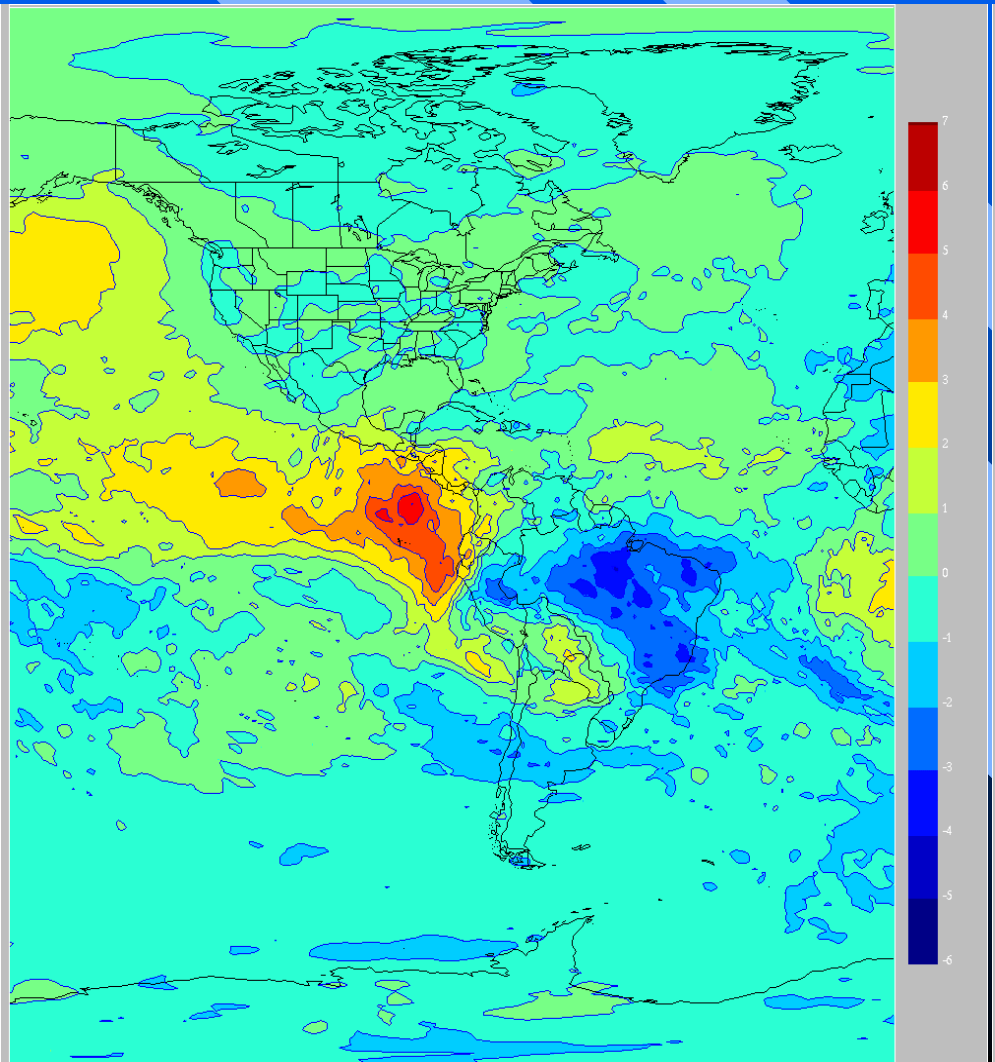


Radiance Monitoring (O-P/O-A)

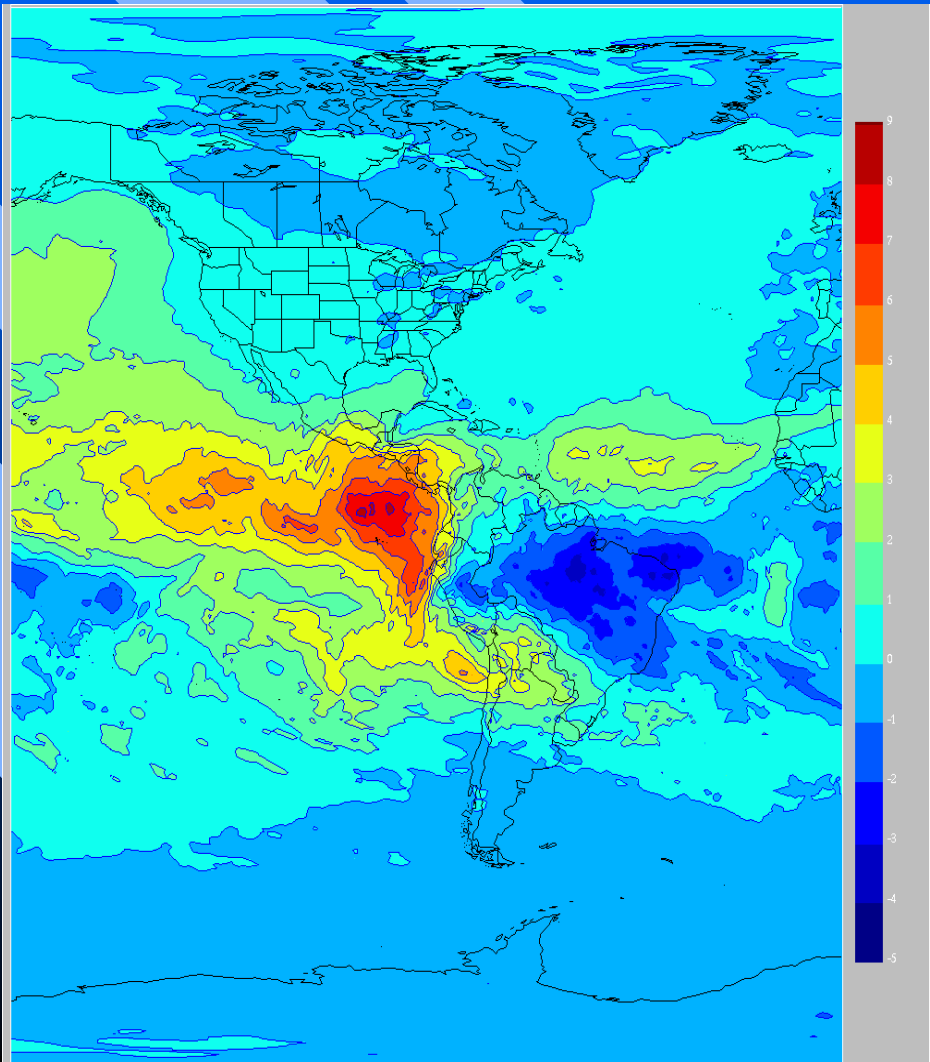


Independent verification; mean 250 hPa ES corrections relative to the operational CMC analysis

