Assimilation of advanced sounders at NCEP

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NOAA/NWS/NCEP/EMC

Improved satellite data assimilation

- Goals
  - Extract more information from observations
  - Prepare for the new data sources
  - Improve NWP guidance
- Unified approach with assimilation and data
  - Assimilation techniques
  - Radiative transfer
  - Data handling and quality control

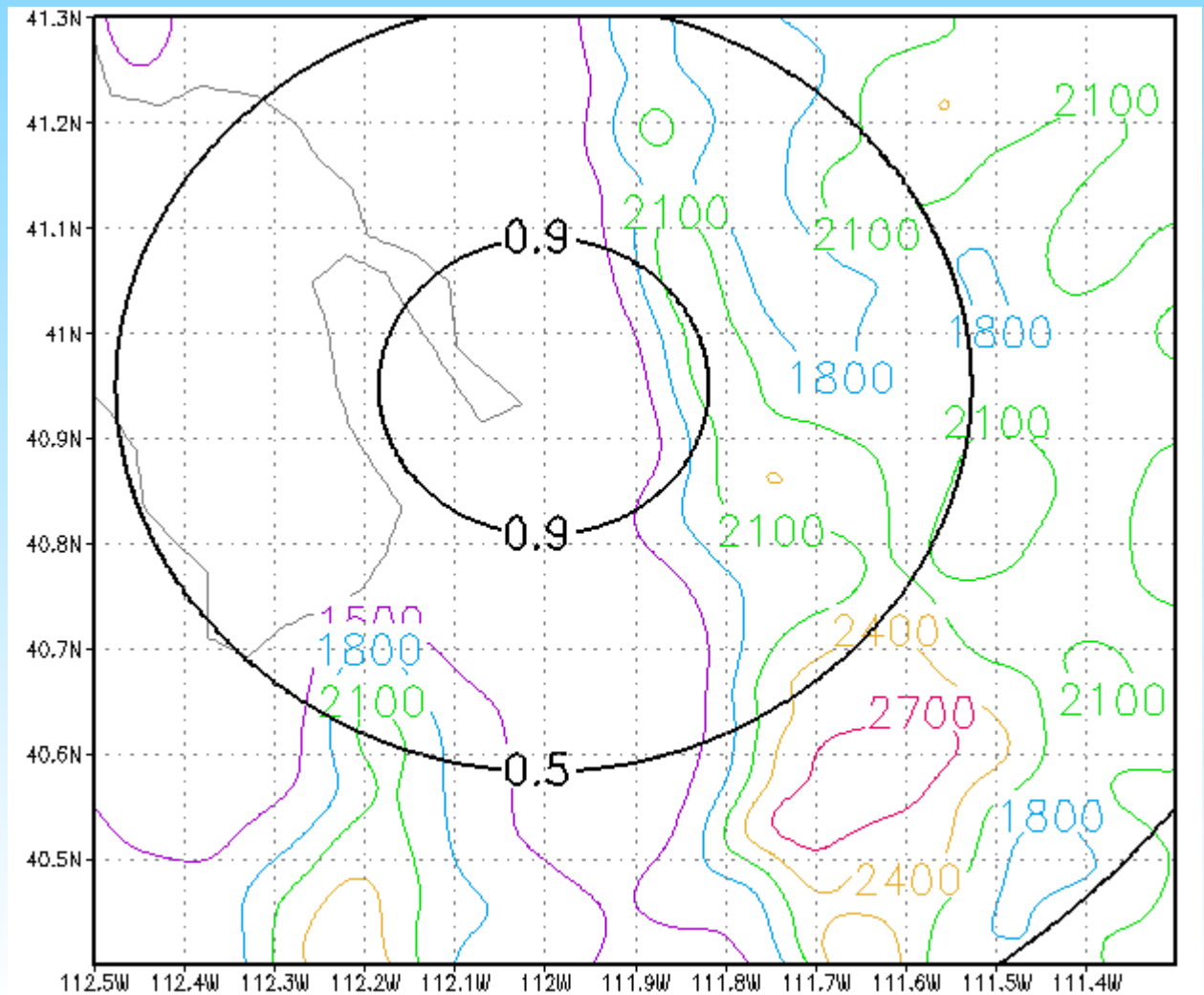
Assimilation Techniques

- Situation dependent background error covariances
- Additional analysis variables (cloud water/ice, ozone, CO2, SST, LST, snow, etc.)
- Improve balance constraints between analysis variables (moist variables)
- Include time variability (simple 4DVAR)
- Improve use of conventional (especially surface data) and radar data
- Improve forecast models

