National Aeronautics and Space Administration

Basic Functionality of SeaDAS

Integrating Remote Sensing into a Water Quality Program

June 5-19, 2019

Objectives & Learning Outcomes

- To learn how to work with aquatic remote sensing imagery using NASA's SeaDAS image processing software

- Learning Outcomes:
  - Gain knowledge about aquatic remote sensing data products
  - Gain knowledge in the processing of remote sensing imagery

Additional Resources

- SeaDAS Introduction (2017): https://seadas.gsfc.nasa.gov/docs/SeaDAS_Intro.pdf
- SeaDAS Tools (2017): https://seadas.gsfc.nasa.gov/docs/SeaDAS_Tools.pdf
- An Exploratory Walk Through: https://seadas.gsfc.nasa.gov/docs/SeaDAS_Walk_Through.pdf
- SeaDAS Help Pages: https://seadas.gsfc.nasa.gov/help/

# Location of Study: Suwannee River Mouth, Florida, USA
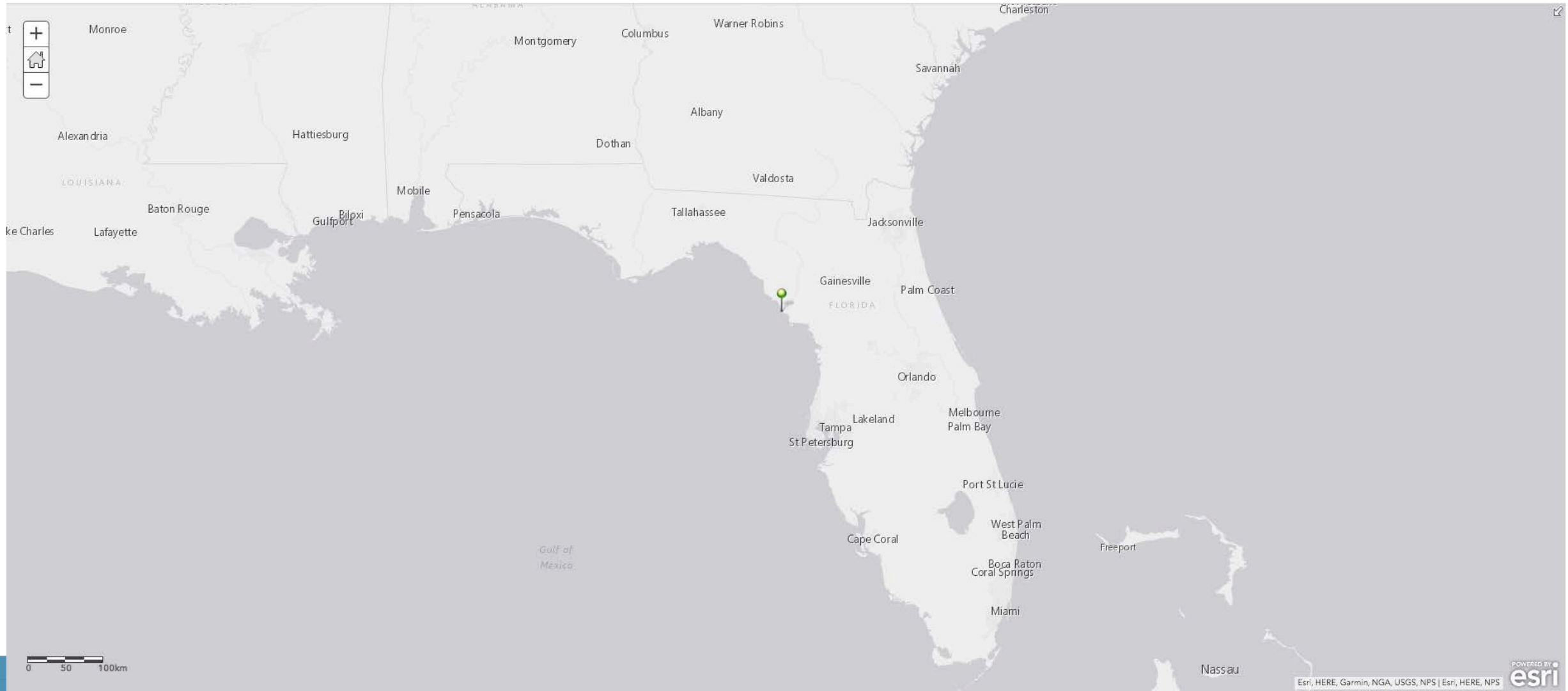
Basic Functionality of SeaDAS

Data Download

- In the Part 1 Demonstration, you were provided with instructions on how to download the data for this exercise. You can also find the data on the course website. The Aqua-MODIS files used for this exercise are:
  - A2015051184000.L2_LAC_OC.nc
  - A2015051184000.L2_LAC_IOP.nc
  - A2015051184000.L2_LAC_SST.nc
- Save these files to a folder that is not too deep in the directory structure.

Launch SeaDAS
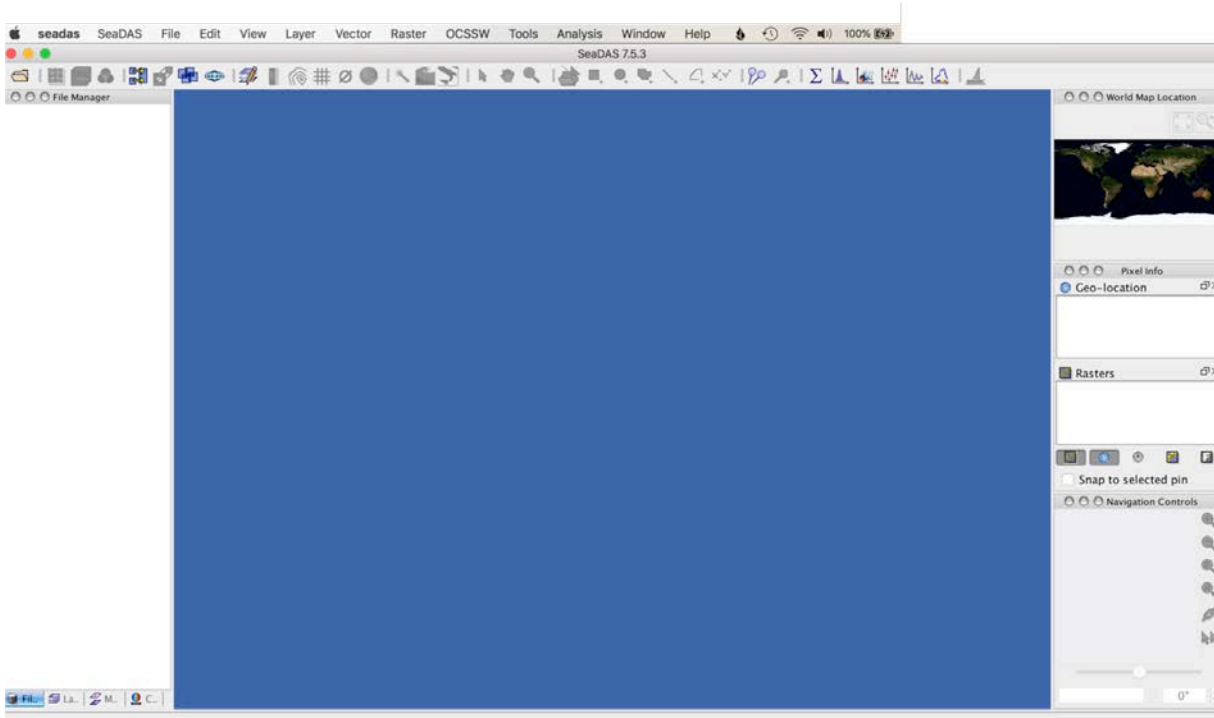
- This is the default viewer
- Note that some of the screen shots shown in this exercise may not look exactly the same as what you see. This is okay.
- The goal of the exercise is to be a roadmap for how to process imagery
- Some reasons for the mismatch could be from:
  - your computer's operating system
  - your version of SeaDAS
  - some user-defined layouts of the SeaDAS viewer

Basic Functionality Skills in SeaDAS

- In this exercise you will learn:
  - how to open a file
  - how to choose rasters
  - basic features of SeaDAS
    - no data
    - synchronizing
    - create color bar
    - export image
    - land masks
    - flags
    - adjust color bar
    - reproject
    - zooming
    - map location
    - gridlines
    - crop

- This document provides general directions on how to use SeaDAS. **Note that not every step will be explained**. As you master each skill, the instructions will assume more autonomy on your part.

Opening a File

1. From the menu bar in SeaDAS, click on **File** > **Open** and a window will pop up
2. Navigate to the folder where you saved the images and click on the file named:
   – A2015051184000.L2_LAC_OC.nc
3. Select the **Open Product** button. You will see the file appear in the **File Manager** pane of the SeaDAS viewer window.
4. Using your mouse, adjust the width of this pane so you can see the full name of the file. Click on each of the three triangles next to **Metadata**, **Flag Bit Coding**, and **Rasters** to expand the view.
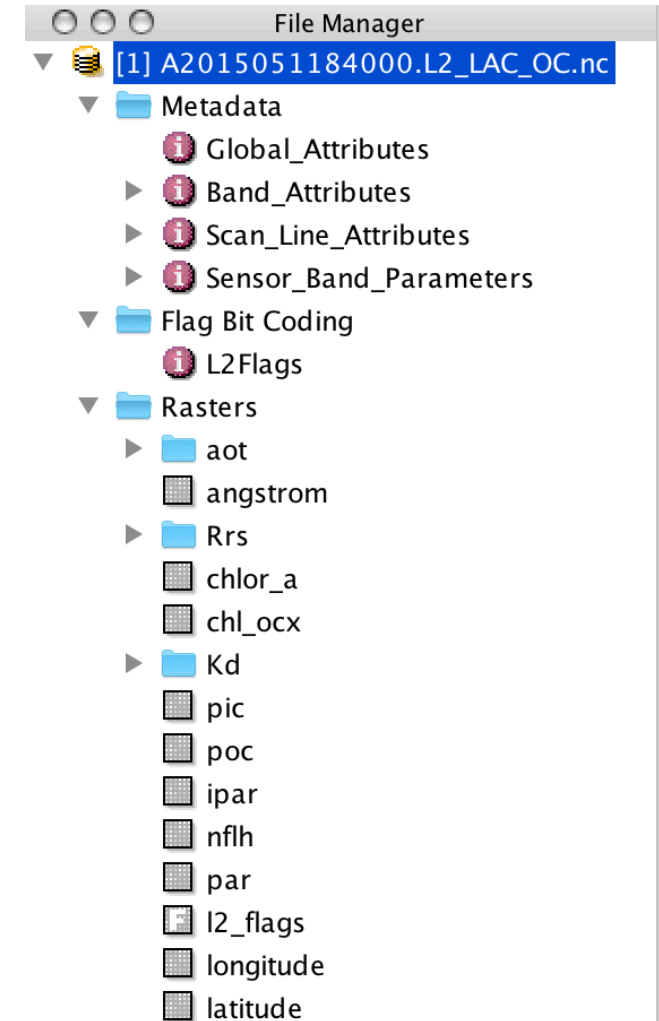
Explore Some File Attributes

- Take some time and click on each of the attributes under the **Metadata** and **Flag Bit Coding** folders

- Windows will pop up as you look through these to provide information such as the attributes of the satellite overpass and sensor, the location and time, the ambient sun angle and atmospheric optical properties, units for the observations, etc.

