Solar Induced Fluorescence: Theory and Measurement Approaches

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Measurements of chlorophyll fluorescence have long been a key method for probing the mechanisms of photosynthesis in laboratory studies. Recent advances in satellite spectroscopy have enabled retrieval of chlorophyll fluorescence from terrestrial ecosystems at a global scale. These retrievals show promising potential as an indicator of photosynthetic rate and environmental stress. This poster will explore the mechanistic basis for interpreting and modeling of solar induced chlorophyll fluorescence (SIF) and approaches we are developing to measure SIF at flux towers.

SIF is essentially a leak of photons from photosynthetic membranes, and it is, therefore, related to the flux of photons absorbed by chlorophyll and to biochemical regulation of photon processing in macro molecular complexes associated with photosystem II.

Satellite retrievals of SIF occur at mid-day, conditions where the capacity for CO_2 fixation usually limits the rate of photosynthesis and absorbed light is in excess. While one might expect SIF to be high under this condition the opposite is observed. Regulatory processes open non-photochemical trapping centers that compete with the photochemical reactions at PSII and with the emission of fluorescence under conditions of over excitation. This serves to minimize photo-damage to the reaction centers by this stress.

We have extended a conventional parameterization for photosynthetic biochemistry to simulate SIF in the SCOPE model. The model was then used to evaluate the potential for using retrievals of SIF to estimate GPP, the integrated Vcmax of the canopy, the presence of water stress, and biophysical properties such as leaf angle distribution and chlorophyll content.

Obtaining accurate measurement of SIF from field instruments has been challenging because of the very high spectral resolution required. We will describe new instrumentation that we have developed for this purpose. This will be installed at the K34 tower near Manaus and the observations will be compared with GPP and COS flux measured at the site; with simulations using the SCOPE model and with satellite retrievals.