DIAGNOSING CONTROLS OVER GPP AND ECOSYSTEM RESPIRATION USING FLUX DATA AND ASSIMILATION MODELING

W. Sacks[1], D. Schimel[1], R. Monson[2], G. Churkina[3]

[1] *National Center for Atmospheric Research*
[2]*University of Colorado*
[3]*Max-Planck-Institute for Biogeochemistry*

ABSTRACT

We used data assimilation to estimate the contributions of GPP, heterotrophic (Rh) and autotrophic (Ra) respiration to Net Ecosystem Exchange at the Niwot Ridge long-term eddy covariance site using 5 years of data. The assimilation problem is solved by optimizing state and parameter values in a version of the PnET ecosystem model by minimizing the misfit between modeled and observed NEE, subject to Bayesian prior estimates of the model parameters and initial state. Seventeen free parameters, about half of the total, are estimated, with the remaining parameters defined from other studies. The model computes GPP, Rh and Ra fluxes for each day and night, and thus produces an estimate of the separation of NEE into its components. We checked the model's partitioning of the NEE into GPP and total respiration by comparing the modeled and observed diurnal NEE cycle, and evaluated the Rh-Ra partitioning by comparing modeled and observed Net Primary Productivity, which constrains this partitioning since GPP-Ra=NPP. While some discrepancies exist, overall the assimilation model had considerable skill on diurnal to interannual timescales. Much of the process information lies in the diurnal cycle: aggregating the data to a daily timestep led to degraded solutions. The results show that while variability is often driven by environmental effects on GPP, aspects of both seasonal and interannual variability were also caused by anomalies in respiration. Both the model and data analyses indicate that much of the observed interannual variability of NEE is driven by changes in growing season length, with most of the variability occurring during the spring snowmelt period. High GPP and NEE are possible then when melting snow produces ample soil moisture but cold sub-nivean temperatures inhibit respiration. While growing season length (GSL) explained much of the variability in annual NEE, the slope of the GSL-NEE curve interannually was about a third of the steady state GSL-NEE relationship estimated from a spatial regression using evergreen sites from the FLUXNET database. This difference in sensitivity may be because transient ecosystem responses are controlled by slow internal ecosystem processes as well as by immediate responses to climate forcing.