- For the purposes of this exercise, we will not be going into great detail about the values in the Metadata

- As you become more proficient in image processing it is a good idea to refer to these files to better understand the conditions under which the imagery were collected and if an processing errors were encountered

- Close all of the windows that opened when you were reviewing Metadata and Flag Bit Coding

- Collapse those folders by clicking on the triangle to the left of the folder name

Choosing a Raster

- When exploring imagery on a server like NASA's Worldview, easy to view imagery includes chlorophyll-a and Sea Surface Temperature (SST). The individual data files that you can download from the Level 1 & 2 Browser includes much more than just chlorophyll-a and SST

- Look at the raster choices in the File Manager. The data products include:
  - Remote Sensing Reflectance at 10 wavelengths (Rrs)
  - chlorophyll-a (chlor_a)
  - diffuse attenuation of light at wavelength 490 nm – a proxy for particles (Kd_490)
  - particulate inorganic carbon (pic)
  - particulate organic carbon (poc)
  - instantaneous photosynthetically active radiation, or light from 400 – 700 nm (ipar)
  - normalized fluorescence line height – a proxy for phytoplankton biomass measured in a different part of the spectrum than chlor_a (nflh)
  - l2_flags
  - Location data
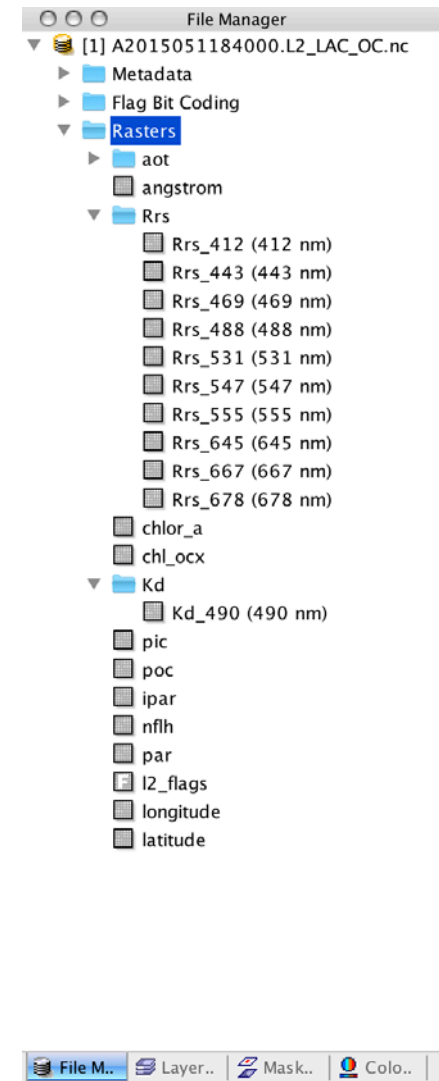
Choosing a Raster

5. Double click on chlor_a in the A2015051184000.L2_LAC_OC.nc file
   – Note that the SST data are missing from this file
   – Recall that this file has 'OC' appended to it to indicate 'ocean color'
   – We also want to view the SST image.
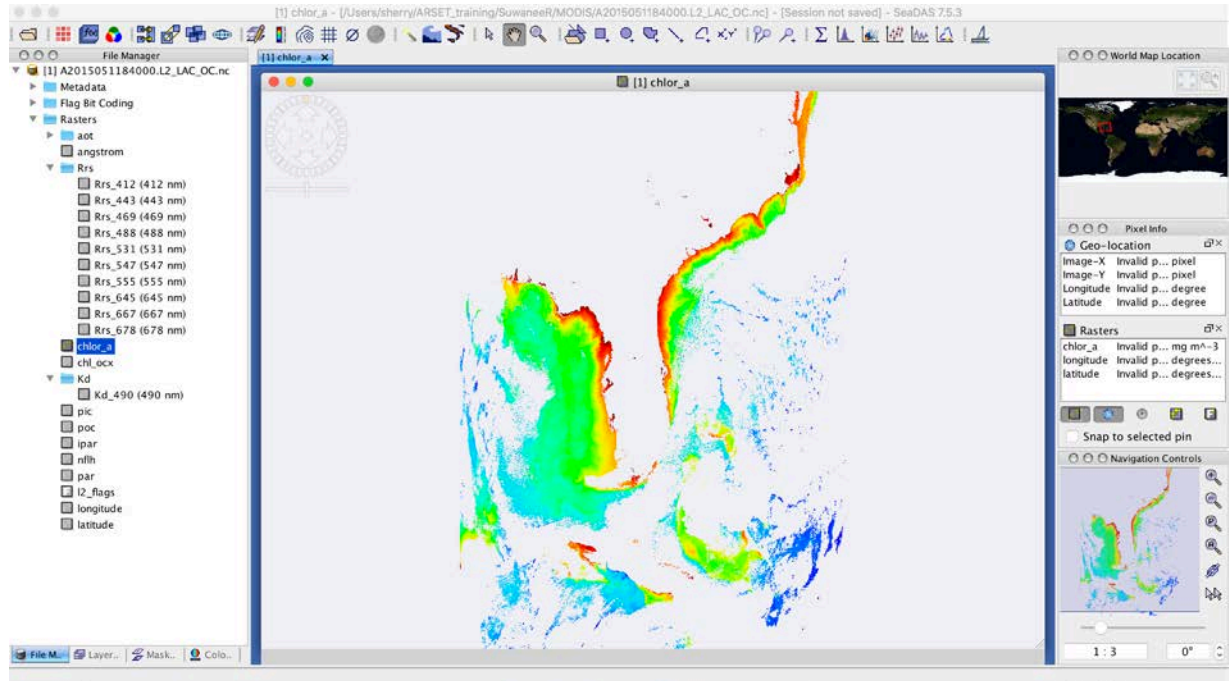
View the SST Image

6. Following the instructions from Step 1, open the file named: A2015051184000.L2_LAC_SST.nc

7. Double click on **SST** under rasters in the A2015051184000.L2_LAC_SST.nc file

   – We want to observe the Suwanee River Plume

   – The river is a naturally occurring "blackwater river," which means it has high concentrations of colored dissolved organic matter (CDOM) in it

   – To observe CDOM, we want to use the data product named **adg_443_giop**
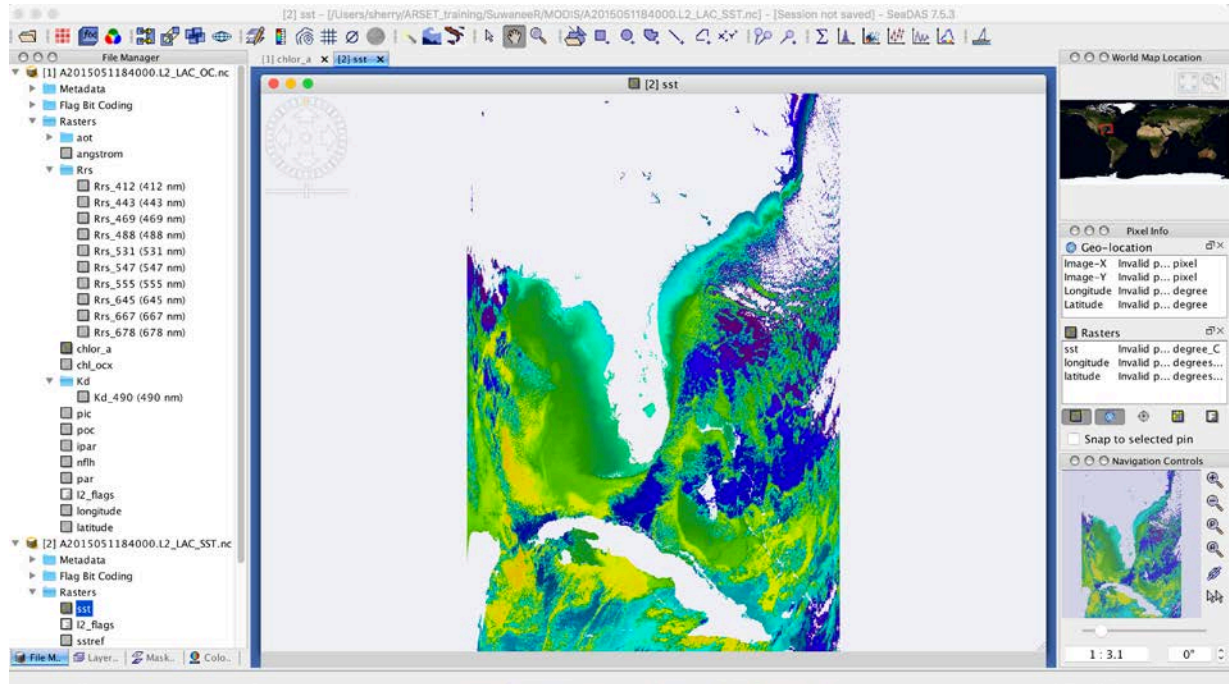
Observe CDOM

- adg_443_giop is an estimate of the absorption coefficient of non-algal material plus CDOM (adg) at 443 nm in m^{-1}
  - Remember that absorption is an inherent optical property (IOP)

