



Monitoring Coastal and Estuarine Water Quality Using Remote Sensing and In Situ Data

Exercise 1



Outline

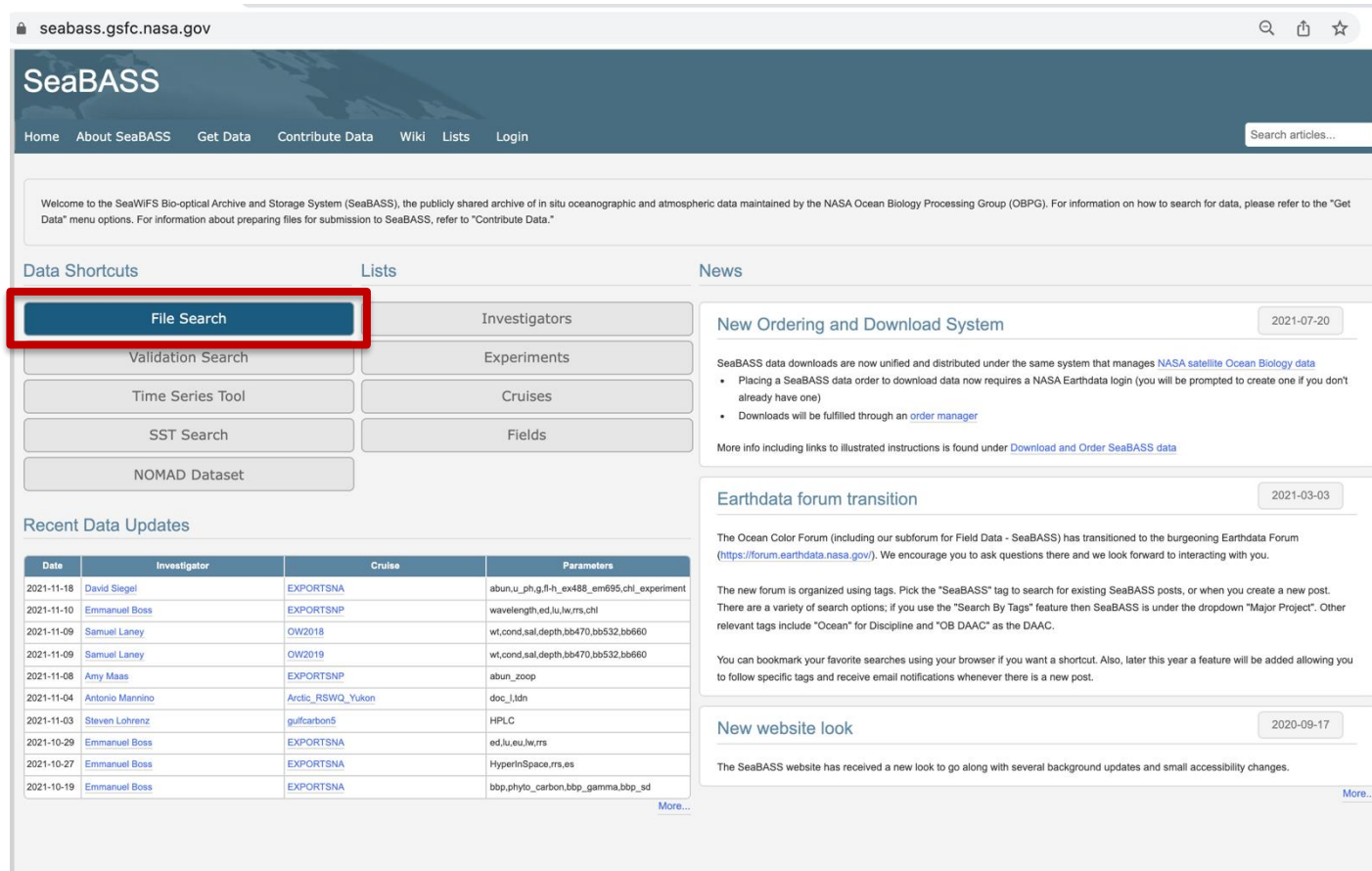
- Select and download in situ data from SeaBASS
- Search for cloud-free satellite images from MODIS and VIIRS for the dates when in situ data are available
- Download MODIS and VIIRS Level-2 Images
- Open the Level-2 Images in SeaDAS and create a daily mosaic
- Import SeaBASS data into SeaDAS
- Select and download in situ data from the Gulf of Mexico Coastal Ocean Observing System (GCOOS)
- Prepare GCOOS data in SeaBASS file format

Note: You will be answering some of the homework questions based on this exercise.



Select and Download In Situ Data from SeaBASS

1. Open the [SeaBASS](https://seabass.gsfc.nasa.gov) website and click on **File Search**.



The screenshot shows the SeaBASS website interface. The 'File Search' button is highlighted with a red box. The website includes a navigation menu, a search bar, and several sections: Data Shortcuts, Lists, News, and Recent Data Updates.

Data Shortcuts

- File Search
- Validation Search
- Time Series Tool
- SST Search
- NOMAD Dataset

Lists

- Investigators
- Experiments
- Cruises
- Fields

Recent Data Updates

Date	Investigator	Cruise	Parameters
2021-11-18	David Siegel	EXPORTSNA	abun_u_ph.g,fl-h_ex488_em695,chl_experiment
2021-11-10	Emmanuel Boss	EXPORTSNP	wavelength,ed_lu,lw,rs,chl
2021-11-09	Samuel Laney	OW2018	wi,cond,sal,depth,bb470,bb532,bb660
2021-11-09	Samuel Laney	OW2019	wi,cond,sal,depth,bb470,bb532,bb660
2021-11-08	Amy Maas	EXPORTSNP	abun_zoop
2021-11-04	Antonio Mannino	Arctic_RSWQ_Yukon	doc_l,ldn
2021-11-03	Steven Lohrenz	gulfcarbon5	HPLC
2021-10-29	Emmanuel Boss	EXPORTSNA	ed_lu,eu,lw,rs
2021-10-27	Emmanuel Boss	EXPORTSNA	HyperInSpace,rs,es
2021-10-19	Emmanuel Boss	EXPORTSNA	bbp.phyto_carbon,bbp_gamma,bbp_sd



Select and Download In Situ Data from SeaBASS

2. In the File Search page under **General Search Parameters:**

- Set start date to **2012-01-01** in **Measured between the dates of** and **Archived between the dates of**.
- Leave the end date as the current date.
- Under **Within the Coordinates**, draw a box around the Gulf of Mexico on the map.

Search Type:

The File Search allows visitors to search the bio-optical archive for in situ measurements of apparent and inherent optical properties, phytoplankton pigment concentrations, and other parameters. Data access and use are governed by the SeaBASS [Data Access Policy](#).

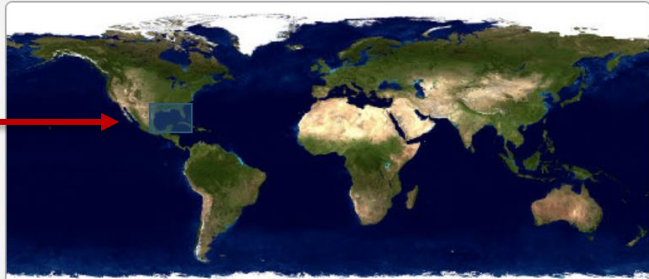
The following search settings are very broad by default. Edit these parameters if you want to limit or refocus the results. [More info](#).

General Search Parameters:

Measured between the dates of and

Archived between the dates of and

Within the coordinates:?



