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Spectral Reflectance

Introduction

Remote sensing is based on the measurement of reflected or emitted radiation from different bodies. Objects having different surface features reflect or absorb the sun's radiation in different ways. The reflectance properties of an object depend on the particular material and its physical and chemical state, the surface roughness as well as the geometric circumstances. The most important surface features are color, structure and surface texture. These differences make it possible to identify different earth surface features or materials by analysing their spectral reflectance patterns or spectral signatures including water, snow, vegetation and the ground itself. The spectral characteristics of vegetation vary due to a compound in leaves called chlorophyll which strongly absorbs radiation in the red and blue wavelengths but reflect green wavelength. The internal structure of healthy leaves act as diffuse reflector of near-infrared wavelengths. Measuring and monitoring the infrared reflectance is one way that scientists determine how healthy particular vegetation may be. The majority of water on the other is not reflected but is either absorbed or transmitted. Longer visible wavelengths and near-infrared radiations are absorbed more by water than the visible wavelengths making water appear to be blue or green. On the other hand the majority of radiation on a surface is either reflected or absorbed and very little is actually transmitted. The characteristics of soil that determine its reflectance properties are its moisture content, texture, structure iron-oxide content. The soil curve shows less peak and valley variations and the presence of moisture in soil decreases its reflectance.

This lab is specifically designed to look at and go over five various spectral reflectances that occur regularly around the world: water, snow, vegetation and the ground itself. The lab requires that we compare these reflectance information and attempt to make observations as to why they appear on the graph in their respective positions.

Methods

During the course of this lab it was the goal to become more familiar with ENVI functions, including opening up multiple views, linking views and changing RBG combinations. To further our understanding and learn how to collect, view and export Spectral Profiles in ENVI as well as be able describe spectral reflectance curves for common materials. As with all labs we first had to set-up our workspace folder to prepare for the task ahead. Once this was done we began the process of taking a look at the various image window views including how to map link two or more images together. After becoming more familiar with the general overview of ENVI we created our first false color composite. For the first false color composite we used “MtShata_2015.dat” data and the Data Manager menu appeared allowing us to select NIR, Red and Green. This displayed the same Landsat image as a false color composite, with near infrared displayed in red, red displayed in green and green displayed in blue. This is a traditional band combination which is useful in seeing changes in plant health, however, because of our desire to see specific spectral comparisons we needed to change the RGB bands to band 6, 5, and 4 where vegetation looks green, bare ground appears reddish and snow appears bright blue (Fig. 2). With the map showing what we want it was time to collect the spectral profiles of water, snow, vegetation and the ground itself. This was done by clicking the Spectral Profile icon on the toolbar or select Display → Profiles → Spectral from the menu bar. Since we were collecting multiple profiles we labeled each of our profiles and created a legend. After all was said and done we did a little bit of formatting (resizing font, labeling Y axis, and changing the background) and then exported the spectral profile plot.

The data that was used originated from a compressed zip file, but the actual data that was utilized was in a “.dat” file. A file with the DAT file extension is usually a generic data file that stores information specific to the application it refers to. Sometimes you'll find them by themselves but often they're with other configuration files. Simply put, DAT files contain data in text or binary format. With that in mind, the file that we worked on was something very similar to a satellite image which allowed us to easily manipulate it to make certain structures more prominent than others. However, this was only possible because the data retrieved was placed in a “.dat” file.

Discussion

For vegetation the reflectance is low in both the blue and red regions of the spectrum, due to absorption by chlorophyll for photosynthesis. It has a peak at the green region. In the near infrared (NIR) region, the reflectance is much higher than that in the visible band due to the cellular structure in the leaves. Hence, vegetation can be identified by the high NIR but generally low visible reflectances. Its curve spikes around 0.8 due to the fact that chlorophyll is unable to absorb large amounts of the spectrum in that area present, but then steadily drops off until it gets close to zero. The reflectance of bare ground generally depends on its composition, however, in general the reflectance increases with increasing wavelength and whether or the soil is damp. This can clearly be seen in its curve where it steadily becomes higher in reflectance and then levels out. Water is generally low, however, the reflectance is maximum at the blue end of the spectrum and decreases as wavelength increases. The curve shows a continuous drop to zero once out of the lower wavelengths. Snow’s reflectance on the other hand is very high in the visible and NIR wavelengths, but drops towards zero in the water absorption bands (drops significantly). The snow curve shows a steady gain in the visible and NIR wavelengths, but drops almost 3/4ths of the way once it starts to become absorbed. Most clouds act as nonselective scatterers and reflect significant amounts of solar irradiance across the 400-2500 nm spectrum, but they generally have a downward trend with increased wavelength.

