HyspIRI VNIR and TIR Data Products
Susan Ustin

Ready and Near Ready Products

Atmospheric calibration for phases of water (vapor, liquid, solid)
Narrow band Indexes (e.g., PRI)
Red edge detection

Linear Mixture models (green vegetation, dry vegetation (NPV), soil, water, impervious surfaces

Multiple endmember spectral mixture analysis (MESMA)

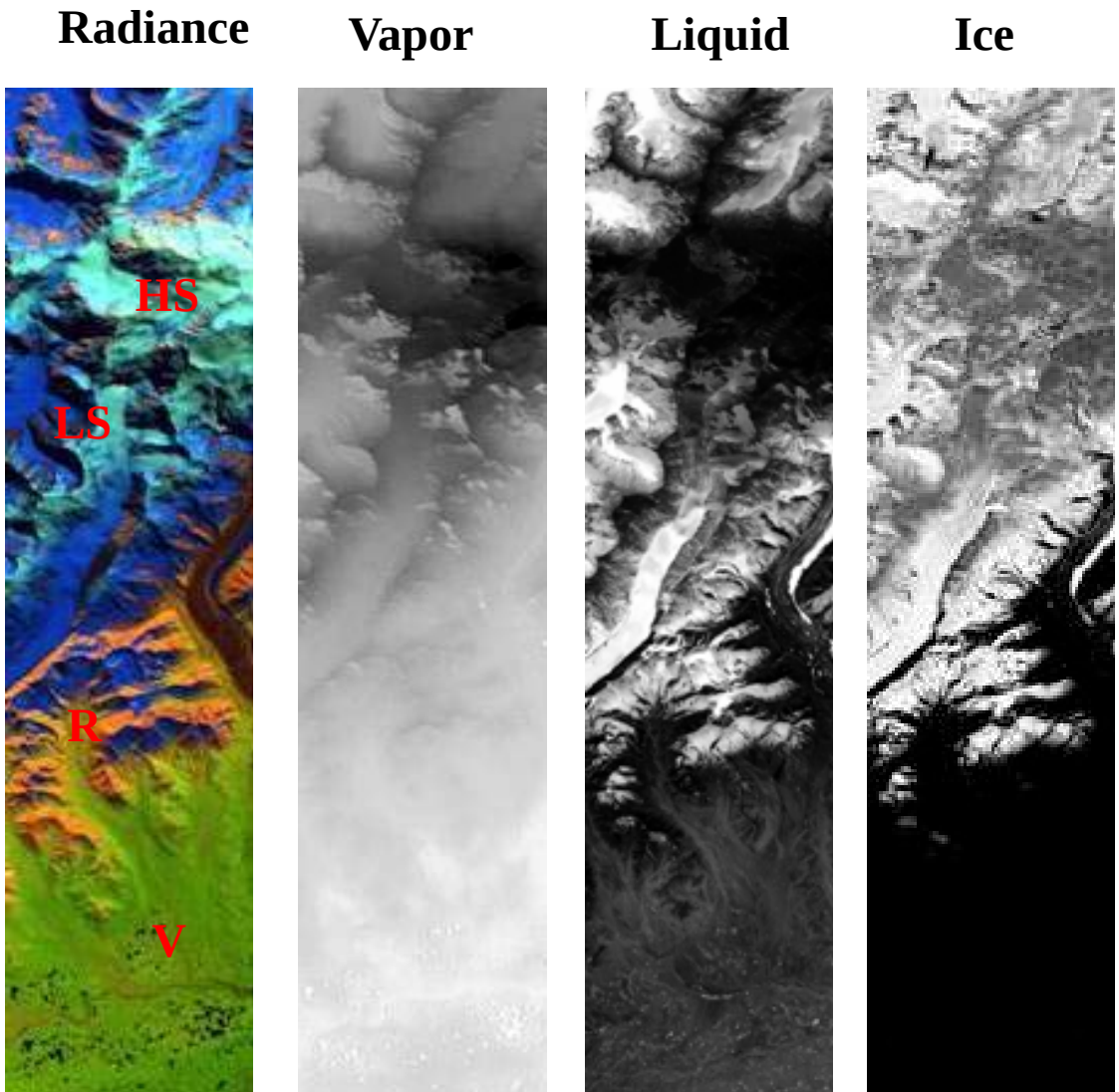
Leaf Area Index

Quantified Chemistry (inversion of PROSPECT models)
Total pigments, carotenoids, chlorophylls,
Equivalent water thickness, canopy water content

Tested but needs more validation on wider range of ecosystems

Steady State Fluorescence
Canopy nitrogen content; other elements: P, K, etc. (see Asner)
Anthocyanin (Gitleson method)
Fuel Moisture Content (PROSPECT inversion)

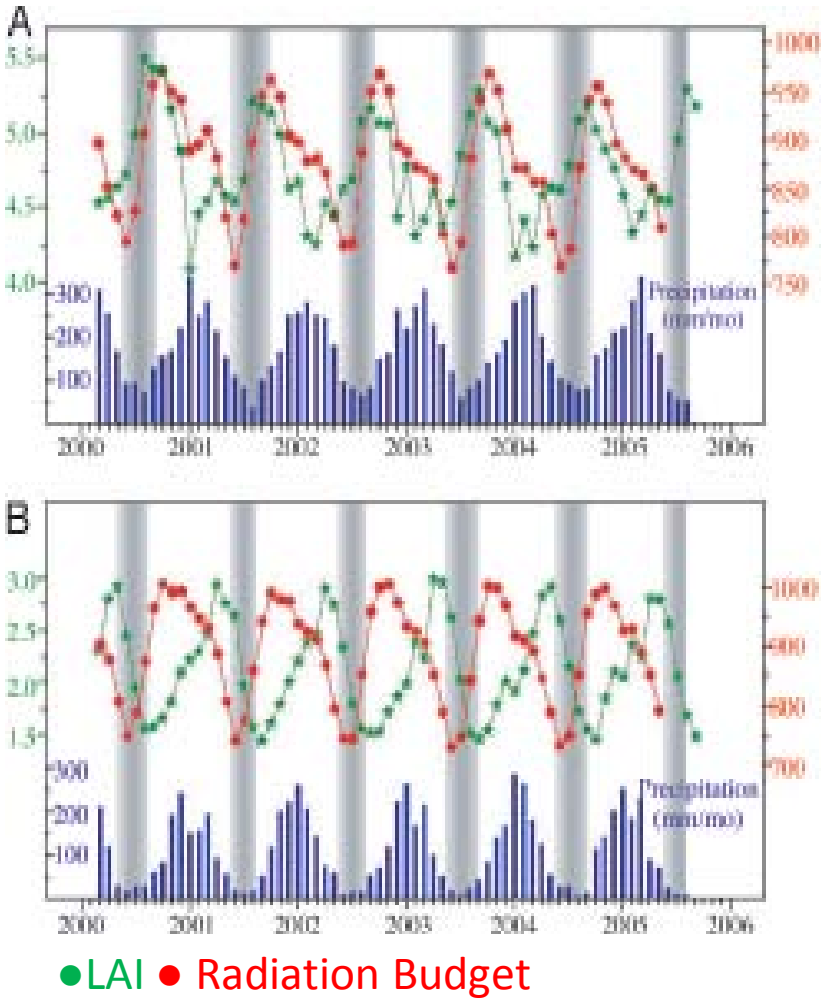
Retrieval of Quantified Water in Different Phases from Atmospheric RT Model

