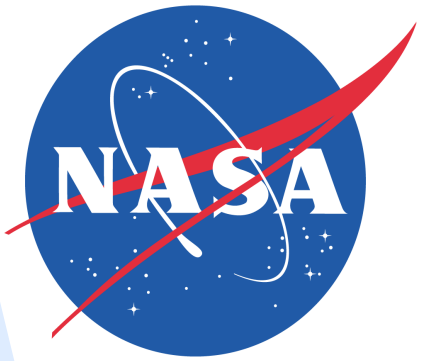


Observation Impact of Satellite Winds in NASA GEOS-5 Forecast System

Dagmar Merkova[1,2] and Ron Gelaro[1]

[1] *GMAO NASA Greenbelt, MD*

[2] *Science System And Applications, Inc.*

with special thanks to

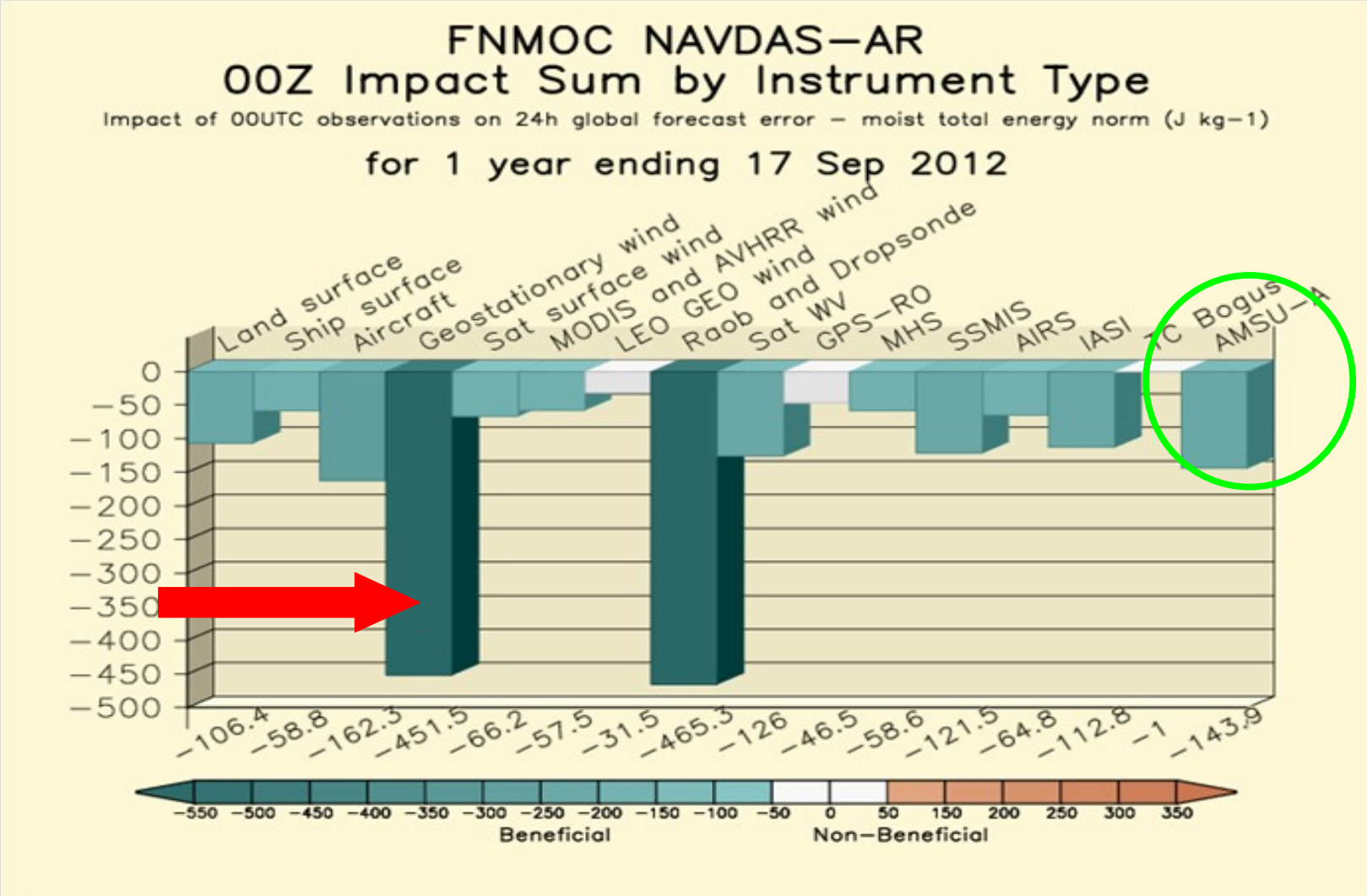
Will McCarty[1], Meta Szienkiewicz[1,2] , King-Sheng Tai[1,2] ,

and

Pat Pauley, Nancy Baker

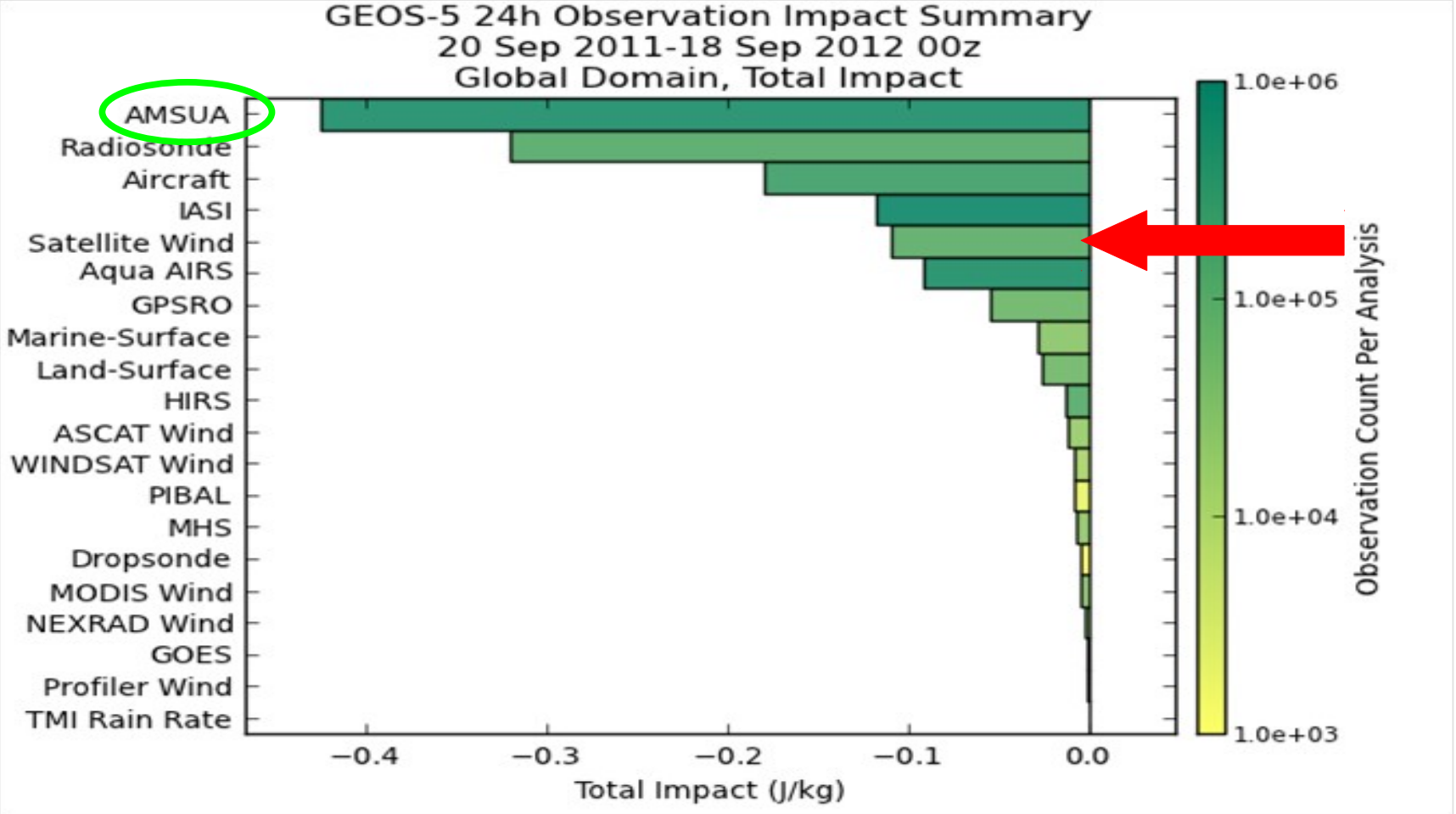
Naval Research Laboratory, USA

Motivation



Source: http://www.nrlmry.navy.mil/obsens/fnmoc/

GMAO Observation Impact



Source: https://gmao.gsfc.nasa.gov/forecasts/systems/fp/obs_impact

Motivation - cont.

Relative observation impact from geostationary winds in NRL NOGAPS data assimilation system is for some period much larger compare to the other forecast centers.

Possible reasons are:

- Greater number of assimilated satellite winds
- Difference in data source and quality control
- Use of super-ob wind vectors
- Data assimilation methods

Observations

	SatWind	*AMSU-A*	*Hyps IR*	*All Obs*
GMAO	90	520	1220	2500
FNMOC	350	350	800	2200

** counts from operational runs May 2011*

Notable differences in observing system

- GMAO assimilates higher number of radiances (1.5x)
- NRL assimilate more satellite geostationary satellite Winds (4x)

Different sources for Satellite winds

- GMAO: NESDIS, EUMETSAT, JMA
- NRL: NESDIS, EUMESAT, JMA, AFWA, CIMSS

Experiment Configuration

GEOS-5 Forecast System (reduced resolution)

- GEOS-5 AGCM + GSI analysis (~½° L72)
- 6-h assimilation cycle, 3DVar
- 5-day forecasts, adjoint-based 24h obs

impacts at 00z (dry energy norm, sfc-150 hPa)

A simple experiment: *Assimilate NRL/FNMOC preprocessed satellite winds in the GMAO forecast system*

GEOS-5 Forecast System (reduced resolution)

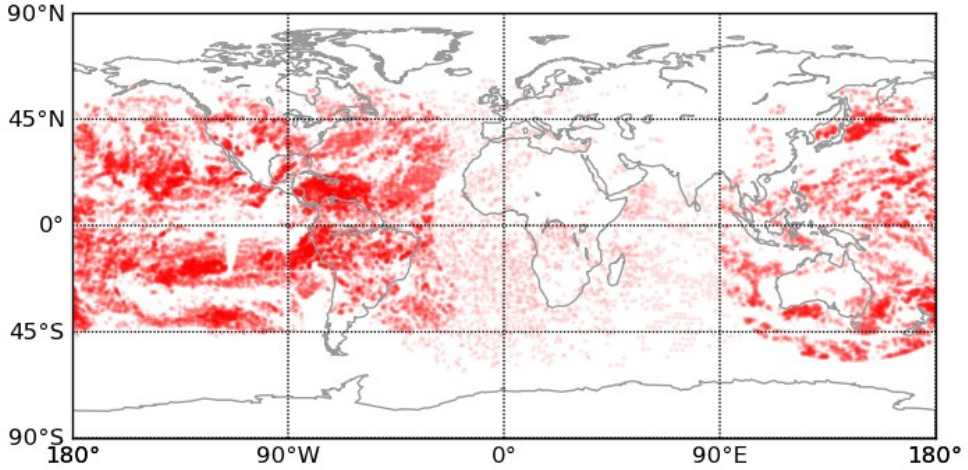
- GEOS-5 AGCM + GSI analysis (~½° L72)
- 6-h assimilation cycle, 3DVar
- 5-day forecasts, adjoint-based 24h obs

impacts at 00z (dry energy norm, sfc-150 hPa)

Geostationary Satellite Winds

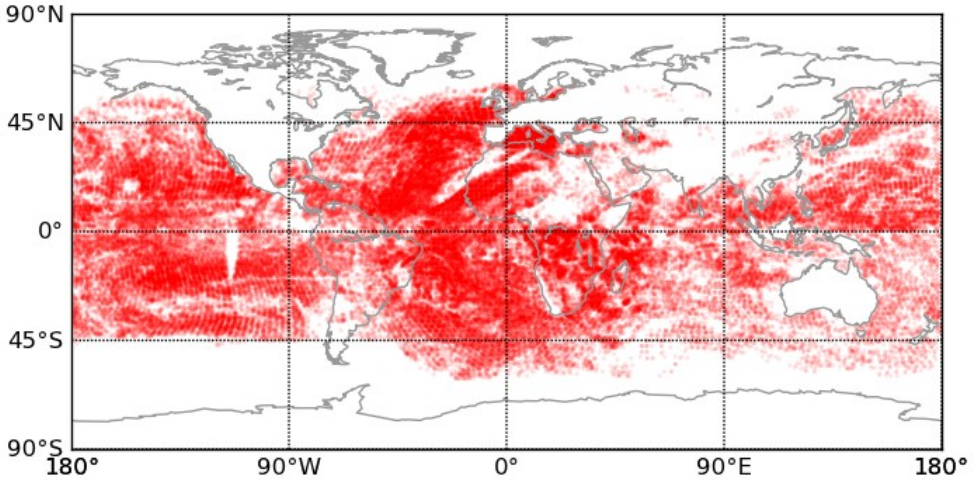
January 10, 2011

Control Experiment



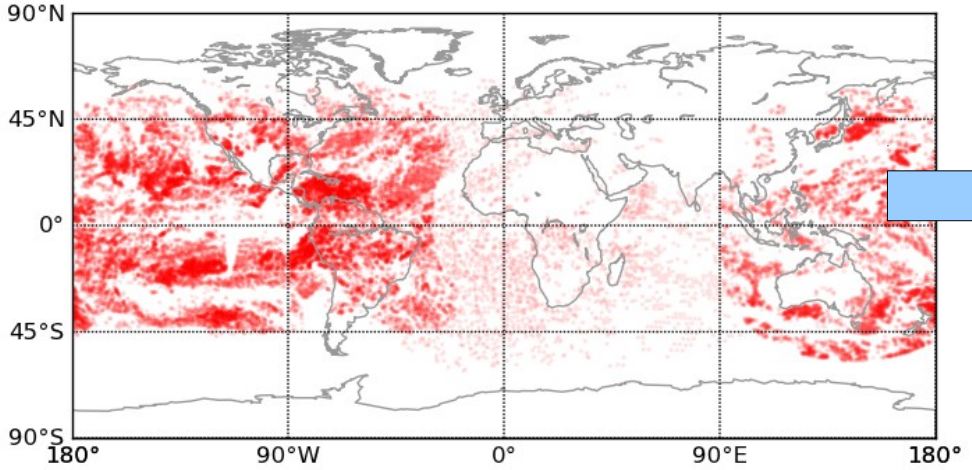
more red
=
higher
density of data

NRLAMV

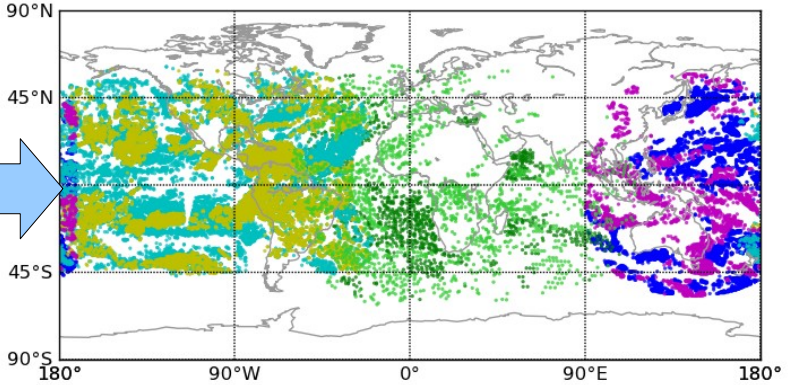


Geostationary Satellite Winds

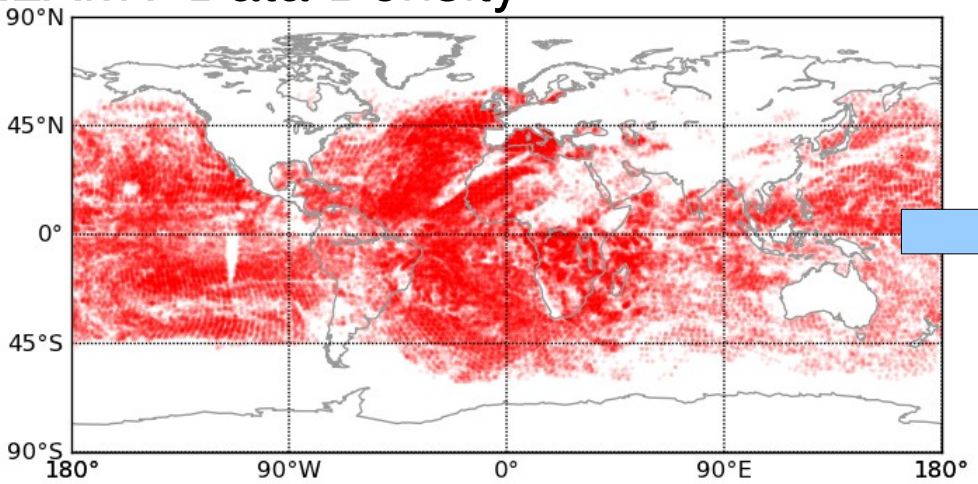
Control Data Density



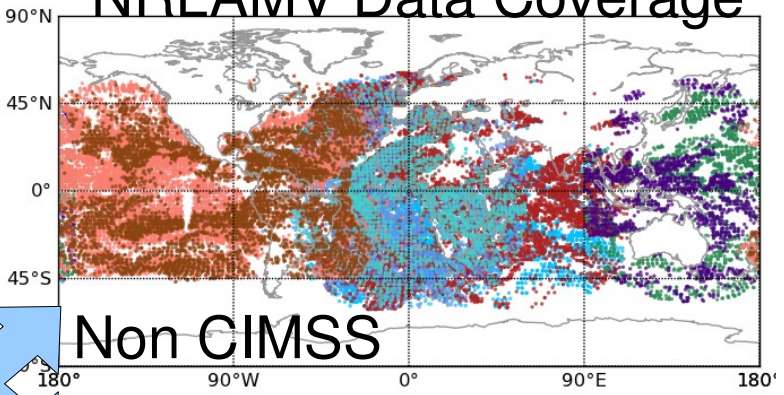
Control Data Coverage

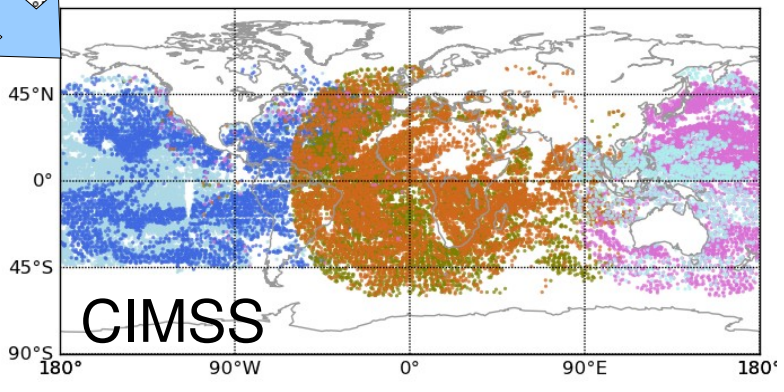


NRLAMV Data Density



NRLAMV Data Coverage





Thinning & Superobing

- Control experiment: asymmetric gross check and a thinning algorithm is applied in GSI (for example thinning for GOES: observation with higher QI+EE, closer to center box and cycle time combination, 100 km x 100 km x 100 mb thinning box)

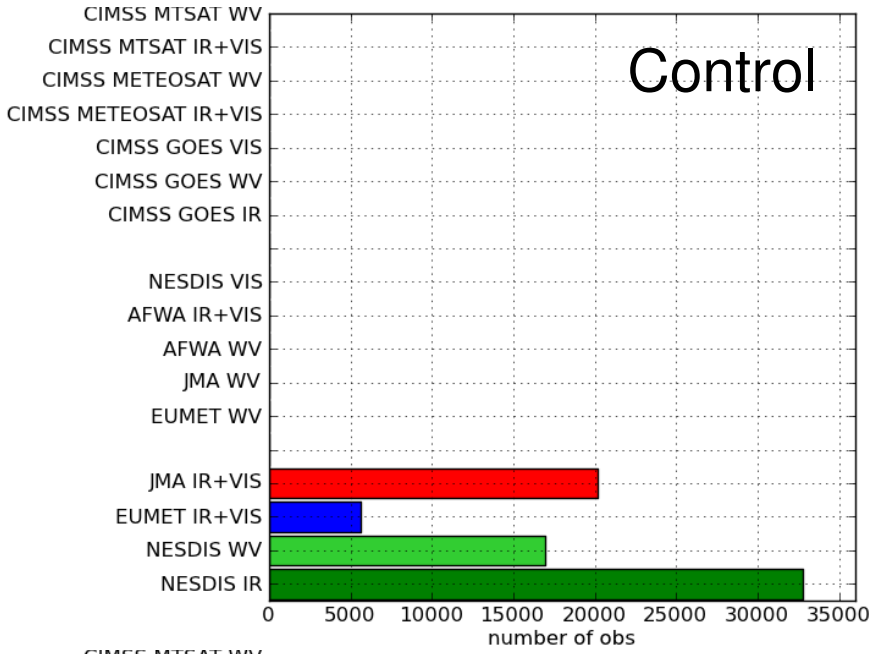
- NRLAMV superobing: after quality control AMV's are binned and averaged in lat-lon prisms (2° x 2°). Prisms for CIMSS data are shifted by 1° from NESDIS, EUMETSAT, and JMA prisms.

