



National Aeronautics and  
Space Administration



# ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

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## Introduction to Remote Sensing for Ocean and Coastal Applications

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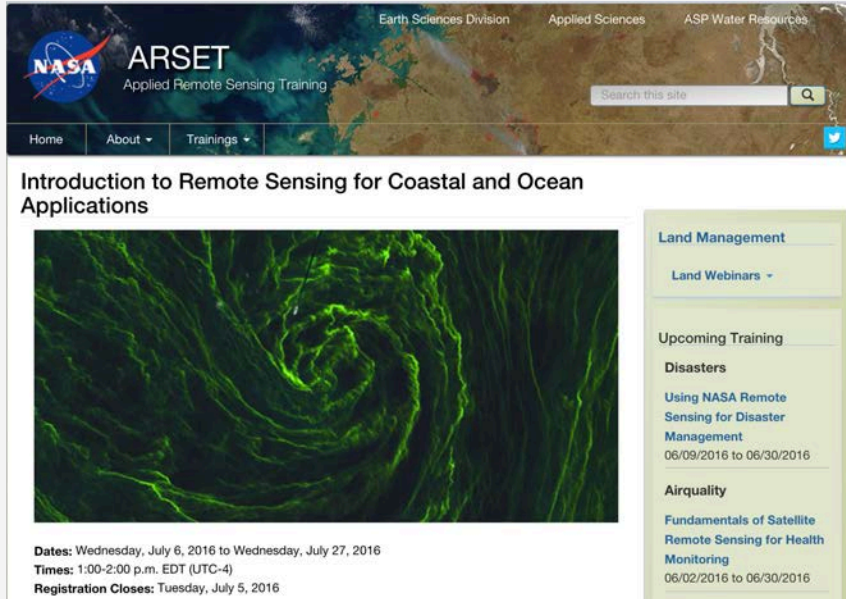
Week 2: Platforms and Sensors for Ocean Observations, Data Access, and Processing Tools

# Course Structure

- One lecture per week – every Wednesday July 6 – July 27
- 1:00 – 2:00 PM EDT (UTC-4)
  - Lectures
  - In-class demonstration
  - Homework exercises, due August 10th
- Webinar recordings, presentations, and homework assignments can be found after each session at:
  - <http://arset.gsfc.nasa.gov/land/webinars/coastal-oceans-2016>
- Q/A: Following each lecture and/or by email ([sherry.l.palacios@nasa.gov](mailto:sherry.l.palacios@nasa.gov))

# Accessing Course Materials

<http://arset.gsfc.nasa.gov/land/webinars/coastal-oceans-2016>



The screenshot shows the ARSET (Applied Remote Sensing Training) website. The header includes the NASA logo, the text 'ARSET Applied Remote Sensing Training', and navigation links for 'Earth Sciences Division', 'Applied Sciences', and 'ASP Water Resources'. A search bar is present. Below the header, there are tabs for 'Home', 'About', and 'Trainings'. The main content area features a large satellite image of a coastal area with green and blue patterns. The title of the course is 'Introduction to Remote Sensing for Coastal and Ocean Applications'. To the right of the image is a sidebar with sections for 'Land Management', 'Land Webinars', 'Upcoming Training', 'Disasters', 'Using NASA Remote Sensing for Disaster Management', 'Airquality', and 'Fundamentals of Satellite Remote Sensing for Health Monitoring'. Below the image, the dates, times, and registration closing date are listed.

**Introduction to Remote Sensing for Coastal and Ocean Applications**

**Dates:** Wednesday, July 6, 2016 to Wednesday, July 27, 2016  
**Times:** 1:00-2:00 p.m. EDT (UTC-4)  
**Registration Closes:** Tuesday, July 5, 2016

## Course Agenda:

[Agenda.pdf](#)

### Session One: Overview of Satellite Remote Sensing of Aquatic Environments

July 6, 2016

An overview of themes in coastal and ocean applied science, how remote sensing is used for coastal and ocean applied science, fundamentals of remote sensing (spatial, temporal, spectral resolutions), and the advantages and limitations of remote sensing in aquatic environments. [View the recording »](#)

- [Presentation Slides »](#)

### Session Two: Platforms and Sensors for Ocean Observations, Data Access, and Processing Tools

July 13, 2016

Satellites and sensors for coastal and ocean applications, satellite data processing levels, NASA satellite data access tools and data processing tools. [View the recording »](#)

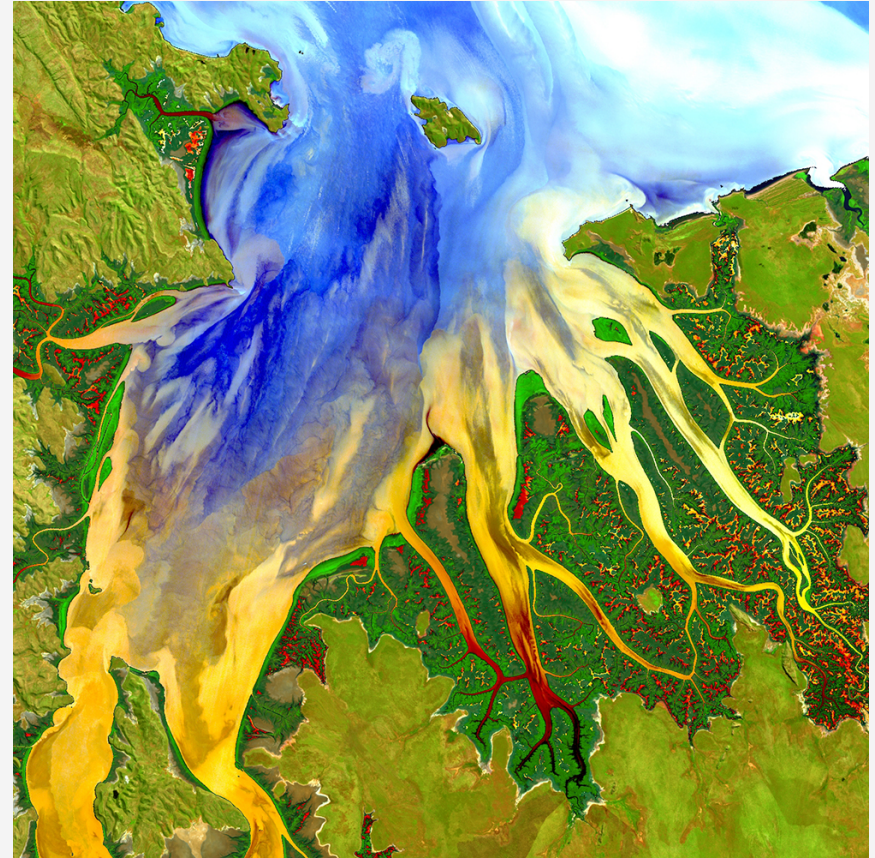
- [Presentation Slides »](#)

# Your Course Instructors

- Sherry Palacios: [sherry.l.palacios@nasa.gov](mailto:sherry.l.palacios@nasa.gov)
- Amber McCullum: [amberjean.mccullum@nasa.gov](mailto:amberjean.mccullum@nasa.gov)
- Cindy Schmidt: [cynthia.l.schmidt@nasa.gov](mailto:cynthia.l.schmidt@nasa.gov)
  
- Guest Speakers:
  - Mitchell Roffer, Roffer's Ocean Fishing Forecast Service (Week 3)
  - Mark Eakin, NOAA Coral Reef Watch (Week 4)
  
- General ARSET Inquiries
  - Ana Prados: [aprados@umbc.edu](mailto:aprados@umbc.edu)

# Course Objectives

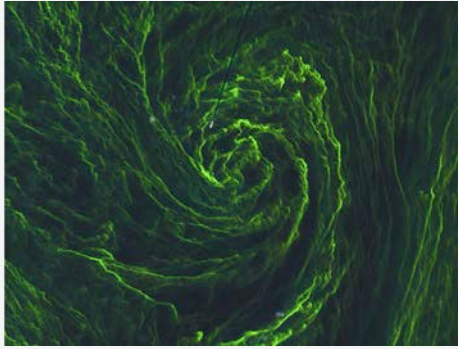
- Overview of NASA Earth Observation resources available for open ocean and coastal applications including:
  - A basic understanding of remote sensing of aquatic systems
  - How to access and visualize NASA Earth science data
  - How to use NASA Earth science data, tools, and products for ocean and coastal applied science issues
- Conduct live demonstrations of useful ocean and coastal applied science tools



Credit: NASA/USGS Landsat; Geoscience Australia

# Course Outline

Week 1  
Overview of  
Satellite  
Remote Sensing

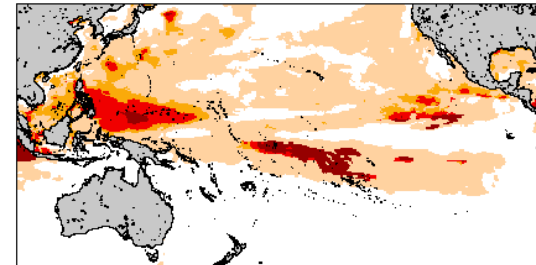


Week 3  
Animal  
Movement



Week 2  
Platforms  
and Sensors  
for Ocean  
Observations

2016 May 17 NOAA 90% Probability Bleaching Thermal Stress for May–Aug 2016  
Experimental, v3.0, CFSv2–based, 28–member




Potential Stress Level: Watch Warning Alert Level 1 Alert Level 2

Week 4  
Coral Reefs

# Week 2 Agenda

- Brief Review of Last Week
- Satellites and sensors for coastal and ocean applications
- Satellite data processing level
- NASA satellite data access tools
- NASA satellite data processing tools

An aerial photograph of a coastal region. A river with a complex delta system flows from the top left towards the center. The water is a light, milky blue, contrasting with the deep blue of the open ocean. The land is green and brown, showing some infrastructure. A semi-transparent white rectangular box is overlaid on the right side of the image, containing the text 'Review of Week 1' and a horizontal line below it.

# Review of Week 1

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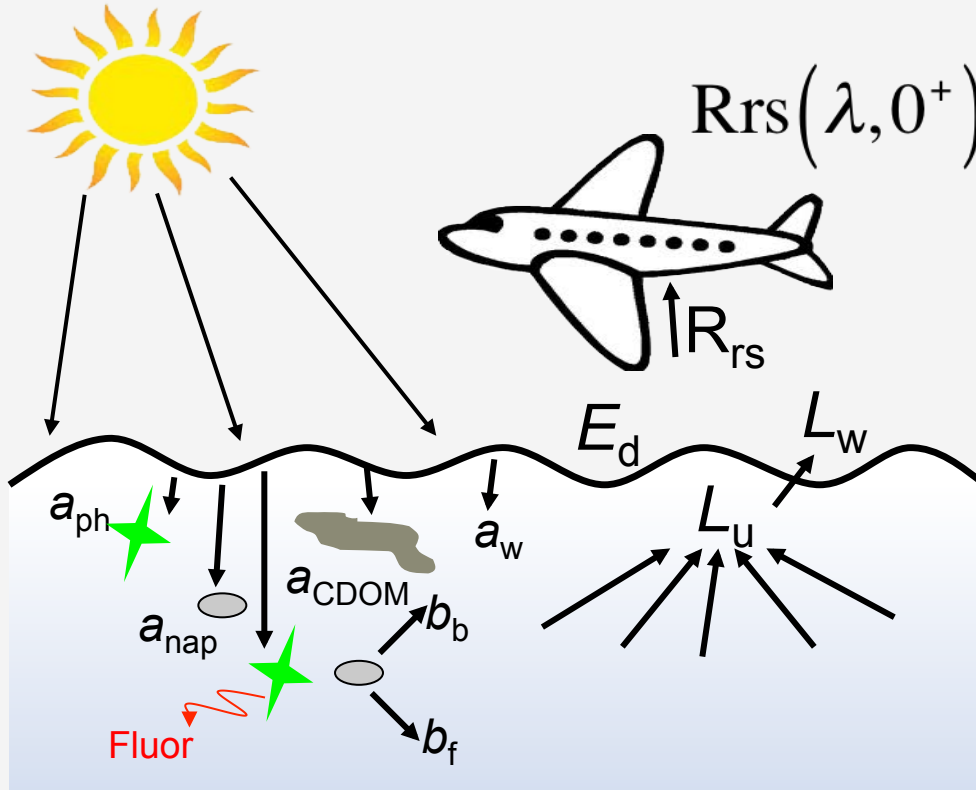


# Coastal and Open Ocean Applied Science Thematic Areas

- Marine Protected Areas
- Marine Fisheries
- Animal Migrations
- Water Quality
- Harmful Algal Blooms (HABs)
- Eutrophication
- Coral Reef Health
- Marsh Subsidence
- Coastal Development
- Coastal Hazards – flooding, sea level rise

# How Light Interacts with the Water

Defining Remote Sensing Reflectance ( $R_{rs}$ ) – or ‘Ocean Color’



$$R_{rs}(\lambda, 0^+) \cong C \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)} = \frac{L_w(\lambda)}{E_d(\lambda, 0^+)}$$

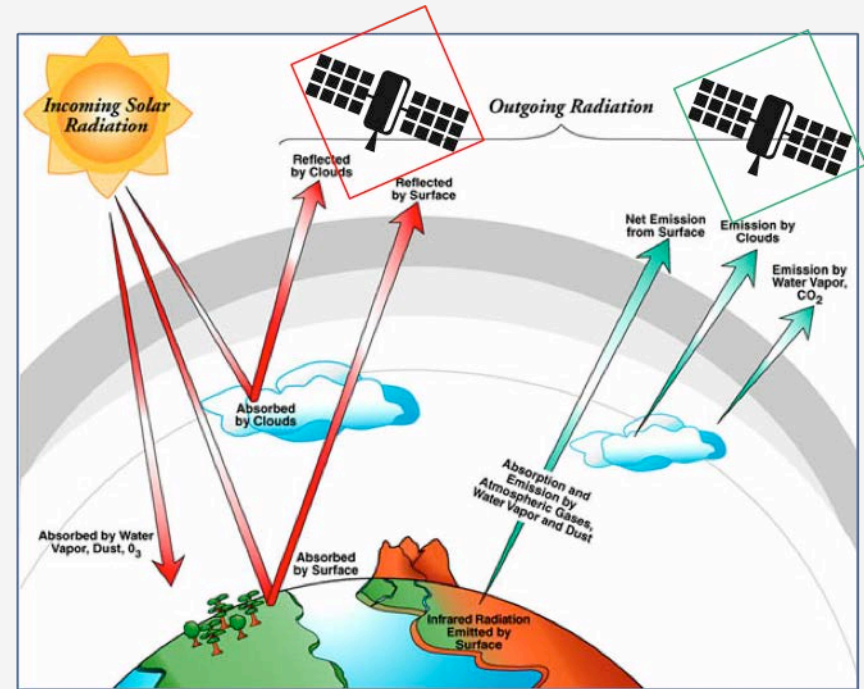
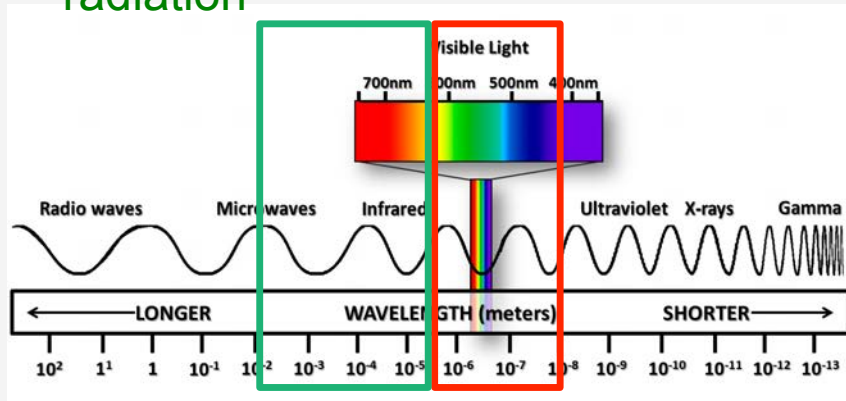
$a$  = absorption  
 $b$  = scattering

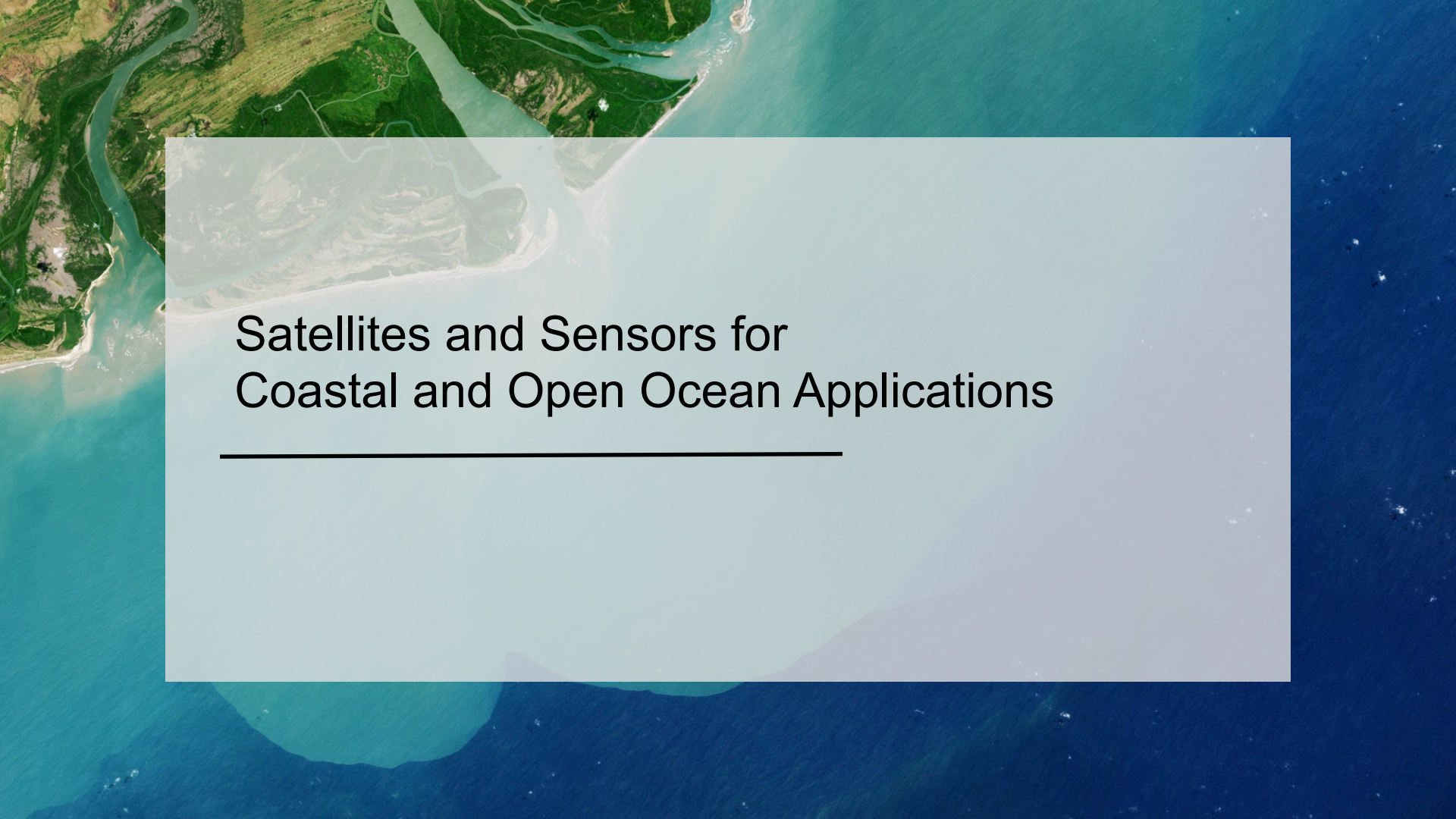
$L_w$  = water leaving radiance  
 $E_d$  = downwelling irradiance

# An Overview of Satellite Remote Sensing

Satellites carry instruments/sensors to measure:

- reflected solar radiation
- emitted infrared and microwave radiation



A satellite image of a coastal region. On the left, a river delta flows into the ocean, with green land and light-colored sediment. The ocean transitions from shallow turquoise near the coast to deep blue further out. A semi-transparent white box is overlaid on the right side of the image, containing the title text.

