Detecting Snow Cover, Bare Ground, Water and Ice Clouds using GOES-9 Multispectral Imagery on Nov. 6, 1996

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1. Introduction

This short case study shows that multispectral GOES-9 imagery is very useful in detecting snow cover, bare ground, water clouds, and ice clouds. Visible, IR (11um), and the reflectivity product will be used to make feature identifications. For a short description of how the reflectivity product is generated, see TALITE 96-08.

2. Inspection of the multispectral imagery

The data that we will inspect is from 2000 UTC on November 6, 1996. Figures 1-4 show the VIS, IR (11um), reflectivity product, and enhanced IR (11um) images, respectively. Examine these images and try to determine where the following features are located: 1) snow cover, 2) bare ground, 3) water clouds, and 4) ice (cirrus) clouds. Figure 4 is enhanced so that every 5 degrees Celsius has a unique color to help better identify temperatures of all features in the scene (not just cold cloud tops).

3. Interpretation of the multispectral imagery

Each type of feature to be detected will be discussed before showing the same imagery as in Figures 1-4, except with all the features identified.
It is evident from looking at the imagery that identification the desired features is not a simple matter. First, lets try to identify snow covered ground. In the visible image snow cover should be white (very reflective). The reflectivity product should show snow cover as dark (snow is poorly reflective at 3.9um, which is used to make this product). The IR image should show the area of snow cover as generally cooler than surrounding bare ground. One location that shows these features is the Sierras of California. Can you find and others?
Second, let's try to identify regions of bare ground. Obviously, the visible data will be mainly used for this identification. It should be noted that bare ground has a wide range of reflectivity in the 3.9um wavelength, so the reflectivity product shows great variation in bare ground regions. It is obvious (from the visible data) that large areas of Nevada are bare ground. Can you find other locations with bare ground?

Third, water clouds are to be identified. In this case, the reflectivity product is going to be very useful. The reflectivity product is enhanced so that the most reflective surfaces are bright white to cyan. Water clouds are very reflective of 3.9um radiation so that in the reflectivity product they should be white or cyan. Also, remember that snow cover is dark in the reflectivity product, this provides a good mechanism to detect water clouds over snow. The visible and IR are complementary in this identification. Over bare ground the visible imagery does quite well detecting clouds. Also, the IR can be used to obtain cloud top temperatures to help determine if the water clouds contain super-cooled water (at least at the cloud top). One area of water clouds in located over southwest Idaho. Can you find any other locations with water clouds?
Finally, cirrus (ice clouds) need to be identified. All 3 image products will be used to identify cirrus clouds. The visible tends to show the cirrus (especially thin cirrus) as wispy and light gray. The IR will tend to show rather cold cloud top temperatures for cirrus (thin cirrus may be warmer than expected due to radiation passing up through the cirrus from the surface). The reflectivity product usually shows cirrus as dark since ice crystals are poorly reflective in the 3.9um wavelength. Cirrus can show up as mottled dark and light in the reflectivity product due to the low signal-to-noise ratio at cold temperatures in the 3.9um channel. One area of cirrus is in northern Nevada (just south of the Oregon/Idaho border). This cirrus is so thin that it is not seen in the reflectivity product. However, it is apparent in the visible image as a light wispy area. It also appears in the IR image as an area of colder temperatures (even though radiation from the surface results in an apparent temperature that is warmer than would be expected for cirrus). Can you find any other areas of cirrus?
Figures 5-8 show they various areas that have been identified as snow cover, bare ground, water clouds, and ice clouds. Not all possible features are identified, but enough are identified to get an idea of how powerful the use of the multispectral imagery is to cloud and surface feature identification.

4. Summary
It is apparent that the use of multispectral imagery is a very powerful tool in identifying surface and cloud features. It is important to use all possible image channels in making feature identifications.

Please send your questions to
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