



# TOOL FOR FORECASTING COOL-SEASON PEAK WINDS ACROSS KENNEDY SPACE CENTER (KSC) AND CAPE CANAVERAL AIR FORCE STATION (CCAFS), PHASE II



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## OVERVIEW

- Peak wind speed is important element in 24-Hour and Weekly Planning Forecasts issued by 45th Weather Squadron (45 WS). Forecasts issued for planning operations at KSC/CCAFS.
- 45 WS wind advisories issued for wind gusts  $\geq 25$  kt, 35 kt and 50 kt from KSC to 300 ft.
- AMU developed cool-season (Oct – Apr) tool to help 45 WS forecast: daily peak wind speed, 5-minute average speed at time of peak wind, and probability peak speed  $\geq 25$  kt, 35 kt, 50 kt.
- AMU tool also forecasts daily average wind speed from 30 ft to 60 ft.
- Phase I and II tools delivered as a Microsoft Excel graphical user interface (GUI).
- Phase II tool also delivered as Meteorological Interactive Data Display System (MIDS) GUI.
- Phase I and II forecast methods were compared to climatology, 45 WS wind advisories and North American Mesoscale model (MesoNAM) forecasts in a verification data set.

## CONCLUSIONS

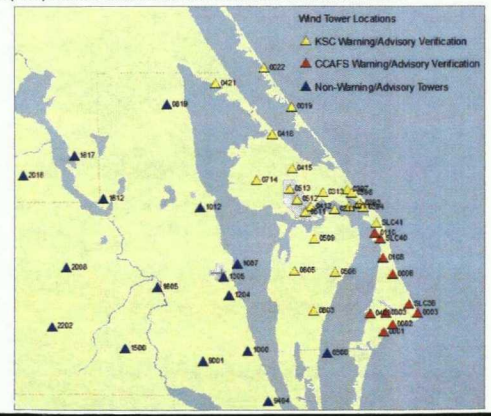
- For daily peak and 5-minute average wind speed, MesoNAM winds performed the best in the verification.
- For timing of the peak wind, none of the forecast methods performed better than climatology. Therefore, Phase II tool does not forecast the timing of the peak wind.
- The forecast equations for the Phase II tool are based on weather observations and model forecasts for the cool-season months of March 2007 to April 2009.
- Weather observations from the Shuttle Landing Facility (identifier TTS). The TTS observations were used to stratify the data by precipitation/non-precipitation days.
- 5-Minute observations from the KSC/CCAFS tower network. The observations were used to determine daily peak wind speed and 5-minute average wind speed at the time of the peak wind. The observations were also used to determine the daily average wind speed at 30-60 ft.
- 0000 and 1200 UTC runs of the 12-km MesoNAM. The MesoNAM forecasts were for the grid point closest to CCAFS. The MesoNAM data included hourly forecasts from 0 to 84 hours. MesoNAM forecast winds from model level 2 (~200 ft MSL) to model level 18 (~3100 ft MSL) were evaluated, along with the strongest winds in the lowest 1000-, 2000-, and 3000-ft.
- Linear regression equations were developed: predictor was the model's 24-hour peak speed and predictand was the tower-observed peak speed or 5-minute average speed. The model level with the most accurate regression equation (lowest Mean Absolute Error (MAE)), was selected. Separate equations were developed for precipitation/non-precipitation days.
- For predicting daily average wind speed, MesoNAM wind speeds at model level 2 were averaged over the 24-hour period. Linear regression equations were developed, in which the predictor was the MesoNAM 24-hour average wind speed and the predictand was the tower-observed 24-hour average wind speed at 30 ft and 60 ft.
- The tool's forecast of peak wind speed is used to calculate the probability the peak wind will be  $\geq 25$  kt, 35 kt and 50 kt. The calculation is based on the error bars of the linear regression:

$$1 - \left[ 0.5 * \left( 1 \pm \sqrt{1 - e^{-2/\pi * ((x-y)/z)^2}} \right) \right]$$

Predicted Peak Speed	Predicted Sigma	Prob. $\geq 35$ kt	Prob. $\geq 50$ kt
30 kt	15 kt	36.9 %	8.8 %
35 kt	15 kt	50.0 %	15.7 %