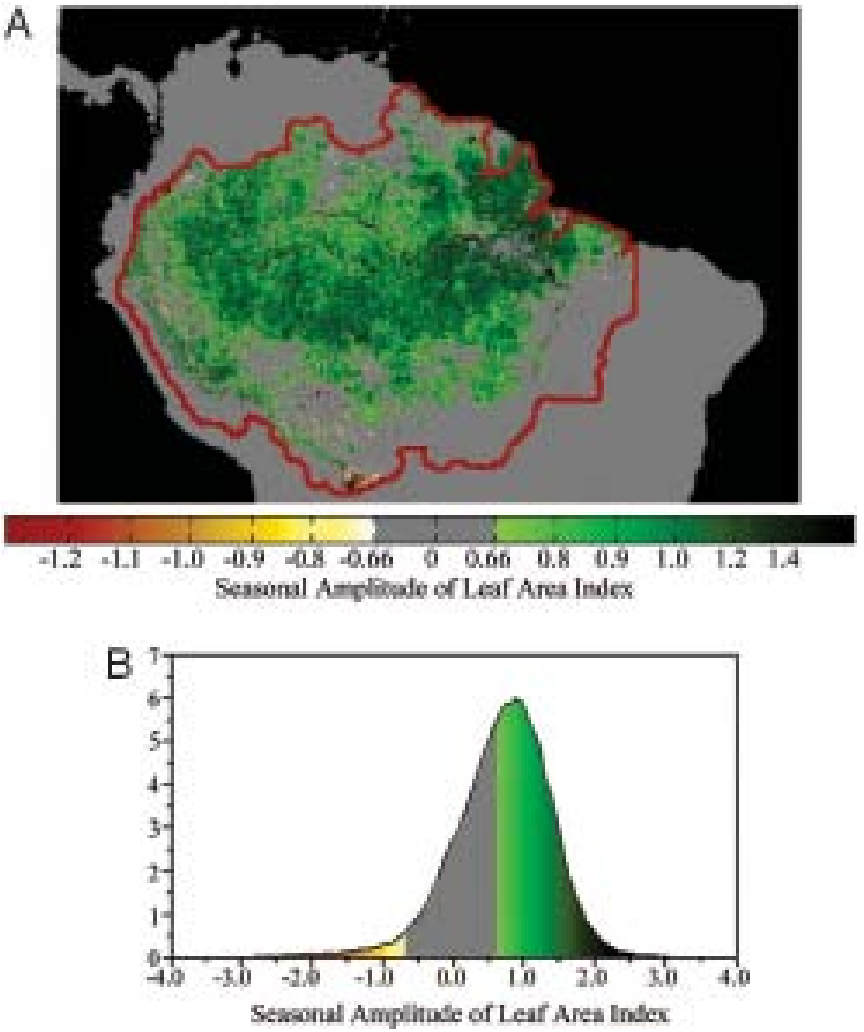


- **Water vapor** 0.51 to12.7mm precipitable water per pixel
- **Liquid water** 0 to 7.4 mm equivalent path transmittance
- **Ice** 0 to 27.9 mm equivalent path transmittance

Robert O. Green

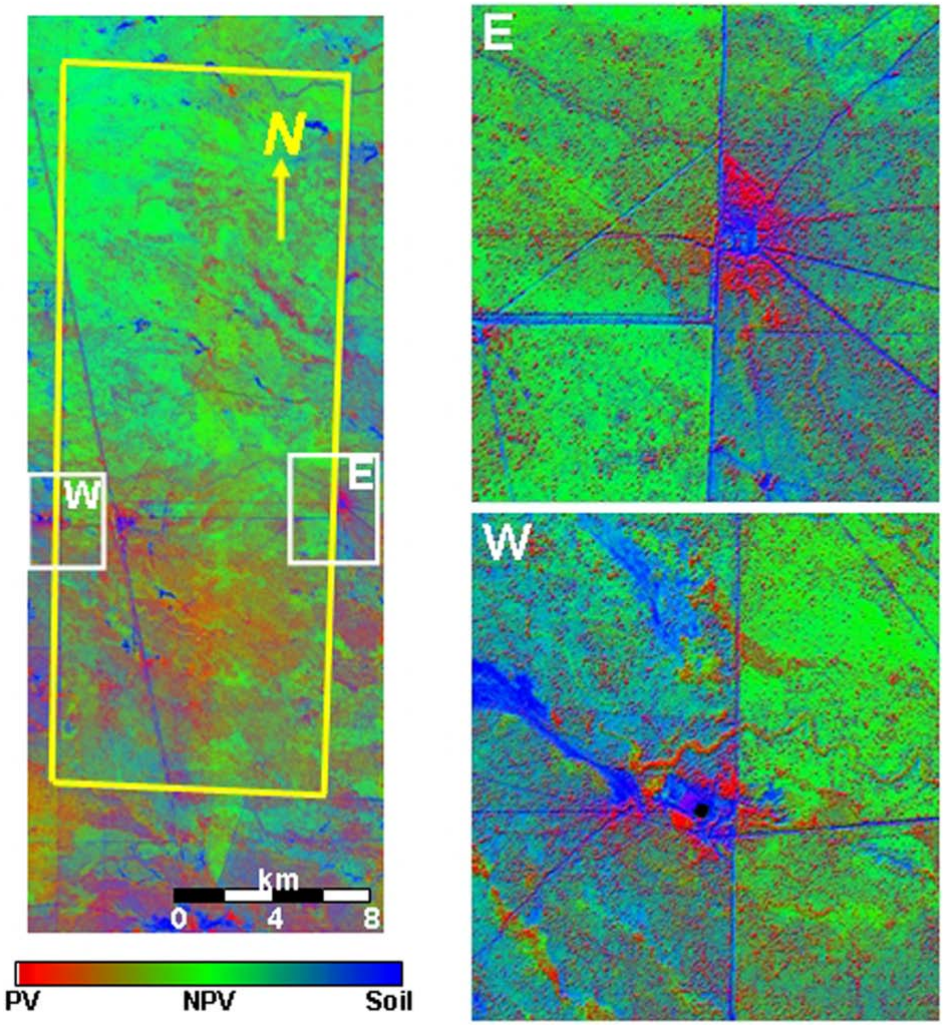
Leaf Area Index is a Critical Variable for Physiological Status and Fluxes





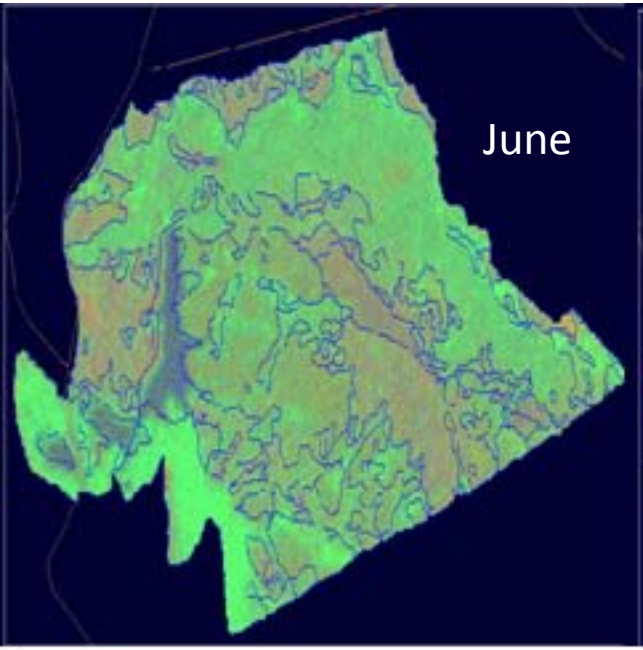
Ranga Myneni et al. 2007. Large seasonal swings in leaf area of Amazon rainforests. NPAS.

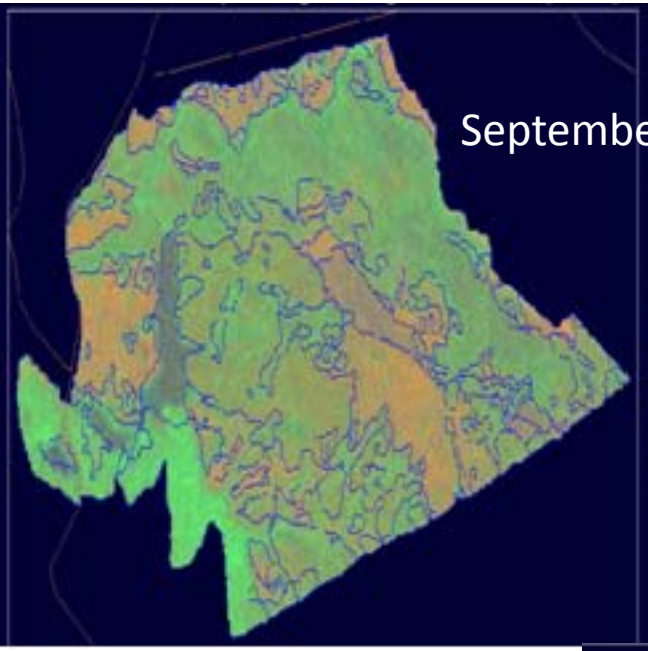
Linear Spectral Mixture Analysis for 3 Endmembers

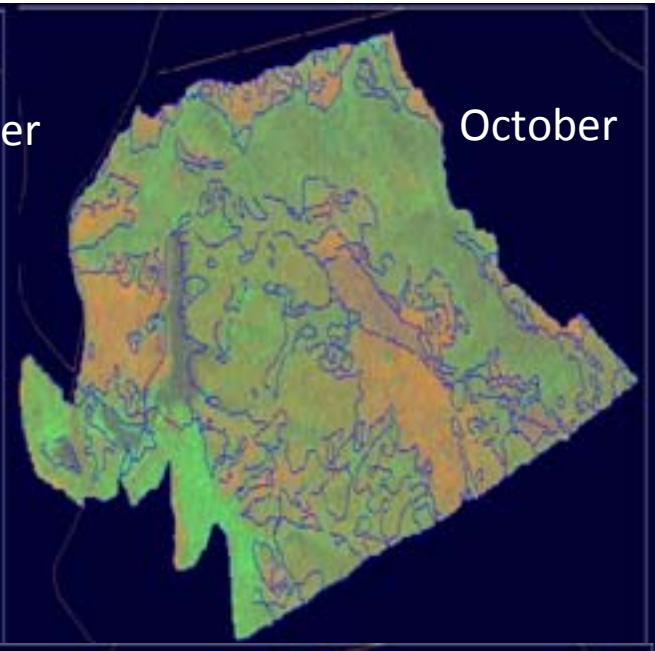


Asner GP, Green RO. 2001. Imaging spectroscopy measures desertification in the Southwest U.S. and Argentina. EOS Transactions. 82(49):601-606.

