Early comparison of MM5 and WRF time series to AWS observations

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Methods

- Collect AWS observations from Antarctic-IDD
  - Do subjective quality control – remove obvious outliers
- Collect model time series from MM5 and WRF forecasts
  - Near-surface data
  - Model integration time step
  - Grid point nearest AWS location
- Temporally interpolate model output and observations to 10-minute intervals.
- Plot the temperature and wind speed time series.
  - Two models
  - Two forecast cycles per day
  - 5-day forecasts
  - 20 different forecasts for any given observation time
- Produce some simple statistics
  - Bias and RMSE as a function of forecast time

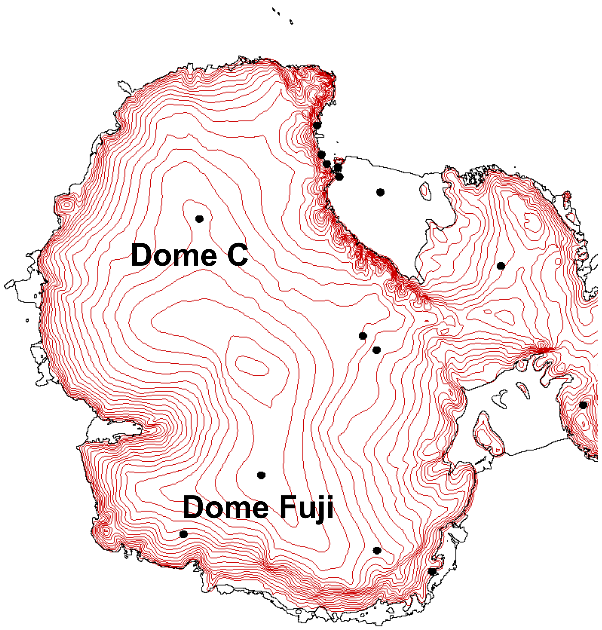
Caveats

- This study represents only the latest several weeks of data
  - Results and interpretation may turn out to be different for other seasons
- MM5 and WRF are on similar grids, with similar terrain fields, but the configuration is not exactly the same
- Differences in model output level:
  - MM5 output at lowest model level (~14 m AGL)
  - WRF output (diagnosed in PBL scheme) at 2 m (T) and 10 m (wind)
    - Think boundary-layer structure
- Surface data offer a very limited look at model behavior
  - Think boundary-layer structure again
- As always, the 0-36 hour of the 20-km grid, where nests are active, isn't straightforward to interpret, because of feedback from nests
- Fix from a few days ago casts doubt on the WRF results
  - Heat flux between atmosphere and sub-surface levels was essentially shut down

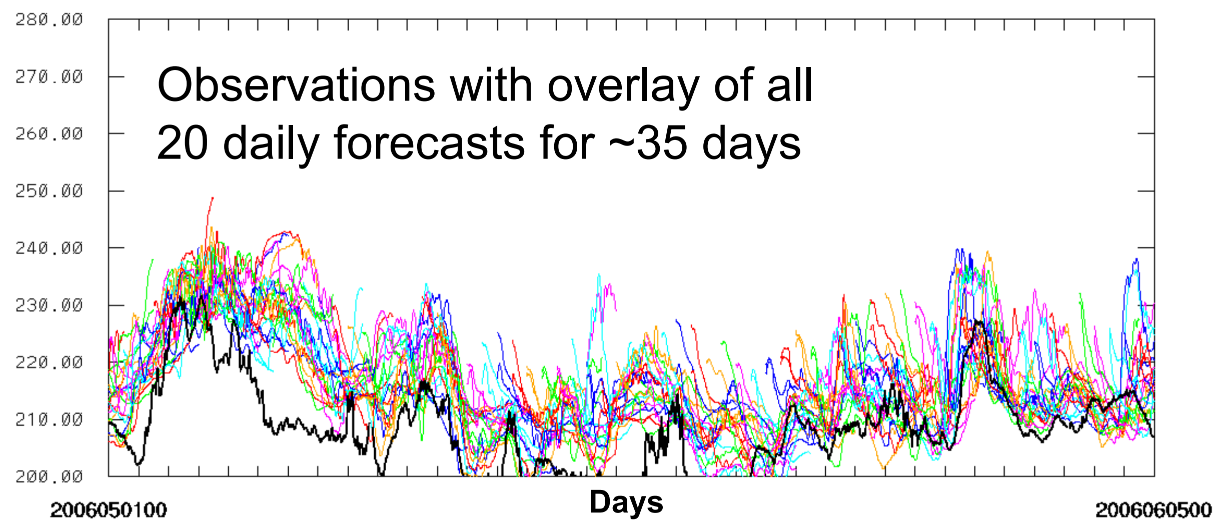
Conclusions

- MM5 and WRF are comparable
  - Similar behavior and similar failings
- Temperature:
  - Warm bias overall
  - WRF generally warmer than MM5
  - Can be a wide range of temperature values forecast for a given observation time
    - WRF seems to have more spread
- Wind speed:
  - Wind events seem to be handled pretty well in both models
  - WRF generally has lower speed bias
- We inherit some problems from the GFS initialization
  - Perhaps this contributes to our overall warm bias?
- If we can address the warm bias, we would have a significant improvement in surface temperature forecasts
  - Possibilities:
    - Initialization
    - Ice temperatures, and initialization thereof
    - Ice, surface-layer physics, radiation, heat fluxes
    - Boundary layer structure, development of stable layer

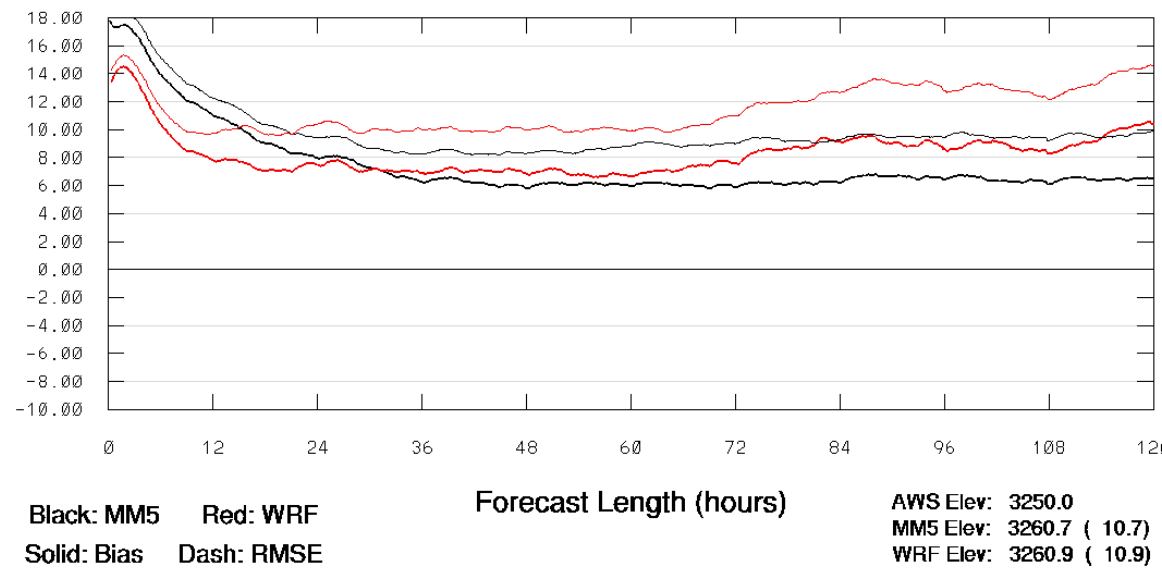
Let’s get to the pictures



Dome C -- Temperature (K)

