Lab Notes 1: Getting to know SeaDAS (using SST images)

In this lab, we are working with AVHRR SST data to get familiar with SeaDAS. The data you will work with was downloaded from:
https://www.ncei.noaa.gov/products/optimum-interpolation-sst

SeaDAS:

During this course we will use SeaDAS 10 (SeaWiFS Data Analysis System, version 10). Although SeaDAS was specifically developed by the Oceancolor Group at NASA for analyzing data from the first ocean color sensor, CZCS, back in 1994. The software now supports analysis of all US and international ocean color satellite data products as well as other sensors.

SeaDAS has many features and can be overwhelming at first! Luckily, there is a detailed help section as well as video tutorials available on the SeaDAS website. It can be downloaded for free, so you can install it on your own laptop as well.

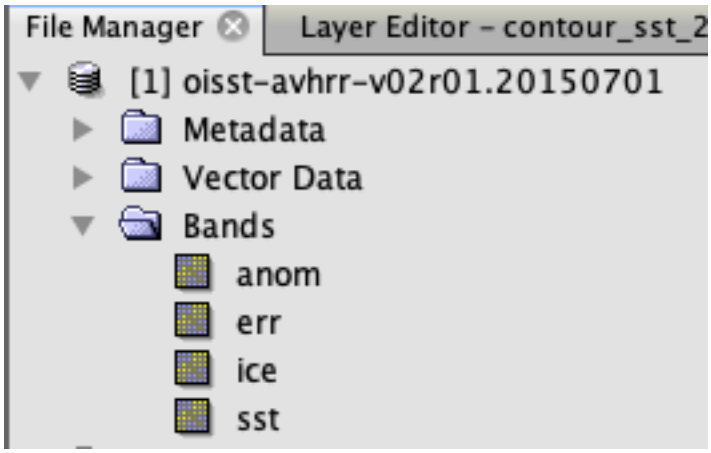
Load SST data into SeaDAS:

In this lab we use OISST (Optimally Interpolated Sea Surface Temperature) satellite data using some basic SeaDAS functions.

1. Go to the course website or Canvas page. Go to Files > Labs > Lab1 and download the two .nc files.by clicking on the "Lab 1" link and then the .nc files.
    a. See the SST files? Notice the file names. Typically, file naming conventions give an indication of the type of data and date
        i. For example, 'oisst-avhrr-v02r01.20150701.nc'
            1. "oisst-avhrr-v02r01" refers to the product and version number
            2. 20150701 refers to July 1, 2015
            3. When is the second file from?
    b. **Download BOTH FILES** into your own computer. It is advised to make a dedicated Lab1 directory in your Documents folder and place these files in it. **DO NOT USE SPACES in this directory title or in any file titles – SeaDAS hates spaces.**

2. Start SeaDAS by clicking the SeaDAS desktop shortcut (Windows/Mac) or by opening a Terminal window and typing "seadas" (Mac only). Open one of the SST files by selecting File > Open File
    a. **Make sure you are opening the files from YOUR directory you created above.**
    b. If prompted, open as Generic NetCDF Data Product

3. Now, in "File Manager" you will see your file displayed. Click on the sideways arrow to reveal the subfiles.
    a. "Bands" (or products) refer to the raster data. In this case, sea surface temperature
    b. "Metadata" describes contents of the file, variable names, dimension, processing etc.
    c. In order to display the SST image, double click the SST band in the Bands subfolder.
        i. If the band does not appear, try double-clicking on the icon next to the name



    d. Under the "Pixel Info" window on the right sidebar, you can see data values (SST) and location (lat, lon) at each pixel as you move your mouse

SeaDAS workspace:

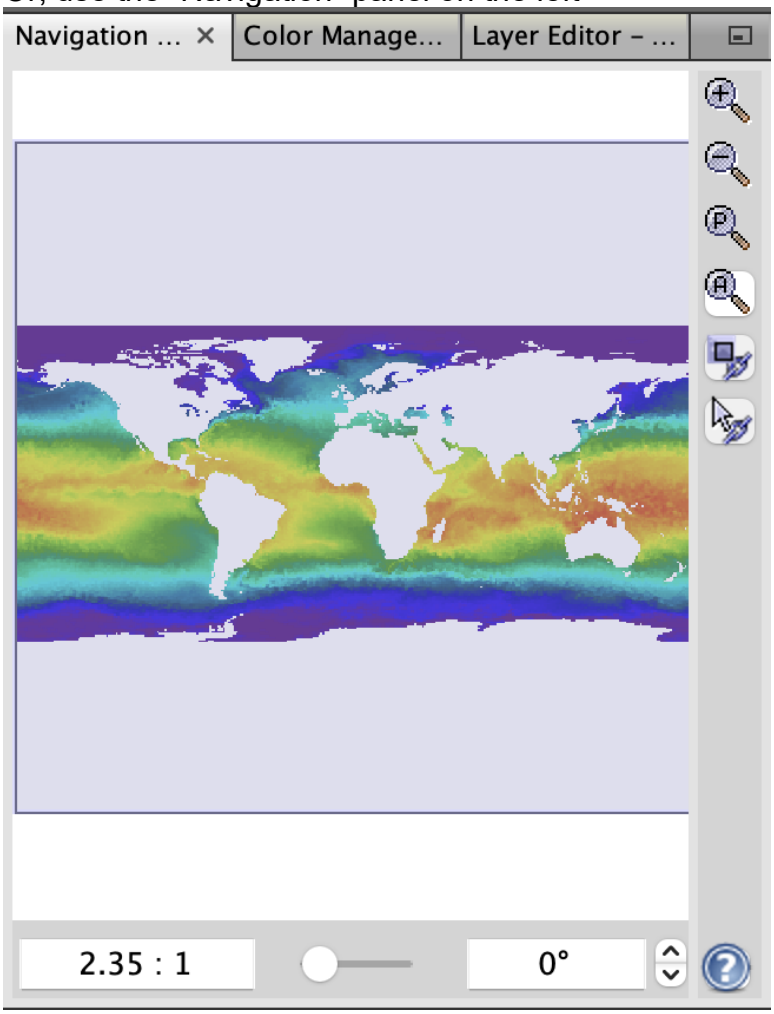
- To get more space to view your image, you can minimize any of the workspace windows (File Manager, World Map Location, Pixel Info, etc.) on the right or left. Once they are minimized, you can hover over the workspace windows to see.
- If you've moved things around and don't like it, you can always "View > Toolbars > Reset Toolbars"
- If you are ever unsure what a button does in SeaDAS, hover over it with your mouse for a tooltip!

SeaDAS display basics:

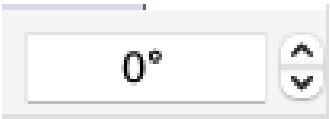
4. In order to zoom and navigate around the image, you can
    a. Click the magnifying box on the top tool bar and draw a box around the area you want to zoom to

b. and click/drag to move location with the hand icon

c. Or, use the “Navigation” panel on the left

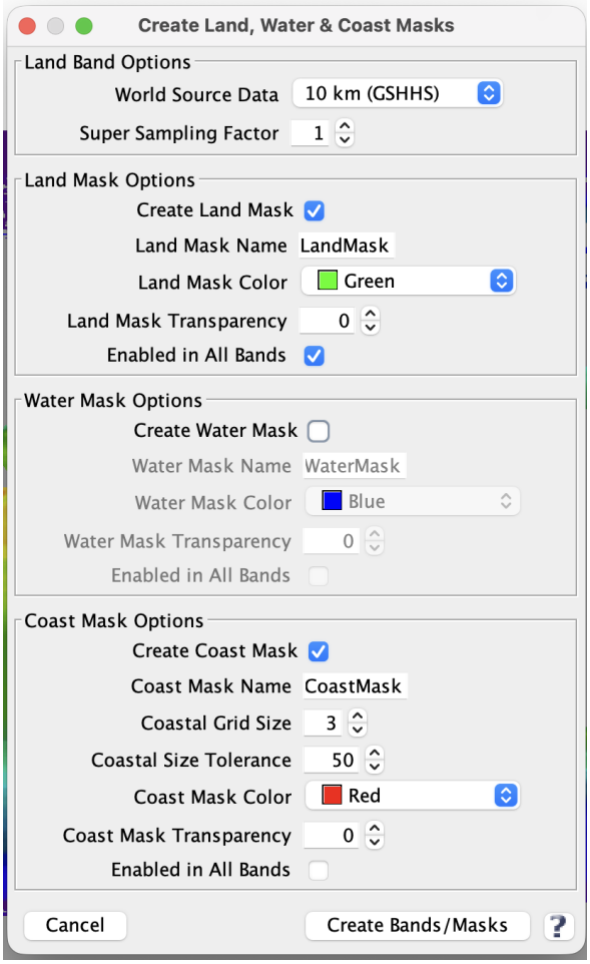


i. The 4th icon down  is a quick way to zoom out to the whole image
ii. You can rotate the image with the arrows at the bottom right of the panel