SMA Endmember Fraction Map Tracks Phenological Changes



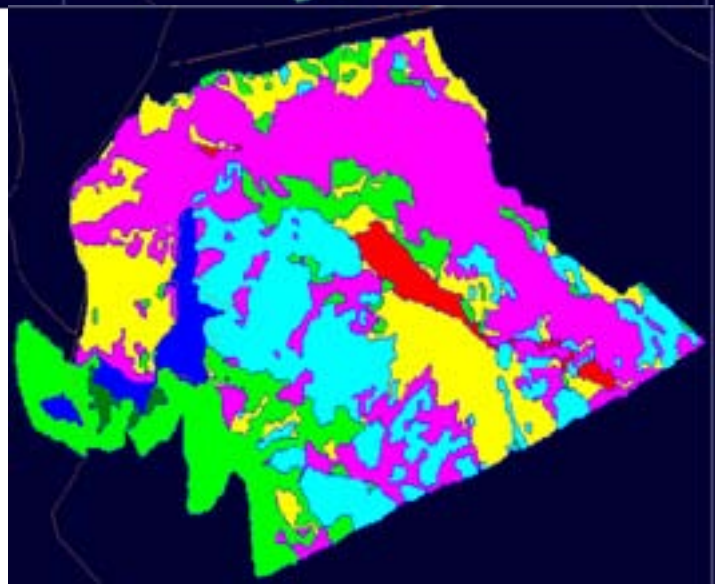




Endmembers:
Green vegetation
Dry vegetation
Soil

Independent Vegetation Map

Deciduous Forest
Mixed Evergreen Forest
Chaparral
Greenstone Grassland
Serpentine Grassland
Wetland
Lake



Ustin et al., 1999

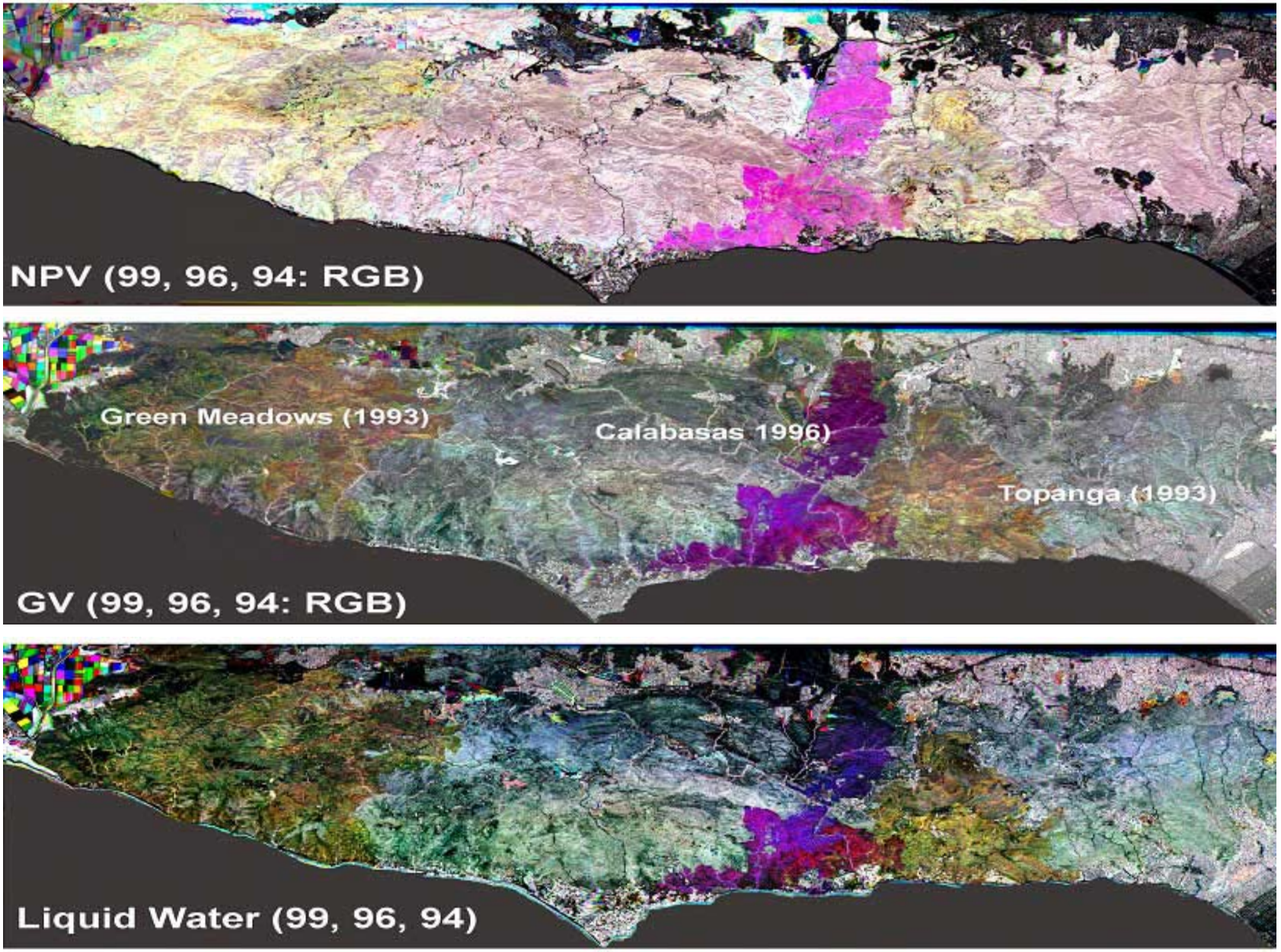
SMA: Monitoring Disturbance History, Forest Composition & Structure

Endmembers:
Soil
Green Vegetation
Shade

What you can see:
- Riparian Hardwood Forest
- Old Growth Forest
- Soil in Clear Cut Forest
- Regrowing conifer forest
- Meadow/agriculture

Wind River Experimental Forest within the Gifford Pinchot National Forest

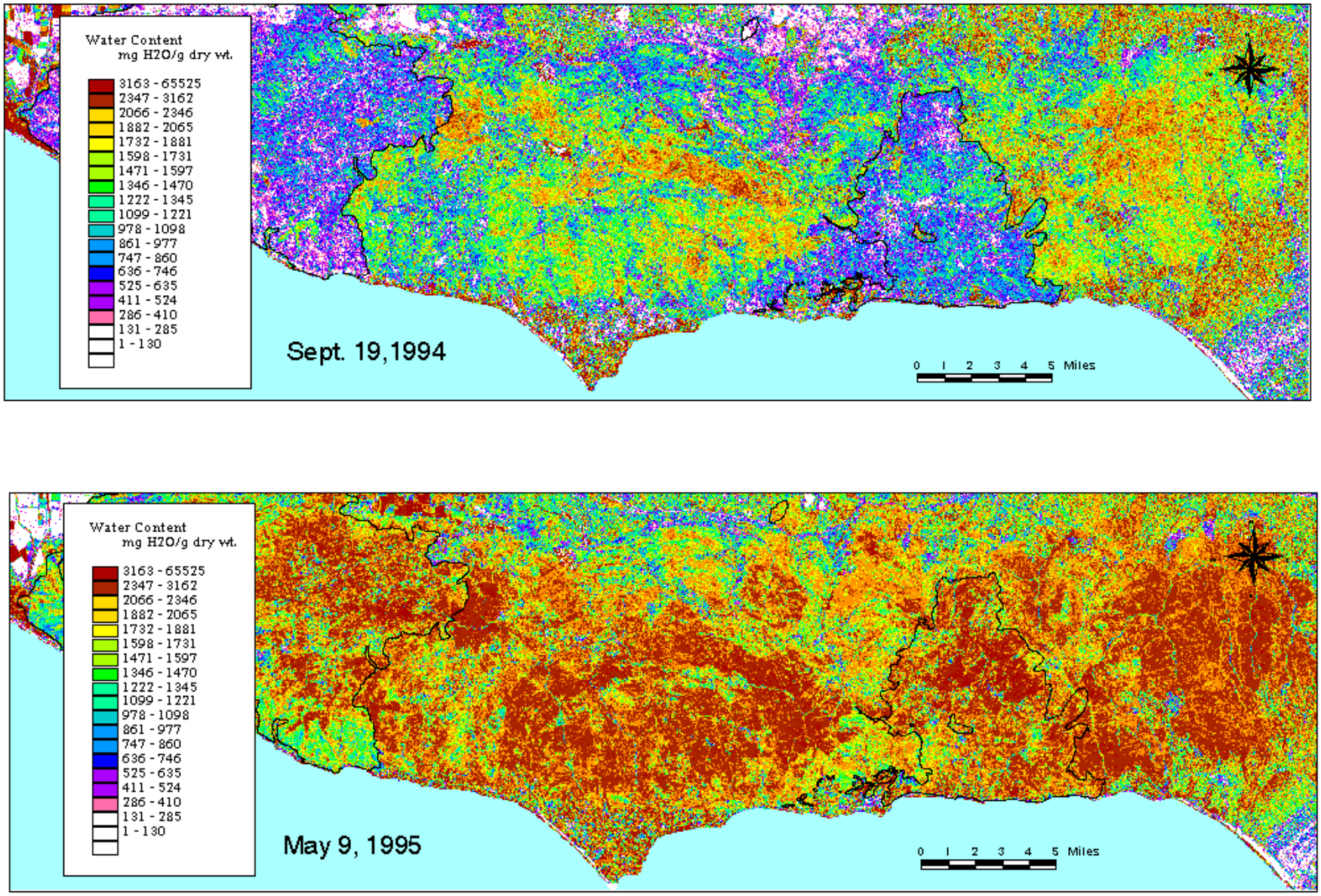
July, 3 Years of Change in NPV, GV, and EWT



