



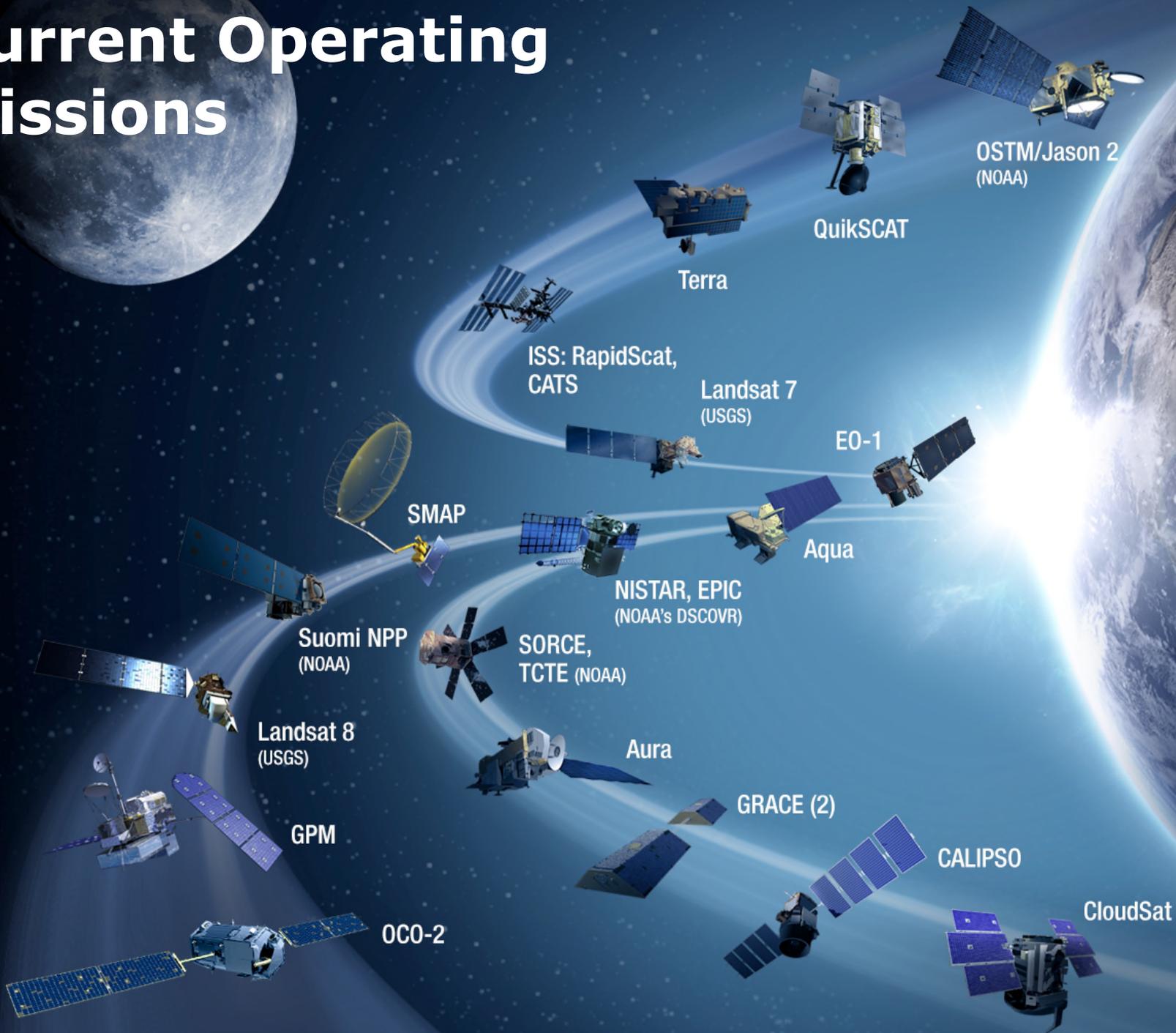
# **NASA Health and Air Quality Applications: The Intersection with Water Quality**

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# NASA Earth Science: Current Operating Missions





**Launch of GPM  
on February 28,  
2014, from  
Tanegashima  
Space Center,  
Japan.**



**Launch of SMAP on  
January 31, 2015,  
from VAFB.**

***Discovering and demonstrating innovative and practical uses of Earth observations in organizations' policy, business, and management decisions.***



***<http://AppliedSciences.NASA.gov>***

## ***Applications***

Prove-out, develop, and transition applications ideas for sustained uses of Earth obs. in decision making.

