AIRS, HIRS and CSBT Experiments Plus Other FY05/06 Results

by

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References

Peer-Reviewed Publications:

Le Marshall, J., J. Jung, J. Derber, M. Chahine, R. Treadon, S. J. Lord, M. Goldberg, W. Wolf, H. C. Liu, J. Joiner, J. Woolen, R. Todling, P. Van Delst and Y. Tahara, 2006: **Atmospheric Infrared Sounder (AIRS) observations improve global analysis and forecast capability.** Submitted to *Bull. Amer. Meteor. Soc*.

Le Marshall, J., J. Jung, T. Zapotocny, J. Derber, R. Treadon, M. Goldberg and W. Wolf, 2006: **The Application of AIRS Radiances in Numerical Weather Prediction.** Submitted to *Aust. Meteor. Mag.* February 2006.

Zapotocny, T. H., J. A. Jung, J. F. Le Marshall, R. E. Treadon, 2006: **A Two Season Impact Study of Satellite and In-Situ Data in the NCEP Global Data Assimilation System.** Submitted to *Weather and Forecasting* May 2006.

Conference Papers/Posters Presented at 14th Conference on Satellite Meteorology and Oceanography or Eighth International Winds Workshop 2006 :

Jung, J. A., T. H. Zapotocny, R. E. Treadon, J. F. LeMarshall, 2006: **Atmospheric Infrared Sounder Assimilation Experiments using the National Center for Environmental Prediction's Global Forecast System.**

Le Marshall, J. F., J. A. Jung, J. Derber, R. Treadon, M. Goldberg, W. Wolf, and T. H. Zapotocny, 2006: **Assimilation of Atmospheric Infrared Sounder (AIRS) Observations at JCSDA.**

Le Marshall, J. F., T. Zapotocny, C. Redder, J. Jung, M. Dunn, R. Seecamp, L. P. Riishojgaard, A. Rea, J. Daniels, D. Santek, C. Velden, W. Bresky, 2006: **Error Characterization and use of Atmospheric Motion Vectors at the JCSDA.**

Santek, D., J. A. Jung, T. H. Zapotocny, J. Key, C. Velden, 2006: **Mechanisms that Propagate Polar Satellite Derived Atmospheric Motion Vector Information into Lower Latitudes.**

Zapotocny, T. H., J. A. Jung, R. E. Treadon, J. F. LeMarshall, 2006: **Recent MODIS Assimilation Experiments in the NCEP GDAS.**

Experiments Presented in This Talk

HIRS Experiment

Data Denial OSE

GOES Imager CSBT Experiment

OSE using AIRS

HIRS Assimilation Experiments

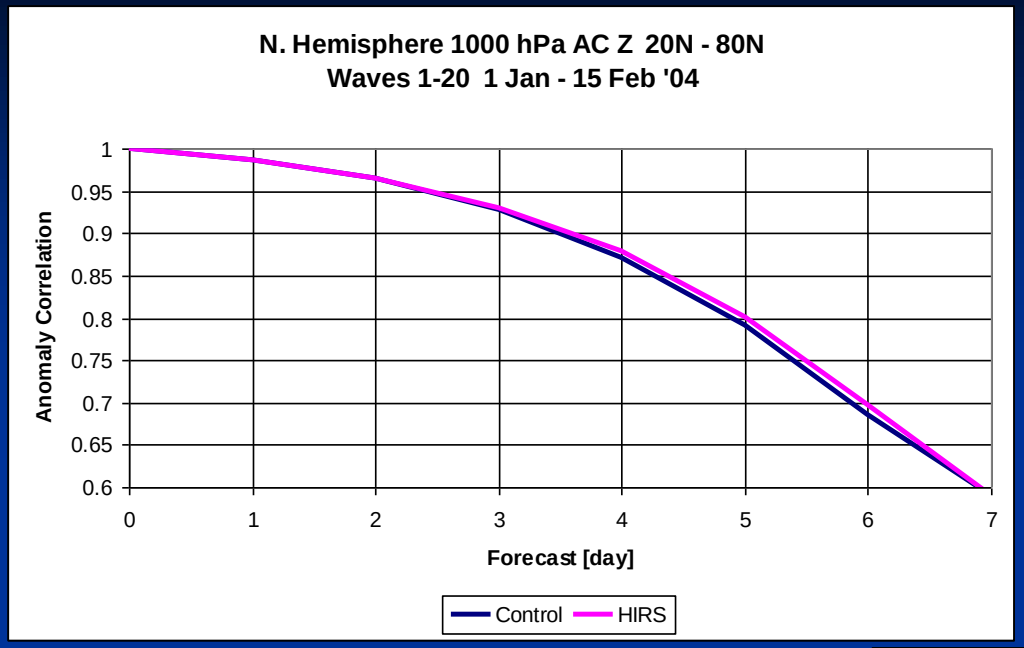
Experiment Design

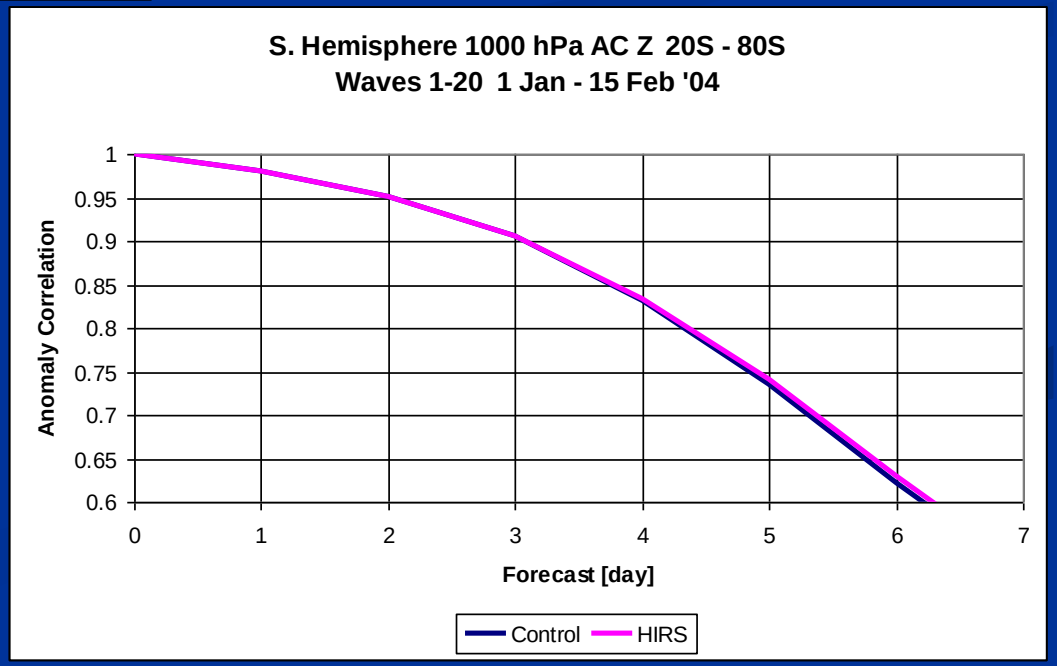
- T254L64
- Operational version of SSI and GFS
- AIRS and Aqua AMSU not used
- AMSU ice emissivity constant
- 1 Jan – 15 Feb 2004

