

# Toward Monitoring the Relationship between Vegetation and Volcanic Activity with HyspIRI

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# Project Objective

Demonstrate that vegetation-volcano relationship will be observable by the NASA *Hyperspectral Infrared Imager* (HyspIRI) Mission

Forward (Bio-Response) Question: For known volcanic activity: what is the impact?

Inverse (Bio-Precursor) Question: What do changes in local vegetation tell us about volcano behavior?

**Performance Period: 5/2011 -5/2012**

we are 4.5 months in the project

## Collaborators:

Peter Mouginis-Mark, University of Hawaii  
Steven Businger, University of Hawaii

# Hyperspectral Infrared Imager (HyspIRI) Mission

Two instruments on the same platform:

Hyperspectral Visible – Near Infrared – Short-wave Infrared

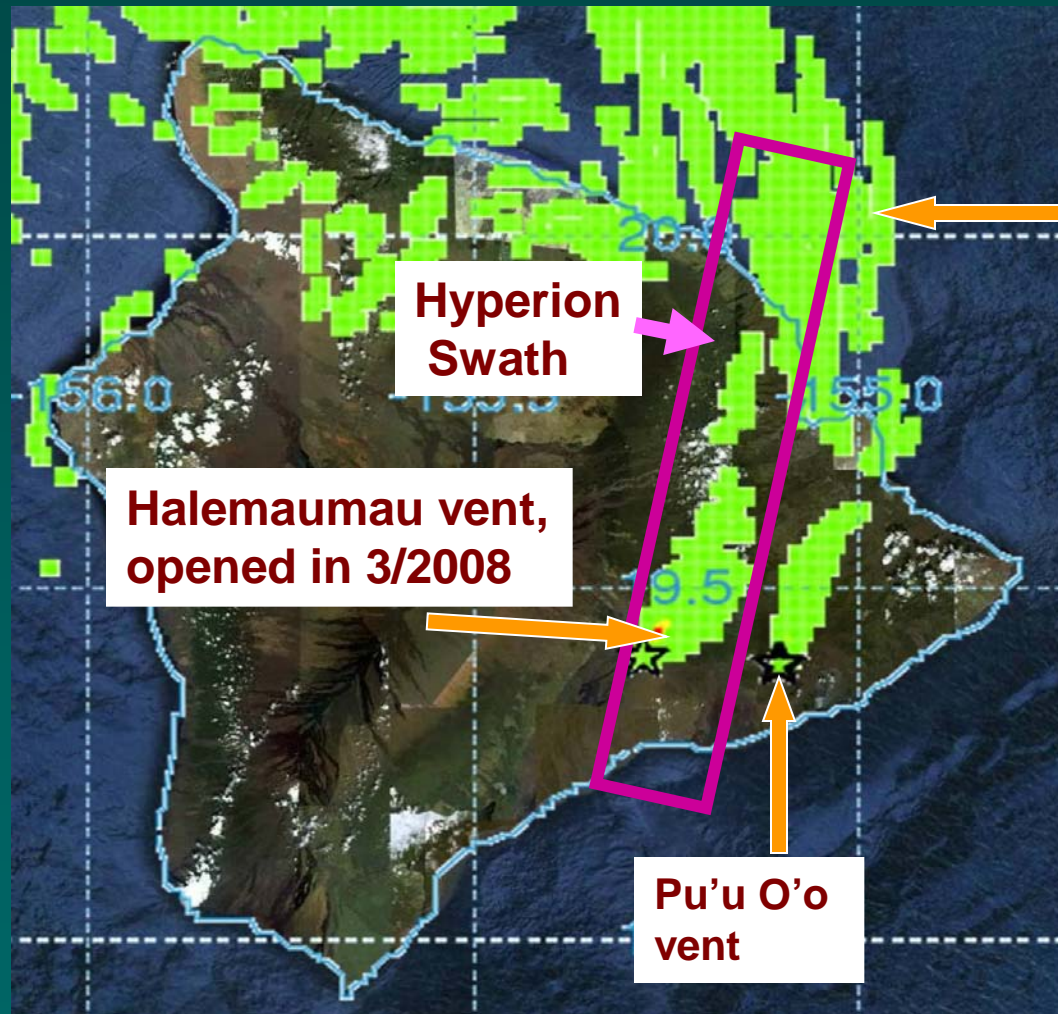
(224 bands, like AVIRIS or Hyperion)

