Welcome to
NASA Applied Remote Sensing Training (ARSET)
Webinar Series

Introduction to Water Quality (WQ) Monitoring From Remote Sensing Measurements

Course Dates: 18, 25, November and 2, December 2014

Time: 8 to 9 am and 1 to 2 pm Eastern US time

ARSET : Applied Remote SEnsing Training

A project of NASA Applied Sciences

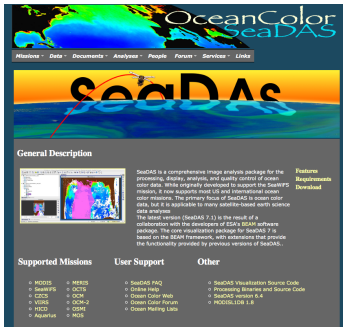
Course Outline

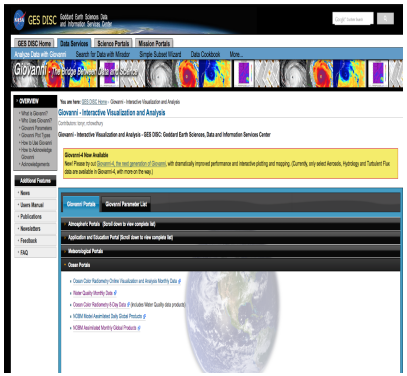
Week 1

Introduction to Remote Sensing of WQ parameters

Week 2

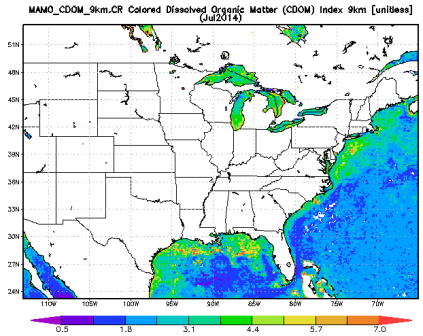
NASA WQ Data, Access, and Tools





Week 3

Overview of WQ Monitoring and Case Studies of Monitoring WQ in Selected Water Bodies



Webinar Information

Speakers Today:

Blake Schaeffer (Week-3) Schaeffer.Blake@epa.gov

Africa Flores Africa.flores@nasa.gov

Brock Blevins (ARSET) bblevins37@gmail.com

Amita Mehta amita.v.mehta@nasa.gov

Week 3: Outline

- Overview of remote sensing for water quality monitoring
- SERVIR Water Quality Application: Case Study of Lake Atitlan
- MODIS and Landsat Data Access : Lake Victoria

Guest Speaker: Dr. Blake Schaeffer

Overview of remote sensing for water quality monitoring

NASA Applied Remote Sensing Training
December 2, 2014

Blake Schaeffer
Office of Research and Development
National Exposure Research Laboratory

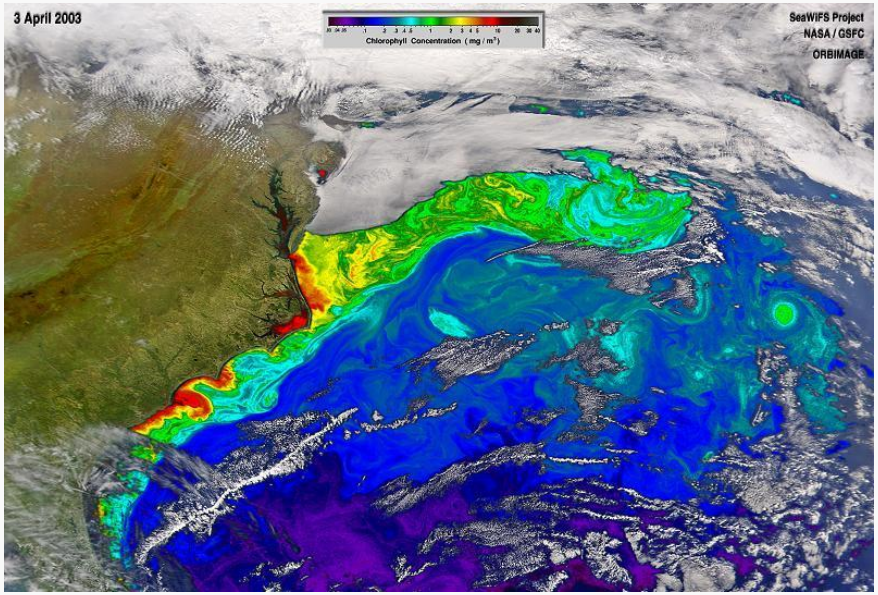
Contributors

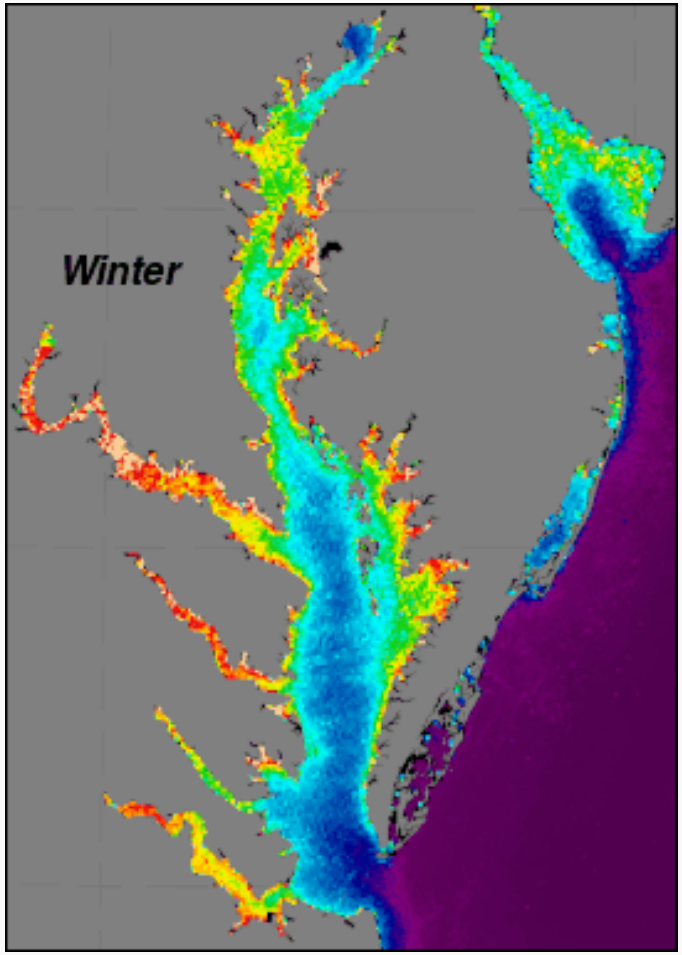
- Steward Bernard CSIR
- Julia Busch Oldenburg
- Carsten Brockmann BC Assoc.
- Arnold Dekker CSIRO
- Paul DiGiacomo NOAA
- Steve Greb WDNR
- Thomas Leeuw Sequoia
- Blake Schaeffer EPA
- Richard Stumpf NOAA
- Andrew Tyler University Stirling

Protect beneficial uses of water

- World Health Organization
  - Collect information on water quality and health.
  - Strengthen capacity to manage water quality.
- United Nations
  - Ensure environmental sustainability.
- World Bank
  - Continued human development, food and energy security, and job creation.
  - Continued economic and social growth.

Ocean and coastal/in-land

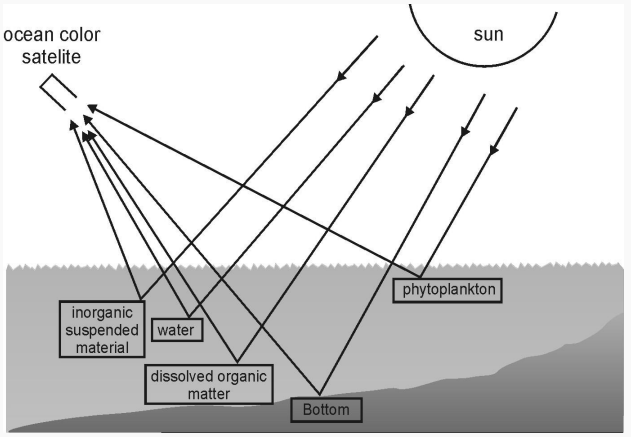




Cost

$$Chl_{MedOC4} = 10^{(0.4424 - 3.686R + 1.076R^2 + 1.684R^3 - 1.437R^4)}$$

Math



Atmospheric Correction

Accuracy

Continuity

Support

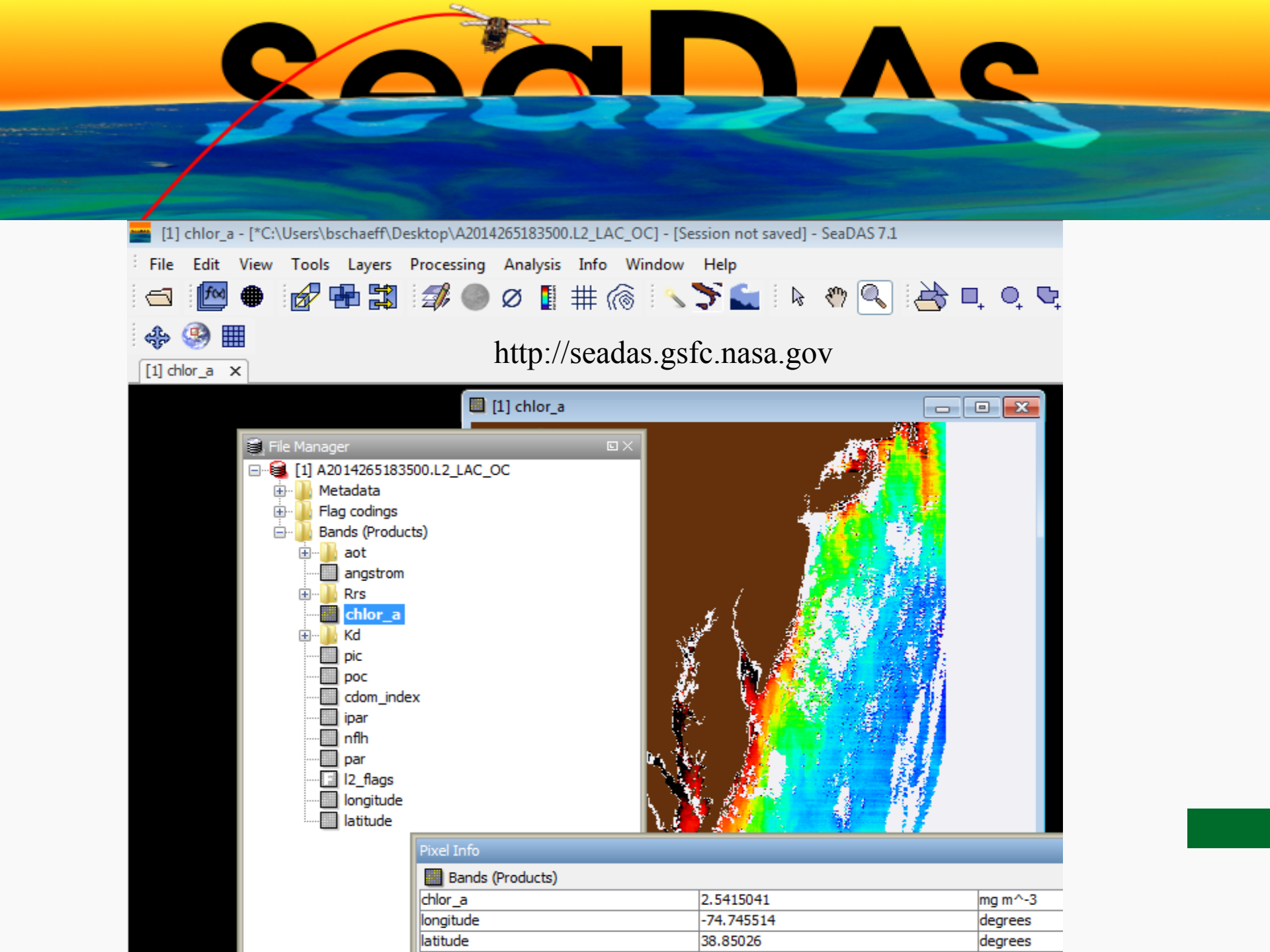
Schaeffer et al. IJRS 2013. 34:7534-7544

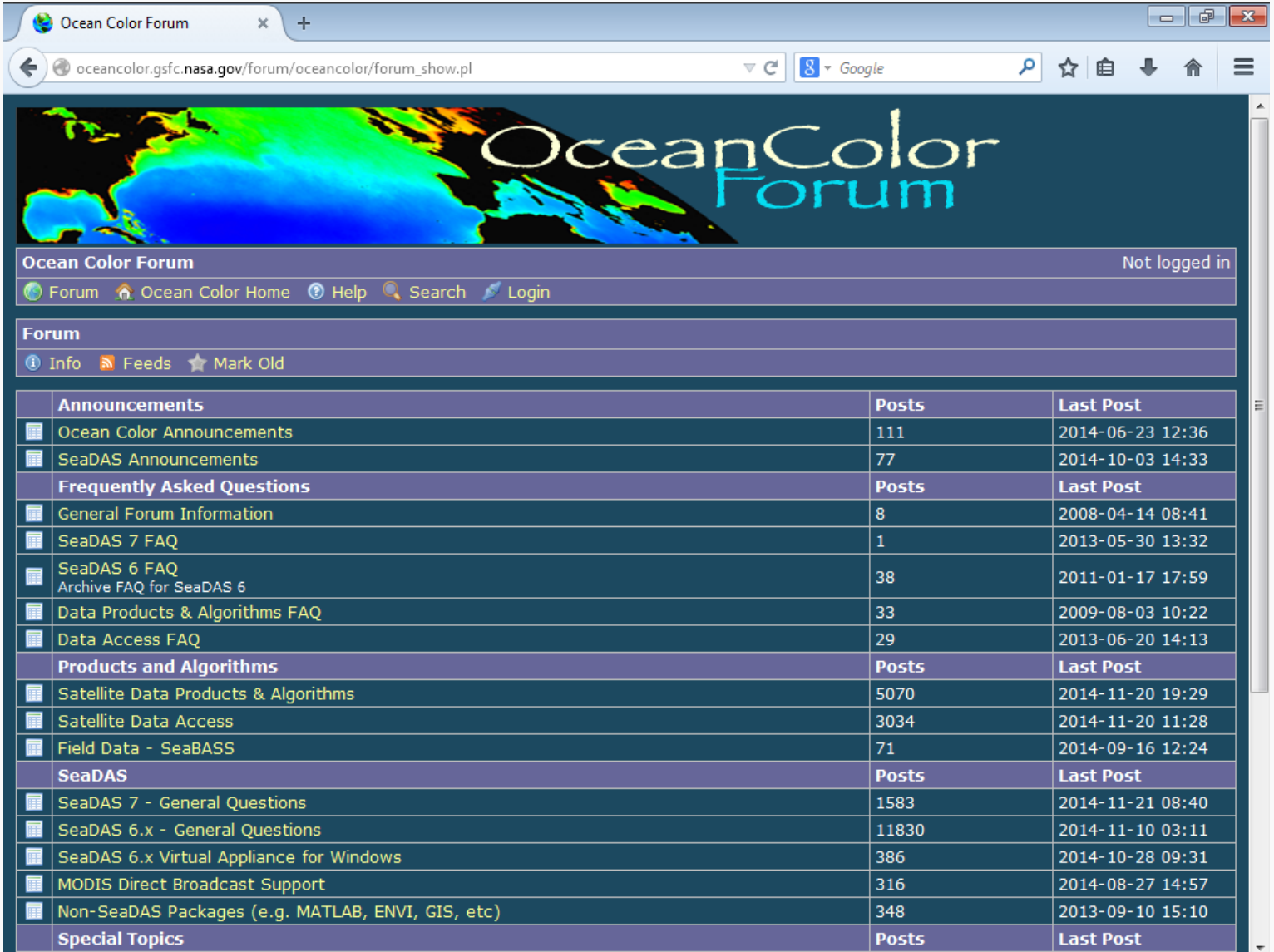
SATELLITE SENSOR SYSTEMS		PIXEL SIZE (M)	SPECTRAL BANDS (400-1000NM)	REVISIT CYCLE	RAW DATA COST PER km^2 (AUD)[a]	WATER QUALITY VARIABLES[b,c]					
						CHL	CYP	TSM	CDOM	K_d	TURB SD
***Current* ocean-coastal low spatial resolution**	MODIS	1000	9	Daily	Free	●	●	●	●	●	●
	MODIS	500	2	Daily	Free	●	●	●	●	●	●
	MODIS	250	2	Daily	Free	●	●	●	●	●	●
	MERIS & OCM-2	300	15	2-3 days	Free	●	●	●	●	●	●
	VIIRS & JPSS	750	7	2x/day	Free	●	●	●	●	●	●
***Current* multi-spectral mid-spatial resolution**	Landsat	30	4	16	Free	●	●	●	●	●	●
***Current* high spatial resolution[a]**	IKONOS, Quickbird, SPOT-5, GeoEYE	2-4	3-4	On-demand 2-60 days	5-15	●	●	●	●	●	●
	RapidEye	6.5	5	Daily	1.5	●	●	●	●	●	●
	Worldview-2	2	8	On-demand	30	●	●	●	●	●	●
***Future* ocean-coastal low spatial resolution**	Sentinel-3	300	21	Daily	Free	●	●	●	●	●	●
***Future* multi-spectral mid-spatial resolution**	LDCM	30	5	16	Free	●	●	●	●	●	●
***Future* hyper-spectral**	EnMap	30	90	On-demand	Free (?)	●	●	●	●	●	●
	PRISMA	20	60	25 days	Free (?)	●	●	●	●	●	●
	HySpIRI	60	60	19 days	Free	●	●	●	●	●	●

