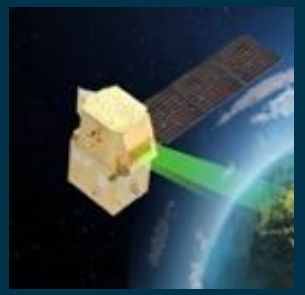
# Ocean Colour Application and Research at the European Space Agency

*Marie-Helene RIO, ESA-ESRIN*



IOCS, Monday 1st December

# Outline

- News from the space segment

(S2, S2-NG, CHIME, EARTHCARE, FLEX)

- EO4Society Science and Application

Ocean Colour related activities

- ESA Ocean Colour Climate Change Initiative
- CEOS Aquatic Carbon Roadmap
- Perspectives

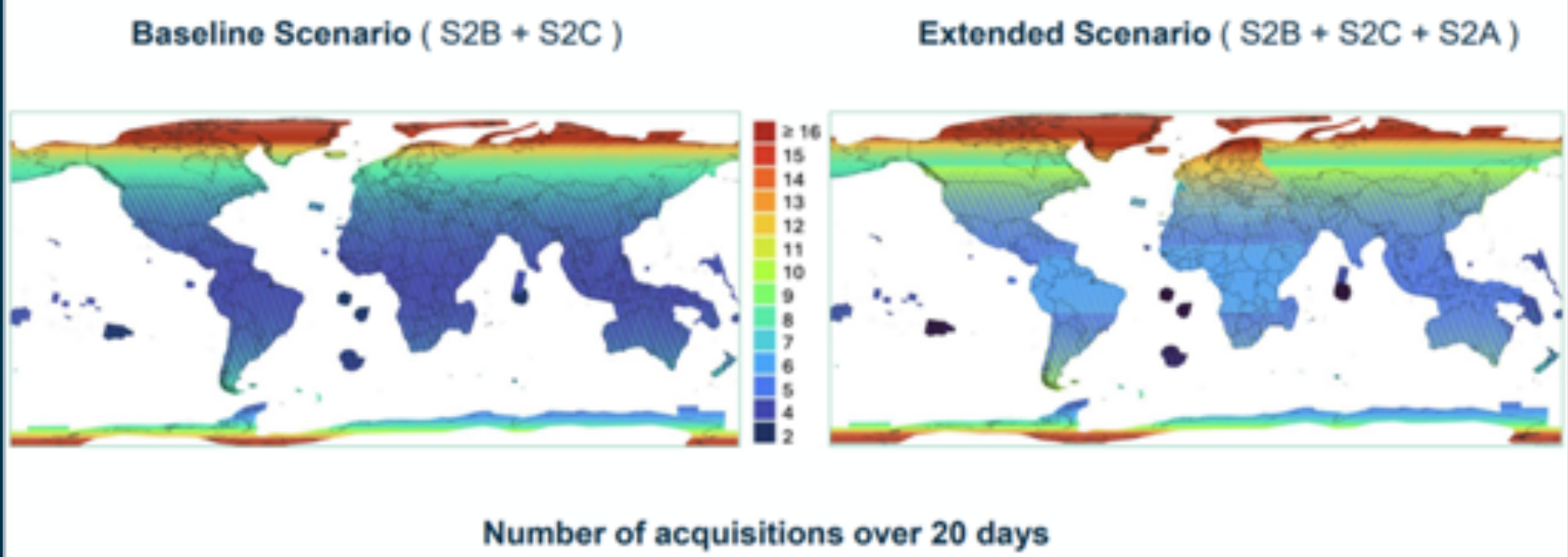
The Committee on Earth Observation Satellites

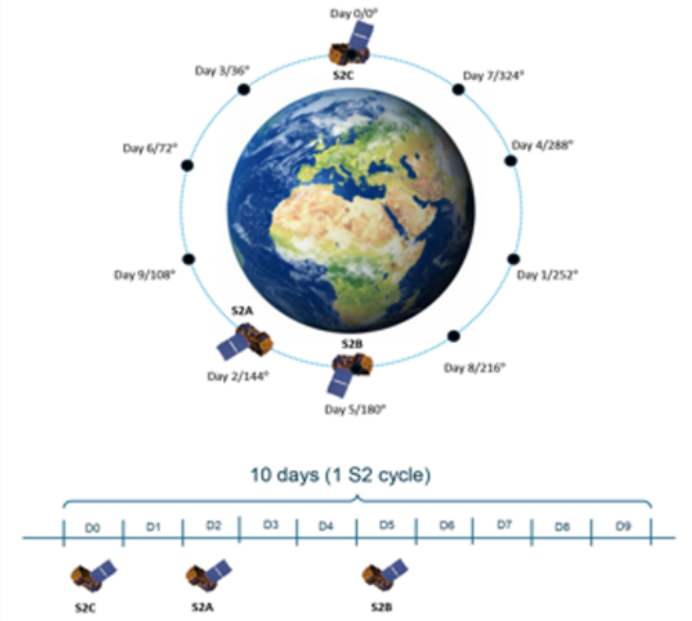
ocean colour cci

# Sentinel-2A Extension Campaign

**Implemented scenario:**

- S-2B & S-2C in full baseline observation scenario
- S-2A in complement acquiring additional data
- S-2A limited observation scenario to preserve satellite heath

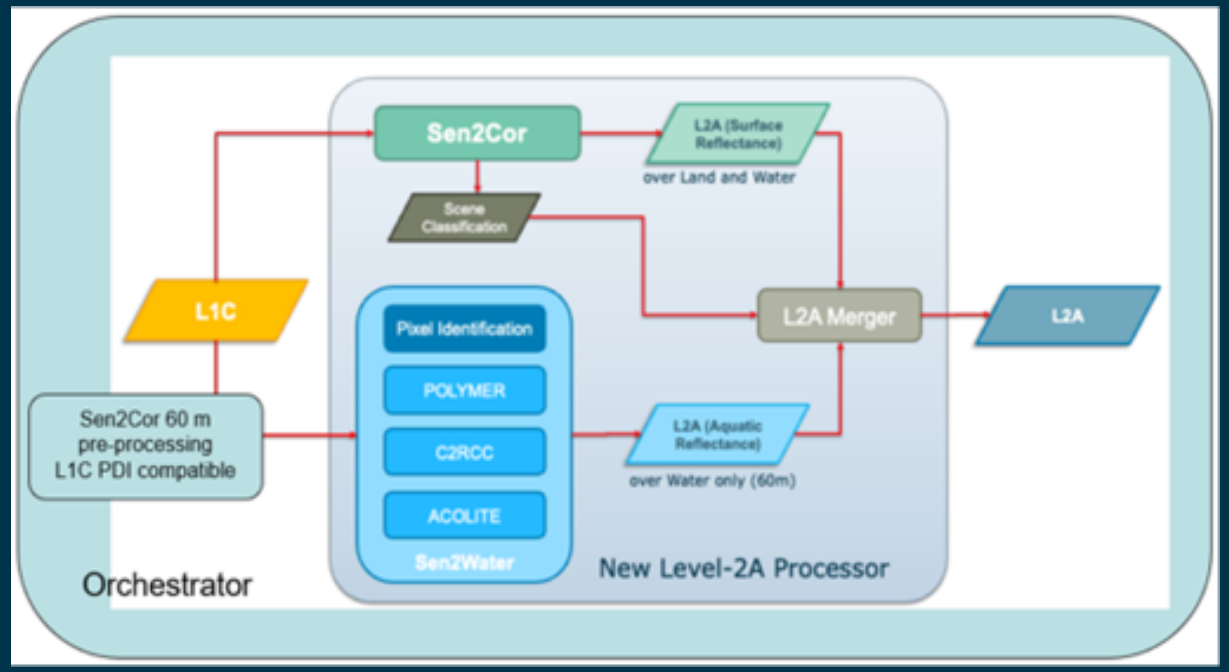
# Sen2water: Toward a Sentinel-2 Aquatic Reflectance

