Harnessing Ocean Data for Coastal Resilience and Blue Economies

Moderator

Shaily Gandhi

Speakers

Steve Diggs

Alberto Azevedo

Pier Luigi Buttigieg

Bapon Fakhruddin

3rd October 2025 (09:00 – 10:00 CEST)

Ocean Data

Stewardship for Ocean Resilience

Steve Diggs: UCOP/CDL/UC3

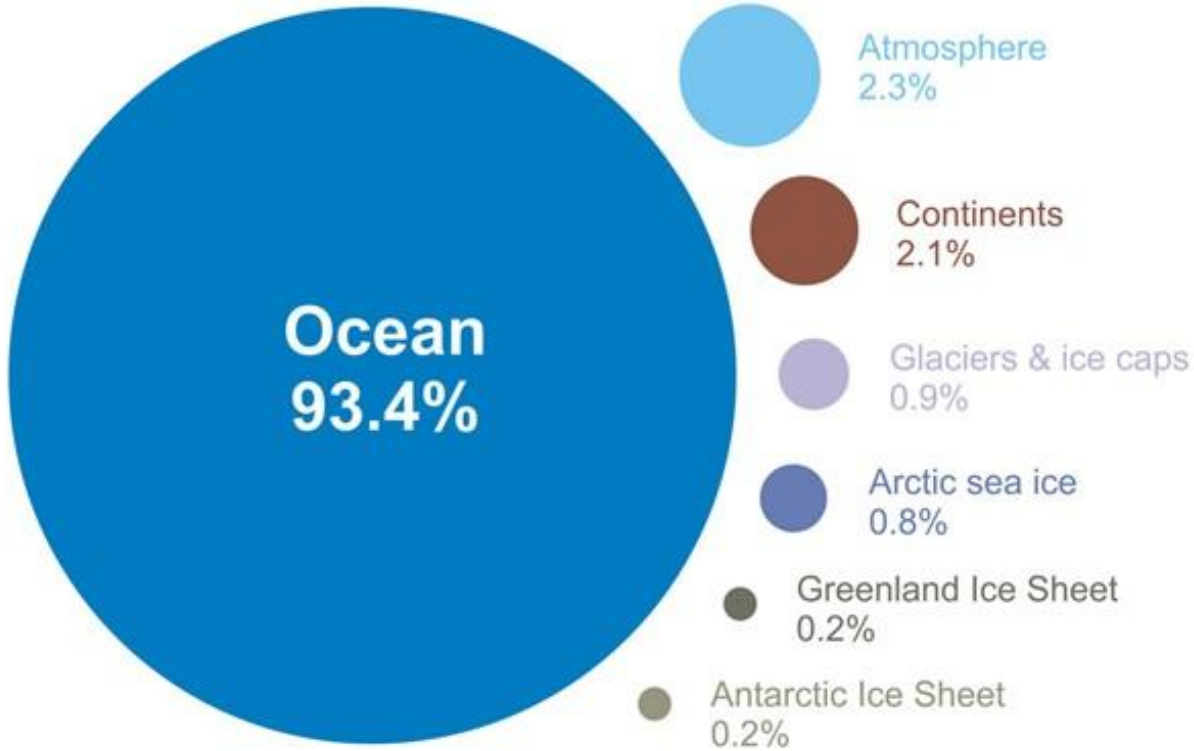
Harnessing Ocean Data for Coastal Resilience and Blue Economies

2025-08-13


1.332 x 10^21 Liters of Water
~352 Quintillion Gallons

Oceans are the “Flywheel of Climate”

Where is global warming going?



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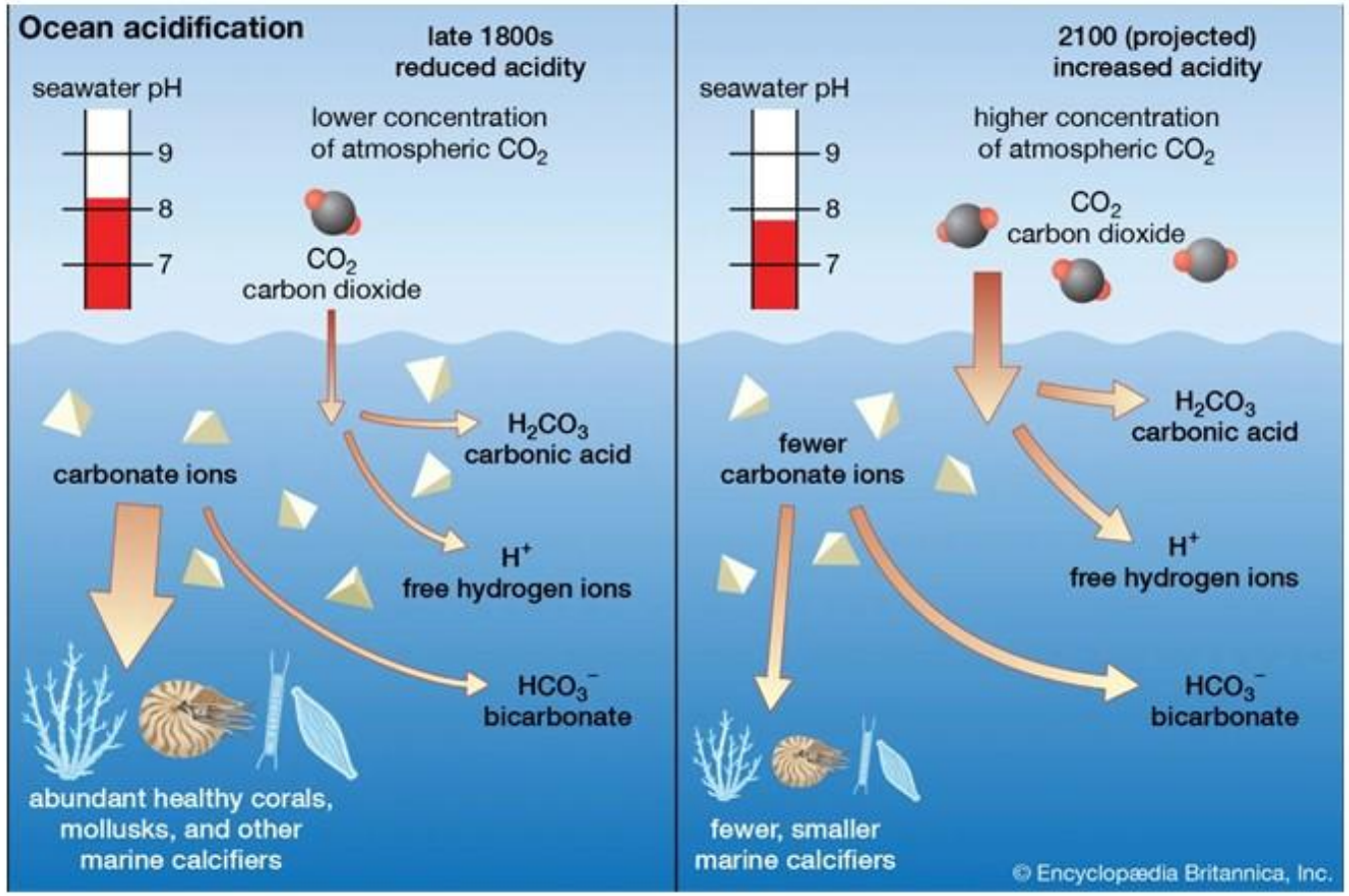
S. Levitus, J. I. Antonov, T. P. Boyer,O. K. Baranova,H. E. Garcia,R. A. Locarnini,A. V. Mishonov,J. R. Reagan,D. Seidov,E. S. Yarosh, and M. M. Zweng | published 17 May 2012

Ocean Acidification



- Approximately 28% of the CO_2 generated by human activities since the mid-1700s has been absorbed by the oceans.
- Current rate of acidification is nearly 10x faster than any period over the past 50 million years.