● Highly Suited ● Suitable ● Potential ● Not Suitable

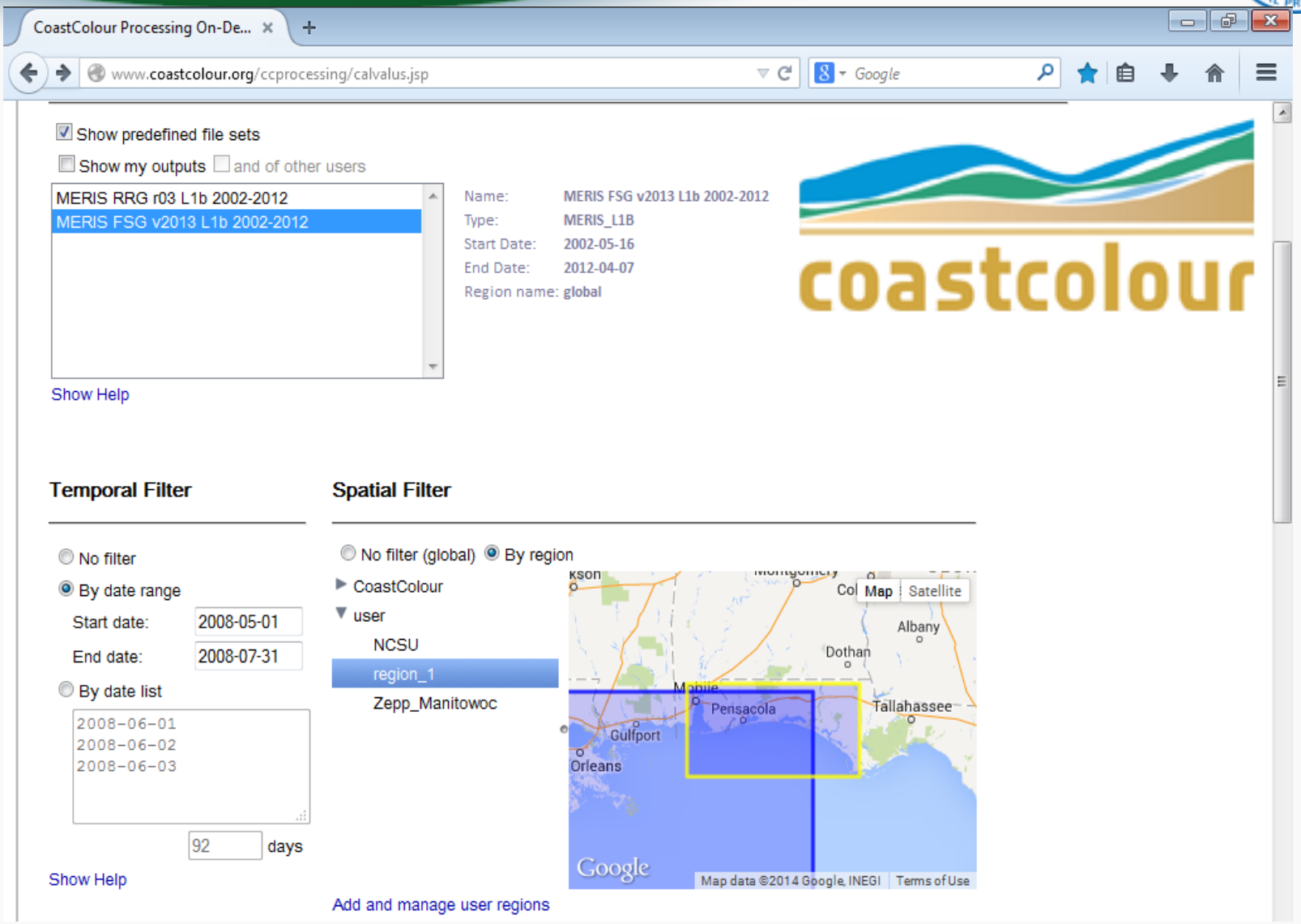
POC: Arnold Dekker

CHL=Chlorophyll; CYP=cyanobacterial pigments such as cyano-phycocyanin and cyano-phycoerythrin; TSM=total suspended matter; CDOM =coloured dissolved organic matter; K_d= vertical attenuation of light coefficient; TURB= turbidity; SD=Secchi Disk transparency


SeaDAS
[1] chlor_a - [*C:\Users\bschaeff\Desktop\A2014265183500.L2_LAC_OC] - [Session not saved] - SeaDAS 7.1
File Edit View Tools Layers Processing Analysis Info Window Help
http://seadas.gsfc.nasa.gov
[1] chlor_a
[1] chlor_a
File Manager
[1] A2014265183500.L2_LAC_OC
Metadata
Flag codings
Bands (Products)
aot
angstrom
Rrs
chlor_a
Kd
pic
poc
cdom_index
ipar
nflh
par
l2_flags
longitude
latitude
Pixel Info
Bands (Products)
chlor_a 2.5415041 mg m^-3
longitude -74.745514 degrees
latitude 38.85026 degrees



	Announcements	Posts	Last Post
	Ocean Color Announcements	111	2014-06-23 12:36
	SeaDAS Announcements	77	2014-10-03 14:33
	Frequently Asked Questions	**Posts**	**Last Post**
	General Forum Information	8	2008-04-14 08:41
	SeaDAS 7 FAQ	1	2013-05-30 13:32
	SeaDAS 6 FAQ Archive FAQ for SeaDAS 6	38	2011-01-17 17:59
	Data Products & Algorithms FAQ	33	2009-08-03 10:22
	Data Access FAQ	29	2013-06-20 14:13
	Products and Algorithms	**Posts**	**Last Post**
	Satellite Data Products & Algorithms	5070	2014-11-20 19:29
	Satellite Data Access	3034	2014-11-20 11:28
	Field Data - SeaBASS	71	2014-09-16 12:24
	SeaDAS	**Posts**	**Last Post**
	SeaDAS 7 - General Questions	1583	2014-11-21 08:40
	SeaDAS 6.x - General Questions	11830	2014-11-10 03:11
	SeaDAS 6.x Virtual Appliance for Windows	386	2014-10-28 09:31
	MODIS Direct Broadcast Support	316	2014-08-27 14:57
	Non-SeaDAS Packages (e.g. MATLAB, ENVI, GIS, etc)	348	2013-09-10 15:10
	Special Topics	**Posts**	**Last Post**



POC: Carsten Brockmann

Home | Geo Water Quality

www.geo-water-quality.org/home

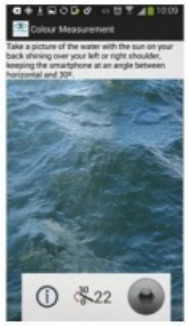
GEO water quality

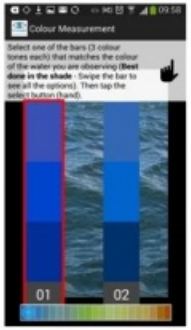
Image: USGS

- Home
- Background
- Water Quality Working Group
- Downloads
- Links

GROUP ON EARTH OBSERVATIONS

GEOSS Portal
Discover. Access. Contribute





One of the objectives of the **Citclops** project is to produce **applied results** by developing new **applications for mobile devices**, and friendlier and more flexible user interfaces to connect citizens and their associations to policy makers. Picture: Citclops

Contact us

in cooperation with

News

2nd International Ocean Colour Science (IOCS) Meeting (16-18 June 2015, San Francisco, USA)

Dr. Mark Matthews wins the 2014 Copernicus Masters Ideas Challenge for CyanoLakes

International Geoscience and Remote Sensing Symposium (July 26-31, 2015, Milan, Italy)

Downloads | Geo Water Qu... | GEO - Group on Earth Obs...

https://www.earthobservations.org/webinar_wq.php

home > meetings > webinar series

search our site here

GROUP ON EARTH OBSERVATIONS

what is GEO | what we do | global initiatives | meetings | documents | how to get involved

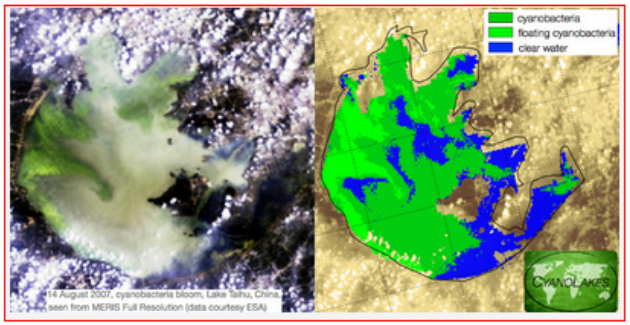
GEO Inland and Coastal Water Quality working group Webinar Series

Next Webinar | Future Webinars | Past Webinar Recordings

Re-calibration of the MPH algorithm: towards a standard operational product for chl-a and cyanobacteria detection for inland/near-coastal waters

20 November 2014

This webinar was presented by **Dr. Mark W. Matthews** (Department of Oceanography, University of Cape Town, Rondebosch, 7701, Cape Town, South Africa)



Abstract: The talk provided an overview of the maximum peak height algorithm, providing some demonstration and details on new advancements related to the recently released plugin for BEAM (including adjacency effect detection). Results of the validation of the MPH algorithm across a wide range of water types performed in the ESA Diversity II project were presented (courtesy Dr. Daniel Odermatt). The talk discussed the re-calibration exercise for the MPH algorithm, in preparation for a publication. Initial results and approaches were presented from the re-calibration.

Bio: Dr. Mark Matthews is an earth observation scientist specialising in the detection of cyanobacteria from space. He graduated from the University of Cape Town in 2014, and has published 8 first author publications (two monographs) in high impact journals, and received several awards and scholarships. He received an innovation award in 2012 from the CSIR for operational monitoring of cyanobacteria and eutrophication in South African inland waters as well as a 2014 Copernicus Masters Ideas Challenge award. His maximum peak height algorithm has been developed as a plugin for the BEAM software. He has worked as a lecturer at the University of the Western Cape,

www.ioccg.org

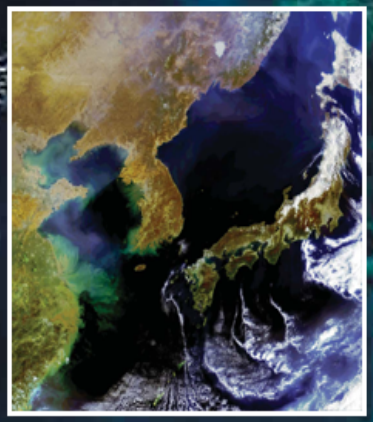
IOCCG

International Ocean-Colour Coordinating Group

An Affiliated Program of SCOR

Contact Us

Feature Image



GOCI/COMS image showing Yangtze River discharge near South Korea (click on image for larger view)

Promoting the application of remotely-sensed ocean-colour data through coordination, training, liaison between providers and users, advocacy and provision of expert advice

IOCCG

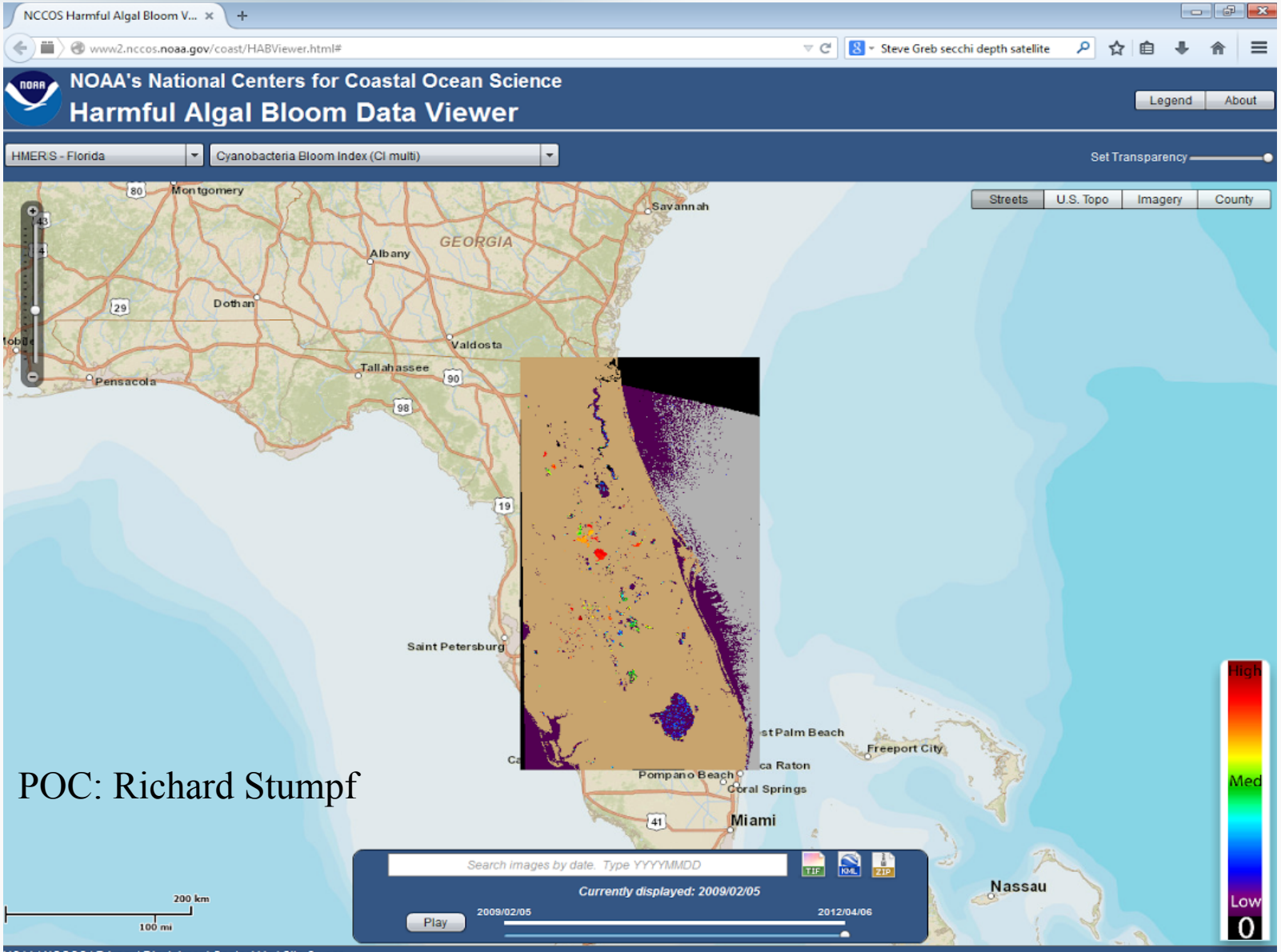
International Ocean-Colour Coordinating Group

- Reports
  - Report #3: *Remote Sensing of Ocean Colour in Coastal, and Other Optically-Complex, Waters*
  - Report #TBD: *Harmful Algal Blooms and Ocean Colour*
    - POC Steward Bernard
  - Report #TBD: *Earth Observations in Support of Global Water Quality Monitoring*
    - POC Steve Greb

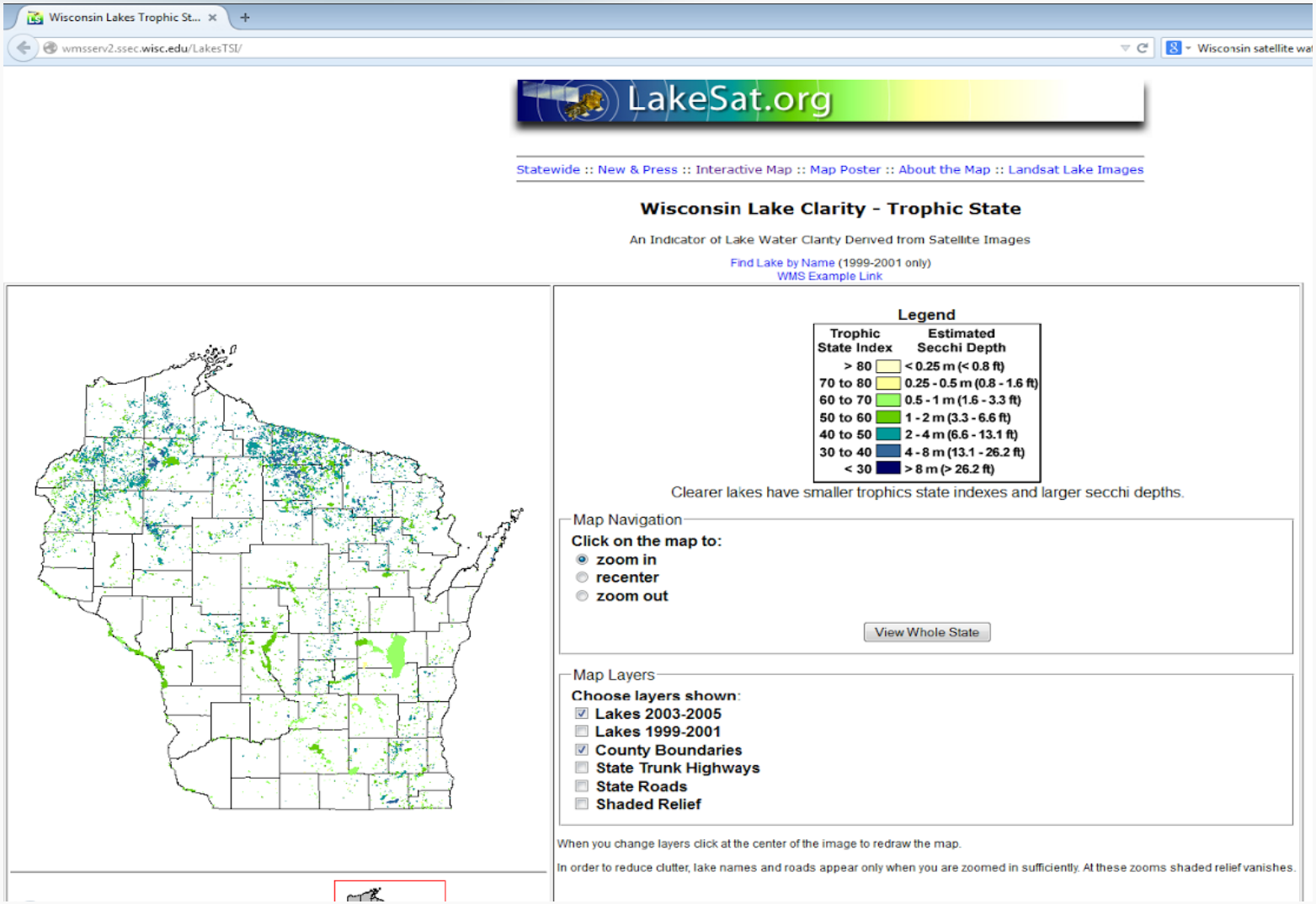
International Ocean Colour Science Meeting 2015

Advancing Global Ocean Colour Observations

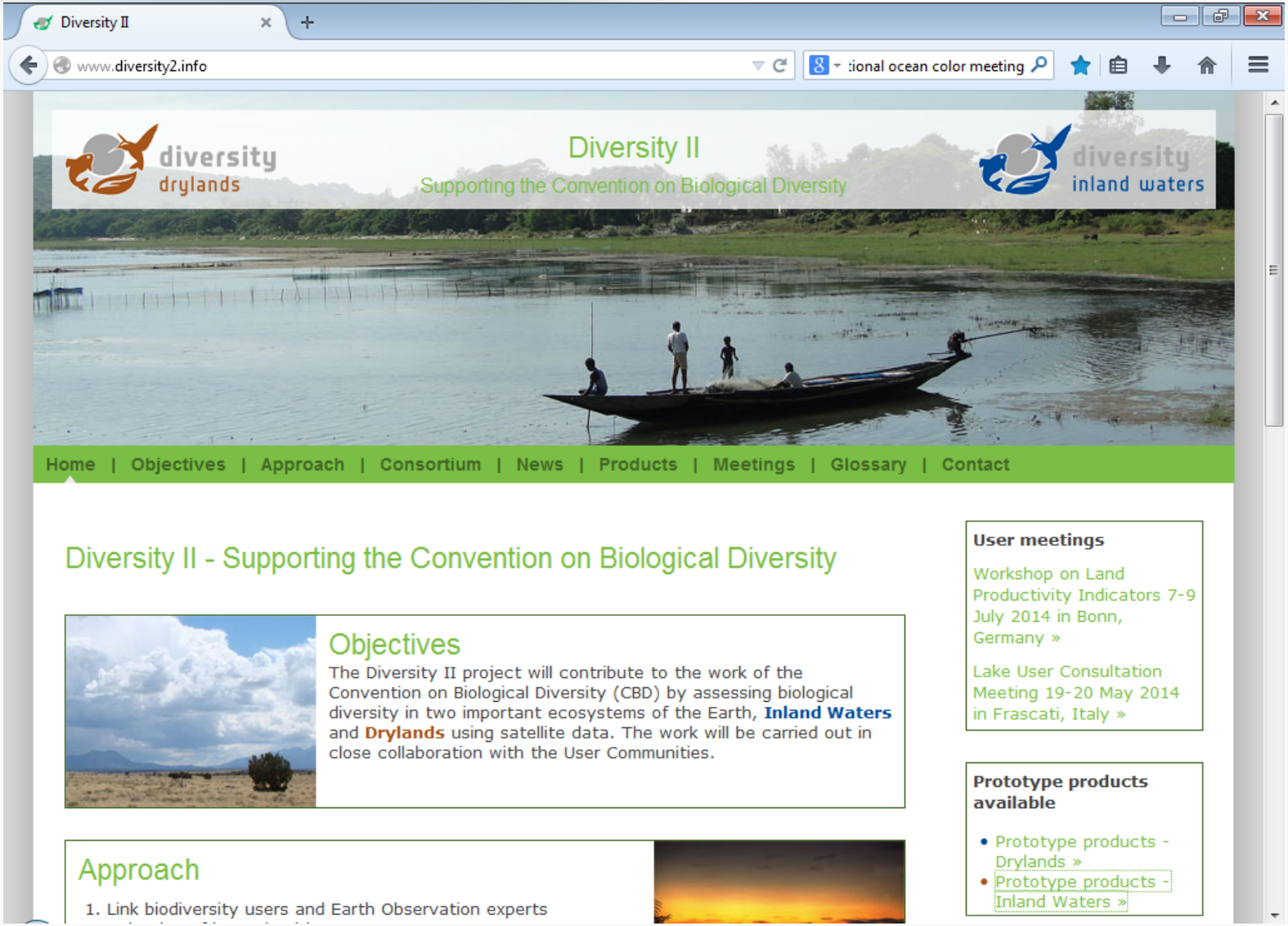
- San Francisco, USA, 16-18 June 2015
- Theme: *Applications of Ocean Colour from Climate to Water Quality*
- Aim of building a strong global user community for ocean colour science and applications



