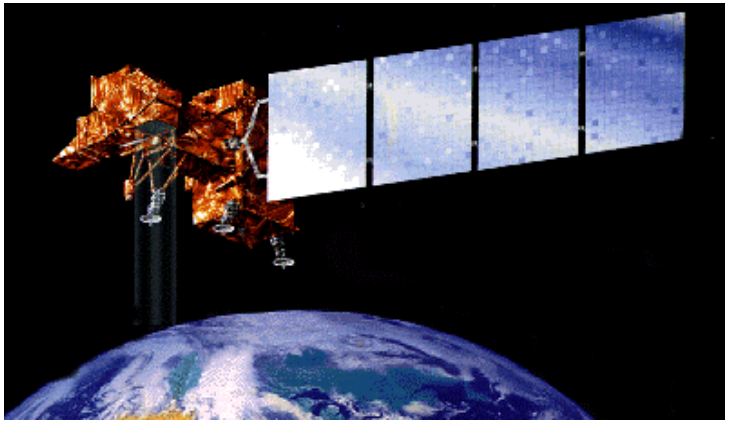


# *What's in This Presentation*

- Introduction to remote sensing
- How Landsat, a land-observing satellite, works
- How teachers and students can answer questions about nature with Landsat images

# *Remote Sensing Overview*

- **What is remote sensing?**
  - Observing or measuring things from a distance

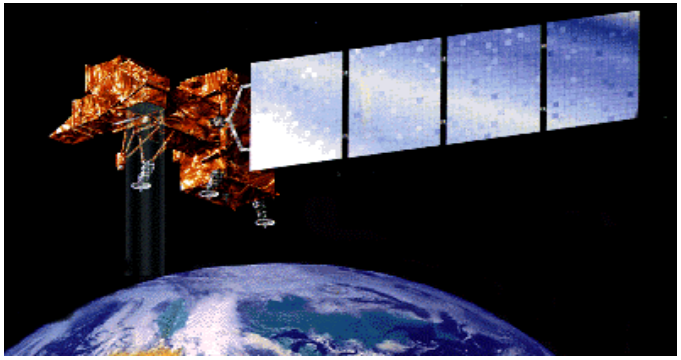
- **How is remote sensing useful?**
  - It enables us to study nature in ways that would otherwise be beyond human capability, across great distances and at wavelengths of light invisible to human eyes.

- **How is remote sensing done?**
  - By employing special detectors to record light as it's emitted or reflected by the objects of interest to us; and
  - By studying and manipulating the recorded images we get, so that we can answer our questions about nature and how people affect it.

# *What Can We Study with Remote Sensing?*

➛ **Land, air, water, rocks, living things, ice and snow**

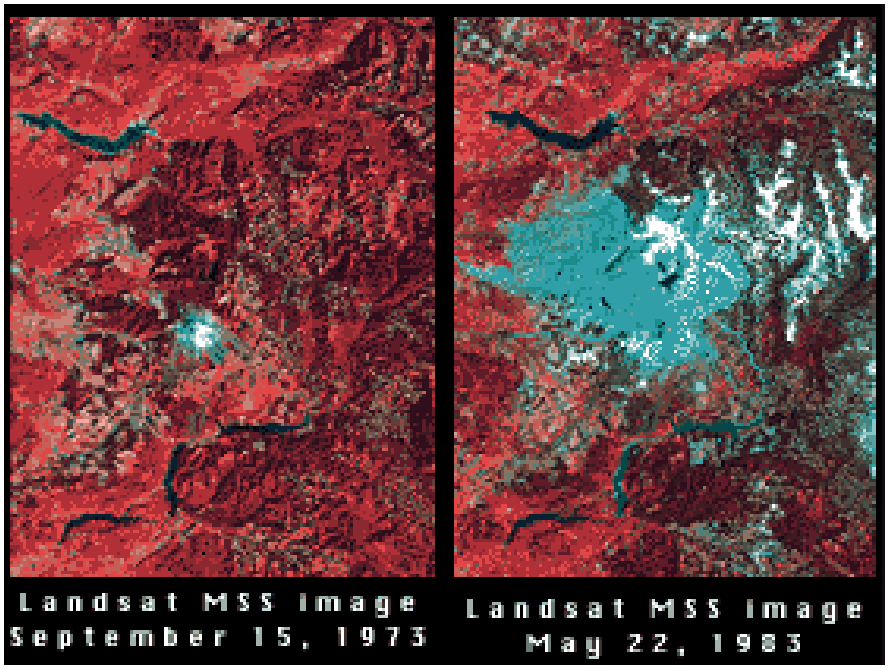
***For example:***



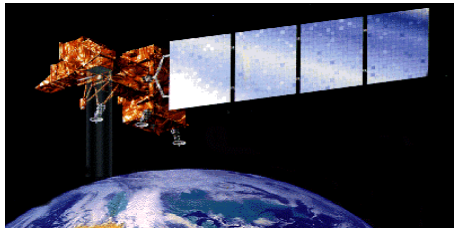
- Climate change and its effects
- Productivity of grasslands
- How human activities change land cover
- Landforms we can't see from the ground
- Photosynthesis on land and in the ocean
- Air quality: chemicals and particles (aerosols)
- The extent of natural hazards such as volcanoes, floods, and drought
- Shifting ecosystem boundaries: deserts, forests, and wetlands

