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Unit 9

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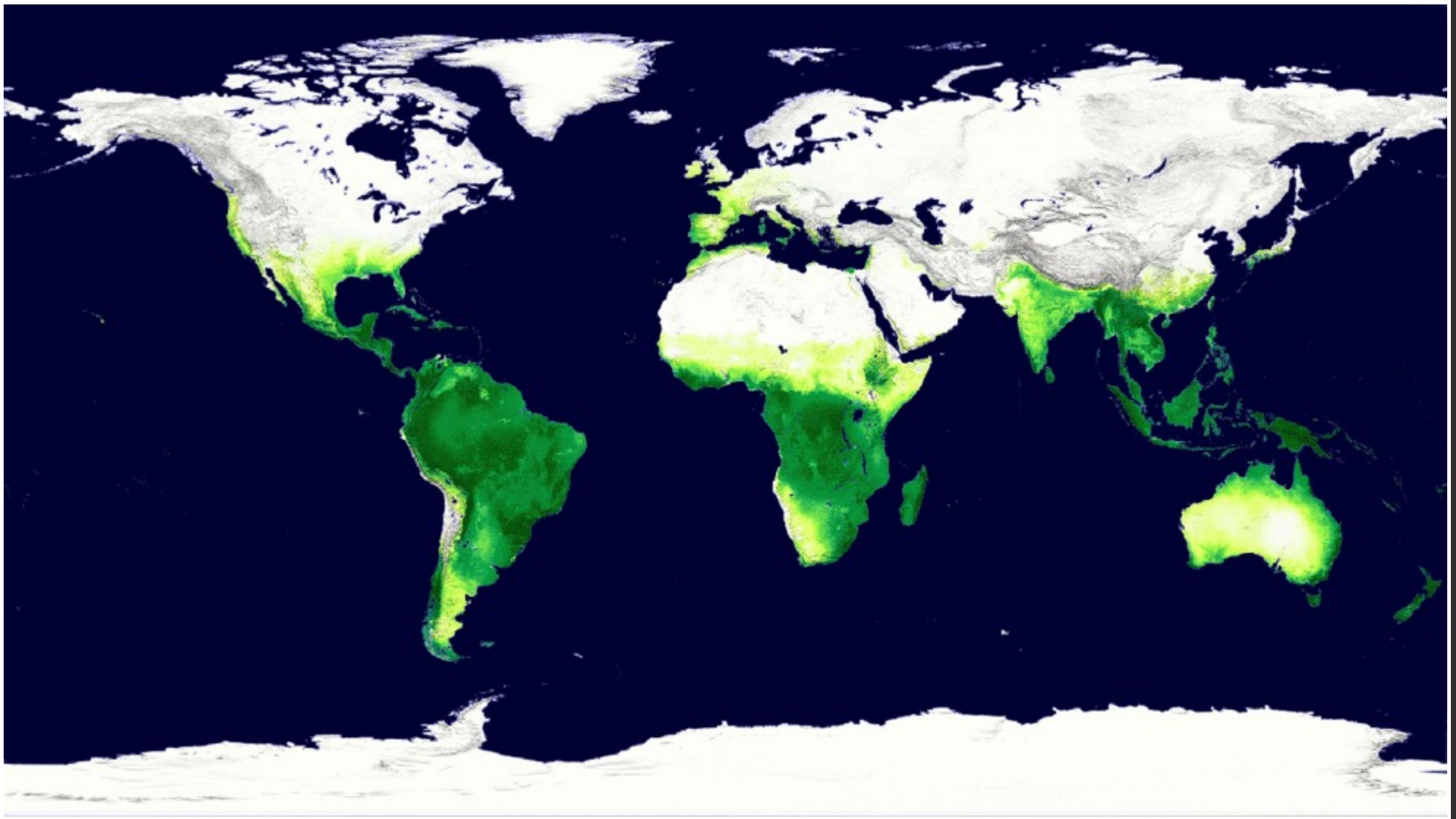
UMassAmherst

Remote Sensing

Forrest J. Bowlick, UMass – Amherst

Intro to GIS



Overview

- Some (more) raster information
- Basics of Remote Sensing
- Examples of applications and analysis

But First, This!

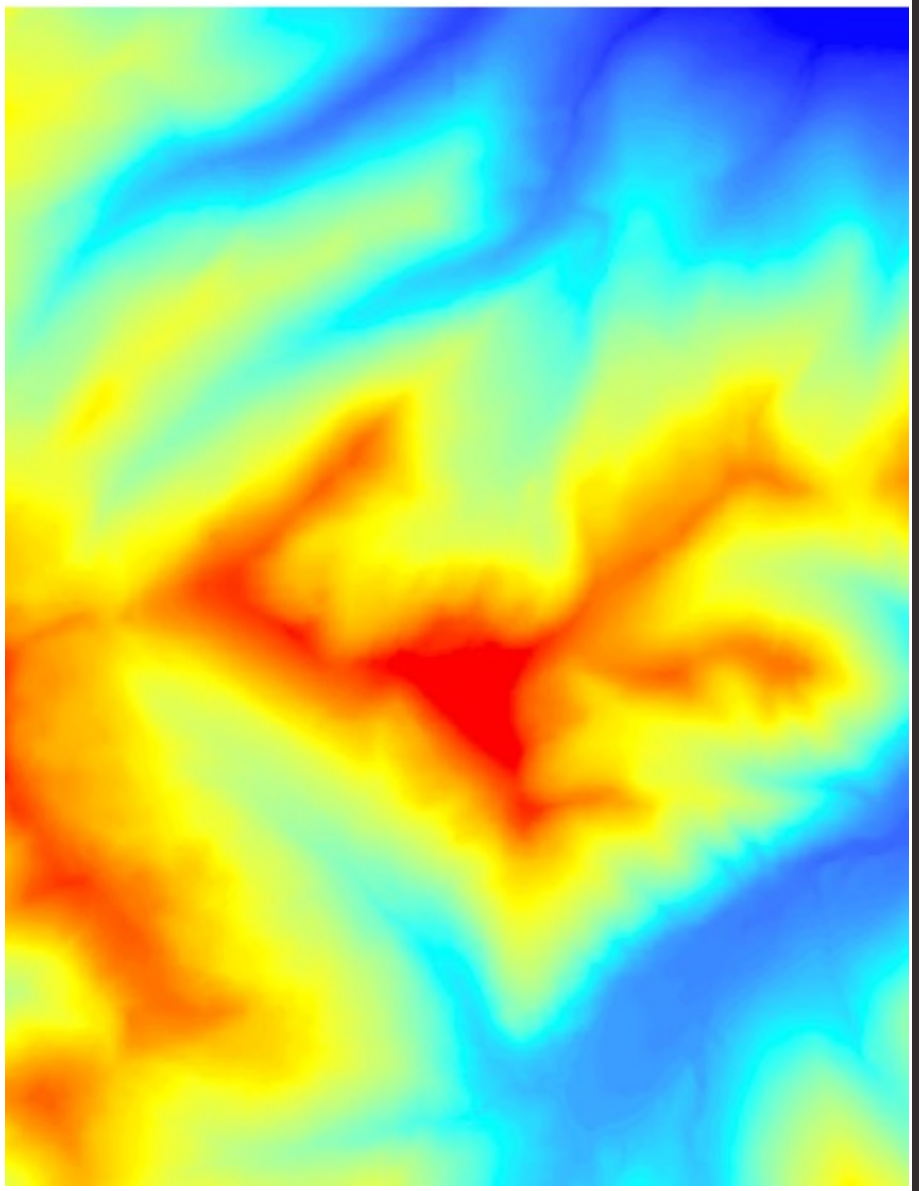
- New Australian Datum!
- https://theconversation.com/australia-on-the-move-how-gps-keeps-up-with-a-continent-in-constant-motion-71883
  - Think about this as a GIS problem!

Tx.ag/GIS8B

How have expanding GIS and geospatially - aware applications complicated Australia's GPS and Datum situation?

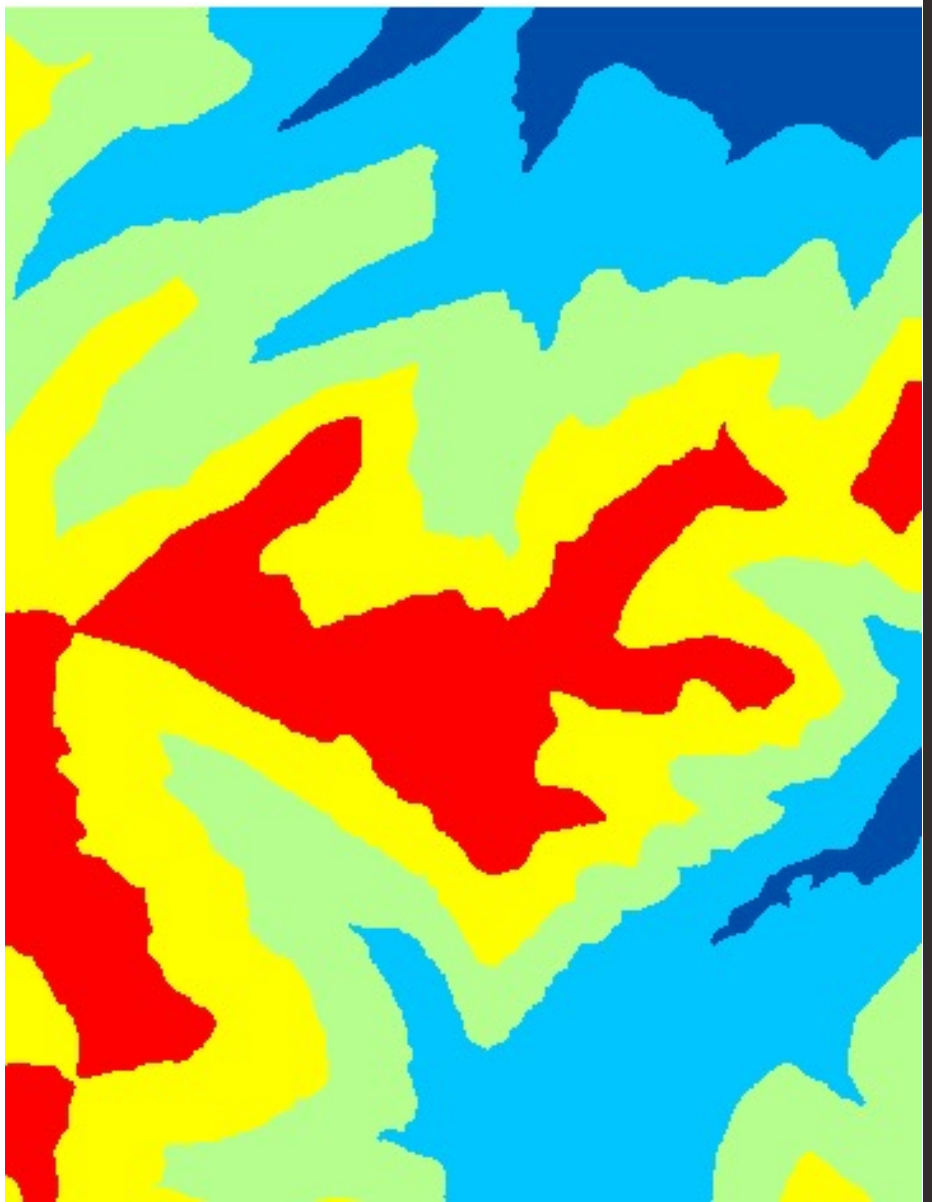
Types of Raster Data

- Continuous
  - Represents a surface or data that is constant
  - Floating point or Integer
  - Examples:
    - Topography,
    - Satellite Imagery,
    - Proximity

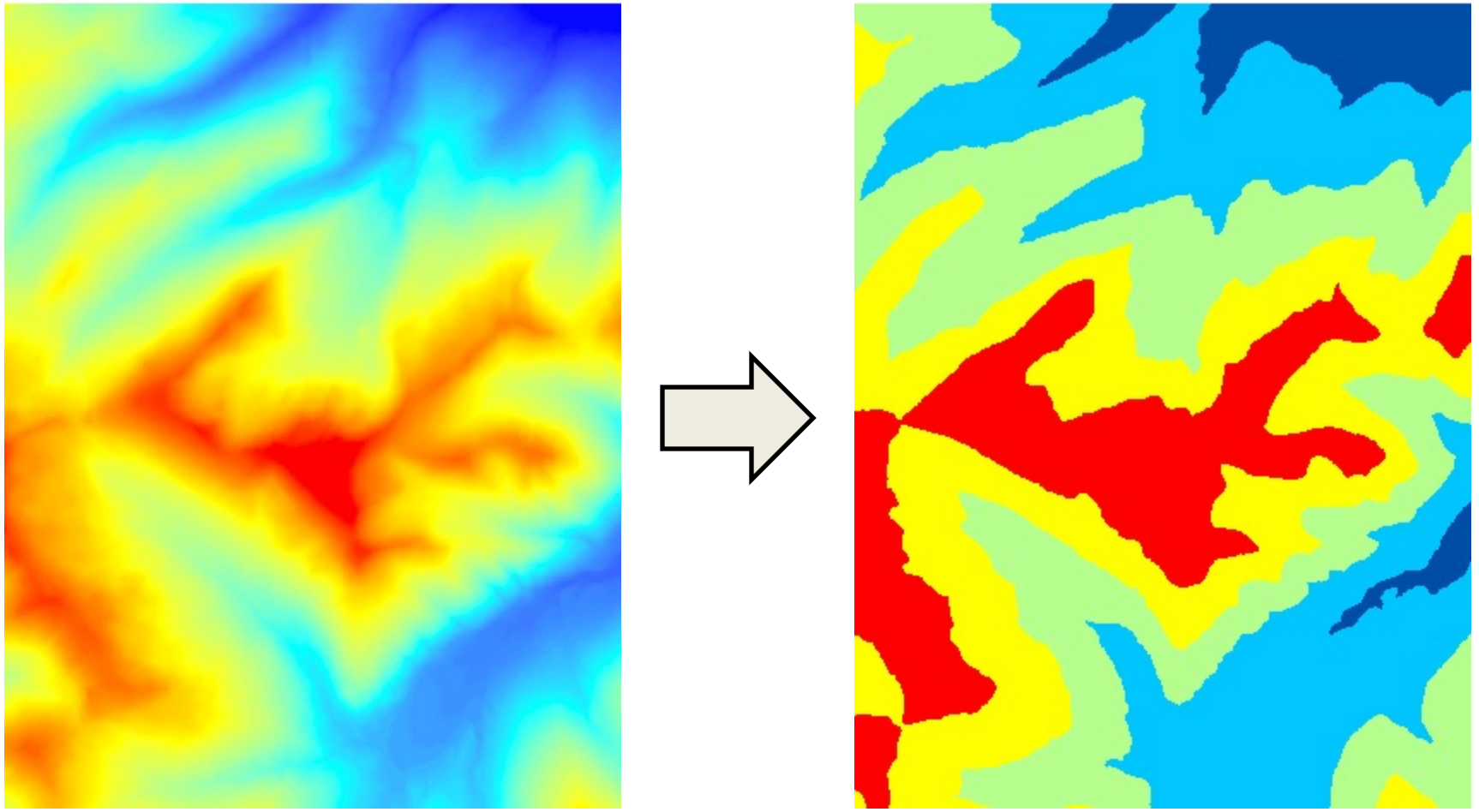


Types of Raster Data

- Discrete
  - Could be binary (1,0)
  - Could be limited number of unique values
  - Examples:
    - Land cover classification,
    - Suitability,
    - Presence/absence



You can always *Reclassify* Continuous to Discrete, but never Discrete to Continuous



Kahoot!

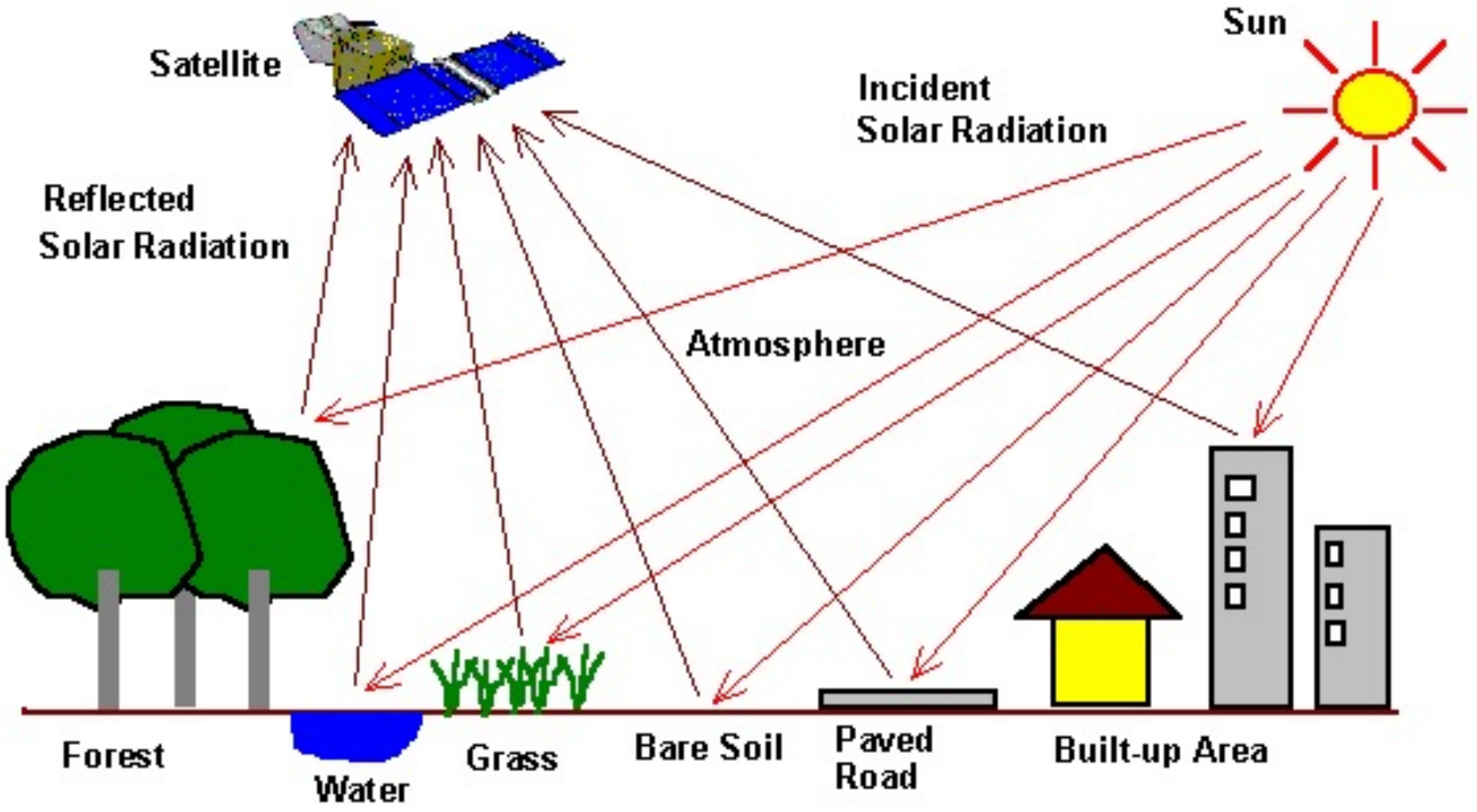
- https://play.kahoot.it/#/k/b31908c1-6a31-4456-b174-9a2d1fc1cc6c

Raster Calculator!

