Improved Forecasts of Respiratory Illness Hazard from Gulf of Mexico *Karenia brevis* Red Tide: 2018 NASA Public Health update

[1]Rick Stumpf, [2]Barbara Kirkpatrick, [1]Wayne Litaker, [2]Robert Courier, [1]Shelly Tomlinson, [1]Andrew Meredith, [4]Tracy Fanara, [3]Andy Reich

[1]NOAA, [2]Gulf of Mexico Coastal Ocean Observing System, [3]Florida Department of Health, [4]Mote Marine Laboratory

Karenia brevis red tide, 2018

Video of Casey Key, Florida, Before (June 2018) and During (August 2018) Red Tide
(video courtesy of Cody Johnson, @codesthedrones)

The New York Times

UPDATE

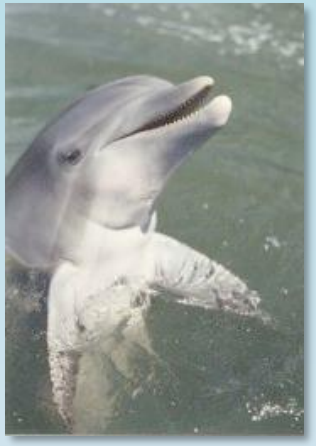
A Red Tide on Florida's Gulf Coast Has Been a Huge Hit to Tourism

Though an algae bloom on the coast is improving, locals and business owners say it may be too little, too late.

https://coastalscience.noaa.gov/news/ncoos-research-and-support-in-response-to-red-tide/

Toxic *Karenia brevis* blooms

- Microalga *K. brevis* forms extensive toxic blooms from Mexico from Texas to Florida
- Late summer/early fall to year long
- Brevetoxins, sodium channel activators
- Toxins kills fish, birds, dolphins and manatees, sea turtles
- Neurotoxic shellfish poisoning
- Economic losses in Florida and Texas
- Respiratory illness in humans



Karenia brevis: brevetoxins

Brevetoxins can aerosolize - particles 3-20 µm range

Healthy people: upper airway irritant. Coughing watery eyes, sinus pain

People with chronic lung disease (like asthma) become ill.

Early-mid 2000s NIH study quantified effects on lung function

Effect of Exposure

Asthmatics 9% of population

One hour walk on the beach during a red tide; 5 days for pulmonary function to return to baseline

54% increase in ER respiratory (asthma, pneumonia, bronchitis)

Sarasota County alone, ER costs increase up to $4 million, depending on bloom severity

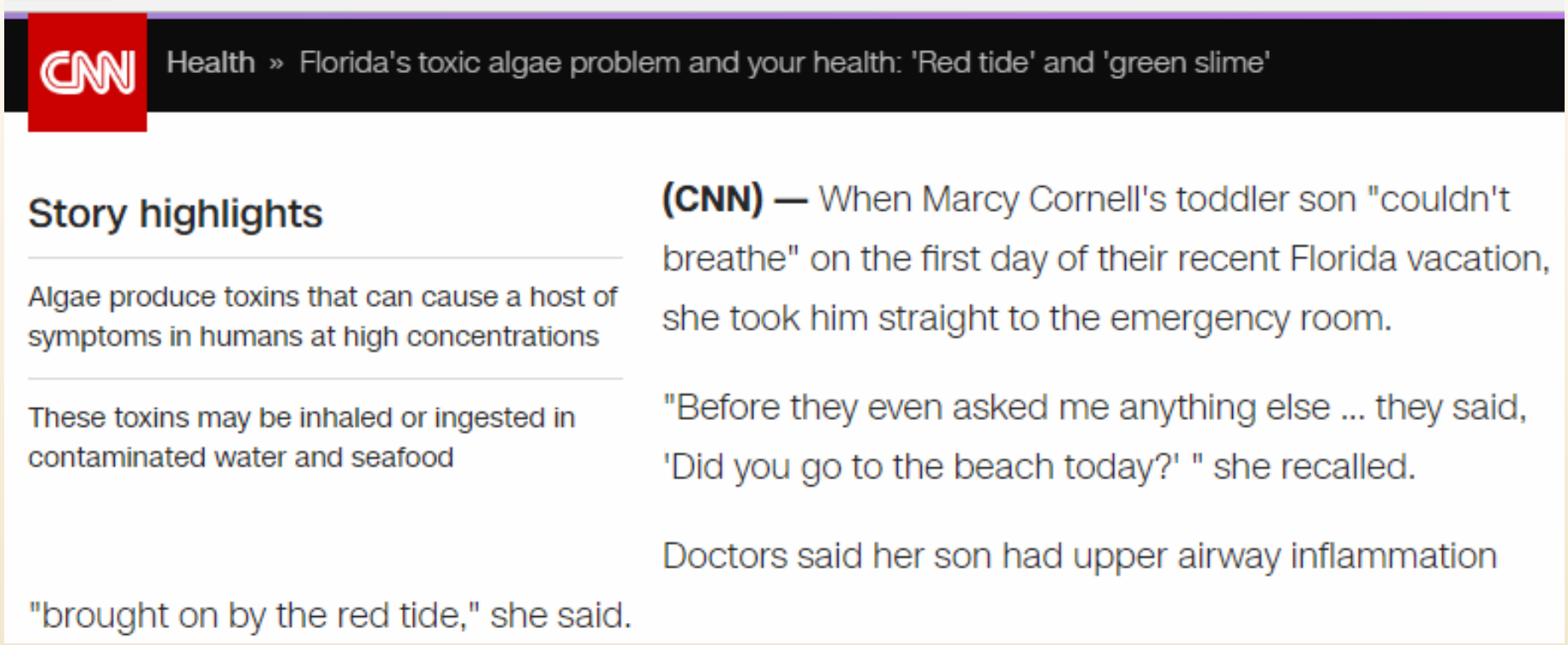
Lifeguards (occupational healthy group) - no pulmonary function normal effect

Loss revenue to area businesses ($6 million/month per county)

Critical need to accurately warn the public

Everyone reacts, useful indicator exposure

Why does this matter?



CNN Health » Florida's toxic algae problem and your health: 'Red tide' and 'green slime'

Story highlights

Algae produce toxins that can cause a host of symptoms in humans at high concentrations

These toxins may be inhaled or ingested in contaminated water and seafood

(CNN) — When Marcy Cornell's toddler son "couldn't breathe" on the first day of their recent Florida vacation, she took him straight to the emergency room.

"Before they even asked me anything else ... they said, 'Did you go to the beach today?' " she recalled.

Doctors said her son had upper airway inflammation "brought on by the red tide," she said.

Florida's toxic algae problem and your health: 'Red tide' and 'green slime'

By Michael Nedelman, CNN

Updated 2:00 PM ET, Sat August 18, 2018

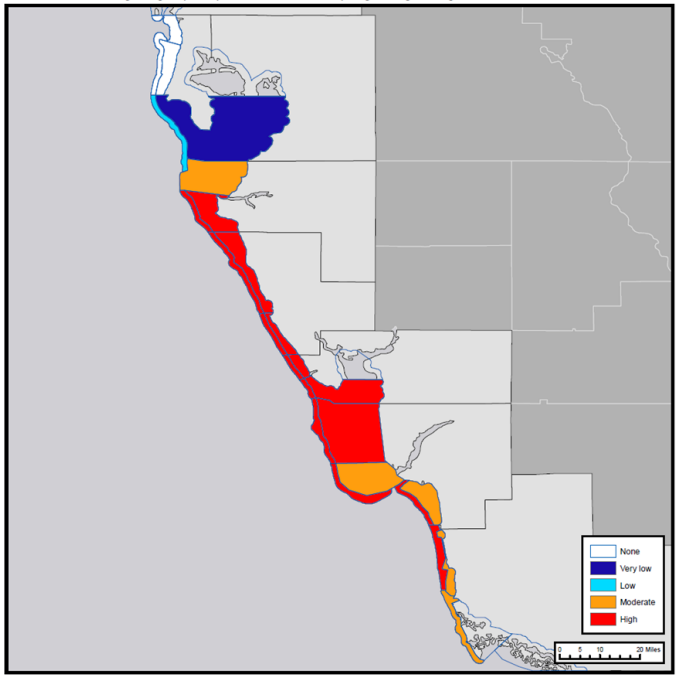
Parts of current NOAA Bulletin

Gulf of Mexico Harmful Algal Bloom Bulletin

Monday, August 20, 2018
NOAA National Ocean Service
NOAA Satellite and Information Service
NOAA National Weather Service

Instructions for viewing this geospatial pdf are available at: https://go.usa.gov/xn9g2.