N:

W: E:

S:



Select and Download In Situ Data from SeaBASS

- Scroll down to **Products** and select **Chl** for chlorophyll concentration.
- Click on **Perform File Search**.

Products?:

Find files containing any of the selected products
 Find files where all the specific products entered below were measured in the same [cruise](#)
 Don't filter based on products

Grouped Products:

AOP PAR Kd a b bb
 c DC PC SPM AOT nutrients
 CTD fluorescence productivity Chl HPLC

Specific Products:

3. You will see a list of available files for the selected region and time period under the Results tab.

Search Parameters:

Date Measured	2012-01-01 to 2021-11-19
Date Archived	2012-01-01 to 2021-11-19
North	33.19
South	18.37
West	-90.84
East	-76.84
Water Depth	0.0 to 10000
Products	Chl

Share Search Parameters

Total number of files: 32

Include all associated files.

Results Individual Download Selection

Show 10 entries Search:

File	Archive	Documents
BOWDOIN/ROESLER/PACE_ABSlosure/Florida2017_ABSlosure/archive/PACE_ABSlosure-chl_2017.sb	archive	documents
BOWDOIN/ROESLER/PACE_ABSlosure/Florida2017_ABSlosure/archive/PACE_ABSlosure-hplc_2017.sb	archive	documents
COLUMBIA_U/subramaniam/LAMONT_GON/jul15gpm/archive/jul15gpm_HPLC.sb	archive	documents
COLUMBIA_U/subramaniam/LAMONT_GON/jun15gpm/archive/jun15gpm_HPLC.sb	archive	documents
COLUMBIA_U/subramaniam/LAMONT_GON/jun17gpm/archive/jun17gpm_HPLC.sb	archive	documents
NASA_GSFC/Cyanate/Cyanate2016/archive/Cyanate-Sharp2016-hplc_201608_R2.sb	archive	documents
NASA_GSFC/ECOA/ecoa-2/archive/ECOA_2018_pigments.sb	archive	documents
NASA_GSFC/GEOCAPE/gpmex_2013/archive/GEOCAPE_GOMEX_HPLC.sb	archive	documents
NASA_GSFC/VIIRS_VALIDATION/viirs_2014_foster/archive/VIIRS_validation_viirs_2014_foster_pigments_R2.sb	archive	documents
NOAA_NESDIS/endrusek/VIIRS_validation/VIIRS_2014_foster/archive/PPS_14_LWN_CHL.sb	archive	documents

Showing 1 to 10 of 32 entries 1 2 3 4



Select and Download In Situ Data from SeaBASS

4. Click on the following links and save the files to your computer.

*You will be prompted to log in using your NASA Earthdata **username** and **password** to download the data.

[USF/HU/Carbon_Estuaries/ntb1/archive/ntb1_chl.sb](https://seabass.gsfc.nasa.gov/USF/HU/Carbon_Estuaries/ntb1/archive/ntb1_chl.sb)

[USF/HU/Tampa_Bay/t1208/archive/T1208_chl.sb](https://seabass.gsfc.nasa.gov/USF/HU/Tampa_Bay/t1208/archive/T1208_chl.sb)

[USF/HU/VIIRS_Val_FLKeys/sf1603/archive/sf1603_chl.sb](https://seabass.gsfc.nasa.gov/USF/HU/VIIRS_Val_FLKeys/sf1603/archive/sf1603_chl.sb)

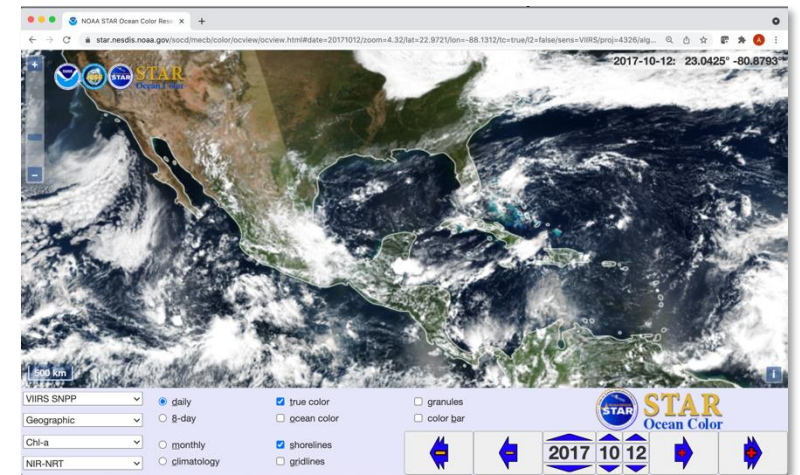
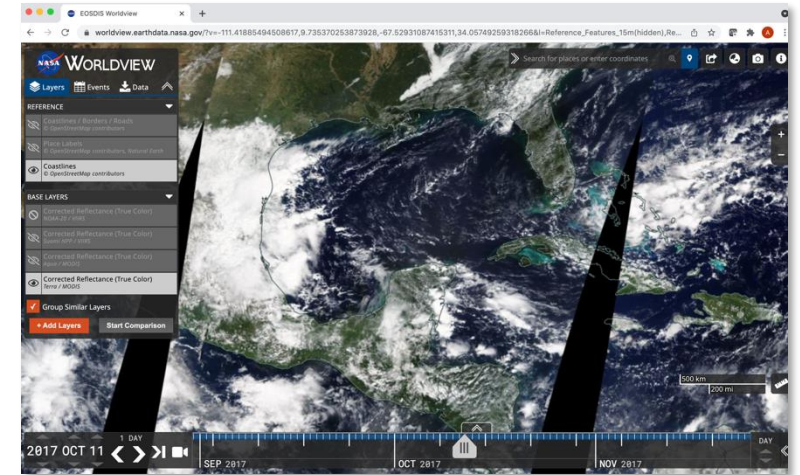


SeaBASS Files

5. List the files you saved on your computer:
 - Open each file using a text editor of your choice and note the year, month, day, etc. documented in each header file.
 - What is the data delimiter in each file?
- Save this information in a document since your homework will ask these questions.
6. Open the file **e29f6ffdc2_ntb1_ch1.sb**. This is the file you will be working with in SeaDAS along with MODIS and VIIRS imagery.

Select Dates for MODIS and VIIRS Images

- Go to [NASA Worldview](https://worldview.earthdata.nasa.gov/) and search for MODIS imagery in the Gulf of Mexico (GM) for the dates covered in **e29f6ffdc2_ntb1_chl.sb**. Make sure at least part of the GM is cloud-free on the days collected for in situ measurements.
 - Select at least one date from the imagery that you think is the most cloud-free over the GM. You will be downloading MODIS imagery for this date.
- Repeat Step-7 for SNPP VIIRS images by going to [NOAA OCVIEW](https://star.nesdis.noaa.gov/).
 - Does VIIRS provide more cloud-free imagery for the GM region for the date you selected than MODIS imagery? If not, take note of the date for the most cloud-free VIIRS image to download.



