

# Monitoring Water Quality Using Satellite Image Processing

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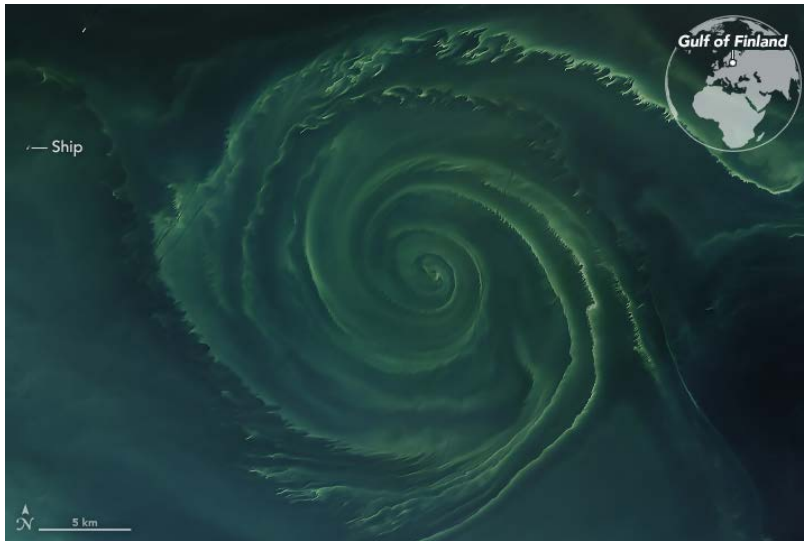
5, 12, and 19 September 2018



# Course Outline

September 5

Overview and Analysis of  
NASA Remote Sensing  
Data for HAB Monitoring



September 12

Introduction to SeaDAS for  
Image Processing and  
Data Analysis

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

The latest version (SeaDAS 7.5.1) 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.

Responsible NASA Official: Gene C. Feldman  
Curator: OceanColor Webmaster  
Authorized by: Gene C. Feldman

