JOINT CENTER FOR SATELLITE DATA ASSIMILATION

NOAA NASA JCSDA Navy Air Force

The Joint Center for Satellite Data Assimilation : Progress Report

John Le Marshall,
JCSDA

Overview

- Background
- The Challenge
- A solution - JCSDA
- Mission, Vision and Goals
- Progress, Major Accomplishments
- Plans/Future Prospects
- Summary

History

April 2000, a small team of senior NASA and NOAA managers release a white paper[1] containing plans to improve and increase the use of satellite data for global numerical weather models.

The white paper provided a specific recommendation to establish a Joint Center for Satellite Data Assimilation (JCSDA).

This white paper came in response to a growing urgency for more accurate and improved weather and climate analyses and forecasts.

These improvements could only be made possible by the development of improved models and data assimilation techniques, which allow models to utilize more and better quality data.

[1] *A NASA and NOAA plan to maximize the utilization of satellite data to improve weather forecasts. Franco Einaudi, Louis Uccellini, James F. W. Purdom, Alexander Mac Donald, April 2000.*

History

In 2001 the Joint Center was established[2] and in 2002, the JCSDA expanded its partnerships to include the U.S. Navy and Air Force weather and oceanography agencies.

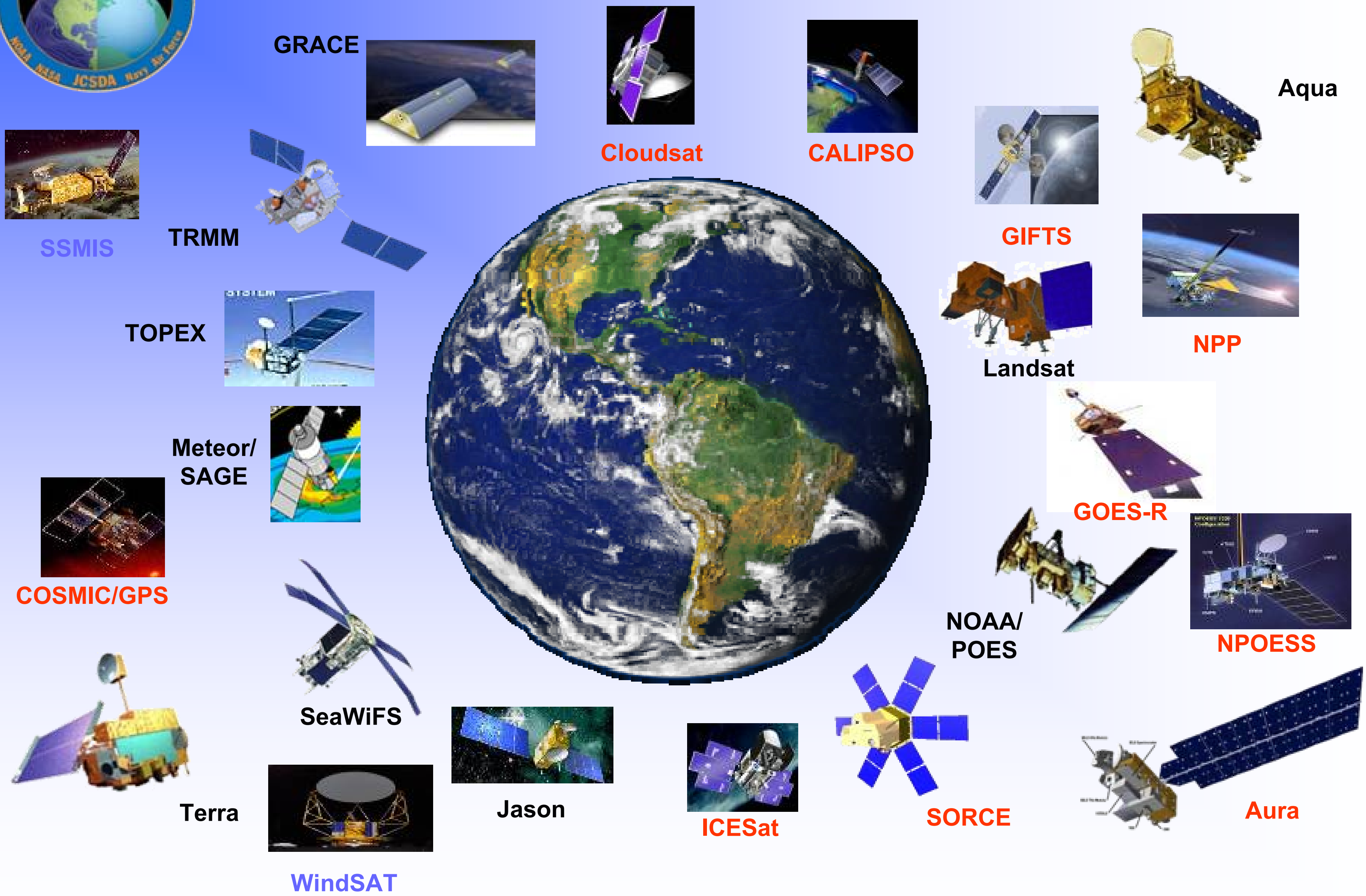
[2] *Joint Center for Satellite Data Assimilation: Luis Uccellini, Franco Einaudi, James F. W. Purdom, David Rogers: April 2000.*

MOA

Memorandum of Agreement
Between The
Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, National Environmental Satellite, Data, and Information Service, and Office of Atmospheric Research
And The
National Aeronautics and Space Administration
Goddard Space Flight Center
Global Modeling and Assimilation Office
And The
Department of Defense
Oceanographer of the Navy,
Naval Research Laboratory,
Air Force Director of Weather, and
Army Research Laboratory
On The
Joint Center for Satellite Data Assimilation

The Challenge

Satellite Systems/Global Measurements



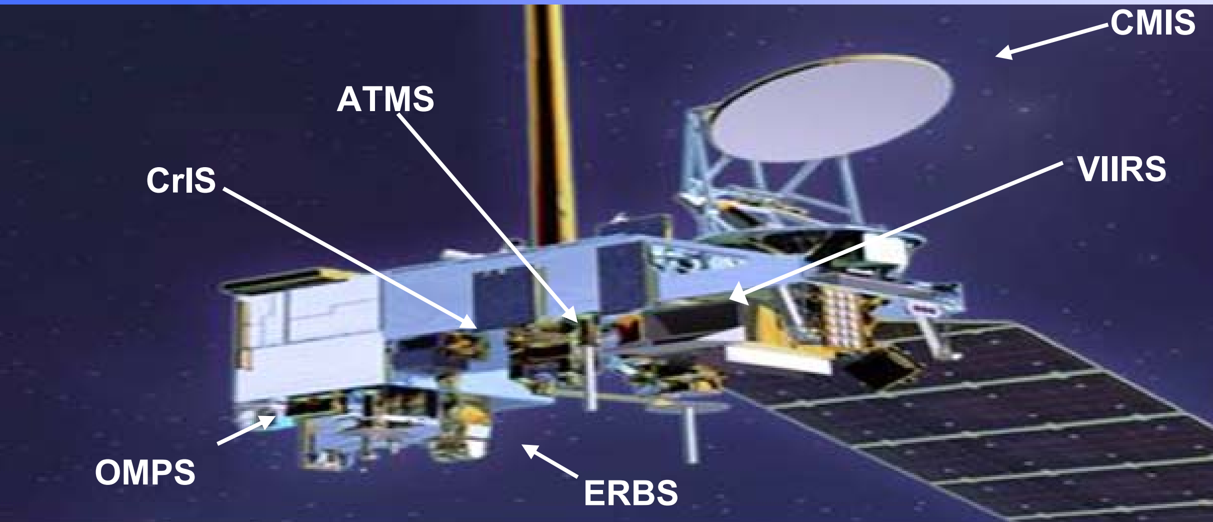
Draft Sample Only

	A	B	C	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Satellite Instruments and Their Characteristics (* = currently assimilated in NWP)																	
2				Primary Information Content										Priority				
3	Platform	Instrument	Status	Temper-ature	Humidity	Cloud	Precip-itation	Wind	Ozone	Land Surface	Ocean Surface	Aerosols	Earth Radiation Budget	NOAA	NAVY	NASA	AIR FORCE	NAVY NON - ASSIM
4	DMSP	SSM/I *	Current		v	v	v	v		v	v			1	1	1	3	1
5		SSM/T*		v										3	3	3	1	2
6		SSM/T-2			v		v							3	3	3	1	2
7		SSMI/S	Current											2	1	2	3	1
8		OLS				v				v				3	2	3	3	2
9	POES	AMSU-A *	Current	v	v	v	v			v	v			1	1	1	3	1
10		AMSU-B *			v		v							1	1	1	3	1
11		HIRS/3 *		v	v	v			v	v	v			1	1	1	3	1
12		AVHRR *				v				v	v	v			1		3	2
13		SBUV *							v					1	1	1	3	2
14	GOES	Imager *	Current		v	v	v	v		v	v	v		2	1	2	3	1
15		Sounder *		v	v	v		v		v	v			3	1	3	3	2
16	GFO	Altimeter*	Current					v			v			1	1	1	1	1
17	GMS (GOES-9)	Imager *	Current		v	v		v		v	v	v		3	1	3	3	1
18	Terra	MODIS*	Current	v	v	v	v	v		v	v	v		2	1	2	1	1
19	TRMM	TMI	Current		v	v		v		v	v			2	2	2	1	1
20		VIRS				v					v	v		3	2	3	1	2
21		PR					v							3	2	3	1	1
22		CERES											v	3	3	3	1	3
23	QuikSCAT	Scatterometer *	Current					v		v				1	1	1	3	1
24	TOPEX	Altimeter *	Current		TPW			v			v			1	1	1	2	1
25	JASON-1	Altimeter*	Current		TPW			v			v			1	1	1	1	1
26	Aqua	AMSR-E	Current		v	v	v	v		v	v			1	1	1	2	1
27		AMSU		v	v	v	v			v	v			1	1	1	1	1
28		HSB			v		v				v			3	n/a	3	1	2
29		AIRS		v	v	v			v	v	v			1	1	1	1	1
30		MODIS*		v	v	v	v	v		v	v	v		2	1	1	1	1
31	Envisat	Altimeter*	Current				v	v			v			1	1	1	2	1
32		MWR			v	v								2	1	2	2	1
33		MIPAS		v					v					2	2	2	2	2
34		AATSR									v			2	1	2	1	2
35		MERIS				v				v	v	v		2	2	2	2	1
36		SCIAMACHY			v	v			v			v		3	3	3	2	3
37		GOMOS							v					2	1	2	1	2

Draft Sample Only

	A	B	C	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
38	**Windsat**	Polarimetric radiometer	Current	SST	TPW		√	√		√	√			2	1	2	2	1
39	**Aura**	OMI	Current						√					1	1	1	1	2
40		MLS							√					2	2	2	1	2
41	**COSMIC**	GPS	2005	√	√									1	2	1	2	1
42	**CHAMP**	GPS	2000											1	1	1	1	1
43	**METOP**	IASI	2005	√	√	√			√	√	√			1	1	1	3	1
44		ASCAT						√		√	√			1	1	1	3	2
45		GRAS		√	√									1	2	1	2	3
46		HIRS		√	√	√			√	√	√			1	1	1	3	3
47		AMSU		√	√	√	√			√	√			1	1	1	3	3
48		MHS			√		√							1	1	1	3	1
49		GOME-2							√					1	1	1	1	3
50		AVHRR		SST		√	√			√	√	√		1	1	1	3	1
51	**NPP**	VIIRS	2006	SST		√		Polar		√	√	√		1	1	1	3	1
52		CRIS		√	√	√			√	√	√			1	1	1	3	1
53		OMPS												1	1	1	1	1
54		ATMS		√	√	√	√			√	√			1	1	1	3	1
55	**EO-3/IGL**	GIFTS	TBD	√	√	√	√	√	√	√	√	?		2	2	2	1	1
56	**SMOS**	MIRAS	2007							√	√			1	2	1	2	1
57	**NPOESS**	VIIRS	2009	SST	TPW	√		Polar		√	√	√		1	1	1	3	1
58		CRIS		√	√	√			√	√	√			1	1	1	3	1
59		ATMS		√	√	√	√			√	√			1	1	1	3	1
60		CMIS		√	√	√	√	√		√	√			1	1	1	3	1
61		GPSOS		√	√									1	2	1	2	2
62		APS										√		2	1	1	2	2
63		ERBS											√	3	3	3	1	3
64		Altimeter						√			√			1	1	1	2	1
65		OMPS							√					1	1	1	1	1
66	**ADM**	Doppler lidar	2009					√						1	1	1	2	1
67	**GPM**	GMI	2010				√	√		√				2	2	2	2	1
68		DPR					√							2	2	2	2	1
69	**GOES R**	ABI	2012			√	√	√		√	√	√		2	1	1	3	1
70		HES		√	√	√		√	√	√	√			1	1	1	3	1

NPOESS Satellite



CMIS- μwave imager
VIIRS- vis/IR imager
CrIS- IR sounder
ATMS- μwave sounder
OMPS- ozone
GPSOS- GPS occultation
ADCS- data collection
SESS- space environment
APS- aerosol polarimeter
SARSAT - search & rescue
TSIS- solar irradiance
ERBS- Earth radiation budget
ALT- altimeter
SS- survivability monitor

The NPOESS spacecraft has the requirement to operate in three different sun synchronous orbits, 1330, 2130 and 1730 with different configurations of fourteen different environmental sensors that provide environmental data records (EDRs) for space, ocean/water, land, radiation clouds and atmospheric parameters.

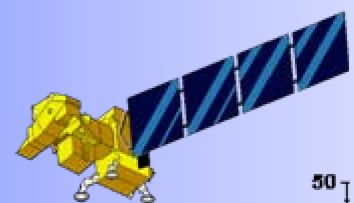
In order to meet this requirement, the prime NPOESS contractor, Northrop Grumman Space Technology, is using their flight-qualified NPOESS T430 spacecraft. This spacecraft leverages extensive experience on NASA's EOS Aqua and Aura programs that integrated similar sensors as NPOESS.

As was required for EOS, the NPOESS T430 structure is an optically and dynamically stable platform specifically designed for earth observation missions with complex sensor suites.

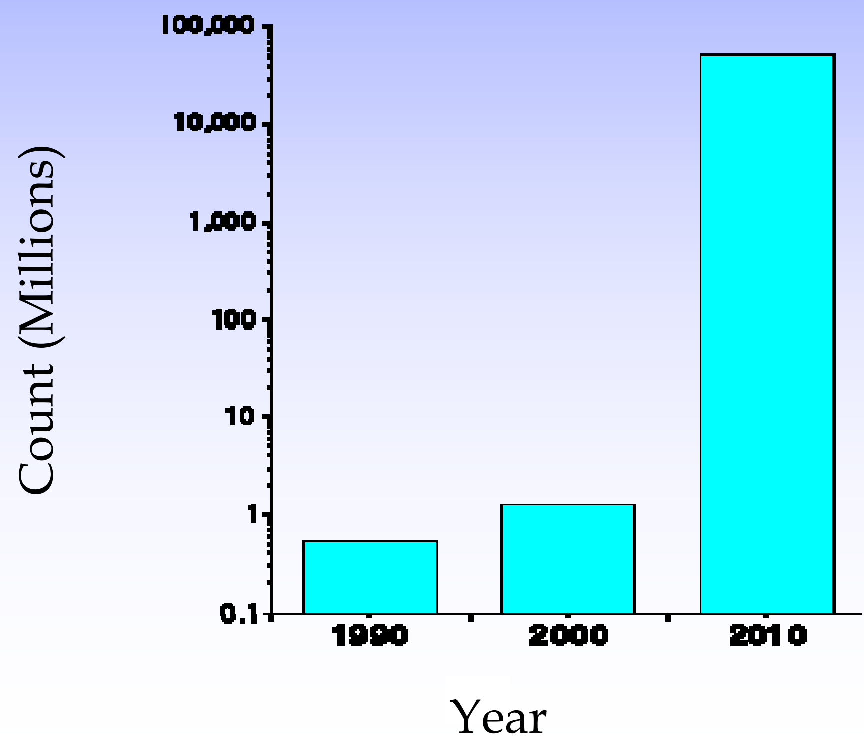
In order to manage engineering, design, and integration risks, a single spacecraft bus for all three orbits provides cost-effective support for accelerated launch call-up and operation requirement changes. In most cases, a sensor can be easily deployed in a different orbit because it will be placed in the same position on the any spacecraft. There are ample resource margins for the sensors, allowing for compensation due to changes in sensor requirements and future planned improvements.

The spacecraft still has reserve mass and power margin for the most stressing 1330 orbit, which has eleven sensors. The five panel solar array, expandable to six, is one design, providing power in the different orbits and configurations.

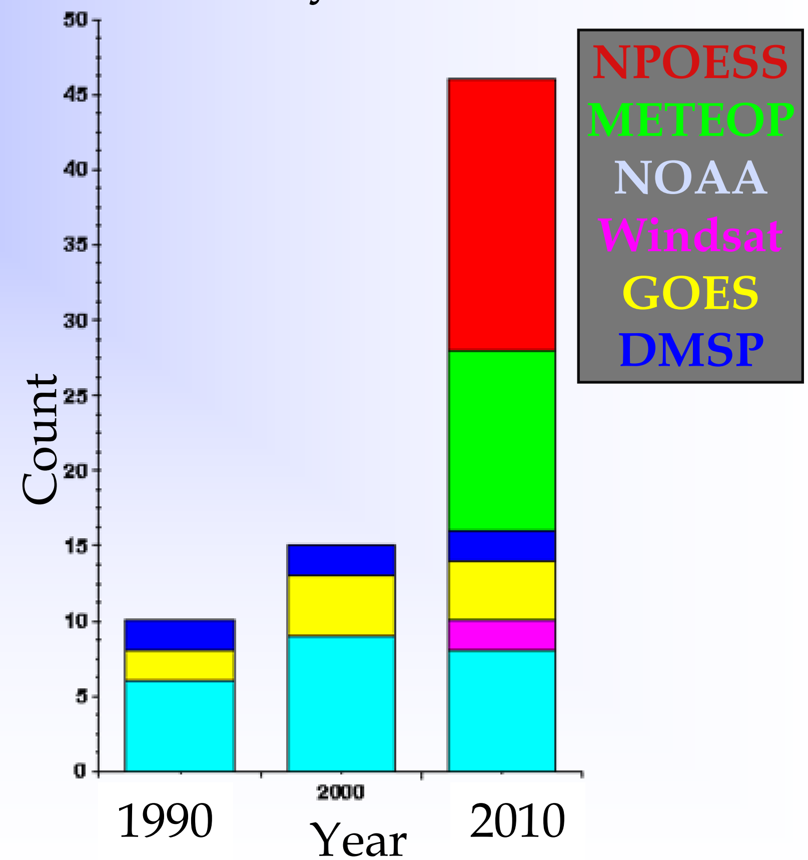
5-Order Magnitude Increase in Satellite Data Over 10 Years



Daily Upper Air Observation Count



Satellite Instruments by Platform



GOES - R

ABI – Advanced Baseline Imager

HES – Hyperspectral Environmental Suite

SEISS – Space Environment In-Situ Suite including the Magnetospheric Particle Sensor (MPS); Energetic Heavy Ion Sensor (EHIS); Solar & Galactic Proton Sensor (SGPS)

SIS – Solar Imaging Suite including the Solar X-Ray Imager (SXI); Solar X-Ray Sensor (SXS); Extreme Ultraviolet Sensor (EUVS)

GLM – GEO Lightning Mapper

Advanced Baseline Imager (ABI)

ABI Band	Wavelength Range (μm)	Central Wavelength (μm)	Sample Objective(s)
1	0.45-0.49	0.47	Daytime aerosol-over-land, Color imagery
2	0.59-0.69	0.64	Daytime clouds fog, insolation, winds
3	0.84-0.88	0.86	Daytime vegetation & aerosol-over-water, winds
4	1.365-1.395	1.38	Daytime cirrus cloud
5	1.58-1.64	1.61	Daytime cloud water, snow
6	2.235 - 2.285	2.26	Day land/cloud properties, particle size, vegetation
7	3.80-4.00	3.9	Sfc. & cloud/fog at night, fire
8	5.77-6.6	6.19	High-level atmospheric water vapor, winds, rainfall
9	6.75-7.15	6.95	Mid-level atmospheric water vapor, winds, rainfall
10	7.24-7.44	7.34	Lower-level water vapor, winds & SO2
11	8.3-8.7	8.5	Total water for stability, cloud phase, dust, SO2
12	9.42-9.8	9.61	Total ozone, turbulence, winds
13	10.1-10.6	10.35	Surface properties, low-level moisture & cloud
14	10.8-11.6	11.2	Total water for SST, clouds, rainfall
16	13.0-13.6	13.3	Air temp & cloud heights and amounts

Advanced Baseline Imager (ABI)

	ABI Requirements	
	ABI	**Current GOES**
Spatial Coverage Rate **Full disk** **CONUS**	 4 per hour 12 per hour	 Every 3 hours ~ 4 per hour
Spatial resolution **0.64 µm VIS** **Other VIS/ near IR** **Bands > 2 µm**	 0.5 km 1.0 km 2.0 km	 ~ 1 km Na ~ 4 km
Spectral coverage	16 bands	5 bands

Total radiances over 24 hours = 172, 500, 000, 000

Hyperspectral Environmental Suite (HES)

Band	**HES Band Number**	**Spectral Range (um)**	**Band Continuity**
LWIR	1	15.38 - 8.33 (T)	Contiguous
MWIR (option 1)	2	6.06 - 4.65 (T)	Contiguous
MWIR (option 2)	2	8.26 - 5.74 (T), 8.26 - 4.65 (G)	Contiguous
SWIR	3	4.65 - 4.44 (T), 4.65 - 3.68 (G)	Contiguous
VIS	4	0.52 - 0.70 (T)	Contiguous
Reflected Solar < 1 um	5	0.40 - 1.0 (T)	Non-Contiguous / Contiguous
0.570 um	5	0.565-0.575	Non-Contiguous
Reflected Solar > 1 um (option 1-CW)	6	1.0 - 2.285 (G)	Contiguous
Reflected Solar > 1 um (option 2-CW)	6	1.35-1.41, 1.55-1.67, 2.235-2.285 (G)	Non-contiguous
LWIR for CW	7	11.2 - 12.3 (G)	Non-contiguous

(T) = Threshold, denotes required coverage

(G) = Goal, denotes coverage under study during formulation

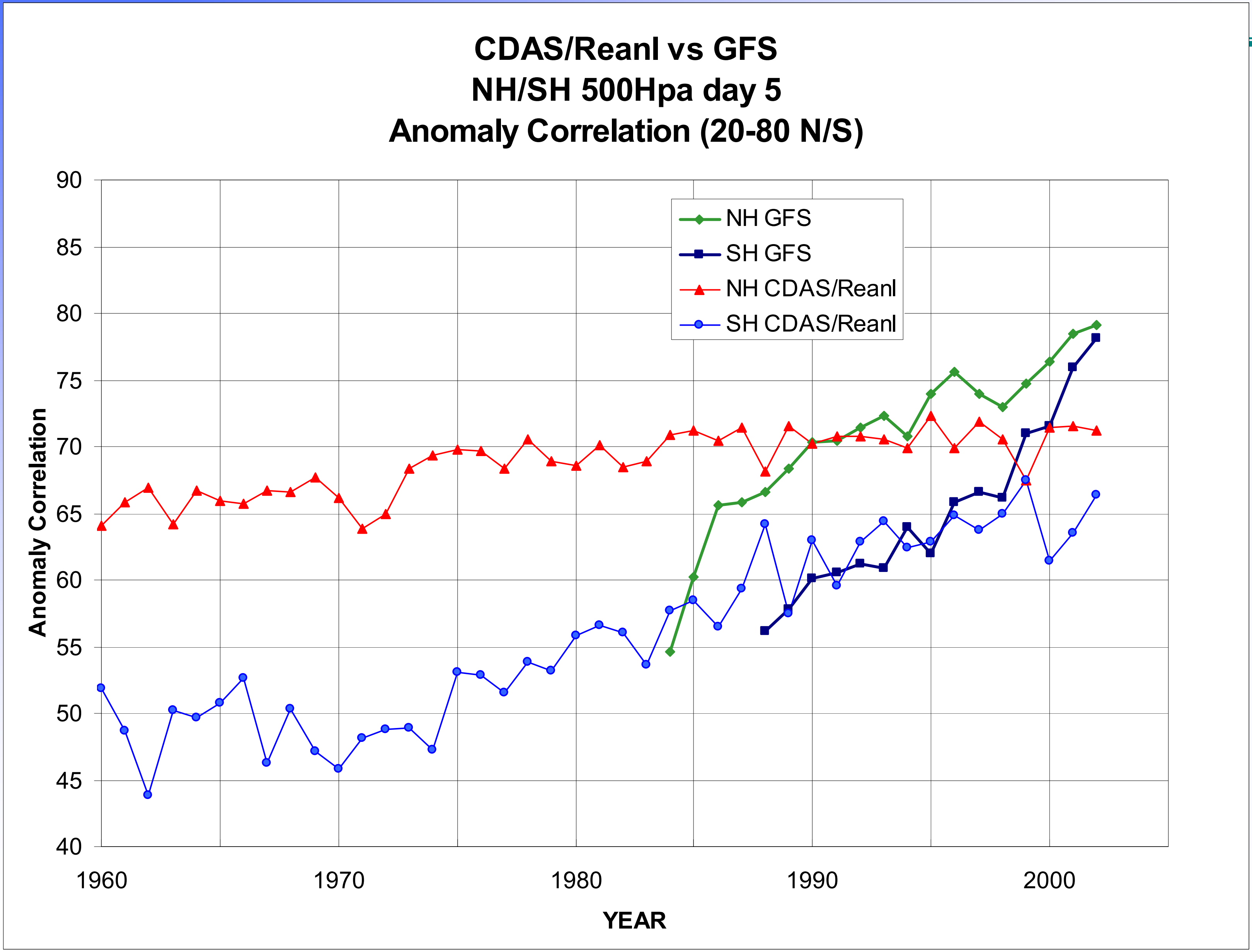
Hyperspectral Environmental Suite (HES)

	HES Requirements	
	HES	**Current GOES**
Coverage Rate	Sounding disk/hr	CONUS/hr
Horizontal Resolution **Sampling distance** **Individual sounding**	 10 km 10 km	 10 km 30 – 50 km
Vertical Resolution	1 km	3 km
Accuracy **Temperature** **Relative Humidity**	 1°K 10%	 2°K 20%