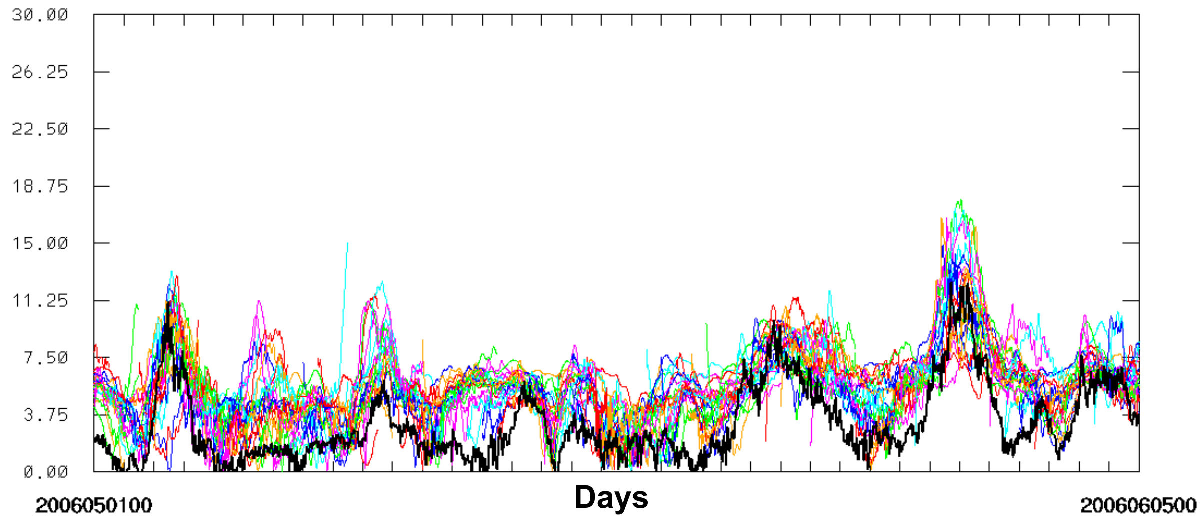


MM5 (black) and WRF (red)
bias (fat) and RMSE (thin)
as a function of forecast hour
(note change in horizontal axis)

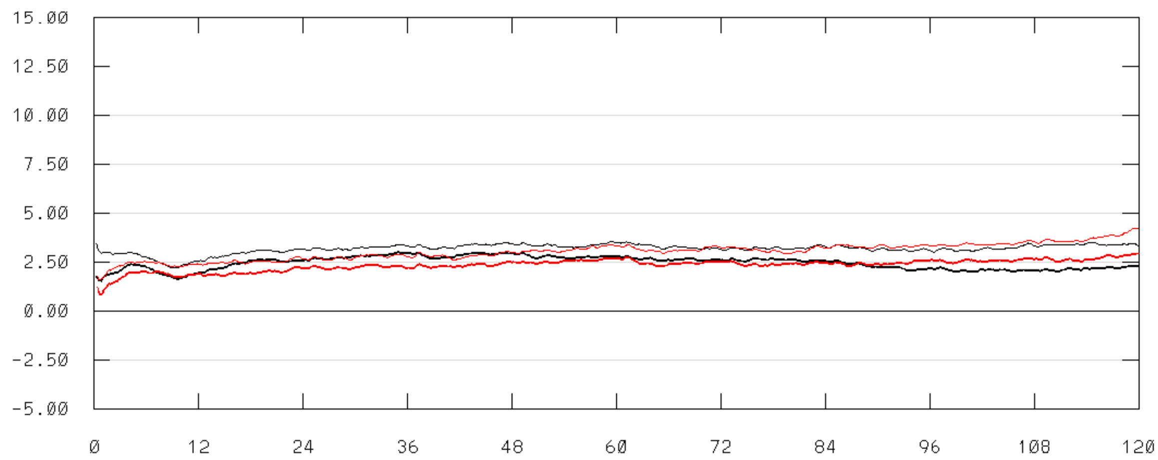


Dome C -- Wind Speed (m s^{-1})

