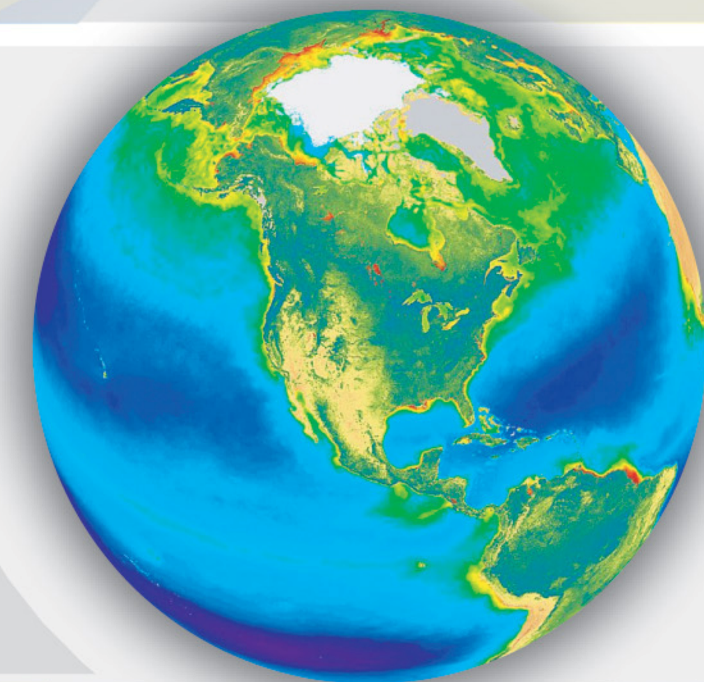
Changes in and Response to Disturbance



Greg Asner ,Carnegie
Bob Knox, GSFC

Overarching question

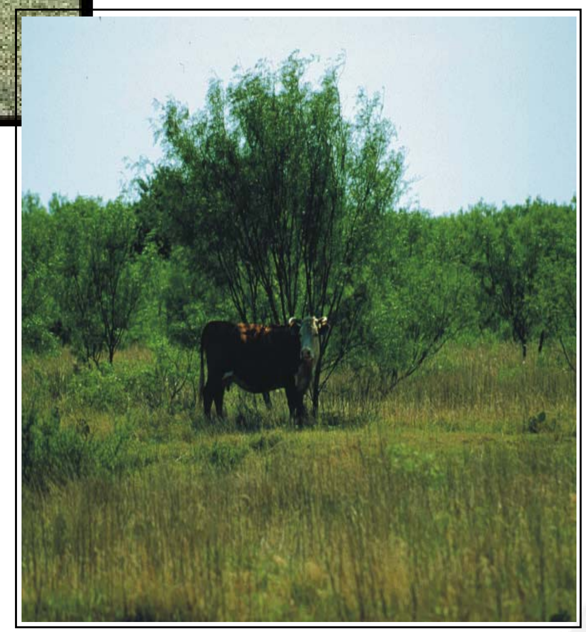
- How are disturbance regimes changing and how do these changes affect the ecosystem processes that support life on Earth?

Notes:

- EOS era identifies major disturbances such as tropical deforestation, and some diffuse disturbances (some logging, some fire, some insect outbreaks)
- But current missions are not specifically resolving the diffuse disturbances with high biophysical, process-oriented fidelity…and…
- We need to step from our current, dominant state: identifying an important process or change (e.g. observe a deforestation or fire event) to …
- …quantifying the ecological effects of the event (e.g. vegetation physiological or biochemical response to forest disturbance).

Chemical and physiological change is central to understanding ecosystem response to disturbance

