

"What is a Forest Ecologist Doing Working for NASA? -  
**The Use of NASA Technology and Models to Study Land Surface Abiotic and Biotic Processes "**



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ESES Graduate Summer Bridge Program  
CCNY

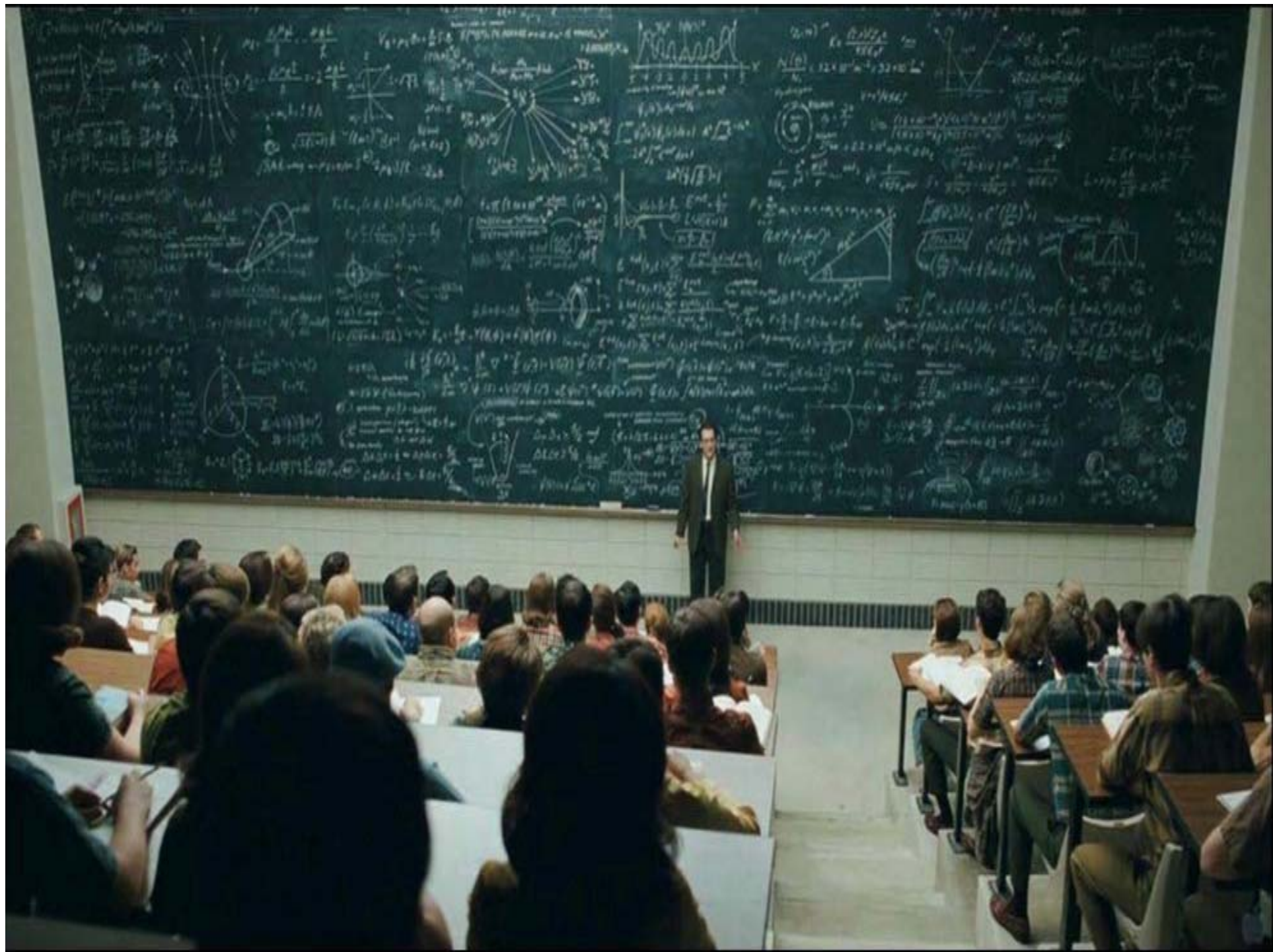






Figure 3-4 Photograph of Gaspard Felix Tournachon (1820-1910), the famous Parisian photographer. He called himself Nadar. Here he is seen kneeling in a fragile balloon gondola. He obtained the first aerial photograph from a balloon in 1858 near Paris, France, and patented the aerial survey as we know it today. Unfortunately, the first aerial photograph did not survive (© Roger-Viollet, Paris, France; used with permission).



Figure 3-5 A portion of an aerial photograph of downtown Boston, MA, obtained by aeronauts James W. Black and Samuel A. King from a tethered balloon at an altitude of 1,200 ft on October 13, 1860. It is believed to be the first aerial photograph taken from a captive balloon in the United States and the earliest aerial photograph still in existence. It was obtained using a wet collodion plate (used with permission of the Smithsonian Institution, Washington, DC; #3B-15472).



A dark blue silhouette of a city skyline with various skyscrapers and buildings of different heights and shapes, set against a lighter blue background.

# Sensors Considerations

1. Spectral sensitivity of the sensors available.
2. Presence or absence of atmospheric windows in the spectral ranges in which one wants to sense.
3. The source, magnitude, and spectral composition of the energy available in these ranges.

# Landsat Satellite Series

Landsat 1: Launched 7/23/72; Deactivated 1/6/78

Landsat 2: Launched 1/22/75; Deactivated 2/25/82

Landsat 3: Launched 3/5/78; Deactivated 3/31/83

Landsat 4: Launched 7/16/82 (no longer collecting data;  
not yet deactivated)

Landsat 5: Launched 3/1/84

Landsat 6: Launched 10/5/93 (failed to achieve orbit)

Landsat 7: Launched 4/15/99





# 2010 NASA Science Plan

The 2010 Science Plan identifies the direction NASA has received from the Administration and Congress, advice received from the nation's science community, principles and strategies guiding the conduct of our activities, and challenges we face. The plan that results enables NASA, as Administrator Bolden says, to "do the best science, not just more science."

The NASA Earth Science strategic goal is stated as, *“Advance Earth System Science to meet the challenges of climate and environmental change.”*

[http://science.nasa.gov/media/medialibrary/2010/08/30/2010SciencePlan\\_TAGGED.pdf](http://science.nasa.gov/media/medialibrary/2010/08/30/2010SciencePlan_TAGGED.pdf)



# Earth System Science



Sun- Earth  
Connection

Climate Variability  
and Change

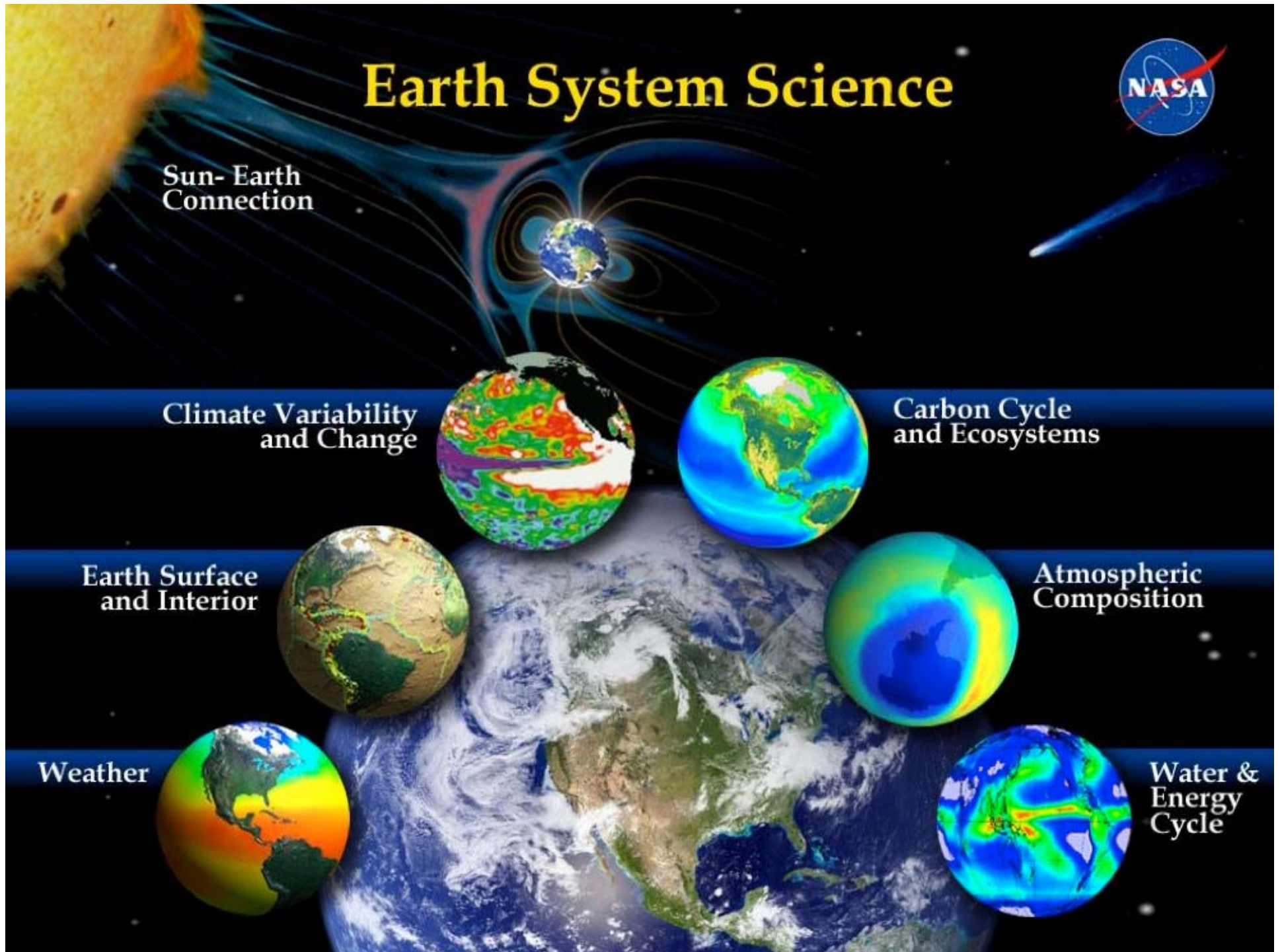
Carbon Cycle  
and Ecosystems

Earth Surface  
and Interior

Atmospheric  
Composition

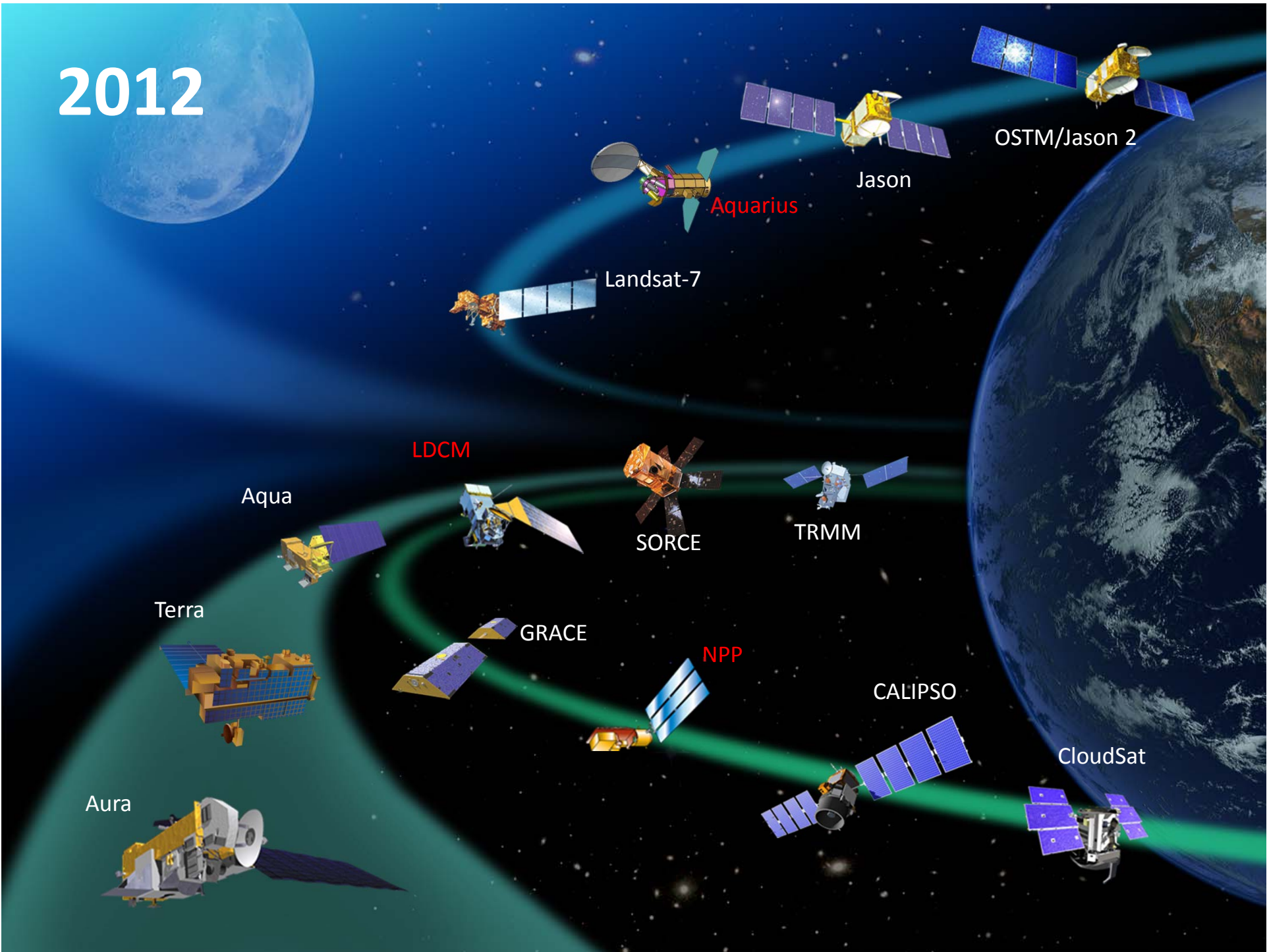
Weather

Water &  
Energy  
Cycle





2012



Aqua

Terra

Aura

LDCM

GRACE

NPP

CALIPSO

CloudSat

TRMM

SORCE

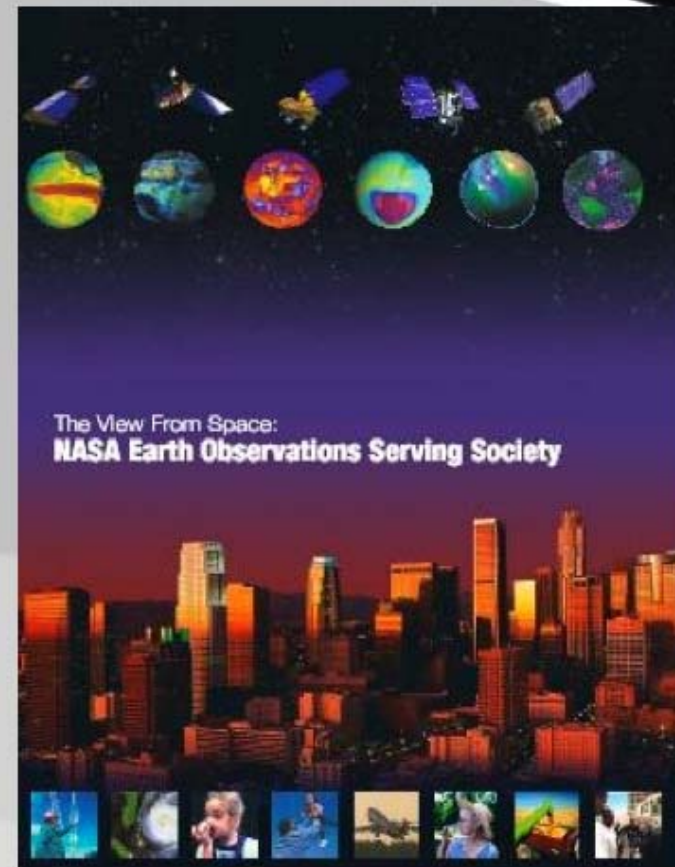
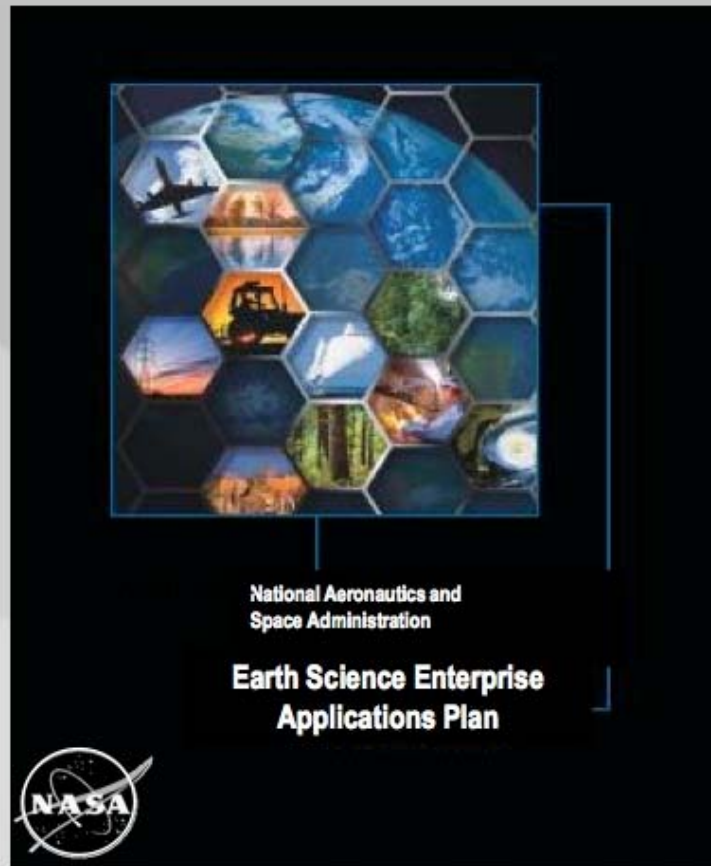
Landsat-7

Aquarius

Jason

OSTM/Jason 2

# Applied Sciences Program

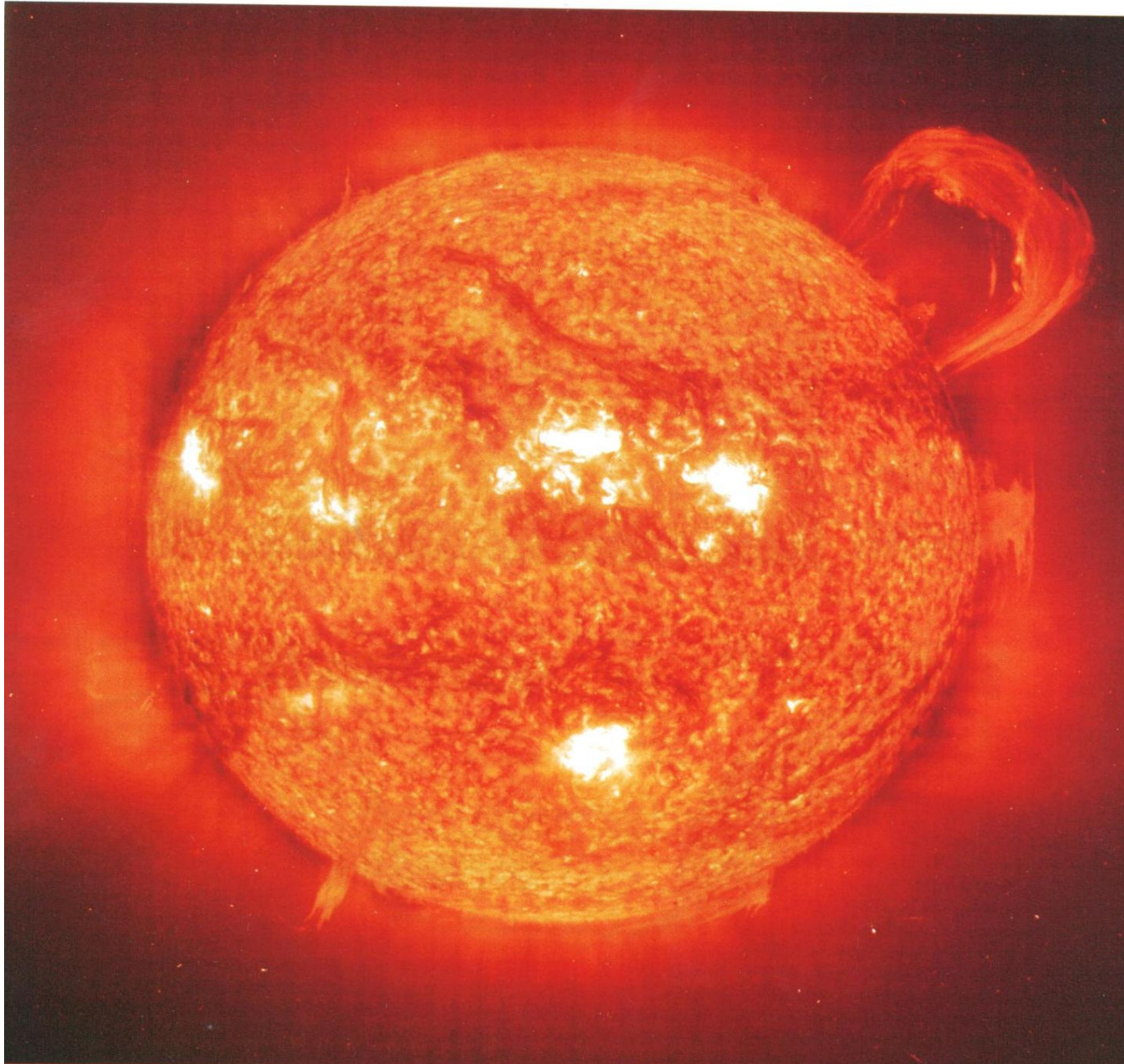


<http://nasascience.nasa.gov/earth-science/applied-sciences>





**Solar and Heliospheric Observatory (SOHO) EIT Image  
of the Sun Obtained on September 14, 1999**



# What Happens to the Sun's Energy

?





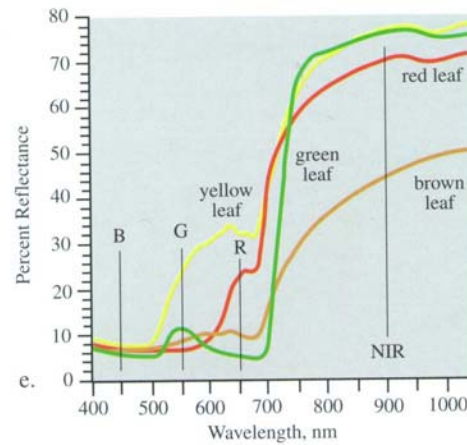
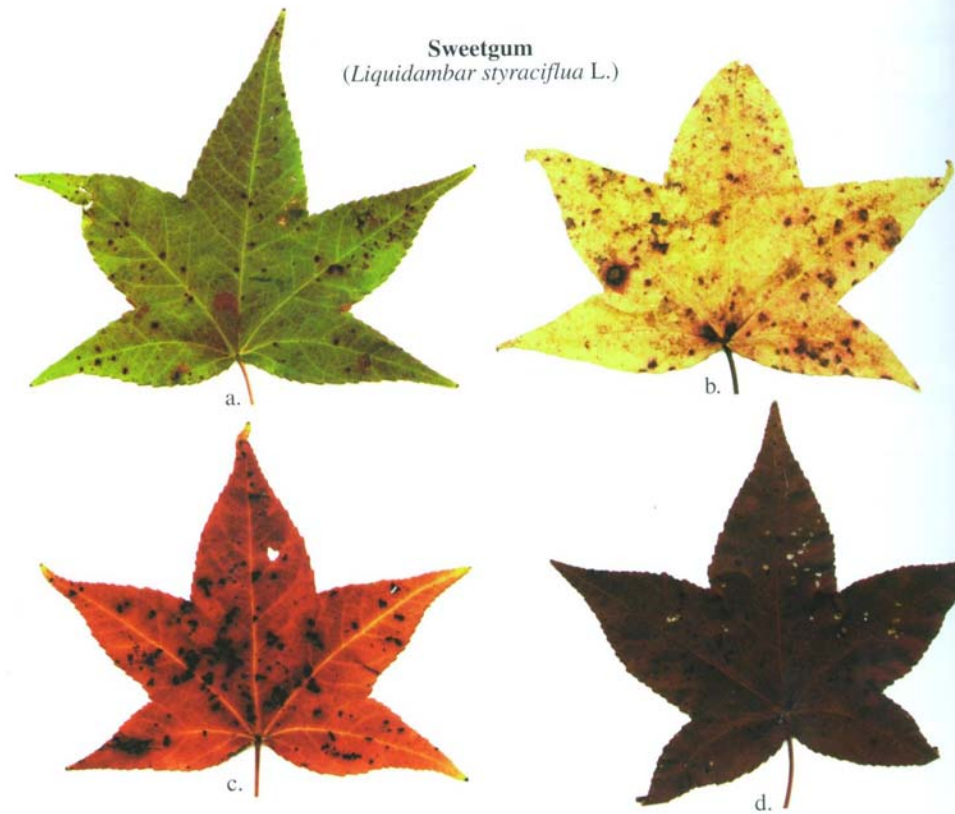
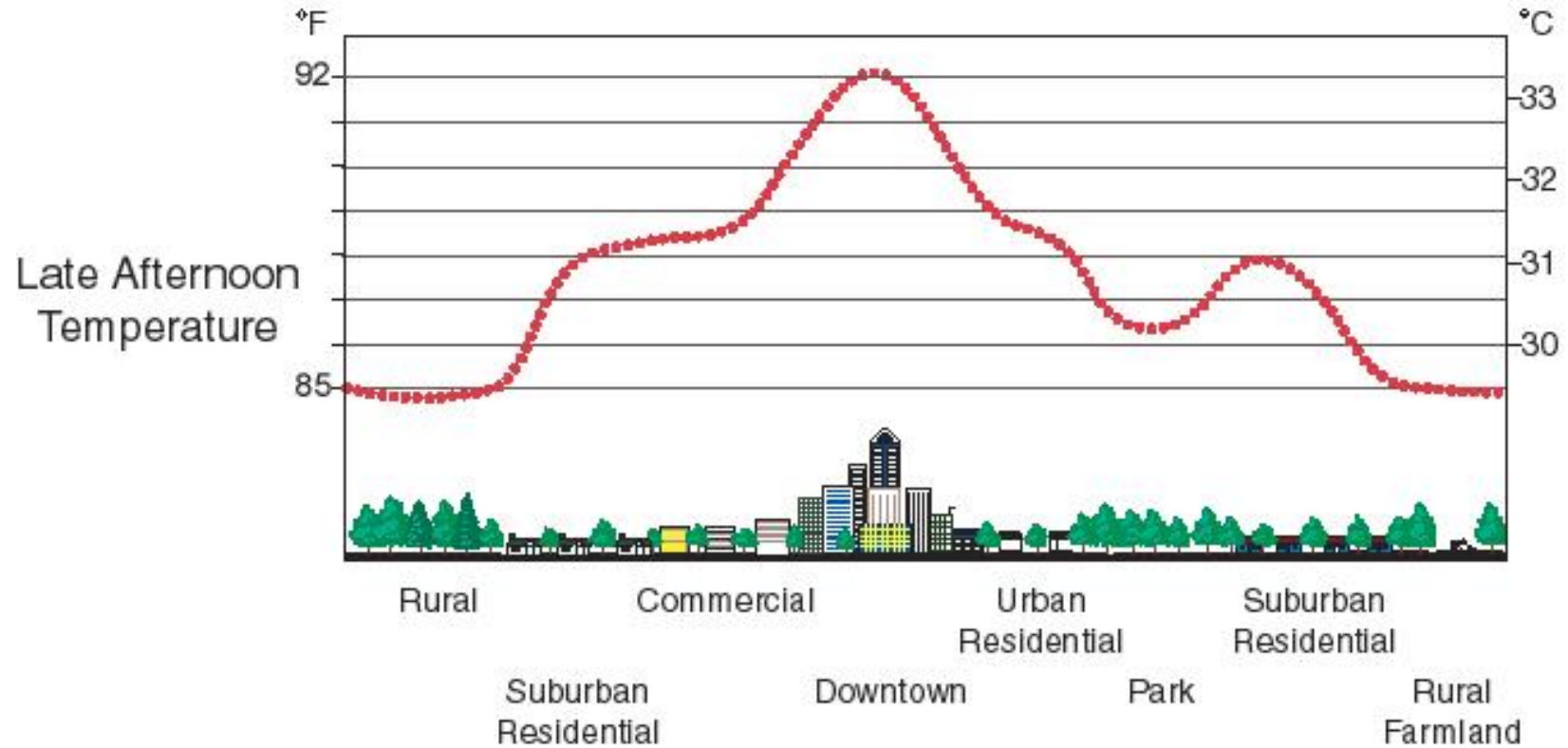


Plate 10-1 a) Photosynthesizing green Sweetgum leaf (*Liquidambar styraciflua* L.) obtained from a tree on November 11, 1998. b-c) Senescing yellow and red Sweetgum leaves obtained from the tree. d) Senesced Sweetgum leaf that was on the ground. e) Geophysical & Environmental Research, Inc. (GER) 1500 spectroradiometer percent reflectance measurements over the wavelength interval 400 – 1050 nm.

# Sketch of an Urban Heat-Island Profile





# Surface Radiation Budget

$$Q^* = (K_{in} + K_{out}) + (L_{in} + L_{out})$$

$Q^*$  = Net Radiation

$K_{in}$  = Incoming Solar

$K_{out}$  = Reflected Solar

$L_{in}$  = Incoming Longwave

$L_{out}$  = Emitted Longwave

A dark blue silhouette of a city skyline with various skyscrapers and buildings of different heights and shapes, set against a lighter blue background.

# Surface Energy Budget

$$Q^* = H + LE + G$$

H = Sensible Heat Flux

LE = Latent Heat Flux

G = Storage (maybe + or -)

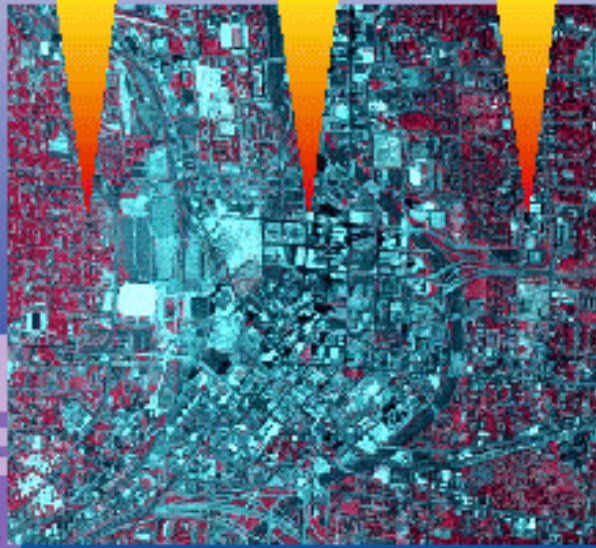




# Urban Remote Sensing and Air Quality Models

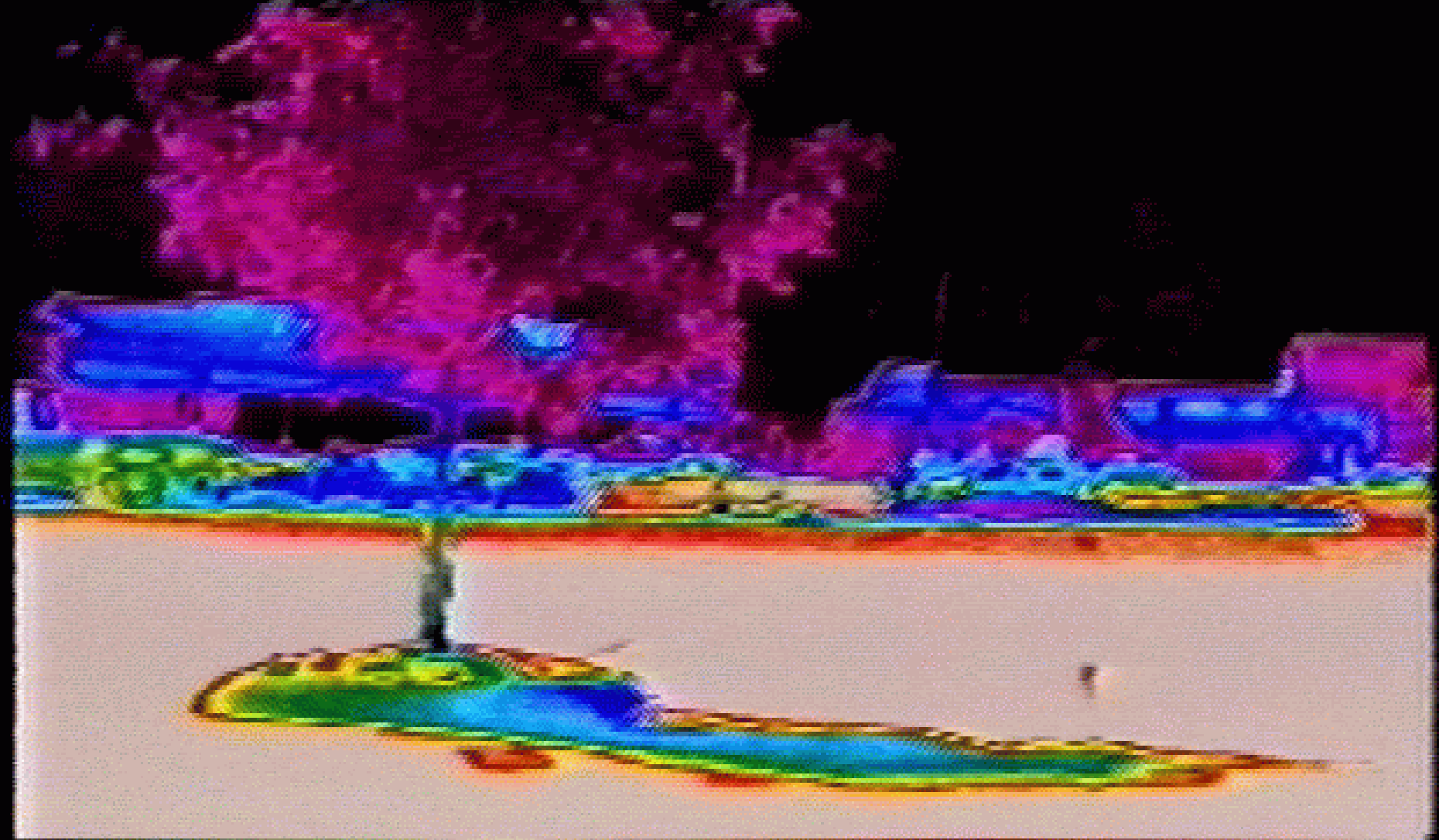
**Volatile Organic Compounds  
+ Nitrogen Oxides  
+ Sunlight**

**→ Ozone**

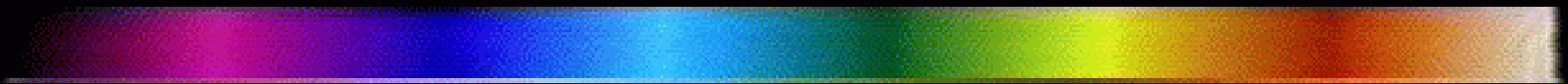


- Air pollution remains a National issue.
- Temperature increases the ozone levels.
- Urban heat island has major effect on temperature and height of mixing layer.
- Measurement program is defining land use patterns and relationship to heat production.
- Remote sensing data are being used to improve air quality modeling.

