POLAR SCIENCE FOR PLANET EARTH

Assessment of the Polar WRF representation of near-surface meteorological variables over West Antarctica

Pranab Deb

Andrew Orr, Scott Hosking, John Turner

The 10th Antarctic Meteorological Observation, Modeling, and Forecasting Workshop

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West Antarctic grant

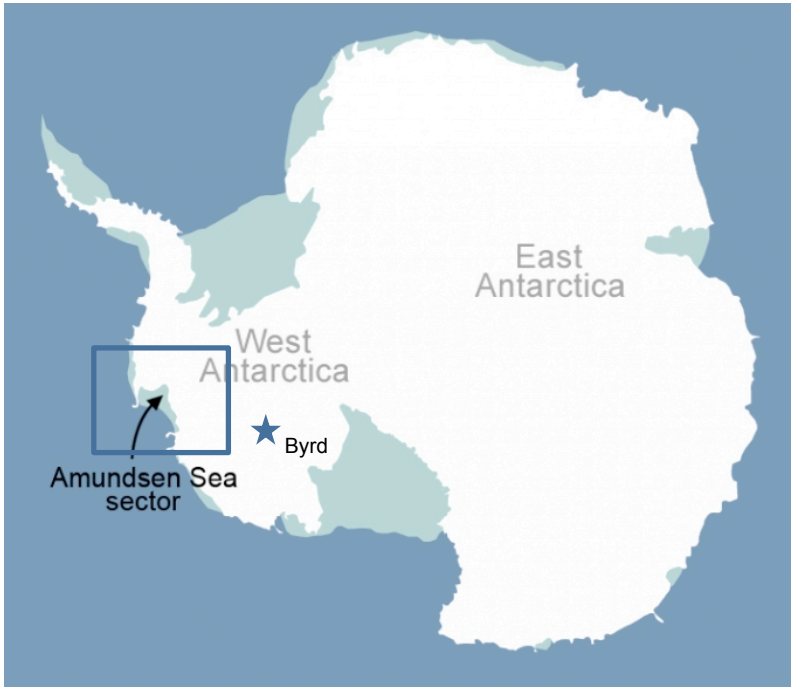
Setting up a high resolution climate model over West Antarctica.

Produce hindcast over the study domain since 1979 and identify main drivers of the West Antarctic climate.

Future projections for the next century using our model – forcing with CMIP5 products.

Why West Antarctica?

•West Antarctica is one of the **fastest warming** regions on Earth - annually averaged near-surface warming rate of **~0.5 °C per decade** at **Byrd Station** (***Bromwich et al.,* 2013**)



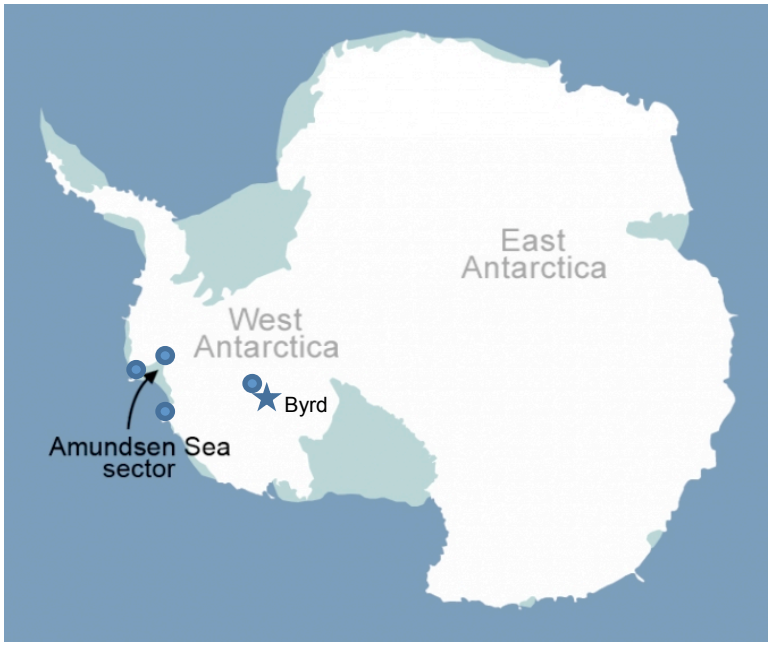
• West Antarctica ice sheet contains enough ice to raise the sea level by ~5 m (*Turner and Marshall,* 2011)

• **acceleration and thinning of ice streams/glaciers** at the edge of WAIS (*Rignot,* 2008) is responsible for 10% of the global sea-level rise (*Church and White*, 2011)

Challenges in understanding the West Antarctic climate

Long term weather records are **limited**
due to remote and hostile environment

Coarse resolution and oversimplified model physics: **reanalysis dataset** is less reliable in complex coastal areas (*Turner et al.*, 2009; *Orr et al.*, 2014)



Correct spatial and temporal variability of **air temperature and precipitation** is still lacking – important for **surface mass balance**

Need for “high resolution” climate models

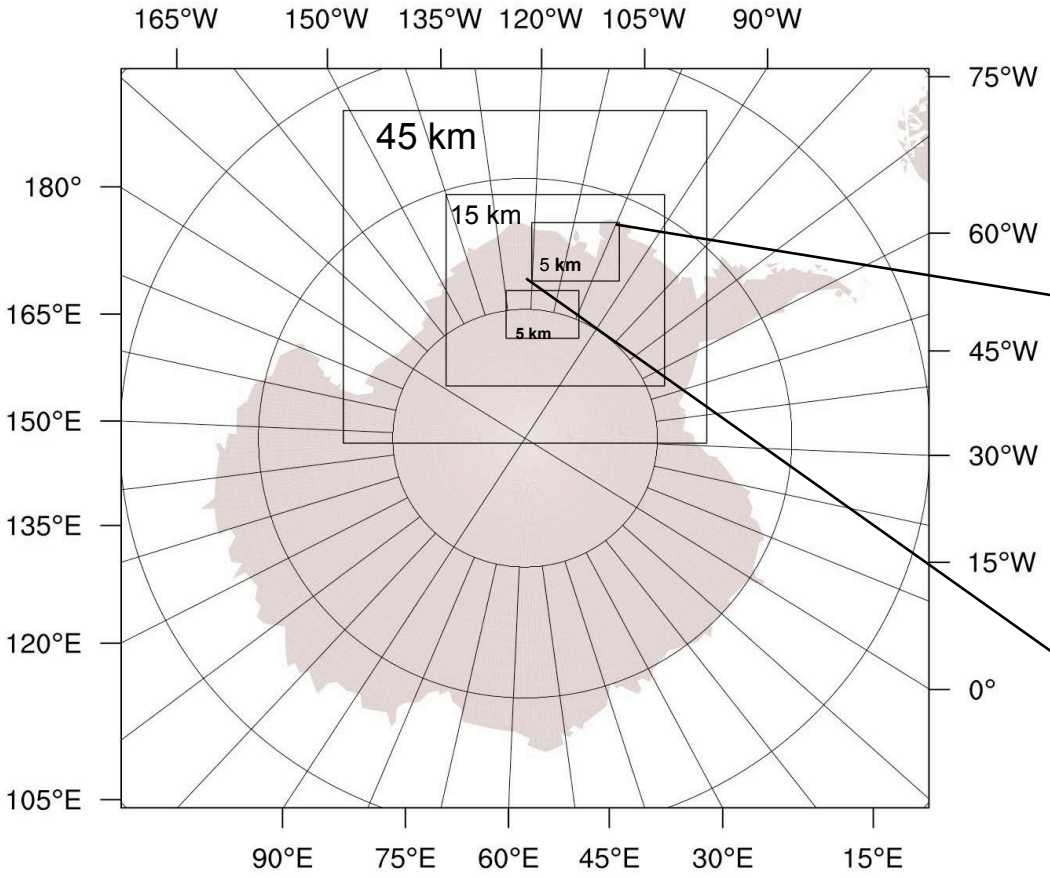
West Antarctica is characterised by the high spatial variability of the **complex orography, coastline, and albedo** - **winds, temperature and precipitation** are highly sensitive to these (*Orr et al.*, 2005, 2014; *Valkonen et al.*, 2010)

In addition, **mesocyclones** are prominent in the Amundsen and Bellingshausen Seas (*Irving et al.*, 2010) and has strong control over local **wind, precipitation and air temperature**