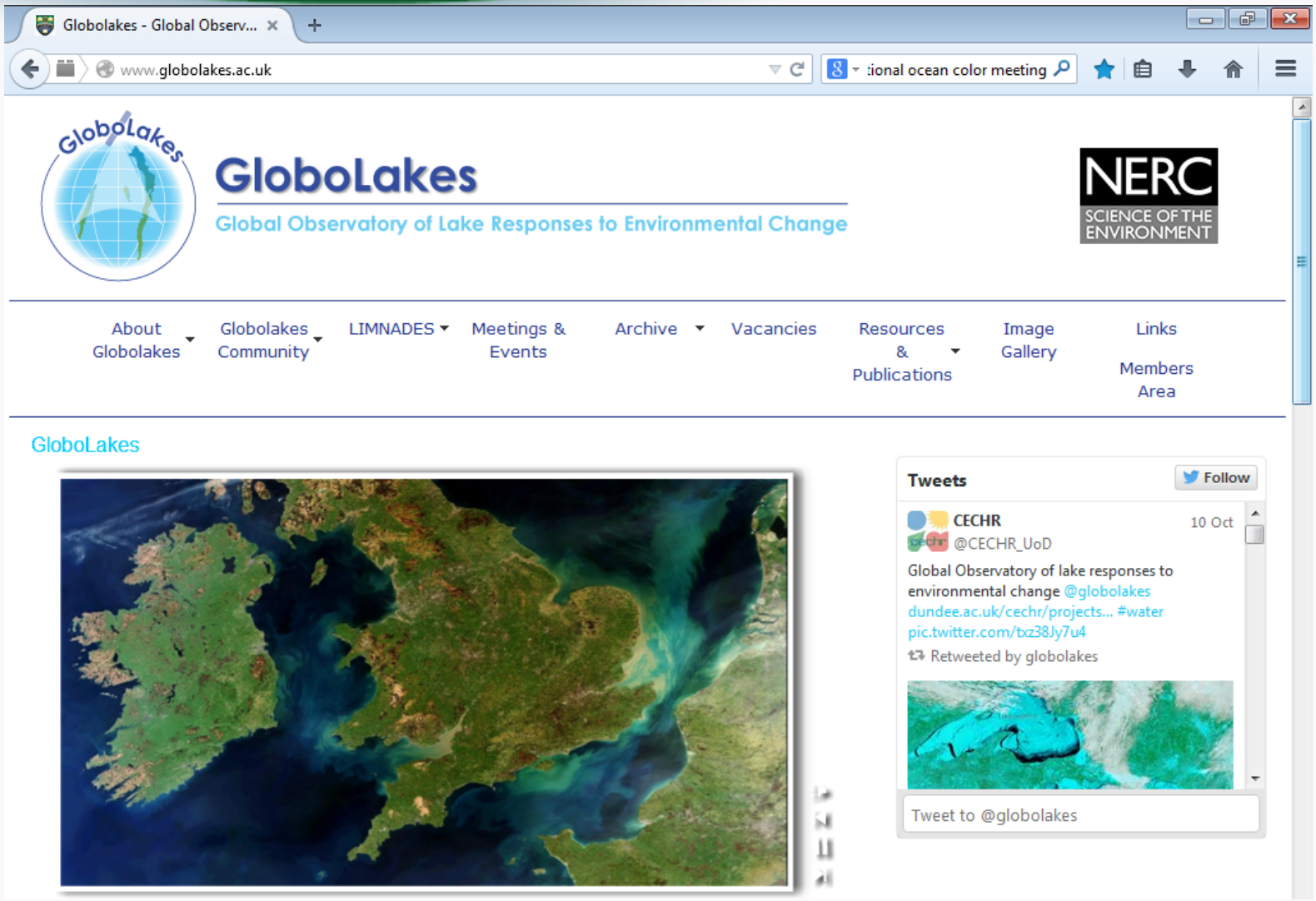
POC: Richard Stumpf



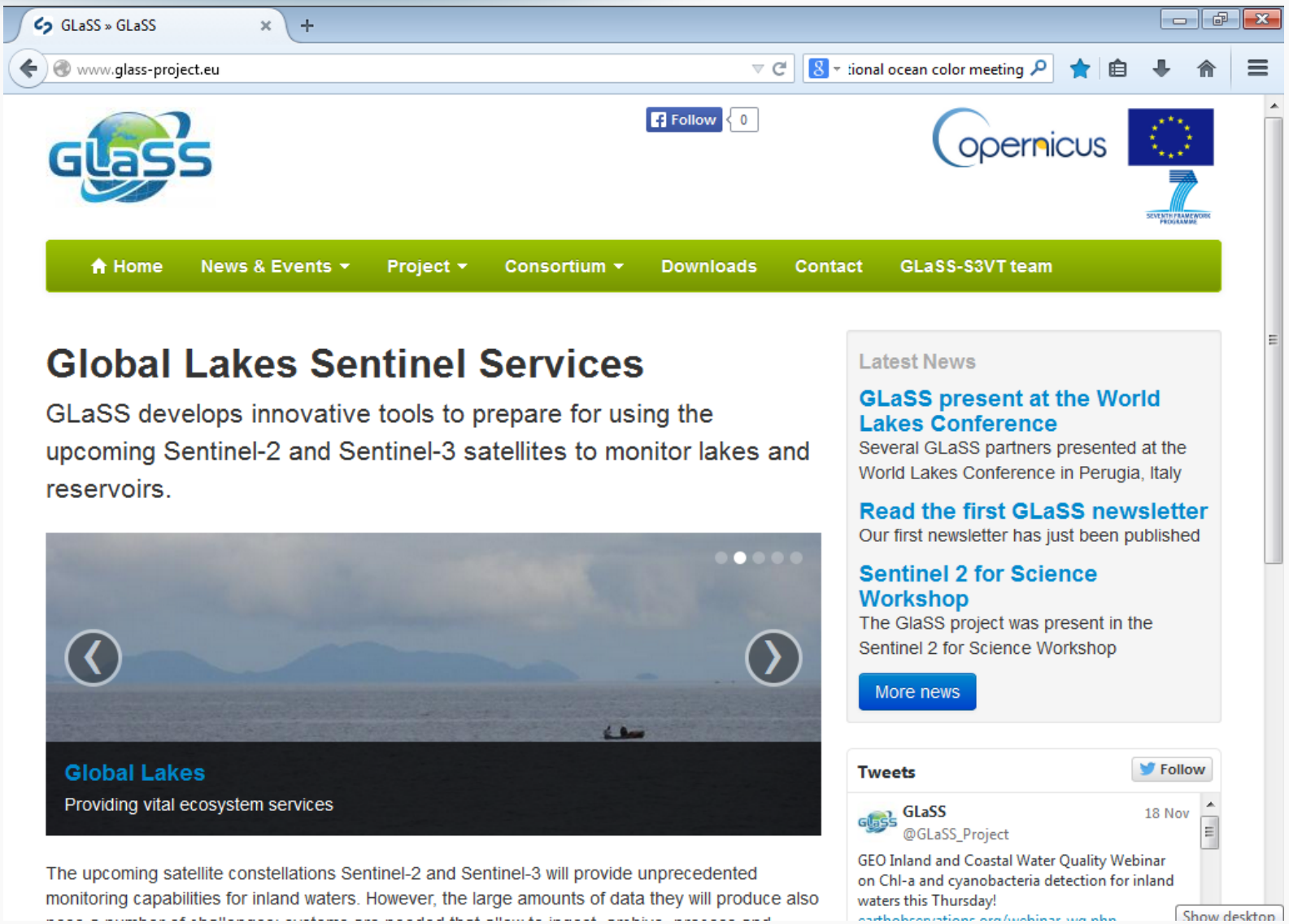
POC: Steve Greb



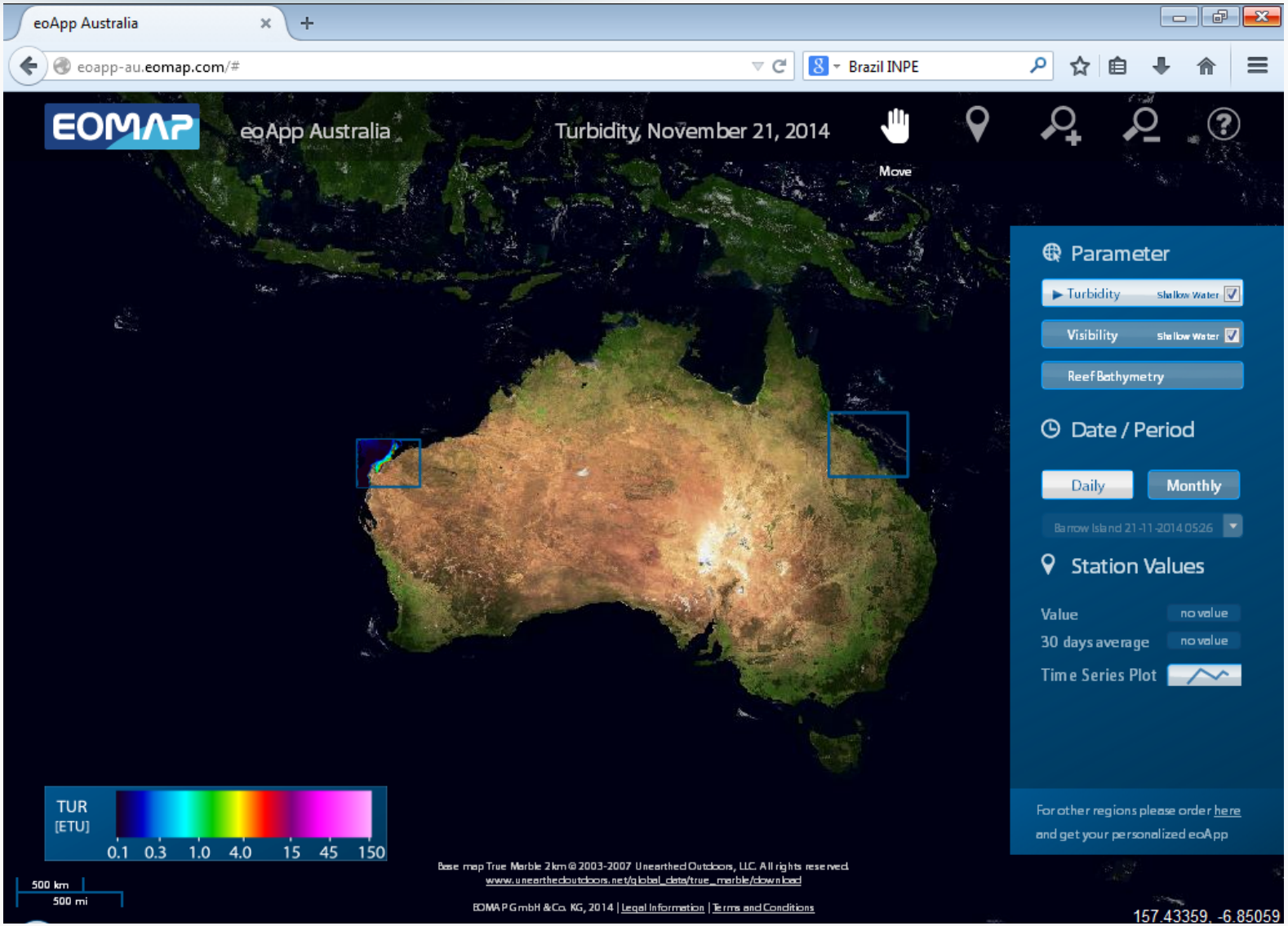
POC: Carsten Brockmann



POC: Andrew Tyler


GLaSS » GLaSS
www.glass-project.eu
tional ocean color meeting
Follow 0
GLaSS
Copernicus
Home
News & Events
Project
Consortium
Downloads
Contact
GLaSS-S3VT team
Global Lakes Sentinel Services
GLaSS develops innovative tools to prepare for using the upcoming Sentinel-2 and Sentinel-3 satellites to monitor lakes and reservoirs.
Global Lakes
Providing vital ecosystem services
The upcoming satellite constellations Sentinel-2 and Sentinel-3 will provide unprecedented monitoring capabilities for inland waters. However, the large amounts of data they will produce also
Latest News
GLaSS present at the World Lakes Conference
Several GLaSS partners presented at the World Lakes Conference in Perugia, Italy
Read the first GLaSS newsletter
Our first newsletter has just been published
Sentinel 2 for Science Workshop
The GlaSS project was present in the Sentinel 2 for Science Workshop
More news
Tweets
Follow
GLaSS
@GLaSS_Project
18 Nov
GEO Inland and Coastal Water Quality Webinar on Chl-a and cyanobacteria detection for inland waters this Thursday!
Show desktop

POC: Steward Bernard


eoApp Australia
eoapp-au.eomap.com/#
Brazil INPE
EOMAP
eoApp Australia
Turbidity, November 21, 2014
Move
Parameter
Turbidity
Shallow Water
Visibility
Shallow Water
Reef Bathymetry
Date / Period
Daily
Monthly
Barrow Island 21-11-2014 05:26
Station Values
Value
no value
30 days average
no value
Time Series Plot
For other regions please order here
and get your personalized eoApp
TUR
[ETU]
0.1 0.3 1.0 4.0 15 45 150
500 km
500 mi
Base map True Marble 2km © 2003-2007 Unearthed Outdoors, LLC. All rights reserved.
www.unearthedoutdoors.net/global_data/true_marble/download
EOMAP GmbH & Co. KG, 2014 | Legal Information | Terms and Conditions
157.43359, -6.85059

Advanced Nutrient Monito...

www2.epa.gov/water-research/advanced-nutrient-monitoring

EPA United States Environmental Protection Agency

Español | 中文: 繁體版 | 中文: 简体版 | Tiếng Việt | 한국어

Learn the Issues | Science & Technology | Laws & Regulations | About EPA

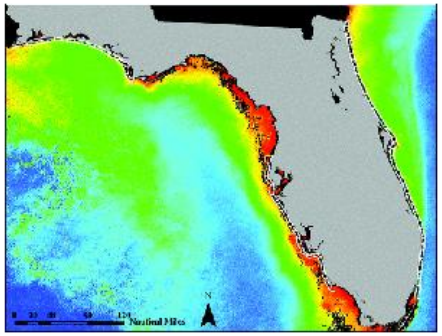
Search EPA.gov

Water Research

Contact Us Share

Advanced Nutrient Monitoring

New technologies are changing the way we monitor pollution levels in the environment. EPA is studying innovative technologies that will measure nutrient pollution in the air and water using satellites, portable and ground remote sensors as well as measurement and model data. These technologies enhance current monitoring activities and also provide cheaper and faster information on nutrients and other pollutants.



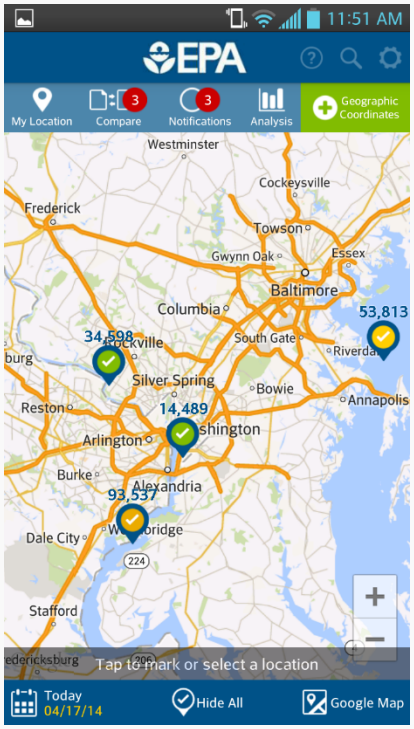
One such study conducted in 2011 focused on Florida's coastal waters. The purpose of the study was to evaluate the use of satellite measurements as a way to analyze water quality and to help regulators set standards for nutrient pollution.

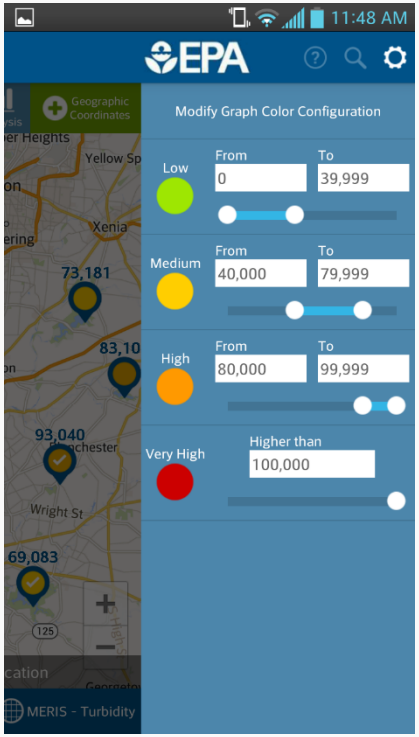
Nutrient pollution, excess nitrogen and phosphorous carried in runoff and other sources from land sparks excessive algal growth in many water bodies, and could also occur in coastal waters. Researchers used the SeaWiFS satellite to measure the amount of chlorophyll-a, a pigment present in algae, as a way of monitoring nutrient pollution in coastal water.

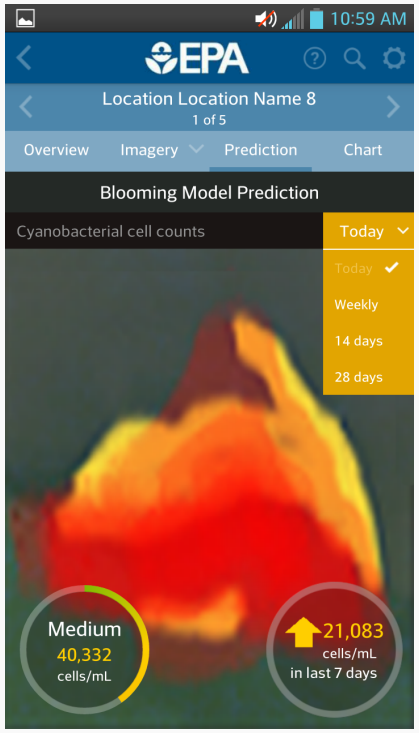
Researchers compared thirteen year's worth of data from the SeaWiFS satellite to measurements from field studies to see if the satellite's readings could be used to measure water quality. The study showed that this unique application of satellite data for monitoring water quality is effective and could be applied to other satellites and other coastal waters. For more information on this study, see the first link below.