26 JUL 96 INFRAMETRICS 768 LM 15:22:21



+32.2°C IMAGE MODE IMG AVG=84 F +42.2°C







# Urban Heat Island Mitigation Strategies

---

## ▲ Albedo Modification

- Lighter colored roofs and pavements
- New materials/coatings

## ▲ Plant trees and increase green space

- Shade buildings, rooftops, parking lots and roads
- Cool the air through transpiration

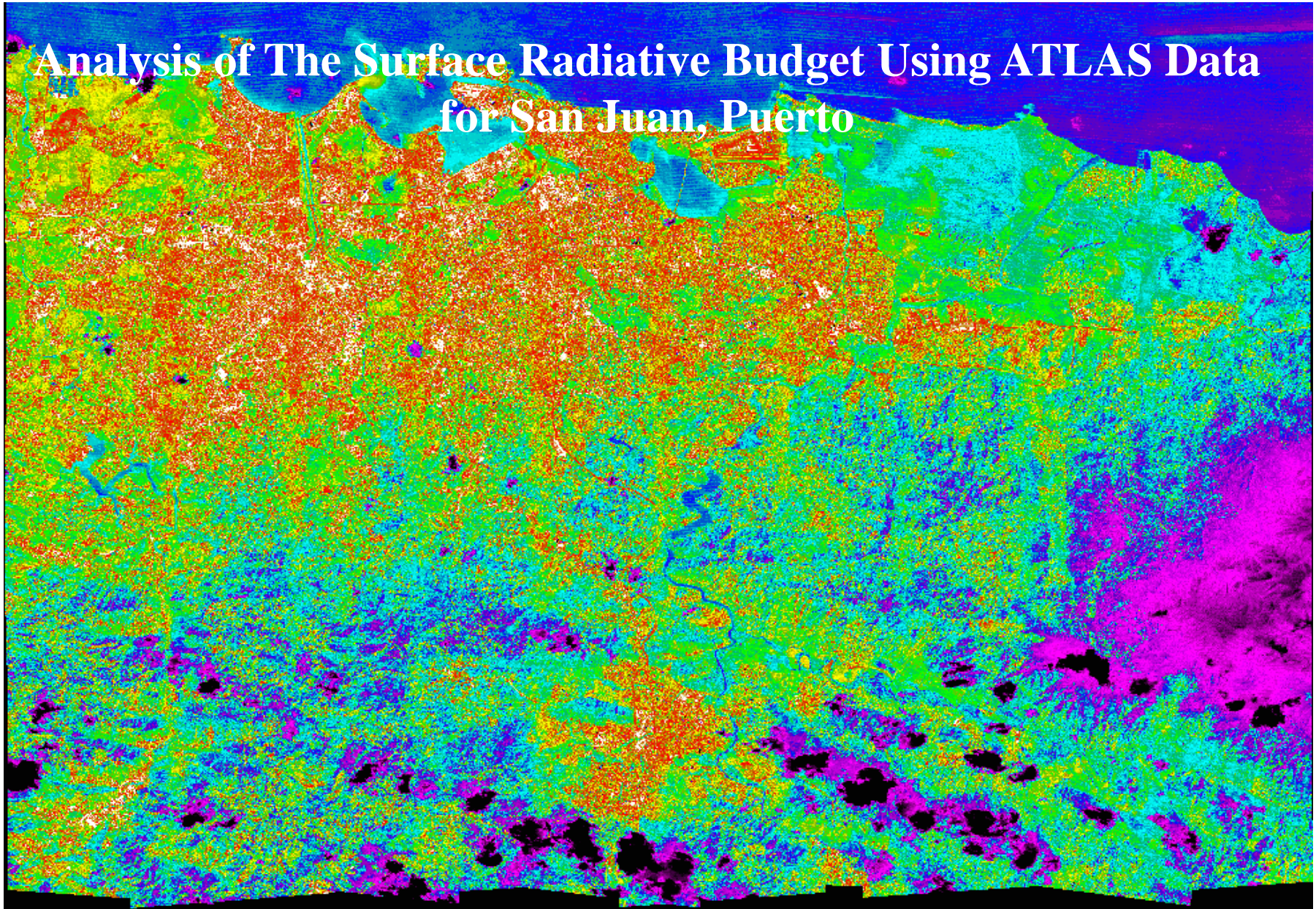
## ▲ Rooftop gardens

- Keep roofs cool by shading and/or transpiration
- storm water reduction





# Analysis of The Surface Radiative Budget Using ATLAS Data for San Juan, Puerto











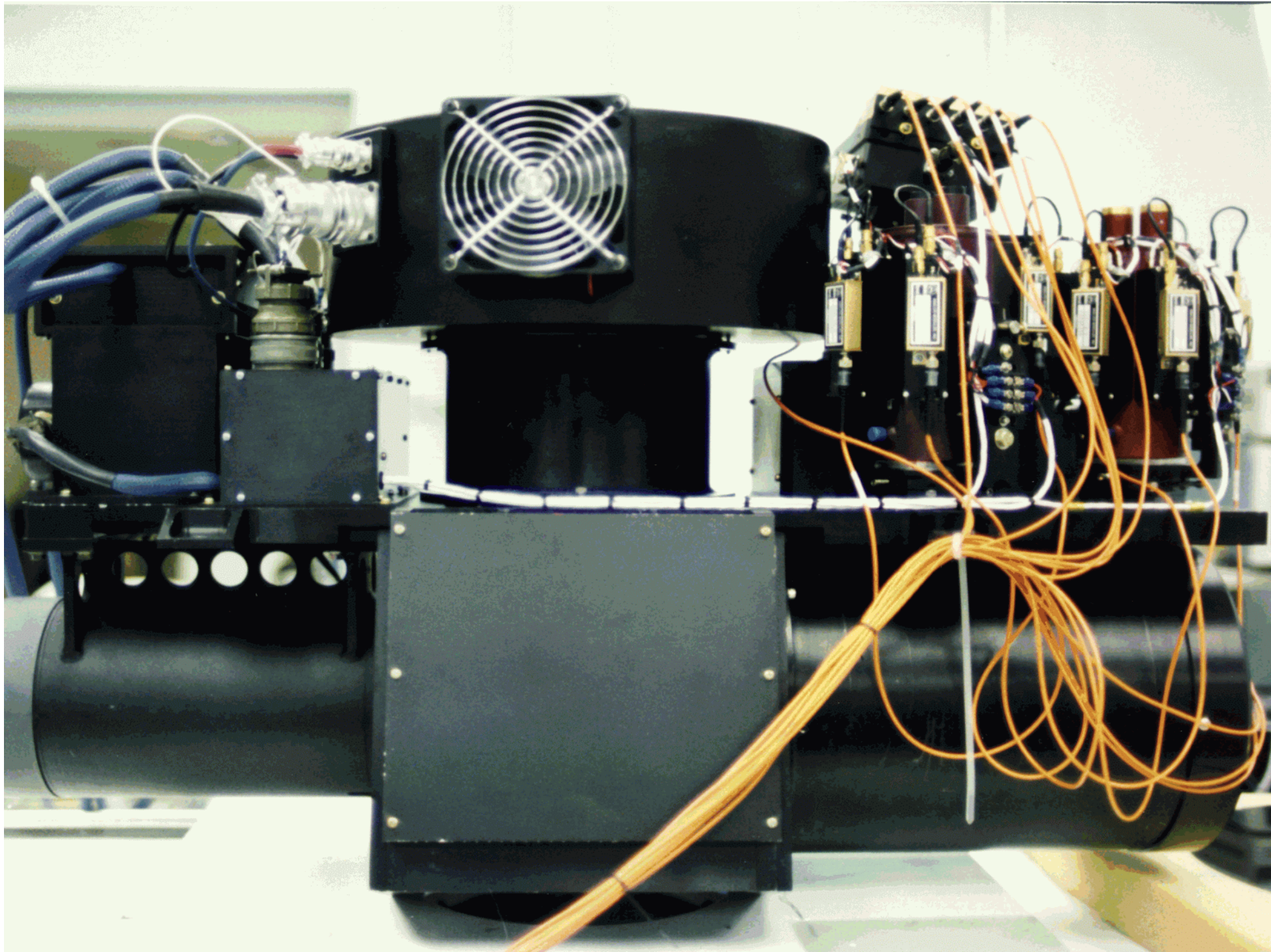








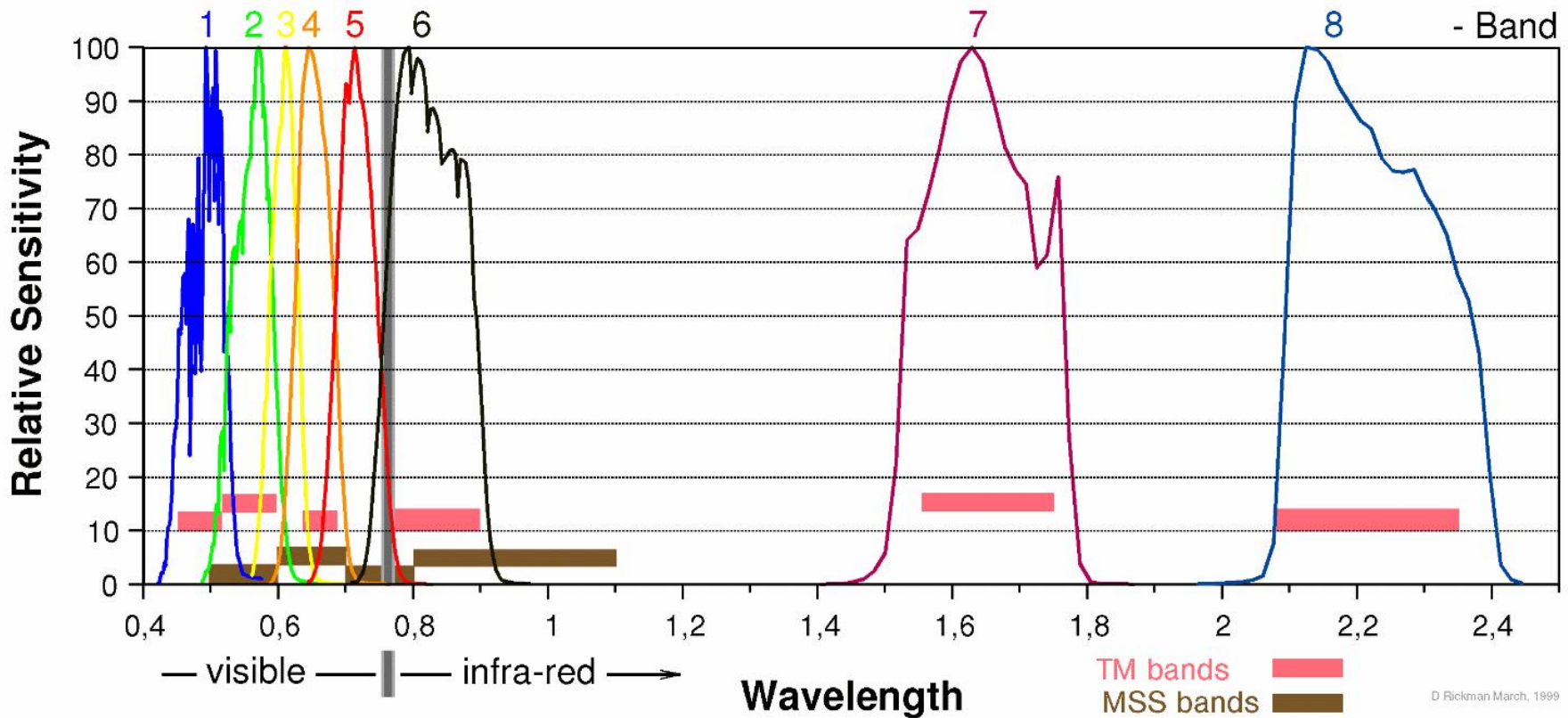






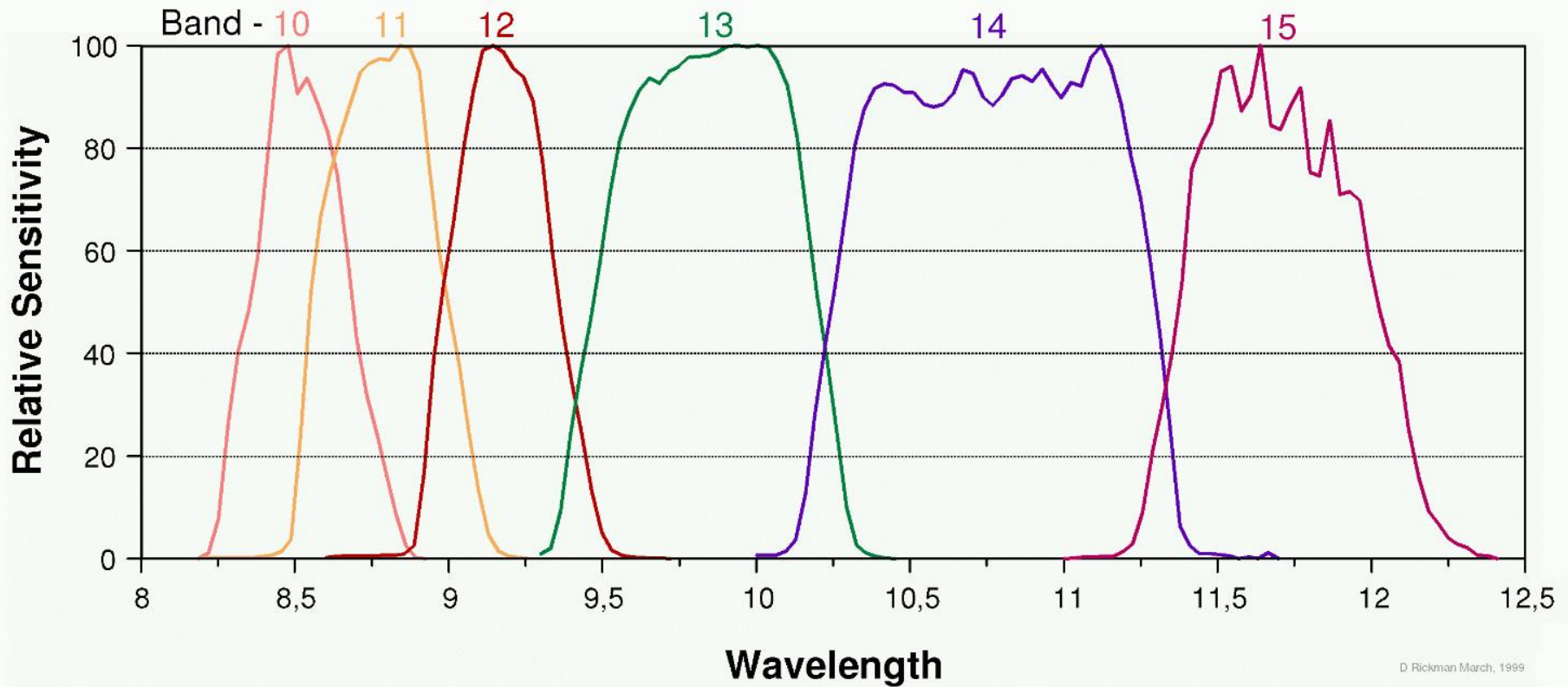
# ATLAS

## Typical Spectral Response Curves Reflected Bands

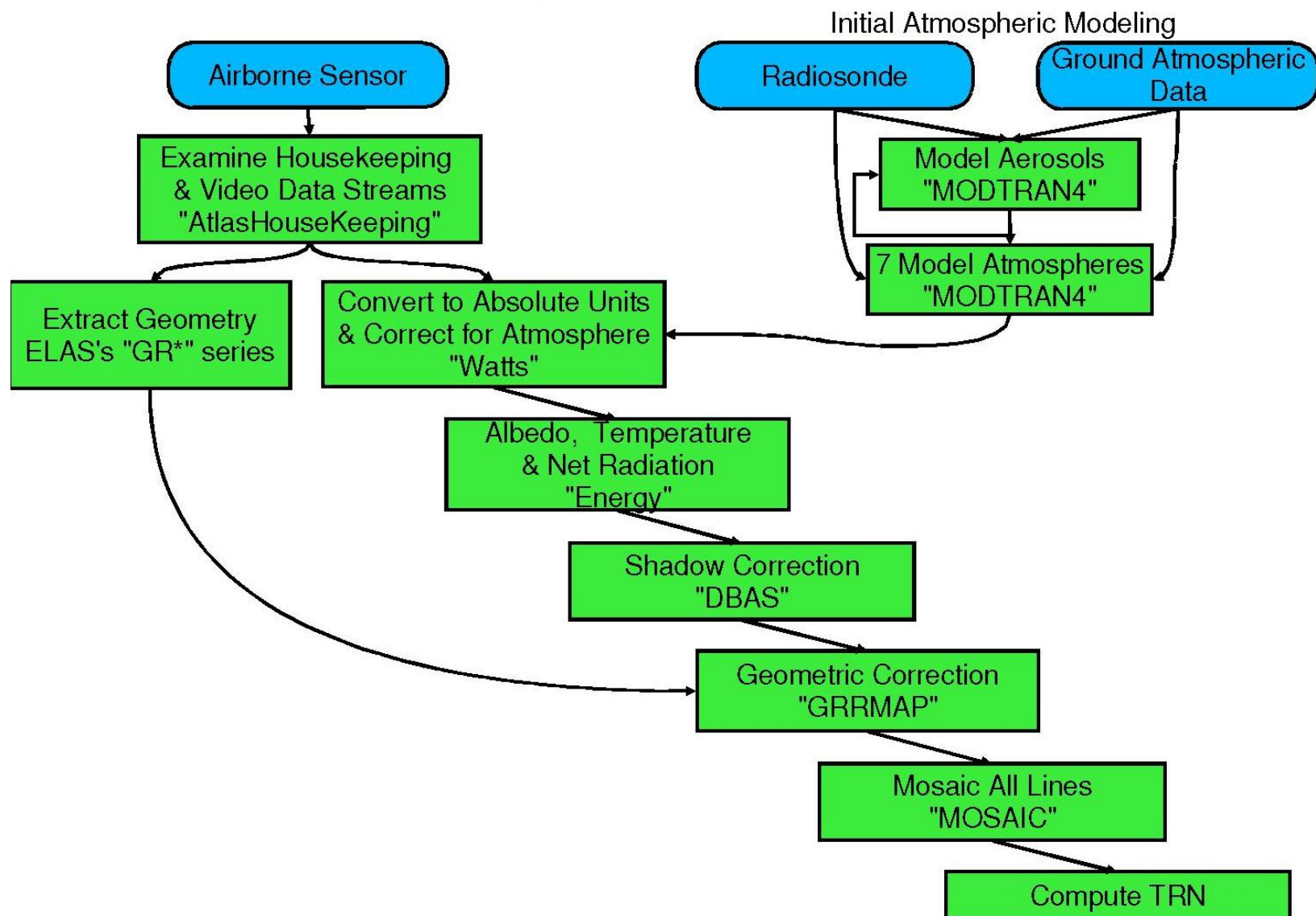


# ATLAS

## Typical Spectral Response Curves Thermal Bands



D Rickman March, 1999

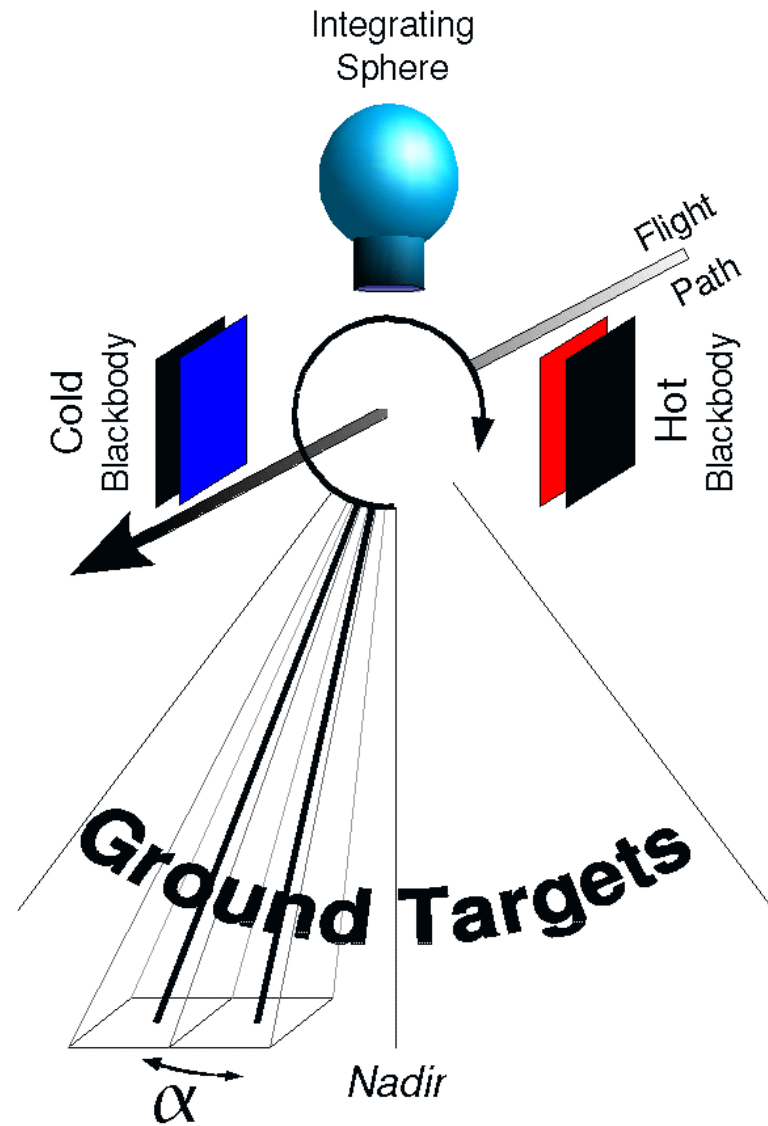




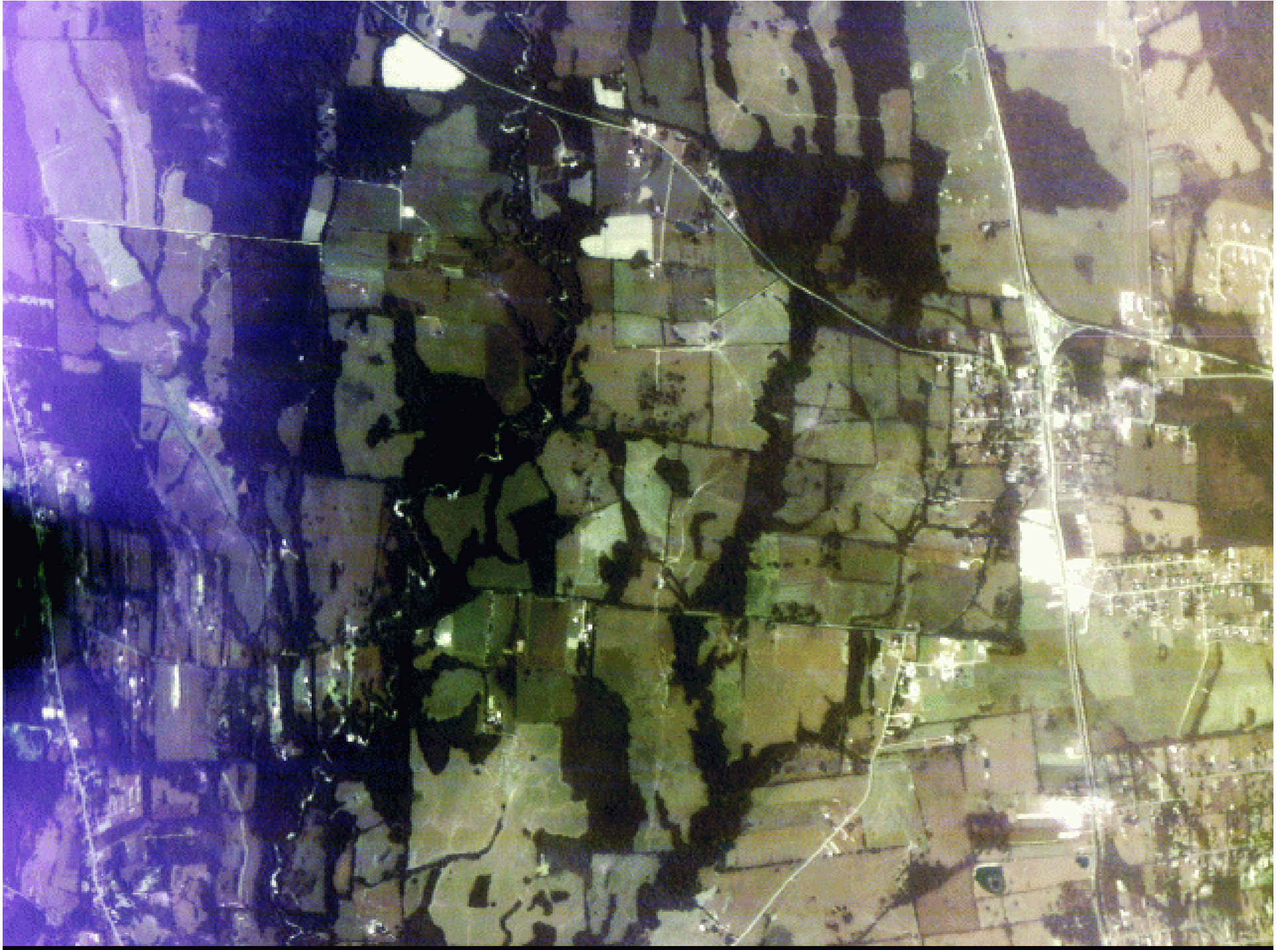
# "Doug" Gordian Knot

1. An intricate knot tied by King Gordius of Phrygia and cut by Alexander the Great.
2. An exceedingly complicated problem or deadlock.
3. To solve a problem by resorting to prompt and bold measures.









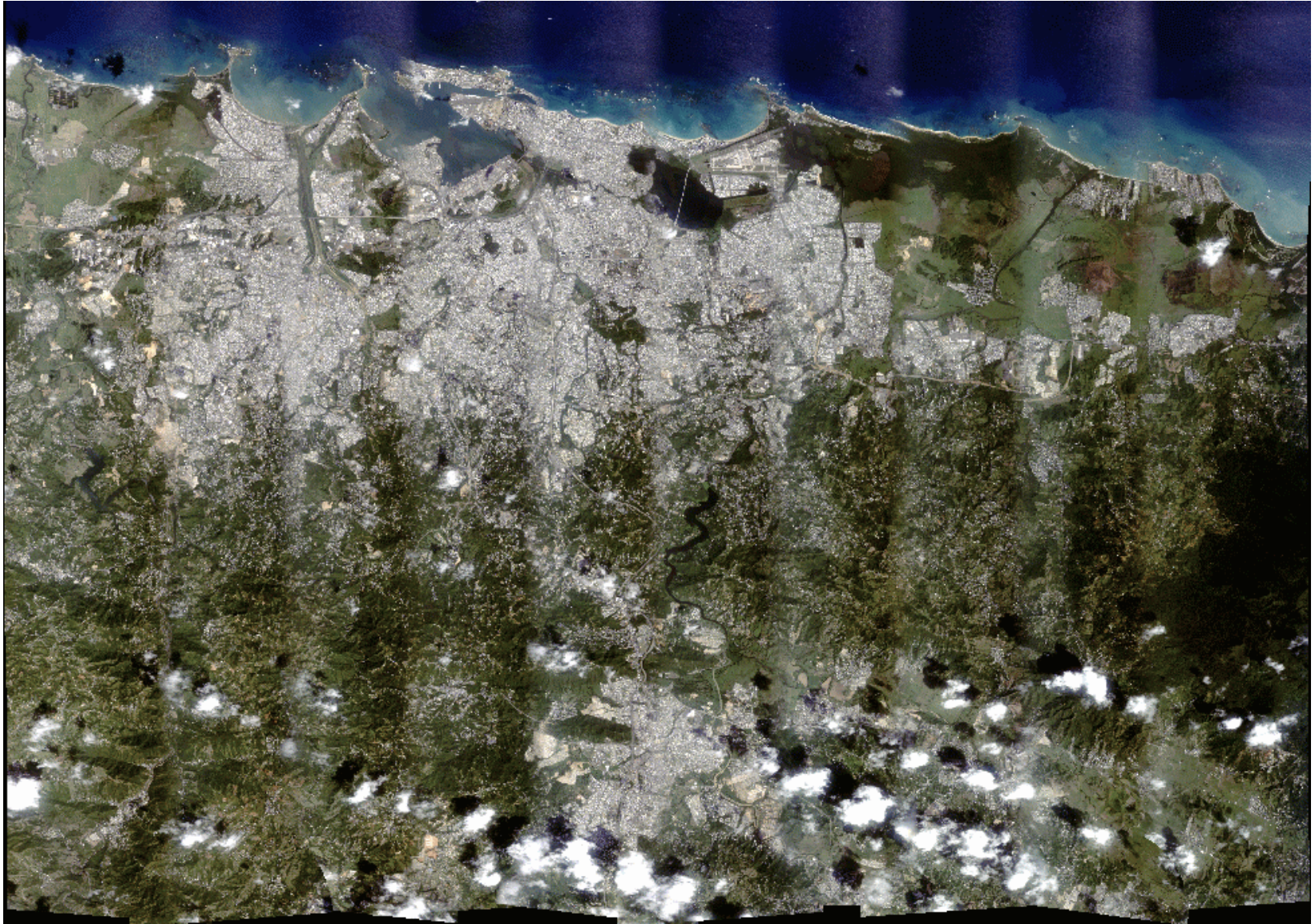






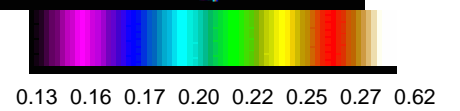
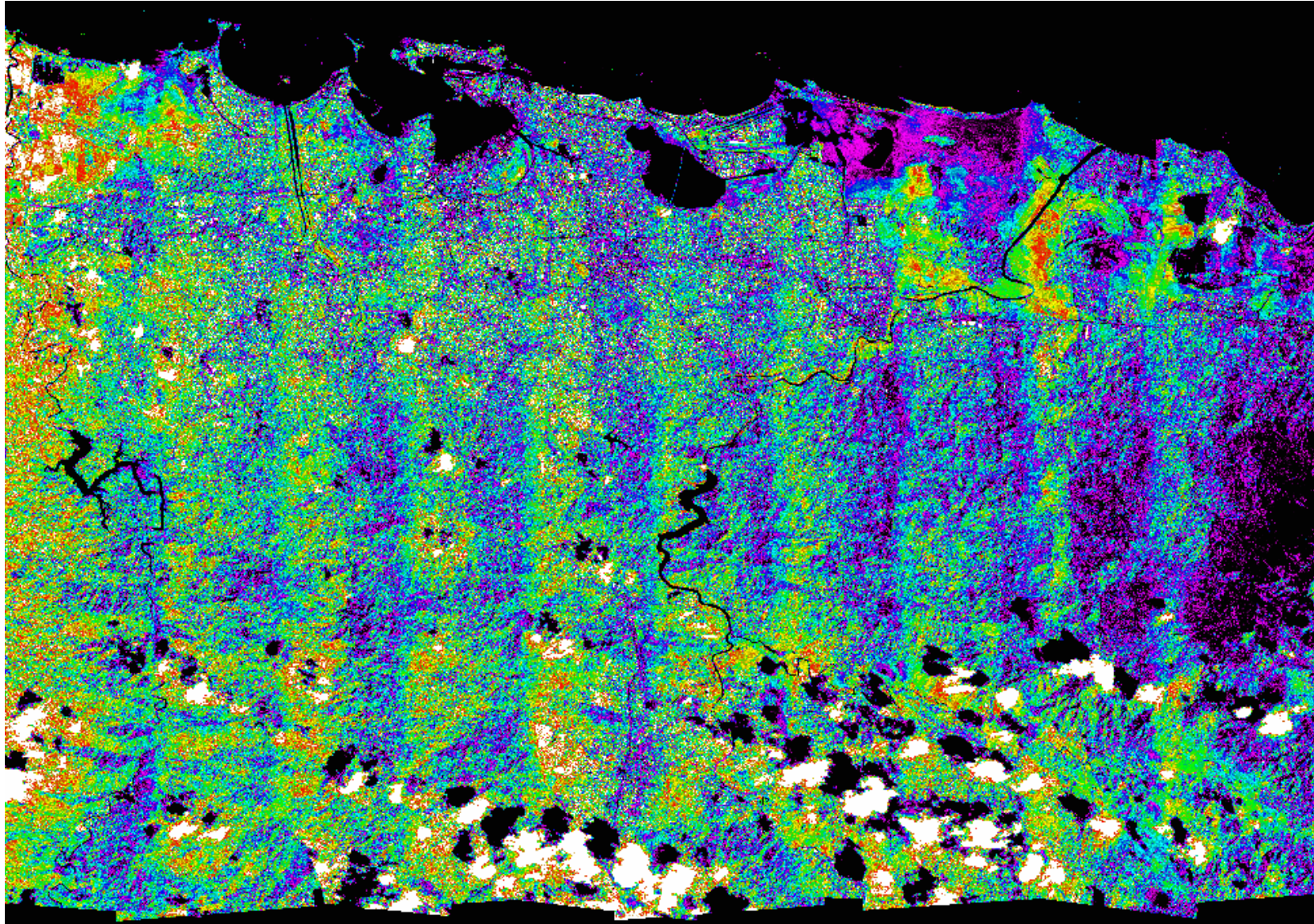


