Developing a Peak Wind Probability Forecast Tool for Kennedy Space Center and Cape Canaveral Air Force Station

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The peak winds are an important forecast element for both the Space Shuttle and Expendable Launch Vehicle (ELV) programs at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) in east-central Florida. The Launch Commit Criteria (LCC) define specific peak wind thresholds for each launch operation that cannot be exceeded in order to ensure the safety of each vehicle. The 45th Weather Squadron (45 WS) has found that peak winds are a challenging parameter to forecast, particularly in the cool season months of October through April. Based on the importance of forecasting peak winds, the 45 WS tasked the Applied Meteorology Unit (AMU) to develop a short-range peak-wind forecast tool to assist in forecasting LCC violations. In previous work, the AMU created cool season climatologies and frequency distributions for all wind sensors used in evaluating LCCs in the seven-year period 1995 – 2001. The values included climatologies of the 5-minute mean and peak winds by month, hour, and direction, and probability distributions of the peak winds as a function of 5-minute mean wind speeds in 1-knot (0.514 m s^{-1}) intervals. The 45 WS requested that the AMU update these mean and peak speed statistics with more data collected since 2001, test several theoretical distributions to determine the best fit to the empirical peak wind distributions, add new time-period stratifications to the peak wind distributions.

The peak and mean wind data for this work are from the towers in the Kennedy Space Center / Cape Canaveral Air Force Station network that are used in making launch decisions for the Space Shuttle, Atlas, Delta II and Delta IV vehicles. The mean wind is the average of the 1-second observations taken over 5 minutes, and the peak is the highest 1-second observation in the 5-minute period. The data for this study are from the cool seasons in the period 1995–2007. Climatologies of the 5-minute mean and 5-minute peak wind speeds and directions will be created to understand mean behavior and variability of the wind speeds. The data will be stratified three ways: 1) by month and hour, 2) by month and direction, and 3) by month, direction, and hour. The means, standard deviations (σ), and number of observations used in the calculations for each of the stratifications were determined and plotted. The number of observations available in each category will show preferred times of day by month for each direction.

The next step will be to calculate how the peak winds are distributed with mean speed so that the probability of meeting and/or exceeding certain peak wind values can be determined. The peak winds will be stratified by month and by observed 5-minute mean wind speed in 1-knot (0.514 m s^{-1}) intervals and empirical probability density functions (PDFs) of the stratified peak winds will be created. An added step in this work is to create peak wind PDFs for 2, 4, 8, and 12 hours past the time of the mean wind. This will add a predictive element to the probabilities. Fitting the PDFs with the proper theoretical distribution is necessary for calculating the appropriate probability values, especially for extreme values that are observed only occasionally. Several tests will be done to determine the most appropriate theoretical distribution of the PDFs. In previous work, the results indicated that most of the PDFs resembled the Weibull distribution. In this work, the Gumbel distribution will also be considered as it has been used in previous studies to model extreme values such as the peak winds. The distribution that produces the better fit overall will be used for the final product.

The presentation will show the data and methods used in the creation of the climatologies and PDFs. It will also show the graphical user interface (GUI) developed by the AMU to be used in operations. The GUI will provide forecasters with a user-friendly way to display the climatologies and probabilities quickly and easily.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
03-07-2007	Conference Paper	June 2007 - June 2008

4. TITLE AND SUBTITLE

Developing a Peak Wind Probability Forecast Tool for Kennedy Space Center and Cape Canaveral Air Force Station

5a. CONTRACT NUMBER

NNK06MA70C

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

NASA
John F. Kennedy Space Center
Code KT-C-H
Kennedy Space Center, FL 32899

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING REPORT NUMBER

12. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified, Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This conference presentation describes the development of a peak wind forecast tool to assist forecasters in determining the probability of violating launch commit criteria (LCC) at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) in east-central Florida. The peak winds are an important forecast element for both the Space Shuttle and Expendable Launch Vehicle (ELV) programs. The LCC define specific peak wind thresholds for each launch operation that cannot be exceeded in order to ensure the safety of the vehicle. The 45th Weather Squadron (45 WS) has found that peak winds are a challenging parameter to forecast, particularly in the cool season months of October through April. Based on the importance of forecasting peak winds, the 45 WS tasked the Applied Meteorology Unit (AMU) to develop a short-range peak-wind forecast tool to assist in forecasting LCC violations.The tool will include climatologies of the 5-minute mean and peak winds by month, hour, and direction, and probability distributions of the peak winds as a function of the 5-minute mean wind speeds.

15. SUBJECT TERMS

Peak winds, Gust, Launch Commit Criteria, Applied Meteorology Unit, AMU, Probability distributions, Climatology

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. Francis J. Merceret
U	U	U	UU	1	19b. TELEPHONE NUMBER *(Include area code)* (321) 867-0818