UNCERTAINTY IN THE SPECIFICATION OF SURFACE CHARACTERISTICS, PART II: HIERARCHY OF INTERACTION-EXPLICIT STATISTICAL ANALYSIS

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Abstract. The uncertainty in the specification of surface characteristics in soil-vegetation-atmosphere-transfer (SVAT) schemes within planetary boundary-layer (PBL) or mesoscale models is addressed. The hypothesis to be tested is whether the errors in the specification of the individual parameters are accumulative or whether they tend to balance each other in the overall sense for the system. A hierarchy of statistical applications is developed: classical one-at-a-time (OAT) approach, level 1; linear analysis of variance (ANOVA), level 1.5; fractional factorial (FF), or level 2; two-factor interaction (TFI) technique, or level 2.5; and a non-linear response surface methodology (RSM), or level 3. Using the First ISLSCP Field Experiment (FIFE) observations for June 6, 1987 as the initial condition for a SVAT scheme dynamically coupled to a PBL model, the interactions between uncertainty errors are analyzed. A secondary objective addresses the temporal changes in the uncertainty pattern using data for morning, afternoon, and evening conditions.

It is found that the outcome from the level 1 OAT-like studies can be considered as the limiting uncertainty values for the majority of mesoscale cases. From the higher-level analyses, it is concluded that for most of the moderate surface scenarios, the effective uncertainty from the individual parameters is balanced and thus lowered. However, for the extreme cases, such as near wilting or saturation soil moisture, the uncertainties add up synergistically and these effects can be even greater than those from the outcomes of the OAT-like studies. Thus, parameter uncertainty cannot be simply related to its deviation alone, but is also dependent on other parameter settings. Also, from the temporal changes in the interaction pattern studies, it is found that, for the morning case soil texture is the important parameter, for afternoon vegetation parameters are crucial, while for the evening case soil moisture is capable of propagating maximum uncertainty in the SVAT processes.

Finally, a generic hypothesis is presented that an appropriate question for analysis has to be rephrased from the previous 'which parameters are significant?' to 'what scenarios make a particular parameter significant?'

Keywords: Planetary boundary layer, SVAT, Factorial analysis, Atmospheric interactions, Uncertainty analysis, Sensitivity analysis.

1. Introduction

Soil-vegetation-atmosphere transfer (SVAT) processes are pivotal in atmospheric analysis. These transfers influence features of such diverse magnitude as evapotranspiration, surface and air temperature, circulation and advection of scalars, and precipitation patterns (Sellers et al., 1997). At a local scale, SVAT regulates

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