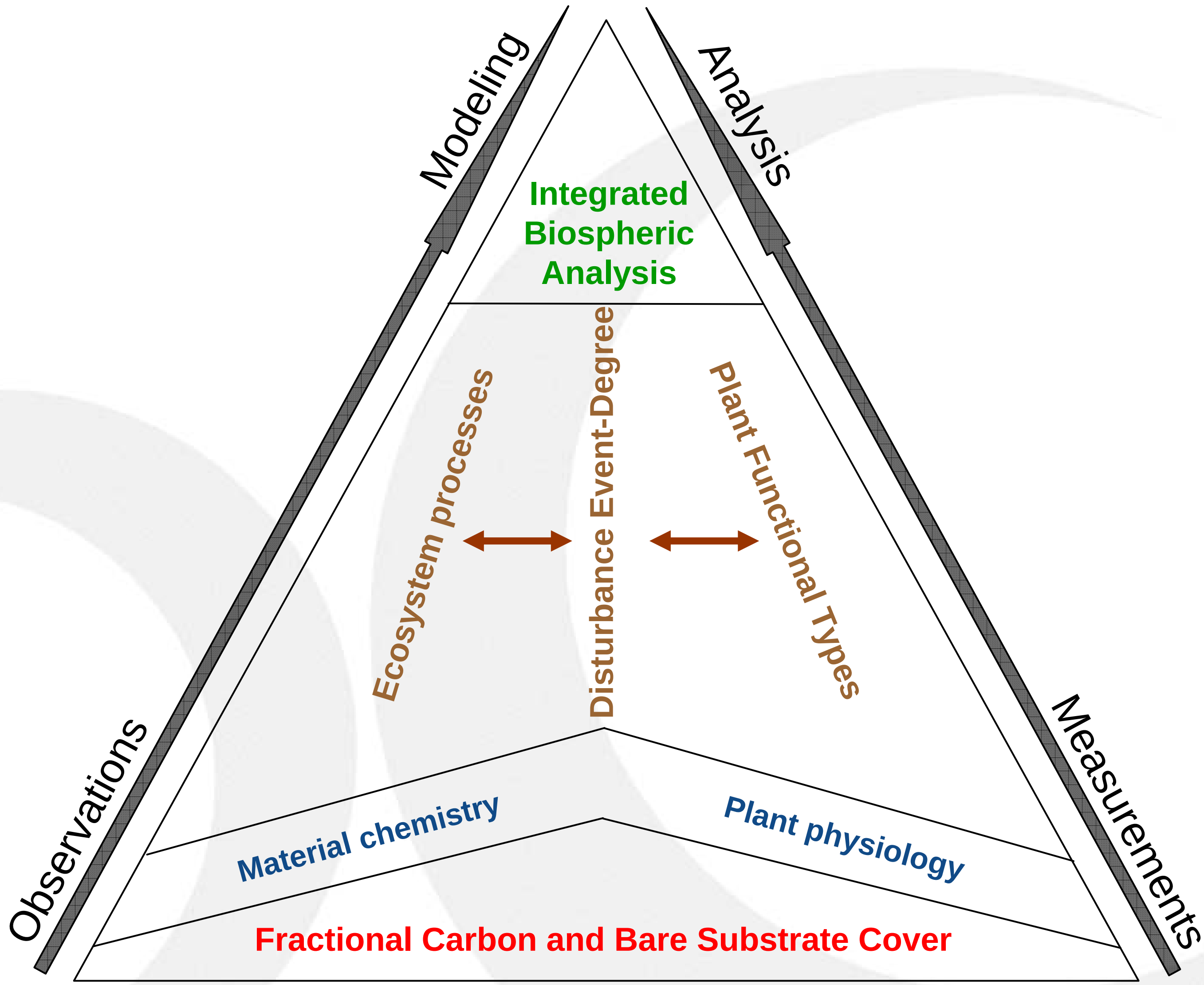
- Canopy stress
- Diffuse ecosystem biophysical change
- Invasive species
- Insect damage
- Fire fuel and fire effects



