Increasing Ocean Observations in the Caribbean Region to Enhance Marine Governance

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Principal

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Functions of the Caribbean Institute for Meteorology & Hydrology (CIMH)

- WMO Regional Training Centre – Trains various categories of meteorological and hydrological personnel;
- Centre for research in meteorology, climatology hydrology and associated sciences and their applications;
- Regional Climate Data Centre – Data collection, quality assurance, storage, & dissemination;
- WMO Regional Instrument Centre – Design, finance, procure, install, maintain, repair, and calibrate regional meteorological & hydrological networks and instruments;
- Regional Centre of Excellence for Training in Satellite Meteorology – one of 13 such centres in the world specializing in the development and delivery of satellite derived meteorological products and services;

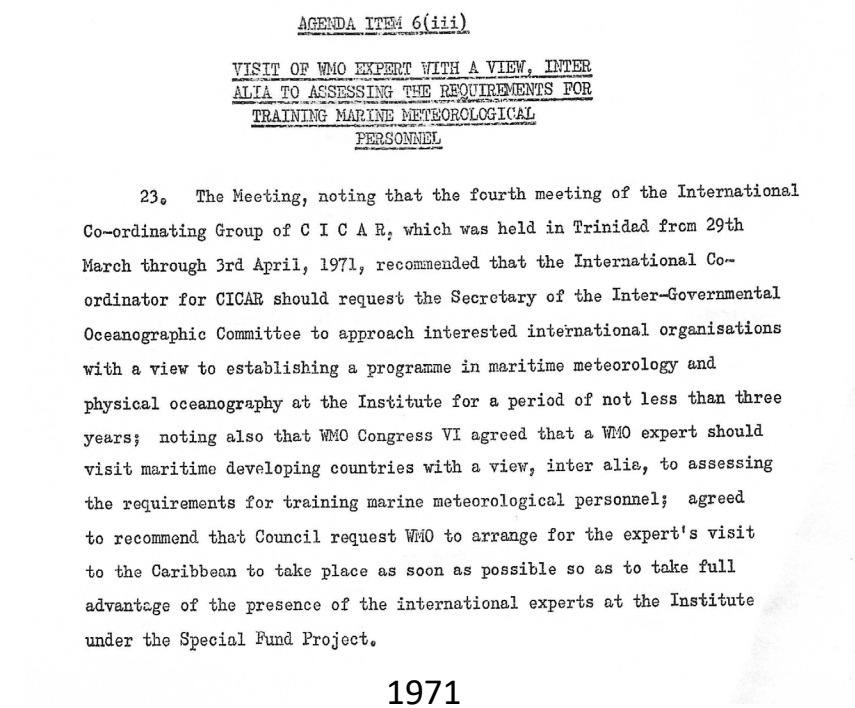
- WMO Regional Climate Centre – develop and deliver climate products and services to climate sensitive sectors across the region.
- Caribbean Centre for Climate and Environmental Simulations – procure and maintain regional computational infrastructure to support regional climate and environmental modeling
- WMO Pan American Centre for Sand & Dust Storm Warning Advisory and Assessment System (SDS-WAS) – Supports the development of aerosol-based observation and forecasting products to support air quality early warning systems;
- Regional Marine Forecasting Support Centre – develop marine products and services to improve ocean policy and governance;
- Advisor to regional governments on climate, meteorology, water related matters;
- Provide specialized services to industry.

CARIBBEAN REGIONAL MARINE FORECAST SUPPORT CENTRE (CIMH)

- Goal:
  - Create a regional marine forecast support centre at CIMH that takes advantage of the existing infrastructure, competencies, resources, products and services as well as international partnerships and collaborations already present at CIMH, to develop a suite of products and services that improve (i) the operations of marine based sectors in the region, (ii) improve marine ecosystems and fisheries, and (iii) ocean governance, planning and policies.
  - Approved in by the Caribbean Meteorological Council in November 2021.

Idea of having a robust related marine programme at CIMH dates back to 1971/1972 meetings of the Board of Governors of the CIMH and the Caribbean Meteorological Council.

Unfortunately, the concept was not advanced until recently.

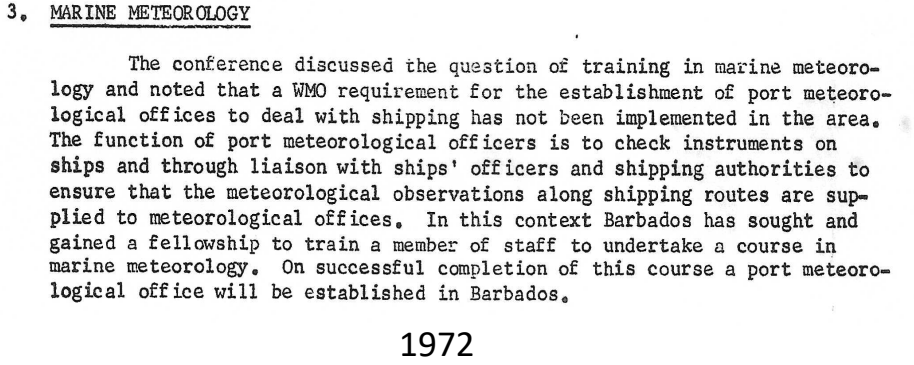


AGENDA ITEM 6(iii)

VISIT OF WMO EXPERT WITH A VIEW, INTER ALIA TO ASSESSING THE REQUIREMENTS FOR TRAINING MARINE METEOROLOGICAL PERSONNEL

23. The Meeting, noting that the fourth meeting of the International Co-ordinating Group of C I C A R, which was held in Trinidad from 29th March through 3rd April, 1971, recommended that the International Co-ordinator for CICAR should request the Secretary of the Inter-Governmental Oceanographic Committee to approach interested international organisations with a view to establishing a programme in maritime meteorology and physical oceanography at the Institute for a period of not less than three years; noting also that WMO Congress VI agreed that a WMO expert should visit maritime developing countries with a view, inter alia, to assessing the requirements for training marine meteorological personnel; agreed to recommend that Council request WMO to arrange for the expert's visit to the Caribbean to take place as soon as possible so as to take full advantage of the presence of the international experts at the Institute under the Special Fund Project.

1971



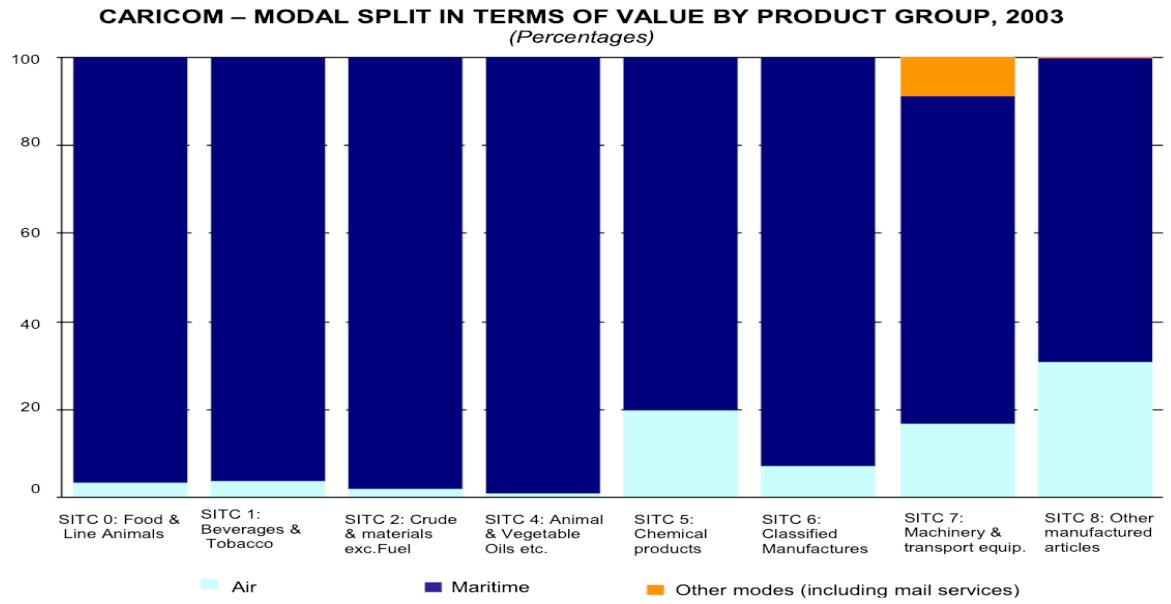
3. MARINE METEOROLOGY

The conference discussed the question of training in marine meteorology and noted that a WMO requirement for the establishment of port meteorological offices to deal with shipping has not been implemented in the area. The function of port meteorological officers is to check instruments on ships and through liaison with ships' officers and shipping authorities to ensure that the meteorological observations along shipping routes are supplied to meteorological offices. In this context Barbados has sought and gained a fellowship to train a member of staff to undertake a course in marine meteorology. On successful completion of this course a port meteorological office will be established in Barbados.

