



Overview of the HyspIRI Mission

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Technology.

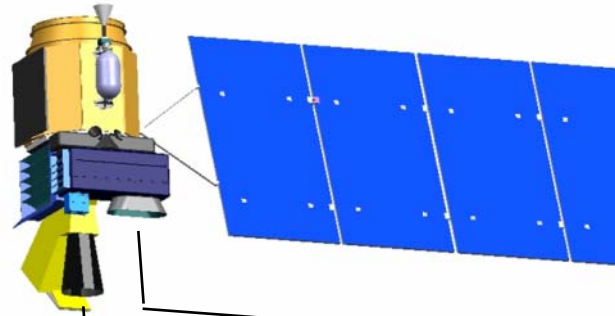
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NRC Decadal Survey HypsIRI



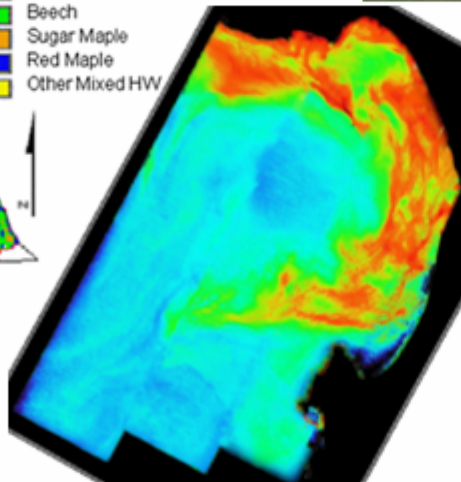
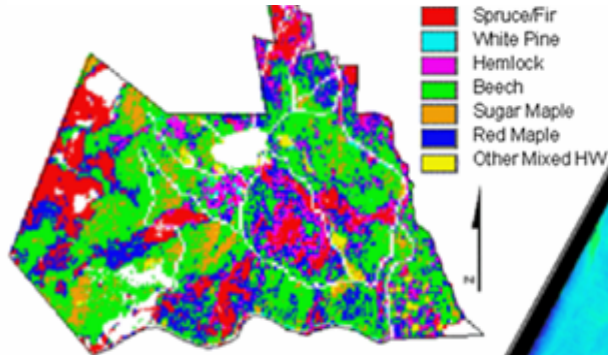
Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer
Multispectral Thermal InfraRed (TIR) Scanner



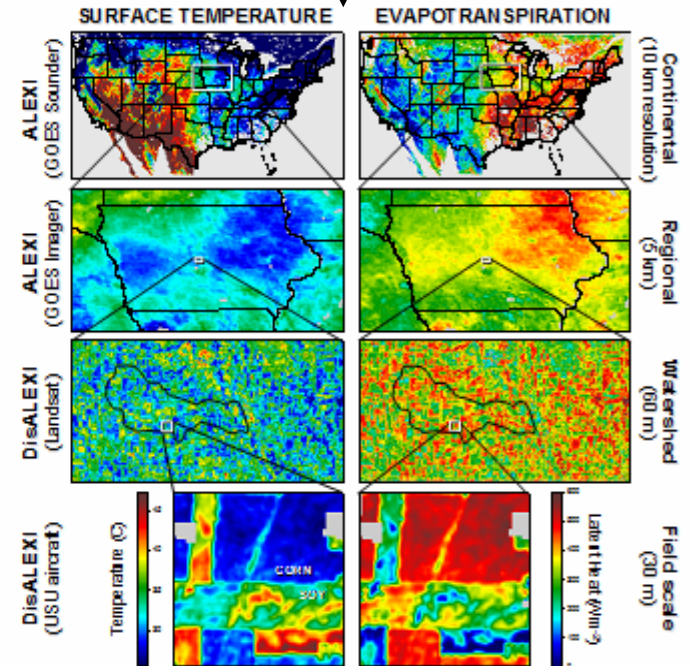
VSWIR: Plant Physiology and
Function Types (PPFT)

Multispectral
TIR Scanner

Map of dominant tree species, Bartlett Forest, NH

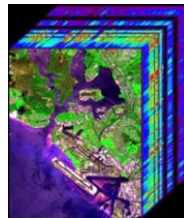
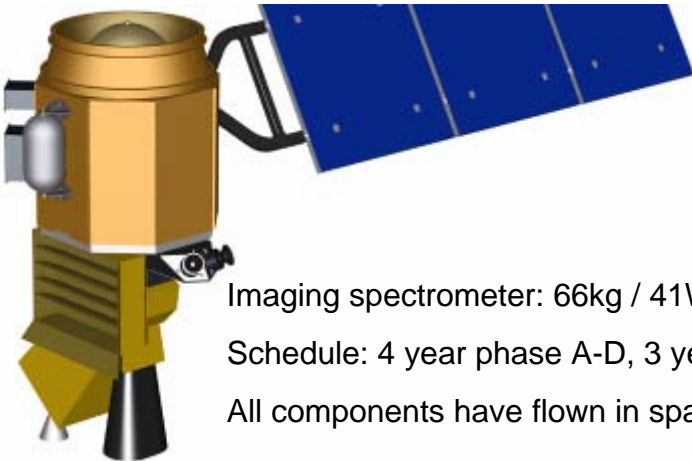


Red tide algal bloom in Monterey Bay, CA





HyspIRI Imaging Spectroscopy Science Measurements



Imaging spectrometer: 66kg / 41W

Schedule: 4 year phase A-D, 3 years operations

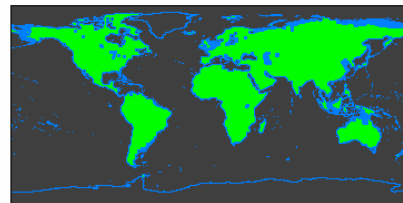
All components have flown in space

Science Questions:

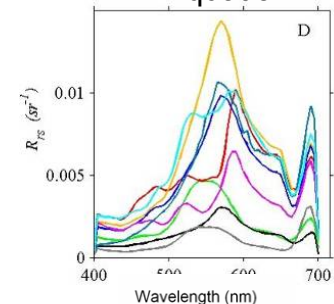
- *What is the composition, function, and health of land and water ecosystems?*
- *How are these ecosystems being altered by human activities and natural causes?*
- *How do these changes affect fundamental ecosystem processes upon which life on Earth depends?*

Measurement:

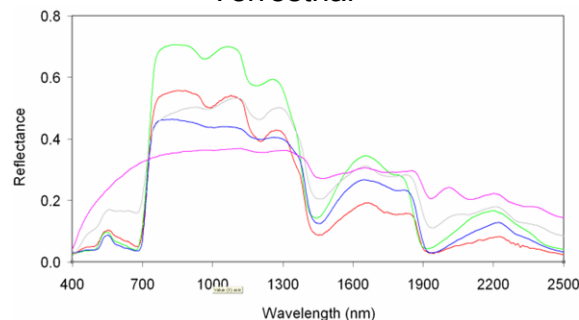
- 380 to 2500 nm in 10nm channels
- Accurate 60 m sampling
- 19 days revisit mapping mission
- Global land and shallow water



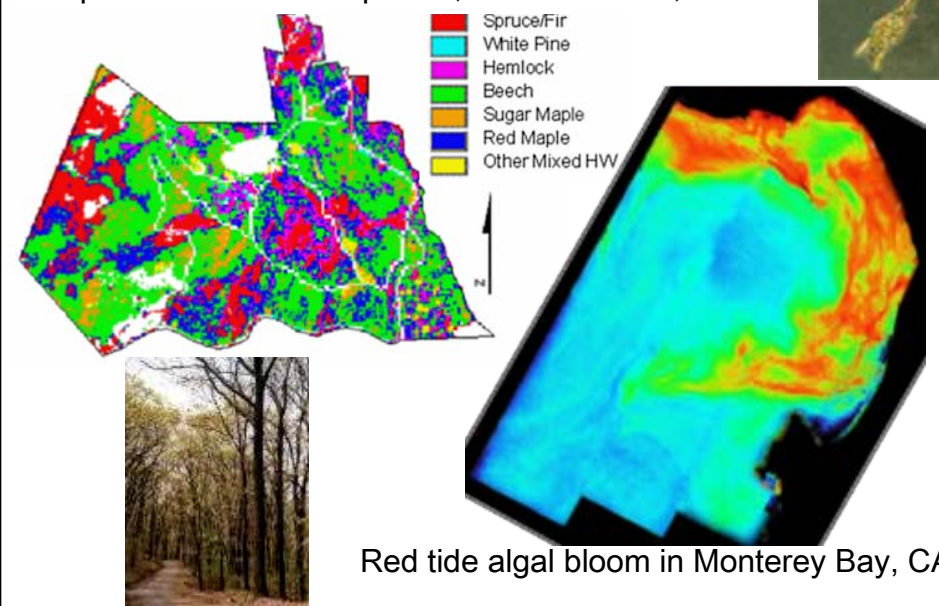
Aquatic



Terrestrial



Map of dominant tree species, Bartlett Forest, NH



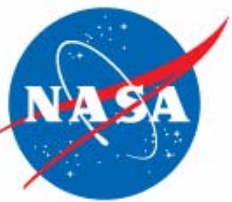
Red tide algal bloom in Monterey Bay, CA