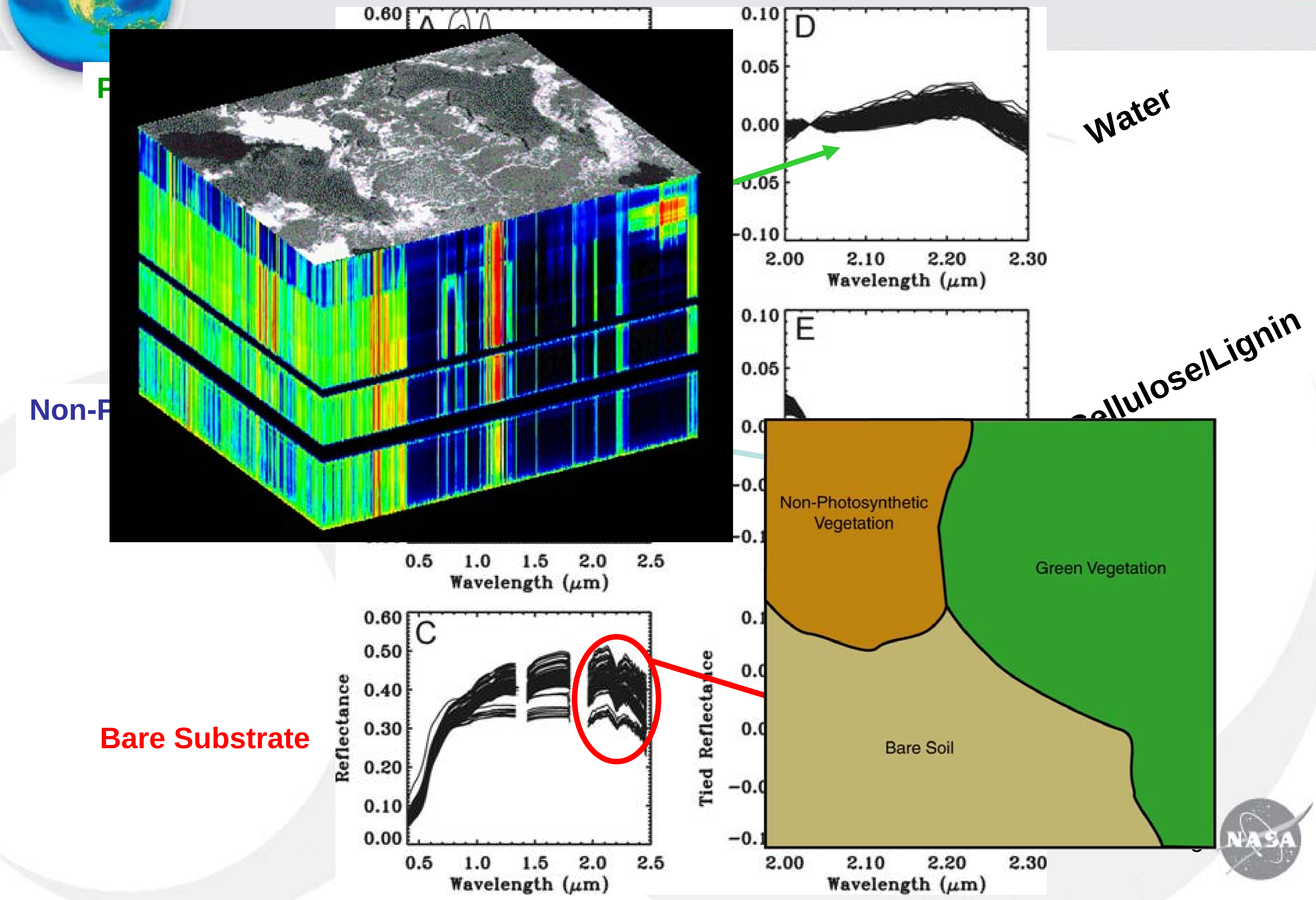
Sub-questions

- How do human-caused and natural disturbances affect the spatial distribution of ecosystems?
- What are the trends in disturbance regimes, compared with previous regional and global observations?
- How do climate changes affect disturbances such as fire and insect damage? [DS 196]
- How do invasive species alter other disturbance regimes?
- How are human-caused and natural disturbances changing the biodiversity composition of ecosystems, e.g.: through changes in the distribution and abundance of organisms, communities, and ecosystems?
- How do climate change, pollution and disturbance augment the vulnerability of ecosystems to invasive species? [DS 114,196]
- What are the effects of disturbances on productivity, water resources, and other ecosystem functions and services? [DS 196]
- How do changes in human uses of ecosystems affect their vulnerability to disturbance and extreme events? [DS 196]

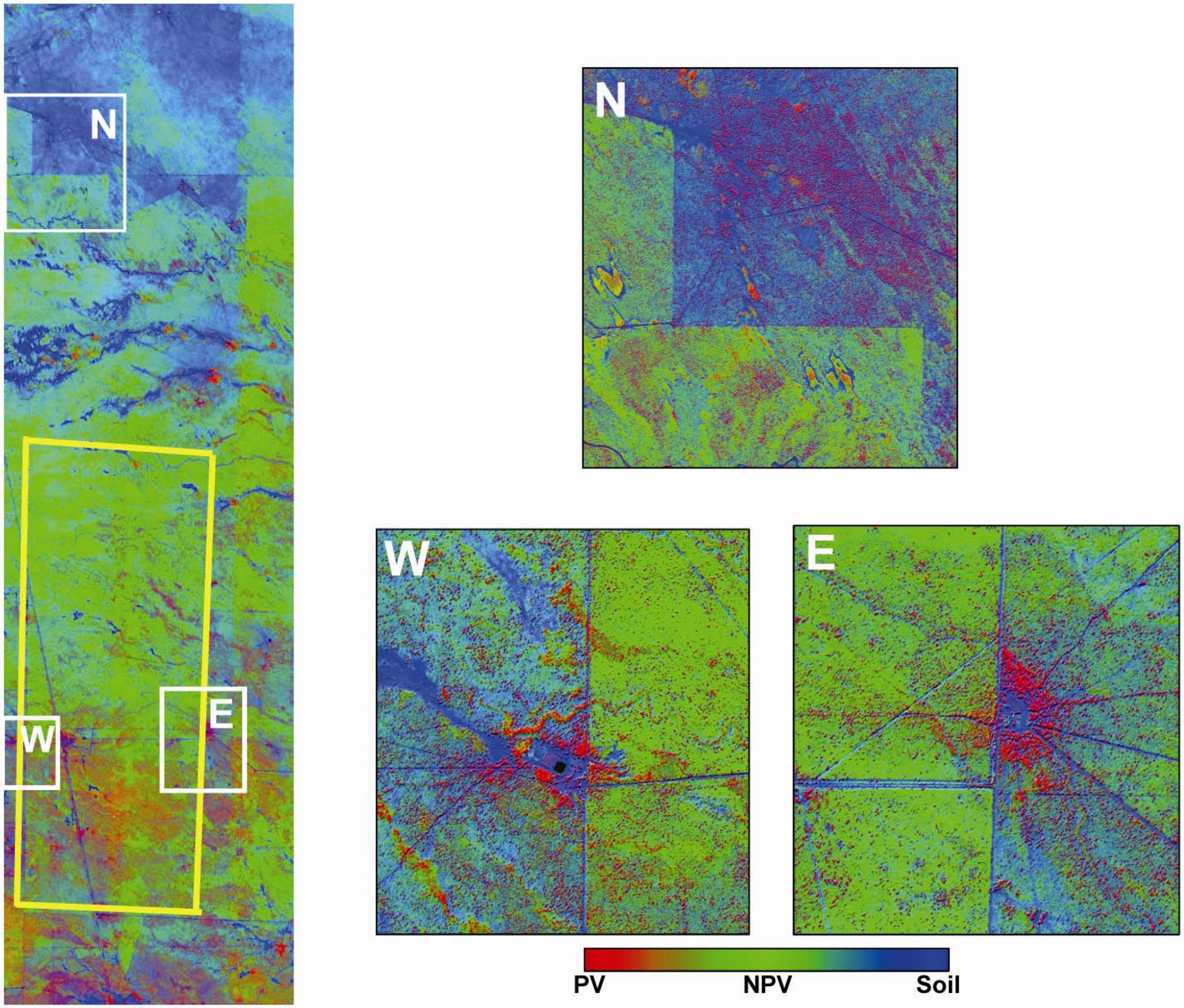
HyspIRI High-fidelity Imaging Spectroscopy



