EuroSea

Observing system design in EuroSea and integration with forecasting systems

Workshop OceanPredict-EuroSea

Sabrina Speich, 11 July 2023

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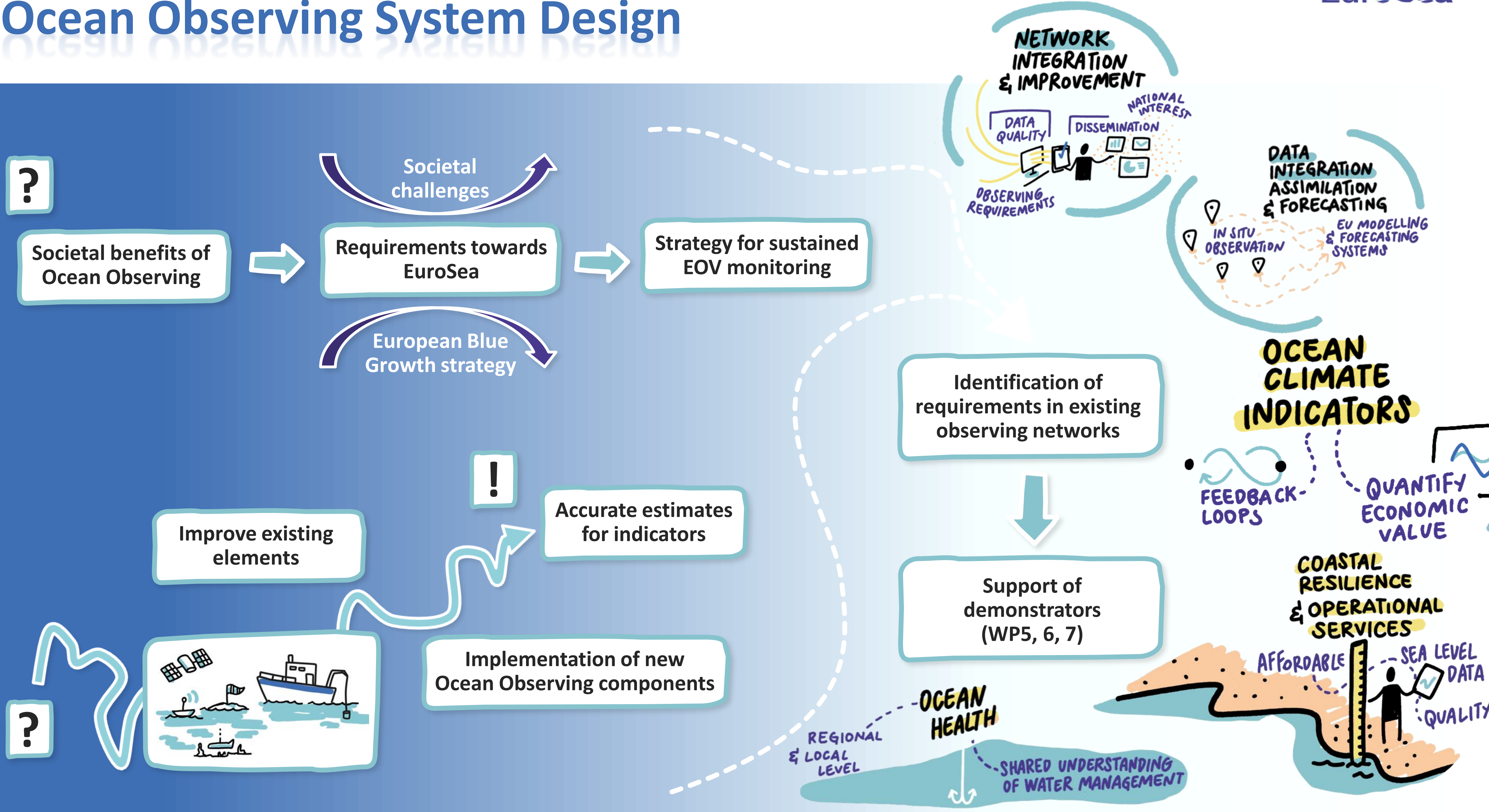
Ocean Observing System Design

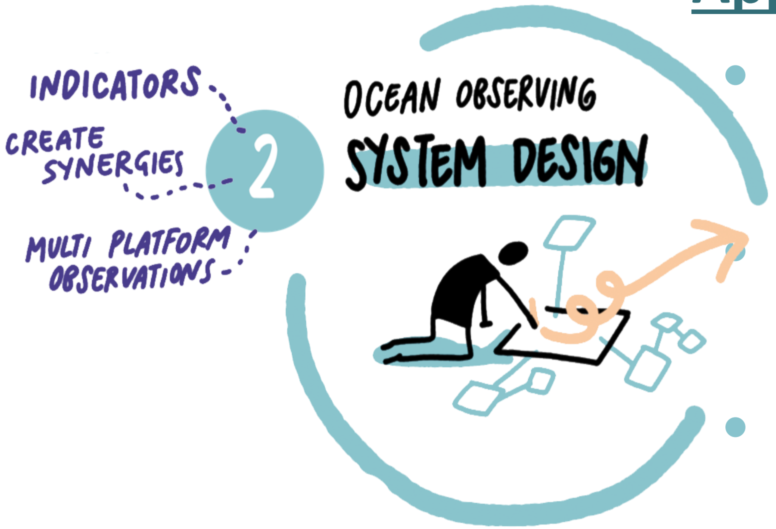


Objectives and Goals

EuroSea

Objectives

To deliver guidance to improve existing elements and/or implement new ocean observing components to EuroSea using OSSEs to optimally merge in-situ and satellite observations with models to provide accurate estimates for indicators.



