CORENDERING THREE ATTRIBUTES AGAINST RED-GREEN-BLUE OR CYAN-MAGENTA-YELLOW – PROGRAM rgb_cmy_plot

Contents

Overview

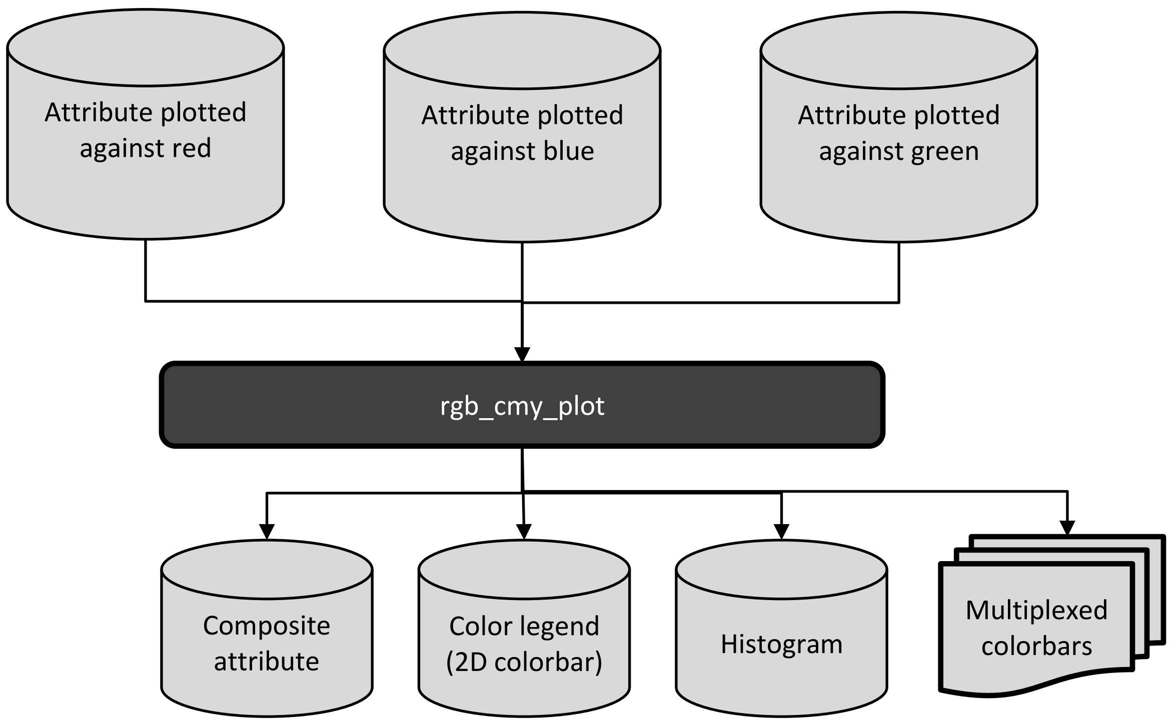
When multiple attribute volumes exhibit the same units and the same range of values they are amenable to color blending. The most common example is corendering three spectral magnitude components against red, green, and blue, where low values of spectral magnitude appear as black and high values are a pure color. Another example is to corender a near, mid, and far offset amplitude volumes against red, green, and blue. In this case, the extreme negative values are mapped against black and the extreme positive values against a pure color.

Some attributes are better represented against cyan, magenta, and yellow. If we compute coherence for three different bandpass filtered seismic amplitude volumes, we will map high coherence against white and low coherence against the pure cyan, magenta, and yellow. In this kind of image, when all three volumes exhibit low coherence, we obtain the same black anomalies as see in conventional coherence displays plotted against a gray scale.

Most, but not all interpretation workstation software provides RGB blending. Some provide CMY blending as well. For those that have RGB blending but not explicit CMY blending, a CMY blended image can be obtained by properly defining the range and polarization of the data and color bars. In the AASPI software package, color blending is most conveniently implemented using program **corender**. Program **rgb_cmy_plot** is provided for those interpreters whose workstation does not provide RGB color blending. For these interpreters, the composite (blended) output volume from program **rgb_cmy_plot** can be loaded into the workstation along with the corresponding multiplexed colorbar for subsequent integration with well control and other kinds of data.

Computation Flow Chart

Program **rgb_cmy_plot** reads in two attribute volumes and outputs a composite volume, a color legend, a histogram, and a suite of multiplexed colorbars that can be used to load the composite volume into the more common interpretation workstations software products.



Output file naming convention

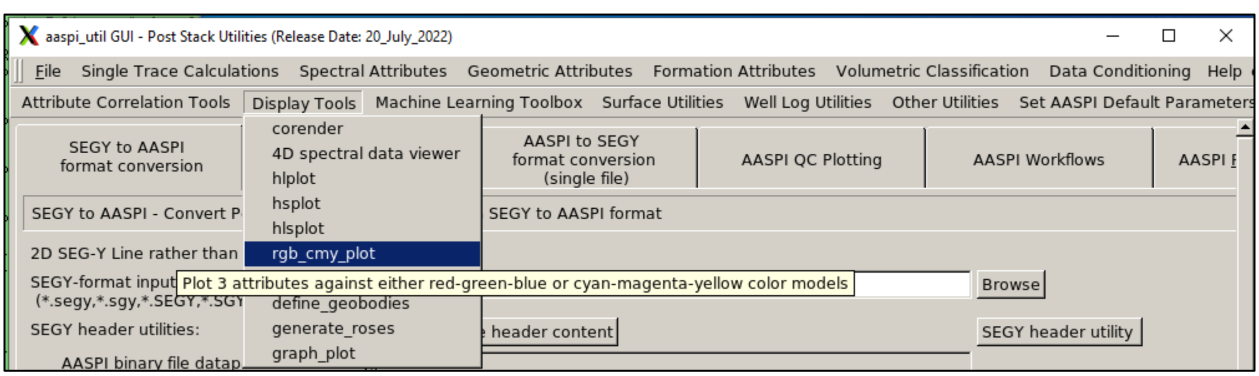
Program **rgb_cmy_plot** will always generate the following output files:

Output file description	File name syntax
Composite attribute	*Hue_axis_title*_vs_*saturation_axis_title*_vs_*lightness_title_unique_project_name*.H
Color legend (2D colorbar)	rgb_cmy_plot_color_legend_*hue_axis_title*_vs_*saturation_axis_title*_vs_*hue_axis_title_unique_project_name*.H
2D histogram	rgb_cmy_plot_histogram_*hue_axis_title*_vs_*saturation_axis_title*_vs_*hue_axis_title_unique_project_name*.H
Multiplexed 1D colorbars	rgb_cmy_colorbar.alut, rgb_cmy_colorbar.CLM, etc
Program log information	rgb_cmy_plot_*unique_project_name*.log
Program error/completion information	rgb_cmy_plot_*unique_project_name*.err

