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The role of evapotranspiration on the relative influence of ozone on regional carbon dynamics

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We have developed a method of scaling evapotranspiration (ET) from the leaf-level at the half-hourly timescale to the canopy-level at the monthly time-scale by using a complex plant physiology model (Soil-Plant-Atmosphere, SPA model) to develop a canopy conductance algorithm. This algorithm was incorporated into a global biogeochemistry model (Terrestrial Ecosystems Model, TEM). We have used the eddy covariance latent-flux data to parameterize the hydraulic flow in the plant physiology model and tested the modeled ET. The resulting canopy conductance formulation is dependent upon climatic and environmental factors, including vapor pressure deficit, soil water potential, leaf area index, and atmospheric carbon dioxide concentrations. The canopy conductance is then used with a Penman-Monteith approach to determine the plant transpiration within TEM, which is then used to influence carbon dynamics. Canopy conductance is also used to directly determine ozone uptake. We have applied this approach for temperate forests and extrapolated the model across the conterminous U.S. under historical climate and future scenarios.

Accurate estimation of ET is important for calculating the water use efficiency of carbon uptake by plants during photosynthesis. We found that carbon uptake is less sensitive to drought conditions with increased water use efficiency, while ozone damage is lower under drought conditions. Relative to older versions of TEM, the new model reduces our estimates of mid-summer ET, thereby increasing water use effi-

ciency, and increasing Net Primary Production (NPP) in regions of the conterminous U.S. predicted to become water stressed. The lower ET values result in less ozone uptake. However, historical ozone levels over the 20^{th} century still contribute to a 6.1% decrease in NPP over forested areas in the U.S. during the 1996-2000 period. The ozone-caused decrease in carbon sequestration is 0.058 PgCyr_{-1} during the 1980s, which is a considerable percentage of the estimated total carbon sequestered (39-53%) by temperate forest trees in the U.S. during that same period by previous studies. New ozone dose-response relationships in mature forests will be required to further refine the magnitude of the ozone effect.