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Characterizing the systematic and random errors in soil moisture estimates from land surface models and satellite retrievals

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Soil moisture regulates the water and energy exchange between the land surface and the overlying atmosphere. Therefore, realistic characterization of soil moisture helps to better understand the interaction of land surface and atmosphere. However, estimates of soil moisture from different sources (i.e. in-situ, model, and satellite) show large discrepancies in both their temporal variability and long-term means. Despite the advancements in monitoring soil moisture through remote sensing methodologies, the global climatology of soil moisture largely remains unknown. Characterizing random error in soil moisture estimates has already been addressed in numerous studies. In particular, data assimilation approaches are often used to combine the information from models and satellite retrievals. These methods, however, only deal with the correction of the random errors components. Most data assimilation and intercomparison studies ignore the systematic error component in the soil moisture estimates, though such biases are often the source of important signals due to the significant heterogeneity and human modifications of the land surface.
In this study, we use an error decomposition methodology to partition the errors in satellite retrievals and land surface model soil moisture estimates into systematic and random components. The results confirm that the systematic errors are the major contributor to the overall errors in soil moisture estimates in both satellite retrievals and models. As a result, methods such as data assimilation focused on improving the random error component are likely to provide small improvements. The study also highlights the need for developing alternative methods for improving the inherent “observability” and information content of soil moisture estimates.