Isotropic Error Correlation in Valley

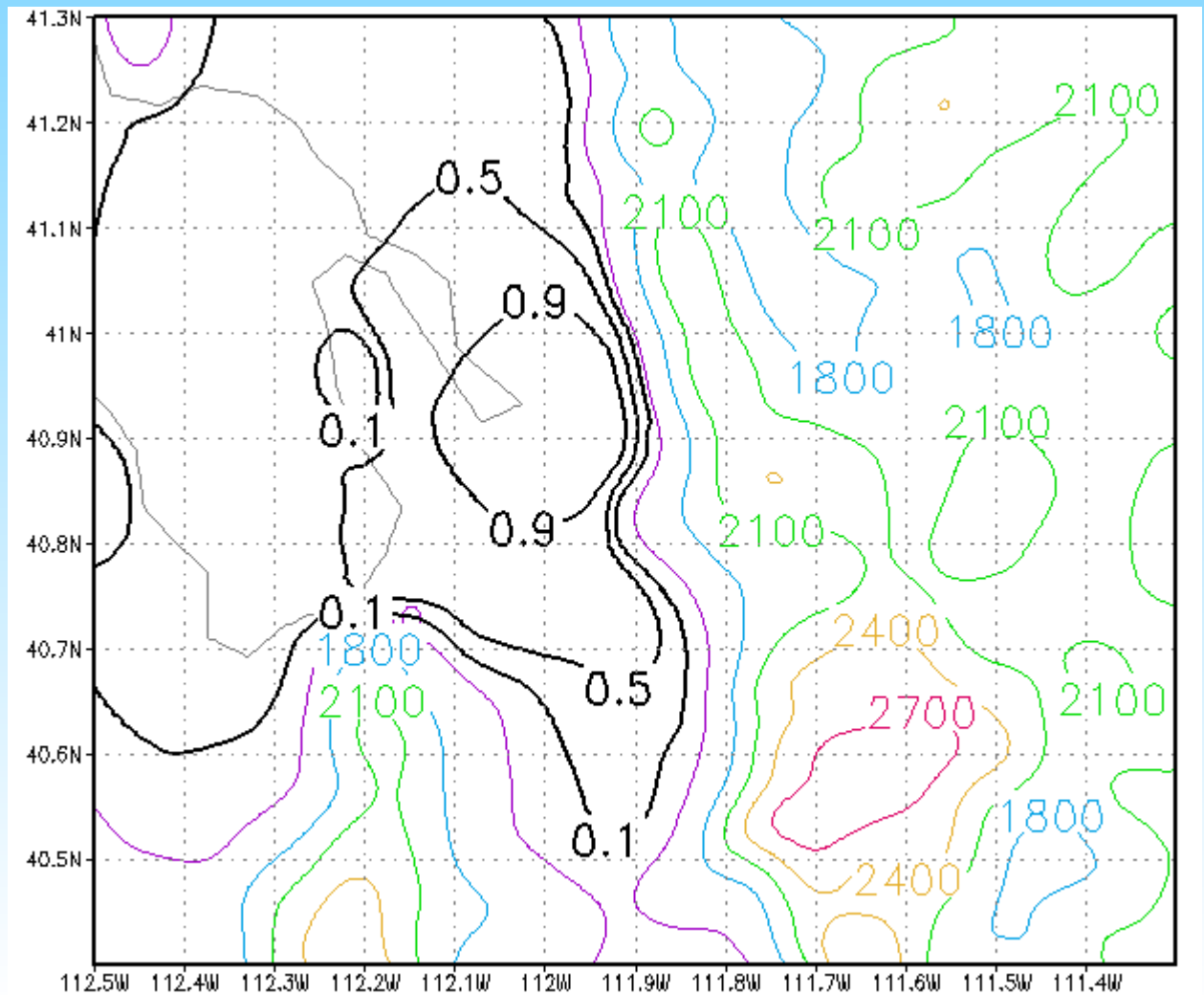
Plotted Over Utah Topography

obs influence extends into mountains indiscriminately



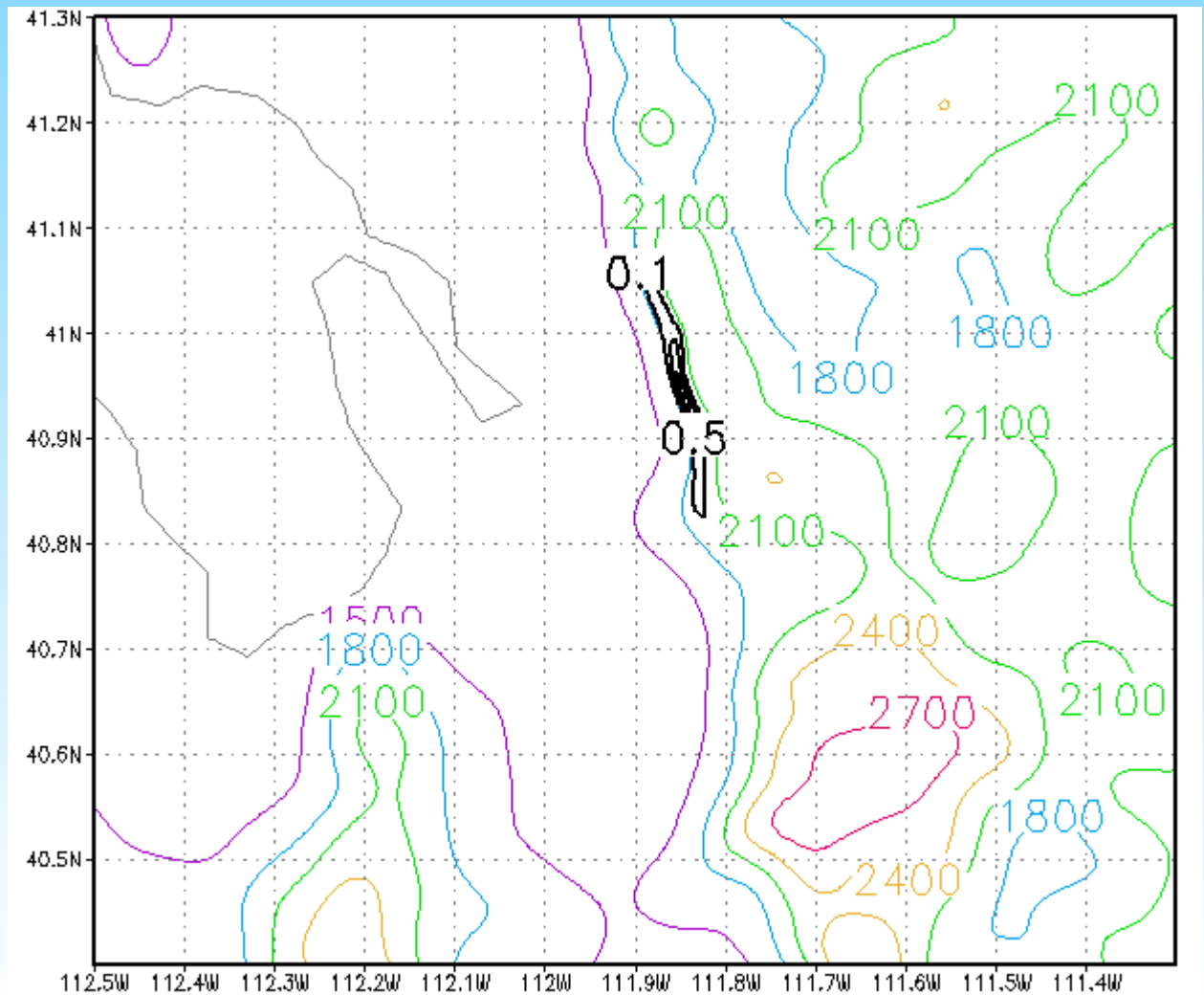
Anisotropic Error Correlation in Valley Plotted Over Utah Topography

