National Aeronautics and
Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

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El Monitoreo a Gran Escala Usando la Teledetección y la Ciencia Ciudadana

26 de septiembre de 2017

Semana 4

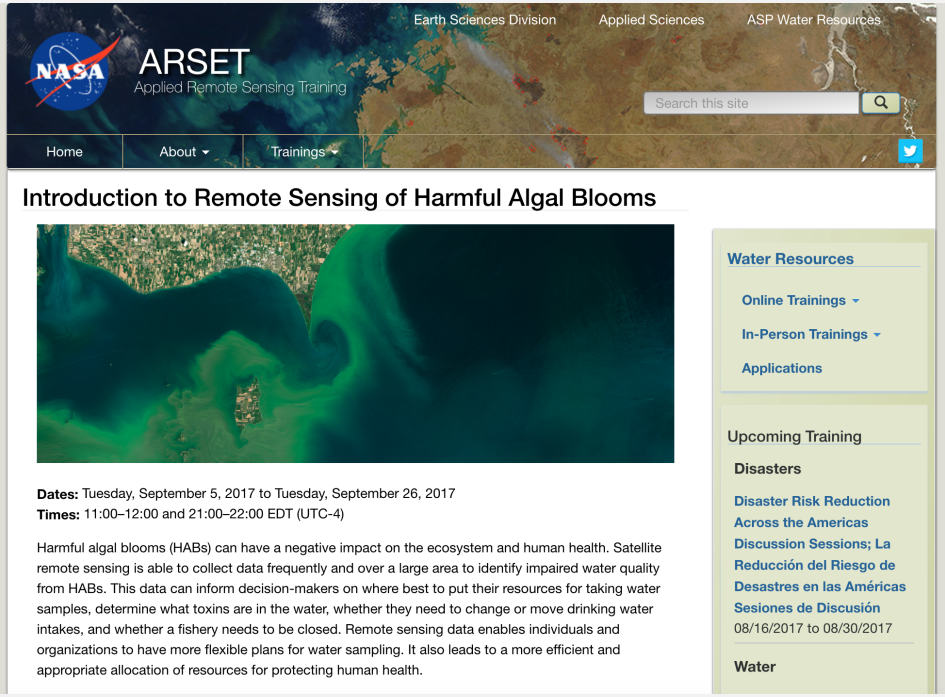
Capacitadoras: Sherry Palacios
Amita Mehta

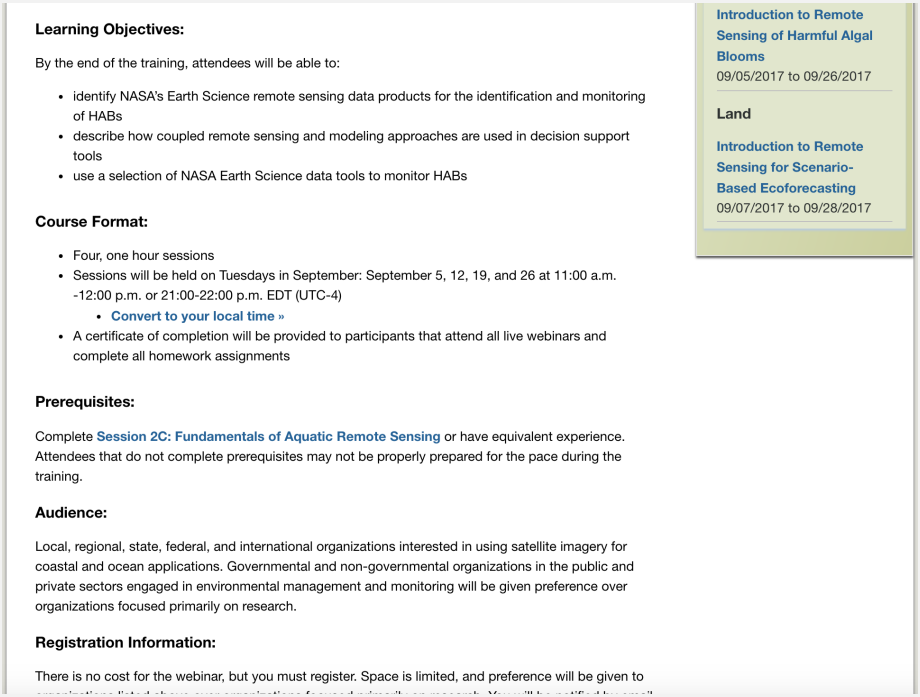
Estructura de la Capacitación

- Cuatro sesiones de 1 hora cada una: Los días martes en septiembre (5, 12, 19, y 26)
- Cada sesión se dará dos veces:
  - Sesión A: 11:00 – 12:00 horario Este de EEUU (UTC-4)
  - Sesión B: 21:00 – 22:00 horario Este de EEUU (UTC-4)
- Presentaciones:
  - Vista general de las Floraciones de Algas Nocivas (HABs por sus siglas en inglés)
  - Plataformas y sensores, acceso a datos y procesamiento de datos
  - Entendiendo las HABs en el ambiente costero
  - El monitoreo a gran escala y la ciencia ciudadana
- Dos Tareas a ser hechas en casa: después de las semanas 2 y 4.
- Preguntas y respuestas después de cada sesión y por correo electrónico a las instructoras

Material del curso

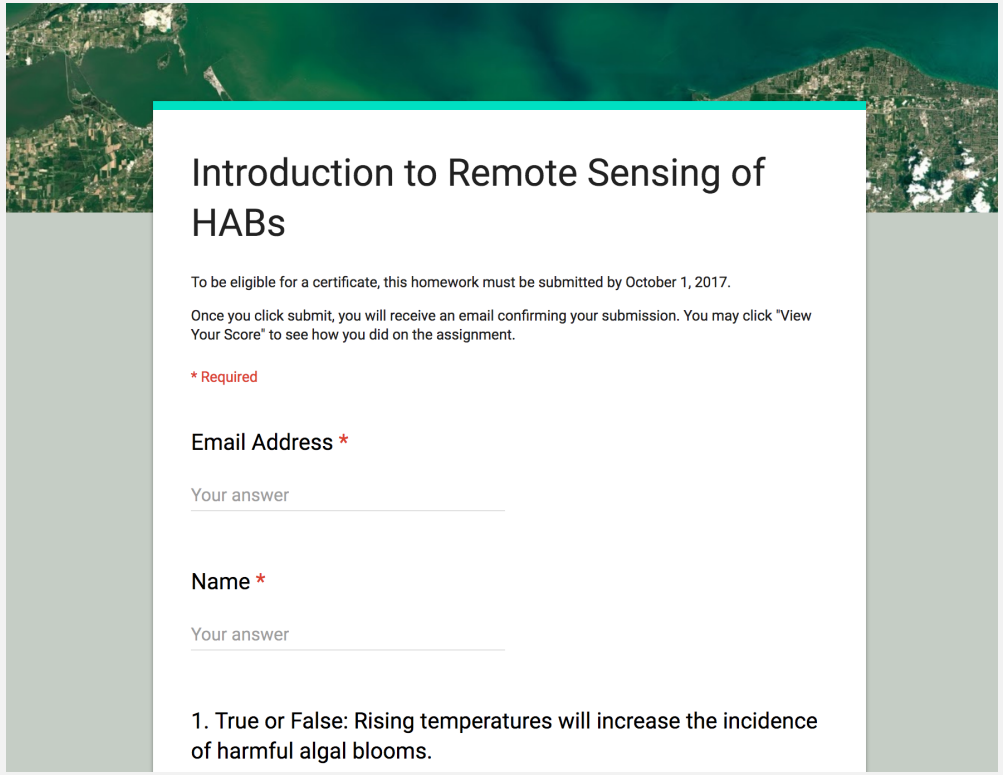
Las grabaciones de las sesiones, las presentaciones y las tareas para la casa están disponibles en: https://arset.gsfc.nasa.gov/water/webinars/HABs17