September 19

Image Analysis Exercise  
Using SeaDAS

# Learn More About ARSET

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

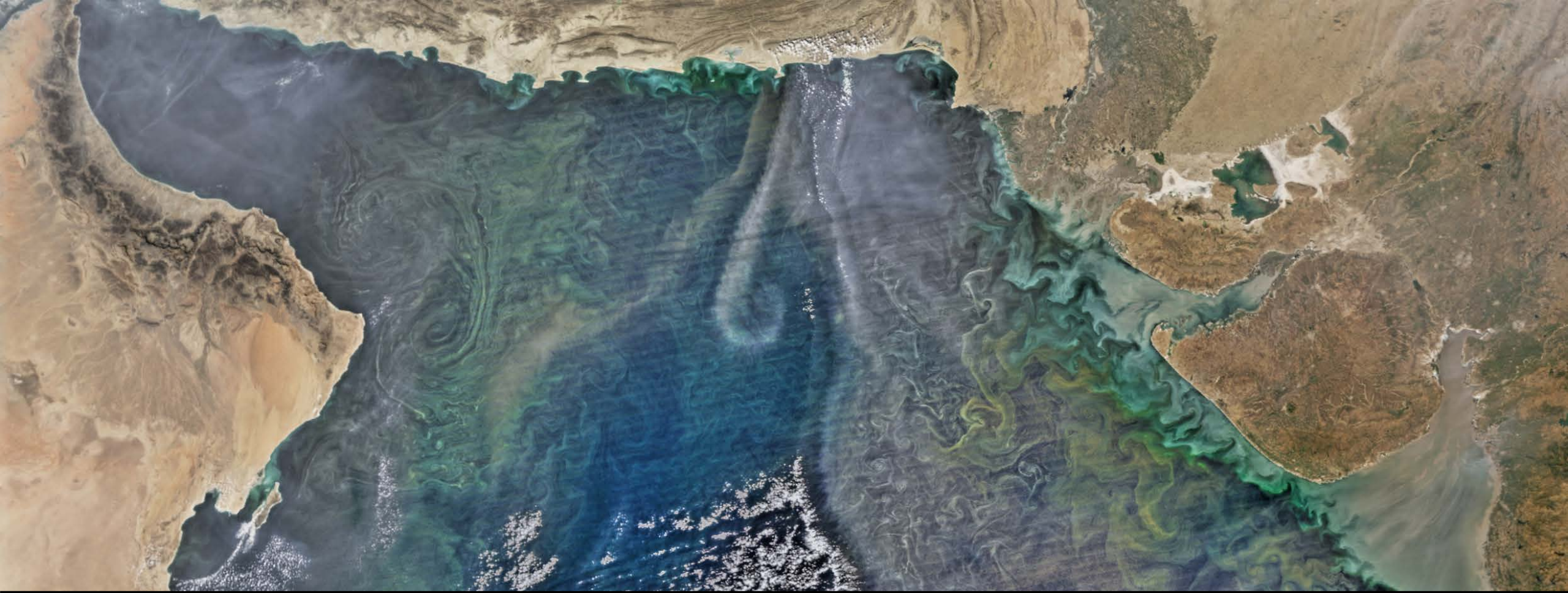
The screenshot displays the ARSET website interface. At the top, the NASA logo and 'ARSET Applied Remote Sensing Training' are visible, along with navigation links for 'Earth Sciences Division', 'Applied Sciences', and 'ASP Water Resources'. A search bar and a Twitter icon are also present. A main navigation menu includes 'Home', 'About', and 'Trainings'. The 'Trainings' menu is open, showing categories: 'Fundamentals', 'Disasters', 'Health & Air Quality', 'Land', and 'Water Resources'. The 'Disasters' category is selected, highlighting a featured training: 'Introduction to Remote Sensing of Harmful Algal Blooms'. The training details include the schedule: 'Tuesdays, Sep 5-26, 2017, 11:00-12:00 or 21:00-22:00 EDT (UTC-4)', and a 'Register Now' button. The background image is a satellite view of a coastal area with greenish water. Below the featured training, there is a credit: 'Image Credit: Landsat 8 OLI, NASA Earth Observatory'. On the right sidebar, under the 'ARSET' heading, there are links for 'Online Trainings', 'In-Person Trainings', 'Sign up for the Listserv' (with a mouse cursor pointing to it), 'Tools Covered', 'Suggest a Training', 'Personnel', and 'Resources'. Below this is a section for 'Upcoming Training' with a sub-heading 'Water' and a link for 'Satellite Observations of Water Quality for'.



# Outline for Week 3

- Overview of Image Processing
- Ocean Color Science Software (OCSSW)
- Demonstration: Analysis of Landsat-8 OLI Image Using SeaDAS/OCSSW
- Convert L-1 data to atmospherically corrected L-2 data
  - Focus: Lake Victoria
- Demonstration: Using Landsat-8 OLI Band Reflectance and In Situ Data for Algorithm Development
  - Focus: Gulf of Mexico
- Summary



