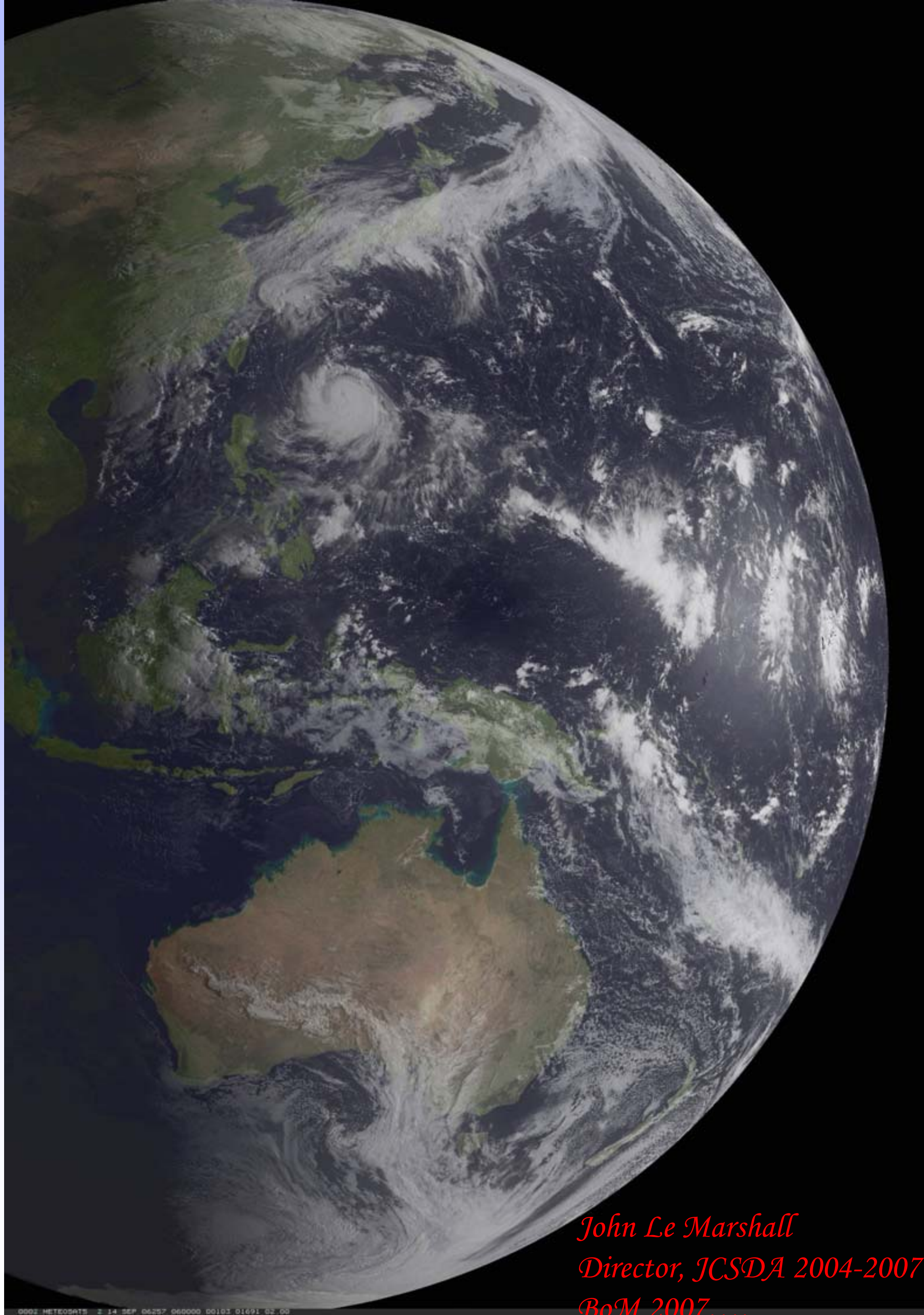
Using Cloudy AIRS Fields of View in Numerical Weather Prediction



John Le Marshall
Director, JCSDA 2004-2007
BoM 2007....

J. Le Marshall

J. Jung

L.-P. Riishojgaard

M. Goldberg

C. Barnet

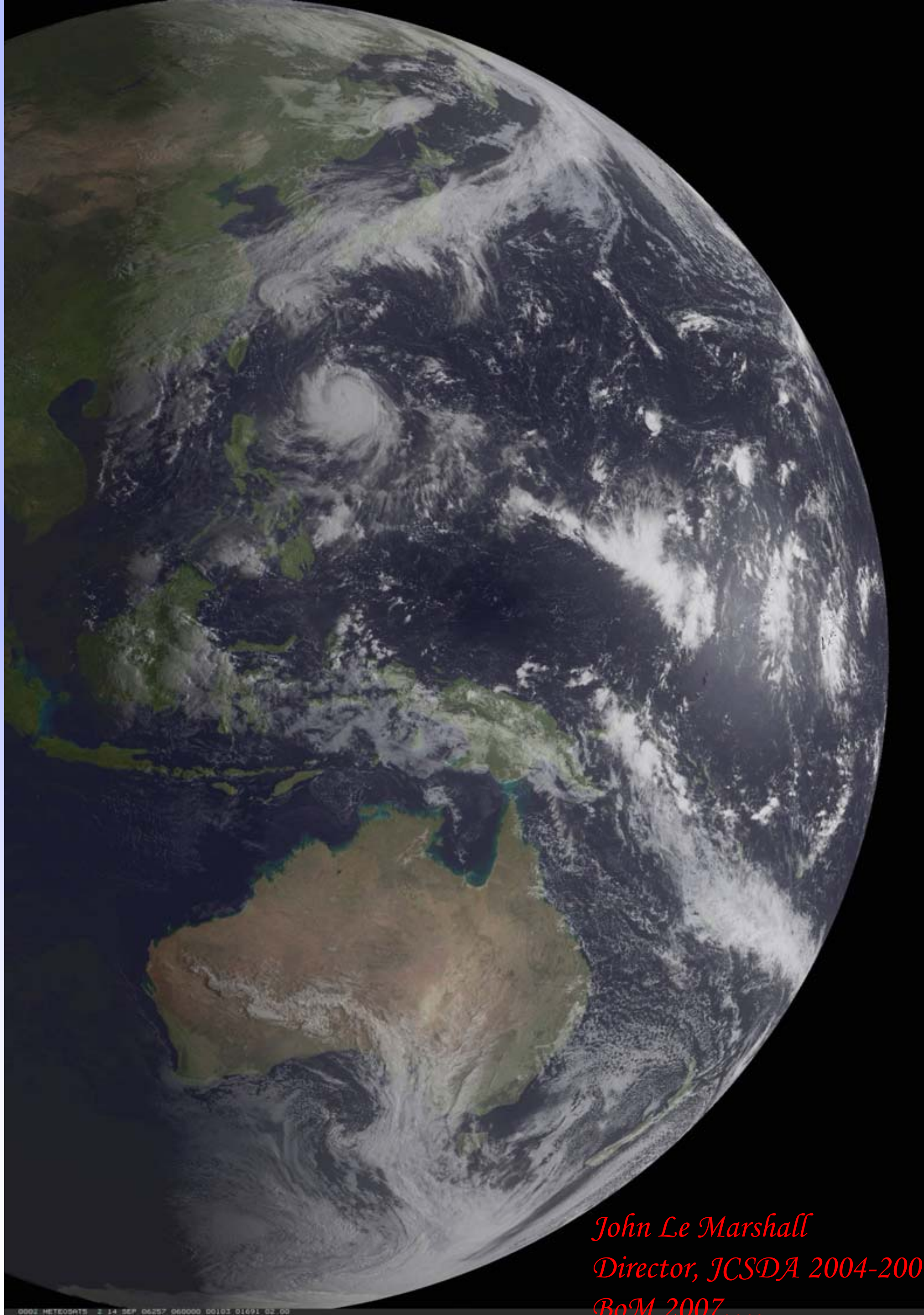
W. Wolf

J. Derber

R. Treadon

S. Lord

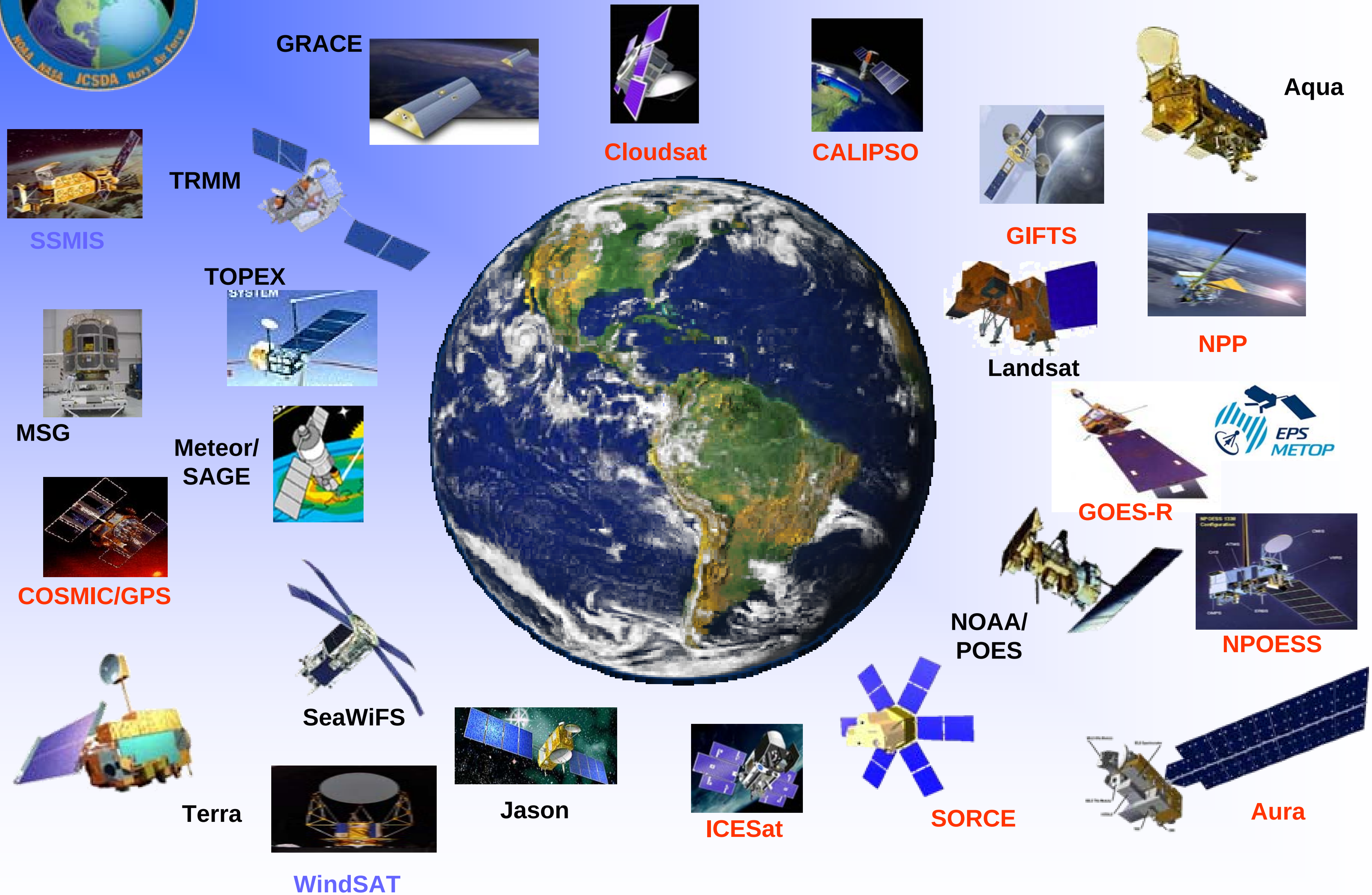
…….



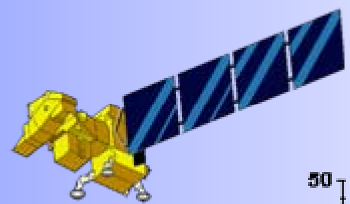
Overview

- The Challenge
- CAWCR
- Recent Data Impact Studies
- Use of hyperspectral radiances in NWP – Cloudy Radiances
- Plans/Future Prospects
- Summary

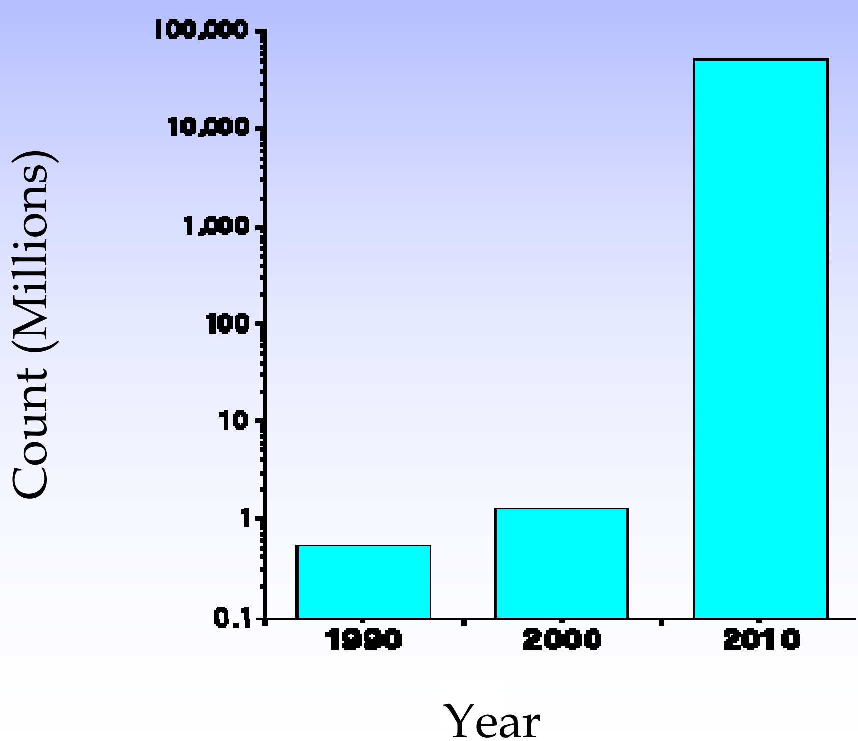
The Challenge
Satellite Systems/Global Measurements



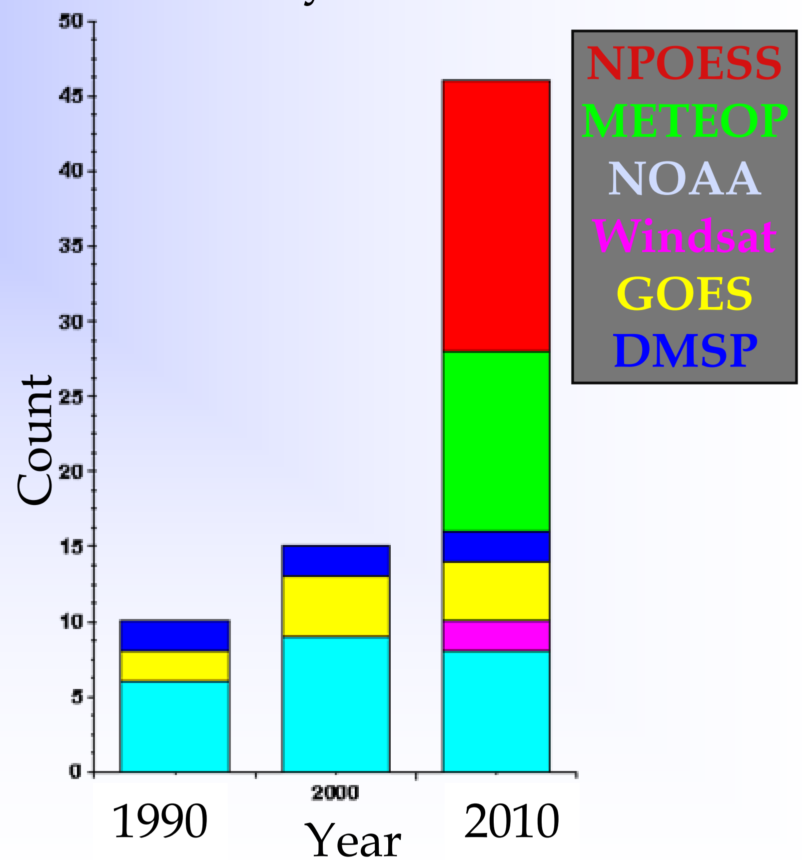
5-Order Magnitude Increase in Satellite Data Over 10 Years



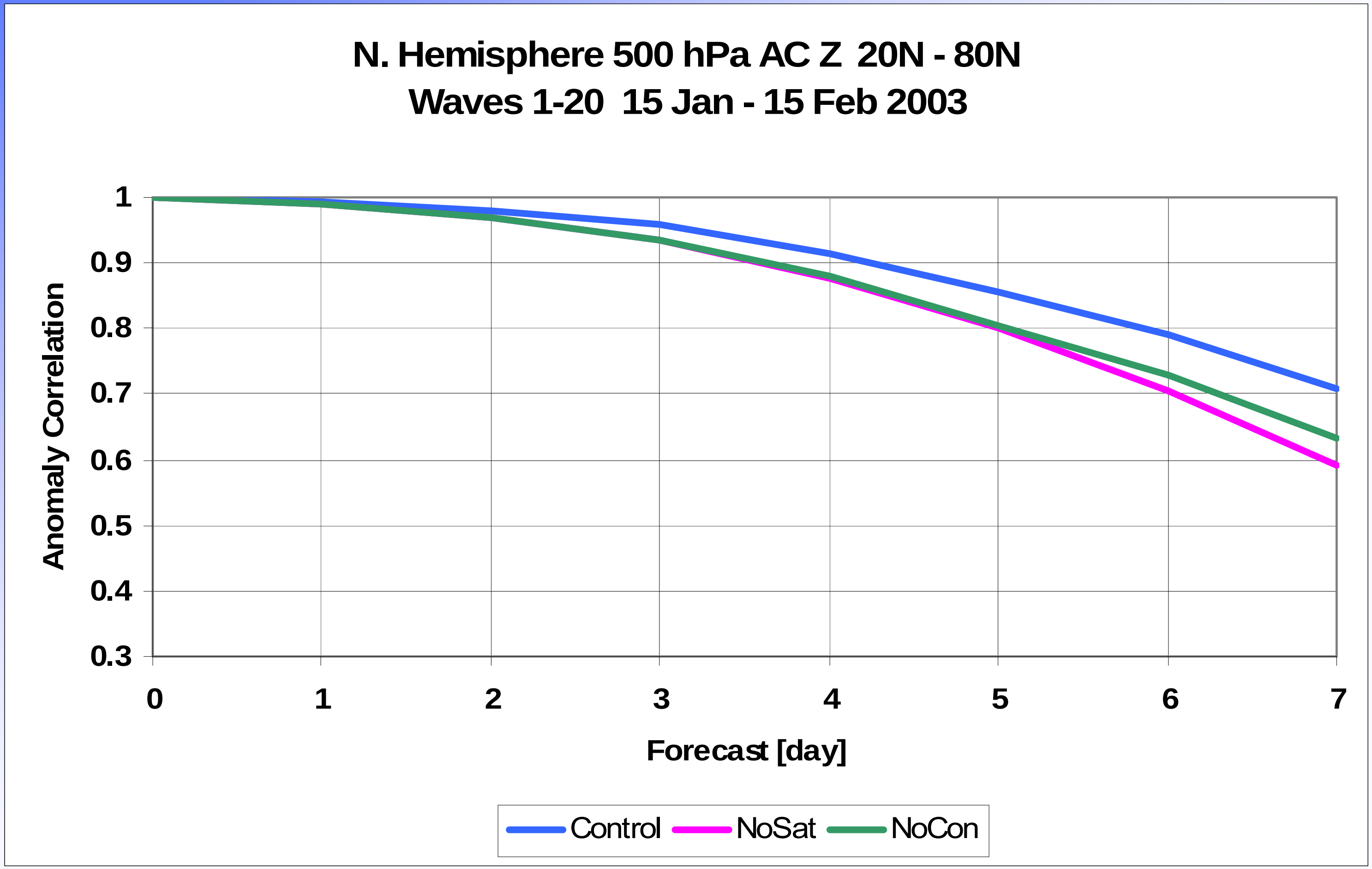
Daily Upper Air Observation Count



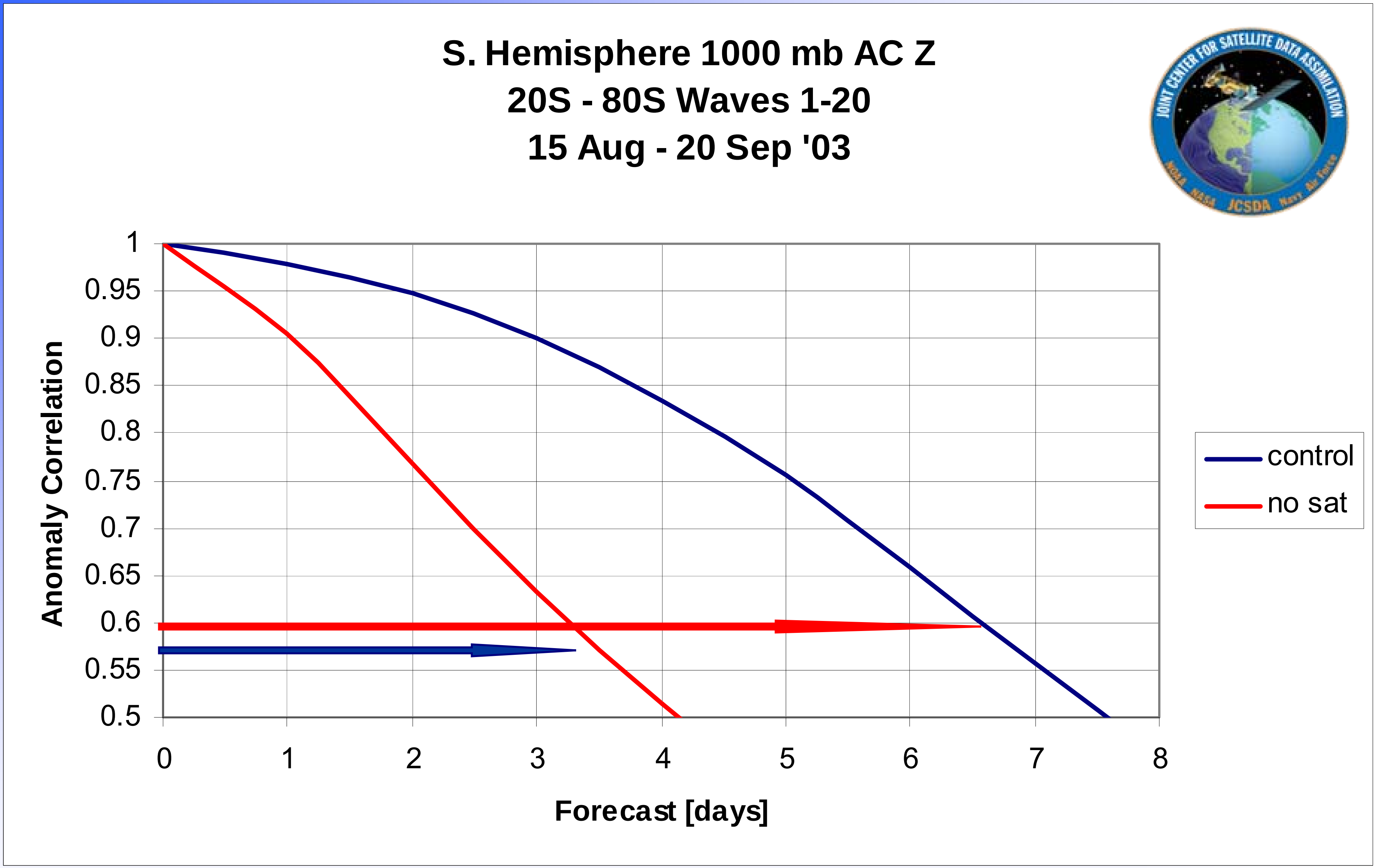
Satellite Instruments by Platform



Data Assimilation Impacts in the NCEP GDAS



Satellite and Conventional data provide nearly the same amount of improvement to the Northern Hemisphere.