VSWIR Overarching Science Questions



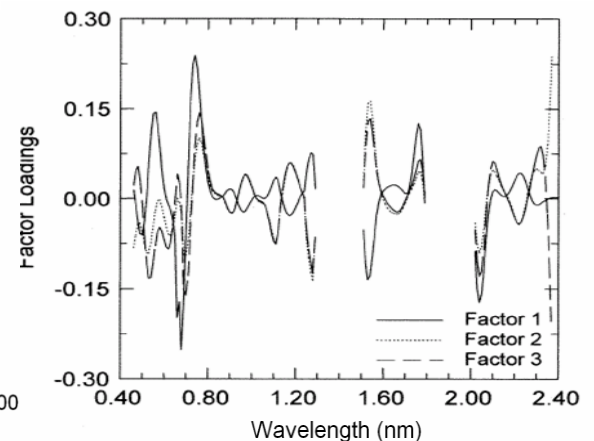
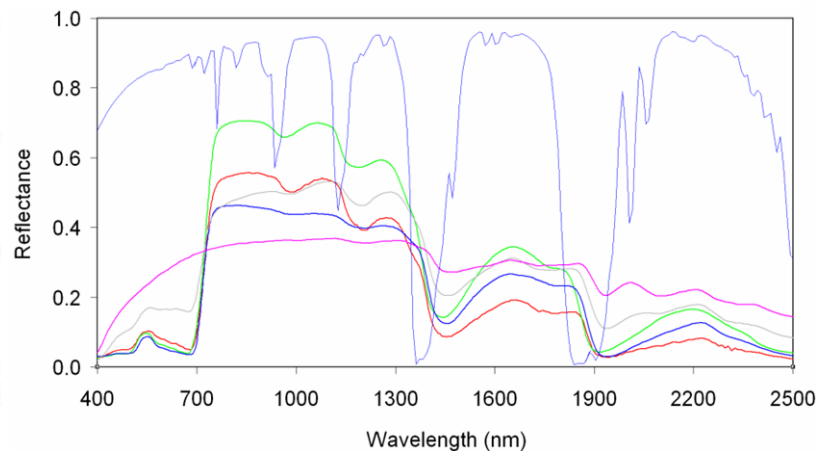
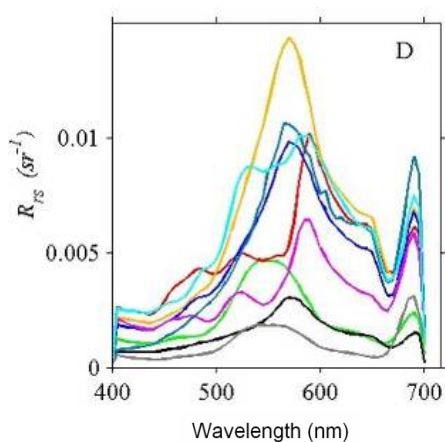
- **VQ1. Pattern and Spatial Distribution of Ecosystems and their Components, (EM,JG)**
 - What is the pattern of ecosystem distribution and how do ecosystems differ in their composition or biodiversity? [DS 195]
- **VQ2. Ecosystem Function, Physiology and Seasonal Activity, (EM,JG)**
 - What are the seasonal expressions and cycles for terrestrial and aquatic ecosystems, functional groups and diagnostic species? How are these being altered by changes in climate, land use, and disturbances? [DS 191, 195, 203]
- **VQ3. Biogeochemical Cycles (SO, SU)**
 - How are biogeochemical cycles for carbon, water and nutrients being altered by natural and human-induced environmental changes?
- **VQ4. Changes in Disturbance Activity (RK,GA)**
 - How are disturbance regimes changing and how do these changes affect the ecosystem processes that support life on Earth?
- **VQ5. Ecosystem and Human Health, (PT,GG)**
 - How do changes in ecosystem composition and function affect human health, resource use, and resource management?
- **VQ6. Land Surface and Shallow Water Substrate Composition (RG, HD)**
 - What is the land surface soil/rock and shallow water substrate composition?



Basis for Continuous Spectral Measurement

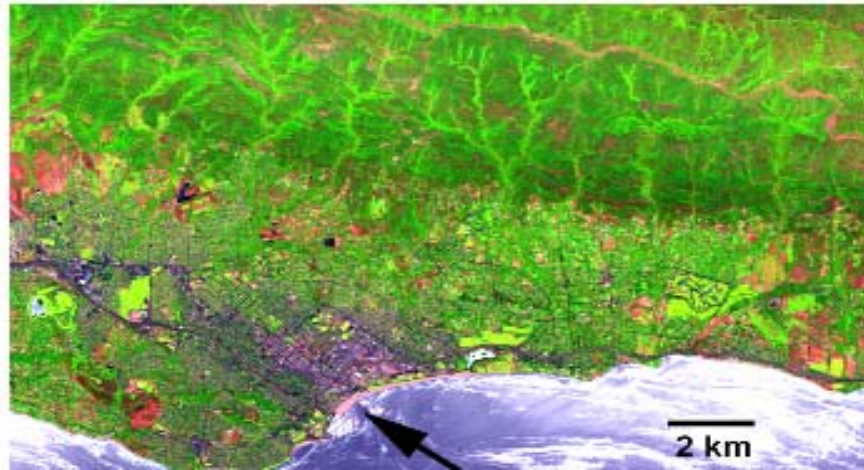


- Plant and phytoplankton functional types and species have biochemical and biophysical properties that are expressed as reflectance and absorption features spanning the spectral region from 380 to 2500 nm.
- Individual bands do not capture the diversity of biochemical and biophysical signatures of plant functional types or species.
- Changes in the chemical and physical configuration of ecosystems are often expressed as changes in the contiguous spectral signatures that relate directly to plant functional types, vegetation health, and species distribution.
- Other constituents of the Earth system (Minerals, Soils, Snow, etc) have spectral characteristics allow use of this spectroscopic measurement approach for corresponding science questions.
- Important atmospheric correction information and calibration feedback is contained within the spectral measurement.