1972

Regional Marine-Ocean Governance Challenges

- Caribbean SIDS possess small land areas compared to their vast oceans areas;
- Many islands derive substantial socio-economic wealth and benefit from their marine ecosystems:
  - Food, mineral resources, cost-effective transportation of goods and services, tourism and recreation;
  - ***Fisheries account for up to 15% of protein intake in the Caribbean, and the fisheries sector is more vulnerable to climate change than in other regions.***
- Marine environment also presents significant challenges that impact socio-economic development:
  - Elevated sea surface temperatures fuel tropical storms and contributes to coral bleaching that impacts coastal ecosystems;
  - Long term sea level rise is expected to enhance coastal flooding from storm surge and large swells and enhance salinization of coastal aquifers;
  - Marine algal blooms and sargassum seaweed at times inundate the marine ecosystem impacting beaches, air quality and marine water quality.



Source: ***https://unctad.org/system/files/non-official-document/cimem7_2014_C2_Martime_CARICOM_en.pdf***

Jamaica: Although detailed coastal zone management strategies are in place, they are made less effective by a lack of up-to-date, modern data. ***(Source Commonwealth Marine Economies Programme Funded by UK Government - Enabling safe and sustainable marine economies across Commonwealth Small Island Developing States – Jamaica Country review)***

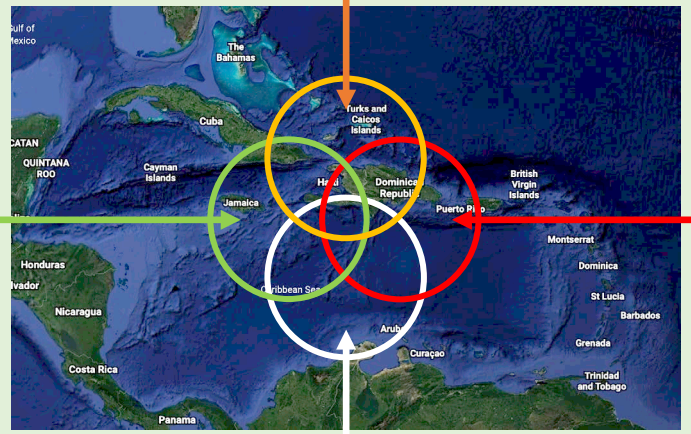
St. Vincent and the Grenadines: All of the data collected has been passed on to the Government of Saint Vincent and the Grenadines, and while some training on effective use of these datasets has been provided, challenges remain for managing, sharing and utilising these datasets. If this data cannot be fully understood, accessed and exploited by local stakeholders, its full value will not be realised. ***(Source Commonwealth Marine Economies Programme Funded by UK Government - Enabling safe and sustainable marine economies across Commonwealth Small Island Developing States – St. Vincent and the Grenadines Country review)***

Regional Resilience & Caribbean Multi-Hazard Early Warning Systems

Development of geo-physical, geological and hydrological based products to support geological and water resources assessments and land use …

Cl

Development and delivery of climate information to sectors to improve planning and decision-making (temperature, heat, drought, SST …)



Gl

HM

Development of daily weather and hydrological products to improve rainfall, wind, temperature, landslide, flood, air quality and energy forecasts …

Development and delivery of marine products to risk-inform marine activities and governance (wave heights, currents, salinity, nutrients …)

Mr

Caribbean Natural Hazards

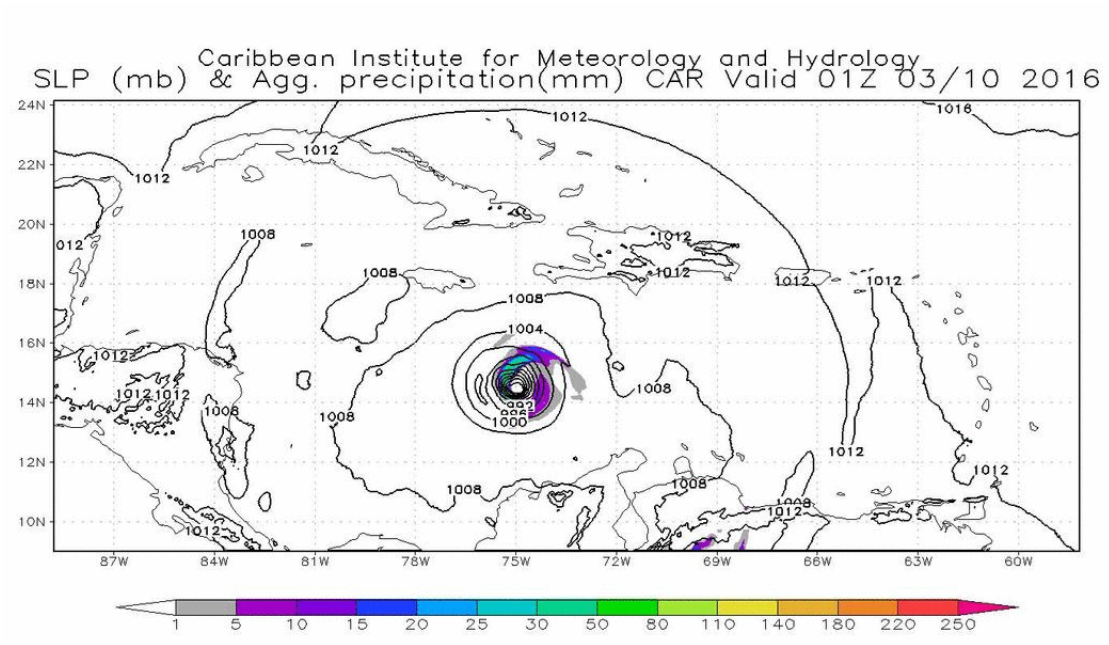
- Hydro-meteorological **(HM)**
- Climate **(Cl)**
- Geological **(Gl)**
- Marine **(Mr)**

CIMH Current Support to Caribbean MHEWS Integrative Framework for Climate Resilient Development