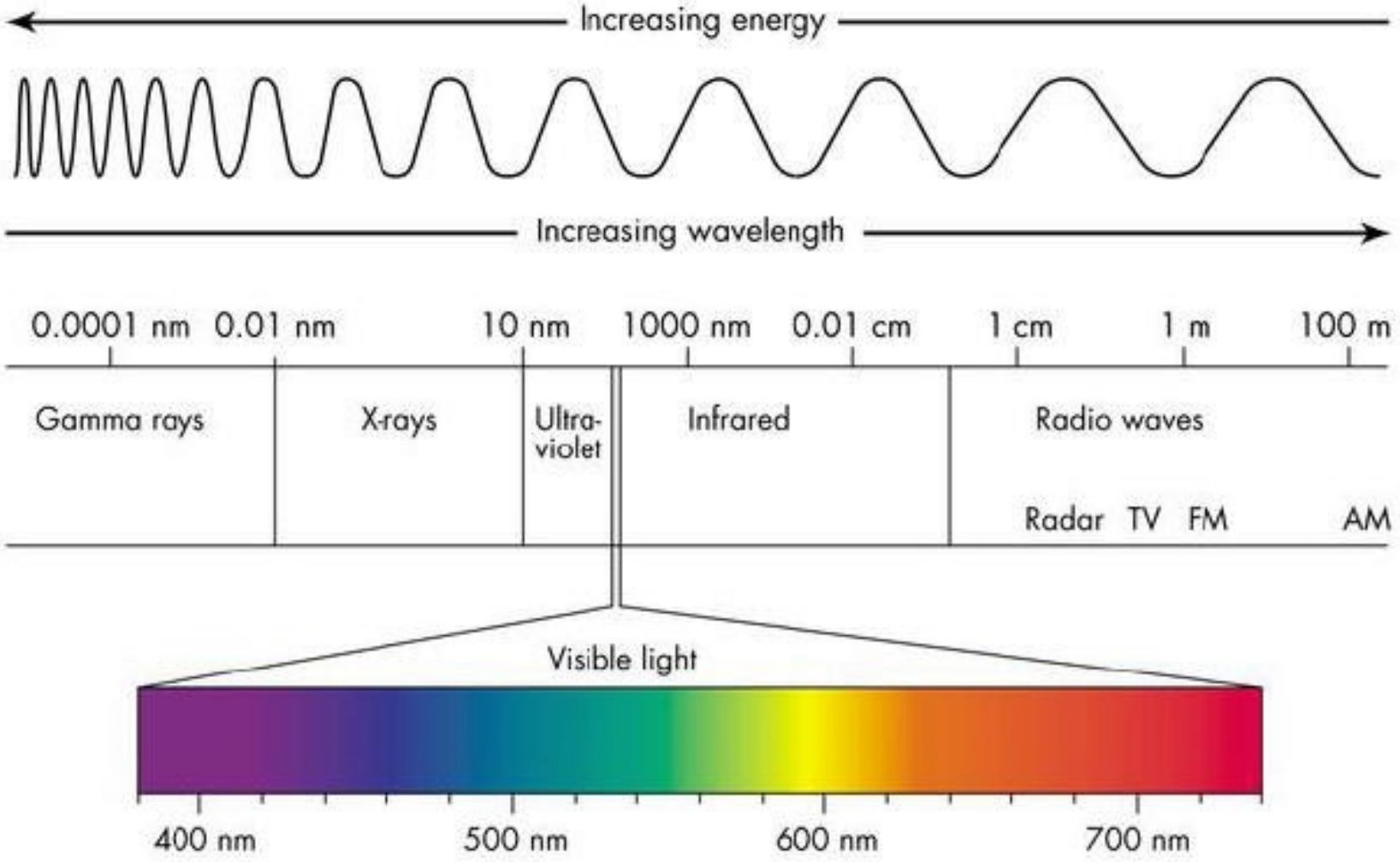
- In lab, we began to grapple with some Raster Calculations.

- Let’s think about how these work in context of our production problem.

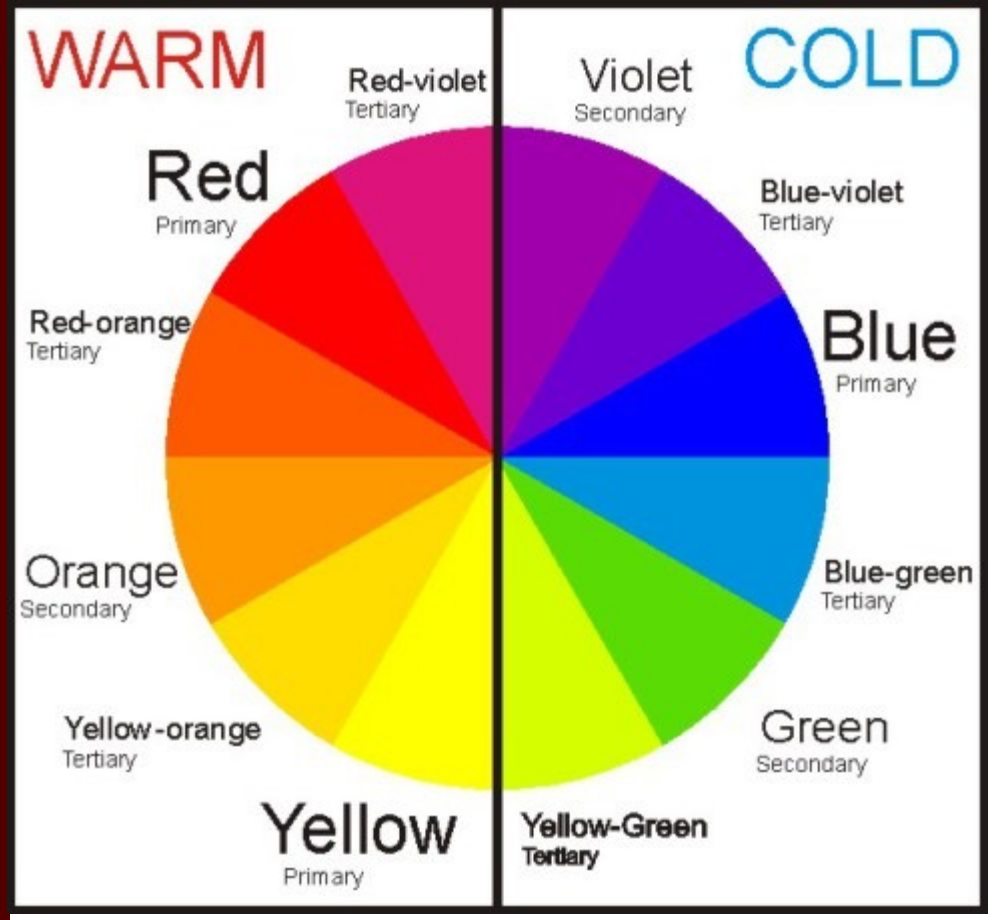
Remote Sensing Components

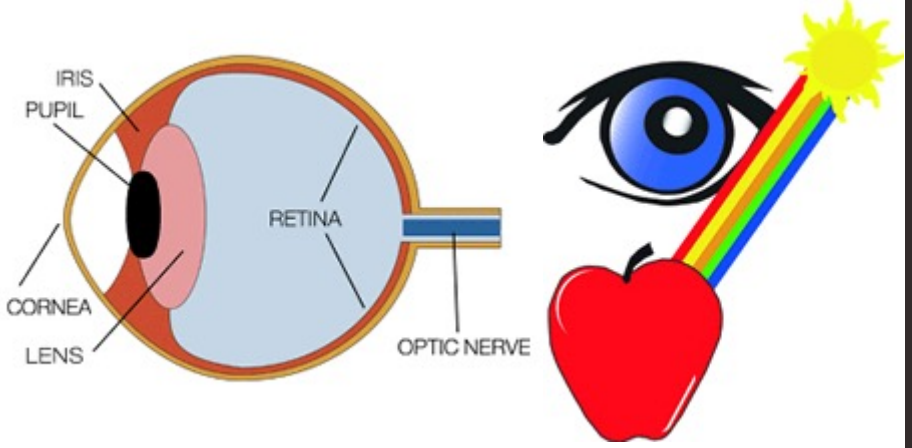


What is Color?



Wang, Kai et al. "Remote Sensing of Forestry Studies." (2012).

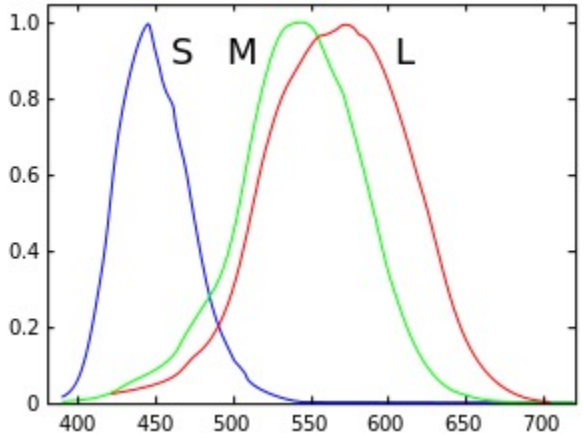




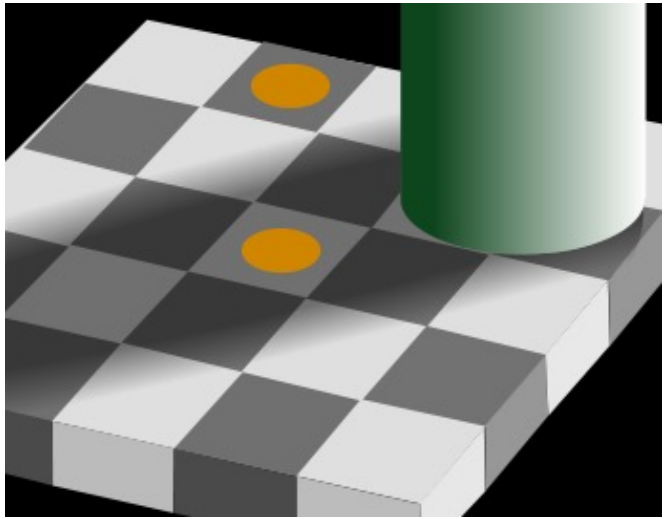
http://www.xrite.com/en/hue-test

Color is:

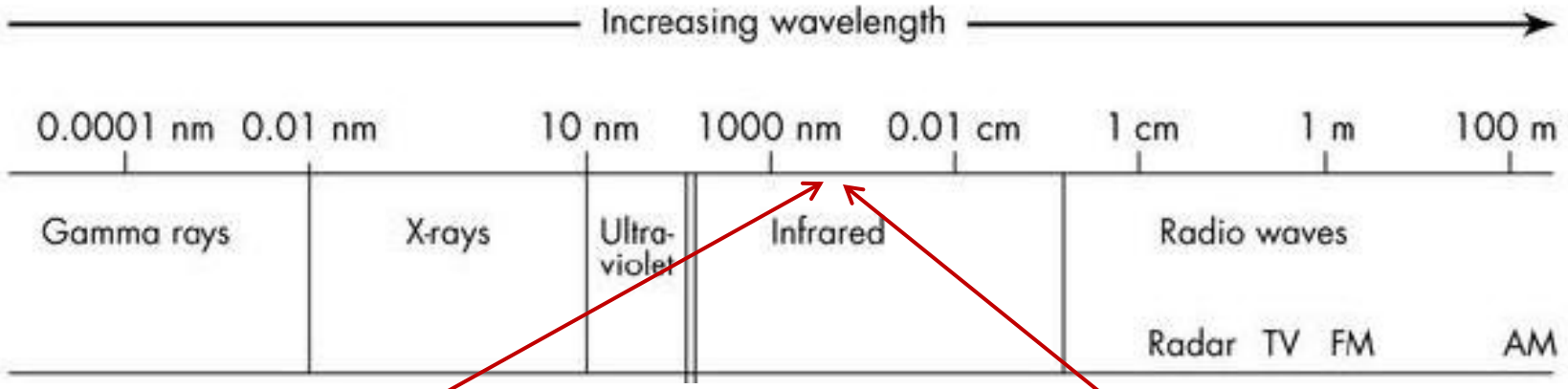
- How we perceive visible light reflected from objects.
- We can see roughly 10 million different colours.



https://upload.wikimedia.org/wikipedia/commons/thumb/1/1e/Cones_SMJ2_E.svg/287px-Cones_SMJ2_E.svg.png



Wavelengths beyond the visual

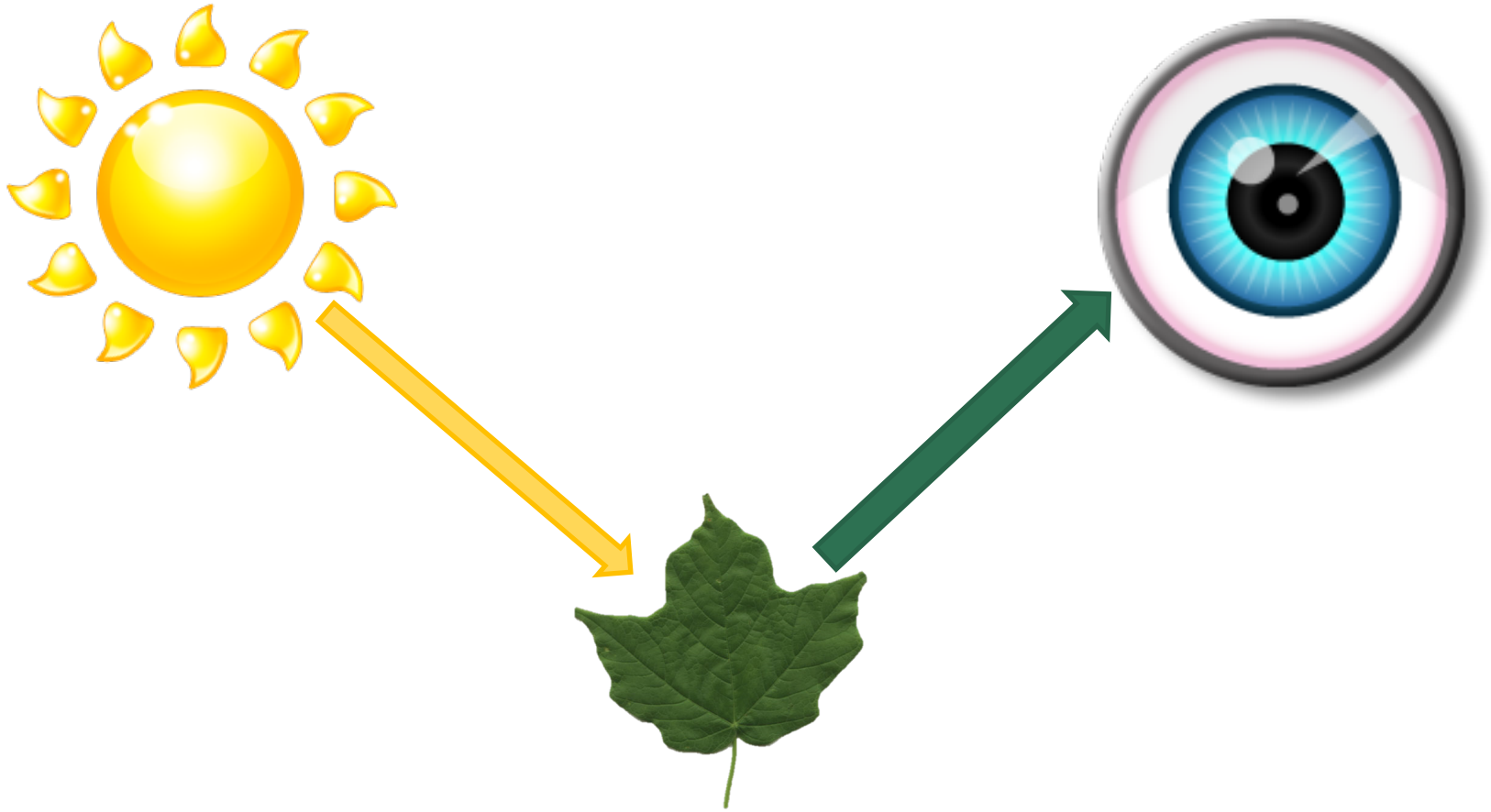


Example: Thermal emissions at infrared wavelengths ~10,000 nm (10 μm)

