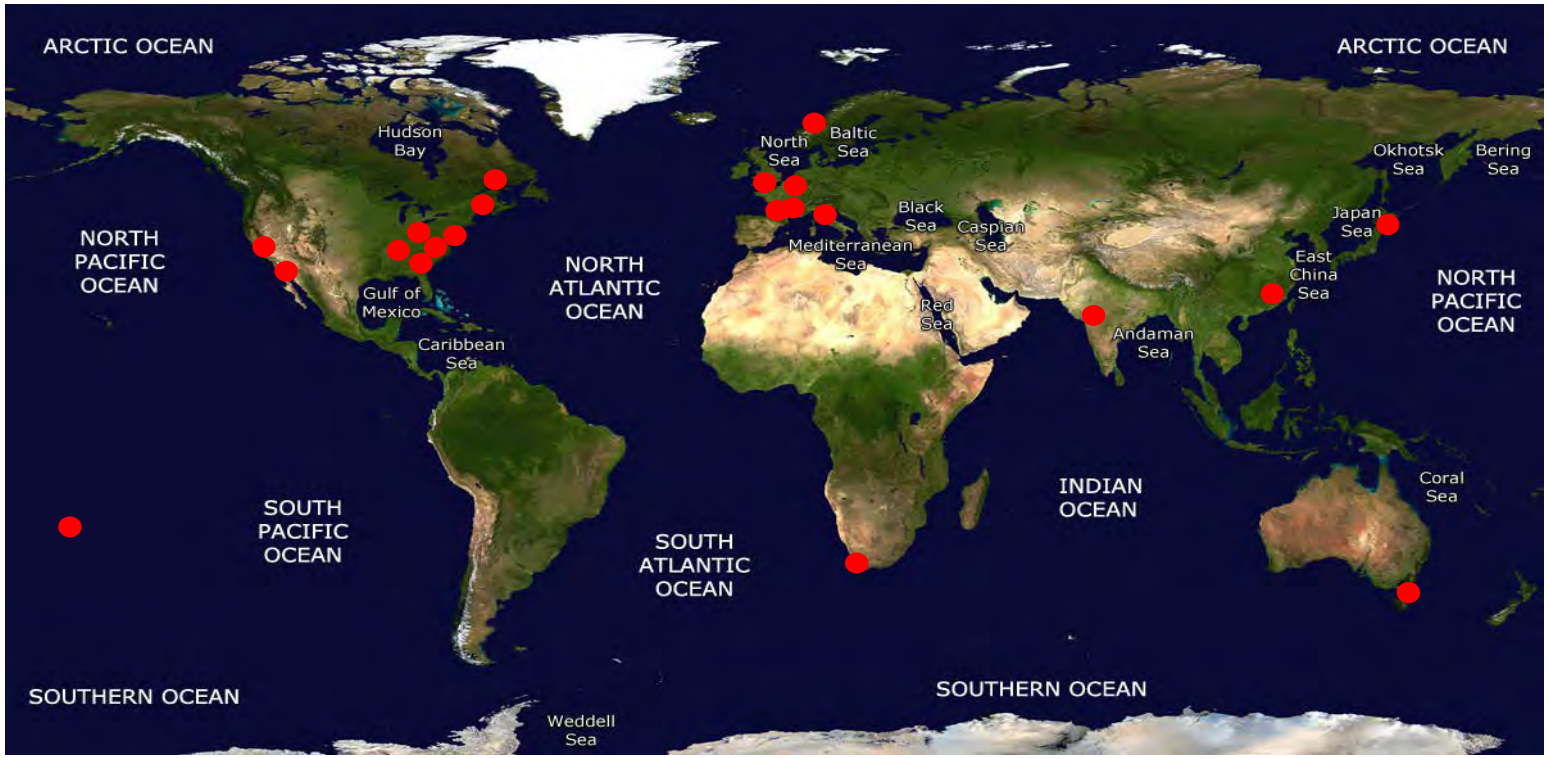
Marine Ecosystem Analysis and Prediction (MEAP) Task Team

Co-chairs:
Liuqian Yu (HKUST(GZ)), Stefano Ciavatta (MOi), Marjorie Friedrichs (VIMS, step-down)

Patron: Paul Di Giacomo (NOAA, USA)

The Marine Ecosystem Analysis and Prediction Task Team

OceanPredict
Advancing the science of ocean prediction



28 members

21 institutes

12 countries

The Marine Ecosystem Analysis and Prediction Task Team

OceanPredict
Advancing the science of ocean prediction

Mission

Advancing the underpinning science and tools for integration of biogeochemical and ecosystem models into operational systems.

"Operational"

- Hindcasts/reanalyses
- Short-term (days to weeks) & seasonal (months) forecasts
- Climate change projections
- Scenario simulations

Applications

1) Carbon cycle research & carbon accounting

- Quantification of carbon fluxes
- Sensitivity of carbon fluxes to climate forcing
- National carbon accounting

2) Marine ecosystem health and productivity

- Fisheries management
- Conservation of endangered species
- Design of MPAs (marine protected areas)
- Marine health indicators (eutrophication, acidification, deoxygenation, …)