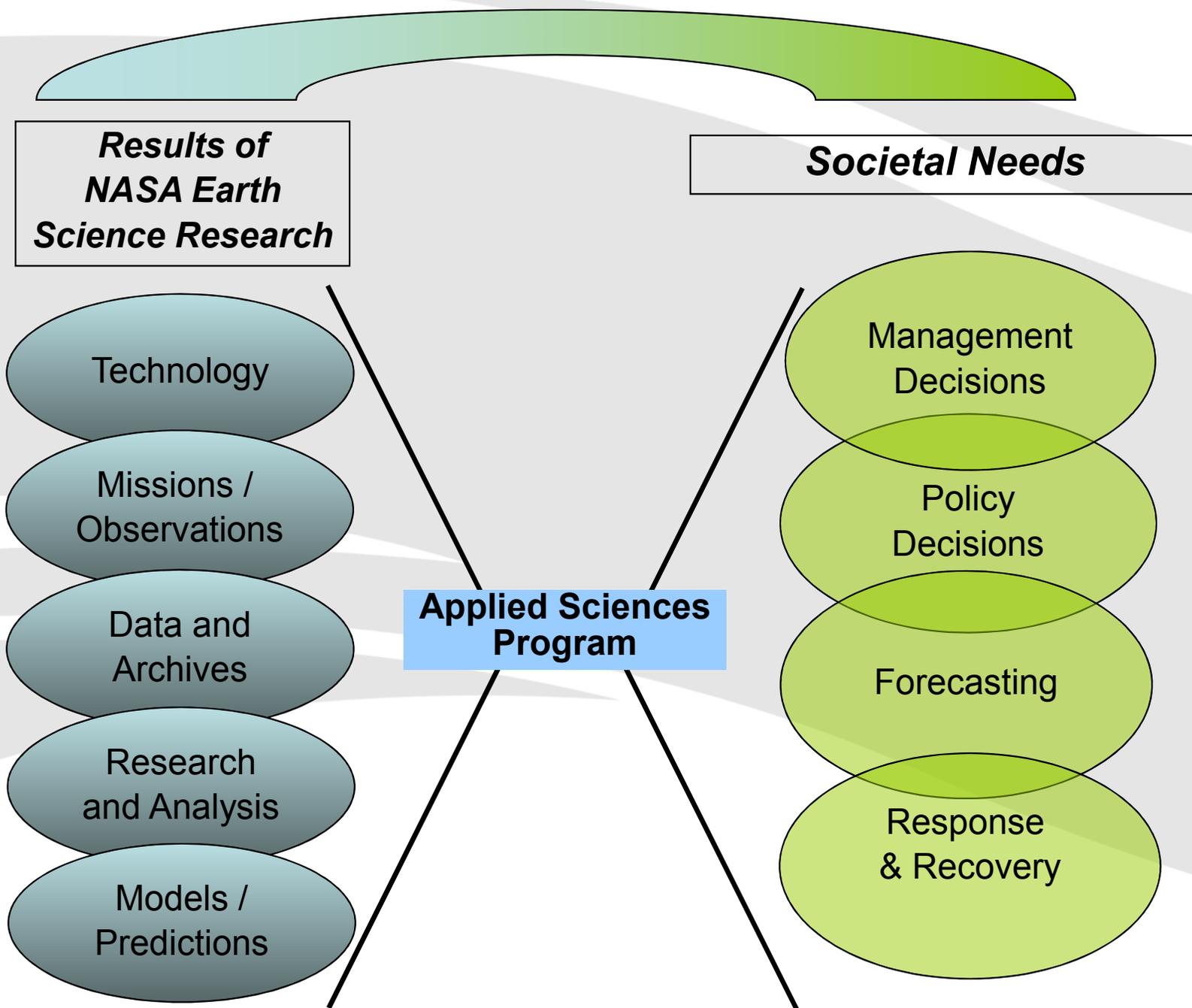
## ***Capacity Building***

Build skills and capabilities in US and developing countries to access Earth observations to benefit society.

## ***Mission Planning***

Identify applications early in mission lifecycle and integrate end-user needs in mission design and development.