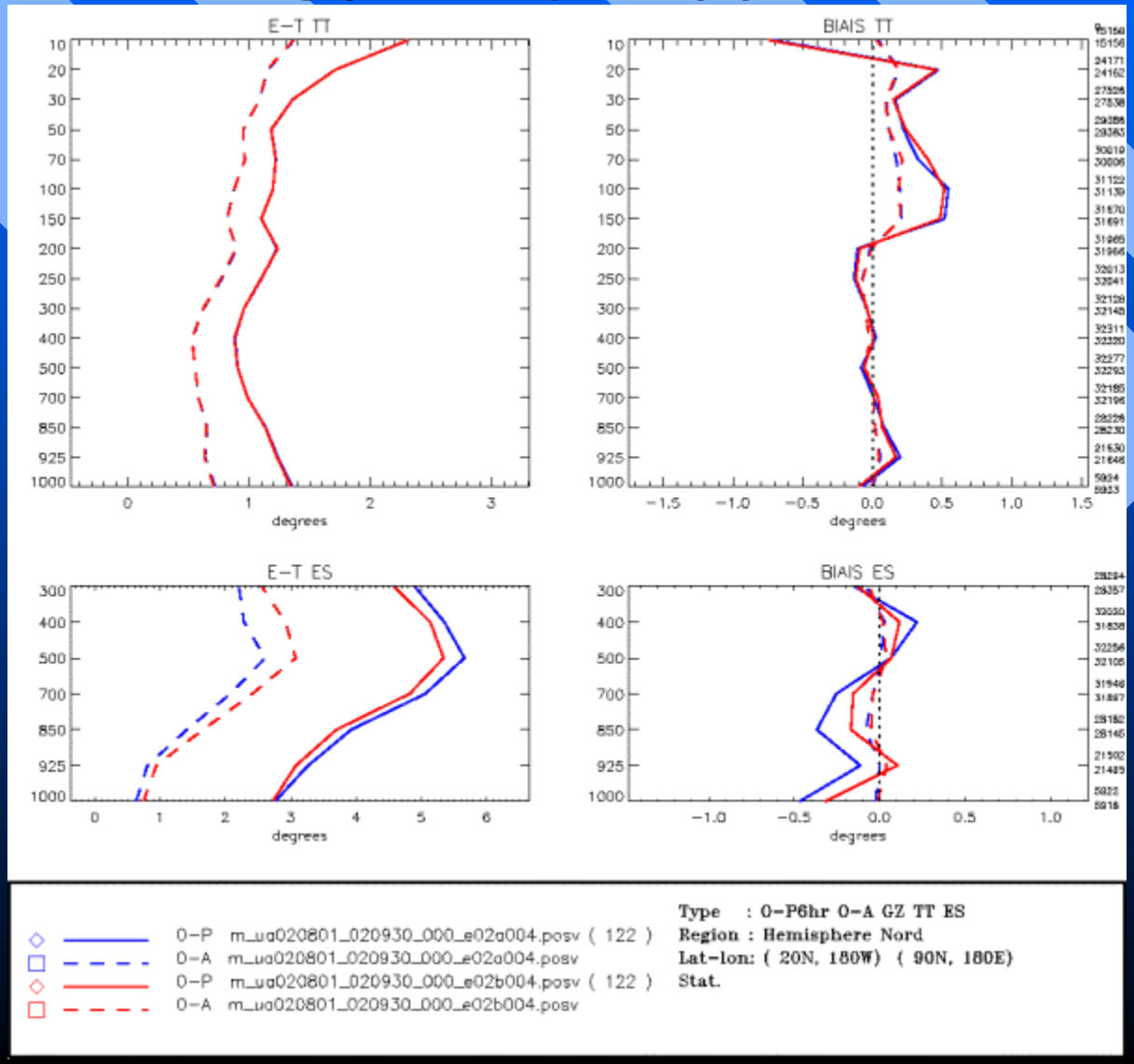
AMSU-B



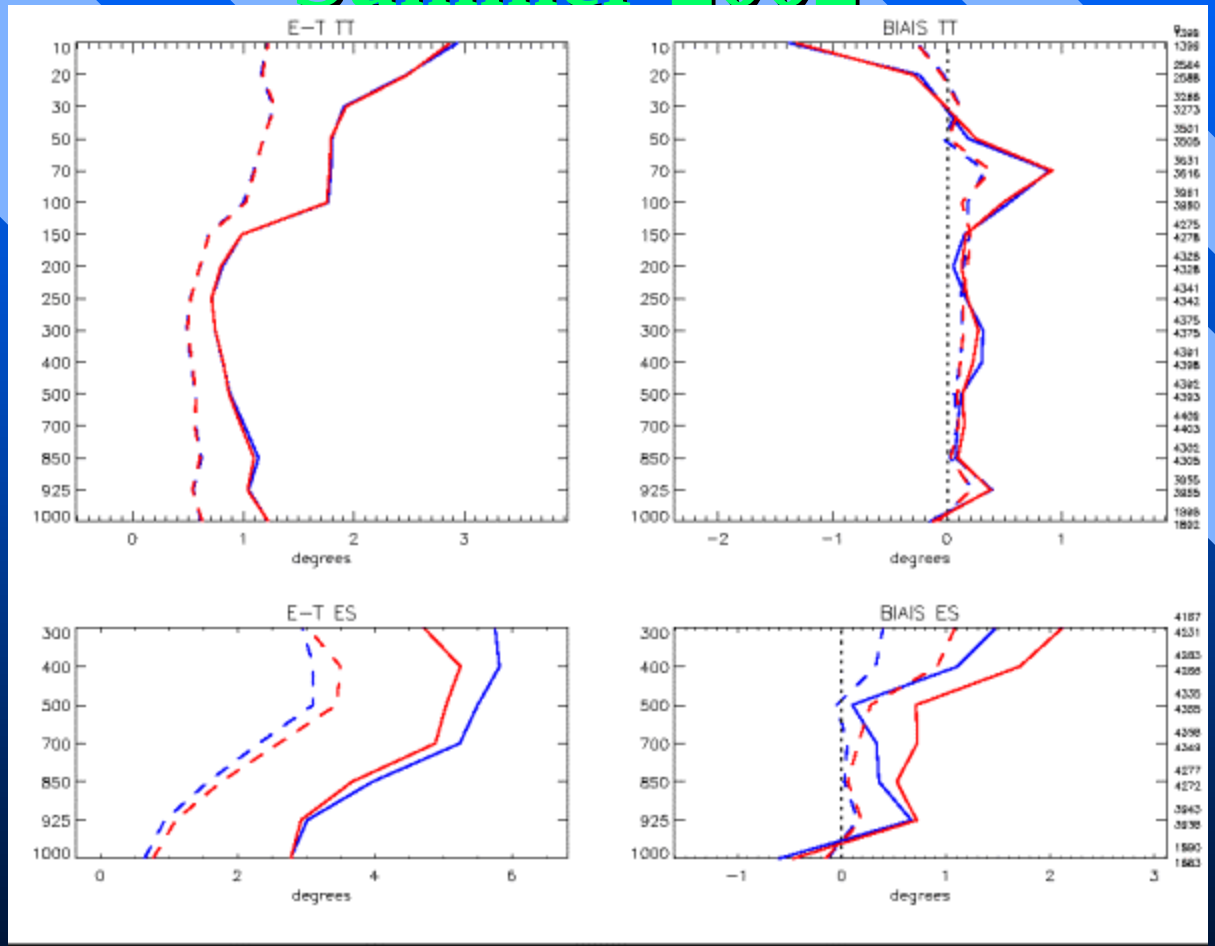
GOES 6.7m