Fennel et al. (2019) https://doi.org/10.3389/fmars.2019.00089

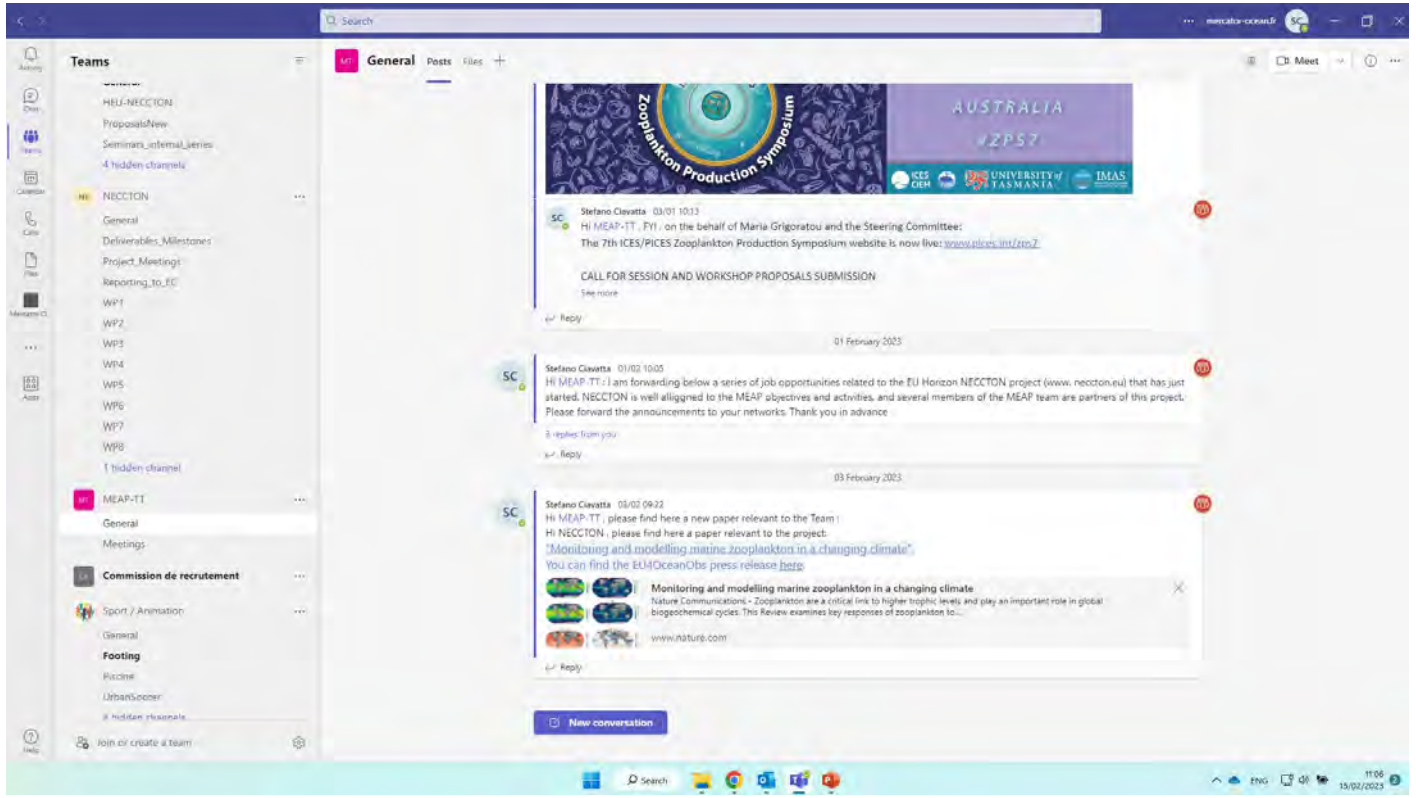
Recent MEAP-TT activities

OceanPredict
Advancing the science of ocean prediction

Networking, sharing, discussions, contributions

Active Microsoft Team Group

- Channels for sharing presentations, MEAP papers, other relevant papers and documents
- Chats on news, scientific challenges, job opportunities



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Monthly scientific meetings

- 1st Wednesday of the month 14 UTC
- Hands-on training workshop on SEAMLESS Ensemble and Assimilation Tool

(https://seamlessproject.org/SEAMLESS_EAT)

Seminars	Date	Topic
MEAP-TT online seminar 6	31 oct 2023	Machine Learning for Multivariate Data Assimilation in Biogeochemical Models
MEAP-TT online seminar 5	4 Oct 2023	Science talk: Biogeochemical (BGC) Argo data calibrate model parameters and model parameterizations for simulating the biological carbon pump (Bin Wang, Dalhousie University
MEAP-TT online seminar 4	6 Sep 2023	How including bio-optics improves biogeochemical models: present and future perspectives
MEAP-TT training workshop	5 July 2023	Hands-on workshop on the use of the SEAMLESS prototype (https://seamlessproject.org/SEAMLESS_Prototype)
MEAP-TT online seminar 3	1 June 2023	Carbon fluxes
MEAP-TT online seminar 2	3 May 2023	Ecosystem modelling (e.g., HTLs, habitats, ...)
MEAP-TT online seminar 1	1 Dec 2022	Integration of "new" observation in models

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  (https://seamlessproject.org/SEAMLESS_EAT)

Active collaborations

- Active MEAP collaborations in projects
  - e.g., SEAMLESS, NECCTON, EARTH-HK, other joint proposals under review)
- Active collaborations in dissemination activities
  - e.g. ETOOFS manual, IOCCP Annual meeting, OceanPredict DCC co-design meeting

Contributions

- UN Decade initiatives
  - e.g., ForeSea SC, SynObs SC, Marine Life 2030, GOOS co-design
  - Together with NOC, UK Met Office and CEFAS, PML has submitted a pilot sites to the GlobalCoast survey of Coast Predict
- OceanPredict DCC SC

Scientific/network/impact highlights of MEAP members

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Scientific results and dissemination (joint papers and reports):

- OSPAR QSR23 – Assessment of Ocean Acidification https://oap.ospar.org/en/ospar-assessments/quality-status-reports/qsr-2023/other-assessments/ocean-acidification/
- Primer article "Ocean biogeochemical modelling" in Nature Reviews Methods Primers by Fennel et al., https://www.nature.com/articles/s43586-022-00154-2
- Decrease in air-sea CO_2 fluxes caused by persistent marine heatwaves. *Nat Commun* **13**, 4300 (2022) by Mignot *et al.* https://doi.org/10.1038/s41467-022-31983-0
- "A solution for autonomous, adaptive monitoring of coastal ocean ecosystems: Integrating ocean robots and operational forecasts" in Front. Mar. Sci. by Ford et al., https://doi.org/10.3389/fmars.2022.1067174
- “Evaluation of biogeochemical models performance and recommendation on observing system design using an unsupervised machine learning algorithm, BGC-Argo floats and assessment metrics”, Mignot et al., Biogeosciences, https://doi.org/10.5194/bg-2021-2
- Observability of the target indicators in the 3D CMEMS MFC systems (D3.4), Brasseur et al., Deliverable report of project H2020 SEAMLESS (grant 101004032.). doi: 10.5281/zenodo.7584865
- Review paper on “Persistent eutrophication and hypoxia in the coastal ocean”, Cambridge Prisms: Coastal Futures, by Dai et al., https://doi.org/10.1017/cft.2023.7
- …

Scientific/network/impact highlights of MEAP members

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New & on-going projects

- Ocean Alk-align project (funded by Additional Ventures, US$11M for 5 years, lead PI: Fennel)
  - focussed on ocean alkalinity enhancement as a mCDR technology
- EARTH-HK project (funded by Hong Kong Research Grants Council, US$ 11M for 2024-2028)
  - aiming at building a digital twin Regional Earth System to support sustainable development under climate change
- Current CoCO2 project (funded by European H2020 program)
  - aiming at building up the next Copernicus CO_2 Monitoring Service
- Mission Atlantic (Horizon Europe 2020-2025) (https://missionatlantic.eu/)
  - map and assess the present and future status of Atlantic marine ecosystems under the influence of climate change and exploitation.
- Horizon Europe project Ocean-ICU (https://ocean-icu.eu/)
  - produce new data, information and understanding on the role of the Ocean in the global carbon cycle
- H2020 SEAMLESS project (2021-2023)
- Horizon Europe NECCTON project (2022-2025)

SERVICES BASED ON ECOSYSTEM DATA ASSIMILATION: ESSENTIAL SCIENCE AND SOLUTIONS (SEAMLESS)

Partners

Advisory board

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004032.