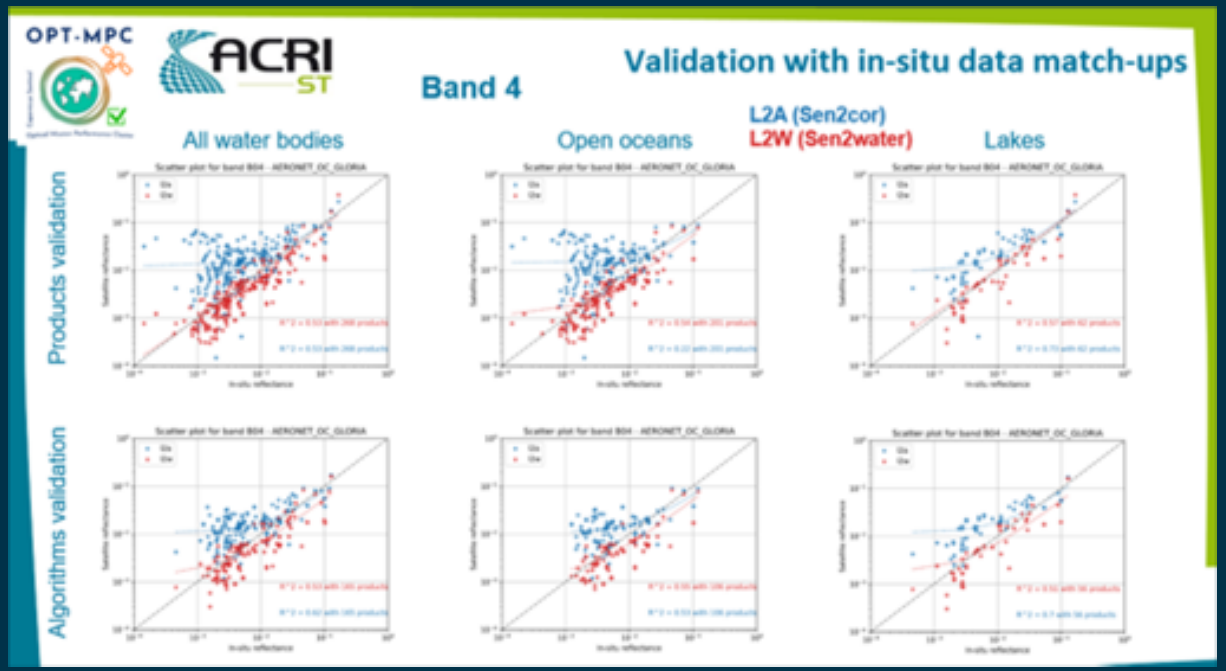
**Goal:** to provide an aquatic reflectance product as part of the ESA S-2 Level 2A product.

**Validation** has been performed following the methodology of the ACIX AQUA benchmark (Pahlevan et al. 2021)

**Timeline:** The aquatic reflectances from Sen2Water will become part of the Level 2A product by 2027. In the meantime, a stand-alone version of Sen2Water is available and integrated into SNAP (v13), similar to Sen2Cor.

See Poster #13 by Brockmann et al



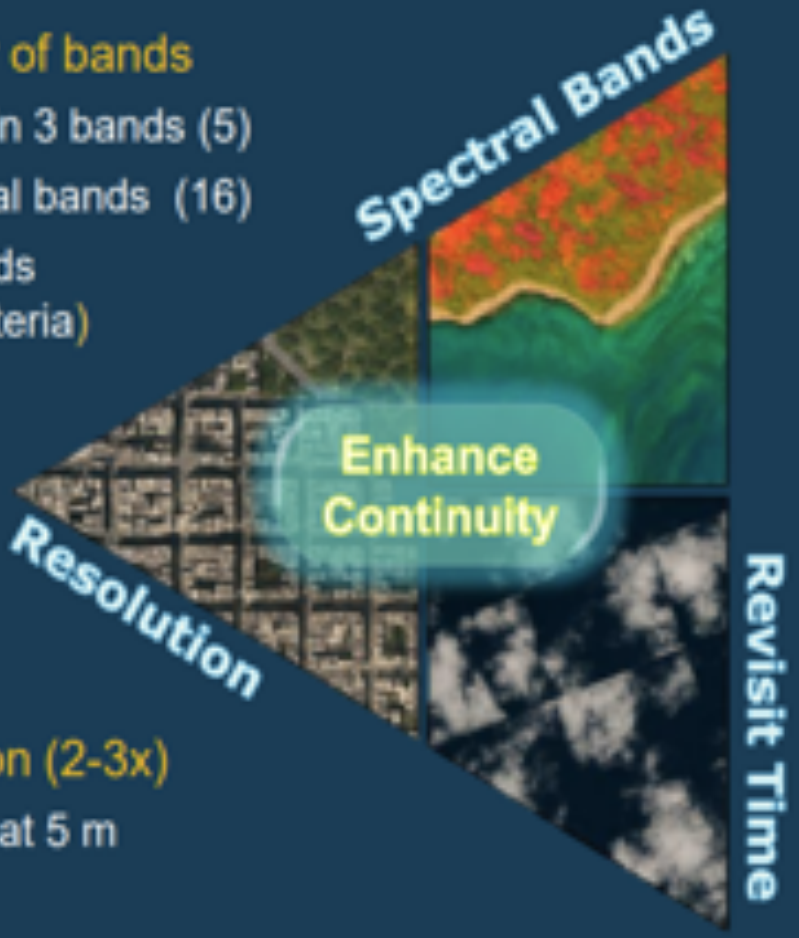
# S2-NG

## Future missions

**Expected launch 2032 +**

Multi-spectral mission ensuring enhanced continuity of service for S-2 products

- Increased number of bands
  - ✓ SWIR: B12 split in 3 bands (5)
  - ✓ VNIR: 6 additional bands (16)
    - Water bands (cyanobacteria)




