PACE Terrestrial Products

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Goals

Use PACE OCI to describe terrestrial ecosystem biochemical and functional traits and their dynamics, focusing on foliar pigments and productivity. We are proposing to produce a set of spectral vegetation indices (SVI) from PACE OCI that have been shown to be related to vegetation canopy structure (leaf area index, canopy coverage, fraction of absorbed photosynthetically active radiation), foliar pigments (chlorophyll, carotenoids, anthocyanins), and plant stress responses (xanthophylls).

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 evaluation.

Data Processing

We start with an OCI surface reflectance product (there are 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) to have spatially and temporally consistent observations (again there are existing approaches).

Finally, the surface reflectances must be cloud screened, where there is a particular issue in detecting sub-pixel clouds and cloud shadows (e.g. Chandra et al., 2016).

SVI will be calculated directly from the surface reflectance N-BAR product.

Accuracy Assessment

As an example, one of the important SVI is the Photochemical Reflectance Index (PRI). PRI is a normalized difference ratio of the reflectance from two narrow visible wavelengths typically using bands at 531 nm, the band sensitive to the epoxidation state of the xanthophyll cycle pigments, and a second nearby, non-responsive band used as a reference, commonly at 570 nm. Changes in xanthophyll pigments are related non-photosynthetic quenching (NPQ) and to photosynthetic light use efficiency (LUE) (Grace et al. 2007, Middleton et al. 2011). Our ground measurements of diurnal/seasonal PRI for crops suggests the need for PRI accuracy of <0.01, or about a 1-3% reflectance uncertainty in the visible wavelengths.

Validation

We will use existing measurement activities for validation and q/a of reflectance and SVI products following CEOS Cal/Val activities (<https://calvalportal.ceos.org/calvalsites>)

1. PICS: Pseudo-Invariant Calibration Sites: Time series of observations of these sites for determination of reflectance product stability.
2. Radcalnet provides SI-traceable Top-of-Atmosphere (TOA) spectrally-resolved reflectances with 10 nm spectral sampling from 380 nm to 2500 nm for several pseudo-invariant sites with automated ground instrumentation to compare with PACE reflectances (see Miura et al. 2021 for an example of using these data to validate SVI)
3. The National Ecological Observatory Network (NEON) operates 45 flux tower sites covering the different bioregions within the United States. The NEON Airborne Observing Platform, which carries an AVIRIS NG imaging spectrometer, flies approximately 20 of these sites every summer near seasonal peak greenness for the site. In addition, AERONET (aerosol and water vapor parameters) and ground measured foliar chemistry measurements are also collected at these sites. AVIRIS reflectances can be averaged to PACE pixel size for comparison with PACE products to examine product variability across vegetated sites. (see Shabanov et al. 2015 for an example).

References

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