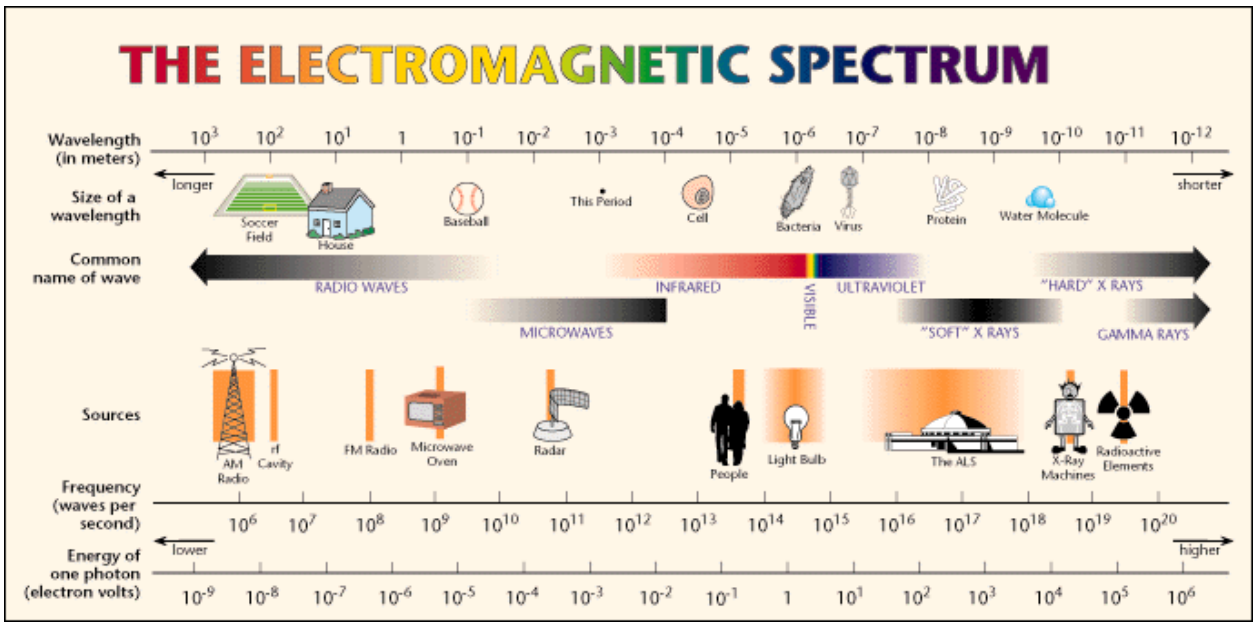
Seeing Satellite Data

Overview:

Satellites are useful for collecting large amounts of data all at approximately the same time. Satellites have sensors on them that detect Electro-magnetic energy like our eyes do, but satellite sensors can sense (or see) parts of the spectrum that human eyes cannot (like ultra-violet and infra-red). Most satellites have multiple sensors, so they can 'see' an area in different spectral bands – like if you could see blue colors with one eye and red ones with the other eye. The data gets recorded and then it must be processed so that it can be seen with the human eye.



http://www.lbl.gov/MicroWorlds/ALSTool/EMSpec/EMSpec2.html

Most scientists prefer to look at satellite sensor data in a spectrum where purple colors = low concentrations and red colors = high concentrations. Scientists prefer this type of color scheme because it gives them the best resolution – subtle differences can be detected because there is a large range in colors. However this type of data display can be difficult to understand if you're not used to looking at data this way.

Always make sure that you read the scale bar on satellite images. Sometimes the spectrum will cover all possible values (from 0 °C – 25 °C) and sometimes the spectrum only covers the range in the data set (like the red-blue sea surface temperature images).

Below are some satellite images displayed using different color palettes that may be more familiar to people. Compare the sets of images and see if that helps when you look at satellite images just in the full-spectrum display.

Sea Surface Temperature (SST)

The following images are of SST. SST is measured using an AVHRR (Advanced Very High Resolution Radiometer) sensor on a polar orbiting weather satellite. Polar orbiting satellites orbit the earth in the polar plane - meaning that they travel around the earth in a North-South orbit. Polar orbiting satellites are good for weather observations because they have global coverage and orbit the earth 14.1 times a day. Currently there are two polar orbiting satellites operated by NOAA with the AVHRR sensors on them.

The other type of satellite is a geostationary orbiter. These satellites stay above the same place at all times. These do not give global coverage, but allow for long-term, constant monitoring of an area. Geostationary satellites are used to monitor hurricanes and other large weather systems.

