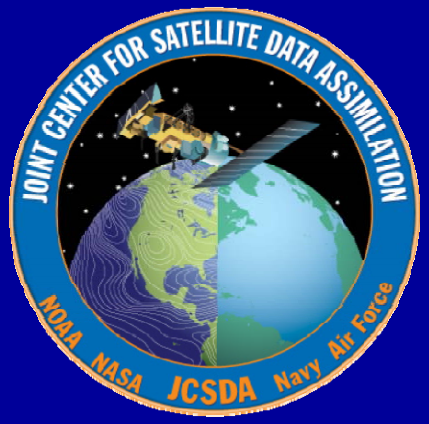


The Joint Center for Satellite Data Assimilation
Report from the Director

Lars Peter Riishojgaard, JCSDA

Overview

I. JCSDA: Past, Present, and Future
II. Focus on Short-Term NWP Goal
III. Strategic Plan, Program Plan, Annual Operating Plan
IV. FY08 Annual Report
V. Preliminary FY09 AOP Milestones
VI. Other aspects -JCSDA Performance Metrics; OSSEs; Training
VII. Summary, issues

I. JCSDA Past, Present and Future

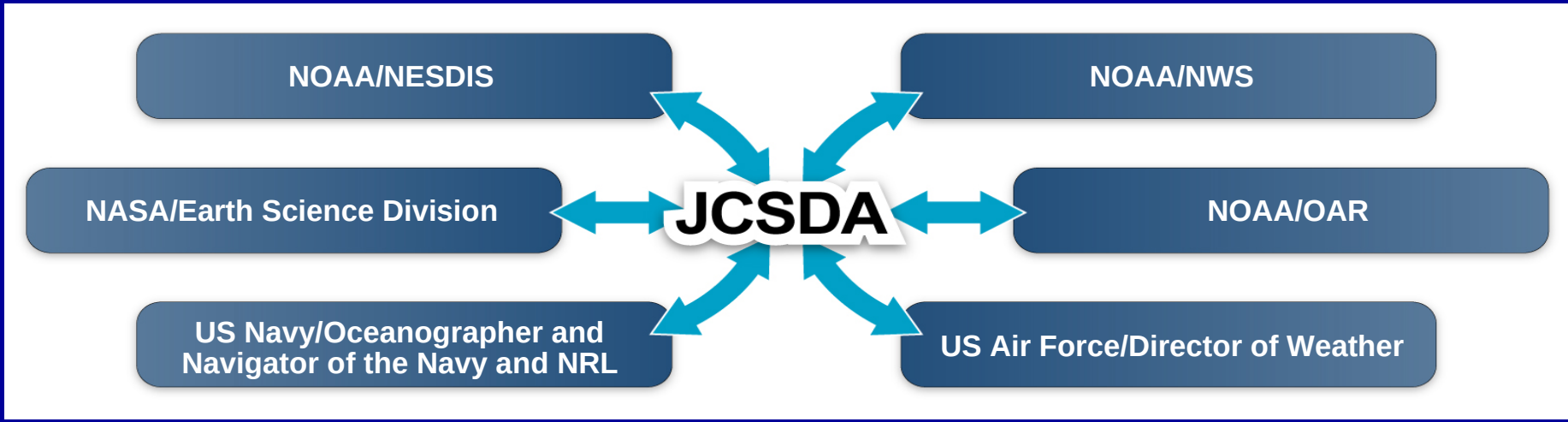
JCSDA History

- NASA/NOAA collaboration initiated by White Paper authored by Uccellini, Einaudi, Purdom, McDonald in 2000
  - Triggered by concern about US leadership in satellite data technology and instrumentation not replicated in environmental applications of data; NWP an example of this
  - Initial partners were GMAO (DAO), NCEP and STAR (ORA)
  - Emphasis on balanced approach involving
    - Modeling
    - Computing
    - Observational data

JCSDA History (II)

- Inclusion of NRL Monterey and AFWA triggered by IPO sponsorship of JCSDA starting in 2002
- First permanent Director hired in 2004 (John Le Marshall)
- Memorandum of Agreement signed May 2008
  - Developed in response to recommendation by Advisory Panel in June 2004

JCSDA Partners, Vision, Mission



Vision:

An interagency partnership working to become a world leader in applying satellite data and research to operational goals in environmental analysis and prediction

Mission:

…to accelerate and improve the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.

JCSDA Management Structure

Advisory Panel

Co-chairs: Jim Purdom, Tom Vonder Haar, CSU

Science Steering Committee

(Chair: Craig Bishop, NRL)

JCSDA Strategic Science Priorities

- Radiative Transfer Modeling (CRTM)
- Preparation for assimilation of data from new instruments
- Clouds and precipitation
- Assimilation of land surface observations
- Assimilation of ocean surface observations
- Atmospheric composition; chemistry and aerosol

Driving the activities of the Joint Center since 2001, approved by the Science Steering Committee

JCSDA Mode of operation

- Directed research
  - Carried out by the partners
  - Mixture of new and leveraged funding
  - JCSDA plays coordinating role
- External research
  - NOAA-administered FFO, open to the broader research community
  - ~$1.4 M/year available => revolving portfolio of ~15 three-year projects
    - NASA, IPO $500K/year
    - NOAA/NESDIS $400K/year
  - Funding outlook not encouraging; IPO redirecting its JCSDA funding

JCSDA Working Groups

- Virtual teams consisting of working level scientists from all JCSDA partners
  - coordination of effort and direct collaboration between partners on specific topics
- CRTM – team working since early 2008
- Hyperspectral IR sounding – new team; first meeting 01/30/2009
- Microwave sounding/imaging – new team; first meeting 02/05/2009
- Ocean data assimilation – currently being established
-

Significant Accomplishments

- Common assimilation infrastructure (NCEP/EMC, NASA/GMAO)
- Community radiative transfer model (all partners)
- Common NOAA/NASA land data assimilation system (EMC, GSFC, AFWA)
- Snow/sea ice emissivity model – 300% increase in number of satellite soundings used in high latitudes
- SSMI/S pre-processor
- MODIS polar winds implemented
- AIRS radiances implemented
- COSMIC implemented
- Improved physically based SST analysis
- Advanced satellite data systems such as DMSP (SSMIS), CHAMP GPS, WindSat, IASI, ASCAT tested for implementation
- Data denial experiments and sensitivity studies for major components of GOS
- Cross-partner Working Groups for CRTM, Hyperspectral IR Sounding and MW sounding created
- Memorandum of Agreement signed May 2008
- MOB Terms of Reference signed August 2008

II. NWP Goal

JCSDA short-term goal *(adopted by MOB 03/2008):*

- *"Contribute to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way"*

Why renewed NWP focus?

