SAMtool: Sargassum detection for operational & seasonal planning

14 - 15 February 2023
9.30 – 17.00 CET
The Hague - NSO Headquarter
Centre Court

e-shape

Fabien Lefèvre

CLS
COLLECTE LOCALISATION SATELLITES

An event co-organised by

eurisy
ACTING COLLECTIVELY TO BRIDGE SPACE AND SOCIETY

Netherlands Space Office

e-shape

ENVIRONMENTAL MONITORING

SUSTAINABLE MANAGEMENT OF FISHERIES

ENERGIES & INFRASTRUCTURES

MARITIME SECURITY

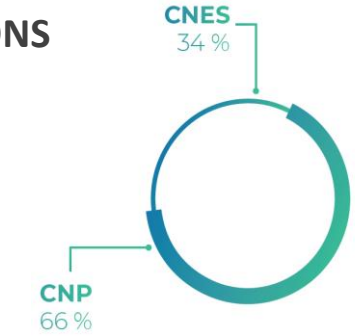
MOBILITY

CLS ACTIVITIES:

USE OF SPACE FOR ENVIRONMENTAL APPLICATIONS

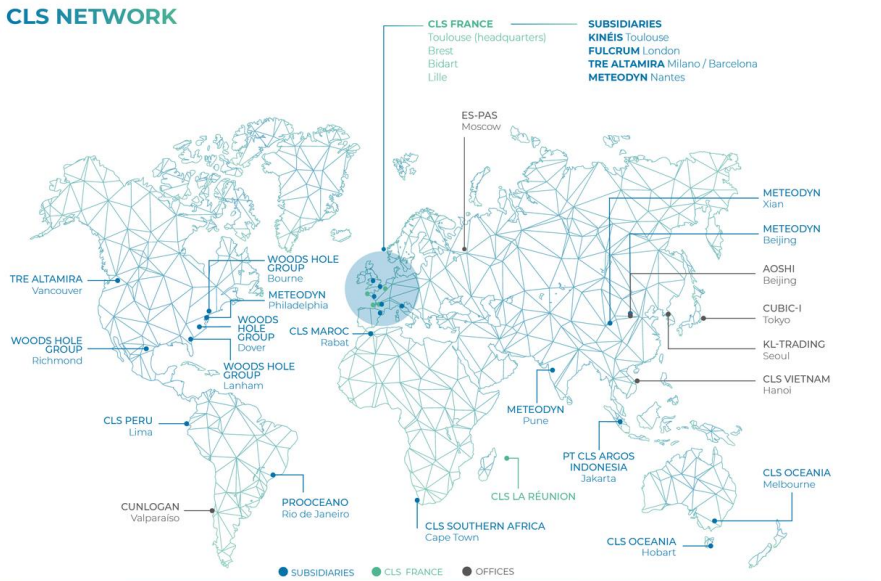
- CLS, based in Toulouse, France, created in 1986.
- Subsidary of CNES and CNP

- Satellite systems operator and provider of space added-value products and services
- Mission to develop and deploy innovative solutions based on the use of satellite systems and data to understand and protect our planet
- Acting in 5 strategic domains



900 collaborators

34 sites



History of Sargassum at CLS

2015

exploring the satellite technologies to detect and monitor sargassum from space

2017

first service for the DEAL Guadeloupe – CLS provides sargassum drift simulation to NBE for its weekly analysis

2018-2020

NBE – CLS has started a project co-funded by ESA (open call EO science for society) :
DEVELOPMENT OF SAMTOOL:

2019

CLS – NBE – I-Sea: provide sargassum satellite detection and analysis to Météo France

2020

SAM tool service operational (ESA support)
Météo France for French Antilles and Guyana

2021

SAMTool service on the shelf
H2020 E-shape project:
SARGASSUM DETECTION FOR SEASONAL PLANNING

2022

SAMTool sold to +20 users
Copernicus Marine Evolution SODA
Developing added value services

EuroGEOSS Showcases: Applications Powered by Europe

Sargassum influxes in the Caribbean and African coasts

Since 2011, huge sargassum mass strandings (Sargassum fluitans and Sargassum natans) have occurred in the wider Caribbean region and in West African countries

