FORECASTING COOL SEASON DAILY PEAK WINDS AT KENNEDY SPACE CENTER (KSC) AND CAPE CANAVERAL AIR FORCE STATION (CCAFS)

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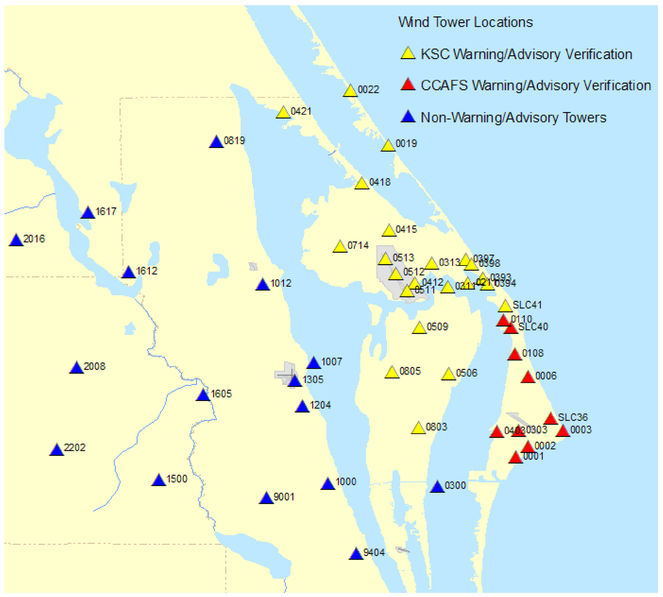
OVERVIEW

The expected peak wind speed for the day is an important element in the daily 24-Hour and Weekly Planning Forecasts issued by the 45th Weather Squadron (45 WS) for planning operations at KSC and CCAFS. The 24-Hour Forecast is valid from 8:00 am to 8:00 am LST. Warnings are issued for wind gusts >= 35 kt, 50 kt, and 60 kt from the surface to 300 ft. The Applied Meteorology Unit developed a forecast tool to help the 45 WS forecast the speed and timing of the daily peak and average wind, from the surface to 300 ft on KSC/CCAFS during the cool season (October to April). The tool uses data available by 1200 UTC.

DATA

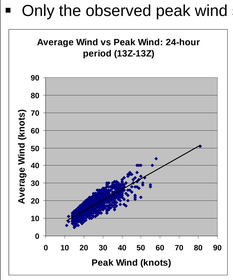
- Weather observations were collected for the cool season months from October 2002 to February 2007.
- Data sources included:
  - 5-minute observations from the KSC/CCAFS tower network (used for 5-minute average wind and peak wind gusts),
    - Wind sensor heights used vary from 6 ft to 294 ft (higher heights not used since above the warning thresholds)
  - hourly and special observations from the Shuttle Landing Facility (SLF) (used to verify the occurrence of precipitation at or near the SLF), and
  - CCAFS morning upper-air soundings (used for temperature inversions and wind speeds at different levels).

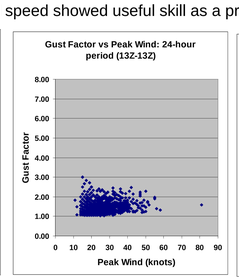
The study used the towers that are used for verifying wind warnings and advisories for KSC (in yellow) and CCAFS (in red). One other tower was used near the southern end of KSC, tower 0300.

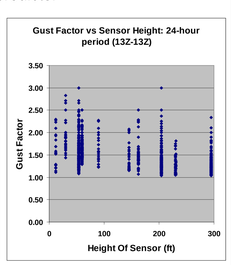


AVERAGE WIND SPEED DURING PEAK WIND SPEED OCCURRENCE

- The following possible predictors were evaluated to predict the 5-minute average wind speed at the time of the peak wind:
  - observed peak wind speed,
  - wind sensor height, and
  - gust factor (ratio of the peak to average wind speed over a given time period, 5 minutes in this case).
- Only the observed peak wind speed showed useful skill as a predictor