Anomaly correlation for days 0 to 7 for 500 hPa geopotential height in the zonal band 20°-80° for January/February. The red arrow indicate use of satellite data in the forecast model has doubled the length of a useful forecast.

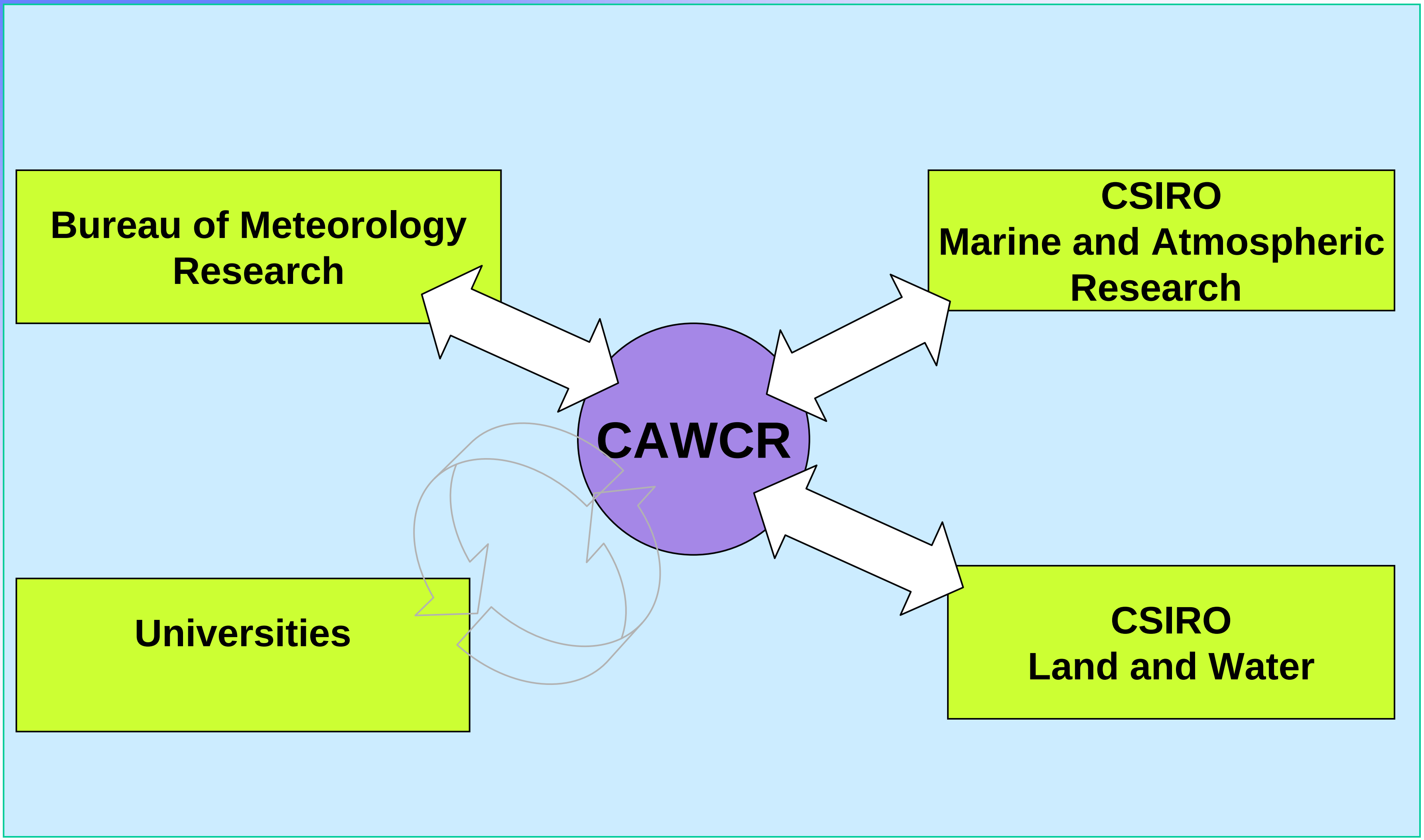
Australian Government
Bureau of Meteorology

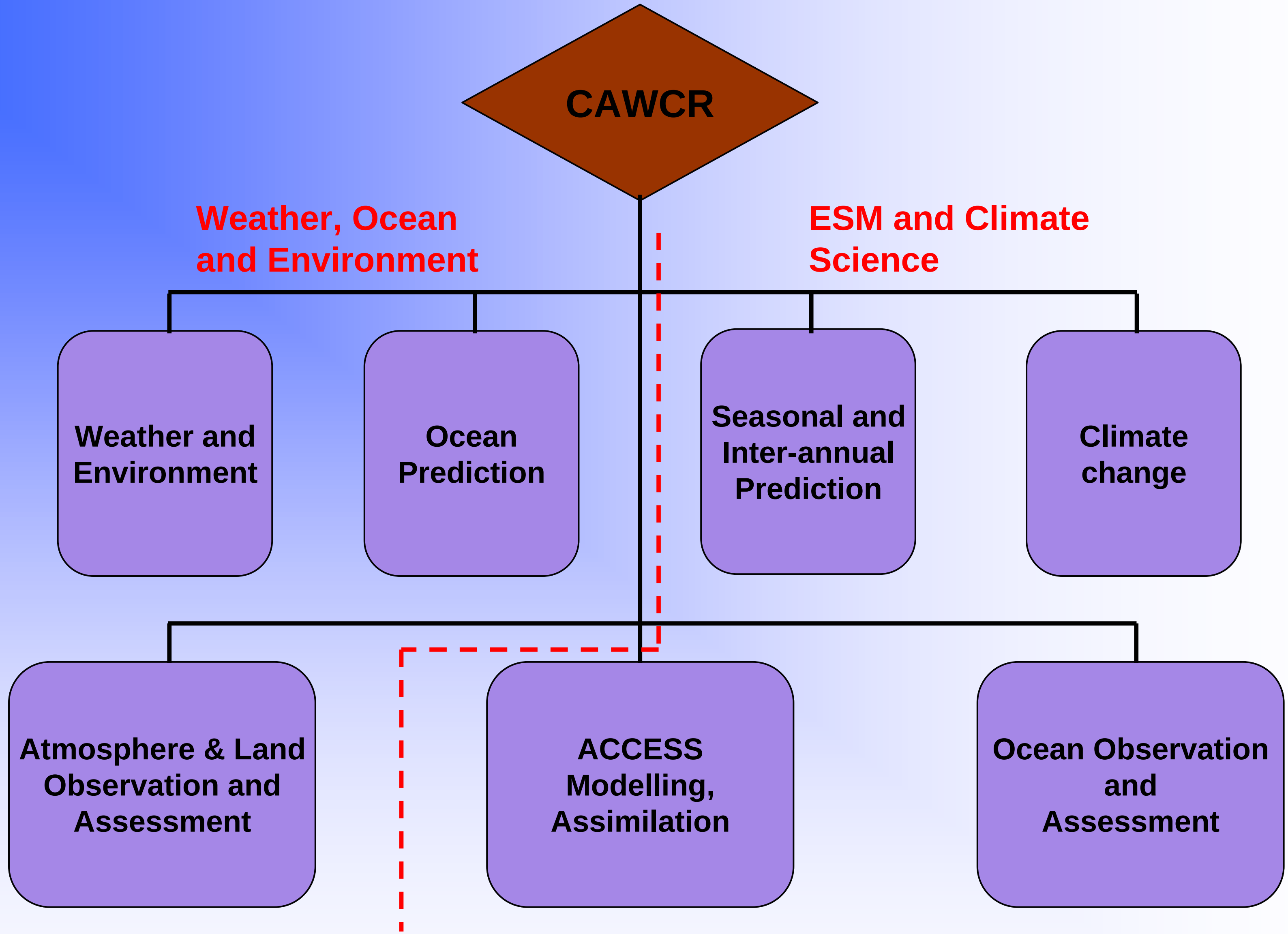
CSIRO

CAWCR

The Centre for Australian Weather and Climate Research

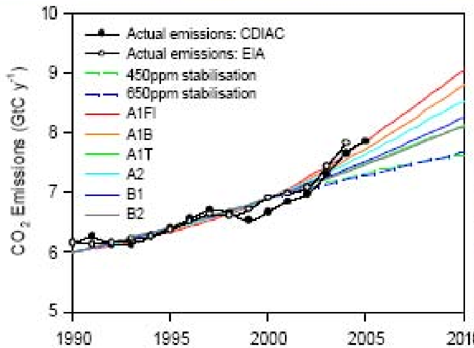
CAWCR Partners




CAWCR
Weather, Ocean and Environment
ESM and Climate Science
Weather and Environment
Ocean Prediction
Seasonal and Inter-annual Prediction
Climate change
Atmosphere & Land Observation and Assessment
ACCESS Modelling, Assimilation
Ocean Observation and Assessment

Atmosphere-Land Observation & Assessment

- Atmospheric composition
  - gases
  - aerosol
- Cloud, radiation and precipitation processes
- Biogeochemical cycles (carbon & water)
- Micrometeorology
- Observing system technologies
- Remote sensing and data assimilation

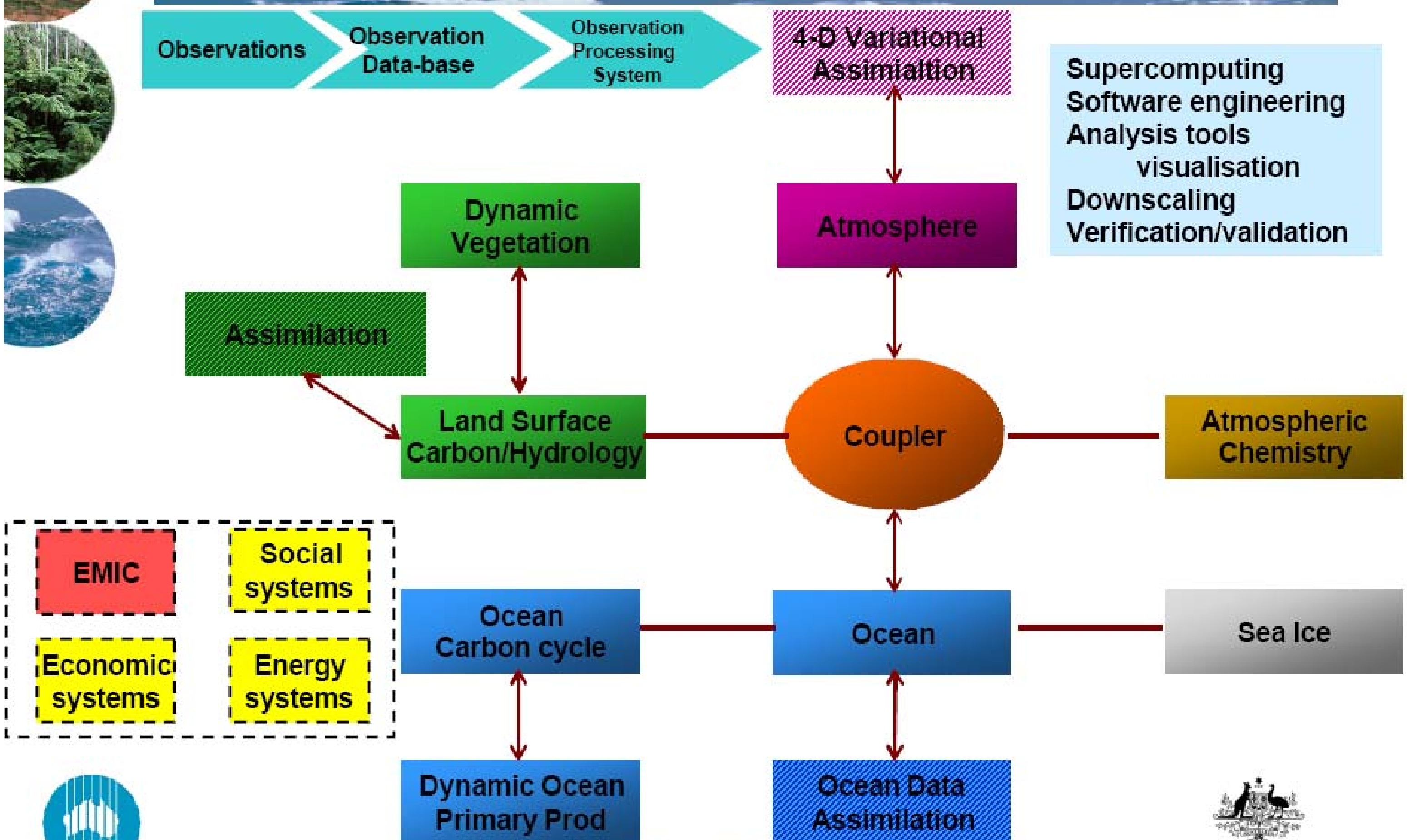


CSIRO

Centre for Australian Weather and Climate Research: a partnership between CSIRO and the Bureau of Meteorology

Australian Government
Bureau of Meteorology

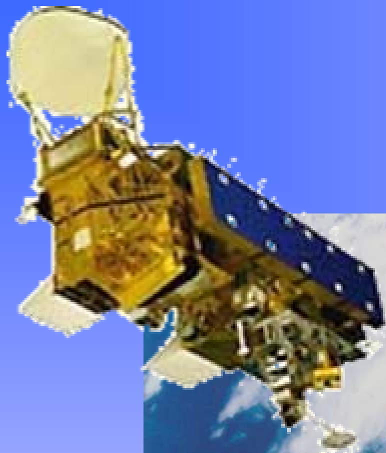
Scope of the Australian Community Climate and Earth System Simulator (ACCESS)



CSIRO

Centre for Australian Weather and Climate Research: a partnership between CSIRO and the Bureau of Meteorology

Australian Government
Bureau of Meteorology



SOME RECENT ADVANCES / DATA IMPACT

OBSERVING SYSTEM EXPERIMENTS

OBSERVING SYSTEM EXPERIMENT WITH SATELLITE AND CONVENTIONAL DATA

T. Zapotocny, J. Jung. J. Le Marshall, R Treadon, ……

The analysis and forecast model used for these observing system experiments is the NCEP Global Data Assimilation/Forecast System (GDAS/GFS).

The OSE consists of 45-day periods during January-February and August-September 2003. During these periods, a T254 - 64 layer version of NCEP's global spectral model was used.

The control run utilizes NCEP's operational data base and consists of all data types routinely assimilated in the GDAS. The two experimental runs have either all the conventional in-situ data denied (NoCon) or all the remotely sensed satellite data denied (NoSat). Differences between the control and experimental runs are accumulated over the 45-day periods and analyzed to demonstrate the forecast impact of these data types through 168 hours.

Note:geographic distribution of impact also calculated

Table 1. Conventional data denied within the NCEP Global Data Assimilation System for this study. Mass observations (temperature and moisture) are shown in the left hand column while wind observations are shown in the right hand column.

Rawinsonde temperature and humidity	Rawinsonde u and v
AIREP and PIREP aircraft temperatures	AIREP and PIREP aircraft u and v
ASDAR aircraft temperatures	ASDAR aircraft u and v
Flight-level reconnaissance and dropsonde temperature, humidity and station pressure	Flight-level reconnaissance and dropsonde u and v
MDCARS aircraft temperatures	MDCARS aircraft u and v
Surface marine ship, buoy and c-man temperature, humidity and station pressure	Surface marine ship, buoy and c-man u and v
Surface land synoptic and Metar temperature, humidity and station pressure	Surface land synoptic and metar u and v
Ship temperature, humidity and station pressure	Wind Profiler u and v
	NEXRAD Vertical Azimuth Display u and v
	Pibal u and v

Table 2. Satellite data denied within the NCEP Global Data Assimilation System for this study.

HIRS sounder radiances	SBUV ozone radiances
MSU radiances	QuikSCAT surface winds
AMSU-A radiances	GOES atmospheric motion vectors
AMSU-B radiances	GMS atmospheric motion vectors
GOES sounder radiances	METEOSAT atmospheric motion vectors
SSM/I precipitation rate	SSM/I surface wind speed
TRMM precipitation rate	

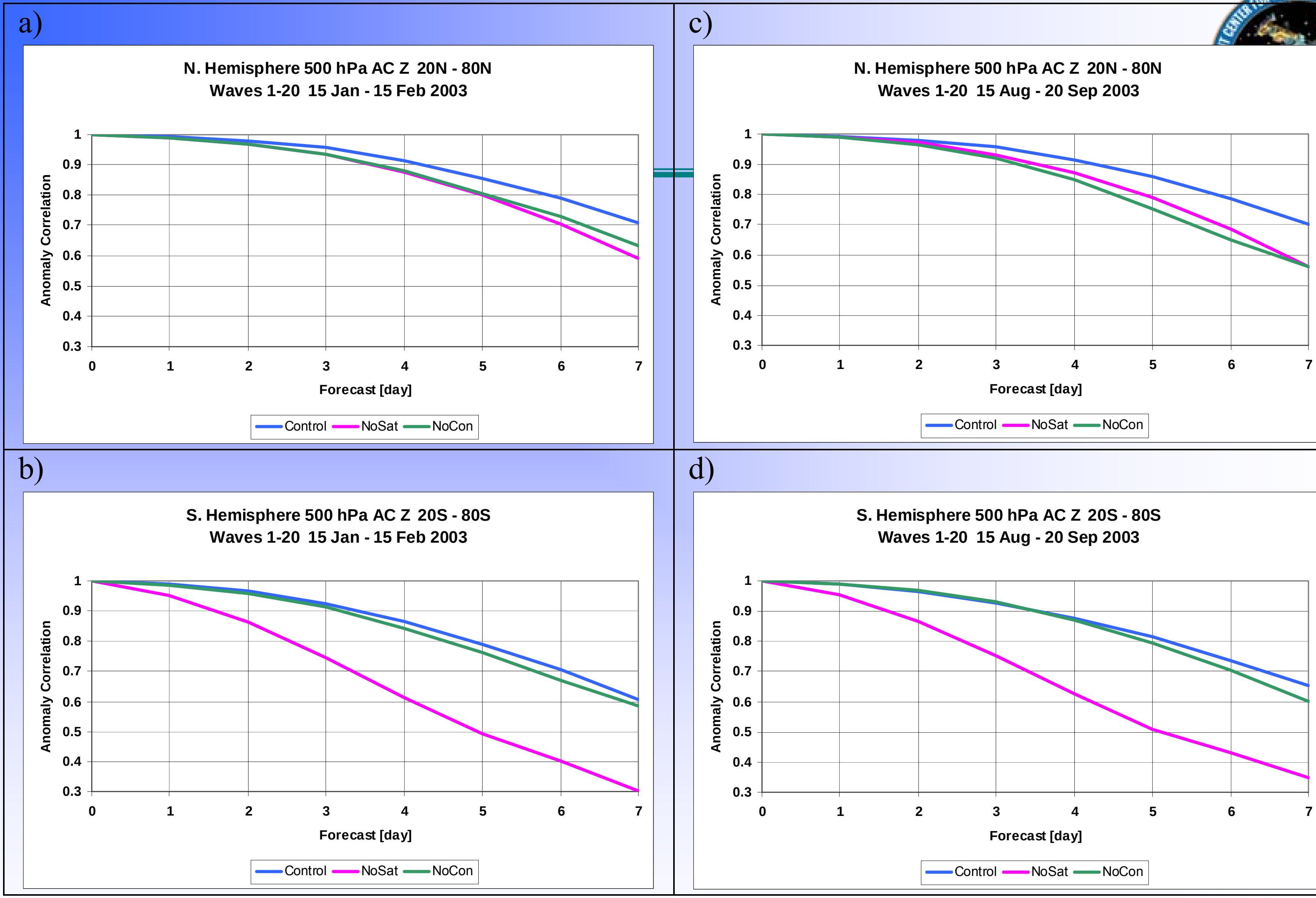
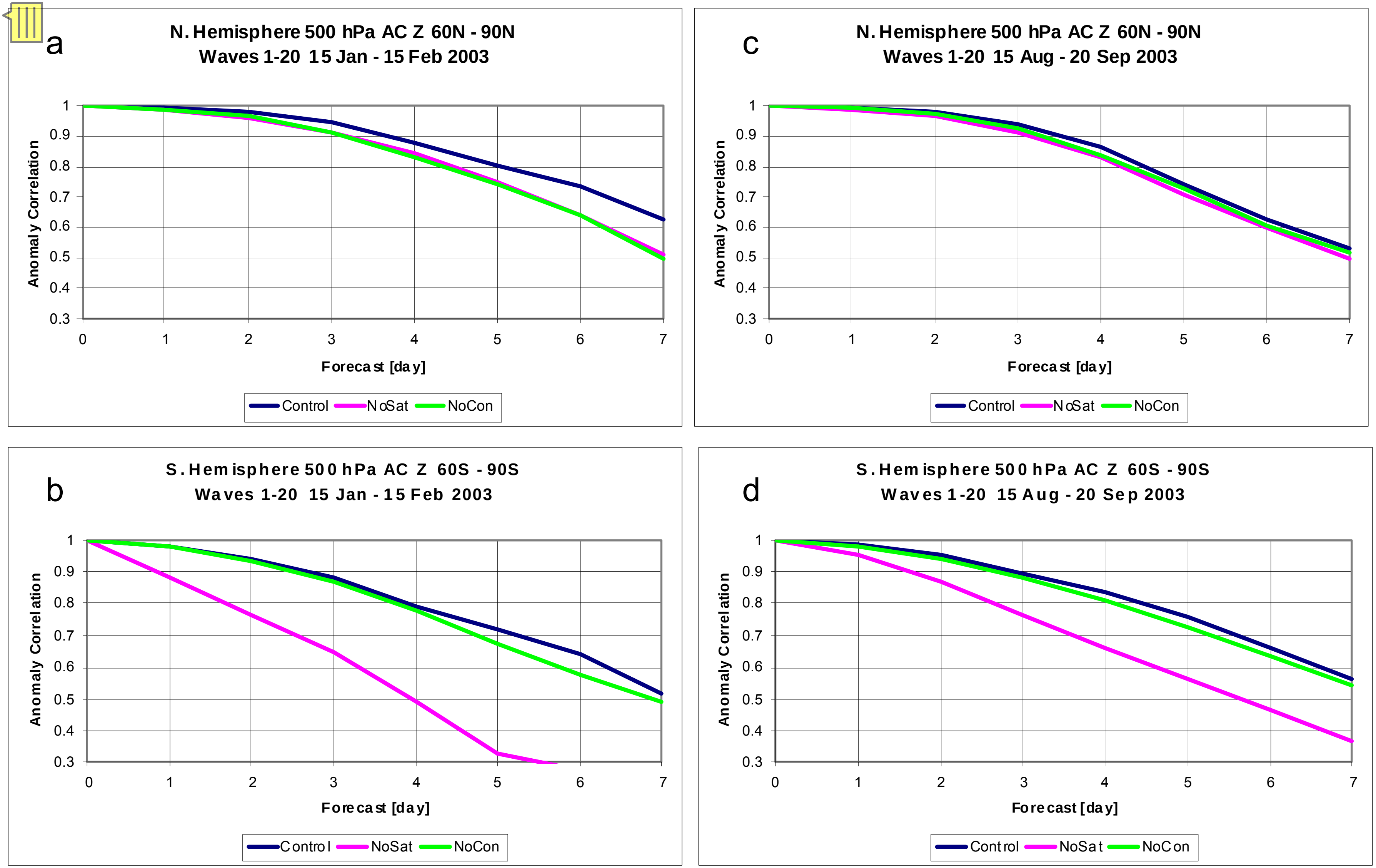


Fig. 6. Anomaly correlation for days 0 to 7 for 500 hPa geopotential height in the zonal band 20°-80° for each Hemisphere and season. The control simulation is shown in blue, while the NoSat and NoCon denial experiments are shown in magenta and green, respectively.