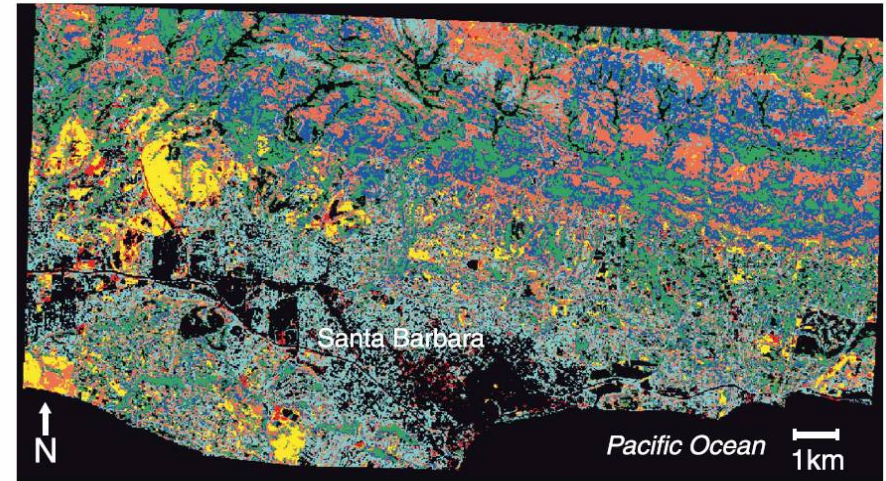


Vegetation Functional Type Analysis, Santa Barbara, CA

Dar Roberts, et al, UCSB



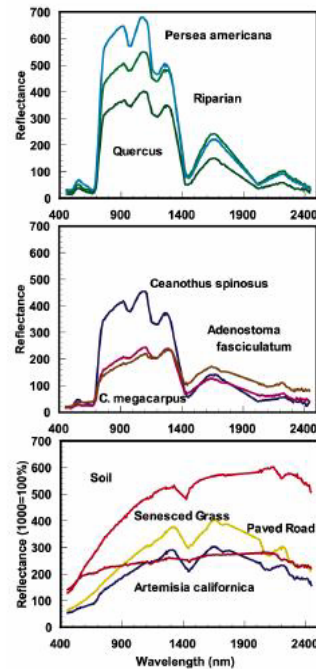
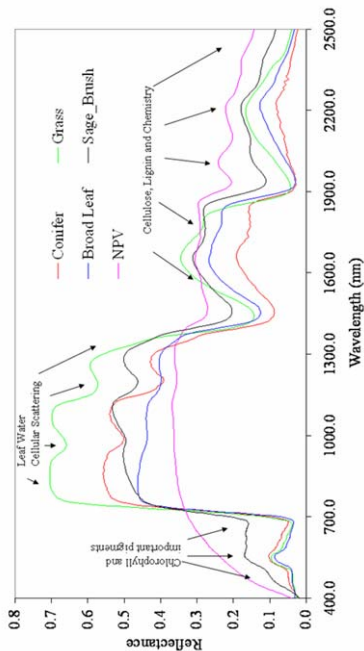
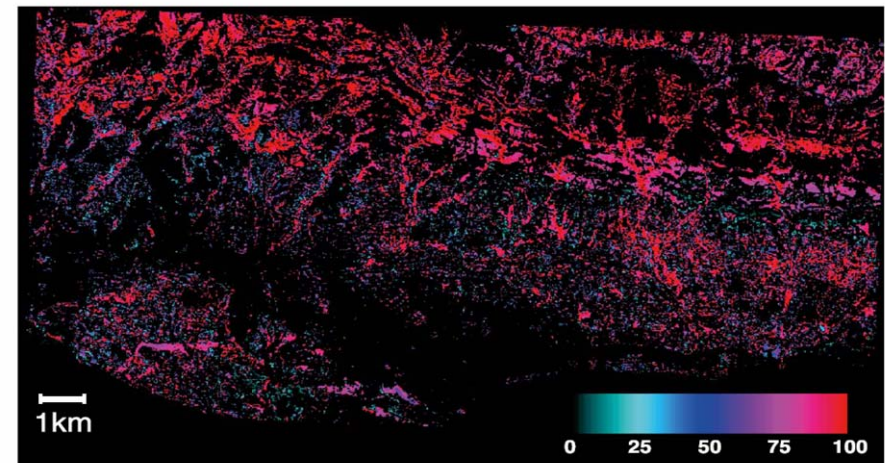
MESMA Species Type 90% accurate



■ *Adenostoma fasciculatum*
■ *Ceanothus megacarpus*
■ *Arctostaphylos* spp.

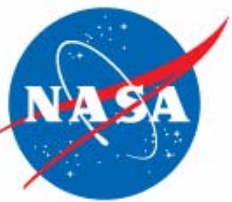
■ *Quercus agrifolia*
■ Grass
■ Soil

Species Fractional Cover



Dennison, P.E., and Roberts, D.A., 2003 Endmember Selection for Multiple Endmember Spectral Mixture Analysis using Endmember Average RSME, *Remote Sens. Environ*, 87(2-3), 123-135.

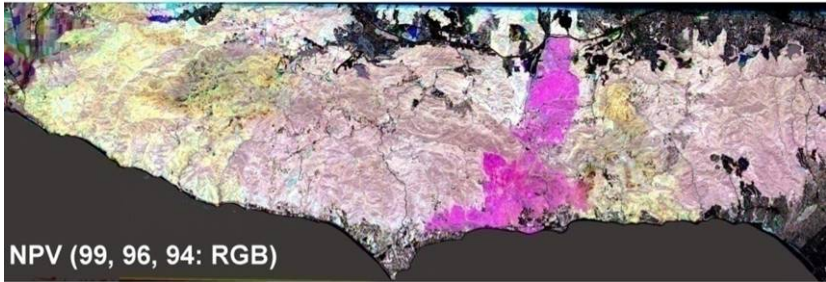
Roberts, D.A., Dennison, P., Ustin, S.L., Reith, E., and Morais, M., 1999, Development of a Regionally Specific Library for the Santa Monica Mountains using High Resolution AVIRIS Data, Proc. 8th AVIRIS Earth Science Workshop, JPL, Pasadena, CA 349-354., Feb 8-11, 1999.