SEAMLESS

OceanPredict
Advancing the science of ocean prediction

1. **New ensemble generation and data assimilation methods** (WP3, P Brasseur, UGA)
   to maximize the flow of information from the new observing networks
   towards the controllable ecosystem indicators

2. **Coupled assimilation of physical and biogeochemical data** (WP4, L Bertino, NERSC)
   to improve the consistency of the biogeochemical and physical simulations

3. **Coupled assimilation of remote sensing & in situ biogeochemical data** (WP5, Cossarini, OGS)
   to link the surface and subsurface ecosystem dynamics

4. **Coupled assimilation for joint state-parameter estimation** (WP6, J Skakala)
   to improve the models and their simulation of biogeochemical indicators

BGC models: PISCES, ERSEM, BFM, ECOSMO, ERGOM, [BAHMBI]

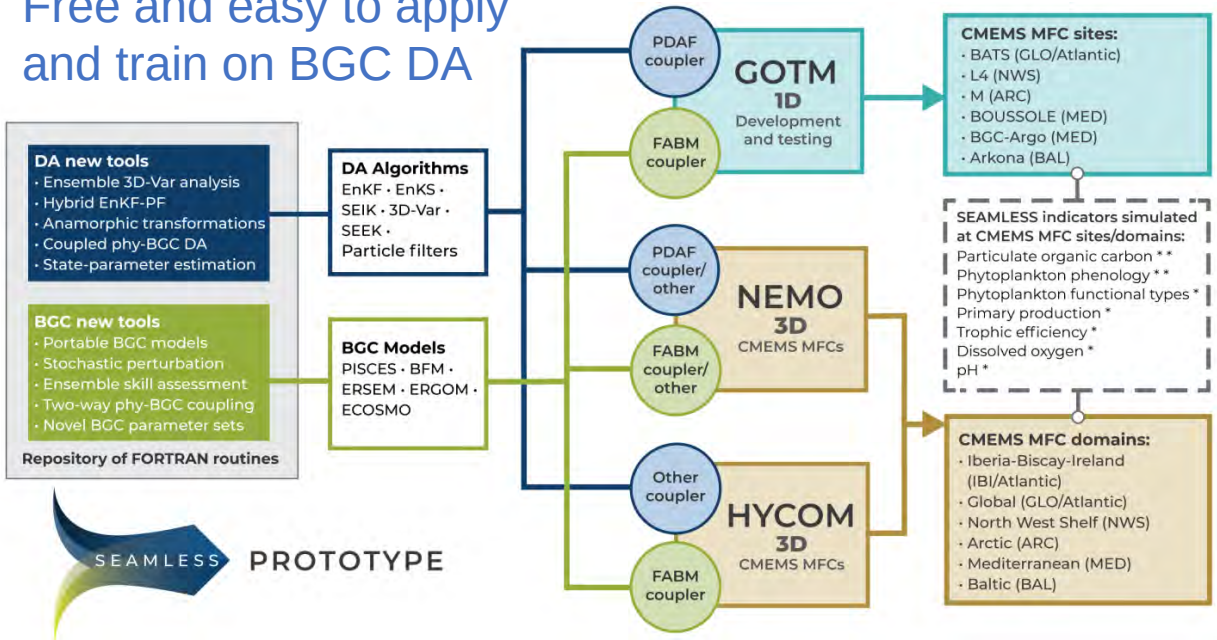
odessa.webp

SEAMLESS Prototype

OceanPredict
Advancing the science of ocean prediction

Ensemble and Assimilation Tool (EAT)

Free and easy to apply and train on BGC DA



Copernicus Marine Service

COPERNICUS MARINE SERVICE
BALTIC SEA MFC
Until 31 Dec. 2024
Contract 21002L2-COP-MFC BAL-5200

European Commission

NECCTON
NEW COPERNICUS CAPABILITY FOR TROPHIC OCEAN NETWORKS

Organized a training session for MEAP Task-Team in July 2023

Organize a training session for Early Career Researchers in North African Countries, in collaboration with MONGOOS, Morocco, 16 November 2023

ACADEMY

Next generation of ocean scientists and assimilators

SEAMLESS (almost) final recommendations (and wait for the roadmap 4CMEMS)

1. **We recommend to fix the model first.** Improve parameterisation and representation of the processes that drive your indicators: ensemble DA might exasperate systematic biases

2. **We advocate for enhanced BGC observation platforms/networks/services** to provide more (both quantity and variety) and quality assured BGC data for assimilation and validation of both outputs and derived indicators: biogeochemical-ARGO floats, BGC gliders, geo-stationary ocean colour satellite, plankton automated observations (videocam, acoustic)

3. **We endorse the use of ensemble BGC DA** approaches because they: (i) enable the representation and use of model uncertainty, (ii) provide means to evaluate the controllability of indicators (iii) provide metrics to evaluate the performance of DA systems

4. **We promote dedicated funding and research on coupled BGC DA** (physics and BGC, in situ and satellite, state and parameter estimation) with the novel ensemble methods and tools (EAT) developed by SEAMLESS

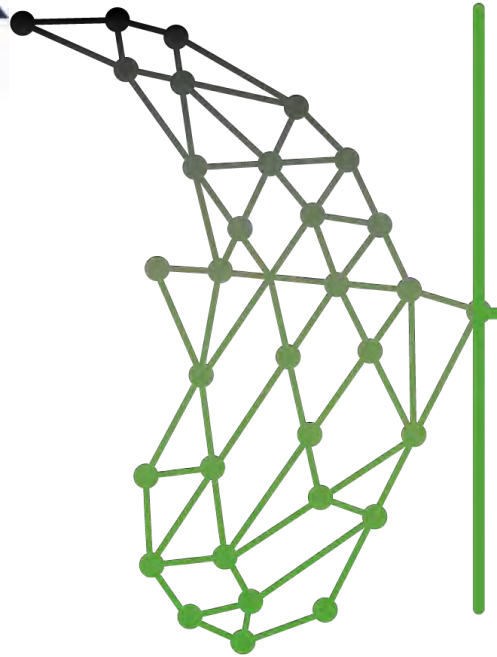
5. **We recommend to use SEAMLESS EAT** to analyse the sensitivity, tune, compare and train BGC DA methods, set-ups, strategies.

Ciavatta et al., in preparation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004032.

MERCATOR OCEAN INTERNATIONAL

OceanPredict
Advancing the science of ocean prediction



NECCTON

NEW COPERNICUS CAPABILITY FOR TROPHIC OCEAN NETWORKS

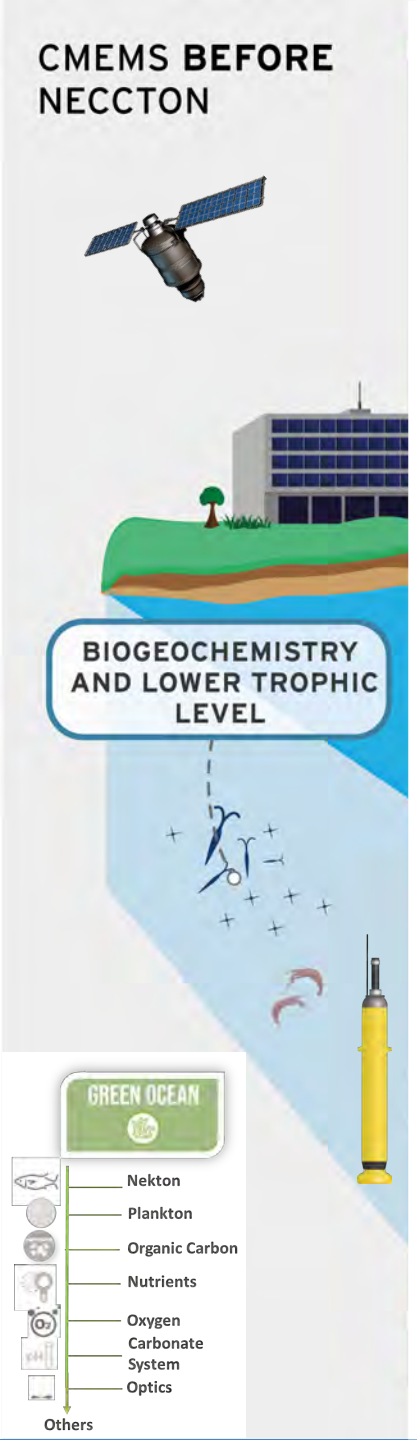
Transforming the European capability to predict and protect the biodiversity of marine ecosystems