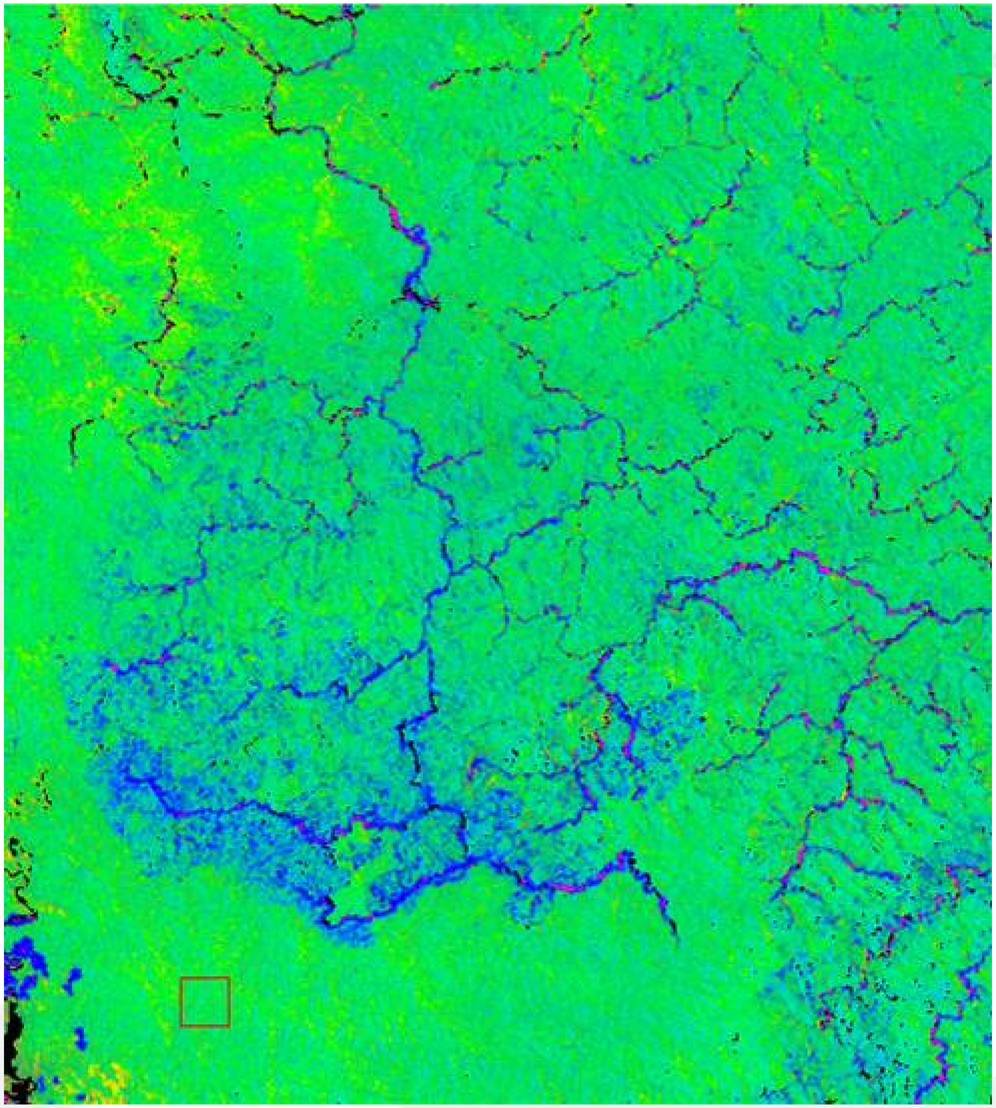
Spectroscopic techniques to detect diffuse disturbance



