Chapter 18

Creating True Color Images

Introduction

Most ocean color sensors measure the visible wavelengths necessary to produce a 'pseudo' true color (RGB) image, which approximates what the human eye would see looking down on the Earth from space. Such images can be useful in data analysis and presentation. SeaDAS provides the capability to generate these images in several different ways.

Goal

This chapter introduces the methods for creating true color images with software provided as part of the SeaDAS package by way of the following sections:

- Understanding the concept of combining three visible bands to create an RGB image
- Creating an RGB 'band' using the *Load True Color Image* utility
- Creating an RGB image in satellite coordinates using `msl1bgen`
- Creating a mapped (Plate-Carré projection) RGB image using `msl1tcpcbox`

18.1 Understanding RGB images

Most ocean color sensors collect data in several different bands in the visible and near infrared part of the electromagnetic spectrum. For each band, the detector measures the intensity of the light that reaches the sensor. When these data are displayed visually, the result is a series of black and white or "gray-scale" images, which look much the same as black and white photographs taken with a series of colored filters over the lens (see Figure 18.1). Different features have different intensities in the various bands. For example, clouds and water appear bright in the blue bands, while land is dark. In the red and infrared bands, it is the land that is bright, while the water is dark. By combining data from just three of these bands, one each in the red, green and blue portions of the spectrum (hence the RGB moniker), a pseudo true color image can be produced. Each band is displayed in a monochromatic scale corresponding to its appropriate color. When these are appropriately combined they produce the entire range of visible colors, creating an image that is fairly close to what the human eye and brain would perceive. This is very similar to the way a color TV produces a range of visible colors on the TV screen, using only red, green, and blue dots.

The data used for the RGB composite images are from L1B, the calibrated, top-of-atmosphere radiances. In the case of SeaWiFS, OCTS, and CZCS, L1A can be used as input, as the code will perform the L1B conversion internally. For MODIS the L1B and Geolocation files must be created prior to using the code described below.

18.1.1 Rayleigh correction

As the photons of light pass through the atmosphere, they interact with molecules in the atmosphere. This interaction produces what is known as atmospheric scattering, where blue light is preferentially scattered in random directions, which is why the sky appears blue. If this scattered atmospheric contribution is not corrected, the RGB image will appear hazy or washed out. Fortunately, this scattering component can be readily calculated using the well-known Rayleigh scattering equation and can therefore be subtracted from the data to produce a more crisp looking image.

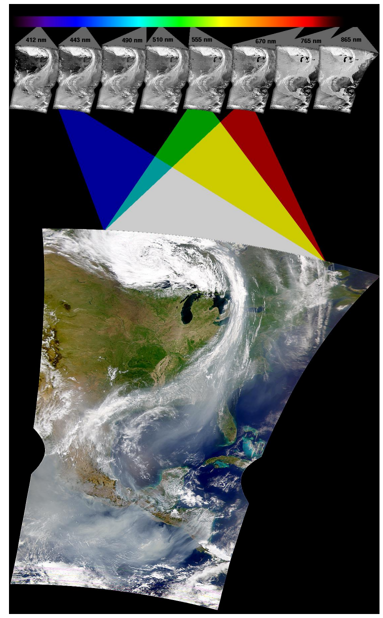

Figure 18.1: Generating an RGB Image

18.1.2 To Map or Not to Map

The top-of-atmosphere satellite data are not in a projection most people are familiar with. The curvature of the Earth, the inclination of the satellite orbit and the way the satellite sensor scans, all combine to produce a warped image. SeaDAS provides two mechanisms to produce an RGB image of this warped satellite data 'as is' (`msl1brsgen` as well as the GUI's true color utility) and another method which will remap the data into a more reasonable projection (`msl1tcpcbox`). Therefore, the user has the option tocreate mapped or non-mapped RGB images to suite their needs.

18.2 Creating an RGB 'band' using the SeaDAS GUI

SeaDAS provides a GUI interface that allows for the creation of an RGB image which will loaded as a SeaDAS 'band'. This utility was originally intended for SeaWiFS only, although it provides the option to create the RGB image from previously loaded 'bands', giving the user the flexibility to define what data are combined. This can be used to allow RGB images from non-SeaWiFS data to be created. The output from this function is an 8-bit image that has not had the Rayleigh correction applied.