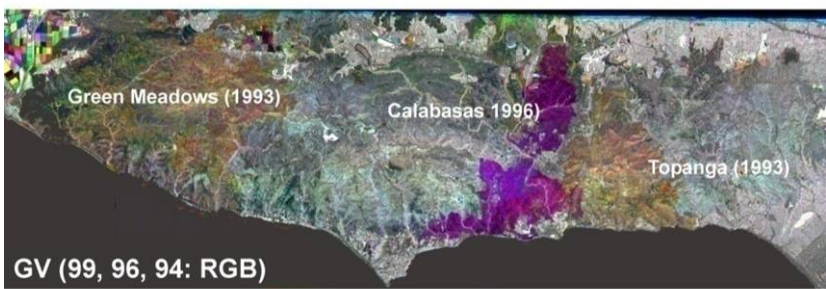
Response to Disturbance



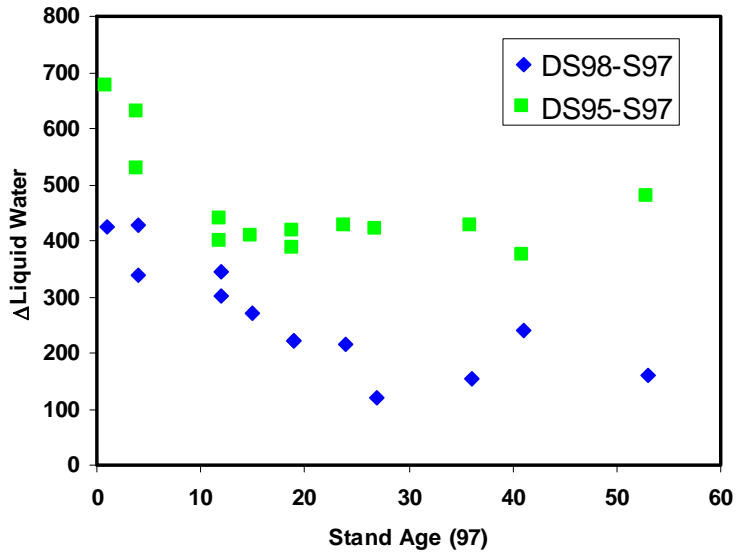
Non
photosynthetic
Vegetation



Green
vegetation



Canopy
Liquid Water



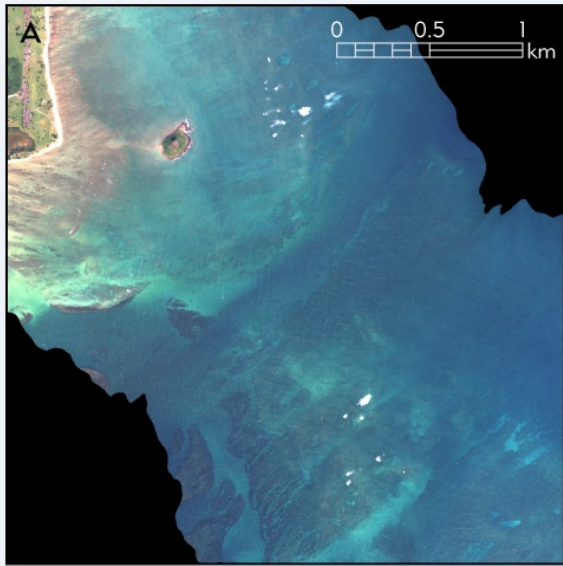
Post-fire response to three different fires, two in 1993 and one in 1996. Canopy moisture is the most sensitive measure of change, as shown by overlap between the 1996 and 1993 Calabajas and Topanga fires. High fire return intervals in Southern California are impacting ecosystems, eliminating some shrub species.

Interannual changes in canopy moisture show significant stand age differences up to 30 years (shown as the difference in canopy moisture between spring98 and spring 97 –blue, and spring97 and spring 95 - green). These results indicate that seasonal drought response is age dependent in shrublands, with older stands less impacted by drought. These results require seasonal imaging spectroscopy observations.