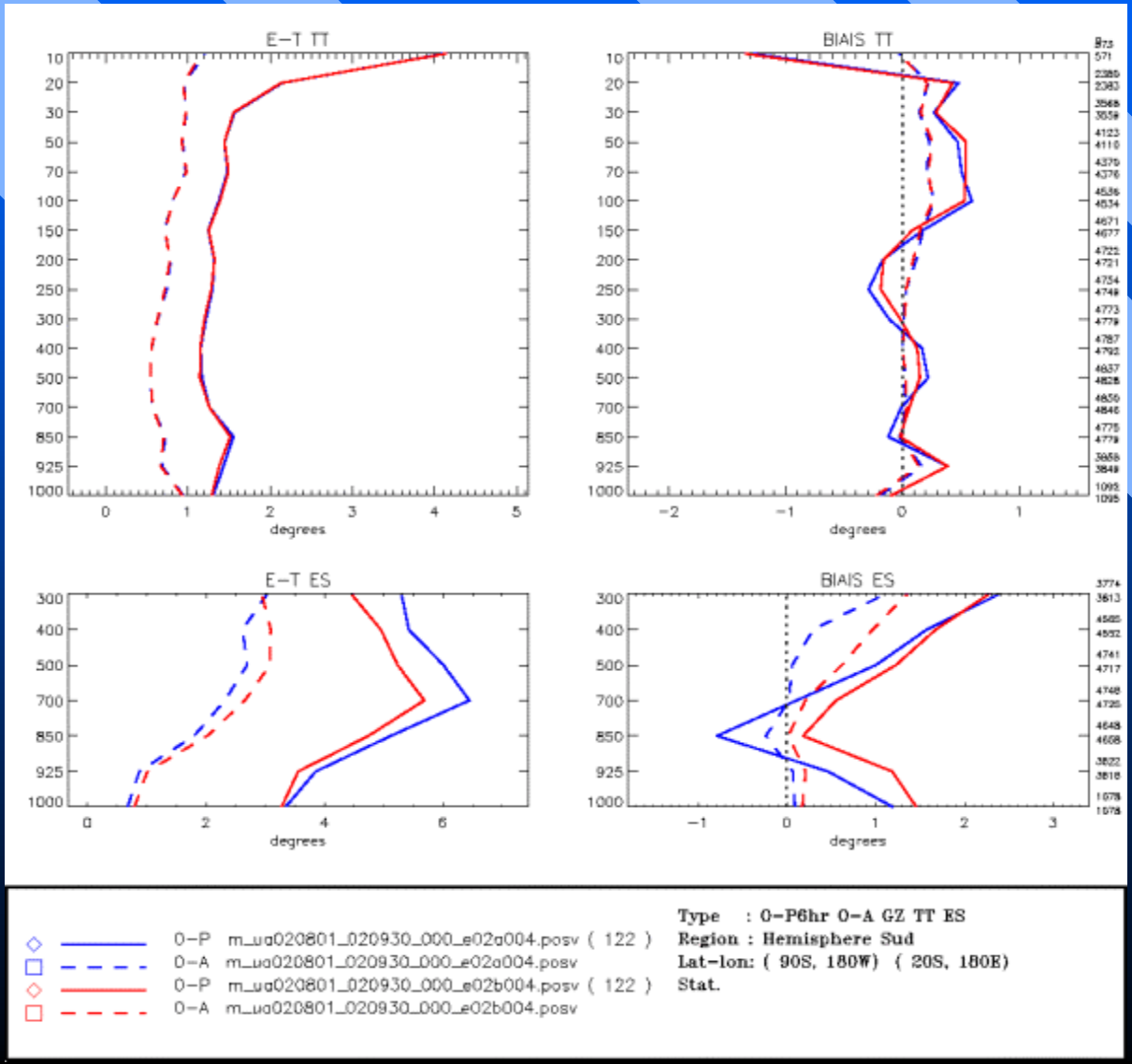
Analysis Impact
O-P/O-A against NH radiosondes
Summer 2002



