The New Normal in Land Surface Modeling

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The rapid development of land surface models (LSMs) over the past three decades has reached a point where these LSMs can adequately represent the surface energy, water, and carbon balances spanning a wide range of space and time scales. LSMs have been used in various weather forecasting and climate prediction/projection studies, such as assessing the coupling between the land surface and the atmosphere, predicting weather and climate from hourly to seasonal timescales, understanding climate and carbon interaction, and quantifying the impacts of land use on climate change. Recently, LSMs are being merged with other types of models including surface hydrology, groundwater, ecology, air quality, and urban flood early warning. New data assimilation methods are being explored to take advantage of remote sensing products, surface flux network measurements, and aircraft datasets to improve LSMs' predictive skills. Multi-physics frameworks have been incorporated in LSMs to allow for multi-hypothesis testing and uncertainty quantification. Hyperresolution modeling at scales of O(100 m) is being proposed to take advantage of the emerging petascale computational resources. Multi-sensor land data assimilation is being actively pursued to produce high-quality datasets of land states and fluxes for earth system science applications. Therefore, next-generation LSMs are becoming more complex as we are facing unprecedented challenges to understand variability and change on all time and space scales, and to quantify the climatic impacts on energy and water resources, ecosystems, etc. for decision-making. As a result, the new development of these LSMs demands much more coordinated and integrated efforts from multi-disciplinary groups.

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