- Economic impact
- Impact on military operations
- US falling behind internationally in terms of NWP skill
- Better use of satellite data is one of the few remaining “growth areas” in NWP
  - Indirect evidence that this is at least part of the reason for skill gap

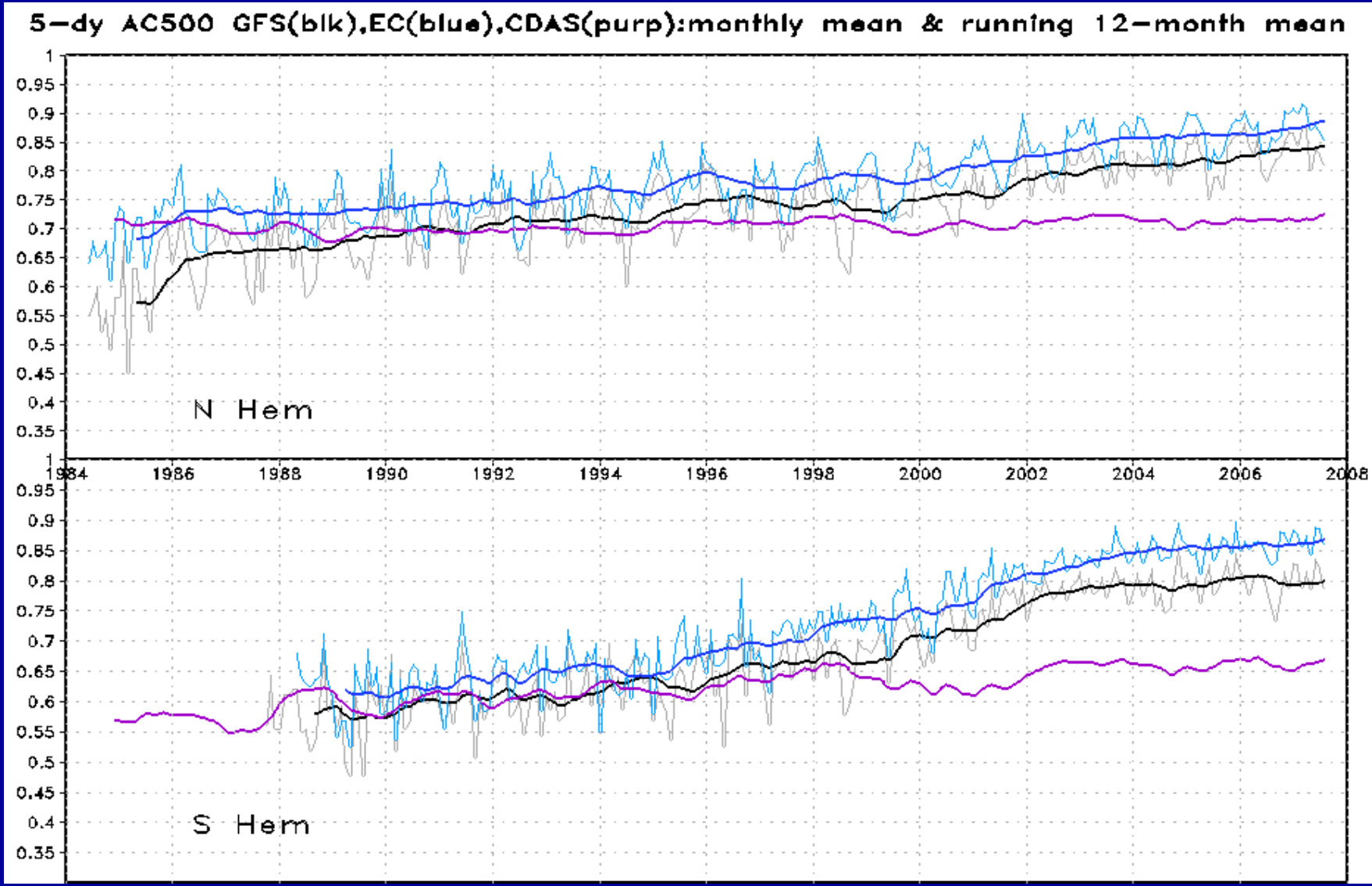
Value of weather forecasting

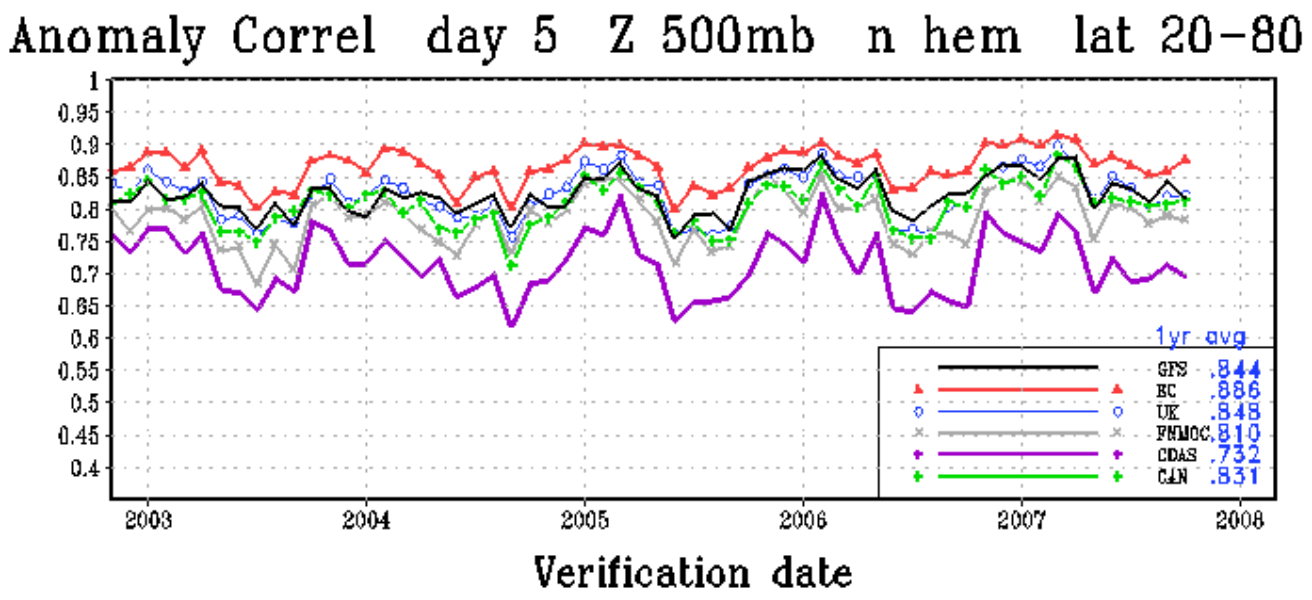
- Department of Commerce: “20% of overall US economy is weather sensitive”: *~$2.8 trillion/year*
- Assume that half of this is “forecast sensitive”: *$1.4 trillion/year*

Value of weather forecasting (II)

- Assume that the potential savings due to weather forecasting amount to 5% of the "forecast sensitive total": *~$70B/year*
- Assume that the savings are distributed linearly over the achieved forecast range for the global NWP system:
  - 0 h useful forecast range => $0 in savings
  - 336 h useful forecast range => $70B in savings
- This implies that the value to the United States economy of NWP is *~200M per hour of forecast range per year* !

