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JERICO-S3 DELIVERABLE

Joint European Research Infrastructure for Coastal Observatories
Science, Services, Sustainability

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Lead beneficiary	SYKE
Lead Author	Jukka Seppälä (SYKE), Constantin Frangoulis (HCMR)
Co-authors	Laurent Coppola (CNRS), Francois Bourrin (CNRS), Holger Brix (Hereon), Klas Ove Möller (Hereon), Alain Lefebvre (IFREMER), Anouk Blauw (DELTARES), George Petihakis (HCMR)
Contributors	Katri Kuuppo (SYKE), Timo Tamminen (SYKE), Pasi Ylöstalo (SYKE), Lauri Laakso (FMI), Milla Johansson (FMI), Martti Honkanen (FMI), Gregor Rehder (IOW), Taavi Liblik (TALTECH), Urmas Lips (TALTECH) John Allen (SOCIB), Behzad Mostajir (CNRS), Maristella Berta (CNR), Begoña Pérez Gómez (PdE), Baptiste Mourre (SOCIB), Yoana Voynova (Hereon), Helene Frigstad (NIVA), Felipe Artigas (CNRS), Clémentine Gallot (CNRS), Zéline Hubert (CNRS), Veronique Creach (CEFAS), Naomi Greenwood, (CEFAS), Klaas Deneudt (VLIZ), Henning Wehde (IMR), Philipp Fischer (AWI), Michael Fettweis (RBINS), Lisette Enserink (RWS), David Devreker (IFREMER), Kostas Tsiaras (HCMR), Melilotus Thyssen (CNRS), Andrew King (NIVA)
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Coordinator	Delauney Laurent	Ifremer	18.01.2023	LD
WP Leaders	Jukka Seppälä Costas Frangoulis	SYKE HCMR	05.01.2023	JS, CF

Diffusion list

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Table of Contents

1. EXECUTIVE SUMMARY

Deliverable D4.3 "*Progress report on PSS implementation"* provides a detailed report of JERICO-S3 Pilot Supersite (PSS) implementation during the first year of PSS period. It reports activities from four PSS regions, comprising altogether 30 different PSS Actions.

Report provides main achievements for all PSS Actions during 2021, highlighting information on regional integration, data flows, dissemination, and development of products. Report includes details how different links, between PSSs, other JERICO-S3 Work Packages or other external initiatives, have been realised. It details changes in partnerships, platforms and data used, which were partly inevitable due to Covid-19 situation.

D4.3 reports the modified PSS implementation workplan, responding to feedback given by D4.2 "*Refined PSS monitoring strategies*". Refinements were modest for most of the Actions, mostly describing more in detail the actual work done so far or to be done in 2022, and how it links to other WPs and initiatives. The overall objectives of PSSs have not been changed.

The second year of PSS implementation should be characterised by better connecting PSSs together and to support other JERICO-RI objectives.

2. INTRODUCTION

2.1 Background for Deliverable D4.3

JERICO-S3 WP4 provides a practical demonstration of how JERICO-RI Pilot Supersites (PSS) are to be implemented in order to become a network of Supersites, by establishing or improving, their communication and steering at multiple levels, and their links to other observatories, RIs and regional initiatives. Background of Supersite concept in environmental Research Infrastructures and JERICO-RI Supersite concept were provided in the JERICO-S3 Deliverable 4.1 "*JERICO-S3 Pilot Supersite monitoring strategies*". That document also provides the overall strategies for PSS implementation and specific implementation strategies for each of four JERICO-S3 PSS.

As given in D4.1, each of the four PSSs have identified several Actions, altogether 30 interlinked studies, to be carried out during a two-year PSS period from January 2021 to November 2022. Actions bring PSS partners together, to test how transnational and transinstitutional integration and sharing is best achieved. Actions include very practical studies related to data collection for specific topics (e.g. carbonate system, phytoplankton), sharing the knowledge (e.g. best practices, research methods), linking to other communities (e.g. modelling, ocean colour, other RIs) or connecting to end-users (e.g. regional conventions). Use of emerging technologies and multiplatform sampling strategies are part of some Actions, while some others concentrate in harmonising existing observation protocols and data flows.

Each of the Action has its own objectives and timelines, presented in D4.1. To follow how the implementation has progressed along the originally planned track, D4.3 will provide a detailed report of the actual work the various Actions have conducted during 2021.

As originally planned, after the first year of PSS implementation, the work done has been analysed and needs for refinement have been identified. This work has been reported in JERICO-S3 D4.2 "*Refined PSS monitoring strategies*". D4.2 provides the basis and

reasoning for the modified workplan for each Action, which will be then released here within D4.3.

2.2. On the structure of D4.3

The actual contents of D4.3 are organised in three sections.

Chapter 3 provides a summary of PSSs activity reports for implementation in 2021.

Chapter 4 provides detailed activity reports for implementation of PSSs Actions in 2021, first 12 months out of 23 months. It has following components:

Key Message from the Action.

Key Message provides a take home message of the work done so far, statement of a highlight or status development of the study. It provides a quick overview of the work content.

Partnership, platforms and data sources.

This part describes shortly if there have been considerable changes in partners involved, platforms included, or data sources used. It allows us to check if there have been substantial changes in the logistics of the Action.

Main achievements

This part provides the progress report of the Action. It describes and details the main parts of the actual work done in 2021, reflecting what was originally proposed in the D4.1. When relevant, it provides information on best practices developed or used, data flows created, data QC routines created or implemented, and data management issues encountered. It describes the key results of the Action obtained so far, how users were engaged and provides information on dissemination and products. It includes information on how the links with other WPs and other communities have been realised.

Regional and pan-European integration

As a summary of Action during 2021, this part describes how this Action has improved regional integration within PSS, or pan-European one between PSSs/RIs etc. as this is the main topic of PSSs.

Explain rationale for changes in plan for 2022

This part provides a short summary of D4.2 for each Action. In the case D4.2 indicates there is a need to change any parts of the Action implementation plan, based on the justification given in D4.2, it will be briefly explained here why there are needs for changes in the Action plan, to meet objectives of Action. In some Actions changes are plenty, and thus more details are needed in this part. While in some other Actions modifications are not really needed, then also deserving only a very short note in this part.

Chapter 5 provides a refined implementation plan to PSS Actions. It clearly shows which parts of the plan have been modified, while the reasoning behind these changes is given already in D4.2, and summarised in Chapter 4.

To create an updated document for PSS implementation, including the changes indicated here in Chapter 5, after acceptance of D4.3 we will update the original deliverable D4.1 with these updates plans.

3. SUMMARY OF PILOT SUPERSITE ACTIVITIES IN 2021 AND THE NEXT STEPS

Pilot Supersites contribute to the Key Scientific Challenges (KSC) identified within JERICO-RI and as given in D1.1 and D4.1. However, as only limited resources are available during the Pilot Supersite phase in 2021-22, PSSs have selected only a subset of KSCs to work with. PSSs have identified common and region-specific research topics, highlighting joint topics, for example, in studying impacts of land-based discharges, transport of water masses and materials, pelagic biogeochemical processes and interactions, and carbon fluxes.

A key objective for PSSs is to identify common and region-specific organizational challenges that prevent or complicate implementing transnational multiplatform observations. PSSs have evaluated their existing overall links to other RIs and communities (e.g. modelling, ocean colour). While planning PSS work, common societal and economic impacts were briefly analysed, highlighting the expected improvements in data quality and coverage as beneficial for various user groups. Each PSS analysed the key regional actors in making observations and working with modelling and ocean colour, to be potentially communicated with during PSS implementation. As well, PSSs collected information on the key users of coastal observations in their region. An outlook on critical gaps in multidisciplinary data provision for user needs was created, highlighting that some gaps are due to lack of methodologies, or deficiencies in the spatio-temporal distribution of observations. These elements are detailed in D4.1.

Starting in January 2021, 30 Actions have been initiated and their implementation is followed using online reporting templates. Each PSS has held a series of its own meetings to share information and organise and harmonise the activities of the different Actions. PSS leads have met to discuss the status of PSSs implementation, to draft joint deliverables and to discuss joint dissemination.

To highlight some joint actions, following all-PSS events were organised:

- During a JERICO-ARW#2, in April 2021, PSSs presented their modelling activities
- In June 2021, PSSs were presented in ASLO meeting
- In September 2021, PSSs organised a workshop to present their progress to other JERICO-WPs and to receive their feedback
- In October 2021, PSSs presented their multiplatform activities in a workshop organised during JERICO-DS General Assembly, including representatives from EuroGOOS, EuroSea, MINKE and NAUTILOS communities
- A web-page to provide overview of PSSs and details of each PSS was created at https://www.jerico-ri.eu/projects/jerico-s3/pilot-supersites/

Activities of each Action are reported in Chapter 4. As a summary, practically all Actions have shown considerable activities in 2021, following the initial implementation plan. Regarding the timetable, the start of the PSSs period was delayed (from September 2020 to January 2021), partly as we expected Covid-19 situation to relax during 2021. We have also postponed the end of the PSS study period, shifting the end date from August 2022 to November 2022, to allow roughly two years of implementation. This postponement can also be justified by the fact that now we can better allow studies and data collection throughout the summer 2022 productive season. Postponement of final reporting of PSS studies is not on the agenda.

Despite Covid-19 has prevented most physical meetings from being held, PSSs have well adopted virtual meetings. In some Actions, physical meetings or joint field expeditions could not really be replaced by virtual ones, and thus not all objectives have not been fully met. Thus, some of the physical workshops for sensor tests and cruises/expeditions have been either replaced by other supportive activities or shifted to take place in 2022.

Specific Covid-19 related issues have been related to unavailability of some platforms (e.g. some FerryBox routes have not been fully operational as passenger traffic was halted, or maintenance of some other platforms have been prevented by travel regulations). However, overall PSS observational activities are less affected than traditional research vessel-based operations. As well, the PSS period has already taught us to share resources between partners, illustrating the value of transnational and multiplatform sampling strategies.

There are some Actions that have not really started yet by the end of 2021. These late starters are the Actions that rely on the outputs from the other Actions, so their delay has been acceptable, but their progress needs to be followed carefully. Some other actions have indicated that their core activities will take place in 2022. These include Actions related to modelling, in which data was collected or sorted out during 2021 but the actual productive period is in 2022. Similarly, the Actions linking to other RIs and user communities, for example, need to wait until there are concrete results available from PSS and have their most activities in 2022.

The refinement of the original implementation plans has been quite modest. As some platforms have not been available as planned (e.g. due to Covid, or as an example, glider facility of ILICO was stopped), there has been some rethinking how to fill in the gaps in data. Only 1 out of 30 Actions refined its objectives (NW-MED #4) as there was a risk that ocean colour related work would not be completed (as these were relying on third party results), and focus was fine-tuned towards carbonate system and use of neural networks. Partnership of Actions remained practically unchanged, while in some Actions (like NSEA and CHANNEL PSS#2) an additional JERICO-S3 partner contributing to Action was identified and several Actions have identified additional data sources and external partners, compared to the original plan.

As already noted, the timetable of PSS implementation period was changed, to end in November 2022, and several, if not all, of the Actions take a benefit to either prolong the period of data collection, or increase the time spent in stakeholder communications or analysis of materials collected. The actual description of action has been fine tuned in several Actions, as practical details are now better known. Regarding the data issues and results of PSSs modest changes have been made, identifying better the different steps in the data value chain. Finally, each PSS analysed better how the different Actions are linked to other WPs and external initiatives.

In 2022 joint PSS progress meetings are being held to report other WPs (in March 2022 during JERICO-ARW#3) and follow developments internally. To foster between PSS collaborations and to connect better IRSs, thematic meetings are planned for 2022. These events should be planned to include other WPs as well. To transfer the knowledge to JERICO-DS, to feed in JERICO-RI conceptual design, PSSs need to meet with various JERICO-DS Work Packages in 2022-23.

Finally, by M38 (March 2023) Deliverable D4.4 *Assessment of PSS implementation* needs to be completed. It provides an outlook on JERICO-RI Supersites and provides a synthesis of PSS implementation.

4. PILOT SUPERSITE ACTIVITY REPORTS

GoF PSS #1 Harmonized observations

Key Message from the Action

Improving regional harmonisation of observations, open dialogue on best practises and trials and errors (and success!), and promotion of shared use of tools and platforms has been welcomed by all PSS partners. As well, participants outside PSS partnership have been engaged.

Partnership, platforms and data sources No changes

Main achievements

A joint sensor calibration workshop was held in February 2021 at SYKE Marine Research Laboratory in Helsinki. Originally it was planned that participants join the workshop physically and bring their sensors along. Fluorometers (Trios micro-fluo and Turner Scufa sensors for Chlorophyll, Coloured dissolved organic matter (CDOM), phycocyanin) from SYKE FerryBoxes, from buoys managed by FMI jointly with Åbo Academi and University of Helsinki, and from SMHI (outside GoF PSS, *link WP3*) were included in the workshop. Chlorophyll and phycocyanin sensors were calibrated with algae cultures, while CDOM sensors with quinine sulphate. The calibration ensures that various FerryBox and buoy platforms produce consistent results, in terms of fluorescence.

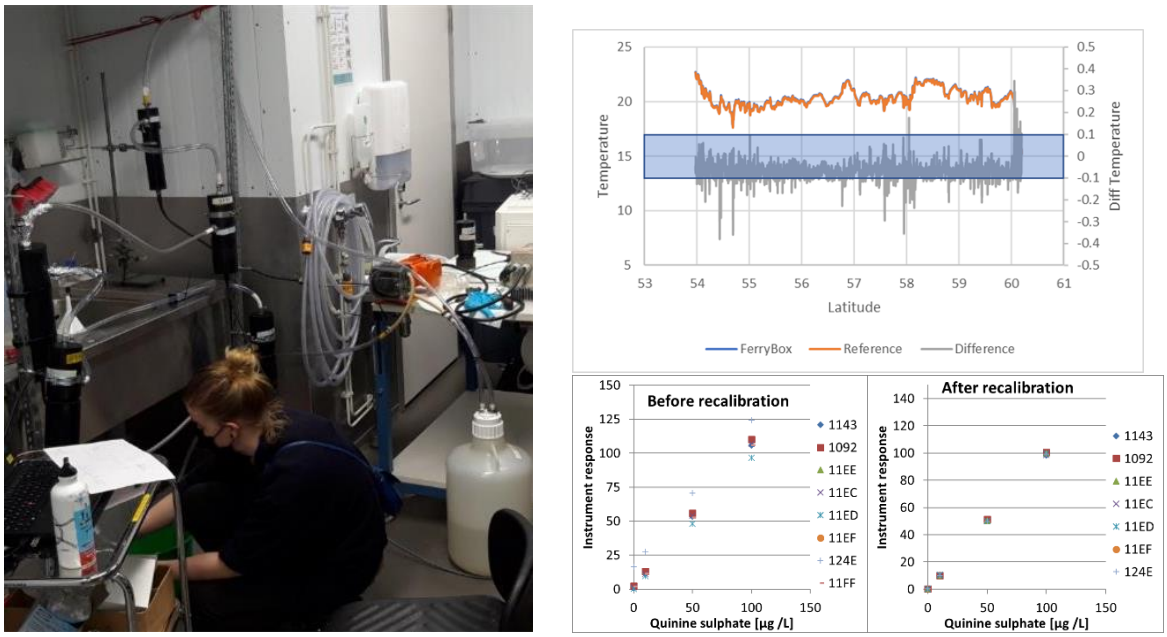


Figure GoF-PSS#1: Left: Calibration of GoF-PSS field fluorometers ongoing. Right, up: Comparison of FerryBox temperature sensor readings with reference sensor. Right, bottom: PSS-GoF CDOM fluorescence sensor responses prior and after joint calibration.

Calibration WS was followed by a workshop on 8 March 2021, discussing the overall harmonisation of sensors and calibration practises. WS took further steps in agreeing QA/QC of sensor observations and to advance consistency of different datasets. The workshop introduced current best practices among partners for different variables. Another aim was to distribute knowledge about which types of activities are ongoing in Baltic region. Participation included all PSS partners and also additional JERICO-S3 partners from Sweden (SMHI, *link WP3*) and Greece (HCMR, *link Cretan PSS*) and non-JERICO participants from Finland (University of Helsinki, City of Hanko, City of Helsinki) and Estonia (Estonian Marine

Institute). Program included 5-10 min plenary talks for different variables: Carbonate system (IOW and FMI), Temperature and salinity (SYKE), Oxygen (TALTECH and IOW) and Fluorescence (SYKE). Presentations are available at WP4 workspace.

Joint cruises for validation of automated measurements could not be organised during the actual PSS period, but already in late 2020 SYKE participated in FMI cruise to validate their glider measurements using water sampling and traditional laboratory analyses (for Chlorophyll and CDOM), linking to FMI activities in EURO-ARGO and GROOM. In addition, linking to *GoF-PSS#6* (Biological interplay with the carbonate system) and *Task 6.3.3*, SYKE and IOW discussed and realised improvements in temperature sensor validation for FerryBox line they operate jointly at ferry FINNMAID. As well, frequency of salinity sensor validation was increased, and results have been immediately communicated between SYKE and IOW.

Additional actions include following:

- A TA project planned and accepted for Chelsea Technologies Ltd (UK) to visit SYKE testing their new V-Lux CDOM fluorometer, allowing further harmonisation between sensor types measuring CDOM. Project is likely to be conducted in spring 2022.
- Meeting with IOW, SYKE and FMI onboard ferry Finnmaid 10.8. 2021; to review recent developments on joint platform, to discuss issues for maintenance, future work & projects, and also data & calibration issues
- Within Finnish Marine Research Infrastructure FINMARI, a national buoy network was established chaired by SYKE and including FMI as member, aiming to streamline maintenance, sensor calibrations, data QA/QC and data availability. As part of GoF-PSS #1, a joint meeting with TalTech was organised on 23 Nov 2021, to present TalTech experiences on buoy operations to FINMARI.
- Flowthrough data QC code developed by SYKE (for CMEMS activities) has been shared with FMI, to be further used in Utö fixed station and linking also to *Task 7.5.2*.
- FMI participated in pCO2 intercalibration WS held by ICOS-OTC in 2021/08, in aim to harmonize/coordinate JERICO coastal and VOS pCO2-observations with ICOS observations (*link to task 6.3.3*), as well as to other PSSs that participated in the same WS
- SYKE was among organisers of a session "Building a Metrology Framework for Ocean Observation" in 2021 IEEE International workshop on Metrology of the Sea (4-6 Oct 2021), and presented a paper co-authored by all GoF-PSS partners (Seppälä et al, 2021) providing an overview of current collaborations within Baltic FerryBox community and an outlook for next actions. This activity links to the MINKE RI project.

Regional and pan-European integration

GoF-PSS had various coordinated actions in 2021 bringing PSS partners together in discussing their best practices in coastal observations and sharing experiences. Although the partners already collaborated prior to PSS, the PSS provides a more structured and focused framework and platform for future collaborations. Sharing between PSSs/RIs needs to be more emphasised during the second year of PSS implementation.

Explain rationale for changes in plan for 2022

Overall GoF PSS#1 has been implemented as planned, though covid-19 did not allow many in-person meetings. The changes in the Action plan are modest, mainly detailing the workplan more accurately.

On top of the originally planned actions, several additional meetings and workshops need to be added in the new Action plan. There is a need to improve exchange of actual written Best Practices and SOP documents, and creation of new ones. As well improvements in between PSS and between WP exchanges need to be increased to facilitate the pan-European harmonisations, in addition to the regional one. New links with WP8 (TA), industry, and RIs (EuroFleets+, ICOS) need to be noted.

GoF PSS #2 The performance of operational forecast models

Key Message from the Action

Data from the PSS is collected, and validation of the model products has started.

Partnership, platforms and data sources

There are no considerable changes. After inventory of the data and specifying the structure of the model performance assessment we will mainly focus on the FerryBox data, Utö and Keri observatory data and Argo floats data.

Main achievements

The time window of a joint data collection trial in the GoF PSS#2 ended in autumn 2021, as planned. The contacts behind each observing platform were mapped and inventory of the measurements were done. Not all the measurements succeeded, e.g. some FerryBox lines stopped due to Covid and there were maintenance problems with profilers. However, on the basis of the data inventory the model performance assessment can be conducted. The key questions to be answered were defined: 1) what are the deviations and biases of parameters in the upper layer and in the vertical structure of the water column? 2) Is there seasonality in the biases? 3) Are there any regularities in discrepancies along or across the Gulf of Finland? 4) Are the biases in biogeochemical parameters correlated to the biases in temperature-salinity-structure?

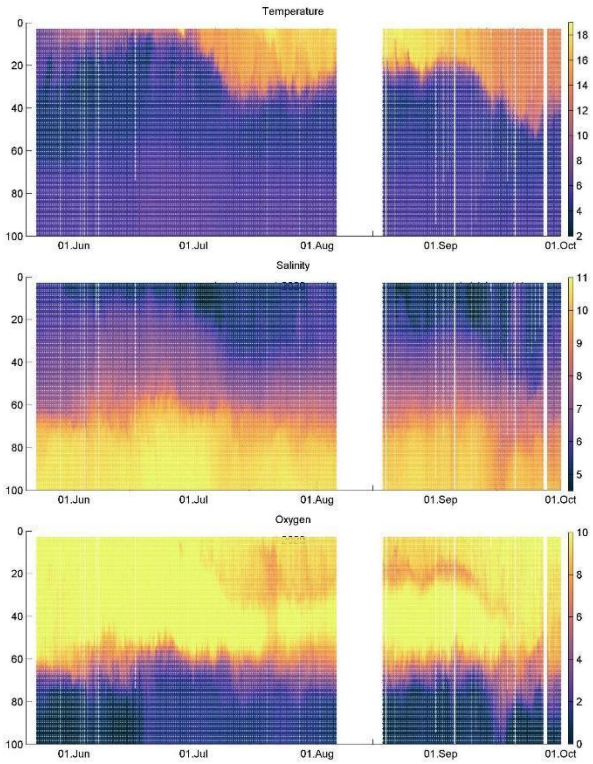


Figure GoF PSS#2. Temperature, salinity, and dissolved oxygen observations in the central GoF, at Keri station from May to October 2020.

In addition, following activities have been conducted:

- Validation of the model products with measurements has started.
- Newsflash on Keri Observatory was published in JERICO-RI website.
- The GoF PSS#2 data were validated and combined with numerical modelling in the study submitted to the Ocean Science (Liblik et al 2022).

Regional and pan-European integration

Contacts of responsible people for each of the observing platforms were mapped and updated. The collection of the data among all GoF PSS partners allows us to learn about data formats and the details of QA/QC of various platforms. This in turn is a good starting point working towards more harmonised data formats and processing procedures.

Explain rationale for changes in plan for 2022

GoF PSS#2 has progressed as planned and there are no considerable changes for 2022. There have been some delays in data delivery, but we expect these to be sorted out soonest. For that reason, the conclusive report from the Action will be delayed (May 2022->Sep 2022) and mainly focus on the data from FerryBox, Utö and Keri observatories and Argo floats. However, the content and objectives remain practically the same.

GoF PSS #3 Optical data for Ocean Color product validation

Key Message from the Action

> Observations using sensors at various platforms and ocean colour data provide complementary views on many coastal processes, but their compatibility still needs to be improved. This Action provides optical observation data to Ocean Color community and also takes regionally important steps ahead in using such data by describing relationships between various optical proxies for phytoplankton and CDOM.

Partnership, platforms and data sources No changes

Main achievements

The main aim of GoF PSS#3 is to demonstrate transnational collaborations in production of multisensor data for Ocean colour use. Due to covid-19 we have a limited proof of transnational component, as key platforms (especially ferries Silja Serenade and Silja Europa) were not fully functional. Thus, multinational aspects need to be better covered in 2022. However, several achievements were accomplished in 2021.

Joint fluorometric sensor intercomparison and calibration with GoF PSS#1 provide a basis for consistent datasets. For 2021 we have complete datasets for Chlorophyll a, phycocyanin and CDOM fluorescence at FerryBox FINNMAID and Utö Observatory. In addition, discrete water samples for laboratory analysis of Chlorophyll (both platforms) and CDOM (Utö) were taken throughout 2021. FINNMAID Chlorophyll results (2007-2020) from discrete samples were made available through CMEMS in 2021 and will be discussed in a paper submitted to Copernicus Ocean State Report #6 (*Link WP2*).

Specific 3-day measuring campaigns at Utö Observatory were conducted in April-September, to measure optically active water constituents by various optical techniques as follows: Chlorophyll a (Continuous measurements: in vivo single waveband fluorescence, spectral absorption, spectral fluorescence; Discrete samples: concentration, spectral absorption, spectral fluorescence), CDOM (Continuous measurements: in vivo single waveband fluorescence; Discrete samples: DOC concentration, spectral absorption, spectral fluorescence), Particulate matter (Continuous measurements: turbidity, backscattering; Discrete samples: Total suspended matter). This data, to be analysed in detail in 2022, allow us to determine specific inherent optical properties and understand better how different optical proxies vary within optically complex water in the Baltic Sea and which type of measurements are better suited for field truthing of satellite data.

There has been a dialogue with the SYKE Earth Observations team, discussing how to better streamline observations with EO data. For a practical demonstration, we have started to extract EO data (raw reflectance data and concentration estimates) for location of Utö observations, to be followed by data mining for FerryBox routes. This will allow us to efficiently create match-ups between EO data and observations and to merge these two data

streams scientific ecosystem studies in future. As second demonstration, already operational, FerryBox FINNMAID results can be overlayed with EO data in SYKE's TARKKA service (See Figure GoF PSS#3)

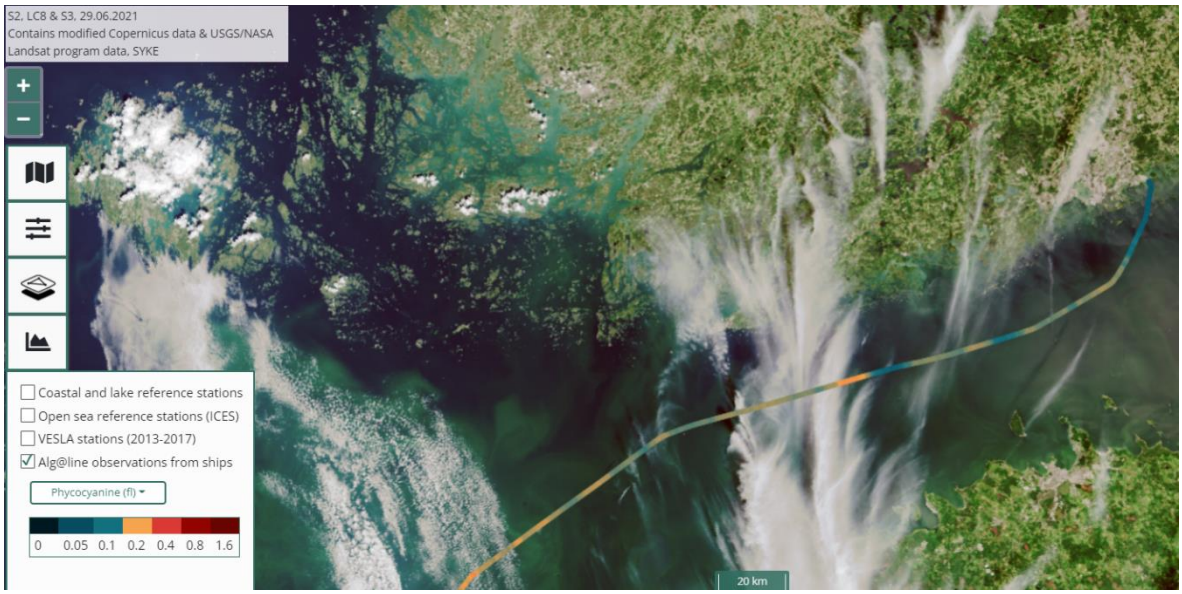


Figure GoF PSS#3. Satellite image of the cyanobacterial bloom in GoF PSS, 29th June 2021, overlayed with FerryBox phycocyanin observations for the same day, as displayed in SYKE TARKKA service (wwwi4.ymparisto.fi/i4/eng/tarkka/). Since late 2021, TARKKA allows overlaying historic FerryBox data (Chlorophyll, turbidity, phycocyanin, salinity, temperature) with satellite observations from Sentinel-3 OLCI, Sentinel-2 MSI, Landsat-8 OLI and Envisat MERIS satellite instruments.

One of the key interests for EO in Baltic are cyanobacteria bloom surface accumulations, causing nuisance for fisheries and recreation and having also cascading effects in ecosystem functioning. As Utö Observatory provides very precise information on cyanobacteria abundance using imaging technologies (See GoF PSS#4), it provides an excellent site to compare with EO data (*Link WP7, D2PTS*). During the preliminary discussions with Dr. Mati Kahru (Scripps Institution of Oceanography, US), a leading expert for the use of EO data in cyanobacteria detection, we noted how the in-water analyses by imaging and analysis of surface accumulations with EO provide complementary view of the bloom development, showing large biomass increase in water column prior their accumulation in the surface.