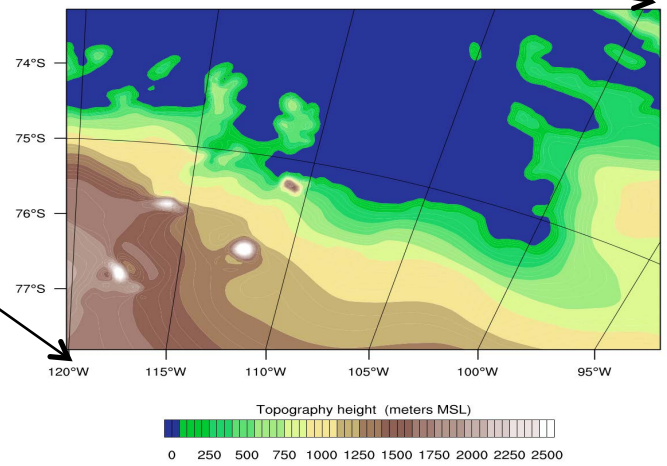
High-resolution regional **atmospheric model** can be used to dynamically downscale the global reanalysis data (*Giorgi et al.*, 1994)

Model configuration

"Standard" atmosphere-only Polar WRF
with one-way nesting
30 vertical levels with model top at 50 hPa



***30-day runs** for*
January
&
July
2013



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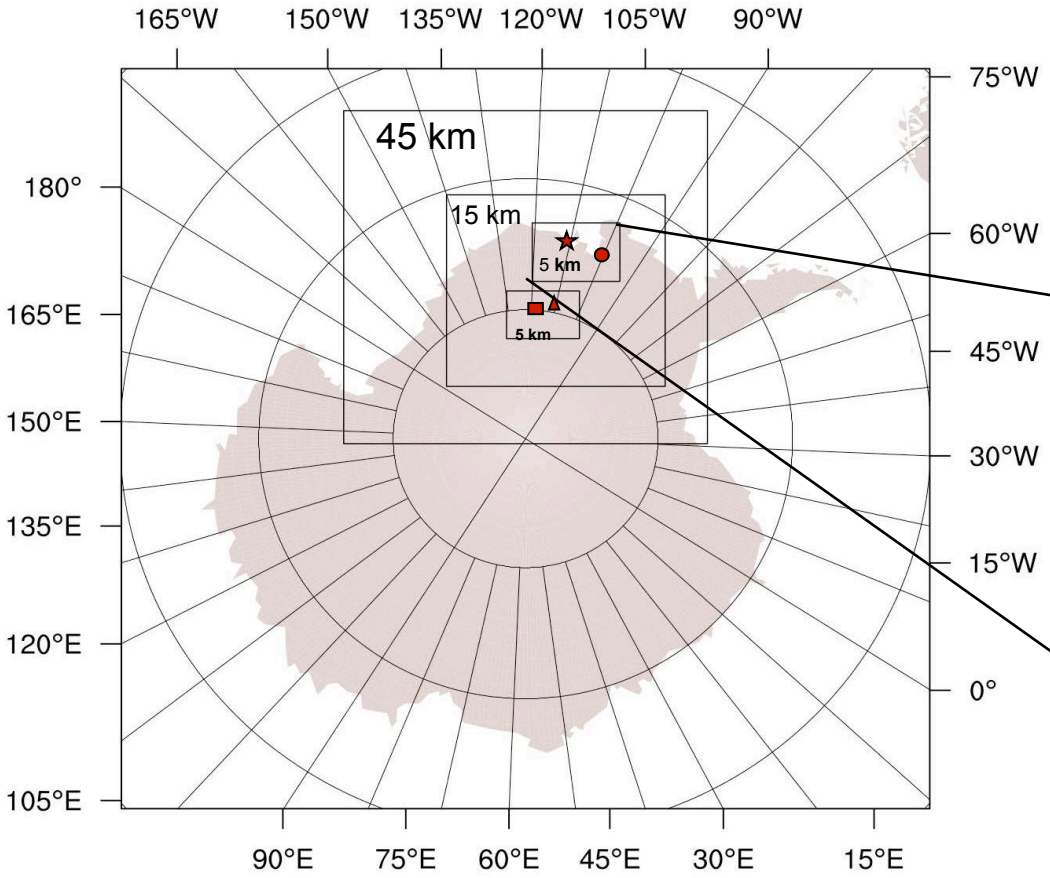
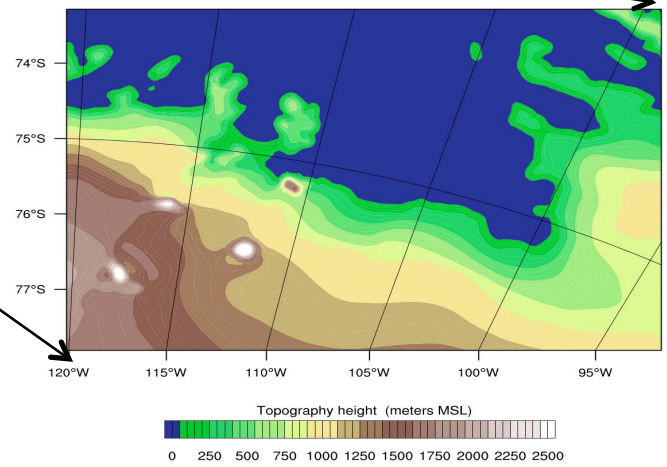
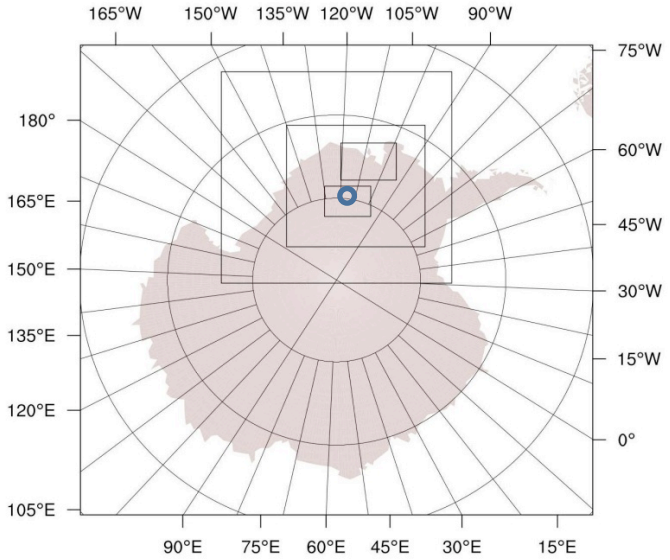
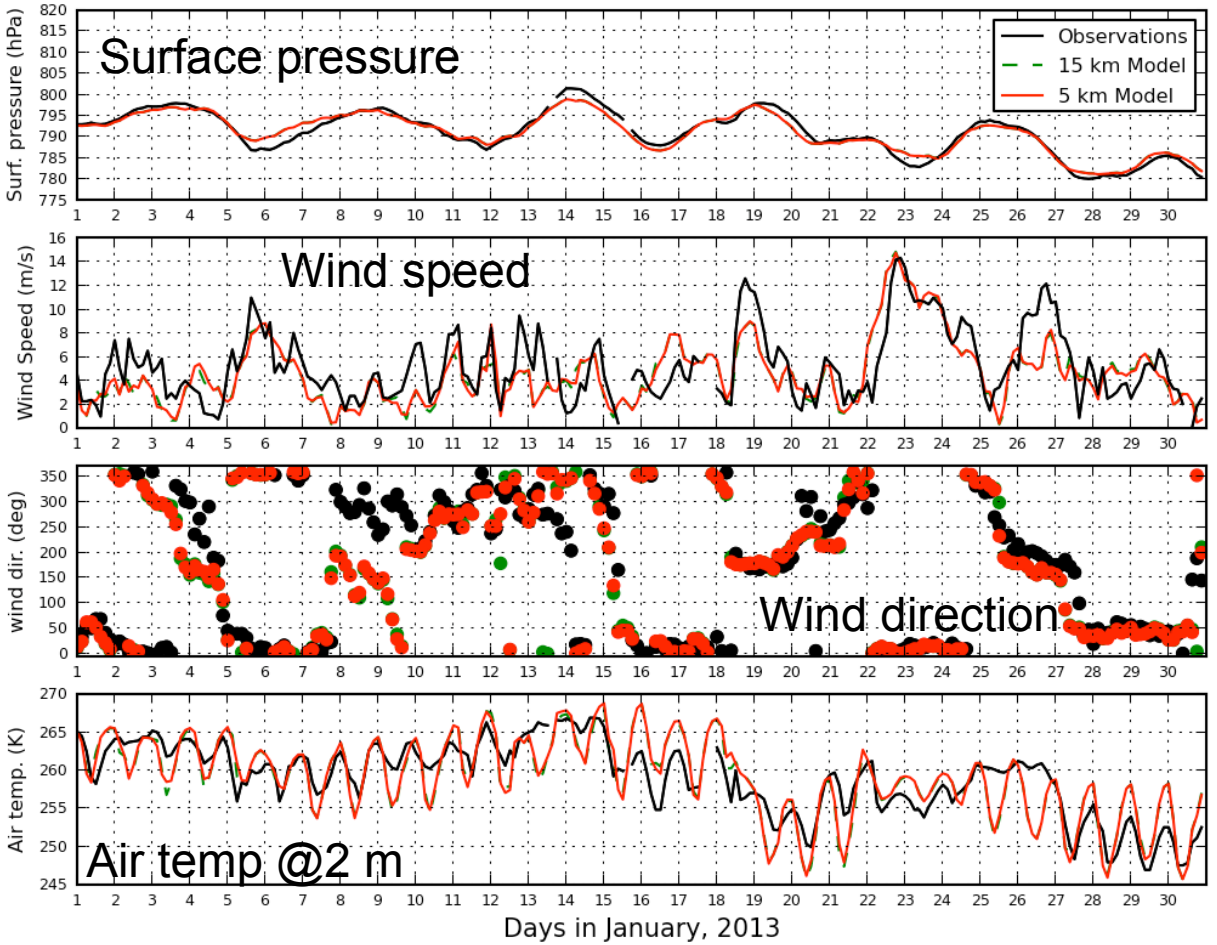




