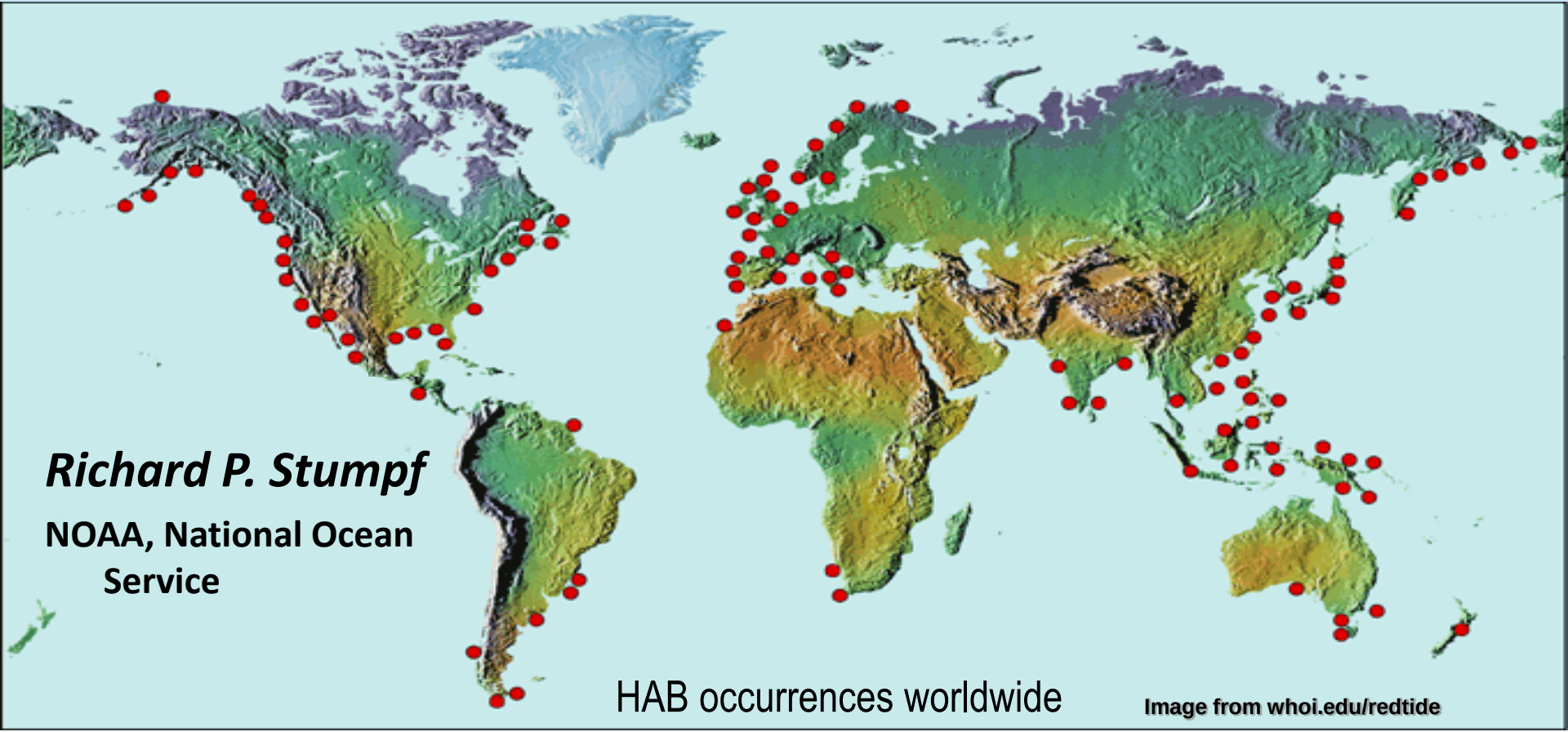
Harmful Algal Blooms (HABs) 5 Applications



HAB applications: short term

Management:

Monitoring and Response

Closing shellfisheries. Do not recall shellfish

Protecting fisheries (pulling mussels, clay-treatment in Korea)

Health advisories (respiratory for Karenia, swimming for cyanobacteria)

Public water supplies in freshwater

HAB applications: long term

Management:

Seasonal planning

Nutrient reduction strategies

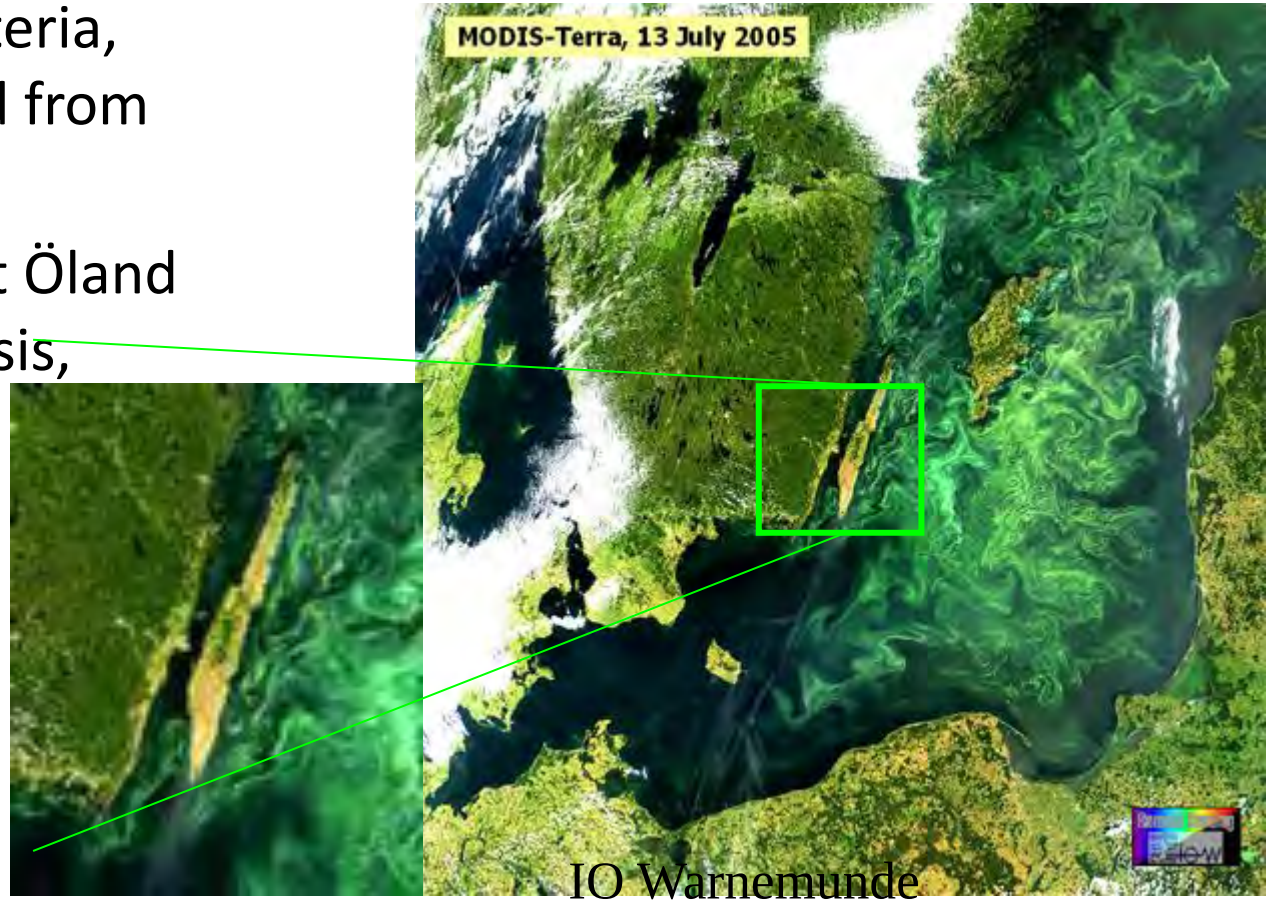
Climate change risks

Understanding bloom ecology and dynamics

Need to get it right for manager, Tourism crisis

Baltic, 2005, cyanobacteria, commonly estimated from satellite.