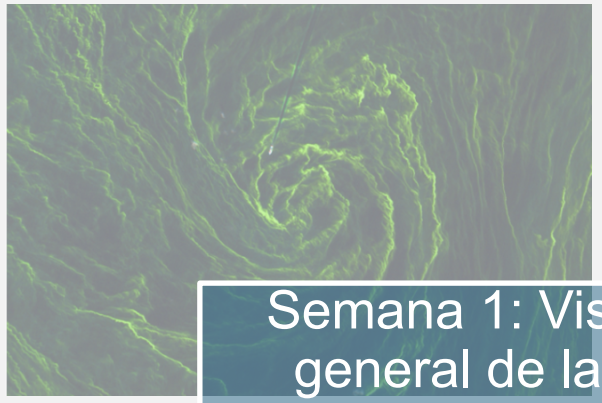


Tarea y certifiados

- Tarea
  - **Debe enviar sus respuestas vía Google Form**
- Certificado de Terminación:
  - Asista a todas las sesiones
  - Complete las tareas asignadas dentro del plazo estipulado (accesibles desde la página en línea de ARSET)
    - **Fechas límite de entrega: El 1ro y el 15 de octubre**
  - Ud. recibirá su certificado aproximadamente dos meses después de la conclusión del curso de: marines.martins@ssaihq.com



Resumen del Curso



Semana 1: Vista general de las Floraciones de Algas Nocivas

Semana 2: Plataformas y sensores, acceso a datos y procesamiento de datos

Credit: Paul Hillman/NOAA

Semana 3: Las HABs en el ambiente costero

Semana 4: El monitoreo a gran escala

Reseña – Sesión 4

- Repaso de las HABs de las semanas 1, 2 y 3
- Resumen general de las HABs cianobacteriales (cyanoHABs)
- Ejemplos de herramientas para el monitoreo de cyanoHABs en el agua dulce (e.g., HAB Tracker, Great Lakes HAB Bulletin)
- Ejemplos de cómo la ciencia ciudadana puede utilizarse para monitorear HABs
- Cyanobacteria Assessment Network* (CyAN)
  - Presentador Invitado: Wilson Salls, EPA

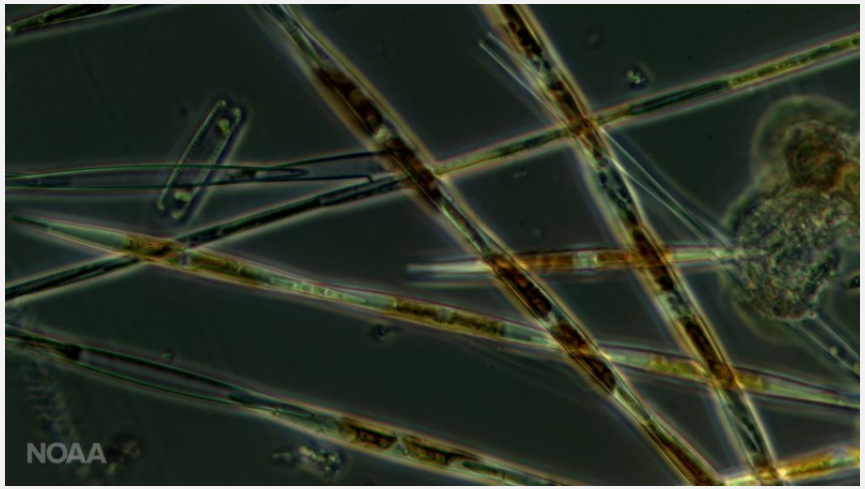
* Red para la Evaluación de Cianobacterias

Photo Credit: Aerial Associates Photography (http://skypics.com)

Repaso de las Semanas 1, 2 y 3

¿Qué son las Floraciones de Algas Nocivas?

“Las floraciones de algas nocivas (Harmful algal blooms, HABs) ocurren cuando las colonias de algas — plantas simples que viven en el mar o en el agua dulce — crecen fuera de control y producen efectos tóxicos o nocivos en las personas, peces, mariscos, mamíferos y aves marinas. Las enfermedades humanas causadas por las HABs, aunque raras, pueden ser debilitantes y hasta mortales.”



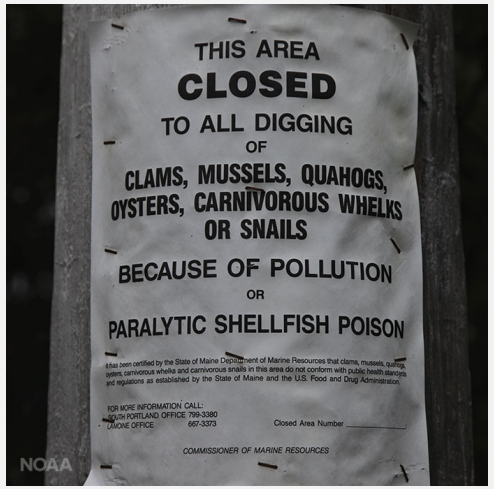


Image credit: http://www.noaa.gov/what-is-harmful-algal-bloom

Satélites para el Monitoreo de HABs

- Misiones Satelitales Actuales:
  - Landsat 7 y Landsat 8
  - Terra
  - Aqua
  - Suomi National Polar Partnership (SNPP)
  - Sentinel-2 y Sentinel-3

Acceso a Datos y Herramientas de Procesamiento para el Monitoreo de HABs

- Estas herramientas permiten la búsqueda de datos, la formación, el análisis y/o visualización de conjuntos de datos espaciales y temporales, :
  - OceanColor Web: https://oceancolor.gsfc.nasa.gov/
  - Giovanni: http://giovanni.gsfc.nasa.gov/giovanni/
  - CoastWatch https://coastwatch.pfeg.noaa.gov/data.html

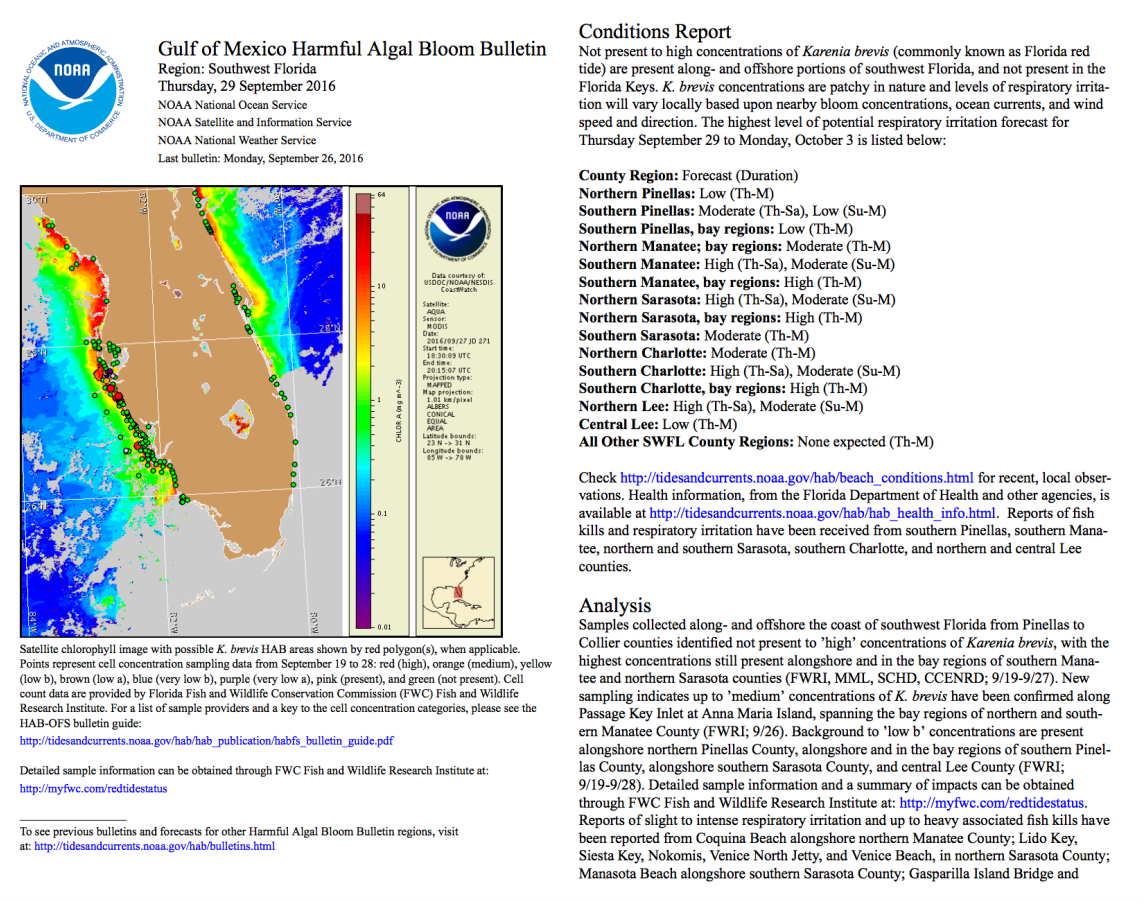
- Software para el Procesamiento y Visualización de datos:
  - SeaDAS: http://seadas.gsfc.nasa.gov/

