Analysis of WRF Model Ensemble Forecast Skill for 80 m Winds over Iowa

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Introduction

Accurate wind speed forecasts are very important for the growing wind energy industry due to the relationship between speed and power. More data analysis is needed using observed wind speeds at "tall tower" heights to determine the accuracy of forecasts since most prior research has extrapolated these speeds from 10m measurements. The purpose of this study is to analyze how well various schemes and ensembles of the WRF can predict wind speeds at 80 m at an Iowa site by examining a total of 32 cases, 8 per season.

Data and Methodology

Wind speeds at 80 m were provided by MidAmerican Energy Corporation from a meteorological tower located within their Pomeroy, IA wind farm in 10 min format and were then averaged hourly. Data spanned the period from June 2008 to May 2009. For this analysis, missing or highly suspect data were eliminated. Forecasted speeds were provided by a graduate student, Adam Deppe, and included 6 different planetary boundary layer schemes and 2 different initializations (GFS and NAM) run at a grid resolution of 10 km for a domain covering Iowa and surrounding states. Ensemble means were calculated for both initializations as well. The hypothesis was tested that WRF can forecast wind speeds at 80 m with an average mean absolute error < 2.0 m s^{-1} for the daytime period on the second full day of the 54 hr forecast period in all seasons with a confidence level of 95%.
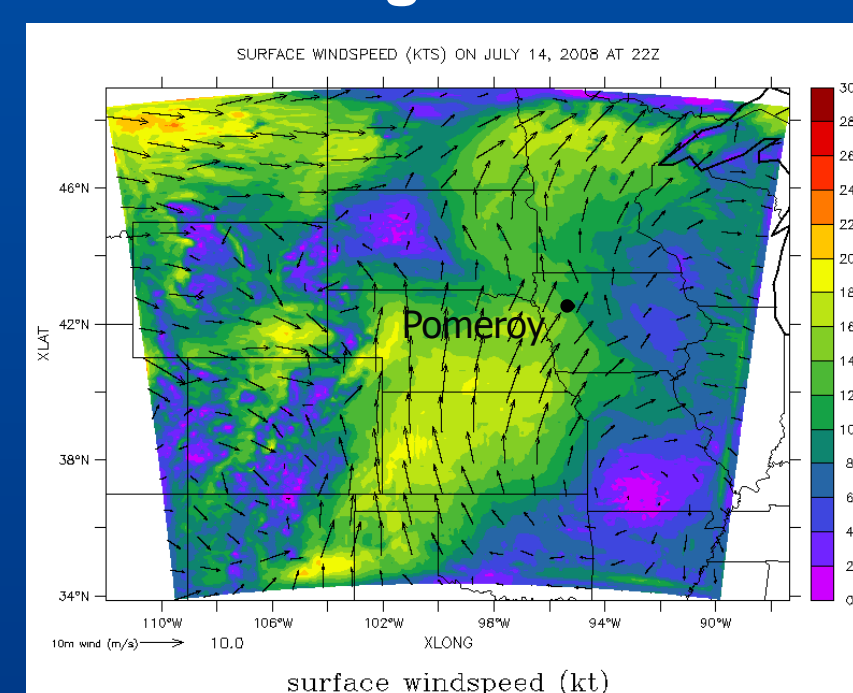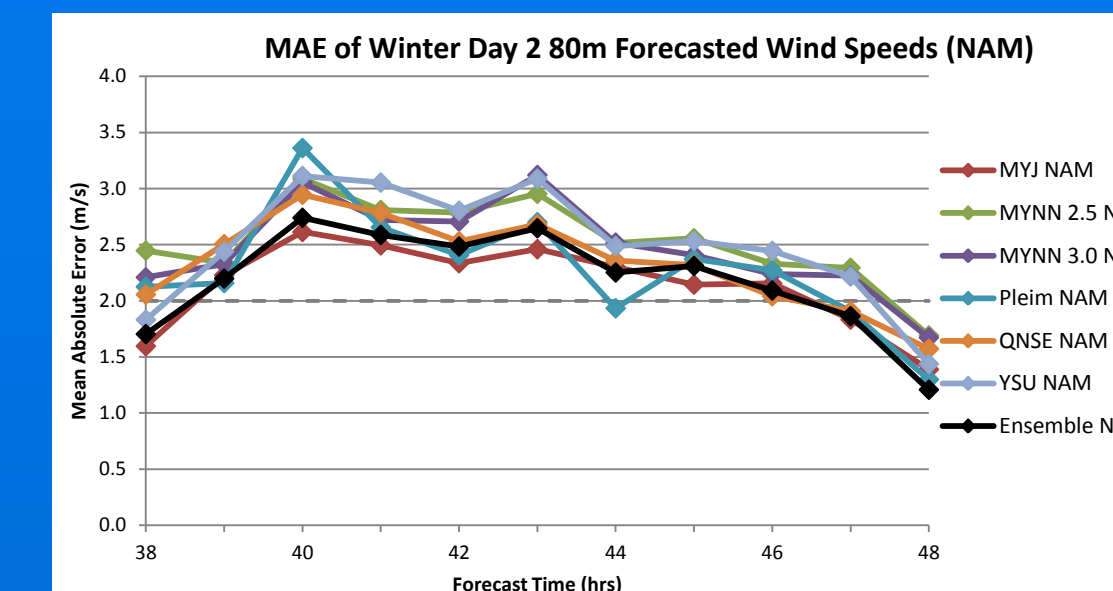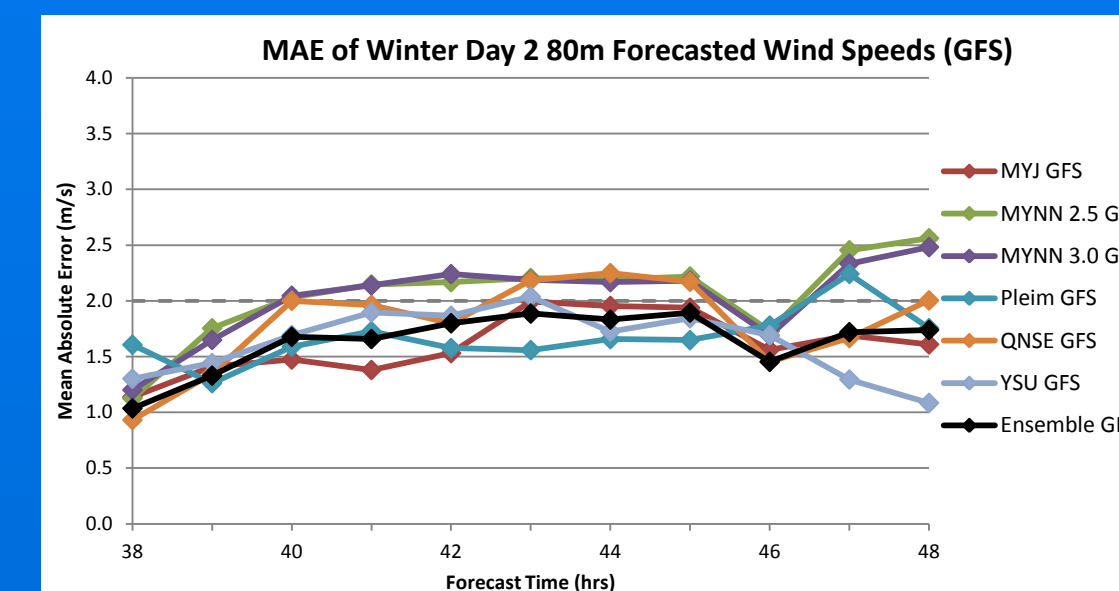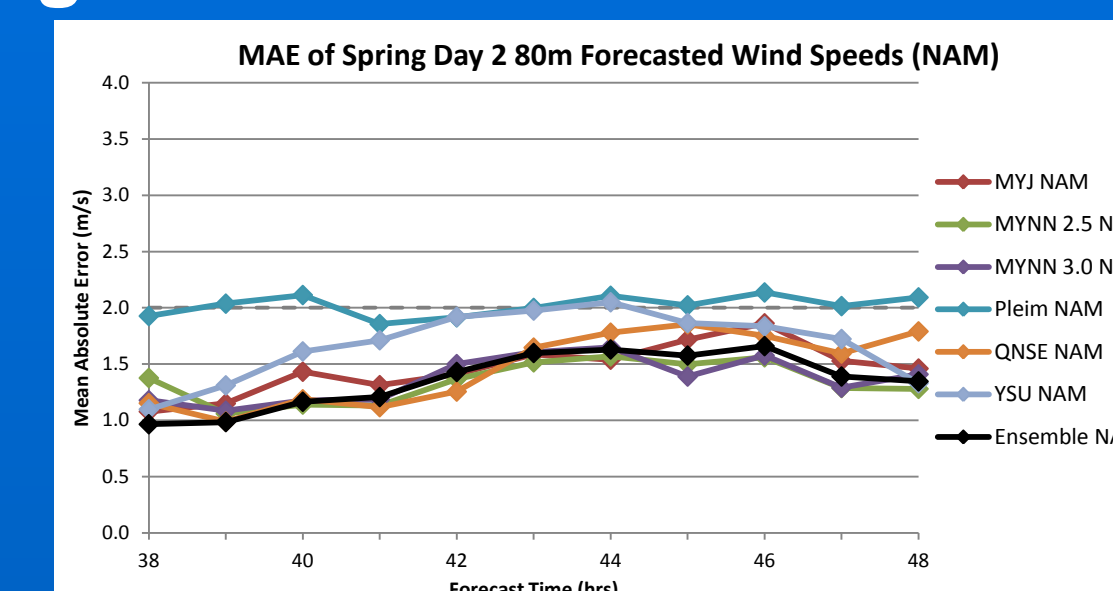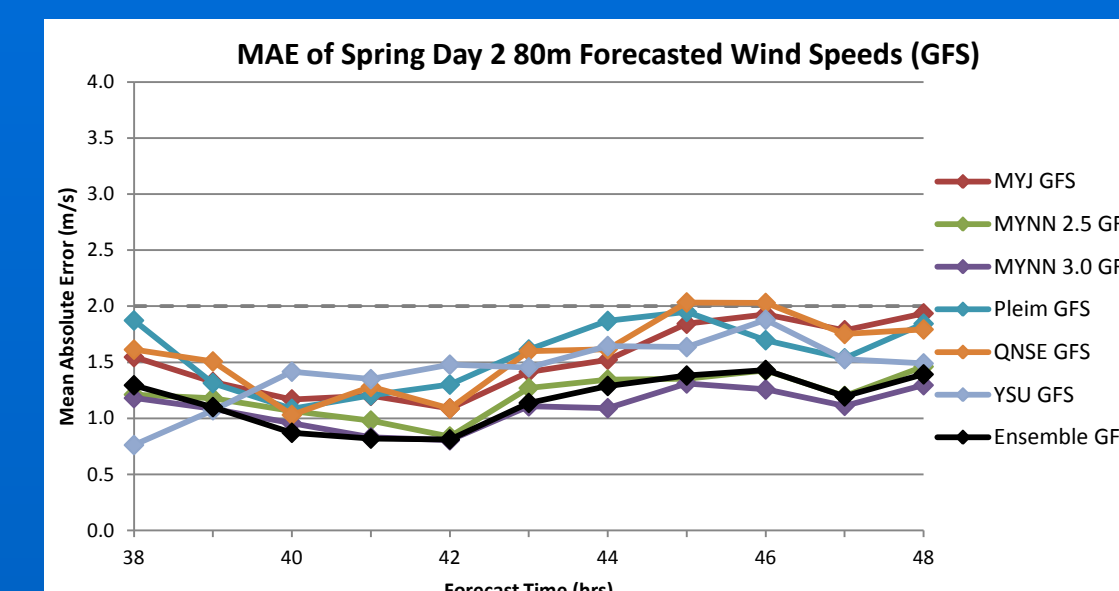
Figure 1