The AVHRR satellite sensors collect data in the infrared range of the spectrum (mainly in wavelengths of 3.7, 11 and 12 microns). Unfortunately, these do not see through clouds and we often have clouds, so we get clear images only now and then. Sometimes it is hard to tell the clouds from the ocean, but clouds are higher in the atmosphere and so are colder than the surface. They have different patterns than the ocean SST patterns, but it takes some experience before one knows the difference.

In the images you look at, see if you can tell the difference between the clear regions and the clouds. What are some of the clues that help you decide if it's the ocean or the clouds?

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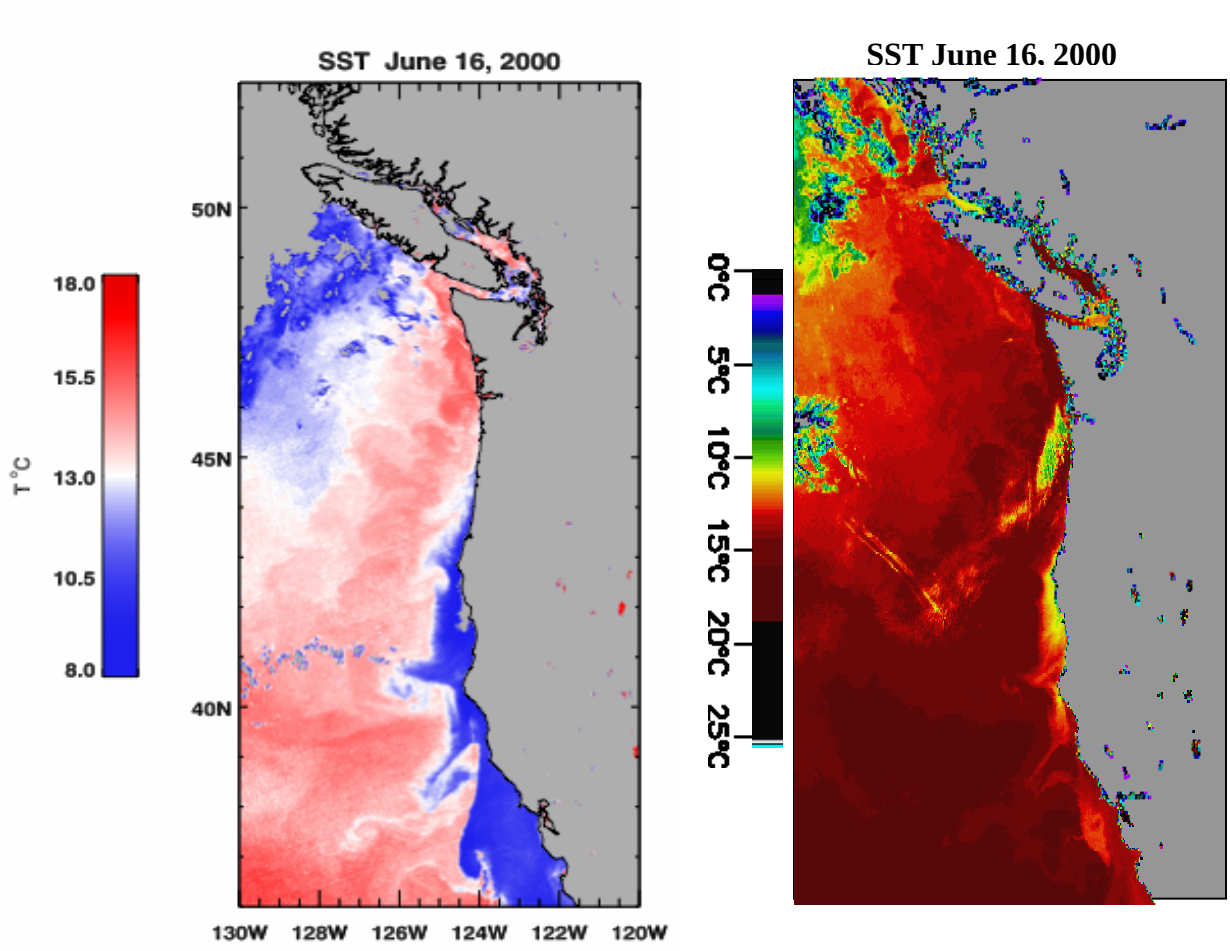
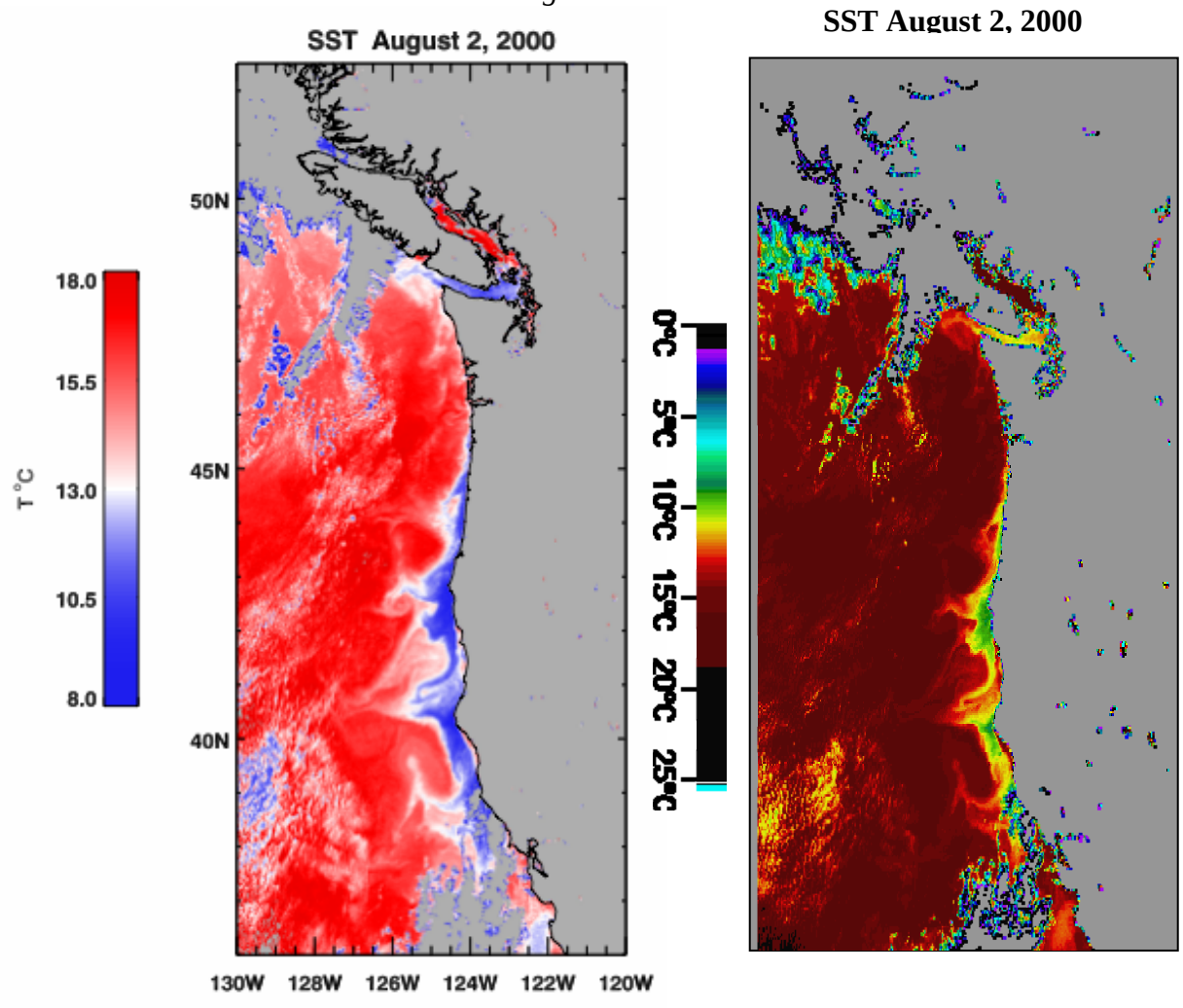