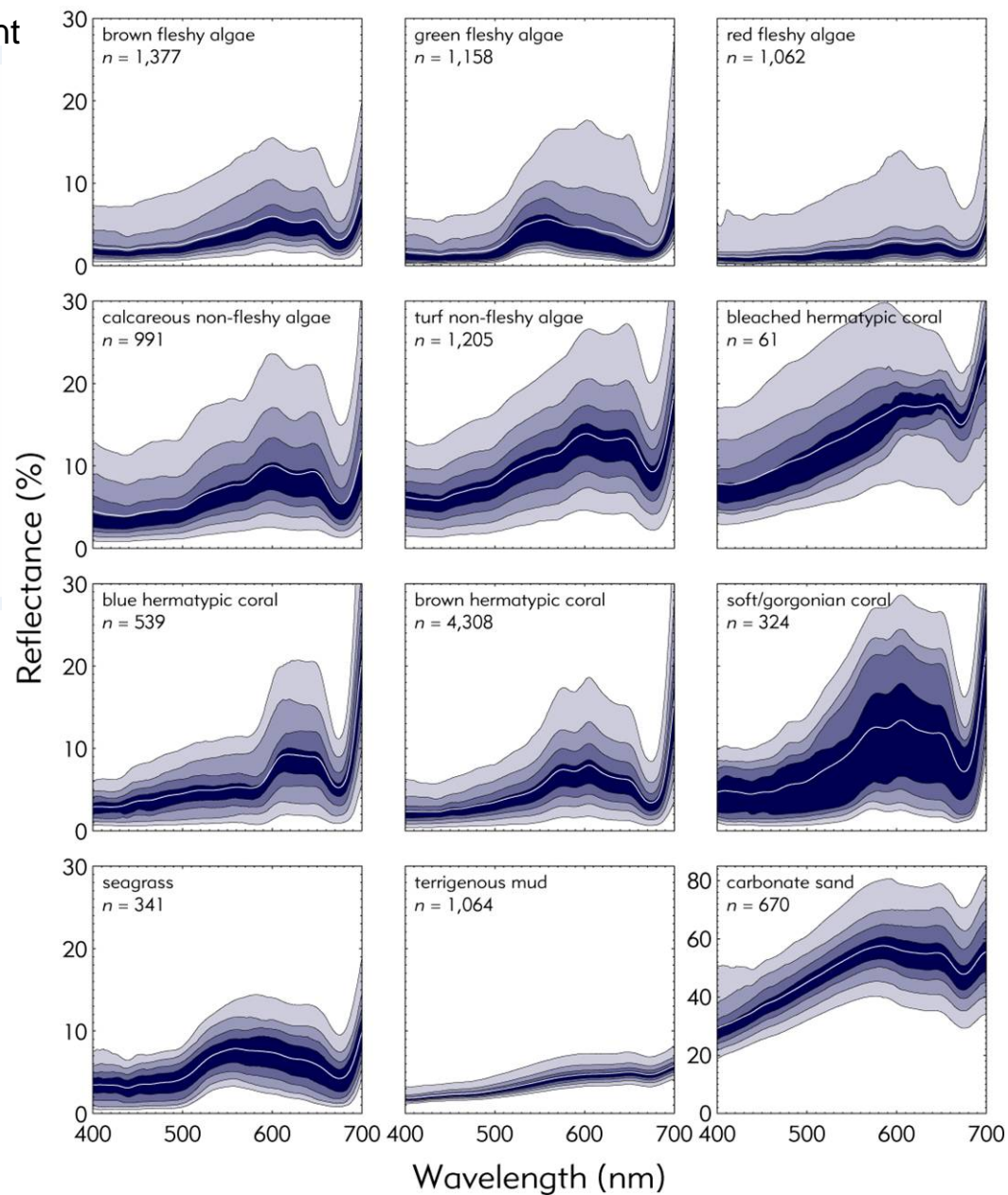
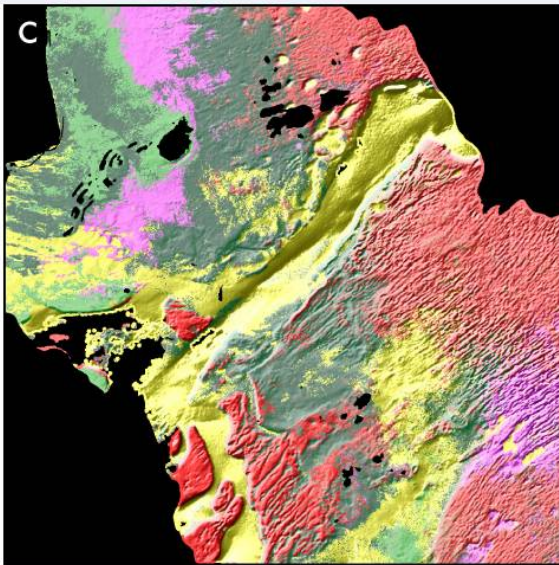
Roberts D.A., 2000, Remotely Sensed Analysis of Successional Patterns following Wildfire in the Santa Monica Mountains, presented at the First Center for Environmental Analysis (CEA-CREST) symposium, Pasadena, CA, May 19, 2000.



Imaging Spectrometer Measurement



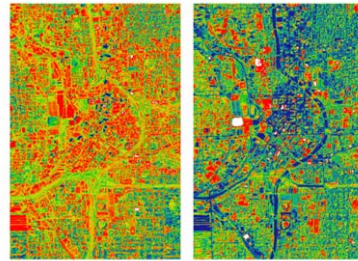
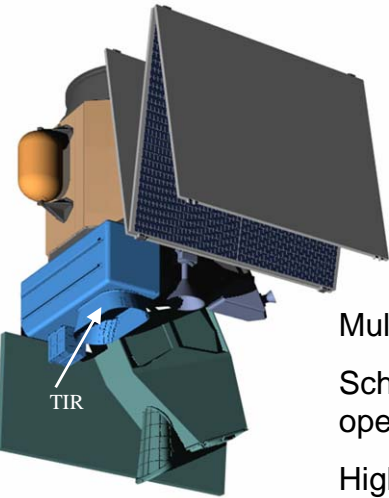
Benthic Compositional Mapping



Spectral Measurements of Shallow Water Benthic Composition (E. Hochberg, Nova Southeastern University, FL)



HyspIRI Thermal Infrared Multispectral (TIR) Science Measurements



Temperature
Albedo
Atlanta, GA - May 1997

Multispectral Scanner

Schedule: 4 year phase A-D, 3 years operations

High Heritage

Science Questions:

TQ1. Volcanoes/Earthquakes (MA,FF)

– How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?

• TQ2. Wildfires (LG,DR)

– What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?

• TQ3. Water Use and Availability, (MA,RA)

– How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?

• TQ4. Urbanization/Human Health, (DQ,GG)

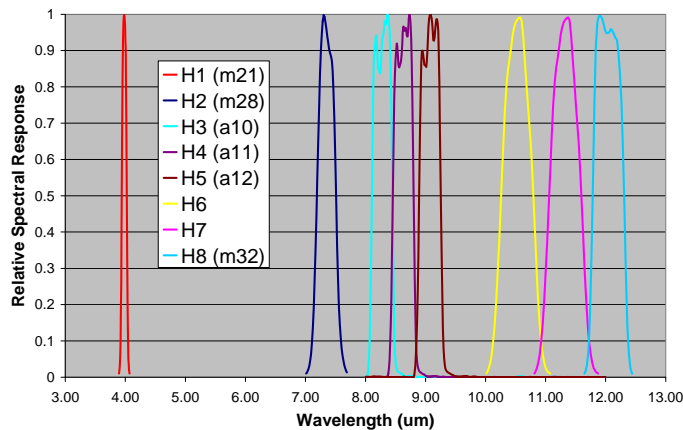
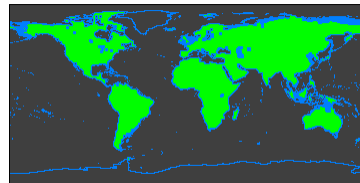
– How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?