NOAA/NCEP vs. ECMWF skill over 20+ years




Anomaly Correl day 5 Z 500mb n hem lat 20-80
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0.7
0.65
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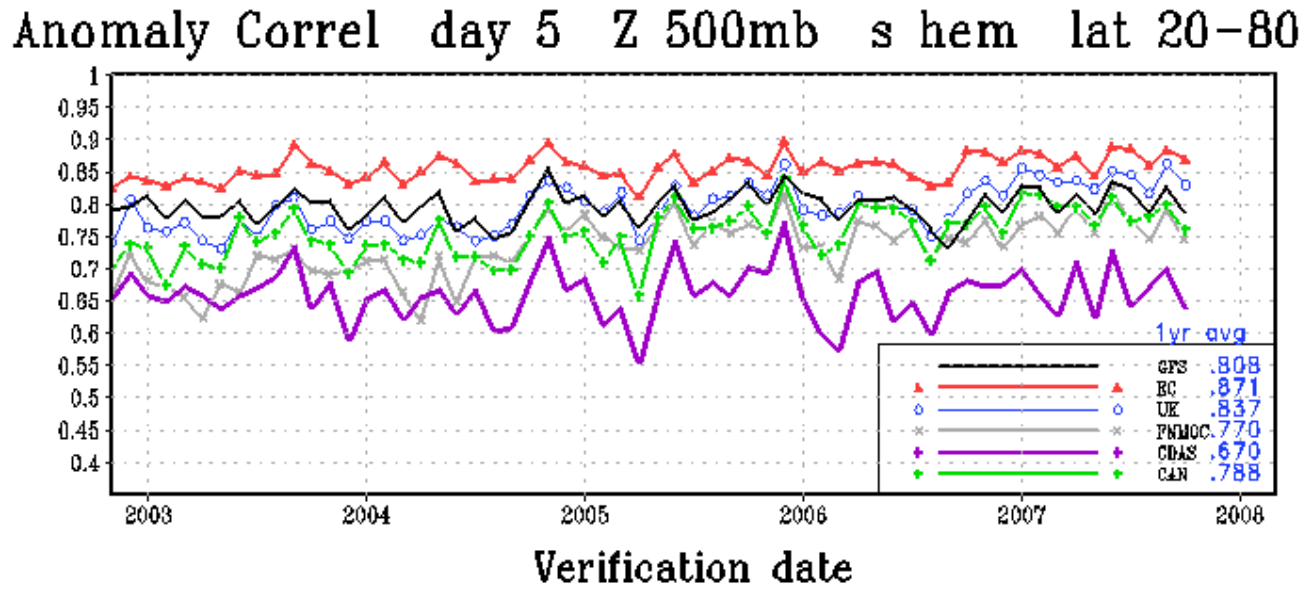
0.55
0.5
0.45
0.4
2003
2004
2005
2006
2007
2008
Verification date
1yr avg
GFS .844
EC .886
UK .848
FNMOC .810
CDAS .732
CAN .831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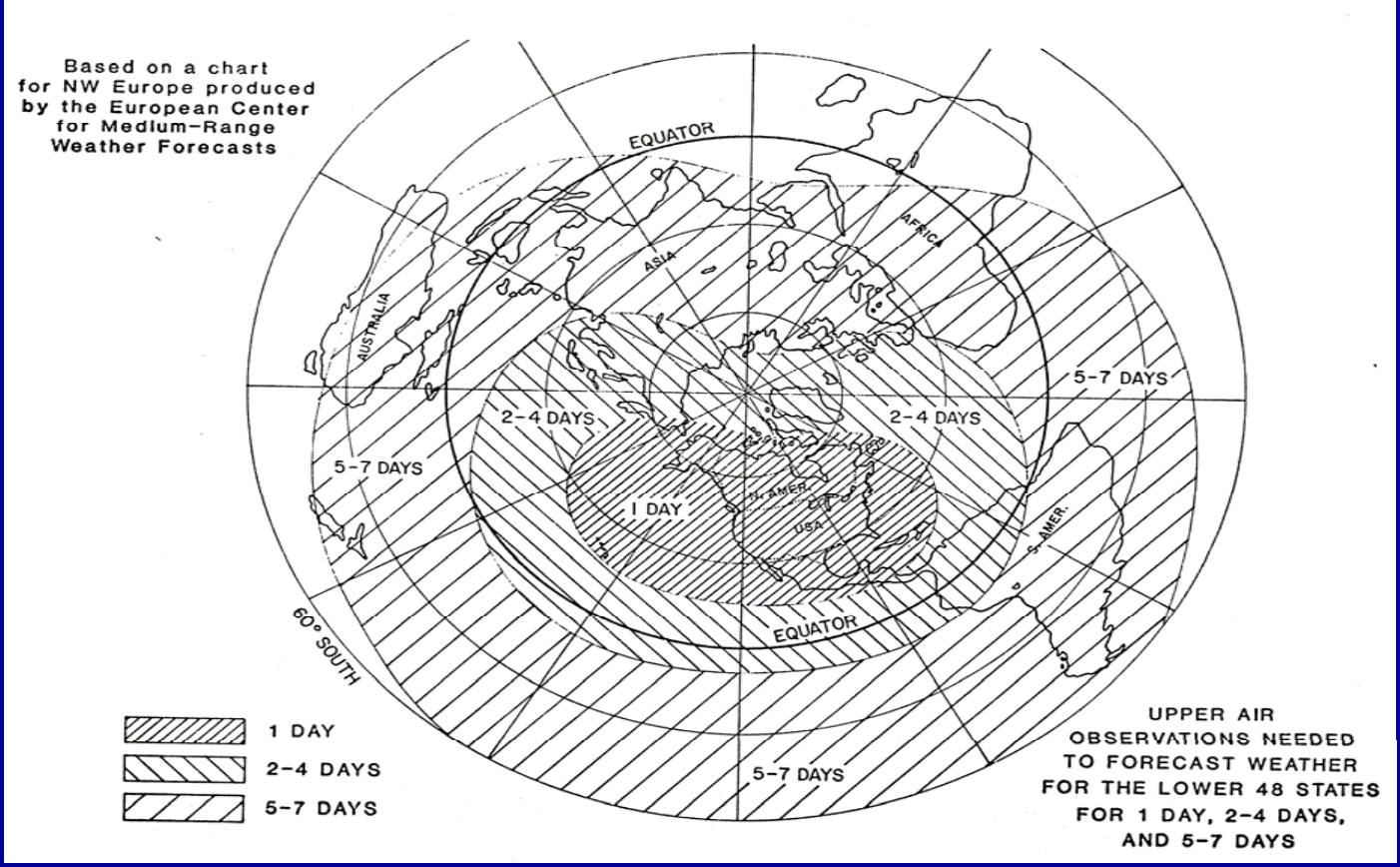
Verification date
1yr avg
GFS .808
EC .871
UK .837
FNMOC .770
CDAS .670
CAN .788

NWP requirements for upper-air data coverage



Why is the US falling behind?

- Use of satellite data; transition to operations for new sensors too slow
  - JCSDA can help, *currently insufficiently resourced to do this across all areas within its mission statement*
- Data assimilation methodology; no unified US move toward next-generation (4D-VAR) data assimilation capability
  - JCSDA has no direct control over this, but can facilitate and coordinate collaboration on satellite data among its partners
- Computing resources; lack of code and platform compatibility across JCSDA partners

Activities needed in support of goal

1. Data impact assessment
2. CRTM maintenance and development
3. Monitoring and improvement of satellite data utilization
4. Preparation for new sensors. Issues related to data flow, data formatting, CRTM

JCSDA Metrics (under implementation)

I. Forecast skill measures:

- A composite JCSDA skill index calculated from key forecast parameters for each system operated by the JCSDA partners.
- 500 hPa anomaly correlation coefficients at day 5, both hemispheres.