# *Remote Sensing Gives Us the Big View*

- With remote sensing, charting changes in the Earth's land, oceans, and atmosphere becomes more comprehensive, easier, quicker, and often less expensive.




**These Landsat images show Mount St. Helen's before and after its 1980 eruption. The light blue in the image at upper right shows the zone of destruction to the north of the volcano's original summit.**



# *Where does remote sensing fit in the curriculum?*

♦ ***With remote sensing, we can teach —***

Agriculture, the atmosphere, biology, the carbon cycle, chemistry, Earth system science, ecology, geography, geology, global environmental change, hydrology, land use, landforms, mapping, natural hazards, oceanography (physical, biological, and geological), planetary geology, weather and climate

— *and more.*

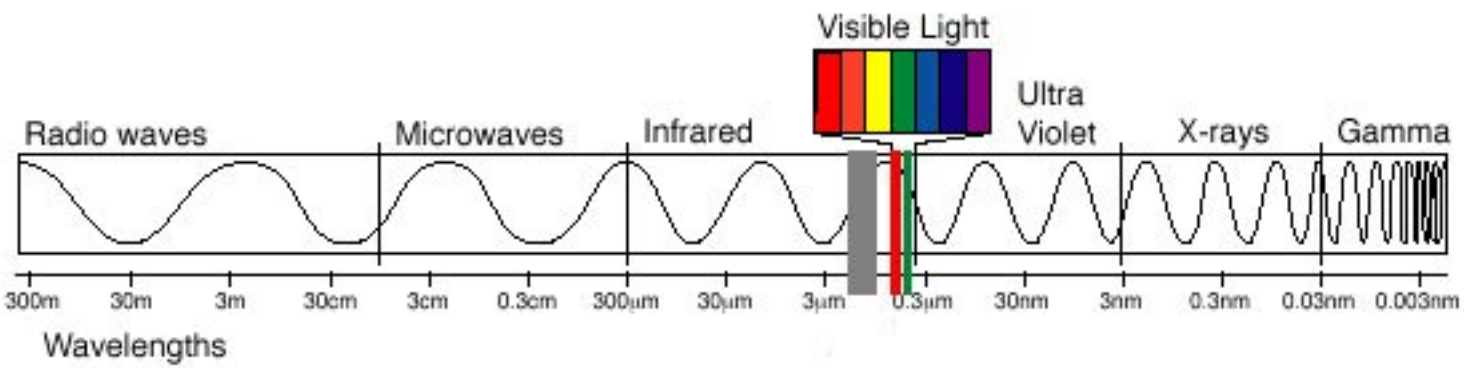
# *What can students do with remote sensing?*

## Students can…

- Study their own neighborhoods from the perspective of space
- Map urban growth
- Measure the extent of lava flows, glaciers, floods, and drought
- Describe changes in land cover over large areas
- Find forest fires, and monitor vegetation recovery over time
- Check the health of coral reefs
- Evaluate water quality in a lake
- Assess damage to a coastline after a hurricane
- Estimate plant photosynthetic activity

# *How does remote sensing work?*

## » *By sensing and measuring radiation* «




**The Electromagnetic Spectrum**

> **Remote sensing uses the radiant energy that is reflected and emitted from the Earth at various wavelengths of the electromagnetic spectrum.**

> **Our eyes are sensitive only to the *visible* wavelengths of the EM spectrum. Special sensors help us to capture the rest, and to translate it into a form we can see and understand.**

## *How can we tell what we're looking at in a remote sensing image?*

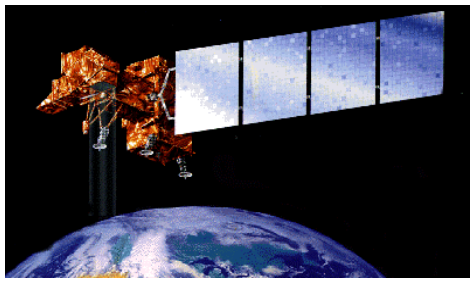
◊ Everything reflects and emits energy at characteristic wavelengths.

