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AGU 2002 Fall Meeting Abstract

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Biotic and Biogeochemical Feedbacks to Climate Change

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Abstract

Feedbacks to paleoclimate change are evident in ice core records showing correlations of temperature with carbon dioxide, nitrous oxide, and methane. Such feedbacks may be explained by plant and microbial responses to climate change, and are likely to occur under impending climate warming, as evidenced by results of ecosystem climate manipulation experiments and biometeorological observations along ecological and climate gradients. Ecosystems exert considerable influence on climate, by controlling the energy and water balance of the land surface as well as being sinks and sources of greenhouse gases. This presentation will focus on biotic and biogeochemical climate feedbacks on decadal to century time scales, emphasizing carbon storage and energy exchange. In addition to the direct effects of climate on decomposition rates and of climate and CO₂ on plant productivity, climate change can alter species composition; because plant species differ in their surface properties, productivity, phenology, and chemistry, climate-induced changes in plant species composition can exert a large influence on the magnitude and sign of climate feedbacks. We discuss the effects of plant species on carbon storage in biomass and soil that result from characteristic differences in plant biomass and lifetime, allocation to roots vs. leaves, litter quality, microclimate for decomposition and the ultimate stabilization of soil organic matter. We compare the effect of species transitions on transpiration, albedo, and other surface properties, with the effect of elevated CO₂ and warming on single species' surface exchange. Global change models and experiments that investigate the effect of climate only on existing vegetation may miss the biggest impacts of climate change on biogeochemical cycling and feedbacks. Quantification of feedbacks will require understanding how species composition and long-term soil processes will change under global warming. Although no single approach, be it experimental, observational, or modeling, can adequately capture the complex factors that govern species distributions over relevant spatial and temporal scales, careful integration of these methods can yield needed insights. The potential for large, rapid, or unexpected feedbacks of biogeochemistry and energy balance to climate change make this a worthwhile challenge.