In connection to other ongoing projects, we have had workshops and meetings planning to improve validation of FerryBox Chlorophyll fluorescence data and provide it to databases to be available with EO data. Within CMEMS Ocean Colour-tac we aim to provide such data from GoF PSS in 2022-23. Providing such spatially extensive data is also of interest to HELCOM (delivered through ICES) and we have negotiated to make a demonstration of trial delivery of validated chlorophyll data in spring 2022.

SYKE has also updated a database for FerryBox data and created an API-service containing flow-through water quality measurements starting from 1998, accessible by OGC-compliant WMS and WFS-requests (*Link to WP11*).

Action still needs to work to improve traceability of calibration procedures and related best practices for fluorometric sensors, partly elaborated in GoF-PSS#1. Pan-european actions for this will be carried out in MINKE project and followed by GoF-PSS#3.

Regional and pan-European integration

Regional integration has not progressed as expected as there were unfortunate breaks in data collection due to covid-19. However, we expect much more interactions in 2022. We also have planned between PSS actions, especially with NW-MED PSS on this topic.

Explain rationale for changes in plan for 2022

The changes in GoF PSS #3 are modest. Connections to regional EO groups have been demonstrated, including also end users of products (CMEMS, HELCOM). Integration of PSS observations used to validate EO (e.g. fully consistent chlorophyll data) is an attractive but a very challenging goal, especially as observations are compromised by covid-19. We therefore underline more that GoF PSS #3 provides demonstration on better availability of observation data for the EO community, not necessarily a final solution.

Slightly more connections and links are found than originally spotted. To increase the regional and pan-European dialogue, for a second year a better collaboration between PSS partners and between PSSs needs to be established.

GoF PSS #4 Detection of cyanobacterial blooms

Key Message from the Action

> Automated routine for near real time recognition of cyanobacteria biomass and species structure was created using imaging methods and artificial intelligence-based classification.

Partnership, platforms and data sources

Due to covid-19, in 2021 we did not have data from ferries Silja Serenade, Silja Europa, or profiling buoys. Therefore, the transnational element was not optimally realised in 2021.

Main achievements

GoF PSS#4 started in Feb 2021 with a calibration of phycocyanin sensors used in FerryBox, Utö Observatory and profiling buoy platforms, as collaboration with GoF PSS#1.

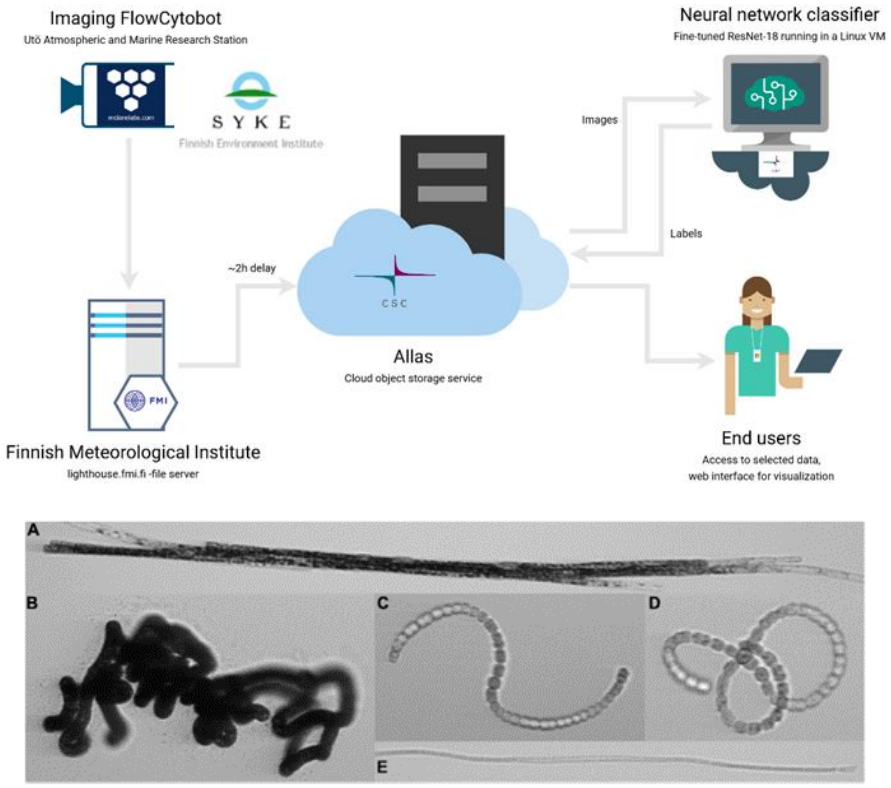
In 2021 FerryBox data for cyanobacteria bloom period was only available from Finnmaid, and it was visualised at marinefinland.fi portal, also as part of VA (*link WP11*). Utö data for phycocyanin was made available through FMI swell portal (also part of VA, *link to WP11*).

At Utö Observatory an Imaging FlowCytobot (IFCB) was installed in the beginning of 2021. Instrument samples local phytoplankton community at 20-min intervals and takes images of chlorophyll *a* containing cells. Data flow was developed with FMI and SYKE from Utö observatory to FMI server and further to cloud computing infrastructure provided by the national scientific computing centre (CSC). Based on the classified images and framework created by Kraft et al (2021), neural network classifier was created and tuned and images were labelled in near real time (2-3 hours after their retrieval). The code is available at https://github.com/veot/syke-pic. The results, biomass and species composition of filamentous cyanobacteria, were thereafter provided back to FMI server and plotted in near real time at swell portal. The development of this service was created in collaboration with the PHIDIAS EU-project and national FASTVISION project. A manuscript has been written describing the method, to be submitted early 2022. As a *link to WP7* D2PTS, we are currently validating manually subsets of automatically classified images and preparing a delivery of these to EcoTaxa. Data management issue has been identified, as there is no service for permanent storage of the images nor there is a general database which takes up the AI-classified phytoplankton data.

Weekly algae review, launched by SYKE in summer, used the data sources described above, to inform the public and authorities on nuisance algae blooms. The reviews were published at SYKE Baltic Sea portal, which is also part of VA (*link WP11*), and they are archived at SYKE website. In 2021, cyanobacteria bloom started as very intense, but despite hot weather

conditions favourable to cyanobacteria development, the observed biomass did not peak to extreme values.

Figure GoF PSS#4. Scheme of phytoplankton image data flows and processing created to obtain NRT products for biomass and species structure during cyanobacteria blooms (up). Examples of the images of bloom forming cyanobacteria (Kraft et al 2021) (down)



As a *link to WP5*, we participated in delivering information to questionnaires for imaging, flowcytometry and fluorescence. In addition, in 2021 Cytosense pulse shape and imaging flowcytometer was taken into operational use in Utö Observatory.

A review of the development in cyanobacterial detection methods was published (Haraguchi et al 2021), highlighting the use of fluorometric and imaging methods and providing examples from GoF PSS data collected in 2021. Newsflashes on the observations and results of the Action have been published in JERICO-RI webpage. The observations made in 2021 have been presented during various meetings, including National FINMARI researcher days, FerryBox workshop, ASLO symposium and BSSC symposium.

An informal European network for IFCB was started in 2021, SYKE being among participants, and various aspects of data collection, analysis and AI-algorithms have been discussed.

Additional internal links within GoF PSS include #3 as ocean colour applications will be demonstrated for cyanobacteria blooms, and #7 data where modelling of cyanobacteria blooms are considered.

Regional and pan-European integration

Regional integration has been facilitated by creating flows for imaging data products to FMI server but needs to be strengthened for other observations. Overall collaboration on fluorometric and imaging technologies has been ongoing within WP5, but more practical and thematic collaboration between PSS/IRS needs to be improved.

Explain rationale for changes in plan for 2022.

Despite the covid-19 prevented the use of all platforms for detection of cyanobacteria blooms, the GoF PSS#4 has progressed mostly as planned. The transnational aspect needs more attention in 2022. The changes in the Action need to include the additional items included in the work, like improved data flows and products for imaging, scientific results obtained and their dissemination, joint work expected with AQUACOSM-plus and the actual collaborations with other WPs.

GoF PSS #5 Mapping the deep water oxygen conditions

Key Message from the Action

> Oxygen data is gathered from multiple GoF PSS platforms and next they will be used in creating spatial maps.

Partnership, platforms and data sources

There has been a major problem with Keri station in 2021. The station has been down and the whole land-sea cable (3 km) must be replaced. We can still use the 2020 data for the mapping. Keri station is obligatory because it describes the offshore conditions in the central Gulf of Finland. The main objective of the activity remains the same.

Main achievements

The time window of a joint data collection trial in the PSS ended in autumn 2021. The main data sources for the activity are the profiles gathered in Keri and Utö station, profiles collected by Argo floats and by RVs. We have received all the data smoothly except the RV data.

There were two possible directions for the oxygen maps production: 1) combining PSS measurements with available CMEMS biogeochemical operative modelling product; 2) relying on the PSS measurements and spatial maps compiled by conventional monitoring data.

The option number 2 will be definitely tested as there is enough data successfully collected for the task. Option number 1 will be decided after activity GoF PSS #2 has revealed the performance of the model products.

Activities in WP5, on best practices of biogeochemical variables, especially those of oxygen, will be followed. Action has links to EURO-ARGO observations and potentially also in making observations during EuroFleets+ cruises in Baltic.

Regional and pan-European integration

Contacts of responsible people for each of the observing platforms potentially contributing to the oxygen mapping were charted. Overall, the Estonian RV monitoring in the southern GoF and Finnish RV monitoring in the northern part, and Keri offshore station in the central GoF; Utö observatory near the western border of the GoF, and Argo floats in the Northern Baltic Proper is a promising international observatory system with spatial coverage to investigate the oxygen dynamics in the PSS area.

Explain rationale for changes in plan for 2022.

GoF PSS#5 activities will be implemented as originally planned. There is a slight change in platforms used and in links. There is a delay in schedule, but no changes in activities.

GoF PSS #6 Biological interplay with the carbonate system

Key Message from the Action

> Carbonate system measurements of coastal sea waters provide important insights into primary production and climate change. However, diverse measuring methods and data processing methods require harmonization.

Partnership, platforms and data sources No changes.

Main achievements

The main aim of the GoF PSS #6 is the development of harmonized carbon system measurements for the ecosystem assessment of the Baltic Sea. So far, the harmonization of the measurement and data procedures has improved, but quality-controlled data is not yet readily available.

During the first year of PSS implementation, pCO2 and pH were measured continuously at Utö observatory with only small maintenance gaps. Due to the covid-19 and ICOS OTC 1st pCO2 intercalibration workshop, pCO2 measurements on board M/S Silja Serenade were offline until September 2021, which produced data gaps on the Helsinki-Stockholm pCO2 measurements. FerryBox measurements onboard FINNMAID have not been compromised by covid pCO2, though a longer shipyard stays and a contamination of the deck where the instrumentation is installed let to a 2-month data gap in spring 2021.

In March 2021, a JERICO-S3 workshop was organized for the best practices of several seawater measurements (GoF PSS#1) and pCO2 were also dealt with. FMI provided information on best practices of Utö Observatory measurements while IOW presented those for FINNMAID, as well as overall questions and challenges for GoF PSS while integrating and harmonising carbonate system measurements. In addition, IOW, SYKE and FMI had a physical meeting onboard FINNMAID in august 2021, to review recent carbonate system measuring technologies used by IOW, to agree on improvements in supporting temperature observations, and to plan forthcoming actions. As short action, a few T-S units operated in the GoF PSS have been calibrated in the certified calibration lab at IOW. To improve dialogue, transfer knowledge between groups, and analyse joint data from the Baltic Sea, PhD student Honkanen (FMI) has visited IOW in 2021 for about 1 month.

FMI participated in the ICOS OTC's 1st pCO2 intercalibration workshop in summer 2021 by providing three instruments (SuperCO2, Sunburst; SAMI-CO2, Sunburst and HydroC, Contros). The workshop aimed for the harmonization of the pCO2 measurements in order to reach high measurement precision. In addition, partners are finalising a manuscript for pCO2 and pH sensor intercomparison experiment INTERCARBO (JERICO-NEXT's TNA intercalibration workshop), which included participants also from other regions. This work will provide information on the current carbon system measurement methods and precisions in the field.

While the backbone of carbon flux estimates in the GoF PSS are surface measurements using FerryBox systems, they have an inbuilt issue that ships with fixed schedules are often at the same location at the same time of day. As there is a strong diurnal variability in the carbonate system in highly productive coastal regions, we did an assessment of the bias this caused to the surface observations. The study (Honkanen et al. 2021) from Utö Observatory estimated this potential bias, showing the power of integration of FerryBox and fixed station multiplatform data at GoF PSS. It also contains a validation of Utö's flow-through system for pCO2 measurements. The effect of the long pipeline on the pCO2 measurements has been tested by using two standalone sensors.

The paper first-authored by IOW (Müller et al., 2021), based on a field survey of vertical pCO2, investigates how the surface pCO2 data from FINNMAID can be best transferred to depth-integrated carbon export from the mixed layer by assessing different ways to derive the depth integration from a high-resolution 3D vertical model, and introducing the temperature penetration depth for individual summer bloom events. This can provide a major step forward in the quantitative assessment of net primary production using FerryBox data and is fully applicable to the GoF PSS area.

Linking to WP6, Subtask 6.3.3: Guidelines and strategy for carbonate systems data management, IOW and FMI are collecting regional protocols for carbonate system measurements, identify gaps in best practices and interact with ICOS-OTC and SOCAT.

Regional and pan-European integration:

Increased harmonization of measurements and data processing within GoF PSS has been improved by common workshops. Joint analysis of datasets has greatly improved knowledge transfer. Analysis of joint INTERCARBO data has improved pan-European collaboration in carbonate system studies and that will further improve in 2022 during joint PSS workshops (also linking to WP6). Through the atmospheric station Utö and the SOOP FINNMAID, both embedded in the European ICOS RI, there exists direct exchange with the respective atmospheric (ATC) and ocean (OTC) European head organisations and networks. Communication of the actions and novel findings within these European networks into the group of GoF-PSS carbon system data providing partners assures better integration and harmonization along the lines of this European RI.

Explain rationale for changes in plan for 2022.

No changes required for the plan, but unified and real time data quality control and assurance protocols have not yet been implemented. Usability of results need to be better highlighted.

GoF PSS #7 Forecast models for cyanobacterial blooms

Key Message from the Action

> In 2021, cyanobacteria observations were collected from Utö Observatory and FerryBox at FINNMAID. Review of existing cyanobacteria models indicate that operational forecast models for cyanobacterial blooms are not well developed.

Partnership, platforms and data sources

There were no changes in project partners. Vertical profiling data were not observed and a limited amount of FerryBox were available due to COVID-19 related challenges.

Main achievements

As already described in GoF PSS#4, availability of cyanobacteria observations was improved, and even species-specific observations are now available in near real time from Utö Observatory. Utö data is transferred to the FMI server and visualised on a www-page. Visualisation of FerryBox FINNMAID data is available at marinefinland.fi portal and at SYKE's TARKKA service.

Additional data sources identified are a profiling buoy network maintained by FINMARI consortium partners, though data is not necessarily available in real time yet.

Literature and the internet were screened for availability of operational cyanobacteria forecast models. It turned out that suitable operational models forecasting the extent of blooms are not available. As a static prognosis, each year SYKE provides an early summer risk assessment of cyanobacterial blooms in the sea areas near Finland, based on the amounts of nitrogen and phosphorus available for the algae measured during the previous winter. The model is very coarse and does not take into account the actual weather conditions driving the blooms. Evaluation of various alternatives is ongoing and is mainly carried out in 2022.

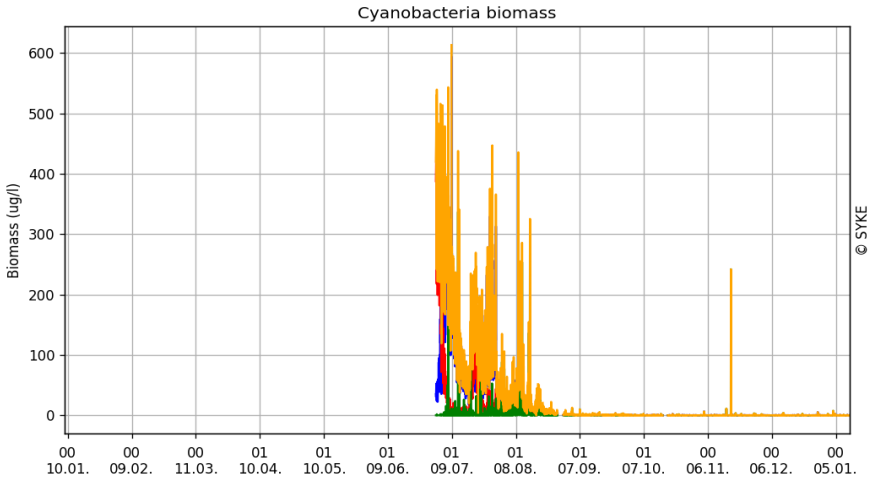


Figure GoF PSS#7. Observations of species-specific cyanobacteria biomass at Utö in 2021, measured with Imaging FlowCytobot. Such data is elemental in developing and validating models. Blue: Aphanizomenon flosaquae; Red: Dolichospermum-Anabaenopsis; Green: Nodularia spumigena; Orange: Filamentous cyanobacteria, sum

Regional and pan-European integration

Integration will be approached in 2022.

Explain rationale for changes in plan for 2022

While cyanobacteria observations were collected and made better available in 2021, models will be evaluated in 2022. This results in slight changes in the timetable.

Due to COVID-19 related reasons, Utö profiling buoy data and Silja Serenade & Silja Europa FerryBox data were not available in summer 2021. The planned activities for 2021 related to these were thus delayed.

Operational forecast models for cyanobacterial blooms are scarce and not readily available for Baltic Sea, to our knowledge. Comparisons with SYKE HAB risk assessments will be carried out instead. Also, a semi-empirical approach (based on Kahru et al 2020) will be considered: the HAB could be predicted by using SST, solar radiation and wind forecasts. NEMO ocean model and Harmonie NWP model outputs could be useful for this. Such forecasts, if found applicable, could be compared with satellite observed cyanobacterial blooms and in situ observations.

GoF PSS #8 Extreme events affecting phytoplankton - AQUACOSM collaboration I

Key Message from the Action

The mesocom experiment will be jointly planned with the AQUACOSM-plus INFRAIA project. Experiment will study the effect of heatwave on the plankton ecosystem and is scheduled for August 2022.

Partnership, platforms and data sources

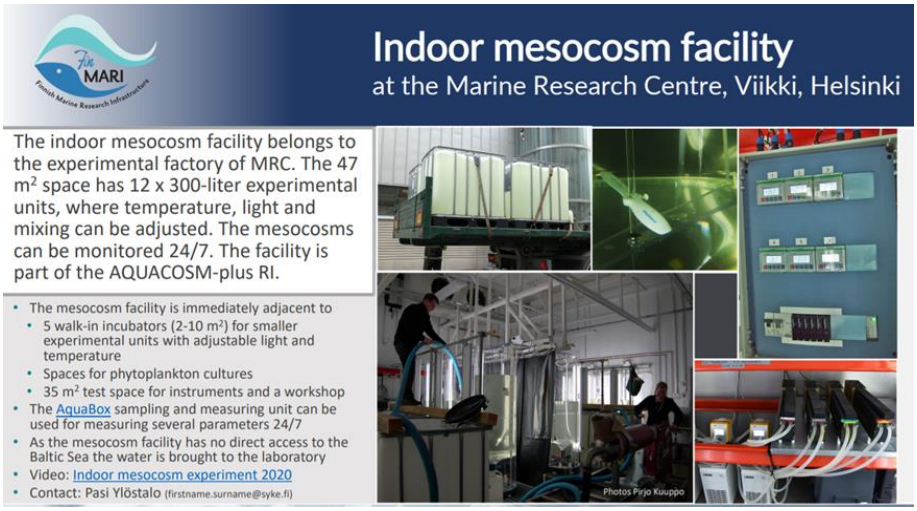
There are no changes to be indicated at this point but use of data from all the platforms named in analysing heatwaves is not very likely.

Main achievements

The mesocosm experiment will take place in late summer in 2022, likely in August and therefore not a lot of activities have taken place yet. The details of experimental setup, manipulations, and variables to be measured are currently under scrutiny.

In the 2nd JERICO-S3 TA call, Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB) applied for access to SYKE MRC-lab during the mesocosm experiment. The main objectives of the proposal were to study how Baltic Sea plankton community is responding to extreme events such as sudden shifts in temperature and to utilise this opportunity for transfer knowledge and harmonisation of competence between European Research infrastructures, by collaboratively further develop best practises and technology solutions especially for plankton imaging. IGB is coordinating the AQUACOSM-plus INFRAIA project which has a considerable amount of research activities in plankton imaging. In addition, we expect additional AQUACOSM-plus partners to participate in the experiment, as well having additional TA projects through AQUACOSM-plus TA calls.

The sea surface temperature anomalies have been studied using FerryBox data 2007-2020, for a transect between Helsinki (FI) and Travemunde (DE). A paper describing climatologies, anomalies and trends temperature, nutrients and chlorophyll *a* have been accepted to be published in CMEMS Ocean State Report #6. This will aid us in determining the realistic manipulations for the experiment.



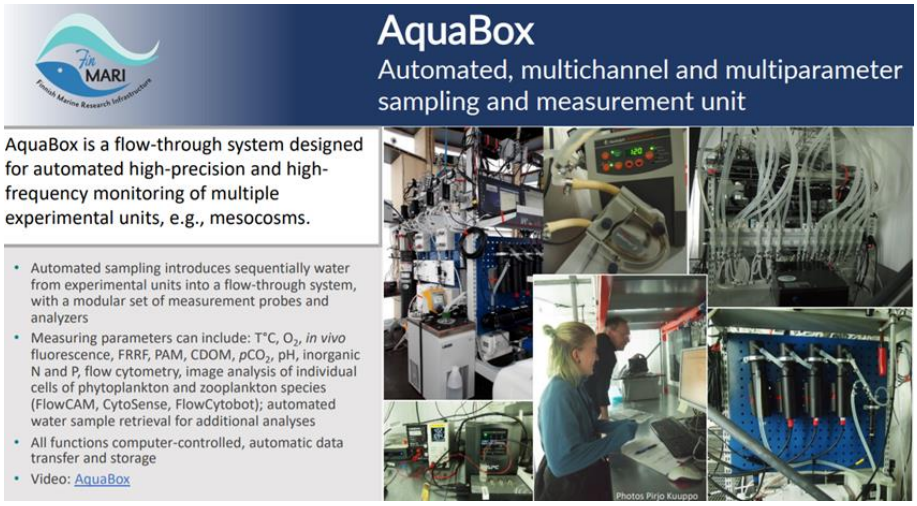


Figure GoF PS#8. Mesocosm experiment will be carried out in late summer 2022 in the SYKE Marine Research laboratory to study the effects of marine heatwaves on plankton ecosystem and will utilise the SYKE indoor mesocosm facility (up) and automated measurement unit AquaBox (bottom). Experiment has open access through JERICO and AQUACOSM TA programmes.

Regional and pan-European integration

The experiment has links to other mesocosm experiments at PSSs, NW-MED PSS#3 experiment already conducted in spring 2021 and Cretan PSS#3 to be carried out in early summer in 2022.

It is expected that such activities improve collaboration between experimentalists and observationalists, in studying the same phenomena with different strategies, yielding more influential results on how ecosystems respond to various disturbances.

Explain rationale for changes in plan for 2022.

Action GoF PSS#8 will be implemented in most part in 2022 and there are not many changes in the original plan. Some modifications for TA calls (Other data sources), timetable, experimental design, and collaboration with AQUACOSM-plus are needed, as planning of experiment has been detailed.

GoF PSS #9 Promotion of the use of PSS data and products

Key Message from the Action

Participation of partners at the meetings of regional stakeholders (BOOS; HELCOM working groups and expert groups) and presentations for local authorities (Estonia, Finnish ministries of environment, etc). The main message conveyed was about the combination of innovative technologies with conventional monitoring to improve the confidence of assessments.

Partnership, platforms and data sources

No changes in partnership, platforms, and data sources. Data from RV flow-through systems collected to be analysed in more detail and included in the indicator assessments and hydrographic background characterization (T, S, DO, Chl *a* fluorescence and carbon system parameters).

Main achievements

GoF PSS activities have been disseminated in BOOS annual meetings in the planning phase of PSS (4-6 Nov 2020) and after the first year of implementation (24-26.11. 2021).

Among other PSSs, GoF PSS Actions have been presented to the JERICO-S3 community in large, during a specific PSS progress report meeting (21.9.2021) and during a workshop of multiplatform observations including EuroGOOS, EuroSea-project, NAUTILOS-project and MINKE-project (18.11.2021).

GoF PSS activities were demonstrated to representatives of the Ministry of Environment, Finland (24.5. 2021).

SYKE has been collaborating with HELCOM, within frames of Baltic Data Flows project, aiming to have FerryBox observations and especially validated chlorophyll fluorescence observations available for assessments.

TALTECH has participated in HELCOM EG EUTRO work for eutrophication assessments, especially to collect oxygen profile data from the Gulf of Finland to be used for the development of shallow water oxygen indicator (EG EUTRO on-line meetings on 22.04.2021, 01-02.09.2021, 25-26.11.2021; GOF shallow water indicator meetings on 22.09.2021, 11.11.2021, 23.11.2021).

TALTECH is responsible for the HELCOM Oxygen debt indicator assessment based on the data from 2016-2021 (agreed at HELCOM S&C WG meeting on 04.03.2021).

TALTECH analysed flow-through data from RV Salme and suggested possibilities to include this data stream into the monitoring and assessment system of surface layer Chl a and pH and/or pCO2 (reports and presentations to the Ministry of the Environment; May 2021 and December 2021).

Regional and pan-European integration

Communication with the relevant regional (BOOS; HELCOM working groups) has started and is continuing. Via BOOS, the JERICO partners can involve more regional institutions and data for their products/services. Participation in the HELCOM work during the indicator development phase is important to include PSS data in the HELCOM environmental assessment products.

Explain rationale for changes in plan for 2022

No changes if the plans of HELCOM HOLAS III assessments will stay as they are.

GoF PSS #10 Connecting the other RIs in the region

Key Message from the Action

> GoF PSS has well established connections to several other environmental RIs active within the region and various collaborative activities have been identified.

Partnership, platforms and data sources No changes.

Main achievements

In the EU, the number of environmental RI's is continuously increasing, leading to potentially overlapping activities and administrative efforts as well as to the increase of synergies and needs for coordination. Coordinating the work may save both administrative and technical efforts and ensure collecting seamless and multi-use datasets.

GoF PSS connects JERICO-RI regionally to several other environmental research infrastructures. Key contacts of these other RIs have been clarified and briefly summarised here. All Finnish components of GoF PSS belong to national FINMARI-RI, while Keri Station in Estonia is part of Estonian Environmental Observatory. Part of the GoF PSS, Utö atmospheric and marine research station is a joint research facility of, ICOS, ACTRIS, HELCOM, EMEP and GAW Regional station. Utö site is also part of national INAR-RI's. FerryBox in FINNMAID is part of ICOS-RI. FMI is a partner in EURO-ARGO ERIC, while Argo data is also supporting GoF PSS observations. SYKE is a partner in EuroFleets+, as well supporting data collection. SYKE is partner in AQUACOSM+, and besides a joint activity for mesocosm experiments (GoF PSS#8), there are overlapping interests for plankton imaging. SYKE is also a partner in the recently started MINKE INFRAIA project, which aims to improve collaboration between national metrology institutes and oceanographic institutes, work which is very relevant for JERICO-RI. The Finnish-Estonian-German activities on GoF PSS are in a close interaction with GOOS.

Specific interactions with other RIs include:

- In aim to increase GoF PSS interactions with other relevant infrastructure, FMI proposed including the current JERICO pCO2 observations on FerryBox at Silja Serenade in the ICOS-OTC VOS network in 2021. In 2021, discussions between the JERICO partners and DANUBIUS were also started.
- Interaction between the GoF PSS partners and ICOS OTC have started in 2021 by the FMI participation in ICOS-OTC intercomparison WS in Belgium, where the experiences from JERICO-NEXT TNA activity INTERCARBO were shared with the participants. In 2021 also a joint research activity combining JERICO-RI and ICOS observations was

published (Grönholm et al 2021), showing that LNG-powered shipping, if equipped with low-pressure engines does not reduce the greenhouse gas emissions. The results were disseminated through several channels, including the largest Finnish newspaper Helsingin Sanomat.

- AQUACOSM-plus partner has been granted a TA project in JERICO-S3 TA call (or actually two of them), to visit SYKE MRC-lab (in frames of GoF PSS#8) and Utö Observatory aiming to improve harmonisation of plankton imaging methods between RIs.