8. Follow the same file open instructions and open the file named: A2015051184000.L2_LAC_IOP.nc

9. Double click on the **adg_443_giop** raster in the A2015051184000.L2_LAC_IOP.nc file
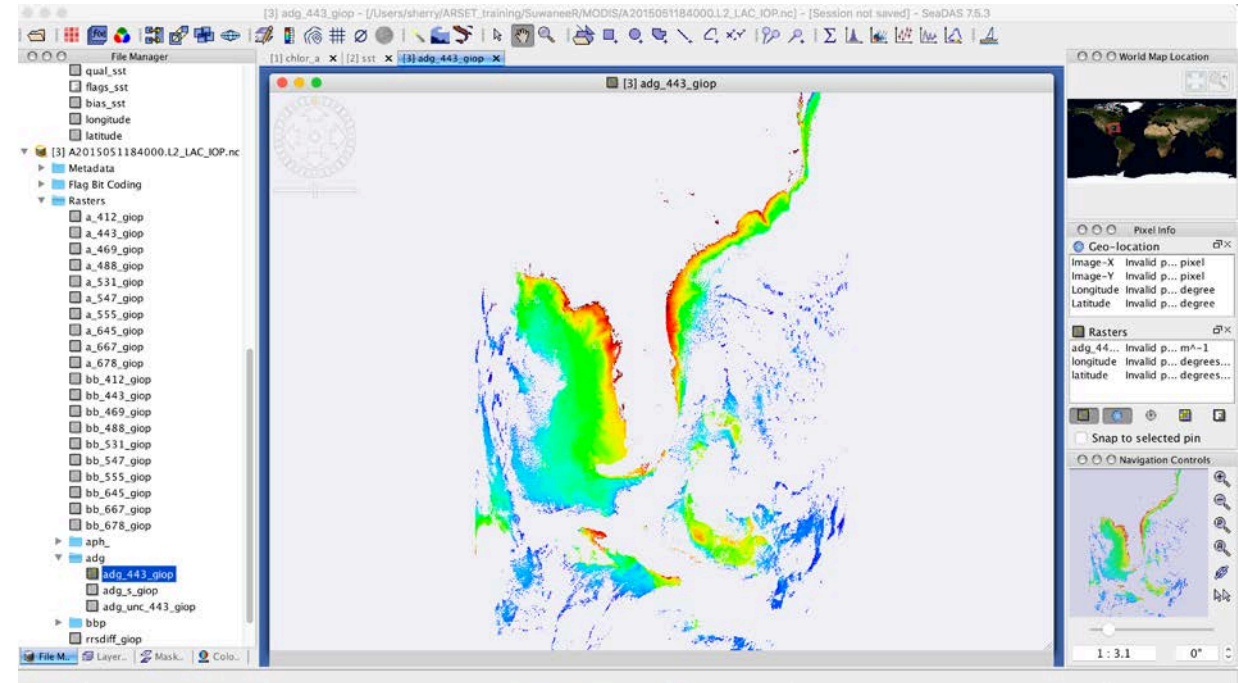
Compare Chlorophyll, SST, and CDOM

10. Click on the chlor_a tab in the main viewing window
    – Take some time now using your mouse to move the image around and to practice using the selection, panning, and zooming tools:

11. Try zooming into the Suwannee, FL area
    – Observe the features offshore
    – Think about what these colors mean
    – Note that this image has not yet been reprojected. We will get to that later. For now, we will try using some of the basic tools of SeaDAS.

Basic Features of SeaDAS

No Data

1. Click on the **No Data** icon ⌀ in the tool bar
   – This action will grey-out no-data values in the layer
2. Resize the pane on the right so you can read the information in the **Pixel Info** pane
3. Using your mouse, roll over the areas where there are no data and where there is data
4. Look at the values for chlor_a and see how they change between no data and data regions of the image

No Data

No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject

Crop

No Data

5. Note the chlor_a values in the **Pixel Info** window

6. My mouse (not visible on slide 18) was hovering over an area to the west of Tampa, FL. Chlor_a had a value of 0.38838354

7. Repeat the **No Data** step with the SST and adg_443_giop images on your own time

8. Save your session by clicking on **File** > **Session Save**

9. Navigate to the folder where the data file is located

10. Name the session SuwaneeR.seadas and select **Save**

Apply a Land Mask

No Data

Land Masks

Zooming

Synchronizing

Map Location
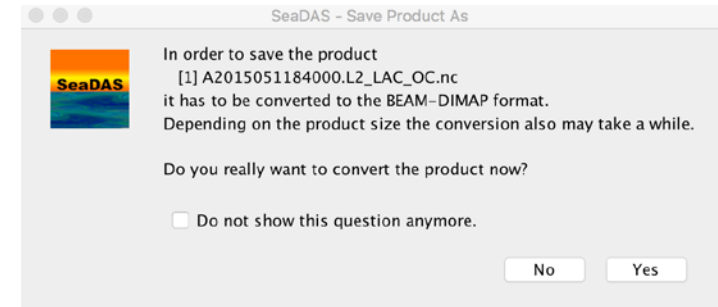
Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject

Crop

1. Look at the tabs on the bottom of the **File Manager** pane. Click on the tab named **Mask.**

2. Click on the box next to the mask named **Land.**
   – Toggle it on and off. What do you think this mask is? Turn off **CLDICE**.

3. Change the **Land** mask color to black by double-clicking on the colored box for that mask choice. Adjust the color of the mask.

4. Repeat with SST and adg_443_giop on your own time.
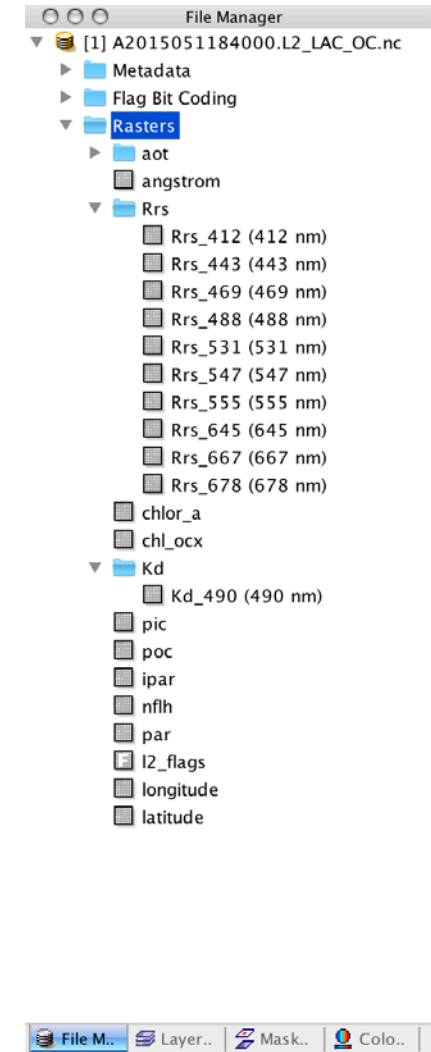
Apply a Land Mask
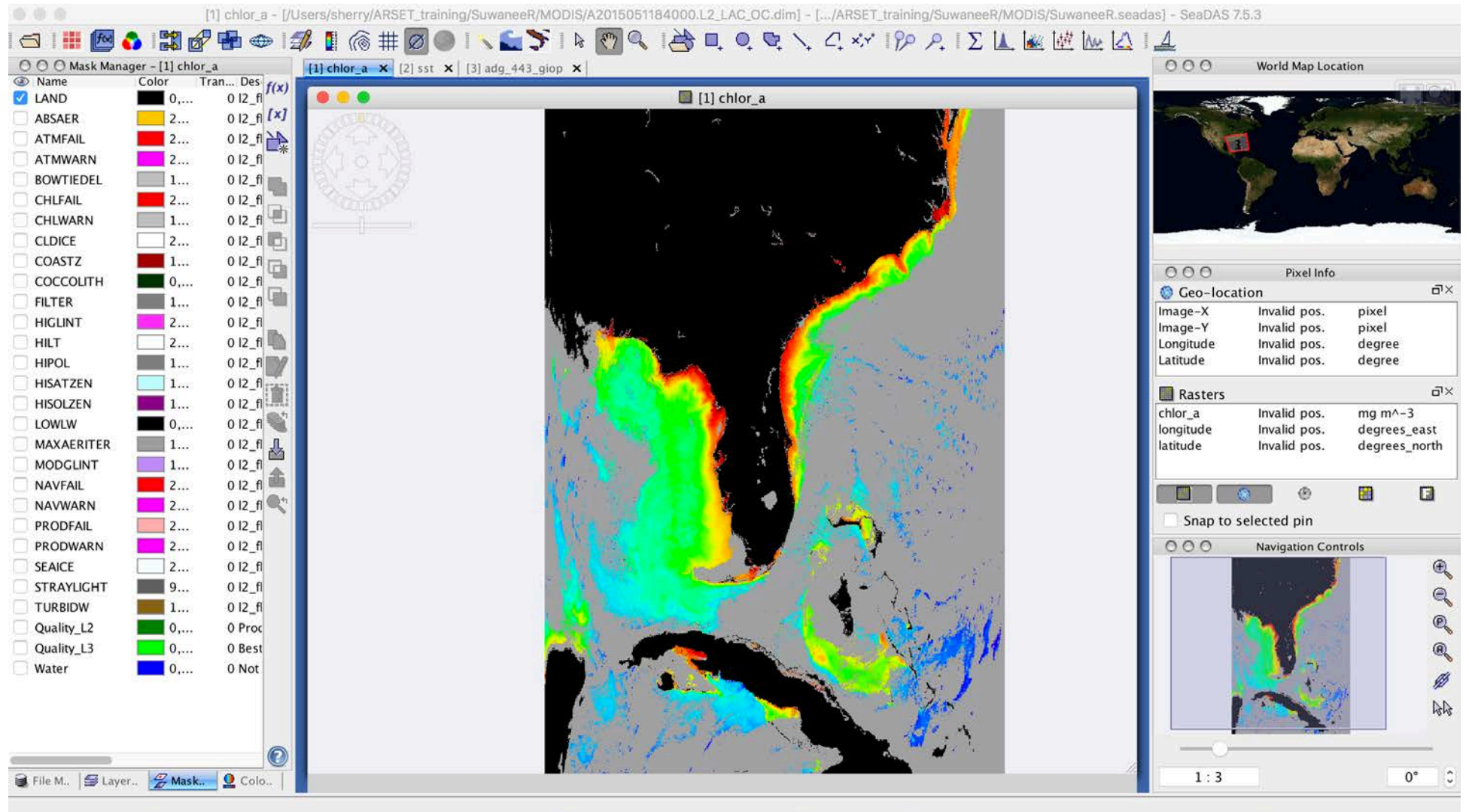
No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject
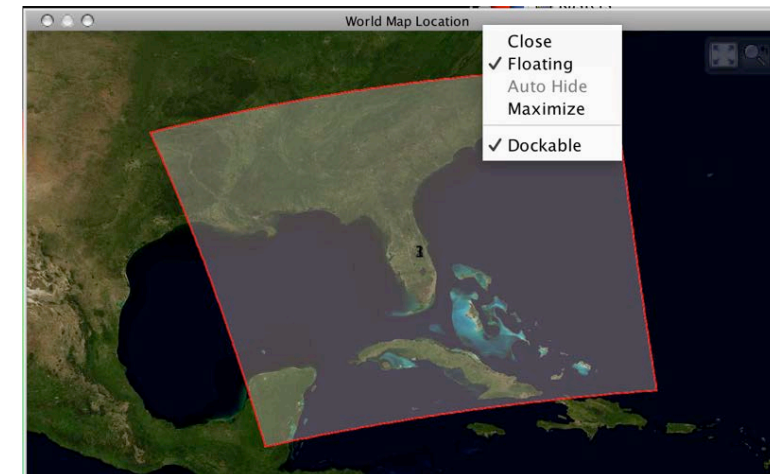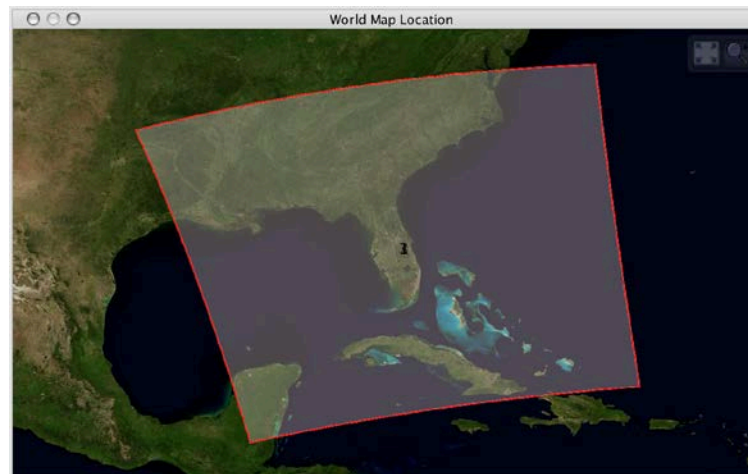
Crop