Semi Arid Chaparral, Santa Monica Mountains, southern California

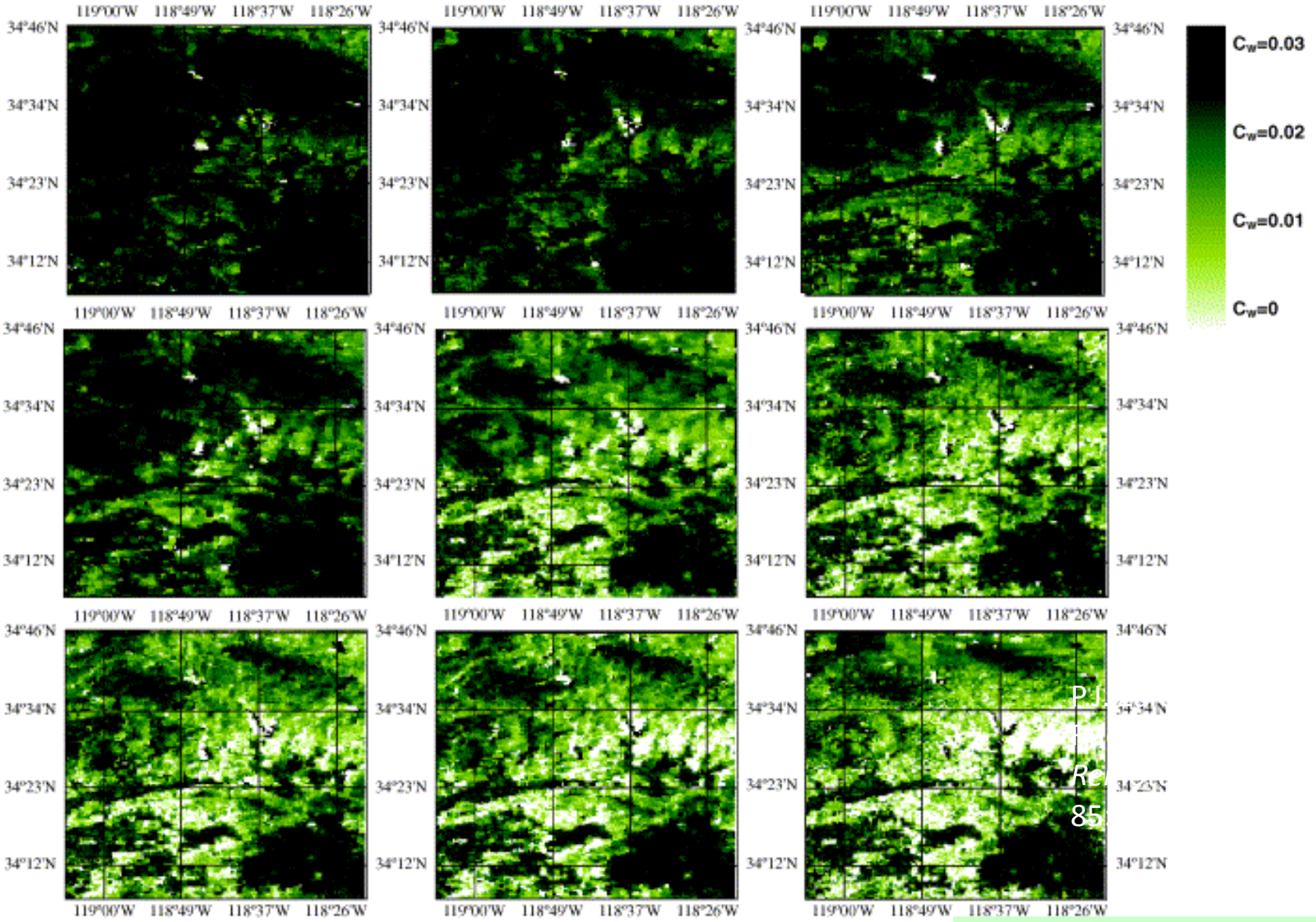
D. Roberts

Canopy Water Content: Seasonal changes



S.L. Ustin 1998, *Remote Sens. Environ.*, 65:280-291.

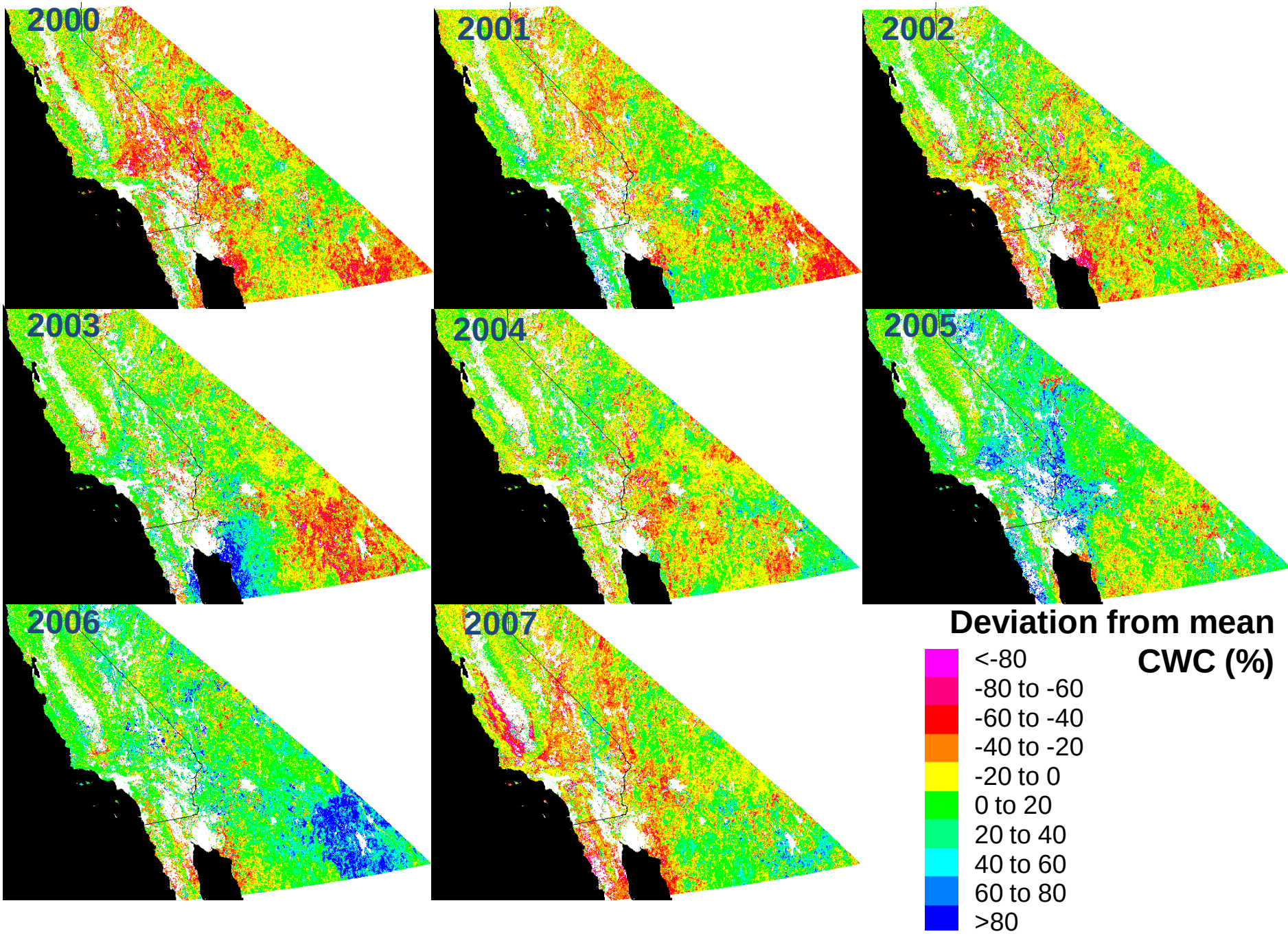
Weekly Retrieval of Water Content at the Canopy Scale