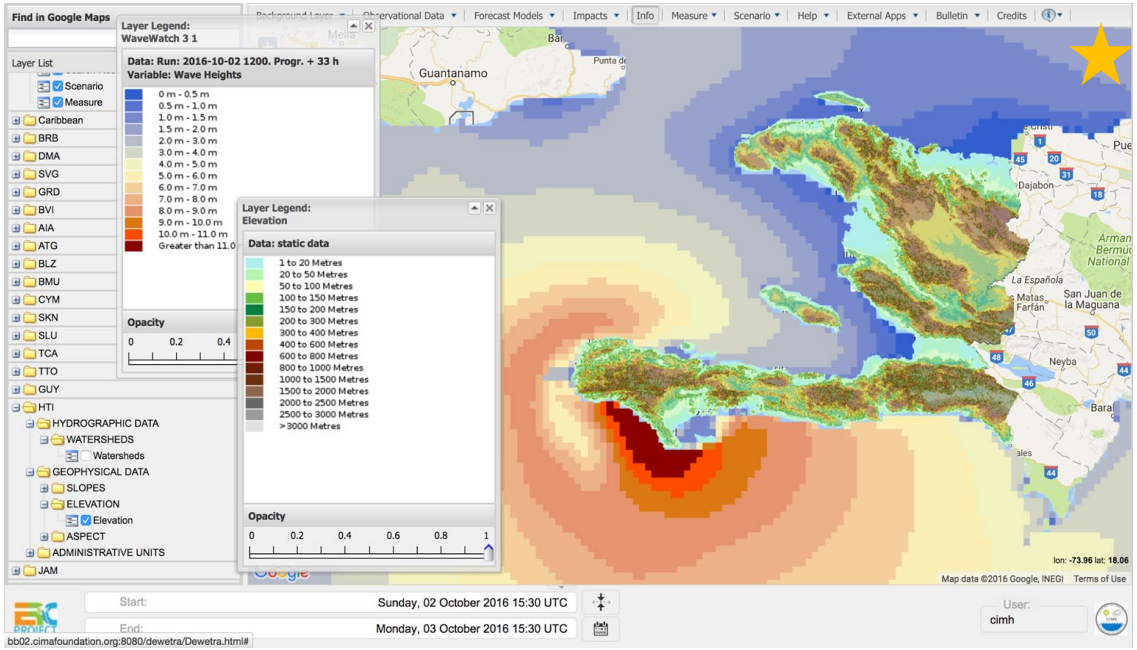
- Multi-hazard warning systems **(MHEWS)** are able to address multiple hazards and/or impacts of different type.
- Hazardous events may occur alone, **simultaneously**, **cascading** or **cumulatively** over time and space taking into account potential inter-related effects.
- **MHEWS, IBF & Forecast-Based Finance**

MHEWS Achievability requires (i) an advanced integrative framework, (ii) access to and development of new technologies and knowhow, (iii) development and nurturing of new skills and thinking, (iv) public, private and academic partnerships for innovation, entrepreneurship and finance and (v) **DATA ACCESS!!!**

Caribbean MHEWS Integration – Haiti Example



Rainfall prediction for Hurricane Matthew near Haiti [courtesy Caribbean Centre for Climate and Environmental Simulations (CCCES)]

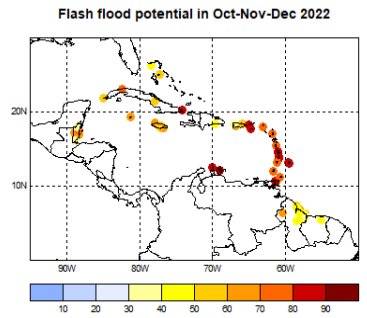


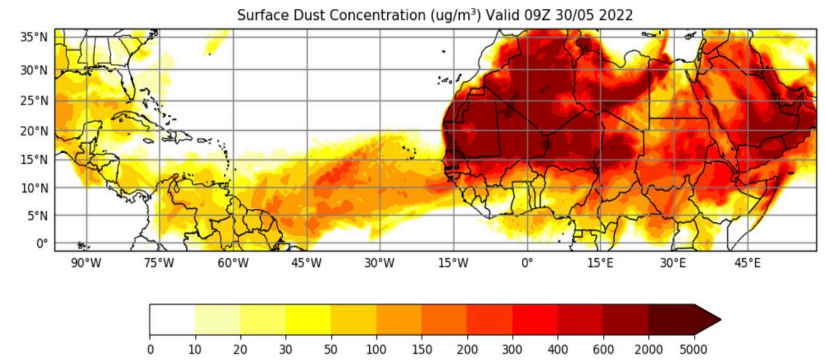
Significant wave height prediction for Hurricane Matthew near Haiti [courtesy Caribbean Centre for Climate and Environmental Simulations (CCCES)]

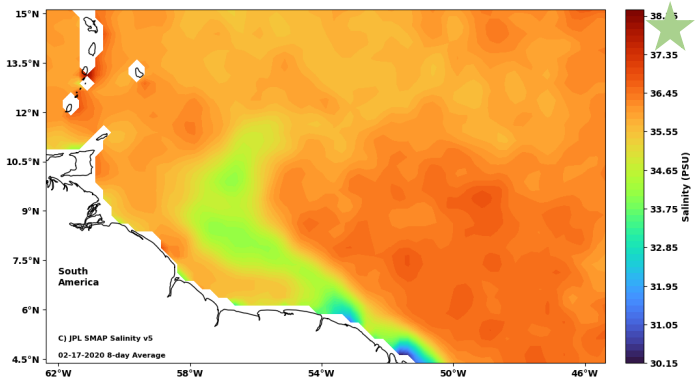
Prior to Hurricane Matthew impacting Haiti, the CIMH met with Eastern Caribbean Partner Development Group – Disaster Management to present its assessment of the likely impacts of the system on Haiti and options for accessing Haiti based on the scenarios assessed and presented. Access points through southern ports were considered low probability and risky.

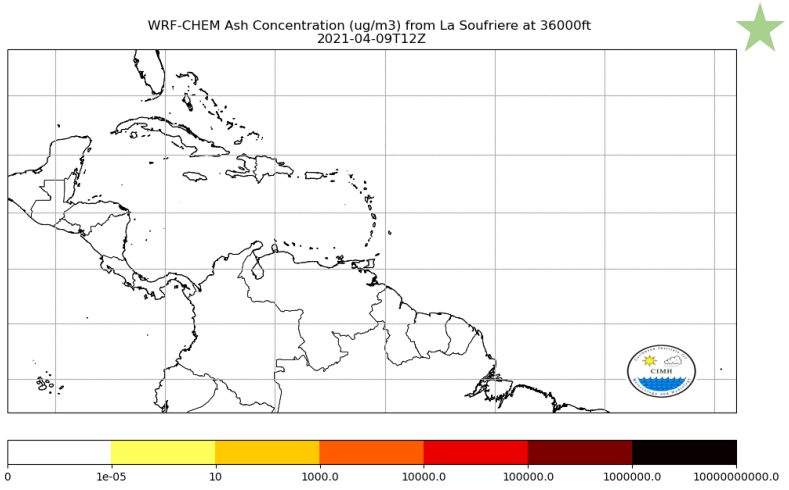
Regional Resilience & Prediction Systems

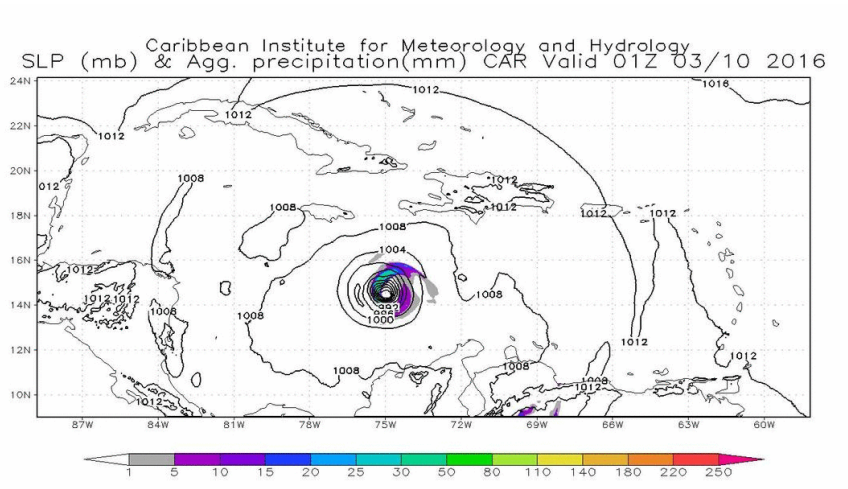
Flash flood potential	Colour codes	Chance of excessive rainfall event
EXTREMELY HIGH		>80%
HIGH		50-80%
MODERATE		20-50%
SLIGHT		10-20%
MARGINAL		0-10%