This bloom missed west Öland beaches, Tourism crisis,
source E. Graneli

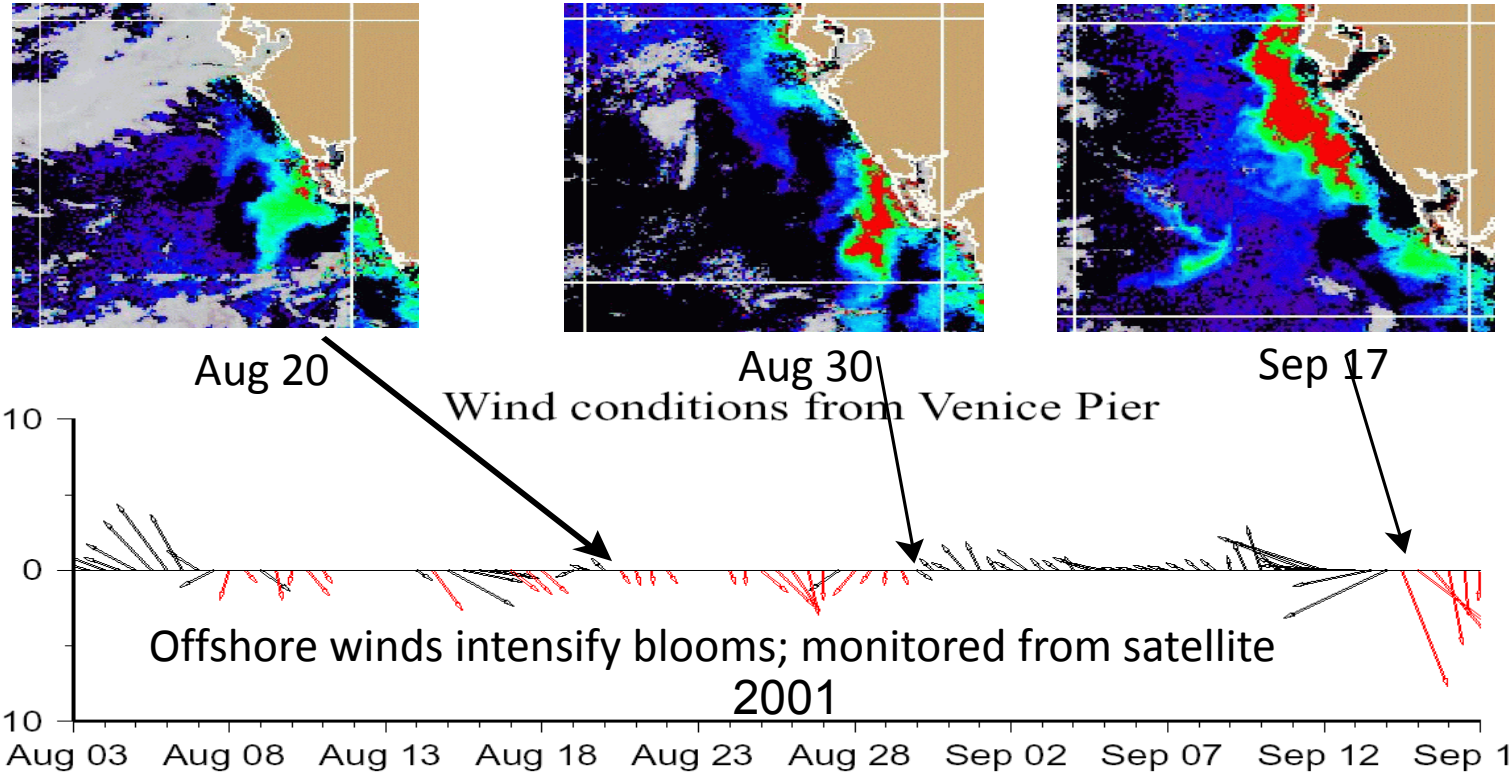


Korea, protecting fish and mussel farms by clay dispersal

Serc.si.edu

Florida, improved detection. HAB initiation and intensification with upwelling

New bloom after upwelling more likely to be HAB)



NOAA work to date:
Lake Erie weekly Bulletin (forecast, now in 4th year)

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-008
08 September 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 22 July 2011

Bloom from satellite

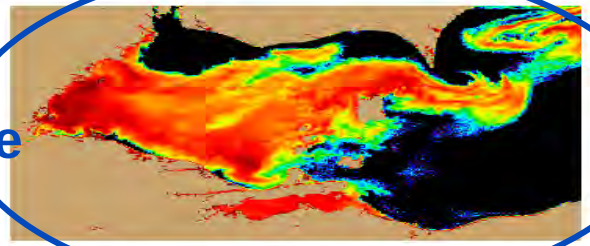


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from September 03, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low) and X (not present).

forecast

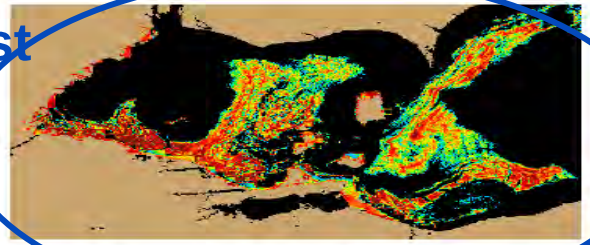


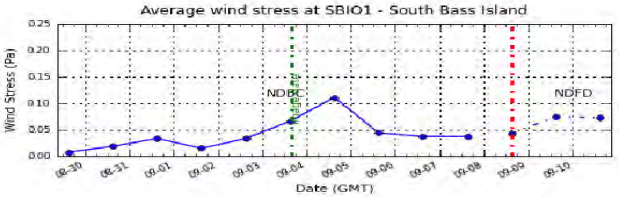
Figure 2. Nowcast position of *Microcystis* spp. bloom for September 08 using GLCFS modeled currents t move the bloom from the September 03 image.

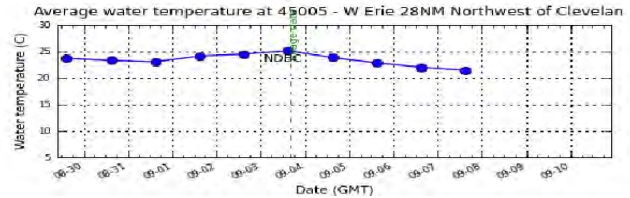
Conditions: A massive *Microcystis* bloom persists throughout most of Lake Erie's Western Basin.

Analysis: As indicated in satellite imagery from Saturday (9/3/2011), an enormous *Microcystis* bloom was present in western Lake Erie. The southern extent of the bloom was remotely observed along the coast of Ohio from Maumee Bay to Catawba Island. The northern extent of the bloom was observed to be consistent along the Michigan coast from Northern Maumee Bay to the mouth of the Detroit River. The eastern-most portion of the bloom was observed past Point Pelee and to the northeast up in to Rondeau Provincial Park.

At the mouth of the Detroit River, a five day nowcast shows a southward suppression of the western-most portions of the bloom. However, the bloom is likely to still persist in much of the Western Basin. The nowcast also suggest the bloom has spread to the east of Sandusky and into the Cleveland area. **(Note: Due to a lack of clear imagery the bloom has not been remotely observed in the Cleveland area.)** A three day forecast also suggests that the bloom will persist to the north of Cleveland through the weekend. Water temperatures remain above 20 degrees Celsius and are forecast to decrease into the weekend; however, conditions remain favorable for bloom growth.