Regional and pan-European integration:

GoF PSS connects to several other RIs active within the region. The contacts are well established, often in-house. It is important for GoF PSS to clarify different roles of RIs nationally, regionally and in pan-European dimension. GoF PSS need to bring this information to WP2, where pan-European collaboration and synergies between RIs are studied.

Explain rationale for changes in plan for 2022.

Analysis of Gof PSS#10 highlights the multiple between-RI interactions. There is not much need for changes in the Action, just some adjustments are needed. These include especially noting the flow of information towards WP2 and including scientists as users of results obtained, as they are the key users of RIs and benefit a lot from the collaborations in the end.

NW-MED PSS #1: Reconstruction of the 3D coastal dynamics

Key Message from the Action

The assimilation of regional data in the North Current region should allow the reconstruction of coastal dynamics in 3-D and analyse its impact on water mass characteristics, particle transport and biological species distribution.

Partnership, platforms and data sources

Glider operations in ILICO (MOOSE) have stopped since July 2021. The AMBO project (CNR) did not occur in April 2021. It has been postponed for 2022 with a new subcontractor (ALSEAMAR).

Main achievements

The WMOP is a high-resolution ocean forecasting system implemented over the Western Mediterranean Sea. It is run operationally on a daily basis, producing 72-hour forecasts of ocean temperature, salinity, sea level and currents (Juza et al., 2016, Mourre et al., 2018). Systematic validation procedures based on the inter-comparison of model outputs and satellite and in-situ observations are implemented to continuously assess the accuracy of the model. Model indicators (volume transports, average temperature, salinity, kinetic energy and heat content, maximum mixed layer depth) are also computed every day to monitor the system.

In 2021, the WMOP data assimilation system was adapted to ingest data from moorings along the NW Mediterranean slope, in addition to satellite SLA & SST, T-S profiles and Ibiza Channel HF radar velocities. SOCIB and Puertos del Estado mooring data are presently being assimilated in the operational model, contributing in particular to help constraining the model surface salinity. In this context, SOCIB has updated the glider-derived Balearic Channels transports by water mass characterisation. This extension provides nearly 10 years continuous monitoring of these transports, supported by high resolution modelling comparisons (paper submitted). These data have investigated the increase in salinity in the mixing line between LIW and WMDW between 2013 and 2019 (long term vs. rapid change). Presentations are available in [WP4 Google Drive].

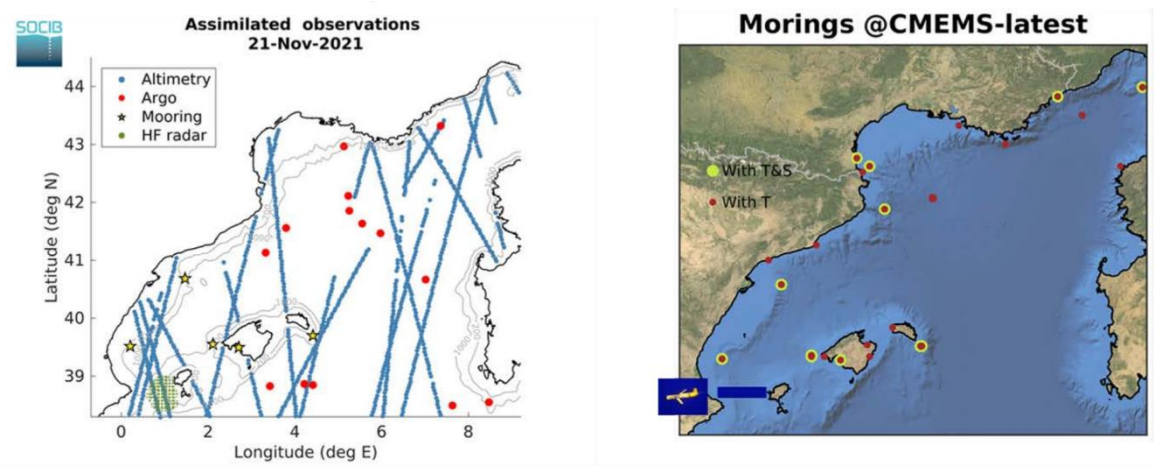


Figure NW-MED#1. Integration of multi-platforms observations into the high resolution WMOP model through data assimilation: altimetry and SST track, Argo profiles, HF radars in Ibiza channel (left) and moorings from SOCIB and PdE (right) have been used

The Action#1 depends strongly on *in situ* platforms deployed regularly to acquire physical data inside the PSS (SOCIB, CNR, ILICO which includes MOOSE, SOMLIT, COAST-HF). In this context, continued occupation of the Canales Ibiza Channel and Mallorca Channel

monitoring lines by glider vehicles (continuous), R/V SOCIB science cruises (seasonal) and ARGO profiler launches updated the Balearic Channels transports by water mass characterisation. With now 10 years near continuous monitoring of these transports, this will be supported by high resolution modelling discussed above. In the Italian side, HF radar network and Corsica Channel mooring are continuously running.

SOCIB was only able to carry out 3 of the seasonal Research Vessel 'Canales' monitoring lines across the Mallorca and Ibiza Channels during 2021 due to technical problems. The winter, spring and autumn cruises were carried out as planned, but the summer cruise had to be cancelled. The cruises made lowered CTD and shipboard ADCP sections across the two channels in addition to separate net sampling and shipboard ADCP sections.

As in previous years, SOCIB launched 3 ARGO floats, however these were delayed until December, as a result of the lack of a summer Canales research vessel cruise. In addition, 9 drifters were deployed as part of SOCIB's continuous monitoring of surface currents supporting HF Radar analysis.

The HF radar system by CNR has been running, with some system updates. The network coverage, which actually includes 4 antennas in Viareggio, Tino island, Monterosso and Portofino, is under expansion to the West by the installation of one more antenna in Celle Ligure (provided by external fundings).

Continuous analysis of drifter data sets and in situ observations of the water column in the western Mediterranean Sea to study the 3D dynamics of fronts has been performed (CALYPSO experiment with CNR and SOCIB). This work aims to study the convergence of marine currents, and the associated vertical velocities, with an application on the transport of biological and polluting particles. The first CALYPSO experiment allowed us to estimate the surface divergence/convergence in the La Spezia area from HF radar velocity fields and to estimate the intensification of the kinematic properties (divergence, vorticity) during extreme wind events.

In addition, a coordinated Lagrangian simulation exercise was defined to analyse the dispersion of materials and litter from the Var and Roya River mouths during an extreme rain event in October 2020. This work will be done in 2022.

The data flows are available by the national coastal research infrastructures through their threads or other web servers and QC routines have been used for RT data flagging of gliders and radar platforms (including links to WP5 and WP6).

During the first year of the implementation, the best practices and standard operations have been established and applied from EURO-ARGO, EMSO and the on-going OceanGliders (EUROSEA project WP3).

Regional and pan-European integration

Action #1 aims to merge and assimilate all physical data provided by the RT platforms deployed in the PSS. It has the potential to include all available data from Italy, France and Spain, which will extend the current representation of the Northern Current. For this action, sustainability and cooperation with EURO-ARGO and the EMSO community are essential to maintain the deployment of the platforms in the PSS in order to improve data provision and quality control procedures.

Explain rationale for changes in plan for 2022

For ocean dispersion analysis, a coordinated Lagrangian simulation exercise will be performed to analyse the dispersion of marine materials and wastes in the NWMed PSS region. An extreme rainfall event affecting the French-Italian border area in October 2020 (storm Alex) will be considered for this exercise. Several coastal models will be used and compared between them, based on a common protocol determining the particle seeding

properties in the different models. This event is new and has not been planned for in D4.1, as it is a meteorological anomaly occurring in late 2020.

In parallel, CNR is planning a float deployment in the Western Med Sea in winter-spring 2022 for the investigation of small-scale frontal structures and a drifter deployment in the Ligurian Sea within the HF radar network.

Finally, the GNF (French glider facility) was shut down in July 2021 which compromised some gliders data provision for the action#1 and in particular the AMBO project (CNR, CNRS). However, this work has been postponed to April 2022 with a subcontractor (ALSEAMAR) which will operate a glider with ADCP and BGC payload in the Ligurian Sea near La Spezia along the CNR radar field for 10 days.

NW-MED PSS #2: Impacts of river discharge to coastal ecosystems

Key Message from the Action

> River input databases from France, Italy and Spain were gathered and compared in order to highlight best practices concerning the same measured parameters, sampling frequency. A demonstration action was conducted in front of the Ebro River with operational platforms to study the impact of river inputs on coastal ecosystems.

Partnership, platforms and data sources No change

Main achievements

The main input for this action was the organisation of a joint campaign on the Garcia del Cid with CSIC which occurred in September 2021 in front of the Ebro River. This campaign was dedicated as a demonstration action using operational services (buoys, satellites, glider, boat) to study the impacts of river discharge to coastal ecosystems and acquire glider ADCP data to validate/compare with HF Radar data.

Real-time river input databases from Spain (Ebro-Llobregat system DANUBIUS), France (IR ILICO MOOSE) and Italy were gathered and compared in terms of acquired parameters, sampling frequency and objectives. The main goal was to uniformize all databases for best practices.

Regional and pan-European integration

River input database of the Ebro River is a part of the DANUBIUS RI and was chosen as an example for other river systems monitored in this PSS.

Explain rationale for changes in plan for 2022

A glider action initially planned in front of the Rhone River was cancelled due to dismantlement of the French glider technical division. This action will be replaced by a glider deployment in the frame of TNA in the Ligurian Sea with CNR and CNRS (see Action #1). This will not, however, bring any changes in the implementation plan.

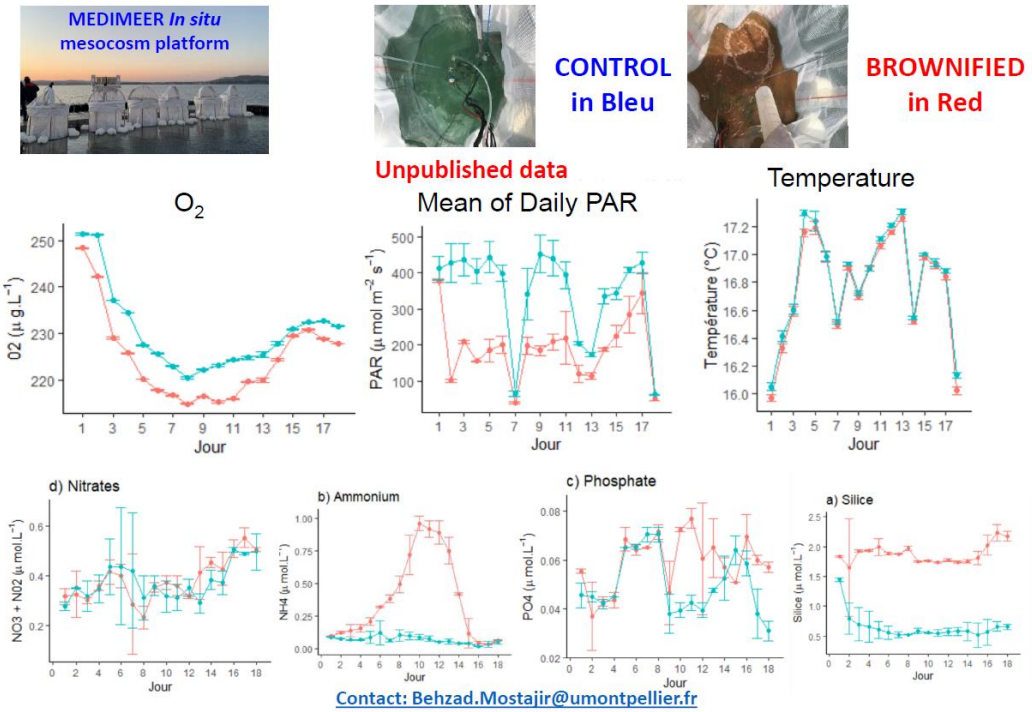
NW-MED PSS #3: Extreme events affecting phytoplankton - AQUACOSM collaboration II

Key Message from the Action

> We demonstrate the importance of combining mesocosms and high frequency observations to elucidate the effects of global warming and ocean acidification on temperate marine ecosystems. Here, we investigated the combined effects of DOC loading and temperature increase on phytoplankton community responses.

Partnership, platforms and data sources

MEDIMEER mesocosms facility in Montpellier and the TA of AQUACOSM-plus have been used in 2021.



Main achievements

As a collaboration with AQUACOSM-plus in the Action#3, a Transnational Access call to MEDIMEER infrastructure was announced and published at the JERICO-S3 website (February 17, 2021).

In May 2021 we performed a large mesocosm experimentation in order to highlight "Marine plankton community responses to terrestrial dissolved organic matter input" (TA Aquacosm). In this experiment, we used oak forest soil, characteristic in south of France mixed with the freshwater of a river near the MEDIMEER installations and matured during the two weeks before being added to the mesocosms filled with the marine water.

This experiment was combined with a water temperature increase experiment in the frame of French ANR national project (responses to terrestrial dissolved organic matter input in freshwater and marine ecosystems in a changing environment, RESTORE) on the MEDIMEER infrastructure.

Carolina Cantoni (CNR) applied to TA-AQUACOSM-plus and her project was approved. She participated in the MEDIMEER mesocosm experiment to study the effect of extreme events on phytoplankton by monitoring alkalinity and pH during the mesocosm experiment. It was the first time we established a synergy between JERICO-S3 observing community and AQUACOSM-plus mesocosm experimenting community.

To encourage future collaboration between the two RI, scientific coordinator of Jerico-S3 was been invited to "2nd International Aquatic Mesocosm Research Symposium - From local processes to cross-domain interactions" (12-16 April, Virtual event) to present Jerico-S3.

Figure NW-MED PSS #3. In situ mesocosm experiment realised in the frame of France national Program (ANR) RESTORE and opened to Transnational Access of European project AQUACOSM-plus (May 2021). The panels show results for oxygen, irradiance, temperature and nutrients measured from control mesocosms (blue) and those treated by addition of terrestrial matter (red).

Regional and pan-European integration

In this action, the PSS involves two communities JERICO-S3 and AQUACOSM-plus. It could be used as a demonstration (observation + experiment) for other PSS where acidification is the main issue for example.

Explain rationale for changes in plan for 2022

There is a possibility to enlarge collaboration with AQUACOSM-plus, as they open funding opportunities for mesocosm experiments in 2022 under its second call for transnational access (TA). Marine systems are facing an increase in the frequency of extreme events and in particular climate change scenarios predict the increase of heatwaves in the future. After this first period of the heatwave, all mesocosms in the experiment will undergo a period of 5 days without heating following the natural water temperature. We look forward to building a link between JERICO-S3 and AQUACOSM-plus for this additional experiment, in addition to one already realized in 2021.

NW-MED PSS #4: Biogeochemical data and ocean colour products

Key Message from the Action

Harmonise and implement joint QC for regional data to improve regional ocean colour and regional BGC model products.

Partnership, platforms and data sources No changes

Main achievements

In the Action#4, the data are provided by national observing systems implemented in the PSS (ILICO, SOCIB, CNR). These data are regularly sent to GDAC after QC procedures following existing Best Practices and cookbooks from EURO-ARGO, EMSO and OceanGliders.

The annual MOOSE-GE was performed in June 2021 with 135 CTD-Niskin bottles deployment and the collection of 3 Argo floats and deployment of 5 new floats inside the PSS (RV Thalassa). The French BGC-gliders maintained its sections from Nice to Calvi (MOOSE T00) during 4 months (from January to May) while the section from Marseille to Menorca (MOOSE T02) was performed from March to April 2021. These platforms are essential to provide BGC data in the PSS region.

The TALPRO cruise (GO-SHIP cruise in the MedSea) was planned for 2021 with north-south sections in the PSS which would increase the BGC sampling in the PSS region. Unfortunately, this cruise has been postponed to May 2022 onboard RV BELGICA II.

In this context, repeated cruises from SOCIB and IEO have been performed on the Spanish side in 2021. For example, the RADMED monitoring program (MFSD) along the Spanish Mediterranean coast occurred in January (RADMED_0121, RV Ramón Margalef) and in May 2021 (RADMED_0521, RV García del Cid).

The PSS area is increasingly equipped with BGC sensors mounted on moorings (surface measurements of pCO2 & pH at DYFAMED) and Argo floats (one Argo O2-pH has been deployed in 2021). At the same time, monthly ship visits are still active at DYFAMED, ANTARES and MOLA sites with BGC sampling from the surface to the deep waters.

The application of the neural network CANYON-MED to predict nutrients and BGC trends has been submitted to JGR-Oceans. The module of carbonates system in the regional model Symphonie-Eco3M-s is still in progress. This new module will provide simulations for seasonal and interannual CO2 air-sea fluxes based on multi-platforms BGC approach and CANYON-MED products.

Regarding the ocean colour products for coastal waters in the PSS, a new ocean colour Sentinel 2 high resolution product is available on CMEMS from April 2021. There was a setting up of specific algorithms to use Sentinel 2 data (slightly different from what is proposed today by CMEMS): atmospheric correction (Polymer), Chla with adaptation of OC5, SPM using IFREMER algorithm and transparency (Secchi). In 2021, there were some validations in very narrow coastal waters in Ireland for Chla and SDD that should be used for the NW MedSea coasts. In parallel, the multispectral algorithm near the Rhone river was improved to remotely sense the wide range of SPM concentrations along a river mouth from ocean satellite data (Ody et al. in prep.).

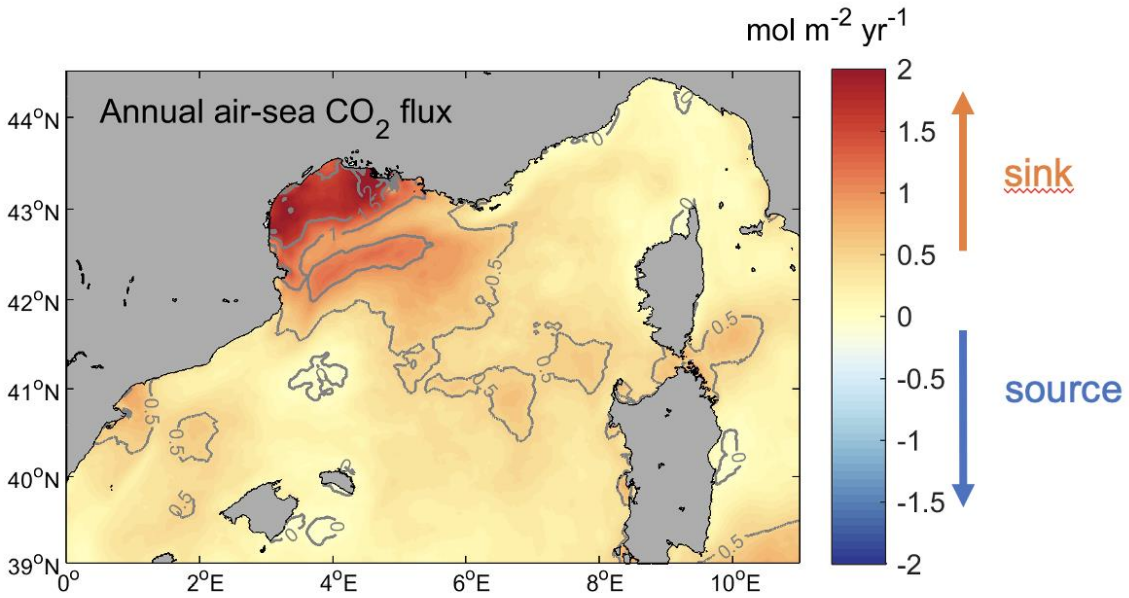


Figure NW-MED PSS#4: First run of the new CO2 module of SYMPHONIE ECO3M-S in the PSS area showing the moderate annual sink for atmospheric CO2 (annual flux of 0.5 mol/m2/yr for the year 2012/13) mostly driven by the coastal area of the Gulf of Lion (Ulses et al., in prep.)

Regional and pan-European integration

In this action, BGC platforms deployment and maintenance are essential to provide QC BGC data and derived products. This implies strong interconnections with ERIC EMSO, ERIC EURO-ARGO and international networks like GO-SHIP and OceanGliders. The repeated cruises are also active in the PSS and essential to provide reference dataset for BGC products. They are very dependent on the support of institutes and nations.

Explain rationale for changes in plan for 2022

As the development of ocean colour algorithms or this action has been delayed (depending on the third party), the original objectives have been revised. Applications of BGC products for building new indicators should be revised. The action will focus more on the observation of the carbonate system in the PSS based on in situ observations and the application of neural networks trained and used in NW-MED PSS.

NW-MED PSS #5: RI interactions

Key Message from the Action

Establish close links with the marine infrastructures active in the NW-MED PSS, EMSO-ERIC, EURO-ARGO-ERIC, EMBRC-ERIC and ICOS-ERIC, to ensure a nearshore-coastal-offshore continuum in observations and modelling.

Partnership, platforms and data sources No changes

Main achievements

The Action#5 is oriented towards RI interactions and integration, which is an objective of JERICO-RI for the ESFRI roadmap. In this context, several interconnections between the NW MedSea PSS and RIs have been demonstrated in actions #1 & #4 (deployment of Argo floats, deployment of gliders between France-Spain-Italy, mooring maintenance...). It is clear that the multi-platforms approach within the PSS is an asset to interconnect the RIs in a dedicated geographical area. It is also relevant to emphasise that the ship's cruises (and its accessibility at the national level) are essential to maintain synergy among the RIs (e.g., the samples and platforms operated on board are useful for many RIs active in the PSS) and the maintenance of the platforms are mutualized.

During the year 2021, several operations have been made conjointly: genomics sampling inside the PSS during MOOSE-GE cruise (CNRS with EMBRC), deployment and collection of Argo floats during the repeated cruises (CNRS, SOCIB with EURO-ARGO), the exploitation of Saildrone demo mission in the NW MedSea conjointly with ICOS (ATL2MED project with SOCIB, CNRS, CNR, OGS), the participation of PSS partners to establish updated best practises for several platforms through the project H2020 EUROSEA (WP3).

In summer 2021, we participated in the ICOS intercomparison sensor exercise which aims to test the precision of different pCO2 sensors mounted on different platforms (coastal and open sea).

Interactions have been possible through several meetings (see action#6)

Regional and pan-European integration

This aspect in the Action#5 is important and performed through mutual sea operations, best practices and SOP exchanges and common meetings for sharing scientific results and implementation strategies. This interaction is also essential in the EUROSEA project (WP3 & 7)

Explain rationale for changes in plan for 2022.

There are no changes but some updates about the sea operations between RIs where PSS partners are involved: the deployment of two benthic crawler near ANTARES site (CNRS) and at Obsea site (UPC) in Spring 2022 and the TALPRO2022 that will occur in May 2022 (GO-SHIP).

NW-MED PSS #6: Transnational integration

Key Message from the Action

> The action#6 aims to promote integration of the regional and European initiatives like MONGOOS (EUROGOOS) and EU projects to disseminate results, new products and to align its strategy towards a regional integrated observing system.

Partnership, platforms and data sources

The collaboration with MONGOOS and EUROGOOS groups is working well. However, we are missing connections with UNEP-MAP. This last partnership should be removed

Main achievements

The transnational integration has been made through several online meetings: Deep-Argo and BGC-Argo workshop from Sept 27th – Oct 1st with cross networks discussion (PSS will be a key example), MONGOOS workshop & General Assembly happened on 26-28 October 2021 with several presentations of PSS platforms included in different EUROGOOS Task Teams.

The online meetings limited the possible discussion and dissemination of PSS activities. This should be improved in 2022.

In parallel, PdE has coordinated collaborative work to review the status of coastal sea level infrastructure in the Mediterranean and Black Seas, including those integrated in this PSS. The work provided a detailed mapping of existing stations and their characteristics, the fit-for-purpose status and an assessment of data availability in different national and international data portals.

Regional and pan-European integration

As for Action#5, this activity was emphasised during meetings and projects. The different joint actions in PSS help to strengthen the collaborations, but we lack meetings between the PSS to exchange on our common activities and the possible harmonisation on the implementation of our platforms for the future.

Explain rationale for changes in plan for 2022

The collaboration with UNEP-MAP is not active. The online meetings limited the potential collaborations and dissemination. However, future EU projects in construction (eg. Horizon InfraTech 01) should help to extend our transnational collaboration with EU nations and RIs.

NSEA PSS #1 Harmonised observations of regional C fluxes

Key Message from the Action

The North Sea PSS has been extensively sensed over the past several years, and now these carbonate system observations are allowing for high-resolution C flux estimates and quantifying recent changes in carbonate chemistry. As a community, we are still learning how to best make these observations, but harmonising observations between JERICO-S3 partners and the international community (ICOS, SOCAT, etc) has and will help in this goal.

Partnership, platforms and data sources

Some stations and platforms in the observation network have been affected by the pandemic. For example, the Lysbris Seaways FerryBox was not operating most of 2021 due to restricted access to the vessel due to Covid-19. As this had an overall minor impact on the work undertaken.

Main achievements

Work has been undertaken to quality control existing data working towards an improved coherence of the available data from the partners in this project. For instance, the long-term dataset of partial pressure of CO_2 (pCO_2) measurements in the North Sea collected onboard two ships of opportunity, the Lysbris Seaways and Hafnia Seaways has been quality controlled and published (Macovei et al. 2021a). These data have been used in intercomparison exercises with SOCAT data (Macovei et al. 2021b). Quality control of CH_4, pCO_2 and pH data sets from all partners is now underway and should be published in 2022. Most of these data sets have been integrated into a database, hosted at Deltares (compare Action #5).

An SOP for pCO_2 quality control from underway systems is still to be developed and this is one task to be done in 2022. The experiences in 2021 were invaluable for this, as new information on instrument manufacturing was acquired, new deployments of membrane-based sensors along General Oceanics systems were undertaken, and two new intercomparison efforts (one JERICO-NEXT TNA experiment in 2019 in Norway, and one 2021 ICOS-OTC in Belgium) are now providing more information, which can be incorporated to provide a better SOP.

Biological imaging processing and data transfer is underway.

Regional and pan-European integration

Actions related to integration were hampered by the pandemic situation. Since the project started, we have held six meetings of the NSea PSS core group, in addition to meetings with the entire EC/NSea PSS. These meetings served the establishment of work plans as well as the creation of working relationships. We have reached out to other partners outside of the JERICO consortium, as well as to SOCAT and ICOS. We were also in contact with the colleagues from the KASKEN IRS, with whom we started planning a shared in-person workshop.

Explain rationale for changes in plan for 2022

No major changes are foreseen in our work plan for 2022. We still have to catch up with some delays stemming from Covid-19 related hindrances, but overall, the plan remains unchanged.

NSEA and CHANNEL PSS #2 Riverine input to the North Sea

Key Message from the Action

Providing harmonized useful data for riverine input to the North Sea (and Channel) remains difficult due to varying measurement strategies and value availability, but improvements can be built on existing methods to be tested and shared at the level of both EC and NSea PSSs.

Partnership, platforms and data sources Partners: IFREMER (Devreker D.) has been included in the work. Data Sources: European River Loads Database curated by NIOZ (van Leeuwen) has been included in the work.

Main achievements

Identification of basic general challenges for the calculation of input of substances into the PSS via rivers, e.g. geographical shift of nutrients and flow measurement points along the same river and different measurement frequencies, complicated the intercomparison of calculation results.

First results show that a good solution for a standardized flux calculation should be using the OSPAR RID method at monthly scales for large rivers of the English Channel, such as the Seine River and the Somme River.

During our research, we experiment with different approaches to the calculation of daily river loads. We developed a simple, linear regression-based, method of calculating multiplication factors to obtain flow values at chemical measurement stations from flow measurements at nearby stations.

While the calculation of a flow value may seem simple a priori, concentration flow, in practice we see that there are a variety of methods depending on the watershed or the scientific context in which it is calculated. To realize this variability, we compared the results of the flow calculation as well as the raw data used for these calculations from 2 different sources: RTrend from the RID group of OSPAR (calculated in France by the SDeS) and the data from entry of the ECOMARS-3D model. RTrend and ECOMARS-3D draw their nutrient concentration and flow data from different databases as follows:

- For nutrient concentrations: NAIADES for RTrend and the Water Agencies for ECOMARS-3D; knowing that the NAIADES data are the centralized and validated Water Agency data (before 2018 RTrend was fed by the Water Agency data but this has changed, passing in NAIADES some data has been deleted, others validated and flow calculations have been updated from this data).
- For flow data: HYDRO + SCHAPI for ECOMARS-3D and HYDRO for RTrend.

In addition, the measurement points considered in the same watercourse are not always the same between the 2 methods.

Flow data from the HYDRO and SCHAPI data banks are acquired on a daily scale while nutrient concentration data is acquired, at best on a weekly scale, if not on a monthly scale.

The annual flow calculations in RTrend consider this frequency variability by adapting the calculation methods as a function of the number of measurements per year.