These two images are showing the same data. Why do they look so different when they're showing the same thing? They are using different scales! The image on the left is using a more familiar blue = cold, red = hot, while the image on the right is using a full spectrum image where purple = coldest and red = hottest.

Have the club members discuss reasons why they think one image is an easier representation to understand, and why the other one is harder. Why do they think that scientists prefer the full spectrum image? Does that one become more understandable after directly comparing it to the more familiar blue = cold, red = hot version? Are there any clouds in this image? How do you know?



Here's another example from later in the summer. These are exactly the same satellite data displayed using different color palettes. Are there any clouds in these images? How do you know?

Chlorophyll

Chlorophyll can be sensed by satellites too, but with a different satellite. Chlorophyll is measured with the SeaWiFS (Sea-viewing Wide Field-of-view Sensor). The SeaWiFS sensor monitors ocean color as a way to monitor changes in phytoplankton concentrations in the ocean. You can learn more about the SeaWiFS sensor at http://oceancolor.gsfc.nasa.gov/SeaWiFS/BACKGROUND/SEAWIFS_BACKGROUND.html. The SeaWiFS sensor is on a sun-synchronous polar orbit. Why would a sensor that measures chlorophyll need to be on a sun-synchronous (follows the sun) satellite? More information on the SeaWiFS sensor and the satellite it's on can be found at http://oceancolor.gsfc.nasa.gov/SeaWiFS/SEASTAR/SPACECRAFT.html.

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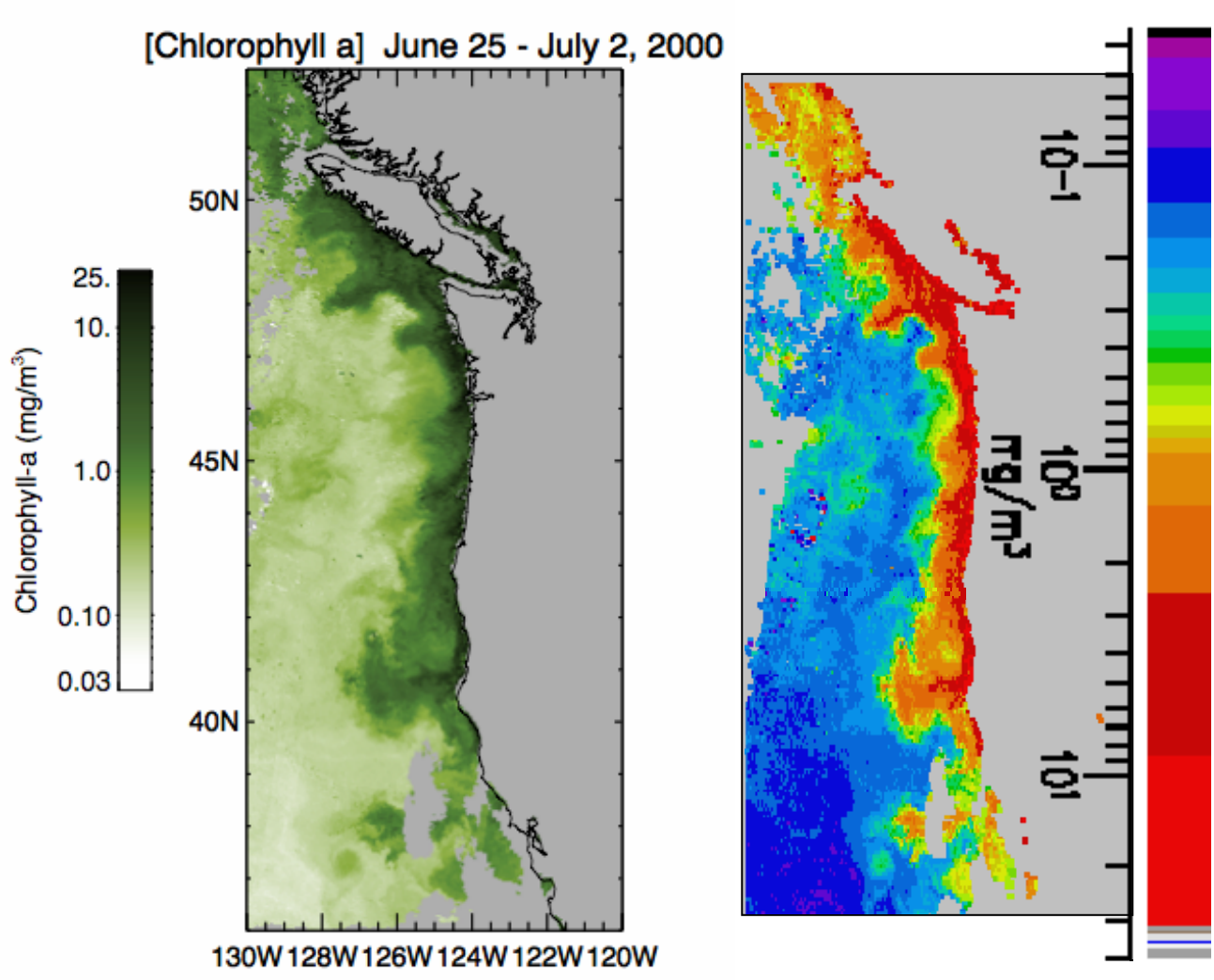
Measuring chlorophyll lets scientists monitor where phytoplankton is, which indicates where the nutrients are.