Tight cluster

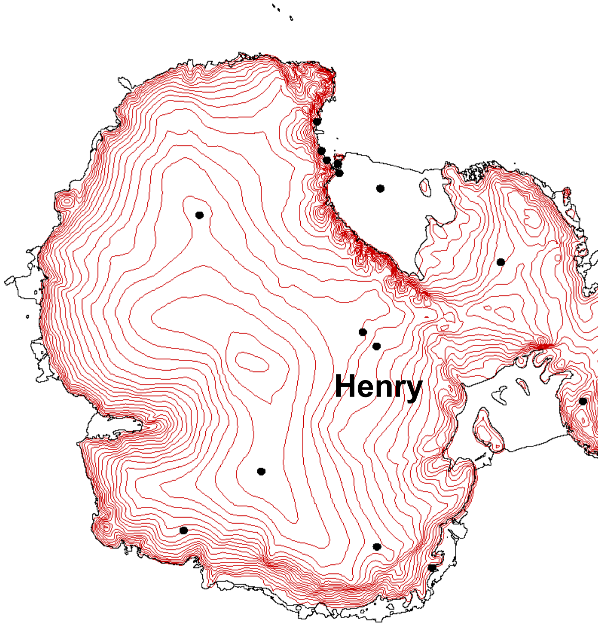


Low bias

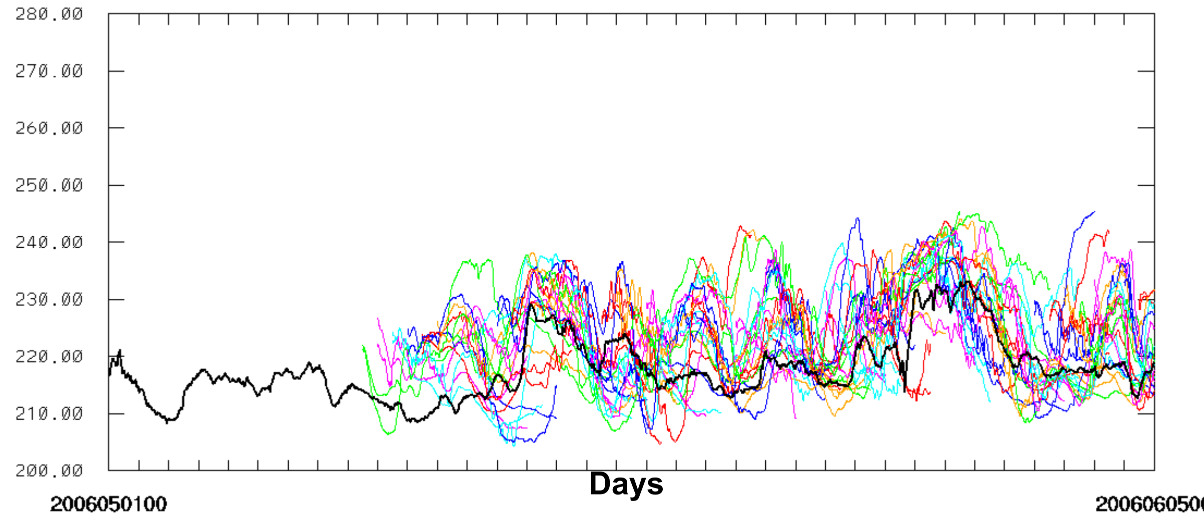


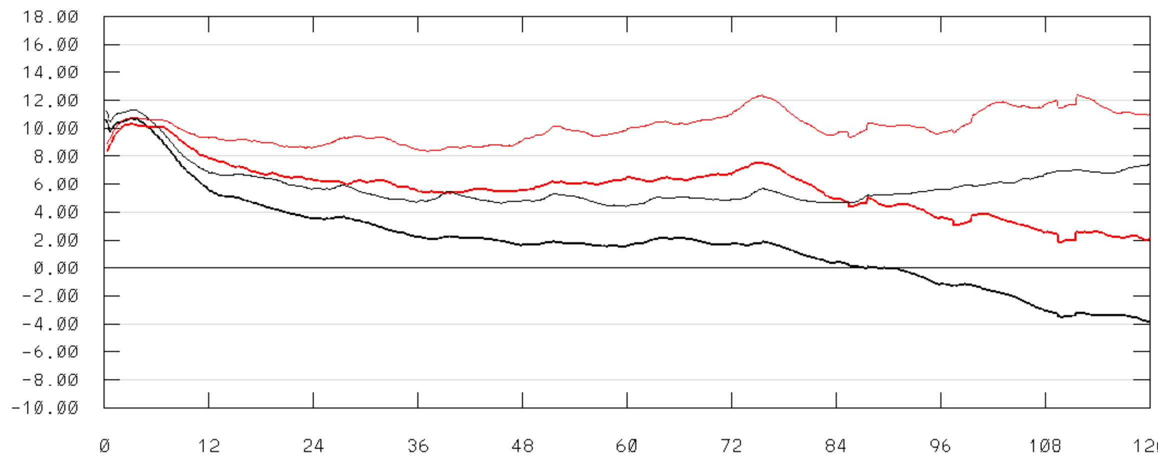
Black: MM5 Red: WRF
Solid: Bias Dash: RMSE

AWS Elev: 3250.0
MM5 Elev: 3260.7 (10.7)
WRF Elev: 3260.9 (10.9)



Henry -- Temperature (K)





Black: MM5 Red: WRF

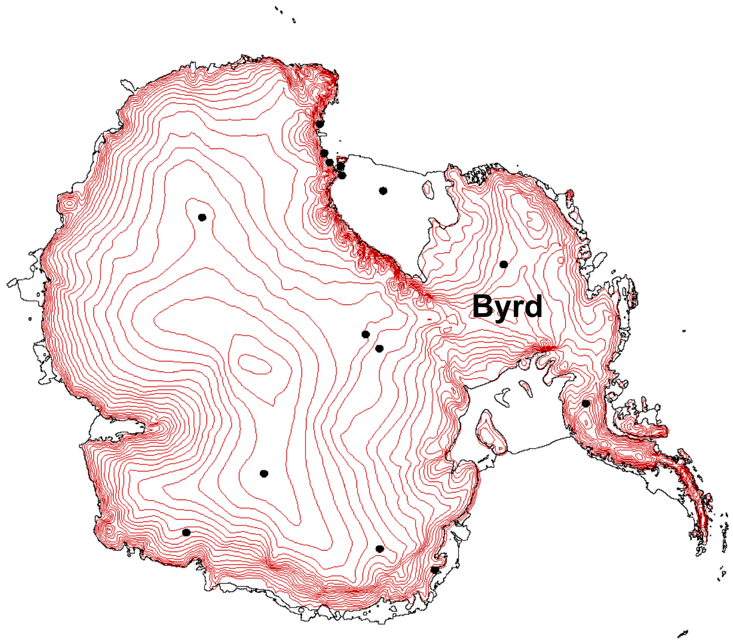
Solid: Bias Dash: RMSE

Forecast Length (hours)

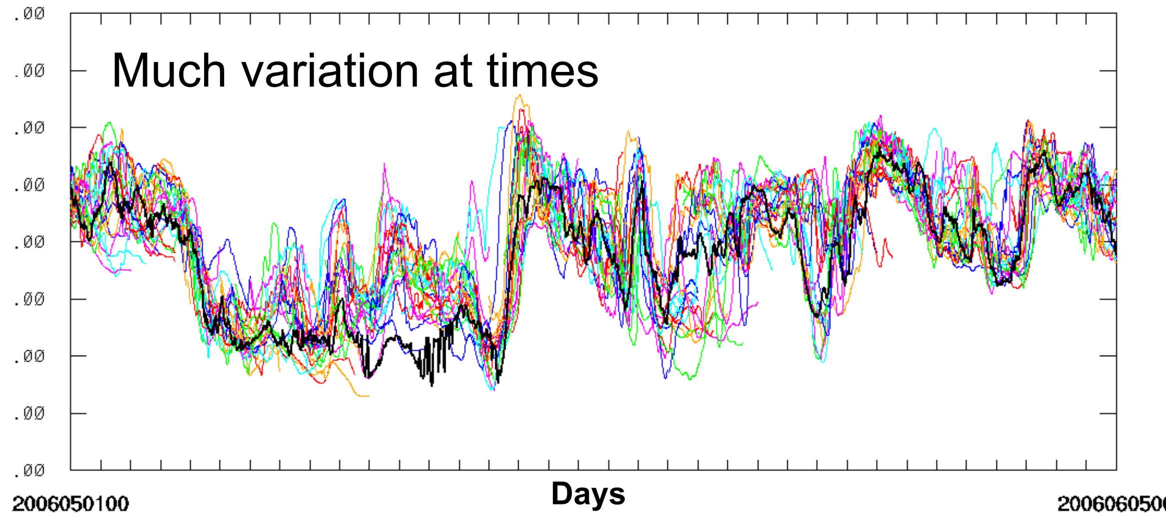
AWS Elev: 2755.0

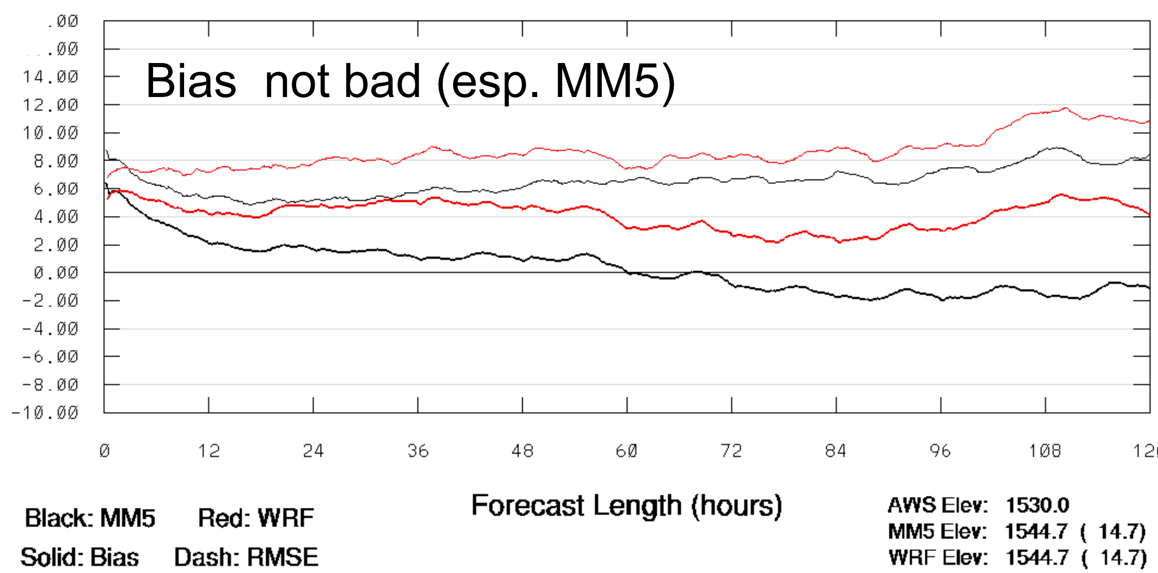
MM5 Elev: 2686.6 (-68.4)