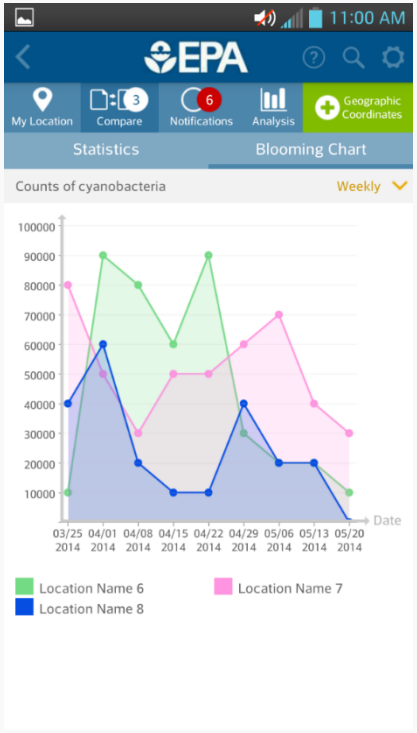
POC: Blake Schaeffer

Crowd Sourced CyAN Mobile Application

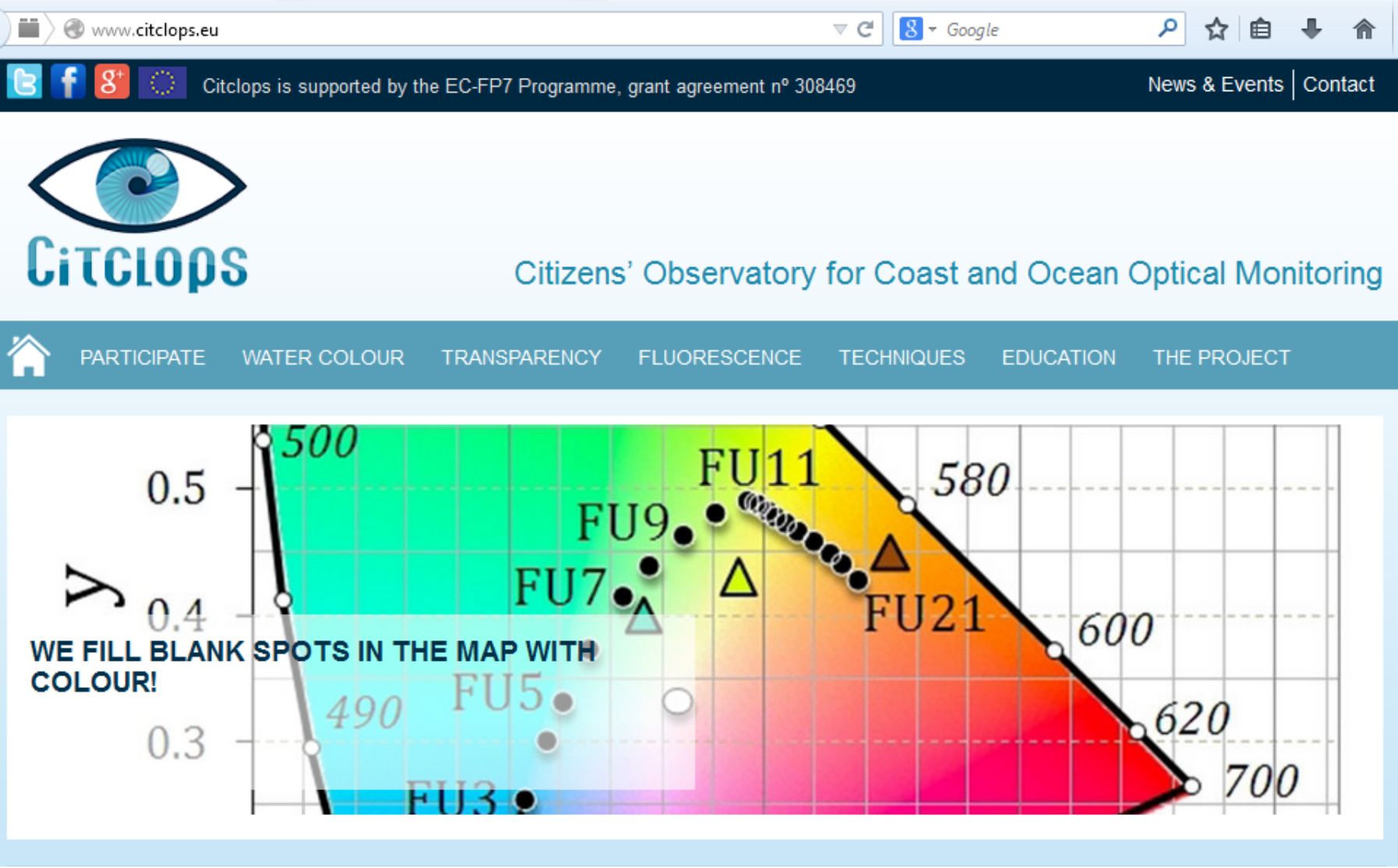








POC: Blake Schaeffer



POC: Julia Busch

POC: Thomas Leeuw

ARTICLE IN PRESS

RSE-09180; No of Pages 8

Remote Sensing of Environment xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Editorial

Remote sensing of inland waters: Challenges, progress and future directions

Stephanie C.J. Palmer [a], Tiit Kutser [b,*], Peter D. Hunter [c]

Balaton Limnological Institute, Hungarian Academy of Sciences Centre for Ecological Research, Klebelsberg K. u. 3, Tihany 8237, Hungary
Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallinn 12618, Estonia
Biological and Environmental Sciences, School of Natural Sciences, University of Stirling, Stirling FK9 4LA, UK

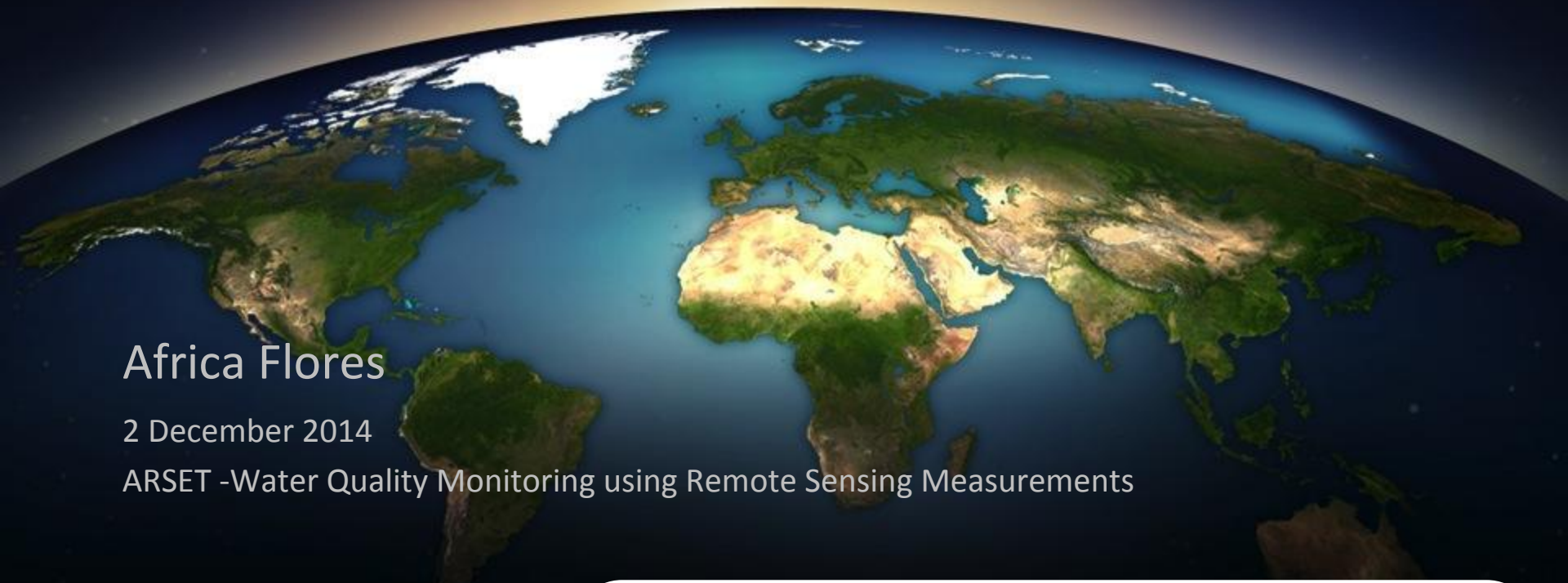
Contact Info

- Steward Bernard (sbernard@csir.co.za)
- Julia Busch (julia.busch@uni-Oldenburg.org)
- Carsten Brockmann(carsten.brockmann@brockmann-consult.de)
- Arnold Dekker (arnold.dekker@csiro.au)
- Paul DiGiacomo (paul.digiacomo@noaa.gov)
- Steve Greb (steven.greb@wisconsin.gov)
- Thomas Leeuw (tleeuw@sequoiasci.com)
- John Lehrter (lehrter.john@epa.gov)
- Blake Schaeffer (schaeffer.blake@epa.gov)
- Richard Stumpf (richard.stumpf@noaa.gov)
- Andrew Tyler (a.n.tyler@stir.ac.uk)

NASA SERVIR WQ Application
Case Study: Lake Atitlan
(Africa Flores)

SERVIR

Water Quality Applications

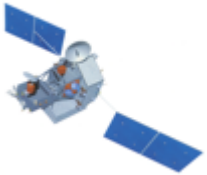


Africa Flores

2 December 2014

ARSET -Water Quality Monitoring using Remote Sensing Measurements

Outline



- SERVIR background
- Water quality monitoring using Remote sensing:
  - Lake Atitlan Case Study
  - Overview: Transition from a qualitative to a quantitative analysis using remote sensing measurements

SERVIR Hubs


NASA MSFC/SERVIR
Coordination Office
USAID Washington
NASA Headquarters
SERVIR-Himalaya
ICIMOD
SERVIR-Mesoamerica
CATHALAC
SERVIR-Eastern &
Southern Africa
RCMRD
SERVIR-Mekong
ADPC

Regions where we work

Lake Atitlan Case Study

Lake Atitlan

Qualitative Analysis

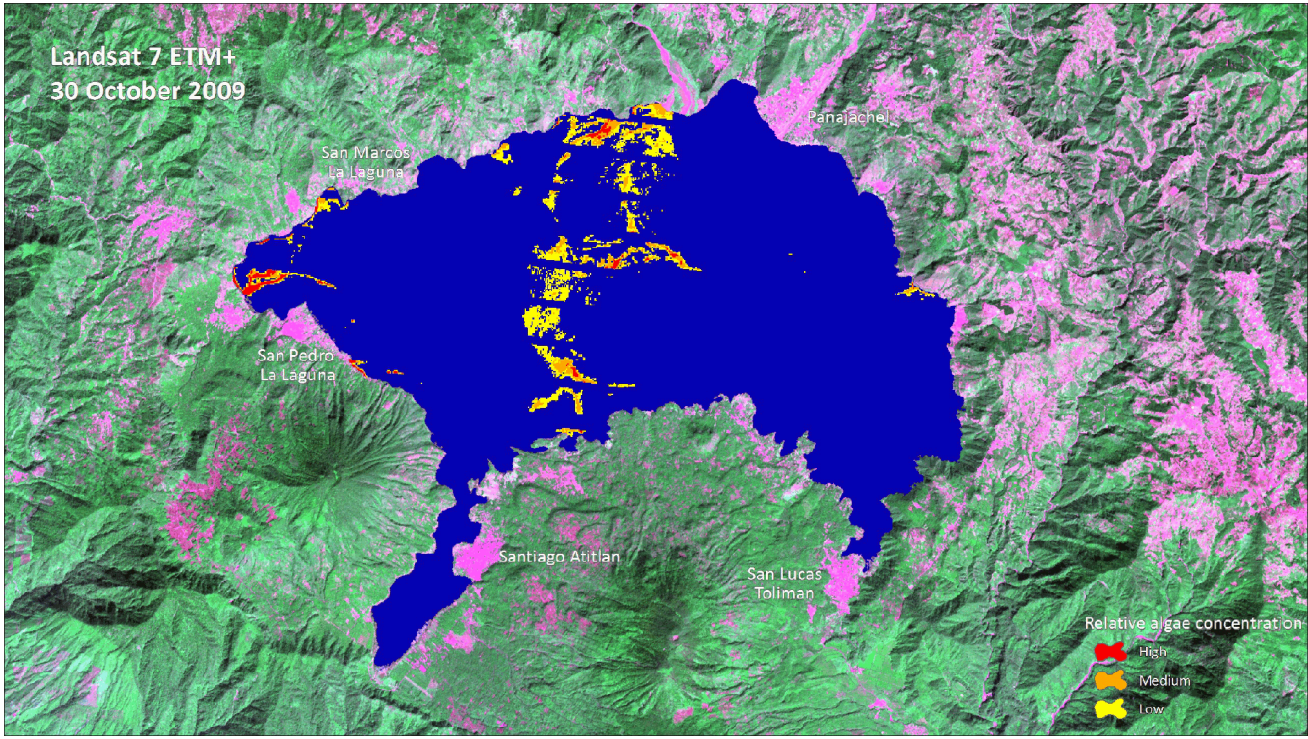
Lake's Atitlan Algal Bloom 2009

Some of the threats affecting Lake's Atitlan health include:

- Unsuitable agriculture and unplanned development in Atitlan's watershed
- Lack of sewage treatment plants
- Soil erosion and agrochemical runoff into the lake

Animation

Algal bloom identification using Red and NIR bands



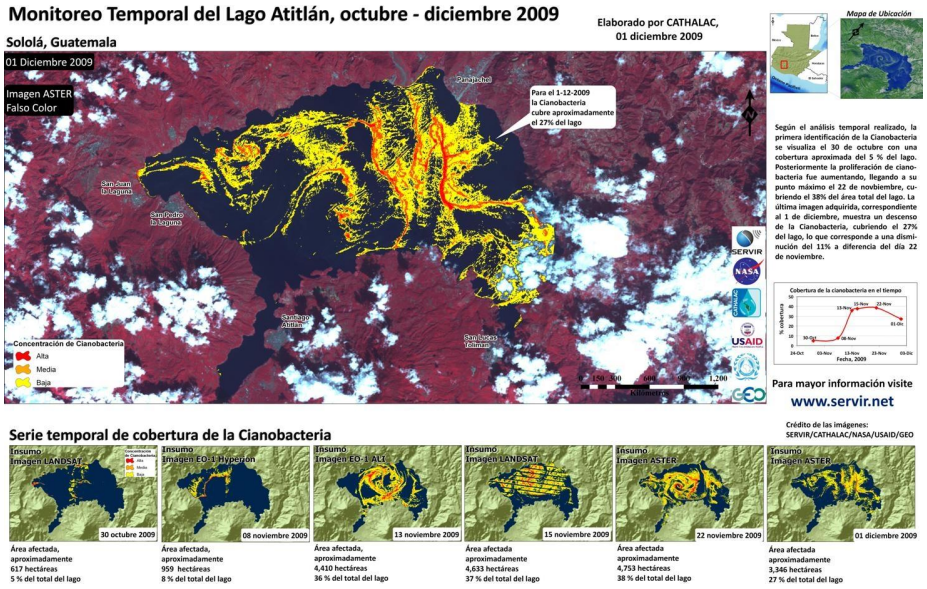
In October 2009 an algal bloom of Cyanobacteria started to develop in the lake.

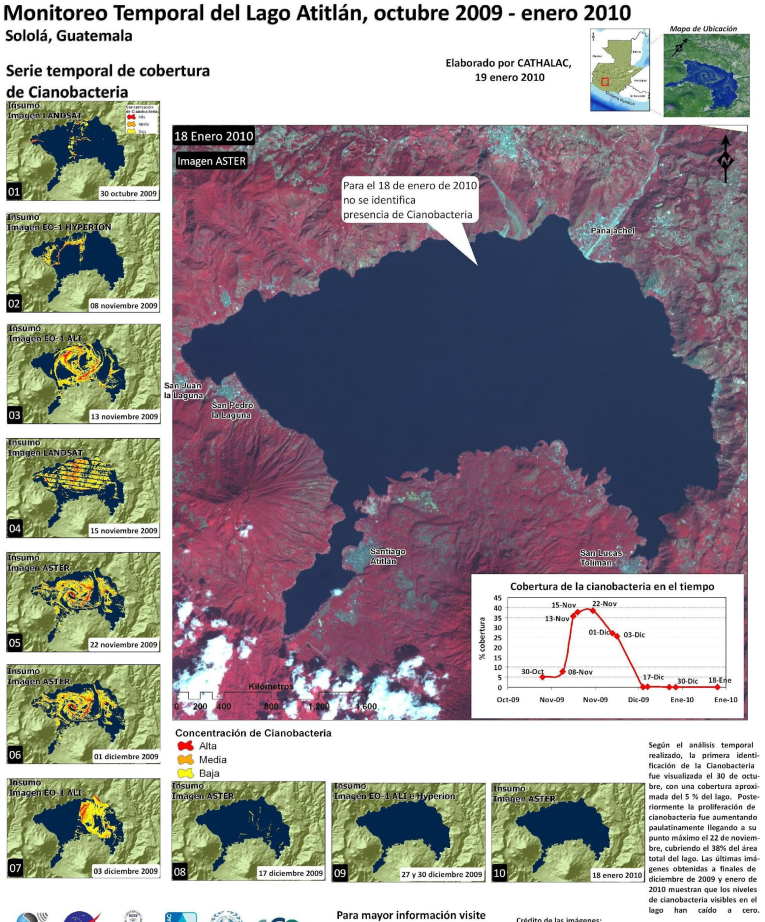
This sequence of images portrays the progress of the algal bloom in the lake from October 30 to the end of December 2009. In order to estimate the area covered by the algal bloom the red and near-infrared bands were used in the multispectral sensors Landsat ETM+, EO-1 ALI and Hyperion, and Terra-ASTER, to take advantage of vegetation's red edge.

Example of a qualitative analysis

Using multiple satellite sensors it was possible to monitor the progression of the algal bloom that affected Lake Atitlan in 2009.
Satellite imagery used:
Landsat ETM+, EO-1 Ali and Hyperion, ASTER

The algal bloom reached its peak in November 2009, covering about 40% of the lake's surface area. By the end of December 2009, the presence of algae on the surface of the lake had disappeared. Even though more recent algal blooms have occurred, the bloom of 2009 has been, so far, the largest recorded in Lake Atitlan.





