Proposal for FLUXNET Synthesis Research

Title: Examining the effects of teleconnection patterns on ecosystem flux exchange at FLUXNET towers along the Pacific Rim

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Focus Group: IAV

Background:
Terrestrial ecosystems along the western coast of North America and eastern coast of Asia are particularly prone to variations in climate via the movement of weather patterns caused by equatorial and extratropical Pacific ocean-atmospheric oscillations. The dominant modes of climate variability over the Pacific Ocean are the Pacific Decadal Oscillation (PDO), Pacific North American Oscillation (PNA) and El Nino-Southern Oscillation (ENSO). Previous flux tower studies indicate that western North American conifer forests have the potential to become weaker or stronger sinks or sources of atmospheric CO_2 during strong ENSO teleconnection events (e.g., Goldstein *et al.* 2000; Morgenstern *et al.* 2004; Schwalm *et al.* 2007; Wharton *et al.* submitted). Furthermore, Wharton *et al.* (submitted) found that when the 3 climate indices are in-phase, i.e. all are negative (cool) or positive (warm), the greatest annual and seasonal anomalies in carbon flux and mechanistic variables (light use-, water use-efficiency) were observed at the Wind River AmeriFlux site. The PDO, PNA and ENSO collectively explained 90% of the variance in annual net ecosystem production (NEP) over the six years. The forest transitioned from an annual net carbon sink (NEP = + 217 g C m^{-2} $year^{-1}$) to a source (NEP = - 100 g C m^{-2} $year^{-1}$) during two dominant teleconnection patterns between 1999 and 2004.

Outline:
With this synthesis activity we plan to examine and compare how teleconnection patterns influence ecosystem mass and energy exchange at eastern and western Pacific Coast FLUXNET sites. This project will use the methodology developed in Wharton *et al.* (submitted): (1) Connections will be made between three Pacific teleconnection events (PDO, PNA and ENSO) leading modes and local weather using historical climate records (we will need at least 50 years of annual temperature and precipitation data from locations as close to possible to the flux towers); (2) The influences of leading or dominant modes and associated weather will be examined with respect to the occurrence of in-phase teleconnection events. This will be done by separating the flux measurement years at each tower based on climate phase strength and occurrence of in-phase events (the flux towers will need to have at least 5 years of eddy covariance data); and (3) Pacific teleconnection events will be related to yearly and monthly variability in ecosystem carbon exchange fluxes, specifically NEP, gross primary productivity (GPP), ecosystem respiration (R_{eco}) and the mechanistic variables, light use efficiency (LUE) and water use efficiency (WUE).

Sites Involved:
FLUXNET towers along the coasts of western North America and eastern Asia will be used. Sites must have at least 5 years of continuous flux data in order to capture both strong positive and negative teleconnection events. Along the eastern Pacific this may include: Blodgett, Vaira/Tonzi, Metolious, Wind River, Campbell River, and Alaskan sites. Along the western Pacific this may include sites in Russia, Japan (Takayama, Teshio), China and Korea (depending on data availability). Ecosystem types may include forests, grasslands and/or tundra.

Co-authorship policy:
Substantial contribution from individual PIs involving data sharing, analysis or intellectual input will result in co-authorship.

References:
Goldstein A, Hultman N, Fracheboud J *et al.* (2000) Effects of climate variability on the carbon dioxide, water and sensible heat fluxes above a ponderosa plantation in the Sierra Nevada (CA). *Agricultural and Forest Meteorology*, **101**, 113-129.

Morgenstern K, Black TA, Humphreys ER *et al.* (2004) Sensitivity and uncertainty of the carbon balance of a Pacific Northwest Douglas-fir forest during an El Niño La Niña cycle. *Agricultural and Forest Meteorology*, **123**, 201-219.

Schwalm CR, Black TA, Morgenstern K, Humphreys ER (2007) A method for deriving net primary productivity and component respiratory fluxes from tower-based eddy covariance data: a case study using a 17-year data record from a Douglas-fir chronosequence. *Global Change Biology*, **13**, 370-385.

Wharton S, Chasmer L, Falk M, Paw U KT. Strong links between teleconnections and canopy CO2 exchange found at a Pacific Northwest old-growth forest. (submitted, *Global Change Biology*)