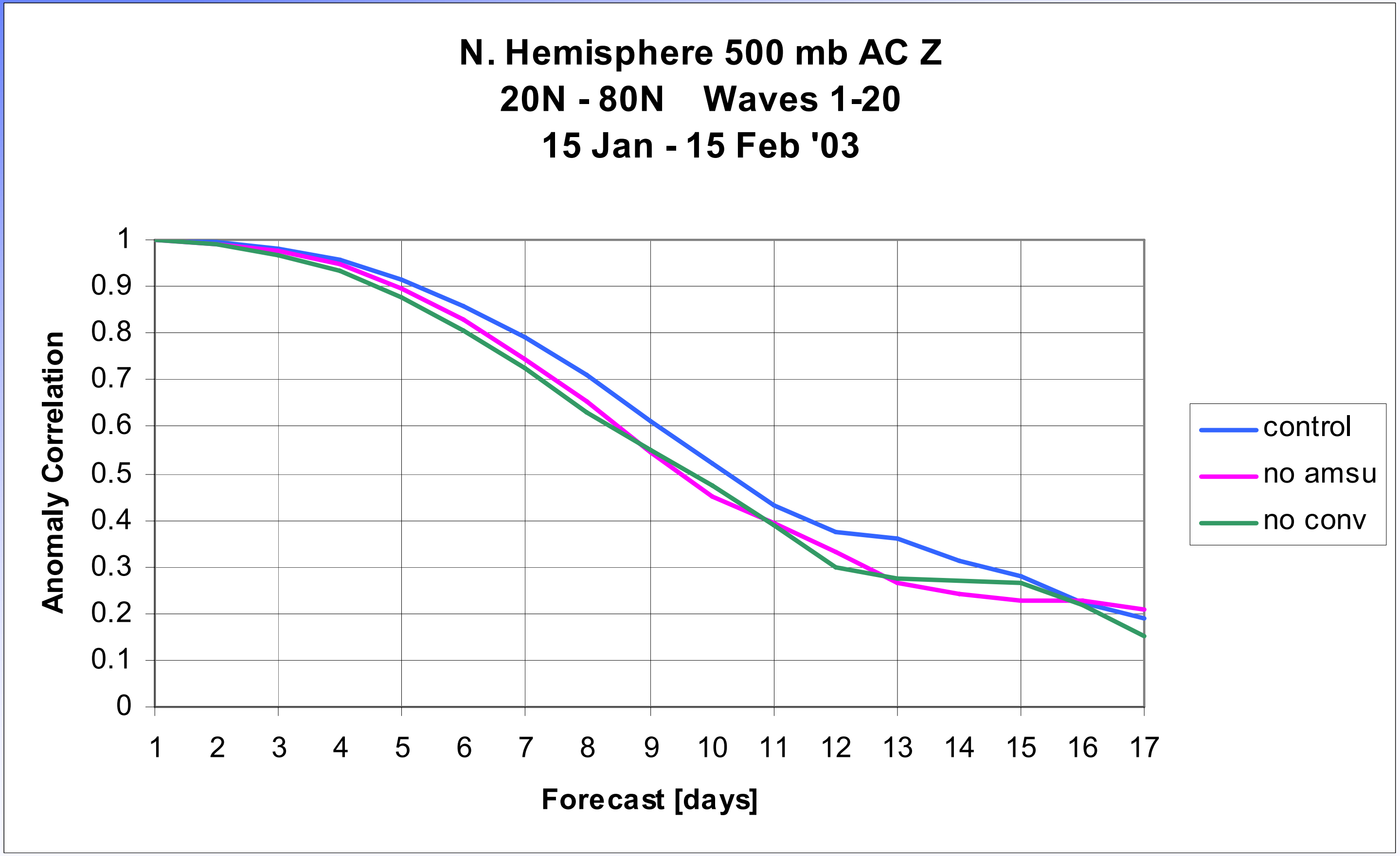
Total radiances over 24 hours = 93, 750, 000, 000

Satellite Data used in NWP

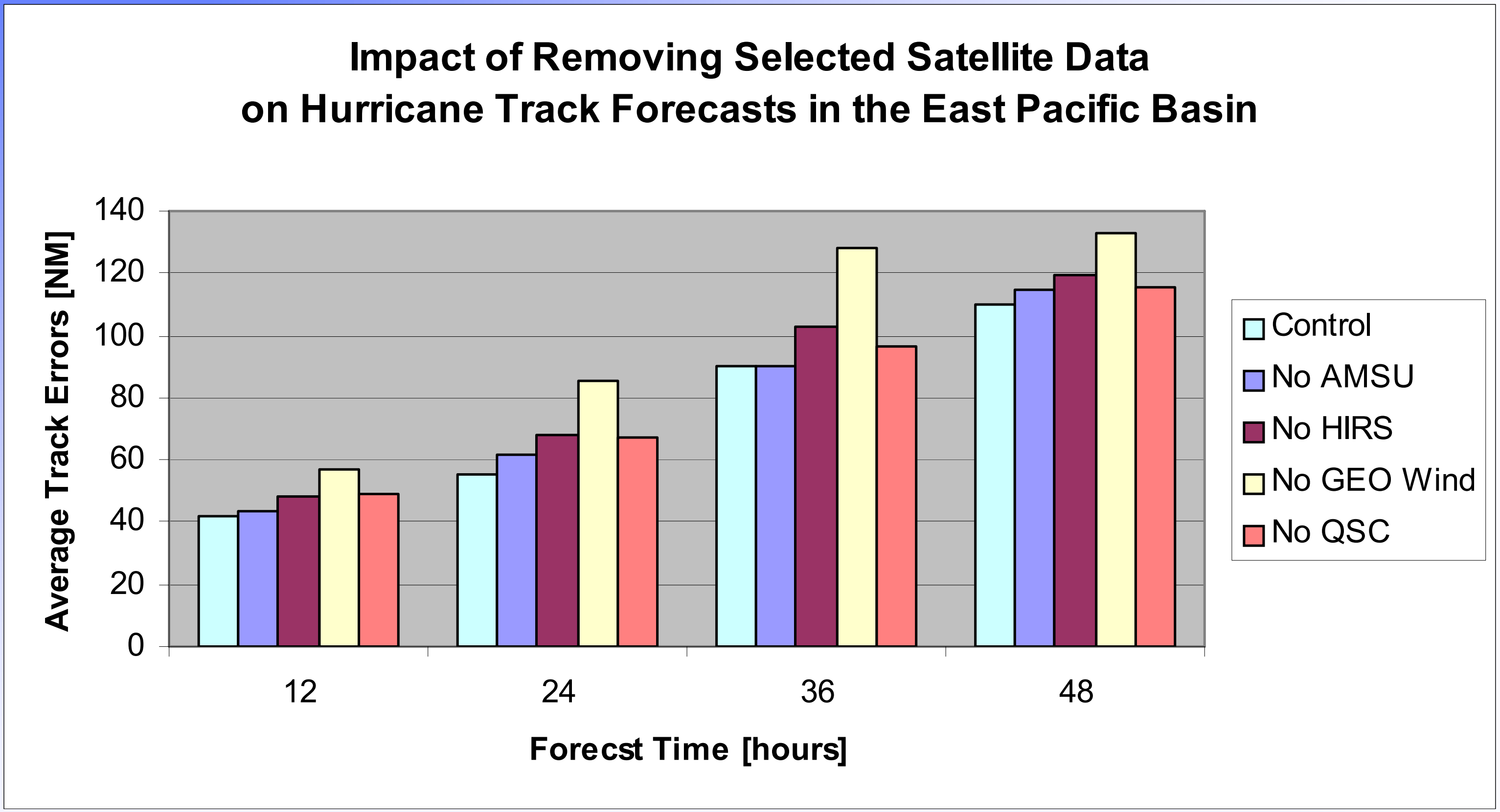
- HIRS sounder radiances
- AMSU-A sounder radiances
- AMSU-B sounder radiances
- GOES sounder radiances
- GOES, Meteosat, GMS winds
- GOES precipitation rate
- SSM/I precipitation rates
- TRMM precipitation rates
- SSM/I ocean surface wind speeds
- ERS-2 ocean surface wind vectors
- Quikscat ocean surface 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
- Altimeter sea level observations (ocean data assimilation)
- AIRS
- Current Upgrade adds;
  MODIS Winds…


CDAS/Reanl vs GFS
NH/SH 500Hpa day 5
Anomaly Correlation (20-80 N/S)
Anomaly Correlation
YEAR
NH GFS
SH GFS
NH CDAS/Reanl
SH CDAS/Reanl
90
85
80
75
70
65
60
55
50
45
40
1960
1970
1980
1990
2000

Data Assimilation Impacts in the NCEP GDAS



AMSU and "All Conventional" data provide nearly the same amount of improvement to the Northern Hemisphere.


Impact of Removing Selected Satellite Data
on Hurricane Track Forecasts in the East Pacific Basin
Average Track Errors [NM]
140
120
100
80
60
40
20
0
12
24
36
48
Forecst Time [hours]
Control
No AMSU
No HIRS
No GEO Wind
No QSC

Joint Center for Satellite Data Assimilation

JOINT CENTER FOR SATELLITE DATA ASSIMILATION

PARTNERS

NASA/Goddard

Global Modeling & Assimilation Office

NOAA/NCEP

Environmental Modeling Center

NOAA/OAR

Office of Weather and Air Quality

US Navy

Oceanographer of the Navy, Office of Naval Research (NRL)

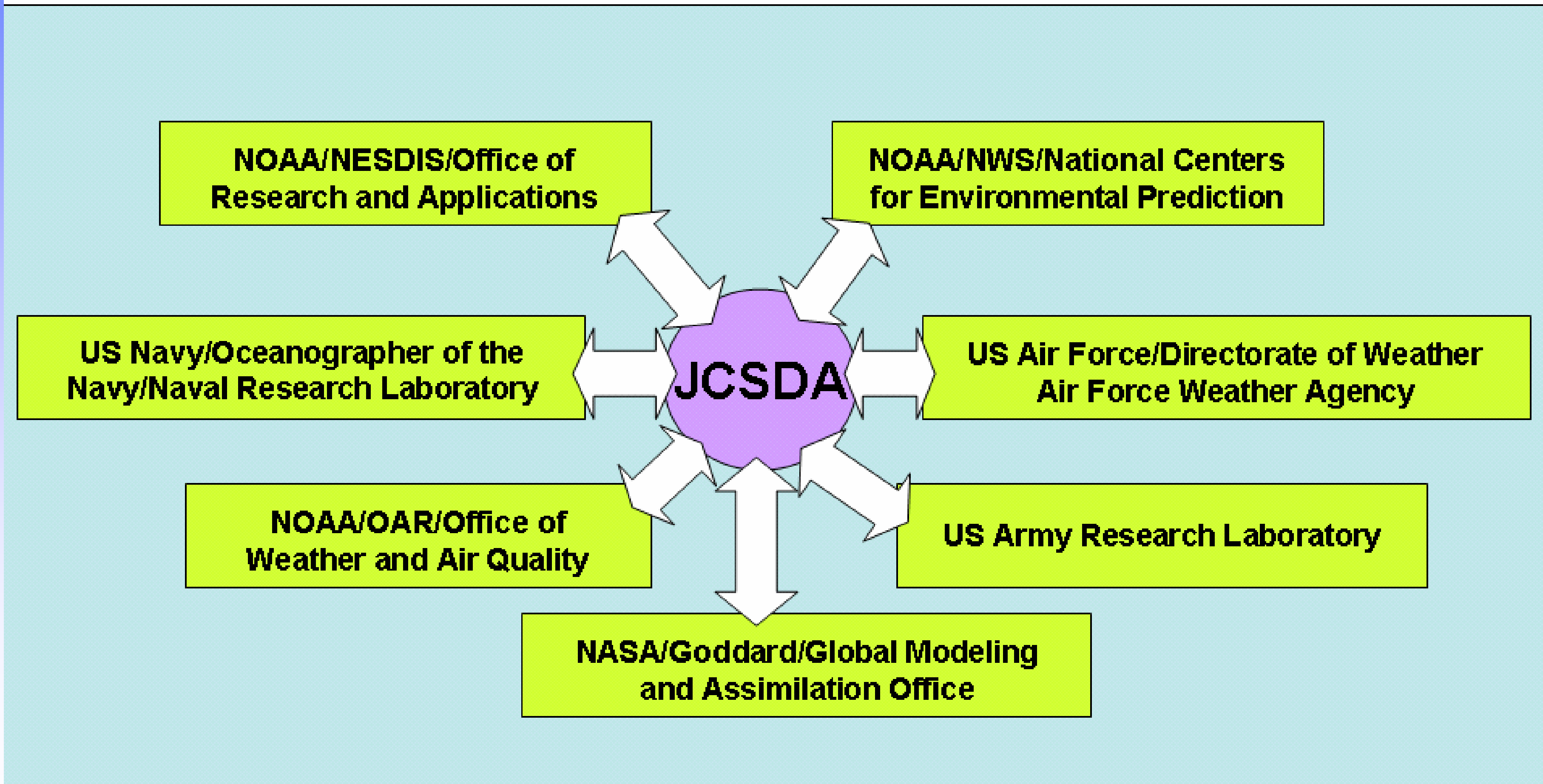
NOAA/NESDIS

Office of Satellite Applications & Research

US Air Force

AF Director of Weather
AF Weather Agency

JCSDA



NOAA/NESDIS/Office of Research and Applications
NOAA/NWS/National Centers for Environmental Prediction
US Navy/Oceanographer of the Navy/Naval Research Laboratory
JCSDA
US Air Force/Directorate of Weather Air Force Weather Agency
NOAA/OAR/Office of Weather and Air Quality
US Army Research Laboratory
NASA/Goddard/Global Modeling and Assimilation Office

JCSDA Structure

Associate Administrators
NASA: Science
NOAA: NESDIS, NWS, OAR
DoD: Navy, Air Force

Management Oversight Board of Directors:
NOAA NWS: L. Uccellini (Chair)
NASA GSFC: F. Einaudi
NOAA NESDIS: M. Colton
NOAA OAR: M. Uhart
Navy: S. Chang
USAF: J. Lanici/M. Farrar

Rotating Chair

Advisory Panel

Joint Center for Satellite Data Assimilation Staff
Director: J. Le Marshall
Deputy Directors:
Stephen Lord – NWS /NCEP
James Yoe - NESDIS
Lars Peter Riishogjaard – GSFC, GMAO
Pat Phoebus – DoD,NRL
Secretary: Ada Armstrong
Consultant: George Ohring

Science Steering Committee

Technical Liaisons:
NASA/GMAO – D. Dee
NOAA/NWS/NCEP – J. Derber
NASA/GMAO – M. Rienecker
NOAA/OAR – A. Gasiewski
NOAA/NESDIS – D. Tarpley
Navy – N. Baker
USAF – M. McATee
Army – G. Mc Williams

JCSDA Advisory Board

- Provides high level guidance to JCSDA Management Oversight Board

Name	Organization
T. Hollingsworth	formerly ECMWF
T. Vonder Haar	CIRA
P. Courtier	Meteo France
E. Kalnay	UMD
R. Anthes	UCAR
J. Purdom	CIRA
P. Rizzoli	MIT

JCSDA Science Steering Committee

- Provides scientific guidance to JCSDA Director
  - Reviews proposals
  - Reviews projects
  - Reviews priorities

Name	Organization
P. Menzel (Chair)	NESDIS
R. Atlas	GSFC
C. Bishop	NRL
R. Errico	GSFC
J. Eyre	UK Met Office
L. Garand	CMC
A. McNally	ECMWF
S.Koch	FSL
B. Navasques	KNMI
F. Toepfer	NWS
A. Busalacchi	ESSIC

JCSDA Technical Liaisons

- Technical Liaisons

  - Represent their organizations
  - Review proposals and project progress
  - Interact with principal investigators

JCSDA Technical Liaisons	
Liaison Name	**Organization**
D. Dee	GMAO
J. Derber	EMC
M. Rienecker	GMAO
A. Gasiewski	OWAQR
D. Tarpley	ORA
N. Baker	NRL
M. McAtee	AFWA

JCSDA Mission and Vision

- Mission: Accelerate and improve the quantitative use of research and operational satellite data in weather climate and environmental analysis and prediction models

- Vision: A weather, climate and environmental analysis and prediction community empowered to effectively assimilate increasing amounts of advanced satellite observations and to effectively use the integrated observations of the GEOSS

Goals – Short/Medium Term

- Increase uses of current and future satellite data in Numerical Weather and Climate Analysis and Prediction models
- Develop the hardware/software systems needed to assimilate data from the advanced satellite sensors
- Advance common NWP models and data assimilation infrastructure
- Develop a common fast radiative transfer system(CRTM)
- Assess impacts of data from advanced satellite sensors on weather and climate analysis and forecasts(OSEs,OSSEs)
- Reduce the average time for operational implementations of new satellite technology from two years to one

Goals – Longer Term

- Provide the “bridge” for the integrated use of GEOSS data within numerical models
- Develop the tools for effective integration of GEOSS observations into environmental models

- Expand assimilation system to provide input to models of:
  - environmental hazards
  - air and water quality and resources
  - terrestrial, coastal, and marine ecosystems
  - climate variability and change
  - agricultural productivity
  - energy resources
  - human health
  - biodiversity

JCSDA SCIENCE PRIORITIES

- **Science Priority I - Improve Radiative Transfer Models**

  - Atmospheric Radiative Transfer Modeling – The Community Radiative Transfer Model (CRTM)

  - Surface Emissivity Modeling

- **Science Priority II - Prepare for Advanced Operational Instruments**

- **Science Priority III -Assimilating Observations of Clouds and Precipitation**

  - Assimilation of Precipitation

  - Direct Assimilation of Radiances in Cloudy and Precipitation Conditions

- **Science Priority IV - Assimilation of Land Surface Observations from Satellites**

- **Science Priority V - Assimilation of Satellite Oceanic Observations**

- **Science Priority VI – Assimilation for air quality forecasts**

Required Capabilities to Achieve Goals

- A satellite data assimilation infrastructure
- A directed research and development program
- A grants program for long-term research
- An education and outreach program

Progress on Achieving Capabilities: *Infrastructure*

- JCSDA physical space established in NOAA Science Center
  - 23 NWS, NESDIS scientists co-located
  - GMAO visiting scientists
  - NSF/AFWA/OSDPD visiting scientists
  - JCSDA Staff
- Common model infrastructure
  - First version of community radiative transfer model developed
  - NCEP Global Data Assimilation System implementation at Goddard
  - NASA land data assimilation system (GLDAS) merged with NCEP land data assimilation system (NOAH)
- Interfaces to external researchers developed for radiative transfer model intercomparisons

Progress on Achieving Capabilities: *Directed R & D Program*

- Supports projects generally aligned with shorter term objectives of JCSDA scientific priorities
- Funded by the individual JCSDA organizations
- Currently 17 projects

Directed R&D Program(05)

Organization	PI	Title
EMC	P. Van Delst	CRTM Upgrades
EMC	P. Van Delst, Yan	Surface emissivity model upgrades
EMC	Xu Li, J. Derber, N. Nalli	Improved SST analysis
EMC	Ferrarro, Gemmill, Katz	AMSR data preparation and testing
EMC	G. Gayno	Land Surface Data Assimilation
EMC	Ramsay, Mitchell	Land Surface product upgrades and testing
ORA	F. Weng	Microwave Emissivity Model Upgrade
ORA	D. Tarpley	Normalized Green Vegetation Fraction
ORA, CPC, EMC	F. Flynn, C.Long	Ozone Science/Product development for Data Assimilation
ORA	Y. Han	Beta Version CRTM Model
ORA	S. Kondragunta	Biomass Burning/AQ Forecasting
CIMMS	T. Zapotoncny, J. Jung	AIRS, MODIS, AMSR Satellite Data Impact Studies
ORA	K. Gallo	Transition of Green Vegetation Fraction
CICS	A. Harris	Physically-based AVHRR Bias Correction
ORA	N. Nalli	IR Aerosol & Ocean Sureface Reflectance Model
CIRA	M. Sengupta, T. Vukcevic	All Weather Observational Operators
FSL	D. Birkenheuer	Improved Moisture Assimilation Using Gradient Information

Progress on Achieving Capabilities: *Grants Program*

- Supports projects with longer term goals

- Two annual Announcements of Opportunity completed
  - 23 grants in place
  - Average grant: $100K/Yr

- Special attention to paths from research to operations and coordination of PIs working in similar research areas

Grants Program (FY03-AO)

Competitive FFO Projects			
Title	Institution	PI	Performance Period
Toward Passive Microwave Radiance Assimilation of clouds and precipitation	Univ of Wisconsin	R. Bennartz	2003-2005
Polar Winds Data Assimilation Experiments	CIMMS	J. Key	2003-2004
Errors in Sea level height analyses: accounting for the small-scale and short-term variability	Columbia University	A. Kaplan	2003-2005
Integration of Satellite Observations with the NOAH Land Model for Snow Data Assimilation	Univ. of Arizona	X. Zeng	2003-2005
Global Microwave Surface Emissivity Error Analysis	Colorado State Univ	A. Jones	2003-2004
Improving Analysis of Tropical Upper Ocean Conditions for Forecasting	Univ of Maryland	J. Carton	2003-2005
Including Atmospheric Aerosols in the Optical Path Transmittance Model (OPTRAN)	Univ of Maryland - Baltimore County	C. Weaver	2003-2004
AIRS and GPS Assimilation	NASA Goddard Modeling and Assimilation Office	J. Joiner	2003-2004
Aerosol contamination in SST	NRL Monterey	J. Cummings	2003-2005

Grants Program (FY04-AO)

Assimilation of MODIS and AMSR-E Land Models into the NOAH LSM	CREW	P. Houser	2004-2006
Development of Improved forward models for retrieval of snow properties from EOS-era satellites	Princeton Univ.	Eric Wood	2004-2006
Development of Improved forward models for retrieval of snow properties from EOS-era satellites	Univ. of Washington	D. Lettenmaier	2004-2006
Real time estimation and assimilation of remotely sensed properties for numerical weather prediction models	Boston University	Mark Friedl	2004-2005
SSMIS Brightness temperature evaluation in the context of data assimilation	Naval Research Lab	Nancy Baker	2004-2005
Development of RT Models based on the Optimal Spectral Sampling (OSS) Method	Atmosperic and Environmental Reseach, Inc.	Jean-Luc Moncet	2004-2006
Fully polarimetric Surface Models and Microwave Radiative Transfer Computer Program for Data Assimilation	NOAA/ETL	Al Gasciewski	2004-2006
UCLA Vector Radiative Transfer Model for Application to Satellite Data Assimilation	Univ California - Los Angeles	K.N. Liou	2004-2005
Assimilation of Passive Mocrowave Radiances over land: Use of the JCSDA Common Microwave Emissivity Model (MEM) in Complex Terrain	Naval Research Lab	Nancy Baker	2004-2005

Grants Program (FY05-AO)

Development of a Global Near-Real Time Aerosol Optical Depth Analysis for Use in Aerosol Transport Models	Naval Research Laboratory	J.S. Reid	June1 2005 - May 31 2008
Improved Photochemical Parameterizations of Stratospheric O3 and H2O for NWP Systems	Naval Research Laboratory	J.P. McCormack	June 1 2005 - May 31, 2007
Assimilation of a Broadband Radiative Variable for Climate Model Diagnostic of Cloud by OLR - A Prefix study	ESSIC - CICS	H.T. Lee	June 1 2005 - May 31, 2006
Assimilation of EOS AURA O3 data for NWP and AQ applications	NASA Goddard Modeling and Assimilation Office	I. Stajner	June 1 2005 - May 31 2008
Satellite Channel selection w/ data assimilation adjoint	Naval Research Laboratory	R.H. Langland	June 1 2005 - May 31 2008

Supported Programs

- OSSEs
- WINDSAT Assimilation Study
- AIRS/MODIS Sounding channels assimilation study
- Cloud Cleared Radiance Assimilation Study
- ….

OSSE's

NPOESS

CrIS
ATMS
VIIRS
AIRS
DWL

GOES-R

HES
(lw/sw comparison OSSE)

GIFTS

CURRENT SATELLITE DATA - STATUS

AIRS v1.	Implemented
AIRS v2.	In Operational Trial
MODIS Winds	In Operational Trial
NOAA-18 AMSU-A	In Operational Trial
NOAA-18 MHS	In Operational Trial
NOAA-17 SBUV Total Ozone	In Operational Trial
NOAA-17 SBUV Ozone Profile	In Operational Trial
SSM/I Radiances	Operational Trial with GSI, prod. now used
COSMIC/CHAMP	Test and Development
SSMIS	Quality Control and Data Selection being Finalized
MODIS Winds v2.	Test and Development
WINDSAT	Wind Vector Assimilation - Active
AMSR/E – Radiance Assimilation	Test and Development
AIRS/MODIS Sounding Channels Assim.	Data in Preparation
GOES – SW Winds	To be Tested
GOES Hourly Winds	To be Tested
GOES 11 and 12 Clear Sky Rad. Assim(6.7µm)	To be Tested
MTSAT 1R Wind Assim.	Data in Preparation
AURA OMI	Test and Development
TOPEX,JASON1,ERS-2 ENVISAT ALTIMETER	Test and Development, Ops 06 GODAS
FY – 2C	Data in Preparation

Progress on Achieving Capabilities: *Education and Outreach*

- JCSDA recognizes the scarcity of trained and qualified data assimilation scientists
- JCSDA plans to establish a university center or consortium for education and training in satellite data assimilation
- Newsletter
- Web Page
- Seminar Series
- Workshops

JCSDA Newsletter

- Issued quarterly
- Science advances
- New personnel
- Seminar schedules
- Workshop/Meeting announcements/summaries
- Other news items of interest

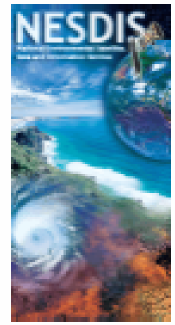
JCSDA Quarterly

No. 6, March, 2004

Joint Center for Satellite Data Assimilation • 5200 Auth Road • Camp Springs • MD • 20746 Editor: George Ohring

News in This Quarter

JCSDA Partner Agencies: Focus on NOAA/NESDIS



Previous Quarterlies summarized satellite data assimilation activities at the US Air Force and US Navy; in this issue, we look at NESDIS. The NOAA/NESDIS Office of Research and Applications (ORA) provides full spectrum science and operational support to national and international NWP centers to conduct state-of-the art satellite data assimilation experiments. ORA scientists work closely with their counterparts at NCEP to: 1) develop fast radiative transfer models, a core component of satellite data assimilation, 2) prepare for operational use of data from upcoming advanced satellite missions, and 3) conduct studies to evaluate the impact of current and planned satellite instruments on weather prediction accuracy. Data assimilation teams are assembled and matrix managed across ORA Divisions and Branches. As listed below, each science team focuses on various tasks.

Radiative Transfer Modeling:

- Update radiative transfer models for new instruments
- Update surface emissivity models
- Develop advanced radiative transfer (RT) models that include the effects of aerosol, cloud, and precipitation particles
- Develop and test 1D-variational assimilation schemes that use advanced RT models

Advanced Instruments:

- Prepare for early access to advanced satellite data (e.g. AMSR-E, SSMIS, IASI, ATMS, CrIS)
- Prepare the data in the format needed by NCEP and other NWP centers
- Provide early diagnostics on instrument biases and develop bias correction techniques
- Test and develop NWP unique algorithms

Satellite Products:

- Upgrade vegetation greenness fraction, and snow products for NWP model initialization
- Prepare a suit of high-quality satellite derived cloud products for NWP model validation
- Develop new products (e.g. soil moisture, land surface temperature, solar insolation) from advanced sensors

Impact Studies:

- Conduct impact studies on MODIS derived winds
- Conduct Observing System Experiments for AIRS, AMSU, HIRS, and winds from GOES using the NCEP forecast system
- Improve 1D-variational (1dvar) scheme for Weather Research and Forecast (WRF) Model applications to advance hurricane prediction capabilities
- Use a cloud resolving model to improve cloud forecasts

To insure effective coordination with JCSDA partners and NOAA Line Offices and the smooth functioning of the Center, the ORA Director, Dr. Marie Colton, has appointed an administrative support team for JCSDA Budget Planning, Quarterly Newsletters, Seminar Series, and Website Maintenance.