Resumen

- La teledetección proporciona una cobertura global continua con observaciones consistentes a comparación con las mediciones limitadas de diferentes puntos en la superficie o del muestreo desde las naves
- Las observaciones de la teledetección ópticas y en tiempo casi real de Landsat, Terra/Aqua MODIS, SNPP VIIRS, Sentinel-2 MSI y Sentinel-3 OLCI se usan de manera operativa para el monitoreo cualitativo y cuantitativa de las HABs (Chl y SST)

El Pronosticar Eventos Causados por HABs Ayuda a Predecir los Impactos

NOAA-- HAB Operational Forecast System (HAB-OFS)



Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Southwest Florida
Thursday, 29 September 2016
NOAA National Ocean Service
NOAA Satellite and Information Service
NOAA National Weather Service
Last bulletin: Monday, September 26, 2016

Satellite chlorophyll image with possible *K. brevis* HAB areas shown by red polygon(s), when applicable. Points represent cell concentration sampling data from September 19 to 28: red (high), orange (medium), yellow (low b), brown (low a), blue (very low b), purple (very low a), pink (present), and green (not present). Cell count data are provided by Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute. For a list of sample providers and a key to the cell concentration categories, please see the HAB-OFS bulletin guide:
http://tidesandcurrents.noaa.gov/hab/hab_publication/habfs_bulletin_guide.pdf

Detailed sample information can be obtained through FWC Fish and Wildlife Research Institute at:
http://myfwc.com/redtidestatus

To see previous bulletins and forecasts for other Harmful Algal Bloom Bulletin regions, visit at: http://tidesandcurrents.noaa.gov/hab/bulletins.html

Conditions Report
Not present to high concentrations of *Karenia brevis* (commonly known as Florida red tide) are present along- and offshore portions of southwest Florida, and not present in the Florida Keys. *K. brevis* concentrations are patchy in nature and levels of respiratory irritation will vary locally based upon nearby bloom concentrations, ocean currents, and wind speed and direction. The highest level of potential respiratory irritation forecast for Thursday September 29 to Monday, October 3 is listed below:

County Region: Forecast (Duration)
Northern Pinellas: Low (Th-M)
Southern Pinellas: Moderate (Th-Sa), Low (Su-M)
Southern Pinellas, bay regions: Low (Th-M)
Northern Manatee; bay regions: Moderate (Th-M)
Southern Manatee: High (Th-Sa), Moderate (Su-M)
Southern Manatee, bay regions: High (Th-M)
Northern Sarasota: High (Th-Sa), Moderate (Su-M)
Northern Sarasota, bay regions: High (Th-M)
Southern Sarasota: Moderate (Th-M)
Northern Charlotte: Moderate (Th-M)
Southern Charlotte: High (Th-Sa), Moderate (Su-M)
Southern Charlotte, bay regions: High (Th-M)
Northern Lee: High (Th-Sa), Moderate (Su-M)
Central Lee: Low (Th-M)
All Other SWFL County Regions: None expected (Th-M)

Check http://tidesandcurrents.noaa.gov/hab/beach_conditions.html for recent, local observations. Health information, from the Florida Department of Health and other agencies, is available at http://tidesandcurrents.noaa.gov/hab/hab_health_info.html. Reports of fish kills and respiratory irritation have been received from southern Pinellas, southern Manatee, northern and southern Sarasota, southern Charlotte, and northern and central Lee counties.

Analysis
Samples collected along- and offshore the coast of southwest Florida from Pinellas to Collier counties identified not present to 'high' concentrations of *Karenia brevis*, with the highest concentrations still present alongshore and in the bay regions of southern Manatee and northern Sarasota counties (FWRI, MML, SCHD, CCENRD; 9/19-9/27). New sampling indicates up to 'medium' concentrations of *K. brevis* have been confirmed along Passage Key Inlet at Anna Maria Island, spanning the bay regions of northern and southern Manatee County (FWRI; 9/26). Background to 'low b' concentrations are present alongshore northern Pinellas County, alongshore and in the bay regions of southern Pinellas County, alongshore southern Sarasota County, and central Lee County (FWRI; 9/19-9/28). Detailed sample information and a summary of impacts can be obtained through FWC Fish and Wildlife Research Institute at: http://myfwc.com/redtidestatus. Reports of slight to intense respiratory irritation and up to heavy associated fish kills have been reported from Coquina Beach alongshore northern Manatee County; Lido Key, Siesta Key, Nokomis, Venice North Jetty, and Venice Beach, in northern Sarasota County; Manasota Beach alongshore southern Sarasota County; Gasparilla Island Bridge and

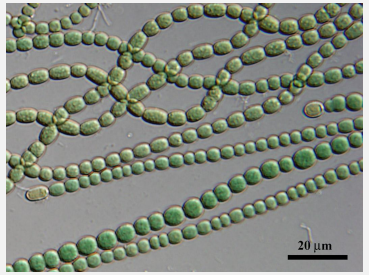
- *Karenia brevis* forma floraciones fragmentarias y el impacto puede variar según el lugar
- Para elaborar su pronóstico, el boletín NOAA HAB Bulletin combina:
  - imágenes oceánicas satelitales
  - observaciones de campo
  - modelos
  - informes de salud pública
  - datos de boyas oceánicas

https://tidesandcurrents.noaa.gov/hab/bulletins.html;
https://tidesandcurrents.noaa.gov/hab/hab_publication/habfs_bulletin_guide.pdf

Vistazo General de las CyanoHABs

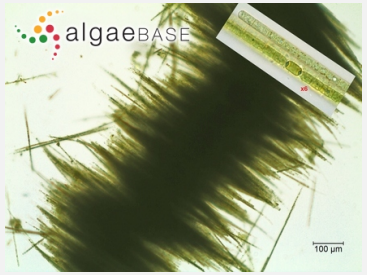
Algunos Tipos de CyanoHABs Comunes y Sus Toxinas

Anabaena



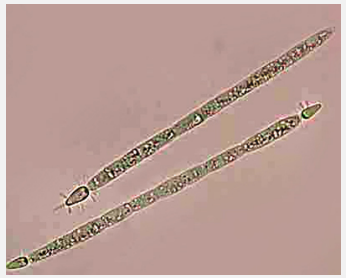
anatoxinas
microcistina
saxitoxinas

Aphanizomenon



saxitoxinas
cilindroespermopsinas

Cylindrospermopsis

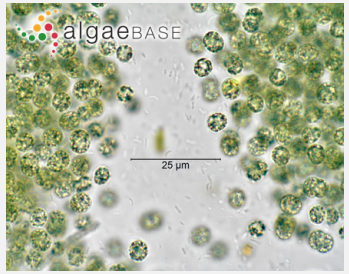


saxitoxinas
cilindroespermopsinas

Lyngbya

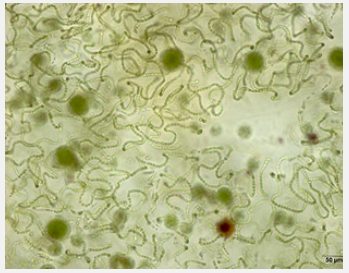
aplisiatoxinas
lingbiatoxina a

Microcystis



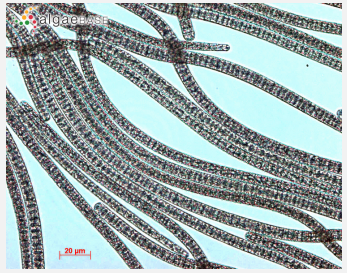
microcistinas

Nostoc



microcistinas

Planktothrix



anatoxinas, aplisiatoxinas
microcistinas, saxitoxinas

Neurotoxina
Hepatotoxina
Irritante cutáneo

photo credits: CCLA, C.F. Carter, UNH Center for Freshwater Biology, R. Barone

CyanoHABs – De Cerca

Lago Taihu, China

Lago Pinto, California

credit (L to R): H. Paerl, UNC-Chapel Hill, R.Kelty

El Impacto de la Gestión

Estudio de Caso: Toledo, Ohio (EEUU)

Science News *from research organizations*

Significant harmful algal bloom predicted in western Lake Erie this summer

Date: July 10, 2014

Source: National Oceanic and Atmospheric Administration

Summary: NOAA and its research partners predict that western Lake Erie will have a significant bloom of cyanobacteria, a toxic blue-green algae, during the 2014 bloom season in late summer. However, the predicted bloom is expected to be smaller than last year's intense bloom, and considerably less than the record-setting 2011 bloom. Bloom impacts will vary across the lake's western basin and are classified by an estimate of both its concentration and how far it spreads.