Hypotheses

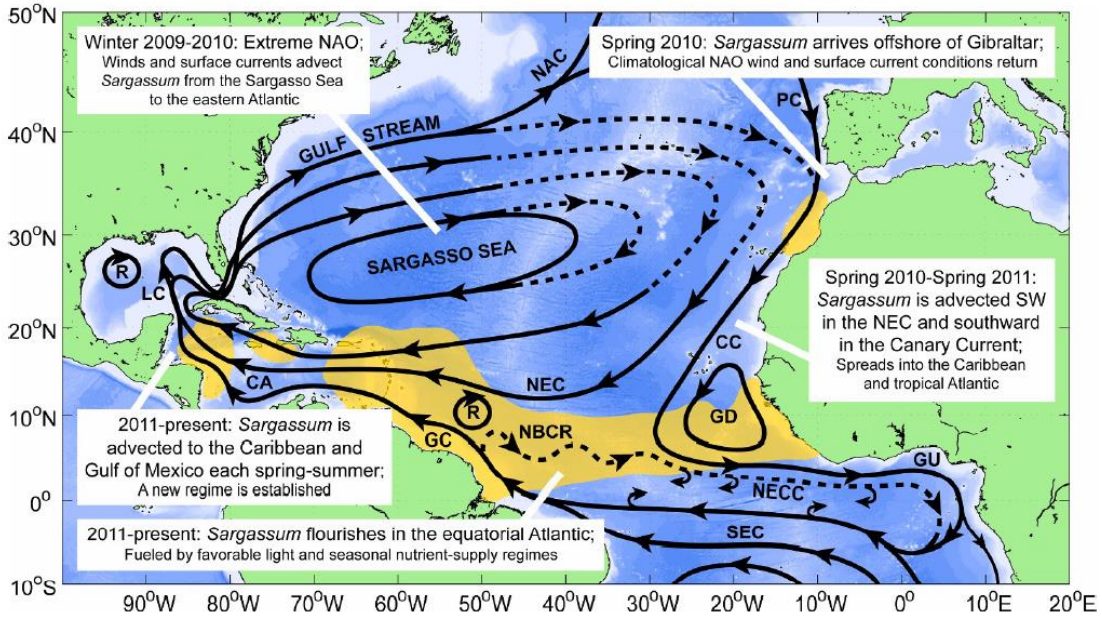
Strong anomaly in the **current circulation** in winter 2009-2010

→ Causing Sargassum to enter the North Atlantic Circulation

Higher sea **temperatures** + **nutrients** from Amazon + African dusts

→ Causing Sargassum to proliferate

→ Scientists referring to the "**New Sargasso Sea**"



Johns et al. 2020
Djakoure et al. 2017
Wand et al. 2019

Coastal and maritime Impacts

Public authorities:

- Mandates in public beach management and public health management
- In charge of cleaning beaches and monitor H2S concentration

Tourism sector:

- Key source of revenue for most countries
- Sargassum ruins the visual aspect of beaches and nuisance for nautical activities

Fisheries :

- Hampered by floating sargassum, especially net fishing
- Fishermen can be trapped in port by Sargassum

Operations at sea & navigation:

- Collection for valorization, seismic surveys stopped by floating sargassum
- Small-size vessels, sailing boats trapped in Sargassum mats

Wildlife protection :

- Floating sargassum is a protection for juveniles

SAMTool operational service: user centric designed

Developed with +40 users

Prepare and support timely sargassum **collection operations**

Raise **awareness** on the upcoming sargassum strandings

Help the key users to **prepare the mitigation** plan in advance to reduce the devastating effects of sargassum on local economies

SAMTool operational service: warning system for sargassum influxes

7 satellite sensors including medium and high resolution

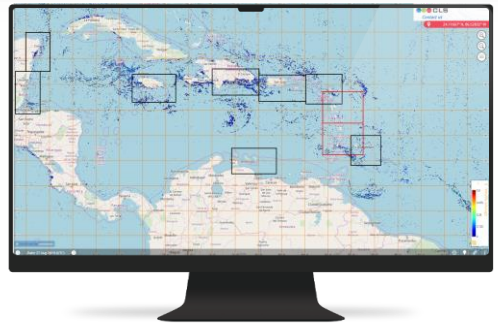
24/7 operational & scalable service

Daily sargassum detection

Drift forecast

User-friendly web platform

Scalable bulletins, early warning



5 days to **5** months forecast

+20 Experts mobilized to develop and operate CLS's sargassum service

esa

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Sargassum detection from satellite

SYNERGY OF 7 SATELLITE SENSORS FOR SARGASSUM DETECTION

3 ocean color satellite instruments with wide swath:

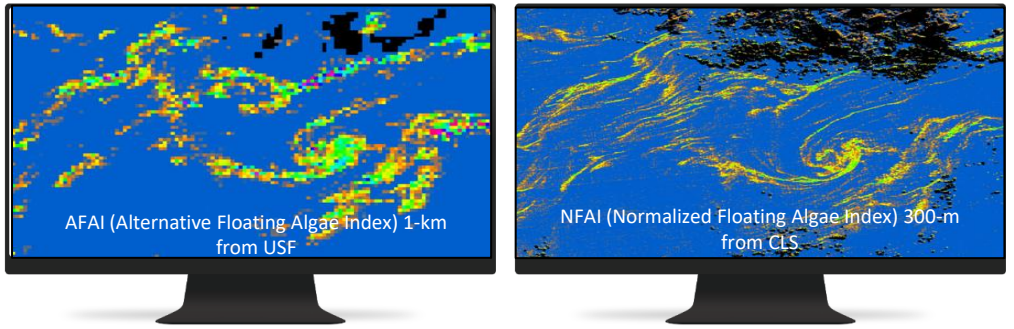
- MODIS on board Aqua and OLCI on board Sentinel-3A and 3B
- extended coverage down to **300m resolution** twice a day

3 High resolution optical sensors

- MSI on-board Sentinel-2A and 2B and OLI onboard Landsat-8
- detection close to shore and immediate landings down to **20m resolution**