# Satellites and Sensors for Coastal and Open Ocean Applications

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# Overview of NASA Satellites & Sensors for Water Quality Monitoring

- Currently several satellites observe water surface properties in:
  - *the open ocean*
  - *coastal oceans and estuaries*
  - *many inland lakes*
- A number of water quality parameters are operationally available from these satellites
  - (e.g. temperature, chlorophyll-a)



# NASA Satellites & Sensors for Ocean and Coastal Systems

Satellite	Sensor	Parameter
Landsat Series (7/1972 - present)	<ul style="list-style-type: none"> <li>• Thematic Mapper (TM)</li> <li>• Enhanced Thematic Mapper (ETM+)</li> <li>• Operational Land Imager (OLI)</li> </ul>	<ul style="list-style-type: none"> <li>• Spectral Reflectance</li> </ul>
Terra (12/1990-present)	Moderate Resolution Imaging Spectroradiometer (MODIS)	<ul style="list-style-type: none"> <li>• Spectral Reflectance</li> <li>• Chlorophyll-a Concentration</li> <li>• Temperature</li> <li>• Colored Dissolved Organic Matter (CDOM)</li> <li>• Turbidity</li> <li>• Euphotic Depth</li> </ul>
Aqua (5/2002-present)		
Terra (12/1999 – present)	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)	<ul style="list-style-type: none"> <li>• Spectral Reflectance</li> <li>• Temperature</li> </ul>

# NASA Satellites & Sensors for Ocean and Coastal Systems

Satellite	Sensor	Parameter
National Polar Partnership (NPP) (11/2011-present)	Visible Infrared Imaging Radiometer Suite (VIIRS)	<ul style="list-style-type: none"> <li>• Spectral Reflectance</li> <li>• Chlorophyll Concentration</li> </ul>
International Space Station	Hyperspectral Imager for the Coastal Ocean (HICO) (2009 – 2014)	<ul style="list-style-type: none"> <li>• Spectral Radiance</li> <li>• Spectral Remote Sensing Reflectance</li> </ul>
Plankton, Aerosols, Clouds, ocean Ecosystems, PACE (proposed for 2022 or 2023)	Ocean Color Instrument	<ul style="list-style-type: none"> <li>• Spectral Reflectance</li> <li>• Optional Polarimeter being considered</li> </ul>

# Landsat Satellites and Sensors

<http://landsat.gsfc.nasa.gov/>



[http://landsat.usgs.gov/about\\_mission\\_history.php](http://landsat.usgs.gov/about_mission_history.php)

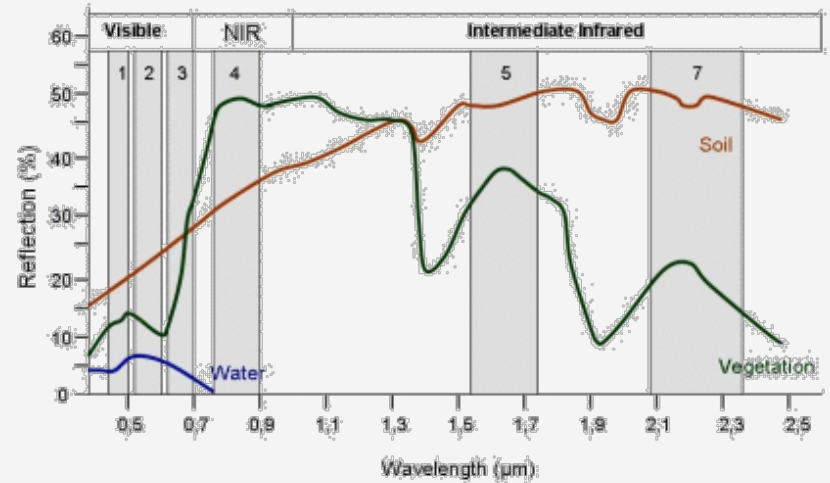
- Near-polar orbit
- 10 a.m. equator-crossing time
- Global coverage
- July 1972 – present
- 16 day revisit time
- Sensors
  - MSS
  - TM
  - ETM+
  - OLI
  - TIRS



# Landsat-7 Enhanced Thematic Mapper (ETM+)

<http://geo.arc.nasa.gov/sge/landsat/l7.html>

- Flying on-board Landsat 7 polar orbiting satellites
- Spatial Coverage and Resolution:
  - Global, swath 185km
  - Spatial Resolution: 15m, 30m, 60m
- Temporal Coverage and Resolution
  - April 15, 1999 – present
  - 16 day revisit time
- Spectral Bands
  - 8 bands (major bands include: blue-green, green, red, reflected and thermal IR, and panchromatic)

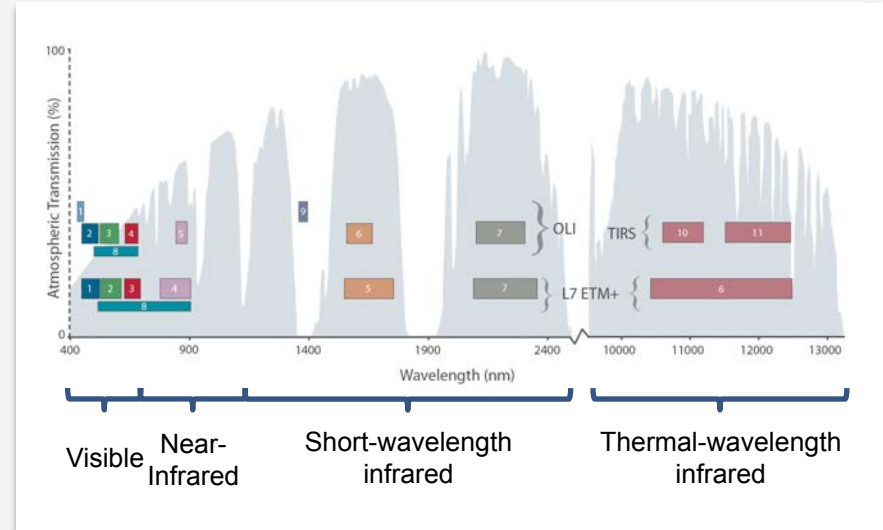


- Spectral Bands
  - Bands 1-5, 7: 30m
  - Band 6: 60m
  - Band 8: 15m

# Landsat-8 Operational Land Imager (OLI)

<http://landsat.usgs.gov/landsat8.php>; <http://landsat.gsfc.nasa.gov/?p=5779>

- Flying on-board Landsat 8 (Landsat Data Continuity Mission – LDCM) polar orbiting satellite
- Spatial Coverage & Resolution:
  - Global, Swath 185km
  - Spatial Resolution: 15m, 30m
- Temporal Coverage & Resolution:
  - February 11, 2013 – present
  - 16 day revisit time
- Spectral Bands
  - 9 bands (major bands include blue-green, red, near IR, shortwave and thermal IR, panchromatic)

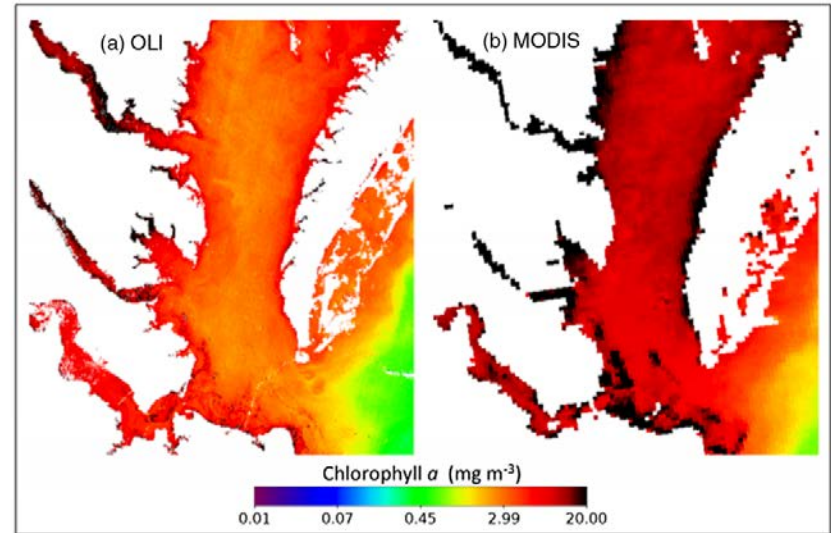


- Spectral Bands
  - Bands 1-7, 9: 30m
  - Band 8: 15m

# Landsat-8 Operational Land Imager (OLI)

<http://landsat.usgs.gov/landsat8.php>; <http://landsat.gsfc.nasa.gov/?p=5779>

- Flying on-board Landsat 8 (Landsat Data Continuity Mission – LDCM) polar orbiting satellite
- Spatial Coverage & Resolution:
  - Global, Swath 185km
  - Spatial Resolution: 15m, 30m
- Temporal Coverage & Resolution:
  - February 11, 2013 – present
  - 16 day revisit time
- Spectral Bands
  - 9 bands (major bands include blue-green, red, near IR, shortwave and thermal IR, panchromatic)



**Fig. 3** Images of chlorophyll *a* concentration retrieved from OLI and MODIS Aqua over Chesapeake Bay on September 5, 2013. The MODIS data were collected on the same day, about 3 h later. The chlorophyll *a* concentration was retrieved using standard NASA ocean color processing in SeaDAS.

Franz et al. 2015

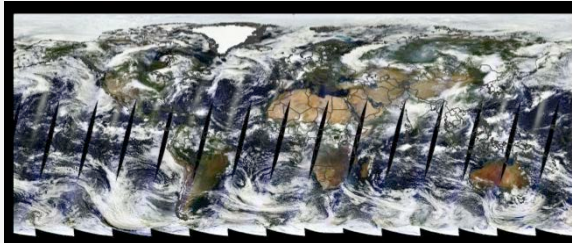
[http://oceancolor.gsfc.nasa.gov/cmsdocs/papers/franz\\_et\\_al\\_2015\\_jars.pdf](http://oceancolor.gsfc.nasa.gov/cmsdocs/papers/franz_et_al_2015_jars.pdf)

# Terra and Aqua

<http://terra.nasa.gov/>; <http://aqua.nasa.gov/>

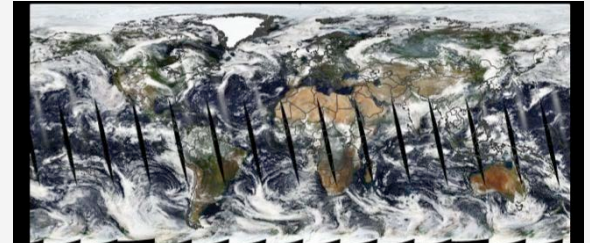
## Terra

- Polar orbit, 10:30 a.m. equator crossing time
- Global Coverage
- December 18, 1999 – present
- 1-2 observations per day
- Sensors:
  - ASTER, CERES, MISR, MODIS, MOPITT



## Aqua

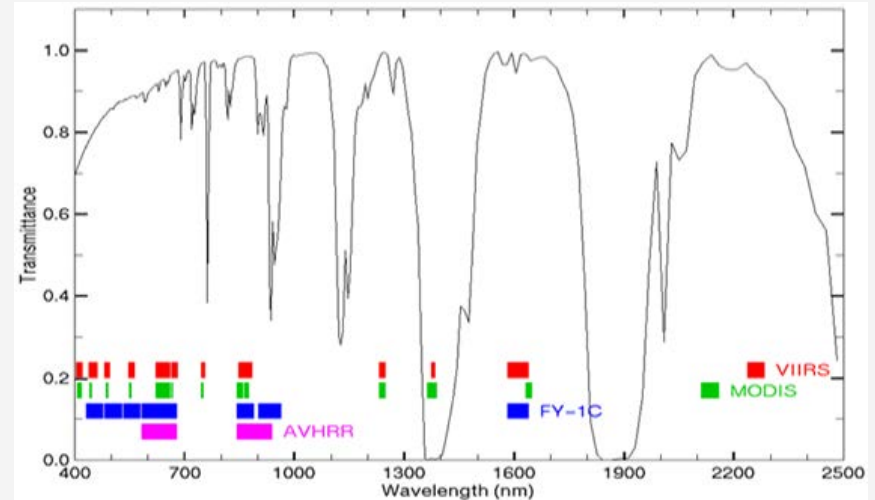
- Polar orbit, 1:30 p.m. equator crossing time
- Global Coverage
- May 4, 2002 – present
- 1-2 observations per day
- Sensors:
  - AIRS, AMSU, CERES, MODIS, AMSR-E



# MODerate Resolution Imaging Spectroradiometer (MODIS)

<http://modis.gsfc.nasa.gov>

- Flying on-board Terra and Aqua – polar orbiting satellites
- Designed for land, atmosphere, ocean, and cryosphere observations
- Spatial Coverage & Resolution
  - Global, swath width 2300km
  - Spatial resolution: 250m, 500m, 1km
- Temporal Coverage and Resolution
  - 2000 – present
  - 2 times per day
- Spectral Bands
  - 36 bands (major bands include red, blue, IR, NIR, MIR)

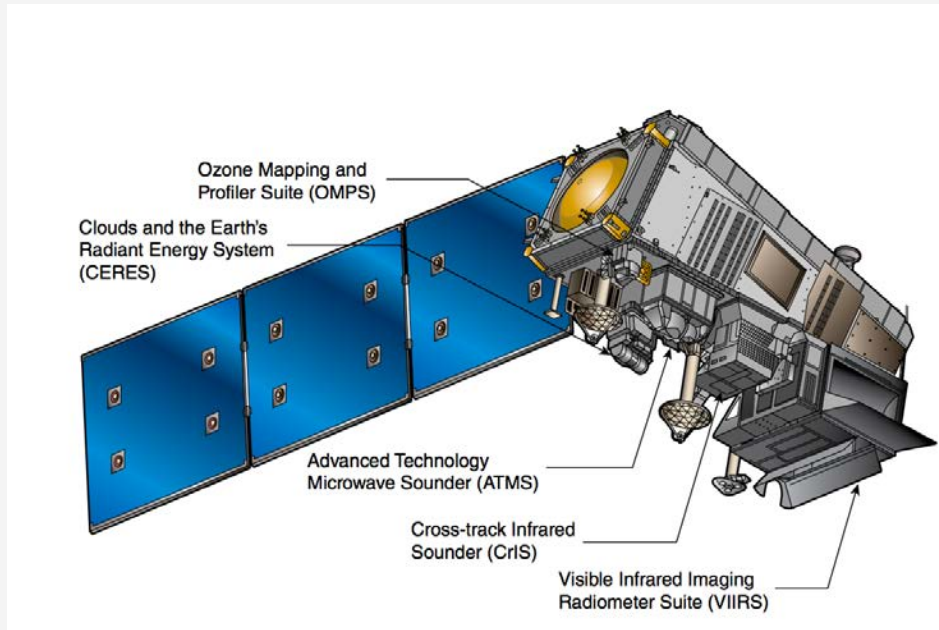


Paul Menzel, <http://cimss.ssec.wisc.edu/>

- Spectral Bands
  - Bands 1-2: 250m
  - Bands 3-7: 500m
  - Bands 8-36: 1000m

# National Polar Partnership (NPP)

[http://www.nasa.gov/mission\\_pages/NPP](http://www.nasa.gov/mission_pages/NPP)



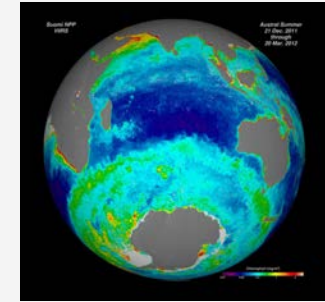
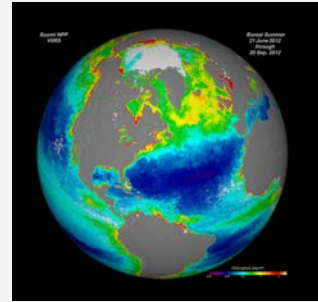
NASA/NOAA

- Polar orbit
- 1:30 p.m. equator crossing time
- Global coverage
- November 21, 2011 – present
- 1-2 observations per day
- Sensors
  - VIIRS
  - ATMS
  - CrIS
  - OMPS
  - CERES

# Visible Infrared Imaging Radiometer Suite (VIIRS)

<http://npp.gsfc.nasa.gov/viirs.html>

- Flying on-board NPP, polar-orbiting satellite
- Designed to collect measurements of clouds, aerosols, ocean color, surface temperature, fires, and albedo
- Spatial Coverage and Resolution:
  - Global, swath width: 3,040 km
  - Spatial resolution: 375m – 750m
- Temporal Coverage
  - October 2011 – present
  - 2 times per day



- Spectral Bands
  - 15 bands (major bands include visible, red, blue, green, short, middle, and long-wave IR)
  - Ocean Color Bands 1-7: 0.402-0.682 $\mu$ m
  - Sea Surface Temperature Bands 12-13: 3.660-4.128 $\mu$ m

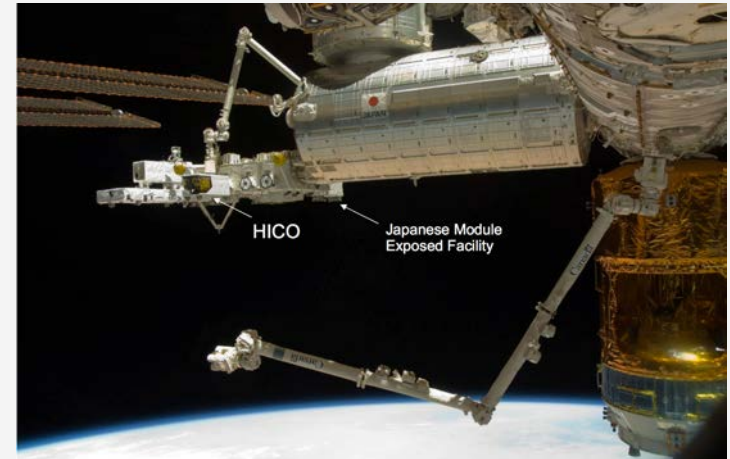
# Hyperspectral Imager for the Coastal Ocean (HICO)

<http://hico.coas.oregonstate.edu/> ; <http://oceancolor.gsfc.nasa.gov/cms/data/hico>

- Partnership with US Naval Research Lab, Office of Naval Research, Oregon State University, and NASA
- Active 2009 – 2014 aboard the International Space Station (ISS)
- 380 nm to 960 nm at 5.7 nm spectral resolution
- 90 m<sup>2</sup> spatial resolution
- Targeted data collection



National Aeronautics and Space Administration



[http://www.ioccg.org/sensors/Davis\\_HICO\\_IOCCG-15.pdf](http://www.ioccg.org/sensors/Davis_HICO_IOCCG-15.pdf)

Applied Remote Sensing Training Program

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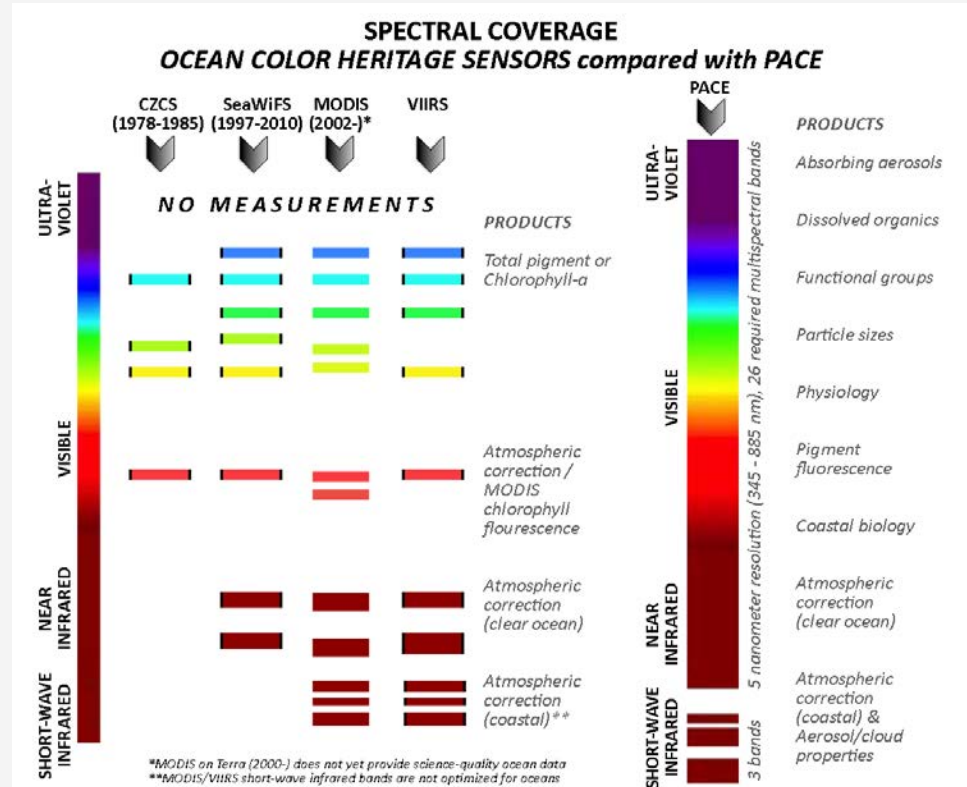


# Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)

<http://pace.gsfc.nasa.gov/>



- Polar orbiting, 2-day revisit
- High spectral resolution
- 1 km ground sample distance
- Optional polarimeter being considered for cloud and aerosol study and to aid in atmospheric correction



From: <http://pace.gsfc.nasa.gov/>

A satellite image of a coastal region, showing a river delta with multiple channels flowing into a body of water. The land is green, and the water is a mix of light blue and dark blue. A semi-transparent white box is overlaid on the image, containing the text "Satellite Data Processing Level" and a horizontal line.

