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# Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions Workshop

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Group Photo



## **Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions Workshop**

**Organized by**

IOCARIBE of IOC UNESCO, its GOOS Regional Alliance IOCARIBE-GOOS and the GEO Blue Planet Initiative

**Hosted by**

The Ministry of Education of Mexico and Mexico National Council of Sciences  
CONACYT

**With the support of**

IOCARIBE of IOC UNESCO, the Government of Mexico, the Government of Flanders and  
NOAA

**Mexico City, Mexico**

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## EXECUTIVE SUMMARY

In recent years, the Caribbean region has faced challenges from oil spills and an influx of floating sargassum seaweed. Large-scale oil spill incidents have included an April 2017 spill at Pointe-à-Pierre, Trinidad and Tobago and a July 2017 oil spill in Kingston Harbor, Jamaica. Illegal dumping of oil-contaminated waste by ships operating in the region is also a common occurrence. An increase in the frequency and volume of sargassum beachings and coastal overabundance has caused another challenge for the region with mats preventing the deployment and retrieval of fishing gear and clogging popular beaches, harbors and bays.

Based on the amounts of Sargassum detected in the Central West Atlantic and the Caribbean and in January – April 2018, researchers at the University of South Florida (USF) predict high amounts of Sargassum in Caribbean in coming months.

In response to these challenges, a meeting of 40 experts from 15 countries was held in May of this year to discuss sargassum and oil spill monitoring in the Caribbean and Adjacent regions. The participants included representatives from various United Nations entities, academia, governments, private companies and international initiatives. The workshop was organized by IOCARIBE of IOC UNESCO and its Global Ocean Observing System Regional Alliance, IOCARIBE-GOOS, and the GEO Blue Planet Initiative, and hosted by the Ministry of Education of Mexico and Mexico National Council of Sciences.

The overarching goal of the workshop was to develop a plan for the development of a region-wide system for monitoring and forecasting oil spills and sargassum presence. At the workshop, experts reviewed the existing technologies and challenges for monitoring and forecasting oil spills and sargassum in the Caribbean and adjacent regions and ultimately drafted a plan to create an information system based on existing efforts.

It was determined that the objective of the information service will be to provide a publicly available monitoring platform and alerting system for oil spills and sargassum based on publically available data (e.g. satellite data and in situ data from countries with open data sharing policies). The service will initially be based on existing technologies and activities, working to augment and improve the framework for information management and delivery and mechanisms for the region and demonstrate the utility of ocean observations and products.

It was agreed that the initial development of the service would be done by partner organizations, and the NOAA CoastWatch program and the Caribbean Marine Atlas volunteered to host service components initially. The long-term goal is to have the information service coordinated and built upon by a regional body in a model similar to that of the International Tsunami Information Centre.

Initial components of the information service will include:

- Data acquisition
  - Satellite imagery for oil spills and sargassum
  - Citizen science imagery/and other approved types of submitted information on oil and sargassum occurrences
  - Openly-available in situ data
- Data repository and clearing house
- Data analysis and processing
  - Satellite sensor analysis
  - Data aggregation
  - Report outputs and resulting datasets
- Information dissemination

- Web service for standard Geo services
  - Web browser
- Report/alert publication
  - PDF, KML, Shapefile
- Sharing of Best Practices in activities like Preparation, Forecasting, Response, and other information for regional partners
- Notification services
  - Email, social media, SMS, app

The meeting participants agreed that engagement with potential users of the service should be included in the development of the service from the beginning, and that the interface should be developed with users through an iterative process. Five working groups were formed with workshop participants at the workshop with additional working group membership open to other interested parties.

Over the coming months, the working groups will be further populated and organized, implementation of the service will be initiated, and funding will be sought for the development and long-term sustainment of the service.





## 1. SESSION 0: WELCOME & INTRODUCTION

The Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions Workshop was held in Mexico City, Mexico, May 2 – 4, 2018. The meeting was organized by IOCARIBE of IOC UNESCO, its GOOS Regional Alliance IOCARIBE-GOOS and the GEO Blue Planet Initiative. It was hosted by the Ministry of Education of Mexico and Mexico National Council of Sciences CONACYT with the support of the Government of Mexico, the Government of Flanders and NOAA.

The meeting was opened on Wednesday May 2, 2018 at the Office of “Secretaria de Educacion Publica” by Mr. Ramon Zamanillo from the Ministry of Education from Mexico and National Focal Point of Mexico for IOCARIBE.

Mr. Zamanillo addressed the meeting and welcomed all participants to the country on behalf of the Government of Mexico.

Mr. Francisco Brizuela, IOCARIBE Chairman briefly addressed the meeting and referred to the importance of the IOC Subsidiary Bodies such as IOCARIBE and also to the importance of achieving the sustainable development goals and the role of the meeting in pursuing them. He acknowledged the important support received by CONACYT and the Government of Flanders for the organization of the meeting. He welcomed all participants to Mexico City and wished them a successful meeting.

Mr. Cesar Toro, Head UNESCO-IOC Regional Secretariat for IOCARIBE and representative of the Intergovernmental Oceanographic Commission (IOC), addressed the meeting on behalf of Mr. Vladimir Ryabinin, Assistant Director General of UNESCO and Executive Secretary of IOC. He reminded participants attending the meeting that the overarching goal of the workshop was to develop a plan for the development of a region-wide system for monitoring and forecasting oil spills and sargassum for the Caribbean Region. He reiterated his appreciation in the name of IOC for the support received by the Government of Mexico and the Government of Flanders for the meeting and wished all participating Delegations a successful and productive meeting and a great stay in Mexico.

Mr. Douglas Wilson, IOCARIBE-GOOS Project Coordinator welcomed as well participants to the meeting. He gave a general introduction about the methodology to be followed and the objectives of the meeting. He invited participants to introduce themselves.

He referred to the project concept: Many of the natural resources in the Caribbean Sea marine environment are threatened by the adverse impacts of environmental changes and man-made hazards. In response, IOCARIBE of IOC UNESCO and its GOOS Regional Alliance IOCARIBE-GOOS, GEO Blue Planet, UNDP Barbados and the OECS have outlined a pilot project to support an integrated approach to monitoring concentrations of Sargassum weed and oil spills – both significant regional water-borne threats - and are seeking partners to further develop the pilot project concept and to secure funding for implementation. The ocean observing, information management, and product delivery framework developed by the pilot would be a basis for further development of other applications and serve as a starting point for expanded ocean observing efforts in the Caribbean.

He recalled that concept directly addresses Recommendation SC-IOCARIBE-XIV.4, SARGASSUM BLOOMS, and brings together a number of existing research, operational, and intergovernmental entities to add value to their activities.

The main Goals of a regional Sargassum Information System would be:

- Aggregate information from existing regional Sargassum identification/tracking/forecast systems
- Strengthen the collaboration with regional interests to develop products and user interfaces for accessing information
- Develop a system to collect, store, and utilize local information (from fishermen, sailors, maritime interests, beaches, coastal managers) about Sargassum location and abundance both offshore and in the coastal zone
- Provide a widely accessible database and archive of regional Sargassum presence and impacts for integration with other regional environmental datasets for research
- Provide a regional framework for aggregating and delivering similar ocean observing products, such as oil spills

Mr. Wilson gave some background information about sargassum and oil spills, as follows:

### **Sargassum**

The regional Sargassum infestation problem is well known; recent events focusing on the problem include the UWI CERMES Sargassum Symposium (2015) 1; BVI Sargassum Regional Conference (2016) 2 and a UNEP/CEP - supported technical session at the 69th meeting of the Gulf and Caribbean Fisheries Institute (2016) 3. At the 2017 Oceans Conference, the Association of Caribbean States committed to controlling the Sargassum Seaweed in the Caribbean Sea through monitoring and exploration of commercial use 4.

There are several projects presently funded to identify (via analysis of satellite observations) and forecast Sargassum concentrations, including Sargassum Watch, University of South Florida 5, and Sargassum Early Advisory System, Texas A&M 6. However, there is significant gap in connecting researchers developing Sargassum identification and forecasting methods with national and regional agencies challenged by dealing with the problem.

### **Oil Spills**

With the exception of a small decline in the 1980s, seaborne oil trade has been consistently increasing in the last 50 years, growing from 60 to 120 million tonnes of total crude oil petroleum and gas loaded per year. Increased movements inherently imply increased environmental risk, in the form of damage or disruption to marine habitats and migration routes through noise, pollution and spills, as well as the increased risks of collisions with marine wildlife.<sup>9</sup>

In addition, more than one-third of oil and gas extracted today comes from offshore deposits. Offshore drilling, especially deep and ultra-deep-water drilling, faces greater technical challenges which further increase the overall environmental risks.

