Assimilation and Forecast Impacts Using the Expected Error in the Quality Control of MODIS Polar Winds

David Santek, Brett Hoover, James Jung
Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin - Madison

11th International Winds Workshop
Auckland, New Zealand
21 February 2012

Outline

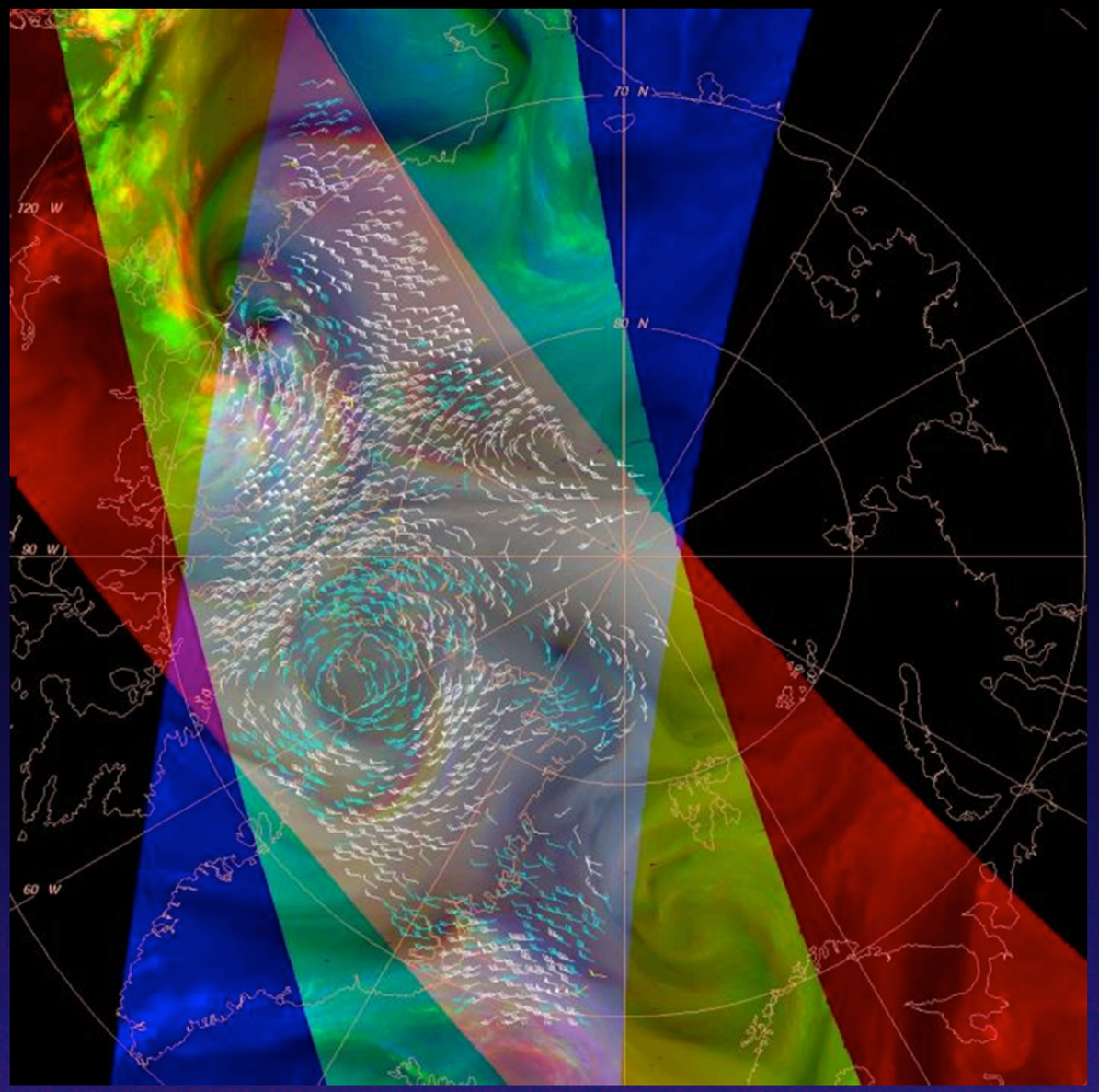
- Polar Winds
- Current NCEP QC method
- What is the Expected Error?
- Comparison of QC methods
- O-B and O-A statistics
- Forecast impact

Satellite-derived Polar 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.

