Title: The canopy structure information content of flux measurements: inferring physiologically-relevant canopy phenology at global scales using Fluxnet data

Outline:

The fractional absorption of photosynthetically active radiation (f_{PAR}) is a key variable in many models describing terrestrial ecosystem-atmosphere interactions, carbon uptake, growth and biogeochemistry. However, methods used to estimate f_{PAR} in the field, whether based on light interception, destructive sampling, or other methods to assess the fractional interception of light during passage through a plant canopy, tend to overestimate the amount of light available to, and used by, chlorophyll. This bias is caused by interference related, in part, to interception by wood in the canopy (stems and branches) but also caused by light absorption by non-photosynthetic materials within the leaves (i.e. any absorption by cellular structures not directly involved in electron transport).

A novel approach to the estimation of the fraction of incident photosynthetically active radiation (PAR) absorbed by the photosynthetic pigments in a plant canopy (f_{Chl}) was developed by Hanan et al. (2002, *Global Change Biology* **8,** 563-574). The method uses measurements of CO_2 flux and incident radiation to estimate light response parameters from which canopy structure (f_{Chl}) is deduced. In the earlier analysis, data from two Ameriflux sites in Oklahoma (tallgrass prairie and wheat) were used to derive 7-day moving average estimates of f_{Chl} during three years (1997-1999). Comparisons with conventional field measurements of PAR absorption by light absorption resulted in good correlations but, as expected, the flux inversion tends to lower values than field measurements. However, since the inverse estimates are based on observed canopy CO_2 uptake they might be considered more biologically relevant than direct measurements that are affected by non-physiologically active components of the canopy.

With this Fluxnet analysis proposal we propose to use the flux inversion technique across a range of sites and bioclimatic conditions to examine seasonal and inter-annual variation in canopy structure and light harvesting capacity as inferred using this biologically determined (flux-determined) methodology. We will examine phenological patterns in space and time and use the inverse estimates of canopy structure to analyze the performance of f_{PAR} retrievals using satellite (MODIS) remote sensing. New remote sensing algorithms, or adjustments to existing algorithms, might thus become better conditioned to "biologically significant" light absorption than is currently possible using traditional f_{PAR} field measurements.

Participants:

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Other interested parties

Fluxnet Sites for Proposed Analysis

We seek to include as many sites as possible in the analysis to represent spatial variability among biomes and bioclimatic types, and the temporal variability associated with inter-annual variability in temperature, rainfall and associated seasonal timing and magnitude. We anticipate that most sites with data in the Fluxnet Synthesis database will have the parameters needed for the analysis. For the basic flux inversion we need only CO2 flux and incident PAR, but field measured temperature, humidity, rainfall and soil moisture would be useful for interpretation and diagnosis of canopy stress conditions.

Proposed Guidelines for Co-Authorship

We will adhere to the Fluxnet Synthesis protocols for co-authorship and err on the side of inclusivity rather than risk any error or appearance of exclusivity. This will include early notification of PIs of any and all sites that we would like to include in the analysis; invitation to site personnel to participate in the analysis, interpretation and written presentation of the results; and appropriate inclusion of co-authors based on contributions to the analysis or participation in the conceptual, numerical and written development of the paper or papers arising.