obs influence restricted to areas of similar elevation



Anisotropic Error Correlation on Slope Plotted Over Utah Topography

obs influence restricted to areas of similar elevation

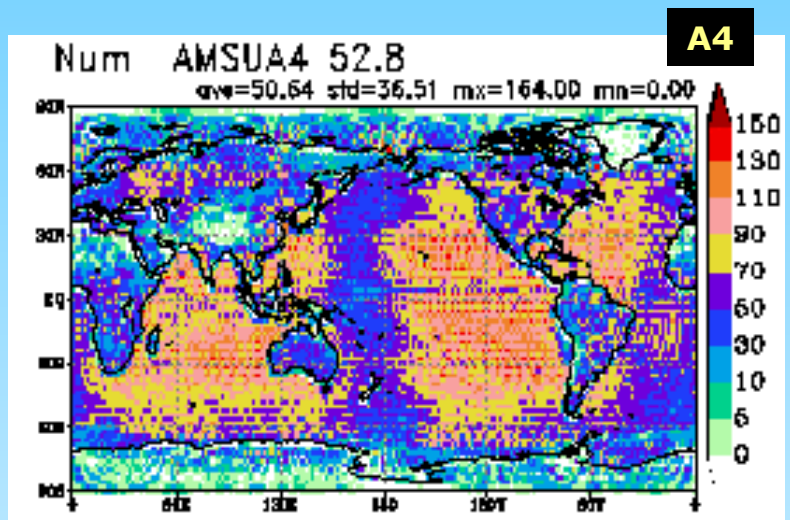


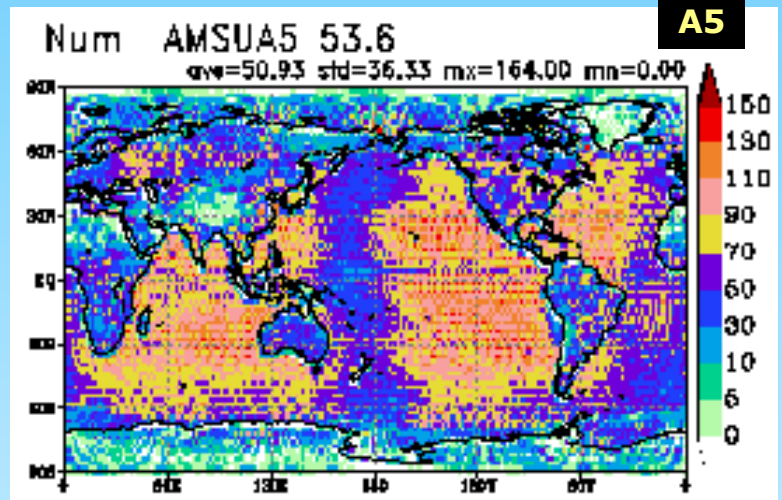
Radiative transfer

- Enhance modular RT system through JCSDA (VanDelst, Yang)
- Inclusion of cloud water and precipitation effects in microwave and IR (Bennartz, Weng, Gasiewski, Liou)
- Improved microwave (Okamoto,Yan and Weng) and IR (VanDelst) oceanic surface emissivity

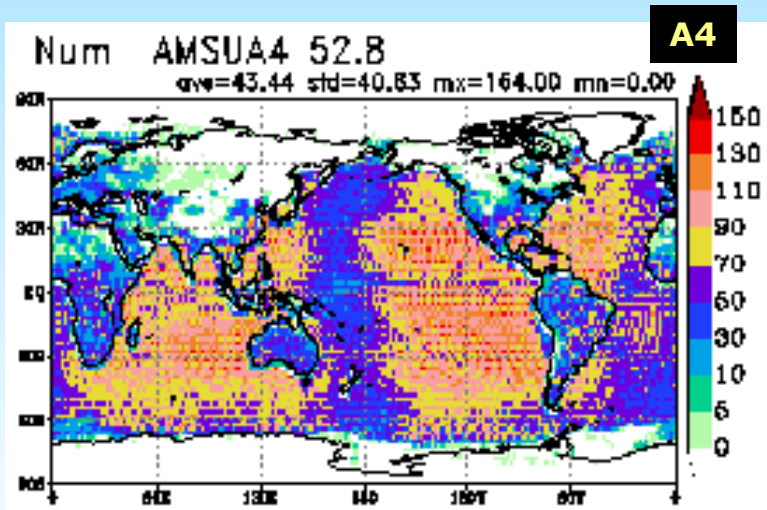
Number Used in 2x2deg for 1-month
AMSU- A4&A5 NOAA15

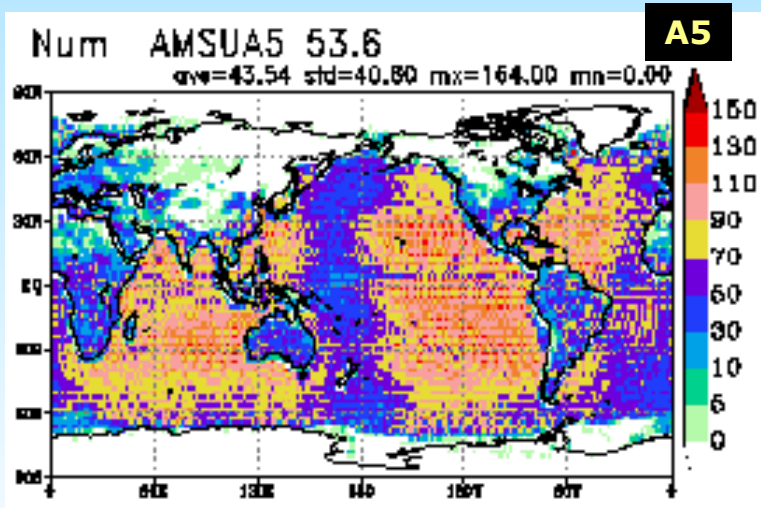
New





Current





Preparation for instruments

- Data flow and format
- Data volume
- Instrument characteristics
- Availability after launch
- Stability of operations
- Quality control
- Monitoring and evaluation