From the SeaDAS Main Window, select ***Utilities⇒Data Visualization⇒Load True Color Image***. You can enter a SeaWiFS L1A file into the selection box, then choose which bands to use for the RGB composite. Clicking on the *Load* button will load an RGB composite into the SeaDAS Band List Selection window for subsequent display/manipulation.

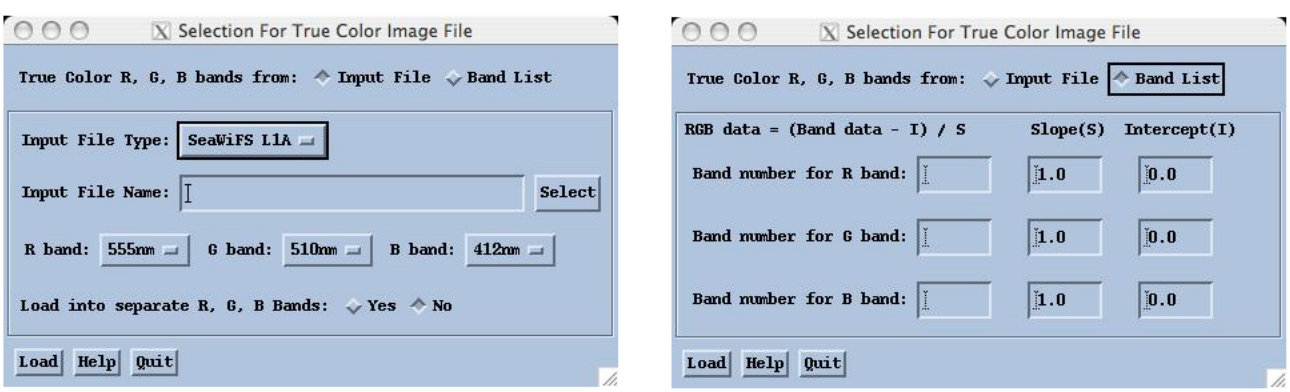

Figure 18.2: Load True Color Image Widgets

Alternatively, you may load an RGB from three arbitrary, previously loaded bands. From the *Load True Color Image* window, select the 'Band List' radio button. This will change the input to allow selection of the three RGB bands. This widget also allows for a slope and intercept to be applied to the data prior to compositing.

18.3 Creating an RGB image using `msl1brsgen`

SeaDAS provides another utility to produce a pseudo true color browse product, `msl1brsgen`. By default, this program produces an HDF file, navigable as any other product within SeaDAS. However, `msl1brsgen` can also produce a 24bit portable pixmap (PPM) image file, which can easily be converted into a JPEG or PNG image file.

`Usage: msl1brsgen [Optional arguments] l1_filename [geo_filename] output_file_name`

The first step, which is only necessary if the satellite data are from MODIS, is to generate the geolocation and L1B files; for the other sensors (SeaWiFS, OCTS, CZCS) `msl1brsgen` accepts L1A as input. For the following example the MODIS Aqua file A2007059122000.L1B_LAC (and it's geolocation file, A2007059122000.GEO] will be used.

Figure 18.3: An RGB Image

Since `msl1brsgen`'s default behavior is to create an HDF file, the optional [-p] switch must be set in order to produce a PPM file as output.

The `msl1brsgen` program has the ability to subsample the satellite data. The default is to subsample by a factor of 10, so a typical MODIS file at 1354 pixels by 2030 scan lines would produce an output image that is 135 by 203 pixels. This is suitable for webpage browse imagery. Higher resolution images can be obtained by changing the subsampling factor by using the optional argument [-r subsample-factor], where 'subsample-factor' is an integer value. For example, -r 2, would subsample every 2nd pixel and scanline effectively producing a 50% scaled image.

The optional argument [-a] will turn on the simplified atmospheric correction (basically, Rayleigh radiance subtraction].

If a desired scanline and/or pixel range is known, the [-f first-scan-number, -l last-scan-number, -s start-pixel-number, and -e end-pixel-number] options can be set to produce an extracted image.