# NASA Applied Sciences Architecture



## Emphasis in 4 Applications Areas



**Health &  
Air Quality**



**Water  
Resources**



**Disasters**

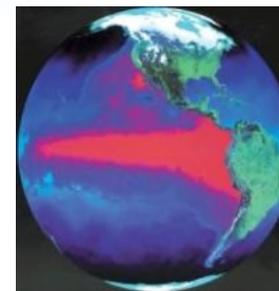


**Ecological  
Forecasting**

## Support opportunities in 5 additional areas



**Agriculture**



**Climate**



**Weather**



**Energy**

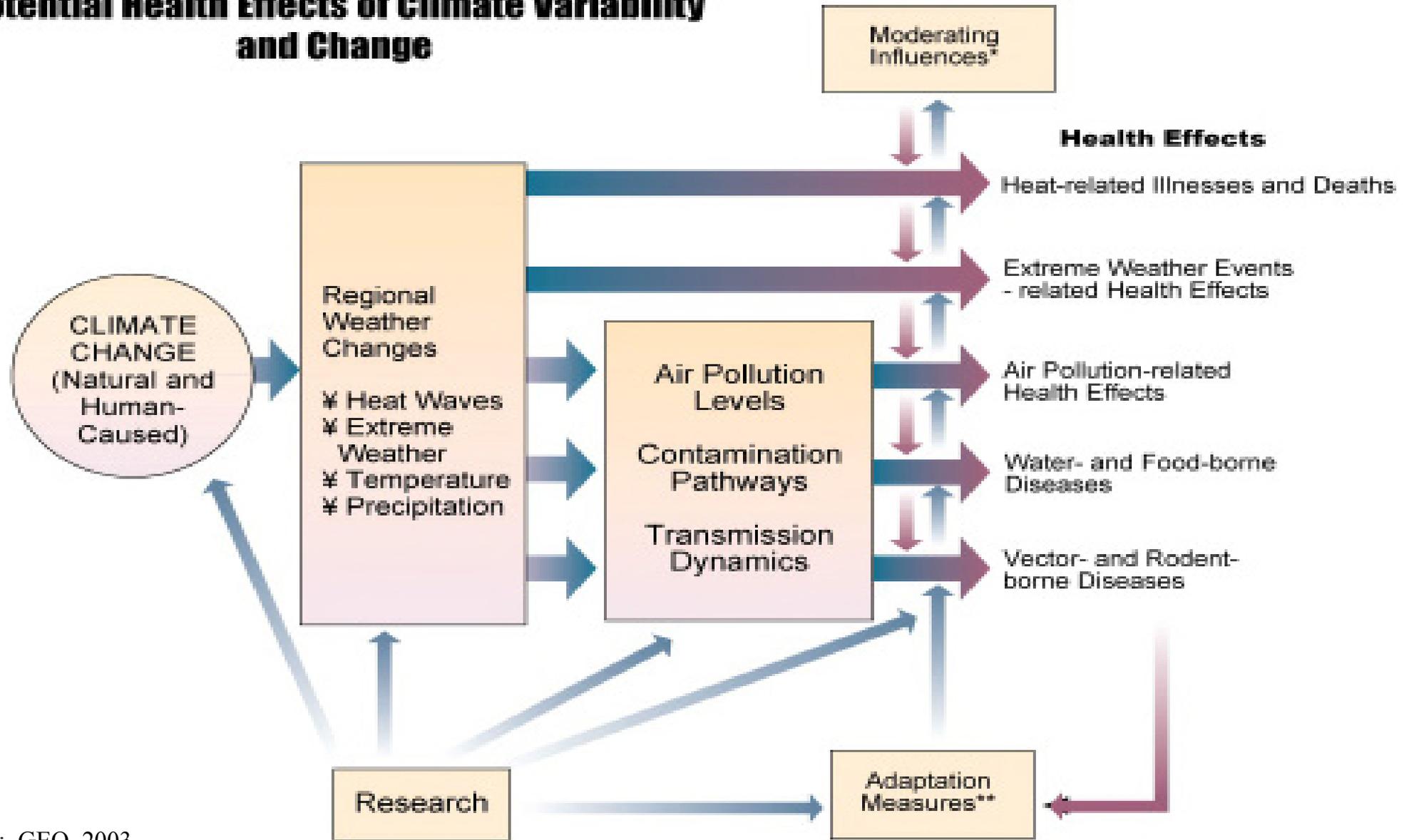


**Oceans**

# Why Health & Air Quality?



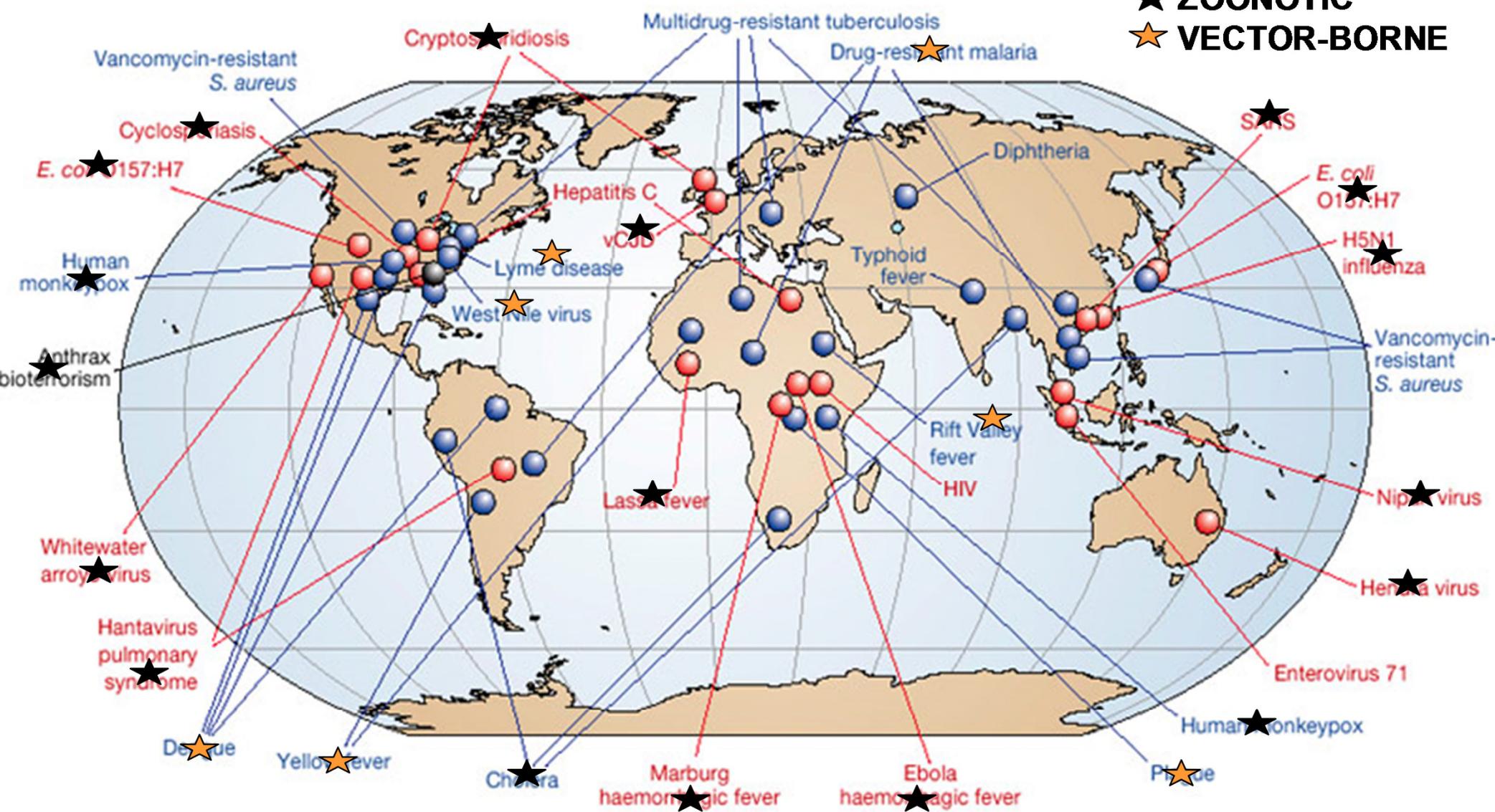
## Potential Health Effects of Climate Variability and Change