http://www.electrical-contractors-las-cruces.com/images/thermo-house.jpg

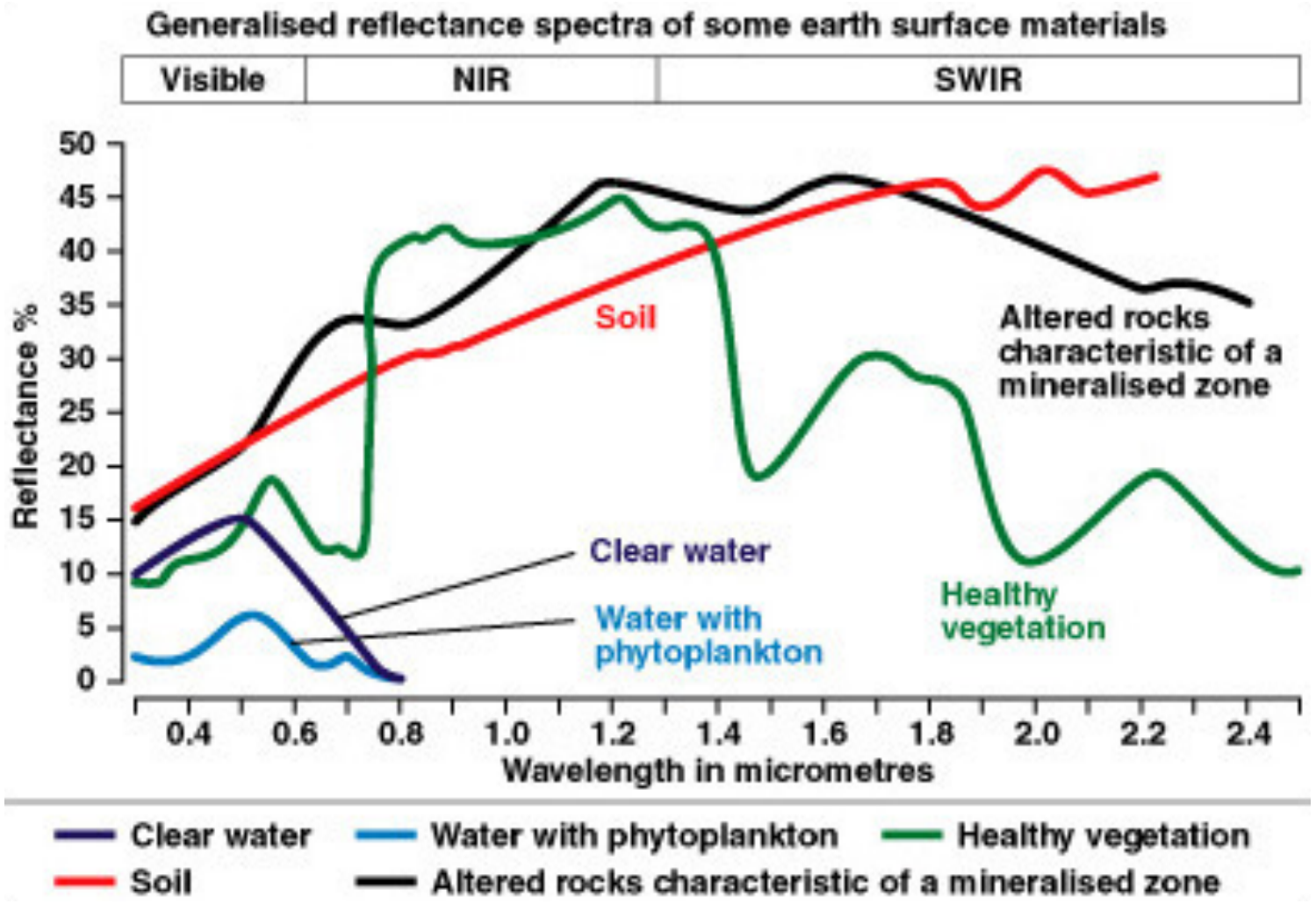
http://images.nationalgeographic.com/wpf/media-live/photos/000/247/cache/energy-savings-misunderstood_24710_600x450.jpg

Light – Object Interactions



http://upload.wikimedia.org/wikipedia/en/9/96/LEAF_bigger.jpg

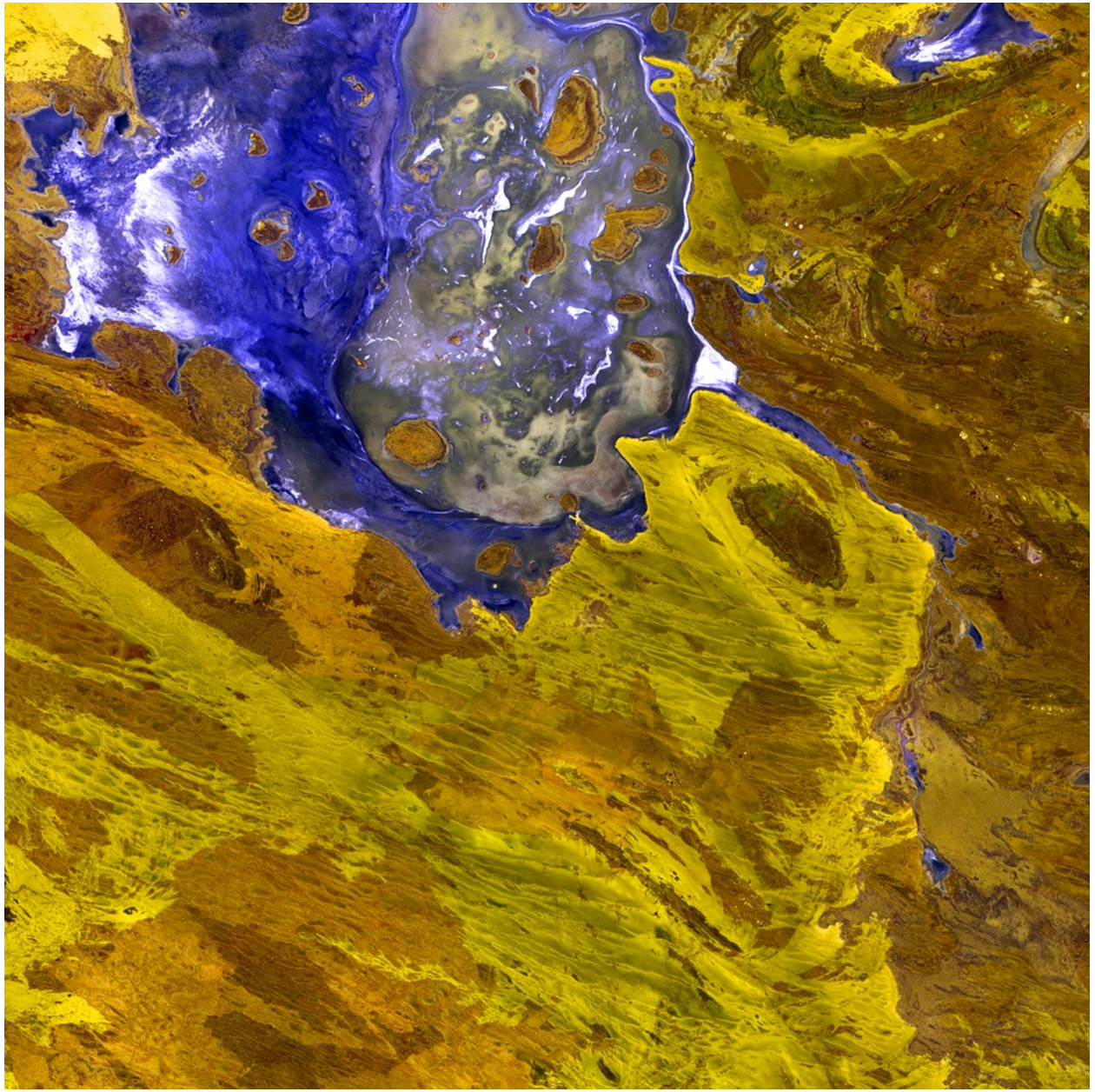
Reflectance Spectra

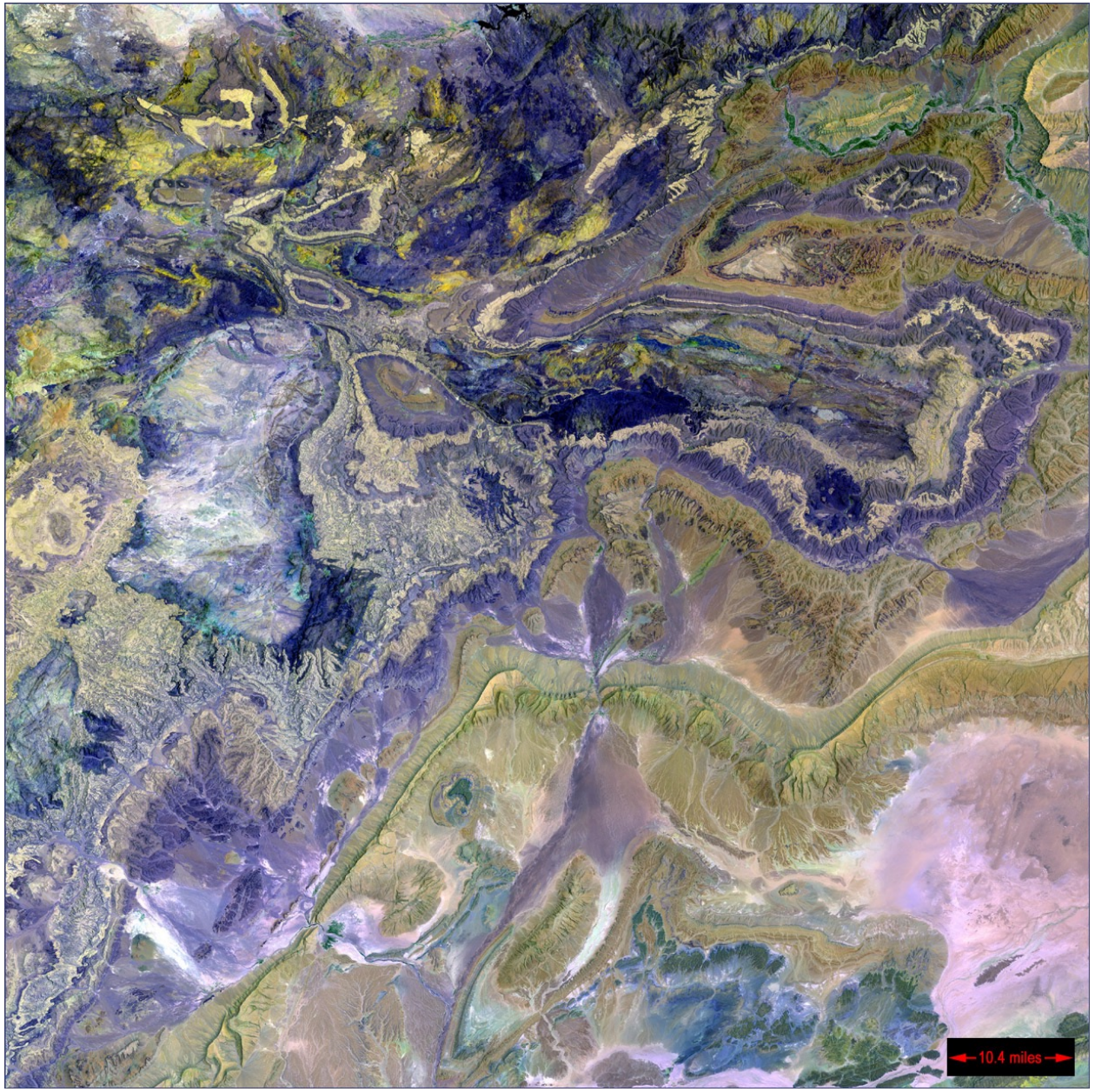


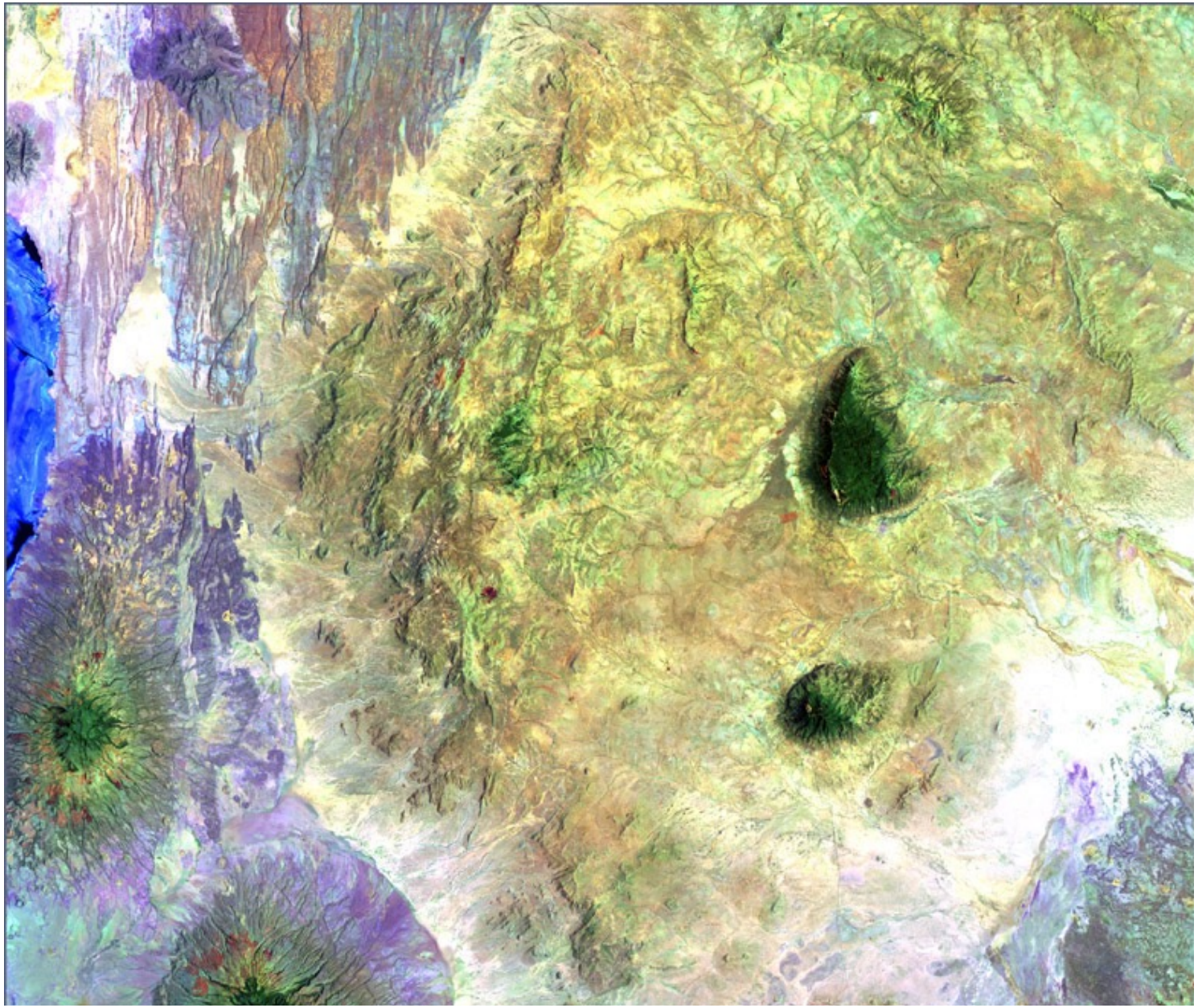
Remote Sensing – Earth Engine

- https://earthengine.google.com/timelapse/

- Let’s see what we can see.



