EUROFLEETS+ Floating University

"State and sustainable use of the ocean biological resources: the case of the *Nephrops norvegicus* (Norway lobster)"

Onboard the R/V Mário Ruivo

Portugal, June 15 – July 5

OCEAN OBSERVATORIES

Tanya M. Silveira

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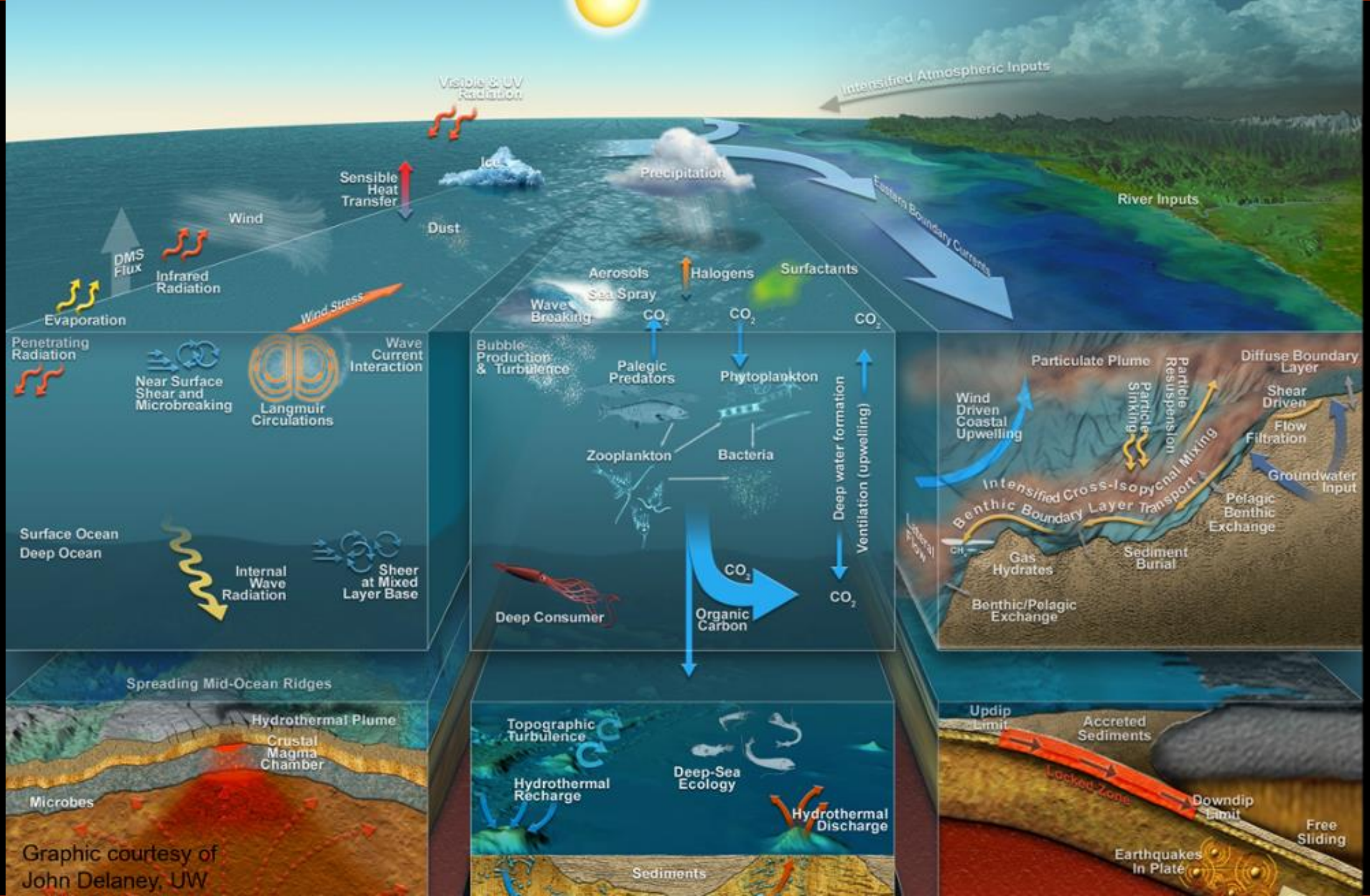
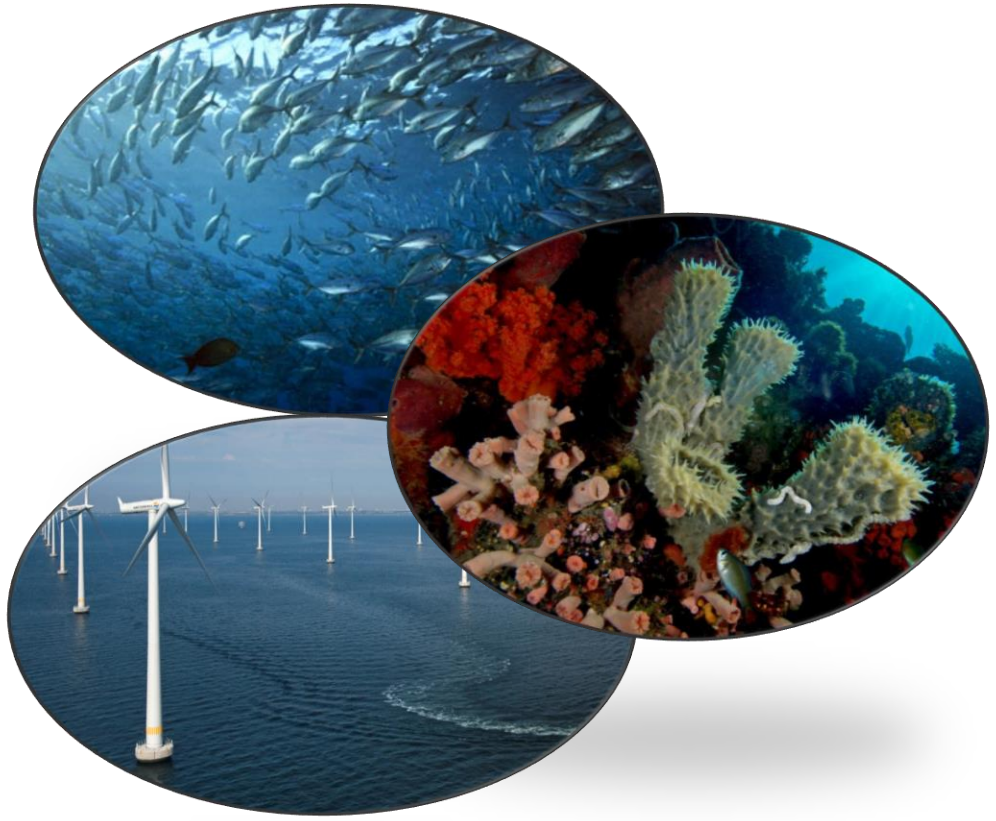
NASA


Visible & UV Radiation
Intensified Atmospheric Inputs
Sensible Heat Transfer
Ice
Precipitation
Eastern Boundary Currents
River Inputs
Wind
Dust
DMS Flux
Infrared Radiation
Evaporation
Wind Stress
Aerosols
Sea Spray
Halogens
Surfactants
Wave Breaking
CO_2
CO_2
CO_2
Penetrating Radiation
Near Surface Shear and Microbreaking
Langmuir Circulations
Wave Current Interaction
Bubble Production & Turbulence
Palegic Predators
Phytoplankton
Zooplankton
Bacteria
Deep water formation
Ventilation (upwelling)
Particulate Plume
Particle Resuspension
Particle Sinking
Diffuse Boundary Layer
Shear Driven
Flow Filtration
Groundwater Input
Wind Driven Coastal Upwelling
Intensified Cross-Isopycnal Mixing
Benthic Boundary Layer Transport
Pelagic Benthic Exchange
Surface Ocean
Deep Ocean
Internal Wave Radiation
Sheer at Mixed Layer Base
CH_4
Gas Hydrates
Sediment Burial
Benthic/Pelagic Exchange
Deep Consumer
CO_2
Organic Carbon
CO_2
Spreading Mid-Ocean Ridges
Hydrothermal Plume
Crustal Magma Chamber
Microbes
Topographic Turbulence
Hydrothermal Recharge
Deep-Sea Ecology
Hydrothermal Discharge
Sediments
Updip Limit
Accreted Sediments
Locked Zone
Downdip Limit
Free Sliding
Earthquakes In Plate
Graphic courtesy of
John Delaney, UW