# San Juan F5 Mosaic True Color



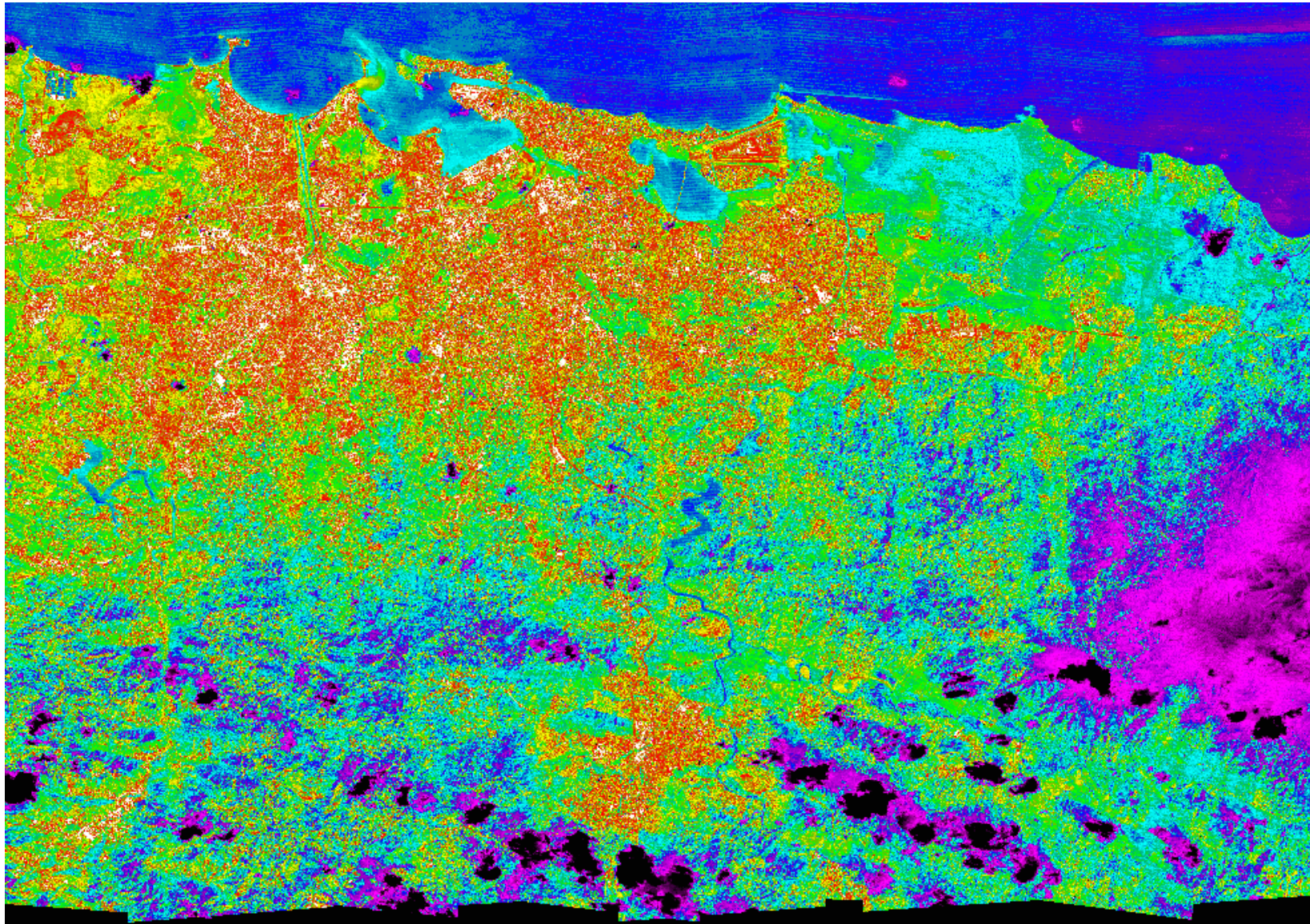


# San Juan F5 Mosaic Albedo





# San Juan F5 Mosaic Temperature

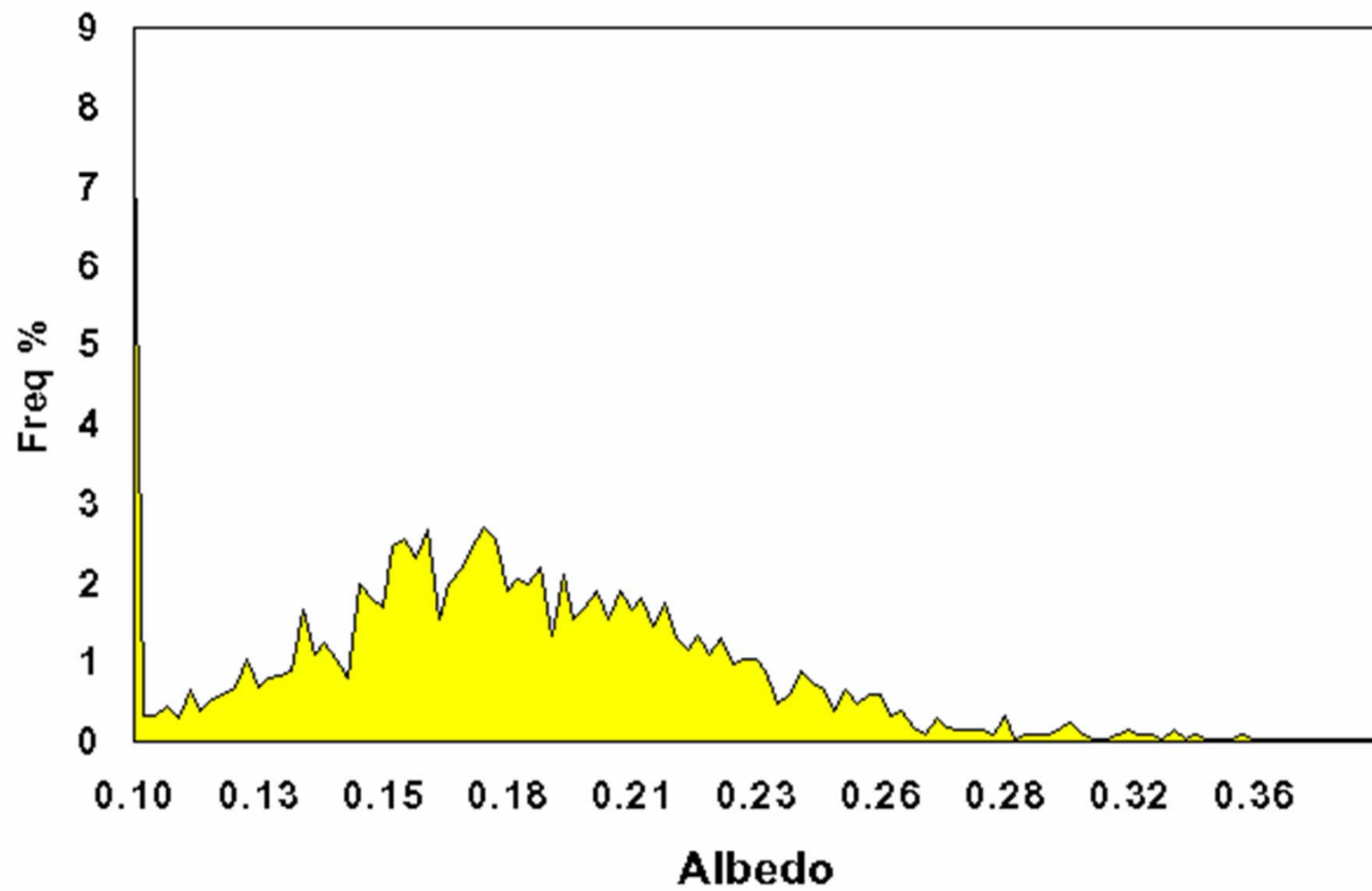


°C 10 20 26 27 28 32 39 41 48



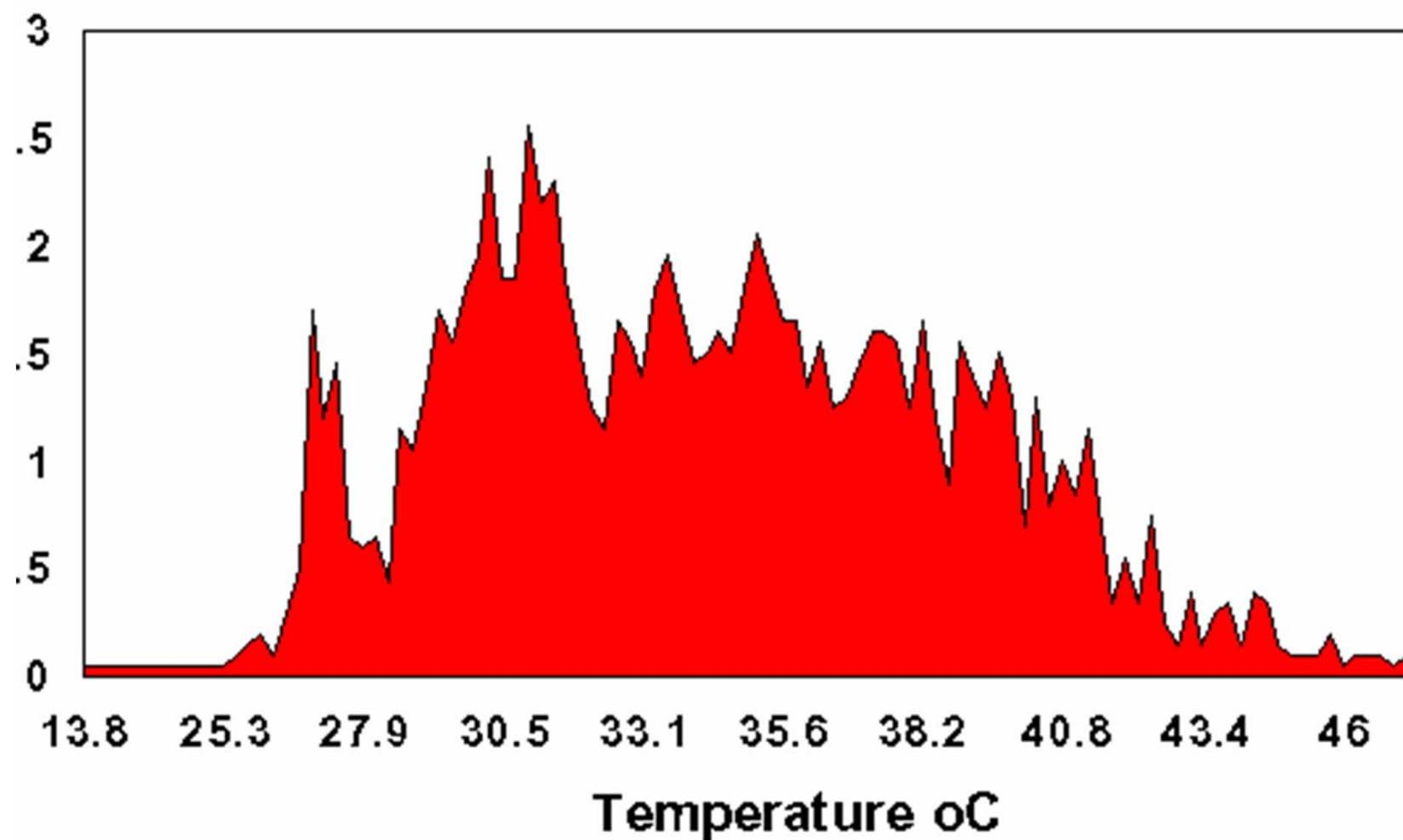


## San Juan Urban Albedo

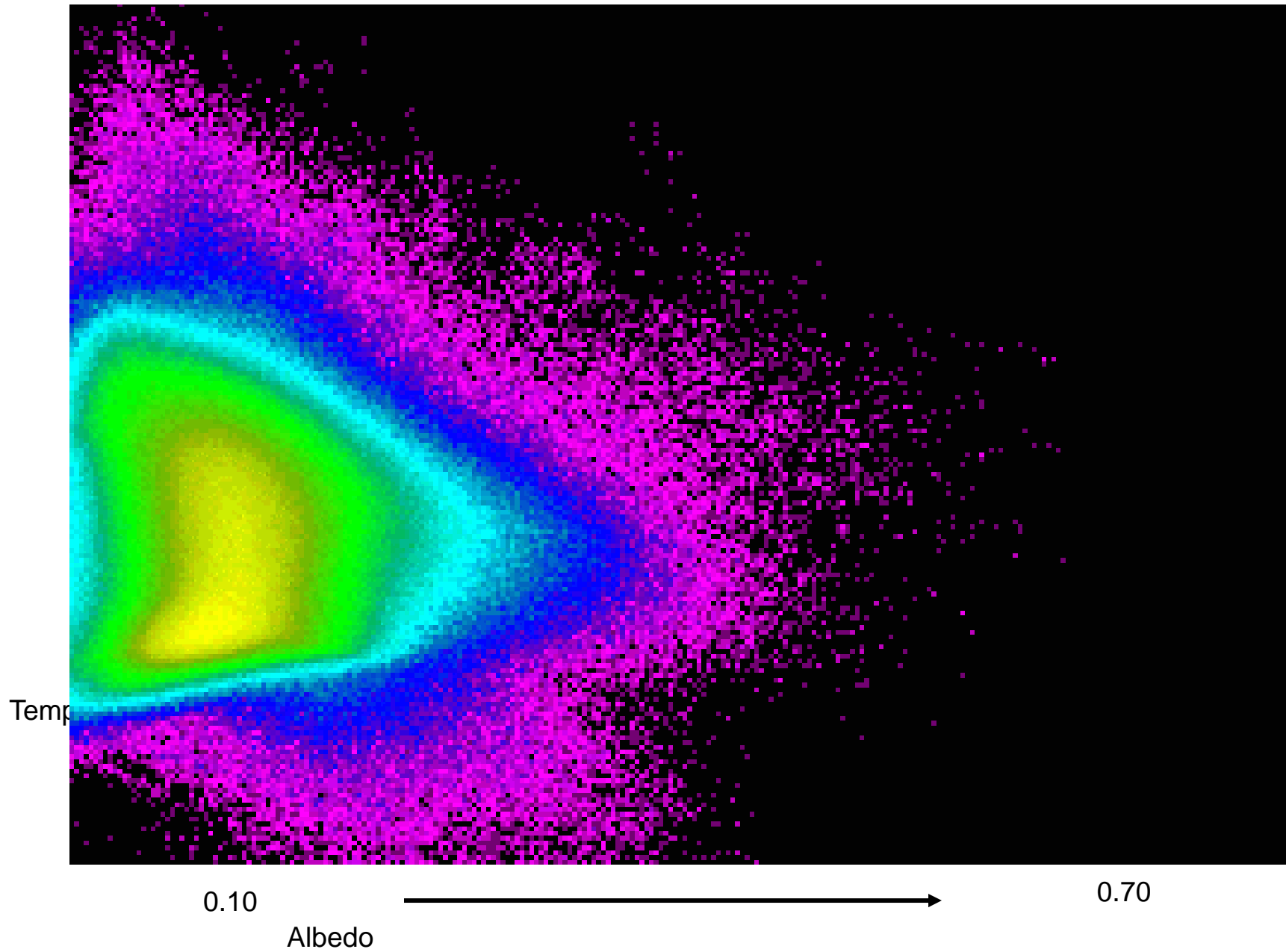


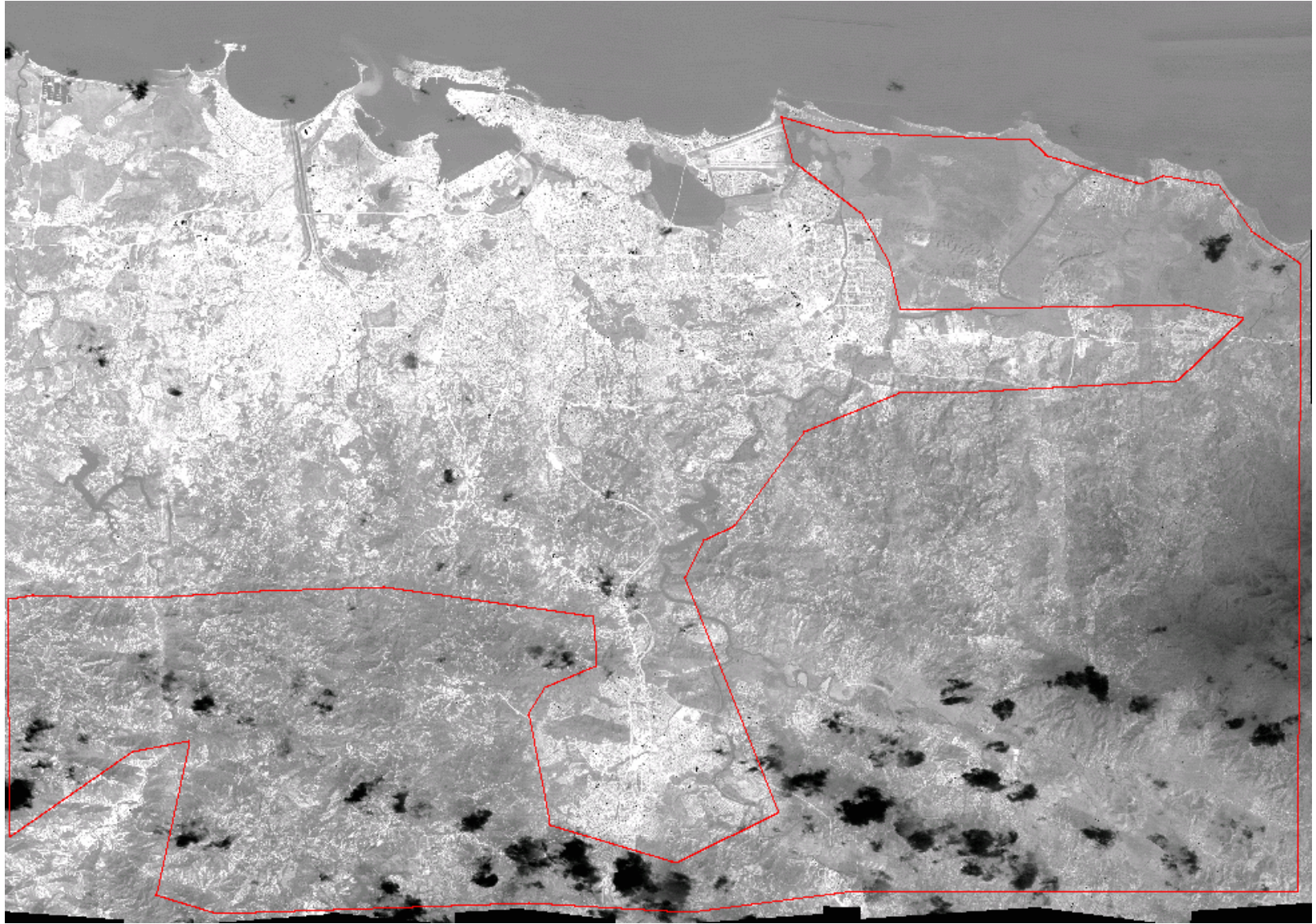


## San Juan Urban Temperature



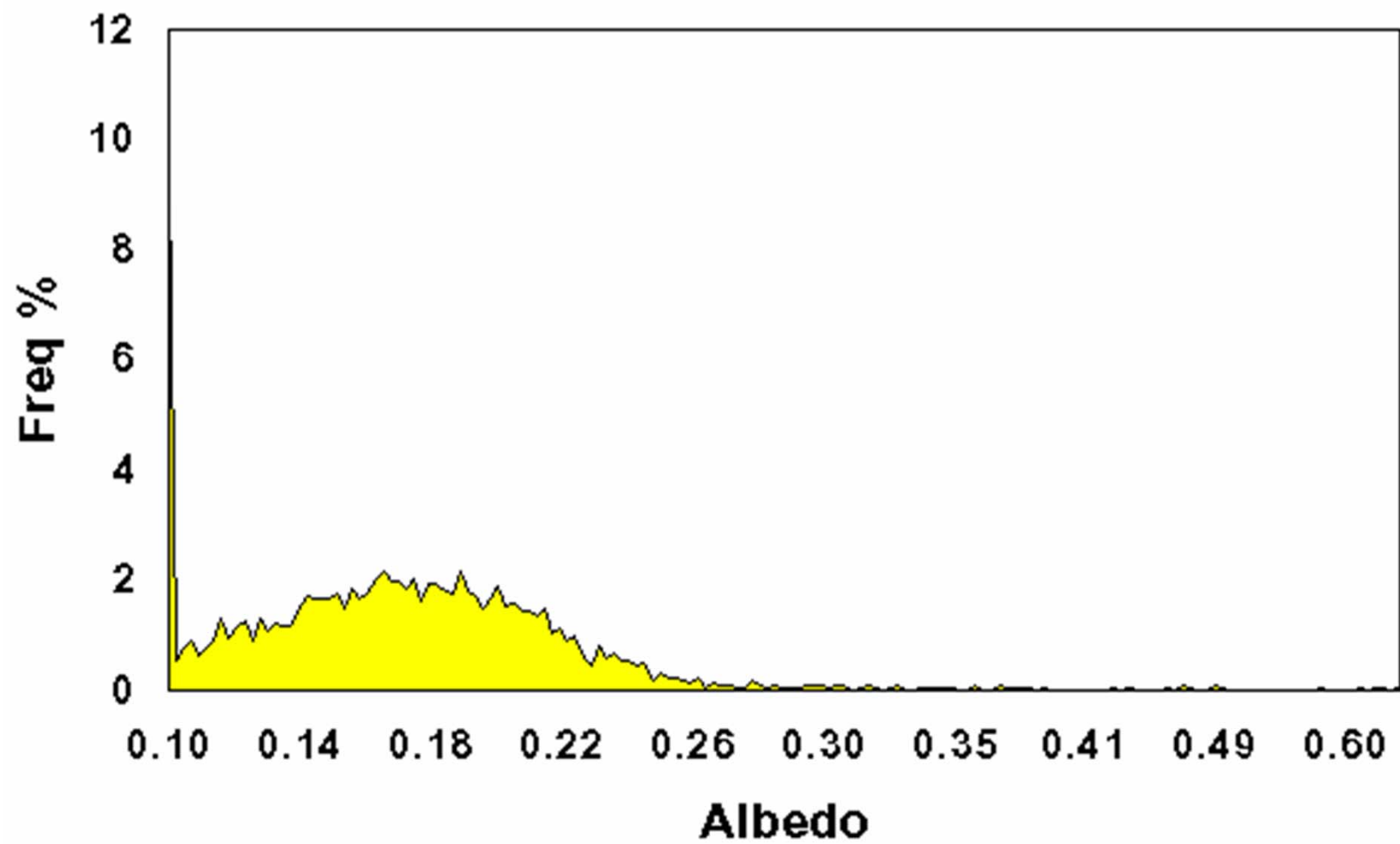
San Juan Puerto Rico  
Albedo vs Temperature



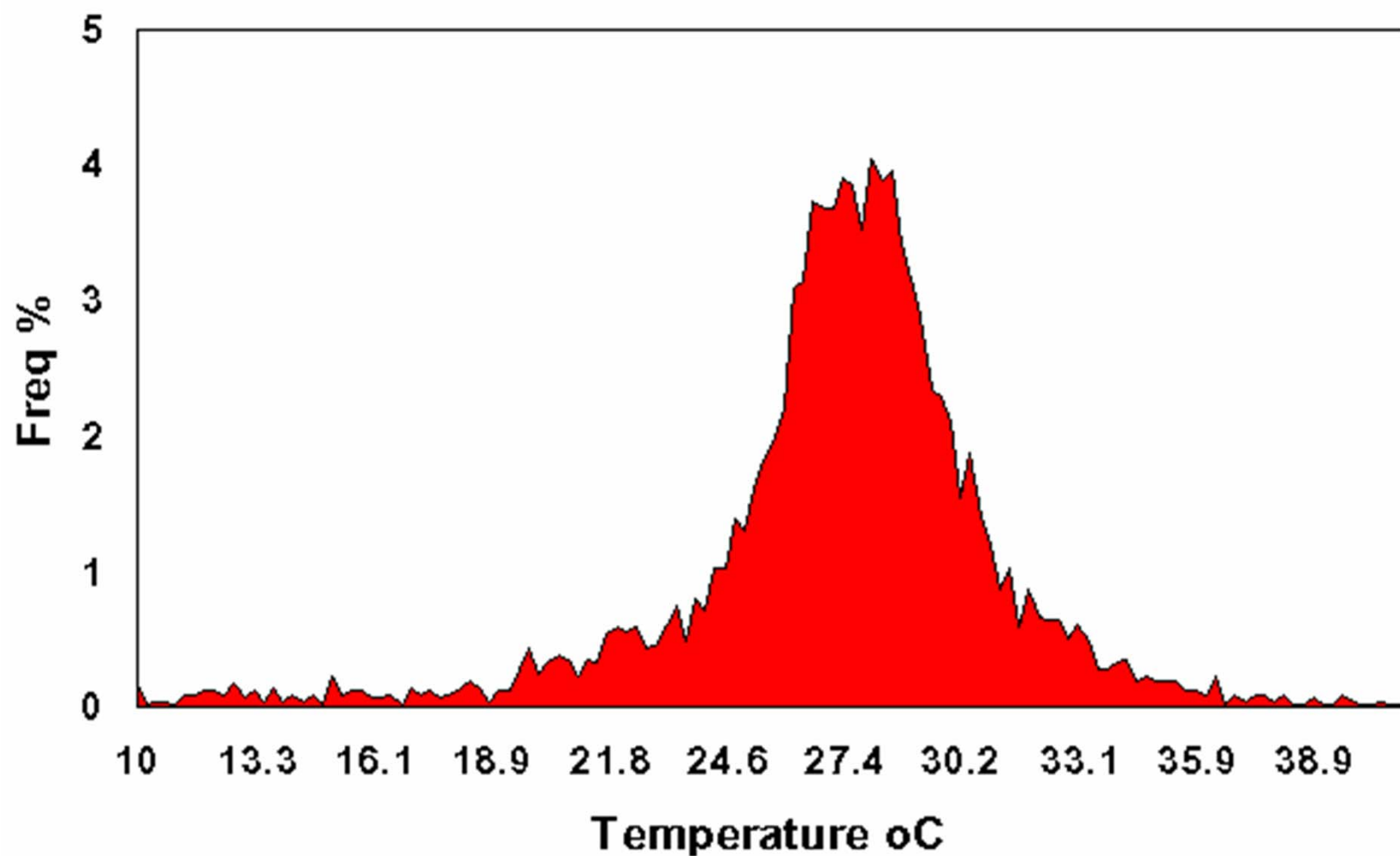




## San Juan Urbanizing Area Albedo

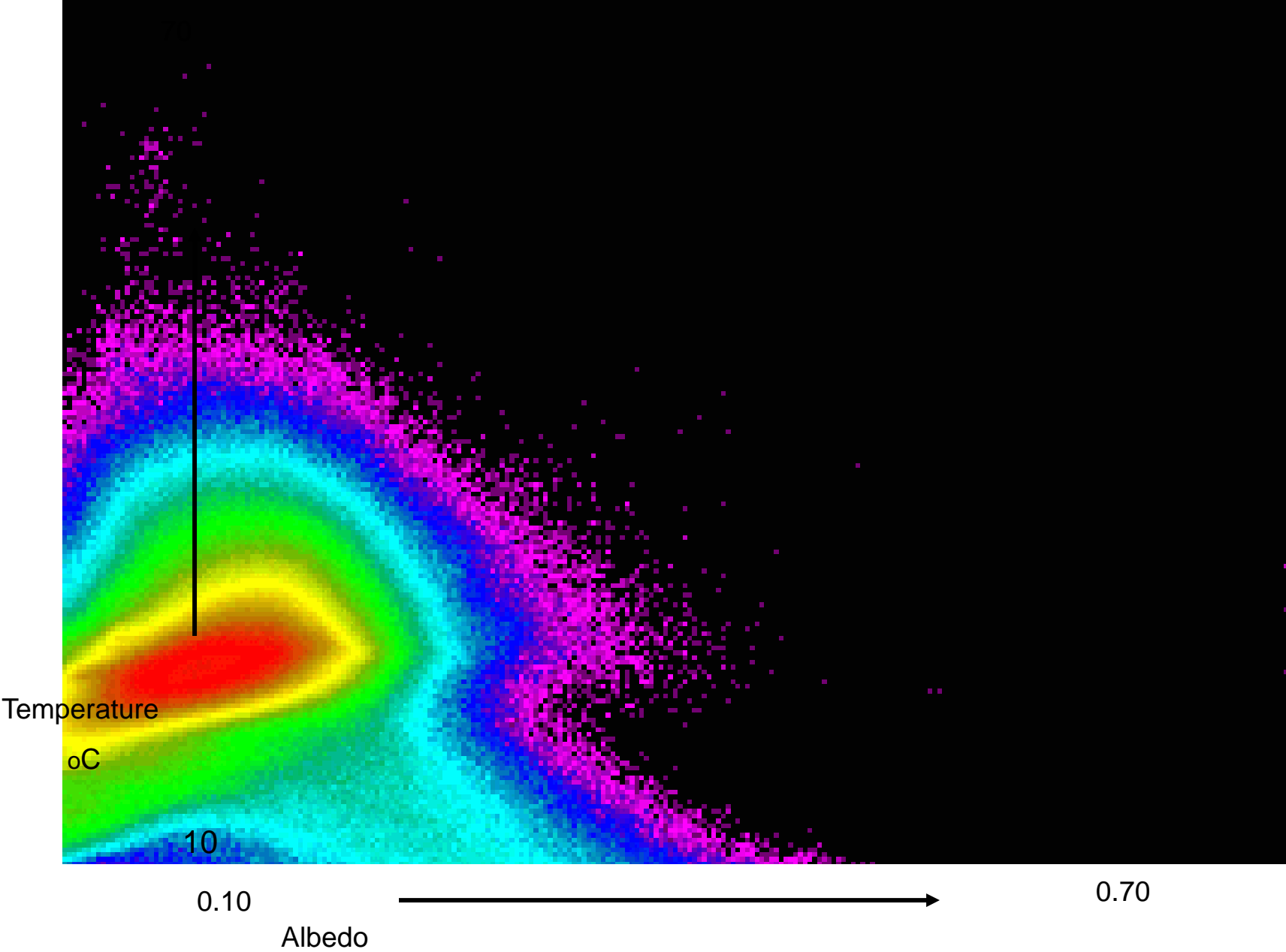


## San Juan Urbanizing Area Temperature

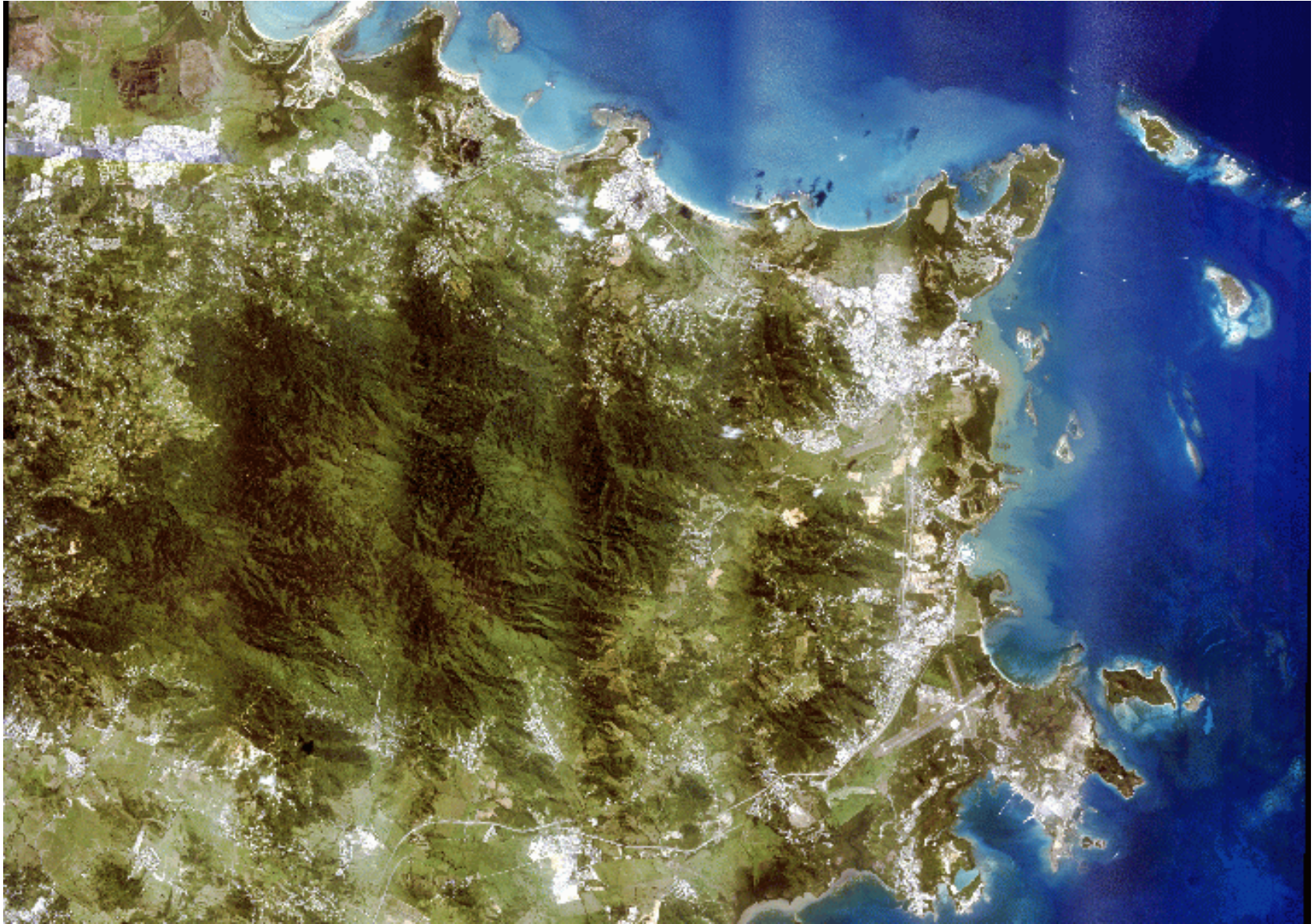




San Juan Puerto Rico Urbanizing Area  
Albedo vs Temperature

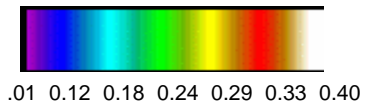
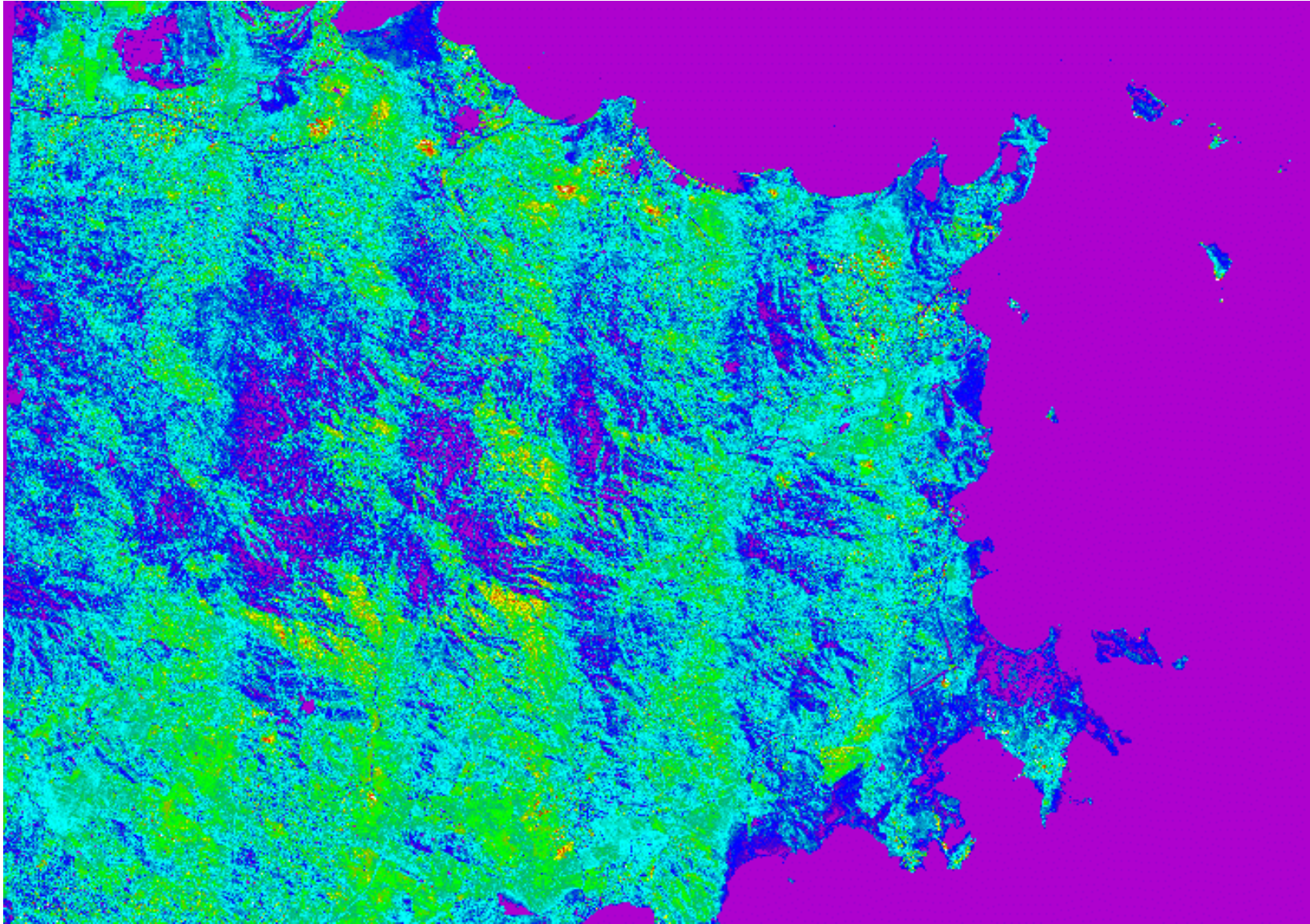