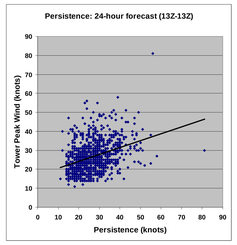


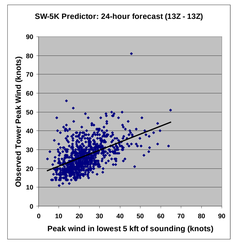


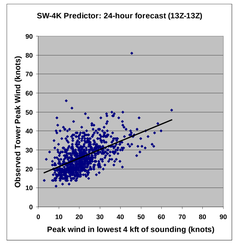


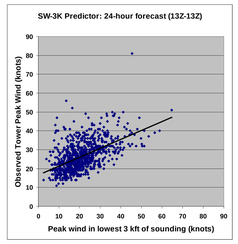
PEAK WIND SPEED OF THE DAY

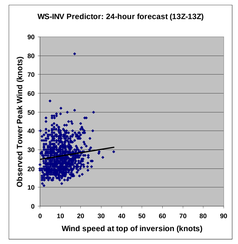
- The following possible predictors were evaluated to predict the daily peak wind speed:
  - strongest wind in the lowest 3000, 4000, and 5000 ft,
  - persistence,
  - inversion depth and strength, and
  - wind speed at top of the surface-based temperature inversion. (If no inversion was observed, the surface wind was used for the wind speed at the top of the inversion and the inversion depth and strength were set to zero.)
- The first prediction equation is a multiple linear regression that combined the strongest wind in the lowest 3000 ft with the inversion depth and strength.

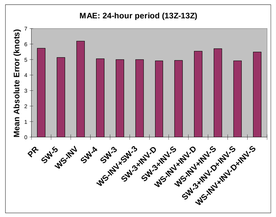




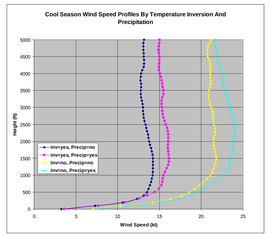


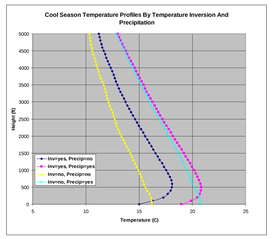


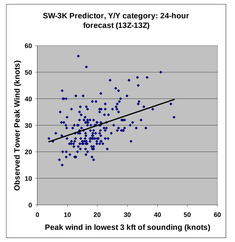


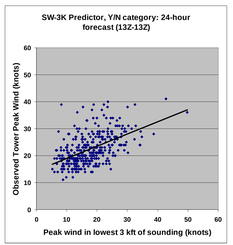


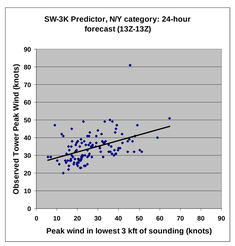
- A second prediction equation was created by stratifying each day into one of four categories, based on the existence or non-existence of a temperature inversion and the occurrence or non-occurrence of precipitation at the SLF. A temperature inversion was defined as an increase in temperature from surface to 500 ft, to ignore very shallow and weak inversions.

