Terrestrial Ecology Products from PACE

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Goals

Develop and test approaches to use PACE OCI to describe terrestrial ecosystem biochemical and functional traits and their dynamics, focusing on foliar pigments and productivity

Potential Applications

Forestry - examining widespread forest productivity, identify forest types, detect stress events (e.g., responses to droughts)

Agriculture - improved estimation of productivity and yield, detect stress events

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Needs

There is a critical need for an OCI surface reflectance product (multiple existing options for this product)

Due to OCI tilt and wide swath we need to further calculate a Nadir Bidirectional Adjusted Reflectance (N-BAR), again there are existing approaches for this

Validation

Potential to use existing CEOS Cal/Val for validation (https://calvalportal.ceos.org/calvalsites)

For example:

Radcalnet for reflectance

National Ecological Observatory Network (NEON) for reflectance and product validation using the airborne NEON imaging spectrometer (based on AVIRISng), ground measured foliar chemistry, and productivity from eddy covariance towers.

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Issues

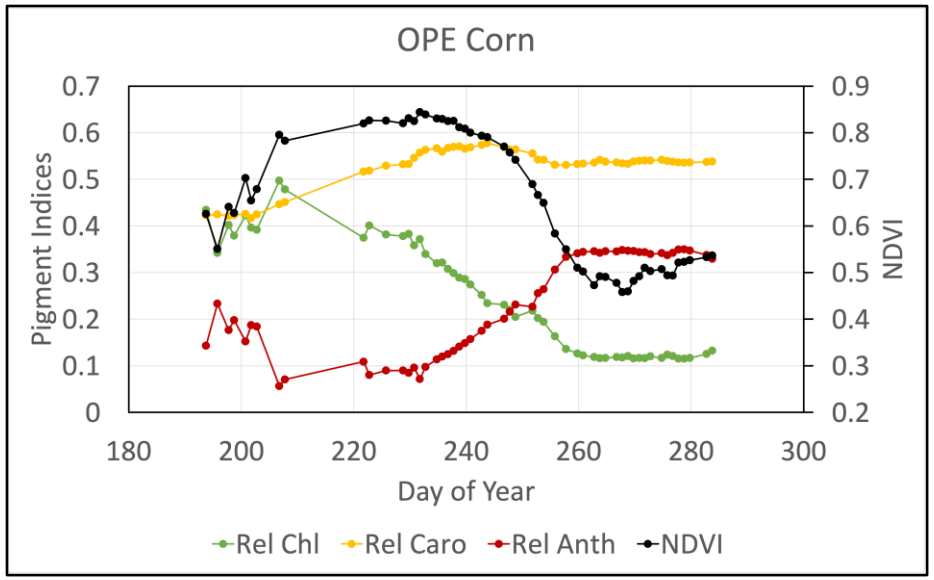
A challenge for the development of terrestrial products and applications is that PACE OCI will produce a novel dataset of frequent, global, hyperspectral observations and there are few existing data collections that replicate these characteristics to use for algorithm development and testing