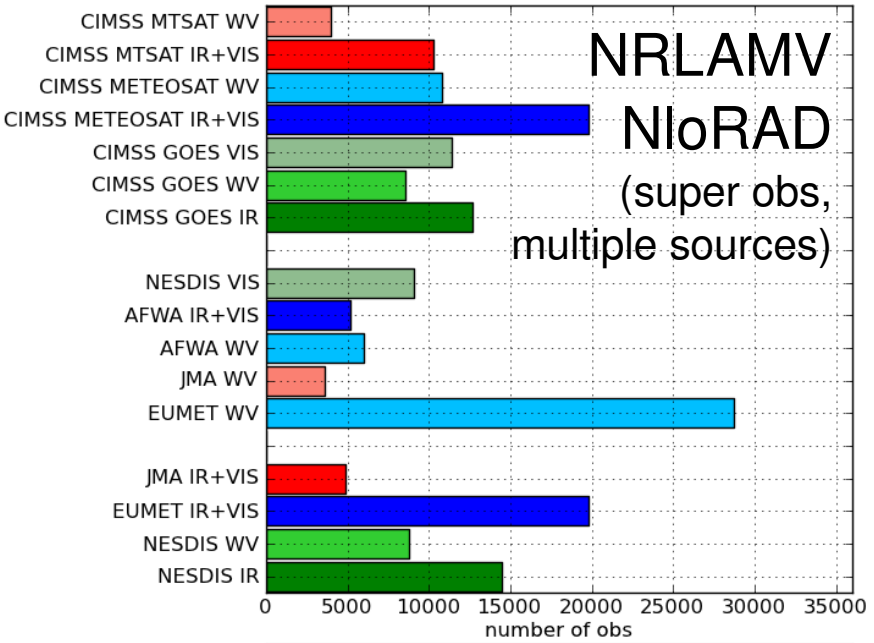
Experiments

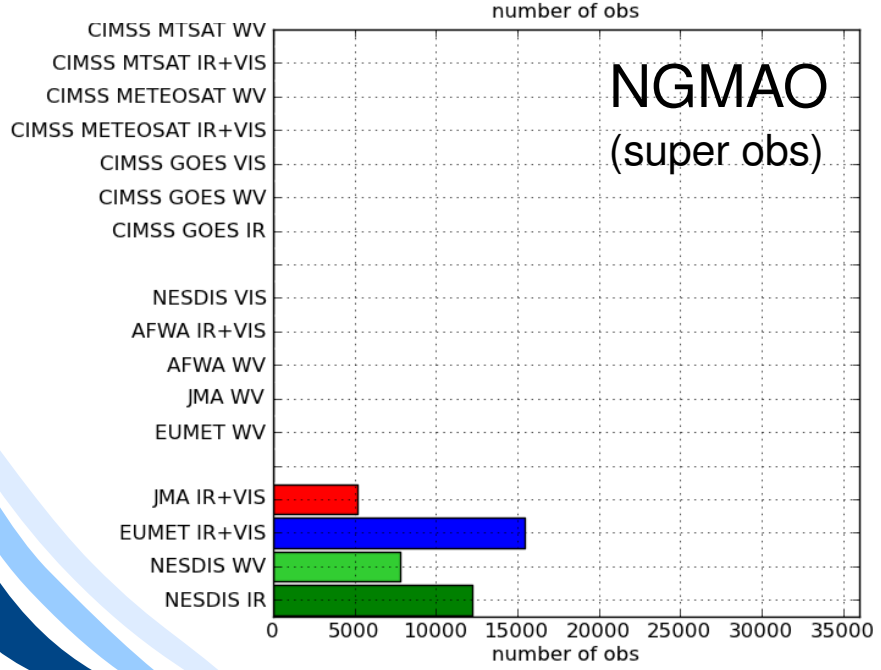
- Control run &
  - Superobs
  - Increased number of superobs
  - All NRL AMV's
  - All NRL AMV's with less radiances

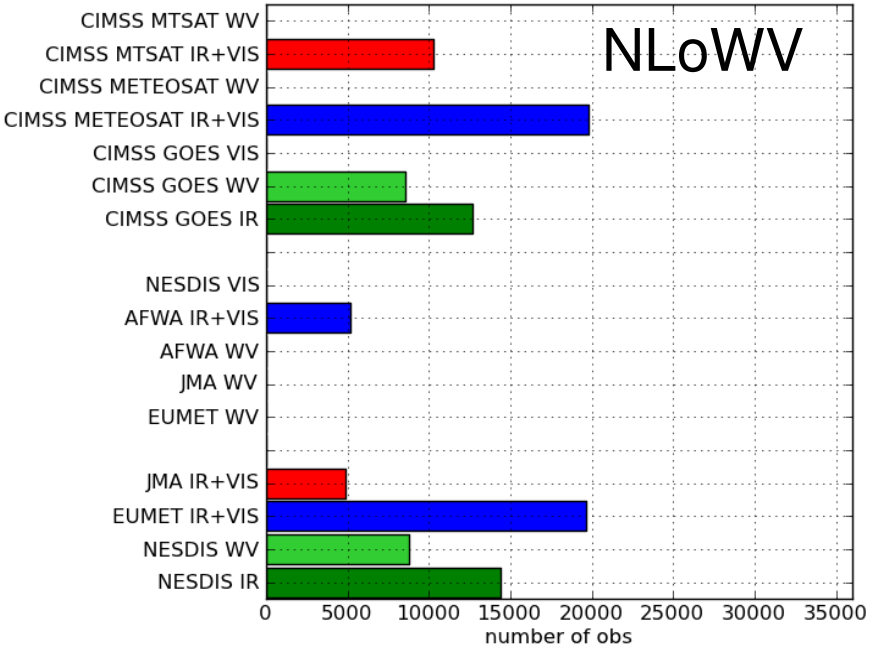
Geo Wind Experiments

Dec-Jan 2011



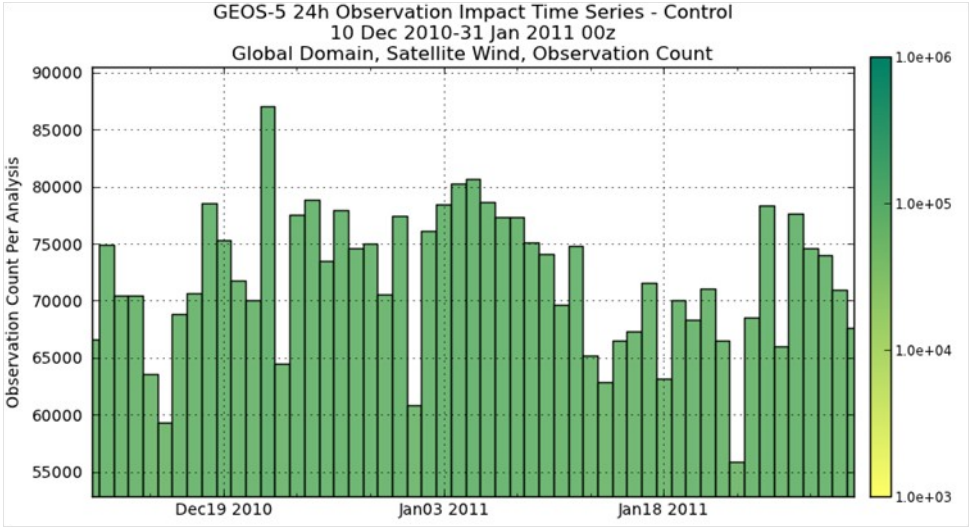






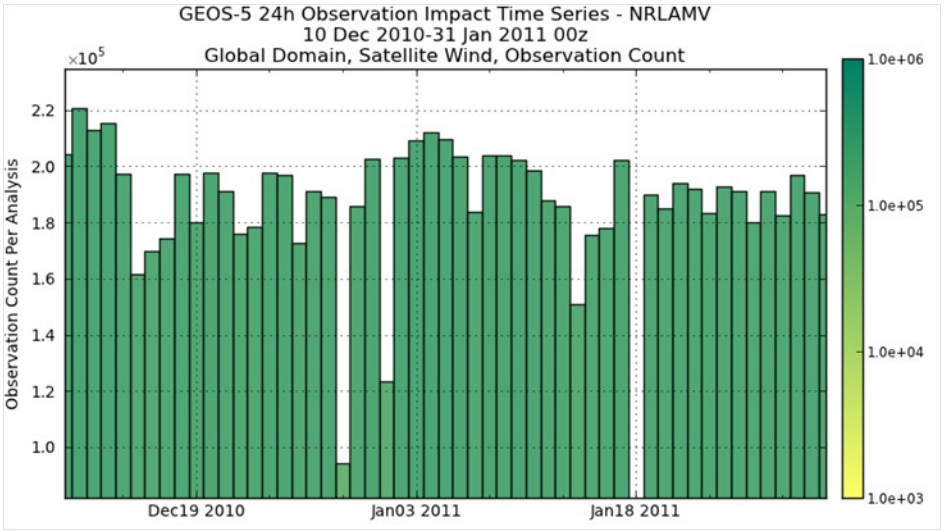
Geo Wind Observation Counts

Control



~ 70K of obs per analysis

NRLAMV

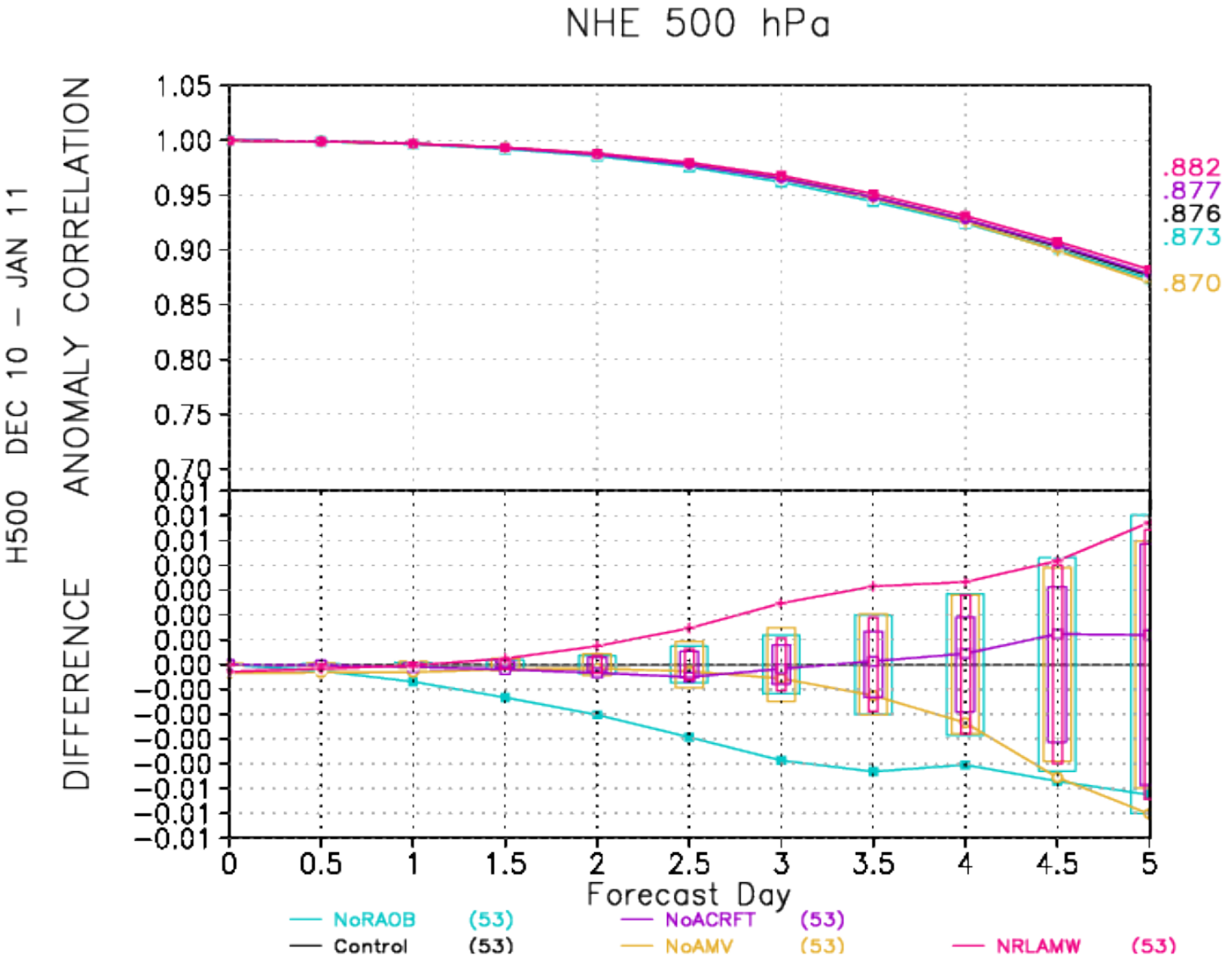


~ 180K of obs per analysis

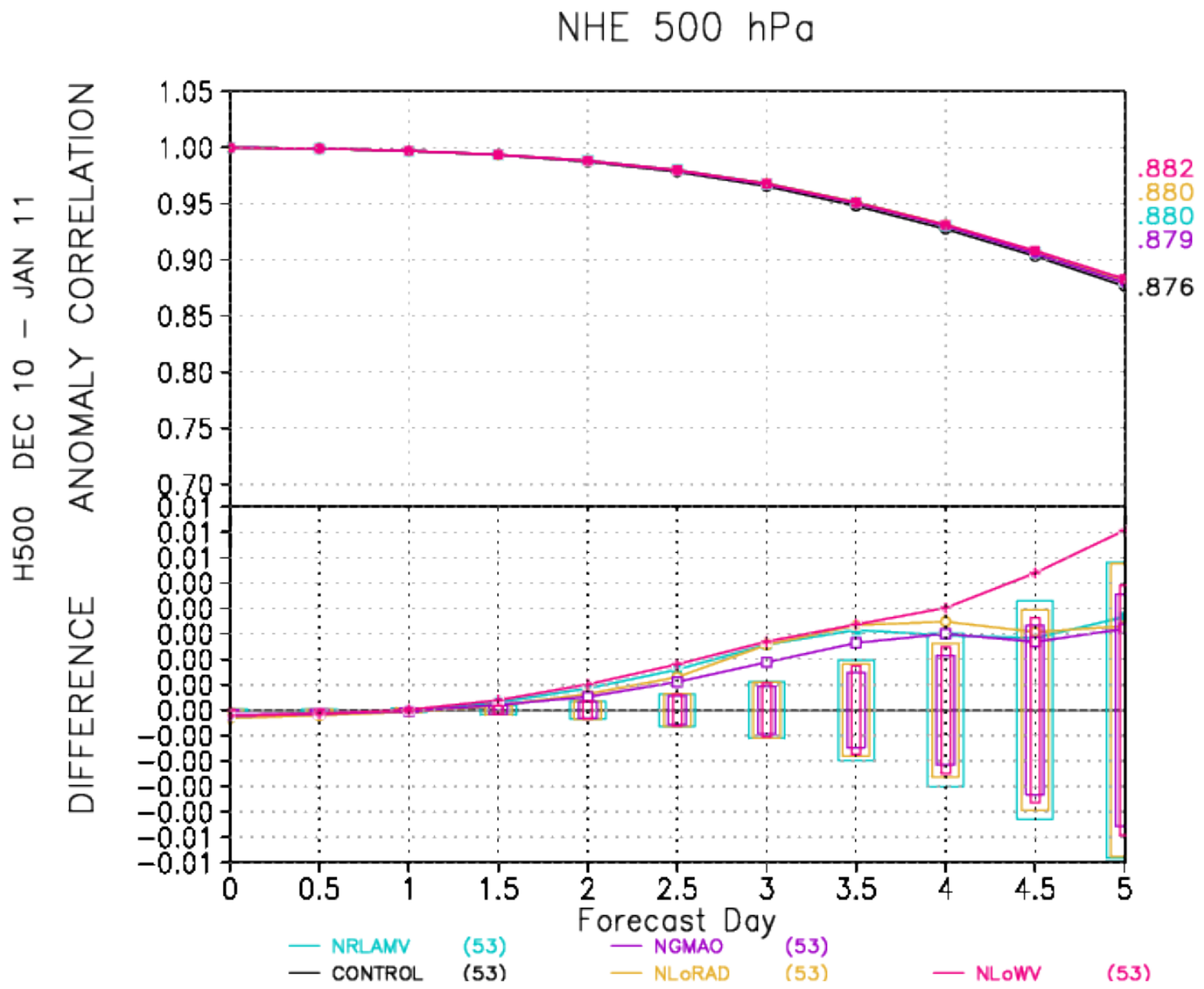
No satwinds recieved on Jan 18.