Anomaly correlation for days 0 to 7 for 500 hPa geopotential height in the polar cap region (60°-90°) of each Hemisphere and season. The control simulation is shown in blue, while the NoSat and NoCon denial experiments are shown in magenta and green, respectively.

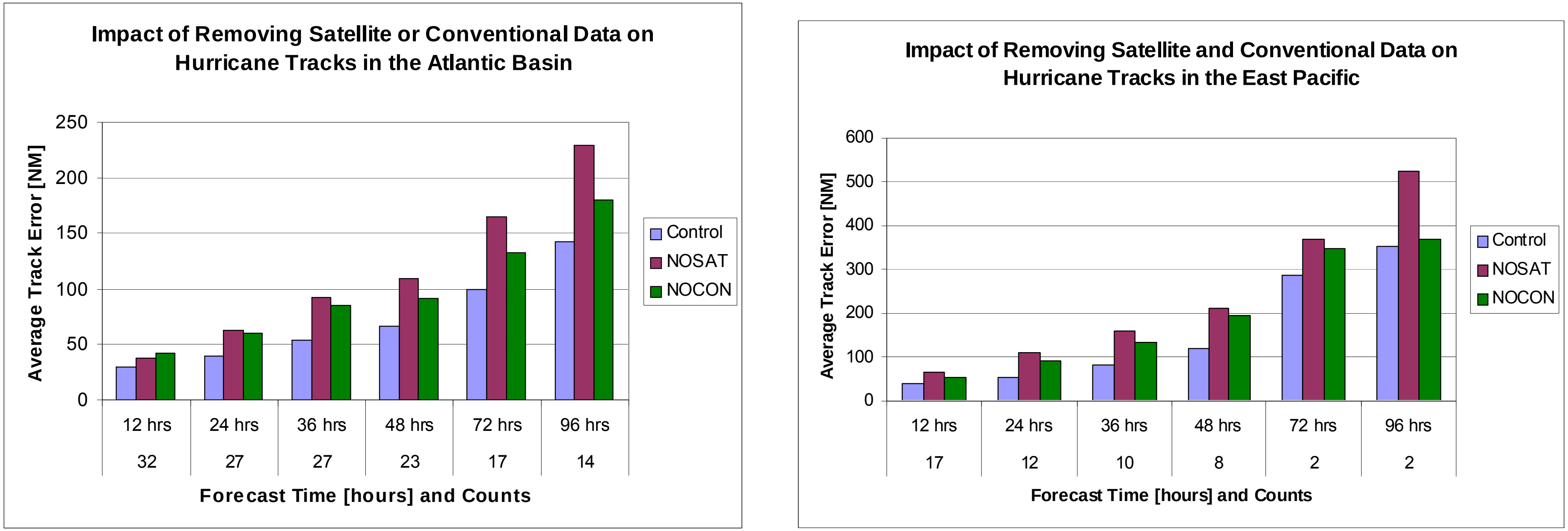


Fig. 7 The impact of removing satellite and in-situ data on hurricane track forecasts in the GFS during the period 15 August to 20 September 2003. Panels (a and b) show the average track error (NM) out to 96 hours for the control experiment and the NoSat and NoCon denials for the Atlantic and Pacific Basins, respectively.

OBSERVING SYSTEM EXPERIMENTS

OBSERVING SYSTEM EXPERIMENT WITH

FOUR SATELLITE DATA TYPES

AND

RAWINSONDE DATA

T. Zapotocny, J. Jung. J. Le Marshall, R Treadon, ……

A series of Observing System Experiments (OSEs) covering two seasons has been undertaken to quantify the contributions to the forecast quality from conventional rawinsonde data and from four types of remotely sensed satellite data.

The impact was measured by comparing the analysis and forecast results from an assimilation/forecast system using all data types in NCEP's operational data base with those from a system excluding a particular observing system.

For these OSEs, the forecast results are compared through 168 hours for periods covering more than a month during two seasons.

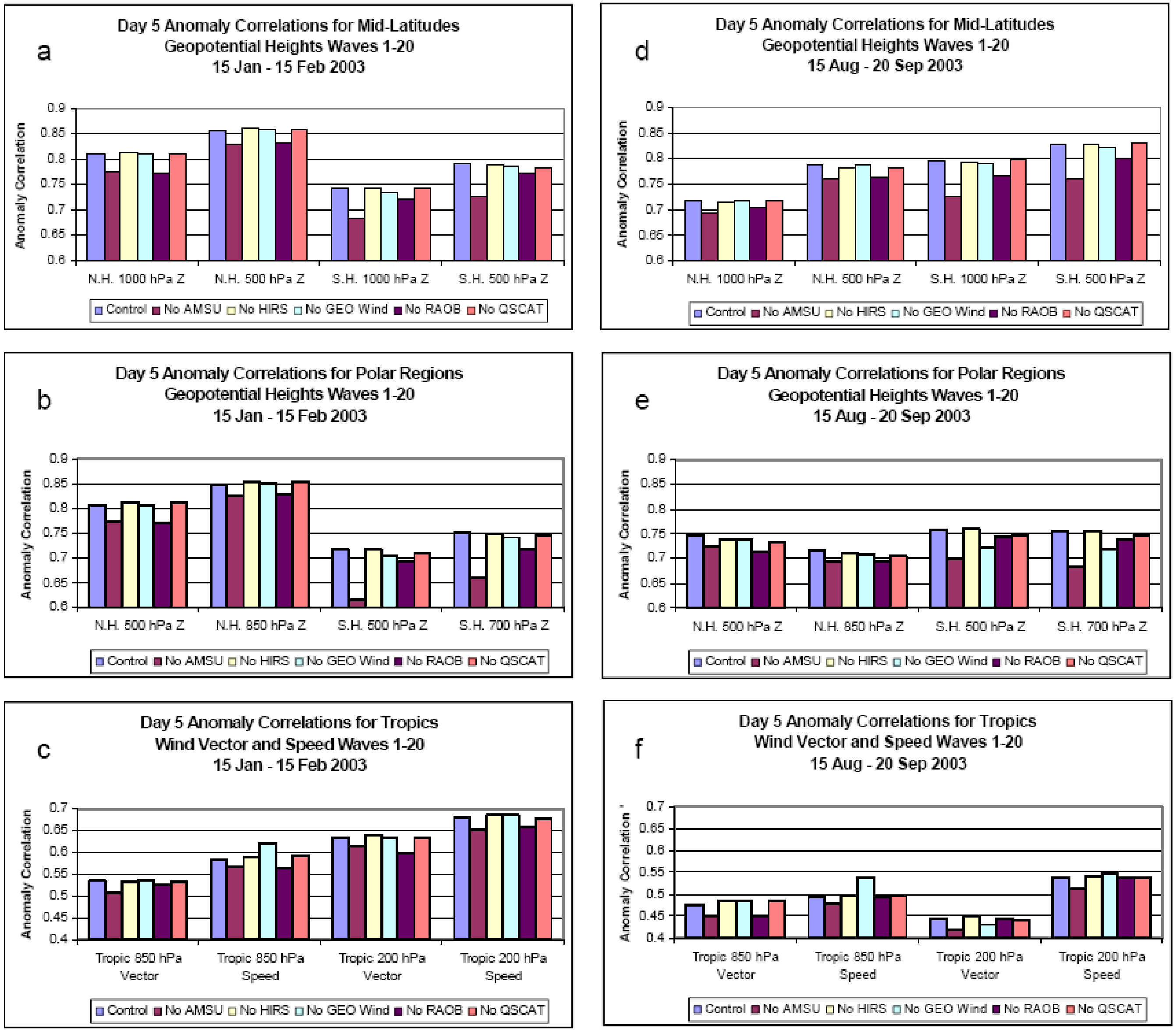


Fig. 8 The day 5 anomaly correlations for waves 1-20 for the (a and d) mid-latitudes, (b and e) polar regions and (c and f) tropics. Experiments shown for each term include, from left to right, the control simulation and denials of AMSU, HIRS, GEO winds, Rawinsondes and QuikSCAT. The 15 January to 15 February 2003 results are shown in the left column and the 15 August to 20 September results are shown in the right column. Note the different vertical scale in (c and f).

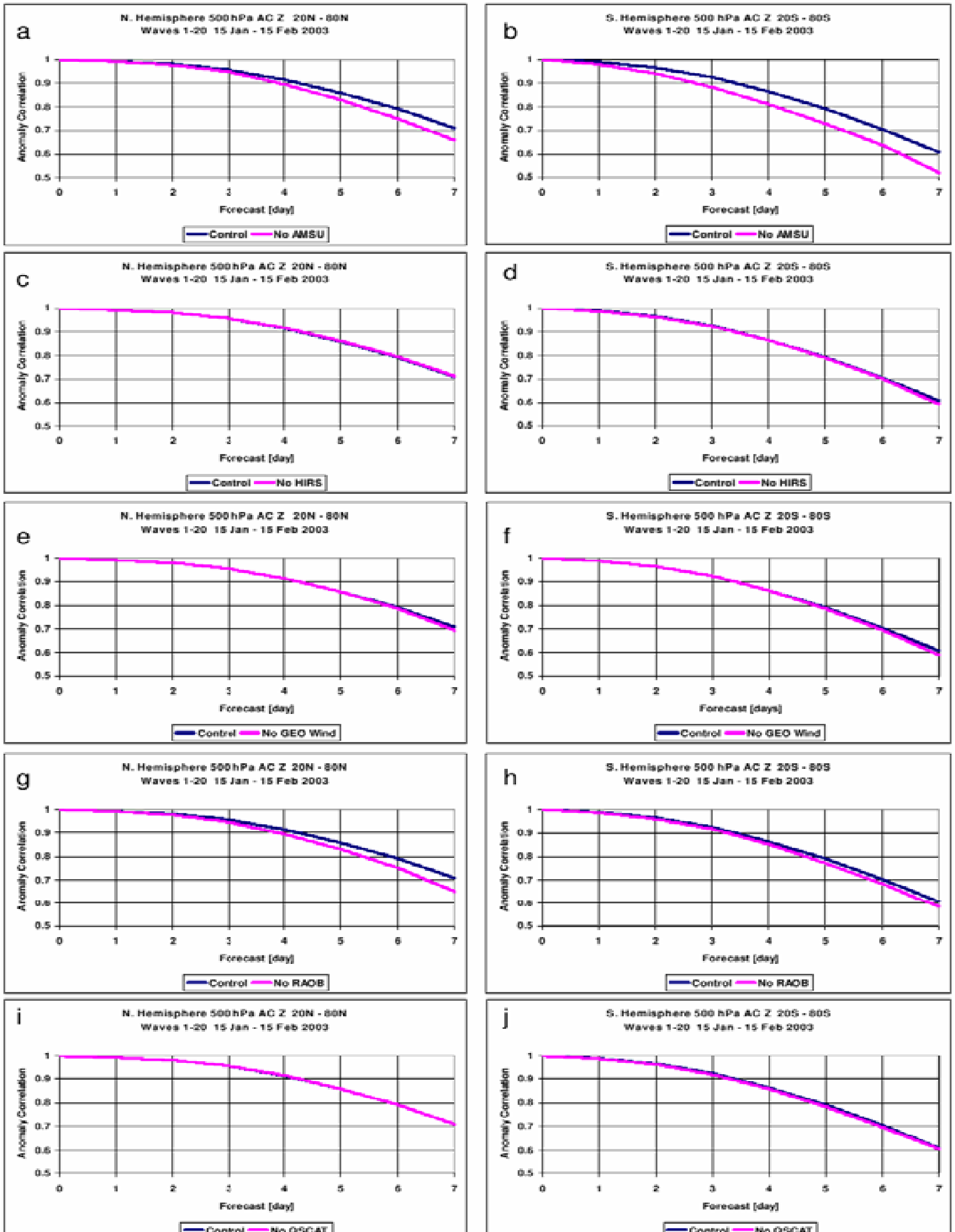


Fig. 9. The 15 January to 15 February 2003 day 0-7 500 hPa geopotential height die-off curves for the control and five denial experiments. The Northern Hemisphere results are shown in the left panels and the Southern Hemisphere results are shown in the right panels.

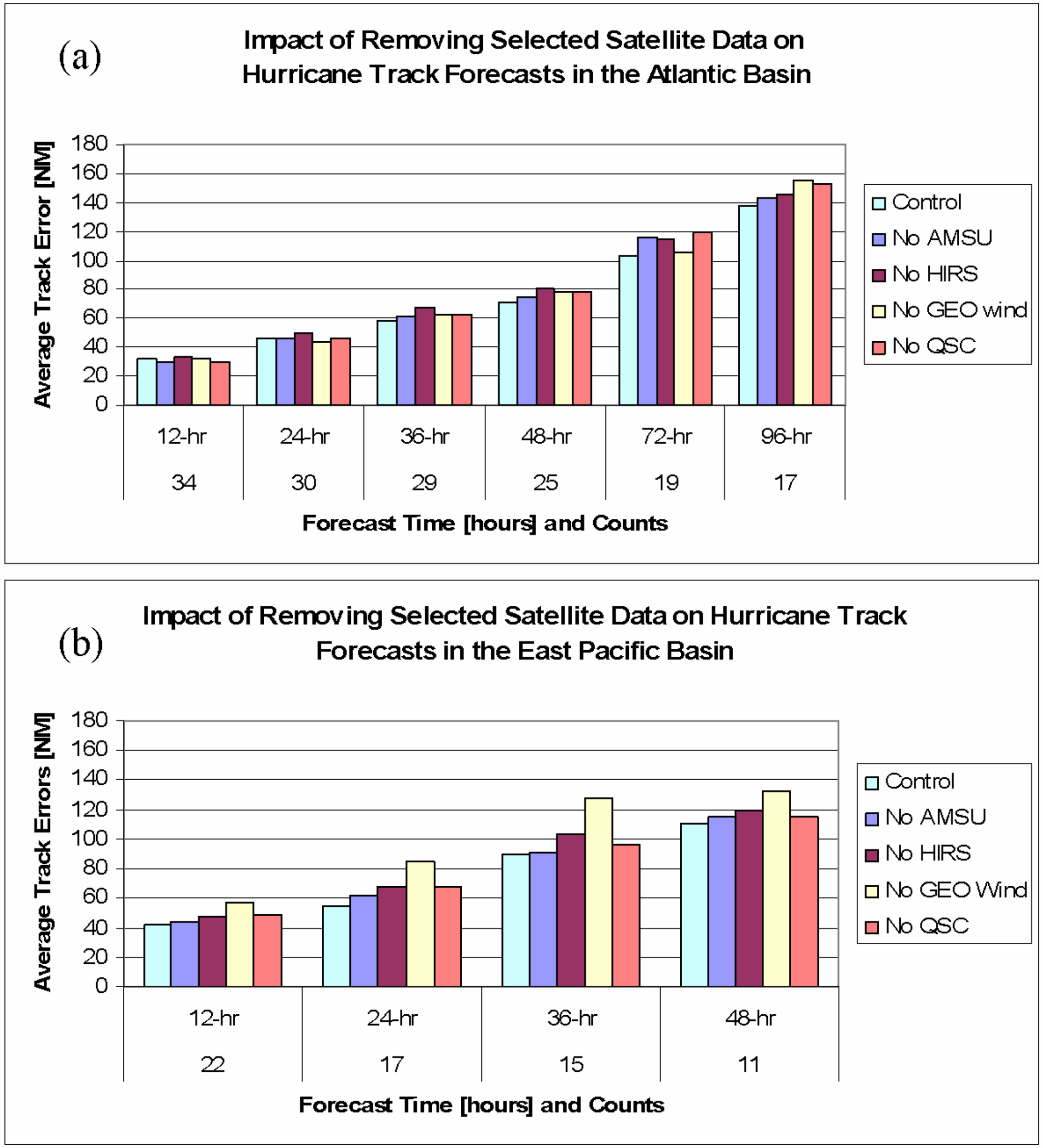


Fig. 10. Average track error (NM) by forecast hour for the control simulation and experiments where AMSU, HIRS, GEO winds and QuikSCAT were denied. The Atlantic Basin results are shown in (a), and the Eastern Pacific Basin results are shown in (b). A small sample size in the number of hurricanes precludes presenting the 96 hour results in the Eastern Pacific Ocean.

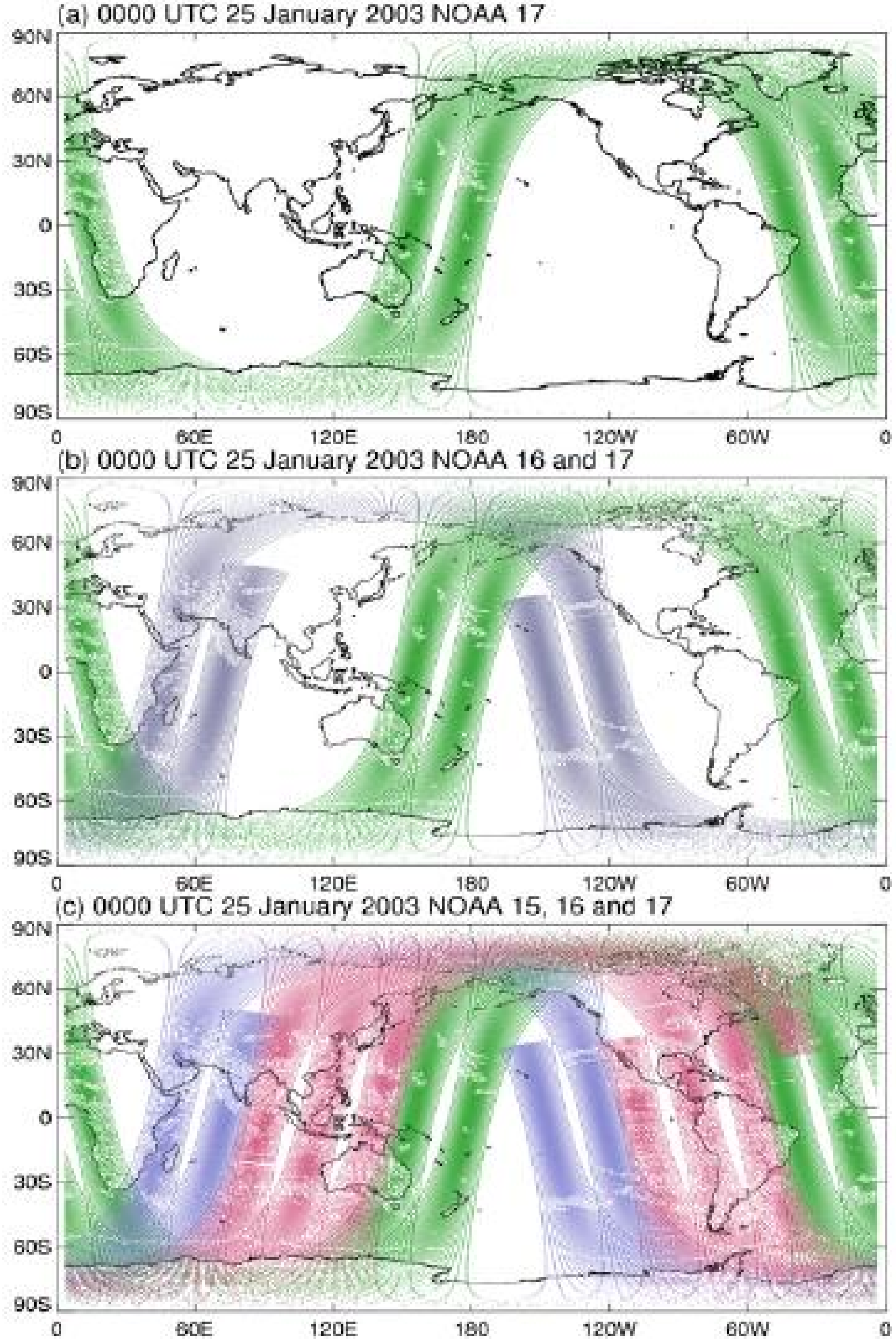
OBSERVING SYSTEM EXPERIMENTS

OBSERVING SYSTEM EXPERIMENT WITH NOAA POLAR ORBITING SATELLITES

J. Jung, T. Zapotocny, J. Le Marshall, R Treadon, ……

An Observing System Experiments (OSEs) during two seasons has been used to quantify the contributions made to forecast quality from the use of the National Oceanic and Atmospheric Administration's (NOAA) polar orbiting satellites.