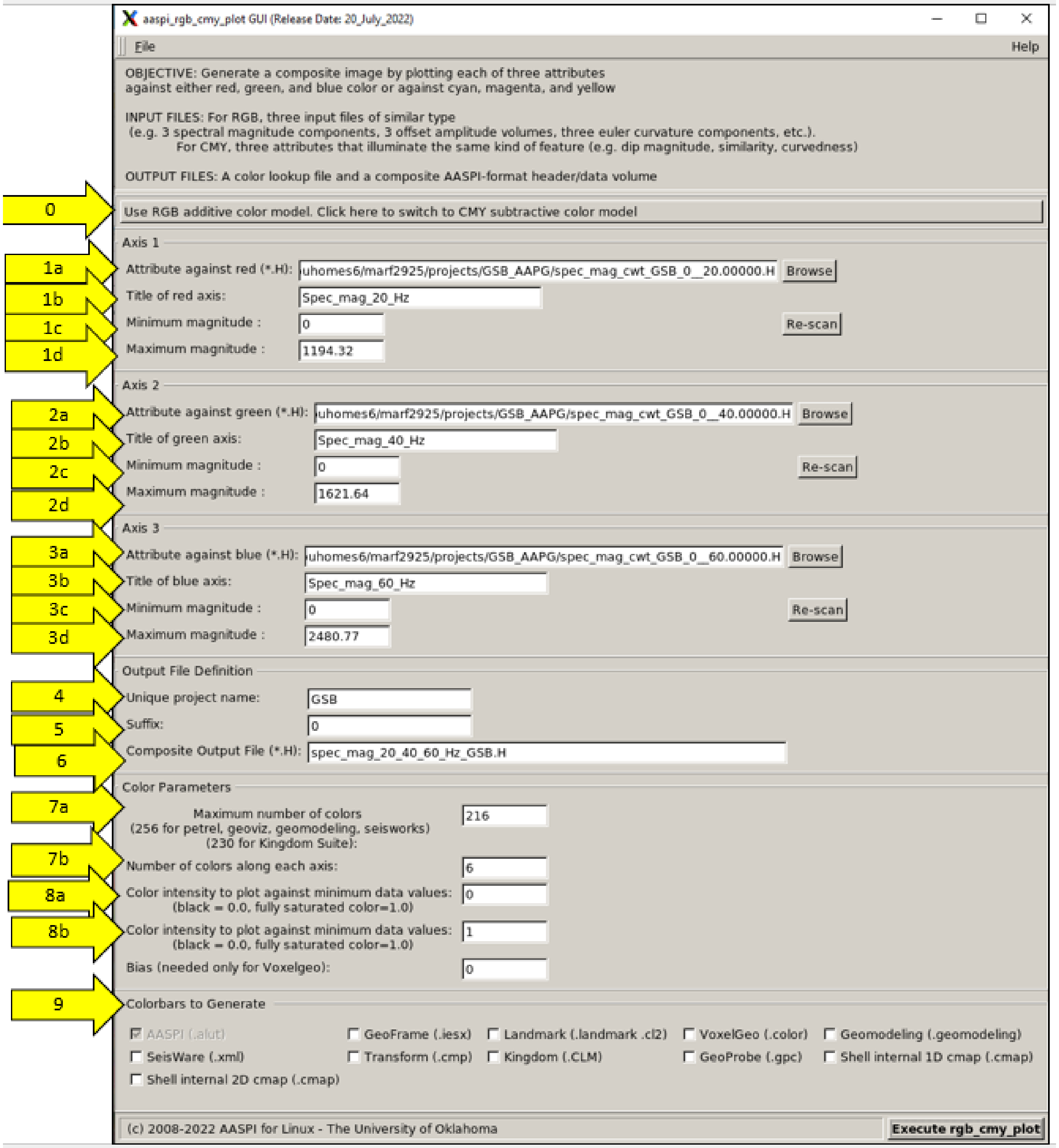
where the values in red are defined by the program GUI. The errors we anticipated will be written to the **.err* file and be displayed in a pop-up window upon program termination. These errors, much of the input information, a description of intermediate variables, and any software trace-back errors will be contained in the **.log* file.

Invoking the rgb_cmy_plot GUI

To invoke program **rgb_cmy_plot**, on the **aaspi_util** GUI select *Display Tools* and then select **rgb_cmy_plot** on the drop-down menu:



The following GUI opens up:



The 0th step is to use the (0) RGB vs CMY toggle to decide whether we wish to plot three attribute volumes against red-green-blue (RGB) or against cyan-magenta-yellow (CMY) color axes. In this example, I have selected the default *RGB additive color model.*

Next, I *Browse* to find the file names of the three attribute volumes I wish to corender. In this example I have selected spectral magnitude components at (1a) 20 Hz to plot against red, (2a) 40

Hz to plot against green, (3a) 60 Hz to plot against blue. The (1b, 2b, 3b) title of the color bar axes are extracted from the titles of the input data volumes and can be edited to make them more meaningful and/or more succinct. When loaded, the (1c, 1d, 2c, 2d, 3c, 3d) minimum and maximum values of each data volume are read from their respective *.H files.

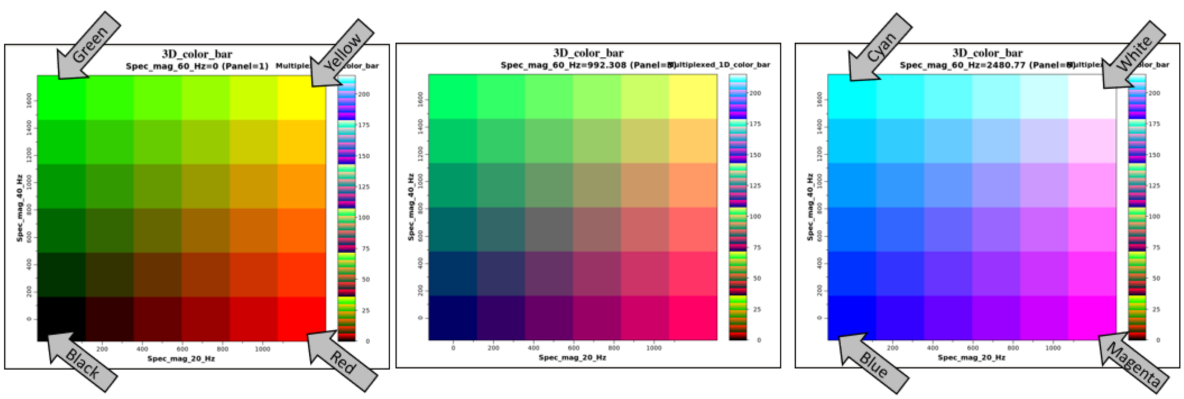
As with almost all AASPI GUIs, I enter (2) a *unique_project_name* and (5) a *Suffix*. The default name of the (6) *Composite output file* will be a concatenation of the three titles of the input data volume with a ".H" added to the end. In general, this file is very long, so in this example I shortened it to be more succinct. **Be sure this file name ends in *.H!**

In general, you will want to use the same number of color levels for R, G, and B. If your commercial interpretation software allows you to only load 256 colors, then the largest cubed value that fits in memory will be 6^3=216, which are the defaults (6b and 6a).