OSE Experiments – Forecast Statistics: Conventional Data

Dec 10 – Jan 31, 2011

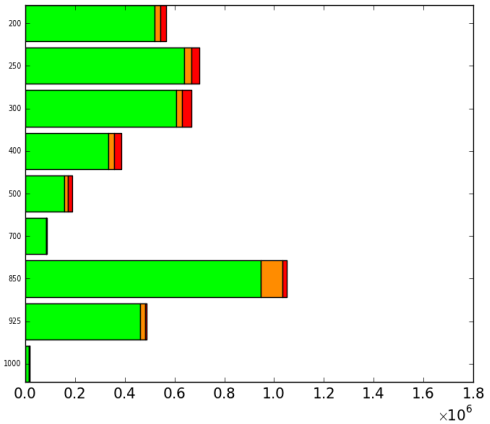
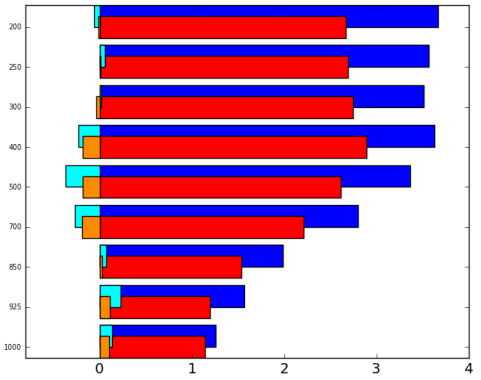
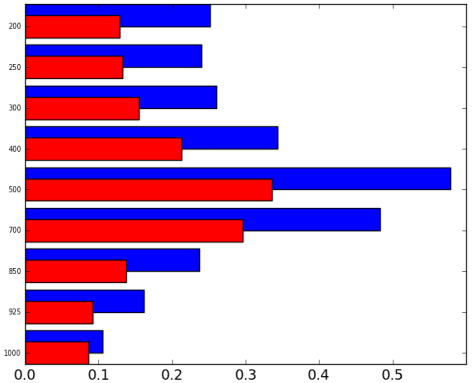
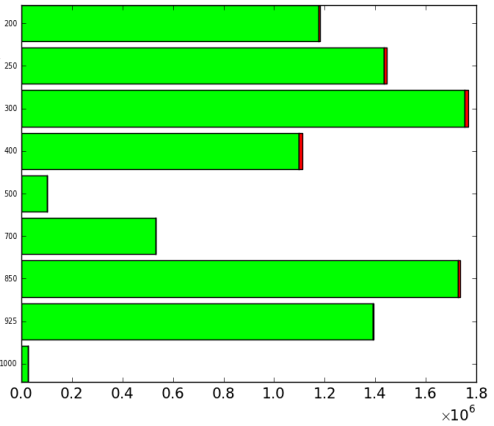
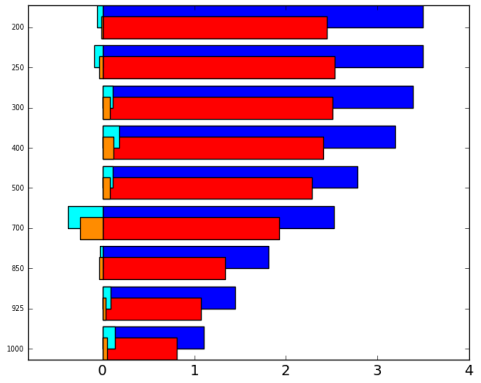
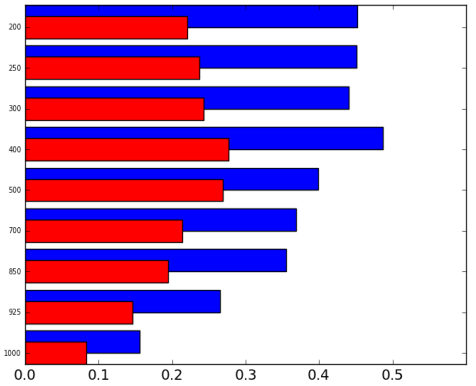


Forecast statistics for super obs experiments



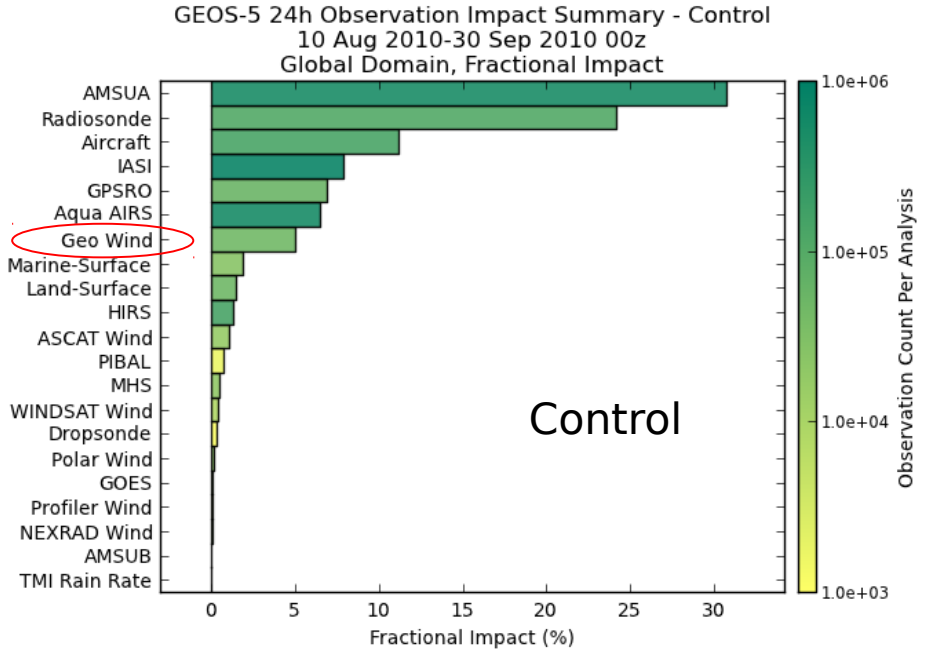
Data Assimilation Statistics for Satellite Winds

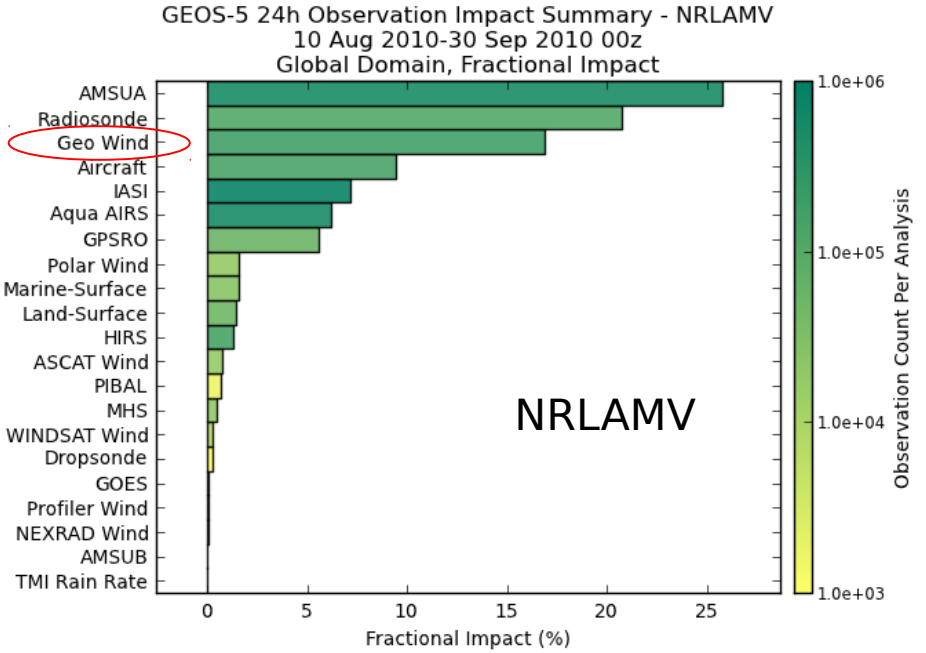
Dec 10 – Jan 31, 2011

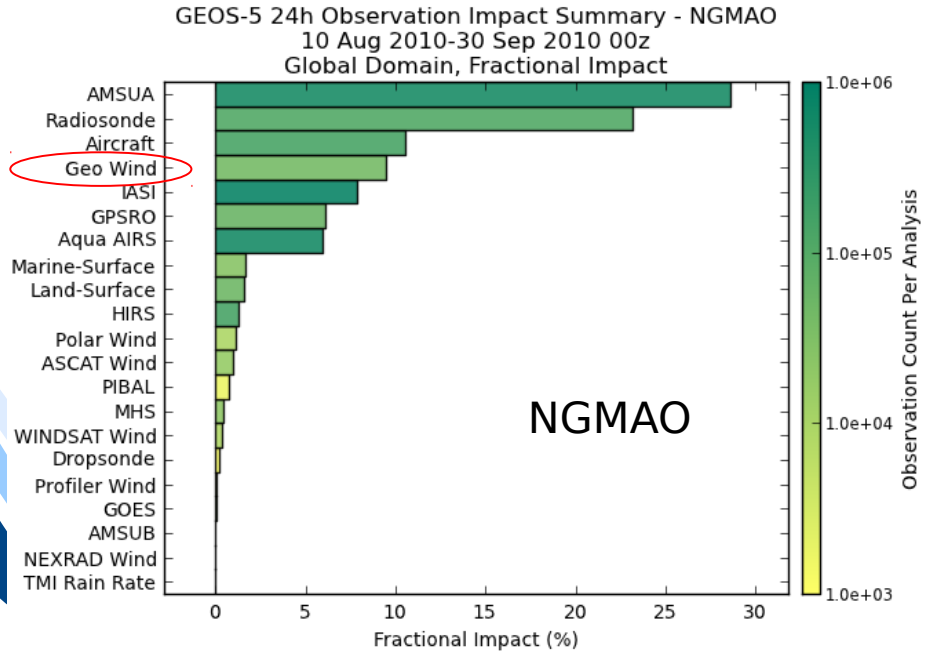
	Data Counts	Departures	Normalized Cost
			Jo(O-B)/p Jo(O-A)/p
Control			
		RMS(O-B) RMS(O-A)	Jo(O-B)/p Jo(O-A)/p
NRLAMV			

