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Abstract

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Tool for Forecasting Cool-Season Peak Winds Across Kennedy Space Center and Cape Canaveral Air Force Station, Phase II

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The expected peak wind speed for the day is an important element in the daily morning forecast for ground and space launch operations at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). The 45th Weather Squadron (45 WS) must issue forecast advisories for KSC/CCAFS when they expect peak gusts for ≥ 25, ≥ 35, and ≥ 50 kt thresholds at any level from the surface to 300 ft. In Phase I of this task, the 45 WS tasked the Applied Meteorology Unit (AMU) to develop a cool-season (October - April) tool to help forecast the non-convective peak wind from the surface to 300 ft at KSC/CCAFS. During the warm season, these wind speeds are rarely exceeded except during convective winds or under the influence of tropical cyclones, for which other techniques are already in use. The tool used single and multiple linear regression equations to predict the peak wind from the morning sounding. The forecaster manually entered several observed sounding parameters into a Microsoft Excel graphical user interface (GUI), and then the tool displayed the forecast peak wind speed, average wind speed at the time of the peak wind, the timing of the peak wind and the probability the peak wind will meet or exceed 35, 50 and 60 kt. The 45 WS customers later dropped the requirement for ≥ 60 kt wind warnings.

During Phase II of this task, the AMU expanded the period of record (POR) by six years to increase the number of observations used to create the forecast equations. A large number of possible predictors were evaluated from archived soundings, including inversion depth and strength, low-level wind shear, mixing height, temperature lapse rate and winds from the surface to 3000 ft. Each day in the POR was stratified in a number of ways, such as by low-level wind direction, synoptic weather pattern, precipitation and Bulk Richardson number. The most accurate Phase II equations were then selected for an independent verification.

The Phase I and II forecast methods were compared using an independent verification data set. The two methods were compared to climatology, wind warnings and advisories issued by the 45 WS, and North American Mesoscale (NAM) model (MesoNAM) forecast winds. The performance of the Phase I and II methods were similar with respect to mean absolute error. Since the Phase I data were not stratified by precipitation, this method's peak wind forecasts had a large negative bias on days with precipitation and a small positive bias on days with no precipitation. Overall, the climatology methods performed the worst while the MesoNAM performed the best. Since the MesoNAM winds were the most accurate in the comparison, the final version of the tool was based on the MesoNAM winds.

The probability the peak wind will meet or exceed the warning thresholds were based on the one standard deviation error bars from the linear regression. For example, the linear regression might forecast the most likely peak speed to be 35 kt and the error bars used to calculate that the probability of ≥ 25 kt = 76%, the probability of ≥ 35 kt = 50%, and the probability of ≥ 50 kt = 19%. The authors have not seen this application of linear regression error bars in any other meteorological applications. Although probability forecast tools should usually be developed with logistic regression, this technique could be easily generalized to any linear regression forecast tool to estimate the probability of exceeding any desired threshold. This could be useful for previously developed linear regression forecast tools or new forecast applications where statistical analysis software to perform logistic regression is not available.

The tool was delivered in two formats - a Microsoft Excel GUI and a Tool Command Language/Tool Kit (Tcl/Tk) GUI in the Meteorological Interactive Data Display System (MIDDS). The Microsoft Excel GUI reads a MesoNAM text file containing hourly forecasts from 0 to 84 hours, from one model run (00 or 12 UTC). The GUI then displays the peak wind speed, average wind speed, and the probability the peak wind will meet or exceed the 25-, 35- and 50-kt thresholds. The user can display the Day-1 through Day-3 peak wind forecasts, and separate forecasts are made for precipitation and non-precipitation days. The

MIDDS GUI uses data from the NAM and Global Forecast System (GFS), instead of the MesoNAM. It can display Day-1 and Day-2 forecasts using NAM data, and Day-1 through Day-5 forecasts using GFS data. The timing of the peak wind is not displayed, since the independent verification showed that none of the forecast methods performed significantly better than climatology. The forecaster should use the climatological timing of the peak wind (2248 UTC) as a first guess and then adjust it based on the movement of weather features.