Region: Southwest Florida



In the map above, the highest level of potential respiratory irritation forecast is displayed as a layer for each day from 08-20-18 to 08-23-18. See next page for a table of the respiratory irritation forecasts.

Conditions Report

Not present to high concentrations of *Karenia brevis* (commonly known as 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.

Recently Reported Impacts (Listed by County):

Respiratory irritation: Manatee, Sarasota, Lee, and Collier
Dead fish: Manatee, Sarasota, Charlotte, Lee, and Collier

Definition of respiratory irritation levels.

	AFFECTED POPULATION				
RESPIRATORY IRRITATION LEVEL	NONE	CHRONIC RESPIRATORY CONDITION	SENSITIVE TO RED TIDE	GENERAL PUBLIC (MILD SYMPTOMS)	GENERAL PUBLIC (INTENSE SYMPTOMS)
None	x				
Very low		x			
Low		x	x		
Moderate		x	x	x	
High		x	x	x	x

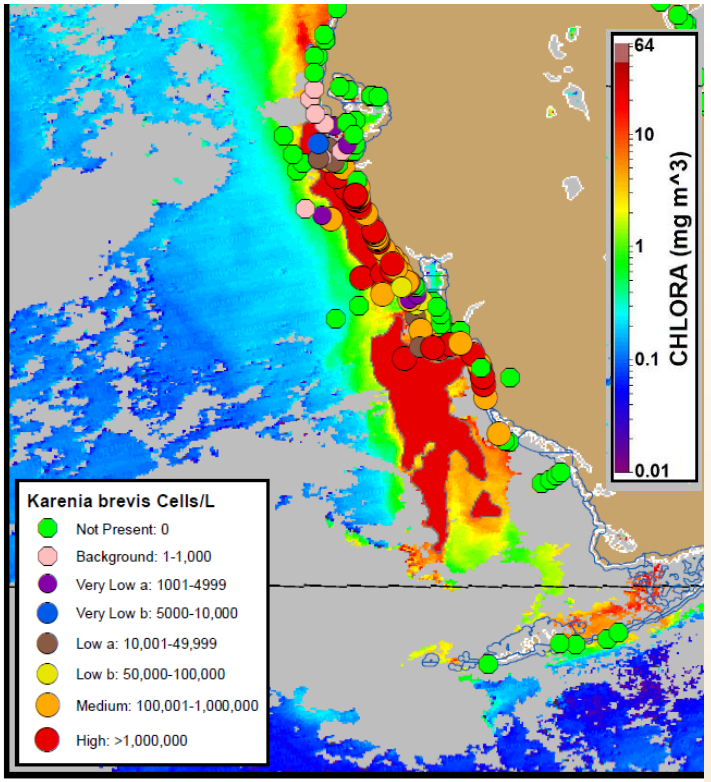
Additional Resources

Health Information:

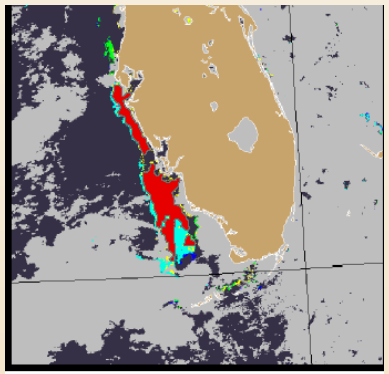
Florida Department of Health:
http://www.floridahealth.gov/environmental-health/aquatic-toxins/red-tide.html
Other resources: https://go.usa.gov/xQNWp

Recent, Local Observations and Data:

Mote Marine Laboratory Daily Beach Conditions:
http://visitbeaches.org
Florida Fish and Wildlife Conservation Commission:
http://myfwc.com/redtidestatus



Karenia brevis cell concentration sampling data from: 08/10/18 through 08/17/18.

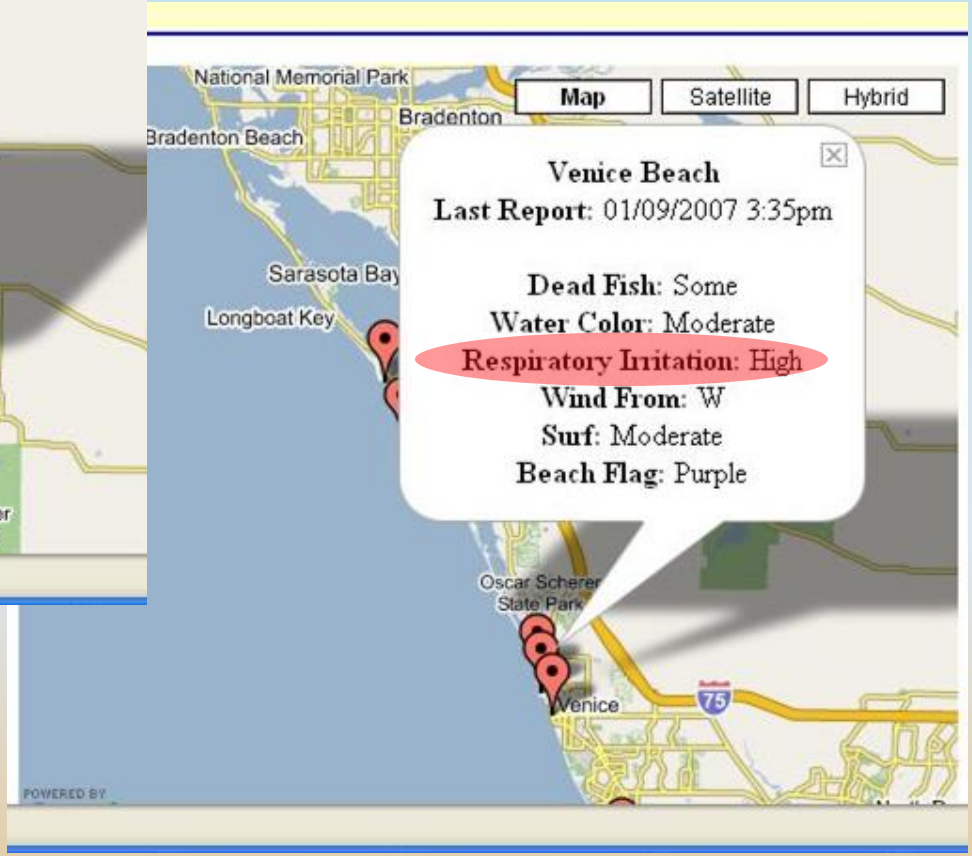


Verified and suspected HAB areas shown in red. Other areas with *K. brevis* optical characteristics shown in yellow (see p. 4 analysis for interpretation).