**We know this is Crater Lake, Oregon, not only because of its rounded shape and where the satellite was pointed when the image was made, but because we know that water looks black in this kind of image.**

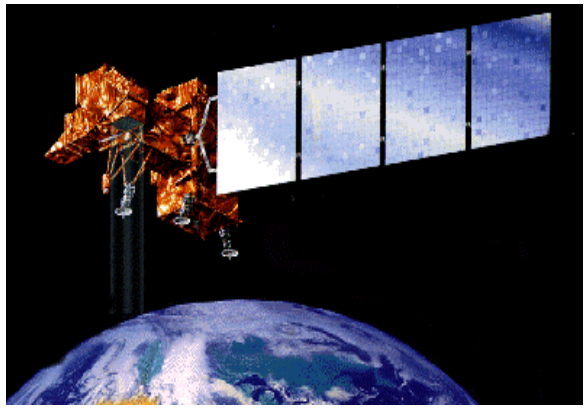
*In remote sensing images like this one from Landsat, we can learn about the Earth in useful ways. The image at right shows North Carolina's Outer Banks after a hurricane.*

# *What's special about Landsat?*

- Landsat has been observing the Earth continuously over a long period of time.
- Landsat covers all of the Earth's land surface at high resolution (captures lots of detail).
- Landsat provides affordable images for learning and teaching.