Apply a Land Mask

5. Save your session by clicking on **File** > **Save As**

6. Navigate to the data folder. You will be asked if you wish to save as BEAM-DIMAP format. Click **Yes**.

SeaDAS - Save Product As

In order to save the product
[1] A2015051184000.L2_LAC_OC.nc
it has to be converted to the BEAM-DIMAP format.
Depending on the product size the conversion also may take a while.

Do you really want to convert the product now?

☐ Do not show this question anymore.

No   Yes

7. Click on each tab in the viewer and repeat these save instructions for SST and adg_443_giop on your own time

8. Save the file as the default:
    –   A2015051184000.L2_LAC_OC.dim
    –   A2015051184000.L2_LAC_SST.dim
    –   A2015051184000.L2_LAC_IOP.dim.

9. Take a moment and save the session to SuwaneeR.seadas using the previous instructions

Zooming with Navigation

1. Look at the lower right pane of the window, named **Navigation Controls**

2. Take some time now to zoom in and zoom out with these controllers in each of the three open tabs

3. Hover your mouse over each of the magnifying glasses to see a description of the tool in the tool tip

4. Zoom all

Synchronize

1. Go to the menu bar to **Window** > **Tile Horizontally**

2. Click on the chlor_a window and **Zoom All**
   - Note that the zoom did not change for the SST window
   - Often, when we explore multiple image files, we wish to synchronize the controllers

3. To synchronize the two layers we're observing, click on the synchronize tool in the **Navigation Controls** window

- Now, when you pan or zoom in one window, both windows will be synchronized. When you are finished, click off the synchronize tool

Map Location

1. Drag the **World Map Location** pane out of the window, resize it, and click on the zoom button in the upper right corner
   – This will show you where the image swatch is in the world
2. Right click the upper part of the window and de-select **Floating** to return it to the viewer
3. Click zoom in the **World Map Location** pane
4. Close the **World Map Location** pane to make more room available

Flags (and Pins)

1. Below the Rasters pane, click on the Flags icon ▢ This will open the Flags pane.

2. Close the Navigation Controls pane

3. In the Pixel Info Pane, close the Geo-location and Rasters sections by clicking on the X at the right of the pane

4. Run the mouse of the scene. "Invalid pos." remains consistent across the list of flags: https://oceancolor.gsfc.nasa.gov/atbd/ocl2flags/

5. Click on the pin tool 🔍₊

6. Find a spot just ocean-ward of the mouth of the Suwannee River

7. Click on the spot while the pin tool is active. You might need to zoom in a little.
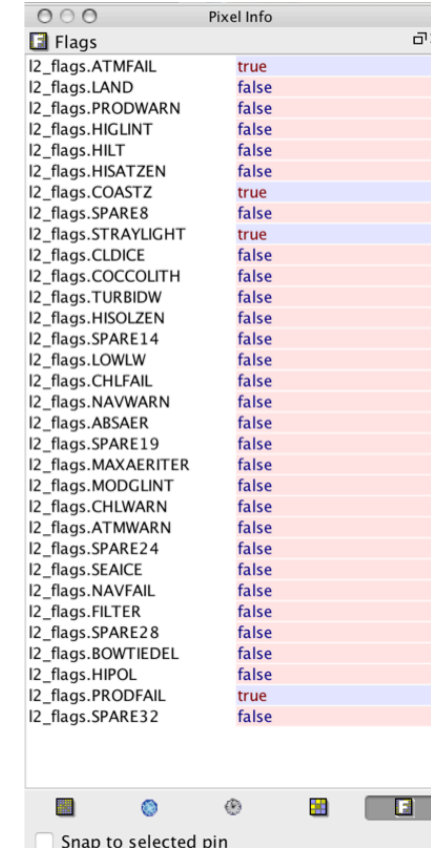
Flags (and Pins)

8. Look towards land from this position and you will see the grey pixels characteristic of "no data." Put a pin into that gray location
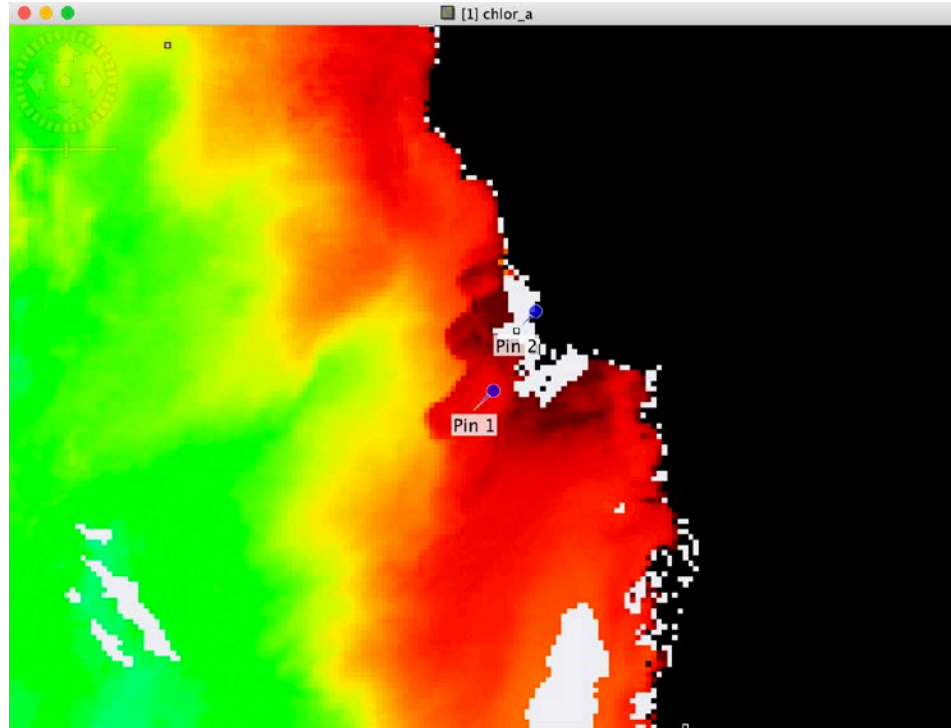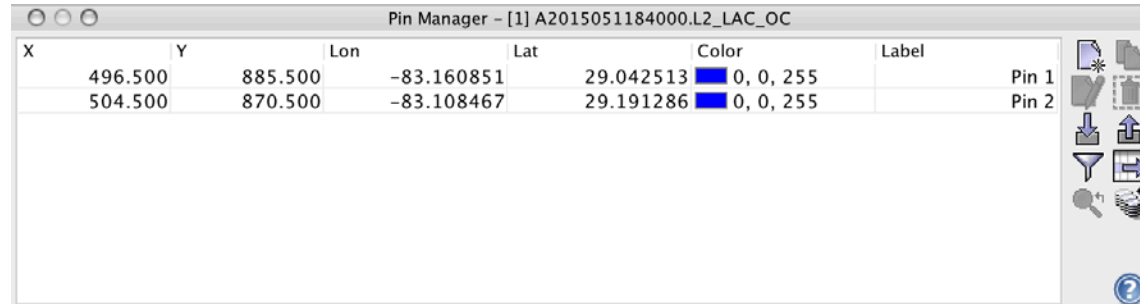

9. Switch from the pin tool to the selection tool (the arrow)

Flags (and Pins)

10. Take turns clicking near the tip of each pin and observe how the Flags information changes.
    – Which flags are present at the tip of Pin 2?