El Yunque F4 Mosaic True Color



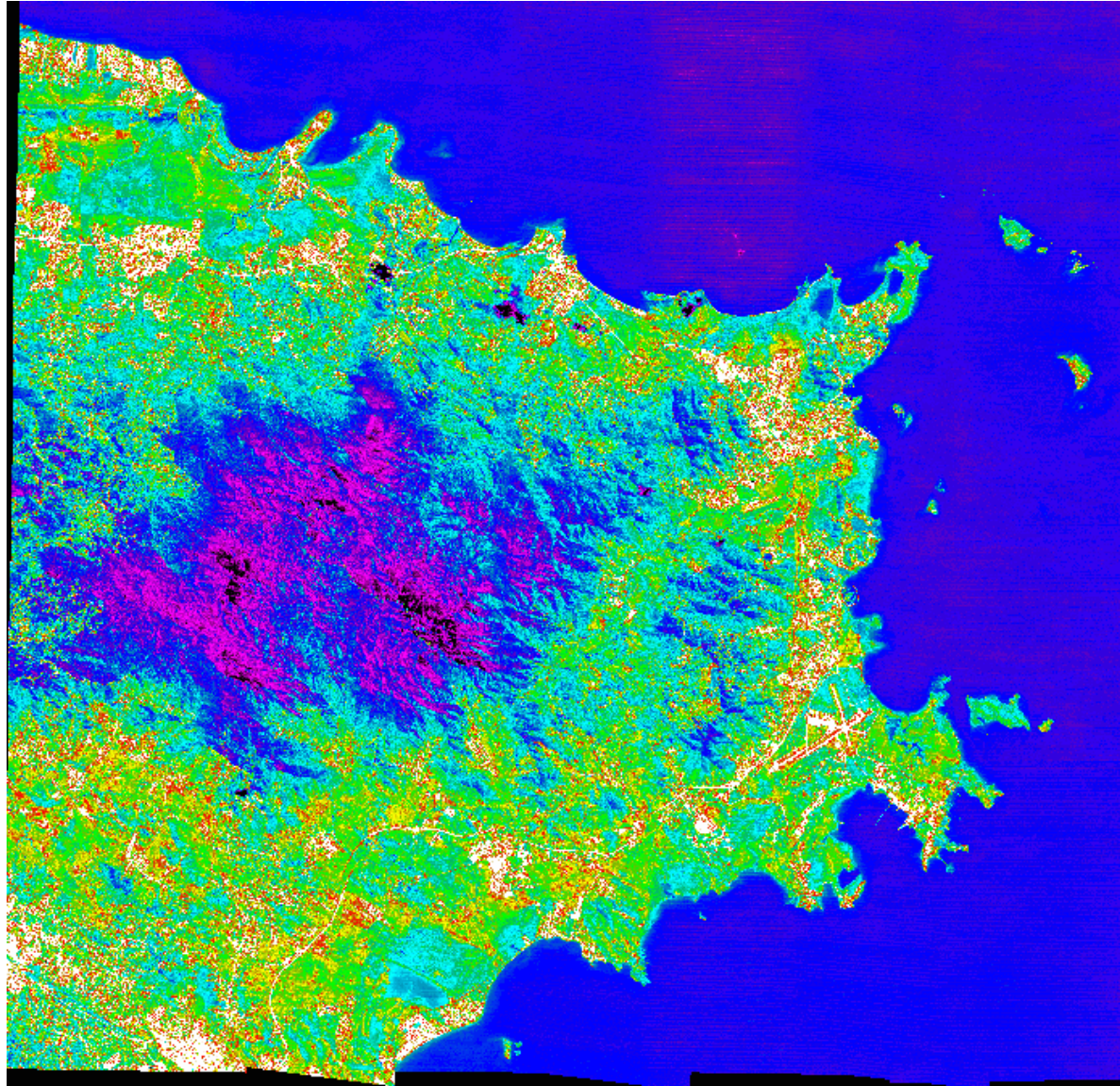


# El Yunque F4 Mosaic Albedo

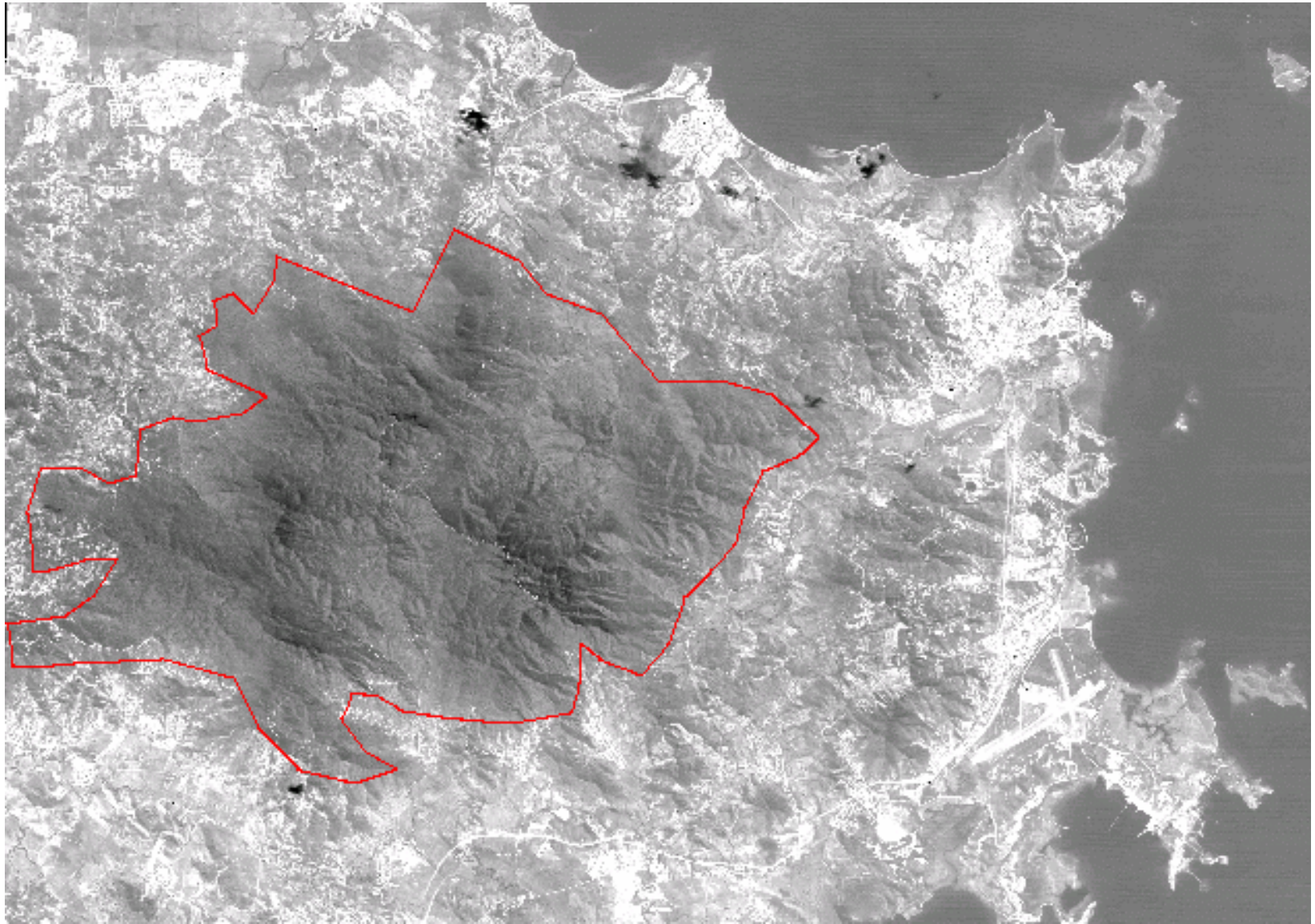




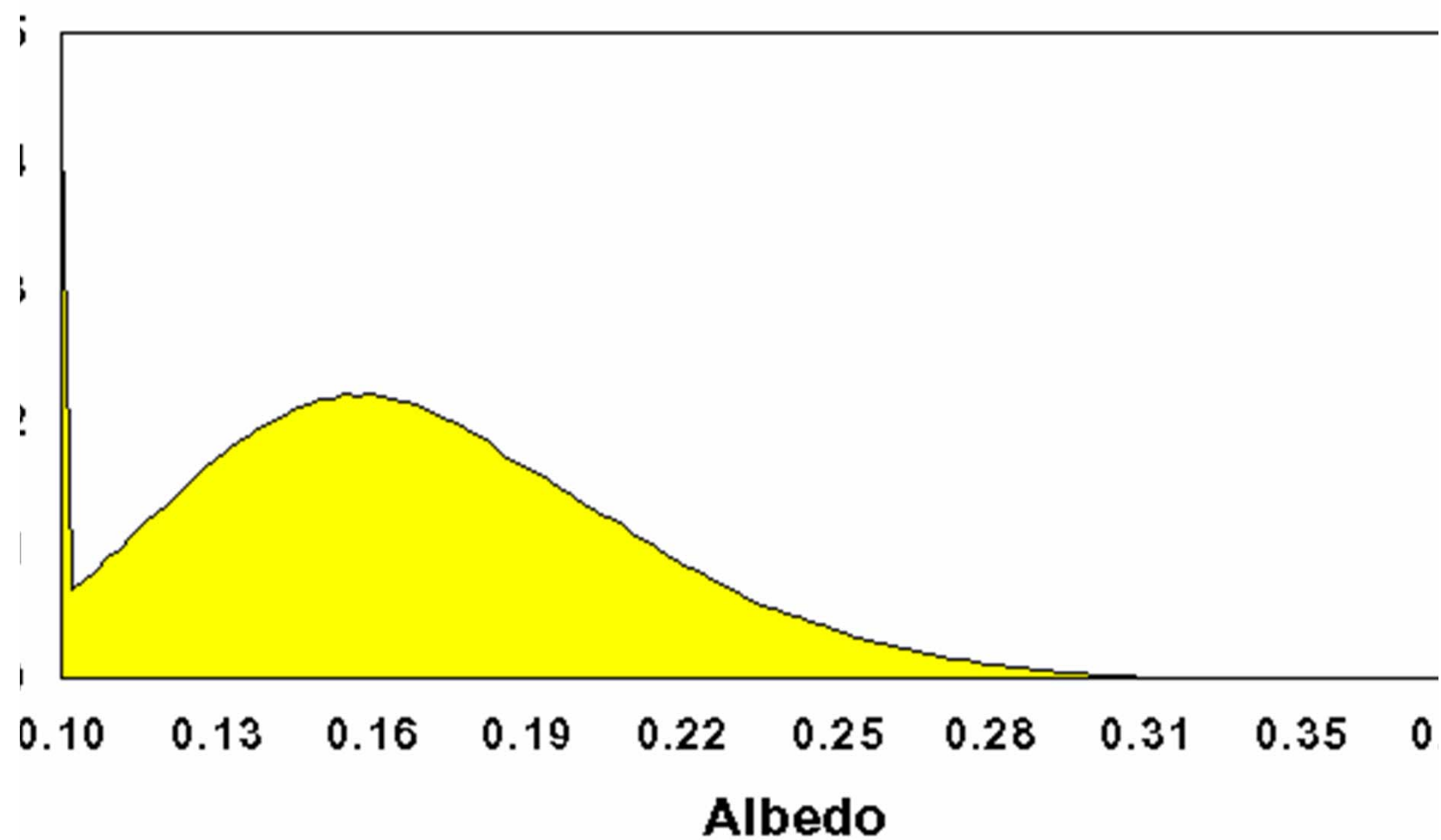
# El Yunque F4 Mosaic Temperature





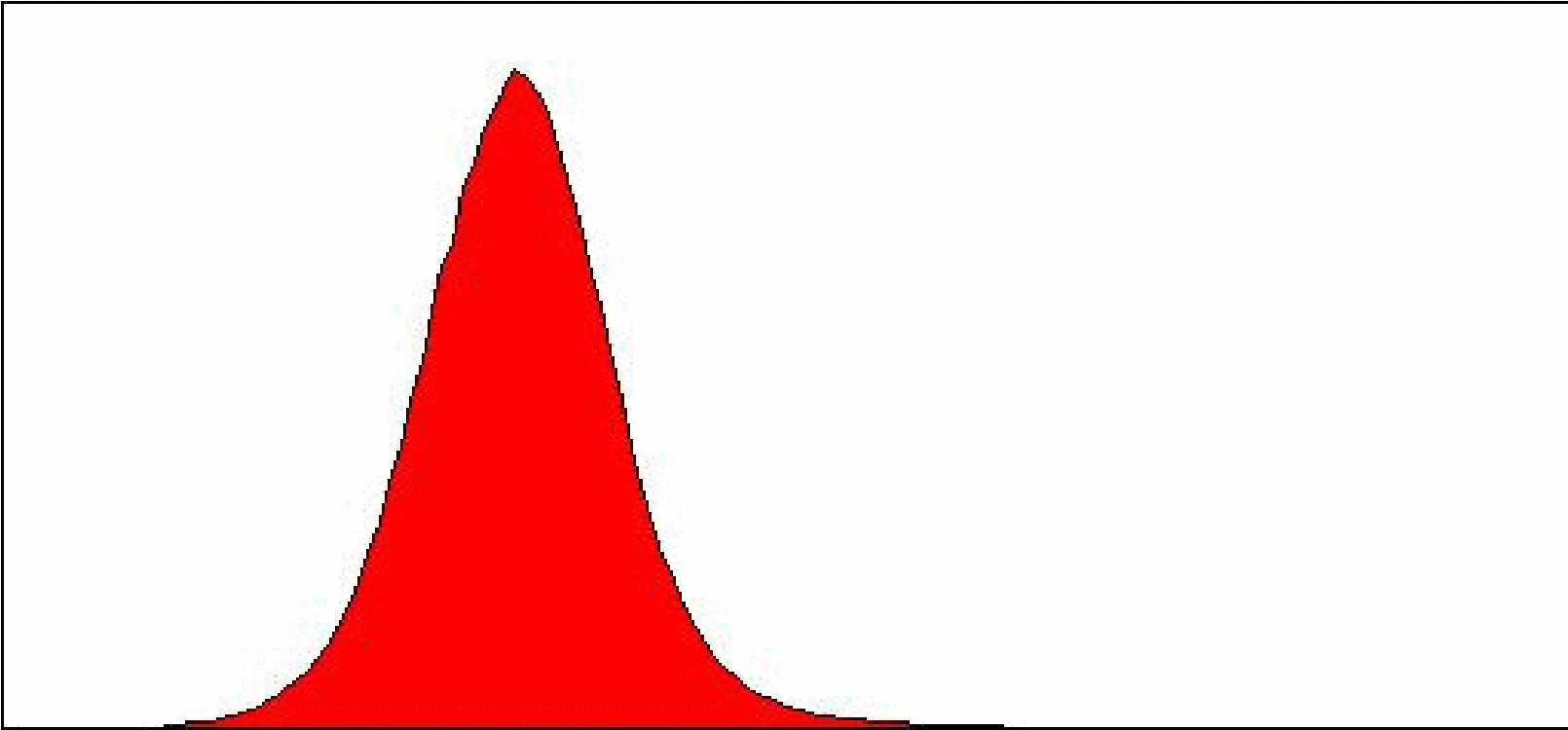


## El Verde Albedo





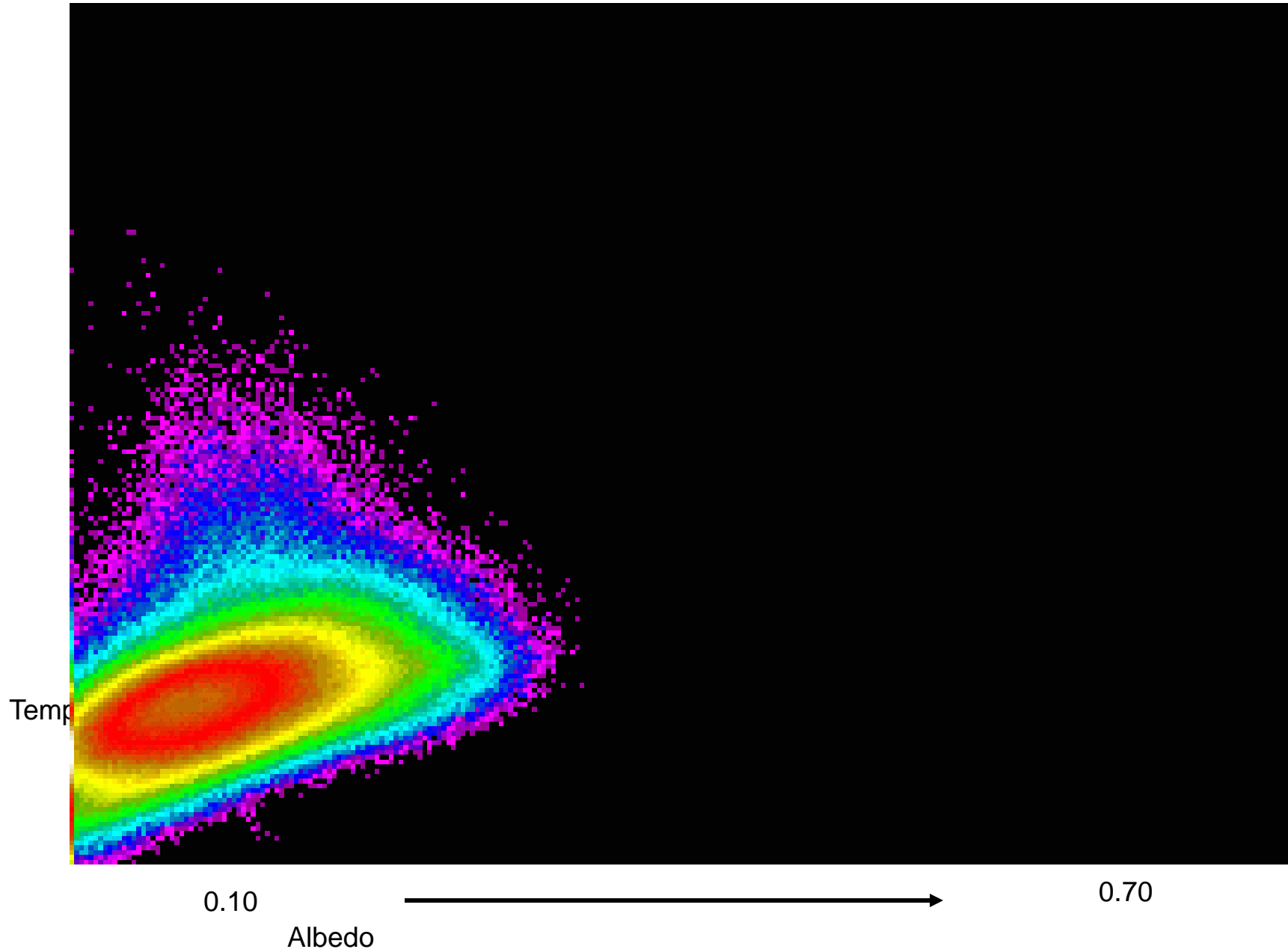
# El Verde Temperature



3.5 18.9 22.7 26.5 30.2 34 37.8 41.5 45.3 49.1

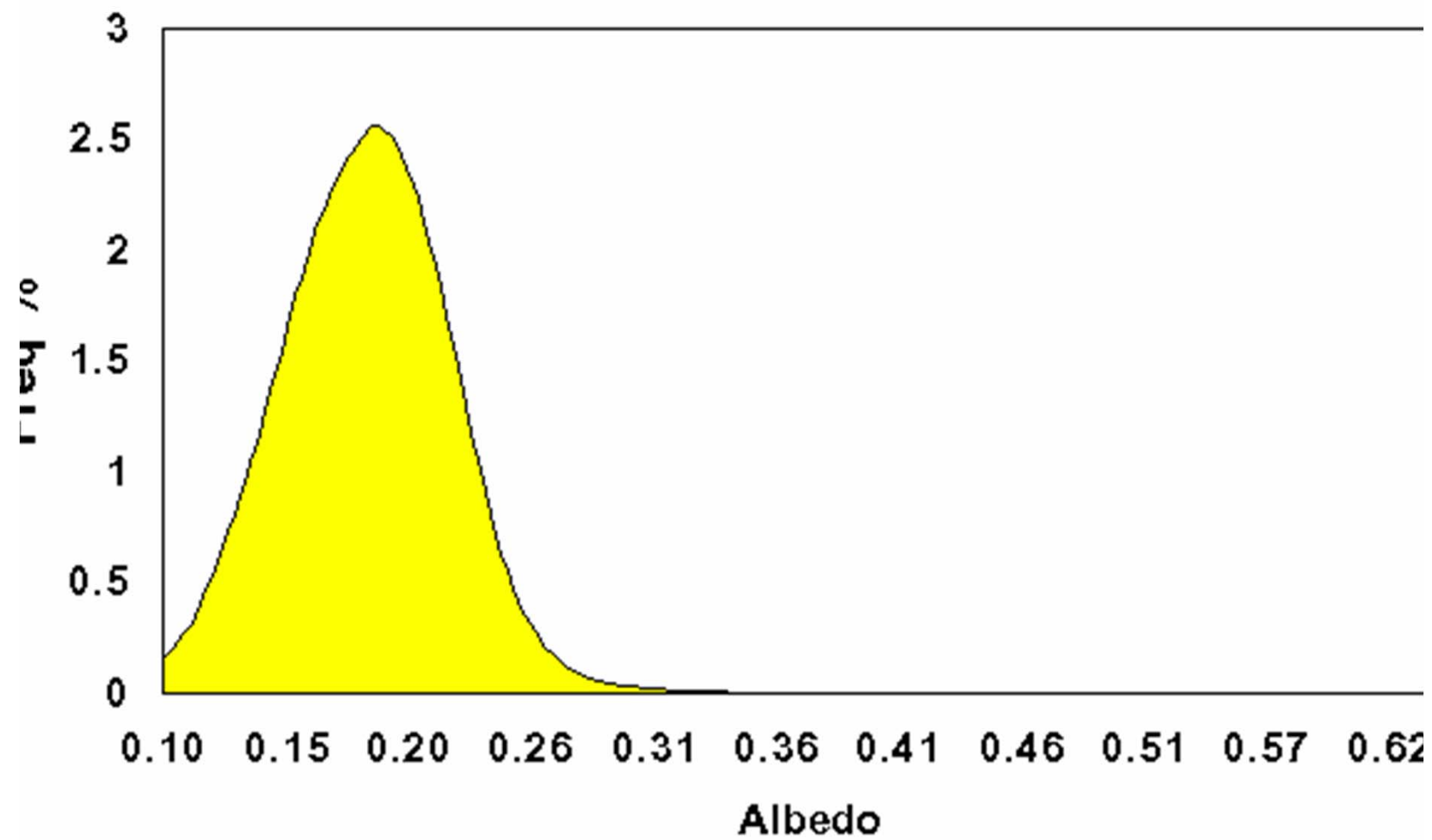
Temperature oC

El Yunque  
Albedo vs Temperature

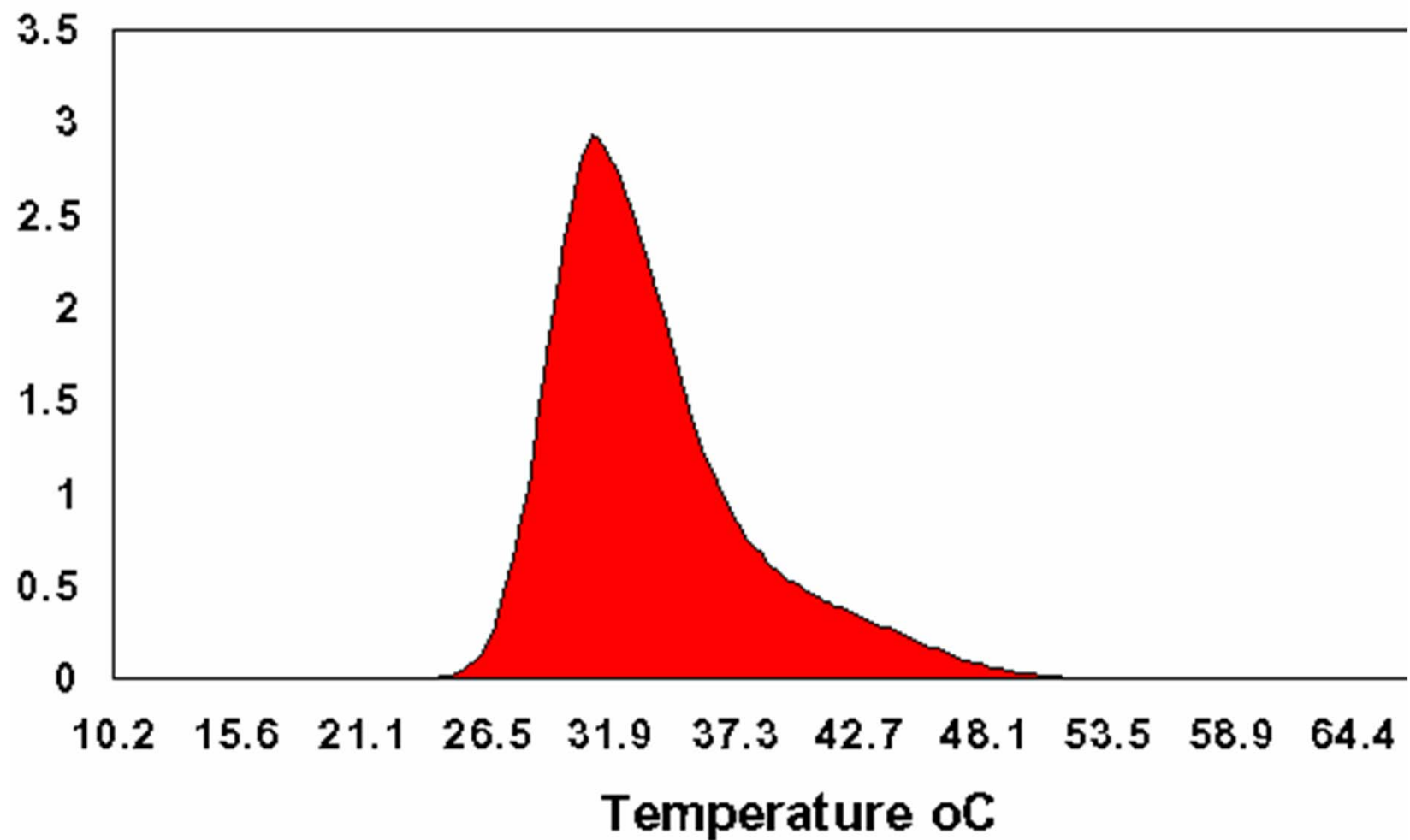




## El Verde "Urban" Albedo



## El Verde "Urban" Temperature





## **LIFE AS A MANIFESTATION OF THE SECOND LAW OF THERMODYNAMICS**

**ERIC D. SCHNEIDER**

National Ocean Service  
National Oceanic and Atmospheric Administration  
Washington, D.C., U.S.A.

**JAMES J. KAY**

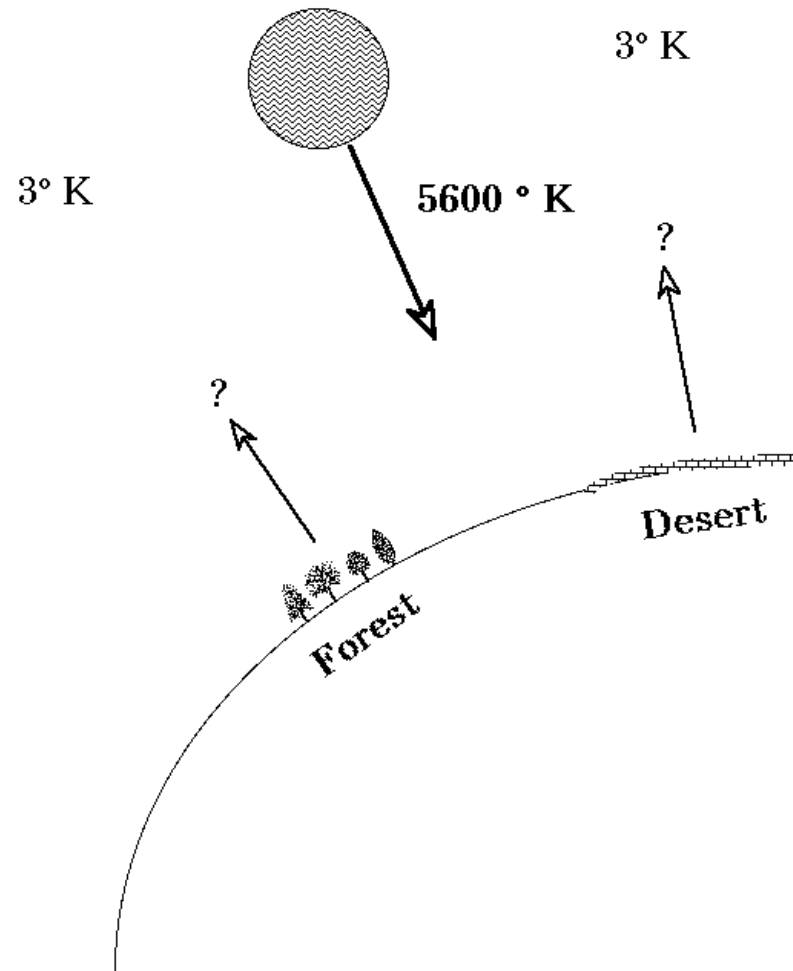
Environment and Resource Studies  
University of Waterloo  
Waterloo, Ontario, Canada, N2L 3G1  
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[www.fes.uwaterloo.ca/u/jjkay/](http://www.fes.uwaterloo.ca/u/jjkay/)

### **ABSTRACT**

We examine the thermodynamic evolution of various evolving systems, from primitive physical systems to complex living systems, and conclude that they involve similar processes which are phenomenological manifestations of the second law of thermodynamics. We take the reformulated second law of thermodynamics of Hatsopoulos and Keenan and Kestin and extend it to nonequilibrium regions, where nonequilibrium is described in terms of gradients maintaining systems at some distance away from equilibrium.

The reformulated second law suggests that as systems are moved away from equilibrium they will take advantage of all available means to resist externally applied gradients. When

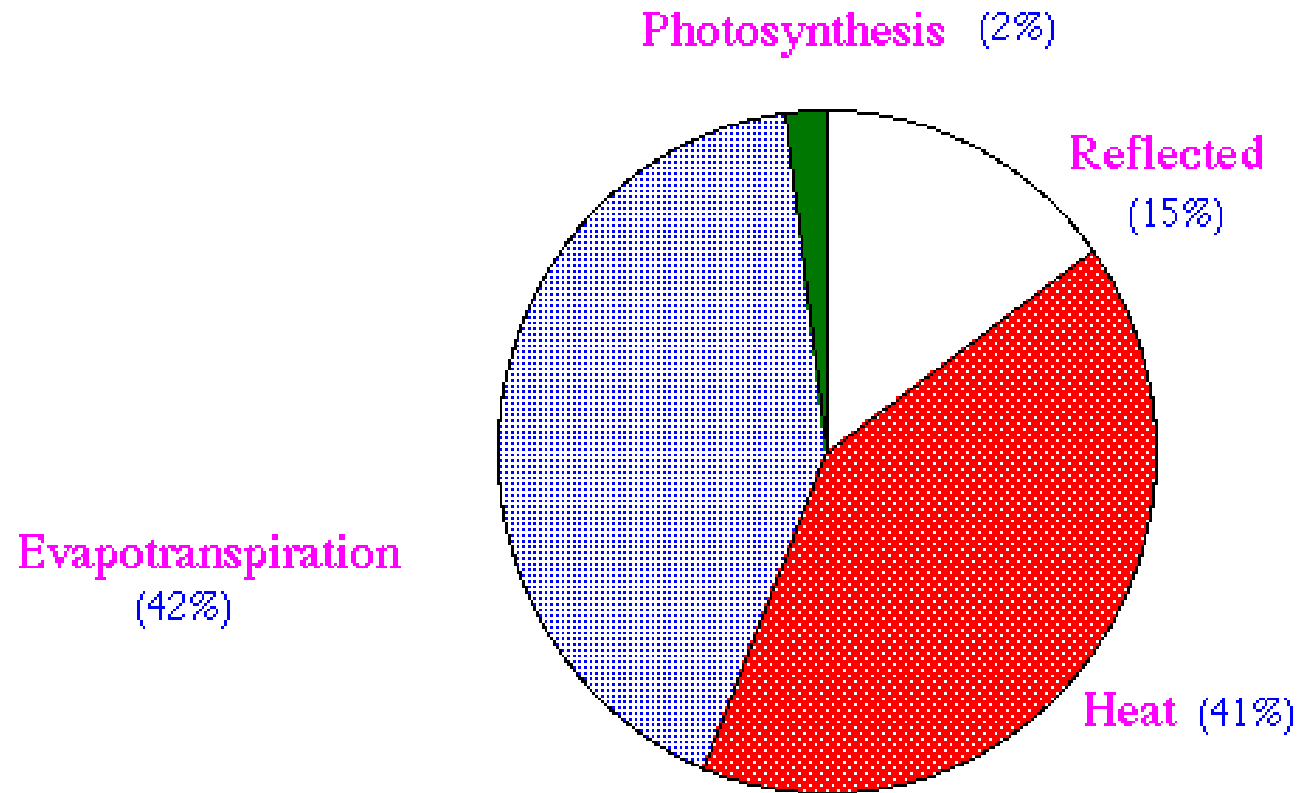
Which degrades more energy?





The distribution of solar energy during the growing season in the Hubbard Brook Forested Ecosystem

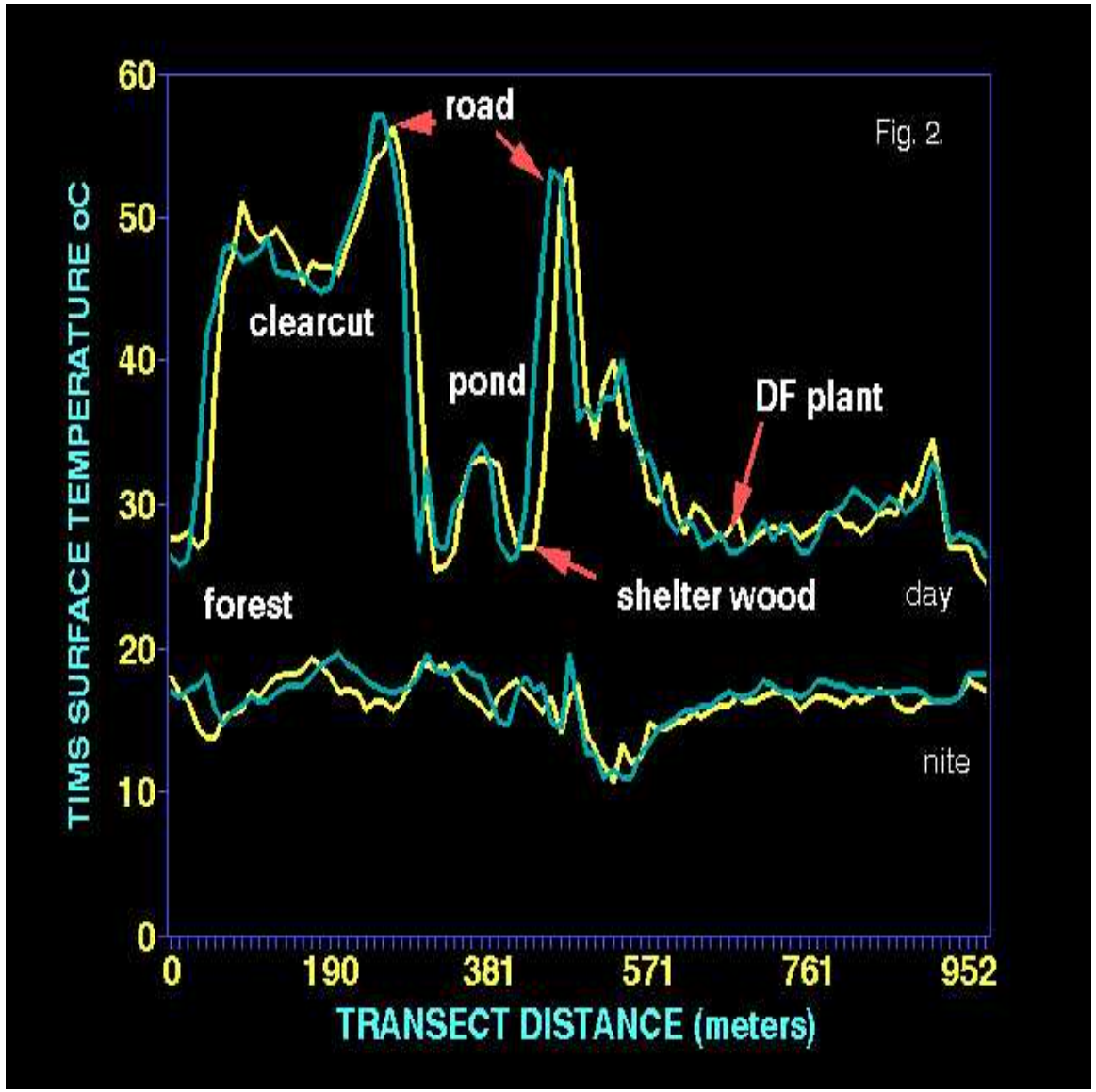
(From Bonmann and Likens, 1978)



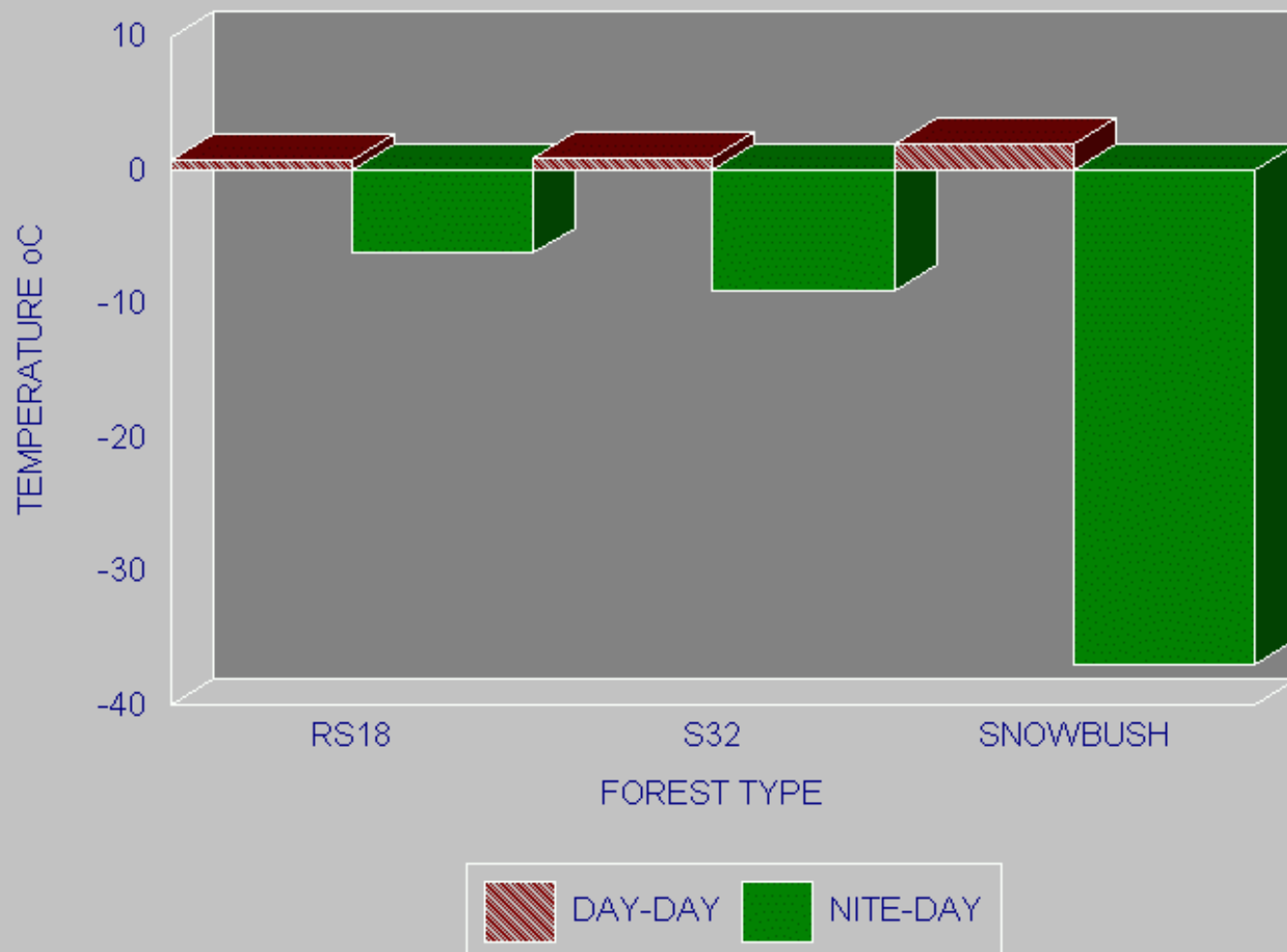
# Nonequilibrium thermodynamic hypotheses concerning ecosystem development

- Exergy utilization will increase
  - $R_n/K^*$  will increase
  - Surface temperature will decrease
- Internal equilibrium will increase
  - Spatial variation in surface temperature will decrease (Beta index increases)
  - Temporal variation in surface temperature will decrease (TRN increases)





# CHANGE IN SURFACE TEMPERATURES





# Thermal Response Number

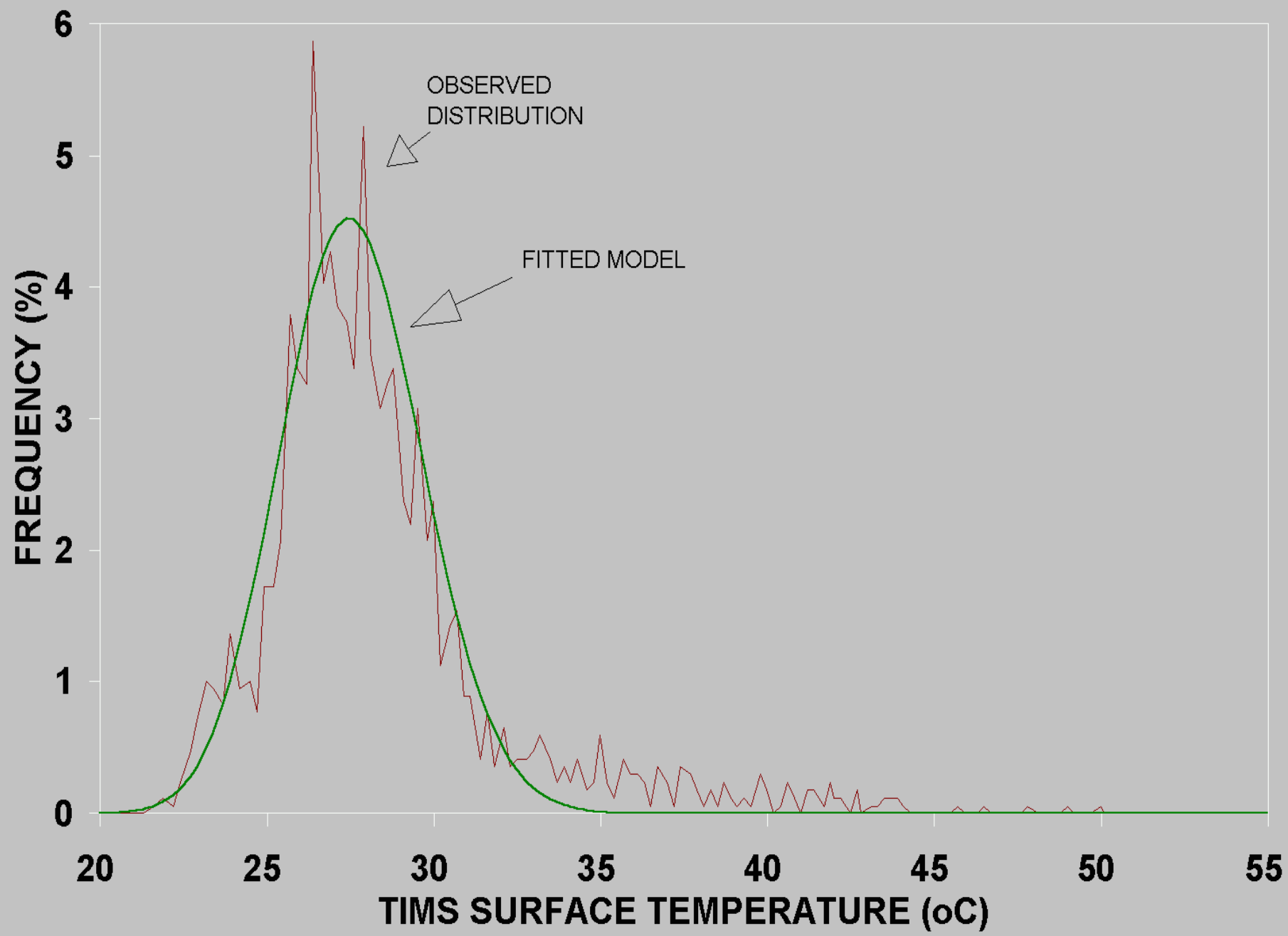
$$\text{TRN} = Q^*/\Delta T$$

where:

$Q^*$  = net radiation

$\Delta T$  = change in temperature

- Uses the change in surface temperature between 2 measurement times
- Uses surface net radiation as amount of energy available the surface for partitioning
- Produces a quantifiable value ( $\text{kJ m}^{-2} \text{ } ^\circ\text{C}^{-1}$ )
- Allows the classification of land use in terms of energy partitioning





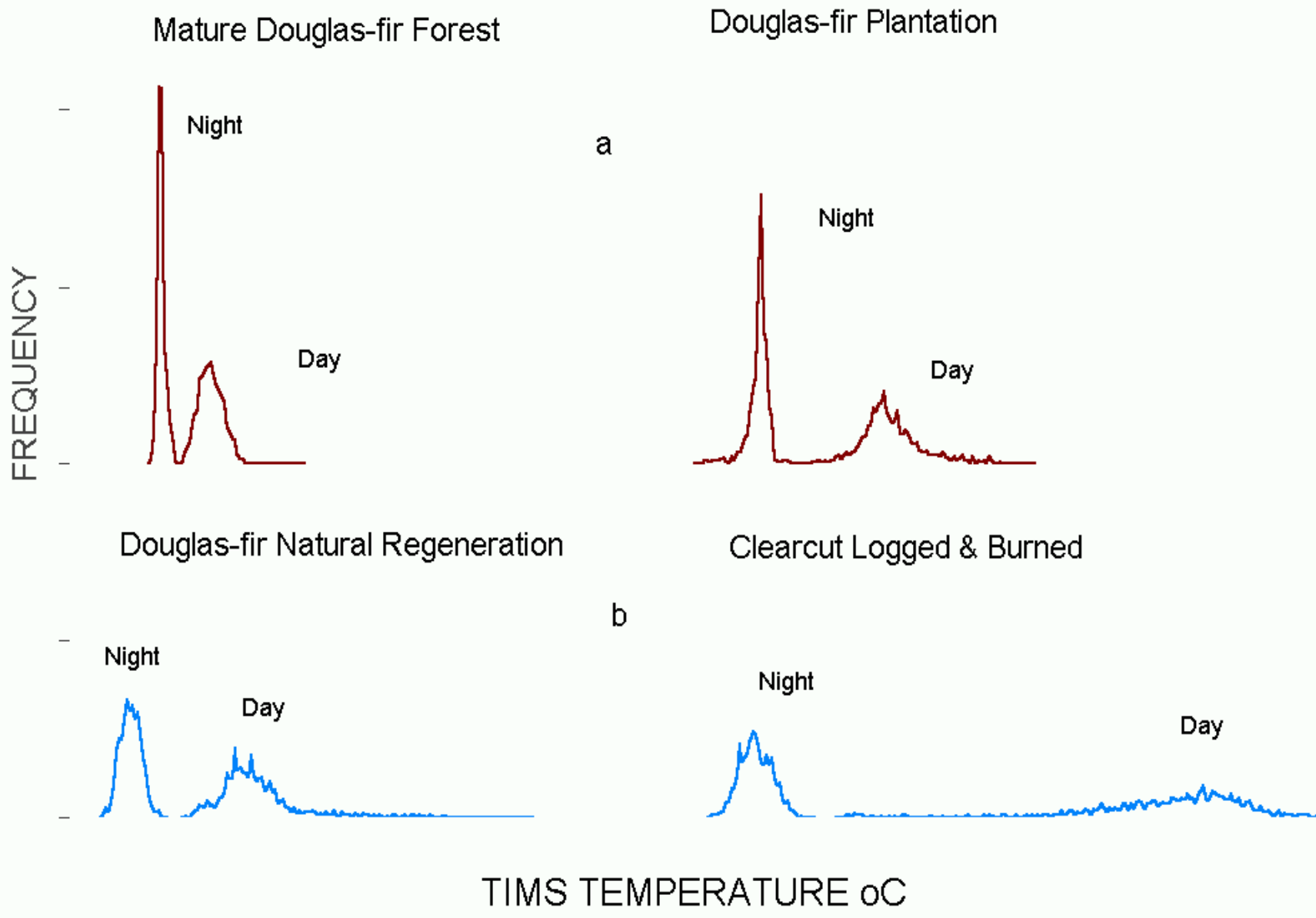


Table 3. Radiative transfer estimates, surface temperatures, Beta Index, and TRN measurements for several surface types at the Andrews Experimental Forest.