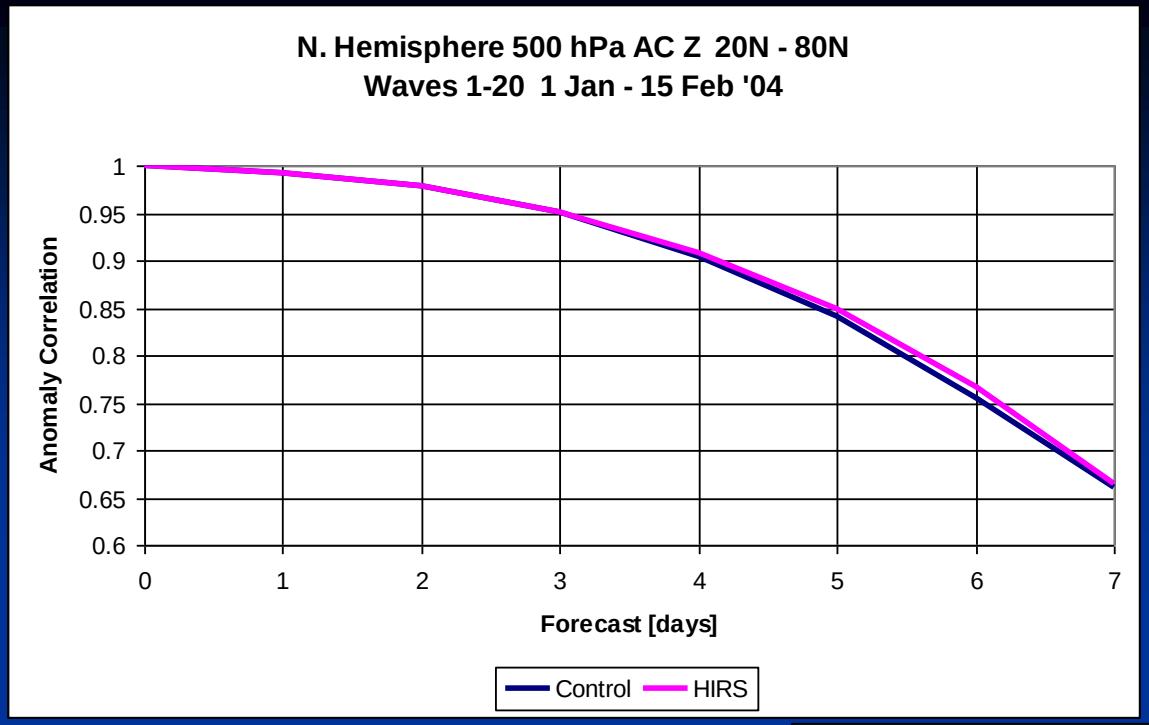
Assimilation Technique

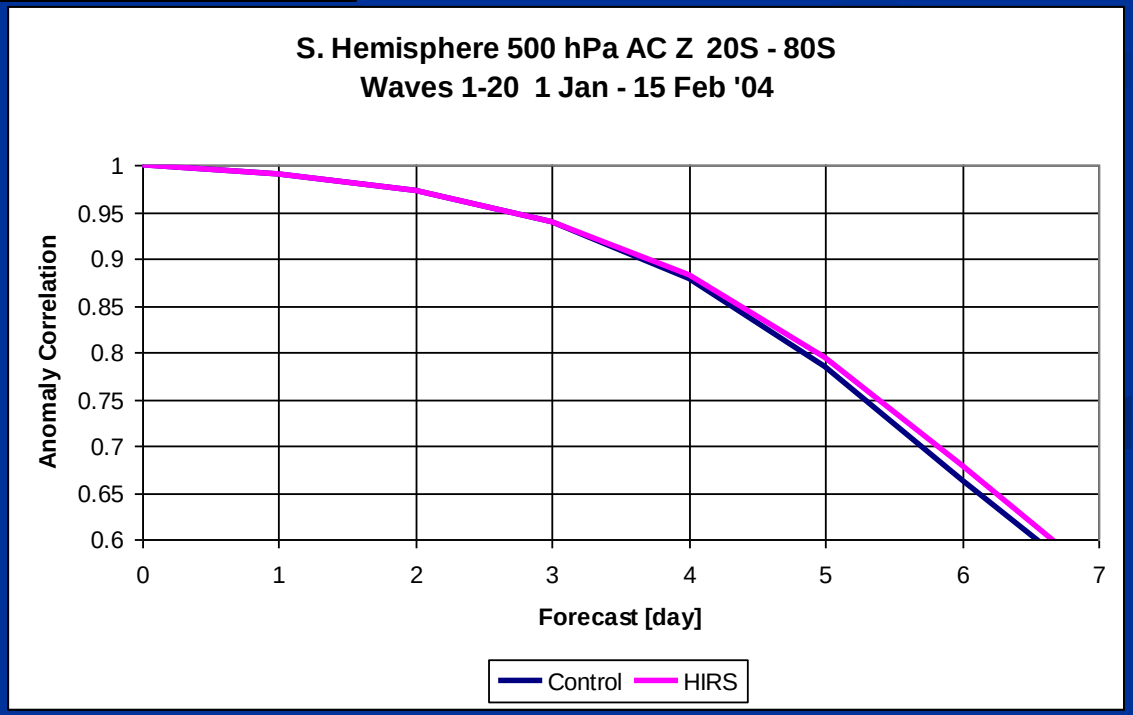
- Adjusted Assimilation Weights
- Night Land/Ocean Clear Test
  - Abs(11.11μm – 4.00μm + 1.0) < 2.0
  - Abs(11.11μm – 3.76μm) < 2.0
  - Abs(4.00μm – 3.76μm + .5) > 0.2
- Polar Inversion Test
  - 7.33μm – 11.11μm > 0.0
- Use warmest field of view in box
  - If other tests fail or not applicable

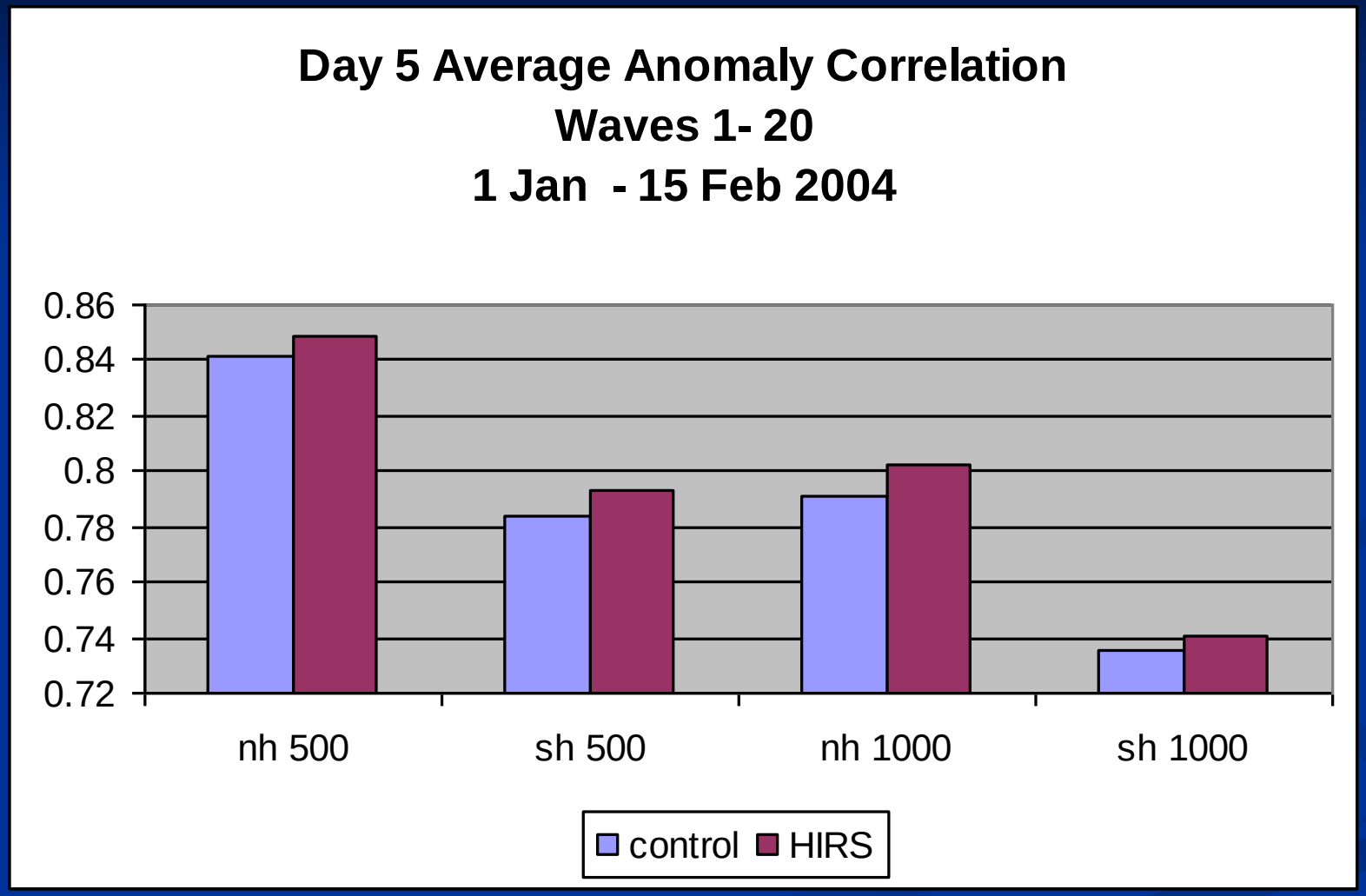
Results


N. Hemisphere 1000 hPa AC Z 20N - 80N
Waves 1-20 1 Jan - 15 Feb '04
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
1
2
3
4
5
6
7
Forecast [day]
Control
HIRS


