

# *Sargassum Watch from Space*

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# What *Sargassum*?

*Sargassum fluitans*



*Sargassum natans*



Photo credit: Amy Sinuda of Sea Education Association

## The Good and the Bad



Photo courtesy: Tracey Villareal (U. Texas)



- *Sargassum* provide food and shade to many animals (fish, young turtles, shrimp, crab, etc.) and serves as an important ecosystem habitat, and it also supports sand dunes and shoreline stabilization
- “The golden floating rainforest of the Atlantic Ocean” (The Sargasso Sea Alliance)

# The Good and the Bad



*Sargassum* beaching in the Caribbean (photo courtesy of Jean-Philippe Maréchal)

Excessive *Sargassum* beaching is bad

- Smells bad, attracts insects,
- Smother turtle nesting sites
- Cause sea turtle and fish mortality
- Negative impact on tourism and economy
- Requires physical removal

## Questions on *Sargassum*

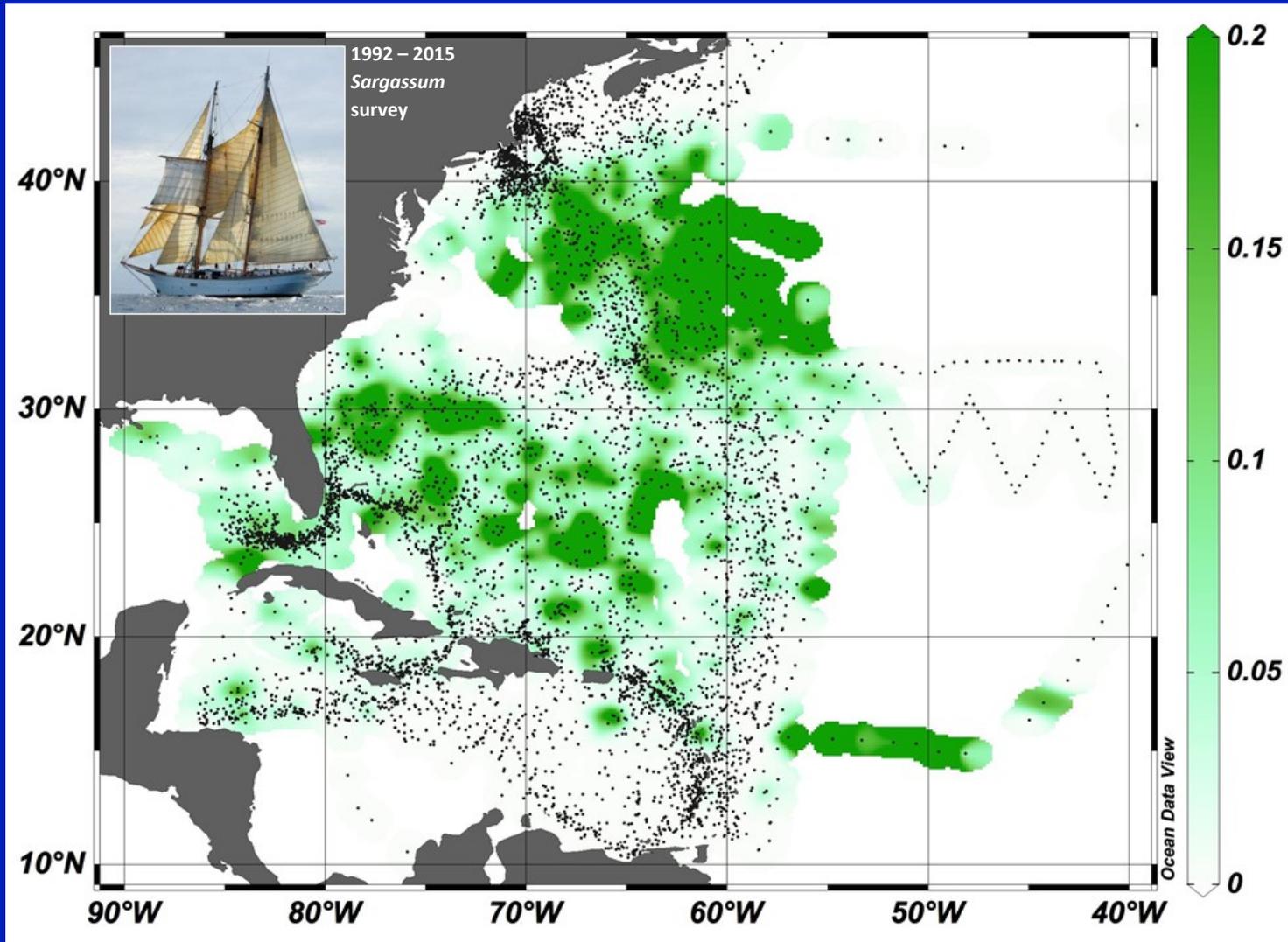
Where? How much? How often? Why? So what?  
Ecological impact? Biogeochemistry? .....

Answers: very few

Reasons: lack of enough observations

# The most comprehensive survey is still not enough

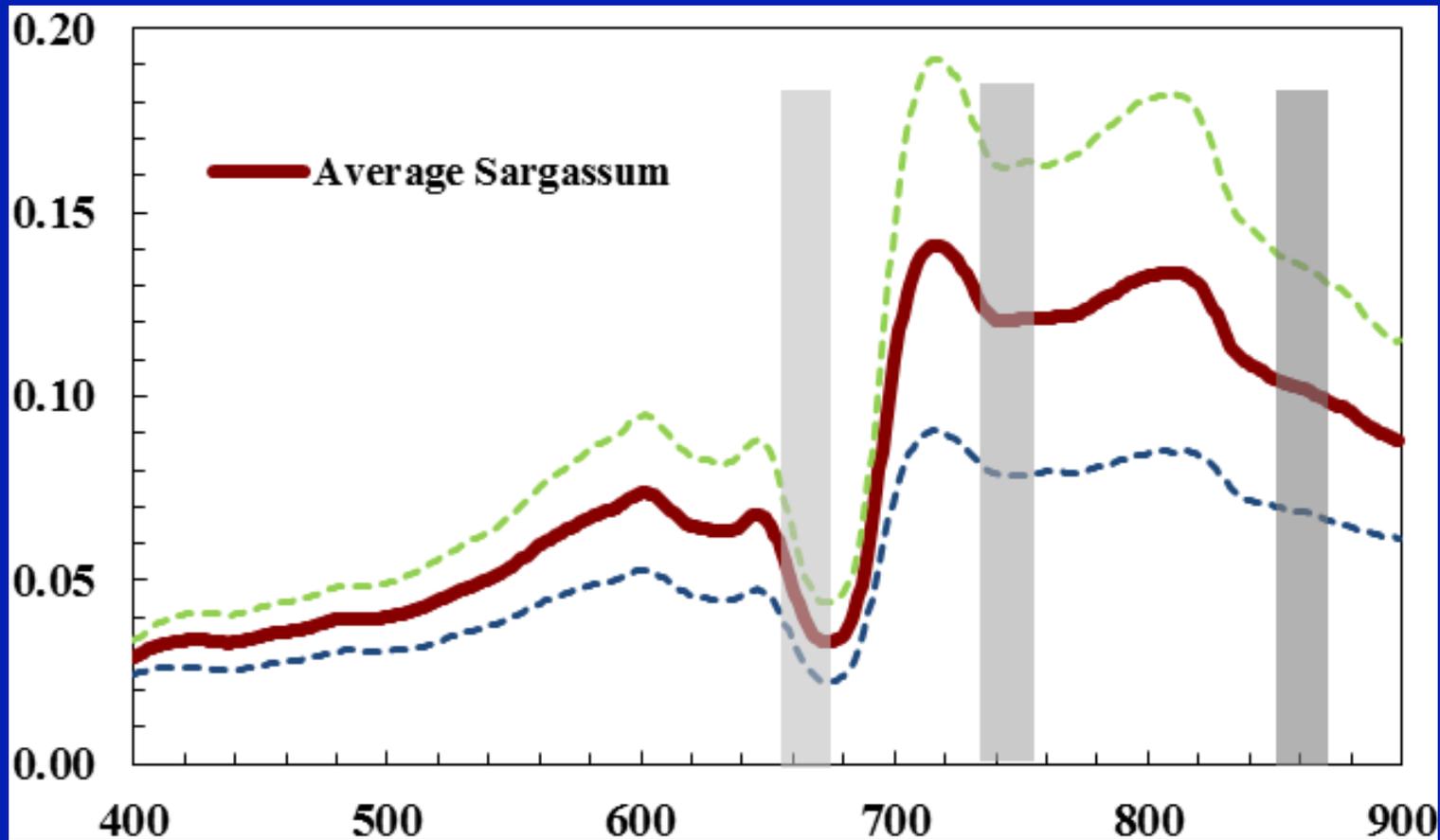
Annual surveys using neuston tows (1992 – 2015). Color represent density in g/m<sup>2</sup>