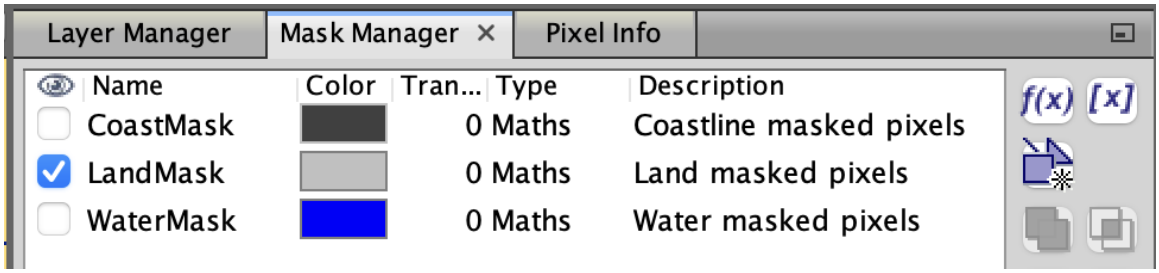


iii. Or you can use the scroll wheel on your mouse.

5. You will be creating different layers on your image
    a. First, to visualize where there is no data (referred to in SeaDAS by NaN, meaning “Not a Number”), click the ‘no data layer’ icon ( ) in the upper tool bar
    b. Add the land or coastline by clicking the landmask icon ( )



        1. Pick the resolution (1km or 10km). Try 10km for now for a global image
        2. A “Super Sampling Factor” value >1 will increase the resolution of the coastline, but will take much longer to process. Try 1 for now, but for your final projects you might experiment with this value
        3. You can change the color of the coastline/land/water masks and enable them by clicking on/off “enabled in all bands” for each of the masks. Add a landmask.
        4. “Create masks” will add the layers to the image (this can take a few minute depending on your selection)
    c. Once you’ve created new layers (including landmasks, coastlines, gridlines) they are all stored in the “Mask Manager” on the right side of your work space



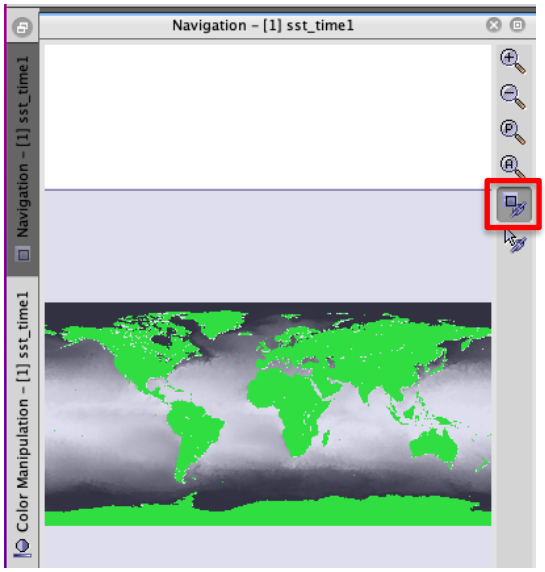
i. You can toggle layers on/off as well as dragging to change the order in which they are displayed
ii. You can also change the color (RGB or selecting on the drop down menu) and transparency (in fraction, 0=not transparent, 1=100% transparent)
iii. Note: if mask manager does not automatically appear it can be found in View > Tool Windows > Mask Manager

d. Add gridlines (aka graticule) by clicking the gridline icon 
   i. To edit how the gridlines look, in the "Layer Manager" click "Map Gridlines," then click the edit icon on the right

ii. This will bring up the layer editor toolbox on the lower left side of the screen, where you can change formatting of the gridlines and associated labels

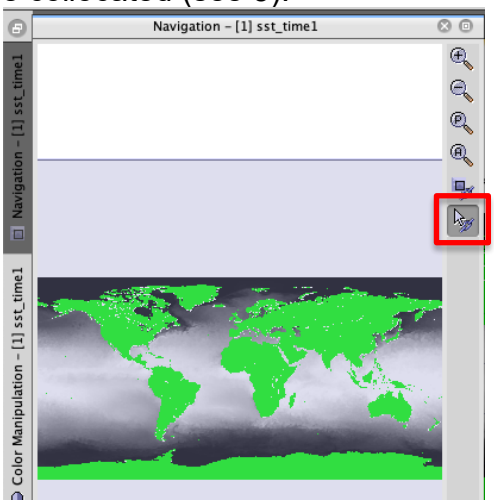
Working with multiple files:

1. Open the second file (from your personal directory) and display SST by double clicking the band.
2. To visualize multiple windows at once, click Window > Tile Evenly (or Horizontally or Vertically, if you prefer)
3. In order to synchronize the windows when you zoom/move, click the icon shown below that says "Synchronize views across multiple image windows" in Navigation Controls when you hover the mouse over it.



   a. Now, if you move one of the images around (with the hand tool) the other one will move as well

4. To synchronize curser motion and the associated pixel info click the lowermost icon. When you hover your cursor over the icon, “Synchronizes Cursor Position across multiple windows” should appear. You will not be able to see the associated pixel information for both files at once until the files are collocated (see 5).