S. Hemisphere 1000 hPa AC Z 20S - 80S
Waves 1-20 1 Jan - 15 Feb '04
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
1
2
3
4
5
6
7
Forecast [day]
Control
HIRS


N. Hemisphere 500 hPa AC Z 20N - 80N
Waves 1-20 1 Jan - 15 Feb '04
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
1
2
3
4
5
6
7
Forecast [days]
Control
HIRS


S. Hemisphere 500 hPa AC Z 20S - 80S
Waves 1-20 1 Jan - 15 Feb '04
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
1
2
3
4
5
6
7
Forecast [day]
Control
HIRS


Day 5 Average Anomaly Correlation
Waves 1- 20
1 Jan - 15 Feb 2004
0.86
0.84
0.82
0.8
0.78
0.76
0.74
0.72
nh 500
sh 500
nh 1000
sh 1000
control
HIRS

Future Plans

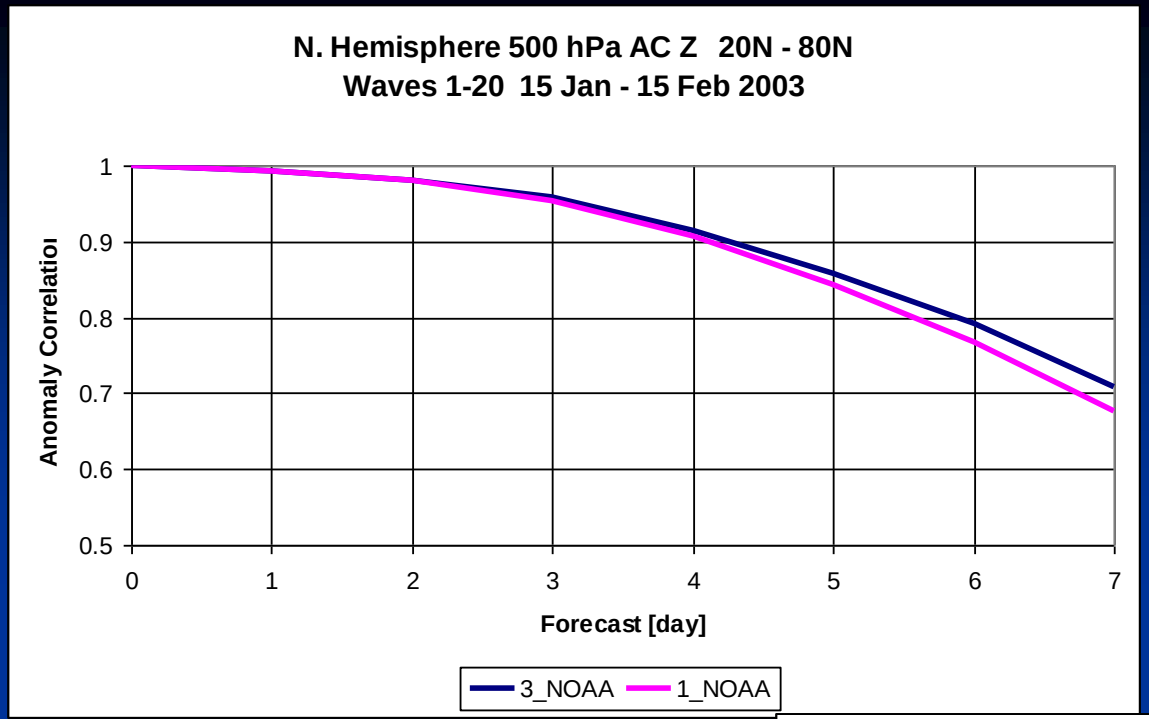
- T382L64
- Latest version of GSI (June 2006)
- Use hybrid version of GFS
- 2 Seasons
- Determine separate selection criteria for land and ocean (night only)
- Re-evaluate observation errors
- Continue literature search for potential selection criteria over snow and ice

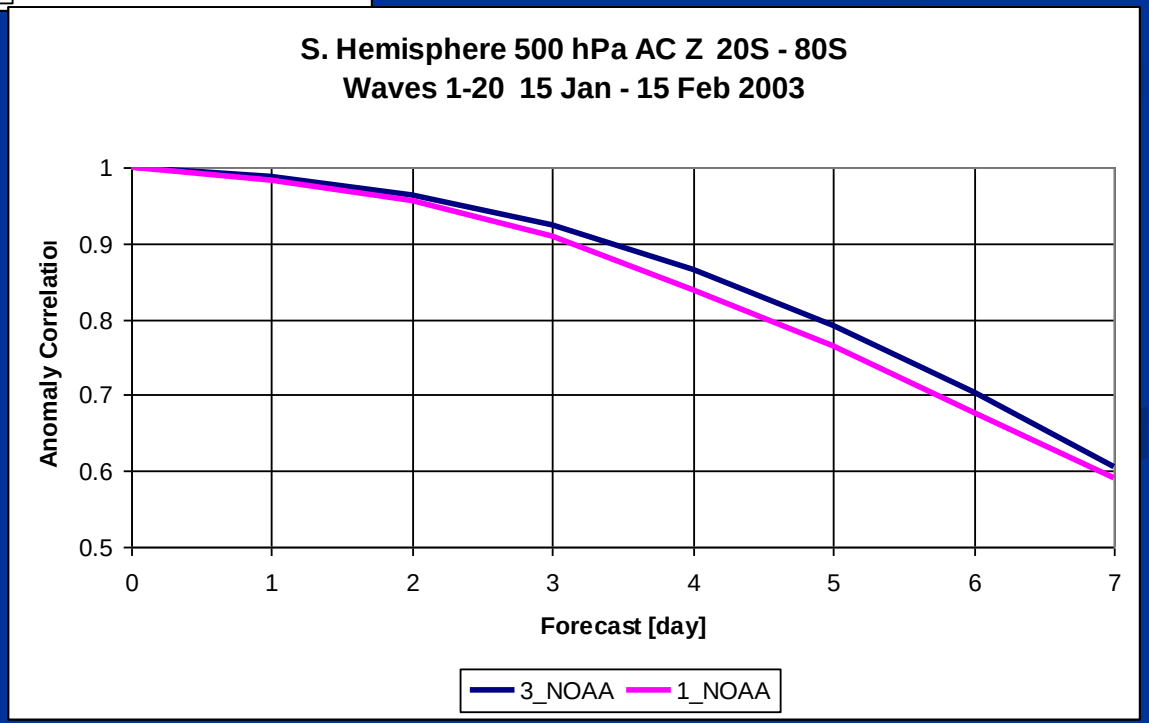
Data Denial Observing System Experiments

