

Berline L. \*, Ody A, André J-M, Chevalier C, Thibaut T, Blanchot J, Doglioli AM, Petrenko AA, \*leo.berline@mio.osupytheas.fr  
 Aix-Marseille University, Mediterranean Institute of Oceanography (MIO), CNRS/INSU, IRD, UM 110, Campus universitaire de Luminy, case 901, 13288 Marseille cedex 09, France.

## Rationale

Since 2011, massive accumulations of pelagic *Sargassum* brown algae (Phaeophyceae, Fucales) have occurred along the southern Caribbean, northern Brazilian and West African coasts. Huge amounts of *Sargassum* have been washed onshore, with negative socio-economic impacts (e.g. on tourism, health). Stranding occurred with a large interannual variability. So far, two holopelagic species (*Sargassum natans* and *fluitans*) are known to be abundant in the Sargasso Sea and Gulf of Mexico. But the origins of these atypical *Sargassum* blooms in the tropical Atlantic remain unknown. Several putative origins can be assumed: an unusual southward expansion of the Sargasso Sea, or the development of a new accumulation zone NE of Brazil, possibly linked with nutrient inputs from the Amazon river. Beyond potential source regions, knowledge is lacking on species identification, population genetic structure, reproduction type, connectivity and effects on the ecosystem.

To address these questions, three actions were launched at MIO.  
 (i) Detection and mapping of *Sargassum* rafts through remote sensing  
 (ii) Campaign onboard ANTEA RV to sample *Sargassum* algae, associated environment and biota and bio-optical properties  
 (iii) Modelling of *Sargassum* transport at basin scale



Figure 1. *Sargassum natans*



Figure 2. Massive stranding in Guadeloupe, May 2015

## Detection and mapping of *Sargassum* rafts

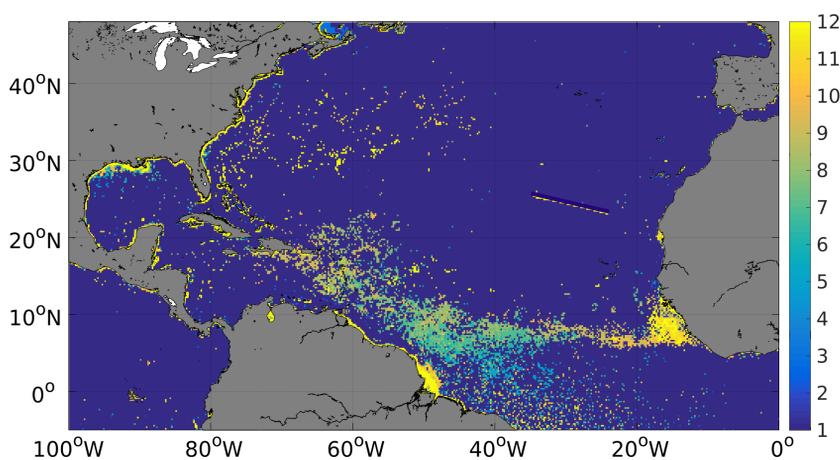
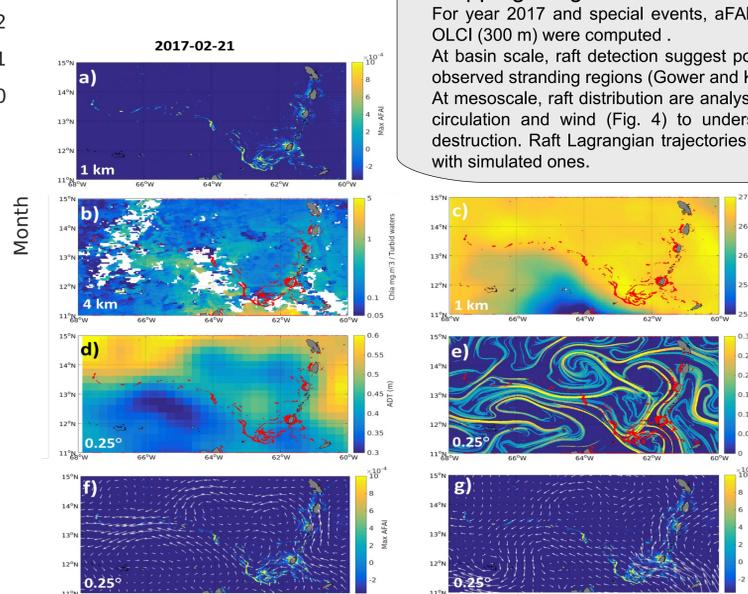


Figure 3 MCI/MERIS spectral index: 2011 composite (data: J. Gower and S. King, pers com). *Sargassum* raft color change with the month. The color gradient shows the westward progress of the area of *Sargassum* occurrence. Random detection near the equator is due to cosmic ray impacting the sensor arrays (NASA 2002, Gower et al., 2013). Coastal areas are impacted by turbid waters



### Mapping *Sargassum* raft at finer scales

For year 2017 and special events, aFAI (Wang and Hu 2016) from MODIS (1 km) and OLCI (300 m) were computed.  
 At basin scale, raft detection suggest potential routes of transport from source regions to observed stranding regions (Gower and King 2009, Gower et al 2013).  
 At mesoscale, raft distribution are analysed in the light of the environmental fields, surface circulation and wind (Fig. 4) to understand the drivers of raft formation, stirring and destruction. Raft Lagrangian trajectories inferred from successive maps will be compared with simulated ones.