The impact is measured by comparing the analysis and forecast results from an assimilation/forecast system using observations from one NOAA polar orbiting satellite, NOAA-17 (1_NOAA), with results from systems using observations from two, NOAA-16 and NOAA-17 (2_NOAA), and three, NOAA-15, 16 and 17 (3_NOAA), polar orbiting satellites.


(a) 0000 UTC 25 January 2003 NOAA 17
(b) 0000 UTC 25 January 2003 NOAA 16 and 17
(c) 0000 UTC 25 January 2003 NOAA 15, 16 and 17
90N
60N
30N
0
30S
60S
90S
0
60E
120E
180
120W
60W
0

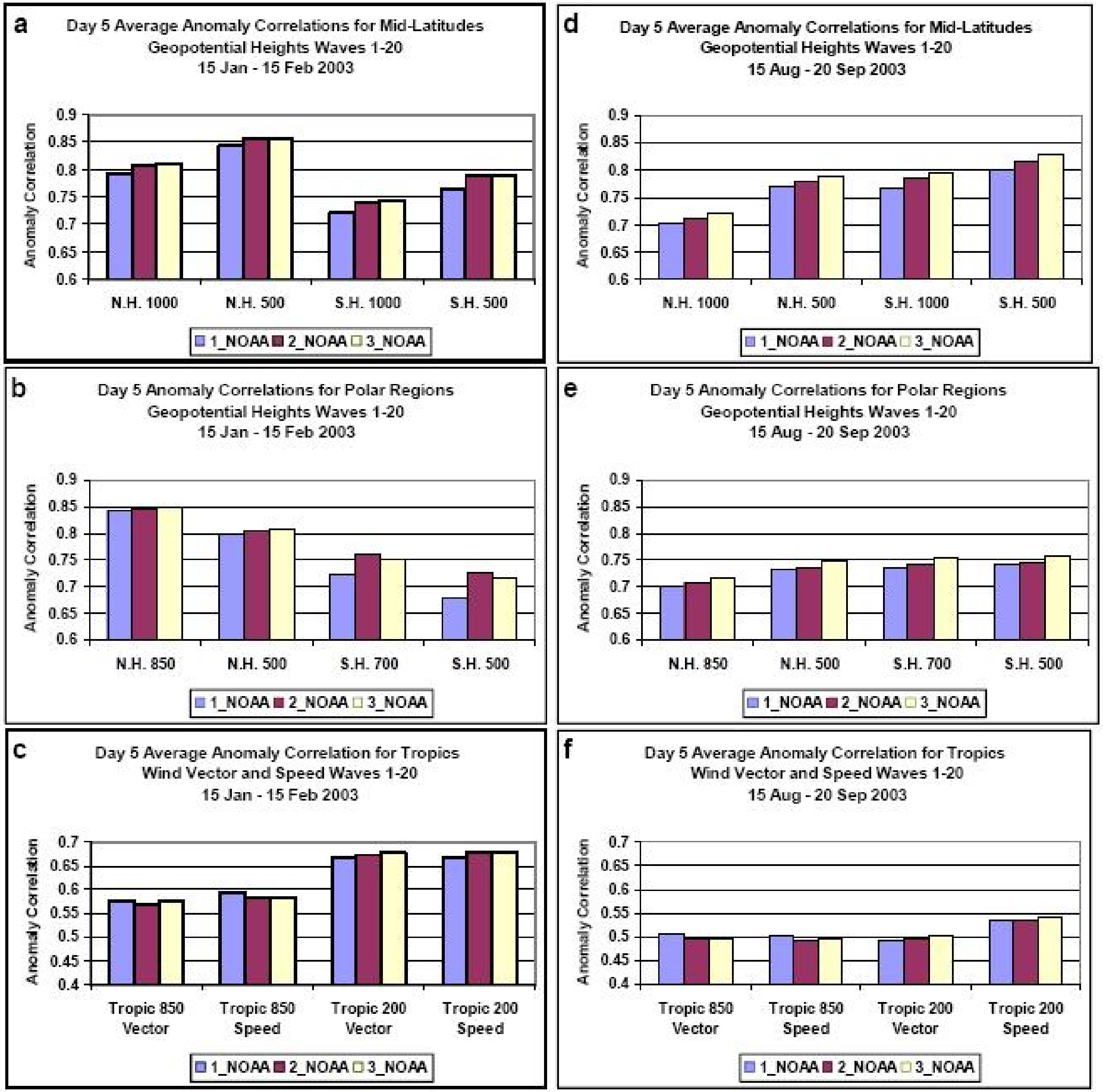


Fig. 12. The day 5 anomaly correlations for waves 1-20 for the (a and d) mid-latitudes, (b and e) polar regions and (c and f) tropics. Experiments include data from 3_NOAA, 2_NOAA, and 1_NOAA satellite(s). The 15 January to 15 February 2003 results are shown in the left column and the 15 August to 20 September 2003 results are shown in the right column. Note the different vertical scale in (c and f).

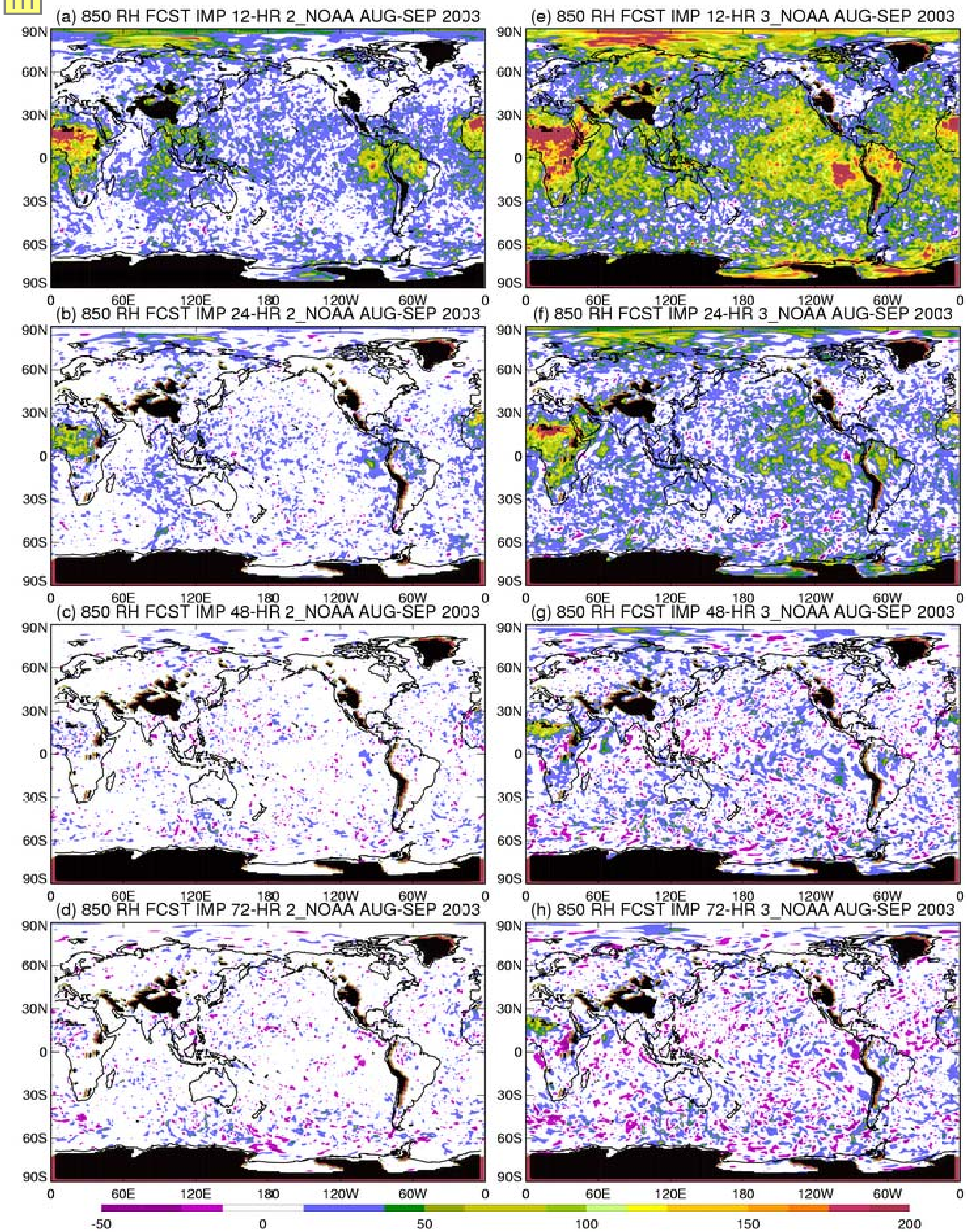


Fig. 15. Geographic distribution of Forecast Impact to 850 hPa relative humidity from the 2_NOAA and 3_NOAA experiments during August-September 2003. The 12, 24, 48 and 72-hr impacts are shown for each time period with the color contour interval 12.5%. Values within 12.5% of zero are white. Regions underground are shaded black.

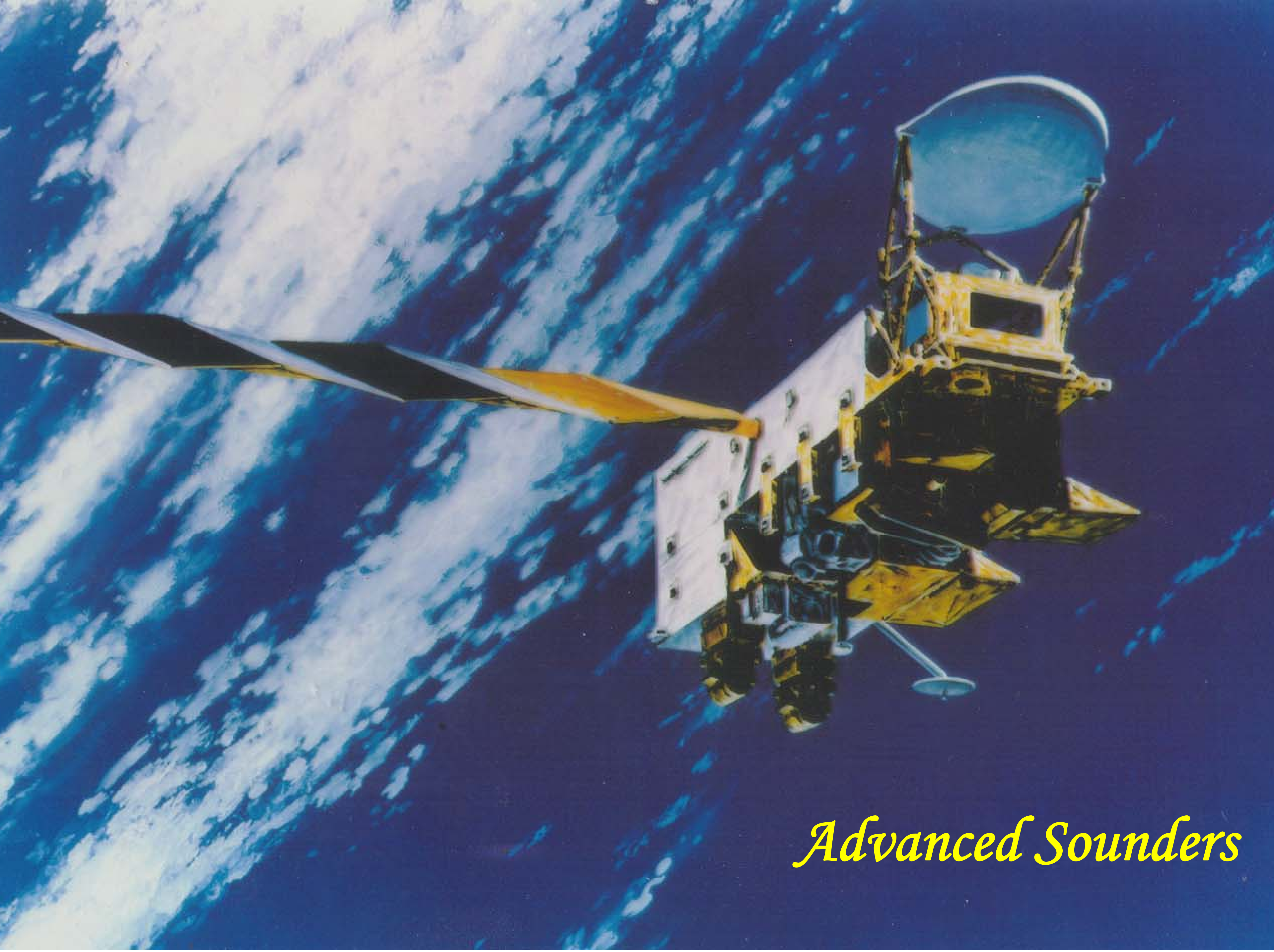
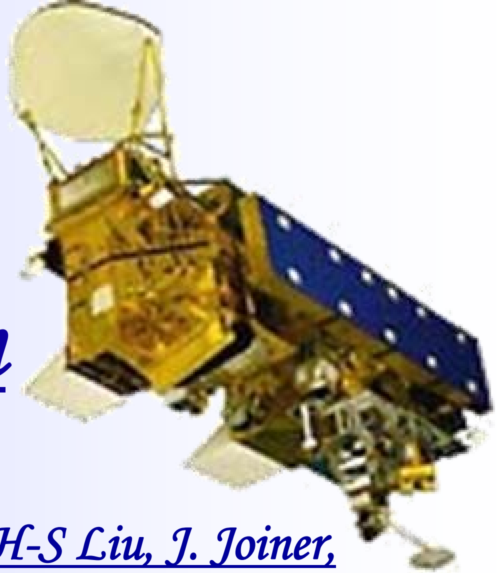

Advanced Sounders

Table 2.4-1 Characteristics of Advanced Infrared Sounders

Name	AIRS	IASI	CrIS	IRFS	GIFTS
Orbit	705 km	833 km	824 km	1000 km	Geostationary
Instrument type	Grating	FTS	FTS	FTS	FTS
Agency and Producer	NASA JPL/LoMIRIS	EUMETSAT/ CNES Alcatel	IPO (DoD/NOAA/ NASA) ITT	Russian Aviation and Space Agency	NASA/NOAA/ Navy. Space Dynamics Lab.
Spectral range (cm^{-1})	649 –1135 1217–1613 2169 –2674	Contiguous 645-2760	650 -1095 1210 –1750 2155 –2550	625 -2000 2200 -5000	685-1130 1650-2250
Unapodized spectral resolving power	1000 – 1400	2000 – 4000	900 – 1800	1200 - 4000	2000-6000
Field of view (km)	13 x 7	12	14	20	4
Sampling density per 50 km square	9	4	9	1	50
Power (W)	225	200	86	120	254
Mass (kg)	140	230	81	70	59
Platform	AQUA (EOS PM1)	METOP-1,-2,-3	NPP and NPOESS C1	METEOR 3MN2	Geostationary
Launch date	Feb 2002	2006	2010 for NPP 2013 NPOESS C1	2010+	2010+?



AIRS Data Assimilation

J. Le Marshall, J. Jung, J. Derber, R. Treadon,

S.J. Lord, M. Goldberg, C. Barnet, W. Wolf and H-S Liu, J. Joiner,

and J Woollen……

1 January 2004 – 31 January 2004

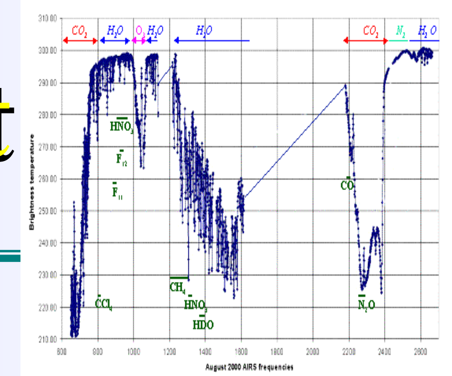
Used operational GFS system as Control

Used Operational GFS system Plus AIRS as Experimental System

Background

- Atmospheric Infrared Sounder (AIRS) was launched on the AQUA satellite on May 4, 2002 - Polar orbit 705 km, 13:30 ECT
- AIRS – high spectral resolution infrared sounder, demonstrated significantly improved accuracy of temperature and moisture soundings.
- NOAA/NESDIS is processing and distributing AIRS data and products in near real-time to operational NWP centers.

AIRS IR Instrument



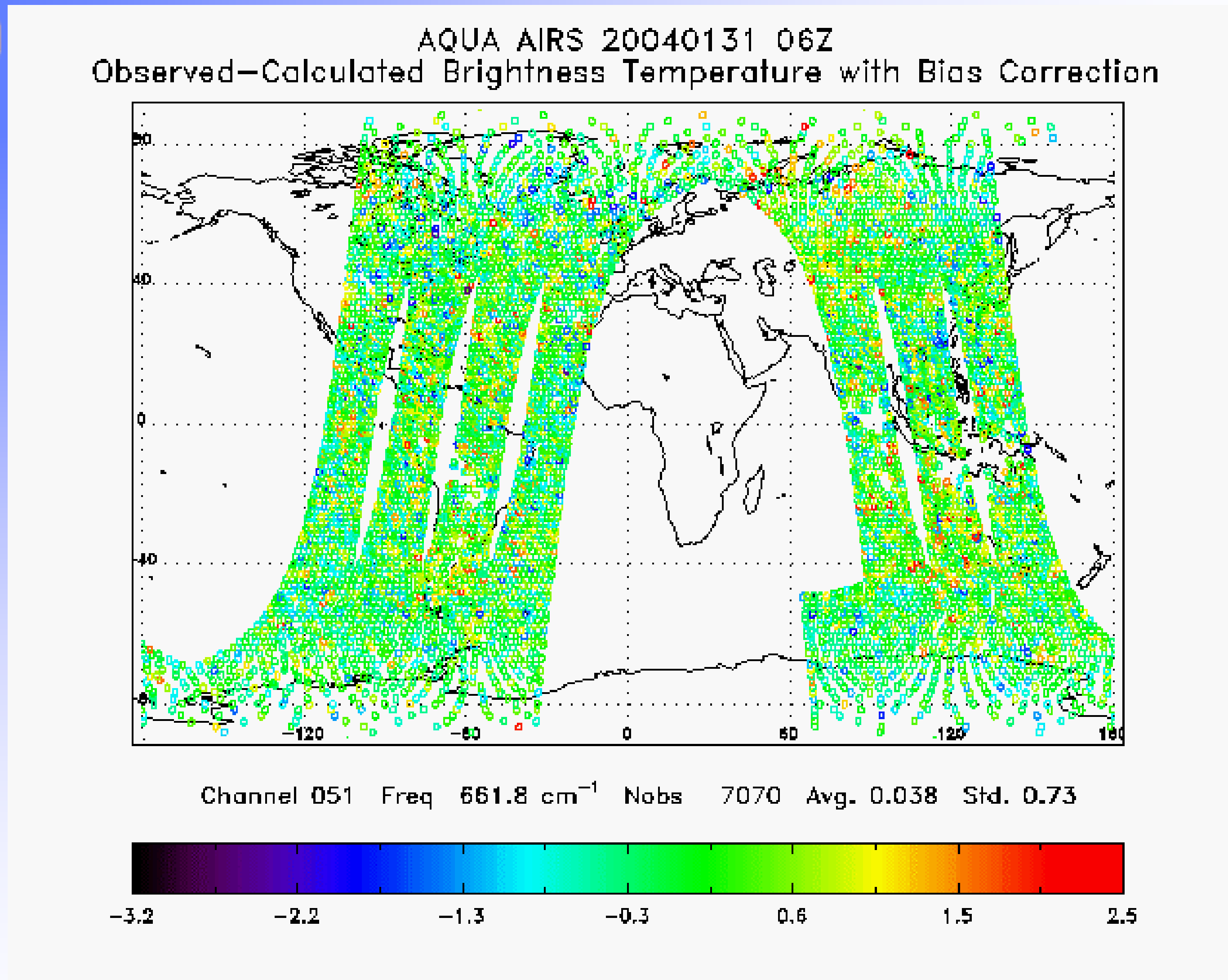
- AIRS is a cooled grating array spectrometer
- Spectral coverage 3.7 to 15.4 microns in 17 arrays with 2378 spectral channels (3.74-4.61 µm, 6.2-8.22 µm, 8.8-15.4 µm)
- Spectral resolution $\lambda/\Delta\lambda$=1200, 14 km FOV from 705km orbit
- Launch – May 2002
- Primary products: temperature profile (< 1 K accuracy), moisture profile (< 15%) , ozone (< 15 % (layers) and 3 % total)
- Research products: CO2, CO, CH4
- The integrated sounder system includes the AIRS VIS/NIR channels and microwave sounders

Table 1: Satellite data used operationally within the NCEP Global Forecast System

HIRS sounder radiances AMSU-A sounder radiances AMSU-B sounder radiances GOES sounder radiances GOES 9,10,12, Meteosat atmospheric motion vectors GOES precipitation rate SSM/I ocean surface wind speeds SSM/I precipitation rates	TRMM precipitation rates ERS-2 ocean surface wind vectors Quikscat ocean surface wind vectors AVHRR SST AVHRR vegetation fraction AVHRR surface type Multi-satellite snow cover Multi-satellite sea ice SBUV/2 ozone profile and total ozone

Global Forecast System Background

- Operational SSI (3DVAR) version used
- Operational GFS T254L64 with reductions in resolution at 84 (T170L42) and 180 (T126L28) hours. 2.5hr cut off



AIRS data coverage at 06 UTC on 31 January 2004. (Obs-Calc. Brightness Temperatures at 661.8 cm^{-1} are shown)

Table 2: AIRS Data Usage per Six Hourly Analysis Cycle

Data Category	Number of AIRS Channels
Total Data Input to Analysis	~200×10^6 radiances (channels)
Data Selected for Possible Use	~2.1×10^6 radiances (channels)
Data Used in 3D VAR Analysis(Clear Radiances)	~0.85×10^6 radiances (channels)