II. Satellite data utilization measures:

- Total number of satellite observations assimilated on average per 24-hour period in a fixed set of partner data assimilation systems.
- Total number of individual satellite sensors contributing to forecast skill.

III. Strategic Plan, Program Plan, Annual Operating Plan

JCSDA Strategic Plan

- Broad vision for the role the Joint Center
- Goals and priorities
  - NWP
  - “Original six”
  - OSSEs
- Opportunities and challenges
  - Data assimilation system development
  - Computing
- Implementation
- FY 2008 Budget

Program Plan

- Implementation plan, budget and planning tool
- Current draft prepared to guide the NOAA budget submission for FY11 - FY15
- Upcoming satellite missions/instruments are prioritized and the major steps to prepare for the earliest use of their data identified
- Links to other activities are also provided, including the NCEP model development plans; the model development plans (operational and research) for the other JCSDA Partners (GMAO, NRL, and AFWA) have been requested and placeholders inserted in the document
- The documented will be updated in March 2009 in preparation for the FY12 - FY16 budget cycle

Annual Operating Plan

- Lists milestones for all partners by fiscal quarter
- Updated on a quarterly basis by JCSDA Executive
- Final version of FY 2008 AOP embedded in FY 2008 Annual Report

IV. FY 2008 Annual Report

- JCSDA Annual Report prepared per request from the JCSDA Science Steering Committee and Management Oversight Board
  - JCSDA Overview
  - Narrative of FY 2008 accomplishments and events
  - Final FY 2008 Annual Operating Plan

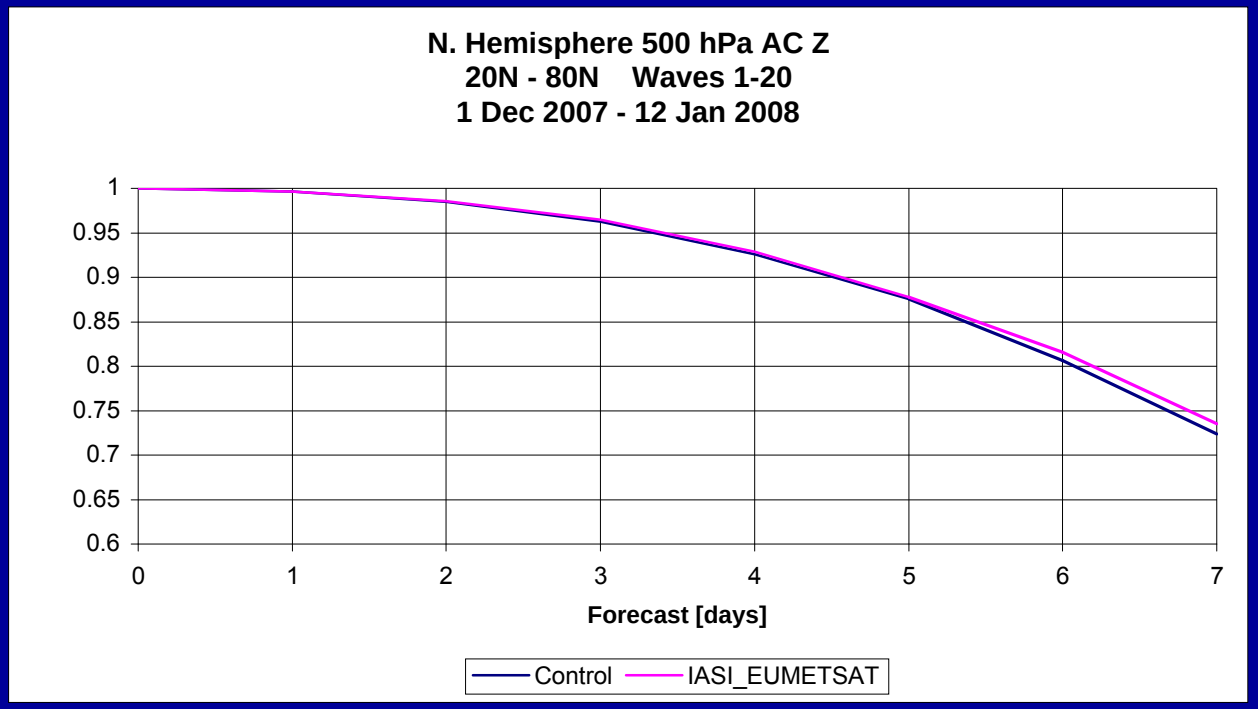
Satellite Data used in JCSDA partner systems as of 01/2009

- 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
- COSMIC radio occultation soundings
- OMI ozone retrievals
- 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
- MODIS Winds
- MLS temperature retrievals
- MLS ozone retrievals