For spectral magnitude, you will want to plot large magnitude values (7a) against fully saturated colors and 0 values (7b) against black. If all three axis are saturated you will obtain white. If you want the limit the range of the color bars you can choose values between 0.0 and 1.0.

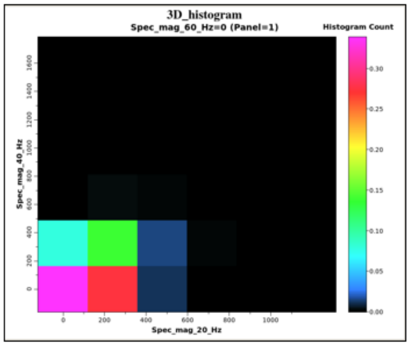
I click *Execute rgb_cmy_plot* and obtain displays of the 3D color legend, the 3D histogram, and time slices through the RGB corendered data volume. All three of these AASPI-format *.H volumes are saved to your local directory.

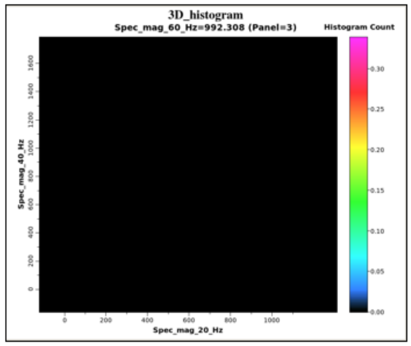
First, I capture the 1st, 3rd, and 6th blue levels of the 6x6x6 colorbar:

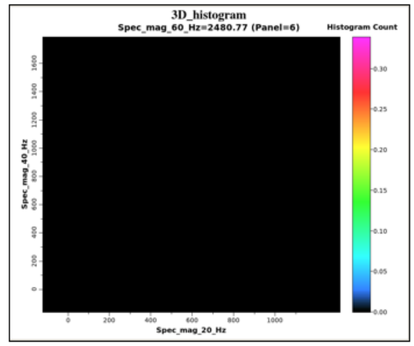


On the first (R, G, B=0) plane, I see that the 20 Hz axis for G=0 ranges from black to red and the 40 Hz axis for R=0, B=0 ranges from black to green. In the upper right corner where the 20 Hz component is maximum, the 40 Hz component is maximum, and the 60 Hz component is minimum, (R=1, G=1, B=0), I get yellow. For the 6th plane where the 60 Hz component is maximum (B=1) I have blue when R=0, G=0, and B=1, cyan when R=0, G=1, B=1, magenta when R=1, G=0, B=1, and white when R=1, G=1, B=1. The middle (3rd panel for B=0.4) I obtain intermediate colors. Note the multiplexed 1D colorbar on the right of each image.

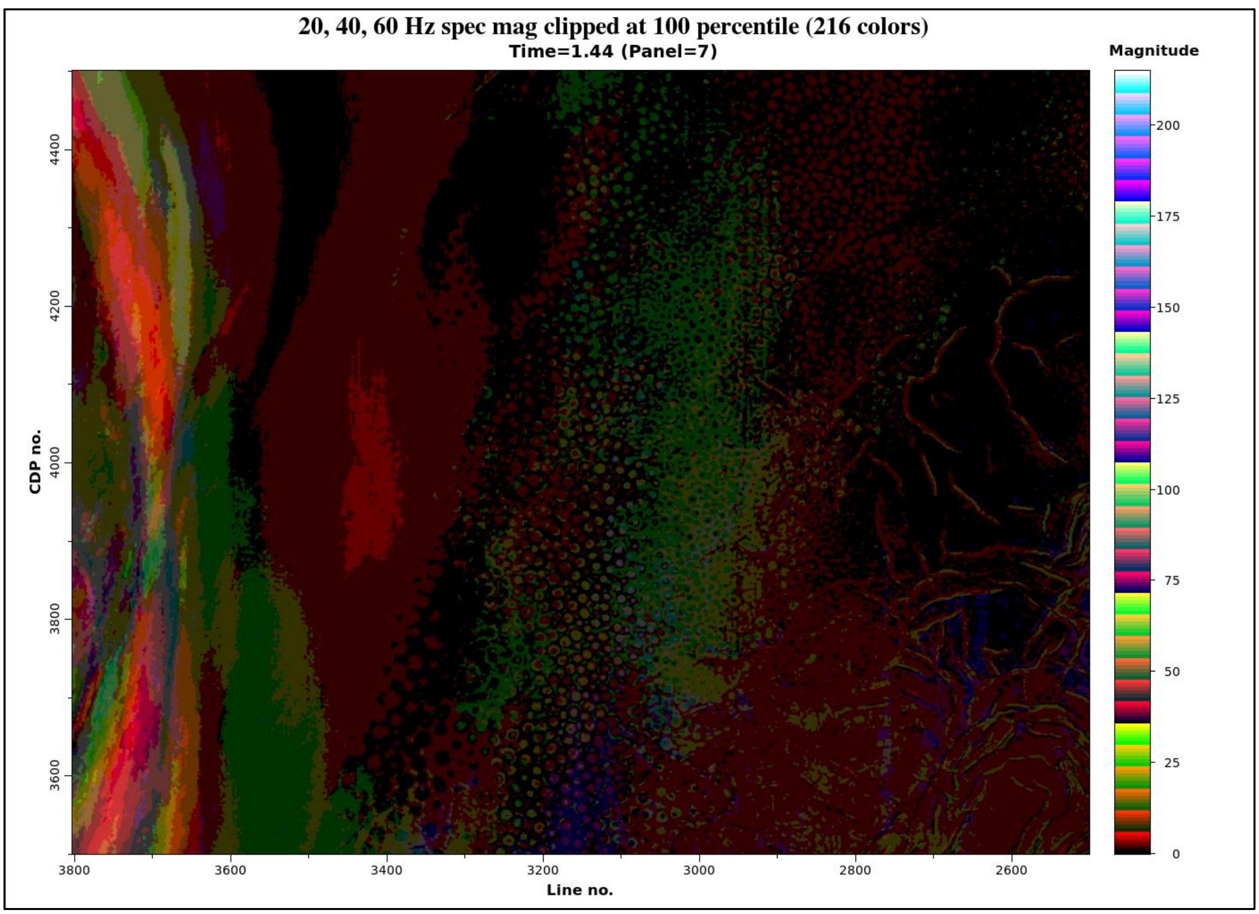
Next, I capture the 1st, 3rd, and 6th blue levels of the 6x6x6 histogram:





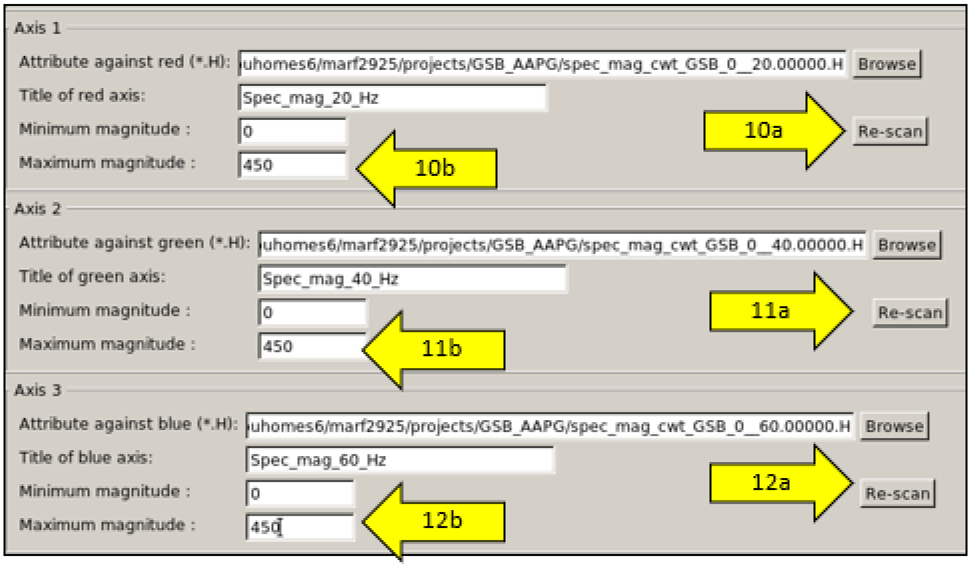


Note that most of the data fall within the first panel, indicating that I need to modify the scaling of my input data to better map against the range of the R, G, and B color axes. This poor scaling where I set my range to the minimum and maximum values of the three spectral components (i.e., an upper percentile of 100) results in this suboptimum time slice at t=1.44 s:

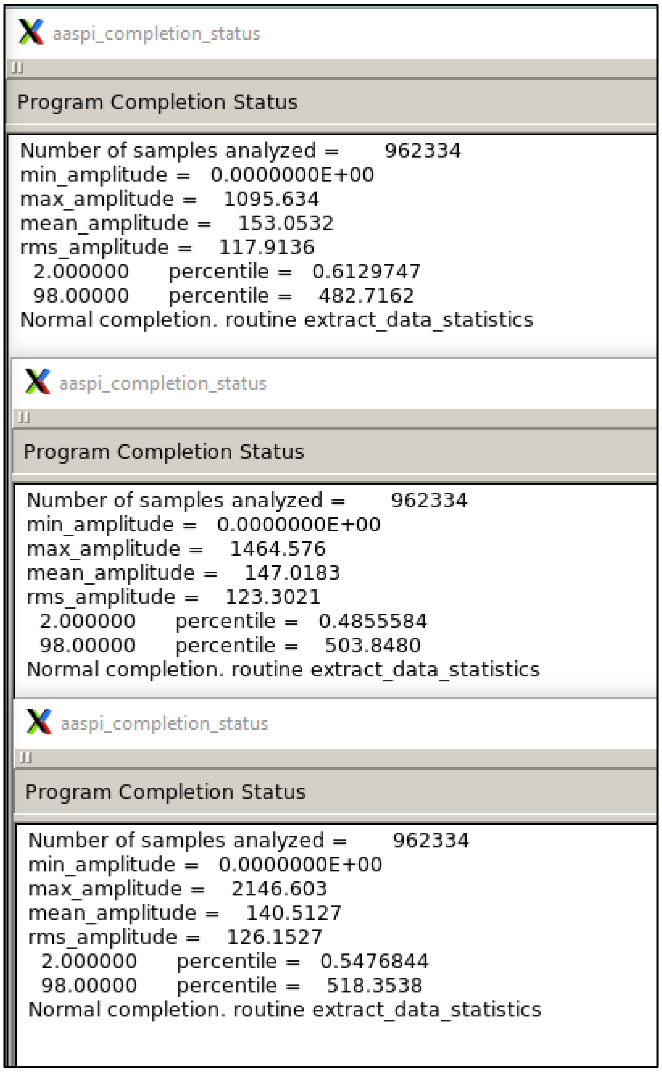


Defining the data range to better map to the color axes

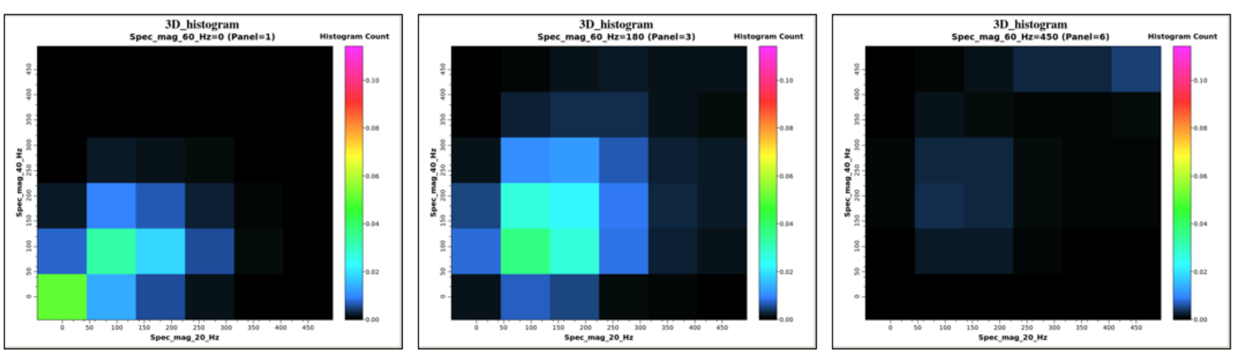
Unlike program **corender**, program **rgb_cmy_plot** is not interactive, requiring a more careful definition of the range of the three input volumes to be plotted against the three different color axes. To better understand the range of my input data, I click the (10a, 11a, 12a) *Re-scan* button for each of the three values