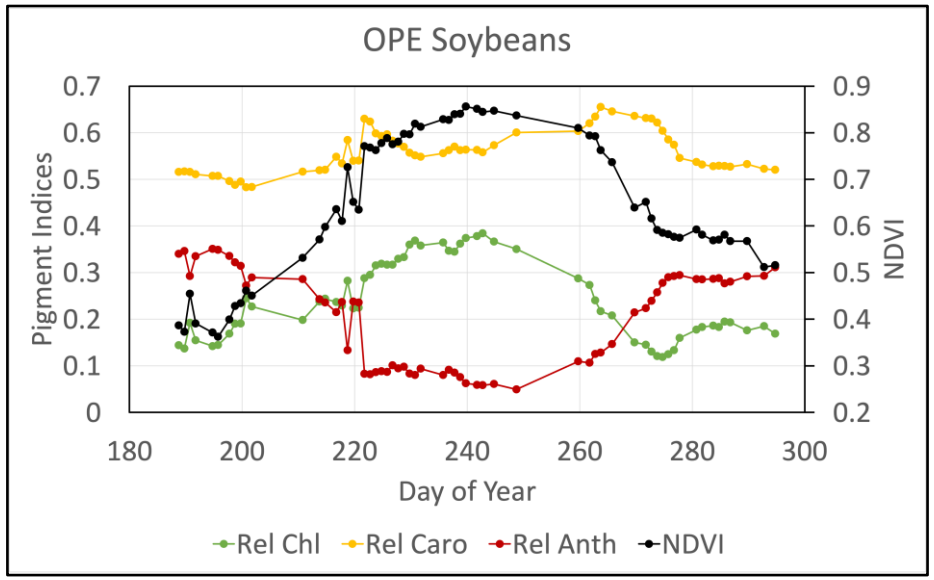
Work this Year

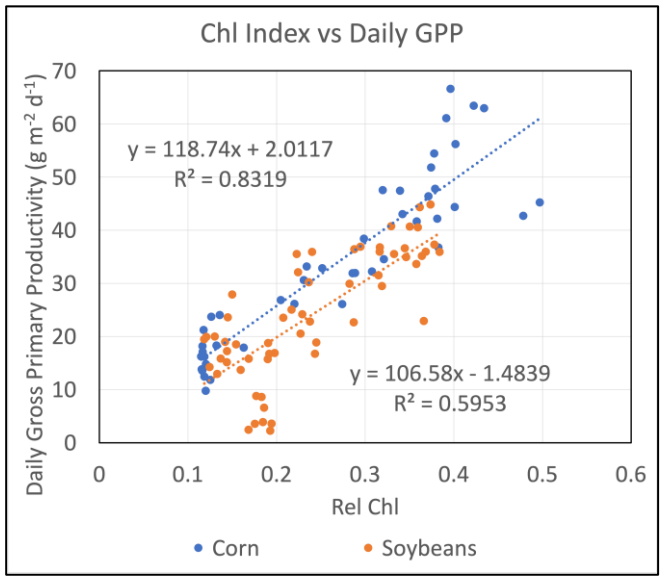
Our work has been focused on using available data examine the different characteristics of PACE OCI for terrestrial ecology studies working at a range of spatial and temporal scales

Seasonal Change in Leaf Pigment Contents

PACE's frequent observations and spectral bands can track seasonal vegetation biochemical changes related to plant productivity and stress responses moving the study of ecosystem dynamics beyond NDVI





