High Latitude Satellite Derived Winds from Combined Geostationary and Polar Orbiting Satellite Data

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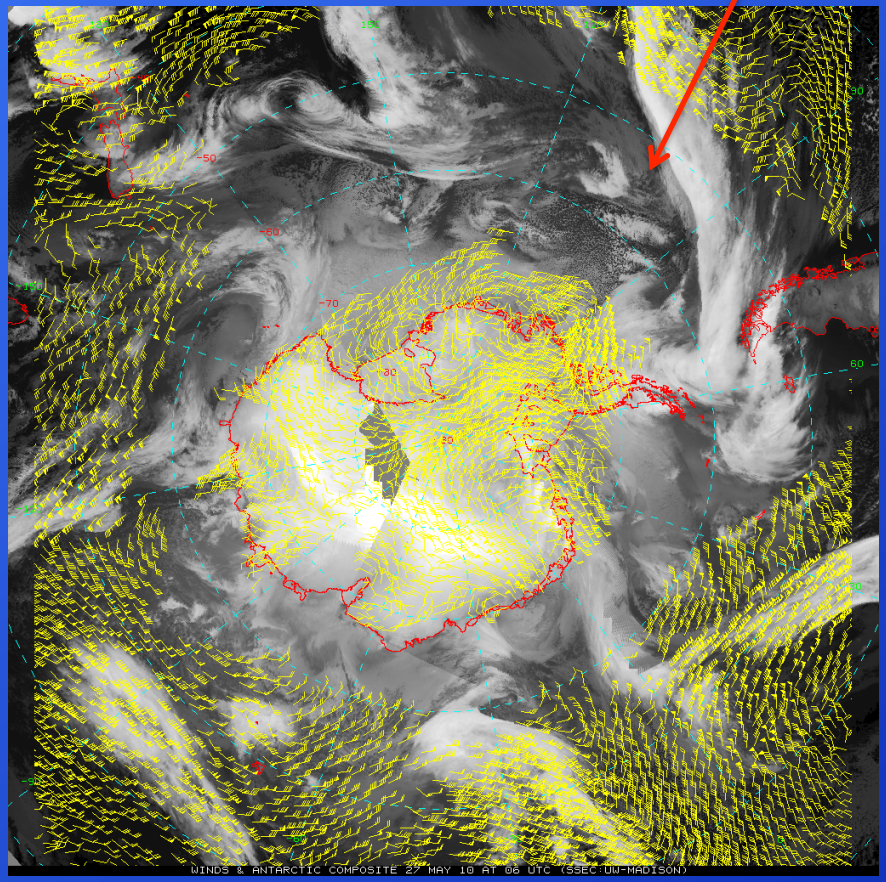
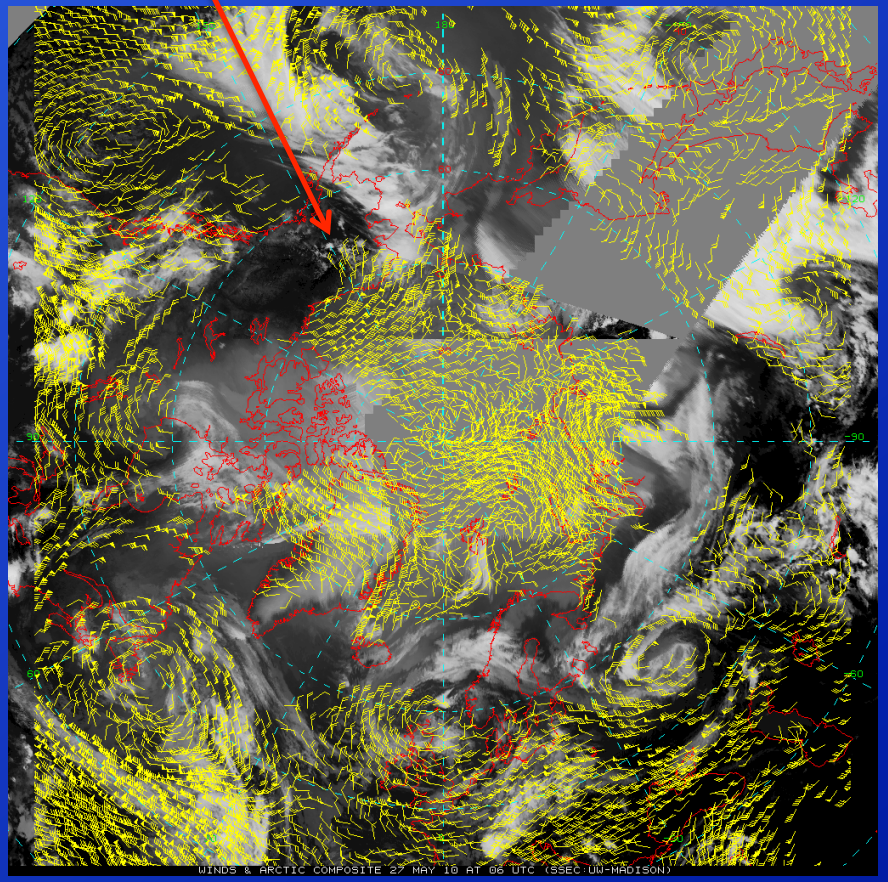
Geostationary and Polar-orbiting Atmospheric Motion Vectors

Missing winds – gap in coverage

- NWP centers: the polar jet stream can be located in this gap; improper model initialization can lead to errors in the forecasts.
- CIMSS research: the addition of the wind information is important in this region.

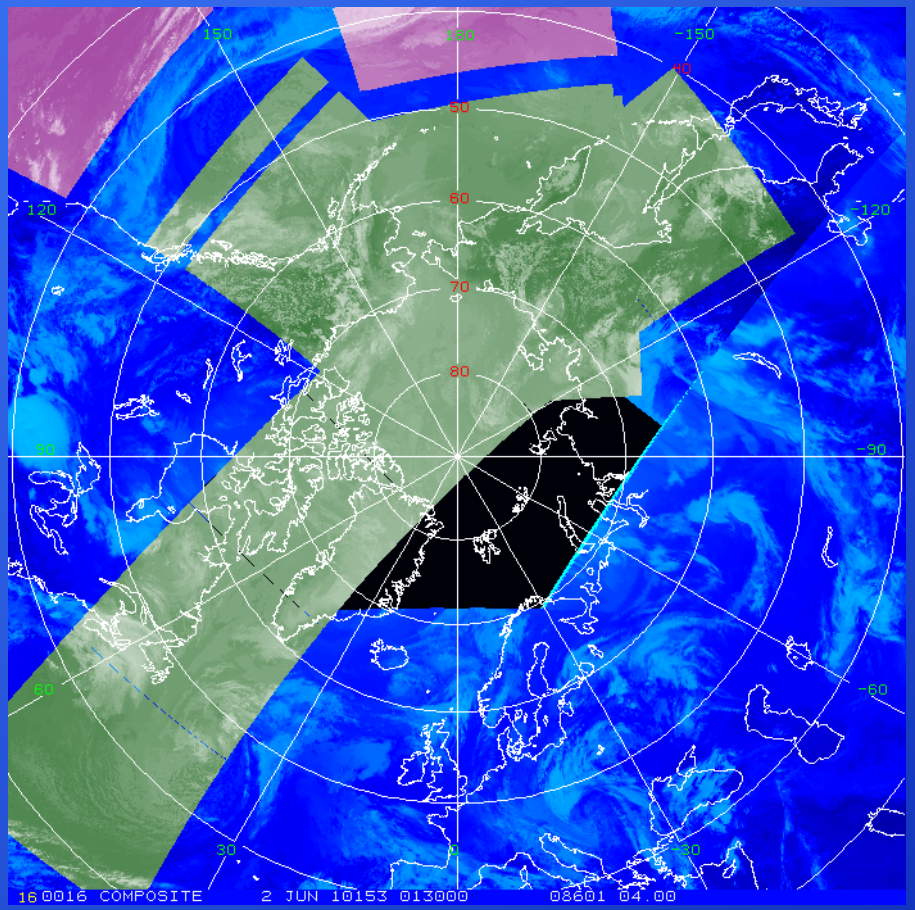


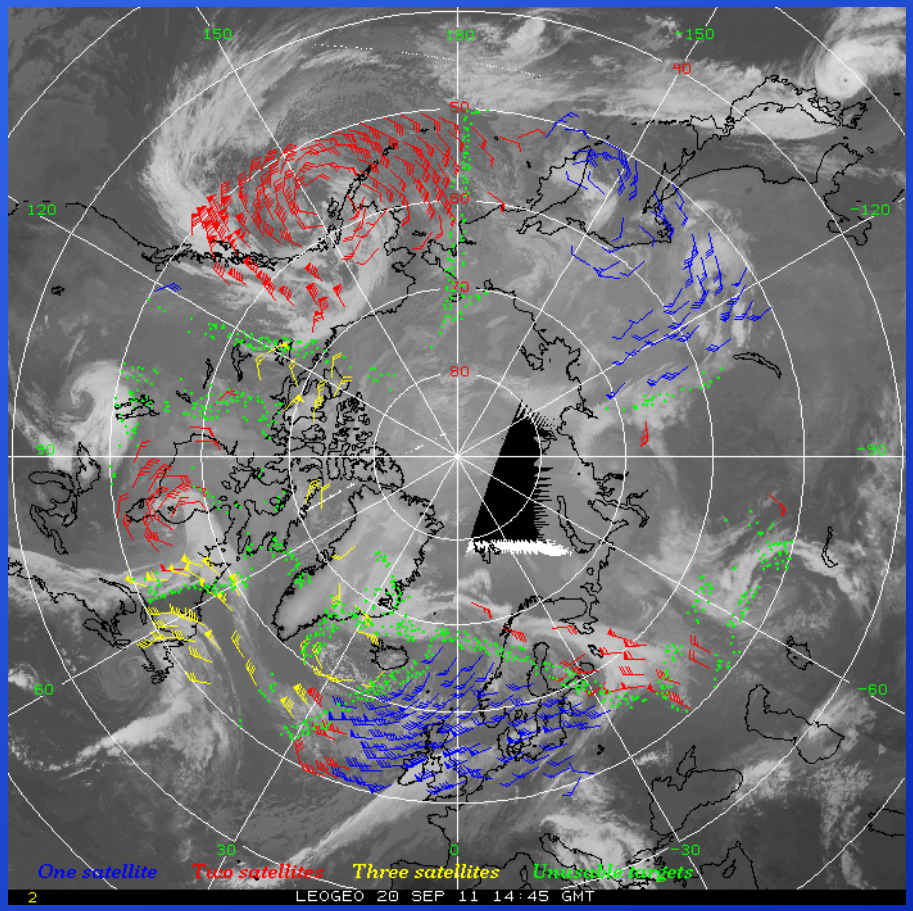


Slide courtesy of Matt Lazzara: Polar Satellite Composite Atmospheric Motion Vectors – AMOMFW2011

Vectors are generated from either single satellite or by mixing two or three satellites.