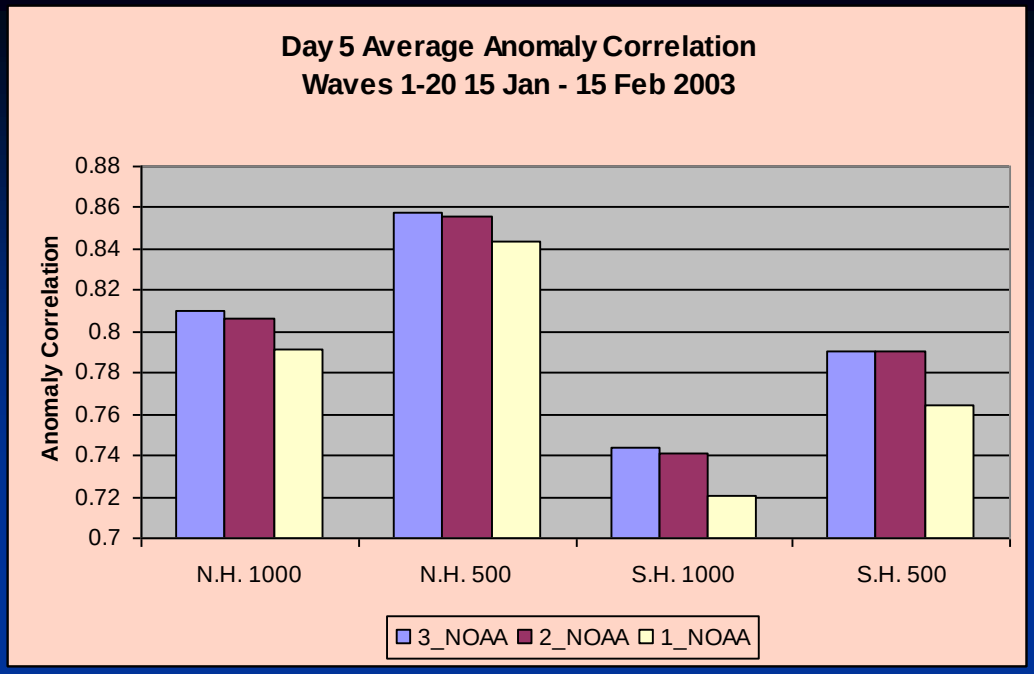
Polar Satellite Denials

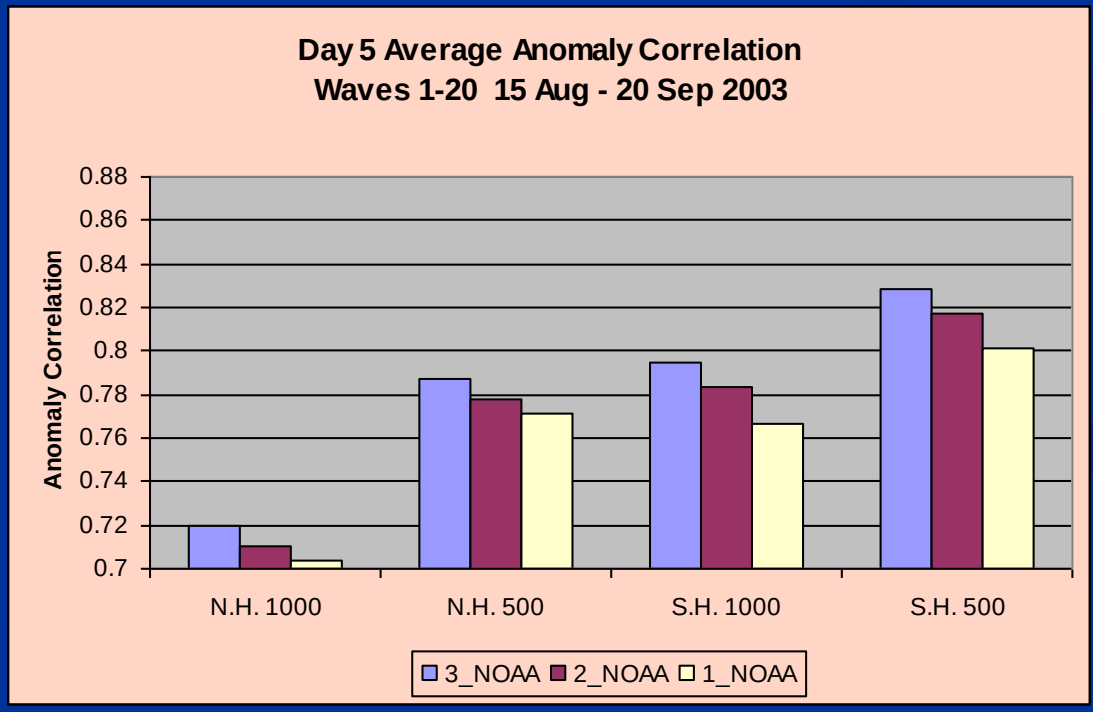
Experiment Design

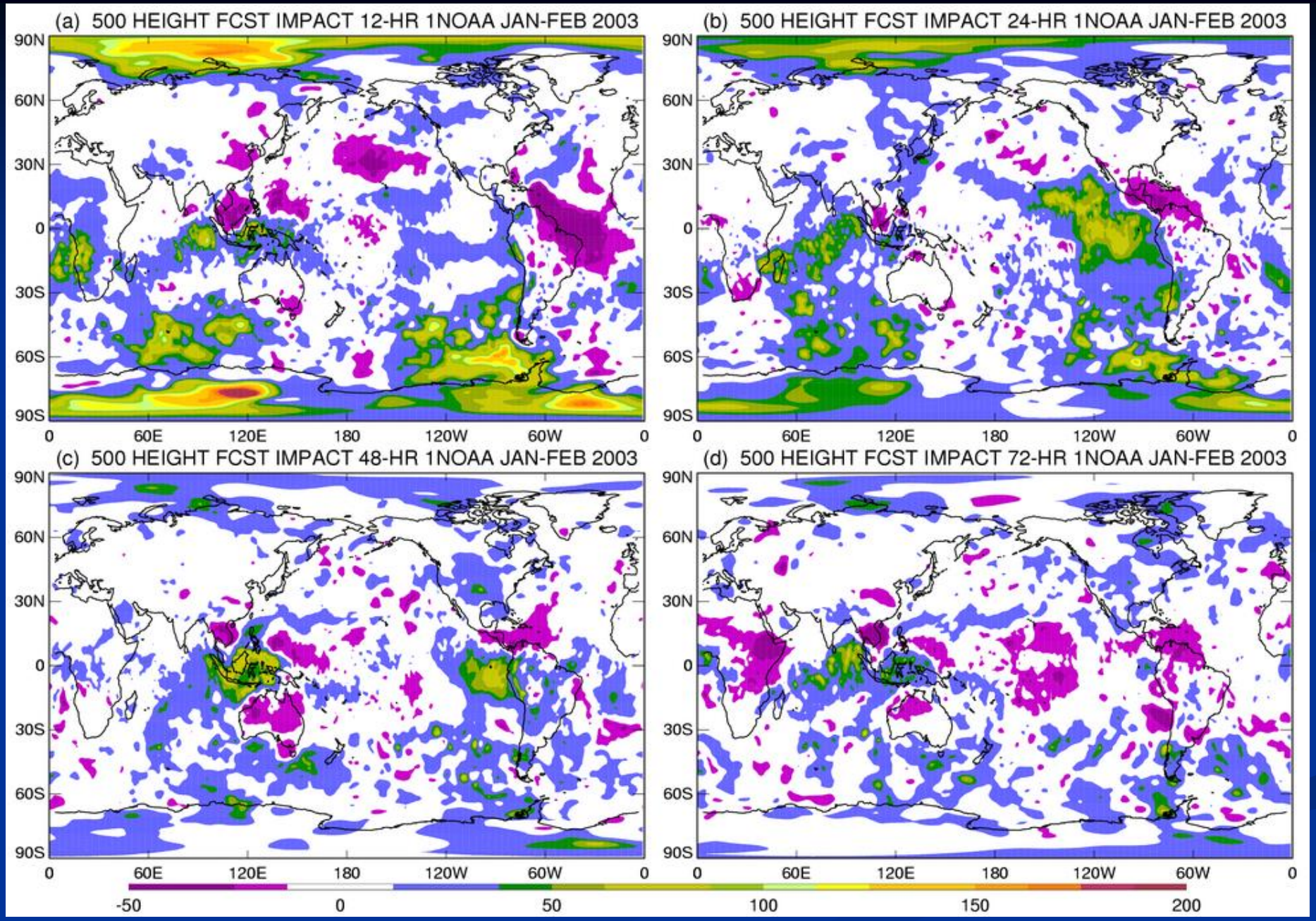
- Pre - Operational GDAS (Oct 2003)
- Control (3_NOAA)
  - All operational data
  - NOAA-15, 16, 17 used
- Deny NOAA – 15 (2_NOAA)
  - AMSU
- Deny NOAA – 15, 16 (1_NOAA)
  - 15 AMSU
  - 16 AMSU and HIRS


N. Hemisphere 500 hPa AC Z 20N - 80N
Waves 1-20 15 Jan - 15 Feb 2003
Anomaly Correlatio
1
0.9
0.8
0.7
0.6
0.5
0
1
2
3
4
5
6
7
Forecast [day]
3_NOAA
1_NOAA


S. Hemisphere 500 hPa AC Z 20S - 80S
Waves 1-20 15 Jan - 15 Feb 2003
Anomaly Correlatio
1
0.9
0.8
0.7
0.6
0.5
0
1
2
3
4
5
6
7
Forecast [day]
3_NOAA
1_NOAA


Day 5 Average Anomaly Correlation
Waves 1-20 15 Jan - 15 Feb 2003
Anomaly Correlation
0.88
0.86
0.84
0.82
0.8
0.78
0.76
0.74
0.72
0.7
N.H. 1000
N.H. 500
S.H. 1000
S.H. 500
3_NOAA
2_NOAA
1_NOAA


Day 5 Average Anomaly Correlation
Waves 1-20 15 Aug - 20 Sep 2003
Anomaly Correlation
0.88
0.86
0.84
0.82
0.8
0.78
0.76
0.74
0.72
0.7
N.H. 1000
N.H. 500
S.H. 1000
S.H. 500
3_NOAA
2_NOAA
1_NOAA



Impact of 3_NOAA vs 1_NOAA

Table: Atlantic Basin average forecast error (km) during 2004.