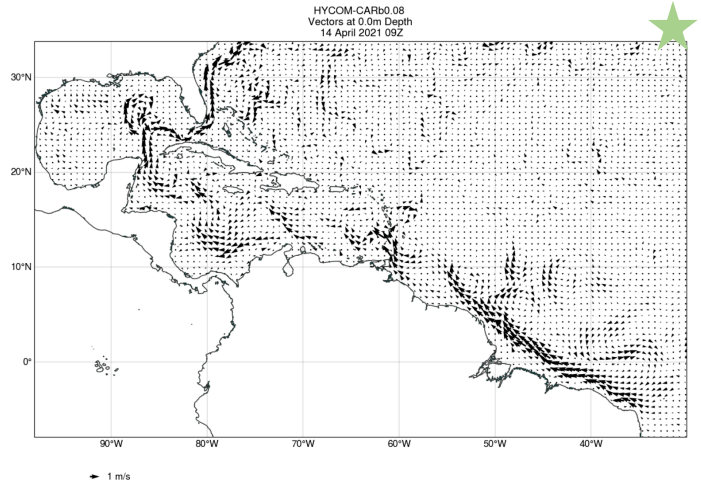






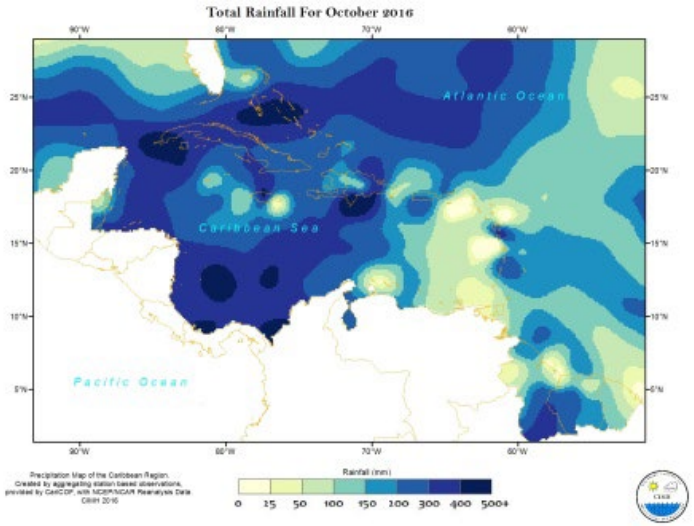


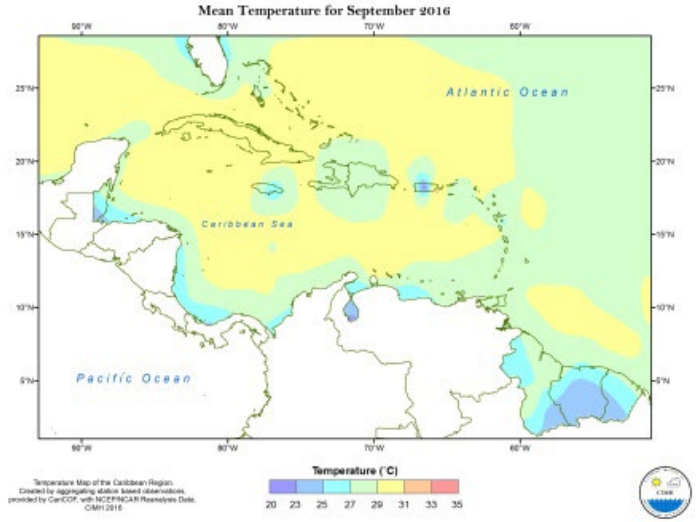


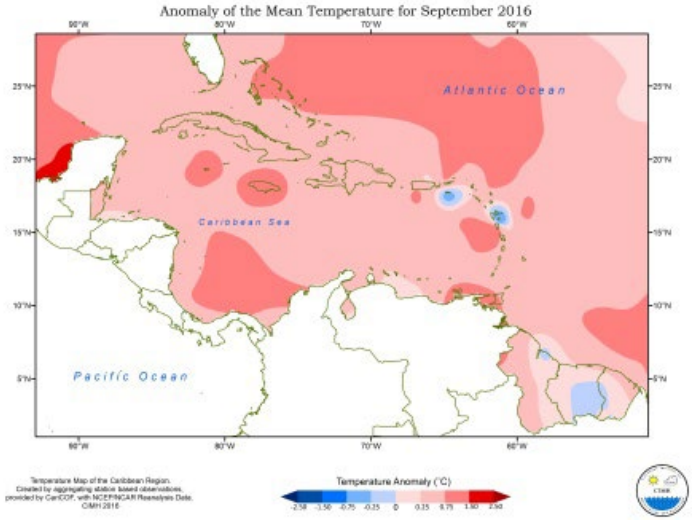


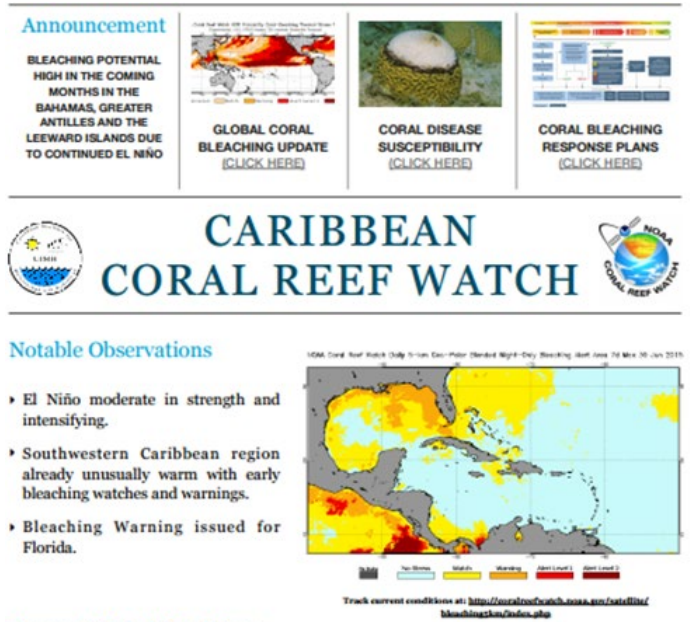
Building capacity to assess and understand weather, climate, water, marine and geological related hazards and impacts to risk inform governance and decision-making