Tracking can use data from different satellites in the 3 images (accounts for the time and parallax information at each pixel)





Target/search box in each individual image must be from a single satellite

Some potential targets that cannot be tracked

Slide courtesy of Dave Santek: The Use and Impact of derived Atmospheric Motion Vectors in Numerical Models – Second Asia/Oceania Meteorological Satellite User's Conference 2011

Validation Against RAOBs

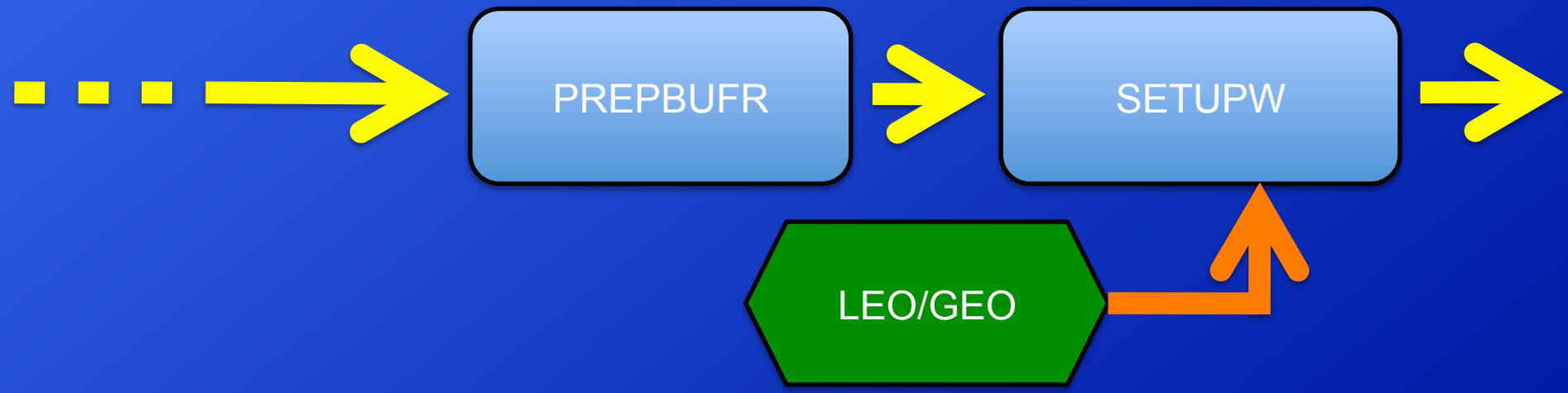
Northern Hemisphere				
POES	# OBS =	3817	V_{rmse} =	5.54
GOES	# OBS =	200953	V_{rmse} =	6.08
MIX	# OBS =	55943	V_{rmse} =	6.77

Southern Hemisphere				
GOES	# OBS =	1738	V_{rmse} =	7.75
MIX	# OBS =	188	V_{rmse} =	7.66

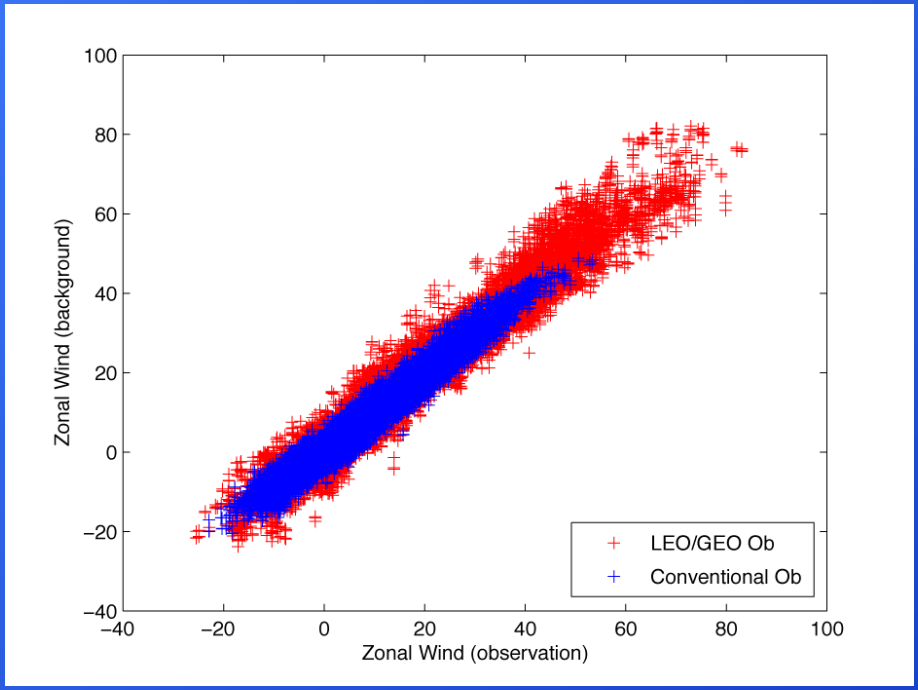
In both hemispheres, mixed-Satellite AMVs express RMSE values on-par with other satellite winds.

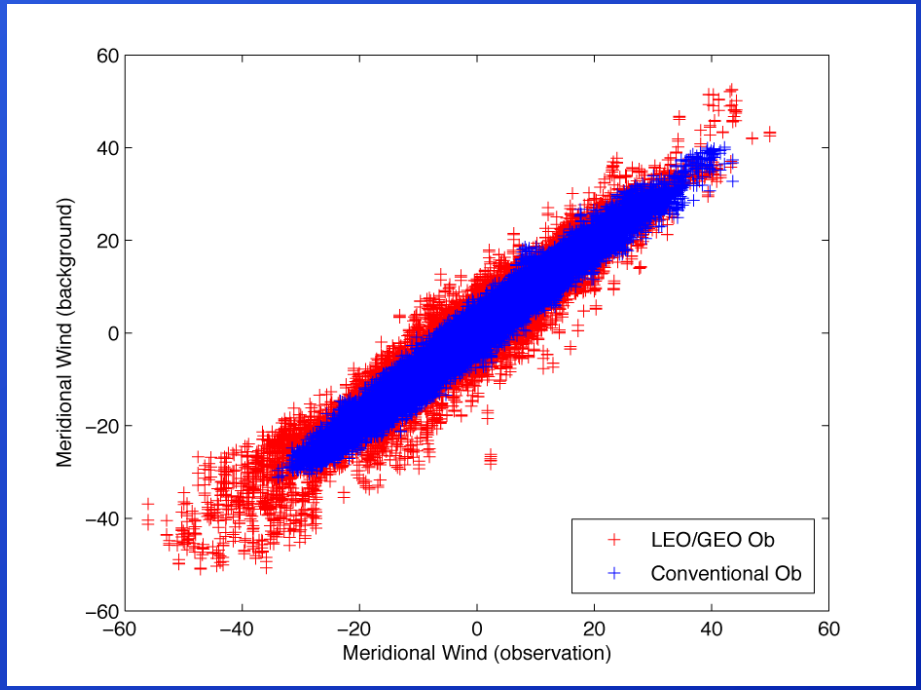
Forecast Impact

- 12-week experiment (02 May 2011 – 24 July 2011)
  - Analyses produced every 6 hours
  - 168 hour forecasts every 0000 UTC
  - Ingest Leo/Geo winds through GSI



