Introduction

Understanding the variability of the wind requires more accurate forecasts to optimise wind energy production.

- Few evaluations exist of model forecasts for winds at 80m, a height where influence of the earth’s surface can vary greatly depending on the time of day, season, and vertical temperature stratification of the boundary layer.

- Traditional wind forecasts have focused on the 10m height where standard measurements are made.

- More accurate 80m wind forecasts are needed to meet national goals for wind energy production.

Data and Methodology

- Weather Research and Forecasting (WRF) model with 10 km horizontal resolution was used to explore improvements in wind speed forecasts at turbine height (80m).

- Models configurations run using Global Forecast System (GFS) and North American Weather Research and Forecasting (WRF) model with 10 km horizontal resolution.

- Each of the nine atmospheric planetary boundary layer (PBL) schemes tested: 
  - Yonsei University Scheme (YSU) - Mellor-Yamada-Janjic (MYJ)
  - Mellor-Yamada-Nakanishi and Niino-Level 3 (MYNN3.0)
  - Mellor-Yamada-Nakanishi and Niino-Level 2 (MYNN2.5)
  - Mellor-Yamada-Nakanishi and Niino-Level 2.5 (MYNN2.5)

- Different PBL schemes were tested:
  - Yonsei University Scheme (YSU) - Mellor-Yamada-Janjic (MYJ)
  - Mellor-Yamada-Nakanishi and Niino-Level 3 (MYNN3.0)

- Result were validated using wind speed measurements at 80 m from a meteorological tower at the Pennypen wind farm in northeastern Iowa and mean absolute error (MAE) was calculated.

- Training of the Model

- Different GFS Perturbations

- Different Time Initializations

- Different PBL Schemes

- Normal Scale Elimination PBL (QNSE)

- Yonsei University Scheme (YSU)

- Different Neighbor Approaches

- Perturbation of GFS

- Neighborhood Approach

- Table 3: MAE associated with different bias corrections developed for each PBL scheme for both 00Z and 18Z time initializations. The deterministic forecast is the best individual model skills from the period studied. Standard deviation (measure of model spread) for each ensemble is also calculated. Best model skill is seen in operational model with wind speed bias correction (red box).

- Table 8: MAE associated with operational model. Ensemble with wind speed bias correction shows better skill than any one individual scheme (red box). This case study used 25 random cases from summer and fall 2010.

Conclusions

- Operational model ensemble developed outperformed all other ensembles tested.

- Highest wind speed skill was seen in Pleim and YSU PBL schemes.

- Pleim and YSU schemes, however, a higher MAE is also created.

- Operational model ensemble developed outperformed other ensembles tested.

- The deterministic forecast is the best individual model skill from the period studied.

- Standard deviation (measure of model spread) for each ensemble is also calculated.

- Best model skill is seen in operational model with wind speed bias correction (red box). This case study used 25 random cases from summer and fall 2010.

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Table 1: MAE associated with different bias corrections developed for each PBL scheme for both 00Z and 18Z time initializations. The deterministic forecast is the best individual model skills from the period studied. Standard deviation (measure of model spread) for each ensemble is also calculated. Best model skill is seen in operational model with wind speed bias correction (red box).

Table 8: MAE associated with operational model. Ensemble with wind speed bias correction shows better skill than any one individual scheme (red box). This case study used 25 random cases from summer and fall 2010.