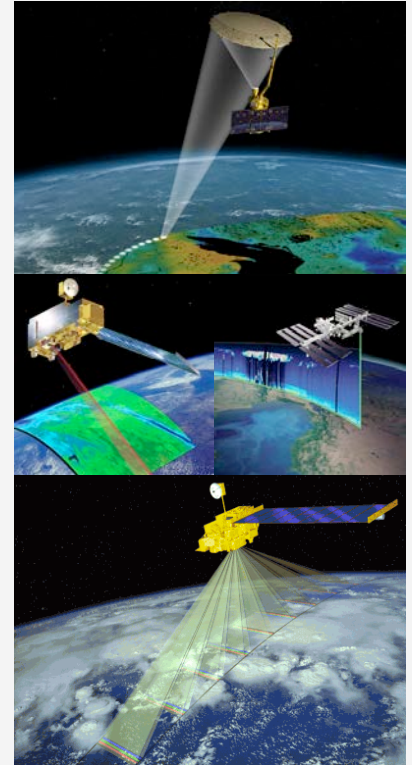
# Satellite Data Processing Level

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# Levels of Data Processing

<http://oceancolor.gsfc.nasa.gov/cms/products>

- Level 0: unprocessed instrument data at full resolution, rawest format available
- Level 1A: reconstructed and unprocessed instrument data at full resolution, Level 1B: L1A data with instrument/radiometric calibrations applied
- Level 2: Derived geophysical variables at same resolution as L1 data
- Level 3: L2 projected onto a well defined spatial grid over a well-defined time period
- Level 4: model output or results from analyses of lower level data (e.g., Primary Productivity)



# Data Processing Levels

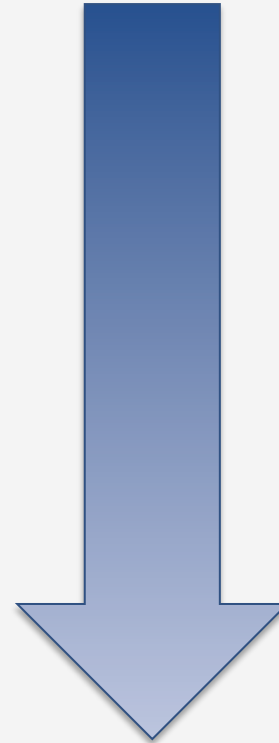
L0: Raw instrument data

L1: Geolocated and calibrated

L2: Products derived from L1B

L3: Gridded and quality controlled

L4: Model output: derived variables



Harder to Use

Easier to Use

A satellite image of a coastal region, likely a river delta, showing a complex network of waterways and land. The water is a mix of light blue and green, indicating varying depths and sediment levels. The land is green and brown, with some white structures visible. The ocean is a deep blue. A semi-transparent white box is overlaid on the image, containing the title text.

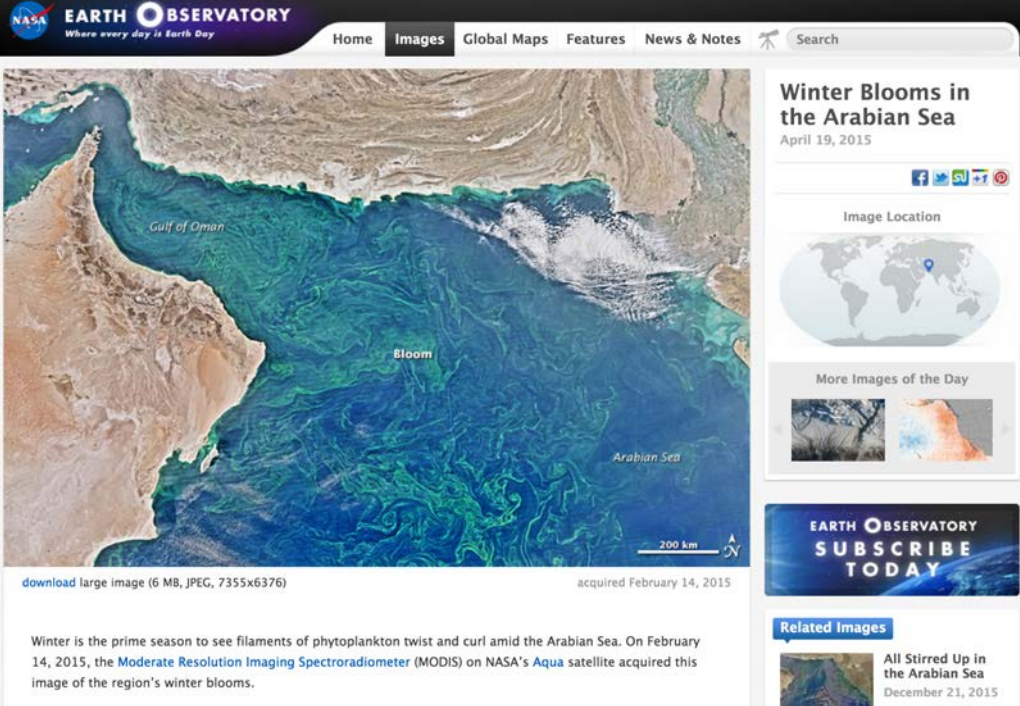
# NASA Satellite Data Access Tools

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# Phytoplankton Bloom in the Arabian Sea

<http://earthobservatory.nasa.gov/IOTD/view.php?id=85718>

- Winter is the prime season for phytoplankton blooms due to monsoon wind shifts that bring more nutrients to the surface
- A recent phase shift from diatoms to dinoflagellates may have an impact on the food web
- The phase shift is due to changing surface oxygen concentrations

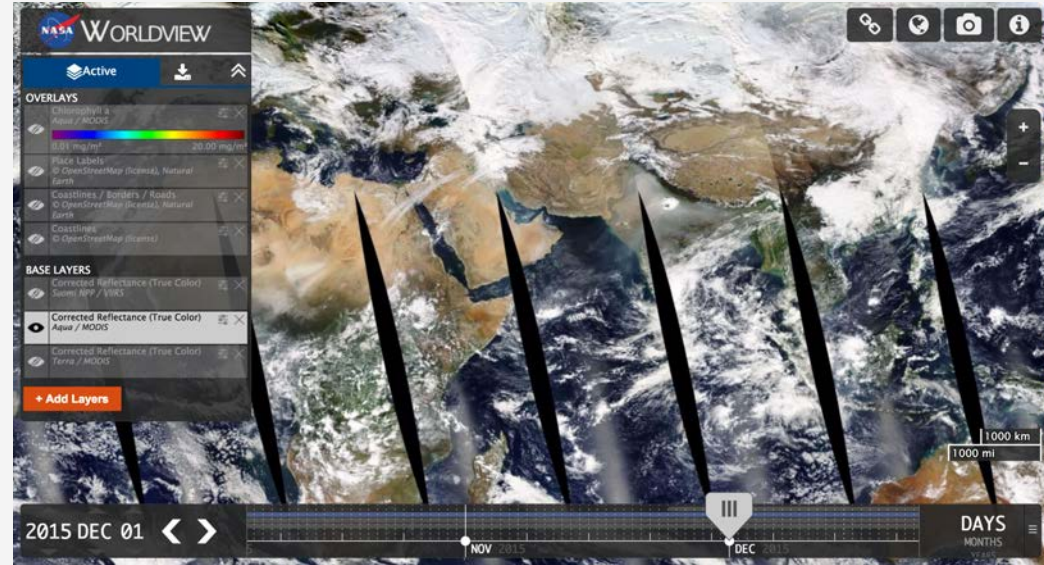


The screenshot displays the NASA Earth Observatory website interface. At the top, the NASA logo and "EARTH OBSERVATORY" text are visible, along with navigation links for Home, Images, Global Maps, Features, News & Notes, and a search bar. The main content area features a satellite image of the Arabian Sea, showing a large, swirling green and blue area labeled "Bloom". The Gulf of Oman is also labeled. Below the image, there is a "download large image (6 MB, JPEG, 7355x6376)" link and a note that the image was "acquired February 14, 2015". A descriptive paragraph states: "Winter is the prime season to see filaments of phytoplankton twist and curl amid the Arabian Sea. On February 14, 2015, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite acquired this image of the region's winter blooms." To the right of the main image, there is a sidebar with a title "Winter Blooms in the Arabian Sea" dated "April 19, 2015", social media sharing icons, an "Image Location" map, "More Images of the Day" thumbnails, a "SUBSCRIBE TODAY" button, and a "Related Images" section with a thumbnail and title "All Stirred Up in the Arabian Sea" dated "December 21, 2015".

# NASA Worldview

<https://worldview.earthdata.nasa.gov/>

- Interactive web-based tool for browsing satellite imagery
- Imagery is generally available within four hours of observation
- Daily imagery from May 2012 to present
- Data can be downloaded
- Image output in JPEG, PNG, GeoTIFF, and KML formats



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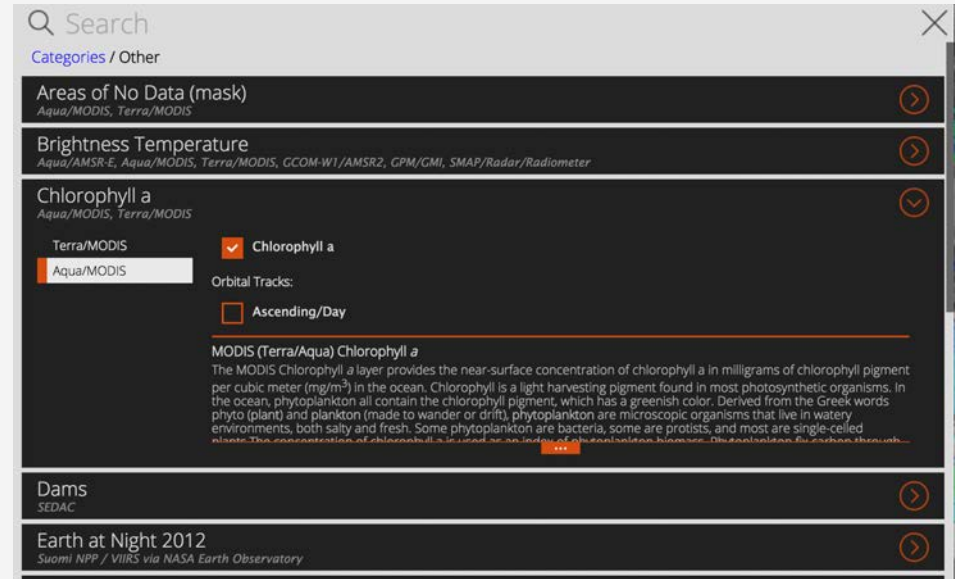
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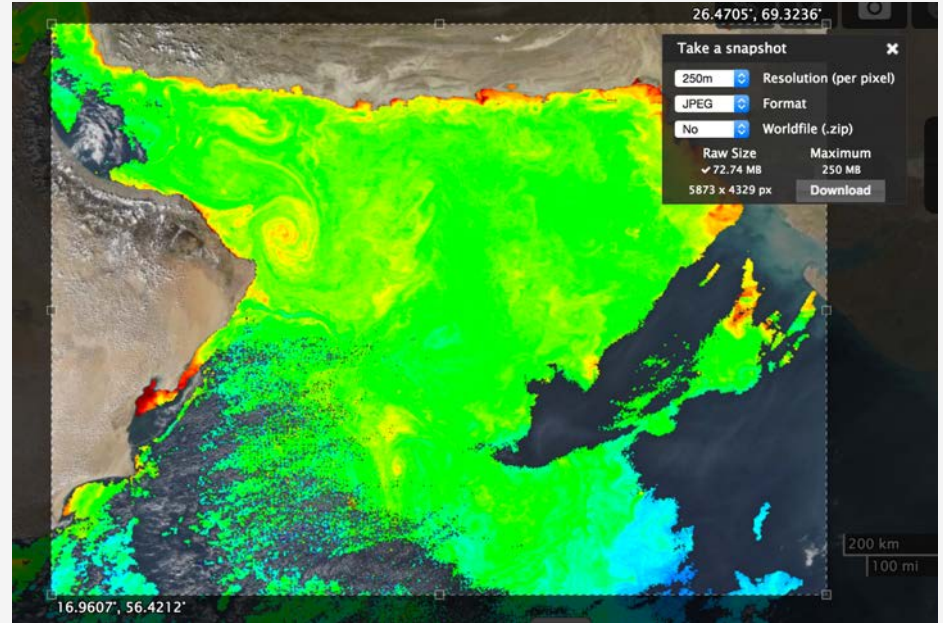
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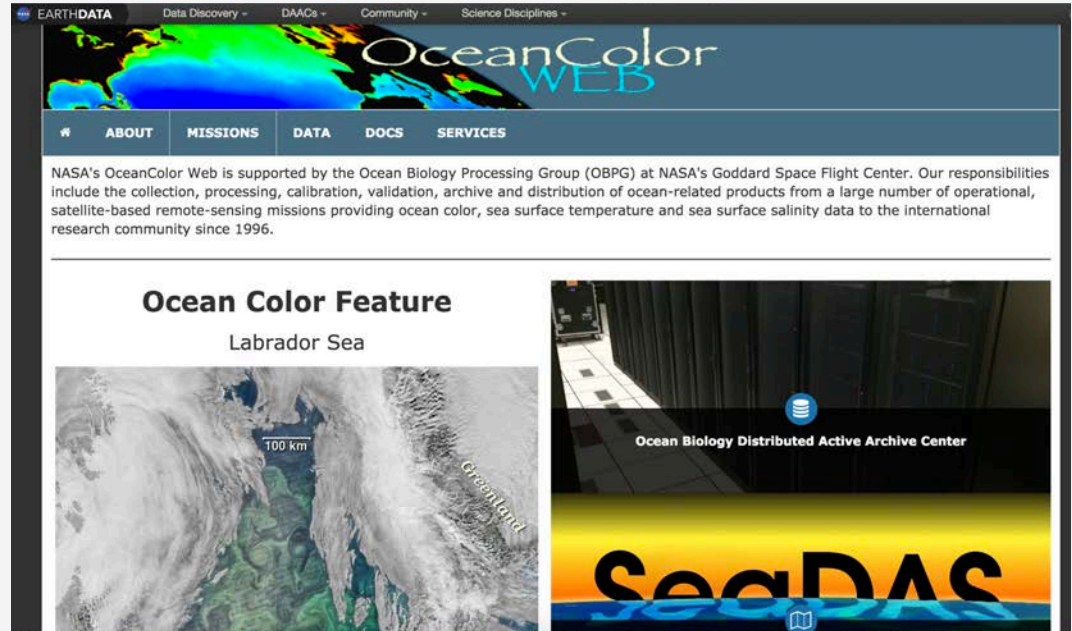
- Interactive web-based tool for browsing satellite imagery
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- Daily imagery from May 2012 to present
- Data can be downloaded
- Image output in JPEG, PNG, GeoTIFF, and KML formats



# NASA OceanColor Web

<http://oceancolor.gsfc.nasa.gov/>

- OceanColor Web is supported by the Ocean Biology Processing Group (OBPG) at NASA Goddard
- OBPG's duties include collection, processing, calibration, validation, archive, and distribution of ocean-related data products from a large number of satellite missions



The screenshot shows the NASA OceanColor Web homepage. At the top, there is a navigation bar with links for "EARTHDATA", "Data Discovery", "DAACs", "Community", and "Science Disciplines". Below this is a large banner image of a satellite ocean color map with the "OceanColor WEB" logo. A secondary navigation bar contains links for "ABOUT", "MISSIONS", "DATA", "DOCS", and "SERVICES". A paragraph of text describes the website's mission: "NASA's OceanColor Web is supported by the Ocean Biology Processing Group (OBPG) at NASA's Goddard Space Flight Center. Our responsibilities include the collection, processing, calibration, validation, archive and distribution of ocean-related products from a large number of operational, satellite-based remote-sensing missions providing ocean color, sea surface temperature and sea surface salinity data to the international research community since 1996." Below this text, there are two main content areas. The left area is titled "Ocean Color Feature" and "Labrador Sea", featuring a satellite image of the Labrador Sea with a 100 km scale bar and the label "Greenland". The right area features a server rack image with the text "Ocean Biology Distributed Active Archive Center" and the "SeaDAS" logo at the bottom.

# NASA OceanColor Web – Data Access

<http://oceancolor.gsfc.nasa.gov/cms/dataaccess>

- Level 1 & 2 Browser
- Level 3 Browser
- Direct Data Access
- Data File Search
- SeaBASS Field Data

## Data Access

The Ocean Biology Processing Group (OBPG) serves as the Distributed Active Archive Center (DAAC) for all Ocean Biology (OB) data produced or collected under NASA's Earth Observing System Data and Information System (EOSDIS). This website thus serves as the primary data access portal to the NASA OB.DAAC. The links below provide a variety of methods to access the holdings of the OB.DAAC, including visual browsers that enable point-and-click access by [data levels](#) and direct access for bulk download. In agreement with partner organizations, some data access requires [user registration](#) to enable better tracking of usage metrics.