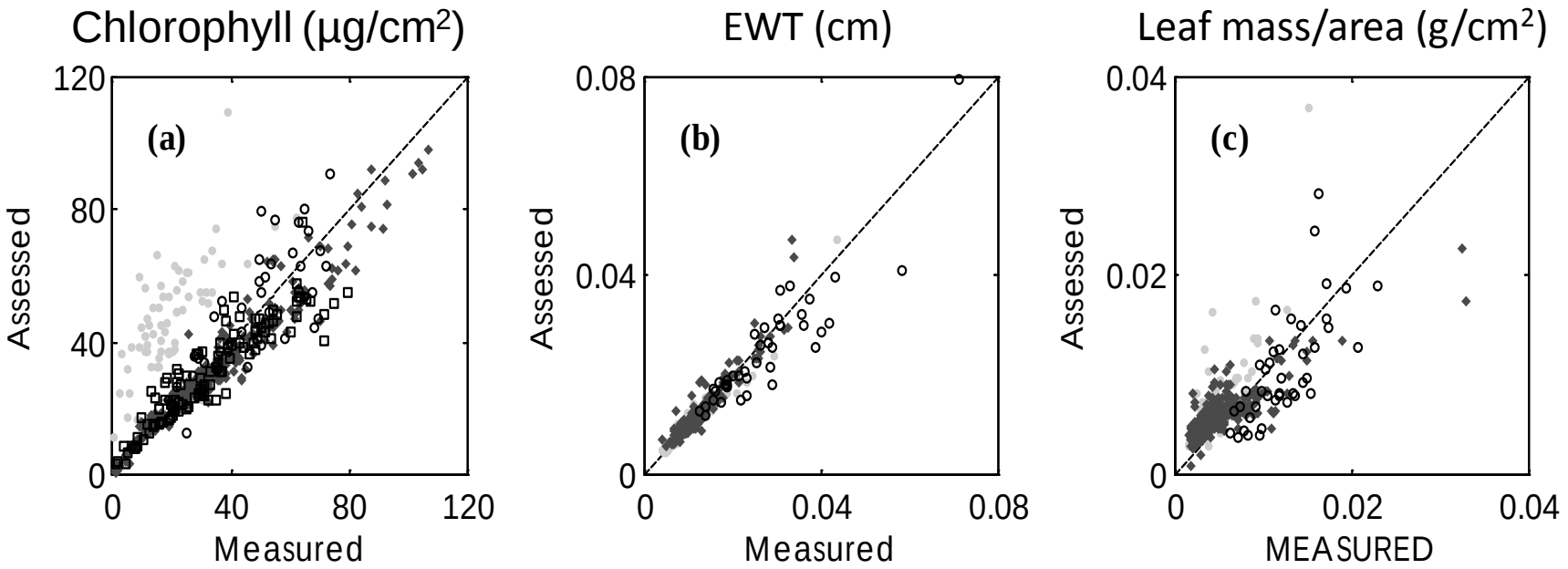
P. Zarco-Tejada et al., RSE 2003

$$\chi^2 = \sum_{i=1}^{n} \left\{ R_i - R_{\text{mod}}(\Theta, \lambda) \right\}^2$$

Interannual September CWC for Southwestern US & Mexico



PROSPECT 4: Data sets ● LOPEX ☐ CALMIT ◆ ANGERS ○ HAWAII

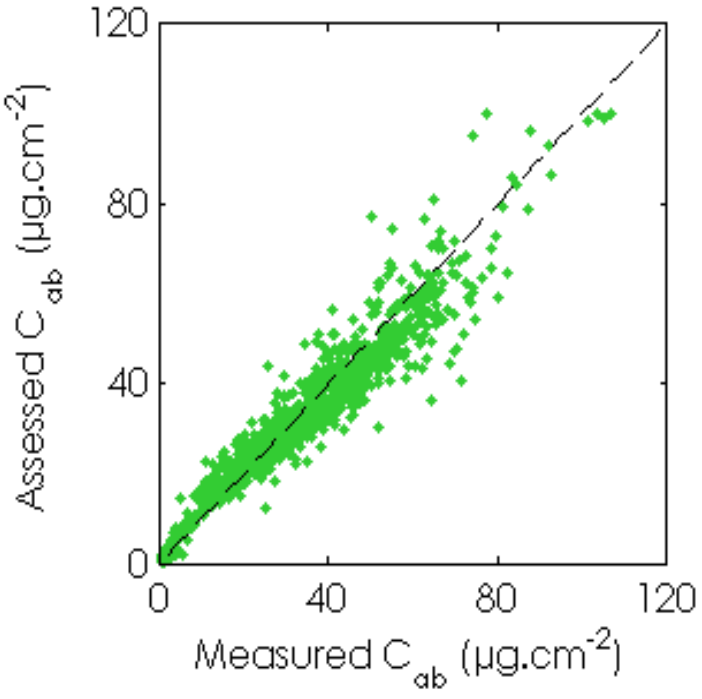


Feret, J-B., François, C. Asner, GP, Gitelson, AA, Martin, RE, Bidel, L.P.R., Ustin, S.L., le Maire, G., and Jacquemoud, S. 2008. PROSPECT-4 and -5: Advances in the Leaf Optical Properties Model Separating Photosynthetic Pigments. Remote Sensing of Environment 112: 3030-3043.