Marine Supporting Products Offered by the Caribbean RCC

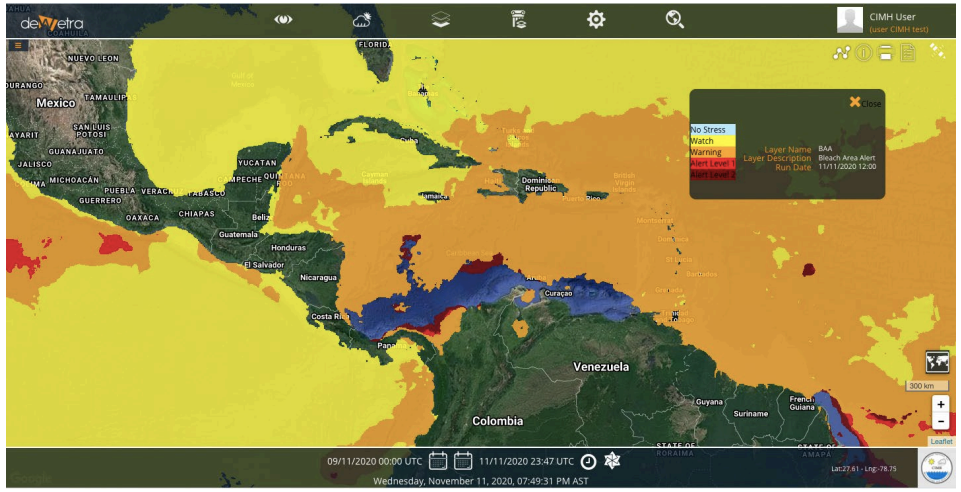




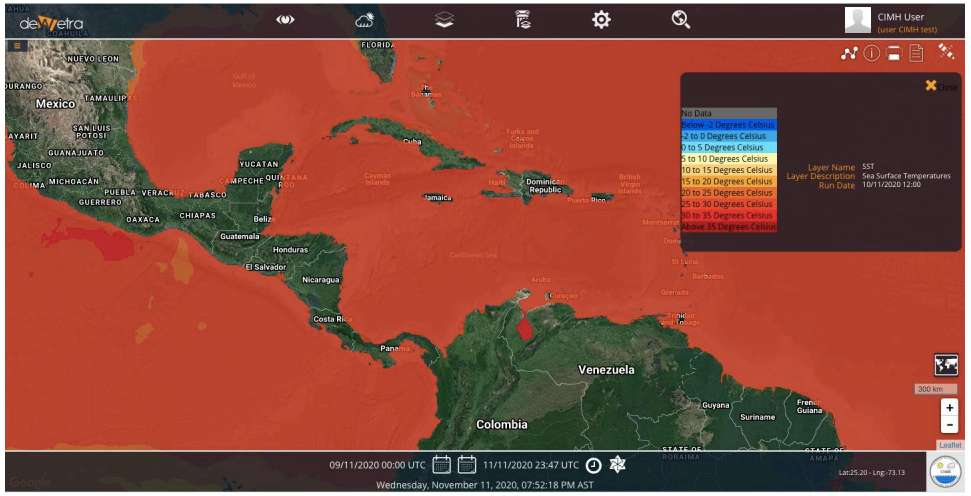




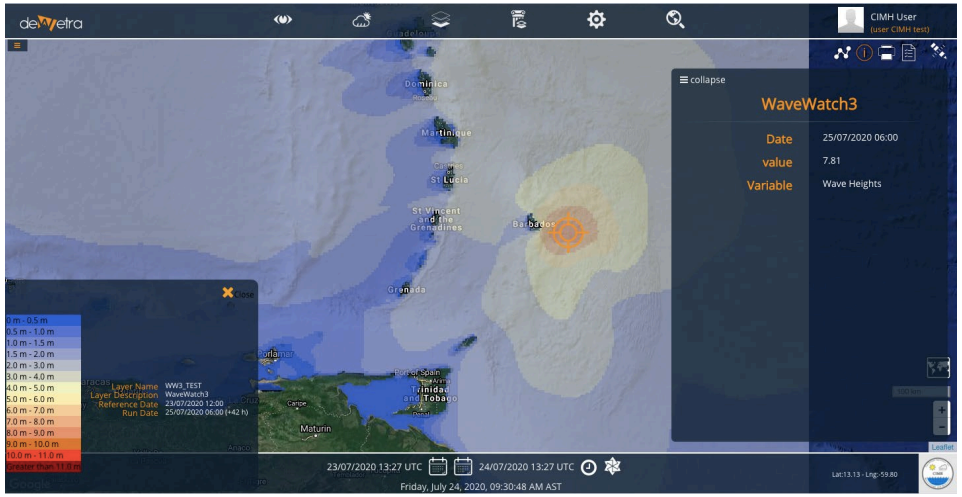
Marine Products in the Online Caribbean Dewetra Platform