For ECOMARS, the concentration data are brought to another time scale chosen by calculating a multiannual trend and a seasonal cycle for each stream and nutrient. The difference between this regression and the in situ measurement gives a point cloud on which a normal or log-normal distribution is made to give a residue. At each desired time step (obtained by linear regression), a random value of this residue is added. The flows are finally calculated by multiplying the flows by these concentrations.

First results show that the RID method provides a simple and robust approach for annual fluxes calculation and could be good also for monthly estimations for rivers that show several nutrients concentration measurements per month such as the Seine River. The ECOMARS3D method is also good but requires a more complex algorithm to adapt data frequency.

First meetings were held to discuss the integration of an existing, frequently updated European River Loads Database curated by Sonja van Leeuwen (NIOZ) with JERICO-RI. Preliminary plans were made to contribute to the Database and host it with JERICO-RI.

A new river station is being established at the Elbe river in Tesperhude by partner Hereon in collaboration with DANUBIUS-RI. This state-of-the-art installation is designed to routinely measure physical, biogeochemical and biological quantities as well as pollutants.

As a summary, Action #2 has managed to collect information on existing databases and analyse their content. It also investigated methods to standardise calculations. First results show that the OSPAR RID method provides a simple and robust approach for annual fluxes calculation and could be good also for monthly estimations for rivers that show several nutrients concentration measurements per month.

Regional and pan-European integration

Actions related to integration were hampered by the pandemic situation. Since the project started, we have held six meetings of the NSea PSS core group, in addition to meetings with the entire EC/NSea PSS. These meetings served the establishment of work plans as well as the creation of working relationships. Integration action will need to be intensified in 2022.

Explain rationale for changes in plan for 2022

The NSea/EC PSS #2 initially included mainly partners from the NSea part of this twin PSS. With the involvement of the EC part, our work expanded in scope. NSea/EC PSS#2 is 1-2 months behind the schedule towards the objective. This is mainly because there have been delays due to the lack of anticipated personal contact due the pandemic situation. Gathering information has proven to be more complicated without the possibility of face-to-face exchange.

After finalizing the inventory of available databases, we expanded our list to integrate an existing, frequently updated European River Loads Database curated by Sonja van Leeuwen (NIOZ) with JERICO-RI. As of now, this database is not yet online, and content has to be requested directly from the curator. Preliminary plans were made to contribute to the database and host it with JERICO-RI. The analysis of the database contents is still ongoing and needs more effort.

New methods for gap filling developed in JERICO need to be implemented in data QC routines.

CHANNEL PSS #3 Harmonised observations of plankton biomass, diversity and productivity dynamics

Key Message from the Action

> During the year 2021, we continued to apply both automated and reference techniques for observing and monitoring phytoplankton communities, dynamics and blooms from small to meso-scale, by combining regular long-term low-frequency (monthly to fortnightly) and higher-frequency (weekly, daily, hourly) monitoring on research vessels and fixed automated stations and moorings. The data gathered is being processed through manual and automated procedures and best practices are still being defined in the frame of international collaboration within and outside the EC NS PSS.

Partnership, platforms and data sources No changes.

Main achievements:

The long-term monitoring of phytoplankton continued to be performed throughout the year 2021 by most partners (CNRS LOG & BOREA, IFREMER, CEFAS, VLIZ, Hereon) on both fixed stations, research cruises and moorings.

Within the JERICO-S3 framework a cruise was conducted (March 2021) into two Norwegian Fjords (Hereon) and with contributions by CNRS-LOV. The overall goal was to compare different in-situ imaging instruments and to harmonise the data output including CPICS, UVP5, UVP6-LP, UVP6-HF, LOKI, PELAGIOS, LISST-Holo, LISST 200 and self-developed imaging systems. The data is currently being analysed and will be published.

Following successful deployment and testing in December 2020, the Helgoland Underwater Observatory (HUWO) equipped with a CPICS plankton and particle imager as well as CTD, oxygen sensor and ADCP, is now operational and maintained jointly by AWI and Hereon. A continuous time-series of plankton diversity, biomass, and behaviour is currently being collected. Additional physical, meteorological and chemical data collected in the same area can be closely associated with data collected at the HUWO.

By the strait of Dover and the Eastern English Channel, automated phytoplankton observations were conducted in 2021 (contributing to a 10-year data series) by the CNRS LOG. The transect, composed of nine points extended over 5.25 nautical miles, is carried out on a weekly basis, including the acquisition of *in vivo* data with automated flow cytometry, multispectral fluorometry and imagery. Photo-physiological parameters and primary production were measured by active fluorescence (FRRf). Automated measurements were also carried out bi-weekly on samples collected within the framework of monitoring networks deployed by Ifremer (SRN-REPHY) and national monitoring networks (SOMLIT).

In March 2021, a collaboration between CNRS LOG, IFREMER/LER and LCSM laboratories allowed for the deployment of an automated flow cytometer for high frequency monitoring of the spring bloom on the MAREL-Carnot instrumented platform in Boulogne-sur-Mer. Moreover, photo-physiological parameters and primary production were also addressed, together with environmental variables, on the automated SMILE buoy.

Automated near-real time visualisation of data was effective through remotely operated sensors and automated analysis, and special attention was given to automated flow cytometry data through the EasyClus software (Thomas Rutten Projects). As part of the observation of plankton diversity and abundance, IFREMER have developed an automated analysis tool for plankton image recognition that can be deployed during cruises in near real time. This tool (combining image processing techniques and deep learning algorithms) was tested on FlowCam data but could be also tested on other acquisition devices.

The smart multisensor marine observation platform, Costof2, was installed on MAREL Carnot in the eastern English Channel. Costof2 was designed to suit various observation systems and to manage the huge variety of sensors used in oceanography, from the simplest sensor to the more complex ones. The MAREL Carnot station is now equipped with a multiparameter probe (T, S, Turb, O2, FLuo, pH), a meteorological station (wind, temp, pressure, PARair) and a nutrient analyser will be implemented soon.

A sampling method comparison was undertaken to investigate the efficiency of two plankton collection methods in the Belgian Part of the North Sea. Plankton net (WP2) and *in situ* imagery (VPR) samples were evaluated for their ability to estimate plankton abundance and community composition. With the aim for more integrated sampling practices, automated image acquisition methods such as the VPR can measure biotic and abiotic data simultaneously and combine both sampling and analytical steps in the process. A trial of the CPICS was performed in the Ostend harbour and at Belgian LifeWatch stations 215, 230 and Fairy Bank to compare the performance of the CPICS (provided by NIOZ) with the VPR, to examine the effects of water turbidity and the influence of vessel speed on the images. In a second study, two digital imaging systems FlowCAM and Zooscan were compared. The results can contribute to the best practices in plankton imaging techniques in WP5.

Best practices are under discussion and will be reworked in the frame of the work in WP5.3.3 ST7 and WP6 6.3.2 (polls and workshops gathering users within and out of JERICO

community. One first workshop on best practices on technical and data flows was carried out in 2021 on automated flow cytometry, two other workshops to be organised in 2022).

All French hydrological and phytoplankton data, which support the WFD/MSFD/OSPAR assessments procedures, have been secured within Ifremer's databases (Quadrige2, Sismer, Coriolis) and within the SIMM (Système d'Information pour le Milieu Marin) French data portal. The data stream to the ICES DOME database was optimised making the link to Actions #4, #5 and #8 needs. Therefore, these datasets can be (re)used for multiple purposes.

Data QC is done by each institute according to their expertise. These processes aim to be homogenised with respect to the recommendations of the dedicated work packages.

Key results for data management include:

- Live visualisation of the results of the automated flow cytometry deployed MAREL on the platform developed by Thomas Rutten Projects (using LiveClus online)
- Open access to numerical tools devoted to Hydrological/Phytoplankton data processing (linked to WP11 on Virtual Access)

Regional and pan-European integration

PSS partners were invited by the VLIZ to take part in the Spring Plankton Cruise scheduled on May 2021. Unfortunately, due to measures for COVID-19, this survey cruise had to be cancelled and will likely be reported to Spring 2022. However, the reserved shipping time for these dates was brought to another use.

The following research paper "Plankton spatial distribution during a snapshot of the productive season in the Southern Bight of the North Sea: an integrative approach from bacteria to zooplankton" (Aubert et al) was submitted to Progress in Oceanography in May 2021. This paper is based on the Joint JERICO-NEXT-LifeWatch cruise of 2017 gathering together VLIZ, CNRS and RWS). As the review process did not start on time, the paper was re-submitted in January 2022 to Frontiers in Marine Science.

Explain rationale for changes in plan for 2022

No change.

CHANNEL PSS #4 Products for Eutrophication Status Assessment

Key Message from the Action,

> Based on (i) expertise gained through implementation of research activities from other actions (#2, #3, #5) and (ii) the best available data from in situ measurements and also from modelling and satellite derived activities/products, EC PSS partners (also involved as OSPAR contracting parties) work on an updated version of the Common Procedure (COMP4) for the Eutrophication assessment and, consequently contribute to the preparation of the next MSFD assessment for Descriptor 5 on Eutrophication in an harmonised way (data flow, indicators, aggregation and integration, thresholds, use of additional data from satellite and modelling).

Partnership, platforms and data sources No changes.

Main achievements

Partners have developed procedures (up to specific tools) to overlay monitoring data that are in ICES databases (and so used in the OSPAR eutrophication tool, COMPEAT) with other datasets, with a view to submitting more datasets to be included in OSPAR eutrophication assessments and streamlining data flows. The work in this Jerico-S3 action shows where Jerico-RI can contribute to filling OSPAR data gaps and what additional activities need to be done (such as quality control and calibration) to make Jerico data useful for OSPAR. In

parallel, data related to the Eutrophication MSFD criteria (Descriptor D5) from Fr monitoring programmes, support to WFD/MSFD/OSPAR needs, have been collected and brought together within the SIMM portal. The data sets from modelling activities (EcoMARS3D model: nutrients, oxygen, Chlorophyll-*a*) and from Earth Observation (satellite-retrieved Chlorophyll-*a* from MODIS) are also available at least for the period 2015-2020. French In situ data are also available from EU portals and databases (e.g., SeaDataNet, CIEM). These data sets will be used for the OSPAR QSR 2024 and for the MSFD Good Environmental Assessment 2024.

IFREMER within the MSFD activities on Descriptor 5 Eutrophication in collaboration with Actimar (for modelling) and Acri-Argans (for Satellite) test the reliability of satellite and modelling-derived products integration in the eutrophication assessment procedure directly (as data to be process) or indirectly (as high-resolution data to support assessment based on low resolution data).

CEFAS is working on a NERC project called CAMPUS to develop and test various monitoring scenarios and the impact on eutrophication assessments. CEFAS is working on integrating different types of data (moorings, gliders, FerryBoxes, remote sensing, ASVs) within 5 monitoring scenarios which reflect the current situation, reduced monitoring, a move to more autonomous monitoring. CEFAS then looks at the impact on the quantity of data and confidence in the assessment (adapted from COMPEAT methods). This work is carried out in a shiny R application where the results can be viewed. The plan is to develop this for use alongside COMPEAT to bring in additional data for the UK assessment. Within CAMPUS there is also work on the economic costs and benefits of each scenario with a focus on a smaller area (likely the Thames plume) as a case study.

While we have successfully implemented innovative technologies in different platforms to acquire autonomously in situ physical, biogeochemical and biological data in the EC PSS, we also aim to investigate how all the different information can be analysed and aggregated to improve the assessment of marine water bodies, explore unusual events to help to develop innovative hierarchical monitoring concepts for coastal seas. In parallel to OSPAR works on COMPEAT, some other complementary tools (based on R scripts) were also developed at the French national level by the MSFD Eutrophication team (Ifremer) to improve the expertise and assessment (e.g., Ferry Box Data Management toolbox, Trend Analysis toolbox).

Low resolution data and conventional statistical methods to produce the regular environmental assessments are still the most used to extract information about status, dynamics and trends of the marine environment at the seasonal and the pluri-annual scales. One of the reasons of not processing high resolution raw data from automated sensors and processed databases is the lack of robust automated analytical tools compared to expert treatment (for raw data) and numerical methodologies which need to take into consideration the huge size of the time series, the complexity of the relationships between parameters, and a certain amount of missing data due to system failures and maintenances. These constraints often prevent optimal extraction of all the available information. In this context, a workshop has been organised by the LISIC (ULCO) and LER/BL (IFREMER) to promote new numerical tools developed for automated sensor data treatment, analysis and mining. These tools should be disseminated within other PSSs and IRSs (link with WP 11 on Virtual Access).

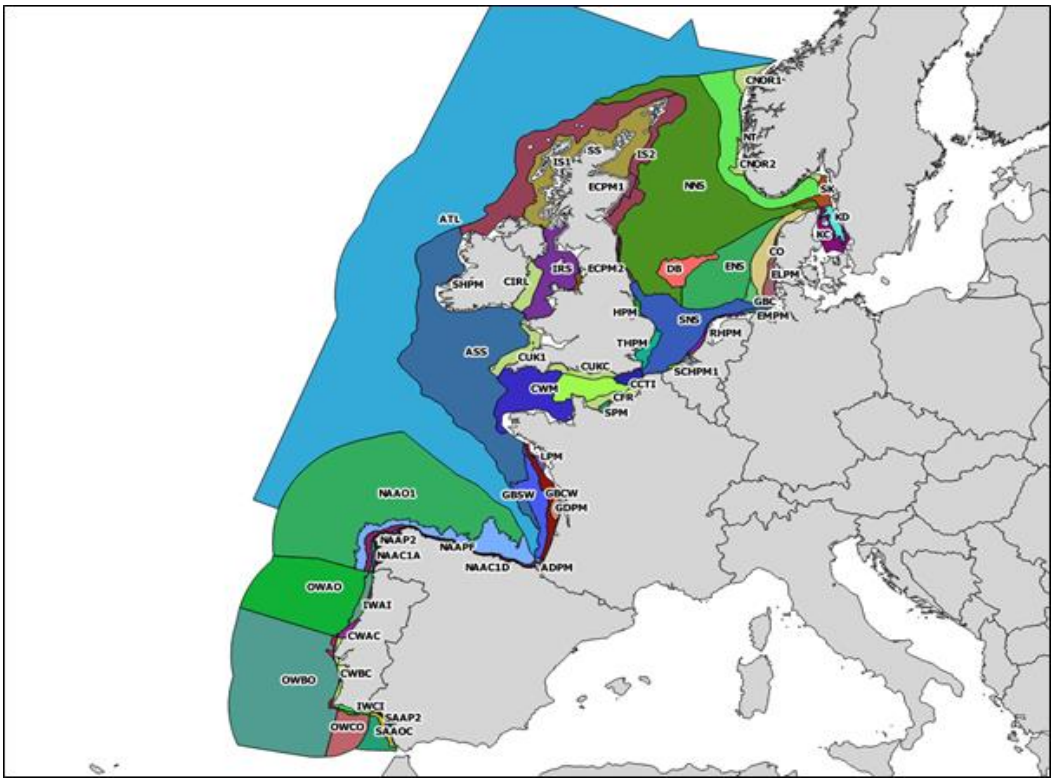


Figure CHANNEL PSS#4. Overview of proposed ecologically relevant eutrophication assessment areas based on duration of stratification, mean surface salinity, depth, suspended particulate matter and primary production (Source: OSPAR).

Regional and pan-European integration

EC PSS partners, that are also OSPAR contracting parties, contribute to the adoption of harmonised assessment areas for OSPAR Regions II (Greater North Sea, incl. the English Channel and part of the Celtic Seas). This work was based on the main results from the EU project Joint Monitoring Programme of the Eutrophication of the North Sea with Satellite data (JMP-EUNOSAT) (Blauw et al., 2019) and on further refinements proposed by contracting parties (mainly Fr and UK for the EC PSS area) (Tew-Kai et al., 2020). Whereas previous assessment was based on a cell grid approach and non-harmonized areas, the geographic scale of areas for eutrophication assessment have been chosen to balance hydrodynamic and ecosystem considerations with issues such as monitoring design, assessment of direct and indirect effects of nutrient enrichment in the sea and links with nutrient inputs and sources (link with Action #2). This work was also implemented for OSPAR regions III (Celtic Seas) and IV (Bay of Biscay), thus linking with the corresponding PSS and IRS.

Explain rationale for changes in plan for 2022

No changes.

NSEA and CHANNEL PSS #5 Intercomparison of phytoplankton distribution using data integration

Key Message from the Action

The Deltares model has been extended with carbon cycling and was run and validated for 2006 - 2017. A database was created bringing together validation data on eutrophication and carbon cycling from the greater North Sea area.

Partnership, platforms and data sources No changes.

Main achievements

In 2021 we built a database with all available monitoring data on variables in the Deltares ecological model for the greater North Sea. The model includes temperature, salinity, nutrients (N, P, Si), phytoplankton (4 species groups), organic matter (C, N, P, Si), oxygen and benthic filter feeders. In 2021 we added inorganic model variables to enable simulation of the carbon cycle, interacting with the phytoplankton dynamics in PSS North Sea. We ran the model for 2006 - 2017. The model domain covers the northern coast of Spain to mid-Norway and the south of Sweden to east of Ireland. The same model has also been used as part of the ensemble modelling approach by the OSPAR working group on ecological modelling, in support of new eutrophication thresholds for OSPAR and MSFD. In this context the model was validated with the ICES assessment dataset. It turned out that this database did not include sufficient monitoring data to validate the models in all assessment areas. For validation of chlorophyll-a model results satellite data have been used from 2 separate datasets. Many JERICO datasets such as FerryBox data have not been used in this OSPAR work yet. The database aims to have a more complete overview and accessibility of existing data, not only for the key indicator variables (DIN, DIP and chlorophyll) but also supporting variables that indirectly reflect ecosystem dynamics driven by phytoplankton, such as turbidity, salinity, light climate, nutrients and inorganic carbon fractions. The database now includes data from EMODNET, SOCAT, FerryBox database by Hereon, JMP-EUNOSAT project data, INTERREG project data, VLIZ data and PML data of primary production. Double data records have been filtered out. Overview plots have been created of data availability per variable and validation plots with these data (maps and time series).

We created an overview of available in-situ observation data and made them available for model validation. To this end we created automated data flows from data repositories from JERICO partners (VLIZ, Hereon, CEFAS) and other data repositories (EMODNET, ICES, SOCAT). We filtered out the double records and homogenized variable names, using uniform European data standards. Access to different parts of the database is controlled through passwords. Based on the data in this database we made overview maps, showing to what extent current spatial and temporal variability is covered with existing monitoring data. The model is being calibrated to these data, so that it can optimally fill up gaps in monitoring data.

Regional and pan-European integration

The model has been used in an ensemble modelling exercise in the context of OSPAR working group of ecological modelling. 7 models were involved, and they were run using as much as possible the same input data. The models were validated with observation data from the ICES database. Member states jointly identified gaps in observation data for model validation (and estimate reliability of model results and threshold values based on those) and for the assessment. Particularly in offshore waters a need for additional monitoring data was identified. The work in this Jerico-S3 action shows where Jerico-RI can contribute to filling OSPAR data gaps and what additional activities need to be done (such as quality control and calibration) to make Jerico data useful for OSPAR.

Explain rationale for changes in plan for 2022

No changes.

NSEA and CHANNEL PSS #6 Identification of Observational Gaps

Key Message from the Action

As this work is based in part on output from other actions, most of its activities will take place in 2022.

Partnership, platforms and data sources No changes.

Main achievements

As this work is based in part on output from other actions, most of its activities will take place in 2022.

Regional and pan-European integration:

As this work is based in part on output from other actions, most of its activities will take place in 2022.

Explain rationale for changes in plan for 2022

No changes

NSEA and CHANNEL PSS #7 Cross-regional communication between PSSs (North Sea and Channel)

Key Message from the Action

> Action will be implemented in 2022, to share experiences between the partners from the 2 parts of the PSS on measuring variables, collecting data and making aware of new capabilities such as a new database and modelling for water quality assessment. It also gives the opportunities to the partners not being involved in one of the tasks (but still interested) to be kept informed of the new development.

Partnership, platforms and data sources Not changes

Main achievements

A series of webinars (60 minutes) has been discussed with the PSS leaders (Holger Bris, Alain Lefebvre) to occur during spring 2022, 3 possibilities of webinars have been discussed on modelling and database as a new facility for the partners to explore (Action 5), Primary production (Action 3) and CO2 measurement (Action 1). The first webinar related to Action 5 took place on the 9th of February 2022. Deltares presented the ecological model for the greater North Sea as well as the database. Partners are welcome to collaborate more closely with Deltares.

Discussion with the leader of the subtask 9.2 aiming to identify the users and their needs in the PSS area has taken place and will be followed (M36).

Common surveys have been discussed between the partners from the Channel (Vliz, Cefas, LOG, Ifremer and Cefas, LOG) but unfortunately postponed due to covid situation.

As a new opportunity for installing a FerryBox, flow cytometer/imager in a cargo crossing the North Sea became more concrete, collaboration between NIVA, Deltares/RWS, Cefas has been discussed. This action is supported by a TNA action awarded in the second call.

Regional and pan-European integration:

The actions described above in the Action 7 help to strengthen the collaborations between the partners in the Channel and the North Sea (regional) and between the different countries (pan-European).

Explain rationale for changes in plan for 2022.

As it was not possible to meet in person due to covid situation, a series of short webinars was proposed. 3 main subjects were identified with the leader of the PSS according to common interest: modelling and database for water quality assessment, CO2 measurement and in situ primary production.

NSEA and CHANNEL PSS #8 Support to EU directives and ecosystem management

Key Message from the Action

As this work is based in part on output from other actions, most of its activities will take place in 2022.

Partnership, platforms and data sources No changes.

Main achievements

As this work is based in part on output from other actions, most of its activities will take place in 2022.

Initial investigation of data needs for the OSPAR eutrophication assessment (COMP4) for the OSPAR Quality Status Report 2023, based on work developed by the eutrophication group ICG-Eut. Some exchanges with NEA PANACEA on data gaps for pelagic habitats and food webs assessments, but this is not yet quantified.

An initial example of data gaps is taken from the OSPAR eutrophication assessment, that uses a joint database and an automated assessment tool (COMPEAT) operated by ICES. The confidence of each of the eutrophication indicators, which is composed of temporal and spatial confidence, is rated according to a set of rules. These rules and class boundaries are explained in the OSPAR COMP Agreement, Annex 14 (in prep). More information on confidence is available in COMPEAT (draft version), accessible only for OSPAR contracting Parties.

The PSS Channel area overlaps with 10 of the 60+ OSPAR eutrophication assessment units (areas) and the confidence assessment identify area and indicator specific data gaps, see Table below.

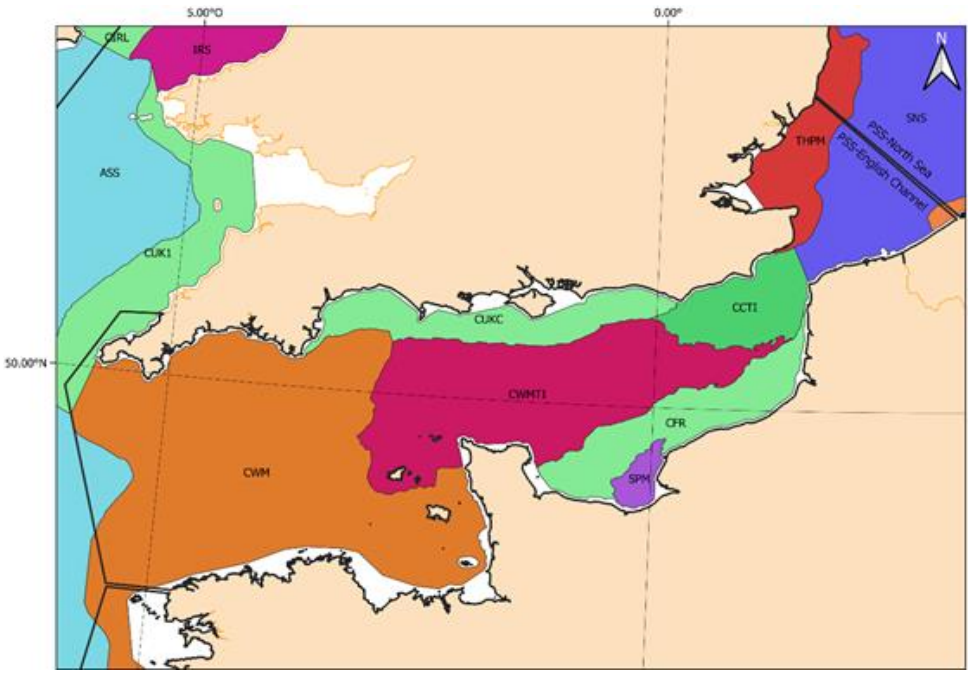


Figure NSEA and CHANNEL PSS #8. OSPAR Eutrophication assessment units in Channel area

The work under this PSS can investigate to which extent new sampling techniques and modelling can contribute to improving the confidence, notably for those indicators that are rated 'low' in specific assessment areas. This will be an iterative process planned for 2022 and when successful, will be expanded by investigating data gaps for other OSPAR

assessments, ie. pelagic habitats (ie. supporting the MSFD D1 and D4 assessments) and potentially the OSPAR assessment of ocean acidification (link with WP 2.5.1).

Table *NSEA and CHANNEL PSS #8* OSPAR Eutrophication confidence 2015-2020 assessment (COMP4)

Assessment unit	Assessment unit code	Country	Confidence			
			DIN[1]	DIP[2]	CHLA in situ[3]	O_2[4]
Scheldt plume 1	SCHPM1	BE, NL	moderate	moderate	moderate	moderate
Thames plume	THPM	UK	moderate	moderate	low	low
Southern North Sea	SNS	UK, BE, FR	high	moderate	high	high
Channel coastal shelf	CCTI	UK, FR	low	low	moderate	unknown
Coastal UK channel	CUKC	UK	low	low	low	low
Coastal FR channel	CFR	FR	moderate	low	moderate	low
Seine plume	SPM	FR	unknown	unknown	unknown	unknown
Channel well mixed tidal	CWMTI	UK, FR	unknown	unknown	low	low
Channel well mixed	CWM	UK, FR	low	low	low	low
Coastal UK 1	CUK1	UK	moderate	low	moderate	low
Atlantic Seasonally	ASS	UK, FR	moderate	moderate	low	low

[1] Dissolved Inorganic Nitrogen (DIN); months: 11-2; depths: 0-10 [m]; metric: mean.
[2] Dissolved Inorganic Phosphorus (DIP); months: 11-2; depths: 0-10 [m]; metric: mean.
[3] Chlorophyll a (in situ); months: 3-10; depths: 0-10 [m]; metric: mean.
[4] Oxygen deficiency. Months: 7-10; depths: 0-500; metric: 5th percentile of deepest sample within 10 meters from bottom.

Note that next to in situ chl a OSPAR uses satellite chla products, provided by RBINS (multi-algorithm multi-mission quality assurance tool) for the North Sea, Celtic Seas and Arctic Waters and by Argans (OC5 algorithm) for the French waters and beyond in the Bay of Biscay and Iberian Coast. Some countries (*eg.* BE, NL, UK) intend to use EO data rather than in situ chla data as a basis for their eutrophication assessment. In these cases, in situ observations will primarily be used as 'match ups' for validation of the satellite chl a products. Low confidence as described above for in situ chl a is not a problem in these countries.

Regional and pan-European integration

Part of the work was done in 2021 within the action #8 and in close collaboration with OSPAR needs. As other outputs are expected from other actions to integrate all the added values of such a PSS strategy, complementary activities will take place in 2022.

Explain rationale for changes in plan for 2022

No changes

NSEA and CHANNEL PSS #9 Interaction with other RIs on ecosystem studies, eutrophication, coastal management and carbon fluxes

Key Message from the Action

Contacts with other RIs have been established on local level as well as on management levels. An intense discussion of collaboration measures has been started during the JERICO week in April 2021.

Partnership, platforms and data sources No changes

Main achievements

During the JERICO-S3 general assembly in April 2021 a dedicated session was organized in collaboration with WP2, discussing overlap and exploring synergies and work toward high level integration. This effort brought together representatives from seven other RIs (e-LTER, Danubius, EMBRC, ICOS, EMSO, EuroARGO, AQUACOSM). Beyond informing all participants about the respective RIs and projects the meeting served to kickstart a discussion about common goals and interests, the pursuit of common research questions and funding opportunities and the setup of a future communication structure.

On the local/regional level, a shared observation station in Tesperhude (Germany) in the lower part of the Elbe river was designed and planned together with DANUBIUS-RI. The installation of the facilities has begun. This collaboration involves agreements on data sharing, shared QA/QC procedures and management of the station. In this context, efforts were undertaken to ensure consistency of the measurement at the new station with the existing Cuxhaven station at the river mouth.

Links to DANUBIUS-PP, EMBRC-ERIC, ICOS-ERIC, LifeWatch-ERIC have been initiated.

Regional and pan-European integration

Regional integration in the Elbe-German Bight area has been fostered with Danubius-RI through implementation of a shared site in Tesperhude.