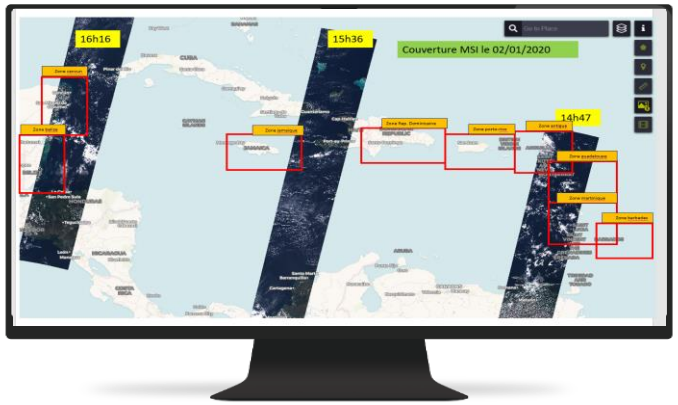
1 geostationary sensor

- HYGEOS algorithm applied on ABI GOES-16
- complement the daily detection with **10-minutes images**



Comparaison of AFAI 1-km USF and NFAI 300-m CLS products

Daily coverage of the MODIS & Sentinel-3 OLCI 300-m sargassum data



Exemple of daily coverage of the S2 MSI 20-m sargassum data

Sargassum detection : NFAI index

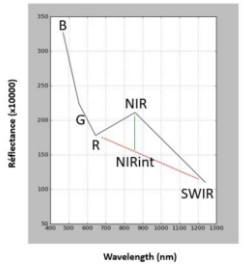
QUALITATIVE VS QUANTITATIVE APPROACH: CALCULATION OF FLOATING ALGAE INDEX ON THE OCEAN SURFACE

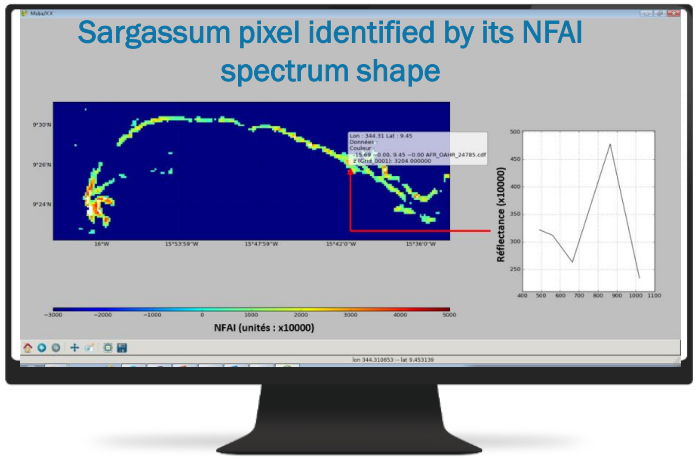
- The reflectance spectrum of sargassum algae increases between the red and infra-red wavelengths, as for land vegetation

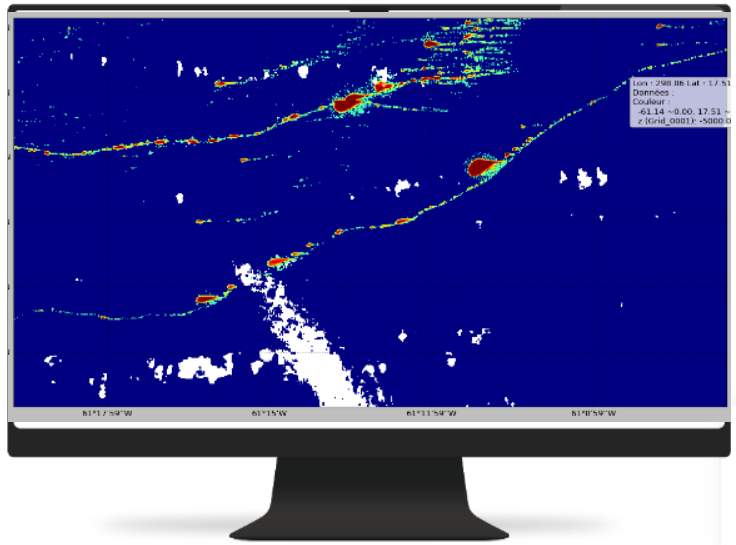
DEVELOPMENT OF A SPECIFIC INDEX: NFAI (Normalized Floating Algae Index), inherited from Hu, 2009

CONTINUOUS IMPROVEMENT to better refine the detection and remove false alarms

$$NFAI = \frac{NIR - NIRint}{NIR + NIRint}$$







→ Automatic calculation of the index on the 7 optical sensors

→ Atlantic Basin (300m resolution) to Island scale (20m resolution)