Respiratory forecast is over entire county only twice a week

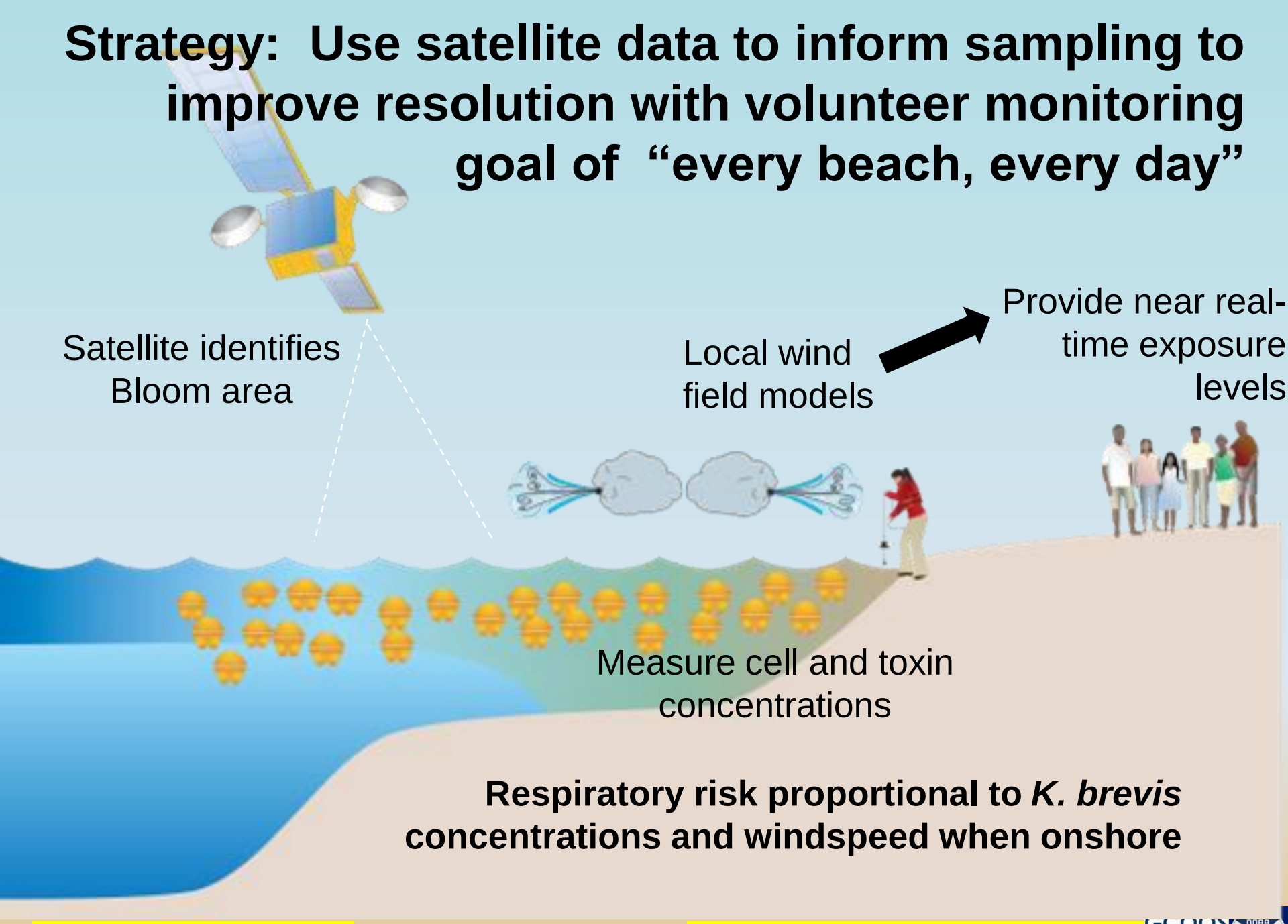
Cell concentration patchy from beach to beach

~10 km apart



Impact changes with cells and wind direction

Strategy: Use satellite data to inform sampling to improve resolution with volunteer monitoring goal of "every beach, every day"



Respiratory risk proportional to *K. brevis* concentrations and windspeed when onshore

Integrating with existing volunteer sampling programs

Mote Marine Laboratory, Education & Outreach Dept.

Texas Red Tide Rangers. Master Naturalist Program supported by UTRGV, Texas Sea Grant, Texas Parks and Wildlife Dept. (TPWD)

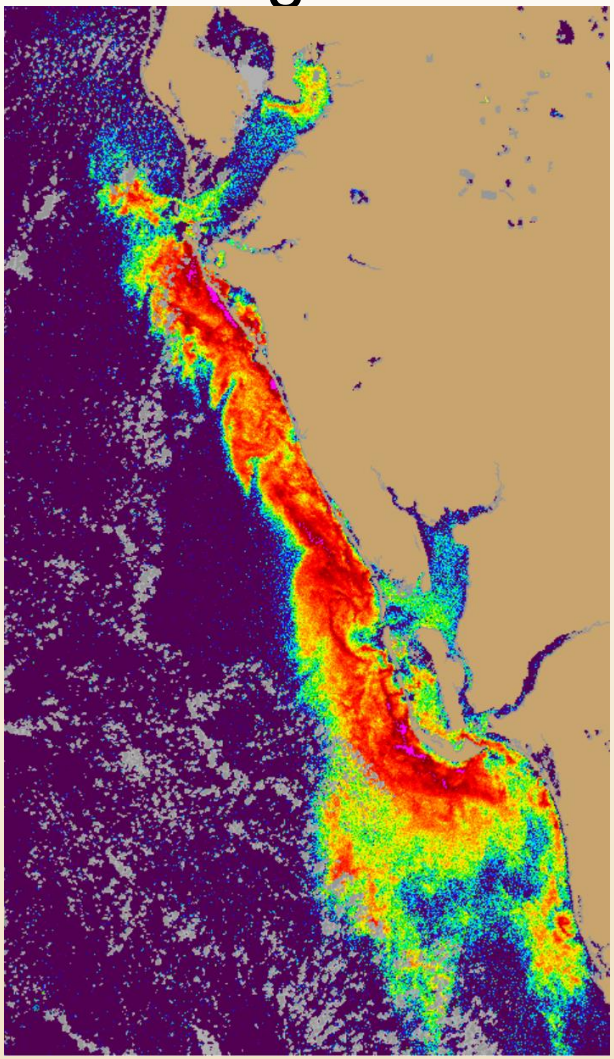
TexHAB program, coordinated by TPWD

Expansion: Florida Fish and Wildlife Research Institute (primary agency in Florida for coastal HAB monitoring)