~35 instruments

IASI impact assessment NCEP GFS

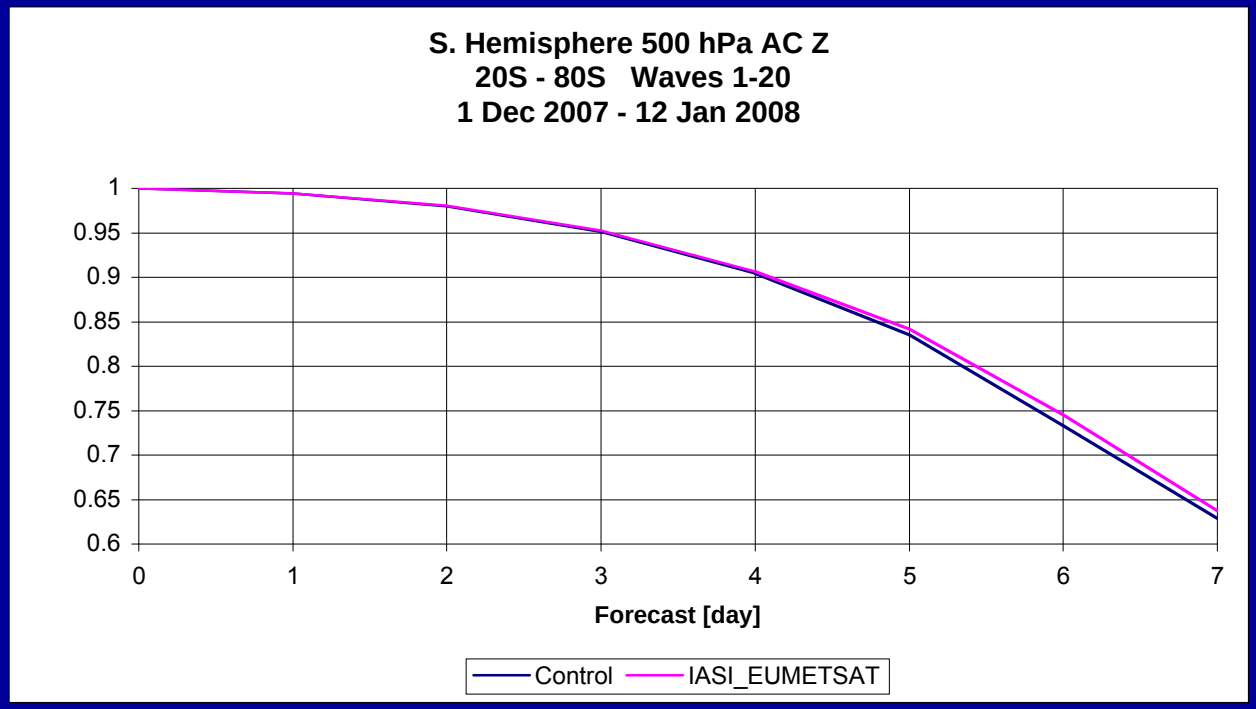
NH Dec 2007



Jung, van Delst, Han, Derber, Treadon, Kleist, …

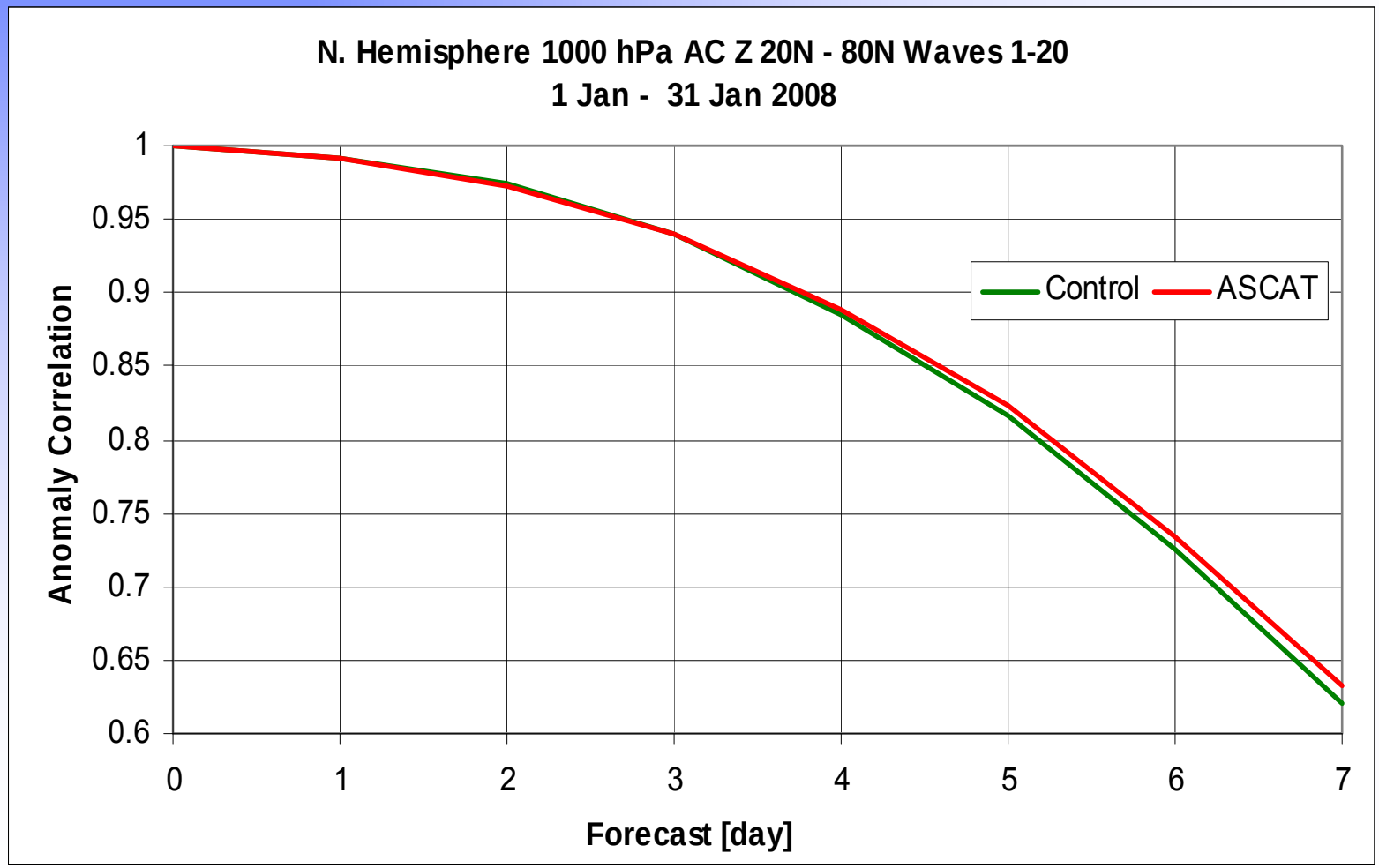
IASI impact assessment NCEP GFS

SH Dec 2007

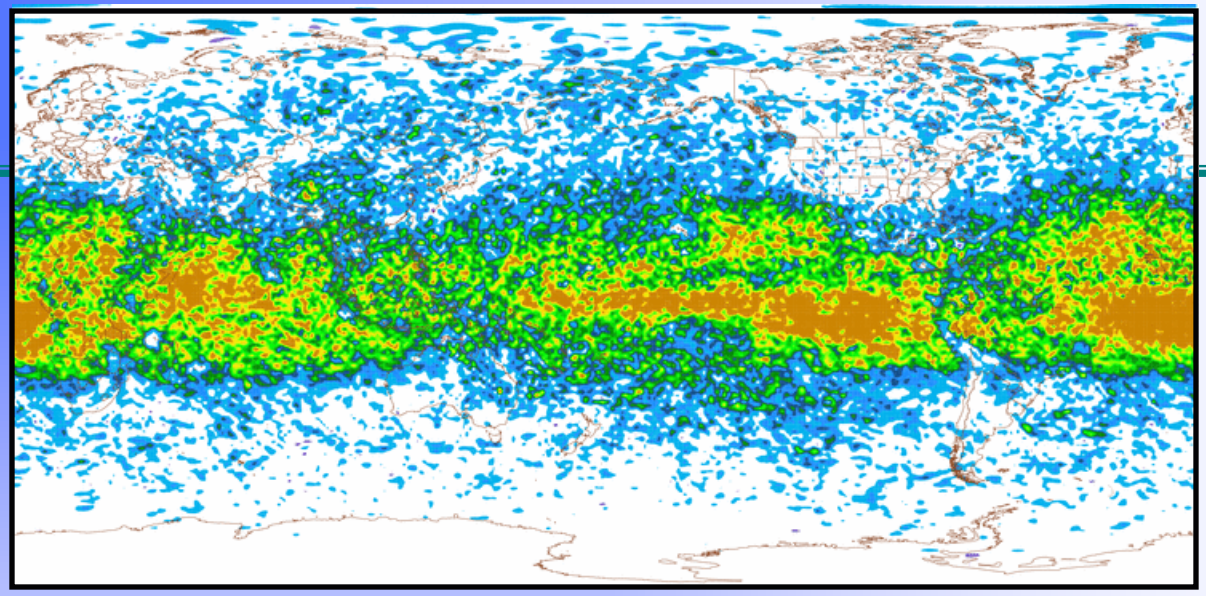


Jung, van Delst, Han, Derber, Treadon, Kleist, …

ASCAT Impact Experiments with GFS (II)