E-shape results

EXTENDED COVERAGE

- Including Gulf of Guinea
- To answer seasonal planning needs

e-shape

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HORIZON 2020

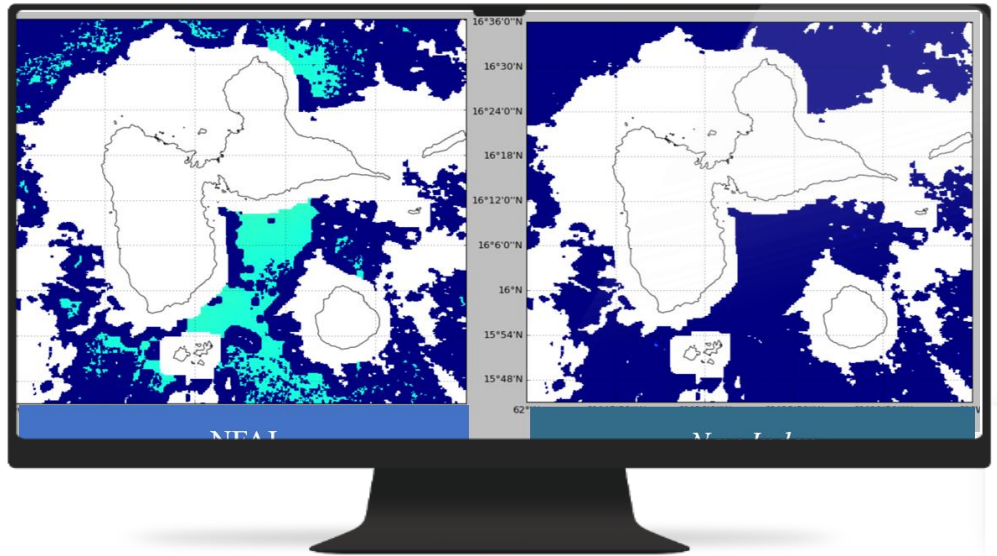
IMPROVED EDITING OF NFAI

- removing « adjency effets » causing false alarms
- To answer operational planning needs

COMPUTATION OF A 1-YEAR REANALYSIS ON SENTINEL-3 DATA (2019)

- Adaptation of the operational detection chain
- Computation on DIAS Sobloo
- Data Available in e-shape project
- Daily, 300m resolution

sobloo



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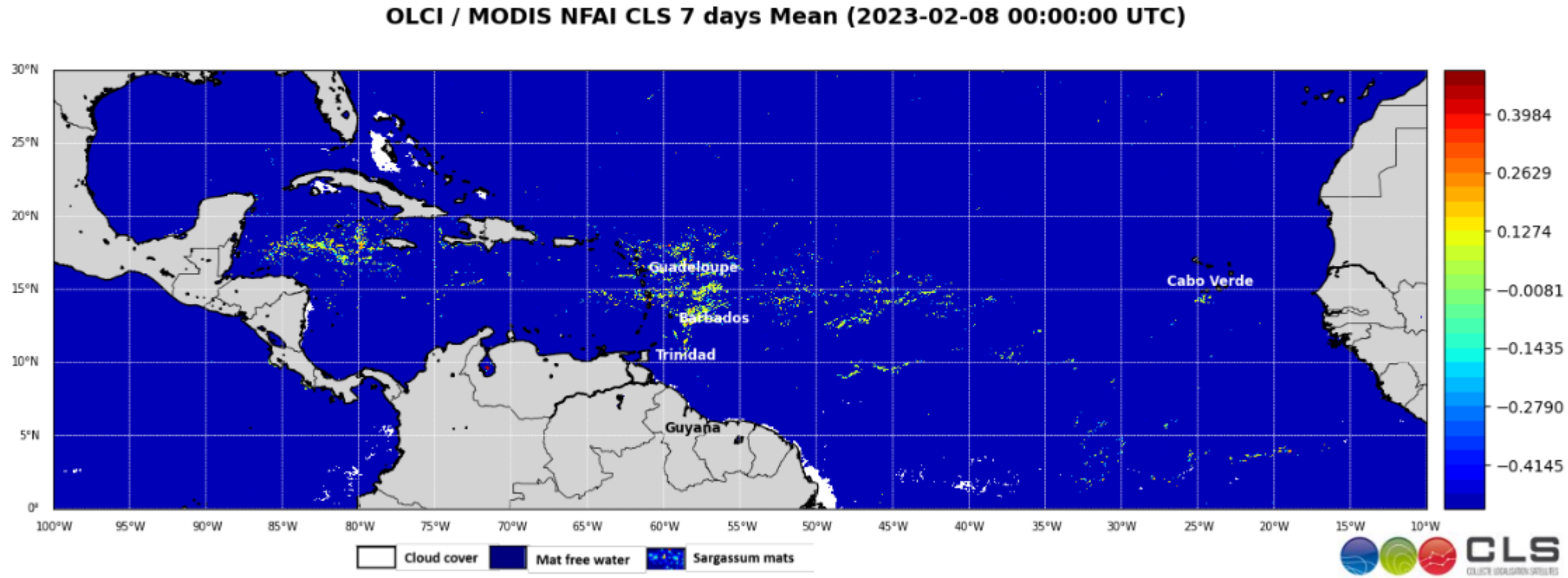
Weekly images over the Atlantic

Latest Weekly Image over the Atlantic

https://datastore.cls.fr/products/samtool-sargassum-detection/

Weekly average of the 300-m resolution CLS NFAI Sargassum Index combining Sentinel-3/OLCI and Aqua/MODIS optical sensors. Dark blue shows waters without any Sargassum detection. Green to Red show sargassum presence over one week. White shows remaining cloud cover.