12.8	**29.3**	45.9	61.1	70.9	105.7	153.6	**196.1**	1 NOAA
14.7	29.6	47.6	65.0	80.4	119.3	156.0	214.7	2 NOAA
12.2	31.8	**45.6**	**59.4**	**70.6**	**103.0**	**137.3**	201.4	3 NOAA
38	36	31	30	25	19	17	15	# cases
00-hr	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr	Fcst Hr

Results compiled by Qingfu Liu

Analysis is continuing

GOES Imager Clear Sky Brightness Temperature Assimilation Experiments (CSBT)

Experiment Design

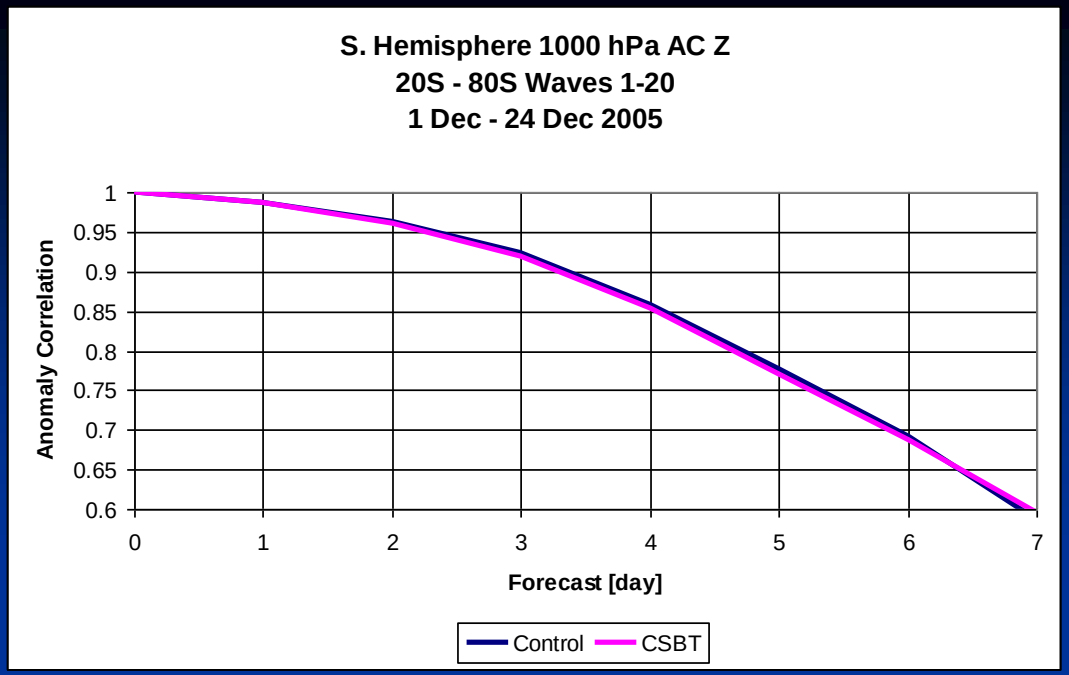
- Current Operational version of GFS and SSI
- T382L64
- Observation errors from table
- 1 Dec – 24 Dec 2005
- Tested 2 scenarios
  - Water vapor channel only (channel 3)
  - The 4 IR channels (channels 2, 3, 4, 5 or 6)
- Collected statistics from all channels

Assimilation Technique

- Thinned to 180 Km assimilation box
  - Introduced since previous test
- Minimum Standard deviation chosen in each box
  - Standard deviation must be less than 0.6
- Must have 20% or more clear pixels
- Channel 2 used only at night
- Surface channels used only over ocean
  - Channels 2, 4, 5 or 6
- Data used only at 6 hour synoptic time

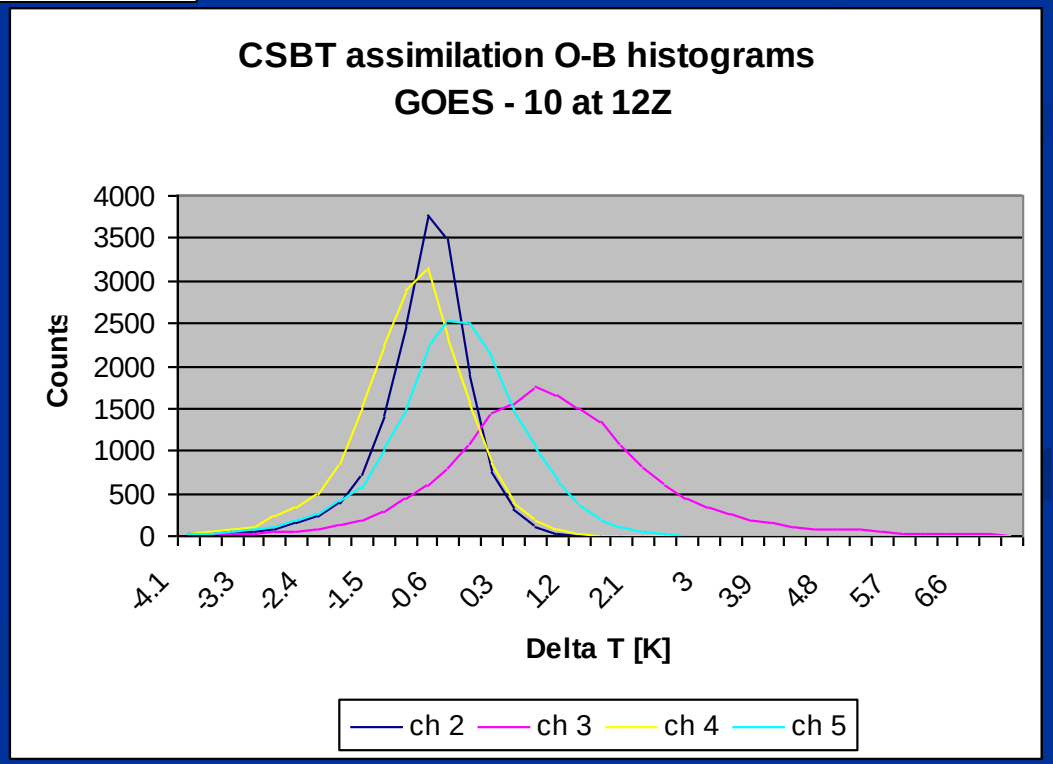
Assimilation Results

- More observations used/passed QC than in previous version
  - Better cloud clearing
  - Midnight effect fixed
- Neutral in Northern Hemisphere
- Slight negative in Southern Hemisphere
- Slight negative in Tropics
- Histograms still have cloud contaminated tail.



Chan 3 OK

Chan 2, 4, 5/6 still have cold tails



Recommendations made to NESDIS

- Change the standard deviation cutoff factor in the cloud mask from 1.2 to 1.0 for channels 4 and 5 (or 6)
  - Remove more cloud contamination from observations
- Increase the precision of the standard deviation in the BUFR file from 0.1 to 0.01
  - Allow for better selection of observations by the assimilation system

Future Plans

- Re-evaluate data and assimilation technique after modifications are made to the real-time data
- Switch to latest version of GSI (June 2006)
- Use Hybrid version GFS
- T382L64 if possible
- Test all 4 channels for impact