Rangeland degradation from fractional material cover



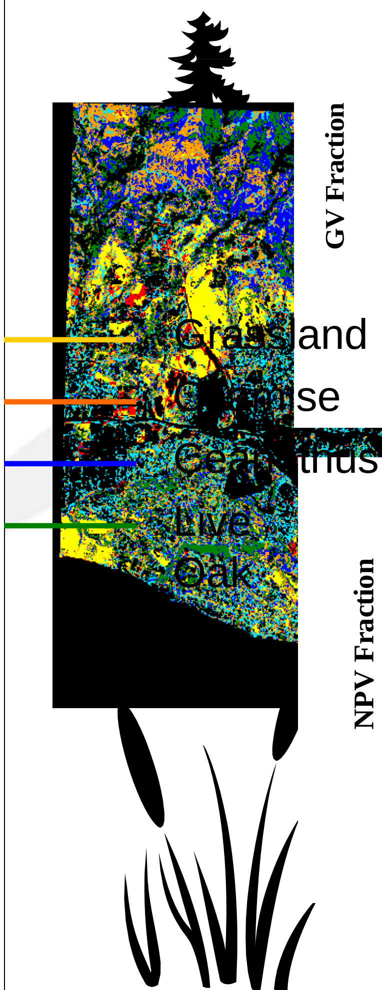
Selective logging with Hyperion

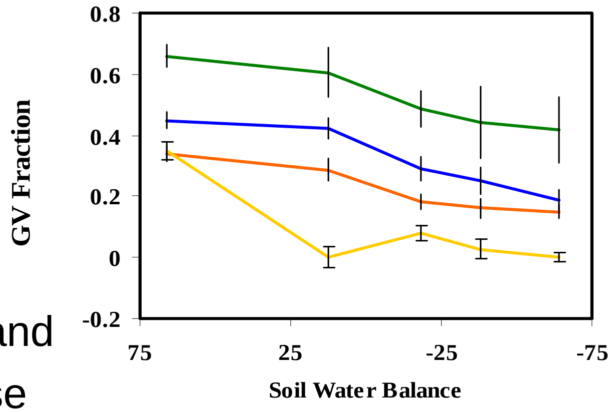


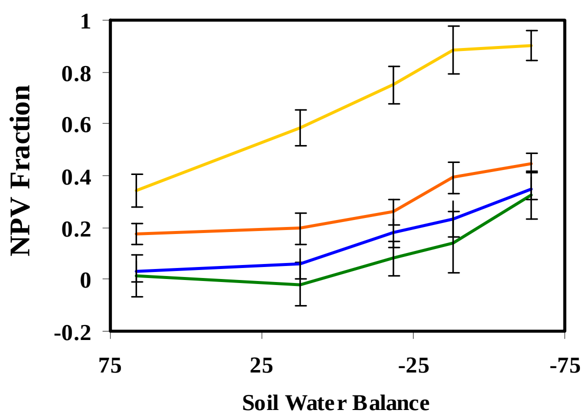
Selective logging: comparing sensor capabilities

Sensor	Spatial Resolution	Number of Optical Channels Used	Geographic Cover (freq., footprint, etc)	% of Forest Damage Classes Missed	Accuracy of Analysis
EO-1 Hyperion	30 m	180	Low	Lowest 5%	>90%
	Low geographic coverage				
EO-1 ALI	30 m	6	Low	Lower 20%	>80%
	Low spectral resolution				
Landsat 7 ETM+	30 m	9	Medium	Lower 20%	>70%
	Low coverage, low spectral resolution				
SPOT MSS	20 m	3	Low	Lower 50%	60-70%
	Low spectral resolution, low coverage				
MISR	1000 m	4 (multi-angle)	Medium-high	Lower 80%	20-25%
	Low spatial resolution, low spectral resolution				
MODIS	1000 m	7	High	Lower 80%	20-25%
	Low spatial resolution, low spectral resolution				