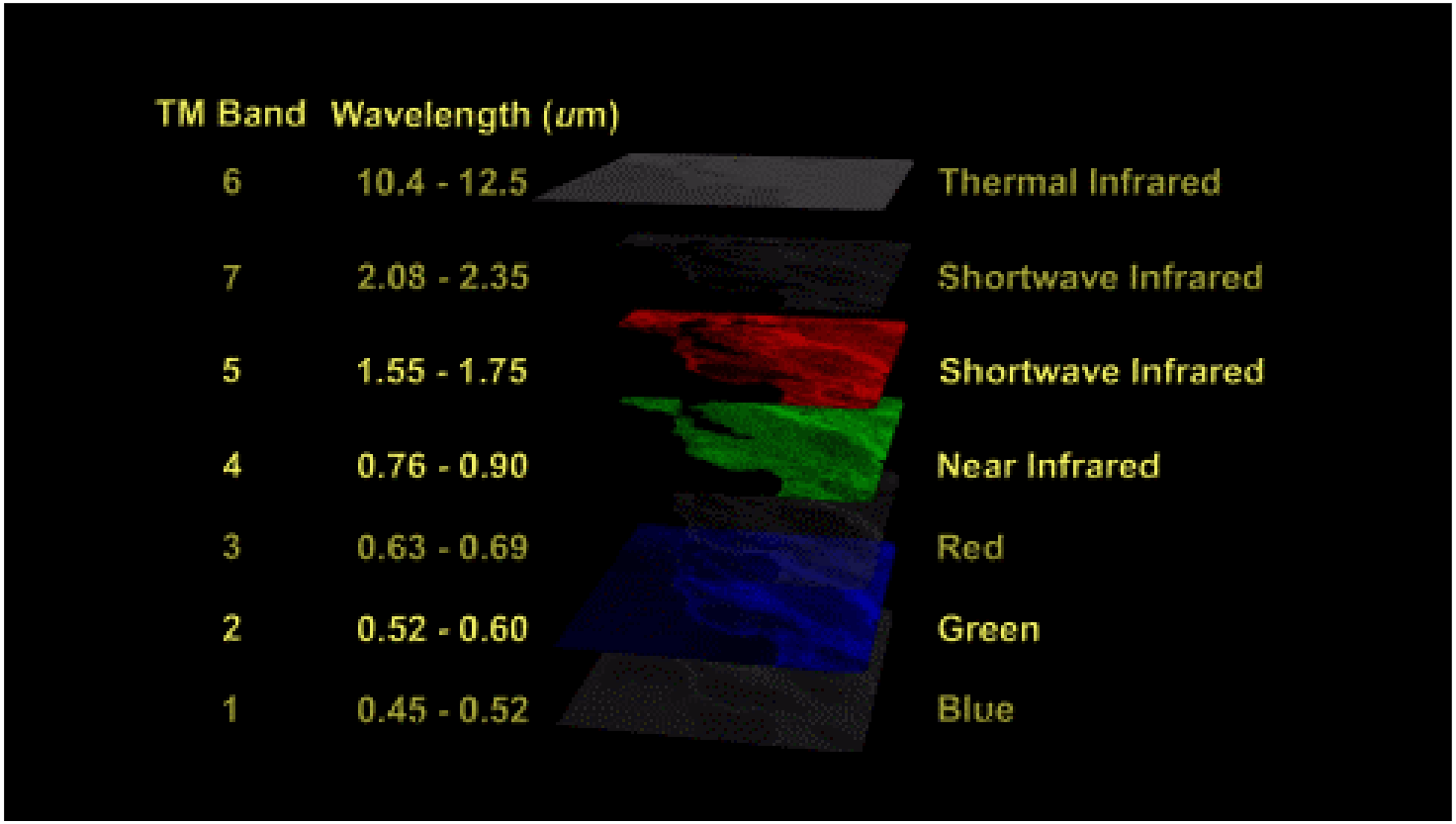
# *How Does Landsat Work?*



***Overview of the next five slides:***

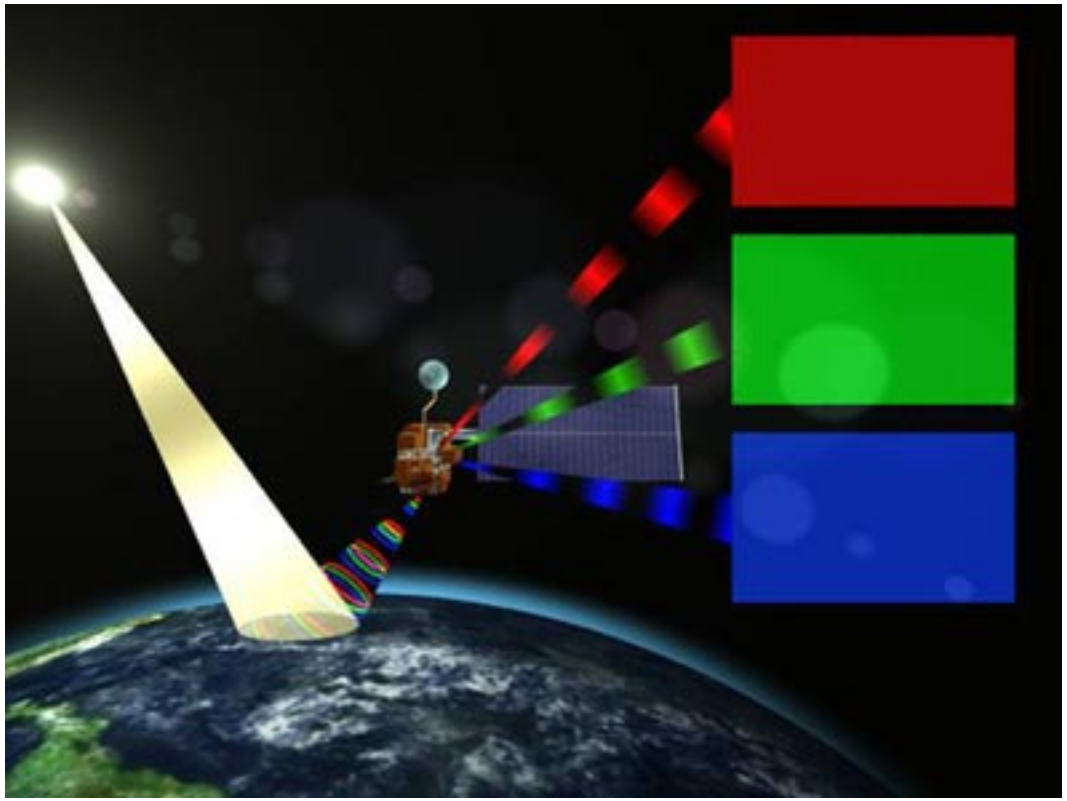
- *Landsat observes radiation at **seven wavelength ranges**, or bands, of the EM spectrum.*
- *You can display any **three** of those seven spectral bands at one time.*
- *Landsat images are made of **pixels** (picture elements).*