Stefano Ciavatta, project lead

This project has received funding from Horizon Europe RIA under Grant Number 101081273

Key-facts

- Copernicus evolution project
- Duration: 4 years (Jan 2023-Dec 2026)
- Budget: 10M Eur
- Coordination: S Ciavatta - Mercator Ocean international
- Management: J Heard – Plymouth Marine Laboratory
- Partners: 23



NECCTON's overall objective

To enable the Copernicus Marine Service to deliver new modelling products for the green ocean: fishes, pollution and benthic habitats

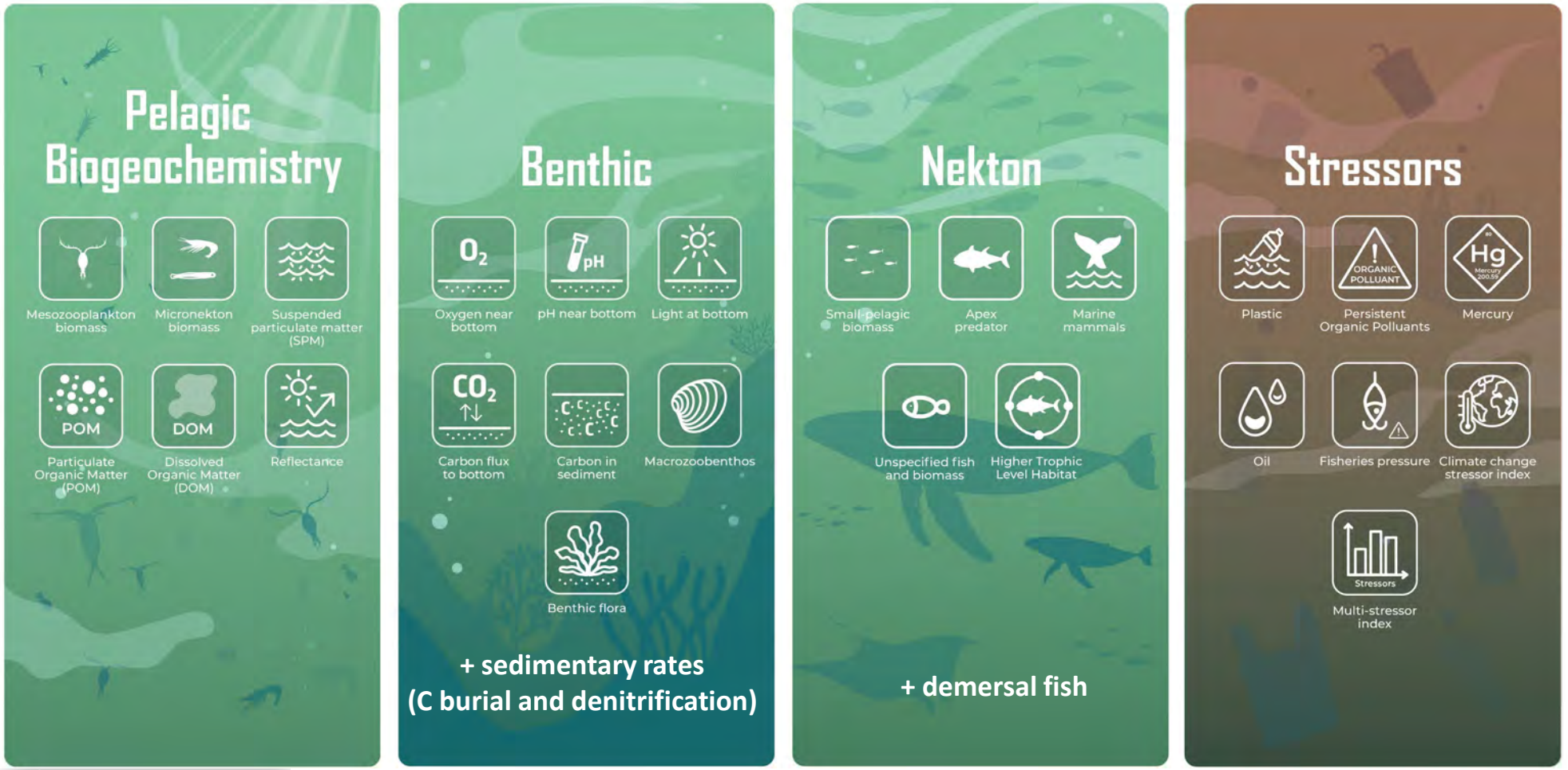
POLICIES & OCEAN GOVERNANCE & MITIGATION

MARINE FOOD

OCEAN HEALTH

CLIMATE & ADAPTATION

The ~~25~~ 26 NECCTON products



GREEN OCEAN

OBSERVATIONS In-situ and satellites › **MODELS** Assimilation and ML › **HINDCASTS** Decadal › **PROJECTIONS** Multi-decadal

44 datasets

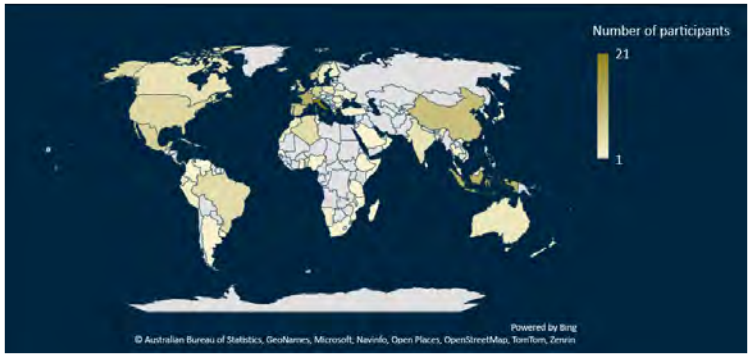
Co-designing products: Stakeholder engagement (WP2)

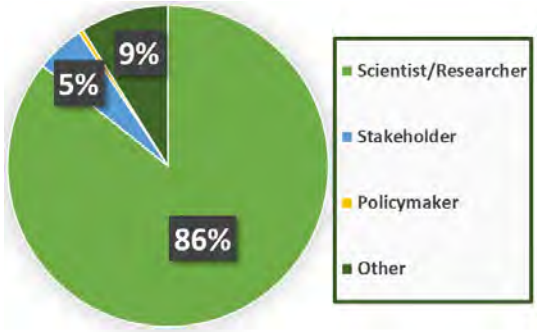
- 2-day workshop
- **Target (KPI):** 100 participants (111 peak)
- Visuality was hired to assist us with the technical details and to bring **new tools**
- 2 rounds of **4 simultaneous parallel sessions**
- Between 15 and 25 participants for each session
- 2 types of tools used: **Slido** and **Mural**
- Each WP leader worked with Visuality in the creative process

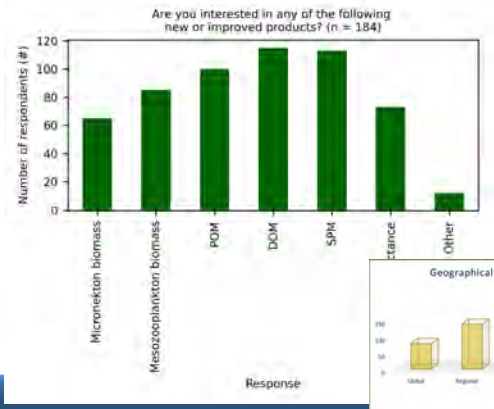
Watch the Plenary Session here:
NECCTON - New Copernicus Capability for Trophic Ocean Networks

