Implementation of Dynamic Leaf Area Index in a Land Surface Model to Improve Water, Energy and Carbon Fluxes

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Phenology defines the photosynthetic active period for plant and thus controls the seasonal activities of various ecosystem processes as well as the interactions and the feedbacks between the terrestrial ecosystems and the climate. In land surface models, phenology and leaf area index (LAI) regularly alters land surface boundary conditions by changing surface albedo, roughness, and surface water and energy fluxes. Therefore, it is a key variable for accurate estimation of seasonal variations of terrestrial ecosystem processes, such as photosynthesis and respiration, as well as land-atmosphere exchange of energy, water and carbon fluxes. In the modeling studies, LAI is prescribed through the use of satellite-based data, while the model accounts for prognostic phenology scheme leading to inconsistency between phonological stages and LAI seasonality. We implement a prognostic LAI method in a land surface model, the Integrated Science Assessment Model (ISAM) based on the leaf carbon content and environmental factors aimed at calculating continuous LAI consistence with plant phonological developments. We perform two model experiments, one with prognostic LAI and other with satellite-based LAI and compare our model results for land-atmosphere water, energy and carbon assimilation fluxes with site measurements. We investigate the advantages of using prognostic LAI for better estimation of the seasonal variation in water, energy and carbon assimilation fluxes. Our analysis reveals that better understanding of the environmental controls on phenology results in a better representation and implementation of phenology and LAI in a land surface model and hence improves the model results for land-atmosphere water, energy and carbon assimilation fluxes.