## Data Management

The data management plan describes the acquisition, generation, management, archive and distribution of science data products generated by the Ocean Data Processing System (ODPS). For a detailed description of science data products, data flows, supported sensors, and data availability, archiving and distribution, please refer to the [plan document](#).

## Data Access Tools

[Level 1 & 2 Browser](#) - visual browse, download and data order access to all supported satellite data for Level-1 and Level-2 scenes at observed geographic scale and temporal granularity including cross satellite and *in situ* data search capabilities.

[Level 3 Browser](#) - visual access to global composites at various spatial and temporal scales.

[Direct Data Access](#) - direct access to all available data through http protocols suitable for [bulk download](#).

[Data File Search](#) - direct access via filename search, including support for wildcard search on partial filenames.

[SeaBASS Field Data](#) - community archive of field data relevant to ocean color research, algorithm development, and validation.

[Other Resources](#) - links to partners that also distribute OB.DAAC products or other products derived from OB.DAAC holdings.

# NASA OceanColor Web – Level 1 & 2 Browser

<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl>

TC  SST  SST4

SeaWiFS <input type="checkbox"/> GAC <input type="checkbox"/> MLAC	MODIS <input checked="" type="checkbox"/> Aqua <input type="checkbox"/> Terra	MERIS <input type="checkbox"/> RR <input type="checkbox"/> FRS
VIIRS (Suomi-NPP)	OCTS (ADEOS)	HICO (ISS)
GOCI (COMS)	CZCS (Nimbus-7)	

Select  Day  Night

Radius (km) about map click or about typed-in location:

<input checked="" type="radio"/> 72
<input type="radio"/> 400
<input type="radio"/> 800
<input type="radio"/> 1200
<input type="radio"/> 1500

Select swaths containing (at least):

<input checked="" type="radio"/> any part
<input type="radio"/> 25 %
<input type="radio"/> 50 %
<input type="radio"/> 75 %
<input type="radio"/> all

Select only scenes having in situ matchups.

Sunday, 23 June 2002 through Saturday, 9 July 2016

Chlorophyll

Display results 10 at a time. [Reconfigure page](#)

[Comment](#) [Help](#)

Select one or more regions:

- AdriaticSea
- AegeanSea
- Antarctica
- ArabianSea
- AralSea
- Arctic
- Australia
- AustraliaCoast
- Azores
- Bahamas
- BalticSea

or specify boundary coordinates or a single location:

N:

W:  :E

S:

[Find swaths](#)

Mission	2002	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2004	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2014	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

May 2016							June 2016							July 2016						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14
15	16	17	18	19	20	21	15	16	17	18	19	20	21	15	16	17	18	19	20	21
22	23	24	25	26	27	28	22	23	24	25	26	27	28	22	23	24	25	26	27	28
29	30	31					29	30	31					29	30	31				

# NASA OceanColor Web – Level 1 & 2 Browser

<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl>

The screenshot shows the NASA OceanColor Web interface. At the top, there are navigation buttons and a color bar for SST. Below this, there are sections for sensor selection, radius and swath size selection, and time selection. A central satellite image shows chlorophyll concentration on Tuesday, 1 December 2015. To the right, there are options for pre-defined regions and defining a custom region. A calendar at the bottom allows for selecting a specific date.

**Choose Sensor**

SeaWiFS  
 GAC  
 MLAC  
 VIIRS (Suomi-NPP)  
 OCTS (ADEOS)  
 HICO (ISS)  
 GOCI (COMS)  
 CZCS (Nimbus-7)

**MODIS**  
 Aqua

MERIS  
 RR  
 FRS

Select  
 Day  
 Night

Radius (km) about map click or about typed-in location:  
 72  
 400  
 800  
 1200  
 1500

Select swaths containing (at least):  
 any part  
 25 %  
 50 %  
 75 %  
 all

Select only scenes having in situ matchups.

Chlorophyll

Display results 10 at a time. Reconfigure page

**Comment** **Help**

Select one or more regions:  
 AdriaticSea  
 AegeanSea  
 Antarctica  
 ArabianSea  
 AralSea  
 Arctic  
 Australia  
 AustraliaCoast  
 Azores  
 Bahamas  
 BalticSea

or specify boundary coordinates of a single location:  
 N:   
 W:  E:   
 S:

**Area and Swath Size Selections**

**Time Selection (Year)**

2002	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

**Time Selection (Month and Day)**

November 2015							December 2015							January 2016						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8	9	10	11	12	13	14	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15	16	17	18	19	20	21	13	14	15	16	17	18	19	20	21	22	23	24	25	26
22	23	24	25	26	27	28	20	21	22	23	24	25	26	27	28	29	30	31	1	2
29	30	***	***	***	***	***	27	28	29	30	31	***	***	***	***	***	***	***	***	***
***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***

**Pre-defined Regions**

**Define own Region**

# NASA OceanColor Web – Level 1 & 2 Browser

<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl>

TC CHL SST SST4

Display 10 at a time. ORDER DATA Comment Help

*A2015335091000.L2_LAC_OC		
*A2015335090000.L2_LAC_OC		
1Dec2015		
****	****	****
List LO	*A2015335090500.L2_LAC_OC	

Select image of interest  
(just click with mouse)

**Search Criteria**  
Time Period: Tuesday, 1 December 2015 (daytime)  
Sensors: Aqua  
Area of Interest: Within 0 km of 89.6N,179.6W

Percentage of AOI that swaths must include: 0  
Number of swaths: 1st through 3rd of 3 swaths

OceanColor WEB



# NASA OceanColor Web – Level 1 & 2 Browser

<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl>

Click on files to download

Product Name	Size
<a href="#">A2015335091000.L0_LAC</a>	284,254,205 bytes
<a href="#">A2015335091000.L2_LAC_OC.nc</a>	39,779,166 bytes
<a href="#">A2015335091000.L2_LAC_SST.nc</a>	20,969,652 bytes

Documentation on these products can be found [HERE](#).

[Select this scene](#)

Quasi True Color      Chlorophyll      Sea Surface Temperature (11  $\mu$ )

Search Criteria  
Time Period: Tuesday, 1 December 2015 (daytime)  
Sensors: Aqua  
Area of Interest: Within 0 km of 89.6N,179.6W

# NASA OceanColor Web – Level 1 & 2 Browser

<http://oceancolor.gsfc.nasa.gov/cgi/browse.pl>

TC  SST

[A2015335091000.L0\\_LAC](#) 284,254,205 bytes  
[A2015335091000.L1A\\_LAC](#) 199,453,461 bytes  
[A2015335091000.L2\\_LAC\\_OC.nc](#) 39,779,166 bytes  
[A2015335091000.L2\\_LAC\\_IOP.nc](#) 47,771,644 bytes  
[A2015335091000.L2\\_LAC\\_SST.nc](#) 20,969,652 bytes

(The above hyperlinks point to [compressed files](#).  
Documentation on these products can be found [HERE](#).)

[Select this scene](#)

Quasi True Color      Chlorophyll      Sea Surface Temperature (11  $\mu$ )

Tuesday, 1 December 2015  
2015335

Search Criteria  
Time Period: Tuesday, 1 December 2015 (daytime)  
Sensors: Aqua  
Area of Interest: Within 0 km of 89.6N,179.6W

A2015335091000.L2\_L...nc  
7.2/37.9 MB, 2 mins left

Show All

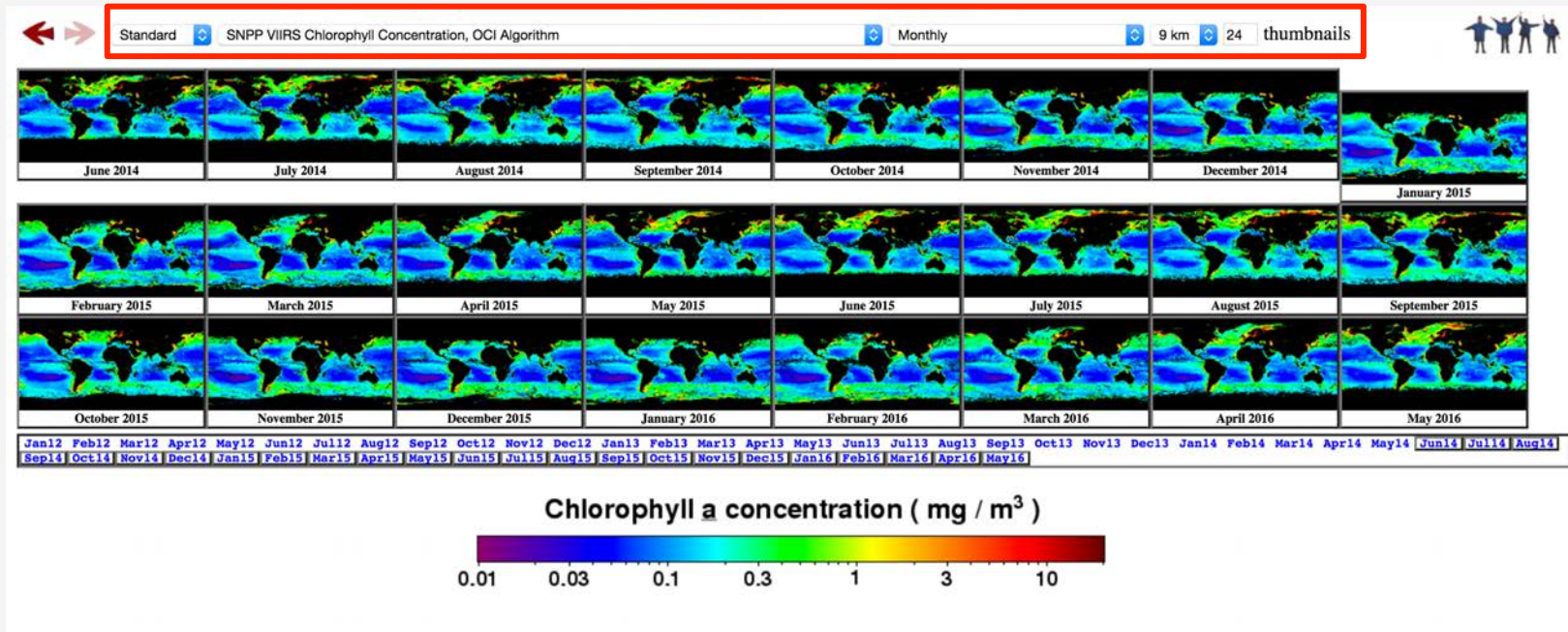
When finished  
downloading,  
open in SeaDAS



# NASA OceanColor Web Level 3 Browser

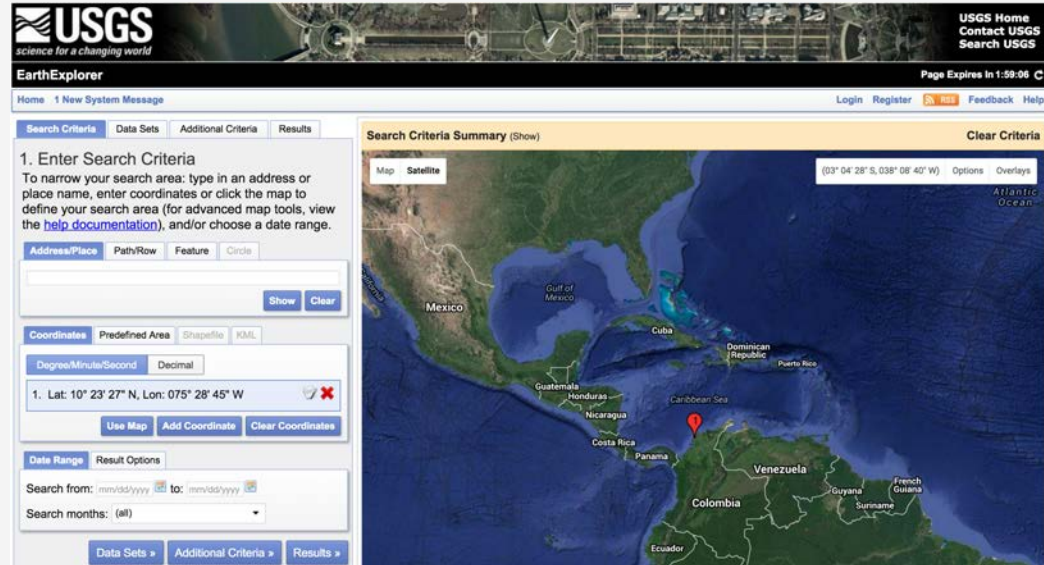
<http://oceancolor.gsfc.nasa.gov/cgi/l3>

## Data Product, Time Selections, and Spatial Resolution Selections



# Some Other Data Access Tools

- NOAA CoastWatch
  - <http://coastwatch.noaa.gov/>
- NASA Giovanni
  - <http://giovanni.gsfc.nasa.gov/giovanni/>
- USGS Earth Explorer
  - <http://earthexplorer.usgs.gov/>



The screenshot displays the USGS Earth Explorer web application. At the top, the USGS logo is on the left, and navigation links for 'Home', 'New System Message', 'Login', 'Register', 'Feedback', and 'Help' are on the right. The main content area is divided into a search interface on the left and a map on the right. The search interface includes tabs for 'Search Criteria', 'Data Sets', 'Additional Criteria', and 'Results'. It features a '1. Enter Search Criteria' section with instructions on how to define a search area. Below this are input fields for 'Address/Place', 'Path/Row', 'Feature', and 'Circle', each with a 'Show' and 'Clear' button. There is also a 'Coordinates' section with a 'Predefined Area' dropdown, 'Shapefile', and 'KML' options. The coordinate input field shows '1. Lat: 10° 23' 27" N, Lon: 075° 28' 45" W'. A 'Date Range' section allows users to specify search dates and months. The map on the right shows a satellite view of the Caribbean region, with a search criteria summary box at the top right displaying the coordinates '03° 04' 28" S, 038° 08' 40" W' and a 'Clear Criteria' button.

# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
- Each node serves needs of regional user community
- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

The screenshot shows the NOAA CoastWatch website. At the top left is the NOAA logo. The main header is "NOAA CoastWatch". Below the header is a navigation menu with links: Home, History, Regional Nodes, Data Access, Data Products, Applications, Science, Reports, and Resources. A search bar is located below the menu. The main content area is divided into three columns. The left column contains a map of the United States with yellow boxes highlighting regional nodes: Central, AK, CenPac, West-Coast, GLERL, East-Coast, and Car-GoMx. The middle column is titled "Central Operations & Regional Nodes" and contains a section for "VIIRS Ocean Color" with text about near real-time data and a "Delayed" section about global 750m level-2 products. The right column is titled "Featured Image" and shows a map of the Gulf of Mexico with the text "Gulf of Mexico loop current. More Information". Below this is a "Water Quality" section and a "News" section with text about a new version of CoastWatch utilities. At the bottom of the page is a footer with the NOAA logo and text: "NOAA Satellites and Information National Environmental Satellite, Data, and Information Service".

# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
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- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

**Regional Nodes**

**Home**  
**History**  
**Regional Nodes**  
**Data Access**  
**Data Products**  
**Applications**  
**Science**  
**Reports**  
**Resources**

Search  
CoastWatch NOAA

NOAA CoastWatch  
NCWCP E/RA3  
College Park, MD 20740  
301.683.3335  
coastwatch.info@noaa.gov

**East Coast**  
PRODUCTS & SERVICES:  
SEA SURFACE TEMPERATURE  
CHLOROPHYLL-A  
SURFACE WINDS  
CLARITY  
OPENDAP  
COASTWATCH EDAC APPLET

**Great Lakes**  
PRODUCTS & SERVICES:  
SEA SURFACE TEMPERATURE  
CHLOROPHYLL-A  
VISIBLE REFLECTANCE  
TRUE COLOR  
ICE COVERAGE  
JAVA BASED GIS

**Car-GOMx**  
PRODUCTS & SERVICES:  
SEA SURFACE TEMPERATURE  
SURFACE WINDS  
UPPER OCEAN HEAT CONTENT  
ALTIMETER  
CO2 FLUX  
JAVA BASED GIS

**Alaska**  
PRODUCTS:  
SEA SURFACE TEMPERATURE  
SURFACE WINDS  
VISIBLE/INFRARED  
VOLCANO

**Central Pacific**  
PRODUCTS & SERVICES:  
SEA SURFACE TEMPERATURE  
SURFACE WINDS  
OCEAN COLOR  
ALTIMETER  
LIVE ACCESS SERVER  
OPENDAP  
THREDDS

**West Coast**  
PRODUCTS & SERVICES:  
SEA SURFACE TEMPERATURE  
SURFACE WINDS  
TRUE COLOR  
ALTIMETER  
LIVE ACCESS SERVER  
COASTWATCH DATA BROWSER  
THREDDS

The six regional nodes are made up of other NOAA line offices that participate in the CoastWatch Program. They are located around the country, hosting equipment and personnel to provide near real-time data distribution and regional scientific expertise to the local user community. Together, central operations and the regional nodes provide for the distribution pathway for CoastWatch data products.

NOAA Satellites and Information  
National Environmental Satellite, Data, and Information Service

Privacy | Customer Survey | Contact Us

Department of Commerce  
National Oceanic & Atmospheric Administration  
Center for Satellite Applications and Research  
Satellite Oceanography & Climatology Division


Web site owner: Satellite Oceanography & Climatology Division

# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
- Each node serves needs of regional user community
- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

HOME DATA ACCESS ▾ TOOLS & TRAINING ▾ ABOUT CONTACT QUICK LINKS ▾

 **NOAA** COASTWATCH  
WEST COAST REGIONAL NODE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

*Providing near real-time satellite data for the coastal ocean*

**Environmental Data**  
View and download over 800 regional and global datasets, including satellite data, model output, and in situ measurements from field sensors.

[Data Catalog](#) [Coastal Conditions](#)

**ERDDAP Data Server**  
The ERDDAP data server provides a simple, consistent way to subset and download environmental datasets in common file formats with options to make graphs and maps.

**Software**  
The Environmental Data Connector (EDC) and Xtractomatic data extraction scripts make it easy to discover and extract data from online servers and download them directly into ArcGIS, R, MatLab, and Excel.

**New**  
ERC [dov](#) [May](#)  
The Sea [May](#)  
POE no I  
Job San  
GHI pro  
Env [dov](#)  
New

NOAA HOME WEATHER OCEANS FISHERIES CHARTING SATELLITES CLIMATE RESEARCH COASTS CAREERS

# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
- Each node serves needs of regional user community
- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

The screenshot displays the NOAA CoastWatch West Coast Regional Node website. The top navigation bar includes links for HOME, DATA ACCESS, TOOLS & TRAINING, ABOUT, CONTACT, and QUICK LINKS. The main header features the NOAA logo and the text "NOAA COASTWATCH WEST COAST REGIONAL NODE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION".

The "Data Catalog" section is active, showing tabs for SST, Ocean Color, Wind & Currents, and All Data. Under "Ocean Color Datasets", a list of data products is provided, including Chlorophyll-a from various sensors and regions. The "Chlorophyll-a, VIIRS, Global, 2012-Now" dataset is selected.

On the right, the "Chlorophyll-a, VIIRS, Global, 2012-Now" visualization is shown. It includes a world map with a color scale for Chlorophyll Concentration (OCI Algorithm) in  $\text{mg m}^{-3}$ , ranging from 0.03 to 30. The map shows higher concentrations in the tropical and subtropical regions. A red box highlights the "Access Data" button.



# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
- Each node serves needs of regional user community
- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

The screenshot shows the ERDDAP 'Make A Graph' interface. At the top, it says 'ERDDAP Easier access to scientific data' and 'Brought to you by NOAA NMES SWESG ERD'. The main title is 'ERDDAP > griddap > Make A Graph'. Below this, it lists the dataset title: 'VIIRSN, Suomi-NPP, Level-3 SMI, Global, 4km, Chlorophyll a, OCI Algorithm, Monthly, DEPRECATED'. It also provides the institution (NASA/GSFC OBPG) and dataset ID (erdV42chiamday). There are links for 'Summary', 'License', 'FGDC', 'ISO 19115', 'Metadata', 'Background', and 'Data Access Form'. The 'Graph Type' is set to 'surface'. The 'X Axis' is 'longitude' and the 'Y Axis' is 'latitude'. The 'Color' is 'chla'. The 'Dimensions' section shows 'time (UTC)' with a 'Start' of '2016-02-15T00:00:00Z' and a 'Stop' of '2016-02-15T00:00:00Z'. The 'latitude (degrees\_north)' range is from 89.97916 to -89.97918, and the 'longitude (degrees\_east)' range is from -179.9792 to 179.9792. The 'Graph Settings' section includes 'Color Bar', 'Continuity', 'Scale', 'Min', 'Max', 'N Sections', and 'Draw the land mask'. There is a 'Redraw the Graph' button and an 'Optional' section for downloading the data or viewing the URL: [http://coastwatch.pfeg.noaa.gov/erddap/griddap/erdV42chiamday.nc?chla\(2016-02-15\)](http://coastwatch.pfeg.noaa.gov/erddap/griddap/erdV42chiamday.nc?chla(2016-02-15)). On the right, there is a map showing a global view of chlorophyll concentration with a color scale from 0.03 to 30. Below the map is a legend for 'Chlorophyll Concentration, OCI Algorithm (mg m<sup>-3</sup>)' and 'VIIRSN, Suomi-NPP, Level-3 SMI, Global, 4km, Chlorophyll a, OCI Algorithm, Monthly, DEPRECATED (2016-02-15T00:00:00Z)'. The legend also notes 'Data courtesy of NASA/GSFC OBPG'.

# NOAA CoastWatch

<http://coastwatch.noaa.gov/>

- CoastWatch is organized into regional nodes (USA only at this time)
- Each node serves needs of regional user community
- Serves image data from a variety of satellite sensors
- Download to work with image processing software such as SeaDAS or CoastWatch Utilities software

The screenshot displays the ERDDAP (Earth Remote Data Display and Access Platform) interface. At the top, it says "ERDDAP Easier access to scientific data" and "Brought to you by NOAA NMFS SWESG ERD". The main heading is "ERDDAP > griddap > Make A Graph". Below this, the dataset information is shown: "Dataset Title: VIIRSN, Suomi-NPP, Level-3 SMI, Global, 4km, Chlorophyll a, OCI Algorithm, Monthly, DEPRECATED". The institution is "NASA/GSFC OBPG" and the dataset ID is "erdVH2chlamday".

The interface is divided into several sections:

- Graph Type:** surface
- X Axis:** longitud
- Y Axis:** latitude
- Color:** chia
- Dimensions:** time (UTC)
- Graph Settings:** A list of file formats is shown, with ".nc" selected.
- Optional:** A section for additional options, including "Download the Data or an Image" and "Select the type of file you want to download."

On the right side, there is a world map showing the data distribution. Below the map is a color scale legend for "Chlorophyll Concentration, OCI Algorithm (mg m<sup>-3</sup>)". The scale ranges from 0.03 to 30, with colors transitioning from purple to red. The legend also includes the text: "VIIRSN, Suomi-NPP, Level-3 SMI, Global, 4km, Chlorophyll a, OCI Algorithm, Monthly, DEPRECATED. Data courtesy of NASA/GSFC OBPG".

# Giovanni

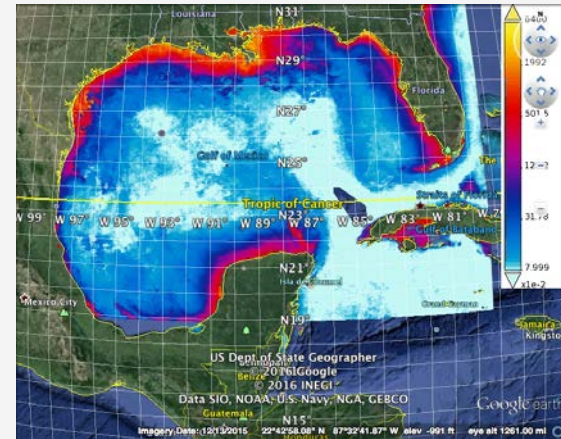
<http://giovanni.gsfc.nasa.gov/giovanni>

- Giovanni: **Geospatial Interactive Online Visualization ANd aNalysis Infrastructure**
- A web-based application developed by Goddard Earth Sciences Data & Information Services Center (GES DISC)
- Provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data

\*Reference: <http://disc.sci.gsfc.nasa.gov/giovanni/>

## Available Data

- MODIS-Aqua Chlorophyll Concentration
- Monthly, 4km (7/2002-2/2016)



# NASA Giovanni

<http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot shows the NASA Giovanni web interface. At the top, there are navigation links for EARTHDATA, Data Discovery, DAACs, Community, and Science Disciplines. The main header includes the Giovanni logo and the tagline "The Bridge Between Data and Science v 4.20". Below this, there are links for Release Notes, Browser Compatibility, and Known Issues. A warning message states: "OMIVRd variables have been temporarily removed from the Giovanni catalog (1 of 4 messages) Read More".

The interface is divided into several sections:

- Select Plot:** Includes dropdown menus for "Maps: Time Averaged Map", "Comparisons: Select...", "Time Series: Select...", "Vertical: Select...", and "Miscellaneous: Select...".
- Select Date Range (UTC):** Features input fields for start and end dates and times. The current selection is from 2004-01-01 00:00 to 2016-01-01 23:59. A "Valid Range" of 1948-01-01 to 2016-07-12 is displayed below.
- Select Region (Bounding Box or Shapefile):** Includes input fields for coordinates (46.4063, 12.6563, 75.2344, 34.4531) and buttons for "Show Map" and "Show Shapes".
- Select Variables:** Contains filters for Disciplines (Ocean Biology, Oceanography), Measurements (Chlorophyll, Energy, Radiation), Platform/Instrument (MODIS-Aqua, NOBM Model), Spatial Resolutions, and Temporal Resolutions (monthly).
- Number of matching Variables: 2 of 1406** and **Total Variable(s) included in Plot: 0**.
- Keyword:** A search bar with "Search" and "Clear" buttons.
- Table of Results:**

Variable	Source	Temp.Res.	Spat.Res.	Begin Date	End Date	Units
<input type="checkbox"/> Chlorophyll a concentration (MODIS_L3m_CHL v2014)	MODIS-Aqua	Monthly	4 km	2002-07-04	2016-05-31	mg m-3
<input type="checkbox"/> Normalized fluorescence line height (MODIS_L3m_FLH v2014)	MODIS-Aqua	Monthly	4 km	2002-07-04	2016-05-31	mW cm <sup>-2</sup> um <sup>-1</sup> sr <sup>-1</sup>

At the bottom, there is contact information for the NASA Official (Steven J. Kempler) and Web Curator (M. Hegde), along with logos for NC, OPeNDAP, and ECHO. A footer bar contains "Help", "Reset", "Feedback", and a prominent "Plot Data" button.

Analysis and Plot Selection

Start and End Date; and Spatial Selection by Map/Latitude-Longitude/Shapefile

# NASA Giovanni

<http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot shows the NASA Giovanni web interface. At the top, it says "EARTHDATA" and "The Bridge Between Data and Science v 4.20". Below that, there are navigation links for "Release Notes", "Browser Compatibility", and "Known Issues". A yellow banner indicates that "Snow melt (GLDAS\_NOAH025\_3H v2.0) temporarily removed...".

The main interface is divided into several sections:

- Select Plot:** Includes options for "Maps: Time Averaged Map", "Comparisons: Select...", "Time Series: Select...", "Vertical: Select...", and "Miscellaneous: Select..."
- Select Date Range (UTC):** Shows a date range from "2015 -12 -01 00 :00" to "2015 -12 -31 23 :59". A "Valid Range: 2002-07-04 to 2016-05-31" is also displayed.
- Select Region (Bounding Box or Shapefile):** Shows a bounding box of "44.2969, 9.8438, 77.3438, 35.8594". A "Show Map" and "Show Shapes" button are present.
- Select Variables:** Includes sections for "Disciplines" (Ocean Biology (3), Oceanography (2)) and "Measurements" (Chlorophyll (3), Phytoplankton (8), Soil Moisture (1)).
- Platform / Instrument, Spatial Resolutions, Temporal Resolutions, Portal:** These sections are currently collapsed.

The central part of the interface features a world map with a grid. A blue bounding box is drawn around the Arabian Sea region. The map shows latitude lines from 45°00'N to 45°00'S and longitude lines from 135°00'W to 135°00'E. A coordinate "80°09'N, 177°53'E" is displayed at the top right of the map.

On the right side of the map, there is a table with the following data:

End Date	Units
2016-05-31	mg m <sup>-3</sup>
2012-12-31	mg chlorophyll/m <sup>3</sup>
2012-12-31	mg chlorophyll/m <sup>3</sup>
2016-05-31	mW cm <sup>-2</sup> um <sup>-1</sup> sr <sup>-1</sup>

At the bottom of the interface, there is a footer with the NASA logo, contact information for Steven J. Kempler and M. Hegde, and logos for "Powered By:" including NC, OPeNDAP, and ECHO. There are also buttons for "Help", "Reset", "Feedback", and "Plot Data".

MODIS-based  
Chlorophyll for  
Dec 2015 in the  
Arabian Sea

# NASA Giovanni - Visualization

<http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot displays the NASA Giovanni web interface. The main map shows a "Time Averaged Map of Chlorophyll a concentration monthly 4 km" over the region of 45°00'W to 90°00'E. The map features a color scale from blue to red, indicating concentration levels. Several yellow callout boxes highlight key interface elements:

- Download Data:** A yellow box points to the "Downloads" link in the left-hand navigation menu.
- Zoom In:** A yellow box points to the zoom-in controls (a blue circle with a plus sign) on the map.
- Save Image:** A yellow box points to the "Download As..." button in the "Map Options" dialog.
- Change Colors and Re-plot:** A yellow box points to the "Change Palette" and "Change Smoothing" sections in the "Map Options" dialog.

The "Map Options" dialog is open, showing the following settings:

- Download As...:** A dropdown menu with options: GEOTIFF, KMZ, PNG.
- Change Data Range:** Minimum: 0.07999, Maximum: 64.
- Change Palette:** A list of color palettes including "Cyan-Red-Yellow (Seq), 65", "Greys, Dark to Light (Seq), 7", "Greens (Seq), 9", "Blue-Yellow-Red (Div), 12", and "Blue-Green-Yellow (Seq), 9".
- Change Smoothing:** Radio buttons for "On" and "Off" (selected).
- Change Scaling:** Radio buttons for "Linear" and "Log" (selected).
- Buttons:** "Restore Defaults" and "Re-Plot".

# NASA Giovanni – Data Download

<http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot shows the NASA Giovanni web interface. At the top, there are navigation tabs for "EARTHDATA", "Data Discovery", "DAACs", "Community", and "Science Disciplines". The main header includes the "GIOVANNI" logo and the tagline "The Bridge Between Data and Science v 4.20", along with links for "Release Notes", "Browser Compatibility", and "Known Issues". A yellow banner at the top of the content area reads "Snow melt (GLDAS\_NOAH025\_3H v2.0) temporarily removed.... [1 of 3 messages] Read More".

On the left side, there is a "Browse History" sidebar with a tree view containing "1. Time Averaged Map", "User Input", "Plots", "Lineage", and "Downloads".

The main content area displays the following information:

- Instruction: "Click on file links to download. Files contain data portrayed in the plot images."
- NetCDF:**  
[g4\\_timeAvgMap.MODISA\\_L3m\\_CHL\\_2014\\_chla.20151201-20151231.44E\\_9N\\_77E\\_35N.nc](#)
- PNG:**  
[g4\\_timeAvgMap.MODISA\\_L3m\\_CHL\\_2014\\_chla.20151201-20151231.44E\\_9N\\_77E\\_35N.png](#)
- GEOTIFF:**  
[g4\\_timeAvgMap.MODISA\\_L3m\\_CHL\\_2014\\_chla.20151201-20151231.44E\\_9N\\_77E\\_35N.geotiff](#)
- KMZ:**  
[g4\\_timeAvgMap.MODISA\\_L3m\\_CHL\\_2014\\_chla.20151201-20151231.44E\\_9N\\_77E\\_35N.kmz](#)

Two yellow callout boxes with red arrows are overlaid on the screenshot:

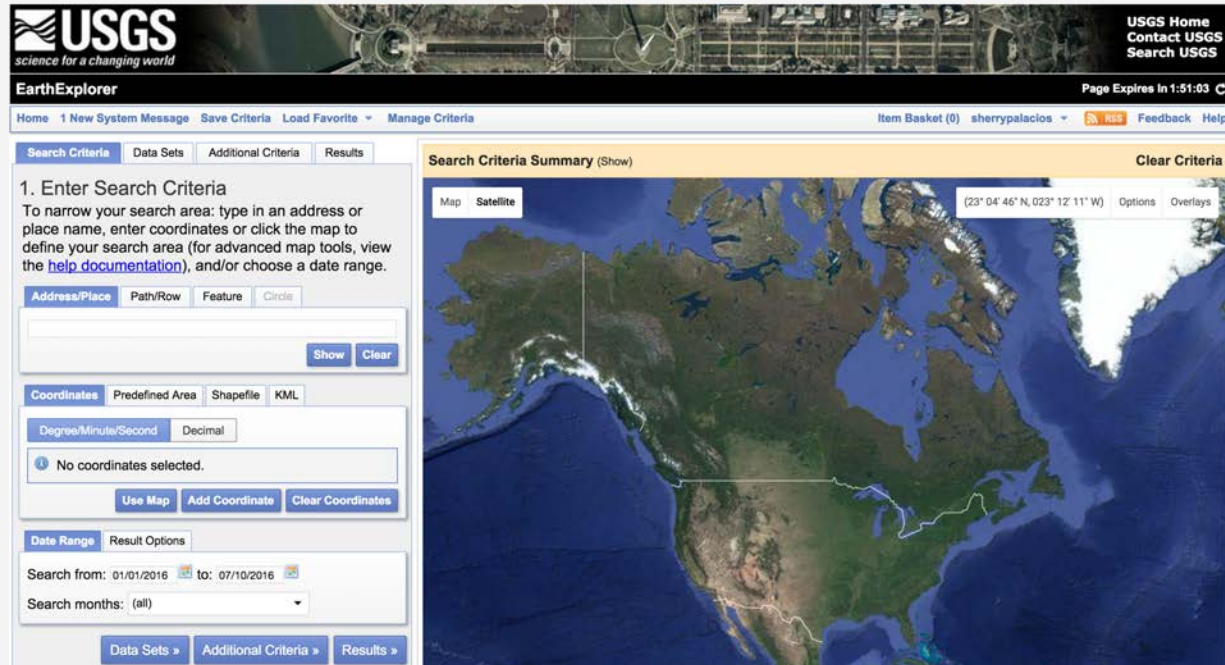
- A box on the left contains the text "Options for multiple formats, including formats used by SeaDAS" with a red arrow pointing to the download links.
- A box on the right contains the text "Back to Data Selection" with a red arrow pointing to the "Back to Data Selection" button in the footer.

The footer of the page includes the NASA logo, contact information for the Responsible NASA Official (Steven.J.Kempner@nasa.gov) and Web Curator (M\_Hagde@gsfc-help-disc@lists.nasa.gov), a link to the "Privacy Policy and Important Notices", an "Acknowledgment Policy" link, and buttons for "Help", "Feedback", and "Back to Data Selection".

# USGS Earth Explorer

<http://earthexplorer.usgs.gov/>

- Search for Landsat and other satellite sensor data
- Download to work with image processing software such as SeaDAS



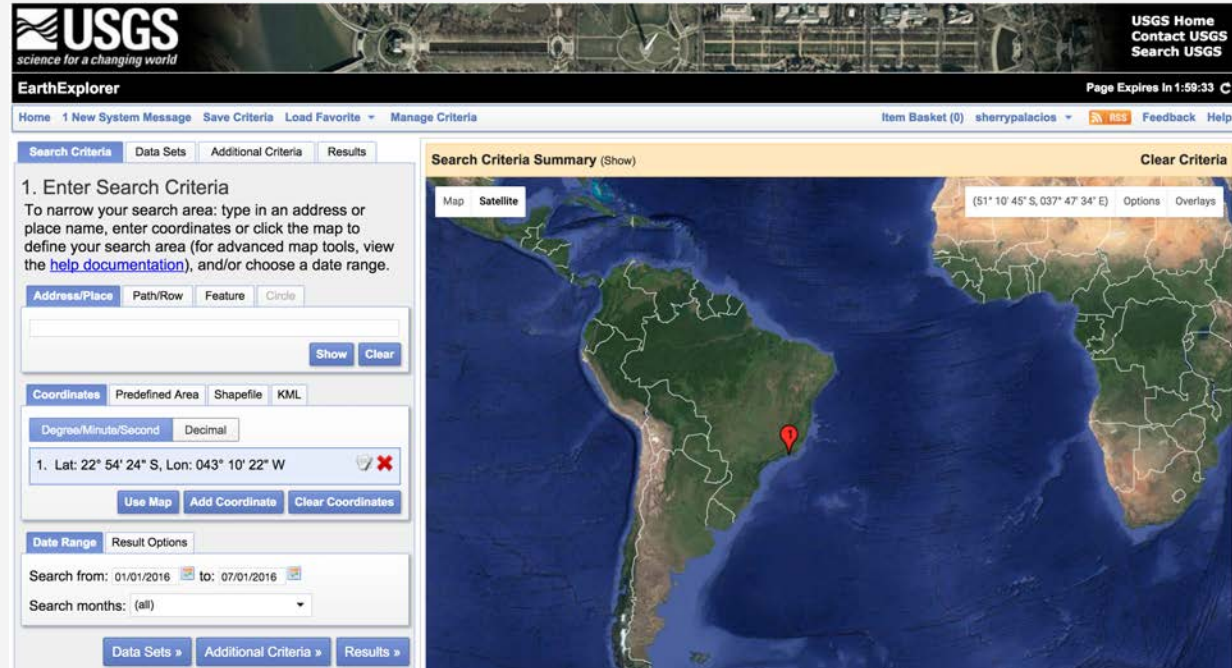
The screenshot displays the USGS Earth Explorer web application. At the top, the USGS logo is visible with the tagline "science for a changing world". The page title is "EarthExplorer". Navigation links include "Home", "New System Message", "Save Criteria", "Load Favorite", and "Manage Criteria". A user profile "sherrypalacios" and an "Item Basket (0)" are shown. The main content area is divided into two sections. On the left, under "Search Criteria", there is a heading "1. Enter Search Criteria" followed by instructions: "To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range." Below this are several input sections: "Address/Place" with a text box and "Show" and "Clear" buttons; "Coordinates" with sub-sections for "Predefined Area", "Shapefile", and "KML", and a "Degree/Minute/Second" vs "Decimal" selector; a message "No coordinates selected." with "Use Map", "Add Coordinate", and "Clear Coordinates" buttons; and "Date Range" with "Result Options", a date range from "01/01/2016" to "07/10/2016", and a "Search months" dropdown set to "(all)". At the bottom of this section are "Data Sets", "Additional Criteria", and "Results" buttons. On the right, the "Search Criteria Summary (Show)" section features a satellite map of North America with a coordinate box showing "23° 04' 46\"