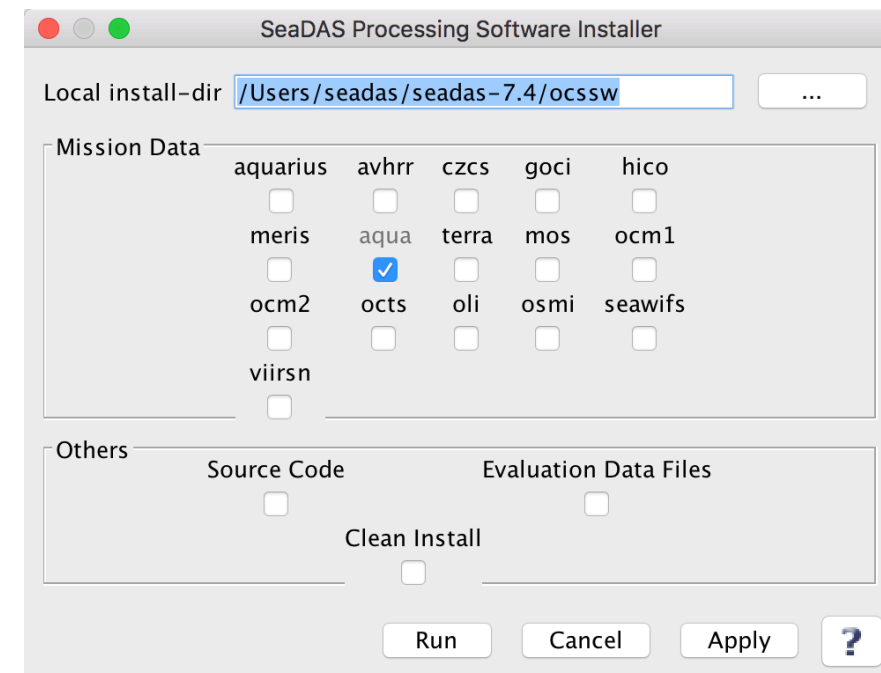


# Overview of Image Processing: Ocean Color Science Software (OCSSW)

Acknowledgement: Daniel Knowles ([Daniel.s.Knowles@nasa.gov](mailto:Daniel.s.Knowles@nasa.gov))  
Ocean Biology Processing Group

# Installation of OCSSW

- OCSSW can be installed or updated for various sensors
- GUI Configuration
  - Automated or...
  - Edit  
`${SEADAS_HOME}/config/seadas.configseadas.ocssw.`  
`root = [OCSSW_root_dir]`
- Command Line Configuration
  - User needs to set
  - Edit “.bashrc” (or equivalent) home file:  
`export`  
`OCSSWROOT=${SEADAS_HOME}/ocssw`  
`source $OCSSWROOT/OCSSW_bash.env`
- Processor failure will occur if mission not installed  
**(and log message may not identify problem)**



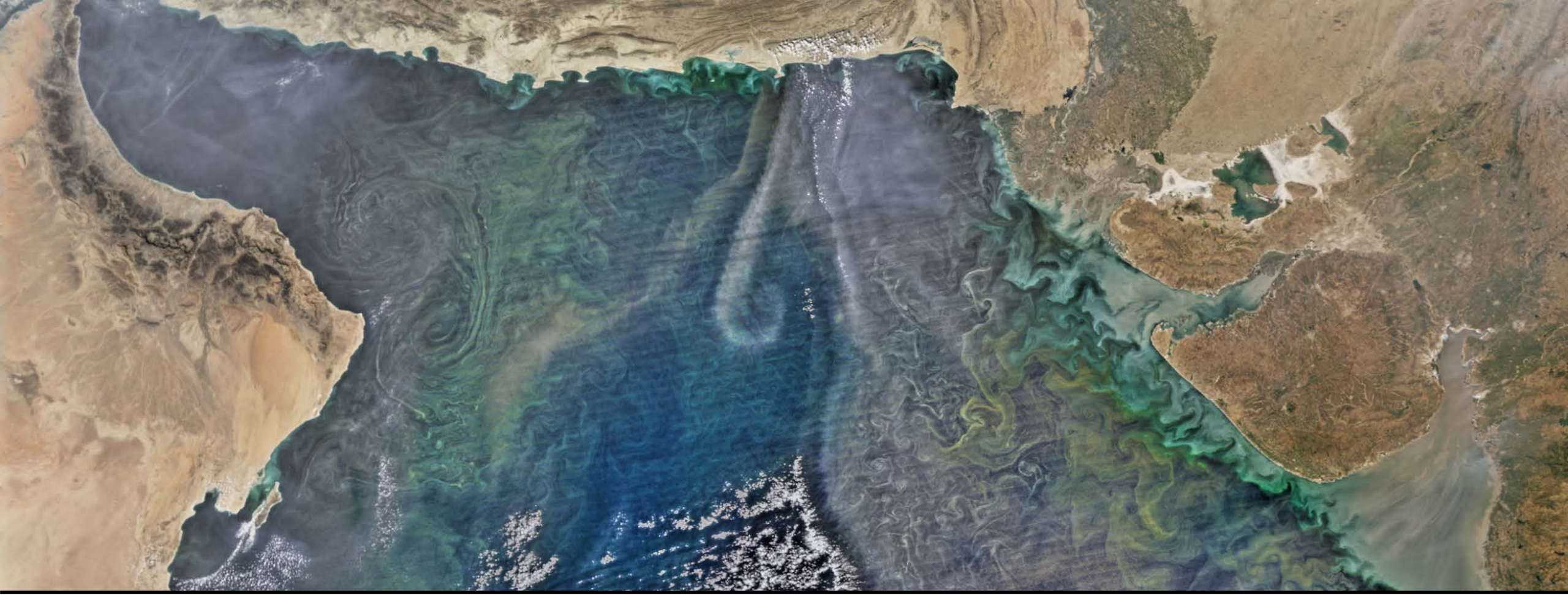
**Note** :For OLCI-S3A currently command line only available  
To install: `install_ocssw.py -i ${OCSSWROOT}-b v7.4 --olci`