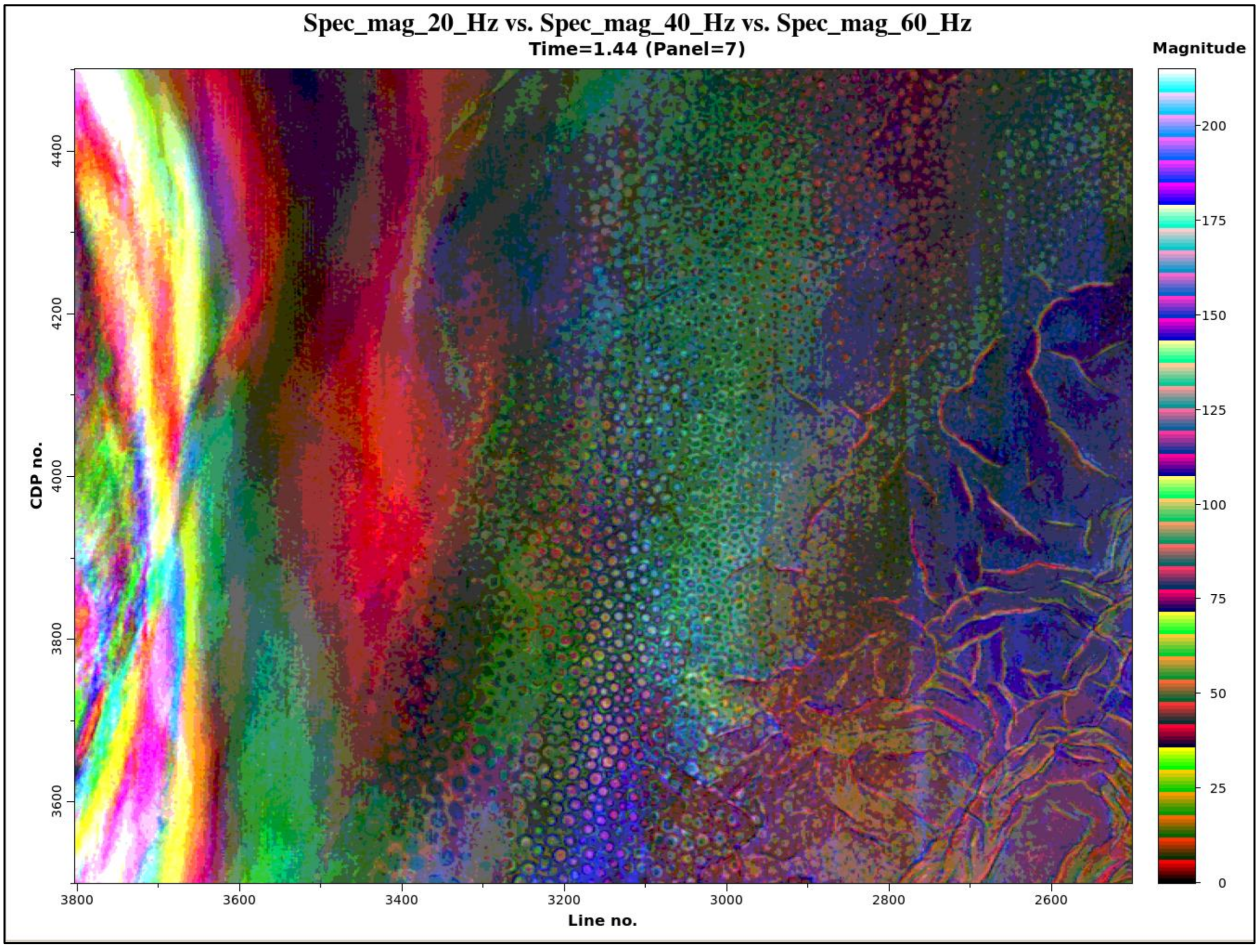
Three windows pop up summarizing providing some useful statistics:



where the 98 percentile values 482, 503, and 518 are copied into the (10b, 11b, 12b) *Maximum magnitude* entry for the three axes. Because I have previously flattened the spectrum, I want these three values to be identical in order to evaluate thin-bed tuning. I therefore type in a slightly smaller value of 450 into each of these entries. Executing the program, I obtain the following histogram:



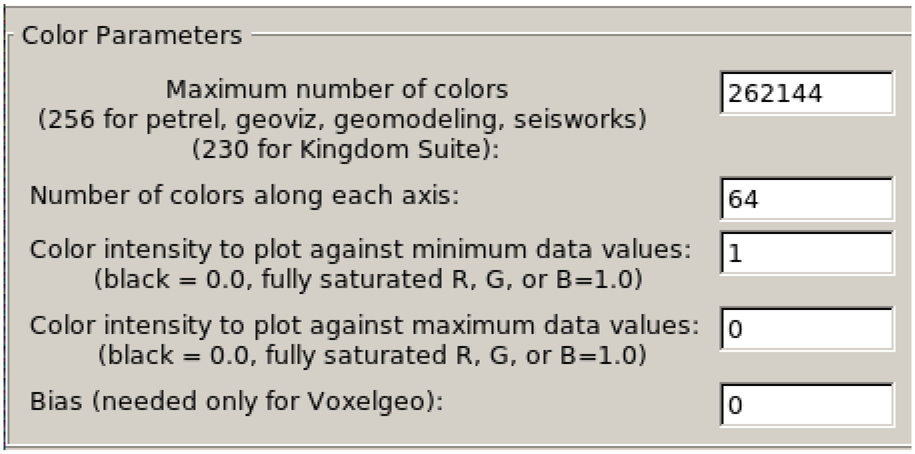
where now I see some values for panel 6. (The peak histogram representing 12% of the data is on panel 2 in bin_r=2, bin_g=2, bin_b=2). The colorbar is the same as before, but now the time slice through the composite data volume at t=1.44 s looks like this:



Changing the color depth (the number of colors)

Although only a few workstation packages allow importing more that 256 colors (and those that do have excellent RGB and CMY color blending tools) you can still generate attributes with greater color depth in the AASPI software. Modern workstations and computer terminals using OpenGL (graphics library) allow 256 levels of R, G, B, and alpha blending, giving 32-bit color. In the next example, I set the *Number of colors along each axis* to be 64. This changes the *Maximum number of colors* to be 64^3=262,144.