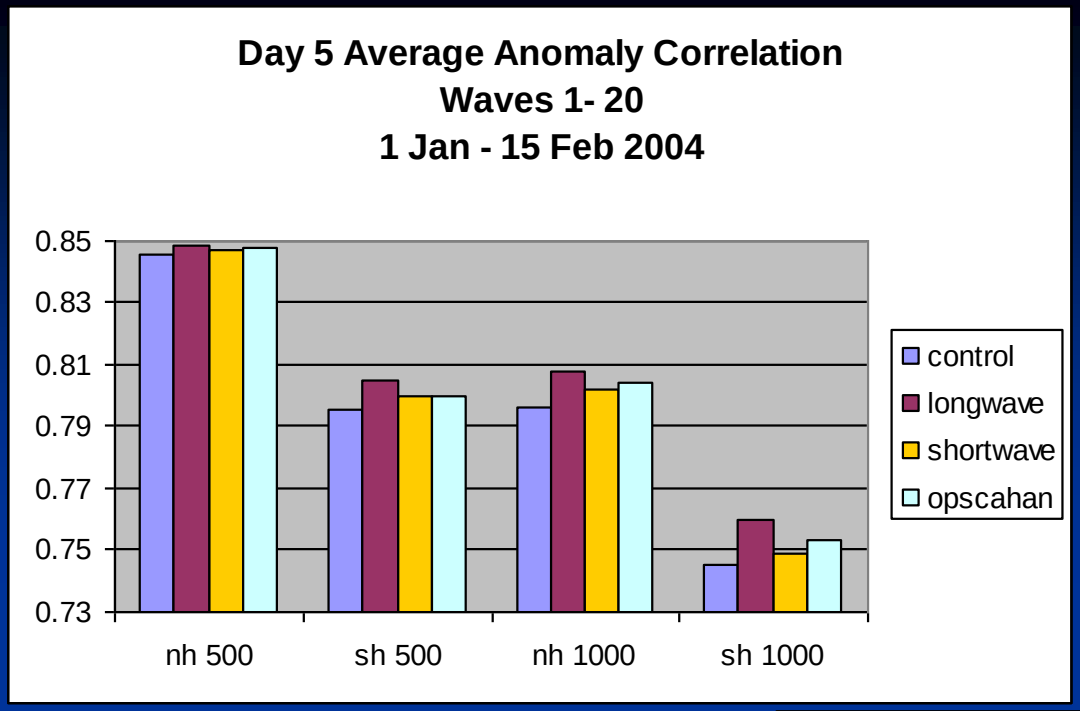
Observing System Experiments Using AIRS

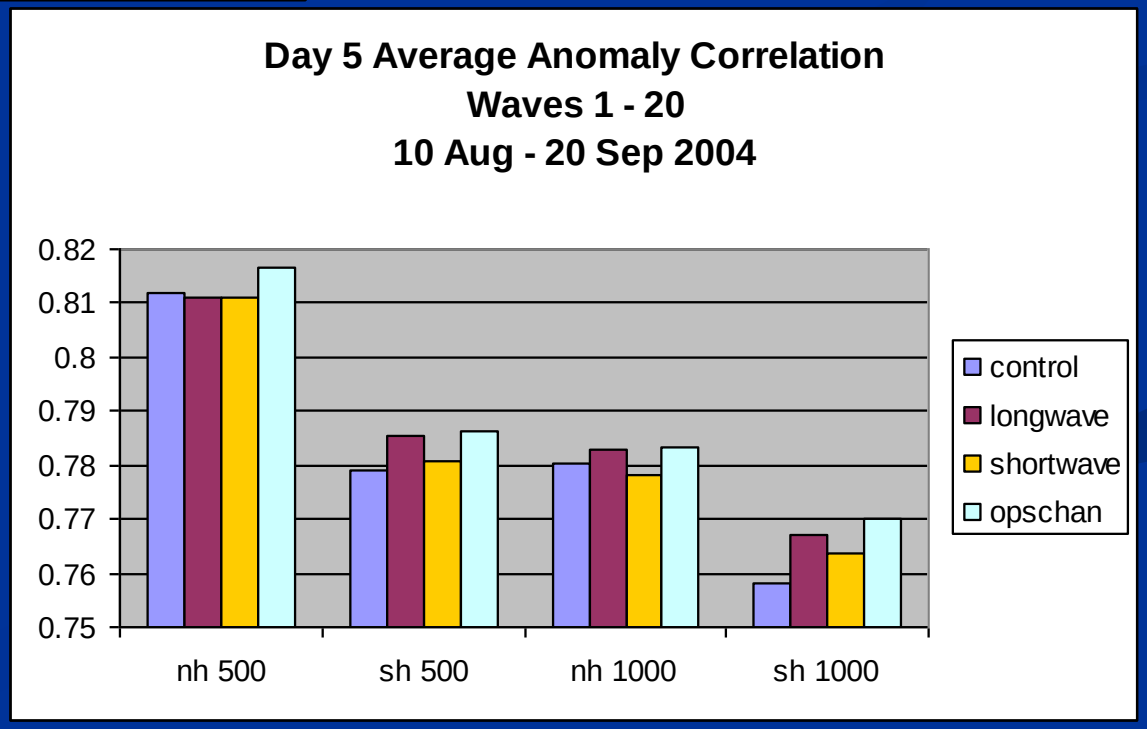
Experiment Design

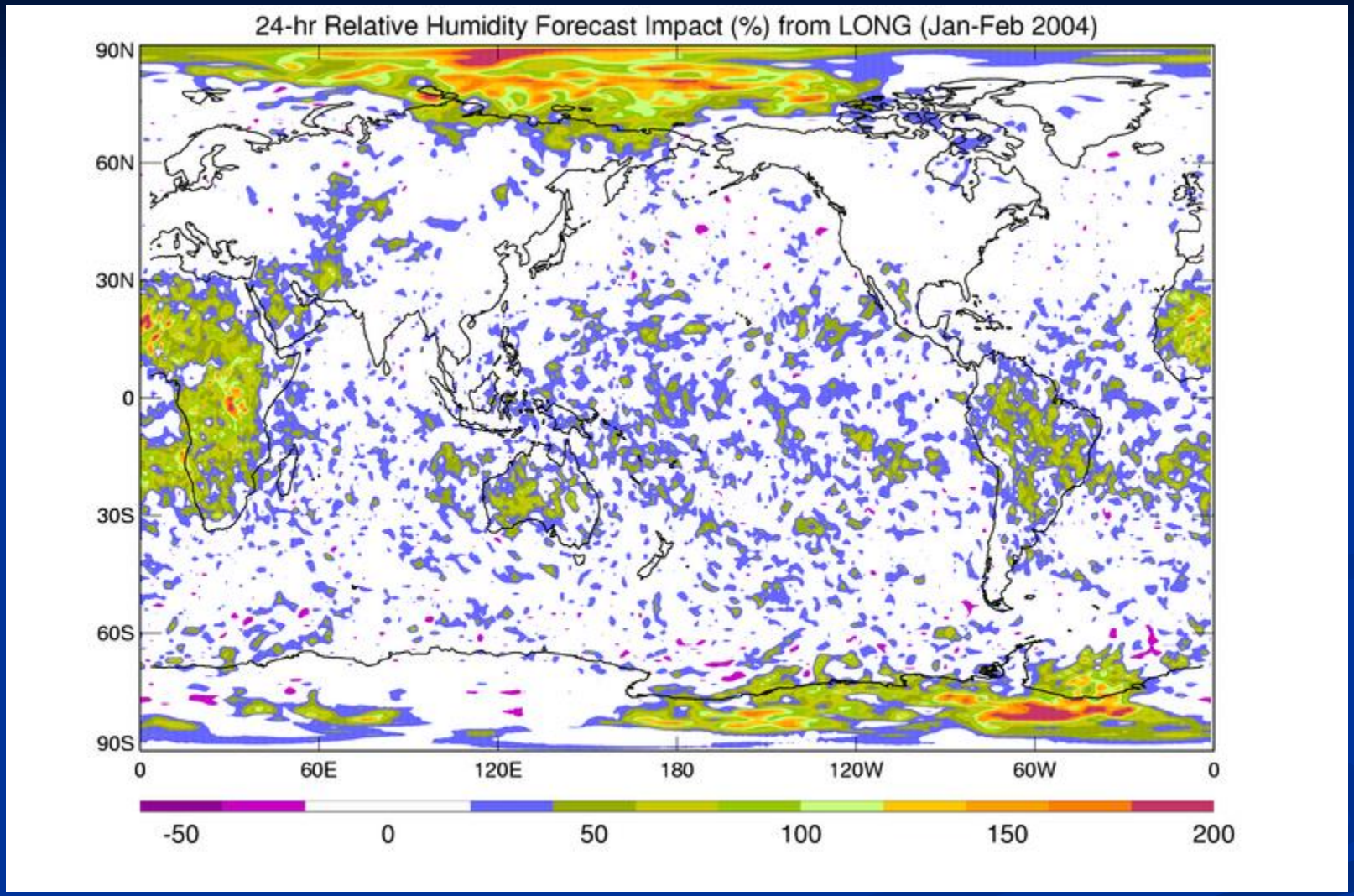
- T254L64
- Operational SSI and GFS
- Operational selection criteria
  - Warmest spot
- Tests checked every field of view
- AMSU ice emissivity constant
- AQUA AMSU on for control and all experiments