Winds must be derived for areas that are covered by three successive orbits

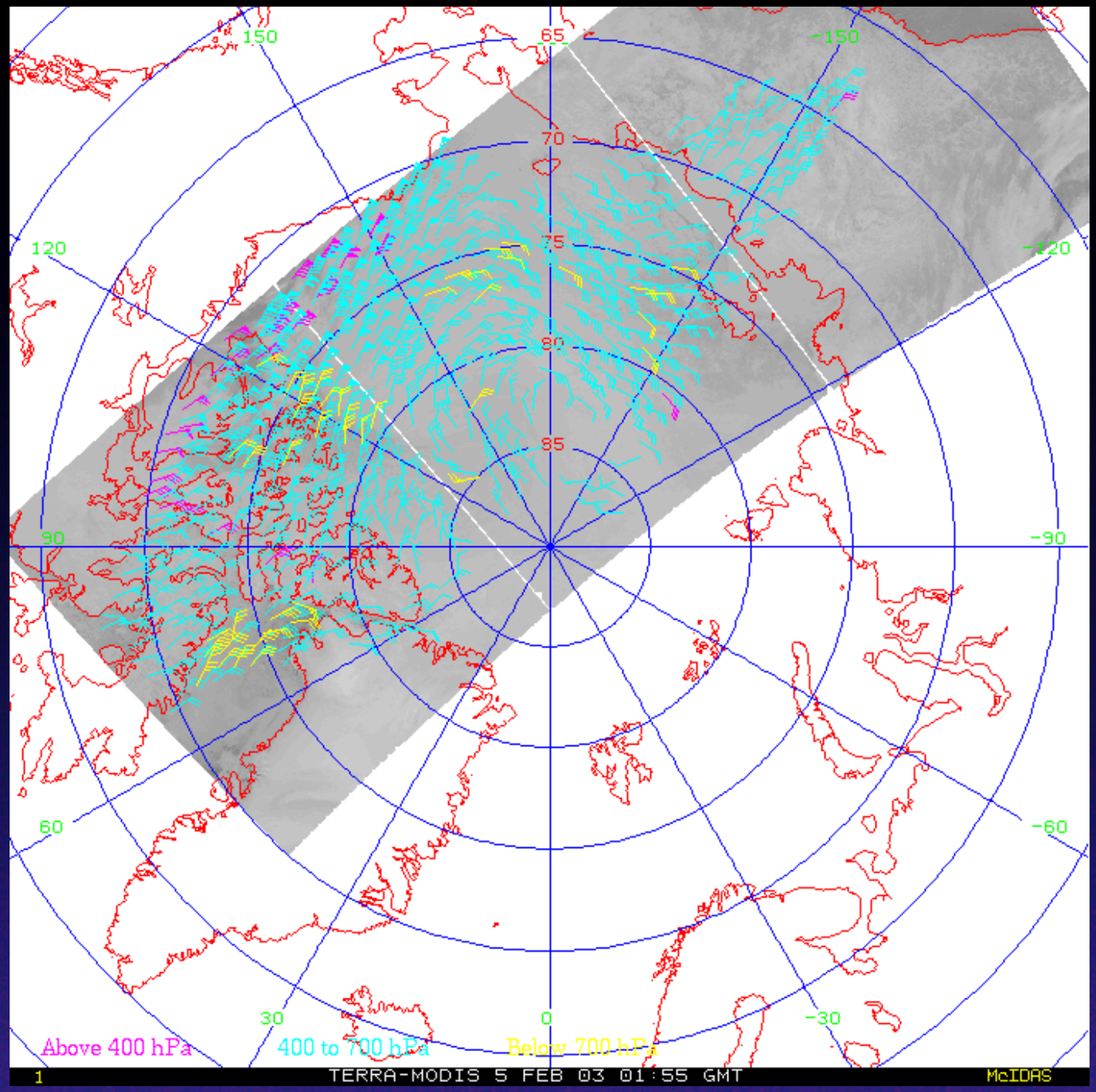
The gray area is the overlap between three orbits.



Three overlapping Aqua MODIS passes, with WV and IR winds superimposed. The white wind barbs are above 400 hPa, cyan are 400 to 700 hPa, and yellow are below 700 hPa.

One Day of Arctic Orbits

Terra MODIS



MODIS band 31 (11 μm)

MODIS Polar Winds QC

NCEP criteria to discard

Within 50 hPa of the tropopause
Within 200 hPa of the surface (if land or ice)

<u>Current</u>

qcU* = qcV = 7 ms^{-1}

$(O\text{-}B)_U$ > qcU OR

$(O\text{-}B)_V$ > qcV

<u>Proposed</u>

EE > 5 ms^{-1} AND

EE > 0.1 * ObsSpd

* Special case:

qcU = qcV = (ObsSpd + 15)/3

(IR wind within 200 hPa of surface OR

WV wind below 400 hPa) AND

(GuessSpd +15)/3 < qcU

Expected Error

Least square regression is used to compute the RMSE (ms^{-1}) from the EE components as compared to co-located RAOBs. Example for Terra cloud drift winds:

Components	Coefficients
Constant	+8.4
Wind speed	+0.1
Wind shear	+0.03
Five QI values	-0.1 to -2.8
Temperature shear	-0.01
Pressure level	-0.003

Expected Error

Components	Terra	Aqua
Constant	+8.4	+8.3
Wind speed	+0.1	+0.07
Wind shear	+0.03	+0.02
QI values		
Speed	-0.4	+0.07
Direction	-0.1	+0.5
VS	-0.6	-0.3
LC	-0.6	-1.6
Forecast	-2.8	-2.1
Temperature shear	-0.01	-0.01
Pressure level	-0.003	-0.003