Slide from Amy Sinuda of Sea Education Association

# Can we "measure" *Sargassum* from space?

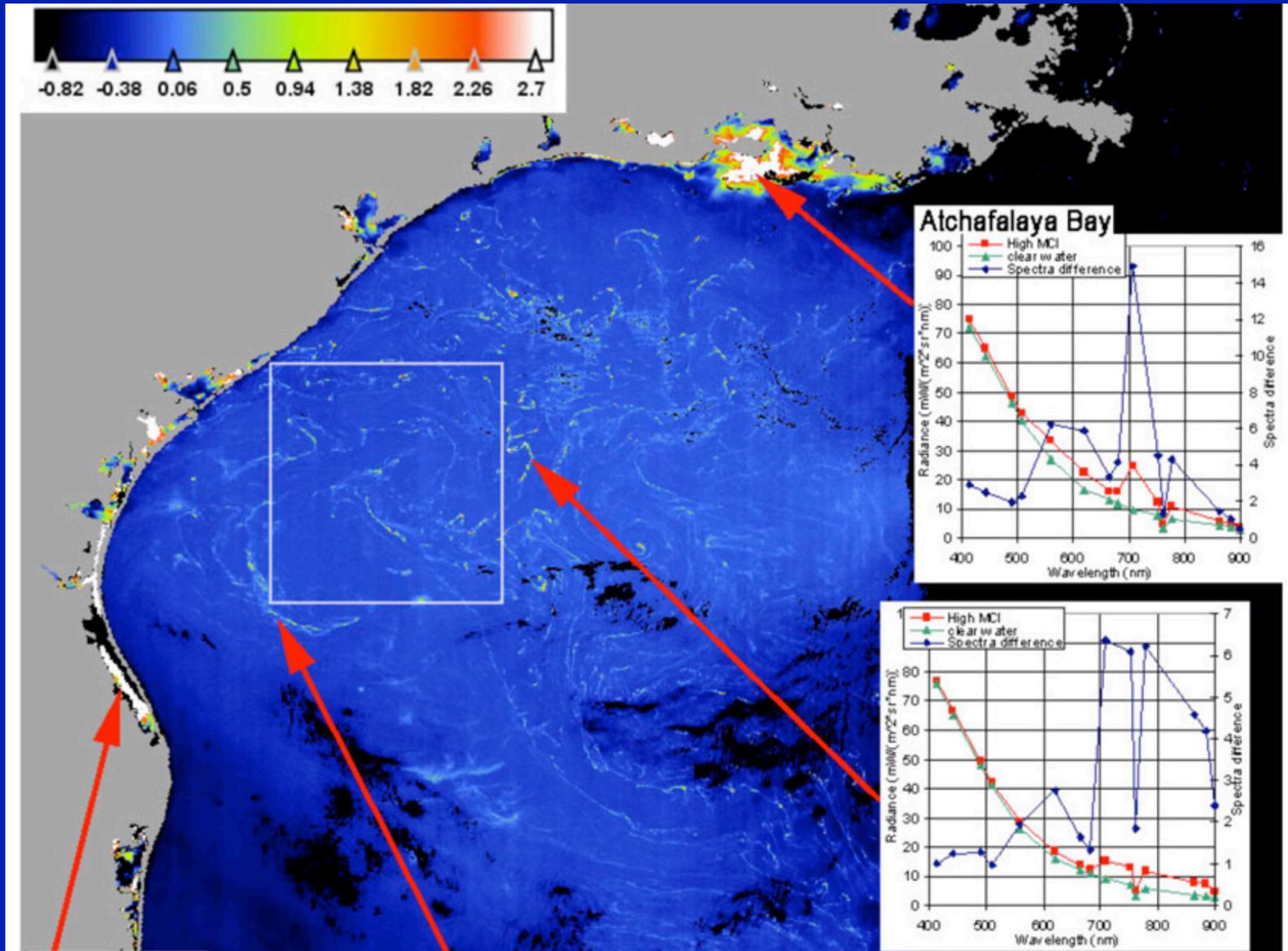
Red-edge reflectance indicative of floating vegetation



From Hu et al., (2015, RSE)

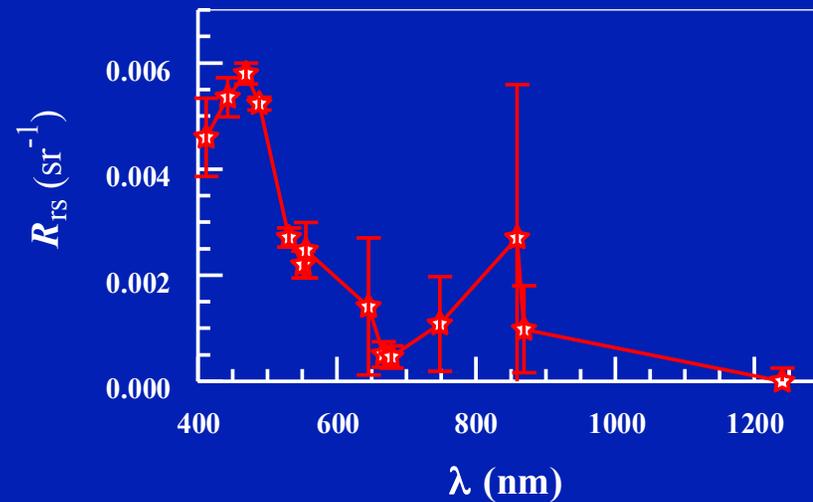
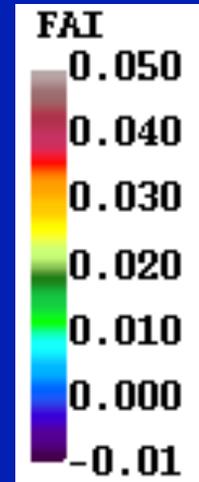
# The first space-based *Sargassum* detection