Assimilation Techniques

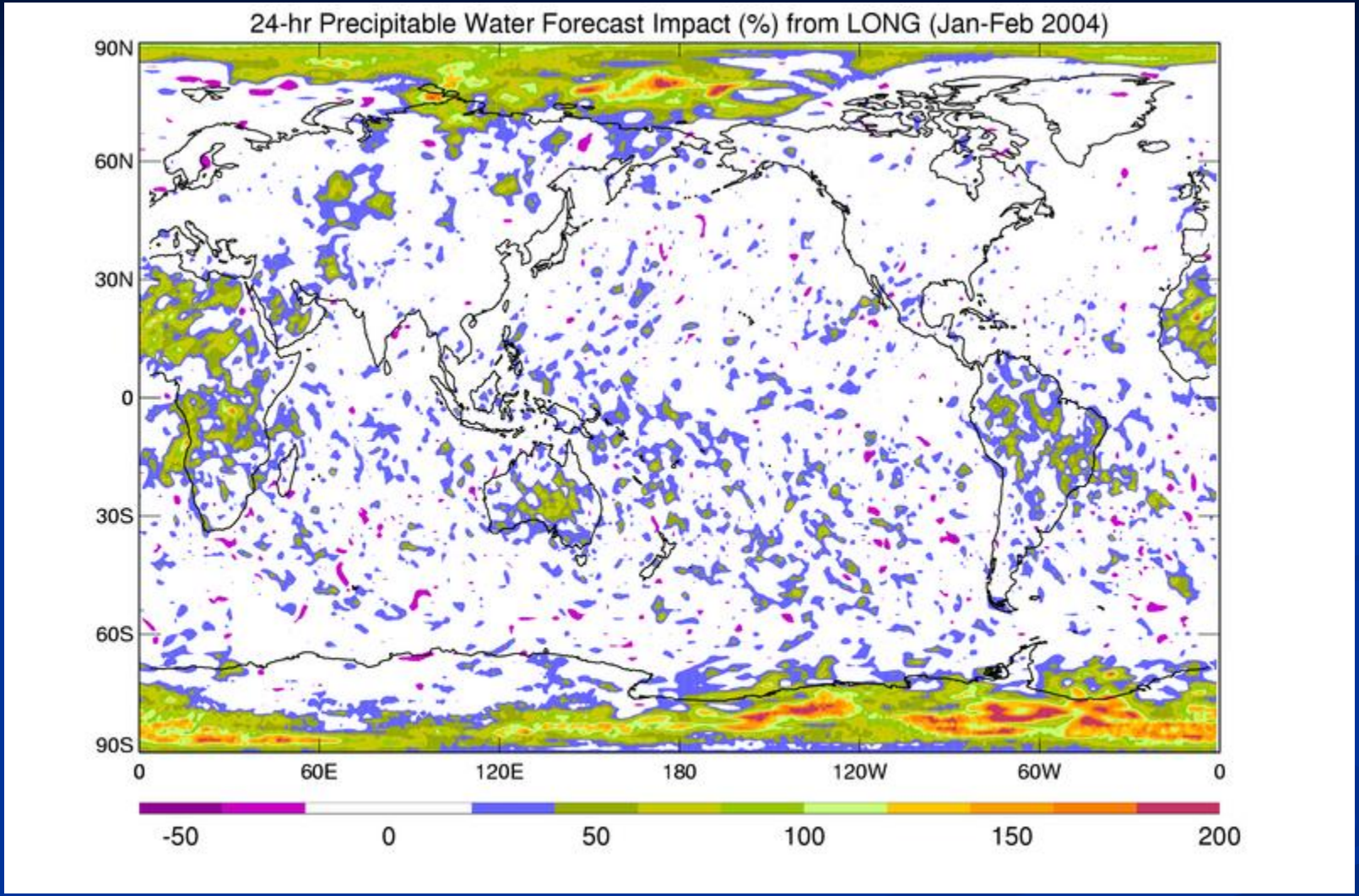
- All AIRS channels off (control)
- 115 Channels on from 3.76 – 9.13μm (shortwave)
- 152 Channels on from 3.76 -15.40μm (opschan)
- 251 Channels on from 3.76 – 15.40μm (longwave)


Day 5 Average Anomaly Correlation
Waves 1- 20
1 Jan - 15 Feb 2004
0.85
0.83
0.81
0.79
0.77
0.75
0.73
nh 500
sh 500
nh 1000
sh 1000
control
longwave
shortwave
opscahan

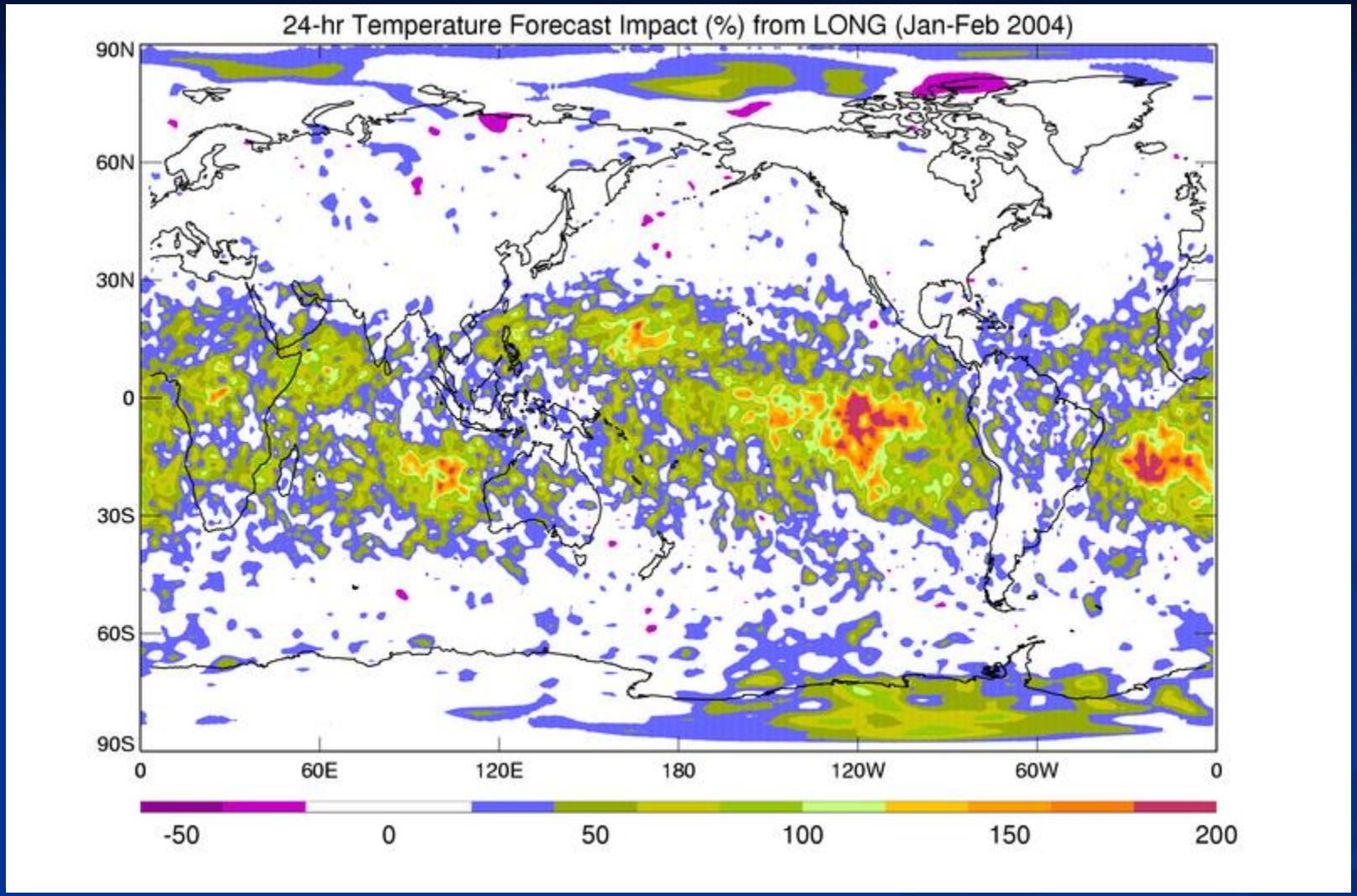

Day 5 Average Anomaly Correlation
Waves 1 - 20
10 Aug - 20 Sep 2004
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
nh 500
sh 500
nh 1000
sh 1000
control
longwave
shortwave
opschan