NECCTON survey

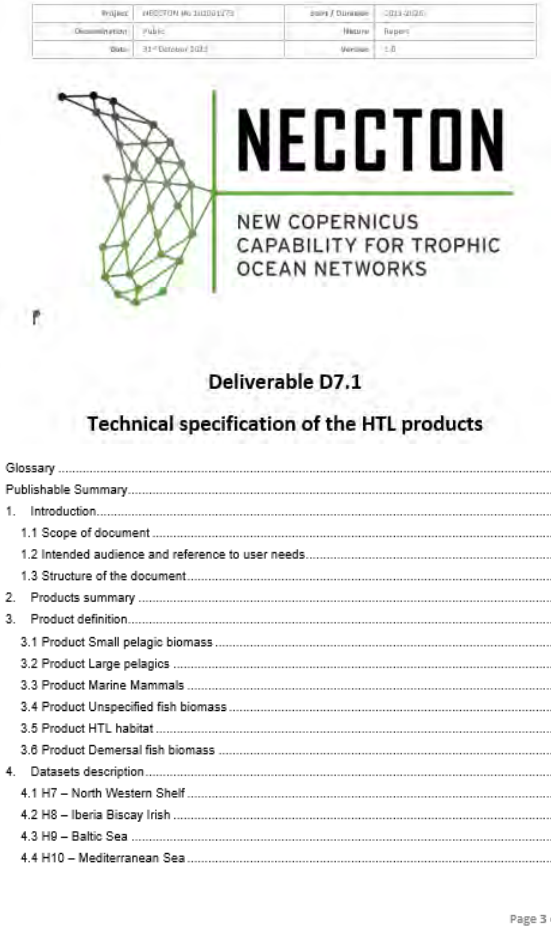
- Opened from 17/07 to 08/09 with 3 reminders (sent to more than 4500 registered users)
- 224 participants
- 124 participants (>55%) agreed to be contacted and would like to receive information about NECCTON







Product standardization



NECCTON

NEW COPERNICUS CAPABILITY FOR TROPHIC OCEAN NETWORKS

Deliverable D7.1

Technical specification of the HTL products

Glossary 3
Publishable Summary 4
1. Introduction 5
1.1 Scope of document 5
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Page 3 of 3

Co-product ID	Co-product in bold and green shade
	Sub-variable in bold and italic
14.1	Small pelagic biomass
Sub-variable name [unit]	***Anchovy adults biomass*** [gWW/m2]
Description	Average monthly spatial biomass distribution of European anchovy *Engraulis encrasicolus*
Long name	Anchovy adults biomass distribution per square kilometre
Short name	Anchovy_biom
Standard_name	mass_content_of_anchovy_adults_expressed_as_wet_weight_in_sea_water
Sub-variable name [unit]	***Anchovy adults age 1 biomass*** [gWW/m2]
Description	Average monthly spatial biomass distribution of European anchovy *Engraulis encrasicolus* (adults age 1 group)
Long name	Anchovy adults age 1 group biomass distribution per square kilometre
Short name	Anchovy_adults_age_1_biom
Standard_name	mass_content_of_anchovy_adults_age_1_expressed_as_wet_weight_in_sea_water

Vision: leading an international effort to expand standards for marine ecosystem model products