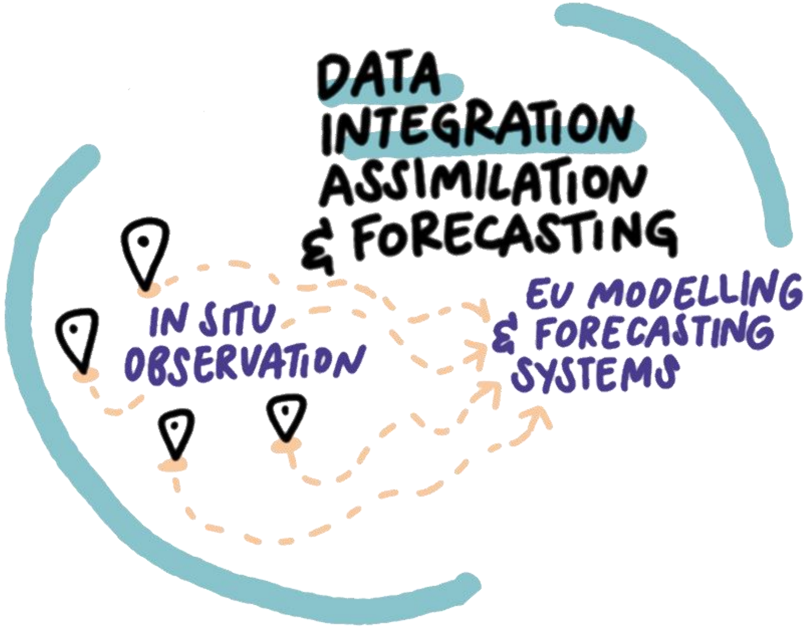
Approach

- **Observing System Design Experiments with global ocean monitoring systems**
- **Observing System Simulation Experiments: impact of multi-platform** observations for the validation of satellite observations
- **Co-Developing Indicators** for observing system networks with end users of Climate, Coastal Resilience, Ocean Health and Seasonal Forecasts

Observing System Design Experiments with global ocean monitoring systems

Objectives

Assessment of the role of in situ networks and their future extension at improving the accuracy of future global CMS physical and BGC analysis and forecasting systems.

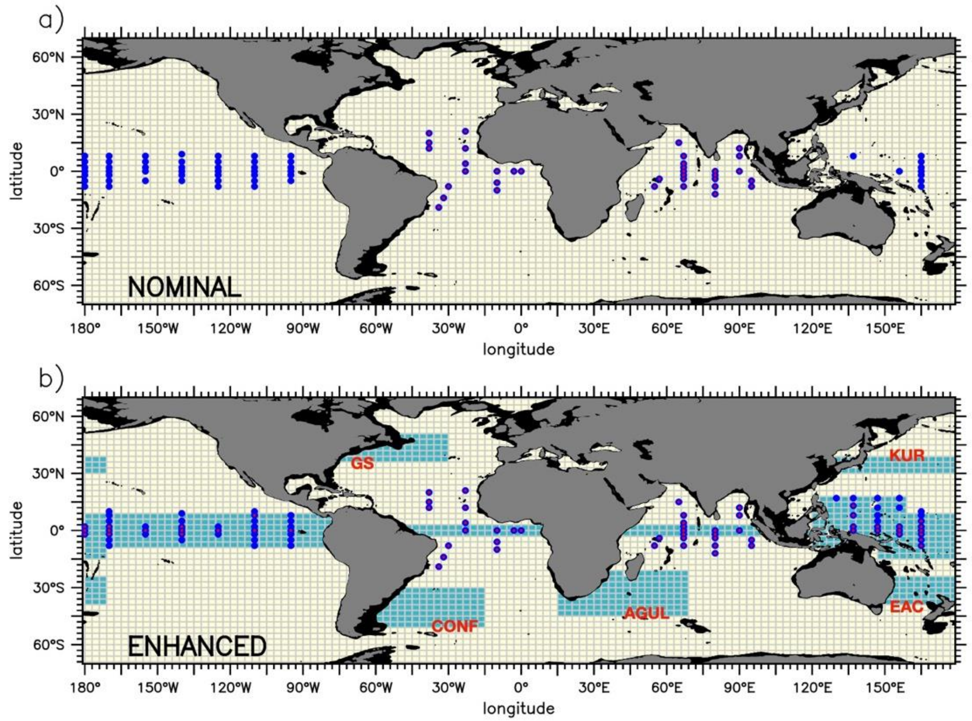


Outcomes

Role of the in situ networks and their planned extension at improving the accuracy of the future version of the global CMS physical monitoring and the ARMOR3D observation based systems:

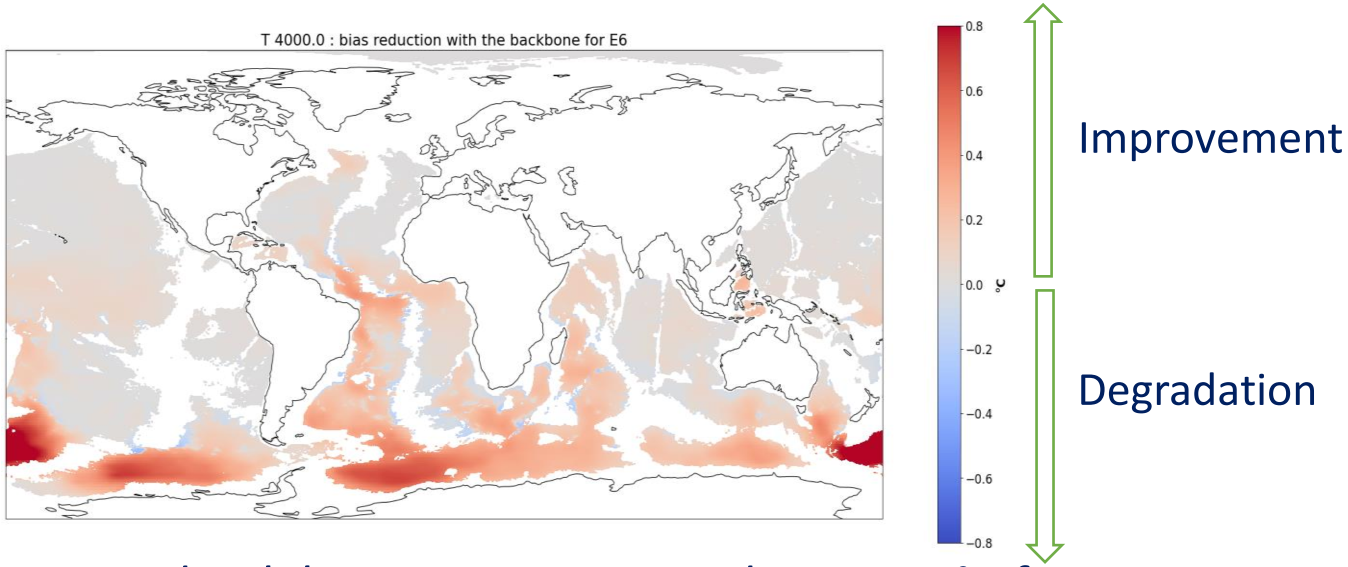
Observing System Design Experiments with global ocean monitoring systems

Today physical Argo and tropical mooring networks (a) and planned extensions tested in the OSSEs (b)



Complementarity of the in situ and altimetry observations in constraining the large and meso scale variability of the global ¼° Mercator ocean analysis

Bias error reduction in the ARMOR 3D temperature analysis when deep Argo floats are added to the NOMINAL analysis.



4000m depth bias temperature reduction in °C for DEEP_FULL_ARGO experiment compared to the NOMINAL experiment

Gasparin et al., 2023

Regional OSSEs assessing the impact of multi-platform observations for the validation of satellite observations

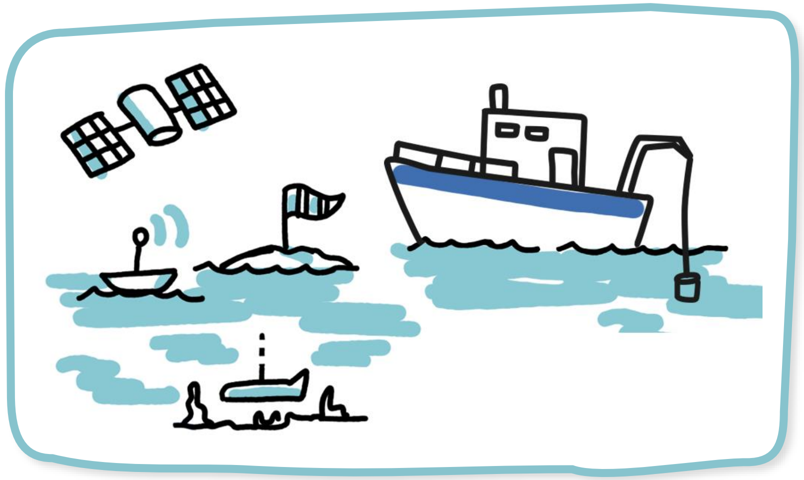
EuroSea

Objectives

Improve the design of multi-platform observations for validation of high-resolution satellite observations with the aim of optimizing the utility of these observing platforms.