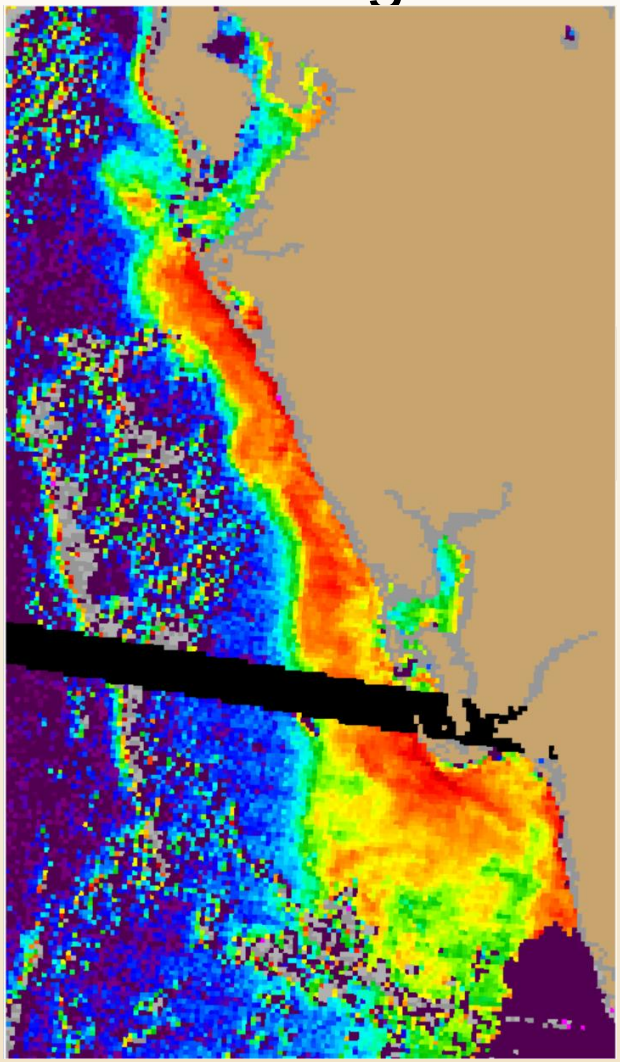
Collier County Pollution Control

MODIS and Sentinel-3 fluorescence detection

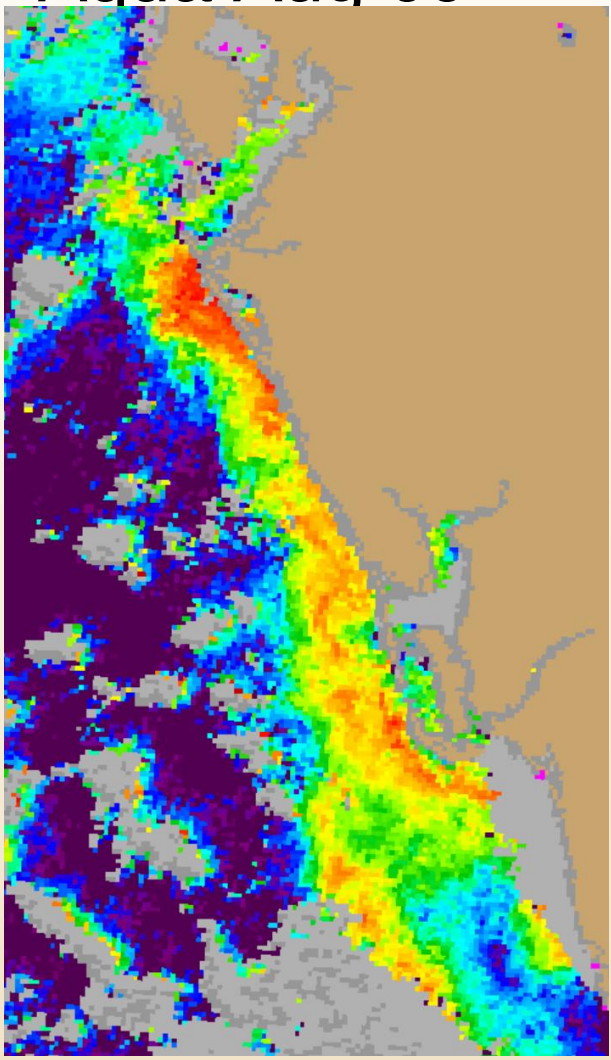
S3 Aug 09



Terra Aug 08

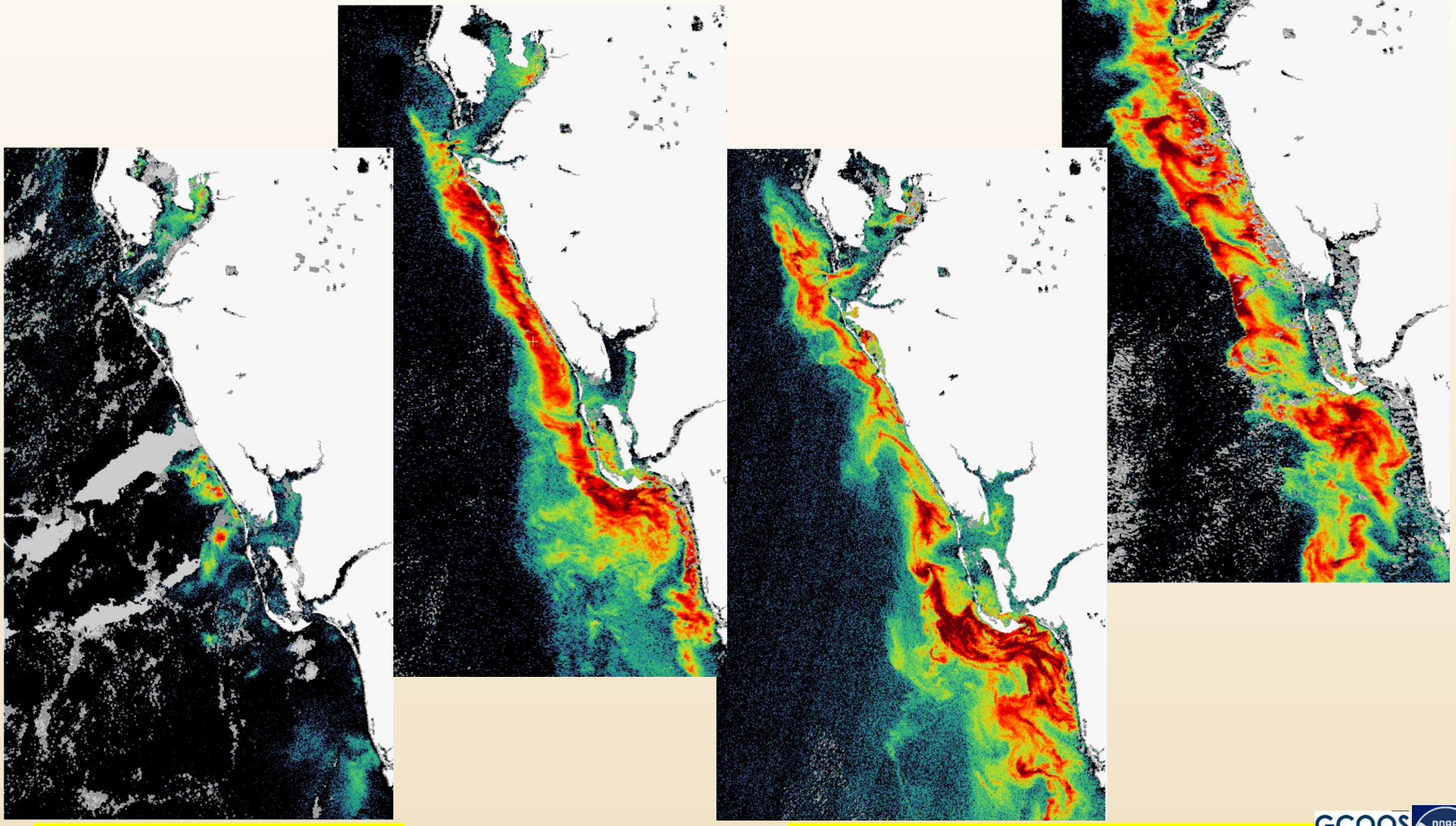


Aqua Aug 09

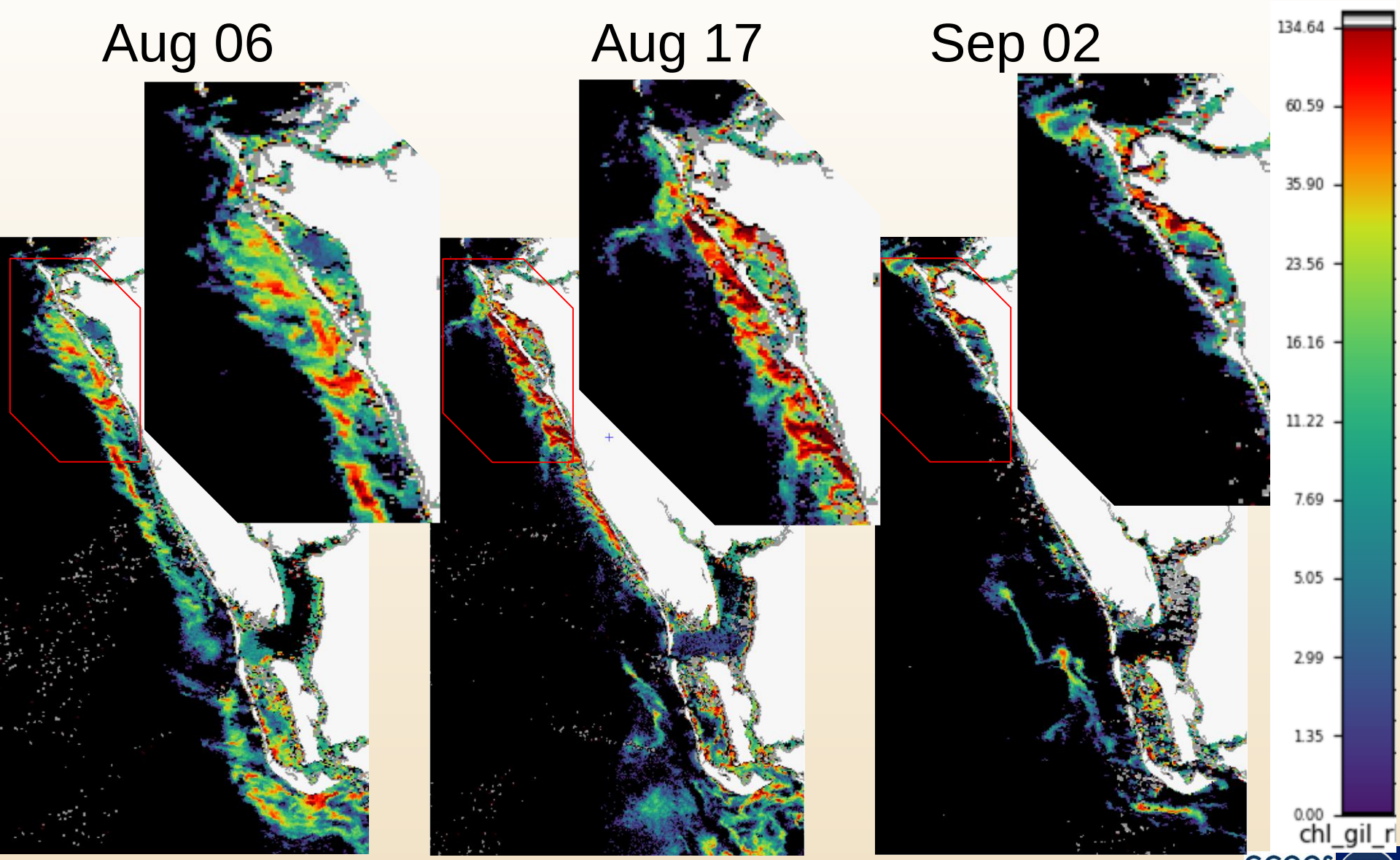


Fluorescence provides area of likely bloom
Sentinel-3 2018

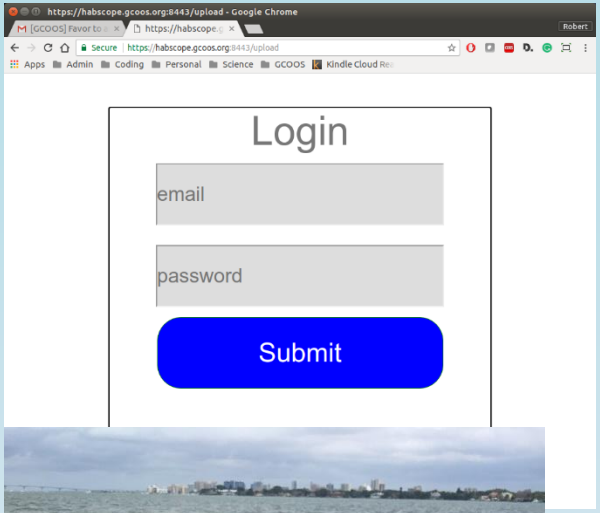
July 17 Aug 06 Aug 28 Sep 06

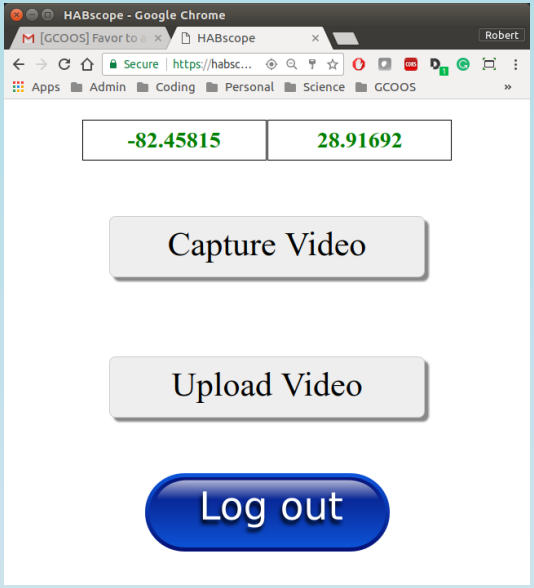


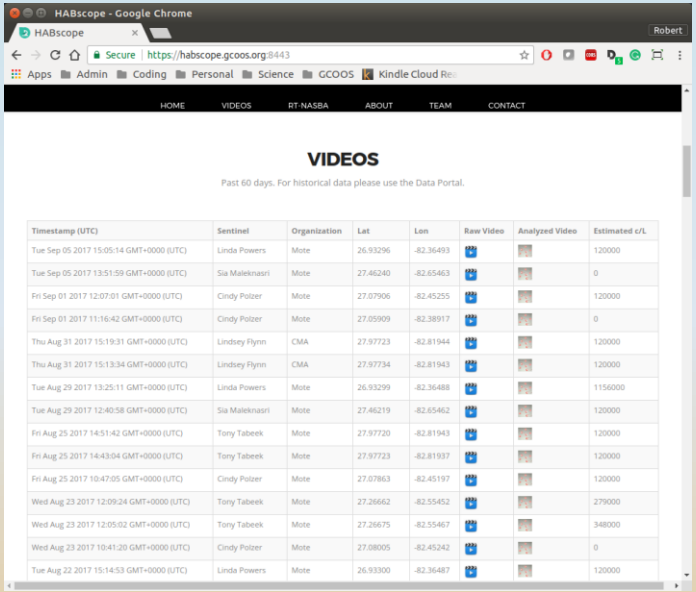