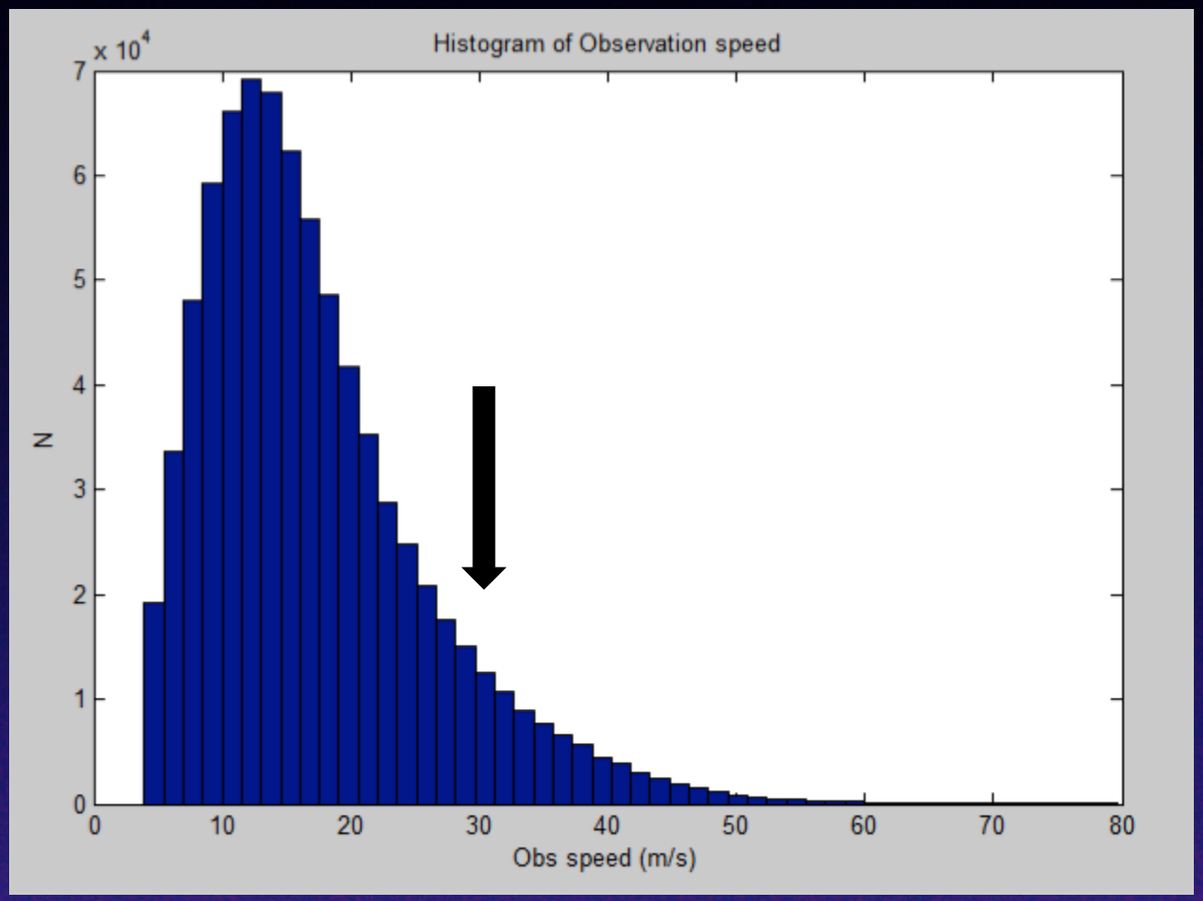
For QI values 0.8 to 0.9 the Aqua EE values are 0.4 ms^{-1} greater

GFS Experiment 1

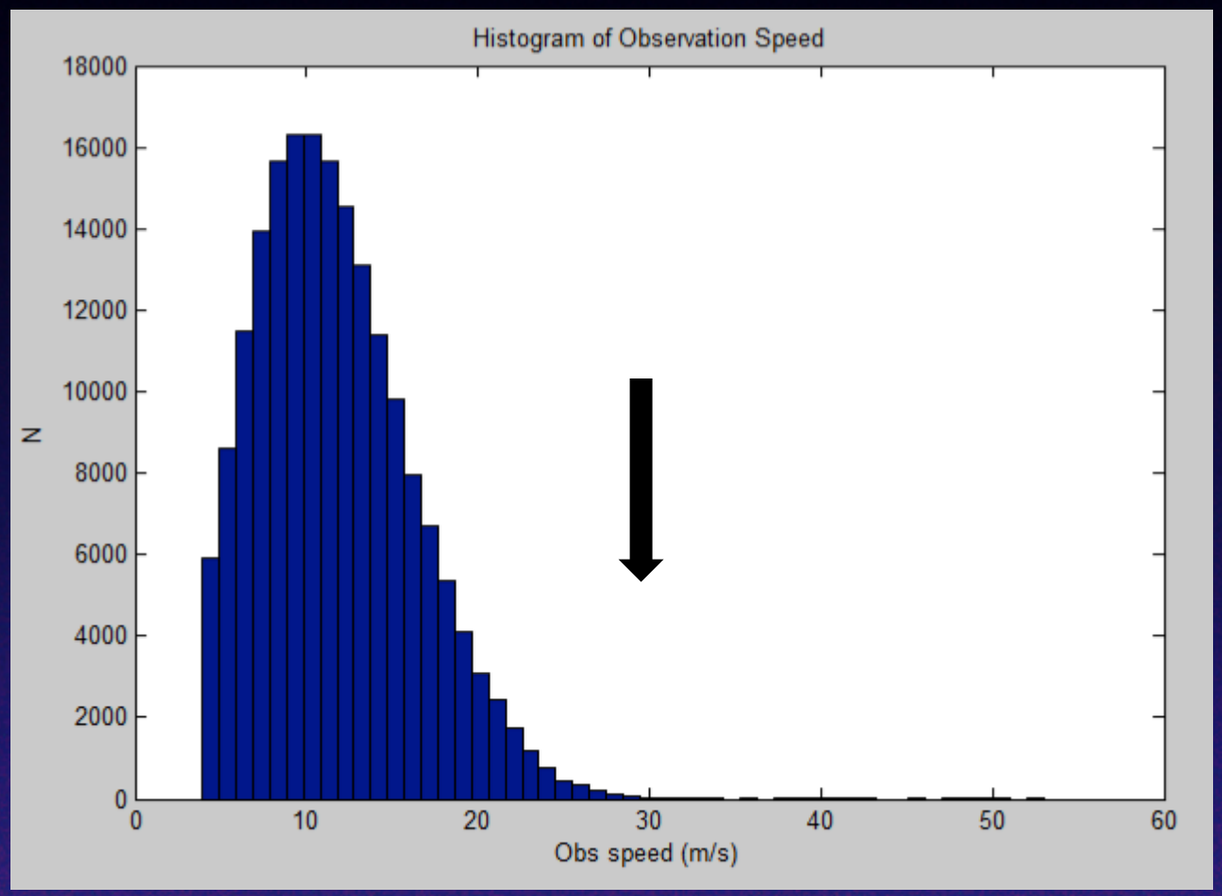
- Running 2010 vsn GDAS/GFS on NCEP development system
- September 2010
- Discard if: EE > 5 ms^{-1} AND EE > 0.1 * ObsSpd
- Following statistics based on 10 days for all winds in both Arctic and Antarctic: 10 to 19 September 2010