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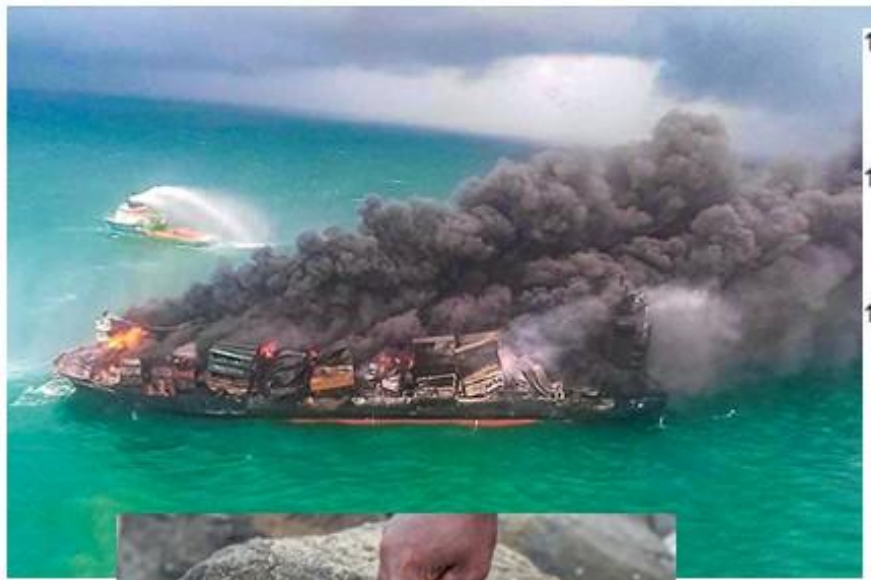
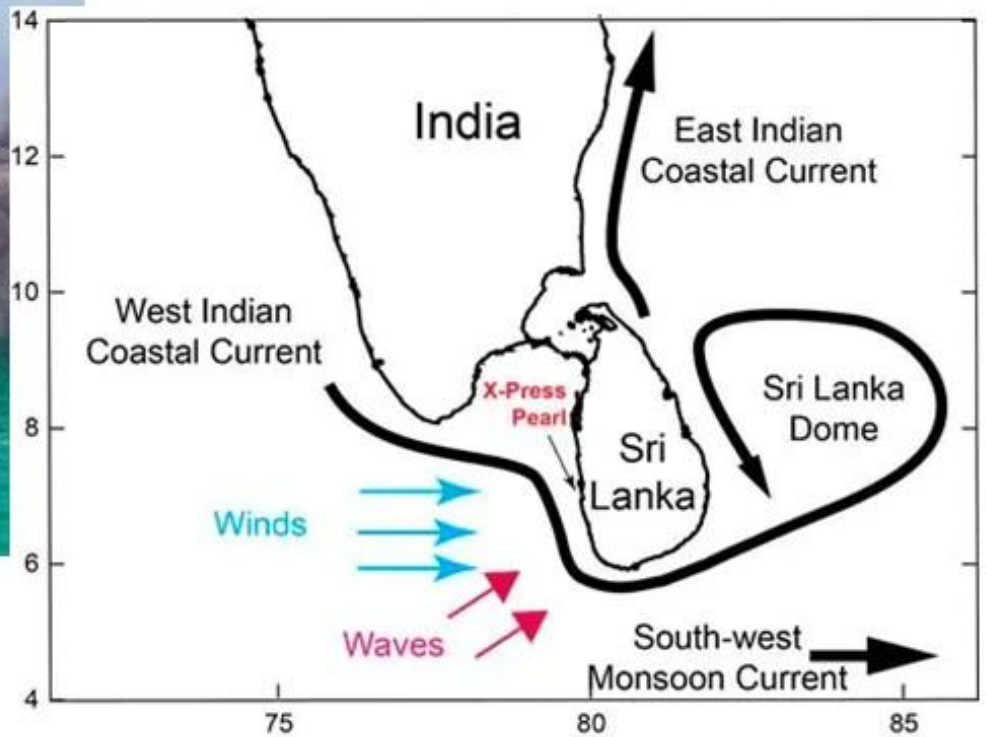
Environmental Remediation

May 2021: The ship Xpress Pearl *caught fire off Colombo and eventually sank, leaking its cargo that contained 25 metric tons of nitric acid and some 50 billion plastic pellets.*





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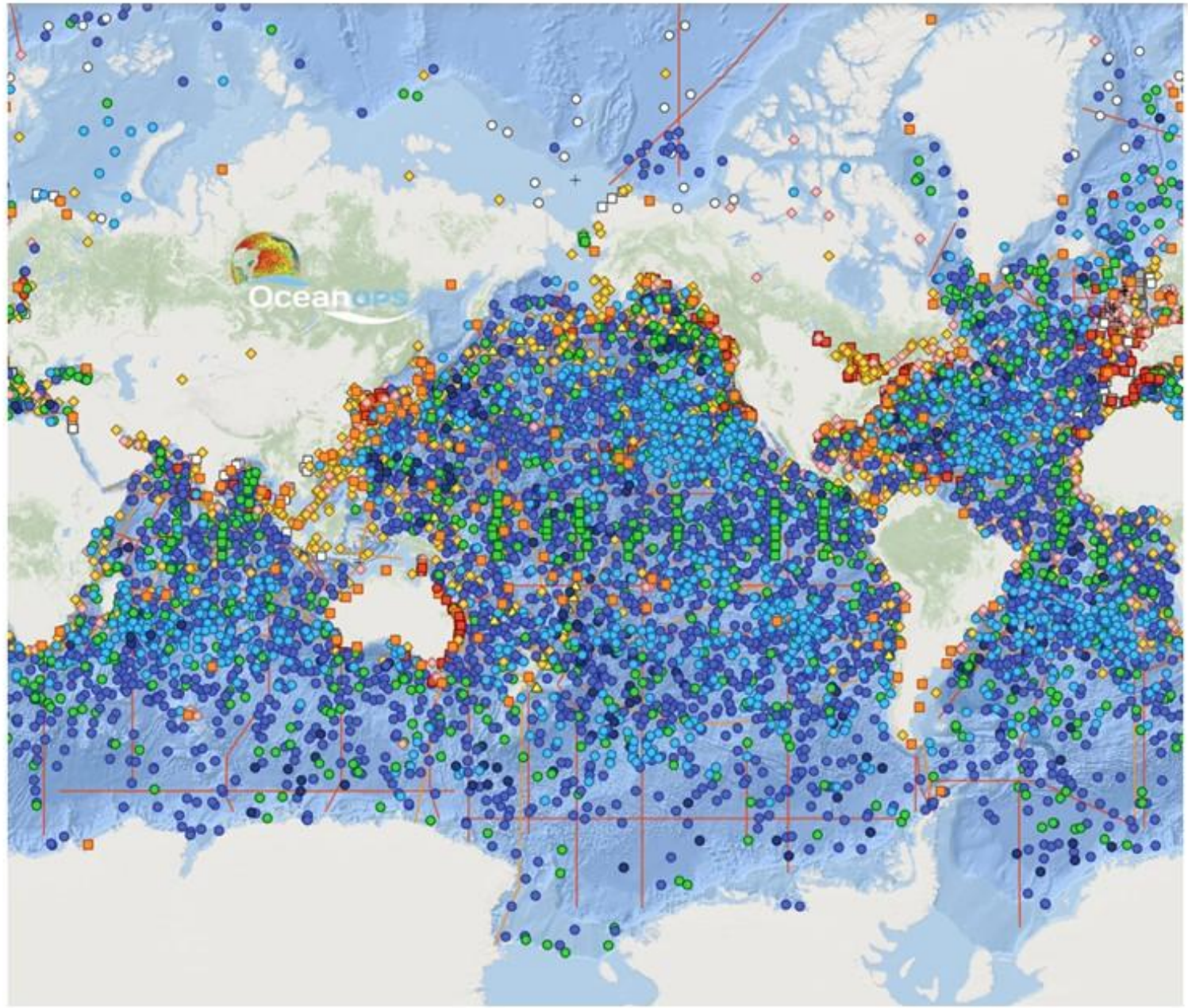
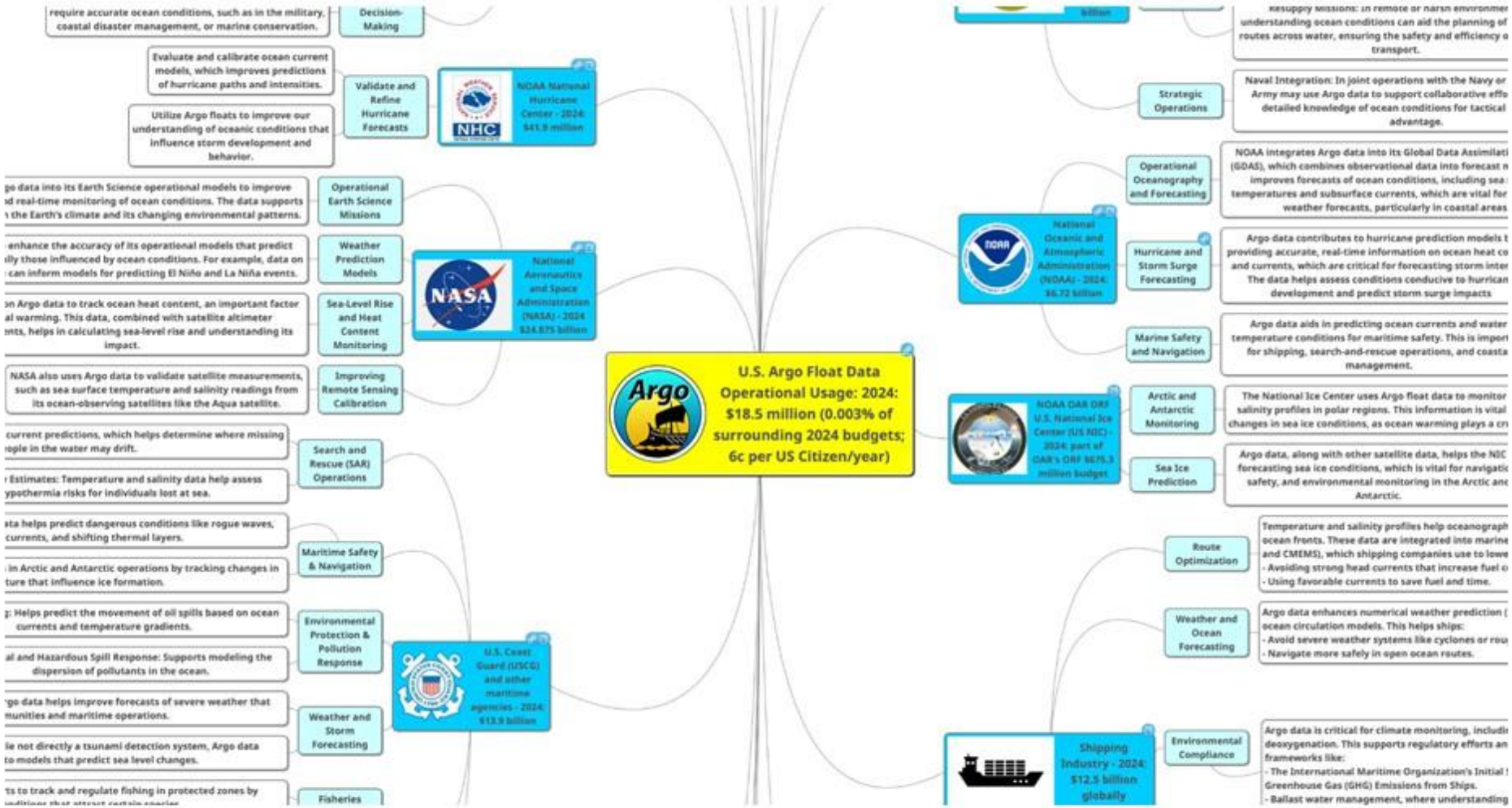
Each Measurement Has Value