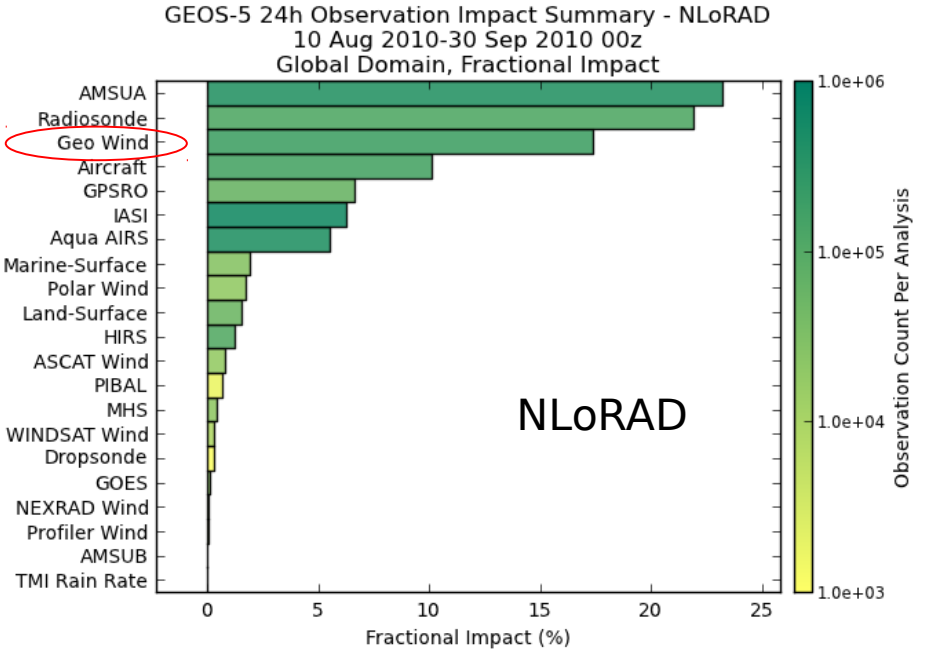
Observation Impact – Global

Aug – Sep 2010



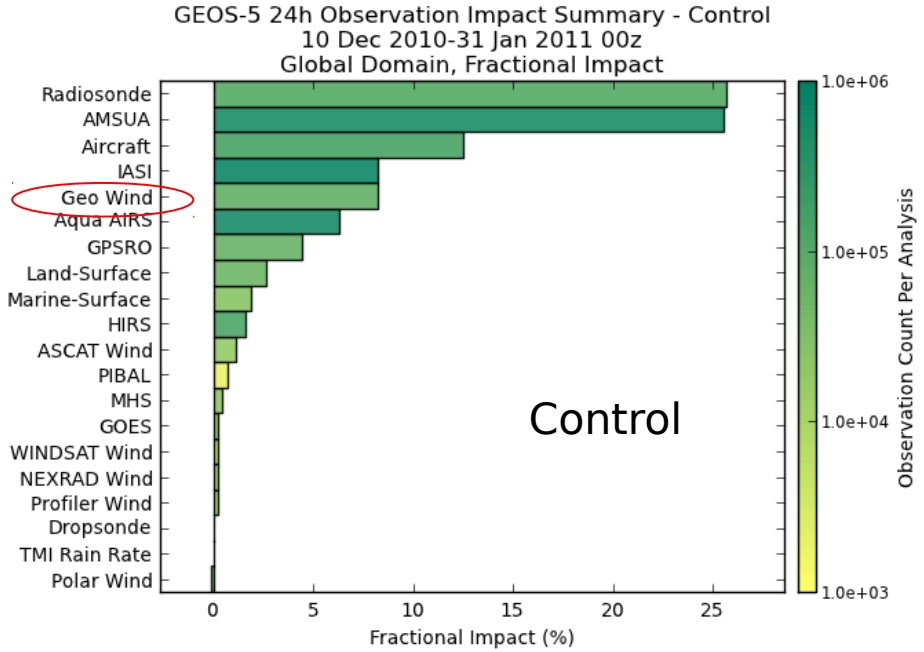


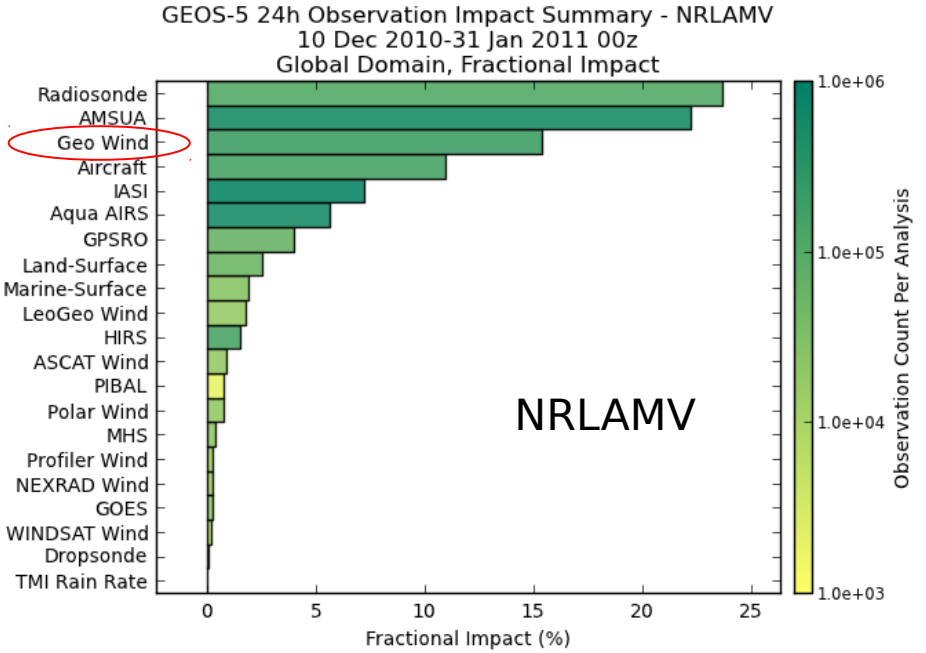


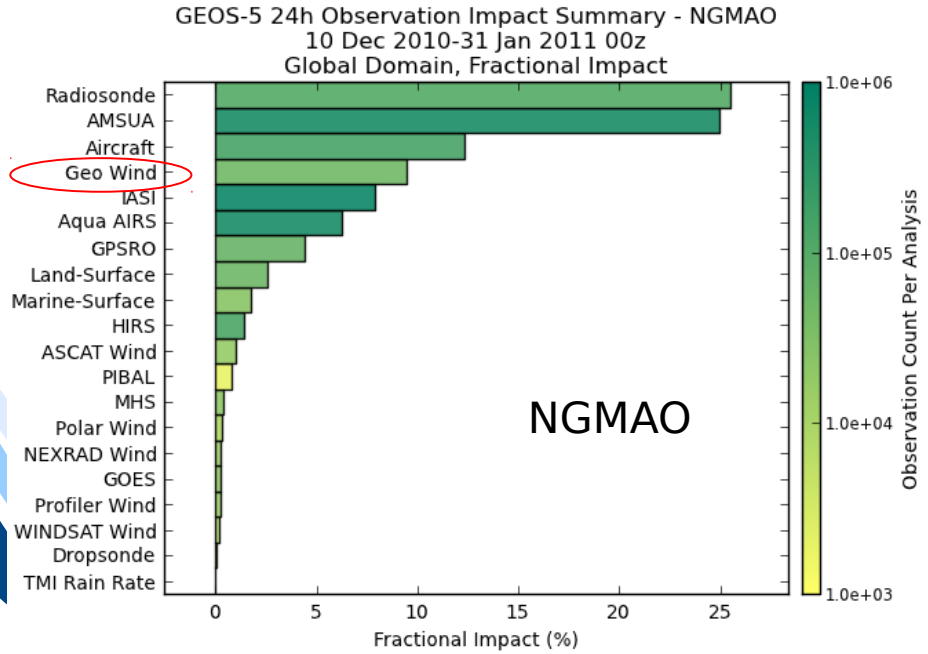


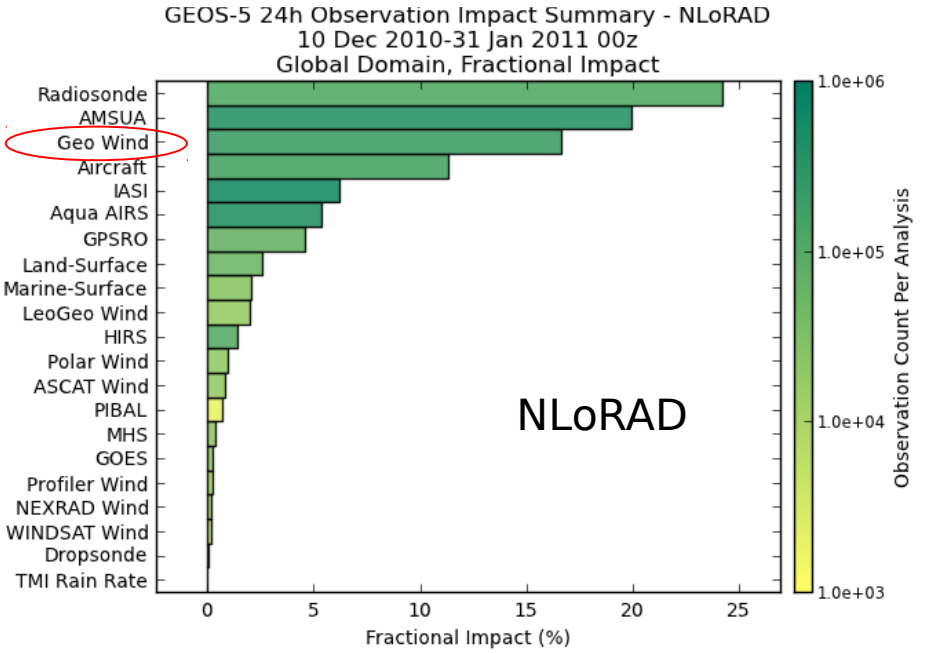
Observation Impact – Global

Dec – Jan 2011



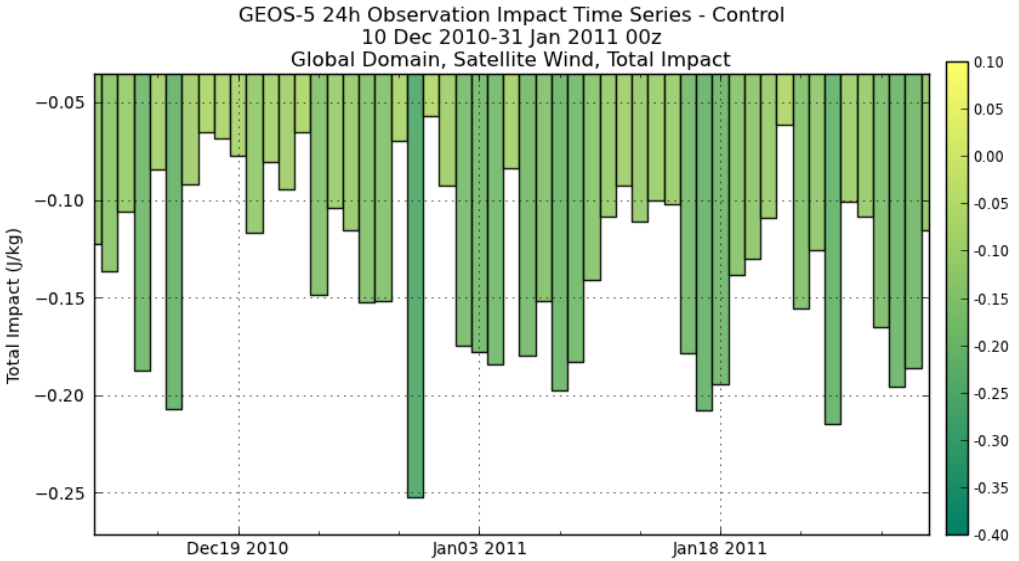




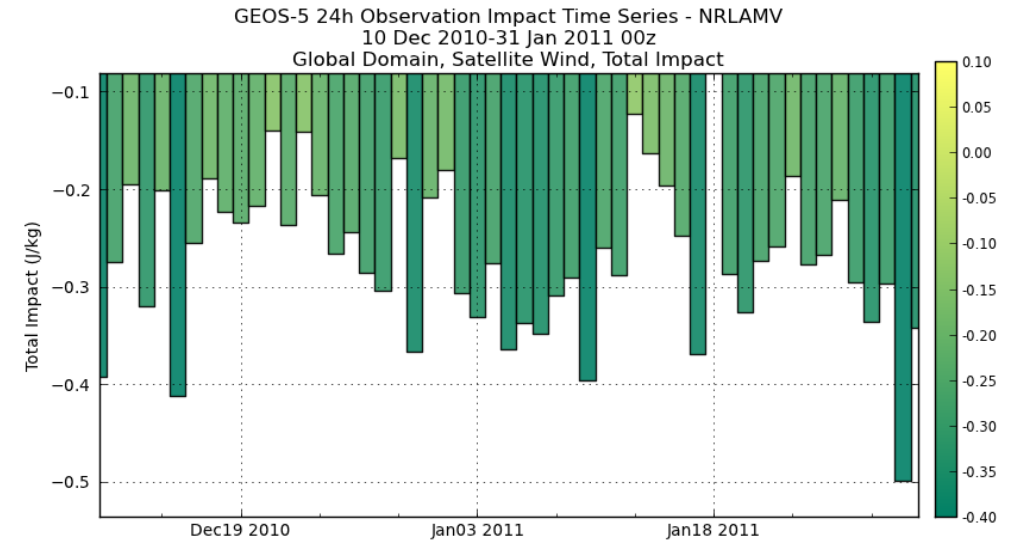


Time Series of Satellite Wind Total Impact – Global

10 Dec 2010 – 31 Jan 2011 00z



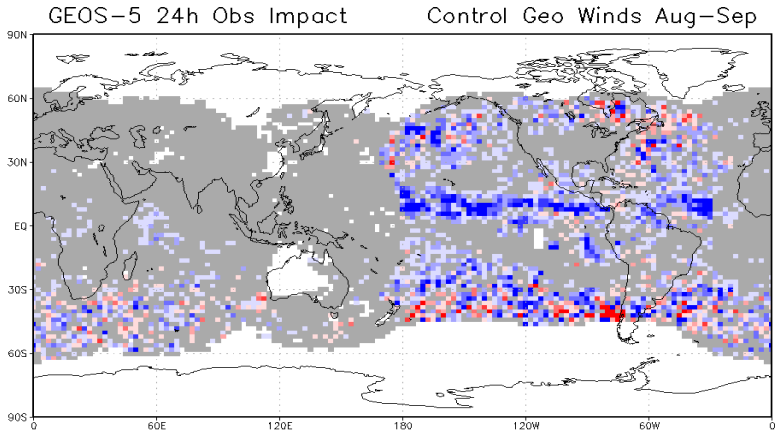
Control

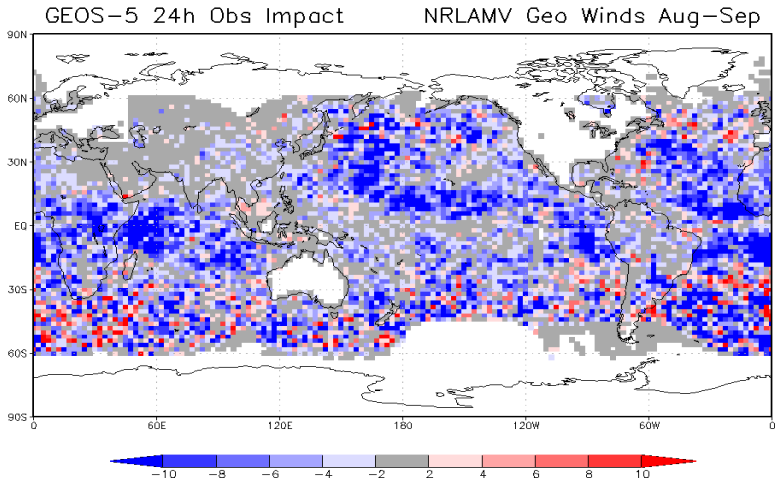


NRLAMV

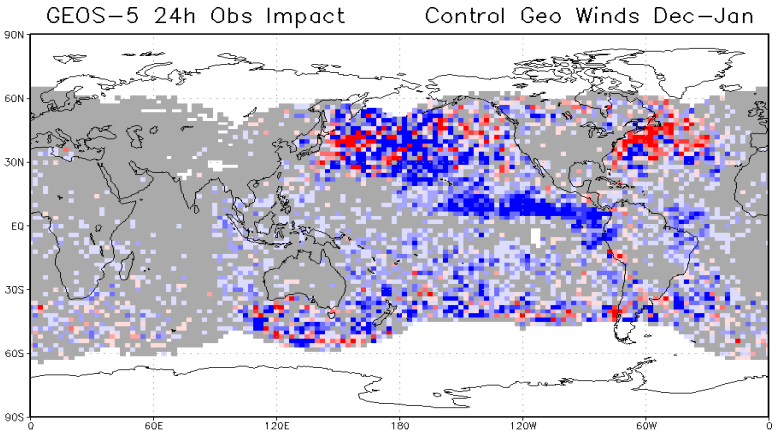
Gridded Vertically Summed Impact of Geo Winds

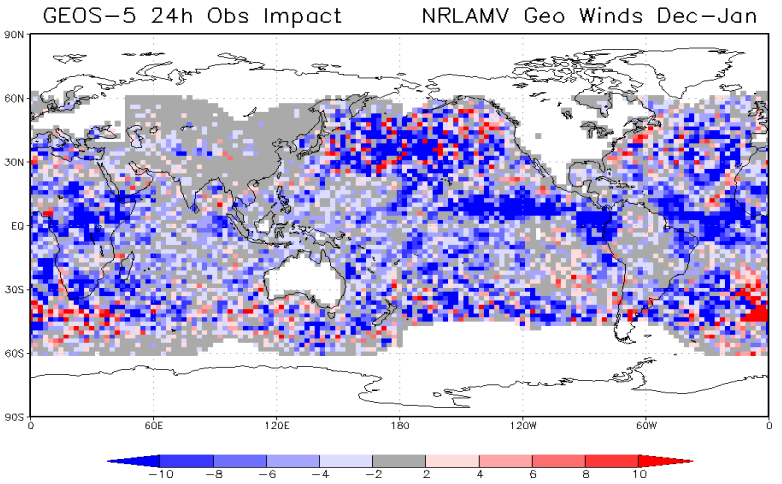
Aug–Sep 2010





Dec–Jan 2011

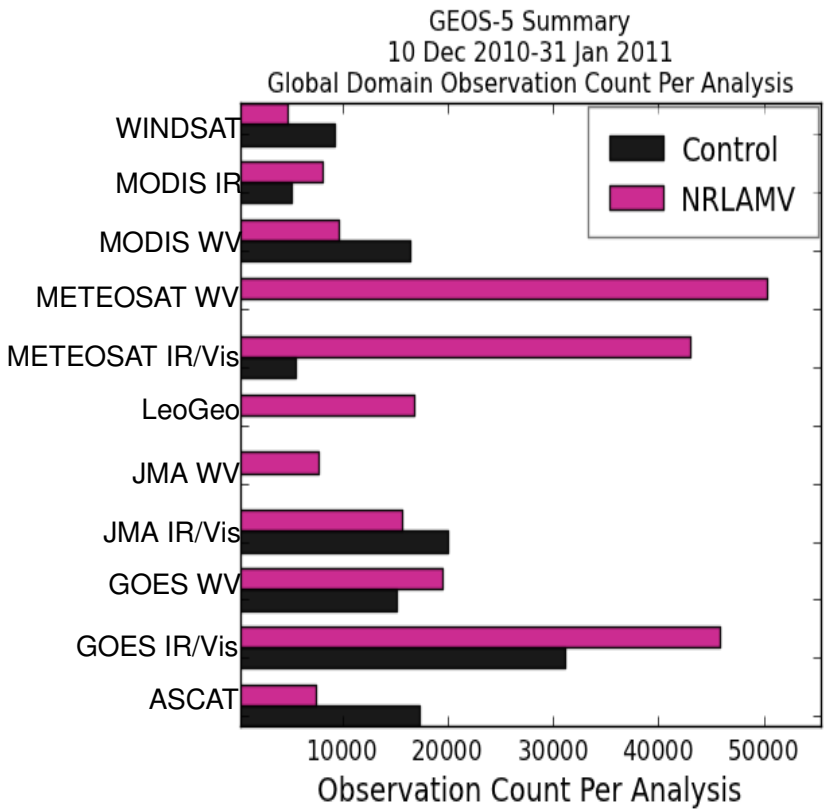




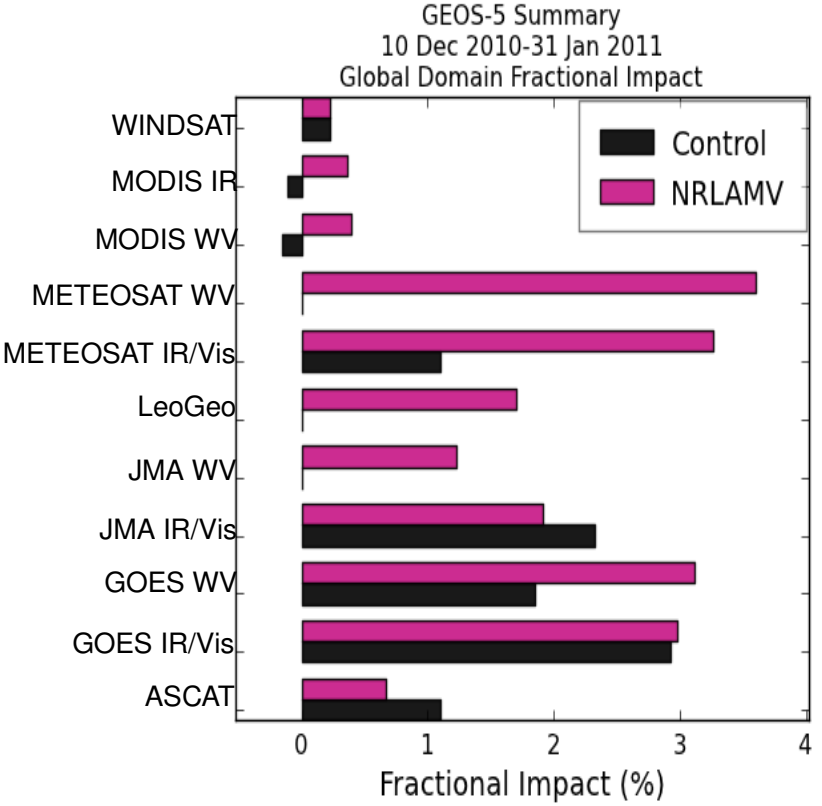
Relative Impacts of Selected AMV Types

Dec – Jan 2011

Global Data Count



Global Total Impact



- Data count correlate well with data counts
- Forecast skill is mostly improved
- Impact of MODIS polar winds is negative in Control run

Gridded Vertically Summed Impact of Geo Winds

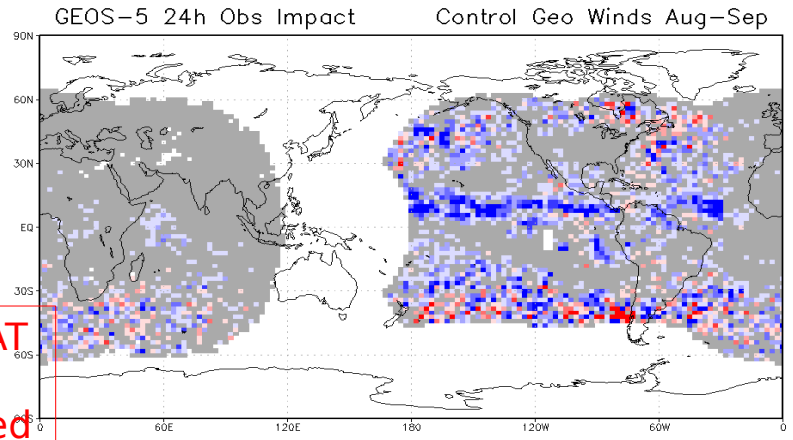
Aug–Sep 2010

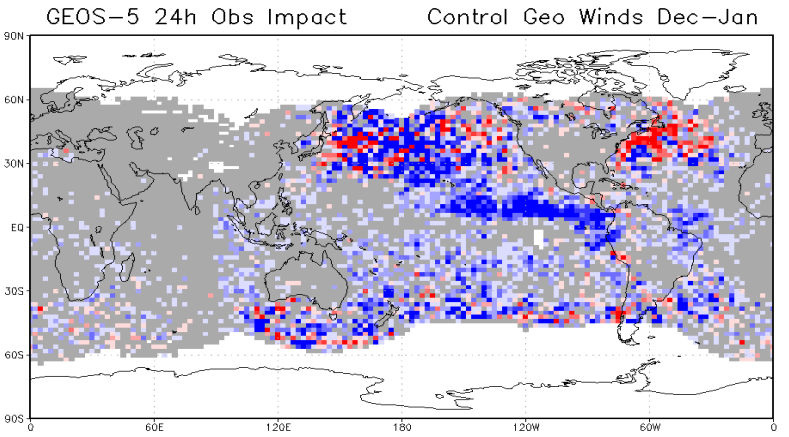
Dec–Jan 2011

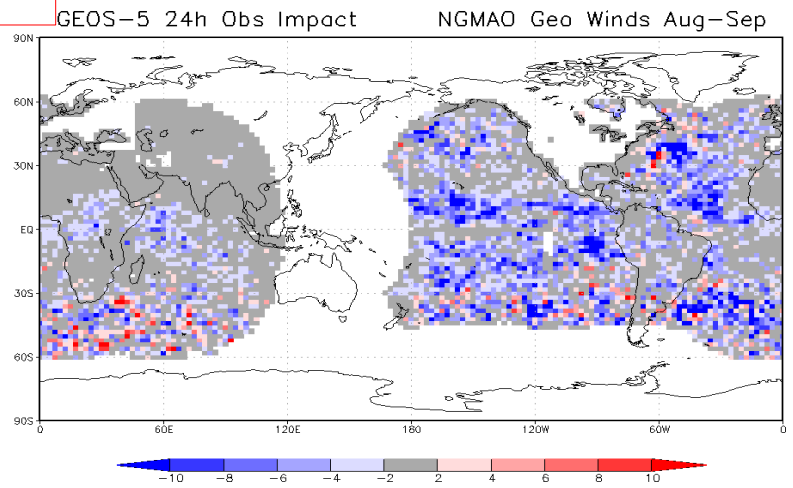
Control

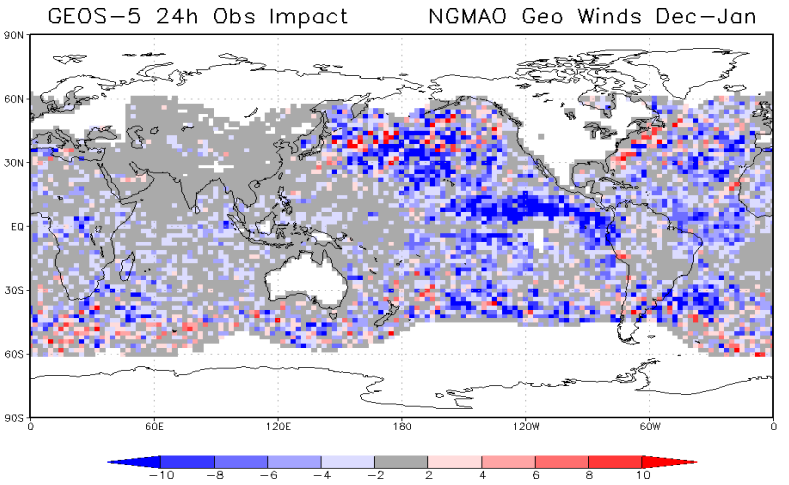
NGMAO

MTSAT not plotted



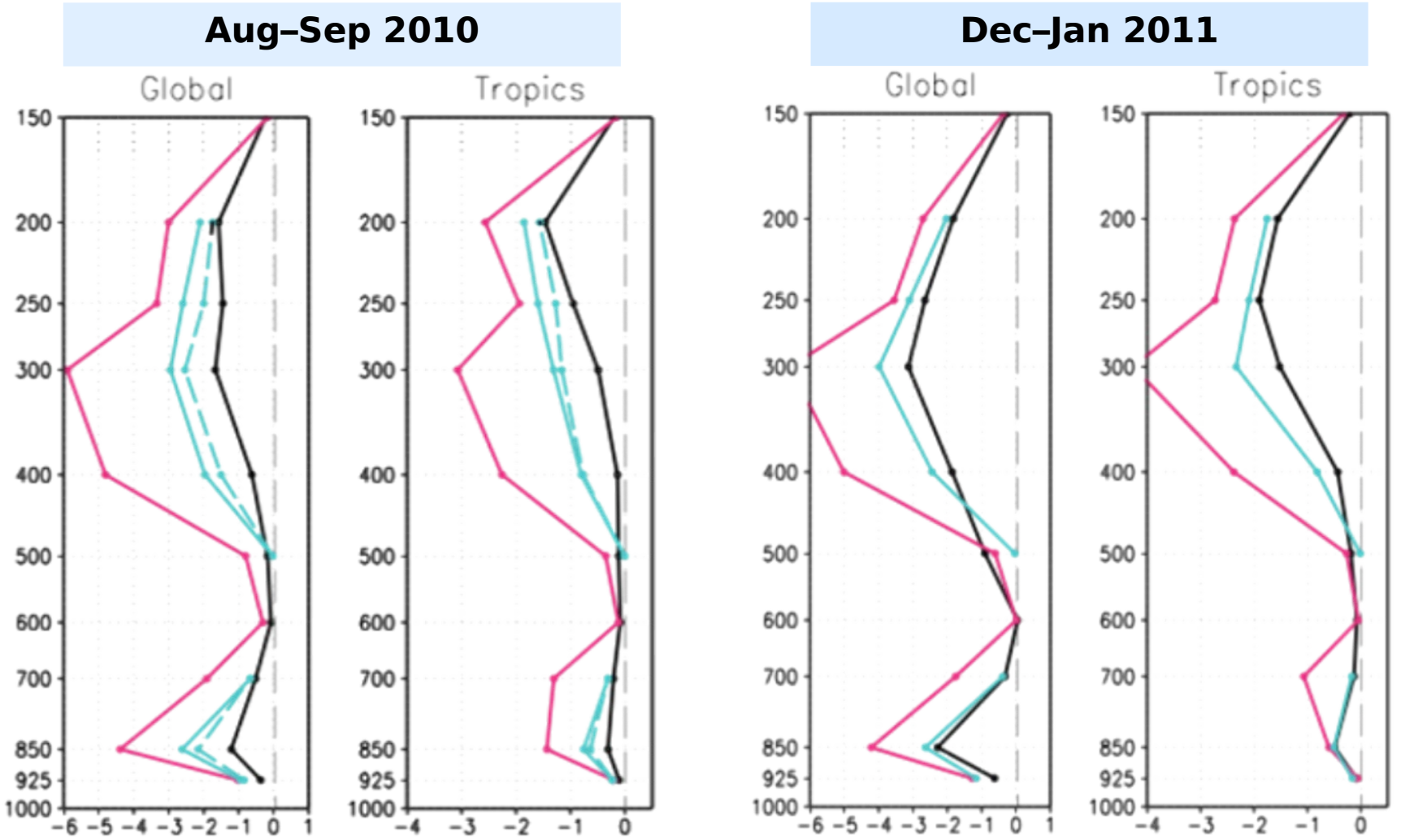






Subset of NRL AMV types and sources matching GMAO control (super obs)