# OCSSW Processing Options

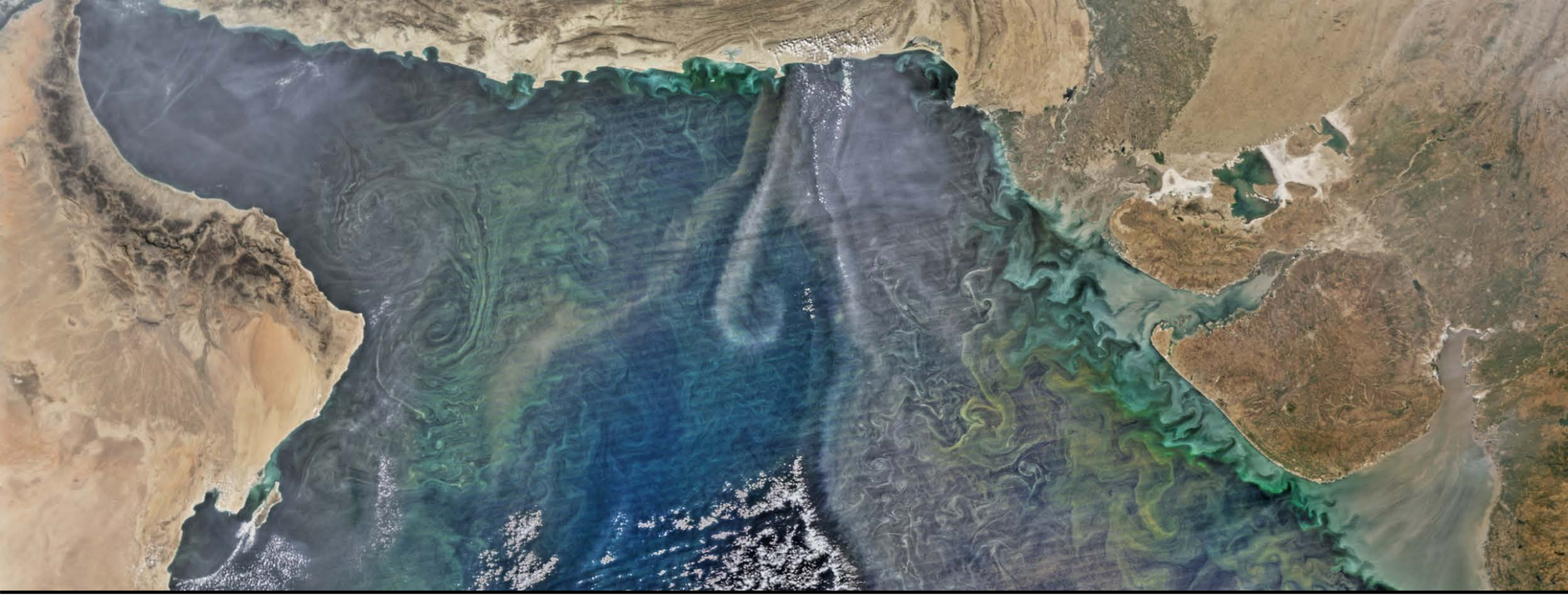
- Level-1: Browser and Map Generator
- Level-2: Browser and Map Generator
- Level-1 to Level-2 Generator
- Get Ancillary Data for Atmospheric Correction
- Geo-location and Calibration [for MODIS and VIIRS only]
- Extractors: Spatial and By Products
- Level-2 Binning For Level-3
- Level-3 Binning from multiple Level-3 files
- Level-3 Map Generator
- Level-3 Metadata Dump
- Multi-Level processing