Here's the same satellite data on chlorophyll concentration in two different color palettes. The one on the left is a monochromatic scale in green where darker green = more chlorophyll and lighter green = less chlorophyll. Note that this scale is logarithmic. The image on the right uses the more standard full spectrum where purple = low concentrations and red = high concentrations. Note that this scale is logarithmic $10^{-1} = 0.1$, $10^{0} = 1$, $10^{1} = 10$.

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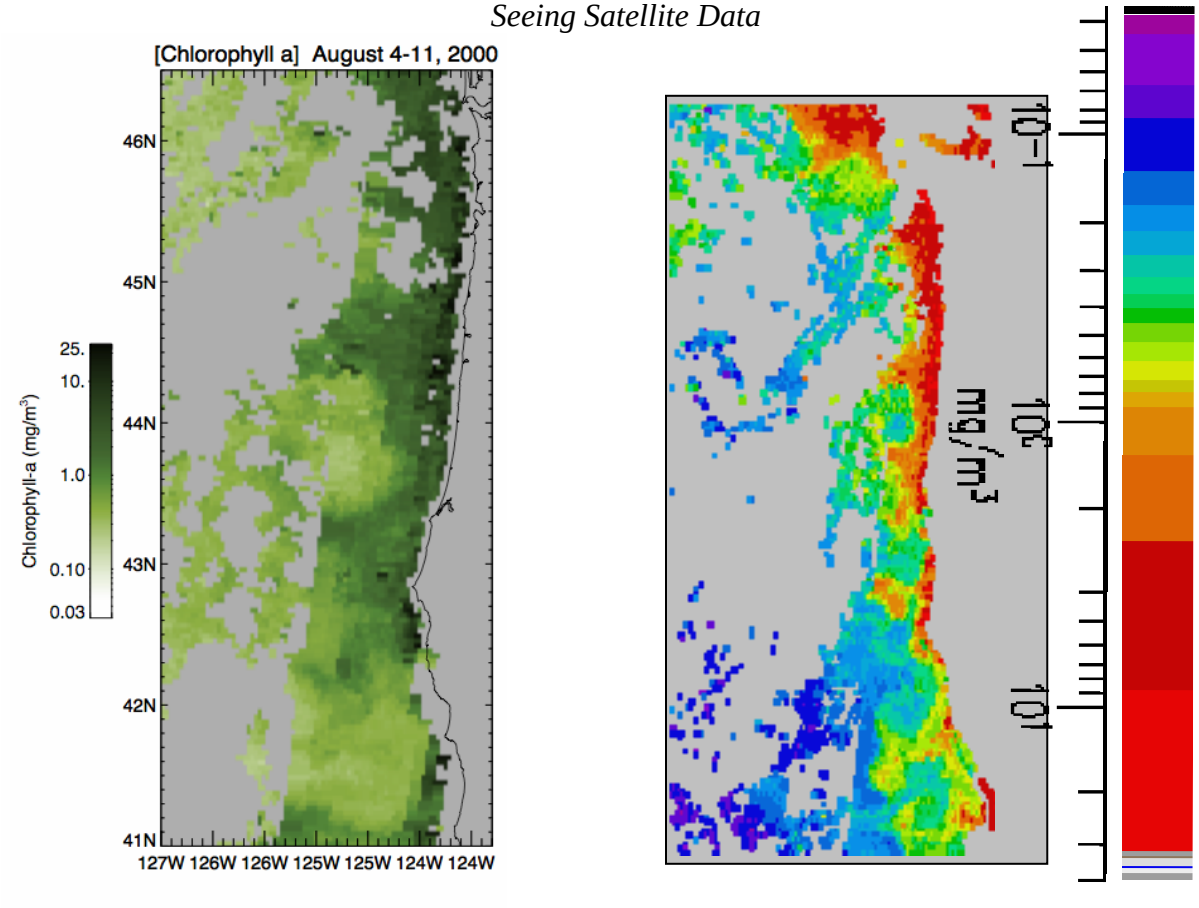

Here's another set of chlorophyll-a data using the same color palettes as the previous chlorophyll images.

Why are these data sets so patchy? (cloud cover) Notice that these images are composites of 8 days worth of data. What are the drawbacks and advantages of taking 8 day averages? The temperature images are NOT averages, but more like snapshots.

What are some advantages to using satellites to collect data? What are some disadvantages?