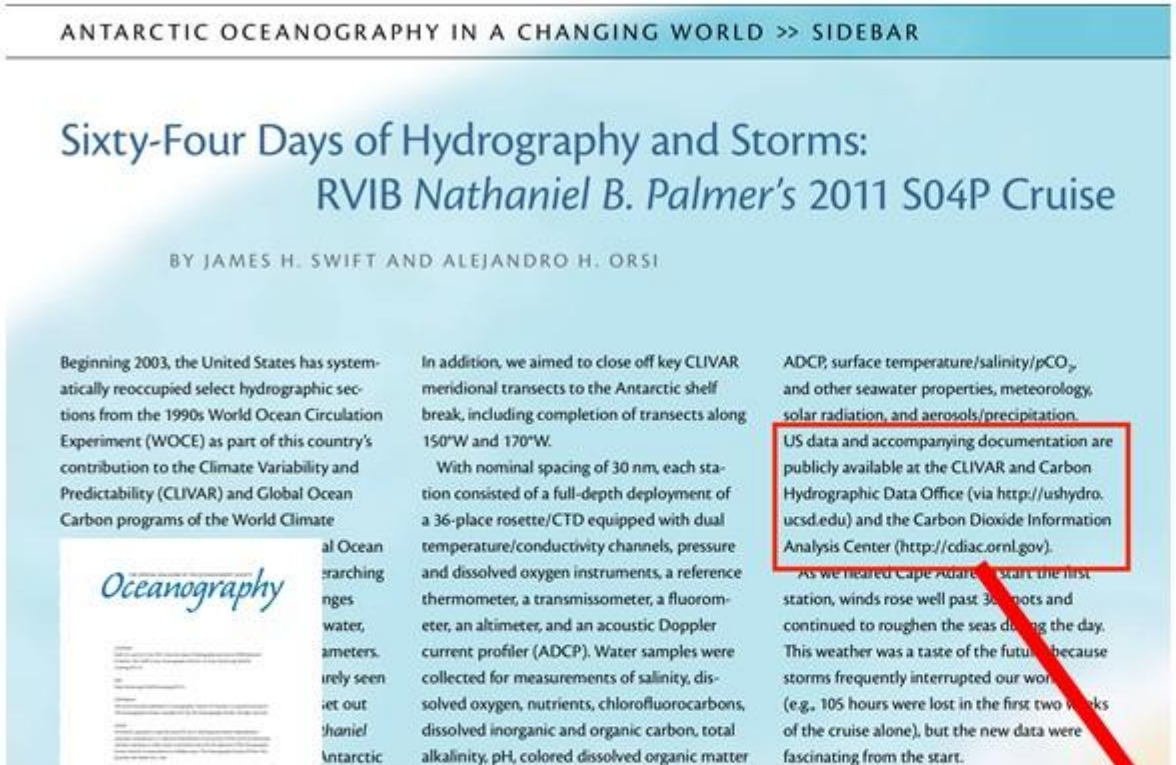
The 20th century was the century of under sampling the ocean.

-Walter Munk

Argo Floats: One Platform, Many Uses



The Best Intentions are not enough …



ANTARCTIC OCEANOGRAPHY IN A CHANGING WORLD >> SIDEBAR

Sixty-Four Days of Hydrography and Storms: RVIB *Nathaniel B. Palmer's* 2011 S04P Cruise

BY JAMES H. SWIFT AND ALEJANDRO H. ORSI

Beginning 2003, the United States has systematically reoccupied select hydrographic sections from the 1990s World Ocean Circulation Experiment (WOCE) as part of this country's contribution to the Climate Variability and Predictability (CLIVAR) and Global Ocean Carbon programs of the World Climate

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In addition, we aimed to close off key CLIVAR meridional transects to the Antarctic shelf break, including completion of transects along 150°W and 170°W.

With nominal spacing of 30 nm, each station consisted of a full-depth deployment of a 36-place rosette/CTD equipped with dual temperature/conductivity channels, pressure and dissolved oxygen instruments, a reference thermometer, a transmissometer, a fluorometer, an altimeter, and an acoustic Doppler current profiler (ADCP). Water samples were collected for measurements of salinity, dissolved oxygen, nutrients, chlorofluorocarbons, dissolved inorganic and organic carbon, total alkalinity, pH, colored dissolved organic matter

ADCP, surface temperature/salinity/pCO_2, and other seawater properties, meteorology, solar radiation, and aerosols/precipitation. US data and accompanying documentation are publicly available at the CLIVAR and Carbon Hydrographic Data Office (via http://ushydro.ucsd.edu) and the Carbon Dioxide Information Analysis Center (http://cdiac.ornl.gov).