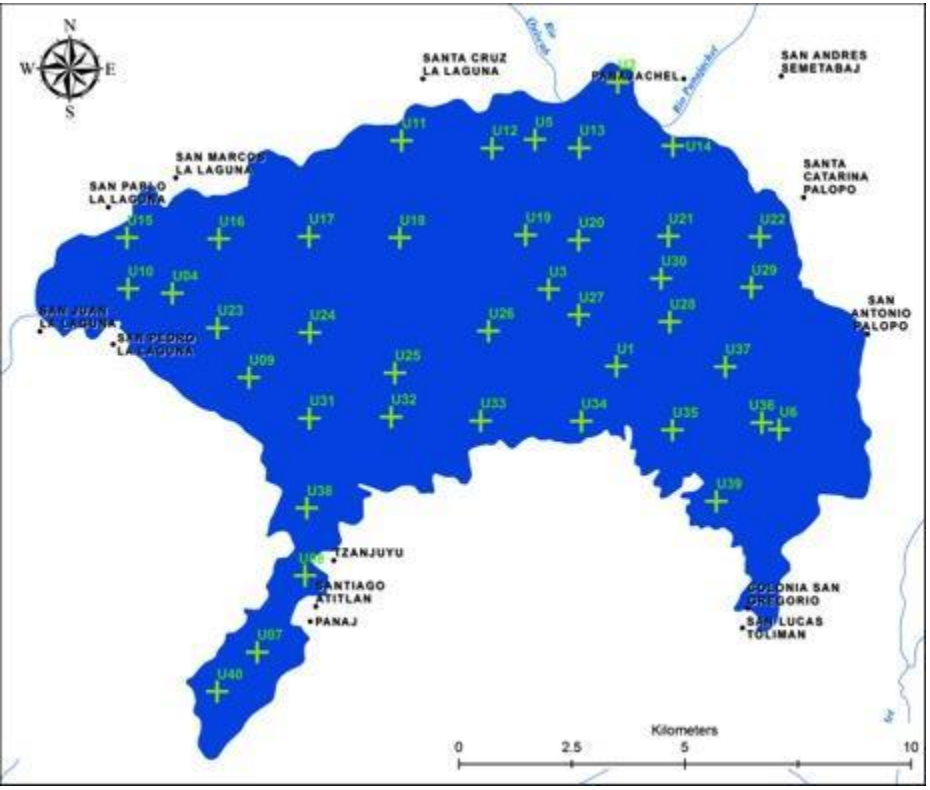
For more info:
https://servirglobal.net/Global/Articles/tabid/86/Article/867/satellite-based-lake-monitoring-in-guatemala.aspx

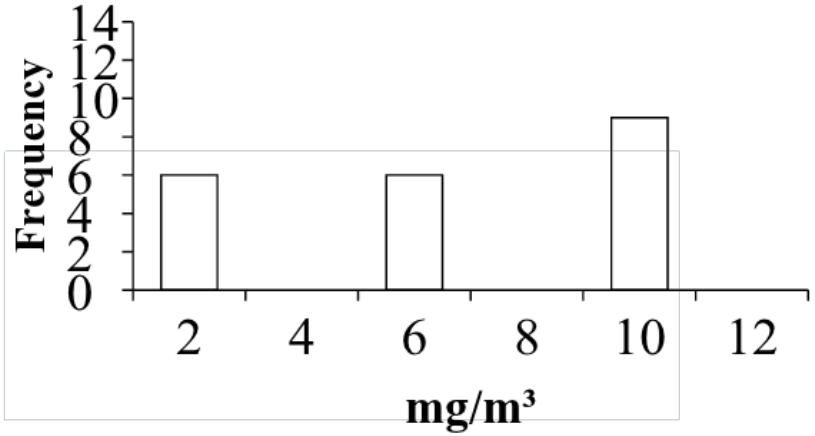
Next steps:
Quantitative Analysis

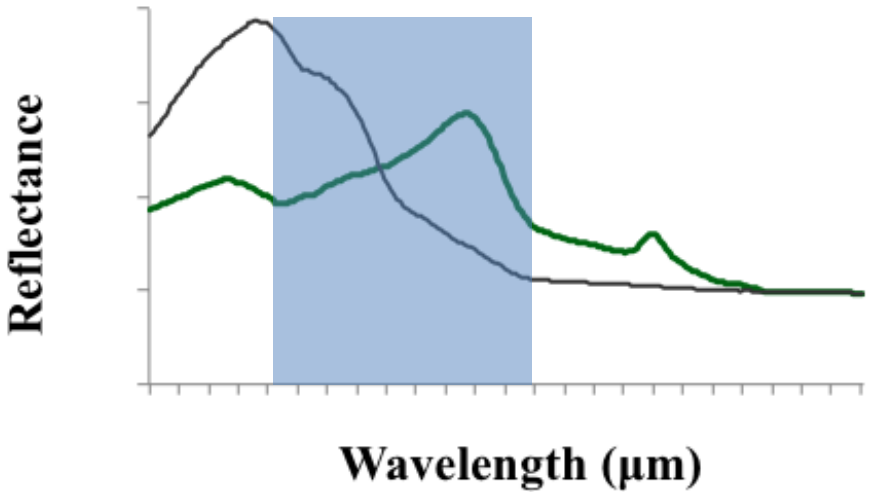
How to estimate *Chl-a* concentrations from remote sensing measurements?

In situ sampling was necessary to transition from a qualitative to a quantitative analysis using remote sensing

- Chl-*a* in situ samples
  - 1.0 – 10.9 mg/m³
  - Data collected during the dry season (Jan-Apr 2013)



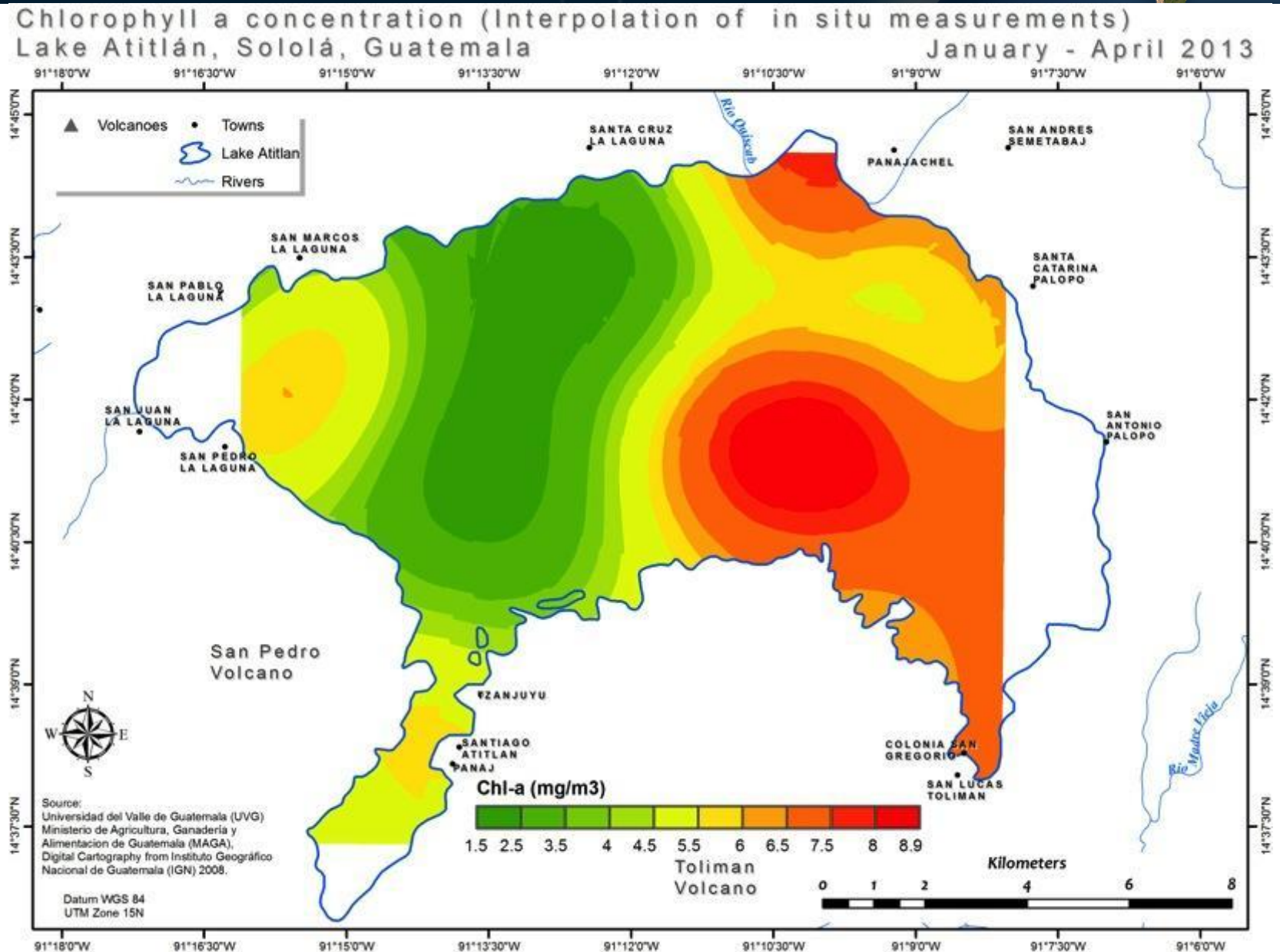




In situ sampling performed by Universidad del Valle and AMSCLAE

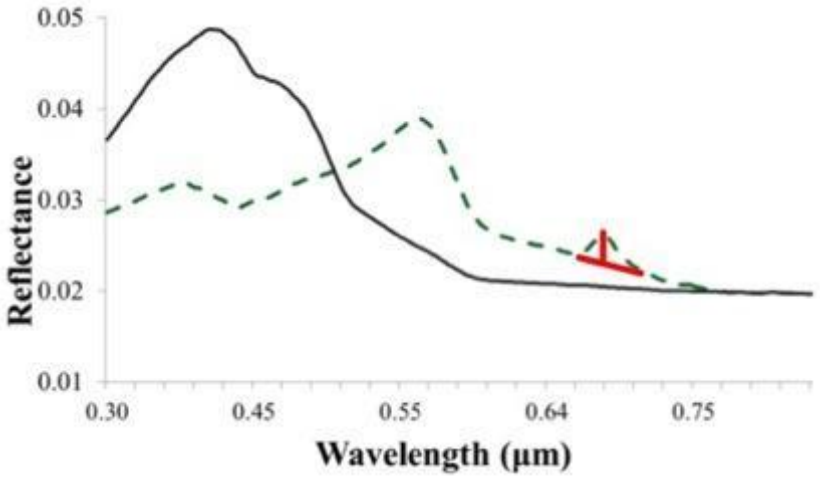
Quantitative Analysis

In situ data



Methods – Algorithms tested

- Blue/green band ratios
- Red/NIR band ratios
- Spectral shape (3-bands)



Example of algorithm to model Chl-a from remote sensing measurements:

Algorithm	Source
$X = \log_{10}\left(R\frac{443}{555}\right)$	O'Reilly 1998, Werdell & Bailey 2005

443 and 555 represent spectral bands

Algorithm development

Test band ratios and SS

- R^2
- Standard error of estimate

R^2 = 0.5-0.7 blue/green
0.2-0.3 red/NIR
0.3 -0.5 SS (685 nm)

Analysis of variance for blue/green

- Results are significant at level 0.01
- F-test

Selected band ratio

- **Polynomial**
- **Log(R467/R559)**

Summary

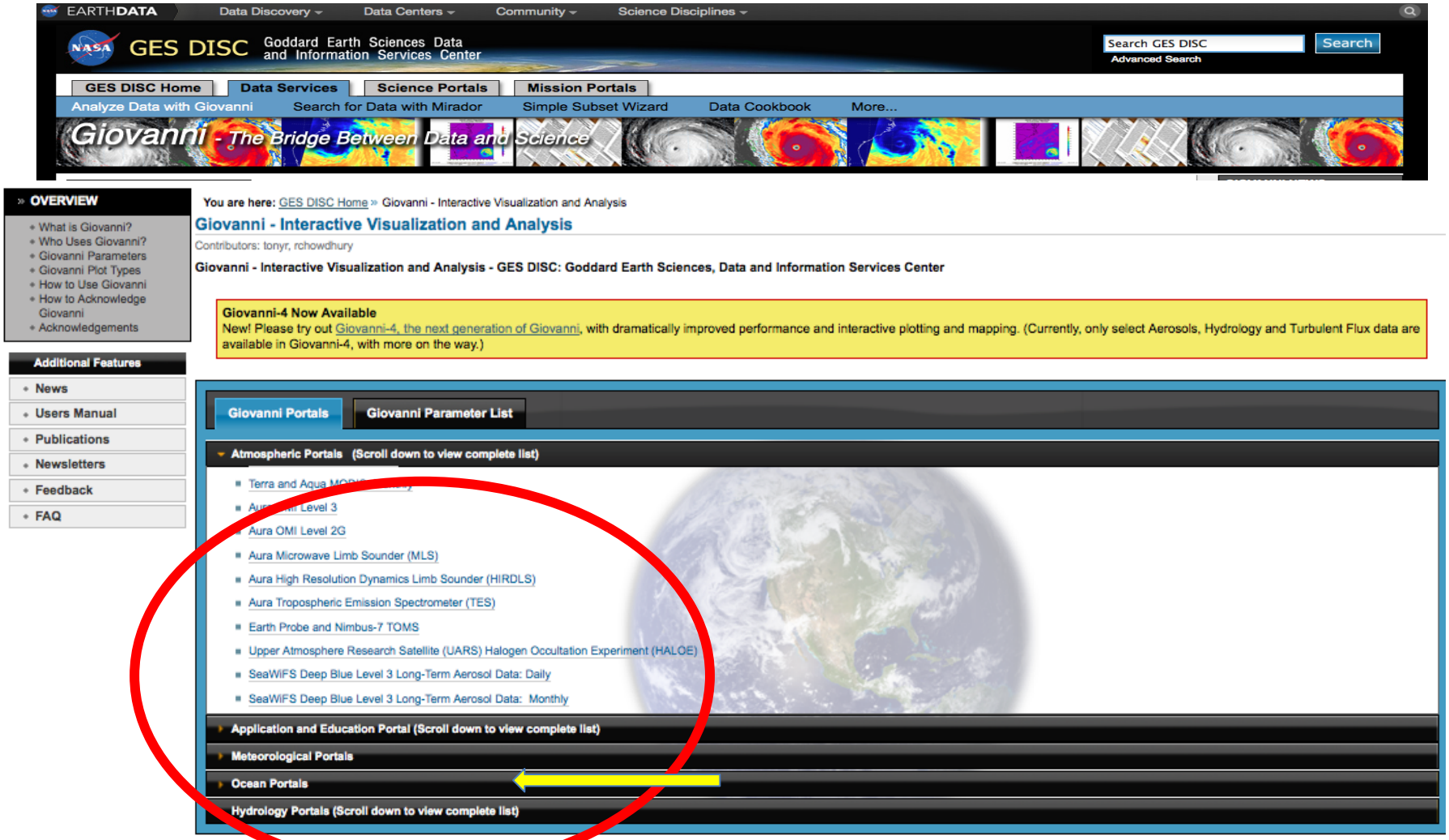
- Understand your area of study as much as possible
- Remote sensing measurements can be extremely valuable for water quality monitoring once their limitations are understood
- *In situ* observations are necessary in order to develop remote sensing-based algorithms to estimate quantitative WQ parameters
  - Keep in mind: conditions under which the *in situ* observations were obtained

Thank you!

MODIS and Landsat Data for Lake Victoria (Brock Blevins and Amita Mehta)

Water Quality Data from Giovanni

GES DISC: Goddard Earth Sciences, Data and Information Services Center
Interactive Visualization and Analysis
http://giovanni.gsfc.nasa.gov/

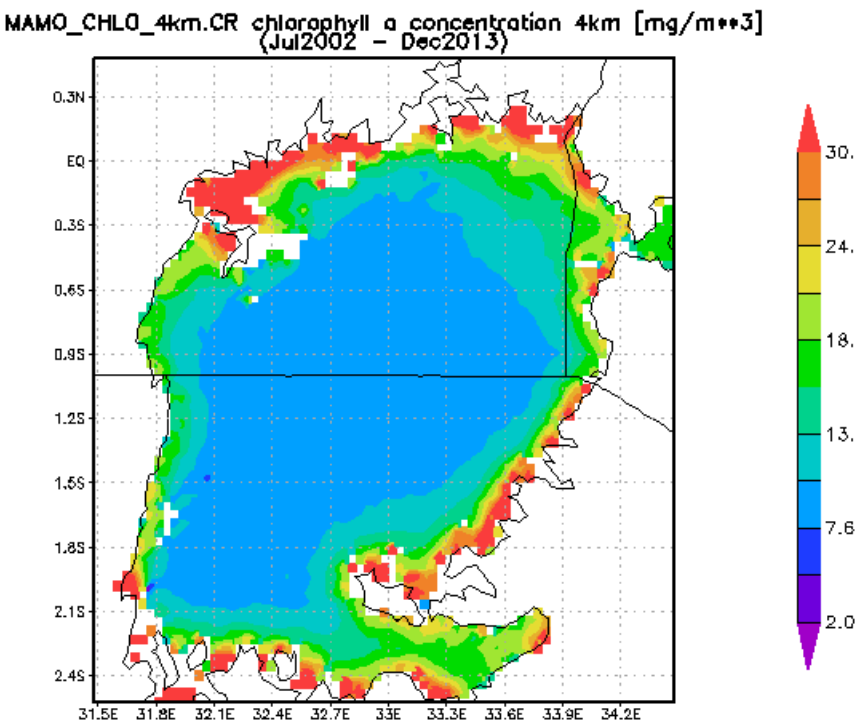


Data Portals

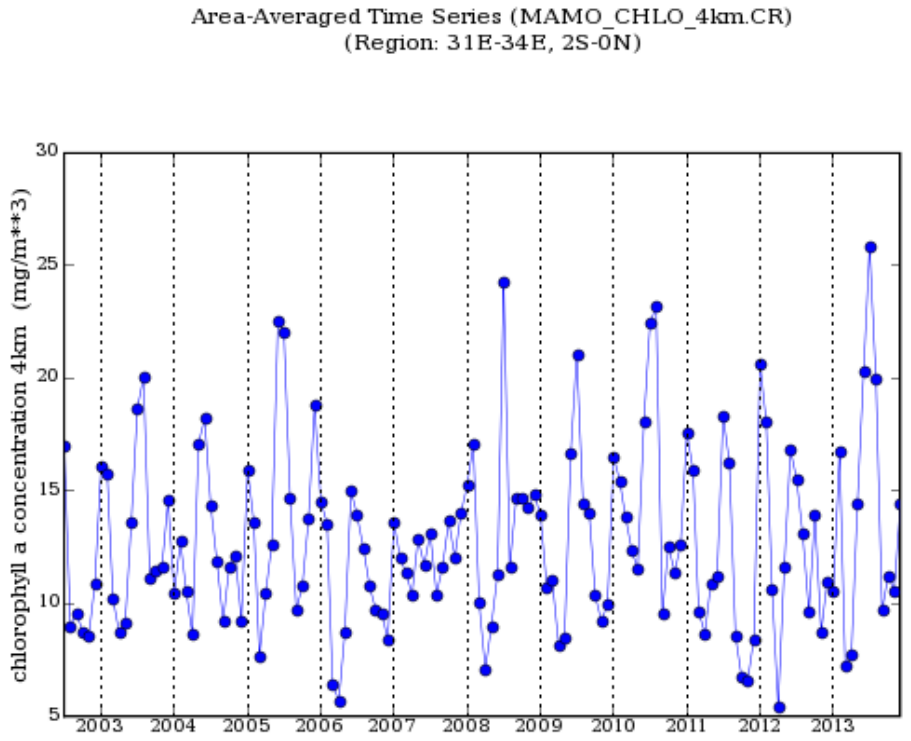
Chlorophyll Concentration (mg/m3) From Aqua MODIS L3 WQ Data

Long Term mean and Monthly Time Series over Lake Victoria Acquired by using Giovanni