**19 day revisit, global coverage** at 60 m spatial resolution

Multispectral Thermal Infrared

5 day revisit, global coverage at 60 m spatial resolution

# Study Site: the Island of Hawaii



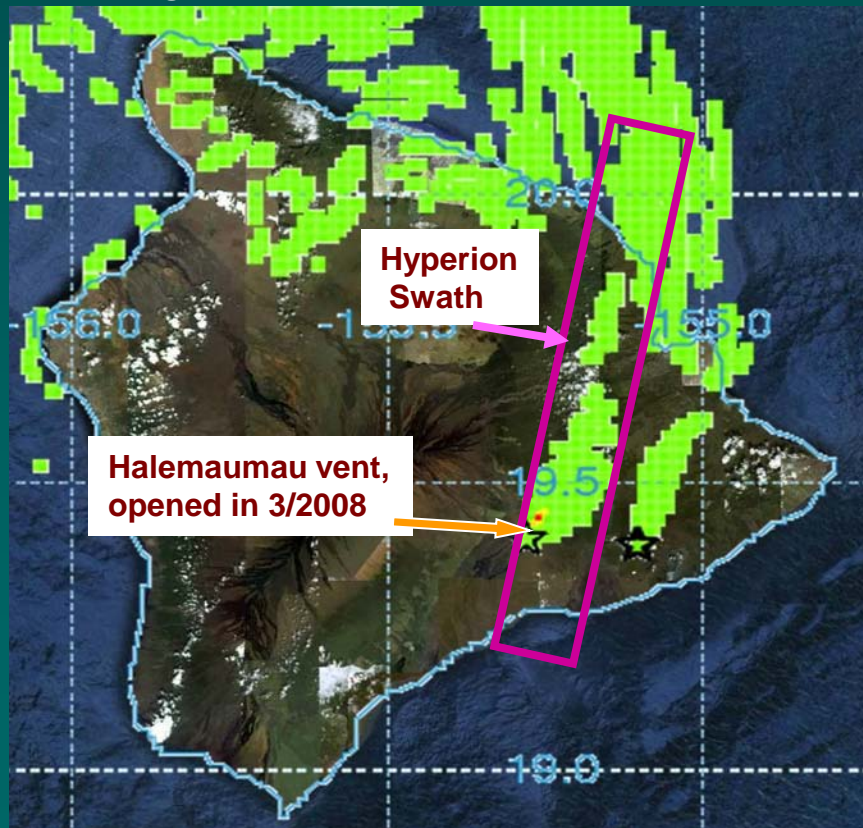
SO<sub>2</sub> concentrations mapped by the Hybrid Single Particle Lagrangian Integrated Trajectory (HY-SPLIT) and dispersion model





# Work Plan

1. HypsIRI-like dataset over the eastern side of the Island:
  - VSWIR image time series from Hyperion (during 2006-2011),
  - Thermal IR from ASTER, where available.
2. Investigate the impact of SO<sub>2</sub> degassing from Halemaumau vent on the vegetation near the volcano.



## Major steps:

- Map vegetation properties, using PROSAILH model inversion
- Assess spatial pattern of SO<sub>2</sub> distribution, based on HY-SPLIT dispersion model outputs
- Relate vegetation stress and the SO<sub>2</sub> distribution pattern.

# Potential Damage to Vegetation



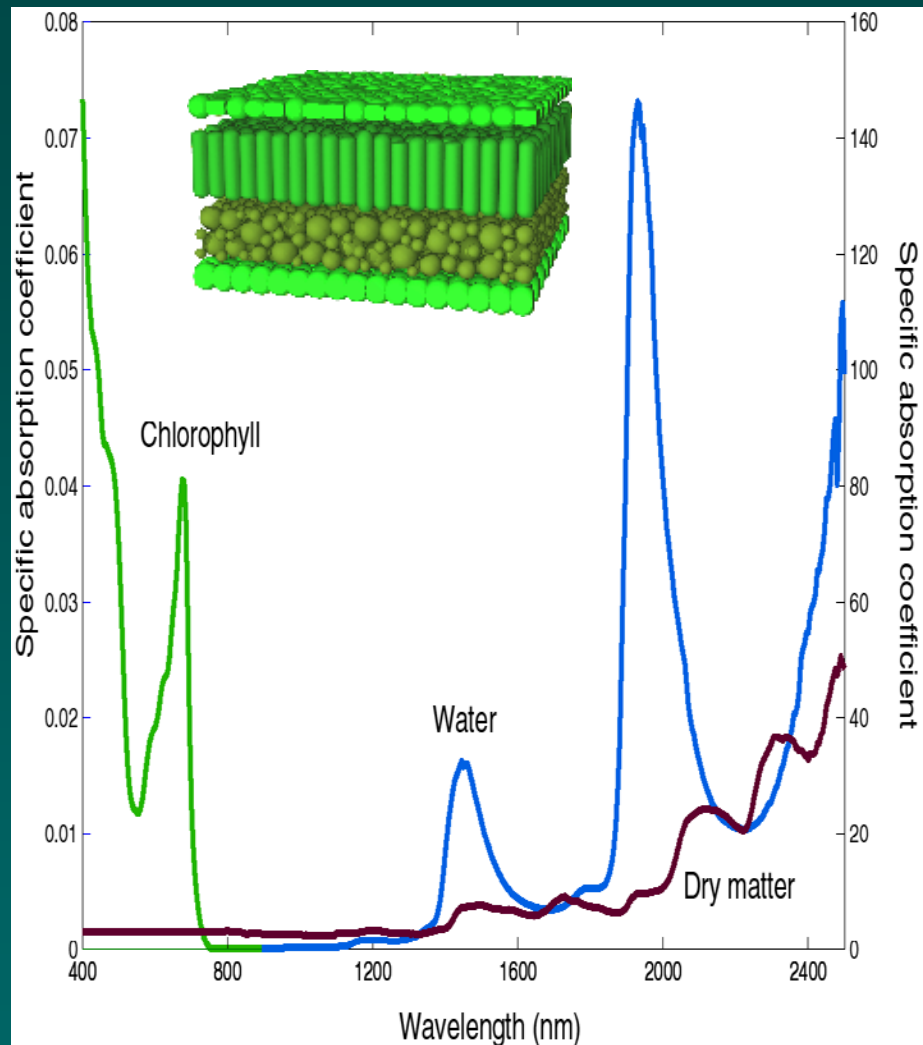
SO<sub>2</sub> enters leaf tissue through stomata and causes plant injury:

- **Chlorophyll** reduces
- **Carotenoids, Brown Pigment** change (yellowing, browning)
- **Leaf Water Content (EWT)** reduces

Damage magnitude and timing depend on duration and intensity of exposure

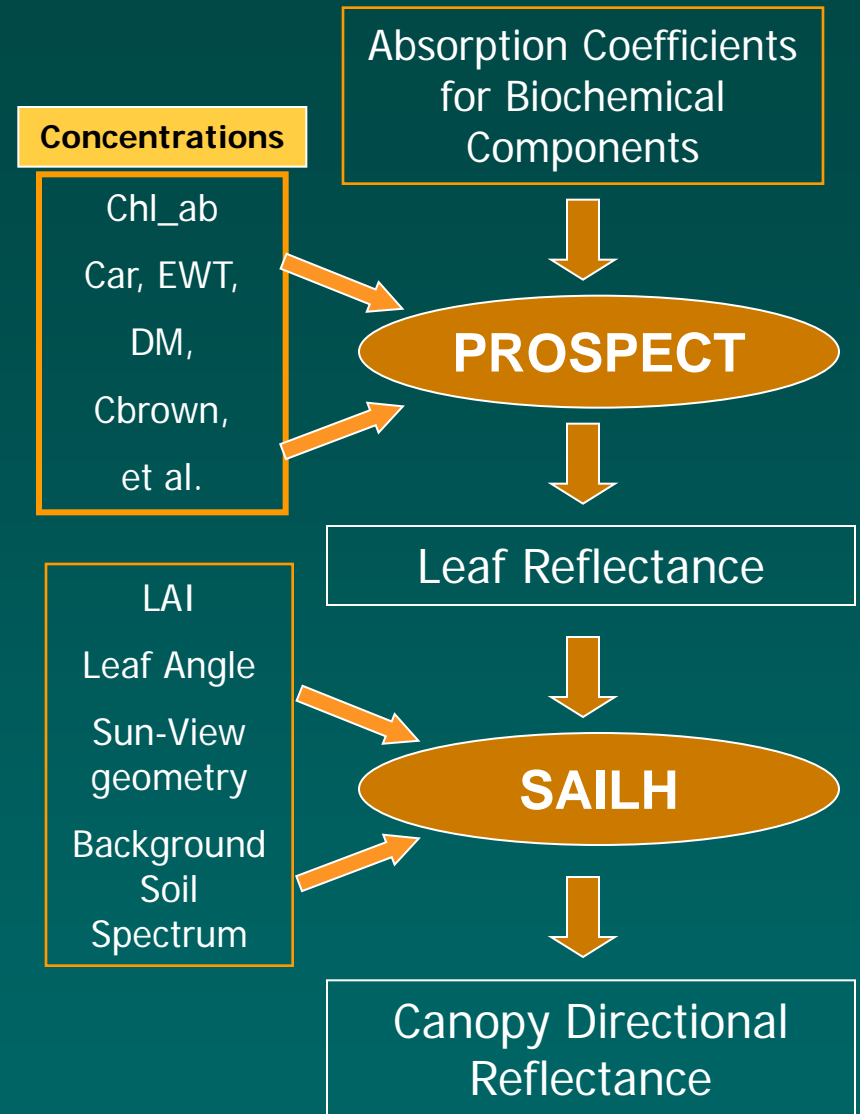
Source: Nelson, S. Sewake, K., (2008) *Plant Disease*, 47

