VIEWING ICOS IN A GLOBAL CONTEXT: LESSONS LEARNED FROM THE GLOBAL NETWORK, FLUXNET

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Regional networks of eddy covariance flux towers have been operating in Europe, North America and parts of Asia for nearly 20 years. Hence, we have collected thousands of site-years of ecosystem-scale carbon, water and energy flux data from hundreds of sites across a broad swath of ecological and climate space. The overarching goal of this flux work is to be able to 'assess fluxes everywhere and all of the time.'

One of the key intellectual attributes of mining relationships from a network of flux data is that we can define how the metabolism of ecosystems responds to environmental drivers at ecosystem time and space scales. In other words, with flux data we can quantify a nearly continuous response functions, identify non-linear responses and scale-emergent processes; these are attributes that are not well defined with ecosystem manipulation experiments, as they are associated with a limited number of samples and treatments that are of a relatively small area.

In this lecture we give an overview of some of the key lessons we have learned by working together, sharing data and producing flux sums on annual to decadal time scales. Some lessons pertain to constraints among gross and net carbon fluxes, water and energy. Other lessons pertain to the timing and length of physiological activity, as defined by phenology. And, other lessons relate to the acclimation of basal rates of soil respiration and optimal rates of photosynthesis to temperature and the response of whole ecosystem metabolism to variations in soil moisture.

Among the key lessons we find are a tight linkage between annual sums of ecosystem photosynthesis and respiration ($r^2 > 0.85$; slope ~ 0.86) and year to year variability; environmental conditions that increase annual GPP increase R_{eco}, and vice versa. We discover how photosynthesis commences when soil temperature matches mean annual air temperature, scale emergent properties that pertain to how diffuse light affects light use efficiency and the effectiveness of how well vapor pressure deficits may serve as a proxy for soil moisture deficits and down regulate light use efficiency.

To assess fluxes at spatial scales larger than flux footprints, networks of flux data are being ingested into machine learning models and produce maps of carbon fluxes. This degree of upscaling gives the global carbon and hydrological science communities a constraint on global gross primary productivity and evaporation that are based on direct flux measurements. And it is only possible when scientists across the world collaborate and share data.