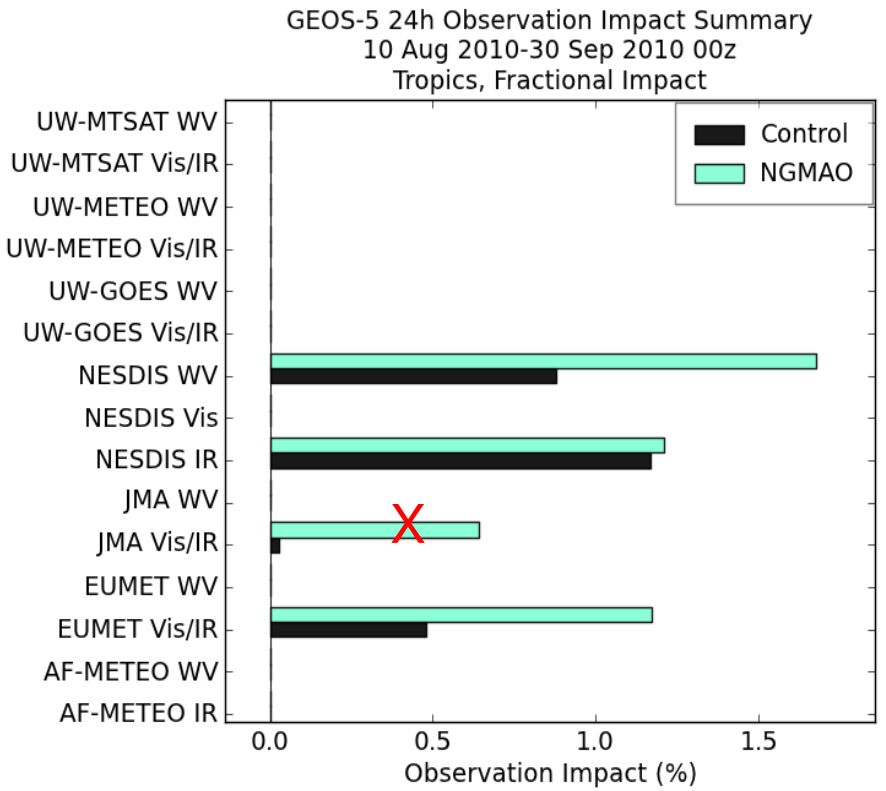
Vertical Profiles of Geo Wind Impact



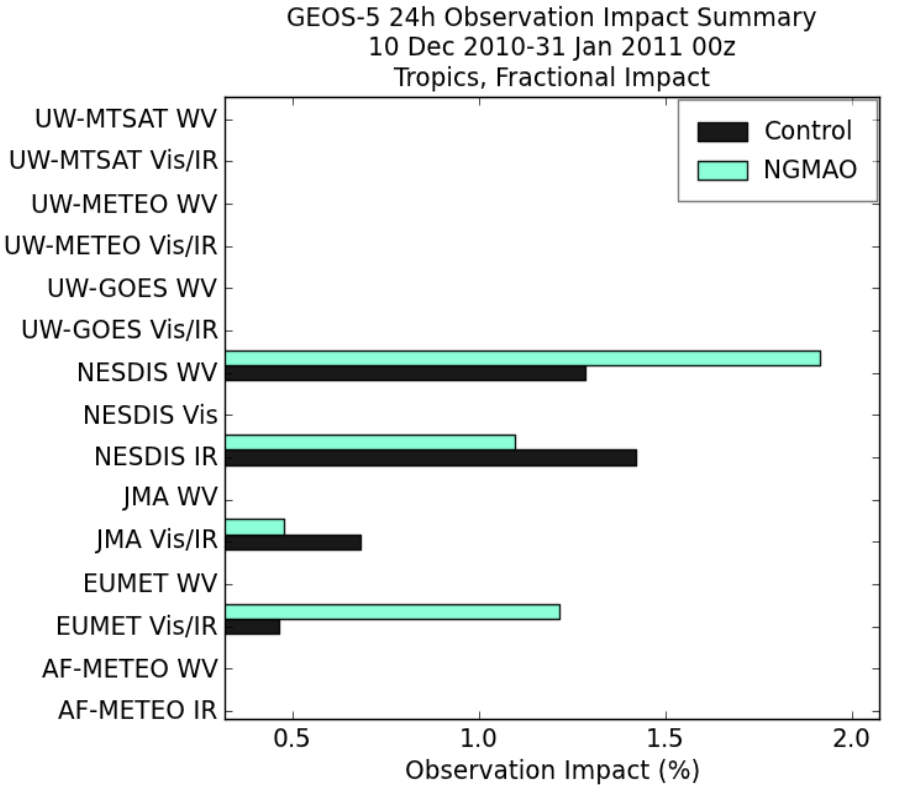
Relative Impacts of Geo Wind Types

Tropics

Aug–Sep 2010



Dec–Jan 2011

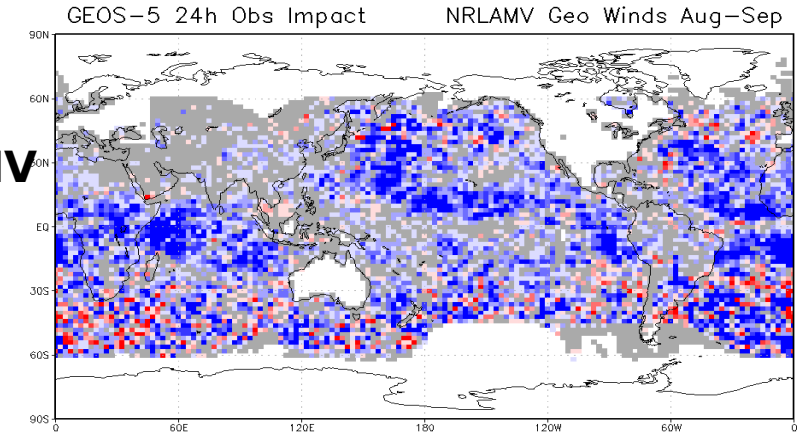


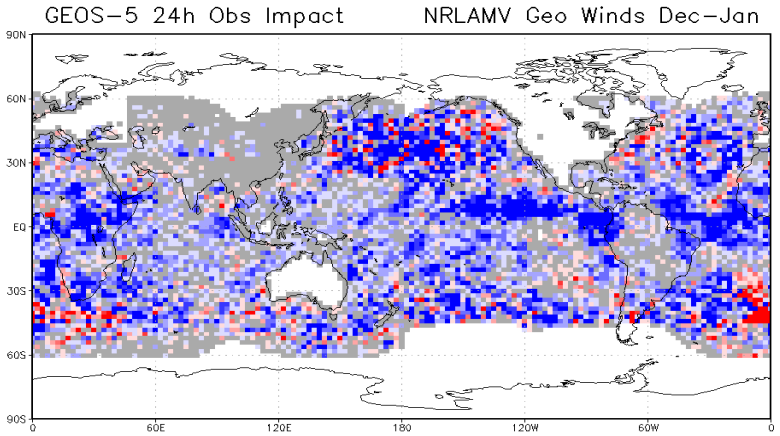
Gridded Vertically Summed Impact of Geo Winds

Aug–Sep 2010

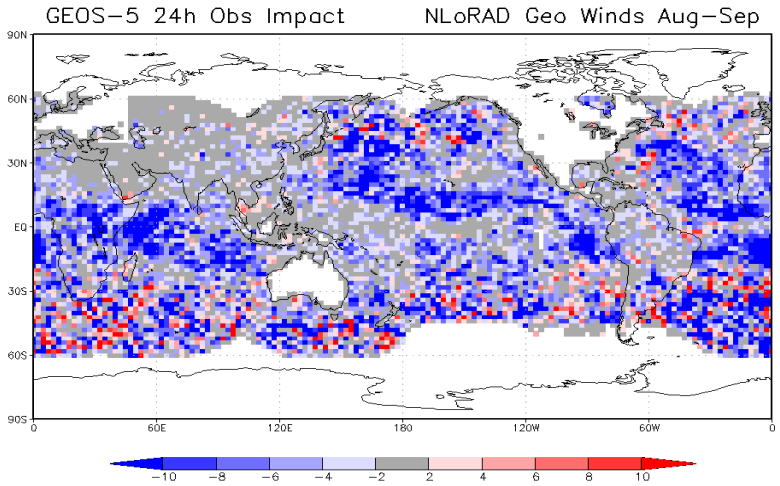
Dec–Jan 2011

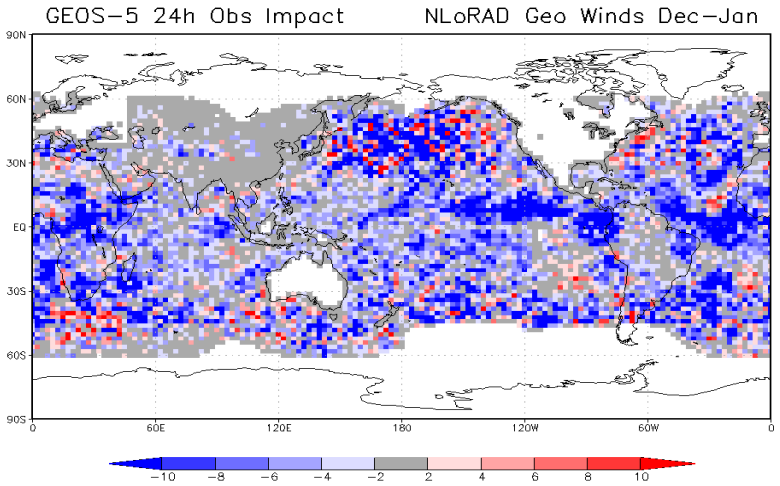
NRLAMV



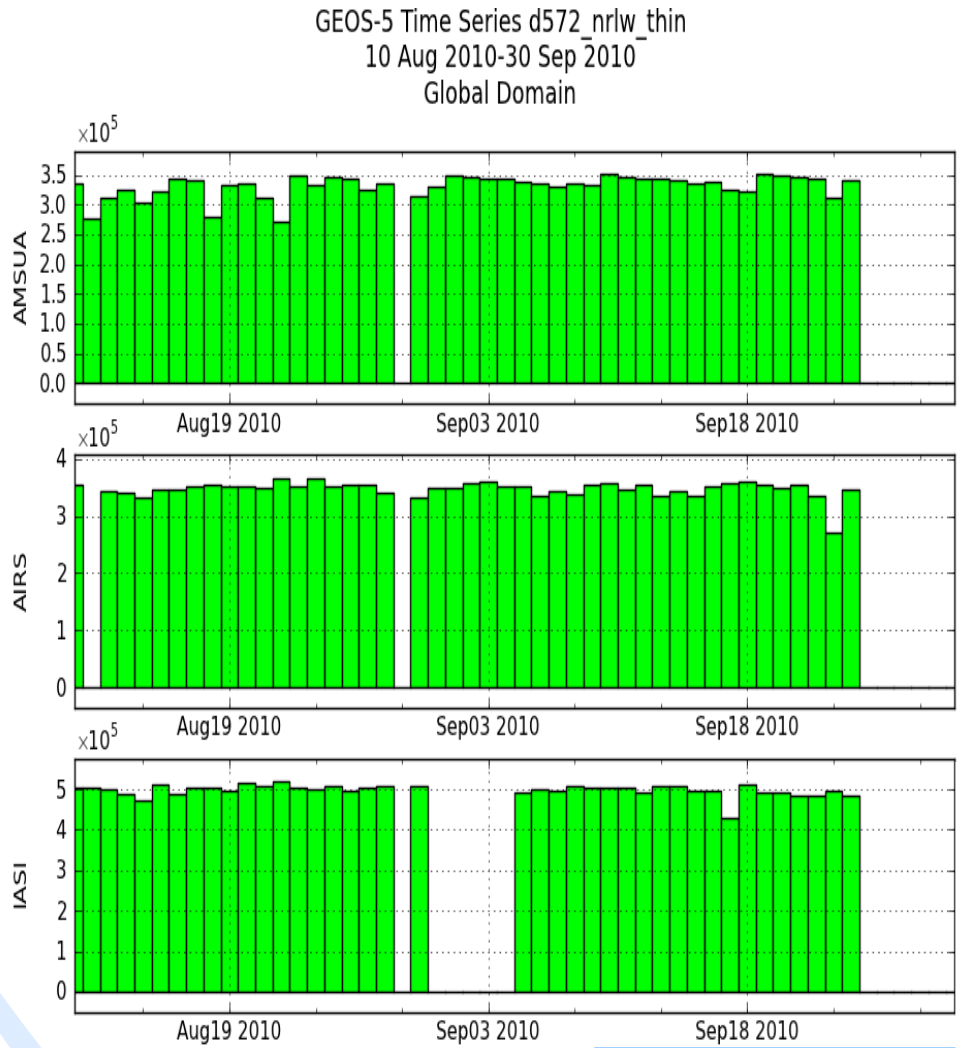


NLoRAD

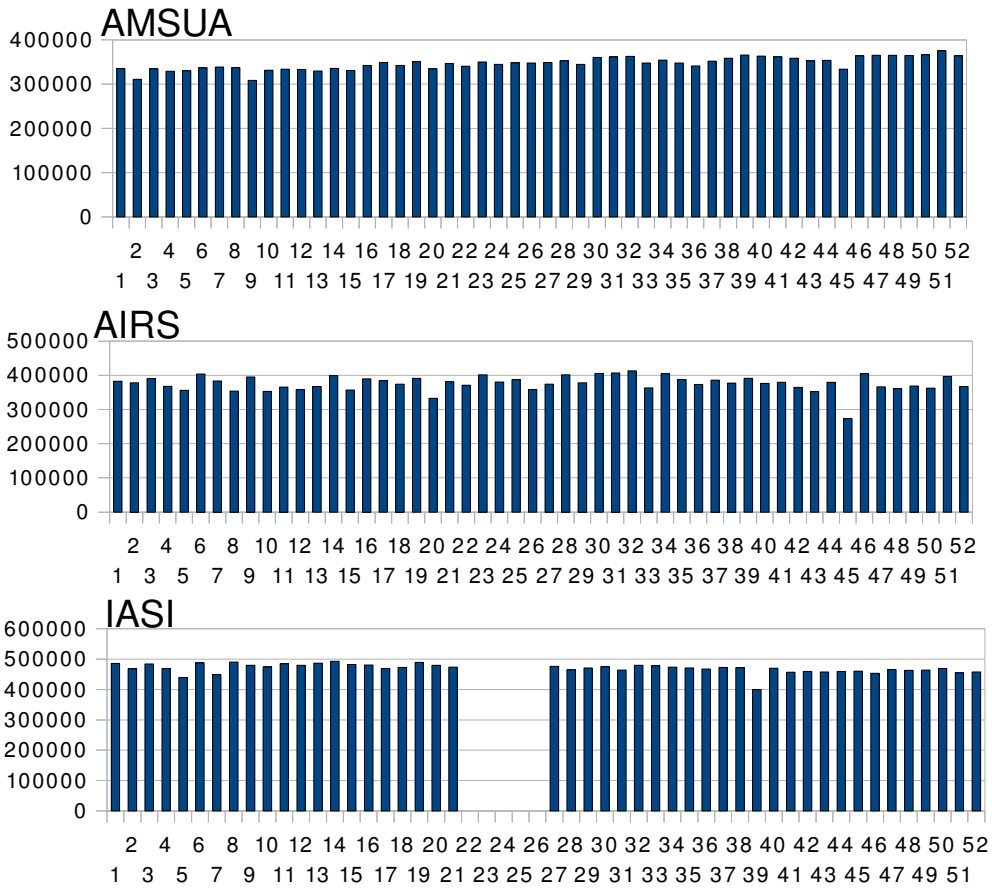




NLoRAD - low radiance count



NRL Time series data count
(Aug 10- Sep 30 2010) Global domain



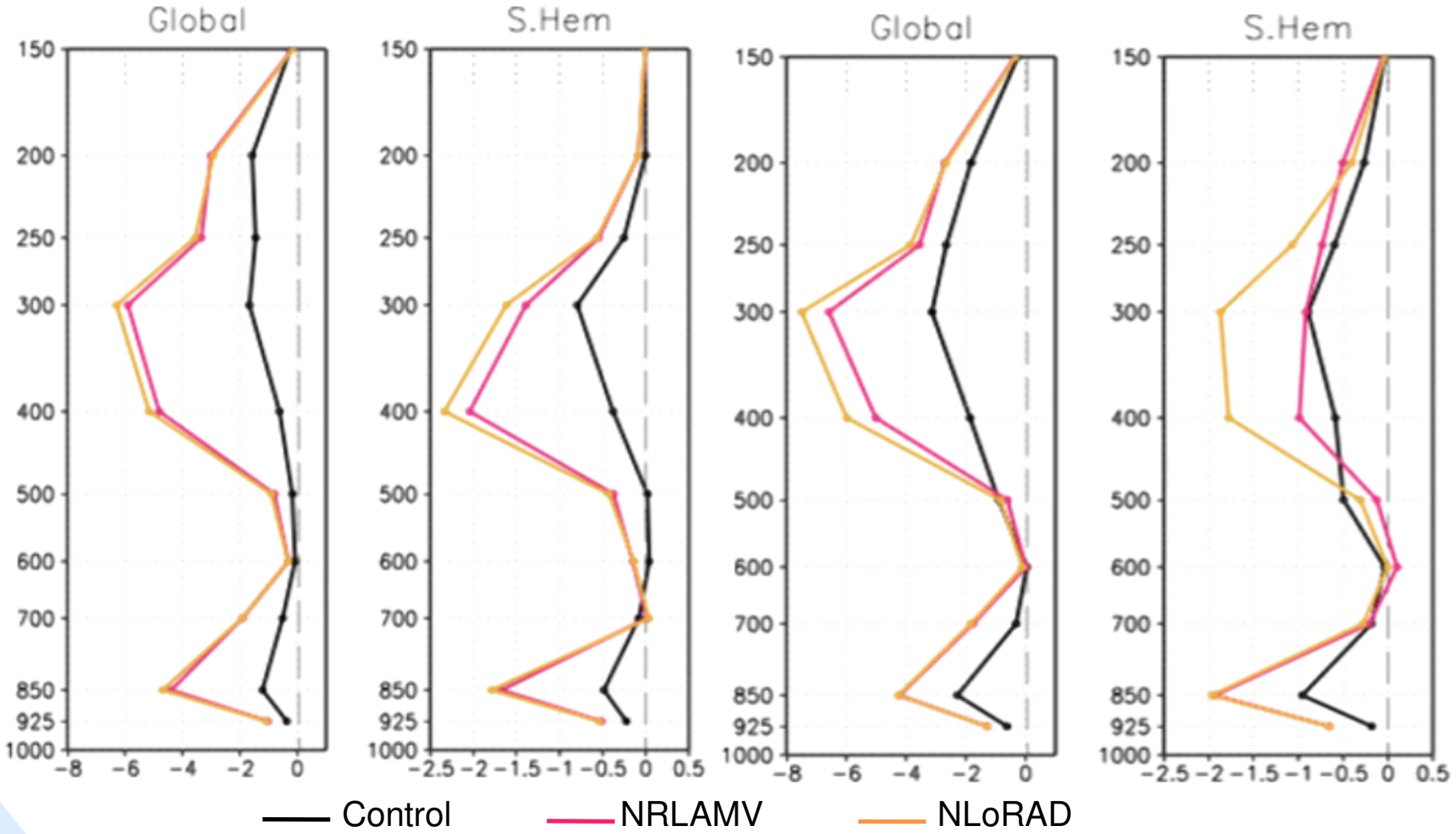
Thinning box is increased :