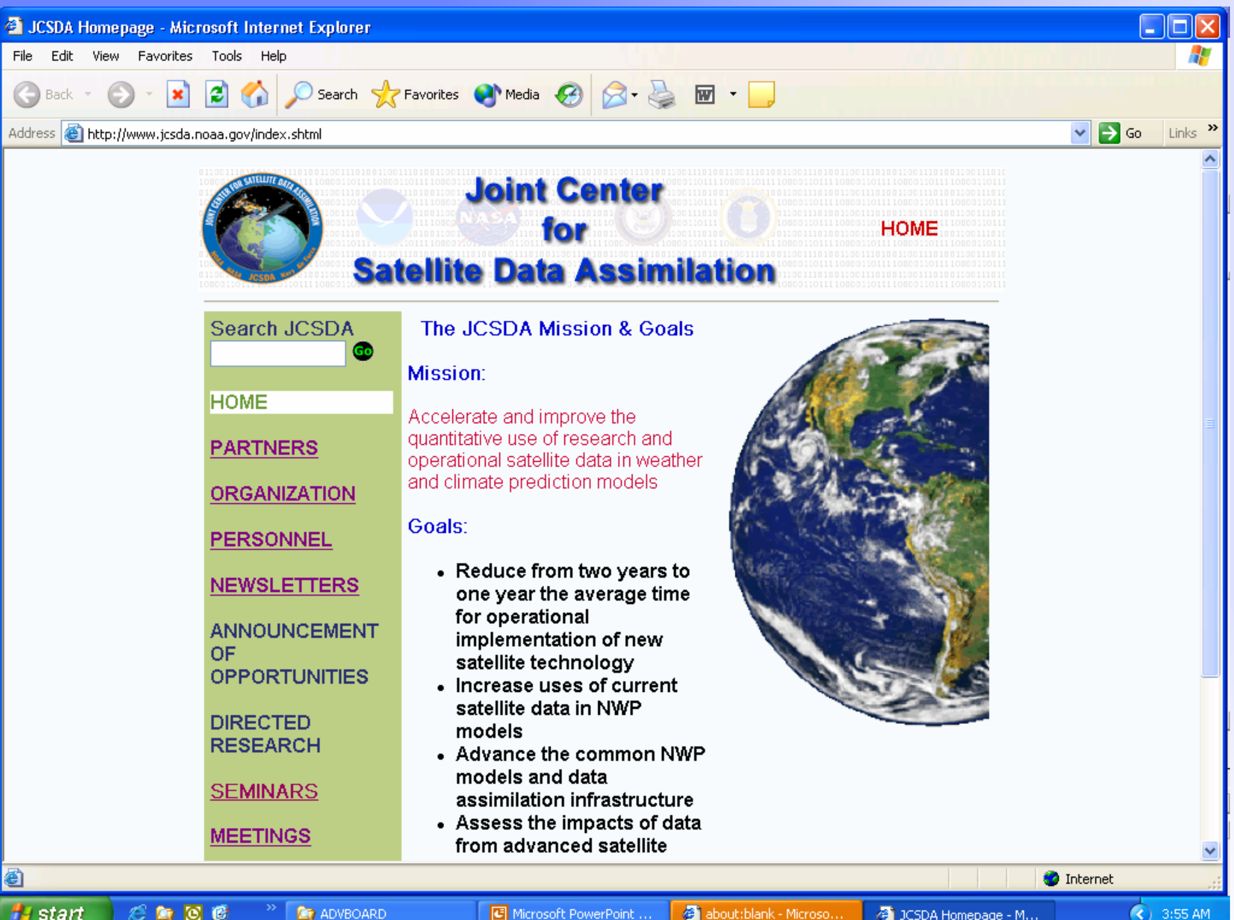
(Fuzhong Weng, NESDIS).

Science Update: Observing System Experiments with NCEP's Global Forecast System

Observing System Experiments (OSEs) with NCEP's Global Forecast System (GFS) show that assimilation of data from three orbiting AMSU instruments reduces the errors of 24-hour predictions of upper air temperatures and relative humidities by as much as 25 – 40 %. The study also indicates an improvement of 0.1 in anomaly correlation (AC) for 500 hPa heights at forecasts longer than 8 days – the equivalent of about a half-day extension of forecast capability – when the AMSU data are added to assimilation stream. These OSEs are being conducted to evaluate the impact of various operational observing systems on NCEP's global forecasts. Both winter and summer 6-week periods are being evaluated, with the last 4 weeks being used to generate impact statistics. The NCEP Global Data Assimilation System (GDAS) is run at the full operational resolution of T254 (55 km) and 64 levels. The following observing systems are being evaluated by denying each system separately in the Global Data Assimilation System: all AMSU data, all HIRS data, and data from one

JCSDA Web Page

www.jcsda.noaa.gov



<u>Note:</u>

All JCSDA research described on web page Under Meetings/3rd Workshop on satellite data assimilation

CRTM and GSI Information soon.

JCSDA Seminar Series

- Monthly
- National and international speakers
- Subjects: upcoming instruments, scientific advances, impacts
- Attendees: remote sensing, radiative transfer, and assimilation scientists in Washington, DC area
- Call-in capability

JOINT CENTER for SATELLITE DATA ASSIMILATION

Presents

Development of a variational data assimilation system for the global ocean

by
Anthony T. Weaver
CERFACS, Toulouse, France
Date: June 16, 2004
Time: 1:30 pm
Place: NSC (WWB), Room 707

Dial-in (tel.): 301-763-8127

JCSDA International Workshops

- Workshop on Assimilation of Satellite cloud and Precipitation observations in NWP Models (May 2005)

  See :www.jcsda.noaa.gov , under Meetings/ JCSDA International Workshop on Assimilation of Satellite cloud and Precipitation observations in NWP Models

- 2nd GPS RO data users Workshop

JCSDA Road Map (2002 – 2010)

JCSDA Road Map (2002 - 2010)

3D VAR ---4D VAR

By 2010, a numerical weather prediction community will be empowered to effectively assimilate increasing amounts of advanced satellite observations

The radiances can be assimilated under all conditions with the state-of-the science NWP models

Resources:

OK

Required

NPOESS sensors (CMIS, ATMS…)
GIFTS, GOES-R

Advanced JCSDA community-based radiative transfer model,
Advanced data thinning techniques

The CRTM include cloud, precipitation, scattering

AIRS,MODIS,ATMS, CrIS, VIIRS, IASI, SSM/IS, AMSR, WINDSAT, GPS ,more products assimilated

The radiances from advanced sounders will be used. Cloudy radiances will be tested under rain-free atmospheres, more products (ozone, water vapor winds)

Improved JCSDA data assimilation science

A beta version of JCSDA community-based radiative transfer model (CRTM) transfer model will be developed, including non-raining clouds, snow and sea ice surface conditions

AMSU, HIRS, SSM/I, Quikscat, AVHRR, TMI, GOES assimilated

The radiances of satellite sounding channels were assimilated into EMC global model under only clear atmospheric conditions. Some satellite surface products (SST, GVI and snow cover, wind) were used in EMC models

Pre-JCSDA data assimilation science

Radiative transfer model, OPTRAN, ocean microwave emissivity, microwave land emissivity model, and GFS data assimilation system were developed

Science Advance

2002 2003 2004 2005 2006 2007 2008 2009 2010

Short Term Priorities 04/05

- **MODIS**: MODIS AMV assessment and enhancement. Accelerate assimilation into operational models.

- **AIRS**: Improved utilization of AIRS
  - Improve data coverage of assimilated data. Improve spectral content in assimilated data.
  - Improve QC using other satellite data (e.g. MODIS, AMSU)
  - Investigate using cloudy scene radiances and cloud clearing options
  - Improve RT Ozone estimates
  - Reduce operational assimilation time penalty (Transmittance Upgrade)

- **SSMIS**: Collaborate with the SSMIS CALVAL Team to jointly help assess SSMIS data. Accelerate assimilation into operational model as appropriate

Short Term Priorities 05/06

- **PREPARATIONS FOR METOP:**
  - -METOP/IASI
    - -Complete Community RTM transmittance preparation for IASI
    - - Upgrade Analysis for IASI
    - -Assimilate synthetic IASI BUFR radiances in preparation for METOP.
  - - Complete preparations for HIRS, AMSU, MHS, ASCAT, GRAS, GOME-2, AVHRR)

- **SSMIS**: Collaborate with the SSMIS CALVAL Team to jointly help assess SSMIS data. Accelerate assimilation into operational model as appropriate

- **GPS**: GPS (CHAMP) assimilation and assessment. Prepare for (COSMIC) assimilation into operational model.

Some Major Accomplishments

- Common assimilation infrastructure at NOAA and NASA
- Common NOAA/NASA land data assimilation system
- Interfaces between JCSDA models and external researchers
- Community radiative transfer model-Significant new developments, New release Fall - 05
- Snow/sea ice emissivity model – permits 300% increase in sounding data usage over high latitudes – improved polar forecasts
- Advanced satellite data systems such as EOS (MODIS Winds, Aqua AIRS) tested for implementation

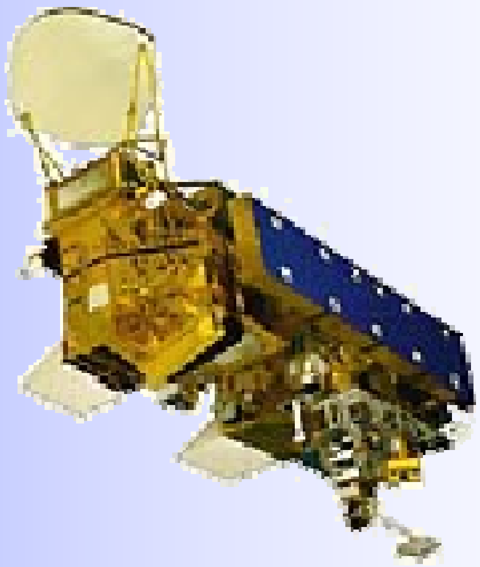
  -Aqua AIRS - improved forecasts. Implemented.

  - MODIS winds, polar regions - improved forecasts. Current Implementation qua .
- Improved physically based SST analysis –Ops. Sept. 05.
- Advanced satellite data systems such as

  -DMSP (SSMIS),

  -CHAMP GPS

  being tested for implementation
- Data denial experiments completed for major data base components

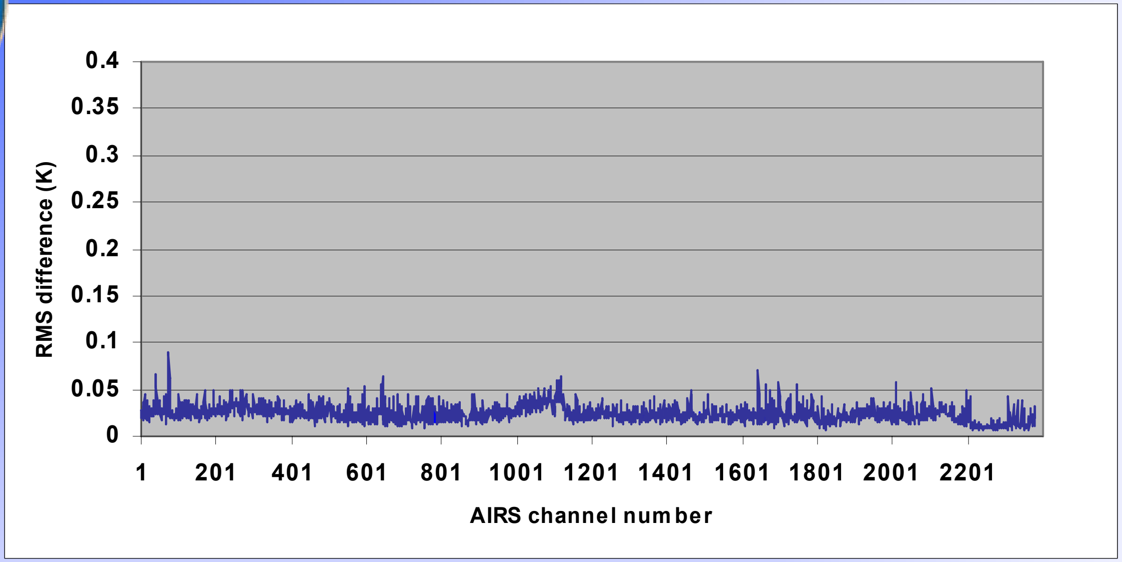


JCSDA

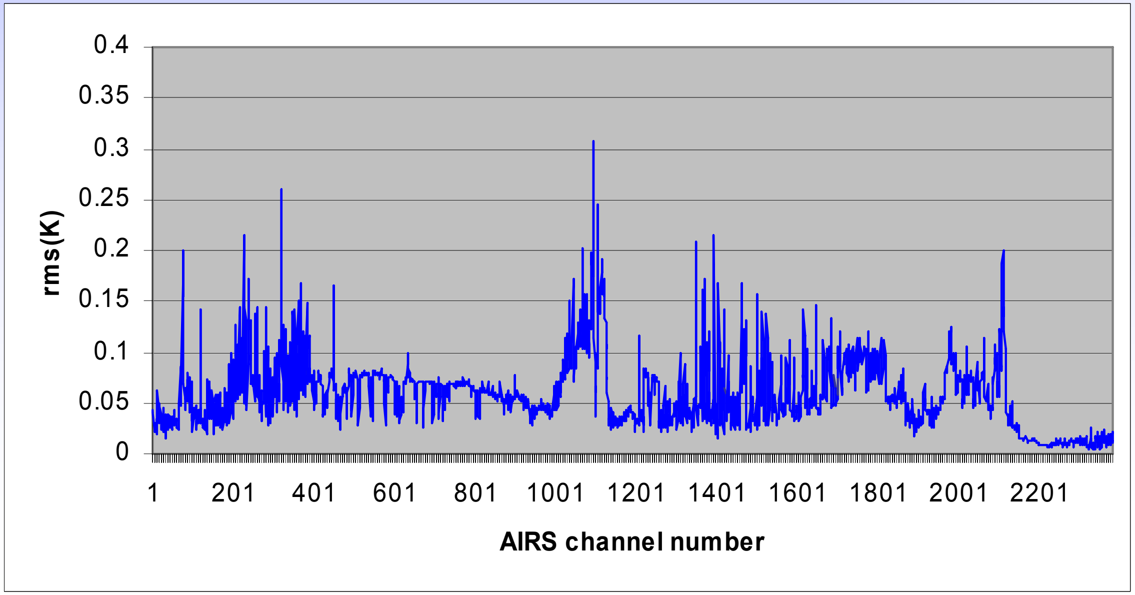
RECENT ADVANCES

IMPROVED COMMUNITY RADIATIVE TRANSFER MODEL

CRTM OPTRAN-V7 vs. OSS at AIRS channels



OSS



OPTRAN

Computation & Memory Efficiency

Time needed to process 48 profiles with 7 observation angles

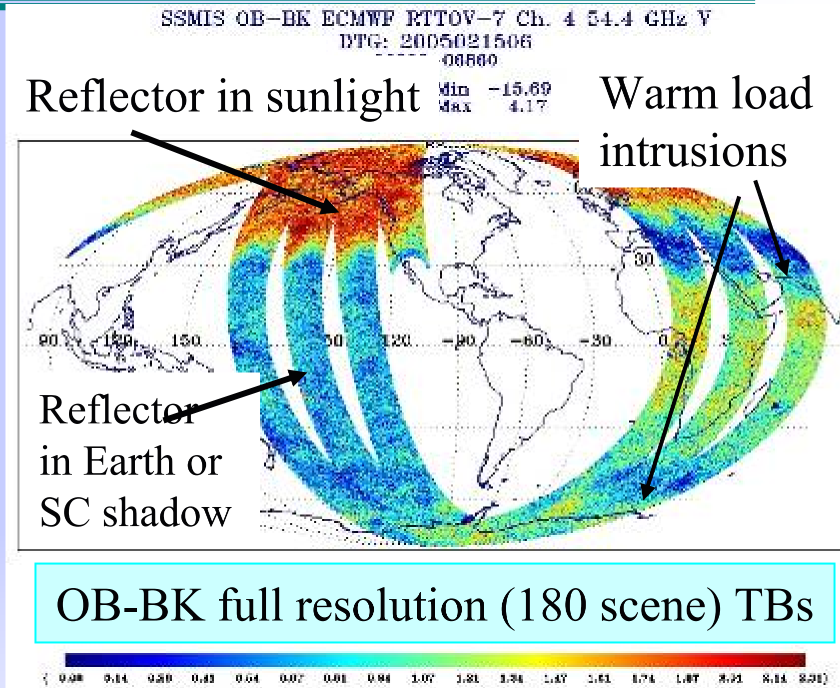
	OPTRAN-V7 Forward, Jacobian+Forward	OPTRAN-comp Forward, Jacobian+Forward	OSS Jacobian+Forward
AIRS	7m20s, 22m36s	10m33s, 35m12	3m10s
HIRS	4s, 13s	5s, 17s	9s

Memory resource required (Megabytes)

	OPTRAN-V7 single, double	OPTRAN-comp double precision	OSS Single precision
AIRS	33, 66	5	97
HIRS	0.26, 0.5	0.04	4

SSMIS Brightness Temperature Evaluation in a Data Assimilation Context

Collaborators: NRL: Nancy Baker (PI), Clay Blankenship, Bill Campbell. Contributors: Steve Swadley (METOC Consulting), Gene Poe (NRL)



OB-BK full resolution (180 scene) TBs

Summary of Accomplishments

- Worked closely with Cal/Val team to understand assimilation implications of the sensor design and calibration anomalies, and to devise techniques to mitigate the calibration issues.
- Completed code to read, process, and quality control observations, apply scan non-uniformity and spillover corrections, perform beam cell averaging of footprints, and compute innovations and associated statistics.
- Developed flexible interface to pCRTM and RTTOV-7.
- Initial results indicate that pCRTM is performing well.

Chan.	pCRTM Bias	pCRTM s.d.	RTTOV-7 Bias	RTTOV-7 s.d.
4	1.70	0.54	1.68	0.53
5	1.59	1.00	1.64	0.97
6	1.81	1.24	1.83	1.24
7	3.53	1.34	3.55	1.44

Future: Real time monitoring of SSMIS TBs. Compare pCRTM with RTTOV-7. Assess observation and forward model bias and errors; determine useful bias predictors. Assess forecast impact of SSMIS assimilation.

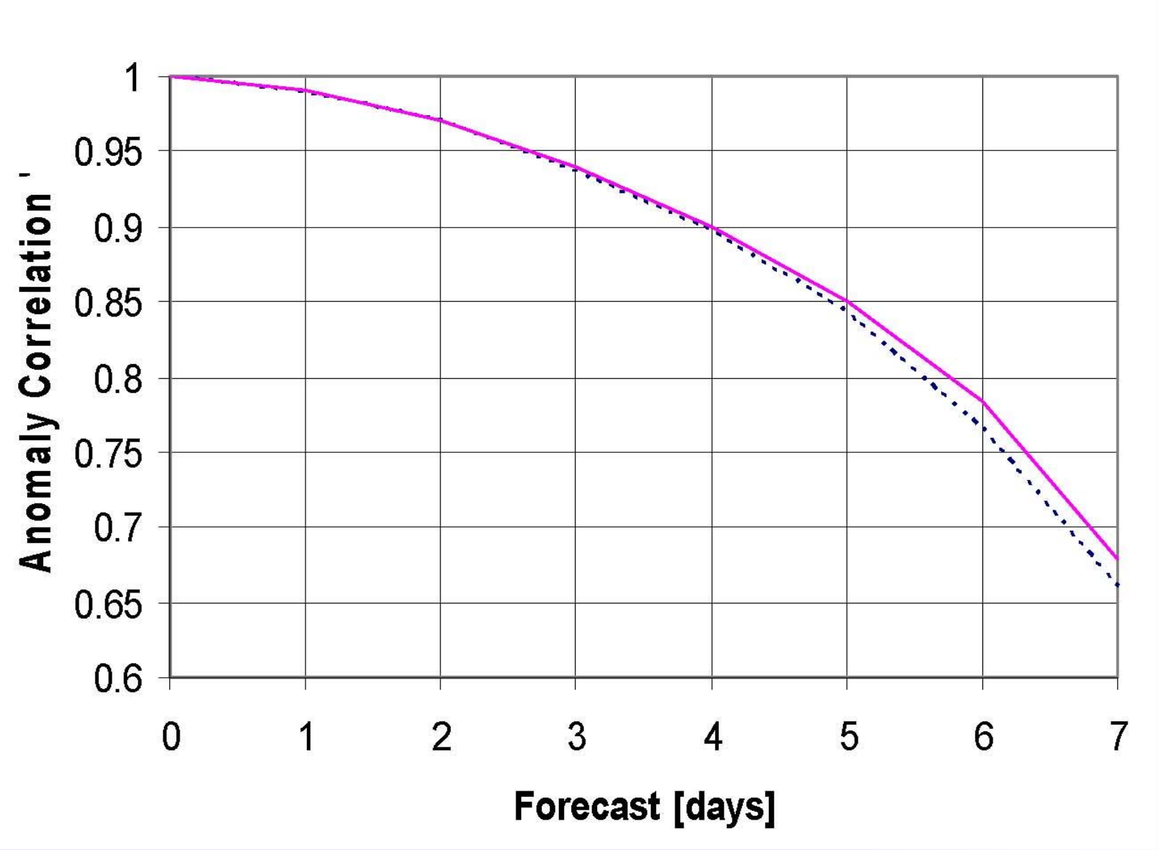
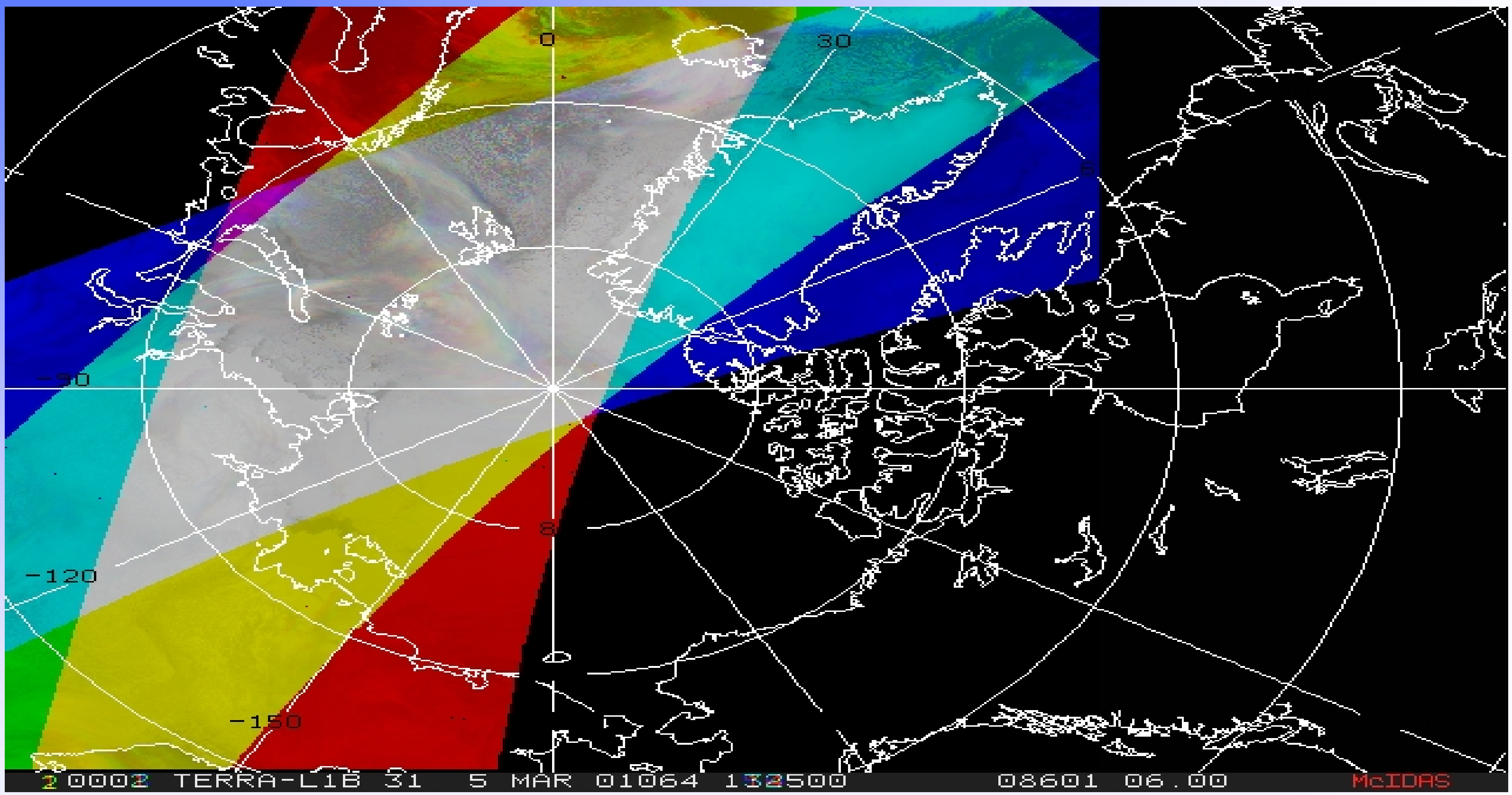


Figure 4. Impact of sea ice and snow emissivity models on the GFS 24 hr. fcst. at 850hPa. (1 Jan. – 15 Feb. 2004); the pink curve shows theACC with new snow and sea ice emissivity models

MODIS Wind Assimilation into the GMAO/NCEP Global Forecast System

Uses of MODIS Winds



Unlike geostationary satellites at lower latitudes, it is not be possible to obtain complete polar coverage at a snapshot in time with one or two polar-orbiters. Instead, winds must be derived for areas that are covered by two or three successive orbits, an example of which is shown here. The whitish area is the overlap between three orbits.