Briggs, Wynne

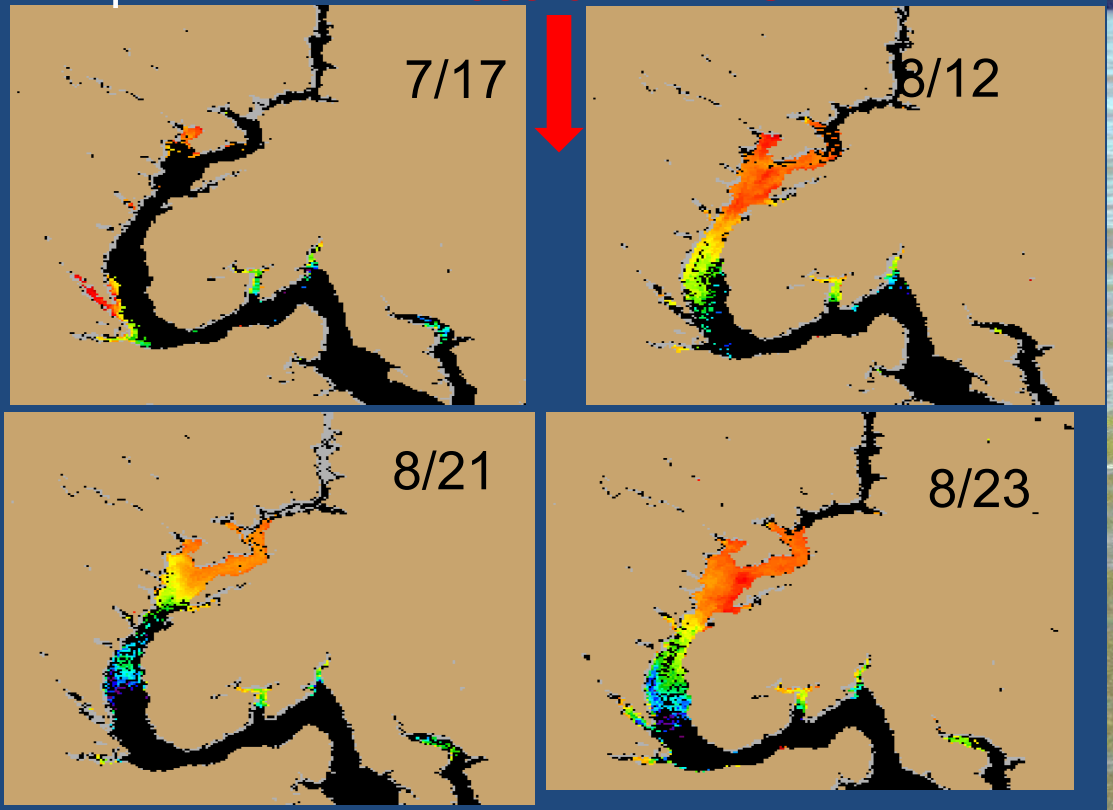




Potomac estuary 2011 *Microcystis* bloom

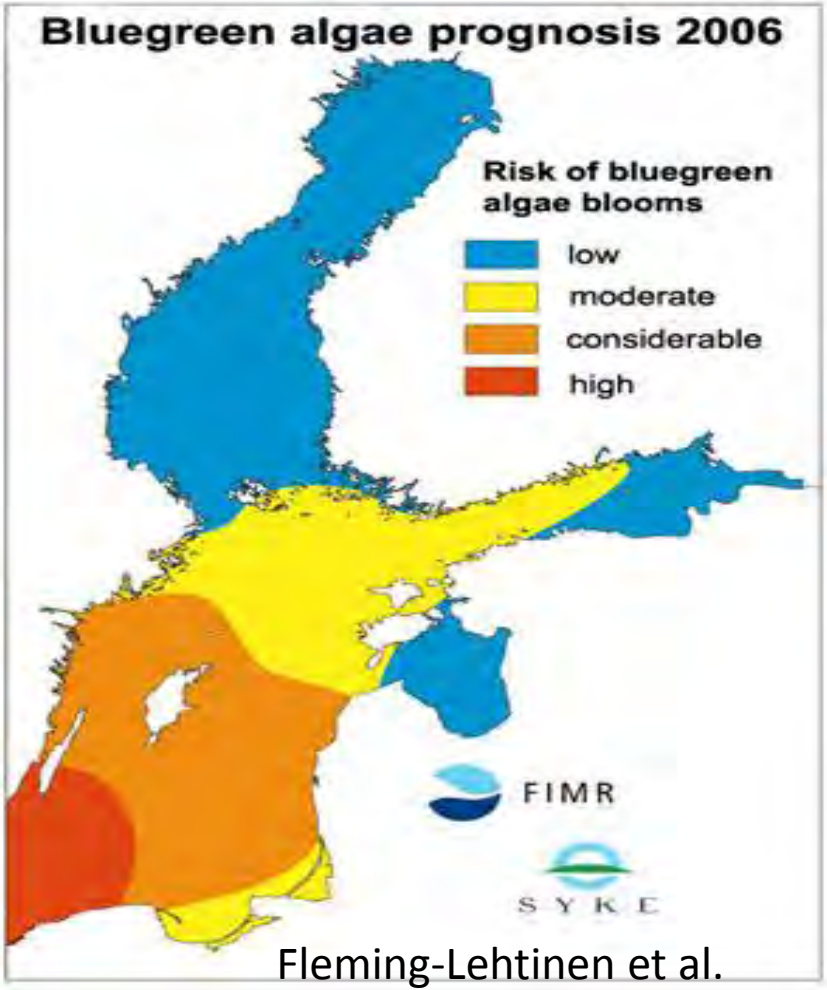
Improved CI

Loss of MERIS



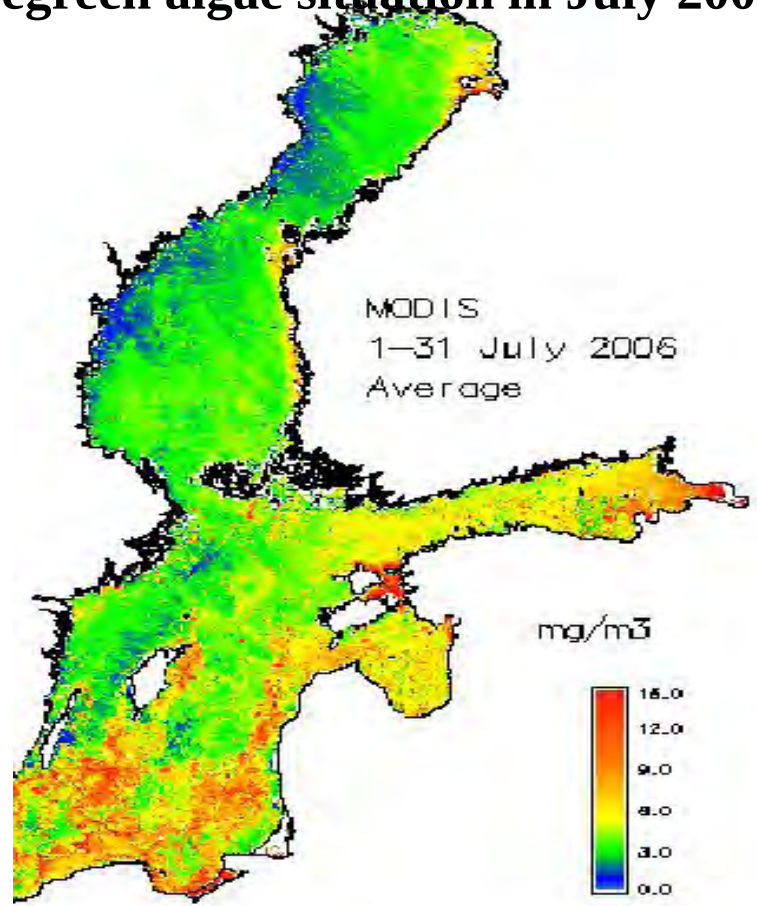
Support State and local govt to reduce monitoring. Transferred algorithm from Lake Erie to Potomac estuary

Jul 27, 2011
Courtesy of Dr. Chris Jones
George Mason Univ.

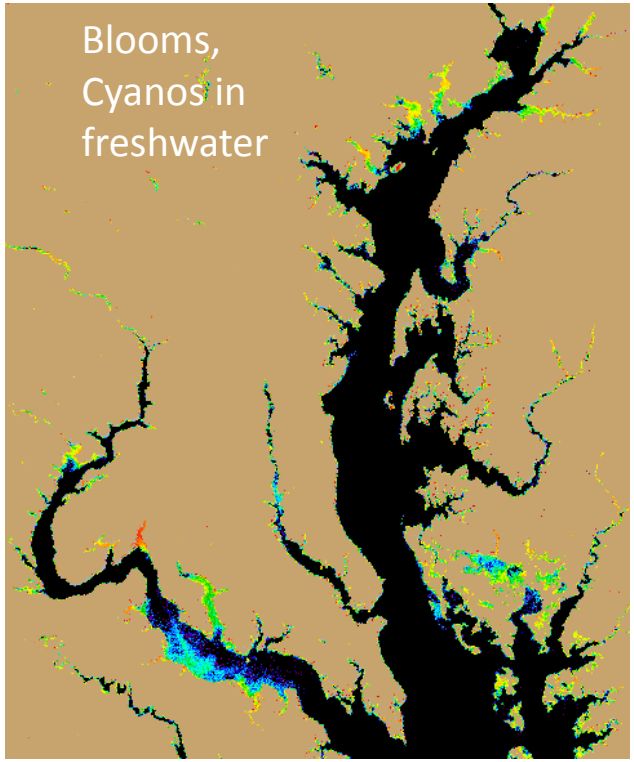


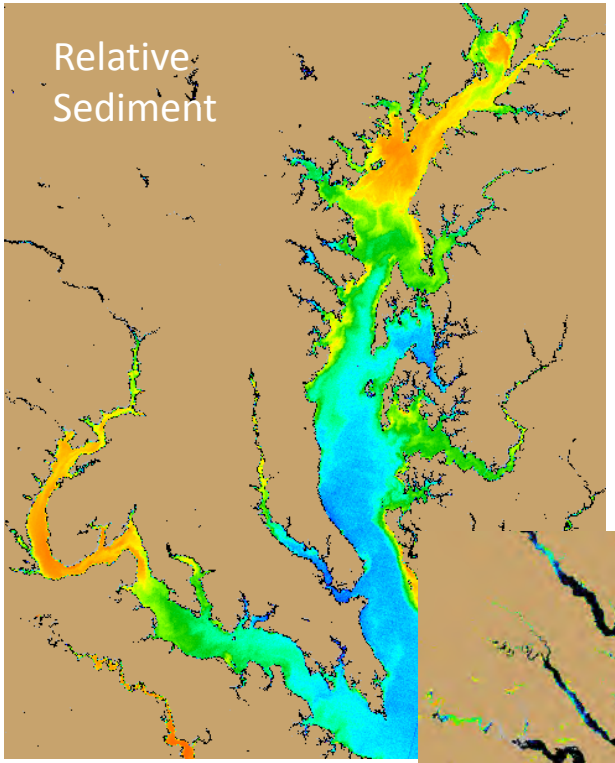
Fleming-Lehtinen et al.