S3 chlorophyll, chla > 5 µg L^{-1} has major impact



HABscope Upload Ap working







Observer training

Mote Education Dept.

Volunteers

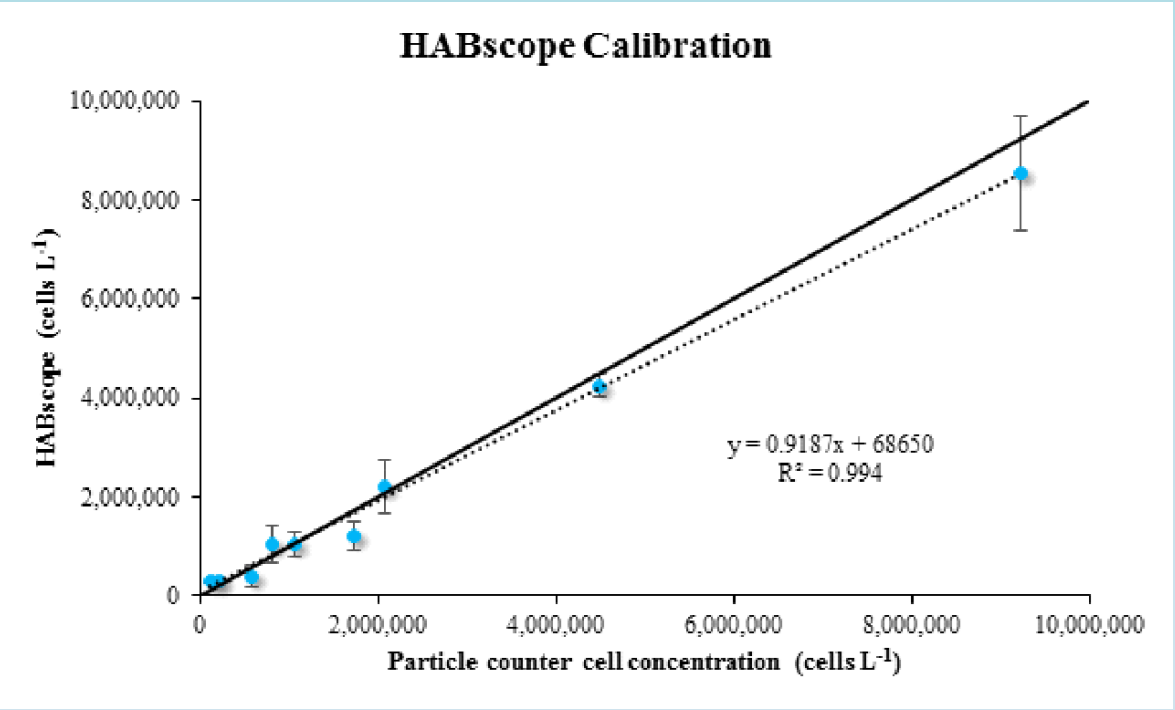
Texas Red Tide Rangers

Retrained Aug 2018

FWRI bringing in parks

Example video, worst case

Validation


HABscope Calibration
HABscope (cells L-1)
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
0
2,000,000
4,000,000
6,000,000
8,000,000
10,000,000
Particle counter cell concentration (cells L-1)
y = 0.9187x + 68650
R² = 0.994