Model skill over inland stations

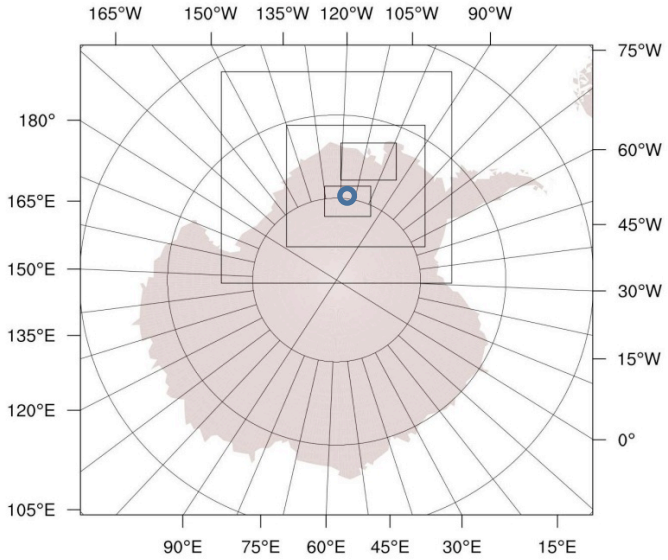


Kominko Slade - January

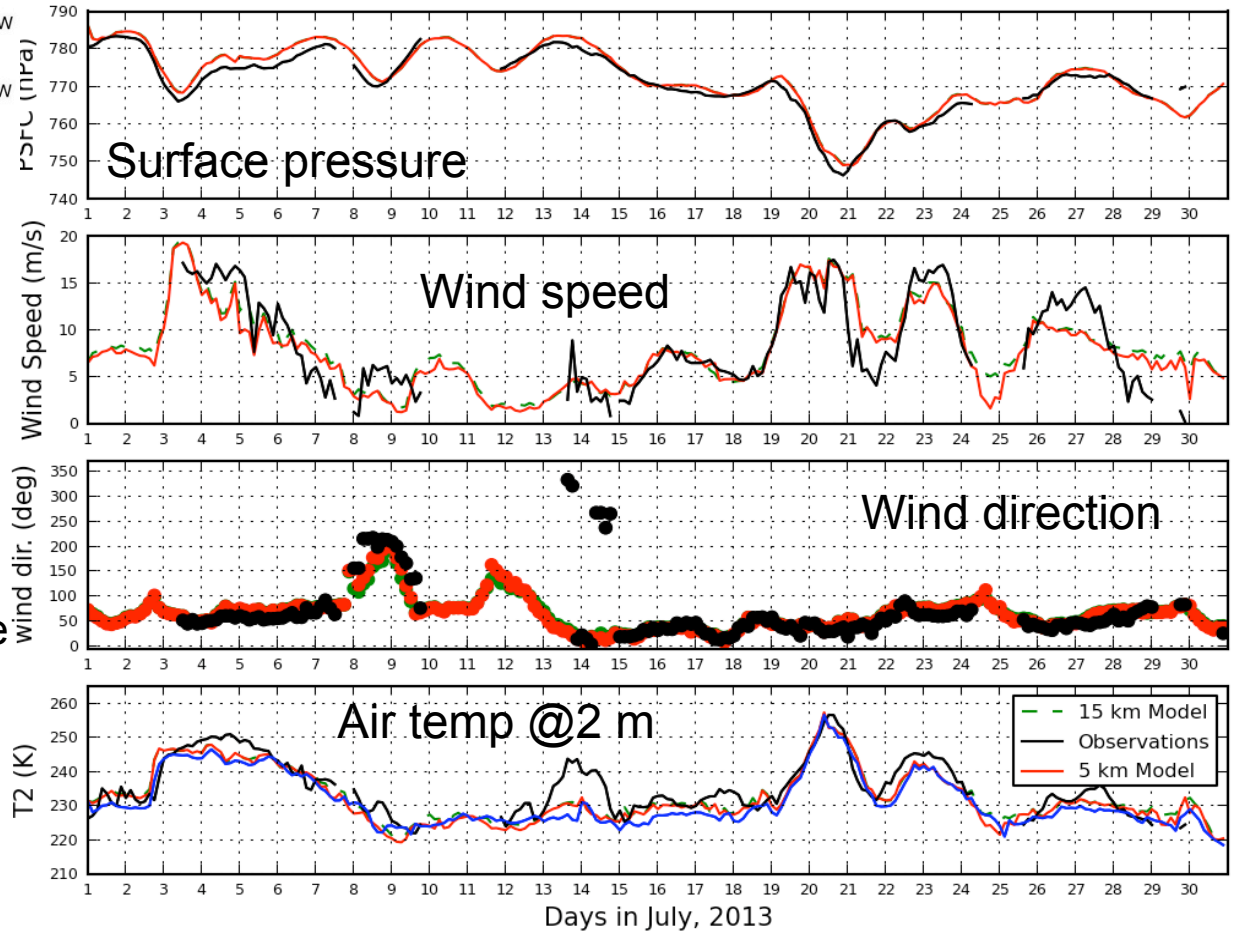


- Accurate representation of pressure, wind speed and wind direction

- Amplified diurnal cycle with larger night time bias

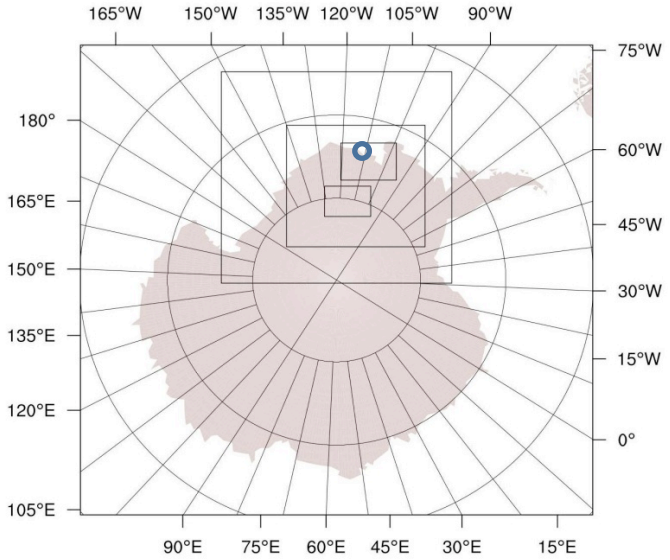


Kominko Slade - July

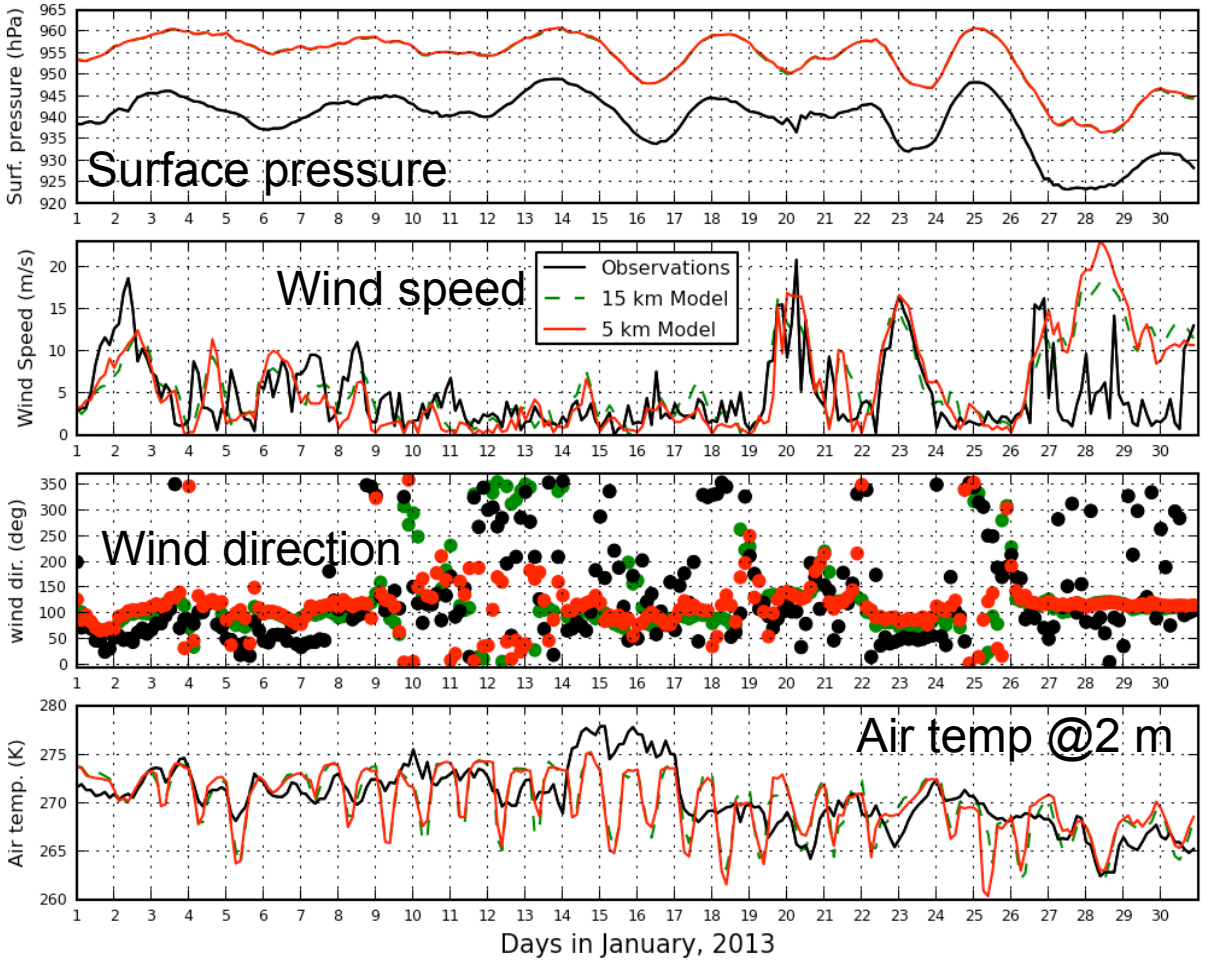


- Accurate representation of pressure, wind and temperature

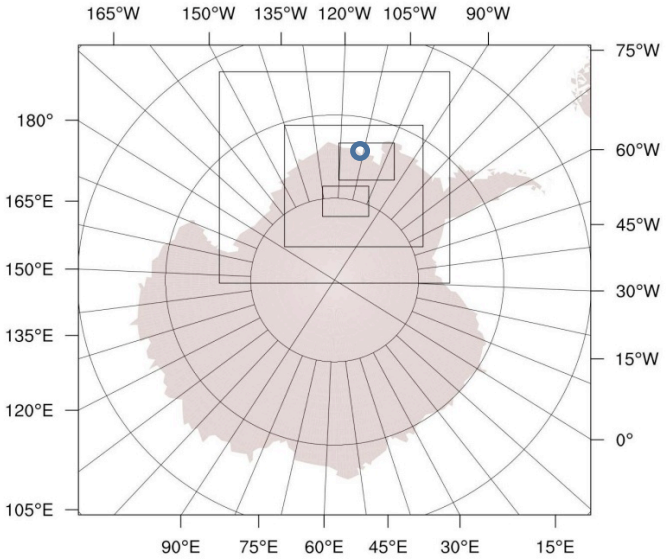
Model skill over coastal stations



BEAR PENINSULA- January



- Consistent positive bias in surface pressure
- Reasonable representation of wind
- Amplified diurnal cycle with larger night time bias



