Description and Evaluation of the Characteristics of the NCAR High-Resolution Land Data Assimilation System

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ABSTRACT

This paper describes important characteristics of an uncoupled high-resolution land data assimilation system (HRLDAS) and presents a systematic evaluation of 18-month-long HRLDAS numerical experiments, conducted in two nested domains (with 12- and 4-km grid spacing) for the period from 1 January 2001 to 30 June 2002, in the context of the International H_2O Project (IHOP_2002). HRLDAS was developed at the National Center for Atmospheric Research (NCAR) to initialize land-state variables of the coupled Weather Research and Forecasting (WRF)–land surface model (LSM) for high-resolution applications. Both uncoupled HRDLAS and coupled WRF are executed on the same grid, sharing the same LSM, land use, soil texture, terrain height, time-varying vegetation fields, and LSM parameters to ensure the same soil moisture climatological description between the two modeling systems so that HRLDAS soil state variables can be used to initialize WRF–LSM without conversion and interpolation. If HRLDAS is initialized with soil conditions previously spun up from other models, it requires roughly 8–10 months for HRLDAS to reach quasi equilibrium and is highly dependent on soil texture. However, the HRLDAS surface heat fluxes can reach quasi-equilibrium state within 3 months for most soil texture categories. Atmospheric forcing conditions used to drive HRLDAS were evaluated against Oklahoma Mesonet data, and the response of HRLDAS to typical errors in each atmospheric forcing variable was examined. HRLDAS-simulated finescale (4 km) soil moisture, temperature, and surface heat fluxes agreed well with the Oklahoma Mesonet and IHOP_2002 field data. One case study shows high correlation between HRLDAS evaporation and the low-level water vapor field derived from radar analysis.

1. Introduction

This paper evaluates a land-state initialization technique for high-resolution coupled Weather Research and Forecast (WRF)–land surface model (LSM) numerical weather forecasts. Subjects discussed in this article include the concept of a high-resolution land data assimilation system (HRLDAS) based on the "Noah" land surface model, its configuration for nested grids, the time required for its spinup to reach quasi-equilibrium state, its sensitivity to various atmospheric forcing conditions, and its verification against observed profiles of soil moisture and temperature, surface heat fluxes, and radar-derived refractivity (i.e., low-level water vapor) fields.

According to experiments with operational models at numerical weather prediction (NWP) centers (Betts et al. 1997; Beljaars et al. 1996; Chen et al. 1997; Ek et al. 2003), the improvement in 1–5-day predictions of boundary layer development, cloud, precipitation, and surface meteorological conditions may rely on the land surface physics and initialization of land state (e.g., vegetation characteristics, soil moisture, and soil temperature). The important role of soil moisture in deep-convection development has also been recognized (Lanicci

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