GCOOS NASA ROSES DEMO
OBJECTS: 4


Aug 21, 2018
Sarasota County

Video assessment

Timestamp (UTC)	Site	GPS	Video	Status	Analyst	HABscope c/L	Manual c/L	Admin
2018-09-08 18:53:35	Little Sarasota Bay	-82.5173 27.2442		Pending		590000	0	
2018-09-08 18:52:27	Little Sarasota Bay	-82.5173 27.2442		Pending		590000	0	
2018-09-08 16:38:26	Venice Beach	-82.4524 27.0830		Pending		694000	0	
2018-09-06 13:42:18	Longboat Key	-82.6546 27.4625		Approved	Chris Holland	642000	0	
2018-09-06 13:15:06	NaN	-82.5774 27.3330		Approved	Chris Holland	50000	0	
2018-09-06 13:11:26	Manasota Key	-82.3648 26.9329		Overestimated	Chris Holland	642000	0	

What are all the pieces that have to work?

Field:

Functioning HABscope, microscope and app

Find location, upload

Training materials and trained volunteers

Volunteer sampling near daily

Video software review

Validation

Post-process:

Review of all videos

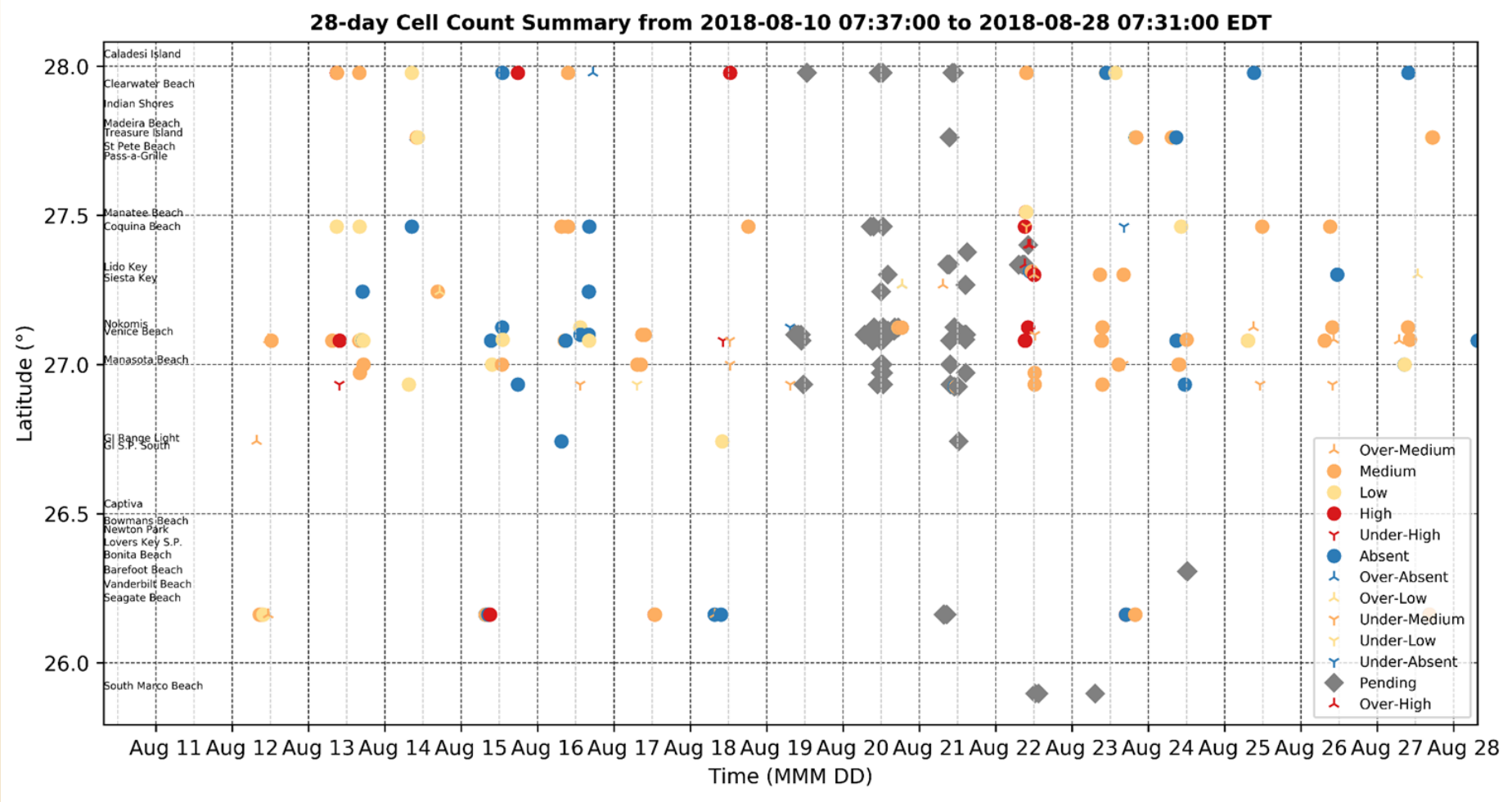
System management

Forecast model

Web posting

Find the gaps, fix, and repeat

Sampling frequency

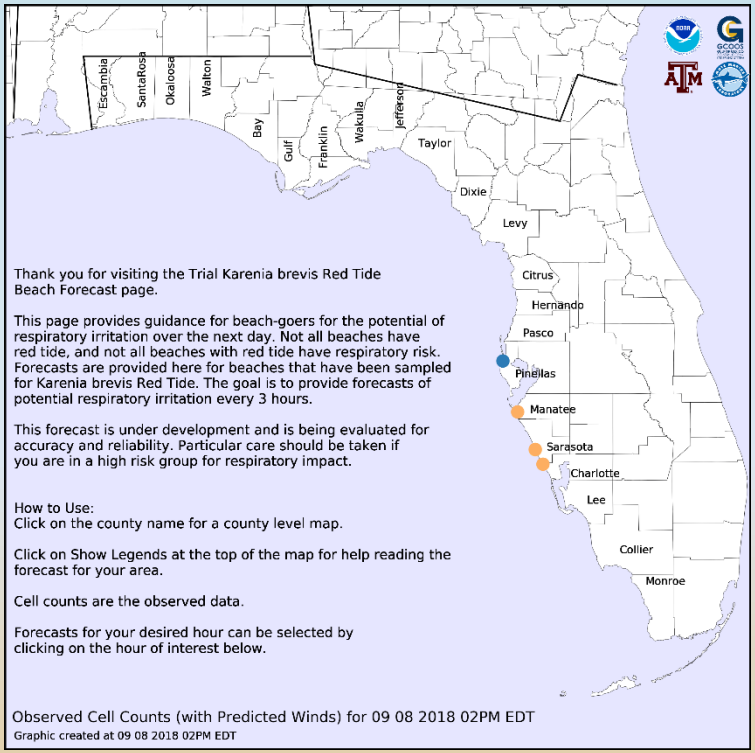


Respiratory model

Model. Python-based, uses NDFD winds and cell counts to predict respiratory over time at each beach.