Bluegreen algae situation in July 2006

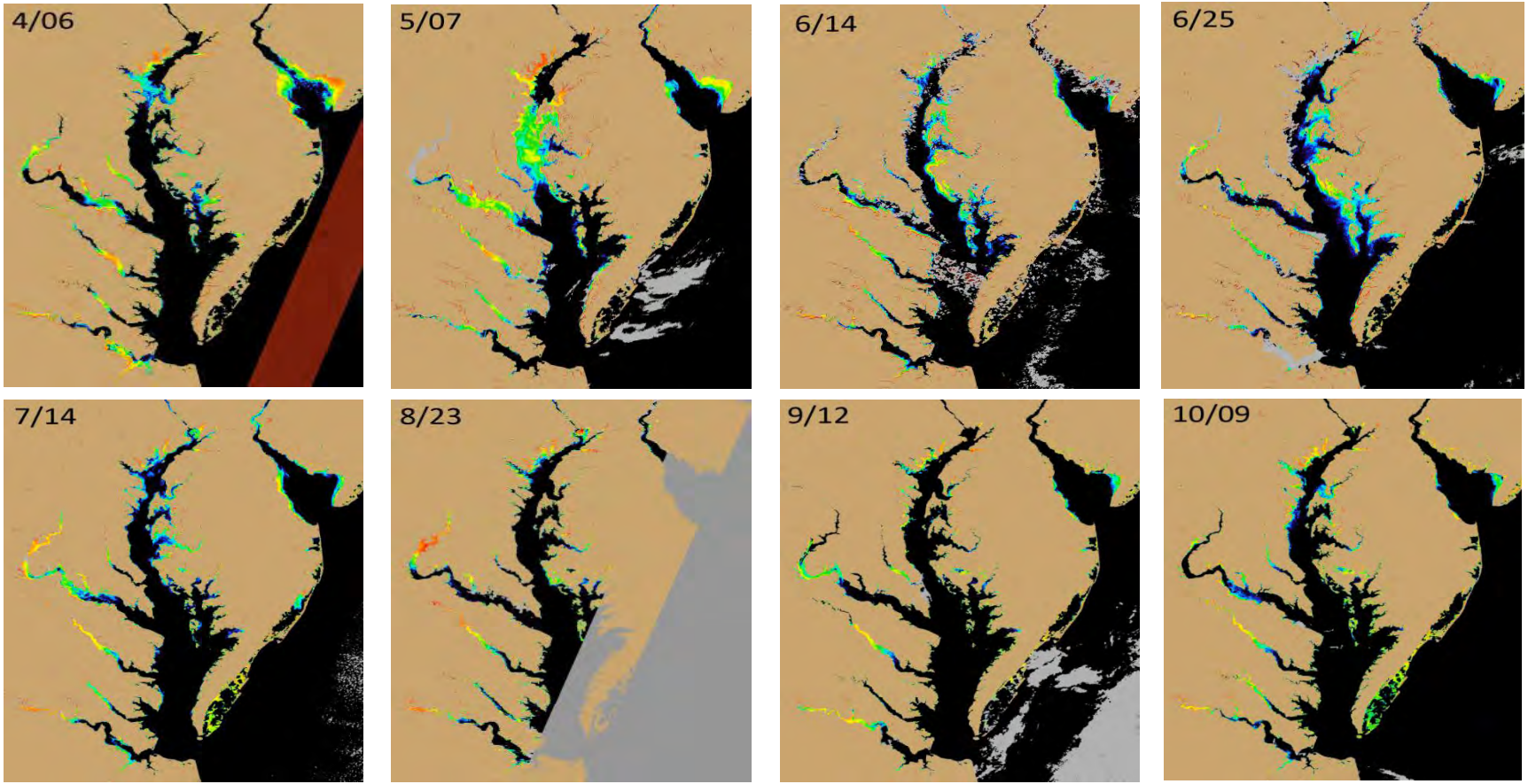


Chesapeake Bay Bloom Detection





Monitoring for blooms, 2011 CI Time Series subset



Report

Mati Kahru, Ulrich Horstmann and Ove Rud

Ambio, 1994

Satellite Detection of Increased Cyanobacteria Blooms in the Baltic Sea: Natural Fluctuation or Ecosystem Change?

Using data from the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA series of satellites, an increase in the area covered by cyanobacteria blooms in the Baltic Sea was detected. The time series of satellite data covers a period of 12 years from 1982 to 1993. The total area covered by surface-floating cyanobacteria (blue-green algae) has increased in the 1990s, reaching over 62 000 km in 1992. From 1992, visible accumulations appeared for the first time in the Gulf of Riga and re-appeared, in the western Gulf of Finland, after being absent from 1984. Conspicuous surface blooms were also present in the early 1980s, coincident with a period of sunny and calm summers. However, when the influence of variable sunshine duration is taken into account, the increase in 1991–1993 is still distinct, indicating significant changes in the Baltic environment. The causal factors for the increased cyanobacteria blooms are still not clear.

from Kahru et al. Ambio, 1994

Figure 6. July–August average monthly sunshine duration and daily surface irradiance over the Baltic Sea in 1982–1993. Sunshine duration (bar plot, left scale) is the average of measurements at two stations (Ölands Södra Udde and Visby) by the Swedish Meteorological and Hydrological Institute with pyrheliometers (time > 120 W m^{-2}). Average daily surface irradiance (1983–1989, line plot, right scale) has been compiled from data produced by the International Satellite Cloud Climatology Program (10) and is an average for the Baltic Proper area.

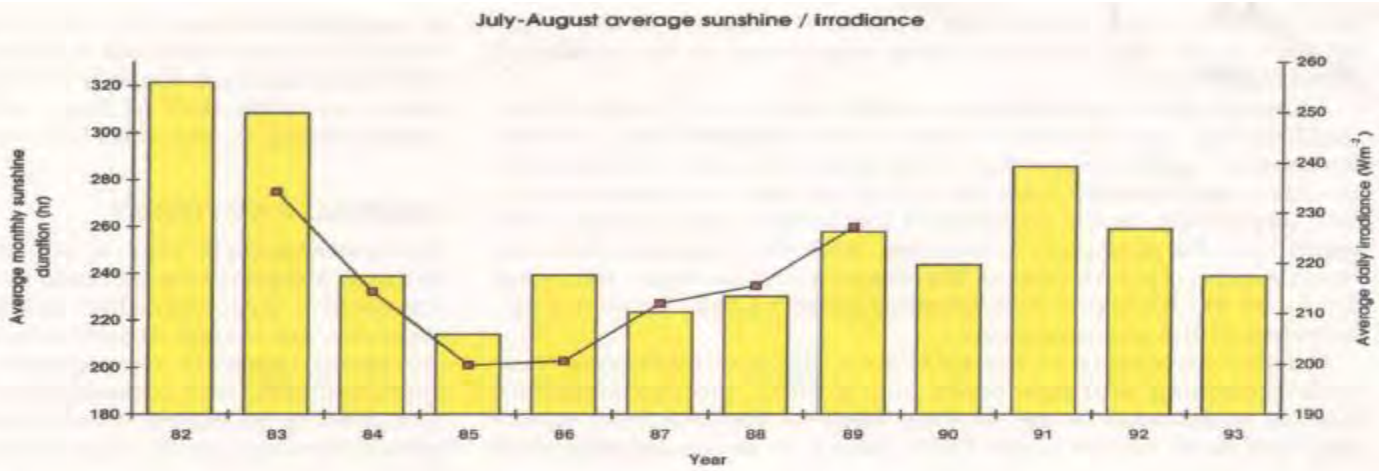
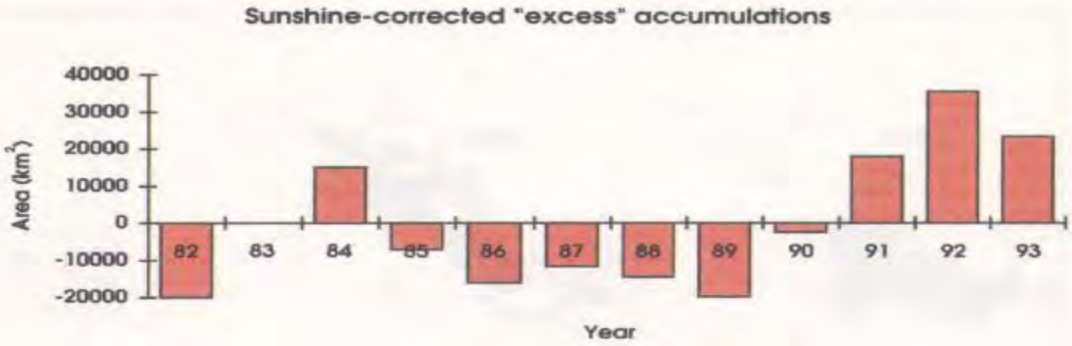
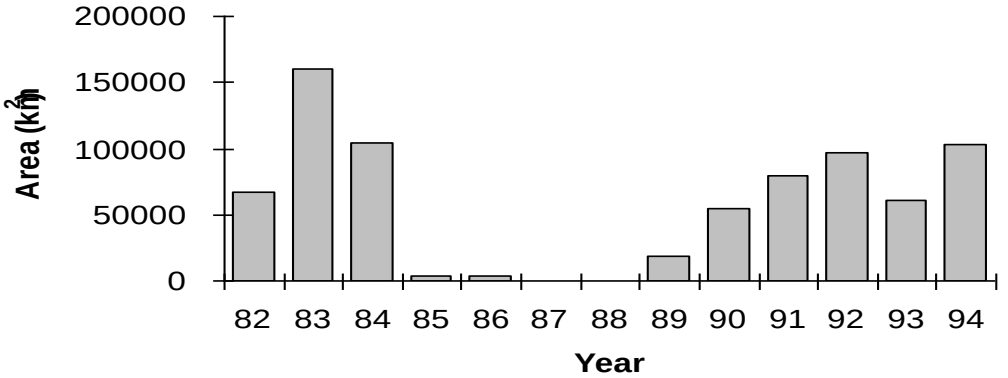