ENVIRONMENT

Toledo Residents Cut Off From Water Supply After Tests Show Toxins

August 3, 2014 · 1:17 AM ET

THE ASSOCIATED PRESS

SCIENCE

Cyanobacteria Are Far From Just Toledo's Problem

Carl Zimmer

MATTER AUG. 7, 2014

Harmful algal blooms continue to plague Lake Erie, threaten drinking water, fish, pets

18 Updated on August 30, 2017 at 10:22 AM, Posted on August 30, 2017 at 10:20 AM

The algae-clogged waters of Lake Erie's western basin at Maumee Bay State Park east of Toledo produced the growth of cyanobacteria and a toxin called microcystin that can be dangerous for people, birds, fish and pets.(The New York Times file photo)

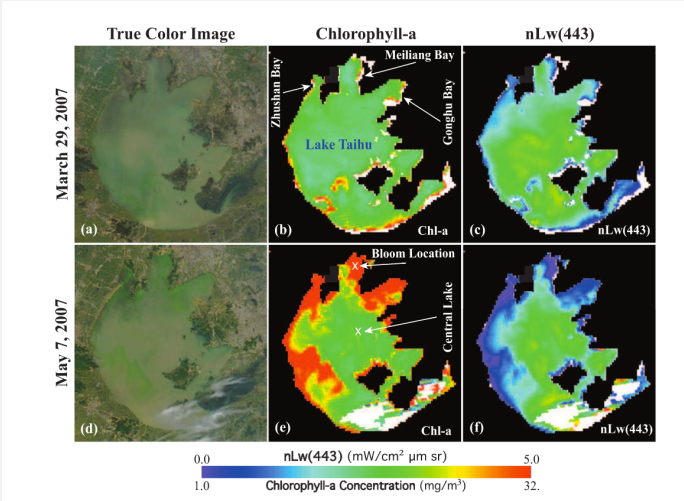
289 shares

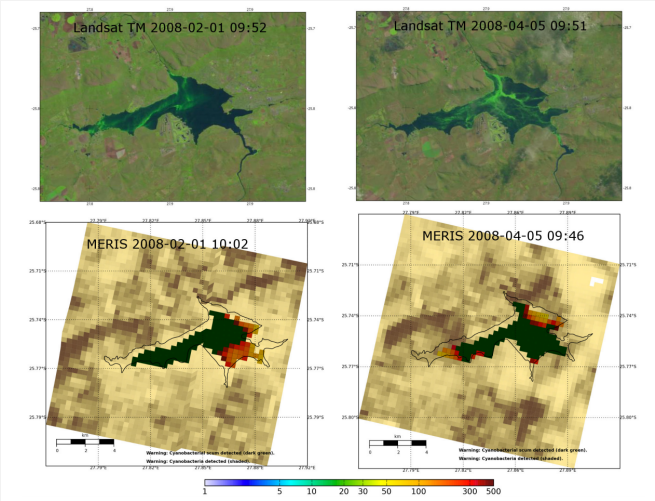
By James F. McCarty, The Plain Dealer, jmccarty@plaind.com

Fuente: AP, New York Times, Cleveland's The Plain Dealer

La Teledetección de CyanoHABs

Lago Taihu, China





Represa Hartbeespoort Sudáfrica

Lago Erie, EEUU

Floración de *Nodularia,* Mar Báltico

Fuente: Lake Taihu (Wang & Shi 2008), Lake Erie (NASA/NOAA-NCCOS)

Fuente: Hartbeespoort Dam (Matthews & Bernard 2015), Baltic Sea (http://www.wimsoft.com/Various_HABs/Satellite_detection_of_HABs.htm)

La Teledetección de Floraciones Cianobacteriales

- Concentración de clorofila-a
- Anomalía de clorofila-a
- Algoritmos dirigidos a la ficocianina
- Índice de cianobacterias (Cyanobacteria Index o CI)

Cyanobacteria Index (CI):
Wynne, TT, Stumpf, RP, Tomlinson, MC, Warner RA, Tester, PA, Dyble, J, and Fahnenstiel, GL (2008) 'Relating spectral shape to cyanobacterial blooms in the Laurentian Great Lakes', International Journal of Remote Sensing, 29:12, 3665 – 3672.

Índice de cianobacterias (Cyanobacteria Index o CI)*

CI = - SS(681)

donde SS es la figura espectral (spectral shape) a 681 nm:

$$SS(681) = nLw(681nm) - nLw(665nm) - [nLw(709nm) - nLw(665nm)] * \frac{(681 - 665)}{(709 - 665)}$$

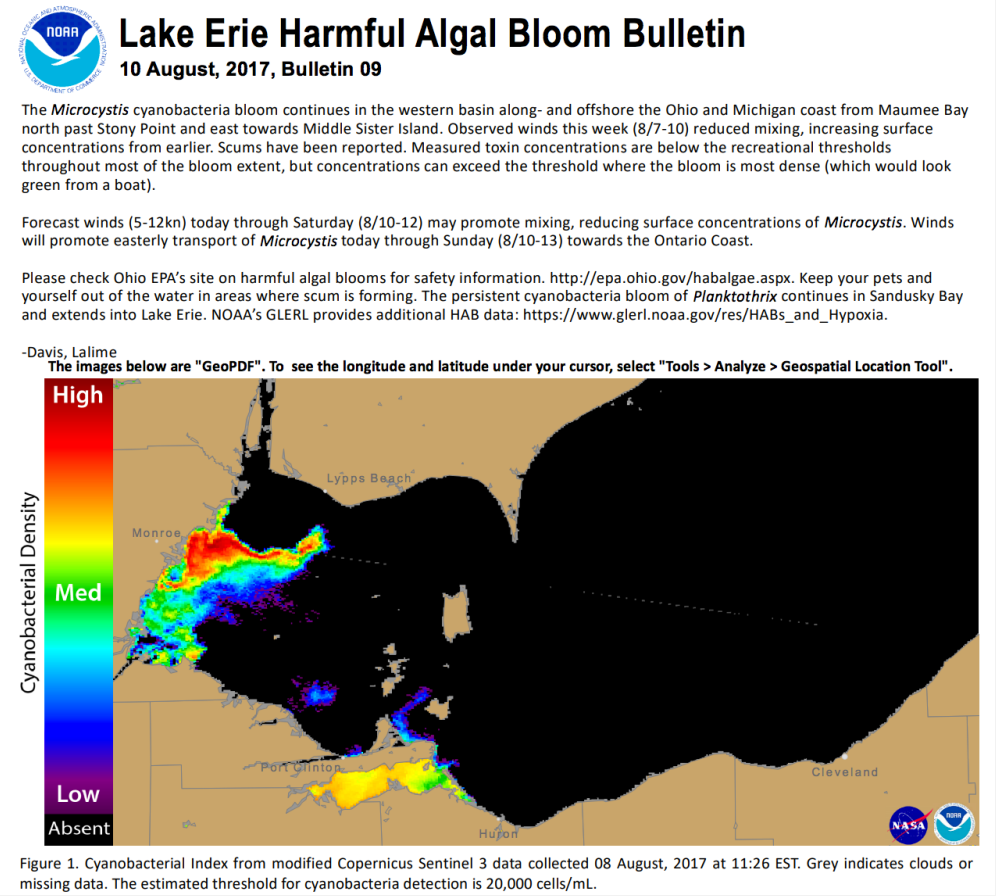
* example using L2 data for MERIS bands

Herramientas para CyanoHABs – Estudios de Caso

El Pronóstico de la Ubicación de CyanoHABs en el Lago Erie

Sistema de pronósticos “NOAA HAB Operational Forecast System”

- *Microcystis aeruginosa* forma espumas distintivas en la superficie
- El boletín ayuda a pronosticar dónde y cuando las floraciones tocarán tierra
- Para elaborar su pronóstico, este boletín combina:
  - imágenes satelitales
  - observaciones de campo
  - observaciones y modelos de dinámica de fluidos
  - modelos predictivos
  - datos de boyas



Lake Erie Harmful Algal Bloom Bulletin

10 August, 2017, Bulletin 09

The *Microcystis* cyanobacteria bloom continues in the western basin along- and offshore the Ohio and Michigan coast from Maumee Bay north past Stony Point and east towards Middle Sister Island. Observed winds this week (8/7-10) reduced mixing, increasing surface concentrations from earlier. Scums have been reported. Measured toxin concentrations are below the recreational thresholds throughout most of the bloom extent, but concentrations can exceed the threshold where the bloom is most dense (which would look green from a boat).