OCEAN OBSERVATION

Besides the understanding of how the Ocean system works and evolves, we are also seeking for solutions to critical challenges that Humans face:

. Atmospheric CO_2 concentrations increase
. Desalinated fresh water
. Food and sustainable protein production
. Alternative renewable energy
. Medicines necessary to assure our well-being
. Risk mitigation



OCEAN OBSERVATION

In situ vs Remote

Fixed vs Mobile

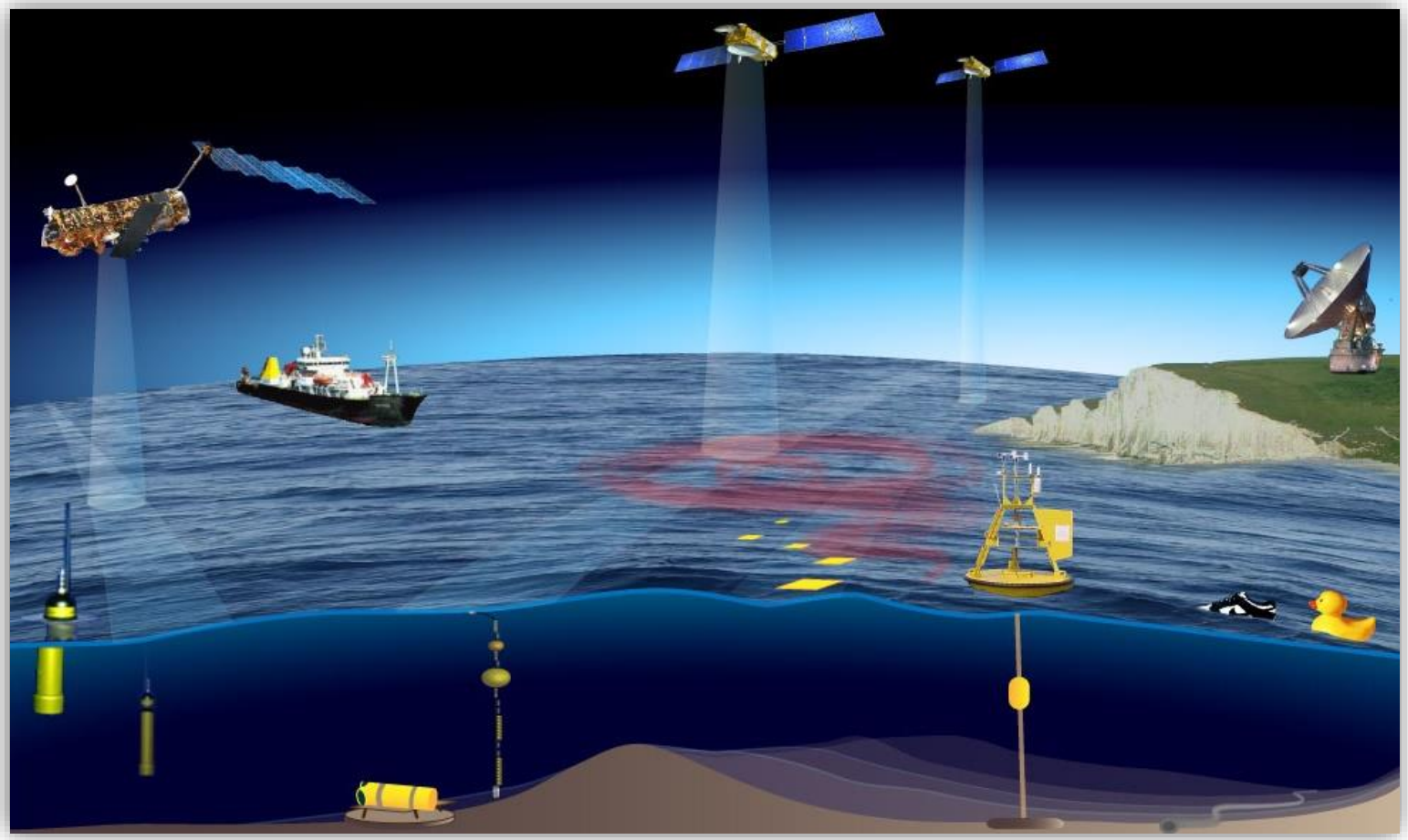
Operated vs Autonomous

Temporary vs Permanent

Subsurface vs Deep ocean

Real time vs Non-real time

Land-based vs Airborne/Spaceborne



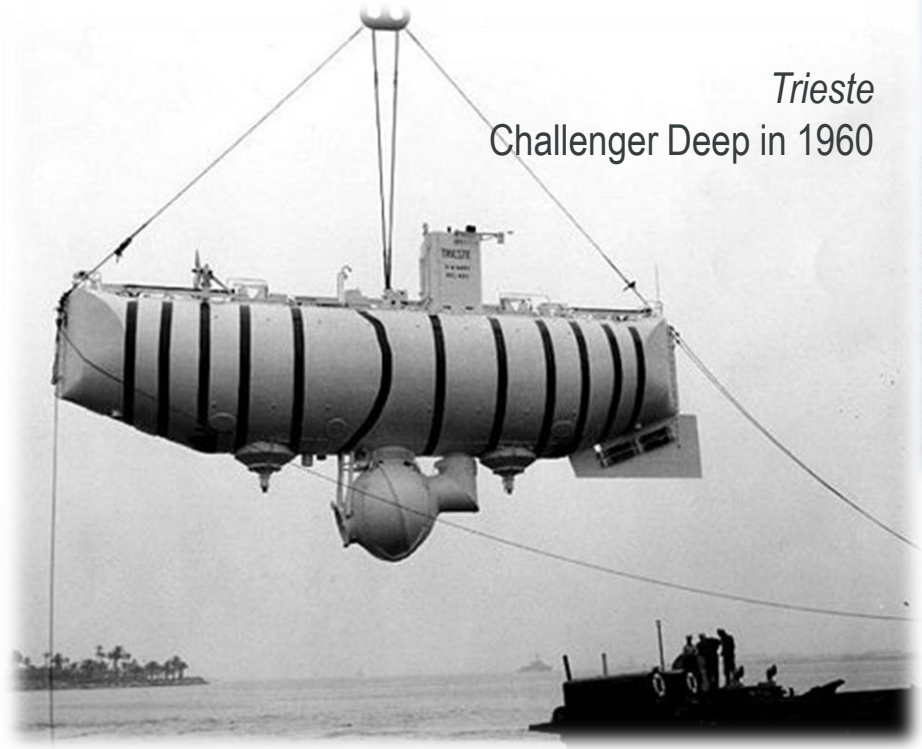
EVOLUTION OF OCEAN OBSERVATION

Research Vessels (RV) and Drilling Vessels (DV)

H.M.S. Challenger under Sail, 1874.