Gower et al (2006) used MERIS MCI and MODIS FLH for the red-edge reflectance



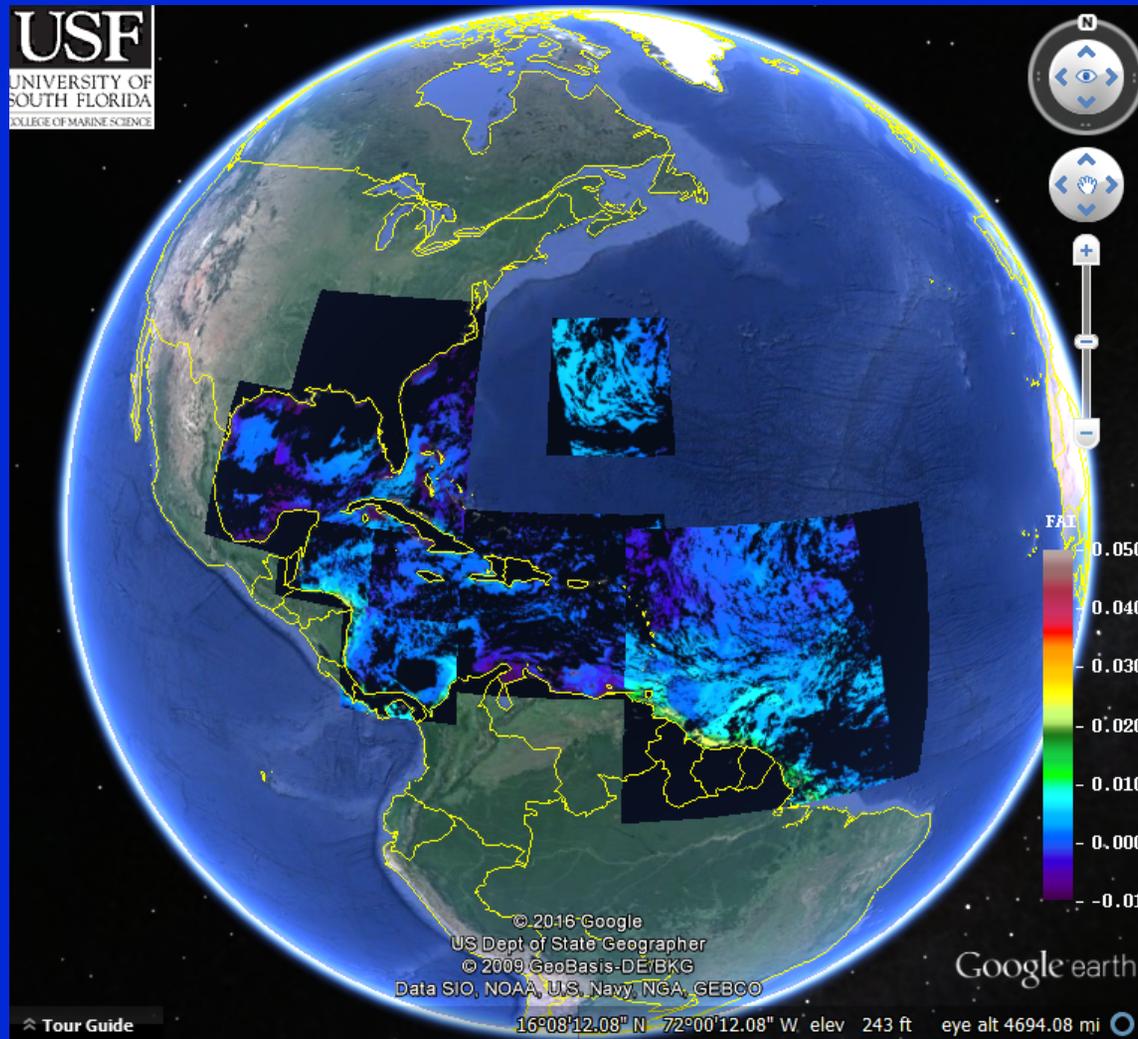
# The second space-based *Sargassum* detection

Hu (2009) used MODIS floating algae index (FAI)



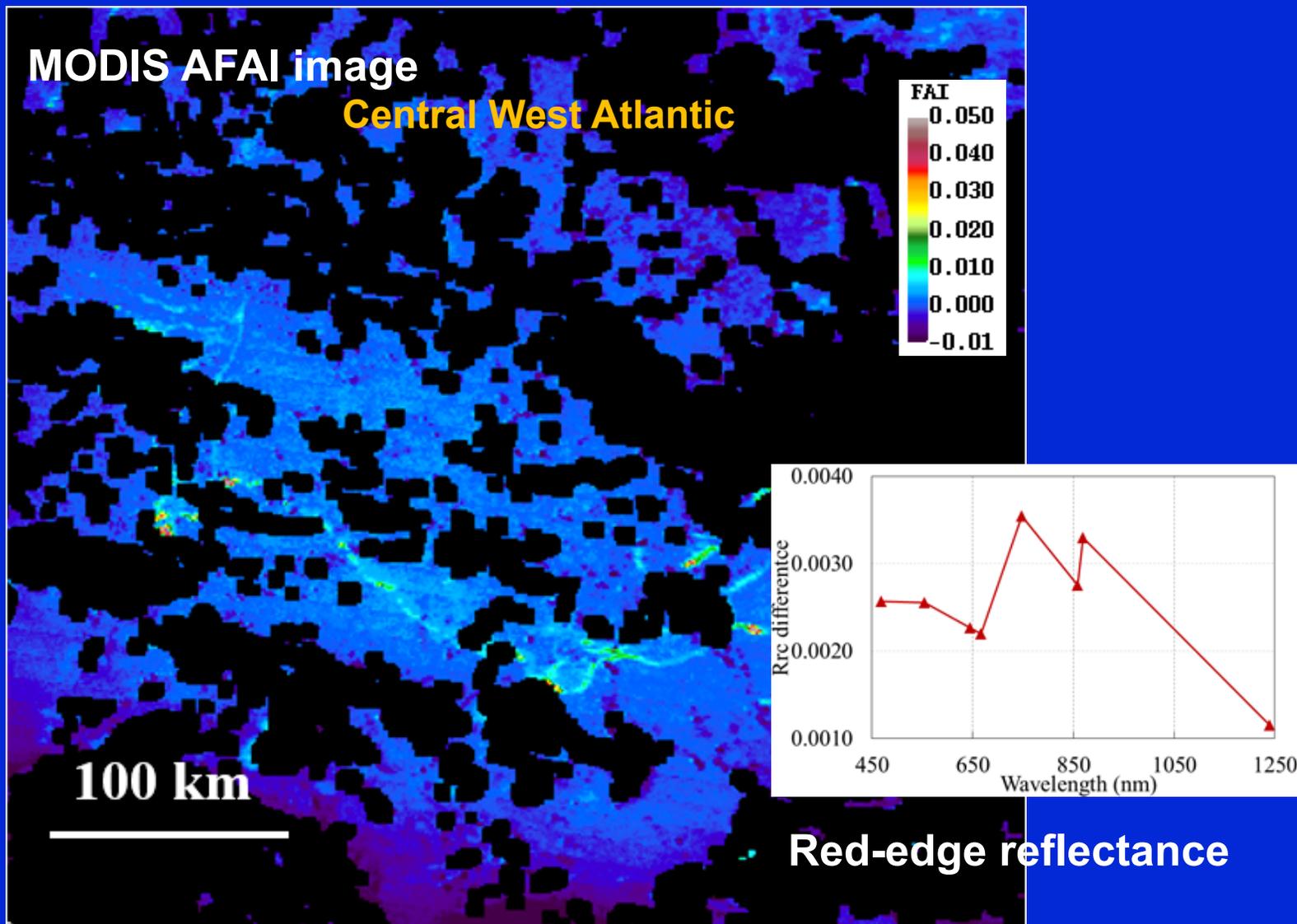
# Satellite-based near real-time *Sargassum* Watch System (SaWS)