While the overall number of large spills is decreasing at a global scale, smaller “operational” spills from tankers, i.e. loading/discharging, bunkering, ballasting, tank cleaning, etc., are not fully observed at global scale and therefore contribute significantly to the critical degradation of the ocean environment and its biodiversity.

The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, also known as the Cartagena Convention, is a regional legal agreement for the protection of the Caribbean Sea. The Convention is supported by three technical agreements or Protocols on Oil Spills, Specially Protected Areas and Wildlife (SPA) and Land Based Sources of Marine Pollution (LBS). With the exception of 3 countries, the

Cartagena Convention Oil Spills protocol has been ratified by all United Nations Member States in the Wider Caribbean Region. It covers the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean adjacent thereto, south of 30°N and within 200 nautical miles of the Atlantic Coasts of the States.

Although this provides a comprehensive framework for the protection of the Caribbean Sea, there remains a recognition for a dynamic and integrated approach to capture and analyze current data pertaining to oil spills both from land and marine-based sources. There is no region-wide resource available to national agencies to detect and monitor spills, to provide forecasts and warnings of impending impacts, and to determine exact sources of coastal pollution.

Mr. Glenn Nolan made a remote presentation entitled “Overview of the GOOS Regional Alliances (GRAs)”

Abstract:

The GOOS Regional Alliances are bodies promoting GOOS principles and activities within geographical regions around the world. As Chair of the GRA Forum and Executive Director of EUROGOOS, Mr. Nolan highlighted efforts of the GOOS Capacity Building Task Team that might be relevant to the Sargassum projects. Through EUROGOOS/EMODNET, there are numerous mapping and visualization services and data portals available that might also contribute. There will be an upcoming G7 call for GRA pilot projects, and GOOS notes that this project is of interest.

Ms. Emily Smail from the NOAA Center for Weather and Climate Prediction introduced the GEO Blue Planet Initiative. She made a presentation entitled “Ocean and Coastal Observations for Societal Benefit: The GEO Blue Planet Initiative”

Abstract:

The Group on Earth Observations (GEO) is a partnership of more than 100 national governments and in excess of 100 participating organizations. There are several ocean related participating organizations in GEO including the Global Ocean Observing System (GOOS), IOC-UNESCO, the Committee on Earth Observation Satellites (CEOS) and the Partnership for the Observation of the Global Ocean (POGO). The GEO community is working to build a Global Earth Observation System of Systems (GEOSS). GEO currently has three priority focus areas – the UN 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, and the Sendai Framework for Disaster Risk Reduction. GEO operates with data sharing principles that include free and open exchange of data. “Oceans and Society: Blue Planet” is an initiative of the Group on Earth Observations (GEO) that aims to ensure the sustained development and use of ocean and coastal observations for the benefit of society. GEO Blue Planet’s mission is to advance and exploit synergies among the many observational programmes devoted to ocean and coastal waters; to improve engagement with a variety of users for enhancing the timeliness, quality and range of services delivered; and to raise awareness of the societal benefits of ocean and coastal observations at the public and policy levels. GEO Blue Planet is a network of ocean and coastal-observers, social scientists and end-user representatives from a variety of stakeholder groups, including international and regional organizations, NGOs, national institutes, universities and government agencies. GEO Blue Planet has four cross-cutting working groups that are tasked with identifying and sharing best practices and supporting Blue Planet projects. These working groups are currently focused on engaging with users to identify data and information needs; clarifying the “seascape” of ocean and coastal observations for user groups and; supporting information needs for sustainable development. GEO Blue Steering Committee also accepts proposals for new thematic activities on an ongoing basis and currently has two thematic working groups: 1) a working group on Earth Observations for surveillance of water-related diseases, and 2) a working group on understanding flooding on reef-lined island coasts. GEO Blue Planet also works to support

custodian agencies with information and methodology development for the SDGs and helps to organize workshops in support of sustainable development goals. GEO Blue Planet work with regional partners includes the support of the development of ocean observing capacity in the Caribbean, including this workshop.

Mr. Frank Muller-Karger from the University of South Florida USF/MBON made a presentation entitled “The Marine Biodiversity Observation Network (MBON)”

Abstract:

Observing life in the sea is one of the most significant challenges facing the scientific and resource management community. Knowledge about marine life is needed to inform public decisions that affect the health of the ocean. The Marine Biodiversity Observation Network (MBON) links groups that collect observations in the world's ocean and provides advice on how to track marine species, their abundance and biomass, and how marine habitats are changing. MBON is working with the Global Ocean Observing System (GOOS) and the Ocean Biogeographic Information System (OBIS), both under the Intergovernmental Oceanographic Commission (IOC), to define the essential measurements needed about living resources to address several UN assessments, to meet the UN Sustainable Development Goals, and to address targets and goals defined under the Convention on Biological Diversity. It should provide guidelines for the International (UN) Decade of Ocean Science for Sustainable Development 2021-2030 (IOC XXIX-1, 2017).

We invite the community to enter a dialogue with MBON, GOOS, and OBIS to further refine these concepts and build an integrated system to observe life in the sea.

Mr Muller-Karger invited the community to enter a dialogue with MBON, GOOS, and OBIS to further refine these concepts and build an integrated system to observe life in the sea.

A group photo was taken at the Auditorium.

## 2. SESSION 1: SARGASSUM AND OIL SPILLS IN THE CARIBBEAN

In this session, speakers addressed the challenges faced by oil spills and sargassum in the Caribbean and Adjacent Regions. Speakers outlined what is known about these issues to date and what additional information is required. What tools are currently available on detection/monitoring/forecasting on sargassum and oil spills?

Mr. Christopher Williams from the Organization of the Eastern Caribbean (OECS) made a presentation entitled “Management of Oil Spills in OECS and the Wider Caribbean”

Abstract:

OECS legally represents seven full member states and three associate member states and has responsibility among those states for many activities relevant to Sargassum and oil spills. Those include Protocol: Article 24 – *Environmental Sustainability ... to minimize environmental vulnerability, improve environmental management and protect the region's natural resource base for optimal social and economic benefits for Member States*; and Treaty: Article 4 - *Member States shall co-ordinate, harmonise and undertake joint actions and pursue joint policies particularly in the fields of (o) matters relating to the sea and its resources.*

Ongoing projects include Caribbean Regional Oceanscape Project (ECROP), with components to Strengthen Ocean Governance, Strengthen Knowledge and Capacity, and Develop the Ocean Economy; and Priorities to Preserve and Protect the Marine Environment.

OECS and members are party to multiple treaties and conventions dealing with oil spills, including the Caribbean Regional Response Team; National Oil Spill Action Group.

A new activity, Supporting Blue Growth and Risk Management through Earth Observation, will focus on using Earth Observation data to address Fisheries and Aquaculture, Maritime Safety and Security, Climate Change and Risk Reduction, and **Sargassum Influxes into Coastal Systems**. Research priorities include: Examination of biophysical, social and economic impacts of Sargassum events;  
Development of models that can predict the timing and size of Sargassum events in advance; and  
Near real-time monitoring of Sargassum

OECS recognizes priority Oil Spill and Sargassum preparedness and response needs as:

- Earth Observation Oceanographic and Weather data for modelling;
- Capacity building in Remote Sensing and Modelling;
- Capacity building in detection of and response to oil spills and sargassum
- More research into viable end-uses of Sargassum;

Ms. Shelly-Ann Cox from the Centre for Resources Management and Environmental Studies (CERMES) from the University of the West Indies (UWI) made a presentation entitled “Towards the prediction of Pelagic Sargassum influx events in the Eastern Caribbean”

#### Abstract:

Since 2011, unprecedented quantities of pelagic sargassum have inundated coastal waters and shorelines of Eastern Caribbean countries, the first such known mass influxes into the region. The quantity of the sargassum in these events and the frequency of event occurrence is creating immense problems for fisheries and tourism industries and present largely unknown consequences for marine ecosystems. Results of our modelled back-traces of pelagic sargassum landings events since 2011 using landings dates and locations in ocean circulation models, indicated that the sargassum arrived from the North Atlantic sub-equatorial region rather than directly from the Sargasso Sea. These findings were supported by experiments we conducted to simulate pelagic sargassum transport pathways derived from archived satellite tracked mixed-layer drifting buoy data. A hypothesis was developed suggesting that climate-related circulation changes in the equatorial Atlantic created conditions for increased pelagic sargassum retention, while warm, nutrient-rich environments aided sargassum bloom conditions. Indications were strong that the pelagic sargassum bloomed in an area we previously termed the North Equatorial Recirculation Region (NERR), inclusive of its Eastern and Western Atlantic consolidation regions (isolated circulation patterns) (Franks et al. 2015, 2016; Franks and Johnson 2018).