Figure 1 shows an example of the WRF domain used, the grid resolution, and the location of the meteorological tower site.

Results

Winter
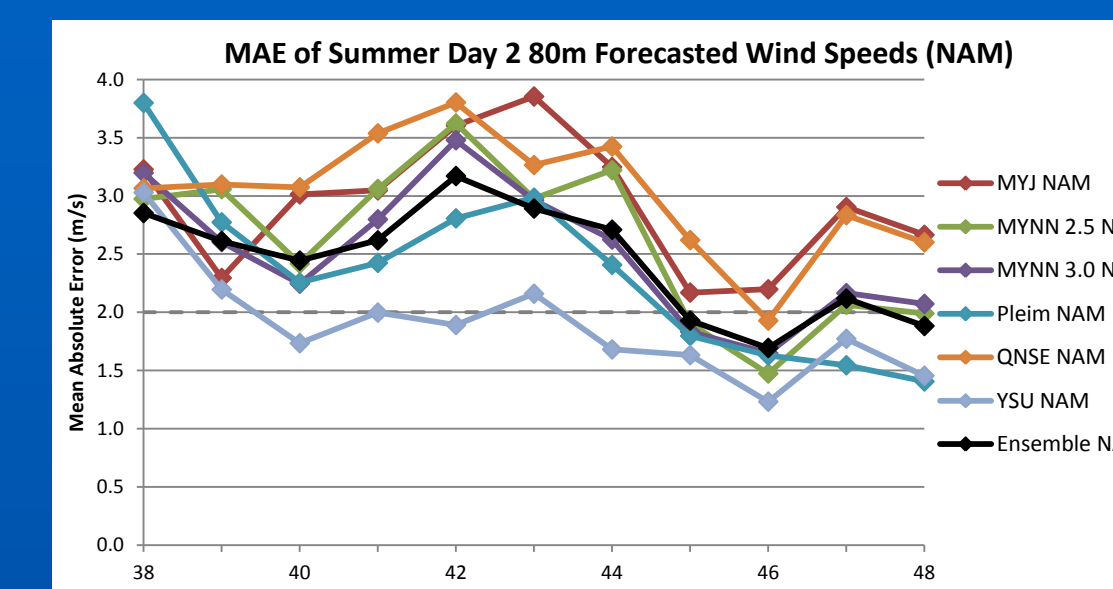
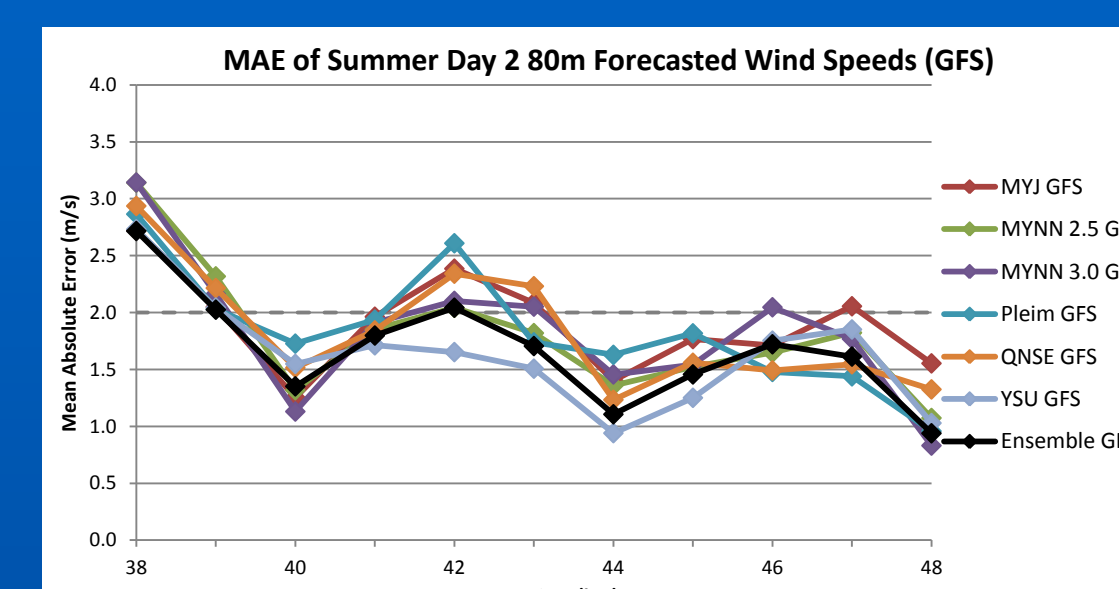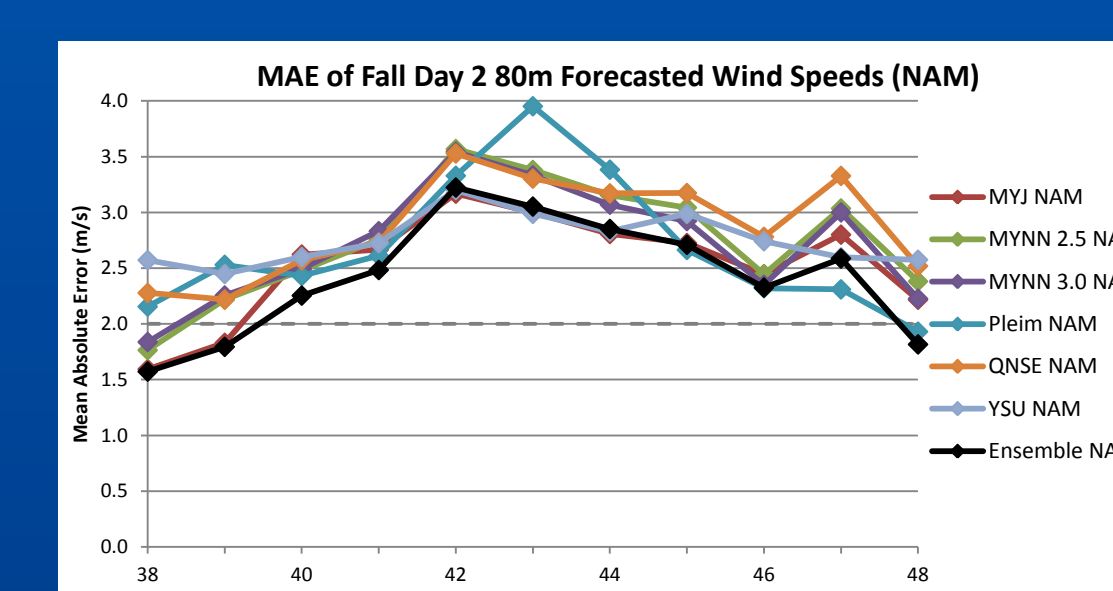### Spring