- for AMSUA (145 --> 180 km)
- AIRS and IASI (180 --> 225)

Vertical Profiles of Geo Wind Impact

Aug–Sep 2010

Dec–Jan 2011

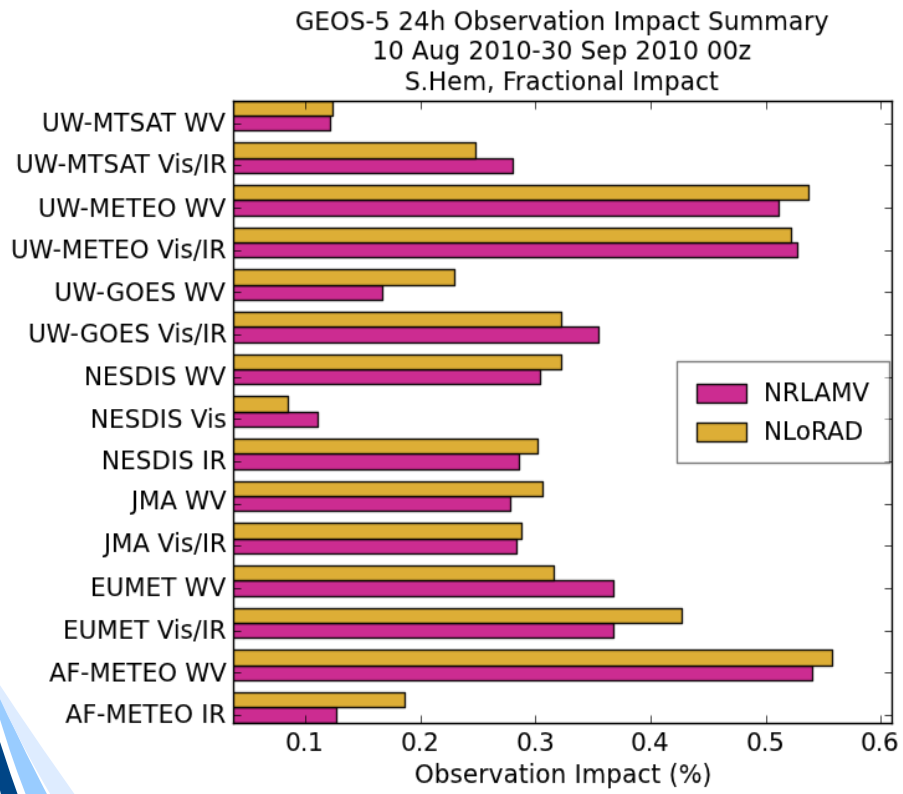


Evidence of larger AMV impact when fewer radiance's assimilated, but mostly in S.Hem during summer

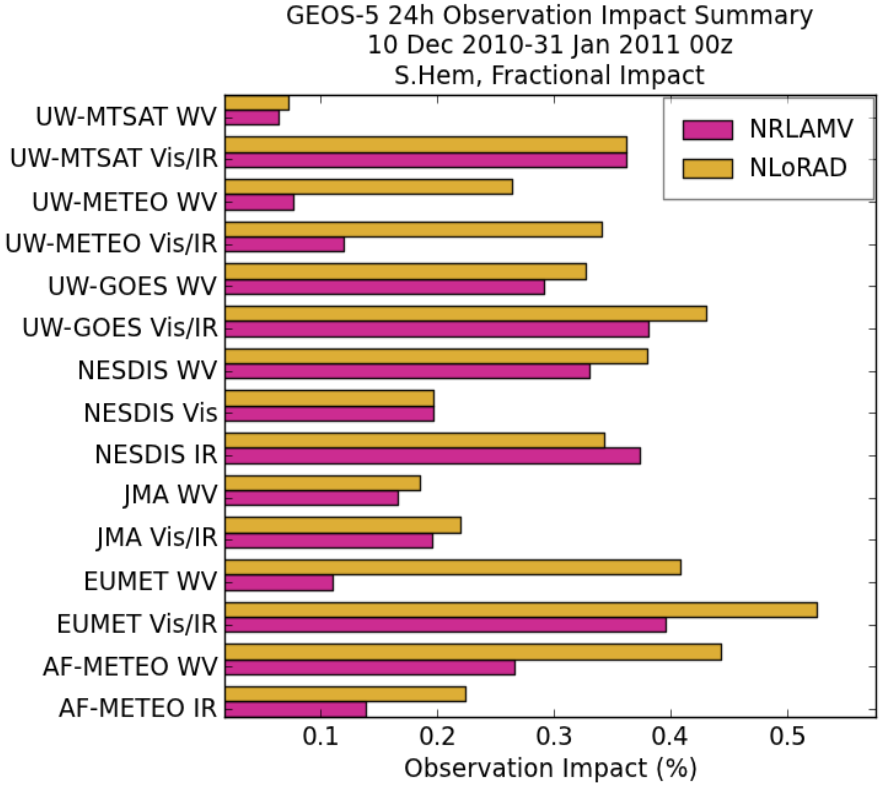
Relative Impacts of Geo Wind Types

Southern Hemisphere

Aug–Sep 2010

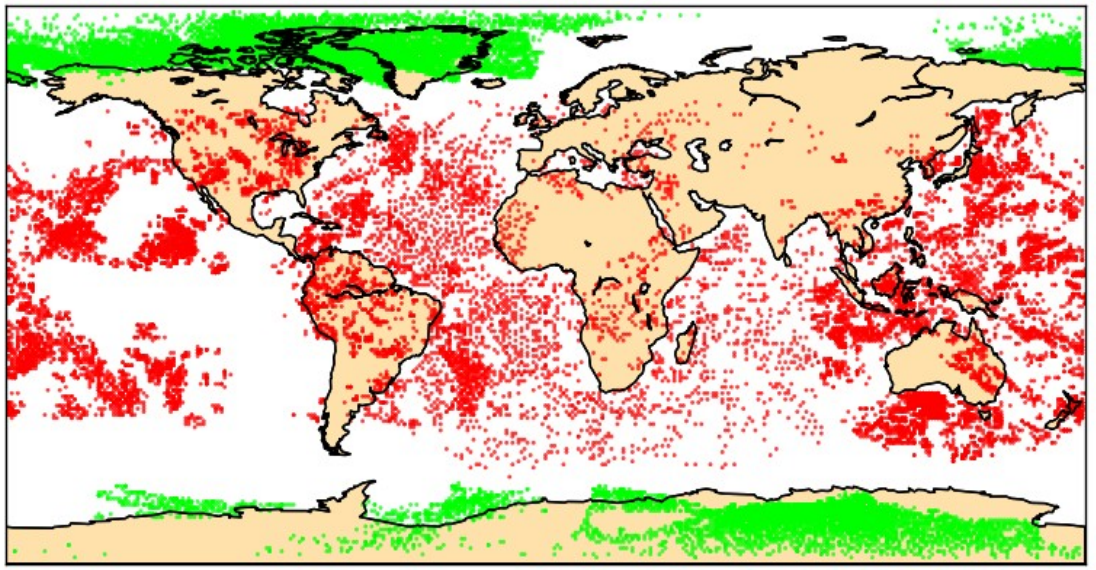


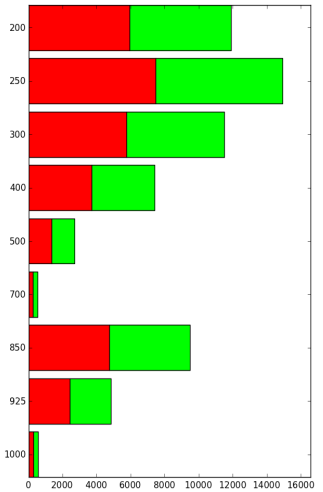
Dec–Jan 2011



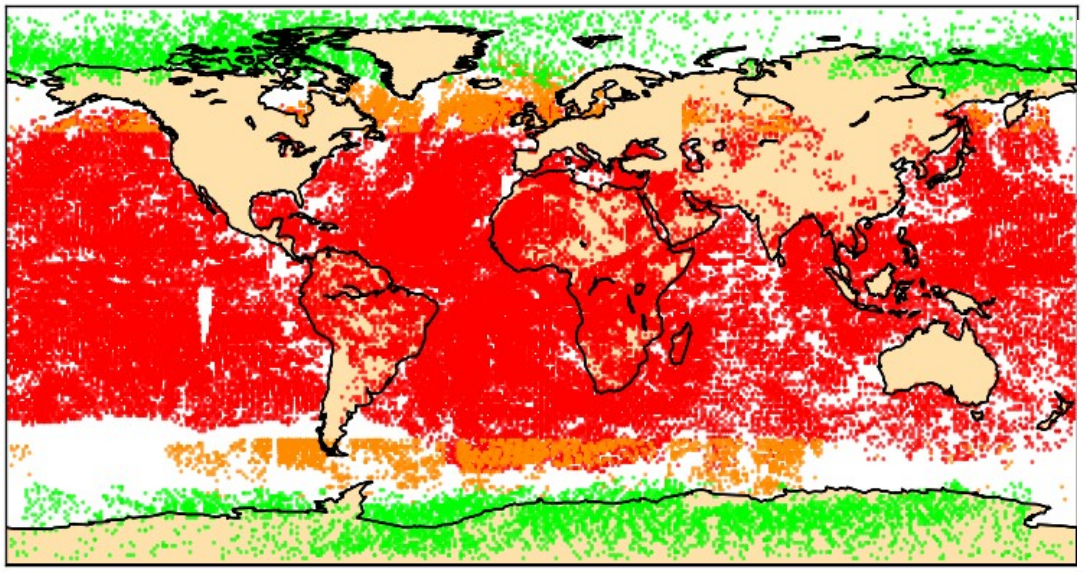
Atmospheric Motion Vectors

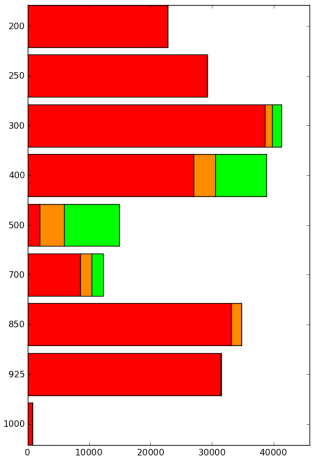
Control





NRLAMV





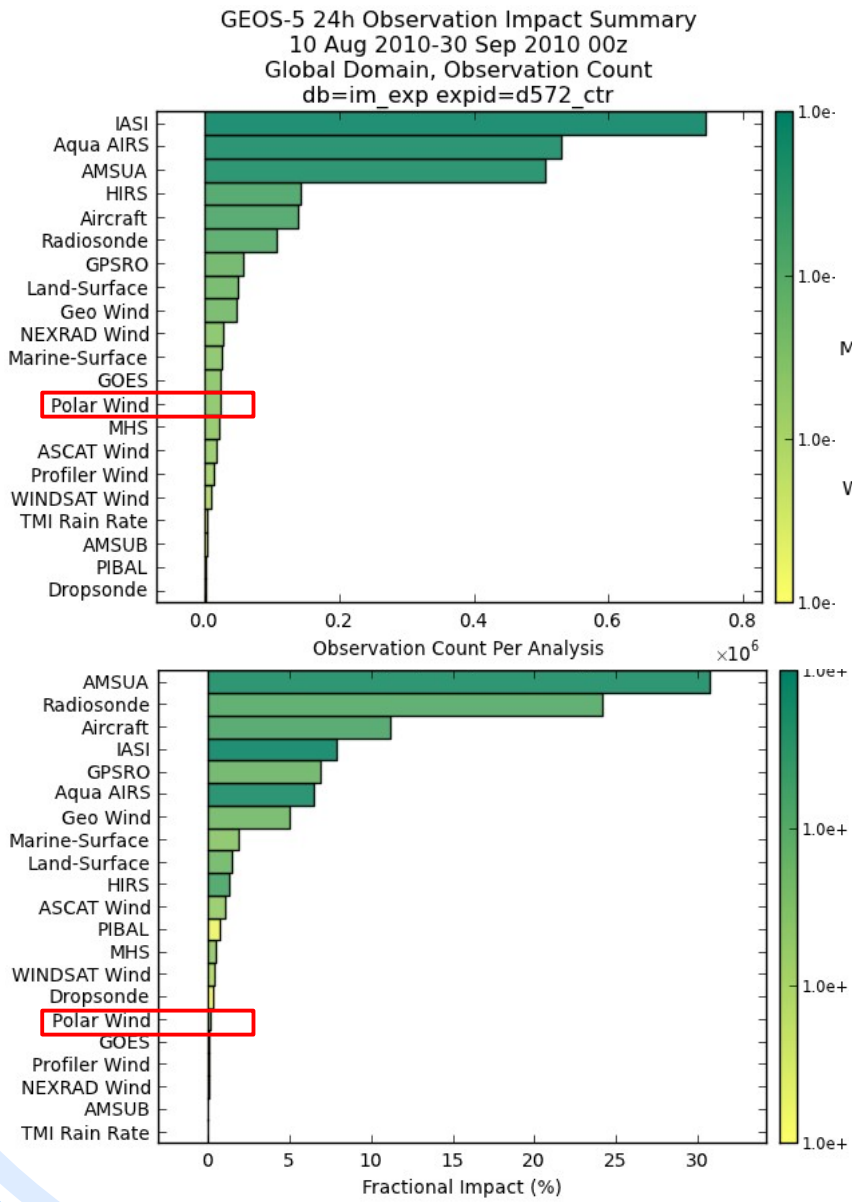
Polar Winds

- Control run
  - MODIS winds (IR,WV-cloudy, WV-clr)
    - AQUA
    - TERRA
- NRLAMV
  - MODIS winds (IR,WV)
    - AQUA
    - TERRA
    - mixed
  - AVHRR winds (IR)
    - NOAA
    - METOP