Gross Error Check

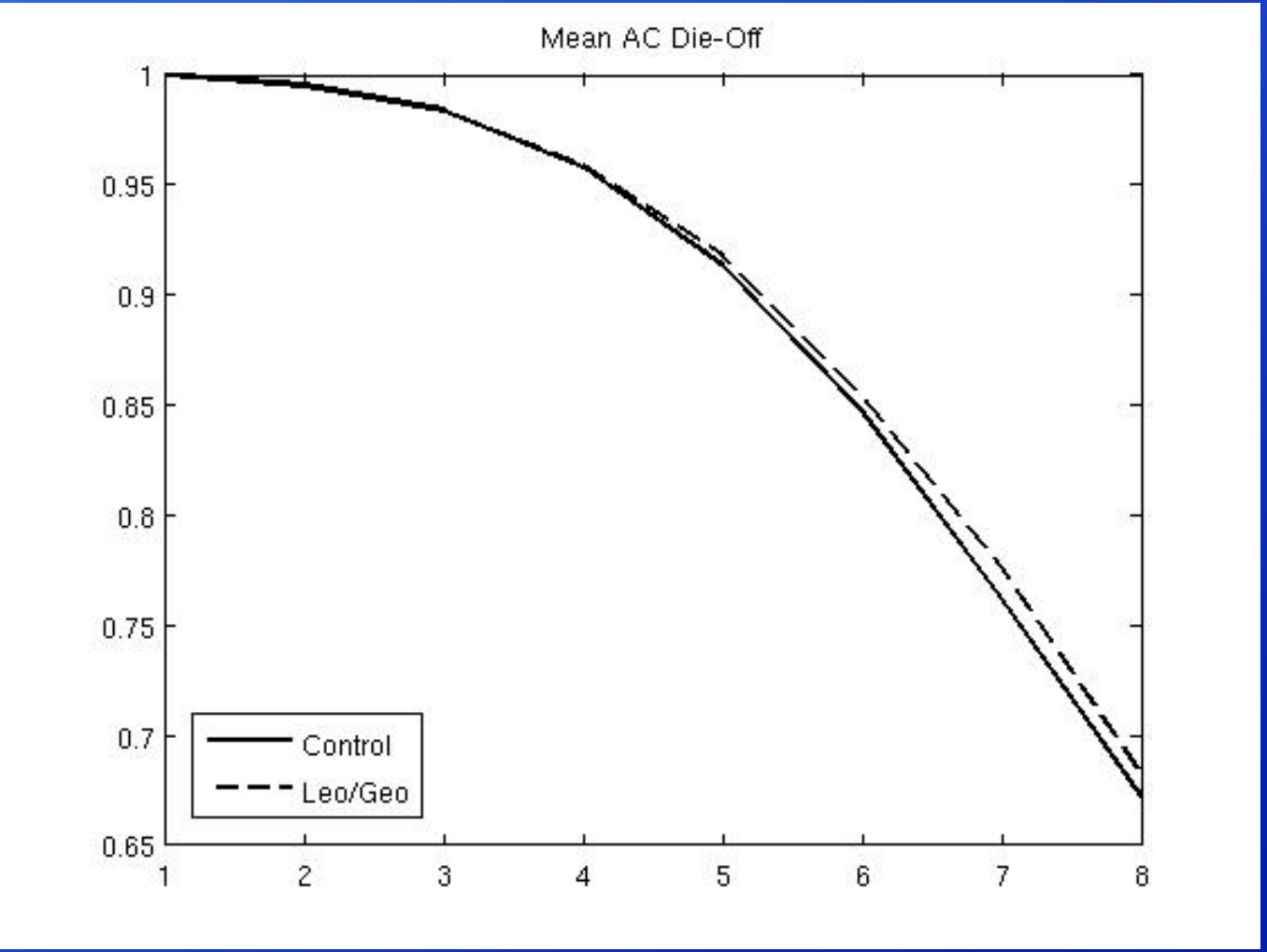




LEO/GEO winds disagree with background winds slightly more than conventional observations, and contribute more observations at extremes

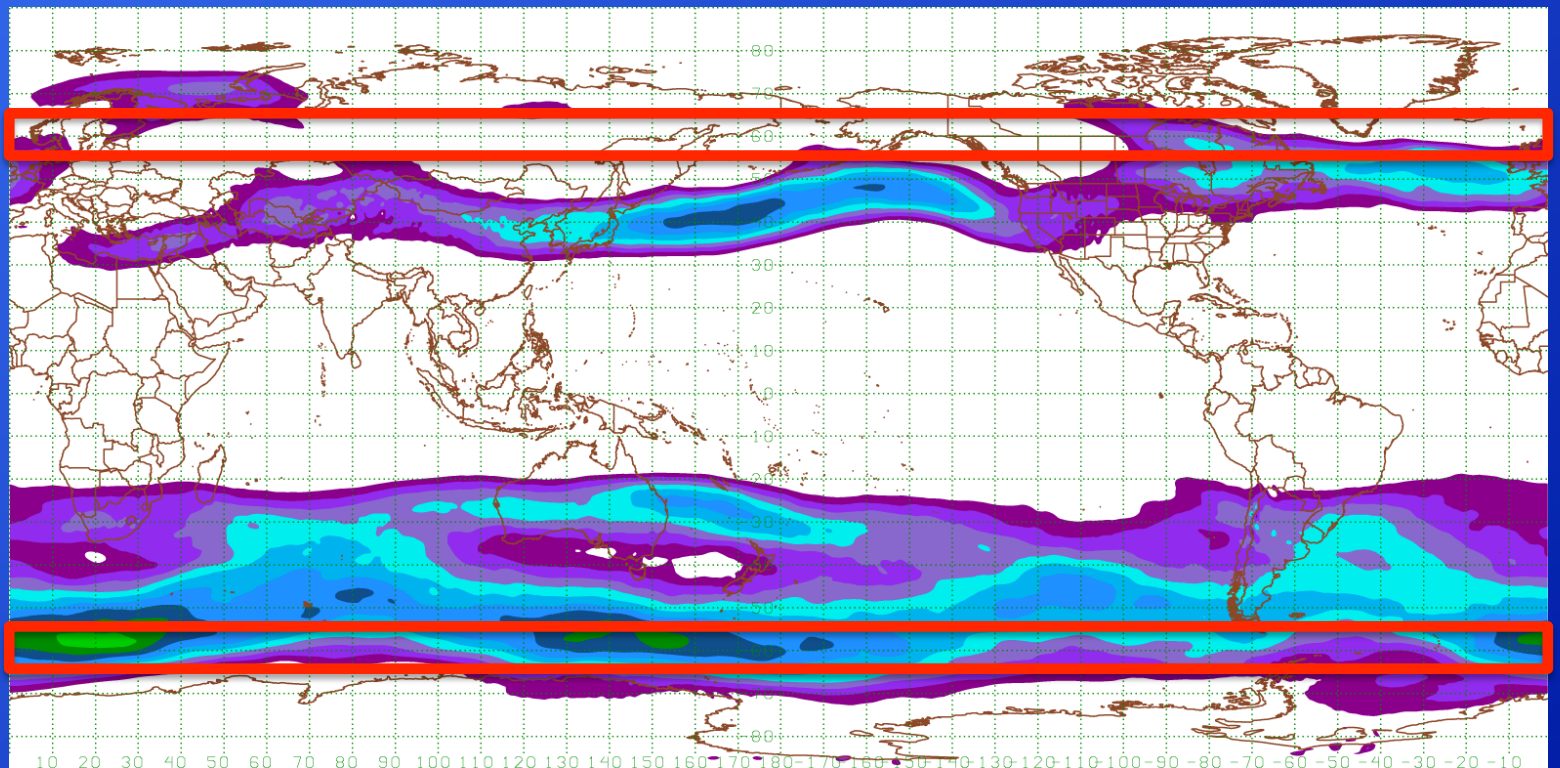
Positive Impact

Mean 500hPa anomaly correlation amongst all 168 hour forecasts reveals positive impact on southern hemispheric scores for days 4-7. Northern hemispheric impact is neutral (not shown).



Results By Hemisphere

- Positive impact in southern hemisphere only
  - Dynamical importance of 60^{o} latitude band?
  - Greater analysis impact in southern hemi.?



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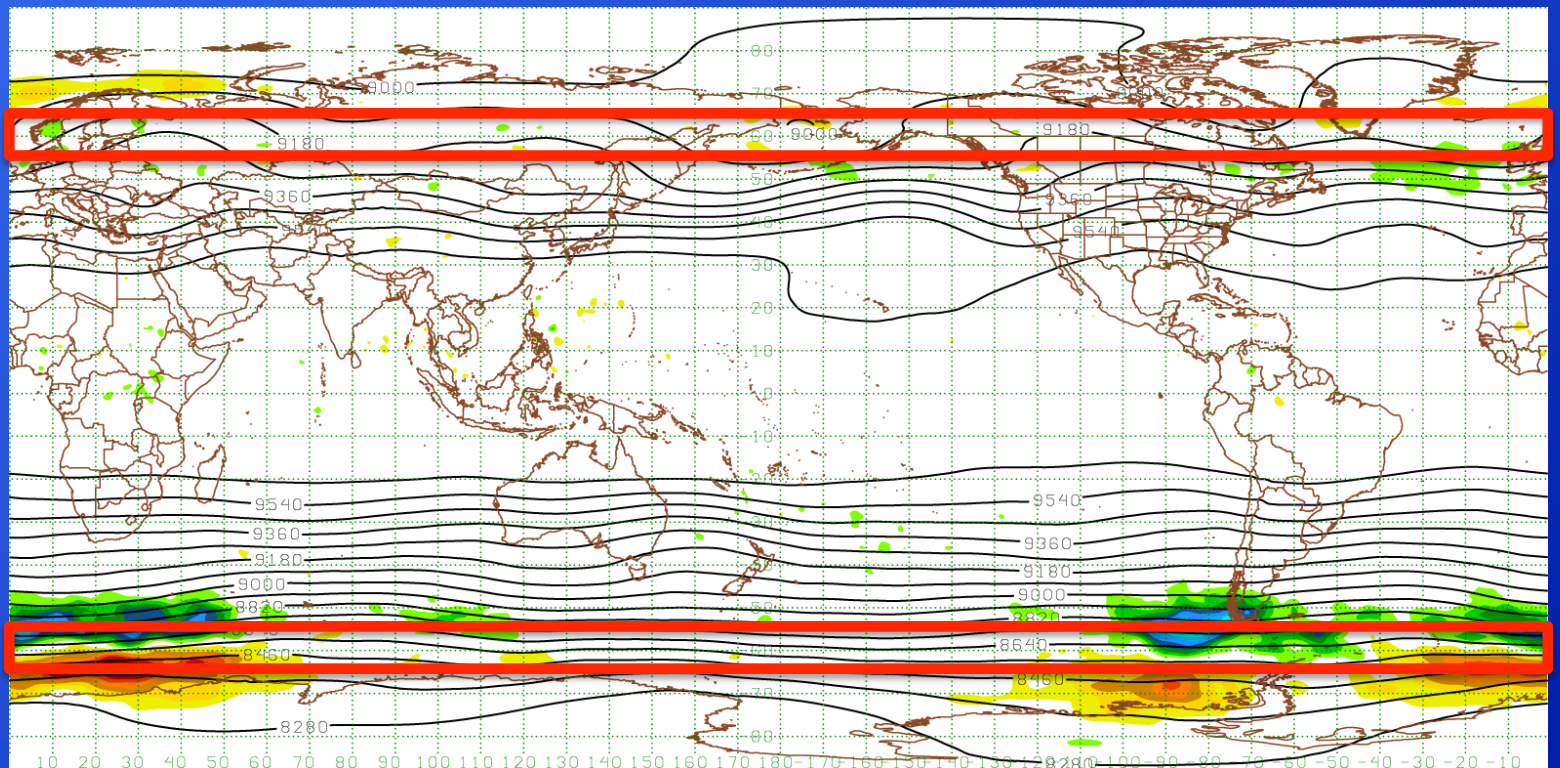
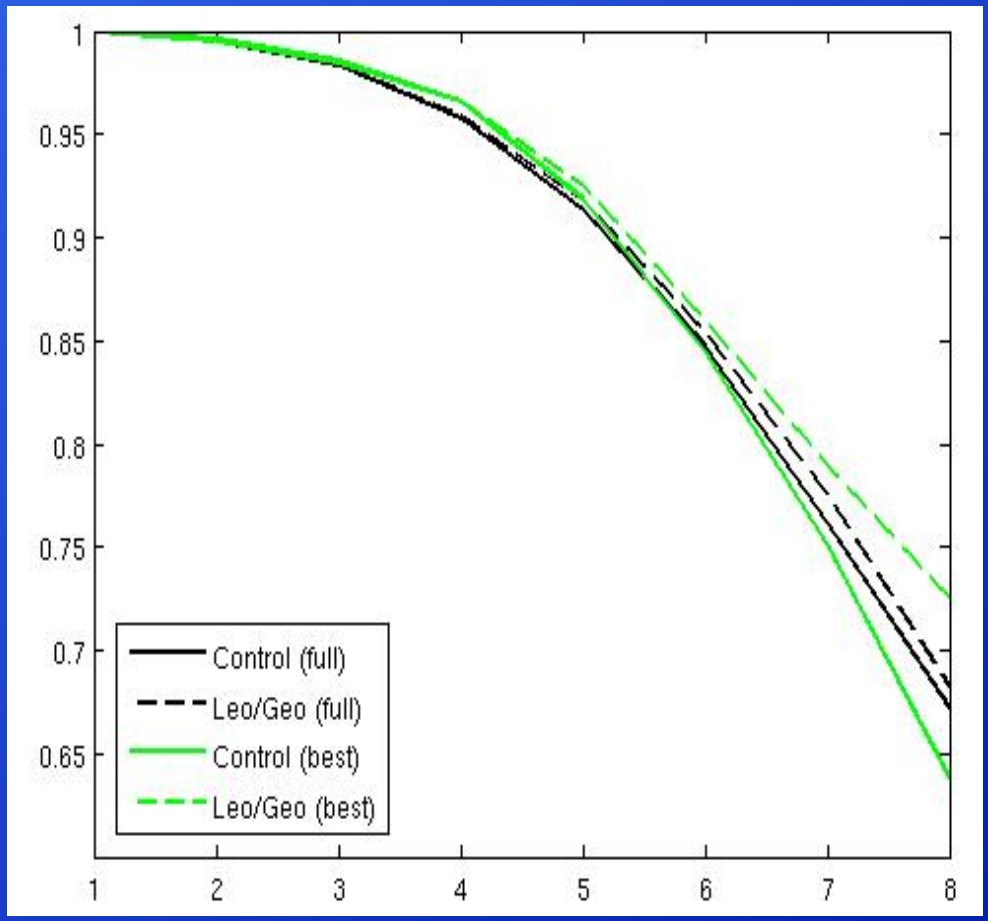