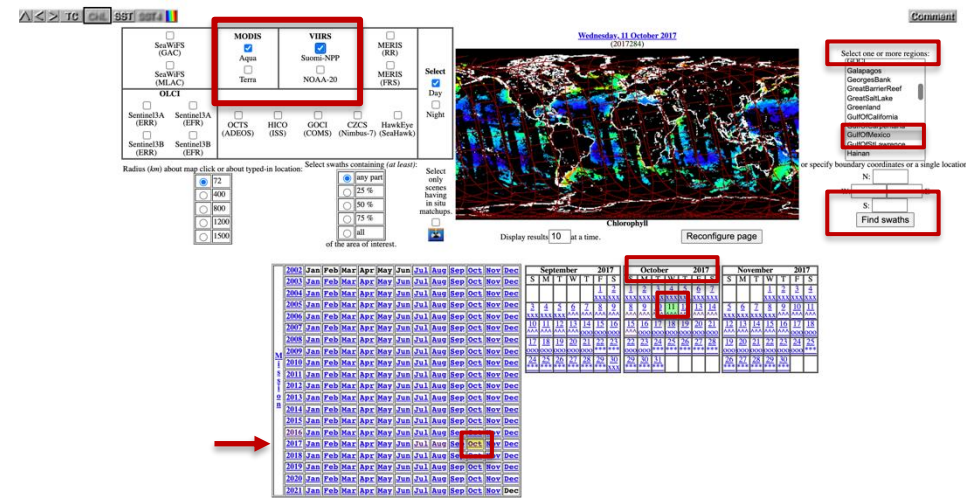
Select MODIS and VIIRS Level-2 Images



9. Go to [NASA OceanColor Web](https://oceancolor.gsfc.nasa.gov/).

On the menu bar, select **Data** → **Level 1&2 Browser** and click on the map.

- You will see the data selection screen—we will use 11 October 2017 for this case study.
- In the **Mission** table, select **2017** (year) and then select **Oct** (month).
- In the **October 2017** calendar, click on **11** (date).
- Under **Select one or more regions**, scroll down to **GulfOfMexico** and select it.
- Select **MODIS Aqua** and **VIIRS Suomi-NPP**.
- Click on **Find swaths**.

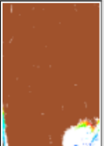


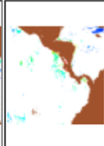
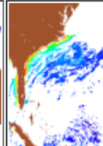
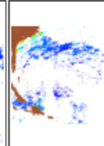


Download MODIS and VIIRS Level-2 Images

10. You will get several swaths for MODIS and VIIRS for the selected date and region.

- How many swaths for MODIS (A2017xxxx) and VIIRS (V2017xxxxx) are selected?

Display at a time. [ORDER DATA](#)

A2017284195500.L2_LAC_OC.nc		A2017284181500.L2_LAC_OC.nc			
V2017284191200.L2_SNPP_OC.nc					
11Oct2017					
****	****	****	****	****	****
					
List LO	A2017284195000.L2_LAC_OC.nc	V2017284173000.L2_SNPP_OC.nc			
		V2017284190600.L2_SNPP_OC.nc			

Search Criteria
Time Period: Wednesday, 11 October 2017 (daytime)
Sensors: Suomi-NPP and Aqua
Area of Interest: GulfOfMexico



Percentage of AOI that swaths must include: 0

Number of swaths: 1st through 6th of 6 swaths



Download MODIS and VIIRS Level-2 Images

11. Click on **each** MODIS and VIIRS swath one by one.
- You will see image file names highlighted in blue with i) Quasi True Color, ii) Chlorophyll, and iii) Sea Surface Temperature images.
 - Click on the Chlorophyll Ocean Color (**OC.nc**) file for each MODIS and VIIRS swath and save to your computer.

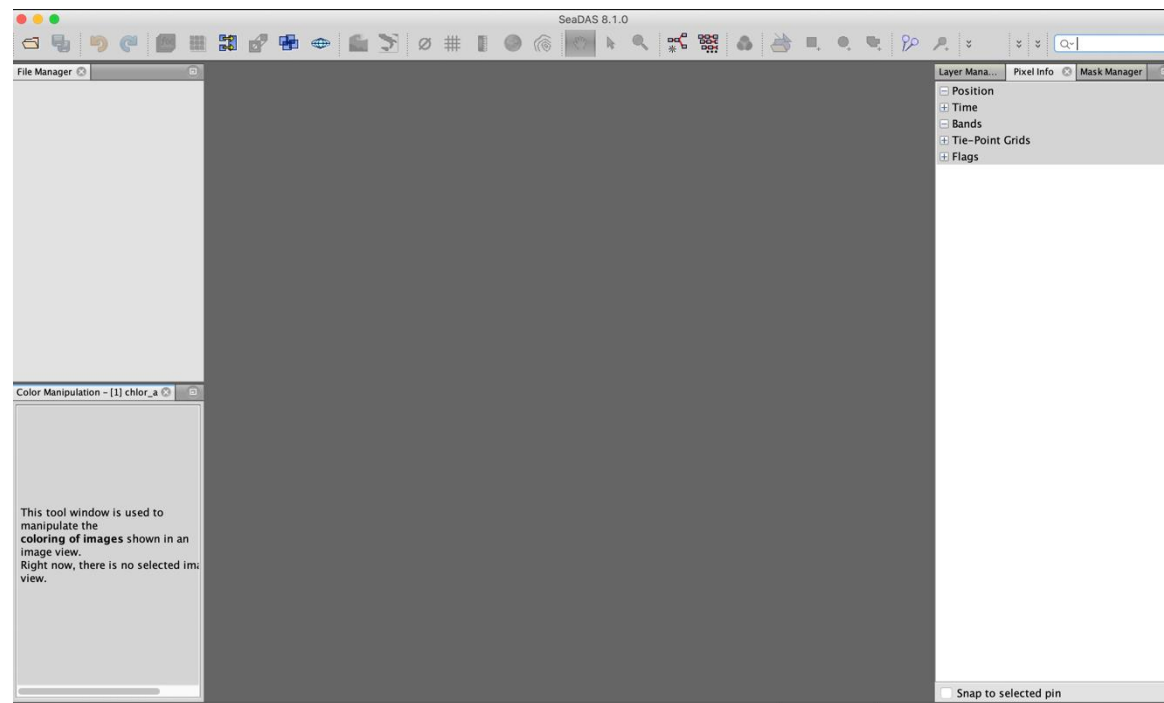
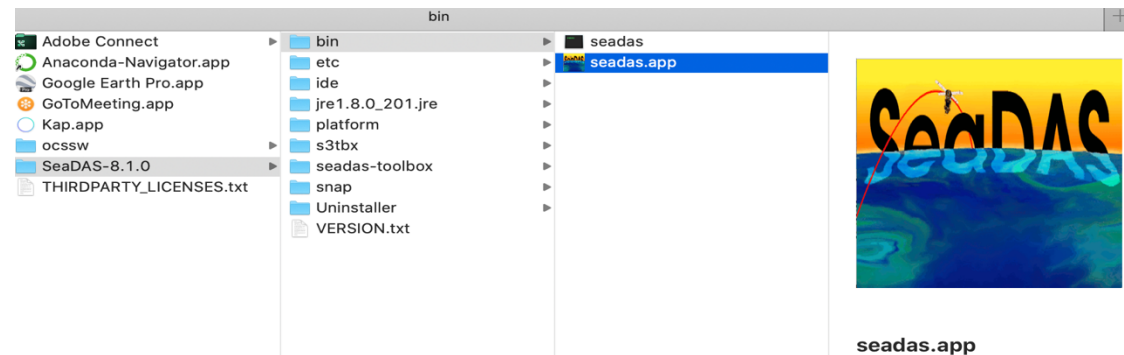
The screenshot displays a satellite data interface. At the top, a list of file names is shown with their corresponding sizes in bytes. A red bracket highlights the first four entries: [MOD00_P2017284_1955_1_PDS](#) (317,685,852 bytes), [A2017284195500.L1A_LAC](#) (229,995,883 bytes), [A2017284195500.L2_LAC_OC.nc](#) (28,783,561 bytes), and [A2017284195500.L2_LAC_IOP.nc](#) (34,744,612 bytes). Below this list are three image thumbnails: 'Quasi True Color', 'Chlorophyll', and 'Sea Surface Temperature (11 μ)'. A red arrow points from the 'Chlorophyll' thumbnail to a search results window. The search results window shows a list of file names: [A2017284181500.L2_LAC_OC.nc](#), [A2017284195000.L2_LAC_OC.nc](#), [A2017284195500.L2_LAC_OC.nc](#), [V2017284173000.L2_SNPP_OC.nc](#), [V2017284190600.L2_SNPP_OC.nc](#), and [V2017284191200.L2_SNPP_OC.nc](#). To the right of the thumbnails is a map of the Gulf of Mexico region with a red square indicating the area of interest. Below the map, search criteria are listed: 'Search Criteria: Time Period: Wednesday, 11 October 2017 (daytime); Sensors: Suomi-NPP and Aqua; Area of Interest: GulfOfMexico'.



