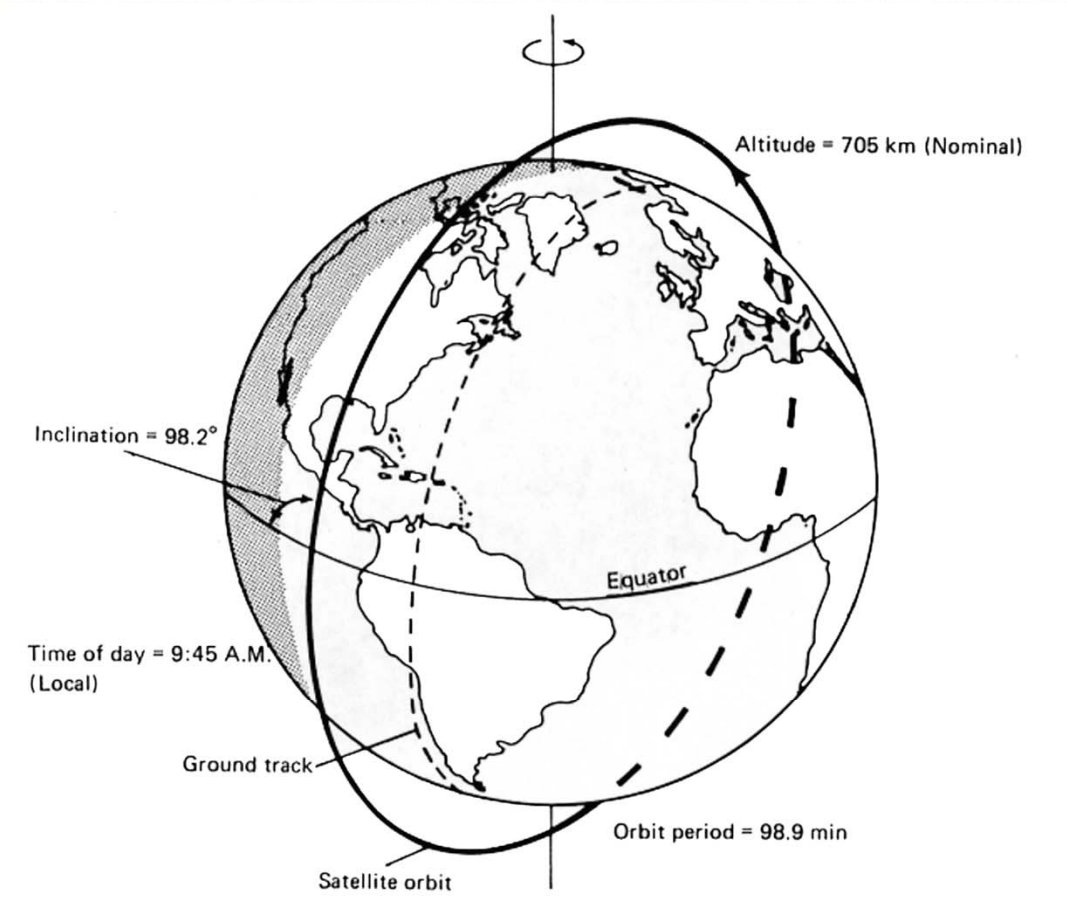
What's Special About Landsat

What's Special About Landsat

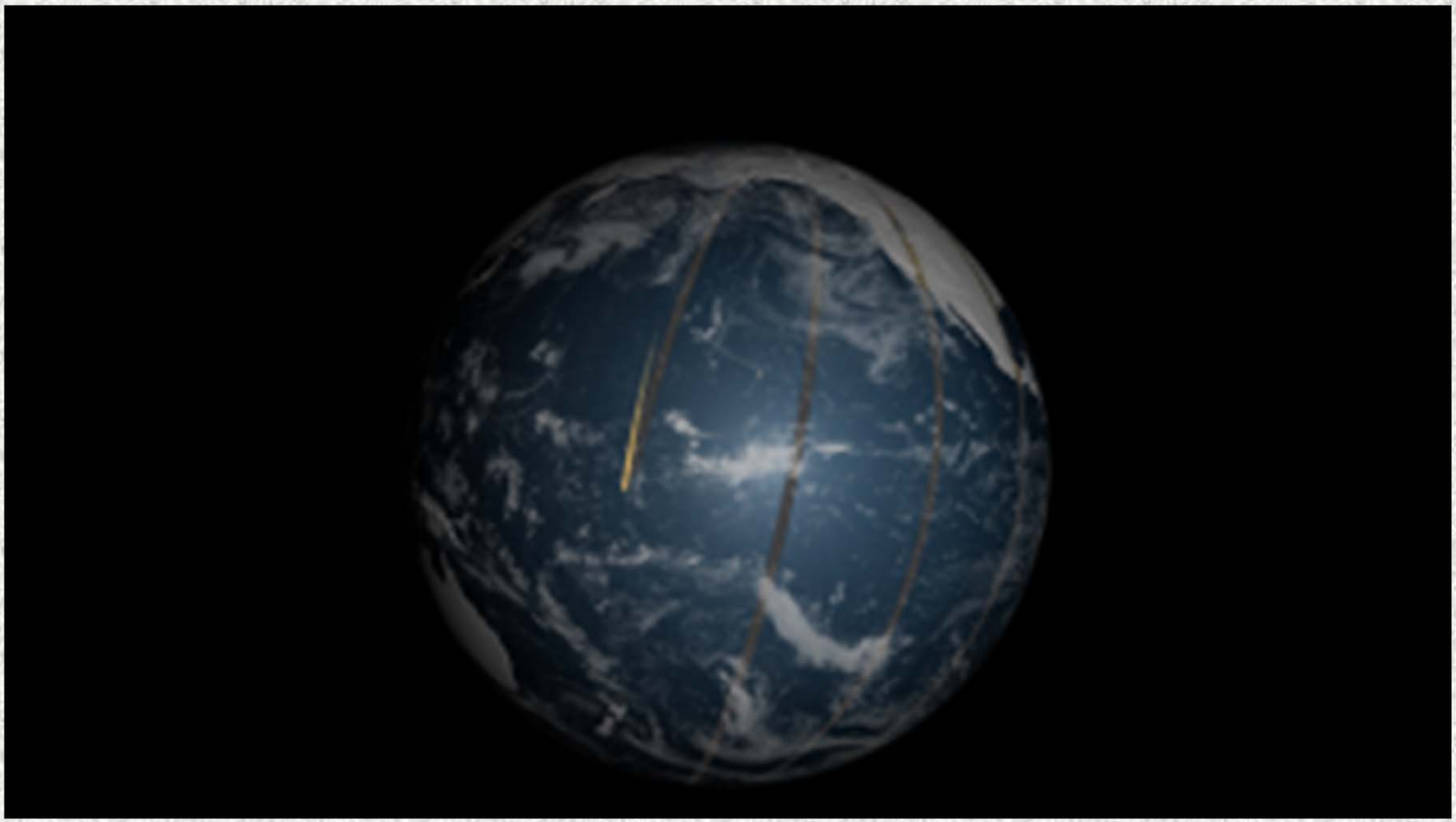
- Primary mission: to map Earth's land surface
- Data consistent since 1972
- 16 day repeat
- 30-meter resolution
- Data publicly available at no cost, thanks to USGS.

Landsat satellites **orbit** the Earth at 705 km above the surface.



Sun-synchronous orbit of Landsat-4 and -5. (Adapted from NASA diagram.)

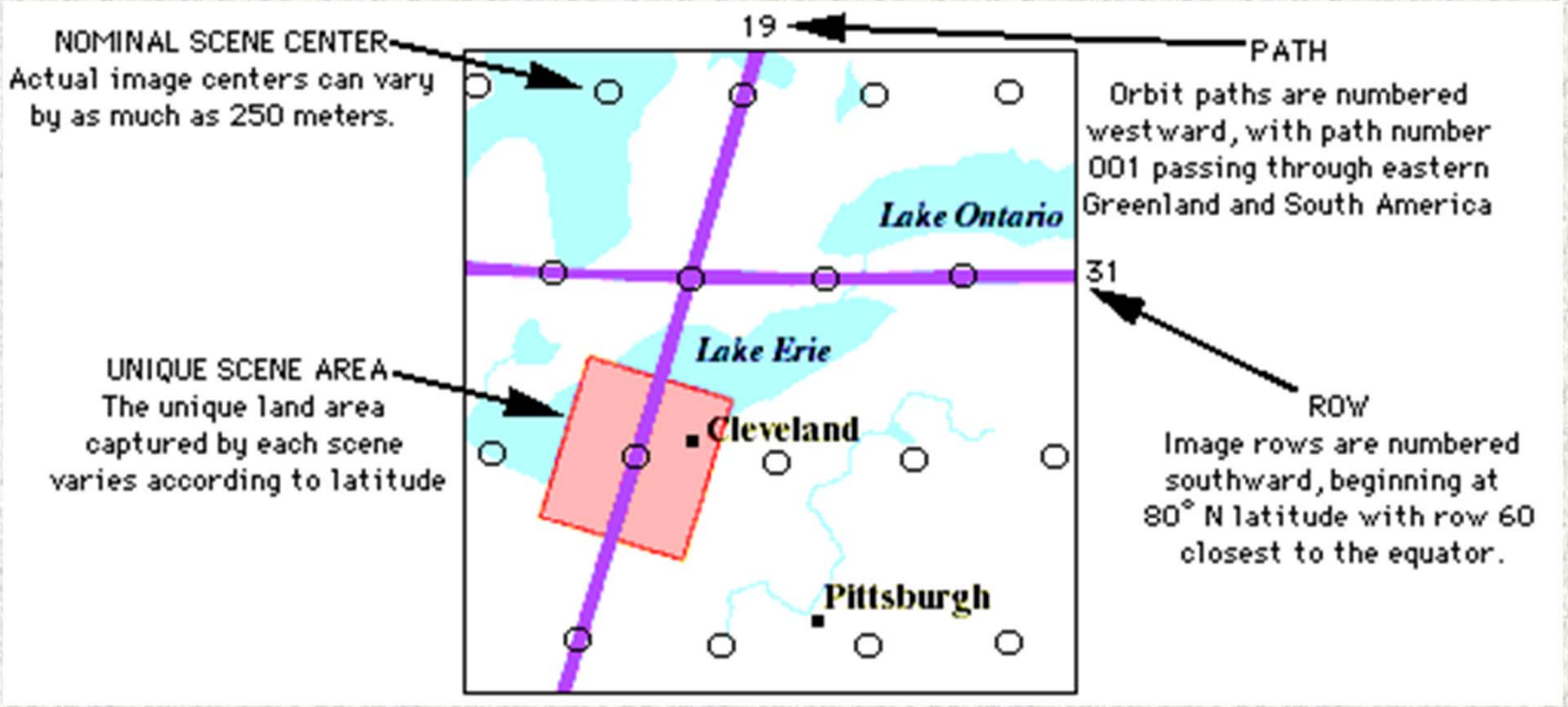
Landsat orbits from pole to pole (north, south north south), as Earth turns under it.



http://svs.gsfc.nasa.gov/vis/a000000/a003900/a003939/index.html

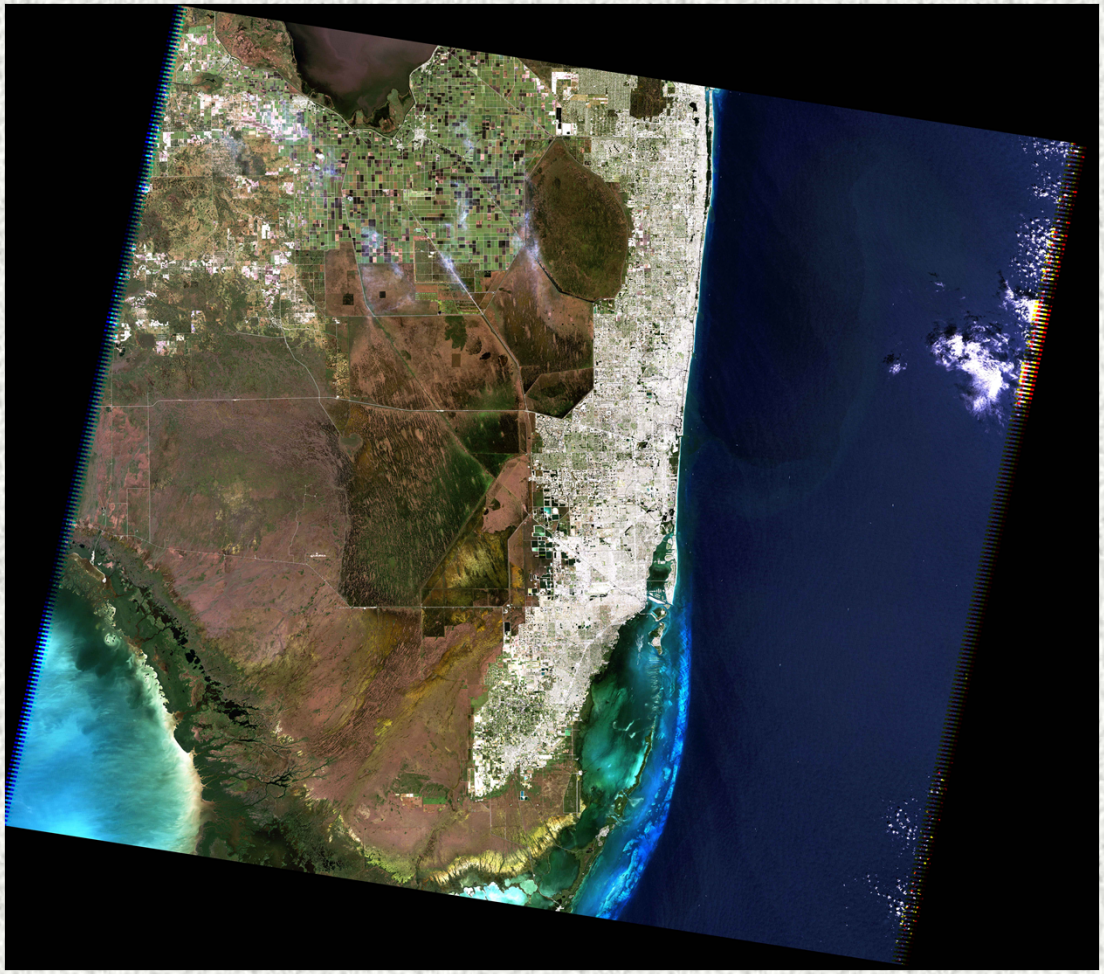
Landsat's observations are organized by those orbit **paths** and also by **row**.

