Clarifying Linkages between Canopy Solar Induced Fluorescence (SIF) and Physiological Function for High Latitude Vegetation

Partner

Team:

PI: K. Fred Huemmrich (University of Maryland Baltimore County)
Co-Is: Craig Tweedie (UTEP)
Petya Campbell (UMBC)
Joanna Joiner (NASA/GSFC)
Yasuko Yoshida (SSAI)
Betsy Middleton (VCU)

Science Objectives:

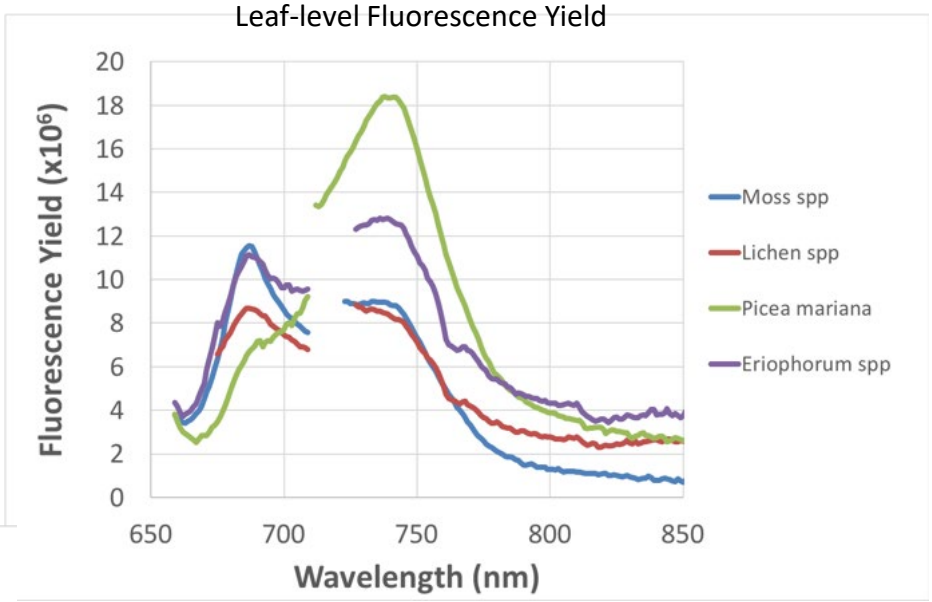
- Determine *in situ* relationships between solar induced fluorescence (SIF) and vegetation photosynthetic capacity for different high latitude species under a range of environmental conditions
- Collect measurements in tundra and boreal forest sites in conjunction with flux tower measurements
- Scale observations from leaf-level to satellite scale
- Parameterize SCOPE model for tundra and boreal forests to simulate directional fluorescence emissions and provide a link to photosynthesis
- Use satellite imagery to describe SIF spatial variability along with diurnal, seasonal and multi-year changes, derive gross primary productivity (GPP) and describe its variability