# Global Emerging Diseases\*



★ ZONOTIC  
★ VECTOR-BORNE



EMERGING  
RE-EMERGING

\* Modified from Morens et al. 2004 Nature 430:242



# New Environmental Threats



This visible image of the Gulf oil slick was taken on May 9, 2010, at 19:05 UTC (3:05 p.m. EDT) from MODIS aboard NASA's Aqua satellite. Crude oil brings volatile organic compounds into the air which can react with nitrogen oxides to produce ozone.



## Objectives:

- NASA's Health & Air Quality Applications Area supports the use of Earth observations in air quality management and public health, particularly regarding **infectious disease and environmental health** issues.
- The area addresses issues of toxic and pathogenic exposure and health-related hazards and their effects for risk characterization and mitigation.
- The area promotes uses of Earth observing data and models regarding **implementation of air quality standards, policy, and regulations** for economic and human welfare.
- The Health & Air Quality Applications Area also addresses **effects of climate change on public health and air quality** to support managers and policy makers in their planning and preparations.

# Enhanced Oil Spill Detection

As of:  
6/30/15

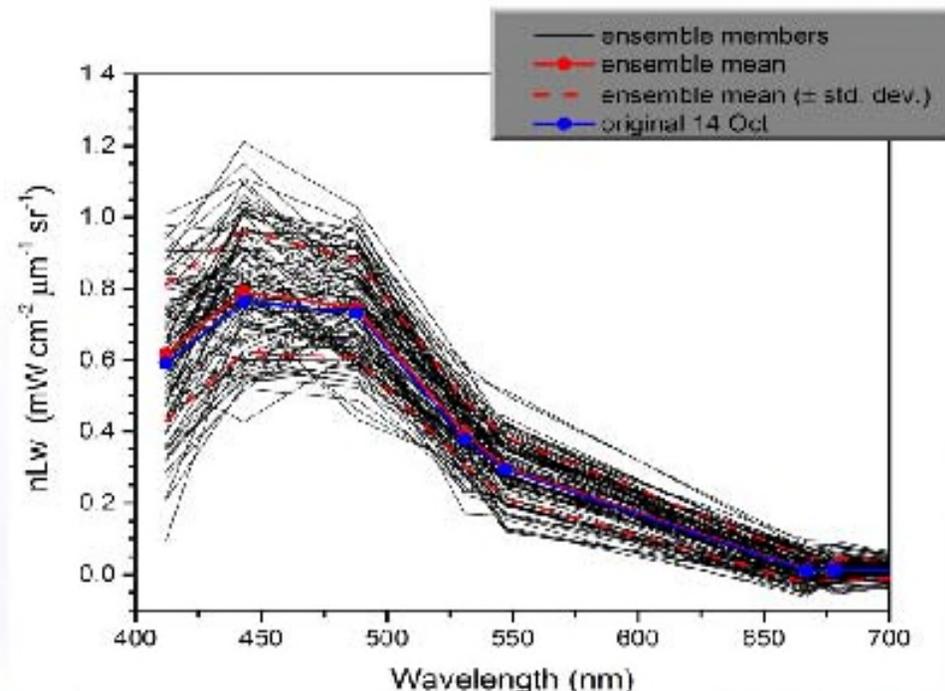


**PI: Sonia Gallegos, Ph.D., SSC**  
**Collaborators: NOAA, NRL**

- Goal: Develop an algorithm to identify thick oil in MODIS non-glinted satellite imagery.
- Data Used: MODIS-Aqua NIR/FIR imagery, and *in-situ* measurements collected during DWH oil spill.
- Methods: 1) Separate oil pixels from low-level cloud pixels using VIS/FIR channels, 2) Identify oil pixels by spectral thresholds, 3) Test other methods.
- Validate algorithm with NOAA products and *in-situ* data.

## Accomplishments

- Continued efforts to remove the noise in the texture algorithm resulting from high loads of sediment in the coastal areas.
- Completed developing the ensemble model set across the 412nm to 2130nm range to extend detection of dispersed oil.
- Completed the analyses for single channel data in the ensemble model.
- Completed the analyses for the slope of two bands in the ensemble model.
- MODIS products were computed for NW Australia for the period from 2002 until 2009 to help develop techniques to enhance detection of oil slicks in sediment-rich coastal waters.



Dispersed oil ensemble model highlighting the ensemble method used



Oil slick and sheen



**PI: Tom Linton, Ph.D., TAMU-Galveston**

**Collaborators: SSC, NRL**

- Goal: Automate the process of providing *Sargassum* landing alerts to coastal stakeholders
- Data Used: Landsat-7 and -8, HYCOM, and buoy data
- Methods: 1) Automate detection of *Sargassum* in satellite imagery, 2) Use ocean circulation and wind data to forecast landings, 3) Provide landing alerts via app, email and/or SMS
- Validate predictions with observations from coastal managers.