# USGS Earth Explorer

<http://earthexplorer.usgs.gov/>

- Search for Landsat and other satellite sensor data
- Download to work with image processing software such as SeaDAS

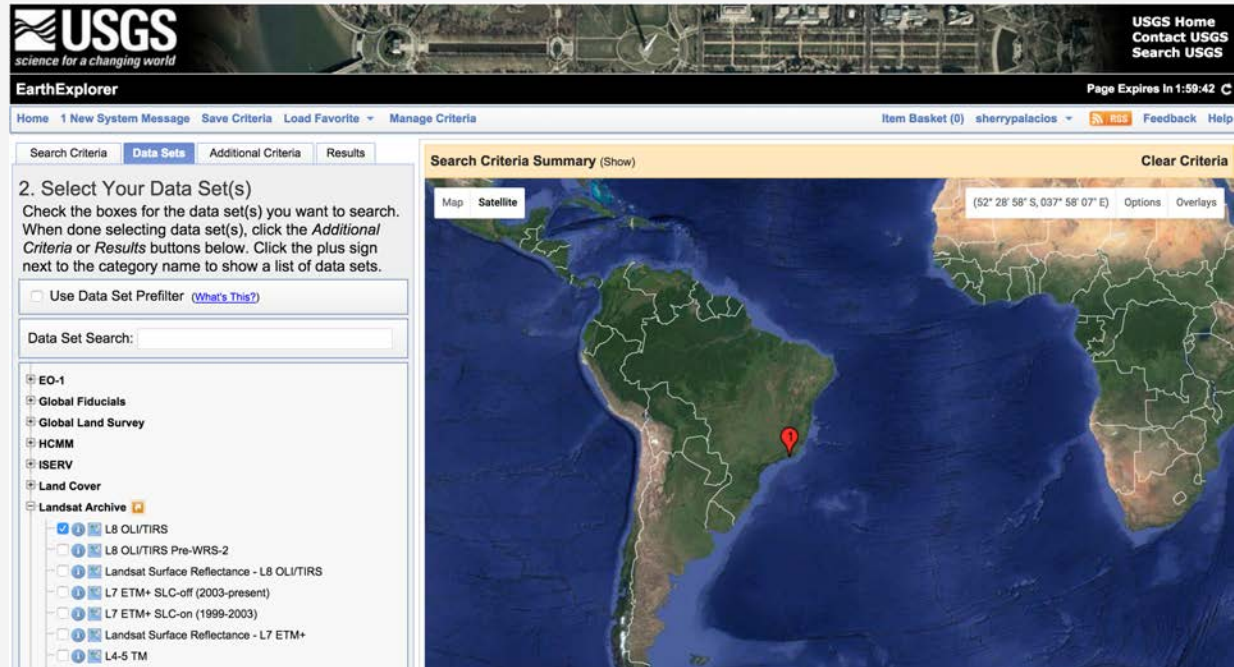


The screenshot displays the USGS Earth Explorer web application. At the top, the USGS logo and tagline "science for a changing world" are visible. The main navigation bar includes "EarthExplorer" and "Page Expires In 1:59:33". Below the navigation bar, there are tabs for "Search Criteria", "Data Sets", "Additional Criteria", and "Results". The "Search Criteria" tab is active, showing a section titled "1. Enter Search Criteria" with instructions: "To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range." There are four input fields: "Address/Place", "Path/Row", "Feature", and "Circle". Below these is a "Coordinates" section with tabs for "Coordinates", "Predefined Area", "Shapefile", and "KML". The "Coordinates" tab is selected, showing "Degree/Minute/Second" and "Decimal" options. The "Degree/Minute/Second" option is active, and the coordinates "1. Lat: 22° 54' 24\" S, Lon: 043° 10' 22\" W" are entered. There are buttons for "Use Map", "Add Coordinate", and "Clear Coordinates". Below the coordinates is a "Date Range" section with "Result Options" and a date range from "01/01/2016" to "07/01/2016". There is also a "Search months" dropdown menu set to "(all)". At the bottom of the search criteria section are buttons for "Data Sets", "Additional Criteria", and "Results". To the right of the search criteria is a "Search Criteria Summary (Show)" section with a "Clear Criteria" button. Below the summary is a satellite map of South America and the Atlantic Ocean. The map shows a red location pin in the Atlantic Ocean. The map has "Map" and "Satellite" tabs, and a coordinate display showing "(51° 10' 45\" S, 037° 47' 34\" E)". There are also "Options" and "Overlays" buttons.

# USGS Earth Explorer

<http://earthexplorer.usgs.gov/>

- Search for Landsat and other satellite sensor data
- Download to work with image processing software such as SeaDAS



The screenshot displays the USGS Earth Explorer interface. At the top, the USGS logo and tagline "science for a changing world" are visible. The page title is "Earth Explorer". Below the header, there are navigation links: "Home", "1 New System Message", "Save Criteria", "Load Favorite", and "Manage Criteria". On the right side, there is a "Page Expires In 1:59:42" timer and a "Item Basket (0)" section with the user name "sherryalacios".

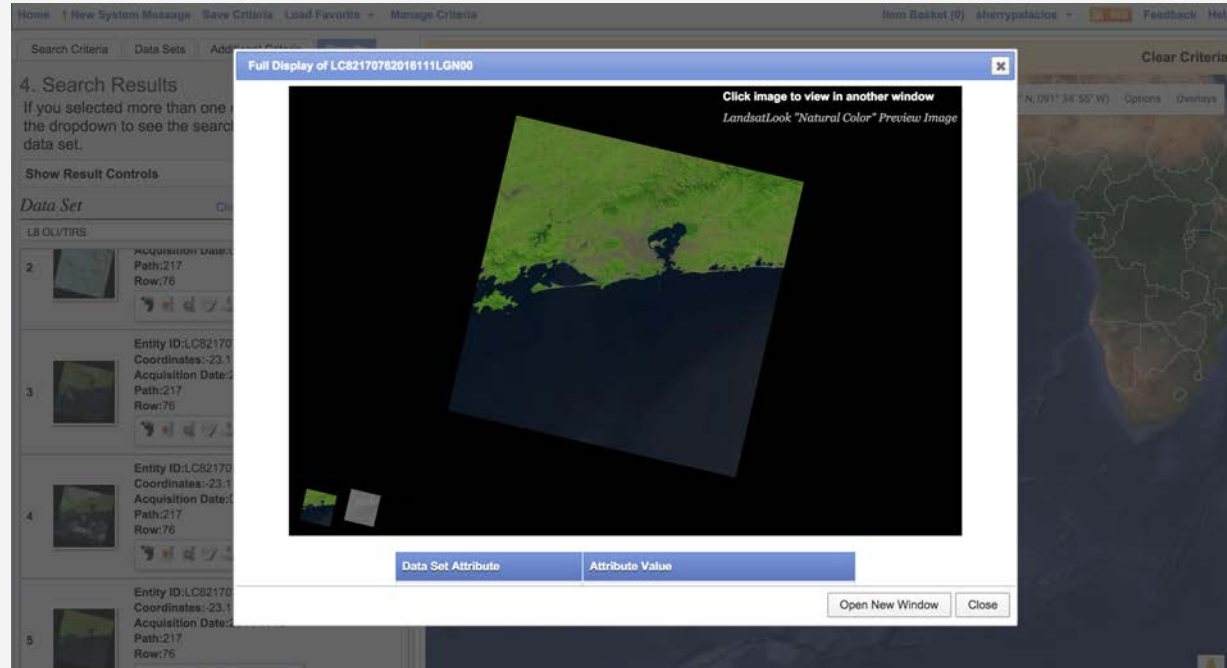
The main content area is titled "Search Criteria Summary (Show)" and "Clear Criteria". It features a "Map" section with a "Satellite" view and coordinates "(52° 28' 58\" S, 037° 58' 07\" E)". Below the map, there is a "Data Set Search:" input field and a list of data sets under the "Landsat Archive" category. The list includes:

- L8 OLI/TIRS
- L8 OLI/TIRS Pre-WRS-2
- Landsat Surface Reflectance - L8 OLI/TIRS
- L7 ETM+ SLC-off (2003-present)
- L7 ETM+ SLC-on (1999-2003)
- Landsat Surface Reflectance - L7 ETM+
- L4-5 TM

# USGS Earth Explorer

<http://earthexplorer.usgs.gov/>

- Search for Landsat and other satellite sensor data
- Download to work with image processing software such as SeaDAS



# USGS Earth Explorer

<http://earthexplorer.usgs.gov/>

- Search for Landsat and other satellite sensor data
- Download to work with image processing software such as SeaDAS

The screenshot displays the USGS Earth Explorer web application. The interface includes a top navigation bar with links like 'Home', 'New System Message', 'Save Criteria', 'Load Favorites', and 'Manage Criteria'. Below this, there are tabs for 'Search Criteria', 'Data Sets', 'Additional Criteria', and 'Results'. The main content area is titled '4. Search Results' and contains a 'Data Set' table with columns for 'Entity ID', 'Coordinates', 'Acquisition Date', 'Path', and 'Row'. A 'Download Options' dialog box is open over the table, listing five download options with their respective file sizes:

Download	Download Options
Download	LandsatLook "Natural Color" Image (5.8 MB)
Download	LandsatLook "Thermal" Image (2.2 MB)
Download	LandsatLook "Quality" Image (440.5 KB)
Download	LandsatLook images with Geographic Reference (8.4 MB)
Download	Level 1 GeoTIFF Data Product (775.3 MB)

A satellite image of a coastal region, likely a river delta, showing a complex network of waterways and land. The water is a mix of light blue and green, indicating varying depths and sediment levels. The land is green and brown, with some white patches. The ocean is a deep blue. A semi-transparent white box is overlaid on the image, containing the title text.

# NASA Satellite Data Processing Tools

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# SeaWiFS Data Analysis System (SeaDAS)

<http://seadas.gsfc.nasa.gov/>

- Image analysis package for the processing, display, analysis, & quality control of ocean color data
- Originally developed for SeaWiFS, but supports most U.S. and international ocean color missions
- Online tutorials, help pages, and an active user community in the Ocean Color Forum
- Attentive & friendly support team based at NASA Goddard

Missions ▾ Data ▾ Documents ▾ Analyses ▾ People ▾ Forum ▾ Services ▾ Links

## SeaDAS

### General Description

SeaDAS is a comprehensive image analysis package for the processing, display, analysis, and quality control of ocean color data. While originally developed to support the SeaWiFS mission, it now supports most US and international ocean color missions. The primary focus of SeaDAS is ocean color data, but it is applicable to many satellite-based earth science data analyses.

The latest version (SeaDAS 7.3.1) is the result of a collaboration with the developers of ESA's BEAM software package. The core visualization package for SeaDAS 7 is based on the BEAM framework, with extensions that provide the functionality provided by previous versions of SeaDAS..

**Features**  
**Requirements**  
**License**  
**Download**

### Supported Missions

- MODIS
- SeaWiFS
- CZCS
- VIIRS
- HICO
- Aquarius
- Landsat8/OLI
- MERIS
- OCTS
- OCM
- OCM-2
- OSMI
- MOS
- GOCI

### User Support

- SeaDAS Video Tutorials and Demos
- SeaDAS FAQ
- SeaDAS Help Pages
- Other SeaDAS Tutorial Material
- Ocean Color Web
- Ocean Color Forum
- SeaDAS Mailing List

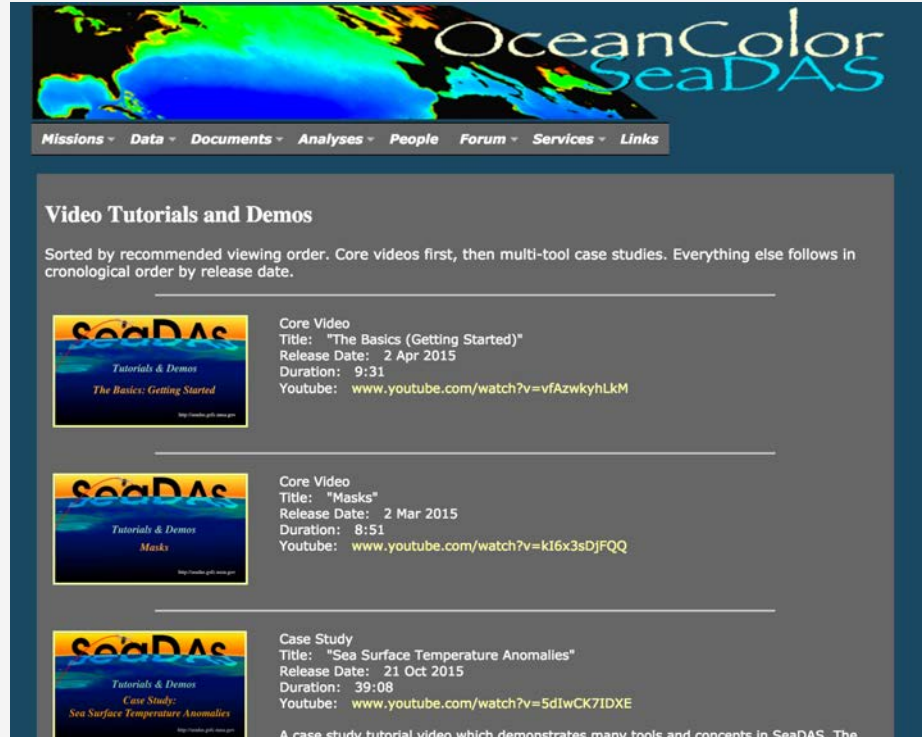
### Other

- SeaDAS Visualization Source Code
- Processing Binaries and Source Code
- SeaDAS version 6.4
- MODISL1DB 1.8

# Online Tutorials and Webinars for SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>

- Strongly recommend completing all of the on-demand tutorials listed on this webpage
- SeaDAS supports a wide variety of satellite sensors so your investment in learning it will be time well spent
- Check out SeaDAS webinar on June 15, 2016:
  - <https://earthdata.nasa.gov/user-resources/webinars-and-tutorials>



The screenshot displays the 'OceanColor SeaDAS' website. At the top, there is a navigation menu with links for Missions, Data, Documents, Analyses, People, Forum, Services, and Links. Below the menu, the page is titled 'Video Tutorials and Demos'. A note indicates that the content is sorted by recommended viewing order, with core videos first, followed by multi-tool case studies, and then other content in chronological order. Three items are listed:

- Core Video**  
Title: "The Basics (Getting Started)"  
Release Date: 2 Apr 2015  
Duration: 9:31  
Youtube: [www.youtube.com/watch?v=vfAzwkyhLkM](http://www.youtube.com/watch?v=vfAzwkyhLkM)
- Core Video**  
Title: "Masks"  
Release Date: 2 Mar 2015  
Duration: 8:51  
Youtube: [www.youtube.com/watch?v=k16x3sDjFQQ](http://www.youtube.com/watch?v=k16x3sDjFQQ)
- Case Study**  
Title: "Sea Surface Temperature Anomalies"  
Release Date: 21 Oct 2015  
Duration: 39:08  
Youtube: [www.youtube.com/watch?v=5dlwCK7IDXE](http://www.youtube.com/watch?v=5dlwCK7IDXE)

Below the third item, a partial sentence is visible: "A case study tutorial video which demonstrates many tools and concepts in SeaDAS. The"

# Features of SeaDAS

<http://seadas.gsfc.nasa.gov/>

## SeaDAS Features

### Visualization

- Very fast image display and navigation even of giga-pixel images
- Advanced layer management allows adding and manipulation of new overlays such as images of other bands, images from WMS servers or ESRI shapefiles
- Rich region-of-interest definitions for statistics and various plotting functions
- Easy bitmask definition and overlay
- Flexible band arithmetic using arbitrary mathematical expressions
- Accurate reprojection and ortho-rectification to common map projections
- Geo-coding and rectification using ground control points
- Coastline, land/water masking for navigated data
- Store and restore the current session including all opened files, views and layers

### Data Processing

SeaDAS offers the ability for users to process satellite data from a number of ocean color missions (both U.S. and International) through the various processing levels:

- Level 0 to Level 1 processing is offered for the MODIS sensors onboard the Terra and Aqua spacecraft
- Level 1 to Level 2 (l2gen)
- Level 2 to Level 3 binned (l2bin)
- Temporal binning of Level 3 (l3bin)
- Mapping of Level 1 data (l1mapgen)
- Mapping of Level 2 data (l2mapgen)
- Mapping of Level 3 binned data (smigen)
- Browse file creation (l1brsgen,l2brsgen)



# System Requirements for SeaDAS

<http://seadas.gsfc.nasa.gov/>

- Visualization only version
- Visualization and data processing version
- Data from multiple missions can be analyzed

## SeaDAS Configuration and Requirements

SeaDAS is currently available for Linux, Mac OS X, and Windows. The Windows version currently does not support the science data processing code. The SeaDAS [source code](#) is publicly available.

### Suggested Hardware Requirements:

<b>Platforms:</b>	Linux Intel Mac OS X
<b>Memory:</b>	256MB minimum, 1GB+ suggested
<b>Disk:</b>	SeaDAS software package (display only version): ~200MB SeaDAS software package (with processing capabilities for all sensors): ~5GB 10GB of free space is also suggested for rudimentary data processing and storage.
<b>Display:</b>	15" Console or X-terminal with 20MB memory 1280x1024 resolution 24-bit X display plane depth 256 colors display minimum

### Requirements:

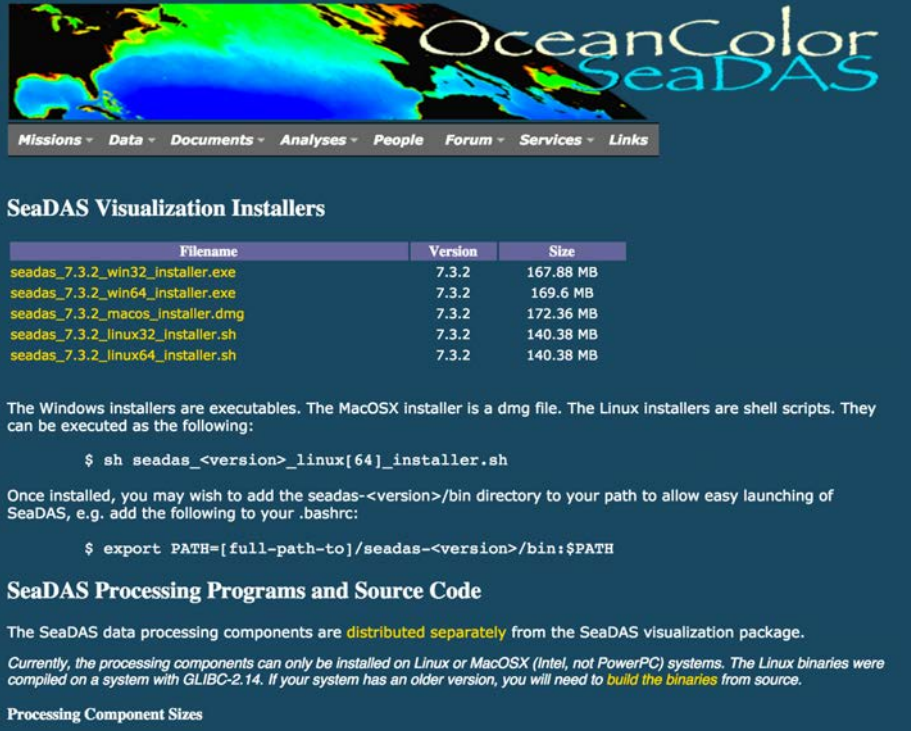
The core visualization package of SeaDAS is written in Java. A minimum Java JRE of version 1.7 is required. A suitable JRE is packaged with the Windows and MacOSX distributions. Linux users will need to separately install a suitable JRE.

