SPECIAL
Impacts of Land Use Change on the Atmosphere
COLLECTION

The Impacts of Indirect Soil Moisture Assimilation and Direct Surface Temperature and Humidity Assimilation on a Mesoscale Model Simulation of an Indian Monsoon Depression

VINODKUMAR AND A. CHANDRASEKAR

Department of Physics and Meteorology, Indian Institute of Technology, Kharagpur, India

K. ALAPATY*

Division of Atmospheric Sciences, National Science Foundation, Arlington, Virginia

DEV NIYOGI

Department of Agronomy, and Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, Indiana

(Manuscript received 26 September 2006, in final form 14 September 2007)

ABSTRACT

This study investigates the impact of the Flux-Adjusting Surface Data Assimilation System (FASDAS) and the four-dimensional data assimilation (FDDA) using analysis nudging on the simulation of a monsoon depression that formed over India during the 1999 Bay of Bengal Monsoon Experiment (BOBMEX) field campaign. FASDAS allows for the indirect assimilation/adjustment of soil moisture and soil temperature together with continuous direct surface data assimilation of surface temperature and surface humidity. Two additional numerical experiments [control (CTRL) and FDDA] were conducted to assess the relative improvements to the simulation by FASDAS. To improve the initial analysis for the FDDA and the surface data assimilation (SDA) runs, the fifth-generation Pennsylvania State University–NCAR Mesoscale Model (MM5) simulation utilized the humidity and temperature profiles from the NOAA Television Infrared Observation Satellite (TIROS) Operational Vertical Sounder (TOVS), surface winds from the Quick Scatterometer (QuikSCAT), and the conventional meteorological upper-air (radiosonde/rawinsonde, pilot balloon) and surface data. The results from the three simulations are compared with each other as well as with NCEP–NCAR reanalysis, the Tropical Rainfall Measuring Mission (TRMM), and the special buoy, ship, and radiosonde observations available during BOBMEX. As compared with the CTRL, the FASDAS and the FDDA runs resulted in (i) a relatively better-developed cyclonic circulation and (ii) a larger spatial area as well as increased rainfall amounts over the coastal regions after landfall. The FASDAS run showed a consistently improved model simulation performance in terms of reduced rms errors of surface humidity and surface temperature as compared with the CTRL and the FDDA runs.

1. Introduction

The quality of an operational numerical weather prediction (NWP) model forecast depends significantly on the accuracy of the initial conditions specifications and also on the ability of the model to simulate well the atmospheric physical and dynamical processes. Data assimilation methods often provide for improved performance of these NWP models (Kalnay 2003). Data assimilation methods combine available past as well as current meteorological observations in order to improve the analysis fields. Much scientific literature on the uses of four-dimensional data assimilation (FDDA) already exists (Anthes 1974; Stauffer and Seaman 1990, 1994; Stauffer et al. 1991). The present study utilizes the continuous (every model time step) dynamical FDDA, using the analysis nudging approach, where forcing

* Current affiliation: Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, Germantown, Maryland.

Corresponding author address: A. Chandrasekar, Department of Physics and Meteorology, Indian Institute of Technology, Kharagpur, West Bengal 721302, India.
E-mail: chand@phy.iitkgp.ernet.in

DOI: 10.1175/2007JAMC1599.1