Plant types, fractional cover and susceptibility to disturbance

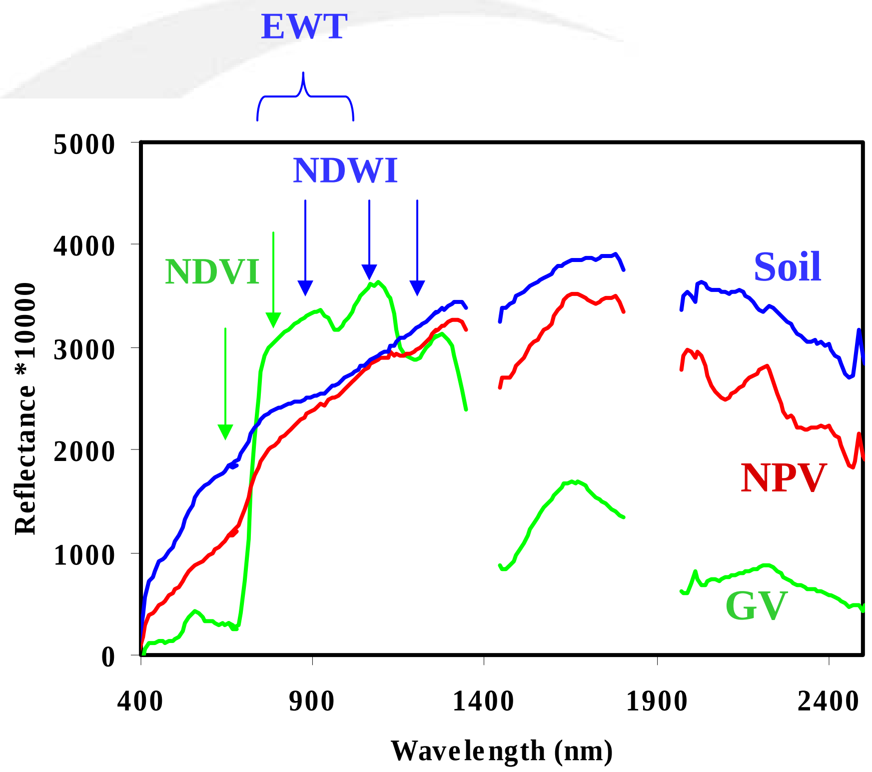






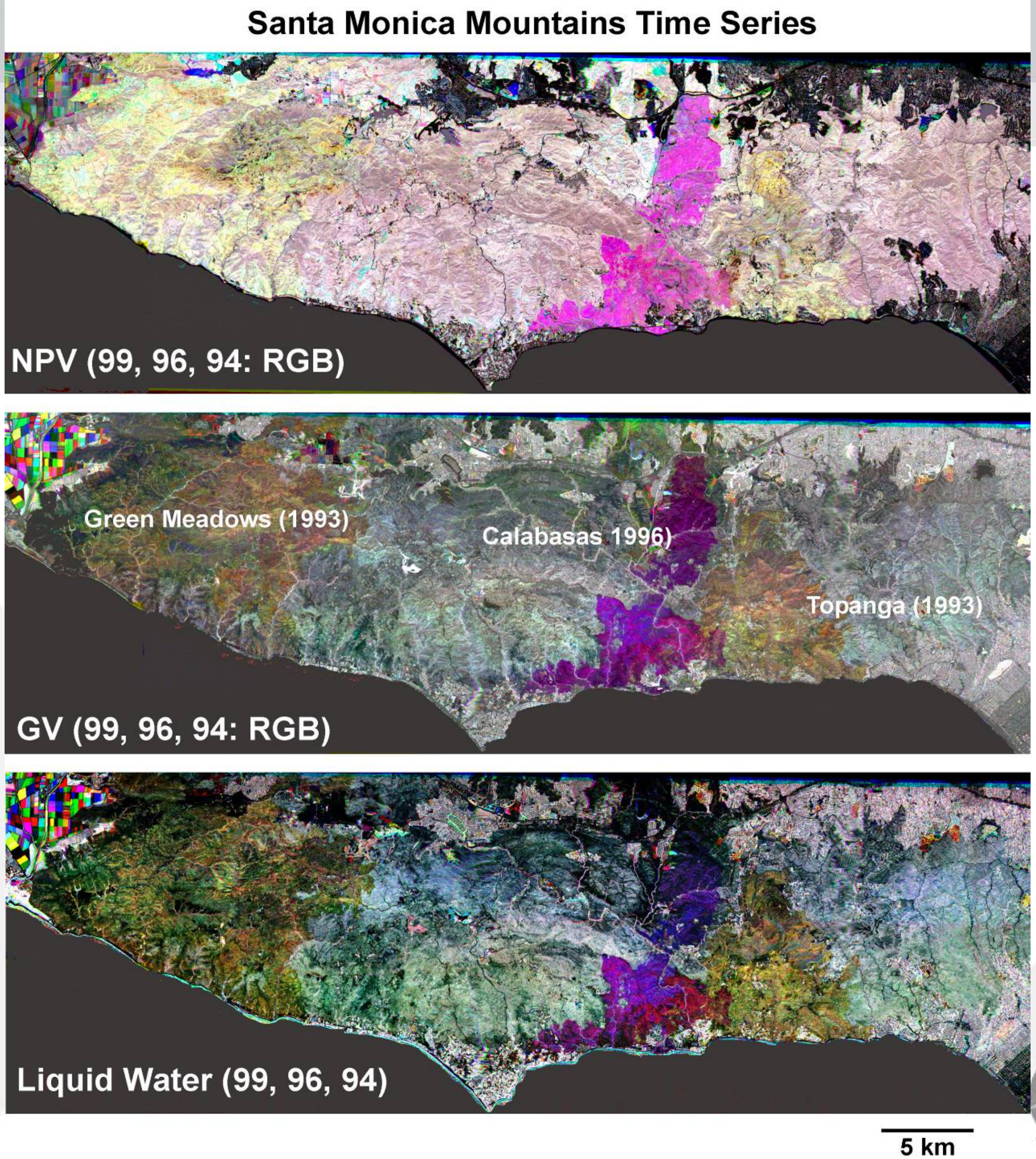
Fuel properties, such a moisture content

- **Fuel Type**
  - **Classification of dominant Plant Functional Types**
- **Fuel Condition**
  - **Live and "Dead" components of Fuels**
  - **Quantified using a Simple Linear Mixture Model**
    - **Green Vegetation, Nonphotosynthetic Vegetation, Soil and Shade**
- **Live Fuel Moisture**
  - **Equivalent Water Thickness (EWT)**
    - **Requires spectra**
  - **SMA (from above)**
  - **Moisture measures**
    - **NDWI (r857-r1241)/(r857+r1241)**
  - **Greenness measures**
    - **NDVI (r793-r677)/(r793+r677)**