Summer

Fall

The figures above show the mean absolute error of the forecasted wind speeds for each WRF scheme and the ensemble mean, both for GFS and NAM initialization. This is for the forecast period of daytime on the second full day. A mean absolute error of 2.0 m s^{-1} is plotted as a reference level for comparisons.
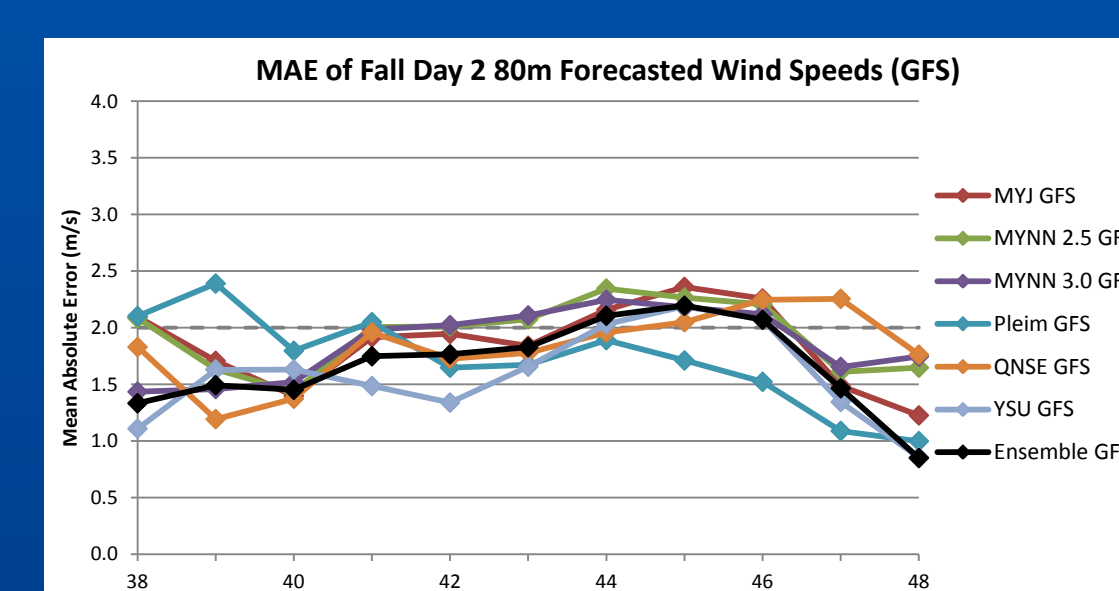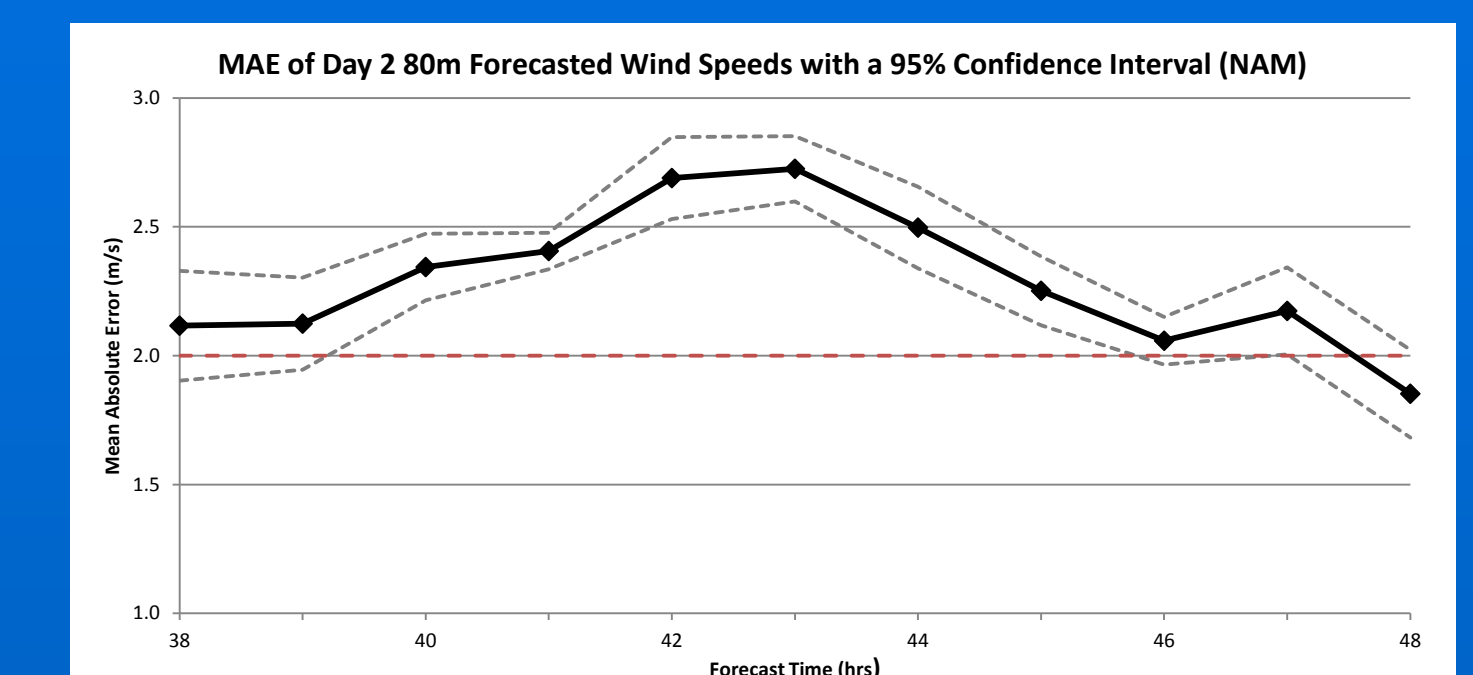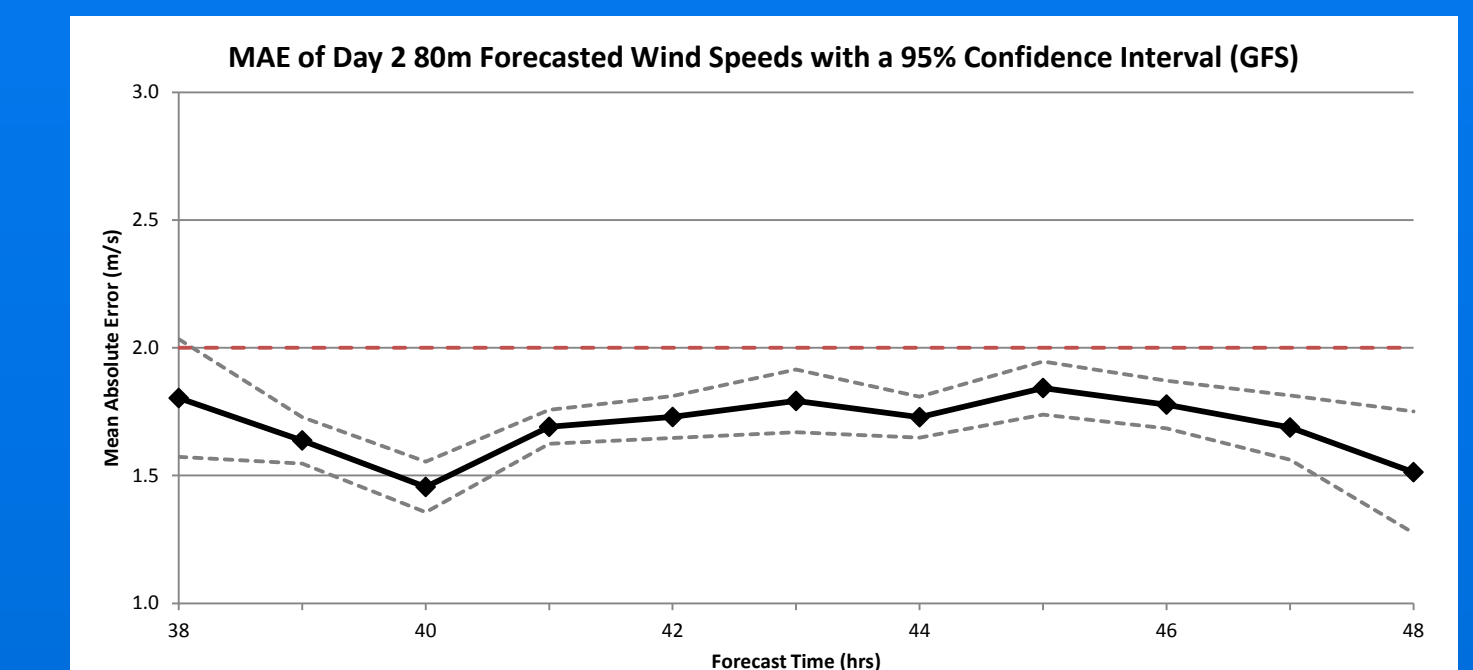
Results (cont.)

The figures above show the mean absolute error of the forecasted wind speeds for all WRF schemes over all 32 cases. A confidence interval of 95% is also shown, as well as the 2.0 m s^{-1} reference line.

Conclusions

•The ensemble mean tends to produce the lowest mean absolute error for both initializations through all seasons, although the YSU also performs well.
•MYNN 2.5 and MYNN 3.0 perform well in the spring but poorly in the winter.
•QNSE has consistently higher mean absolute error values than the other schemes through both initializations and all seasons.
•The hypothesis proved false for both initializations, with an average mean absolute error greater than 2.0 m s^{-1} (with a confidence interval of 95%) for all seasons except spring. However, the GFS was much closer to the threshold (< 0.1 m s^{-1} over, through all seasons) and would have proven true without the confidence interval.