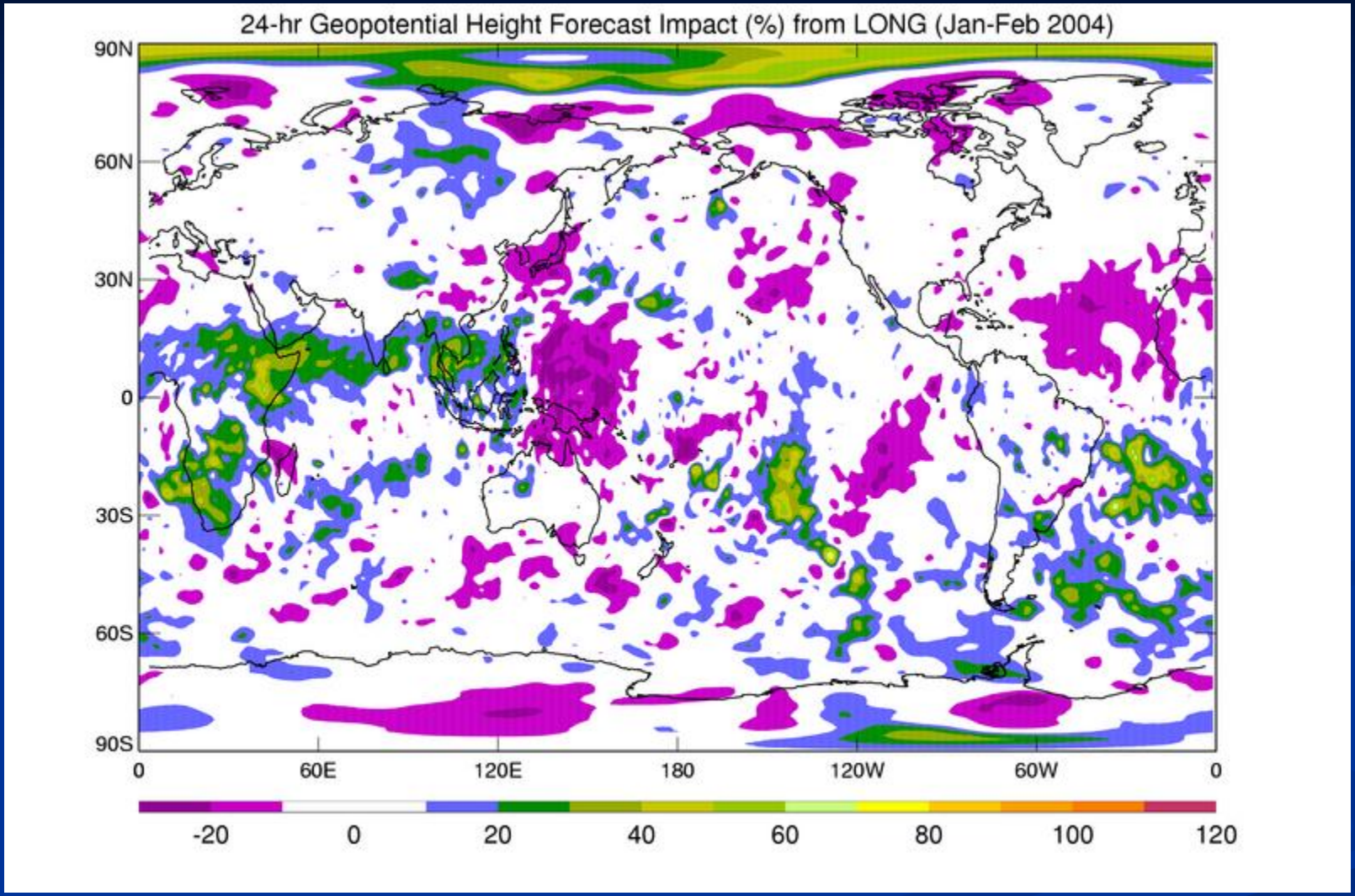
24-hr 850 hPa Relative Humidity for longwave experiment



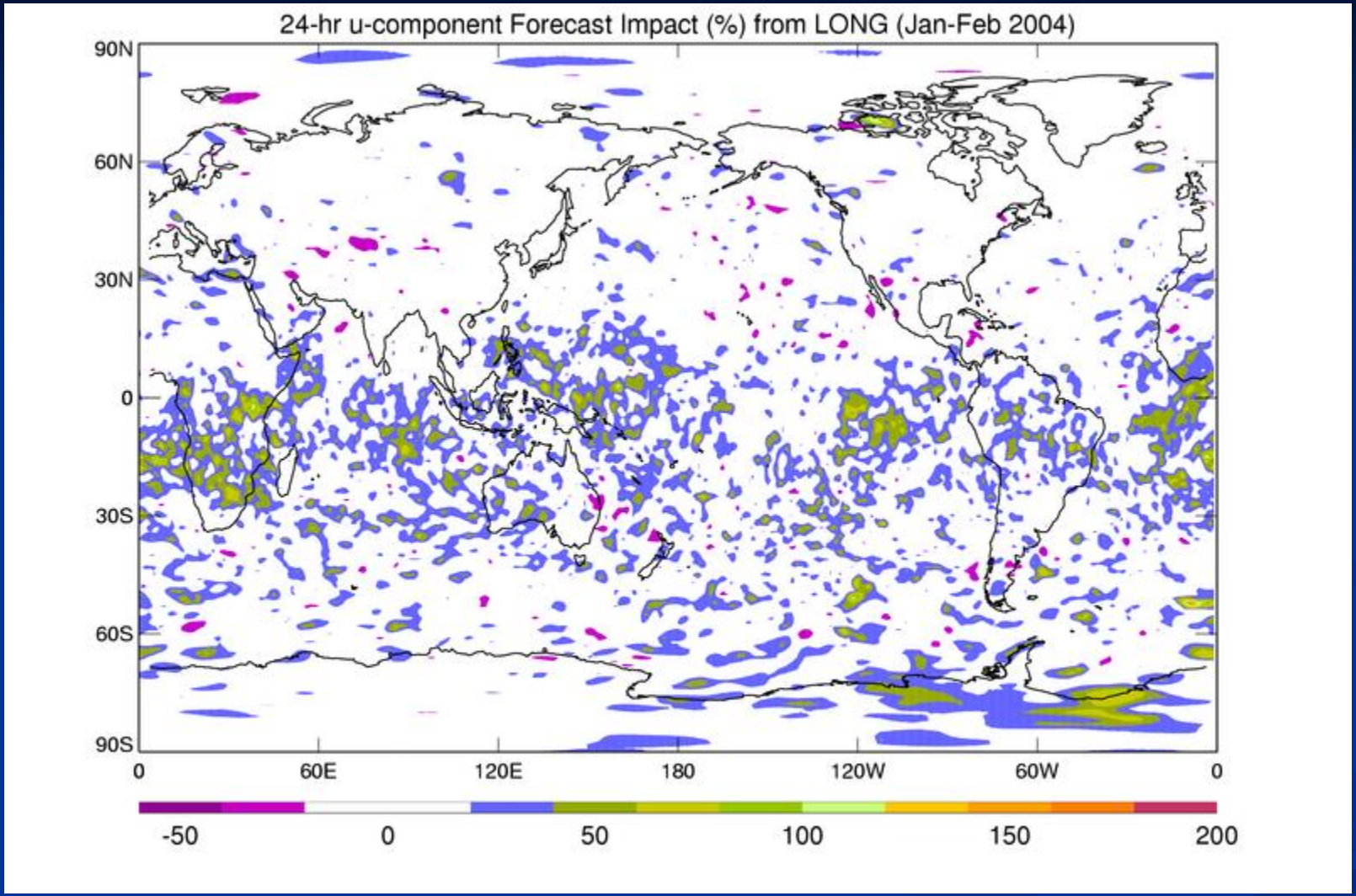
24-hr Precipitable Water for longwave experiment



24-hr 500 hPa Temperature for longwave experiment



24-hr 500 hPa Geopotential Height for longwave experiment



24-hr 250 hPa U - Component for longwave experiment

Thank you:

Russ Treadon for coding, scripts and verification assistance.

NCEP (Stephen Lord) for computer resources and tape space.

Stacie Bender and Dennis Keyser for collecting and processing our various data streams.

The AIRS Science team.