The actions carried out within the EC PSS have been highlighted in various regional and European bodies. This has contributed to the initiation of reflections for the setting up of projects in this workshop area (PPR Ocean & Climat, PEPR One Ocean). Moreover, in the framework of strategic reflection on the role of Coastal Observation in the Ifremer Coastal Unit, the EC PSS model could be used as an example.

Explain rationale for changes in plan for 2022

No major changes for this action are foreseen beyond an adjustment of the discussion with other RIs taking into account the results of the JERICO ESFRI roadmap application. The main consequence of the necessary reorientation will be a shift of discussion away from the overall European RI landscape to individual interactions between JERICO-RI and individual other RIs. This will mainly affect the collaboration strategy in WP2. For regional aspects, such as for this PSS, no major changes are anticipated as the interaction is already mainly on a one-on-one basis.

CRETAN PSS #1 Solubility and biological pumps

Key Message from the Action

The first year of Action #1 implementation focused on collection of in situ carbonate system data and was overall successful. The combination of two platforms, HCB with regular RV visits for water sampling, as well as the interaction within CS PSS partners and with ICOS was key for this success.

Partnership, platforms and data sources

There have been no changes in partnership. Issues with some platforms were strong delays faced with the Ferrybox operation and Saronikos buoy lost at sea.

As additional data sources the following were used: a) satellite T, Chla (CMEMS SST; CHL-a) used to derive CO_2 (see action #5) b) SMAP salinity (from www.remss.com) used to derive TA (see Action #5) c) reanalysis carbonate products from satellite data from CMEMS (Feudale et al. 2021).

Main achievements

Since December 2020 a pH sensor and a pCO_2 sensor are deployed in the Cretan Sea PSS (contributing also to Actions #4, #5). The pH sensor (SP200-SM, Sensorlab) is deployed at subsurface, on the POSEIDON Heraklion Coastal Buoy (HCB) providing pH data every 3 hours in near real time (NRT). The CO_2 sensor (CO2-Pro Atmosphere, ProOceanus) is also deployed at subsurface on the POSEIDON Heraklion Coastal Buoy (HCB) providing air and sea CO_2 data every 6 hours in delayed mode (DM). In parallel, to check the sensors operation, during the regular RV visits at HCB, water samples are taken for pH analysis as well as for CT&AT analysis. The pH samples are analysed using a lab pH instrument (AFT-pH, Sunburst Sensors), which is regularly checked against TRIS buffer as reference material. The CT&AT samples are analysed using a VINDTA 3C which is regularly checked against seawater reference materials.

The CO_2 sensor was removed from April to August in order to participate in the ICOS pCO_2 instrument inter-comparison workshop.

Best practices, both for sensor operation and data processing for pH and pCO_2, were established in HCMR-NIVA collaboration (meetings: July 2021 for pH, August 2021 for CO_2).

The best practices for CO_2 were also developed in collaboration with other users of ProOceanus CO2 ATM (VLIZ, Thanos Gritzalis) as well as the manufacturer (ProOceanus). For best practices for installation of CO_2 sensors on Ferrybox a HCMR-NIVA meeting was done in June 2021.

Data QC routines for delayed mode data were established for CO_2 and pH, whereas the NRT data QC procedure is under improvement to automatically include a correction from temperature and salinity data obtained by the nearby conductivity-temperature sensor. The DM best practices for CO_2 data processing were discussed with other users of ProOceanus CO2 ATM (VLIZ, Thanos Gritzalis) as well as manufacturer ProOceanus.

Data flows a) for carbonate system associated variables (T, S, meteo, O_2, Chl-a) were already handled, by CMEMS In Situ Thematic Assembly Center (INS TAC) b) whereas for pCO2 a first submission was made to SOCAT in January 2022.

A key result was the annual pH cycle obtained, which is to the best of our knowledge the second one at high frequency (<day) obtained in the eastern Mediterranean (another cycle done in Saronikos Gulf in 2013; González-Dávila et al. 2016). The delayed mode data provided by the pH sensor, after processing, are in good agreement with data from samples. The comparison of seawater CO_2 from the sensor with estimates of CO_2 (calculated from pH &AT and pH&CT of seawater samples) using CO2SYS showed 15-20 µatm difference. The comparison of air CO_2 from HCB with a nearby atmospheric station measuring air CO_2 (with

PICARRO) showed good correlation during the entire deployment period, with a difference of approx. 5 ppm. The pCO_2 data was used to study existing and new regional algorithms (see Action #5)

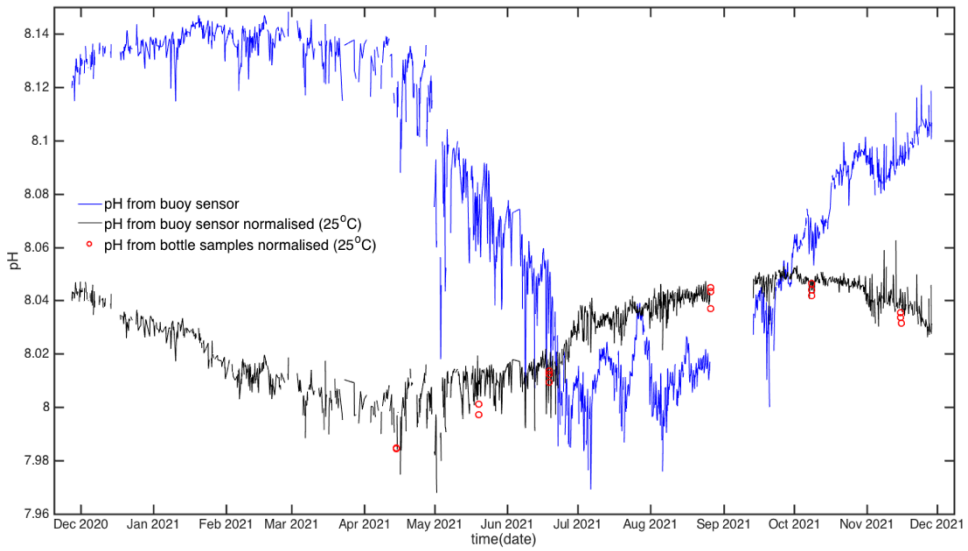


Figure CS PSS #1. pH data (from sensor and bottle samples) at POSEIDON HCB

The dissemination of results was made via a post on the JS3 webpage and a post on the POSEIDON webpage, as well as via the Ocean Carbon from Space Workshop 2022.

Interaction was established with users from ICOS, SOCAT, as well as with pH and pCO_2 sensor manufacturers (Sensorlab, ProOceanus).

Important products were the provision of NRT pH and submission of CO_2 to SOCAT.

Action progress was presented to all PSSs, the JERICO-S3 community and WP leads in meetings organised by WP4 in September 2021.

Regional and pan-European integration

The action contributed to integration by providing and promoting open access data in an area with strong lack of carbonate variable data, useful to regional and pan-European efforts in modelling and development of remote sensing algorithms. It also exchanged knowledge with PSS partners (several being members of other PSSs and IRSs), SOCAT, ICOS and Mediterranean colleagues (from JS3 and outside) working on pH and CO_2 as well as with sensor manufacturers.

Explain rationale for changes in plan for 2022

Changes requested for 2022 for Action #1 concern maximising the available dataset by extension of timetable to November 2022 and by additional data sources. Backup platforms and/or external data sources are also considered to cover the eventual gap of data from FerryBox. There is also inclusion of additional variables, additional databases, improved RT QC procedure, collaboration with additional RIs and more ways to increase expected results, their users and dissemination.

CRETAN PSS #2 Improved approximations of Primary Production

Key Message from the Action

Overall, the first year of Action #2 implementation, focused on collection of in situ data to upgrade model PP predictions, was successful. The multiplatform, multivariable approach played a key role in this data collection. TA calls offered by WP8 opened additional possibilities.

Partnership, platforms and data sources

There have been no changes in partnership. Concerning the platforms, glider transects were very few in 2021 otherwise other platforms are operating overall well (with exception of some sensors). Satellite Chla from CMEMS were also used.

Main achievements

The first year of this action was focused on data collection (used for the model improvement done during the second year). Data collected from buoys were from a) HCB fixed platform (SST; pH, pCO_2) and b) E1-M3A fixed platform (T, Chla, O_2 at 20, 50, 75, 100 m). One glider section was made in May 2021 (T, S, O_2 every 1m down to 700m). RV visits at HCB were done almost every month (nutrients, plankton from subsurface until 120m). At E1M3A RV visits were in September (nutrients, plankton from subsurface until 1445m i.e. bottom) and November (nutrients, plankton from subsurface until 120m). Satellite Chla from CMEMS were used to compare with those collected in situ.

For the practices of optical fluorescence sensors, email communications and meetings were made between PSSs partners (HCMR, SYKE), as well as attendance by HCMR to GoF PSS #1 Algaline fluorometer sensor harmonization workshop in Feb 2021.

Beneficial to this action will be the work done in actions #3, #5 to test a novel PP sensor (LabSTAF) in oligotrophic waters (TA from Chelsea Technologies, UK) as well as setting the stage for a mesocosm experiment with intercomparison of PP methods to which all PSS partners participate.

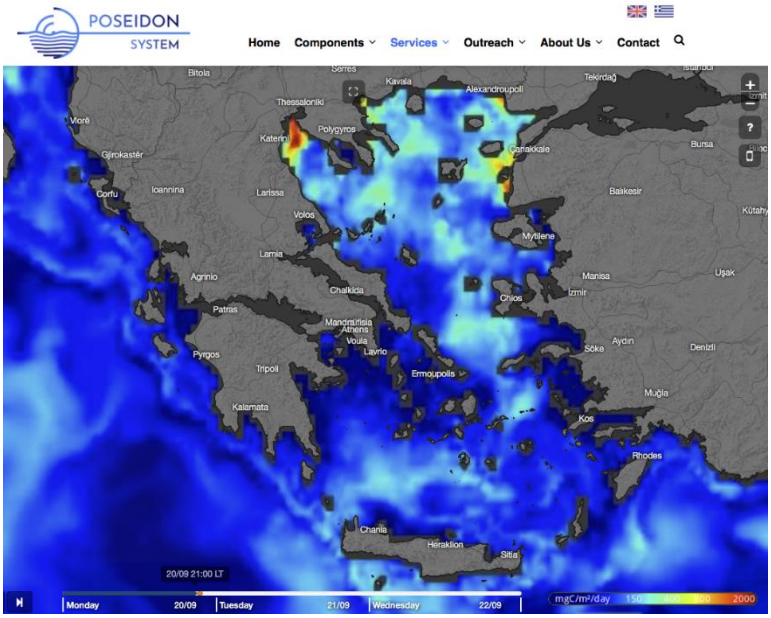


Figure CS PSS #2 Example of Primary Production forecast from POSEIDON Operational model

For the time being data management, QC routines remain as they were with data flows handled by CMEMS INS TAC. Improvement in Chla data QC routines may be considered later.

There are no key results or products yet since the first year was focused on data collection. These are expected in the second year especially after upgrading of the model. This will engage links to other WPs and communities.

Concerning links there is an important collaboration with an industry user (Chelsea Technologies, UK) with interest in applications in oligotrophic areas. This collaboration was promoted as a post on the JS3 webpage and on the POSEIDON webpage.

Action progress was presented to all PSS, JERICO-S3 community and WP leads in September 2021.

Regional and pan-European integration

During the first year, integration was obtained from transfer of knowledge to PSS partners (several being members of other PSSs and IRSs) on new technology tools for measuring primary production in oligotrophic water. This was also promoted to a wider community via announcement from JS3 and POSEIDON website as well as to members of AQUACOSM-Plus. However, it is during the second year that the strong integration will be obtained after providing and promoting improved primary production data in an oligotrophic area where a large part of primary production is held most time of the year at depths that are not at satellite reach.

Explain rationale for changes in plan for 2022

Changes requested for 2022 for action #2 concern maximising the available dataset by extension of timetable to November 2022 as well as by inclusion of additional variables, data sources and platforms that could contribute to goals as well as of a backup plan in case glider transects remain limited. As refinement WP6 activities to follow are described in more detail. Finally, some clarifications are given in linking activities.

CRETAN PSS #3 Extreme events affecting phytoplankton - AQUACOSM collaboration III

Key Message from the Action

> Setting the stage of a joint JERICOS3-AQUACOSM-plus mesocosm experiment to analyse effects of extreme events on phytoplankton communities.

Partnership, platforms and data sources

There have been no changes in partners or platforms. Satellite data were added as an additional source to explore extreme events.

Main achievements

First year of Action #3 was for setting the stage for the mesocosm experiment to be held in 2022: a) a novel PP sensor LabSTAF (TA from Chelsea Technologies Ltd), that will be used in the mesocosm, was tested in the PCL (input from Action 5#), b) several preparatory meetings of PSS partners and the HCMR members of AQUACOSM-plus (June & December 2021, January 2022), and c) on site visit of mesocosms (HCMR, SYKE, Chelsea Technologies Ltd). The type of extreme event to be studied in the mesocosm experiment has been decided by AQUACOSM-plus and concerns the effect of episodic introduction of airborne microbes into the marine ecosystem. Experimental plan of mesocosm experiment, the overall timing, and variables to be measured have been discussed and preliminary agreed within partnership and with AQUACOSM-plus. Details for the selected method/sensor were requested to be given by participants by February 2022.

Second, in situ and satellite data have been collected (from 2019 until present, e.g. rain, temperature, Chla from POSEIDON database and CMEMS) that could allow detect extreme events.

There were no data management issues at this stage as first year was based on field data collection using the existing data flow and QC from CMEMS INS TAC. Key results, dissemination and products are planned for second year.

Existing links with AQUACOSM-plus were strengthen, and TA calls offered by WP8 opened possibilities for testing additional sensors and to connect with industry users. Action progress was presented to all PSS, JERICO-S3 community and WP leads in September 2021.

Regional and pan-European integration

During the first year, integration was obtained by interaction with PSS partners (several being members of other PSSs and IRSs), industry and with AQUACOSM-Plus. However, it is during the second year that the strong integration between experimental and observational marine communities studying the same ecological questions will be done.

Explain rationale for changes in plan for 2022

Changes requested for 2022 for Action #3 concern extension of timetable to November 2022 to increase probability to encounter additional extreme events, as well as to explore additional data sources and platforms that could contribute. As refinement, the mesocosm experiment subject is defined, the contribution of a novel PP sensor is described, and some clarifications given in linking activities

CRETAN PSS #4 Upscale of Regional Data to a wider area

Key Message from the Action

The data collection (activity of Action #1) needed for the model upgrade, is overall in good progress.

Partnership, platforms and data sources

No changes in partners. Concerning changes in platforms, see Action #1. Additional data sources (in situ and satellite data from CMEMS) offering data from the wider Mediterranean area are included to evaluate the representativity ("footprint") of the Cretan Sea solubility pump.

Main achievements

The action per se starts in February 2022 so there is no main achievements as model results during first year, only preparatory activities: a) data collection and management (detailed in Action #1), b) internal HCMR meetings for data collected, model general setup (September, December 2021), c) review and testing of existing regional carbonate algorithms, development of new ones (detailed in Action #5).

The contact established with users (such as ICOS, SOCAT) in Action #1, will be used useful once the first model results are released.

The plans of the action were presented, together with modelling activities from other PSSs, in April 2021 during a Modelling session of the JS3 ARW#2 with participants the JS3 community. The actions objectives, target variables, type of model (hydrodynamic/BGC/Carbonate ecosystem model - POM-ERSEM-HALTAFAL) and data sources to be used were presented. These were also presented to PSSs, J-S3 community and WP leads, during a meeting organised by WP4 in September 2021.

Regional and pan-European integration

The communications of planned activities during the two JS3 sessions mentioned above have set basis for integration, as well as activities of Action #1, although main integration of the action will result from 2022 modelling activities.

Explain rationale for changes in plan for 2022

Changes in Action #4 are only those associated to data input from Action #1 (additional inputs/databases/platforms, extension to November 2022), refinement of dissemination activities and consideration of additional RIs

CRETAN PSS #5 New sampling strategies, new technologies, best practices

Key Message from the Action

Advances in sampling strategies, testing/development of estimation algorithms for carbonate system variables, testing of novel PP sensor. Common benefit sampling strategy initiated with EMBRC-ERIC.

Partnership, platforms and data sources

There are no changes in partnership. Concerning the platforms, strong delays are faced with the Ferrybox operation, otherwise no changes.

Main achievements

Overall, during the first year a large part of the objectives of Action #5 were met. Advances were made in new sampling strategies, data management, testing/developing algorithms for carbonate variables as well as testing a novel sensor for primary production and setting the stage of a mesocosm experiment for intercomparison of various phytoplankton sensors.

Practices for field operation/maintenance of pH and CO_2 sensors, as well as for lab analysis of samples for pH, CT&AT were largely established, with some refinements expected in the future (see also data collection described in Action #1). These practices as well as the related data processing were established by HCMR-NIVA in collaboration with other users of similar sensors as well as with the manufacturers (details given in Action #1). Participation in ICOS instrument inter-comparison workshop provided additional experience on practices with CO_2 sensors. The data resulting from the workshop are under processing and a related publication is planned.

The carbonate data collected allowed to study the best pair of carbonate variables (out of pH, CT, AT) to estimate CO_2 (using CO2Sys). Preliminary results suggest pH and AT combination to be the best to estimate pCO_2.

Another important product was testing various regional algorithms of CO_2 estimation (Gonzalez-Davilla et al., 2016, Schneider et al., 2007, Cossarini et al., 2015, Hassoun et al., 2015) in comparison to the measured CO_2 data obtained at HCB. Results are shown in the figure's top panel. In addition, new algorithms for CO_2 estimation using satellite data (SST or SST with Chla; shown in figure bottom panel) as well as estimation of TA using satellite SSS were developed and compared to measured CO_2 data.

Additional field water sampling was initiated in September 2021 (samples taken in September, October, December) for EMBRC-ERIC to provide info on abundance of procaryotes and small eucaryotes as well as info on metabolism related to bacteria. More information will be given once the samples are analysed (after late spring 2022). This sampling activity is continued at bi-monthly frequency.

Planning for the mesocosm experiment was made, where a large set of sensors will be tested to evaluate and identify optimum optical sensors (including optimum combinations) for phytoplankton sensing under low phytoplankton biomass (details given in Action #3).

TA calls offered by WP8 opened the possibility to increase linking with industry and test in October 2021 a novel lab PP sensor (LabSTAF, Chelsea Technologies Ltd) for the first time in the region, in comparison with C14 measurements. For this activity the HCMR PCL was used during a joint experiment with participation of Chelsea Technologies Ltd, HCMR and SYKE. This collaboration will be pursued in 2022 as plans were made to also test a novel field sensor (AutoSTAF Chelsea Technologies Ltd) during the mesocosm experiment (see Action #3) where a comparison of various PP methods will be made with the aim to identify optima under low phytoplankton biomass.

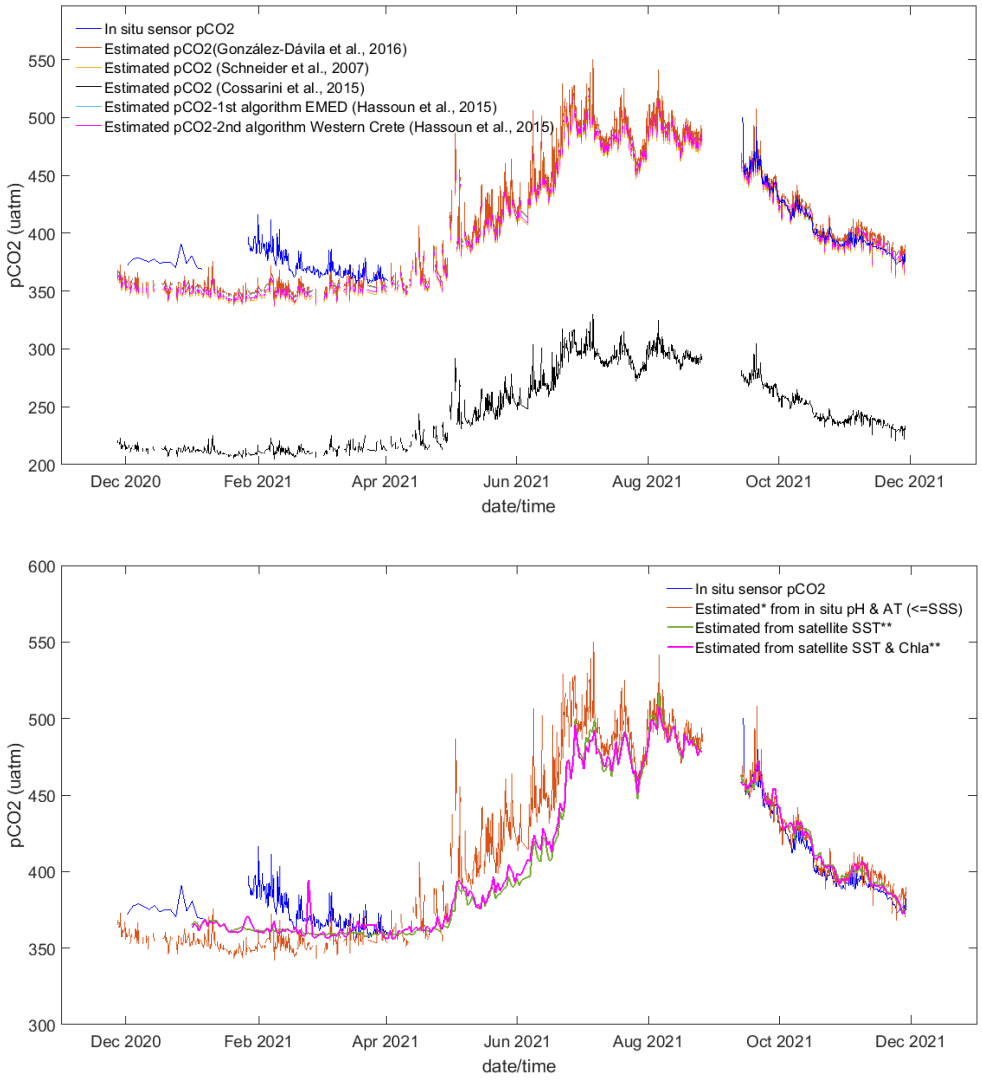


Figure CS PSS #5 Top panel: comparison of in situ CO2 data from HCB with existing published regional algorithms. Bottom panel: comparison of in situ CO2 data from HCB (CO2 sensor and estimation from pH and SSS sensor) with newly developed algorithms using satellite SST and Chla)

Dissemination of the TA Chelsea TA was made in late October to PSS partners as well as via a post on the JS3 webpage and via POSEIDON webpage. Tested existing and new carbonate algorithms were presented in the Ocean Carbon from Space Workshop 2022.

Action progress was presented to all PSS, JS3 community and WP leads in September 2021.

Regional and pan-European integration

During the first year, integration was obtained from transfer of knowledge on new PP technology tools with PSS partners (several being members of other PSSs and IRSs), via announcement from JS3 and POSEIDON website, as well as by communication with members of AQUACOSM-Plus. Integration was obtained for the tested regional algorithms, via the above communication pathways and presentation to the SOLAS community. Finally, integration was also obtained by interaction with SOCAT, ICOS and Mediterranean colleagues (from JS3 and outside) working on pH and CO2.

Explain rationale for changes in plan for 2022

Changes for action #5 concern extension of timetable to November 2022 due to the non-operation of FB and to optimise setup for sensors tested in the field, as well as addition of development of new algorithms.

CRETAN PSS #6 Partnership building

Key Message from the Action

Overall, during the first year the action #6 met the objectives of establishing contacts and planning or starting common interest activities

Partnership, platforms and data sources

No changes in partnership. For changes in platforms and data sources see Actions #1 to #5.

Main achievements

In 2021 the partnership building activities were with:

- AQUACOSM-plus: planning done for joint activity in 2022 (see Action #3)
- ICOS-ERIC: Participation in ICOS intercomparison workshop in June 2021, preparation of joint paper together with other PSSs partners (see Actions #1, #5).
- EMBRC-ERIC: Initiated in September 2021 providing additional EBV data of common benefit data (see Action #5).
- LifeWatch-ERIC: Contacts made, interest in pH data obtained at Cretan Sea was expressed, but no common activity planned yet.
- EURO-ARGO ERIC: contact with HCMR colleagues participating in Euro-Argo ERIC to find activities of common interest (e.g. provision of CTD casts in NRT) was made.
- EuroGOOS: contacts with EuroGOOS groups established (coastal group, biology group, Ferrybox task team). Several CS PSS partners participate in those groups.
- SOLAS: participation to the Ocean Carbon from Space Workshop 2022 (see Actions #1, #5)

Collaboration between PSS and IRS as well as to wider JS3 community was pursued by presentation of PSSs activities during: a) a modelling session of the JS3 ARW#2 in April 2021, b) a WP4 progress meeting in September 2021, and c) a JERICO-DS GA workshop where PSSs presented their objectives and experiences from multiplatform observations. HCMR attended the GoF PSS Algaline fluorometer sensor harmonization workshop in Feb 2021 and participated in the one of Feb 2022.

The above ongoing collaborations offered first elements to develop partnership practices with other PSSs, RIs and regional initiatives. Exchange of results and data related activities is planned for the second year. First dissemination activities via JS3 and POSEIDON webpages (see Action #5) have contributed to partnership building.

Regional and pan-European integration

All above achievements contribute and set the basis for further regional and pan-European integration.

Explain rationale for changes in plan for 2022.

Refinement for Action #6 concerns extension of timetable to November 2022 to follow activities of other actions, and consideration of some additional links, users and best practices.

5. REFINED IMPLEMENTATION STRATEGIES FOR PILOT SUPERSITES

This section includes refined implementation strategies for JERICO-RI Pilot Supersites. Original strategies have been provided in D4.1 "*JERICO-S3 Pilot Supersite monitoring strategies*". After one year of PSS implementation, the activities were analysed how well the original objectives have been met and if there are needs to refine activities for the remaining PSS period. These analyses are presented in D4.2 "*Refined PSS monitoring strategies*", and shortly summarised above in section 3, for each Action separately. The text below is a copy from D4.1, including text additions (in red) and text deletions (~~in strikethrough~~) as suggested in D4.2.

5.1. Implementation strategies: Gulf of Finland Pilot Supersite

JERICO-S3 subtask 4.3.1. Pilot Supersite at Gulf of Finland, Baltic Sea; GoF PSS (Lead partner SYKE, partners FMI, IOW, TALTECH)

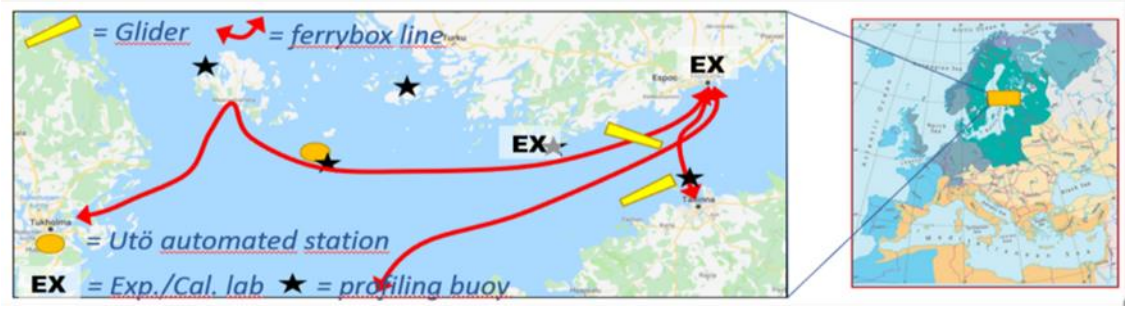


Figure 5.1. Map showing the key GoF PSS sustained platforms. Red lines represent FerryBox lines, stars are for profiling buoys, EX stands for experimental facility or calibration lab and the orange oval symbol is for Utö Atmospheric and Marine Station.

Table 5.1. Platforms in GoF PSS

Operational observation systems & platforms in the region	Operational status	Parameters
FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH)	operational (Silja Serenade and Silja Europa have been occasionally non-operational due to covid)	T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, Phycoerythrin-Fluo, O_2, pH, CO_2, sampler

Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH)	Mostly operational, some components not operational due to maintenance issues, affected by covid	Utö: T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, O_2, pH, CO_2, Meteorology, IFCB, Cytosense, FRRF, discrete samples Keri: T, S, Chla-Fluo, Turbidity, Phycocyanin-Fluo, O_2, Meteorology
Gliders (FMI, TALTECH)	operational	T, S, Chla-Fluo, CDOM-Fluo,
Argo floats (FMI)	operational	T, S, Chla-Fluo, O_2
Profiling buoys (FMI, SYKE, TALTECH)	operational, some components under maintenance	T, S, Chla-Fluo, CDOM-Fluo, O_2, Phycocyanin-Fluo,
Wave riders (TALTECH, FMI),	Operational	wave height
monitoring by R/V (All).	Occasional	Annual program with several cruises & stations in the GoF area.
experimental and calibration facilities (SYKE)	as needed	

GoF PSS #1 Harmonized observations

Objectives: The Action aims in improving harmonisation of GoF PSS data, produced by various institutes. Such harmonisation is the first step in merging data from different sources and creation of consistent datasets for multiple uses. Harmonisation protocols are demonstrated especially for observations on phytoplankton communities, HABs, oxygen and carbonate system dynamics. Shared management actions and communication schemes, and joint QC/QA practices for key observations will allow unified data flows and products, which will also facilitate their discovery, access, and use. Interactions between other PSSs, JERICO-S3 WPs and other communities need to be established to improve pan-European harmonisation.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Haavisto), FMI (Laakso), TALTECH (Liblik, Kikas), IOW (Rehder)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: Additional partners from JERICO-S3 and other national/international collaborators and private sector representatives may participate in the workshops and calibration and validation activities. This may expand the regional impact of study.

