Forecasts of Pelagic *Sargassum* Blooms and Transports in the Intra-Americas Sea and Tropical Atlantic: Improving a Prototype Decision-making Tool

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NASA Award #: NNX17AE57G

Collaborators and partners: Brian Barnes, Mengqiu Wang, Brock Murch, Brian Lapointe, Amy Sinuda, Jean-Philippe Maréchal, Jim Franks, Frank Hernandez, Sargasso Sea Commission, ……

NASA Biodiversity and Ecological Forecasting Team Meeting, May 21-23, 2019,
Hyatt Regency Crystal City
2799 Richmond Highway, Arlington, VA

What *Sargassum*?

Sargassum blooms in the Caribbean Sea

An important habitat

- Food and shade to many animals (fish, young turtles, shrimp, crab, etc.), and it also supports sand dunes and shoreline stabilization
- “Golden floating rainforest of the Atlantic Ocean” (The Sargasso Sea Alliance)

What *Sargassum*?

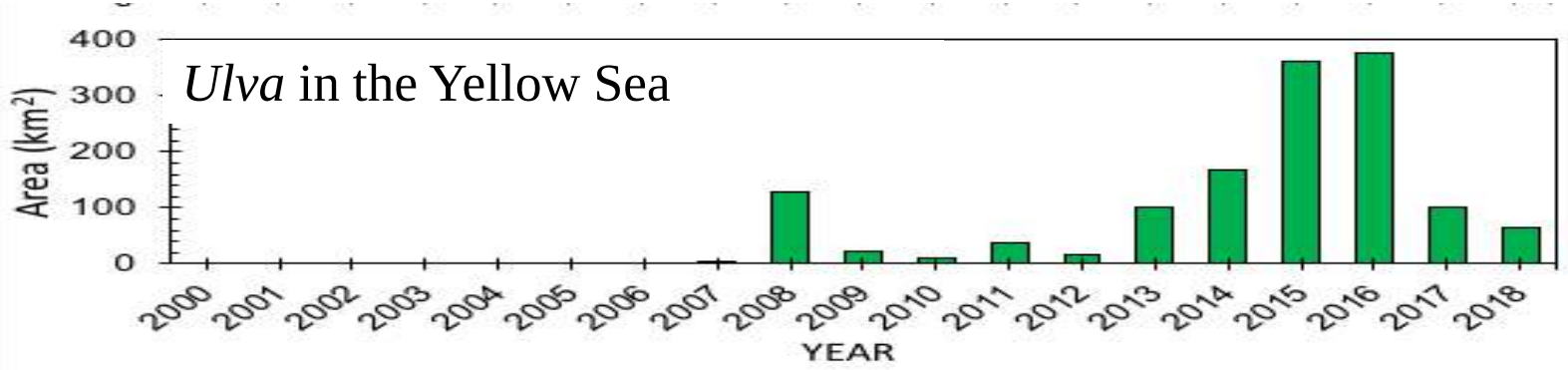
Sargassum blooms in the Caribbean Sea

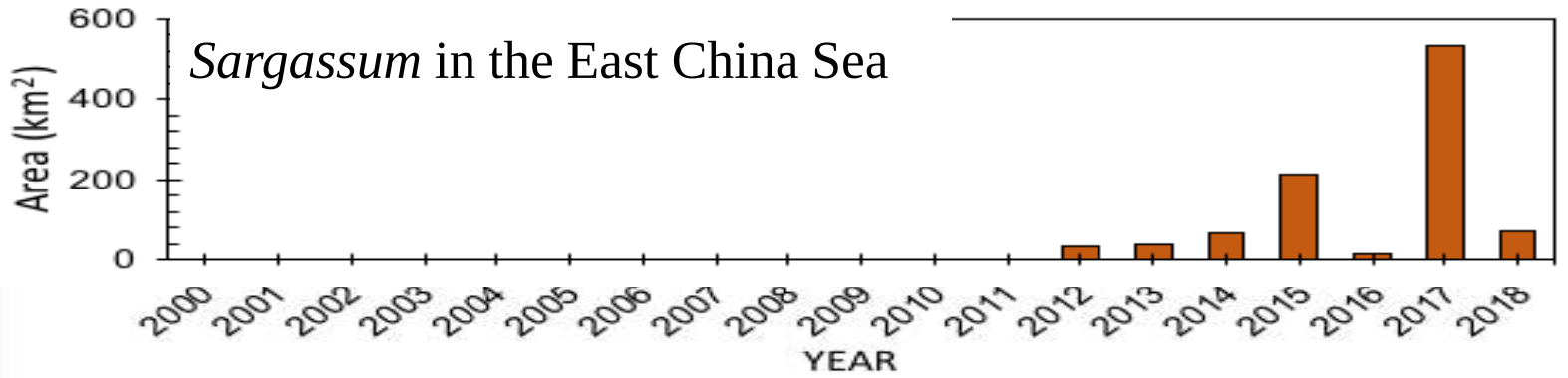
A beach nuisance

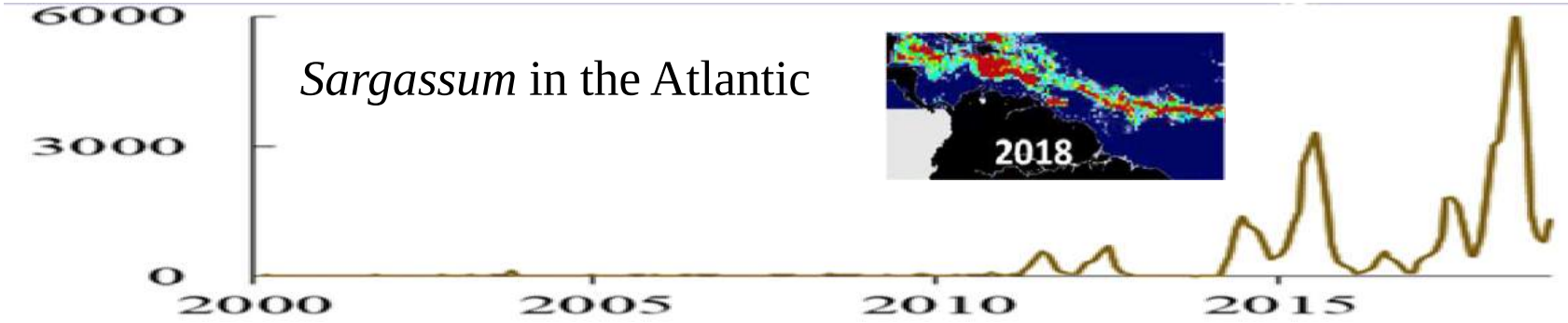
- Smells bad, attracts insects,
- Smother turtle nesting sites, causing turtle and fish mortality
- Negative impact on tourism and economy

A regime shift?