## Accomplishments

- SSC and TAMU-Galveston organized and hosted the 2015 *Sargassum* Symposium held in Galveston, TX on April 2-3, 2015.
- Released version 1.1 of the *Sargassum* web application that featured refinements to the forecasting engine and the *Sargassum* identification algorithm.
- Began testing an approach to automate the retrieval of Landsat images from the DAAC.
- NRL delivered another version of the Landsat-8 *Sargassum* detection algorithm.



Oiled *Sargassum* seaweed in the Gulf of Mexico after Deepwater Horizon oil spill



Enhanced image of approaching *Sargassum* in the Gulf of Mexico

# Monitoring and Forecasting Harmful Cyanobacterial Blooms in Lake Erie

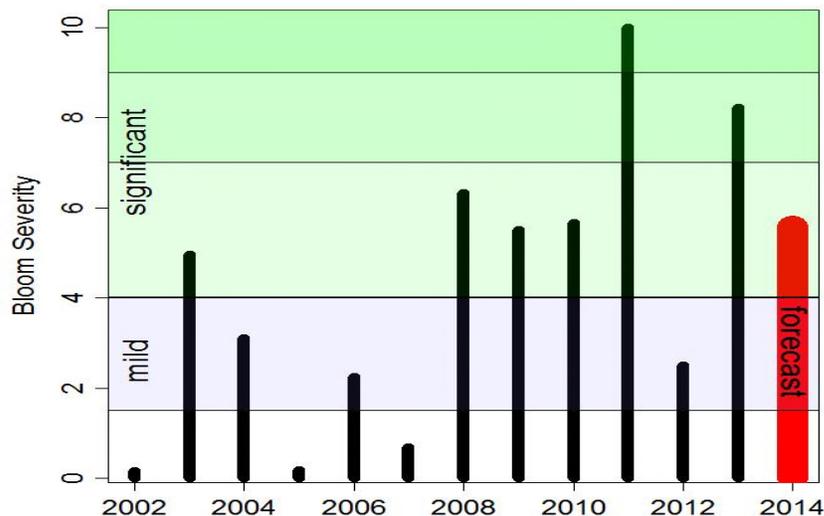
Rick Stumpf, NOAA, PI



On Aug 02, 2014, City of Toledo issued “do-not-drink” for 400,000 people.

This project gave Toledo advance warning to monitor for toxic drinking water.

Seasonal forecast for 2014, warning of a significant bloom (models developed in Stumpf et al., 2012, PLoS ONE)



## Timeline of 2014 events:

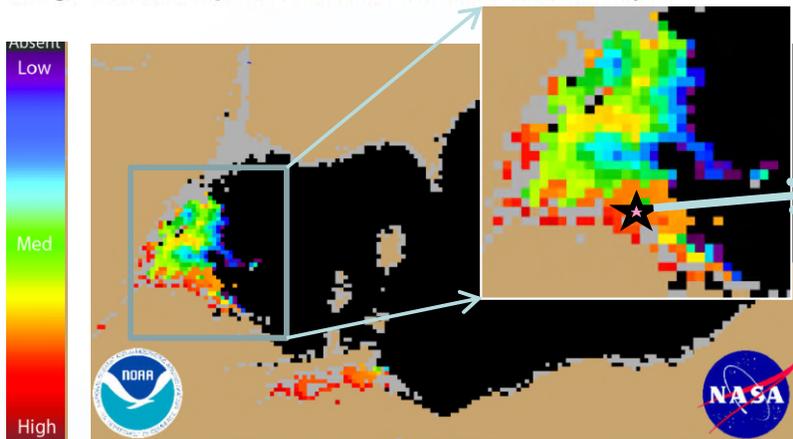
- June 5 first bulletin (#1) this year
- July 10 **Seasonal forecast issued**
- July 17 #7 bloom first indicated in Maumee Bay
- July 18 supplemental to Ohio EPA, bloom on Ohio coast.
- July 21 EPA samples & posts Maumee Bay State Park
- July 28 **#8 bloom identified along Ohio coast**
- Aug 01 **#9 Bulletin reports intensification**
- Aug 02 **Toledo finds microcystin in finished water**
- Aug 04 **#10 Bulletin update of other areas at risk**
- Aug 05 Toledo cancels water notice.

## Experimental Lake Erie Harmful Algal Bloom Bulletin

National Centers for Coastal Ocean Science and Great Lakes Environmental Research Laboratory

1 August 2014, Bulletin 09

The bloom near the Maumee River has expanded since last weeks bulletin. Low winds (<10 knots) are forecast for the weekend, which may lead to scum formation in the Western basin near the Maumee River. A slight eastern transport has been forecasted for the next few days.



geocaching.com

Toledo water intake

*“[The Aug 01 Bulletin] put everyone on their toes. The extra vigilance is important for catching blooms in the vicinity of our intakes and beaches.”*

Email from Ohio EPA, 04 Aug 2014

02 August 2014

### Urgent water notice!

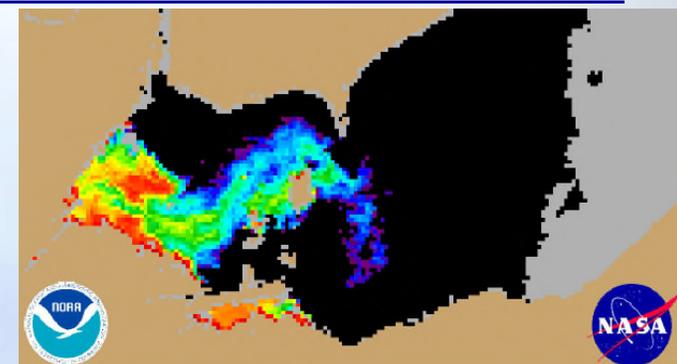
URGENT NOTICE TO RESIDENTS OF TOLEDO & LUCAS COUNTY WHO RECEIVE WATER FROM THE CITY OF TOLEDO

DO NOT DRINK THE WATER  
DO NOT BOIL THE WATER

**Bulletins continued to be issued twice weekly until end of season (Oct. 2014).**

### 4 August 2014, Bulletin 10

The microcystin bloom has intensified since last Thursday. . . Today and Tuesday expect slight northeast transport (away from the Maumee Bay area).