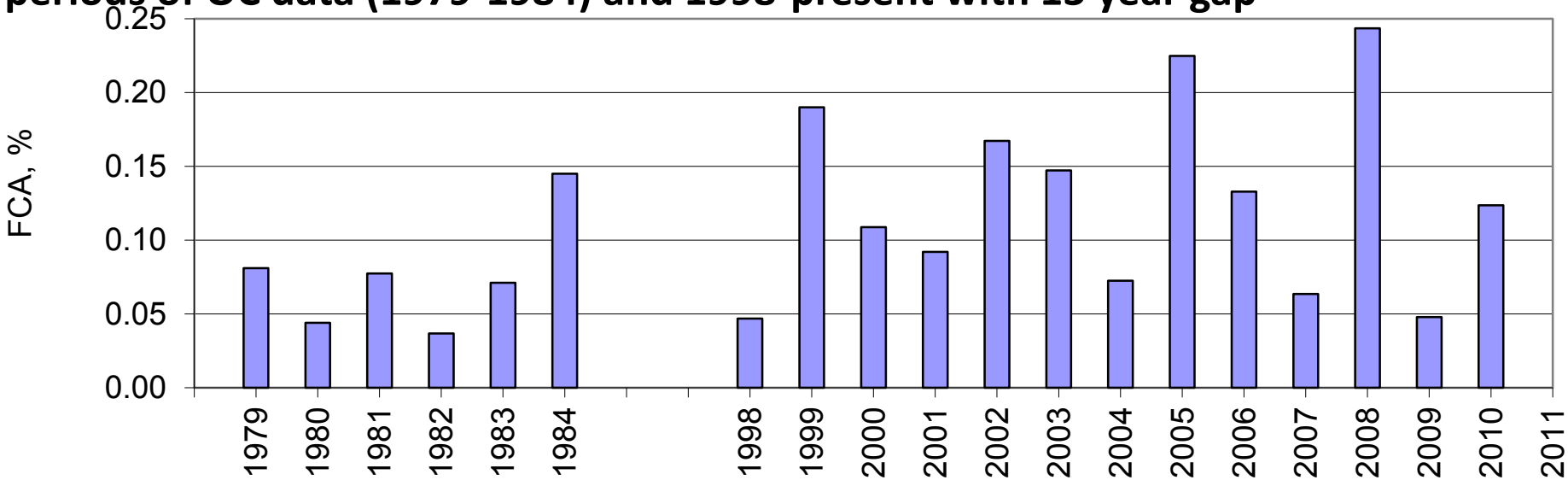
Figure 7. Dynamics of the total area of cyanobacterial accumulations corrected for the monthly average (July–August) sunshine duration.