Mean : July 2002-December 2013



Area-averaged Time series

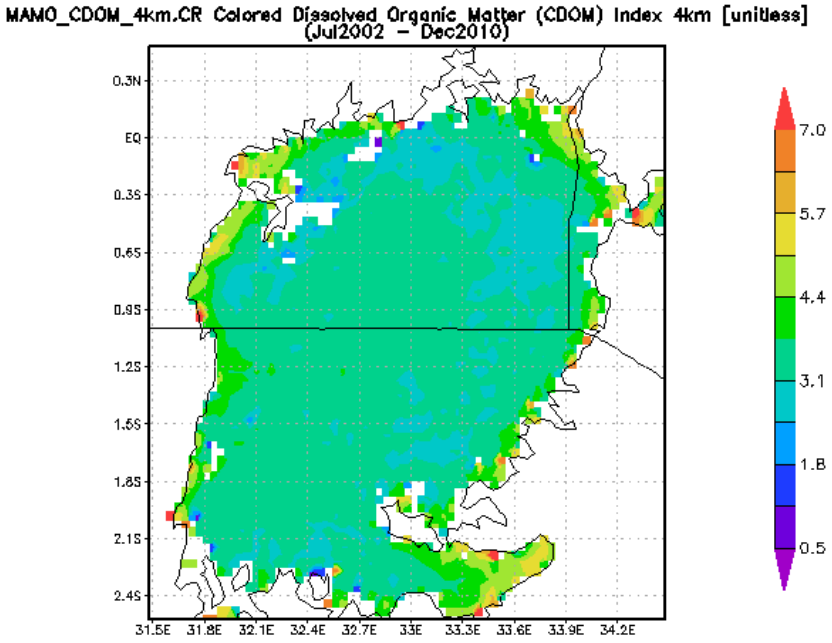


Substantial Seasonal to Inter-annual Variability

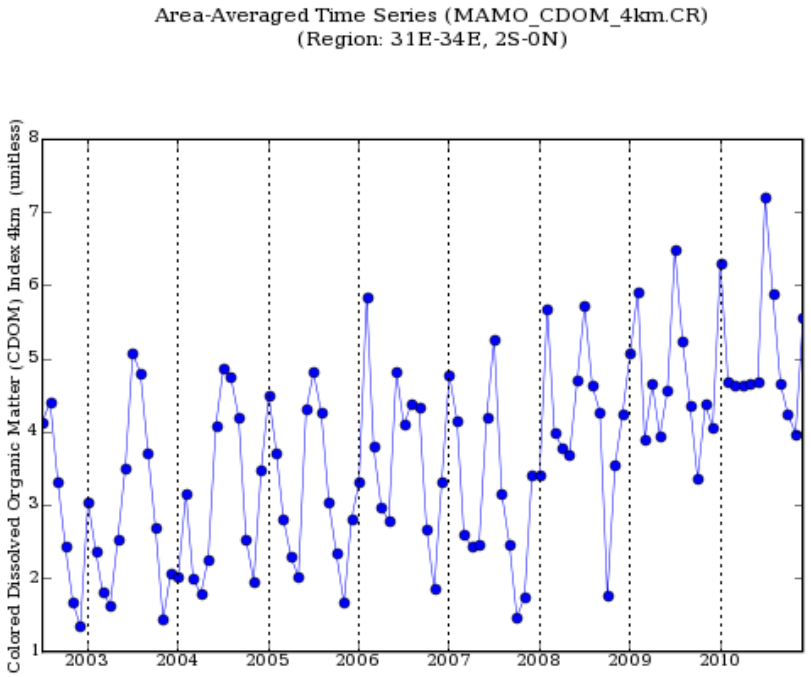
Colored Dissolved Organic Matter Index From Aqua MODIS L3 WQ Data

Long Term mean and Monthly Time Series over Lake Victoria Acquired by using Giovanni

Mean : July 2002-December 2013



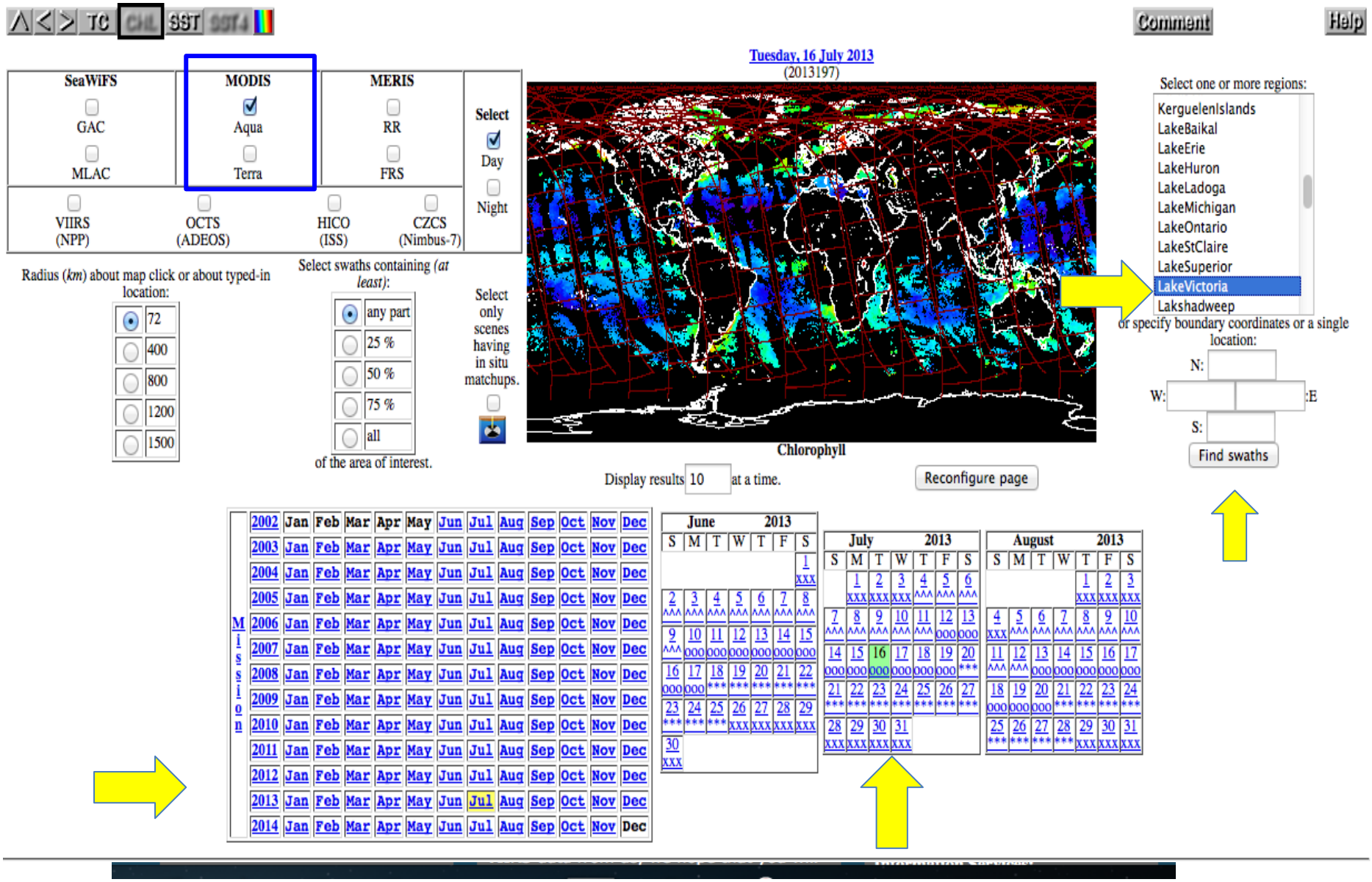
Area-averaged Time series



Increase in CDOM?

Chlorophyll Concentration Data from OceanColorWeb

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

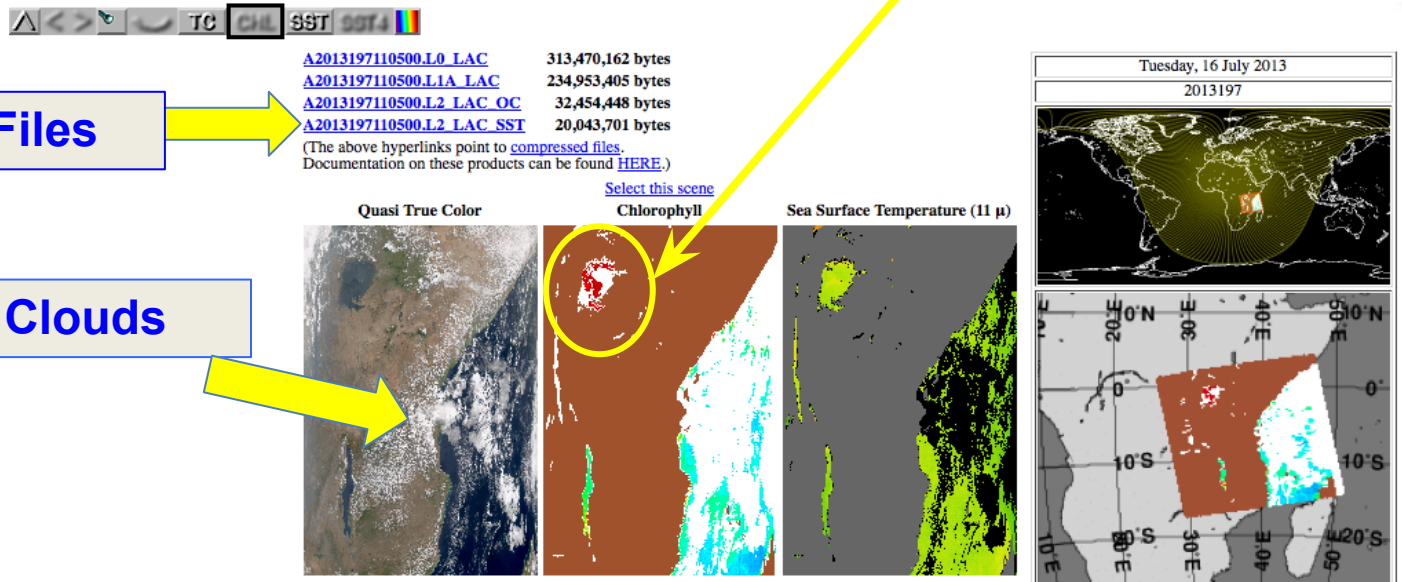


Chlorophyll Concentration From Aqua MODIS

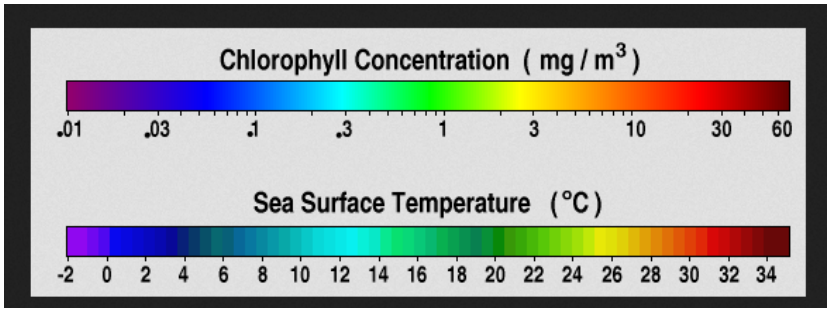
Daily Swath Data Over Lake Victoria Acquired by using OcenColorWeb

Data Files

Clouds



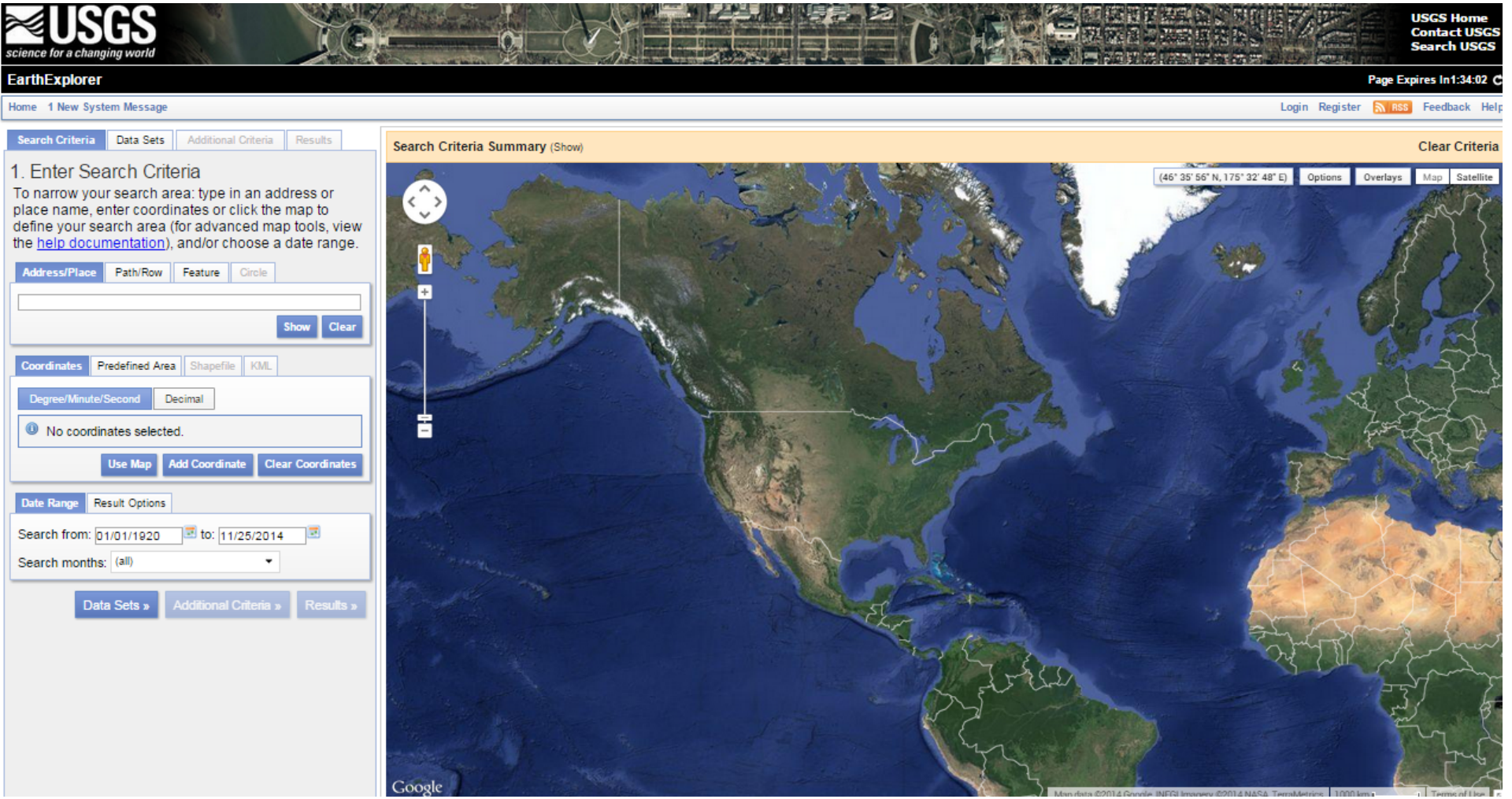
July 16, 2013



Landsat Data for Lake Victoria
EarthExplorer Demo

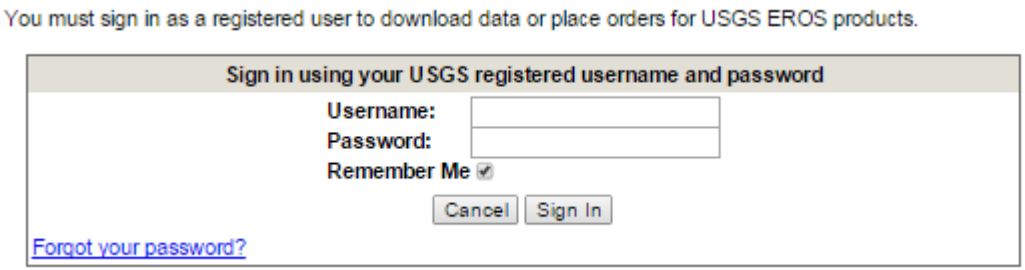
EarthExplorer

http://earthexplorer.usgs.gov/



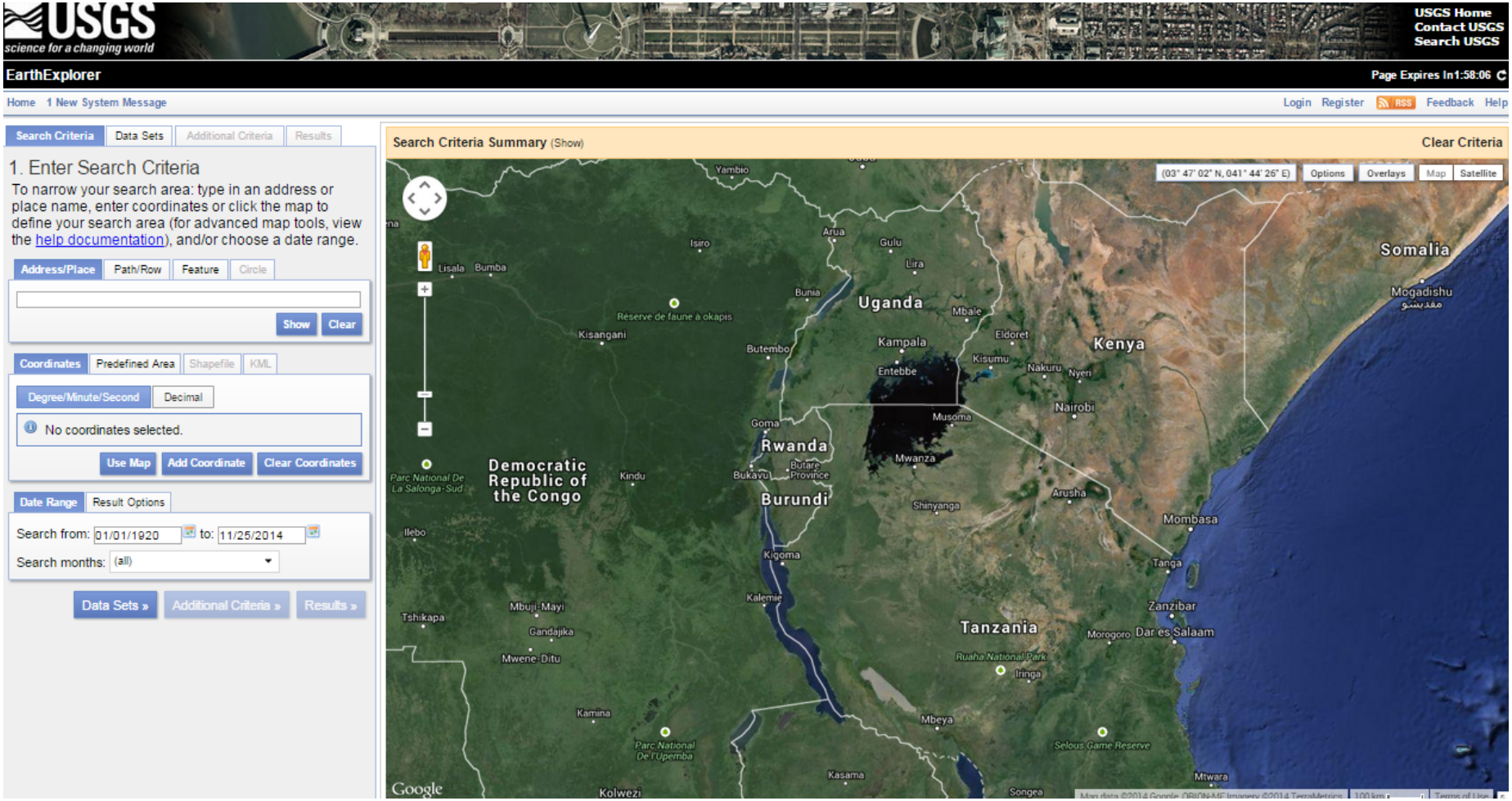
EarthExplorer

http://earthexplorer.usgs.gov/

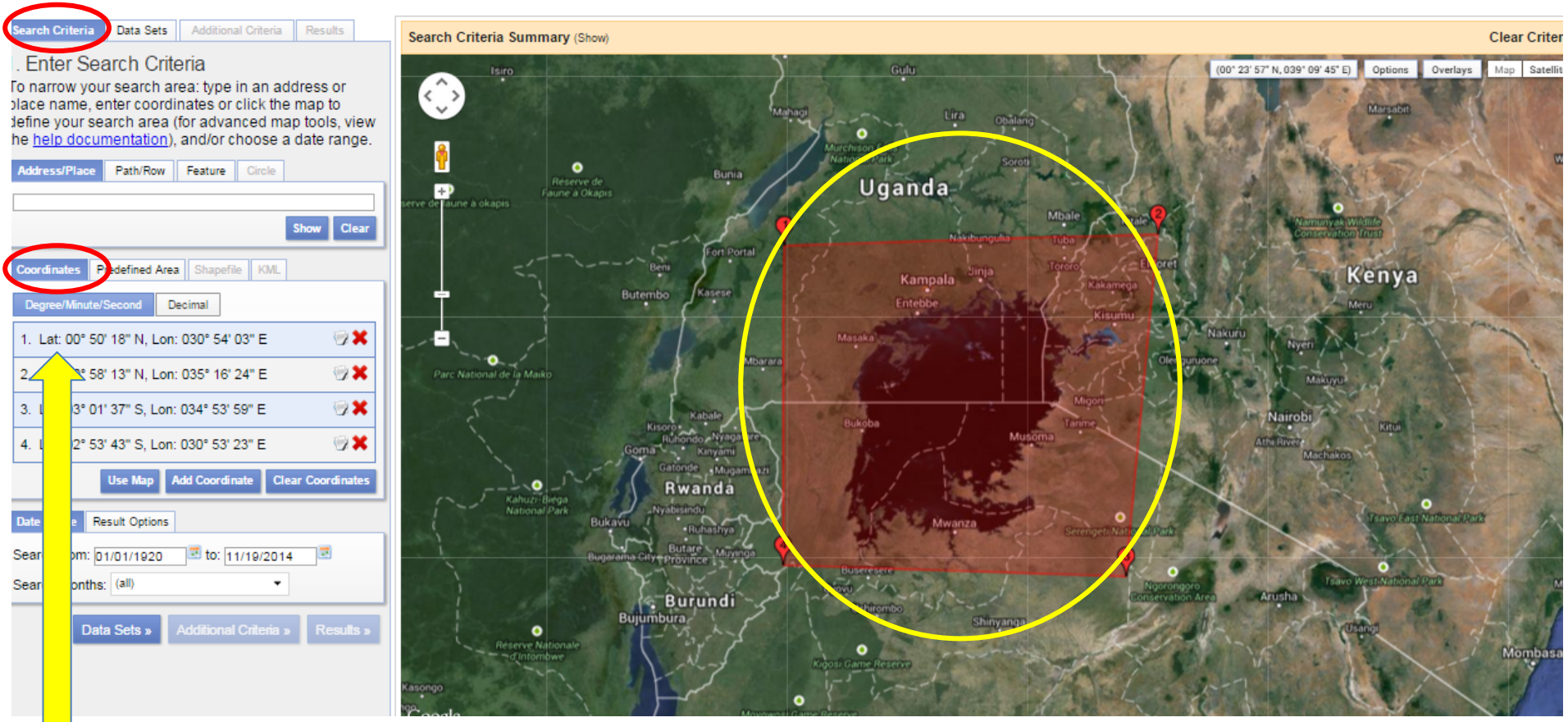


In order to obtain data from EarthExplorer, you must first register and login.