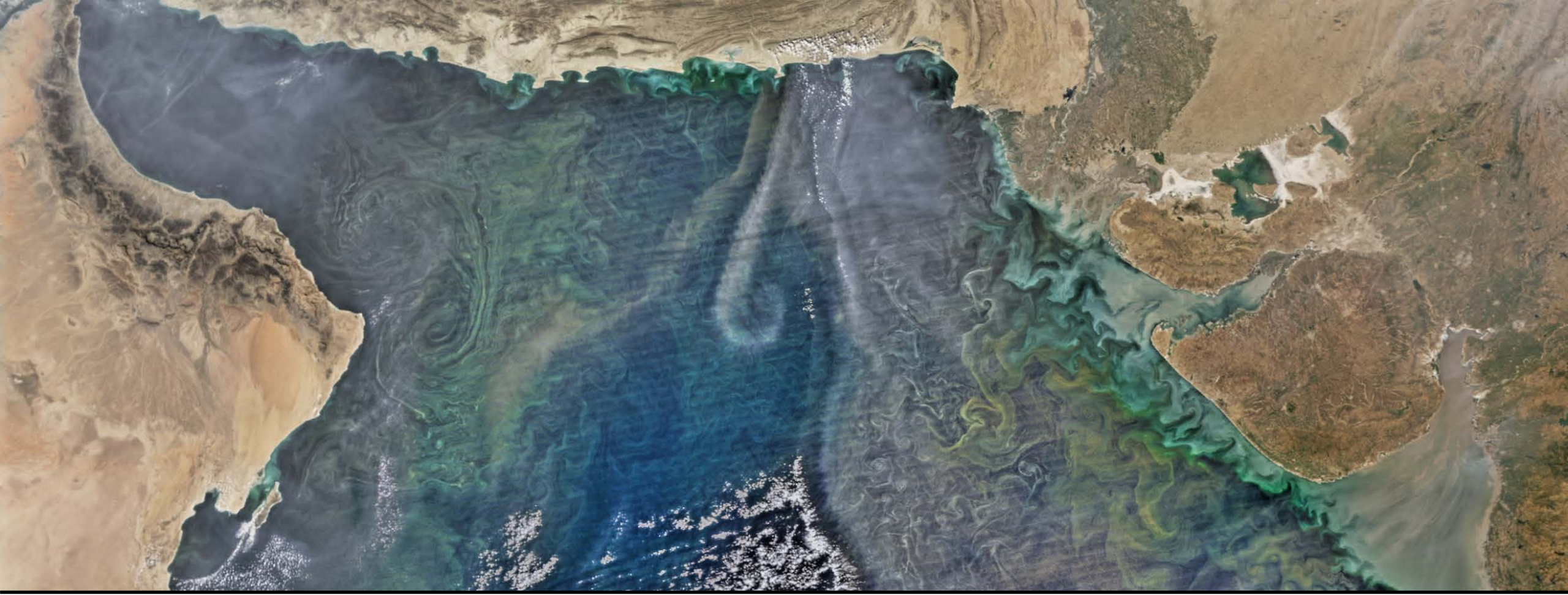


Demonstration: Convert Landsat 8 (OLI) L-1 Data to  
Atmospherically Corrected L-2 Data





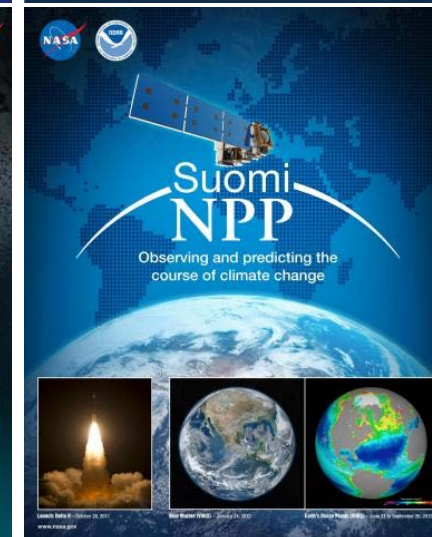
Demonstration: Assessing MODIS L2 data with In Situ Data – Use of custom algorithms to derive Chl-a