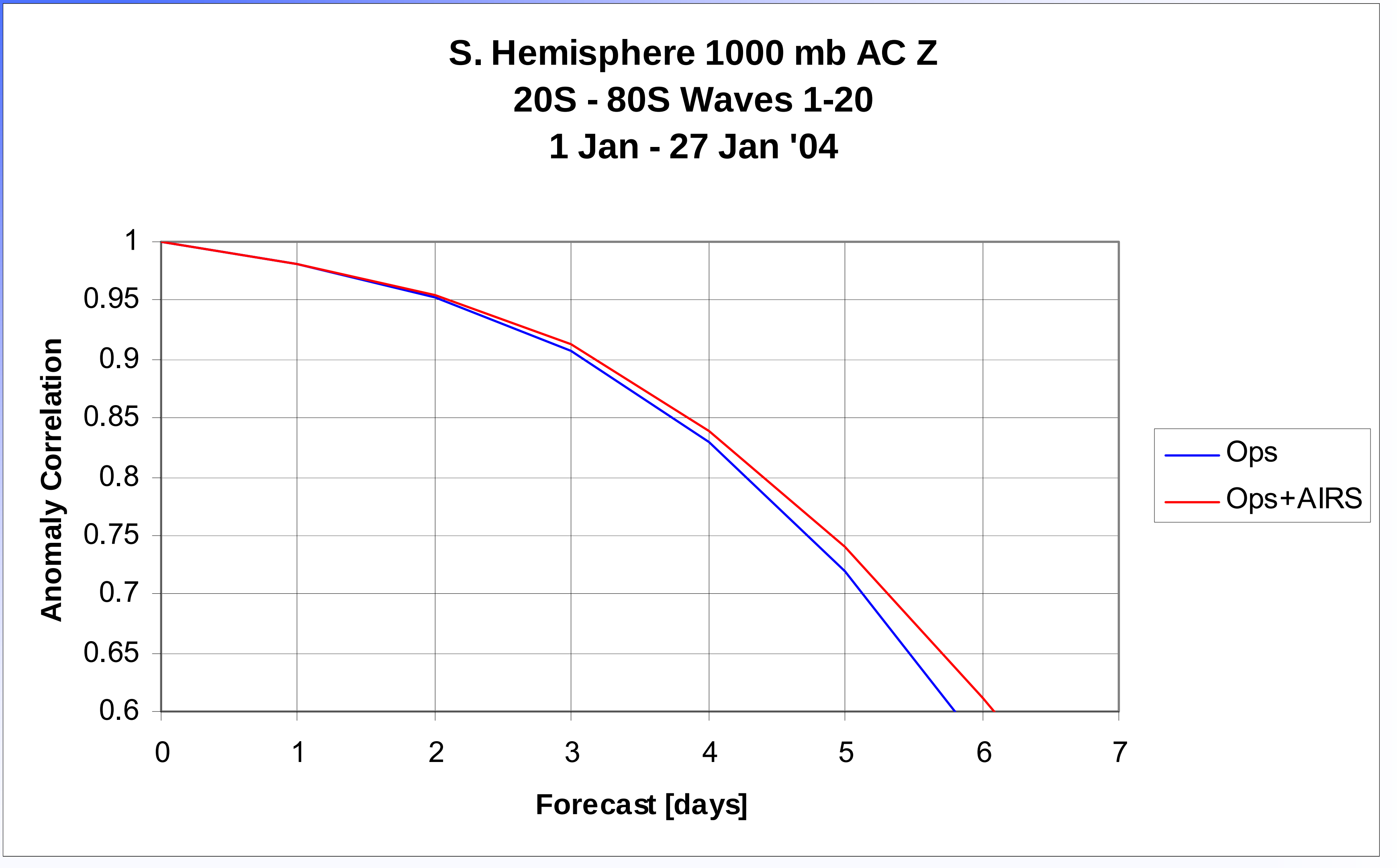


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

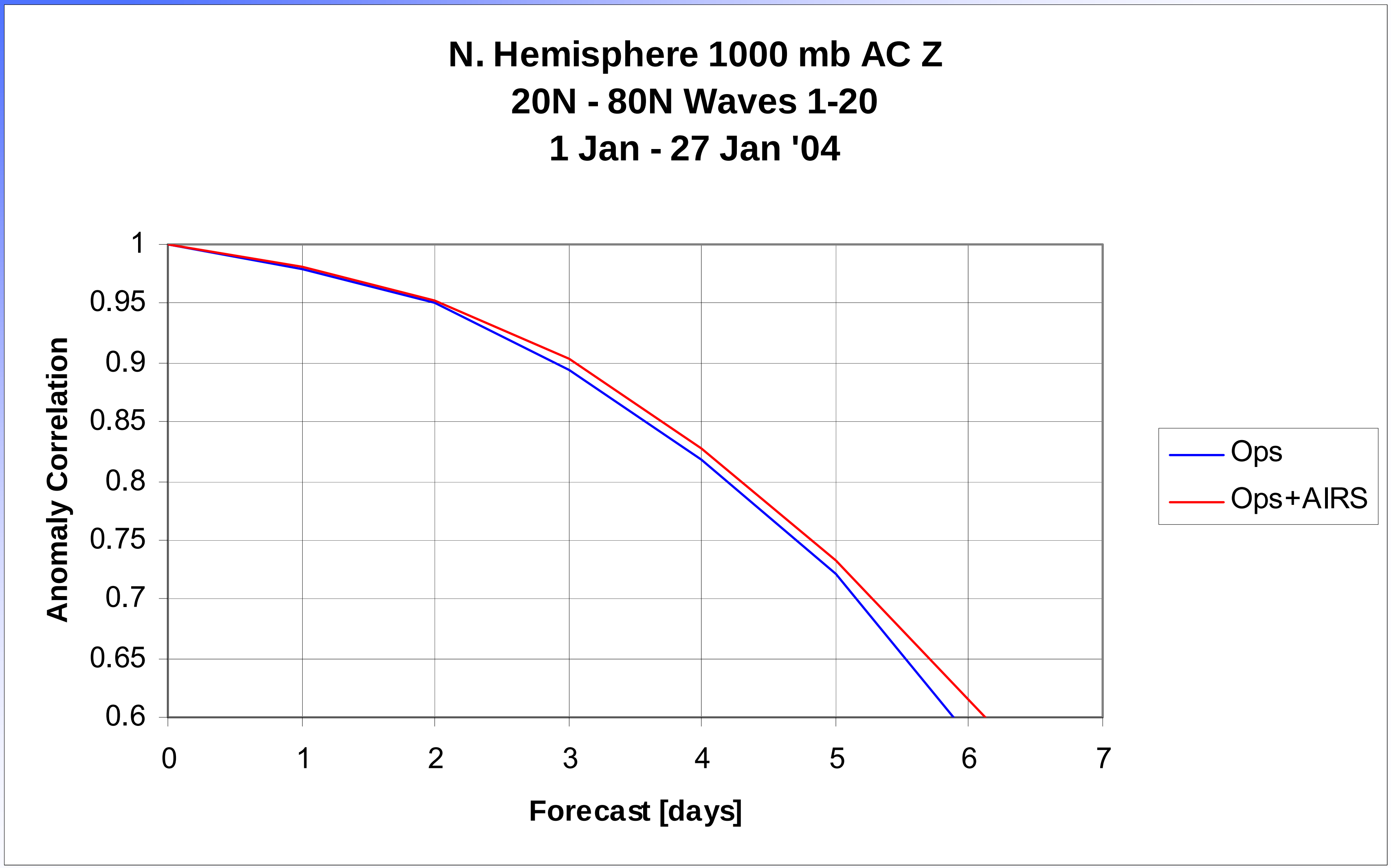
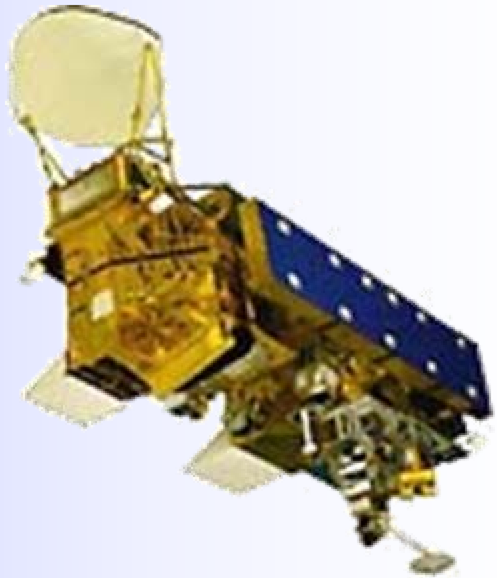


Figure3(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern hemisphere, January 2004

AIRS Data Assimilation

J. Le Marshall, J. Jung, J. Derber, R. Treadon, S.J. Lord,
M. Goldberg, W. Wolf and H-S Liu, J. Joiner and J Woollen

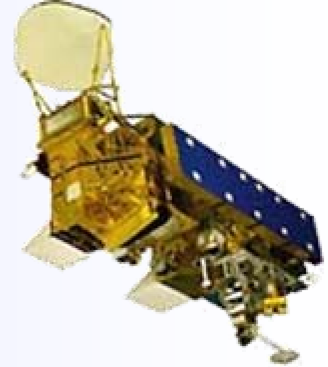


January 2004

Used operational GFS system as Control

Used Operational GFS system Plus AIRS as Experimental System

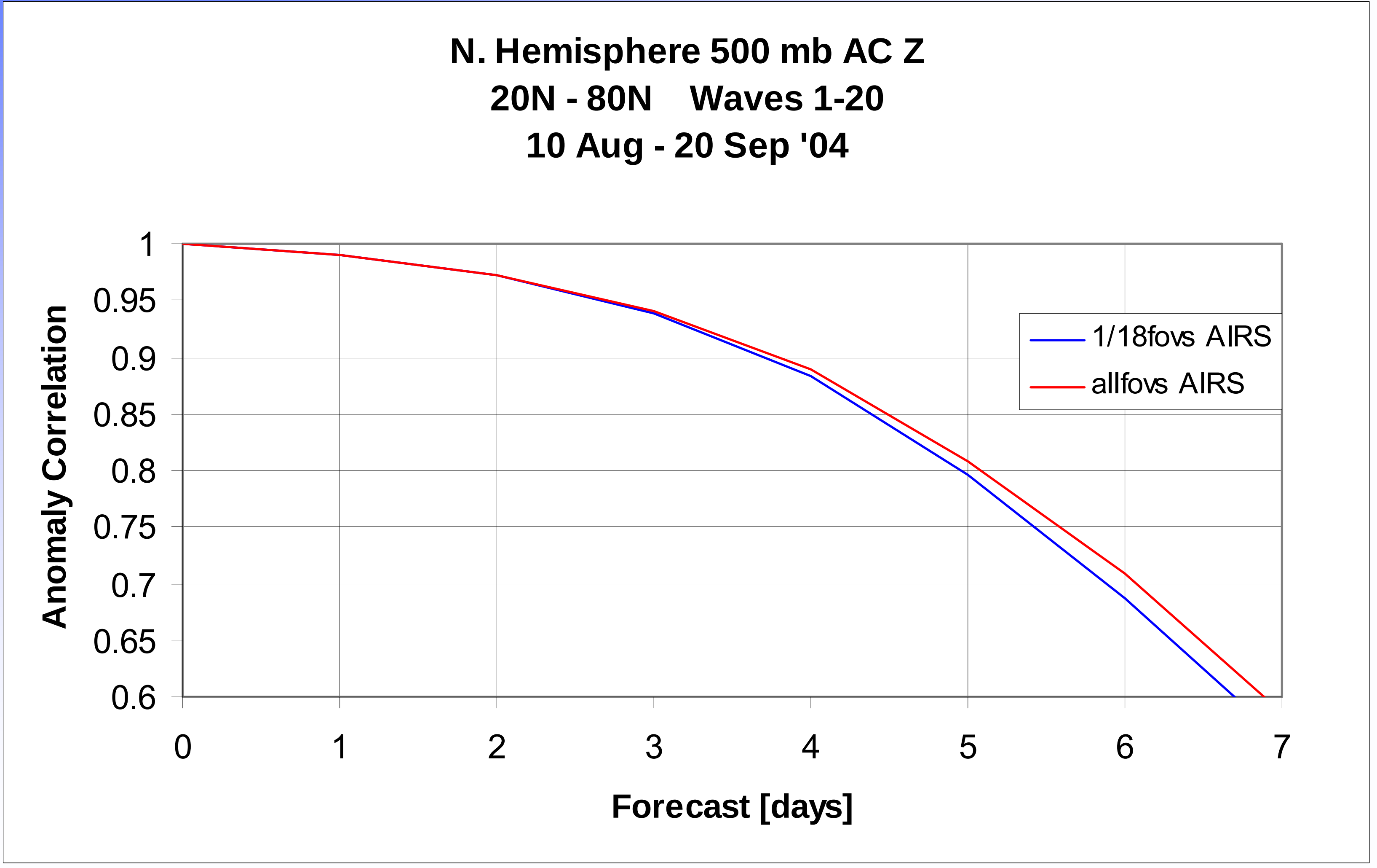
Clear Positive Impact Both Hemispheres.Implemented -2005

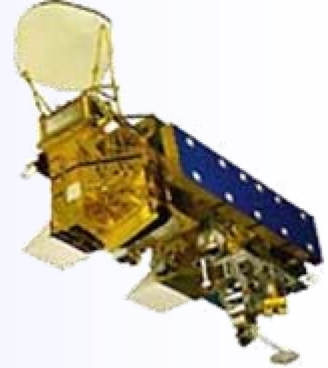


AIRS Data Assimilation

Impact of Data density...

10 August – 20 September 2004

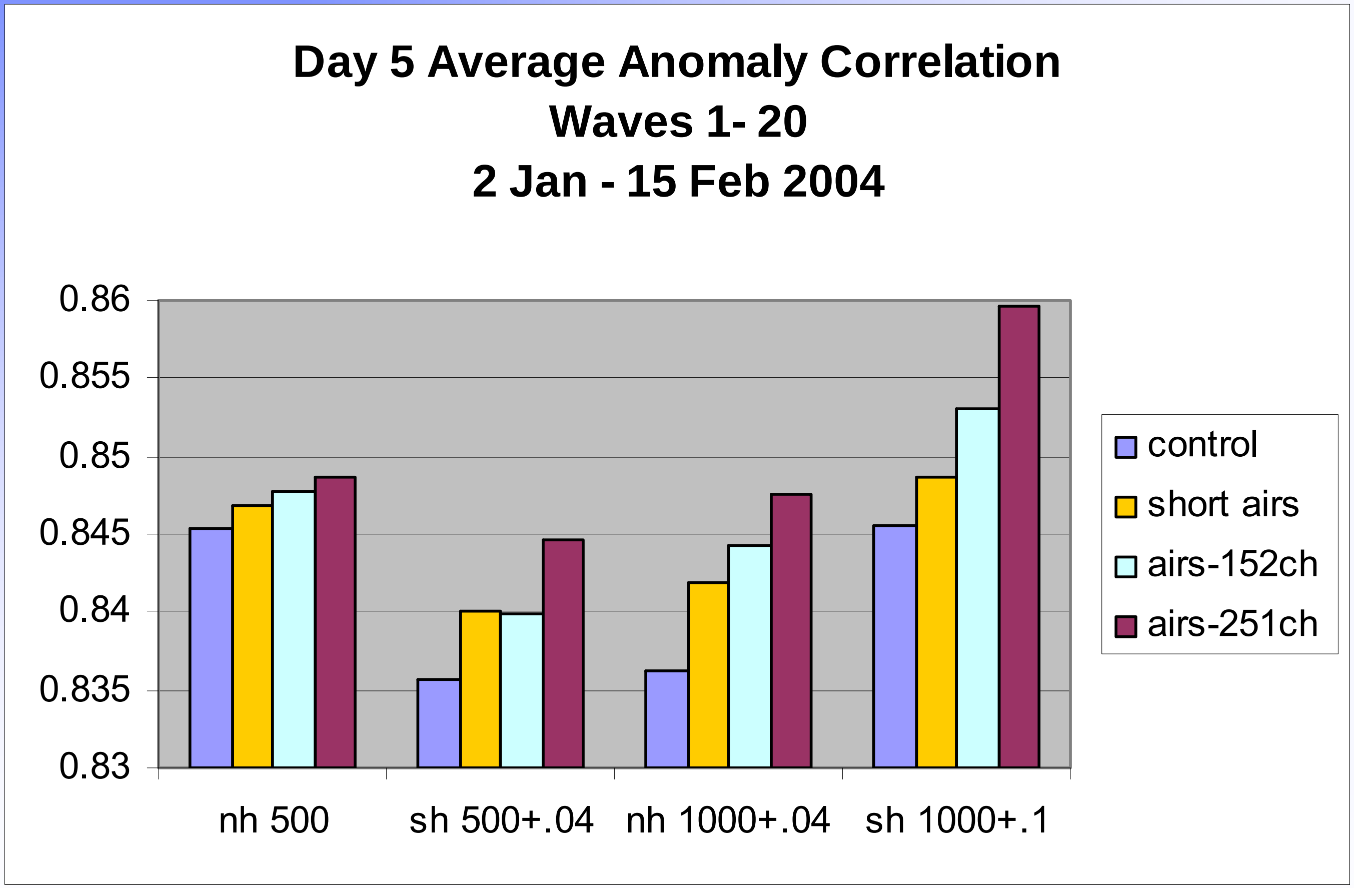

N. Hemisphere 500 mb AC Z
20N - 80N Waves 1-20
10 Aug - 20 Sep '04
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
1
2
3
4
5
6
7
Forecast [days]
1/18fovs AIRS
allfovs AIRS



AIRS Data Assimilation

Impact of Spectral coverage...

10 August – 20 September 2004


Day 5 Average Anomaly Correlation
Waves 1- 20
2 Jan - 15 Feb 2004
0.86
0.855
0.85
0.845
0.84
0.835
0.83
nh 500
sh 500+.04
nh 1000+.04
sh 1000+.1
control
short airs
airs-152ch
airs-251ch

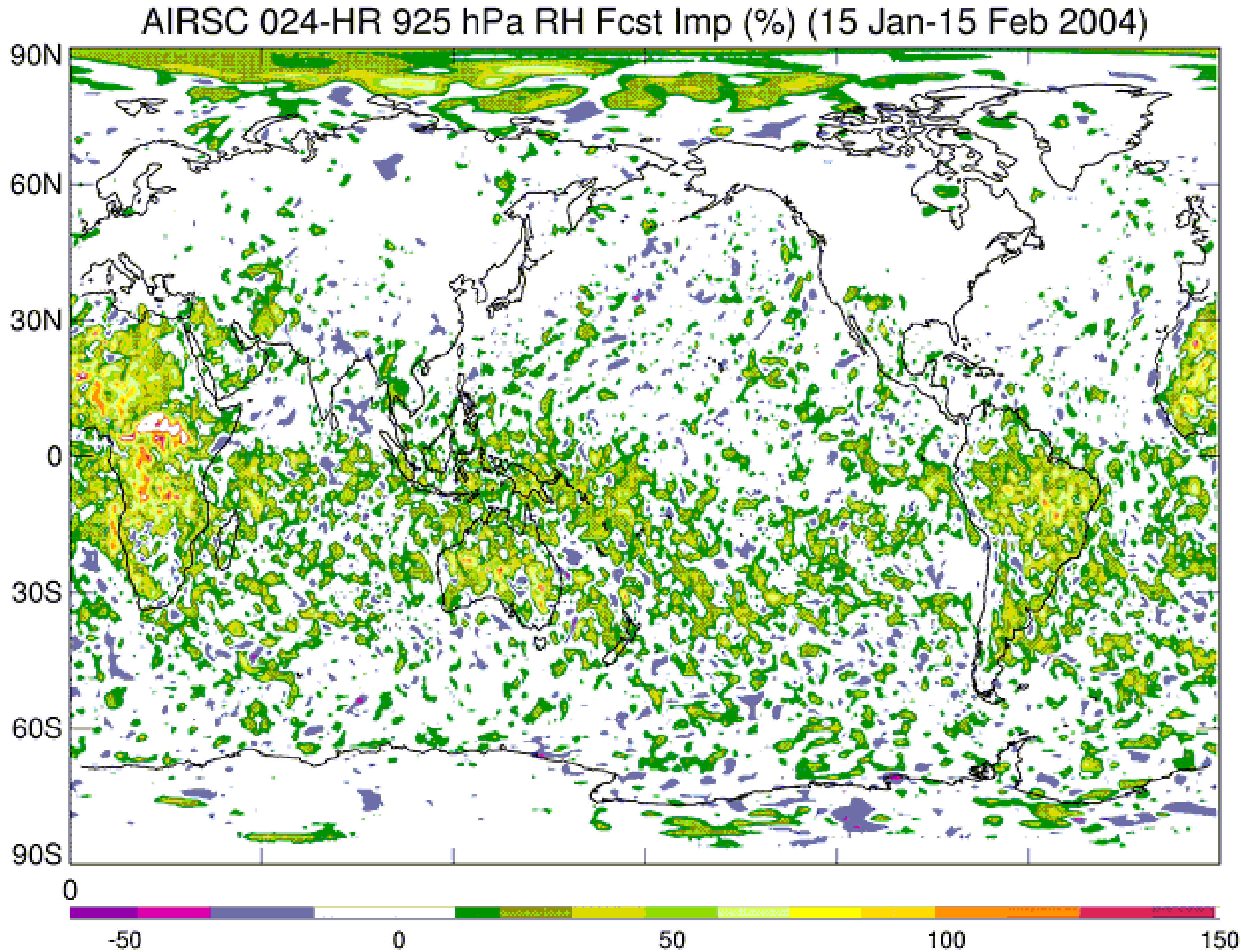
AIRS Data Assimilation

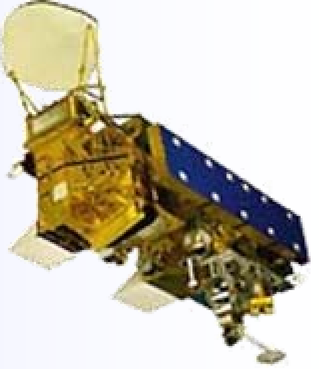
MOISTURE

Forecast Impact evaluates which forecast (with or without AIRS) is closer to the analysis valid at the same time.

Impact = 100* [Err(Cntl) – Err(AIRS)]/Err(Cntl)

Where the first term on the right is the error in the Cntl forecast. The second term is the error in the AIRS forecast. Dividing by the error in the control forecast and multiplying by 100 normalizes the results and provides a percent improvement/degradation. A positive Forecast Impact means the forecast is better with AIRS included.


AIRSC 024-HR 925 hPa RH Fcst Imp (%) (15 Jan-15 Feb 2004)
90N
60N
30N
0
30S
60S
90S
0
-50
0
50
100
150



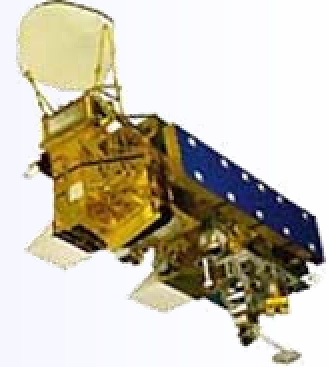
AIRS Data Assimilation

Using Cloudy Fields of View

1 January – 24 February 2007

AIRS Data Assimilation

Using Cloudy Fields of View



Initial Experiments: 1 January – 24 February 2007

Intention:

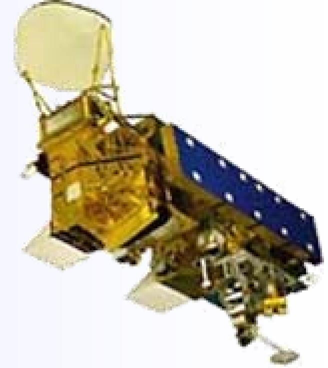
Assimilate radiances from cloudy fovs preferably with single level cloud.

