MODIS Lab

Biology 3380, Advanced Ecology

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2015

Scientists have access to more information today than ever before. The information comes in the form of research publications but also as research quality data. Often, these resources are free. We can therefore study just about anything we are interested in. The problem is knowing where to look and how the data may be used. The purpose of this lab is to expose you to research quality remotely sensed data.

Remote sensing consists of measurements that are taken without making physical contact with the object of interest. Radiation emitted or reflected from an object can be sensed remotely with instruments called radiometers. The characteristics of the radiation relate to the properties of the object. The longwave radiation emitted from an object relates directly to its temperature and allows for remotely sensed temperature readings with hand-held instruments. Similarly, satellite-based instruments measure properties of the Earth's surface by sensing reflected solar (short-wave) radiation.

We are concerned with satellite measurements of reflected solar radiation. Radiation is electromagnetic energy and has a range of energy levels corresponding to wavelengths (fig. 1). Solar radiation includes a range of electromagnetic wavelengths that include the visible range – violet through red.

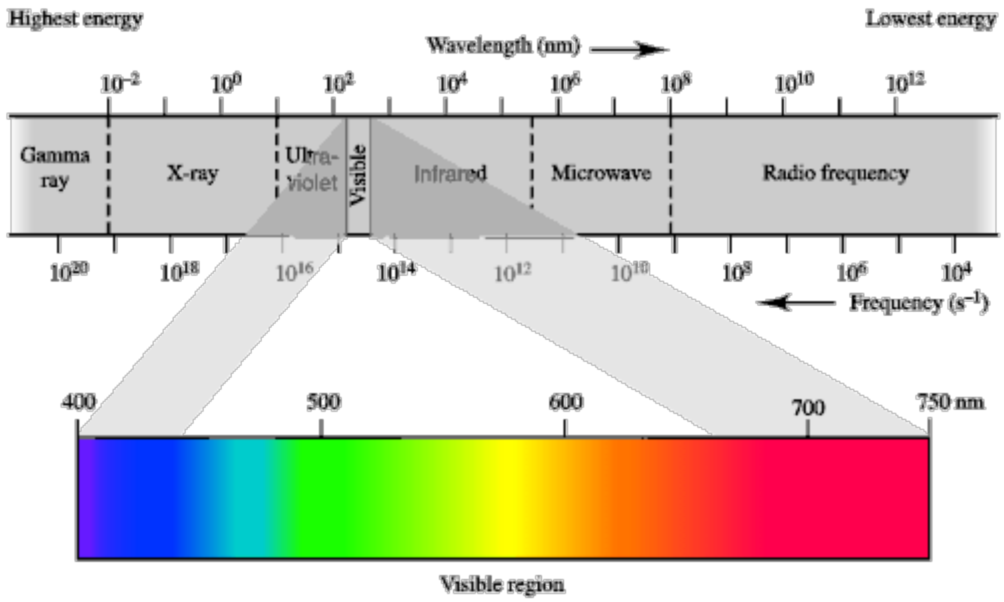

Figure 1. The electromagnetic spectrum

Solar radiation that is reflected from the surface of the Earth can be detected by radiometers on satellites. Reflected wavelengths are characteristic of the particular materials on the surface (fig. 2). The **absorption spectrum** of a material refers to its characteristic set of absorptance and reflectance across wavelengths. The green pigment (chlorophyll) in plants that is responsible for photosynthesis absorbs in the blue and red range but reflects green. The radiometer will detect reflected green from plant leaves. Chlorophyll also reflects in the near-infrared range which is slightly longer wavelength than visible red. The result in the absorption spectrum of chlorophyll is a sharp transition in absorptance and reflectance called 'the Red Edge' where red is absorbed but near infrared is reflected (fig. 2). In contrast, soil absorbs in the visible and reflects in longer wavelengths but the absorption spectrum has a more gradual transition across wavelengths compared to chlorophyll. This contrast in the absorption spectrum of chlorophyll and soil is the basis of separating reflectance signals from green vegetation and the background. Vegetation indices such as the Normalized Difference Vegetation Index (NDVI) are based on this contrast.

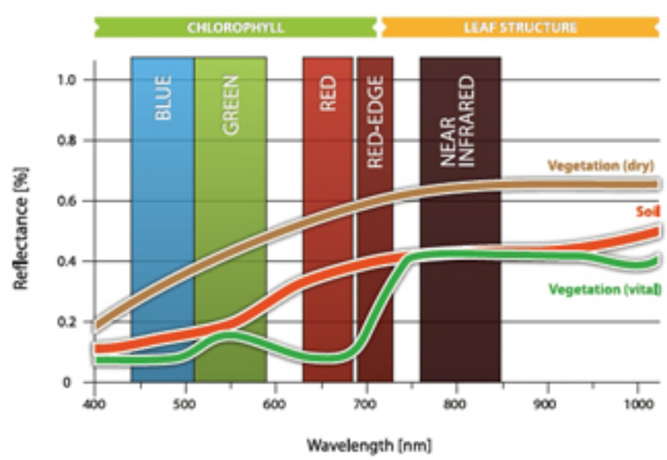

Figure 2. The absorption spectrum of vegetation and soil. Copied from https://apollomapping.com/wp-content/user_uploads/2012/07/RapidEye-Red-Edge-White-Paper.pdf

Reflectance data collected from satellites is collected the same way all over the globe which minimizes spatial variability in data quality. However, the signal is detected through the atmosphere which is not homogenous. As a result, there are many corrections applied to the data that may not be spatially homogenous. Correlations of vegetation indices to leaf area and chlorophyll amount are not perfect but there are steady improvements because this is an active area of research. As the process improves, the estimates should become more reliable with time.

In this lab we will access remotely sensed data that has been modified to generate an index of vegetation (NDVI and EVI). NDVI is (NIR-RED)/(NIR+RED) where NIR is the near infrared reflectance of the land area and RED is the surface reflectance of the red wavelength. Other vegetation indices have been generated due to specific issues with NDVI but there is no silver bullet so far. For the purposes of learning how to access this type of data and getting an idea of how sensitive it is, NDVI will suffice in this lab. If you are interested in using remotely sensed data in the future for research, it is necessary to gain more of an understanding of the technique. The MODIS website has a lot of information and there are courses in Remote Sensing offered in the Geography Department. This lab is merely an introduction.

Your project in this lab is to access NDVI data from the MODIS data set available from the Oakridge National Laboratory. You will pick a location and generate a hypothesis on how you would expect the NDVI to change over time – seasonally or over some period where you know there has been a change in the vegetation due to large scale activities such as construction, volcanic events, fires, etc. You will then access the remote sensing data and test your hypothesis. You will have two weeks to submit a formal lab report that should be approximately 6 pages in length. Please see Lab Report Guidelines posted on Blackboard. Data can be accessed here:

http://daac.ornl.gov/modisglobal