PROSPECT 4, 5: Assessment of Leaf Pigment Content

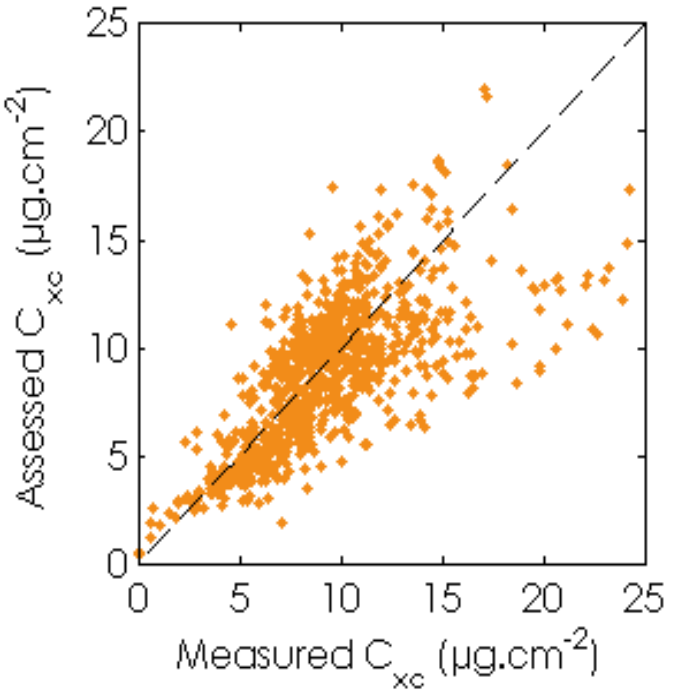
Chlorophyll

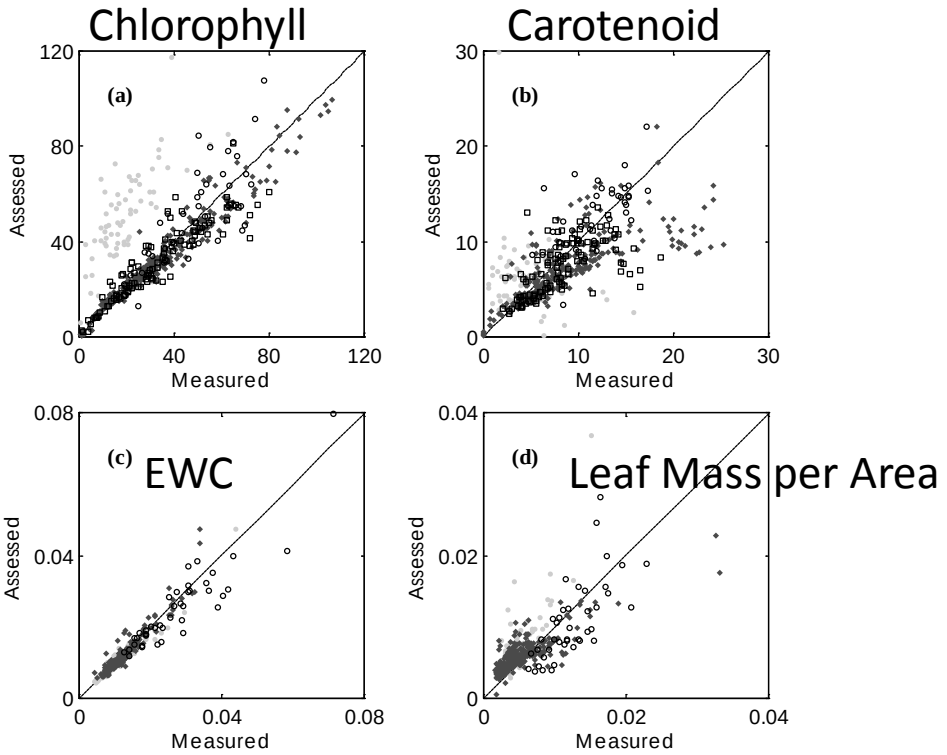
RMSE = 6.0 µg.cm^{-2}



Carotenoids

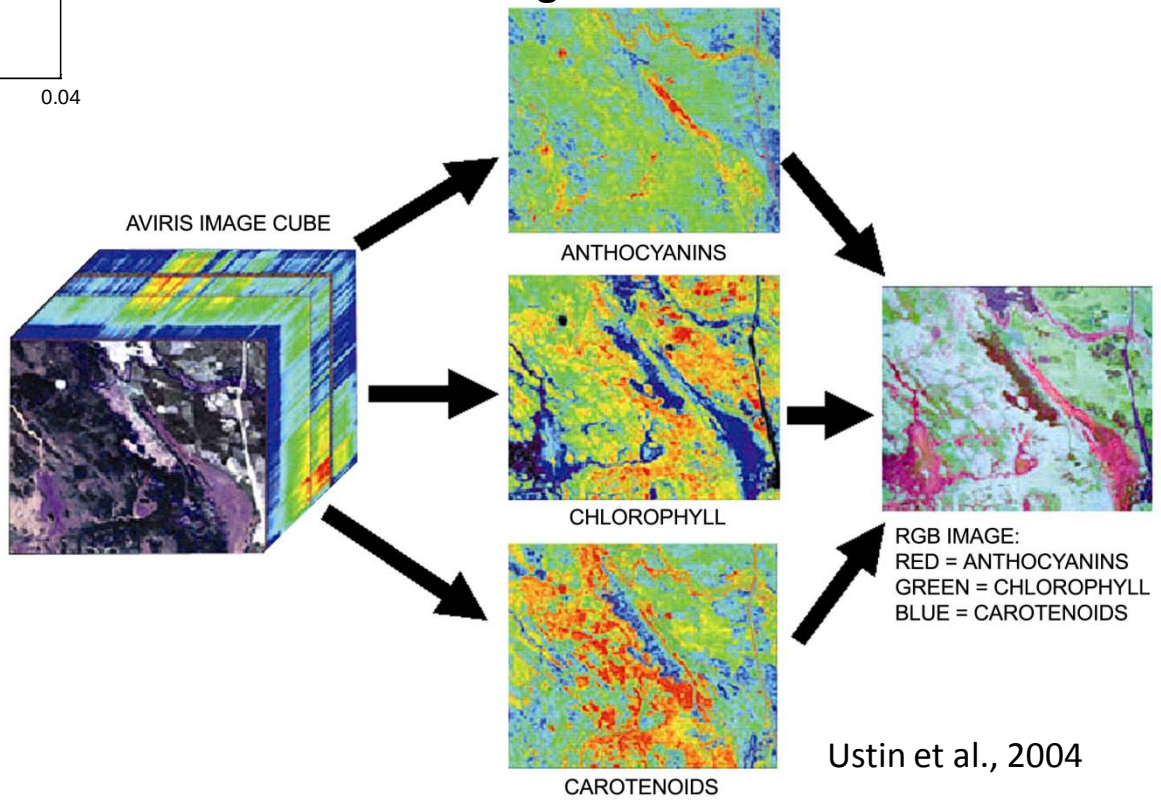
RMSE = 2.8 µg.cm^{-2}





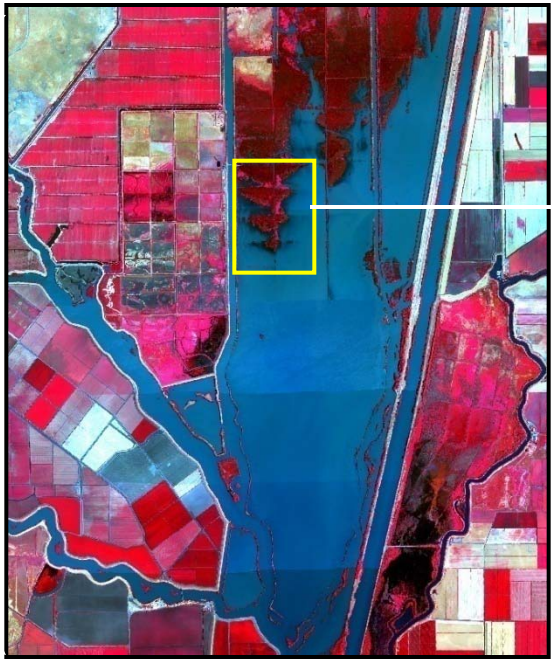
Feret et al. 2009. Remote Sensing of Environment 112: 3030-3043.