# *Landsat observes radiation at seven wavelength ranges, or bands, of the EM spectrum.*




**Each band is assigned a number from 1 to 7.**

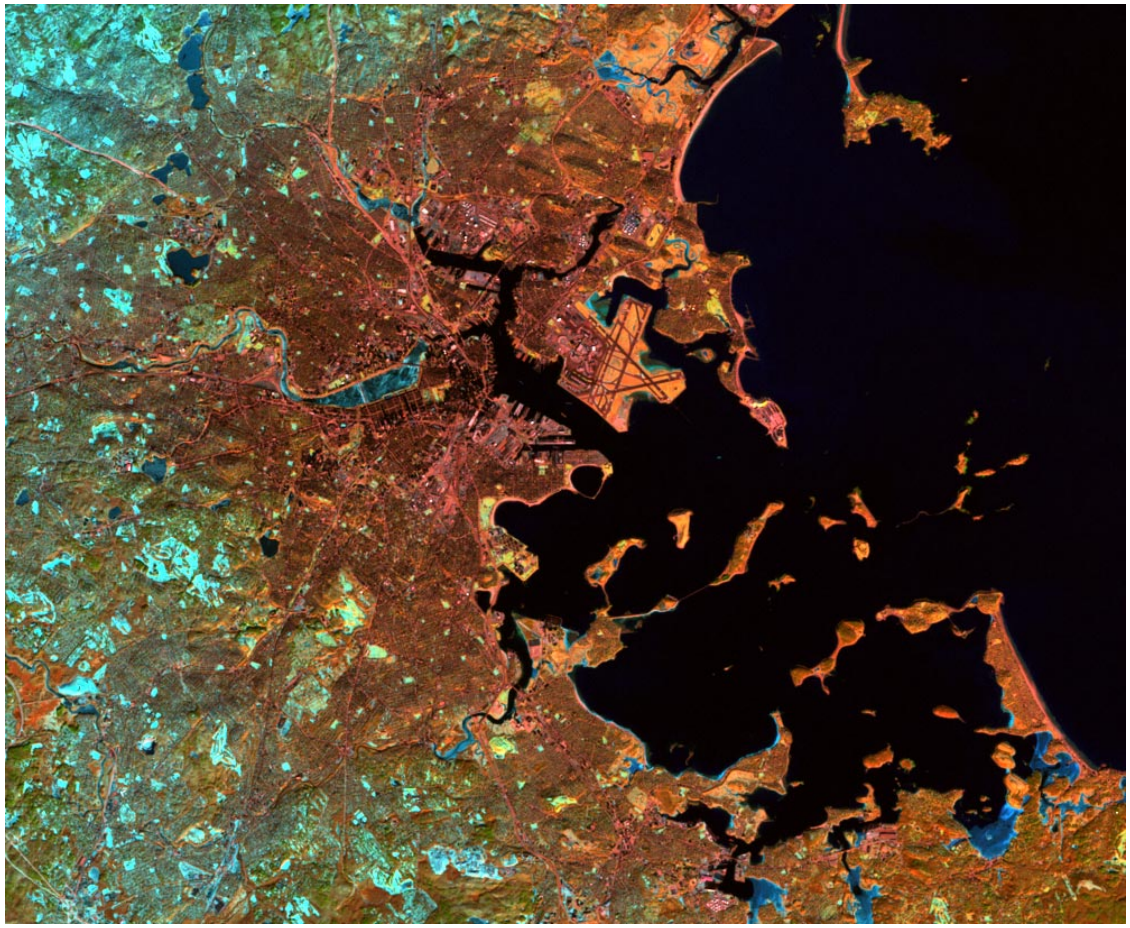
## *Each image use only <u>three</u> of the seven spectral bands. Why?*



**The human eye is not sensitive to ultra-violet or infrared light. To build a composite image from remote sensing data that <u>makes sense to our eyes</u>, we must use colors from the visible portion of the EM spectrum — red, green, and blue.**