No other properties show such dramatic changes



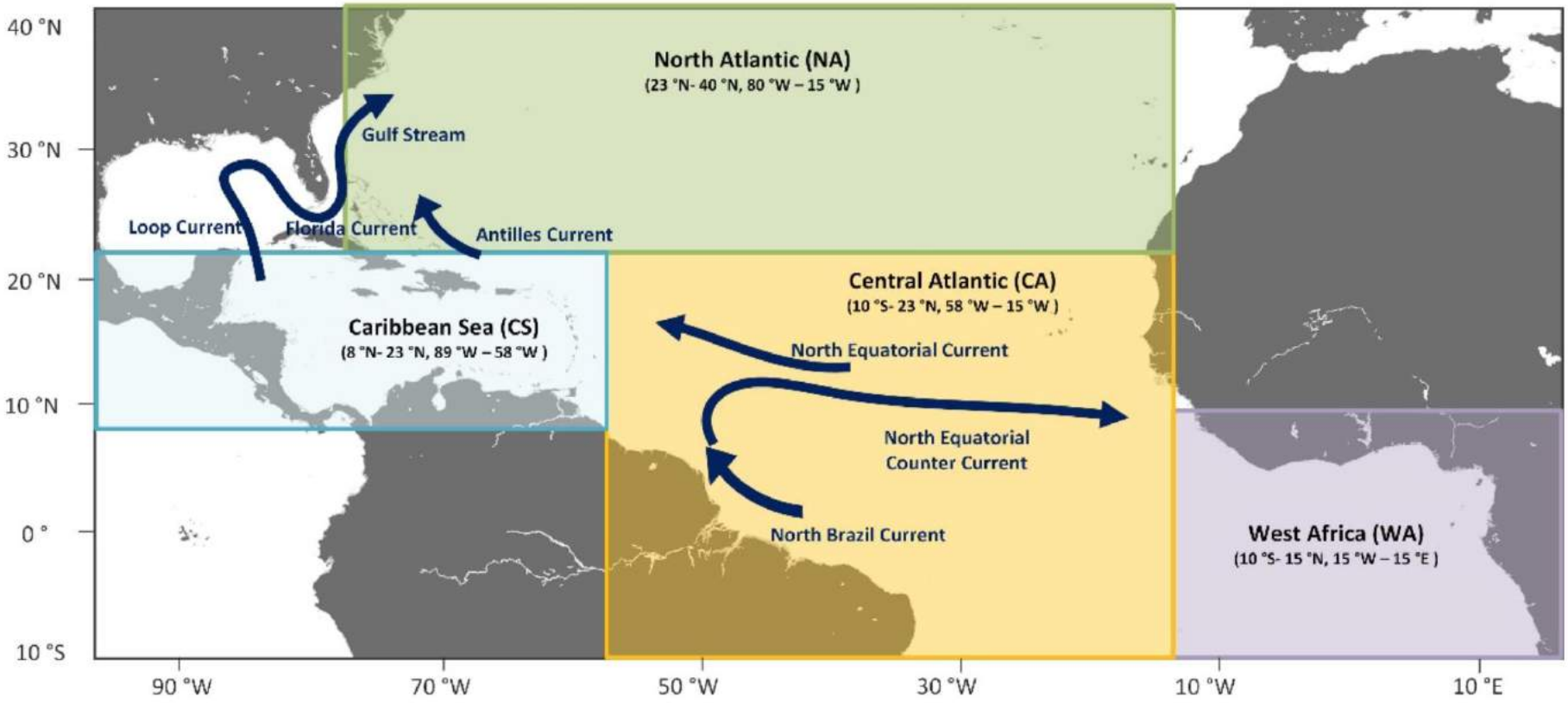




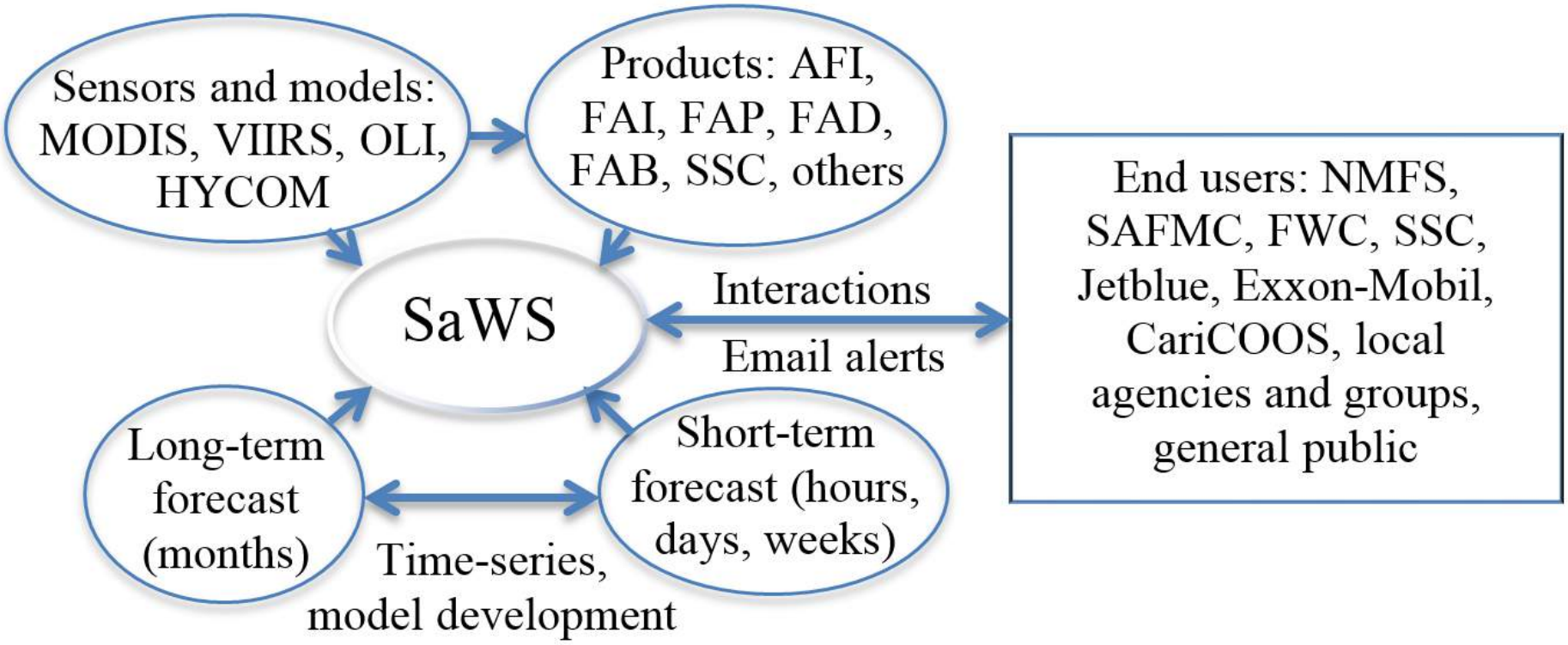