Best Forecasts

09	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	01	02	03	04	05
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	01	02	03
04	05	06	07	08	09	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24



Best forecasts **organize into streaks**, hinting that what distinguishes one from the other is **NOT a random process**

Best Forecasts

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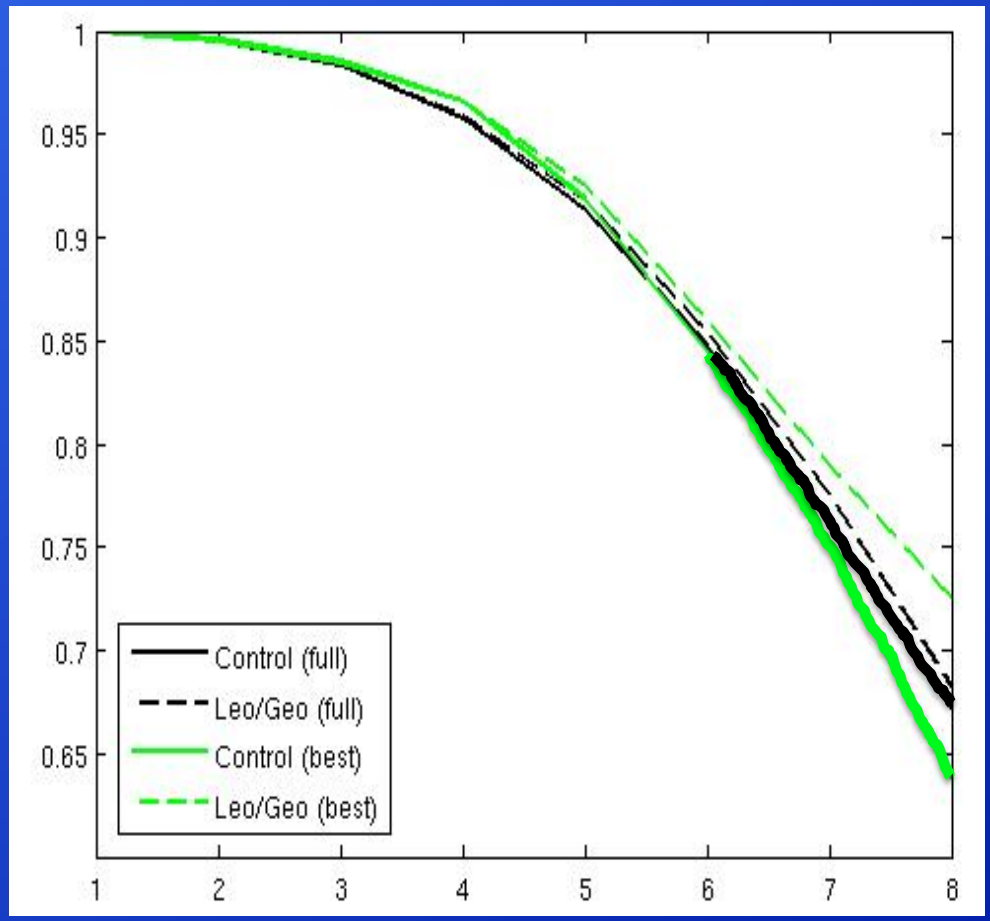
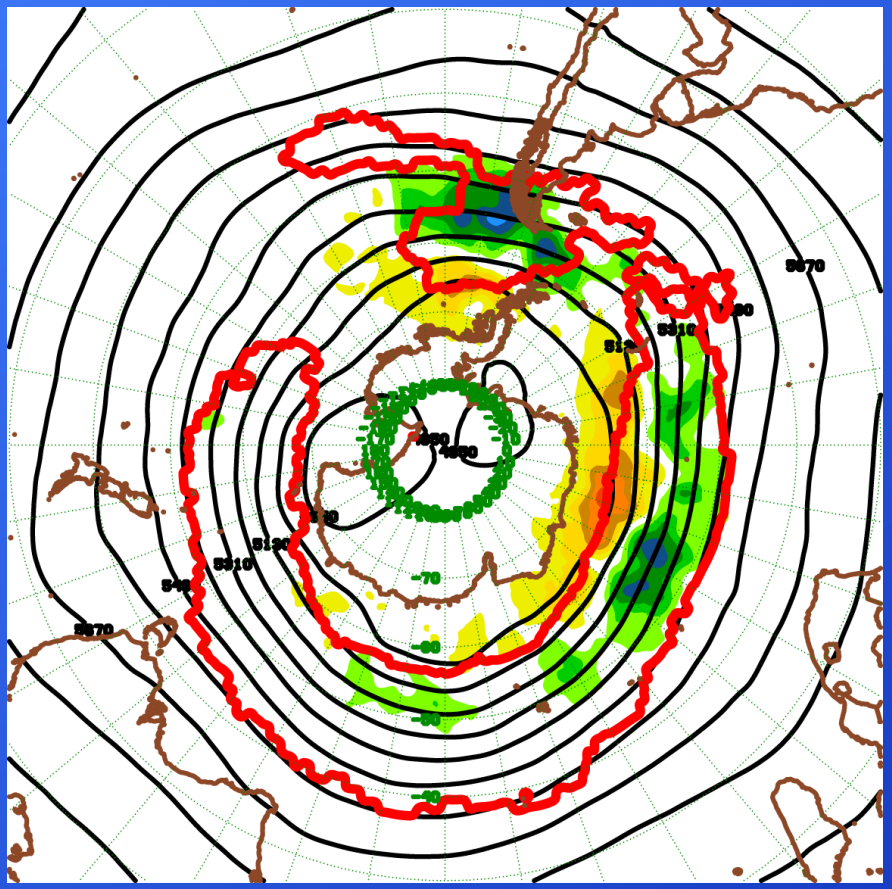
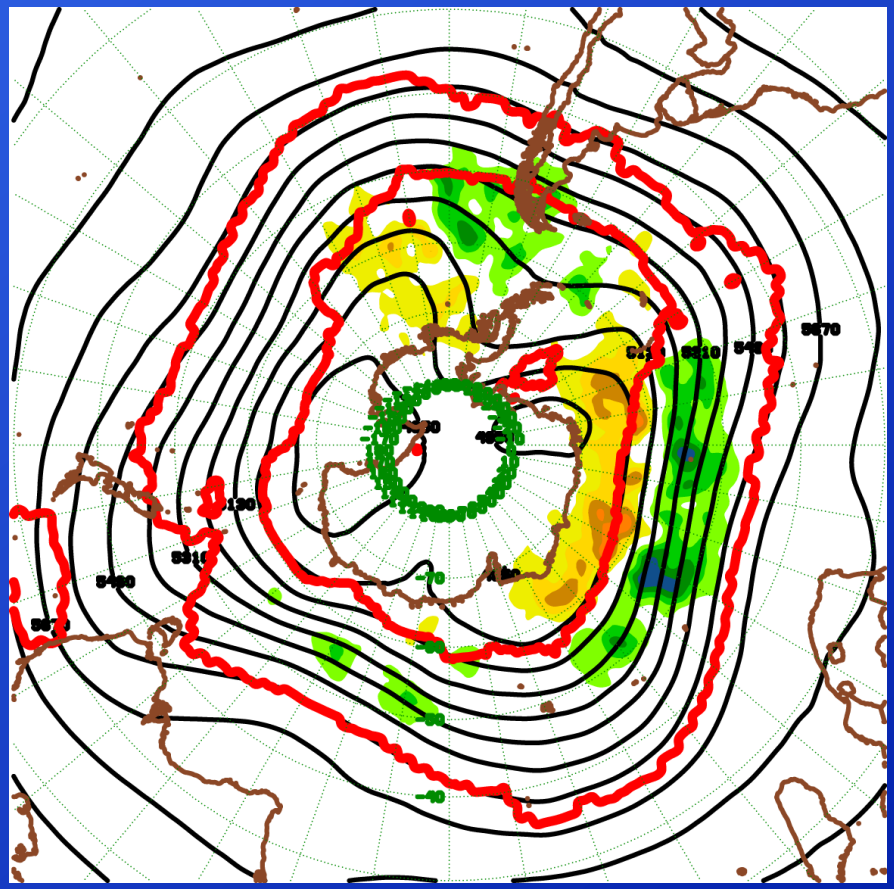


Why does the **control forecast underperform** in these cases where Leo/Geo winds have the **largest positive impact**?