- In the equation: x is the threshold value (25, 35 or 50 kt), y is the predicted peak speed and z is the predicted sigma (estimated error of the linear regression equation)

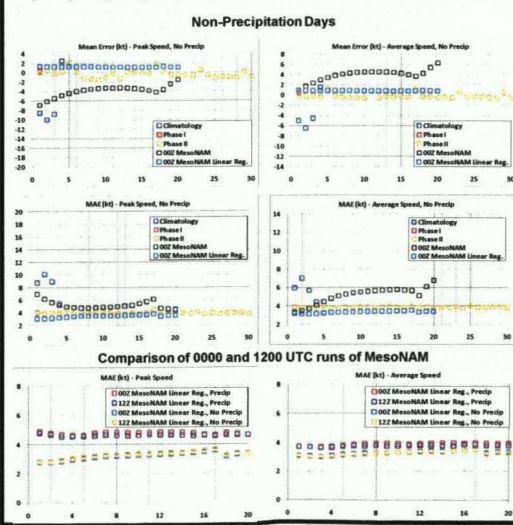
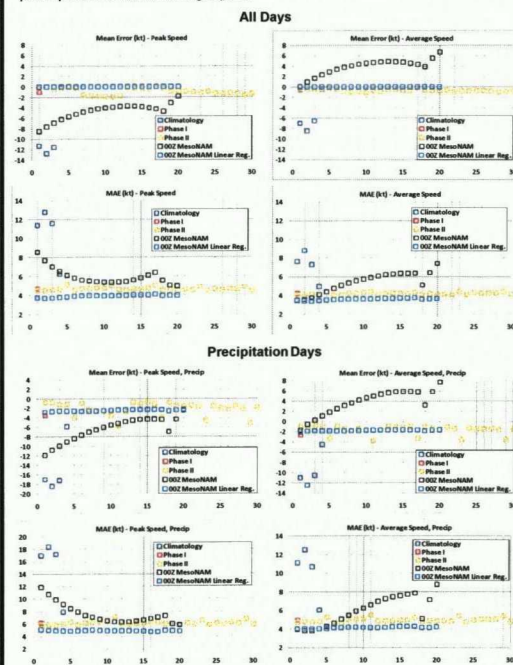
The task used the towers the 45 WS uses to verify wind warnings and advisories for KSC (in yellow) and CCAFS (in red). One other tower was used near the southern end of KSC, tower 0300.



## INDEPENDENT VERIFICATION OF PHASE I AND II METHODS FOR PEAK AND 5-MINUTE AVERAGE WIND SPEED

The Phase I and II methods were compared to climatology and 0000 UTC MesoNAM forecast winds. Two sets of MesoNAM winds were used in the comparison:

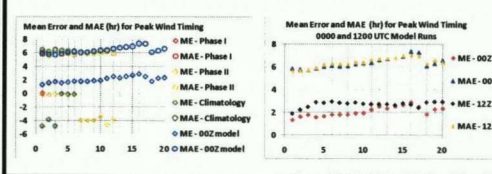
- Strongest 24-hour wind speed at each model level (in black).
- Least-squares single linear regression equations, in which the predictor was the model level's strongest 24-hour wind speed and the predictand was tower-observed peak speed or 5-minute average speed.



## INDEPENDENT VERIFICATION OF PHASE I AND II METHODS FOR TIMING OF THE PEAK WIND

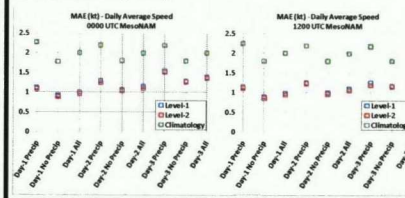
The Phase I and II methods were compared to climatology and 0000 UTC MesoNAM forecast winds.

The 0000 and 1200 UTC runs of MesoNAM were compared for Mean Error (ME) and MAE.