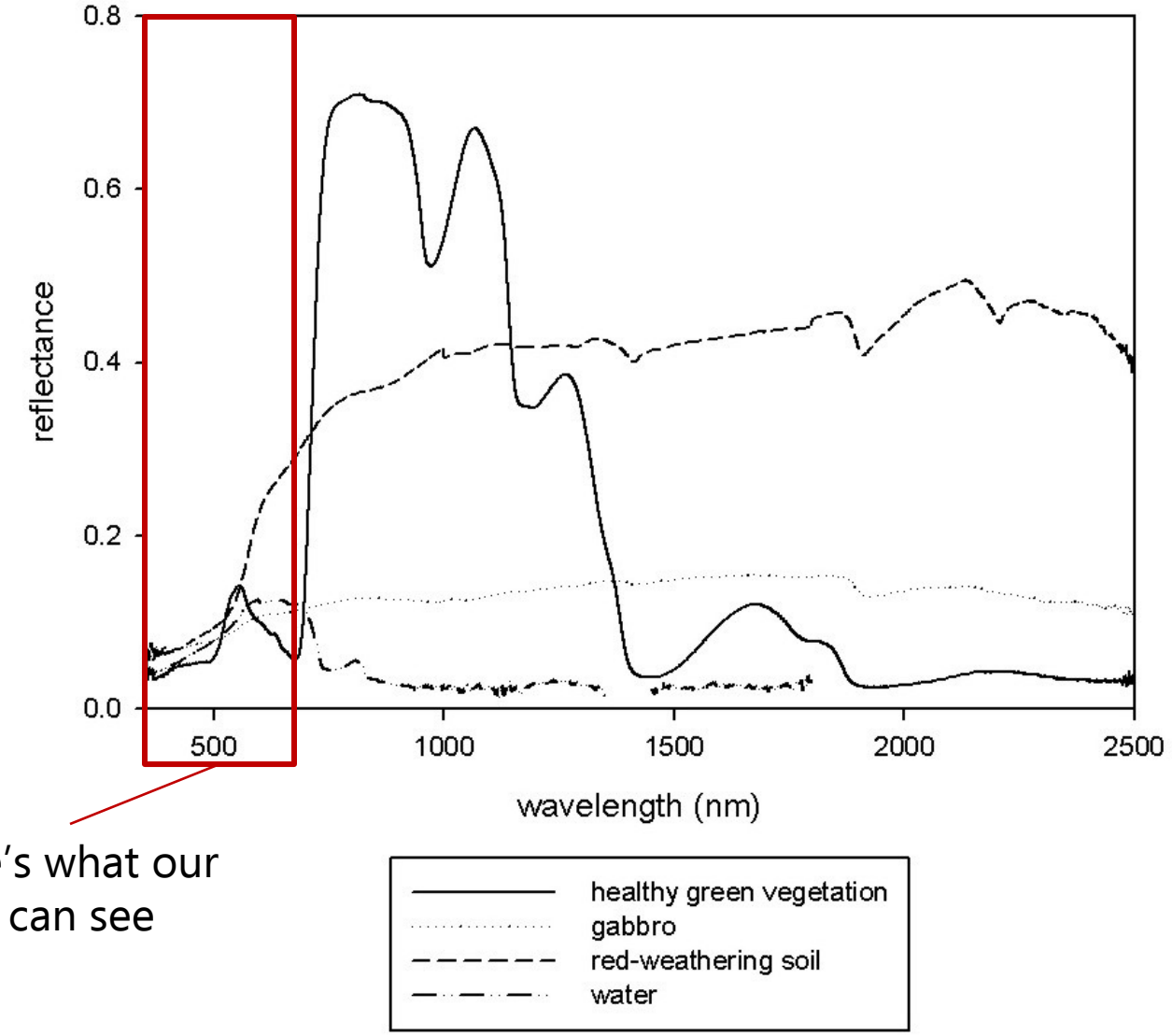

10.4 miles



http://www.crisp.nus.edu.sg/~research/tutorial/texture1.gif

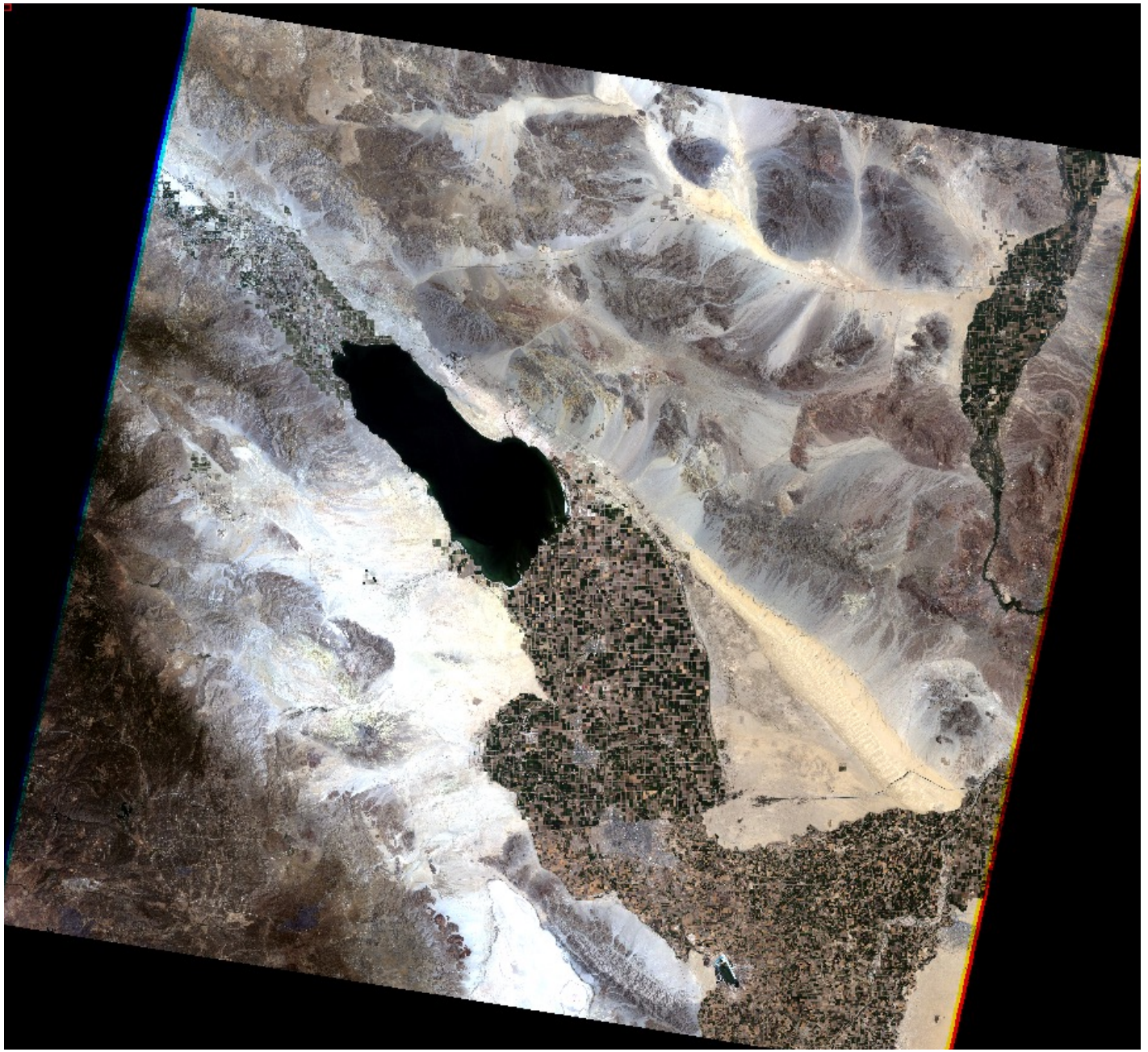
5.2 miles

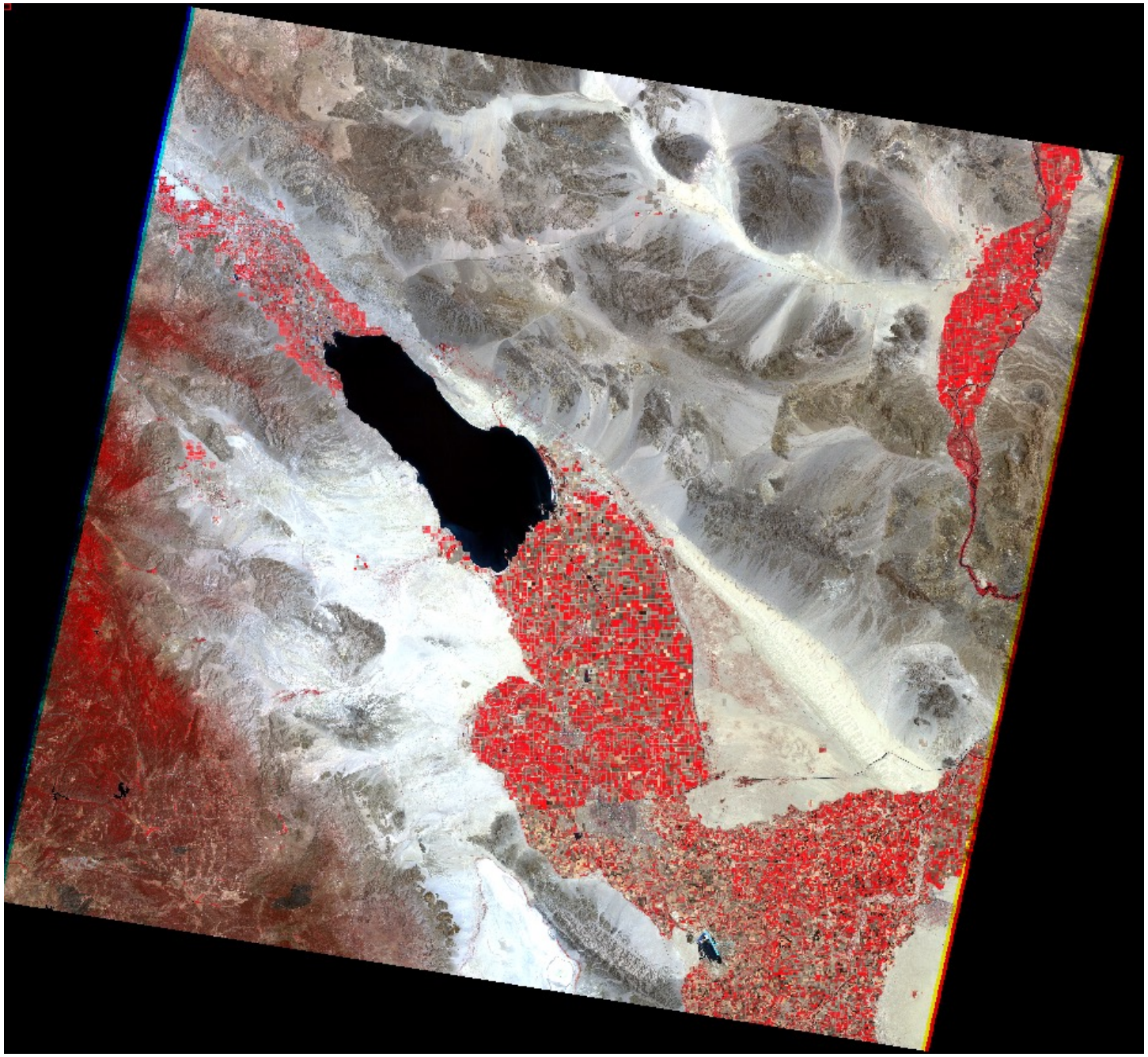
Why do we keep using false color?

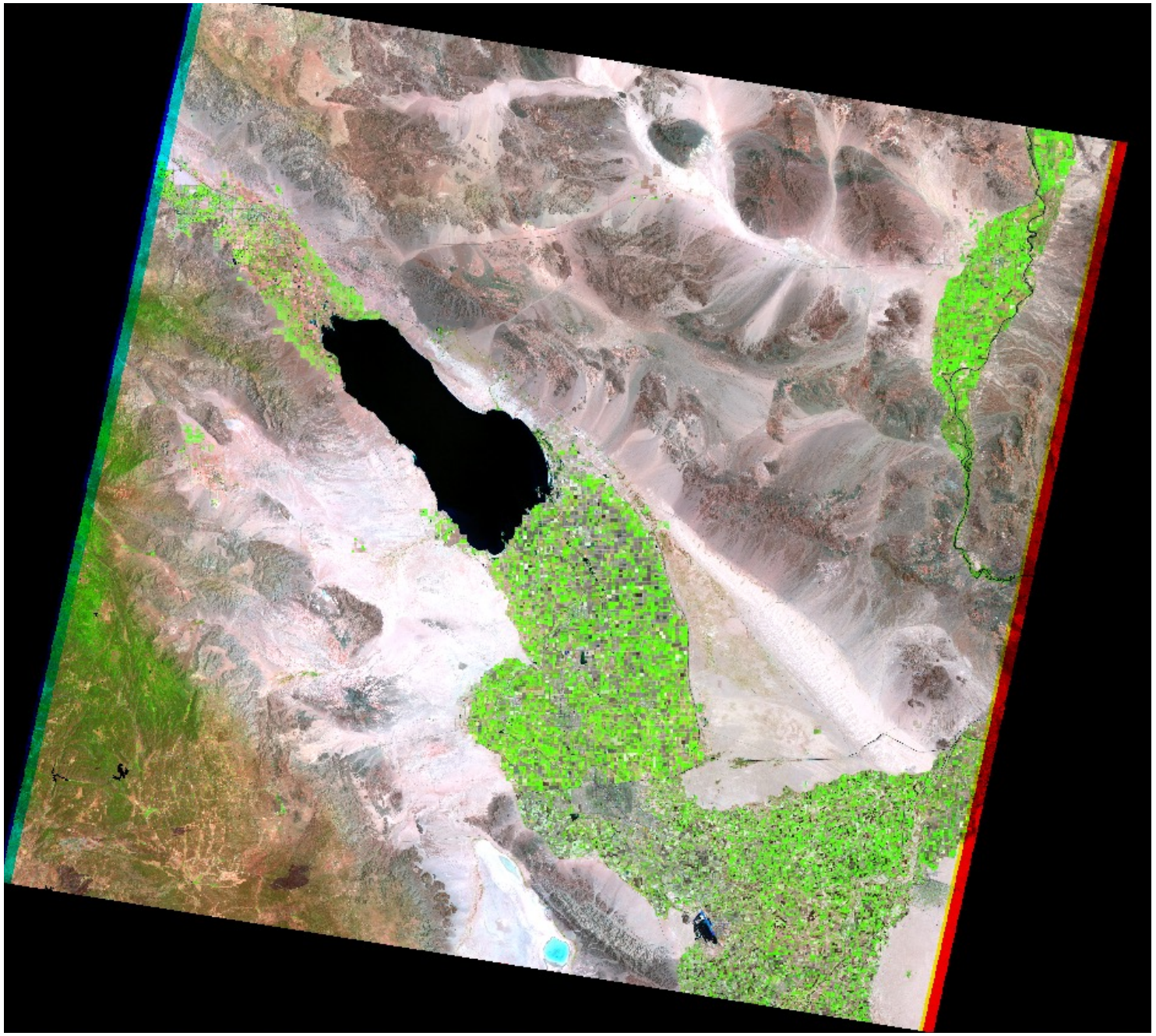


Here's what our eyes can see

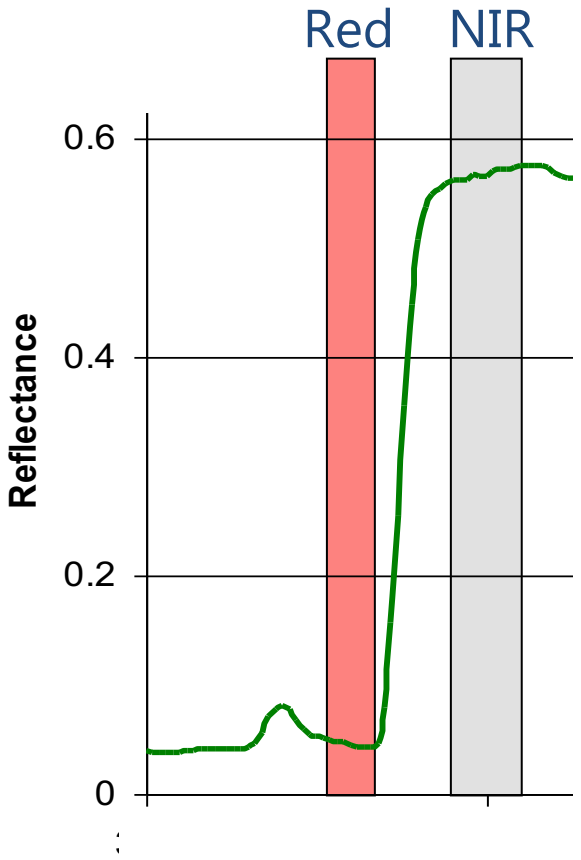
http://www.webpages.ttu.edu/dleverin/hyperspectral/fig_3_leverington.jpg