Composite: Initial Analyses of 14 Most Improved Forecasts



Composite: Initial Analyses of 14 Most Degraded Forecasts



Mean 500 hPa **analysis increments** for analyses producing best/worst forecasts have **essentially the same structure**, though the **amplitude is slightly higher** in the best cases.

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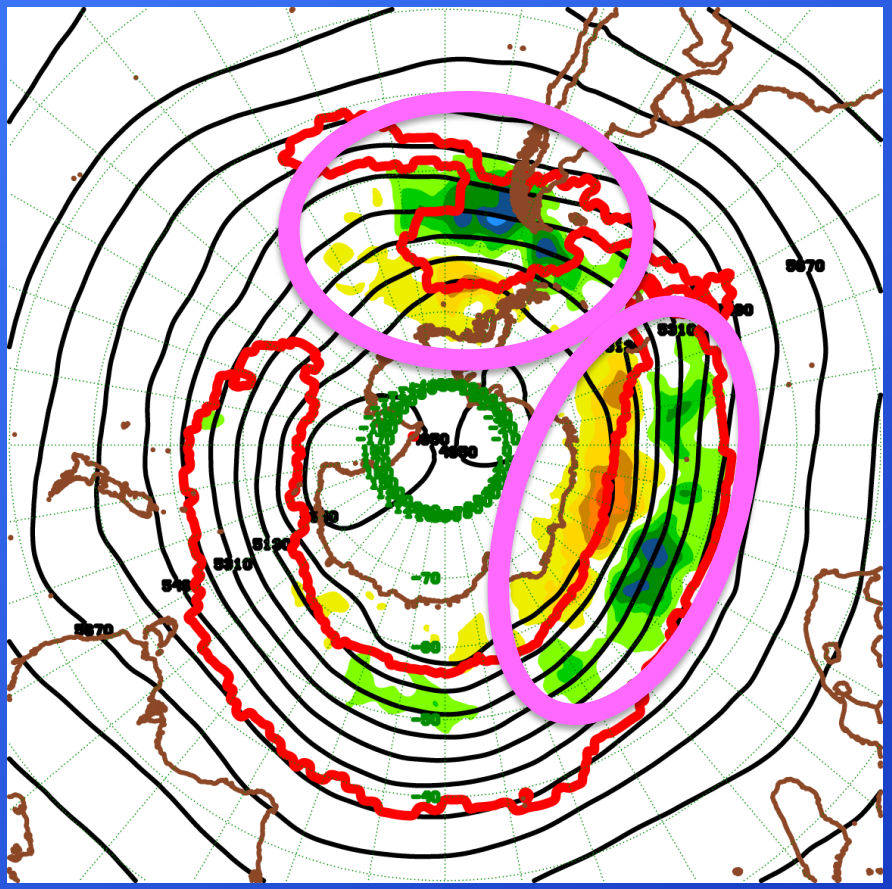

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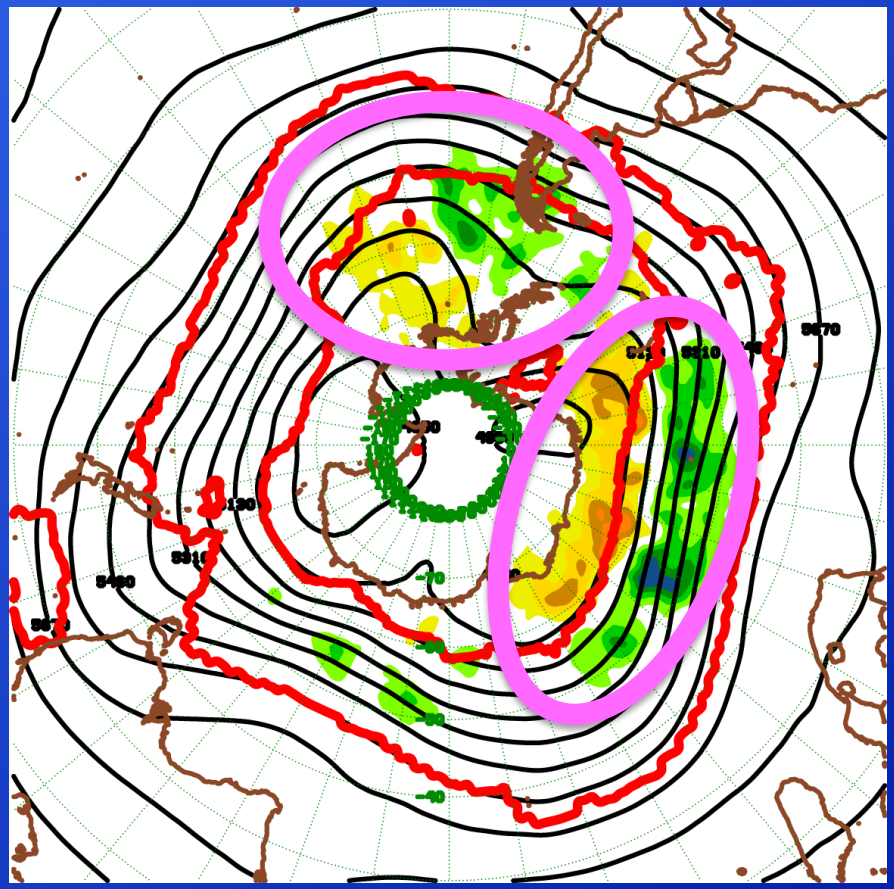

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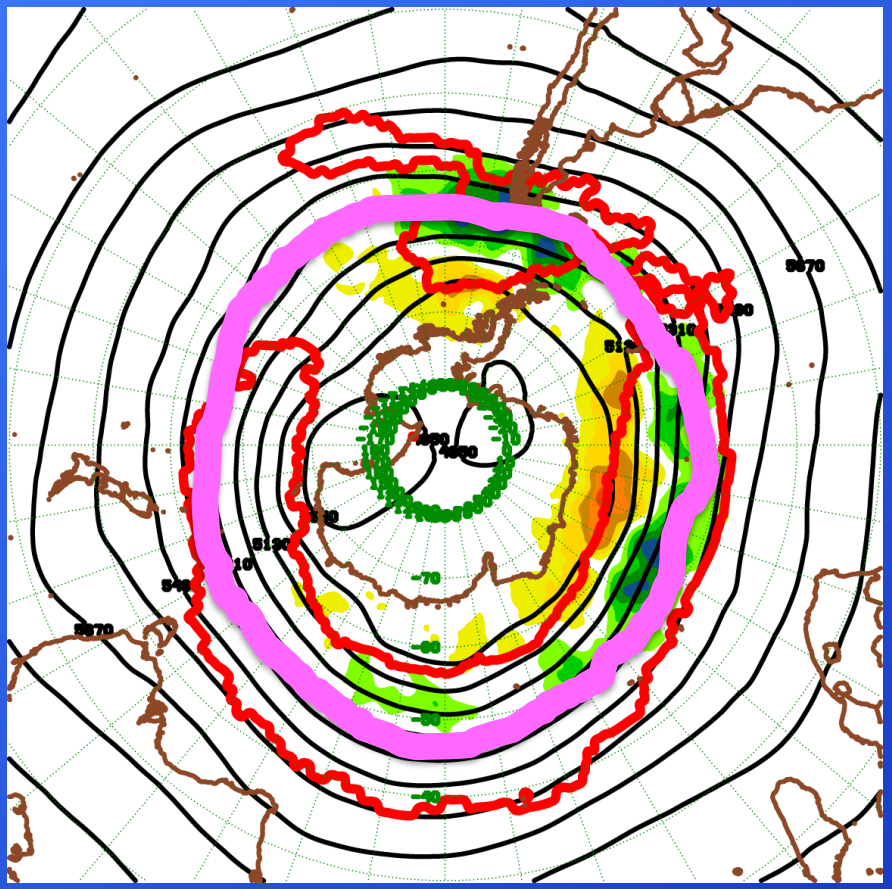