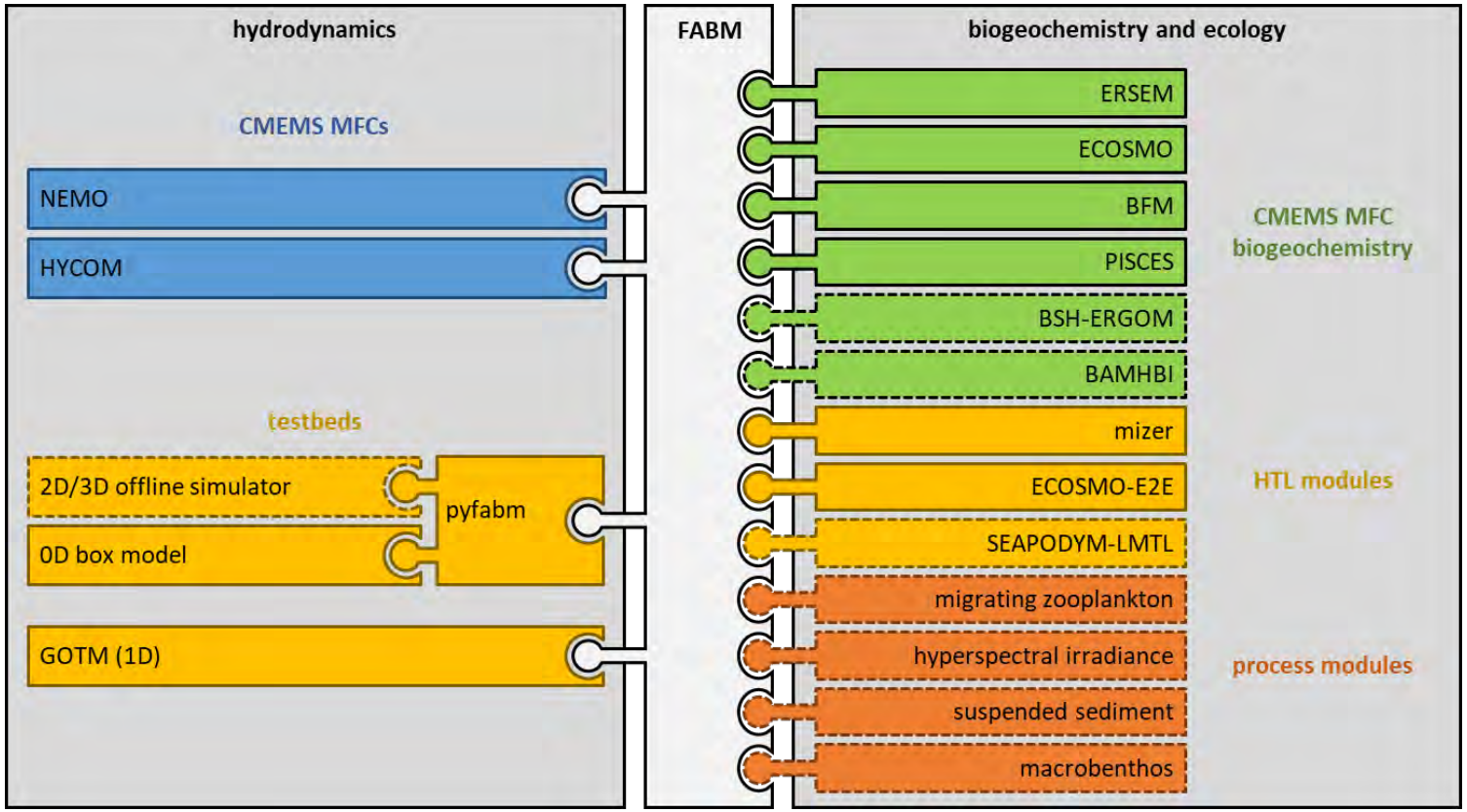
4.4 H10 – Mediterranean Sea

ID dataset	H10
Products names (product IDs)	Small pelagic biomass (14.9), Large pelagics (15.5), Unspecified fish biomass (17.10), Demersal fish biomas (27.4)
Name sub-variables	small_pelagic_biom, small_pelagic_SSB, small_pelagic_feeding_level, small_pelagic_average_adult_weight, small_pelagic_average_maturity_flux, small_pelagic_predation_mortality, large_pelagic_biom, large_pelagic_SSB, large_pelagic_feeding_level, large_pelagic_average_adult_weight, large_pelagic_average_maturity_flux, large_pelagic_predation_mortality, total_fish_biom, total_fish_SSB, total_pelagic_average_maturity_flux, demersal_fish_biom, demersal_fish_SSB, demersal_fish_feeding_level, demersal_fish_average_adult_weight, demersal_fish_average_maturity_flux, demersal_fish_predation_mortality
Geographical coverage	MED
Horizontal resolution	1/24 deg
Vertical resolution	none
Time period	2011-2020
Temporal resolution	Annual
Format	netCDF
Partner producer and contact	DTU Aqua, Ken H Andersen
Datasets used for calibration/validation/assimilation	A set of model parameters has been calibrated to observational estimates of peak catches in large marine ecosystems by implementing a fishing mortality that approximates maximum sustainable yield
Method	One-way coupled FEISTY
Name of output file(s)	FEISTY_NWS
Expected total max size of the data	1 Gb

- Specification Sheets of the Essential Ocean Variables, defined by the Expert Panels of the Global Ocean Observing System (GOOS)
- New CF metadata convention propositions
- Engagement of experts from AB and international programmes and projects (e.g. FishMIP, Marine Life 2030, H2020 EcoScope, …)
- Feedback to G7 FSOI, EU4OceanObs, ECOTIP

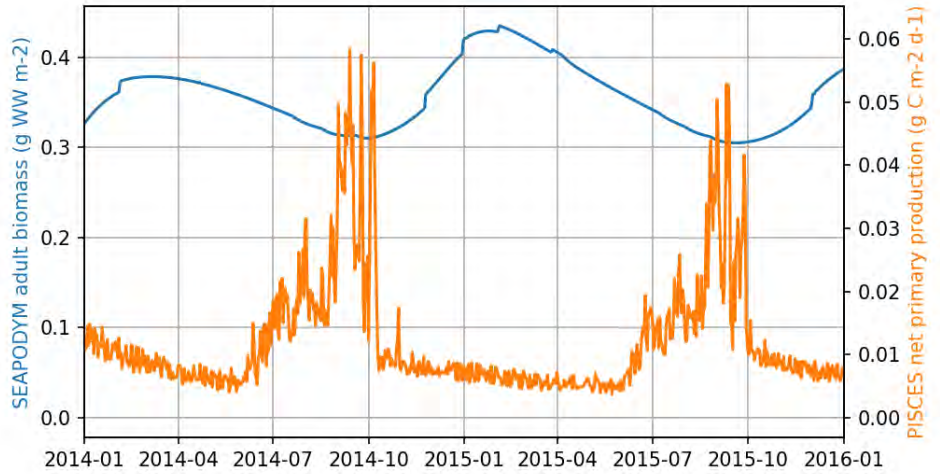
Developing a shared modelling framework

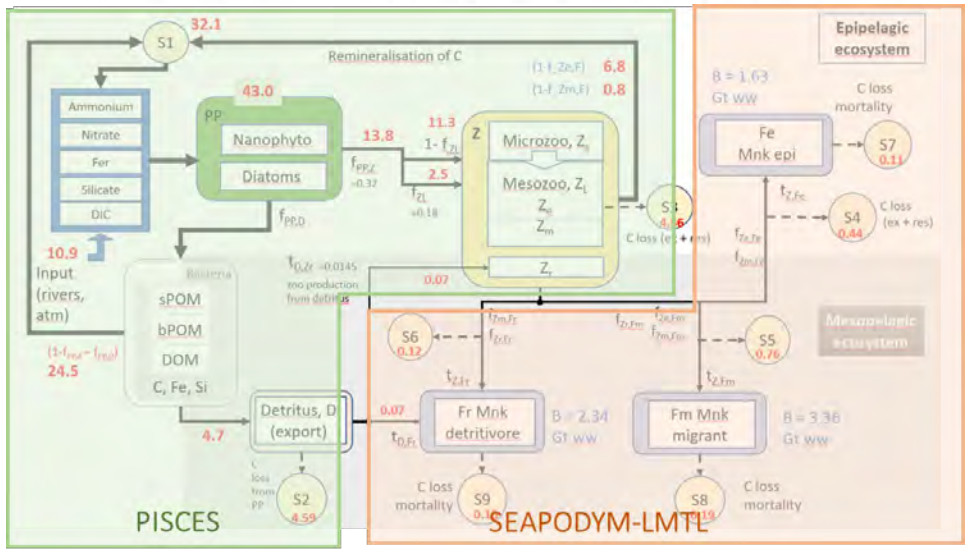
OceanPredict
Advancing the science of ocean prediction



FABM: Framework for aquatic biogeochemical modelling

PISCES + SEAPODYM micronekton





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004032.

GOTM-PISCES-SEAPODYM, Tasman Sea
Courtesy of Sarah Albernhe (CLS)

EARTH-HK
Ocean-Land-Atmosphere
卓越學科領域計劃
Areas of Excellence Scheme

OceanPredict
Advancing the science of ocean prediction

Study of the regional earth system (RES) for sustainable development under climate change in the Greater Bay Area

The Hong Kong University of Science and Technology (HKUST)

Project Coordinator: Jianping Gan

Co-PIs: Minhan Dai; Jimmy Jiao; Dabo Guan

Co-Is: Hongbin Liu; Jie Xu; Benoit Thibodeau; Huamin Qu, Liuqian Yu, et al.

International Advisory Committee

Donald Anderson (WHOI)

Sean Crowe (UBC)

Dale Durran (U of Washington)

Katja Fennel (Dalhousie)

Jim McWilliams (UCLA)

Matthias Peichl (SLU)