… into a World Reference System (WRS) associated with latitude and longitude.

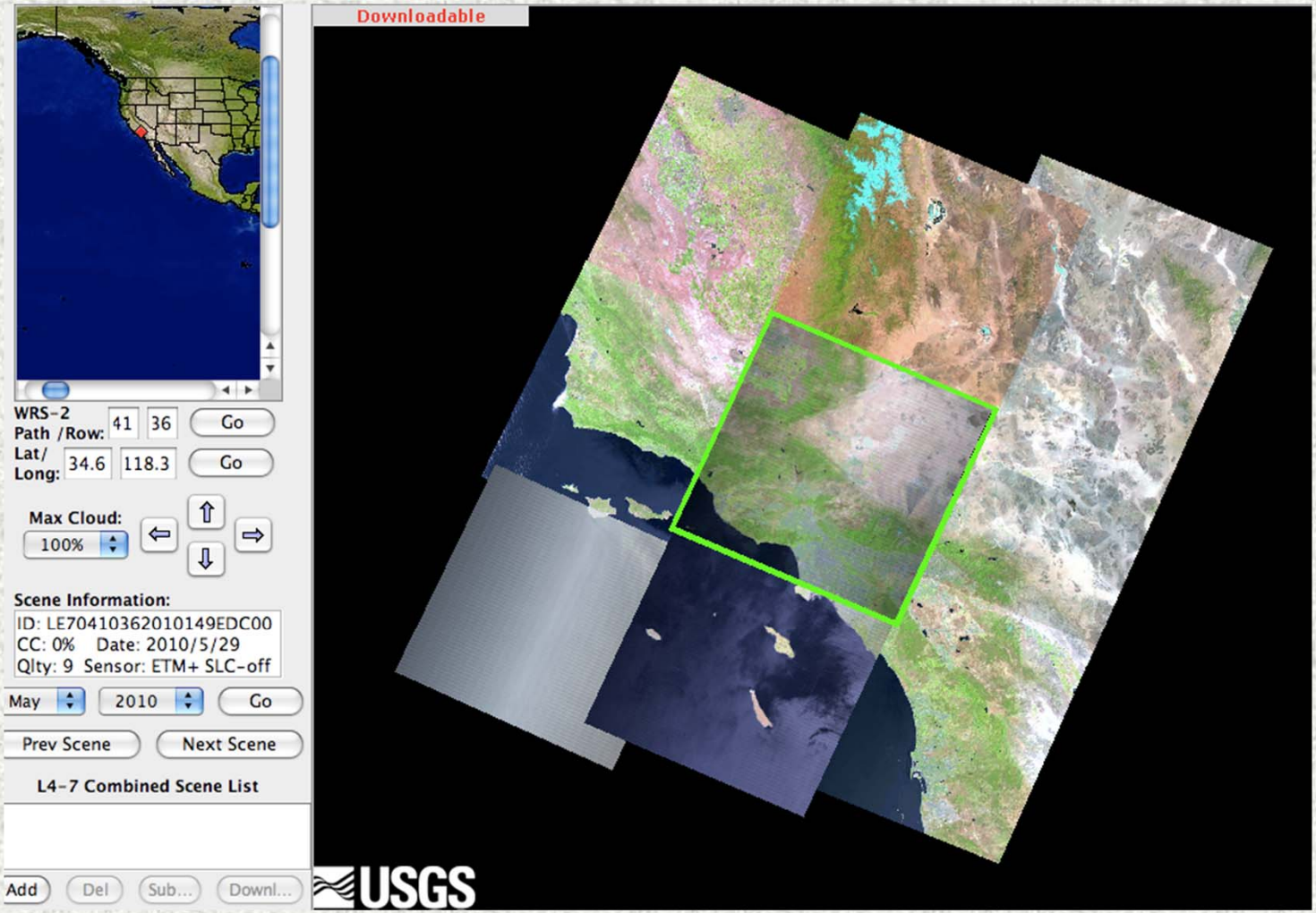


Each location on Earth's lands can be identified by its Landsat path and row, which does not change.

The Landsat scene including Miami, FL is Path 15, Row 42



When you go to a USGS website to download a Landsat scene, you can use the scene's path and row numbers (*or* its latitude and longitude).

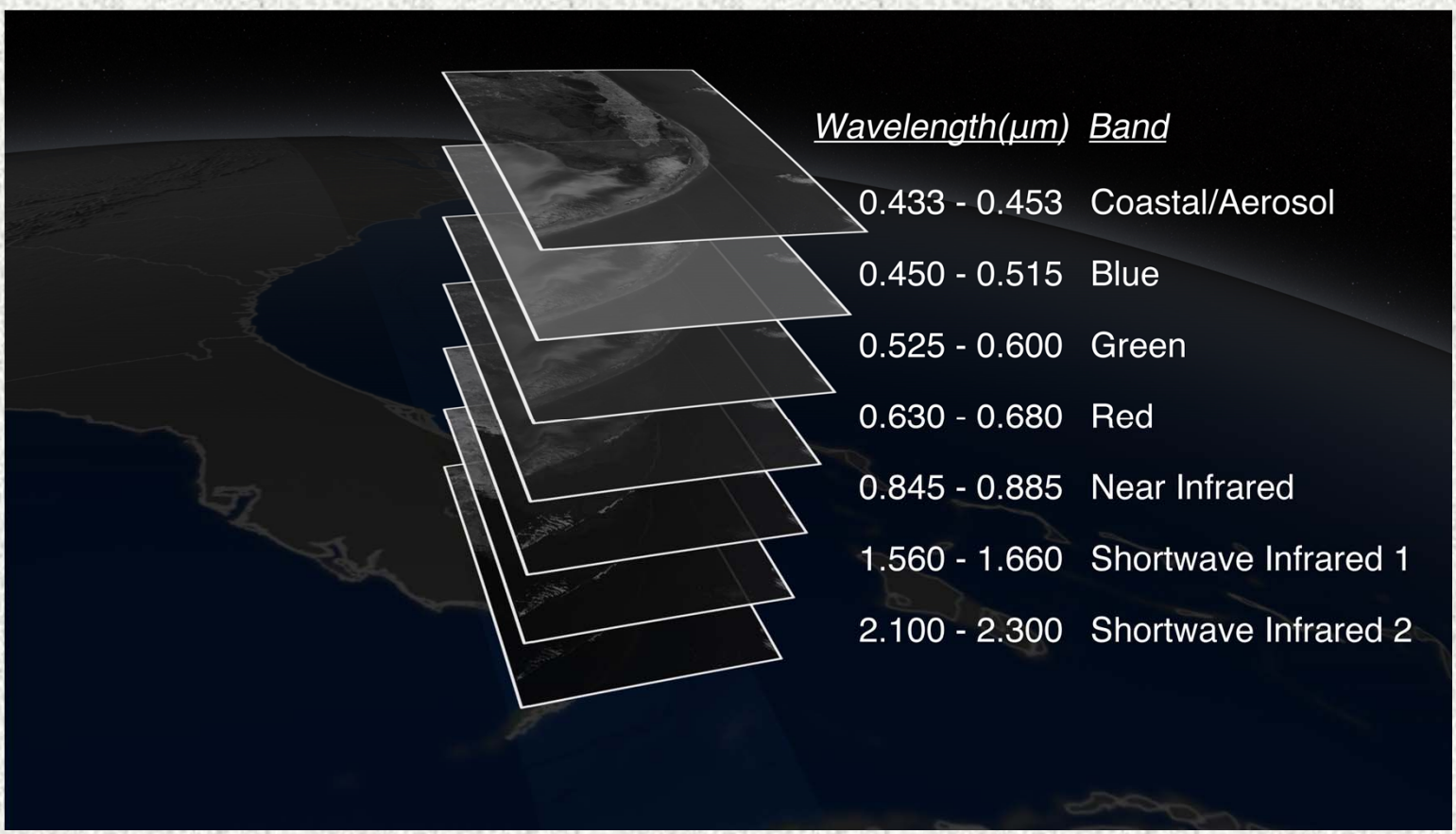


Landsat has a **spatial resolution of 30 meters**.

This means the smallest area on the ground it measures is a 30 m square.

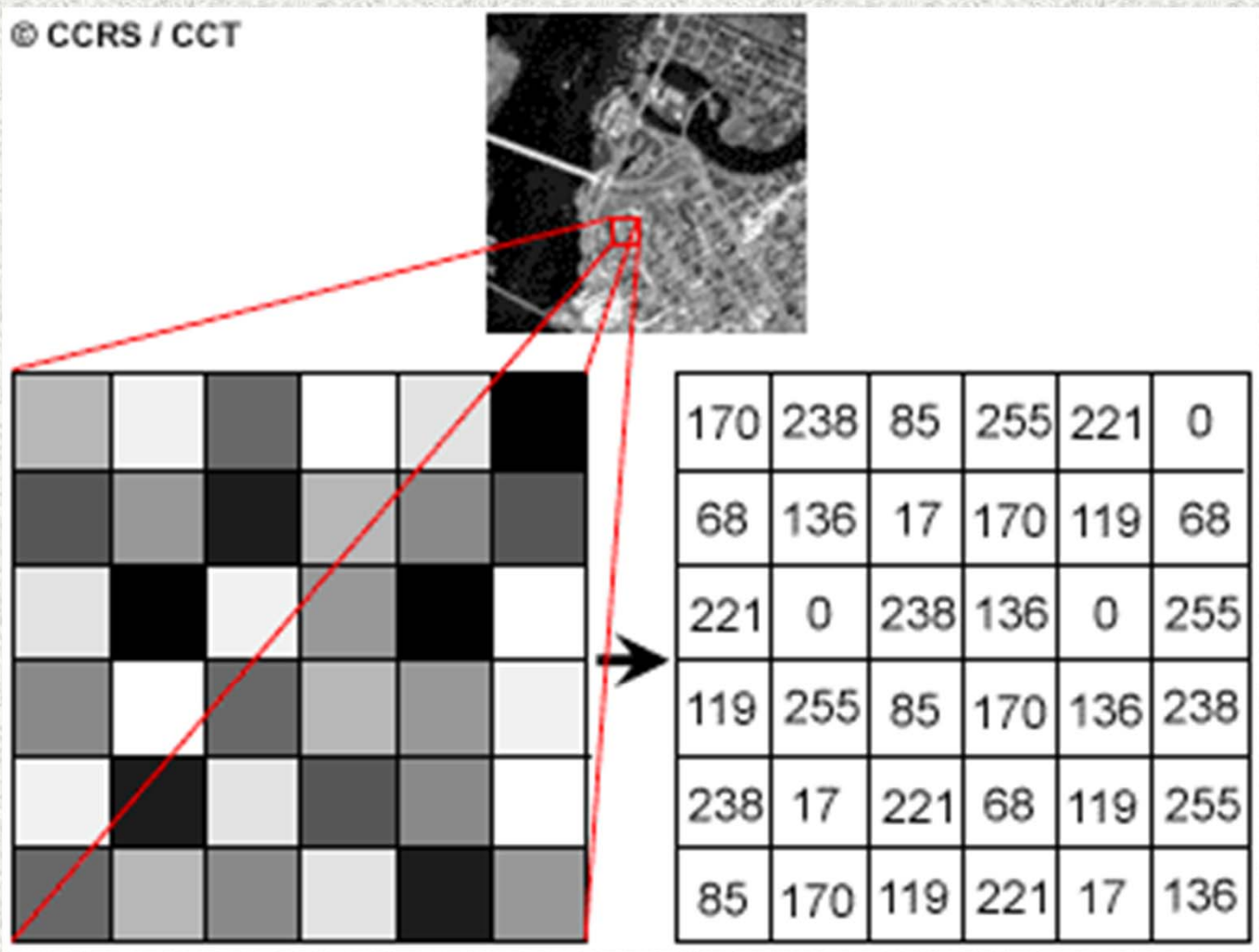
Landsat scenes are made up of these 30-meter squares, or ***pixels***.