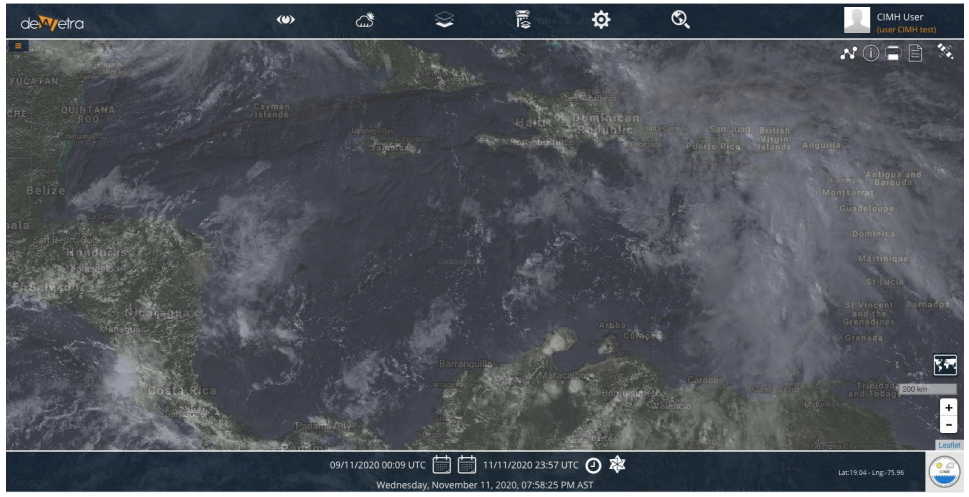
NOAA Bleach Area Alert



NOAA Sea Surface Temperatures

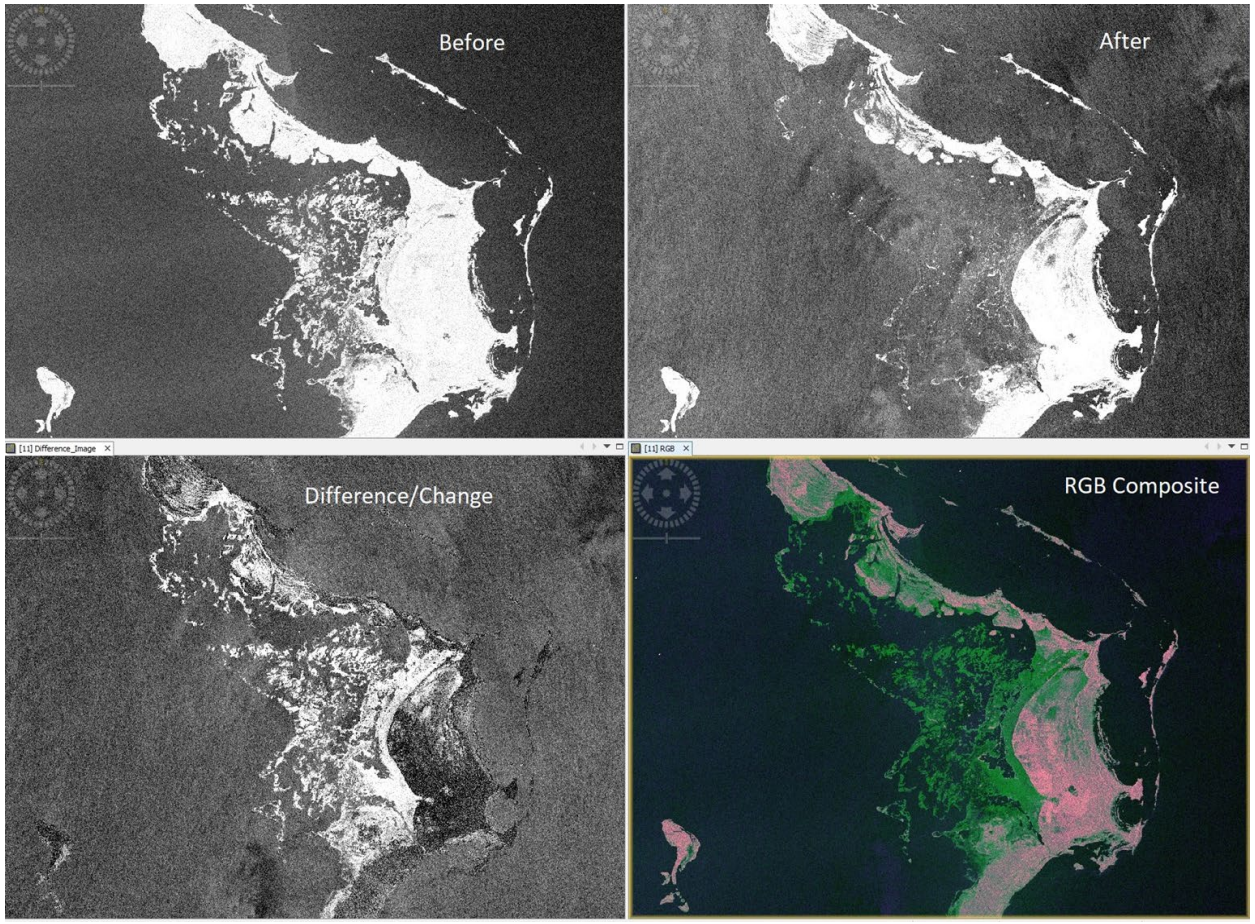


CIMH WaveWatch-3 Forecast

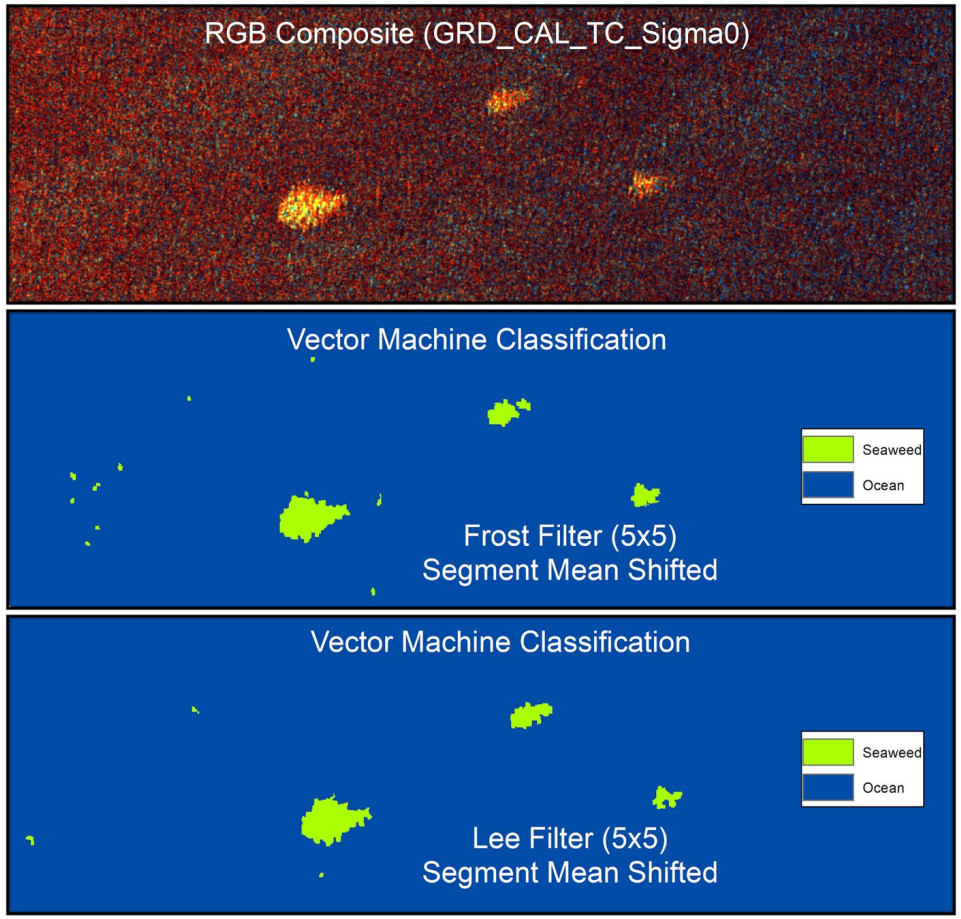


GOES-16 Satellite Imagery

SAR/InSAR Modeling Applications



Coastal inundation in the Bahamas following Hurricane Dorian (CIMH 2019)



Sargassum monitoring and detection (CIMH 2019)

Building Regional Marine Forecaster Competency

Marine Forecaster Training (Online) – November 9 – 27, 2020

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Week 1 – Marine Forecasting

	All times in Atlantic Standard Time (GMT-4)
Monday 9 November	
Introductions	09:00 to 10:00
The Circulation of the Oceans	10:30 to 11:30
Ocean Waves and Tides	13:00 to 15:30
Tuesday 10 November	
Marine Observations and observing platforms	09:00 to 11:30
Remote Marine Observation Tools	13:00 to 15:30
Wednesday 11 November	
Tropical Meteorology and Extra-tropical transition	09:00 to 11:30
Marine Cyclogenesis	13:00 to 15:30
Thursday 12 November	
Marine Forecast Tools	09:00 to 11:30
National Centers (NC) and NC Product Suites	13:00 to 15:30

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Week 2 Hydrodynamic modelling

Description	Times (GMT-4)
Monday 16th of November	
Introduction to BlueKenue	09h00-10h00
Creating/editing lines, points, polygons	10h15-11h15
Creating grids and regular meshes	11h30-12h30
Tuesday 17th of November	
Creating variable density meshes – Part 1	09h00-10h30
Creating variable density meshes – Part 2	10h45-12h15
Module 1 & 2 - Wrap-up, Questions, help	12h30-13h00
Wednesday 18th of November	
Numerical modelling study progression and good practice	09h00-10h15
Introduction to the TELEMAC system	10h30-11h15
Running a TELEMAC simulation and visualizing results	11h30-12h30
Thursday 19th of November	
Tidal processes and currents and TELEMAC-2D	09h00-10h30
Modifying TELEMAC simulations and analysing results	10h45-12h15
Module 3 & 4 - Wrap-up, Questions, help	12h30-13h00
Friday 20th of November	
TELEMAC applied to the Caribbean	09h00-10h30
TELEMAC and forecasting	10h45-12h15

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Week 3 Wave modelling

- **Definitions and conventions**
  - Wave spectra
  - Integrated parameters
- **Generation of waves:**
  - Wind waves
  - Swell waves
  - Bimodal seas
- **Physical processes**
- **Introduction to SWAN**
  - Underlying principles
  - SWAN model grids
  - Boundary conditions
  - Wind input
- **SWAN representation of physical processes**
- **Setting up a SWAN model**
  - SWAN bathymetry
  - Model settings
  - Forcing options
- **Stationary and non-stationary modes**
- **Nested grids**
- **SWAN nesting within WW3**
- **The Caribbean wave climate**
  - Application of SWAN in the Caribbean
- **Application of SWAN for operational forecasting**