Deliver products to GCOOS, BCRS, NOAA/CO-OPS

Visual review of model for forecasts



Forecast

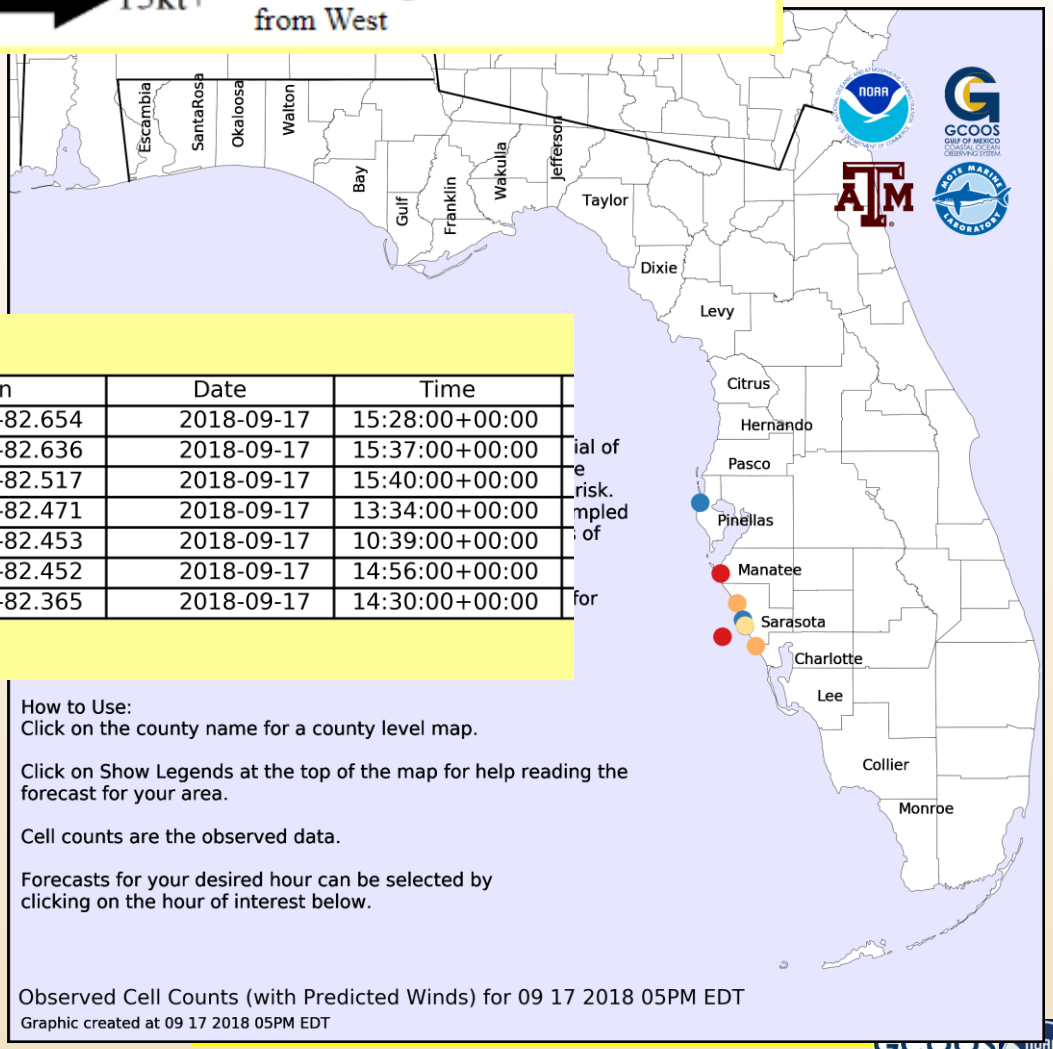
Python-based, uses NDFD winds and cell counts

Click to Show Legends

Cell Counts	Absent	Very low	Low	Medium	High
Forecasts	Absent	Very low	Low	Moderate	High
Winds	0-5kt	5-15kt	15kt+	Winds in legend from West	

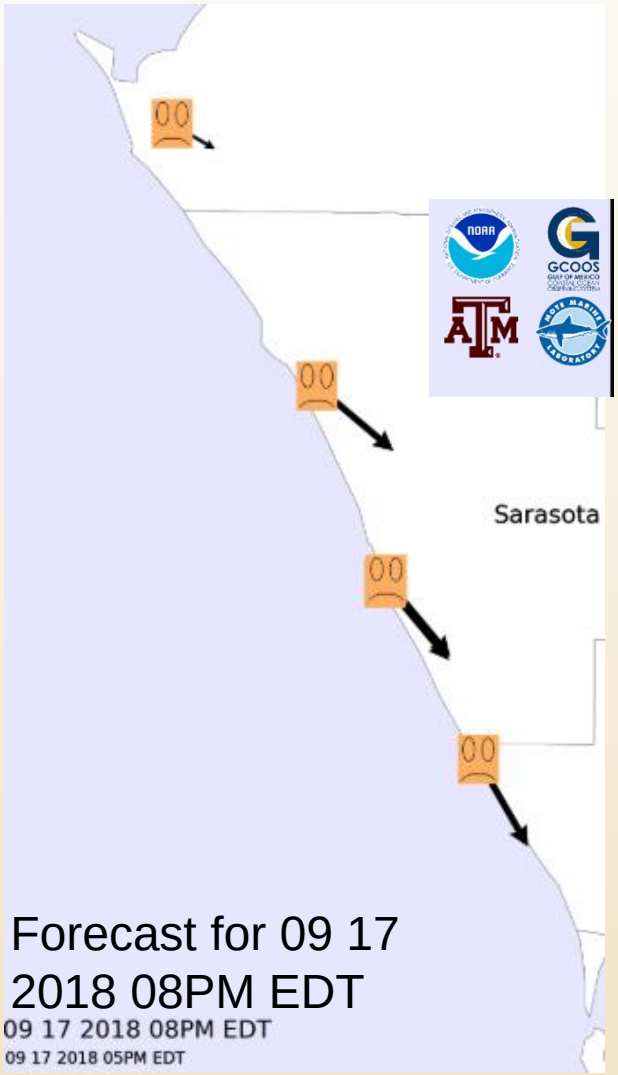
Intent to deliver to GCOOS and other locations

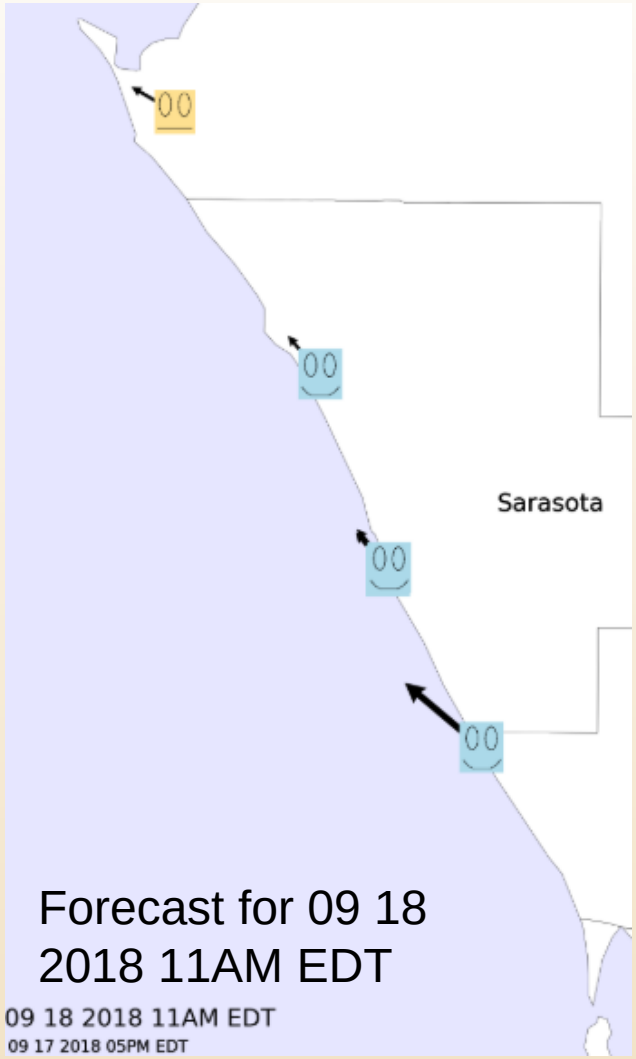
Num	Cell Count	Lat	Lon	Date	Time
02	High	27.462	-82.654	2018-09-17	15:28:00+00:00
03	High	27.0	-82.636	2018-09-17	15:37:00+00:00
04	Medium	27.244	-82.517	2018-09-17	15:40:00+00:00
05	None	27.125	-82.471	2018-09-17	13:34:00+00:00
06	None	27.08	-82.453	2018-09-17	10:39:00+00:00
07	Low	27.083	-82.452	2018-09-17	14:56:00+00:00
08	Medium	26.933	-82.365	2018-09-17	14:30:00+00:00