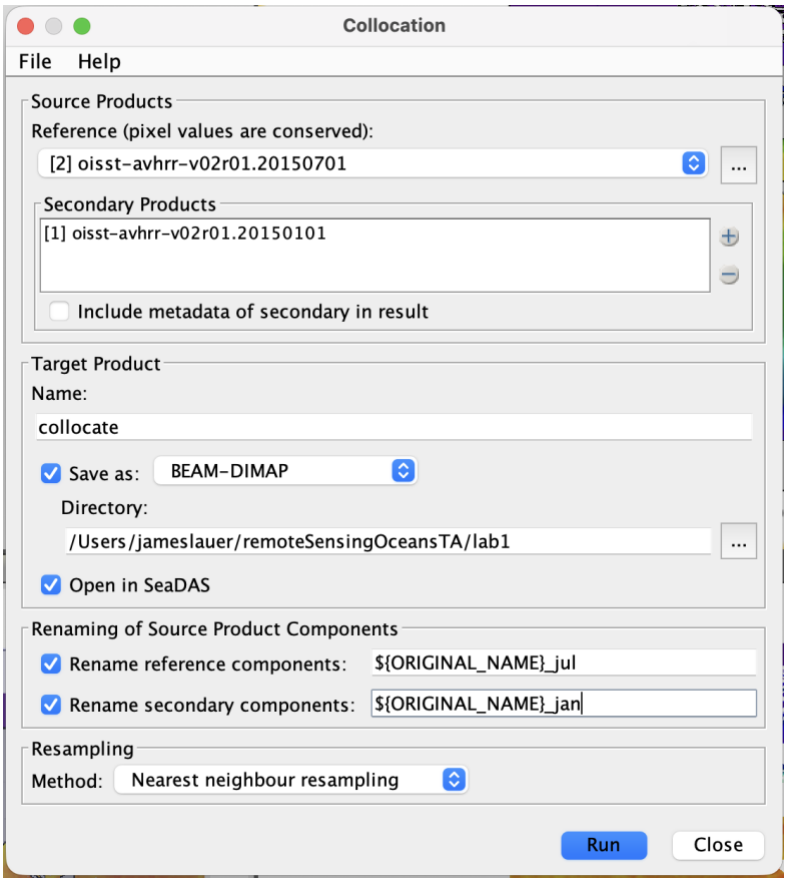


5. If you want to do analysis on bands from different files (like adding or subtracting one band from another), you may have to create a single file that has bands from multiple files. To do this, you use the collocation tool in the top toolbar () which can combine two files (including all the associated bands) at once

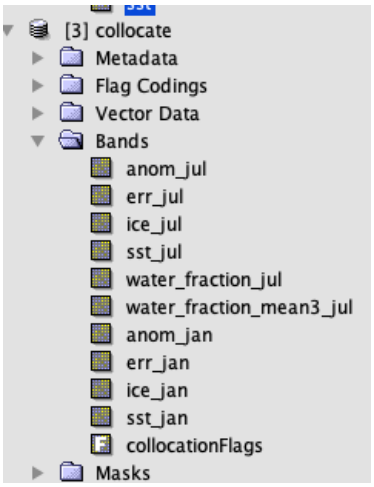
   a. In SeaDAS, these files are considered the ‘Reference’ file and the ‘Secondary’ files, though past versions of the software have used different terminology, and some menus may not reflect this change (see here for why this terminology was historically used and efforts to modernize this language in coding). The projection of the

reference will be conserved in the new file.