Expected Outcomes

- **Optimize the design of multi-platform in-situ experiments aimed to validate SWOT in the Mediterranean Sea and in the northwest Atlantic**
- **Compare different methods of reconstruction to validate simulated observations of SWOT**
- **Explore the capability of the existing observing system networks to validate SWOT**

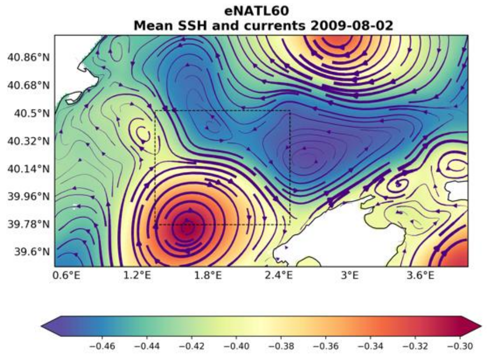


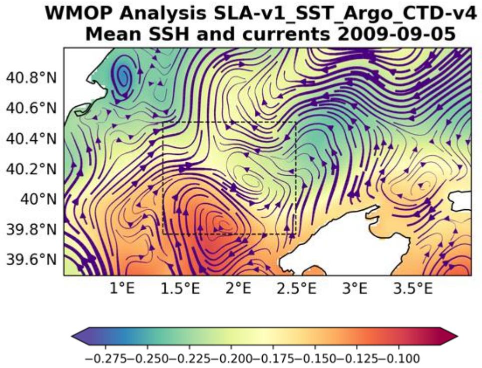
Regional OSSEs assessing the impact of multi-platform observations for the validation of satellite observations

Experiments to **evaluate the impact of assimilating CTDs** together with SLA, SST and Argo TS in the whole domain (simulated from eNATL60)

GNR + CTDs → RMSD reduction of 23% in SSH with respect to CR

For now, WMOP DA experiments are not able to properly reproduce the main circulation of the Nature Run

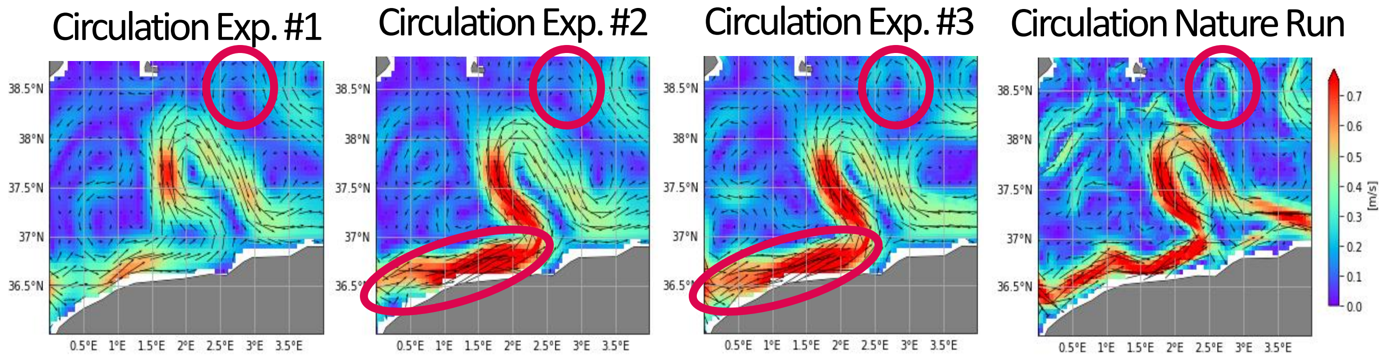




Testing the impact of surface drifters in improving the upper-ocean circulation

Experiments	Average RMSEs	Standard dev. of RMSEs
#1 Alti Only	0,940	0,027
#2 Alti + actual number of drifters	0,941	0,026
#3 Alti + 3x actual number of drifters	0,942	0,025

Qualitative improvement in maps of total currents, not represented in point-by-point RMSE metrics: need to find other diagnostic metrics



Pascual et al., 2023; Barcélo-Llul et al., 2023

Co-Developing Indicators for observing system networks with EuroSea Demonstrators

EuroSea

Objectives

Define the high-level requirements of EuroSea based on the societal benefits, providing a direct link to societal challenges. T