Primary New Satellites

- SSM/IS
- AQUA/TERRA
- WindSat
- NPP
- COSMIC
- METOP
- NPOESS
- GOES-R

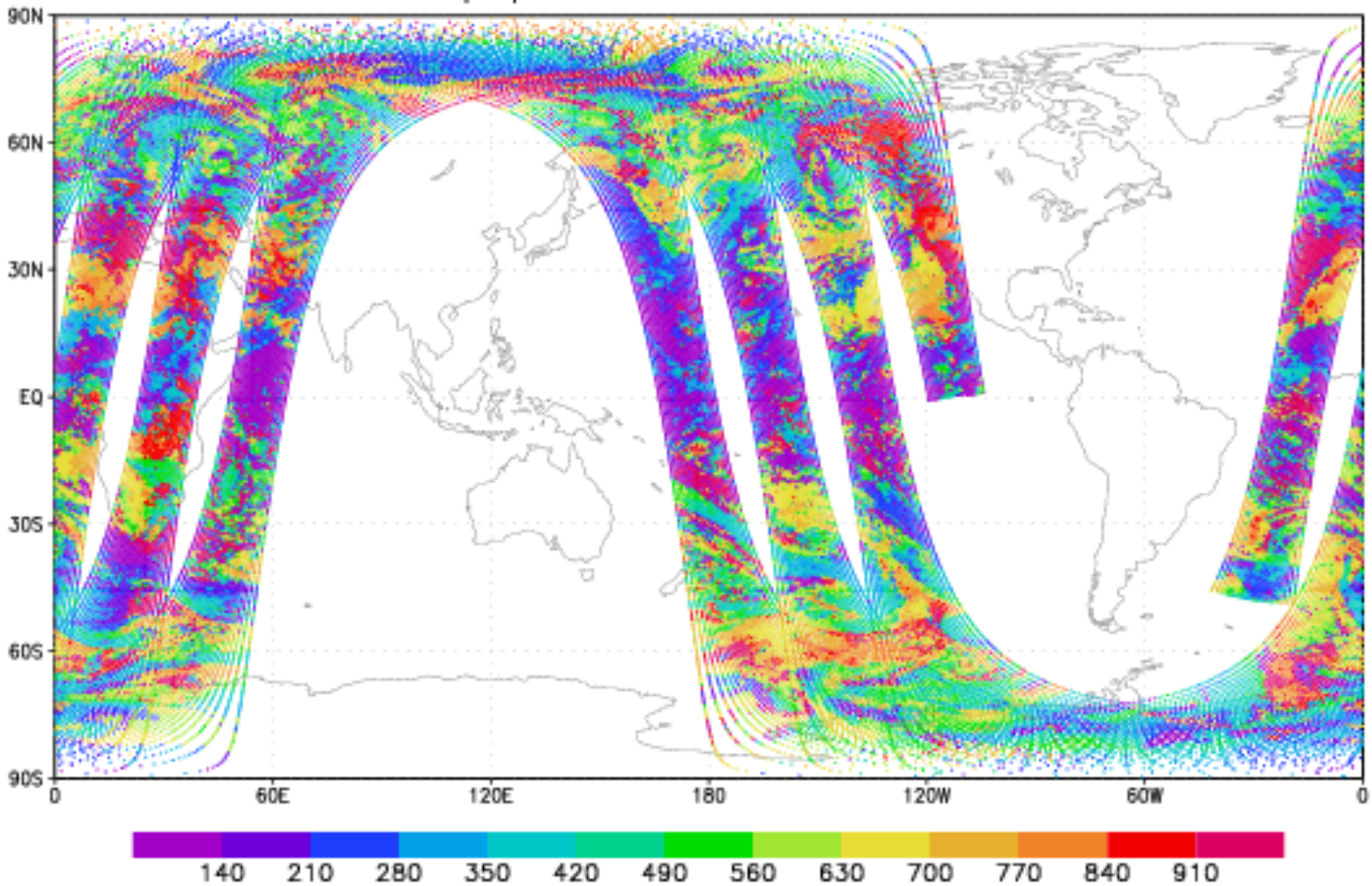
- Conical microwave
- High resolution IR
- Microwave polarimetry
- GPS radio-occultation
- High resolution imagers
- Ozone (OMPS, etc.)