EARTH-HK
Ocean-Land-Atmosphere
卓越學科領域計劃
Areas of Excellence Scheme

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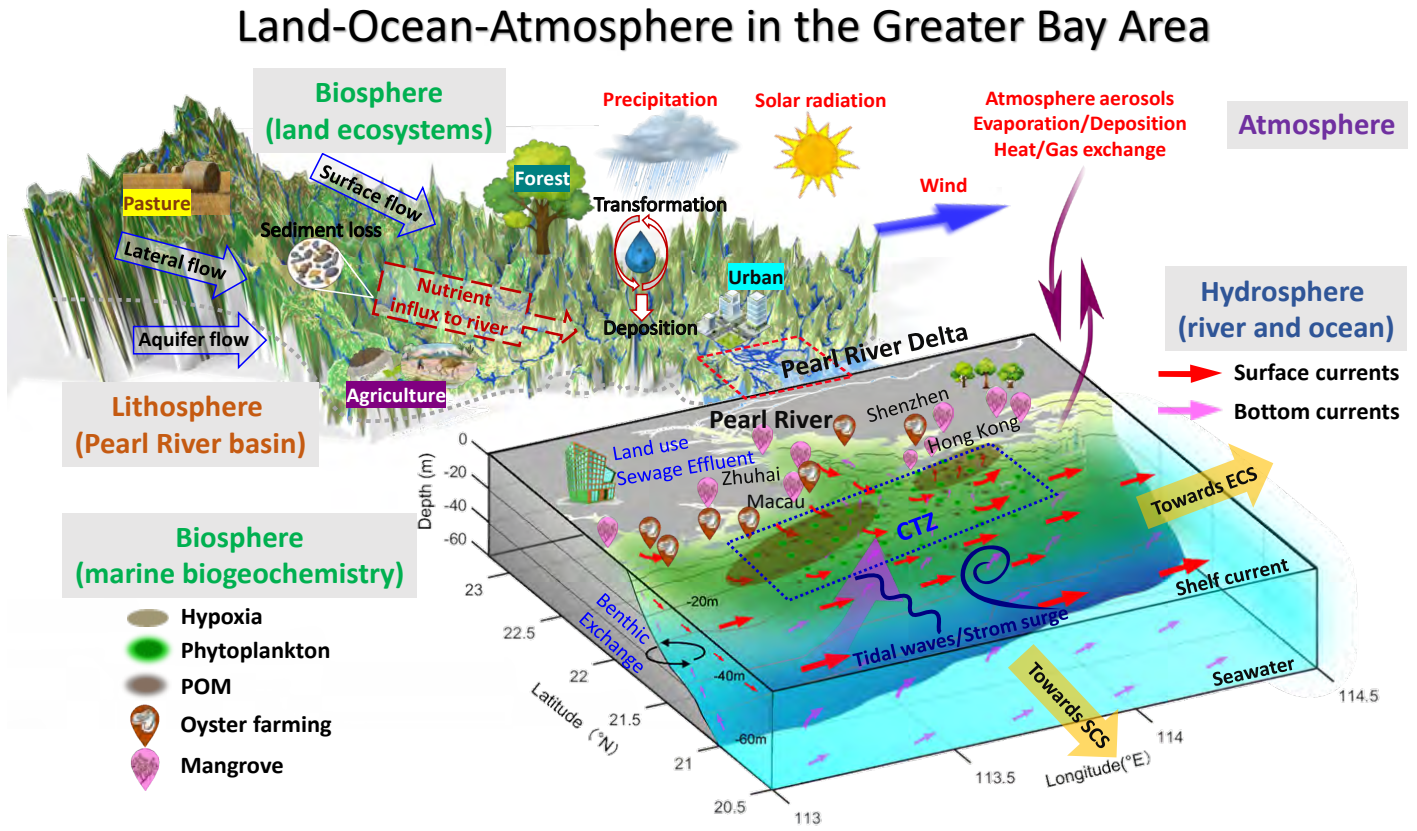
Study of the regional earth system (RES) for sustainable development under climate change in the Greater Bay Area



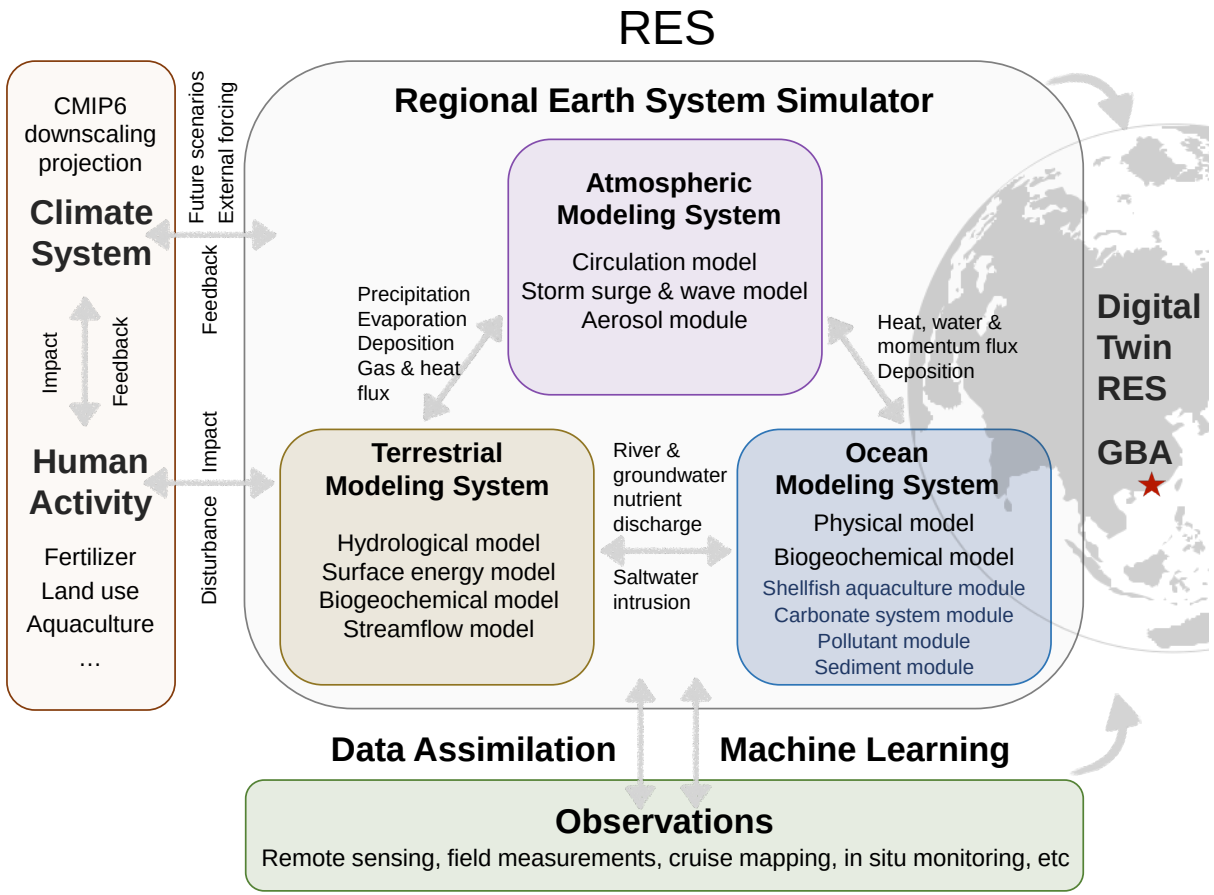
Mission & Goals

Mission

provide science-based understanding, planning and mitigation strategies and solutions through a *digital twin* to subsequently safeguarding environmental sustainability and resilience against human activities and climate change in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA).