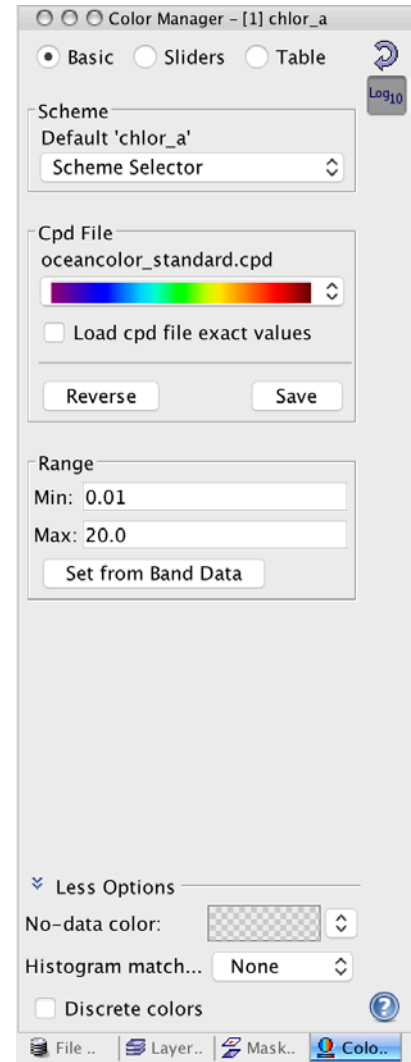11. Next, click on the pin manager tool 🔎 This will open the following window

12. Click on each row to highlight it, and then click on the garbage can icon to the right of the window to delete it.

13. Remove all pins this way, and then close the pin manager

14. Click on **View** > **Reset to Default Layout** to return the viewer to the default pane setup

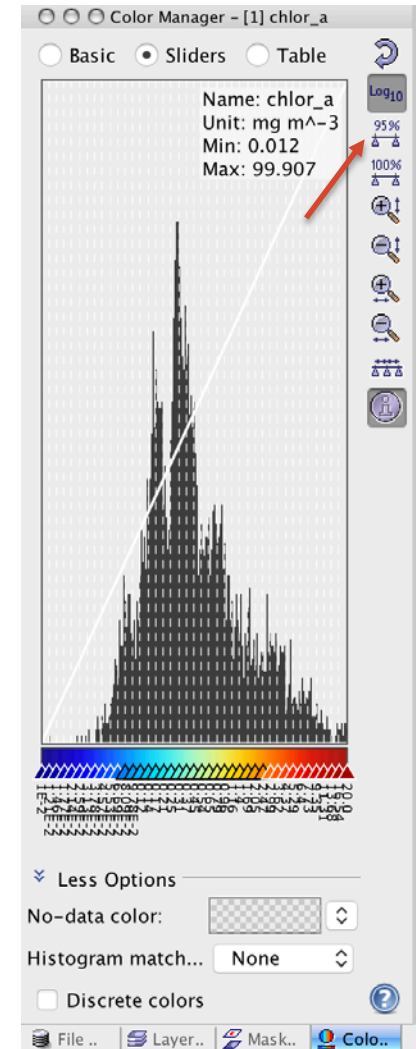# Adjusting the Color Bar

1. Click on the chlor_a window

2. On the lower, left side of the viewer, click on the **Color Manager** tab Colo..

3. The **Basic** button is already selected. Under **Scheme**, click on **Scheme Selector**

4. Look at the available options. Choose the Chl (UniBr-Palette), which will load the Cpd File **universal_bluered.cpd**

5. Look at the top of the Color Manager panel and click on the **Sliders** button

Color Manager – [1] chlor_a

- Basic   Sliders   Table

Log₁₀

Scheme
Default 'chlor_a'
Scheme Selector

Cpd File
oceancolor_standard.cpd

☐ Load cpd file exact values

Reverse   Save

Range
Min: 0.01
Max: 20.0
Set from Band Data

Less Options
No-data color:
Histogram match... None
☐ Discrete colors

File ..   Layer..   Mask..   Colo..

Adjusting the Color Bar

6. There is a lot of functionality in this pane. For our purposes, we are going to adjust the color by choosing a spread of 95% instead of 100%.

7. Click on the icon along the upper right of the color manager named 95%

Adjusting the Color Bar
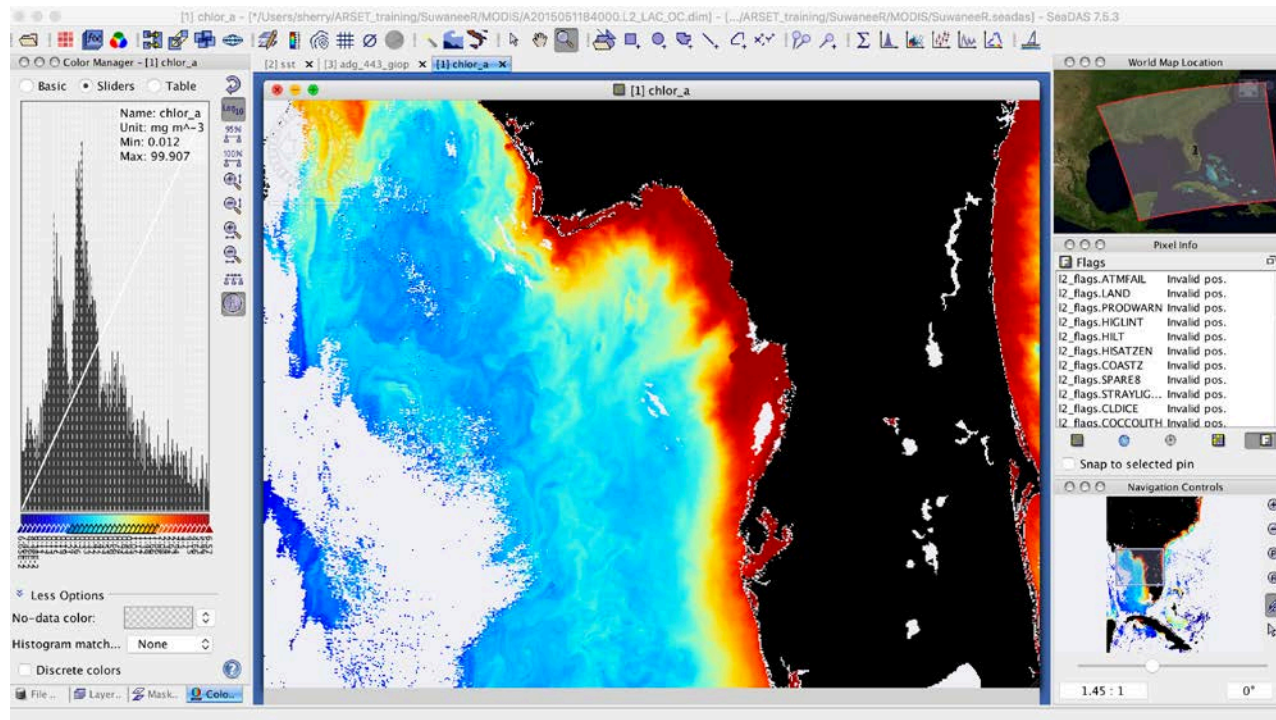
- Note the difference in the histogram views before and after adjusting the spread of the color bar across the data
- What do you think this setting just did?
- Why do you think we would want to make such an adjustment?

Adjusting the Color Bar

8. Take some time to make adjustments to the spread, Log_{10}, and Histogram matching. Observe how it changes the display of the imagery.

9. When you are finished, return the settings to Log_{10}=on (looks dark), 100%, and Histogram matching=none

10. Click the button next to **Basic** at the top of the Color Manager pane and try changing the CPD File to change the color palette to one of the many options. Explore different palettes.

11. When you are finished, return to the **universal_bluered.cpd** palette. This is a color blindness compliant palette. Read more on this palette in SeaDAS »

12. To adjust the color range in the Color Manager pane, click on **Set from Band Data**

Adjusting the Color Bar

13. Look at the image. Zoom in if you need to see features more clearly.

14. In the Pixel Info pane on the right, click on the Show/Hide Rasters icon so that you can see information about the image as you pan your mouse over the scene

15. Close the Flags pane if it is still open

16. Pan your mouse over the scene making sure to look at regions of low values (blue in this palette) and high values.

  − If you are not seeing values, be sure to turn off **Snap to selected pin**

17. Return to the Color Manager pane

18. Click on **Set from Band Data**

Adjusting the Color Bar

19. Double click the **Max: cell**, type 15, and hit return. What happens?

20. Try setting the minimum and maximum manually
   - **There appears to be a bug in SeaDAS here**

21. If you find no change, re-hit **Set from Band Data** and try again.
   - What range makes sense to you?

A given region tends to have typical chlorophyll concentrations during non-bloom periods. The West Florida Shelf has a median chlorophyll concentration of 0.26 µg/L (or mg/m^3), and a range of 0.2 to 13.3 mg/L.

With this in mind, try choosing a narrower chlorophyll range than what is being suggested from the full range of the band data. Do this to get a more sensible dynamic range. Note: the display is showing a log-scale as the default.

Adjusting the Color Bar

22. Repeat setting the palette and ranges for the SST and adg_443_giop data products on your own time. For SST use color bar **Scheme > SST**. For adg_443_giop choose the same scheme as the one used for chlorophyll

23. Use your judgement and the Pixel Info data as you move your mouse over the image to choose a meaningful Min/Max range for SST and adg_443_giop **Important note:** your images will not match exactly to these because your Min/Max choices will differ.

24. Click on **Window** > **Tile Horizontally**
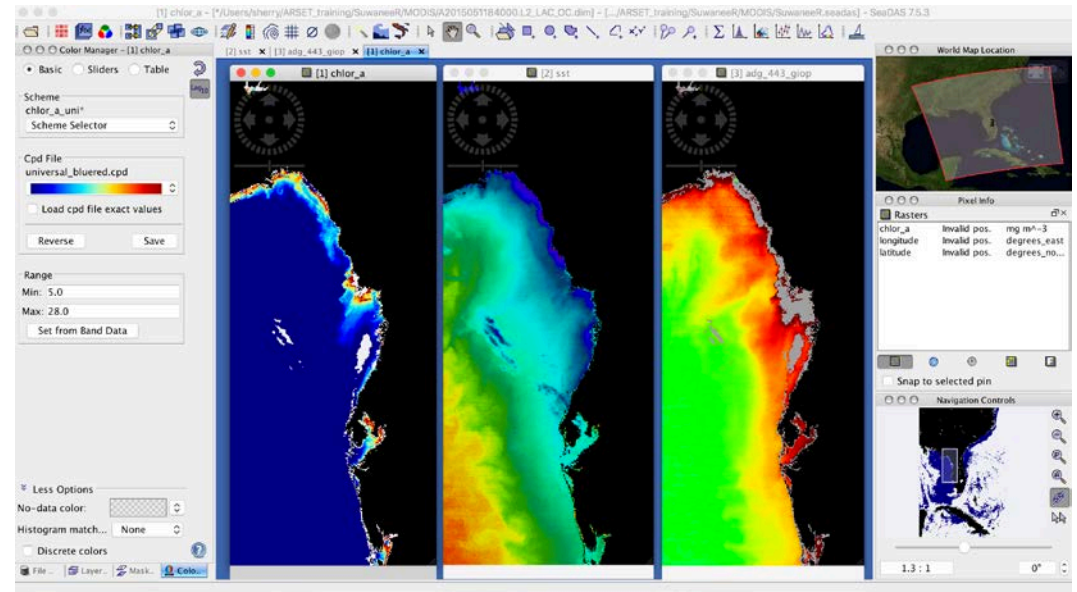
Adjusting the Color Bar

25. Tidy up your viewer by synchronizing your windows and adjusting the pane size so you can maximize viewing the imagery

26. Save the session

27. Look at the adg_433_giop pane.
    – What do you think is going on at the mouth of the Suwannee River?
    – What does the L2 flag say for this?