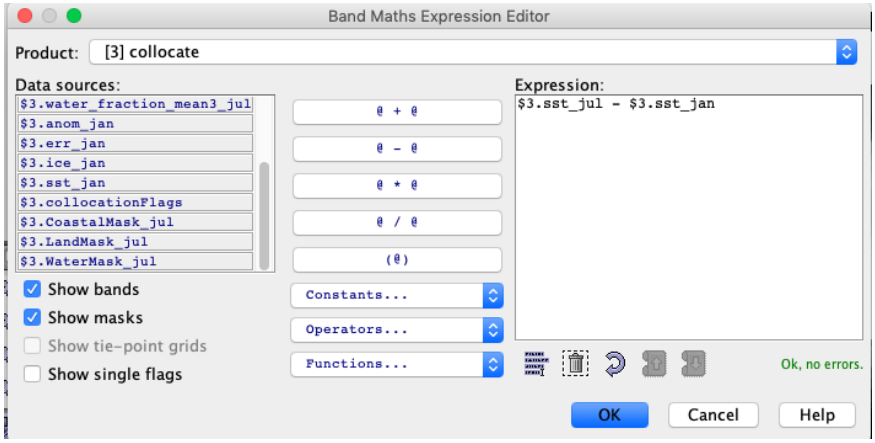
b. Select the Reference file
    i. Note: it does not matter which file you select as the Reference and which is the Secondary
c. Select the Secondary file (click the + symbol, and select 'Add product(s)' to select the other file that is loaded in the File Manager already. If the file was not opened already select "Add product file(s)"
d. Name the new file, and change the target directory to the folder you created earlier
e. Change suffixes to match the reference and secondary. For example below, I have the reference file set as file '20150701', so I will identify the bands from this original file by using the suffix "jul".
f. When you are ready, click "Run" to combine the files into a collocated file.



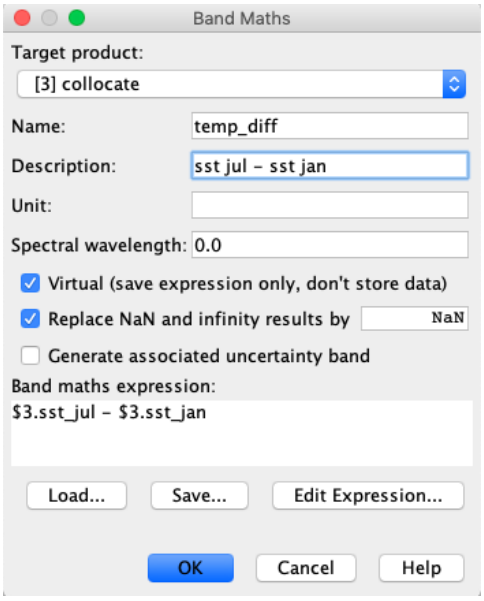
g. The new file will be added to File Manager. Note that the original bands can now be identified by the suffix you provided



6. What if you want to do some band-arithmetic? For instance, to find the SST difference between two months? Or the average of two or more scenes?
    a. Click “band-math” icon in the top toolbar ( )
        i. The ‘target product’ will store the band you will make using ‘band-math’. Select your collocated file.
        ii. Edit the math expression (click “Edit Expression…”). For example, let’s find the SST difference between summer (July) and winter (January) of 2015. To do so:
            1. Select the bands and arithmetic functions



            a. You can also do other math expressions including “if/then” statements etc. (check out the drop down options under constants, operators, functions)
        iii. Name the new band
        iv. Add to “description” as a reminder



v. Click “Ok”

b. Use your mouse to get a sense of the SST differences.
   i. What is the general range? What are the units? What general trend do you notice? Does that make sense for the band-arithmetic that you calculated?
   ii. Hover over the band in ‘File Manager’ to remind yourself of the band-math description

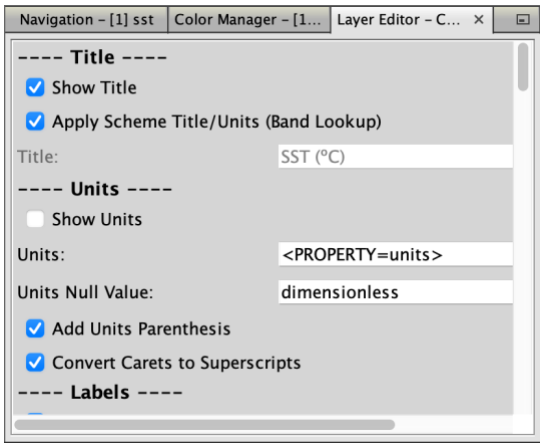
Color scheme:

1. You can pick from pre-made color bars in “Color Manager” on the left side of your workspace
   a. Under scheme, SeaDAS pairs typical color schemes with products. These are designed for typical ranges/distributions of oceanic parameters (like, Chl).
   b. You can also pick from a CPD (Color Palette Definition) file directly
   c. Try applying different color schemes to both the temperature difference band as well as original SST bands. Make sure to enter the correct range.
      i. How does that change the way your data look? Choosing an appropriate color scheme is very important for how you report data!
      ii. A helpful trick for setting the range – Within the Color Manager “Basic” view, click “From Data” or under “Sliders” you can see the minimum and maximum of your data range

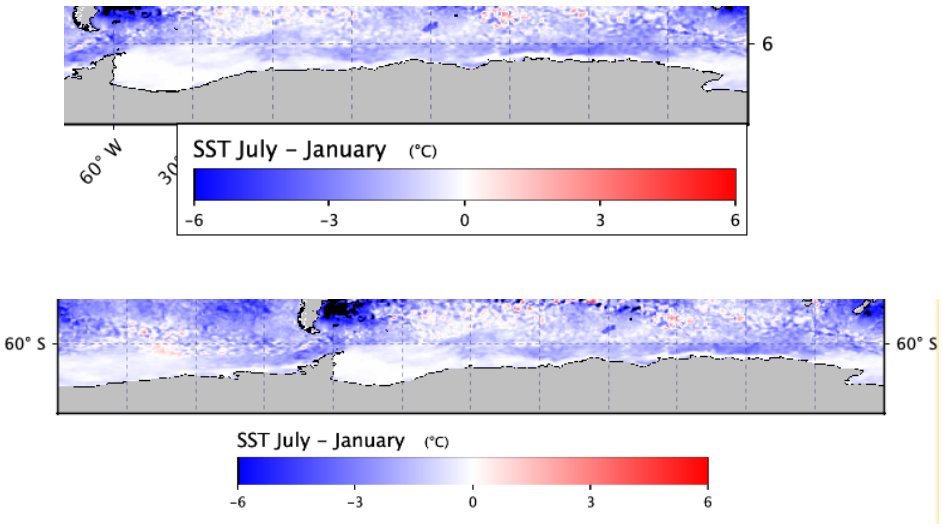
2. You can add a color bar by clicking the color bar icon at the top ( )
   a. Within Layer Manager > Color Bar Legend, you can edit (ex. Title, Units) in the Layer Editor (tab next to Color Manager on the left

side).

i. Mac Tip: if you want to make the degree symbol °, hold shift-option-8!
ii. Windows Tip: turn on numLock then hold alt and type '0176' on the number pad. The degrees symbol should appear



iii. You can either choose SeaDAS to automatically space the numbers on the bar OR you can manually choose what numbers are displayed (in the above example the minimum and maximum should be the same so that no difference (zero) is white, whole numbers will look better too, so you can change to -15,-10,-5,0,5,10,15)
iv. If your color bar looks weird, make sure that the log scale is turned off (in the "Color Manager" panel, make sure that the log10 button in the top right is not depressed, it's grey if it's turned on. You should also re-set the range of the colorbar to center on 0, with negative and positive values as the range limits.
v. SeaDAS will automatically make the color bar horizontal, but if you prefer you can select a vertical orientation
vi. If you want to change the size, open the color bar settings again and you can edit the legend scaling (Layer Editor – ColorBar > Size & Scaling section) bigger or smaller
    1. If some of your gridlines overlap with your colorbar, you can turn off those labels. In this example, you would turn off the South Labels in the Gridline Edit menu (Layer Manager -> Graticule -> Edit icon) or you can remove the colorbar title.

