Performance of the WRF Model for Surface Wind Prediction around Qatar

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(Manuscript received 19 July 2017, in final form 22 January 2018)

ABSTRACT

The performance of the Weather Research and Forecasting (WRF) Model is examined for the region around Qatar in the context of surface winds. The wind fields around this peninsula can be complicated owing to its small size, to a complex pattern of land and sea breezes influenced by the prevailing shamal winds, and to its dry and arid nature. Modeled winds are verified with data from 19 land stations and two offshore buoys. A comparison with these data shows that nonlocal planetary boundary layer (PBL) schemes generally perform better than local schemes over land stations during the daytime, when convective conditions prevail; at nighttime, over land and over water, both schemes yield similar results. Among other parameters, modifications to standard USGS land-use descriptors were necessary to reduce model errors. The RMSE values are comparable to those reported elsewhere. Simulated winds, when used with a wave model, result in wave heights comparable to buoy measurements. Furthermore, WRF results, confirmed by data, show that at times sea breezes develop from both coasts, leading to convergence in the middle of the country; at other times, the large-scale wind impedes the formation of sea breezes on one or both coasts. Simulations also indicate greater land/sea-breeze activity in the summer than in the winter. Differences in the diurnal evolution of surface winds over land and water are found to be related to differences in the boundary layer stability. Overall, the results indicate that the WRF Model as configured here yields reliable simulations and can be used for various practical applications.

1. Introduction

Wind fields around Qatar are important for many reasons. On the marine side, applications such as circulation and wave modeling, marine safety, coastal erosion, and contaminant transport all rely on suitable wind model predictions (e.g., Moeini et al. 2010; Liao and Kaihatu 2016). On the terrestrial side, emerging needs include studies pertaining to the installation of solar energy panels and the transport and settling of dust, which are becoming increasingly prominent (Shao 2008; Hamidi et al. 2014). Near-surface conditions for the Arabian Gulf may be obtained from "global" models run by various international agencies, such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the U.S. National Center for Environmental Prediction (NCEP), NASA, and others; however, their resolution is coarse, typically on the

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DOI: 10.1175/JTECH-D-17-0125.1