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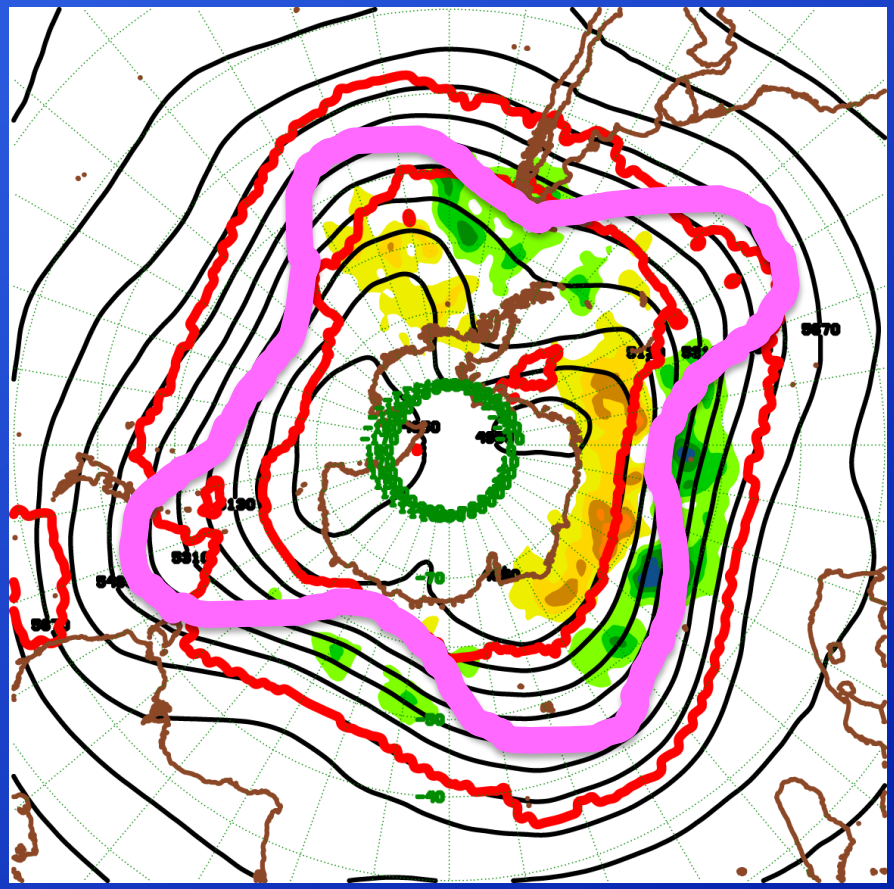
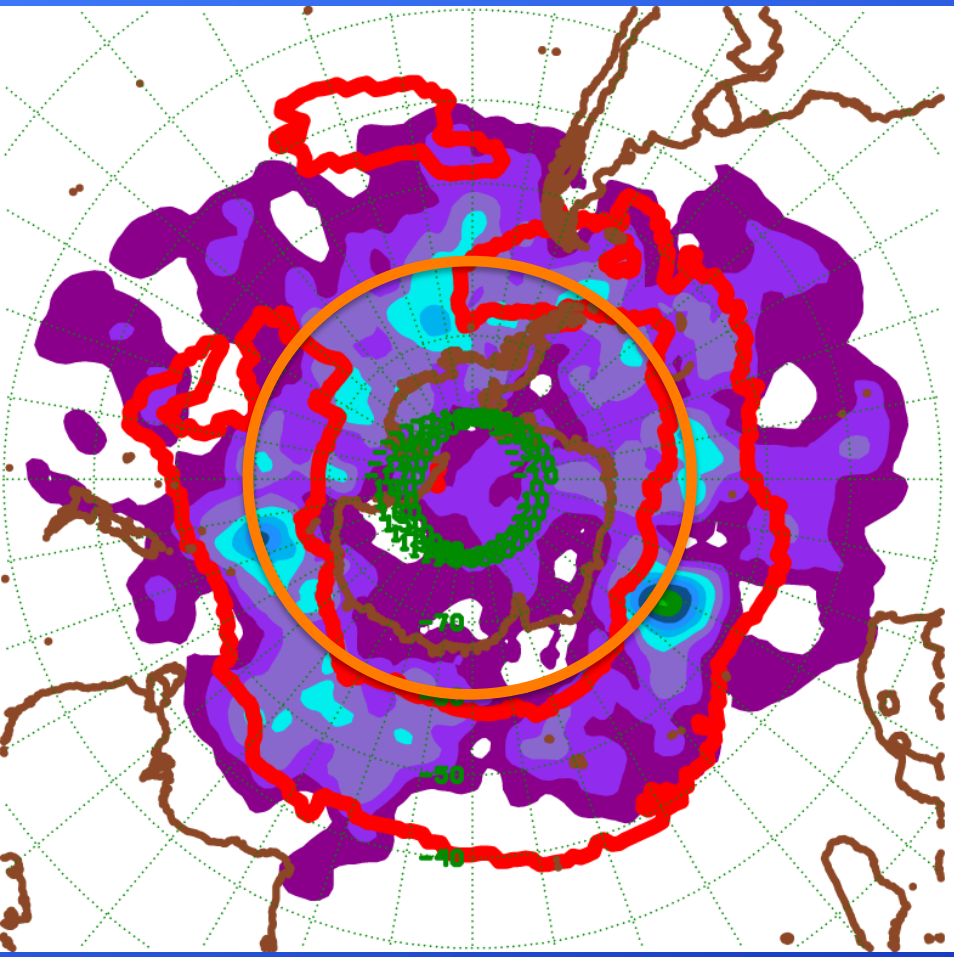


However, the **structure** of the 500 hPa height surface is very **different between best/worst cases**, with the **worst cases** typified by **high-amplitude wave activity** and **powerful jets**.

Composite: Day-4 RMSE of 14 Most Improved Forecasts



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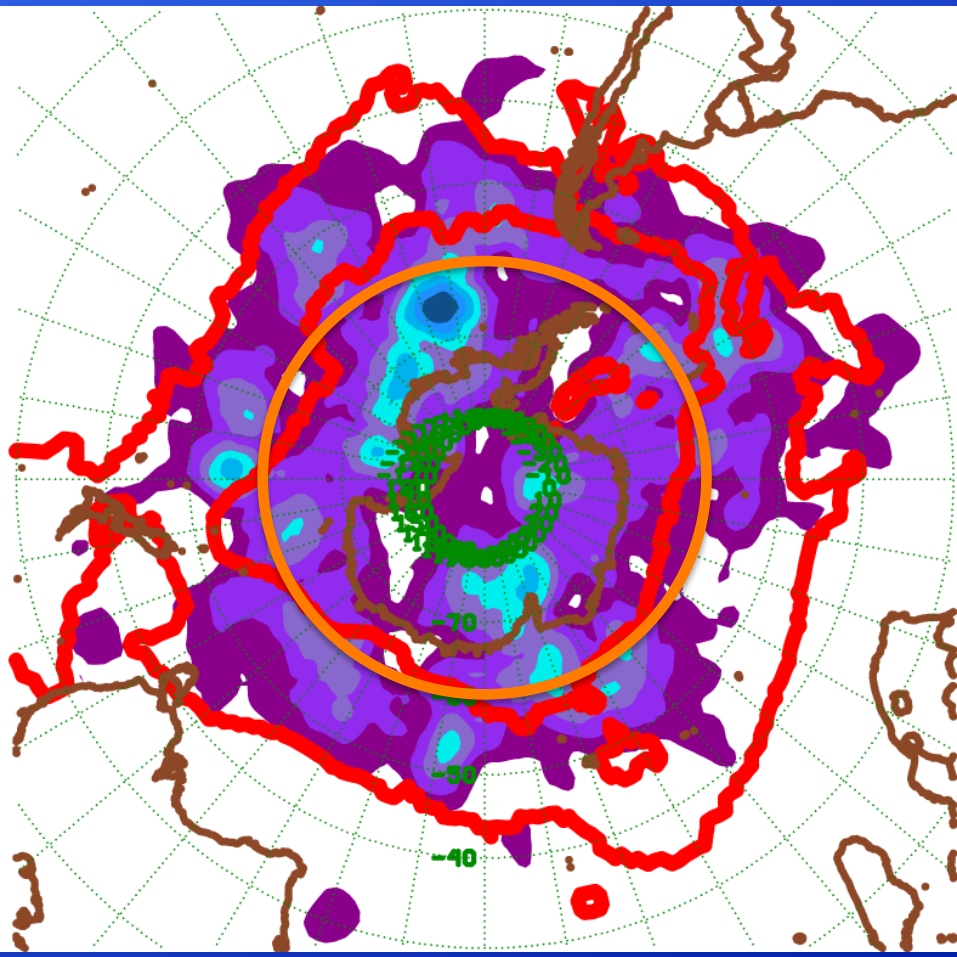
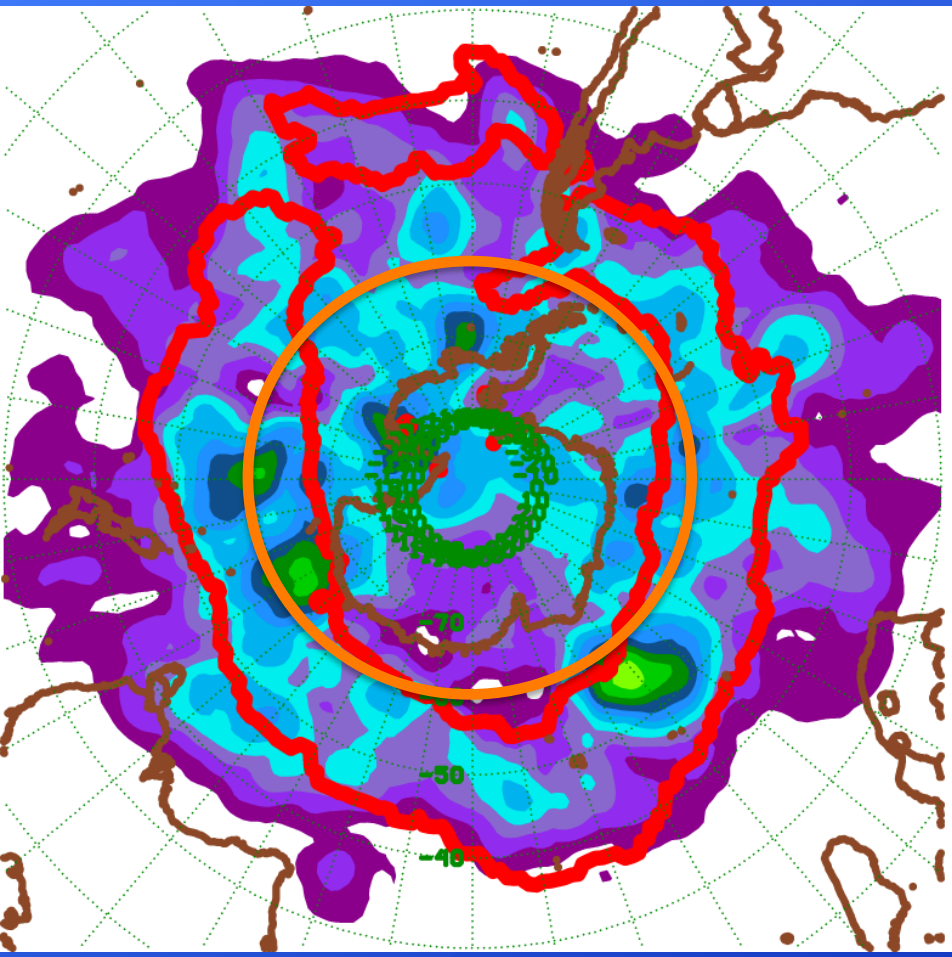