Landsat simultaneously observes the Earth in several ranges (or bands) of the electromagnetic spectrum.



http://svs.gsfc.nasa.gov/vis/a000000/a004000/a004040/index.html

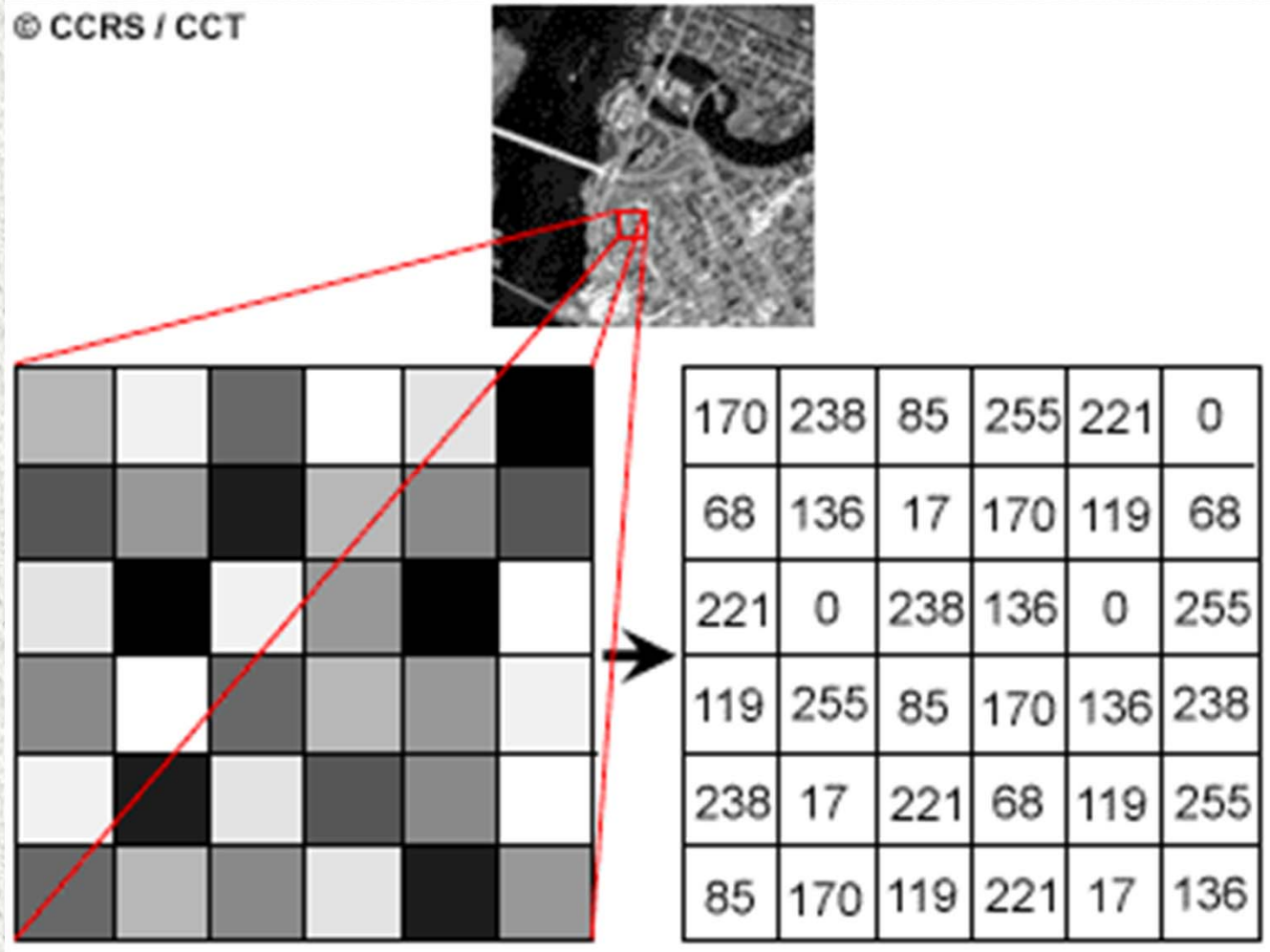
Let’s look at how it works for just 1 band from Landsat 7. In this illustration, each square represents a 30m x 30m piece of land surface (one Landsat pixel).



The Landsat 7 instrument records the amount of **reflected light in each band** for each 30 m pixel, on a scale of 0 to 255.

A numerical value of 0 represents *no* reflected light.

A numerical value of 255 represents *maximum* reflected light.

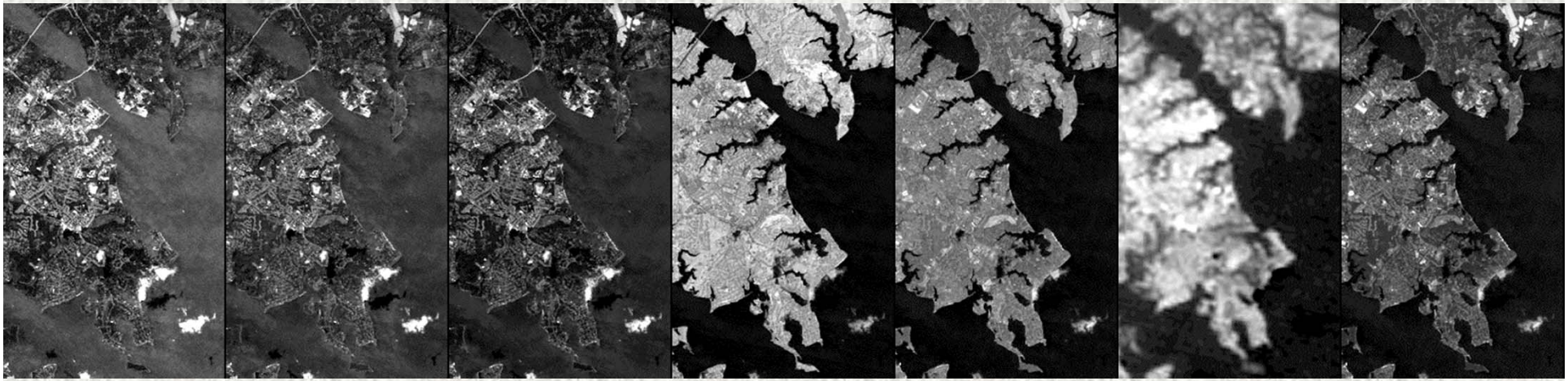


170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

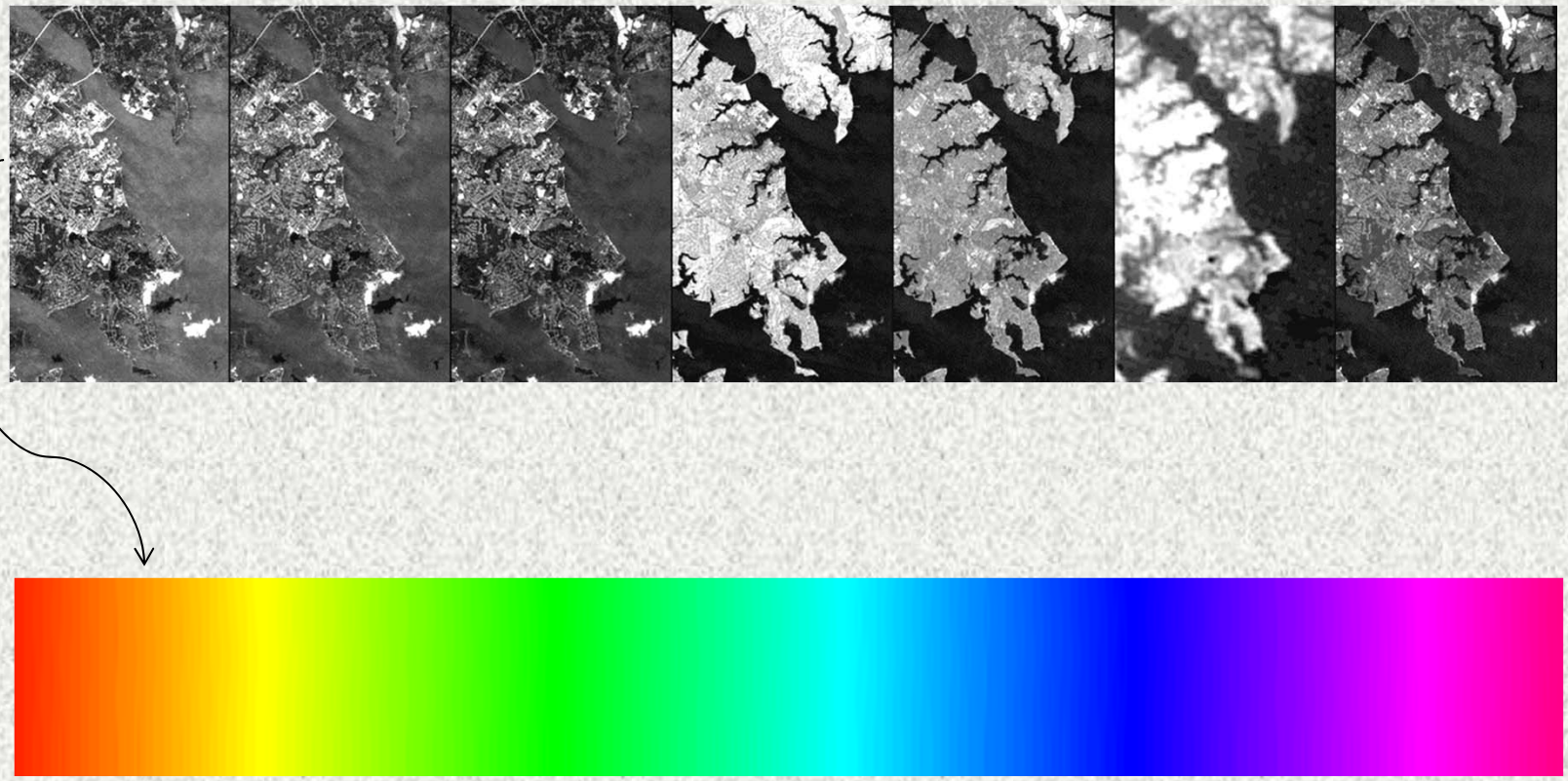
← **0**: See the corresponding black pixel in gray-scale array.

← **255**: See the corresponding white pixel in gray-scale array.