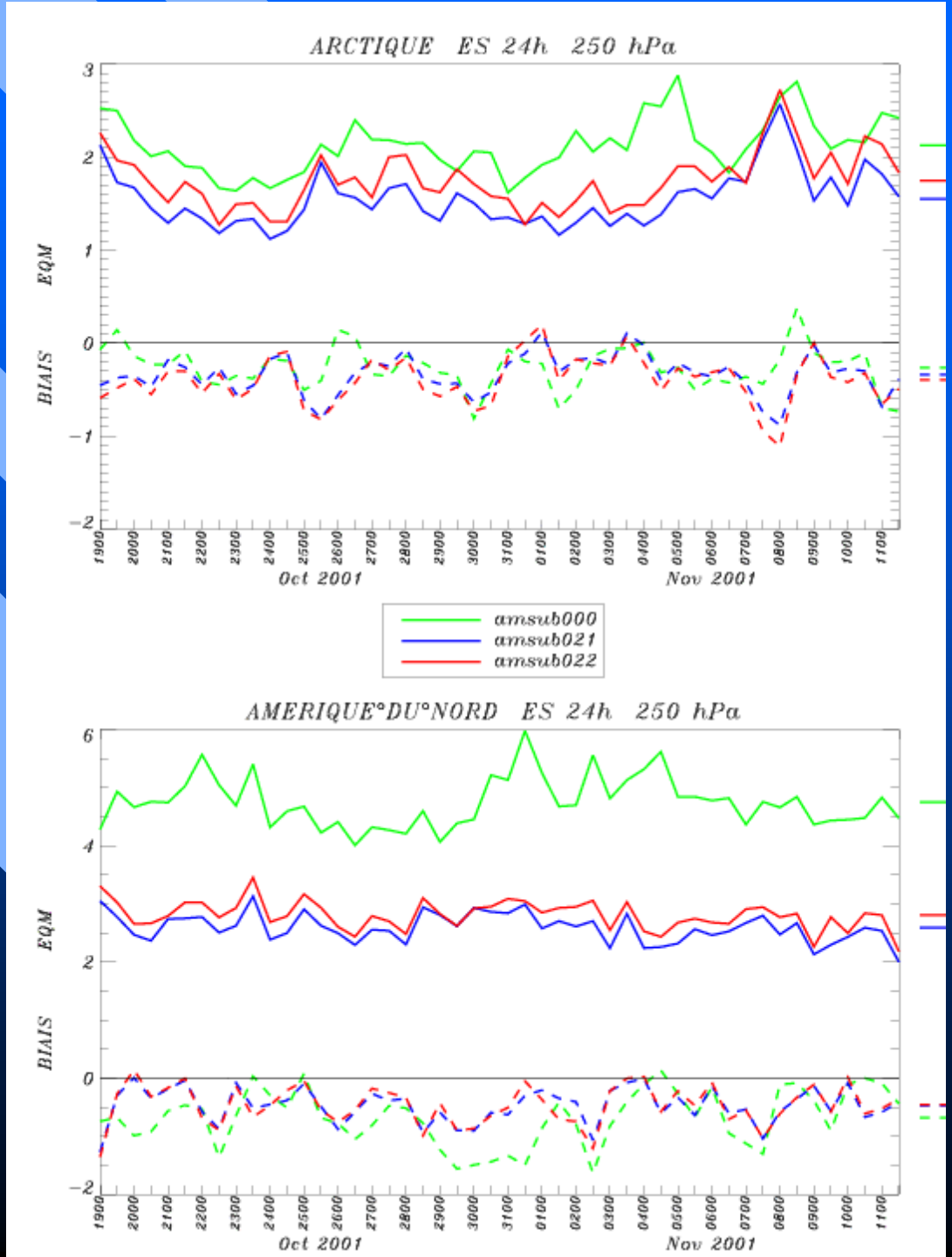
Analysis Impact
O-P/O-A against Tropical radiosondes
Summer 2002



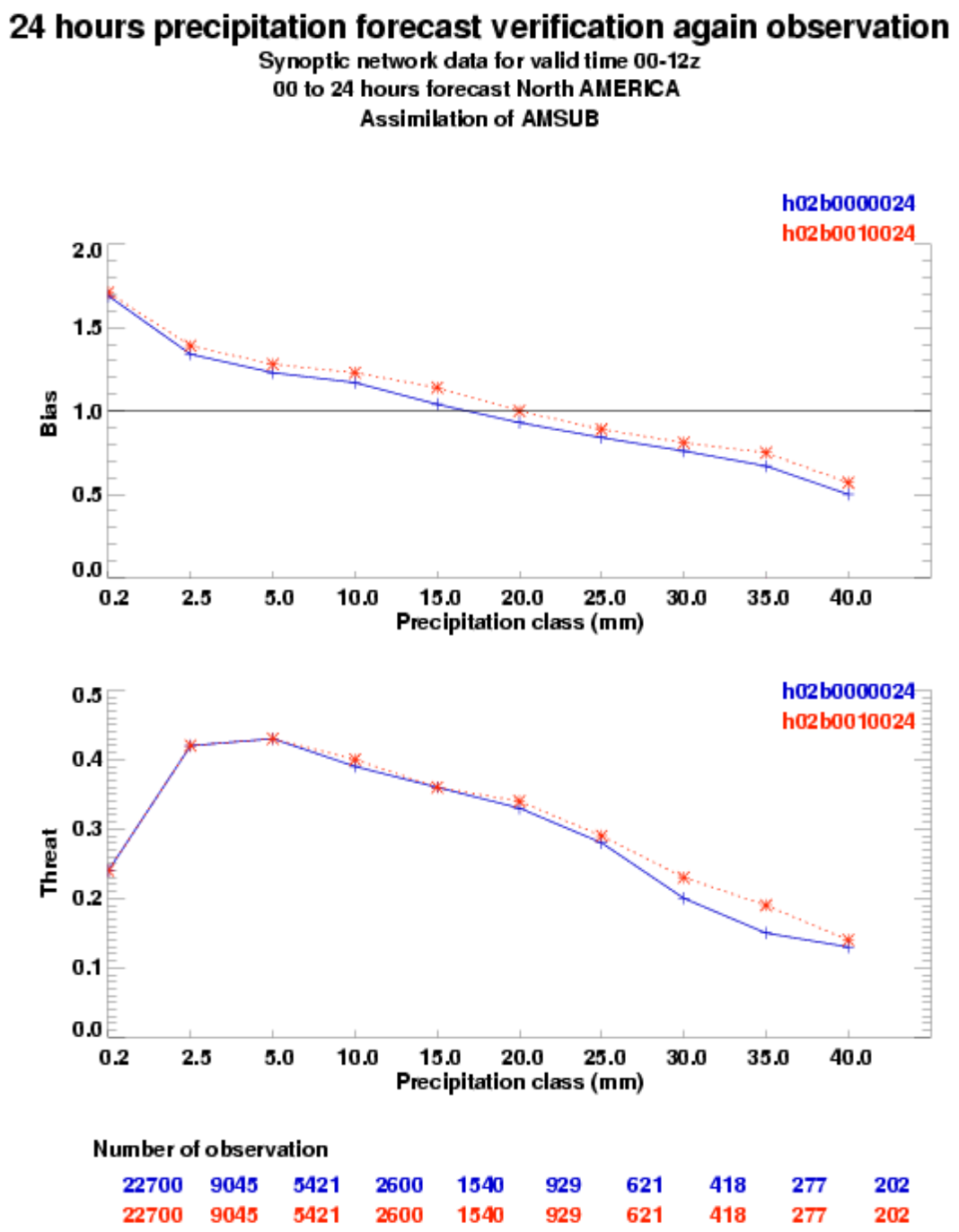
Analysis Impact
O-P/O-A against SH radiosondes
Summer 2002