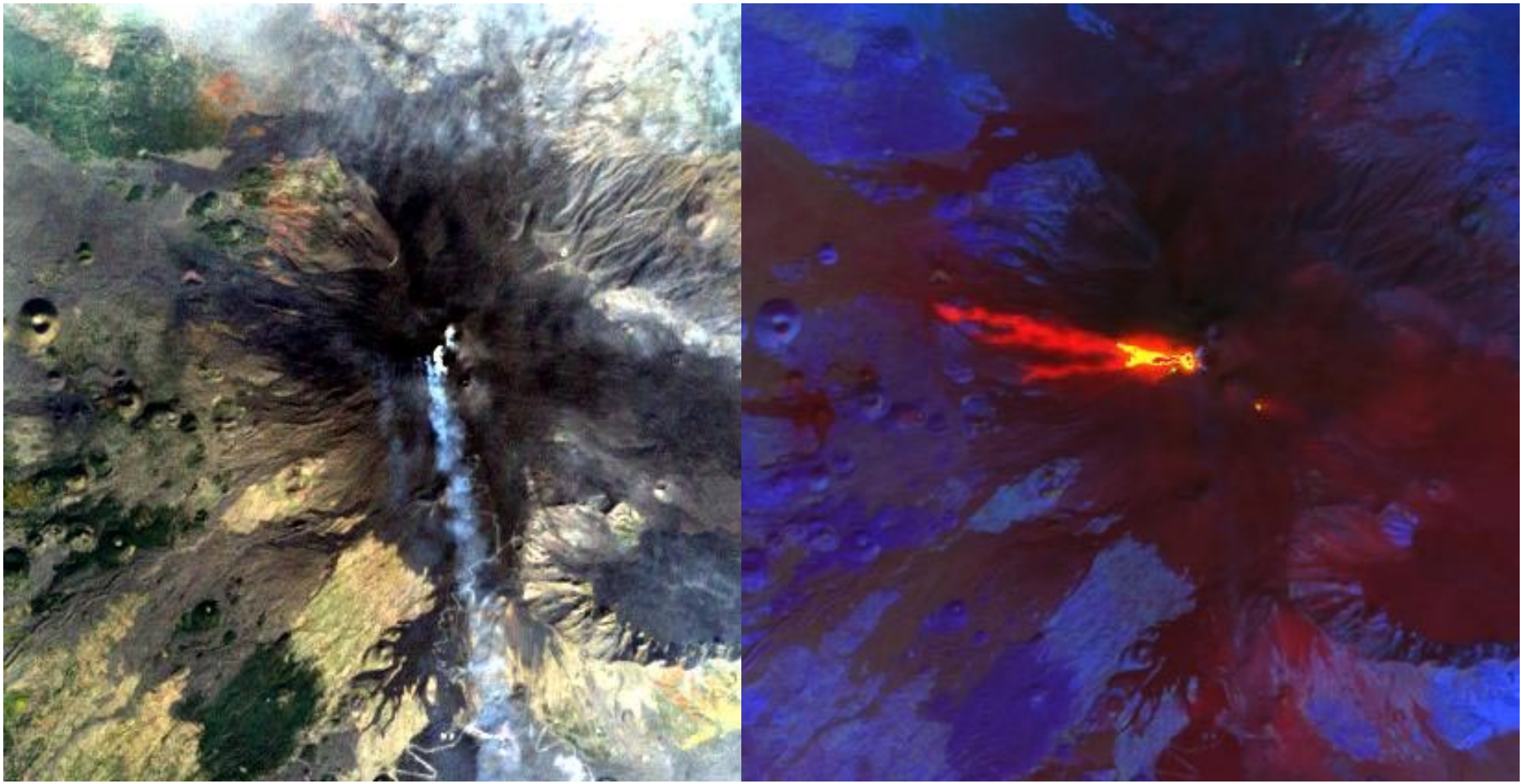
- ***People choose <u>which three</u> of the seven bands they want to use for any given image.***

There are lots of possible combinations.



***This image of Boston uses the "5, 4, 2" combination, for what appears to our eyes as red, green, and blue. What appears to our eyes as red is actually radiation in the Band 5 wavelength range; what appears to us as green is actually Band 4; and what appears as blue is Band 2.***

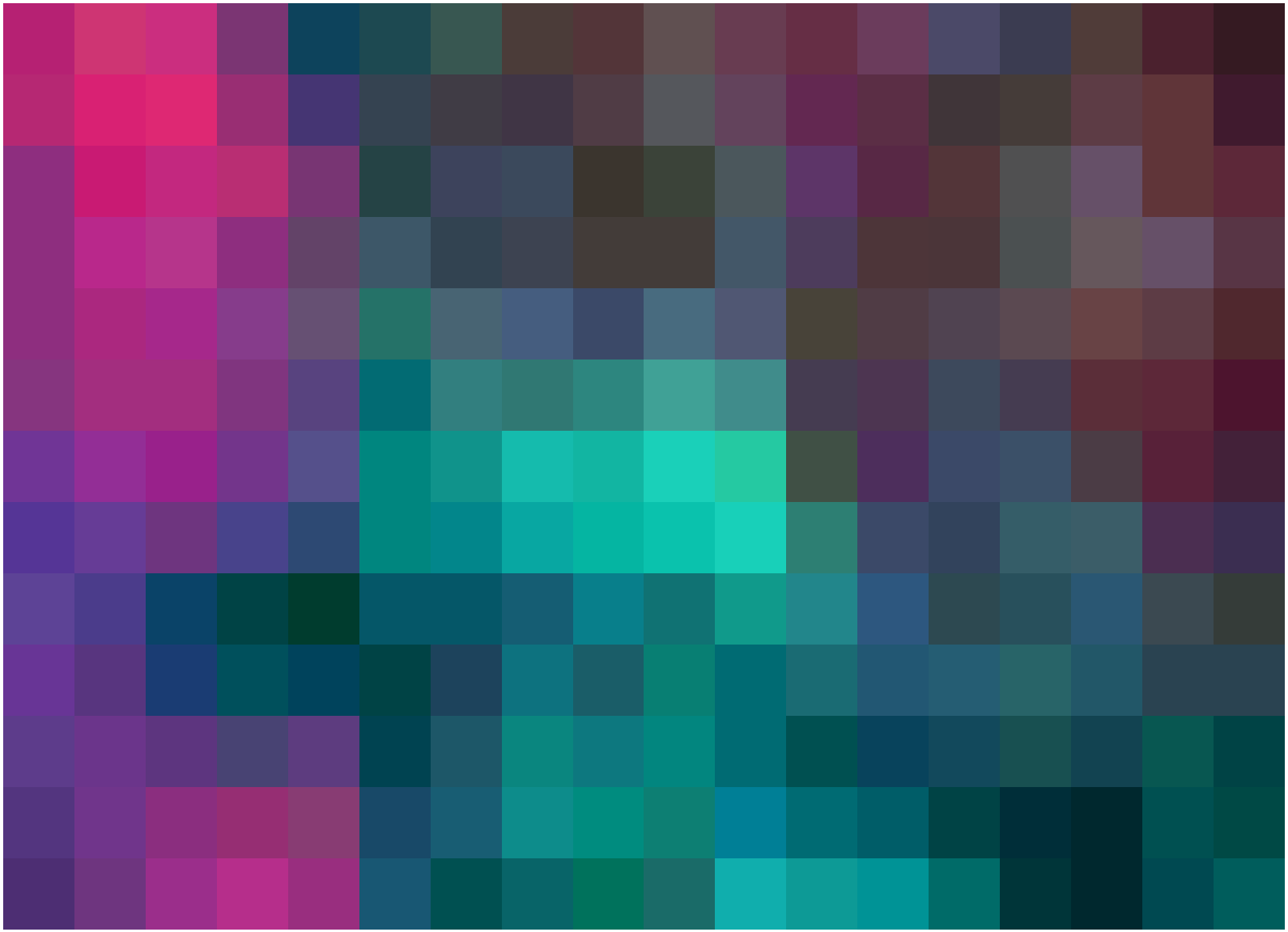
# *Different combinations of bands show different things about the land surface.*