- Improved resolution (2-3x)
  - ✓ B2, B3, B4 & B8 at 5 m

- Expanded coverage mask
  - ✓ Maritime Exclusive Economic Zone
  - ✓ Night-time observations
  - ✓ Twilight (ice / snow monitoring)

- Revisit time
  - ✓ 5 days globally with 2-satellites
  - ✓ 3 days at European latitudes with 3-sat
  - ✓ Synergy with Landsat-next

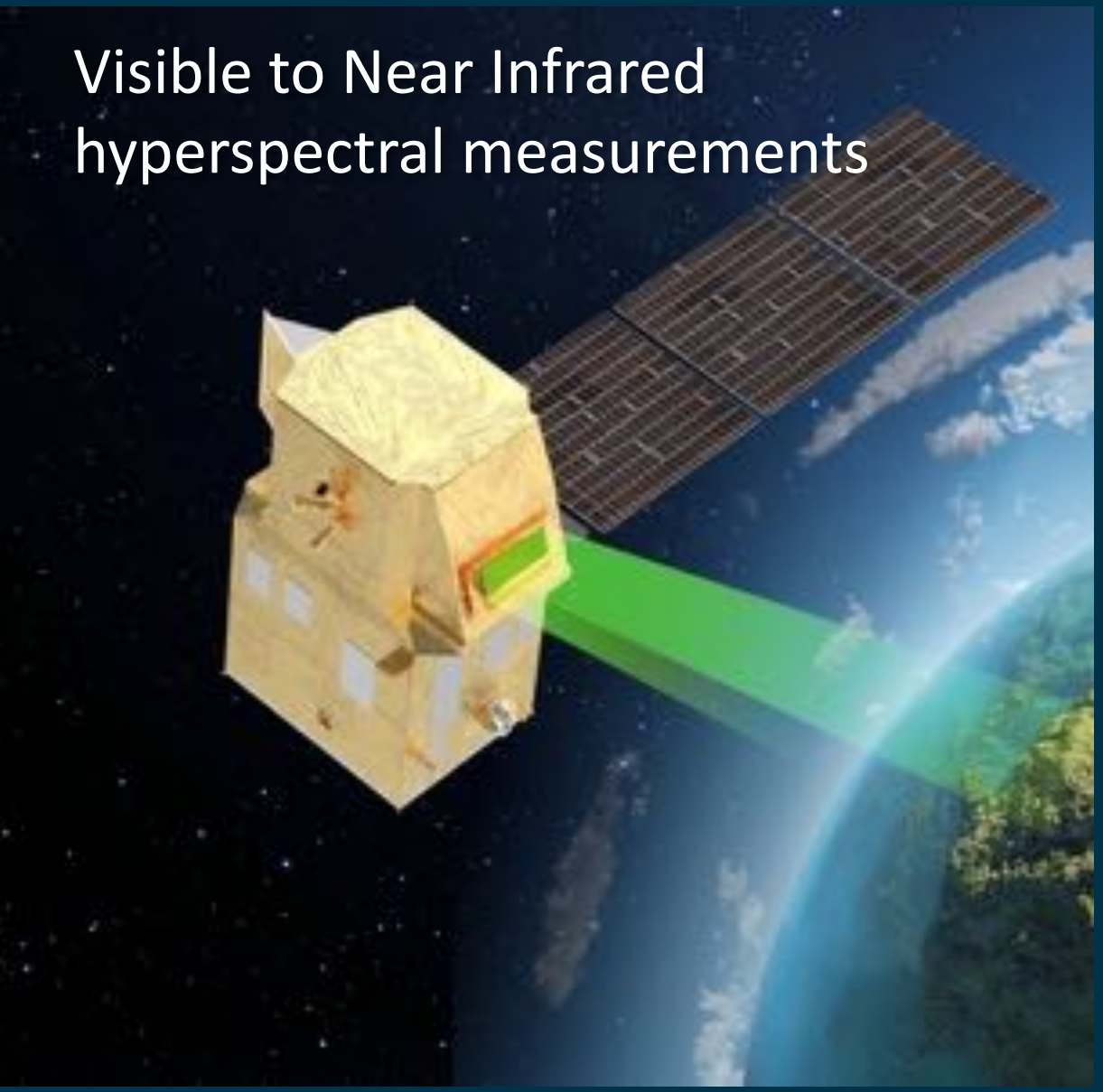
- Improved data latency
  - ✓ L1C products from 6 hours to 3 hours
  - ✓ L2A products in less than 4 hours

# CHIME

## Future missions

**Expected launch 2029**

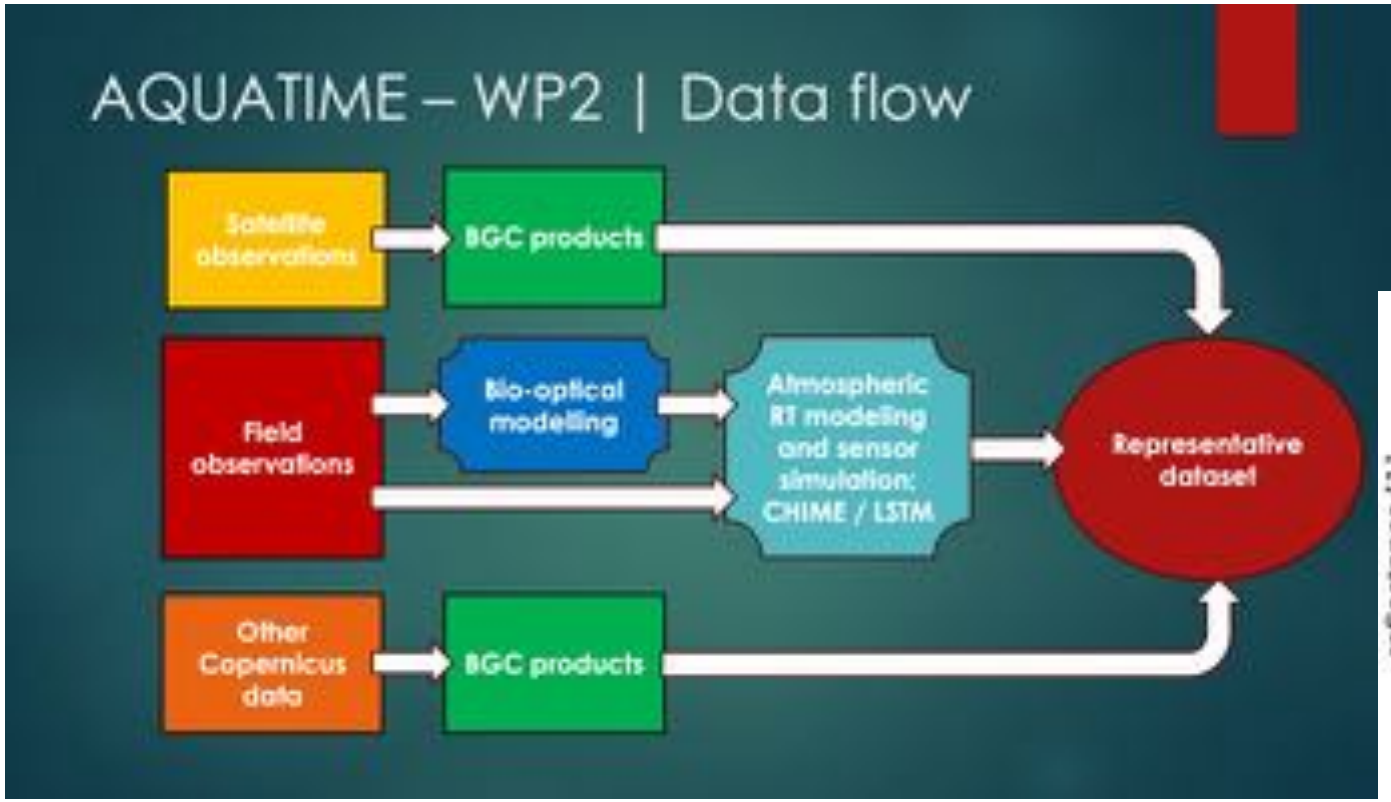
Visible to Near Infrared hyperspectral measurements

