PROPOSAL FOR FLUXNET SYNTHESIS PUBLICATION FOR FLUXNET-LA-THUILE DATA SET

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TITLE OF PAPER AND OUTLINE

TITLE

Phenological and physiological controls of net ecosystem production and its response to climate change

PROPOSED SITES TO BE INVOLVED

All available sites in LaThuile datasets

PROPOSED RULES FOR CO-AUTHORSHIP

1. All the PIs of the sites where we decide to use the data will be invited to be co-authors if they make intellectual contributions;
2. Those who provide comments and suggestions on the manuscript will be placed in the front of the authors' list;
3. We will acknowledge the data source as a citation or in the acknowledgements if no citation is available.

OUTLINE

1. Why do we study

Climate change exerts strong influence on the terrestrial carbon balances by directly impacting its physiological processes and also indirectly by mediating phenology (Barr et al., 2009). In temperature and boreal ecosystems, phenology plays even more important role in controlling the spatial and temporal variation in carbon sequestration (Baldocchi, 2008, Goulden et al., 1996, Piao et al., 2008). Recent studies showed plant phenology is very sensitive to climate warming (Wang *et al.*, 2011, Yu *et al.*, 2011). However, previous study documented inconsistent results on the relationship between climate warming, growing season length, and NEP. Spring warming can stimulate early spring onset and increase GEP and NEP (Richardson *et al.*, 2010), while autumn warming may cause early ending of carbon uptake, leading to less NEP (Piao *et al.*, 2008). Across spatial scales, annual NEP is closely related to canopy carbon uptake period (Baldocchi & Wilson, 2001, Churkina *et al.*, 2005, White & Nemani, 2003), but the contrast results had been reported also with longer growing seasons lead to less carbon sequestration, which is due to water limitation (Hu *et al.*, 2010). This suggests that other limiting factors (e.g., precipitation) may regulate the relationship between the length of carbon uptake period and annual NEP. Despite of these efforts, the connection between climate change and phenological variability and the terrestrial carbon cycling is still incompletely understood.

The maximum carbon uptake capacity is another key characteristics controlling annual NEP (Falge *et al.*, 2002). With the same carbon uptake period, ecosystems with a higher NEP capacity will have larger annual NEP because the proportion (ratio) of annual carbon uptake to annual carbon release is relatively invariant (2.73 ±1.08, Churkina et al. 2005). Peak NEP usually occurs during the mid-growing season and may be regulated by precipitation in water-limited ecosystems. Here we hypothesize that in temperature-limited ecosystems, the responses of annual NEP to climate change will be primarily regulated by the response of carbon uptake phenology, while in water-limited ecosystem, the responses of annual NEP to climate change will be primarily controlled by the responses of the maximum carbon uptake capacity. Nevertheless, the relative roles of carbon uptake phenology and physiology in regulating annual NEP in its response to climate change in different ecosystems are to be revealed.

2. What do we want to look at?

How does carbon uptake phenology (beginning and end of carbon uptake and the length of carbon uptake period) respond to temperature changes across broad temporal and spatial scales? How do carbon uptake phenology and physiology control annual NEP in different vegetation types or climate areas? Are there any tradeoffs between phenological and physiological changes in different seasons? Will the carry over effects of NEP among different seasons overcompensate the tradeoffs effects among seasons?

3. How to study

Carbon uptake period will be estimated by the beginning and the ending date (DOY) of carbon sink. We will estimate the seasonal (spring, summer, autumn, winter) and annual NEP, air temperature, soil temperature, precipitation, global radiation, etc. , and then calculate the seasonal and annual anomalies of these variables and the anomalies of beginning data of carbon sink, end data of carbon sink, the length of carbon uptake period, and the maximum carbon uptake capacity. The relationship between the temperature anomaly and phenology anomaly and the relationship between the phenology anomaly and seasonal or annual NEP anomaly will be explored by simple or multiple regressions.

4. The uniqueness of this study

The goals of this study are to quantify the roles of carbon uptake phenological and physiological controls in annual net ecosystem production and their response to climate change. The probable tradeoff effects among seasons in their response to climate change through changing carbon uptake phenology or physiology will provide a mechanism for understanding the contradictory results in the previous studies. We examined all the proposals at the La Heuila webpage (http://www.fluxdata.org/DataInfo/Dataset%20Doc%20Lib/PaperWritingTeamsInfo.aspx) and found no one is working on the same issues as proposed here.