Forecast winds (5-12kn) today through Saturday (8/10-12) may promote mixing, reducing surface concentrations of *Microcystis*. Winds will promote easterly transport of *Microcystis* today through Sunday (8/10-13) towards the Ontario Coast.

Please check Ohio EPA’s site on harmful algal blooms for safety information. http://epa.ohio.gov/habalgae.aspx. Keep your pets and yourself out of the water in areas where scum is forming. The persistent cyanobacteria bloom of *Planktothrix* continues in Sandusky Bay and extends into Lake Erie. NOAA’s GLERL provides additional HAB data: https://www.glerl.noaa.gov/res/HABs_and_Hypoxia.

-Davis, Lalime

The images below are "GeoPDF". To see the longitude and latitude under your cursor, select "Tools > Analyze > Geospatial Location Tool".

Figure 1. Cyanobacterial Index from modified Copernicus Sentinel 3 data collected 08 August, 2017 at 11:26 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.

https://tidesandcurrents.noaa.gov/hab/lakeerie.html
https://tidesandcurrents.noaa.gov/hab/hab_publication/Lake_Erie_HAB_Bulletin_Guide.pdf

Bulletin Credit: https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/bulletin.html

El Pronóstico de la Ubicación de CyanoHABs en el Lago Erie

CI de Sentinel-3

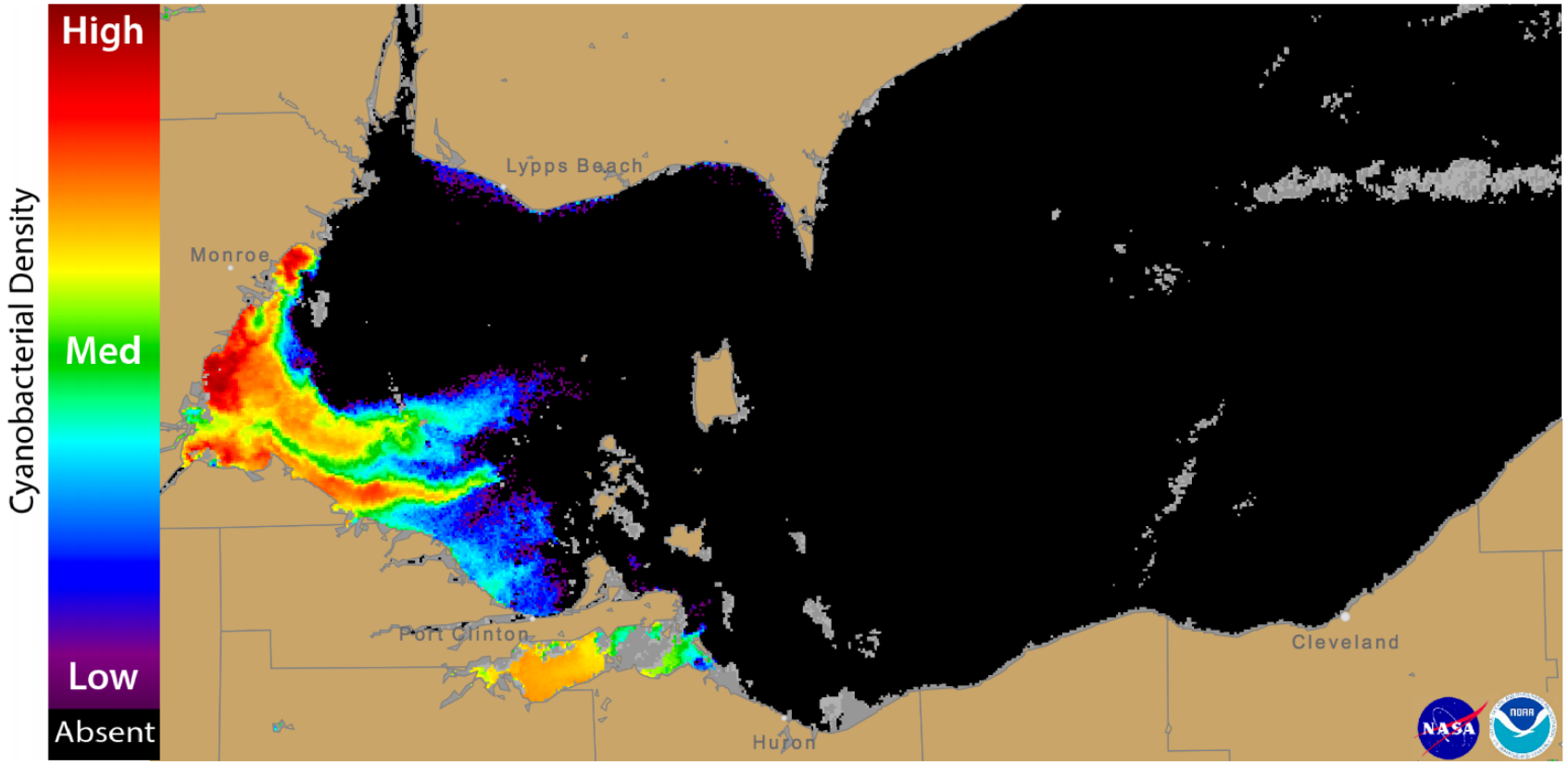


Figure 1. Cyanobacterial Index from modified Copernicus Sentinel 3 data collected 30 August, 2017 at 11:55 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.

https://tidesandcurrents.noaa.gov/hab/lakeerie.html
https://tidesandcurrents.noaa.gov/hab/hab_publication/Lake_Erie_HAB_Bulletin_Guide.pdf