<b>Operating Systems:</b>	<b>Linux:</b> tested on various versions of CentOS, Fedora, and Ubuntu <b>Intel Mac:</b> OS X 10.10	
<b>Optional Compilers:</b>	gcc/g++/gfortran (version 4.5 or higher) or <a href="#">Intel Compilers</a>	
Program	Version	Notes
Java	JRE 1.7 or above	Windows and MacOSX distributions come with a suitable JRE Linux users will need to separately install a suitable JRE
Bash	4.x	version 3.x should work, but not tested necessary only for science code, thus not required for Windows distributions
Python	2.6.5 or above	necessary only for science code, thus not required for Windows distributions; not (yet) compatible with version 3 and above
Git	1.7.9 or above	necessary only for science code install/update option, thus not required for Windows distributions
cURL	7.x or above	necessary only for science code install/update option, thus not required for Windows distributions

# Downloading SeaDAS

<http://seadas.gsfc.nasa.gov/installers/>

- Follow the instructions on the download webpage
- The “The Basics (getting started)” tutorial provides step-by-step directions on downloading and installing SeaDAS on your computer



**SeaDAS Visualization Installers**

Filename	Version	Size
<a href="#">seadas_7.3.2_win32_installer.exe</a>	7.3.2	167.88 MB
<a href="#">seadas_7.3.2_win64_installer.exe</a>	7.3.2	169.6 MB
<a href="#">seadas_7.3.2_macos_installer.dmg</a>	7.3.2	172.36 MB
<a href="#">seadas_7.3.2_linux32_installer.sh</a>	7.3.2	140.38 MB
<a href="#">seadas_7.3.2_linux64_installer.sh</a>	7.3.2	140.38 MB

The Windows installers are executables. The MacOSX installer is a dmg file. The Linux installers are shell scripts. They can be executed as the following:

```
$ sh seadas_<version>_linux[64]_installer.sh
```

Once installed, you may wish to add the seadas-<version>/bin directory to your path to allow easy launching of SeaDAS, e.g. add the following to your .bashrc:

```
$ export PATH=[full-path-to]/seadas-<version>/bin:$PATH
```

**SeaDAS Processing Programs and Source Code**

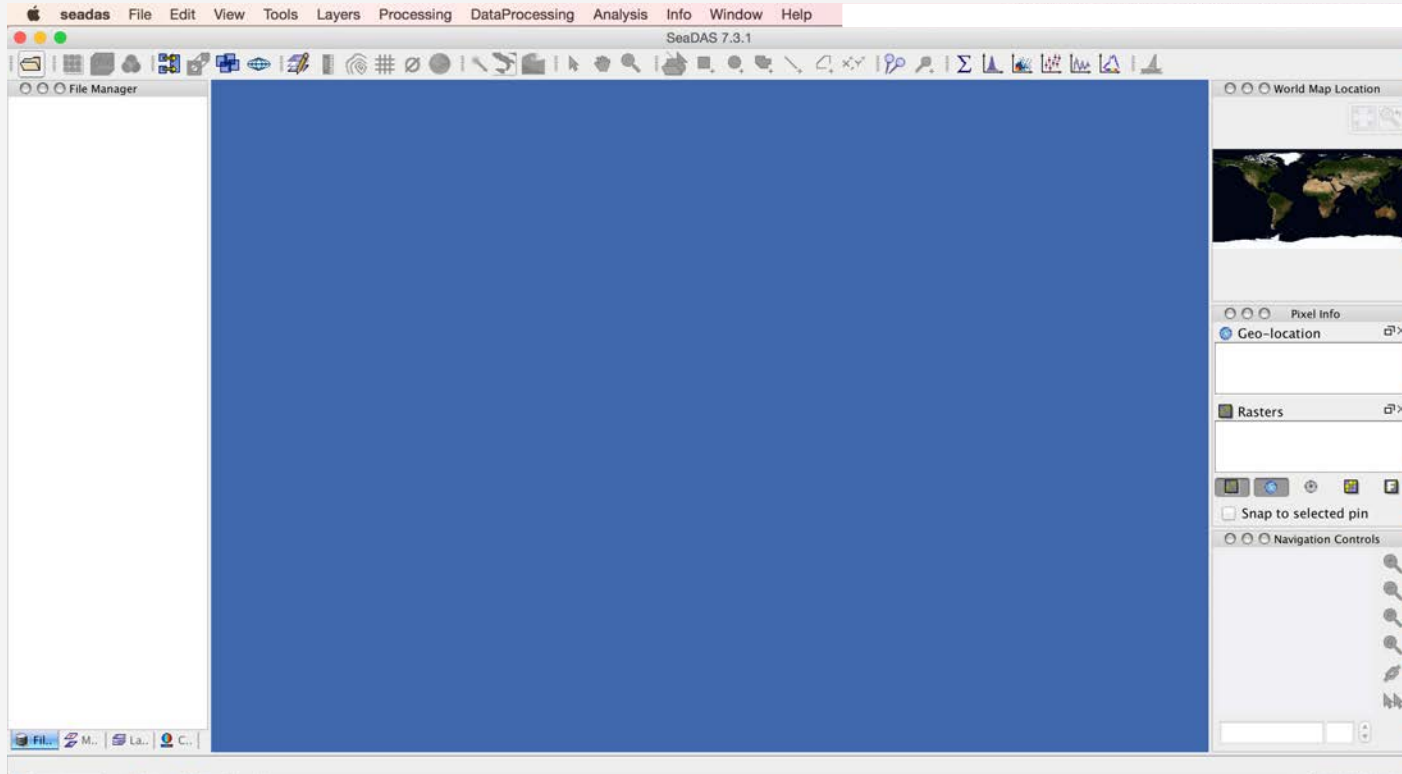
The SeaDAS data processing components are **distributed separately** from the SeaDAS visualization package.

*Currently, the processing components can only be installed on Linux or MacOSX (Intel, not PowerPC) systems. The Linux binaries were compiled on a system with GLIBC-2.14. If your system has an older version, you will need to **build the binaries** from source.*

**Processing Component Sizes**

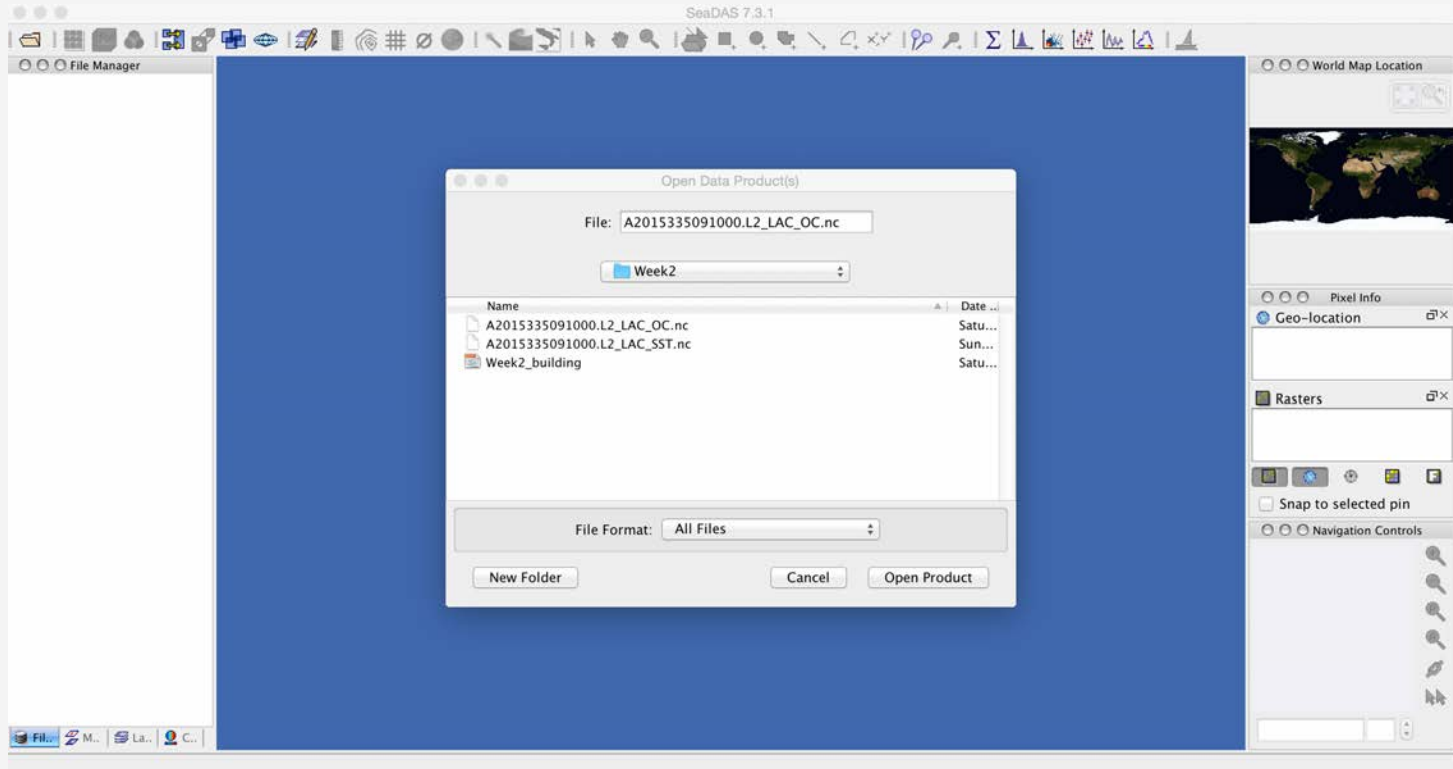
# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>



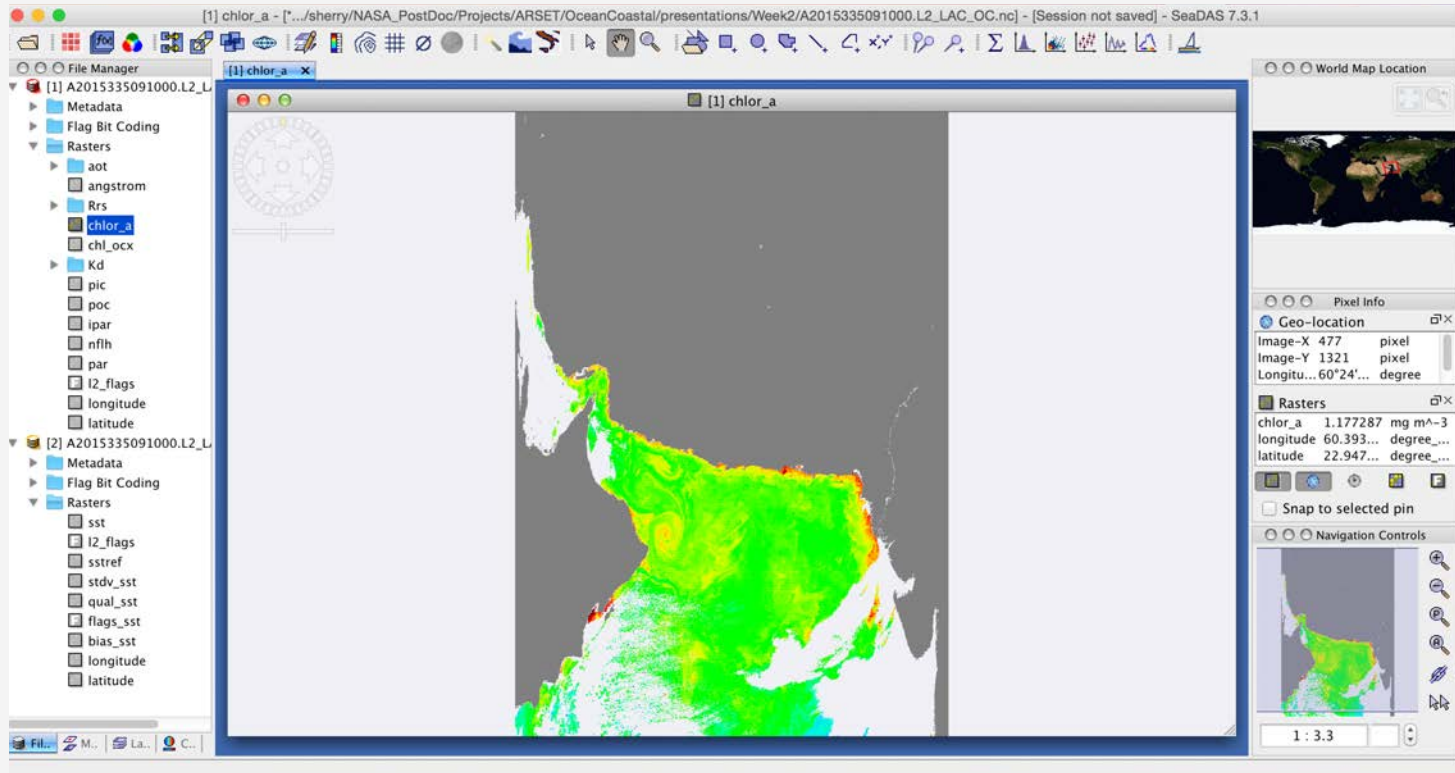
# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>



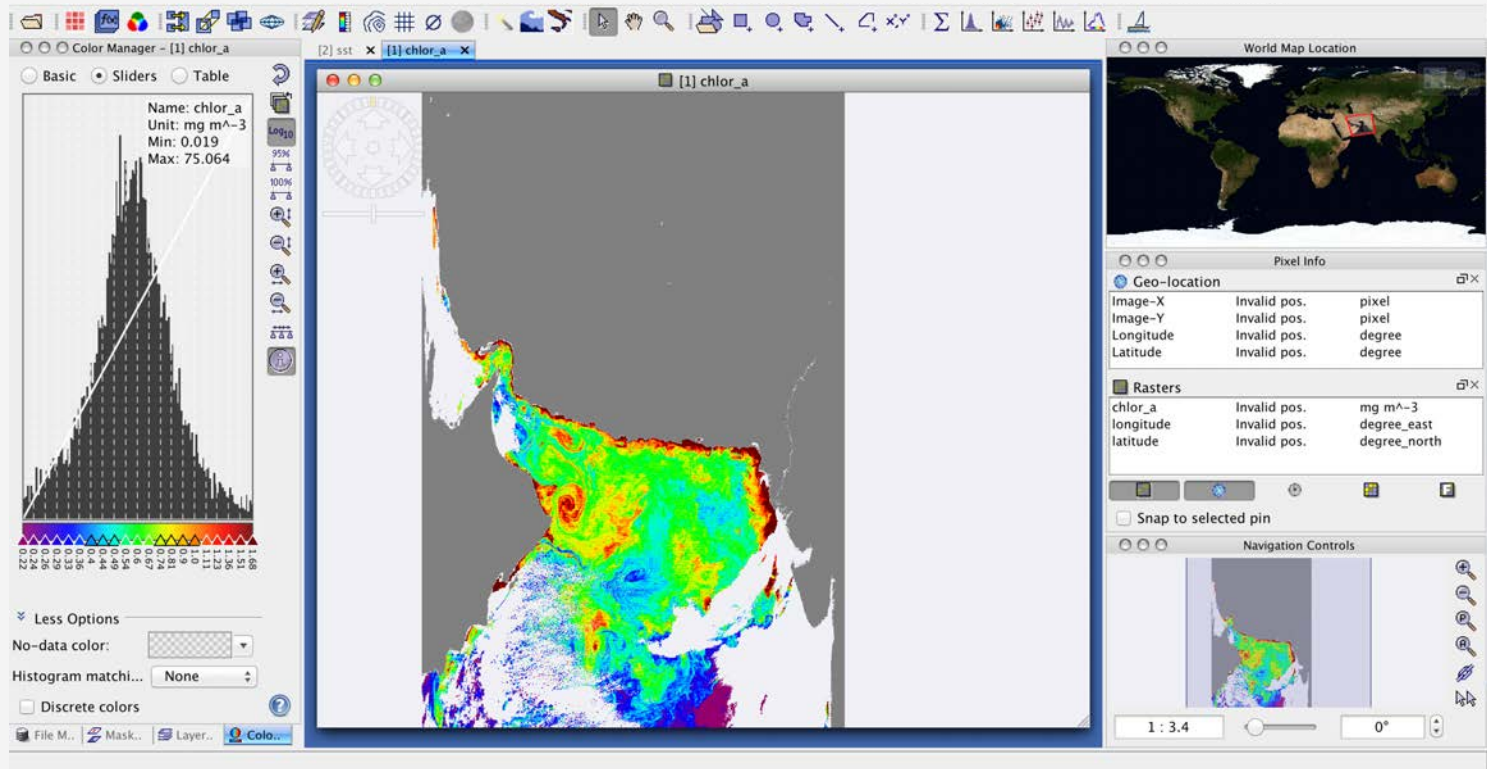
# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>



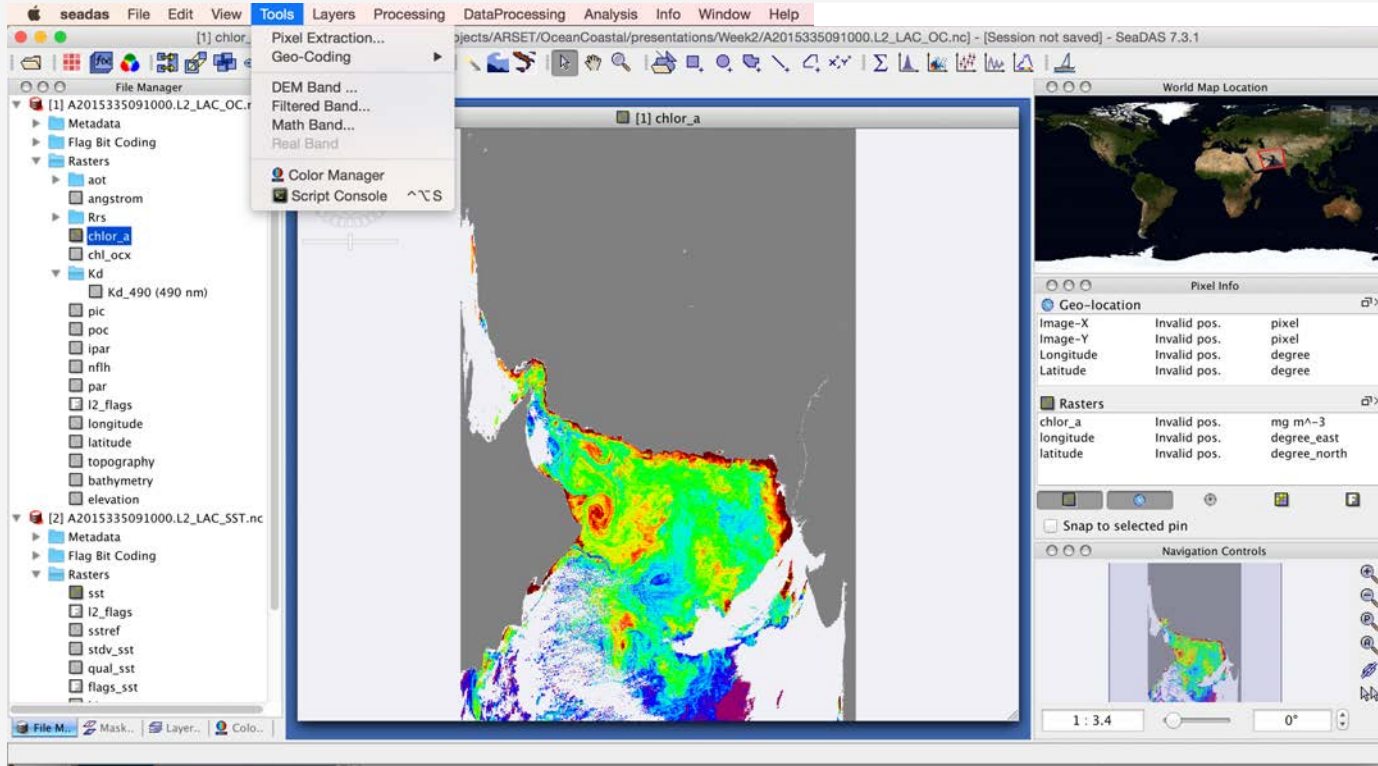
# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>



