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ORIGINAL PAPER

Simulations of Cyclone Sidr in the Bay of Bengal with a high-resolution model: sensitivity to large-scale boundary forcing

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Abstract The predictability of Cyclone Sidr in the Bay of Bengal was explored in terms of track and intensity using the Advanced Research Hurricane Weather Research Forecast (AHW) model. This constitutes the first application of the AHW over an area that lies outside the region of the North Atlantic for which this model was developed and tested. Several experiments were conducted to understand the possible contributing factors that affected Sidr's intensity and track simulation by varying the initial start time and domain size. Results show that Sidr's track was strongly controlled by the synoptic flow at the 500-hPa level, seen especially due to the strong mid-latitude westerly over north-central India. A 96-h forecast produced westerly winds over north-central India at the 500-hPa level that were notably weaker; this likely caused the modeled cyclone track to drift from the observed actual track. Reducing the model domain size reduced model error in the synoptic-scale winds at 500 hPa and produced an improved cyclone track. Specifically, the cyclone track appeared to be sensitive to the upstream synoptic flow, and was, therefore, sensitive to the location of the western boundary of the domain. However, cyclone intensity remained largely unaffected by this synoptic wind error at the 500-hPa level. Comparison of the high resolution, moving nested domain with a single coarser resolution domain showed little difference in tracks, but resulted in significantly different intensities. Experiments on the domain size with regard to the total precipitation simulated by the model showed that precipitation patterns and 10-m surface winds were also different. This was mainly due to the mid-latitude westerly flow across the west side of the model domain. The analysis also suggested that the total precipitation pattern and track was unchanged when the domain was extended toward the east, north, and south. Furthermore, this highlights our conclusion that Sidr was influenced from the west side of the domain. The displacement error was significantly reduced after the domain size from the western model boundary was decreased. Study results demonstrate the capability and need of a high-resolution mesoscale modeling framework for simulating the complex interactions that contribute to the formation of tropical cyclones over the Bay of Bengal region.

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1 Introduction

Accurate cyclone track and intensity predictions remain a challenging task for atmospheric scientists and the research community. A large number of cyclones form in the Bay of Bengal (hereafter BOB) region and make landfall along the coastal regions of India, Bangladesh, and Myanmar. These cyclones have been responsible for billions of dollars in property damage, loss of agriculture crops, and thousands of human lives (e.g., Paul 2010). Between October and December, cyclonically favorable, large-scale atmospheric conditions are typical over BOB.

This study concerns the simulation of a recent, notable BOB storm—Cyclone Sidr using the Advanced Research

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