10 – 19 Sept. 2010

	Control	Experiment
Raw vectors	2500K	2500K
Good vectors	790K	187K



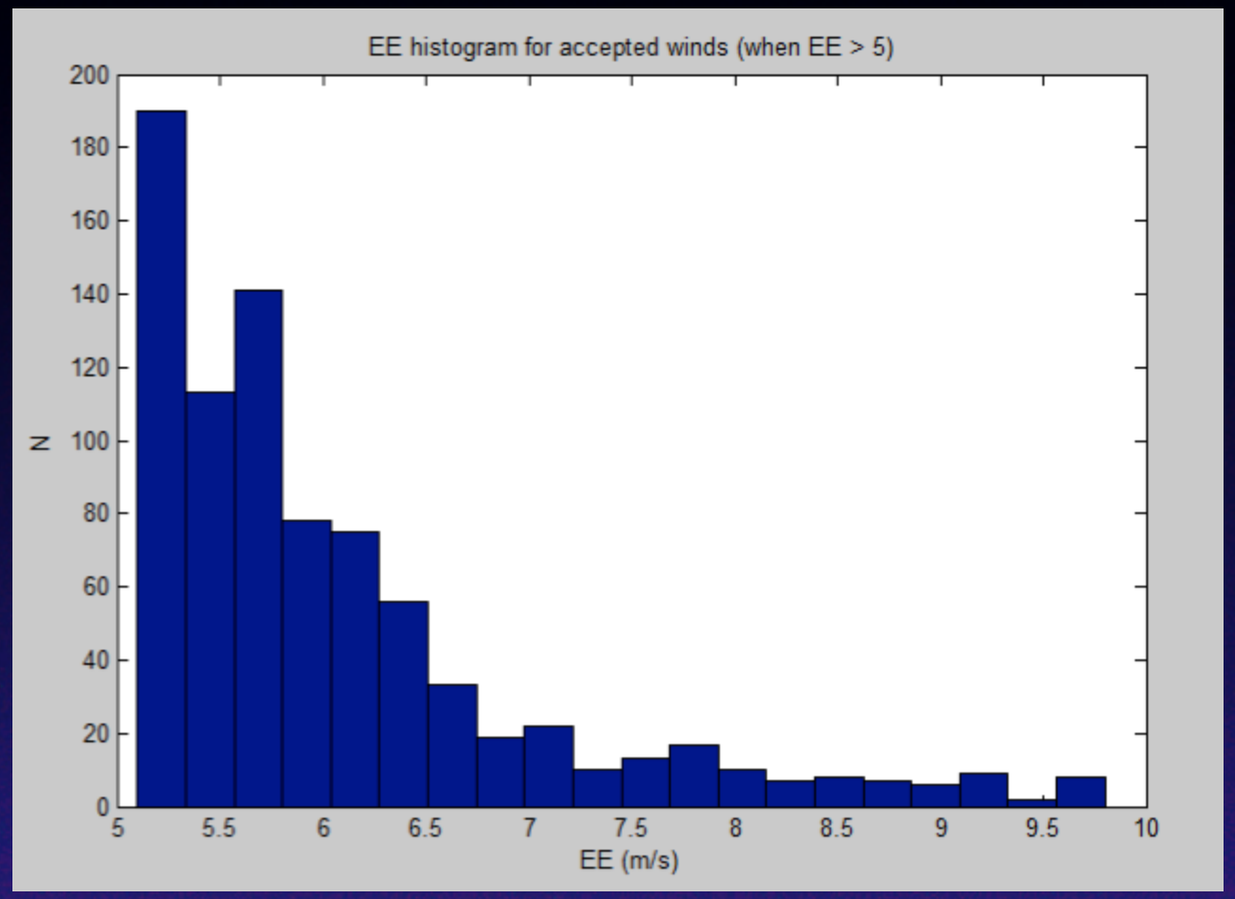
Control accepted obs



Experiment accepted obs

Experiment I
EE > 5 m/s

Some winds are retained by allowing the EE larger than 5 m/s for high wind speeds (however, only about 0.1% for this first run)