EVOLUTION OF OCEAN OBSERVATION

Human Occupied Vehicles (HOV)



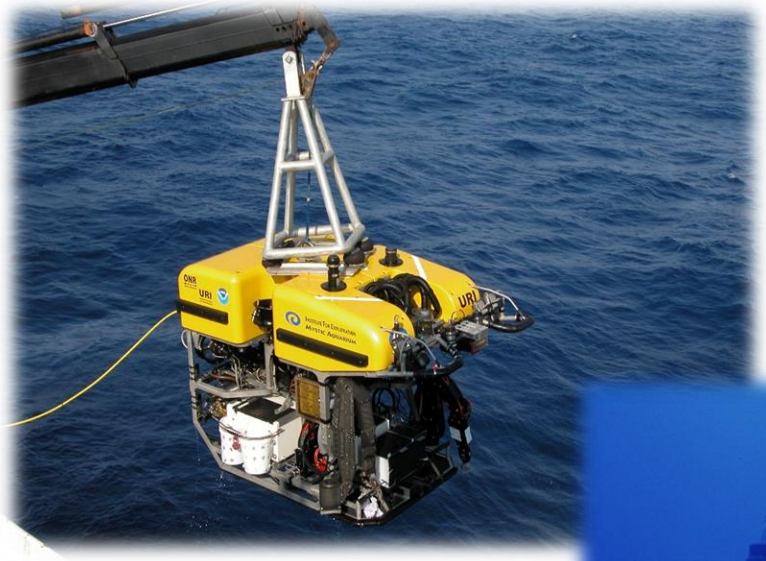
Trieste
Challenger Deep in 1960

Limiting Factor
Challenger Deep in 2019

Kathy Sullivan and Victor Vescovo after their record 10 934 m dive to the Challenger Deep (june 2020)

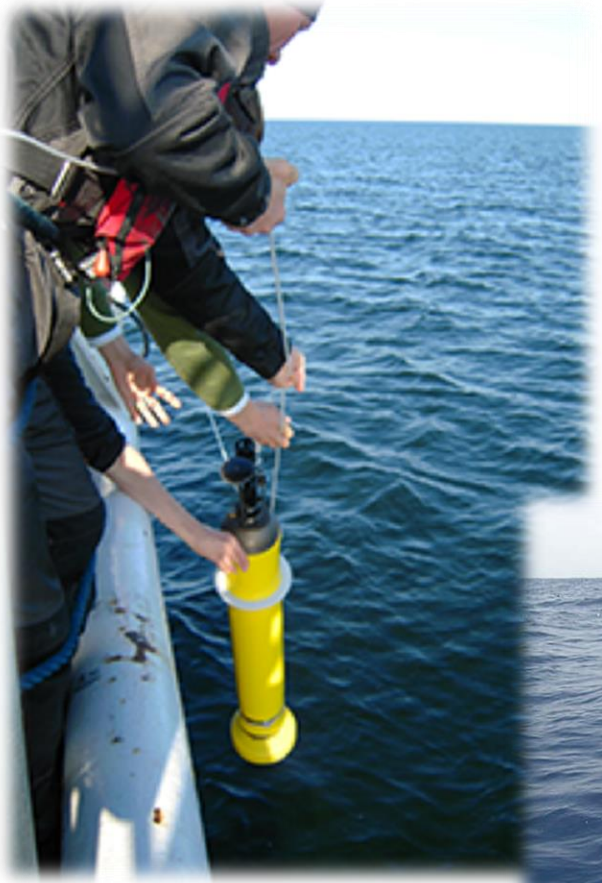
EVOLUTION OF OCEAN OBSERVATION

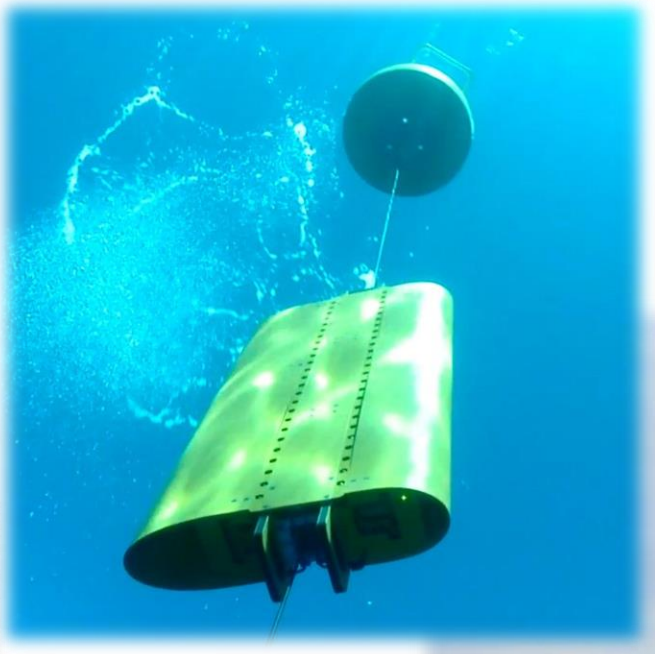
Remote Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV)



EVOLUTION OF OCEAN OBSERVATION

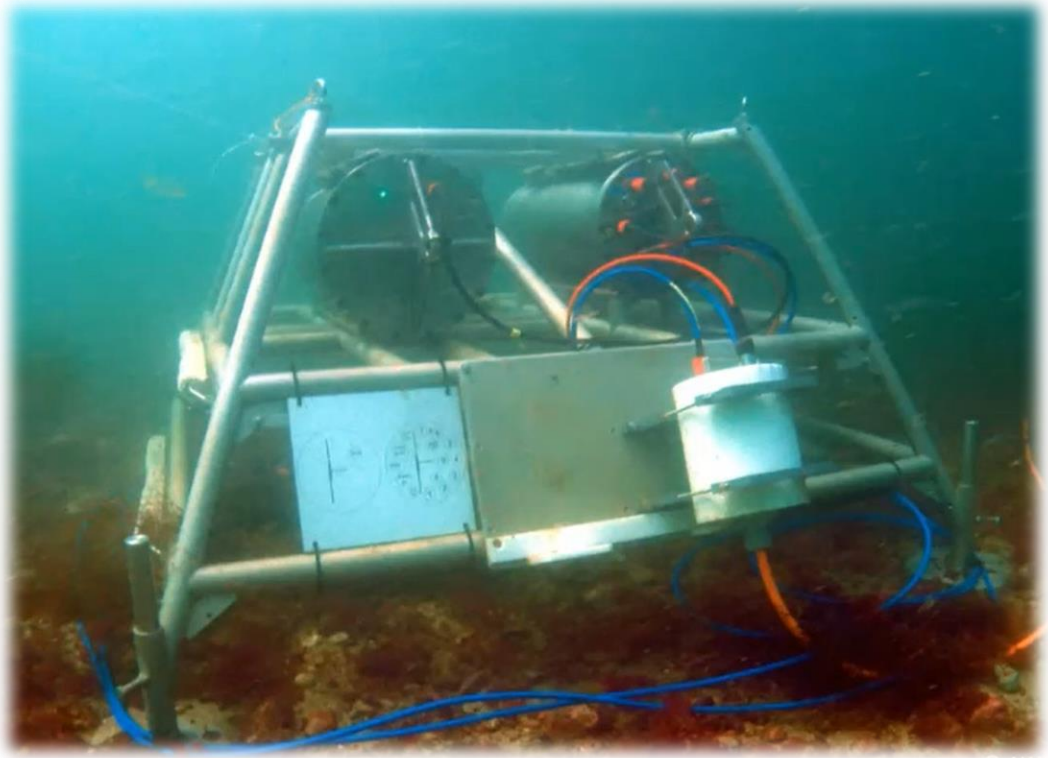
Profiling floats, Moored buoys and Vertical Profilers