WRF Elev: 2686.3 (-68.7)

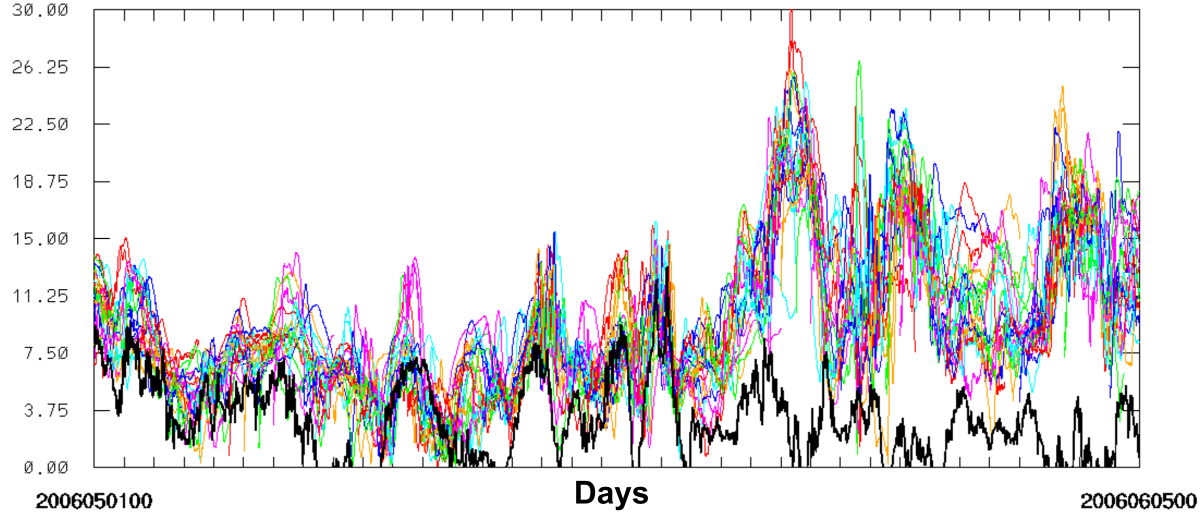


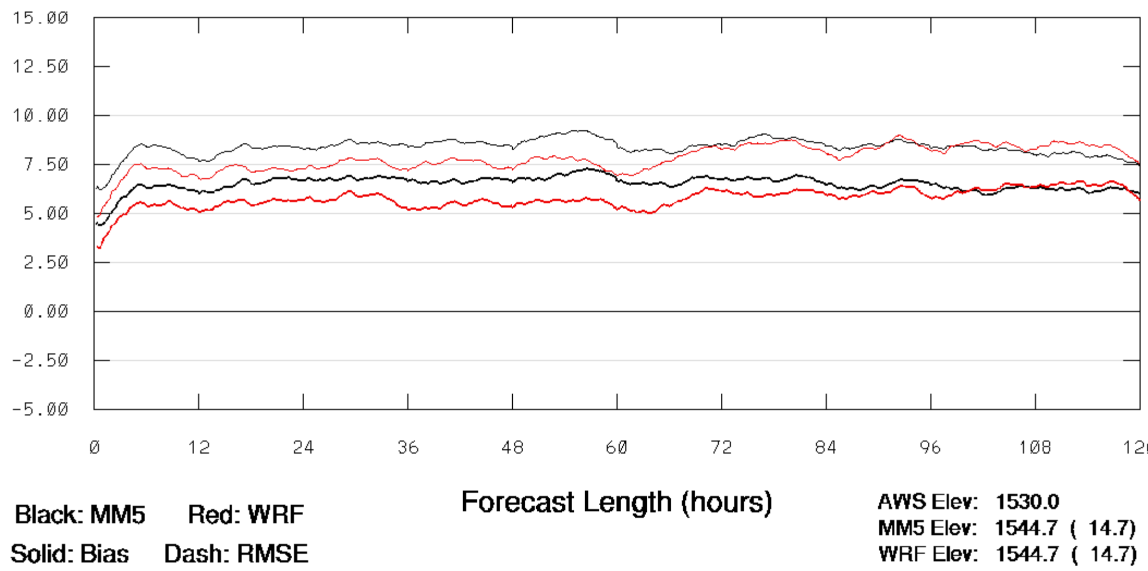
Byrd Station -- Temperature (K)