Verifications of 24-h forecasts against analyses over Arctic&NA; (250 hPa ES)



(00-24 h) Precipitation verification over NA Winter 2002

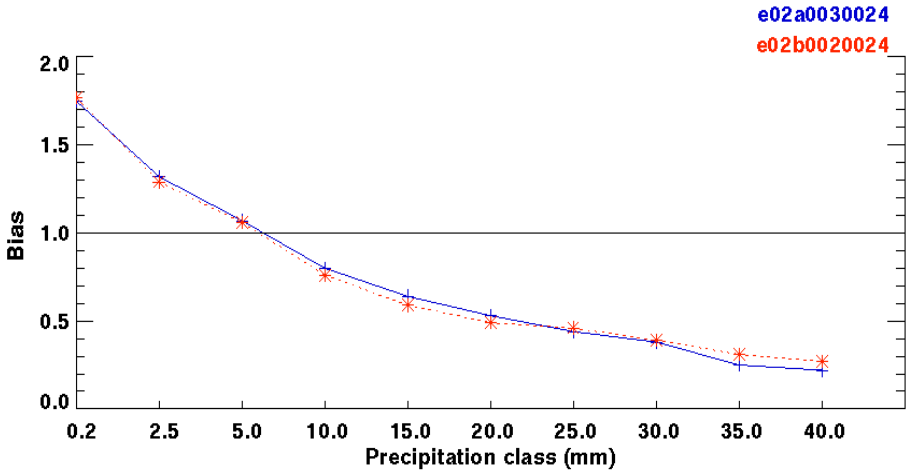


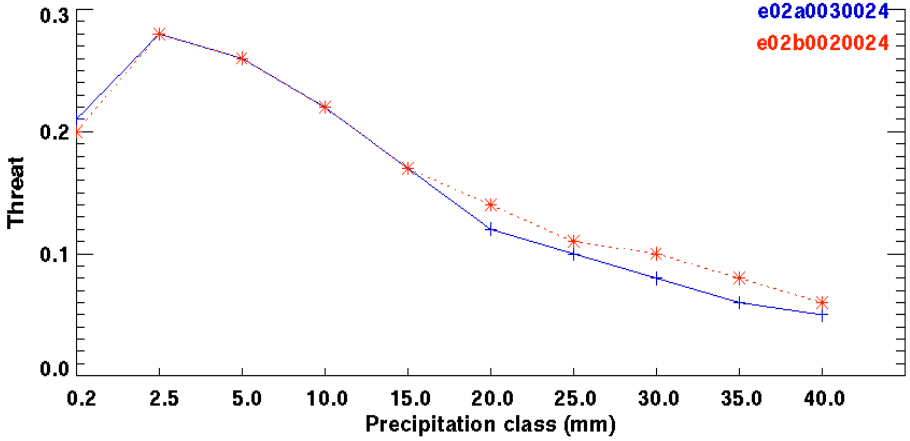
(00-24 h) Precipitation verification over NA Summer 2002

Centre Meteorologique Canadien, Environnement Canada
Canadien Meteorological Center, Environment Canada

24 hours precipitation forecast verification again observation

Synoptic network data for valid time 00-12z
00 to 24 hours forecast North AMERICA
Assimilation of AMSUB