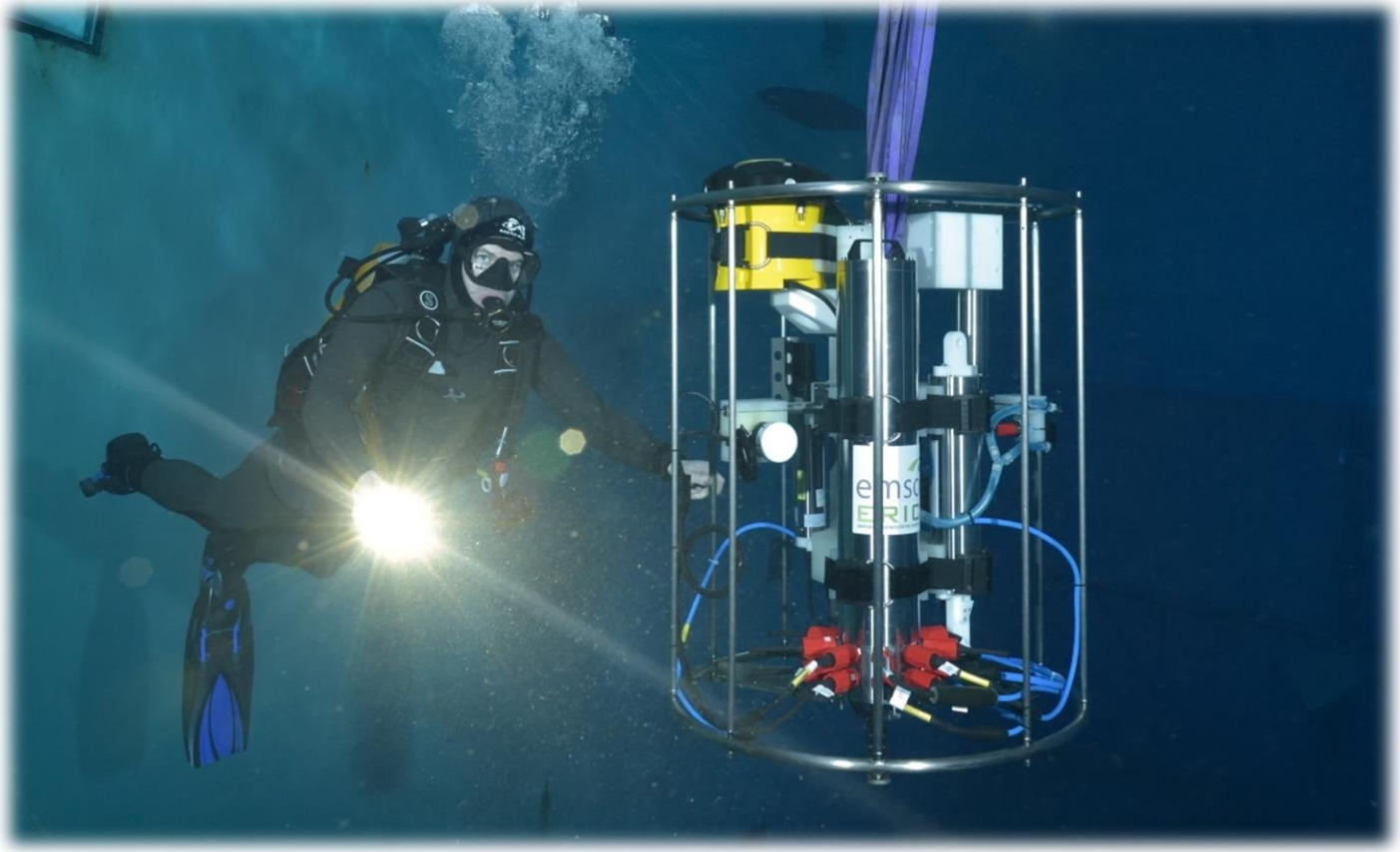




EVOLUTION OF OCEAN OBSERVATION

Submarine fixed stations





EVOLUTION OF OCEAN OBSERVATION

Monitoring opportunities

Ferrybox in ships of opportunity

Undersea telecommunications cables

Animal-Borne Instruments

EVOLUTION OF OCEAN OBSERVATION

Remote sensing techniques

Satellite

HF Radar

LiDAR

Echosounder

(single beam and multi-beam)

EVOLUTION OF OCEAN OBSERVATION

Multitude of Sensors and Equipment

EVOLUTION OF OCEAN OBSERVATORIES

A suite of platforms and sensors measuring and collecting data with the aim of studying the ocean in a certain location, for a period of time, constitute an Ocean Observatory. This infrastructure also includes the land-based facility where data is collected and stored.

Benefited from:

. Long-term power supplies (fiber-optic cables, digital batteries, new technologies that harvest renewable energy from the environment)

. Communication technology (underwater acoustics, radio or satellite beacons, cables, GNSS)

New technology platforms collected more data on the oceans in 2018 than was gathered during the entire twentieth century.
Tanhua et al. (2019)

EVOLUTION OF OCEAN OBSERVATORIES

From local to global:

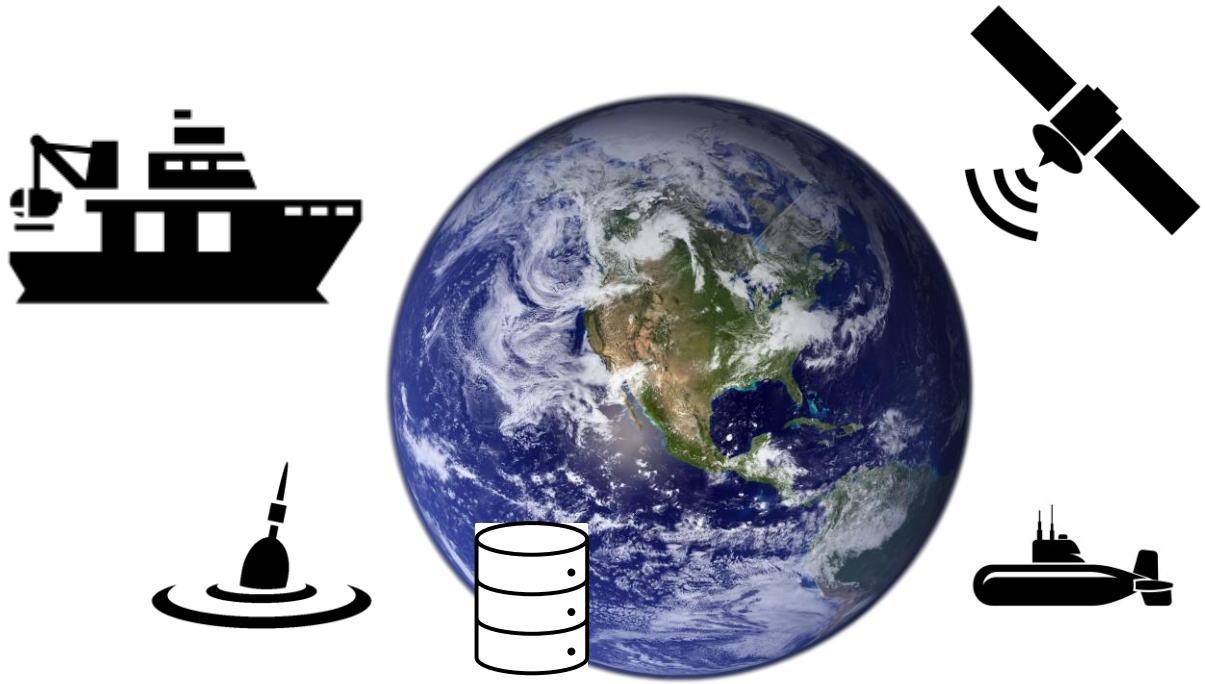
. One Global Ocean

. Networks of platforms and sensors

. Multiple observatories

. Data sharing

. FAIR data - Findable, Accessible, Interoperable, Reusable



EVOLUTION OF OCEAN OBSERVATORIES

Great variety of platforms and sensors collecting a wide number of parameters

. **Ocean Data Standards and Best Practices** (IODE - International Oceanographic Data and Information Exchange)

. **Essential Ocean Variables** (GOOS - Global Ocean Observing System)

Generation of BIG DATA creates a BIG CHALLENGE and implies:

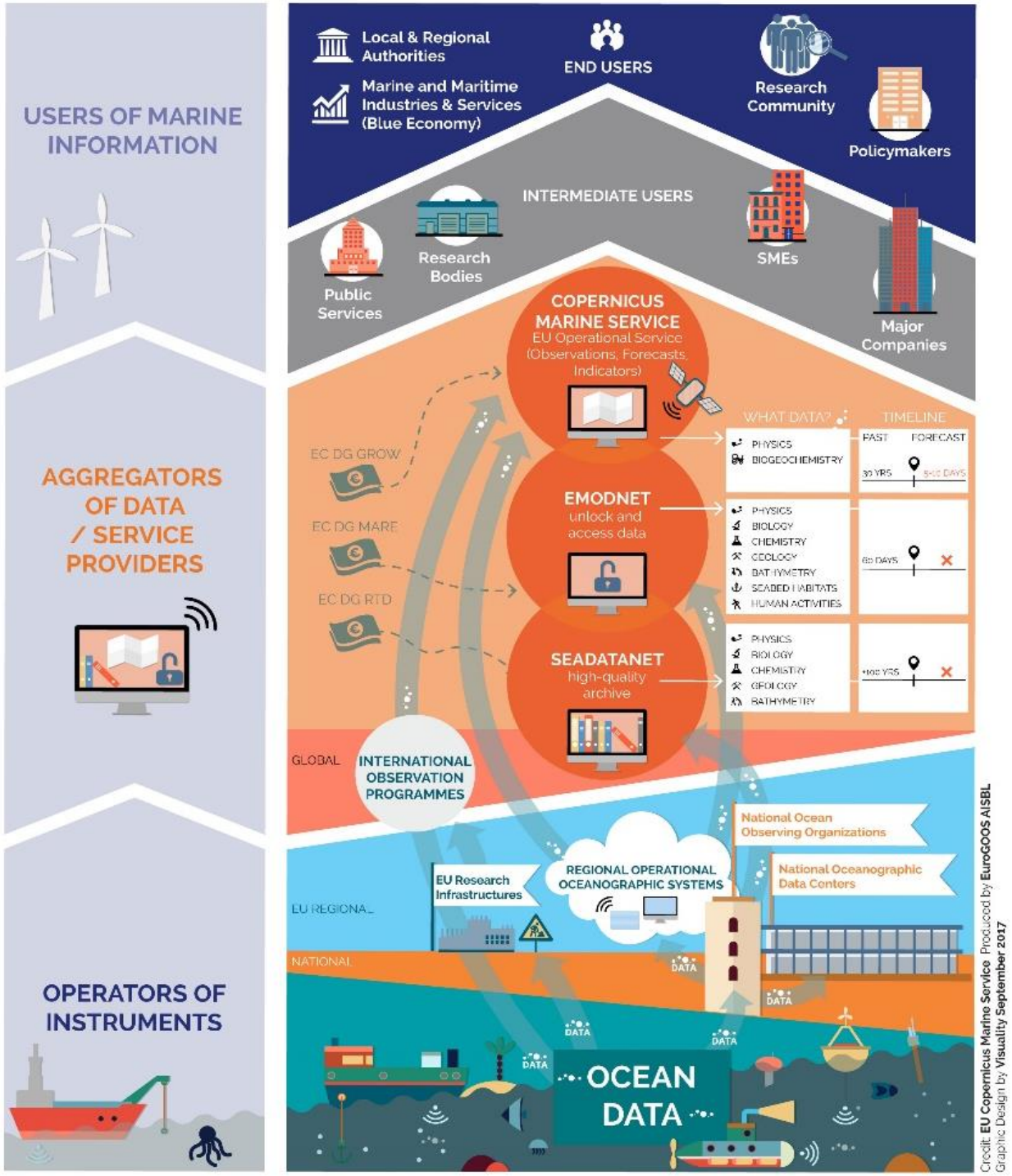
. Large digital databases and archives

. Need for sophisticated web-based tools

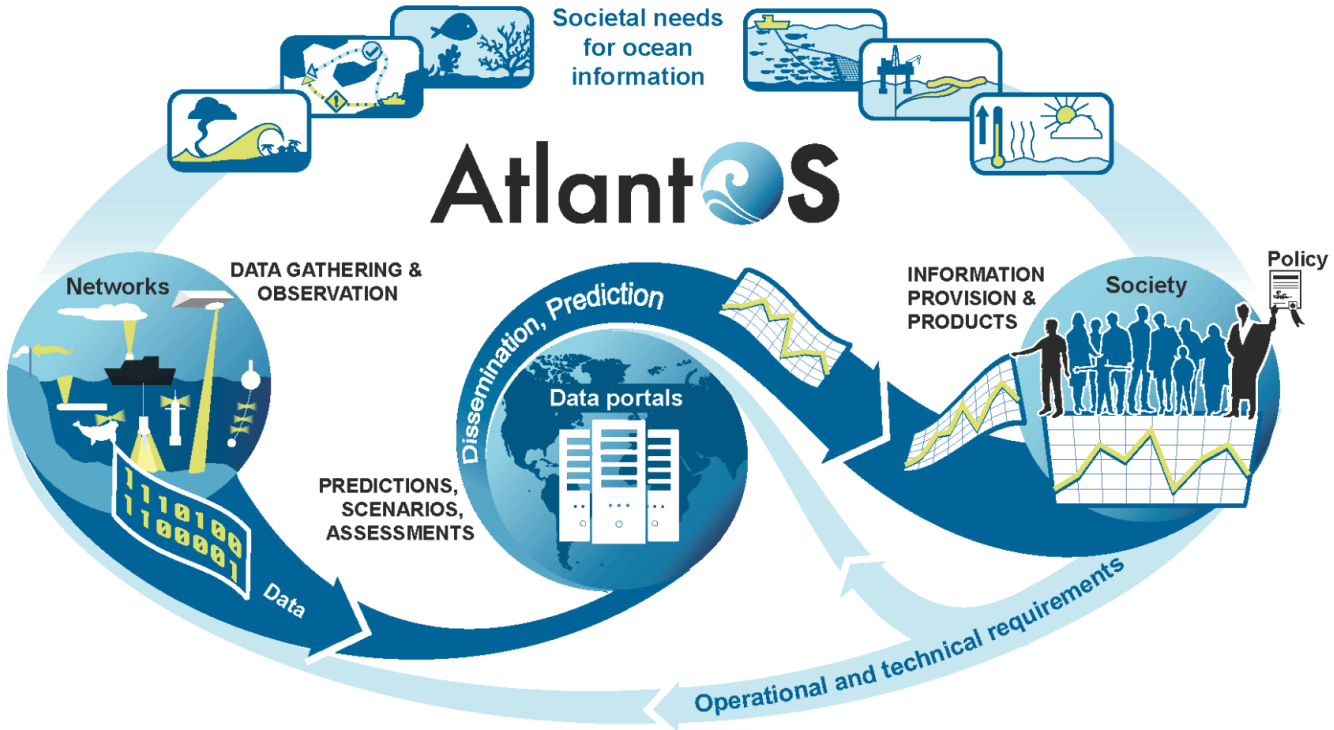
- Need for powerful machines

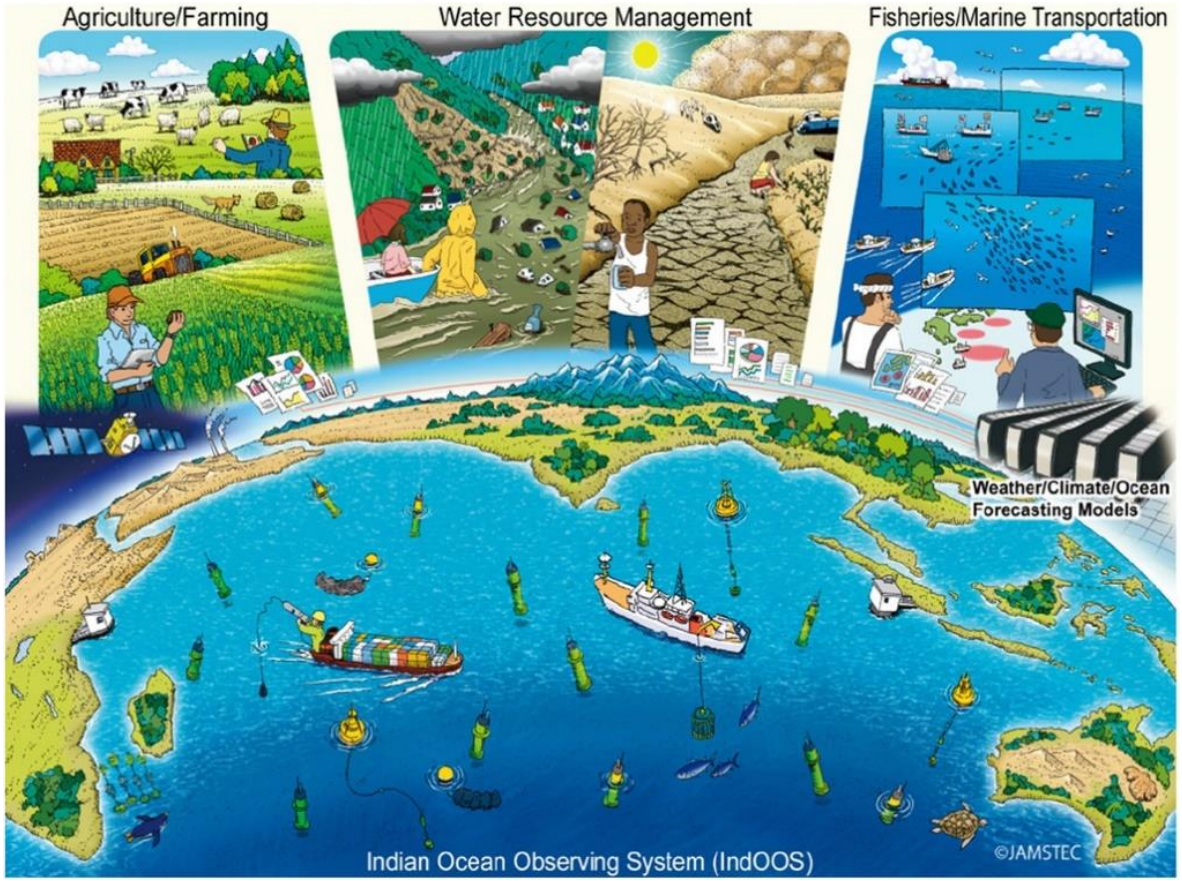
OCEAN OBSERVATION VALUE CHAIN

Data aggregators foster ocean databases and avoid duplication, complying with metadata standards, assuring data interoperability and, most importantly, providing data quality control and guidelines.