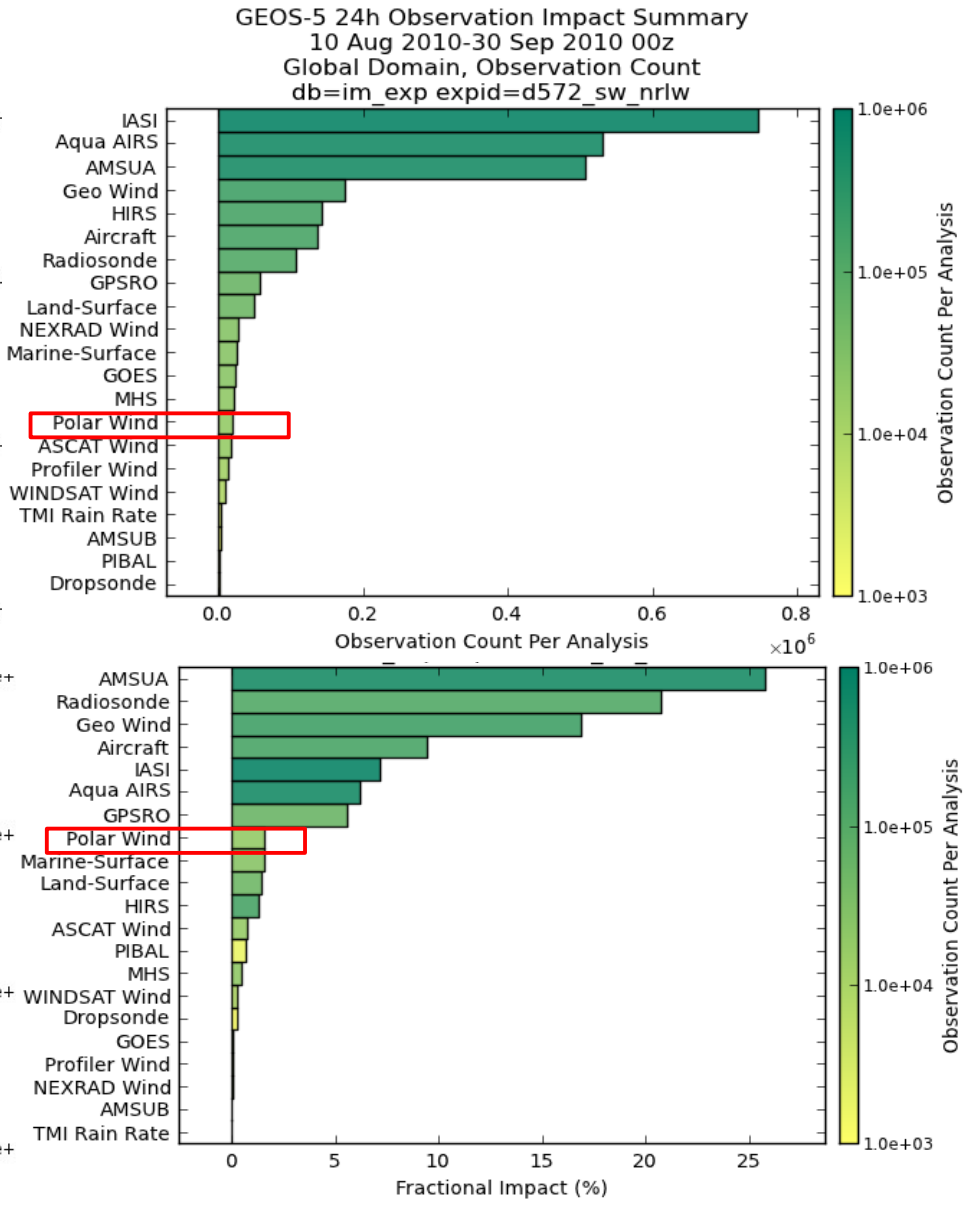
Observation Impact – Global

Aug10-Sep30 2010

CONTROL



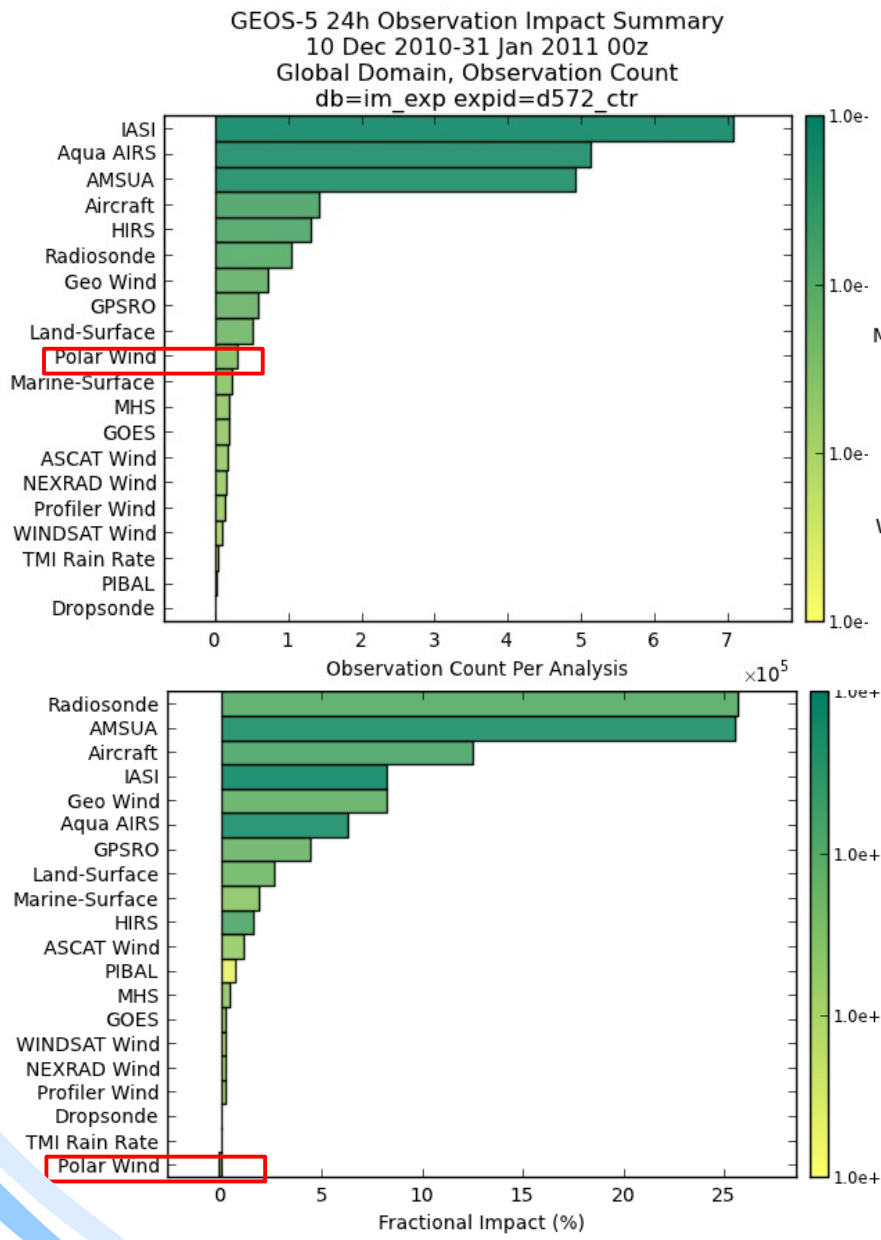
NRLAMV



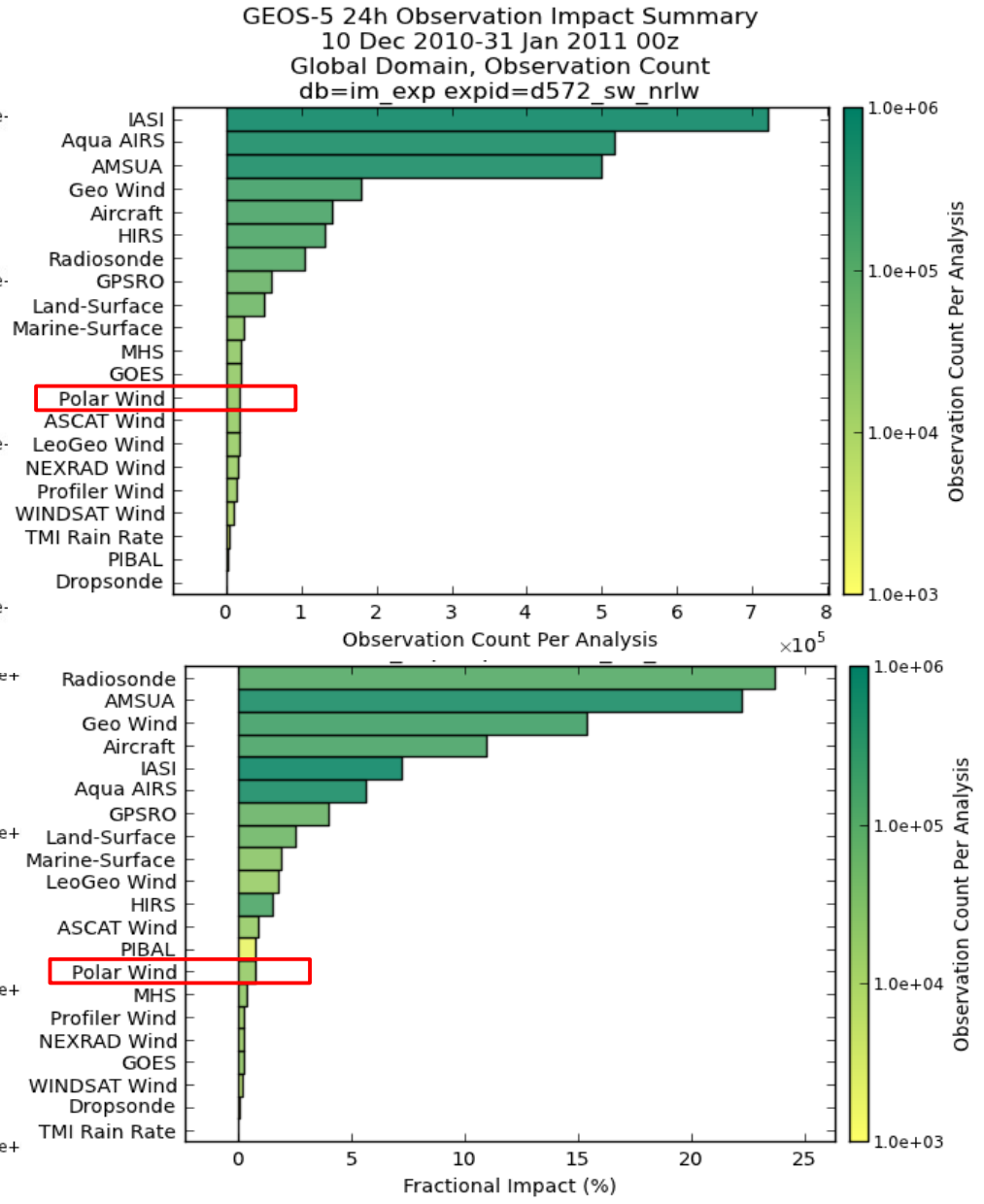
Observation Impact – Global

Dec10 2010 -Jan31 2011

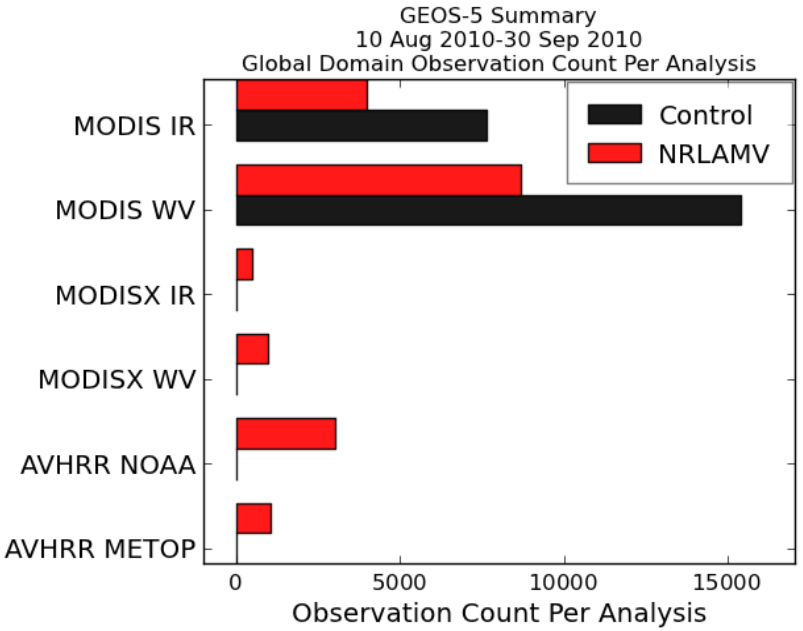
CONTROL

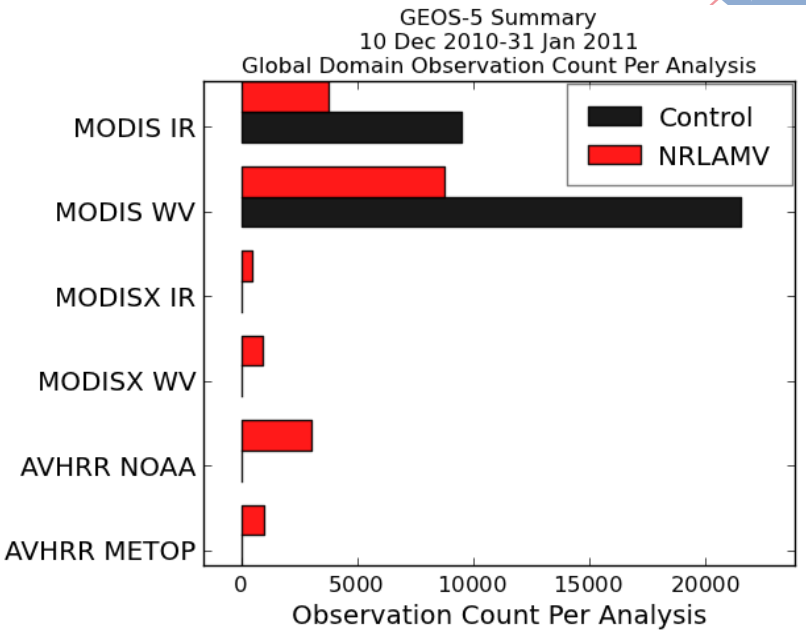


NRLAMV

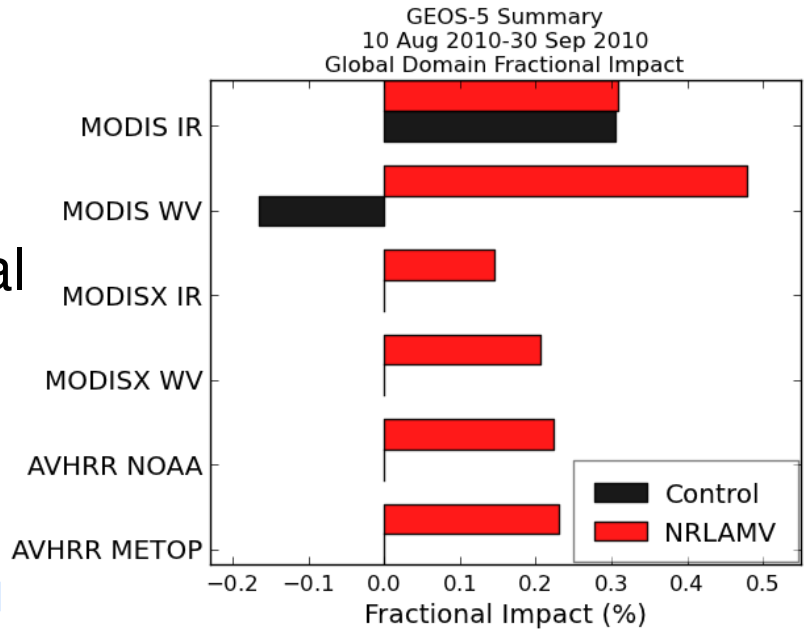


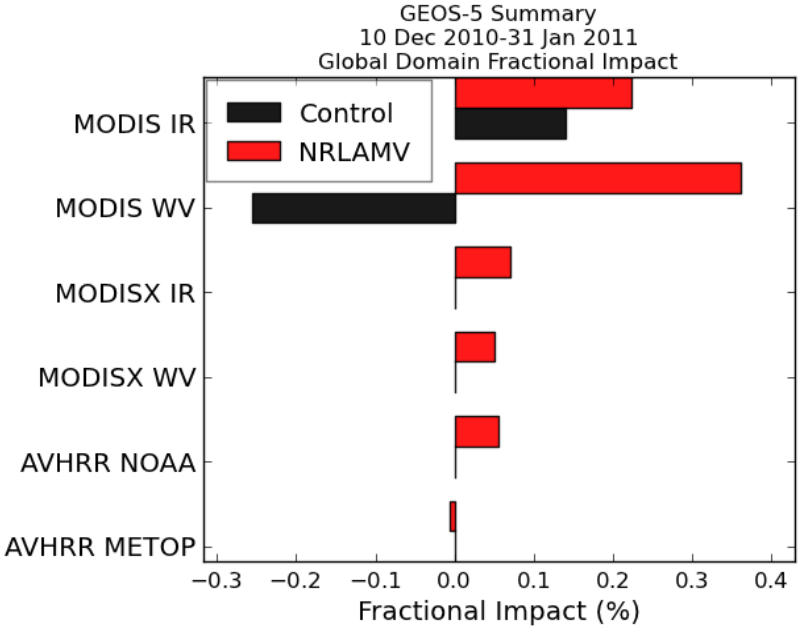
Number of obs



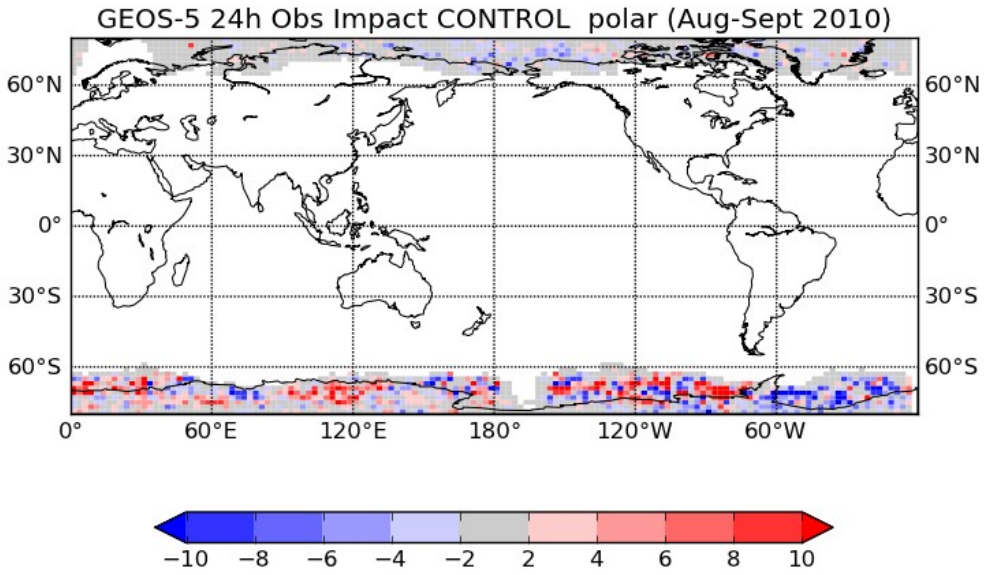


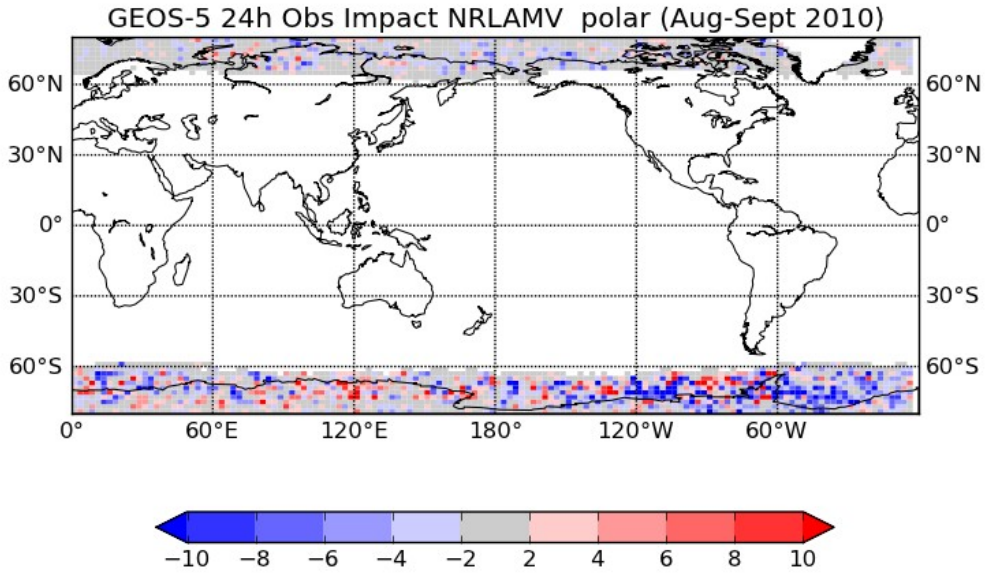
Fractional Impact

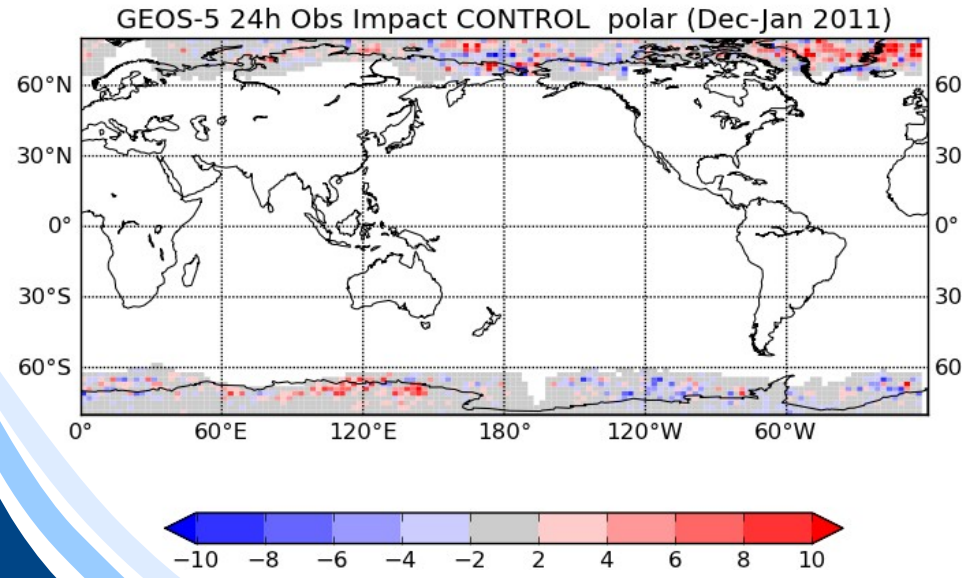


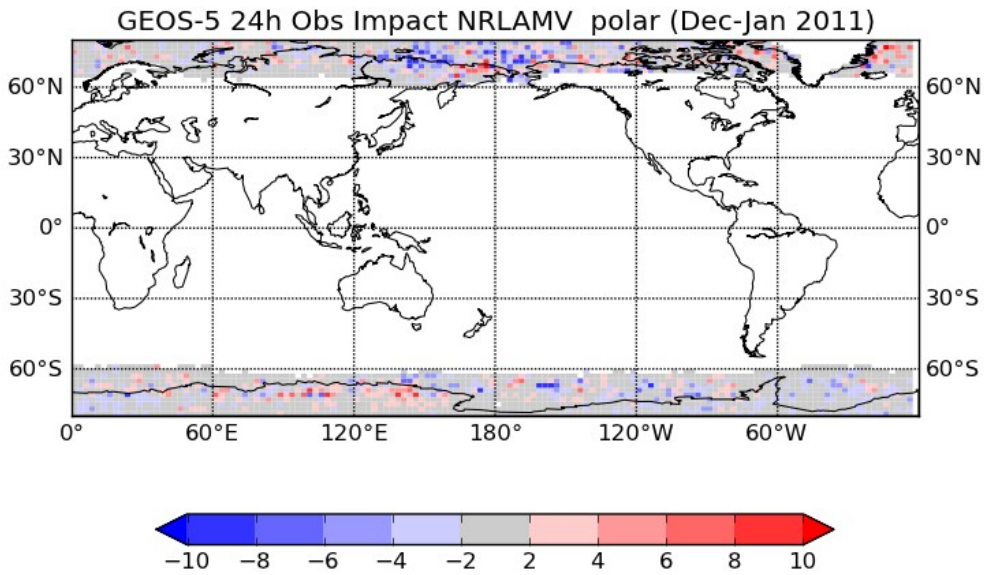


Observation Impact for Polar Winds

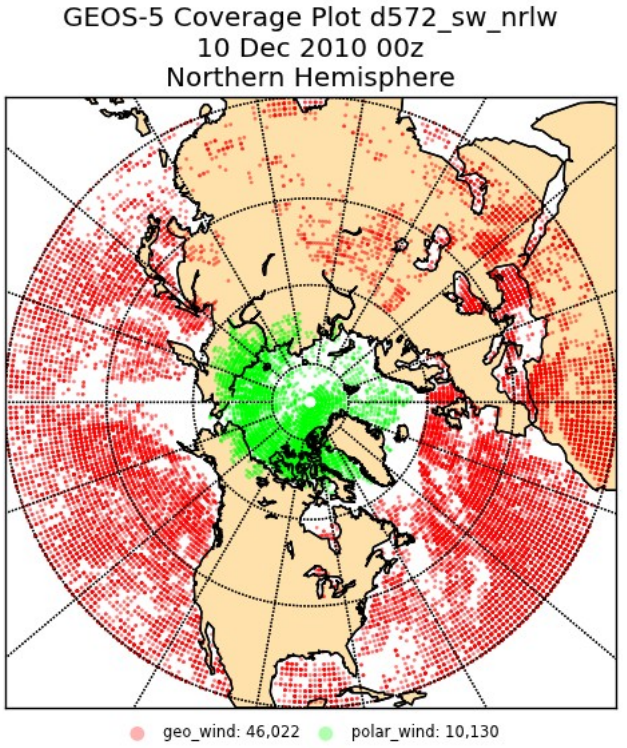


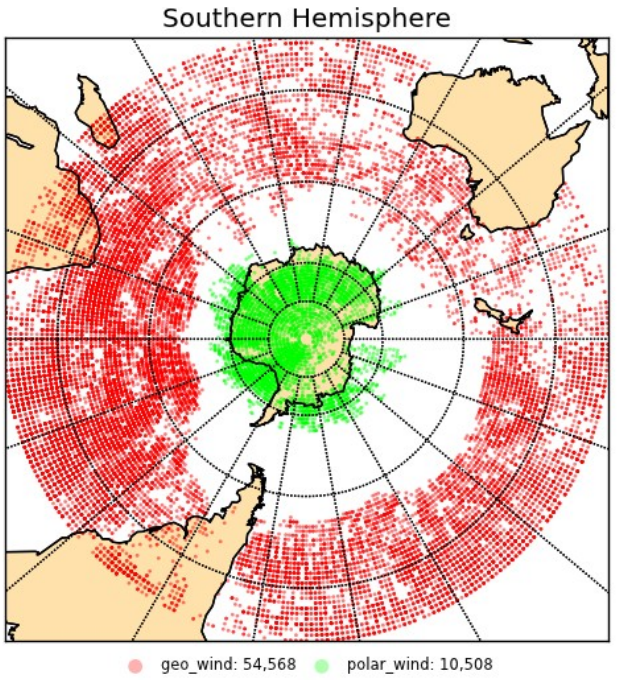






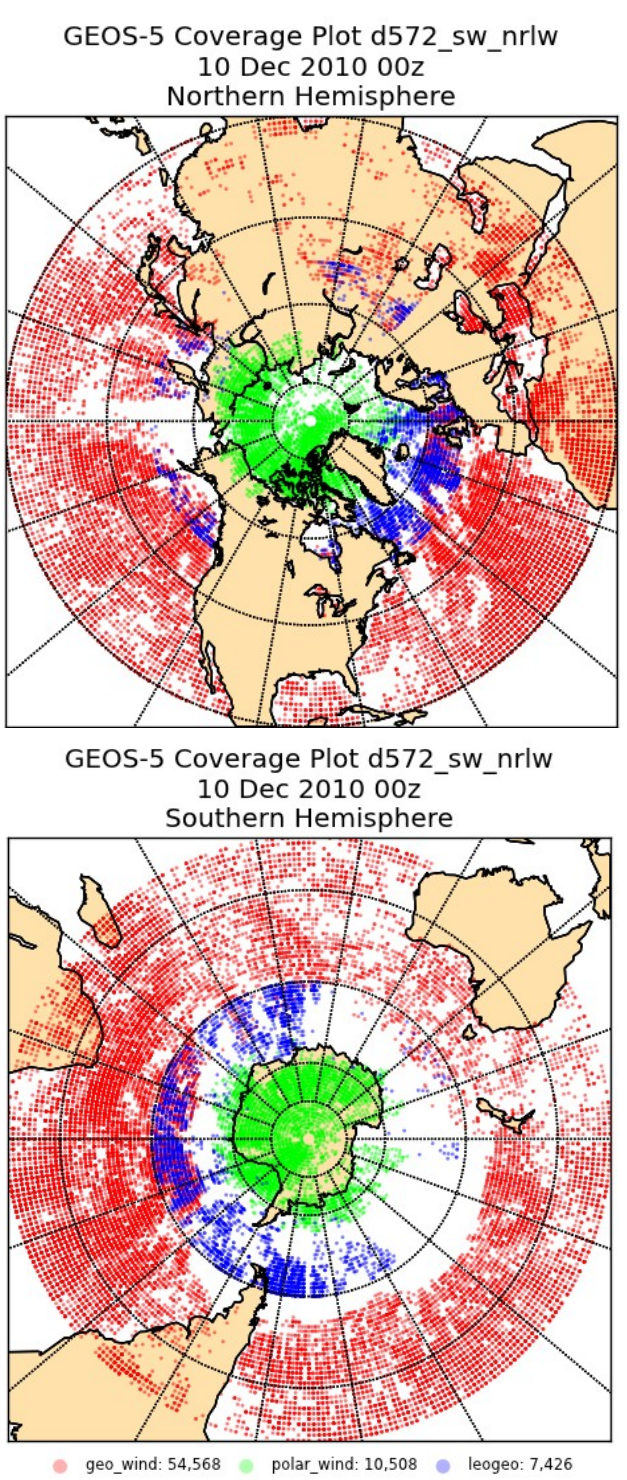
LeoGeo Winds





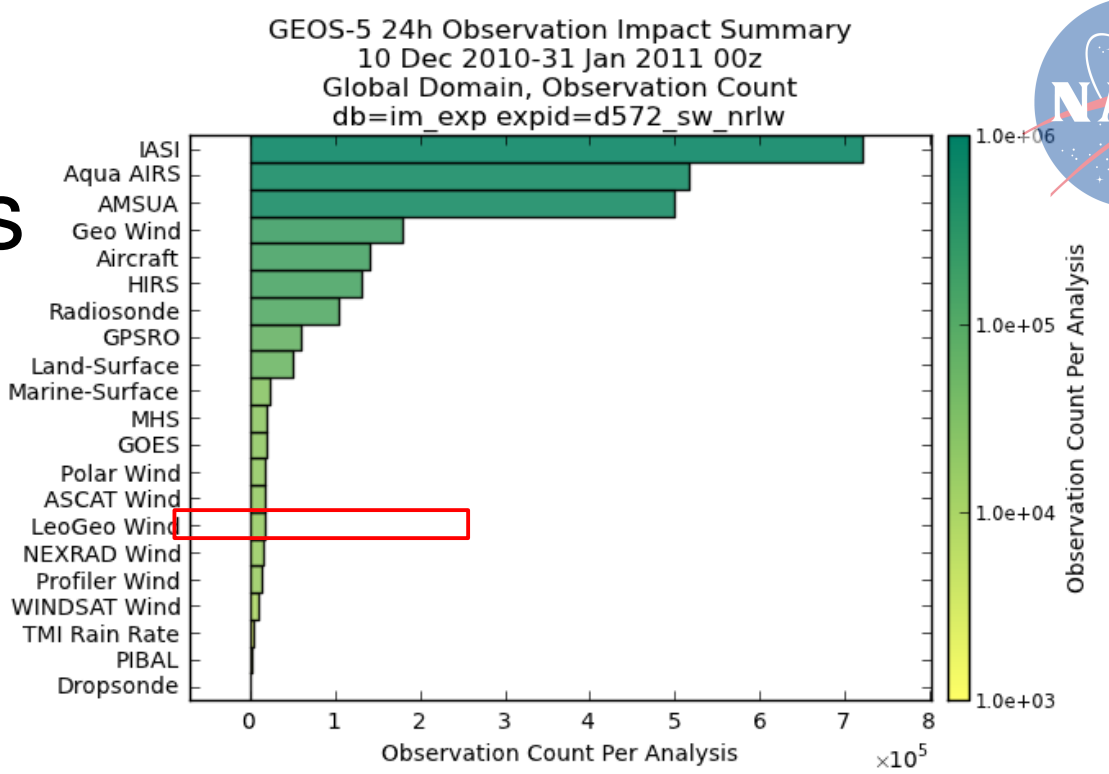
LeoGeo Winds

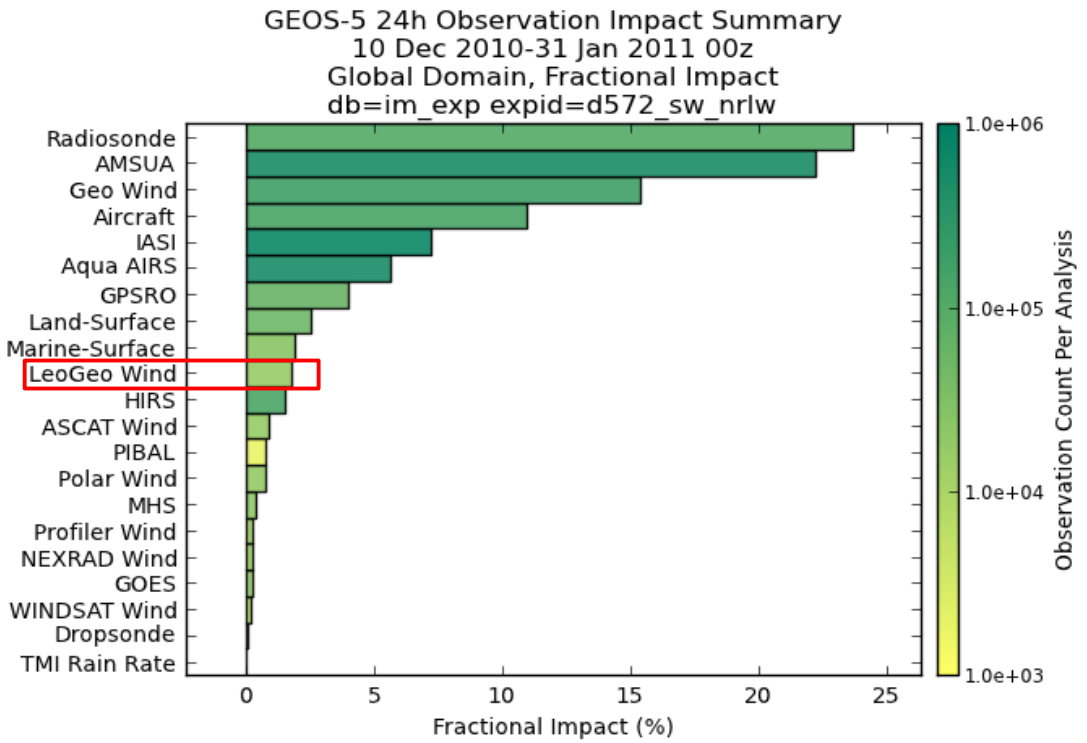
- Combined Geo/Leo AMV (GEOS,METEOSAT,FY-2,MTSAT+NOAA,MODIS,MetOp
- Filling the gap in AMVs