Initially use radiances where cloud coverage and uniformity of fovs allow accurate estimation of radiances from clear part of fovs

Initially measure impact from use of clear air radiances

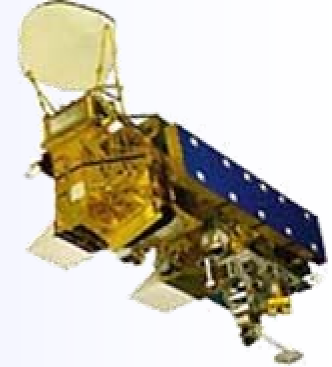
(Later use α and p_c in 3D Var.)

AIRS Data Assimilation Using Cloudy Fields of View



Initial approach to use 9 AIRS fovs and AMSU-A data to provide cloud level information and provide error characterized radiances from clear part of fov.

Subsequently MODIS information to be used as well to improve cloud characterization (ensure single level cloud) and provide error characterized radiances from clear part of fov, cloud height and cloud amount.



AIRS Data Assimilation Using Cloudy Fields of View

Initial Experiments: 1 January – 24 February 2007

Assume :

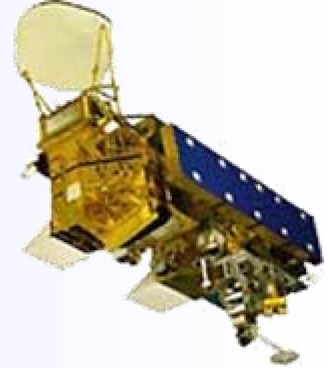
$$R_j = (1 - \alpha_j) R_{clr} + \alpha_j R_{cld}$$

Only variability in AIRS fov is cloud amount α_j

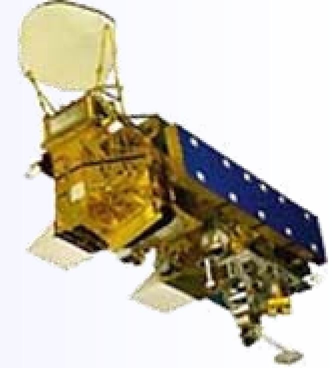
9 AIRS fovs on each AMSU-A footprint used to estimate R_{clr}

AIRS Data Assimilation

Using Cloudy Fields of View



Susskind, J., C.D. Barnet and J.M. Blaisdell 2003. Retrieval of atmospheric and surface parameters from AIRS/AMSU/HSB data in the presence of clouds. IEEE Trans. Geosci. Remote Sens., 41, 390-409.



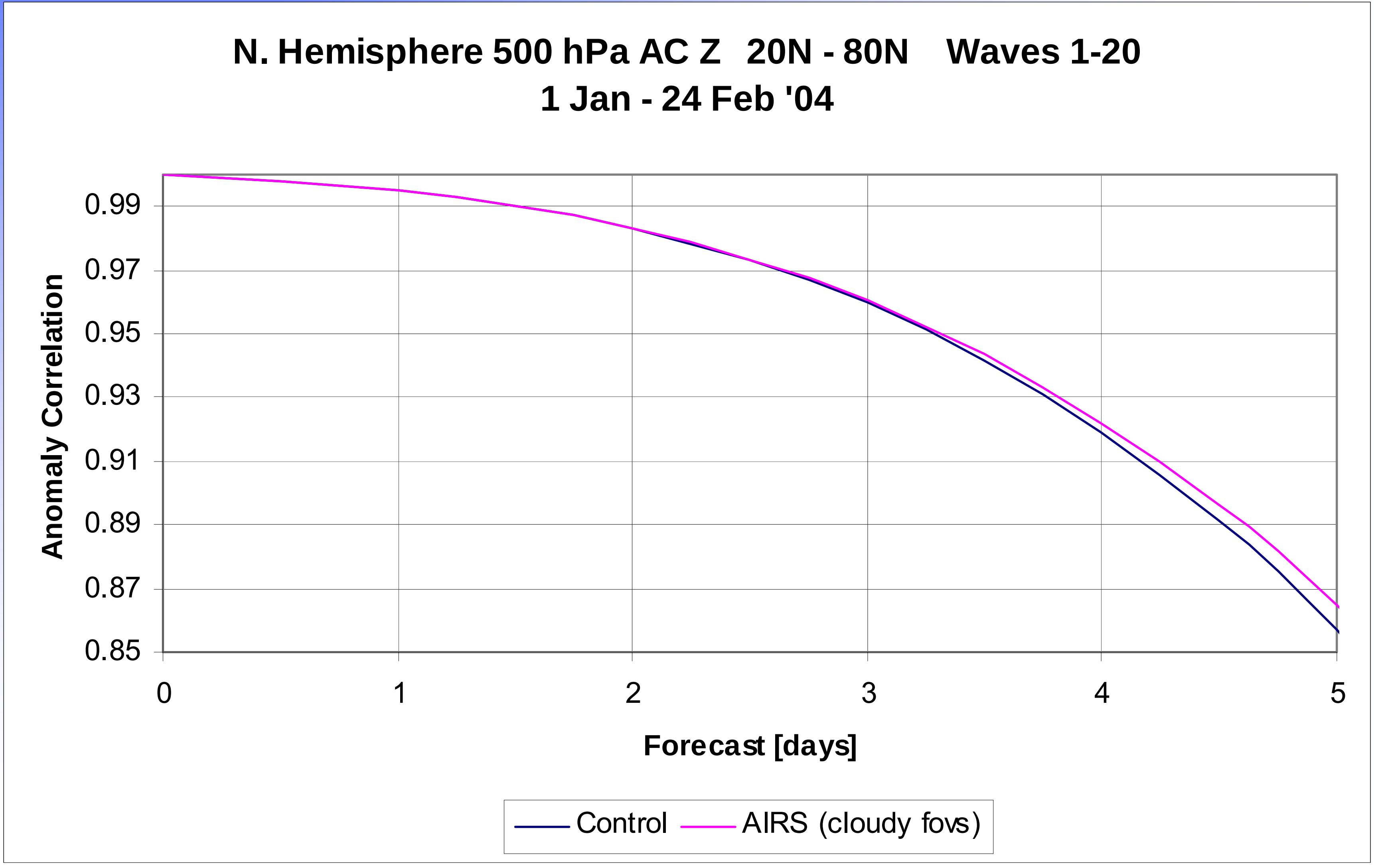
AIRS Data Assimilation

Using Cloudy Fields of View

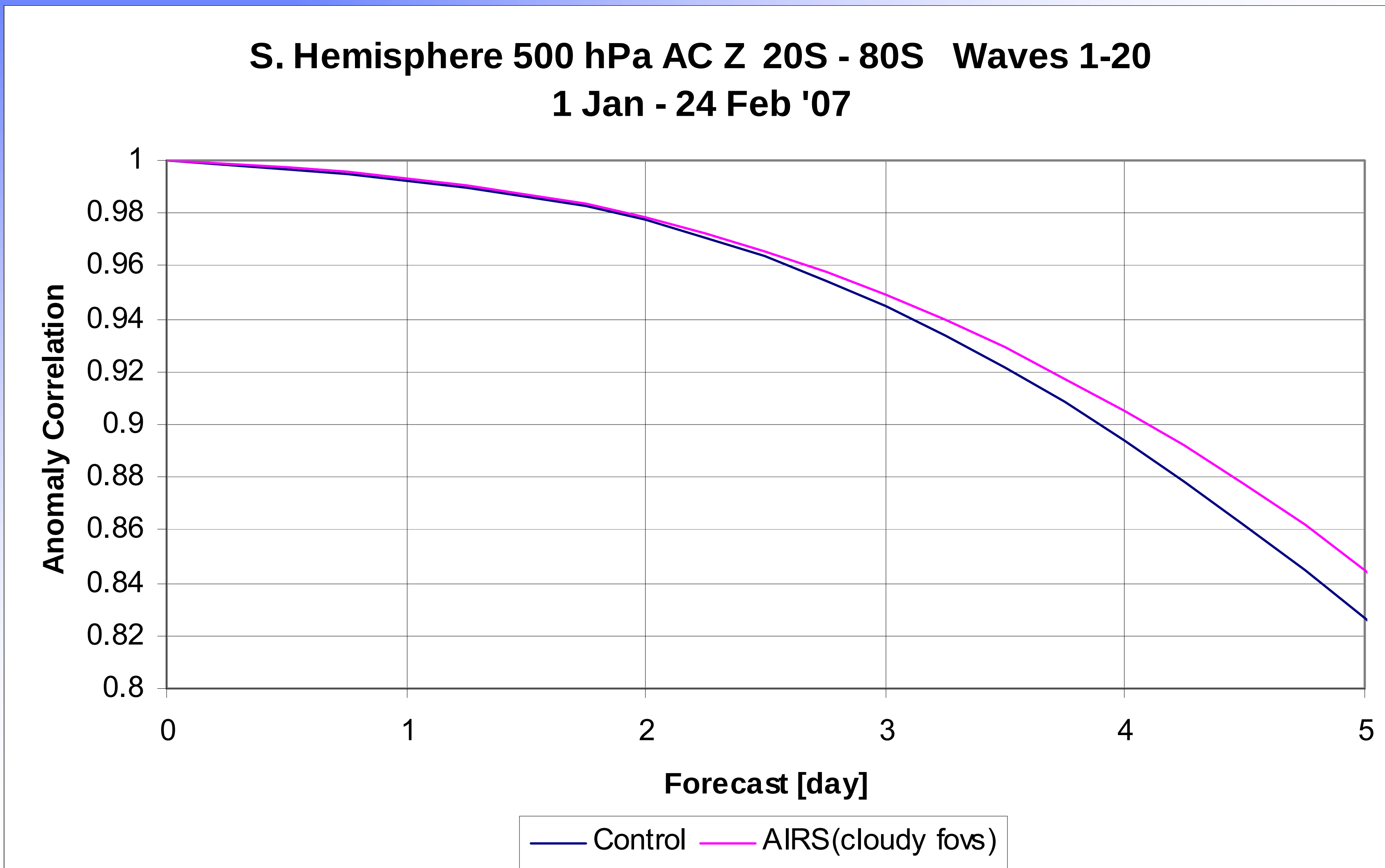
Initial Experiments: 1 January – 24 February 2007

Control – Current Ops. (OP. data coverage - Uses 152 AIRS channels from all fovs with operational thinning)

Experiment- Op. data coverage, minus Op. AIRS plus AIRS radiances from channels free from cloud effects and radiances from the clear air part of selected cloudy fovs (with operational thinning).

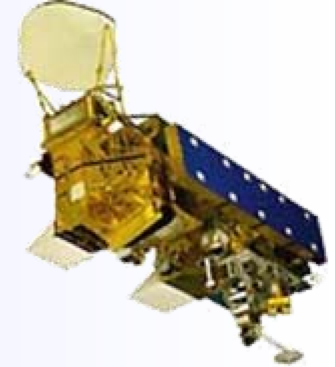


N. Hemisphere 500 hPa AC Z 20N - 80N Waves 1-20
1 Jan - 24 Feb '04
Anomaly Correlation
0.99
0.97
0.95
0.93
0.91
0.89
0.87
0.85
0
1
2
3
4
5
Forecast [days]
Control
AIRS (cloudy fovs)


S. Hemisphere 500 hPa AC Z 20S - 80S Waves 1-20
1 Jan - 24 Feb '07
Anomaly Correlation
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
0.8
0
1
2
3
4
5
Forecast [day]
Control
AIRS(cloudy fovs)

AIRS Data Assimilation

Using Cloudy Fields of View



Initial Experiments: 1 January – 24 February 2007

Results:

Assimilation of radiances from cloudy fovs resulted in improved anomaly correlations for the experimental system during the period studied.

Southern Hemisphere results significant at near the

95% level, accounting for serial correlation of forecast differences (Seaman, 1992)

Further R2O activity restricted by loss of RT data set.

Surface Emissivity (ε) Estimation

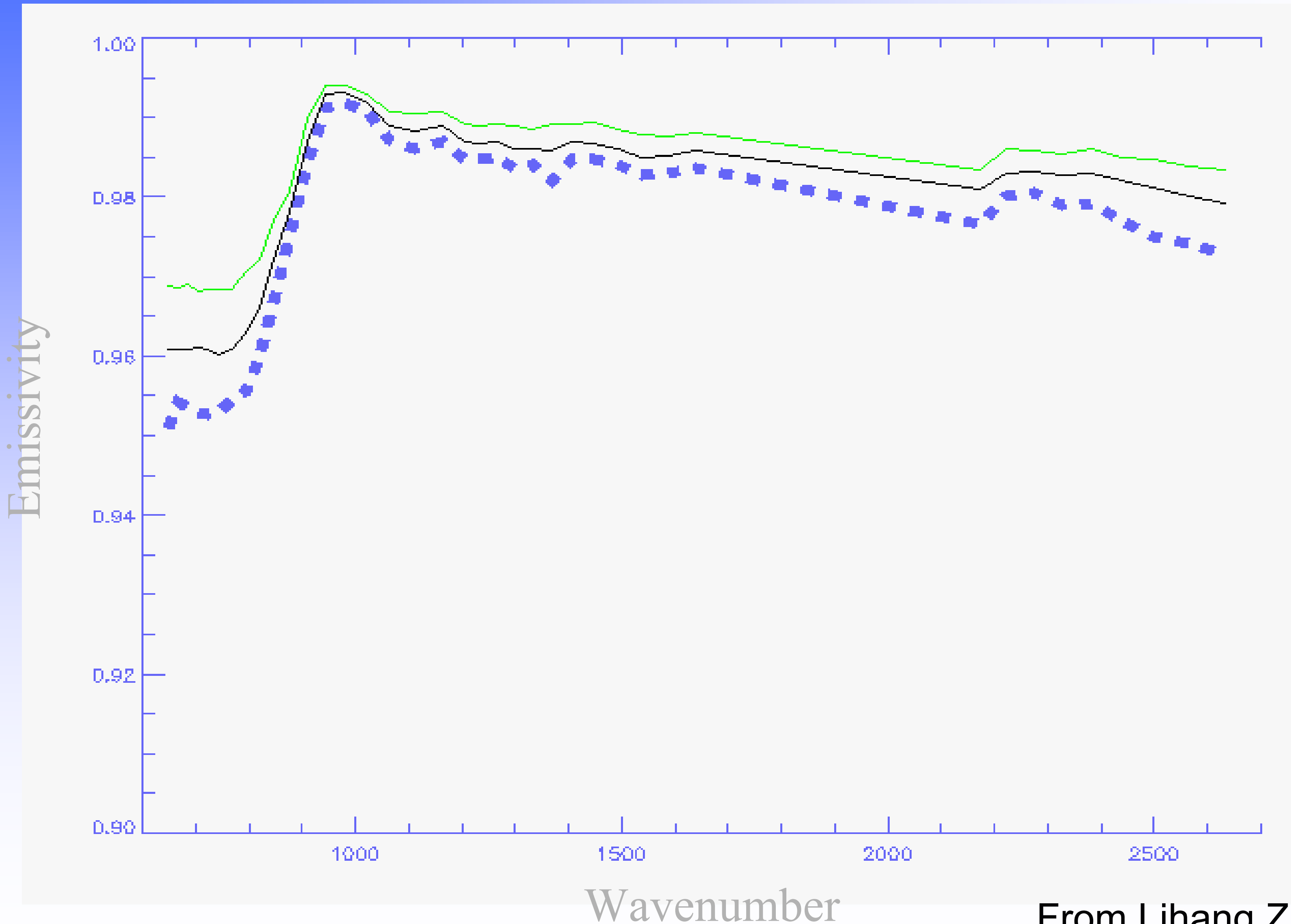
Emissivity (ε) required for

- Accurate surface temperature
- Accurate Boundary layer temperature
- Accurate Boundary layer moisture

Surface Emissivity (ε) Estimation Methods

- Geographic Look Up Tables (LUTs) - CRTM
- Regression based on theoretical estimates
  - Lihang Zhou
- Minimum Variance, provides T_{surf} and ε *
- Eigenvector technique
  - Dan Zhou and Bill Smith
- Variational Minimisation – goal

Regression IR HYPERSPECTRAL EMISSIVITY - ICE and SNOW
Sample Max/Min Mean computed from synthetic radiance sample



From Lihang Zhou

Surface Emissivity (ε) Estimation Methods

JCSDA IR Sea Surface Emissivity Model (IRSSE)

Initial NCEP IRSSE Model based on Masuda et al. (1998)

Updated to calculate Sea Surface Emissivities via Wu and Smith (1997)

Van Delst and Wu (2000)

Includes high spectral resolution (for instruments such as AIRS)

Includes sea surface reflection for larger angles

JCSDA Infrared Sea Surface Emissivity Model – Paul Van Delst
Proceedings of the 13th International TOVS Study Conference
Ste. Adele, Canada, 29 October - 4 November 2003

AIRS SST and ε Determination

Use AIRS bias corrected radiances from GSI

AIRS channels used are :
119 – 129 (11)
154 – 167 (14)
263 – 281 (19)

Method is the minimum (emissivity) variance technique

Channels used in Pairs : 119, 120; 120, 121; 121, 122; . . etc

For a downward looking infrared sensor:

$$I_\nu = \int_0^Z B_\nu[T(z)] \frac{\partial \tau_\nu(z,Z)}{\partial z} dz + \varepsilon_\nu \bullet B_\nu(T_S) \bullet \tau_\nu(0,Z) +$$

$$(1-\varepsilon_\nu) \bullet \tau_\nu(0,Z) \int_\infty^0 B_\nu[T(z)] \frac{\partial \tau_\nu(z,Z)}{\partial z} dz$$

where I_ν, ε_ν, B_ν, T_S, $\tau_\nu(z_1, z_2)$, Z and $T(z)$ are observed spectral radiance, spectral emissivity, spectral Planck function, the surface temperature, spectral transmittance at wavenumber ν from altitude z_1 *to* z_2, sensor altitude z, and air temperature at altitutide z respectively.

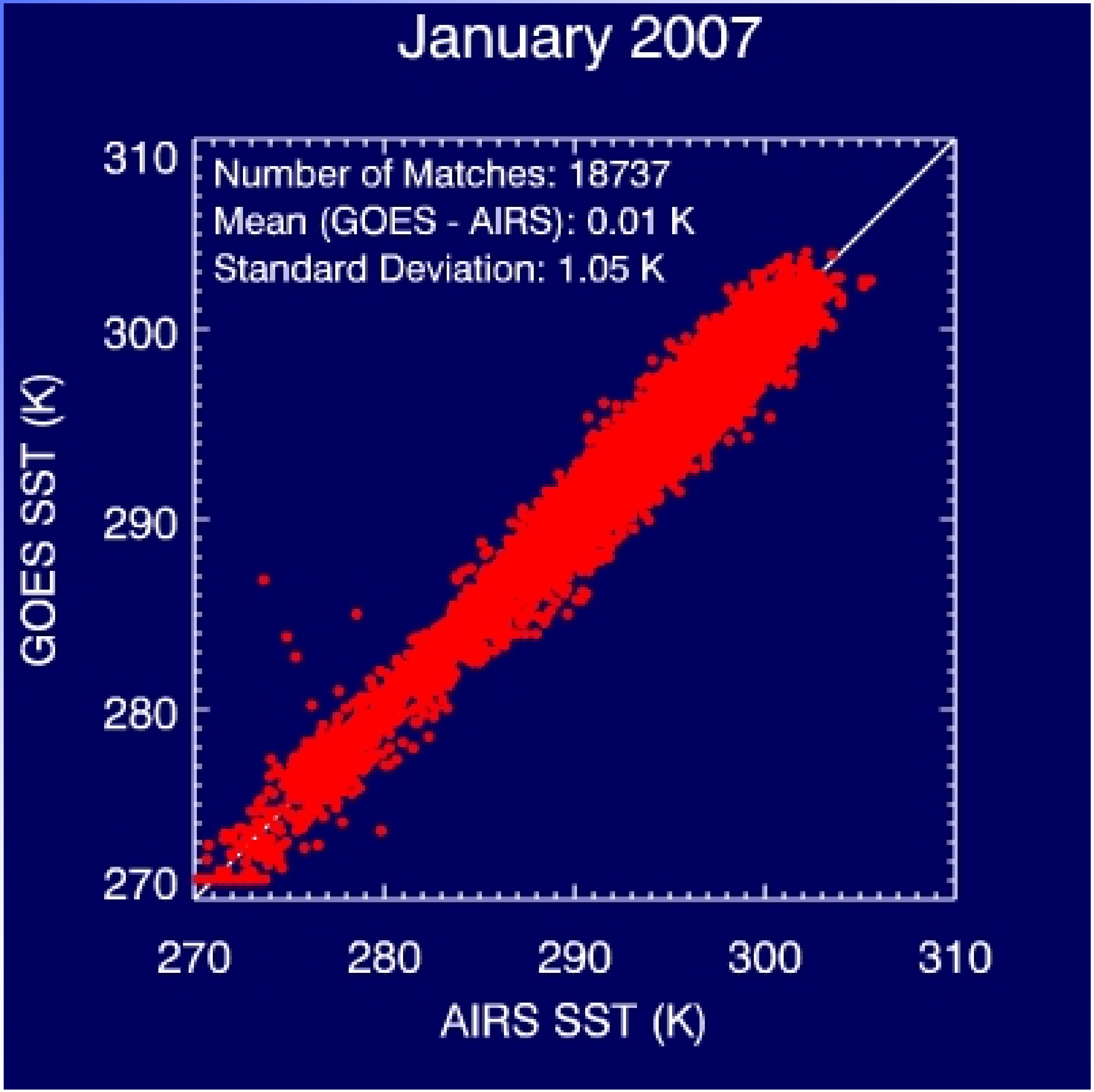
The solution can be written as :

$$\hat{\varepsilon}_{\nu} = \frac{\left[R_{\nu}^{OBS} - N_{\nu}^{\uparrow}\right] - \tau_{\nu}\overline{N_{\nu}^{\downarrow}}}{\tau_{\nu}B_{\nu}\left(\hat{T}_{S}\right) - \tau_{\nu}\overline{N_{\nu}^{\downarrow}}}$$

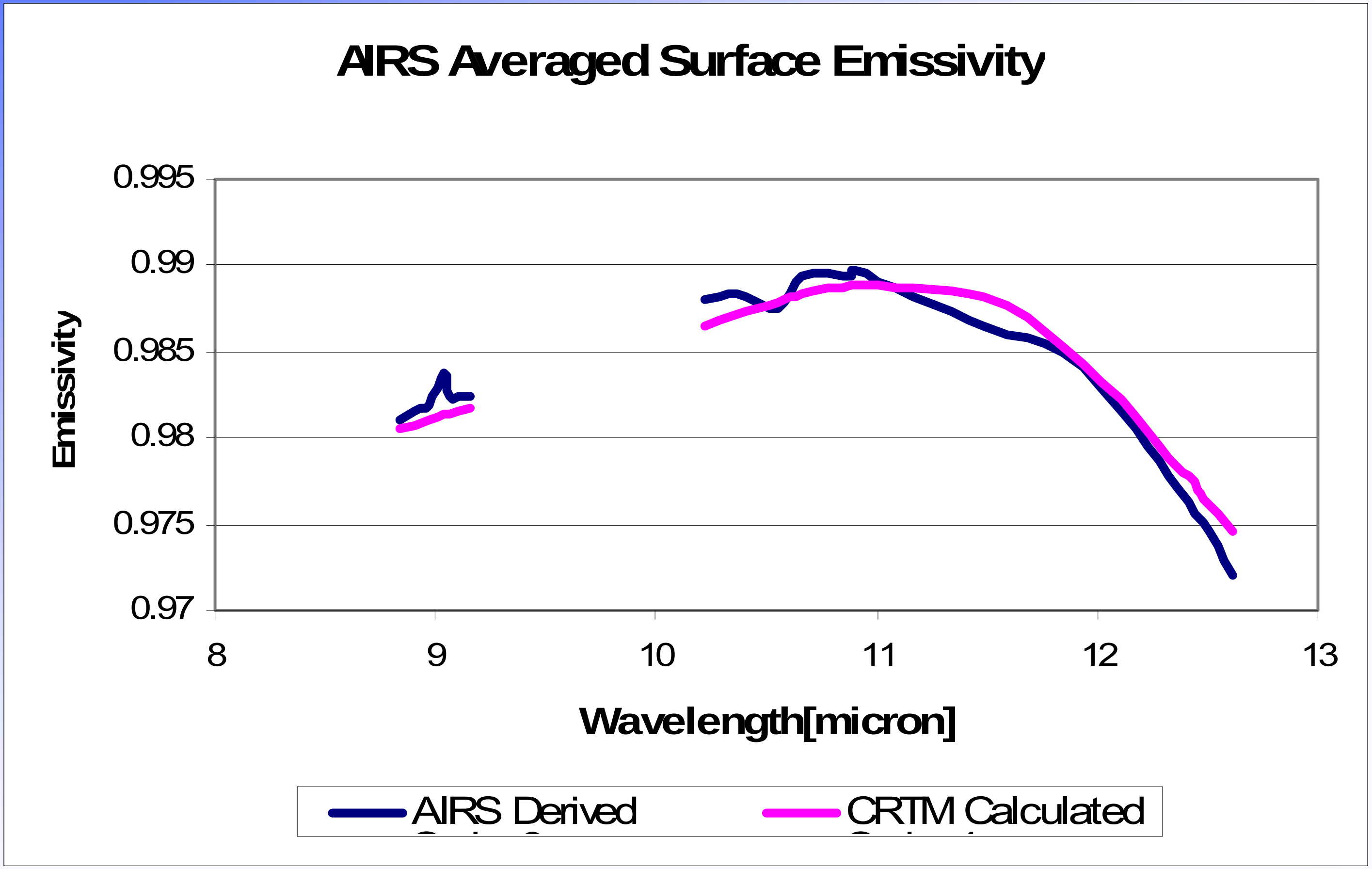
Where R^{OBS} is the observed upwelling radiance, N↑ represents the upwelling emission from the atmosphere only and N↓ represents the downwelling flux at the surface. The ^ symbol denotes the "effective" quantities as defined in Knuteson et al. (2003).