What caused *Sargassum* blooms in the Atlantic?

Some hypotheses, but picture not clear

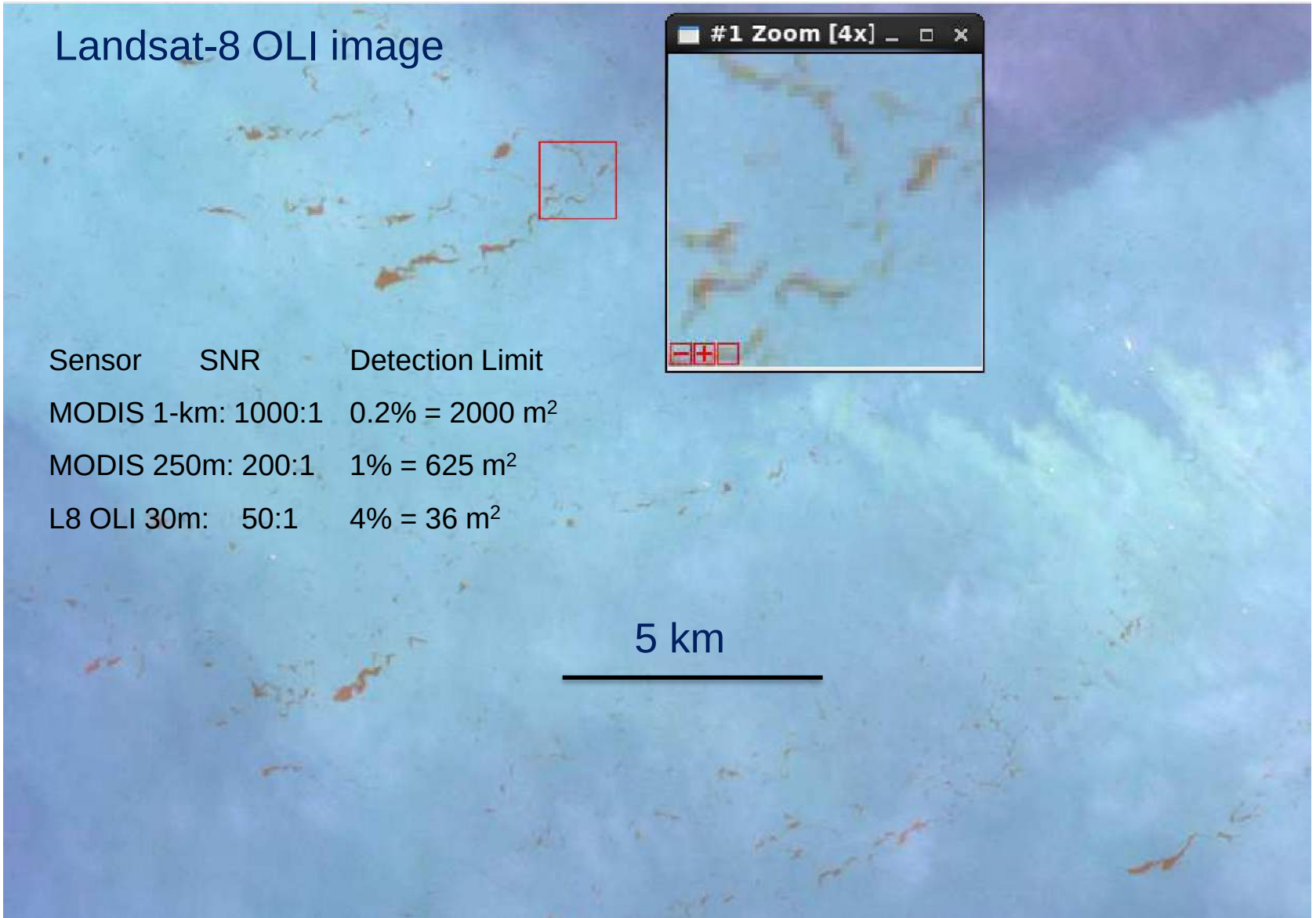
The vast ocean is connected through ocean currents