The focus of this project was to advance the fundamental knowledge of recent pelagic sargassum blooms and mass influxes into the Eastern Caribbean, and contribute input toward the process of identifying methodological steps towards building a prediction scheme to model mass transport of pelagic sargassum within the North Equatorial Recirculation Region (NERR) and the Eastern Caribbean. Work included identification of factors critical to understanding dynamics of the bloom events and testing components of a methodology that can be applied to future routine prediction. Building a pelagic sargassum prediction model presents multiple challenges due to unknown variables and requires a process that extends beyond this project.

Processed satellite images of pelagic sargassum available from the University of South Florida (USF) Optical Oceanography Laboratory were used in the Modelling process. From the images processed on specific dates, starting points were selected for forward tracking using the climatology of the Hybrid Coordinate Ocean Model (HYCOM) ocean current data (years 2006-2016). These projections appear promising and could be compared with actual observations. However, both pelagic sargassum growth and mortality are of major importance for predicting the intensity of sargassum inundation events, and these two critical unknowns require investigation. This project contributed to the development of sargassum prediction capabilities (seasonal and annual) applicable to Eastern Caribbean and other tropical Atlantic nations in support of risk assessments, emergency response strategies, the tourism industry, resource management and protection, and scientific studies.

Mr. Milton Haughton, Executive Director of the Caribbean Regional Fisheries Mechanism (CRFM) gave a presentation entitled “ Sargassum Impacts and Management”

Abstract:

Mr. Haughton noted that regional Caribbean Fisheries were primarily small-scale, artisanal, and near-shore in nature, and that most commercially targeted species are fully- or overexploited. Marine fish production from CRFM countries had trended upward from 2003 to 2013 but declined in 2014 and 2015, around the time that Sargassum began to appear in the region in overabundance.

While Sargassum is an important component of the regional marine ecosystem, overabundant Sargassum has clear negative impacts on fisheries: Impact on fishing boats and gear; and impact on catch and income, including decreases in catch and changes in species composition. The presence of decaying Sargassum in coastal areas and beaches is a health and safety problem, and causes ecosystem damage.

Mr. Julio Sheinbaum, Director Physical Oceanography of the CICESE, Mexico gave a presentation entitled “Oceanographic Observational Platforms, Baseline Studies, Model Simulations and Scenarios of the Natural Response to Large-Scale Oil Spills in the Gulf of Mexico”

Abstract:

The Gulf of Mexico Research Consortium (CIGoM in Spanish) was founded in 2015 as a consortium of scientific research and consulting services by many of the most important universities and research centers of Mexico (<https://cigom.org/>). It specializes in multidisciplinary projects related to possible environmental impacts of the oil and gas industry in the marine ecosystems of the Gulf of Mexico. This initiative arose from the realization -by the scientific community and the Mexican oil company (PEMEX)- of the lack of information of base line conditions, particularly in Mexican waters of the Gulf of Mexico, and the necessity to develop scenarios and remedy strategies in case of large-scale oil spills in the region.

CIGoM is currently developing the project (2015-2020) "Implementation of oceanographic observation networks (physical, geochemical, ecological) for the generation of base line conditions and scenarios in the face of possible contingencies related to the exploration and production of hydrocarbons in the deep waters of the Gulf of Mexico". This initiative is financed by the Hydrocarbons Fund of the National Council of Science and Technology (CONACYT) and the Ministry of Energy (Secretaría de Energía) and is the largest scientific project ever funded to investigate the Gulf of Mexico. Its main goals are:

- To perform physical, chemical, and biological measurements to establish a baseline for the present-state and the natural variability of the greater ecosystem of the Gulf of Mexico.

- Use and develop cutting-edge technologies to observe the ocean continuously -in some cases in real-time- and use the information with numerical models to develop scenarios in the case of an oil spill that will allow to estimate its dispersion and possible consequences.
- Generate risk maps, arrival times, and estimate impacts taking into account the chemical characteristics of the hydrocarbons, weathering, biodegradation and the location and depth of possible large hydrocarbon spills.

During the project special attention has been given to identify Sargassum from satellite imagery developing new methods [Cuevas et. al., 2018] and investigate the trophic chains of several of its occupant species including endangered ones such as sea turtles. Mathematical methods to explain its movement and their relation to Lagrangian Coherent Structures (LCS, Beron-Vera et al., 2015) have also been addressed.

All the observational infrastructure and knowledge acquired during this project may well be used in the IOC efforts to build regional (Caribbean and Gulf of Mexico) monitoring and forecasting capabilities of Sargassum behavior and oil spills in the near future.

#### References:

Cuevas, E., Uribe-Martínez, A. & de los Ángeles Liceaga-Correa, M., 2018. A satellite remote-sensing multi-index approach to discriminate pelagic Sargassum in the waters of the Yucatan Peninsula, Mexico. *International Journal of Remote Sensing*, 39(11), pp.3608–3627.

Beron-Vera, F.J. et al., 2015. Dissipative inertial transport patterns near coherent Lagrangian eddies in the ocean. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 25(8), p.087412.

Mr. Juan Luis Torres Perez (AMES - remotely) made a presentation entitled “NASA DEVELOP Caribbean Sargassum Monitoring Project “. It was presented by Ms. Laura Lorenzini from NASA

#### Abstract:

##### NASA Ames Research Center, DEVELOP Program

Investigating Inundation Events: A study of remote sensing techniques and novel data sources for Sargassum detection and quantification in the Caribbean Sea  
In 2015, Caribbean nations were overwhelmed by an unprecedented quantity of Sargassum that washed ashore. This issue prompted international discussion to better understand the origin, distribution, and movement of Sargassum, a free-floating brown seaweed with ecological, environmental, and economic importance. In the open ocean, Sargassum mats serve a vital ecological function. However, when large quantities appear onshore without warning, Sargassum threatens local tourist industries and near-shore ecosystems. As part of the international response, this project investigated the proliferation of this seaweed using National Aeronautics and Space Administration (NASA) Earth observations for detection of Sargassum and available nutrients across the region. The NASA DEVELOP National Program Caribbean Oceans team at the NASA Ames Research Center compared Landsat 8 Operational Land Imager (OLI) imagery to Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) and Sentinel II MultiSpectral Instrument (MSI) imagery across a number of indices for the identification of Sargassum. The presence of Sargassum was then compared to ground truth data points from Sea Education Association cruises and social media platforms, as well as various oceanic variables, to determine the ideal pelagic environment for Sargassum growth. As part of the international effort to better understand the life cycle of Sargassum in the Caribbean, the results of this project assisted local economies and help promote sustainable management practices.

Mr. Tom Linton and Mike Wurl (TAMGU) from Texas A & M University made a presentation entitled “The Sargassum Early Advisory System (SEAS).”

Abstract:

In recent years the amount of Sargassum that has entered the Caribbean Sea has increased. This has created a need for a system to alert beach managers and local governments of impending landings of Sargassum mats. In the Sargassum Early Advisory System (SEAS) satellite data is used to forecast and predict Sargassum landings throughout the Gulf of Mexico (GoM) and Caribbean Sea. Using a variety of satellites allows for shorter wait periods between images thus, allowing more forecasts to be created for each location. The SEAS program also uses a combination of the wind's effect on surface of the ocean and the ocean's top current layer to determine the direction of the Sargassum mats in a given location. This combination gives SEAS the ability to determine the location and direction that Sargassum is headed and potentially landing locations for the Sargassum. Using government funded satellite sources allows the SEAS program forecasts as many locations as necessary while keeping costs at a minimum. This low cost ensures anyone can receive the forecasts and knowledge of imminent landings. Currently there are 30 locations that receive forecasting for Sargassum and this number is expected to grow by 20% in the next 12 months. Sargassum forecasting is not like the weather forecasting, there are only two entities that do Sargassum forecasting. The South Florida University and SEAS. The University of South Florida provides large scale images. SEAS predictions focuses on small-scale forecasts that allow people to understand the areas that will be most likely to be impacted by Sargassum.