El Pronóstico de la Ubicación de CyanoHABs en el Lago Erie

‘Actual-nóstico’ de una imagen de Sentinel-3

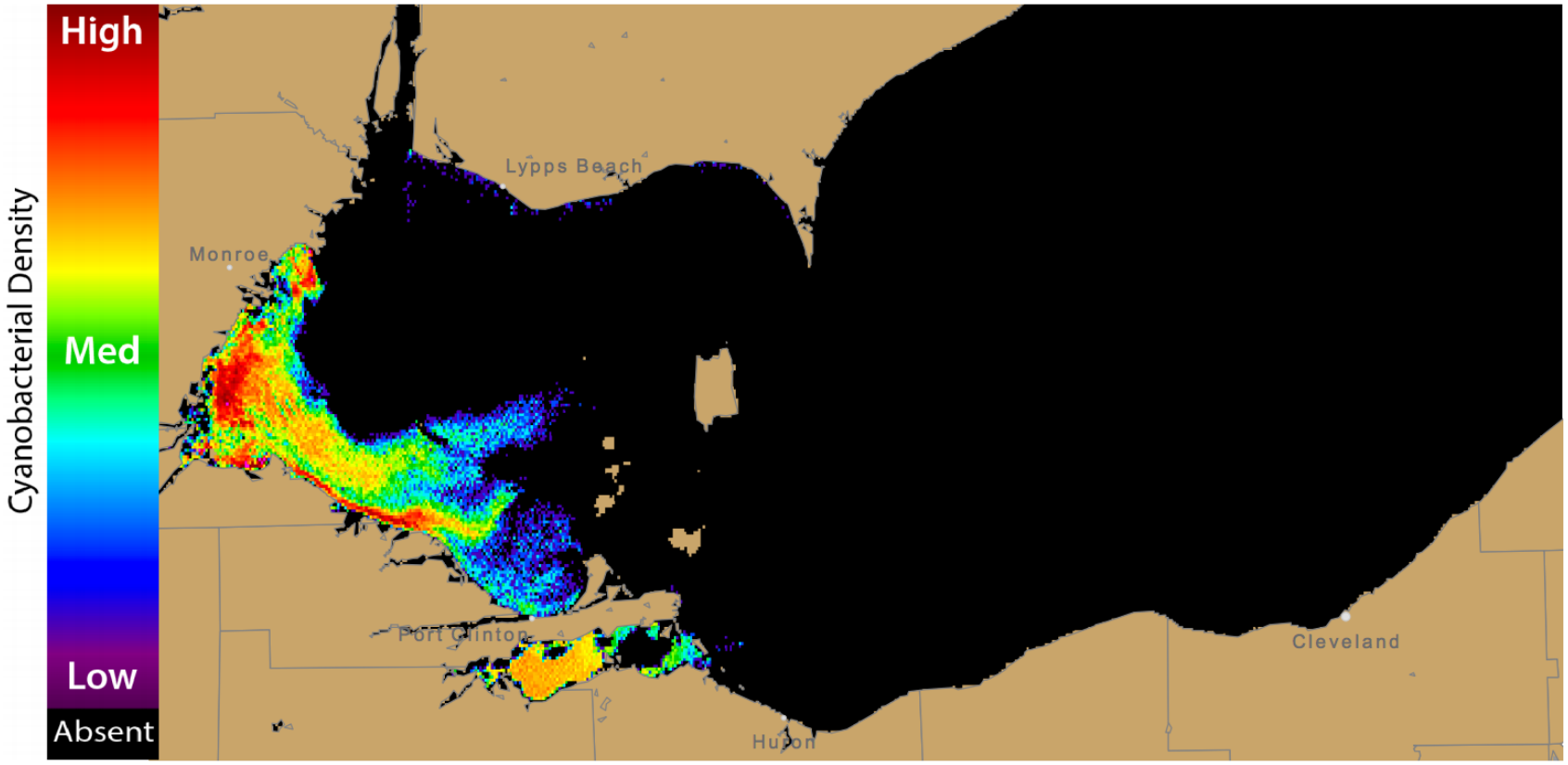
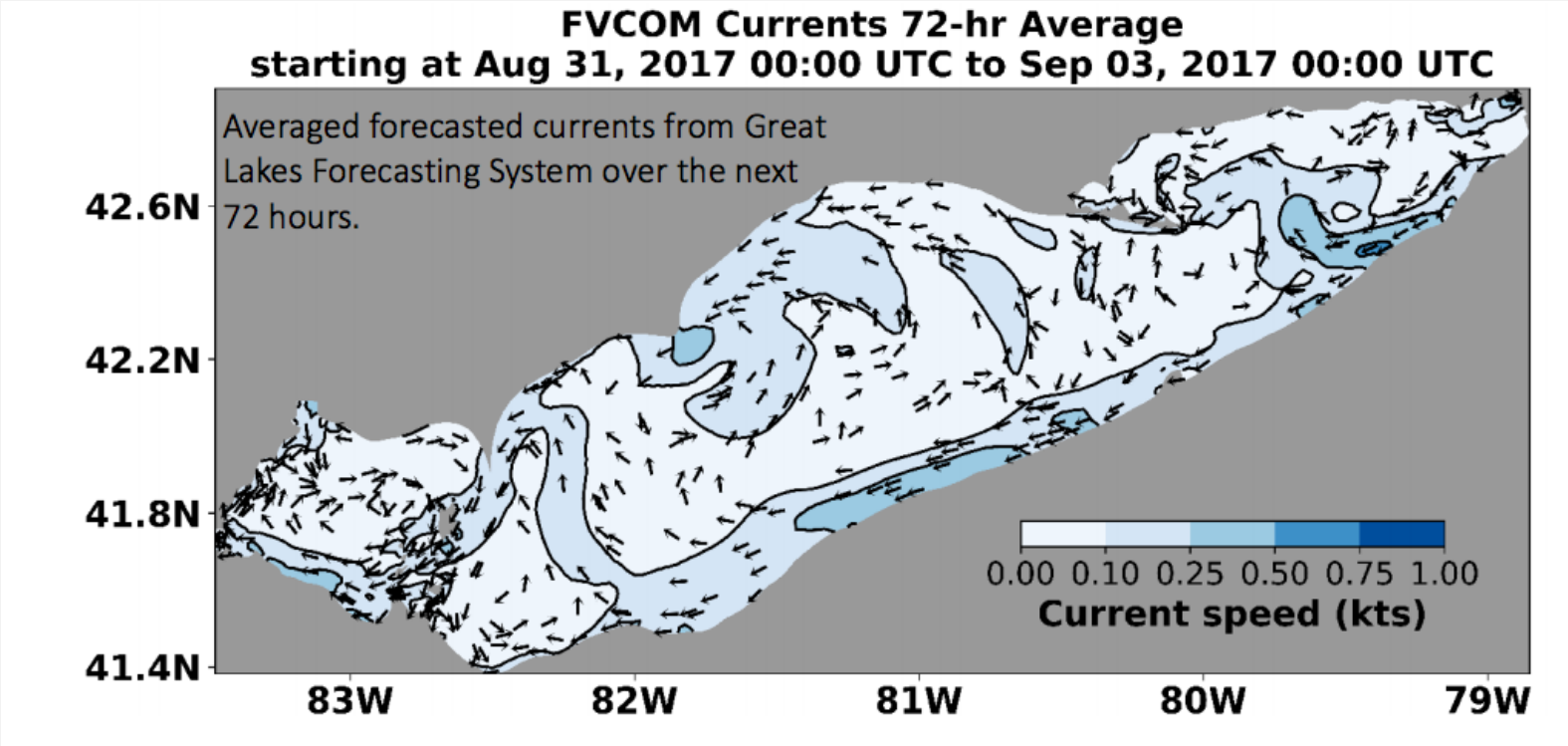


Figure 3. Nowcast position of bloom for 31 August, 2017 using GLFS modelled currents to move the bloom from the 30 August, 2017 image.

https://tidesandcurrents.noaa.gov/hab/lakeerie.html
https://tidesandcurrents.noaa.gov/hab/hab_publication/Lake_Erie_HAB_Bulletin_Guide.pdf

El Pronóstico de la Ubicación de CyanoHABs en el Lago Erie

Pronóstico de Corrientes Superficiales de 72 Horas



https://tidesandcurrents.noaa.gov/hab/lakeerie.html
https://tidesandcurrents.noaa.gov/hab/hab_publication/Lake_Erie_HAB_Bulletin_Guide.pdf