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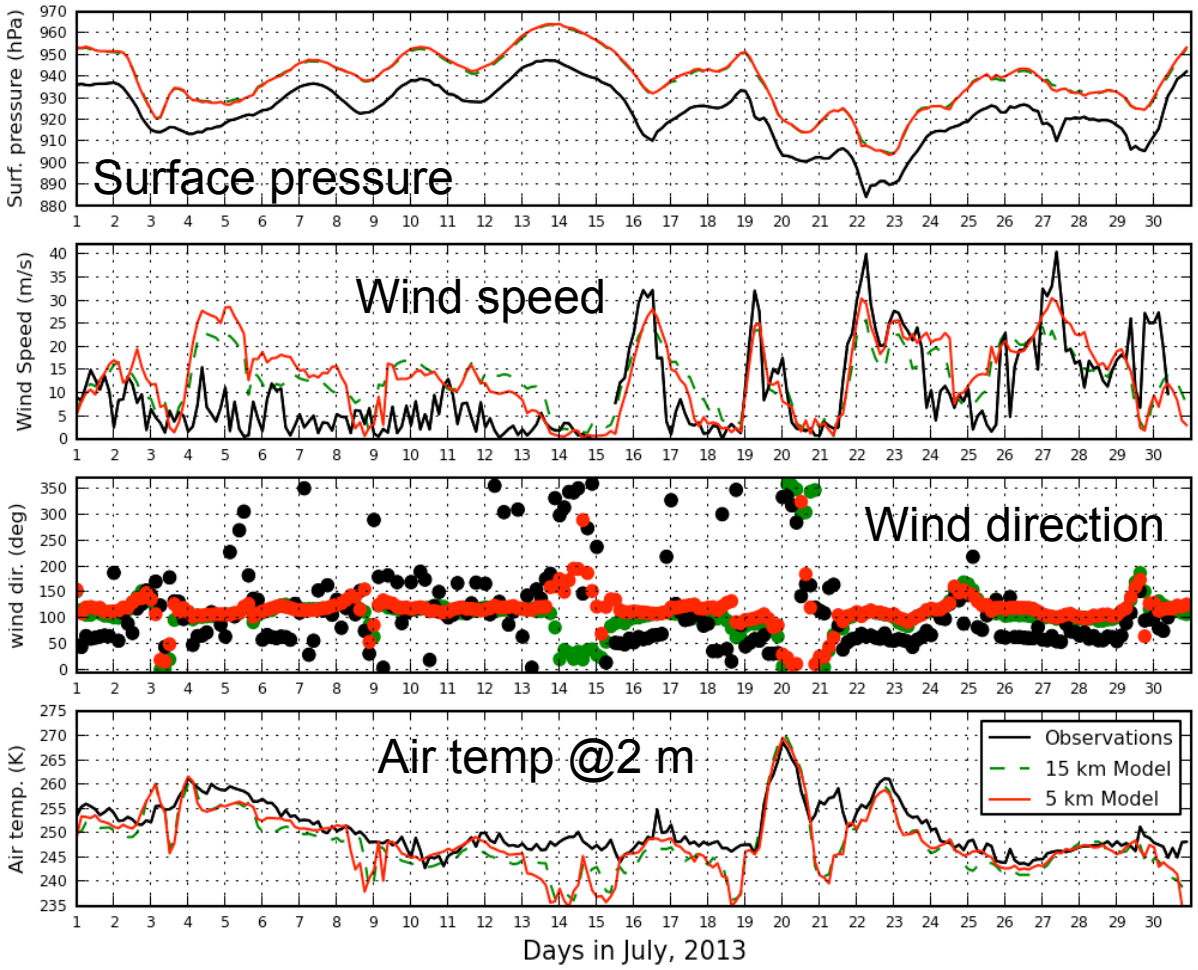
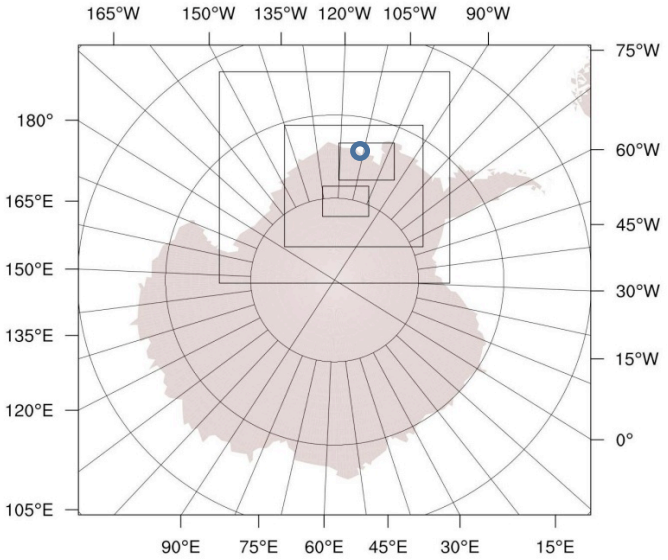
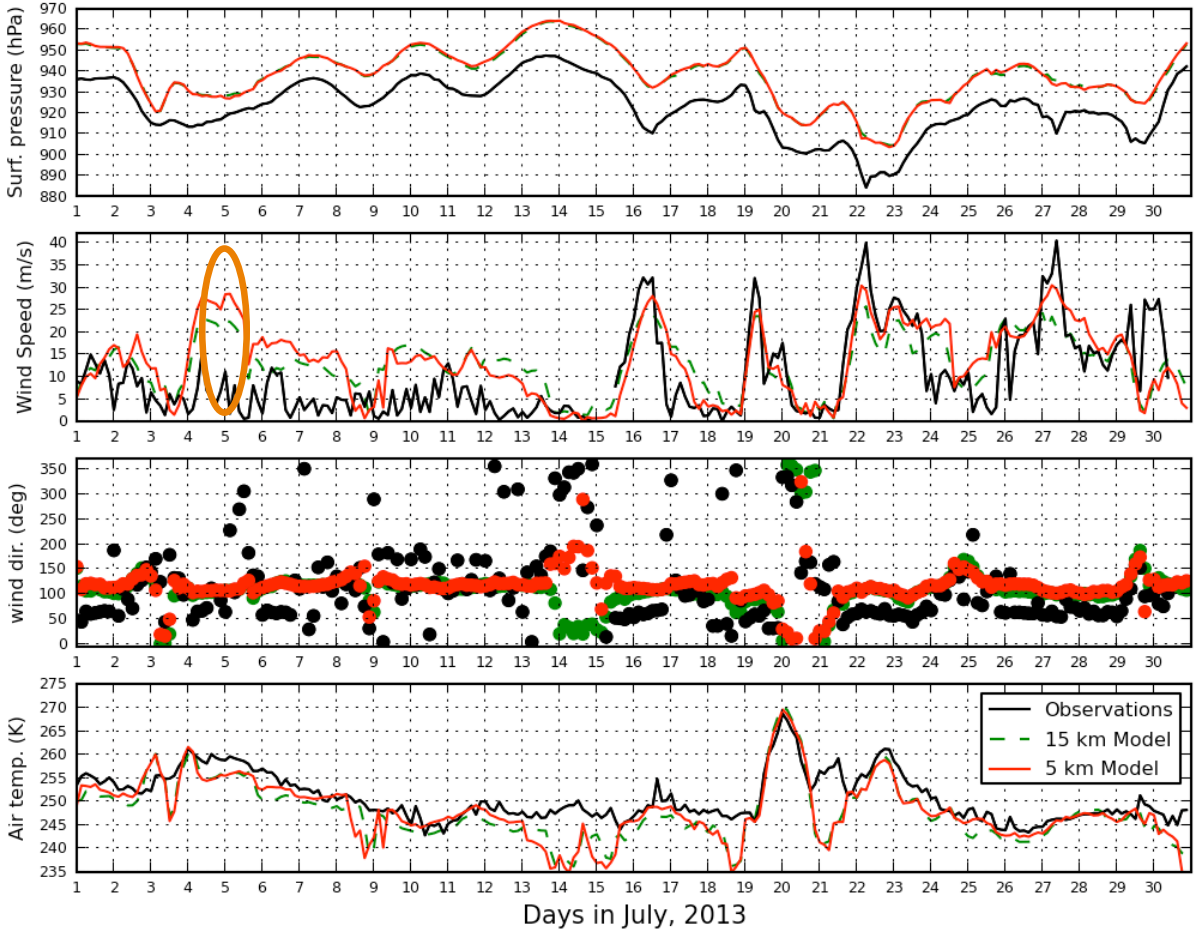


- Strong wind events captured effectively during the second half of July
- Overestimation of wind speed between 4th and 9th July
- Cold bias due to bias in wind direction