	QUARRY	CLRCUT	NATREG	PLANT	MATUREF
$K^*$ $W m^{-2}$	718	799	895	854	924
Albedo	0.25	0.22	0.15	0.15	0.8
$L^*$ $W m^{-2}$	273	281	124	124	92
$R_n$ $W m^{-2}$	445	517	771	730	832
$R_n/K^*$ %	62	65	86	85	90
T °C	50.7	51.8	29.4	29.5	24.3
$\Delta T$ °C	4.5	2.2	1.7	0.8	0.7
Beta Parameter $\epsilon, \beta$	41,8	20,4	55,95	120,200	210,520
Beta Index <sup>1</sup>	-12.9	-6.3	17.2	34.4	130.1
TRN k J $m^{-2} °C^{-1}$	168	406	788	1,631	2063

$K^*$  = net incoming solar radiation,  $L^*$  = net long wave,  $R_n$  = net radiation,  $R_n/K^*$  = percent of net incoming solar radiation degraded into non-radiative processes. T = averaged site surface temperatures from first and second flights.

<sup>1</sup> Beta index values were calculated from the second mid-day flight



## Conclusions

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- Ecosystems develop structure and function that degrades the quality of the incoming energy more effectively.
- The ecosystem  $T$  and  $R_n/K^*$  and TRN are excellent candidates for indicators of ecological integrity.
- The potential for these methods to be used for remote sensed ecosystem classification and ecosystem health/integrity evaluation is apparent.

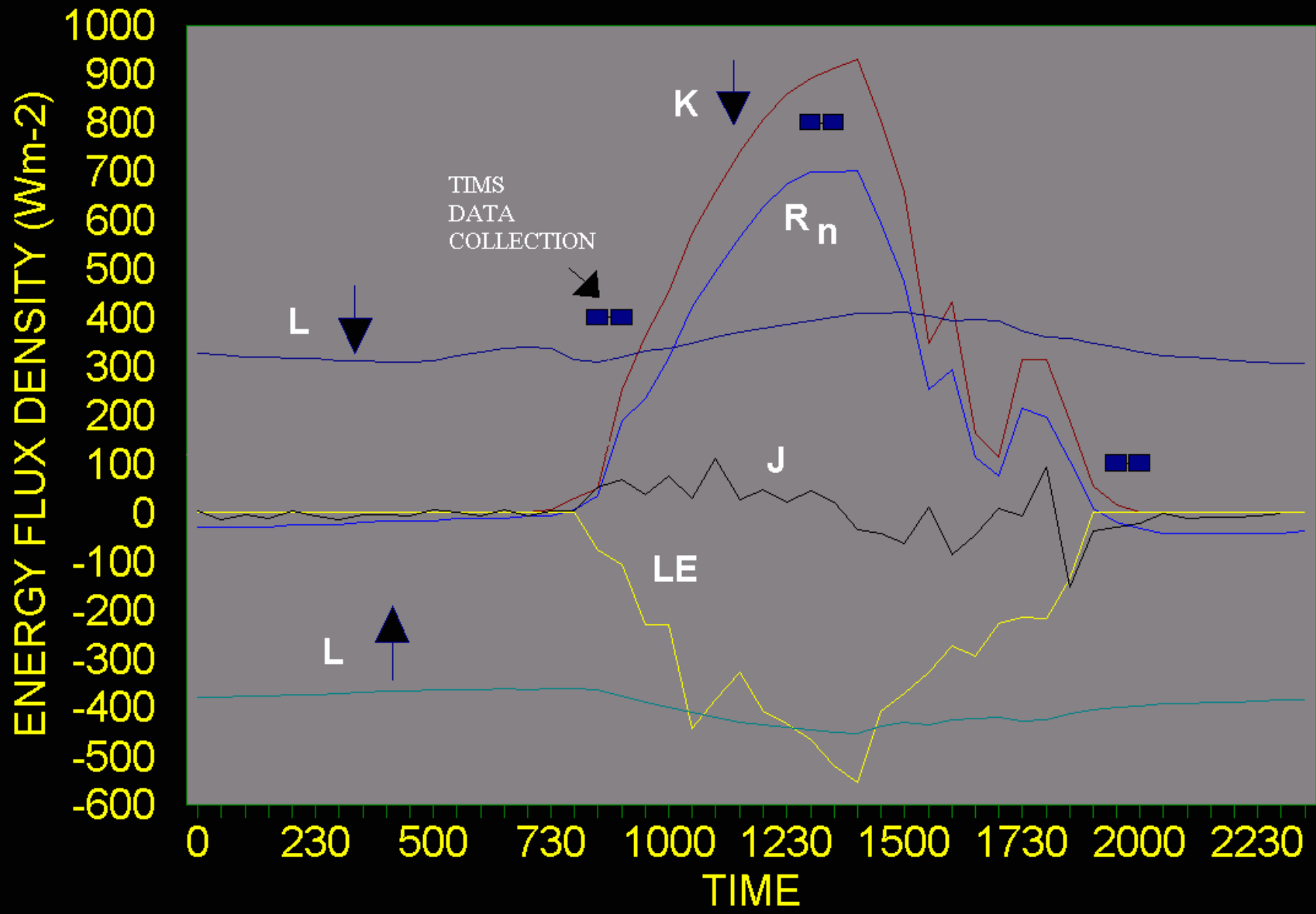
## Surface Temperature

$$T_s = T_a + \frac{R_b}{C_\rho} (R_n - E)$$

## Penman Monteith equation

$$E = \left( \frac{s(R_n - G) + \left[ \frac{\rho_a C_p D}{R_a} \right]}{s + \gamma \left[ 1 + \frac{R_c}{R_a} \right]} \right)$$





# **Direct Measurement of Evapotranspiration and Carbon Sequestration Via Remote Sensing**

# Precision Agriculture:

**Find and map the differences  
between and within fields.**

**Make the farmer more profit!**

Fields are treated as uniform blocks.

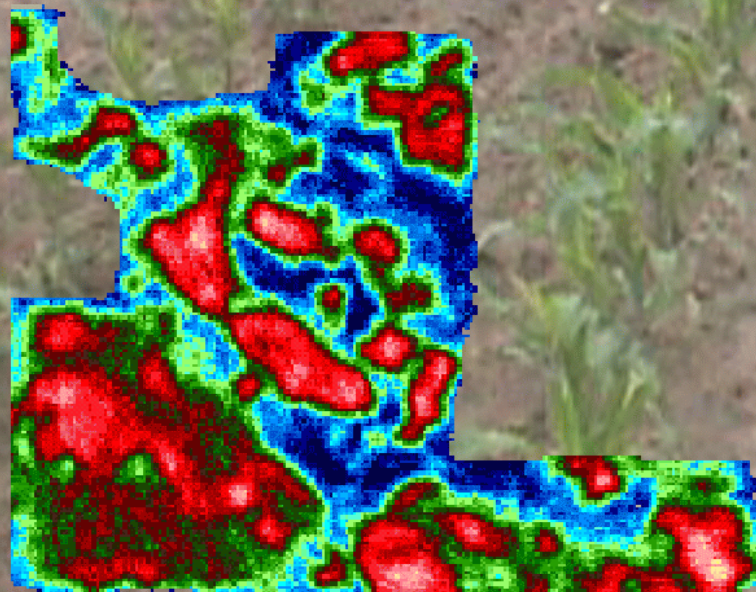
But fields are very heterogeneous on  
the scale of a few meters!

A cooperative project  
between Alabama, Georgia  
NASA

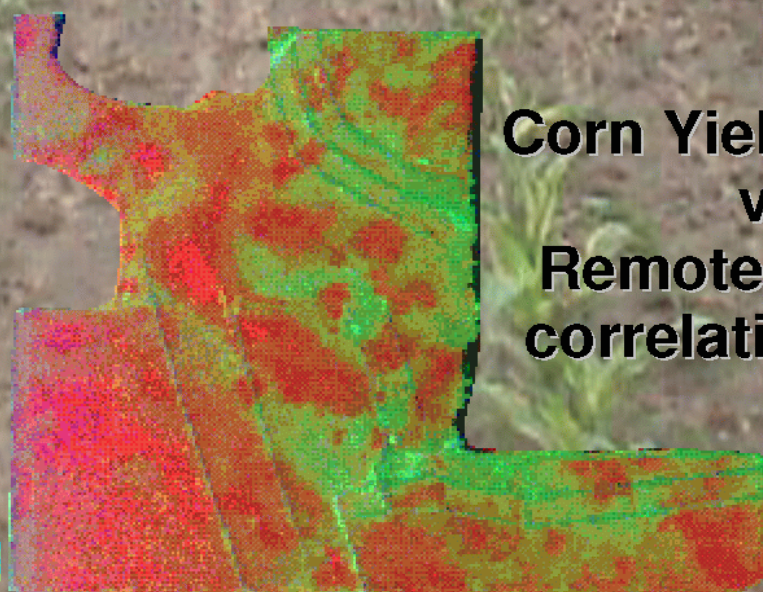
Funded by AL and GA Space  
Grant Consortia

Remote Sensing can

- map soils
- find variation in crop vigor
- predict yield 2 months  
before harvest



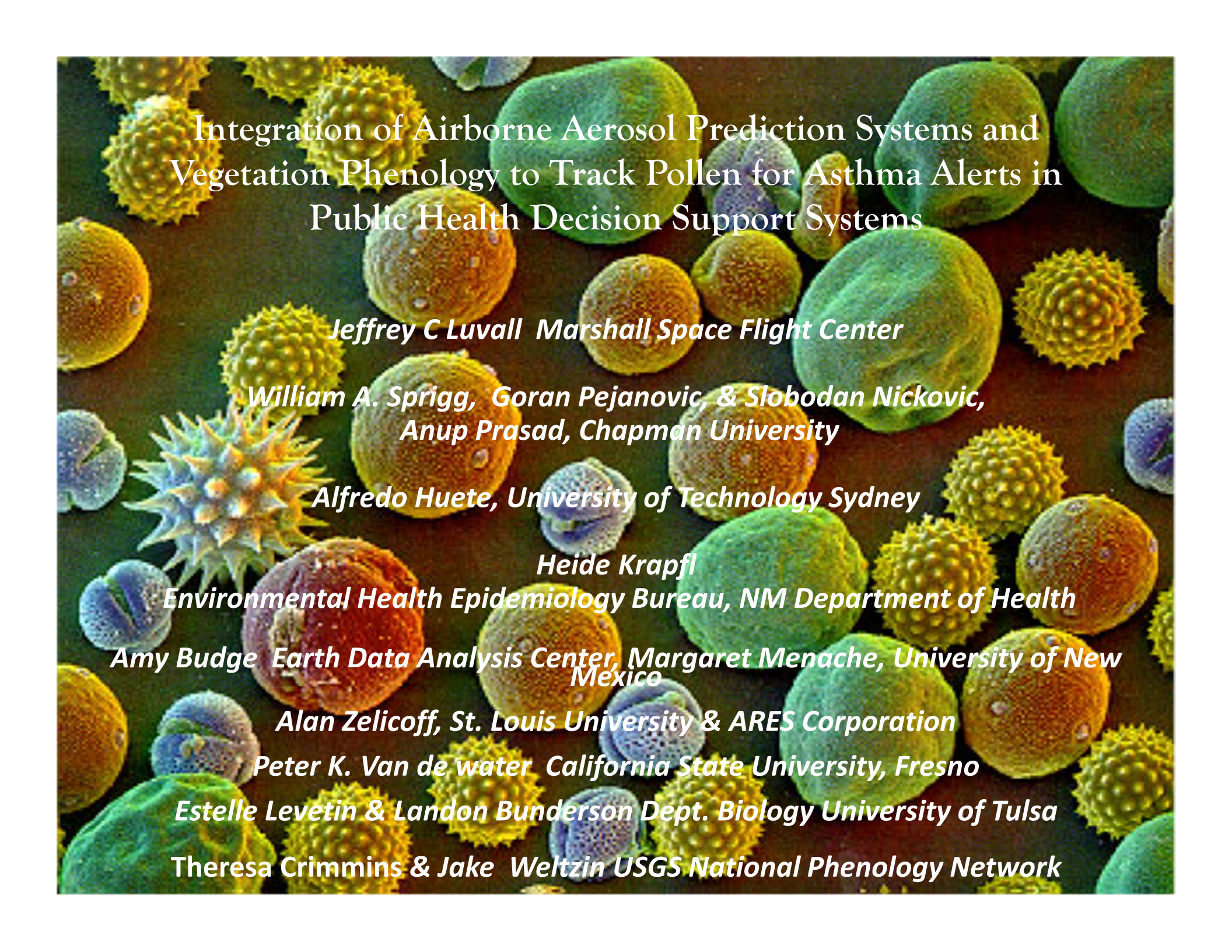
Harvest- September, 1998



Overflight- June 26, 1998

Corn Yield (far left)  
vs.  
Remote Sensing  
correlation  $> 0.87$





**Integration of Airborne Aerosol Prediction Systems and  
Vegetation Phenology to Track Pollen for Asthma Alerts in  
Public Health Decision Support Systems**

***Jeffrey C Luvall Marshall Space Flight Center***

***William A. Sprigg, Goran Pejanovic, & Slobodan Nickovic,  
Anup Prasad, Chapman University***

***Alfredo Huete, University of Technology Sydney***

***Heide Krapfl***

***Environmental Health Epidemiology Bureau, NM Department of Health***

***Amy Budge Earth Data Analysis Center, Margaret Menache, University of New  
Mexico***

***Alan Zelicoff, St. Louis University & ARES Corporation***

***Peter K. Van de water California State University, Fresno***

***Estelle Levetin & Landon Bunderson Dept. Biology University of Tulsa***

***Theresa Crimmins & Jake Weltzin USGS National Phenology Network***



# PollenCast for Tucson, Arizona



Tree

Grass

Weed

## Reported Levels

Tree pollen count for today, 03/31/08:

**Moderate**

[See past pollen counts for Tucson, Arizona](#)

## Forecasted Levels

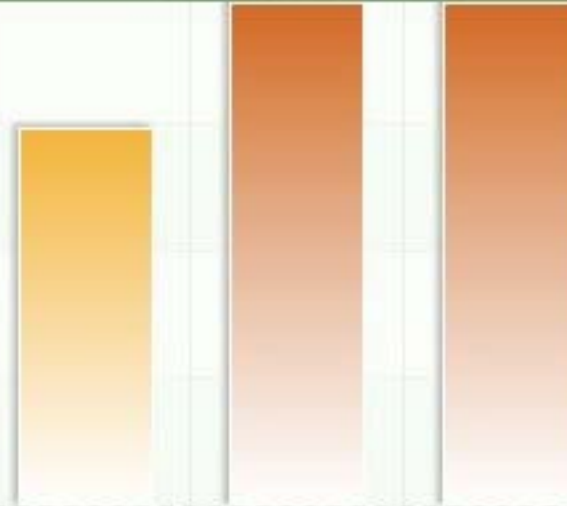
VERY HIGH

HIGH

MEDIUM

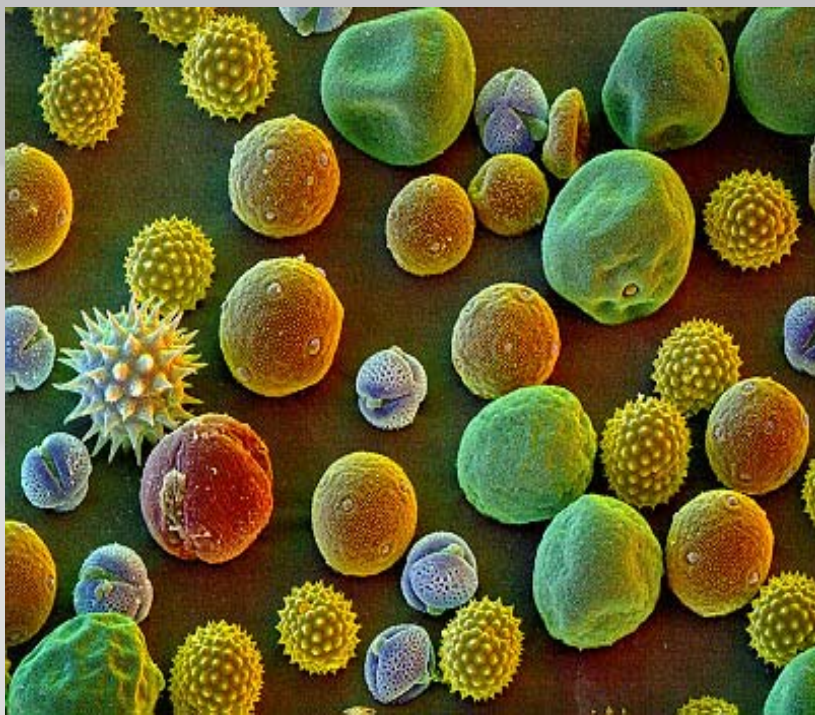
LOW

NO ACTIVITY



Forecast not available

# Top pollen-producing species



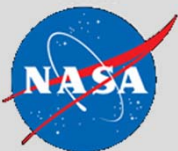
## Los Alamos

juniper  
sagebrush  
pine  
Alternaria\*  
oak  
grass  
ragweed  
goosefoot  
Cladosporium\*  
Myxomycete\*  
cottonwood  
mulberry  
aster  
elm

## Albuquerque

mulberry  
juniper  
ash  
goosefoot  
cottonwood  
grass  
sagebrush  
pine  
elm  
aster  
ragweed  
sycamore  
oak  
willow

\*fungal / slime mold spores





# Pollen and Respiratory Disease: What little is known<sup>2</sup>

Increase in mortality of  
these disorders:

Cardiovascular disease  
Chronic obstructive pulmonary disease  
Pneumonia  
Total

Poaceae pollen concentrations (grains per m<sup>3</sup> air)

<22	22-77	78-135	>135
Relative risk	Relative risk (95% CI)	Relative risk (95% CI)	Relative risk (95% CI)
1.000	1.015 (1.002-1.029)	1.012 (0.994-1.029)	1.061 (1.038-1.084)
1.000	1.095 (1.053-1.139)	1.124 (1.069-1.181)	1.150 (1.079-1.225)
1.000	1.104 (1.049-1.163)	1.093 (1.023-1.168)	1.168 (1.077-1.266)
1.000	1.019 (1.010-1.028)	1.019 (1.008-1.031)	1.043 (1.028-1.058)

- High concentrations of pollen allergens have also been shown to occur in thoracic particles (<10 microns in diameter) and respirable particles (<2.5 microns and these correlated well in time with airborne pollen concentrations. ... airborne pollen results in exposure of the lower airways and lung to pollen allergens.
- The association between air pollution and the number of daily deaths may be related to the inflammatory potential of very small particles
- ...suggests that high airborne pollen concentrations, which nowadays are mainly seen as triggers of allergic symptoms, may have far more serious effects than previously thought."

<sup>2</sup> Bert Brunekreef, Gerard Hoek, Paul Fischer, Frits Th M Spijksma. Relation between airborne pollen concentrations and daily cardiovascular and respiratory-disease mortality. Lancet Vol 355 (2000): 1517-8.





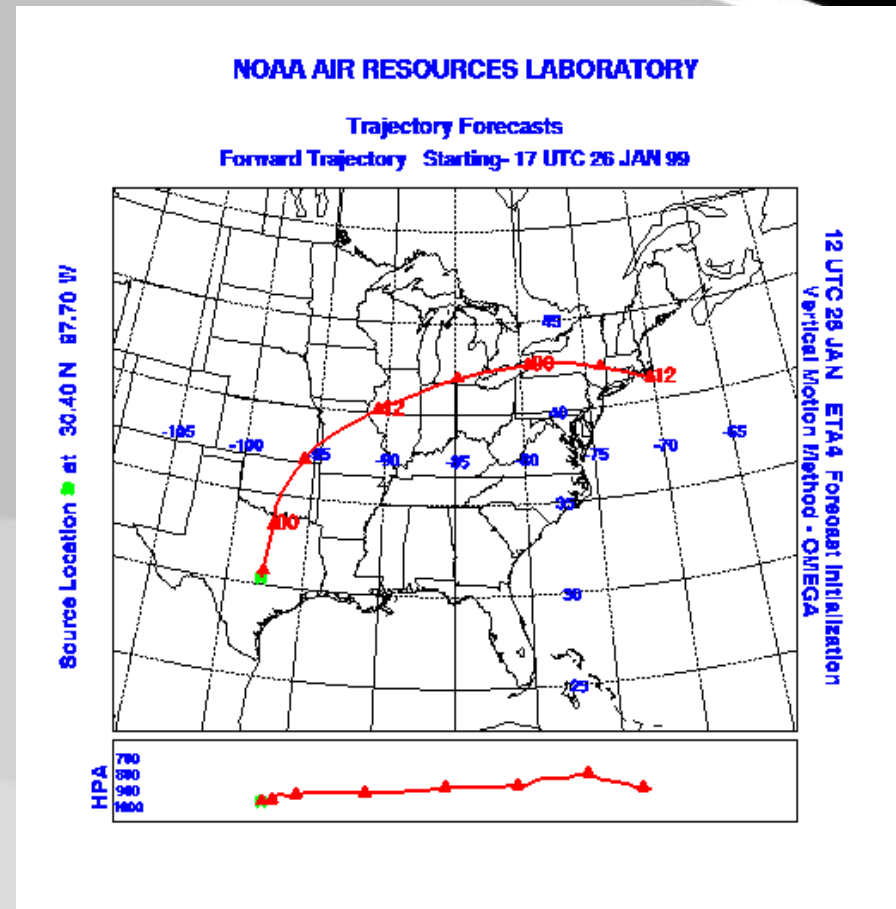
# Limitations of Pollen Sampling

- Lack of stations
- Count frequency & reporting lag time
- Different sampling instruments Rotorod Sampler/Burkard Spore Trap
- Only indentifiable pollen “grains”
- Expertise in counting/indentification
- Refusal to release sampling information-” *We do not reveal the sources for our data for privacy and proprietary, competitive reasons. Some pollen counts are conducted privately, and are not meant to be broadcast to the public* ”



# Continental transport

- 27 Jan 99, Jim Anderson in London, Ontario reported atmospheric *Juniperus* pollen - 58 pollen grains/m<sup>3</sup>
- Trajectories show that the source of this pollen was Texas population of *Juniperus ashei*
- Our Jan 26 forecast indicated that the “pollen has the potential to travel very long distances.”











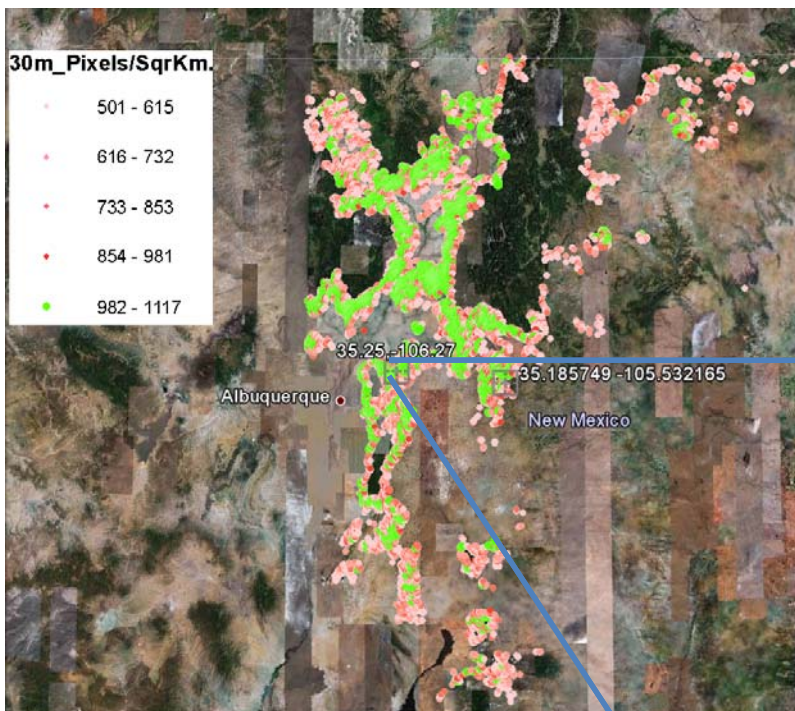




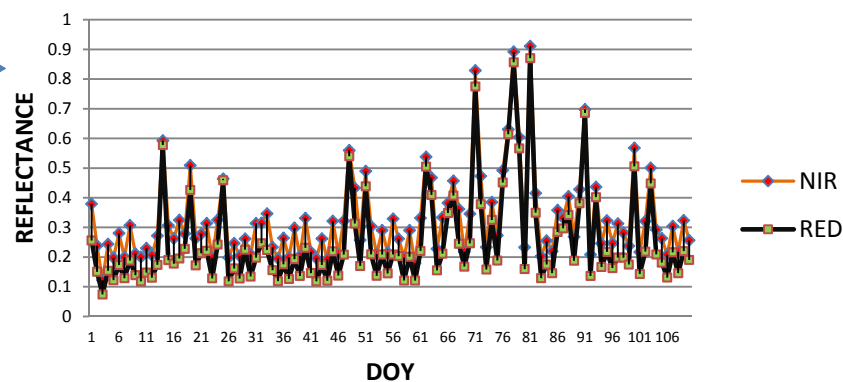


# Density of S038 class

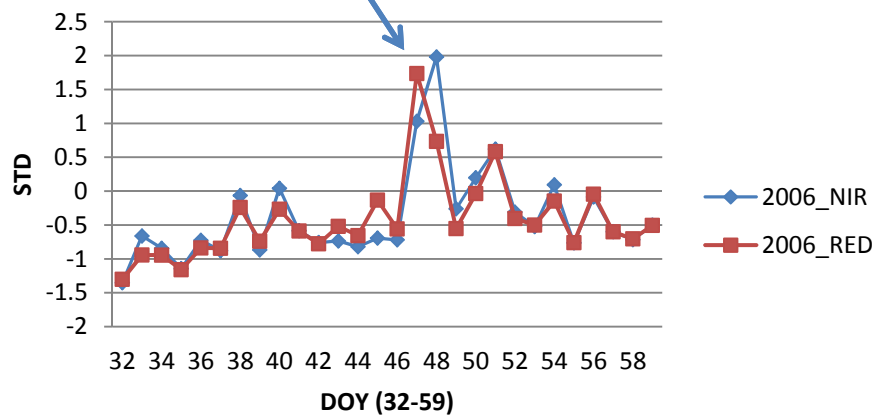
Site 1 S038



**2006 Daily\_250m pixel (MOD09GQ) Site\_1 (20 Miles east-Albuquerque)**



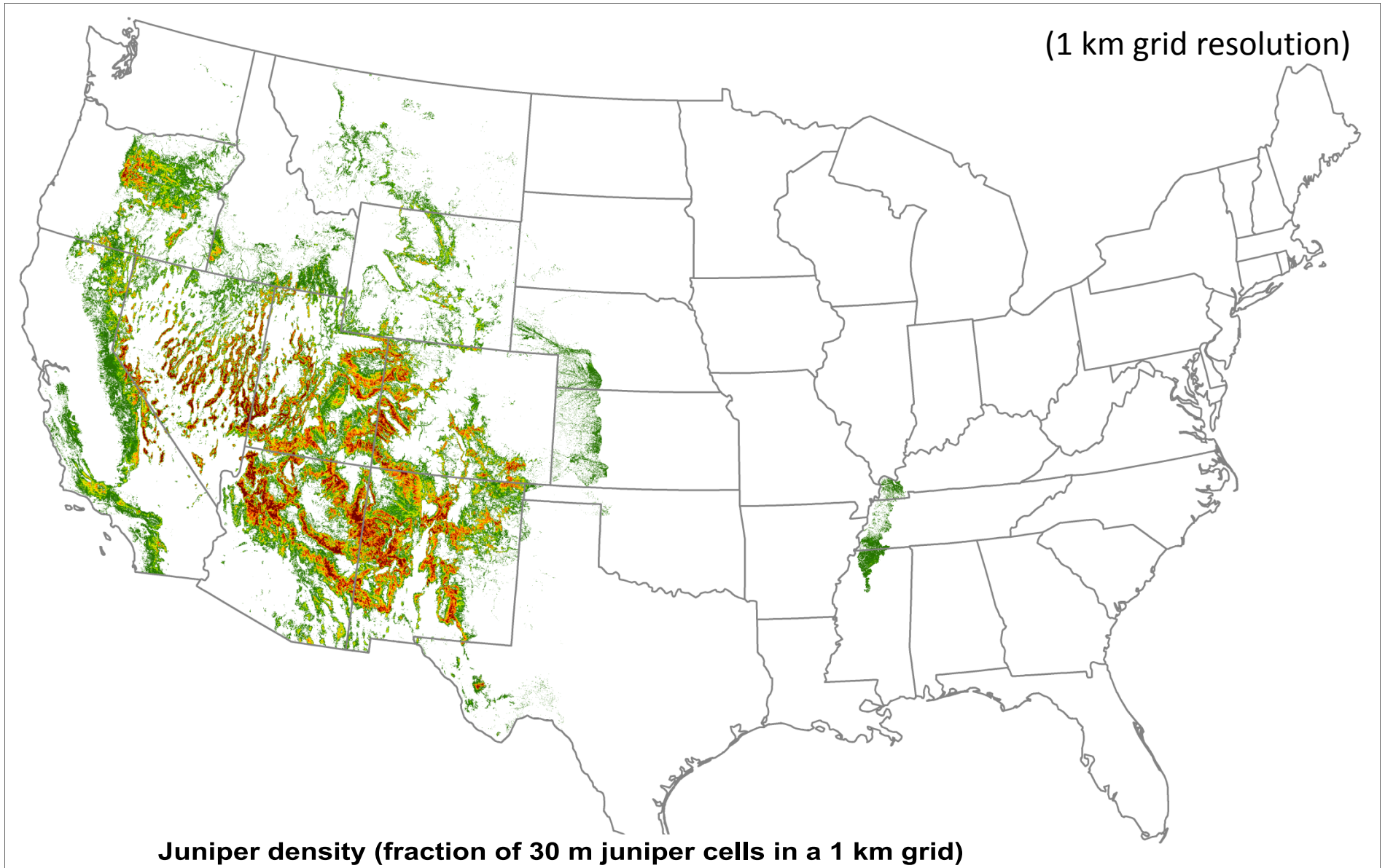
**Anomaly\_MOD09GQ\_250m-Pixel Site\_1 - February-2006**





# Juniper density\* distribution over USA

(1 km grid resolution)



Juniper density (fraction of 30 m juniper cells in a 1 km grid)



0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1





04/13/2009 14:11



04/13/2009 15:05



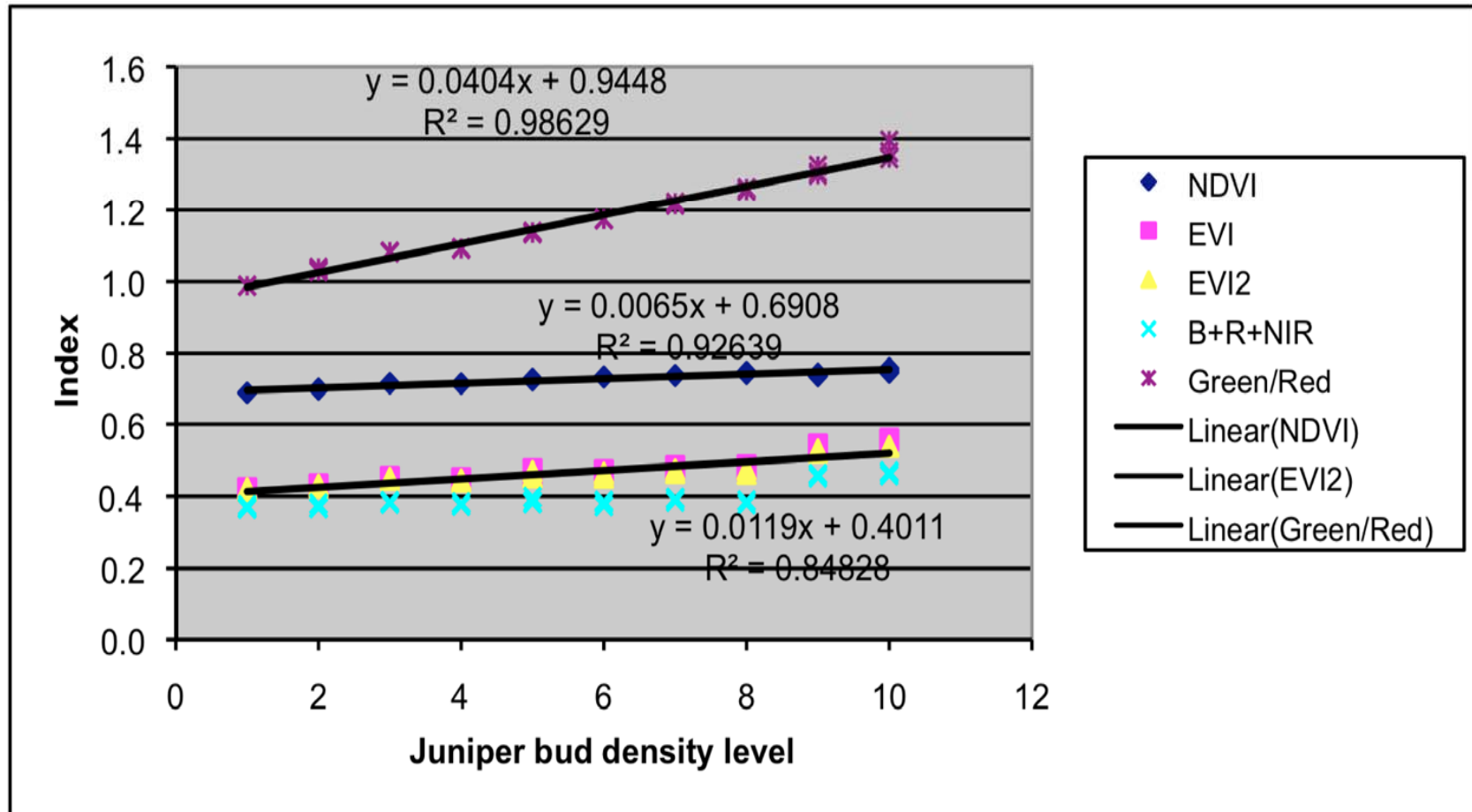
# Spectral characteristics of male juniper canopies at different bud density levels

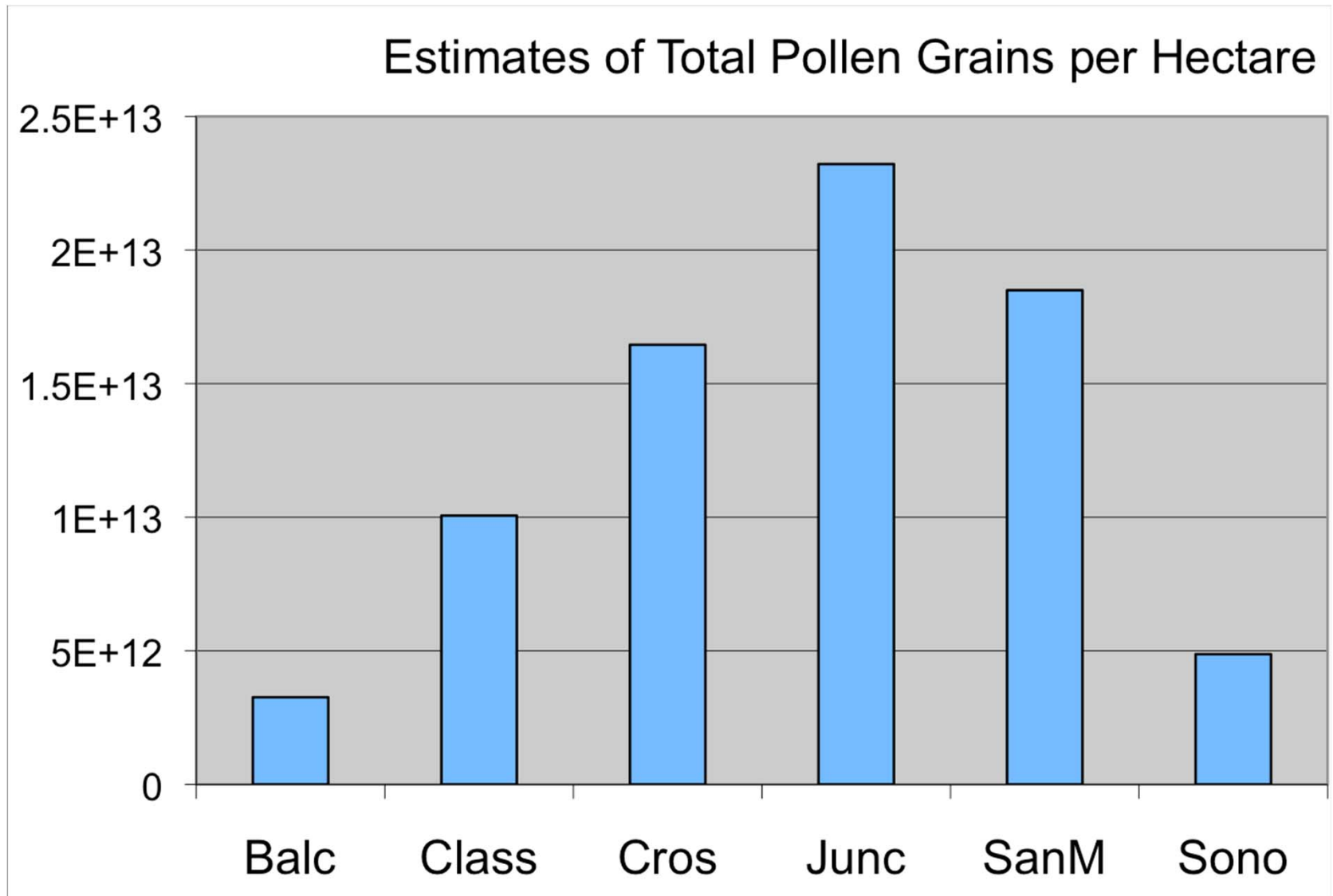


Density level	Bud density (g/m <sup>2</sup> )
1	204.2
2	190.0
3	176.9
4	164.9
5	151.1
6	136.2
7	115.8
8	92.9
9	45.9
10	0.0