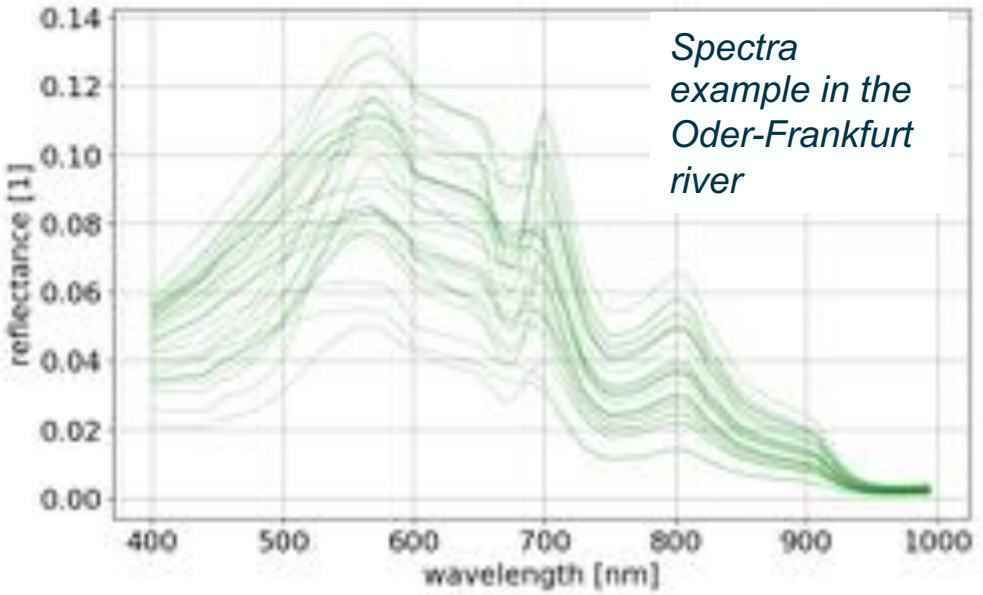


- **Characteristics**
  - ✓ 30 m ground resolution
  - ✓ swath width 130 km and 2 satellite mission -> 11 day revisit time
  - ✓ 200+ bands 400 – 2500 nm
  - ✓ coastal areas coverage up to 370 km from land

- **Application domains:** biodiversity and ecosystem sustainability, forestry management, environmental degradation, lake/coastal ecosystems, water quality, and snow characteristics.
- **In inland and coastal waters** Hyperspectral information is expected to provide more accurate assessments of:
  - ✓ turbidity and transparency measures,
  - ✓ chl-a,
  - ✓ suspended matter,
  - ✓ coloured dissolved organic matter concentration
  - ✓ It will enable more sophisticated phytoplankton information products that also include secondary pigments as proxies for harmful algae blooms and the identification of phytoplankton types.

**AQUATIME** "Novel phytoplankton information products for improved understanding of aquatic ecosystems and biodiversity based on synergistic time series analysis of Sentinel Expansion and Sentinel Missions for launch 2028"




*Spectra example in the Oder-Frankfurt river*

# EarthCARE (EE6)

Launched on May, 28th 2024

esa

Global measurements of aerosols, high altitude clouds and Earth radiative budget

Study of natural and anthropogenic Climate Change

→ THE EUROPEAN SPACE AGENCY

# EarthCare+Innovation: Ocean Color EarthCARE Analysis

OCEAN

ESA | JAXA

earthcare

The **objective** of the OCEAN (Ocean Color EarthCARE ANalysis) project is to derive in-water EarthCARE products from the analysis of the ocean sub-surface backscattered components of the 355 nm signal acquired by the ATLID (ATmospheric LIDar). The project will focus on the potential retrieval of the ocean optical properties at 355 nm.

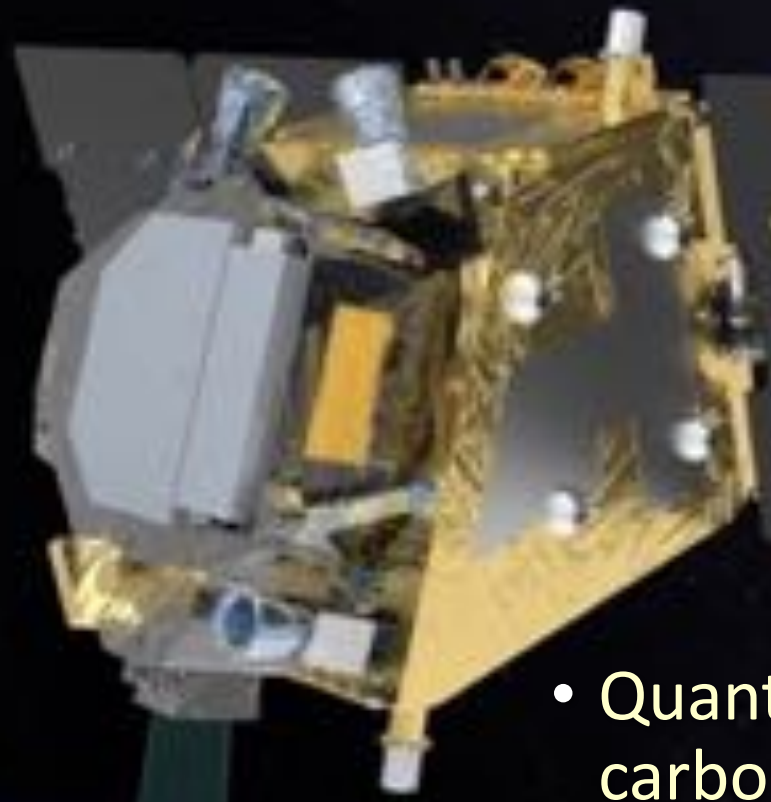
Æquamra consulting

LOG Laboratoire d'Océanologie et de Géosciences

INNUERE CONSULTING

# FLEX (EE8)

Visible to Near Infrared Spectrometer measuring photosynthesis and vegetation stress