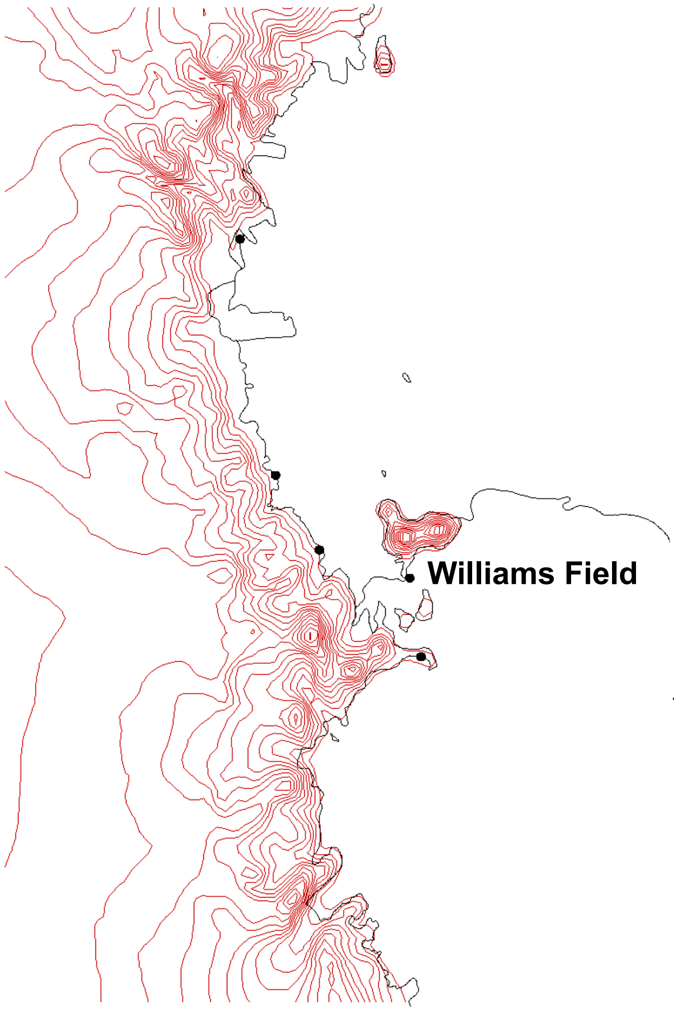




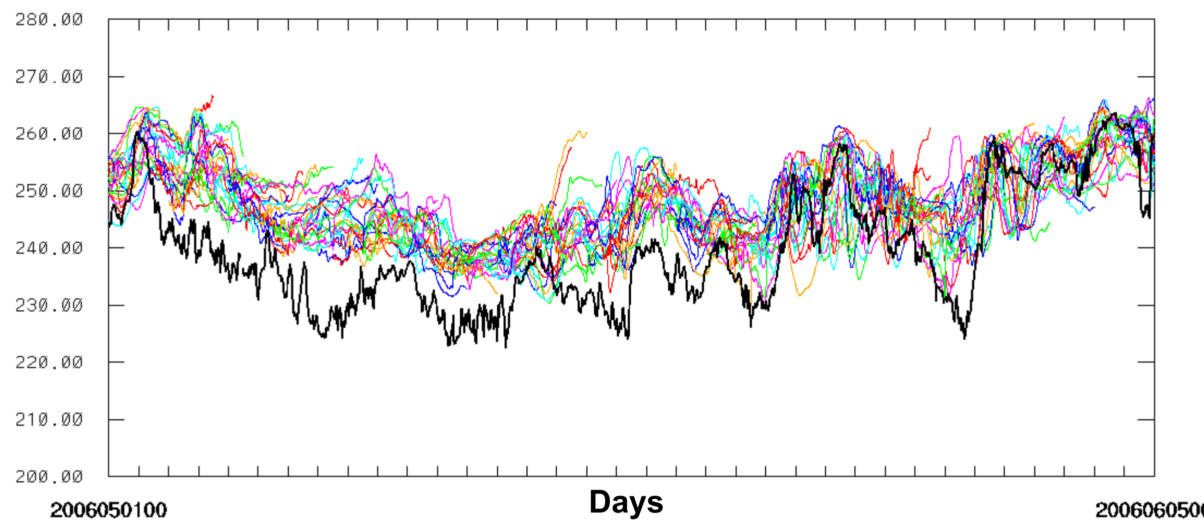
Byrd Station -- Wind Speed (m s^{-1})

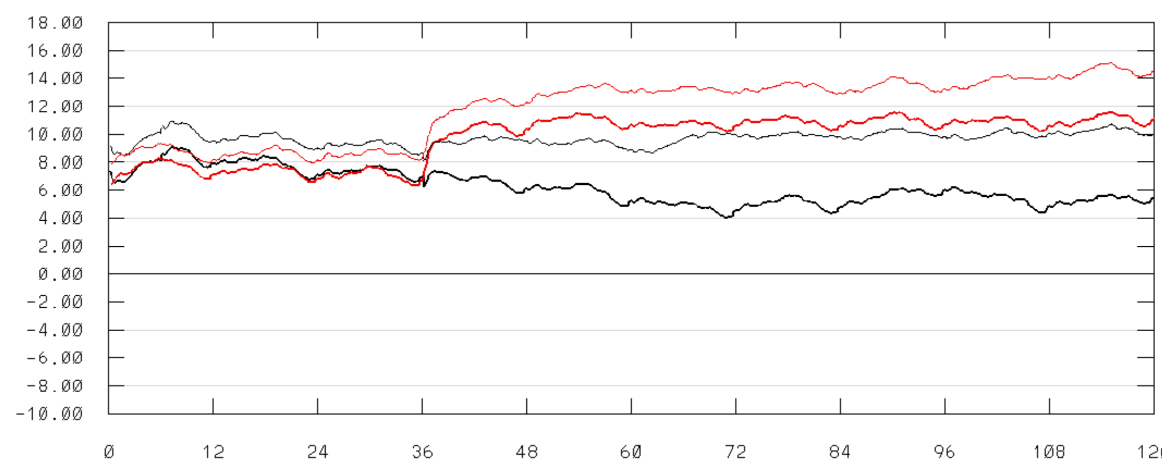






Williams Field -- Temperature (K)



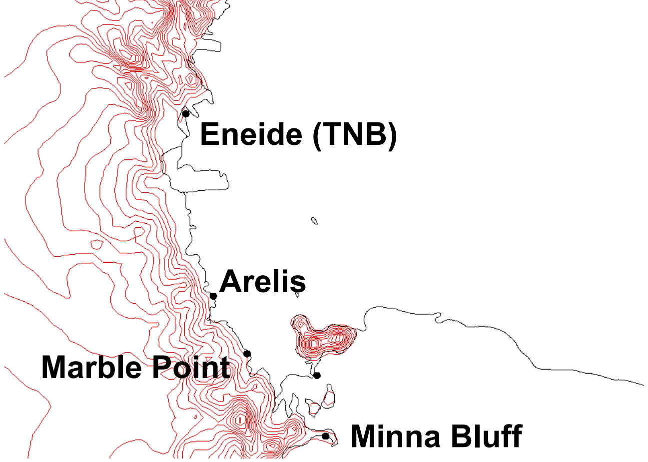


Forecast Length (hours)

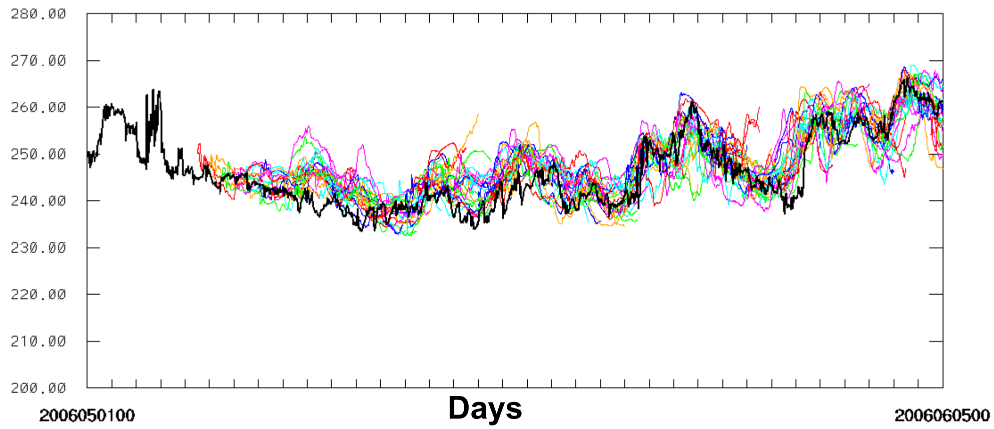
Black: MM5 Red: WRF
Solid: Bias Dash: RMSE

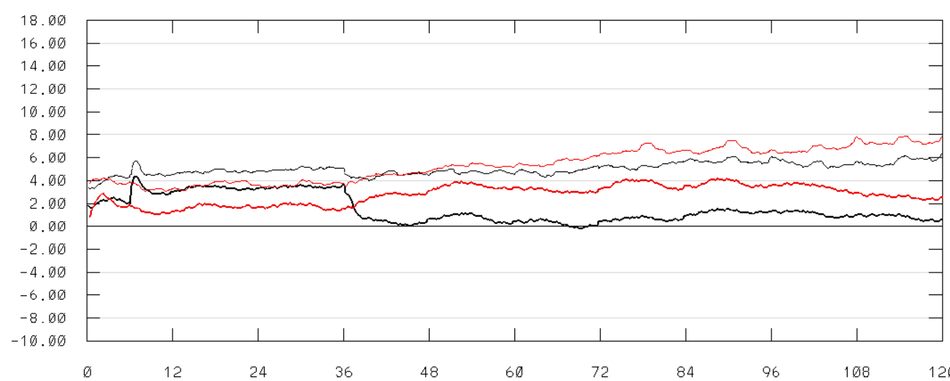
AWS Elev: 14.0
MM5 Elev: 115.8 (101.8)
WRF Elev: 83.2 (69.2)