# Using SeaDAS

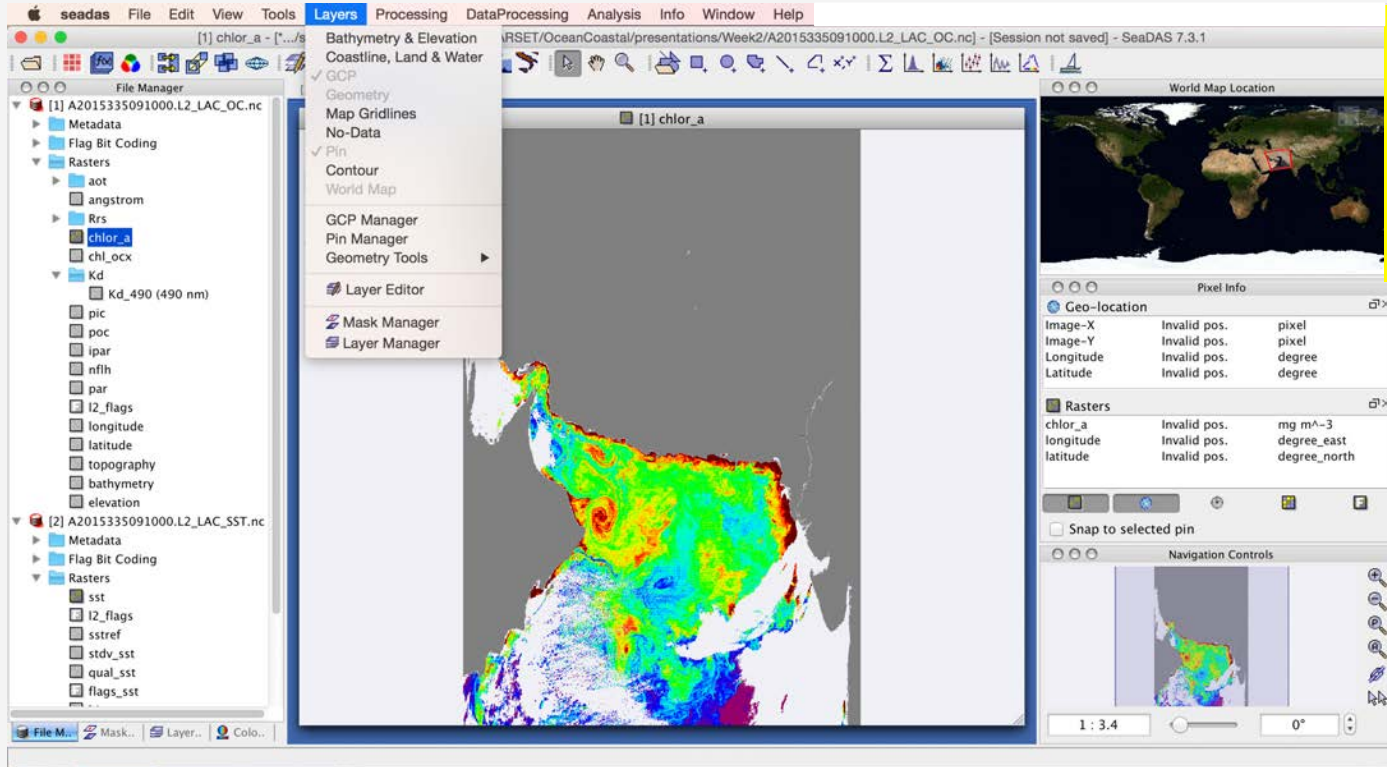
<http://seadas.gsfc.nasa.gov/tutorial/>



The tutorials and webinar review the functionality of SeaDAS in more depth

# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>

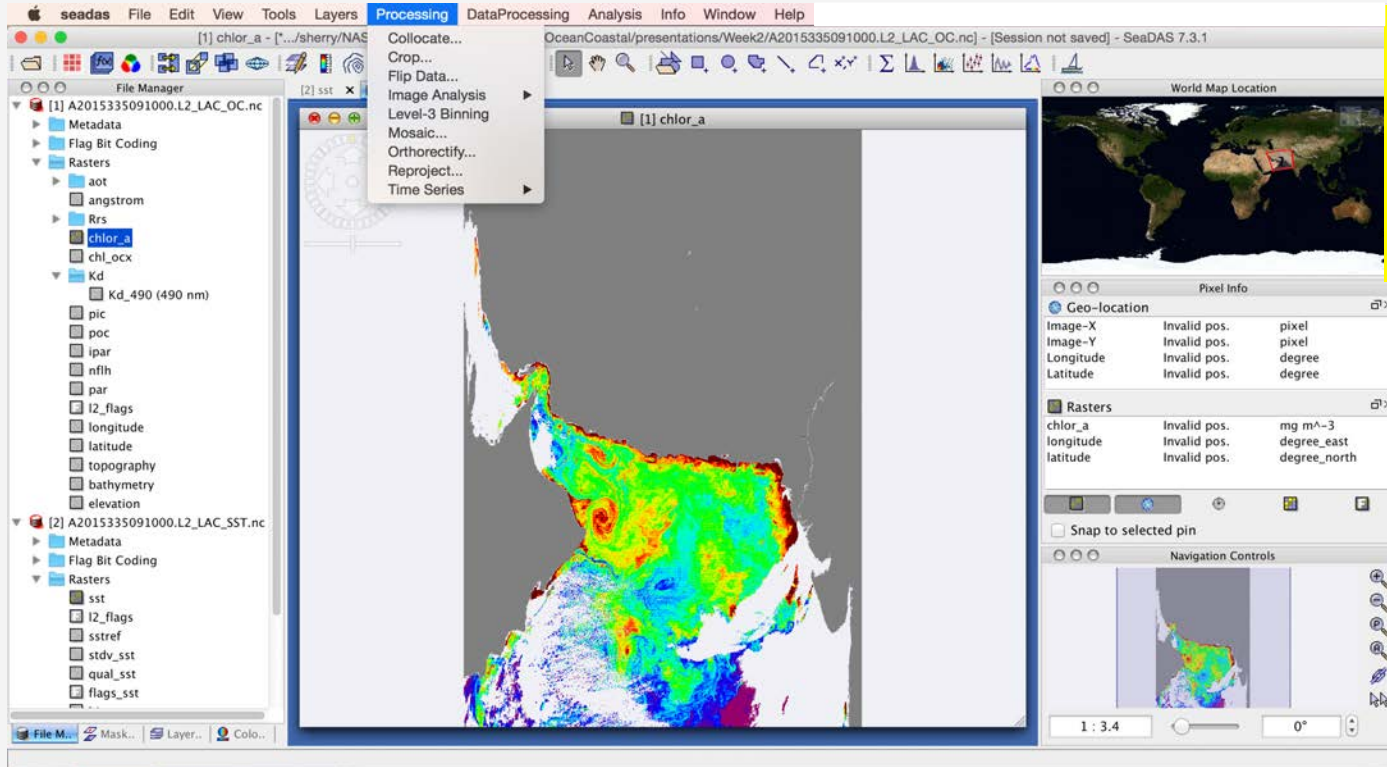


The tutorials and webinar review the functionality of SeaDAS in more depth



# Using SeaDAS

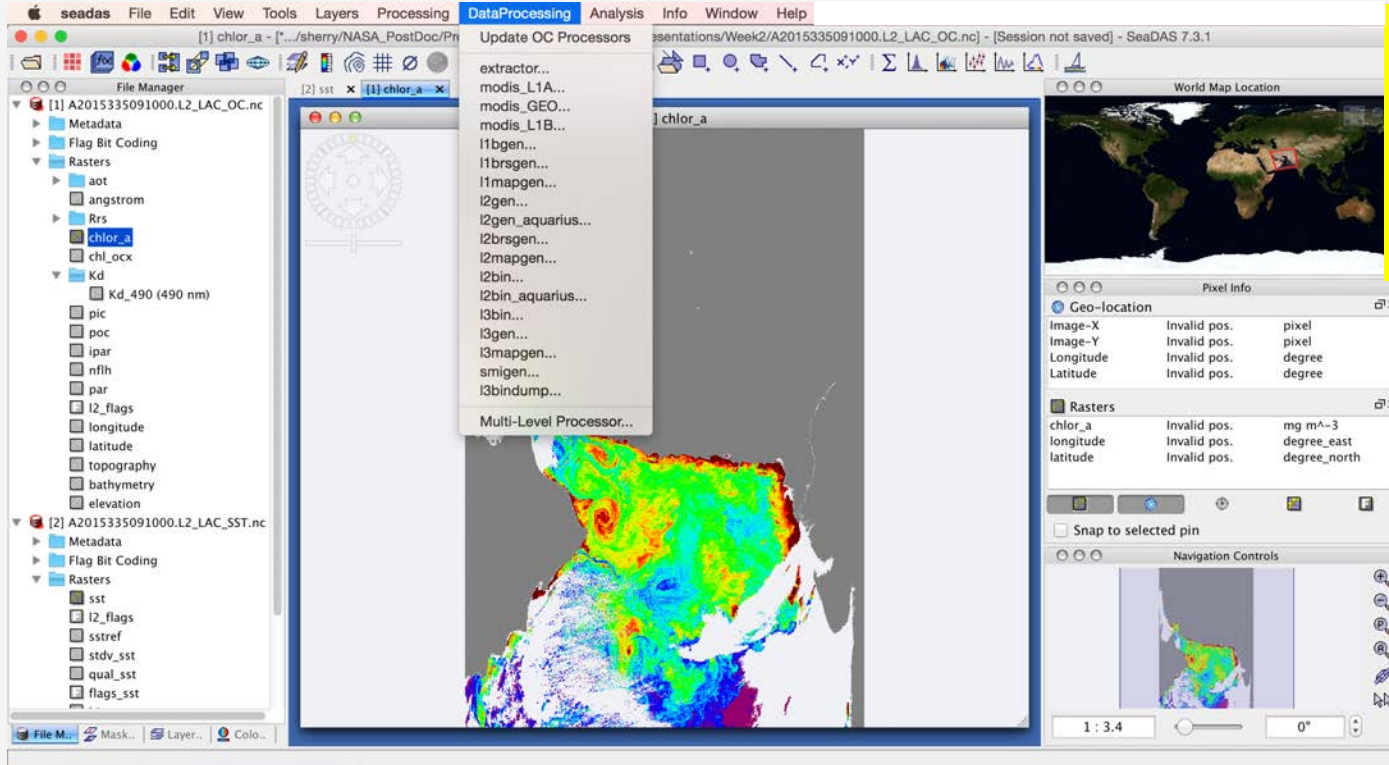
<http://seadas.gsfc.nasa.gov/tutorial/>



The tutorials and webinar review the functionality of SeaDAS in more depth

# Using SeaDAS

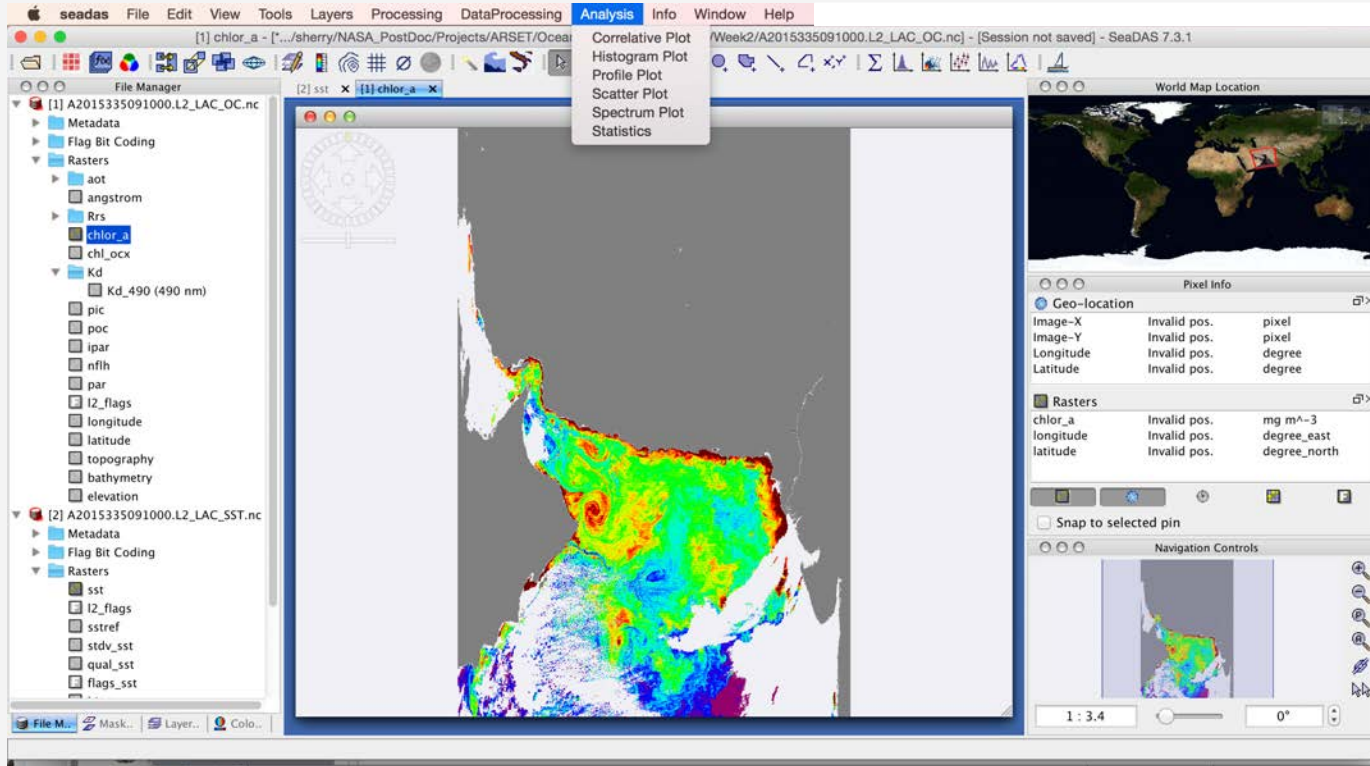
<http://seadas.gsfc.nasa.gov/tutorial/>



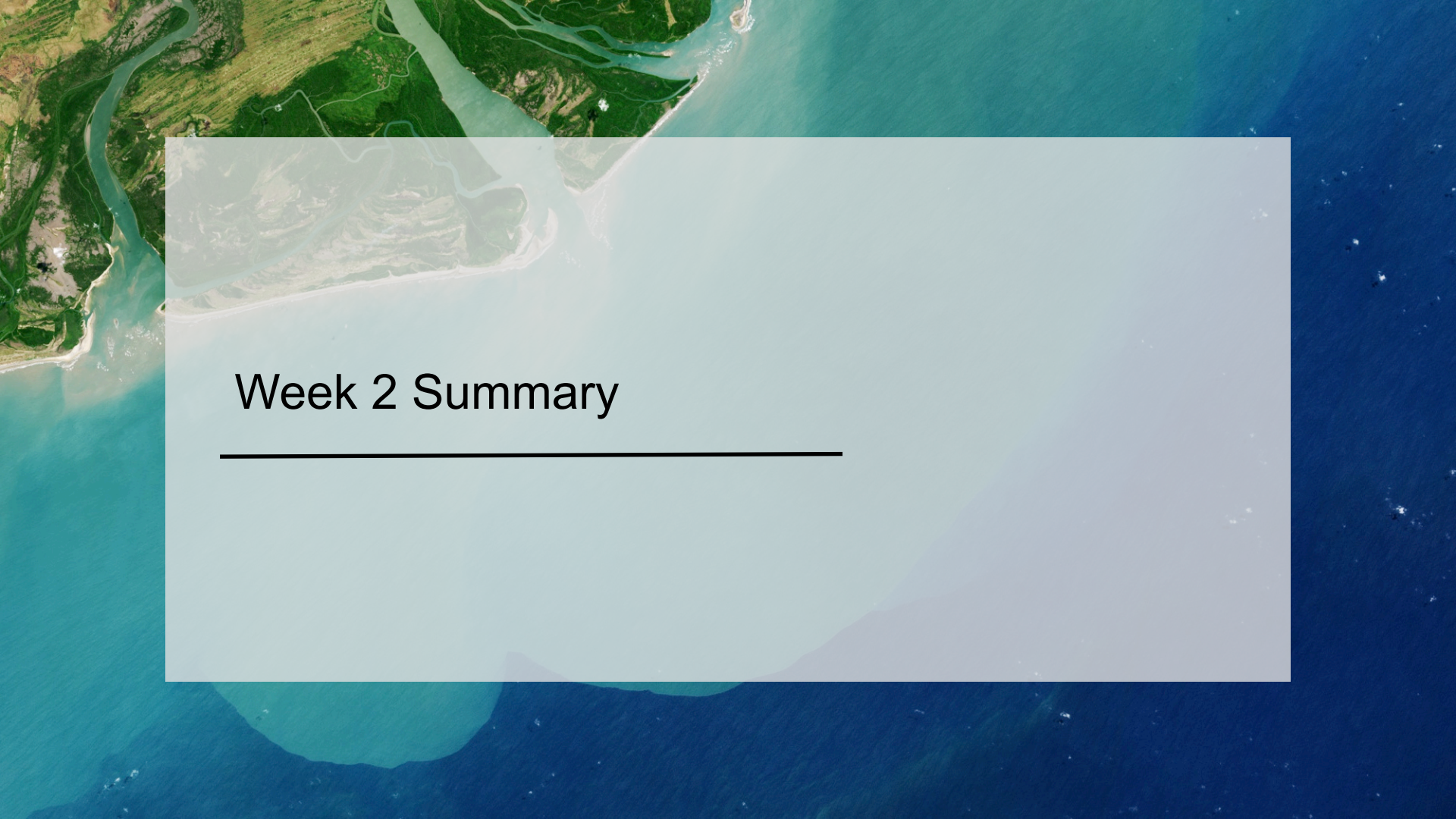
The tutorials and webinar review the functionality of SeaDAS in more depth

# Using SeaDAS

<http://seadas.gsfc.nasa.gov/tutorial/>



The tutorials and webinar review the functionality of SeaDAS in more depth

An aerial photograph of a coastal region. A river with a complex delta system flows from the top left towards the center. The water is a vibrant turquoise color, contrasting with the deep blue of the open ocean. The land is green and brown, showing some infrastructure. A semi-transparent white rectangular box is overlaid on the right side of the image, containing the text 'Week 2 Summary' and a horizontal line.

## Week 2 Summary

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## Week 2 Review

- Brief Review of Last Week
- Satellites and sensors for coastal and ocean applications
- Satellite data processing level
- NASA satellite data access tools
- NASA satellite data processing tools



National Aeronautics and  
Space Administration



# ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

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# Thank you!

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Next Week:

Animal Movement and Migration