Mr. Joaquin Triñanes (NOAA CoastWatch) gave a presentation entitled “Sargassum-related products from Atlantic OceanWatch at NOAA/AOML: An interoperable approach for the distribution and visualization of operational geospatial data”

Abstract:

The CoastWatch and OceanWatch nodes at the NOAA Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML) in Miami, produce and distribute satellite data and products through interoperable channels, using a service-oriented architecture and international recognized standards for data and metadata. The main goal is to provide integrated data and tools to scientists and other stakeholders to better understand the physical, biological, and chemical ocean processes. Both CoastWatch and OceanWatch efforts run in parallel, with the latter focusing on a larger region of interest, primarily the Atlantic basin and global oceans.

Our presentation at the meeting focused on the products directly related to the detection and tracking of Sargassum. The nodes distribute daily, 3-day and weekly gridded Alternative Floating Algae Index (AFAI) fields, originally generated by C. Hu at USF from MODIS and VIIRS data. In addition, we estimate the Maximum Chlorophyll Index (MCI) fields from the OLCI sensor in Sentinel-3 at spatial resolutions of 300m (Full Resolution) and 1km (Reduced Resolution mode). Both AFAI and MCI allow us to identify the Sargassum patches and lines.

We presented some examples showing how these fields could be as an essential contribution to a Sargassum monitoring system.

Mr. Marc Lucas from Collecte Localisation Satellites (CLS) made a presentation entitled “Sargassum Monitoring at CLS.”

Abstract:

CLS, an international company based in France with branches in the US, Brazil, Peru and elsewhere, specializes in the processing of satellite observation data and the delivery of high end (large scale?) services to customers all over the world. CLS has been working on the sargassum issue since 2015, when the first Sargassum monitoring and drift forecast service was set up to monitor the sargassum algae from the Amazon river mouth to the Caribbean islands. This service was based on satellite ocean color data from the MODIS sensor, satellite Synthetic Aperture Radar (SAR) imagery (Sentinel-1) and high resolution optical (Landsat-8) satellite acquisitions for the detection of Sargassum rafts. A state of the art drift model was then used to forecast the movement of the rafts and establish their most likely beaching site. This information allowed the local authorities of Guadeloupe in charge of the coordination of this environmental issue (DEAL) to better plan their response to the Sargassum invasion during the 2017 season. Since then, CLS has improved its detection capabilities through the inclusion of the Sentinel 3 OLCI and Sentinel 2 MSI sensors data and the computation of a revised Sargassum Detection Index. CLS is in a position to offer a high-end Sargassum Detection, Forecasting and Operational Support Service anywhere in the Wider Caribbean Region and Atlantic Ocean with immediate effect.

Mr. Edgard Cabrera, Invited Expert made a presentation entitled “Marine Environmental Emergencies Response – International context of coordination”

Abstract:

A summary of the status of the working arrangements and current activity and International Organization’s responsibilities was presented. It is becoming apparent that for this work to progress successfully, an increased level of collaboration would be required with agencies at the UN level involved (WMO-IOC through the work of JCOMM Marine Environmental Emergency Response (MEER), Expert Teams and the former Marine Pollution Emergency Response Support System (MPERSS), the IMO, the Marine Environment Committee and International Atomic Energy Agency – IAEA-). For the purpose of the project a proper governance and identification of the partners is required.

Mr. Eric Comerma (from the RPS group) made a presentation entitled “Data Downstream Services in support of Decision Making: Operational Spill Emergency Response and marine Resource Management.”

Abstract:

RPS is focused on Data for Decision Making. Their solution-based approach integrates multiple data sources – including ocean and meteorological observations, remote sensing, forecasts, historical data - using Modelling, mapping, aggregation, analyses, and visualization tools – to develop planning, analysis, and support services for users. Sample users/products include US IOOS and Regional Associations, Oil Spill Predictions, Coastal Flooding Modelling and visualization, and ocean search and rescue.

Ms. Ileana Lopez from the UN Environment made a presentation entitled “Oil spill Impacts and Management in the Caribbean and Adjacent Regions.”

Abstract:

It was presented an overview of the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (WCR) or Cartagena Convention, a regional legal agreement for the protection of the Caribbean Sea.

The Convention is supported by three technical agreements or Protocols on Oil Spills, Specially Protected Areas and Wildlife (SPAW) and Land Based Sources of Marine Pollution (LBS).

The SPAW protocol is regional agreement for the protection and sustainable use of coastal and marine biodiversity in the Wider Caribbean Region. The protocol focuses on Marine Protected Areas and Wildlife, Threatened and Endangered Marine Species and Marine and Coastal Ecosystems.

The Convention covers several aspects of marine pollution for which the Contracting Parties must adopt specific measures. These measures include to prevent, reduce and control: pollution from ships, pollution caused by dumping, pollution from sea-bed activities, airborne pollution, pollution from land-based sources and activities

Countries who are Contracting Parties to the Convention are also required to protect and preserve rare or fragile ecosystems and habitats of depleted, threatened or endangered species; and develop technical and other guidelines for the planning and environmental impact assessments of important development projects.

It was highlighted the interlinkage with the 2030 Agenda for sustainable Development and the Strategic Action Plan for the CLME+ among others.

It was noted that the Cartagena Convention works in support of other global environmental conventions, and multilateral agreements and commitments such as the Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS), RAMSAR Convention on Wetlands, Convention on International Trade in Endangered Species (CITES), Stockholm Convention on chemicals management and Basel Convention on hazardous waste.

Finally, it was indicated that exist a Memorandum of Understanding between the United Nations Environment Programme and the Sargasso Sea Commission envisaged to exchange scientific and other relevant information concerning ongoing projects undertaken by themselves and other organizations or progress in scientific knowledge, including, among others, large-scale stranding of Sargassum, how they affect coastal communities and how the latter may respond to the economic and ecological effects caused.

Mr. Samy Djavidnia from GEO Blue Planet gave a presentation entitled "Operational Oil Spill Monitoring Services: Current state and future prospects."

Abstract:

As shown by the United Nations Conference on Trade and Development (UNCTAD) the trend in world seaborne trade is continuously rising. This includes the percentage change in oil (and gas) trade which in the last 2 years has increased constantly at a rate of approximately 5%. In 2007 UN/GESAMP estimated the release of oil in our ocean to be approximately 500,000 tons per year. An exercise by PWC calculated that every ton of oil released in the ocean corresponds to an environmental degradation, economic and societal cost equivalent to 150,000 Euros. An European Space Agency (ESA) study reported that prior to 2000, the biggest contributor to oil pollution in the World's oceans (some 45%) is operational discharges from tankers (i.e. oil dumped during cleaning operations) and that only 7% of the oil in the sea can be directly attributed to accidents.

There is legislation in place in the Caribbean Sea (see Cartagena Convention & Oil Spill Protocol) which sets measures on the communication of information and reporting of oil spills as well operational guidance. In September 2005, EU adopted Directive on ship-source pollution and on the introduction of penalties, including criminal penalties, for pollution offences. The Directive tasks to "work with the member states in developing technical solutions and providing technical assistance in actions such as tracing discharges by satellite monitoring and surveillance."

Examples exist of user driven approaches to build an effective operational regional monitoring and detection oil spill service. One such operational which makes use of satellite remote sensing technology (Earth Observation SAR imagery), is built on existing state-of-the-art technology and is able to: a) Regularly monitors regional seas and detect “operational” as well as “accidental” oil spills; b) Finds potential polluters and provides reliable evidence for enforcement and investigation purposes; c) Optimises use of national surveillance assets, and; d) Sends timely alerts (warnings) directly to response teams. Based on previous experiences in Europe, we can identify a set of critical success factors which have benefited the set-up, uptake and operationalisation of an oil spill monitoring service. These include : i) Respond to user requirements: User driven approach – cannot be only technical/scientific; ii) Based on Policy/Legislation; iii) Detection only useful if it fits into the national/regional monitoring, preparedness and response chain (Standard Operating Procedures); iv) Response chain relies on timeliness and reliability of detection and alert (Service Level Agreements); v) Ownership and governance: user group meetings for continuous development cycle, and; vi) Enables greater cooperation between environmental and maritime authorities. In developing an oil spill monitoring service for the Caribbean Sea and adjacent regions we have many opportunities to capitalise on. These opportunities have deep positive impacts on many different societal benefit areas, such as: economic & environmental (e.g. reduce oil spill occurrences at sea, reduce quantity of oil reaching shoreline, and contribute to monitoring and reporting of SDG14.1 at national level); capacity building (e.g. boost local knowledge and expertise, and increase both trans-national and intra-national cooperation), and; technical & operational (e.g. enhance vessel traffic monitoring and reporting situational awareness, and data relevant for multiple areas - see fisheries activities monitoring, IUU).

Mr. Nazeer Gopal from Coastal Dynamics Limited, Trinidad and Tobago gave a presentation entitled “An Overview of Oil Spill Modelling and Monitoring in Trinidad and Tobago.”