Sargassum drift forecast

DRIFT MODELLING OF THE DETECTED RAFTS AND ESTIMATION OF LANDINGS

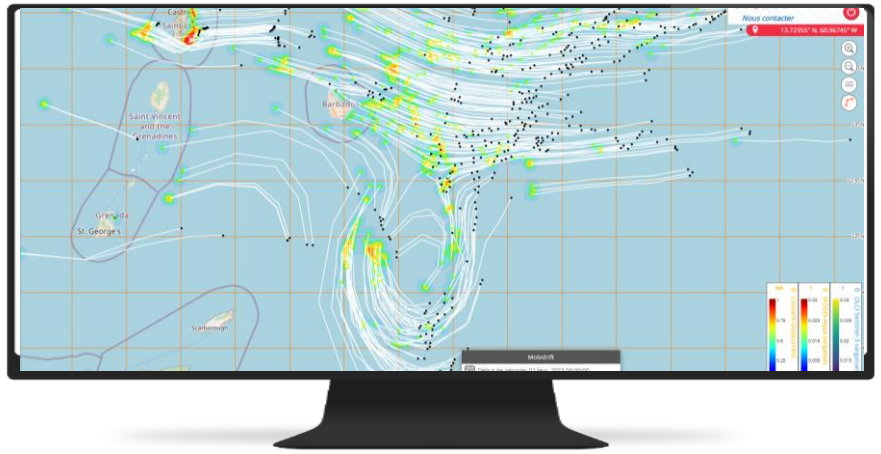
- Using a validated and experienced drift model
  - Configured for the Caribbean area and for the drift of sargassum rafts
  - Model results validated with CLS drifting buoys

SHORT TERM PREDICTION (3-5 days)

→ Estimation of probability of IMMEDIATE landings

LONG TERM PREDICTION (3-5 months) AT BASIN SCALE

→ Estimation of probability of SEASONAL INFLUXES



5-days drift forecast around Barbados on 6th February 2022

5-months drift forecasted from 16th June 2020

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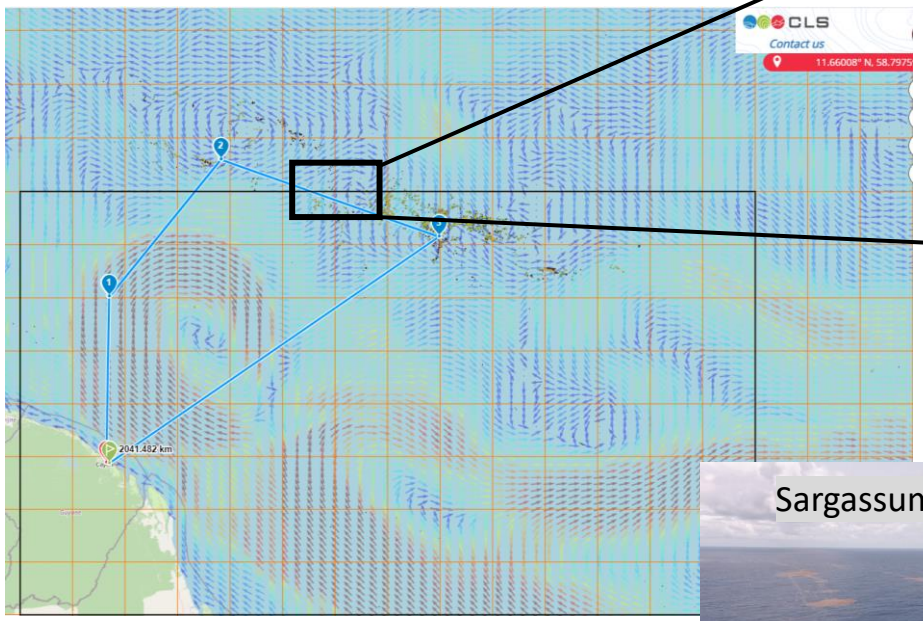
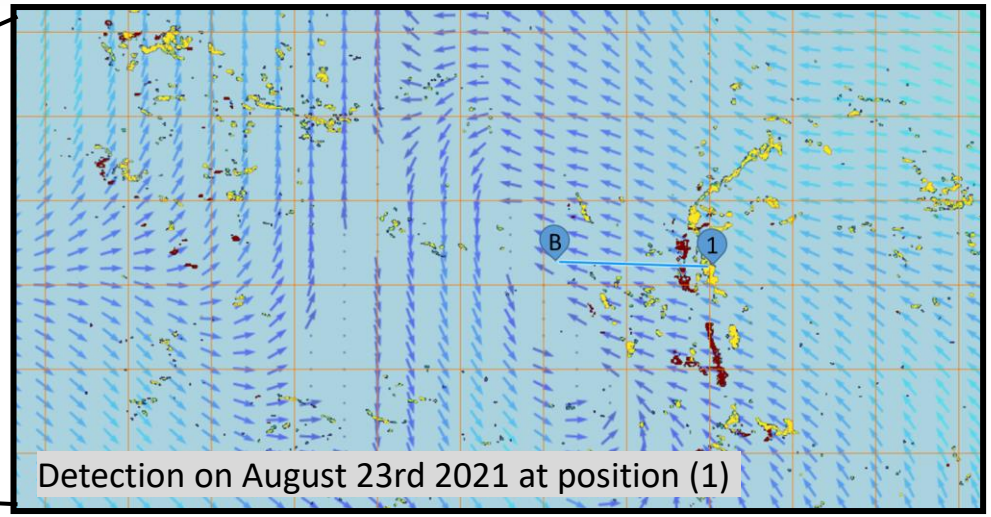
User workflow 1: operational monitoring for sargassum collection

User need:

- **localise** sargassum mats in open ocean
- monitor their drift to plan for **collection operation**