As we neared Cape Adare to start the first station, winds rose well past 30 knots and continued to roughen the seas during the day. This weather was a taste of the future because storms frequently interrupted our work (e.g., 105 hours were lost in the first two weeks of the cruise alone), but the new data were fascinating from the start.

ADCP, surface temperature/salinity/pCO_2, and other seawater properties, meteorology, solar radiation, and aerosols/precipitation. US data and accompanying documentation are publicly available at the CLIVAR and Carbon Hydrographic Data Office (via http://ushydro.ucsd.edu) and the Carbon Dioxide Information Analysis Center (http://cdiac.ornl.gov).

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True Data Resilience

THIS IS A DIGITAL FOSSIL

Simple data copying

THIS IS A LIVING ORGANISM / ARCHIVE

Full curation and synchronized mirroring

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STUDYING THE OCEANS

Helped end the Cold War ✓

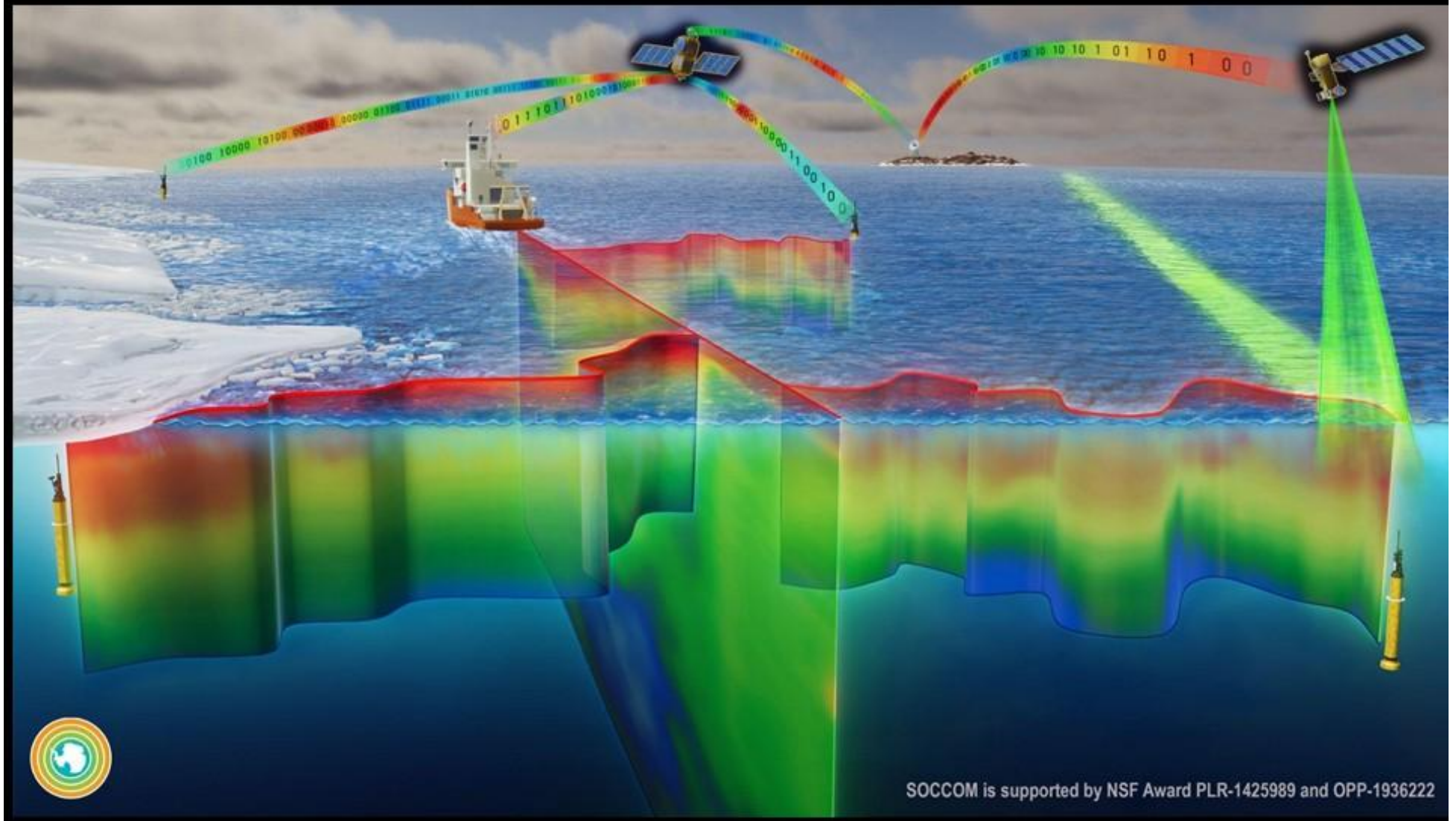
Keeps us fed & healthy ✓

Unlocks sources of energy ✓

Is key to forecasting weather ✓

Tells us about the origins of life ✓

Improves our quality of life ✓


SOCCOM is supported by NSF Award PLR-1425989 and OPP-1936222

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LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

Harnessing Ocean Data for Coastal Resilience and Blue Economies

Applied Innovation: OPENHIDRA — Forecasting & Remote Sensing Tools

Alberto Azevedo - aazevedo@lnec.pt

Funded by the European Union

03 | 10 | 2025 by Alberto Azevedo

Project: 101188248 – HORIZON-INFRA-2024-EOSC-01

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OPENHIDRA

IPMA Instituto Português do Mar e da Atmosfera

RÉPUBLIQUE FRANÇAISE

METEO FRANCE

METEOGALICIA

National Centers for Environmental Information
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

ECMWF

EMODnet European Marine Observation and Data Network

Copernicus Marine Service

Copernicus sentinel

WORSICA

Wave buoys

Gyroscopes

Oceanographic Data: water levels and waves (csv and NetCDF)

Atmospheric Data: atmospheric parameters (winds, pressure, precipitation) (NetCDF)

Oceanographic and Atmospheric Data: waves, winds, pressure (grib)

Oceanographic Data: waves (txt/csv)

Wave overtopping Data (wmv, mpeg4, etc)

6 DoF ship motions (csv)

Oceanographic Data: water levels, salinity, temperature and waves (csv and NetCDF)

Oceanographic Data: Satellite images (GeoTiff)

Output Data: water levels, velocity, topobathymetry (csv, NetCDF and GeoTIFF)

OSOM

Water Masks and Topo-bathymetry *retrieved from satellite images (GeoTiFF, shp)*

Output data for other added-value services: time series (csv) and spatial data (NetCDF)

Output data for other added-value services: time series (csv, txt), risk levels (txt) and spatial data (grd)

Diagnosis of current, evolution, and risk conditions of maritime structures *(pdf report)*

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OPENCoastS

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A service for empowering users to build coastal forecasts

Make the implementation of coastal forecasts fast and easy:

- build forecast systems for a location chosen by the user, using a browser-based
- user-friendly, interface

Make the service flexible in its configuration:

- forcings, processes and model parameters

Applicable to all circulation (tides, surge, wind, waves, wave and current interactions, baroclinic flows and all combinations) **and water quality processes** (fecal contamination, generic tracer, includes sediment-related processes)

Flexible IT architecture that can grow to additional processes/models/processing tools