Create a Color Bar
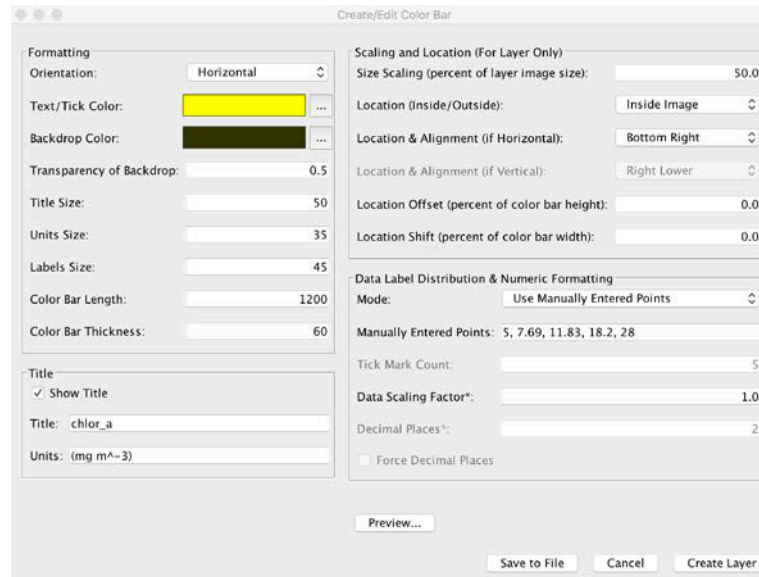
1. Click on the chlor_a window so that it is the active layer
2. Look along the tool bar. Find and click the color bar tool

3. Click on **Create Layer**
4. Zoom all to see the color bar
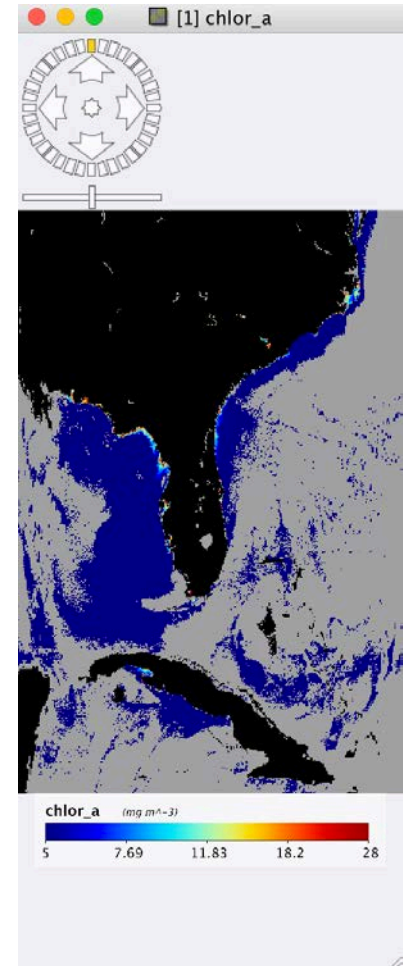
Create a Color Bar

5. The image has a color bar, but it is small and hard to see

6. Click on the color bar tool again. This time, change the following settings: Title > chlor_a, Units > (mg m^-3), Size Scaling > 90.0, Location > Outside Image, Location & Alignment > Bottom Center to put the color bar outside the image. Leave other settings alone.
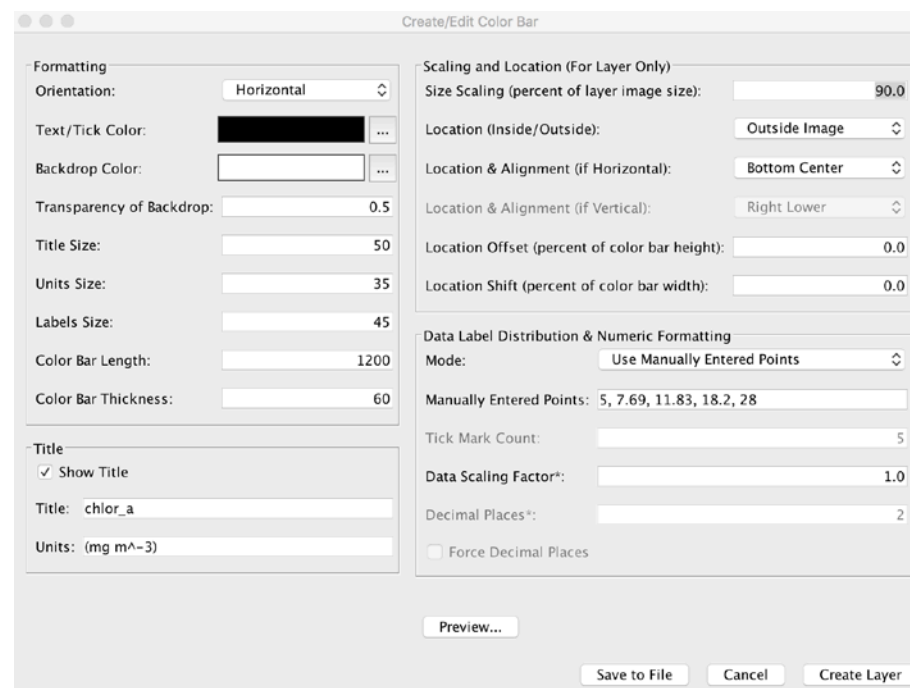
Create a Color Bar

7. Click on the preview to see it is what you want. When you are satisfied, click on **Create Layer**. Your output should look like the image on the right.

8. Repeat the steps to make a color bar for your SST and adg_443_giop images on your own time. Be sure to use the appropriate Title and Units for those data products: SST (degrees C), adg (m^-1).

Create a Color Bar

No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject

Crop

1. Click on the chlor_a pane and re-size it so that you can see the entire image

2. Look along the tool bar and find the gridlines tool and click it:

3. Look at your scene. This tool adds the gridlines to your image.

4. Look closely at the bottom part of the scene near the color bar. The notation for the coordinates at the bottom is running into the color bar.

5. It is possible to remedy this. Verify that the gridline tool is the active tool, then click on the **Edit Layers Properties** tool:

Create a Color Bar

No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject

Crop

6. The window below will open. Click **Show Longitude Labels – South** to remove the longitude labels so they will no longer be in conflict with the color bar

7. Close the window after you make the change

Create a Color Bar

- Note that the labels along the bottom of the image are gone
- As long as the gridlines are active, you can return to the **Edit Layers** tool to make changes to the format of the gridlines
- These changes will be preserved when you export the image to an image file
8. Repeat this gridlines step with the SST and adg_443_giop images on your own time

