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ABSTRACT TITLE: Findings from a decade-plus study of comparative carbon, water and energy fluxes from an oak

ABSTRACT: We have been collecting carbon and water fluxes of an oak savanna and annual grassland in the Mediterranean climate of California since 2000. This long and continuous and comparative data record gives us an unprecedented ability to understand and quantify the interannual variations in carbon, water and energy exchange of contrasting functional types and how they respond to the highly variable annual precipitation inputs.

Our scientific approach uses the eddy covariance to measure the net and gross fluxes of trace gases between ecosystems and the atmosphere. We augment these measurements with a variety of mechanistic studies that examine the physiological and biophysical control on these fluxes. These efforts involve laboratory and field measurements on the exchange of gases from the soil, leaves and plants, like understory eddy flux measurements, pre-dawn water potential, photosynthetic capacity, soil respiration, soil moisture, monitoring the water table and excavation of roots. To upscale our flux measurements we rely on an assortment of remote sensing measurements. These efforts include measuring light transmission through vegetation, monitoring hyperspectral reflectance of the vegetation, time series of canopy photos to monitor phenology and LIDAR surveys of vegetation structure.

Based on data through the 2010 hydrological year we find that net ecosystem exchange, ecosystem photosynthesis and respiration are -101 +/- 67, 1302 +/- 195 and 1193 +/- 161 gC m^{-2} y^{-1}, respectively, for the oak savanna, indicating it is a sink for carbon. In comparison, the annual grassland is carbon neutral; its mean annual sums for net ecosystem exchange, ecosystem photosynthesis and respiration are 19 +/- 109, 814 +/- 251 and 833 +/- 251 gC m^{-2} y^{-1}, respectively.

Together we digest, distill and evaluate this information fluxes and biophysical structure and function of the canopies through a hierarchy of biophysical models, derived from the CANVEG family. Our most recent efforts have been to build on the efforts from our field work to develop two contrasting models. One model, CANOAK-3D, simulates the complex three-dimensional light environment of the savanna to compute photosynthesis and leaf energy balance fluxes. The other model, the Breathing Earth System Simulator--BESS, runs with remote sensing information derived from MODIS to produce flux information on carbon and water exchange at high spatial resolution (1-5 km) across the globe, from days to years. Both models were found to perform well, when compared with data from either the savanna site or the Ameriflux network.