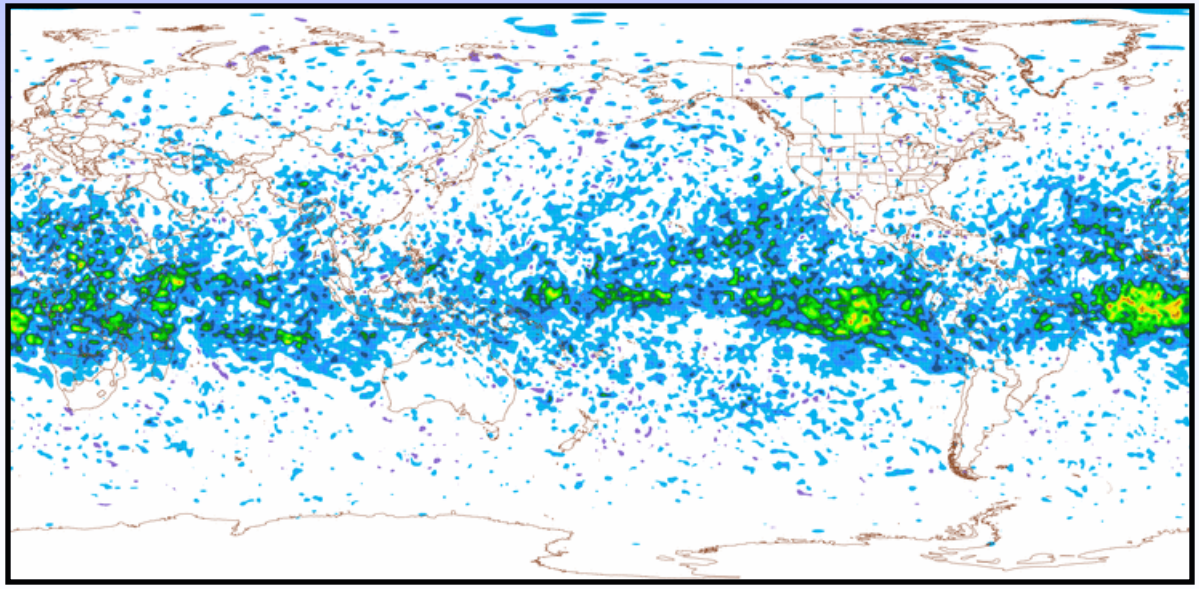


(a) 500hPa WIND SPEED FCST IMPACT [%] 6HR ASCAT 1-31 Aug 2007

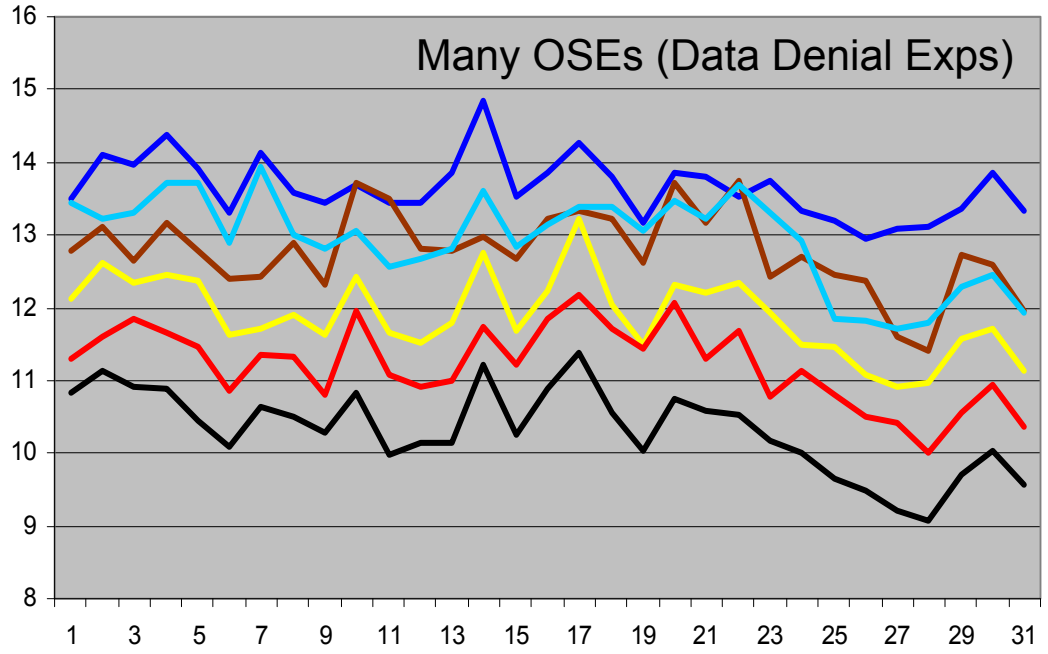


Bi, Jung, …

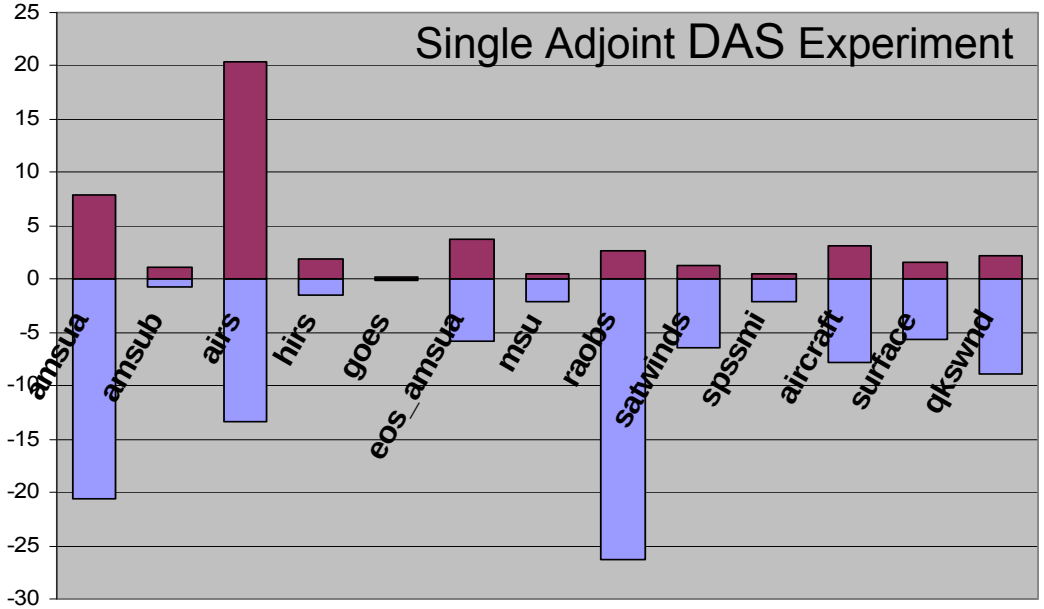
(b) 500hPa WIND SPEED FCST IMPACT [%] 24HR ASCAT 1-31 Aug 2007