Display Tools: Program **rgb_cmy_plot**


Color Parameters

Maximum number of colors (256 for petrel, geoviz, geomodeling, seisworks) (230 for Kingdom Suite): 262144

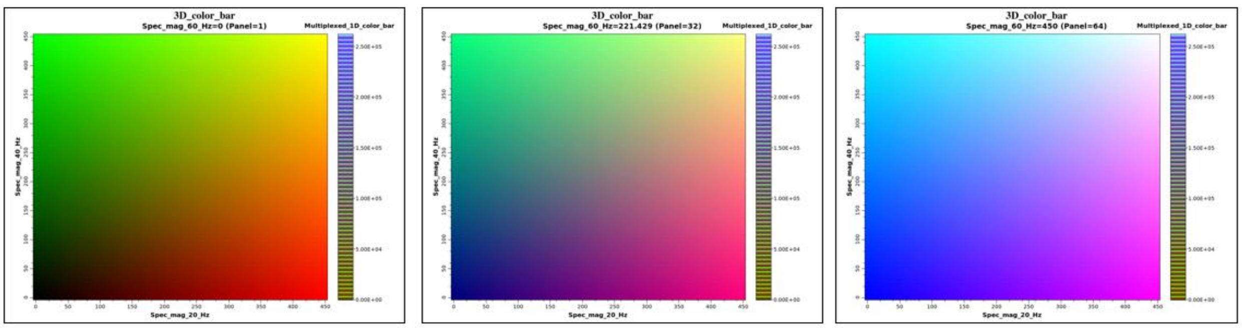
Number of colors along each axis: 64

Color intensity to plot against minimum data values: (black = 0.0, fully saturated R, G, or B=1.0) 1

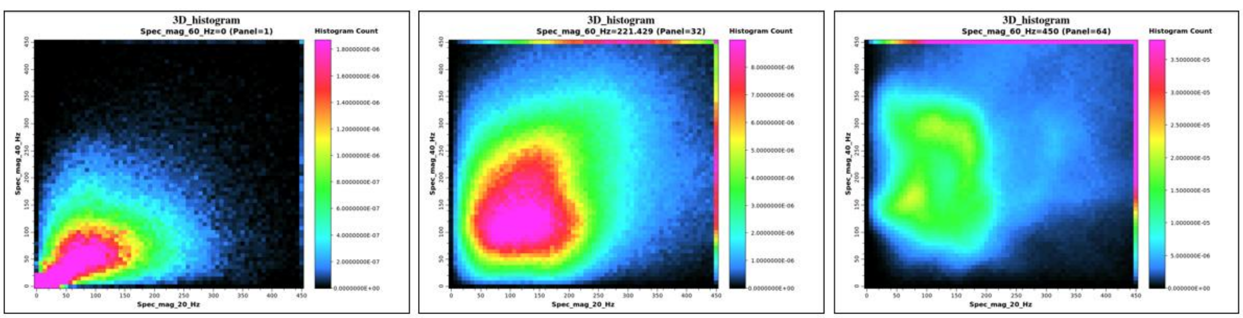
Color intensity to plot against maximum data values: (black = 0.0, fully saturated R, G, or B=1.0) 0

Bias (needed only for Voxelgeo): 0

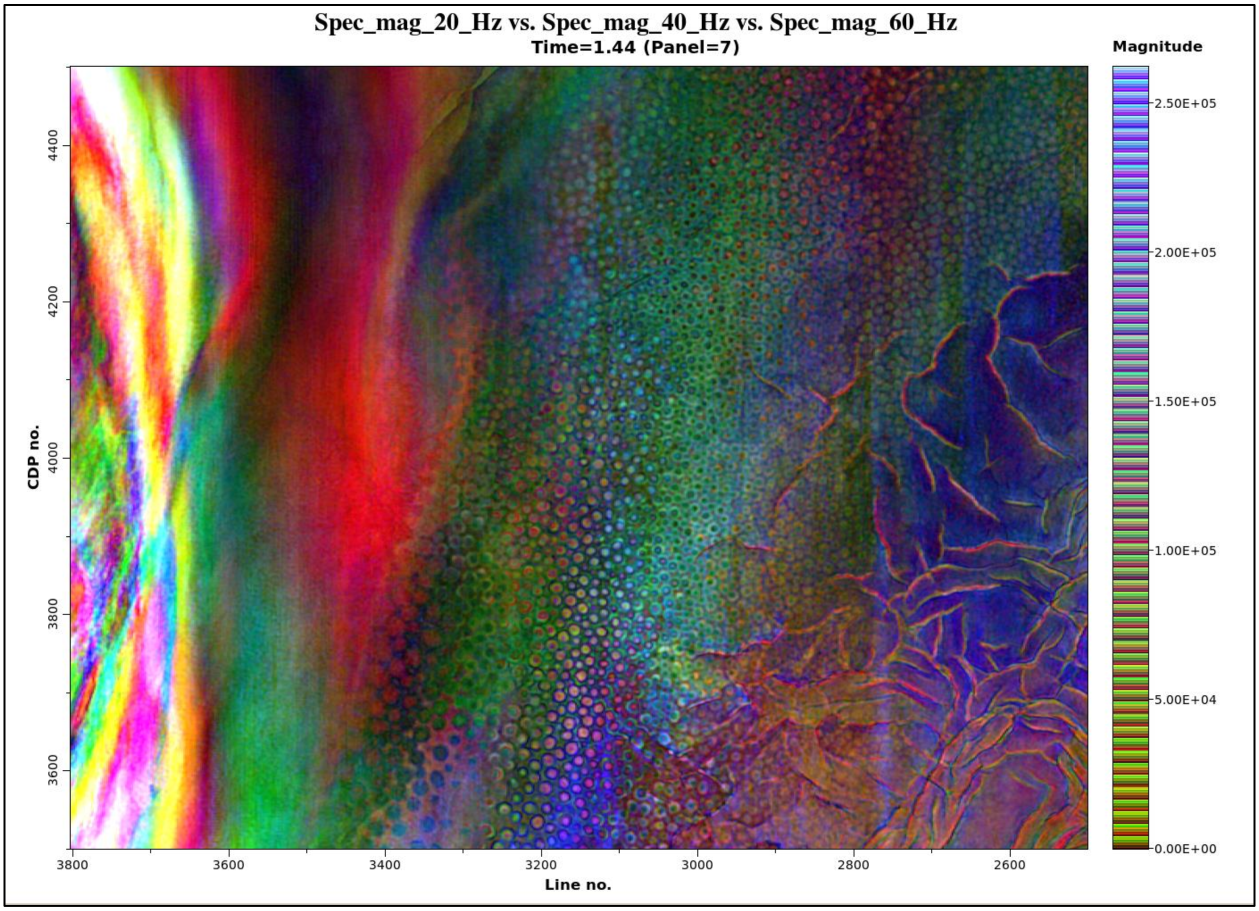
Executing the program for the same three volumes and data ranges, I obtain the following 3D color bar (only three of the 64 panels are shown):



and a more detailed histogram (consisting of 64^3=262,144 bins):