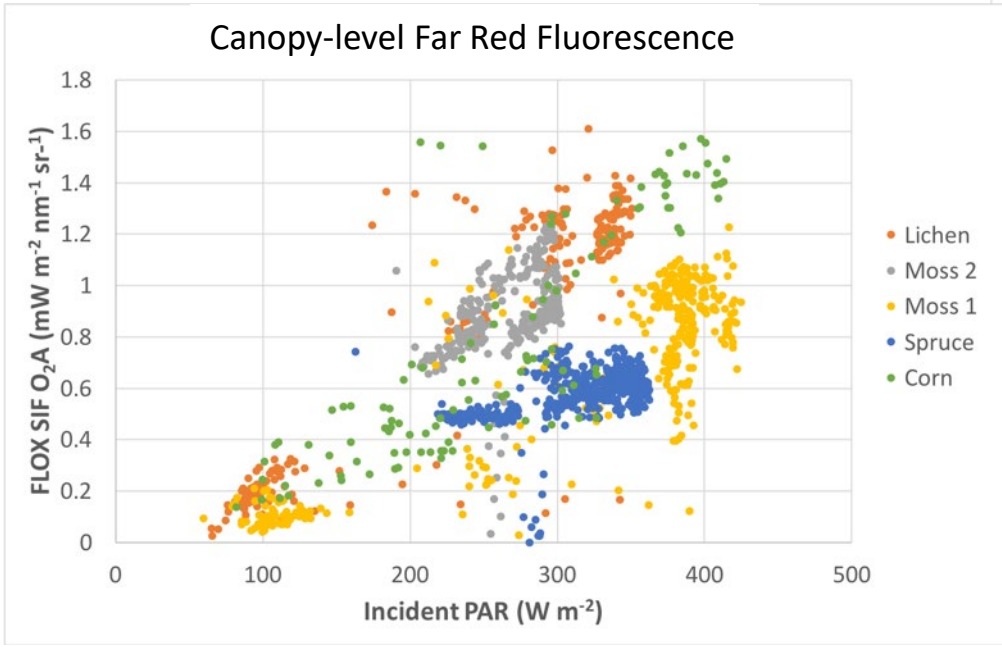
Thanks to Sarah Sackett, Mariana Orejel, Tabatha Fuson, Hector Dominguez, Sergio Vargas, Julio C. for data collection.
This work is supported by NASA grant 80NSSC19M0110.

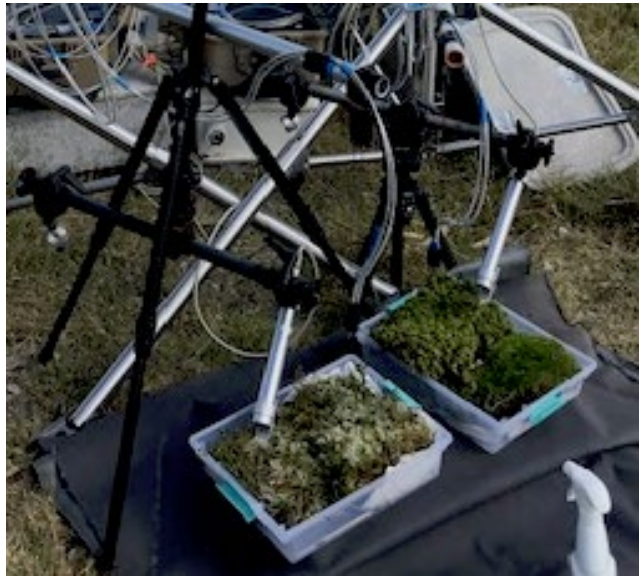
Partner

Measurements of Plant Samples

- Applied field instrumentation to plant samples sent from AK
- Testing out instrumentation and protocols prior to field deployment