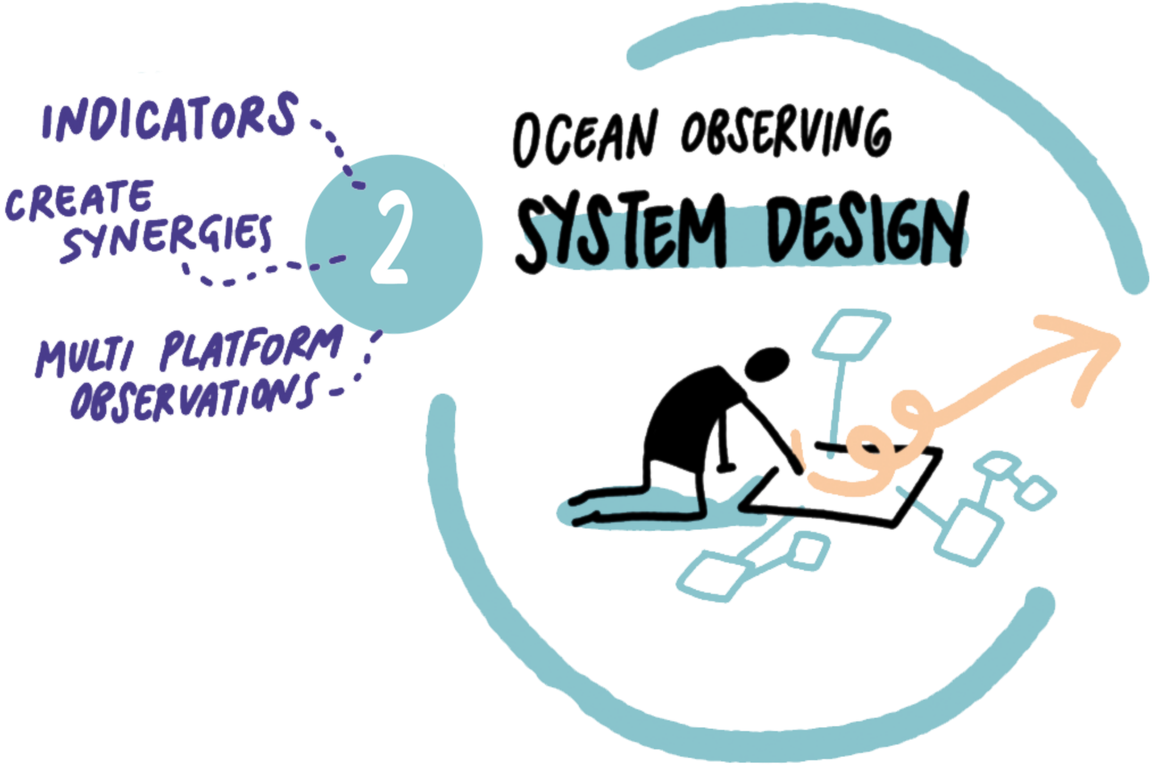
These requirements have been translated into strategic recommendations about sustained monitoring of EOVs and linked with LR7 and LR8 societal relevant indicators.

Outcomes

Societal requirements will be expressed as the space-time resolution and accuracy required for sustained observations of the physical, biogeochemical, and biological EOVs defined by GOOS.

Co-Developing Indicators for observing system networks with EuroSea Demonstrators

EuroSea



Apply the systems design processes of the Framework for Ocean Observing (FOO) on the EuroSea observing system

↓

Co-definition with demonstrators (Climate, Ocean Health, Coastal Resilience and Operational Services, S2S Forecasts) **stakeholders needs in terms of indicators**

↓

Refinement of EOVs for the European sea Regions (Atlantic, Mediterranean Sea) **in connection with end-users** (demonstrators)

↓

Requirements of EOVs and platforms for sustaining indicators for Climate, Ocean Health, Coastal Resilience and Operational Services, S2S Forecasts from global to local scales

The Indicator concept as assessed in EuroSea

EuroSea

INDICATORS

- They are relatively classical for the “physical state” more complex for “ocean health” (multi EOVs)
- Yet, even the more simple indicator relying on physics EOVs is not uniquely defined nor are the related requirements (ex. Ocean Heat Content: what depth threshold, what horizontal/vertical resolution and frequency, what accuracy?)
- Different requirements depending on stakeholders and end-users
- Most end-users rely on reanalyzed or predicted EOVs:
  - are model consistent with the end-user/stakeholders requirements (global versus regional and local numerical approaches)? What is the accuracy?
  - What is the impact of observations versus numerics on indicators in these systems?