Abstract:

Trinidad and Tobago has had a long history of oil exploration and production with recent activities that include trans-shipment and lightering of crude oils within the Gulf of Paria. The activities associated with oil exploration and production has the potential to cause harm to the environment. Within recent years, there have been several small spills which have occurred in the local marine environment and the wider Caribbean Sea, with significant impacts to the marine ecosystems. The response to spills is managed under the TT National Oil Spill Contingency Plan (NOSCP). A brief description is provided of the Incident Command System for the NOSCP and the responsible parties for identification, assessments, surveillance and response in cases of a spill in the region. Coastal Dynamics Limited presented its 3D operational forecast hydrodynamic model which is used to predict spill trajectories within the region, and provided recommendations for utilization of existing data sources and requirements for the region.

Mr. Jay Coady from NOAA made a remote presentation entitled “NOAA Office of Response and Restoration Environmental Response Data Visualization and Modelling of Oil Spills”

Abstract

Data aggregation, visualization, and dissemination are key features and functions that the Environmental Response Management Application, ERMA®, provides during an oil spill response or in planning. The ERMA map application is an asset that can be utilized to collect specific incident or study-related data and overlay it with ERMA’s foundational base environmental and socioeconomic data. Leveraging its architecture, data can be made public or placed in varying permission levels assigned to user accounts until the data is vetted for public release. This allows ERMA to quickly ingest data to provide situational awareness for

users during an incident response. Data such as trajectory forecasts, oceanographic Modelling, and response activities is aggregated throughout a response.

Mr. Chuanmin Hu from the University of South Florida gave a presentation entitled “The Satellite-based Sargassum Watch System (SaWS)”

#### Abstract

Chuanmin Hu and collaborators ask, regarding Sargassum: Where? How much? How often? Why? So what? Ecological impact? Prediction? They recognize that there are not enough observations to answer these questions, but are addressing via satellite observations.

The Sargassum watch system (<https://optics.marine.usf.edu/projects/SaWS.html>) uses multiple satellite sensor products to create analyses and forecasts for the public, focused on the Intra-Americas Sea region.

They conclude that

- Satellite remote sensing provides critical tools to quantify macroalgae blooms
- Requirements of spectral, spatial, and radiometric resolutions are well understood;
- Sargassum blooms show increasing trends
- Reasons behind these trends are still unclear
- Near real-time SaWS helps monitor Sargassum
- Short-term prediction of beaching events possible
- Statistics-based long-term prediction is also possible

Mr. Keith Donough, IMO Consultant gave a remote presentation entitled “Regional Marine Pollution Emergency Information and Training Center.”

#### Abstract

The Caribbean region has 50+ major petroleum infrastructure components located throughout, including refineries, offshore installations, navigational hazards, oil terminals, and chemical plants – and is highly trafficked by vessels transporting potentially dangerous cargoes utilizing them. There is an ongoing high risk of spills, releases, and discharges of: Oil or other HNS carried as cargo; Oil from bunker tanks; Oil & gas from offshore production; Invasive species in ballast water; Toxins in antifouling paint; Ship generated waste such as oil, HNS, garbage, sewage, and emissions. The Cartagena Convention (The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region) includes an Oil Spills Protocol and established a Region Activity Center (RAC), the REIMPEITC to develop sustainable all aspects of tis national & regional capabilities to implement international standards to prevent & respond to threats to the marine environment from shipping.

The RAC supports frequent regional workshops and exercises on all aspects of response, planning, incident management, and preparedness for oil spills and pollution occurrences.

Ms. Karen Day from Fulcrum Maritime Services gave a presentation entitled “Oil Spill Detection - Exporting the Clean Sea Net Regional Model to the Caribbean”

#### Abstract:

Every 3 days, a 300-Ton ship is wrecked somewhere in the world. Some 6 million tons of oil find their way into the sea each year. CLS offers services to detect accidental or intentional oil spills, identify polluters and forecast pollution drift. CLS has a fully operational 24 x 7 service and has over 10 years of experience in the field providing services in Europe to the European Maritime Safety Agency (EMSA). Fulcrum Maritime Systems is a subsidiary of CLS based in the UK and has been seeking support for a proposal to create a region wide system for the Wider Caribbean Region to include oil spill detection, sargassum detection

and detection of illegal activity, in order to create a tool to help protect the ocean, provide information for better ocean governance and to promote sustainable economic activity. Fulcrum has been working with Caribbean Flag States since 2003, providing a number of services, including the Caribbean Cooperative Data Centre for Ship Tracking under the SOLAS Regulations. This system provides one framework that could be leveraged for the secure exchange of data. Our approach is to work with national agencies and regional organisations, such as the OECS. The CLS Data Analysis and Operations Centre and our skilled, experienced analysts provide advice and guidance to ensure that the best possible service is provided, and work with national agencies to provide real time, near real time or historical data analysis reports in an easily understandable, accessible format.

Ms. Alexandra Rodriguez from NOAA gave a presentation entitled "The NOAA/NESDIS Satellite Monitoring of Marine Oil"

Abstract:

The Marine Debris and Oil Spill Monitoring Program is one of five operational desks at the Satellite Analysis Branch (SAB) which is part of the U.S. National Oceanic and Atmospheric Administration (NOAA) Satellite and Information Service (NESDIS). We are based on the outskirts of Washington D.C. in College Park, Maryland. We are staffed 24 hours a day, 7 days a week. In 2009, NOAA's Office of Response and Restoration (OR&R), specifically the Emergency Response Division (ERD), requested satellite support of oil spill emergencies and for assistance in monitoring intentional and accidental crude oil discharges in U.S. waters within the Exclusive Economic Zone (EEZ), their approaches, and internationally when requested. The Marine Debris and Oil Spill Monitoring program became fully operational in 2011. As of now, our customers/users include the U.S. Coast Guard, NOAA/National Ocean Service, the Bureau of Safety and Environmental Enforcement (BSEE), the Environmental Protection Agency (EPA), and State Agencies (e.g. Florida Fish and Wildlife, Texas General Land Office). Our operational workflow consists of marine analysts downloading and manually analyzing satellite imagery, such as SAR and Optical, for possible oil anomalies based on a visual inspection, but also consulting a wide array of ancillary information to help rule out false positives. If believed to be the result of man-made discharge, a Marine Pollution Surveillance Report is created and disseminated onto the web. As of March 2018, MPSRs are publically available through our website: <https://www.ospo.noaa.gov/Products/ocean/marinepollution/>.

Mr. Jorge Zavala Hidalgo from the UNAM, Mexico gave a presentation entitled "Numerical Modelling at Centro de Ciencias de la Atmosfera, UNAM"

Abstract:

The Centro de Ciencias de la Atmosfera of UNAM (CCA) supports multiple forecast systems for the Caribbean, including WRF weather models, WWIII Wave model, ADCIRC and FVCOM storm surge and coastal circulation; and HYCOM for Ocean circulation. These are supported by supercomputer resources.

These systems are applied to problems like hurricane forecasting, oil spill simulations and forecasting, and regional and local ocean circulation. They also support >27 sea level stations.

Mr. Douglas Wilson provided a summary and provided a break group guidance to the participants for the working groups.

### **3. SESSION 2: PRODUCT REQUIREMENTS FOR SARGASSUM & OIL SPILL MONITORING AND FORECASTING**

In this session, in parallel breakout discussions, user representatives worked with the technical experts to identify the potential users of and requirements for a sargassum product and an oil spill product. Each breakout session started with an introductory talk followed by a moderated discussion.

#### **3.1 Sargassum Breakout**

Prior to the discussion, Mr. Joaquin Trinanés from NOAA made an introduction to NOAA AOML Sargassum tracking experiments.

##### **Abstract**

The experimental goal was to understand and assess impact of ocean dynamics and wind on sargassum (and debris in general), by carrying out experiments with objects, including sargassum, of different buoyancy, shapes, weights, and track their trajectories under a suite of different current and wind conditions. More than 60 satellite tracked drifting platforms that simulated Sargassum were deployed in the Tropical Atlantic and Caribbean region. This is an ongoing project; scientists will compare results with remote sensing fields and in-situ measurements; analyze the impact the debris characteristics has on trajectories; hoping to provide an insight on the behaviour of sargassum patches under different conditions of currents and winds.

##### **Discussion outcomes**

###### Objective and scope

The group outlined an objective to design a Sargassum forecasting and tracking system and an implementation plan, including the development of a prototype / pilot of the system to test the concept.

