DaytimeSnowRGB_TalkingPoints

Title Slide 1: Identifying Snow with Daytime RGB Satellite Products

This is a brief presentation on RGB image combinations that can be used to identify snow during the day. RGB stands for the Red/Green/Blue color combinations used to digitally produce a color image. If you want or need more background on how that is done, I recommend the COMET module that focuses on Multispectral Satellite Applications – RGB Products Explained. The reference is listed at the end of this presentation as well as on the student guide page.

The **RGB color model** is an additive **color model** in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the **model** comes from the initials of the three additive primary colors, red, green, and blue.

Slide 2 I put this presentation together to address questions that I had been hearing both in my office and from forecasters out in the field. The two most common questions were:

How can snow be determined from day-time multispectral imagery? AND How many different RGB combinations are available?

Here I'm focusing on theRGBs that are potentially available through AWIPS I or II. Three of these are derived from imagery from polar orbiting satellites and one is derived from GOES imagery. If this were a live session, I would ask if you have seen any of these RGBs and also what methods have you used to identify snow. Answers I get back for the methods used to currently identify snow are animation of visible imagery (clouds move and snow doesn't)and texture and context. For instance, snow on mountains and in river valleys will show dendritic patterns. If you use the 3.9 imagery alone or with the 10.7 imagery, snow is not reflective during the day so some type of difference product will highlight that.

RGBs have been around for a long time, why are we starting to look at them now? At the Cooperative Institutes (here at CIRA in Colorado and CIMSS in Wisconsin) as well as at SPoRT (Short-term Prediction Research and Transition Center) in Alabama, efforts are underway to prepare for the next generation of satellites. GOES-R will have many new channels and many of the new channels (or close approximations to the new channels) are available on current polar orbiting satellites: the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor on Terra and Aqua Satellites (part of NASA's EOS Earth Observing System) and the VIIRS (Visible Infrared Imaging Radiometer Suite) sensor on the Suomi NPP (National Polar-orbiting Partnership). RGBs are being looked to as a way to combine information from many channels into one image.

Slide 3 – Why are there different techniques?

- Purpose of the product: Some were created with snow detection in mind, some were created for something else and it was discovered that you could also identify snow.

- Not an easy solution: Different developers, with different ideas and different visual capabilities;
- Algorithm mask for input to models or GFE (yes/no type of answer) VS. contextual visualization (what is the geography, where are the low and high clouds, etc.
- Different sensors, different channels available

Overall, some techniques are simple, and some are complex.

Slide 4 – Which ones have you seen? And if you can't tell by the name, when I show the pictures, you can start associating a name with a picture.

MODIS and VIIRS based: Cloud Layers and Snow Cover, False Color Snow, False Color

GOES and SEVERI (Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imagery (SEVIRI) based: Snow / cloud Discriminator and Natural Color

Slide 5 – A few notes for clarification:

- RGB imagery is being promoted by the GOES-R and JPSS Proving Grounds to help interpret multi-channel information
- The presenter does not know of an "officially designated" snow RGB
- RGB imagery cannot currently be created in AWIPS I
- Creation of RGB imagery in AWIPS II is a goal

Slide 6 – These RGBs have some things in common:

- They all use at least one visible or near IR channel in which snow is highly reflective
- They all use at least one channel in which snow is highly absorptive (ie not reflective).

Slide 7 – How do we distinguish snow, vegetation (here lawn grass) and bare ground (here sandy loam from Texas)? By their reflectance characteristics in different channels.

a) A reflectance of 1 means it appears bright white and a reflectance down around 0 means it appears very dark. For reference, the current GOES visible channel is centered at 0.6 µm. The other lines are for MODIS channels and that correspond with future GOES-R channels

Interpretation: If you focus on grass, there is a dramatic change in reflectance from low at 0.4 and 0.6 µm to a high at 0.8 µm. In contrast to this, snow has a higher reflectance for the 3 lower channels (0.4, 0.6, and 0.8 µm) but drops off for the 1.6 and 2.1 µm channels. This bare sandy loam soil is in between with a lower reflectance at the shorter visible wavelengths and slowly increasing to a mid reflectance in the near IR.

b) . I didn't find a good uncluttered example for cloud reflectance, so I took some measurements from what were opaque ice and water cloud as well as no clouds over the ocean. Overall, you see that ocean (or any water surface with depth) is not reflective across the whole spectrum shown here whereas ice cloud and water cloud are highly reflective at shorter wavelengths and then decrease in reflectance out to 2.5µm. Note that at 1.3 µm, the water cloud goes to no reflectance. It's actually part of the story. This is a channel that is affected by water vapor absorption – similar to the effect we see in what we call the water vapor channels in the infrared region. The satellite cannot sense down to the surface when there is moisture. (There are a few exceptions, particularly when there is a dry airmass over mountainous terrain) So actually for the previous graph (in 7a), the same can be said for the snow, grass, and ocean.