BEAR PENINSULA- July



British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

POLAR SCIENCE FOR PLANET EARTH

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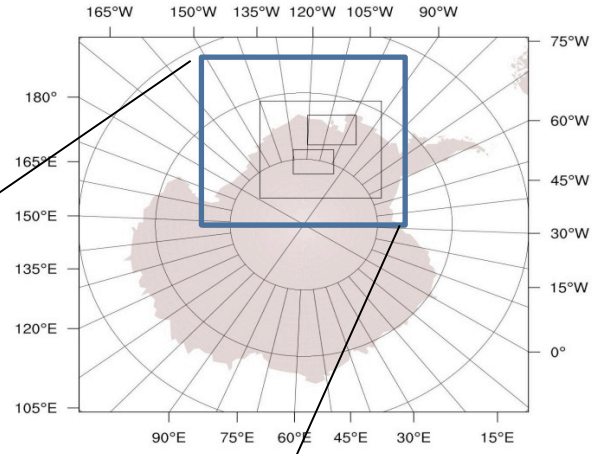
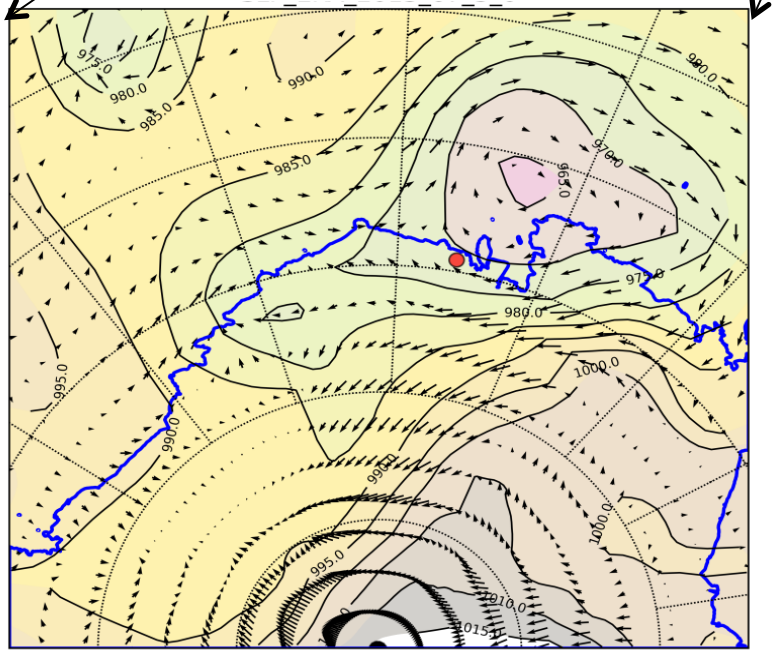
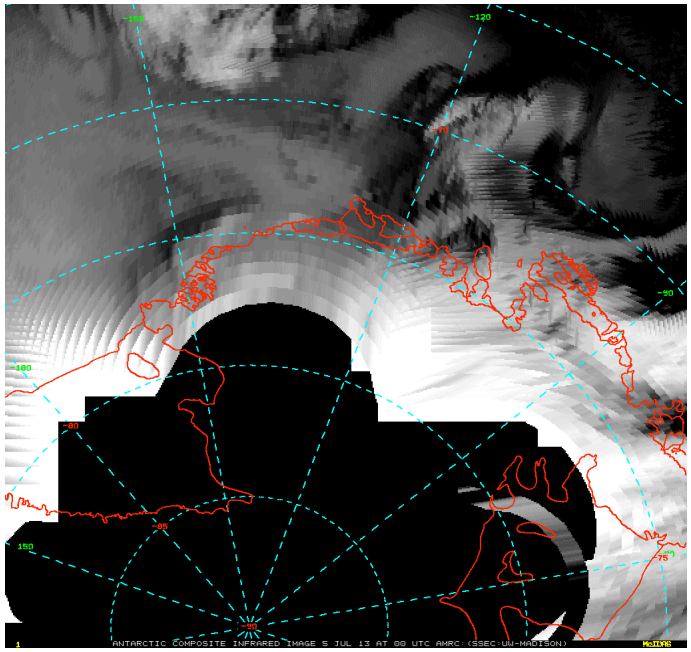
05-07-2013