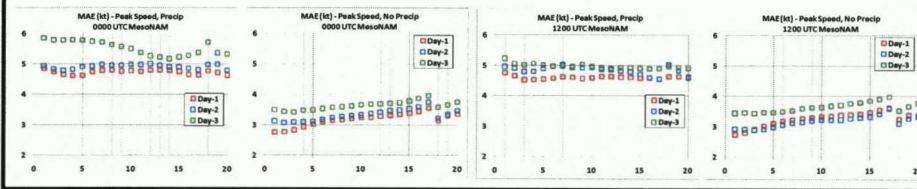
## DAILY AVERAGE WIND SPEED IN PHASE II TOOL

MAE for MesoNAM forecasts of daily average wind speed (30 ft – 60 ft). Forecasts using model level 2 (~200 ft) were more accurate than model level 1 (~70 ft).



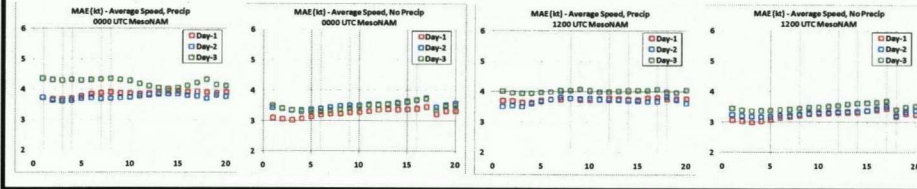
## EVALUATING EQUATIONS FOR PEAK WIND SPEED IN PHASE II TOOL

MAE for MesoNAM forecasts of daily peak wind speed (surface – 300 ft). Points 1-17 along the x-axis depict model levels 1-17 and points 18-20 depict strongest winds in the lowest 1000-, 2000-, and 3000-ft of the model. The model levels with the lowest MAE were used in the tool.



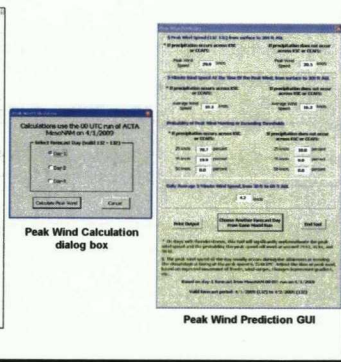
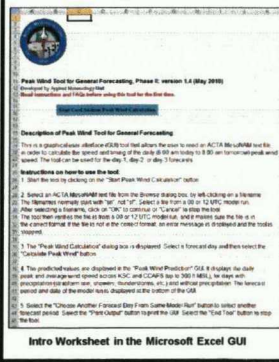
## EVALUATING EQUATIONS FOR AVERAGE WIND SPEED IN PHASE II TOOL

MAE for MesoNAM forecasts of 5-minute wind speed at time of the peak wind. Points 1-17 along the x-axis depict model levels 1-17 and points 18-20 depict strongest winds in the lowest 1000-, 2000-, and 3000-ft of the model. The model levels with the lowest MAE were used in the tool.



## USING MICROSOFT EXCEL GUI FOR PEAK WIND TOOL, PHASE II

- The forecaster opens the Excel file to the Intro worksheet and then selects the "Start Cool-Season Peak Wind Calculation" button.
- The tool displays a "Browse" dialog box containing a list of files.
- The tool verifies the file is in the correct format and from a 0000 or 1200 UTC run of the MesoNAM.
- The "Peak Wind Calculation" dialog box is displayed. The forecaster selects a forecast day (Day-1 to Day-3). The Peak Wind Prediction GUI is then displayed. The left/right side of the GUI shows the forecast for precipitation/non-precipitation days.



## USING MIDS GUI FOR PEAK WIND TOOL, PHASE II

- The forecaster opens the GUI from the MIDS Weather Menu. The tool reads in MesoNAM and Global Forecast System (GFS) model data from the latest 0000 and 1200 UTC runs.
- The forecaster selects a model name (GFS or NAM) and model run ("00Z" or "12Z").
- The tool calculates and displays the forecasts. MesoNAM forecasts go from Day-1 to Day-3, while GFS forecasts go from Day-1 to Day-7.
- The forecaster can print the displayed forecasts by selecting "Print Display" button.