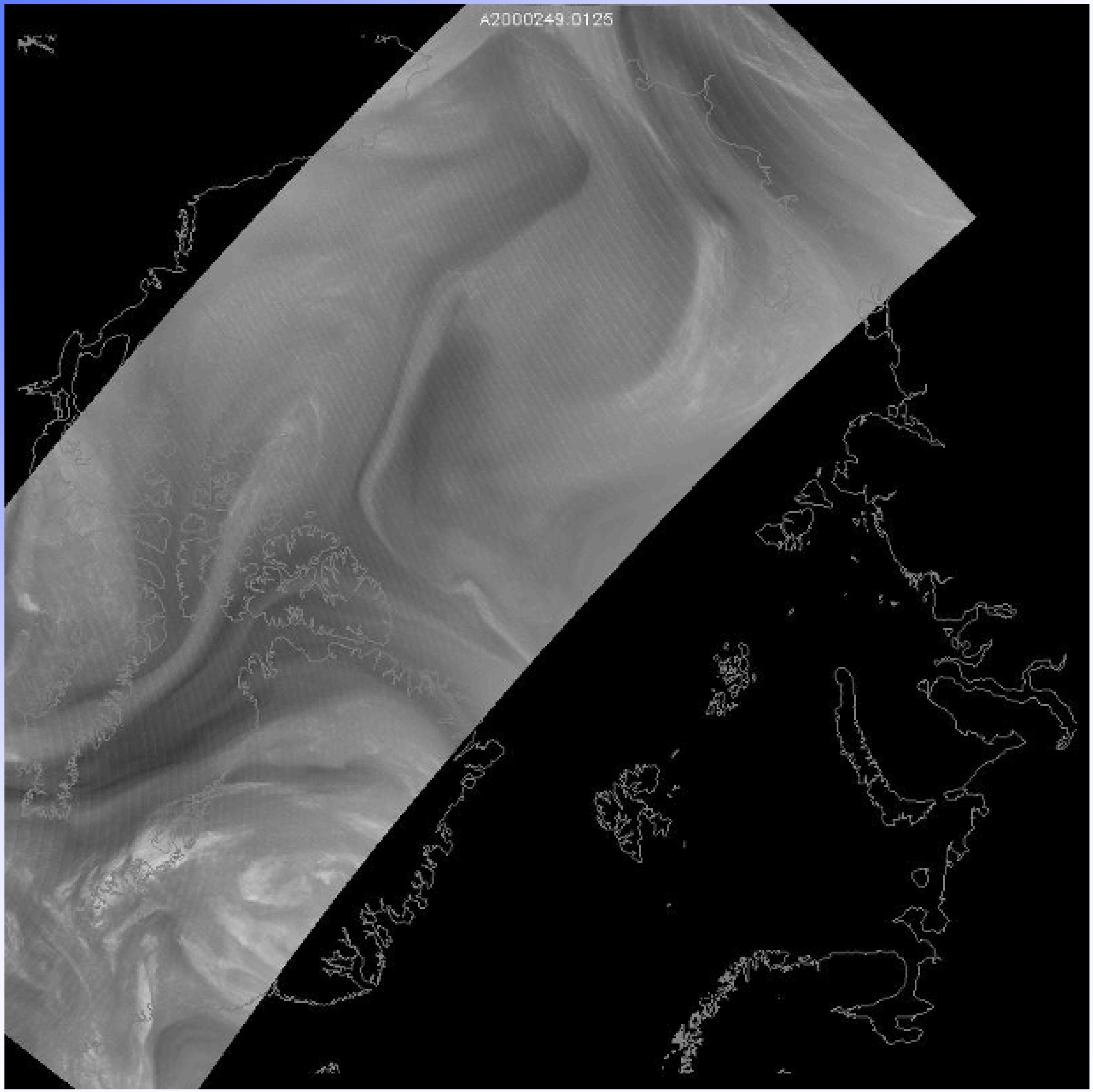
AMV

ESTIMATION

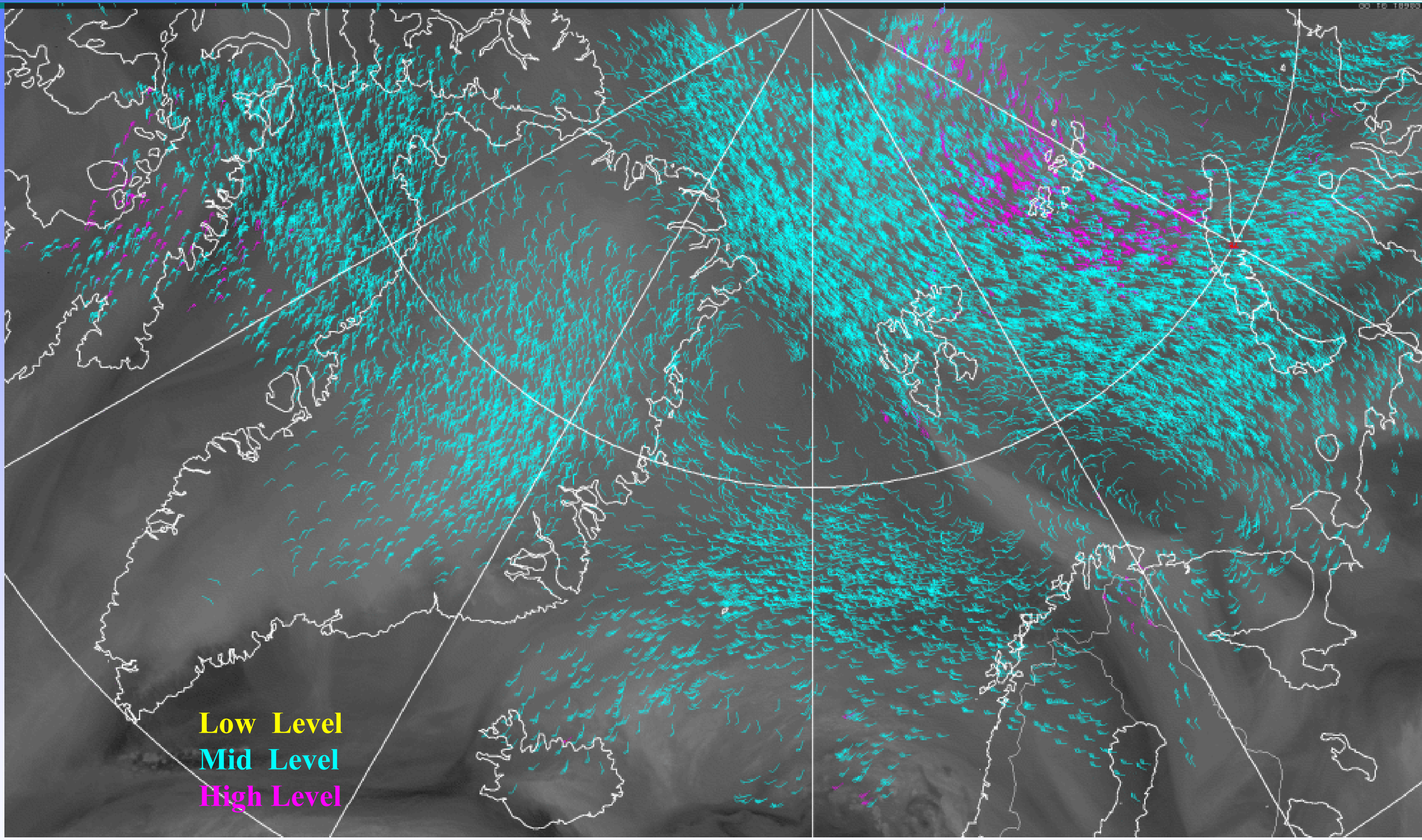
11µm and 6.7 µm gradient features tracked

Tracers selected in middle image

Histogram, H_2O intercept method, forecast model and auto editor used for height assignment



Water Vapor Winds



05 March 2001: Daily composite of 6.7 micron MODIS data over half of the Arctic region. Winds were derived over a period of 12 hours. There are about 13,000 vectors in the image. Vector colors indicate pressure level - yellow: below 700 hPa, cyan: 400-700 hPa, purple: above 400 hPa.

Global Forecast System
Background

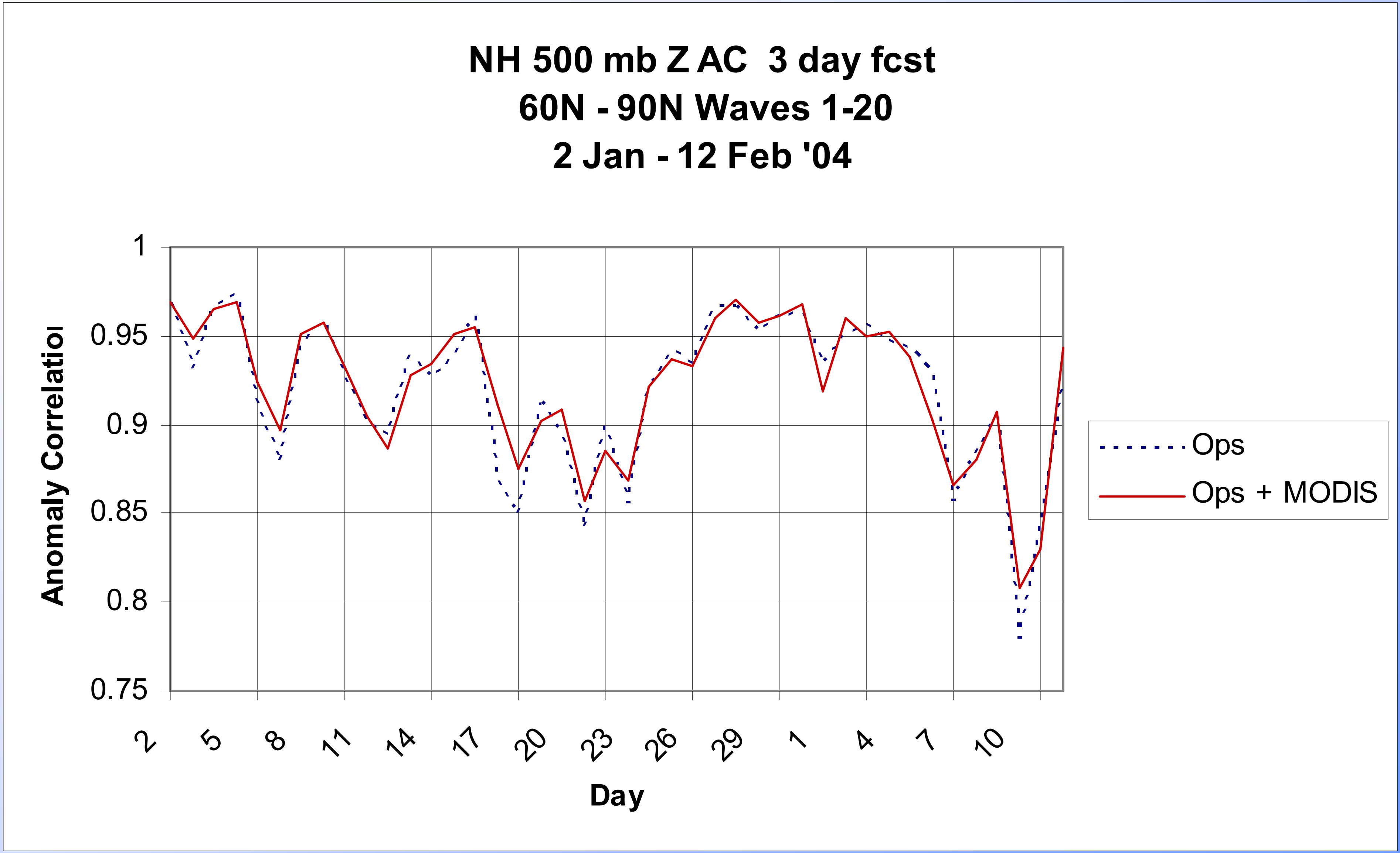
- Operational SSI (3DVAR) version used
- Operational GFS T254L64 with reductions in resolution at 84 (T170L42) and 180 (T126L28) hours. 2.5hr cut off

Table 1: Satellite data used operationally within the GMAO/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

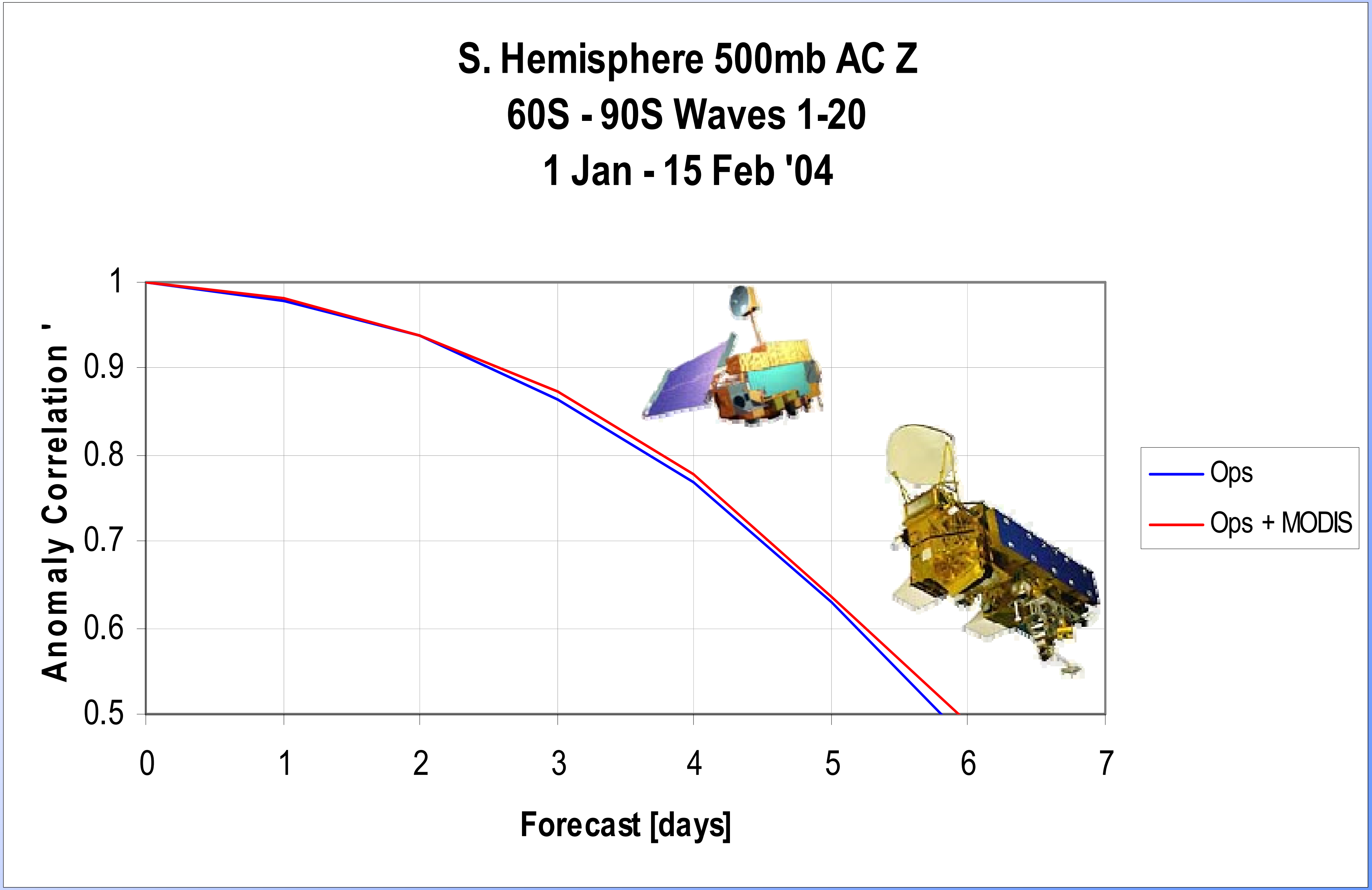
Results

Northern Hemisphere / The Arctic



NH 500 mb Z AC 3 day fcst
60N - 90N Waves 1-20
2 Jan - 12 Feb '04
Anomaly Correlatio
1
0.95
0.9
0.85
0.8
0.75
2
5
8
11
14
17
20
23
26
29
1
4
7
10
Day
Ops
Ops + MODIS

Southern Hemisphere / Antarctica



S. Hemisphere 500mb AC Z
60S - 90S Waves 1-20
1 Jan - 15 Feb '04
Anomaly Correlation
1
0.9
0.8
0.7
0.6
0.5
0
1
2
3
4
5
6
7
Forecast [days]
Ops
Ops + MODIS

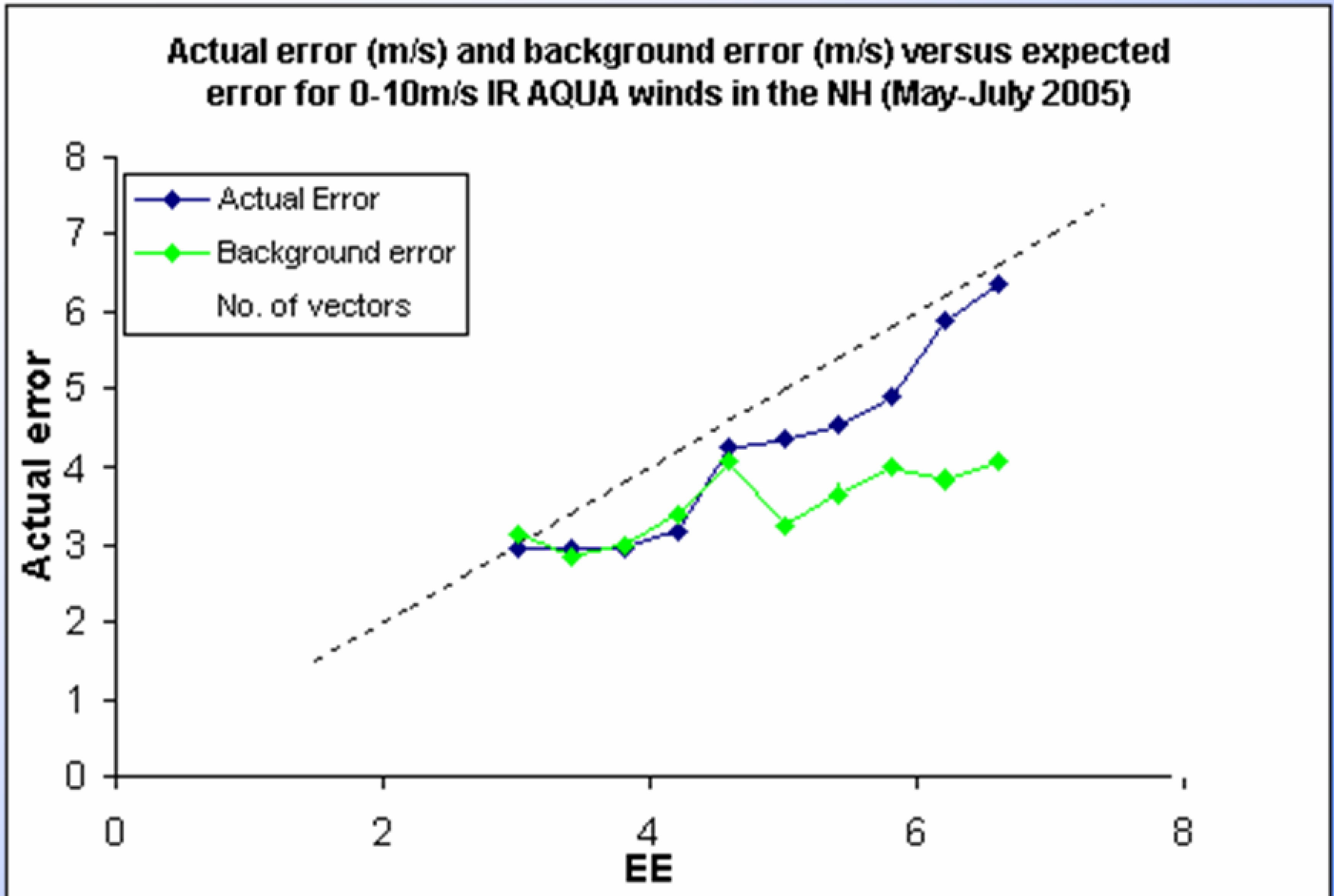
2004 ATLANTIC BASIN
AVERAGE HURRICANE TRACK ERRORS (NM)

13.2	43.6	66.5	94.9	102.8	157.1	227.9	301.1	Cntrl
11.4	34.8	60.4	82.6	89.0	135.3	183.0	252.0	Cntrl + MODIS
74	68	64	61	52	46	39	34	Cases (#)
00-h	12-h	24-h	36-h	48-h	72-h	96-h	120-h	Time

Results compiled by Qing Fu Liu.

Discussion and Conclusions

- Overall positive impact
- Post NESDIS QC used, particularly for gross errors cf. background and for winds above tropopause
- Repeated with emissivity corrections for ice and snow in GFC
- In Current Operational Trial



Actual error (m/s) and background error (m/s) versus expected error for 0-10m/s IR AQUA winds in the NH (May-July 2005)
Actual Error
Background error
No. of vectors
Actual error
EE
0
1
2
3
4
5
6
7
8
0
2
4
6
8

AQUA

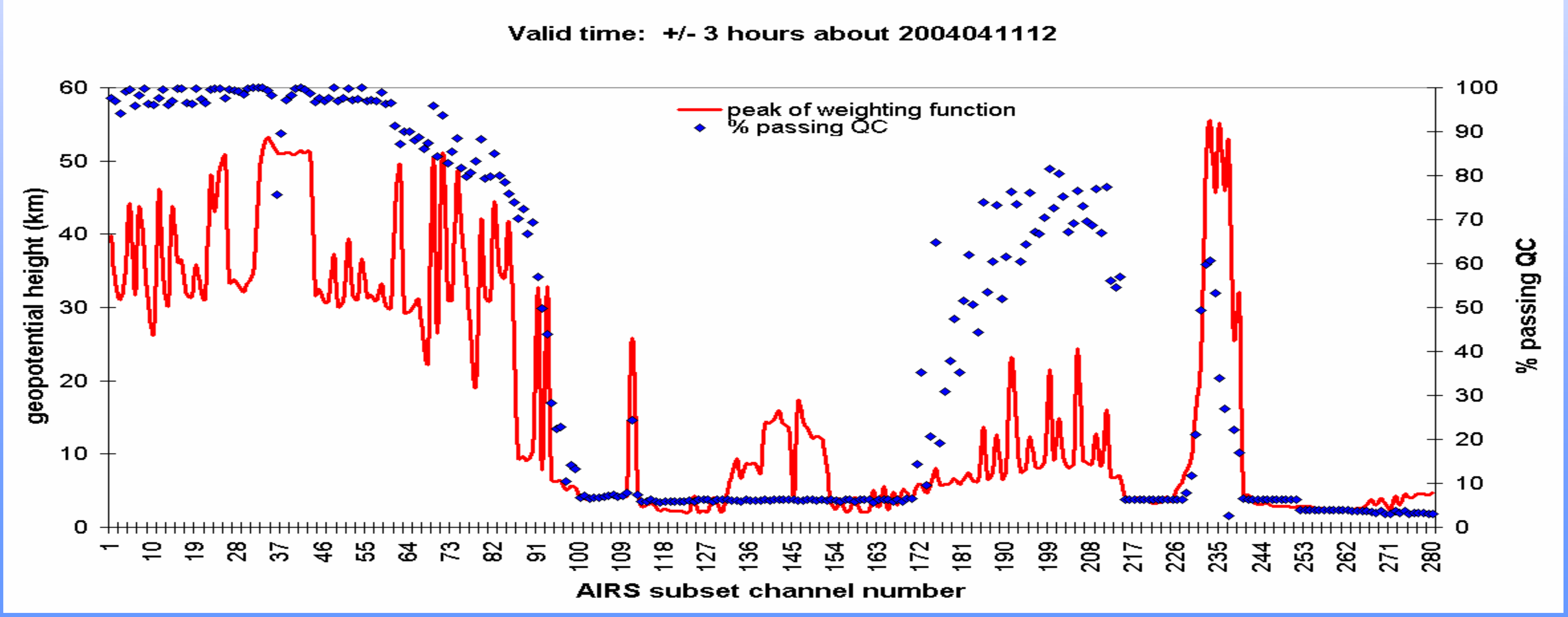
Hyperspectral Data Assimilation

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.