The spectral profiles differ for each of the areas sampled because of their respective absorption and natural reflection. For instance, snow reflects visible light extremely well, however, because it has similar properties to water it still absorbs energy from light extremely well which is easily seen (Fig. 1). On the other hand vegetation which easily absorbs certain kinds of light is unable to absorb the whole spectrum so instead it reflects (Fig. 1). This false color composite in Figure 1 displays the shortwave infrared (Band 6) in red, near-infrared band (Band 5) in green, the red band (Band 4) is displayed in blue. In this composite vegetation looks green, bare ground appears reddish and snow appears bright blue. These colors relate to the spectral profiles by having the brighter colors reflect more and the darker colors reflect less. It is an easily recognized pattern throughout the entire figure. By measuring the energy that is reflected by targets on earth’s surface over

a variety of different wavelengths, we can build up a spectral signature for that object. And by comparing the response pattern of different features we may be able to distinguish between them, which we may not be able to do if we only compare them at one wavelength. Remote sensing technology has developed from balloon photography to aerial photography to multi-spectral satellite imaging. Radiation interaction characteristics of earth and atmosphere in different regions of electromagnetic blocking effect of atmosphere spectrum are very useful for identifying and characterizing earth and atmospheric features.

Figures

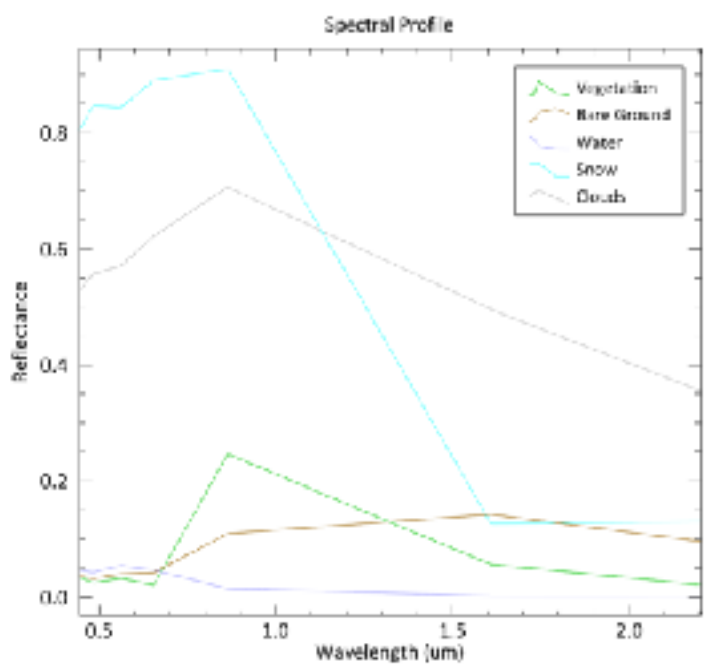

Figure 1. The figure above shows the various spectral profiles for vegetation (green), bare ground (brown), water (blue), snow (light blue), and clouds (grey). It was created based on using the false color composite in Figure 2.

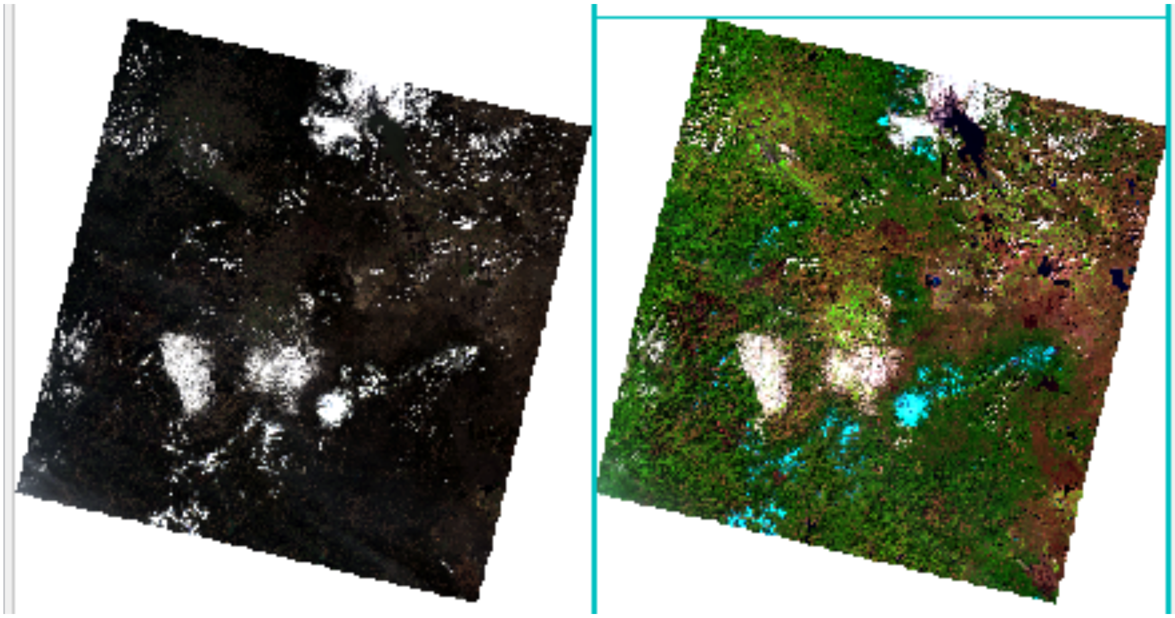

Figure 2. There are two separate images being shown: an original satellite image as well as a false color composite of that satellite image. The original shows everything as a true color, however, its very difficult to tell the difference between areas. On the other hand the false color composite displays the shortwave infrared (Band 6) in red, near-infrared band (Band 5) in green, the red band (Band 4) is displayed in blue. In this composite vegetation looks green, bare ground appears reddish and snow appears bright blue.