WP2 Indicators experience from WP4-7 interactions

EuroSea

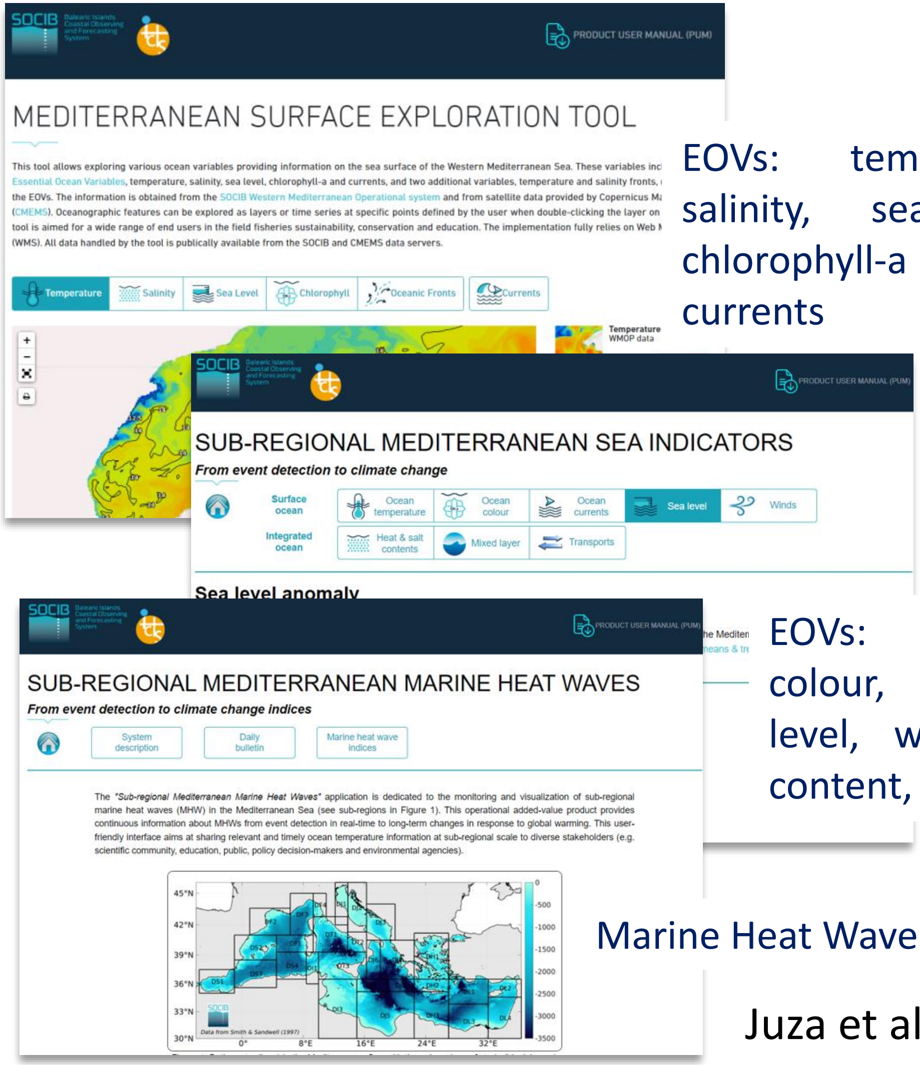
INDICATORS ARE LOUSLY DEFINED

- Ocean Heat Content:
  - What depth or isopycnal?
- Marine Heat Waves:
  - Climatology choice
  - Threshold (statistical versus fixed threshold)
  - SST versus T(z) EOVs & Ocean Heat Content
- Marine Productivity/Upwelling intensity defined as Mixing Layer Depth and at monthly (Mean? Median?) frequency
- Ocean Health:
  - Multi EOVs: are these and their requirements standard?
- Which Indicators/EOVs requirements can be “universal” and valid at all scales (from global to local)?

EuroSea demonstrators & integration

"Extreme Marine Events" Ocean Observing & Forecasting

MEDITERRANEAN SEA: Improved operational indicator and early warning system



EOVs: temperature, salinity, sea level, chlorophyll-a and currents

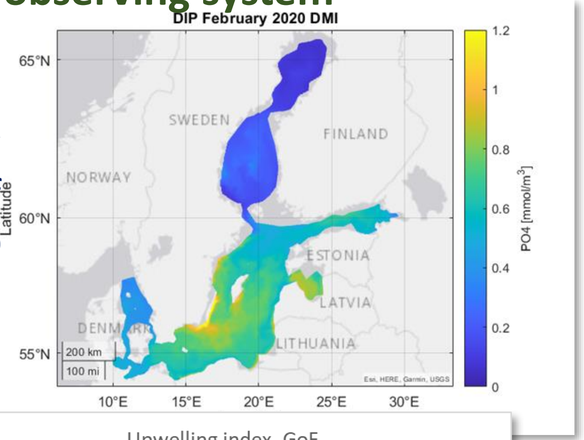
EOVs: temperature, ocean colour, ocean currents, sea level, winds, heat and salt content, mixed layer depth

Marine Heat Waves

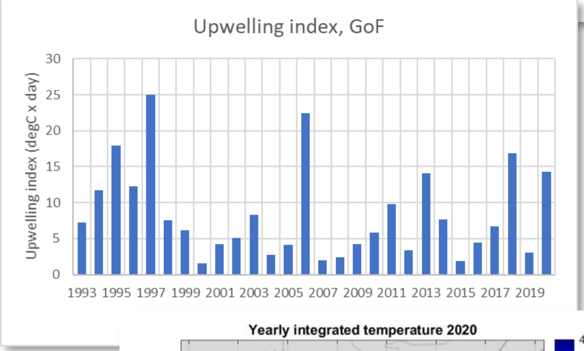
Juza et al., 2021; 2022

BALTIC SEA: Improved operational forecasting system for HELCOM users by integrating all available observing system

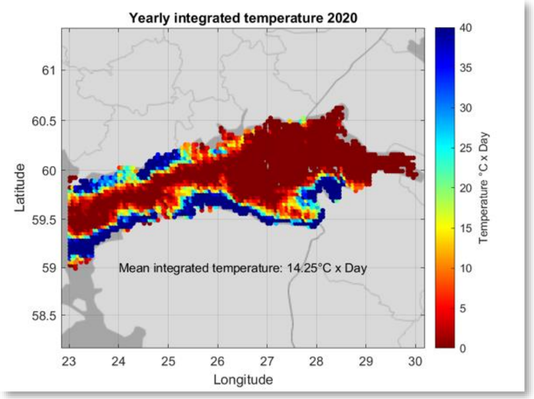
Summer upwelling index in the Gulf of Finland in 2020



Gulf of Finland Upwelling index time series in 1993-2020



Dissolved inorganic phosphorus in the surface layer of the Baltic Sea in 2020 – an improved product