Error growth in best forecasts takes place within jets; in worst forecasts wave activity pushes jets equatorward of errors

Composite: Day-5 RMSE of 14 Most Improved Forecasts



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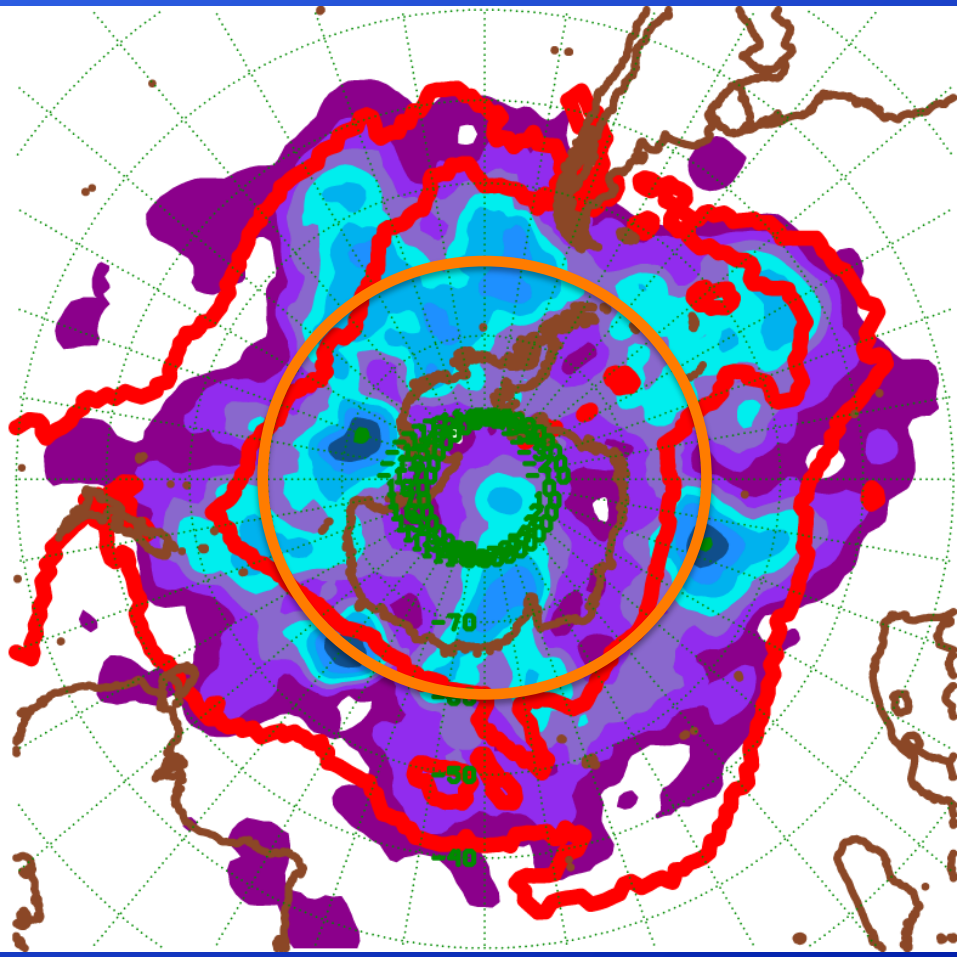
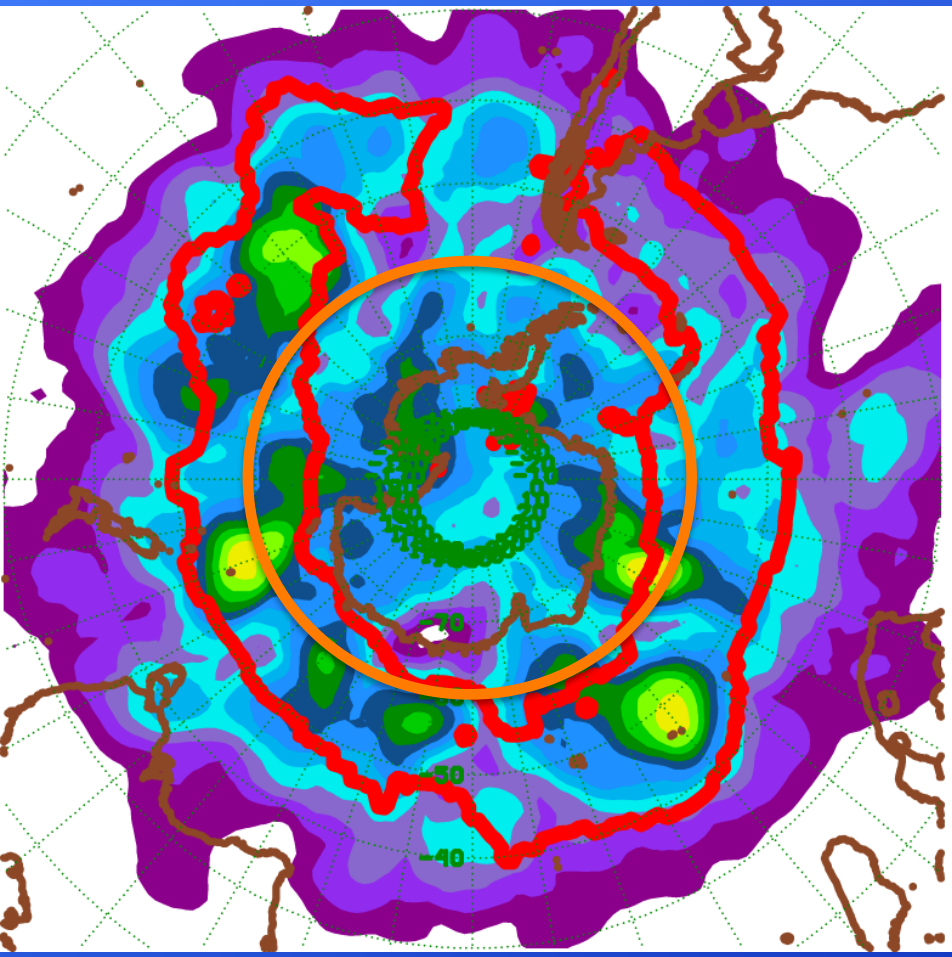


Jet location in best forecasts allows errors at 60S to grow rapidly in forecasts most improved by LEO/GEO winds