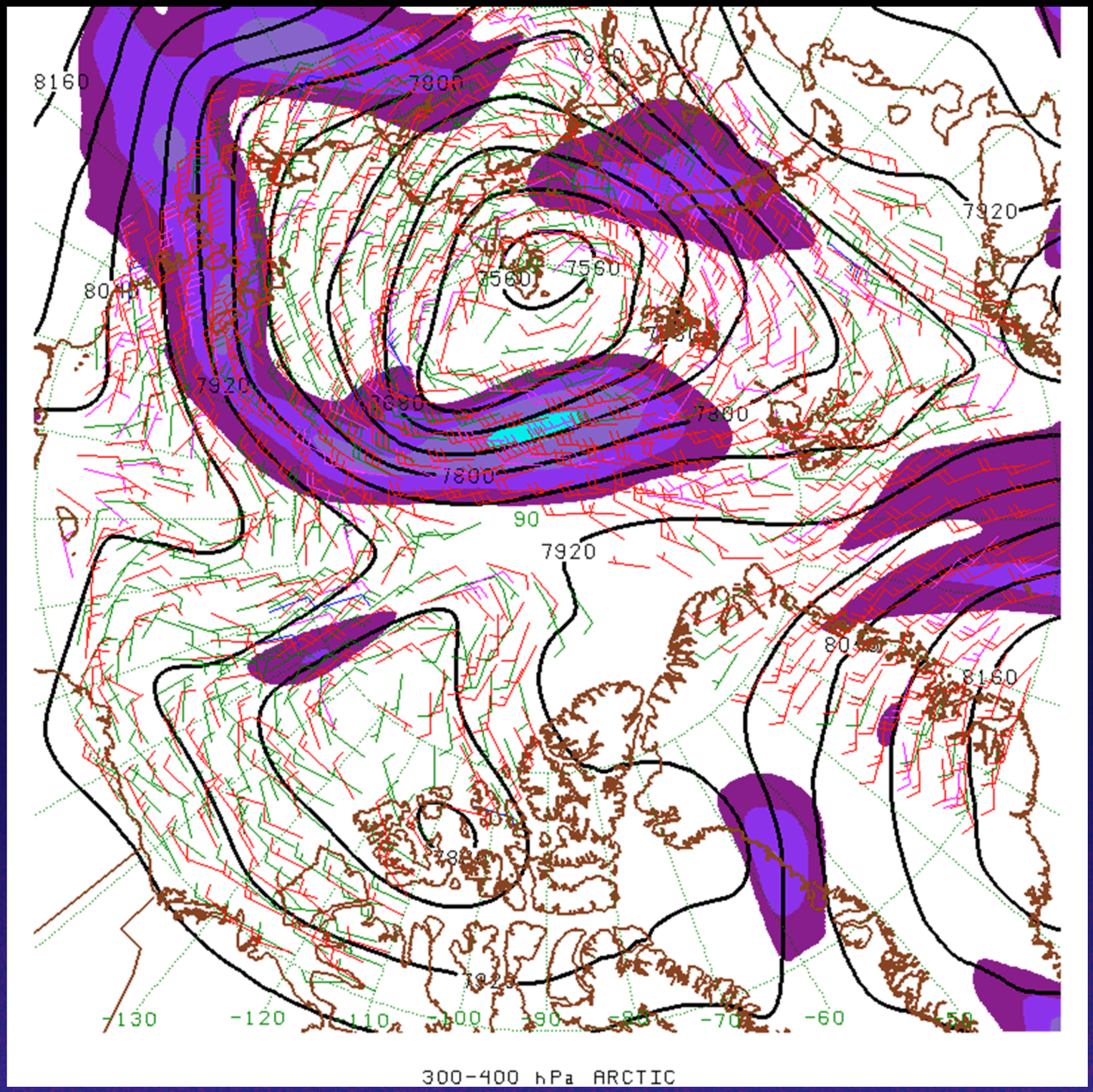
Example QC Difference

- Green: communal accepted
- Magenta: communal rejected
- Blue: EE accepted
- Red: EE rejected