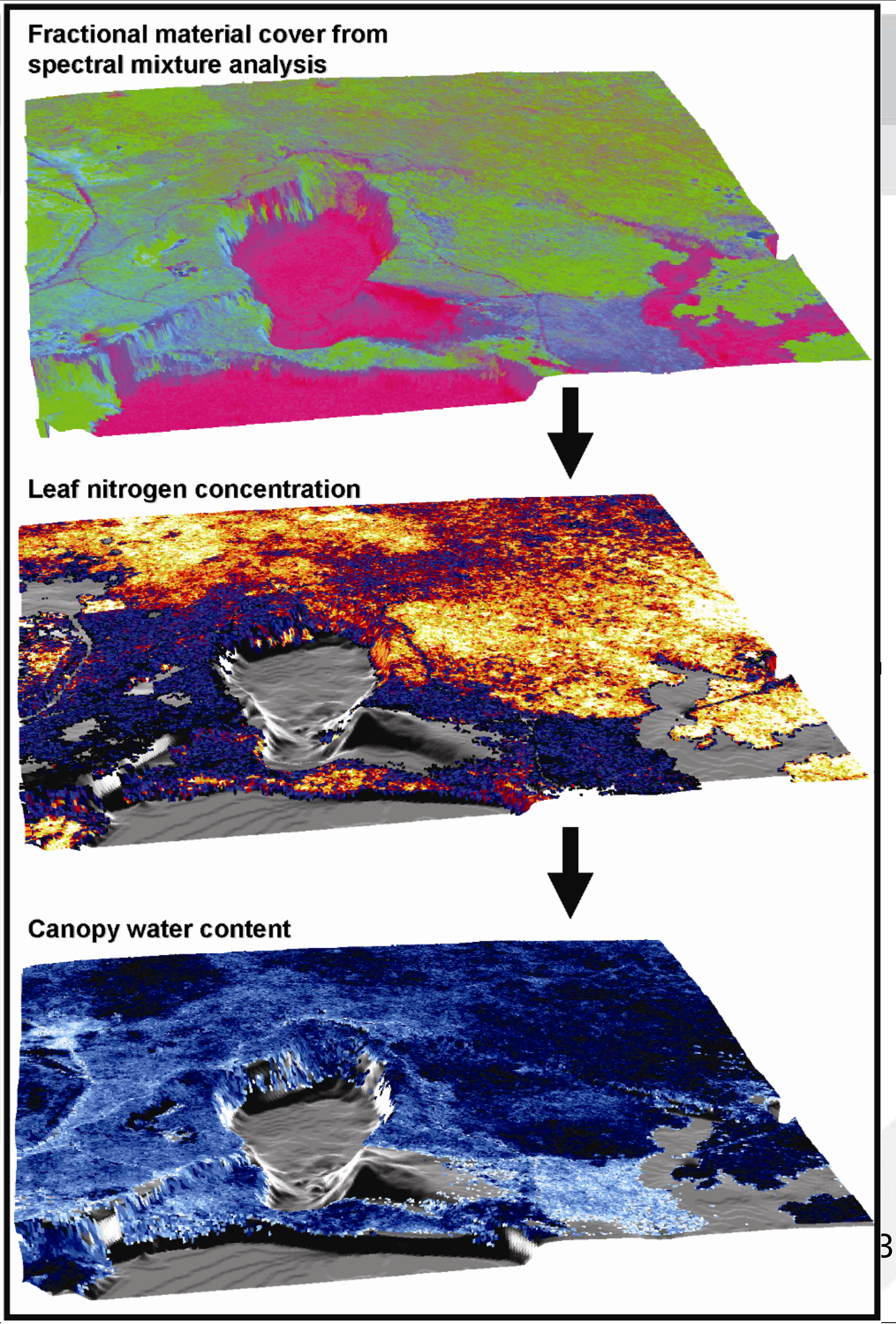


AVIRIS Temporal Coverage:

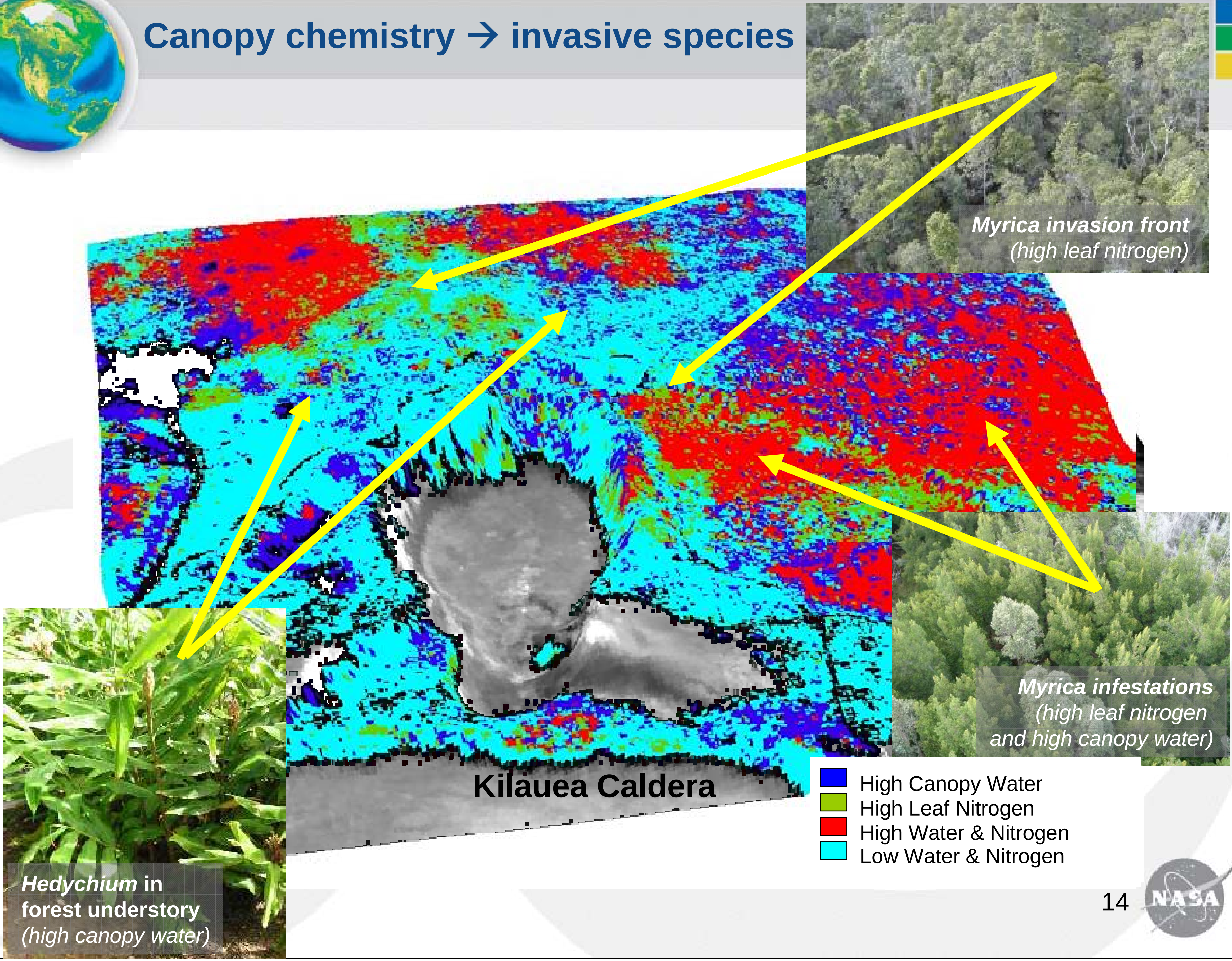
Spring/Fall pairs most years from 1994 to 2002