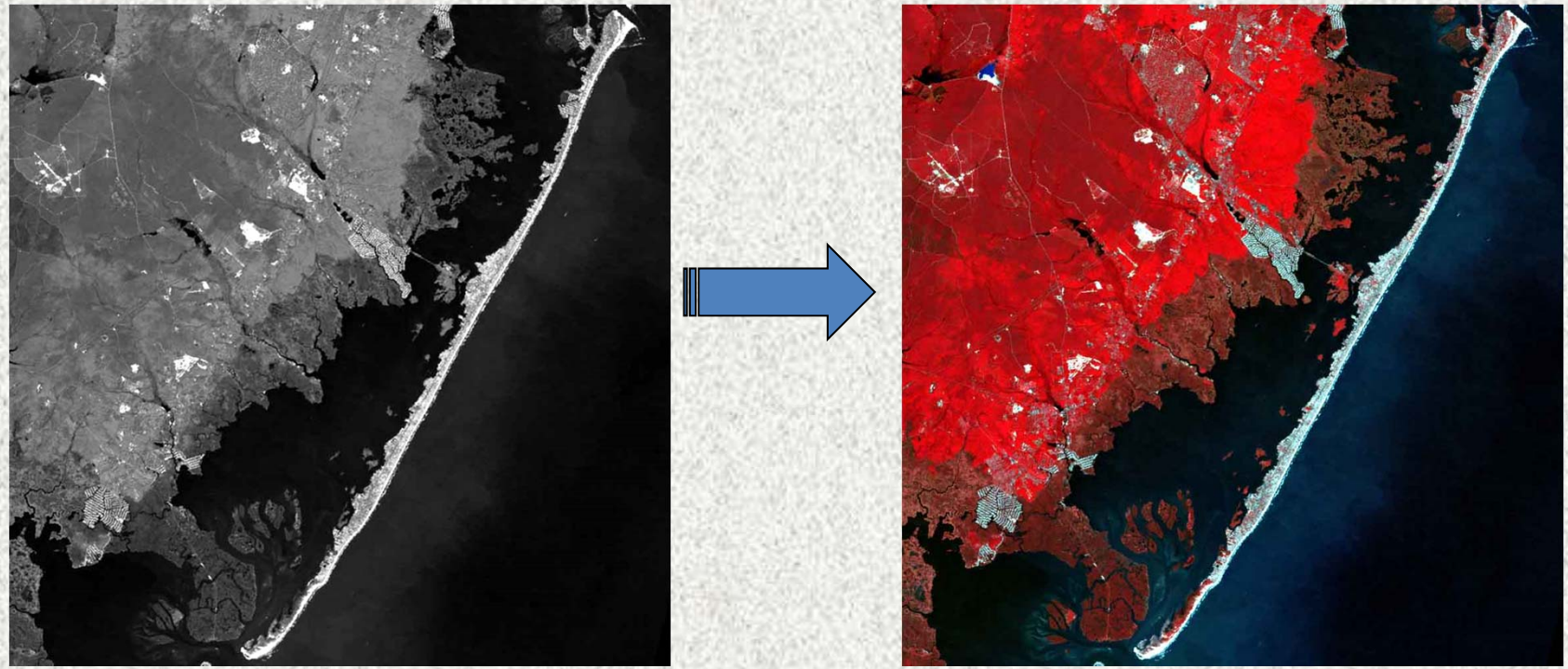
7 bands of data looked at side by side in shades of gray



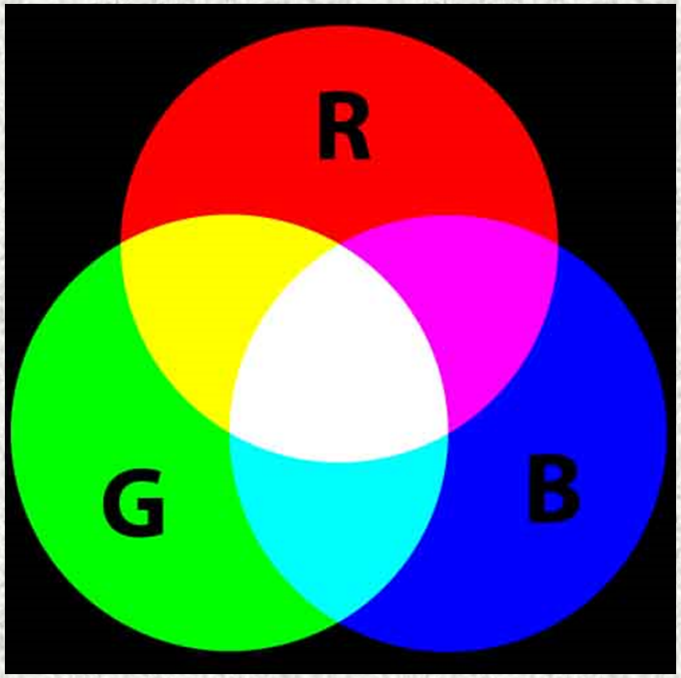
Now – how do we make *color* images of all that grayscale data so we can work with it more easily?



We have to *assign* **Colors** to represent Landsat bands
(using computer software).



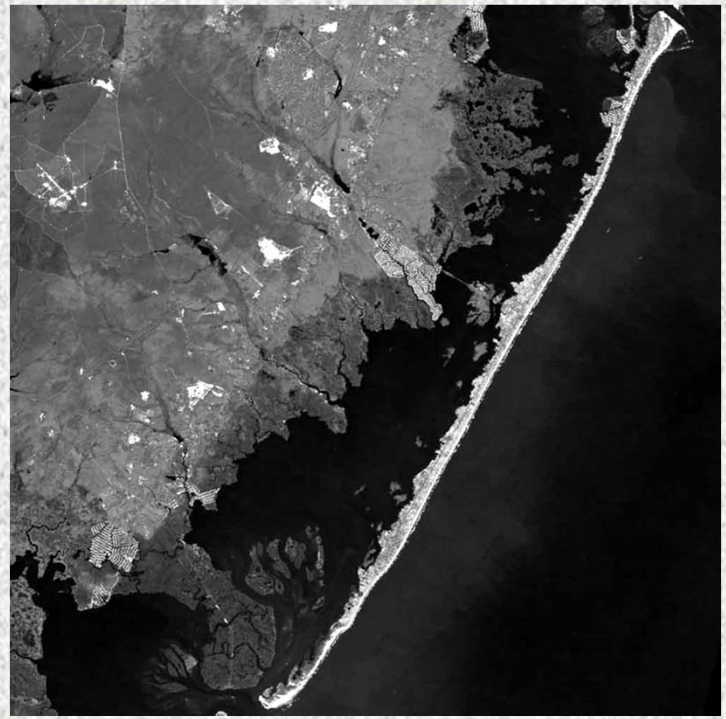
Remember, Landsat uses some bands of ***infrared light.*** And the human eye is ***not sensitive*** to infrared. So to build an image we can see that includes data about infrared light gathered by Landsat, we must represent that data with colors we can see: red, green, and blue.



Here's an example.

In the images of New Jersey Barrier Islands below, data about reflected near-infrared light has been assigned the color red in the image at lower right.

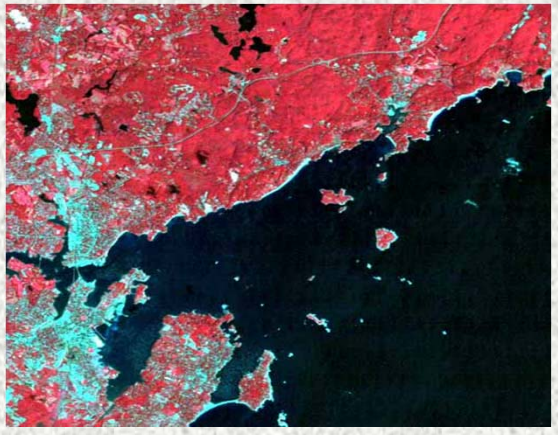
Reflected near-infrared light appears in shades of *gray*.

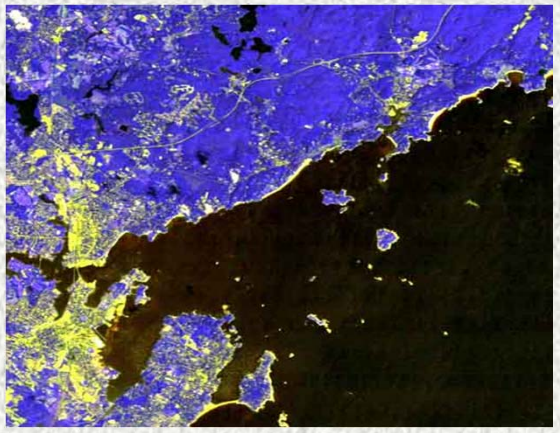


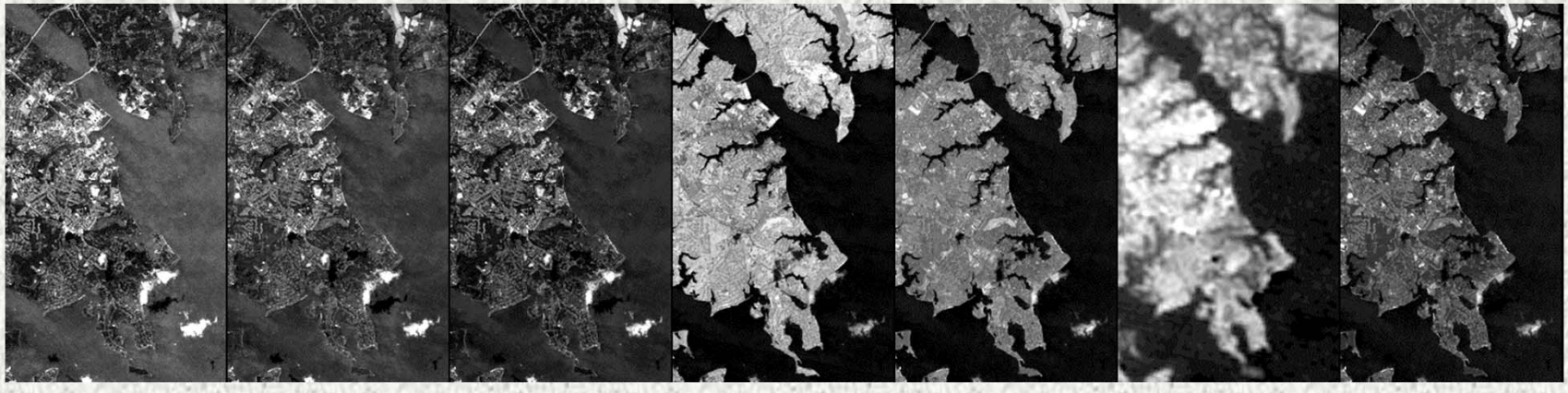
Reflected near-infrared light appears in shades of *red*.

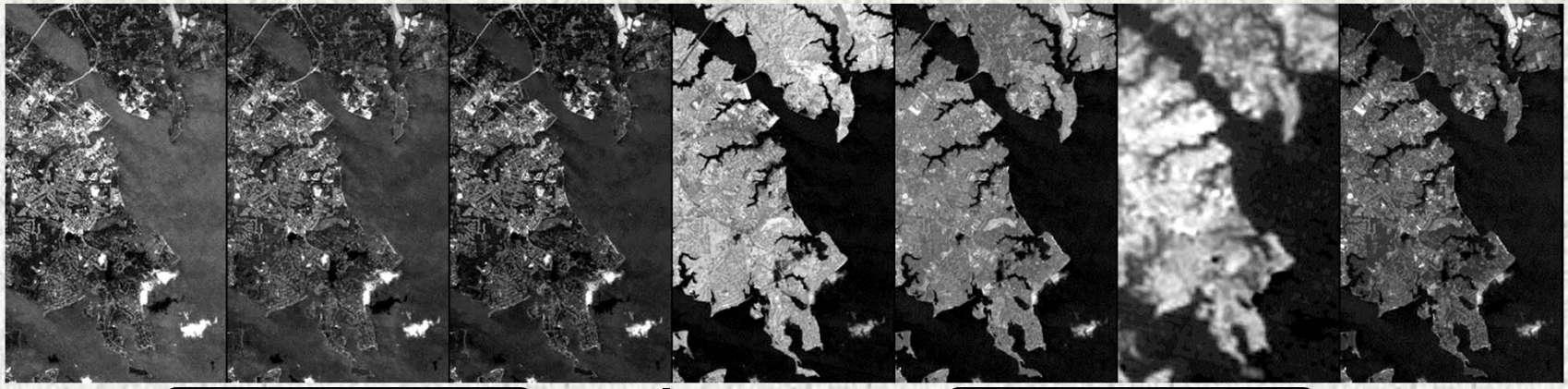
People can choose red, green, or blue to represent any of the wavelength ranges they like.

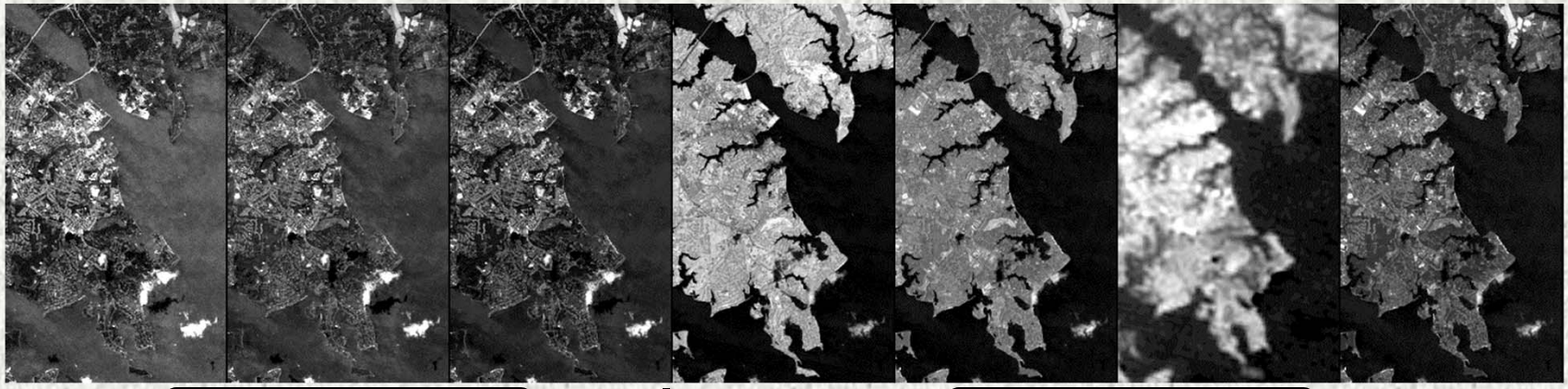
One can make lots of color combinations. (This is Beverly, MA.)