Uses the EOSC infrastructure and core-services to access computational resources

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OPENCoastS

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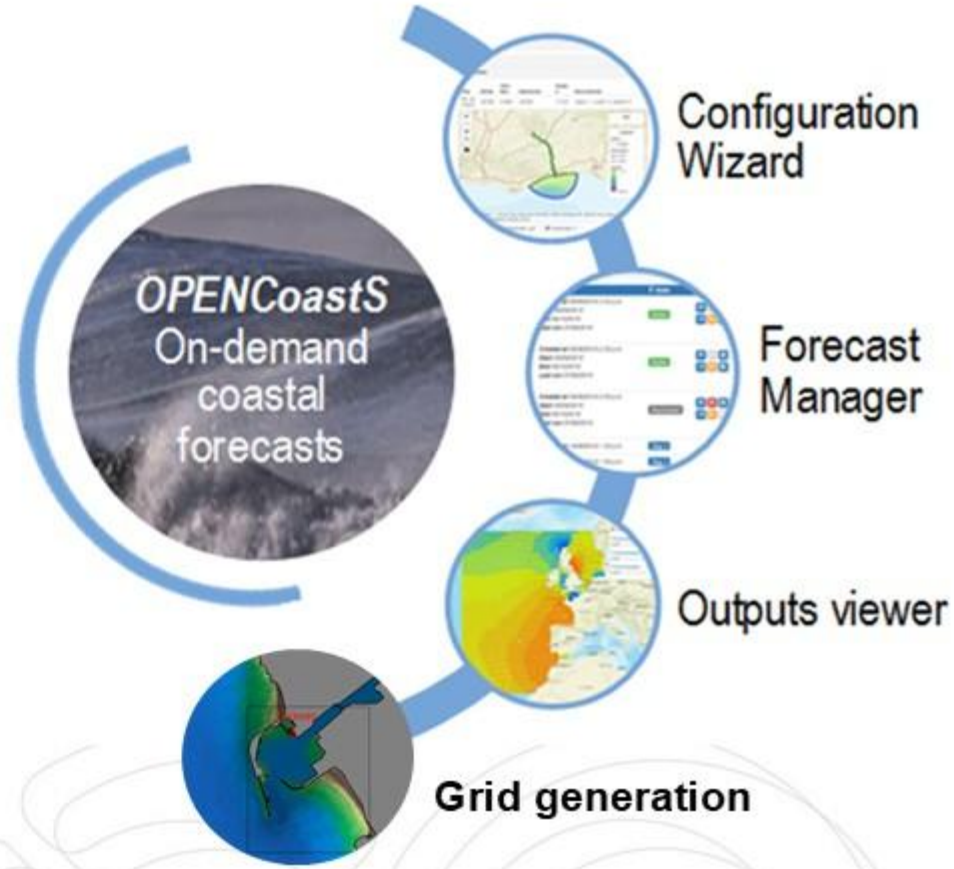
- **Daily forecasts** of water levels, wave parameters, 2D and 3D velocities, and 3D salinities, temperatures and water quality variables
- Numerical simulations of all relevant physical and biogeochemical processes using **the modeling suite SCHISM**, with **unstructured triangular grids** for adequate cross-scale representation/land interactions
- Multiple **forcings**:
  - Atmosphere: NOAA, MeteoFrance, MeteoGalicia
  - Ocean: FES2014, CMEMs
  - Rivers: climatology, tailored forecasts (url)
- Automatic comparison with data from EMODNet
- Comparison with land/water interface from processed Sentinel 2 images (embedded **WORSICA** remote sensing service)

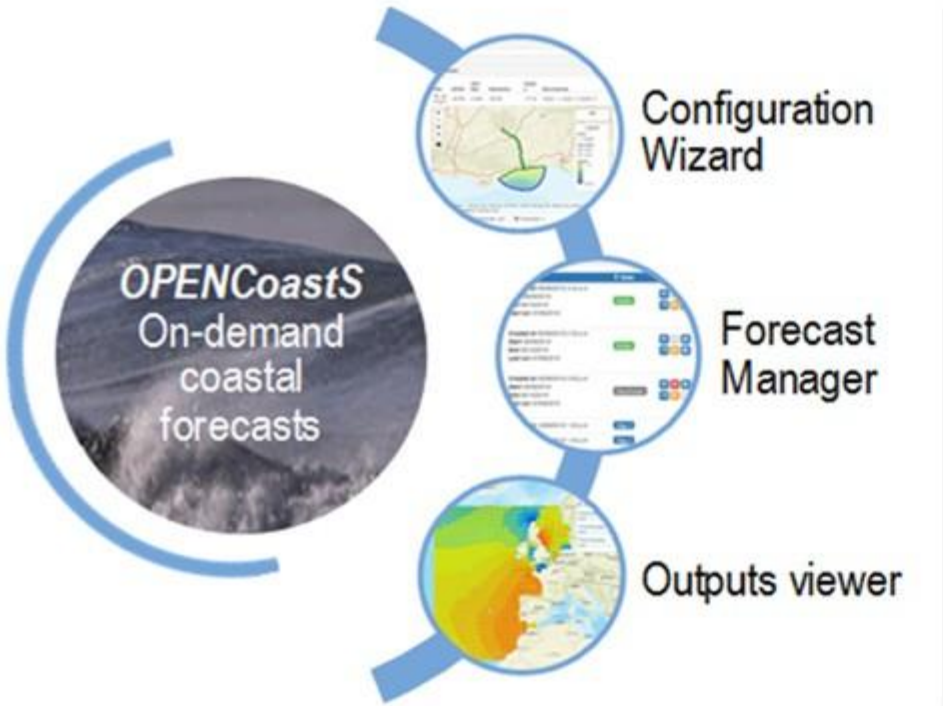


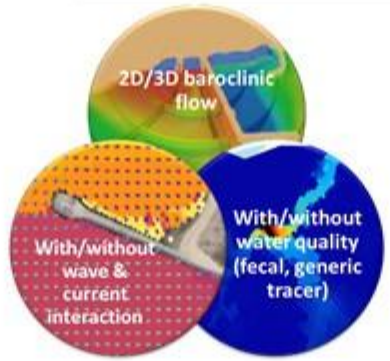
WORSICA

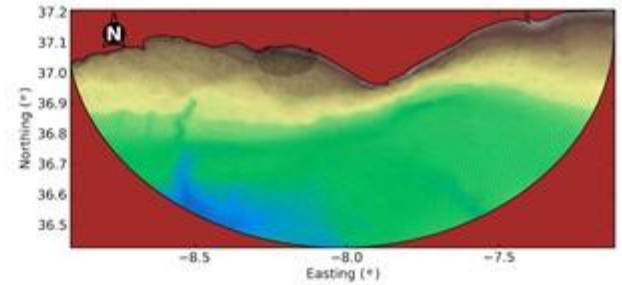
OPENCoastS

Configuration Concept

- One-stop-shop for all forecast activities
- User-selected options on every step







EMODnet
European Marine Observation and Data Network

meteogalicia

FES2014 TIDE

SCHISM

METEO FRANCE

GFS
Global Forecast System

Copernicus Marine Service

WAVEWATCH III

LNEC LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

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OPENCoastS

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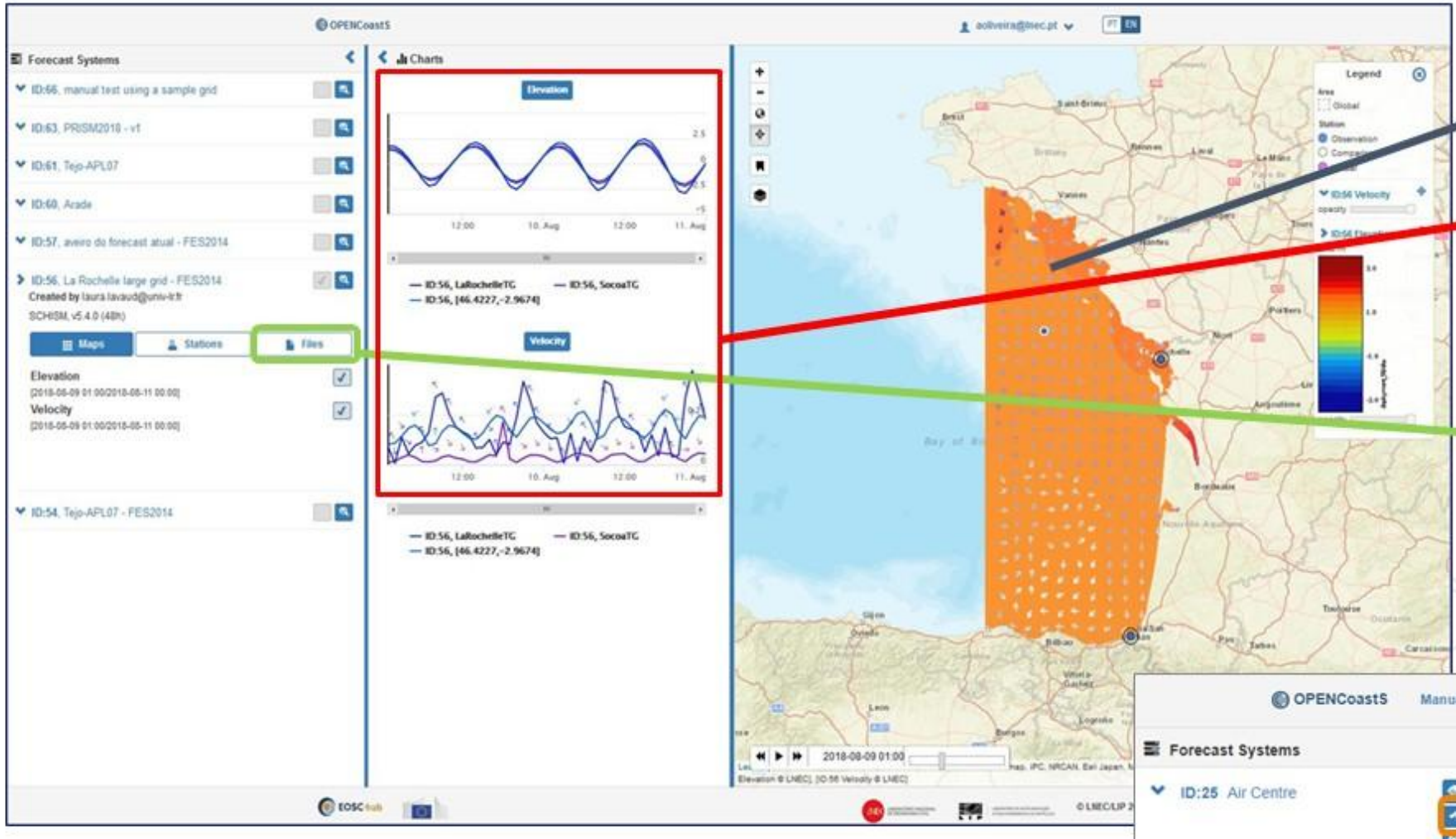
Outputs viewer