# PROSAILH = PROSPECT + SAILH



Jacquemoud S., et al. (2009), *Rem. Sens. Env.*

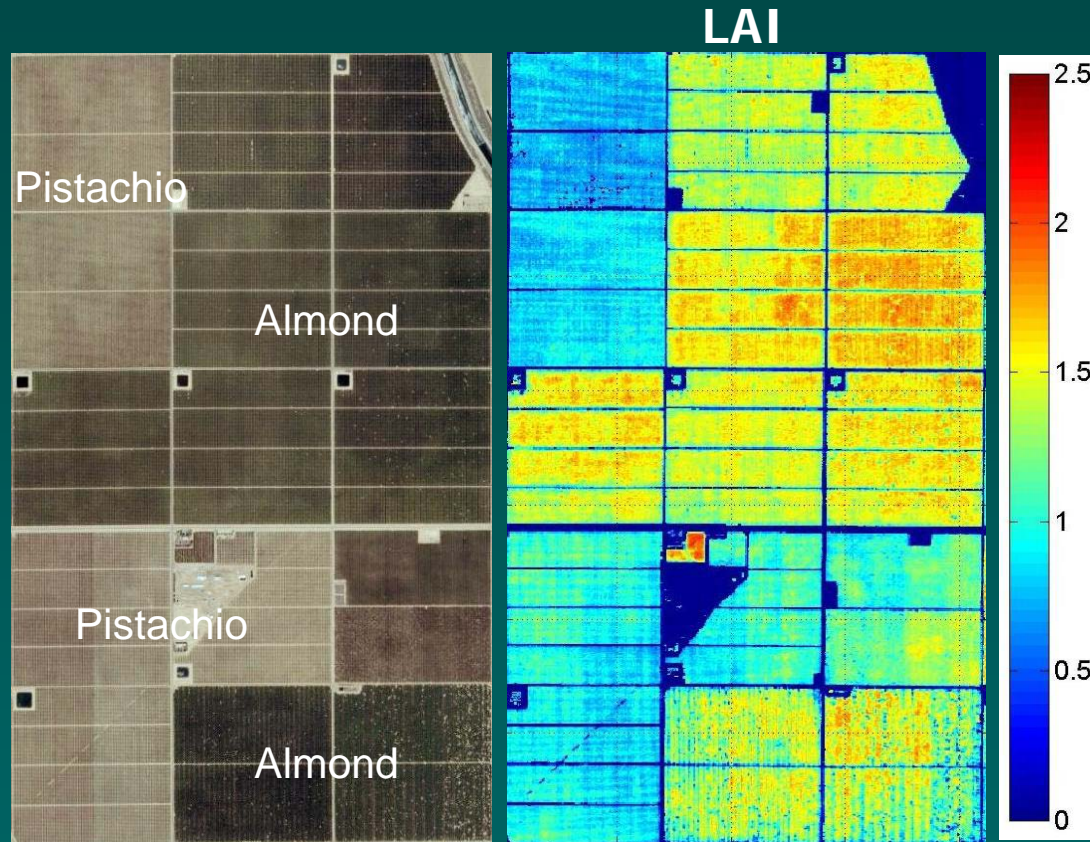
Verhoef, W. (1985). *Rem. Sens. Env.*



Next: Example



# Example: Belridge Orchards, San Joaquin Valley, CA



**MASTER: The MODIS-  
ASTER Airborne  
Simulator** (operated by  
NASA - Ames)

July 2010:  
2 flights same day:  
morning & afternoon;  
pixel = 7x7 m



# PROSAILH retrievals for EWT



We are able to detect small changes occurred over the 4-hour period

EWT decreases:

- where the tree planting structure is different



# Vegetation Properties retrieved from Hyperion: the Island of Hawaii

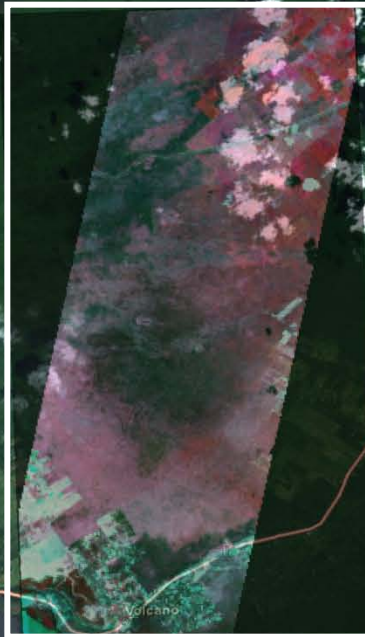
*Metrosideros polymorpha*

*Acacia koa*

*Native trees/shrubs*

*Open to closed canopies*

*Tall (overstory) to  
moderate (understory)  
statue trees*



## Hyperion Images:

1. Dec 1, 2007  
(before eruption)
2. Aug 23, 2008  
(after eruption)

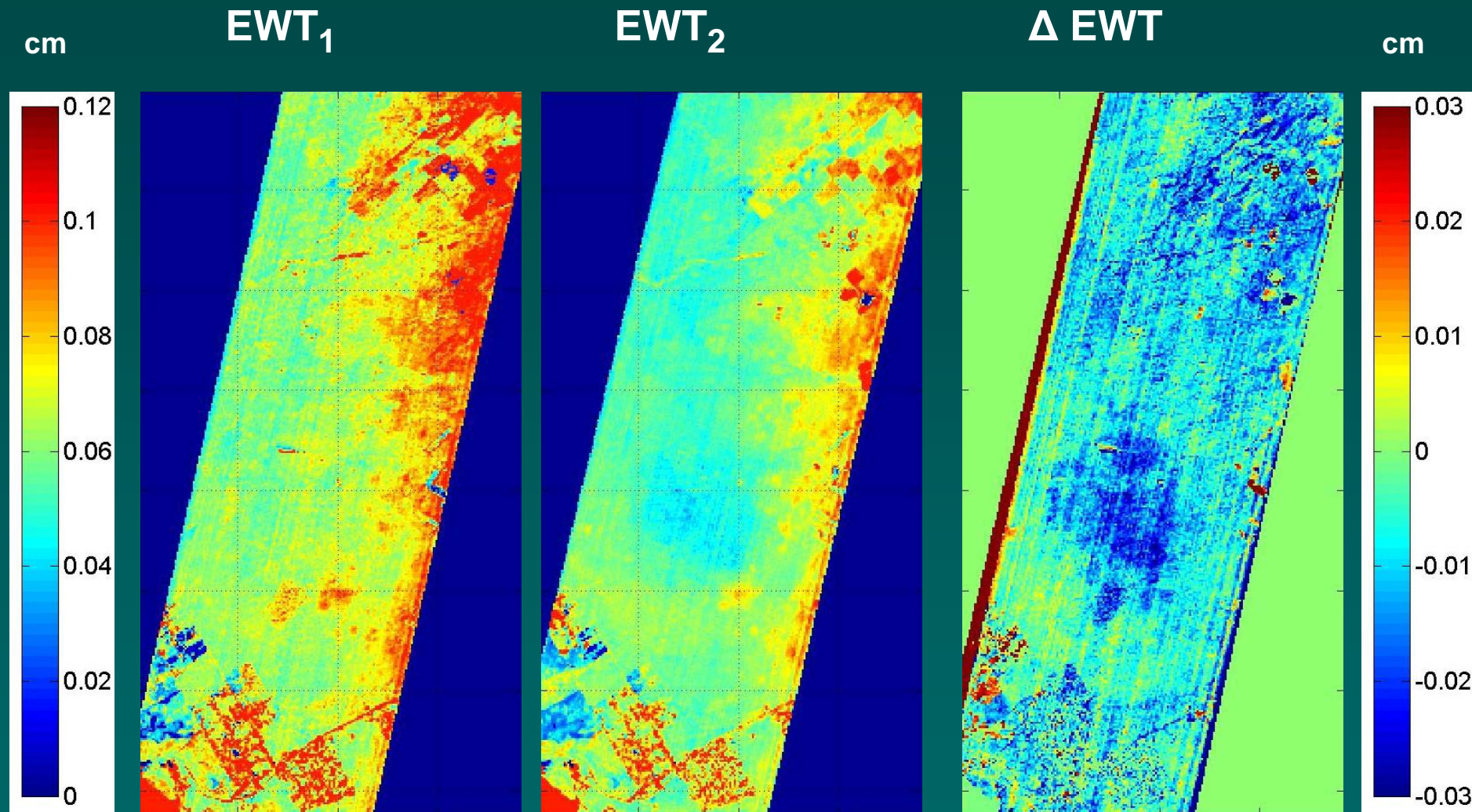
Halemaumau  
vent

Pu'u O'o  
vent

Next: EWT



# Leaf Water (Equivalent Water Thickness)



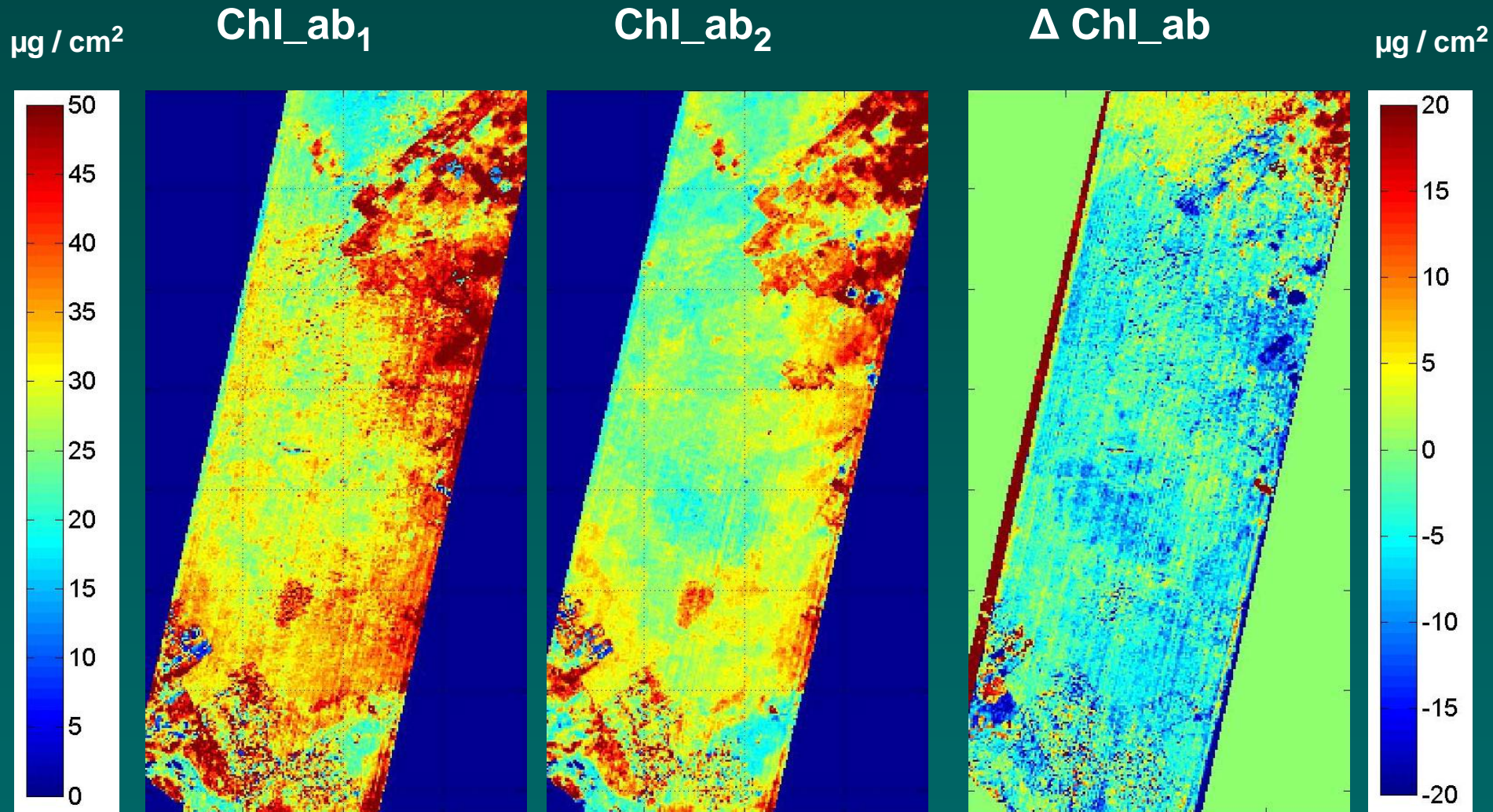
Dec 2007

Aug 2008

Next: Chlorophyll



# Leaf Chlorophyll a & b Concentration



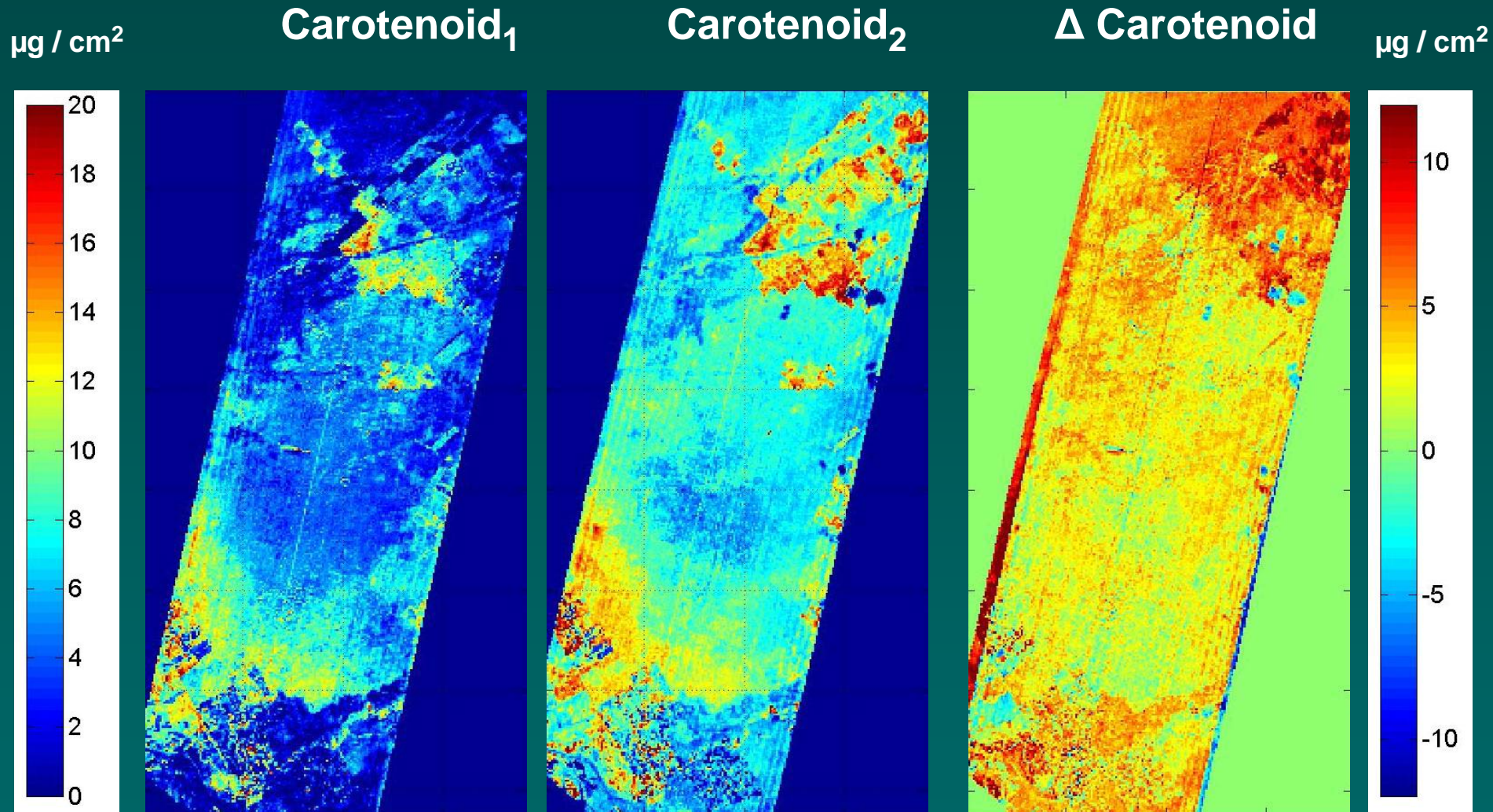
Dec 2007

Aug 2008