<http://optics.marine.usf.edu/projects/SaWS.html>



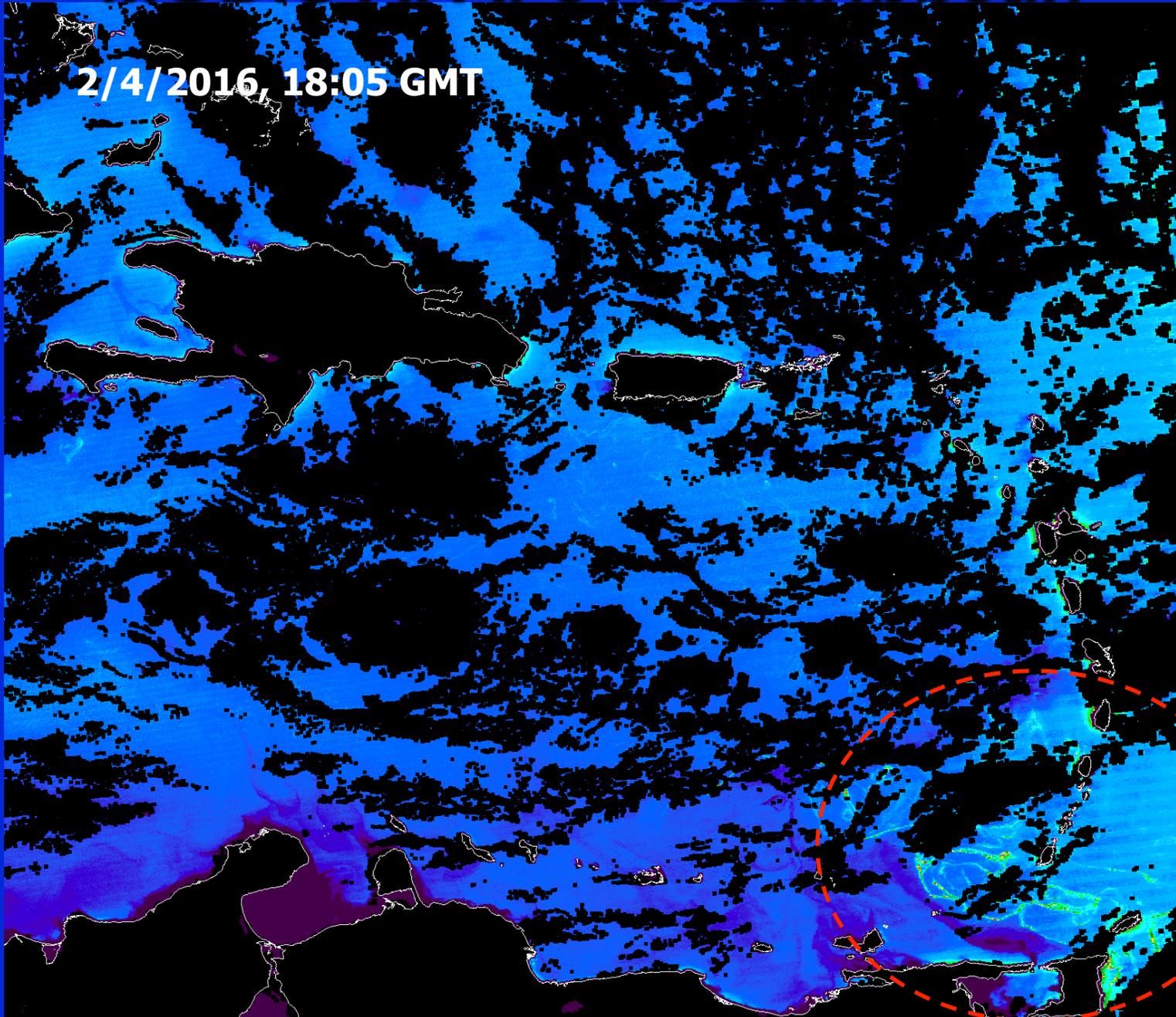
# Near real-time MODIS products for the Intra-Americas Sea