Open SeaDAS



12. Navigate to the directory on your computer where SeaDAS is installed and click on the app to launch SeaDAS.

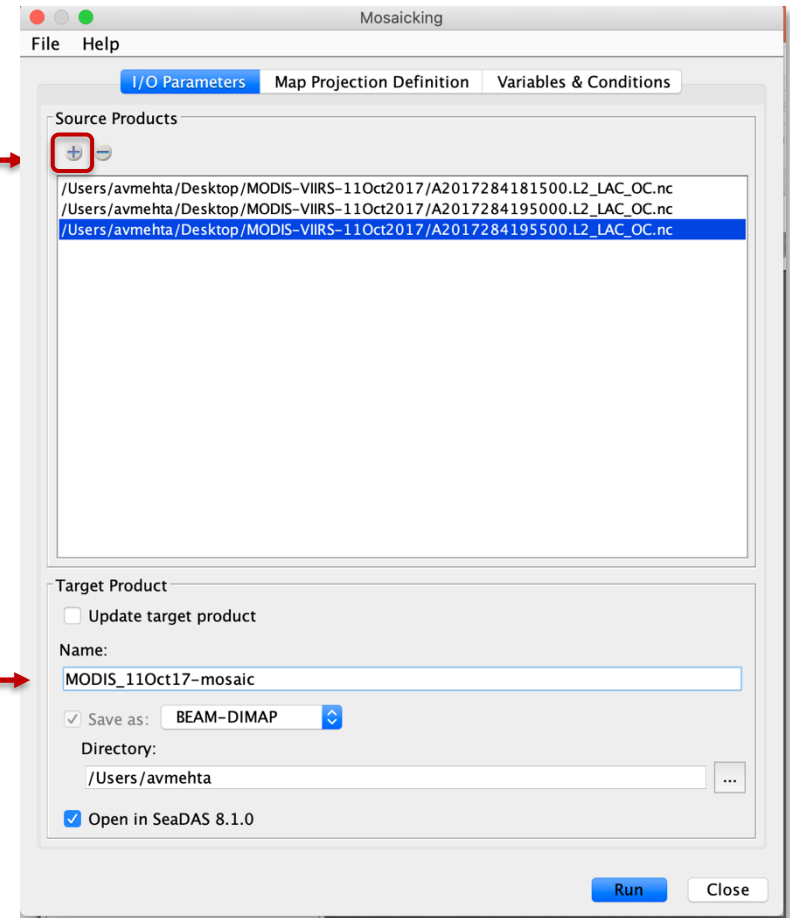
- The SeaDAS 8.1.0 Graphical User Interface (GUI) window.



Mosaic MODIS Level-2 Images

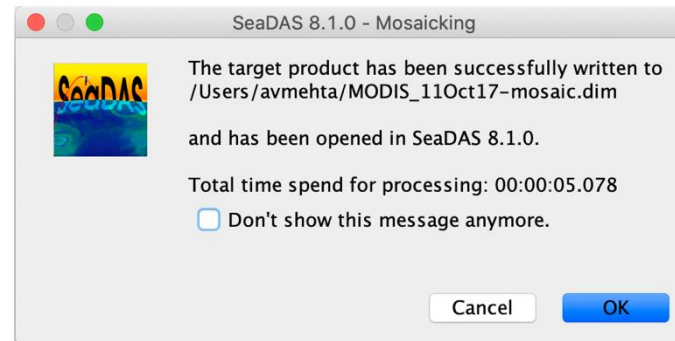
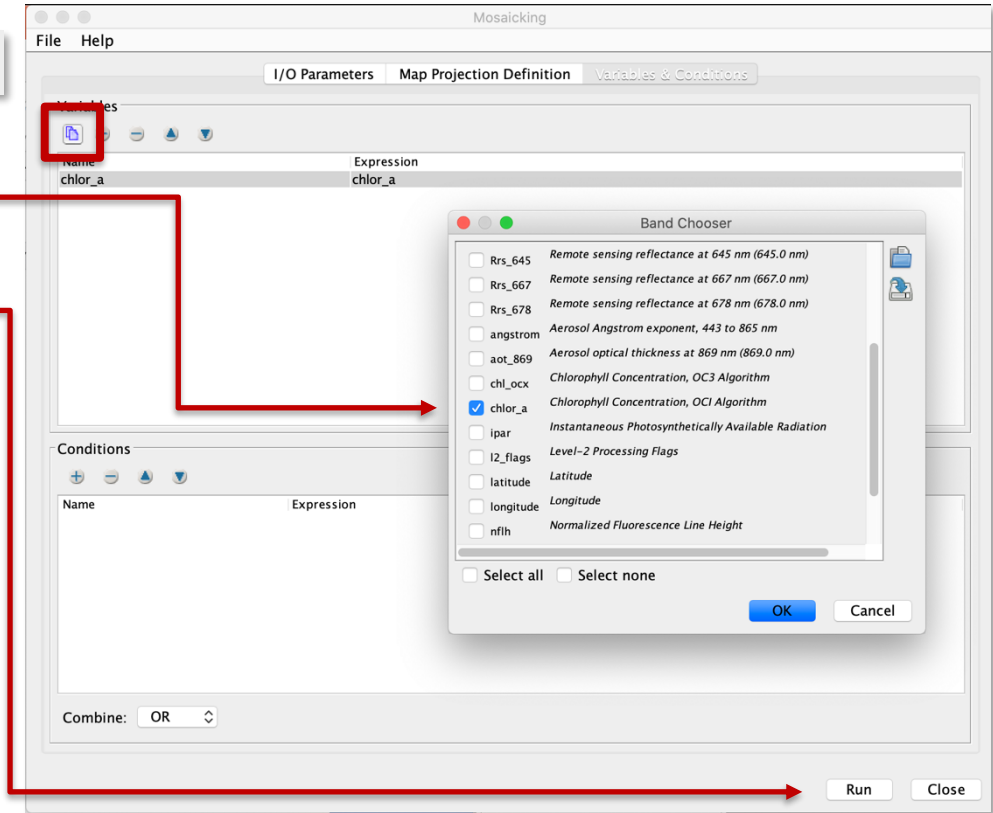
13. Click on the **Creates a mosaic aggregation of multiple files** icon  on the tool bar.

- This will open the **Mosaicking** window.
- For the **I/O Parameters → Source Products**, click on the **+** icon. 
- This will allow you to add files to the mosaic.
- Select all MODIS swaths (hold down the Ctrl key [PC] or Command key [Mac] and click on each file name) for the 11 October 2017 files you saved to your computer in Step 11.
- Enter the **Name** for the output mosaic file: **MODIS_11Oct17-mosaic**. 