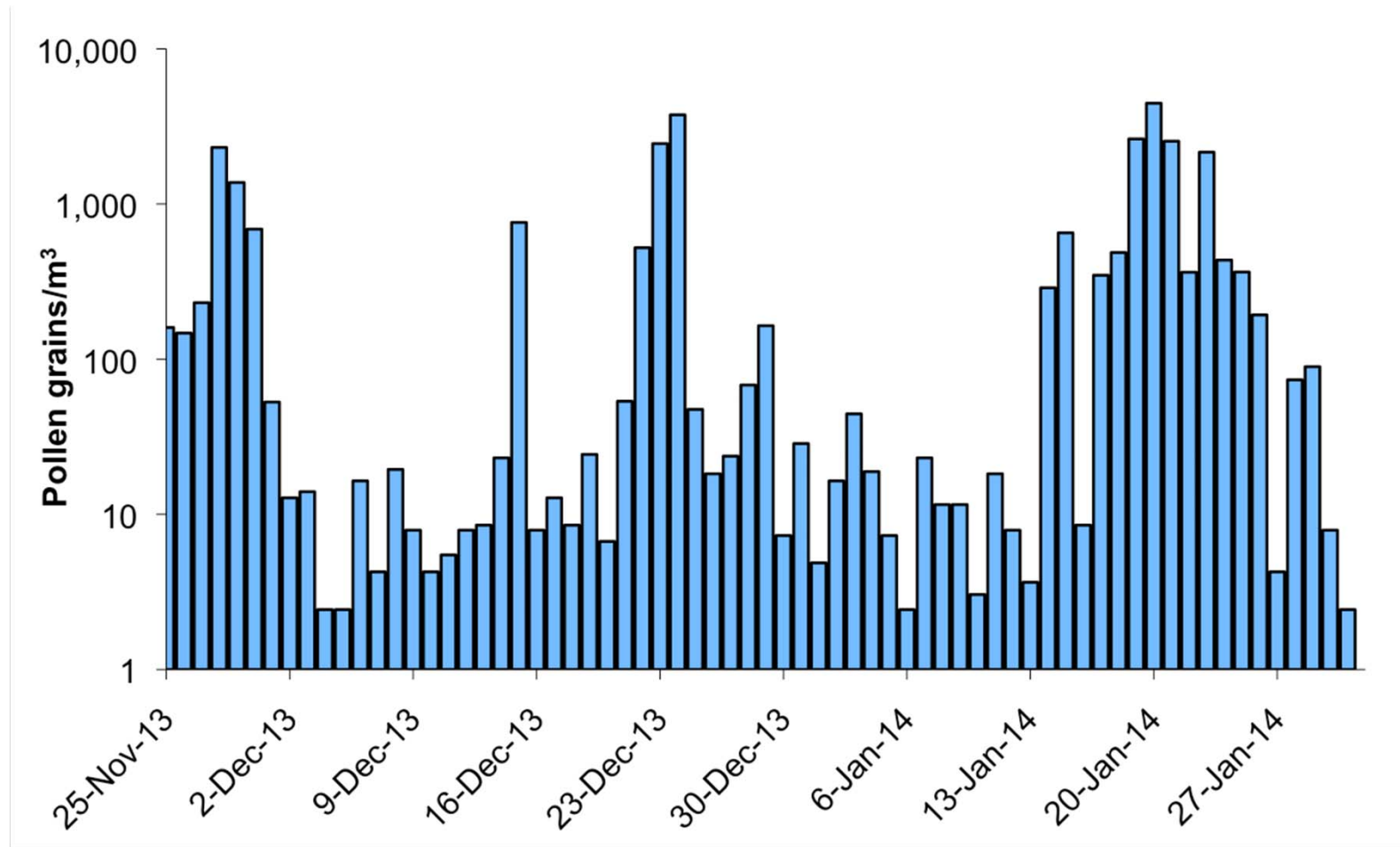


# Relationships between spectral indices and juniper bud density levels





# Mean Daily Concentration\* of Airborne *Juniperus ashei* Pollen at Camp Classen, Davis, OK



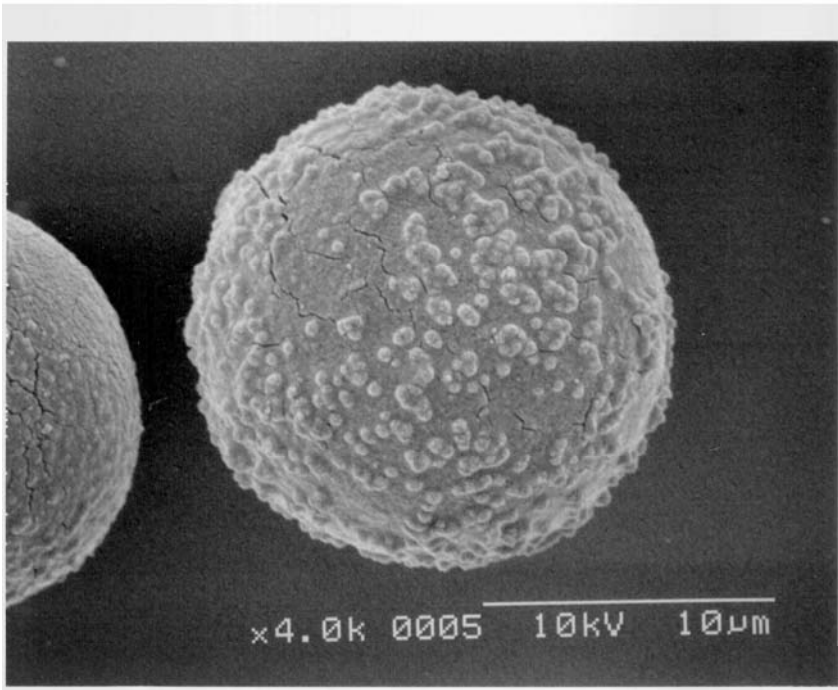
\*Concentration for each day is the mean of 12 bihourly concentrations



# Juniper Pollen

## Good News for Modeling

- Pollination Feb-March, little confusion with other pollinating plants
- *Juniperus* pollens are (mostly) spherical
- Distinct, large, 2-week pollination events: 2006 & 2007



*Juniperus virginiana*

# Airborne Dust Simulations and Forecasts

University of Arizona

With NASA Earth System Science & University of New Mexico

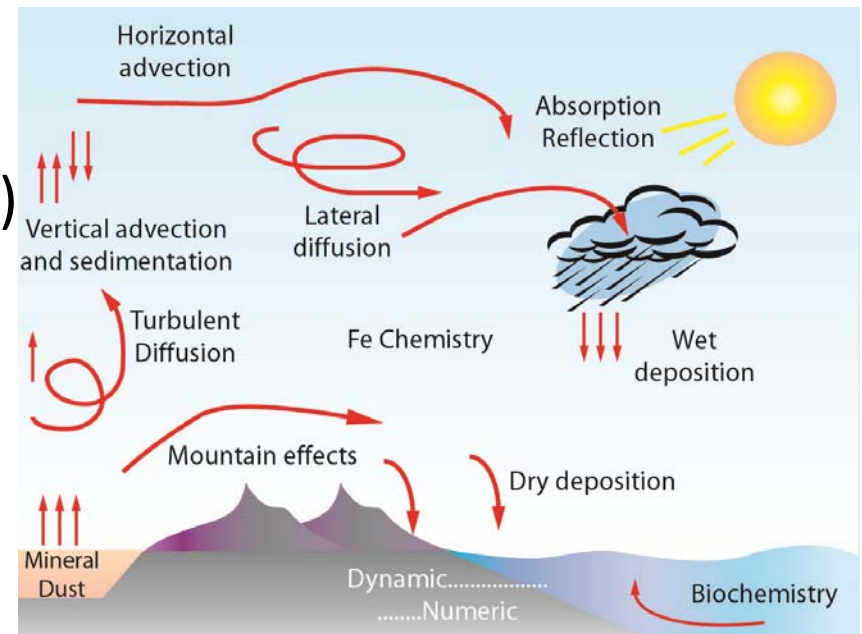


Department of Atmospheric Sciences

<http://www.atmo.arizona.edu/faculty/research/dust/dust.html>

# DREAM 4-8 particle bins

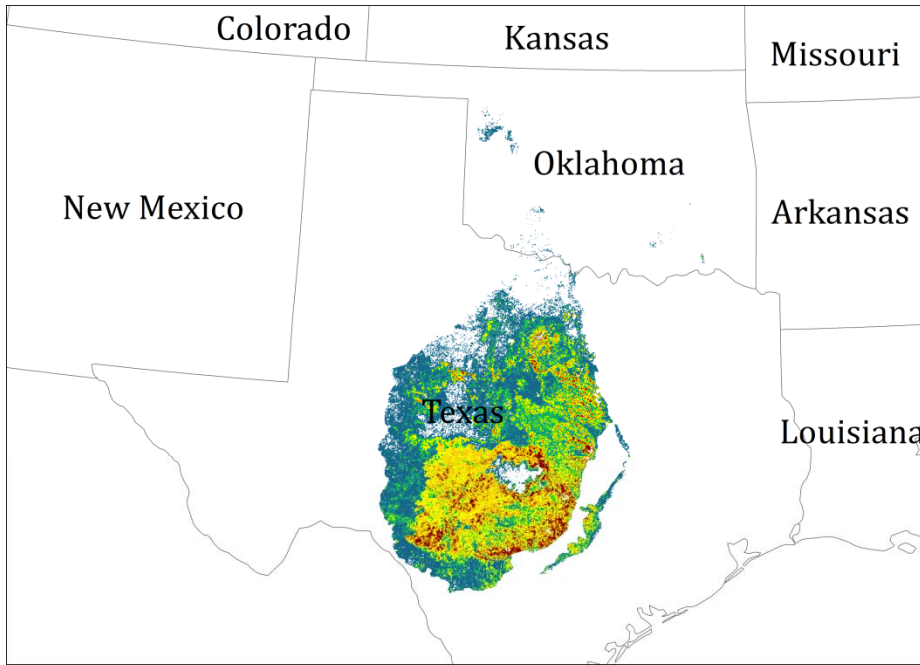
- **Model predictions (72-h):**
- Horizontal distribution
  - Surface concentration
  - Total column mass (dust load)
  - Wet, dry, total deposition
  - Meteorological variables
- Vertical distribution
  - Concentration
  - Cross sections
  - Fixed point/time profiles
- Fixed point (selected sites/cities)



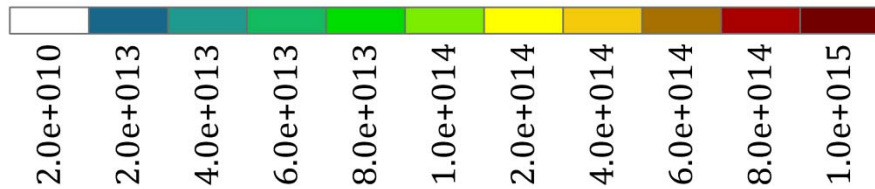


# Juniper Ashei

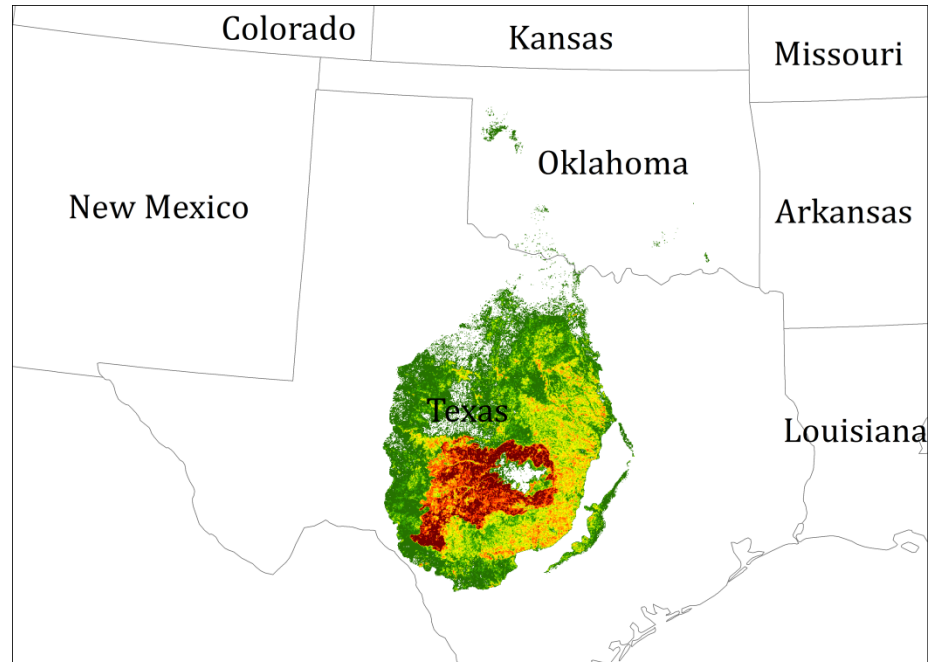
December to January



Pollen Count at Source



Pollen Count at Source



GAP derived Juniper distribution

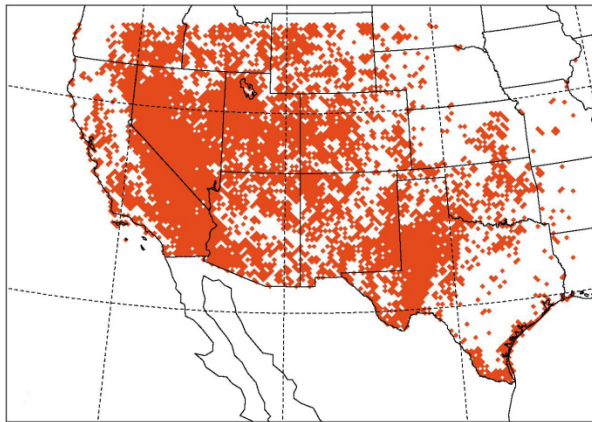


Distribution from GAP

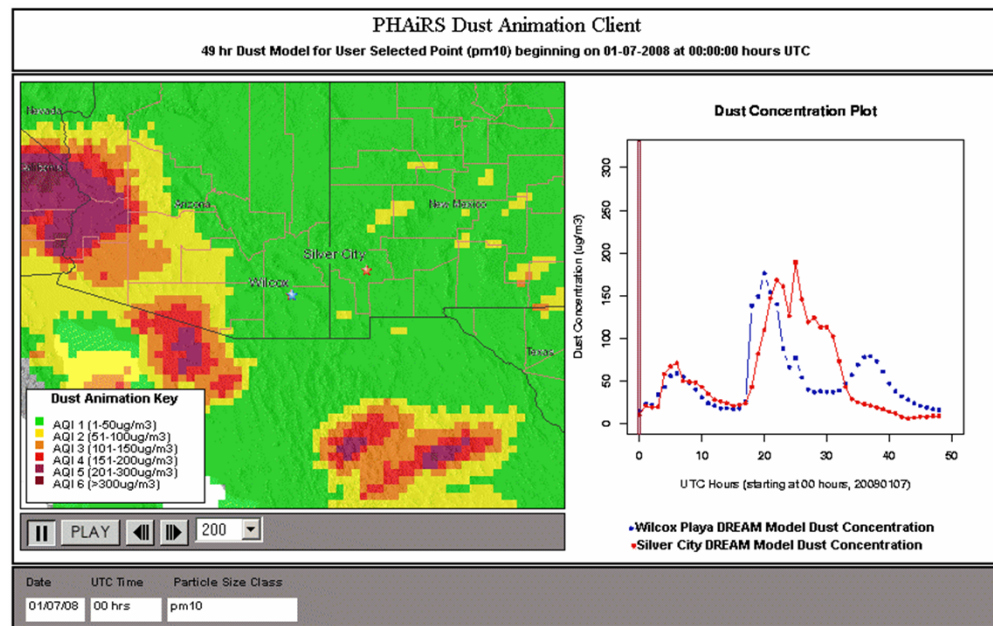
Grid resolution is ~1 km (990 m)

# Phenology and Pollen Transport

NASA Remote Sensing



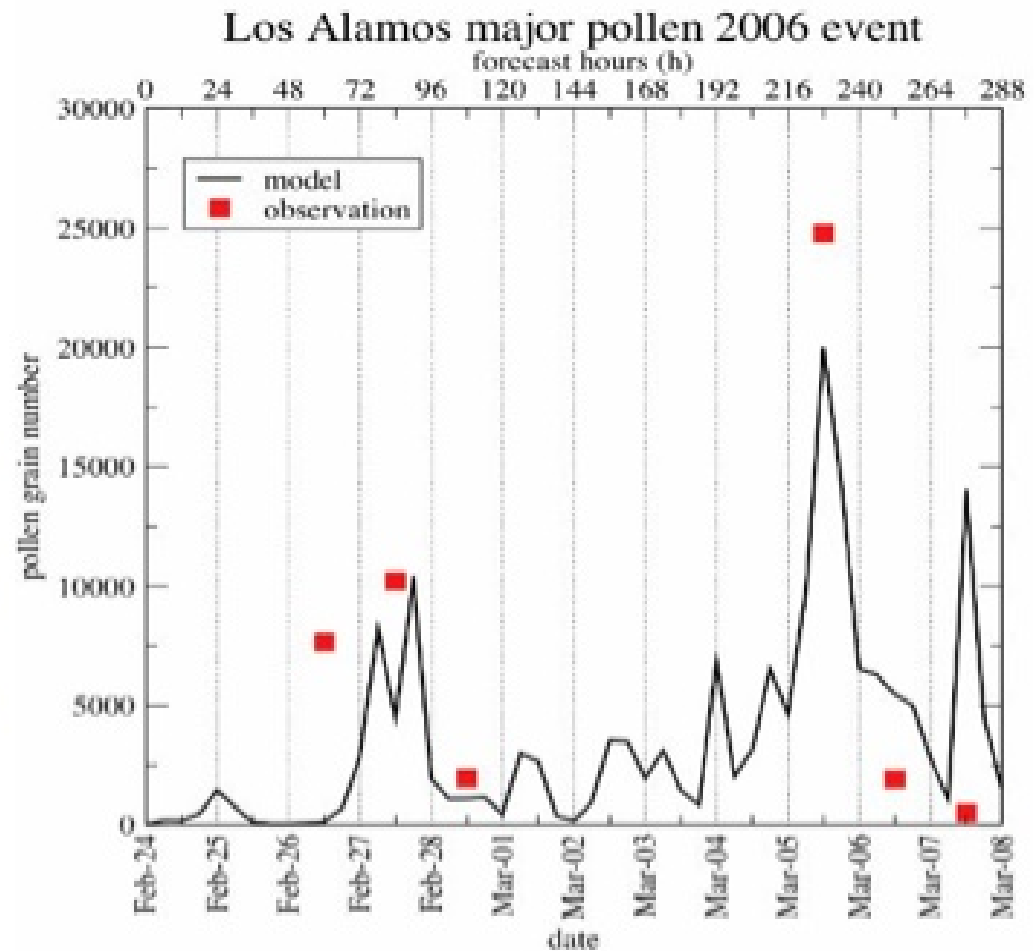
Currently - dust source regions  
Future - pollen sources derived from phenological maps



Final Product - predicted concentrations of pollen in time and space

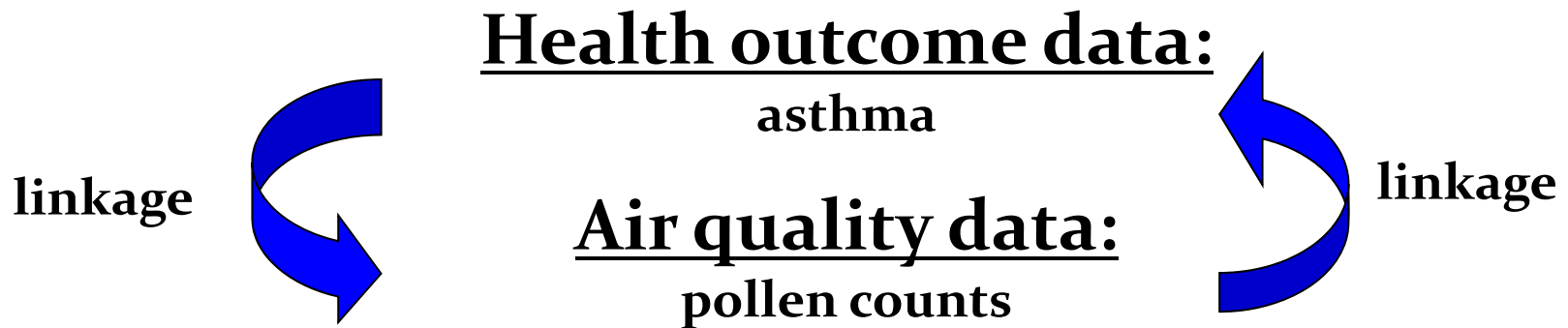


**DREAM** (Dust  
Regional  
Atmospheric Model)  
-- as --  
**PREAM** (Phenology  
Regional  
Atmospheric Model)

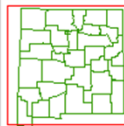




# CDC and New Mexico EPHTS



## Welcome to the New Mexico EPHT Mapping Applications Page

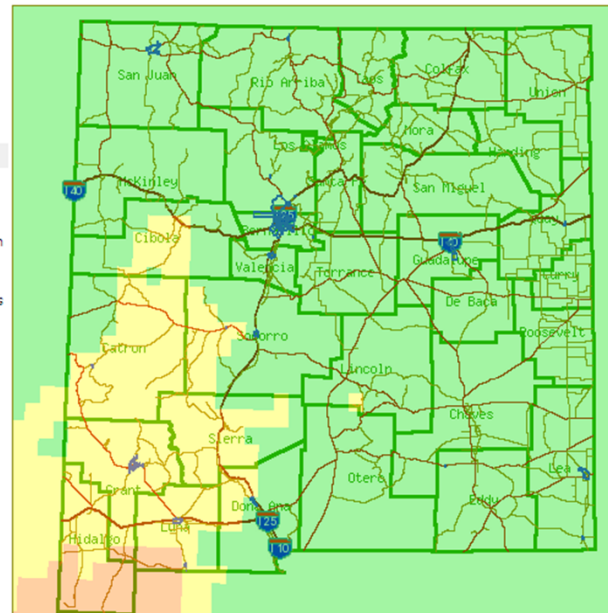


### How to use this map

The layers that you have requested to map are listed below. To add them to the map click 'add to map'. When you first add your EPHT query layer it will appear above the other layers in your map. You can use the arrowed buttons beside each layer in the table of contents to move layers up and down in the list for viewing. Navigation controls for the map are just below the map. Hovering over any of the controls gives you directions for their use. You must have popups enabled in your web browser in order to be able to query features in the map. You can use the small locator map above to zoom on the map in addition to using the zoom button below the map, just click and drag.

### Map Layers from: your EPHT data search

DREAM dust output PM2.5 -  
Classified 24-Hr Mean 2009-04-11T00:00:00Z **add to map**



lon:      lat:

### Table of Contents

1	<input checked="" type="checkbox"/>		DREAM dust output PM2.5 - Classified 24-Hr Mean 2009-04-11T00:00:00Z
	<input type="checkbox"/>	Excellent	
	<input type="checkbox"/>	Good	
	<input type="checkbox"/>	Moderate	
	<input type="checkbox"/>	Unhealthy for Sensitive Groups	
	<input type="checkbox"/>	Unhealthy	
	<input type="checkbox"/>	Very Unhealthy	
	<input type="checkbox"/>	Hazardous	
2	<input checked="" type="checkbox"/>		Water System Boundaries
	<input type="checkbox"/>	Water System Boundaries	

# ephtracking.cdc.gov

National Environmental Public Health Tracking Network - Windows Internet Explorer

http://ephtracking.cdc.gov/showHome.action

File Edit View Favorites Tools Help

Convert Select

National Environmental Public Health Tracking N...


CDC Home  
**CDC** Centers for Disease Control and Prevention  
Your Online Source for Credible Health Information

## National Environmental Public Health Tracking Network

Home About Tracking Program State & Local Tracking Portals Indicators & Data Secure Portal

Tracking A-Z Index A B C D E F G H I J K L M N O P Q R S T U V W X Y Z #

GLOSSARY CDC A-Z TRACKING A-Z



Environmental causes of chronic diseases are hard to identify. Measuring amounts of hazardous substances in our environment in a standard way, tracing the spread of these over time and area, seeing how they show up in human tissues, and understanding how they may cause illness is critical. The National Environmental Public Health Tracking Network is the start of that system.

The National Environmental Public Health Tracking Network is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. On the Tracking Network, you can explore information and view maps, tables, and charts about health and environment across the country. [Learn more about tracking.](#)

**Page Options**

Text Size: - +

- Printer-friendly version
- Get Email Updates
- Bookmark and Share

**Tracking Hot Topics**


- Healthy Homes
- National Environmental Public Health Conference: Oct 26-28, Atlanta

**Resources**


- Communication Features
- Document Library
- Quick Reports
- Technical Notes

**Contact Us**


**Environments**



**Health Effects**



**Info by Location**



Internet | Protected Mode: On 100%

6 Microsoft Offic... 5 Windows Explor... SAS Novell GroupWise -... National Environm...

8:57 AM



# Syndrome Reporting Information System™



# *The SYRIS system provides:*

- Real-time, Syndrome-Based Reporting Tool
- 2-Way Real-time Communication System - 24/7
- Automated, Immediate 'Alerts' to Public Health Officials (PHO's)
- Health 'Alerts' to Vets, Doctors, Hospitals, & Schools
- Web-Based Tool for Easy Syndrome Entry and Communication
- Geographic Mapping of Disease Outbreaks
- Connects All Health Care Providers to a Common Database
- Instantaneous Geographic Mapping of Disease Outbreaks
- Full compliance with the requirements of Public Law 109-417 (the Pandemic and All-Hazards Preparedness Act)

## Clinical Findings: Chronic Lung Disease Exacerbation

### Symptoms (Reported by Patient)



Productive Cough?  Yes  No Nasal Discharge?  Yes  No

Sore Throat?  Yes  No Wheezing?  Yes  No

Underlying Lung Disease (Asthma/COPD)?  Yes  No

### Clinical Signs (from Physical Examination)



Temp(C)  < 37.0  37.0 - 37.9  38.0 - 38.9  39.0 - 39.9

Predominant Lung Findings  Rales  Wheezing  Bilateral  Unilateral

Skin Rash?  Yes  No Oral Lesions?  Yes  No

Lymphadenopathy?  Yes  No  Diffuse  Localized

Splenomegaly?  Yes  No Hepatomegaly?  Yes  No

### Laboratory and X-Ray Data



WBC Count:  < 5,000  5,000 - 10,000  10,001 - 15,000  > 15,000

Platelet Ct.  < 50,000  50,000 - 100,000  100,001 - 150,000  > 150,000

Chest X-Ray:  Normal  Abnormal

Infiltrate  Hyperinflation  Cardiomegaly  Effusion

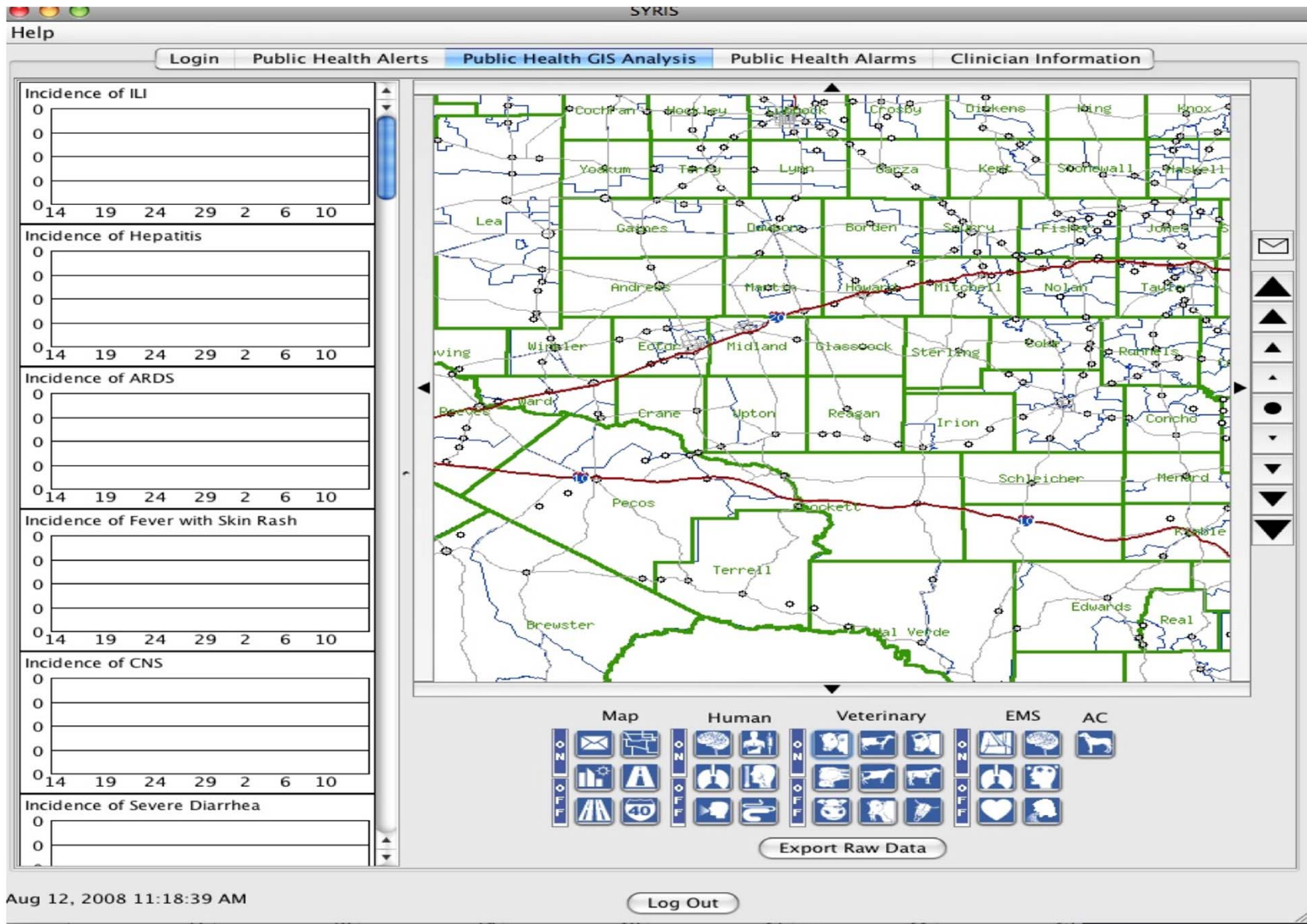
O2 Sat. (Room Air)  Normal  Abnormal

Help

Cancel

Submit Report





SYRIS will be used by Public Health Officials for interactive display of PREAM pollen maps, syndrome reporting and alerts



*A new data resource—a national network of integrated phenological observations across space and time*

*Key Goal*

*Understand how plants, animals and landscapes respond to environmental variation and climate change*



western columbine  
[View All Species](#)

## Join Us!

We are looking for volunteers to help us monitor plant and animal species found across the United States. Click "Observe" to join us!

 [Observe](#)

### Featured Projects



### Sponsors

## USA National Phenology Network

The USA National Phenology Network brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone.






[Learn more about us](#)

### What is phenology?

Phenology refers to recurring plant and animal life cycle stages, or phenophases, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. Many of these events are sensitive to climatic variation and change, and are simple to observe and record. As an USA-NPN observer, you can help scientists identify and understand environmental trends so we can better adapt to climate change.

[Why is phenology important?](#)

[USA-NPN News](#) [Phenology Feed](#) [Join the Conversation](#)

- ▶ [Phenoclimatology Position at UA](#)
  - ▶ [Introducing the USA-NPN Video](#) 
  - ▶ **Nature's Notebook:** "How to Observe" Handbook  and Training Videos 
  - ▶ [Phenology Special Issue in the Philosophical Transactions of the Royal Society](#)
  - ▶ [USA-NPN Reports \(including Strategic Plan and 2009 Annual Report\)](#) 
  - ▶ [Call for Papers: 4th Annual PROSE in Tucson, AZ, October 2010](#) 
- 
- ▶ [Recent Media Reports](#)
  - ▶ [Newsletter Archive](#)

 **Are you...?**

- [New to phenology?](#)
- [Ready to start observing?](#)
- [One of our partners?](#)
- [Interested in creating a partnership?](#)
- [An educator?](#)
- [Interested in finding data to use?](#)
- [A media outlet?](#)





September 05 2008

# NRC Decadal Survey HypsIRI

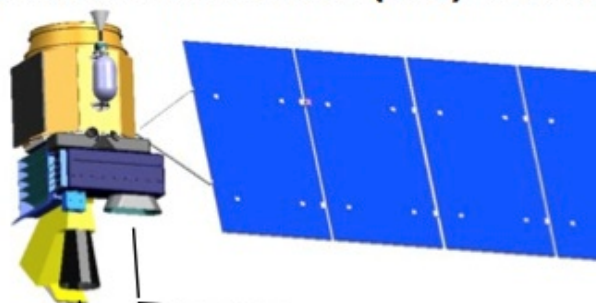


Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer  
+  
Multispectral Thermal InfraRed (TIR) Scanner

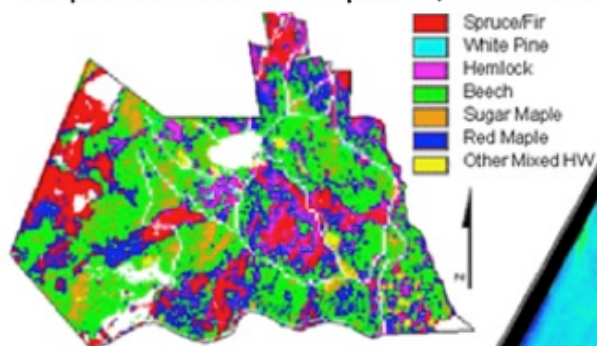
Charts by  
JPL/Rob Green &  
Simon Hook

VSWIR: Plant Physiology and  
Function Types (PPFT)

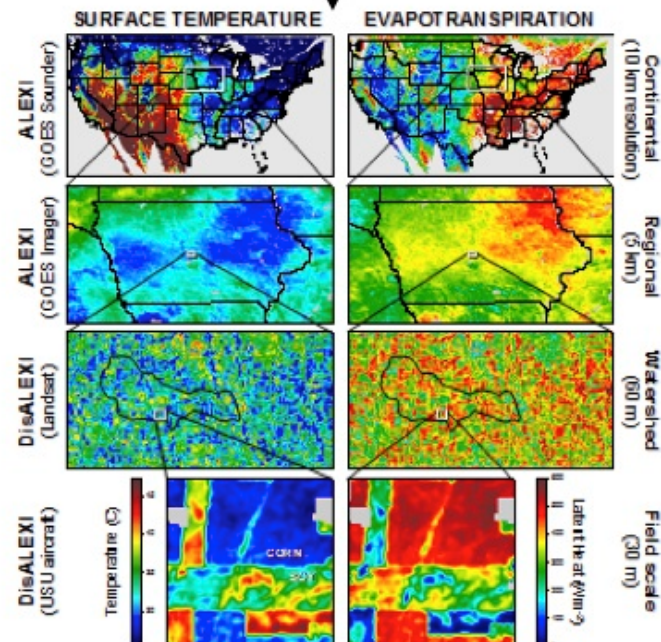
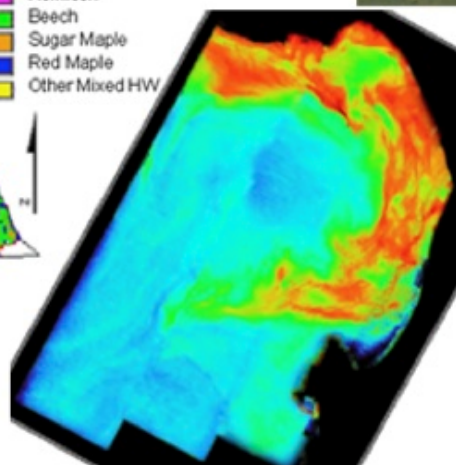
Multispectral  
TIR Scanner



Map of dominant tree species, Bartlett Forest, NH



Red tide algal bloom in Monterey Bay, CA



# **HYSPIRI SCIENCE AND APPLICATIONS**

Dr Simon J. Hook

Jet Propulsion Laboratory, California Institute of Technology.

With contributions from:

Elizabeth Middleton

Robert O Green

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California Institute of Technology. Government sponsorship  
acknowledged.

# HyspIRI and the NRC Decadal Survey

- January 2007: NRC releases Earth Science & Applications from Space report (the Decadal Survey) to NASA, NOAA, & USGS
- Calls for 17 satellite missions as an integrated set of



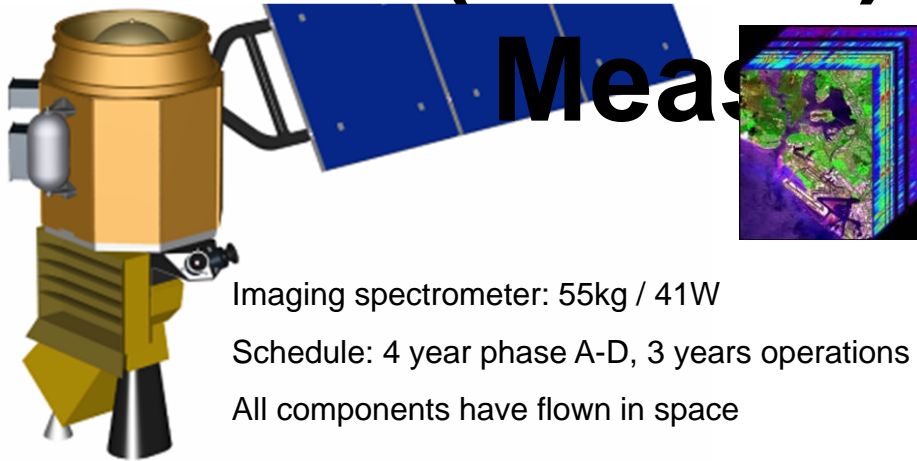
# VSWIR Overarching Science Questions

- **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?