The SST is the T_S that minimises :

$$\sum \left(\varepsilon_{i} - \varepsilon_{i+1}\right)^{2}$$

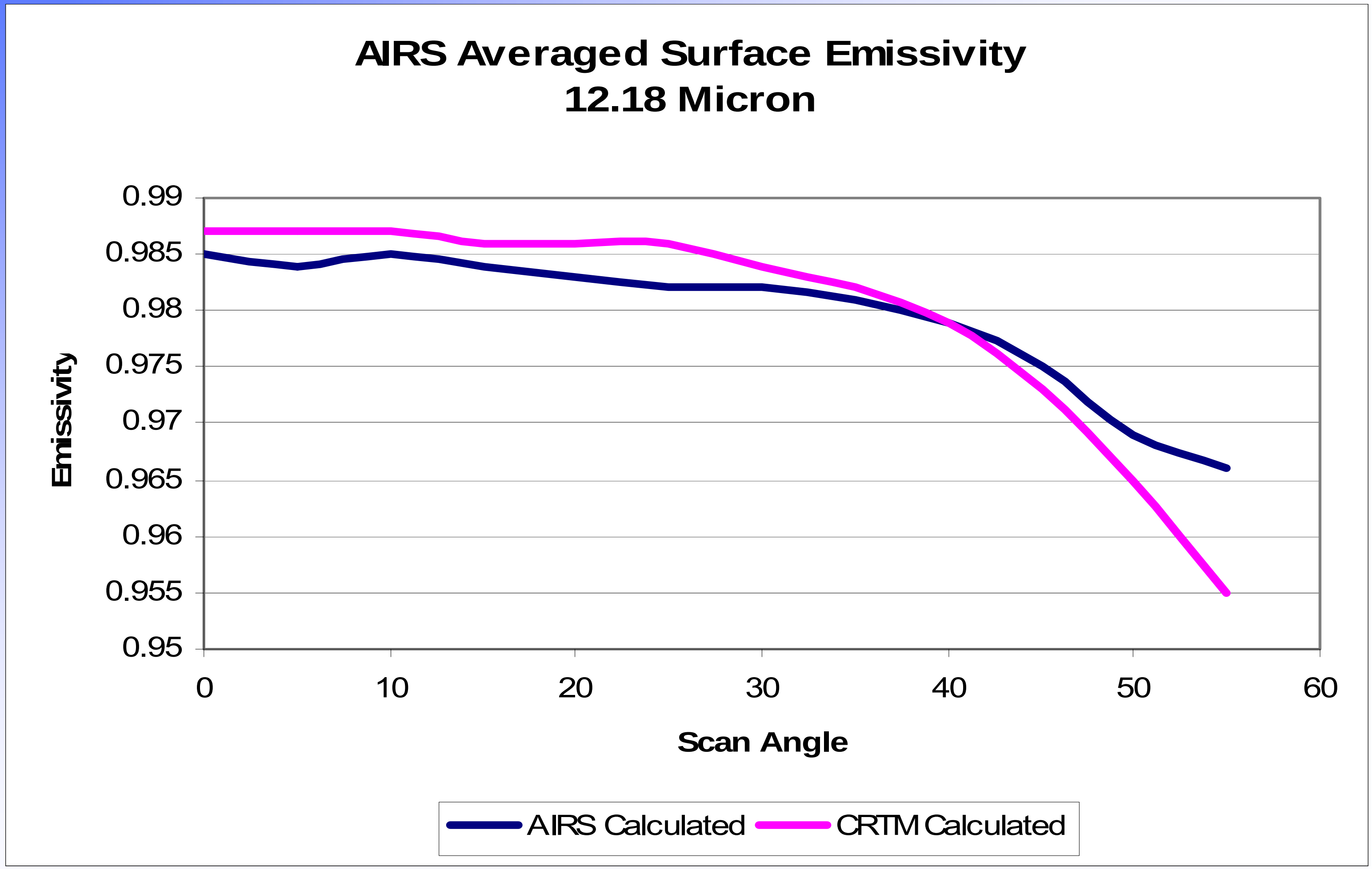

January 2007
Number of Matches: 18737
Mean (GOES - AIRS): 0.01 K
Standard Deviation: 1.05 K
GOES SST (K)
310
300
290
280
270
270
280
290
300
310
AIRS SST (K)

Ocean Surface Emissivity Comparisons



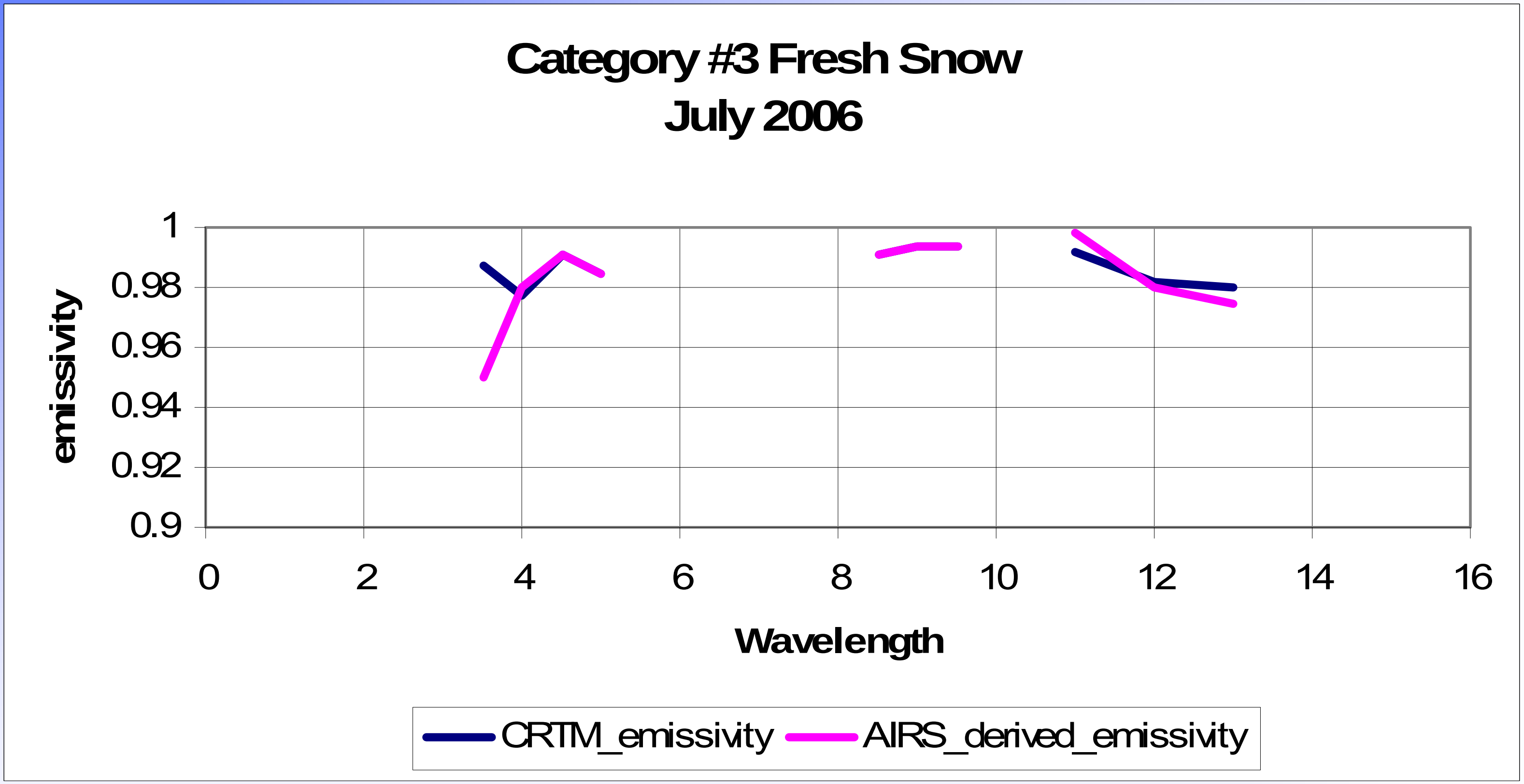
Average surface emissivity over ocean as derived from AIRS using the minimum variance (AIRS Derived) and values from the ocean emissivity model within the CRTM (CRTM Calculated).

Ocean Emissivity Scan Angle Comparisons



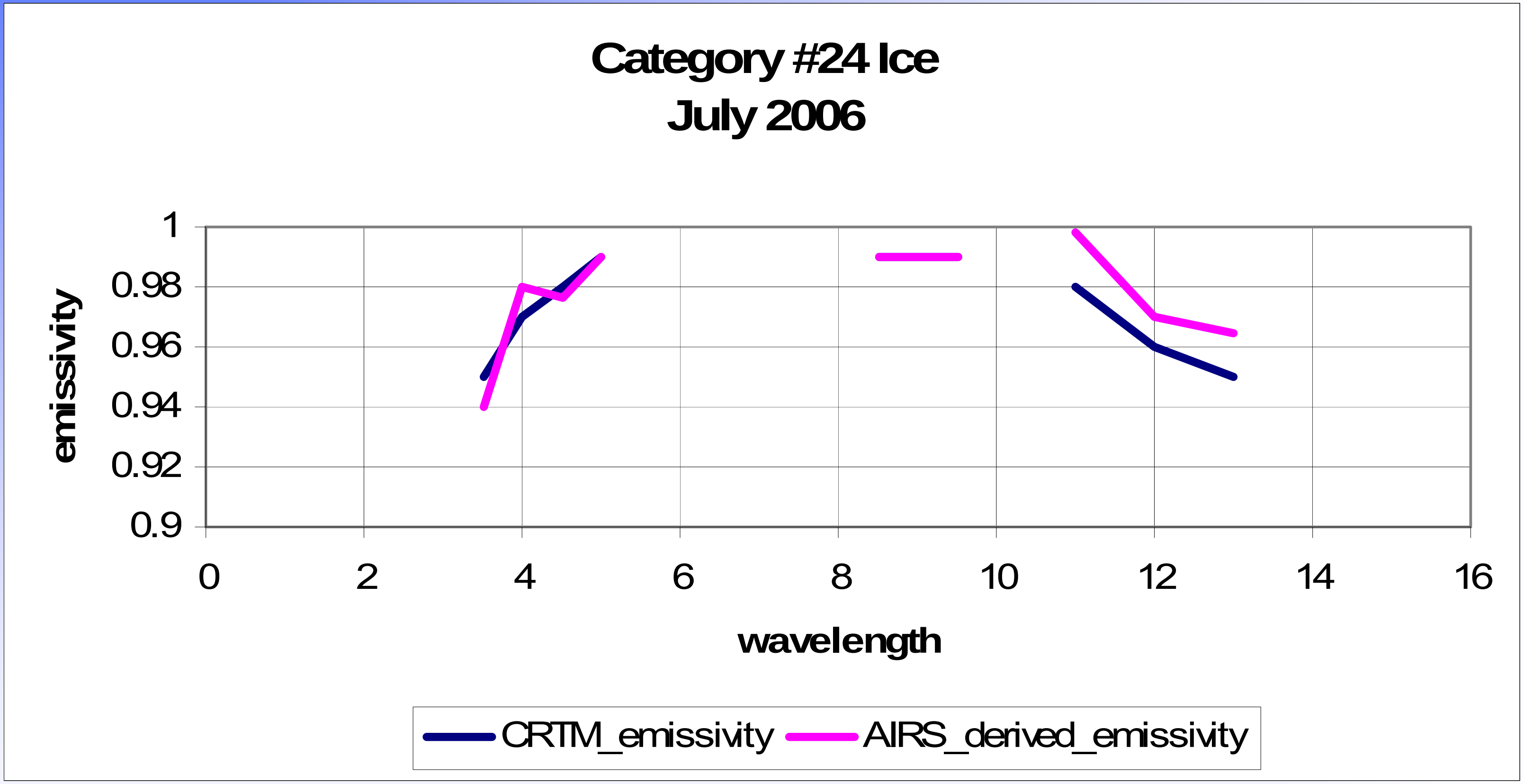
Average surface emissivity over ocean by scan angle as derived from AIRS using the minimum variance (AIRS Calculated) and values from the ocean emissivity model within the CRTM (CRTM Calculated).

Surface Emissivity Comparisons for Snow



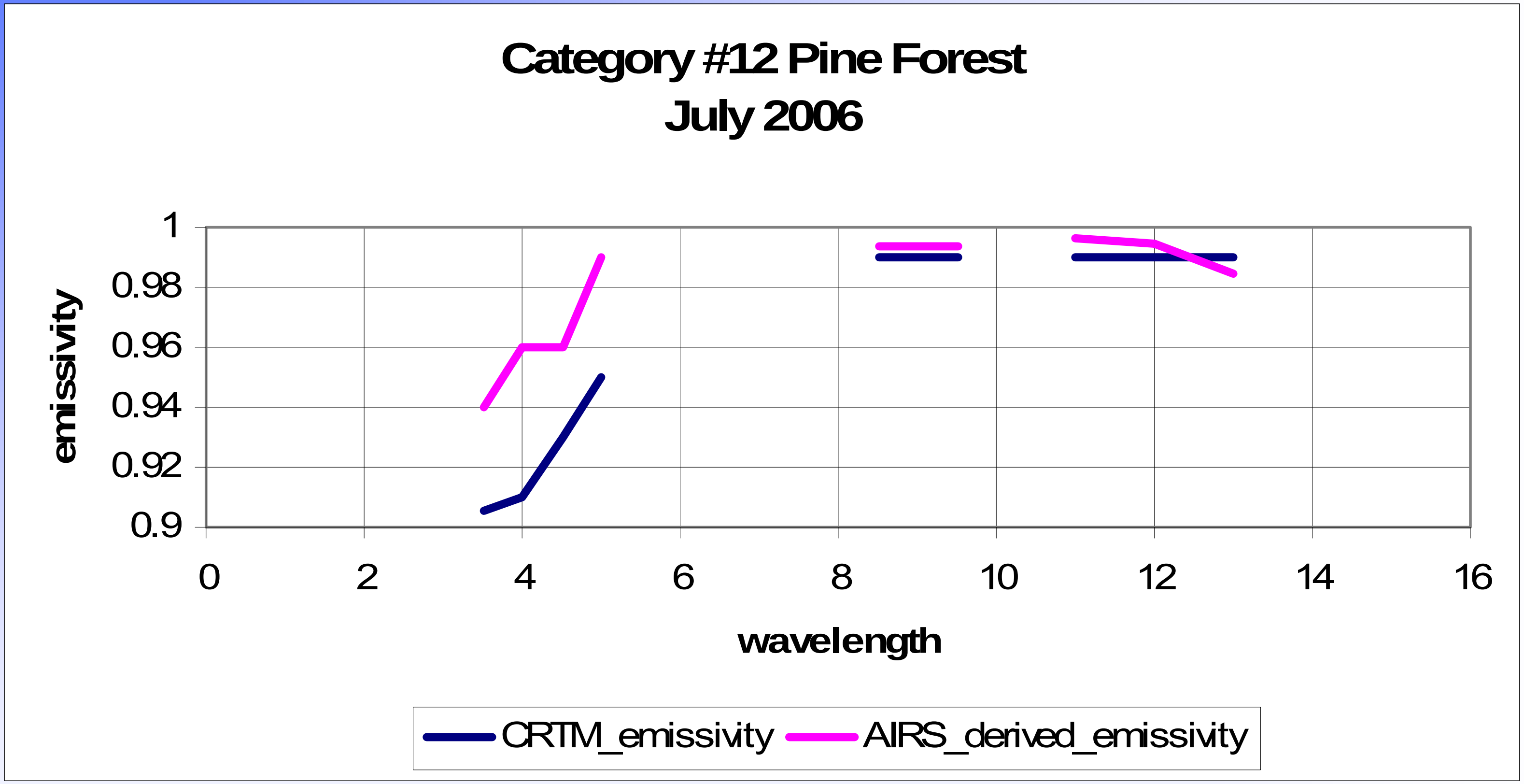
Comparison of surface emissivity for snow from the CRTM lookup table (CRTM_emissivity) with the emissivity derived from AIRS using minimum variance (AIRS_derived_emissivity)

Surface Emissivity Comparisons for Ice



Comparison of surface emissivity for ice from the CRTM lookup table (CRTM_emissivity) with the emissivity derived from AIRS using minimum variance (AIRS_derived_emissivity).