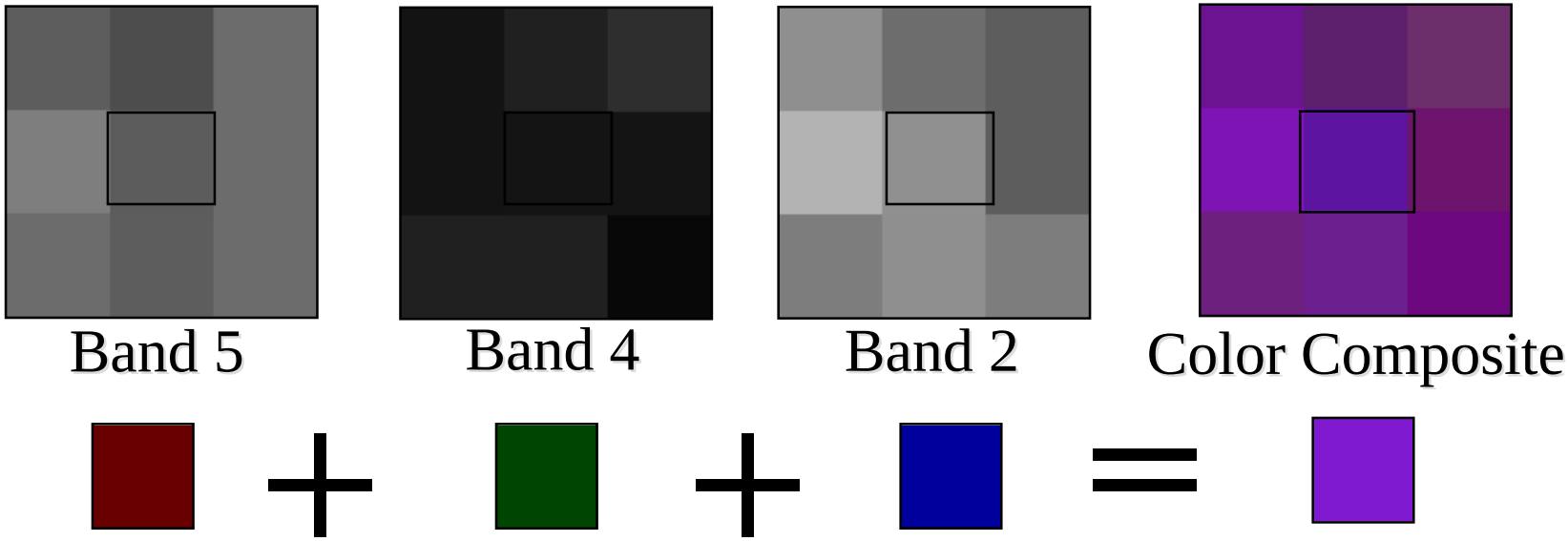
Mount Etna volcano: One set of data, two different band selections. Above left, the 3, 2, 1 band combination shows a smoke plume . Above right, the 6, 5, 4 band combination shows lava flows. Both features of the volcano are recorded in the same Landsat image, but appear best with different band combinations.