To produce an RGB browse image of A2007059122000.L1A_LAC:

msl1brsgen -p -r 3 A2007059122000.L1B_LAC A2007059122000.GEO A2007059122000.BRS.ppm

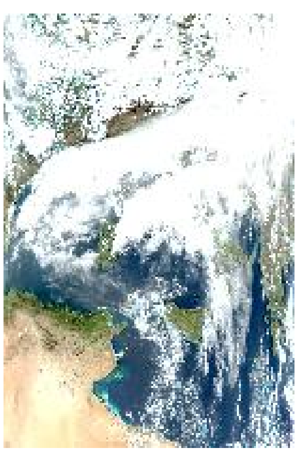

Figure 18.4: An RGB Image with Rayleigh Correction

To produce an RGB browse image of A2007059122000.L1A_LAC with the data Rayleigh corrected:

msl1brsgen -a -p -r 3 A2007059122000.L1B_LAC A2007059122000.GEO A2007059122000.BRS_atmcorr.ppm

Since MODIS Aqua scans from west to east and is an ascending orbit, the above images 18.4 and 18.5 were flipped top-to-bottom and left-to-right to present the data in a normal NSEW orientation. A Netpbm program was also used to convert the PPM file to a JPEG. The Netpbm programs, pamflip and ppmtojpeg were used. From the Netpbm website:

```
Netpbm is a toolkit for manipulation of graphic images, including
conversion of images between a variety of different formats.
...
For more information on what the package does, see
http://netpbm.sourceforge.net/doc
```

18.4 Creating a mapped (Plate-Carré projection) RGB image

SeaDAS provides the `msl1tcpcbox` utility to enable generation of a Plate-Carré mapped, pseudo true color product. As with the `msl1brsgen` program, the output is a 24bit PPM image.

`Usage: msl1tcpcbox [optional arguments] width n s w e thresh fname [geofname] ofile`

The argument 'width' is the output number of pixels for the image to be produced.

The n, s, e, and w arguments are for indicating North, South, East and West coordinates to which the image is to be mapped.

The 'thresh' argument is the minimum percentage of valid pixels that are necessary in order for a map to actually be produced.

The fname, geofname and ofile arguments are the input L1[A—B] file, geolocation file and output filenames respectively.

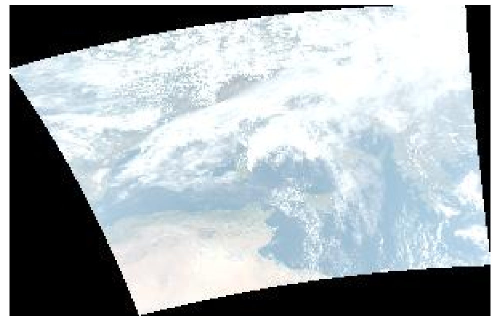

Figure 18.5: An RGB Image Mapped

msl1tcpcbox 600 51.16 29.68 -7.22 26.06 0.1 A2007059122000.L1B_LAC A2007059122000.GEO A2007059122000_mapped.ppm

As with the `msl1brsgen` program, the `msl1tcpcbox` program accepts an optional argument, [-a], for applying a simplified atmospheric correction to the data.

msl1tcpcbox -a 600 51.16 29.68 -7.22 26.06 0.1 A2007059122000.L1B_LAC A2007059122000.GEO A2007059122000_mapped_atmcorr.ppm

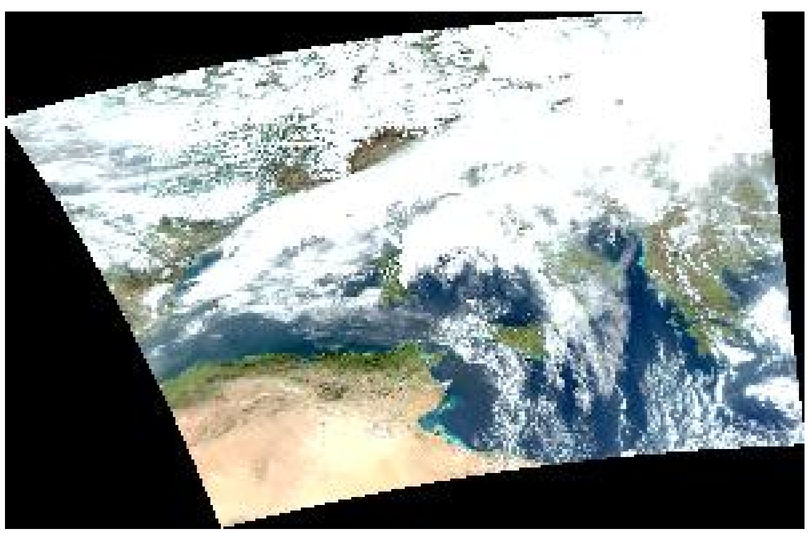

Figure 18.6: An RGB Image Mapped with Rayleigh Correction