Efficient Estimation of Observation Impact



NASA GEOS-5
July 2005 00z



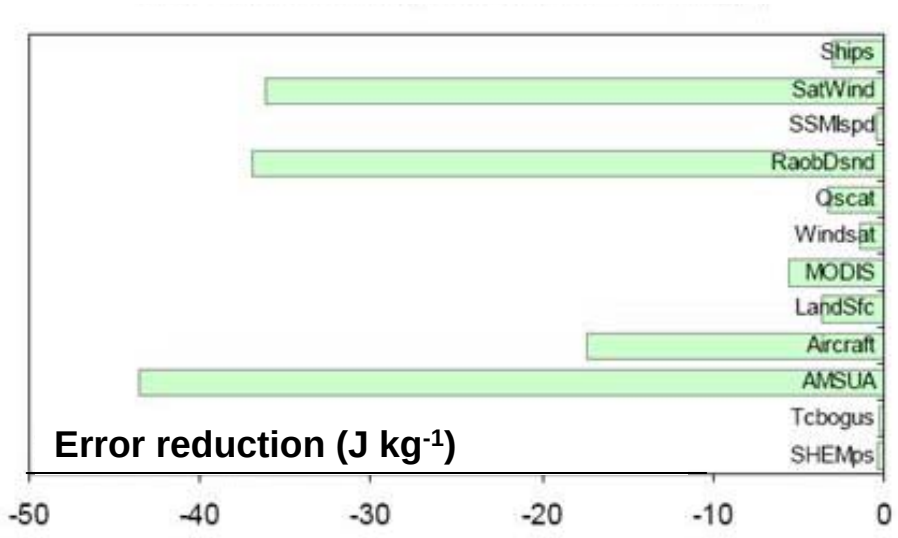
Gelaro, Zhu, …

Advanced Targeting and Observation Selection

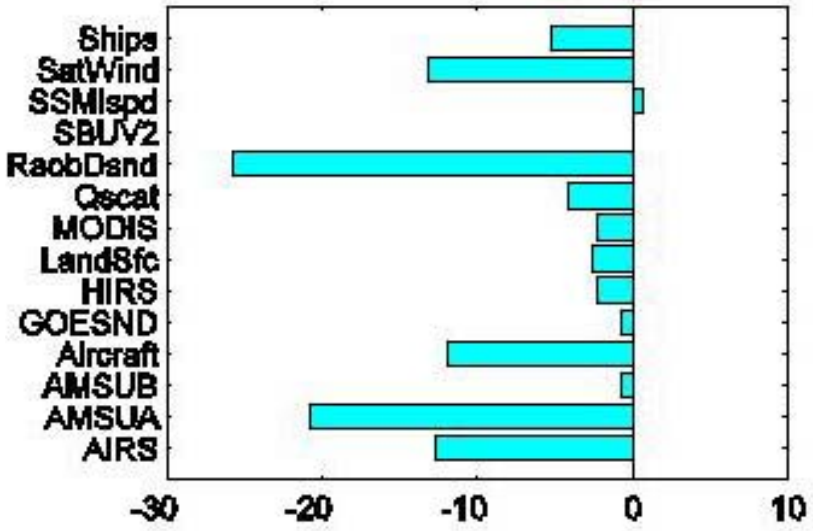
Comparison of Observation Impact on 24h Forecast Error

01-30 January 2008 – using 00UTC observations

NAVDAS / NOGAPS



GEOS5 (NASA model)

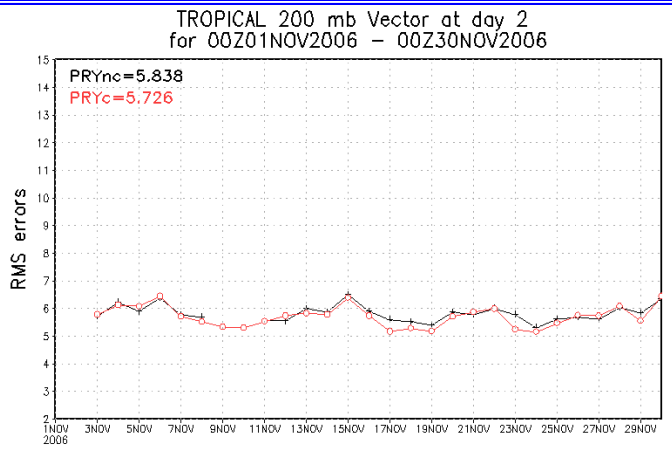


Results show largest reductions of forecast error in both forecast systems are from: 1) **satellite winds**, 2) **radiosonde profiles**, 3) **aircraft observations**, and 4) **AMSU-A / AIRS**

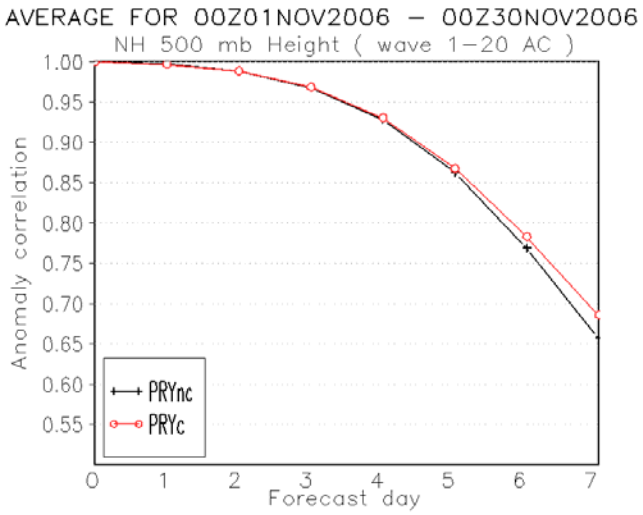
COSMIC pre-operational implementation run *(Cucurull)*

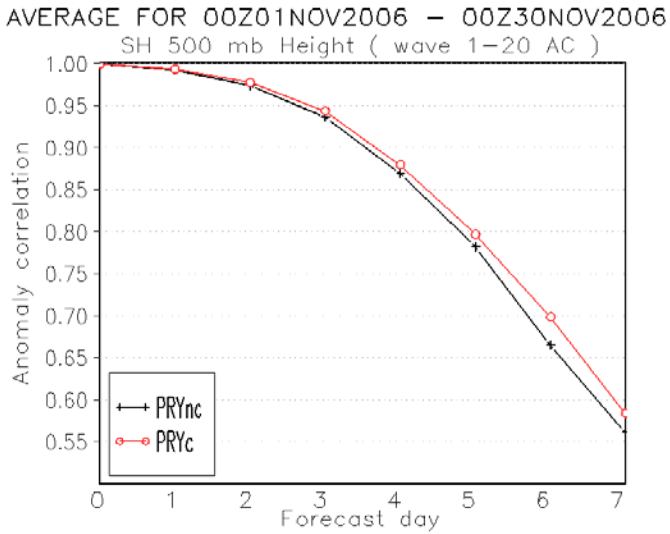
- PRYnc (assimilation of operational obs),
- PRYc (PRYnc + COSMIC refractivity)
- We assimilated around 1,000 COSMIC profiles per day

rms error (wind)



Anomaly correlation as a function of forecast day (geopotential height)