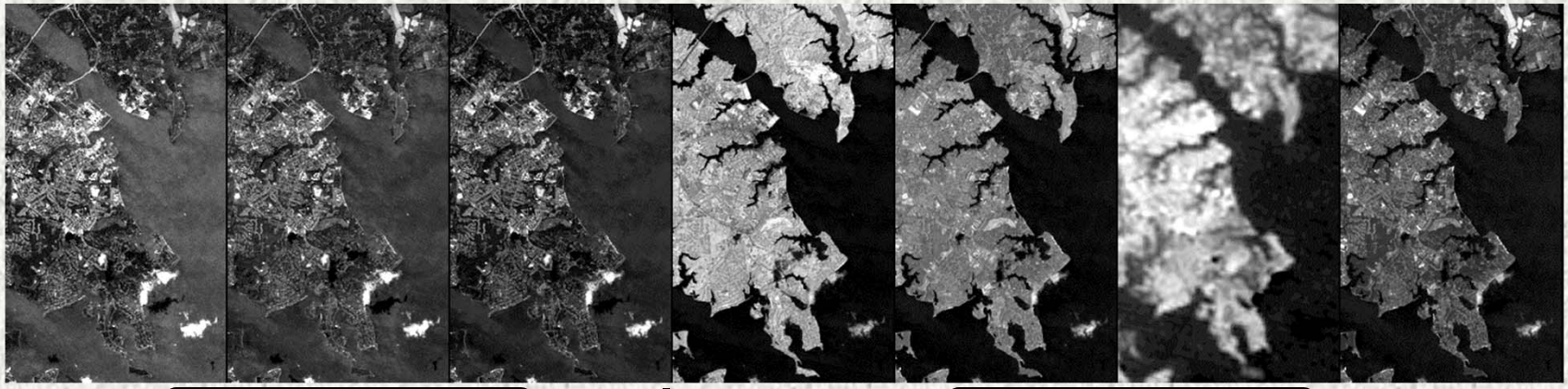

Visible
Infrared



Visible

Infrared

1 2 3 4 5 6 7

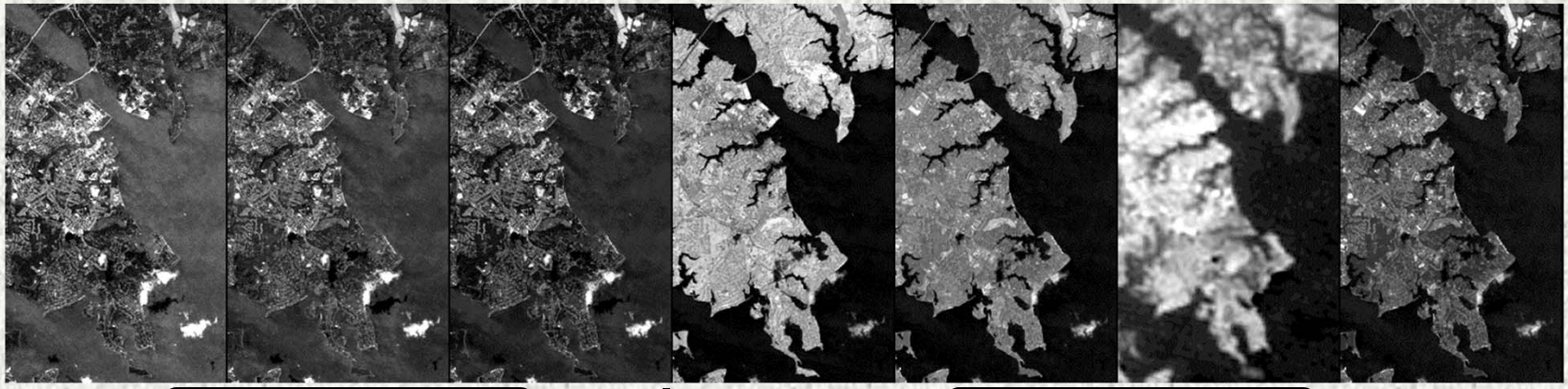


Visible

Infrared

1 2 3 4 5 6 7

3,2,1

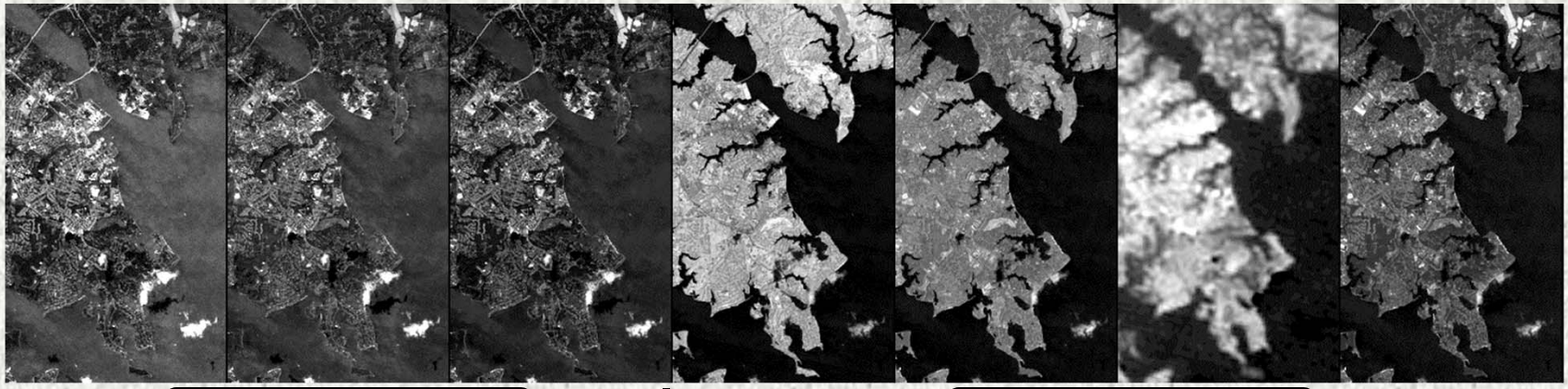


Visible

Infrared

1 2 3 4 5 6 7

3,2,1



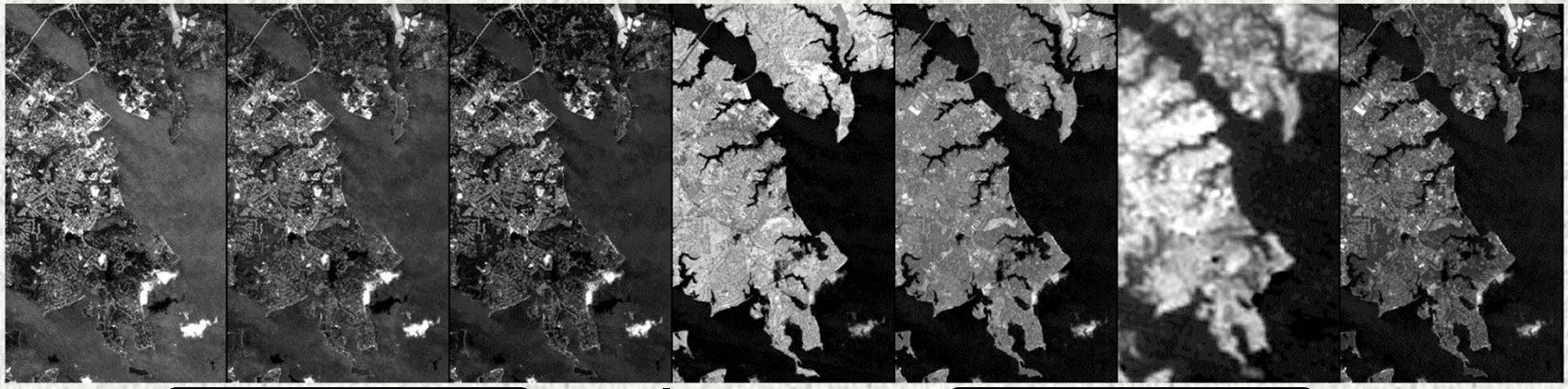
Visible

Infrared

1 2 3 4 5 6 7

3,2,1

Red Data is shown as Red

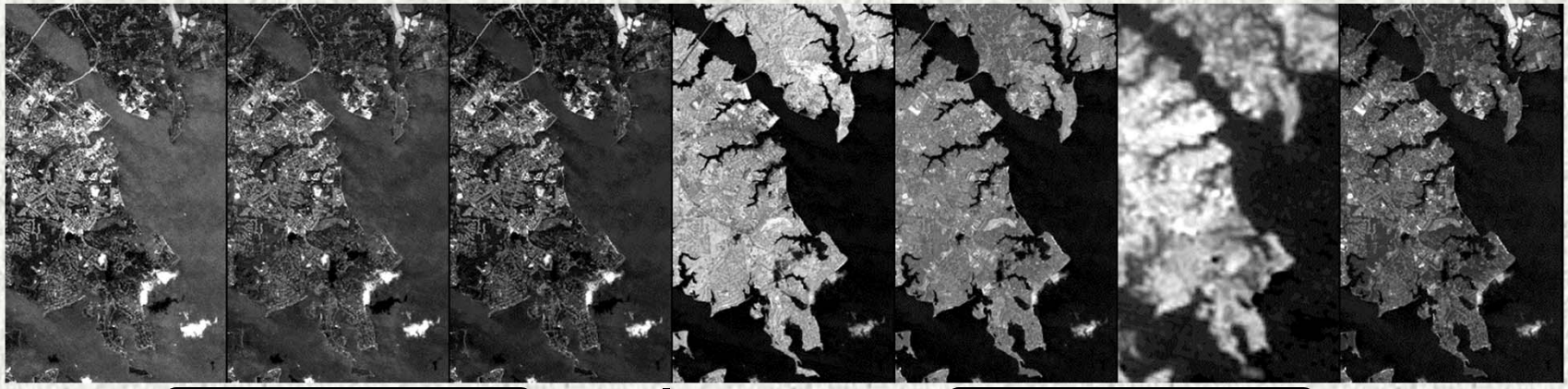


Visible

Infrared

1 2 3 4 5 6 7

3,2,1



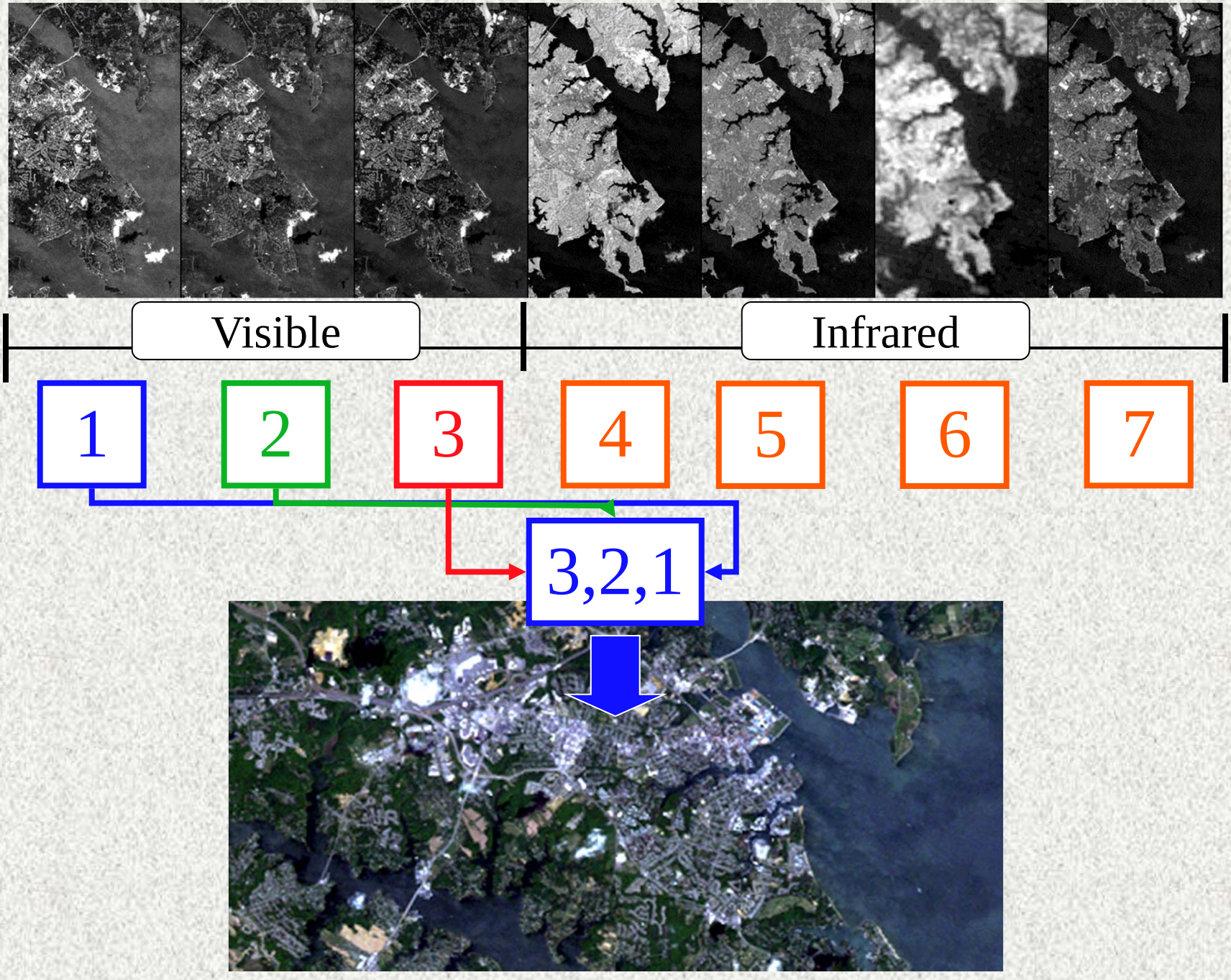
Visible

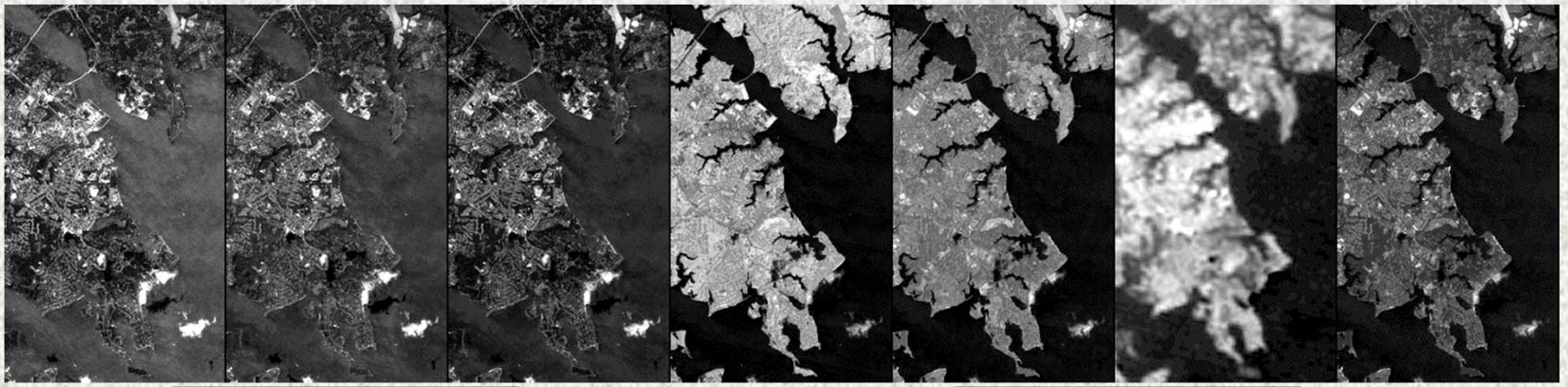
Infrared

1 2 3 4 5 6 7

3,2,1

Blue Data is shown as Blue


Visible
Infrared
1
2
3
4
5
6
7
3,2,1

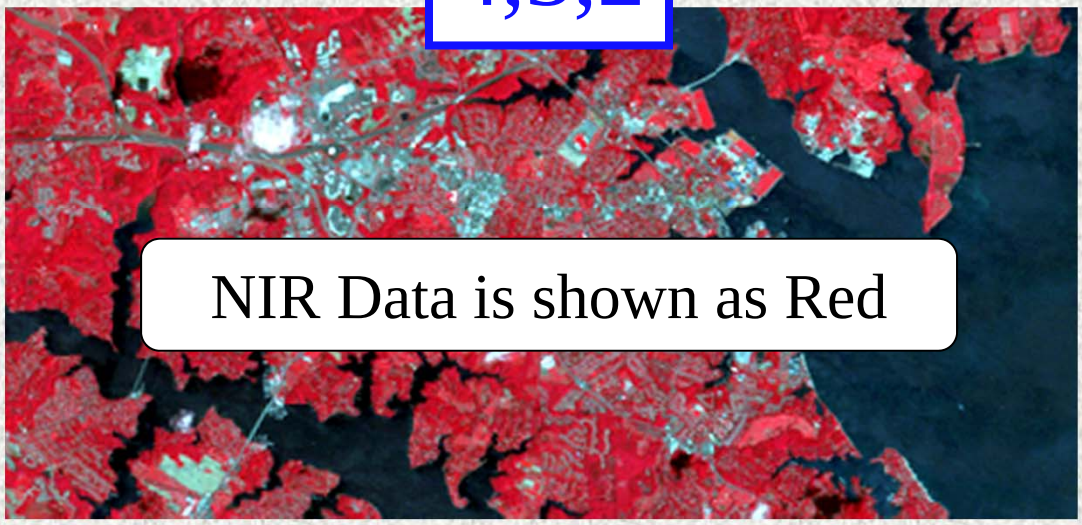


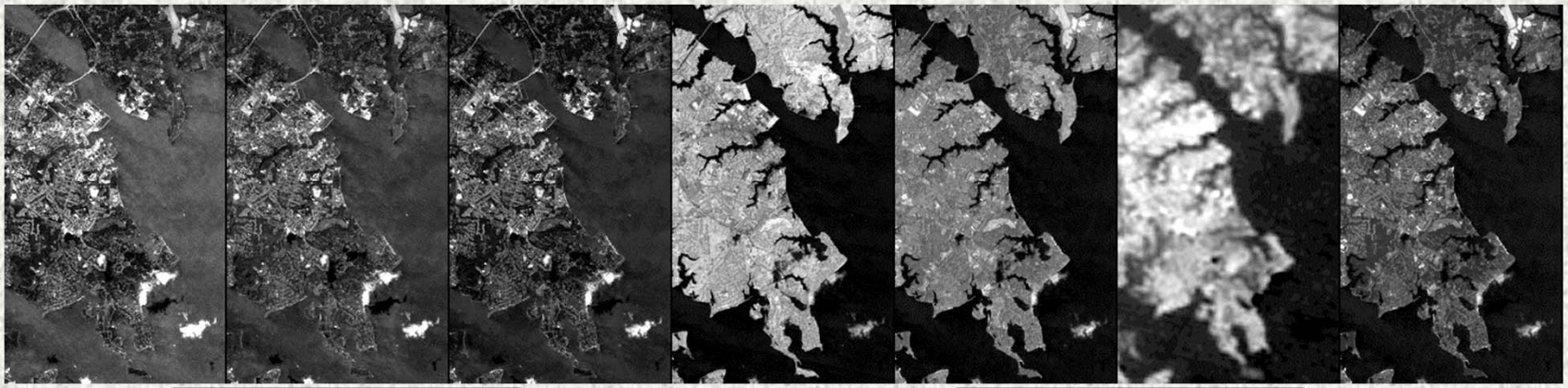
Visible

Infrared

1 2 3 4 5 6 7

4,3,2



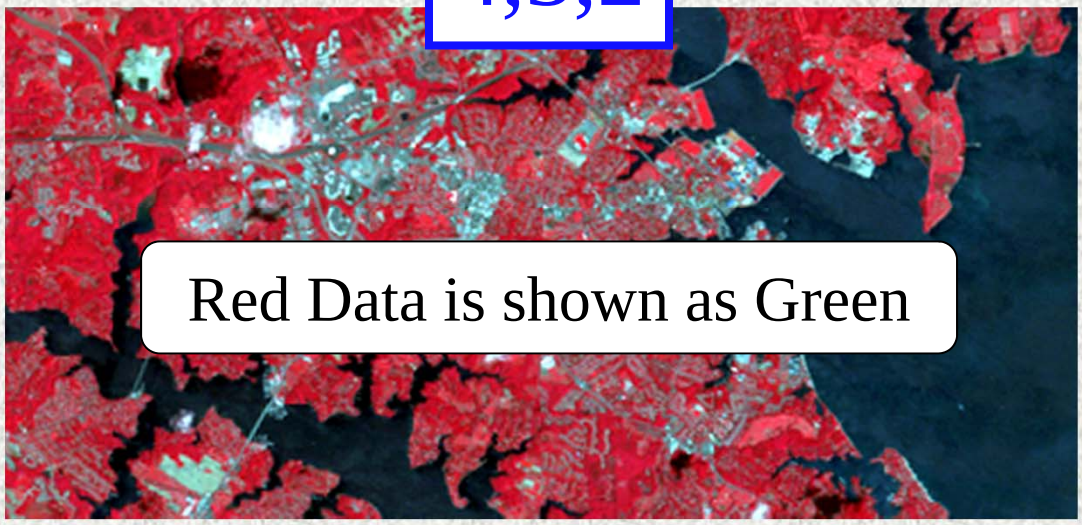


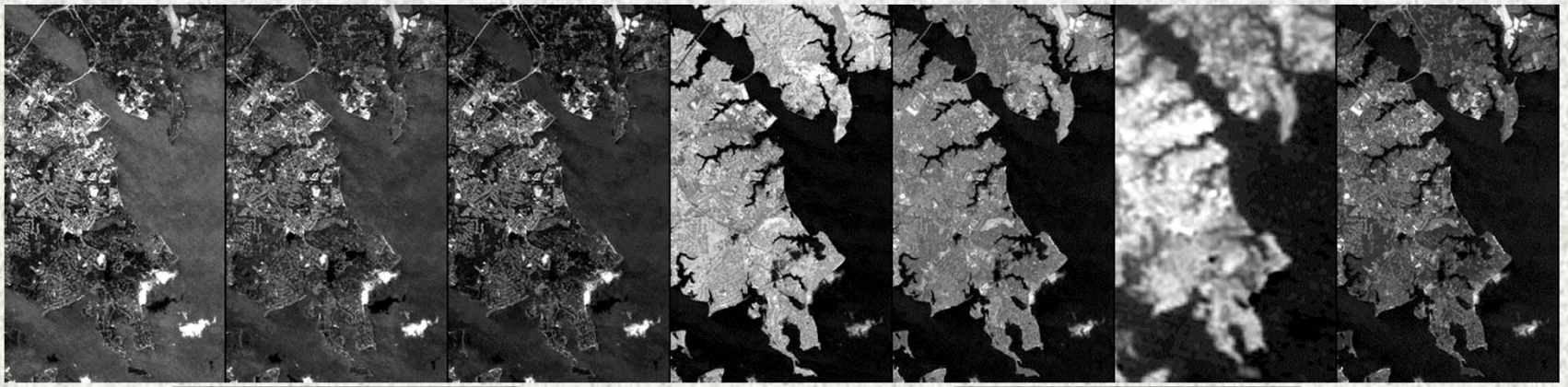
Visible

Infrared

1 2 3 4 5 6 7

4,3,2



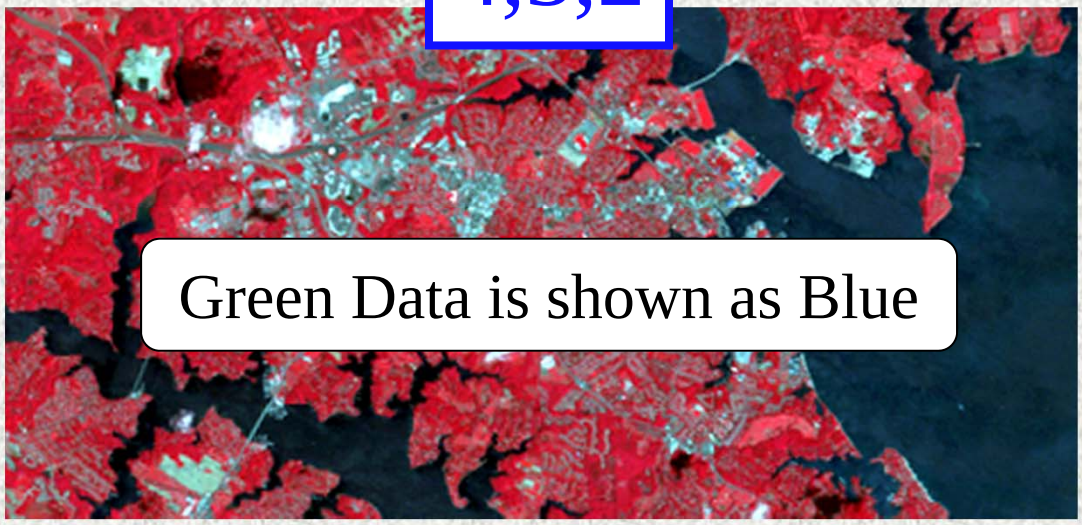


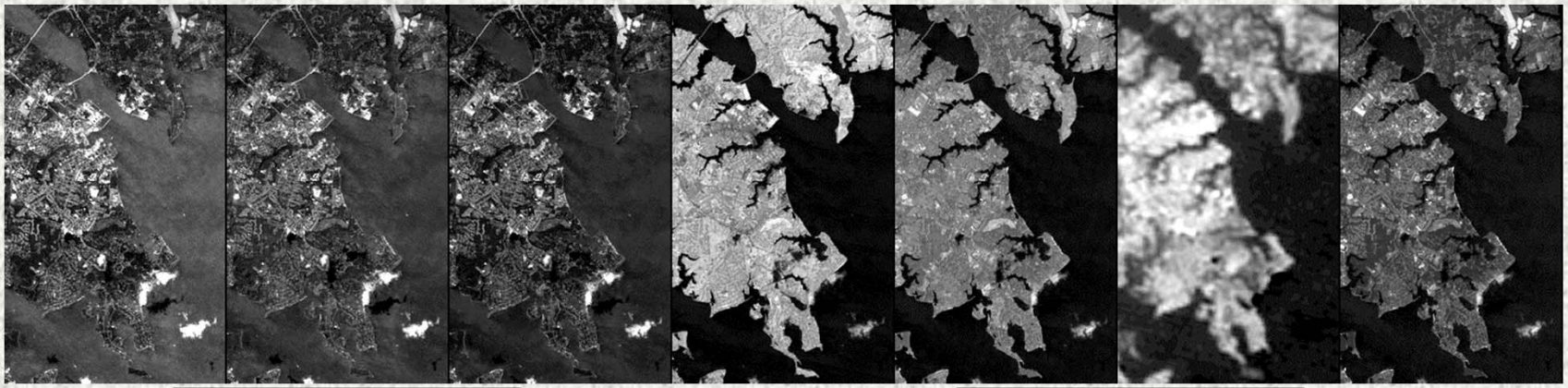
