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# Continental-scale multiobservation calibration and assessment of Colorado State University Unified Land Model by application of Moderate Resolution Imaging Spectroradiometer (MODIS) surface albedo

Toshihisa Matsui,[1,2] Adriana Beltrán-Przekurat,[3] Roger A. Pielke Sr.,[3] Dev Niyogi,[4] and Michael B. Coughenour[5]

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[1] This study attempts to establish the first continental-scale multiobservation calibration and assessment of a land surface model (LSM) over the conterminous United States by using the Colorado State University Unified Land Model (CSU ULM) within the NASA GSFC's Land Information System and the Parameter Estimation (PEST) model. This study aims to calibrate the vegetation and soil optical parameters in different landcover classes by comparing model-predicted surface albedo and those derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) (including black- and white-sky albedo for visible and near-infrared band). The sum of squared deviations ($\Psi$) between model- and MODIS-derived albedo is iteratively reduced via the Gauss-Marquardt-Levenberg (GML) algorithm. The first calibration process (1) reduced $\Psi$ by about 80% for noncalibrated as well as calibrated seasons and years, (2) revealed the functional biases related to diffuse-radiation upscattering parameters in two-stream canopy radiation scheme (which was fixed before the second calibration), and (3) shows that the parameter related to the leaf angle distribution function could not be tuned. The second calibration was implemented from the lessons learned from the first calibration, and results in the more realistic convergence of the parameters. After calibration, the summertime surface energy budget simulated by offline ULM changed significantly over the less vegetated regions; for example, net shortwave radiation and available energy increased by more than 40 W m$^{-2}$ and radiative temperature increased by more than 1.6 K in the postcalibrated experiment.

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## 1. Introduction

[2] Land surface models (LSM) diagnose terrestrial mass and energy flux and biogeochemical processes, which are critical for applications in numerical weather forecasting and climate diagnostics. In the last several decades, hydrology and climate communities have developed a number of different types of LSMs for their research applications [*Pitman*, 2003]. Many LSMs participated in the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS) [*Henderson-Sellers et al.*, 2002]. PILPS' Phase 1 and Phase 2 experiments found a significant diversity in the performances of different LSMs [*Pitman et al.*, 1999]. This is because each LSM contain a number of different functional equations that represent soil-vegetation-atmosphere-transfer (SVAT) processes, and each function consists of different tunable parameters that usually cannot be measured directly or extensively in time and space.

[3] The agreement between model output and observations can be improved by modifying tunable parameters. This process is called model calibration. Model calibration can be accomplished manually (i.e., by hand) for the simply structured LSM. However, as the structures of LSMs become more complicated, a manual calibration becomes difficult even for the experienced modeler. This is because parameterizations within LSMs are nonlinear and coupled; for example, a change in the surface albedo results in the modification of turbulent heat flux, radiative temperature,

[1]Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado, USA.
[2]Now at NASA Goddard Space Flight Center, Greenbelt, Maryland, USA.
[3]Department of Atmospheric and Oceanic Sciences, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, USA.
[4]Department of Agronomy and Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, Indiana, USA.
[5]Natural Resource and Environmental Laboratory, Colorado State University, Fort Collins, Colorado, USA.


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