13-year gap (1985-1997) gap has AVHRR data

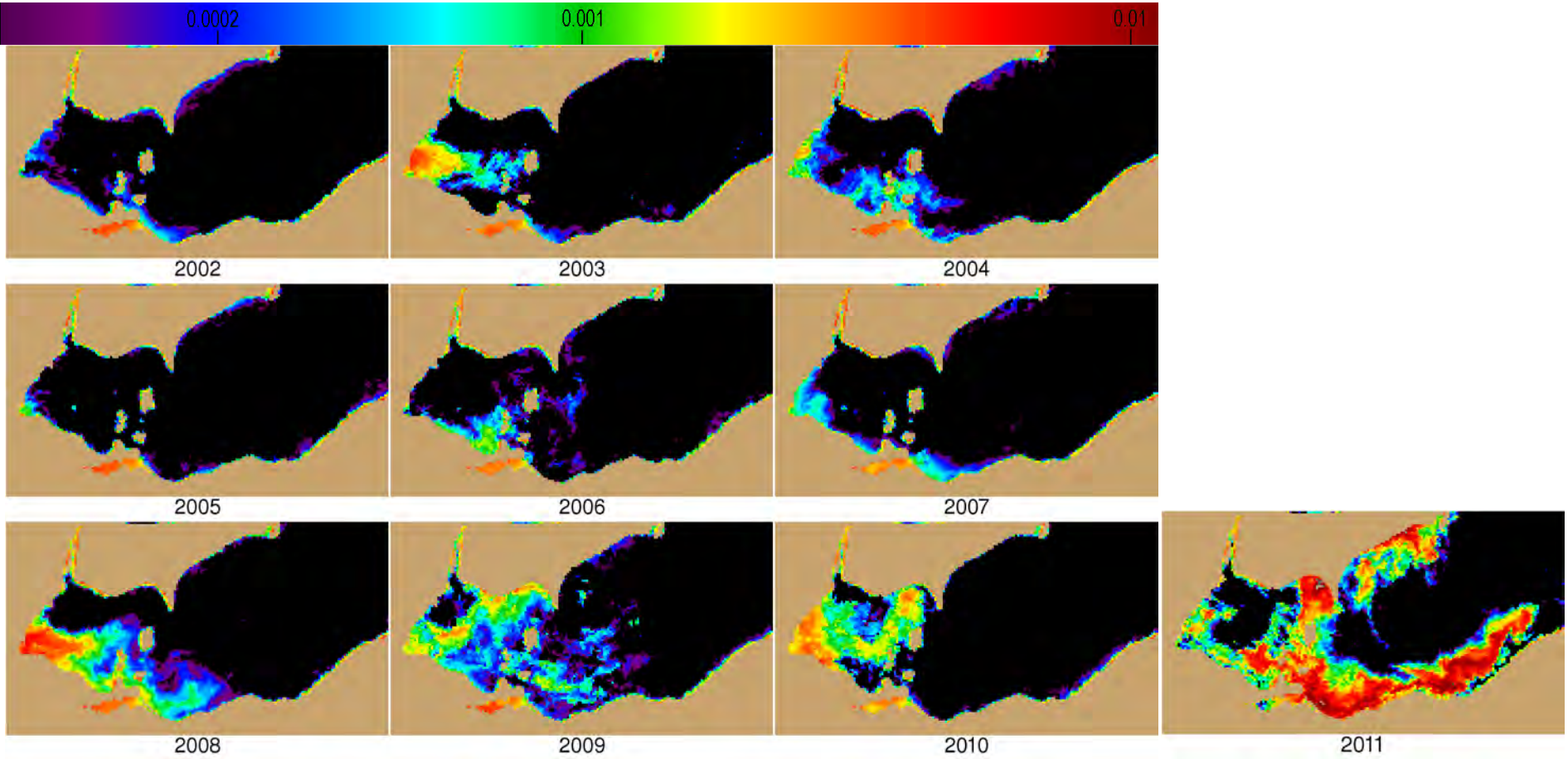


2 periods of OC data (1979-1984) and 1998-present with 13 year gap

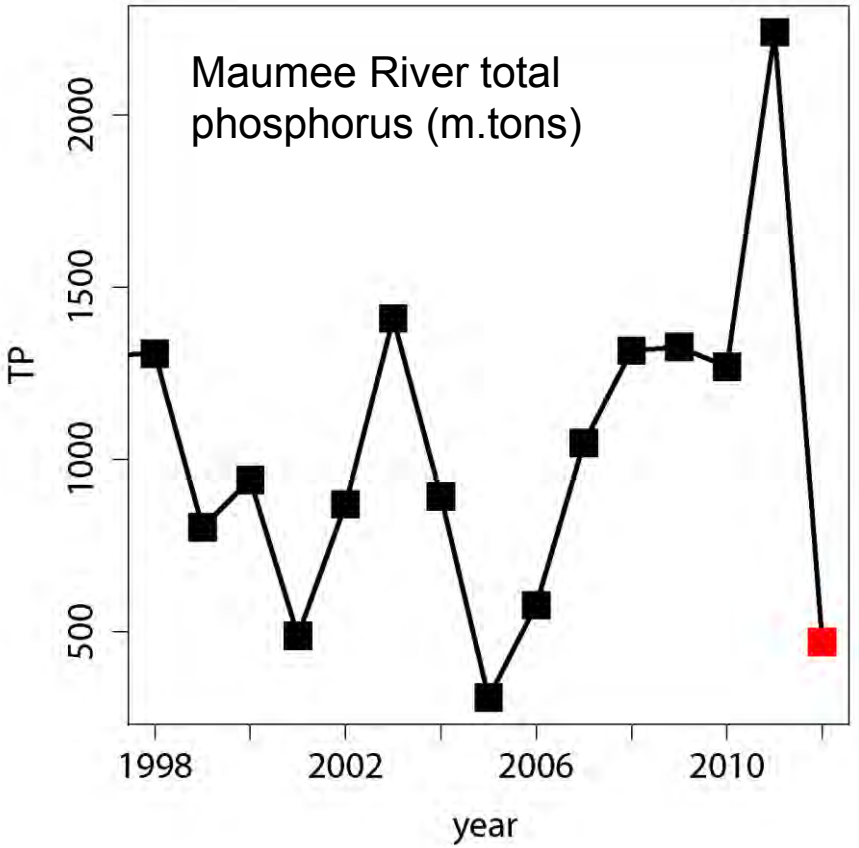


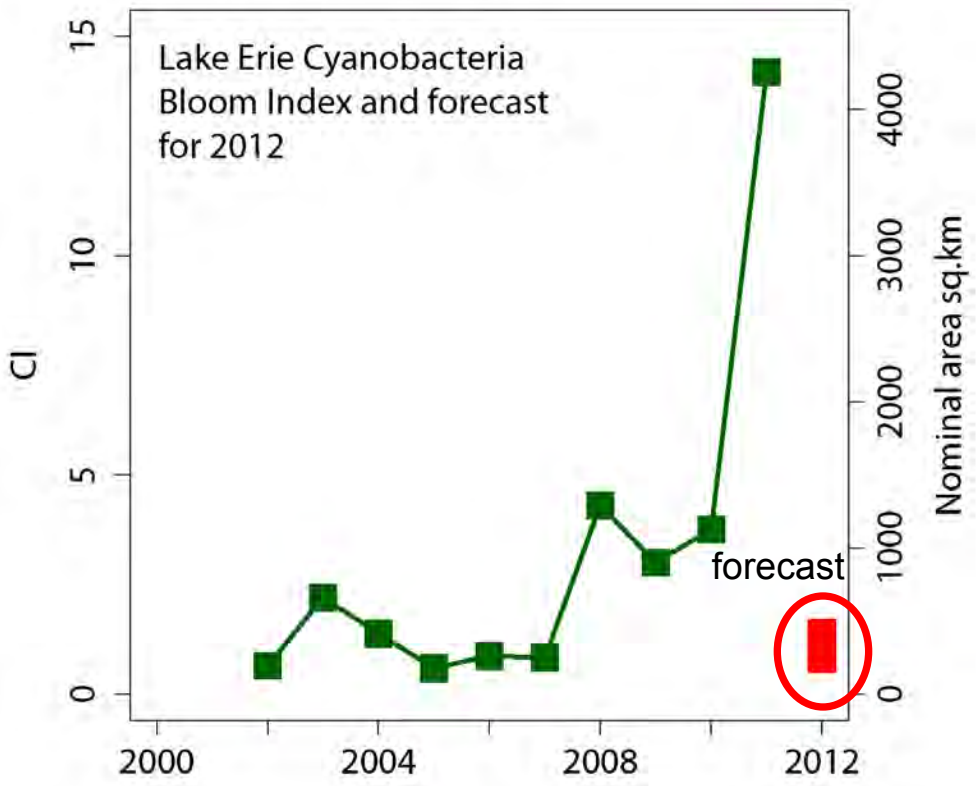
After 2006, 13% increase in FCA from period 1 to period 2 (not sig). Kahru 2007

Lake Erie inter-annual variation



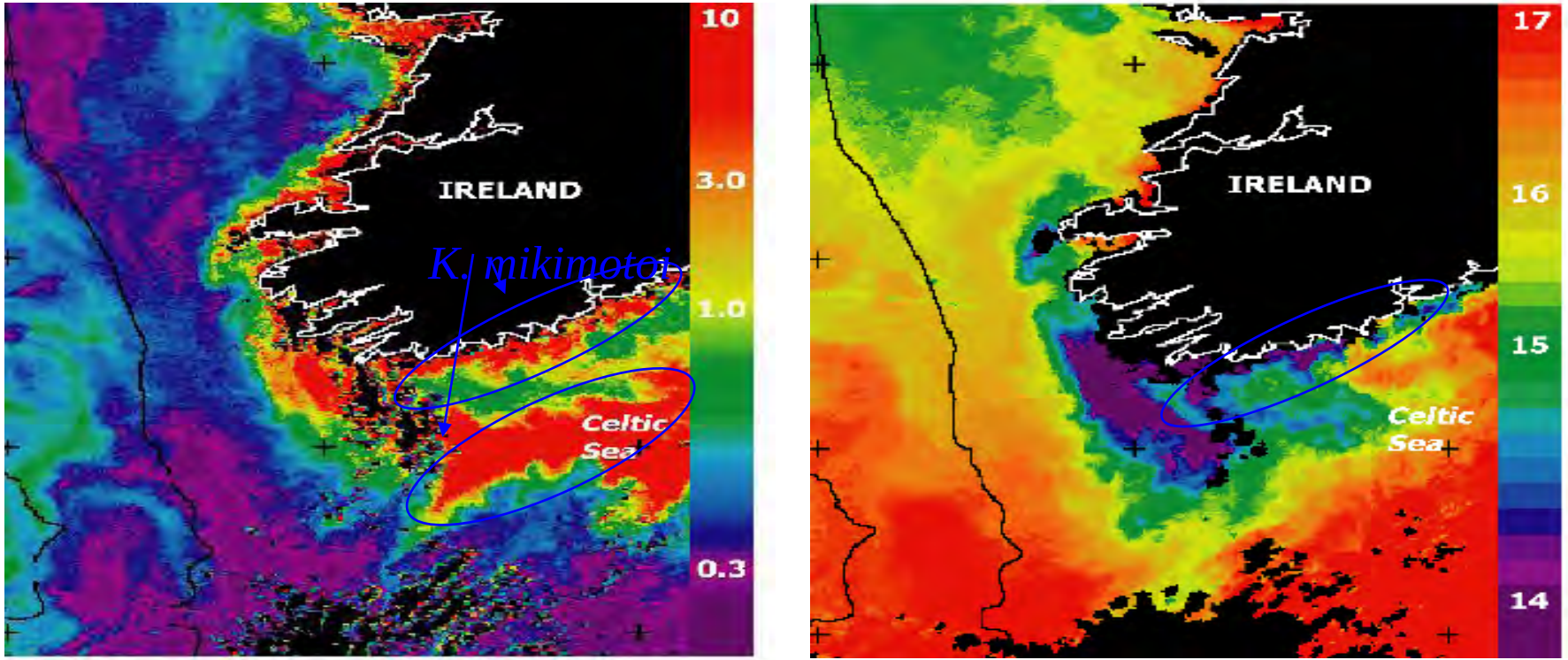
Analysis of bloom size. Comparison with phosphorus load (and discharge) for a forecast (Stumpf et al, in press)





Combining satellite data sets help.