Visible

Infrared

1 2 3 4 5 6 7

4,3,2





Visible

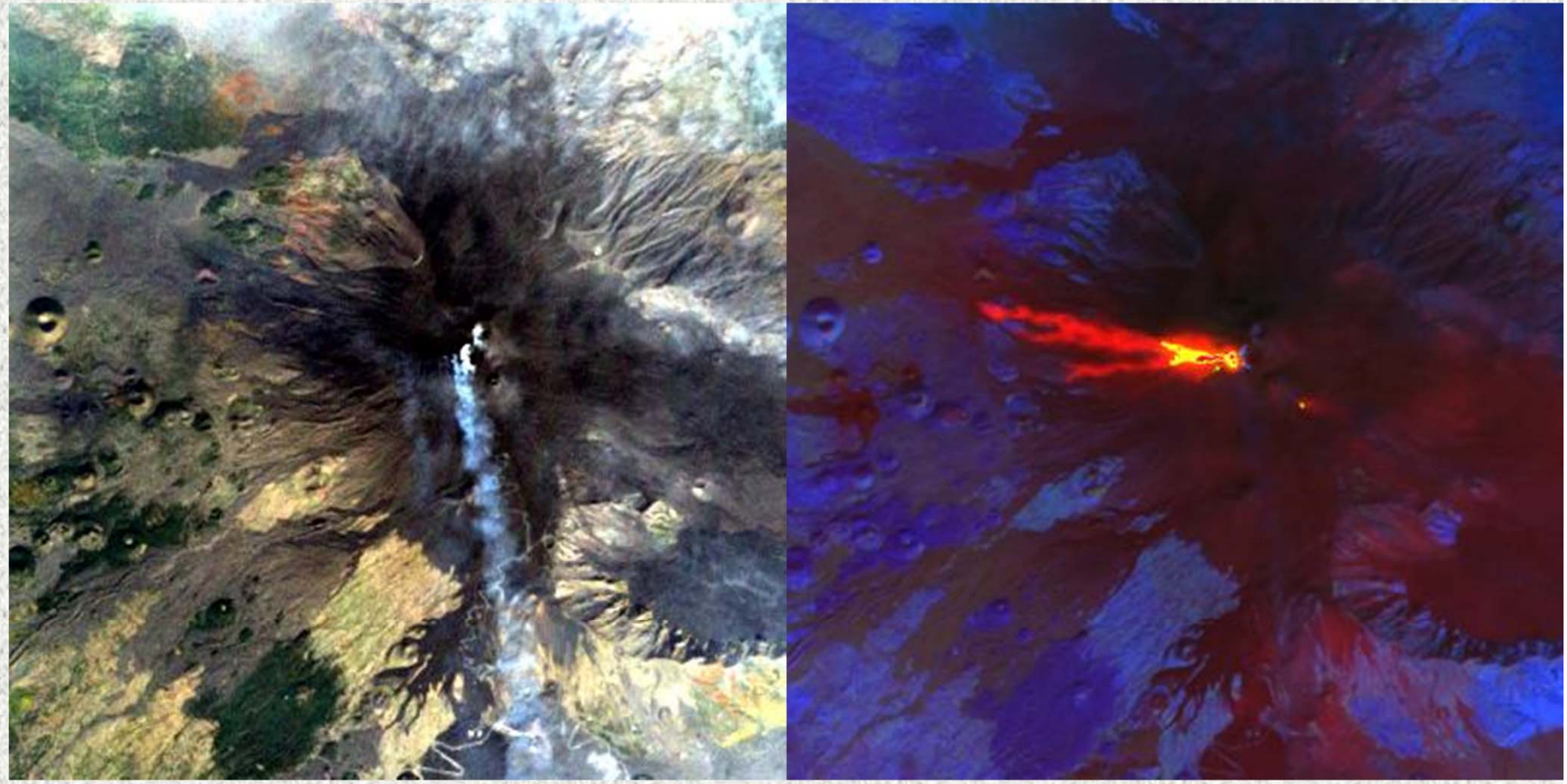
Infrared

1 2 3 4 5 6 7

4,3,2

Making images with different band combinations, we see more than we could otherwise.

Same scene, different wavelengths



Visible wavelengths

Infrared wavelengths

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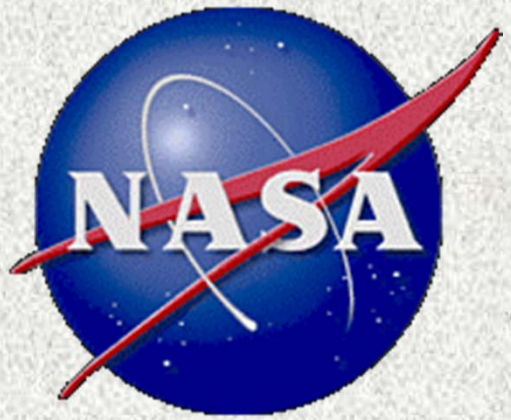


National Aeronautics and Space Administration
http://www.nasa.gov

Landsat
http://landsat.gsfc.nasa.gov
http://ldcm.gsfc.nasa.gov
http://landsat.usgs.gov
https://www.facebook.com/NASA.Landsat

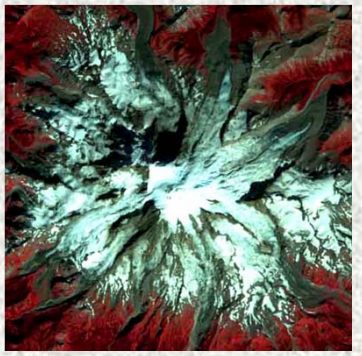
Some common Landsat 7 band combinations…

True-Color Composite (3,2,1)

True-color composite images approximate the range of vision for the human eye, and hence these images appear to be close to what we would expect to see in a normal photograph. True-color images tend to be low in contrast and somewhat hazy in appearance. This is because blue light is more susceptible