SSI modifications

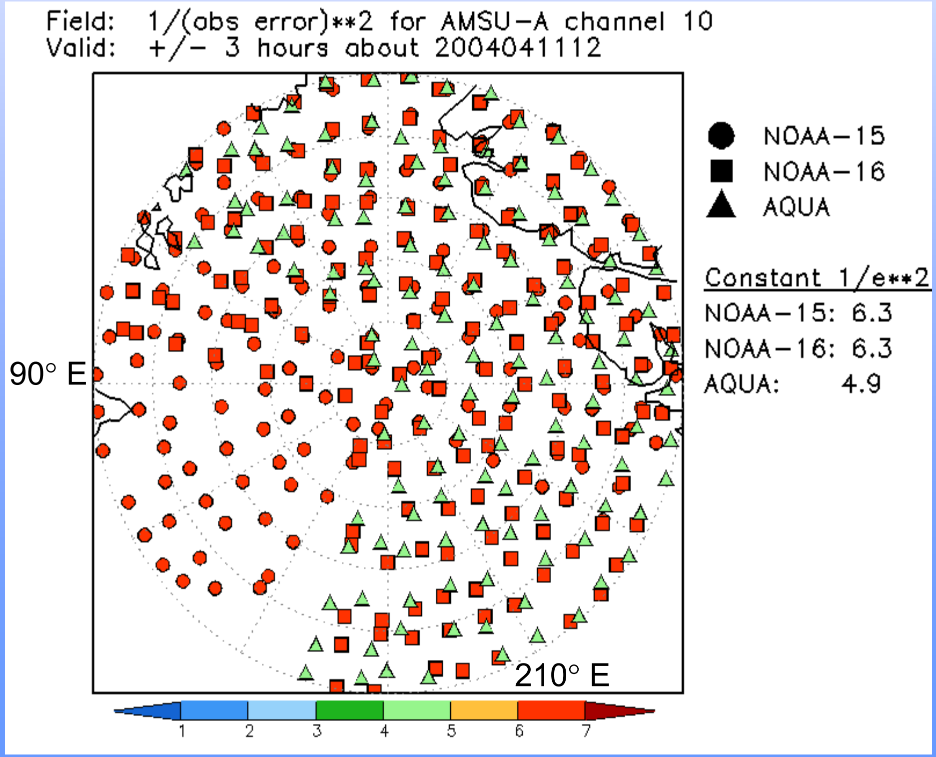
- conservative detection of IR cloudy radiances
  - examine sensitivity, δT_b, of simulated T_b to presence of cloud and skin temperature
  - those channels for which δT_b exceeds an empirical threshold are not assimilated



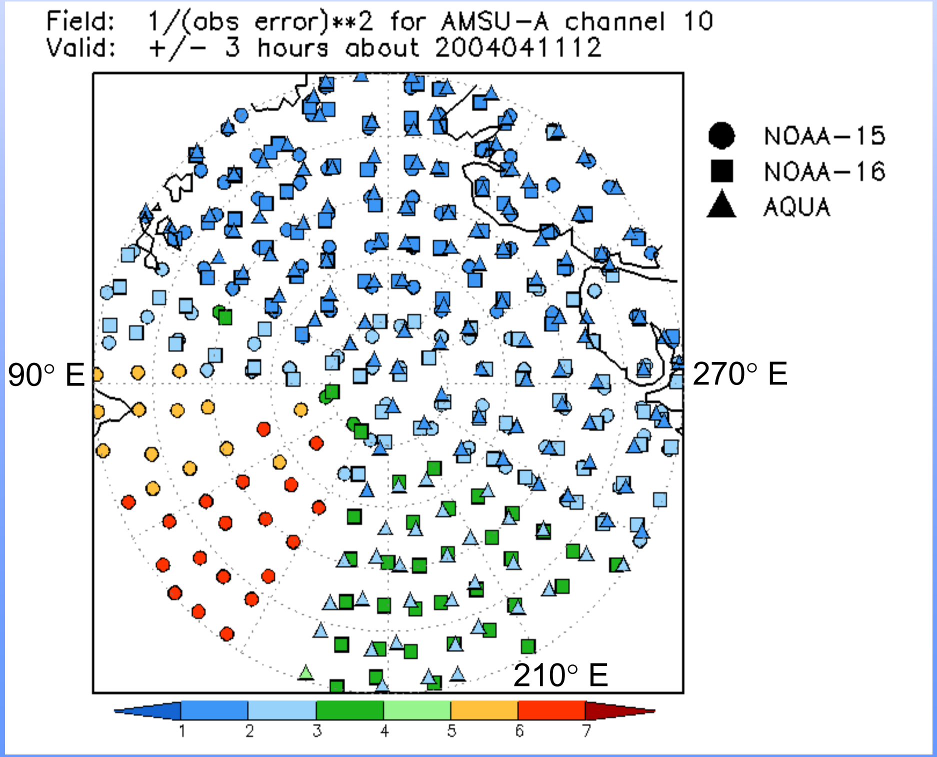
SSI modifications

- more flexible horizontal thinning/weighting
  - account for sensors measuring similar quantities
    - specify sensor groupings (all IR, all AMSU-A, etc)
    - specify relative weighting for sensors within group

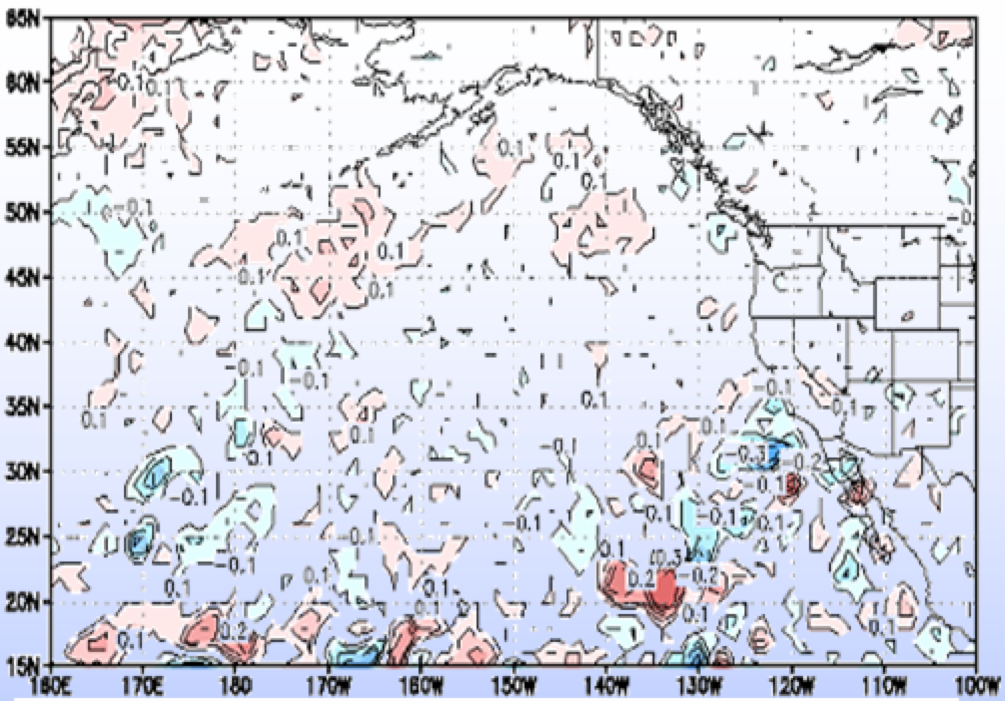
Old thinning/weighting

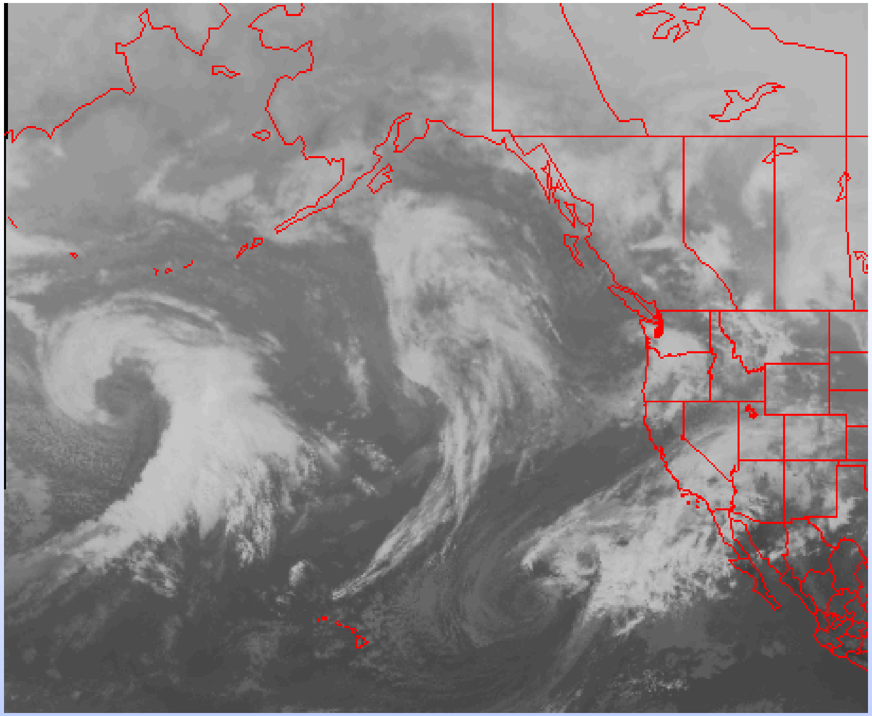


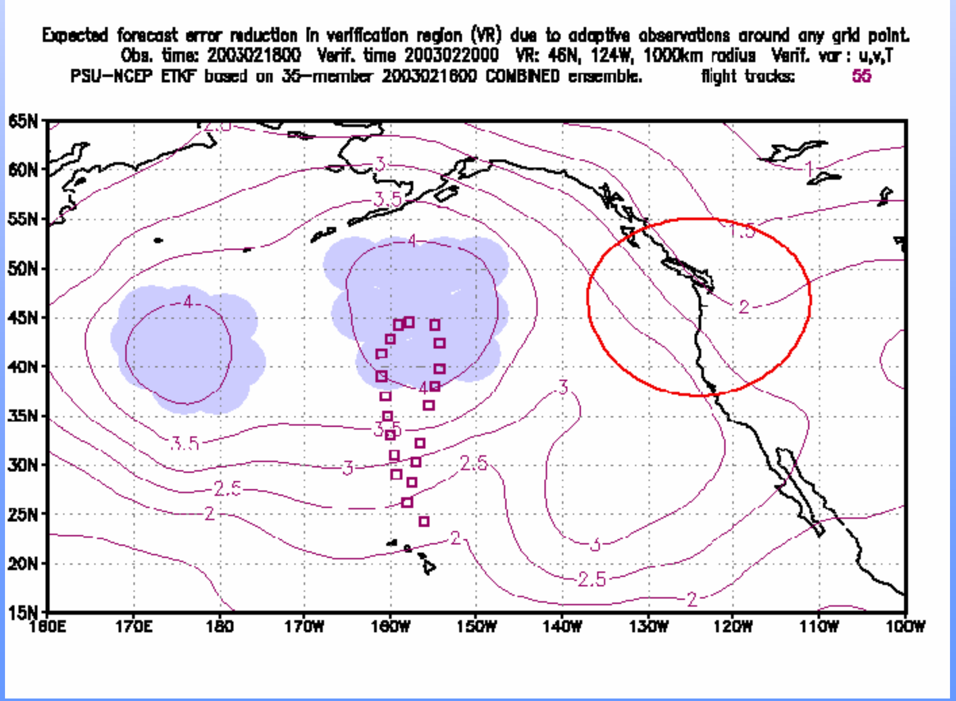
New thinning/weighting



Sensitivity (Targeting) Studies







Data Impact of AIRS on 500 hPa Temperature (top left), IR Satellite Image (top right), and estimated sensitivity (left) for 18 Feb 2003 at 00 UTC

Impact outside the targeted areas is due to small differences between the first guess forecasts. Sensitive areas show no data impact due to cloud coverage.

- Light purple shading indicates AIRS data selection
- Violet squares indicate dropsonde locations
- Red ellipse shows verification region

Assimilation of advanced sounders at NCEP

John C. Derber, Russ Treadon, and Paul VanDelst
NOAA/NWS/NCEP/EMC

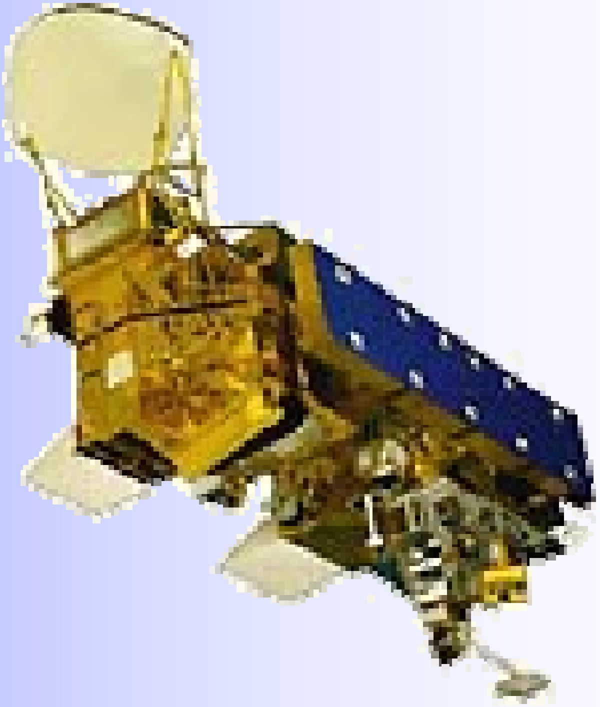
28 June 2004

ECMWF workshop on Assimilation of high spectral resolution sounders

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)

JCSDA



RECENT STUDIES

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……

1 January 2004 – 31 January 2004

Used operational GFS system as Control

Used Operational GFS system Plus Enhanced AIRS Processing as Experimental System

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

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

The Trials – Assim1

- Used `full AIRS data stream used (JPL)
  - NESDIS (ORA) generated BUFR files
  - All FOVs, 324(281) channels
  - 1 Jan – 15 Feb '04

- Similar assimilation methodology to that used for operations
- Operational data cut-offs used
- Additional cloud handling added to 3D Var.
- Data thinning to ensure satisfying operational time constraints

The Trials – Assim1

- Used NCEP Operational verification scheme.

AIRS Assimilation

- Used 251 Out of 281 Channels

  - 73 - 86 Removed (Channels peak too High)

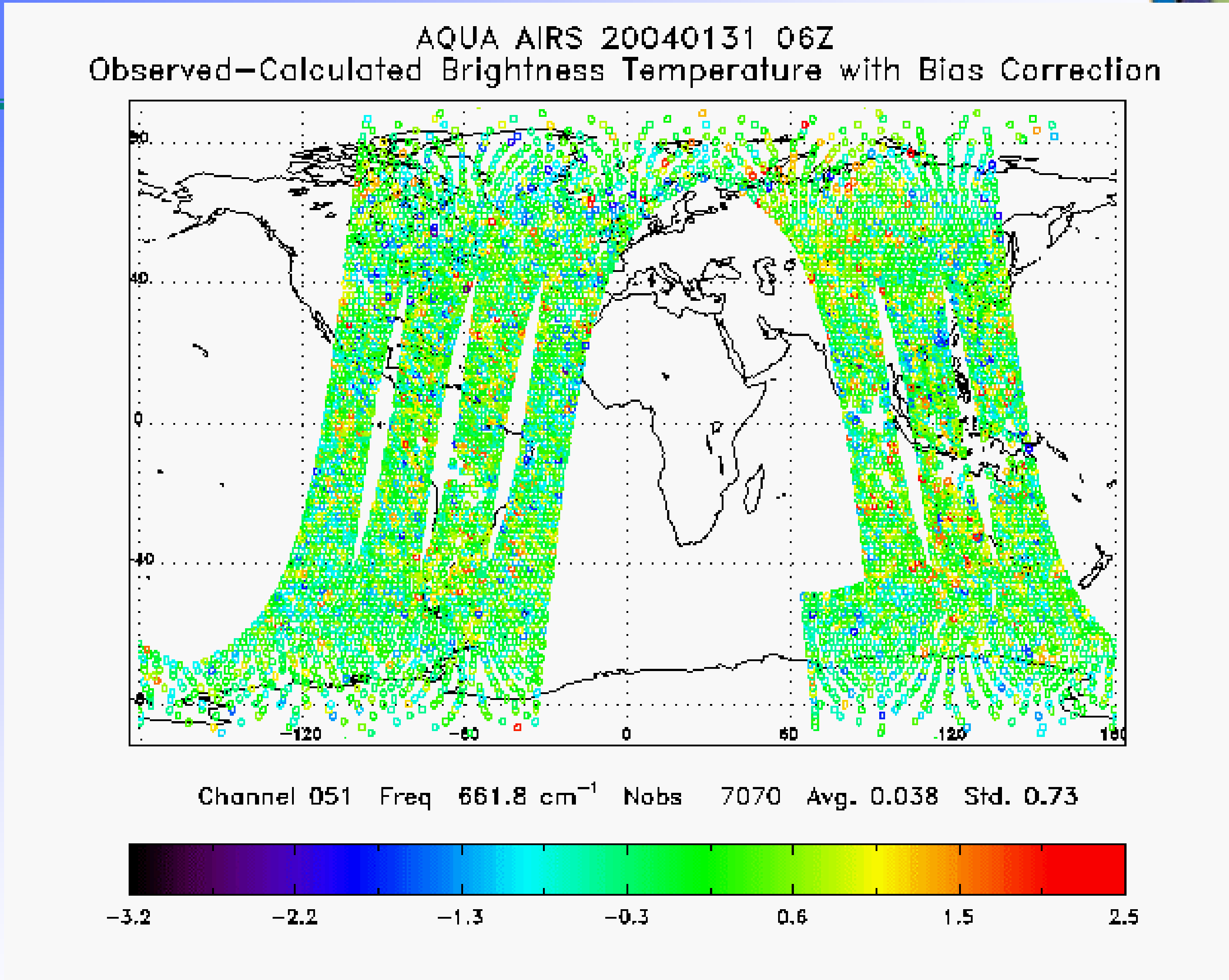
  - 1937 - 2109 Removed (Non LTE)

  - 2357 Removed (Large Obs – Background Diff.)

- Used Shortwave at Night

  – Wavenumber > 2000 cm^{-1} Downweighted

  – Wavenumber > 2400cm^{-1} Removed



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

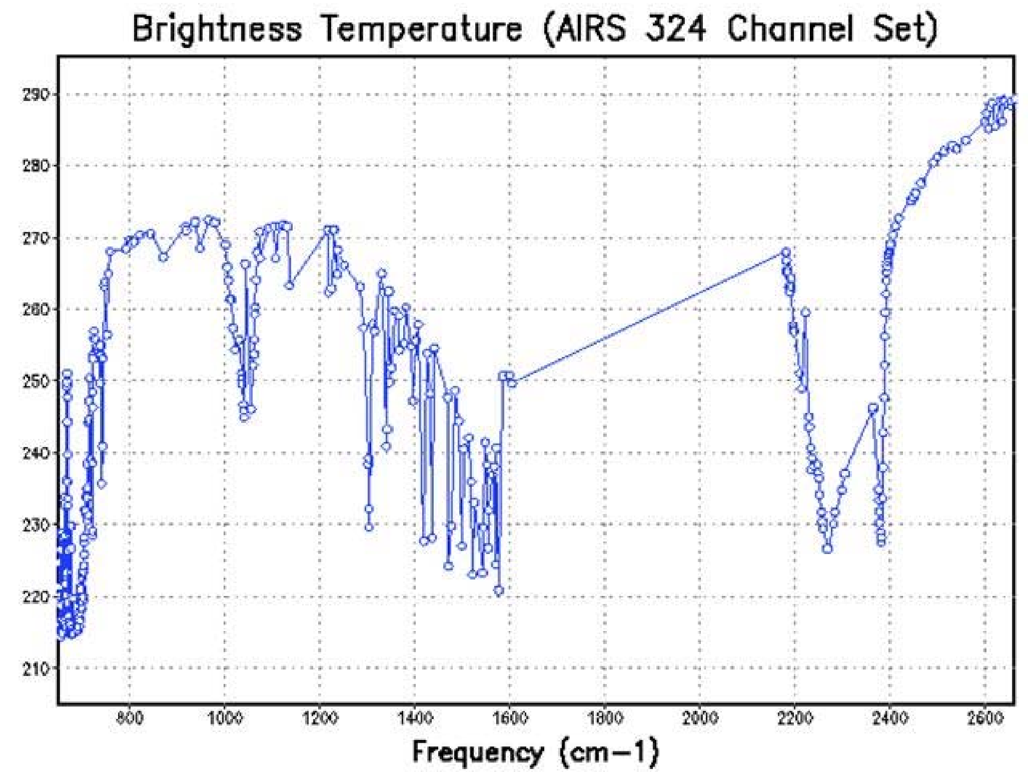


Figure 5.Spectral locations for 324 AIRS thinned channel data distributed to NWP centers.

Table 2: AIRS Data Usage per Six Hourly Analysis Cycle

Data Category	Number of AIRS Channels
Total Data Input to Analysis	~200x10^6 radiances (channels)
Data Selected for Possible Use	~2.1x10^6 radiances (channels)
Data Used in 3D VAR Analysis(Clear Radiances)	~0.85x10^6 radiances (channels)

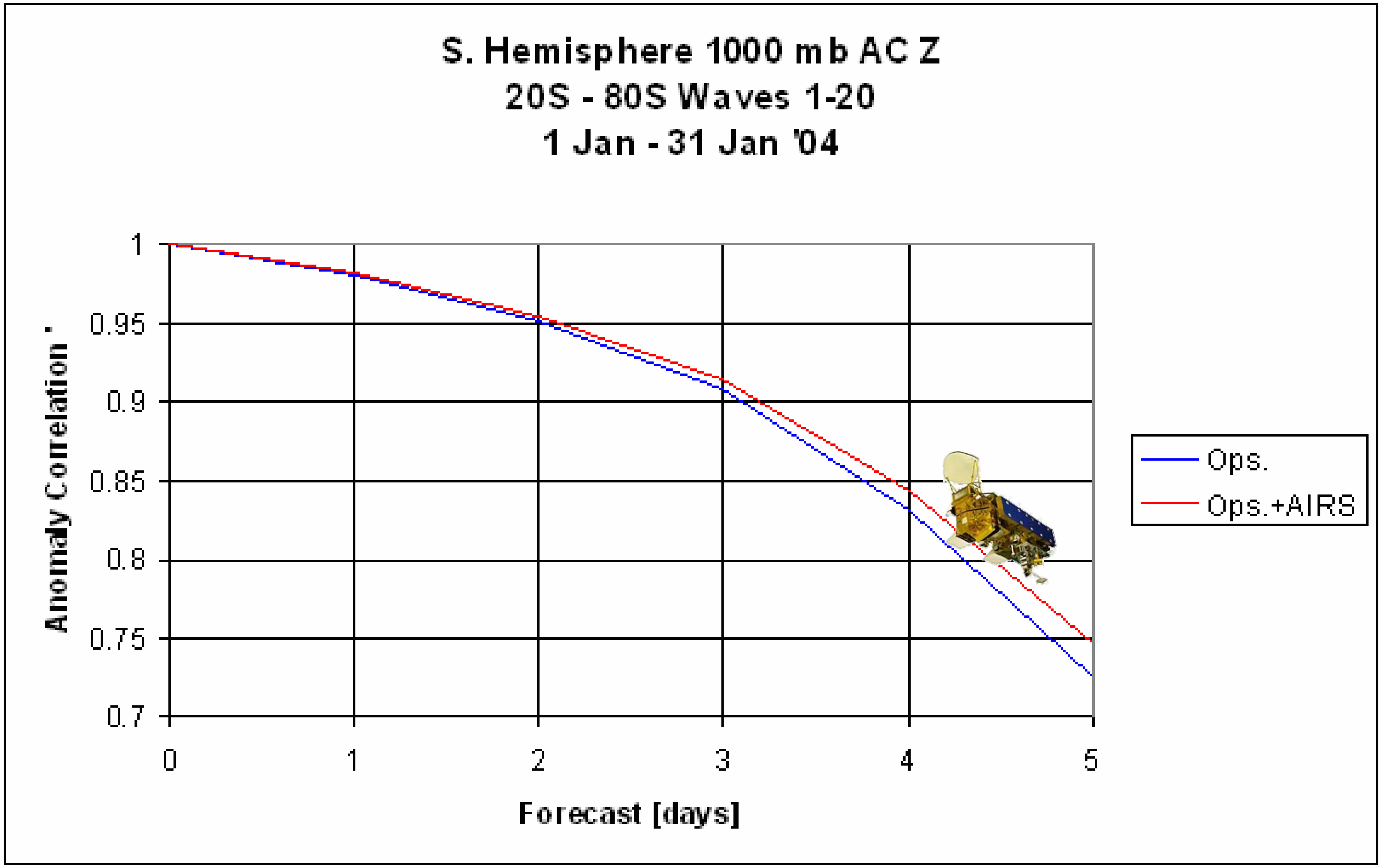


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004- Assim1

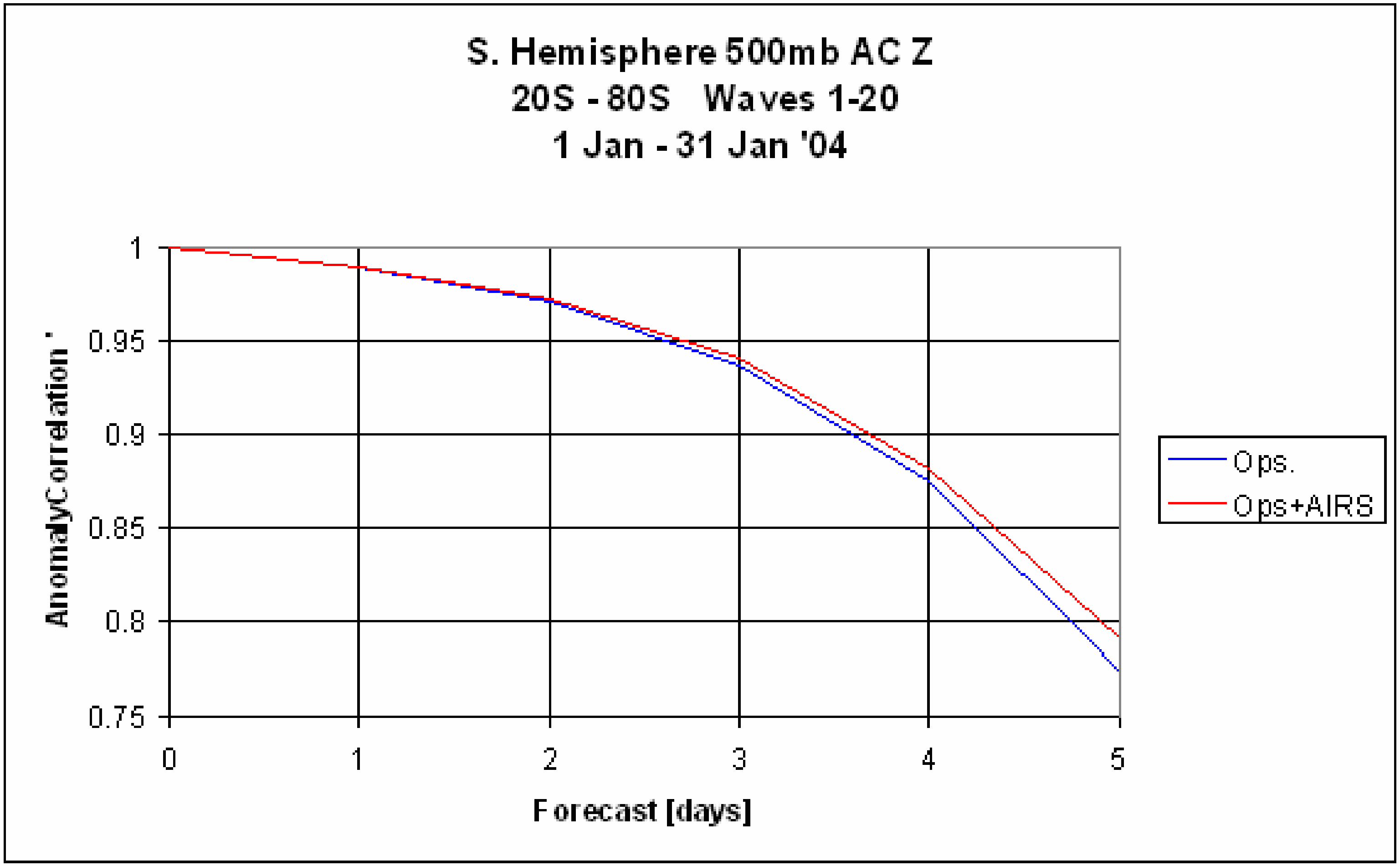


Figure1(a). 500hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004 – Assim1