Arctic

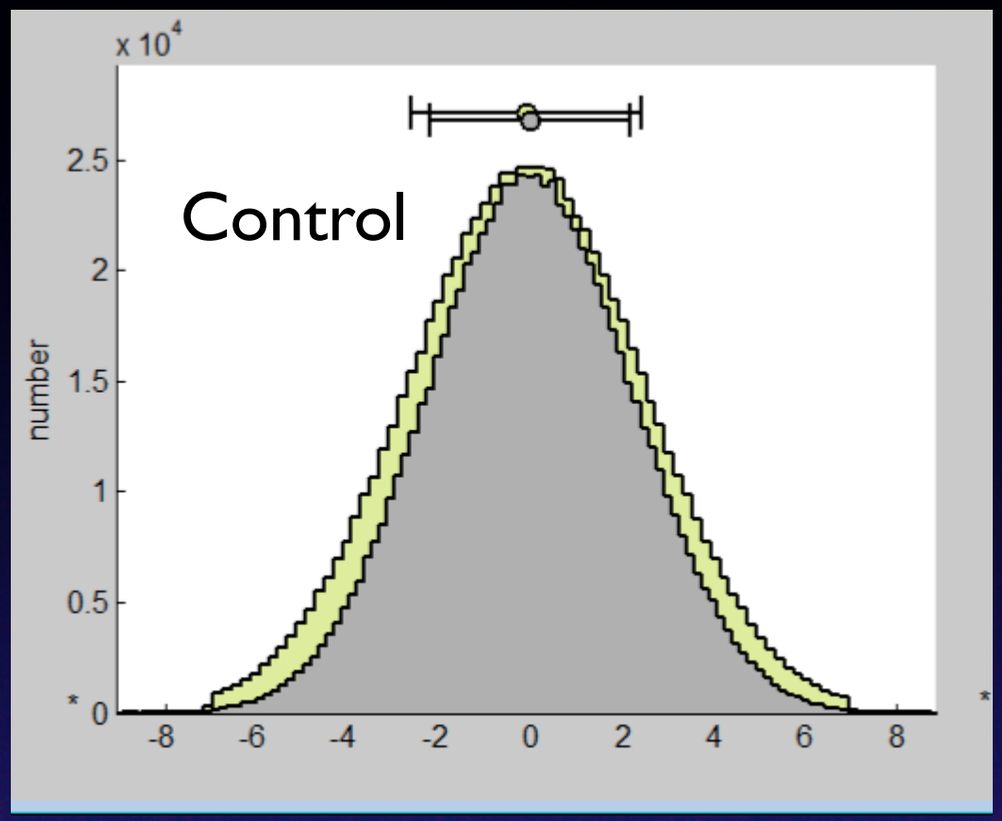
01 Sept 2010 06 UTC

300 – 400 hPa winds



Control vs. Experiment

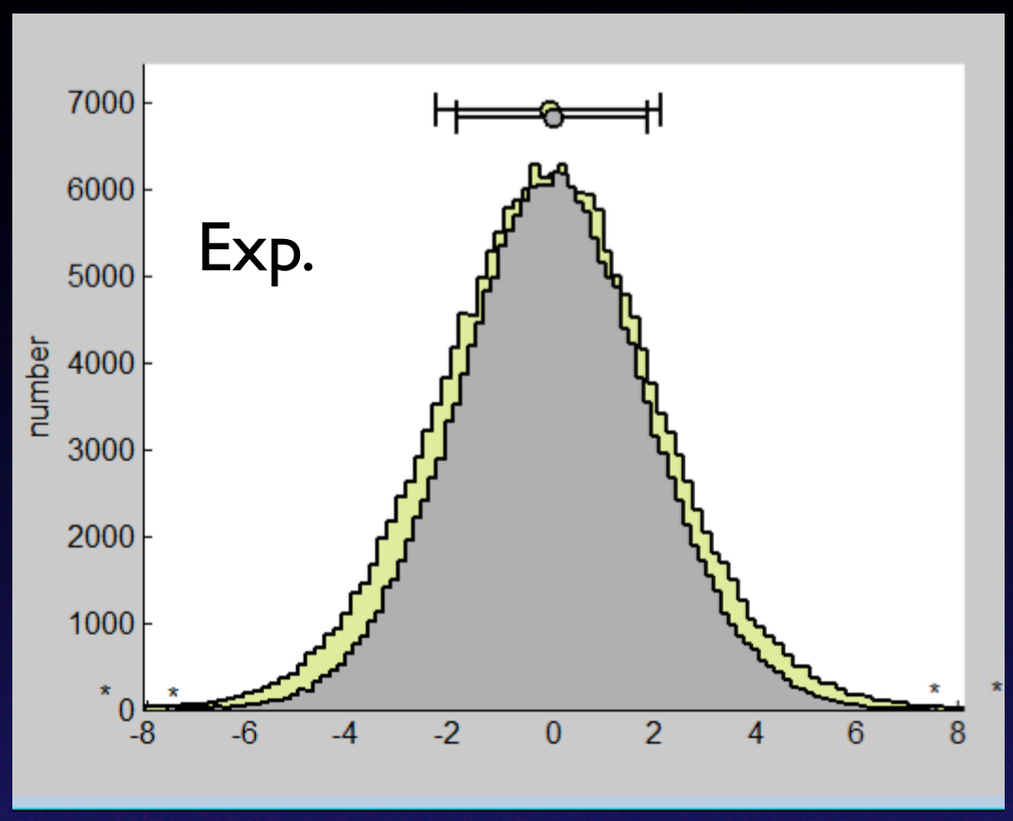
Observation minus background and analysis



U-component (ms^{-1})

O-B: mean = -0.1 stddev = 2.5

O-A: mean = 0.0 stddev = 2.2



U-component (ms^{-1})