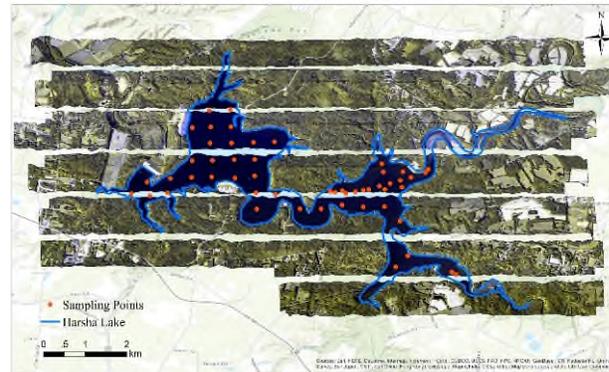
# 2015 Harmful Algal Blooms Campaign

## August 31 – October 22

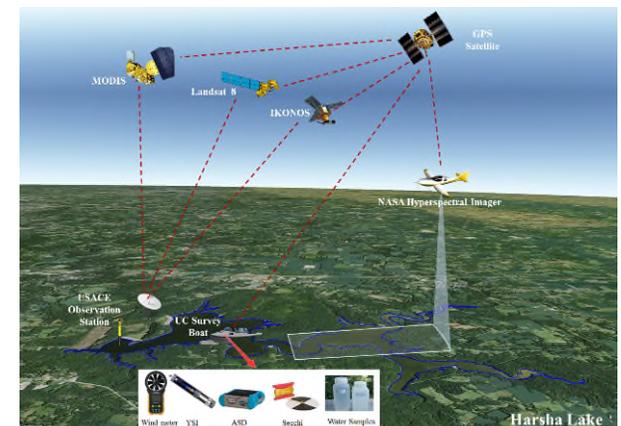
- Glenn Research Center's Twin Otter continued to make ~weekly flights over Lake Erie to study algae concentrations and their contributions to Harmful Algal Blooms that may affect drinking water quality and availability. Additional coverage included Ohio River, etc. where significant blooms occurred
  - Total flight hours accrued: 80 hours
  - All instruments & systems have functioned properly
- Relevant MODIS and LANDSAT satellite data were referenced and in-situ calibration were collected on ground and water by partners: Michigan Tech Research Institute, NOAA, University of Toledo, Kent State University, Bowling Green State University, Ohio State University, and University of Cincinnati, with calibration support from MSFC and South Dakota State Univ.
- Data have been shared within 2 business days with regional entities and archived for public access
- Coordinated a coincidental flight with the NOAA hyperspectral sensor flight
- NASA Flights are now put on standby as the blooms subside
- First campaign data workshop November 12-13 @ Lake Erie Center, Oregon, Ohio
- Draft of first NASA TM scheduled for February 2016