Following Fuentes et al. 2001

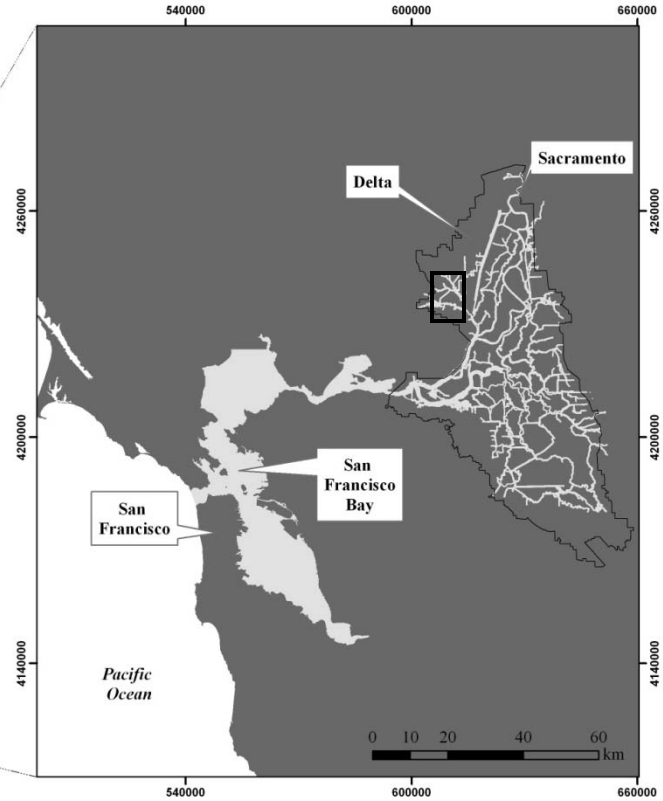


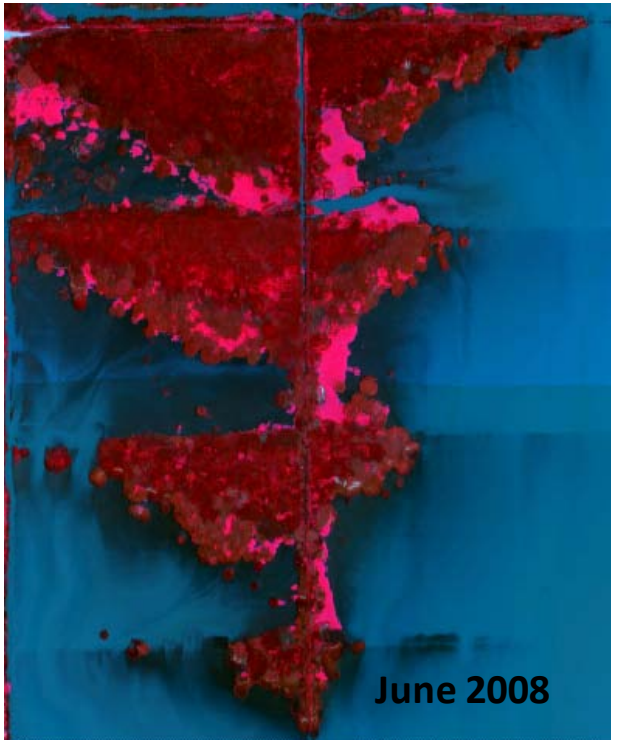
Ustin et al., 2004

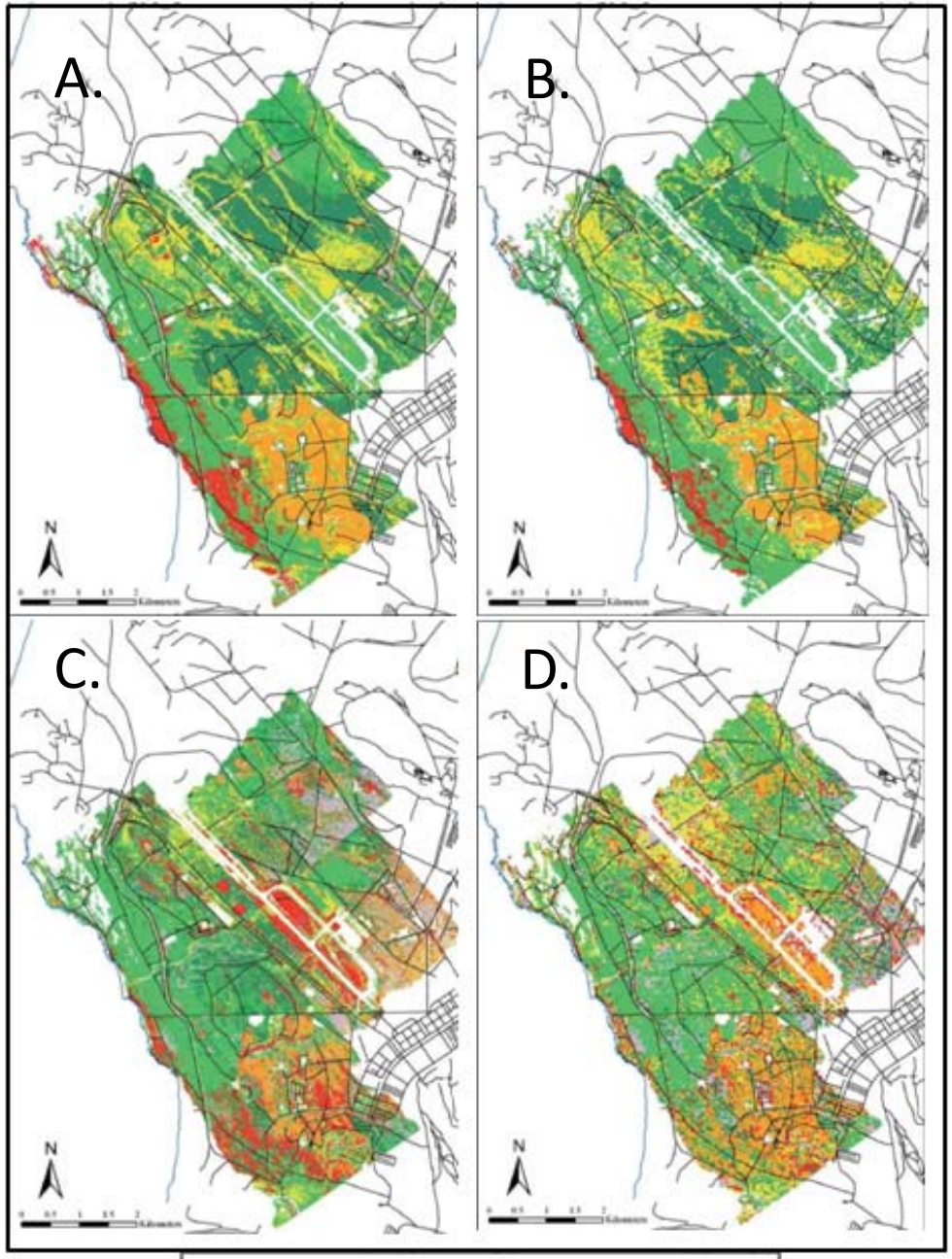
Expansion of Native Tule Marsh into flooded Liberty Island in four years



Liberty Island (flooded, former agricultural land)







Spatial Resolution is Less Important for Species/Community Mapping than Spectral Resolution

A. Full AVIRIS spectral resolution, 3m IFOV
B. Full AVIRIS spectral resolution, 30m IFOV
C. Landsat TM bands, 3m IFOV
D. Landsat TM bands, 30m IFOV

Underwood, E. S.L. Ustin and C. Ramirez. 2006. A comparison of spatial and spectral image resolution for mapping invasive plants in coastal California, Ecological Management, 39 (1): 63-83.

Fire Risk Maps of Roof and Building Composition, Impervious Surfaces and Vegetation

A: Red tile roof
B: Wood shingle roof
C: Grey composite shingle roof

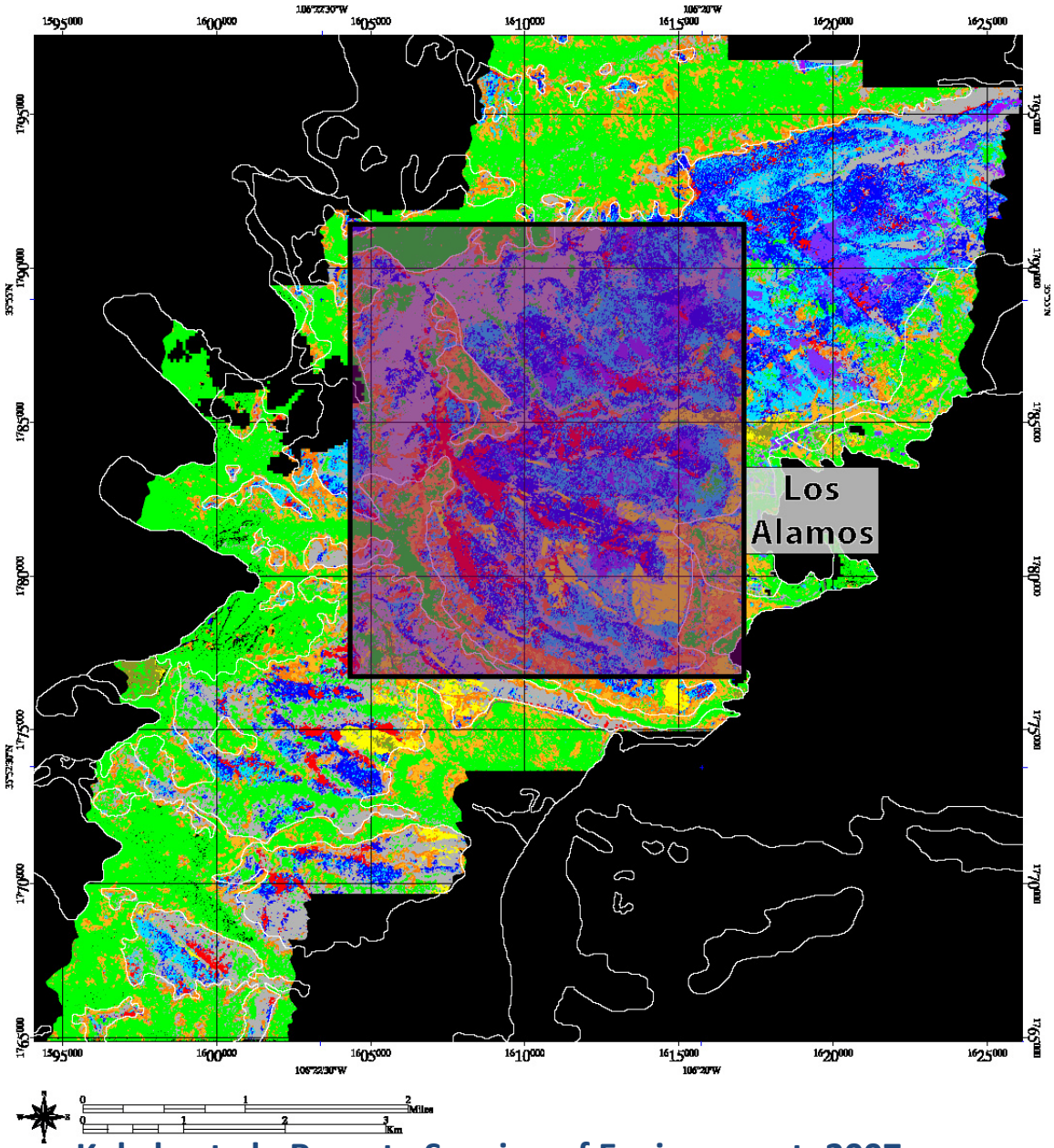
D: Concrete road
E: Asphalt road
F: Parking lot

G: Green vegetation
H: Non-photosynthetic vegetation
I: Bare soil

High resolution AVIRIS image
RGB: 2338nm/846nm/438nm
Goleta, CA, June 2000

Dar Roberts lab

AVIRIS Maps of Wildfire Disturbance: Burned and Unburned Land Cover within Burn Scar Area