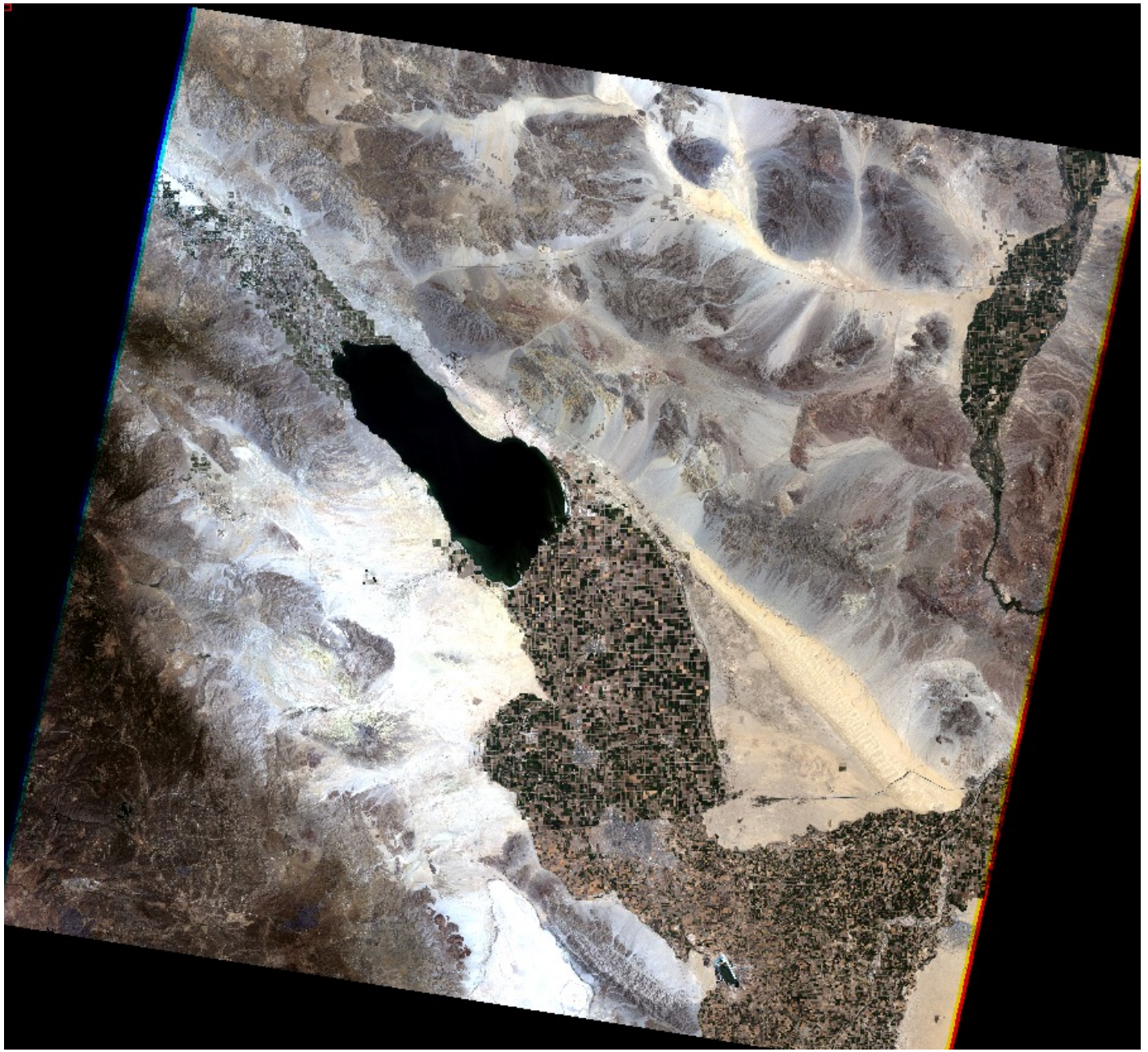
Example Application: NDVI

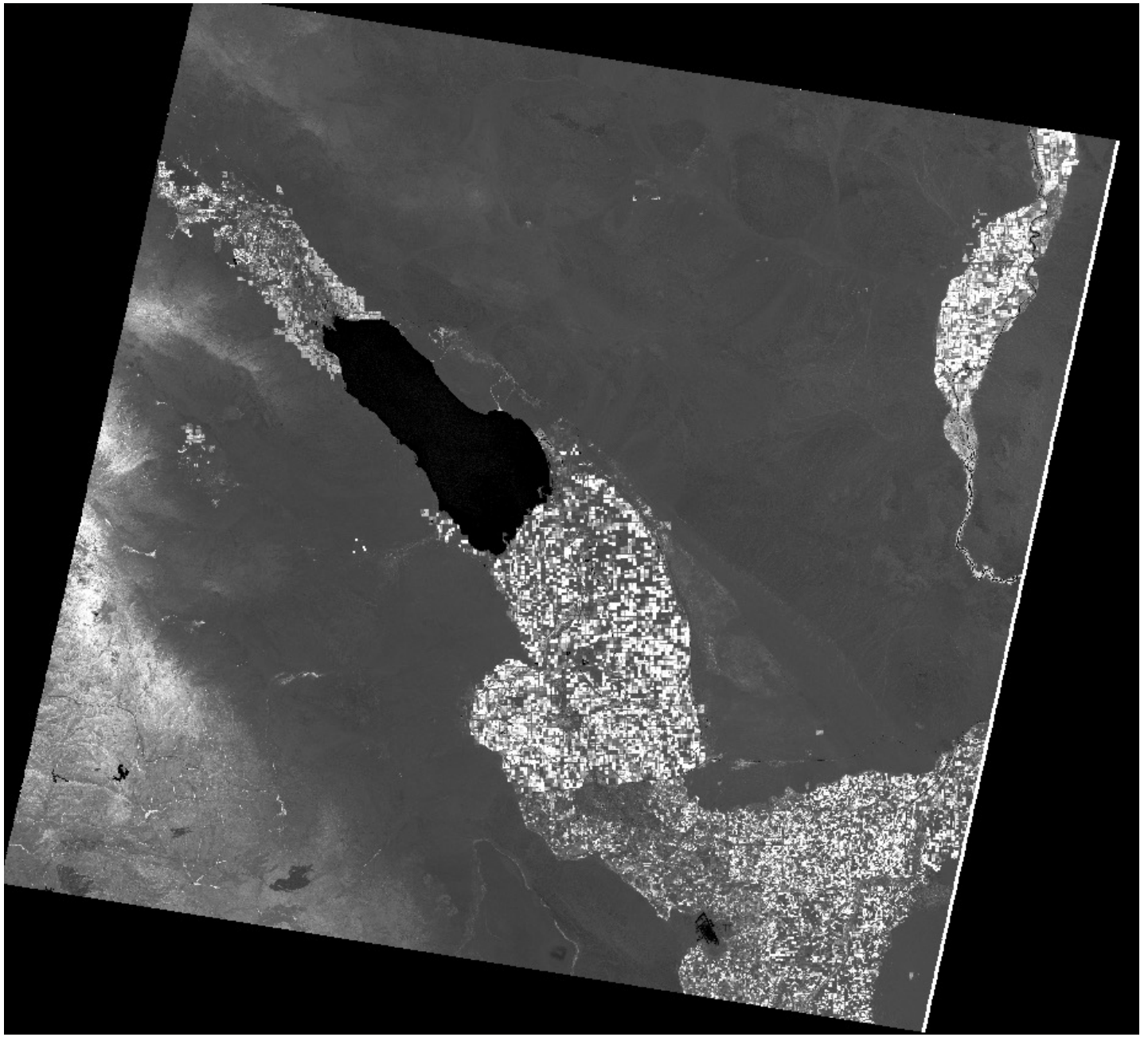


$$NDVI = \frac{NIR - Red}{NIR + Red}$$

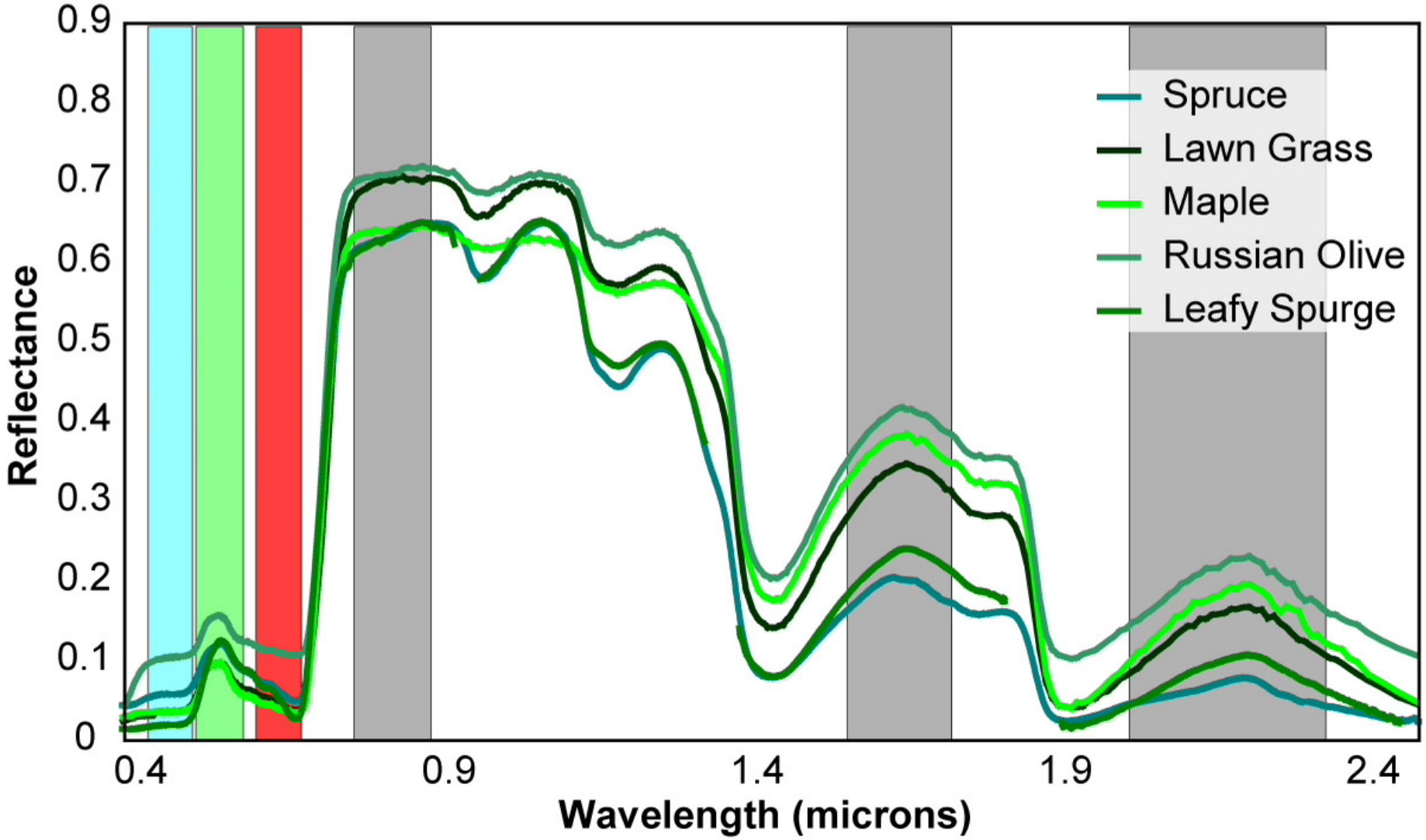
NDVI Scale:

1	Highly Vegetated
0.5	Moderately Vegetated
0	Non-Vegetated
<0	Clouds, Snow, Ice

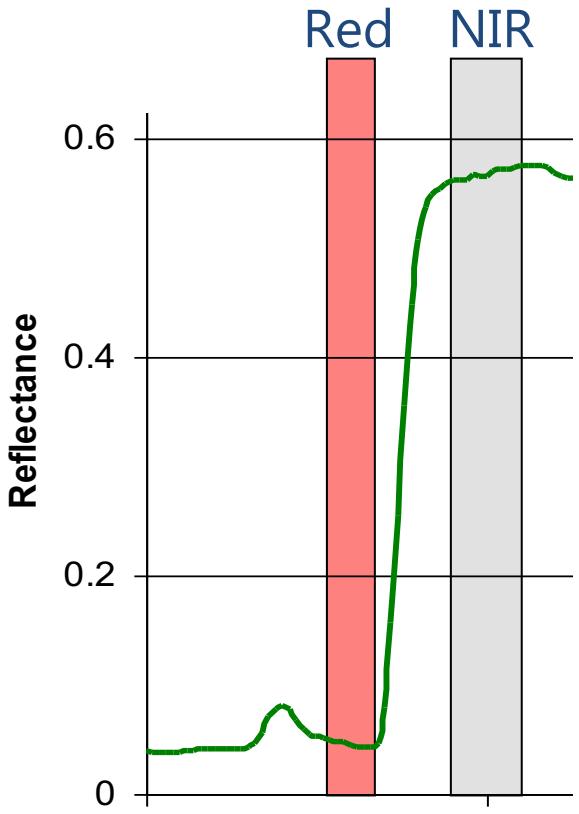




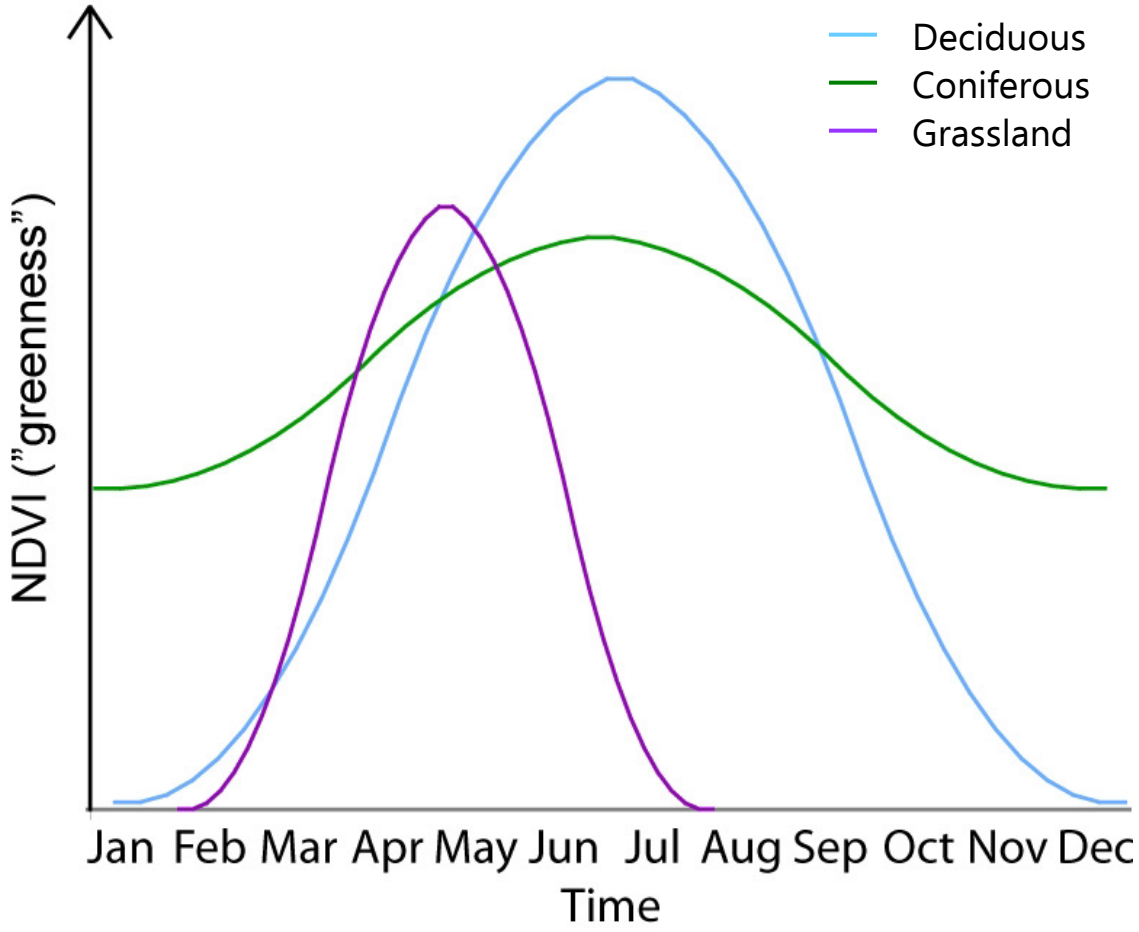
Difficult to Differentiate Plants



Identifying Land Cover

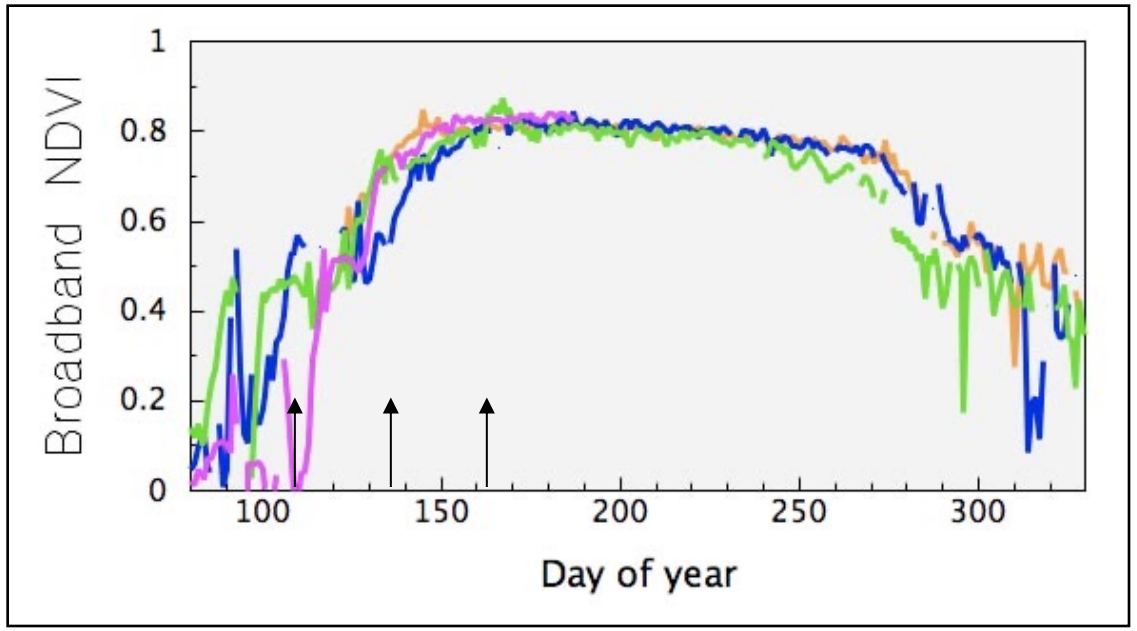


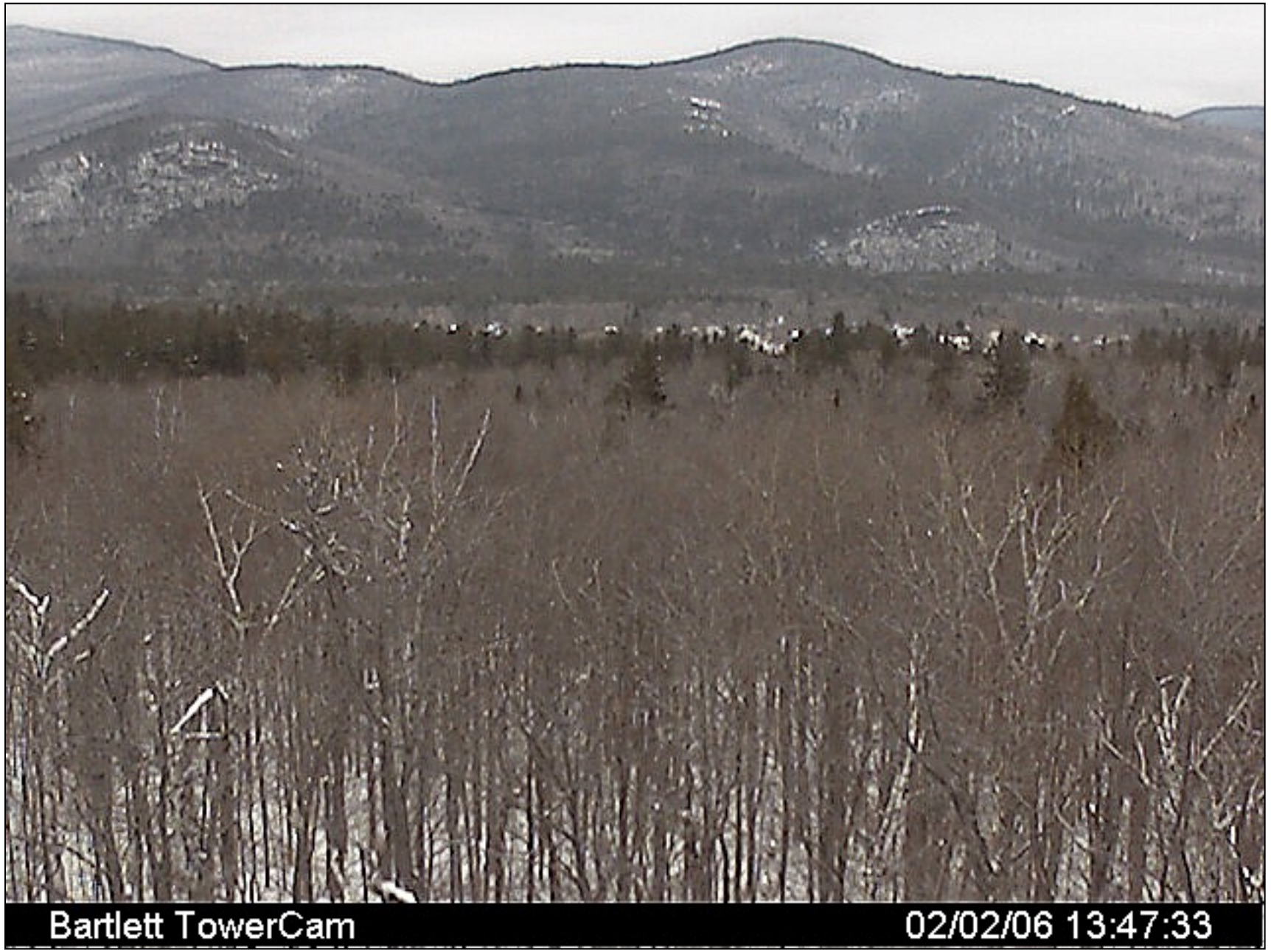
$$NDVI = \frac{NIR - Red}{NIR + Red}$$



Spring green-up

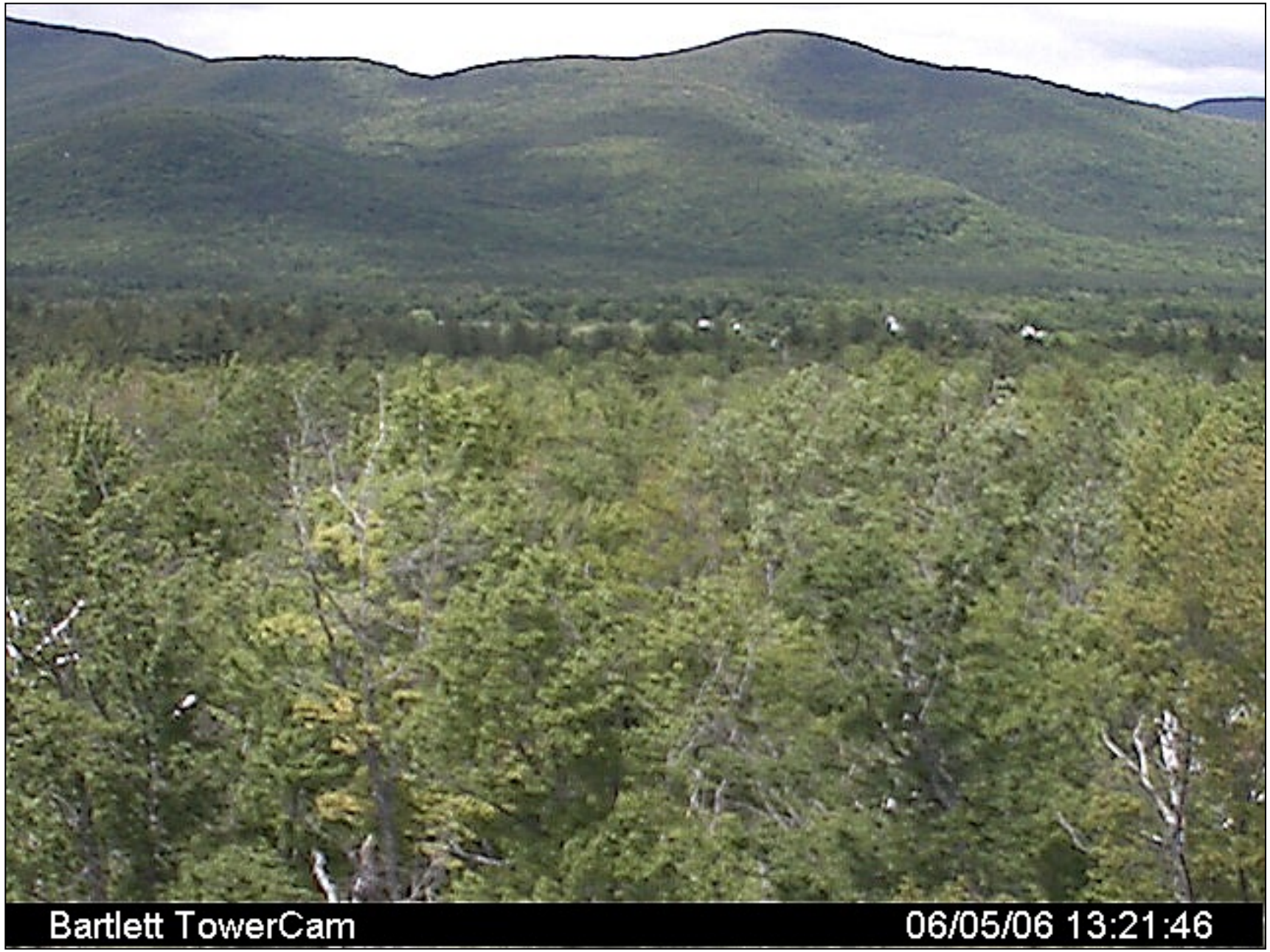
Day 121 Day 138 Day 165




Bartlett TowerCam
02/02/06 13:47:33

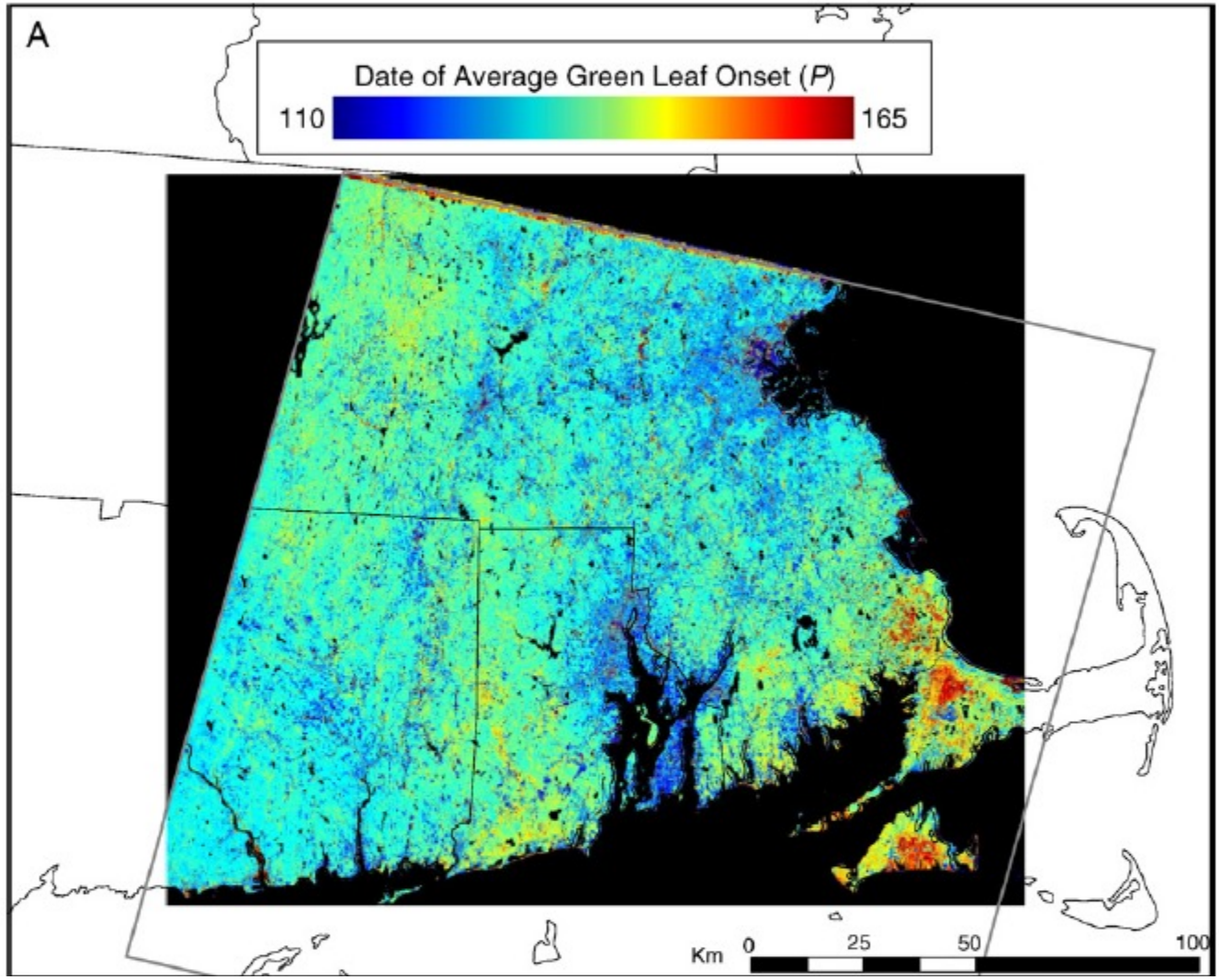
Bartlett TowerCam
04/28/06 13:53:46

Bartlett TowerCam
05/14/06 13:37:15

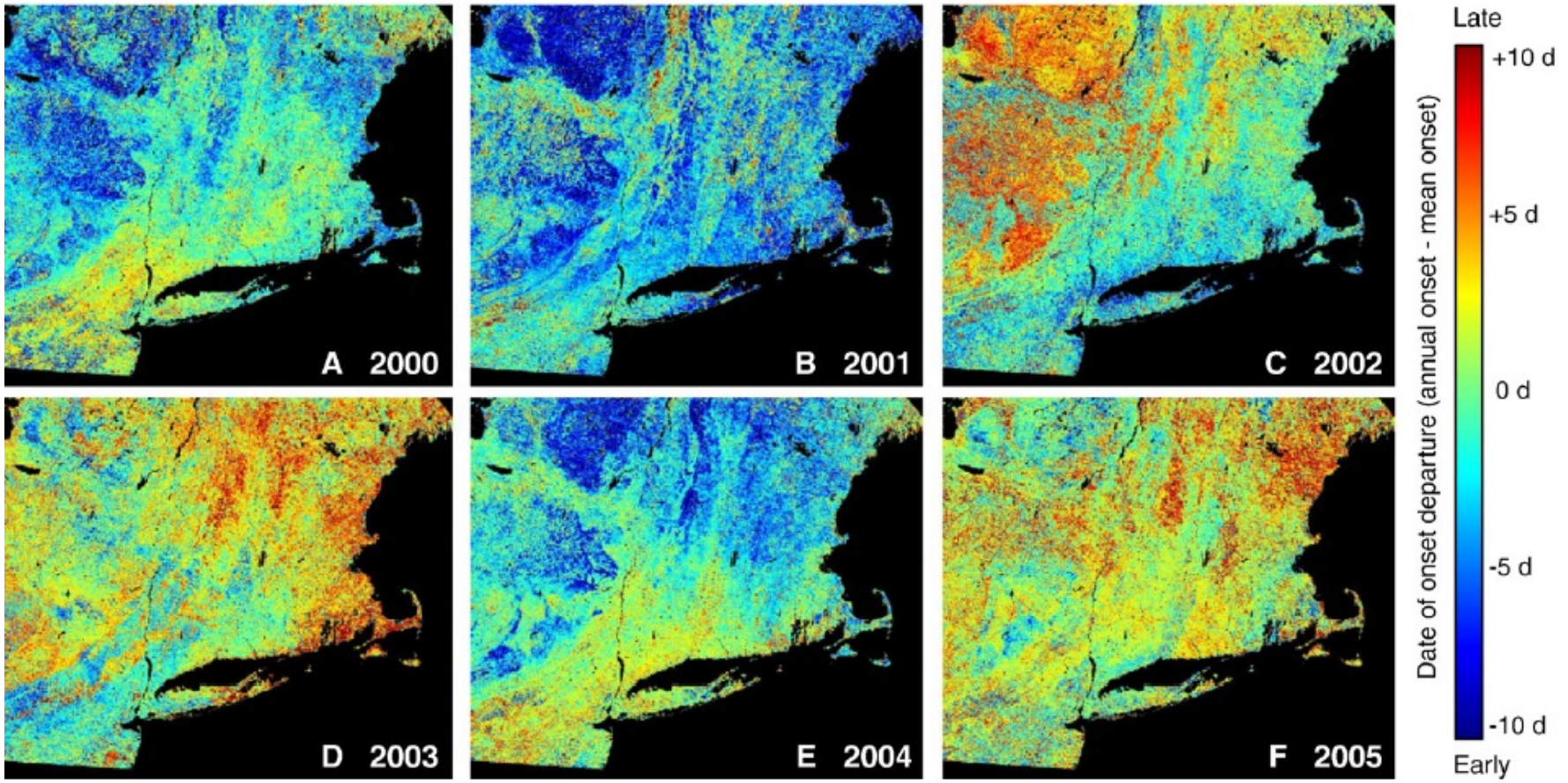

Bartlett TowerCam
06/05/06 13:21:46

Bartlett TowerCam
10/03/06 13:37:25

Timing of green-up in New England

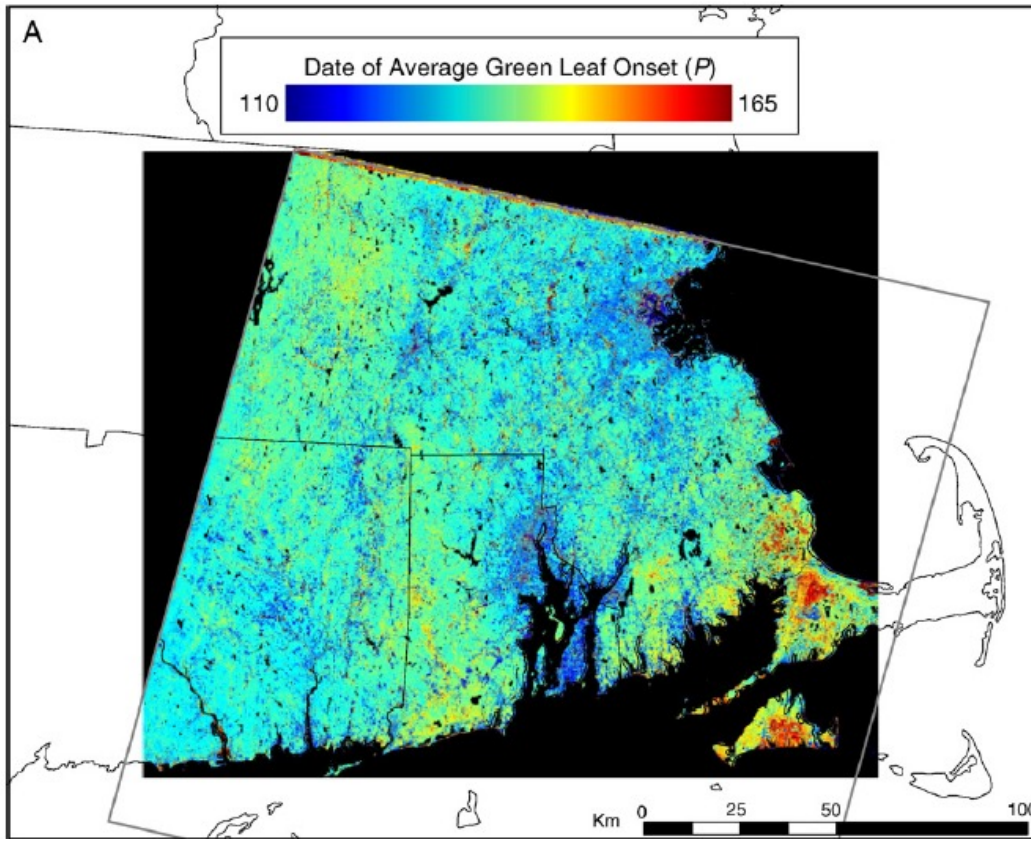


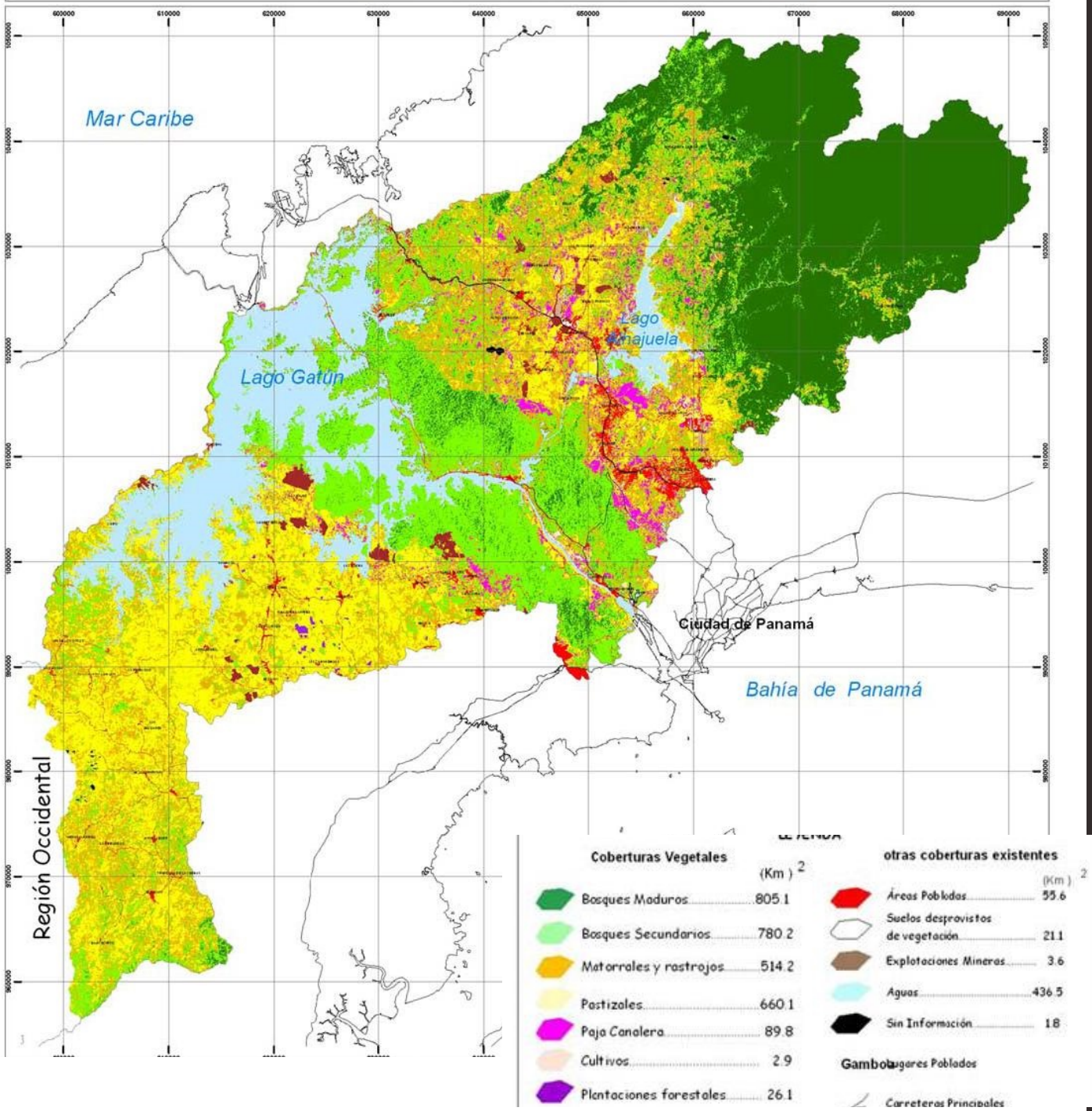
Inter-annual variability of green-up



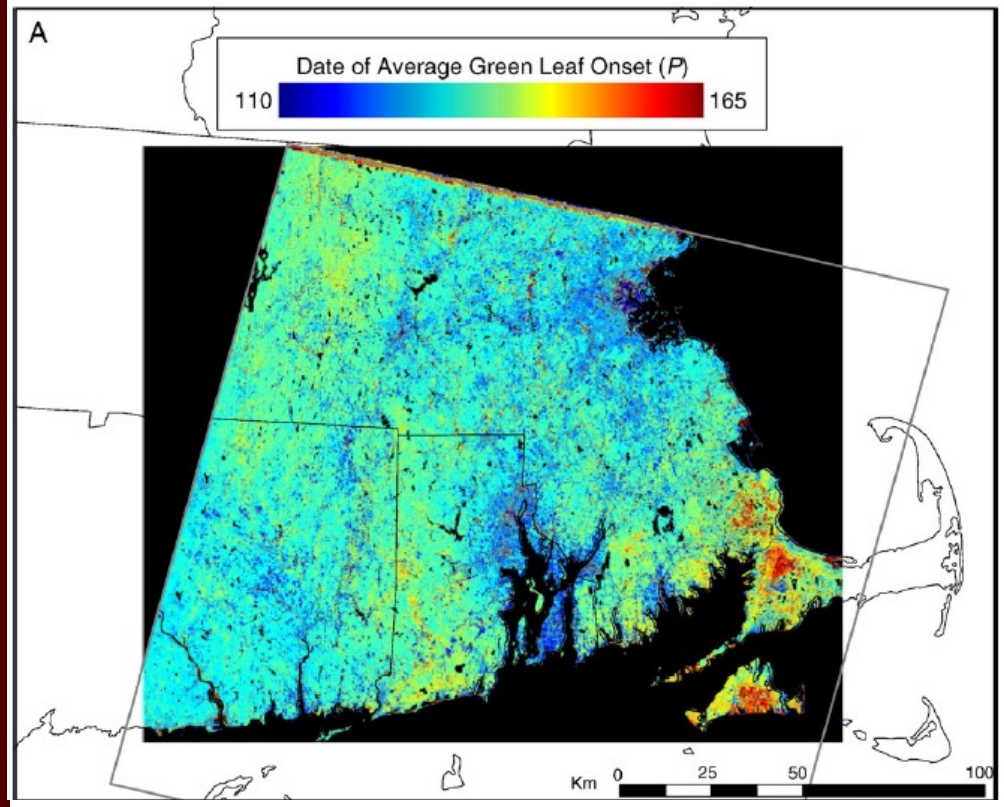
Land Cover

Phenolog

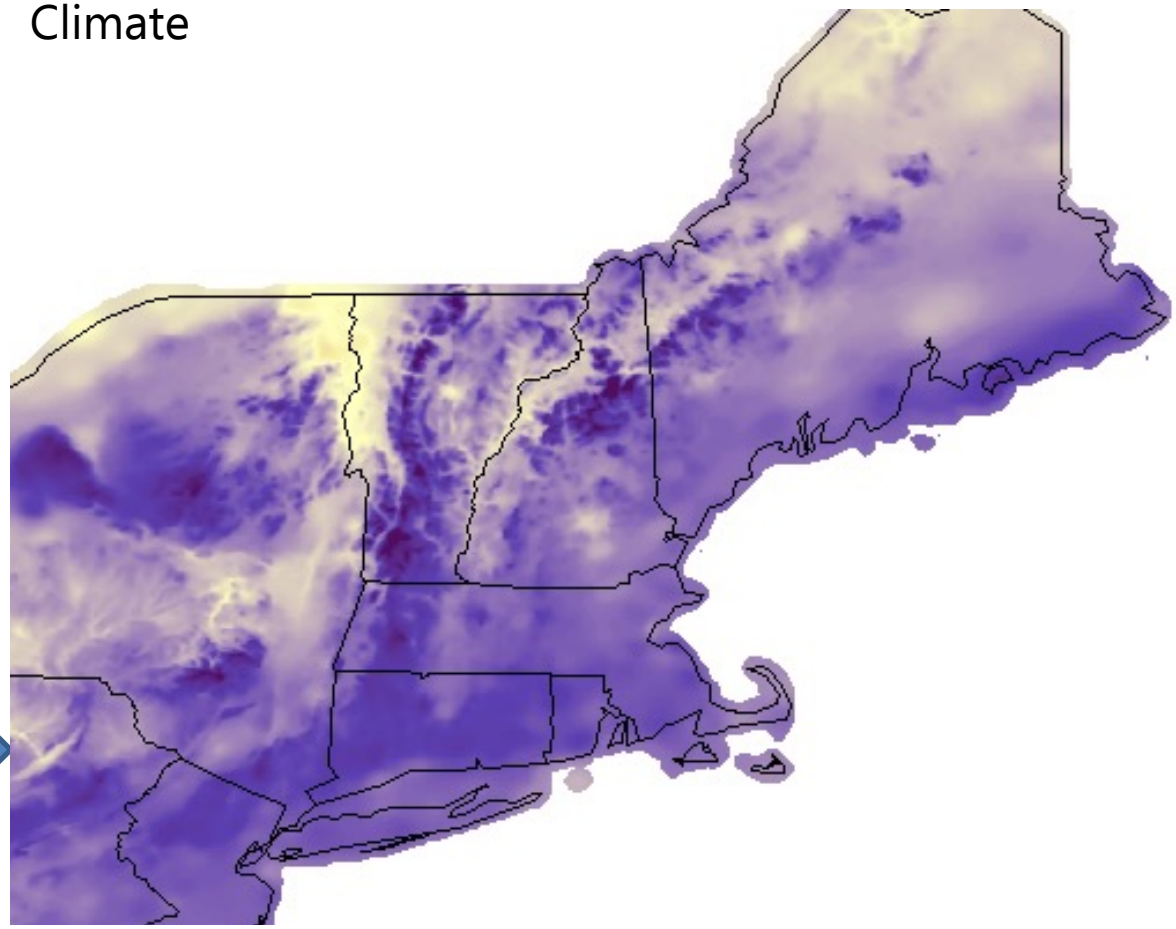




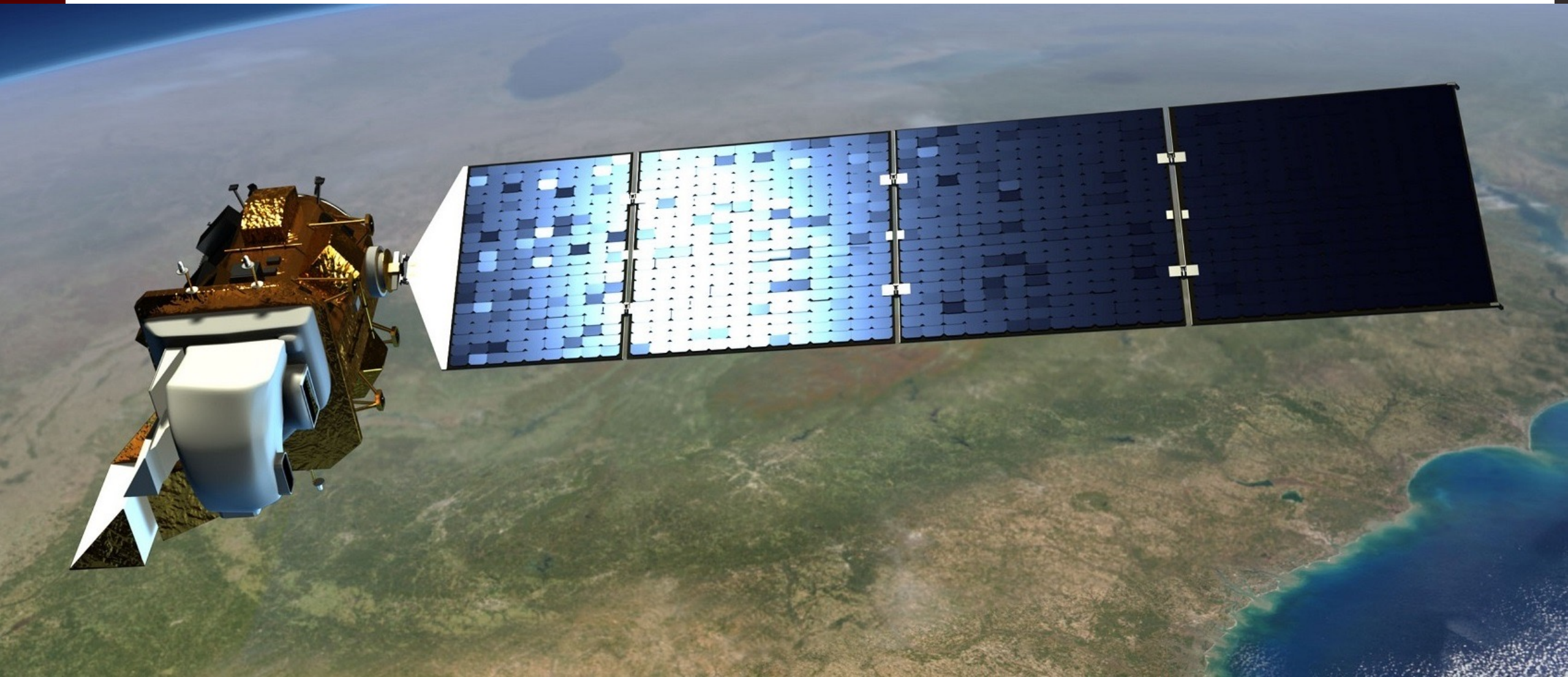
Phenology



Climate

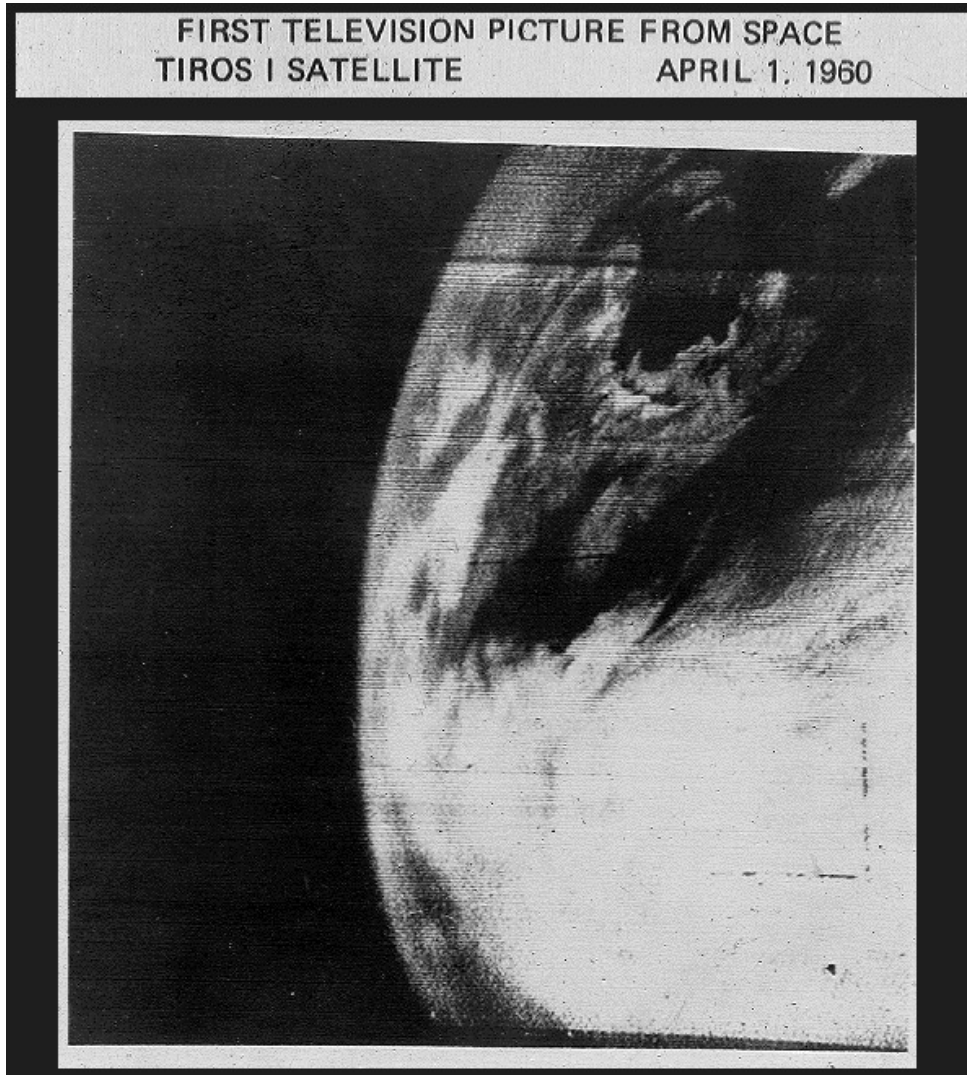


Talking About Landsat

