Extracting and Viewing Bit-Level Metadata in EOS Files

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***Abstract*- We describe a project that is exploring new methods of selecting and combining bit-level elements from MODIS data products, and displaying them simultaneously with images of a geophysical parameters such as snow cover.**

I. Introduction

Interpreting the data from NASA's Terra and Aqua satellites is key to fulfilling NASA's Earth Science Enterprise goal of understanding how the earth system's component parts interact and evolve. The MODerate resolution Imaging Spectroradiometer (MODIS), carried on both platforms, is being used to generate global data products describing the land, oceans, and lower atmosphere of our planet[1].

All MODIS standard products are in the Hierarchal Data Format (HDF). The MODIS science team has made good use of HDF, packing a great deal of information into each data file. For example, the Level 2 MODIS snow product [2] contains a data array for surface classification (snow, cloud, snow-free land, lake ice, etc.), plus a pixel-level Quality Assurance array. The metadata, and especially the QA array are important for understanding and interpreting the science data.

Currently, researchers are limited in their ability to access and decode information stored as individual bits in many of the MODIS science products. Commercial and public domain utilities give users access, in varying degrees, to the elements inside MODIS HDF files. However, when attempting to visualize the data users are confronted with the fact that the many of the elements actually represent eight different 1-bit arrays packed into a single eight bit integer array.

II. Objective

This prototype is exploring new methods of selecting and combining bit-level elements from MODIS data products, and displaying them simultaneously with images of a geophysical parameters. The code is designed in such a way that it may be incorporated into a component-based framework where these visualization services could be applied to any data sets conforming to predefined standards.

III. MODIS Cloud Mask

As with many of the MODIS land products, the snow product uses as input other MODIS products, particularly the cloud mask (MOD35). Shortcomings in the snow product have been traced to the cloud mask, and therefore it is very useful in diagnosing the snow product to be able to examine the corresponding cloud mask product. The cloud mask information (processing path and results of individual cloud tests) is conveyed in a 48-bit word which cannot be interpreted by simply visualizing the array. An image made from the first 8-bit word of the cloud mask will have 256 possible colors (Fig. 1), and is essentially useless for determining which of the 8 bits are on and off for any given pixel.

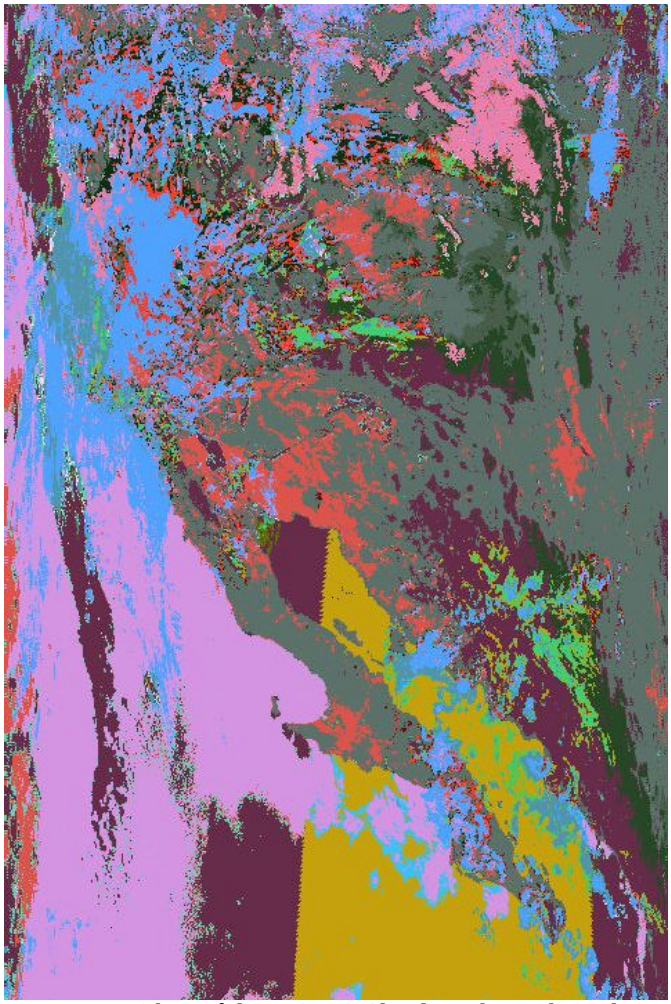

Fig. 1 First 8 bits of the MODIS Cloud Mask swath product, over the Southwest U.S.

Our tool design allows a user to draw a box on an image such as the one shown in Fig. 1, and then display, at a user-selected magnification, up to four different bits of the QA array in that box. The background of this image can also be selected; currently the snow cover product or the Level 1b visible radiance product are the choices. Fig. 2 gives an example where two cloud bits are displayed over a snow cover map.

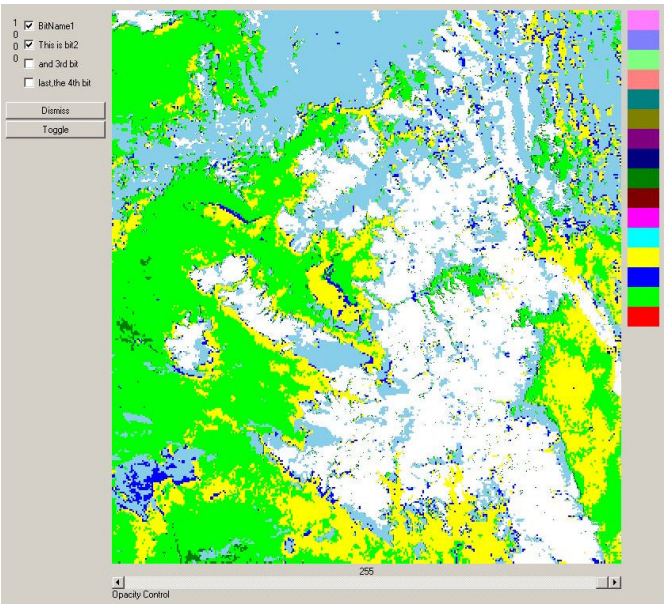

Fig. 2 Two cloud mask bits displayed over snow coverage.

At the upper left are radio buttons allowing the user to select which of the four bits (selected on a previous screen) to display (these will be labeled appropriately in later versions of the software). To the left of these buttons a user can read the state of each bit as the cursor is passed over the image. The "Toggle" bar below this allows the user to toggle between the background images, or black.

The slider at the bottom of the screen allows the user to control the opacity of the bit layer. In this way the bit layer can be viewed as "coloring" the background image. This is particularly useful when the background is an image of sensor radiance data.

In Fig. 2, where all the selected bits are "off" the image beneath is visible, in this case snow cover with snow as white and clouds as light blue. This figure shows that the two cloud mask bits selected (Visible Reflectance Test and Visible Ratio Test) do not explain the cloud determination that is made on the margins of the snow cover (light blue).

A user may wish to view the concurrence of bit elements from two or more separate products, for example the non-cloud obstruction flag (bit 1 of byte 2 of the cloud mask) and high band 6 uncertainty (bit 4 of snow QA array). We are exploring ways of allowing the user to select a set of bits from any of the bit array input fields and apply Boolean operators to produce a simple on/off outcome which could then be viewed in window such as shown in Fig. 2.

The prototype version of this tool is already proving to be quite valuable in research leading to improvements in the MODIS product suite.

ACKNOWLEDGMENTS

This work is being funded by NASA's Earth Science Technology Office, Goddard Space Flight Center, MD. Programming assistance by Matt Savoie, a NSIDC staff programmer, is gratefully acknowledged.

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