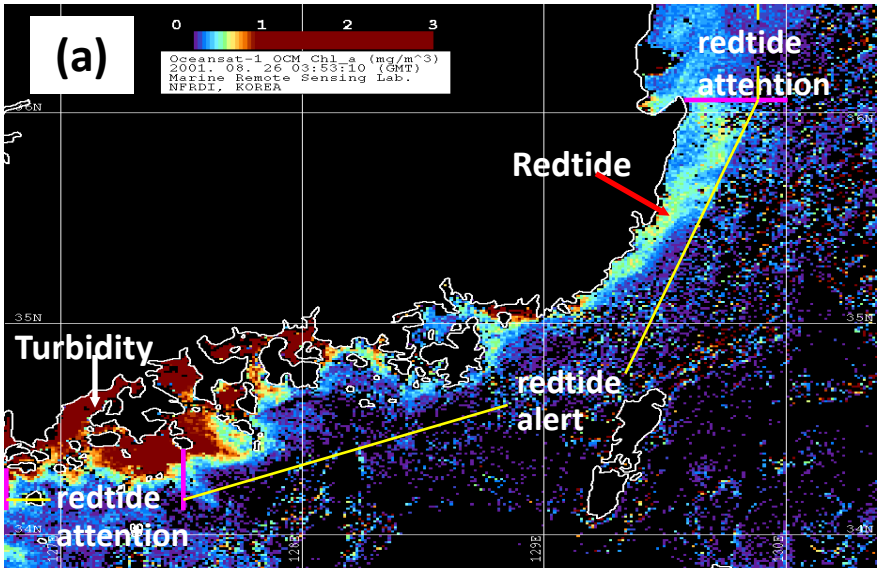
K. mikimotoi starts at pycnocline, appears at the coast in upwelled cold water (Raine et al., 2001)

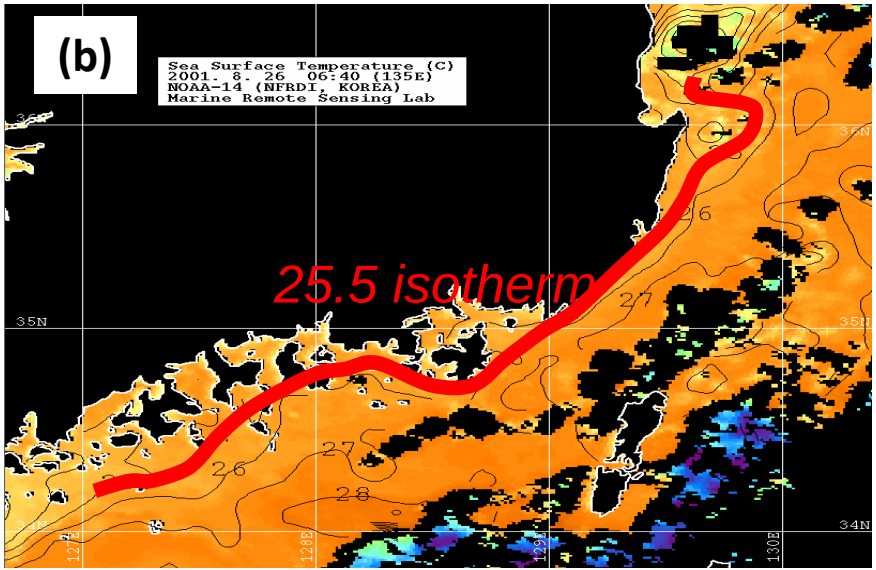


Korea HAB linkage to 25-26 ºC line

Chlorophyll

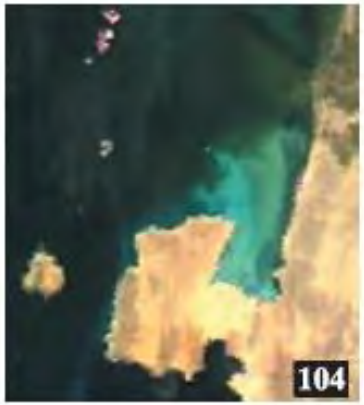
SST

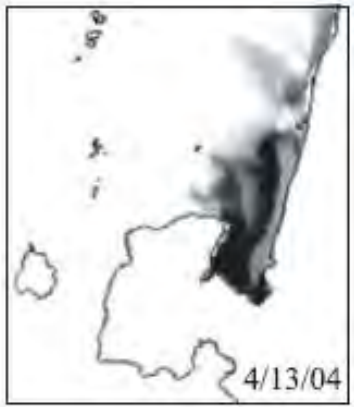


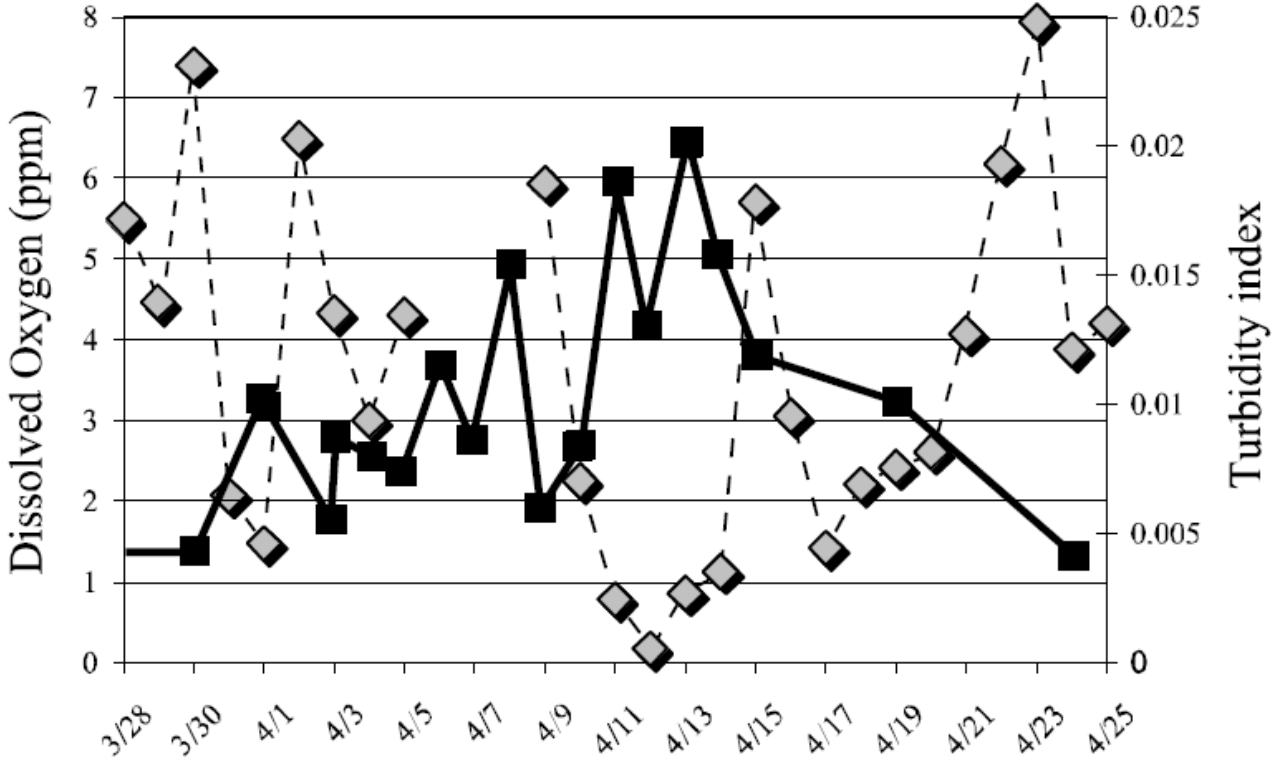


Suh et al., 2004

Comparing data to impacts (e.g., low oxygen with HABs)







