Evaluation of the Noah Land Surface Model Using Data from a Fair-Weather IHOP_2002 Day with Heterogeneous Surface Fluxes

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ABSTRACT

Sources of differences between observations and simulations for a case study using the Noah land surface model–based High-Resolution Land Data Assimilation System (HRLDAS) are examined for sensible and latent heat fluxes H and LE, respectively; surface temperature T_s; and vertical temperature difference $T_0 - T_s$, where T_0 is at 2 m. The observational data were collected on 29 May 2002, using the University of Wyoming King Air and four surface towers placed along a sparsely vegetated 60-km north–south flight track in the Oklahoma Panhandle. This day had nearly clear skies and a strong north–south soil-moisture gradient, with wet soils and widespread puddles at the south end of the track and drier soils to the north. Relative amplitudes of H and LE horizontal variation were estimated by taking the slope of the least squares best-fit straight line $\Delta LE/\Delta H$ on plots of time-averaged LE as a function of time-averaged H for values along the track. It is argued that observed H and LE values departing significantly from their slope line are not associated with surface processes and, hence, need not be replicated by HRLDAS. Reasonable agreement between HRLDAS results and observed data was found only after adjusting the coefficient C in the Zilitinkevich equation relating the roughness lengths for momentum and heat in HRLDAS from its default value of 0.1 to a new value of 0.5. Using $C = 0.1$ and adjusting soil moisture to match the observed near-surface values increased horizontal variability in the right sense, raising LE and lowering H over the moist south end. However, both the magnitude of H and the amplitude of its horizontal variability relative to LE remained too large; adjustment of the green vegetation fraction had only a minor effect. With $C = 0.5$, model-input green vegetation fraction, and our best-estimate soil moisture, H, LE, $\Delta LE/\Delta H$, and $T_0 - T_s$, were all close to observed values. The remaining inconsistency between model and observations—too high a value of H and too low a value of LE over the wet southern end of the track—could be due to HRLDAS ignoring the effect of open water. Neglecting the effect of moist soils on the albedo could also have contributed.

1. Introduction

This paper is the third of a series that addresses the horizontal variability of sensible and latent heat fluxes, H and LE, and their representation in land surface models, this time in the form of the Noah land surface model–based High-Resolution Land Data Assimilation System (HRLDAS; Chen et al. 2007). In the first two papers (LeMone et al. 2003, 2007b), we examined horizontal variability along the amply watered and densely vegetated eastern track in Fig. 1, using data from the International H_2O Project (IHOP_2002; Weckwerth et al. 2004; LeMone et al. 2007a) and the 1997 Cooperative Atmosphere–Surface Exchange Study (CASES-97; LeMone et al. 2000). Here we focus on the more sparsely vegetated IHOP_2002 western track, located in the Oklahoma Panhandle.

IHOP_2002 was organized to improve prediction of warm-season precipitation; the surface and boundary layer component looked at how surface processes affect the planetary boundary layer (PBL) and subsequent

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