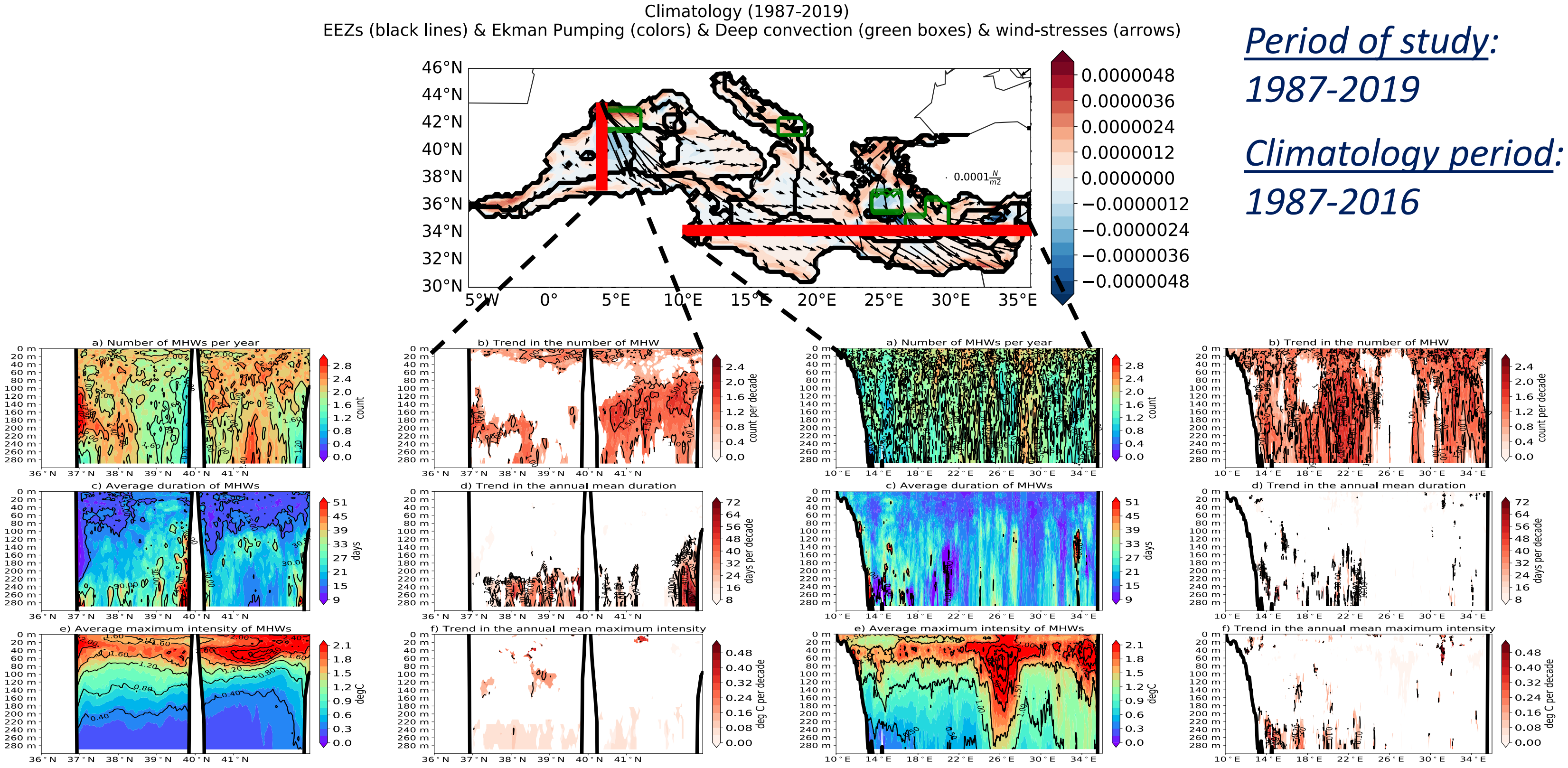
Mack et al., 2020; Liblik et al., 2023

EuroSea demonstrators & integration

MARINE HEAT WAVES

Consultation of stakeholders & end users indicates that MHWs indicators based on SST is not sufficient: Going deeper in the water column

Trend/mean characteristics of MHWs in subsurface



Period of study:
1987-2019

Climatology period:
1987-2016

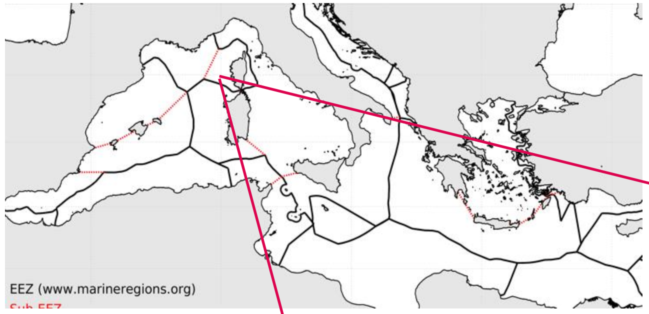
- Detection of MHWs up to several hundred meters
- Strong signature in the upper 50m (high biological activity, main economic activities)