Overall timetable of Action: Jan 2021 - November 2022

Description of Action: Joint actions in calibration and validation, as well as improving and sharing the best practices, will provide a baseline for collecting comparable data for the region. Sharing maintenance actions may provide economic benefits and improve the data coverage due to decreased downtime of sensors.

The practical work includes (Timetable, Lead, partners):

- joint workshops for improving and sharing best practices, QA/QC methods and for sharing sensor/platform maintenance (winter 2021 and 2022, SYKE, all)
- joint workshop for regional harmonisation of observations, including other PSSs and WPs (Autumn 2022, SYKE, all)
- joint workshops for sensor calibration (winter 2021 and 2022, SYKE, TALTECH, IOW, FMI)
- joint cruises for validation of automated measurements (FerryBox, Gliders, Argo floats, profiling buoys) (cruise in autumn 2020 FMI, SYKE; Eurofleets+ cruise in spring, FMI, SYKE, TALTECH;
- Platform specific joint meetings to agree common maintenance, share of work, data QC, and to share experience. FerryBox meeting August 2021 (SYKE, IOW, FMI); Buoy meeting November 2021 (Syke, TalTech, FMI, national finnish partners within FINMARI)
- participation in ICOS-OTC pCO2 calibration workshop (August 2021, FMI)
- participation in organising a session in international metrology conference MetroSea 2021 and presenting joint Baltic FerryBox community activities (October 2021, SYKE, all)

Best practices used or developed: Several new best practices agreed for the region, aiming to harmonized measurements for phytoplankton, oxygen and carbonate system dynamics.

Data flows: Action will not collect new observation data but provide means for improved data quality and interoperability.

Data QC routines: Sharing Best Practices for QA/QC agreed and discussed among best practices

Data management issues: Metadata issues noted in best practices

Expected results: Conceptual protocols for transnational platform maintenance, harmonization of observations, and QA/QC protocols, including the analyses of challenges. New transnational practices for sharing sensor calibration, data validation, and platform maintenance action, including Best practices documentation.

Users of results: Primarily GoF PSS partners but shared to the Baltic monitoring community in large. Disseminate the conceptual work for other PSS as well

Dissemination of results: Results (best practices) shared preferably by JERICO e-infrastructure. Publication of the most advanced practices as scientific papers and/or technical documents. Dissemination to other PSSs, WPs, regional collaborators and international community done during various workshops and conferences. The transnational interoperability concept links to GoF PSS #9 and #10.

Links: Results will be efficiently communicated for other PSS, aiming to future joint harmonization workshops. As well, the experiences on transnational knowledge transfer as disseminated towards WP1 and WP3.

Link to WP5, T5.2, T5.3

Link to WP6, T6.3

Link to WP7, T7.5 especially aiming to provide demonstration of shared documentation for D2PTS

WP8 as part of the TA project accepted.

Links to metrology community, especially collaborating with INFRAIA project MINKE. Links to EuroFLEETS+ and ICOS.

Links to industry, especially though TA project (accepted) for fluorometric sensors

GoF PSS #2 The performance of operational forecast models

Objectives: The Action will analyse and disseminate discrepancies in hydrography and biogeochemistry between in-situ and CMEMS operational forecast model products at the GoF PSS. The main outcome of the topic is the conclusive report of the model performances in the area. Possible sources of the discrepancies will be discussed and instructions for users of the products will be provided.

Action Lead and other Partners (with contact persons): TALTECH (Liblik), SYKE (Seppälä, Ehrhart), FMI (Laakso), IOW (Rehder)

JS3 Platforms included: FerryBox: Silja Serenade, Finnmaid, Silja Europa (SYKE, FMI, IOW, TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), monitoring by R/V (All), Primary data sources: FerryBox data, Utö and Keri observatory data and Argo floats data, others supporting if data available.

Other data sources and external partners for implementation: Data from the data repositories, such as ICES HELCOM database will be included if necessary. Data from the fixed level sensors (moorings) might be used.

Overall timetable of action: Data will be collected in February 2020 - September 2021, analysis will be conducted from October 2021 – September 2022.

Description of action: The GoF is well known by its rapid temporal changes in the physical and biogeochemical parameters. Thus, the core analysis will be based on measurements at observatories (Keri and Utö) and FerryBox systems. Latter will be supported by the data from other sources. To compile comprehensive analysis of the model performance, data will be shared transnationally and transinstitutionally. The enhanced understanding of the model performance will lead to increased societal value of observations and CMEMS operational forecast model products.

Further actions are planned:

- Collection of the data (February 2020 - September 2021).
- Compiling the datasets (August - October 2021)
- Analyses of the discrepancies between in-situ measurements and CMEMS operative model products in hydrography and biogeochemistry (November 2021 - March 2022).
- Compiling conclusive report (April-September 2022)

Best practices used or developed: Validation characteristics, e.g. necessary temporal and spatial resolution, which most adequately describes the processes in the GoF will be agreed among partners.

Data flows: Action will not arrange operative data flows but collects the data from partners in autumn 2021. This link the action to WP7 T7.5 D2PTS, where regional data products will be generated.

Data QC routines Action not deal with QC routines but relies on GoF PSS #1 and on WP7 T7.5 D2PTS.

Data management issues: Minor issues can occur, when partners must agree on data formats.

Expected results: The Action streamlines observations and modelling by different partners of GoF PSS. Main result from this collaboration is the improved understanding on the operative model performances in the GoF PSS area. The discrepancies between the observations and model results, and the observed challenges in the process, will provide valuable feedback for future improvements.

Users of results: Researchers dealing with Eastern Baltic Sea, authorities responsible for the assessments of the environmental status of marine areas.

Dissemination of results: Results will be shared by JERICO e-infrastructure. The Action provides information to the GoF PSS #5. Results will be disseminated both to the modelling and observing communities, e.g. through BOOS annual meetings.

Links: The Action will provide input to WP2 T2.4 in providing insight on existing observational and technological gaps in the region. Action has direct link to WP7, T7.5, regional pilot of D2PTS #3, which provides regional multiplatform observations products.

Action links to EURO-ARGO, using Argo data, and CMEMS, using their model products.

GoF PSS #3 Optical data for Ocean Color product validation

Objectives: Ocean Colour algorithm development and product validation benefit largely from in situ measurements of optically active compounds, their concentrations and/or specific optical properties, and match-up (synoptic) measurements at different sites. Key challenges with some optical sensors (fluorescence, turbidity) are that results are not clearly traceable and in effect they are represented in the relative scale. The lack of standards for sensors and their calibration and validation make the intercomparison between sensors difficult. This task builds on the results of GoF PSS #1, intercalibration between sensors and improved QC. It provides Regional Data, as consistent as possible within technological limits, to Ocean Colour groups for evaluation.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Ylöstalo), TALTECH (Liblik, Salm)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE), Silja Europa (TALTECH), Utö Observatory (SYKE), Keri Observatory (TALTECH); calibration lab (SYKE).

Other data sources and external partners for implementation: Ocean Color data from Sentinel satellites. Work includes remote sensing groups of participating partners.

Overall timetable of action: January 2021 - November 2022

Description of action: Optical sensor measurements of aquatic optically active compounds are often rather incomparable between actors, due to lack of standardised methods. This hinders the use of such data for Ocean Colour match-ups and ground-truthing. To improve the use of multisource sensor data, joint steering of the sensor QA/QC and sharing sensor validation practices and data are required. This topic will demonstrate transnational collaborations in production of multisensor data.

The practical actions include sensor intercomparison workshops (winter 2021 & 2022, jointly with GoF PSS #1). Optical multisensor data will be collected in 2021 at fixed platforms and FerryBoxes, including optical proxy measurements (Chla and CDOM fluorescence), measurements of inherent optical properties (absorption, scattering) and specific inherent optical properties for water quality parameters (algae, CDOM).

Best practices used or developed: For optical measurements we aim to follow best practices developed for satellite ocean color sensor validation by The International Ocean-Colour Coordinating Group (IOCCG). Their further adjustments for Baltic conditions will be done as needed.

Data flows: Primary data from FerryBoxes flows to EMODnet Physics and CMEMS. Fixed Station data and data from exploratory sensors remain at the hosting institutes and is available on request. Opening these datasets is desirable via VA (WP11) during the PSS implementation, through developments made in WP7 T7.5 D2PTS,

Data QC routines: New steps in operational data QC protocols are required for temperature compensation of CDOM fluorescence and for spike detection of Chla fluorescence.

Data management issues: Review of data vocabularies need to be carried out, as data measured with various methods and sensors are not directly comparable.

Expected results: The topic will provide demonstrations in using Regional Data, with shared QC, and EO data in a complementary way, and provide datasets for EO product match-ups and validation. Secondly, the topic provides improved estimates of how well the sensor data (fluorescence) describes the actual variability of the phytoplankton and CDOM abundance in the Baltic Sea as estimated by satellite data or traditional laboratory methods.

Users of results: Ocean Colour community

Dissemination of results: Dissemination is primarily targeted to remote sensing groups in the Baltic Sea, via participation in workshops, seminars and by targeted contacting groups asking them to evaluate the data for scientific use.

Links: Action will open a dialogue with WP 2, T2.3 on how the JERICO-RI observations may be promoted to Ocean Colour community. Observation data is merged with Ocean Colour data during WP7 D2PTS, and likely made available through WP11 (VA). Link to other PSSs with similar actions need to be elaborated. Action links to MINKE RI-project, for better harmonisation of optical data. Data is delivered to EMODnet physics, EMODnet chemistry and CMEMS. Collaboration with ICES and HELCOM has been established, to improve availability of observation data and merging it with EO data. As well, collaboration with CMEMS Ocean Colour tac has been established, aiming to provide validated chlorophyll fluorescence observations for EO data validation and match-ups.

GoF PSS #4 Detection of cyanobacterial blooms

Objectives: The Action aims to improve transnational and trans institutional joint observations for HAB detection and creating concepts and mechanisms for sharing the information and production of HAB reviews. Task will gather comparable and complementary data to analyse spatiotemporal variability of cyanobacteria blooms in the Gulf of Finland. The collected online data will support weekly HAB reviews, carried out by SYKE. These reviews are targeted for public and different marine users and are distributed through SYKE web-pages and press releases. The concept of HAB reviews will be demonstrated to other partners within the PSS and between PSSs. In addition, QC data will promote scientific analyses of the causes and consequences of the blooms.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Lehtinen), TALTECH (Liblik, Kikas)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE), Silja Europa (TALTECH), Utö Observatory (SYKE), Keri Observatory (TALTECH); profiling buoys (SYKE), calibration lab (SYKE).

Other data sources and external partners for implementation: monitoring by RV (depending on the cruises), observations from public, Ocean Color

Overall timetable of action: Data collection and reviews done in summer 2021 and summer 2022. Data analysis until Nov 2022.

Description of action: Algae blooms in the Baltic Sea are each summer affecting the use of marine areas and have also effects on marine ecosystems. These events are of public concern and SYKE provides weekly updated information on the status of blooms and prediction on their developments. Sensor observations at fixed stations and FerryBoxes support these reviews by providing real time data. This topic will improve the transnational availability of data, thereby improving the reliability of the reviews. The joint harmonisation of measurements (GoF PSS #1) and developments in Ocean Colour methods (GoF PSS #3) and in modelling approaches (GoF PSS #7) together with coordinated data flows improve further the timeliness of HAB reviews. The concept of HAB review, its organisational structuration, usage of multisource data and dissemination policies, are presented in partnership.

Cyanobacterial abundance is measured using phycocyanin fluorescence sensors installed on platforms (all) and Imaging Flow Cytobot at Utö (or in ferry in 2022). Data collection covers cyanobacteria growth seasons (June-August) in 2021-22. Visual maps and trajectories of the data will be used by SYKE in making weekly HAB reviews. Intercomparison of the methods is carried out during laboratory tests (Action GoF PSS #1) and partners share best practices for sensor calibration, validation and maintenance through e-infrastructure.

Data flows and data analysis methods for Imaging FlowCytobot will be created using available cloud computing resources. As there is no general permanent storage for images or AI-classified data, this will be discussed with other WPs.

In the case there are still abundant cyanobacteria during a planned TA-project visiting MRC-LAB and Utö observatory, harmonisation of imaging and knowledge transfer between JERICO-RI and AQUACOSM-plus may be carried out. In addition, the developed methods for imaging cyanobacteria will be widely disseminated during international meetings and through publications.

Best practices used or developed: Structural concept for HAB reviews, using multisource data and involving various national actors, will be created. For Imaging FlowCytobot, the method for data flows, data analysis and creation of products will be developed and published.

Data flows: As phycocyanin fluorescence is still considered as explanatory variable, the flow to EMODnet or CMEMS has not been realised. Potential to do so will be examined. Partners are responsible for their own data flows, storage and distribution to data aggregators and at minimum data is available on request. As well, the data aggregator and related data flows for phytoplankton image data are still under construction. The developments in WP7, T7.5. D2PTS, Ecotaxa are closely followed. Within D2PTS a joint aggregation of results will be carried out, utilizing commonly agreed QC procedures.

Data QC routines. Sensor calibration routines are used as recommended at GoF PSS i) and robust real-time QC routines are further developed, as for the applications like here informing the public, the reliability of data is of concern.

Data management issues: Vocabularies and metadata are not well developed for all of the methods used in this topic and need to be targeted.

Expected results: The Action will create online data for cyanobacteria distribution (also for species abundance) supporting weekly HAB reviews. The concept for HAB reviews will be published. Delayed mode QC data will provide input for developments in Ocean Colour methods (GoF PSS #3) and in modelling approaches (GoF PSS #6). Scientific papers and presentations will be delivered.

Users of results: General public, fisheries and aquaculture, enterprises providing coastal services, cities. Ocean Colour and modelling communities. Coastal sea management. Scientists working with phytoplankton ecology and ecosystem processes.

Dissemination of results: Data is disseminated through publishing online data and weekly HAB reviews by SYKE. We aim to produce a joint press release in Finland and Estonia, demonstrating the value of joint observations in bloom detection. HAB Algae reviews and scientific results will be further disseminated in regional and international workshops, especially including other PSSs and IRSs.

Links: Links to WP5 for best practices for observing biological variables, WP6 to data management of biological sensors, WP6, T6.2.3. providing input to combining citizen observations with sensor observations. WP T7.4 in image recognition methods, WP 7 T7.5 for JERICO-EcoTaxa D2PTS and Wp11 Virtual Access.

There is a link to AQUACOSM-plus, in developing and comparing imaging methods, to be realised as TA project.

GoF PSS #5 Mapping the deep-water oxygen conditions

Objectives: Sub-surface oxygen conditions in the Gulf of Finland are very sensitive to the atmospheric forcing. The area occupied by hypoxic water varies between 0 – 7000 km^2 and considerable changes can occur within a few days, i.e. in much shorter time-scales than conventional monitoring can capture. Main aim of the topic is to estimate oxygen distribution in the gulf with at least weekly temporal resolution. Latter allows calculation of statistics of the near bottom oxygen conditions.

Action Lead and other Partners (with contact persons): TALTECH (Liblik), SYKE (Seppälä), FMI (Laakso), IOW (Bittig)

JS3 Platforms included: Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Argo floats (FMI), monitoring by R/V (All).

Other data sources and external partners for implementation: HELCOM ICES database and operational model data from CMEMS (if the GoF PSS #2 performance assessment supports it), including the input from GoF PSS topic ii).

Overall timetable of action: collection of data February 2020 – September 2021, compilation oxygen maps, adjusting the method and compiling a report May 2022 - October 2022.

Description of action: The oxygen depletion issue in the near bottom layers of the Baltic Sea is a cross-border issue and its monitoring needs a coordinated international collaboration. The Action includes data collection, developing the mapping method and producing the near-bottom oxygen maps in the GoF. The core in-situ dataset will be based on measurements at observatories (Keri and Utö), monitoring by R/Vs and Argo float measurements. The two possible directions for the oxygen maps production can be foreseen: 1) Available CMEMS biogeochemical operative modelling product dedicated to the Baltic Sea will be validated with in-situ measurements (GoF PSS topic ii) and if possible, systematic empirical corrections for the modelled fields will be estimated. If the corrections are reliable over time and/or various states of the sea, they will be used to estimate near-bottom oxygen conditions in the GoF by CMEMS products; 2) Spatial maps compiled by conventional monitoring will be combined with the high temporal resolution measurements conducted at observatories. The linkage between the two could be utilized to create oxygen maps in a weekly temporal resolution. The topic calls for coordinated international collaboration in planning long term deployments and short-term missions and sharing of results. The action needs to include a joint identification of vulnerable areas and especially communicating which are the most important areas lacking consistent observations. Planning the new observation sites, sharing experiences in the deployments and communicating best practices for QC are important components of the topic. The flow of data into joint databases (e.g. CMEMS) needs to be guaranteed for all platforms. The implementation of the topic is a step forward in the coordinated international monitoring of the subsurface oxygen distributions in the area of PSS.

Timetable for Action:

- Collection of the data (February 2020 - September 2021).
- Compiling the datasets (April 2021 - October 2021)
- Developing the method for the compilation of oxygen maps (May 2021 - September 2021).
- Compiling the oxygen maps, adjusting the method (May 2022 - September 2022).
- Compiling the report on the oxygen dynamics

Best practices used or developed: The best method(s) for the estimation of near-bottom oxygen distribution in the GoF will be documented.

Data flows: Action will not arrange operative data flows, but collects the data from partners in autumn 2021.

Data QC routines: Action will not deal with QC routines, but relies on GoF PSS #1.

Data management issues: Minor issues can occur, when partners must agree on data formats.

Expected results: The main result is the time-series of the near-bottom oxygen distributions (maps) in relevant timescales for the GoF.

Users of results: Researchers dealing with Eastern Baltic Sea, authorities responsible for the assessments of the environmental status of marine areas.

Dissemination of results: Results will be shared by JERICO e-infrastructure, At least one scientific paper is planned to publish on the topic during the project period. Results will be introduced to the relevant working group in HELCOM.

Links: The Action links to WP2 T2.4 highlighting the coupling of observations and modelling communities, further detailing how these connections may be improved. Activities in WP5, on best practices of biogeochemical variables, especially those of oxygen, will be followed. Action has links to EURO-ARGO observations and potentially also in making observations during EuroFleets+ cruises in Baltic

GoF PSS #6 Biological interplay with the carbonate system

Objectives: Eutrophication, and with it changes in primary production and mineralization, are of major concern for the Baltic Sea and the GoF PSS area in particular. The inorganic carbon cycle can be used as a powerful quantitative indicator in this complex interplay, as it is the major constituent of organic biomass, and the oxidation of organic carbon is by far the largest contributor to the oxygen demand in deeper waters. It becomes more and more evident that not only the summer N-fixation period, but also the later part of the spring bloom show high variability in C/N/P ratios, thus the link of production of biomass to oxygen demand requires tracing of the carbon cycle. Homogenization of data flows and data quality, definition of gaps and integrated assessment and interpretation are essential to make full use of these data for ecosystem assessment in the GoF PSS target area.

Action Lead and other Partners (with contact persons): IOW (Rehder , Bittig), SYKE (Seppälä), FMI (Laakso, Honkanen), TALTECH (Lips, Kikas)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH), monitoring by R/V (All)

Other data sources and external partners for implementation: potential inclusion of data submitted to the SOCAT database on CO2 parameters in the area (e.g. SOOP Tavastland, Shark database entries of SMHI, data from other projects in the area).

Overall timetable of action: January 2021-November 2022. Some data are collected continuously over the course of JERICO-S3 as part of long-term measurement programs of the partners. Major focus will however lie on data collected over the years 2021-2022.

Description of action: We will assess the availability of carbon system data provided in the area and identify gaps and needs for quality control in the area. Surface pCO2 measurements are continuously operational on SOOP Finnmaid using ICOS-conform methodology, as well as on Silja Serenade and Silja Europa (assuming the current stop of operation due to the COCID 19 pandemic will end in spring 2021). The Action will promote transfer of knowledge on data QA/QC, and improve homogenization and inter-comparability of data and protocols. The group will assess how the carbon system, biological and physical data may be jointly analysed and provide outlook if there are needs to improve coordination of observations and if some key parameters need to be further included.

Best practices used or developed: pCO2 measurements are in general following SOCAT recommendations; CT, AT measurements are well established, yet currently calibrated by the entire community against an open ocean standard (CRM, Scripps). Currently, round robin tests are on the way to check whether this is fully appropriate for brackish water samples. For pH, spectrophotometric measurements are now more and more established and will be further monitored and introduced for the monitoring of brackish waters. Streamlining and QC here will strongly follow and interact with the WP 6, Task 6.3.3.

Data flows: pCO2 and continuous surface carbon parameters via SOCAT, discrete measurements from RV-based monitoring through established databases.

Data QC routines: SOCAT / ICOS routines and QC-ing as documented in the Guide for Best Practises for Ocean CO2 measurements (Dickson et al., 2007) will be followed and/or established for all data streams.

Data management issues: Data management issues are jointly analysed with WP6 T 6.3.3 with expected synergistic effects.

Expected results: The action will improve partners capacity to provide consistent high-quality carbonate system measurements and to analyse the results with auxiliary biological and physical data. The Action improves the overall coordination of carbonate system measurements in the region and contributes to pan-European integration.

Users of results: Scientist working with climate change and ecosystem functioning; managers making assessments of the effects of climate change, eutrophication, and acidification; other parties involved in carbonate measurements. Results will be applicable especially in directing institutional, national and regional sampling strategies for holistic and efficient carbonate system monitoring in the Baltic Sea. This includes tracking of acidification, which has been realized as an important need in the update of the BSAP and the MSFD.

Dissemination of results: Results will be disseminated during scientific and management-supporting meetings and workshops, including those of JERICO-S3, ICOS ERIC, BOOS and HELCOM.

Links: The action links to WP6 Task 6.3.3. working with the guidelines and strategy for carbonate systems data management. It also links to carbonate system actions in other PSS; the already existing link to the ICOS ERIC will be intensified.

GoF PSS #7 Forecast models for cyanobacterial blooms

Objectives: Forecast modelling of cyanobacteria growth and their blooms are challenging tasks but there is a growing demand for such action. Depending on the time horizon, different modelling tools may be used. Long-term scenario models (months) are based on ecosystem models supported by observations of nutrients as a key driver of blooms and expert opinions. The short-term models (days-weeks) may include more detailed parameterization of cyanobacteria vs. other algae groups and taking into account the weather as key drivers. This Action will analyse the performance of the forecast models for cyanobacterial blooms in the Gulf of Finland by comparing to in-situ data obtained from the GoF PSS. Estimate the performance and greatest challenges of the current models and develop ideas on how the models could be advanced.

Action Lead and other Partners (with contact persons): FMI (Laakso), SYKE (Seppälä, Lehtinen)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI), Utö Observatory (FMI, SYKE), profiling buoys (FMI, SYKE), monitoring by R/V (SYKE, FMI).

Other data sources and external partners for implementation: NEMO ocean model and Harmonie NWP model forecasts will be used. Action has links #2 and #5, which target biogeochemical parameters.

Overall timetable of action: Data will be collected in 2021-22, model performance analysis and advancing modelling 20~~21~~-22.

Description of action: Action will improve the availability of observations for the modelling community. The adjustment of observations (time/location/parameters) will be jointly discussed. Though not each PSS partner is participating in this topic, the availability of additional data will be screened.

The Action will merge the relevant observation data from data producers for 2021 and 2022. Model performances will be analysed by comparing the results with in-situ data. This will follow by joint analyses to identify the biggest challenges in model performance. The outlook will be created, with the institutes involved, how to further develop the models.

Best practices used or developed: The best practices as developed in GoF PSS #1 will be followed

Data flows: Data from Action #1 and # 4.

Data QC routines Quality controlled data from topics GoF PSS i) and GoF PSS iv) will be used.

Data management issues: No particular issues foreseen.

Expected results: Improved understanding on cyanobacterial bloom forecast model performance in the GoF area. Plans on improvements on models.

Users of results: Researchers, model developers, people responsible for giving cyanobacterial bloom information to the general public

Dissemination of results: Results will be disseminated during workshops and meetings and if possible, shared by JERICO e-infrastructure.

Links: Topic will link WP2 T2.4 by analysing the current status of cyanobacteria modelling and providing future outlook how it needs to be advanced further. It also links to Wp7, T7.5 D2PTS, in merging regional data.

GoF PSS #8 Extreme events affecting phytoplankton - AQUACOSM collaboration I

Objectives: Plankton ecosystem reacts rapidly to the shifts in various environmental pressures. These responses may be tracked using high-resolution observations with state-of-art sensors, but still many of the interactions in the planktonic realm may remain hidden. For example, rate measurements and food web interactions are hard to measure without enclosing the plankton communities for the period when measurements are done. As well, understanding the responses of planktonic systems to some specific perturbations may require that part of the ecosystem is isolated and studied experimentally. This topic will study how the Baltic Sea phytoplankton communities are affected by extreme climatic forcing, in collaboration with experimental work of AQUACOSM-plus and supported by long-term observational data.

Action Lead and other Partners (with contact persons): SYKE (Seppälä), FMI (Laakso)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI), Utö Observatory (FMI, SYKE), Gliders (FMI), profiling buoys (FMI, SYKE), Argo floats (FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: External partners will be involved through TA calls, both from JERICO-S3 and AQUACOSM-plus.

Overall timetable of action: Planning of the experiment in 2021- early 2022, experiment period in late summer 2022. Analysis of results until Nov 2022.

Description of action: The Action will discover how observations and experimentation may improve our knowledge on ecosystem responses to perturbations. It includes analyses of existing timeseries, to understand which are the frequencies, ranges and durations of extreme events (in this case, temperature and heat waves), jointly with observation and experimental communities. This work is also shared between NW-MED PSS and CRETAN PSS, with similar approach.

Experiment is planned for 2022, likely studying the combined effects of temperature and river load of humic materials (to be precised early 2022, after completion of all TA calls). Water (4 m^3) will be collected from the open Baltic Sea during a research cruise. In the research laboratory it will be distributed into 12 300-L mesocosm units, which are individually controlled for temperature and light. Mesocosm experiment will last 2-3 weeks and the responses of the plankton system will be followed continuously using AQUABOX-device, developed under AQUACOSM project, measuring the key biological, chemical and physical variables. The online measurements are supported by an array of laboratory measurements to get relevant insight on plankton processes. The observed shifts in the plankton community will be analysed against trajectories observed in nature.

A specific topic for the experiment is imaging of plankton organisms and analysing the growth/loss rates based on these observations. Collaboration on this topic will be carried out with AQUACOSM-plus, as there is already one TA project accepted focusing on imaging.

Best practices used or developed: Best practices created and used by JERICO-RI and AQUACOSM-RI communities are compared.

Data flows: Experimental data will form a separate package, and made openly available with DOI

Data QC routines QC routines for continuously collected online experimental data are under scrutiny and the developments benefit from experiences of JERICO-RI

Data management issues: Likely the data will be available through host institute,

Expected results: Primary result of the Action, jointly with similar Actions under NW-MED PSS and CRETAN PSS is advancing the communication between different coastal marine research disciplines, in studying similar phenomena. The conceptual steps in this collaboration includes analysing which types of available observations may support experimental studies, e.g. by showing how common the studied disturbances may be in the region, or which regions may be most affected. Then, the results of the experimentation may guide the observations further, e.g. by showing if the observation capacities are optimal for following such events and their effects. Naturally the experiment combined with relevant time series of observations is expected to produce relevant and new scientific data and publications.

Users of results: Scientific community, management of seas areas and planning countermeasures

Dissemination of results: Results will be disseminated both in the JERICO-RI and AQUACOSM-RI communities in their annual meetings. Another target group for dissemination are ministries and institutes financing coastal studies, showing that such collaborative schemes may yield very important and focused information for specific questions. Additional dissemination in scientific workshops.

Links: Strong between PSS-link and link to AQUACOSM-RI community are evident. Additional link to between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged. Link to WP8, as provision of TA is elemental for the Action.