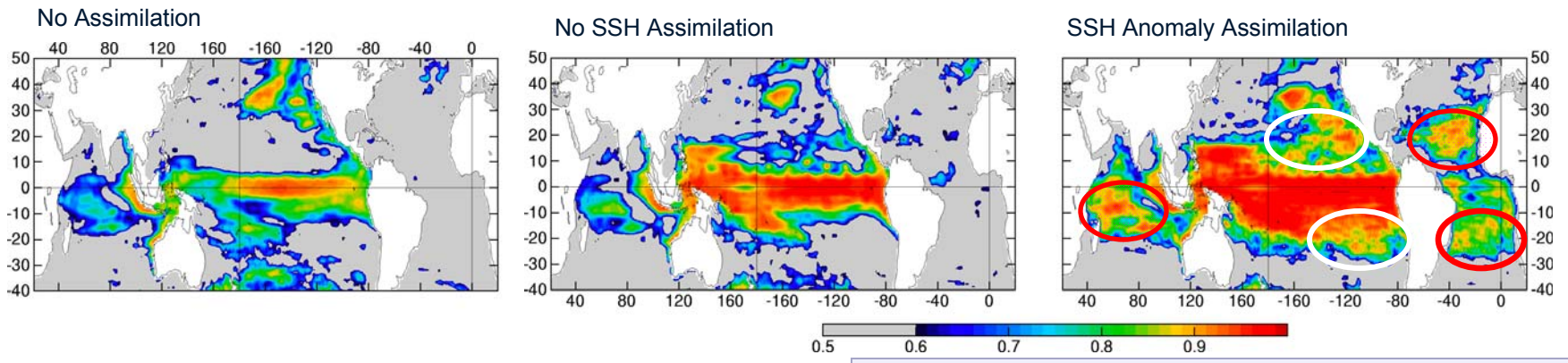




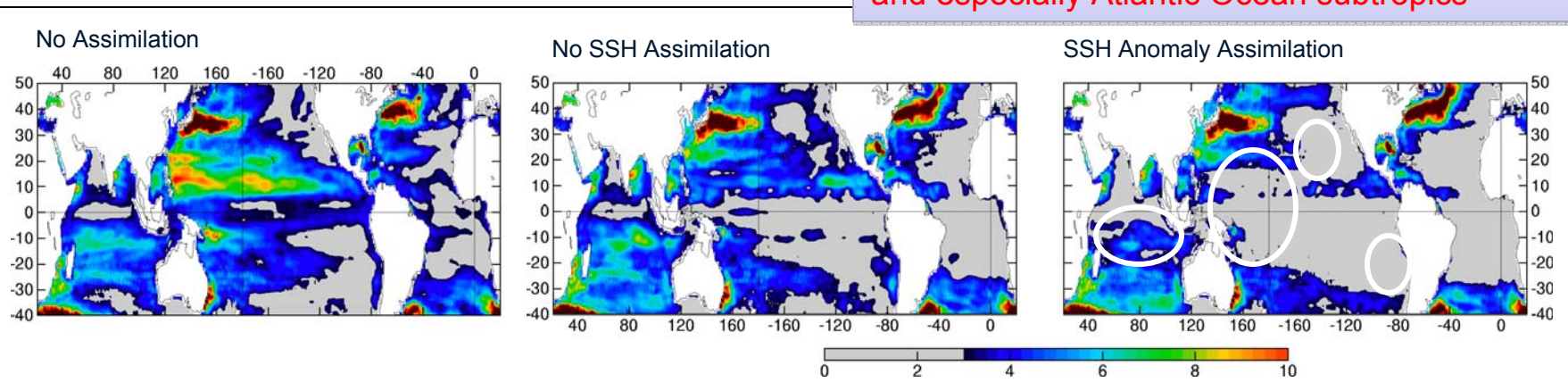
Impact of Topex/Jason altimetry in global ocean SSH analyses, 1993-2007

Example from GODAS

Anomaly Correlation with Observed SSH



Broader areas of agreement in the Pacific outside the equatorial waveguide; the Eq. Indian Ocean and especially Atlantic Ocean subtropics



V. FY 2009 AOP

List of FY 2009 milestones by quarter, priority area (1-4) and metric (I,II)

1. Data impact assessment
2. CRTM maintenance and development
3. Monitoring and improvement of satellite data utilization
4. Preparation for new sensors. Issues related to data flow, data formatting, CRTM

I. Forecast skill measures
II. Satellite data utilization measures

High priorities for FY 2009

- Continued CRTM development
- IASI, ASCAT
- NPP readiness (CrIS, ATMS, OMPS)
  - CRTM
  - Dataflow
  - Cal/Val contribution
- ADM readiness

- JCSDA Working Groups expected to play important role in all these activities

VI. Other aspects – Data Assimilation Development, OSSEs, Training,…

GMAO/EMC/AFWA interaction

- Strong existing GSI collaboration between EMC and GMAO
  - AFWA interested in joining GSI team; code management issues still to be resolved
- Separate, but coordinated 4D-VAR plans within EMC and GMAO
  - AFWA interested in joint 4D-VAR development
  - Plans for long-term strategy involving FOTO and classical 4D-VAR with multiple model cores still to be developed
- AFWA sponsorship of three additional scientists to be located in the WWB to foster collaboration on these and other issues

Observing System Simulation Experiments (OSSEs)

- Tool for assessing impact of candidate observing systems before making decision to develop and fly them
  - Operational data assimilation systems and skill metrics applied to simulated atmosphere and observations
  - Quantitative and “objective” results
  - Resource-intensive if credible results are to be obtained
- Both NASA and NOAA/NESDIS expressing need for this capability
- OSSE initiative for NOAA proposed for the FY11-15 budget cycle

OSSEs (II)

- JCSDA has for almost two years coordinated informal “Joint OSSE” collaboration involving more than 30 researchers inside and outside the US
- Joint OSSE presentation favorably received at recent WMO GOS impact Workshop
  - Requests for studies, e.g. GPSRO, Wind Lidar, GEO-IR, Scatterometers,…
- JCSDA tasked by MoA Signatories drafting Terms of Reference for an OSSE Steering Group with management representatives from NWS, NESDIS, OAR, GSFC and JCSDA to
  - Oversee Joint OSSE effort
  - Develop comprehensive OSSE Plan for agency review
- NOAA USWRP Executive Committee has launched an OSSE Testbed initiative

Past training activities

- JSCDA International Workshop on the Assimilation of Satellite-Observed Cloud and Precipitation Observations 05/02-05/04, 2005, Landsdowne, VA

- JCSDA Workshop on Applications of Remotely Sensed Observations in Data Assimilation; 07/23-08/10 2007 at UMD; 15+15 participants, mostly Ph.D. students and early-career researchers

JCSDA Summer Colloquium on Data Assimilation

- Scheduled for 07/7-07/17 2009 in Stevenson, WA
- International group of 19 lecturers and 50+ student applications – expecting 30-40 participants
- Sponsored by NASA, NOAA and NRL/Monterey

VII. Summary, issues

Summary

- Improved NWP skill elevated to being explicit rather than implicit goal
  - Accelerated and improved use of satellite data
  - Learn from past successes (e.g. COSMIC) and failures (e.g. MetOp)
- Steps taken to improve collaboration and facilitate transfer of research and technology between partners

Issues

- JCSDA goals versus resources
  - Pressure to strengthen “new” areas such as oceans, AQ versus increased focus on NWP?
- Balanced approach; Models, computing, observational data
  - Computing
    - Computer resources for JCSDA pre-operational testing and ongoing impact assessment are scarce by international standards
    - Diversity of assimilation systems and computing platforms across JCSDA partners create difficulties
  - Interactions with external research community
    - FFO is the primary vehicle; funding is sub-critical