ERA interim



IR imagery



(source: University of Wisconsin-Madison Antarctic Meteorological Research Center)

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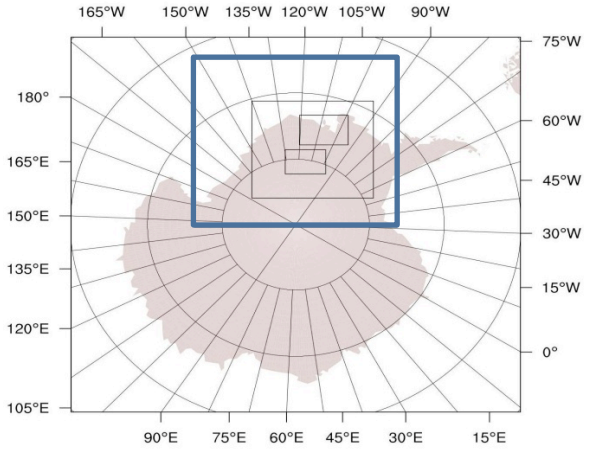

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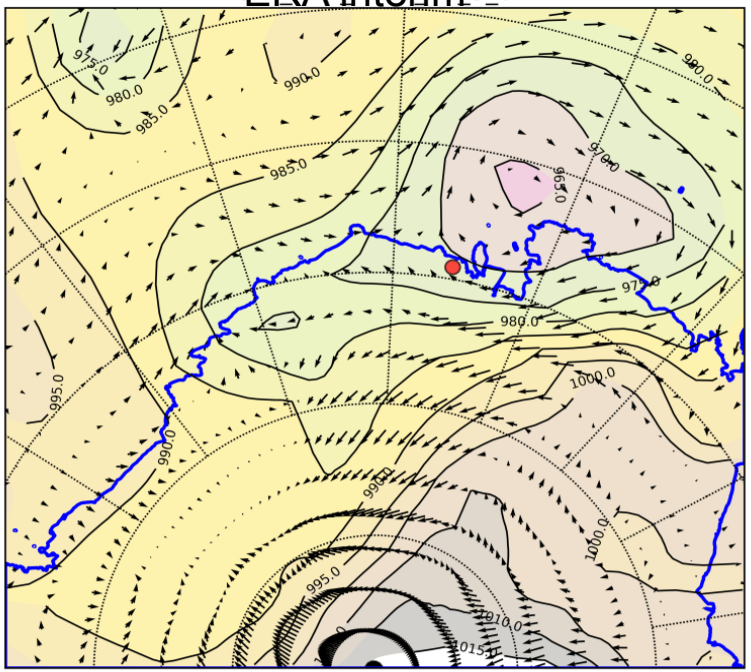
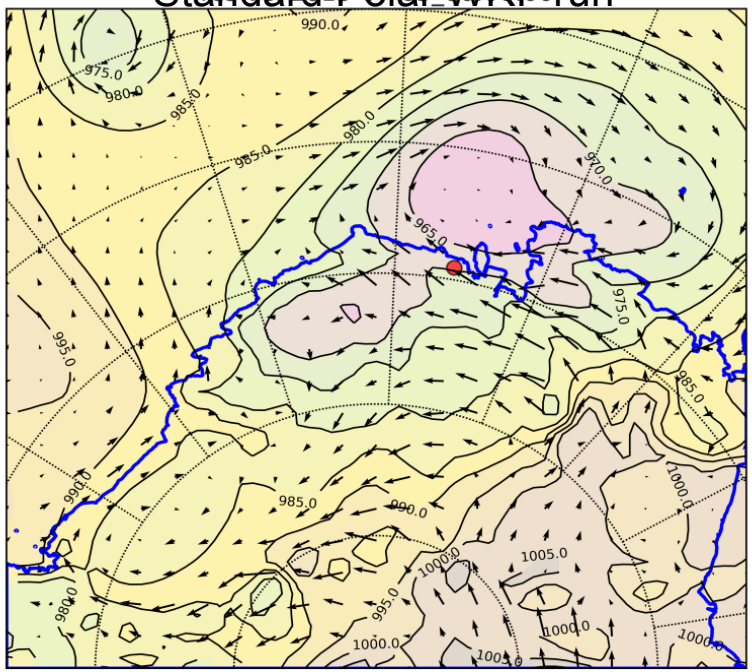


Standard Polar WRF run



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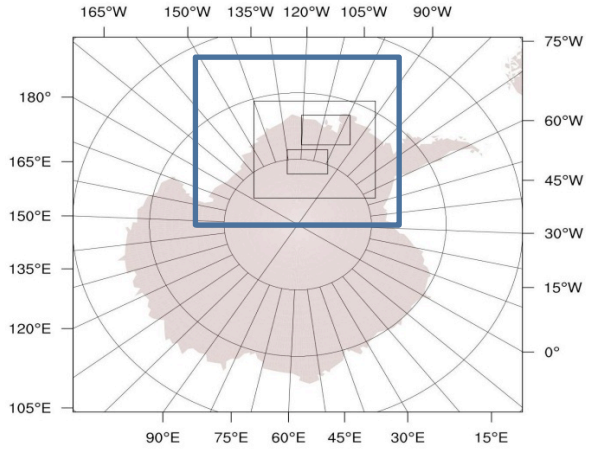
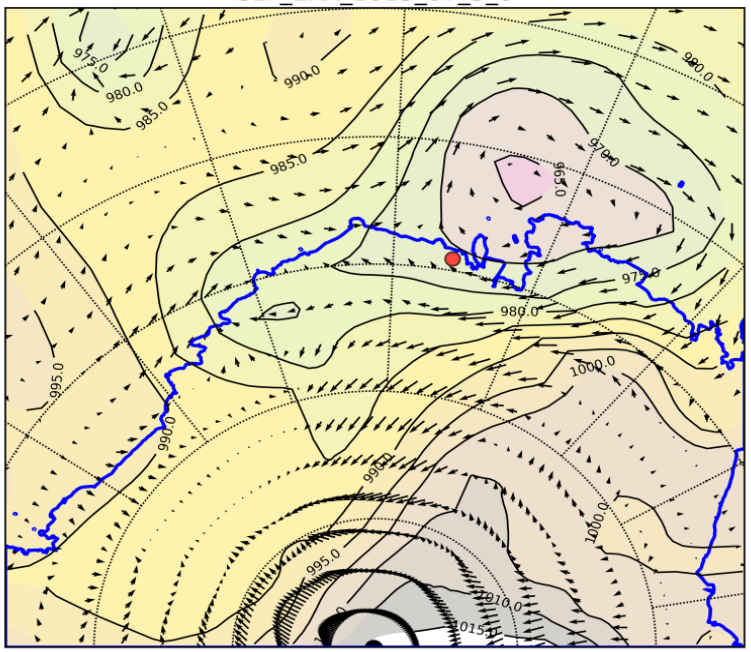
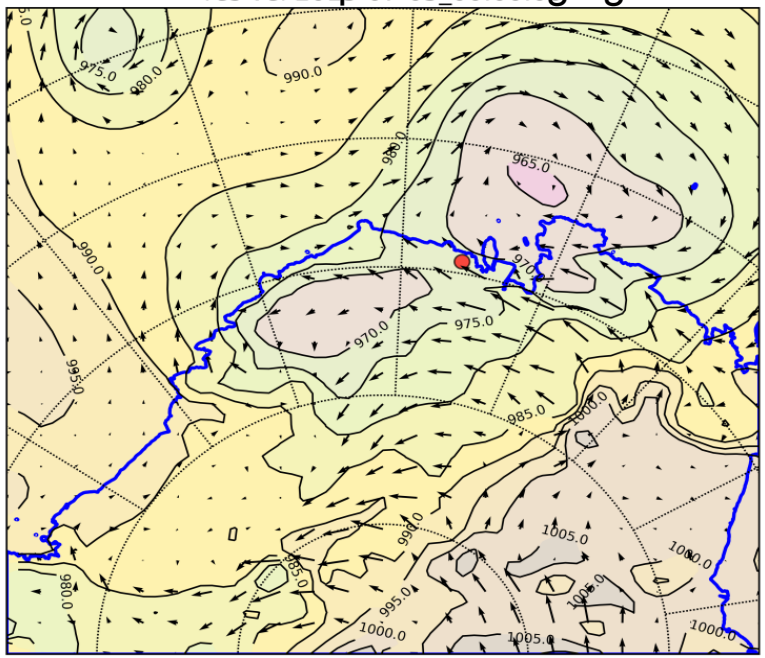
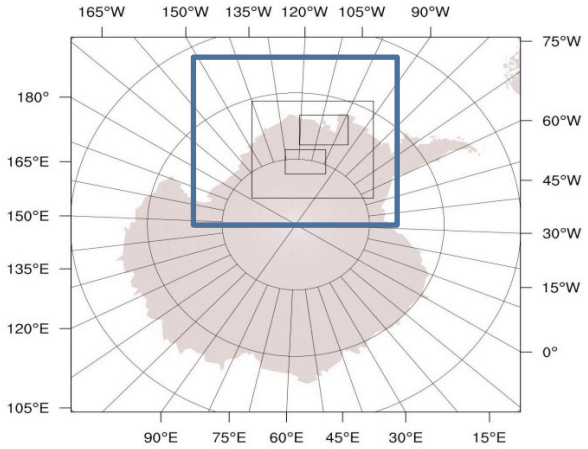