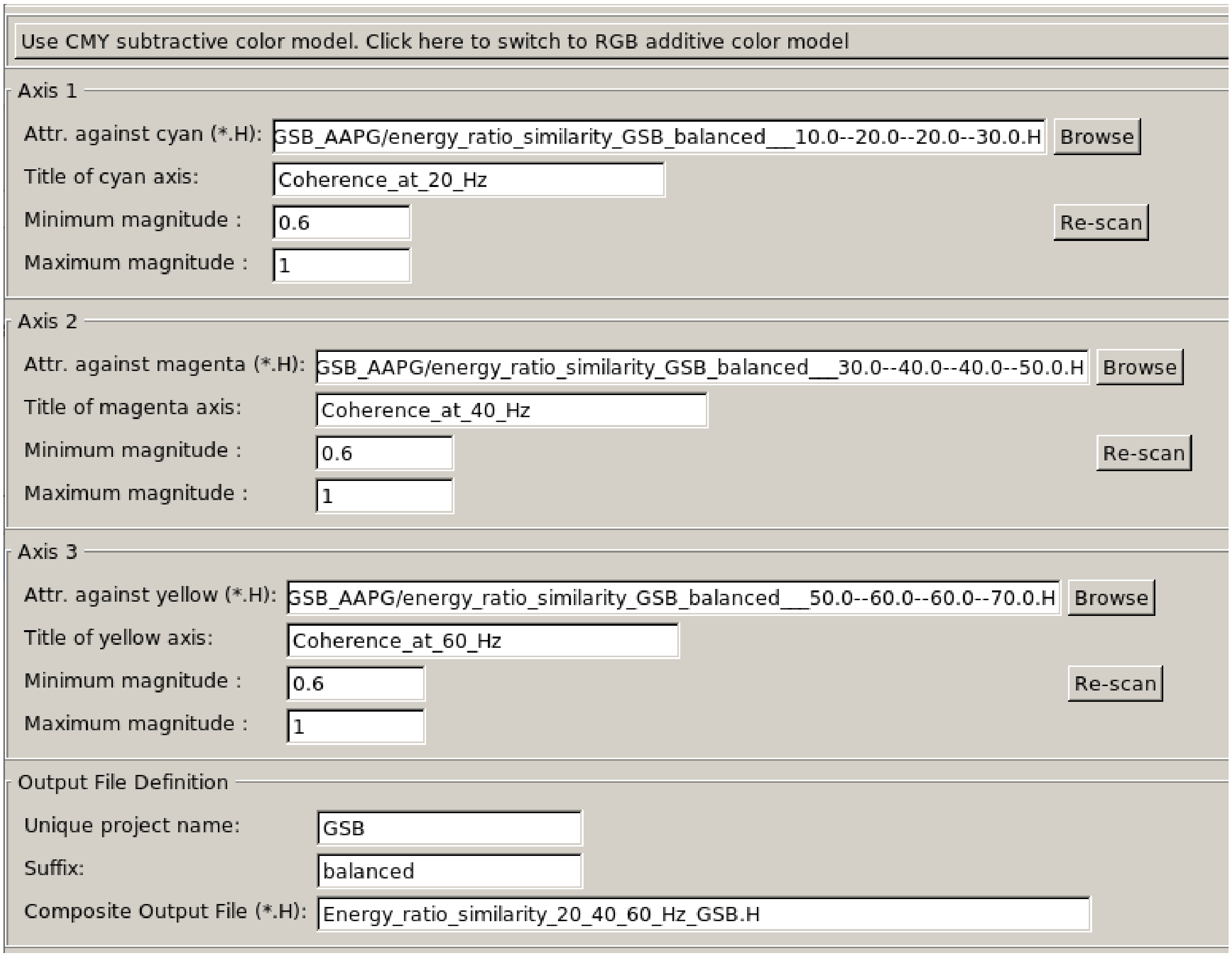


Resulting in a corendered image with increased color depth:

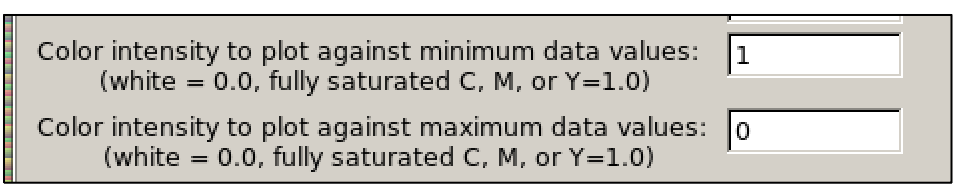


Plotting against CMY

To plot against CMY rather than against RGB, I go back to the original GUI and toggle the (0) *Use CMY subtractive color model* option. Then I enter the three volumes I wish to plot against CMY, in this case energy ratio similarity (coherence) computed about 20, 40, and 60 Hz.

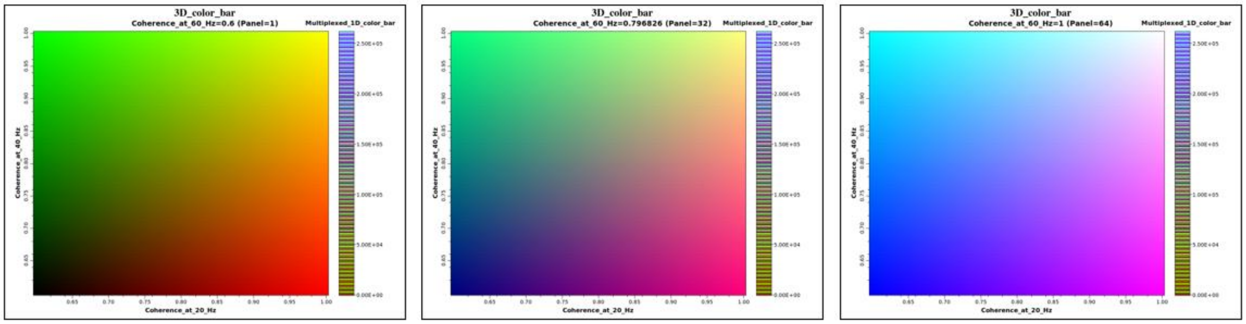


Coherence is a little different than most single polarity attributes in that the anomalously low values are the ones that delineate features of interest. I want these low values to plot against strong values of cyan, magenta, and yellow, whereby if all three values are totally saturated, I obtain a black image. To do so, I need to map the minimum values (similarity = 0.6 in the three axes) against the maximum saturation (1) and the maximum values (similarity =1.0 in the three axes) against minimum color saturation (white):