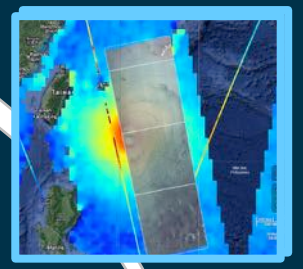
- Quantify the exchange of carbon between plants and the atmosphere, vegetation Provide better insight into plant functioning, health, and stress

Launch date: 2026

# ESA EO4Society Science and Application Projects

# Ocean Science Cluster Projects

## Ocean Extremes

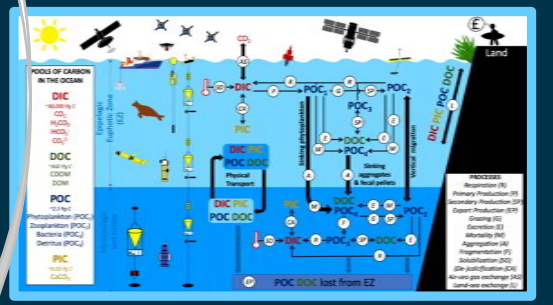


- https://eo4society.esa.int/
- https://eo4society.esa.int/communities/scientists/esa-ocean-science-cluster/

## Ocean Health and Biodiversity

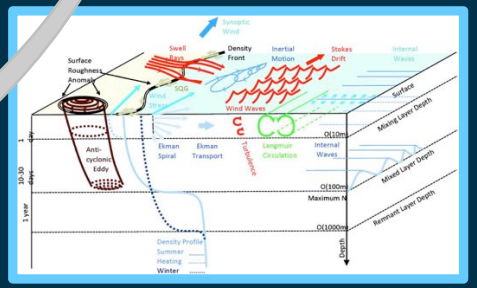
## Coastal Ocean incl. Land-Sea interactions


## Ocean Carbon



## Ocean's role in Earth and Climate System

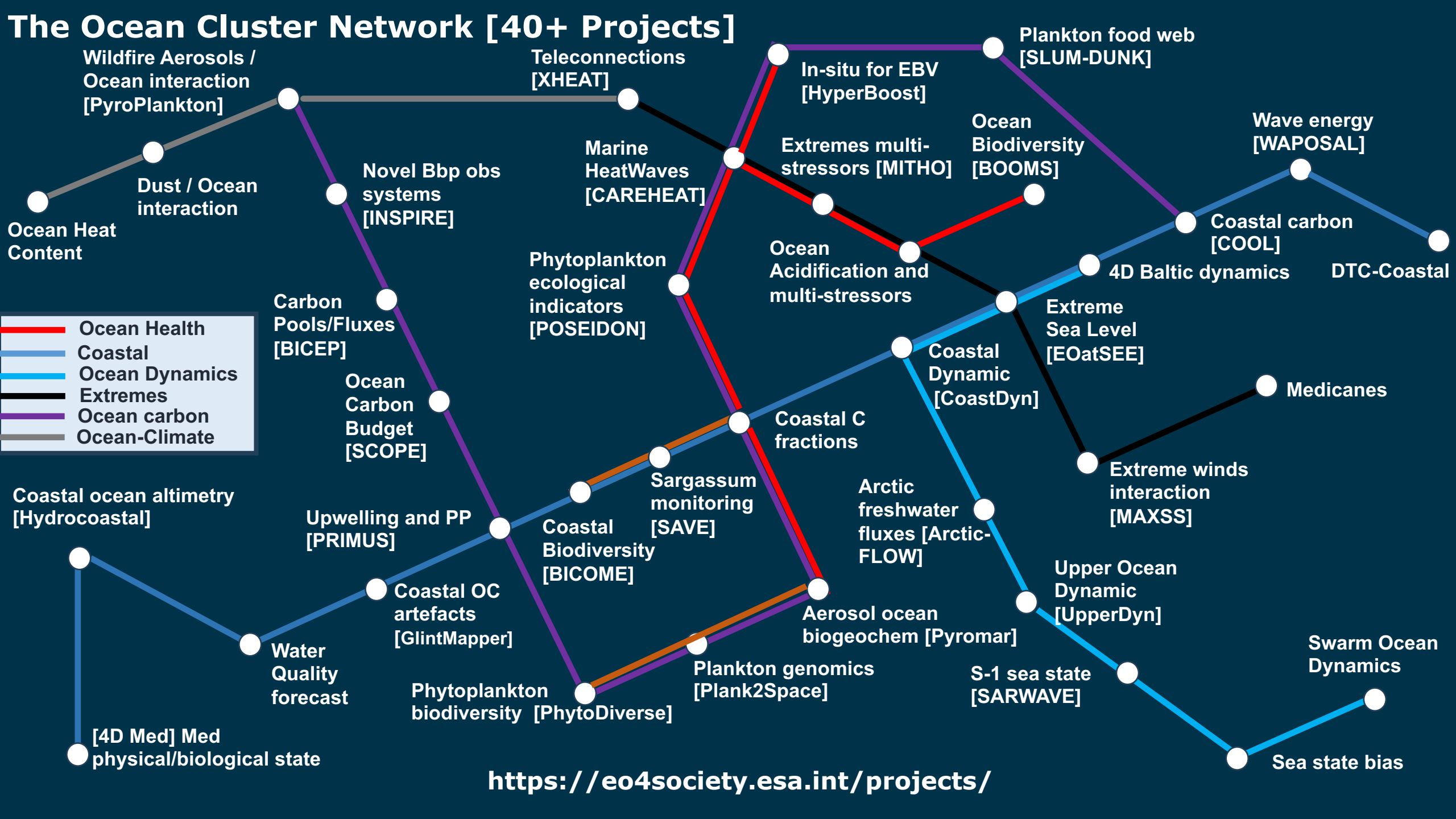
## Upper-ocean dynamics including air-sea interactions