# TIR Overarching 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?

# Shortwave Infrared (VSWIR) Science Measurements



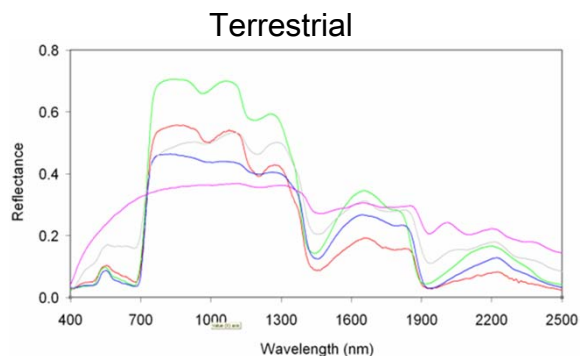
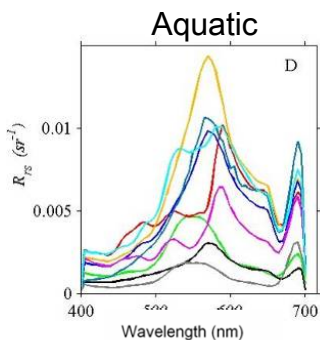
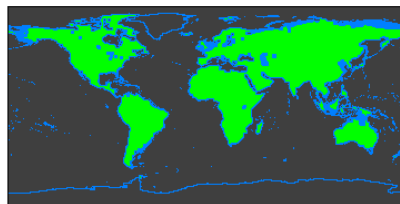
## Science Questions:

*What is the composition, function, and health of land and water ecosystems?*

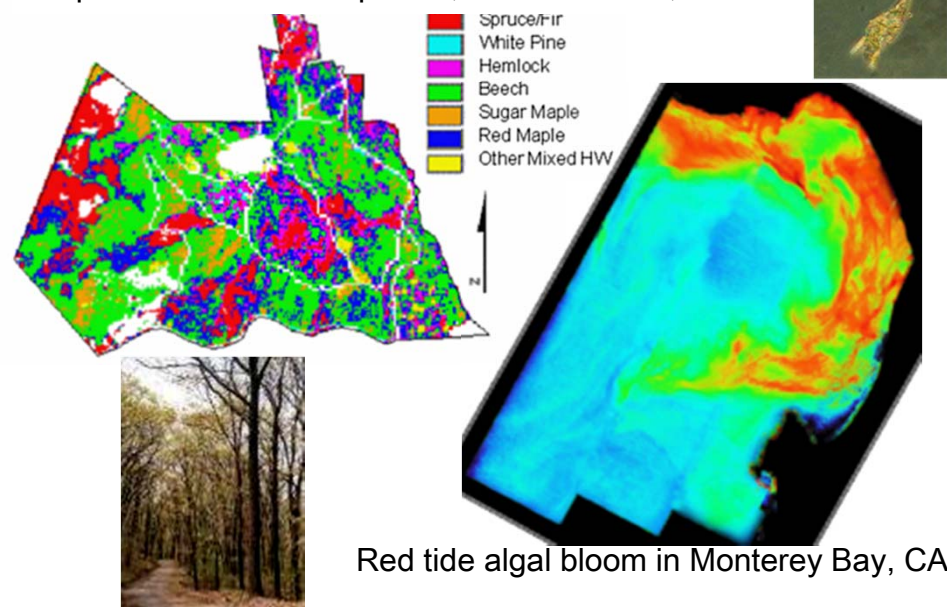
- *How are these ecosystems being altered by human activities and natural causes?*
- *How do these changes affect fundamental ecosystem processes upon which life on Earth depends?*

## Measurement:

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



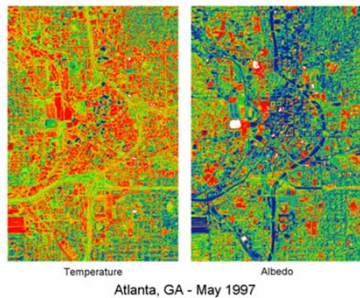
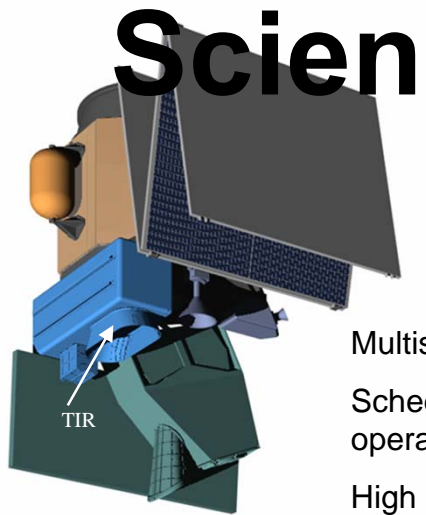
## Map of dominant tree species, Bartlett Forest, NH





# Earth Science Measurements

## Multispectral (TIR)



Multispectral Scanner: 60kg / 103W

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

High Heritage

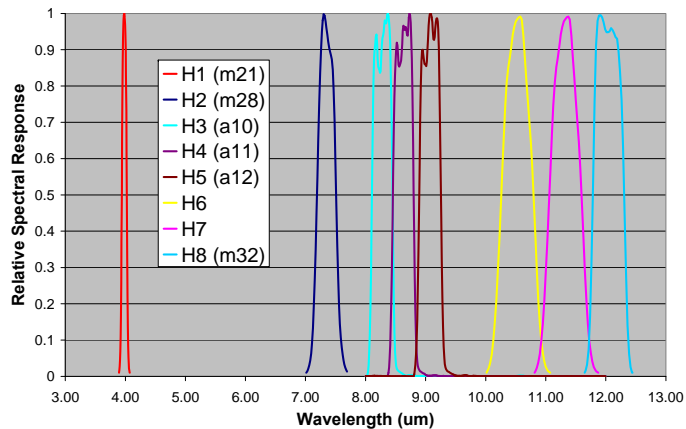
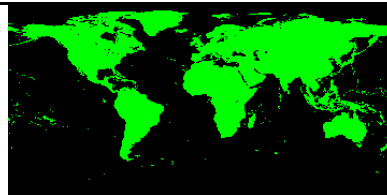
## Measurements

Science Questions:  
 TQ1. Volcanic Earthquakes (MA,RA)  
 How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?

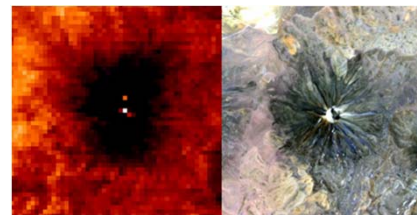
- TQ2. Wildfires (LG,DR)
  - What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?
- TQ3. Water Use and Availability, (MA,RA)
  - How is consumptive use of global freshwater supplies responding to changes in climate and demand, 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  $\mu\text{m}$  and 1 band at 4  $\mu\text{m}$
- 60 m resolution, 5 days revisit
- Global land and shallow water

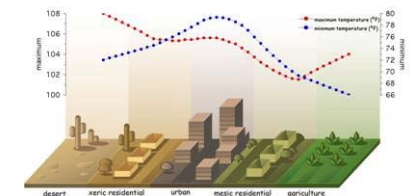


Andean volcano heats up

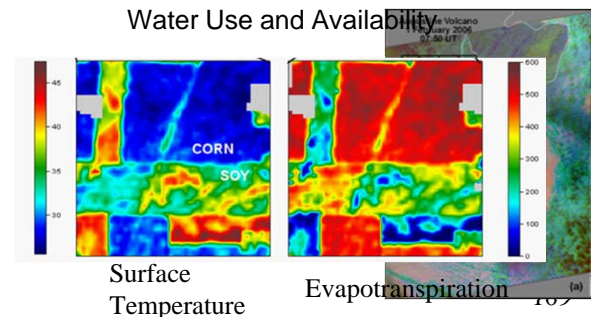


Volcanoes

Urbanization



Water Use and Availability



# HyspIRI Mission Concept - 2010

## Payload

### Science Instruments:

- **VSWIR: Imaging Spectrometer**
  - 380-2500 nm in 10 nm bands
  - 60m spatial resolution
  - Day-side ( 23% duty cycle)
  - 55 Kg, 41 W
- **TIR: Thermal Infrared Scanner**
  - 8 bands between 3-12  $\mu\text{m}$
  - 60m spatial resolution
  - Day and night-side (100% duty cycle)
  - 60 Kg, 103 W

### Intelligent Payload Module (IPM)

- 24/7 Direct Broadcast capability
- subset of science data
- X-band @ 20 Mbps
- 11 Kg, 86 W

## Implementation

**Launch Date:** 2014 - 2020

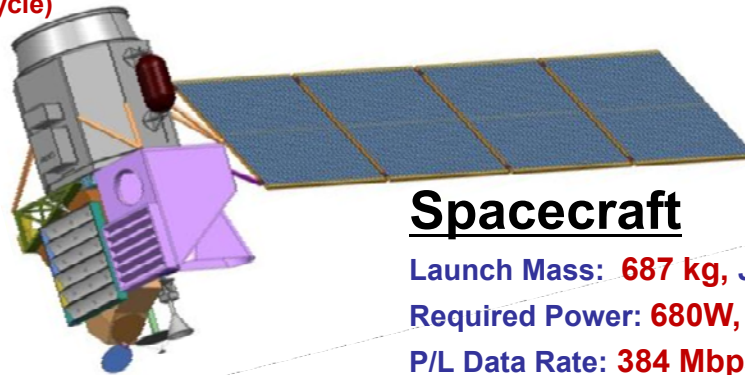
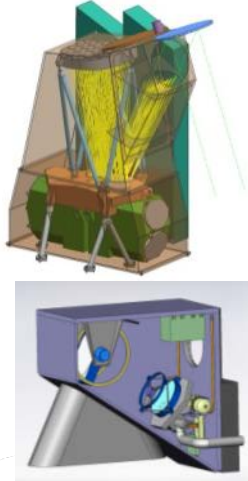
**Lifetime:** 3 years, with consumables for 5

**Cost :** Low to Moderate cost Mission

**Partners:** JPL, GSFC

**Mission Class:** C, with selected redundancy

**Hardware Model:** Protoflight



## Mission Architecture

- **Orbit:** 626 km Sun-Synchronous, 10:30am LTDN
- **Repeat:** 19 day VSWIR / 5 day TIR
- **Downlink:** Contacts nearly every orbit to Svalbard (North) and Troll (Antarctica)
- **Science Data:** 5.7 Tbits/day
- **Launch Vehicle:** Taurus 3210, 2m fairing, 790 kg capability

## Spacecraft

**Launch Mass:** 687 kg, JPL DP Margin: 30%

**Required Power:** 680W, 7.1 m<sup>2</sup> array (965 W capability)

**P/L Data Rate:** 384 Mbps

**Downlink Data Rate:** 800 Mbps Dual-pol X-band

**Stabilization:** 3-axis

**Pointing:** Control = 720 arcsec (per axis 3 $\sigma$ )

Knowledge = 5.6 arcsec (Pitch/Roll axis 3 $\sigma$ );  
15 arcsec (Yaw axis 3 $\sigma$ )

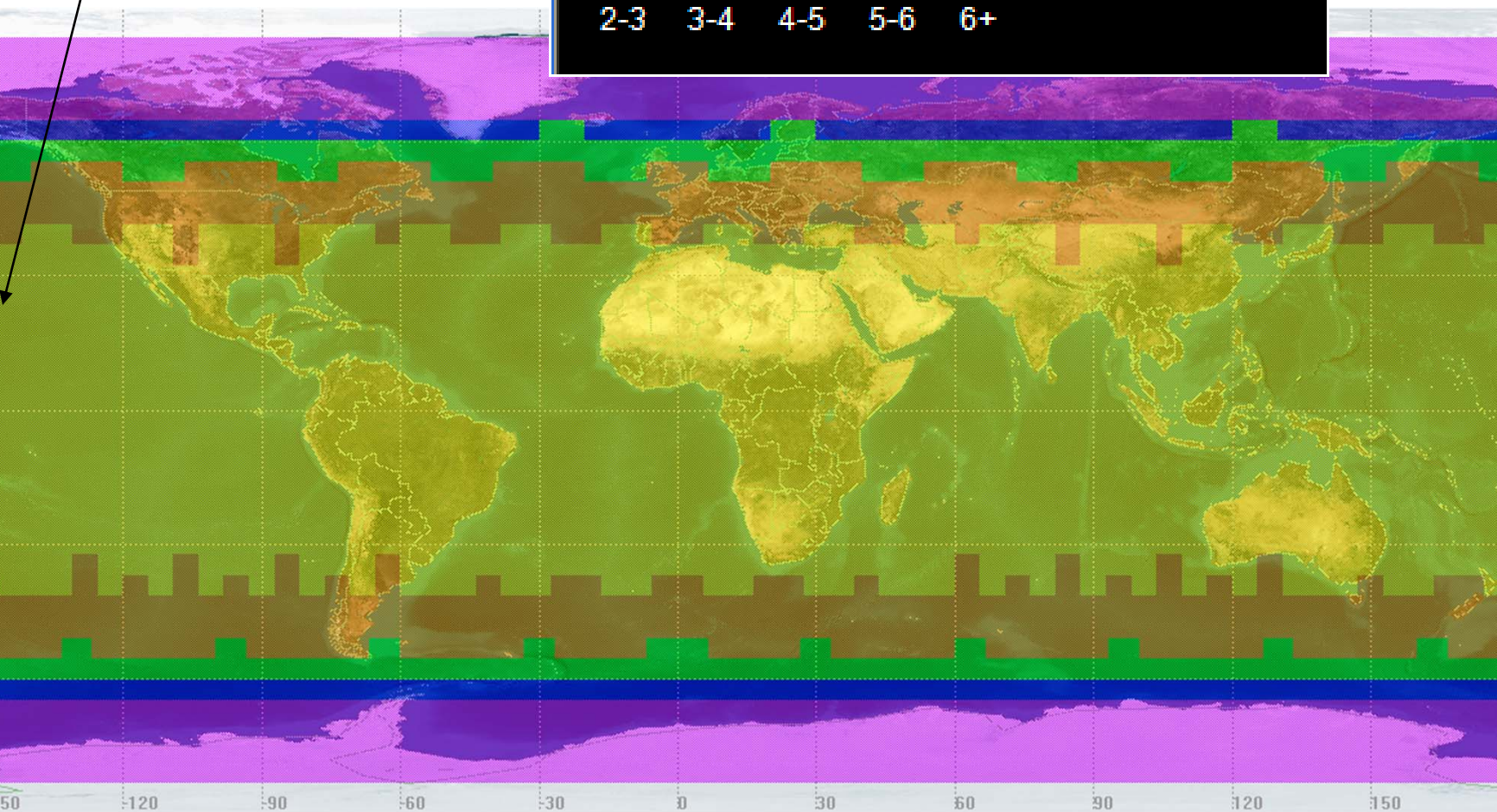
Stability = 5 arcsec/sec (per axis 3 $\sigma$ )



# Annual TIR imaging opportunities in a 5-day near-repeating orbit, 1 yr. simulation

Oceans average to 1 km

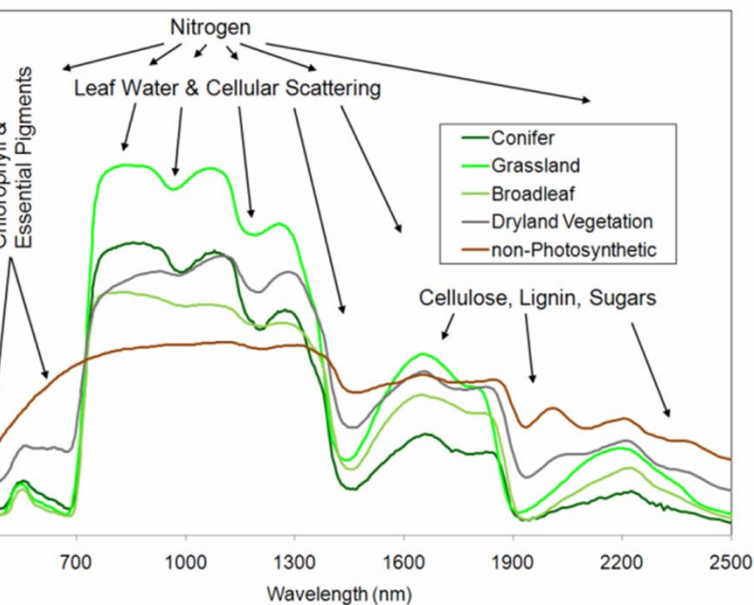
Total number of views (day + night) each 5 days



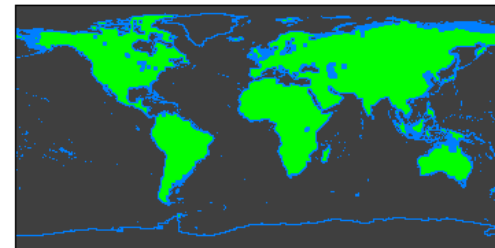
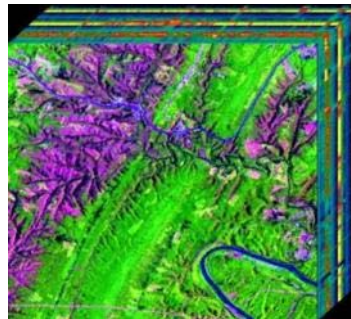


# Ecosystem Measurements for Climate Feedbacks

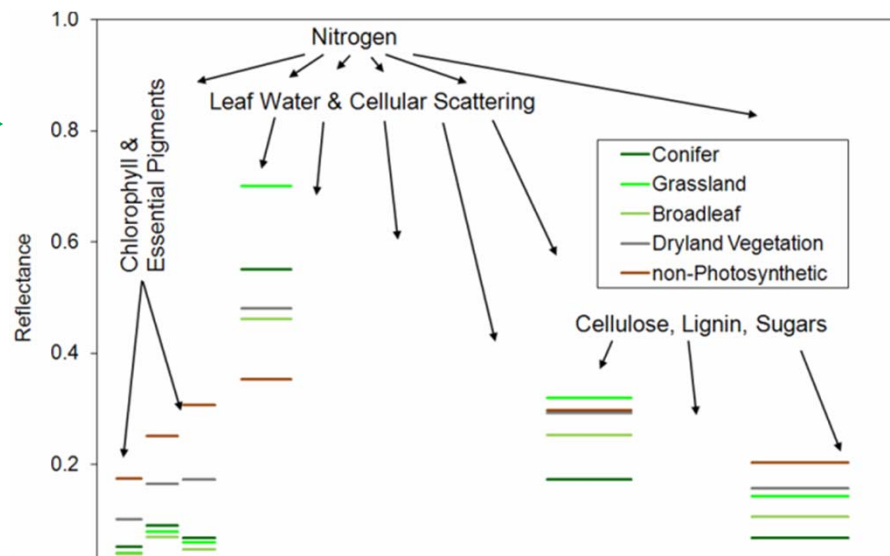
## Measuring the Terrestrial Biosphere



← Imaging Spectroscopy is required to measure critical variables of the terrestrial biosphere.



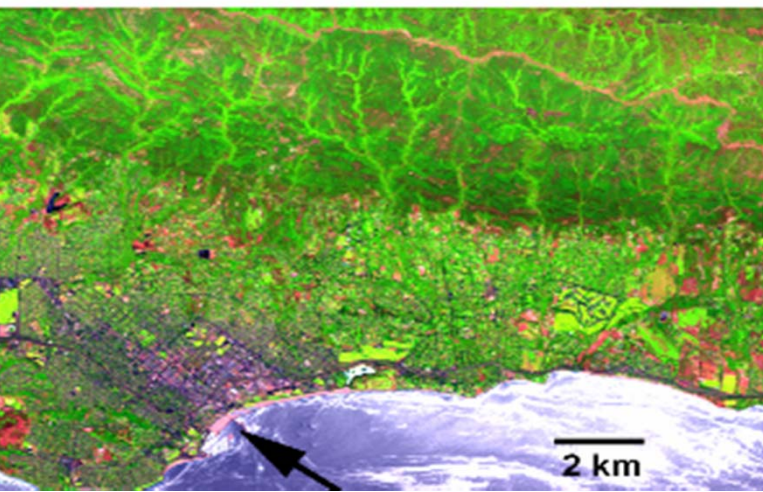
hyperspectral imaging is insufficient →



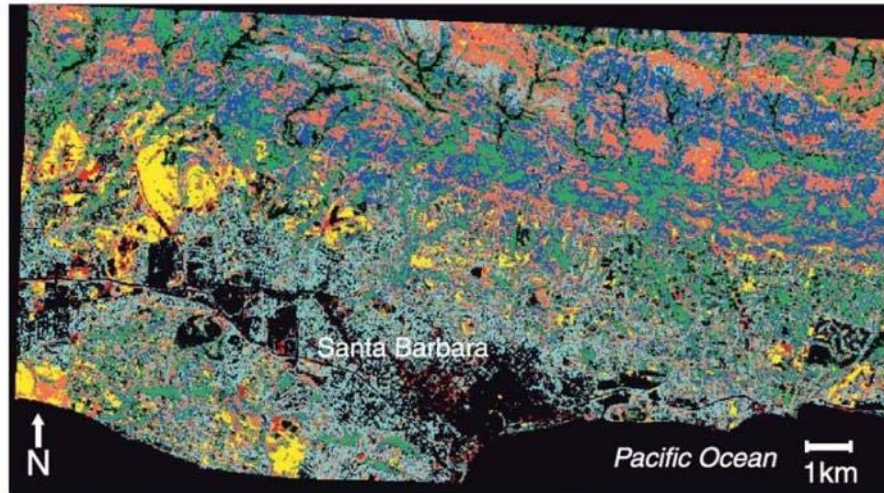
# Ecosystem Measurements for Climate Feedbacks

## Vegetation Species/Functional-type & Fractional Cover

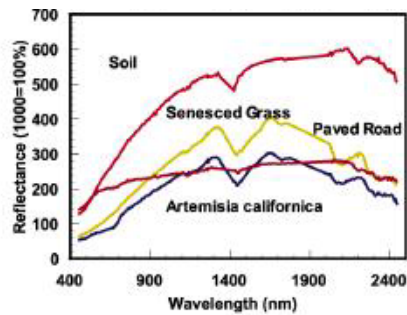
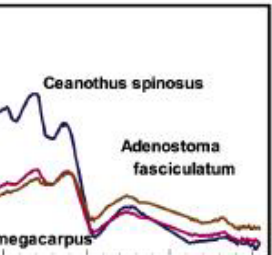
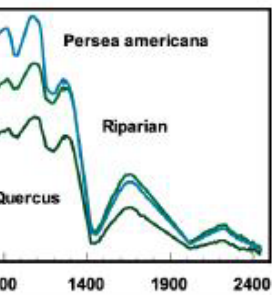
Santa Barbara, CA Coast Range



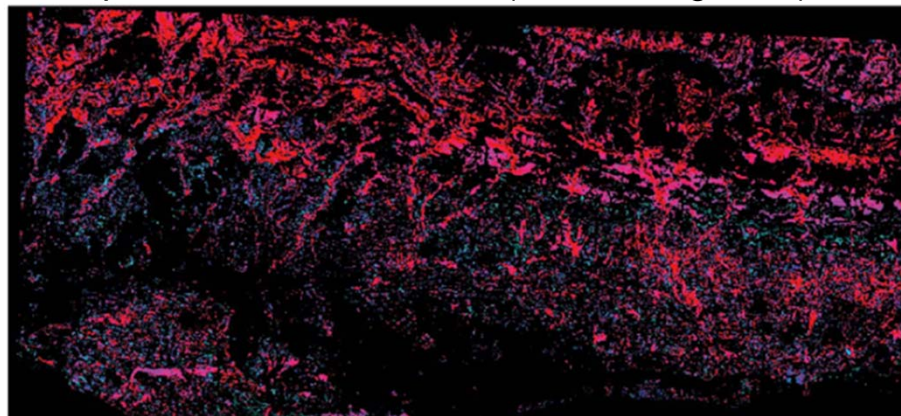
Species Type 90% accurate



- *Adenostoma fasciculatum*
- *Quercus agrifolia*
- *Ceanothus megacarpus*
- Grass
- *Arctostaphylos spp.*
- Soil



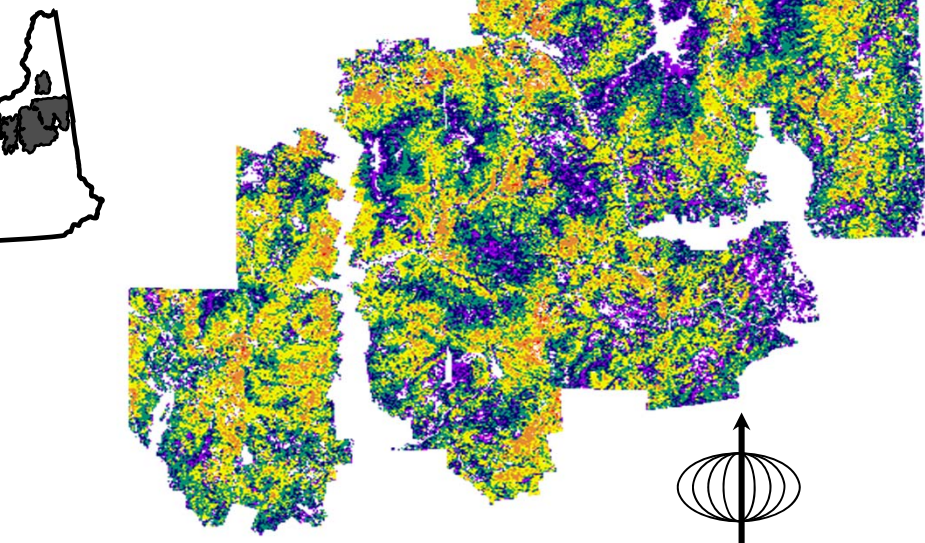
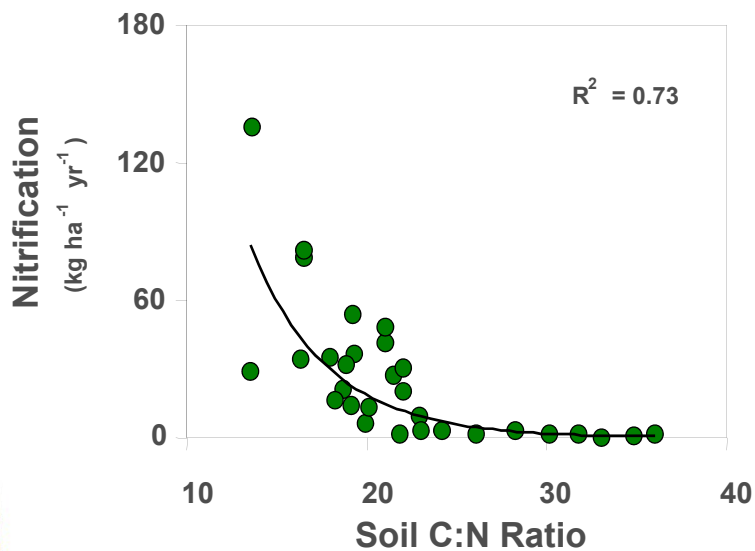
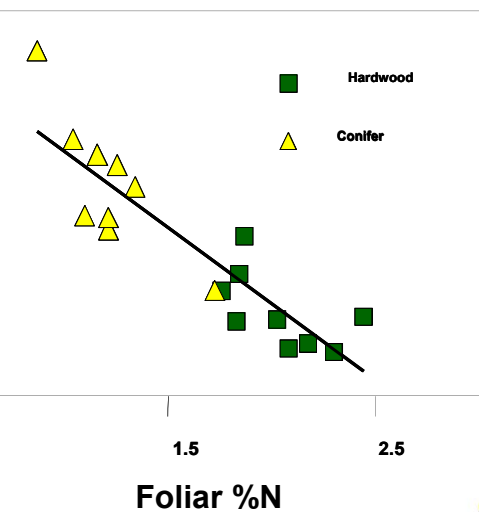
Species Fractional Cover (*Quercus agrifolia*)



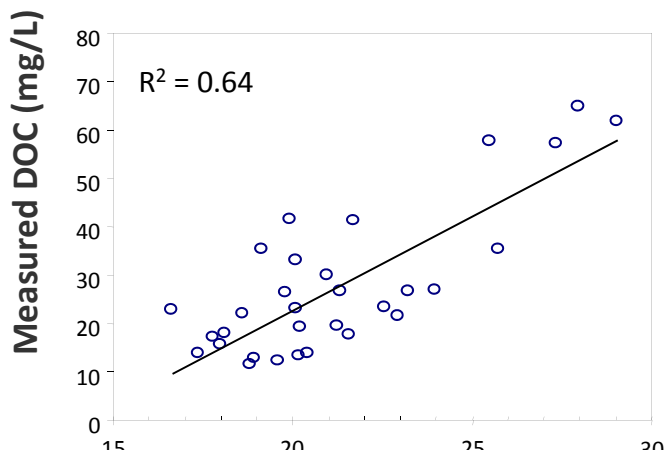


# Ecosystem Measurements for Climate Feedbacks

## Imaging Spectroscopy Foliar Chemistry Used to Estimate Soil Nitrogen Cycling

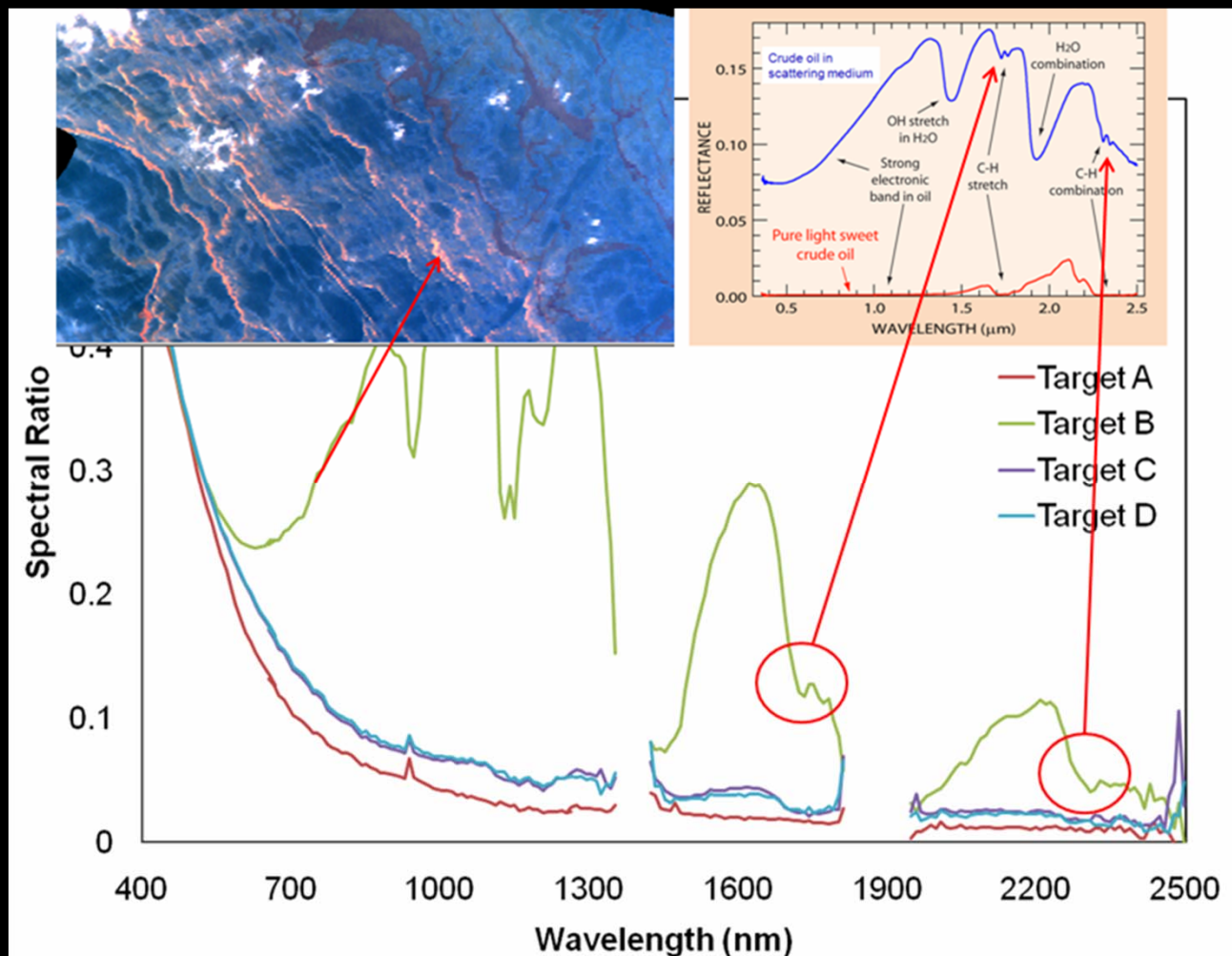


### Predicted C:N versus Stream DOC





# IS Measurements of Carbon-Hydrogen Bond Spectral Signature in Gulf Oil Spill



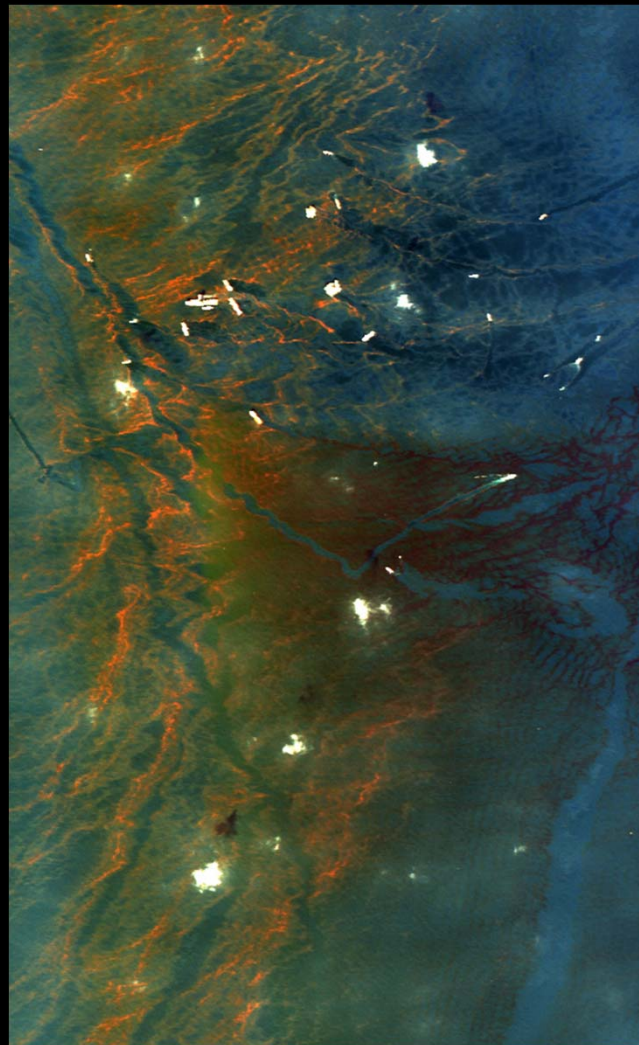
results from AVIRIS over the Gulf Oil Spill that show the spectroscopic signature of the crude oil carbon-hydrogen bond absorption features in the infrared portion of the spectrum. This infrared spectral signature enables estimation of the location, type, and indicates aspects of the oil on the water.

# AVIRIS 17 May 2010, FL11

## Blue Water

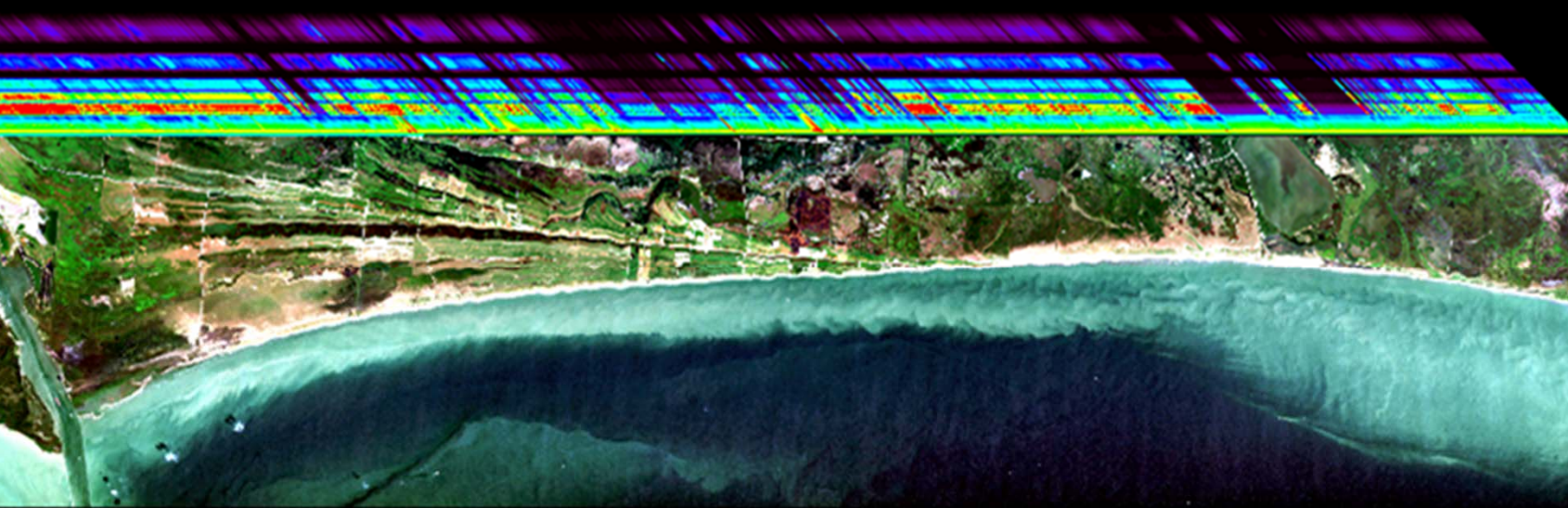


## Spill Source Region



Spectral signature of the oil measured in the infrared portion of the spectrum enables a new  
physically-based approach to measure the oil concentration and estimate the thickness

# Example AVIRIS Baseline Measurements Along the Gulf Coast



AVIRIS imaging spectrometer measurements along the Gulf coast to measure the ecosystem habitat characteristics and condition before possible oil contamination and impact. The location is near Johnson's Bayou and along the Gulf Beach Highway, between Port Arthur, LA to the West and Cameron, LA to the East. The west corner includes part of the Texas Point National Wildlife Refuge. The 224 wavelengths of light measured by AVIRIS from the visible to infrared are depicted in the top and left panels. The spectrum measured for each point in the image will be used to help assess the characteristics and conditions of the coastal ecosystems and

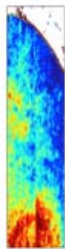


# Ocean and Coastal Applications

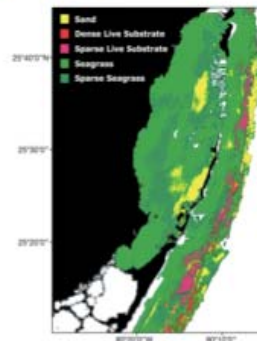
- Products
  - Sea color (e.g. Chlorophyll-A, Fluorescent line height, Maximum Chlorophyll Index,...) (VSWIR)
  - Sea Surface Temperature (SST) (TIR)
- Heritage: MODIS, AVHRR, MERIS, SeaWifs, ASTER, Landsat ETM, VIIRS, Hyperion, CZCS, OCTS
- Applications
  - River plumes, reef studies, HAB, Oil spills, TSS, Chlorophyll, Carbon



False Color  
Level  
1G  
Hyperion



FLH From  
Level 0.5R  
Hyperion  
[Chien et al  
2009]



Reef  
classification  
map derived  
from  
Landsat ETM  
[Moses et al.  
2008]

- Challenges
  - Atmospheric correction, cloud rejection (SST)
  - Case 2 waters (CDOM, TSS)

## Carbon Release from Biomass Burning

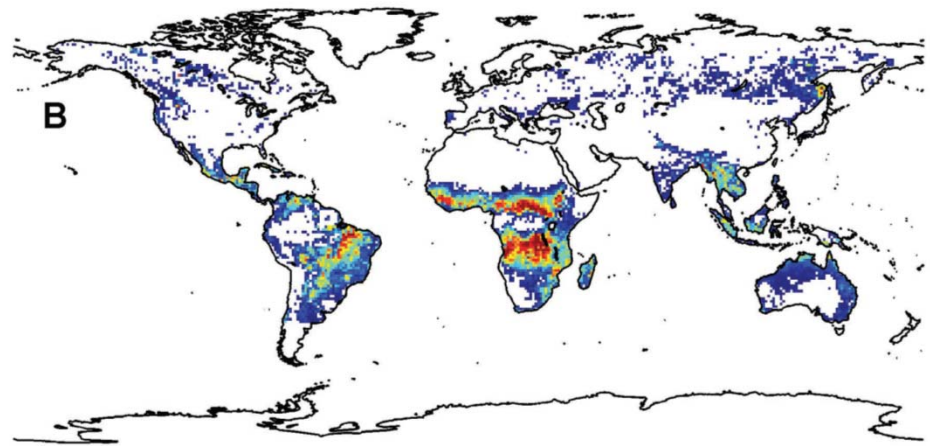
# Global Characterization of Fire Emission Sources

Biomass burning and fossil fuel emissions release  $\sim 10^{15}$  g of carbon (C) to the atmosphere each year. Biomass burning constitutes  $\sim 36\%$  of all global C emissions.