• TQ5. Earth surface composition and change, (AP,JC)

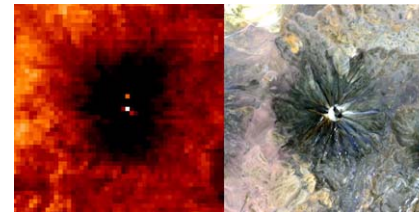
– What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

Measurement:

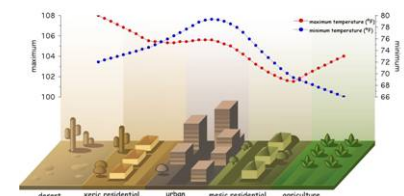
- 7 bands between 7.5-12 μm and 1 band at 4 μm
- 60 m resolution, 5 days revisit
- Global land and shallow water



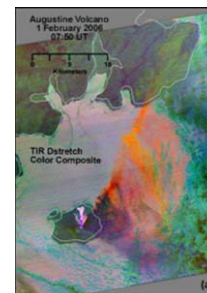
Andean volcano heats up



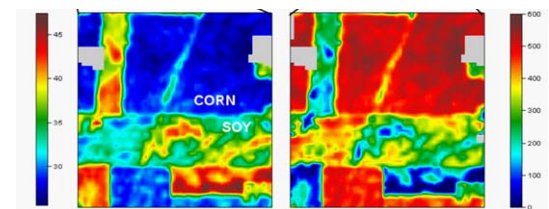
Urbanization



Volcanoes



Water Use and Availability



Surface
Temperature

Evapotranspiration



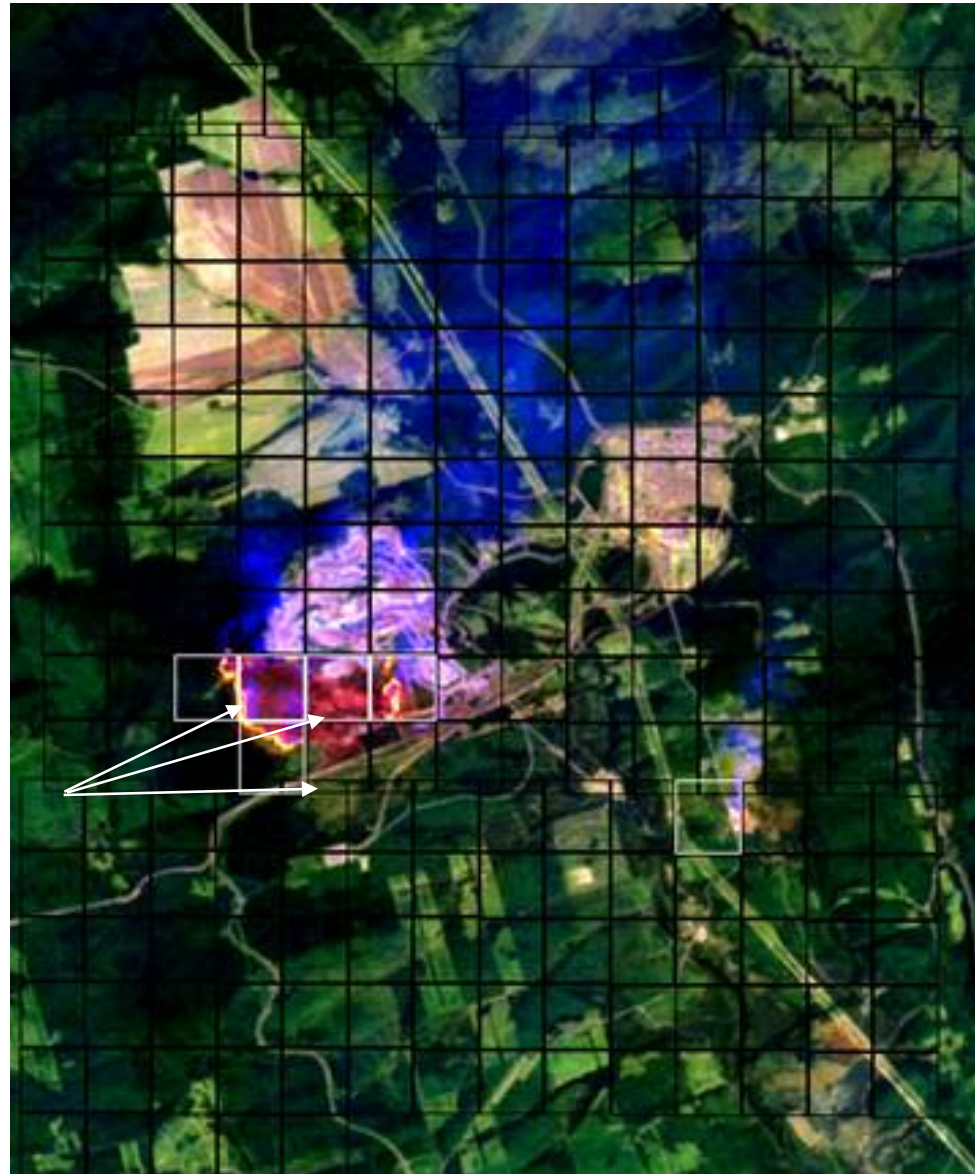
Wildfires:

How are global fire regimes changing?



