B42A-04: Detection of Extreme Climate Event Impacts to Terrestrial Productivity From Airborne Hyperspectral Imagery

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Integrating Remote Sensing Observations and Eddy Covariance I
GPP = Gross Primary Productivity

UMT NTSG
Moral: Spectral resolution matters

• Pretty pictures are great, but how can we use these observations to inform us about GPP response to drought?
  – We’ve had a paradigm that works at large spatial scales, but no so much at picking up variation in regions or over time, limiting our ability to detect extreme climate impacts

• Turns out, we can’t capture drought sensitivity with current broadband satellite sensors
  – Hyperspectral sensors can, and therefore we should focus on spectral resolution and algorithms over spatial resolution enhancement
Spectroscopic Measurements for Ecosystem Measurement

20th Century Multi-Spectral Measurements

21st Century Spectroscopic Measurement

Multi-spectral imaging: insufficient to derive some important terrestrial parameters

Full range imaging spectroscopy: composition, chemistry, health and change of ecosystems.

c/o Rob Green, NASA JPL
Seeing trees for the forest:
Broadband sees mostly the big picture

Heinsch et al., 2006
Stress is in the details

Courtesy of A. Singh
Flux towers show a variety of responses of GPP to drought

Wolf et al., in review
California is a good place to study climate extremes
Building a better drought-trap

- Eddy covariance flux towers provide anchor points for evaluation of relationships between spectra and photosynthesis parameters or magnitude.
  - Tower PIs shared carbon, water, and energy fluxes for region across elevation, precipitation, and land cover gradients during drought period

- Applied single flux partitioning (Desai-Cook model) and flux footprint (Kljun) model for 20 towers to extract Gross Primary Productivity estimates during exact time of HyspIRI overflights.
  - GPP compared to footprint weighted spectra and 2-band indices
  - Total 104 tower footprint spectra extracted
Band ratios across all sites reveal strong correlations across a number of broad and narrow features.
BUT: When looking for variation within a single biome or region, broadband falls apart. Instead, no-ce small areas of high correlation along the diagonal line – narrowband features.
PLSR uses multiple bands to better capture both intra- and inter-site variation in GPP across time and space during drought.
Main points

• Narrowband features detect response of plants to extreme climate stress that broadband cannot
• Satellites now being considered – need for mechanistic algorithm development
• Where are we going from here:
  – Mapping photosynthesis parameters and inverting ecosystem models radiative transfer
  – Paper (Dubois, Desai et al) on this project to be submitted soon
Future Missions: HyspIRI

Tech Specs:
60m pixel size
128x128km footprint (Landsat-like)
VSWIR: 380 – 2500nm
TIR: 3 – 12 μm
Bandwidth: 10nm
Revisit: 5/19 days
Drought is going to be a common climate extreme

Schwalm et al., 2012, Nature Geosci.
Also see:

GC22D-06 HyspIRI Measurements of Agricultural Systems in California: 2013-2015 (TOWNSEND)
  TUE 1135 MW 3014

B53B-0544 Linking vegetation structure, function and physiology through spectroscopic remote sensing (SERBIN)
  FRI 1340 MS Posters

B54D-01 Mapping Variation in Vegetation Functioning with Imaging Spectroscopy (TOWNSEND)
  FRI 1600 MW 2006

B53D-0594 Applications of spectral inversion to understanding vegetation functional trait relationships (SHIKLOMANOV)
  FRI 1340 MS Poster

Thank you!
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