El Pronóstico de la Ubicación de CyanoHABs en el Lago Erie

Pronóstico de CI 72 Horas en el Futuro

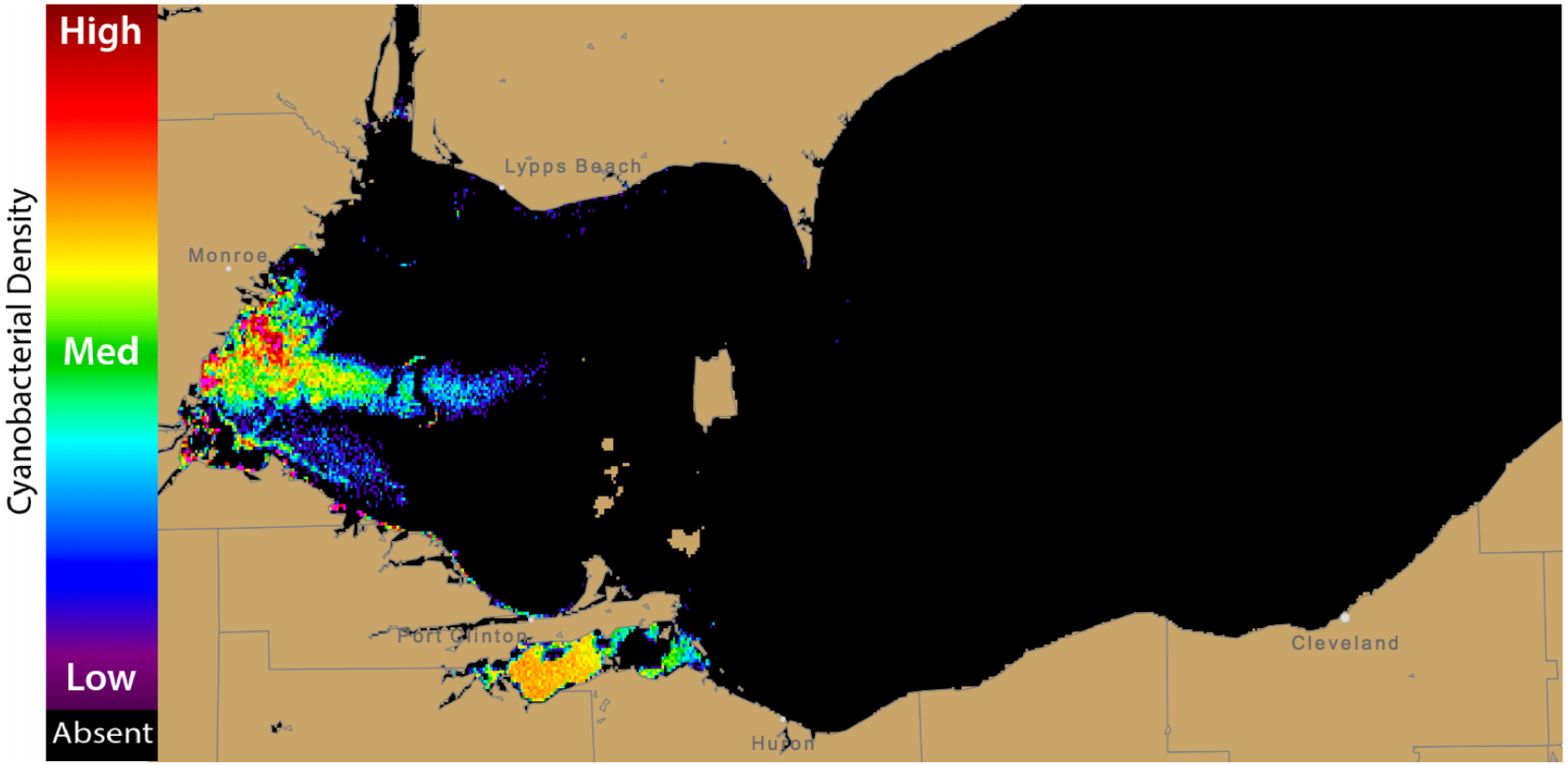


Figure 4. Forecast position of bloom for 03 September, 2017 using GLFS modelled currents to move the bloom from the 30 August, 2017

https://tidesandcurrents.noaa.gov/hab/lakeerie.html
https://tidesandcurrents.noaa.gov/hab/hab_publication/Lake_Erie_HAB_Bulletin_Guide.pdf

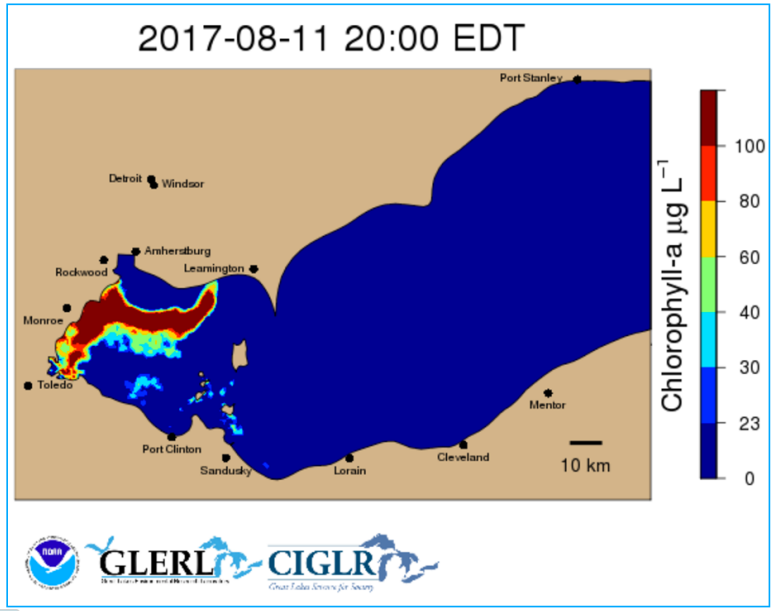
Datos de la Teledetección Acoplados con Modelos Geofísicos Models

Estudio de Caso – HAB Tracker

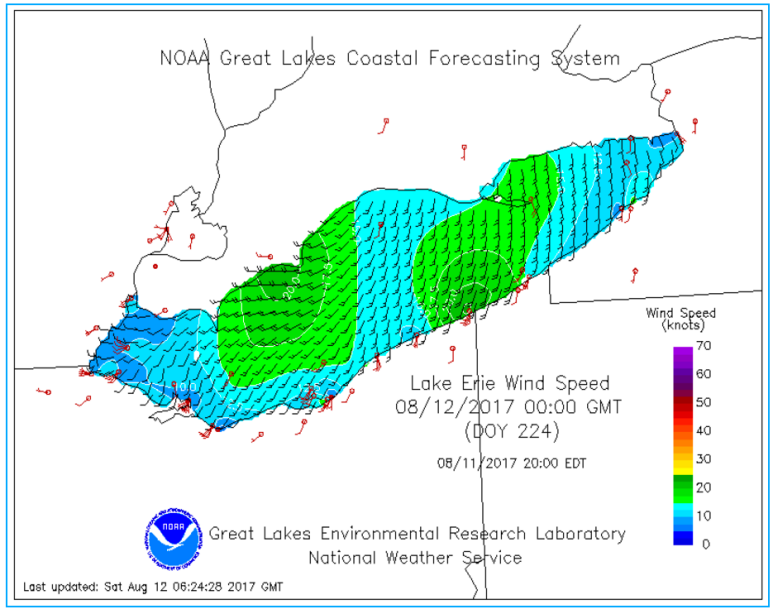
Experimental Lake Erie Harmful Algal Bloom (HAB) Tracker

The upper left panel below shows the HAB Tracker lake surface forecast. The other panels provide additional information on lake conditions. See ***panel descriptions*** *below. For more information on the HAB Tracker, visit the* ***About the Lake Erie HAB Tracker*** *page. For the latest images, refresh your browser and/or clear its cache.*

HAB Tracker forecast



GLCFS nowcast & 5-day wind speed forecast



https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html; https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker_about.html

La Ciencia Ciudadana en el Monitoreo de HABs

Programas de Ciencia Ciudadana

Estudios de Caso

- Phytoplankton Monitoring Network
- Cyanobacteria Monitoring Collaborative
- Pilotos de aviación general recolectando imágenes
- CyAN (Presentador Invitado Wilson Salls)

Phytoplankton Monitoring Network

(Red de monitoreo de fitoplancton)

https://products.coastalscience.noaa.gov/pmn/

Phytoplankton Monitoring Network

(Red de monitoreo de fitoplancton)

https://www.ncddc.noaa.gov/website/PMN/viewer.htm

Cyanobacteria Monitoring Collaborative

https://cyanos.org/

Pilotos de Aviación General como Científicos Ciudadanos

https://re.grc.nasa.gov/citizen-scientists-track-algal-blooms/

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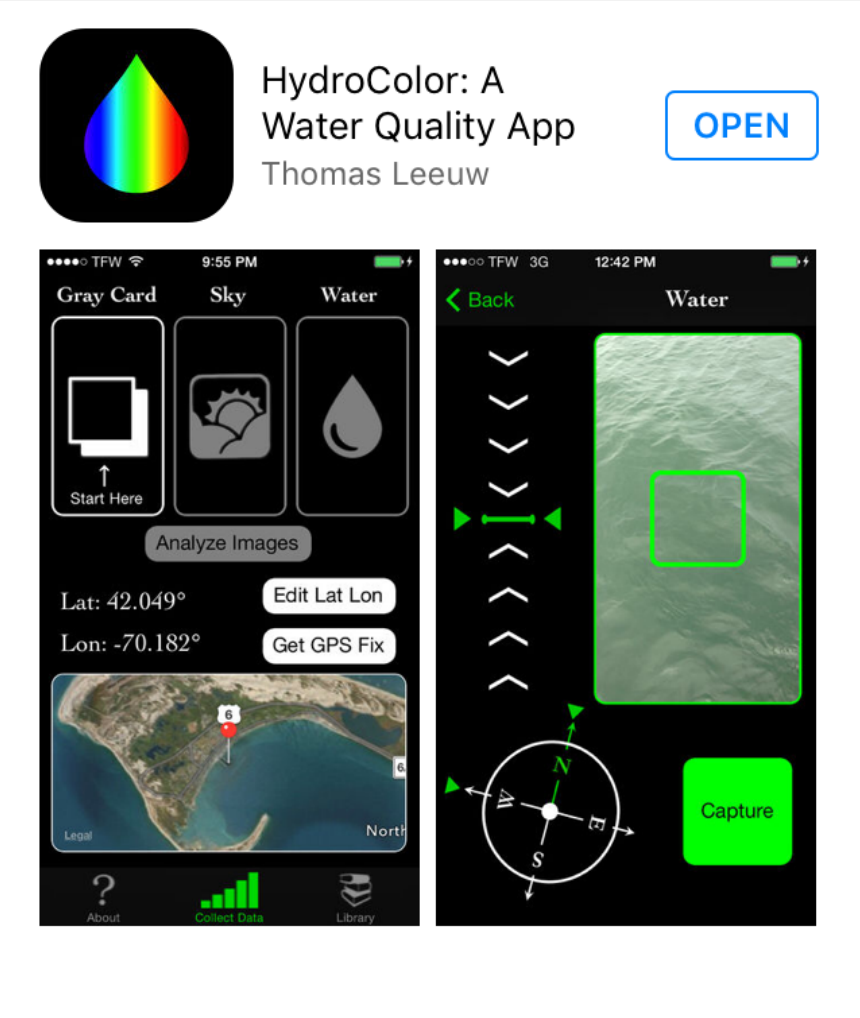
Herramientas de la Ciencia Ciudadana