It was agreed that the Pilot Project should aim to demonstrate the utility of ocean observations and products to countries in the region by focusing on a complete end-to-end delivery of usable products. In addition, the group agreed that the pilot project should be based on existing technologies and activities, working to augment and improve the framework for information management and delivery and mechanisms for product development and usage.

###### Potential users of the system

The group outlined potential users of a sargassum system as outlined below:

- Authorities / Municipalities
  - Environmental managers and authorities
  - Emergency Responders
  - Coast Guard, Navy and other navigational safety stakeholders
  - Public health ministries

- National finance ministries
- Private Sector
  - Hotels
  - Other tourism industries (recreational fishing, cruise lines, water sports, etc.)
  - Commercial Fisheries
  - Parties interested in utilizing sargassum
- Policy makers (National / Regional /Local)
- Researchers
- Local communities

### System requirements

It was agreed that a coordinated approach is needed for the region and that an intergovernmental group so be responsible for coordination. A summary of the requirements identified in the breakout are outlined below.

- Historical baseline of impacts
- Documentation of social and economic impacts and responses
- Long Range Forecasts (at least 3 months in advance)
- Short term forecasts by beach or region
- Volume and abundance of sargassum
- Ongoing improvements based on research and development findings

### System components

The group discussed the components of the system and agreed that the system should include remote sensing data, field data, data and information management functionality, and Modelling and forecasting functionality. Additional details are summarized below.

#### *Remote sensing data*

- Landsat data (High Resolution)
- Modis data (Lower Resolution)
- Image processing capability
- Providing levels of resolution, confidence, latency

#### *Field Data*

- Sources of validation data
  - Fisherfolk
  - Ferries, Cruise Lines, other commercial marine stakeholders
  - Hotels and beachfront establishments
  - Voluntary reporting by citizens
  - Aerial surveys (Coast Guard, UAVs)
  - Openly available existing data

#### *Data and Information Management*

The data and information management components were then discussed. A summary of the discussion is presented below.

- Clearinghouse for processed satellite images
- Clearinghouse of field data
- Data collection protocols, including metadata
- Processed image archives
- Ancillary data (fisheries, socioeconomic data, etc.)
- Product visualization and dissemination functionality
  - Push to agency stakeholders and interested subscribers
  - Various products based on identified user needs and feedback

### *Modelling and Forecasting*

The group discussed that medium to long range forecast models are someone specialized and are still under development. It was agreed that there is a lack of adequate coastal scale models in the region and a lack of forcing field and bathymetry information. It was agreed that local/regional capability would need to be enhanced in order to produce accurate forecasts. The need for higher resolution dedicated satellite data was also discussed.

### Research and Development

The breakout session closed with a discussion of additional research that needs to be done in order to understand the drivers of sargassum abundance and distribution. The following research topics were outlined as priorities:

- Sargassum developmental biology, ecology and impact on the environment
- Hindcasting experiments to evaluate data on sargassum growth
- Additional in situ measurements of sargassum growth
- Sargassum drifting behavior
- Impacts of land-based/nutrient inputs
- Impacts of climate/interannual variability on sargassum abundance/distribution
- Multivariate analysis of tropical Atlantic conditions and circulation
- Biodiversity changes associated with sargassum presence/abundance

## **3.2 Oil Spill Breakout**

Prior to the discussion Mr. Gianluca Luraschi made an introductory talk on smart response systems architecture.

### Abstract

Development of a smart response system architecture depends on addressing performance and interoperability. Responding to a natural or artificial emergency (sargassum, oil spills, etc.) requires accessing, sharing, and understanding of many types of geospatial data sets provided by several types of sensors operated by different organizations. In Europe, this is approached through the European Interoperability Framework that takes into account various aspects of interoperability including legal (EU Directives and other legislation), organizational (standard operating procedures), semantic (data standards), and technology (resource/service-oriented architecture). There are three viewpoints to be considered: enterprise viewpoints, information viewpoints, service viewpoints and deployment viewpoints.

- **Enterprise Viewpoint**, includes a definition of the monitoring & alerting service, the target audience (Users) and stakeholders, and the service Use Case(s).

- **Information Viewpoint**, outlines the specific information and data that is delivered through the service, and defines the basic governing principles.
- **Services Viewpoint**, includes the interfaces and workflows pertinent to the service using a service oriented architecture.
- **Deployment Viewpoint**, identifies the system components required to support the delivery of the service.

In summary, a smart response system not only senses and shares information but is also smart by considering the various viewpoints and this project should aim to develop a smart response system for this project.

## Discussion outcomes

### Objective and scope

The group outlined an objective to develop a system that identifies oil spills and provides an alerting system for regional bodies privy to the Cartagena Convention & interested national agencies and stakeholders.

It was agreed that the service should provide a publically available platform and alerting system that is based on publically available data (e.g. satellite data and in situ data from countries with open data sharing policies). The group discussed that the service should be provided by a coordinated regional body (such as Hurricane Centre, Tsunami Centre) and be distributed by national and local entities. Regarding high-resolution products, it was agreed that it would be appropriate for the private sector to provider more specific, high-resolution products.

### Potential users of the system

The group outlined potential users of a regional oil spill monitoring system as outlined below:

- Regional & intergovernmental bodies
  - Regional Marine Pollution Emergency Information and Training Center
  - IMO
  - WMO (JCOMM)
  - IOCARIBE of IOC UNESCO
  - Regional frameworks (tsunami system, etc.)
- National Entities
  - National emergency management or disaster
  - Ministry of foreign affairs
  - Environmental management agencies
  - Ministries of energy
  - Navy
  - Coast Guards
  - Maritime agencies
- Other Interested Parties
  - NGOs
  - Citizens

The group agreed that users have three primary needs that would need to be met by the system:

1. Detection and monitoring of oil spill accidents and operational discharges

2. Alerts and information dissemination
3. Forecasting and backtracking of oil spills

### System requirements

The group then discussed the type of information that would need to be included and provided by the system. Major points are summarized below.

- Alerting system for national agencies that are interested and regional bodies that are privy to the Cartagena convention
- Contextual information (what assets/ecosystems are near the spill? What type of activity/population/etc. is in the area of the spill)
- Regional points of contacts
- Planning (model outputs) where is the oil going to end up
- Thickness of the oil
- Interoperability/data transformation capabilities
- Coordinate reference system
- Catalogue service: metadata requirements
- Cartographic symbolization
- Scale of use and accuracy (quality, level of information)
- Graphical web interface that can be enriched with additional functionality
- Iterative development with users including involvement of governments including maritime authorities in the development process
- Sustained funding for infrastructure

### System components

The group discussed the components of the system and agreed that the system should include data and information, data architecture components, processing and analysis capability, user clients and Modelling and forecasting functionality. Additional details are summarized below.

#### *Data & Information*

- Satellite data catalogue (provided by operational agencies (NOAA, EUMETSAT, CMEMS, ESA, etc.))
- In situ data (existing data)
- Community reporting information (for reports from fishers, agencies, etc. for visible oil spill)

#### *Architecture*

- Satellite data catalogue (provided by operational agencies (NOAA, EUMETSAT, CMEMS, ESA, etc.))
- In situ data catalogue (existing data)
- Community reporting information (for reports from fishers, agencies, etc. for visible oil spill)
- "Metaplatfrom" that harvests from existing data sets, platforms, and services

#### *Processing and analysis*

- In country/regional training for analyzing satellite data products at agencies, universities, institutes *OR*
- An international/intergovernmental service for the region for cost-sharing, service maintenance

#### *User Clients*

- Web interface
- App
- Email Alerts
- SMS/Social Media Alerts

#### *Modelling*

The group discussed that there are not sufficient regional models and that this should be developed. It was agreed that eventually, an ensemble approach for models would be desirable. The group agreed that a phased approach for models would be appropriate with existing regional modelers providing support in phase I, regional oil spill model results being provided by the service in phase II with a goal of eventually providing an ensemble model approach.

It was agreed that training on how to utilize models was also needed for the region.

## **4. SESSION 3: SERVICE DEVELOPMENT AND SUSTAINMENT**

In this session, Mr. Doug Wilson provided a summary of the sargassum breakout session and Ms. Emily Smail presented a summary of the oil spill breakout session. Meeting participants then discussed a merged description of users, data, system architecture and infrastructure and potential contributions. A summary of the discussion and agreed upon framework is outlined below.

### Challenges and Considerations

#### *Oil Spills*

For oil spills, it was discussed that it is important to identify the culprit so the type of oil can be identified. Participants highlighted that commercial satellite providers will provide high resolution satellite data free of cost in the case of emergencies.