than other bandwidths to scattering by the atmosphere. Broad-based analysis of underwater features and landcover are representative applications for true-color composites.

Near Infrared Composite (4,3,2)

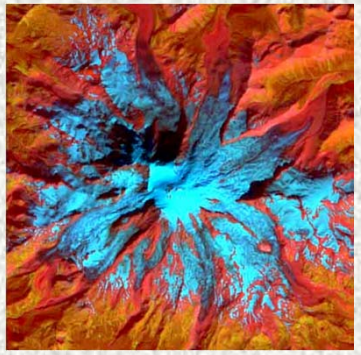
Adding a near infrared (NIR) band and dropping the visible blue band creates a near infrared composite image. Vegetation in the NIR band is highly reflective due to chlorophyll, and an NIR composite vividly shows vegetation in various shades of red. Water appears dark, almost black, due to the absorption of energy in the visible red and NIR bands.



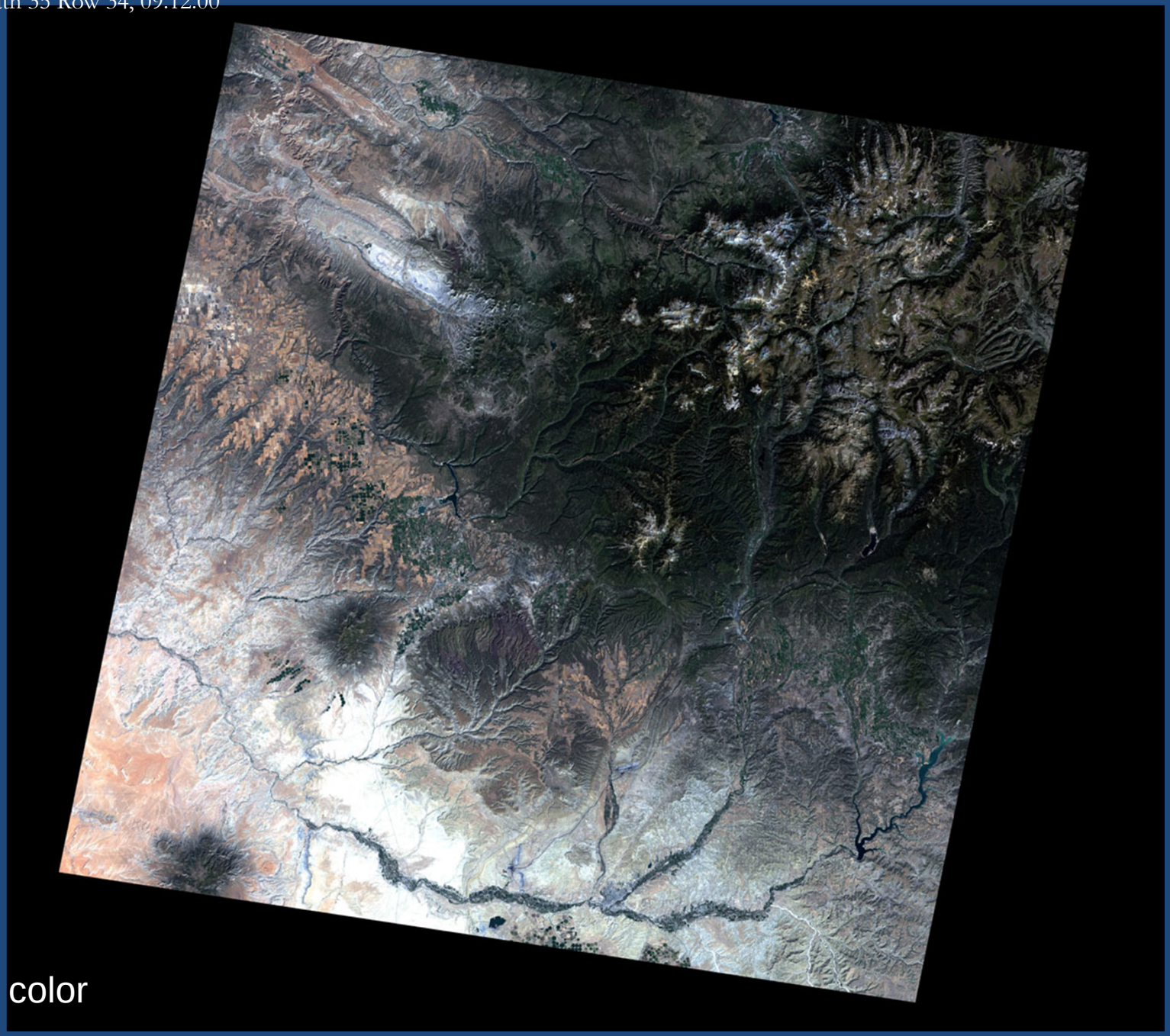
Shortwave Infrared Composite (7,4,3 or 7,4,2)

A shortwave infrared composite image is one that contains at least one shortwave infrared (SWIR) band. Reflectance in the SWIR region is due primarily to moisture content. SWIR bands are especially suited for camouflage detection, change detection, disturbed soils, soil type, and vegetation stress.