Severe blooms in Ohio River this year



Swaths over Harsha Lake 10/05/15

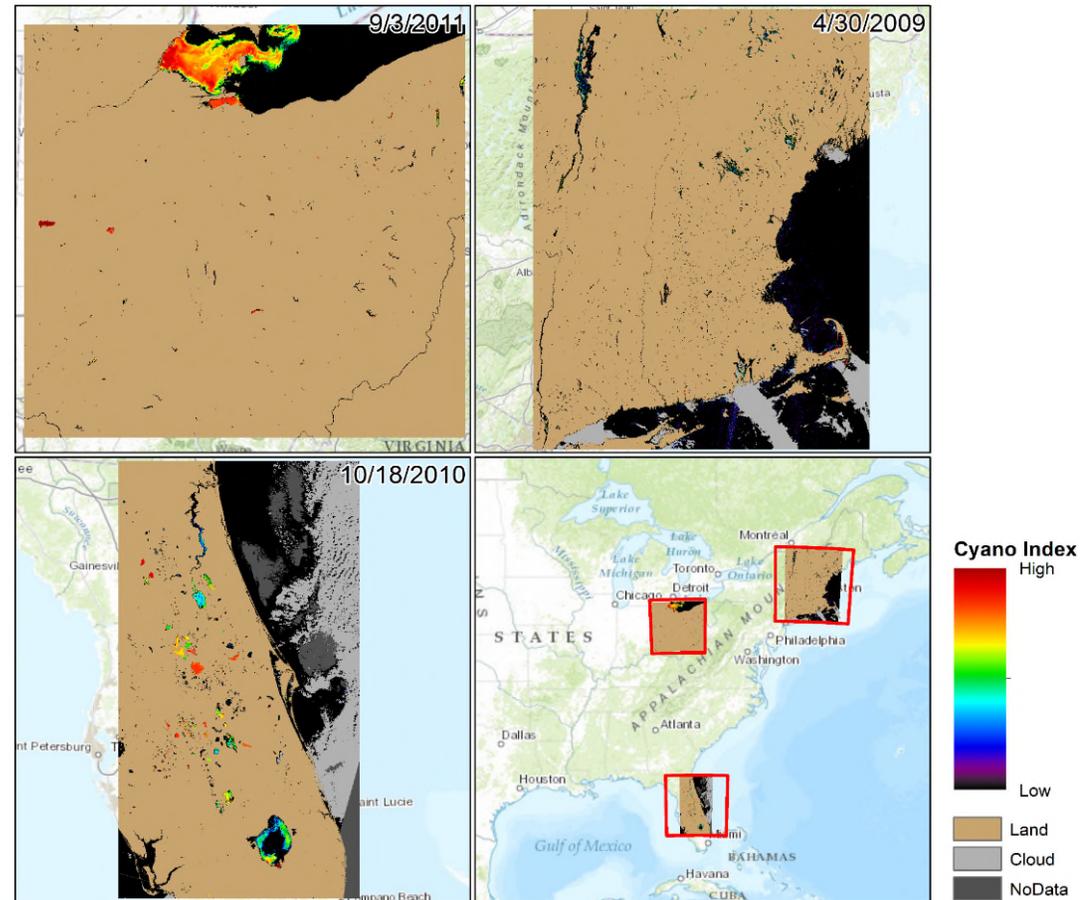


Collaborate with University of Cincinnati to develop algorithm

# Cyanobacteria Assessment Network (CyAN)



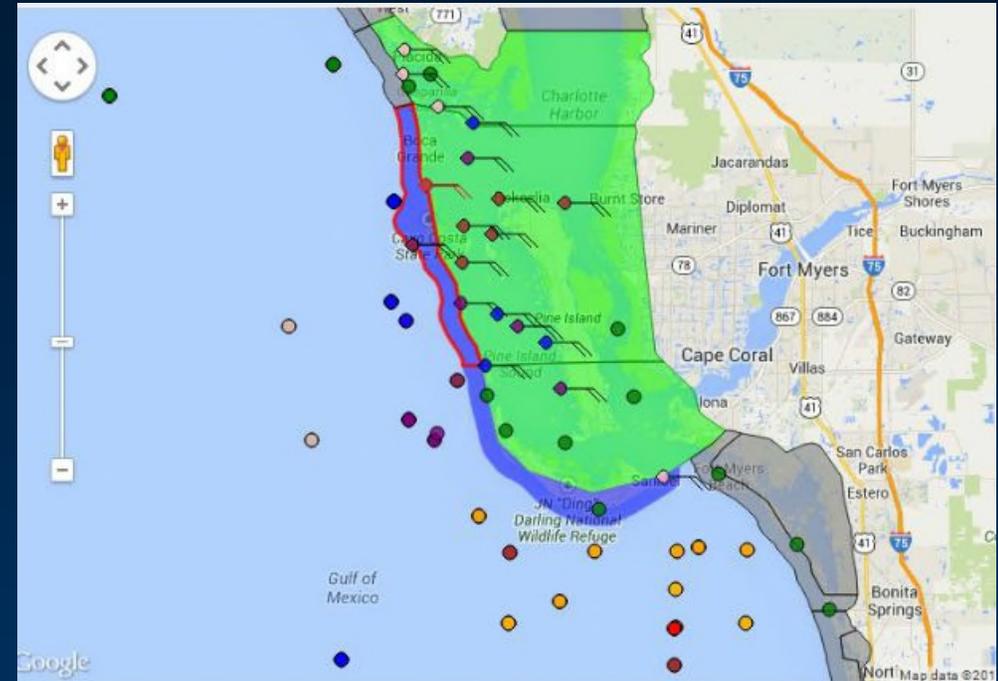
- Five year consortium of NASA, EPA, USGS, and NOAA.
- Create a uniform and systematic approach for identifying cyanobacteria blooms through remote sensing across the CONUS.
- Estimate exposure and human health effects in drinking and recreational waters.
- Assess behavioral responses and economic value of the early warning system.
- Utilize data from Landsat, Sentinel 2, Sentinel 3, NPP/VIIRS, and MODIS.
- POC: Blake Schaeffer, EPA



# Prototype Model for Improved Forecasts of Respiratory Illness Hazard from GOM Red Tide

PI: Richard Stumpf, NOAA

- Visual products of potential risk provided routinely to the CO-OPS forecasters
- Python, JavaScript and Google Maps uses basis forecast analysis
- Report respiratory forecast each beach every day on FL Gulf Coast
- Satellite based assessment for offshore exposure (MODIS/VIIRS ocean color)
- Forecasts disseminated :
  - NOAA HAB Operational Forecast System
  - Motes Marine Lab Beach Conditions Reporting System® (BCRS)
  - NWS Beach Hazards site