Export Image

No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

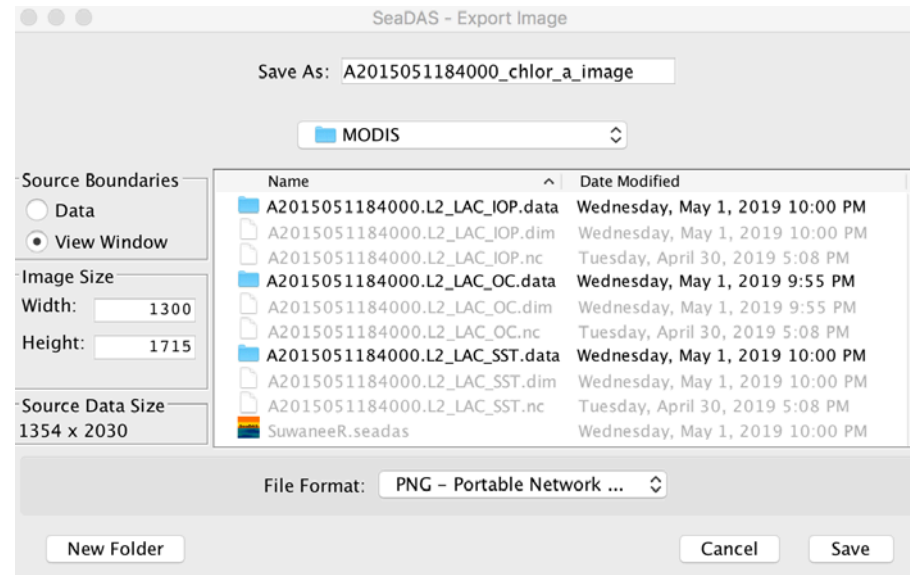**Export Image**

Reproject

Crop

1. Now you have an image with a color bar and gridlines. Zoom all for all images
2. Resize the image windows so that you can see just the area you would like to export
3. Make sure the gridline labels are visible in the window
4. Right click on the image you want to export and click on **Export Image**
5. This will open a window
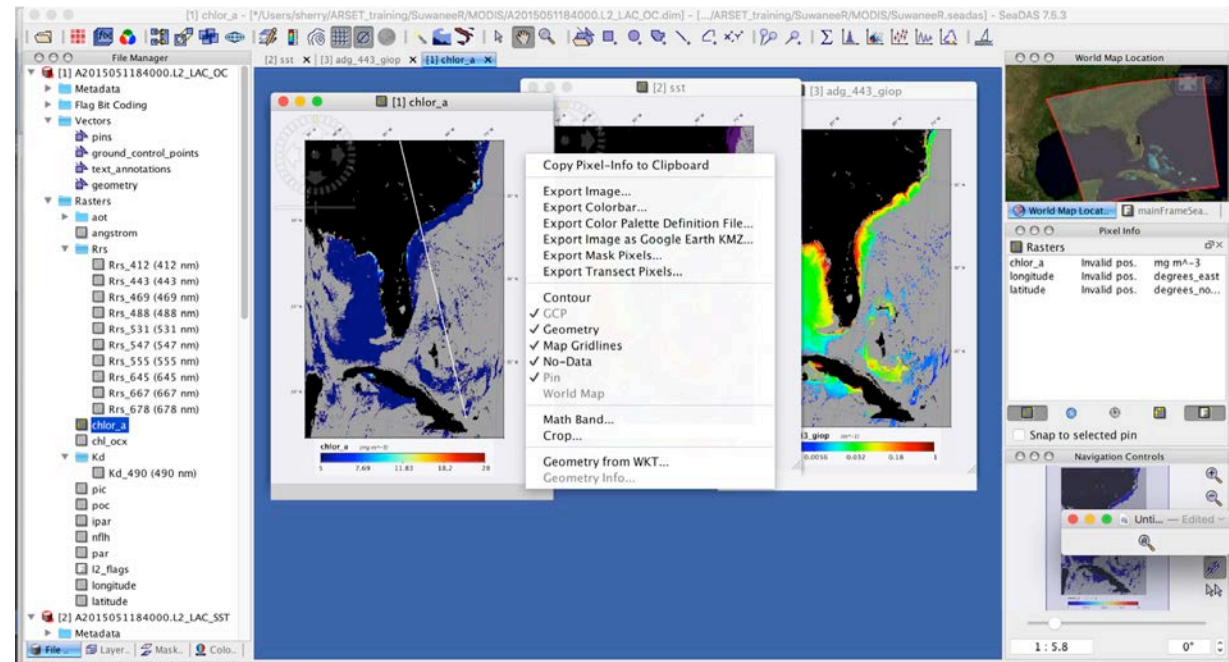
Export Image

No Data

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Create Color Bar

Gridlines

Export Image

Reproject

Crop

6. You could choose to just save the image with the default settings, but that is going to give you an image with coarse resolution

7. Instead, it would be a good idea to adjust the width and height of the image size

8. Save it with the file name and "_image" appended to the name, like the example below:

Export Image

9. Repeat these steps for SST and adg_443_giop images on your own time

- If you are not satisfied with the output, change the gridline, color bar, or export options to arrive at an image you like

10. Make sure to **Save As** a new file name for the different examples you produce, unless you want to overwrite your earlier attempts
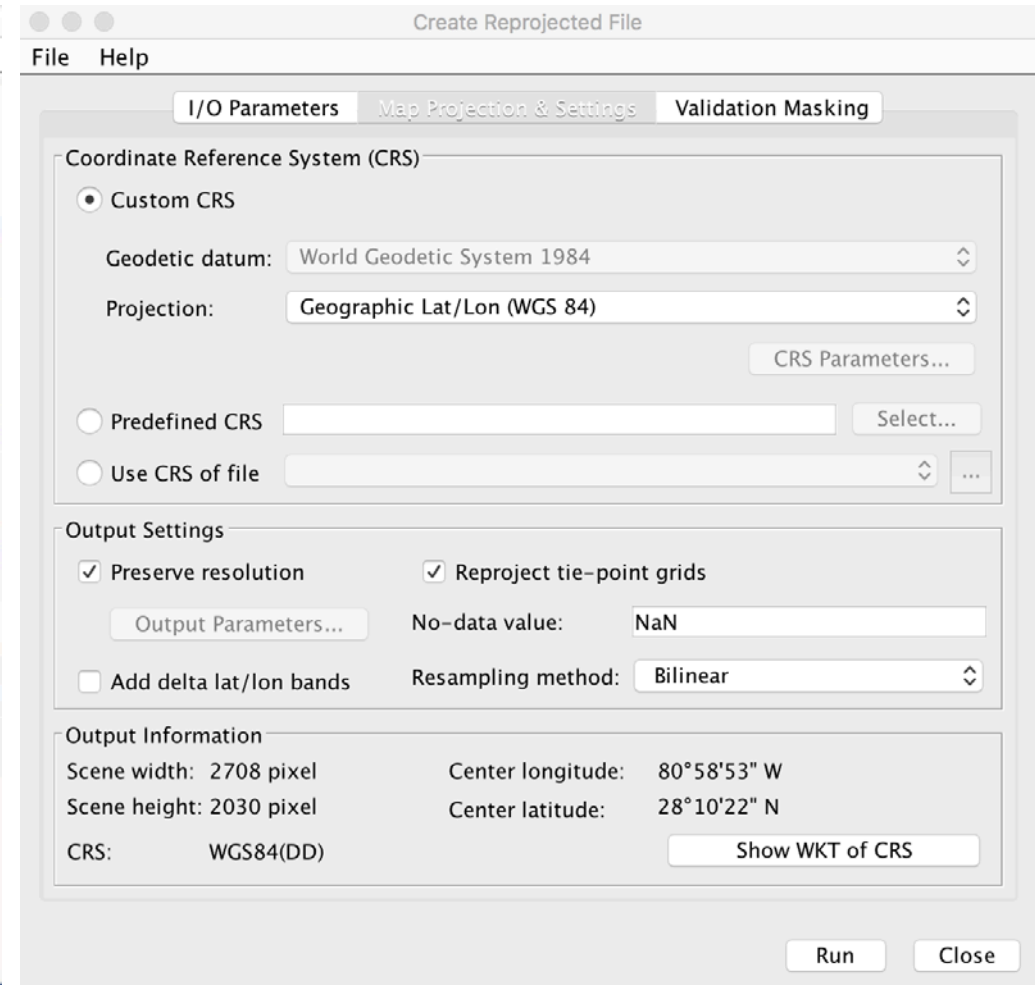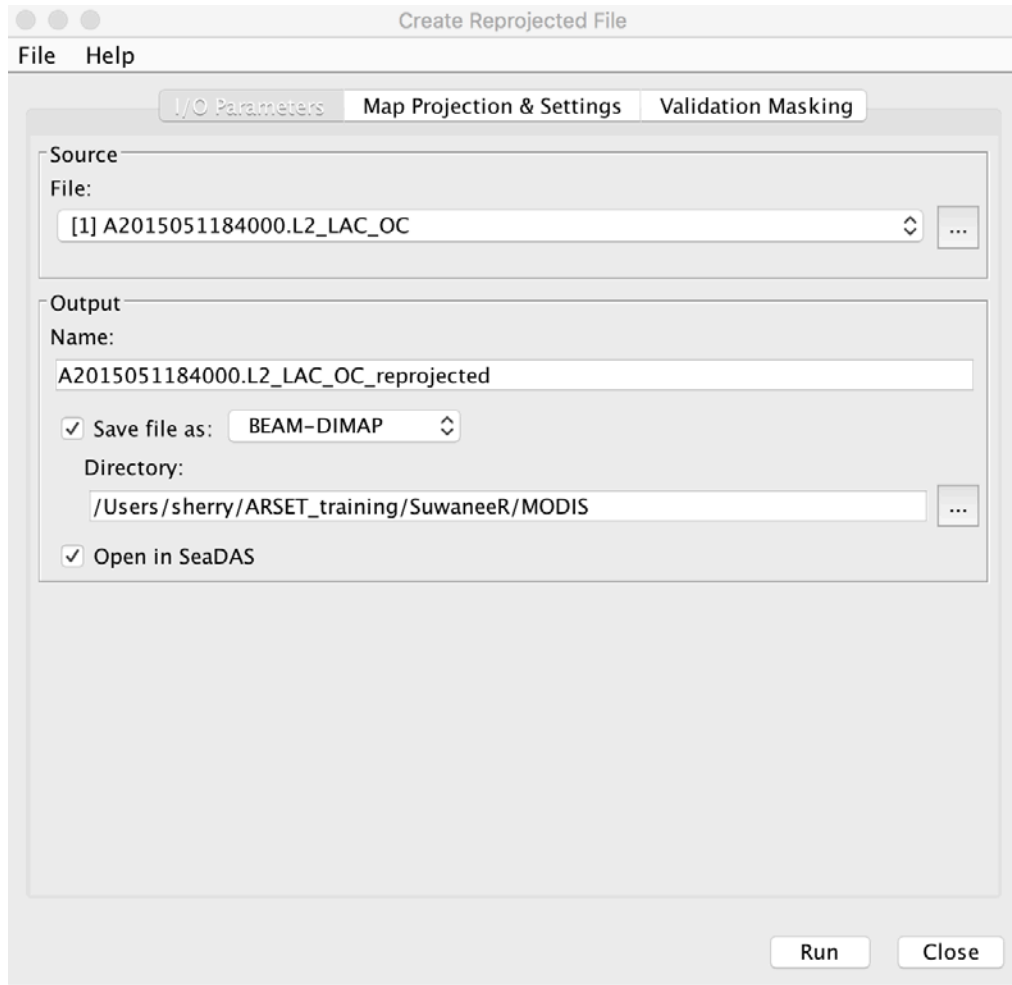
Reproject

- Congratulations on getting this far! The images you produced in the previous section are not projected the way we need, so we will re-project them and export new images

