Fluxnet: Variation of ecosystem metabolic rain response along a 2000 mm rainfall gradient

G. Darrel Jenerette[1,], Russell Scott[2], Travis E. Huxman[1]

[1]Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ 85721
[2]Southwest Watershed Research Center, USDA-ARS, Tucson, AZ 85719

Sites involved: All native habitat sites between 0-2000 mm yr^{-1} rainfall

Proposal Background

Our recent research developed a quantitative interpretation of a coupled ecosystem pulse response to precipitation and ecosystem metabolic theories (currently in review at Ecology). The coupled theory describes ecosystem metabolism as a dynamic Arrhneious temperature dependency. Precipitation affects ecosystem metabolism by reducing the whole system activation energy. Following a rain event the response is maximized with an exponential return to previous conditions. This quantitative theory was consistent with observations for 11 site years of eddy-covariance flux data in upland and riparian Sonoran desert ecosystems. The modeling design was developed specifically as a multi-site synthesis tool for high temporal resolution eddy-covariance data. We propose to implement this quantitative theory for the comprehensive Fluxnet database to evaluate the suitability of the pulse-metabolic theory to ecosystems throughout a broad climate gradient. The variation along a climate gradient in the response of terrestrial carbon fluxes to precipitation events is described by three competing hypotheses: the monotonic responses hypothesis, the intermediate maximum hypothesis, and the arid discontinuity hypothesis. The monotonic response hypothesis suggest that the ecosystem functioning in response to precipitation variability are consistent throughout a water availability gradient with the importance of precipitation event importance decreasing in conjunction with the number of events. The intermediate maximum response results from two competing mechanisms, water saturation, (access to deeper ground water sources, and large biotic buffering capacity) at high annual precipitation and carbon limitation in low annual precipitation (for example see Knapp and Smith 2001). The arid discontinuity hypothesis suggests that mechanisms of carbon fluxes in arid-lands are distinct from those in more mesic environments (for example see Austin and Vivanco 2006). Because the dominant vegetation life-form may have important consequences for precipitation responses, we specifically look to account for potential interactions with woody:grass biomass differences.

Research Plan

1) Evaluate the coupled pulse-metabolic ecosystem theory for each site year of data. This process uses an inverse approach to estimate both the scaling constant and ecosystem activation energy at a daily resolution using only dry-time data. The error in the model is evaluated following all precipitation events. Prediction error is analytically converted to a precipitation induced activation energy. The suitability of the pulse-decay model is tested and if acceptable the initial reduction in ecosystem activation energy and decay rate are estimated.

2) Examine the sensitivity of the derived whole ecosystem responses to precipitation, initial reduction and decay rate, along gradients in mean annual precipitation and woody-grass coverage.

3) Bayesian model selection will be used to identify the most effective model and as a general framework for propogating error from stages in the analysis. The combined variables will be analyzed with CART, PATH, and other statistical approaches to predict C flux response to precipitation at multiple sites across the climate gradient.

Authorship Policy

The resulting manuscript will be submitted to an appropriate journal pending results with an interest in contributing to a combined special issue. The lead author will be GD Jenerette. Anyone interested in participating are invited to contribute to the analysis, interpretation, and dissemination of the proposed manuscript. Authorship will reflect a contribution to the research and resulting manuscript. Potential opportunities for collaboration include model refinement and optimization for large network syntheses, data extraction routines for examining specific periods (e.g. mid-summer dates only), and development appropriate tests to discriminate between hypothesized responses and observations. Where possible we aim to be inclusive of all interested researchers and data providers.