Project goals: Improve SaWS and its operational use

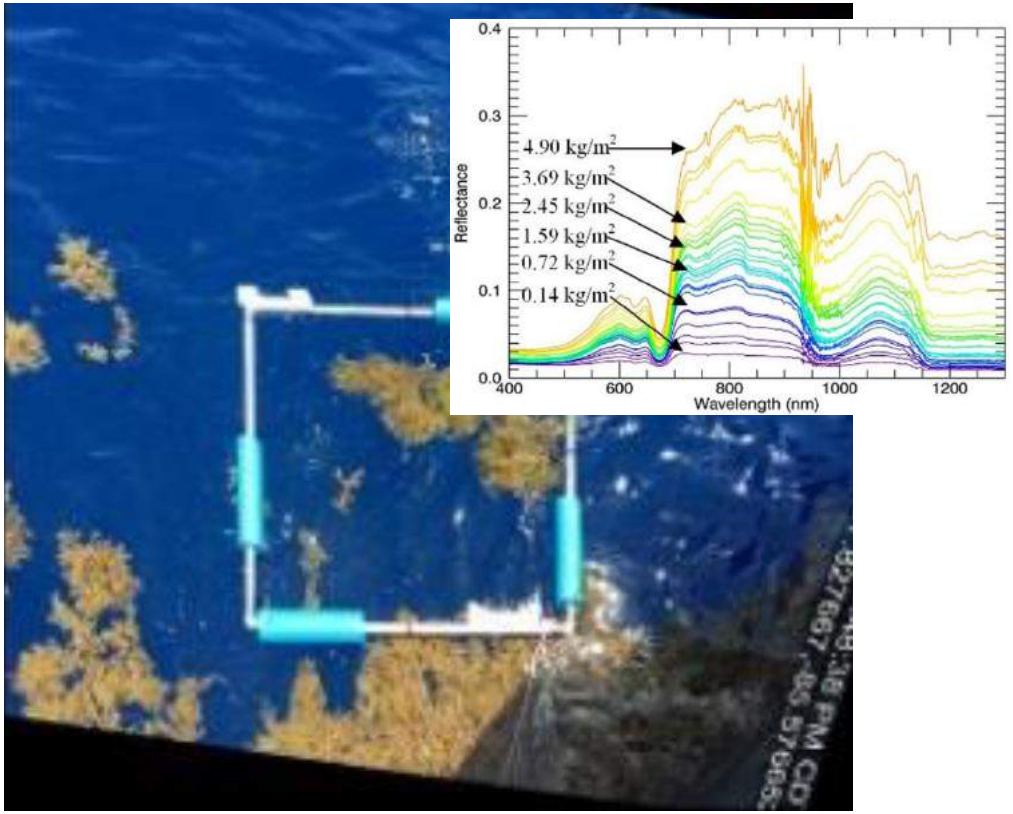


Achievements to date: remote sensing of biomass



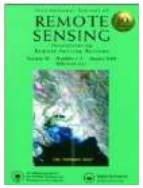
Achievements to date: remote sensing of biomass

Field measurement, algorithm tuning, and validation



Wang et al. (2018, GRL)

Achievements to date: Publications



On the continuity of quantifying floating algae of the Central West Atlantic between MODIS and VIIRS

Mengqiu Wang & Chuanmin Hu

Remote Sensing Applications: Society and Environment

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

A simple, fast, and reliable method to predict Sargassum washing ashore in the Lesser Antilles

Jean-Philippe Maréchal[a,*], Claire Hellio[b], Chuanmin Hu[c]

Geophysical Research Letters

RESEARCH LETTER

10.1002/2017GL072932

Predicting *Sargassum* blooms in the Caribbean Sea from MODIS observations

Mengqiu Wang[1] and Chuanmin Hu[1]

Key Points:

- *Sargassum* blooms in the Caribbean

Geophysical Research Letters

RESEARCH LETTER

10.1029/2018GL078858

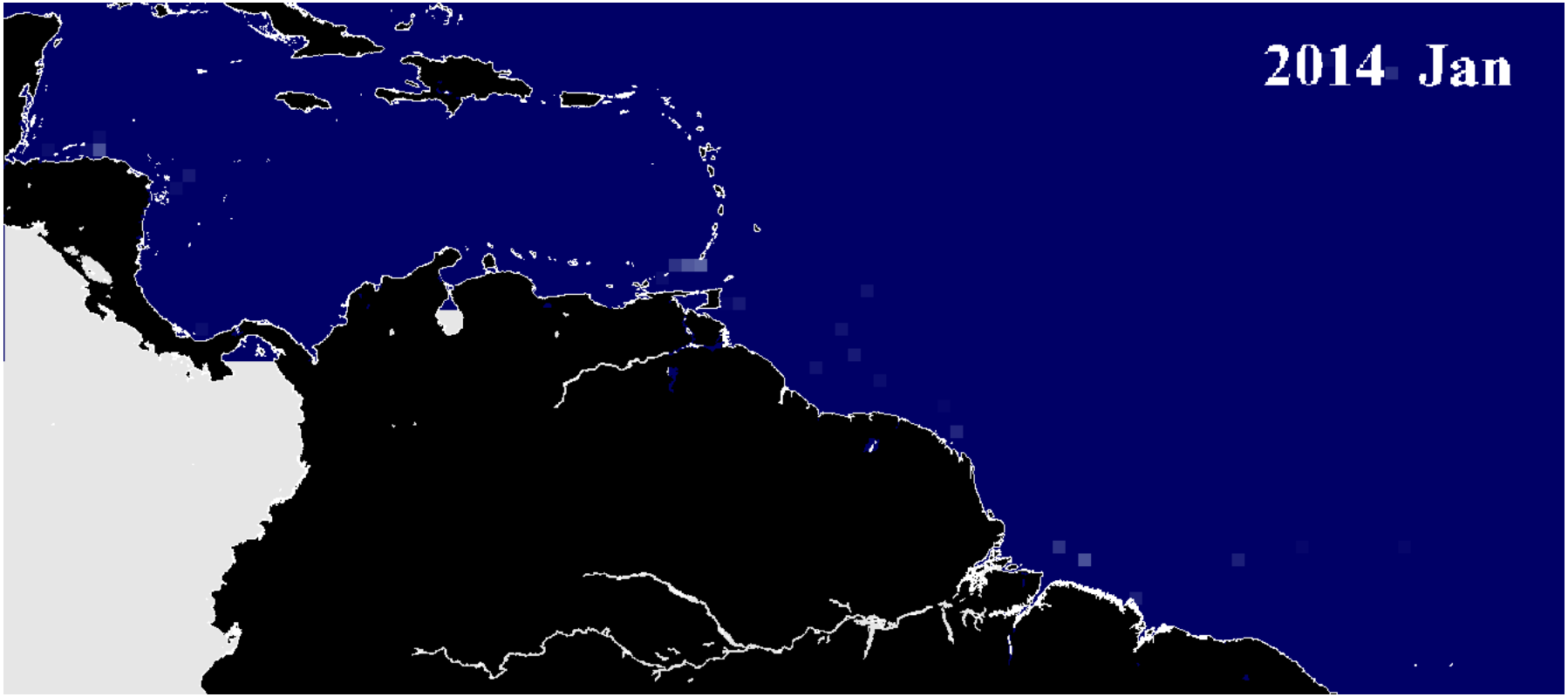
Remote Sensing of *Sargassum* Biomass, Nutrients, and Pigments

Mengqiu Wang[1], Chuanmin Hu[1], Jennifer Cannizzaro[1], David English[1], Xingxing Han[1], David Naar[1], Brian Lapointe[2], Rachel Brewton[2], and Frank Hernandez[3]

Key Points:

- An AFAI-biomass density model was established to estimate *Sargassum*

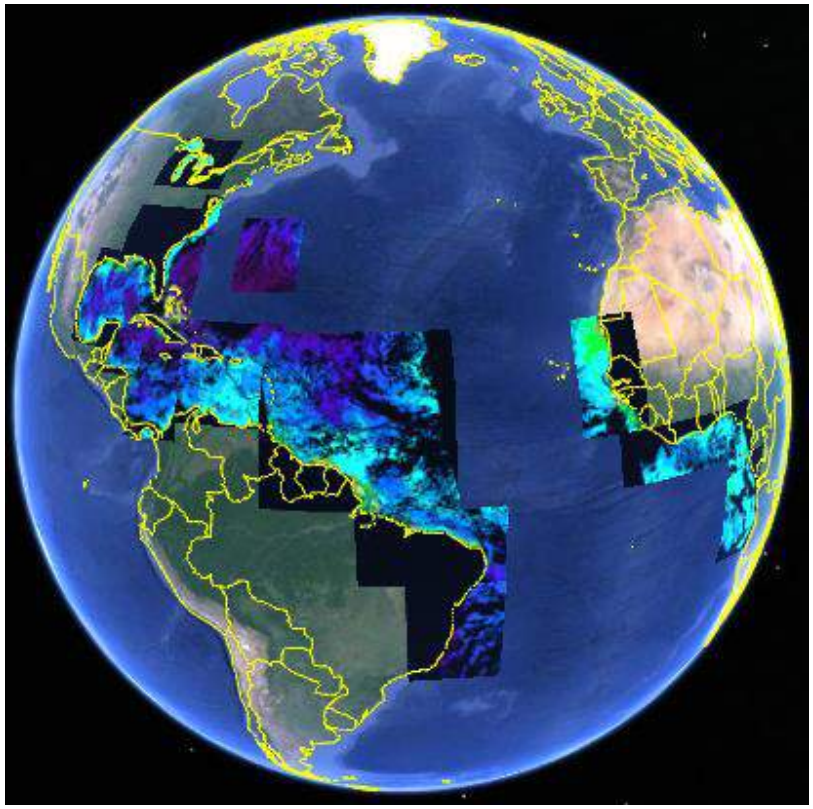
Achievements to date: Publications

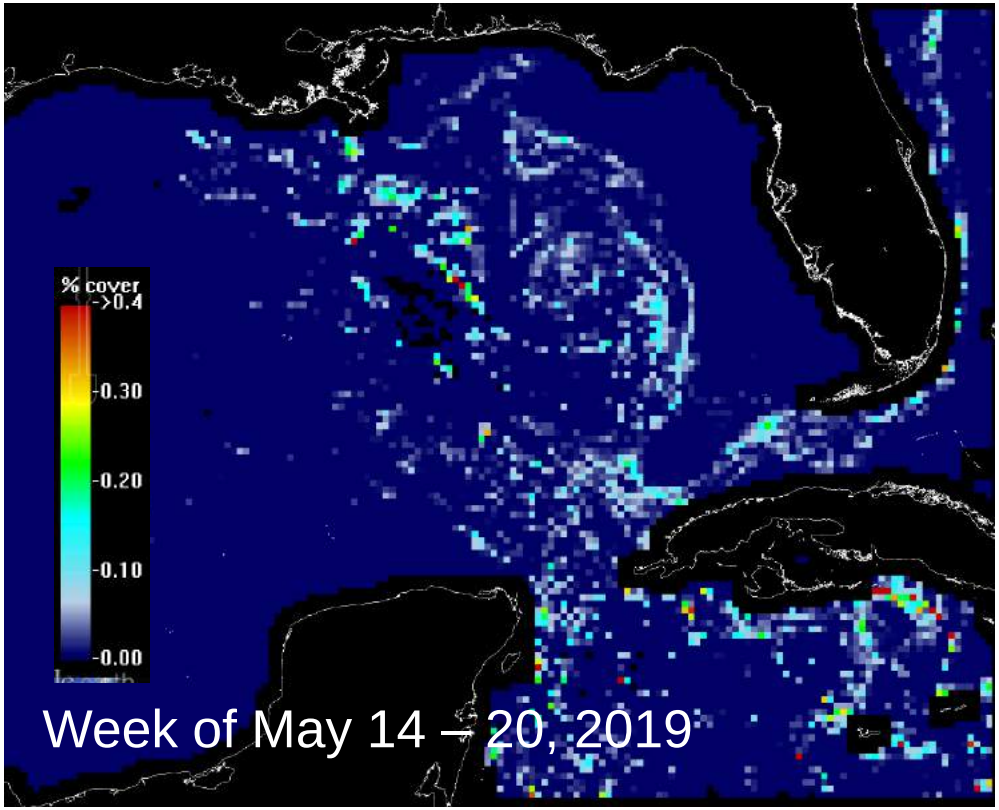


Wang and Hu (2017, GRL)

Achievements to date: improved online tools

1. Coverage expanded to South America and West Africa
2. Added VIIRS data products
3. Added new Floating Algae Density (FAD) product





Achievements to date: user group interactions

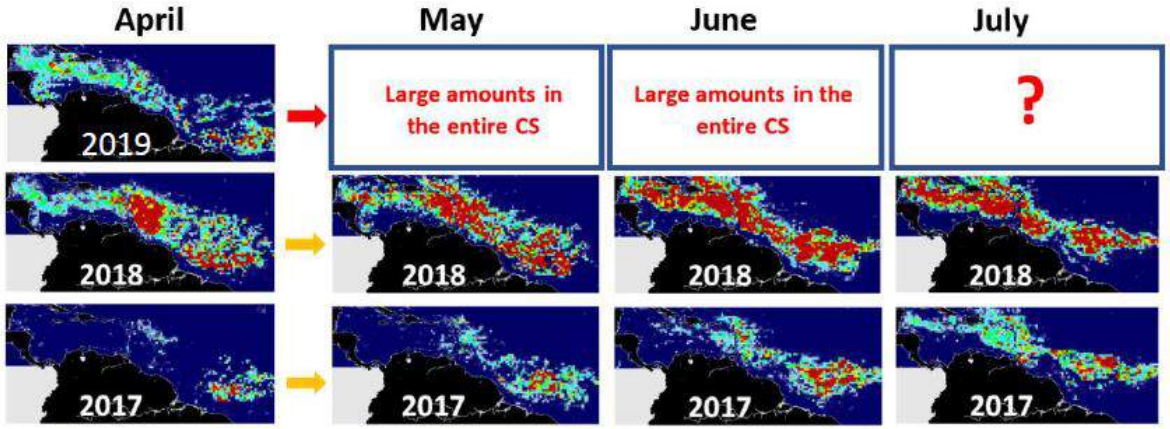
1. Workshops: French – American Workshop on *Sargassum*, Texas, Jan 2018
   Blue growth and risk management workshop, St. Lucia, Jan 2018
2. Partnership with Sargasso Sea Commission, CariCOOS…
3. Webinars and online presentations: Feb 2019, Mar 2019
4. User group communications and interviews
5. *Sargassum* monthly bulletins – updated by end of the month since Feb 2018

USF UNIVERSITY OF SOUTH FLORIDA

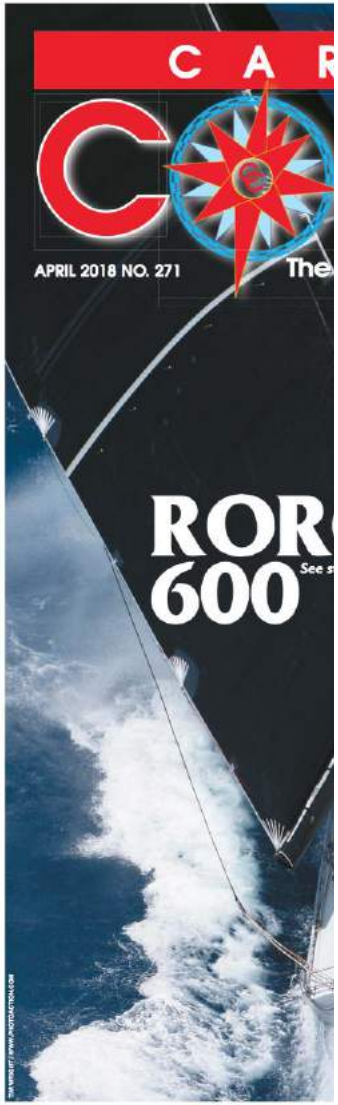
Outlook of 2019 *Sargassum* blooms in the Caribbean Sea*

April 30th, 2019, by University of South Florida Optical Oceanography Lab
(mengqiu@mail.usf.edu)