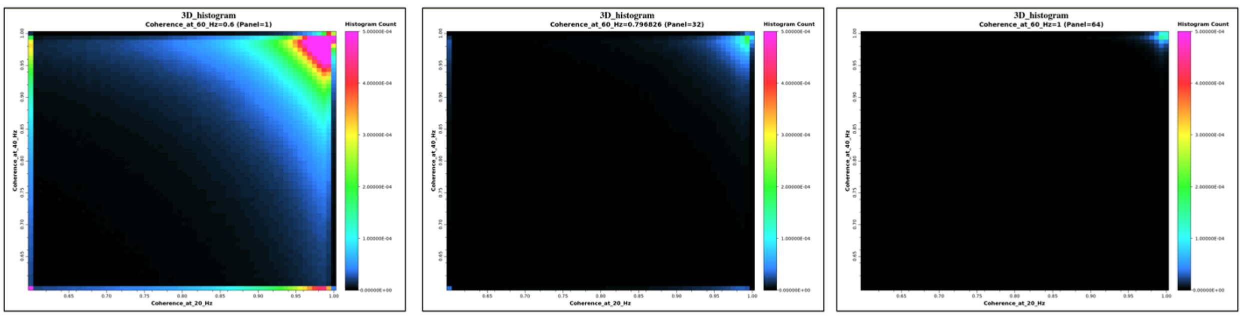


Because of this flipping of the axes, the color bar will plot up the same as before (for 64^3=262,144 colors):

Display Tools: Program **rgb_cmy_plot**

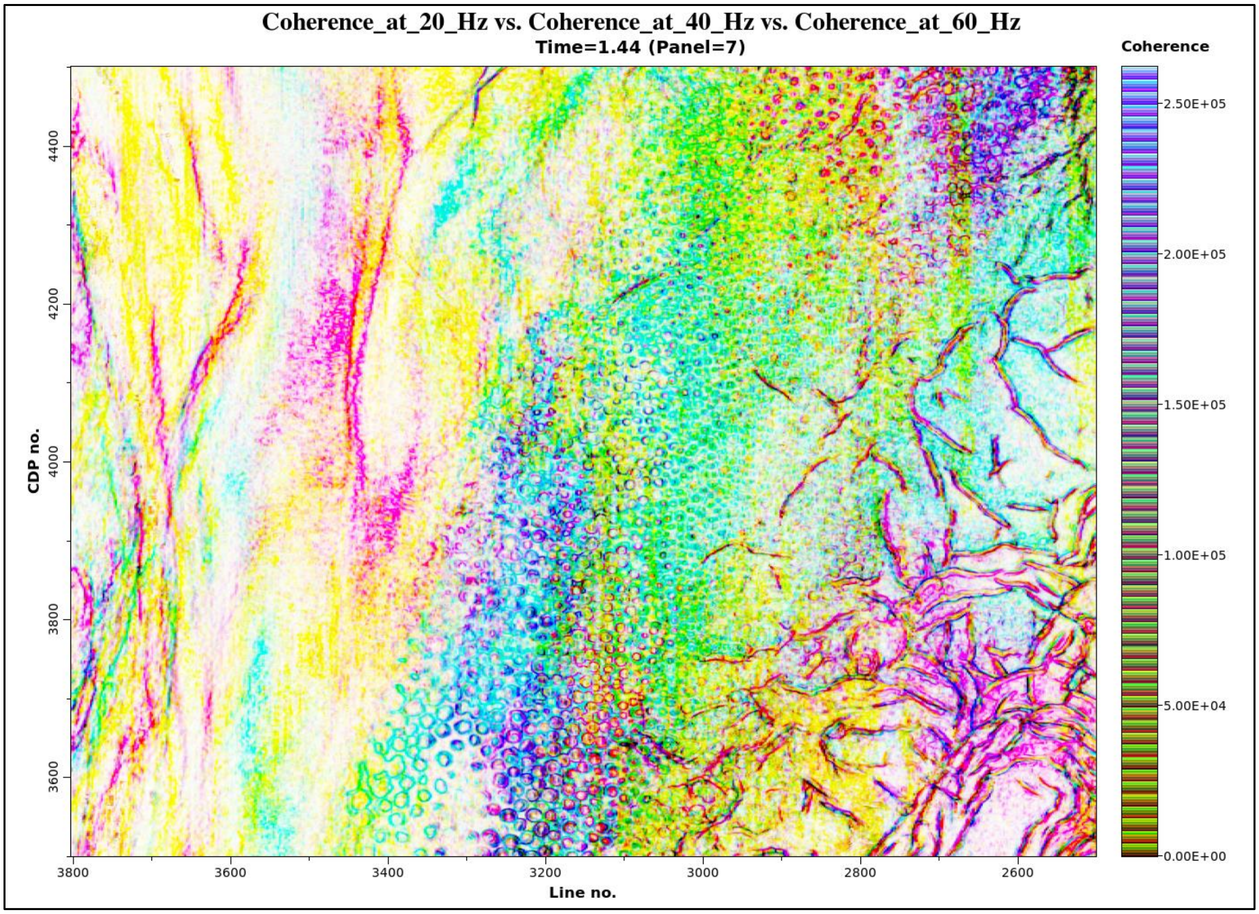


If values of similarity for each attribute are close to 1.0, the voxel will be white. If values of similarity of each attribute are less than or equal to 0.6 (the minimum value), the voxel will be black. The corresponding three panels of the histogram look like this:



Where most the data cluster about similarity=1 for each axis. The values along three left and bottom edges of the first panel correspond to clipped values of similarity < 0.6.

The resulting composite color image at t=1.44 s looks like this:



where we recognize that most of the throughgoing faults have stronger anomalies at the 40 Hz component and appear as magenta (with a smaller subset appearing as black). In contrast, many of the syneresis features change colors, depending on the thickness of the stratigraphic layer cut by this time slice. For this reason, the cyan syneresis features correlate to thicker units tuned about 20 Hz and the yellow correlate to thinner units tuned at 60 Hz.

References

Guo, H., S. Lewis, and K. J. Marfurt, 2008, Mapping multiple attributes to three- and four-component color models – a tutorial: Geophysics, **73**, W7-W19.

Marfurt, K. J., 2015, Techniques and best practices in multiattribute display: Interpretation, **3**, 1-24.