



Model meets data: Challenges and opportunities to implement land management in Earth System Models

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Land-based demand for food and fibre is projected to increase in the future. In light of global sustainability challenges only part of this increase will be met by expansion of land use into relatively untouched regions. Additional demand will have to be fulfilled by intensification and other adjustments in management of land that already is under agricultural and forestry use. Such land management today occurs on about half of the ice-free land surface, as compared to only about one quarter that has undergone a change in land cover. As the number of studies revealing substantial biogeophysical and biogeochemical effects of land management is increasing, moving beyond land cover change towards including land management has become a key focus for Earth system modeling. However, a basis for prioritizing land management activities for implementation in models is lacking.

We lay this basis for prioritization in a collaborative project across the disciplines of Earth system modeling, land system science, and Earth observation. We first assess the status and plans of implementing land management in Earth system and dynamic global vegetation models. A clear trend towards higher complexity of land use representation is visible. We then assess five criteria for prioritizing the implementation of land management activities: (1) spatial extent, (2) evidence for substantial effects on the Earth system, (3) process understanding, (4) possibility to link the management activity to existing concepts and structures of models, (5) availability of data required as model input. While the first three criteria have been assessed by an earlier study for ten common management activities, we review strategies for implementation in models and the availability of required datasets. We can thus evaluate the management activities for their performance in terms of importance for the Earth system, possibility of technical implementation in models, and data availability. This synthesis reveals some “low-hanging” fruits for model implementation, but also challenges for the assessment of land management effects by modeling. The identified gaps can guide prioritization within the data community from the Earth system and Earth system modeling perspective.