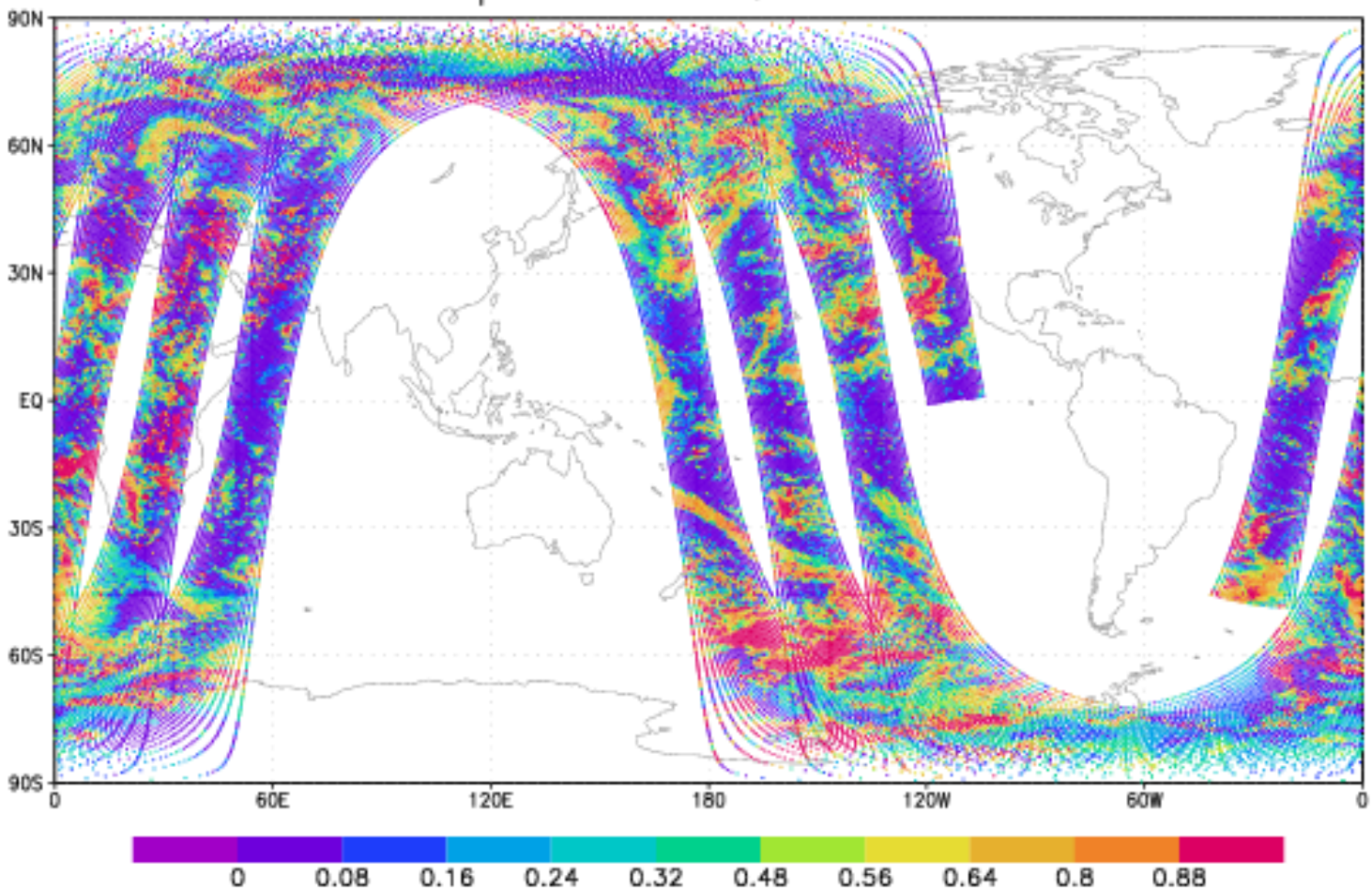
AIRS assimilation

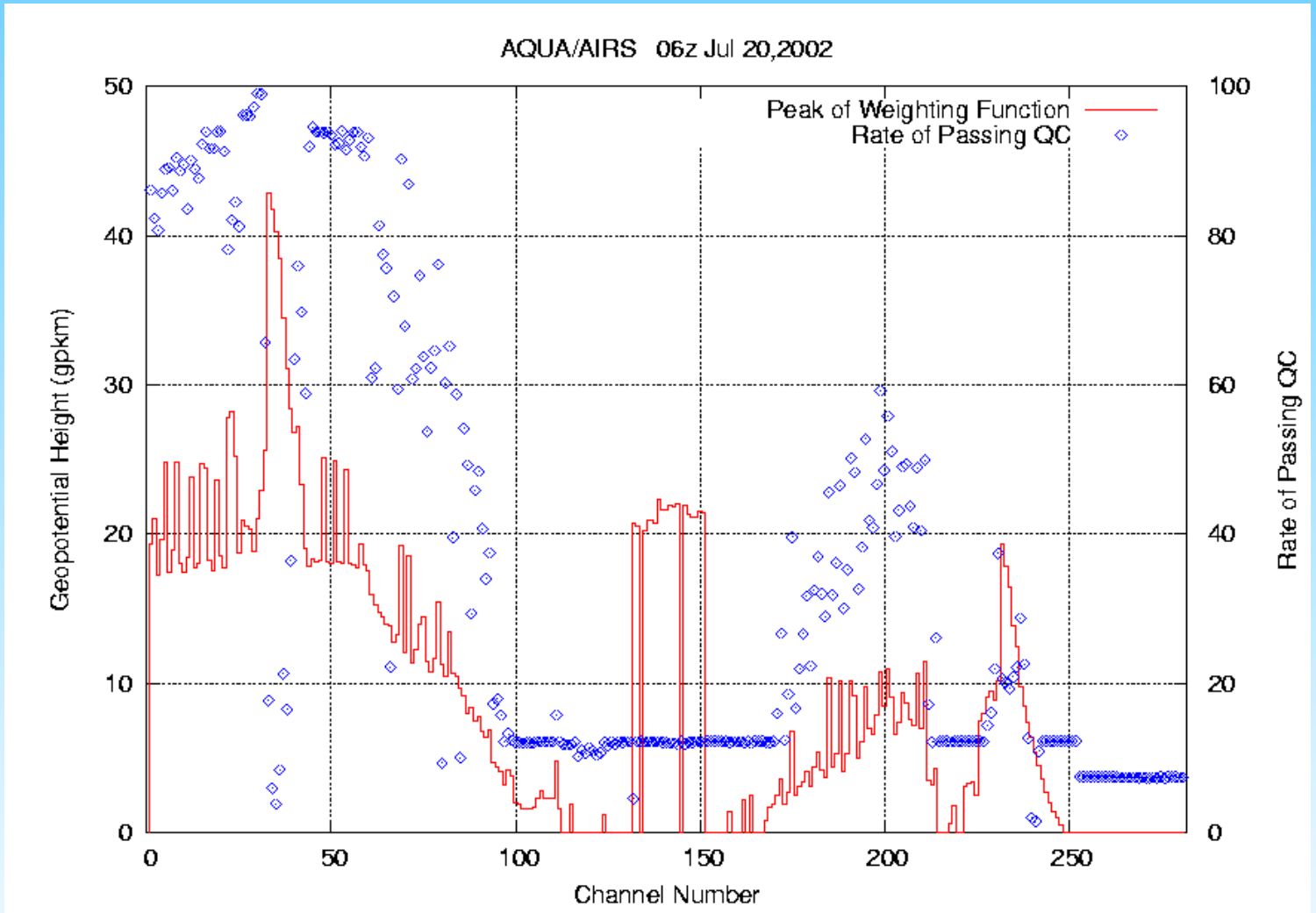
- Using current operational SSI analysis system
- Updates to radiative transfer
  - Updated microwave and IR LBL calculations
  - VanDelst's high spectral resolution ocean surface emissivity (similar to V. Sherlock)

AIRS quality control/data selection

- Equal area data selection based on:
  - Likelihood of passing QC
  - Center of box
  - Smallest time difference
- Weighting of instruments within data box
  - AIRS heavily weighted relative to HIRS
  - AMSU-A instruments equally weighted
- IR QC based on estimating cloud top and percentage from ΔT_b


cloud top pressure for QC 00Z 220604
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
140
210
280
350
420
490
560
630
700
770
840
910