ERA interim



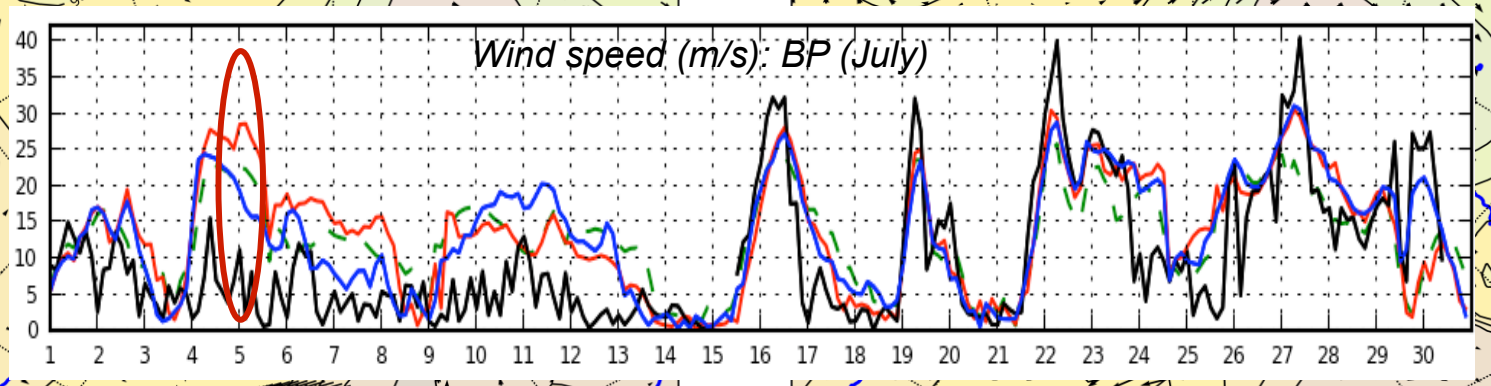
Run with spectral nudging

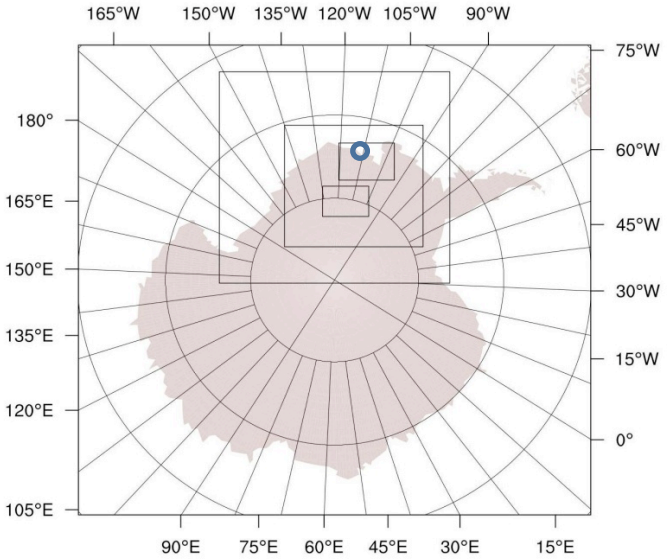




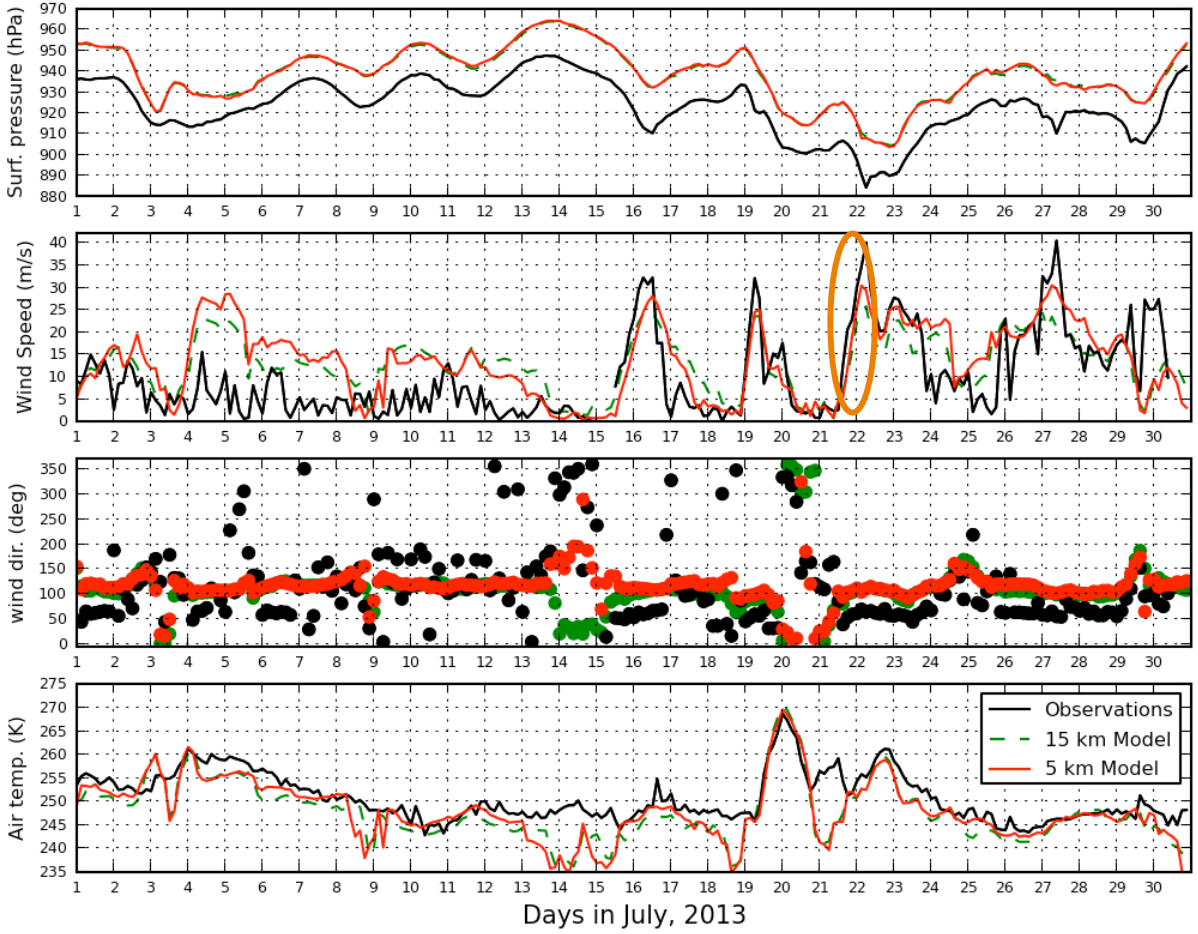
ERA interim

Run E





BEAR PENINSULA- JULY



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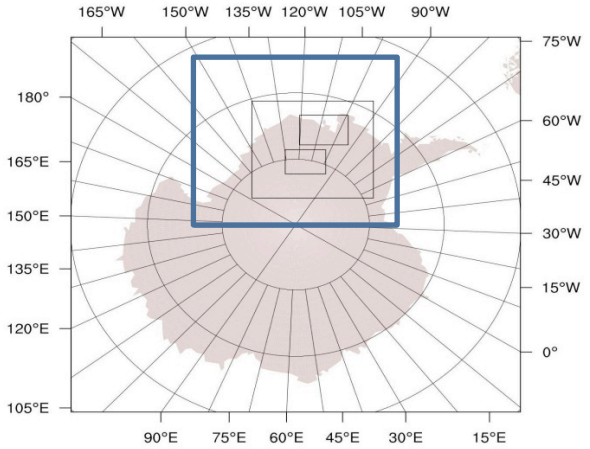