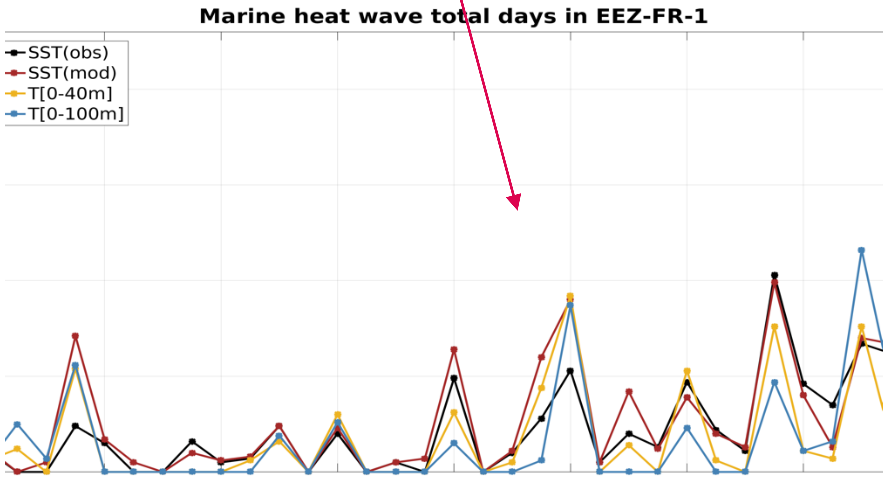
Dayan et al., 2022; 2023; McAdam et al., 2023

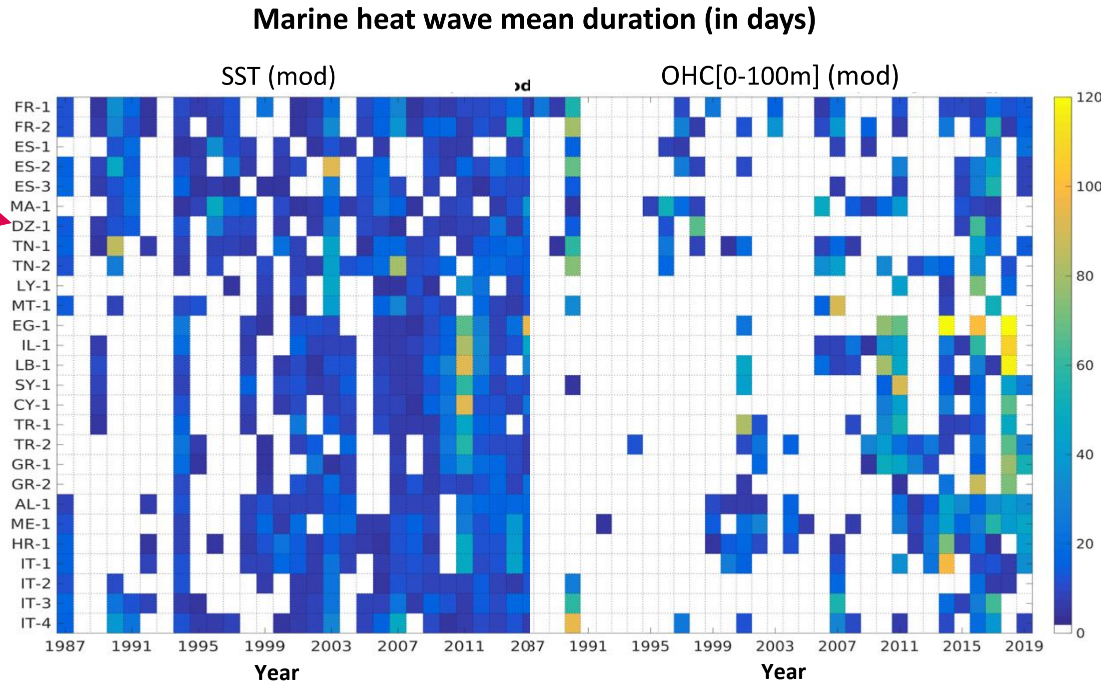
EuroSea demonstrators & integration

From basin to regional and local scales

Integrating the information at the **Exclusive Economic Zones** scale







EEZ integrated information to establish mitigation & adaptation strategies at local/national scales

- Good agreement obs/model surface MHWs
- Propagation in depth of some events

Dayan et al., 2022; 2023; McAdam et al., 2023

Indicators approach as co-design outcomes

Going from global to regional and local

- EuroSea stakeholder and user needs (WPs 4–7) expressed as indicators
- This translates into EOVs requirements
- Many EuroSea stakeholders and end users rely on reanalyses and forecasts/predictions (global & regional – Baltic & Med seas)
- Related dependence on the numerical tool on the observations assimilated but also on the model numerics and on the assimilation scheme implemented
- Work on Marine Heat Waves as a complex indicator proves the need for co-design.
- Development of Best Practices on how to approach indicators (and related requirements) at different scales (from basin to local)
- Also, stakeholders and end-user requirements are often at local scale: validation of reanalyses/predictions at regional and local scales if not new developments.