José Eduardo Martinelli from the Federal University of Pará pointed out that there is a need for an oil spill monitoring program for the Brazilian Amazon coast since oil and gas exploration will take place at the Amazon shelf in the next few years.

#### *Sargassum*

In the case of sargassum, participants stressed the urgency for dealing with the issue. It was suggested that an additional workshop should be planned that involves stakeholders and funding agencies. The need for mitigation and ways to utilize and remove the sargassum were also discussed.

José Eduardo Martinelli from the Federal University of Pará added that Brazil has been monitoring pelagic sargassum occurrence for the Brazilian Amazon coast since 2014. He added that the potential of algae as a vector of invasive, invertebrate taxa, the biomass of stranded algae on beaches, impacts and management. He added that there is variability in the distribution of sargassum accumulation with the Amazon coast receiving only a small amount of fragmented algae in 2018 despite the large impacts in the Caribbean.

Tom Linton from UT-Galveston stated that the variability from year to year creates a challenge for investment in materials to harvest, clear and utilize sargassum. He suggested that a mechanism for sharing equipment across the region would be useful.

Researchers from UNAM stressed the importance of sargassum as an ecosystem and nursery ground for turtles and other species and the need to understand the impacts of harvesting sargassum on other species.

### Users and system requirements

#### *Users*

The participants reviewed the sargassum and oil spill breakout summaries and produced the below consensus on target users, requirements and

- Regional & intergovernmental bodies
  - Regional Marine Pollution Emergency Information and Training Center
  - IMO
  - WMO (JCOMM)
  - OECS
  - IOCARIBE of IOC UNESCO
  - RAC/REMPEITC-Caribe
  - Regional frameworks (tsunami system, etc.)
- National Entities
  - Ministries of finance
  - National emergency management or disaster
  - Ministry of foreign affairs
  - Environmental management agencies
  - Ministries of energy
  - Navies
  - Ministries of tourism
  - Coast Guards
  - Maritime agencies
  - Public health ministries
- Private Sector
  - Hotels
  - Other tourism industries (recreational fishing, cruise lines, water sports, etc.)
  - Commercial Fisheries
  - Parties interested in utilizing sargassum
- Other Interested Parties
  - NGOs
  - Citizens
  - The research community
  - Local communities

### *User requirements*

The group discussed user requirements and components of the project that would be needed to meet these requirements. It was agreed that the project should meet the following needs:

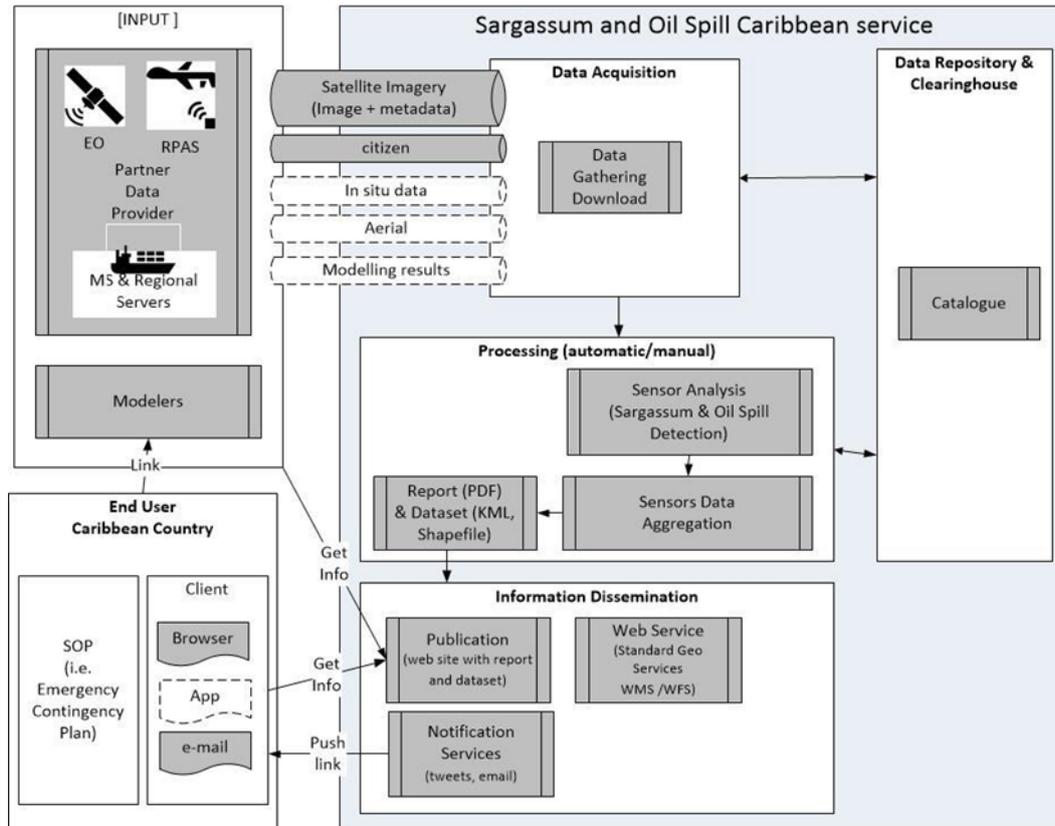
1. Detection and monitoring of oil spills, discharges and sargassum
2. Alerts and information dissemination
3. Forecasting and backtracking
4. Local training and capacity building
5. Collation for best practices for mitigation

### *System development*

The group converged on the below components for the development of the system.

- Data acquisition
  - Satellite imagery for oil spills and sargassum
  - Citizen science imagery/alerts to oil and sargassum occurrences
  - Openly-available in situ data
- Data repository and clearing house
- Data analysis and processing
  - Satellite sensor analysis
  - Data aggregation
  - Report outputs and resulting datasets
- Information dissemination
  - Web service for standard Geo services
    - Web browser
  - Report/alert publication
    - PDF, KML, Shapefile
  - Notification services
    - Email, social media, SMS, app

A draft diagram of the architecture (Figure 1) was produced by Gianluca Luraschi.



**Figure 1:** Draft architecture of the sargassum and oil spill service.

### Sustainment

The need to develop a governmental policy and coordinated approach for ocean monitoring in the region was discussed. It was agreed that ideally, a regional coordination body would take over the operational maintenance of the system or one would be created. Christopher Williams of OECS stated that several OECS countries are creating coordinated management plans. The participants agreed that ideally, an intergovernmental group should coordinate the development of the project into an operational system. The Cartagena Convention was presented as a possible framework to drive the project.

### Working Groups and Contributions

The working groups were discussed and it was agreed that there should be a dedicated working group on capacity building and training. The following working groups were agreed to:

- Working Group 1: Project Coordination and Support
- Working Group 2: User Engagement and Outreach
- Working Group 3: Data and Product Development
- Working Group 4: System Design and Integration
- Working Group 5: Capacity Building and Training

Workshop participants then discussed potential contributions to the project. For primary infrastructure, NOAA CoastWatch / OceanWatch offered to host and help develop the initial service and INVEMAR offered to host the in situ data/imagery collected for the project through IOC of UNESCO Caribbean Marine Atlas project. It was also suggested that a citizen science app similar to that used in the NASA DEVELOP Caribbean Sargassum monitoring project be incorporated into the service. Other workshop participants expressed interest in supporting training, project support, user engagement and modelling efforts pending approval from their host institutions.

## 5. SESSION 4: SUMMARY, NEXT STEPS AND CONCLUSIONS

### Summary

In summary, the workshop participants determined that the objective of the information service will be to provide a publically available monitoring platform and alerting system for oil spills and sargassum based on publically available data (e.g. satellite data and in situ data from countries with open data sharing policies). The service will be based on existing technologies and activities, working to augment and improve the framework for information management and delivery and mechanisms for the region and demonstrate the utility of ocean observations and products.

It was agreed that the initial development of the service would be done by partner organizations and that the NOAA CoastWatch program and the IOC OF UNESCO Caribbean Marine Atlas would host the service initially. The long-term goal is to have the information service coordinated and built upon by a regional body in a model similar to that of the IOC of UNESCO International Tsunami Information Centre.

Initial components of the information service will include:

- Data acquisition
  - Satellite imagery for oil spills and sargassum
  - Citizen science imagery/alerts to oil and sargassum occurrences
  - Openly-available in situ data
- Data repository and clearing house
- Data analysis and processing
  - Satellite sensor analysis
  - Data aggregation
  - Report outputs and resulting datasets
- Information dissemination
  - Web service for standard Geo services
    - Web browser
  - Report/alert publication
    - PDF, KML, Shapefile
  - Notification services
    - Email, social media, SMS, app

The meeting participants agreed that engagement with potential users of the service should be included in the development service early on and that the interface should be developed with users through an iterative process. Five working groups were formed with workshop participants at the workshop with additional working group membership open to other

interested parties.