# *Landsat Images Are Made of Pixels*

*(picture elements)*

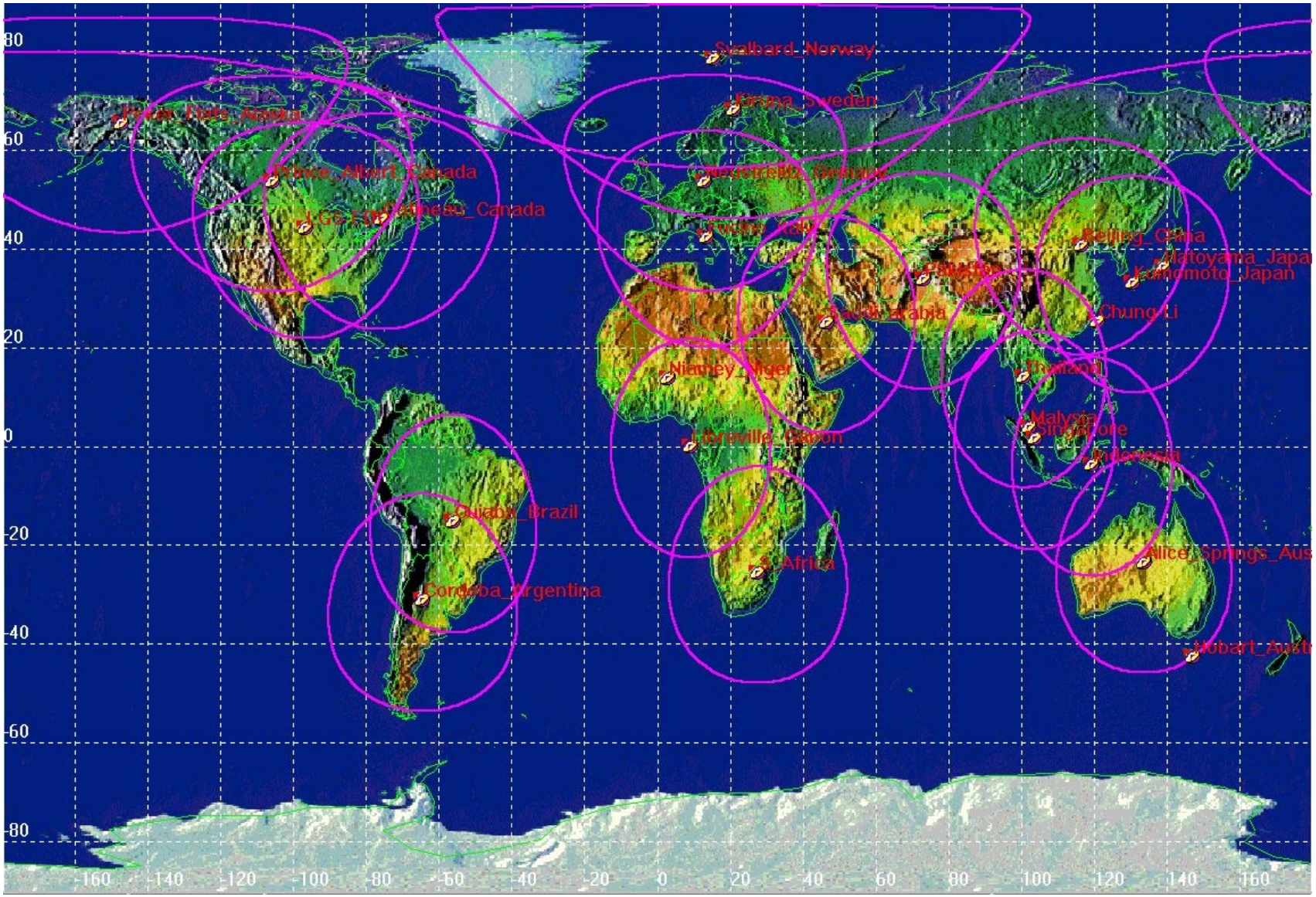


***<u>Each pixel</u> shows a <u>combination</u> of the three wavelength bands that have been selected to make up the image, just as the whole image does.***




In this particular image, **red** shows the intensity of radiation at Band 5's wavelength range; **green** shows the intensity of radiation at Band 4's wavelength range; and **blue** shows the intensity of radiation at Band 2's wavelength range. The composite blends all three. One pixel is highlighted in the center of each box for study as an example.

**Landsat data are sent to ground stations around the world, where scientists, teachers, and students can use it.**



# *Teachers and students can learn to analyze Landsat images.*

- You and your students can use Landsat to get the "big picture" and to pursue your questions about how the Earth is changing.
- To do this, you can use special software called "MultiSpec". It is available at no cost.
- When using MultiSpec for the first time, use the GLOBE MultiSpec Tutorial provided on this website.
- To download the MultiSpec software itself, go to: http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/