on  
 ral and northern South  
 rica  
 nern South America  
 nern Africa  
 nern Africa  
 neast Asia  
 al (north of 38°N)  
 r  
 al

Fire emissions  
 1997-2001 average  
 ( $10^{15}$  g C yr $^{-1}$ )

0.27  
 0.80  
 0.80  
 1.02  
 0.37  
 0.14  
 0.13  
 3.53



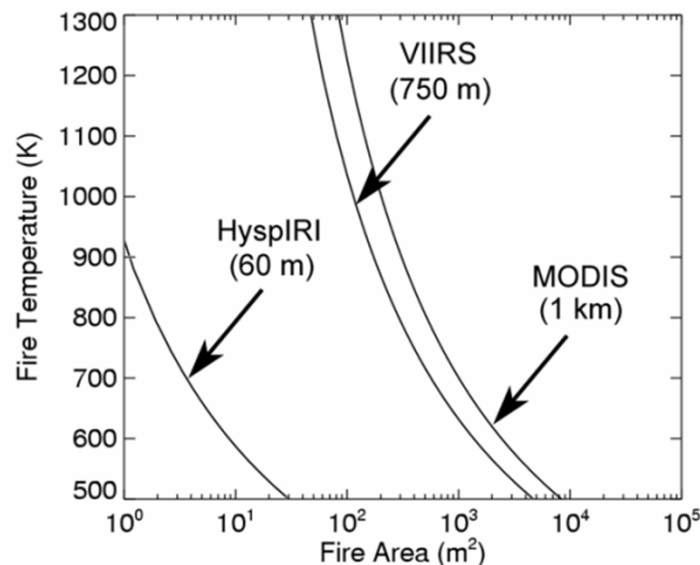
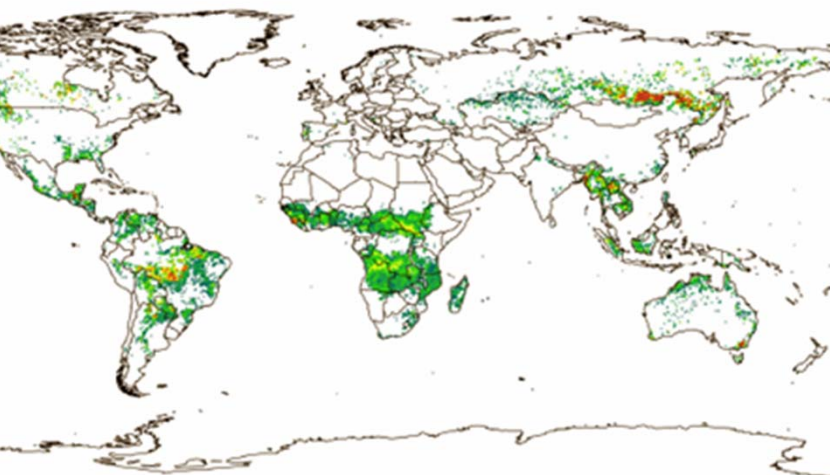
*Van der Werf et al., 2004*

Carbon Release from Biomass Burning

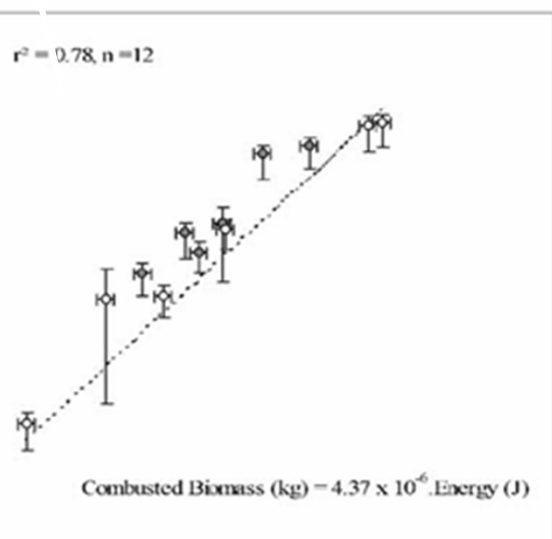
# Fire Radiative

# Energy

FRE-based Estimated OCBC : 2003



90% probability of detection; boreal forest;  
nadir view



**Use Fire Radiative Energy to  
estimate combusted biomass:  
Need 3-5 um data**

*Ellicott et al 2009*

*Wooster et al 2002 and 2003*



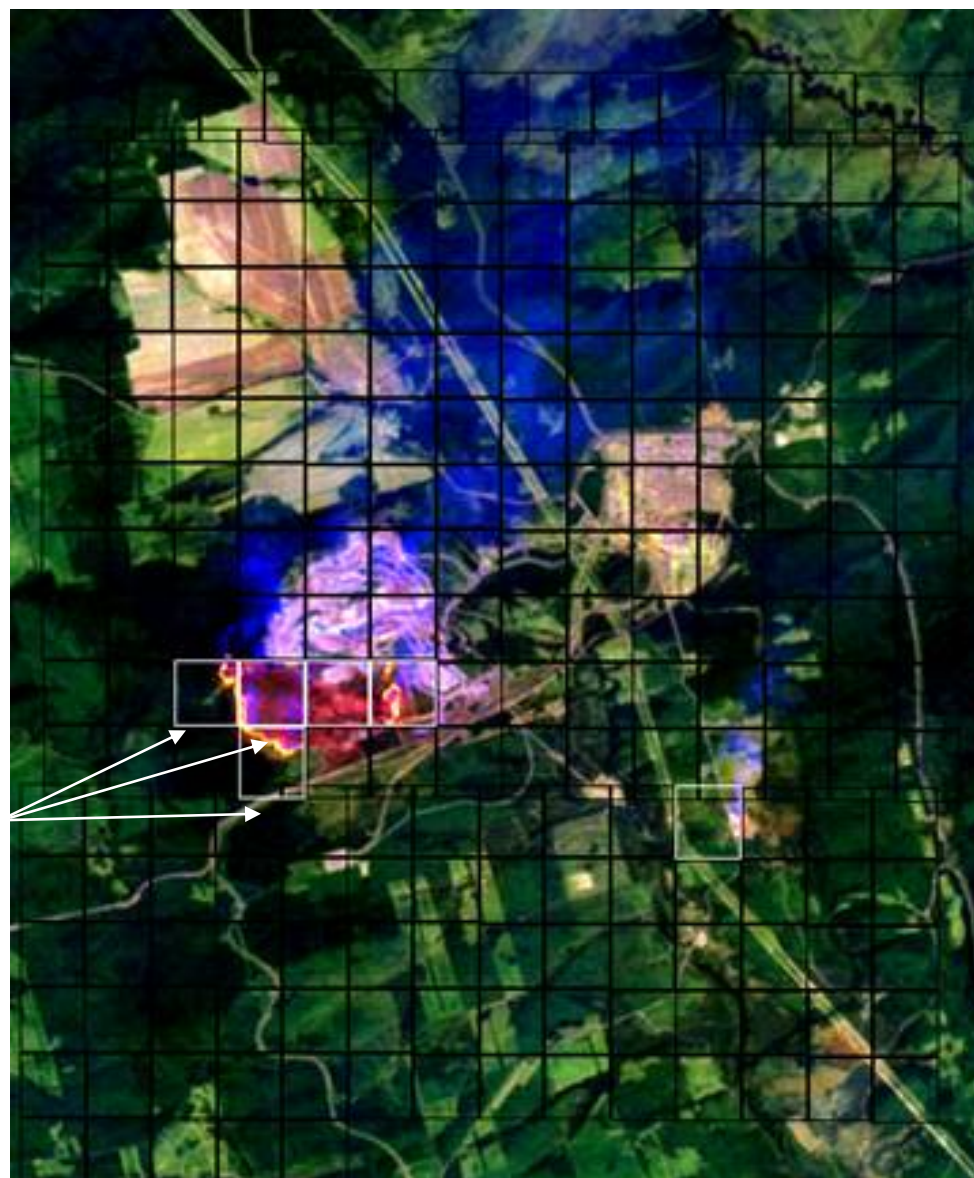
# Carbon Release from Biomass Burning

## How are global fire regimes changing? (patterns of fire occurrences, frequency, size, severity)

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

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



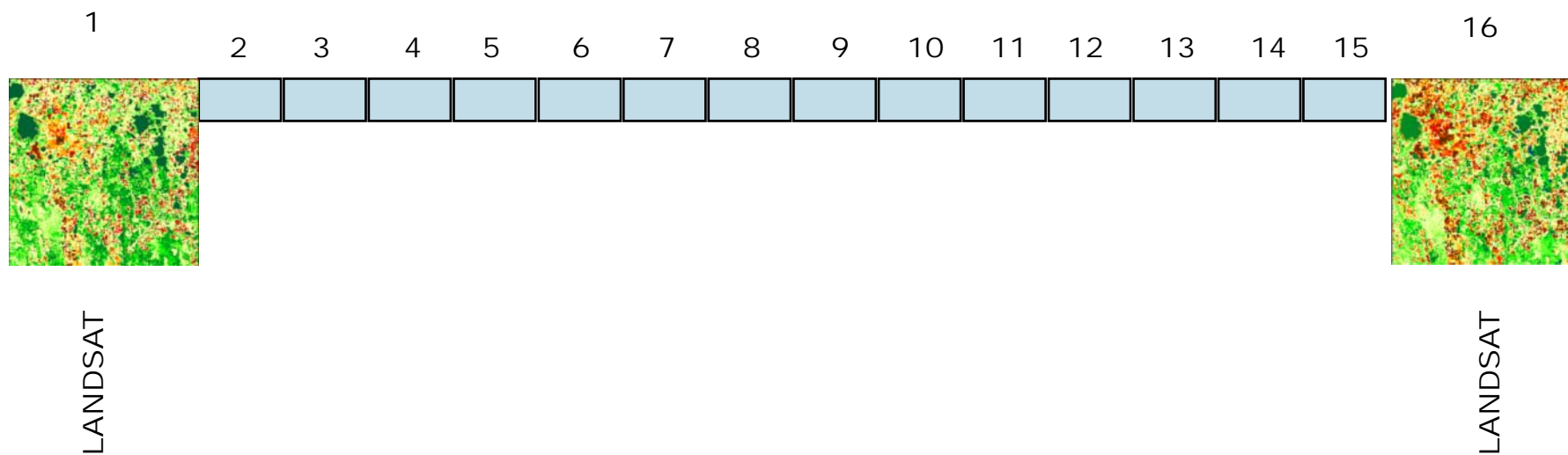
30 m ASTER  
scene with  
MODIS pixels  
superimposed  
(black squares)

Central Siberia  
30 May 2001

# Evapotranspiration and Water Use and Availability

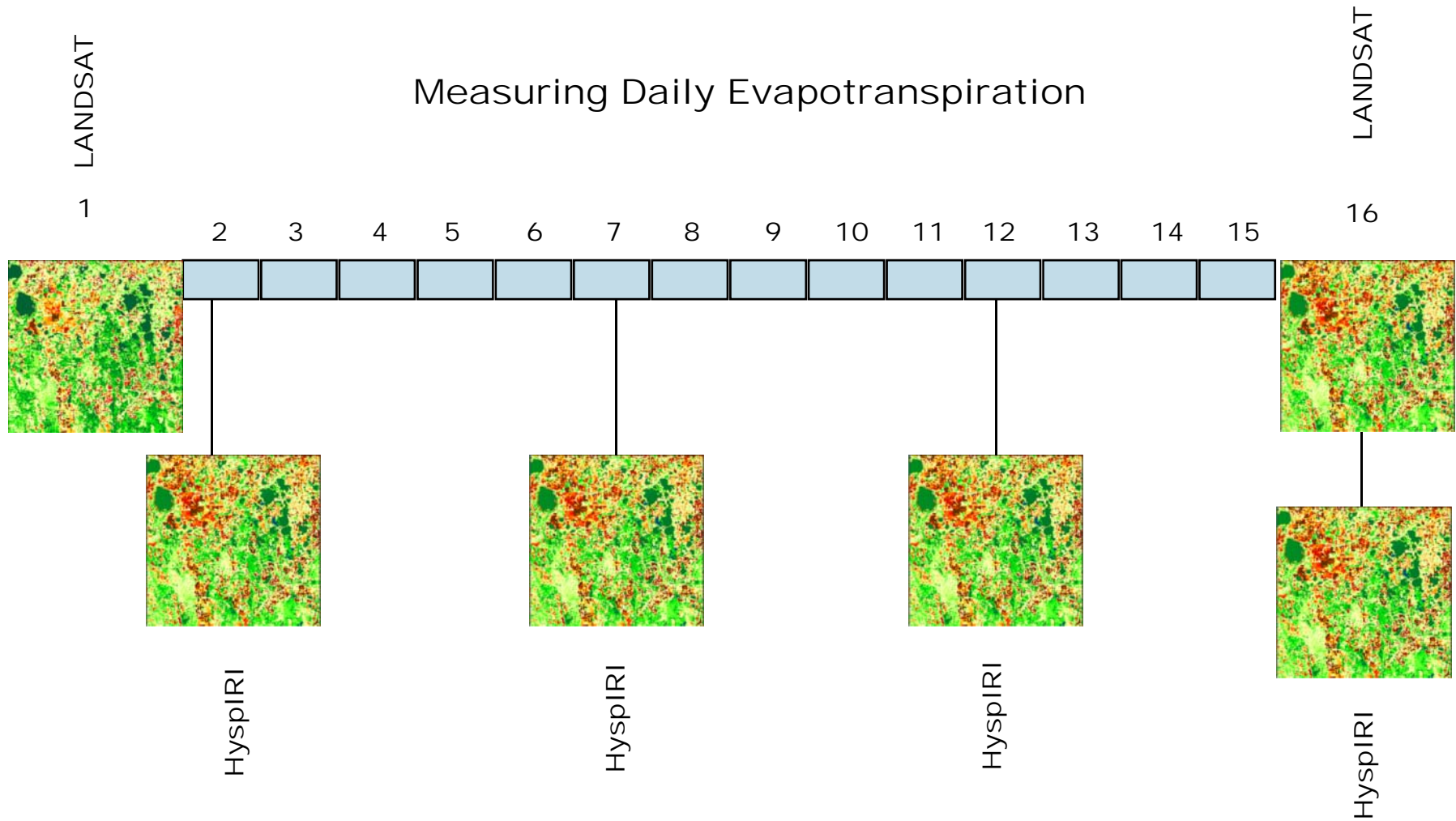
## HIGH-RESOLUTION EVAPOTRANSPIRATION

Measuring Daily Evapotranspiration



# Evapotranspiration and Water Use and Availability

## HIGH-RESOLUTION EVAPOTRANSPIRATION





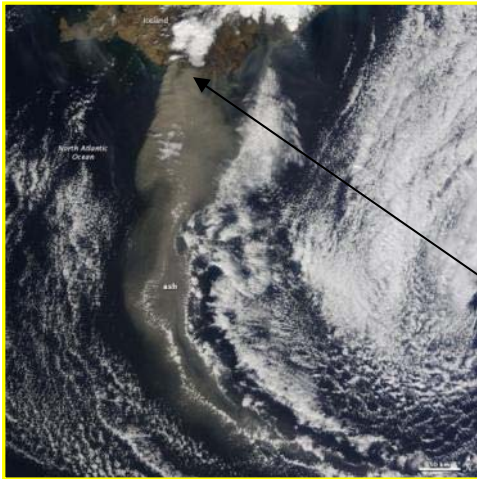
Gas and thermal anomalies,  
plume composition including SO<sub>2</sub>  
and ash content on weekly basis

# Characterizing and Understanding Volcanic Eruptions

“Likewise, the Tier 2 **Hyperspectral Infrared Imager (HyspIRI)** mission would include measurements over a range of optical and infrared wavelengths useful for detecting volcanic eruptions, determining the ash content of volcanic plumes, and identifying the occurrence and effects of associated landslides.”

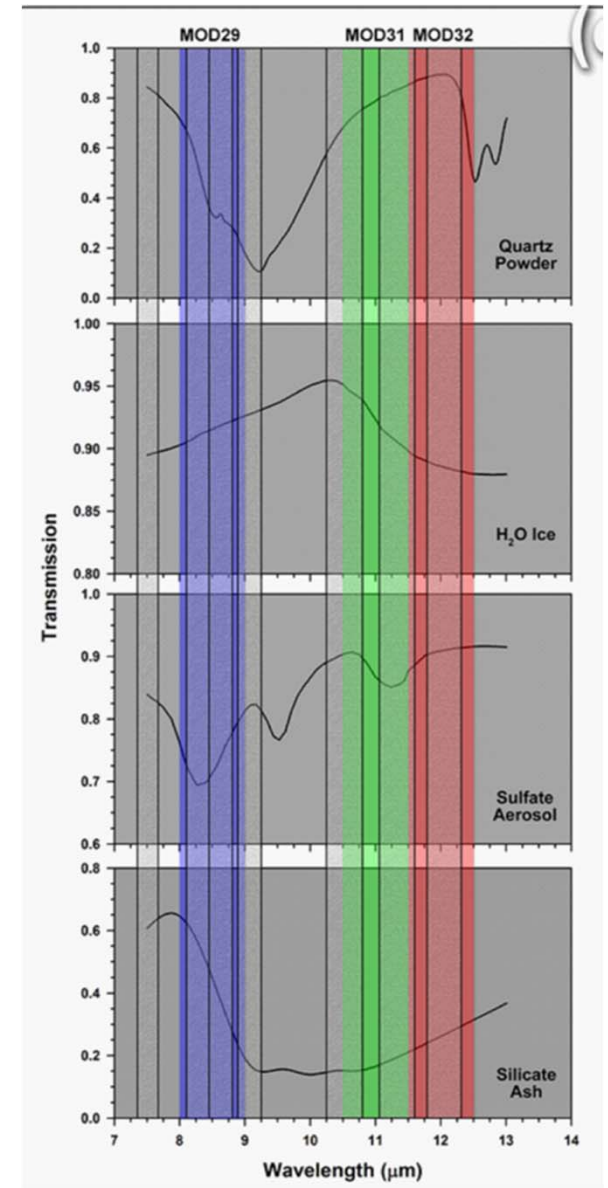
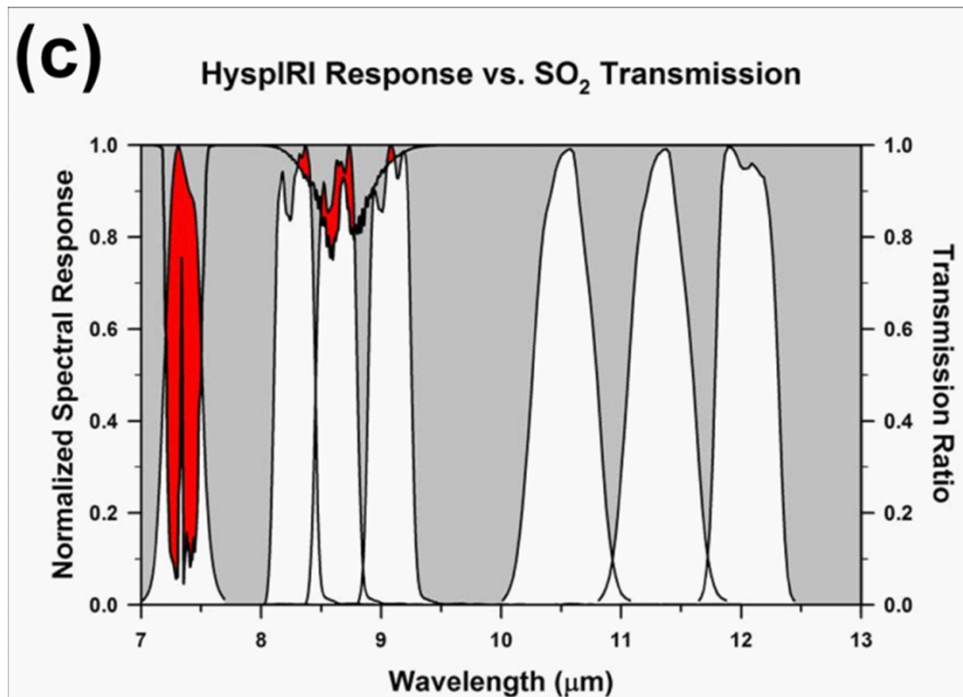
Source: Dr Jack Kaye, Presented to  
Subcommittee on Space and Aeronautics  
Committee on Science and Technology  
United States House of Representatives,  
May 5, 2010

# Characterizing and Understanding Volcanic Eruptions



## Eyjafjallajökull Iceland Volcano Eruption

April 19 2010 MODIS  
image of ash plume.

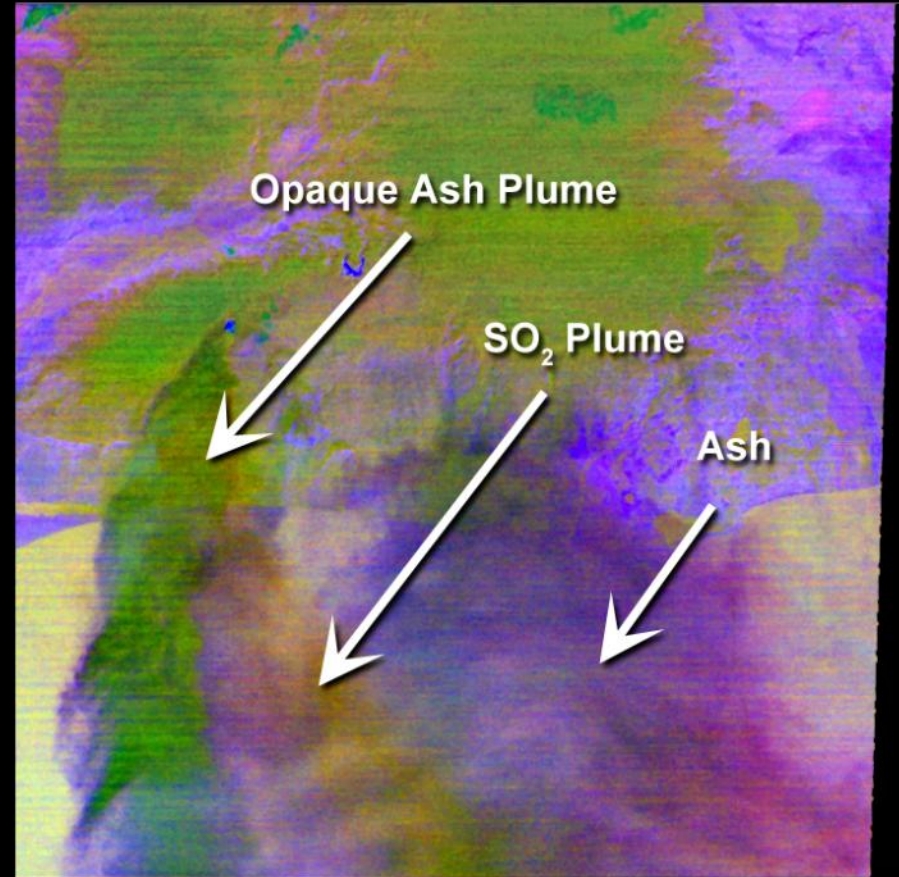


# Characterizing and Understanding Volcanic Eruptions

## ASTER Observations of the Eyjafjallajökull Eruption 19 April 2010 - 12:51 UTC



Visible - Near Infrared



Thermal Infrared

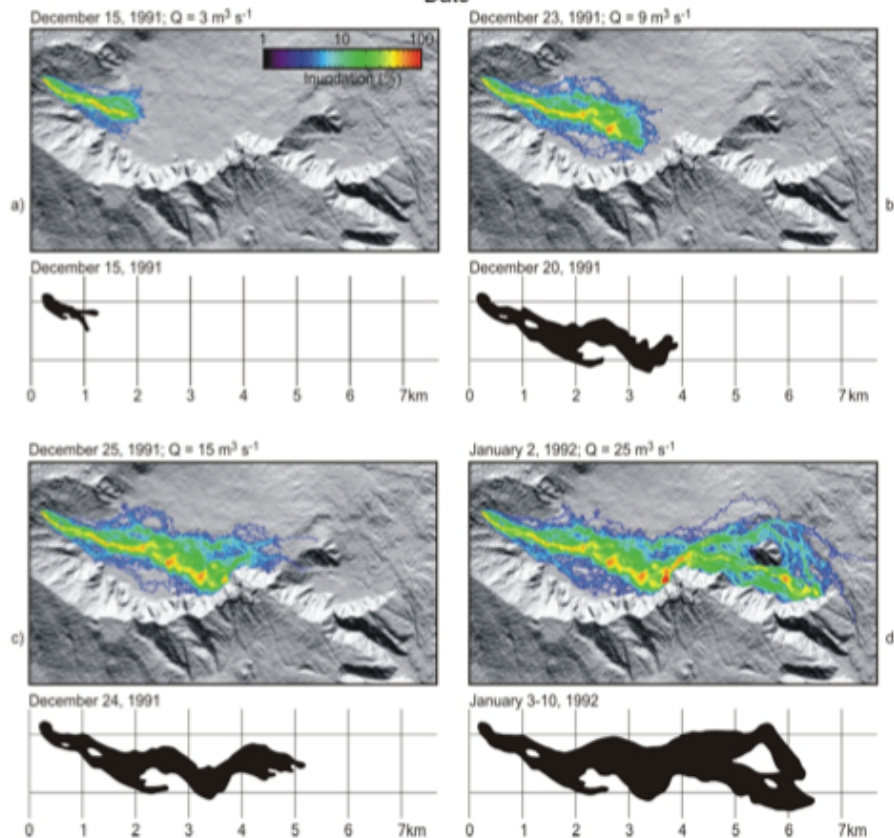
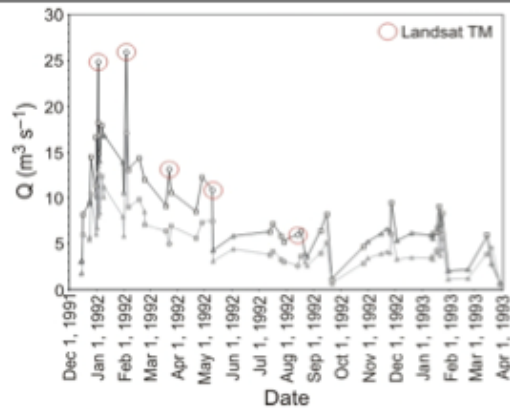
kilometers

0

36



## TQ1b: What do changes in the rate of lava effusion tell us about the maximum lengths that lava flows can attain, and the likely duration of lava flow-forming eruptions?



Wright et al. (2008). *Geophysical Research Letters*, 35, L19307.

### **Science Issue:**

- After lava composition, the volumetric effusion rate (modulated by surface cooling) determines how far a lava flow can extend from the vent before it solidifies. Effusion rates vary dramatically during eruptions, but can be quantified using infrared satellite data (top left; AVHRR, ATSR and TM data). By acquiring high spatial resolution TIR data, HypsIRI will allow us to determine effusion rates twice every five days during a lava flow forming eruption for any volcano on Earth. These data can be used to drive numerical models that predict the hazards that these flows will pose

### **Tools:**

- Satellite observations from HypsIRI TIR; requires band at  $\sim 4 \mu\text{m}$  (saturation temperature of  $\sim 1600 \text{ K}$ ) with moderate-high spatial resolution ( $< 100 \text{ m}$ ) for determining the area of active lava at any given time during an eruption and estimating the radiant energy flux from the flow surface.
- Pre-HypsIRI DEMs (e.g. SRTM) of all volcanoes likely to erupt basaltic lava flows
- Time-series of effusion rates determined using higher temporal resolution MODIS data for calibration.

### **Approach:**

- Implement automatic analysis algorithms to flag anomalous thermal activity, determine active lava area and thermal flux, and, subsequently, a HypsIRI-derived effusion rate. Using this, a DEM, the vent location as recorded in the HypsIRI data, and a numerical lava flow model, generate simulations of likely lava flow paths for the given effusion rate. Autonomously update the hazard simulation as most recent HypsIRI derived effusion rates become available (lower left).

### **Results:**

- A global, near-real-time lava flow hazard assessment tool, driven by HypsIRI TIR data.



# Prototyping Science As A Service with Intelligent Payload Module

Daniel Mandl - NASA\GSFC

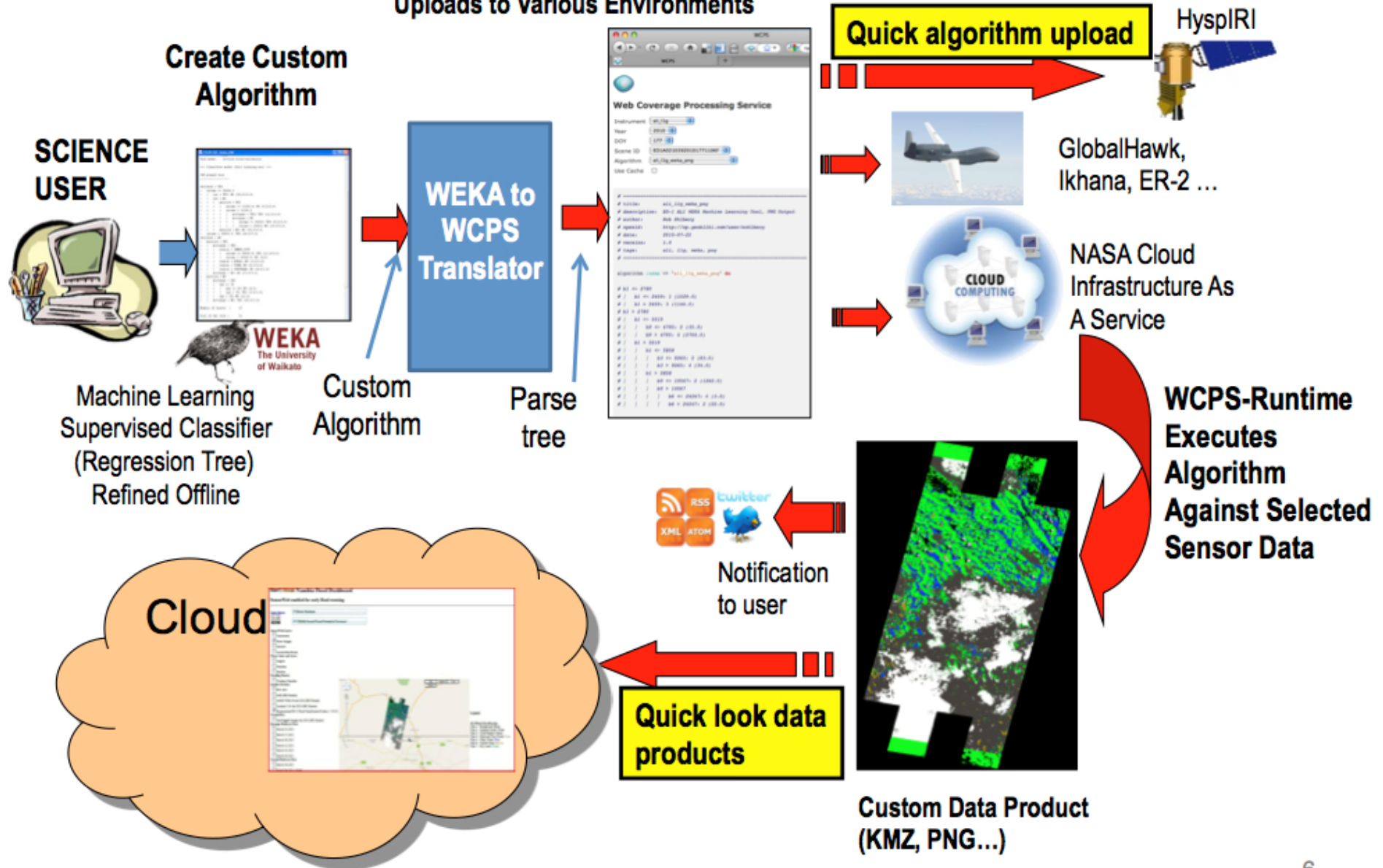
May 17, 2012



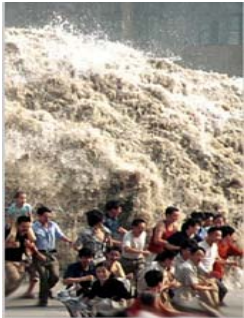
# Experimental IPM Quick Load/Quick Look Ops Con

Enhanced Ops Con from Baseline IPM Ops Con

Web Coverage Processing Service (WCPS)-Client  
Uploads to Various Environments





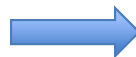


# The New Data Products Paradigm



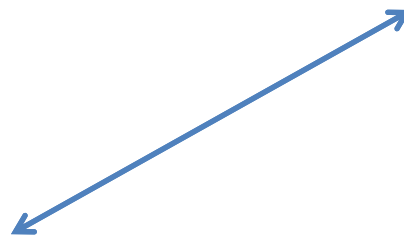
## 1. Tasking Request

- ✓ User requests low-latency imaging and specific product(s) by area and theme of interest.
- ✓ HypsIRI is one of the available SensorWeb assets.
- ✓ Request is submitted to satellite(s).
- ✓ One or more products are immediately downloaded as possible.
- ✓ User is notified upon product availability via data feed.
- ✓ User displays product on Google Earth or IPAD or desktop.



## 2. Cloud Processing

- ✓ User decides to [re-] process data from specific area or specific task request.
- ✓ User picks algorithm to execute against specific data set.
- ✓ User is notified when product is generated
- ✓ User selects product from data feed and display it on Google Earth



## 3. New Algorithm on the Cloud

- ✓ User decides to customize an existing algorithm or create a new one.
- ✓ User could even use WEKA (Machine Learning Tool) and upload its output to WCPS.

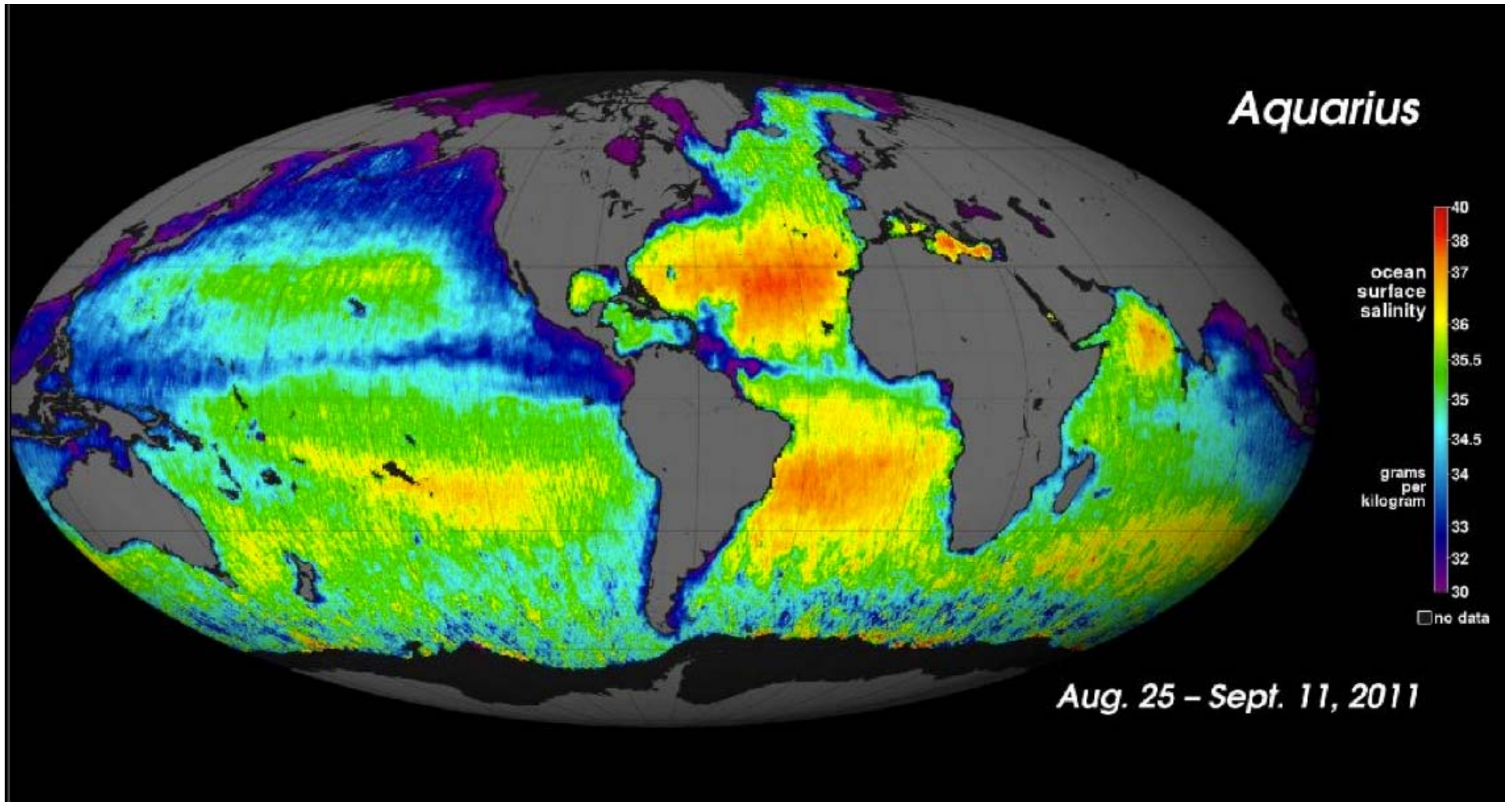


## 3. New Algorithm Onboard

- ✓ User is satisfied with new algorithm.
- ✓ User submits algorithm for upload to HypsIRI
- ✓ Algorithm is now available for ad-hoc custom processing

HyspIRI Webpage

**<http://hyspiri.jpl.nasa.gov>**



Aquarius instrument has produced its first global map of the salinity, or saltiness.



2013



OCO-2

Aquarius

OSTM/Jason 2

GPM

Landsat-7

Aqua

SORCE

TRMM

Terra

NPP

LDCM

CALIPSO

Aura

CloudSat

2014



OCO-2

Aquarius

OSTM/Jason 2

Landsat-7

Aqua

SORCE

NPP

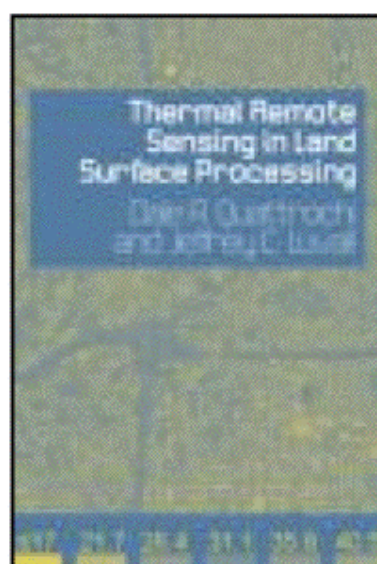
LDCM

SMAP

GPM

## **Thermal Remote Sensing in Land Surface Processing**

*Dale A. Quattrochi, Jeffrey C. Luvall*



<b>Publisher:</b>	Taylor & Francis
<b>ISBN:</b>	0415302242
<b>Pub Date:</b>	30 APR 2004
<b>Type:</b>	Hardback Book
<b>Price:</b>	£60.99
<b>Extent:</b>	440 pages (Dimensions 234x156 mm)
<b>Illustrations:</b>	8 pages of colour photos