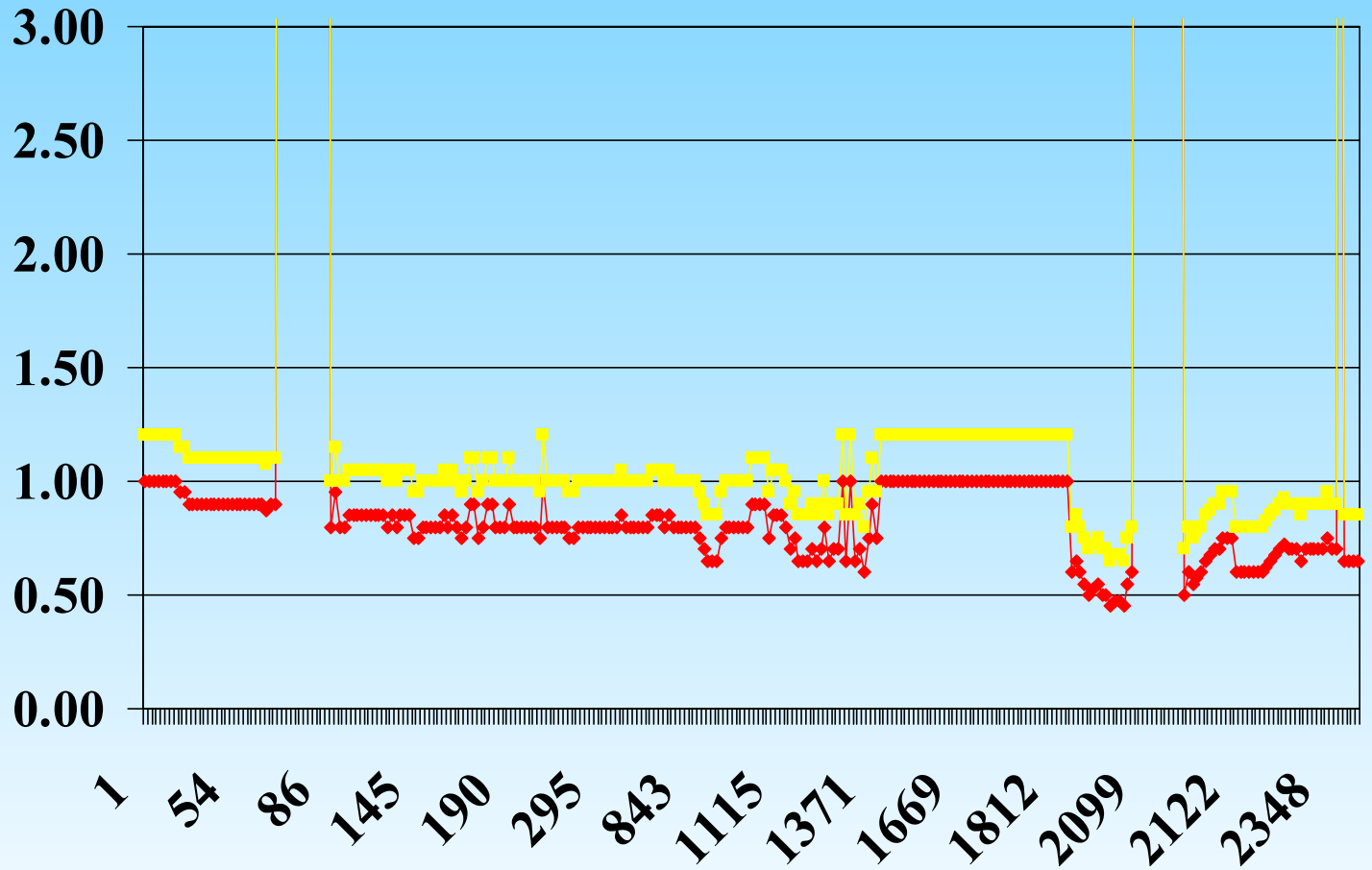

cloud percent for QC 00Z 220604
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
0
0.08
0.16
0.24
0.32
0.48
0.56
0.64
0.8
0.88


AQUA/AIRS 06z Jul 20,2002
Peak of Weighting Function
Rate of Passing QC
Geopotential Height (gpkm)
Rate of Passing QC
Channel Number
0
10
20
30
40
50
0
20
40
60
80
100
0
50
100
150
200
250

AIRS data

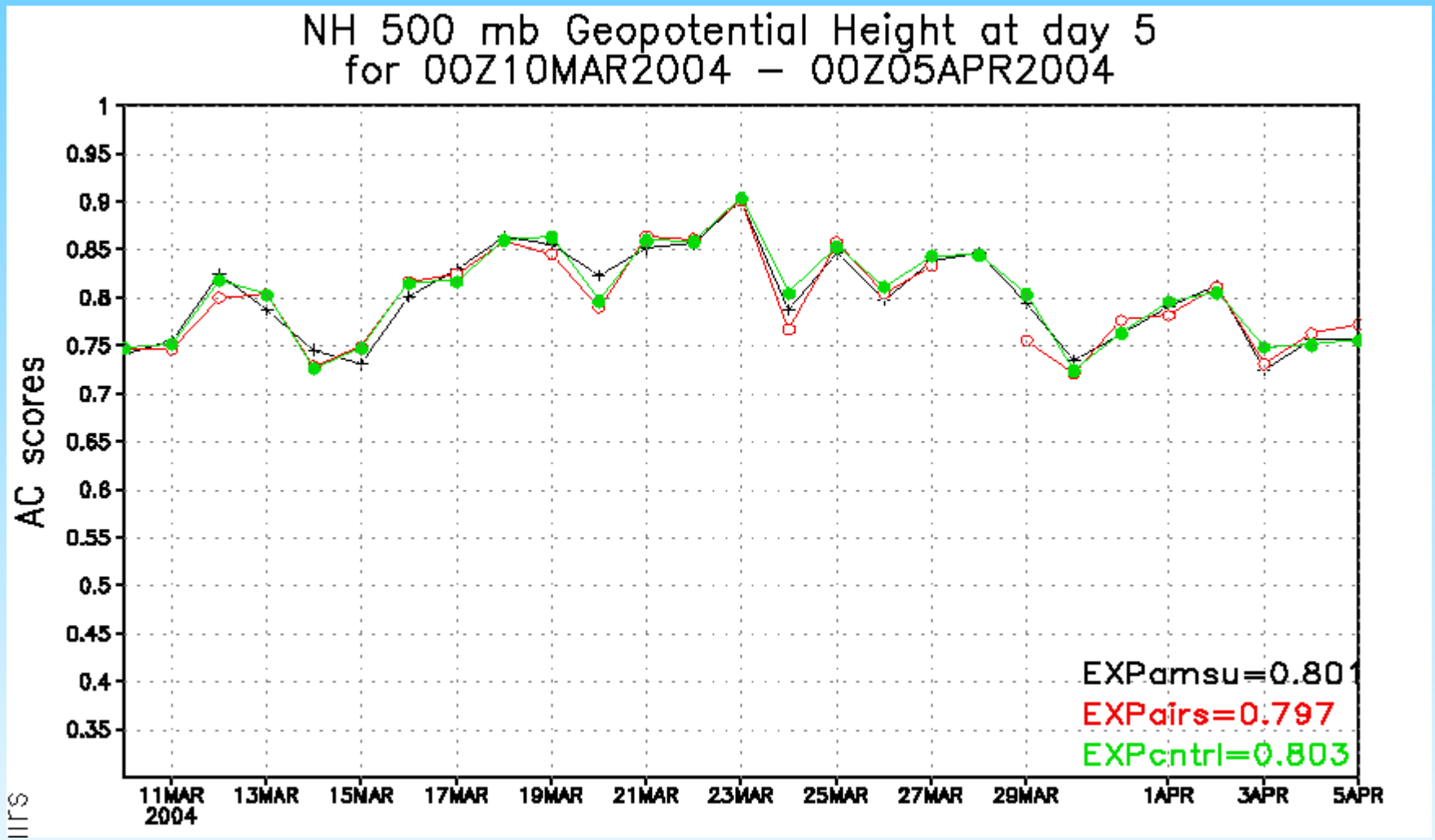
- 254 out of 281 channels used
  - 73-86 removed (channels peak too high)
  - 1937-2109 removed (non-LTE)
  - 2357 removed (large obs-background diff.)
- Shortwave channels during day
  - (wavenumber > 2000) down weighted
  - (wavenumber > 2400) removed

