2010 National Weather Association Meeting
Abstract

Tucson, AZ
2–7 October 2010

Statistical Analysis of Model Data for Operational Space Launch Weather Support at Kennedy Space Center and Cape Canaveral Air Force Station

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The 12-km resolution North American Mesoscale (NAM) model (MesoNAM) is used by the 45th Weather Squadron (45 WS) Launch Weather Officers at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) to support space launch weather operations. The 45 WS tasked the Applied Meteorology Unit to conduct an objective statistics-based analysis of MesoNAM output compared to wind tower mesonet observations and then develop a an operational tool to display the results.

The National Centers for Environmental Prediction began running the current version of the MesoNAM in mid-August 2006. The period of record for the dataset was 1 September 2006 - 31 January 2010. The AMU evaluated MesoNAM hourly forecasts from 0 to 84 hours based on model initialization times of 00, 06, 12 and 18 UTC. The MesoNAM forecast winds, temperature and dew point were compared to the observed values of these parameters from the sensors in the KSC/CCAFS wind tower network.

The data sets were stratified by model initialization time, month and onshore/offshore flow for each wind tower. Statistics computed included bias (mean difference), standard deviation of the bias, root mean square error (RMSE) and a hypothesis test for bias = 0. Twelve wind towers located in close proximity to key launch complexes were used for the statistical analysis with the sensors on the towers positioned at varying heights to include 6 ft, 30 ft, 54 ft, 60 ft, 90 ft, 162 ft, 204 ft and 230 ft depending on the launch vehicle and associated weather launch commit criteria being evaluated. These twelve wind towers support activities for the Space Shuttle (launch and landing), Delta IV, Atlas V and Falcon 9 launch vehicles.

For all twelve towers, the results indicate a diurnal signal in the bias of temperature (T) and weaker but discernable diurnal signal in the bias of dewpoint temperature (T_d) in the MesoNAM forecasts. Also, the standard deviation of the bias and RMSE of T, T_d, wind speed and wind direction indicated the model error increased with the forecast period all four parameters. The hypothesis testing uses statistics to determine the probability that a given hypothesis is true. The goal of using the hypothesis test was to determine if the model bias of any of the parameters assessed throughout the model forecast period was statistically zero. For this dataset, if this test produced a value ≥ -1.96 or ≤ 1.96 for a data point, then the bias at that point was effectively zero and the model forecast for that point was considered to have no error.

A graphical user interface (GUI) was developed so the 45 WS would have an operational tool at their disposal that would be easy to navigate among the multiple stratifications of information to include tower locations, month, model initialization times, sensor heights and onshore/offshore flow. The AMU developed the GUI using HyperText Markup Language (HTML) so the tool could be used in most popular web browsers with computers running different operating systems such as Microsoft Windows and Linux.