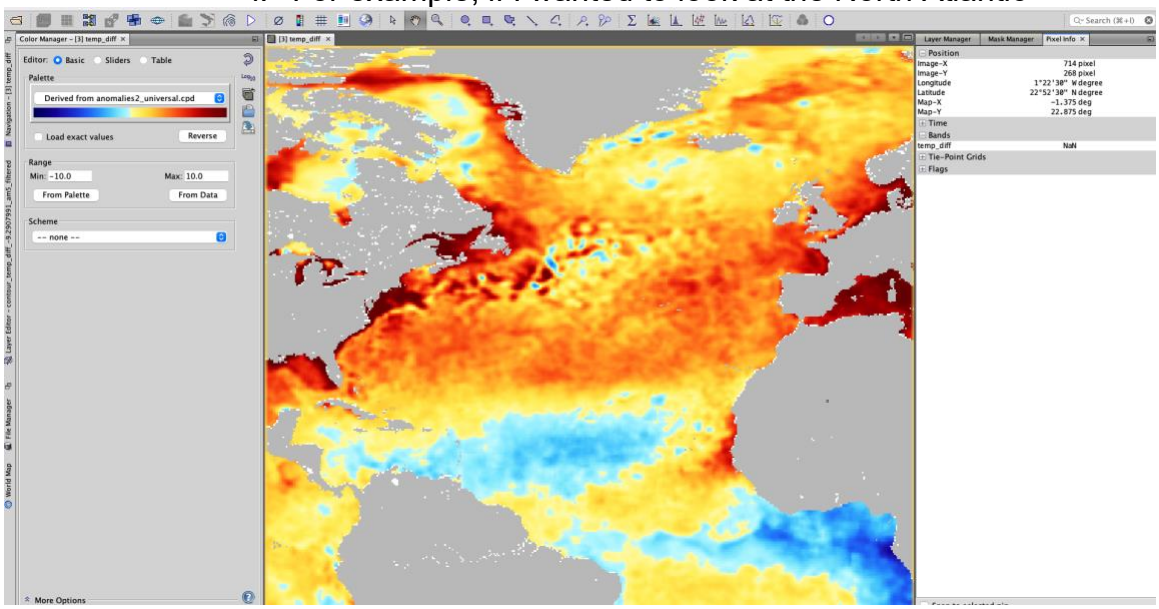


Contour Lines:

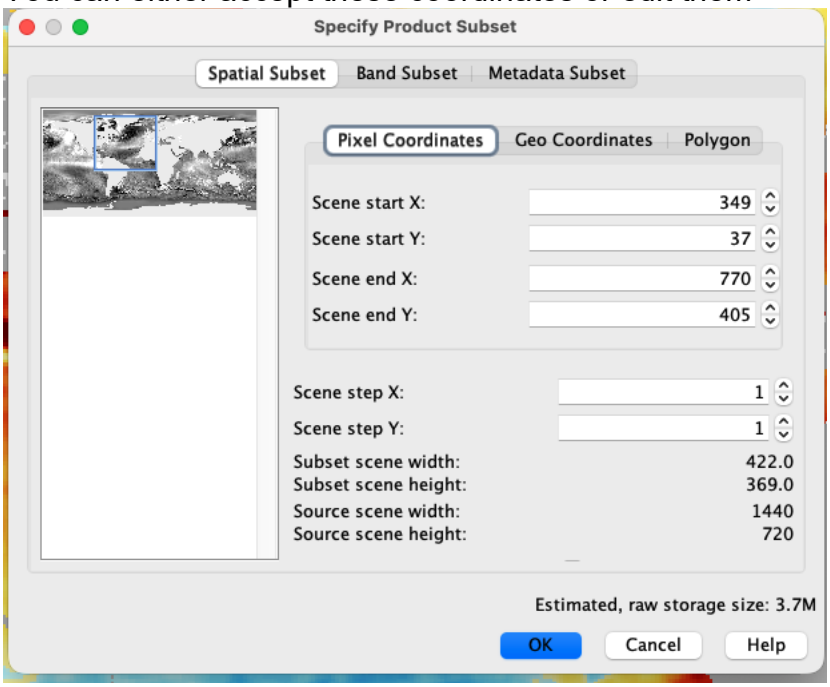
1. To add contour lines to your data, click 
    a. Select the start and end value to your contour interval as well as the number of intervals
    b. Select log if you want a log distribution of intervals
    c. Preview/edit allows you to edit the contour value/color
    d. You can add another 'set' of contour intervals by clicking the +

Subset:

1. If you want to only view part of your region, you can subset the image
    a. First resize the window (by zooming and moving) to roughly what you'd want your cropped image to look like.
        i. For example, if I wanted to look at the North Atlantic



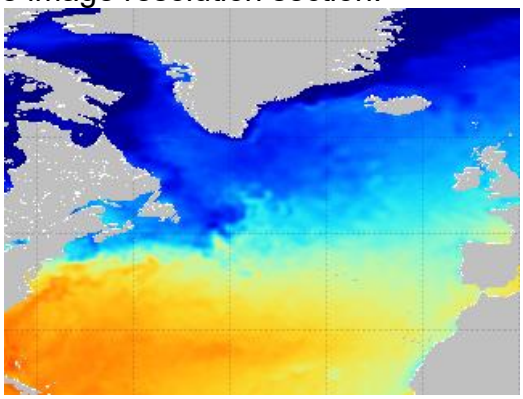
b. Click the subset tool ( ) which will default to the boundaries you set by zooming in
    i. You can either accept these coordinates or edit them