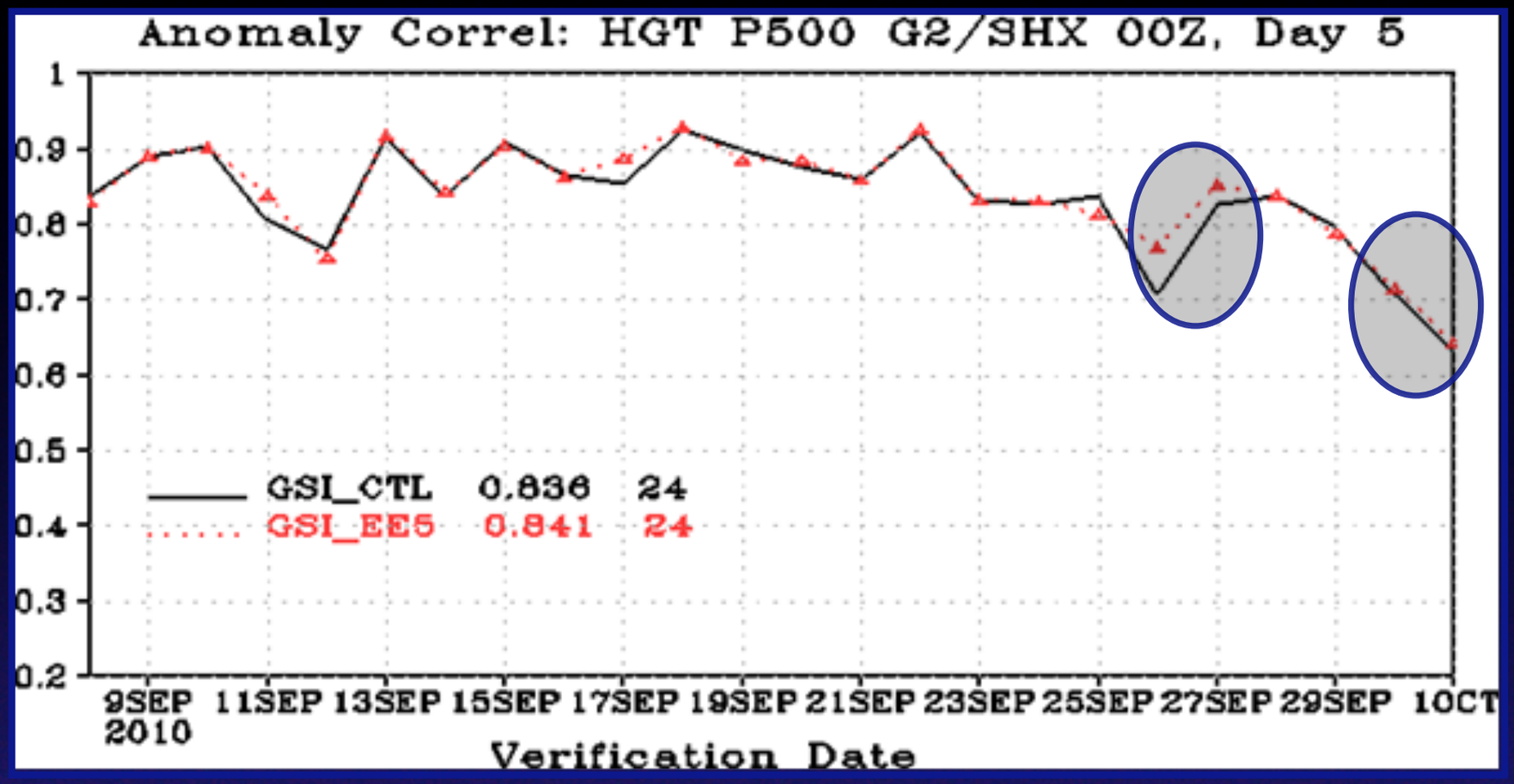
O-B: mean = -0.1 stddev = 2.2

O-A: mean = 0.0 stddev = 1.9

Yellow: Obs – Background Gray: Obs - Analysis

Forecast Impact

Anomaly Correlation Coefficient

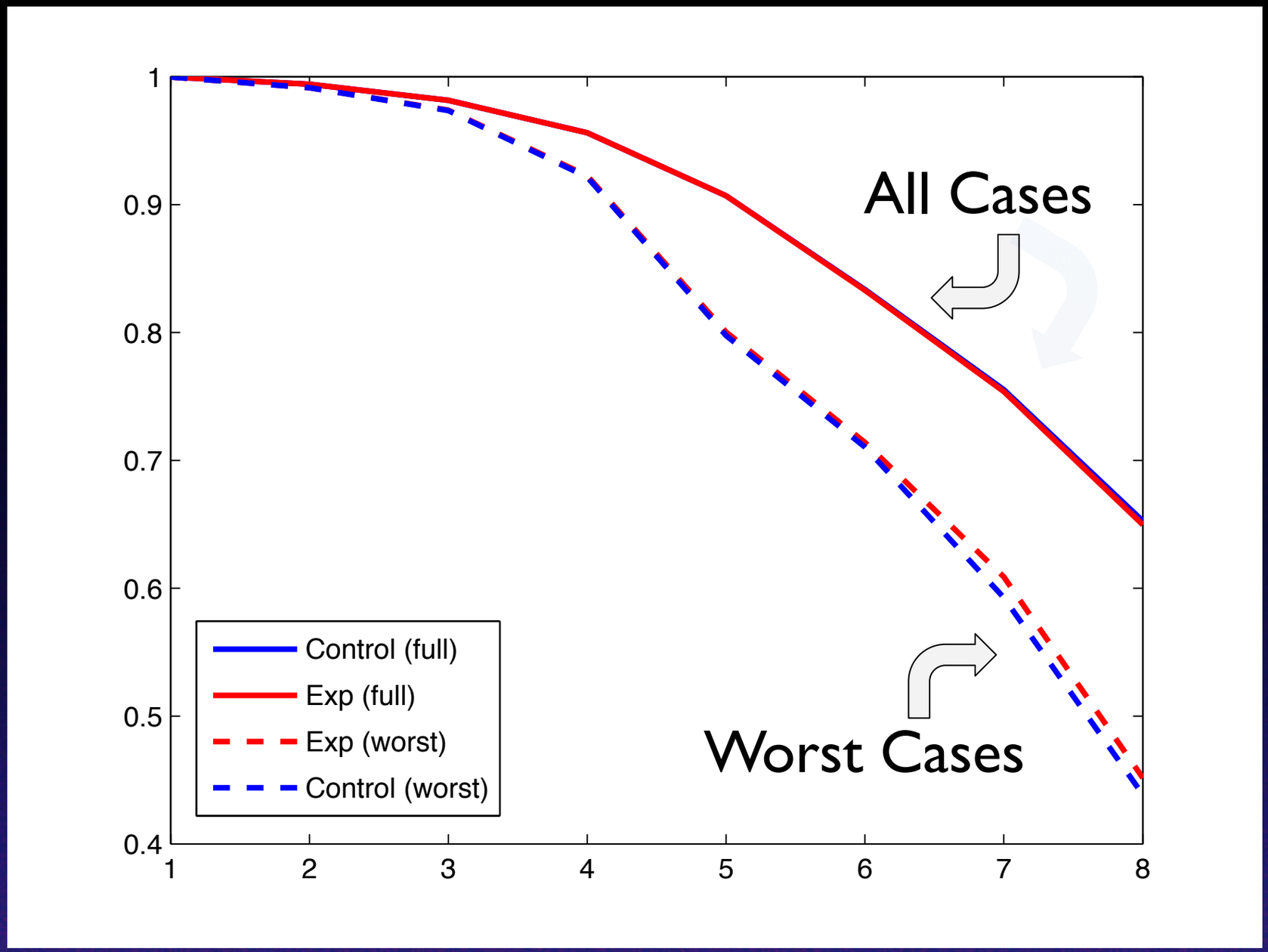


- Day 5 500 hPa geopotential height ACC
- 08 September to 01 October 2010
- Southern Hemisphere: control (black); experiment (red)

GFS Experiment II

- Running 2010 vsn GDAS/GFS on NCEP development system
- 01 September to 03 October 2010
- Discard if: EE > 9 ms^{-1} AND ObsSpd < EE
  - Retains higher speed winds
  - Neutral impact, except for an improvement in S. Hemi. 'worst' cases (lower than 1 std. dev. below the mean)

