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14. ABSTRACT

This conference abstract 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.

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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 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. 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 KSC/CCAFS network 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 12 cool seasons in the period January 1995 to April 2007. Climatologies of the 5-minute mean and 5-minute peak wind speeds and directions were created to understand mean behavior and variability of the wind speeds. The data were 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 show preferred times of day by month for each direction.

The next step was to calculate how the peak winds are distributed with mean speed so that the probability of meeting and/or exceeding certain peak wind values could be determined. The peak winds were 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 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 adds 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. In this work, the Gumbel distribution was used to be consistent with previous studies at Marshall Space Flight Center that found this distribution an excellent fit to the peak winds in the KSC/CCAFS tower network.

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.