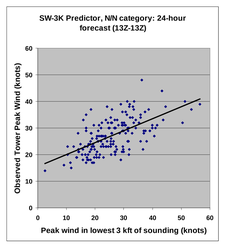




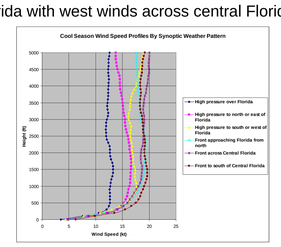


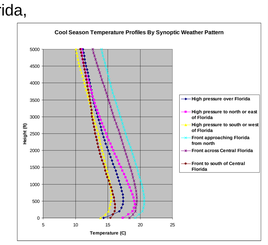




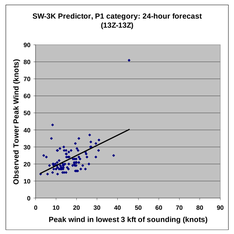


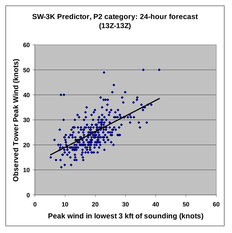
- A third prediction equation was created by stratifying each day into one of six categories, based on the synoptic weather pattern at 1200 UTC:
  - Surface high pressure over or near Florida with variable winds across central Florida,
  - Surface high pressure north or east of Florida with east winds across central Florida,
  - Surface high pressure south or west of Florida with west winds across central Florida,
  - Front approaching Florida from the north,
  - Front across central Florida, and
  - Front to the south of central Florida.

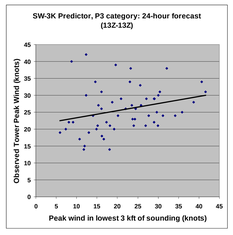


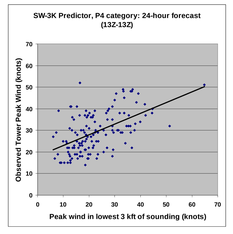


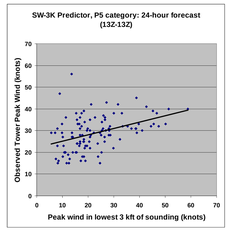
PEAK WIND SPEED OF THE DAY (continued)

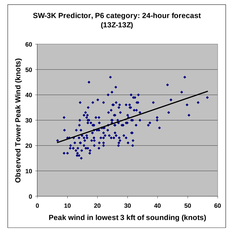












TIMING OF THE PEAK WIND SPEED OF THE DAY

- Three separate prediction methods were created to predict the timing of the peak wind speed of the day.
- The first is a multiple linear regression, with inversion depth and strength as predictors.
- The second used the average time of peak wind occurrence based on the synoptic weather pattern.
- The third used the average time of peak wind occurrence based on the inversion/precipitation stratification.

PEAK WIND FORECAST TOOL

- The forecast tool was created in Microsoft Excel, using the Visual Basic for Applications programming language.
- The tool also predicts the probability of exceeding the warning thresholds for peak wind speeds of 35 kt, 50 kt, and 60 kt.
- Graphical User Interface (GUI):
  - Calculates the following from the forecaster's inputs:
    - peak wind speed,
    - timing of peak wind speed, and
    - 5-minute average speed associated with the peak wind speed.

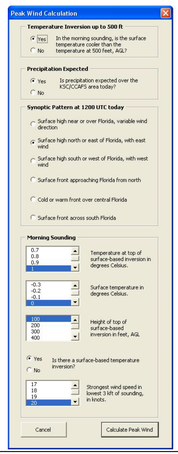
    The first and second parameters are calculated from the average of three prediction equations, weighted by each equation's mean absolute error. The average speed is calculated from the predicted peak wind speed.
  - Calculates probability of exceeding the three warning thresholds using the 1-σ error estimates from the linear regression using the following equation:

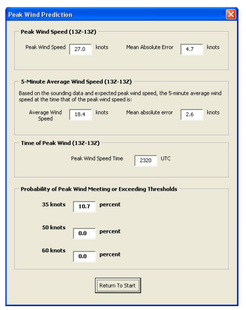
$$1-\left[0.5*\left(1\pm\sqrt{1-e^{\left(-2/\pi*((x-y)/z)^2\right)}}\right)\right]$$

    where x is the threshold value (35, 50, or 60), y is the predicted peak wind speed,

    and z is the predicted sigma (estimated error of the linear regression equation).
  - The tool performs some internal consistency checks of the input data. For example, if there is a surface-based temperature inversion, then the temperature at the top of the inversion must be warmer than the surface.

Input GUI showing the default values.





Output GUI showing the predicted peak wind speed, average wind speed, timing of the peak wind, and the probability that the peak wind speed will meet or exceeding the warning thresholds.