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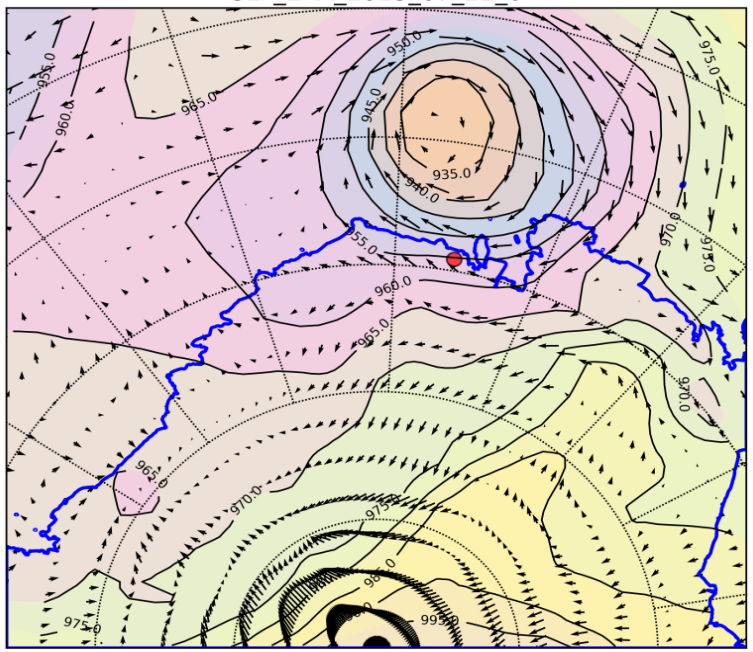

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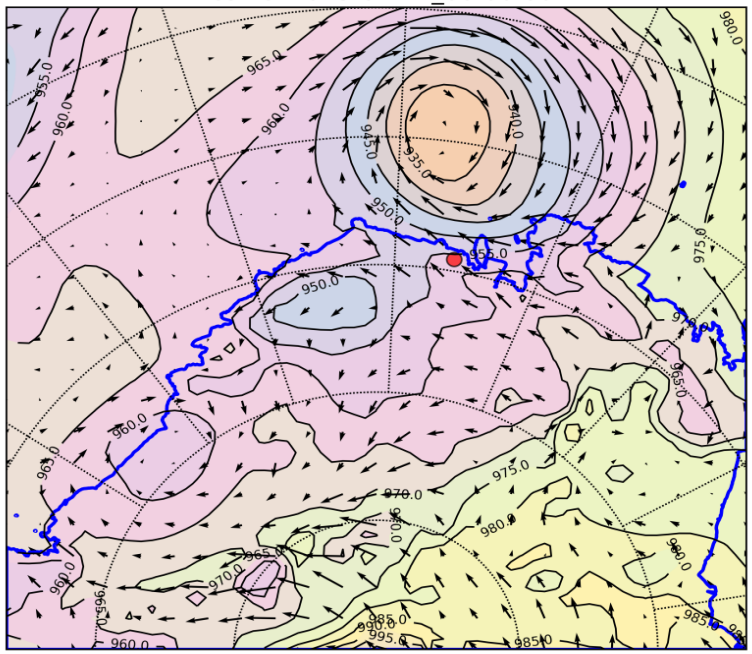
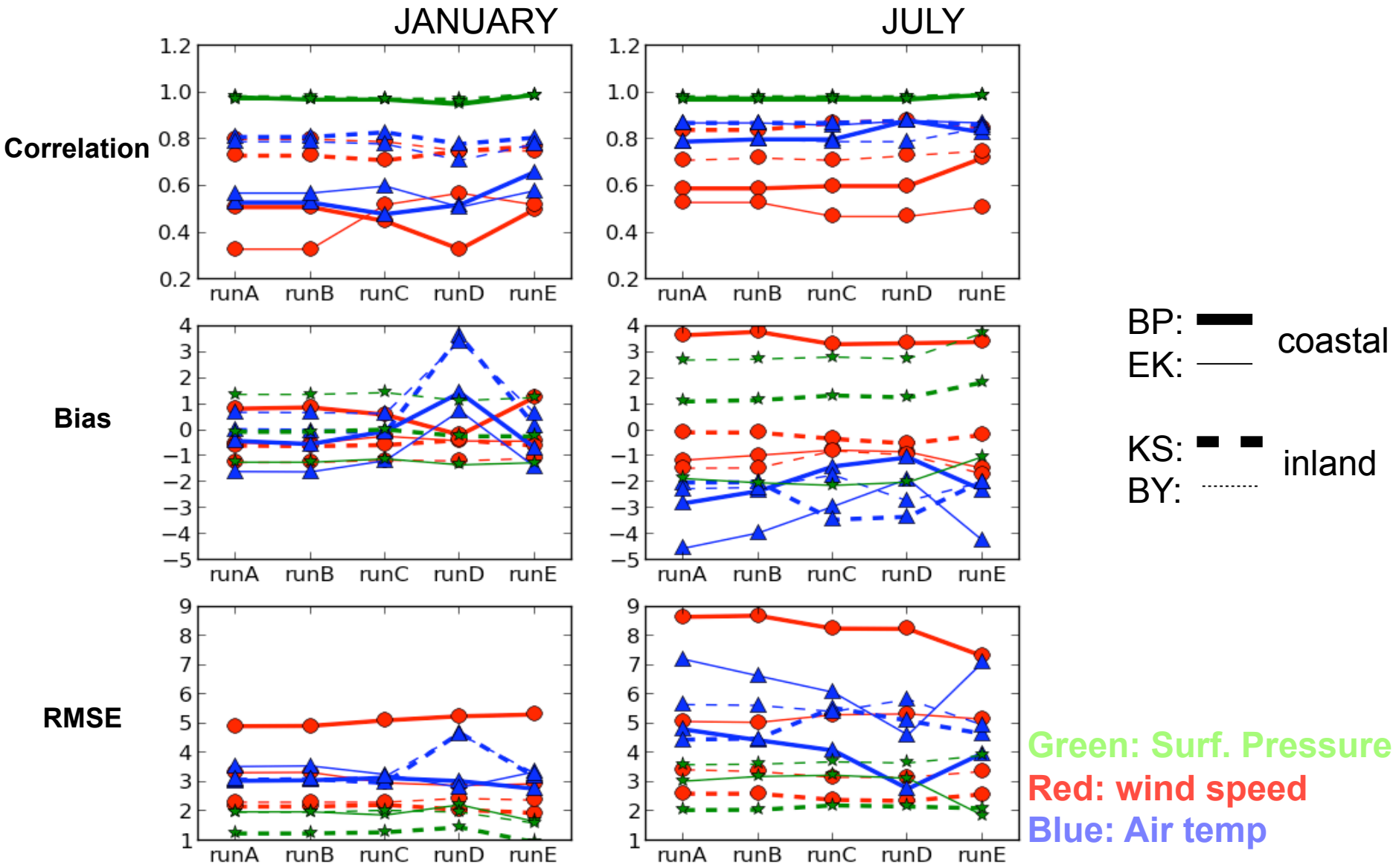


Sensitivity Studies

Labels	Description
Run A	Basic run with ERA interim forcing, USGS topography data and Noah LSM
Run B	Run A + high resolution bootstrap sea ice data from NSIDC + high resolution SST data from AVHRR
Run C	Run B + Bedmap2 topography data
Run D	Run C + Noah MP LSM
Run E	Run A + spectral nudging above PBL


JANUARY
JULY
Correlation
Bias
RMSE
runA
runB
runC
runD
runE
BP:
EK:
coastal
KS:
BY:
inland
Green: Surf. Pressure
Red: wind speed
Blue: Air temp

Conclusions

- Surface pressure shows the best skill, followed by air temperature and wind; comparatively better performance seen over ‘homogeneous’ inland stations than ‘complex’ coastal stations

- Cyclones simulated reasonably well, except a few instances when the interaction of coastal topography and cyclone introduces large errors, nudging improves the results

- Realistic sea ice & SST and Bedmap2 has an overall positive impact on model statistics, Noah MP improves temperature simulation in coastal regions

Conclusions from the sensitivity studies:

- realistic sea ice /SST improves results in winter

- Bedmap2 improves model statistics in all seasons, but the effect on wind is variable

- Noah MP improves air temperature simulation for coastal stations but worsens for inland stations

- Nudging has a significant positive impact on all parameters

Acknowledgements:

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University of Wisconsin-Madison Automatic Weather Station Program

University of Wisconsin-Madison Antarctic Meteorological Research Center

Thank you for listening!