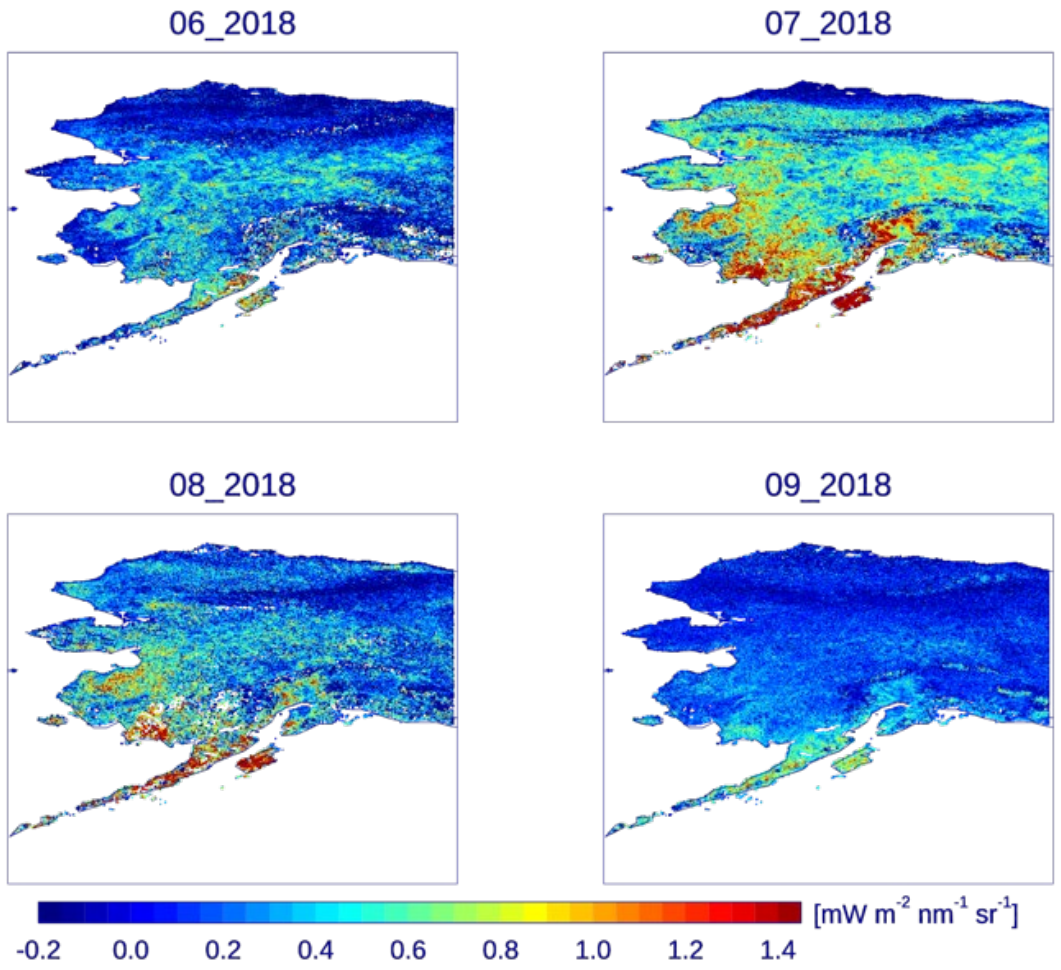
Chl F emissions from the four boreal vegetation types were distinctly different in magnitude and spectral shape, which is much greater that the variability observed in leaves from temperate and tropical forests and crops.

Only the spruce needles exhibited a distinct far-red peak, which indicates a re-absorption of the red Chl F signal

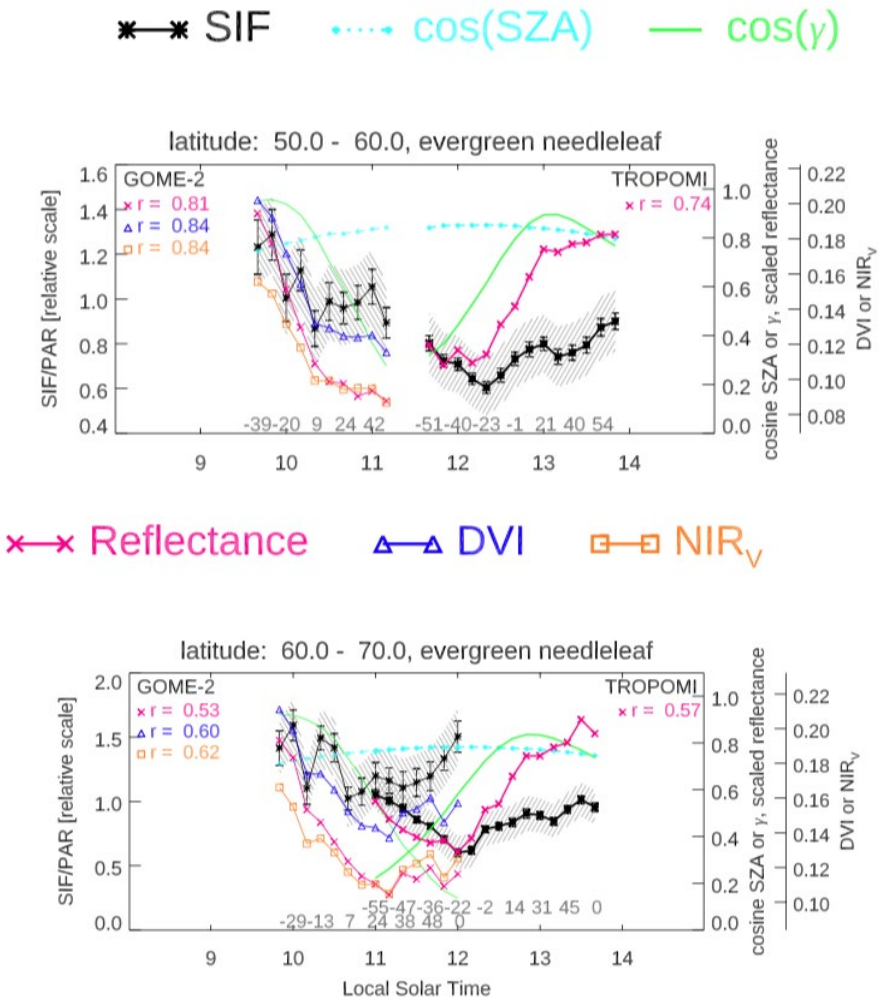
TROPOspheric Monitoring Instrument (TROPOMI) SIF