Composite: Day-6 RMSE of 14 Most Improved Forecasts



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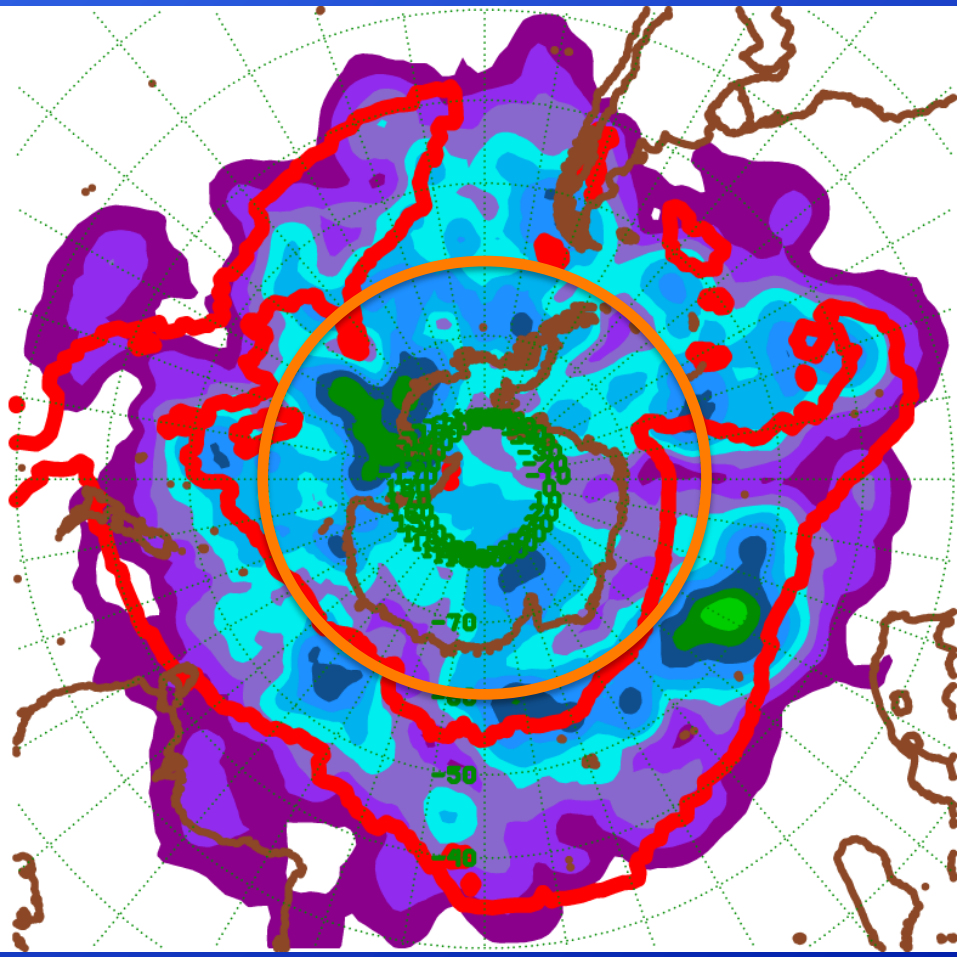
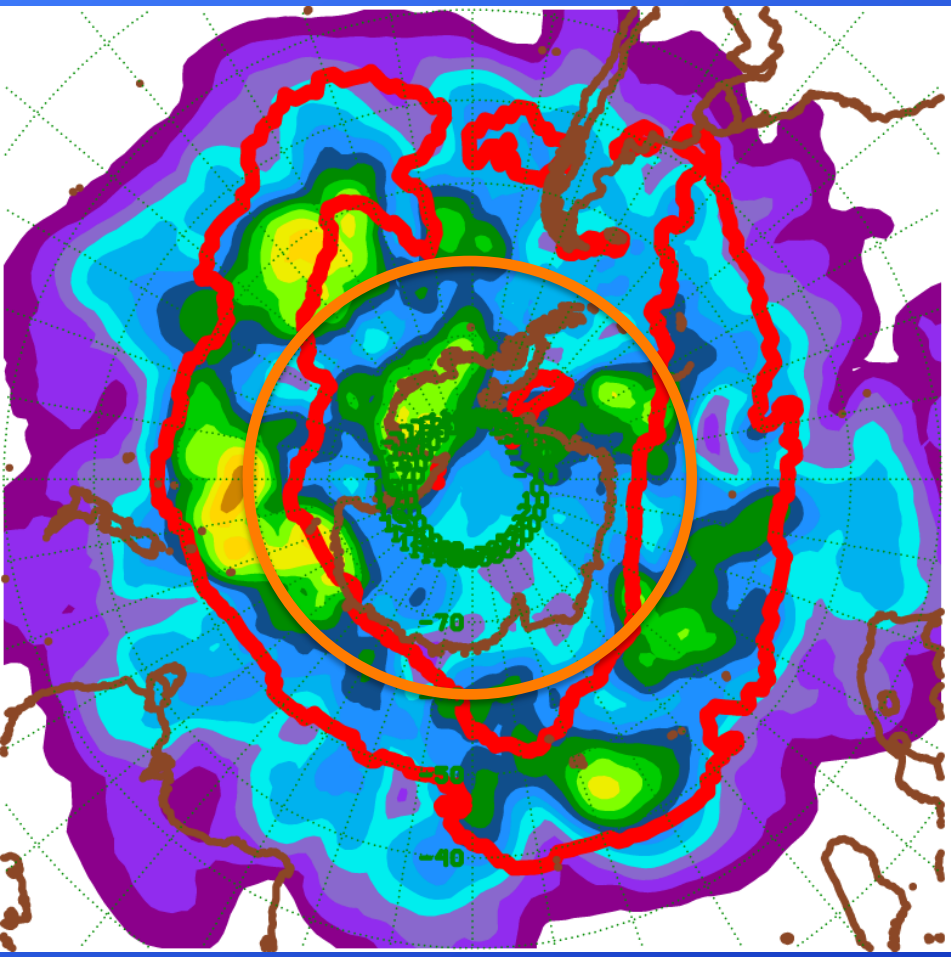
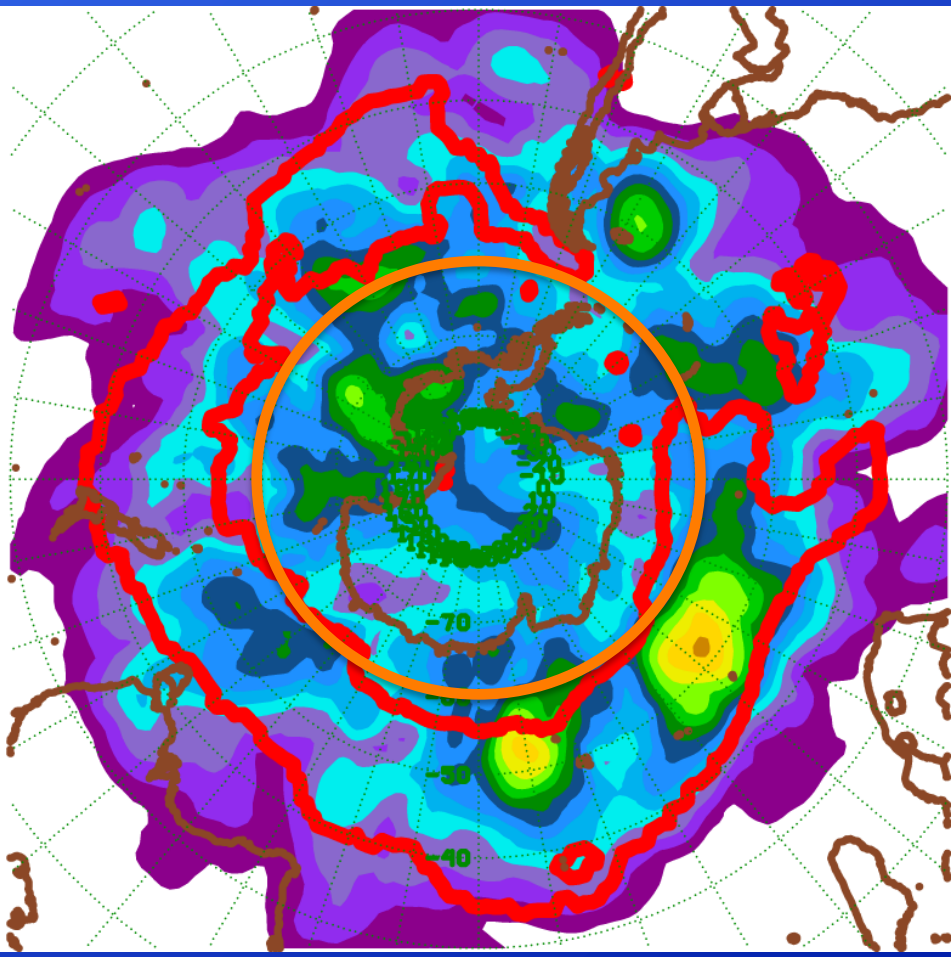


Composite: Day-7 RMSE of 14 Most Improved Forecasts

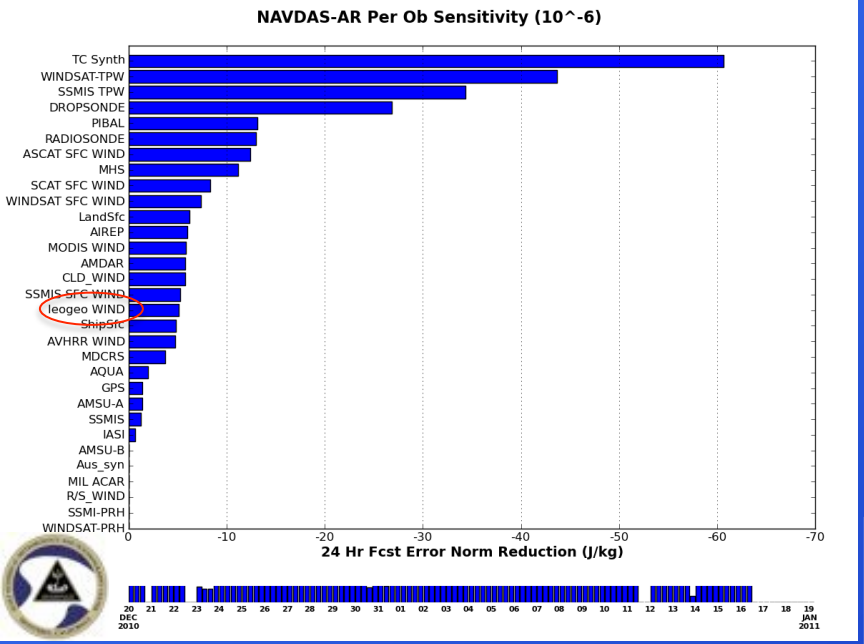


Composite: Day-7 RMSE of 14 Most Degraded Forecasts



By day-7, errors are larger in best forecasts than in worst forecasts

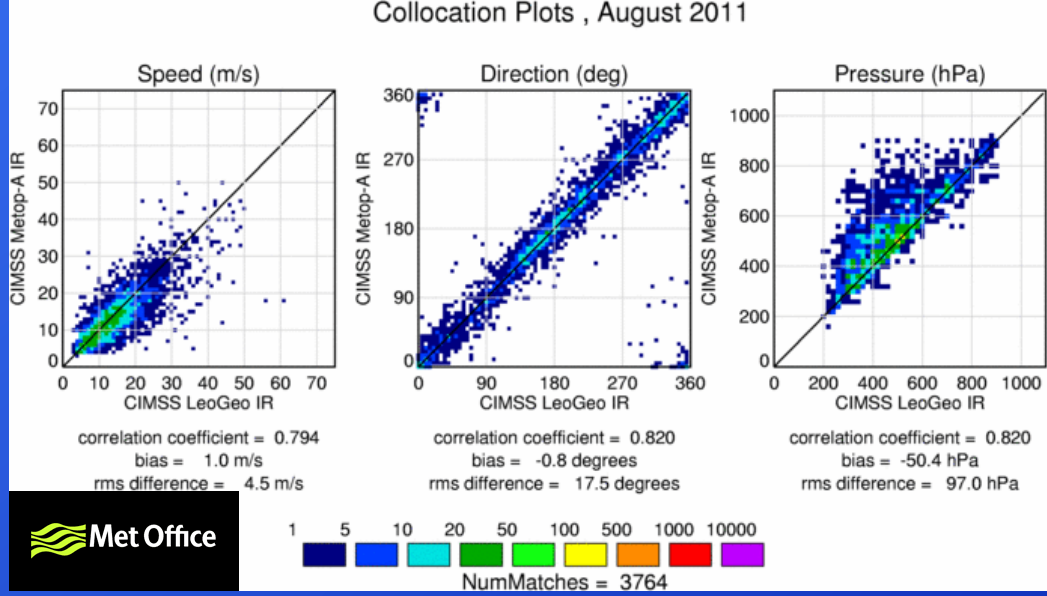
Leo/Geo in Operations



Plot courtesy of Matt Lazzara: Polar Satellite Composite Atmospheric Motion Vectors – AMOMFW2011

The US Navy has demonstrated positive impact of Leo/Geo winds on par with other, equivalent AMV types.

In addition, the NCAR Antarctic Mesoscale Prediction System has used Leo/Geo winds since August 2011



Plot courtesy of James Cotton: LeoGeo AMVs - ECMWF, 5 October 2011

The UK Met Office is interested in these winds, and is monitoring them

Future Work

- Optimize QC?
- Equivalent winter experiment
- Look into having NESDIS operations generate Leo/Geo winds

NOAA GOES-R Risk Reduction Program: NA06NES4400002