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Remote sensing of vegetation ecophysiological function for improved eco-hydrologic prediction

Darren Drewry (1) and Benjamin Ruddell (2)

(1) Jet Propulsion Laboratory, NASA, Climate Physics Group, Pasadena, United States (drewryd@gmail.com), (2) Arizona State University, Mesa, Arizona, USA

Land surface hydrology in vegetated landscapes is strongly controlled by ecophysiological function. The coupling between photosynthesis, stomatal dynamics and leaf energy balance fundamentally links the hydrologic and carbon cycles, and provides a basis for examining the utility of observations of functional plant traits for hydrologic prediction. Here we explore the potential of solar induced fluorescence (SIF) and thermal infrared (TIR) remote sensing observations to improve the accuracy and reduce the uncertainty of hydrologic predictions. While SIF represents an emission of radiation associated with photosynthesis, TIR provides information on foliage temperature and is related to stomatal function and water stress. Here we explore the synergistic potential of these ecophysiological observations to constrain traits controlling land surface function.

A set of remote observing system simulation experiments are conducted to quantify the value of remotely sensed observations of SIF and TIR when assimilated into a detailed vegetation biophysical model. The MLCan model discretizes a dense plant canopy to resolve vertical variation in photosynthesis, water vapor and energy exchange. Here MLCan is extended to allow for direct computation of the canopy emission of both SIF and TIR. The detailed representation of the physical environment and biological functioning of structurally complex canopies makes MLCan an ideal simulation tool for exploring the impact of these two unique, and potentially synergistic observables. This work specifically addresses remote sensing capabilities on both recently launched (OCO-2) and near-term (ECOSTRESS) satellite platforms.