Mosaic MODIS Level-2 Images

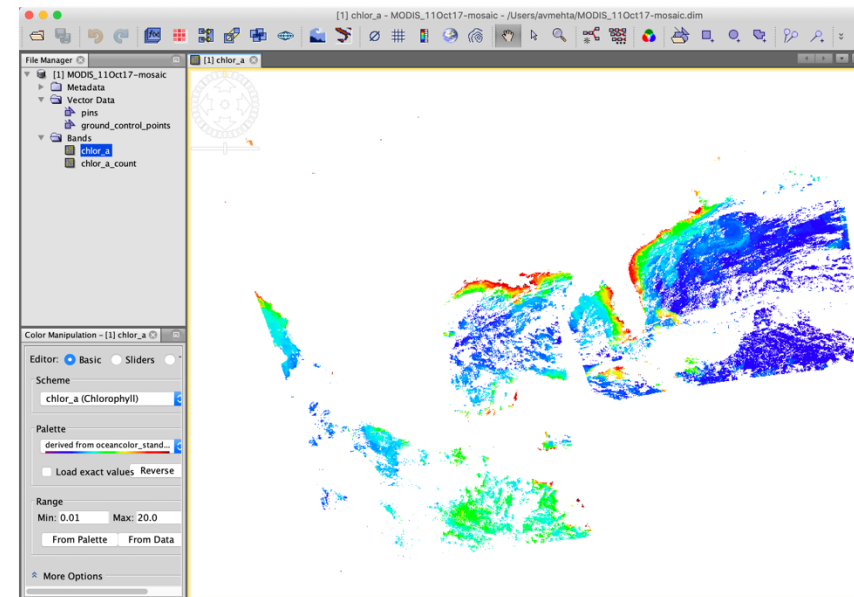
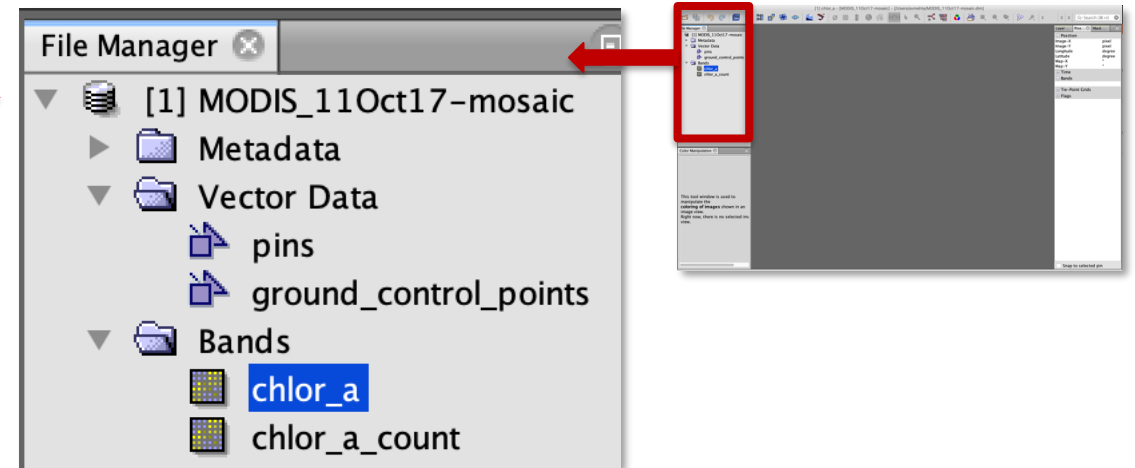
- Click on **Variables and Conditions**, then click on the **Choose the bands to process** icon.
- From the **Band Chooser** list, select **chlora** and click **OK**.
- Click **Run**.
- You will receive a mosaicked image of the MODIS swaths.
- You will also get the following window with a message when the processing is done.
- Click **OK**.



Open MODIS Mosaic Image

14. In the SeaDAS window, you will see the MODIS mosaic file name in the **File Manager**:

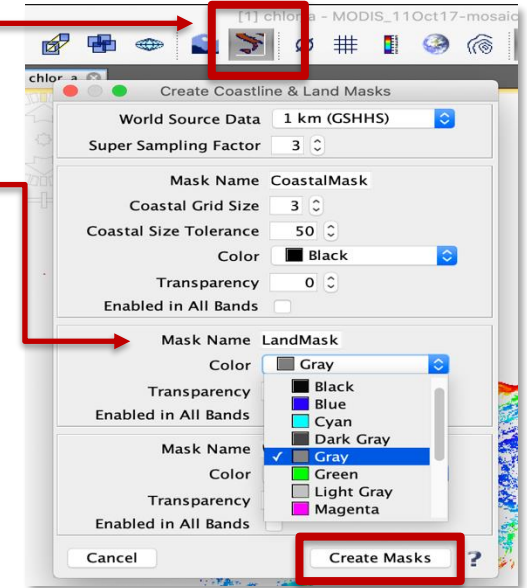
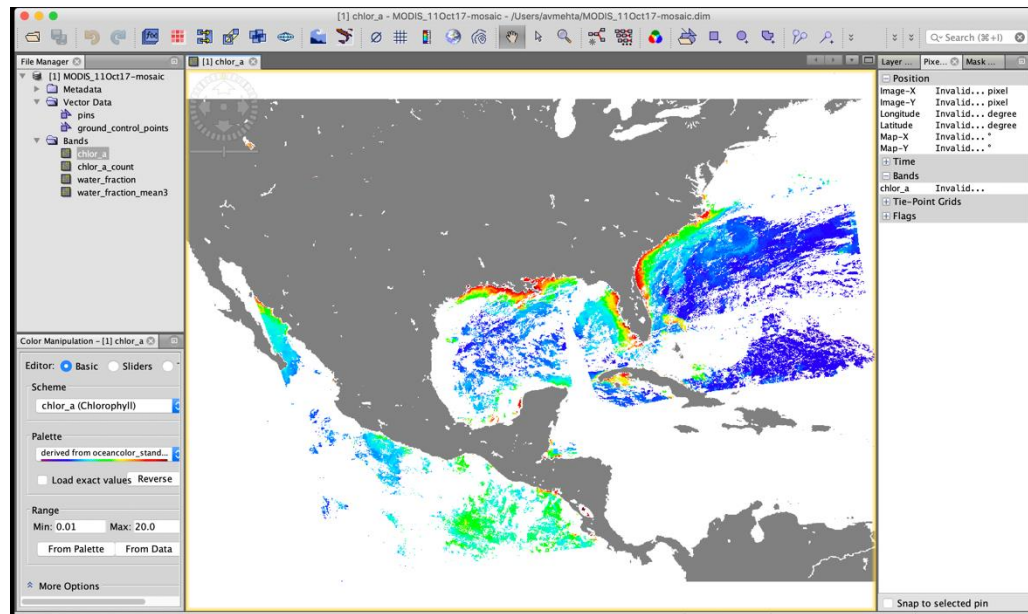
- Click on the down arrow next to the file name:
MODIS_11Oct17-mosaic → **Bands** → **chlor-a**.
- Double-click on **chlor-a** to view the mosaicked image.



Add Land Mask to the MODIS Image

15. Click on the Add coastline, land, and water masks symbol  on the tool bar:

- In **Mask Name** → **LandMask**, use the drop-down arrow and select **Gray** and click on **Create Masks**.
- You now see the MODIS image with the land mask.