Next: Carotenoids



# Leaf Carotenoids Concentration



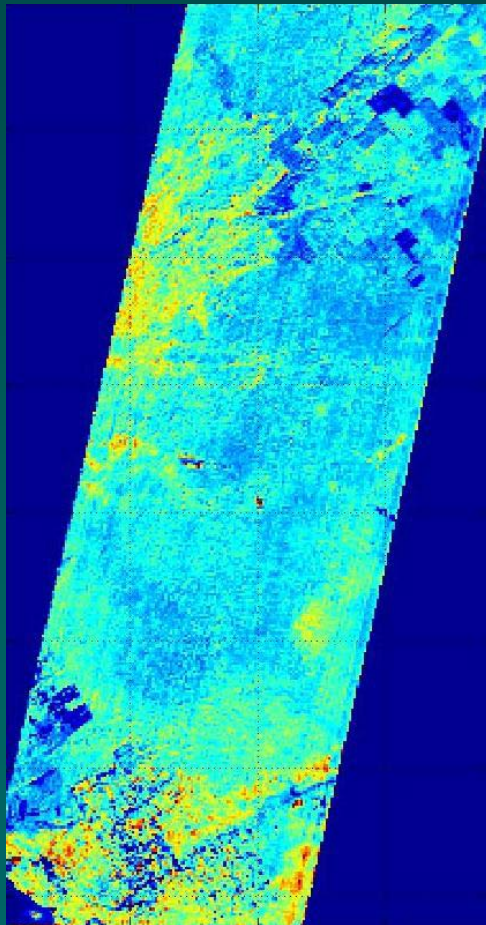
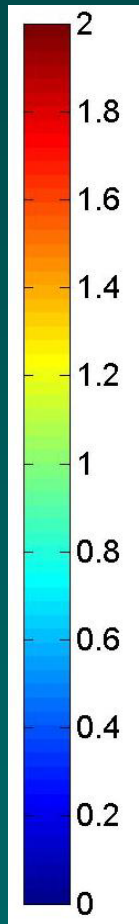
Dec 2007

Aug 2008

Next: Brown Pigments

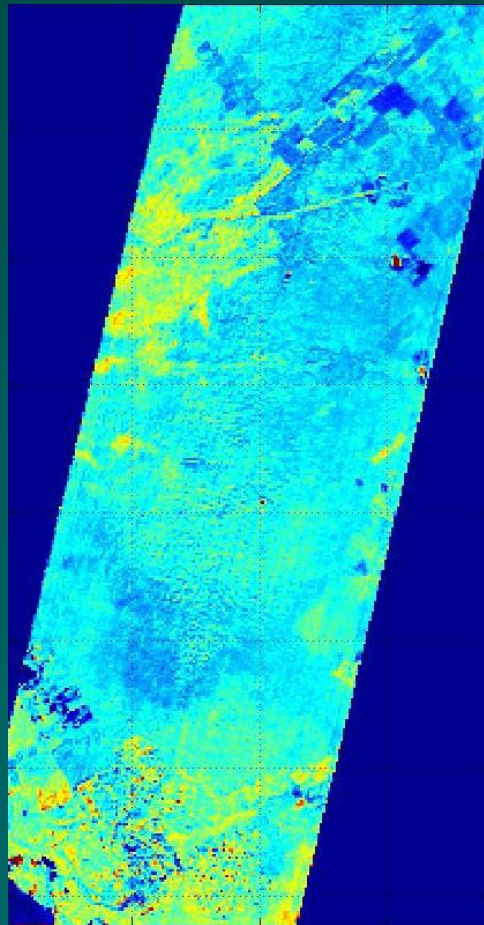
# Brown Pigment Content

Brown Pigm<sub>1</sub>



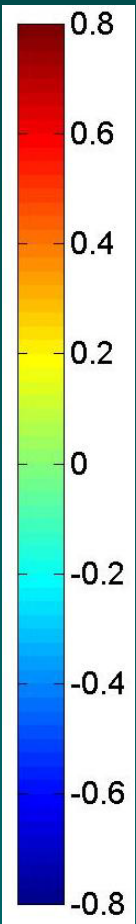
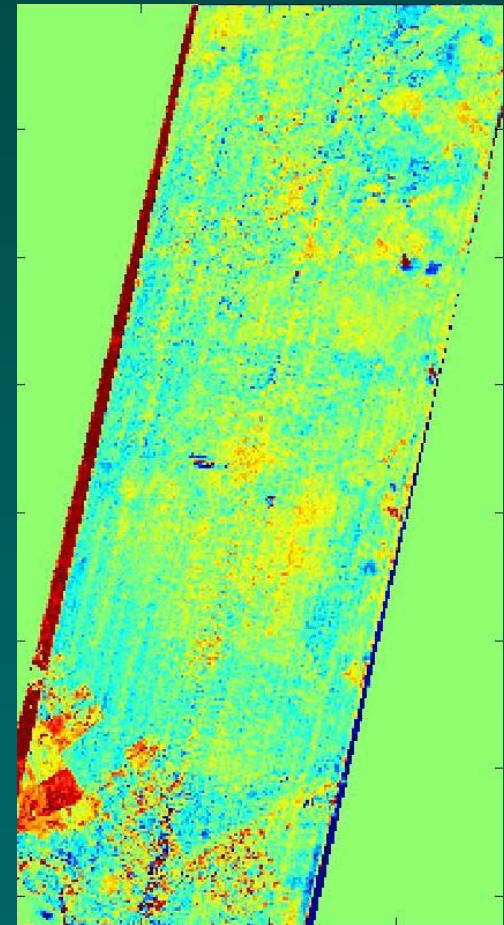
Dec 2007