ESA OCEAN SCIENCE CLUSTER

EO SCIENCE FOR SOCIETY

# The Ocean Cluster Network [40+ Projects]




https://eo4society.esa.int/projects/

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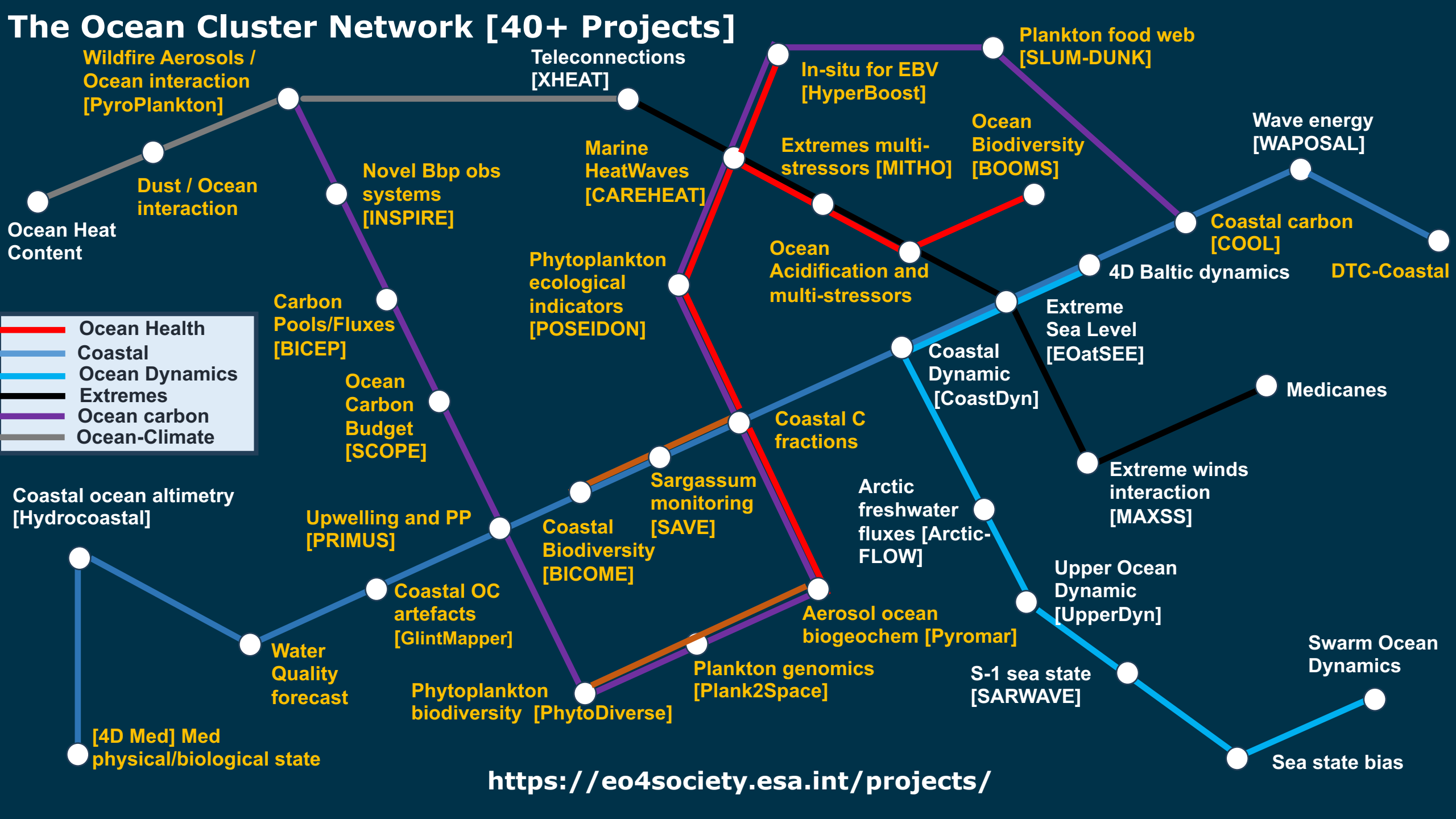
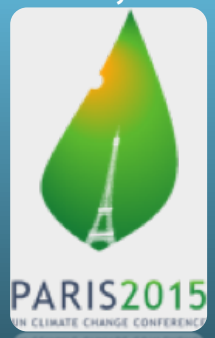