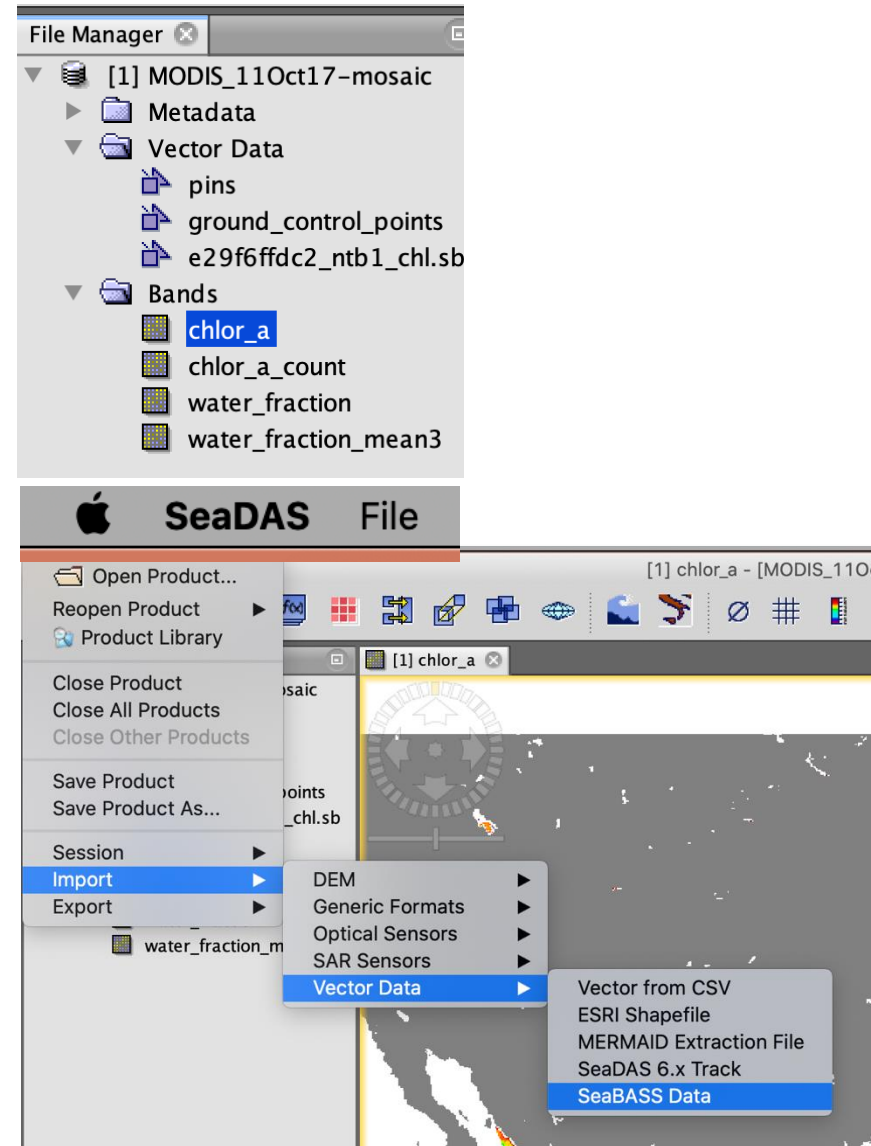


Add SeaBASS Chlorophyll Data to the MODIS Image

16. In the SeaBASS file **e29f6ffdc2_ntb1_chl.sb**, delete lines with dates other than 11 October 2017.

17. In the SeaDAS window → **File Manger** panel, highlight the **chlор_a**:

- From the main top ribbon, click on **File** → **Import** → **Vector Data** → **SeaBASS Data**.
- You will be able to select and add the file **e29f6ffdc2_ntb1_chl.sb**.

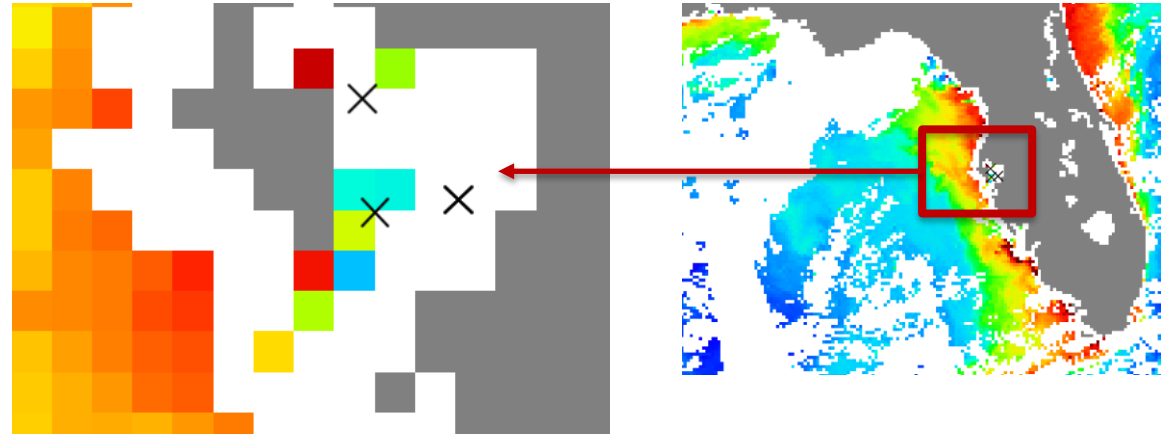


Add SeaBASS Chlorophyll Data to the MODIS Image

18. You will see the SeaBASS data locations added to the image.

To change the symbology of the SeaBASS data locations marker, see the next slide.

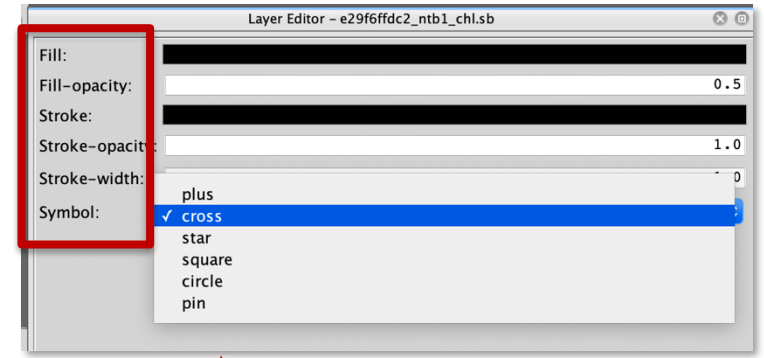
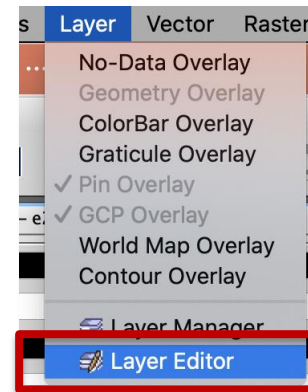
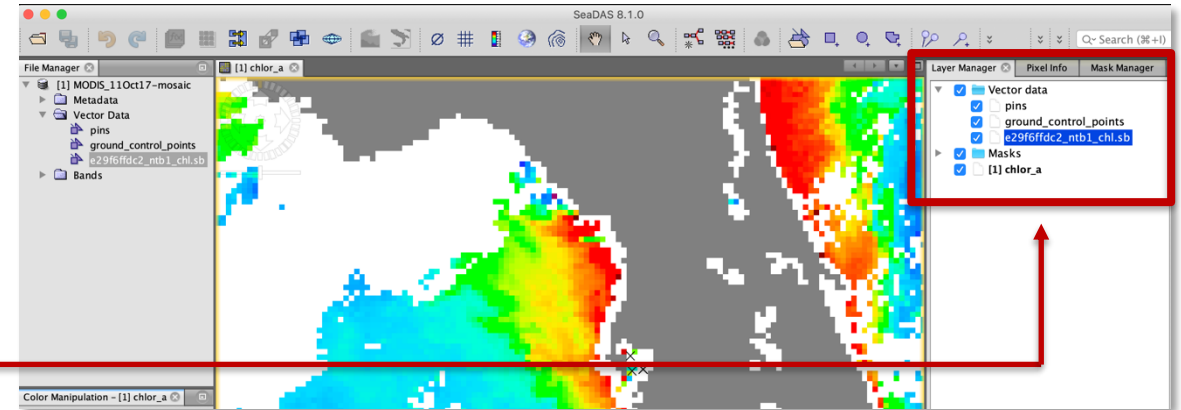
- How many data points are there in the SeaBASS file?
- How many do you see on the image? Can you explain the difference?