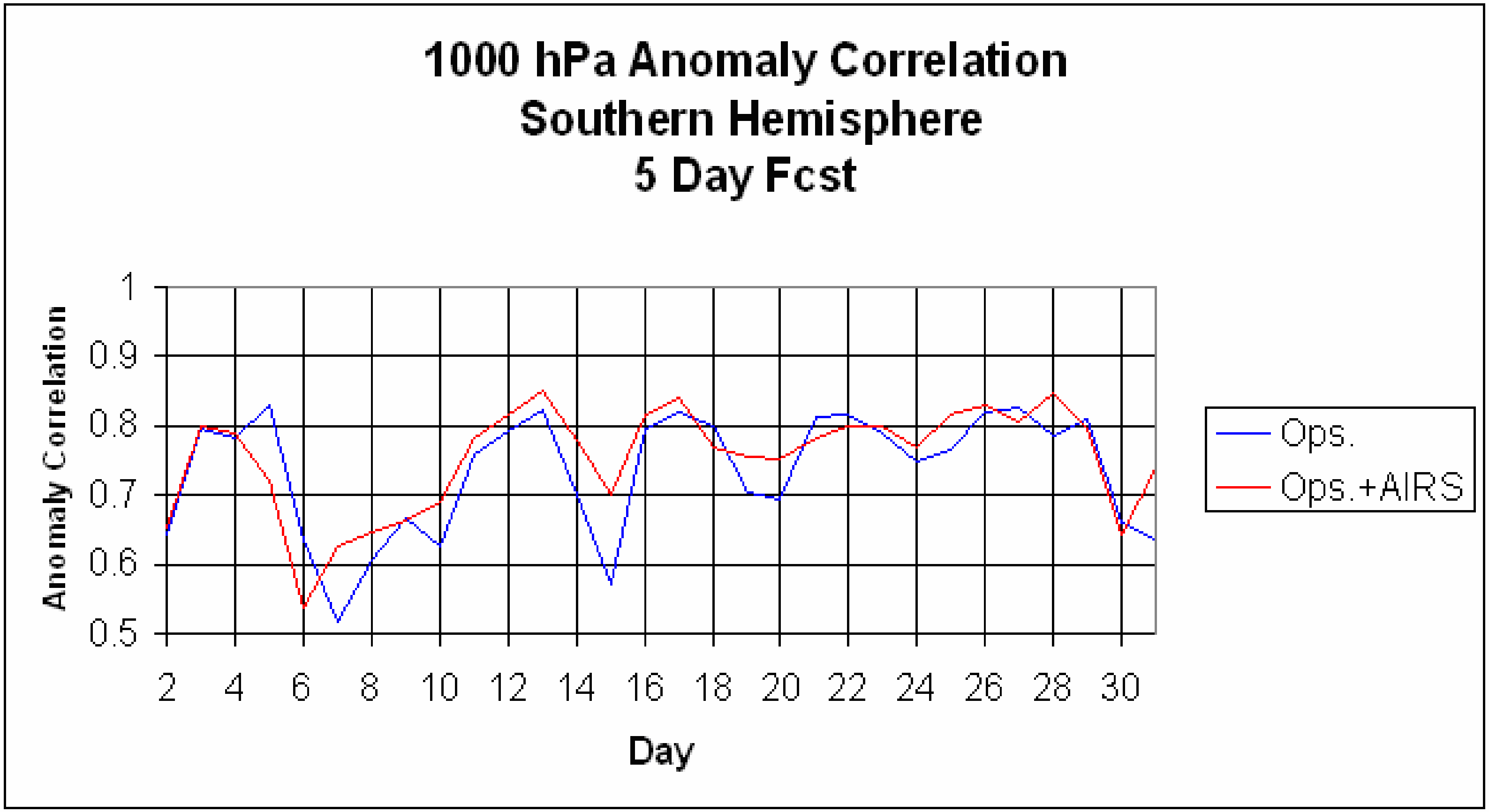


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

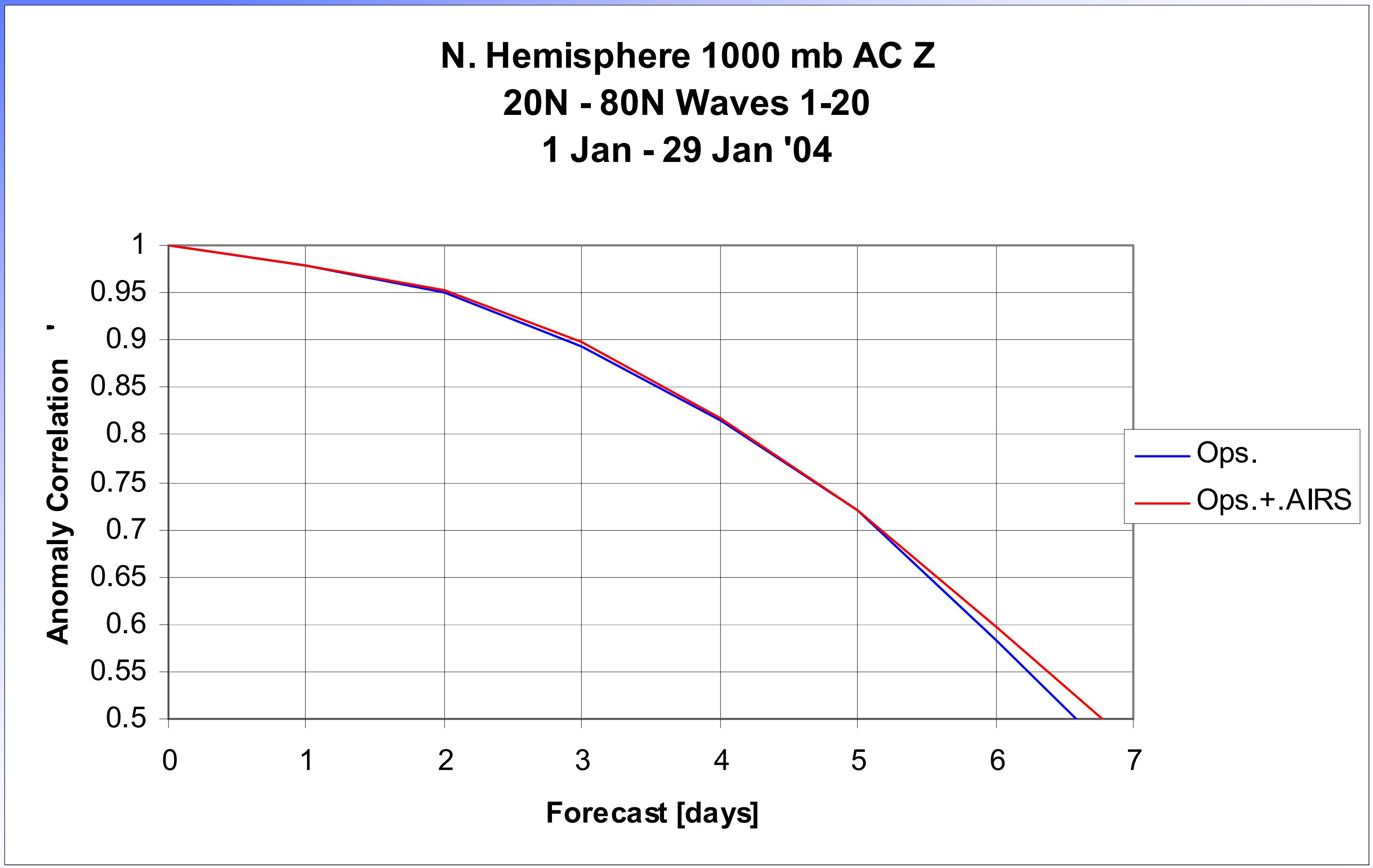


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern Hemisphere, January 2004

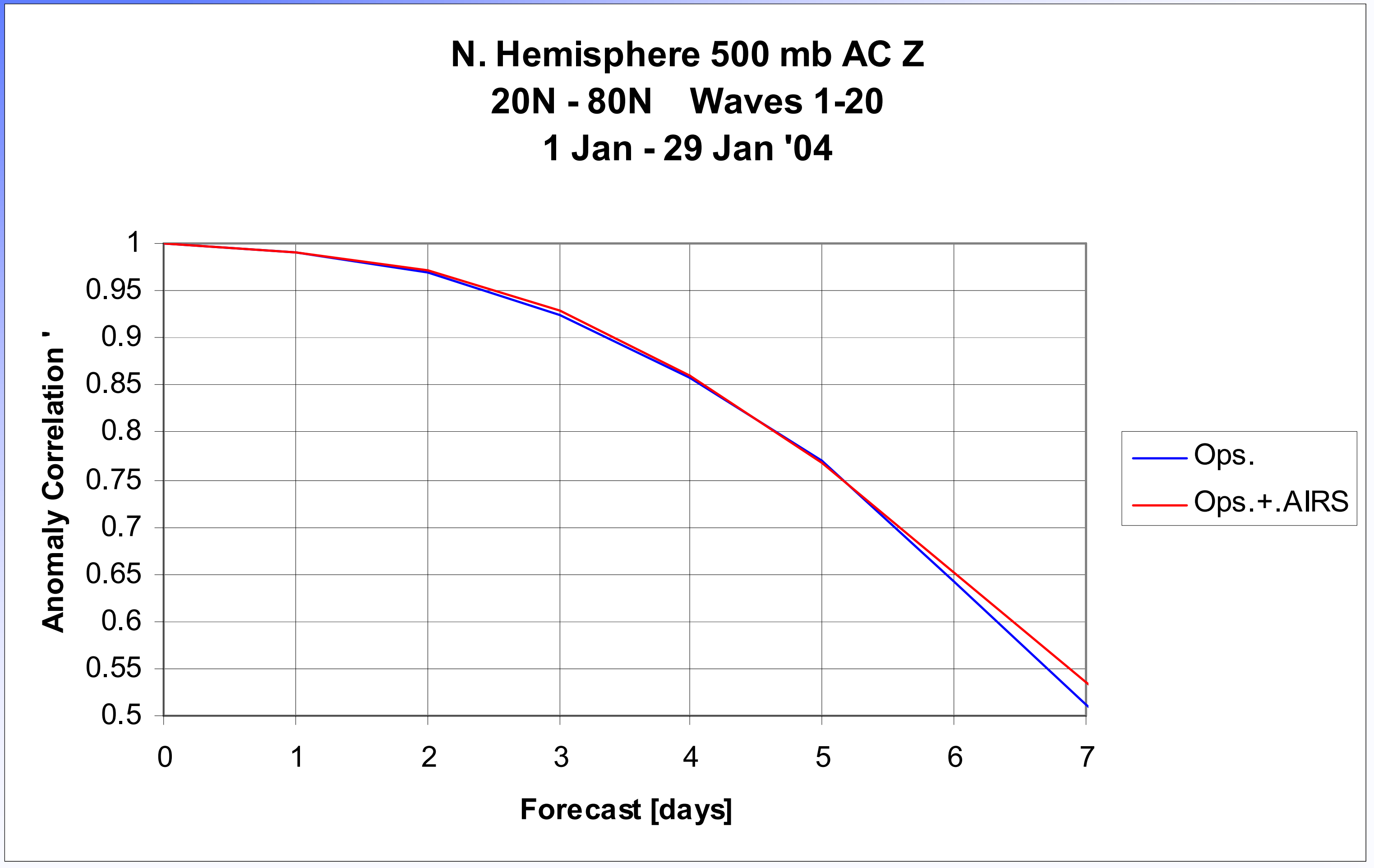


Figure1(a). 500hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern Hemisphere, January 2004

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

1-31 January 2004

Used operational GFS system as Control

Used Operational GFS system Plus Enhanced AIRS Processing as Experimental System

Clear Positive Impact

The Trials – Assim 2

- Used `full AIRS data stream used (JPL)
  - NESDIS (ORA) generated BUFR files
  - All FOVs, 324(281) channels
  - 1 Jan – 27 Jan '04
- Similar assimilation methodology to that used for operations
- Operational data cut-offs used
- Additional cloud handling added to 3D Var.
- Data thinning to ensure satisfying operational time constraints

The Trials – Assim 2

- AIRS related weights/noise modified
- Used NCEP Operational verification scheme.

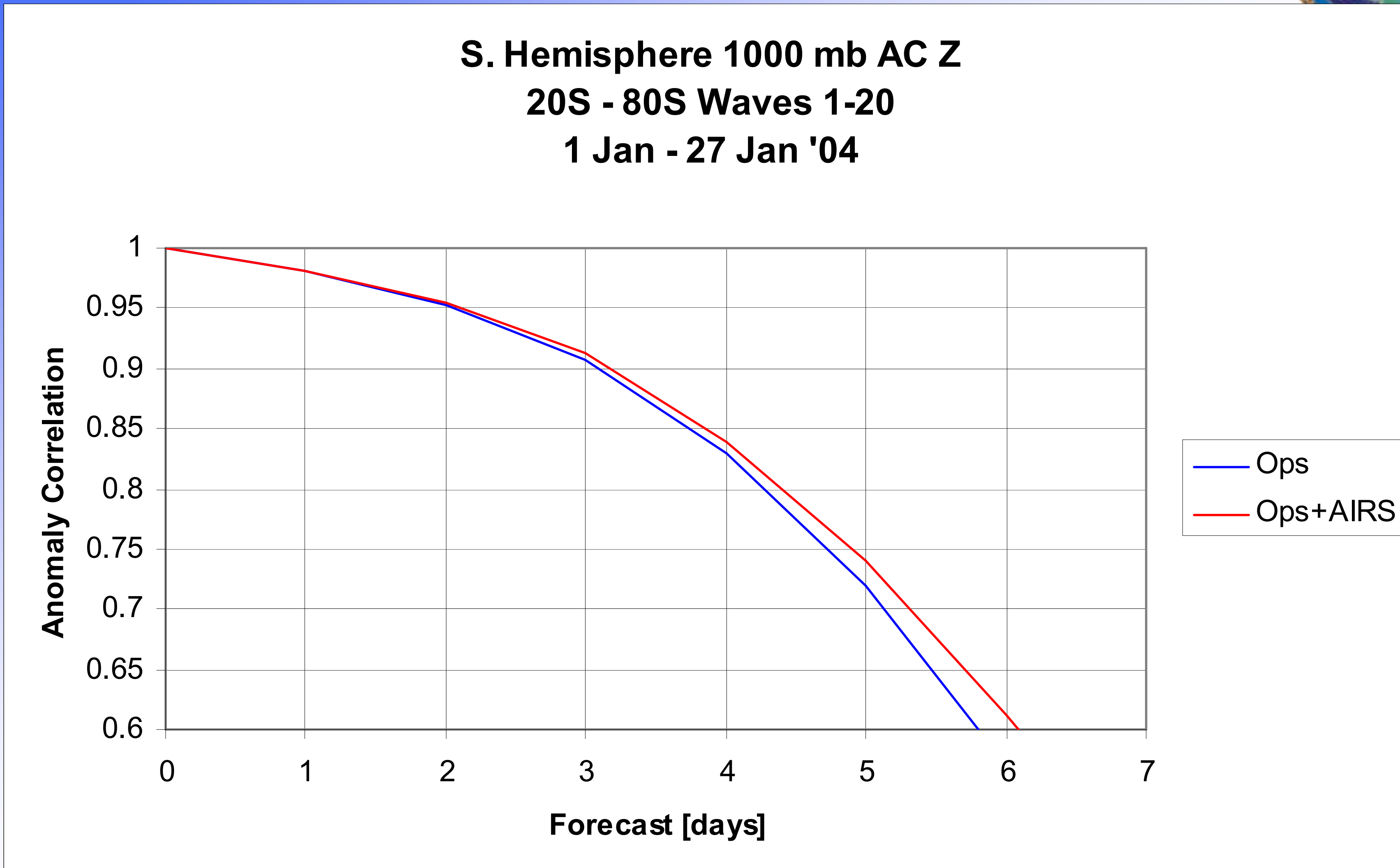


Figure1(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

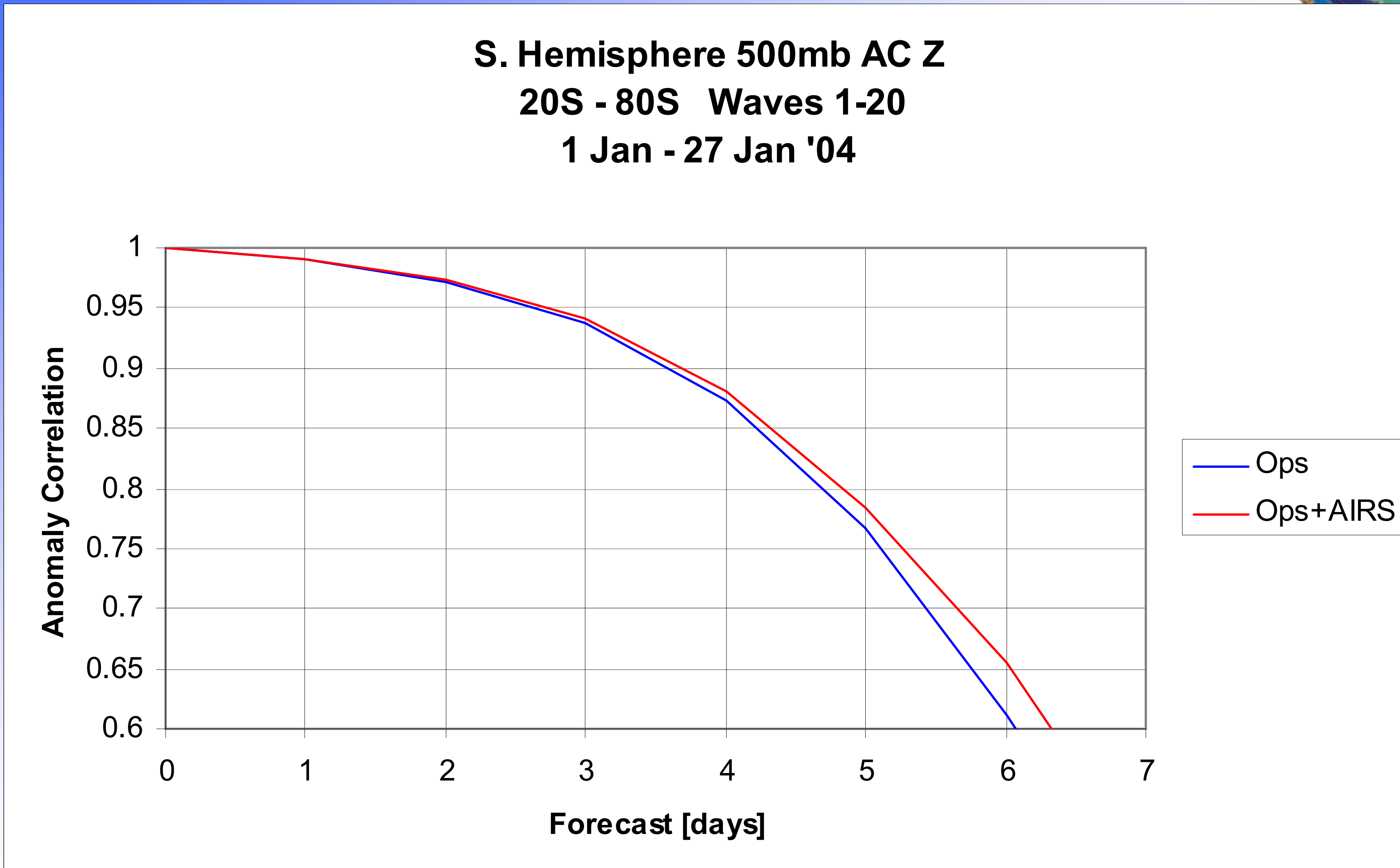


Figure 1(b). 500hPa Z Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004

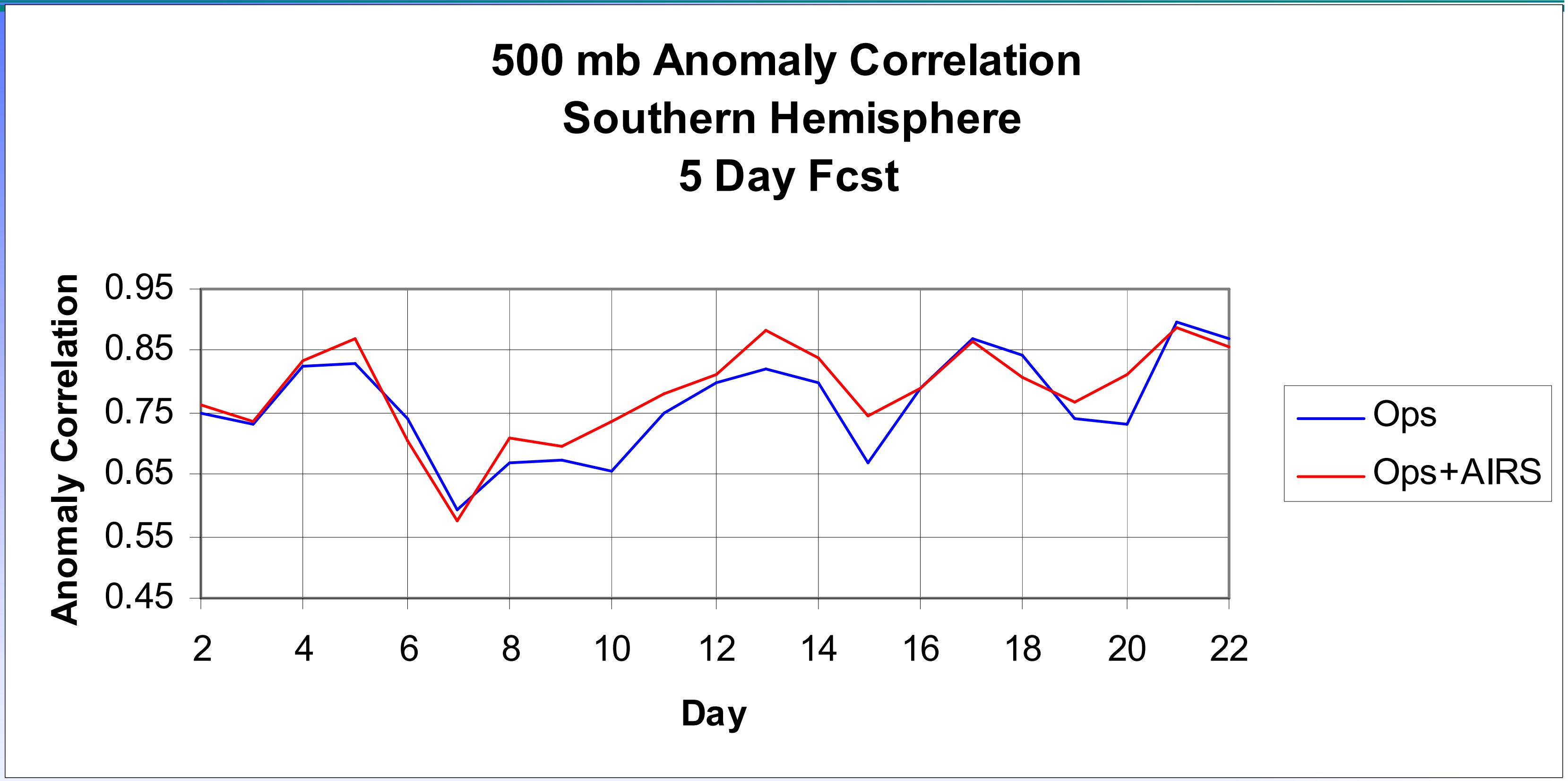


Figure 2. 500hPa Z Anomaly Correlations 5 Day Forecast for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, (1-27) January 2004

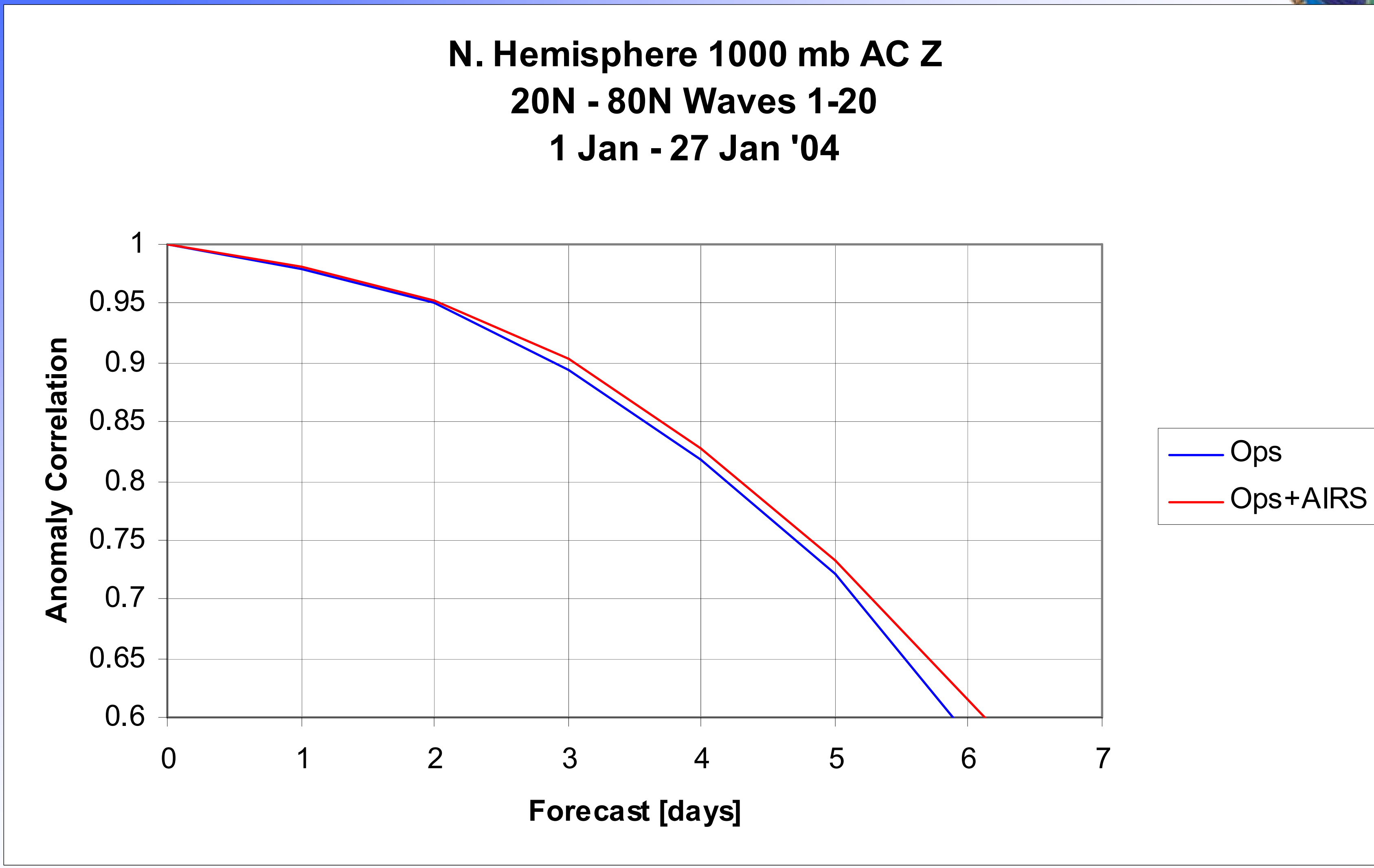


Figure3(a). 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern hemisphere, January 2004