Customized imagery to detect and track floating algae rafts



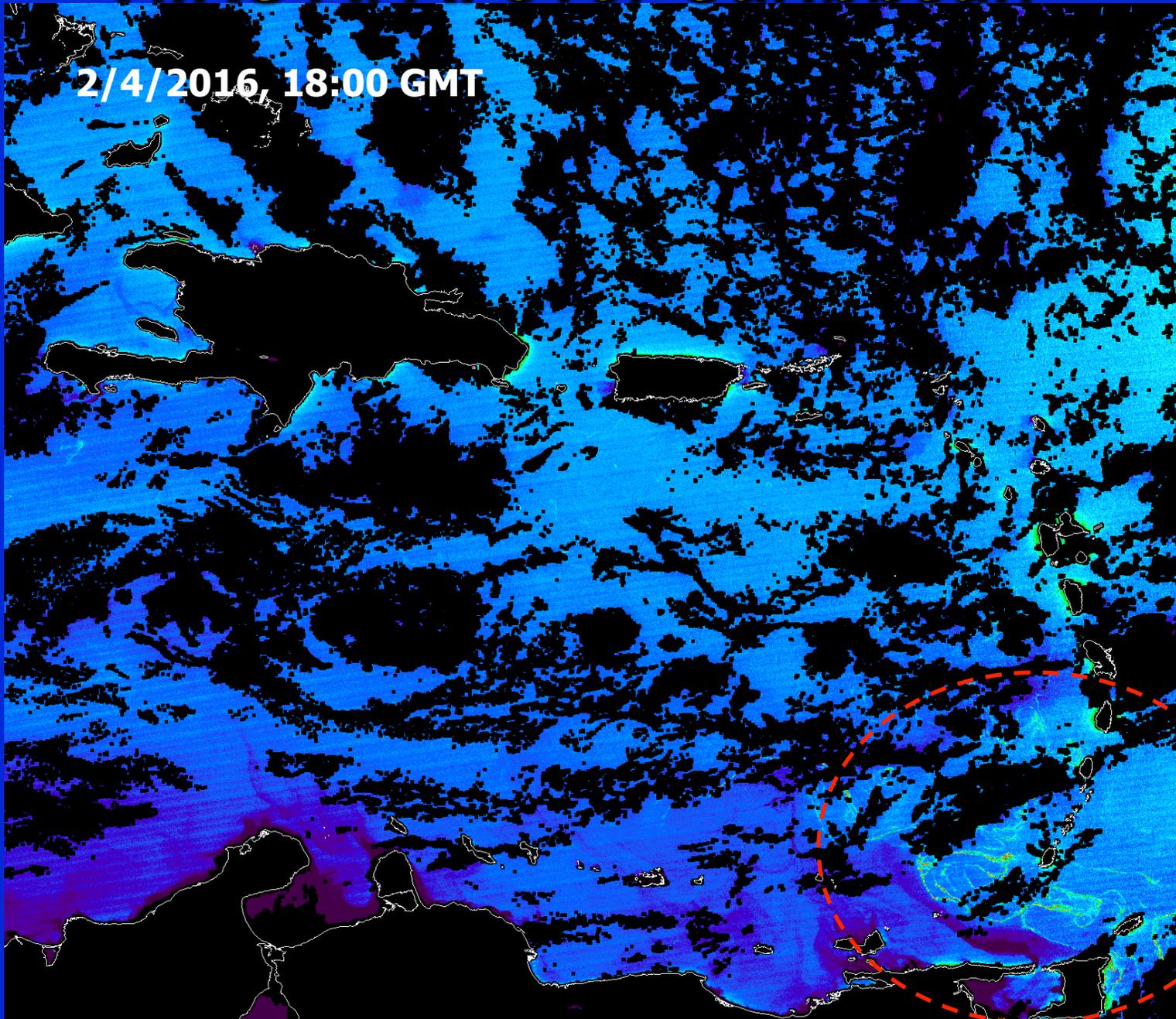
# MODIS AFAI over Caribbean

2/4/2016, 18:05 GMT

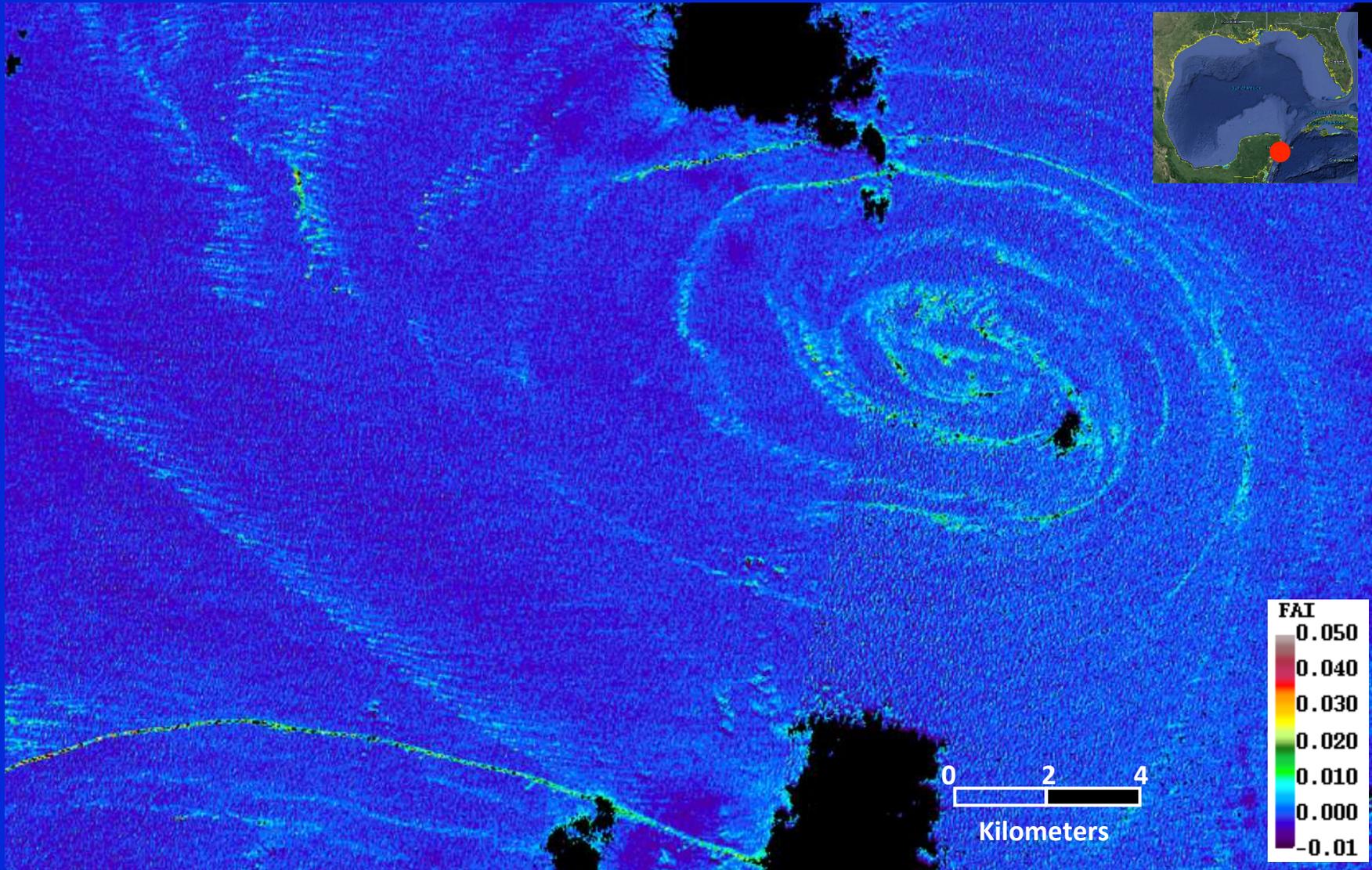


# VIIRS AFAI over Caribbean

2/4/2016, 18:00 GMT

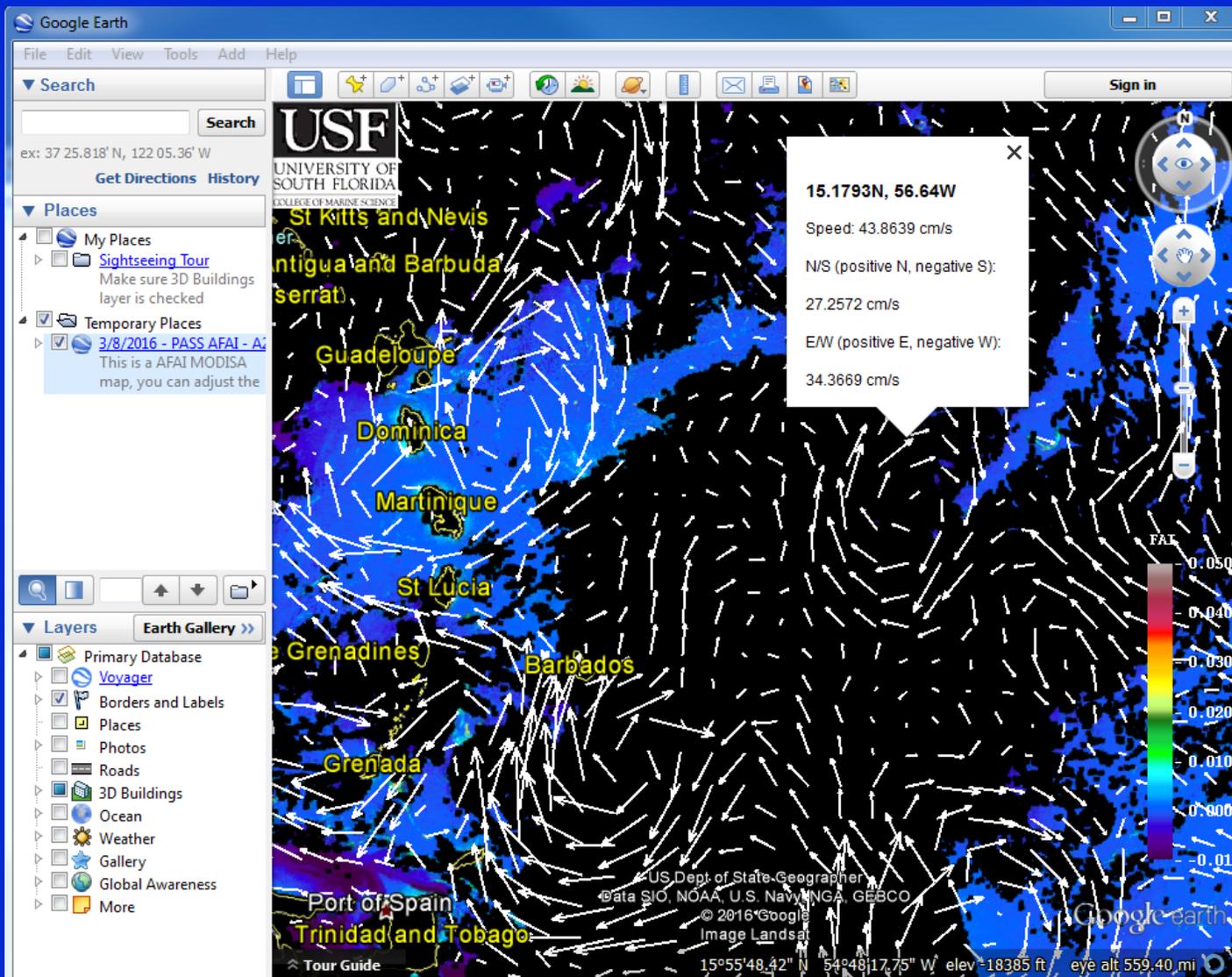


# Landsat-8 OLI off Mexico



# Near real-time products for the Intra-Americas Sea

## Integration with HYCOM currents in Google Earth



## Now what?

### Mapping, quantifying, and statistics

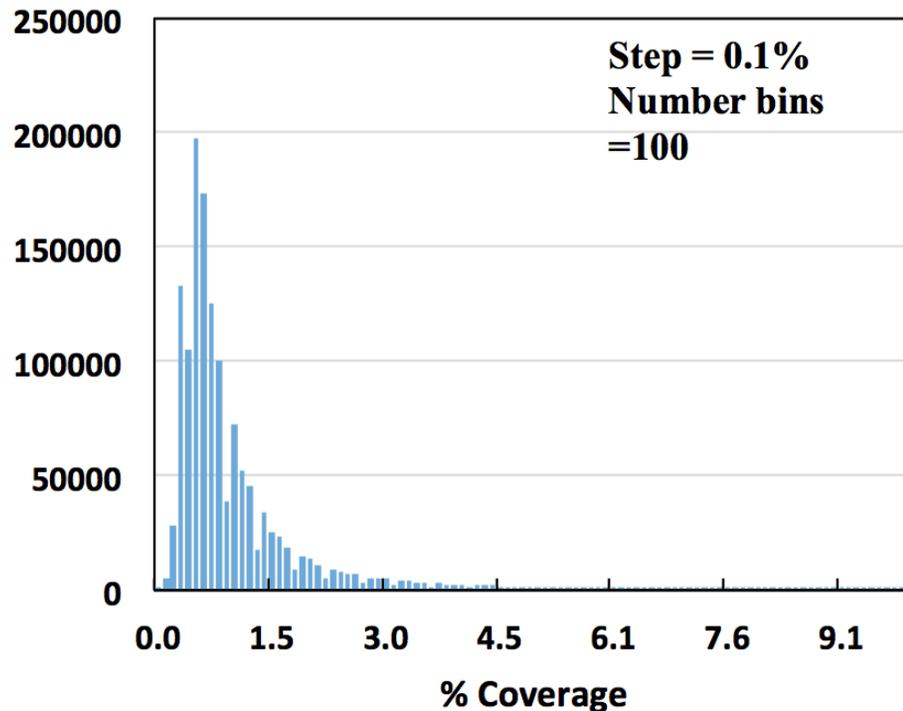
