Proposed manuscript title: Climate control of terrestrial carbon sequestration

Lead coordinator: Chuixiang Yi (Queens College)

Other proposing group members needing data access: Daniel M. Ricciuto (Oak Ridge National Laboratory), Russell K. Monson (University of Colorado Boulder)

Sites requested: all with >= 2 years of complete gap-filled NEE data

Co-authorship rules: in addition to the proposing group members, co-authorship will be offered to up to two representatives for each FLUXNET site at their discretion.

Proposed activity:

We have synthesized results independently from multiple flux tower networks and drafted a manuscript that has been circulated to a number of site PIs. We would like to redo our analysis using the La Thuile synthesis dataset to take advantage of the standardized data format and additional sites that are available there. This analysis also takes advantage of a new gap-filling algorithm that we have developed for tower meteorological data that uses data from nearby climate stations or flux towers. As a product of this manuscript, we are willing to share these gap-filled data with the community. The abstract is below:

Understanding the climate controls of terrestrial carbon sequestration is key to predictions of future levels of atmospheric carbon dioxide due to the potential acceleration effects of positive climate-carbon cycle feedbacks. However, the controlling climate factors of terrestrial CO_2 exchange with the atmosphere on yearly to decadal scales remains highly uncertain. Here we present data of net terrestrial carbon sequestration and climate measured by the eddy-flux tower technique, including 106 unique sites and 495 total site-years worldwide. We find that these terrestrial ecosystems can be divided into two groups: (1) carbon sequestration of ecosystems (consisting of 76 % forests) is controlled by mean annual temperature (R^2=0.65) ; (2) carbon sequestration of ecosystems (71% cropland, grassland, shrublands, planted forests, and savanna) is controlled by the dryness index ($= R_n / (LP)$, R^2=0.64), where R_n is mean annual net radiation (MJ m^{-2} yr^{-1}) and L(=2.5 MJ kg^{-1}) is the enthalpy of vaporization. We also find that 81% of the sites of the temperature-sensitive group were located between 42°N and 70°N, while 71% of the sites of the dryness-sensitive group were located between 12°S and 42°N. The temperature control of terrestrial carbon sequestration is broken down as mean annual temperature approaches a threshold value (~16 °C) beyond which terrestrial carbon sequestration is controlled by dryness. These results demonstrate that terrestrial carbon sequestration in Boreal and Temperate climate zones is controlled largely by the mean annual temperature, while in Tropical and Subtropical climate zones is governed mainly by susceptibility to drought, measured by the dryness index.

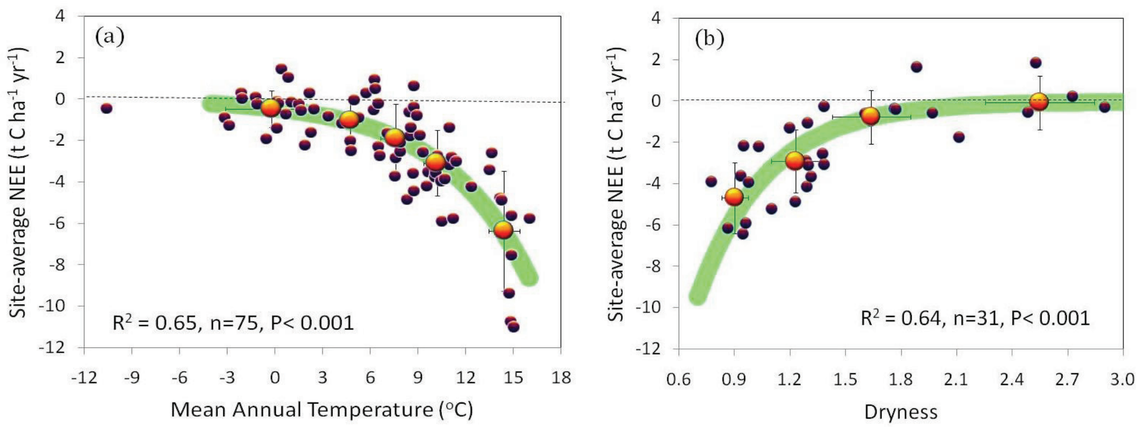

Figure 1. Climatic controls of the site-average net ecosystem exchanges (NEE) of CO_2 across the FLUXNET sites (see table 1): (a) temperature group; and (b) dryness group. The negative NEE values indicate that atmoshpric carbon is absorbed by terrestrial ecosystems, while the positive NEE values indicate that terrestrial organic carbon is decomposed into atmospheric carbon. Small filled circles are site-average NEE, the large filled circles with standard deviation bars are bined-average