### Next Steps and Conclusions

The next steps of the project are to develop an implementation plan for the pilot project and explore funding opportunities for the project. Development of the implementation plan will include the identification of responsible parties, working group members, activities, deliverables and required resources.

The pilot project should incorporate a sustainability plan for long-term development, expansion and maintenance of the service.

## **6. CLOSING OF THE MEETING**

Mr. Cesar Toro, Head UNESCO-IOC Regional Secretariat for IOCARIBE closed the meeting. He expressed his great appreciation for the commitment and participation of the group. He thanked the Government of Mexico and the General Directorate of Marine Sciences and Technology of the Ministry of Education of Mexico for hosting the meeting and for the excellent facilities provided for the organization of the meeting.

The Workshop Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions was closed at 13:00 hrs on Friday May 4, 2018.e meeting was closed on Friday 13 December at 15h00.

## **ANNEX I**

### **AGENDA**

#### **Workshop Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions**

**When:** May 2 - 4, 2018

**Where:** Oficinas de la Secretaria de Educación Pública SEP. Av. Revolución No. 1425, Col. Campestre. México DF, México

**Hosted by:** Mexico Ministry of Education (Secretaria de Educacion Publica) and National Council of Science

**Organisers:** IOCARIBE of IOC UNESCO, GEO Blue Planet, UNDP Barbados and the OECS

#### **Programme Description**

##### **Session 0: Welcome and Introduction**

This session will introduce participants to the project and goals of the workshop.

##### **Session 1: Sargassum and Oil Spills in the Caribbean**

In this session, speakers will address the challenges faced by oil spills and sargassum in the Caribbean and Adjacent Regions. Speakers will outline what is known about these issues to date and what additional information is required. What tools are currently available on detection/monitoring/forecasting on sargassum and oil spills?

##### **Session 2: Product Requirements for Sargassum & Oil Spill Monitoring and Forecasting**

In this session, user representatives will work with the technical experts to identify the requirements for the product.

##### **Session 3: Service Development and Sustainment**

In this session, discussions will focus on what investments, infrastructure and agreements need to be put in place to produce an operational system for sargassum and oil spill monitoring and forecasting in the Caribbean.

##### **Session 4: Summary, Next Steps and Conclusion**

<b>Day 1 – May 2, 2018</b>		
<b>Time</b>	<b>Activity</b>	<b>Speaker (s)</b>
08:30 – 09:00	Registration	
<b>Session 0: Welcome and Introduction</b>		
10:00 – 10:10	Opening remarks	
10:10 - 10:20	IOC Welcome	Cesar Toro (IOCARIBE of IOC UNESCO)
10:20 - 10:30	Participant introductions	Cesar Toro
10:30 – 10:50	Project introduction	Doug Wilson (IOCARIBE - GOOS)
<b>10:50 – 11:10</b>	<b>Coffee Break</b>	
11:10 – 11:20	Group Photo	
11:20 – 11:40	Overview of GOOS Regional Alliances (GRA)	Glenn Nolan (EuroGOOS - remotely)
11:40 – 12:00	The GEO Blue Planet Initiative	Emily Smail (GEO Blue Planet)
12:00 – 12:20	The Marine Biodiversity Network	Frank Muller-Karger (USF/MBON)
<b>Session 1: Sargassum and Oil Spills in the Caribbean</b>		
12:20 – 12:40	Management of Oil Spill in OECS and Wider Caribbean	Christopher Williams (OECS)
<b>Panel on Sargassum in the Caribbean and Adjacent Regions</b>		
12:40 – 13:00	Towards the prediction of pelagic sargassum influx events in the Eastern Caribbean	Shelly-Ann Cox (UWI)
13:00 – 13:20	Sargassum impacts and management	Milton Haughton (CRFM)
13:20 – 13:40	Oceanographic Observational Platforms, Baseline studies, Model Simulations, and Scenarios of the Natural Response to Large-Scale Oil Spills in the Gulf of Mexico	Julio Sheinbaum (CIGOM-CICESE)
13:40 – 14:00	NASA DEVELOP Caribbean Sargassum monitoring project	Laura Lorenzoni (NASA - remotely) on behalf of Juan Luis Torres Perez (AMES - remotely)

<b>14:00 – 15:00</b>	<b>Lunch</b>	
15:00 – 15:20	The Sargassum Early Advisory System (SEAS)	Tom Linton and Mike Wurl (TAMGU)
15:20 – 15:40	Sargassum-related products from Atlantic OceanWatch at NOAA/AOML: An interoperable approach for the distribution and visualization of operational geospatial data	Joaquin Trinannes (NOAA CoastWatch)
15:40 – 16:00	Sargassum Monitoring at CLS	Marc Lucas (CLS)
<b>Session 1 (continued): Sargassum and Oil Spills in the Caribbean</b>		
<b>Panel on Oil Spills in the Caribbean and Adjacent Regions</b>		
16:00 - 16:20	Marine Environmental Emergencies Response – International coordination	Edgard Cabrera (Invited Expert)
16:20 - 16:40	Data Downstream Services in support of Decision Making: Operational Spill Emergency Response and Marine Resource Management	Eric Comerma (RPS group)
16:40 – 17:00	Oil spill impacts and management in the Caribbean and adjacent regions	Ileana Lopez (UN Environment)
17:00 – 17:20	Operational oil spill monitoring services: current state and future prospects	Samy Djavidnia (GEO Blue Planet)
17:20 – 17:40	An Overview of Oil Spill Modelling and Monitoring in Trinidad and Tobago	Nazeer Goupal (Coastal Dynamics)
17:40 – 18:00	NOAA Office of Response and Restoration Environmental Response Data Visualization and Modeling of Oil Spills	Jay Coady (NOAA - remotely)

<b>Day 2 – May 3, 2018</b>		
<b>Time</b>	<b>Activity</b>	<b>Speaker (s)</b>
<b>Session 1 (continued): Sargassum and Oil Spills in the Caribbean</b>		
09:00 - 09:20	The Satellite-based Sargassum Watch System (SaWS)	Chuanmin Hu (USF)
09:20 - 09:40	The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention)	Keith Donough (IMO Consultant - remotely)
09:40 – 09:55	Oil Spill Detection - Exporting the Clean Sea Net Regional Model to the Caribbean	Karen Day (Fulcrum)
09:55 – 10:10	The NOAA/NESDIS Satellite Monitoring of Marine Oil	Alexandra Rodriguez (NOAA)
10:10 – 10:20	Numerical Modeling at Centro de Ciencias de la Atmósfera, UNAM, México	Jorge Zavala Hidalgo (UNAM)
10:20 – 10:30	Break group guidance (system components & architecture)	Doug Wilson (IOCARIBE-GOOS)
<b>10:30 - 10:45</b>	<b>Coffee Break</b>	
<b>Session 2: Product Requirements for Sargassum &amp; Oil Spill Monitoring and Forecasting</b>		
<b>Breakout Group 1: Product Requirements for Sargassum Monitoring and Forecasting</b>		
10:45 - 11:00	An introduction to sargassum tracking experiments	Joaquin Trinnanes and Gustavo Goni (NOAA)
10:00 – 14:00	Moderated Discussion	
<b>14:00 - 15:00</b>	<b>Lunch</b>	
15:00 - 16:30	Moderated Discussion	
<b>Breakout Group 2: Product Requirements for Oil Spill Monitoring and Forecasting</b>		
10:45 - 14:00	Introductory presentation	Gianluca Luraschi (Invited Expert)
10:00 – 14:00	Moderated Discussion	

<b>14:00 - 15:00</b>	<b>Lunch</b>	
15:00 - 16:30	Moderated Discussion	

<b>Day 3 – May 4, 2018</b>		
<b>Time</b>	<b>Activity</b>	<b>Speaker (s)</b>
<b>Session 5: Product Development and Next Steps</b>		
09:00 – 10:00	Review of summary reports	
10:00 – 11:00	Moderated discussion and review of end to end system design and development	Moderators: Cesar Toro, Doug Wilson, Emily Smail
11:00 – 11:20	Coffee Break	
11:20 – 12:30	Moderated discussion and review of end to end system design and development	Moderator: Cesar Toro, Doug Wilson, Emily Smail
12:30 – 14:00	Working groups, next steps and conclusion	Moderator: Cesar Toro, Doug Wilson, Emily Smail
14:00	Lunch	



## ANNEX II

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