Acquiring Landsat Images



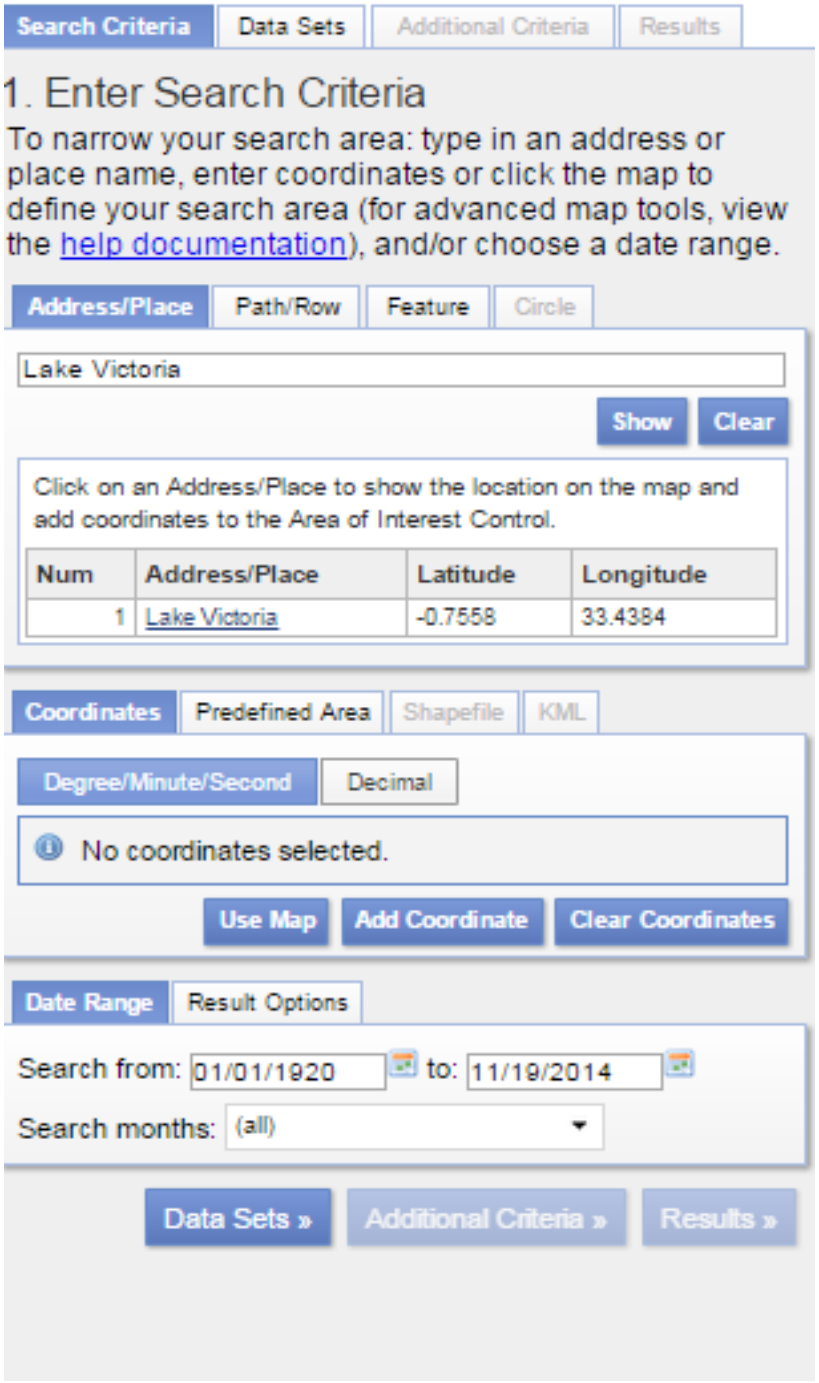
The interactive map interface allows you to span the globe and zoom to your region of interest.

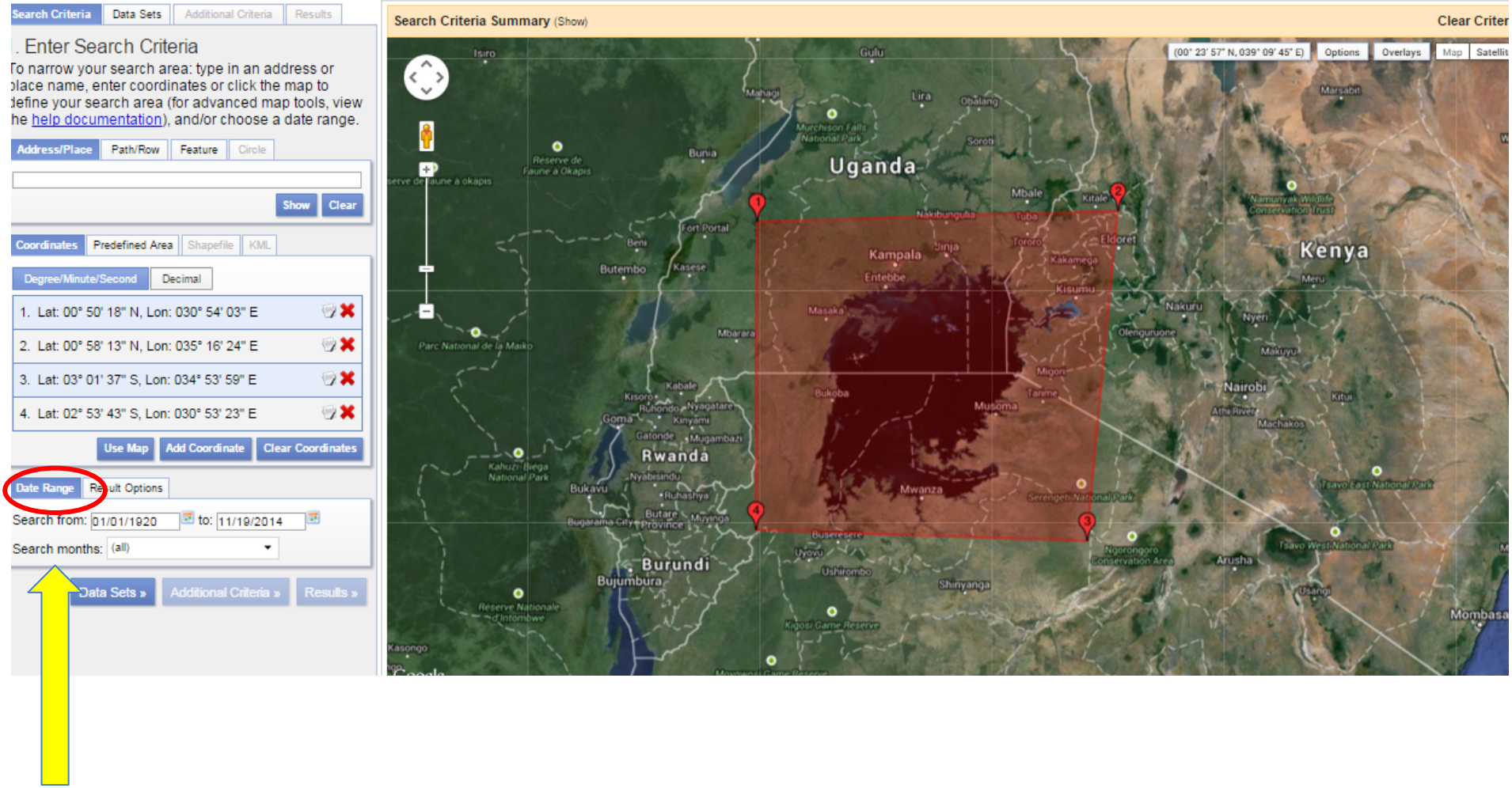


Setting your Search Criteria Location:

Select your region of interest by enabling the Coordinates tab and creating a polygon by clicking 4 points on the map

Alternatively, you can search the database for common global features, in this case, Lake Victoria, Uganda/Tanzania, Africa.





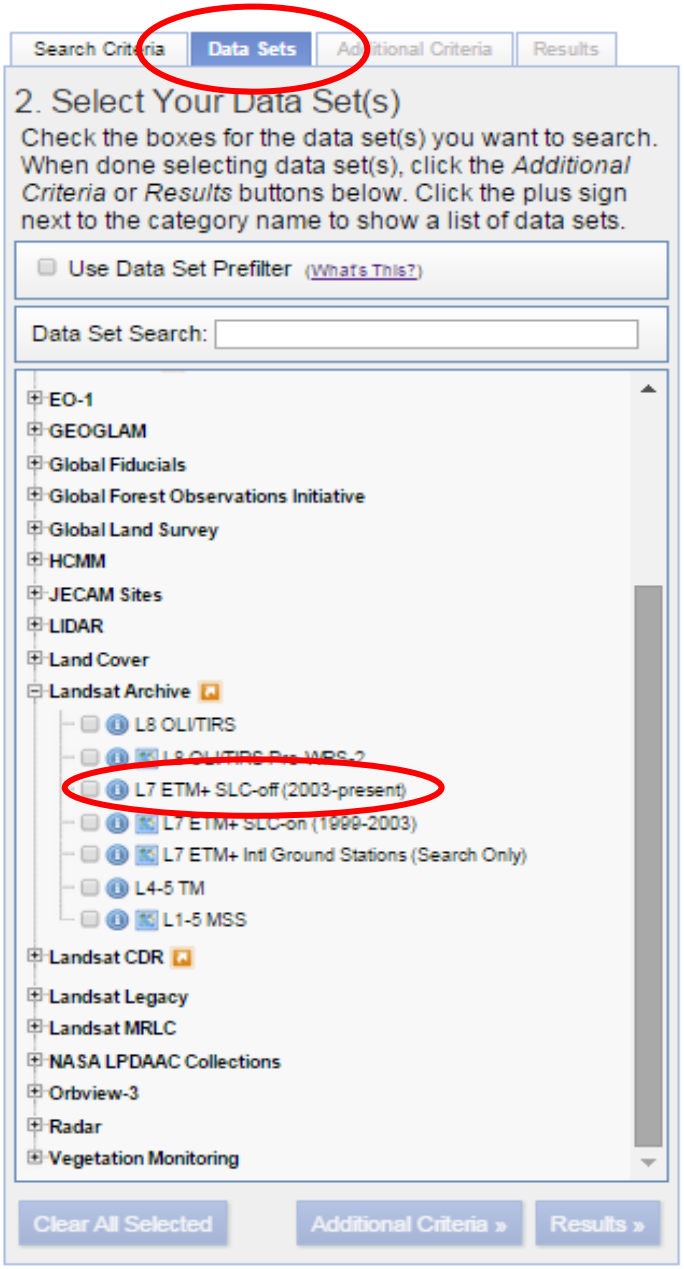
Setting your Search Criteria Date Range:
Type or use the calendar to select the date range of interest

Open the Data Sets Tab

Expand the Landsat Archive

Select the Landsat data product of choice

Here we are selecting Landsat 7 ETM+ SLC-off (2003-present)



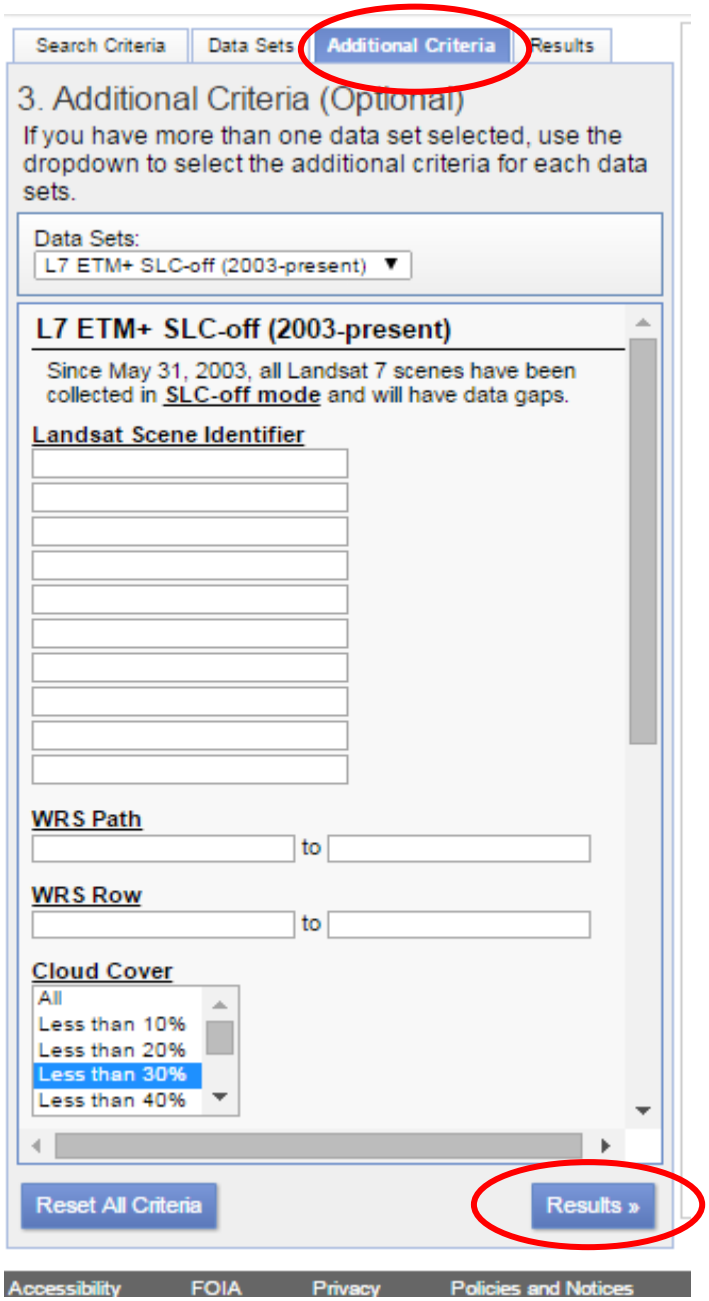
Open the Additional Criteria Tab (Optional)

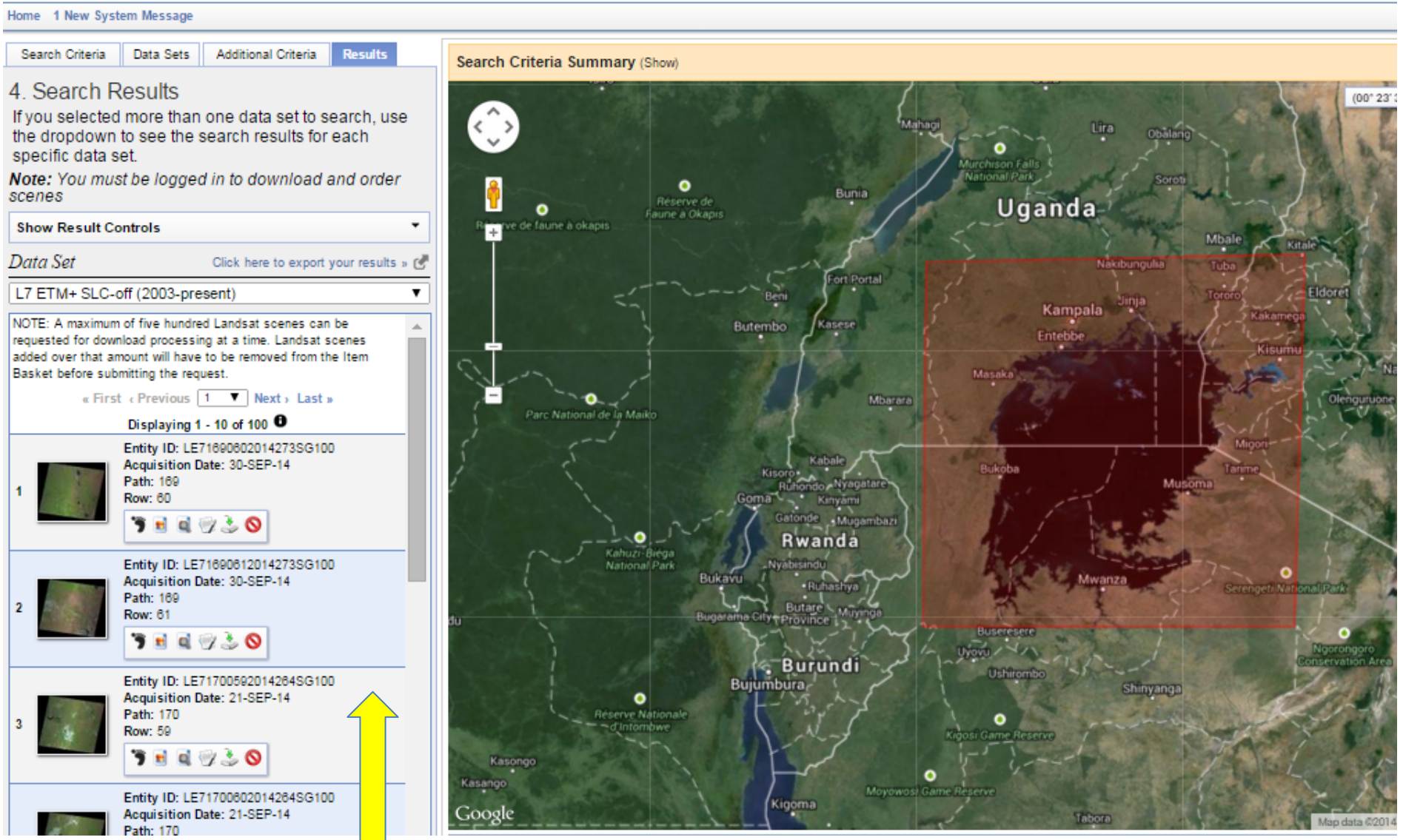
You may select specific path and row combinations to include in the search criteria