Marble Point -- Temperature (K)



20-km Grid



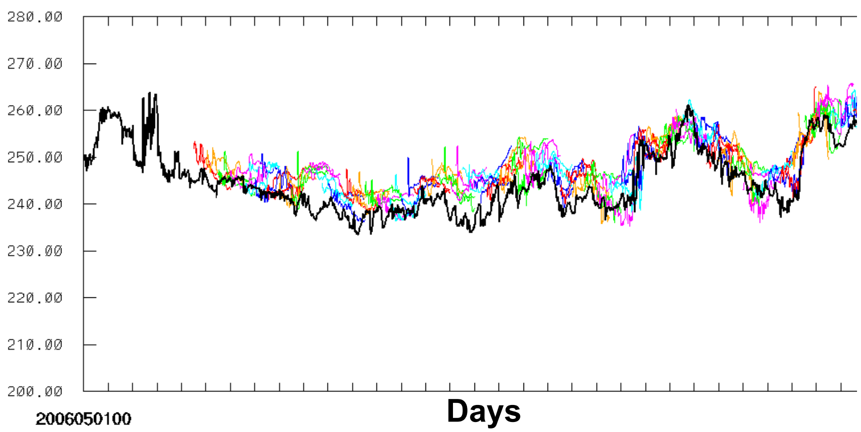


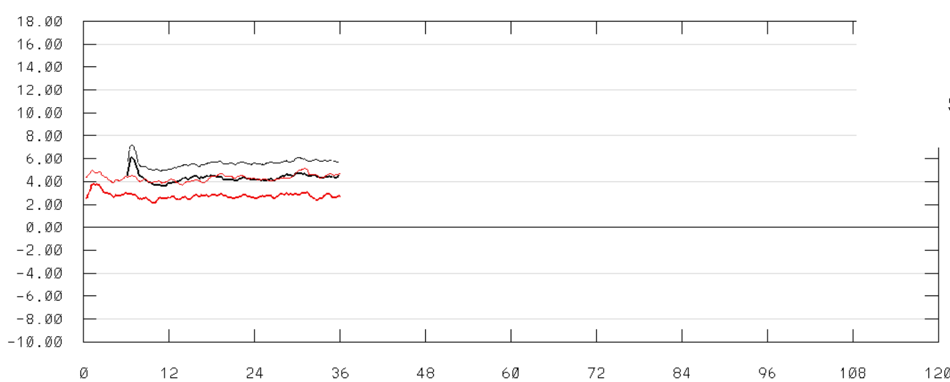
Forecast Length (hours)

Black: MM5 Red: WRF
Solid: Bias Dash: RMSE

AWS Elev: 108.0
MM5 Elev: 304.5 (196.5)
WRF Elev: 313.7 (205.7)

2.2-km Grid



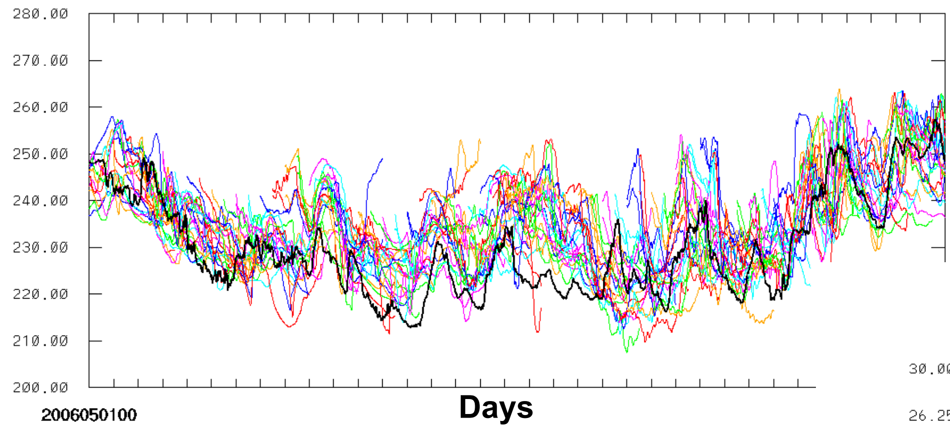


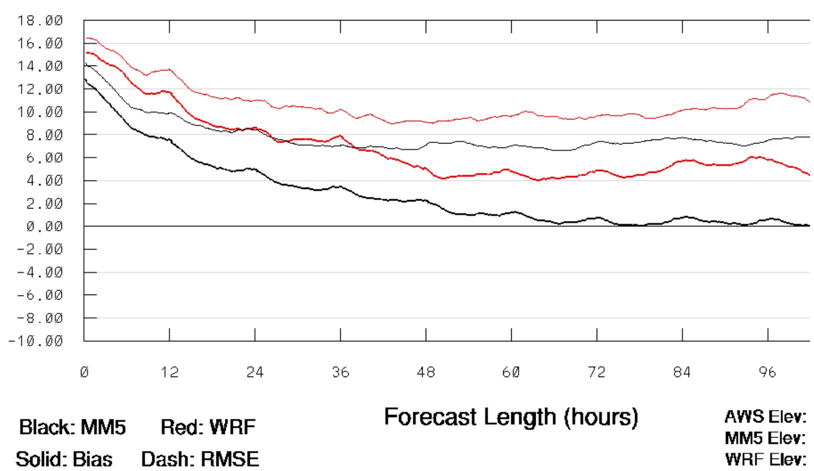
Forecast Length (hours)

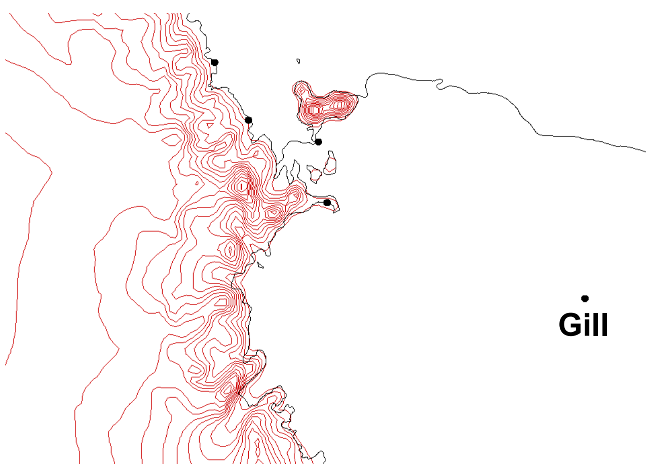
Black: MM5 Red: WRF
Solid: Bias Dash: RMSE

AWS Elev: 108.0
MM5 Elev: 36.7 (-71.3)
WRF Elev: 39.4 (-68.6)

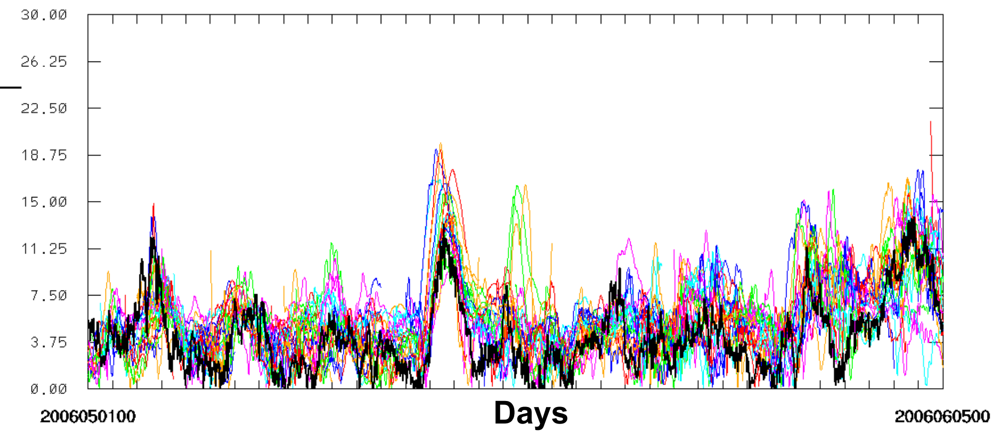
Gill -- Temperature (K)