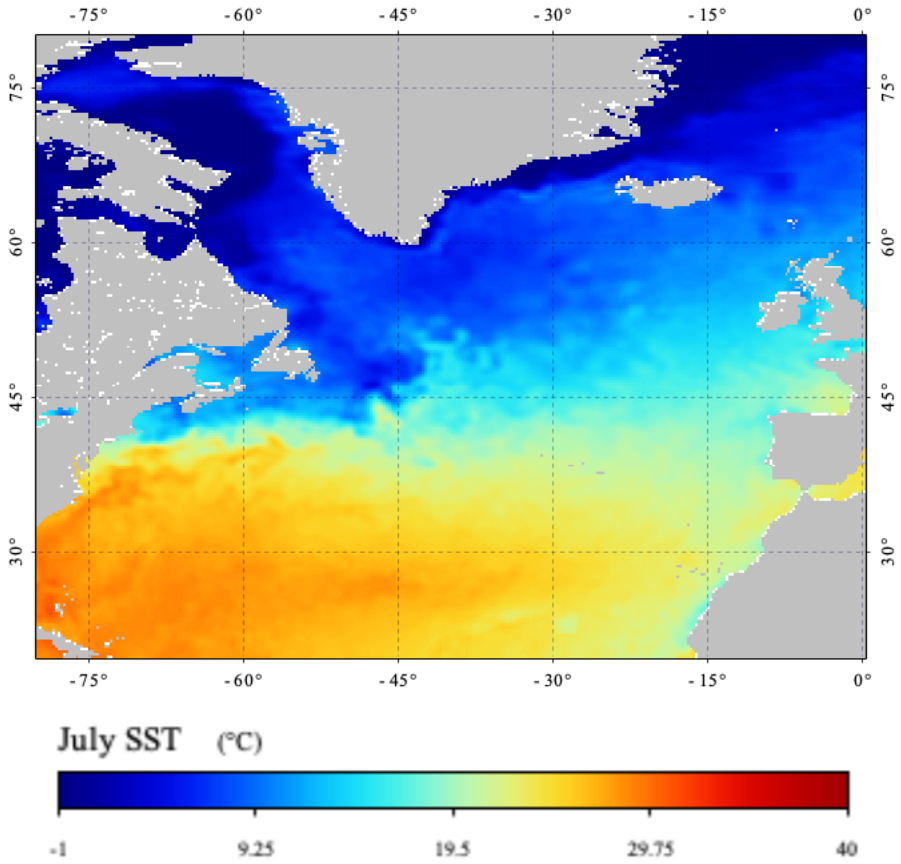
c. This creates a new file in File Manager

Saving:

1. Save an image
    a. Right click on the image and click “Export View as Image”. To right-click on a mac, press control-click. Alternately, go to the top menu and click on File > Export > Other > View as Image
        i. Select your personal directory
        ii. To import only the image of the data (within the boundaries) in the original resolution of the raster data, select “View region” in the image region section and “Full resolution” in the image resolution section.



        iii. But if you want to include anything outside the image, like the color-bar and gridline labels, select “Full scene”



1. However, when you select view region, SeaDAS might reduce the image size. If you want to have a higher resolution, change one of the dimensions image size to match the source data size (the other dimension will scale in proportion)

2. Save the color bar as a separate file
    a. Right-click on the image and click “Export Color Bar Legend”
3. Save a data file:
    a. In File Manager, right click on File > Save Product As.
4. You can save your SeaDAS session (which saves what bands and windows you have open)
    a. File > Session > Save Session (As)
        i. Now, you can open this session when you resume work and SeaDAS will remember the windows open, the masks/layers on/off, which files are open etc. It will restore SeaDAS exactly as you see it.’

5. Quit SeaDAS

TO GET CREDIT FOR LAB 1:
Please send Kevin (arrigo@stanford.edu) the image you just exported!

Please send the "full scene" and make sure your colorbar is shown. Name your file as follows:
{yourFirstName}_{yourLastName}_lab1.png

Lastly, in preparation for Lab 2:

1. Register with EARTH DATA here: https://urs.earthdata.nasa.gov/home and make sure you save your login info for yourself somewhere. Don't put special characters (like /&*) in your password, since it might mess up the next step.
2. Create a .netrc using your Earthdata login credentials from the Terminal (NOTE: this step will not work on Windows. If you are on a windows computer, skip this step):

```
echo "machine urs.earthdata.nasa.gov login USERNAME
password PASSWD" > ~/.netrc

chmod 0600 ~/.netrc
```

(press enter after each of these lines)
Replace USERNAME and PASSWD with your Earthdata username and password.