or

Choose to refine the results to only include scenes with Less than % Cloud Cover

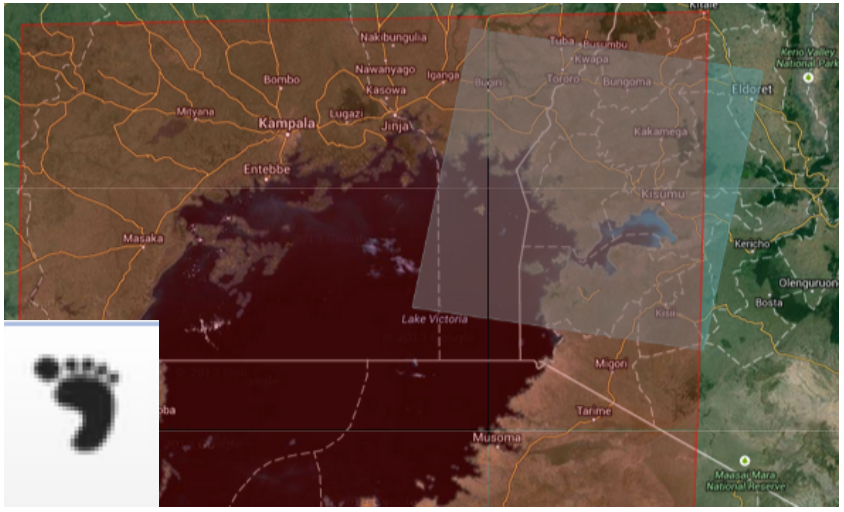
Click Results



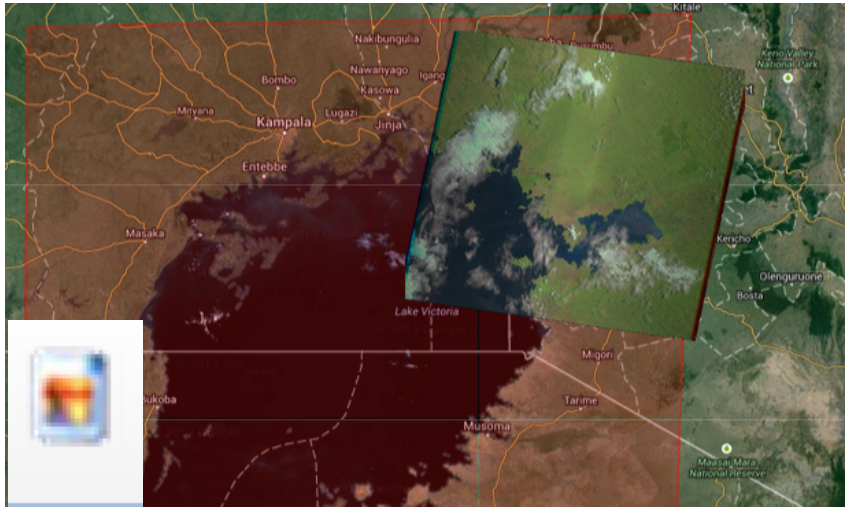


Results will gather and display on the left and display resulting scenes retrieved.

Each result has controls that allows one to:



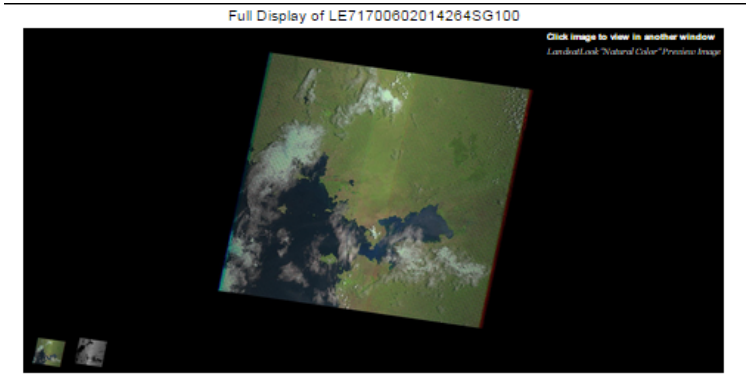
A. Observe the footprint of the Landsat scene result



B. Observe the Landsat scene in true color

Additionally, you can choose to browse multiple results at once

Review the metadata

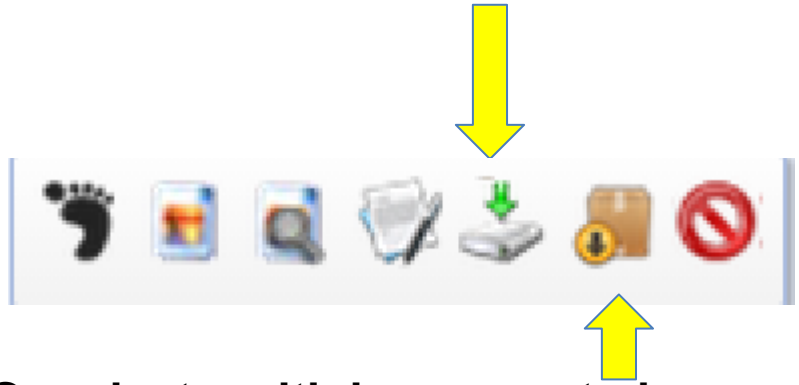


Data Set Attribute	Attribute Value
Landsat Scene Identifier	LE71700602014264SG100
Sensor Mode	BUMPER
Station Identifier	SG1
Day/Night	DAY
WRS Path	170
WRS Row	060
Date Acquired	2014/09/21
Start Time	2014:264:07:52:39.0774999
Stop Time	2014:264:07:53:05.8316249
Image Quality VCID 1	9
Image Quality VCID 2	9
Processing Software Version	LPGS_12.5.0
Calibration Parameter File	L7CPF20140701_20140930.06
Cloud Cover	21.59
Cloud Cover Quad Upper Left	29.45
Cloud Cover Quad Upper Right	3.05
Cloud Cover Quad Lower Left	33.28
Cloud Cover Quad Lower Right	20.80
Sun Elevation	64.25275421
Data Type Level 1	ETM+ L1T
Sun Azimuth	88.39611053
Full Aperture Calibration	N
Gain Band 1	L
Gain Band 2	L
Gain Band 3	L
Gain Band 4	L
Gain Band 5	L
Gain Band 6 VCID 1	L

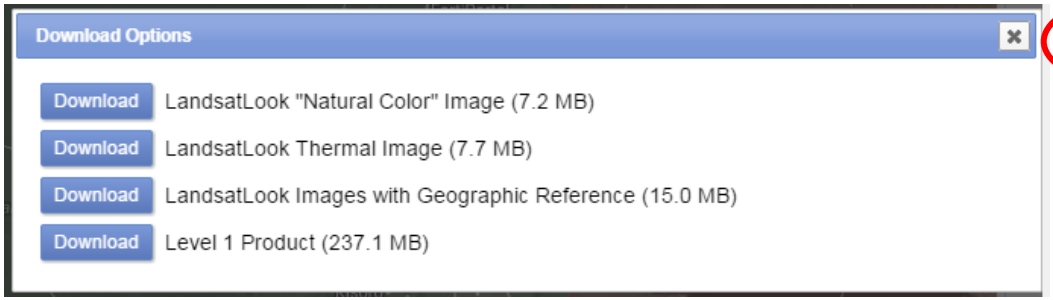
Metadata

These options allow you to be sure you are selecting the correct Landsat scenes to eventually download (by date and geographic extent).

You may download one scene



Or select multiple scenes to be placed in a Bulk Download Order (will be placed in your Item Basket)



Download Options:

LandsatLook "Natural Color" Image (7.2 MB)

LandsatLook Thermal Image (7.7 MB)

LandsatLook Images with Geographic Reference (15.0 MB)

Level 1 Product (237.1 MB)

To acquire all Landsat bands, choose the Level 1 Product. Level 1 Product links are delivered in an email after placing the order in the "Item Basket"

The data will be delivered in a zipped tar.gz format

Summary

This webinar introduced satellite remote sensing observations useful for Water Quality monitoring

- Water Quality parameters (e.g. Chlorophyll Concentration, Colored Dissolved Organic Matter Index, Euphotic Depth, Temperature, Spectral Reflectances) are available since June 2002 to present from:
  Aqua MODIS L3 data gridded at 4 km and 9 km (from Giovanni)
  Terra and Aqua MODIS L2 swath data at 1 km (from OceanColorWeb)
  NPP/VIIRS Chlorophyll Concentration L2 swath at 750 m (from NOAA STAR)

- Qualitative information about Water Quality properties can be obtained from Landsat/TM,ETM+ and OLI imagery (1972 to present from USGS EarthExplorer, LandsatLook, GloVis) but further processing and algorithm development have to be carried out regionally for more quantitative information from Landsat sensors

- Remote sensing observations are used in Water Quality research and applications for regional decision support activities for in-land lakes, estuaries, and coastal oceans

Summary

This webinar introduced satellite remote sensing observations useful for Water Quality monitoring

- Past Water Quality parameters are available from (Orbview/SeaWIFFS, and ENVSAT/MERIS) from OceanColorWeb (1997 to 2012)
- Water Quality properties can be derived from Imagery and spectral reflectance data from experimental, hyper-spectral data from EO1-Hyperion and HICO available upon request from USGS/EarthExplorer and Oregon State University respectively
- Water Quality parameters from NASA Ocean Biogeochemical Model (NOBM) data are available from Giovanni
- **In situ measurements are critical in addition to the remote sensing observations to derive and validate Water Quality parameters**

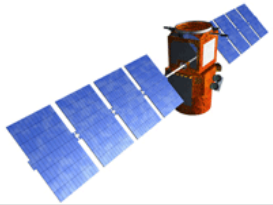
Remote Sensing Observations: Trade Offs

- It is very difficult to obtain extremely high spectral, spatial, temporal and radiometric resolution at the same time
- Several sensors can obtain global coverage every one to two days because of their wide swath width (Terra/Aqua)
- Higher spatial resolution polar orbiting satellites may take 8 – 16 days to attain global coverage (Landsat, EO-1)
- Multiple sources and large amount of data with varying formats
- Data applications may require additional *in situ* measurements and processing

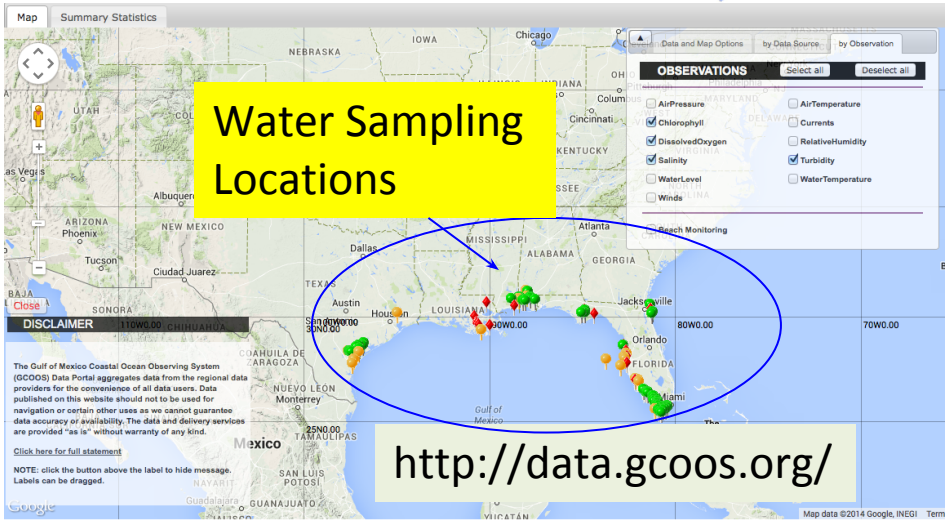
For water quality parameters:

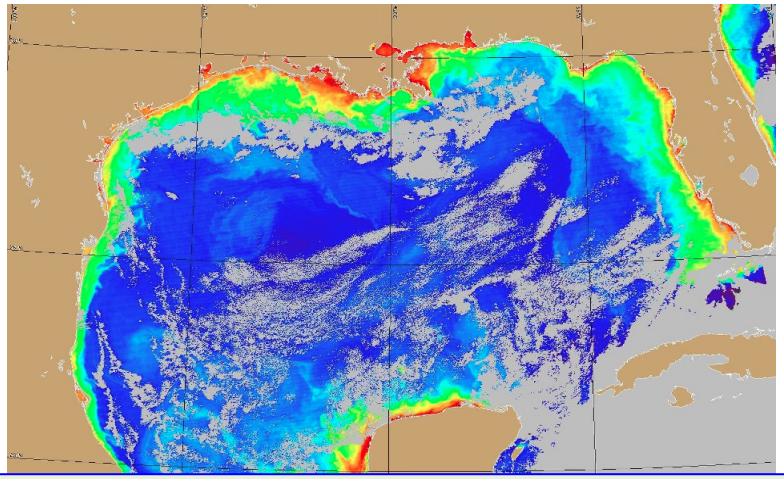
- Spectral reflectance in the presence of clouds may be unsuitable to use
- Atmospheric contribution to the reflectance has to be corrected to get the surface water properties
- Medium-spectral bands data may contain effects of multiple WQ parameters
- Data may contain land contribution

Why use Remote Sensing for WQ Monitoring?



- Provides information where there are no surface-based measurements available and augments where they are
- Provides global/near-global coverage with consistent observations
- Provides continuous coverage in comparison to point measurements





MODIS Aqua satellite image from October 23, 2011, showing areas of elevated chlorophyll a (in red and orange)

Concluding Remarks

- NASA Applied Sciences Program offers 'research to application' opportunities through competitive grants/proposals program (http://nspires.nasaprs.com/external/)

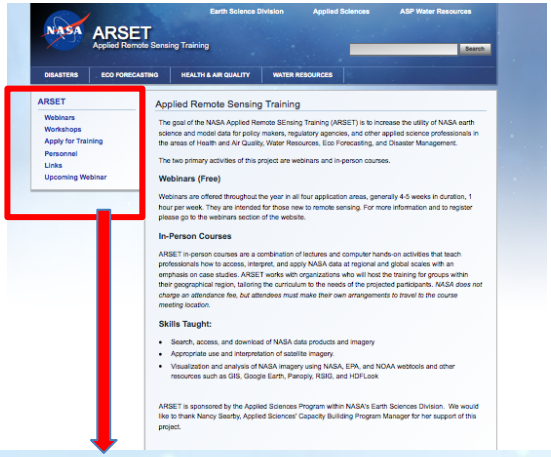
- NASA DEVELOP program offers opportunities to utilize NASA products for specific environmental application involving student liaisons (http://develop.larc.nasa.gov/

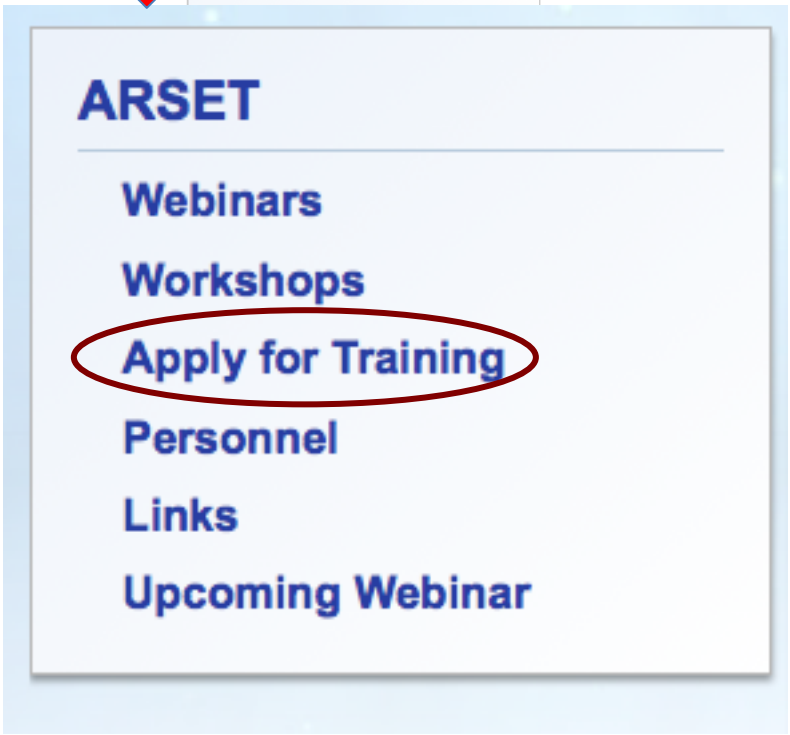
- **ARSET provides on-line and in-person trainings on Air Quality, Eco Forecasting, Water Resources, and Disasters (Flooding) Management**

- **Introductory and advanced on-line trainings, and in-person trainings focused on specific environmental applications and geographic regions can be requested (http://arset.gsfc.nasa.gov/training)**

ARSET Web Page

http://arset.gsfc.nasa.gov





Water Quality Monitoring Using Remote Sensing Measurements

11/18/2014 to 12/02/2014

Times: Course-I: 8-9 AM, Course-II: 1-2 PM, Course-III: 10-11 AM (Eastern US time)

There are three identical courses offered at three different times

Courses I and II are in English, and Course III is in Spanish

Please sign up for any ONE course.

Course-I (8-9 AM, English) Information and Registration

Course-II (1-2 PM, English) Information and Registration

Course III (10-11 AM, Spanish) Information and Registration

Course Objective: To introduce remote sensing data, their access, analysis, and applications for water quality (WQ) monitoring in coastal oceans, estuaries, and in-land lakes.

Course Agenda:

Week-1: Introduction to Remote Sensing of WQ parameters

Week-2: NASA WQ Data, Access, and Tools

Week-3: Overview and Future Prospects of Remote Sensing of WQ Monitoring and Case Studies of Accessing WQ Data

A certificate will be awarded to participants who attend all three sessions and submit completed homework assigned during the course.

Agenda: **WQ Webinar Agenda**
GIS: True
Keywords: **Satellite Imagery, Tools**
Instruments: **Aqua, Landsat, MODIS, Terra, VIIRS**

Presentations and Reccordings

Week	Date	Title	Presentation	Recording	H
1	November 18, 2014	Introduction to Remote Sensing of WQ parameters	Session-1 (English) Session-1 (Spanish)	View Week 1 Recording (English) View Week 1 Recording (Spanish)	N/A
2	November 25, 2014	NASA WQ Data, Access, and Tools			
3	December 2, 2014	Overview and Future Prospects of Remote Sensing of WQ Monitoring and Case Studies of Accessing WQ Data			

Session Presentations and Recordings

Homework Assignment
Due by 31st of December

Please use the following link:

https://docs.google.com/forms/d/1Ub4JvIHEULLqTSST_aUnzHVsdRbDqqotaeCKnWSSutQ/edit?usp=sharing

Certificates will be awarded to the participants who attended all three sessions and submit completed homework

Sign up to the listserve for more information and program updates

https://lists.nasa.gov/mailman/listinfo/arset

Webinar Information

Presentation URL: http://arset.gsfc.nasa.gov/webinar

Contact for requesting Certificate and more information about the course material

Marines Martins : marines.martins@ssaihq.com

Acknowledgment:

Blake Schaeffer Schaeffer.Blake@epa.gov
Africa Flores Africa.flores@nasa.gov
Ana Prados (ARSET) Ana.I.Prados@nasa.gov
Brock Blevins (ARSET) bblevins37@gmail.com
David Barbato (Spanish Translation) (ARSET) barbato1@umbc.edu
Christine Lee christine.m.lee@jpl.nasa.gov

Thank You!

Amita Mehta **email: amita.v.mehta@nasa.gov**