Summary

# Current Satellite Missions for Water Quality Monitoring

- Landsat 7 (4/15/1999 – present)
- Landsat 8 (2/1/2013 – present)
- Terra (12/18/1999 – present)
- Aqua (5/4/2002 – present)
- Suomi National Polar Partnership (SNPP) (11/21/2011 – present)
- Joint Polar Satellite System (JPSS) (11/21/2017 – Present)
- Sentinel-2A (6/23/2015 - present)
- Sentinel-2B (3/7/2017 – present)
- Sentinel-3A (2/16/2016 – present)



# Satellites and Sensors for Monitoring Water Quality

Satellites	Sensors	Resolution
Landsat 7	Enhanced Thematic Mapper (ETM+)	185 km swath; 15 m, 30 m, 60 m; 16 day revisit
Landsat 8	Operational Land Imager (OLI)	185 km swath; 15 m, 30 m, 60 m; 16 day revisit
Terra & Aqua	MODerate Resolution Imaging Spectroradiometer (MODIS)	2330 km swath; 250 m, 500 m, 1 km; 1-2 day revisit
Suomi NPP & Joint Polar Satellite System	Visible Infrared Imaging Radiometer Suite (VIIRS)	3040 km swath; 375 m – 750 m; 1-2 day revisit
Sentinel 2A and 2B	Multi Spectral Imager (MSI)	290 km swath; 10 m, 20 m, 60 m; 5 day revisit
Sentinel 3A	Ocean and Land Color Instrument (OLCI)	1270 km swath; 300 m; 27 day revisit

Reference



# NASA Water Quality Data and Tools

## Data Available from MODIS and VIIRS:

- Chlorophyll Concentration
- Sea Surface Temperature
- Particulate Organic Carbon
- Particulate Inorganic Carbon
- Inherent Optical Properties

## Data Access Tools:

- Ocean Color Web: <https://oceancolor.gsfc.nasa.gov/>
- Giovanni: <https://giovanni.gsfc.nasa.gov/giovanni/>