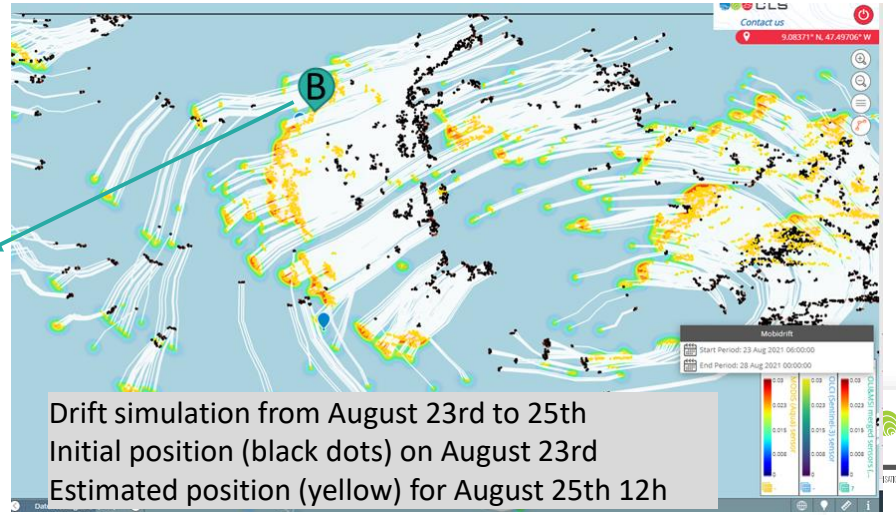


GUYANE PORT
L'Europe au carrefour des Amériques



Detection on August 23rd 2021 at position (1)

Sargassum mats found on (B)

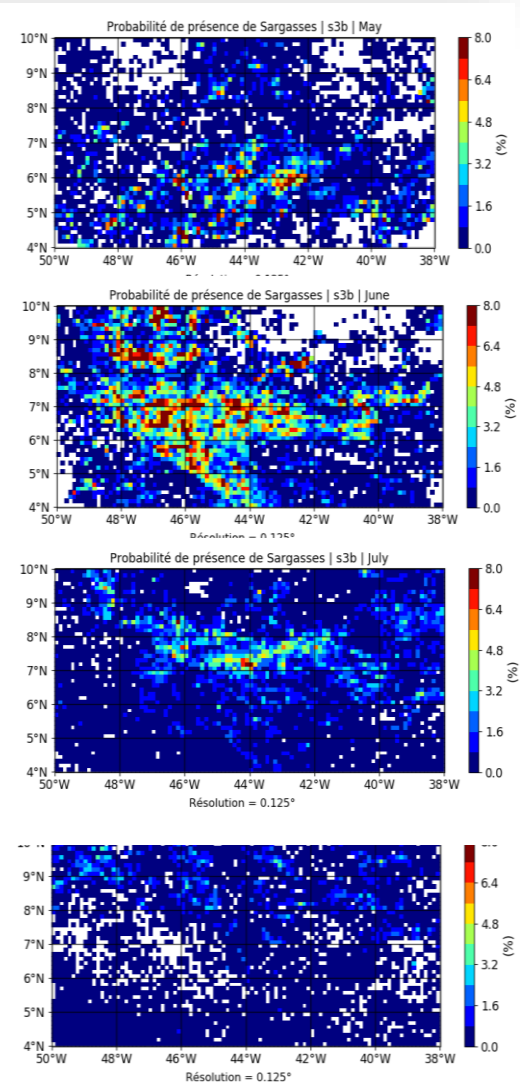


Drift simulation from August 23rd to 25th
Initial position (black dots) on August 23rd
Estimated position (yellow) for August 25th 12h

User workflow 2: sargassum detection for seasonal planning

User need: **Gain knowledge** on sargassum seasonal presence

- Since e-shape first developement: 4 years (2019-on-going) of sargassum data covering the Tropical Atlantic Basin
- Capacity to run large scale seasonal forecast simulations to understand long-term sargassum drift