OCEAN OBSERVATION VALUE CHAIN

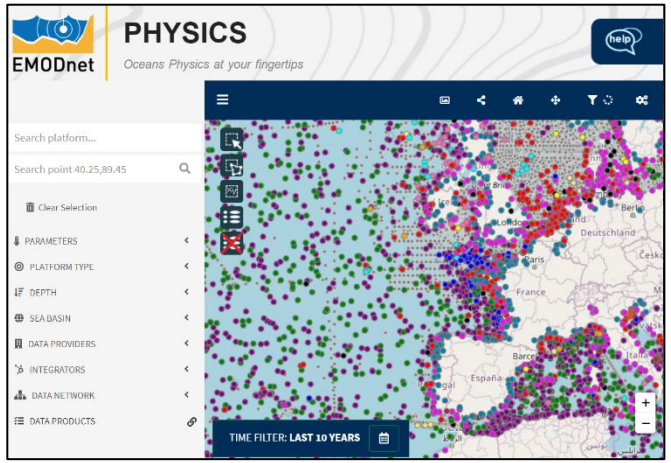




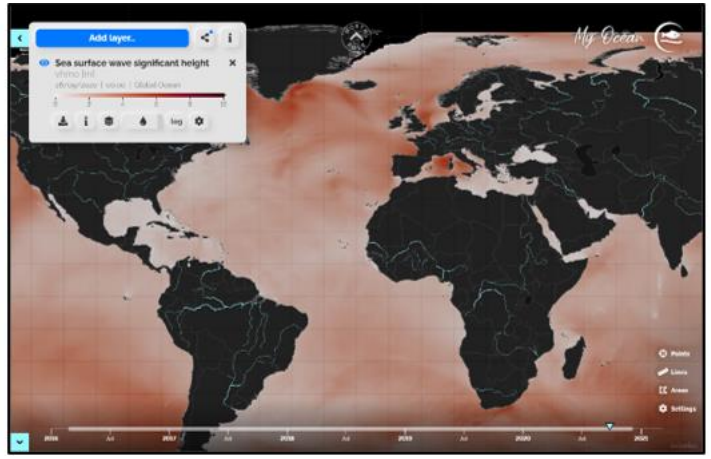
Ocean observatories, though local, have evolved to perform at wider scales, providing and utilising data globally and fostering a comprehensive and integrated approach to marine sciences and ocean issues.

OCEAN OBSERVATION VALUE CHAIN

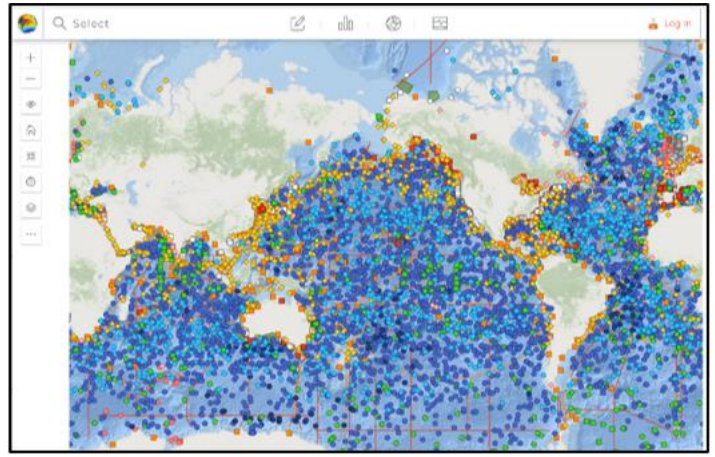
Data platforms



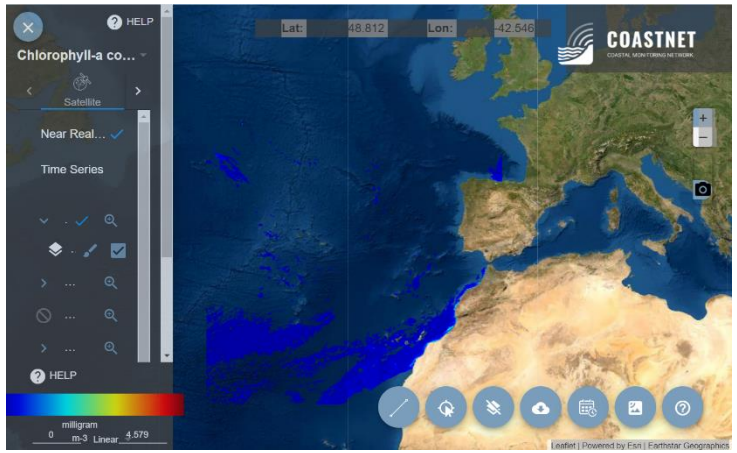
EMODnet



My Ocean by CMEMS

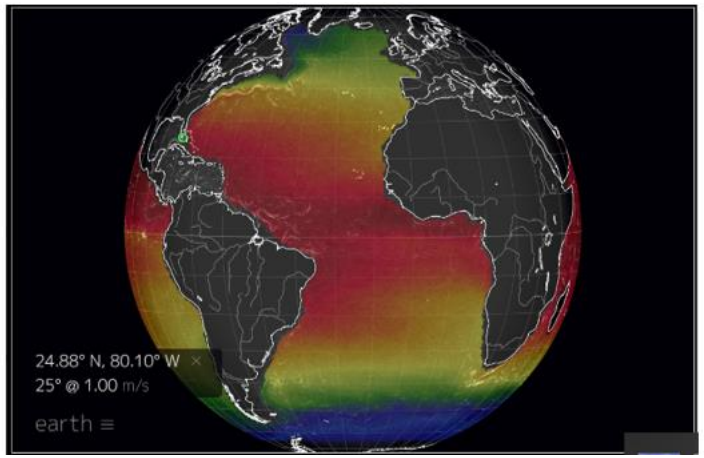


OceanOPS by JCOMMOPS



COASTNET

Blue Earth Data by Deltares



Earth.nullschool.net

DESTINATION:
THE DIGITAL TWIN OF THE OCEAN

The ultimate goal:

Ocean observation will collect and make available the right information to allow models to mimic ocean processes and create virtual reality of ocean behaviour, a Digital Twin of the Ocean (DTO).