GoF PSS #9 Promotion of the use of PSS data and products

Objectives: Aims of PSSs are to harmonize regional observations, integrate transnational operations, jointly steer data collection, provide joint products with added value and to connect to other regions. Such actions have a strong need for regional coordination, which is not only the task for JERICO-RI, but also other regional initiatives. This action will disseminate the results from GoF PSS to major regional actors and ask for their feedback to develop observation strategies further. The integrated coastal observations done within GoF PSS, as well as the overall sampling strategy of coastal JERICO-RI Supersites, will be communicated to regional actors, especially HELCOM, EUBSR, and BOOS.

Action Lead and other Partners (with contact persons): TALTECH (Lips), IOW (Rehder), SYKE (Seppälä)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), Wave riders (TALTECH, FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: HELCOM ICES database and CMEMS operational and re-analysis products; input from GoF PSS #2-#8

Overall timetable of action: Analysis of applicability of PSS data for indicators to be used in indicator-based assessments (2021). Sharing of the potential use of data and the product development plans with the environmental authorities, including HELCOM, getting feedback (2021). Presentation of the impact of using PSS data for indicators/assessment and presentation of PSS products, adjustments, if needed (2022). Publication and recommendations of potential use of PSS data and products in the future (2022-2023).

Description of action: An analysis will be carried out to define what PSS data could be used for the indicator-based assessments, either combined into the already developed indicators (e.g. HELCOM core indicators as Chlorophyll-a, Oxygen debt, etc.) or indicators under development (acidification indicator, shallow water oxygen indicator, etc.). Demonstration of the impact of combining PSS data into the indicator assessments (e.g. increased spatial and temporal coverage leading to a better confidence of assessments). Demonstration of PSS products from GoF PSS #2-#8 and their use to the national and local environmental authorities and HELCOM. It needs to be noted that the uptake of results/products also depends on HELCOM HOLAS III assessment process. Development of recommendations of the potential use of PSS data and products in the future to meet the needs of local and regional authorities (e.g. for MSFD

Best practices used or developed: Best practices of the use of PSS data and products to meet the needs of local and regional environmental authorities.

Data flows: No operational data flows are arranged but collects the data from partners and other sources. Recommendations for the data flows in the future will be developed.

Data QC routines: The Action relies QC routines developed/agreed in GoF PSS #1.

Data management issues: The agreements between partners must be in place.

Expected results: Indicator-based assessment products with confidence estimates when combining conventional data with PSS data.

Users of results: Local and regional environmental authorities (including HELCOM).

Dissemination of results: Results will be shared via JERICO e-infrastructure, potentially also via HELCOM web site, if agreed so.

Links: The topic links to WP2 T 2.5 in analysing which type of environmental policy needs there exist in the region and if PSS actions may contribute to those needs.

GoF PSS #10 Connecting the other RIs in the region

Objectives: Many of the Grand Environmental Challenges affect several environmental domains (land-sea-air) and cannot be studied in isolation within one domain only. Streamlining observations, experimentation and data-analysis within European RI-landscape requires that regional and practical bottom-up collaborations between RIs develop parallel to higher level and strategic top-down collaborations (which are dealt in WP2). Connecting RIs at the regional level will highlight existing synergies, helps to identify overlaps and research topics where collaboration needs to be strengthened. Specifically in GoF PSS we seek to establish connections to other RIs by contributing to carbonate system measurement guidelines for coastal seas (ICOS ERIC), sharing data (AQUACOSM-plus, EURO-ARGO ERIC, ICOS ERIC), and seeking possibilities for future joint activities (ACTRIS PPP, EMBRC-ERIC, EUROFLEETS+, MINKE)

Action Lead and other Partners (with contact persons): FMI (Laakso), TALTECH (Liblik, Lips) , IOW (Rehder), SYKE (Seppälä)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), Wave riders (TALTECH, FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: TBD

Overall timetable of action: January 2021- November 2022

Description of action: The action starts by defining and contacting the key regional actors of other RIs. Already shared actions and collaborations will be mapped. For practical regional work, the geographical, scientific and technological interfaces between RIs will be identified. Some actions at GoF PSS (6 and 8) already have clear between-RI components and these demonstrations will be analysed in terms of scientific advances and other synergies achieved and disseminated towards other RIs and also between PSS. Potential new schemes of collaborations will be mutually discussed.

The Action will end up with collating examples of between RI collaborations within GoF PSS, followed by analysis of potential future interactions, to be disseminated to WP2.

Best practices used or developed: Sharing the best practices between RIs will be promoted.

Data flows: Sharing data flows will be promoted. Discussions between the ICOS OTC and JERICO on data issues to be started.

Data QC routines Action will support the transfer of knowledge on QC

Data management issues: Data management practices of different RIs will be studied

Expected results: This action will result in improved exchange of knowledge between regional actors of various RIs and on-going root level co-operation between the different RI's on daily basis. It is expected that opening the forum for joint activities and planning will result in improved efficiency of observations and use of data. Action will also inform WP2 on the ongoing practical collaborations, future collaboration possibilities and possible obstacles to cooperation, providing important bottom-up feedback on how future RI-collaborations need to be developed.

Users of results: All RIs, JERICO-S3 WP2, WP3 and WP9, JERICO-DS, also national RIs and national authorities responsible for RIs. Scientific community and policy-makers.

Dissemination of results: Work is disseminated during workshops where several RIs are present. Scientific publications, press releases, www-pages and media.

Links: Action provide direct inputs to WP2 T2.2 and various task in WP9. Action will also inform WP3 on regional RI collaborations. Action has links to all environmental RIs active within the region.

5.2. Implementation strategies: North-West Mediterranean Pilot Supersite

JERICO-S3 subtask 4.3.2. Pilot Supersite at North-West Mediterranean; NW-MED PSS (Lead partner CNRS, partners CNR, PdE, SOCIB, UPC)

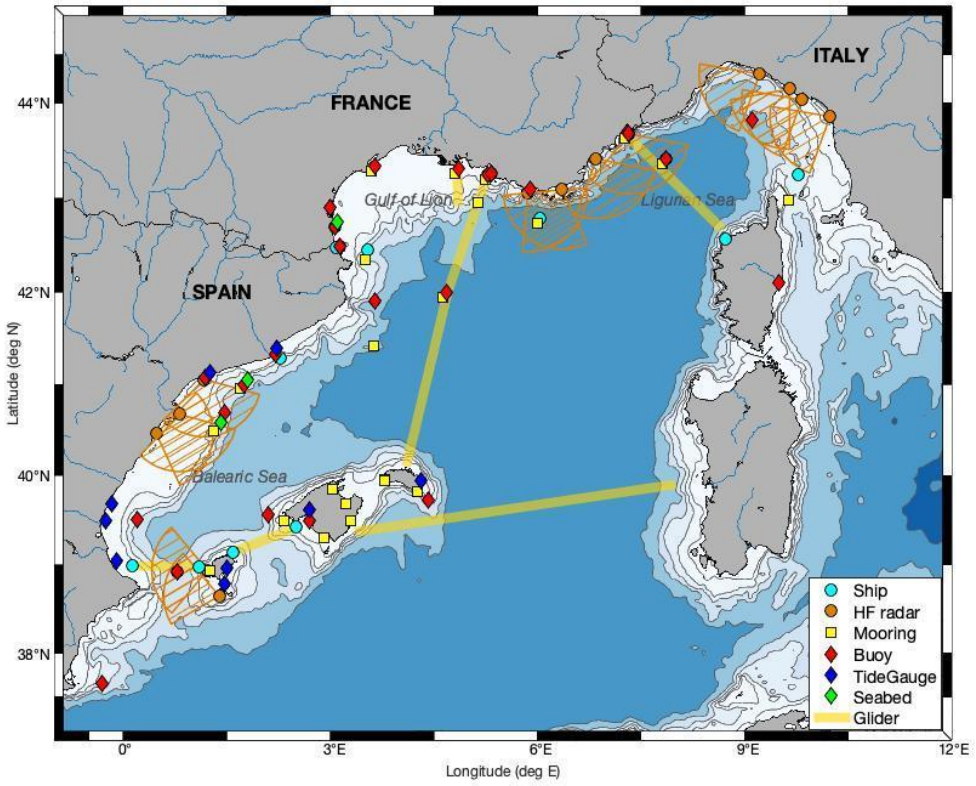


Figure 5.2. Map showing the key NW-MED PSS sustained platforms and existing stations

Table 5.2. Platforms in NW-MED PSS

Operational observation systems & platforms in the region	Operational status	Parameters
Ships (ILICO, SOCIB, CNR)	operational (different frequency)	Profiles: T, S, O2, fluorescence Bottles: nutrients, carbonate, zooplankton, phytoplankton, genomics
HF radars (CNR, PdE, ILICO, SOCIB)	operational	surface currents (speed, direction)
Moorings (ILICO, CNR)	operational	T, S, O2, currents, particle flux, images

Buoys (ILICO, PdE, UPC, SOCIB)	operational	meteorology, currents, waves, PAR, T, S, O_2, fluorescence, pH, pCO_2
Tide gauges (PdE, SOCIB)	operational	sea level
River stations (ILICO)	operational	Discharge, particles load, nutrients, metals
Seabed (UPC)	operational	T, S, depth, currents, waves, underwater sound. seismometer, video-camera, biodiversity
Gliders (ILICO, SOCIB) for ILICO (MOOSE) the GNF is not operational since July 2021. The endurance lines are operated from MIO and LOV (sub-contractor ALSEAMAR)	operational	T, S, fluo, turbidity, O_2, CDOM, BB700 (routinely), particles size, current motion (occasionally)
Numerical models (SOCIB, IFREMER, PdE, CNRS)	operational/semi-operational	(3D) T, S, currents, waves, sea level

NW-MED PSS #1: Reconstruction of the 3D coastal dynamics

Objectives: This Action provides a transnational approach to study the Northern Current overall dynamics, encompassing and connecting specific sea areas under investigation by the partners involved. It uses the Regional Data in the Northern Current region, to reconstruct the 3-D coastal dynamics and, in combination with modelling, to analyse dispersion of marine life (larvae, jellyfish, phyto- and zooplankton) in different current scenarios, with possible applications to distribution of pollutants, jellyfish, alien species and in support of fisheries and regional management. [Action is a combination of original topics i & ii]

Action Lead and other Partners (with contact persons): CNR (Berta, Griffa), SOCIB (Mourre), CNRS (Coppola), PdE (Sotillo), UPC (del Rio)

JS3 Platforms included: ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), gliders, HF radar, moorings and numerical model from the Coastal Ocean Observing and Forecasting System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE); Additional infrastructure: HF radars (CNRS, PdE), buoys (CNRS, PdE), tide gauges (PdE), coastal moorings, river stations (CNRS), monitoring by R/V (SOCIB, CNRS, CNR), SIROCCO modelling system (CNRS). The French gliders have stopped since July 2021 and they are now operated by MIO (Marseille - Menorca) and LOV (Nice-Calvi) using subcontractors (CSCS, ALSEAMAR). CNR is planning a float deployment in the Western Med Sea in winter-spring 2022 for the investigation of small-scale frontal structures and a drifter deployment in the Ligurian Sea within the HF radar network

Other data sources and external partners for implementation: CMEMS satellite and model data. The CMEMS Mediterranean forecasting model will provide boundary conditions for our high-resolution models. Possibly data is also obtained from LABMARE mooring (CNR, ENEA, DLTM, INGV, IIM), additional HFR antennas (LAMMA consortium), ALBATROSS mooring (EMSO-ERIC) and new bio-glider (LOV CNRS), pre-operational forecasting modelling system MENOR and coastal buoy (MESURHO, IFREMER).

Overall timetable of action: Jan 2021-Nov 2022

Description of action: The planned multiplatform network covering the NW-MED will include a wide range of observations managed at transnational level. Several observing systems based on autonomous platforms are already active and will cover the whole duration of the project (remote and in situ fixed stations, example HF radars and moorings). Other targeted field activities and samplings (ships and gliders) will be planned by each partner during 2021-2022. The Action will explore best practices to integrate the multiplatform observations (at the sea surface and at depth) and investigate the overall dynamics at various scales. In-situ measurements can be used to validate/calibrate remote measures. The investigation of circulation effects on dispersion of biological and pollutant particles will be supported by historical dispersion datasets in the NW-MED (e.g. drifters at various depths, CMEMS products) and targeted in situ trajectories collected in specific sites of the PSS.

Several numerical models will also be used in this action. The data-assimilative WMOP hydrodynamic model (SOCIB) will integrate multiplatform coastal observations from HF radar, gliders and moorings along the whole path of the Northern Current. The results of the MENOR pre-operational model (IFREMER) covering the whole PSS area will be made available both for comparison with recorded data and dispersion modelling. Two-way nested zooms (with a horizontal resolution in the range of 400 m) will be activated in chosen aeras (mainly where radars are installed) allowing local comparison with observations. Moreover, the SYMPHONIE/SIROCCO model (CNRS) will be used to specifically analyse cross-shelf exchanges and dispersion associated with the

meandering of the Northern Current. Model intercomparisons using the whole set of PSS observations will be carried out to better understand model performance and limitations. This activity will benefit from the availability of standardized and quality-controlled coastal data made available by the different countries and institutions involved in the NW-MED PSS, demonstrating the added value of transnational data integration.

Best practices used or developed: Application of best practices as provided in WP5 and WP6.

Data flows: Data will be made available by the national coastal research infrastructures through their threads or other web servers.

Data QC routines: QARTOD QC routines can be used for RT data flagging, including links to WP5 and WP6.

Data management issues: Some issues need to be clarified during the Action, e.g. if data is provided in real-time or periodically, and which formats will be used

Expected results: Improved coordination of independent and complementary observing and modelling systems for the characterization of the 3D coastal dynamics over the NW-MED coastal area, allowing a better understanding of the variability and instabilities of the slope current and the analysis of the dispersion of nutrients, fish larvae, contaminants, plastics or jellyfish. The organic suspended matter as well contaminants distribution driven by currents affects water quality, whose characterization provides useful information for fisheries and marine regional management.

Users of results: Scientific community, managers of coastal areas in the NW-MED PSS region

Dissemination of results: Results will be made available as peer-reviewed publications and presentations in conferences related to coastal ocean dynamics.

Links: Links to WP1 for multidisciplinary integrated observations approach, WP 5 and 6 for infrastructures and data management, WP9 (sustainability of observations), WP10 (communication), WP2 (interaction with complementary RIs in the region), WP11 (VA of data). The original link with WP7 is limited due to the choice of the location of the demo mission which is planned in the Bay of Seine (coastal buoy with c-EGIM)

NW-MED PSS #2: Impacts of river discharge to coastal ecosystems

Objectives: This Action deals with the quantification and characterization of riverine inputs of particles as well as nutrients and contaminants and estimate their potential impact in the coastal adjacent area (accumulation rates and impact on benthos, partition between deposit and plume). Mediterranean rivers are characterized by short-term but violent flash-flood events. There is a need to augment and coordinate regional river observations of riverine particle load and their coastal impacts and develop scenarios how riverine inputs and flooding may affect coastal ecosystems and how it should be observed.

Action Lead and other Partners (with contact persons): CNRS (Bourrin), CNR (Cantoni), UPC (del Rio)

JS3 Platforms included: ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), Coastal Ocean Observing, Forecasting and Monitoring System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE). Additional infrastructure: Gliders (SOCIB), HF radars (CNRS, PdE), buoys (CNRS, PdE, SOCIB), tide gauges (PdE), coastal moorings, river stations (CNRS, SAIH Ebro), monitoring by R/V (SOCIB, CNRS).

Other data sources and external partners for implementation: IFREMER (Verney, Pairaud) for land to sea interface particle fluxes and behaviour in the coastal area for the Rhône River. Ocean colour data (COPERNICUS) for turbidity in front of rivers. DANUBIUS-RI (Ebro delta, Vicente Gracia Garcia, UPC)

Overall timetable of action: January 2021-November 2022

Description of action: We will focus on 3 sub-actions:

A) We need to increase transnational access to databases for river input data in terms of river discharge, particle and nutrient loads. There are national databases (Spain, France, Italy) and even local databases which need to be gathered and mentioned in the same document. Timetable: due at the end of 2021.

B) Extreme events such as flash-floods are typical of the Mediterranean climate and can have a strong impact (economic, coastal erosion, and biological impact). There is a need to access high-frequency and high-resolution data through coastal monitoring stations (buoys, gliders) and satellite data, to address those impacts. We propose here to focus on extreme events (i.e. Gloria events of January 2020) which affected the whole NW-MED Sea to access the impact of such events in the coastal area. We will gather all available data or papers from this extreme event and analyse the impact on each side of the NW-MED PSS. Timetable: due in August 2022

C) We propose here to design a suitable research infrastructure and conduct experiments to monitor the impact of extreme events (i.e. flash-flood and storm) on the coastal ecosystem in the Mediterranean environment. A joint monitoring of river inputs (from river quality station), coastal buoys, HF radar and glider will be set in the Ebro ROFI in fall 2021 to address the impact of potential events in the coastal area. A similar experiment was designed in the Rhone ROFI inside the DeltaRhone French project and will focus on the impact of riverine inputs to the delta and prodelta bottom sediments and associated benthic ecosystem. Timetable: due in August 2022

The definition of common questions should lead to answers based on local dataset. It should be followed by an enhanced collaboration across river-coastal systems to define commonalities and differences between the systems. This would lead to a better understanding of the main common constraints on these marine systems, and thus a better understanding of the main drivers of their functioning. These actions would require

the organisation of an inter-system workshop (or mini-conference with round tables) at the JERICO level for several river-coastal systems (with all PSSs and IRSs having river-coastal activities).

Best practices used or developed: The Action will apply best practices defined in DANUBIUS to JERICO-S3 river system network

Data flows: The Action will check interoperability of river quality databases. Experimental data (gliders, buoys, river stations, HF radar) will be available to JERICO-S3 consortium.

Data QC routines: QC routines from regional observatories will be adapted to those employed in DANUBIUS-RI.

Data management issues: Databases are hosted by the different national agencies and there is no common database.

Expected results: Gather regional river databases following DANUBIUS-RI best practices and QC routines. Define a research strategy to observe river inputs and their impact in the coastal area at the level of Mediterranean systems (and others). An example experiment following the defined research strategy will be tested in the Ebro delta in fall 2021.

Users of results: National water agencies, marine protected areas

Dissemination of results: Results will be disseminated in NW-Med PSS meeting and J3 general assembly. Results could also be disseminated inside DANUBIUS-RI meetings.

Links: Link to Po River system in the Adriatic system (WP3), Ebro River in DANUBIUS-RI (WP2).

NW-MED PSS #3: Extreme events affecting phytoplankton - AQUACOSM collaboration II

Objectives: Phytoplankton communities are affected by extreme coastal events and global warming. Phytoplankton is often responding very rapidly to perturbations and impacts of those cannot always be studied effectively using observations only, but an experimental approach is required. The strategic plan of this Action is to improve synergies between JERICO-S3 observing community and AQUACOSM-plus mesocosm experimenting community in studying dynamics of coastal phytoplankton populations. The Regional Data of NW-MED PSS can be used to identify the range of the water temperature, conductivity, turbidity, nutrients, timing of phytoplankton bloom, etc. Such information can improve the mesocosm experimental plans and protocols, in defining realistic experimental treatments. In addition, the range of some other parameters such as dissolved organic carbon (DOC) concentrations and water temperature can be considered for an experimental mesocosm investigation to study separate and combining effects of DOC load and temperature increase in the phytoplankton community responses.

Action Lead and other Partners (with contact persons): CNRS (Mostajir), CNR (Cantoni)

JS3 Platforms included: All platforms providing data on extreme events and global warming: gliders, buoys, rivers, ships. ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), Coastal Ocean Observing, Forecasting and Monitoring System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE); Additional infrastructure: Gliders (SOCIB), HF radars (CNRS, PdE), buoys (CNRS, PdE, SOCIB), tide gauges (PdE), coastal moorings, river stations (CNRS), monitoring by R/V (SOCIB, CNRS).

Other data sources and external partners for implementation: AQUACOSM-plus data/results and experiments. Additional collaborations may be achieved by opening this mesocosm experiment through transnational Access (TA) of AQUACOSM -plus.

Overall timetable of action: May 2021-Nov 2022

Description of action: The Action shows the use of observation data to improve experimental mesocosm plans, contributing to more realistic treatments. In addition, mesocosms experiments would help scientists (observers) to parametrize specific processes in "controlled" conditions, processes difficult to observe and understand fully on the field (need to modify/adapt measurements frequency, additional variables, etc.). Combining experiments and models, the results could provide answers on the trends and anomalies recorded in the time series.

A mesocosm experiment to simulate an "extreme event", alone, and combined also with water temperature increase was scheduled to carry out between April 19 and May 21 of 2021 (if COVID restrictions permit). This experiment will be realized in the frame of French ANR national project entitled: *Microbial responses to terrestrial dissolved organic matter input in freshwater and marine ecosystems in a changing environment (RESTORE)* on the MEDIMEER infrastructure (https://www.aquacosm.eu/mesocosm/medimeer).

In 2022, there is a possibility to increase collaboration between JERICO-RI and AQUACOSM-plus, by having a new experiment on heat waves: effects of consecutive heat waves on the resistance, resilience and recovery of marine plankton communities for 2022

In this new experiment, planktonic communities will be submitted to 2 consecutive periods of heatwaves and post heatwaves and the results will be compared with those

of Control mesocosms based on the daily sampling of chemical , physical and biological parameters, continuous high-frequency sensor measurements , as well as the key ecological processes like Gross Primary Production, Respiration, Net Community Production, Growth and Loss of phytoplankton.

Best practices used or developed: Best practices created and used by JERICO-RI and AQUACOSM-RI communities are compared.

Data flows: The data produced or measured during the mesocosm experiment by participants benefiting from TA of AQUACOSM-plus will be registered in the AQUACOSM-plus web site.

Data QC routines: QC of experimental data is done according to AQUACOSM-plus practices.

Data management issues: Experimental data is available through ANR project members, according to their Data Management Plan.

Expected results: Primary result of the topic, jointly with similar topics under GoF PSS and CRETAN PSS is advancing the communication between different coastal marine research disciplines, in studying similar phenomena. Experimental results obtained will guide the sampling strategies for future improvements of observations. On the other hand, information from observations will guide the determination of realistic experimental plans in future experiments. Collaborative schemes created for the region and for pan-European communities will facilitate future collaboration for various scientific questions.

Users of results: Scientific community, science-based management of the area.

Dissemination of results: Results will be disseminated both in the JERICO-RI and AQUACOSM-RI communities in their annual meetings. Additional dissemination in scientific workshops and in between-RI events, by publishing the results of the collaboration between two communities of observation and experimentation as "Success Story".

Links: Strong links between PSSs and to AQUACOSM-RI community are evident. Additional link between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged.

NW-MED PSS #4: Biogeochemical data and ocean colour products

Objectives: Provide BGC products based on the multiplatforms approach, regional model development and algorithms to improve the satellite ocean colour product. This action will focus in particular on the observation of the carbonate system in the PSS based on in situ observations and the application of neural networks trained and used in MedSea NW. This action will also establish the needs in terms of BGC/optical variables for in situ coastal observations in order to improve the models and the quality of the ocean colour products for coastal waters.

Action Lead and other Partners (with contact persons): CNRS (Coppola, Doxaran, Ulses)**,** SOCIB (Allen)

JS3 Platforms included: Several JERICO platforms: gliders, coastal moorings, buoys, repeated R/V cruises. Other platforms: ocean colour satellite products, Argo floats

Other data sources and external partners for implementation: Other data sources include CMEMS, in situ data for cal/val (BOUSSOLE), coastal gliders from CNRS, model SIROCCO SYMPHONIE-Eco3MS from CNRS and Mercator BGC forecasting models. The Action connects to external partners ACRI, MERCATOR and LEGOS. Neural network CANYON-MED products.

Overall timetable of action: Jan 2021-Nov 2022

Description of action: For BGC regional models, a focus of CO2 variables and O2 between the water column and the atmosphere in the shelf area is planned in the Gulf of Lion (SIROCCO SYMPHONIE-Eco3MS). The BGC in situ data will also be used in assimilation, a field under development at Mercator as well as at our European partners within the framework of CMEMS. For the coastal environment, the aim is to improve river inputs (nutrients, carbon and suspended solids) as well as exchanges with the sediment. For OC products, cal/val method will be applied for coastal waters using existing in situ data and algorithms.

The Action aims to avoid duplication of efforts by coordination of existing and new infrastructures across the PSS observing and forecasting platforms and networks. It will adopt common strategies, standards and dissemination routes with a focus on common EOVs.

The Action will use the regional knowledge of marine BGC to support the QC procedures and the validation of OC derived products compared to in situ data. The spatial representation of OC products will complete the punctual sampling of in situ sensors (gliders, buoys) and could provide a consistent and comprehensive picture of the daily situation.

Having identified societal and scientific requirements for biogeochemical observations, monitoring and forecasting, we will coordinate existing infrastructures to leverage the individual elements for connective multi-parameter analyses across the NW-MED region.

The BGC platforms are already active in the PSS area. For satellite QC products, the in situ sampling points will be listed and will be used for the automatic matchup tool. For moving devices, a list of locations will be updated every week/month to compute and deliver the matchups.

Best practices used or developed: The Action applies best practices developed in EURO-ARGO ERIC and EMSO-ERIC. New best practices will be developed through EUROSEA WP3 (on going).

Data flows: BGC EOV observation data flows into EMODnet. Satellite products are obtained from CMEMS, EUMETSAT and HERMES data server. SYMPHONIE-ECO3M & Mercator products are available in CMEMS

Data QC routines: Automatic flags (clouds, haze, glint, hilt) are implemented in satellite data processing software (e.g., in the Sentinels Application Platform: http://step.esa.int/). Protocols have been defined and recently updated for ocean Color product validations in comparison with in situ measurements (EUMETSAT 2019).

Coastal moorings will follow EMSO-ERIC & OceanSites QC protocols.

Glider inter-calibration techniques will follow the recommendations of EURO-ARGO ERIC (e.g. O2, Chla).

Data management issues: The validity of ocean colour algorithms in turbid and highly absorbing coastal waters still represents an issue. This must be highlighted by ocean colour experts. A significant effort is still required to multiply quality matchups between satellite and in situ data in such waters, notably using autonomous field platforms.

Expected results: Validated ocean colour satellite products (water turbidity, concentrations of suspended particulate matter and chlorophyll-a with associated uncertainties). Harmonising approaches across the PSS will provide the synthesis for quantifying critical region wide processes such as community and export production, nutrient cycling, ocean acidification, coastal eutrophication and pollution.

Users of results: Persons in charge of water quality monitoring based on in situ field sampling and scientists in charge of biogeochemical models and in situ observations (eg. time series)

Dissemination of results: MONGOOS workshops, annual JERICO- S3 and EUROSEA meetings, peer review articles

Links: T2.4 to improve connectivity and identifying the gaps, WP5 & WP6 to elaborate best practices on BGC variables and QC procedures. Links to MONGOOS and EuroSea project.

NW-MED PSS #5: RI interactions

Objectives: Establish strong links with existing open ocean and land-coastal RIs EMSO-ERIC, EURO-ARGO ERIC, EMBRC-ERIC and ICOS ERIC, to secure littoral-coast-open sea continuum in observations and modelling. The open sea observatories, especially EMSO-ERIC, will provide open access data for NW-MED PSS needs and the expertise on biogeochemical sensors and QC procedures will be shared. The repeated observations of biodiversity in the PSS region (through imagery and genomics approaches) is also a strong opportunity to set up interactions between EMBRC-ERIC and JERICO and reinforce collaborations between the communities.

Action Lead and other Partners (with contact persons): CNRS (Coppola)**,** UPC (del Rio), SOCIB (Allen), CNR (Cantoni, Bozzano)

JS3 Platforms included: Coastal moorings & buoys, seabed platforms (OBSEA)

Other data sources and external partners for implementation: AQUACOSM: see Action #3; EURO-ARGO ERIC: BGC-Argo floats are deployed regularly in the PSS area; EMSO-ERIC: fixed observatories (cabled and standalone): Dyfamed, Albatross, Lion; ICOS buoys: W1M3A, Dyfamed; Benthic crawler in EMSO-ERIC Ligure will be deployed in 2020 for observing and monitoring the deep-sea environment in the nearshore NW-MED in the framework of EMSO-France. Deployment of benthic crawlers in 2022.

Overall timetable of action: Jan 2021-Nov 2022

Description of action: In the NW-MED PSS there are strong interactions between RIs regarding the platforms locations and variables observed. In order to harmonise efforts and investments, best practices and data control procedures will be proposed for the different RI platforms taking into account the specific needs of JERICO-RI. Joint workshops/projects between RIs should strengthen interactions. In this context, actions#5 and 6 are strongly connected.

Best practices used or developed: Many RIs have already produced BP (ICOS ERIC, EMSO-ERIC and EURO-ARGO ERIC). OceanSites & EMSO-ERIC will work on a new version of BP with EUROSEA WP3.

