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Joint State and Parameter Estimation in CLM4 with Remotely Sensed Brightness Temperature

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The Community Land Model (CLM4) includes many parameterizations to characterize the water and energy balance. The biased soil parameters can introduce additional errors and uncertainties into the predictions based on land surface data assimilation. Data assimilation provides an approach to update unknown parameters together with the states while considering the uncertainties from the model and forcing data. The objectives of this study are: (1) evaluation of the feasibility of joint state and parameter estimation in CLM with sequential data assimilation; (2) study of the impact of joint state and parameter estimation on the model states (soil moisture, soil temperature) and surface fluxes.
The joint state and parameter estimation method was evaluated in CLM by assimilating synthetic L-band brightness temperature data. The soil moisture and soil parameters (sand fraction, clay fraction and organic fraction) are updated through the state augmentation method implemented in combination with the Local Ensemble Transform Kalman Filter (LETKF). The results show that the characterization of the soil parameters strongly improves with assimilation of brightness temperature data. The optimized soil parameter values also improve the characterization of soil moisture, soil temperature and surface fluxes. If soil hydraulic parameters are biased, assimilation of soil moisture data with only state updates declines the estimates of latent heat flux and soil heat flux. For forested areas no brightness temperature data are available and it was shown that in case of significant spatial autocorrelation, soil moisture at these locations can be updated using the local surrounding L-band brightness temperature data from non-covered regions. It was also found that the use of a multiplicative inflation method for the soil parameters avoided ensemble collapse and improved estimation results.