UNCERTAINTY IN THE SPECIFICATION OF SURFACE CHARACTERISTICS: A STUDY OF PREDICTION ERRORS IN THE BOUNDARY LAYER

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Abstract. The effects of uncertainty in the specification of surface characteristics on simulated atmospheric boundary layer (ABL) processes and structure were investigated using a one-dimensional soil-vegetation-boundary layer model. Observational data from the First International Satellite Land Surface Climatology Project Field Experiment were selected to quantify prediction errors in simulated boundary-layer parameters. Several numerical 12-hour simulations were performed to simulate the convective boundary-layer structure, starting at 0700 LT 6 June 1987.

In the control simulation, measured surface parameters and atmospheric data were used to simulate observed boundary-layer processes. In the remaining simulations, five surface parameters – soil texture, initial soil moisture, minimum stomatal resistance, leaf area index, and vegetation cover – were varied systematically to study how uncertainty in the specification of these surface parameters affects simulated boundary-layer processes.

The simulated uncertainty in the specification of these five surface parameters resulted in a wide range of errors in the prediction of turbulent fluxes, mean thermodynamic structure, and the depth of the ABL. Under certain conditions uncertainty in the specifications of soil texture and minimum stomatal resistance had the greatest influence on the boundary-layer structure. A lesser but still moderately strong effect on the simulated ABL resulted from (1) a small decrease (4%) in the observed initial soil moisture (although a large increase [40%] had only a marginal effect), and (2) a large reduction (66%) in the observed vegetation cover. High uncertainty in the specification of leaf area index had only a marginal impact on the simulated ABL. It was also found that the variations in these five surface parameters had a negligible effect on the simulated horizontal wind fields. On the other hand, these variations had a significant effect on the vertical distribution of turbulent heat fluxes, and on the predicted maximum boundary-layer depth, which varied from about 1400–2300 m across the 11 simulations. Thus, uncertainties in the specification of surface parameters can significantly affect the simulated boundary-layer structure in terms of meteorological and air quality model predictions.

Key words: Uncertainty, boundary layer, surface characteristics, prediction errors.

1. Introduction

There are several sophisticated soil-vegetation parameterization schemes that provide realistic representations of land surface-atmosphere exchange processes in meteorological models. However, using these comprehensive schemes requires

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