- Hydrodynamic and water quality maps
- Time series (pre-defined stations or stations defined on-the-fly)
- Download inputs e outputs
- View remote sensing water limits on top of predictions

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Copernicus Marine Service

Overview application/product

Forecast data from ECMWF and Copernicus

Data from wave buoys

Video cameras

R&D Expertise in ports and coastal areas

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Scientists and technical expertise

In-house applications

Freeware models

In-house models

72 h

Forecast updated daily

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Local forecasted general parameters

Tide Level

Waves

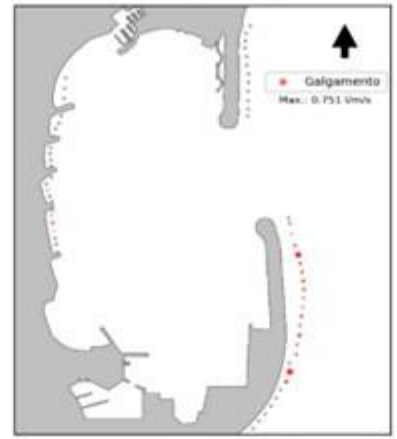
Wind

Currents

Specific effects parameters

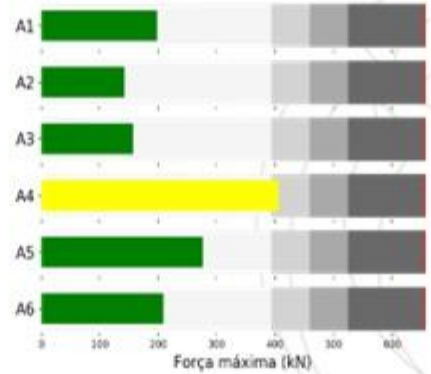
Neural Network & Process based models

Overtopping Volumes



In-house Numerical models

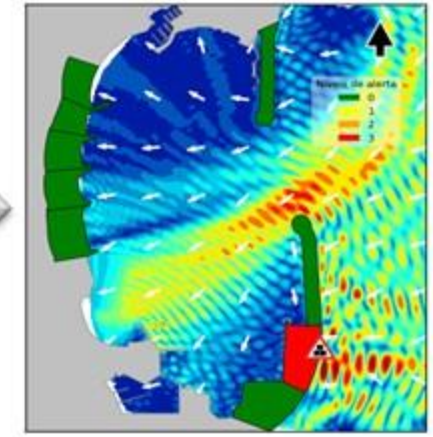
Moored Ships Movements & Forces



Alert

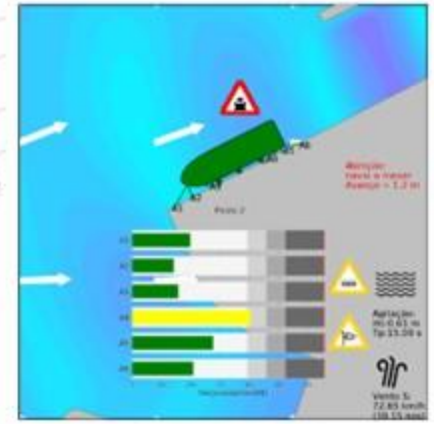
Safety Thresholds

Overtopping Alert



Port Safety & Operational Limits

Moored ships Alert



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Early Warning System

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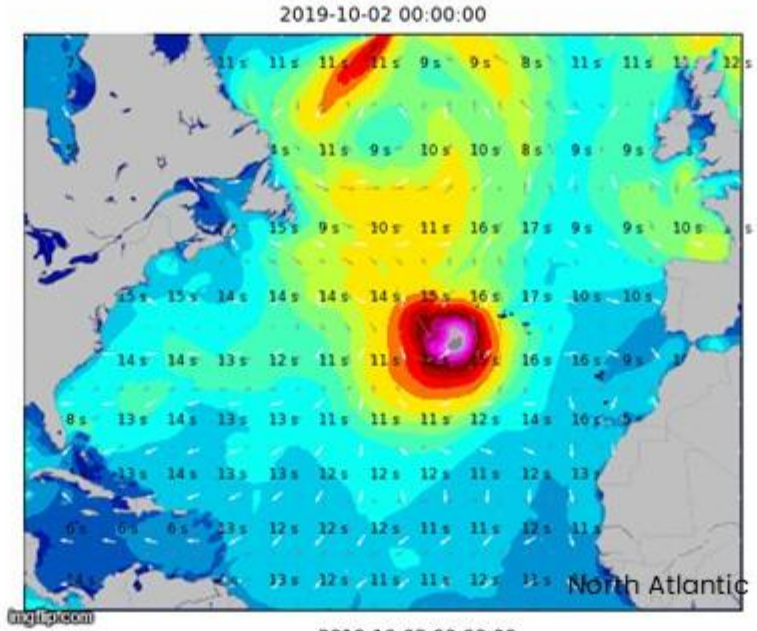