Number of observation

12286	6143	4091	2175	1391	894	571	391	296	229
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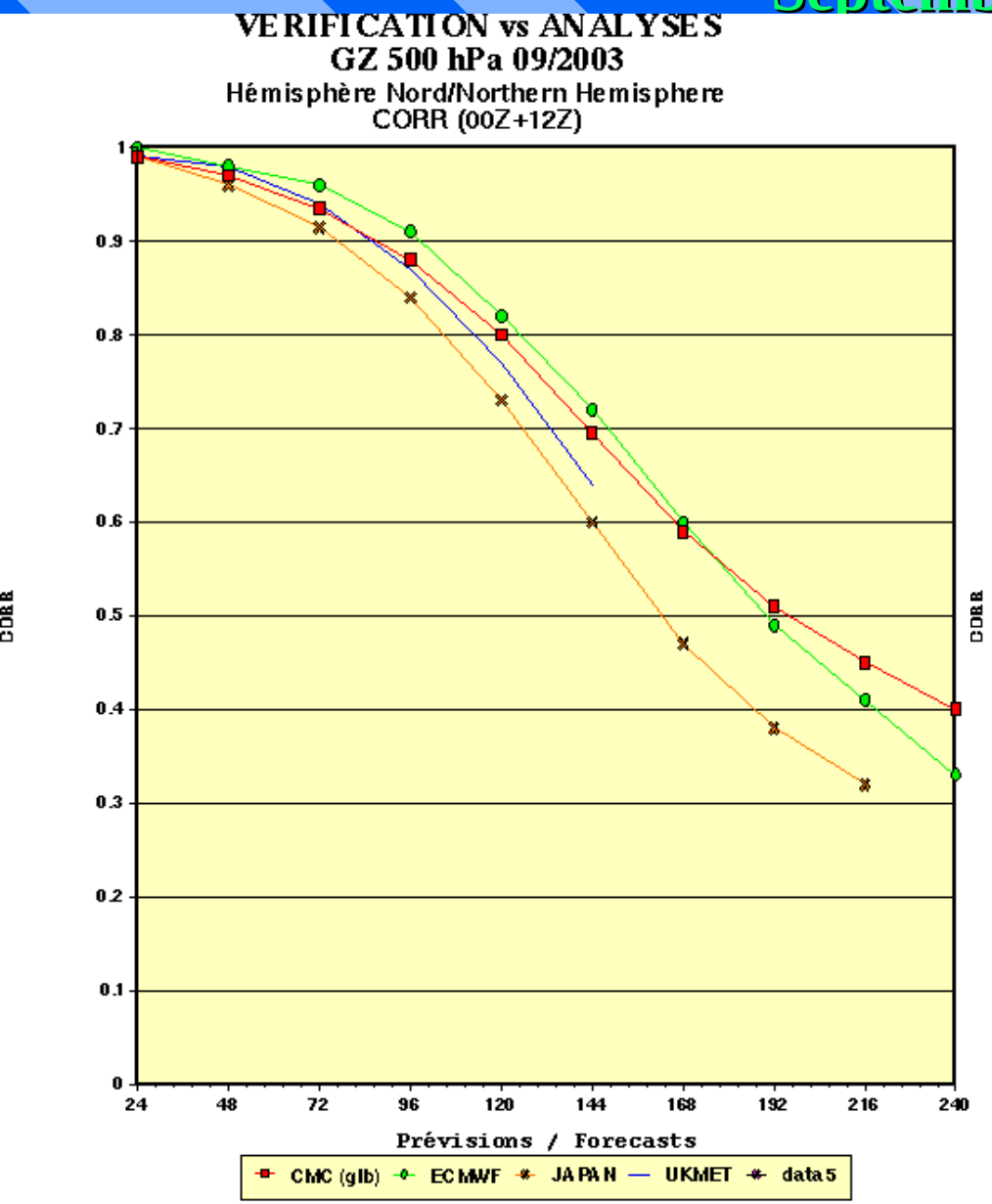
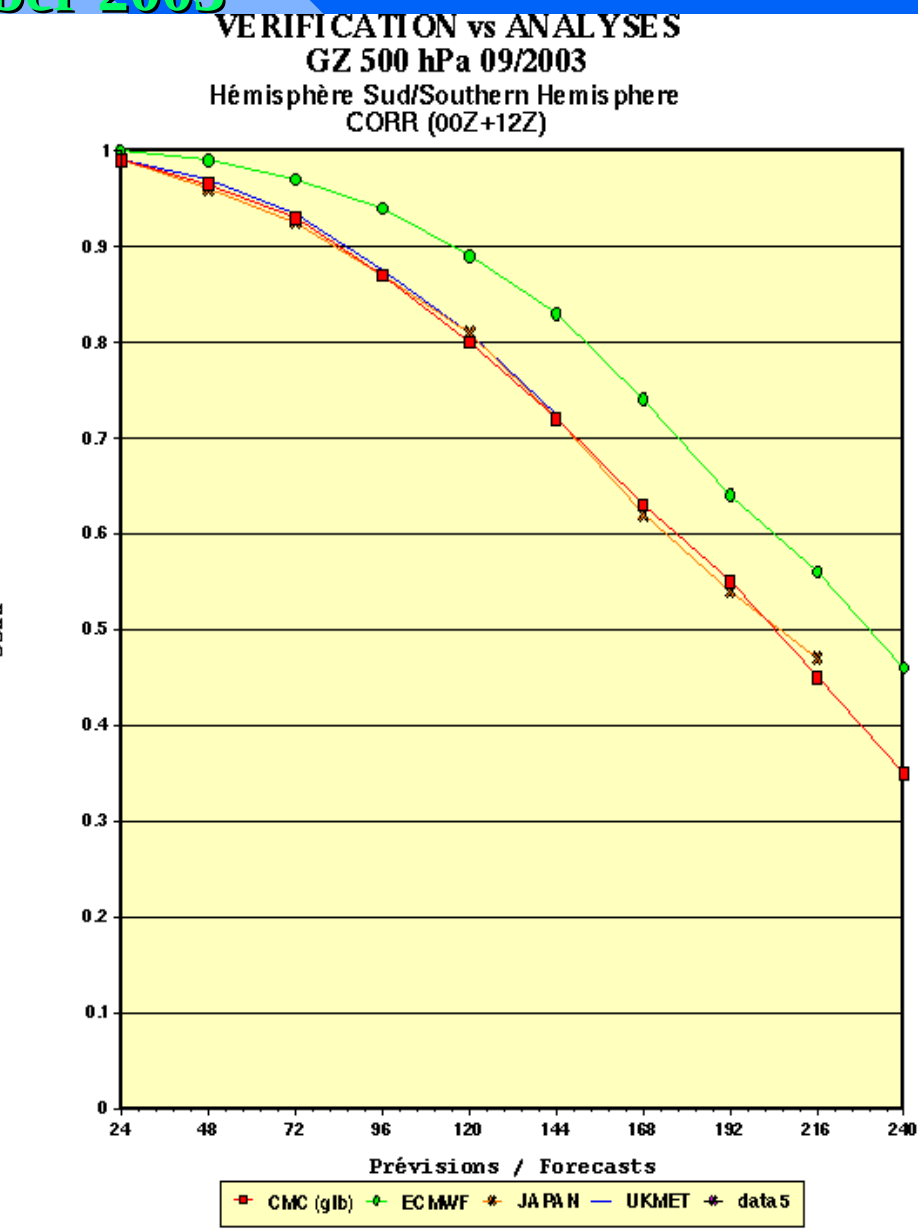
Anomaly correlation scores at 500 hPa at NWP Centres; September 2003