#### Three steps

- Detection through classification of image pixels: No observation; Algae-containing; Algae-free
- Unmixing: determine global and local lower and upper bounds for 0% and 100% sub-pixel algae
- Mapping and statistics: put weighted pixels in pre-defined grid cells for each month, and calculate mean density (i.e., % cover)

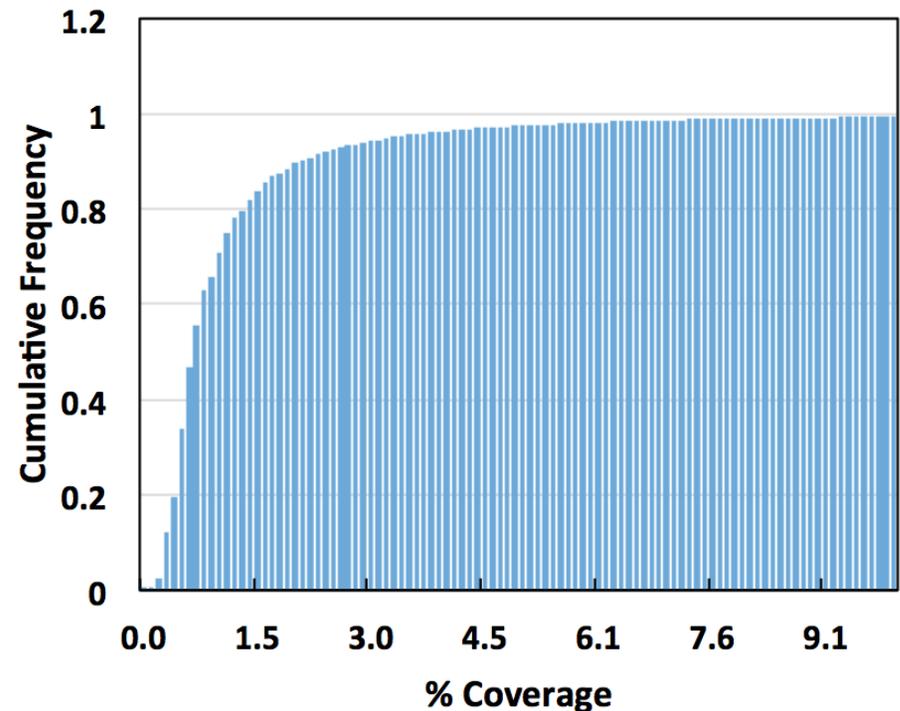
# Sub-pixel fractional coverage from all algae-containing pixels during July 2015 (1-km pixels)