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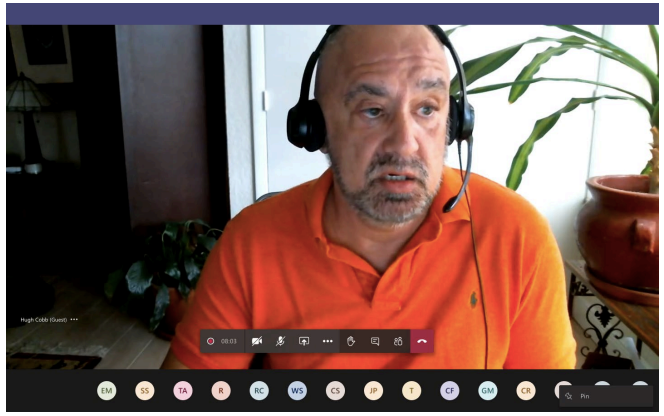
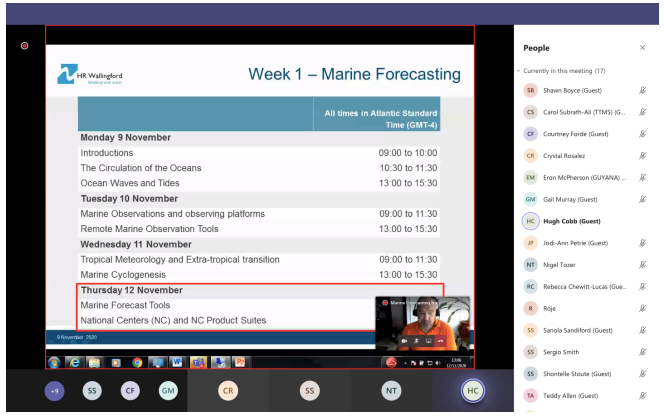
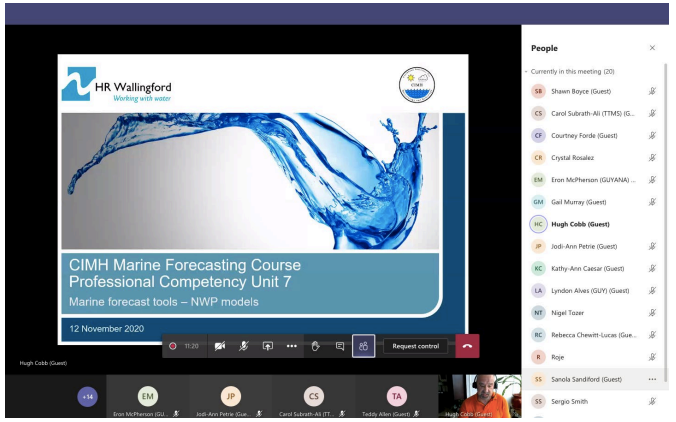
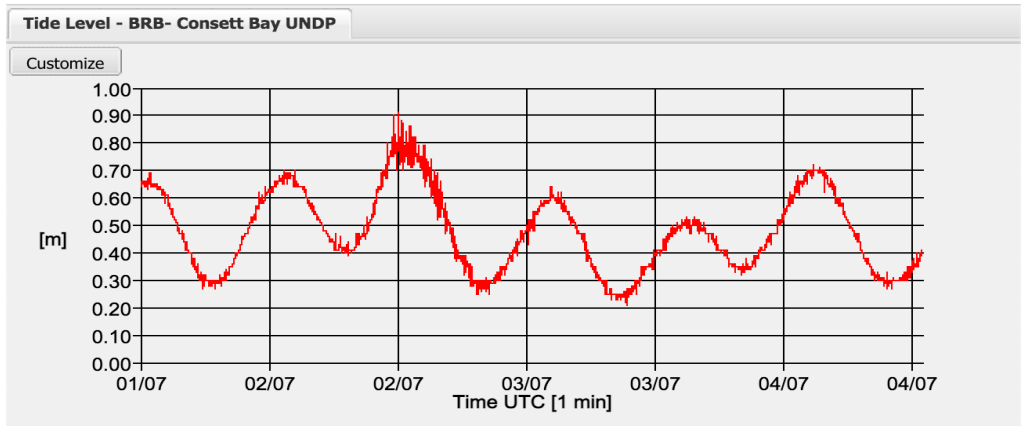




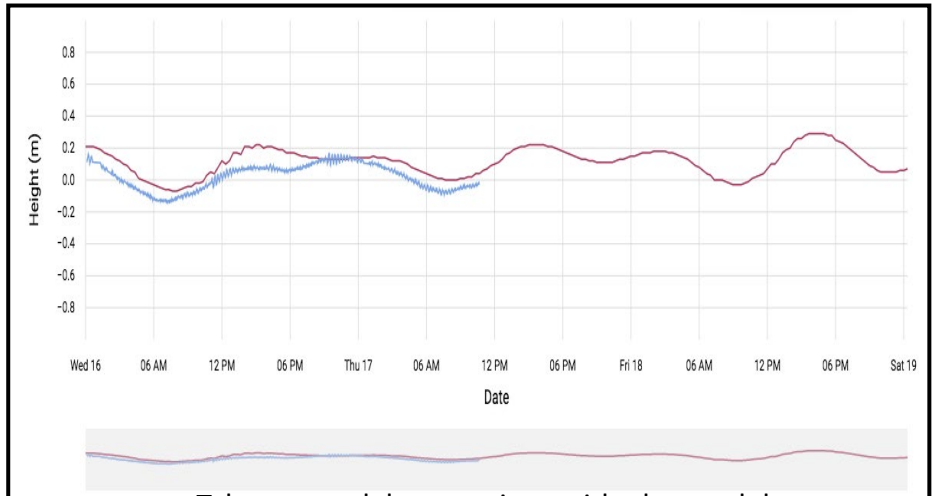


Strong focus on building regional marine modeling skill in Telemac and Swan

Improving Caribbean Marine Ocean Governance: Observations to Support Science, Forecasting, Innovation, Decision-making & Policy

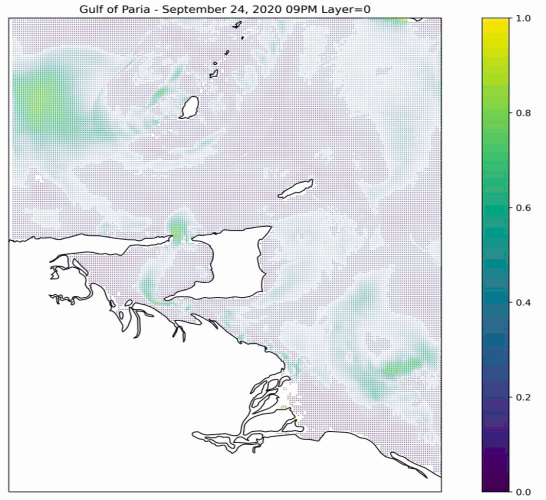


CIMH sea level station at Conset Bay, Barbados



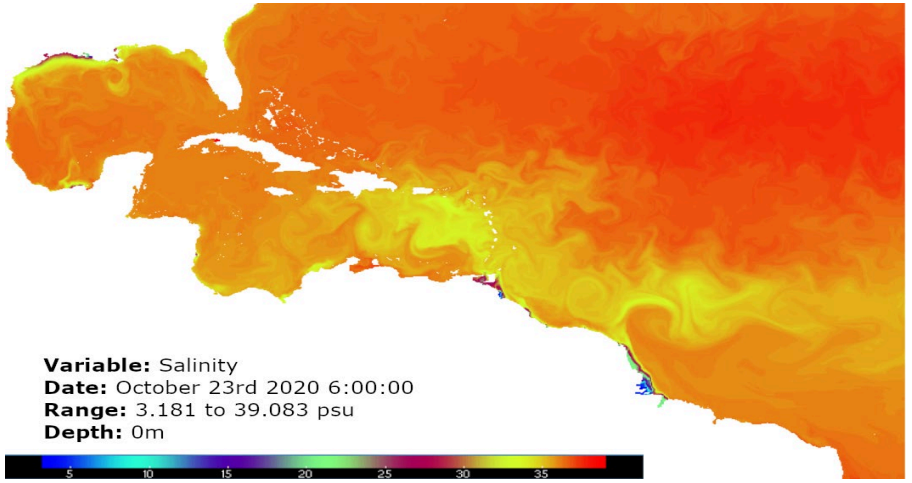
Telemac model comparison with observed data (Ganter's Bay, Saint Lucia

CREWS Station, South Water Caye, Belize



High-resolution fate and transport modeling

CIMH HYCOM Regional Simulation Platform



Improving Caribbean Marine Ocean Governance: Building Regional Research and Development Capacity – EUREC4A-ATOMIC-OA

Research Vessels

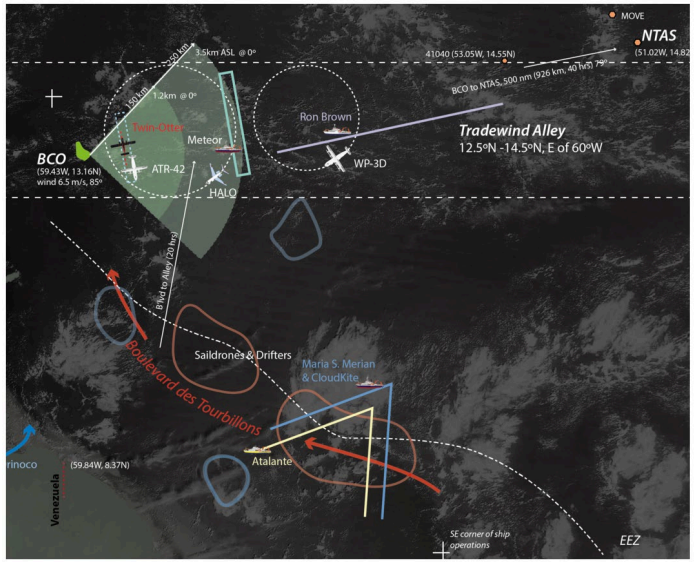
Atalante (A, FR) | Maria S Merian (MSM, DE) | Meteor (M, DE) | Ron Brown (RB, USA)

+ Barbados Defense Force ?