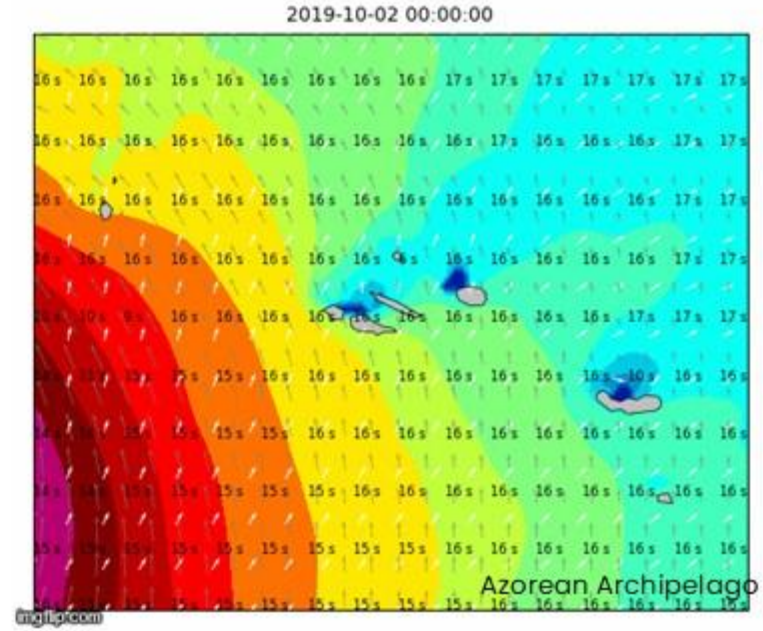

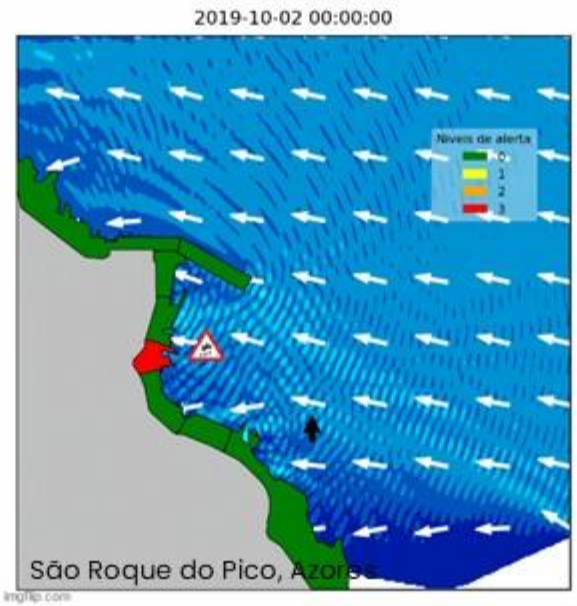

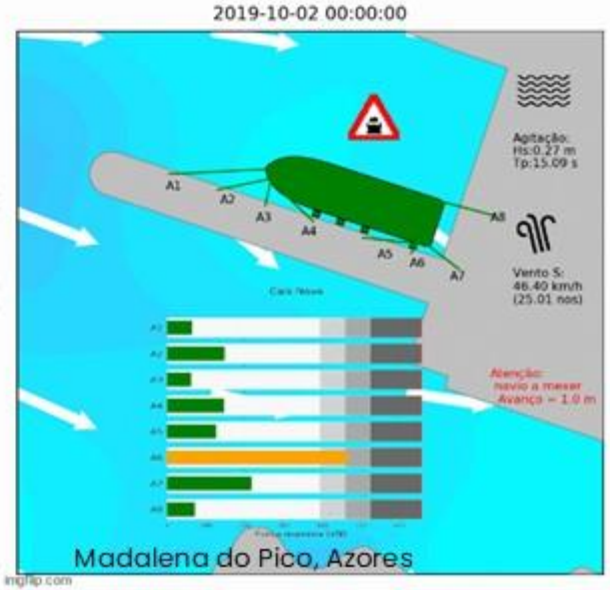

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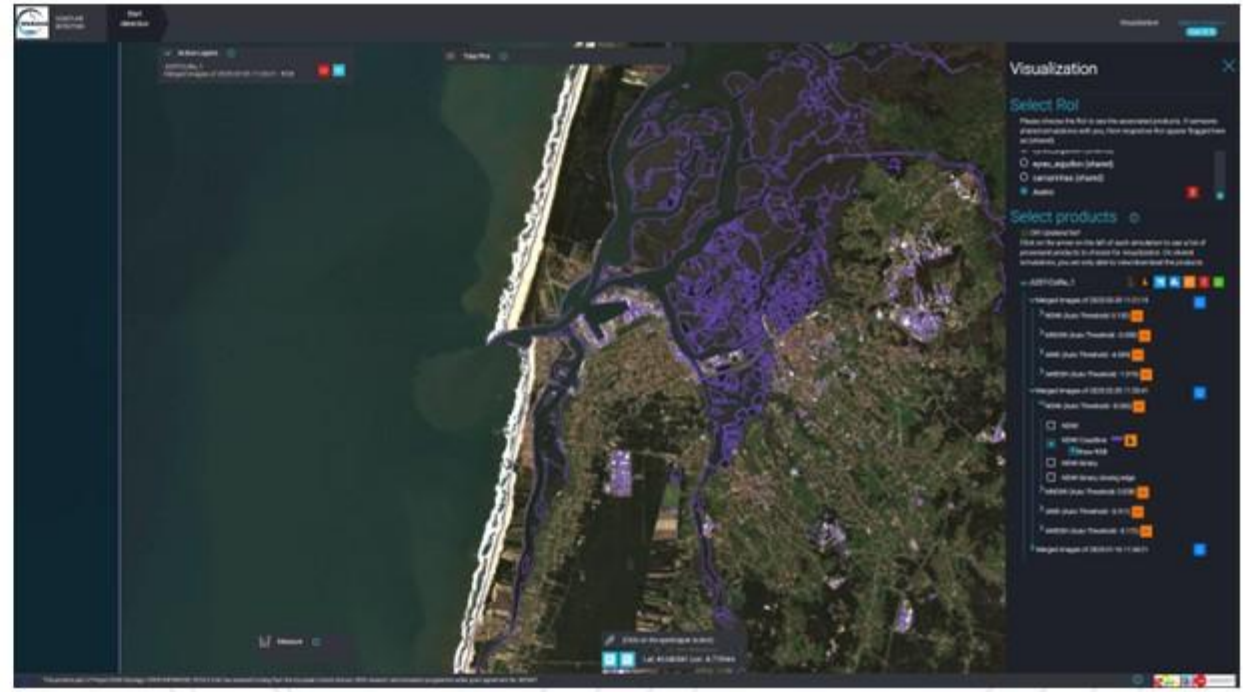
WORSICA – a satellite monitoring service for water detection

- **WORSICA** (Water Monitoring Sentinel Cloud Platform) service leverages Copernicus Sentinel-2 satellite imagery and UAV data to provide real-time, **remote sensing-based monitoring of water bodies in both coastal and inland regions**.
- The service utilizes various water and vegetation indices (e.g. **NDWI**, **MNDWI** and **NDVI)**, to assess water and vegetation presence and dynamics. It integrates the **FES** global tidal model for improved estimation of intertidal levels observed in satellite imagery.
- WORSICA incorporates the **Flood2Topo** methodology to **derive topobathymetric information in intertidal zones**, enhancing the understanding of coastal dynamics and supporting sustainable coastal management and risk assessment.



Systematic observation of maritime structures

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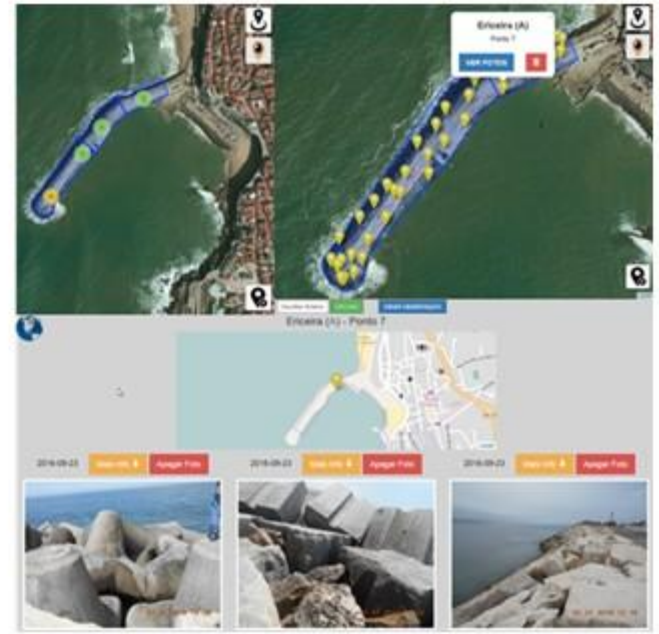
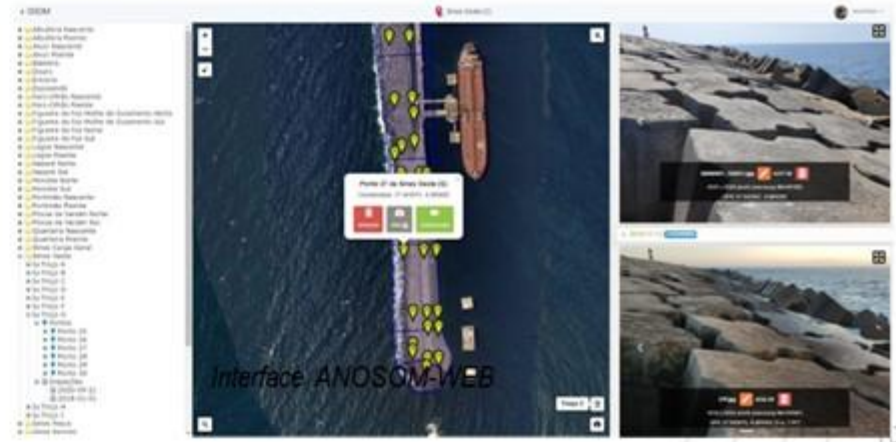
In-situ visual inspection (comparison of photos - current vs reference) at GCP

Visual inspections by a specialized technician (photos, videos, measurements), GPS-tagged

Use of drone for observation of emerged areas - photos, videos, ortophotos, contour maps, DTM...