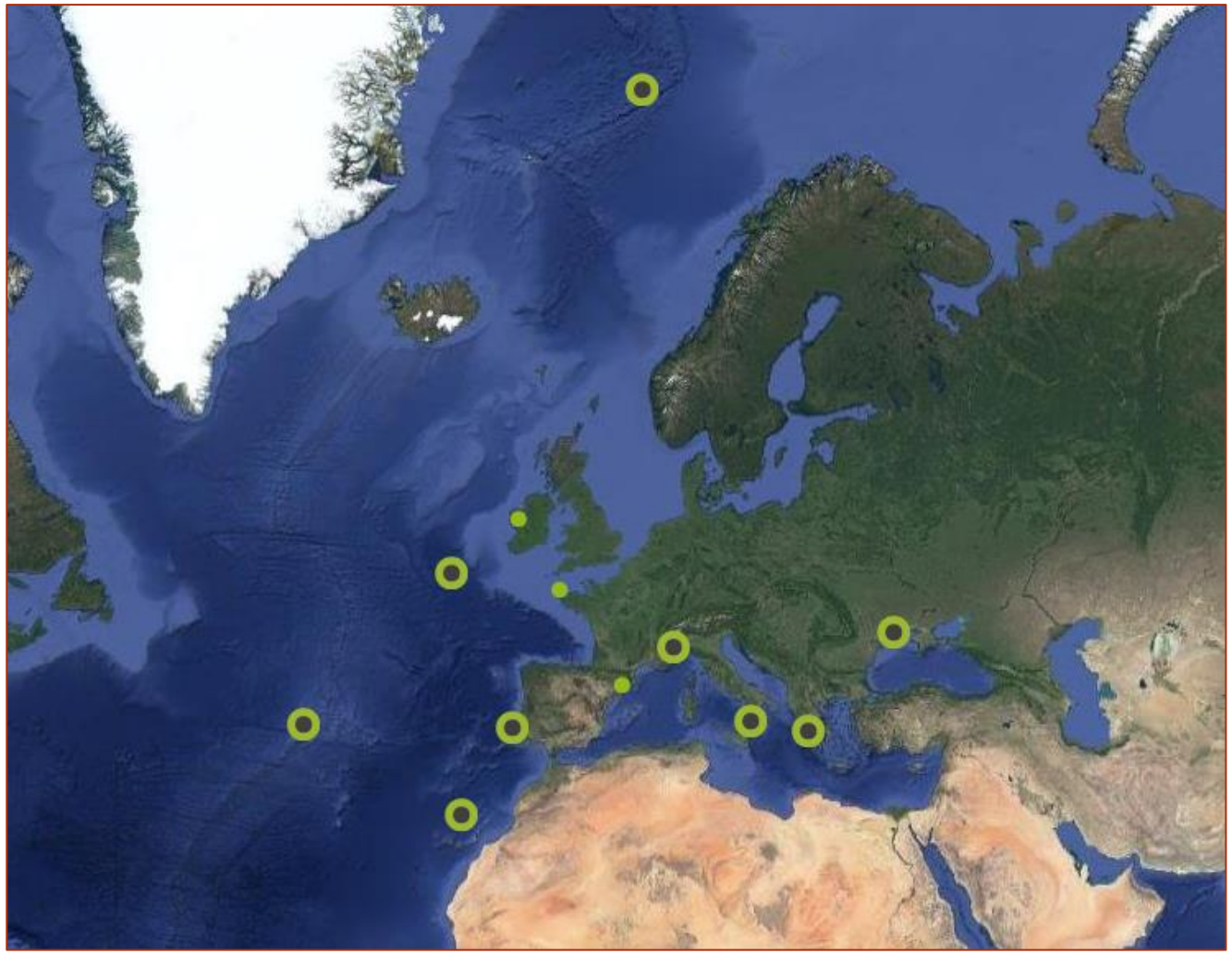
But we are not there yet…

The greatest challenge is the integration of the different ocean processes. Satellite-based data, in situ data, and numerical modelling must be capable of representing all variables across the **blue** (physical), white (sea ice) and **green** (biogeochemical) ocean, guarantee their interoperability, and simulate past, present and future conditions.

EMSO-PT

The **European Multidisciplinary Seafloor and water column Observatory** (EMSO) aims to explore the oceans, to gain a better understanding of phenomena happening within and below them, and to explain the critical role that these phenomena play in the broader Earth systems.

12 regional facilities – 3 test sites



The **Cadiz Station:**

- ✓ African and European tectonic plates convergent boundary
- ✓ Mediterranean Outflow Water
- ✓ Highly diverse benthic communities, marine mammals and fish species

HTTPS://WWW.YOUTUBE.COM/WATCH?V=JNBFV3V5EJ0

ATLANTIC OBSERVATORY
DATA AND MONITORING INFRASTRUCTURE

Creation of an integrated, efficient, low-cost and scalable marine observation system, focused on the Atlantic Basin

- ✓ Creation of a digital infrastructure for data collection
- ✓ Aggregation of data from other entities operating in the Portuguese, continental and autonomous regions
- ✓ Strengthening of existing means for ocean monitoring in the Portuguese marine research community

IPMA Instituto Português do Mar e da Atmosfera

FRCT Fundo Regional para a Ciência e Tecnologia

arditi agência regional para o desenvolvimento da investigação tecnologia e inovação

