Development of the Flux-Adjusting Surface Data Assimilation System for Mesoscale Models

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ABSTRACT

The flux-adjusting surface data assimilation system (FASDAS) is developed to provide continuous adjustments for initial soil moisture and temperature and for surface air temperature and water vapor mixing ratio for mesoscale models. In the FASDAS approach, surface air temperature and water vapor mixing ratio are directly assimilated by using the analyzed surface observations. Then, the difference between the analyzed surface observations and model predictions of surface layer temperature and water vapor mixing ratio are converted into respective heat fluxes, referred to as adjustment heat fluxes of sensible and latent heat. These adjustment heat fluxes are then used in the prognostic equations for soil temperature and moisture via indirect assimilation in the form of several new adjustment evaporative fluxes. Thus, simulated surface fluxes for the subsequent model time step are affected such that the predicted surface air temperature and water vapor mixing ratio conform more closely to observations. The simultaneous application of indirect and direct data assimilation maintains greater consistency between the soil temperature–moisture and the surface layer mass-field variables. The FASDAS is coupled to a land surface submodel in a three-dimensional mesoscale model and tests are performed for a 10-day period with three one-way nested domains. The FASDAS is applied in the analysis nudging mode for two coarse-resolution nested domains and in the observational nudging mode for a fine-resolution nested domain. Further, the effects of FASDAS on two different initial specifications of a three-dimensional soil moisture field are also studied. Results indicate that the FASDAS consistently improved the accuracy of the model simulations.

1. Introduction

In recent years, much of the research designed to improve atmospheric boundary layer (ABL) simulations has focused on the surface boundary conditions used in atmospheric models. For a given synoptic con-