Partner

TROPOMI SIF



Testing reflectance-based indices to account for geometrical dependence of SIF across a satellite track

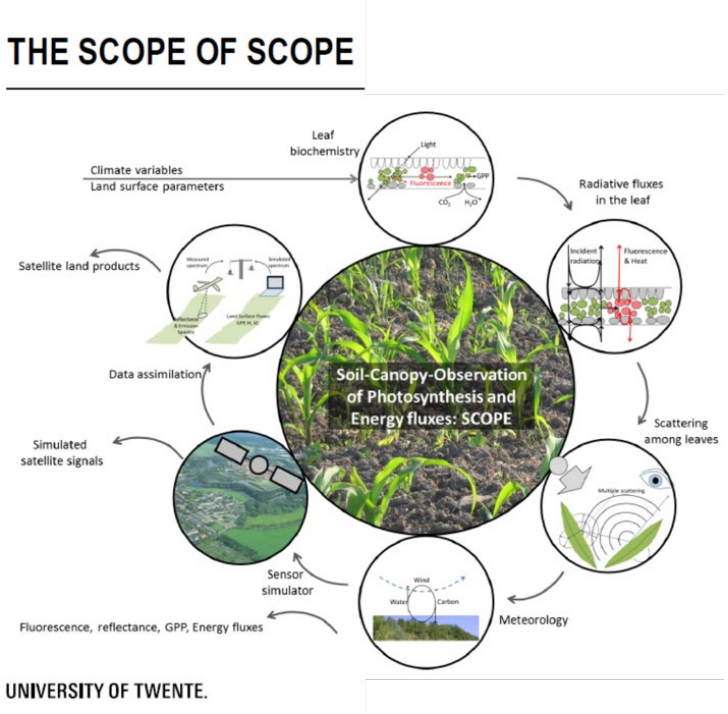


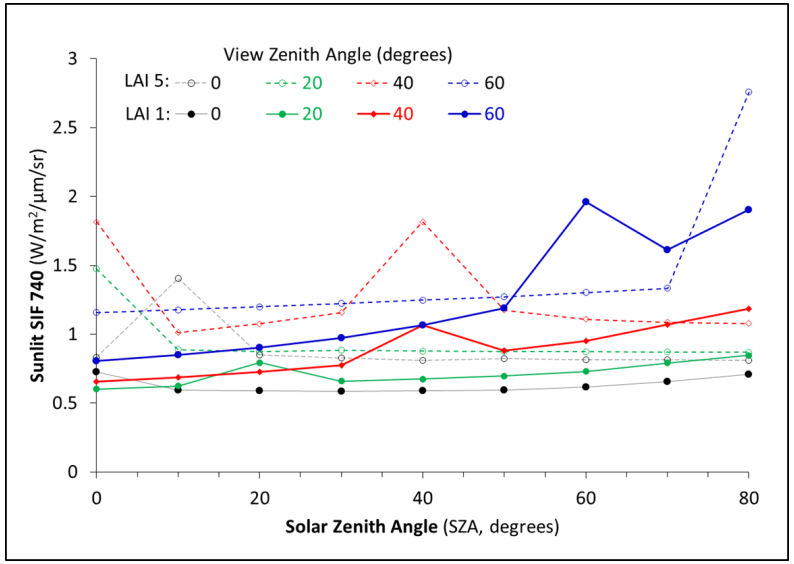
Partner

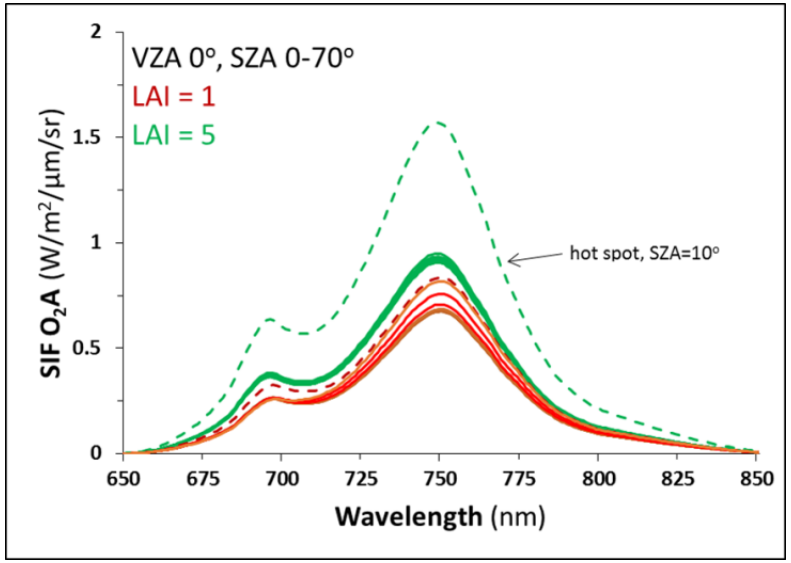
SCOPE Simulations of Canopy SIF

SCOPE (Soil Canopy Observation, Photochemistry and Energy fluxes) simulates directional fluorescence and provides a link to photosynthesis

We are working to parameterize SCOPE for tundra and boreal landscapes







Simulating effects of changing view zenith angle on canopy SIF using SCOPE

- With increasing VZA and SZA SIF increases
- In general, higher SIF is observed at higher LAI

Partner

Engagement with Others

SCOPE model collaborations

We have been collaborating with Christiaan Van der Tol, the developer of SCOPE, using our field measurements to describe Chl F properties of major tundra and boreal forest plant types

SCOPE has not been used in these landscapes before

This collaboration is providing information on high latitude ecosystems to the ESA FLEX (Fluorescence Explorer) mission through Dr. Van der Tol

Partner

Impacts of the loss of the 2020 field season

Coronavirus impacts:

- Serious impacts, we were planning for a full field season of measurements that now must be postponed

Responses:

- If GSFC and ABoVE field offices re-open during the summer, we are requesting plant samples to be sent from Alaska for lab measurements to obtain data for model parameterization
- We are working with NEON to deploy our FLoX sensor on the SERC tower in MD to learn how to mount and operate these sensors on NEON towers

Future directions

- Scope model development - collect light curves + traits and spectra to parameterize the leaf and canopy portions of SCOPE
- Satellite data analysis - collocate GPP from available flux towers with TROPOMI and MODIS data (new FluxSat GPP product) to examine whether these data sets are capable of detecting GPP variability on various time scales
- Paper submitted to Remote Sensing. "Systematic orbital geometry-dependent variations in satellite solar-induced fluorescence (SIF) retrievals"
- Plan for fieldwork next year