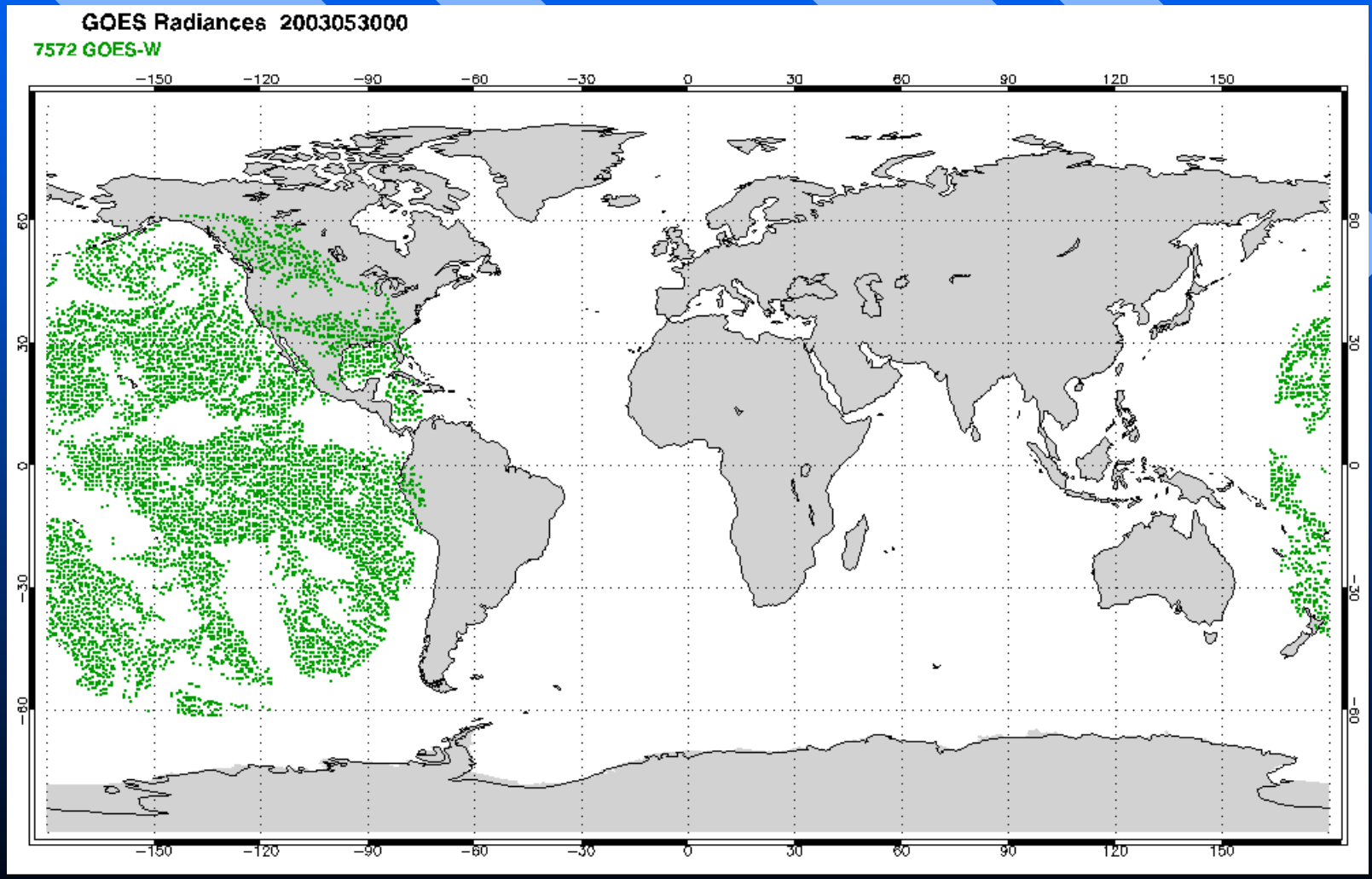
Conclusion

- The AMSU-B data of the NOAA-15, 16, and 17 platforms and the GOES 6.7μ (see N. Wagneur's poster) have a large impact on the moisture analyses of our global forecast system.
- The improvement of the upper and lower troposphere moisture analyses (250 & 850 hPa) persist through to 4 days of forecast and beyond with some positive impact on other variables such as winds and temperature.
- D. Anselmo's cross-validation of AMSU-B impacts with SSM/I TPW.