Brown Pigm<sub>2</sub>



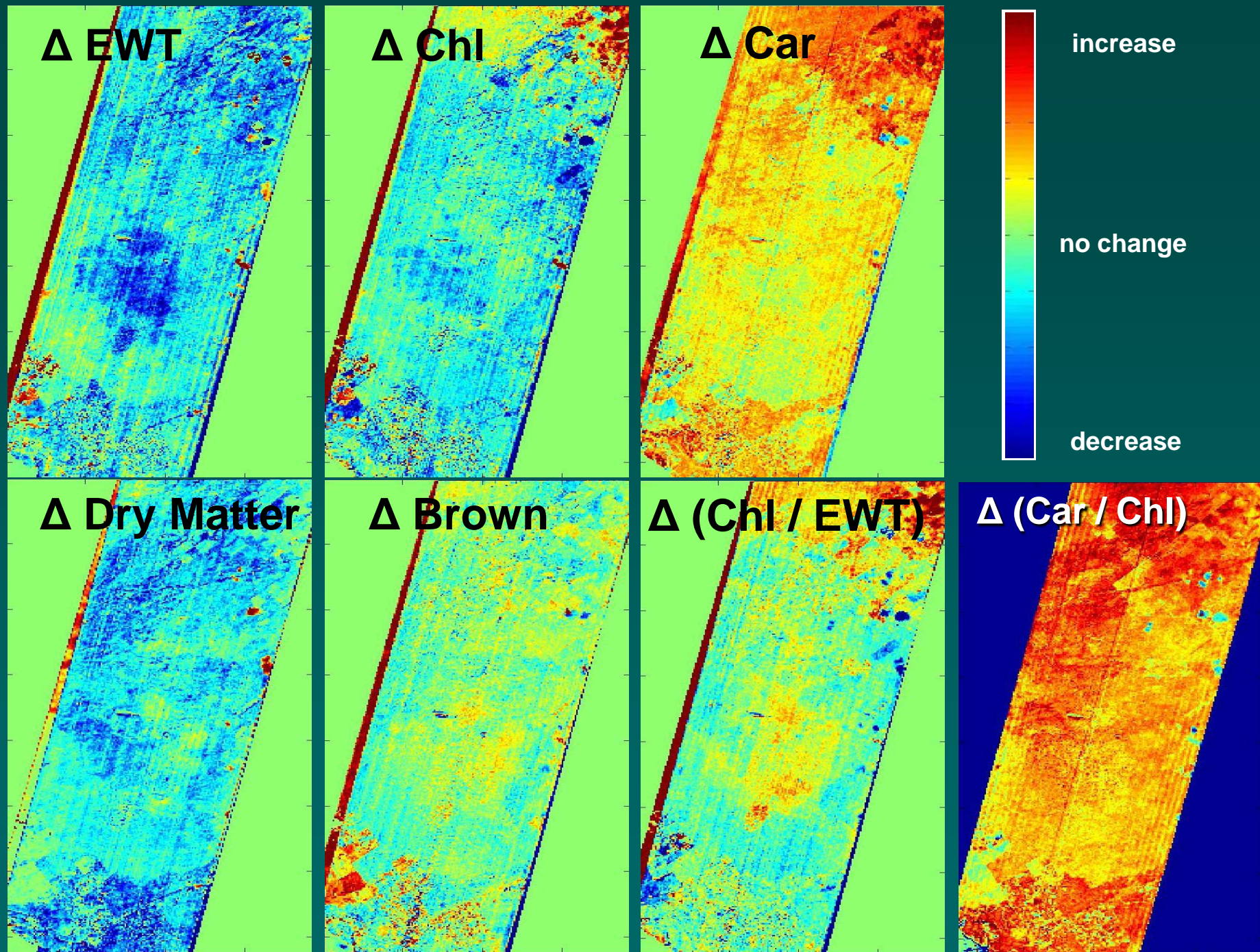
Aug 2008

$\Delta$  Brown Pigm



Next: changes summary





# Preliminary Result Summary

1. PROSAILH inversion appears to work
2. Temporal gradients of biochemical properties are generally consistent with typical patterns of growth and/or damage
3. Different interesting stories for different locations



# Questions

Should the observed changes in vegetation be attributed to volcanic activity, and in particular, to the SO<sub>2</sub> emissions?

Forward (Bio-Response) Question: For known volcanic activity: what is the impact?

Inverse (Bio-Precursor) Question: What do changes in local vegetation tell us about volcano behavior?

## Answer

# HyspIRI

## image time series

- will allow monitoring vegetation conditions and their changes
- will help formulate hypotheses and locate ROIs
- will help explain changes and detect anomalies

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Peter Mougini-Mark,	Univ. of Hawaii
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Mike Whiting,	UC Davis

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- NASA Student Airborne Research Program