Lower detection limit: 0.2% sub-pixel coverage; Spectral discrimination: ~5%

**Histogram**



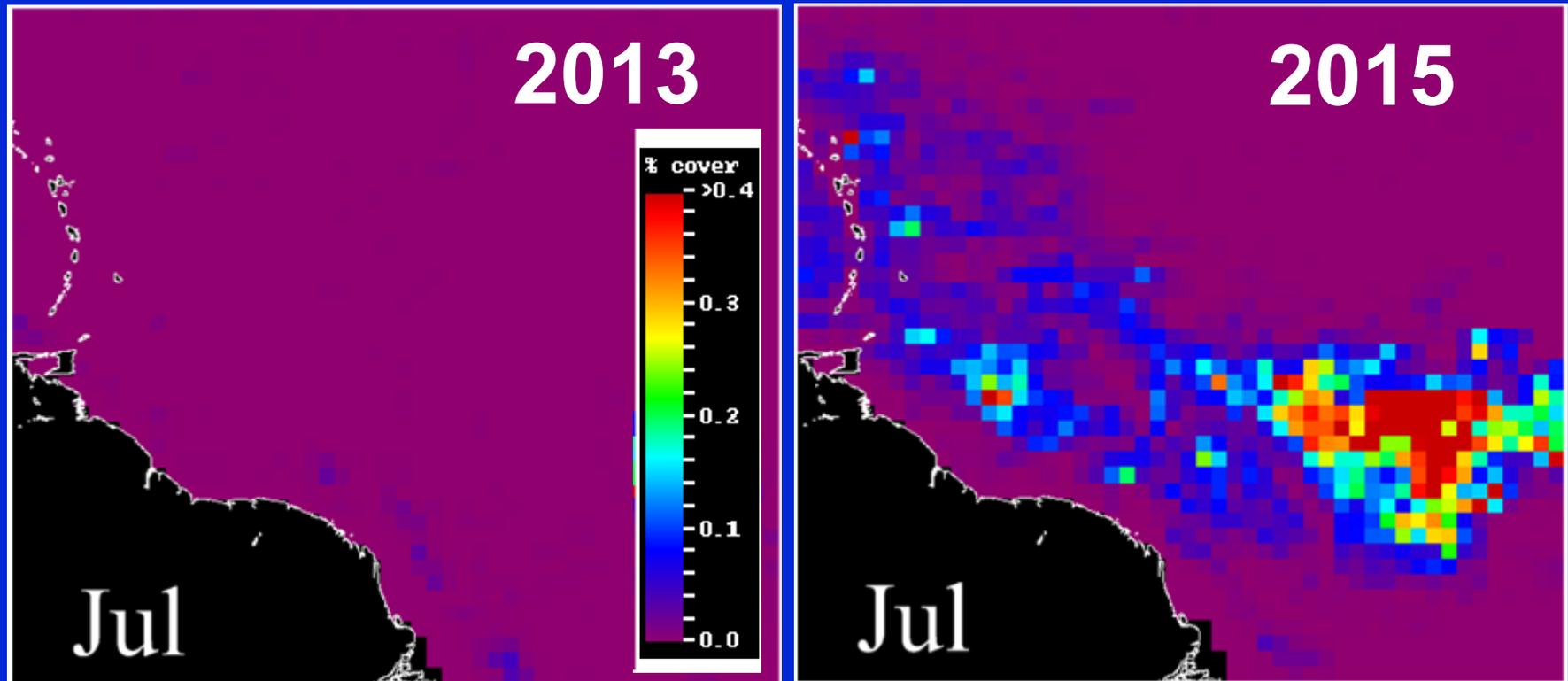
**Cumulative Histogram**



Statistics for July 2015, Central West Atlantic

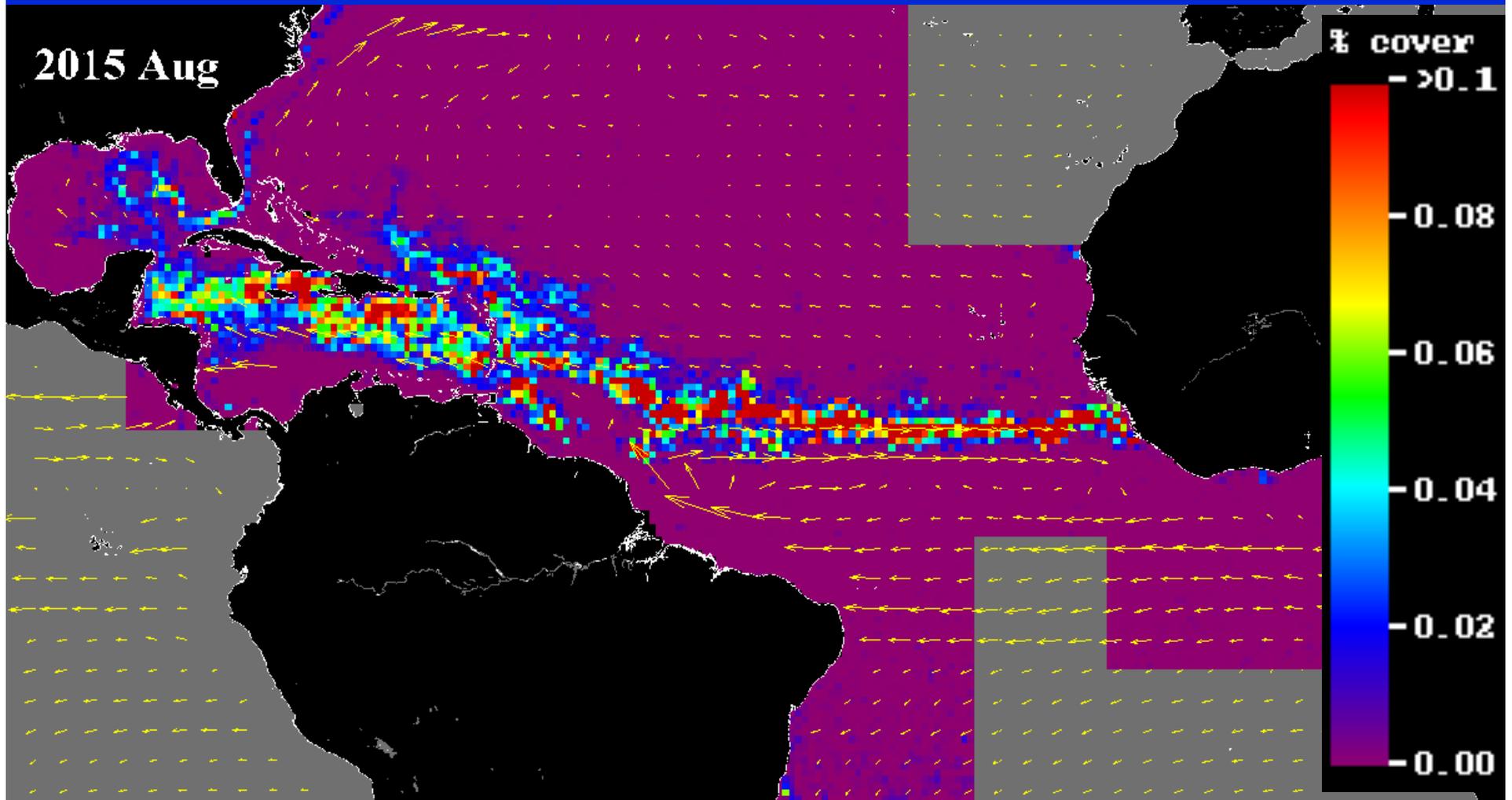
# Mapping and quantifying *Sargassum* density