https://eo4society.esa.int/projects/

# EO to enable International and European Policy Frameworks

## UN Resolutions, Treaties & Int. Conventions

## European Regulations, Directive and Strategies









ESA Coastal Blue Carbon PROJECT



DEEPBLUE*2


DIOMEDEO


EO4SA


BLUERISM

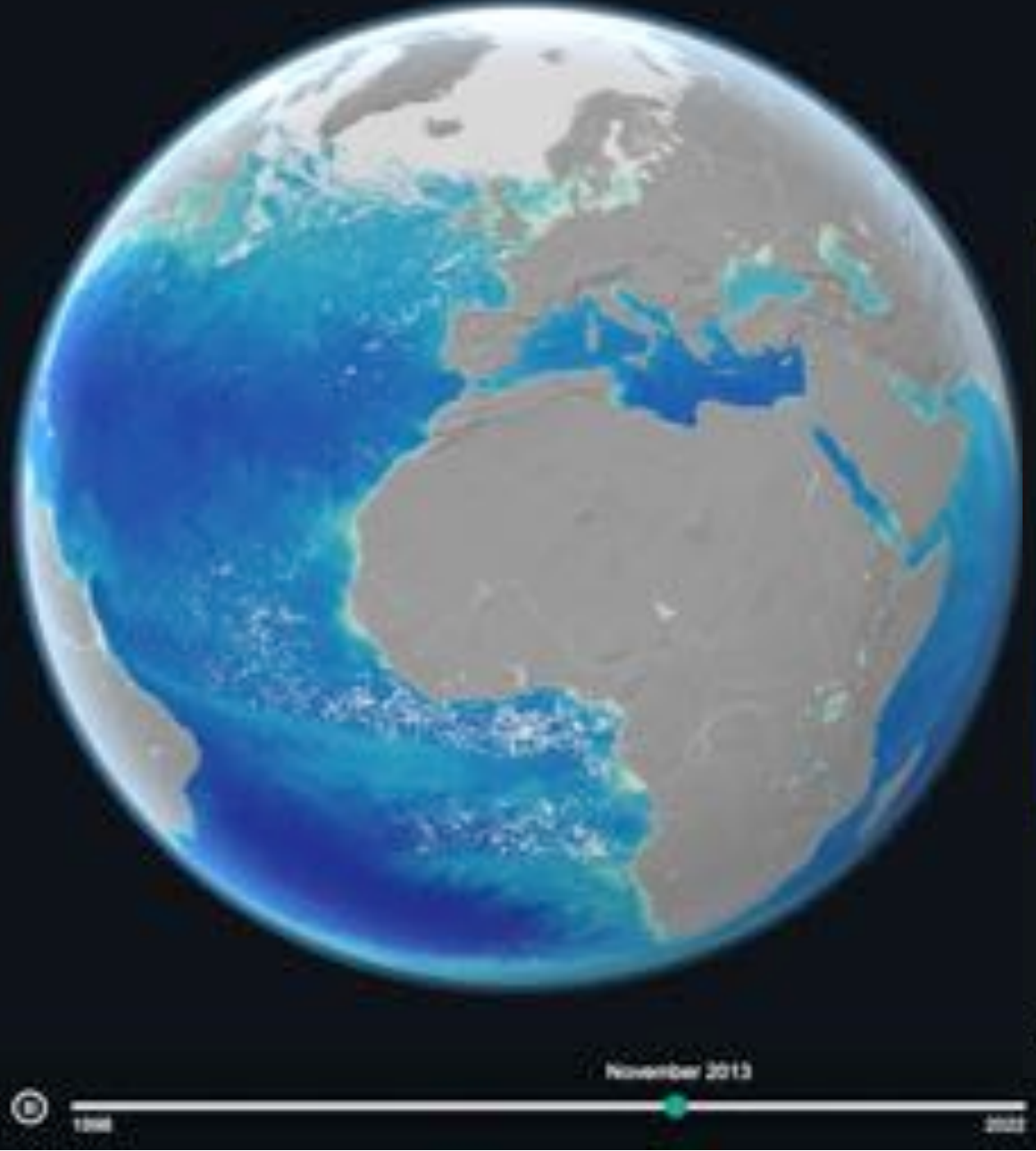

**Dedicated dredge plume monitoring with EO (PLUMES)**

# Climate Change Initiative Ocean Colour 1997-2022

**Latest News**

- **ESA-ECSAT will host the IOCCG Secretariat for the new Task Force on *Harmonizing Global Ocean Colour for Long-Term Climate and Ecosystem Monitoring,*** *https://ioccg.org/group/ltts/*

- **New CCI Phytoplankton ECV**
  - ✓ Phytoplankton carbon biomass and pigment diversity
  - ✓ Aim 1997-2025 timeframe for climate data record



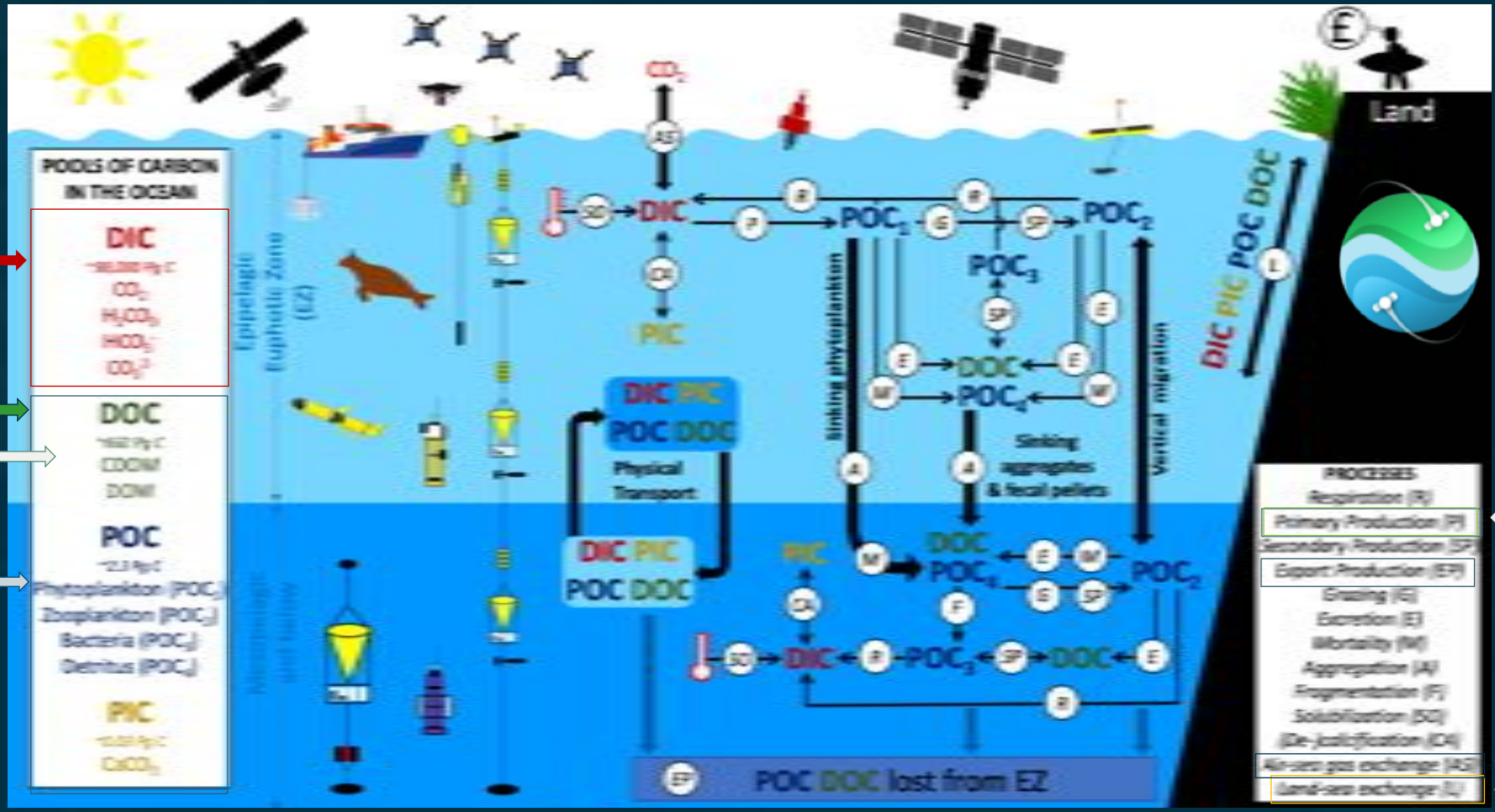

Global record 1997-2022 (monthy) 4km resolution

Addresses Ocean Colour GCOS ECV including data products for:

- Radiance
- Chlorophyll-a
- Optical properties

- Multisensor time series includes data from SeaWiFS, MODIS, MERIS VIIRS, Sentinel 3A & 3B OLCI

# Ocean Carbon Projects: Pools, fluxes and processes that form the ocean solubility and biological carbon pump




OceanSODA Ocean Health - Acidification

BICEP*

Aeolus+ S5P+OC

Physioglob

ARI-EBUS-PRIMUS

AMT4OceanSatFlux

OceanFlux-ghg

SeaLaBio

COOL

From Brewin et al, 2021. Sensing the ocean biological carbon pump from space: A review of capabilities, concepts, research gaps and future developments, Earth-Science Reviews 217 (2021) 103604.