GFS Experiment II

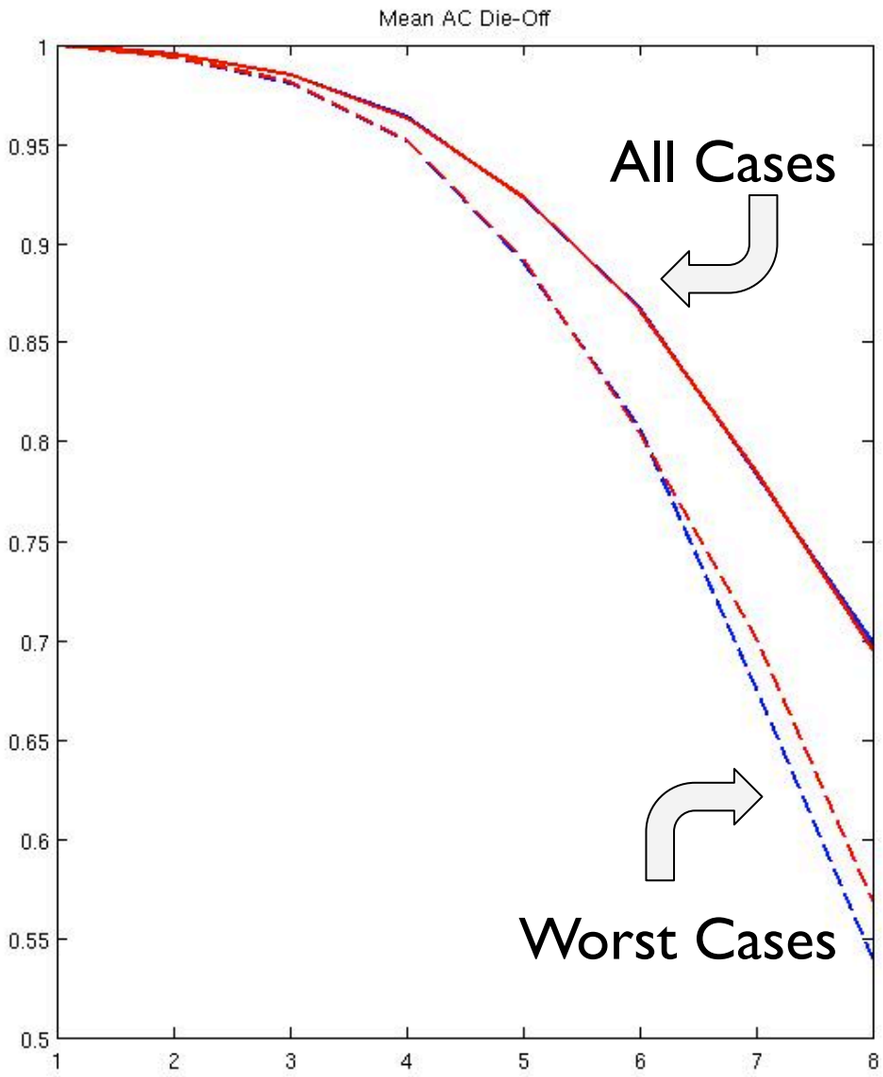


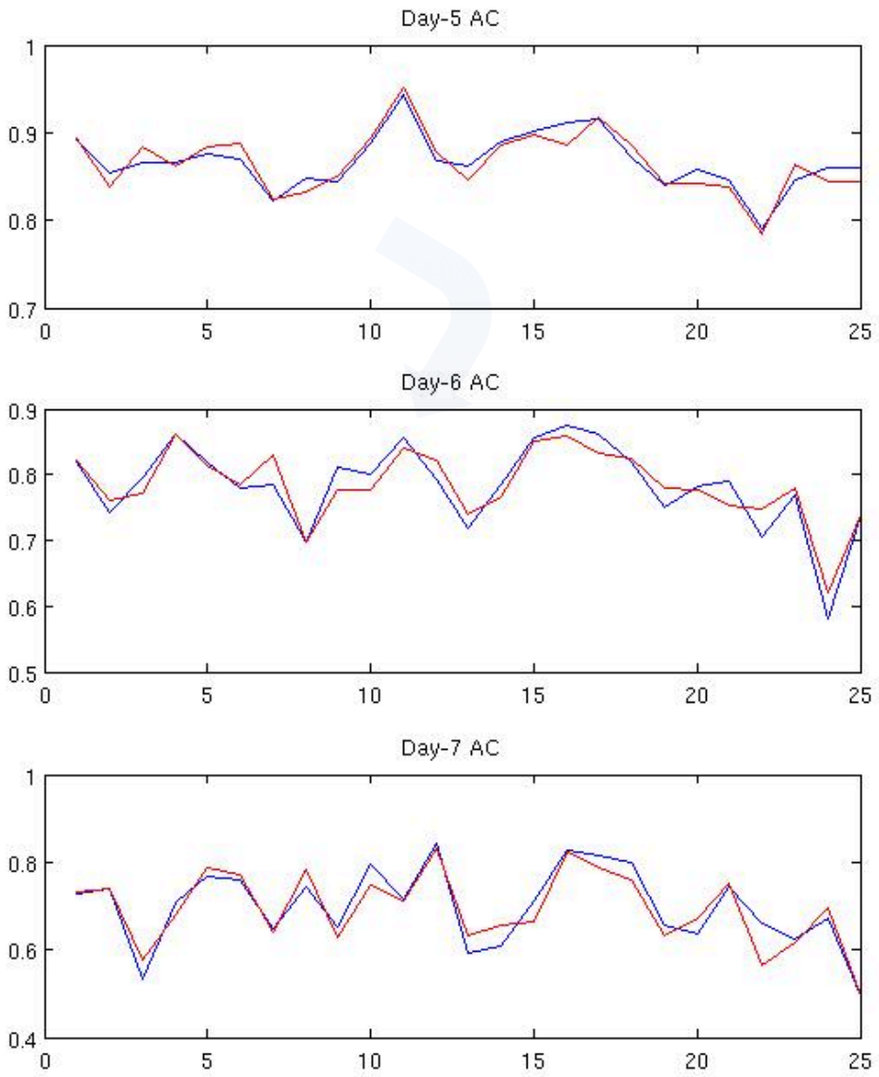
Southern Hemisphere 500 hPa ACC

GFS Experiment III

- Running 2010 vsn GDAS/GFS on NCEP development system
- 01 – 27 September 2010
- Retain all winds, but assign the observation error to the EE (control set to 7 ms^{-1})
- Observation error: minimum of 3 ms^{-1}
- Neutral impact in Northern Hemisphere; slight negative in Southern Hemisphere
- Improvement in worst cases in N. Hemi; neutral in S. Hemi.

GFS Experiment III





Northern Hemisphere 500 hPa ACC

Blue: control Red: experiment

Summary

- O-B and O-A statistics are comparable to current QC method
- On-going analysis of the two-season experiments
- The overall impact is neutral, but there is evidence that the worst cases are improved
- Examining flow-dependency on polar winds impact
- Suggest that EE coefficients be recomputed

NOAA: NA10NES4400011