Canopy properties reveal vegetation change



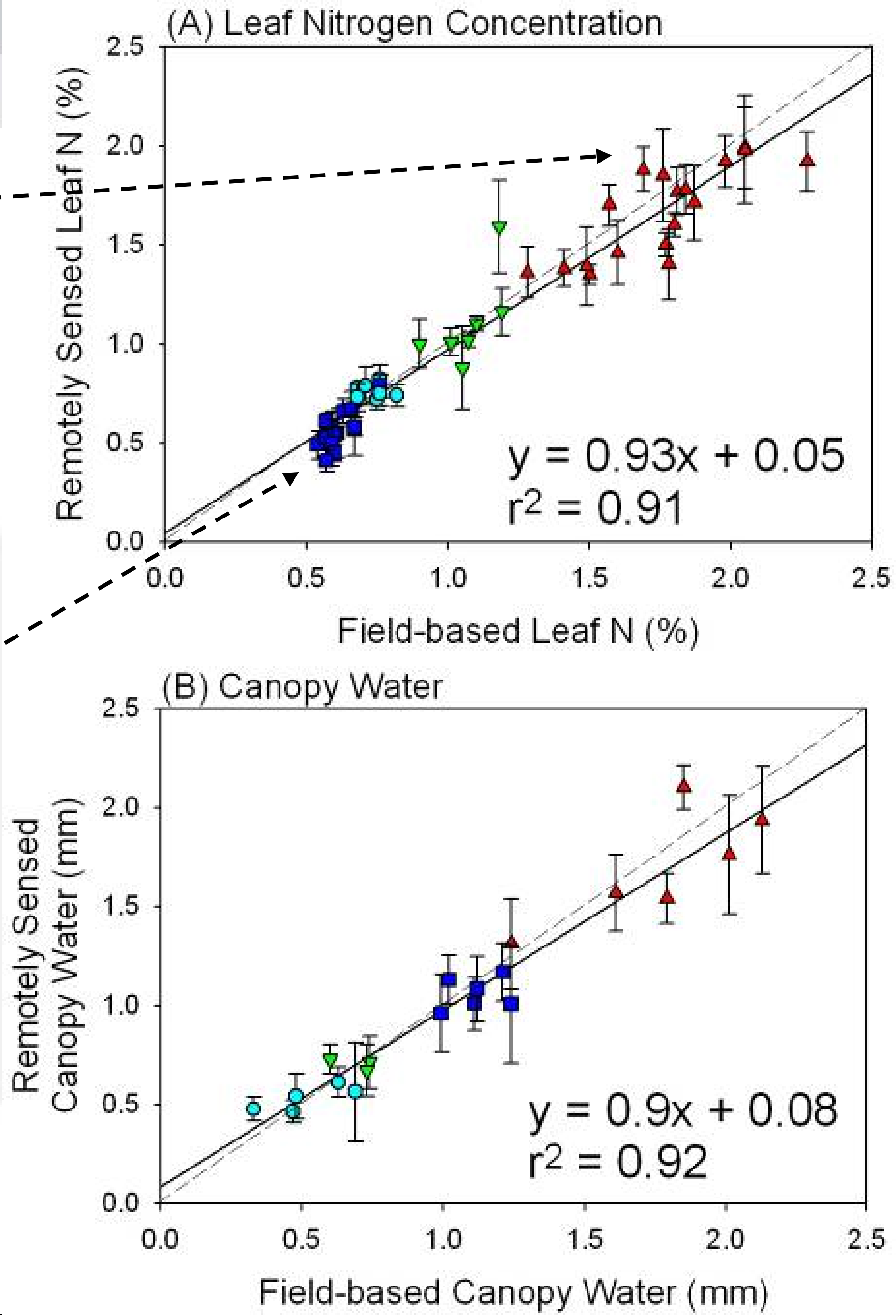
Canopy chemistry → invasive species



Effects of invasion

Overstory invader providing nitrogen to the ecosystem

Understory invader stealing nitrogen from the native overstory canopy



Summary

- Disturbance is a major component of ecosystem dynamics and global change
- Many disturbances are subtle but widespread, with broad and diffuse consequences
- HyspIRI will quantitatively resolve the material composition, chemical attributes, and physiological responses of vegetation to disturbance, and thus the role that disturbance plays in shaping landscape, regional and global ecological processes.

Spare slides