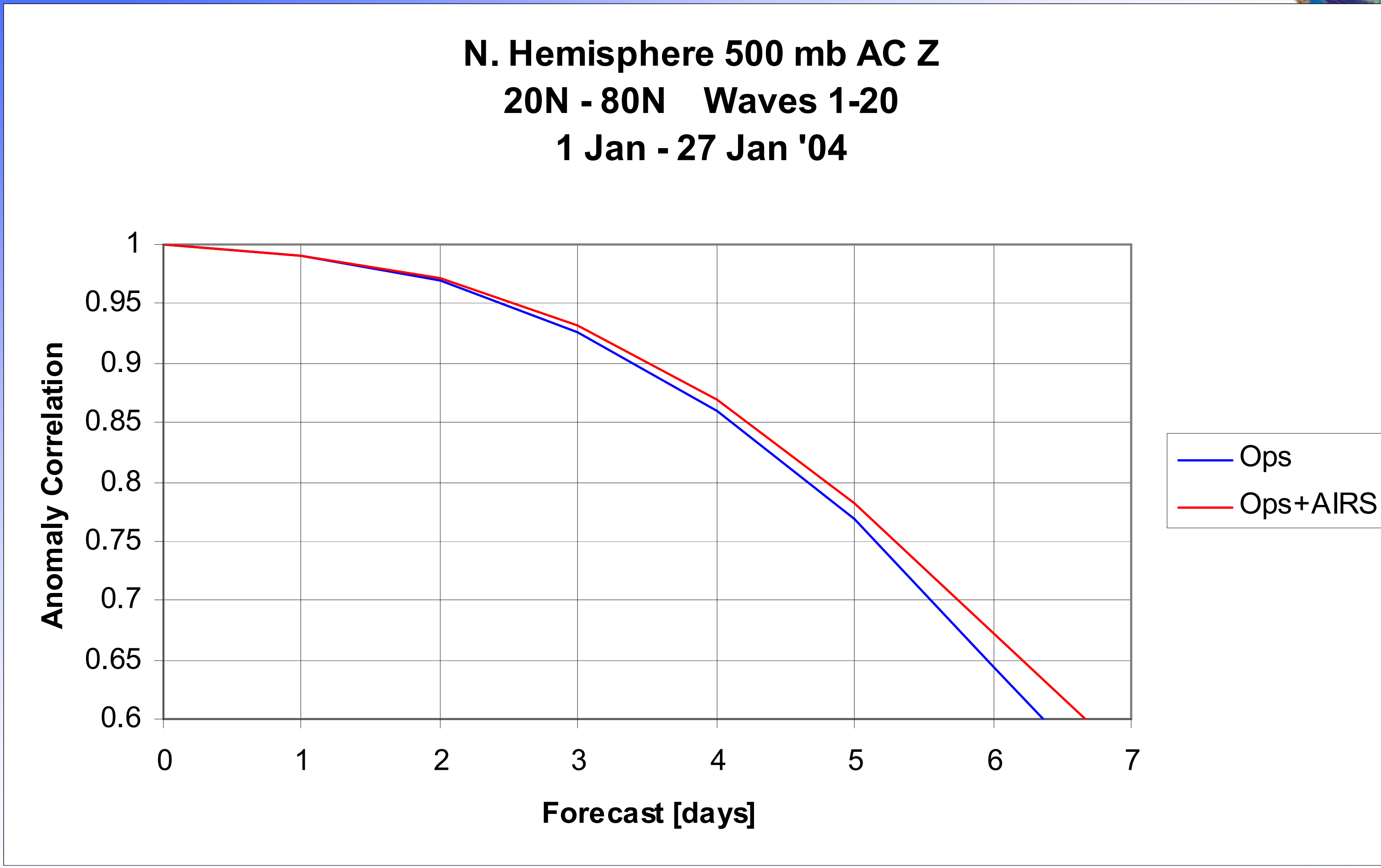


Figure 3(b). 500hPa Z Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Northern hemisphere, January 2004

AIRS Data Assimilation

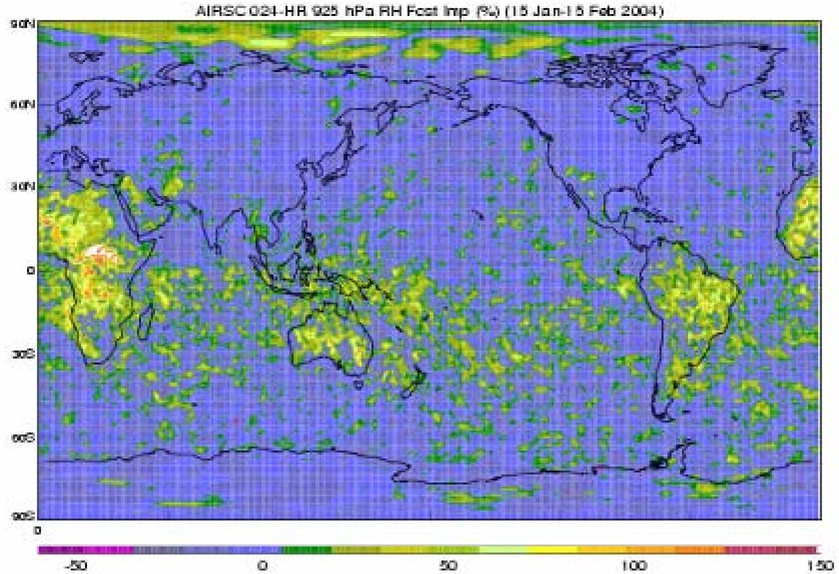
MOISTURE

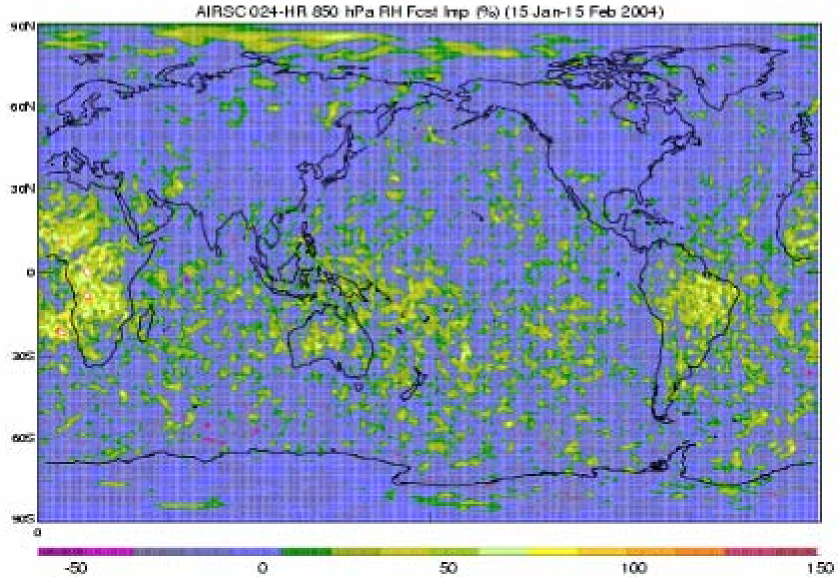
Forecast Impact evaluates which forecast (with or without AIRS) is closer to the analysis valid at the same time.

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

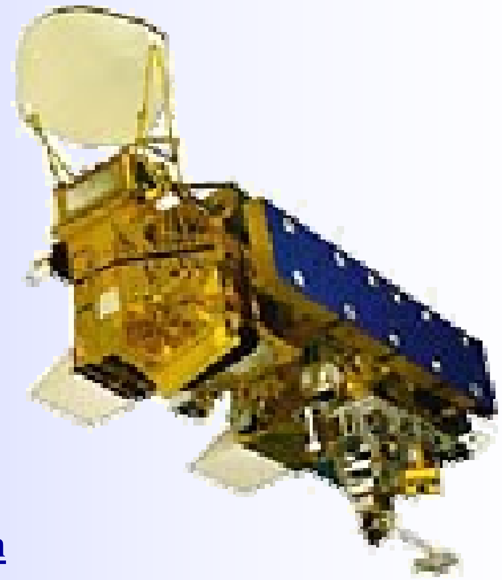
Where the first term on the right is the error in the Cntl forecast. The second term is the error in the AIRS forecast. Dividing by the error in the control forecast and multiplying by 100 normalizes the results and provides a percent improvement/degradation. A positive Forecast Impact means the forecast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

Low Level Relative Humidity





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 Enhanced AIRS Processing as Experimental System

Clear Positive Impact Both Hemispheres

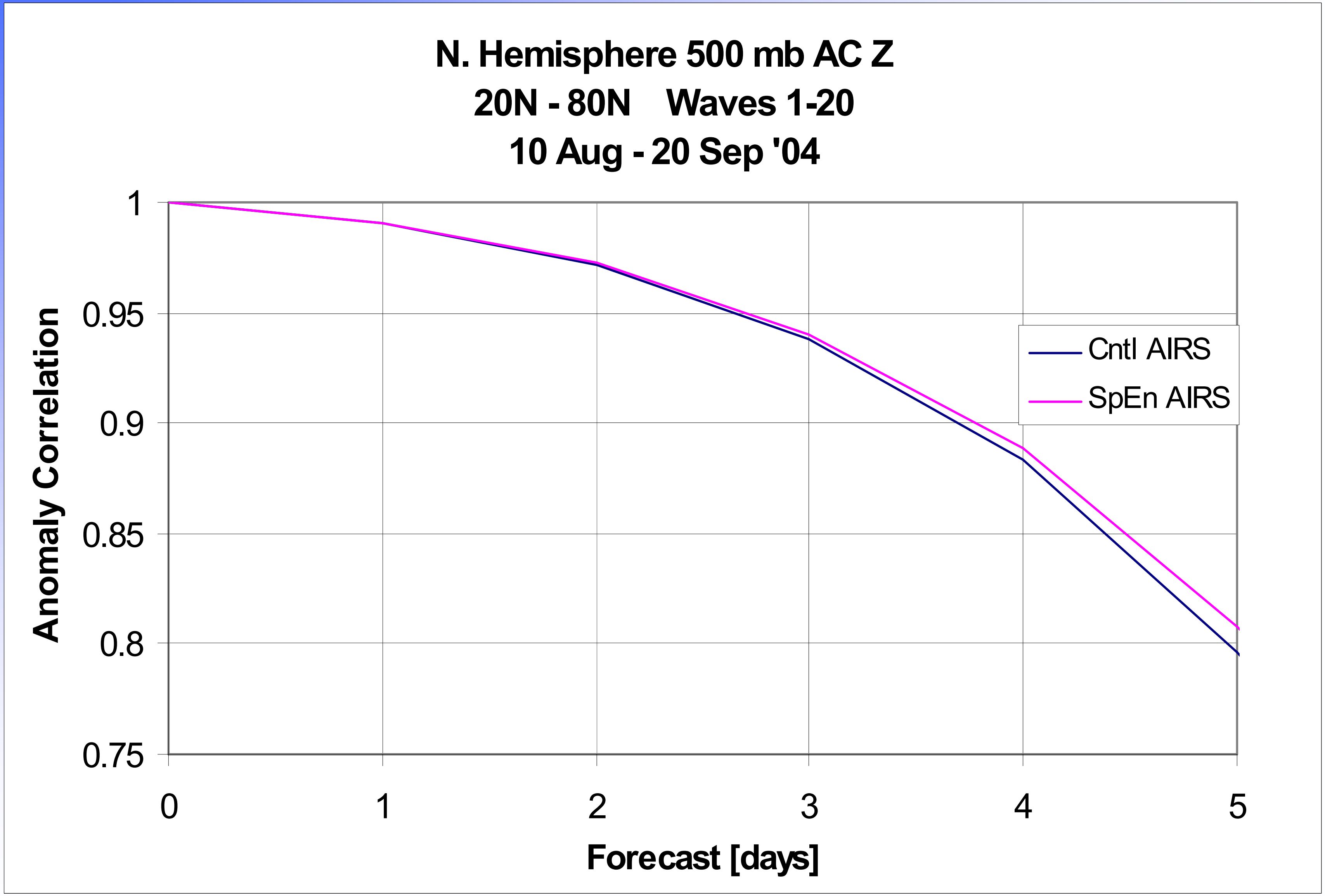
AIRS Data Assimilation

Impact of Data density…

10 August – 20 September 2004

Impact of AIRS spatial data density/QC

(Snow, SSI/eo/April 2005/nw)



AIRS Data Assimilation
-The Next Steps

Fast Radiative Transfer Modelling (OSS, Superfast RTM)

GFS Assimilation studies using:

full spatial resolution AIRS data (ć Є & MODIS)
full spatial resolution AIRS data with recon. radiances
full spatial res. AIRS with cld. cleared radiances
(ć AMSU/MODIS/MFG use)
full spatial and spectral res. AIRS data
full spatial and spectral res. raw cloudy AIRS
(ć MODIS/AMSU) data
(full cloudy inversion with cloud parameters etc.)

JCSDA Hyperspectral Radiance Assimilation

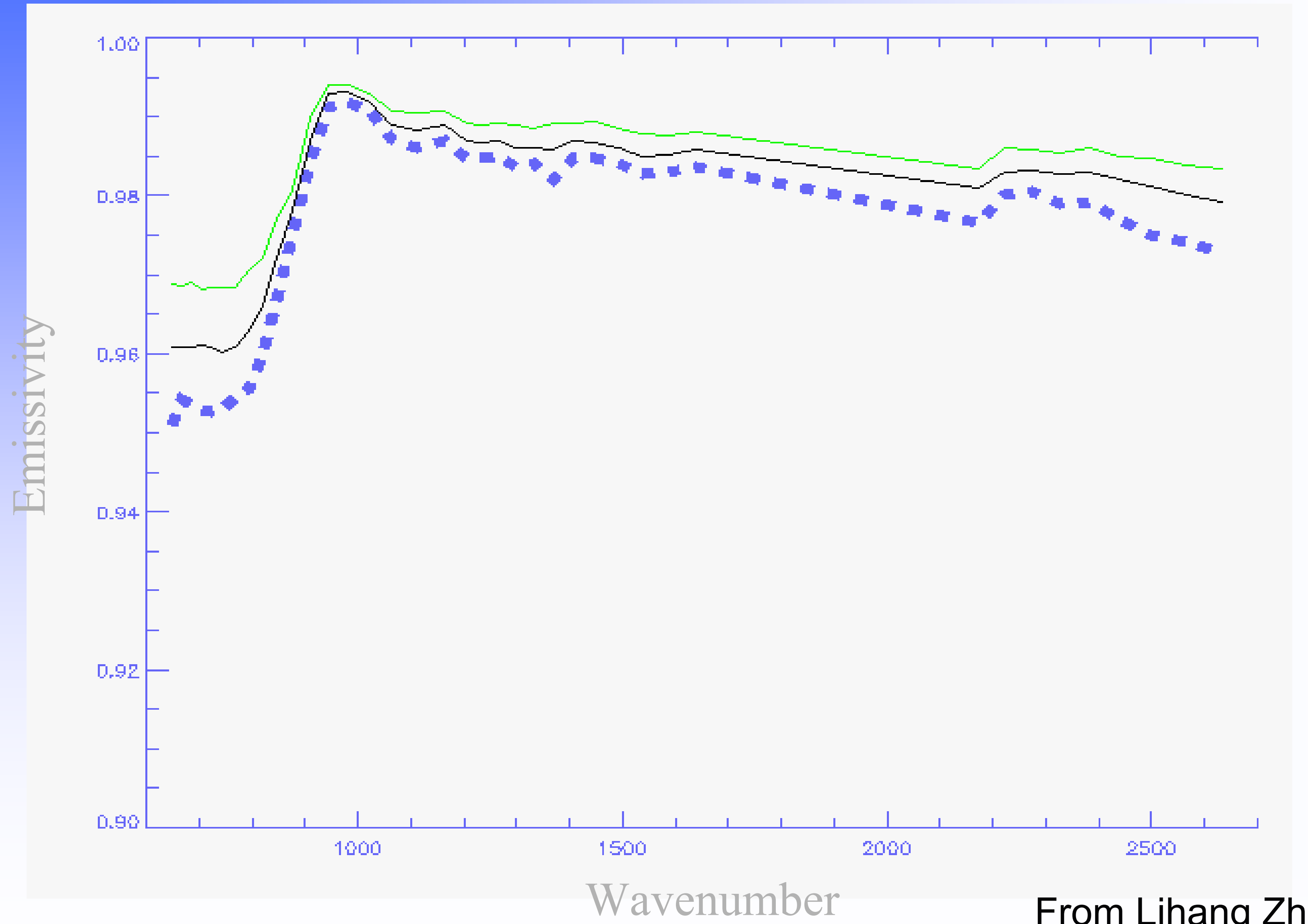
- Assimilation over land a priority area
- Assimilation of cloudy radiances a priority area
- Both benefit from estimation of emissivity

Surface Emissivity (ε) Estimation Methods

- Geographic Look Up Tables (LUTs) - (2)
- Regression based on theoretical estimates – (2)
- Minimum Variance, provides T_{surf} and ε *
- Eigenvector technique
- Variational Minimisation – goal

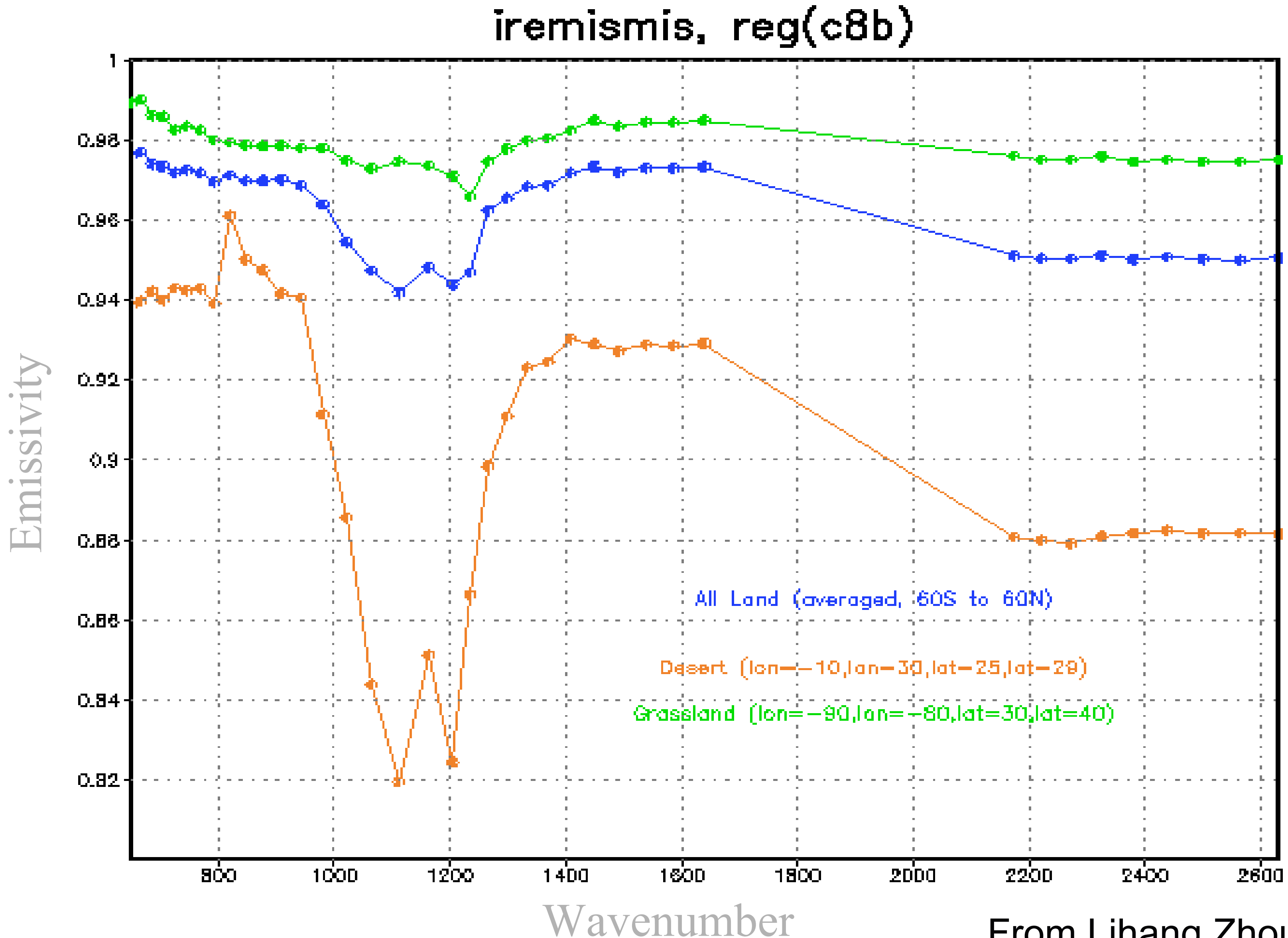
* In use currently in experiments

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



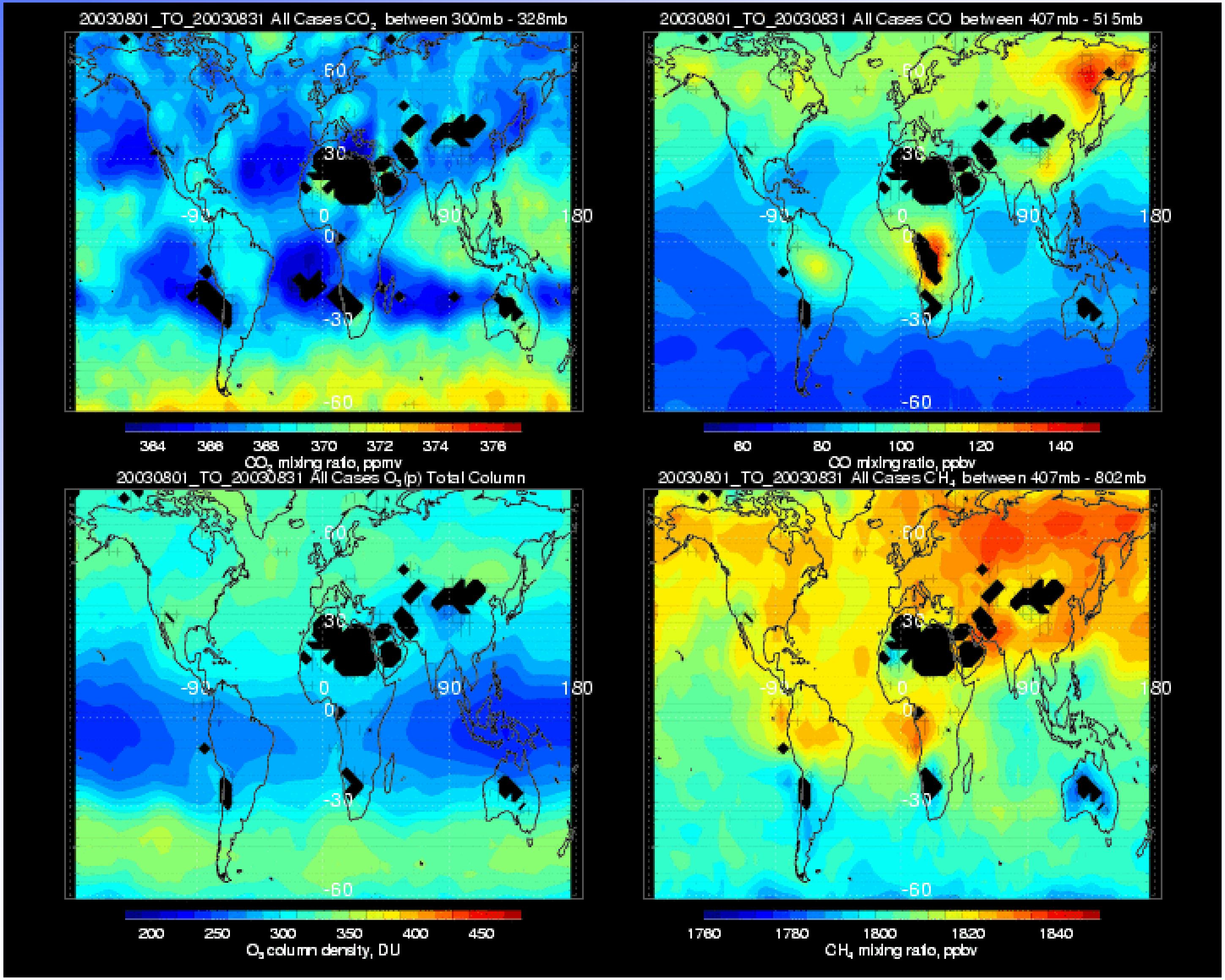
From Lihang Zhou

IR HYPERSPECTRAL EMISSIVITY - LAND
Sample Max/Min Mean computed from synthetic radiance sample



From Lihang Zhou

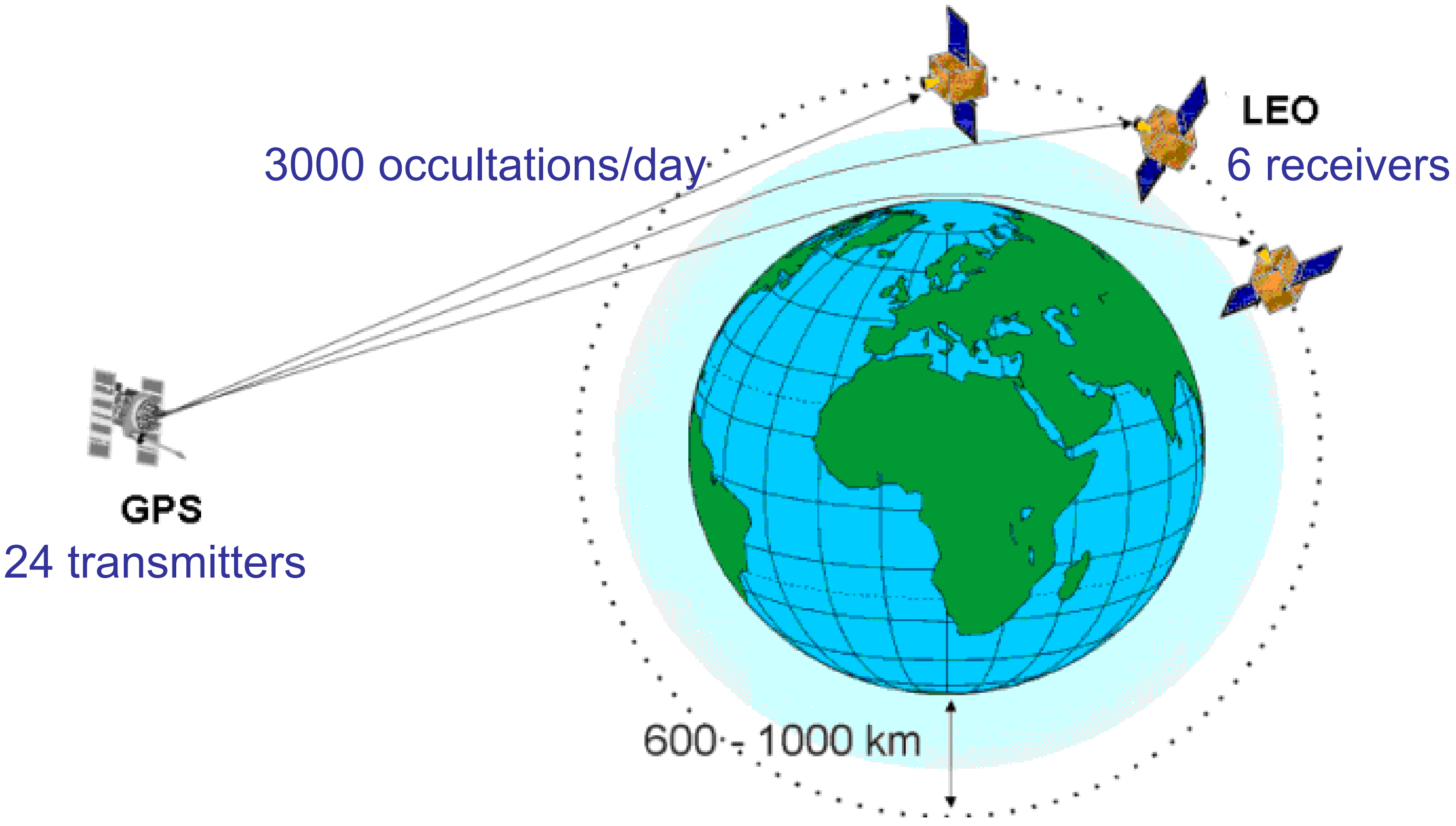
Preliminary Trace Gas Maps (Maddy & Barnet)



Assimilation of GPS RO observations at JCSDA

Lidia Cucurull, John Derber, Russ Treadon, Martin Bohman, Jim Yeo…

GPS/COSMIC



3000 occultations/day
LEO
6 receivers
GPS
24 transmitters
600 - 1000 km

COSMIC :