Surface Emissivity Comparisons for Pine Forest



Comparison of surface emissivity for Pine Forest from the CRTM lookup table (CRTM_emissivity) with the emissivity derived from AIRS using minimum variance (AIRS_derived_emissivity)

The Future

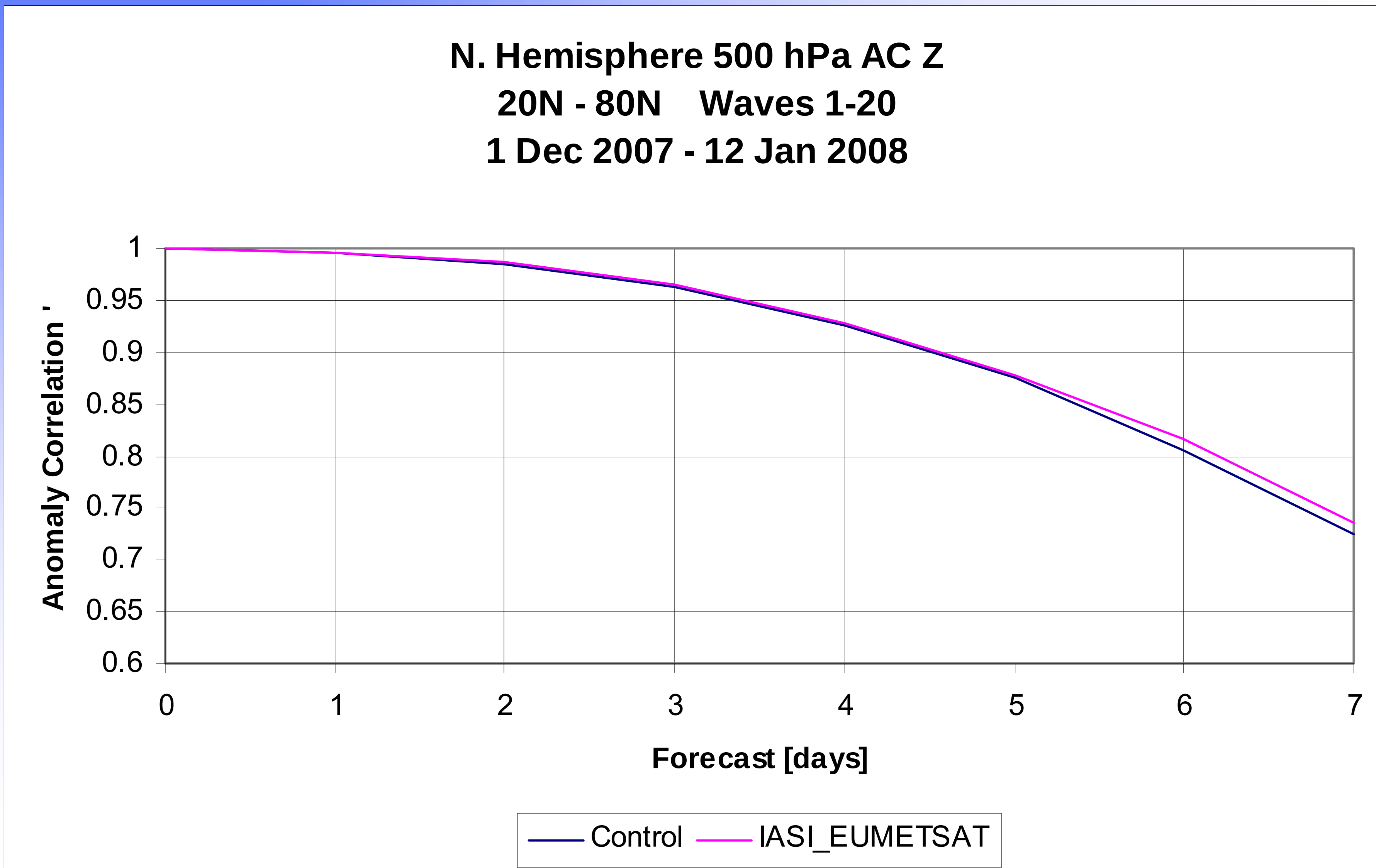
- Expanded use of the hyperspectral - IASI
- Expanded use of cloudy radiances
- Improved surface emissivity characterization
- Expanded use of spectral content
- Enhanced use of moisture information
- ACCESS – UKUM

Use of Continuous Data in 4D-VAR (Regional 37.5km)

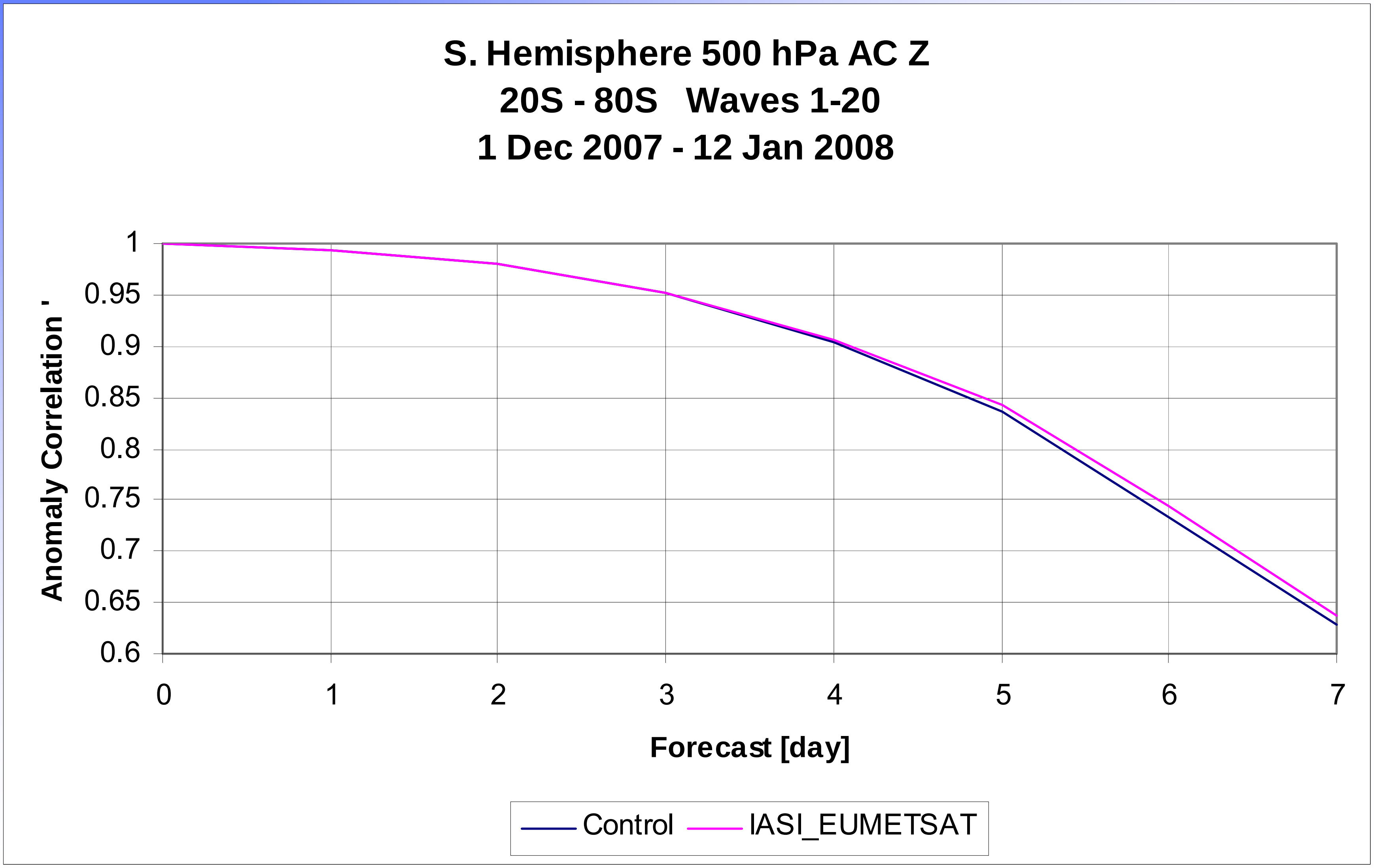
eg.TC Nicholas Western Australian region February 2008

- ………..

The Future


N. Hemisphere 500 hPa AC Z
20N - 80N Waves 1-20
1 Dec 2007 - 12 Jan 2008
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
IASI_EUMETSAT

The Future


S. Hemisphere 500 hPa AC Z
20S - 80S Waves 1-20
1 Dec 2007 - 12 Jan 2008
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
IASI_EUMETSAT

The Future

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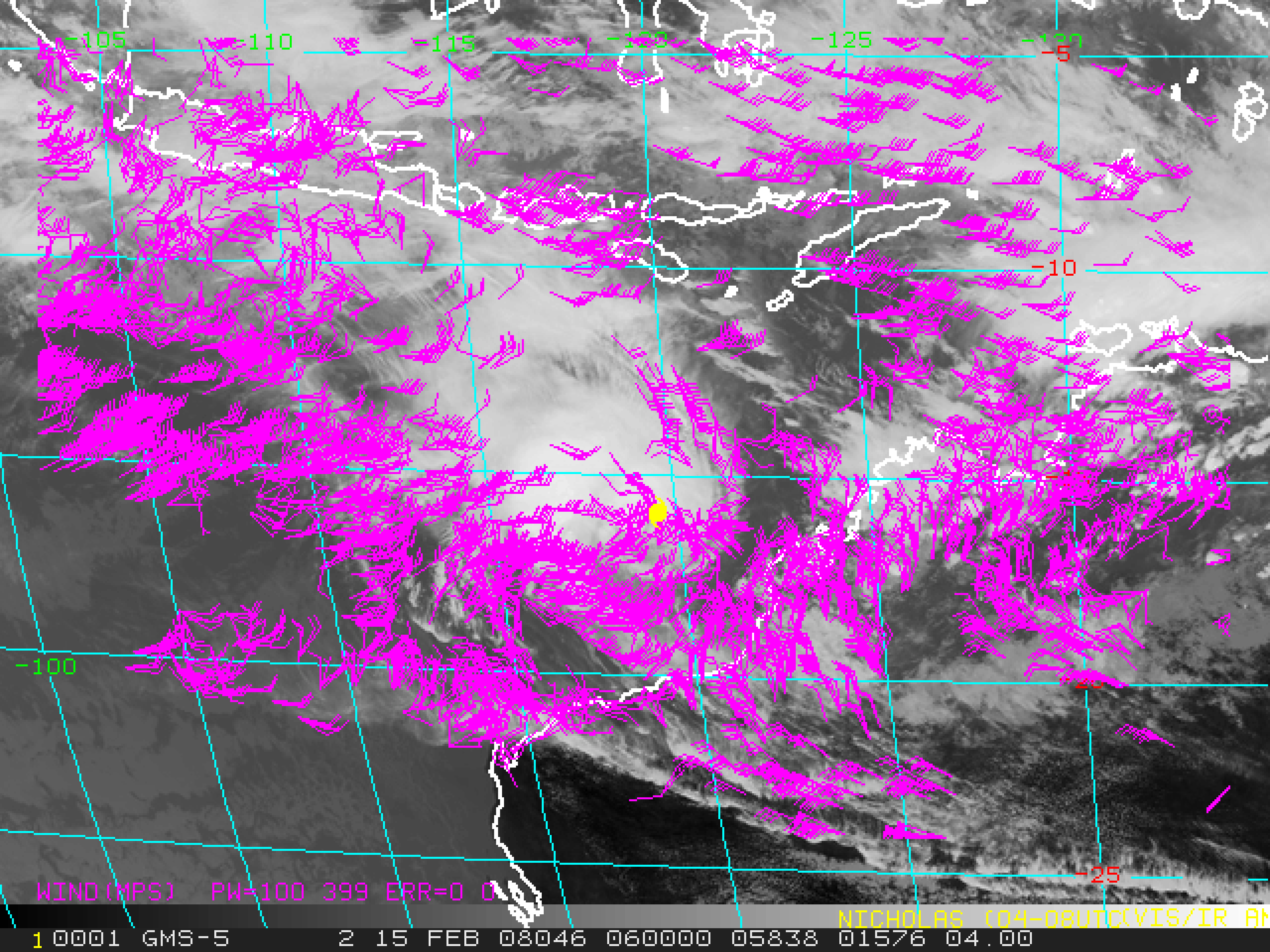
Use of Continuous Data in 4D-VAR (Regional 37.5km)

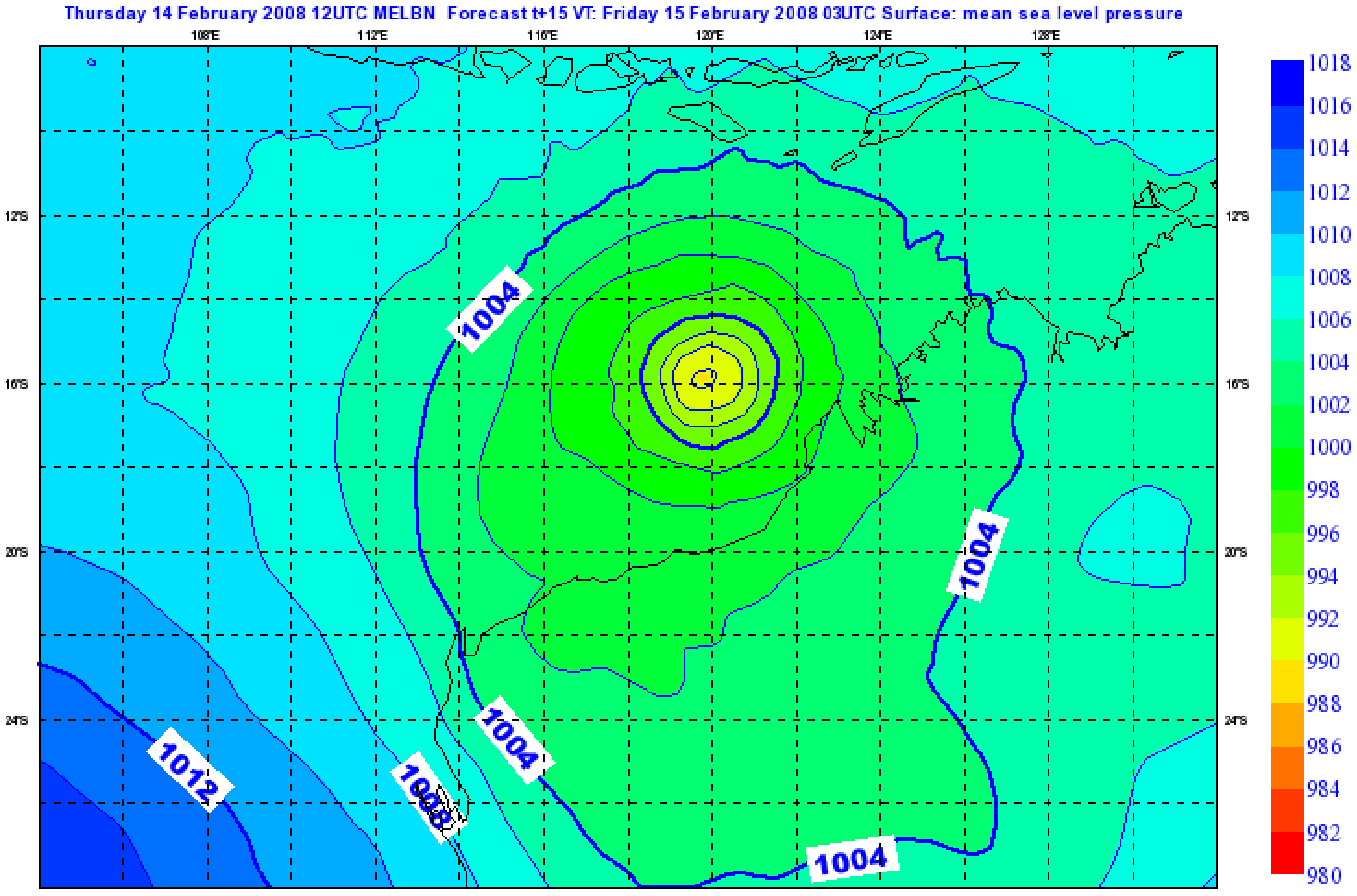
eg.TC Nicholas Western Australian region February 2008

- ………..

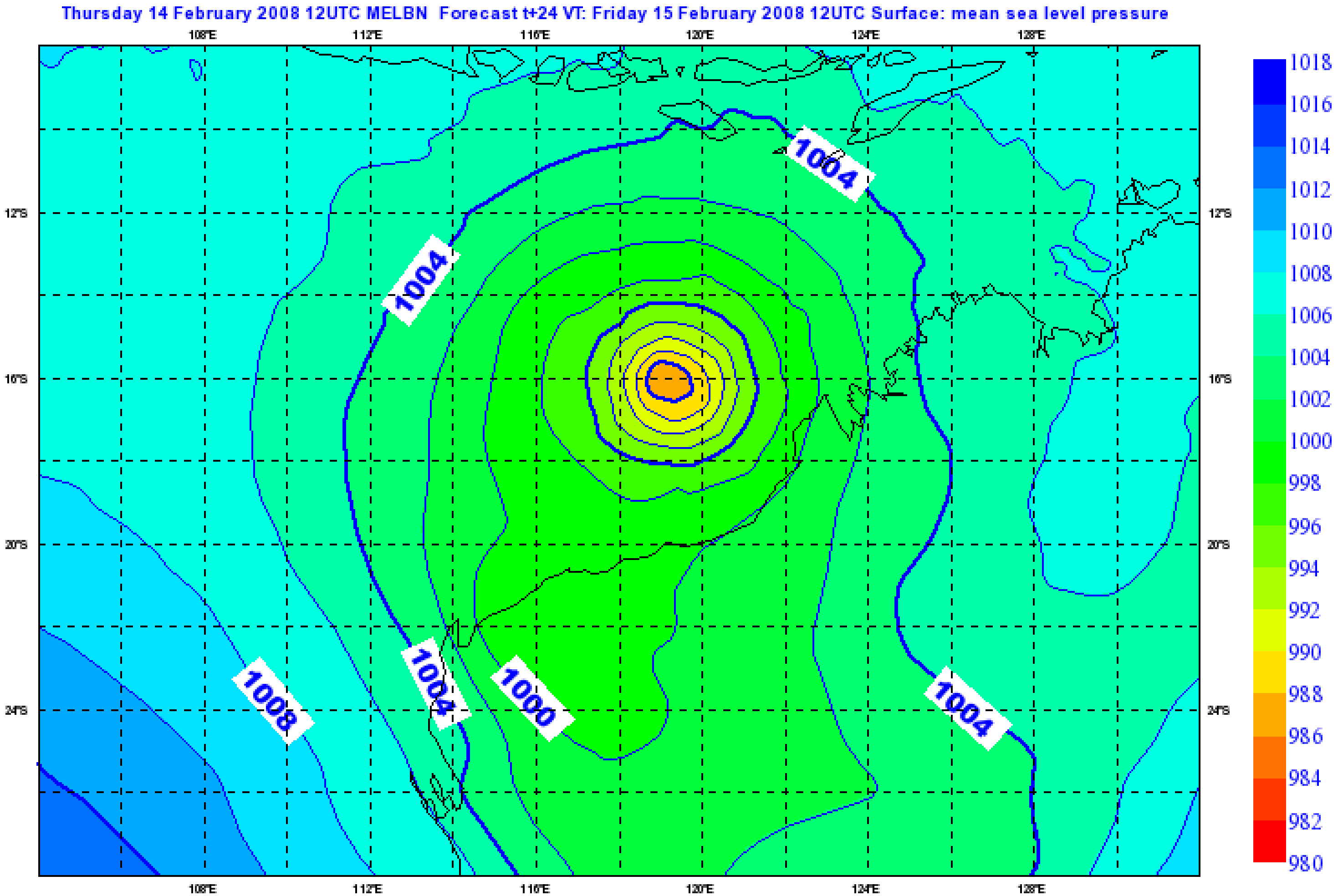
Satellite data used within the ACCESS (UKUM) Forecast System Includes

HIRS sounder radiances AMSU-A sounder radiances AMSU-B sounder radiances GOES 10,12, Meteosat, MTSat-1R atmospheric motion vectors SSM/I ocean surface wind speeds	ERS-2 ocean surface wind vectors Quikscat ocean surface wind vectors AIRS sounder radiances Local hourly AMVs ………..


-105
-110
-115
-125
-5
-10
-25
-100
WIND(MPS) PW=100 399 ERR=0 0
NICHOLAS (04-08UTC)(VIS/IR A
1 0001 GMS-5 2 15 FEB 08046 060000 05838 01576 04.00



Thursday 14 February 2008 12UTC MELBN Forecast t+15 VT: Friday 15 February 2008 03UTC Surface: mean sea level pressure
108°E
112°E
116°E
120°E
124°E
128°E
12°S
16°S
20°S
24°S
1004
1004
1004
1004
1012
1008
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
996
994
992
990
988
986
984
982
980


Thursday 14 February 2008 12UTC MELBN Forecast t+24 VT: Friday 15 February 2008 12UTC Surface: mean sea level pressure
108°E
112°E
116°E
120°E
124°E
128°E
12°S
16°S
20°S
24°S
1004
1004
1004
1004
1000
1008
1018
1016
1014
1012
1010
1008
1006
1004
1002
1000
998
996
994
992
990
988
986
984
982
980

Summary

Key components of the operational data base have been assessed in terms global forecast impact.

Quantitative estimates (ACs, FIs and hurricane forecast track errors) have been used to quantify the impact of conventional data, satellite data, and that of particular instruments and rawinsonde data in a number of OSEs.

In these studies the significant impacts of AMSU and rawinsondes were noted.

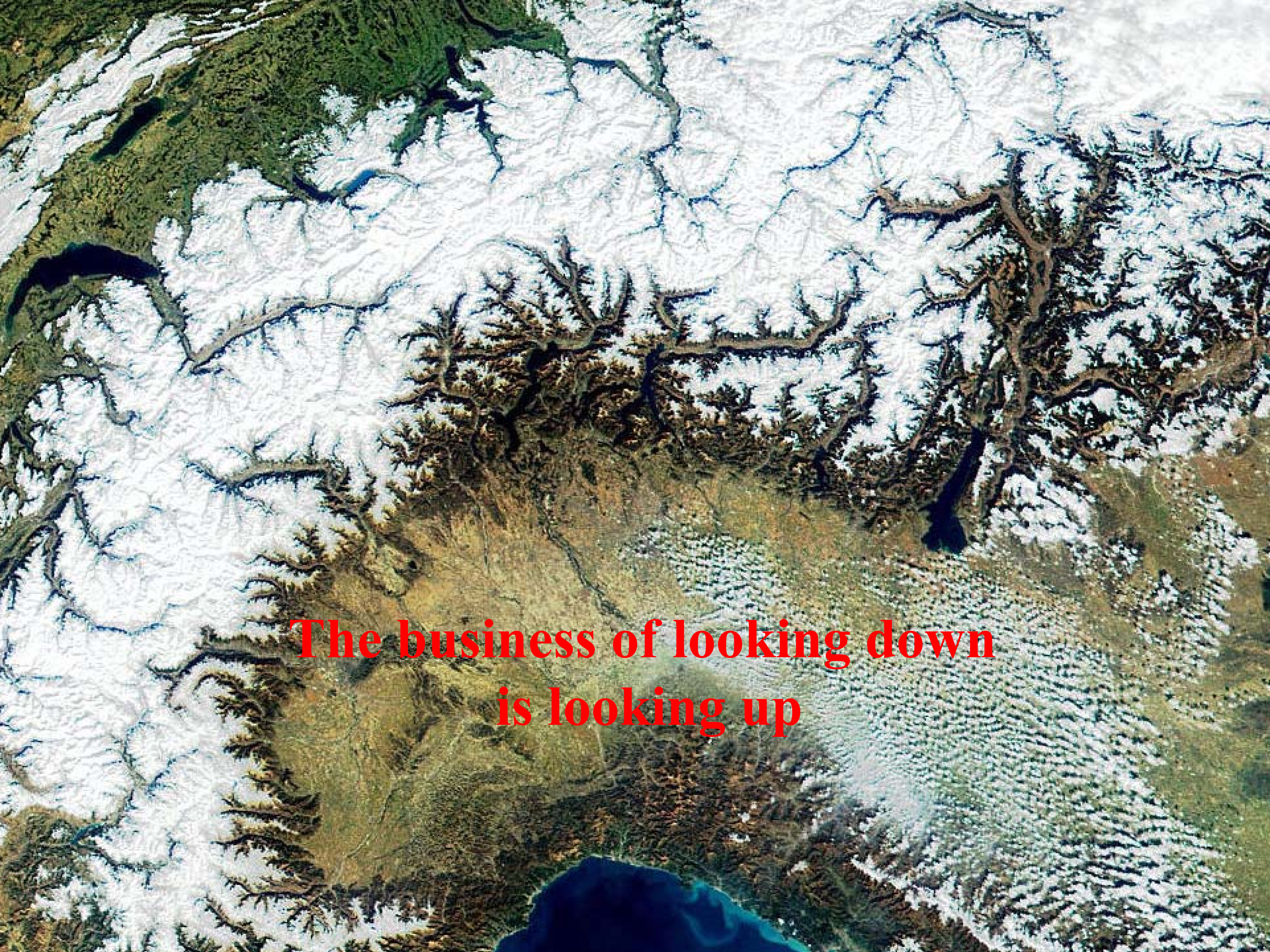
Summary / Cont'd

AIRS (hyperspectral radiance) data have been shown to make a very significant contribution globally to operational NWP.

The significant potential for larger benefits to operational meteorology from use of these hyperspectral radiances has also demonstrated:

Data impact studies showing the importance of using improved spatial and spectral resolution data and showing the benefit of using cloud effected radiances have been presented.

Assimilatiom studies with UKUM based ACCESS model underway and showing good forecast skill.


The business of looking down
is looking up

Australian Government

Bureau of Meteorology

CSIRO

JOINT CENTER FOR SATELLITE DATA ASSIMILATION

NOAA NASA JCSDA Navy Air Force