Figure 4 a) MODIS (1 km) aFAI daily maximum-composite over the Caribbean Sea, west of the lesser Antilles for February 21th 2017. *Sargassum* detection (aFAI > 0, red) are plotted over : b) Chlorophyll 8-days composite (log(Chla), 4 km, gsm algorithm); c) Sea Surface Temperature (SST, 1 km); d) AVISO Absolute Dynamic Topography (ADT, 0.25°); e) Altimetry-based finite-size Lyapunov exponents (FSLE) derived over dt=40 days (0.25°). Surface current direction and magnitude issued from AVISO altimetry and MERCATOR model (0.25°) are also represented by white arrow over *Sargassum* aFAI maps in f) and g), respectively. Data source : CMEMS (Chlorophyll, SST), AVISO+ (ADT), processed with SPASSO software (<http://www.mio.univ-amu.fr/SPASSO>).

## SARGASSES campaign (PI T Thibaut) 19th June – 13th July 2017

Ongoing! check online at <https://www.mio.univ-amu.fr/SARGASSES/>

### Objectives

- *Sargassum* species identification
- Connectivity through population genetic and isotopes (marker of Amazon waters)
- Trophic network *within* and *near* raft
- Bio-optical properties of raft

### Sampling

- Opportunity stations: when the boat encounters a raft
- 10-20 long stations *within* and *near* raft plus short sampling stations
- *Sargassum* algae and associated biota (diving and micronection net)
- Environment (physics and chemistry)
- In situ *Sargassum* spectra collection (TRIOS)



Figure 5. ANTEA research vessel

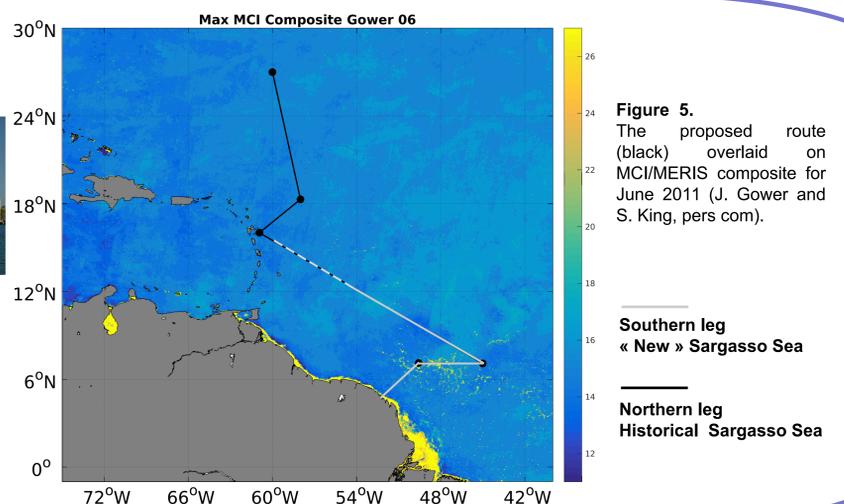


Figure 5. The proposed route (black) overlaid on MCI/MERIS composite for June 2011 (J. Gower and S. King, pers com).

## Lagrangian modelling of *Sargassum* transport and growth (upcoming)

### Objectives

Quantify the connectivity of *Sargassum* at the scale of the North Atlantic Basin, taking into account the combined effects of surface circulation and *Sargassum* biology and physiology (growth, decay). The simulations will allow to explore the possible sources and drift routes of *Sargassum* toward the stranding areas. The transport routes will be tested quantitatively (from Central West Atlantic to Caribbean Sea, hypothesized by Franks et al (2011, 2014, 2016) and Wang and Hu (2017), transport to West Africa. We will model individual *Sargassum* thalli but not raft as an aggregation of individuals.

### Methods

Unlike raft observed through remote sensing, only detected above a detection limit, *Sargassum* sightings span the Atlantic coasts from 0°N to 55°N, supporting homogeneous initial positions of *Sargassum* particles (Siuda 2011). The time duration of particle tracking simulations will be one to two years based on observed raft distribution seasonal pattern (Gower & King 2009). Indeed satellite detection suggest that biomass seasonal peak depends on the region (Gulf of Mexico-spring, Gulf Stream-summer, Bahamas-winter, Central West Atlantic-winter, Caribbean-spring). Lagrangian simulations will be carried out using Ichthyop software (Lett et al 2008) forced by velocity fields from Mercator PSY4V3R1 (1/12°) configuration over 2007-2016. Virtual *Sargassum* will stay at the surface and grow as a function of their environment. Ensemble of particles will be released every day and tracked for each year over the period 2007-2016.

3D Ocean simulations

PSY4V3R1  
U, V, T

BIOMER  
Nutrients



Lagrangian Tool

Ichthyop

*Sargassum* thalli trajectories and biomass