Goals

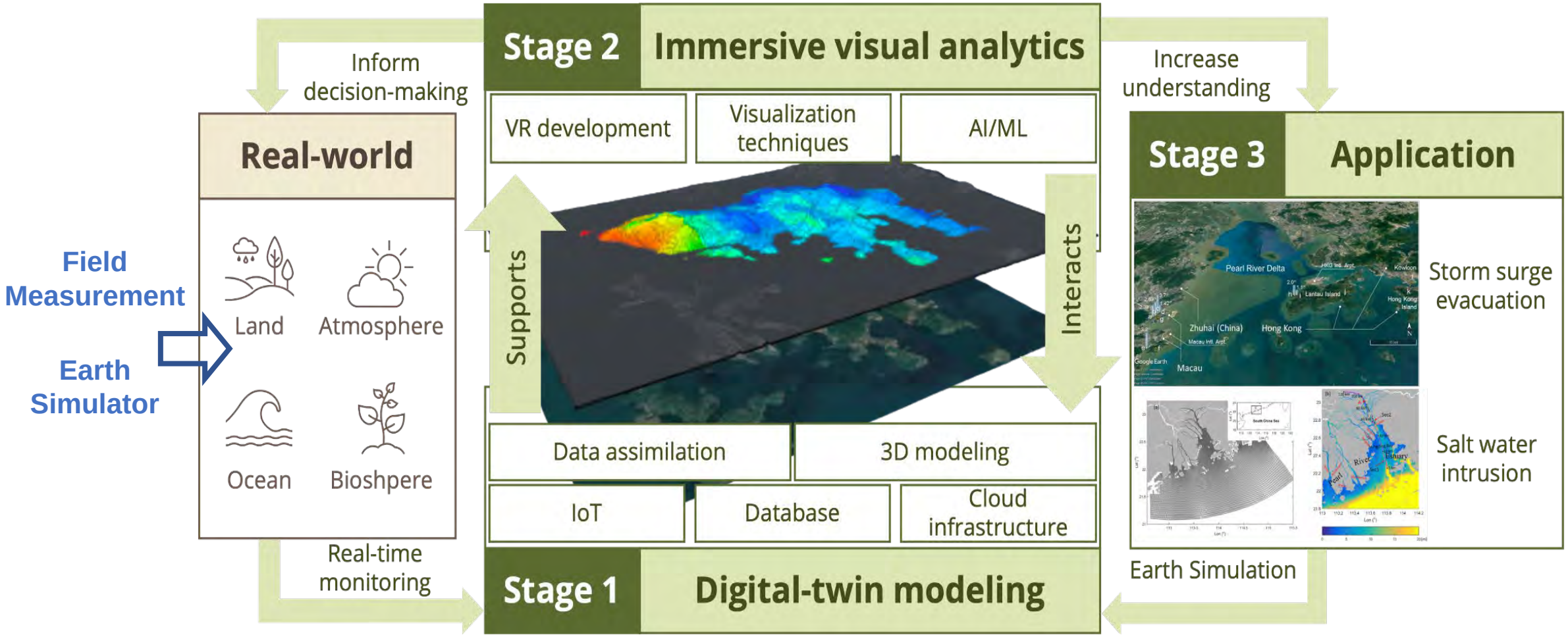
- Investigate integrated terrestrial (river basin), oceanic, and atmospheric processes that govern the cross-sphere exchanges of material and energy in the RES.
- Diagnose the human activities and climate change and their interaction with the natural ecosystem of the GBA *via a human-RES integrated assessment framework*.
- Assess and quantify the key processes, environmental hazards, and their future trends and the underlying mechanisms across time and space in the GBA using the *digital twin*.



EARTH-HK
Ocean-Land-Atmosphere
卓越學科領域計劃
Areas of Excellence Scheme

Deliverables: digital-twin framework

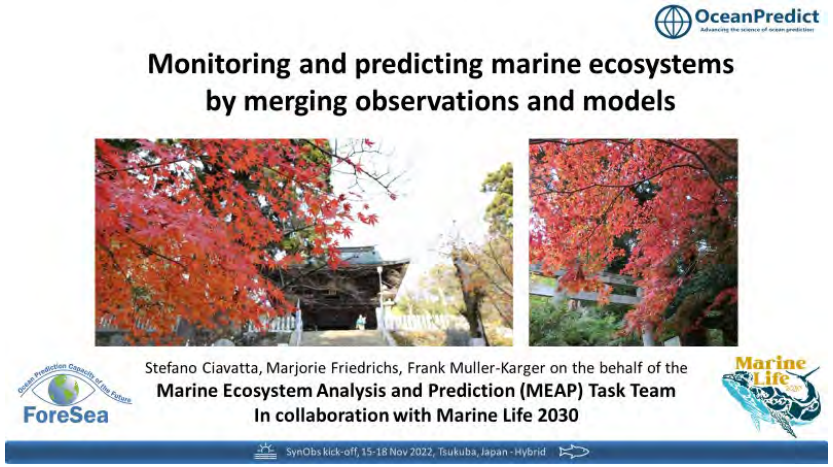
OceanPredict
Advancing the science of ocean prediction

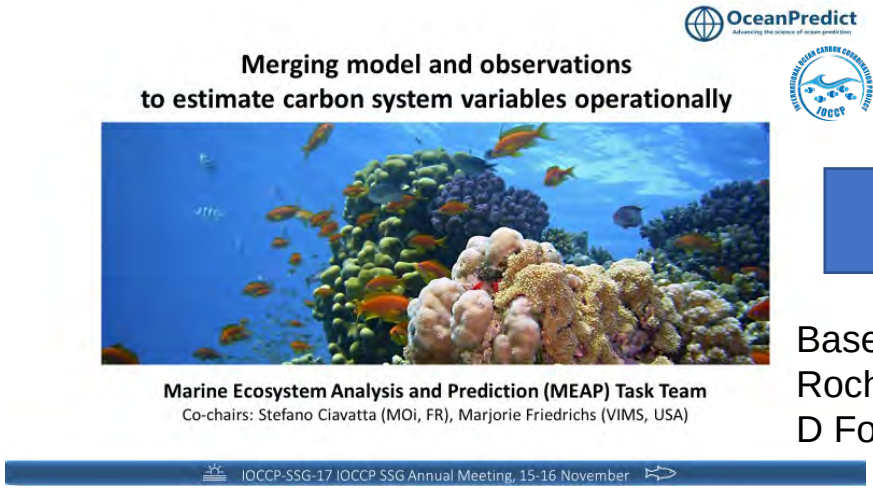


Scientific/network/impact highlights of MEAP members

OceanPredict
Advancing the science of ocean prediction

Remarkable engagements of stakeholders and working groups





International Ocean Carbon Coordination Project
Towards a sustained global observation network for marine biogeochemistry

Impact!

Based on results by A Rochner (U Exeter) & D Ford (Met Office)

IOCCP will run an intercomparison between carbonate products from floats and ships

Scientific/network/impact highlights of MEAP members

OceanPredict
Advancing the science of ocean prediction

Remarkable engagements of stakeholders and working groups

- 2 training workshops in Ocean-ICU project
  - Introduction to a range of biogeochemical models including ERSEM,
  - 'hands-on' workshop and included MOPS, BFM and ERSEM.
    - Target audience: non modellers
    - Aim: familiarise non-modellers with models and encourage collaboration in order to include processes of interest.

- 1 training workshop in MEAP-TT
  - Introduction to SEAMLESS Ensemble and Assimilation Tool (EAT)
  - 'hands-on' workshop

Future plans

- Plan as part of UKCMAS/NCEO to develop AMM15 high-resolution biogeochemical "operational" capacity for the North West Shelf (led by PLM)
- Collaborate with Indonesian ocean institutes and UNEP (UN Environment Programe) to conduct comparative analysis of typical coastal ecosystems in China and Indonesia. (led by HKUST)
- …
- Organize an in-person meeting
  - AMEAR 2024 (Plymouth UK, 8-11 July 2024) or OceanPredict Symposium 2024 (Paris, 18-22 Nov 2024)
- “Refresh” membership, strengthening internal collaborations (new projects)
- Strengthening the “higher-trophic-level component” of MEAP
- Expanding the remit to include AI/ML (e.g. marine ecosystem emulators, digital twins, what-if-scenarios, DA)
- Working more closely with UN Decade (e.g., submitted application for Marine Life 2030 for endorsement of NECCTON, contribution to OceanPredict DCC co-design, …)

Thank you!