## Data Processing Software:

- SeaDAS: <https://seadas.gsfc.nasa.gov/>



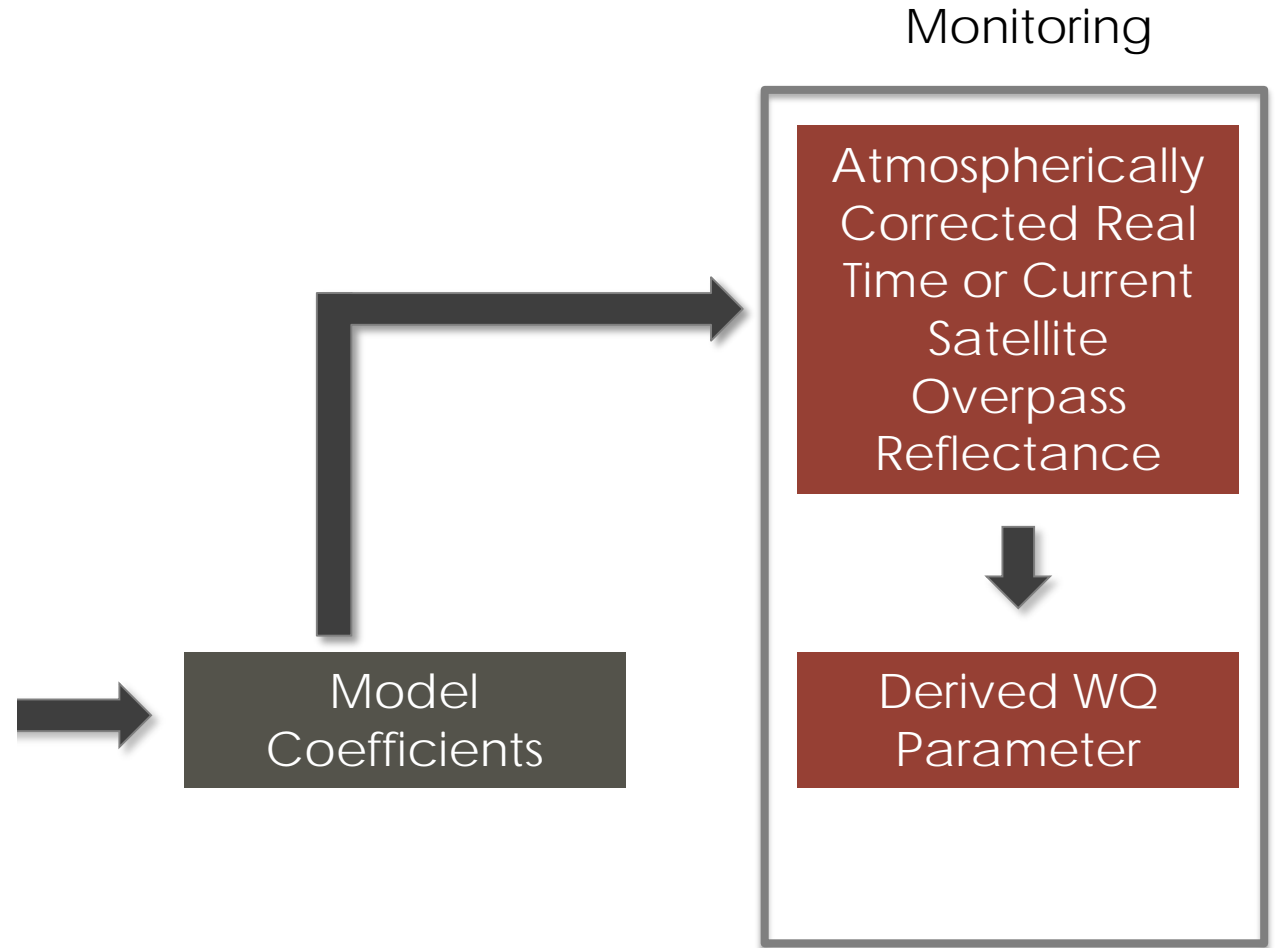
# Water Quality Parameters from Remote Sensing Observations

## Quantitative Technique

Algorithm Development

Algorithms use optical, NIR, IR, and MW remote sensing observations for quantitative water quality monitoring in lakes, estuaries, and coastal oceans

See a review in Golizadeh et al., 2016 and references included in the review



Reference: Gholizadeh, M. H., A. M/ Melesse, L. Reddy, 2016: Spaceborne and airborne sensors in water quality assessment, International J. of Remote Sensing, 37, 3143-3180.



# Challenges in Monitoring Water Quality (WQ)

- For accurate and quantitative WQ monitoring analysis of spatially and temporally co-located, in situ measurements and satellite observations are required
- Feasibility of WQ monitoring in coastal and inland water bodies depends on spatial, temporal, and spectral resolutions of remote sensing observations
- Difficult to separate WQ parameters when sediments, dissolved matter, and Chl-a all are present
- It is not possible to characterize algal types or toxins only from remote sensing observations
- Remote sensing reflectance has to be corrected to account for contributions from atmospheric constituents such as aerosols
- Optical remote sensing observations cannot view the surface in the presence of clouds



# Operational Water Quality Monitoring

- Combination of data from multiple satellites is useful for monitoring water quality
- Monitoring water quality in inland lakes depends on the size of lakes
  - Landsat can monitor close to 170,240 lakes globally
  - MODIS/OLCI would resolve ~1,862 lakes globally [Wilson Salls, EPA]
- Examples of remote sensing-based regional water quality monitoring:
  - [Cyanobacteria Assessment Network \(CyAN\)](#)
  - [Lake Erie HAB Tracker](#)
  - [NOAA Coast Watch](#)
  - [Copernicus Marine Environment Monitoring Service](#)
  - [Near Real-Time Algal Bloom Monitoring Services in the North Atlantic](#)
  - All of these tools are discussed in the ARSET Training [Introduction to Remote Sensing for Harmful Algal Blooms](#)







Thank You