Institute of Marine Research

NTNU Norwegian University of Science and Technology

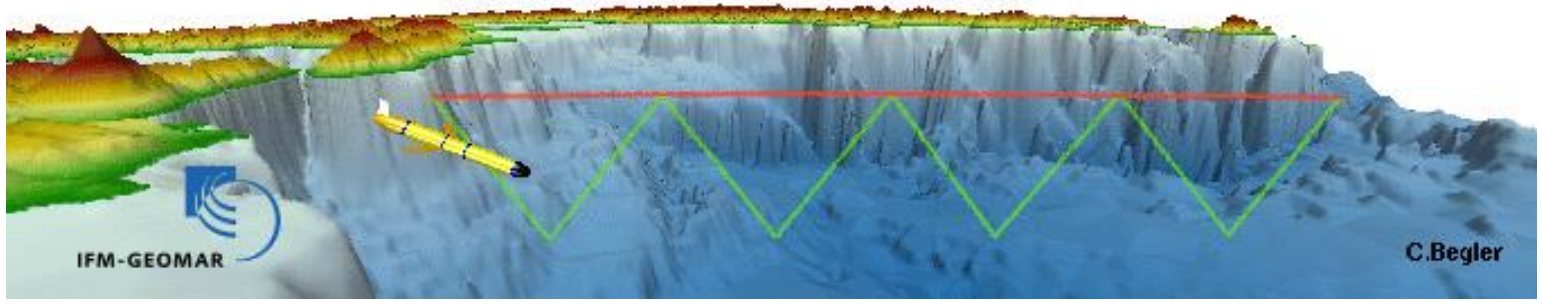
University of Bergen

Marine & Freshwater Research Institute

ATLANTIC OBSERVATORY
DATA AND MONITORING INFRASTRUCTURE

GLIDERS

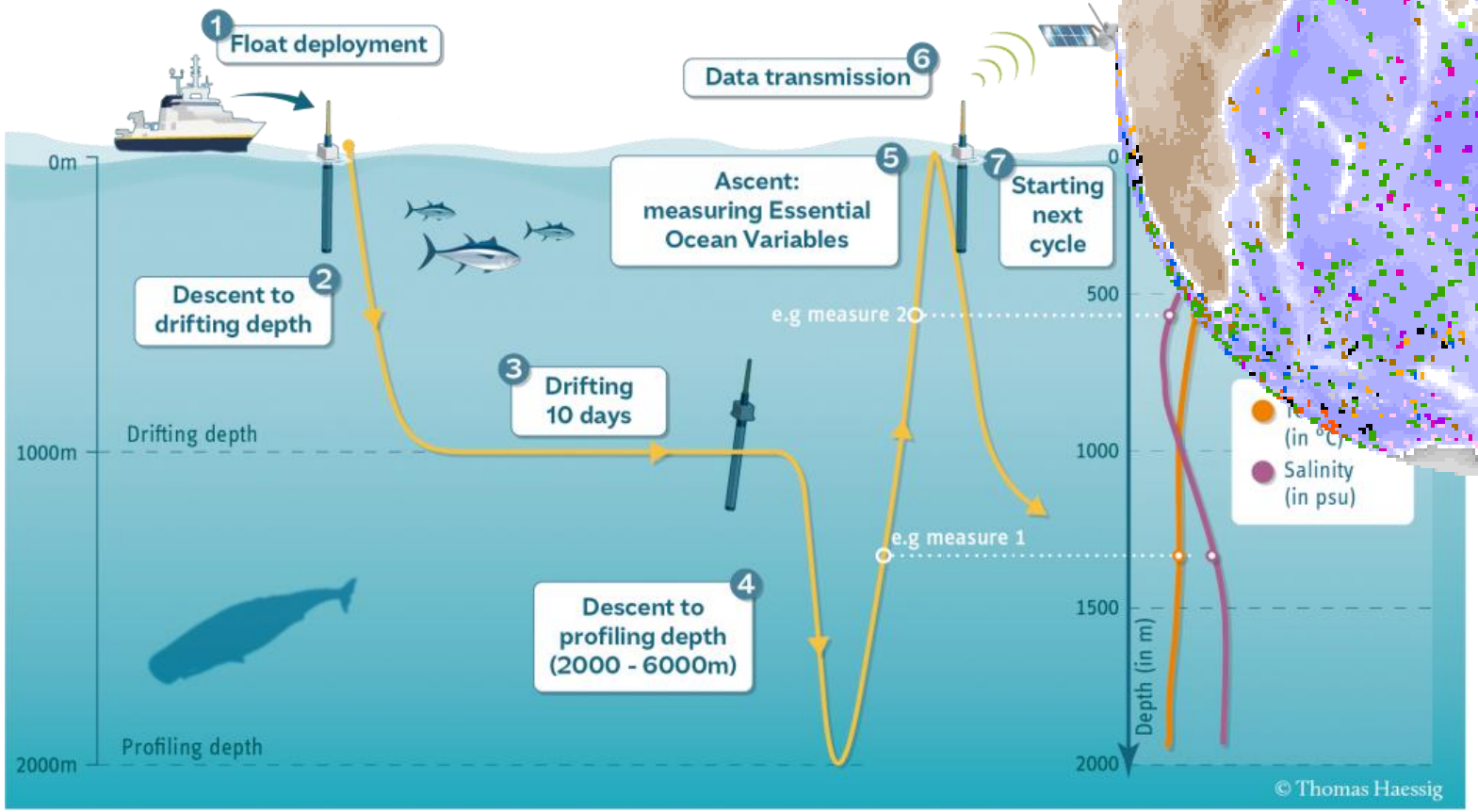
https://geo-matching.com/

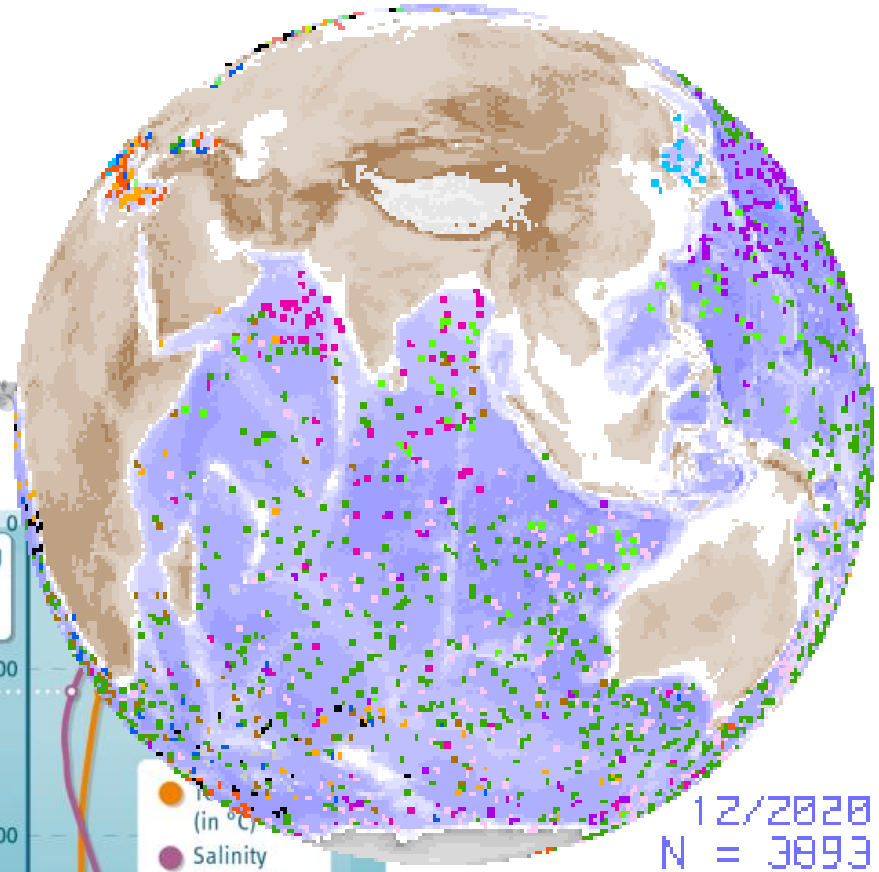


ATLANTIC OBSERVATORY
DATA AND MONITORING INFRASTRUCTURE

ARGO FLOATS

http://www.argo.org.cn/



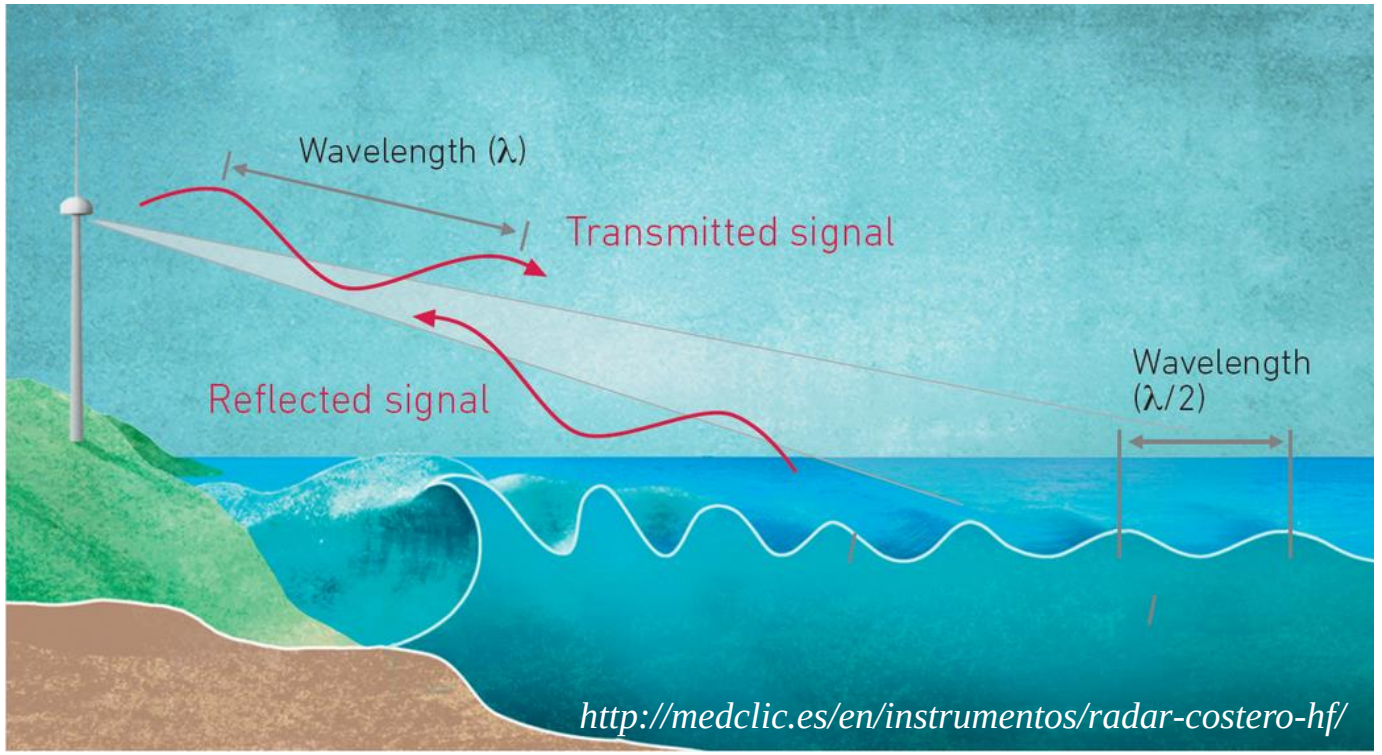


Created by Howard Freeland
https://argo.ucsd.edu/

ATLANTIC OBSERVATORY
DATA AND MONITORING INFRASTRUCTURE

HF Radars

http://www.mongoos.eu/hf-radars



http://medclic.es/en/instrumentos/radar-costero-hf/

ATLANTIC OBSERVATORY

DATA AND MONITORING INFRASTRUCTURE

DATA BASE AND REPOSITORY

WEB USER INTERFACE

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"State and sustainable use of the ocean biological resources: the case of the *Nephrops norvegicus* (Norway lobster)"

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Eurofleets+

An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities

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IPMA Instituto Português do Mar e da Atmosfera

pnab programa nacional de amostragem biológica