What Unique HyspIRI Products Relevant to Climate Change Science can be Produced at the Global Scale?

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Workshop on Climate Modeling and HyspIRI Global Science Products
Future Workshop on global HyspIRI Products

Plan to hold workshop near end of year at Carnegie Institution at Stanford with modeling community

Sponsored by: Mike Freilich, NASA HQ, Decadal Survey
Hosted by: Chris Field and Susan Ustin

Goal: White Paper on Global Products Relevant for Climate Research Ecosystem and Climate Modeling Communities

Request for HyspIRI Community Input:

Send ideas, papers, comments to me by email: slustin@ucdavis.edu
We must get HyspIRI products incorporated into the next generation Ecosystem Models.
Many Possible HyspIRI Indexes:

PVI Index tracks Carbon and Water Fluxes

An operational PRI product could improve ecosystem carbon flux estimates, capturing physiological change under disturbance, stress, and changing vegetation composition.
Combined VNIR-SWIR
Physiological/Thermal Stress Indicators:
Unique HyspIRI Measurements

Scaled EVI*LST compared to carbon uptake from flux towers.

Improved estimates of carbon uptake using PRI established using flux data and AVIRIS

MODIS estimates of carbon uptake improved using LST, vegetation index and 60m pixels (from Sims et al., 2008)
Develop Robust Algorithms to Quantitatively Predict Photosynthetic Processes: Spectroscopy Provides Quantitative Measurements of Optical Properties

PLSR waveband selection

PLSR waveband selection and the state of knowledge

Nmass = nitrogen concentration
Marea = mass area$^{-1}$
Vcmax = Assimilation limit by Rubisco
Jmax = Assimilation limit by e$^{-}$ transport

Continuing large uncertainty in flux of CO$_2$ due to land use change.
Global Monitoring of Physiological Processes using HyspIRI Thermal-based Flux Mapping

![Graph showing LUE as a function of Cab](image)

- **LUE** = f(Cab) (this study)
- Landcover specific asymptotes

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**Surfacer Temperature**

**Evapotranspiration**

**ALEXI (GOES Sounder)**

**ALEXI (GOES Imager)**

**DisALEXI (MODIS)**

**DisALEXI (Landsat)**

**DisALEXI (USU aircraft)**

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USDA Beltsville
Identifying Disruption of the Carbon, Water, and Nitrogen Cycles

Carbon budgets are sensitive to:
1. Land cover characteristics
2. Disturbance period & Successional stages
3. Species composition
4. Land use history/management
5. Variable weather & climate
6. Nutrient status, LAI

Figure from S.V. Ollinger and M.L. Smith, (2005)
What HysPIRI products can be produced routinely at the global scale? Relevant for Climate Research? Identified as Climate Relevant?

- Plant Functional Types
- Spectral Endmember Composition & Changes in Endmembers over time
- All commonly used spectral indexes (>50 for plants, soil, snow, etc.)
- Types of disturbance, frequency & land use change
- Quantify snow/water partitioning & extent
Vegetation Mapping at local scales is well established.

Can HyspIRI improve global vegetation maps? Can we demonstrate or develop a path to do this?
Changing Land Cover Causes Major Uncertainty in Carbon Budgets:
HyspIRI can Monitor and Quantify Land Use Change and Changing Disturbance Regimes

Increased Wildfire Frequency and Extent will lead to net increased CO$_2$ emissions

**Sub-Pixel Fire Fraction**

**Sub-Pixel Fire Temperature**

AVIRIS 2003
Dennison et al. 2006
Radiative and Hydrologic Forcing in Snow
Can we develop robust estimates of dust concentration on snow?

Societal Applications: Monitoring Global Environmental Disasters and Conditions

**SWIR** - thermal vent visible

**VIS** - plumes coating everything to the South-East making the ice brown/gray

TIR imager will make daily passes at latitude of Iceland

Imaging of Eyjafjallajökull Volcano Eruption 17 April 2010
Responding to Environmental Disasters: Deepwater Oil Spill

AVIRIS Oil Flight 100506r17

- Oil on Water
- Burning Oil
- Oil on Water Surface

Spectra from locations (A,B,C) Note: Strong Infrared Signal

AVIRIS Spectra 400 to 2500 nm
Decadal Survey: HyspIRI Recommendation, by Ecosystem, Climate and Land Use Change Panels

“A hyperspectral sensor combined with a multispectral thermal sensor in low Earth orbit is part of an integrated mission concept that is relevant to several panels, especially the climate variability panel.” p. 368.

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer
Multispectral Thermal InfraRed (TIR) Scanner
Spectral Bands Identified As Useful by Discipline

All Bands Seem Relevant to Some Discipline: Can we prioritize development of global climate relevant products?