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The role of vegetation change on surface energy partitioning: insights from a global flux monitoring network

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Vegetation contributes to the absorption and partitioning of energy at the Earth's surface and the surface-atmosphere flux of important greenhouse gases. Changes to vegetation alter the surface energy balance and biogeochemical fluxes. Recent publications have stressed the need to quantify both biogeochemical and biogeophysical effects of land cover change on regional and global climate using a combination of observations and models. This presentation focuses on the observational record by synthesizing surface-atmosphere radiation balance characteristics – including surface albedo and the fluxes of latent and sensible heat – across global ecosystems in the FLUXNET database. We present characteristic seasonal courses of energy balance components across globally distributed ecosystems and demonstrate the impacts of vegetation change on the surface energy balance. We then perform a perturbation analysis on the energy balance equation to quantify the effects of land cover change on surface radiometric and aerodynamic temperatures in paired eddy covariance towers across the globe. Results emphasize the importance of evapotranspiritive cooling in addition to alterations in albedo on surface temperature change. For example, in the Duke Forest experiment, increases in albedo during a shift from abandoned field to pine or hardwood forest warmed the surface by ca. 1° C on an annual basis, but enhanced evapotranspiration cooled the surface by ca. 2 to 3° C such that reforestation induced a net surface cooling. Results using a general methodology agreed with previous results (Juang et al., 2007, Geophysical Research Letters, L21408). Global modeling exercises may underemphasize the role of evaporative cooling versus that of albedo in surface energy balance studies.