1. Close the SST and adg_443_giop files

2. Click on the chlor_a pane to make it the active layer

3. Click on the map projection tool

4. This will open the **Create Reprojected File** window. Use the images on the next slide to change the tabs in this window to match. <u>**Be sure the directory path you enter matches the correct path for the system you are using**</u>.
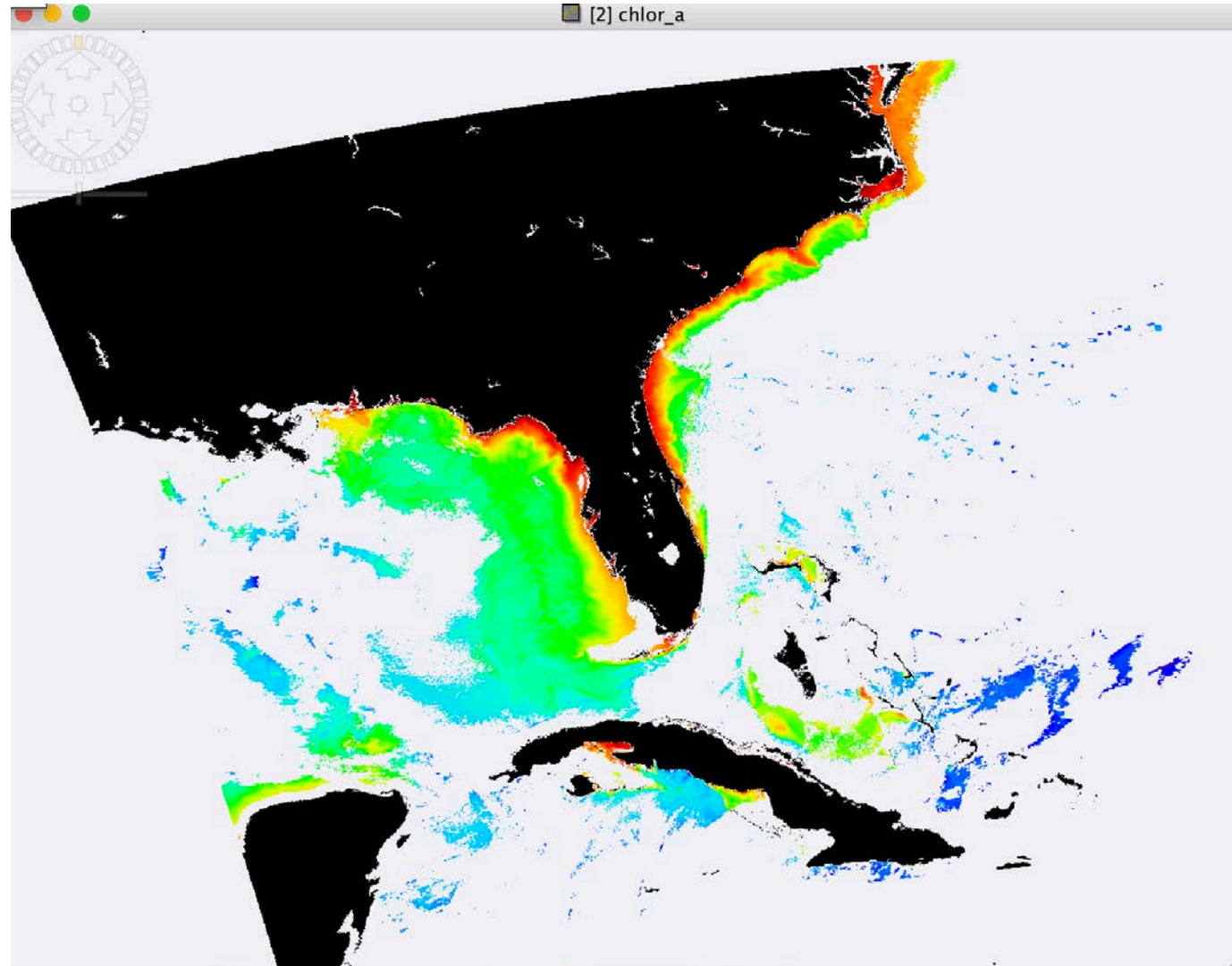
Reproject

No Data

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Reproject

7. Use the bilinear resampling method

8. Click **Run** when you are satisfied with your settings

9. When the process is complete, click **Close**

10. These settings will automatically save the new, reprojected file and open it in SeaDAS.

11. If you want to see how the projection works, without saving, be sure to click off the **Save file as** button on the I/O Parameters tab of this window

12. When the process is complete, open the chlor_a layer of the newly reprojected file

13. Close the previous file

Reproject
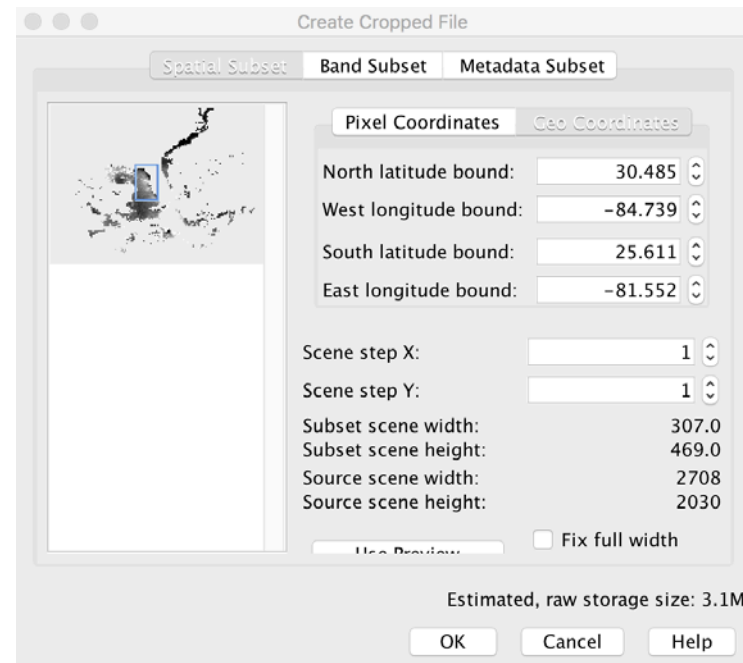
No Data

Land Masks

Zooming

Synchronizing

Map Location

Flags (and Pins)

Adjust Color Bar

Create Color Bar

Gridlines

Export Image

Reproject

Crop

[2] chlor_a

Crop

- The image of the reprojected chlorophyll a layer illustrates the need to crop the image to the region of interest

- There are a number of methods to crop using SeaDAS. The method here is the simplest and most straightforward

1. Open the cropping tool from the tool bar

2. This will open the **Create Cropped File** window

3. Stay in the **Spatial Subset** setting

4. If you know the geographic coordinates for the region of interest, click on the button labeled **Geo Coordinates** and enter your coordinates

5. If you are not sure, click on the **Pixel Coordinates** button and set the boundaries manually by adjusting the rectangular region in the pane on the left of the cropping window

Crop

6. When you are satisfied with your bounding box, return to **Geo Coordinates** and write down all of the latitude and longitude values for the bounding box

7. Leave all of the other settings on default
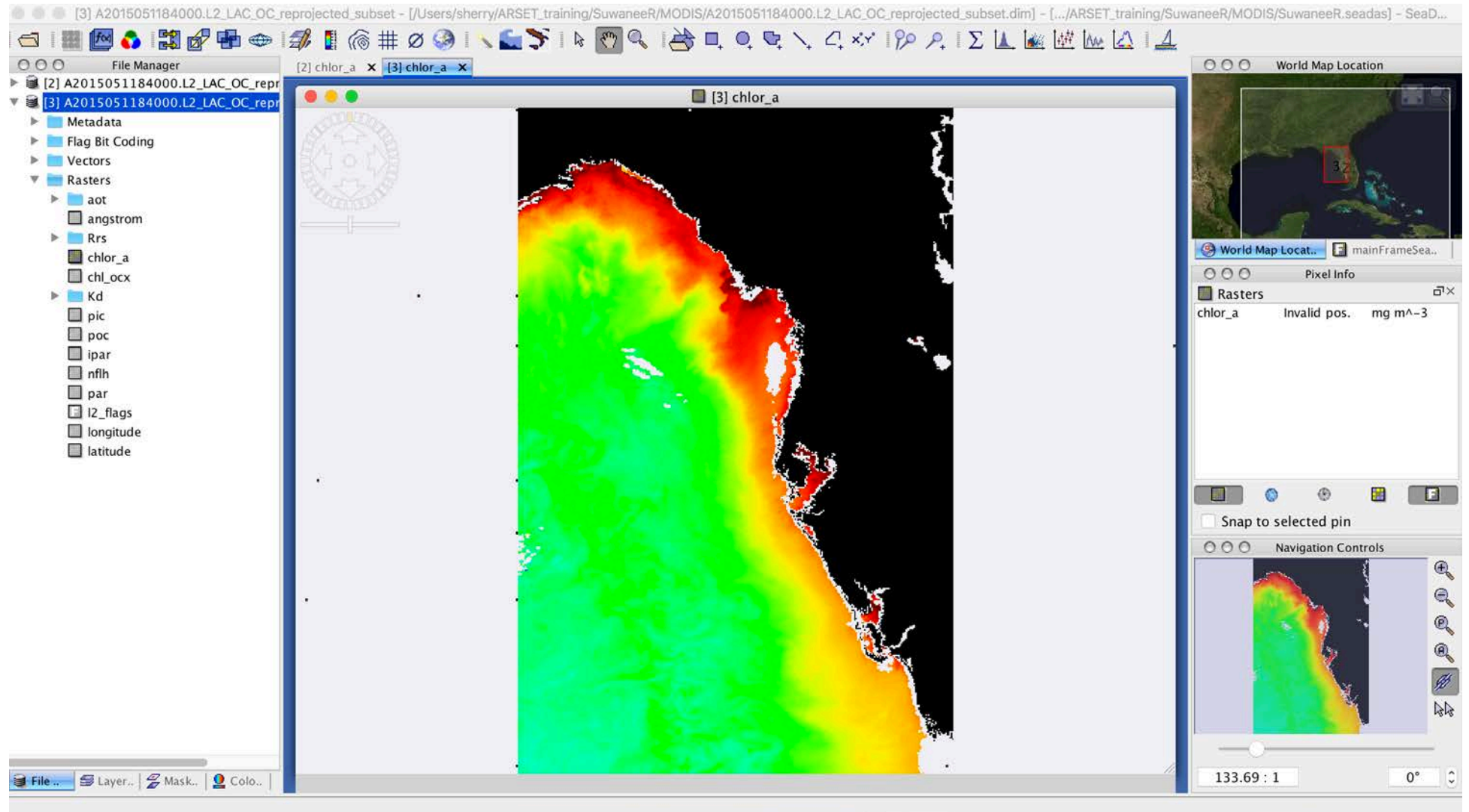
8. Click **OK**

Crop

9. This creates a new file that is visible in the **File Manager**. Note the odd color next to the layers icon at the file name (it looks like a stack of pancakes). This tells us the file needs to be saved.

10. Take a moment to open a raster and observe if the cropping was done to your preference.

11. Right click and choose **Save As**

12. A new window will appear with a default file name. Change the name so that you don't accidentally overwrite the original file

13. Name it A2015051184000.L2_LAC_OC_reprojected_subset.dim and click **Save**

Crop

No Data

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Create Color Bar

Gridlines

Export Image

Reproject

Crop

Crop

14. Take a moment to close some of the files you have open in the **File Manager.**

15. It is up to you whether you want to save any changes made to the file

16. The newly cropped file should be the only file still in the **File Manager**

17. Repeat the steps for adjust color, color bar, gridlines, and export to produce a new, exported image of this reprojected and cropped region

18. When you are finished, save the session and close SeaDAS

19. On your own time, repeat these steps for the SST an adg_443_giop images. **Note: Be sure to use the exact same geographic coordinates used for chlor_a when cropping these other files.**