Ash / Charcoal

Mineral / Ash

Mineral-1μm

Mineral-2μm

Dry Conifer

Dry & Green Conifer

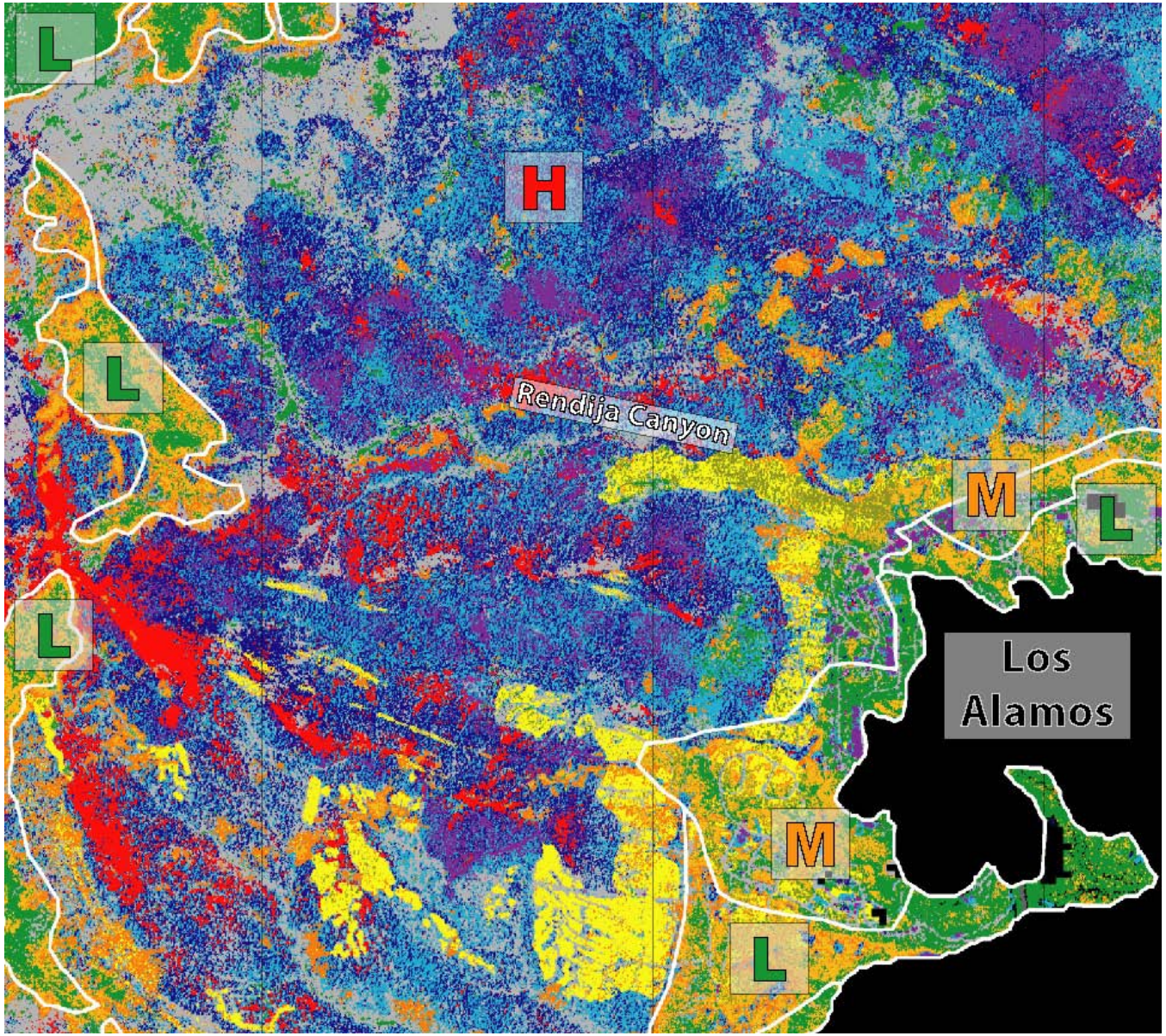
Straw matting

Straw matting & Green grass

Green Vegetation

Kokaly et al., Remote Sensing of Environment, 2007

Recovery and Revegetation Depend on Survival Patterns



Ash/Charcoal

Mineral/Ash

Mineral-1μm

Mineral-2μm

Dry Conifer

Dry & Green Conifer

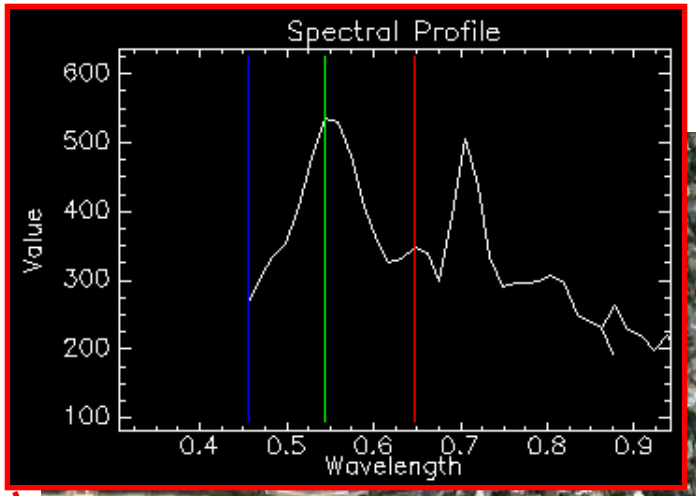
Straw matting

Straw matting & Green grass

Green Vegetation

Kokaly et al., Remote Sensing of Environment, 2007

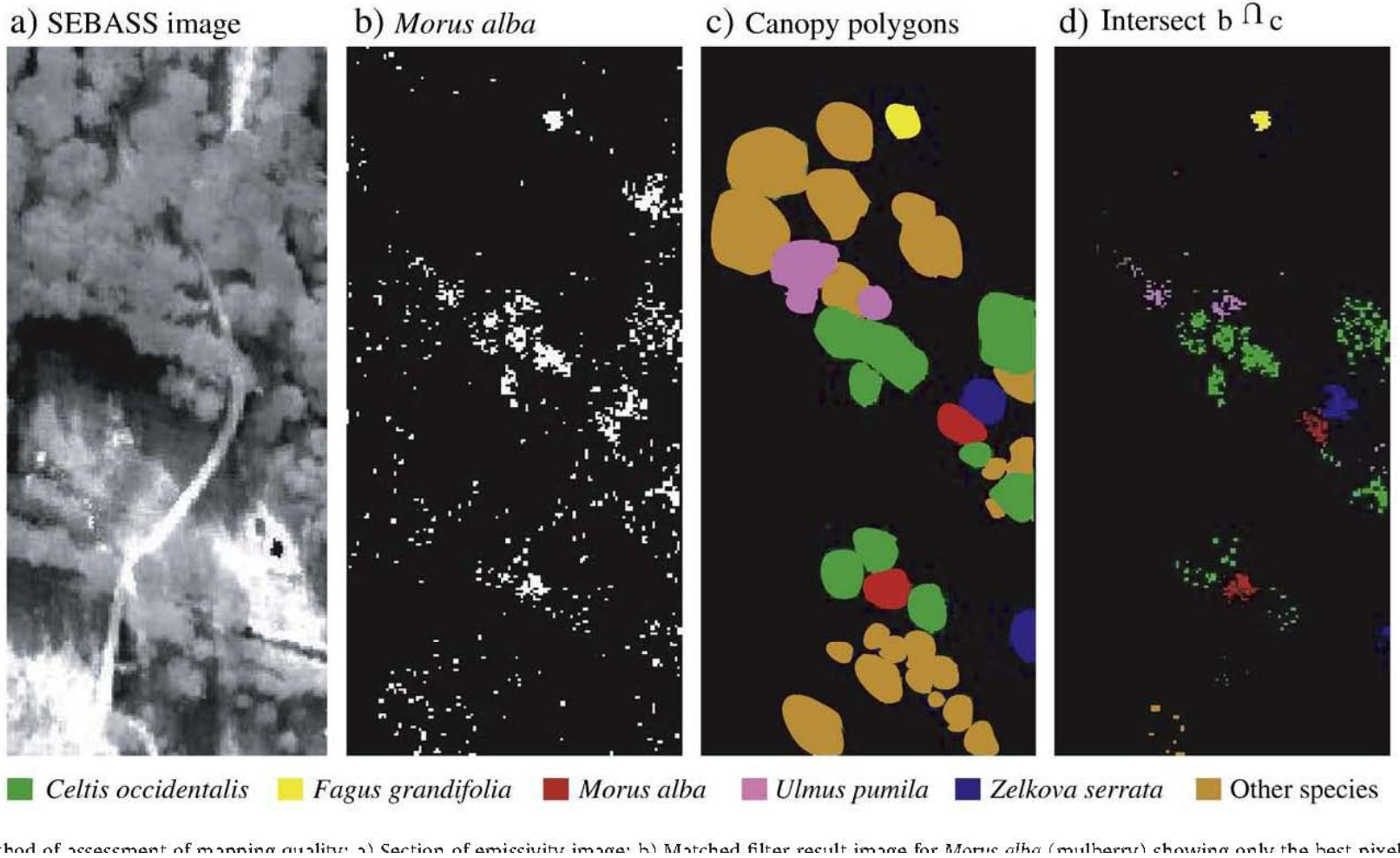
Toxic Algae: Microcystis bloom



HyMap imaging spectrometer true-color image

Port of Stockton July 2, 2004

Vegetation Mapping is Improved using Multiband and Hyperspectral TIR Imagery



Method of assessment of mapping quality: a) Section of emissivity image; b) Matched filter result image for *Morus alba* (mulberry) showing only the best pixel m

Identification of plant species by using high spatial and spectral resolution thermal infrared (8.0–13.5 µm) imagery

Beatriz Ribeiro da Luz , James K. Crowley, RSE 2010