SCOPE | SATELLITE-BASED OBSERVATIONS OF CARBON IN THE OCEAN: POOLS, FLUXES AND EXCHANGES

Ocean Carbon for Climate

# 2nd Ocean Carbon From Space WS


**4 Themes:**

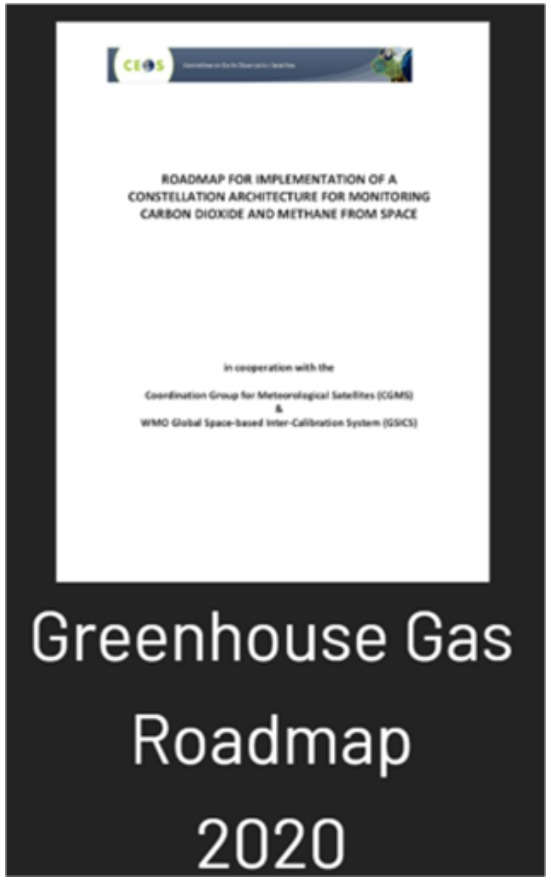
- **Theme 1** – Algorithm development and validation
- **Theme 2** – Physical and biological processes that underpin the ocean carbon cycle
- **Theme 3** – Impact of climate change on the ocean carbon cycle
- **Theme 4** – Closing the ocean and global carbon budget

**4 Keynotes**

**32 Oral presentations**
**23 Posters**

# Contribution to CEOS Workplan: Toward an Aquatic Carbon Roadmap

CEOS Global Stocktake strategy paper -> demonstrate the value of Earth Observation satellite datasets to support the Global Stocktake process



## CEOS Aquatic Carbon Roadmap

**Coordination Team:**

Marie-Helene Rio (ESA), Laura Lorenzoni (NASA), Hiroshi Murakami (JAXA)

**Scientific leaders:**

Jamie Shutler (University of Exeter), Robert Brewin (University of Exeter)' Cecile Rousseaux (GSFC-NASA), KelseyBisson (NASA)

**Objective:** To provide a framework and serve as a guiding vision for long term (~ 15+ years) coordination of CEOS agency observing programmes regarding the science and policy needs for Aquatic Carbon related information in the context of the CEOS carbon strategy

# Outcome of CMIP25

**Planned Activities 2026-2028**

**Carbon**
Carbon budget
Blue Carbon
mCDR

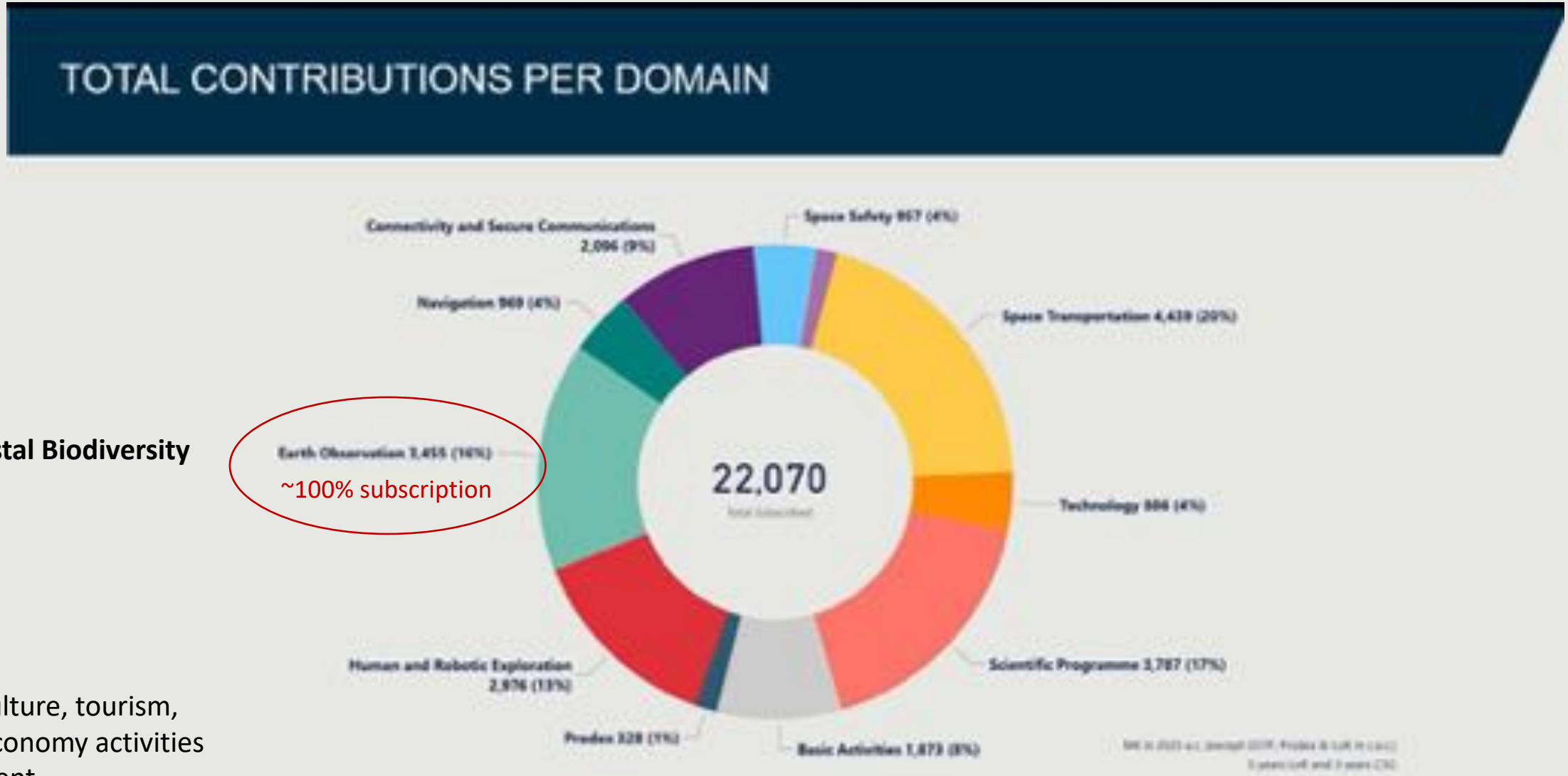
**Water Pollution**

**Marine and Coastal Biodiversity**

**Ocean Extremes**

**Polar Seas**

**Blue Economy**
Fisheries, aquaculture, tourism,
Impact of blue economy activities on the environment



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# Ocean Science Cluster mailing list

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https://esacontact.esa.int/ocean-science-cluster-newsletter-subscribe/

Thanks!