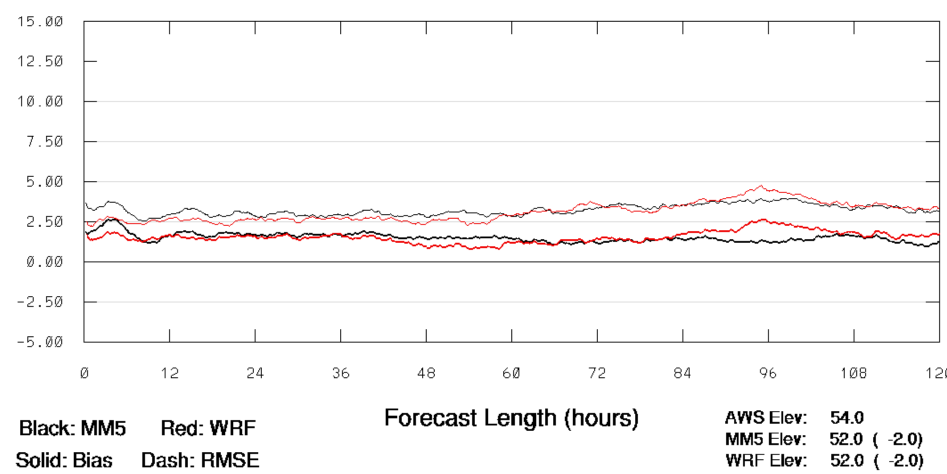




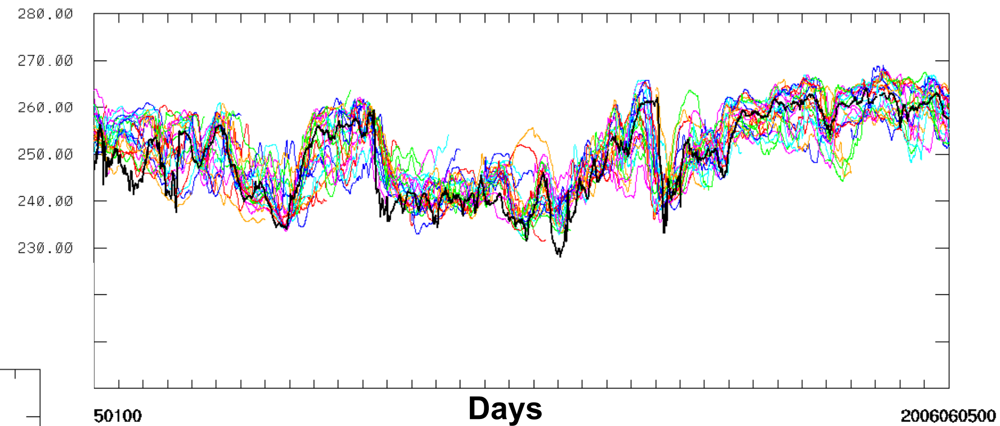


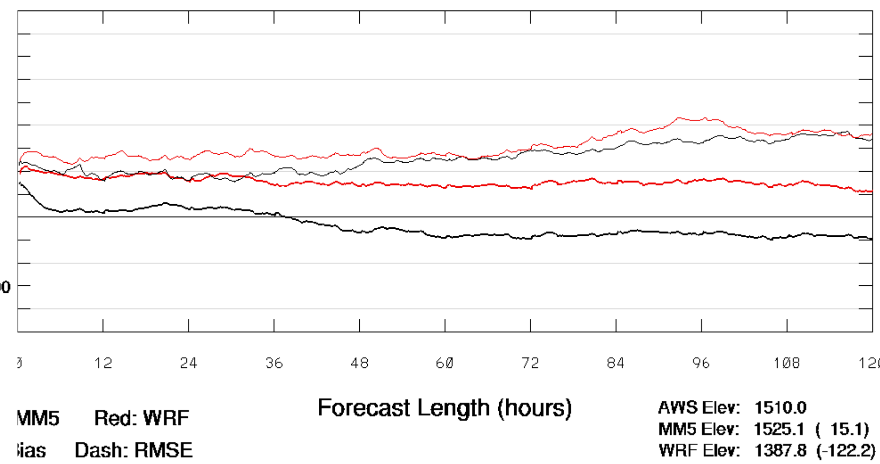
Gill -- Wind Speed



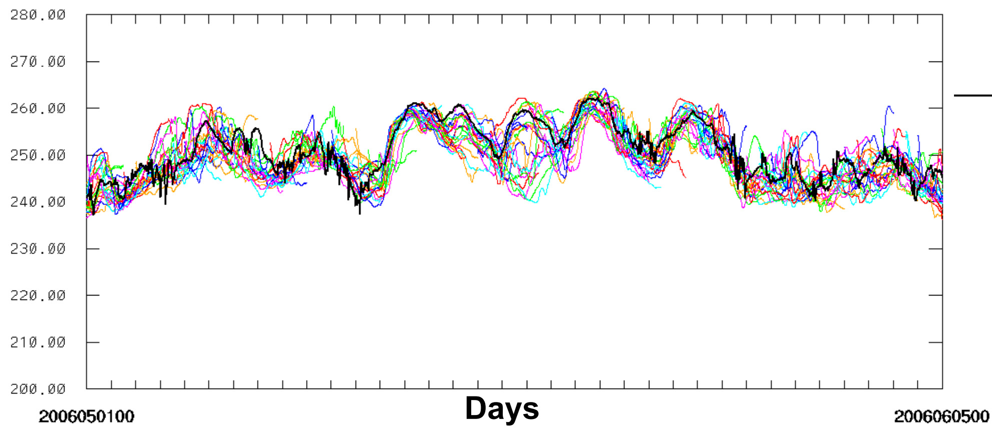


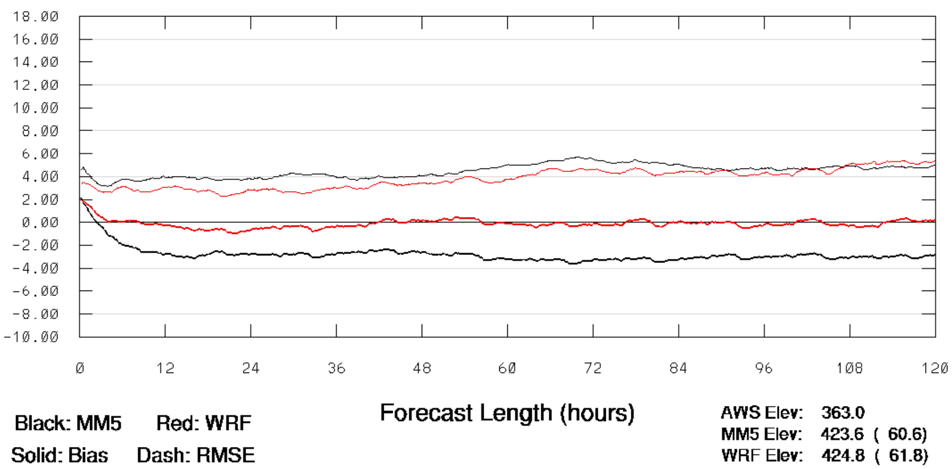
Sky-Blu -- Temperature (K)