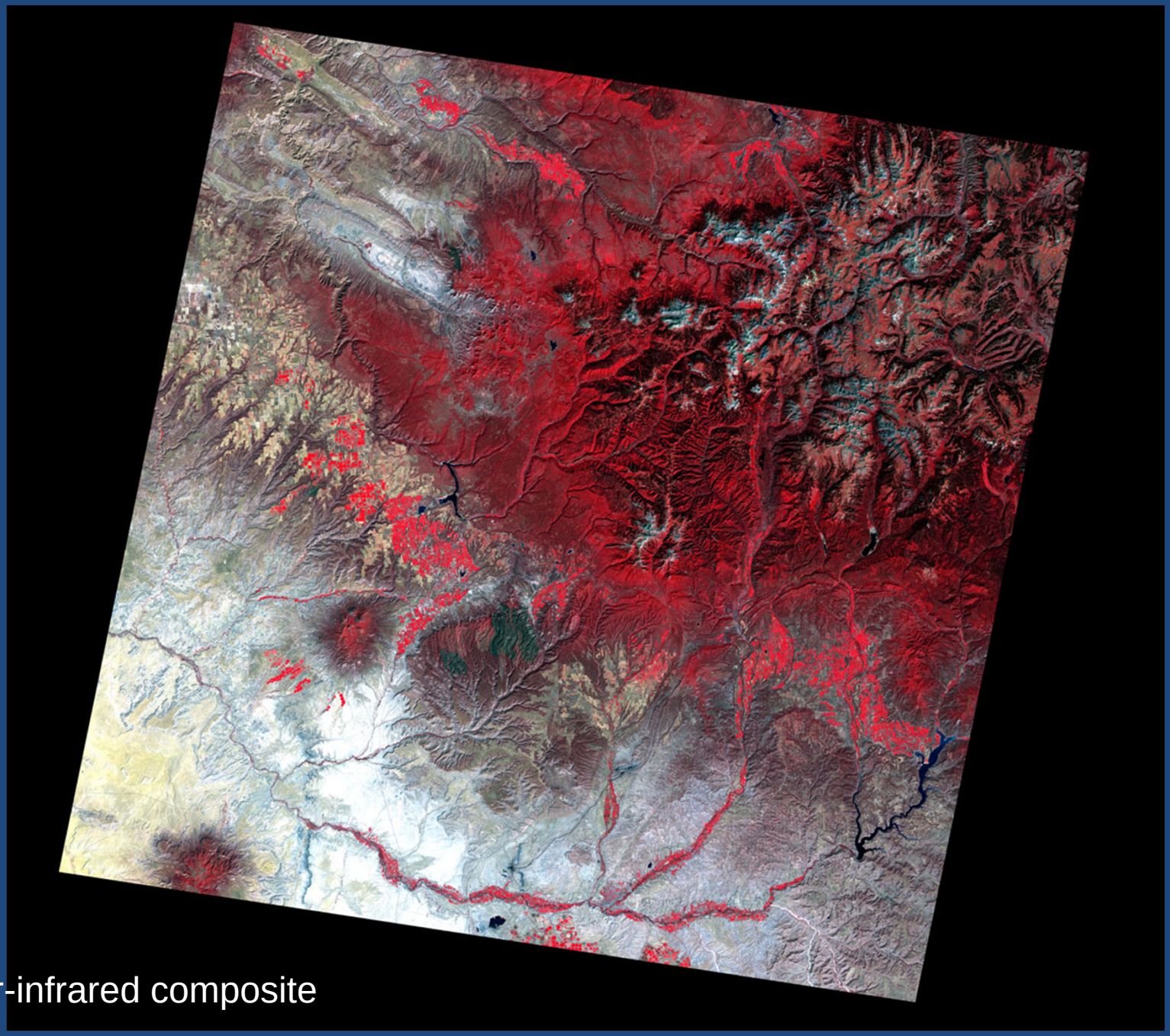
Mount Rainier



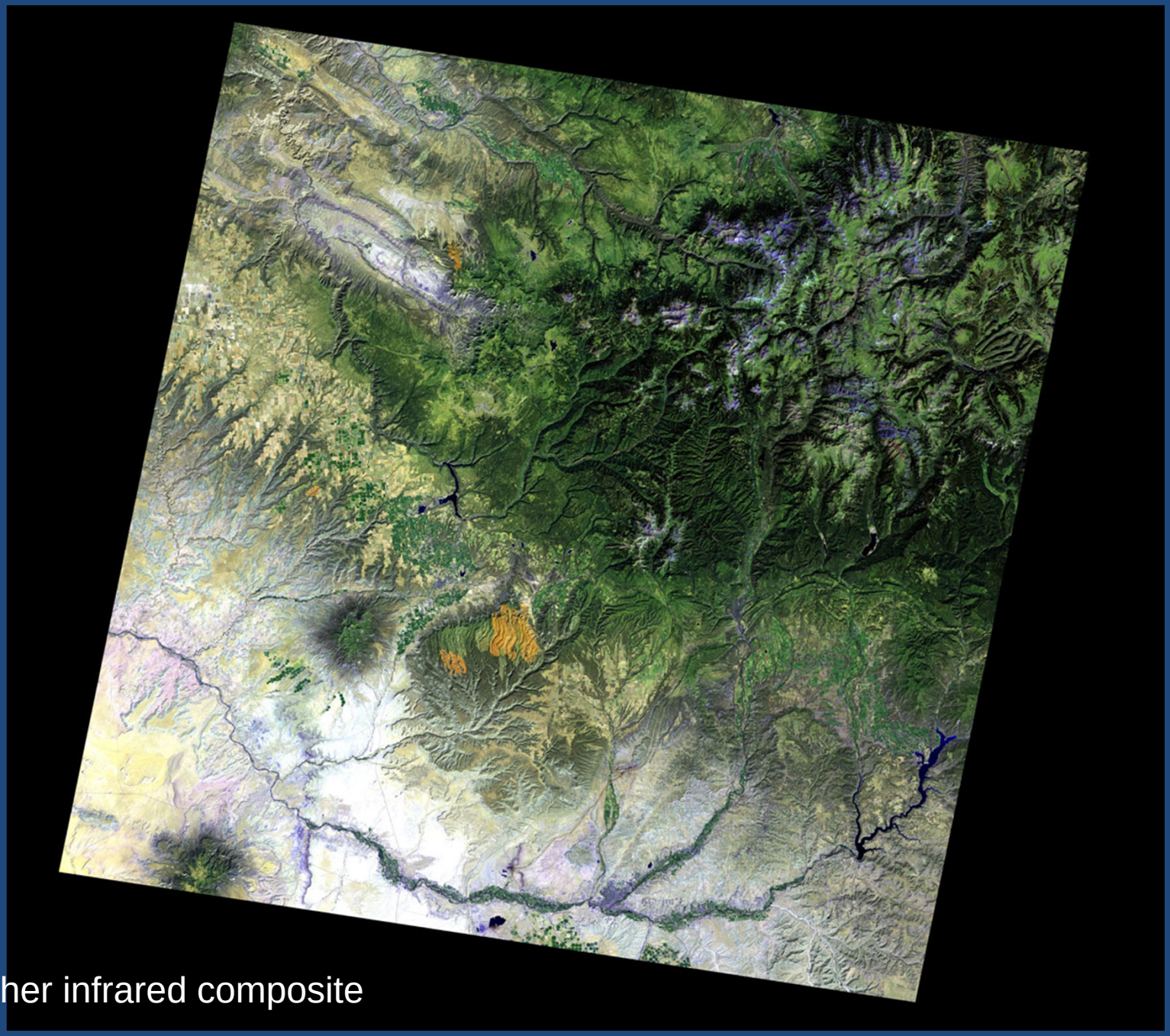
Landsat 7, Path 35 Row 34, 09.12.00



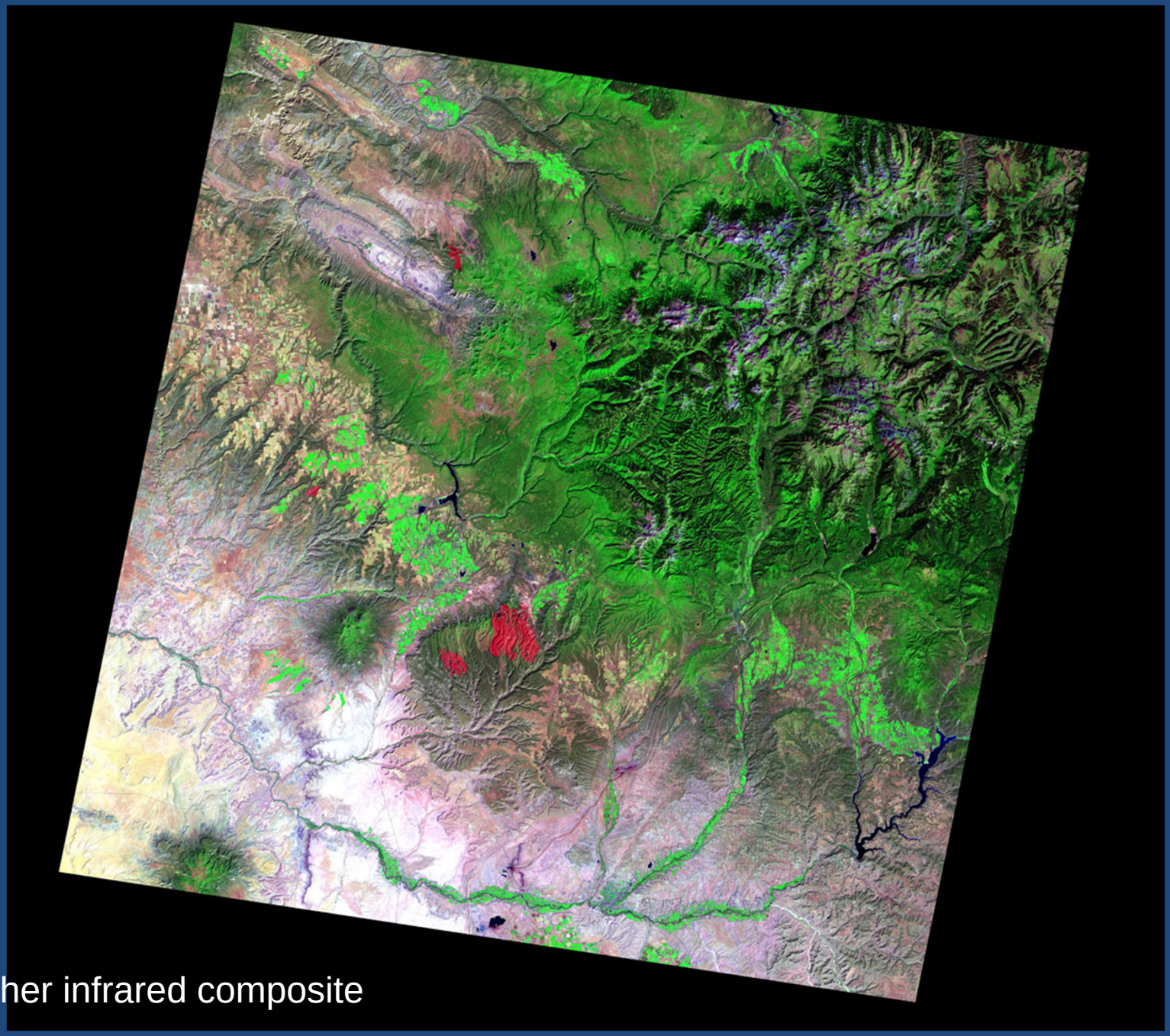
True color



Near-infrared composite



Another infrared composite



Another infrared composite

A little more to know:

The newest Landsat satellite, Landsat 8, measures the amounts of reflected light on a *finer scale* than Landsat 7's scale of 0-255.

Landsat 8 measures light on a scale of 0-1024.

With Landsat 8 we can see many more shades of the light we are measuring, and we can study greater nuance in our scenes of interest.

Landsat 8 also uses more bands of light than Landsat 7, and the band numbers are a little different.

To learn the differences between Landsat 7 and Landsat 8 spectral bands, go to this URL:

http://landsat.usgs.gov/L8_band_combos.php

What scientists & students can do with Landsat

- Learn what's behind Google Earth, and the power of data behind the imagery
- Map, analyze, and predict urban growth and impervious surfaces
- Monitor crop health
- Monitor forest health
- Measure deforestation and reforestation
- Quantify amount of land used in surface mining
- Track mountaintop removal
- Determine the extent of flood zones for emergency response and assessment of insurance claims
- Map extent and severity of forest fires
- Monitor seasonal wetlands to help predict the spread of pest-borne diseases

With Landsat, scientists can also –

- Estimate amounts of carbon stockpiled in vegetation.
- Quantify water use on specific farms and rangelands.
- Improve forest inventories to predict tree growth and product yield

Graduate students in forestry from the University of California, Los Angeles take a break from field work in Siberia.

Photo Credit: Kenneth J. Ranson