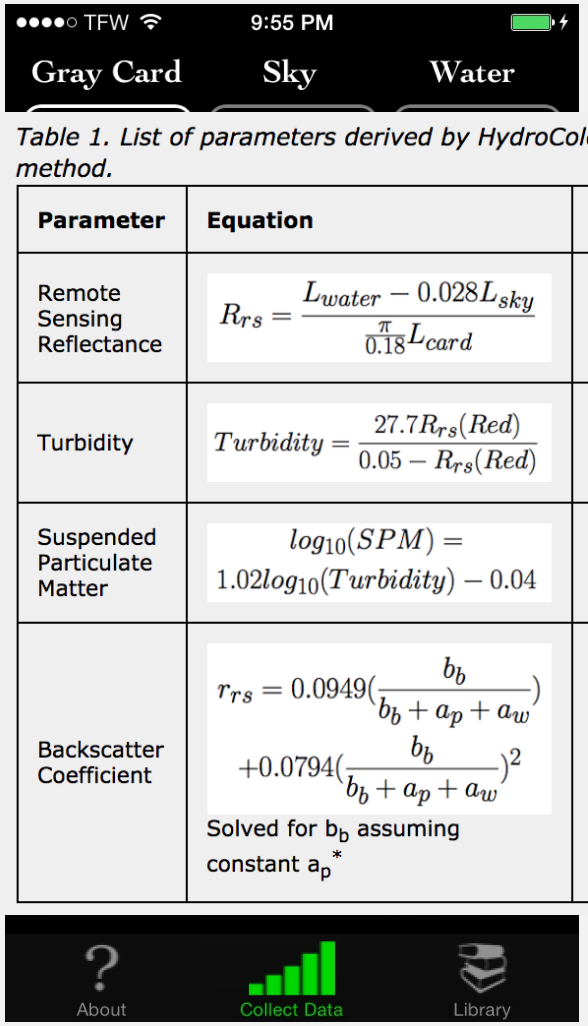
Estudios de Caso – Apps!



Midiendo la Reflectancia con un Teléfono Inteligente

HydroColor

- Estima la reflectancia de teledetección (remote sensing reflectance o Rrs) usando las curvas de respuesta espectral del teléfono
- Computa Turbiedad, Materia Particulada Suspendida (Suspended Particulate Matter o SPM) y el coeficiente de retrodispersión a partir del la Rrs
- Capacidad “apunte y dispare”
- Disponible para iPhone y iPod Touch



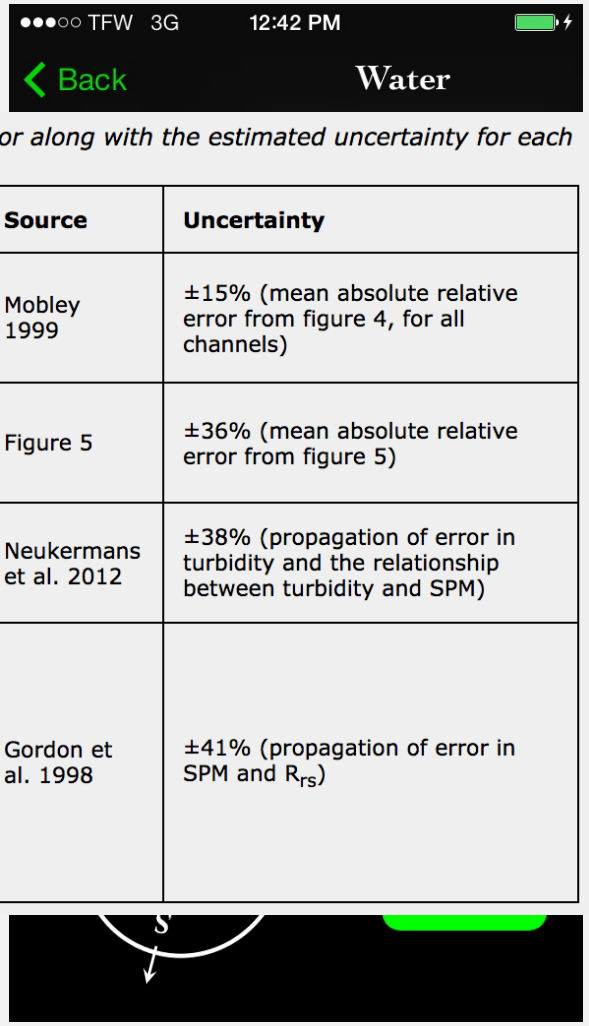


Table 1. List of parameters derived by HydroColor along with the estimated uncertainty for each method.

Parameter	Equation	Source	Uncertainty
Remote Sensing Reflectance	$R_{rs} = \frac{L_{water} - 0.028 L_{sky}}{\frac{\pi}{0.18} L_{card}}$	Mobley 1999	±15% (mean absolute relative error from figure 4, for all channels)
Turbidity	$Turbidity = \frac{27.7 R_{rs}(Red)}{0.05 - R_{rs}(Red)}$	Figure 5	±36% (mean absolute relative error from figure 5)
Suspended Particulate Matter	$log_{10}(SPM) = 1.02 log_{10}(Turbidity) - 0.04$	Neukermans et al. 2012	±38% (propagation of error in turbidity and the relationship between turbidity and SPM)
Backscatter Coefficient	$r_{rs} = 0.0949(\frac{b_b}{b_b + a_p + a_w}) + 0.0794(\frac{b_b}{b_b + a_p + a_w})^2$ Solved for b_b assuming constant a_p^*	Gordon et al. 1998	±41% (propagation of error in SPM and R_{rs})

http://misclab.umeoce.maine.edu/research/HydroColor.php

Cyanobacteria Assessment Network* (CyAN)

Wilson Salls, EPA

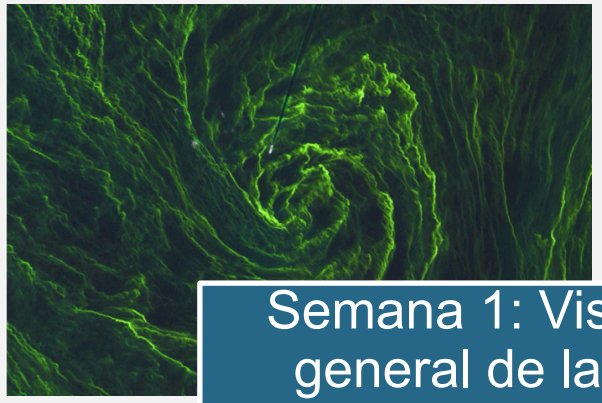
* Red para la Evaluación de Cianobacterias

Reseña – Sesión 4

- Resumen general de las HABs cianobacteriales (cyanoHABs)
- Ejemplos de herramientas para el monitoreo de cyanoHABs en el agua dulce
- Ejemplos de cómo la ciencia ciudadana puede utilizarse para monitorear HABs
- Cyanobacteria Assessment Network (CyAN)

Photo Credit: Aerial Associates Photography (http://skypics.com)

Resumen del Curso



Semana 1: Vista general de las Floraciones de Algas Nocivas

Semana 2: Plataformas y sensores, acceso a datos y procesamiento de datos

Credit: Paul Hillman/NOAA

Semana 3: Las HABs en el ambiente costero

Semana 4: El monitoreo a gran escala

National Aeronautics and
Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

@NASAARSET

¡Gracias!