Improved land-atmosphere fluxes from including interactive crop management in the Community Earth System Model

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Some Earth System Models include crop-specific algorithms for the simulation of interactive planting, growth, and harvesting, to better represent effects of human management on land surface properties with minimal need for new data sets. We evaluate such a model (the CESM1) with two present-day coupled atmosphere-land (CAM4/CLM4CN) simulations: A CONTROL that represents crops as unmanaged grasses, and a CROP that includes special algorithms for mid-latitude corn, wheat, and soybean carbon allocation and plant phenology. CROP simulates a more realistic annual cycle of leaf area index (LAI) for the three managed crops than the CONTROL does for the unmanaged crop. CROP reduces winter LAI and sharpens the spring planting and fall harvest periods. At the peak of the growing season, CROP simulates higher crop LAI.

These changes reduce the latent heat flux of evaporation (LE) but less so in summer. Less moisture recycling leads to reduced precipitation and soil moisture. In midwestern North America, where the three managed crops coexist in highest concentrations and contribute greater differences between the simulations, CROP's reduced summer precipitation agrees better with observations. The annual cycle of net ecosystem exchange (NEE) at Ameriflux site grid-boxes in midwestern North America also improves in CROP. For a global perspective, we extrapolate annual cycles of CO_2 from simulated NEE and compare against representative GLOBALVIEW monitoring stations, to find increased, and thus also improved, amplitude of the annual cycle in CROP. These regional and global-scale refinements have promising implications for the improvement of the Community Earth System Model, particularly in simulations of prognostic atmospheric CO_2.