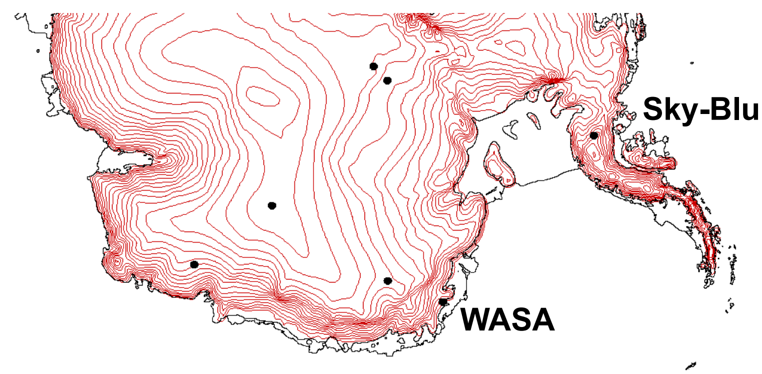


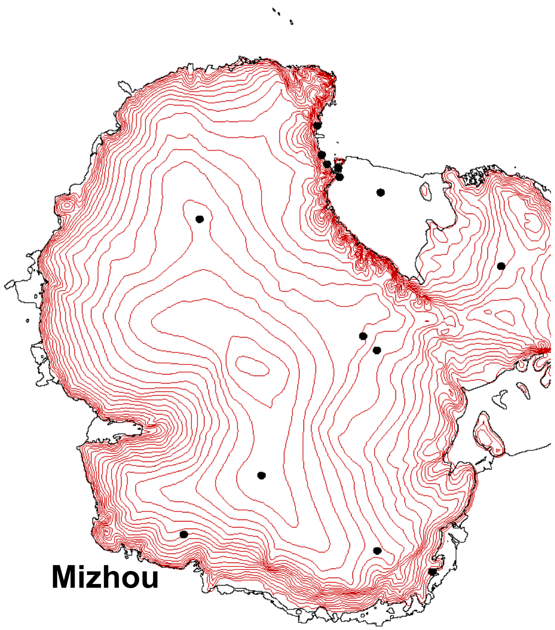


WASA -- Temperature (K)

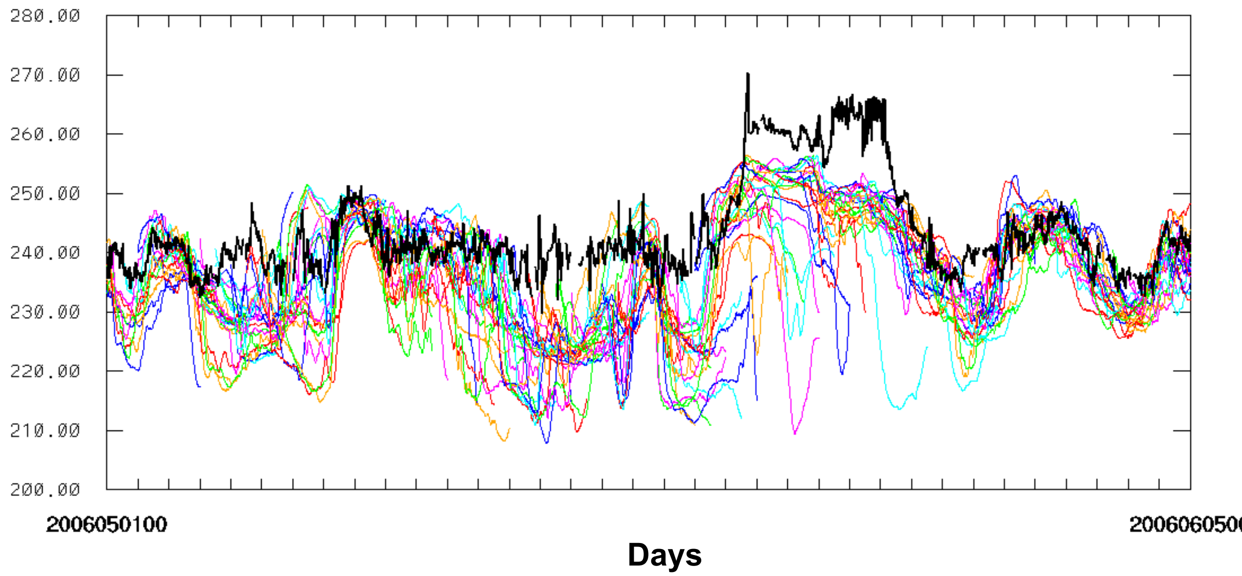


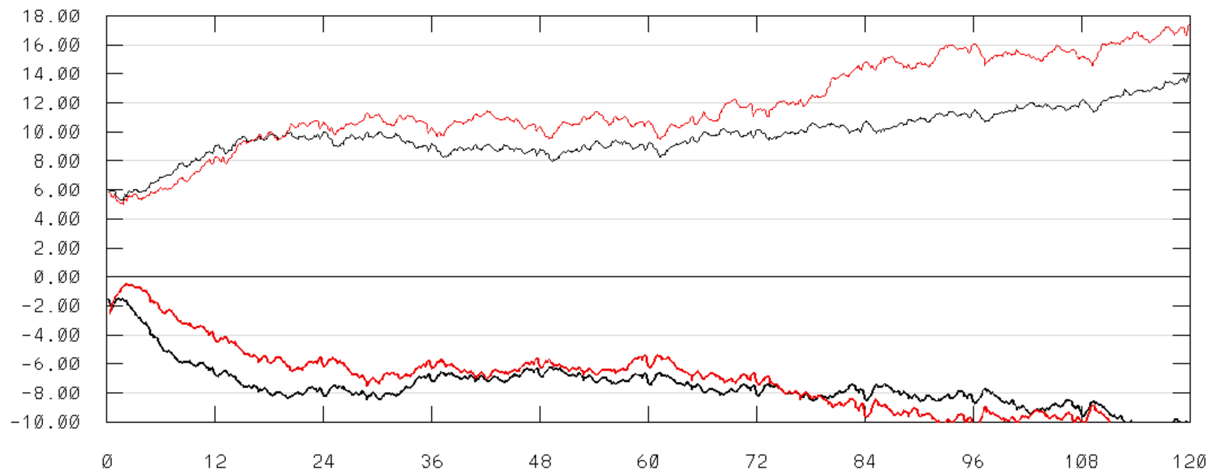






Mizhou -- Temperature (K)





Black: MM5 Red: WRF

Solid: Bias Dash: RMSE

AWS Elev: 2260.0
MM5 Elev: 2231.4 (-28.6)
WRF Elev: 2230.6 (-29.4)

Discussion

- Useful statistics for forecasters?
  - Statistical correction to model time-series output?
- Initialization
  - GFS – Too warm over plateau; too warm over Ross Ice Shelf
  - Ice temperature?
- Warm bias on the plateau
  - Strategies to investigate and address?
- Why such variability among forecasts?
- Default Noah LSM setup probably not optimal for Antarctica
  - “Soil” characteristics?
- Additional stations available in real time?