Add SeaBASS Chlorophyll Data to the MODIS Image

19. To change the symbology of the SeaBASS data locations:

- Select **Layer Manager** → **Vector data** → **SeaBASS filename (e29f6ffdc2_ntb1_chl.sb)**.
- From the top ribbon, go to **Layer** → **Layer Editor**.
- In the **Layer Editor** window change **Fill**, **Stroke**, and **Symbol** to your desired color/symbol for display.



Select In Situ Measurements from GCOOS

20. Go to the [GCOOS](https://data.gcoos.org) data site.

21. Go to **Data Portal** → **Web Accessible Folder**.

The screenshot shows the GCOOS Data Portal website. The navigation menu includes 'DATA PORTAL', which is highlighted with a red box. A dropdown menu is open under 'DATA PORTAL', with 'Web Accessible Folder' also highlighted with a red box. The main content area features a map of the Gulf of Mexico with numerous green location markers. Below the map is a 'BSEE Notice to Lessees and Operators (NTL) Data Repository and Registry' section. On the right side, there is a statistics dashboard with the following data:

Number of Data Partners	55
Total Number of Regional Stations	261
Total Number of Federal Stations	159
Total Number of Sensors	



Select In Situ Measurements from GCOOS

22. On the **GCOOS Web Accessible Folder** page, click **csv by observation**.

23. You will see the following annual folders:

Index of /data/waf/csv_by_observation

Name	Last modified	Size	Description
Parent Directory		-	
1995/	2020-07-28 21:09	-	
1996/	2020-07-28 21:09	-	
1997/	2020-07-28 21:09	-	
1998/	2020-07-28 21:09	-	
1999/	2020-07-28 21:09	-	
2000/	2020-07-28 21:09	-	
2001/	2020-07-28 21:09	-	
2002/	2020-07-28 21:09	-	
2003/	2020-07-28 21:09	-	
2004/	2020-07-28 21:09	-	
2005/	2020-07-28 21:11	-	
2006/	2020-07-28 21:12	-	
2007/	2020-07-28 21:12	-	
2008/	2020-07-28 21:13	-	
2009/	2020-07-28 21:14	-	
2010/	2019-12-16 18:01	-	
2011/	2019-12-16 18:06	-	
2012/	2019-12-16 18:12	-	
2013/	2019-12-16 18:19	-	
2014/	2019-12-16 18:29	-	
2015/	2019-12-16 18:38	-	
2016/	2019-12-16 18:46	-	
2017/	2019-12-16 18:52	-	
2018/	2019-12-16 19:00	-	

Gulf of Mexico Coastal Ocean Observing System

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GCOOS Web Accessible Folder

To facilitate data access, GCOOS maintains a **Web Accessible Folder (WAF)** for all of its holdings. The WAF (<https://data.gcoos.org/data/waf>) is structured as shown in the left.

NOTES:

GCOOS provide data in various forms. The data aggregated by observable parameters are offered in Comma Separated Values (CSV). Aggregations by platform or stations are offered in CSV or netCDF format. These netCDF files may also be accessed through [GCOOS ERDDAP servers](#).

Data folders may contain a SHA384 hash file (SHA384SUM) that can be used for any collision-resistant application. SHA384SUM can be used to validate downloaded files, check if a file was modified, or use it as a folder manifest to check if there are new files added to the folder. The nc_by_platform folders will contain a SHA384SUM_Archive manifest to guide archival centers to what data can be archived to national archival repositories.

The data folders are summarized by observation, and segregated by year. All files in these folders follow the same file naming syntax as above:

`gcoos_+year+ "_" +month+ "_" +variable+.csv"`

File are suffixed with '.csv' to indicate the data format, i.e. *Comma Separate Values*. The files in these folders have a corresponding [ISO 19115-2](#), a recommended presentation of ISO 19139 standard. The metadata files uses the same file naming syntax as above but suffixed with '.xml' to indicate XML data format.



Select In Situ Measurements from GCOOS

24. Click on **2017** and scroll down to find data files for **October (GCOSS_2017_10)**, then click on **mass concentration of chlorophyll in sea water.csv** and save the file to your computer.
25. Select the same date as the SeaBASS data (11 October). You will have chlorophyll data for several locations every hour.
26. Select the time **18:00Z** on 11 October (close to the time of Aqua overpass of 1:45 PM local time).

*For your convenience, the edited file for this date/time has been made available on the ARSET [website](#).

GCOOS_Ch_20171011.xlsx



gcoos 2017 10 air_pressure.csv	2019-12-16 18:47	28M
gcoos 2017 10 air_pressure.xml	2020-07-28 21:26	22K
gcoos 2017 10 air_temperature.csv	2019-12-16 18:47	23M
gcoos 2017 10 air_temperature.xml	2020-07-28 21:26	22K
gcoos 2017 10 dew_point_temperature.csv	2019-12-16 18:47	266K
gcoos 2017 10 dew_point_temperature.xml	2020-07-28 21:26	22K
gcoos 2017 10 mass concentration of chlorophyll in sea water.csv	2019-12-16 18:47	185K
gcoos 2017 10 mass concentration of chlorophyll in sea water.xml	2020-07-28 21:26	23K
gcoos 2017 10 mass concentration of oxygen in sea water.csv	2019-12-16 18:47	782K
gcoos 2017 10 mass concentration of oxygen in sea water.xml	2020-07-28 21:26	23K
gcoos 2017 10 relative_humidity.csv	2019-12-16 18:47	3.3M
gcoos 2017 10 relative_humidity.xml	2020-07-28 21:26	22K
gcoos 2017 10 sea_surface_height_above_sea_level.csv	2019-12-16 18:47	16M
gcoos 2017 10 sea_surface_height_above_sea_level.xml	2020-07-28 21:26	22K

A	B	C	D	E	F	G
SCCF RECON	ioos:station:SCCF:11	26.4679	-82.063	2017-10-11T18:00:00Z	7.98	1111122
SCCF RECON	ioos:station:SCCF:13	26.5255	-82.003	2017-10-11T18:00:00Z	5.12	1111122
SCCF RECON	ioos:station:SCCF:56	26.4645	-82.104	2017-10-11T18:00:00Z	10.02	1111122



Write GCOOS Data in SeaBASS File Format

27. Now, using the SeaBASS file **e29f6ffdc2_ntb1_chl.sb** you saved in steps 16-17 as a template, write the data from **GCOOS_Ch_20171011.xlsx** in the SeaBASS format.