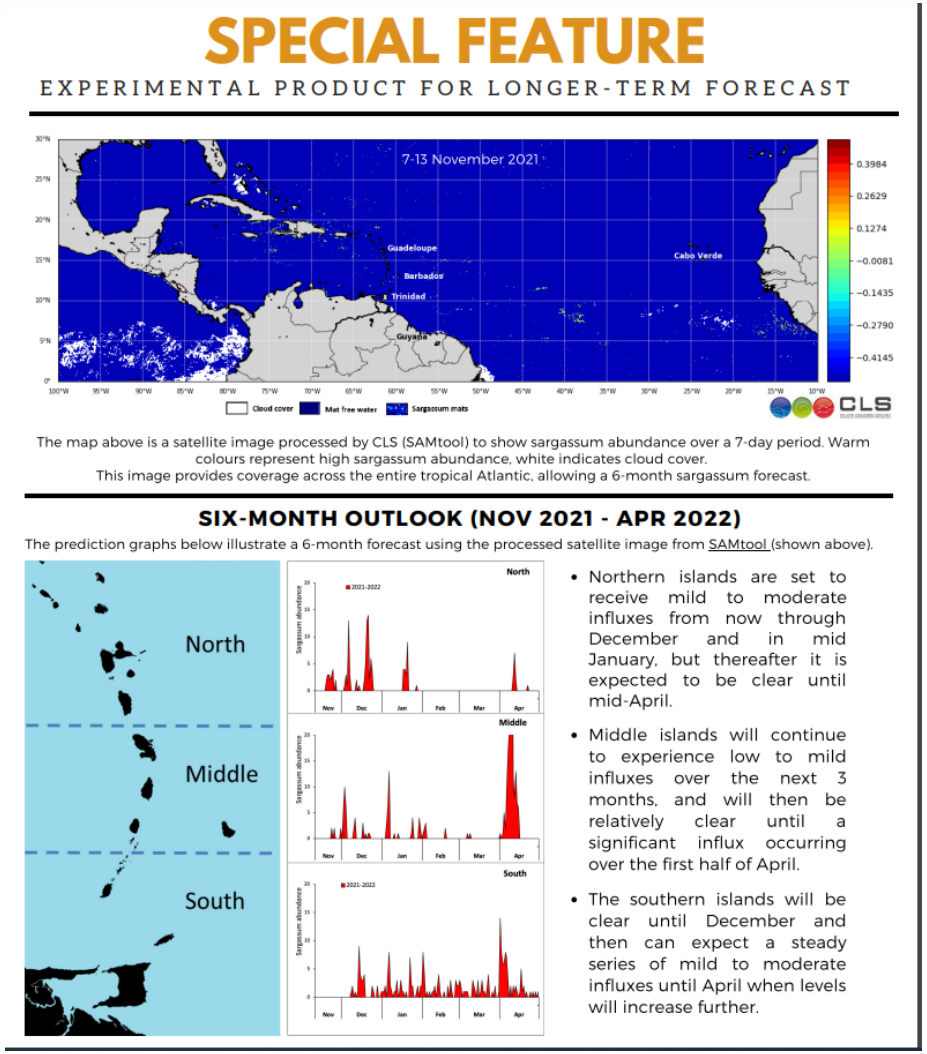
User workflow 3: seasonal prediction of sargassum influxes

User need: **anticipate** sargassum influxes and **impacts** on fisheries and tourism

- Providing CERMES (University of West Indies) sargassum detection for their Special Feature in the bi-monthly sargassum bulletin

Centre for Resource Management and Environmental Studies (CERMES)

The University of the West Indies at Cave Hill, Barbados



SPECIAL FEATURE

EXPERIMENTAL PRODUCT FOR LONGER-TERM FORECAST

The map above is a satellite image processed by CLS (SAMtool) to show sargassum abundance over a 7-day period. Warm colours represent high sargassum abundance, white indicates cloud cover.
This image provides coverage across the entire tropical Atlantic, allowing a 6-month sargassum forecast.

SIX-MONTH OUTLOOK (NOV 2021 - APR 2022)

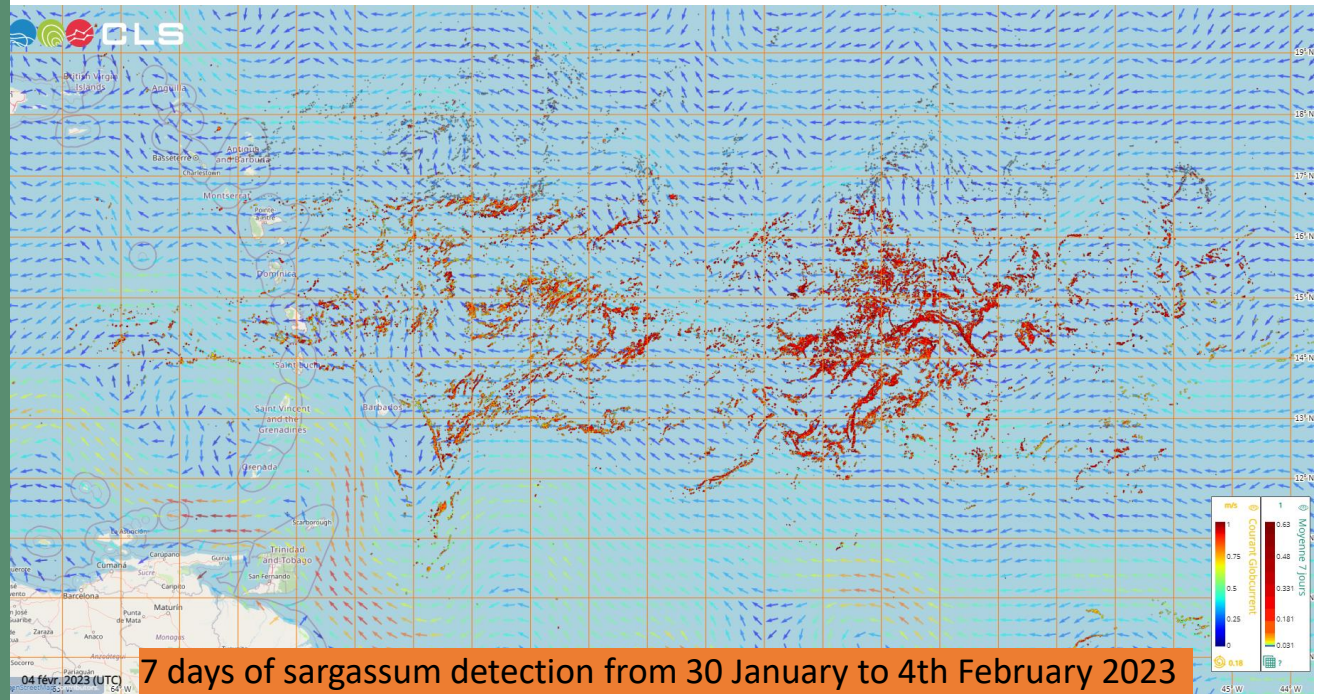
The prediction graphs below illustrate a 6-month forecast using the processed satellite image from SAMtool (shown above).