Examples

Slide 8a: In the upper right part of this slide, three images have snow that is highly reflective (0.4, 0.6, and 0.8) while at the bottom of the slide, two images have snow that is much less reflective (1.6 and 2.1).

The RGB shown in the center is simple and straightforward. I've seen it called the False Color Snow. It uses one channel where snow is reflective, and 2 channels where the snow is less reflective. The reflective snow channel is on the red color gun and since there is little contribution from the green and blue components where snow is less reflective, snow shows up reddish. On the CIMSS Blog, Scott Bachmeier has created a snow RGB with 375 m resolution VIIRS imagery using two channels: .64 on red, 1.6 on both the blue and the green. The product looks similar to this with snow appearing reddish.

Slide 8b. This slide uses a setup similar to the previous slide, but here it highlights what is called a false color image. It uses 2 channels where snow is reflective and one channel where snow is less reflective. This is a another simple RGB composite. Since the reflective channels are on the blue and green color guns, snow shows up as cyan. Note: MSG SEVERI does not have a 2.1µm channel and so the EUMETSAT Natural Color product uses 1.6 µm for red; .8 µm for green, and 0.6 µm for blue. It results in a product that looks similar to this.

Slide 8c. Similar setup to the previous 2 slides and here I am showing the GOES based cloud and snow product. This is a relatively simple RGB, it uses the visible albedo on red, the short wave albedo on green, and IR 10.7 µm brightness temperature (BT) on blue. In general, snow shows up as deep fuchsia and high ice clouds show up as pink.

Slide 8d. – Again a similar setup to the previous 3 slides. This is the Cloud Layers and Snow product. It is what I'll classify as a complicated RGB. Five channels are used and are combined such that 3 channels are used to determine each RGB component. A paper by Steve Miller has been written on the way this is done. It includes channels that have reflective and less reflective snow as well as other channels to help distinguish between low and high clouds. It does a very nice job of showing snow as white, clear soil and vegetation background as green, ocean as blue, low water cloud as yellow, and ice cloud as orange and pink.

Slide 9 a-d Full images of the 4 RGBs: I will quickly go through them so that you can see how the snow is represented and how low water cloud, high ice cloud, and background surface features appear in context. Three of these are represented in 1km resolution and provide nice detail. The GOES product is at a coarser resolution. I do realize that animation, particularly in a temporal resolution that we see with GOES, is currently not possible in three of these RGBs over the region of the US because the channels that are used to create them are only available from polar based sensors.

Slide 10a – RGBs are new to many of us to use as a tool to aid in the interpretation of cloud and ground features. Both positive and negative feedback on their use or on the content presented here is welcome. Think of it as being beneficial to the developers, trainers, and other users. Perhaps you use the RGB in the same way that the developer intended and it reinforces what they perceive. Perhaps you use it in a different way than what the developer/trainer intended and is a point to be taken note of for future adaptations or reference.

Your feedback on RGB usage will also help in the distribution of the product in the future. Some products are relatively simple and we are hoping that with AWIPS II, they can be produced “on the go” and “tweaked” for a particular region or season if necessary. When I was starting to create my own RGBs, I noticed seasonal and regional variability and I asked European trainers about this since they are very familiar with RGBs. They said but of course, we provide guidelines to who we train on how to adjust an RGB for an area.

On the other hand, other products that are complicated will be produced in a centralized location and either sent out or be provided on demand.

Slide 10b Here is a list of references and links to products available via web pages. These references and links are also available on the VISIT student guide web page. Some of these products have been made available in AWIPS I and AWIPS II. If you are interested in getting them in your AWIPS, send me an email (bernie dot connell at colostate dot edu) and I’ll forward it to the appropriate developer. Also, if you have any questions or comments, I’d be happy to hear them! bernie dot connell at colostate dot edu

Slide 11 I included this last set of images for those that want to see what the individual channels look like (I’m that kind of person). If you download the pdf or VISITview version, you can take your time looking at them and viewing the features talked about.

Thanks for listening in! Over and out.