ANOSOM-WEB interface and app



- Periodic, systematic, visual inspections by a specialized technician who travels along the breakwater
- Use of drones and an application for mobile devices
- Use of GIS ANOSOM-WEB database, to store and view information of monitoring campaigns, and diagnose current, evolution and risk conditions of structures;

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OPENHIDRA - A Climate Change Adaptation Service for Ports and Coastal Areas

OPENHIDRA is envisioned as an **innovative climate adaptation service** designed to enhance the resilience of **European ports and coastal areas** against climate-related hazards

By integrating **Hidralerta** (a port alert system) with **OPENCoastS** (an EOSC-based coastal forecasting service), OPENHIDRA aims to provide **on-demand, high-resolution simulations** for coastal and lagoon circulation, enabling both **long-term climate adaptation planning** and **real-time early warning systems**

This open-access service will empower **port authorities, coastal managers, SMEs (including aquaculture, sailing schools, fishing, and tourism), and local communities** to make **data-driven decisions**. It aims to reduce risks from coastal flooding, sea-level rise, and extreme weather events while fostering collaboration through the European Open Science Cloud (**EOSC**).

AI-LLM chatbot designed to provide fine-tuned information to each user type accessing the service, adapting to the user's preferred format and complexity level. Its purpose is to improve usability and support efficient knowledge absorption across the user community (e.g., translating scientific data for all types of users).

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LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

TEAM

Alberto Azevedo

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Liliana Pinheiro

Alphonse Nahon

Rui Capitão

António Antunes

Vera Serrazina

Gonçalo Jesus

Ana Mendes

Rute Lemos

Ricardo Martins

Marta Rodrigues

Blue Co

A Sustainable Blue Economy Co-Investment Platform for the Caribbean, Pacific, Asia, Indian Ocean and Mediterranean

Bapon Fakhruddin, *PhD*

GREEN CLIMATE FUND

Challenges

- **Economic & Social Context-**
  - Tourism drop, increased SIDS debt burden, rising energy prices. Many SIDS considering suspending ocean conservation commitments to preserve community livelihoods.
  - Higher-income status does not remove SIDS' vulnerability to climate change.
- **Technical -**
  - Coastal Resilience - Coastal ecosystem services are grossly undervalued, provide billions of USD in storm protection and food security
  - Food Security and Water – Climate resilient food security and fresh water have unique Pacific related issues
  - Climate Resilient Infrastructure - Climate-proofing national / local infrastructure
- **Financial -**
  - Pacific SIDS face challenges in accessing capital markets and limited absorptive capacity requires new and innovative financial modalities from **debt-swaps to bonds to microfinance**
  - Lack of supply of Blue Economy projects to meet investor demand.

Blue finance gap

- Investment gap required to achieve sustainable oceans is enormous
- SDG 14 is the least funded of all 17 SDGs:
  - 0.01% of all SDG funding from ODA (up to 2019)
  - 0.56% of all SDG funding from philanthropies (2016 to 2020)
  - Lowest proportion of impact investment of all SDGs
  - 0.7% of GEF funding
  - Less than 2% of GCF investments

Sumaila, U. R. et al. (2021) 'Financing a sustainable ocean economy', Nature Communications, 12(1). doi: 10.1038/s41467-021-23168-y

Blue Co – A Sustainable Blue Economy Co-Investment Platform

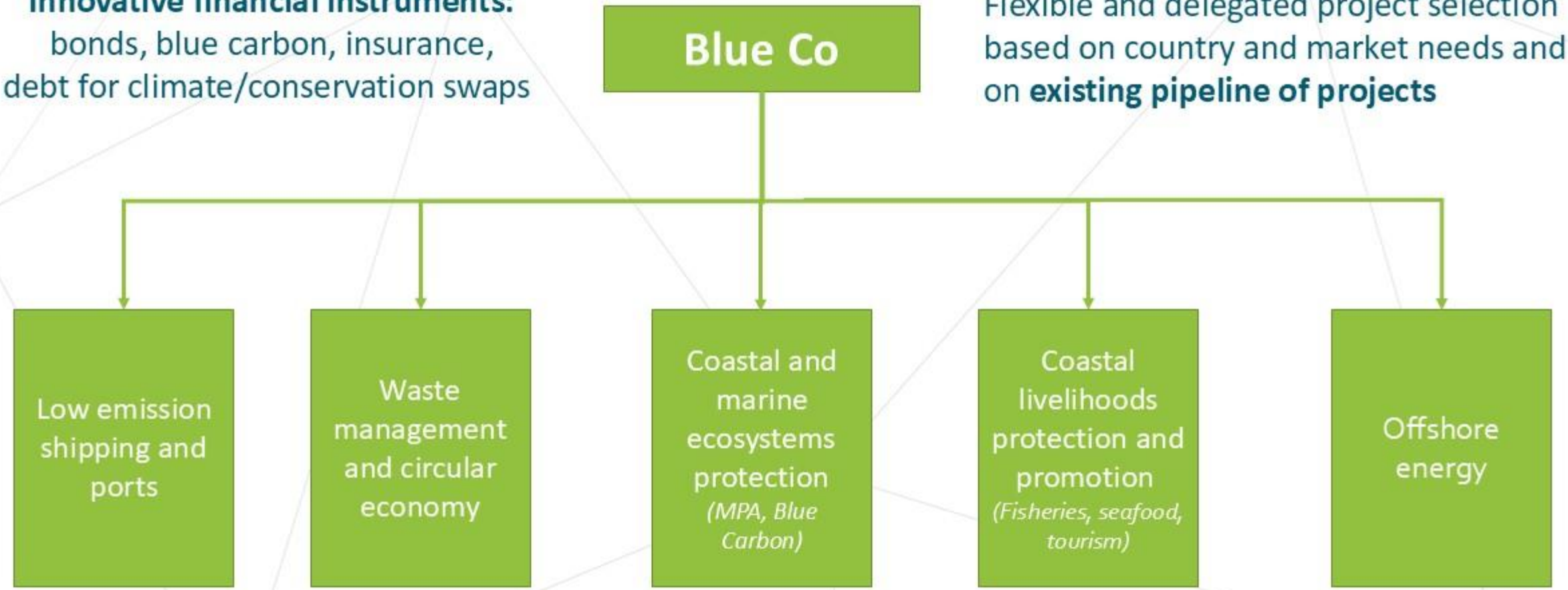
A blended finance partnership to meet Paris Agreement and SDG14 targets, particularly in SIDS

- **Coordinated yet flexible programmatic approach** building on and consistent with existing country programmes and national priorities
- Blends flexible investment capital in an open investment platform
- **Crowds in development partners, philantrophies and the private sector** at fund and project levels
- Provides **different levels of risk mitigation** to attract private investments through targeted interventions

Blue Economy: Country-Driven Priority Areas

Innovative financial instruments:
bonds, blue carbon, insurance,
debt for climate/conservation swaps

Flexible and delegated project selection based on country and market needs and on **existing pipeline of projects**



Proposed Coordination Project

First project proposal
by GCF, AE and Regional Coordinating Body
to enable coordination

Blue Co
Umbrella Coordination

Develop/update blue economy frameworks

Regional Coordination
(via Regional Body)

Pilot Projects (TBD)
(via technical partners)

Project Preparation Facility Grant

Consultation with all stakeholders

Support for developing draft regional blue economy framework

Feasibility studies on financial instruments; tailored blending of instruments for each country

Feasibility work for the selected pilot projects

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