High resolution thermal instrument can distinguish between the forest and non-forest parts of the flaming front allowing the fire type, intensity, etc., to be determined which indicates fire regime.

White squares show fire pixels detected by MODIS. Insufficient information to detect fire type

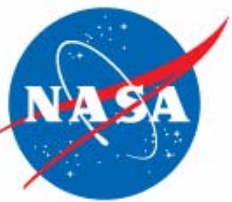


30 m ASTER scene with MODIS pixels superimposed (black squares)

Central Siberia
30 May 2001

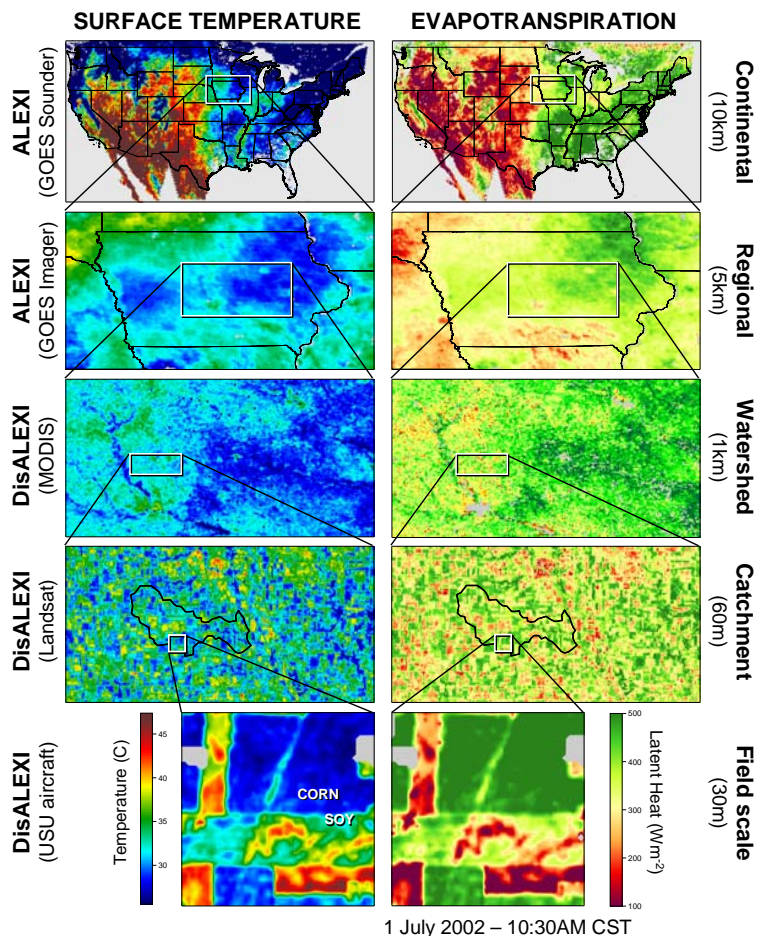
HyspIRI will provide high spatial resolution mid to thermal infrared data for determining the fire regime and allowing flux estimation on a weekly basis

MIR band provides radiant flux to estimate rate at which biomass combusted and instantaneous emission estimate



TQ3a: How is climate variability impacting the evaporative component of the global water cycle over natural and managed landscapes?

(DS 166, 196, 203, 257, 368; WGA)



Multi-scale ET maps for 1 July 2002 produced using surface temperature data from aircraft (30-m resolution), Landsat-7 ETM+ (60-m), Terra MODIS (1-km), and GOES Imager (5-km) instruments (Anderson and Kustas (2008), Eos, 89, 233-234)

Science Issue:

- Based on principles of surface energy balance, the land-surface temperature signal conveys valuable information about the evaporative component of the hydrologic cycle and its response to varying climatic drivers. If we can accurately monitor this response in relationship to land-use and land-cover conditions, we will improve our ability to forecast water consumption and demand and to develop effective climate adaptation strategies for our water systems.

Tools:

- HyspIRI TIR observations of surface brightness temperature at <100m resolution to resolve field-scale land use, preferably with 3+ bands in the 8-12 μ m region for atmospheric and emissivity corrections. The weekly revisit of HyspIRI will improve accuracy of seasonally integrated ET estimates.
- Collocated/contemporaneous maps of vegetation index and landuse.
- Insolation data to estimate net radiation.
- Regional scale ET maps using coarser resolution TIR imagery from geostationary satellites and MODIS/VIIRS provide spatial context for local assessments.

Approach:

- Periodic maps of instantaneous clear-sky ET from a TIR-based surface energy balance algorithm can be interpolated to produce daily ET maps using time-continuous observations of reference ET or available energy from met stations or geostationary satellites.
- Record of daily ET at scales resolving major land use patterns can be analyzed in conjunction with gridded climate data.



Summary



We have developed a sets of science questions that are well aligned with the HypsIRI Mission called for in the NASA Earth Science and Applications Decadal Survey.

We have reviewed and refined these questions that relate to both science and applications objectives and developed traceability to a set of science measurements.

We have established a high heritage and low risk approach for acquiring the HypsIRI VSWIR and TIR science measurements

Upcoming Events

HypsIRI Symposium

May 4-5, Goddard Space Flight Center, Md

HypsIRI Workshop

Aug 24-26, Pasadena, CA