Atmospheric Profiling
- UAS, Cloud-Kite or Quad Copters (M, MS
- W-band cloud radar (M, MSM, RB)
- Raman Lidear (M, MSM)
- Radio Sondes (A, M, MSM, RB)
- Microwave Radiometer (M, MSM, RB)
- Sun photometer (A, M, MSM)
- Wind lidar (M, RB)

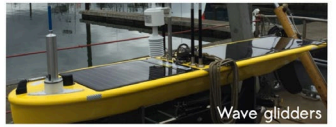
Ocean Profiling
- Standard Ocn., incl. CTDs (A, M, MSM, RB)
- Gliders (A, M, MSM, RB) & Drifters (M, MSM, RB)
- Biology (Nitrogen Fixation, Amonia Oxidation M, MSM)
- ADCP (MSM,
- Multibeam Echo Sounder (MSM)
- Moving vessel profiler — towed buoy (MSM)
- Microstructure sonde (MSM)
- X-band WaveRadar (MSM)
- Upper ocean pCO2 (MSM)

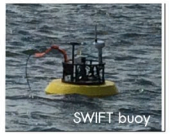
Near surface air measurements
- Standard Met (A, M, MSM, RB)
- Enthalpy and momentum eddy co-variance (M & RB)
- Isotopic Measurements (A, M, & RB)
- CO_2 fluxes (MSM)
- Disdrometer (M, MSM)
- Broadband SW & IR (M, MSM), Hyperspectral IR (RB)
- Aerosol (M, RB)

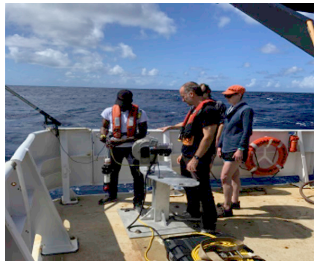


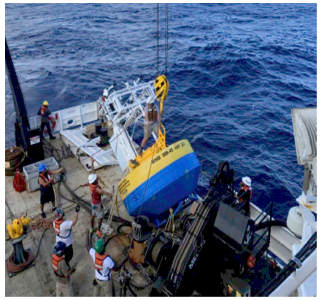
A blooming of autonomous observing systems

DJI Mavic Pro







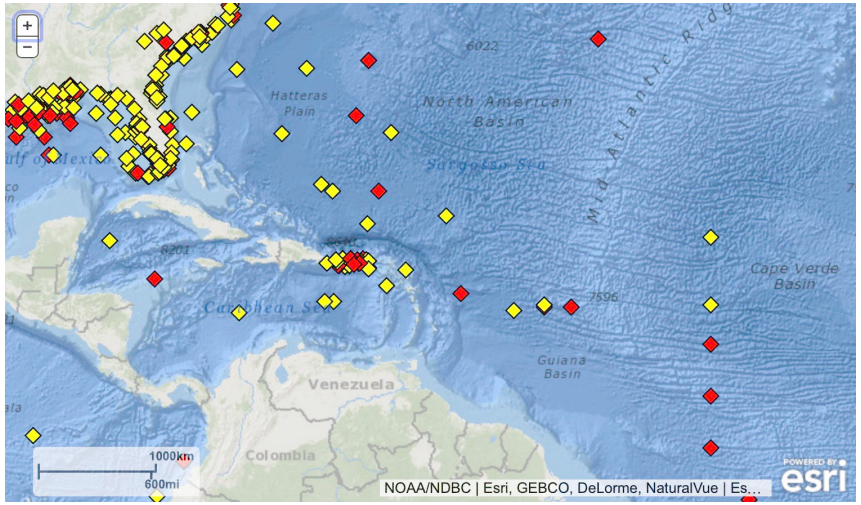


Improving Caribbean Marine Ocean Governance: Data, Science & Innovation

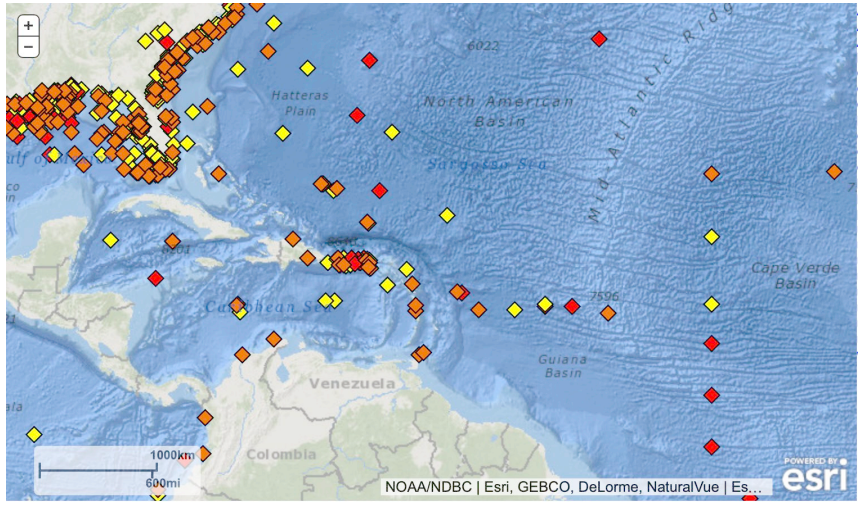
- There is a strong regional need to improve marine ocean observation and prediction systems (meteorological, oceanography and quality/chemistry) to improve management, decision-making and governance by:
  - **<u>Significantly increasing in the number of *in-situ* observation and monitoring platforms required [deep sea and coastal buoys, coastal sea level stations, measurement of physical and chemical parameters];</u>**
  - Capacity building activities in national and regional institutions;
  - Cooperation, coordination and coherence of strategies and activities among partners;
  - Enhancing prediction and forecasting platforms across weather and climate time scales;

Partnerships

- **Caricom Institutions**
  - CIMH, CMO HQ, CDEMA, CCCCC, CFRM, UWI, OECS Commission and NMHSs among others.
- **Development Partners**
  - CDB, IDB, WB, CCRIF, USDAID, NOAA, UN, EU, Environment and Climate Change Canada



Recent Data: July 29, 2021



Historical Data

- Stations with recent data
- Stations with historical data only
- Stations with no data in last 8 hours (24 hours for tsunami stations)
- Tsunami station in event mode (within previous 24 hours)

Source: https://www.ndbc.noaa.gov/obs.shtml

Enhancing Regional Marine Observations

- During the next two years starting in 2023, the CIMH will be working the regional development partners to enhance the number of near-shore continuous marine observations across the region:
  - The current plan is to procure approximately 48 buoys to be installed around in the waters of Member States of Caribbean Meteorological Organization:
    - Buoys are to be jointly maintained by the CIMH and the Member States;
    - Data will be provided free of charge to governments and the academic community;
    - CIMH will develop products and services from the data collected;
    - Data collected will be used to enhance local and regional marine models.

  - Enhance coastal monitoring through the deployment of additional sea-level monitoring stations (increase the number of Conset Bay types stations across the Caribbean):
    - Accurate, low cost and easy to maintain;
    - Low cost data transmission.

Thank You