- Optimal spatial and temporal resolution from geostationary and polar orbiting satellite



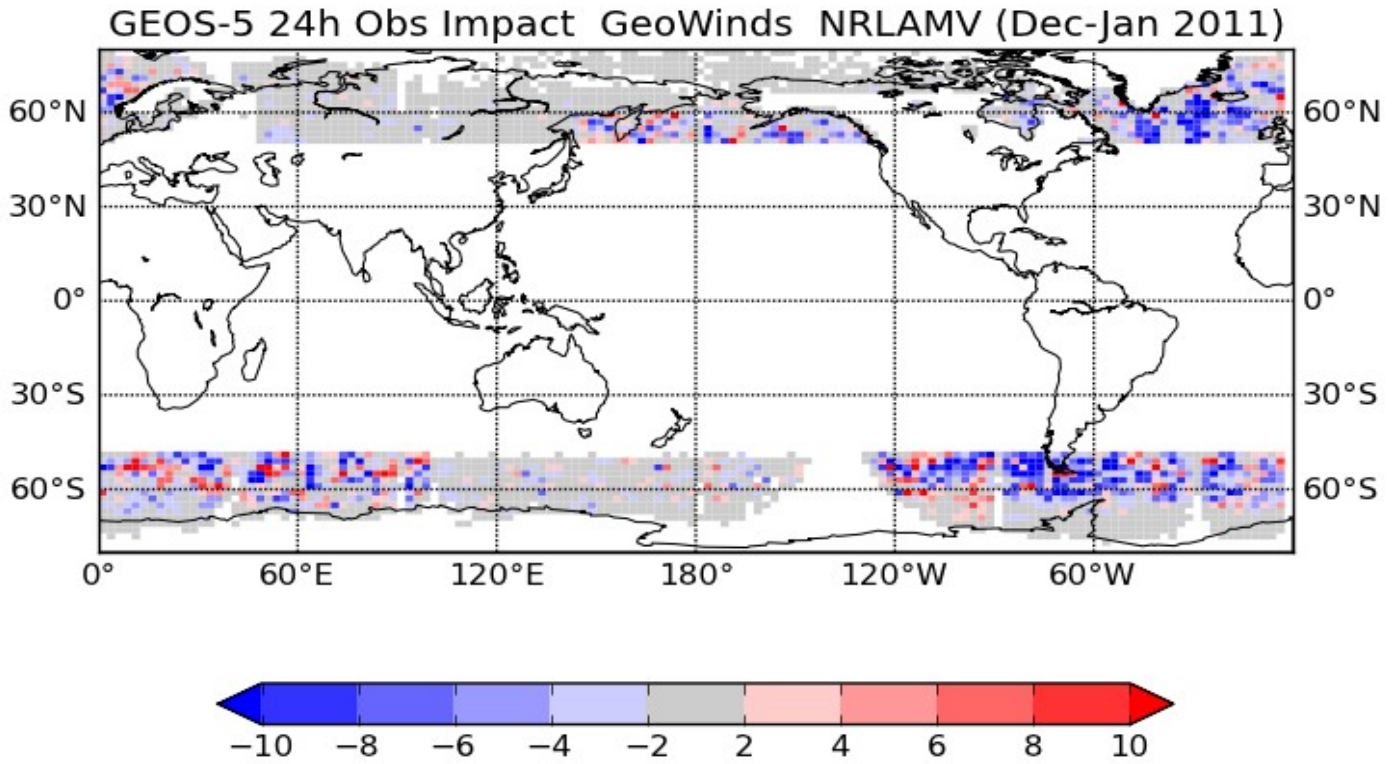
Leo-Geo Winds

Dec10 2010 -Jan31 2011

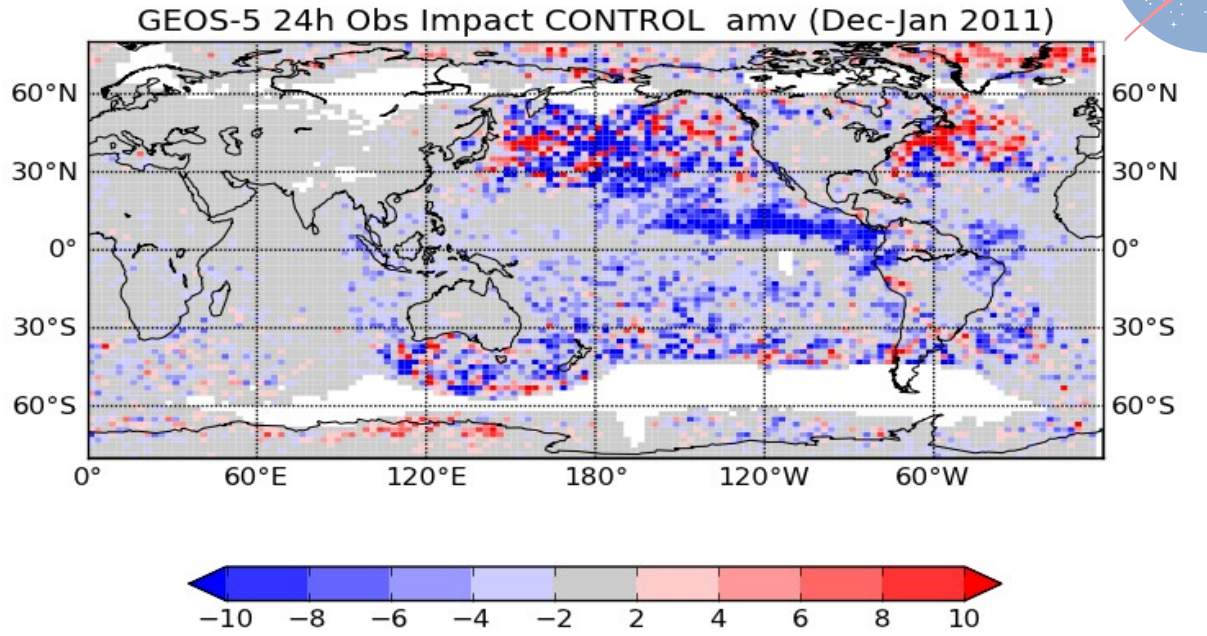


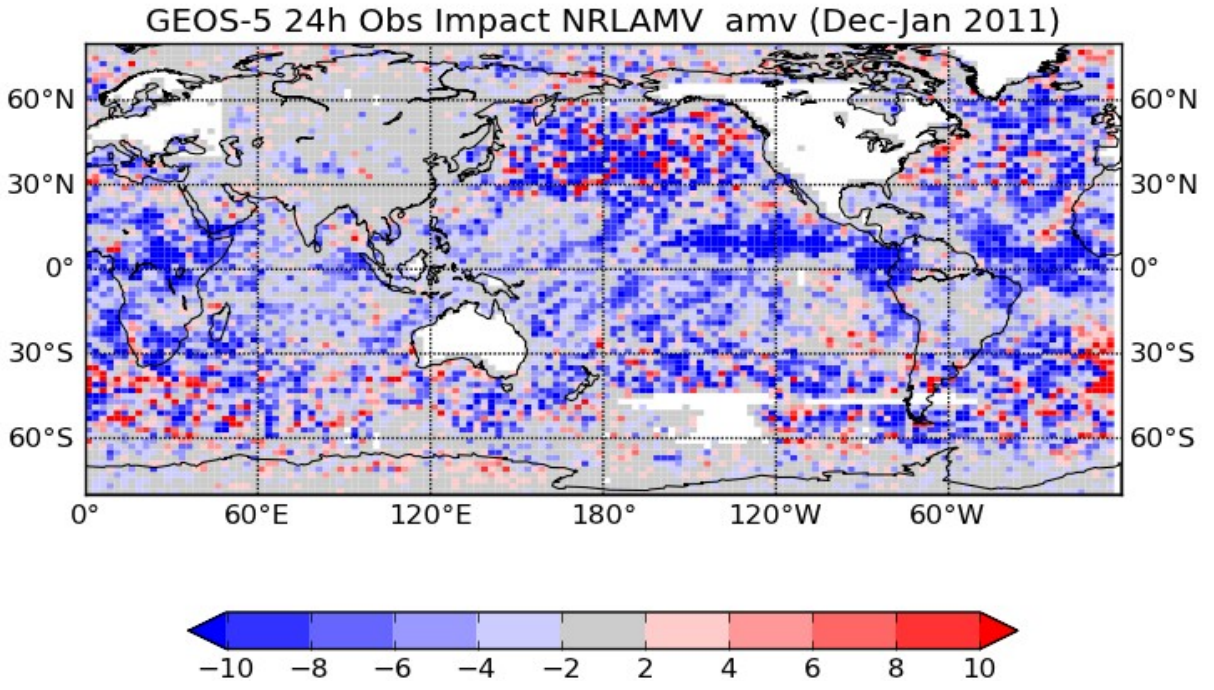


Observation Impact of Leo-Geo Winds



... and all together





Conclusions

• Assimilation of NRL AMVs improved observation impact of satellite winds in GEOS-5 data assimilation system.

• The greater volume of the NRL AMVs appears to be primary reason for larger impact

• Other differences (superobing, , radiance reduction) seems to have more seasonal and spatial variations

• Additional AMV from sub-polar regions (Leo-Geo) in NRL AMV set of observations had positive impact on the system.

• Forecast skill of the system using any subset of the NRL AMV's was generally improved.

• Robustness of the system suggest that removing some part of the observing system will be compensated by remaining observations.

Observation Impact of Geo Winds