From Wang and Hu (2016, RSE)



# Extend to the entire IAS?

Computing speed: currently 2 years of MODIS data per month



## Summary

### A near real-time satellite-based SaWS

- Sensors: MODIST (daily), MODISA (daily), VIIRS (daily), L8 (16-day)
- Products: AFAI (1-km), CI (1-km), HyCOM; L8 FAI and CI (30-m)
- Where: <http://optics.marine.usf.edu/projects/SaWS.html>; GE compatible

### Requirements of spectral, spatial, and radiometric resolutions for detecting and quantifying *Sargassum*

- Spectra: current 15 or 20-band specifications not optimized for *Sargassum*
- Spatial and radiometric: the higher the better; detection limits quantified

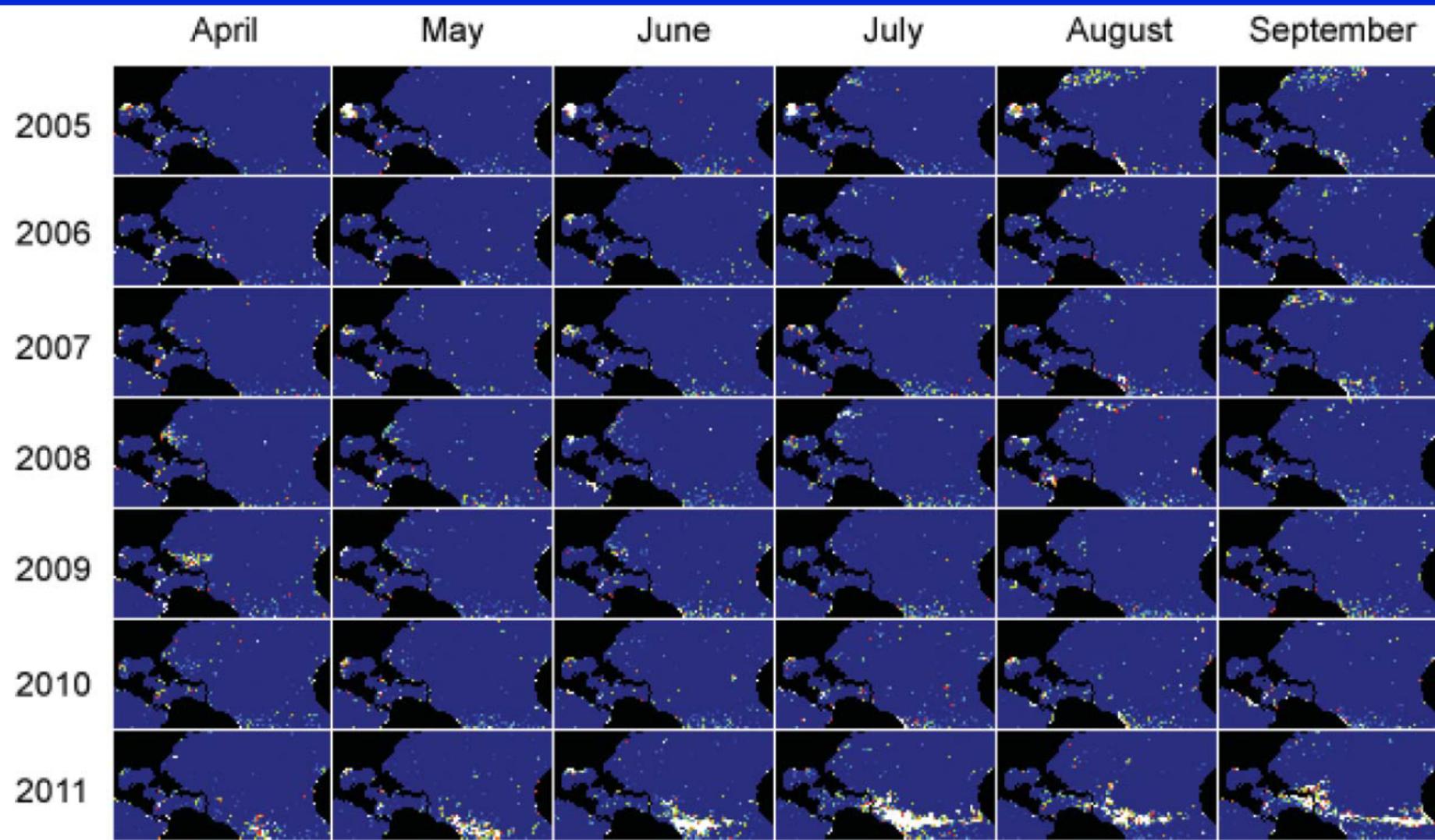
### MODIS-based mapping and quantification

- Several regions finished; Unprecedented information on spatial temporal distributions and abundance
- Entire IAS and Tropic Atlantic: very exciting results, but data still being processed

### What's next

- Refine current algorithms and protocols, integrate field observations
- Improvements in accuracy and reduction in uncertainties
- Targeted studies on *Sargassum* ecology and biogeochemistry

## MERIS time-series (Gower et al., 2013)



# Approach: MODIS Data Products

## MODIS FAI definition:

$$\begin{aligned} \text{➤ } R_{rc,\lambda}(\theta_0, \theta, \Delta\phi) &= \pi L_{t,\lambda}^*(\theta_0, \theta, \Delta\phi) / (F_{0,\lambda} \times \cos\theta_0) \\ &\quad - R_{r,\lambda}(\theta_0, \theta, \Delta\phi) \end{aligned}$$

$$\text{➤ } \text{FAI} = R_{rc,\text{NIR}} - R_{rc,\text{NIR}}'$$

➤ Both model simulations and observations showed more stability in FAI than in NDVI or EVI (Hu, 2009)

➤ MODIS FAI images: 250-m per pixel resolution, Sargassum slicks of > 5 m in width can be detected!

➤ Coverage: daily for GOM and SAB