- In the header section keep (at least):
/start_date, /end_date, /north_latitude,
/south_latitude, /west_longitude,
/east_longitude, /missing, /delimiter.
- Use the data fields: year, month, day,
lat, lon, CHL.
- Save the file as:
GCOOS_Ch_20171011.sb
(note that you can use .txt also).

e29f6ffdc2_ntb1_chl.sb

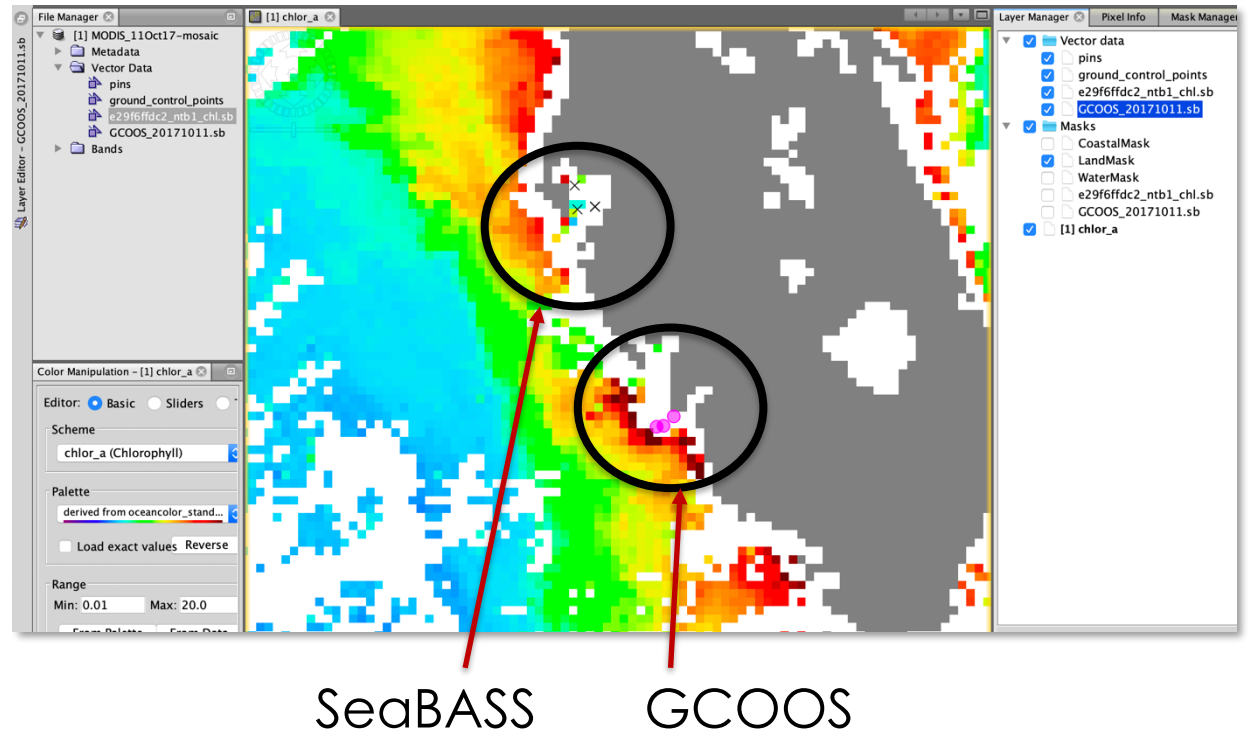
```
/begin_header
/identifier_product_doi=10.5067/SeaBASS/CARBON_ESTUARIES/DATA001
/received=20190731
/investigators=Chuanmin_Hu
/affiliations=University_of_South_Florida
/contact=huc@usf.edu
/experiment=Carbon_Estuaries
!/experiment=Carbon_cycling
/cruise=ntb1
/station=-999
/data_file_name=ntb1_chl.sb
/documents=ntb1_cruise_report.pdf
/calibration_files=no_calibration.txt
/data_type=pigment
/data_status=final
/start_date=20171010
/end_date=20171019
/start_time=16:15:00[GMT]
/end_time=19:00:00[GMT]
/north_latitude=27.8897[DEG]
/south_latitude=27.5853[DEG]
/west_longitude=-82.6470[DEG]
/east_longitude=-82.4693[DEG]
/measurement_depth=-999
/water_depth=-999
/cloud_percent=-999
/wave_height=-999
/wind_speed=-999
/secchi_depth=-999
/instrument_manufacturer=Turner_Designs
/instrument_model=10AU_Field_Fluorometer
/calibration_date=20170724
!
! CRUISE: NTB1
!   October 10-12,17-18, 2017
!   NASA Carbon Cycling project
!
!/missing=-999
/delimiter=space
/fields=year,month,day,hour,minute,second,lat,lon,station,depth,CHL,PHAE0
/units=yyyy,mo,dd,hh,mm,ss,degrees,degrees,none,m,mg/m^3,mg/m^3
/end_header
2017 10 11 15 00 00 27.7653 -82.4693 NTB3 0.5 18.11290 1.91940
2017 10 11 15 50 00 27.7653 -82.4693 NTB3 0.5 18.78390 1.65430
2017 10 11 18 20 00 27.8897 -82.5874 NTB2 0.5 10.84820 2.36680
2017 10 11 19 17 00 27.7492 -82.5720 NTB1 0.5 16.63690 1.61550
```



Add GCOOS Data to the MODIS Image

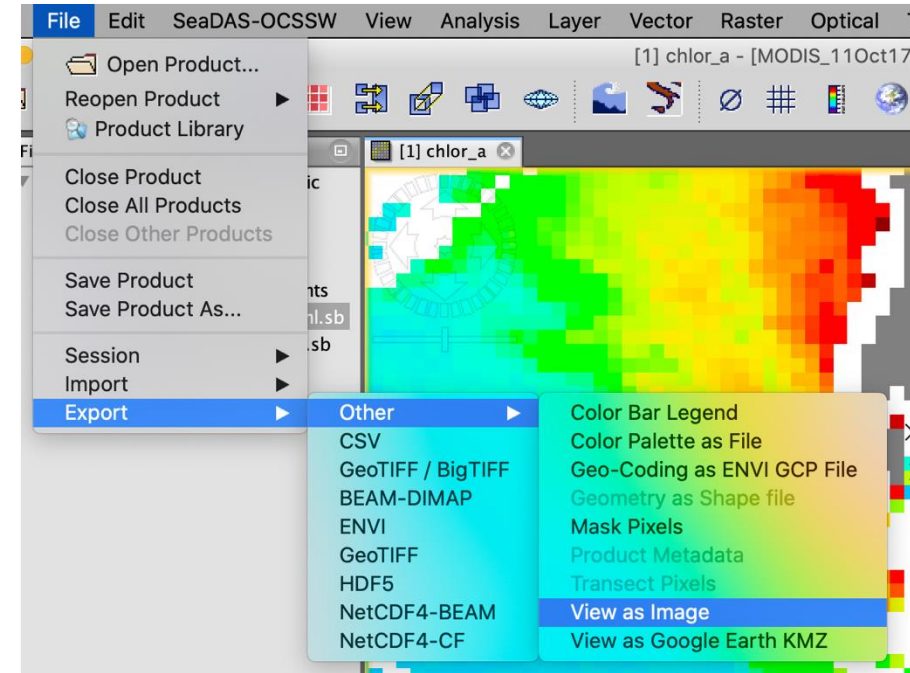
28. Now follow the procedure in steps 16-19 to import the file **GCOOS_Ch_20171011.sb** you just created into SeaDAS.

- You can choose different symbology to portray the GCOOS data.



Save the SeaDAS Display

29. Go to **File** → **Export** → **Other** → **View as Image** and save the SeaDAS display as a PNG image.



For Homework

30. Repeat Steps 13-19 and 29-30 using the VIIRS swaths you saved for the same date in place of the MODIS image. You may want to start a new SeaDAS project.
 - You will submit the VIIRS image with the SeaBASS and GCOOS data points in the homework at the end of the webinar.