Looking ahead, because the amount of *Sargassum* in the CWA in April 2019 is considerably lower than in April 2018, the amount of *Sargassum* transported from the CWA to the CS (i.e., "new" *Sargassum* to the CS) during May – June 2019 may be lower than in May - June 2018. However, this transport will still be higher than most of the previous "*Sargassum* years" during the same months. Furthermore, because



Achievements to date: user group interactions



Early Warning of 'Invasions':

Tracking Sargassum Seaweed via Satellite — And How Boaters Can

by Joan Conover

Starting primarily in 2011, massive quantities of pelagic (floating) sargassum seaweed, also known as sargasso, floated throughout the Caribbean, impacting marine resources, fisheries, shorelines, waterways, and tourism. Similar events have occurred since that time. The amount of observable weed has lessened since the large influx of October 2015, however this process is cyclical and the coming season is projected to see a significant increase of this ocean-carried weed.

It will be during this upcoming season of 2017-18 when Caribbean governments and private citizens — including local boaters and visiting cruisers — will again need to develop procedures to address the problems that have been experienced in past "Sargasso Seasons".

The actual sargassum route and cycle are not well known, but amounts do seem to be increasing with each season's cycle; theories for this include increasing heat and/or additional nutrients introduced into the Atlantic that create or enhance massive blooms of this foliage. Recent research also suggests that Atlantic algae responds positively to increased CO_2 and acidity in seawater, a major change in the former theory of slower growth.

A first-hand report last month from the southern Caribbean mentions, "The smell at the moment is near intolerable; the build-up has increased massively in the last week or so, and now there is too much aggregated for the tide to remove it. Furthermore, there is so much ashore already that the new influx can only sit on and in the water. The wet sargassum rots on the shore, and sea life dies on the mass floating at the shoreline."

In cases where sargassum accumulates and decomposes in large quantities, the smell of rotten eggs can occur. This is the odor of hydrogen sulfide gas, which is given off as part of natural decomposition. The US Occupational Safety and Health Administration notes that when the smell is described as "more offensive" (three to five parts per million), prolonged exposure might cause effects such as nausea, tearing of the eyes, headaches and loss of sleep. Asthma sufferers may experience airway problems. Full details are at www.osha.gov/SLTC/hydrogensulfide/hazards.html.

Sargassum also has impacts on fishing gear and motors: for example, engine cooling-water intakes get clogged and rudders get jammed. Some fishers and other boaters are coming up with devices to free rudders of weed and to deflect sargassum from propellers, and are using strainers across water intakes to prevent blockage and engine overheating. Those navigating through the islands need to be with gear complications plus possibl steering, and plan for the safety im especially when underway at night.

Heavy mats of sargassum along the occurred on the windward coast of Bar prevent hatchling sea turtles from rea

Becoming proactive and keeping i location of these floating mats of se new reality for those in the Caribbea sailors alike. This sargassum issue and as one observer says, "This prol which will ultimate adversely affect should be working together to be pre ter, rather than merely reactive or i

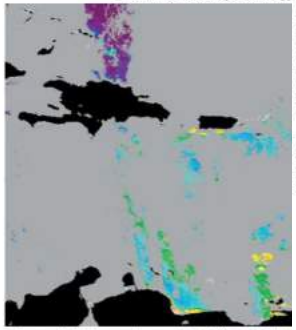
Some Caribbean island governme in Tobago, are already looking at s help cope with sargassum inunda tpsnews.net/2017/07/tobago-gears invasion for details).

Satellites Spot Sargassum

Over the past several years, sever ties have been developing technologi lite imagery to identify the location (See: (https://eos.org/features/s warns-of-incoming-seaweed).

While this seems simple, it has ground, or in this case sea, knowle unces of weed occur. This then allow satellite data to develop suitable app

By sending reports of sightings, boaters can help verify satellite imagery showing rafts of sargassum drifting through the Caribbean.



eral years, private "citizen scientists ers have reported their sargassum fi Coast Research Laboratory's (C research group headed by Jim Frank of Southern Mississippi.

These data are used to model the s gassum in the tropical North Atlantic the Caribbean region. These data ha to determine the source of the mass research indicates a sargassum sour torial origin, rather than connectio Sea. The GCRL research conducte oceanographer colleague Dr. Don Jol

Another effort to provide a satellite tion was being developed by Dr. Chu at the University of South Florida. announce there is now an internet imagery views of sargasso.sm, which c warning of where or when this seas impact an area. While still in the de this is a huge step forward for pre weed will be and could allow countr areas time to prepare. Basically, t Sargassum Watch System (SaWS) marine.usf.edu/projects/saws.html

—Con

Major Seaweed Invasion Underway — and What We Can Do About It

by Joan Conover

Over recent years, quantities of *Sargassum*, a type of seaweed commonly known as sargasso, have continued to wash up on beaches and appear in the waters of the Atlantic, the Caribbean Sea and the Gulf of Mexico. The 2015 season was the heaviest sargasso inundation on record, with the years of 2016 and 2017 showing a downturn.

Based on satellite imagery and reports from citizens, this year the impacts can be expected to be even worse. But new online tracking systems and suggestions for clean-up of affected beaches are highlighted in this article, along with ways of detecting the hydrogen sulfide gas given off by the decomposing weed and warnings on possible health impacts.

Major infestations of sargasso were reported in Barbados, in the Grenadines and in Bonaire as early as February this year, and islands to their north, including St. Lucia and Martinique, are starting to see mats and patches of the weed. Their windward beaches are becoming filled with rotting material off-gassing hydrogen sulfide, which can be a health risk.