- The COnstellation of Satellites for Meteorology, Ionosphere, and Climate

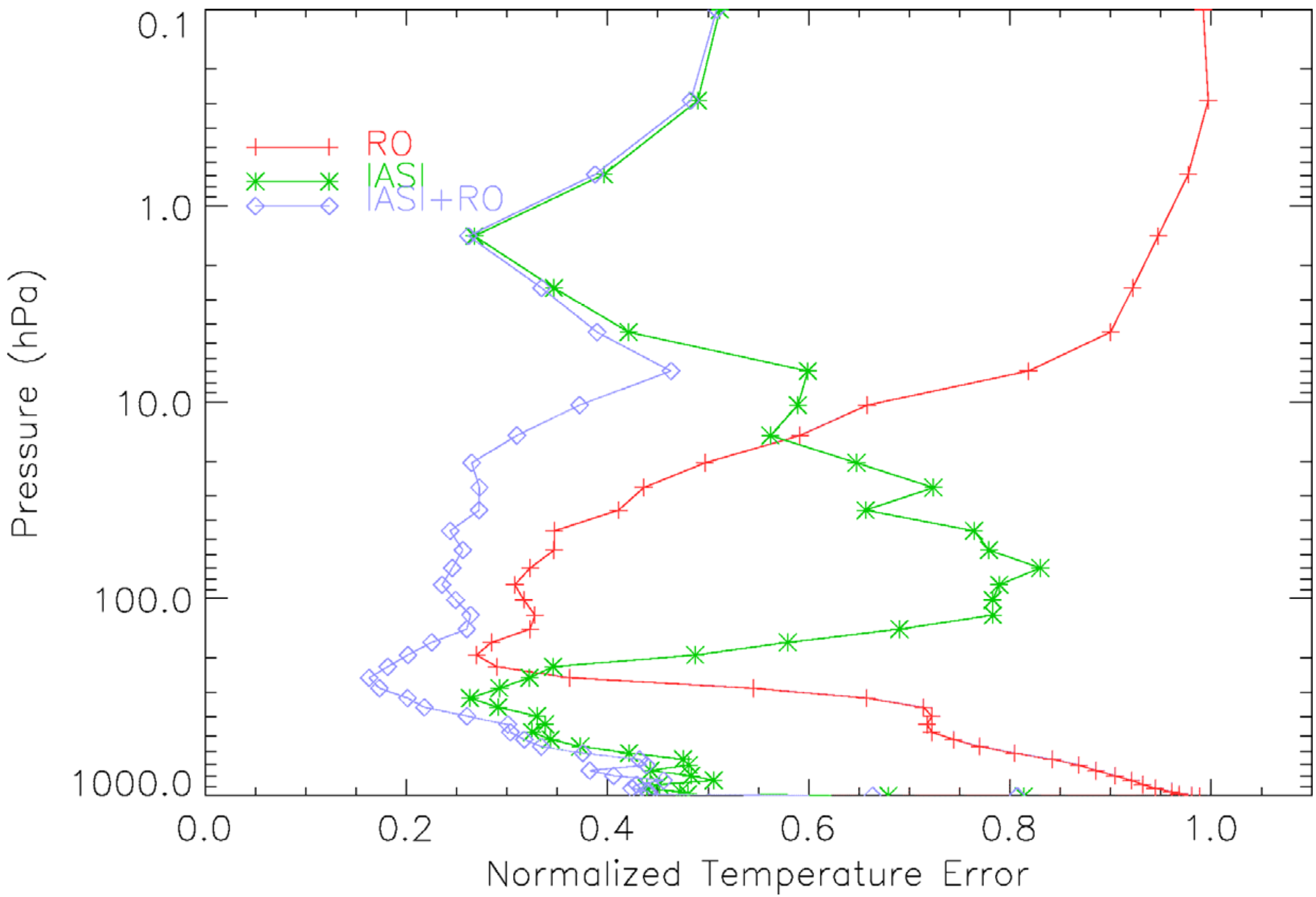
- A Multinational Program
  - Taiwan and the United States of America
- A Multi-agency Effort
  - NSPO (Taiwan), NSF, UCAR, NOAA, NASA, USAF
- Based on the GPS Radio Occultation Method

COSMIC :

Goals are to provide:

- Limb soundings with high vertical resolution
- All-weather operating capability
- Measurements of Doppler delay based on temperature and humidity variations, convertible to bending angle, refractivity, and higher order products (i.e., temperature/humidity)
- Suitable for direct assimilation in NWP models
- Self-calibrated soundings at low cost for climate benchmark

Information content from1D-Var studies
IASI (Infrared Atmospheric Sounding Interferometer)
RO (Radio Occultation)



(Collard+Healy, QJRMS,2003)

COSMIC (cont'd):

- Scheduled launch March 2006
- Lifetime 5 years
- Operations funded through March 08

Improved NCEP SST Analysis

Xu Li, John Derber
EMC/NCEP

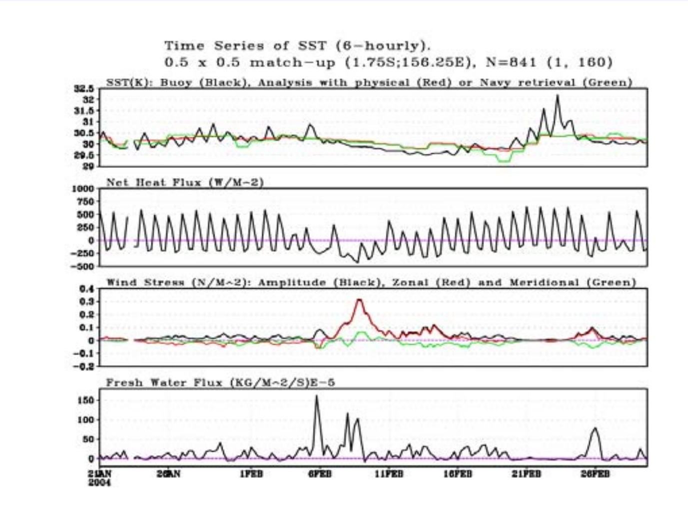
Project Objective:

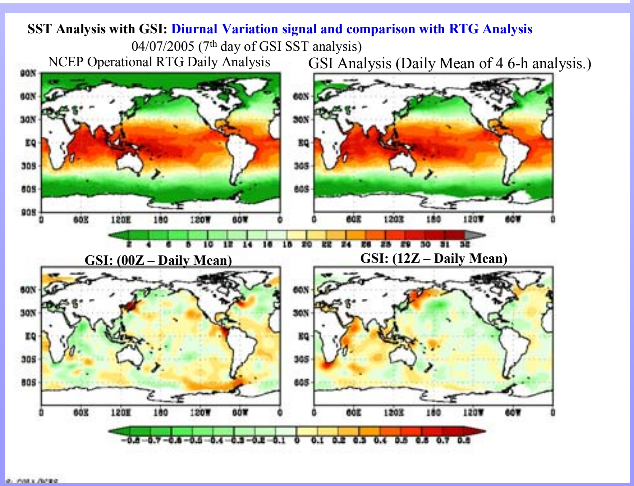
To Improve SST Analysis

- **Use satellite data more effectively**
- **Resolve diurnal variation**
- **Improve first guess**

Improved NCEP SST Analysis

Xu Li, John Derber
EMC/NCEP





Progress

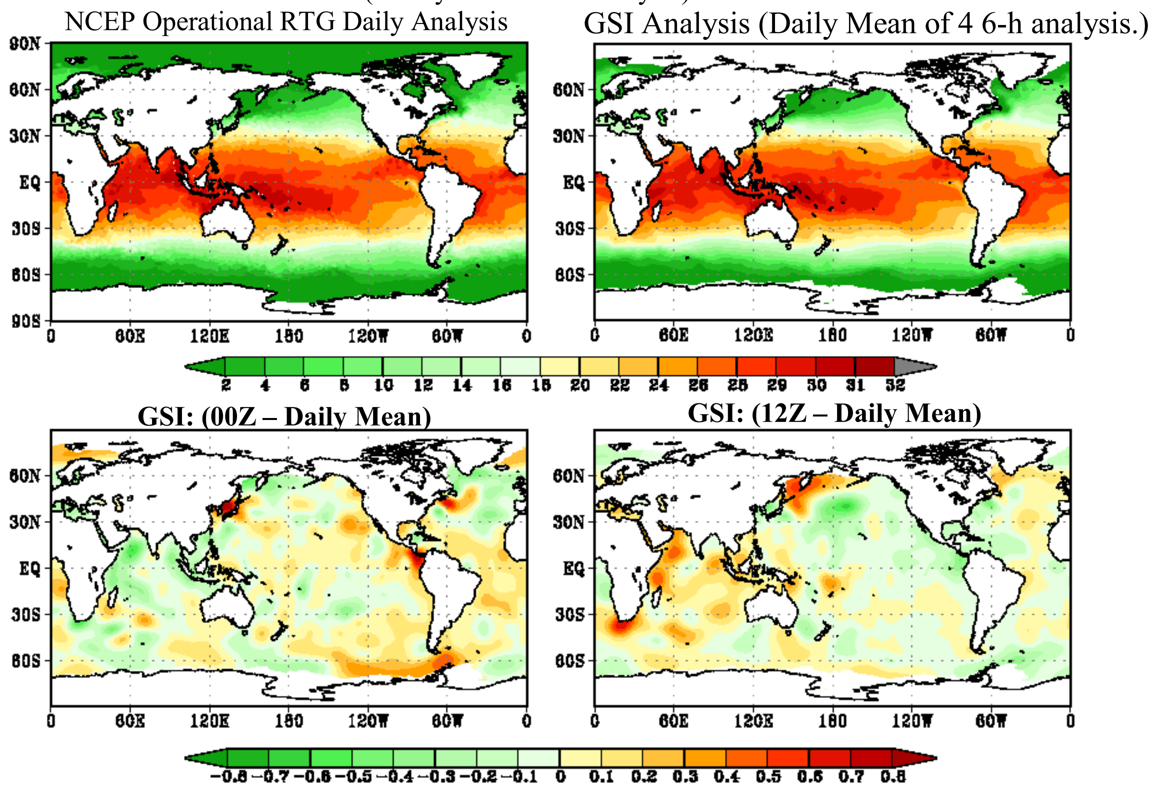
- SST physical retrieval code has been merged into GSI and provided to NCEP marine branch for test in operational mode
- An extensive diagnostic study on the diurnal variation signals in in situ and satellite observations, SST retrievals, SST analysis and associated air-sea fluxes (NCEP GFS product) shows the SST diurnal variation needs to be addressed to improve the SST analysis product.
- 7-day 6-hourly SST analysis has been produced with GSI, after a new analysis variable, in situ and AVHRR data were introduced into GSI.

Plan

- Analyze SST by assimilating satellite radiances directly with GSI
- Active ocean in the GFS
- Aerosol effects

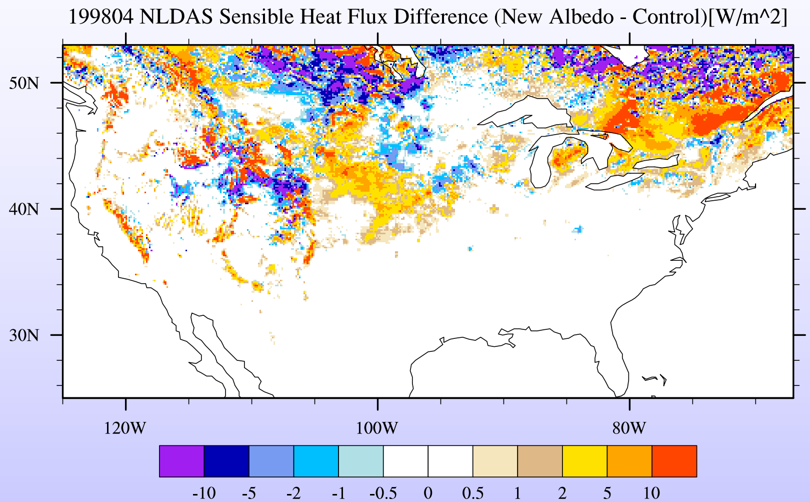
SST Analysis with GSI: Diurnal Variation signal and comparison with RTG Analysis

04/07/2005 (7th day of GSI SST analysis)



Integration of Satellite Observations with the Noah Land Model for Snow Data Assimilation

Xubin Zeng, Mike Barlage, Mike Brunke,
Jesse Miller, University of Arizona, Tucson



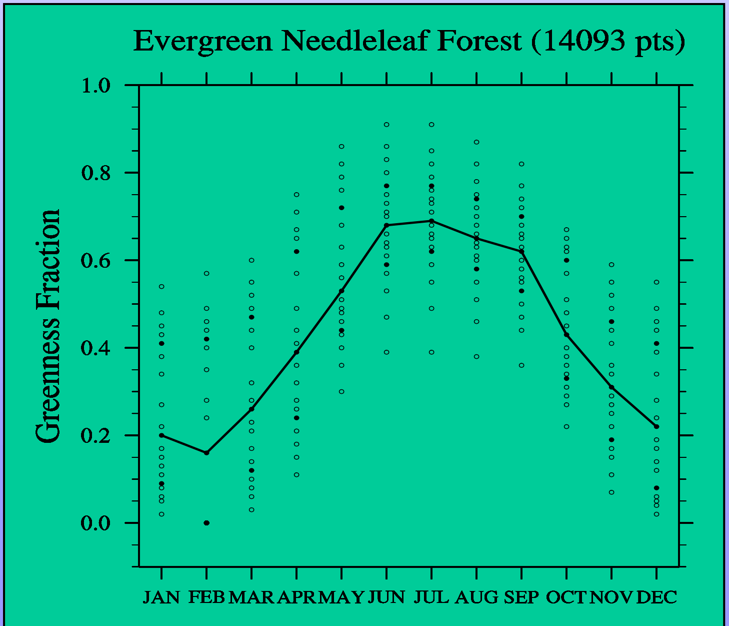
Summary of Accomplishments

(a) Generate and deliver a global 5km maximum snow albedo data set; deliver utility code; and finish the preliminary impact study.

(b) Intercompare bulk algorithms for the computation of sea ice surface turbulent fluxes as used in NCEP and other models; develop new formulations for sea ice roughness lengths.

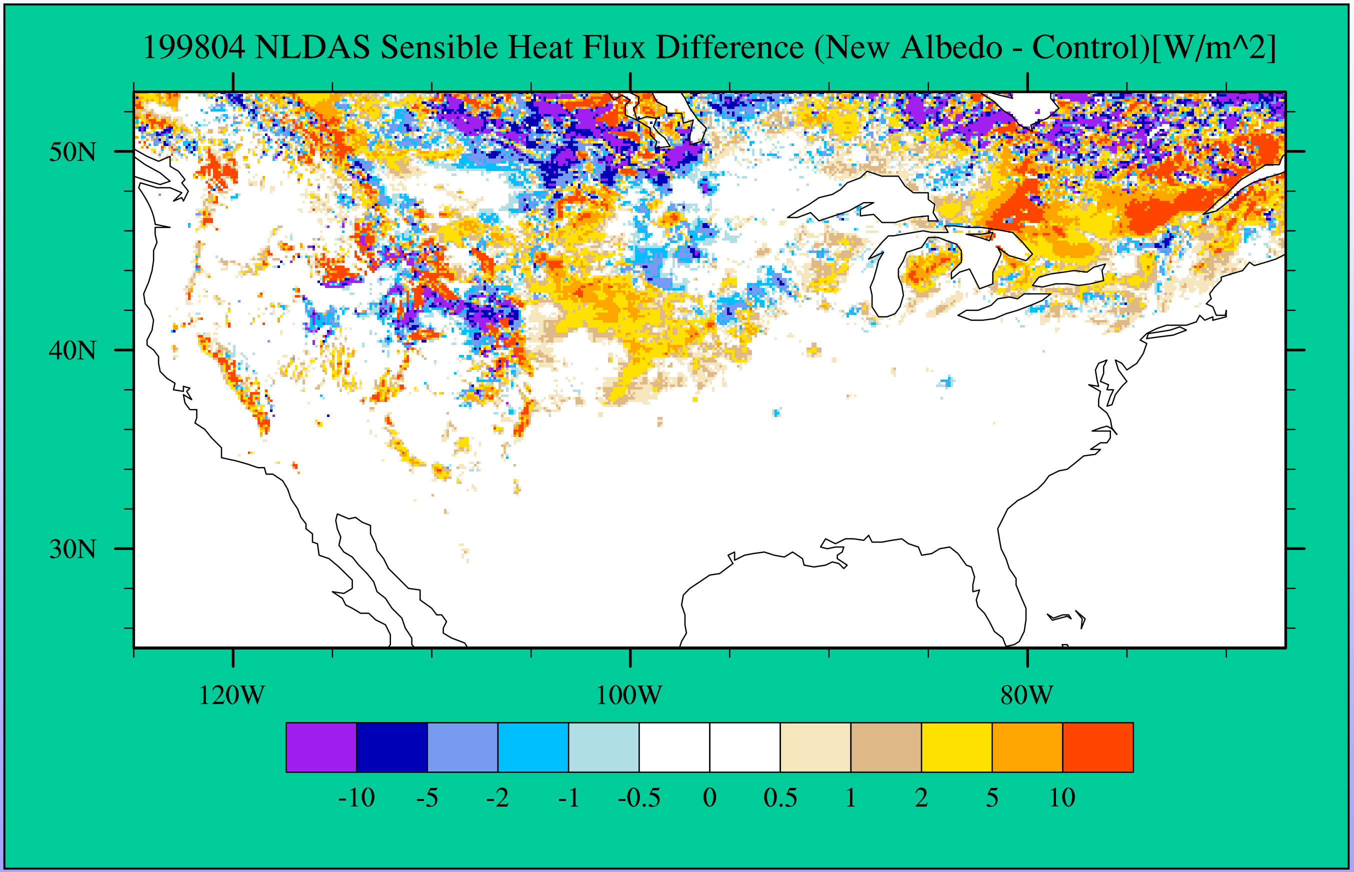
(c) Preliminary evaluation of wintertime vegetation data and its coupling with snow processes in the Noah land model.

(d) Use and help improve the Noah model testbed.



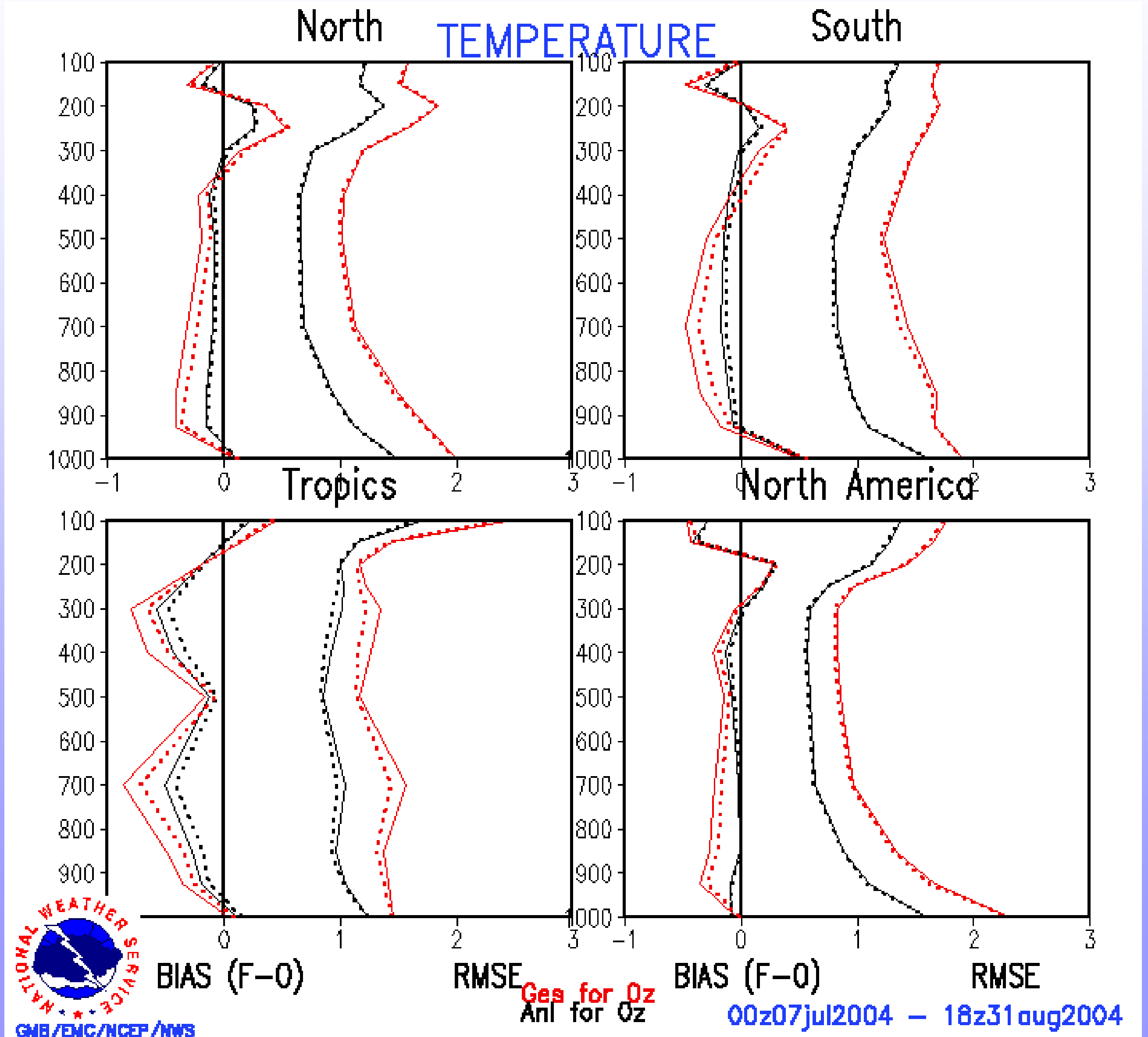
Additional impact study of snow albedo data; Study of wintertime vegetation data; and Improve snow processes in the Noah model

0.05° Dataset Inclusion in NLDAS



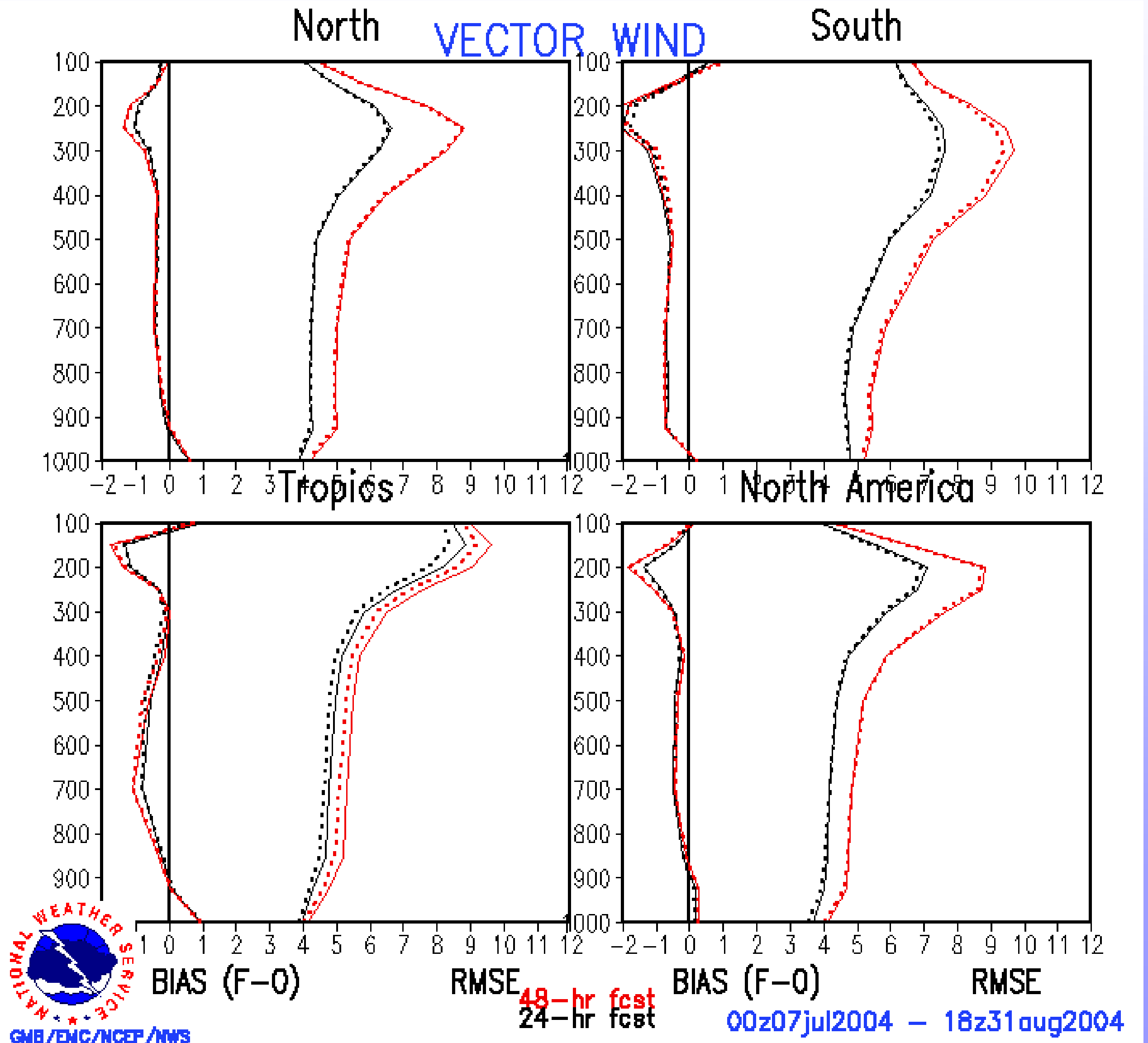
Impact of SSM/I radiances on the operational GFS forecast

RMSE/BIAS of Anal/Guess: T[K] against RAOB



*Impact of SSM/I radiances **on the operational GFS forecast***

RMSE/BIAS of F24/F48 : W [m/s] against RAOB



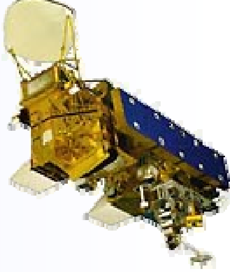
cntl FT48
test FT48
cntl FT24
test FT24

Summary:

Over the past three years the JCSDA has been developing a balanced program to support operational data assimilation in NASA, NOAA and the DoD.

Due deference to the science priority areas has facilitated this balance.

The current and future satellite programs have been examined to develop a strategy to prepare for efficient implementation of satellite data as it becomes available.



Summary:

A most important activity for the Center is planning in relation to the form of the next generation assimilation systems to be used by the partners.. Current strategic planning involves the use of the 4D variational approach.

Prologue

- JCSDA is well positioned to exploit the observational data base to be provided by the GEOSS in terms of:
- Assimilation science
- Modeling science.
- Computing power

The next generation of the environmental satellites promises to be every bit as exciting as the first, given the opportunities provided by new observations, modern data assimilation techniques, improving environmental modeling capacity and burgeoning computer power.

The Joint Center will play a key role in enabling the use of advanced satellite data, from both current and future advanced systems, for environmental modeling.

USA Inc. and the Global Community will be significant beneficiaries from the Centers activity.

JOINT CENTER FOR SATELLITE DATA ASSIMILATION

NOAA NASA JCSDA Navy Air Force

JOINT CENTER FOR SATELLITE DATA ASSIMILATION

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