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A novel partial grid search approach for handling complex multi-dimensional parameter estimation and state improvement at the catchment scale.

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The integration of satellite data with physically based models can enable the characterization of earth systems and lead to improved management of natural resources at the catchment and regional scales. The reliability of simulations from physically based models depends on the accuracy of the forcing data and the model parameters. Forcing data obtained from satellites or other sources are often plagued with uncertainties and the model parameters require updates to capture the ever-changing environmental conditions. Although comprehensive data assimilation schemes for dual state and parameter updating have been proposed for improving the reliability of model simulations, their computational cost is sometimes prohibitively high. In this contribution, we propose a cost-effective and efficient alternative to handling complex multi-dimensional parameter and state improvement at the catchment scale. Our approach demystifies the complex multi-dimensional parameter estimation and state improvement problem by combining 1-dimensional exhaustive gridding with sensitivity-pushing, Newton-Raphson based guided random sampling and feedback from historical inverse estimates. In a numerical case study in the joint Rur and Erft Catchments in Germany, we apply our novel partial grid search approach to the estimation of soil surface roughness and vegetation opacity from disaggregated SMOS (Soil Moisture and Ocean Salinity Satellite) brightness temperature using the Community Microwave Emission Modeling platform (CMEM). Besides plausibly good estimates of the soil surface roughness and vegetation opacity at the catchment scale, our method also leads to improvement of the system states like soil surface moisture and soil temperature profile. Our method therefore has data assimilation capabilities without the associated computational cost incurred in ensemble-based data assimilation approaches. The partial grid search approach to parameter estimation is therefore a promising tool for multi-dimensional parameter estimation and state improvement in earth systems.