Kahru et al., 2004

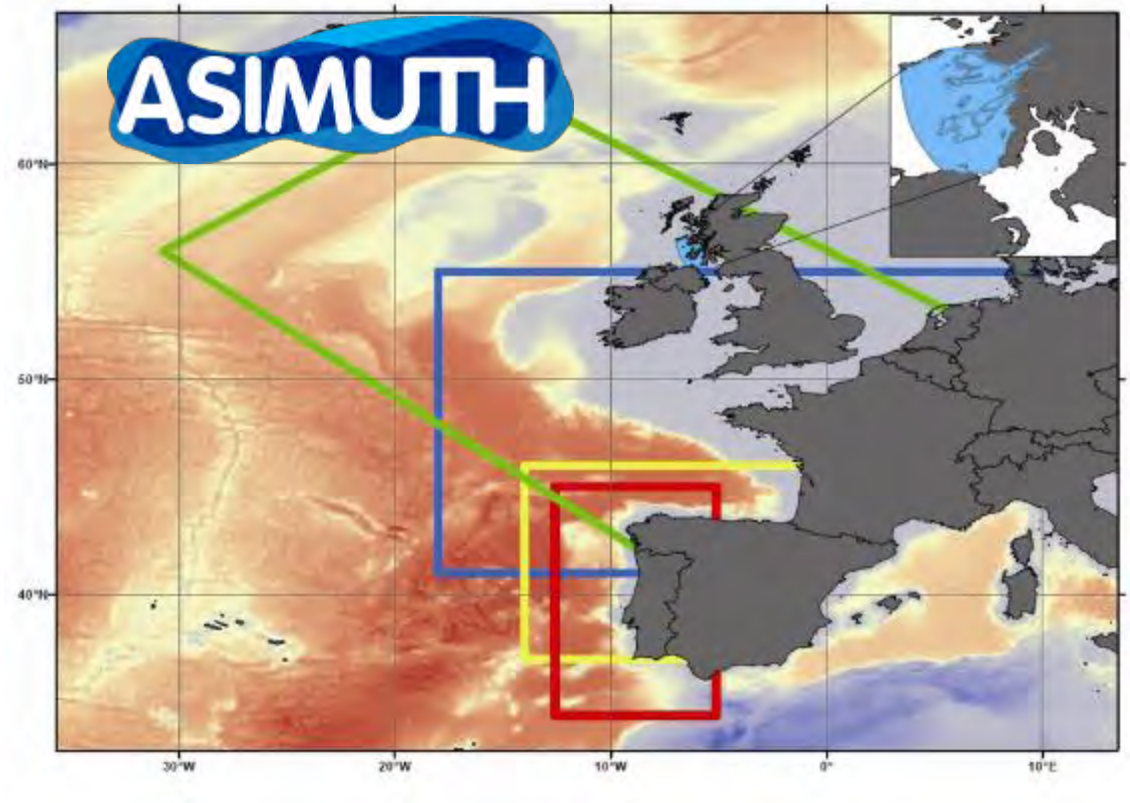
Some HABs detected or monitored with remote sensing

HAB Species	Region	Sensing Type	Impact
Pseudo-nitzschia	Upwelling regions	SST, chlorophyll	ASP, variable
Karenia brevis	Gulf of Mexico	Test models with user input	NSP, respiratory, fish toxin
Karenia mikimotoi	Coastal ocean (Hong Kong, Ireland, New Zealand)	SST chlorophyll	NSP
Gymnodinium catenatum	Estuaries, coastal ocean, upwelling	SST chlorophyll	PSP
Alexandrium spp.	Coastal ocean (Gulf of Maine, Gulf of Alaska)	SST	PSP
Gonyaulax	Upwelling regions	Chlorophyll, possible UV absorption	Fish toxin
Cochlodinium	Coastal ocean (British Columbia, Korea)	SST, chlorophyll	Shellfish toxin
Nodularia	Enclosed Brackish	Color	Hepatotoxin

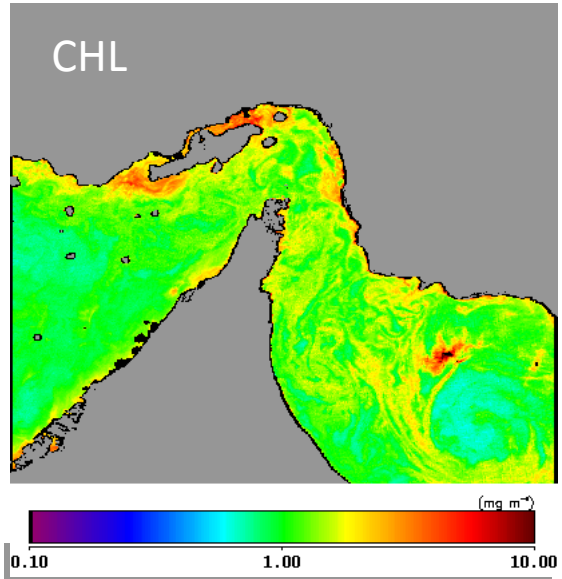
Other major HABs not clearly monitored with remote sensing

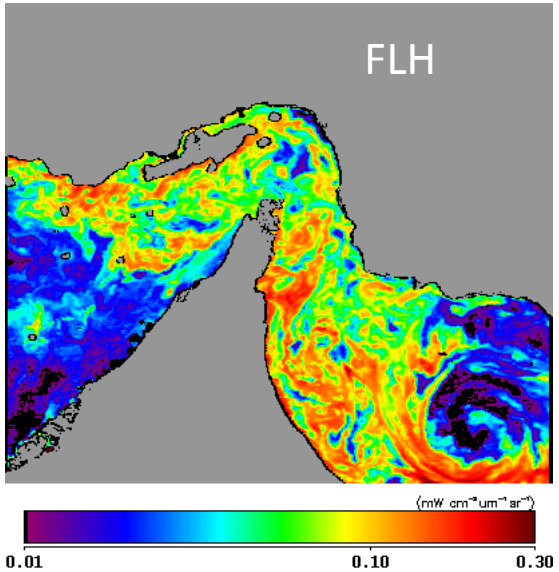
Dinophysis	Ireland, Portugal, Norway	SST	Shellfish toxin

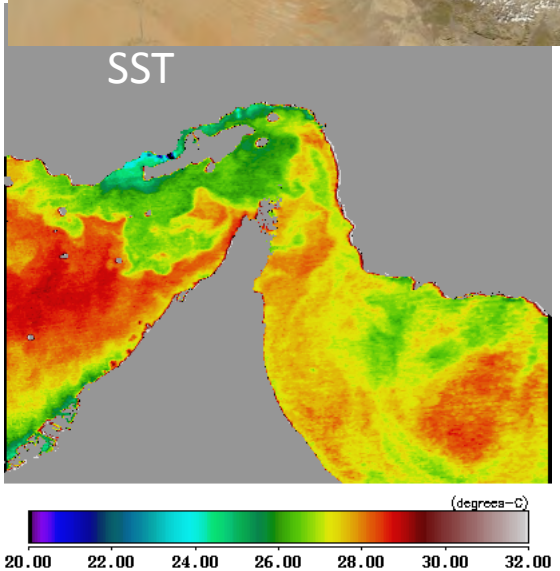
In the EU, improved modeling to support forecasts

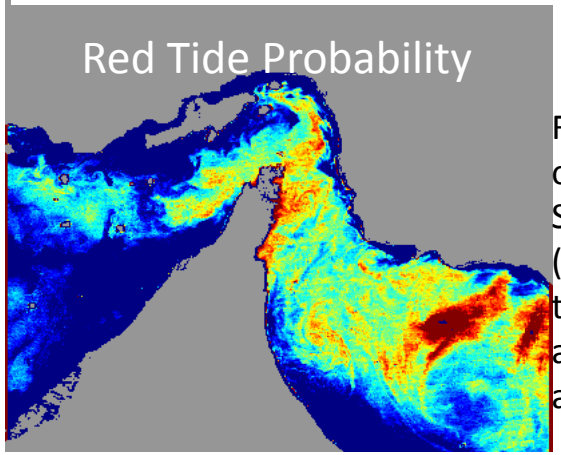


Applied **S**imulations and **I**ntegrated **M**odelling for the **U**nderstanding of **T**oxic and **H**armful Algal Blooms









Crisis for desalination plants

Figure 4. 250 m MODIS data processed with optimized atmospheric correction showing SST, CHL, FLH, and red tide probability (relative index) for 19 November 2008. Note the cyclonic eddy in the Gulf of Oman, associated with higher probability of red tide at the NE edge. Kudela et al., in press

Tough Applications

Foam from ocean algae bloom killing thousands of birds
www.oregonlive.com; 22-Oct-2009; photo: P. CHILTON/Coastal Observation and Seabird Survey Team.
Akashiwo sanguinea bloom

Dead marine mammals

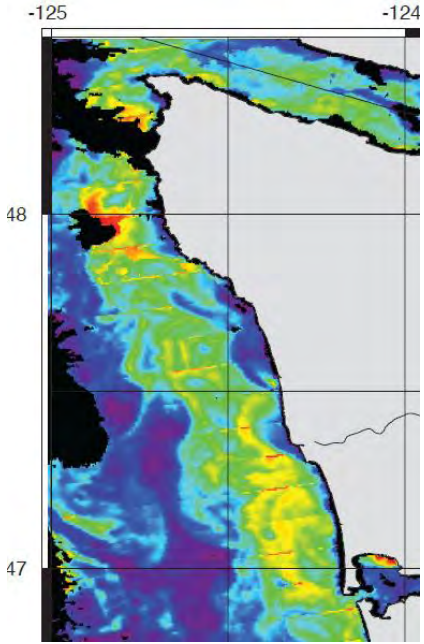
Dead birds

Unexpected fish kills

New bloom for the region.

MODIS FLH
01-Nov-2009

NOAA
CoastWatch



Response strategy

- What is the bloom?
- Where?
- Has anything changed?
- Is it different than other years?
- What needs to be answered, how much, where?

Harmful Algal Blooms (HABs)