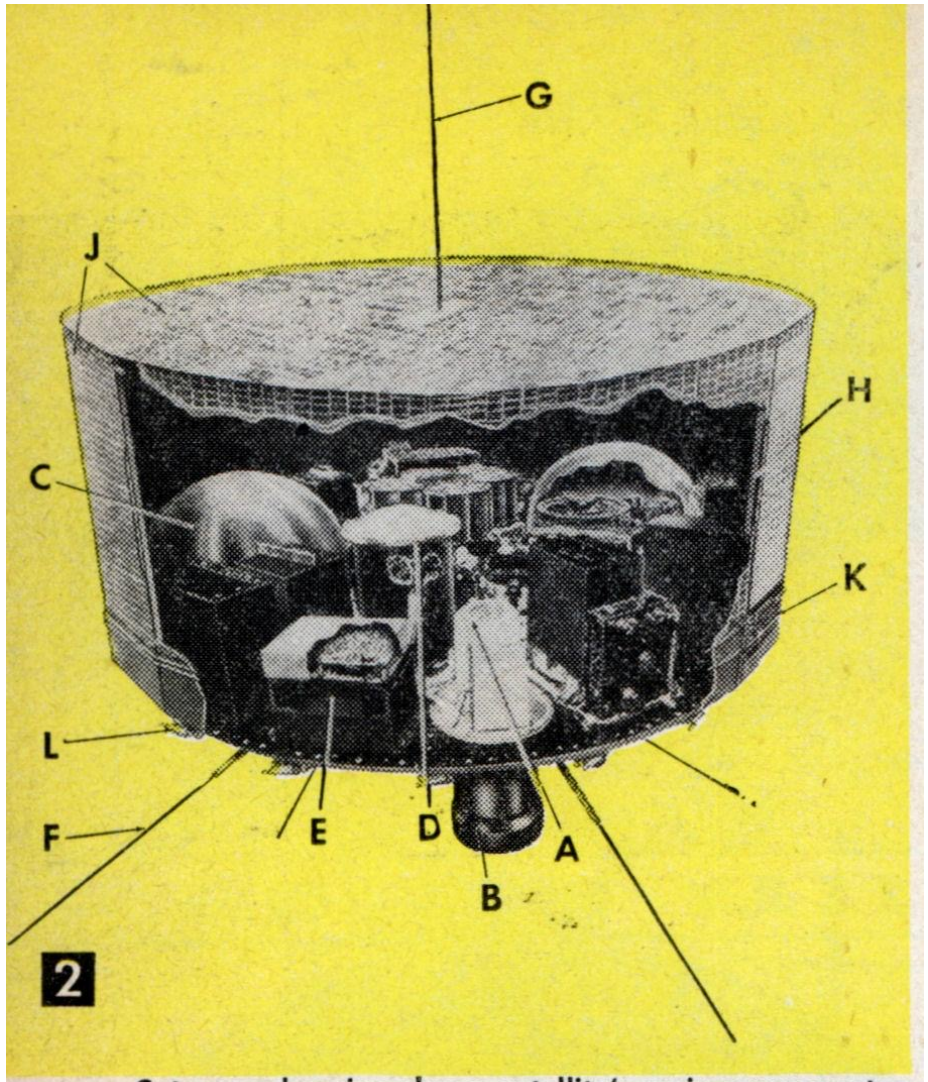


Beginning of Satellite RS

- TIROS sent first orbital images of Earth.
- Eventually, the DoD & NOAA launched their own weather satellites.



Left, TIROS diagram from 1960s magazine ‘Science and Mechanics’; Right, TIROS satellite model from NASA.



Cutaway drawing shows satellite's main components. (A) is one of the TV cameras; (B) is wide-angle camera lens; (C) indicates tape recorders; (D) electronic timer; (E) TV transmitter; (F) transmitting antennas; (G) receiving antenna; (H) solar sensor to measure position of Tiros with respect to sun; (J) solar cells; (K) de-spin mechanism, and (L) spin-up rockets.

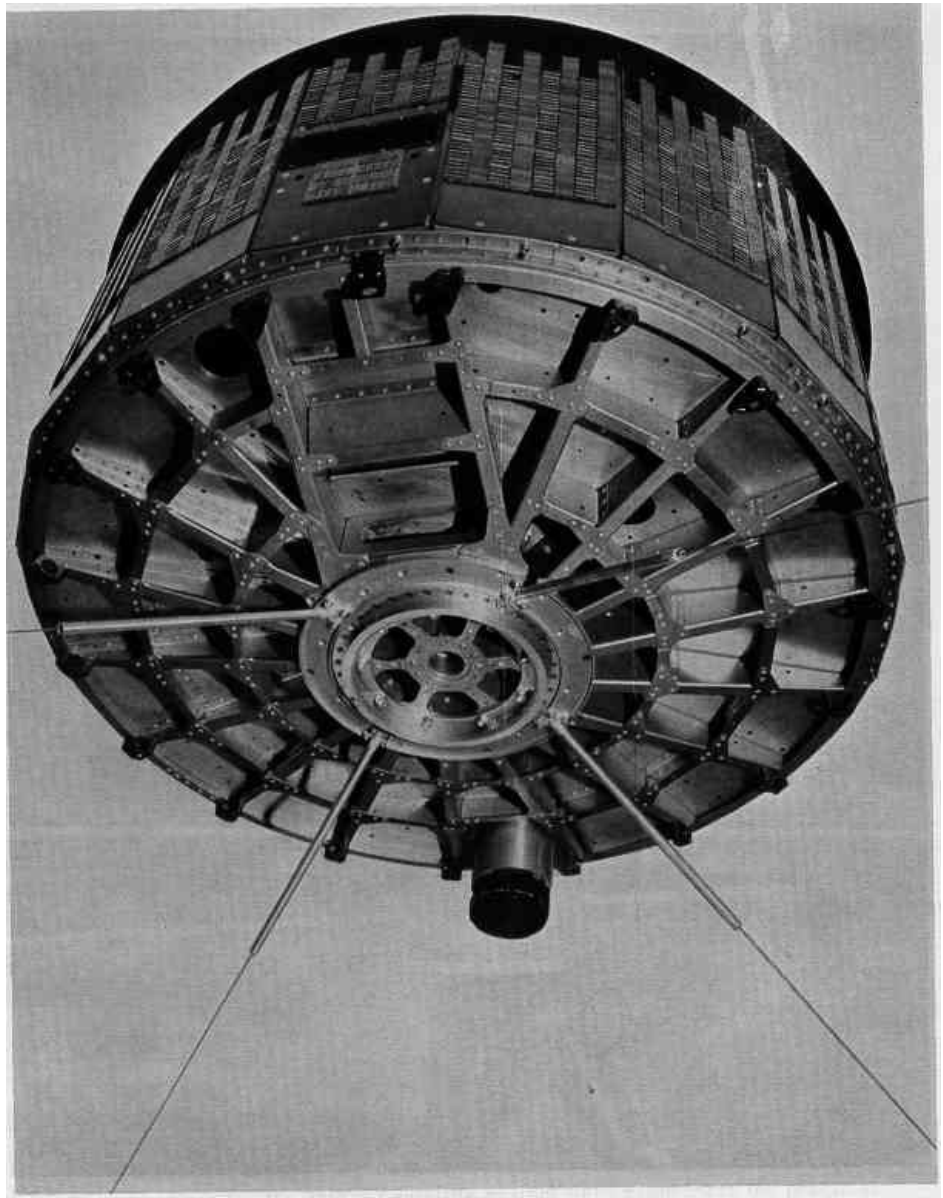


Figure 12 – The TIROS I satellite

Political Perceptions

"The benefits which a satellite system should make possible within a few years will stem largely from a vastly increased capacity to exchange information cheaply and reliably with all parts of the world by telephone, telegraph, radio, and television." –President John F. Kennedy, statement when signing the 'Communications Satellite Act' in 1964.