- Northern islands are set to receive mild to moderate influxes from now through December and in mid January, but thereafter it is expected to be clear until mid-April.
- Middle islands will continue to experience low to mild influxes over the next 3 months, and will then be relatively clear until a significant influx occurring over the first half of April.
- The southern islands will be clear until December and then can expect a steady series of mild to moderate influxes until April when levels will increase further.

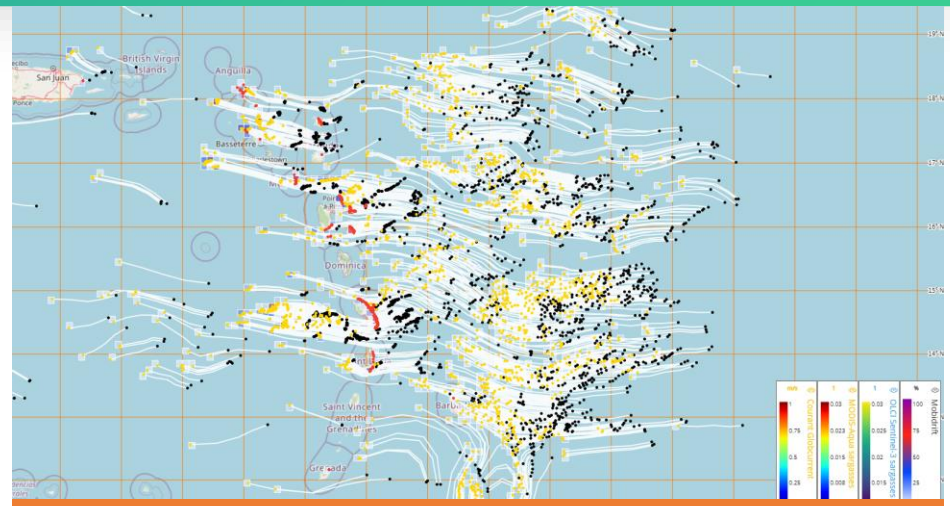
Latest situation preview

Detection and drift modelling reveals a severe season to come

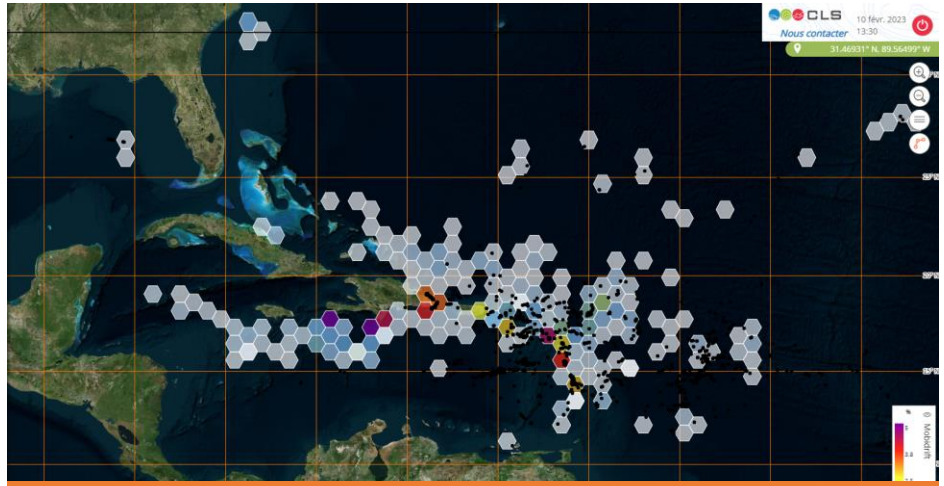
- Detection for February 2023 shows an important quantity of sargassum in the Atlanticat
- Long term drift predicts a large quantity to enter the Northern Caribbean region



7 days of sargassum detection from 30 January to 4th February 2023



5-days drift simulation results from 3rd February situation



Probability of sargassum presence in May 2023 predicted from the observations of 3rd February and simulation of drift

Uptake from E-shape project

IMPROVEMENT OF CLS SARGASSUM SERVICES

- Improved sargassum detection removing false alarms
- Extended area to answer seasonal planning needs

https://e-shape.eu/index.php/showcases/pilot5-4-sargassum-detection-for-seasonal-planning

SET UP OF A REANALYSIS CHAIN FOR SENTINEL-3 DATA

- Use of DIAS Platform (SoBloo) cloud technologies
- 2019 reanalysis data shared with the scientific community

https://datastore.cls.fr/sargassum-seasonal/#!&page=loginPage

https://www.aviso.altimetry.fr/en/data/products/value-added-products/sargassum.html

ON-GOING PROJECT TO IMPROVE AND PROMOTE SARGASSUM DETECTION PRODUCTS THROUGH COPERNICUS MARINE SERVICE

https://marine.copernicus.eu/about/research-development-projects/2022-2024/soda

Thank you!

Questions

https://datastore.cls.fr/products/sargassum

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