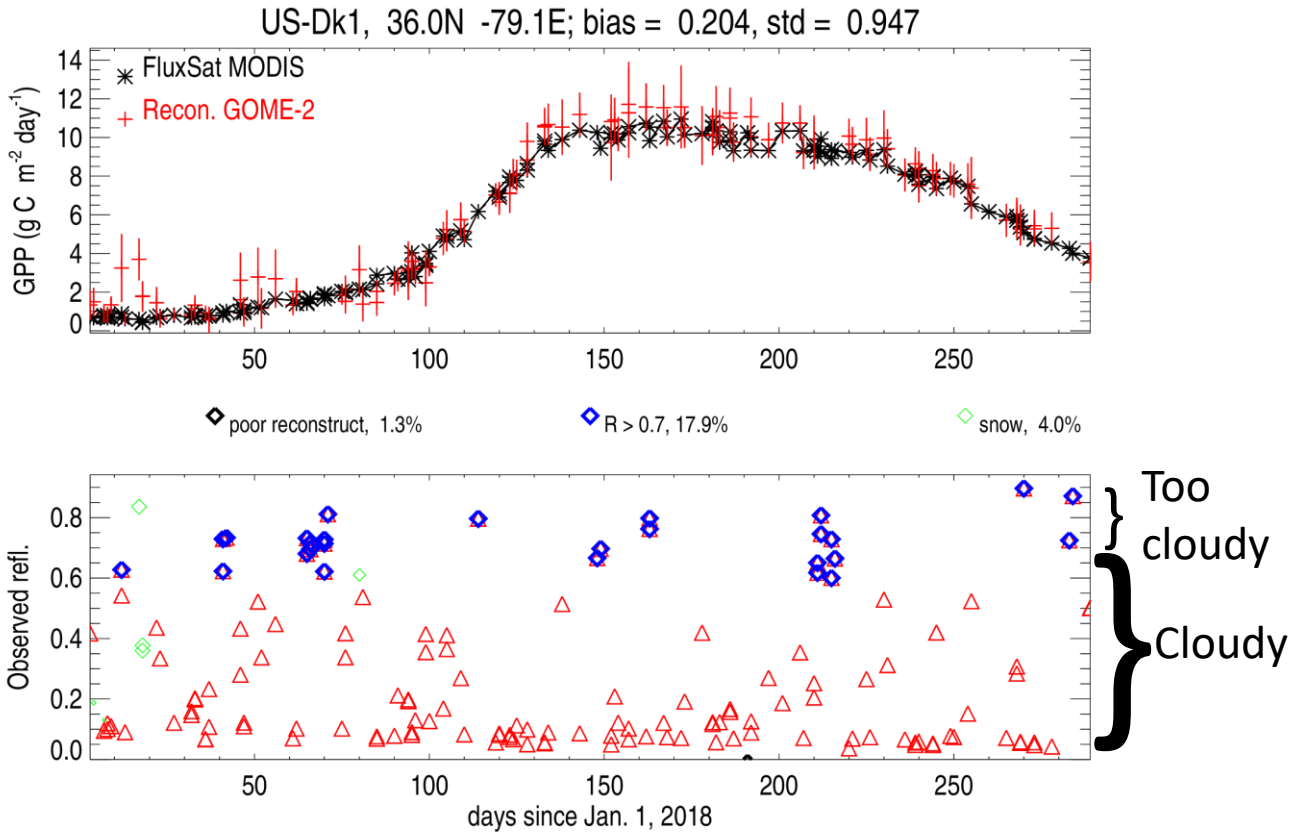


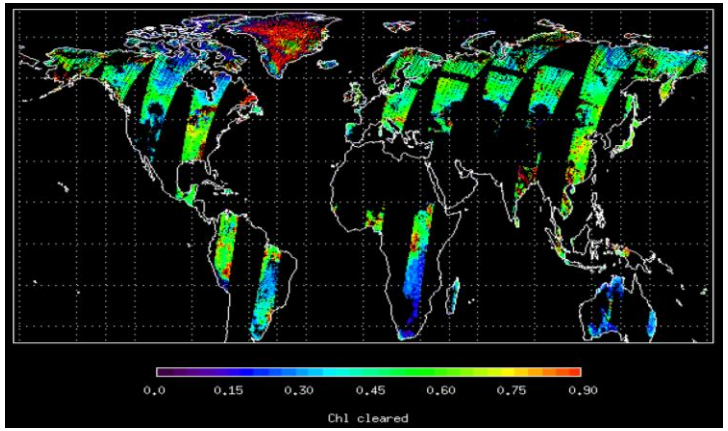
Midday observations of a field in Beltsville, MD for two different crops from the automated FLoX sensor. Gross primary productivity (GPP) measured from flux tower in same field.

NDVI seasonal pattern differs from those of Chlorophyll, Carotenoid, and Anthocyanin indices
- NDVI does not track GPP as well as chlorophyll content

Gross Primary Production from GOME-2

- Using machine learning, we can estimate GPP (gross carbon taken up by plants) efficiently even in cloudy conditions from PACE OCI hyper-spectral data (can be a “day 1” product using products from MODIS or VIIRS for training – MODIS products typically not available until 2 weeks after overpass due to large amount of processing needed).
- Using GOME-2 (400-800 nm) as a proxy for PACE OCI, we show that GPP can be estimated even in cloudy conditions (see figure on right).
  - shallow neural network does atmospheric correction, BRDF adjustments, and cross calibration.
    - Cloud clearing does not work with MODIS data
  - trained on a MODIS-based GPP product that was in turn trained on many years of collocated eddy-covariance data
  - does not work well over snow, so snow must be detected (GPP=0 over most snowy conditions)





Chl index from GOME-2 with cloud clearing

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Next Year

- Use FLoX automated sensors to collect high temporal resolution spectral reflectance measurements through the growing season at temperate deciduous and boreal evergreen forest sites
- Extend analysis of DESIS imagery across the NEON sites to examine cross site variability
- Continue machine learning work with GOME-2 data for handling clouds and calculation of GPP at global scales