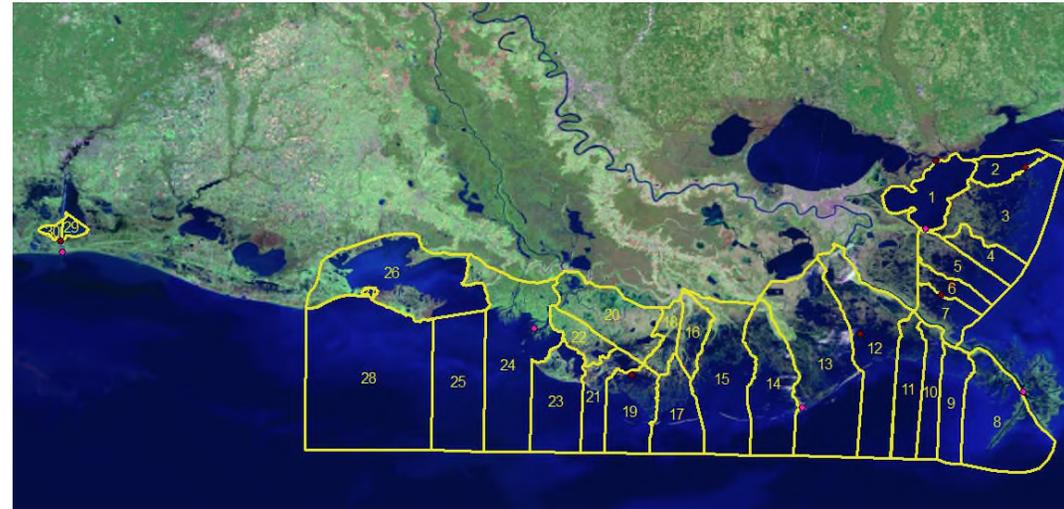
Prototype forecast tool combining NDFD wind with *K. brevis* cell concentrations. Shapefiles allow selection of information at individual points or regions.

# Feasibility Study of Satellite-Assisted Detection and Forecasting of Oyster Norovirus Outbreak

PI: Zhiqiang Deng, LSU



The goal of this project was to test and demonstrate the feasibility of utilizing Terra and Aqua MODIS observations (SST, salinity, solar radiation) in detection and forecasting of oyster norovirus outbreaks in coastal Louisiana. A Detection and Forecasting System (DAFS) for oyster norovirus outbreaks was developed by combining (1) environmental data from NASA Terra/Aqua MODIS sensors and in-situ sensors, (2) bacteriological data from field sampling and laboratory analysis of oysters and water, and (3) developing a predictive model.



Map showing the 30 Louisiana oyster growing areas under study.

The most sensitive environmental factors have been found to be SST and low tide or gauge height. The model successfully predicted the norovirus outbreak in coastal Louisiana in December 2012.

The primary partner is the Louisiana Department of Health and Hospitals (LDHH): Shellfish Program. Results are also shared with the Mississippi DOH.

Mr. Glenn T. Cambre (P.H. Executive Director of LDHH) stated: “Such new insights will greatly enhance the usefulness of our program in helping detect and forecast infectious diseases within oysters and provide additional public health assurances to the citizens of Louisiana.”

# Cholera Prediction Model



## Epidemic Cholera

- Sporadic outbreak
- Usually occurs following floods or inundation of large landscapes
- Warm temperatures may increase growth of bacteria in aquatic bodies.

Typical cholera seasonality



## Mixed-mode Cholera

- Usually two seasonal peaks
- One peak related to seawater intrusion; Second peak associated with widespread inundation
- Specific to Bengal Delta region



## Endemic Cholera

- Cholera persists throughout year in coastal regions
- Seawater Intrusion from coasts to inland
- Cholera outbreaks occur during low river flow season



Background image: Bangladesh and Bay of Bengal



## Satellites data and products

- LANDSAT: ▲ ▲  
Land Use, NDVI
- MODIS/ MERIS: ▲ ▲ ▲ ▲  
Surface Temperature, Ocean Color
- SWOT\*: ▲ ▲ ▲  
River Discharge
- SMAP\*: ▲ ▲  
Soil Moisture
- GRACE: ▲ ▲ ▲  
Water Storage, River Discharge
- TRMM/GPM: ▲ ▲  
Precipitation
- TOPEX/JASON: ▲ ▲  
Sea Surface Height
- AVHRR: ▲ ▲  
Sea surface temperature

\* denotes utility for future missions





Publicly-Available Modules

Case Studies

Water Resources Training also available!

The screenshot shows the ARSET website interface. At the top left is the NASA logo and the text "National Aeronautics & Space Administration Goddard Space Flight Center". To the right is a search bar labeled "Search SED Site" with a "GO" button and the text "Flight Projects | Sciences and Exploration". The main header features a satellite image of Earth with the text "Applied Remote Sensing Education & Training Air Quality". A left-hand navigation menu includes: Home, Training Materials, Courses & Workshops, Air Quality Case Studies, Project Consultants, Links, Calendar, Publications, and Personnel. The main content area is titled "ARSET: Air Quality" and contains a paragraph about the project's goal, two bullet points describing activities, a paragraph about course content, and a list of topics including Case Studies and Satellite aerosol and trace gas products. On the right side, there is a section for "ARSET Email Alerts" with a sign-up box and a "Scheduled Trainings" section listing "NASA Training for LADCO (Lake Michigan Air Directors Consortium) University of Wisconsin at Madison March 12 - 15, 2012".

Upcoming trainings

### ARSET Email Alerts

*If you would like to be informed of new materials and upcoming workshops please sign up for our list serv.*

### Scheduled Trainings

- ▶ NASA Training for LADCO (Lake Michigan Air Directors Consortium) University of Wisconsin at Madison March 12 - 15, 2012

Please contact us if you are interested in applying for a NASA Remote Sensing Workshop

National Aeronautics and  
Space Administration



**Questions:**

**John Haynes, Program Manager  
Health & Air Quality Applications  
NASA Headquarters / Earth Science  
JHaynes@nasa.gov**

*<http://AppliedSciences.NASA.gov>*