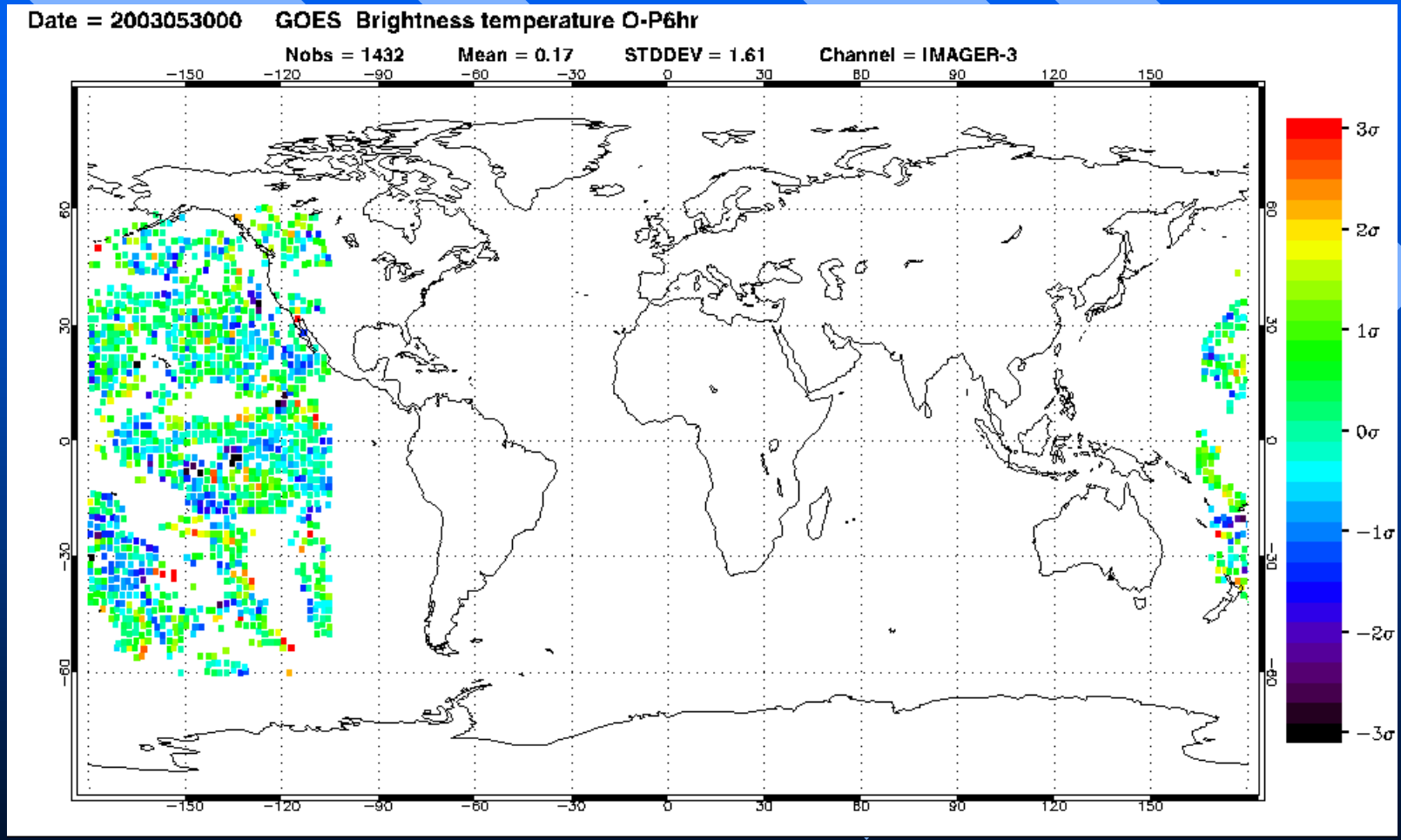
Future work in 3D-Var

- Regional Forecast System; done.
- QC-Var for TOVS data to increase the use of marginal data; Antarctica
- Raise the top of model and analysis from 10 hPa to 0.1 hPa in a hybrid vertical coordinate (AIRS project, stratospheric chemistry, support to Canadian Space Agency missions); still difficulties with moisture around and above 100 hPa; difficulties with RTTOV-7.
- IR radiances (2003 +)
  - assimilation of Meteosat and GMS
  - assimilation of AIRS and NOAA IR radiances
  - link the assimilation of Ts over land to soil moisture.

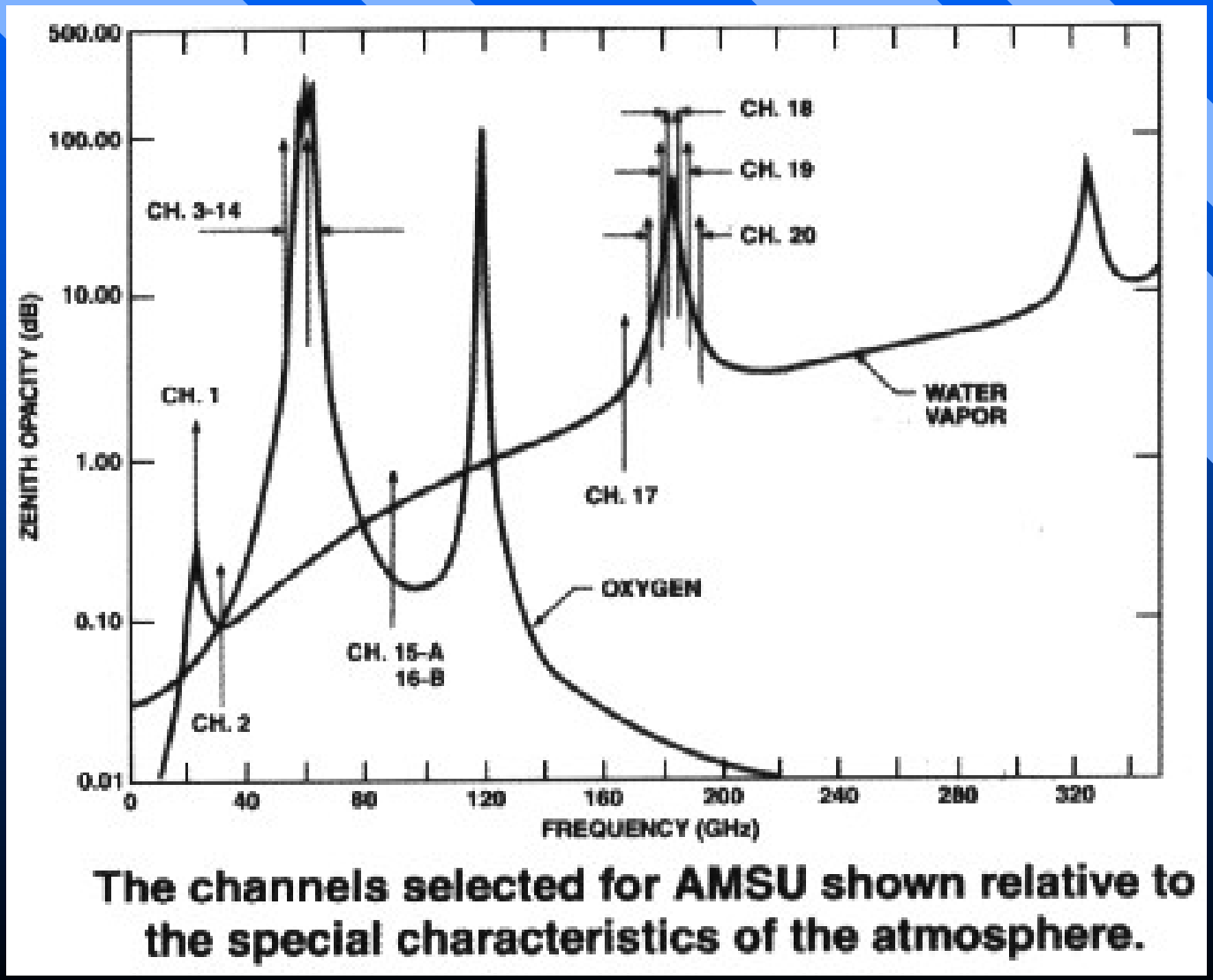
Coverage of GOES 6.7μm radiances (GOES West only currently)



Final GOES 6.7m selection for analysis



Current AMSU-A and AMSU-B radiances of NOAA series



The channels selected for AMSU shown relative to the special characteristics of the atmosphere.