The Gas in Sargasso

Since 2015, taking the risk seriously, the Government of Martinique has established an online website with updates on weed volumes and hydrogen sulfide levels, an excellent example for other islands. Two parts of hydrogen sulfide per million can cause spontaneous abortion in pregnant woman; 100 PPM is deadly, according to Martinique's website, www.anses.fr/en/content/exposure-emissions-sargassum-seaweed-washed-shore.

The US Occupational Safety and Health Administration states that prolonged exposure to three to five parts of hydrogen sulfide per million may cause effects such as nausea, tearing of the eyes, headaches and loss of sleep. Asthma sufferers may experience airway problems. Full details are at www.osha.gov/SLTC/hydrogensulfide/hazards.html.

Tarnishing of metals and discoloration of paint have also been reported in areas affected by a sargasso influx and the subsequent release of hydrogen sulfide. One 2015 report cited "[silver tarnishing in days not months] as an illustration of how concentrated the gas is, even away from the beaches.... we lost over $10,000 of electronic equipment solely through hydrogen sulfide damage." Another commented about the "appalling, nauseating smell, the damage to health, electronics, metals, and paint that occurred last time there was an inundation of this magnitude."

The gases in water can destroy reverse osmosis desalination systems' membranes and filters as well. Virgin Gorda lost its desalination system, located in Spanish Town, in the 2015-2016 sargasso season.

Tourism finds major problems with shorelines being fouled with off-gassing weed, sometimes with a smell strong enough to sicken beach-goers.

Other Problems with Sargasso

Environmentalists find turtle nesting beaches covered with thick strands of weed trapping hatchings and adult turtles alike, and preventing female turtles from getting onto the sand to lay their eggs. Offshore, the weed is friendlier, and fish and sealife travel and live in its strands.

However, yachting and shipping interests recognize the problems this weed causes with propeller fouling, raw-water intake-blockage and loss of steerage. Boaters should also be aware that mats of sargasso accumulate debris, such as floating nylon ropes, nets and other trash.

Another concern is the potential for this seaweed to accumulate heavy metals or other toxic materials. New testing, currently in progress with the University of South Florida, is obtaining samples and processing for this type of contamination. However, as samples are just now being provided, it will take time to analyze and determine what, if any, issues there are.

Sargasso Tracking and Prediction

The excessive growth of sargasso in 2018 seems grim. Researchers from the University of South Florida and NASA tell us, "The past months of January and February 2018 showed the largest bloom in the central West Atlantic, as compared to the same months in history." USF researcher Dr. Chuanmin Hu warns of the likelihood of "major beaching events this year as it is more and more becoming a reality — the total amount of sargasso we have seen in February (usually a low month) has now exceeded the maximum month of July/August of 2015."

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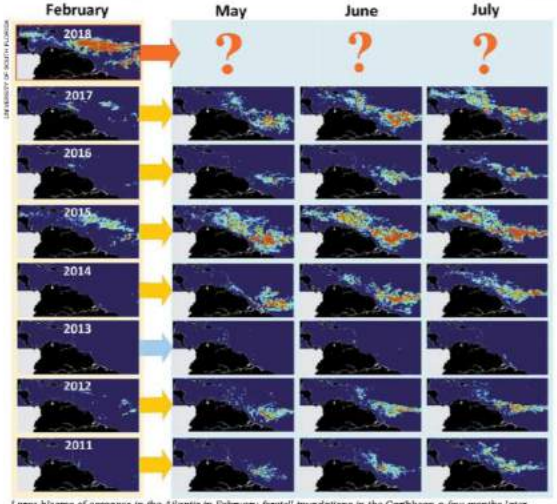

Large blooms of sargasso in the Atlantic in February foretell inundations in the Caribbean a few months later. February 2018 saw the largest bloom yet, and forewarned can be forearmed

Achievements to date: user group interactions

"Over the last six months, the National Meteorological Service has used the images as a guide in providing a weekly sargassum statement to assist in the management, clean up and awareness of the sargassum mats along the coast of Belize."

- **National Meteorological Service of Belize, April 30, 2019**

"I am the developer of the sailing apps called SailGrib WR, we exchanged emails a year ago. I have been publishing a daily sargassum report for the Easter Caribbeans for the past year. As of Dec 21st, no more sat images are available either for both satellites:

https://optics.marine.usf.edu/subscription/modis/C_ATLANTIC/2018/daily/

Can you confirm this is due to the US government shutdown and that the service will be back when it ends?"

- Henri Sailgrib <henri@sailgrib.com> January 3, 2019

"Greetings from CANADA! We appreciate the great work you are doing.
My wife and I recently went to Punta Cana from April 9-16, 2019 & we did come across the 'Beach Killer Algae!' YUCK!
In planning for next winters (cold/icy/snowy/miserable up north here in Montreal, Quebec, CANADA) '***getaway***;' what places would you recommend that do NOT receive this 'Sea-Weed' on its beaches? During research on this subject, I see that it travels in a pattern in the Caribbean Sea. Thanks again for your great work-research. Yours truly"

- Ian & Diane (Stewart), May 7, 2019

So what?

Biogeochemistry, ecology, environment, economy

House made of *Sargassum* bricks

https://www.riviera-maya-news.com/hotel-for-tulum-to-be-built-of-local-sargasso-bricks/2019.html [riviera-maya-news.com]

So what?

Biogeochemistry, ecology, environment, economy

Eco-shoes made with *Sargassum* and plastic bottles

https://mexiconewsdaily.com/news/eco-shoes-are-made-with-sargassum-seaweed/

Summary

- A prototype SaWS has been improved, based on research and in response to user needs
- Coverage extended, VIIRS added
- New product of Floating Algae Density added
- User groups expanded (governmental agencies, environmental groups, private industry, citizens…)

What's next?

- Incorporation of high-resolution sensors
- Seek sustainable funding support through partnerships