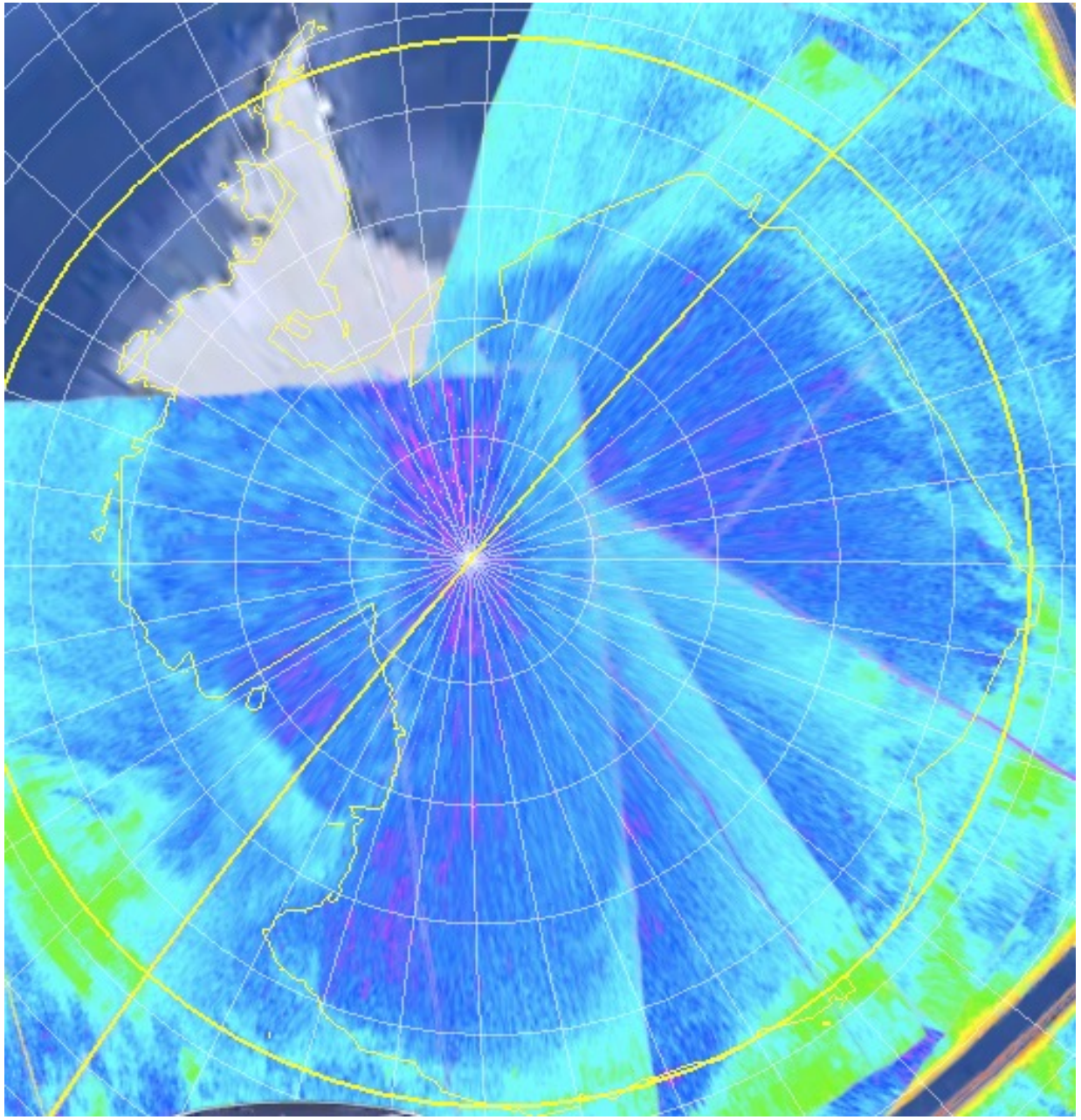
Political Recognition

"The diversity of our activities in space shows that space technology has become an integral part of our lives—in communications, in **remote sensing** for defense and civilian purposes, and in studies of the earth and the universe. " –President Jimmy Carter, 1980 State of the Union Address.

Nimbus

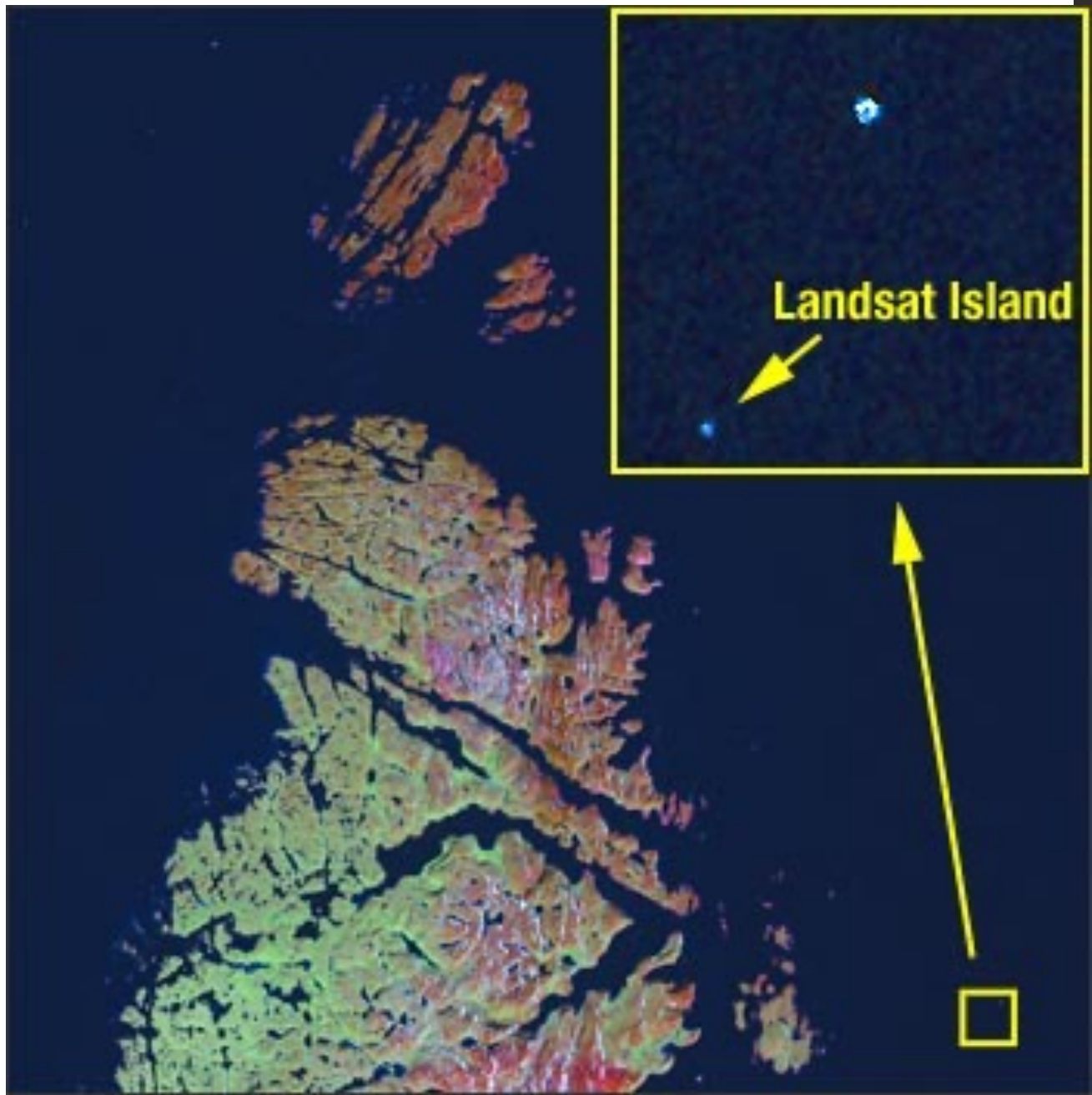
- Nimbus platforms expanded US technological capabilities in the 1960s and 1970s.

- Right, Nimbus temperature data of Antarctica, Sept. 23, 1966



Landsat -1970's

- Beginning in the 1970s, Landsat, equipped with the Multi Spectral Sensor, changed the remote sensing paradigm in the United States.



The Landsat ‘Football’

- Despite the usability of Landsat, as a program it has been transferred five times.

- 1979: NASA to NOAA
- 1984: NOAA to EOSAT
- 1992: EOSAT to NASA/DOD
- 1994: DOD out, NOAA in
- 1998: NOAA out, USGS in

Landsat Issues

- Landsat 6 failed to make orbit (ruptured manifold on rocket).
- Landsat 7’s faulty scan line error negatively impacts usability.
- Landsat 8 is so amazing, though.

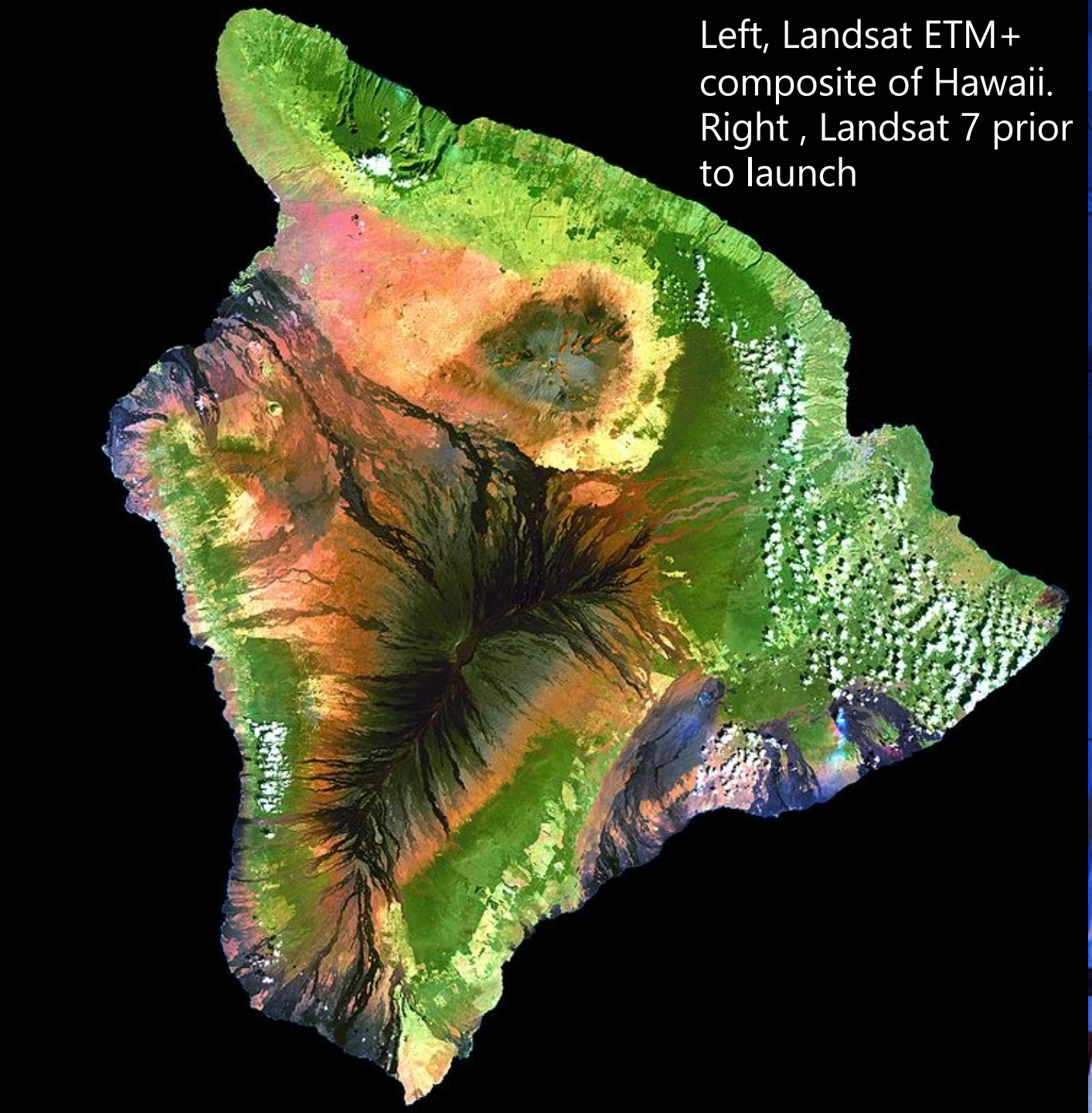
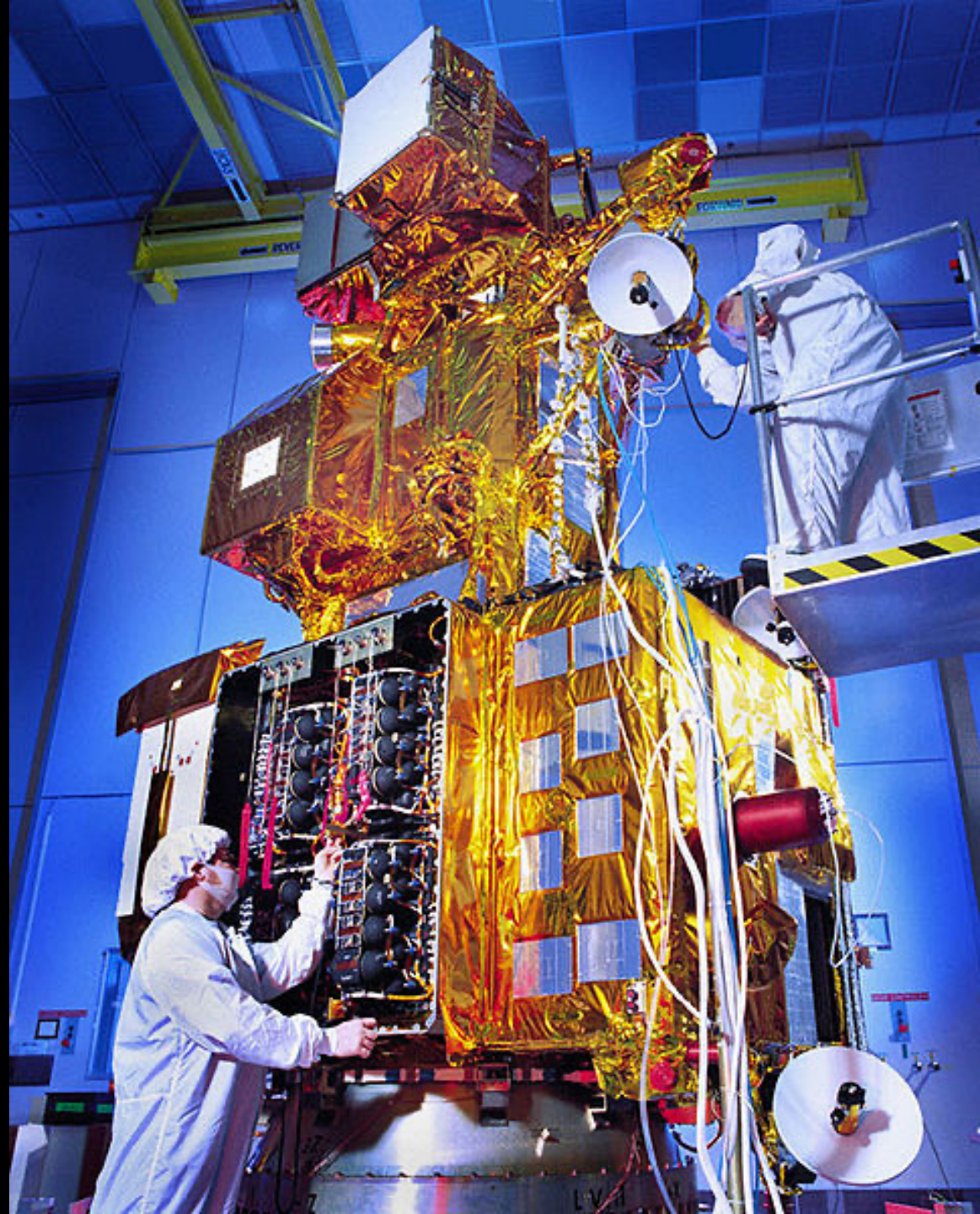
Political Reality

“ We all want a Government that lives within its means, but there are still things we need to pay for as a country, things like new roads and bridges, weather satellites and food inspection, services to veterans and medical research.” – President Barack Obama, Address to the Nation on the Federal Budget, July 25, 2011

Political Reality II

"It (the new budget strategy) will mean terminating unnecessary and lower-priority programs such as the C-27 airlift aircraft and a new weather satellite…." –President Barack Obama, 'The Budget Message of the President', February 13, 2012.

Political Reality III

- “The budget outline does keep funding for NOAA’s current generation of polar satellites, a key part of what the National Weather Service uses for weather forecasting. But it also calls for “savings” in funding for the Polar Follow-On satellite program, which would launch two satellites in the coming decade. If the budget does affect those satellites, it could degrade monitoring capabilities for events like snowstorms and hurricanes”
- https://www.scientificamerican.com/article/trump-wants-deep-cuts-in-environmental-monitoring/

Left, Landsat ETM+ composite of Hawaii. Right , Landsat 7 prior to launch