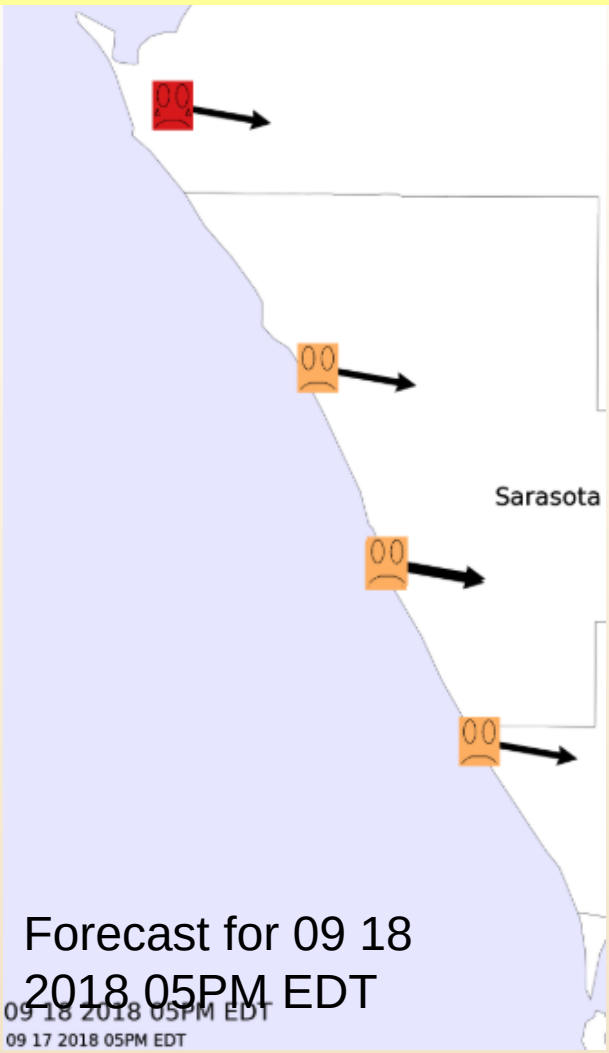


Forecast turnaround every 3 hours. As fast as video review

Cell Count	Lat	Lon	Date	Time
High	27.462	-82.654	2018-09-17	15:28:00+00:00
High	27.0	-82.636	2018-09-17	15:37:00+00:00
Medium	27.244	-82.517	2018-09-17	15:40:00+00:00
None	27.125	-82.471	2018-09-17	13:34:00+00:00
None	27.08	-82.453	2018-09-17	10:39:00+00:00
Low	27.083	-82.452	2018-09-17	14:56:00+00:00
Medium	26.933	-82.365	2018-09-17	14:30:00+00:00







Milestones	2019 continuation year
Started at ARL 3, Viability established Currently ARL 6 Potential demonstrated	ARL 7: functionality demonstrated Late 2019, ARL 8 functionality proven
Satellite Modeling Development (RS)	Satellite data being posted for state use
Forecast Creation (RS) Code developed, python based	Continue model validation, design “gap filling” for missing days
Integrate weather (NDFD) & data	Bring in other data to expand forecast
Forecast Distribution (RS/BK)	Review of products,
Skill Assessment (RS)	Complete skill assessment
Smartphone Communication (BK)	Maintain app
Community group recruit/training (BK)	Expanding network
Training materials for sentinel groups and forecasters. (BK)	Multiple trainers
End User workshops (BK)	Comment by a variety of users
Public outreach (BK)	Design media engagement

Risks to project

Major risk: consistency, reliability and public perception

Weekends, holidays, hurricanes for review

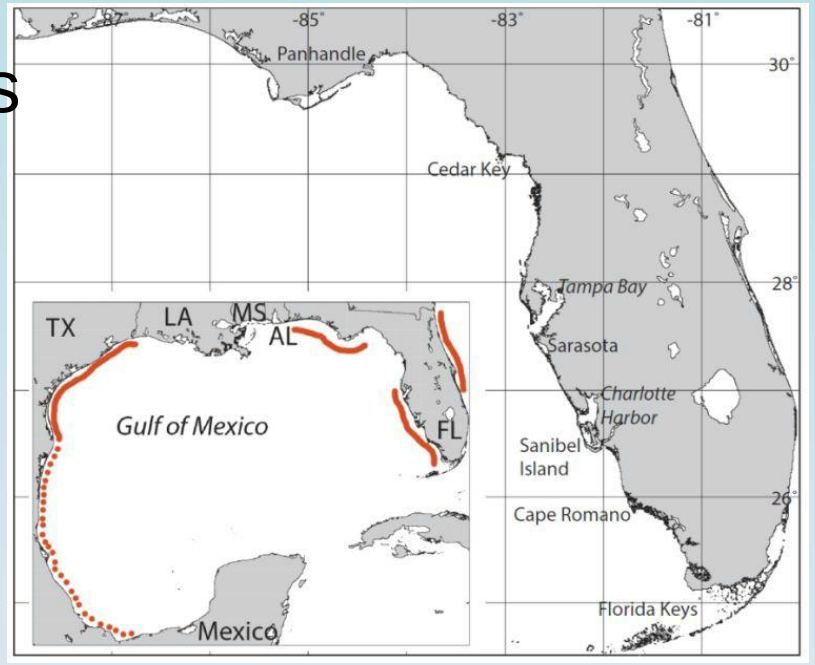
May be working through 2019 bloom season, potential additional extension.

Papers are starting now, drafts now for:

HABscope validation

Bloom severity metric

Chlorophyll algorithm assessment



Red indicates regions where *K. brevis* blooms adversely impact coastal communities most often.

Performance Metrics

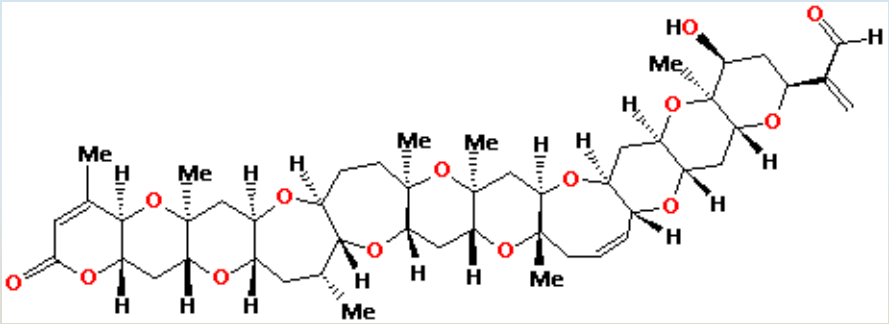
Metric	Measures	
Forecast resolution	# of beaches during red tide	
Forecast frequency	# daily forecasts during red tide	
Skill	Accuracy of risk prediction	Accuracy of wind forecasts
Visibility	Number of Web hits, Feeds, # and freq. media outlets	# of media outlets and frequency
Training	Organizations trained in field program	Managers informed of products
Monitoring skill	Accuracy of volunteer beach reports	
Operational Efficiency	Total time per week required for forecasts	
End user satisfaction	Quantitative assessment Qualitative assessment Feedback/concern logbook	Initial and then ongoing annual

Questions

Richard.stumpf@noaa.gov

barb.kirkpatrick@gcoos.org

K. brevis cell



Brevetoxin structure