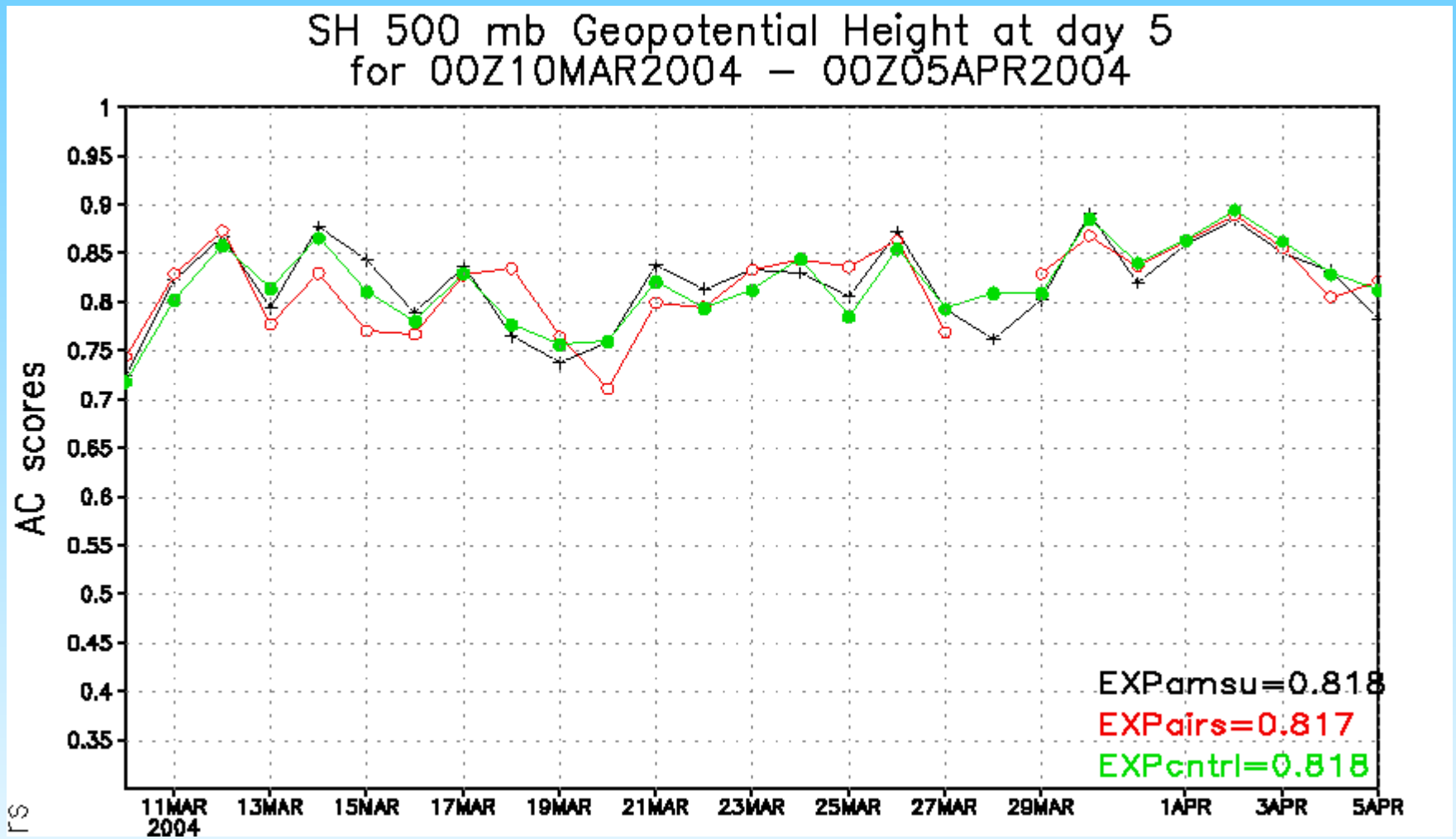
AIRS observational errors

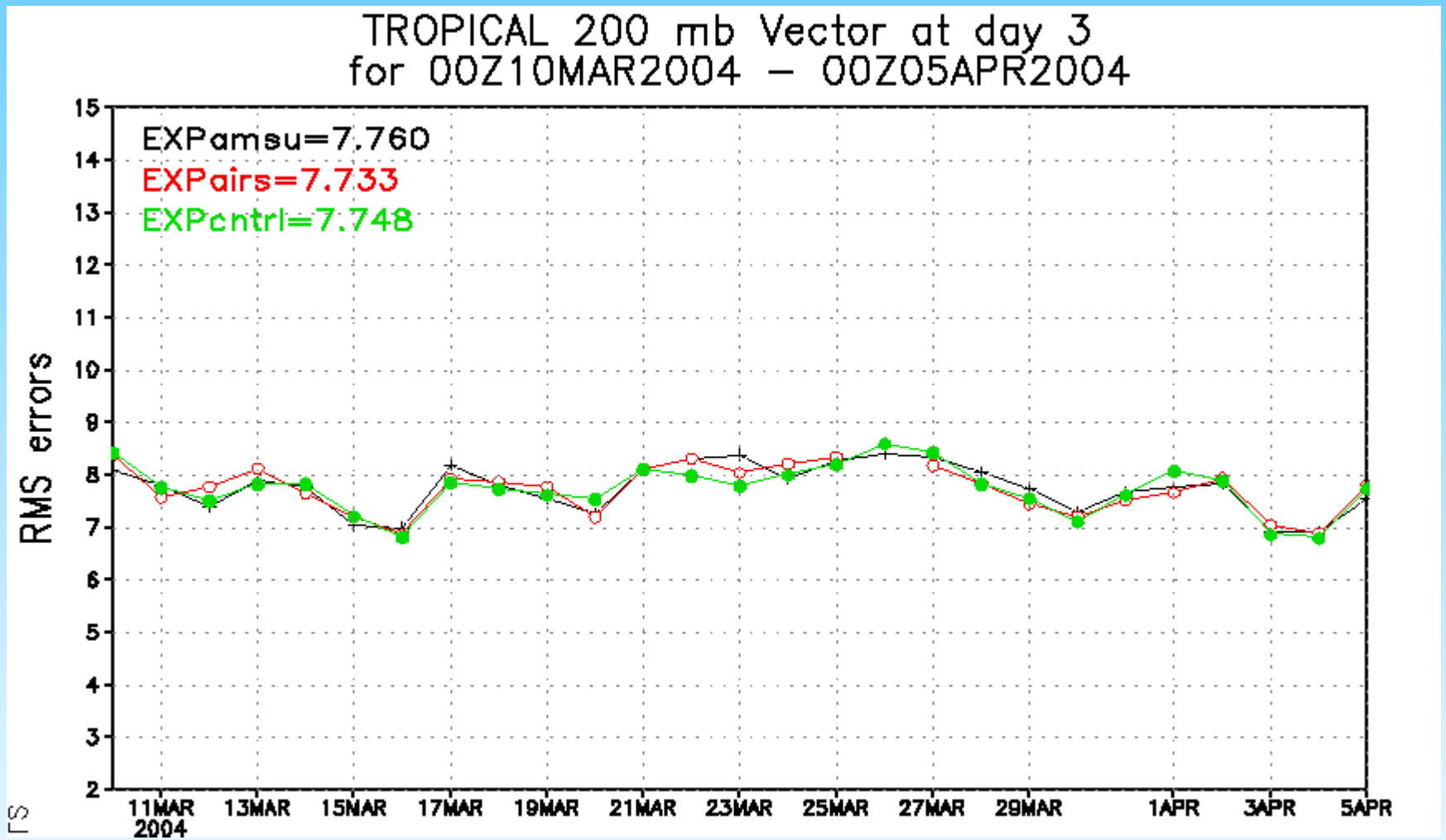


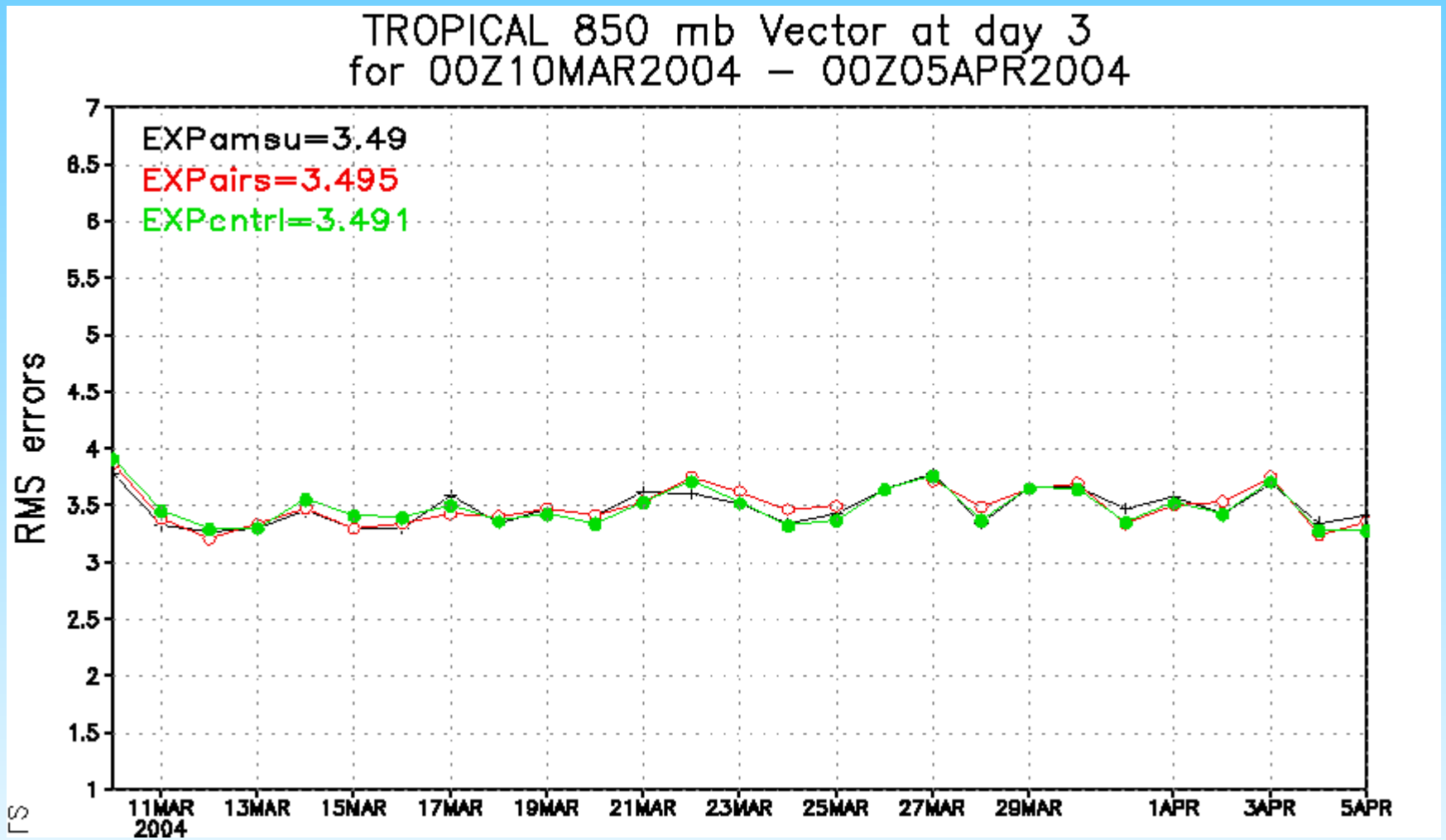
AQUA impact studies

- Test period 10 Mar – 5 Apr 2004
- Uses data operational at time of experiment
- Mass storage problems on our machine, so some incomplete evaluation
- Experiments
  - Current operational
  - Current + AIRS
  - Current + AQUA AMSU
  - Current + AIRS + AQUA AMSU (underway)


NH 500 mb Geopotential Height at day 5
for 00Z10MAR2004 – 00Z05APR2004
AC scores
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
11MAR 2004
13MAR
15MAR
17MAR
19MAR
21MAR
23MAR
25MAR
27MAR
29MAR
1APR
3APR
5APR
EXPamsu=0.801
EXPairs=0.797
EXPcntrl=0.803


SH 500 mb Geopotential Height at day 5
for 00Z10MAR2004 – 00Z05APR2004
AC scores
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
11MAR
2004
13MAR
15MAR
17MAR
19MAR
21MAR
23MAR
25MAR
27MAR
29MAR
1APR
3APR
5APR
EXPamsu=0.818
EXPairs=0.817
EXPcntrl=0.818


TROPICAL 200 mb Vector at day 3
for 00Z10MAR2004 – 00Z05APR2004
EXPamsu=7.760
EXPairs=7.733
EXPcntrl=7.748
RMS errors
15
14
13
12
11
10
9
8
7
6
5
4
3
2
11MAR
2004
13MAR
15MAR
17MAR
19MAR
21MAR
23MAR
25MAR
27MAR
29MAR
1APR
3APR
5APR


TROPICAL 850 mb Vector at day 3
for 00Z10MAR2004 – 00Z05APR2004
EXPamsu=3.49
EXPairs=3.495
EXPcntrl=3.491
RMS errors
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
11MAR
2004
13MAR
15MAR
17MAR
19MAR
21MAR
23MAR
25MAR
27MAR
29MAR
1APR
3APR
5APR

AIRS Comments

- Results with both AIRS and AQUA AMSU similar so far
- AIRS data used when radiances clear (above and between clouds) – 38 % of thinned data used
- To date – little impact of AIRS data
- Adds 7-8 minutes to analysis wall time
- Impact studies continuing

Final Comments

- Improvements in assimilation results dependent on all components of assimilation system
  - Development of next generation GSI analysis system with situation dependent background errors
  - Improvements to RT, forecast models, bias correction, quality control and data selection procedures
  - Incorporation of many new microwave, IR, GPS based sensors (including high spectral resolution IR sensors)
- Use of data must also satisfy operational constraints concerning timeliness and computational cost.

Final Comments

- To date, high spectral resolution IR radiances have not shown significant impact on our system
- Many additional experiments could be performed:
  - Superchannels
  - Principle components
  - Cloud cleared radiances
  - Higher spatial resolution
  - Different channel selection
- Where does this fit is priorities?