Data flows: Existing data flows from others RIs

Data QC routines: Existing GDACs (as CORIOLIS) manage Argo, EMSO-ERIC/OceanSites, gliders, GO-SHIP datasets with QC and format procedures. They are based on different cookbooks established during DMT meetings. These cookbooks allow to harmonise data QC procedures provided by different platforms. OBSEA is using QARTOP QC routines to flag real time data generation. Some discussion and demonstrations took place within some EMSO-ERIC partners to use such routines

Data management issues: For EMSO-ERIC discussions with the global consortium (OceanSites) is planned through H2020 EUROSEA WP3 to improve and establish common BP and metadata catalogue. This includes especially BGC variables provided by moorings.

Expected results: BP and QC procedures common for several RIs

Users of results: Scientists, operational oceanography

Dissemination of results: Through RIs disseminations (workshops, reports, annual meeting) and peer reviewed articles

Links: T2.2 and WP5 for best practices

NW-MED PSS #6: Transnational integration

Objectives: The NW-MED will promote integration of the regional and European initiatives like MONGOOS and EUROGOOS tasks and working groups to disseminate results, new products and to align its strategy towards a regional integrated observing system. The PSS products will be presented regularly during MONGOOS and EUROGOOS workshops and general assemblies.

Action Lead and other Partners (with contact persons): CNRS (Coppola, Bourrin), PdE (Pérez Gómez), SOCIB (Allen), UPC (del Rio), CNR (Cantoni, Berta)

JS3 Platforms included: All JERICO-RI platforms will be involved here:

Other data sources and external partners for implementation: MONGOOS observation task team

Overall timetable of action: Jan 2021 - Nov 2022

Description of action: Data from the NW-MED PSS observing platforms will be available to ensure their availability and contribution to existing regional programs or activities. The most relevant programs in the region are: MONGOOS, ~~UNEP-MAP,~~ EuroGOOS (EuroGOOS Coastal Working Group), and CMEMS.

The EuroGOOS Coastal Working Group will be connected to the PSS community in the analysis of the entire value chain from coastal observations (in-situ and satellite), to models, products and services for final coastal users, along European coasts. In this context, the PSS will harmonize its strategy by this group. The CMEMS In Situ TAC ~~of~~ provides consistent and reliable access to a range of in situ data for the production and validation of services. The PSS will promote the in situ observations activities and new variables to disseminate its actions.

Best practices used or developed: Not relevant for Action

Data flows: Not relevant for Action

Data QC routines: Not relevant for Action

Data management issues: Not relevant for Action

Expected results: Identification of gaps, problems and new products & variables of interest for the mentioned programs and activities

Users of results: task team leaders, MONGOOS coordination

Dissemination of results: Workshops, reports, collaborations through joint promotion with CS PSS and Adriatic IRS to MONGOOS~~, UNEPMAP~~

Links: to WP2

5.3. Implementation strategies: North Sea and English Channel Pilot Supersite

J-S3 Subtask 4.3.3. Pilot Supersite at North Sea and English Channel; NSEA PSS and CHANNEL PSS (Lead partners Hereon, IFREMER, partners AWI, CEFAS, CNRS, DELTARES, IMR, NIVA, RBINS, RWS, VLIZ)

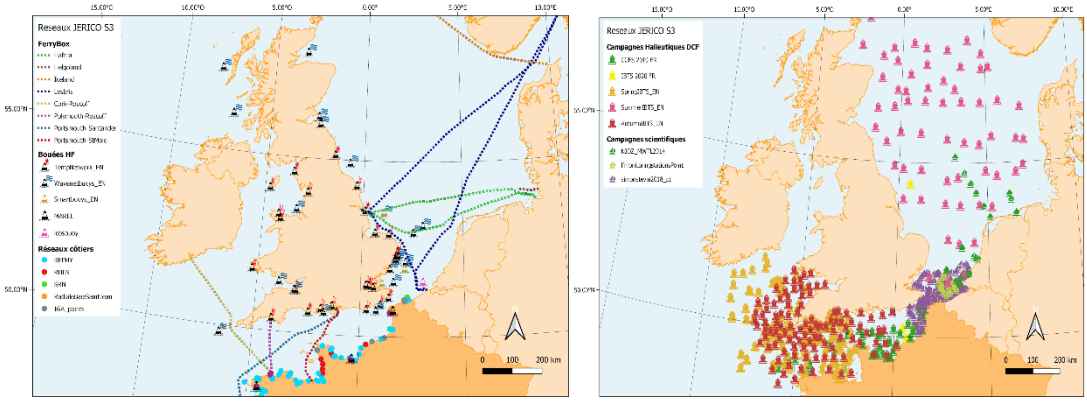


Figure 5.3. Left, a map showing the region of the NSEA and CHANNEL PSSs with FerryBox routes (existing, potential and stopped routes). Stationary platforms and other measurement platforms operated by the partners are also mapped and listed in the table below. Right, a map showing the locations of the main sampling stations from ecosystemic/scientific cruises.

Table 5.3. Platforms of NSEA and CHANNEL PSS

Operational observation systems & platforms in the region	Operational status	Parameters
MAREL Carnot instrumented station (IFREMER)	Operational from 2005 onward	Temperature, salinity, turbidity, fluorescence, oxygen conc. + Nutrients, PAR and meteo to be implemented in 2021.
Smile buoy (Ifremer, CNRS)	Operational from 2017 onward	Temperature, salinity, turbidity, fluorescence, oxygen conc.
Scenes buoy (Ifremer)	Operational from 2017 onward	Temperature, salinity, turbidity, fluorescence + benthic lander: Temperature, salinity, turbidity, waves, currents
Astan buoy (CNRS)	Operational since 2007	Temperature (air/water), wind, atm. pressure, salinity, fluorescence, oxygen, pCO_2

Warp and /WestGabbard (2 x SmartBuoys)	Operational 2000	Temperature (water), salinity, fluorescence, oxygen, turbidity, PAR (0, 1 and 2 meters), phosphate, silicate, ammonia, nitrate, nitrite, phytoplankton (species abundance)
Thornton buoy (VLIZ)	Operational since 2015	Temperature, salinity, conductivity, pH, turbidity, dissolved oxygen, current intensity
Benthic Lander MOW1 (RBINS)	Operational since 2005	Temperature, salinity, acoustic and optic backscatter (turbidity and SPM concentration), turbulence, current velocity, suspended particle size
Lysbris FerryBox (Hereon)	operational (routes changed in 2019)	fluorescence, DO, pCO_2, pH, salinity, temperature, turbidity, TA
Magnolia Seaways FerryBox (Hereon)	operational	CDOM, fluorescence, DO, pCO_2, pH, salinity, TA, temperature, turbidity
FunnyGirl Ferry Box (Hereon)	operational (April - October)	CDOM, pH, DO, fluorescence, salinity, temperature, turbidity,
Cuxhaven (stationary) Ferry Box (Hereon)	operational	DO, salinity, temperature, CDOM, fluorescence, PAR, pH, turbidity, phosphate, silicate, ammonia, nitrate, nitrite
Norrona FerryBox (NIVA)	installed, but has technical issues, and we cannot access the ship due to COVID	salinity, temperature, turbidity, chl a and cDOM fluorescence, DOsat, DOconc, pCO_2/pH (in 2021)
Connector FerryBox (NIVA / RWS)	installation is delayed, but we expect installation to be complete by early 2021.	salinity, temperature, turbidity, chl a and cDOM fluorescence, DOsat, DOconc, pCO_2/pH (in 2021)

RV Thalassa FerryBox (IFREMER)	FB operational since 2018	Temperature, salinity, oxygen conc. and saturation, turbidity, spectral fluorescence.
RV Côtes de la Manche (CNRS)		Temperature, salinity, possibility of connecting other sensors
RV Antéa (IRD)		Temperature, salinity, possibility of connecting other sensors
RV Sepia II (CNRS)		Temperature, salinity, possibility of connecting other sensors
RV Cefas Endeavour FerryBox (CEFAS)	since 2009	Temperature, salinity, fluorescence, turbidity, oxygen, spectral fluorescence (possibility connection with flow cytometry)
RV Simon Stevin underway system (VLIZ)	Operational since 2001	Temperature, conductivity, turbidity, oxygen, nutrients (nitrate, phosphate and silicium), surface pCO_2 and fluorescence
COSYNA Helgoland cable observatory (AWI/Hereon)	Operational since 2012	Temperature, salinity, turbidity, fluorescence, oxygen, underwater camera system
Vertical Profiling Lander Helgoland (AWI/Hereon)	Operational since December 2020	Temperature, Salinity, turbidity, fluorescence, plankton and particle imaging, seafloor properties

NSEA PSS #1 Harmonised observations of regional C fluxes.

Objectives: At NSEA-PSS, regional data is augmented with data related to carbon cycling, which will lay the foundation to advance the regional carbon budget by improving coherent observations of regional C fluxes (air-sea, land-sea, pelagic-benthic, and microbial processes). First objective will be to harmonise measurements from available platforms in the NSEA-PSS, including applying respective QA/QC. Whenever possible, data will be harmonized with available measurements from the ICOS ERIC. After this is achieved, another objective will be to combine the quality-controlled data with available models and earth observations.

Action Lead and other Partners (with contact persons): Hereon (Voynova, Möller, Brix), NIVA (Frigstad), AWI (Fischer, Bussmann), DELTARES (Blauw), IMR (Wehde)

JS3 Platforms included: FerryBox: Lysbris Seaways (Hereon), Magnolia Seaways (Hereon), FunnyGirl (Hereon), Norrona (NIVA), Connector (NIVA/RWS, projected), Cabled observatory COSYNA Helgoland and Profiling Lander (AWI, Hereon);

Other data sources and external partners for implementation: RWS monitoring programme including precise measurements of pCO2, pH, DIC and alkalinity and satellite images and remote sensing algorithms developed. DANUBIUS-RI infrastructures delivering river data

Overall timetable of action: Jan 2021-Nov 2022

Description of action: To create carbon budgets for a large shelf sea such as the North Sea a coordinated effort and methodology to capture natural and anthropogenic variability as well as trends is needed. This is especially relevant for analysing and closing measurement gaps. Measuring both greenhouse carbon compounds (CH4 and CO2) in the dissolved and atmospheric phase together with basic oceanographic and meteorological data will allow better understanding of sea - air flux of these compounds and is necessary. The Action will investigate the coherence of current carbonate system parameters in the NSEA-PSS (pCO_2, pH, A_T, DIC) available from partners involved in NSEA-PSS region (Hereon, NIVA, AWI within JERICO-S3, and other relevant partners). It compares available operational data to data from the ICOS community, from the SOCAT database measurements, as well as from other available measurements (example: Macovei et al., in review). Transfer of knowledge will be facilitated through a collection of available data, information and data base locations that will be made publicly available. A workshop to involve the research community will be held. Active cooperation with other RIs, especially DANUBIUS-RI, will be established and expanded

Best practices used or developed: A SOP for pCO2 quality control from underway systems is still to be developed building on the experience of 2021. Furthermore, best practices of biological imaging with respect to high-resolution observation and quantification are developed in collaboration with partners in WP6.

Data flows: Information about location of data will be collected. Data managers will be contacted to facilitate cross referencing and data exchange whenever possible. For instance, databases such as the Hereon's COSYNA database, AWI's O2A and Pangea will be included. Data will be shared with Deltares to allow model validation and 'smart interpolation' in time and space. Imaging data will be transferred to EcoTaxa (contribution to WP11) and OBIS via new developed API (WP6 effort)

Data QC routines: Data (e.g., from SOOPs) that are reported in near real time are usually QC'd automatically and need to undergo the process of delayed QC before they can be assigned finalized data quality flags. Carbonate system parameters in particular require rigorous and delayed mode QA/QC. Existing processes for QA/QC will be analysed and to the extent possible harmonized.

Data management issues: N/A, but QA/QC procedures will be investigated and alignment between institutions will be initiated, data archiving options explored.

Expected results: Improved understanding of carbon budgets including the sea to air flux of GHG CH4 & CO2, support for identification of gaps

Users of results: Scientists within the carbon community, scientists and stakeholders within the NSEA PSS, and other regions within JERICO-S3.

Dissemination of results: Results will be disseminated to the scientific community, and to relevant stakeholders through reports within JERICO-S3, scientific publications, and workshops and international meetings.

Links: WP2 (connection to other RIs, tasks 2.3 and 2.4), WP3 (IRS), WP5 (Harmonization), WP6 (task 6.3.3). DANUBIUS-RI, ICOS ERIC. More intensified information flow to other PSSs.

NSEA and CHANNEL PSS #2 Riverine input to the North Sea

Objectives: This task aims to compile data of river water runoff and composition from different ongoing measurements. The purpose of this analysis will be the creation of temporally and spatially explicit information about carbon and nutrient transport from land to the North Sea and the Channel that can be used as input values and/or boundary conditions for carbon and nutrient budgets. Collaboration with other RIs (especially DANUBIUS-RI) is central for this task.

Action Lead and other Partners (with contact persons): Hereon (Brix, Voynova, Kaiser), AWI (Fischer), DELTARES (Blauw), NIVA (King, Frigstad), IFREMER (Devreker)

JS3 Platforms included: FerryBox Land Station Cuxhaven (Hereon), Simon Stevin (VLIZ)

Other data sources and external partners for implementation: many state/country governments provide access to data from monitoring stations, e.g. France (https://sextant.ifremer.fr/ and http://hydro.eaufrance.fr/), Germany (http://undine.bafg.de/index.html), Netherlands (https://waterinfo.rws.nl/#!/nav/index/), Denmark (https://arealinformation.miljoeportal.dk/html5/index.html?viewer=distribution), and Norway (Vannmiljø (miljodirektoratet.no)). European River Loads Database curated by NIOZ (van Leeuwen)

Compiled databases/repositories are kept by e.g., NIOZ (Texel, Netherlands) and IfM (Hamburg, Germany)

Overall timetable of action: Jan 2021-Nov 2022.

Description of action: This task aims to compile data of river water runoff and composition from different ongoing measurements. Due to their heterogeneity in spatio-temporal resolution, in the number and type of recorded parameters and metadata, and in the ease of access, harmonization of metadata and data quality control is needed. This task will therefore compile available information, enabling tracking, for example, the effects of land use change and extreme events, as well as corresponding changes in estuarine and coastal biogeochemistry and their bottom-up consequences including changes in eutrophication status and phytoplankton production and biodiversity. Concentrated information of riverine inputs will also aid the improvement of descriptors of (coastal) ecosystem status. This work will make use of the collaboration efforts with DANUBIUS-RI and will also facilitate cooperation with the NW-MED PSS. This task will contribute to the identification of observational gaps in data availability and measurement efforts.

Best practices used or developed: Investigation of state-of-the-art BP with regard to metadata.

Data flows: Data sources will be compiled in a document and made available to all interested parties. The project will work towards a shared database, the structure of which is yet to be determined with guidance from WP6 and DANUBIUS-RI.

The document of data sources should be a list of freely available data from flow and chemistry measurement stations and should be separated into sources that are (a) automatically downloadable (via scripts), (b) manually downloadable from data provider, (c) requestable as data files from responsible program or station personnel.

Define protocols for regular data retrieval from these sources.

Provide digital infrastructure to (save and) distribute the data.

Data QC routines: Implement new methods for gap filling developed in JERICO (https://mawenzi.univ-littoral.fr/).

Data management issues: Protocols for regular data retrieval from different (types of) sources and digital infrastructures to (save and) distribute the data need to be defined

Expected results: easy to use inventory and access possibilities to harmonized river water discharge and composition data for the North Sea PSSs; common statement with regional DANUBIUS-RI sites/representatives on data exchange and standards.

Users of results: scientific community, other RIs (incl. DANUBIUS-RI), potentially government agencies / management

Dissemination of results: website (hosting either at Hereon or through JERICO), communication / report of results to DANUBIUS-RI

Links. Links to other PSS (especially CHANNEL PSS, joint studies, shared best practices, merging data for pan - European products)

Link to other WP2 regarding cooperation with DANUBIUS-RI

Link with regional DANUBIUS-RI sites

CHANNEL PSS #3 Harmonised observations of plankton biomass, diversity and productivity dynamics

Objectives: The English Channel and the southern North Sea are characterised by diverse ecosystems of strong hydrodynamical influence on biogeochemical and biological processes (as primary productivity) and plankton accumulation and dispersion, low to high riverine inputs, and significant connectivity to adjacent sea areas. These two marginal seas are considered as areas of medium to high productivity and recurring phytoplankton blooms (some of them being considered as Harmful Algal Blooms-HABs of potential impact on marine food webs as well as human health and economy). We aim to harmonise our in situ observation, and data processing to better characterise and understand the drivers of phytoplankton outbursts and community occurrence and changes at the different scales and consequently implement the ecosystem approach monitoring.

Action Lead and other Partners (with contact persons): CNRS-LOG (Artigas, Lizon), IFREMER (Lefebvre, Wacquet), CEFAS (Creach, Greenwood), Deltares (Blauw), VLIZ (Debusschere, Mortelmans), CNRS-BOREA (Claquin), RBINS (Fettweis), Hereon (Voynova)

JS3 Platforms included: Thalassa (IFREMER), Côtes de la Manche (CNRS), Sepia II (CNRS), Antéa (IRD), RV Cefas Endeavour (CEFAS), Connector (NIVA/RWS), Simon Stevin (VLIZ); Buoys: ASTAN (CNRS), SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP and WEST GABBARD (CEFAS), Thornton (VLIZ); Benthic lander MOW1 (RBINS); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: monitoring by R/V.

Other data sources and external partners for implementation: The collection of phytoplankton biomass, diversity and productivity data is also carried out outside the framework of automated platforms, with measurements constituting time series along environmental gradients in the eastern Channel. These data are available in national data infrastructures as well physical, chemical and biogeochemical data. ICES databases, CMEMS products and EMODnet (biology, physics and chemistry) data infrastructures will be used if needed.

Overall timetable of action: Jan 2021 – Nov 2022.

Description of action: The practical work will include:

- Workshops (virtual and non-virtual) for:

1. discussing the way to implement QA/QC methods at sensor/platform level (spring 2021 and 2022), and to facilitate the data flow to the institutional, national (e.g. ODATIS, MEDIN) or European data infrastructures (SeaDataNet and EMODnet). The discussion will focus mainly on automated flow cytometry, imagery and multispectral fluorometry (link WP5 and WP6) (CNRS-LOG and all).
2. testing new data processing tools and approaches (link to WP7) between partners for improving the data flow and forecasting phytoplankton diversity and outbreaks (IFREMER and all)
3. sharing experience for measuring in situ primary production and investigating the use of the data in ecosystem approach monitoring (CNRS-LOG + CNRS-BOREA and all).

- Determine the added value of the data from emerging technologies in regular assessment for WFD and MSFD (Eutrophication, Biodiversity, Food Web) in combination with other approaches such as modelling and remote sensing (2022, CEFAS and all) (Link to actions # 4 and #8).

- Participating in common surveys (besides the regular ones) in 2021 and 2022 as a proof of concept for sharing best practices using guidelines from WP5 for emerging technologies (Flow cytometry, imagery and multi-spectrofluorometry) (VLIZ and all).

Best practices used or developed: We will test, develop and apply our best practices according to dedicated work on WP5.

Data flows: Data will be shared preferably from existing portals, so other partners can download and process the data with automated scripts that can be easily updated in the future. Where this is not feasible, the data files can be shared with other ad-hoc approaches, such as mails or cloud servers. Data flows will follow recommendations from WP6 (particularly subtasks 6.3.1 and 6.3.2 for phytoplankton data).

Data QC routines: Each institute is responsible for the QC on its own data. The data from emerging technology will follow the discussed and defined QC processes from WP5 (raw data treatment) and WP6 (processed data). Phytoplankton analysis will follow the OSPAR JAMP phytoplankton monitoring guidelines.

Data management issues: To be discussed in the frame of WP6.

Expected results: A realistic frame of what augmented approaches can be persistently implemented in both the NS and the EC, consolidating national observatories and RIs (as ILICO in France) and establishing lasting regional collaboration in common recurrently joint actions benefiting of the existing platforms and programmes, adding innovative approaches developed during JERICO- NEXT and other previous projects.

Users of results: OSPAR/MSFD working groups for eutrophication, biodiversity, food web and ocean acidification, marine researchers, national and European water managers and the scientific community.

Dissemination of results: actions will take place from January 2021 to November 2022 and the results will be presented in workshops, symposia and will be published; participation to ICES working groups (WGPME, WGHAB).

Links: Link to adjacent PSS (Baltic) and IRS (Bay of Biscay), and other remote PSS and IRS (i.e., with more contrasted conditions and trophic regimes: Iberian Margin (combined upwelling conditions), NW Mediterranean (meso oligotrophic), Northern Adriatic Sea (important blooms) Cretan Sea (oligotrophic) through workshop on harmonisation of best practices and data management (WP10). Links with WP5 (best practices in biological plankton sensors), WP6 (data management), WP7 (development/improving of software tools for automated data treatment and analysis), WP8 & WP11 (TA and VA), WP1 & WP2 (overall strategy and link with environmental management and policies).

CHANNEL PSS #4 Products for Eutrophication Status Assessment

Objectives: High resolution (in time and/or in space) monitoring programmes from the Channel-PSS combines different types of biological observations across the region and will be used for demonstrating new shared products to support/complement eutrophication assessments as defined by EU Directives and Regional Sea Convention. These products should help to provide a final classification when there is some doubt about pressure/impact relationship for a given assessed eutrophication area.

Action Lead and other Partners (with contact persons): IFREMER (Lefebvre, Devreker), DELTARES (Blauw), CEFAS (Collingridge, Creach), CNRS (Artigas), VLIZ (Debusschere, Mortelmans)

JS3 Platforms included:FerryBox: Thalassa (IFREMER); RV Cefas Endeavour (Cefas); Buoys: SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP TH1 and WEST GABBARD (CEFAS), Thornton (VLIZ); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: low resolution monitoring by R/V.

Other data sources and external partners for implementation: SIMM/ODATIS data portal (coastal and offshore MSFD specific data) for data within Fr Marine Regions, ICES Database, VLIZ Database. External partners: OFB, Fr, (Vincent), French Water Agencies.

Overall timetable of action: Jan 2021- Nov 2022.

Description of action: The action will communicate with MSFD Descriptor 5, OSPAR Eutrophication and WFD, aggregation and integration methods. It will contribute to data integration (*in situ*, satellite, modelling). The Action will provide a comparison of assessment results between EU Directives and Regional Sea Convention and between countries (transboundary issue). It will interact with policy makers and stakeholders towards better assessment and management plan definition working groups. It will contribute to the development of new metrics, thresholds and reference values.

Best practices used or developed: Work based on existing assessment methodologies (such as the MSFD Good Environmental Status assessment, the OSPAR Common Procedure) and ongoing development under specific national and EU research projects.

Data flows: MSFD data flow.

Data QC routines: QC from MSFD-supporting monitoring programmes.

Data management issues: MSFD data management (from national to regional level).

Expected results: Contribution to the optimisation and implementation of existing eutrophication assessment procedures with emphasis on procedure harmonization, data sharing and integration, shared transnational assessment results providing good basis for management plan issues.

Users of results: MSFD/OSPAR/WFD and scientific communities, stakeholders, Society at large.

Dissemination of results: MSFD/OSPAR/WFD specific reports; Accessibility to Fr reports via Archimer; contribution to MSFD/OSPAR/WFD Working Groups.

Links: Links to Bay of Biscay, GoF PSSs (shared products => contribution to a pan - European approach as needed for Directives and Regional Sea Convention implementation).

Links to EC PSS Actions #2 Riverine input to the North Sea and the English Channel, #3 Harmonized observations of plankton biomass, diversity and productivity dynamics,

#5 Intercomparison of phytoplankton distribution using data integration, #6 Identification of Observational Gaps, #8 Support to EU directives and ecosystem management.

Contacts with other initiatives (InterReg S3 EuroHAB, CPER IDEAL, EU MSFD NEA PANACEA, PPR Riomar) and RIs (IR ILICO, EMBRC).

NSEA and CHANNEL PSS #5 Intercomparison of phytoplankton distribution using data integration

Objectives: Create and integrate representation of phytoplankton combining different data sources: *in-situ* observations from various platforms and sensors, satellite data and model data. This activity involves a range of drivers of phytoplankton dynamics, including hydrodynamic transport, river loads (through models), underwater light climate and associated turbidity, and suspended particulate matter (SPM) dynamics. It aims at quantifying the impacts of phytoplankton dynamics in terms of eutrophication and carbon fluxes. This action will also evaluate the potential of merging multi-source knowledge to estimate the spatial and temporal variability of phytoplankton and SPM concentration in response to intense/extreme events and long-term trends.

Action Lead and other Partners (with contact persons): DELTARES (Blauw, Van Kessel), IFREMER (Lefebvre, Verney), CNRS (Artigas), CEFAS (Collingridge, Greenwood), VLIZ (Debusschere), Hereon (Voynova) RBINS (Fettweis).

JS3 Platforms included: FerryBox: Lysbris (Hereon), Magnolia Seaways (Hereon), FunnyGirl (Hereon), Thalassa (IFREMER), Côtes de la Manche (CNRS), Sepîa II (CNRS), Antéa (IRD), Norrona (NIVA), Connector (NIVA/RWS), Simon Stevin (VLIZ); Buoys: ASTAN (CNRS), SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP TH1 and WEST GABBARD (CEFAS), Thornton (VLIZ); Benthic lander MOW1 (RBINS); Cabled observatory COSYNA Helgoland (AWI, Hereon); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: monitoring by R/V

Other data sources and external partners for implementation: Available satellite data on chlorophyll-*a*, suspended particulate matter, primary productivity and sea surface temperature could provide useful additional data with good spatial and temporal coverage.

Overall timetable of action: Jan 2021-Nov 2022.

Description of action: Despite the presence of observational platforms in both the Channel and North Sea, observational infrastructures are operated by regional and national entities and have been hardly connected so far. Usually the field data are obtained from different locations and times and cannot be directly compared. Satellite and model data are available for the whole area (both Channel and North Sea) for long periods. For this action the models of DELTARES and IFREMER (ECOMARS-3D) will be used as 'smart interpolation' tools of observation data. These will provide coherent baselines in space and time to cross-validate the different available data sources and gain a better understanding of the drivers of spatial and temporal variability of phytoplankton and carbon fluxes and underlying nutrient and SPM concentration fields. Therefore, we will first start with creating the overview of available in situ and remote sensing observation data and making (part of) these data available for model validation. Processing of existing data files into coherent datasets that have comparable variable definitions with model variables will be done as far as feasible. Some data files may require too much work to be processed in this context or lack knowledge on how to convert them.

The Action will investigate how the aggregation of coastal observatory databases, satellite ocean colour databases and model results can resolve the spatio-temporal variability of phytoplankton, carbon and SPM dynamics. This question will be examined from regional to inter-regional and PSS spatial scales and will look for innovative methods to decipher the contribution of « expected seasonal dynamics », unexpected, rare or extreme events and long-term trends.

This action will not involve additional monitoring activities. However, the results of the comparison will provide information on the comparability of data from different platforms

and equipment. This supports the planning of the next steps towards more coherent monitoring, which will possibly involve the sharing of platforms and equipment.

Best practices used or developed: N/A as no specific sampling planned.

Data flows: Partners collecting *in situ* marine data will share these data with other partners working on the comparison with satellite and model data.

Data QC routines: Each institute is responsible for the QC on its own data. When sharing the data with other partners involved, the metadata on applied QC procedures will be shared as well.

Data management issues: Data will be shared preferably from existing portals, so other partners can download and process the data with automated scripts that can be easily updated in the future. Where this is not feasible, the data files can be shared with other ad-hoc approaches, such as mails or cloud servers.

Expected results: The comparison of the various sources of *in-situ* data with coherent satellite and model data is expected to provide information on: 1) the comparability and quality of the sensor-based *in-situ* data and 2) the reliability of the satellite and model data and 3) possible next steps to reduce differences between information from different data sources.

Users of results: An integrated representation of eutrophication indicators (nutrients, chlorophyll-a) and biodiversity indicators (primary production and phytoplankton species composition) would enable more complete and coherent ecosystem assessments for OSPAR and MSFD. Furthermore, JERICO partners and OSPAR member states can improve their monitoring and QC strategies based on our experiences with combining data from different monitoring methods.

Dissemination of results: Results will be presented in relevant meetings of the project, conferences and OSPAR/MSFD meetings.

Links: This action will contribute to Action #6 (Identification of Observational Gaps) by identifying gaps in data availability and measurement efforts and is linked to tasks 2.3 (satellite data), 2.4 (linking across different scales and regions; coupling of observations and modelling communities) and task 2.5 (linking to political realm).

Action links to ICOS,by using ICOS data, downloaded from SOCAT as validation data. Action#5 also link with OSPAR groups dealing with eutrophication and related subjects (modelling, Earth Observation, Riverine Inputs) making the connection with this action's needs as well as with other actions (#2, #4, #7, #8).

NSEA and CHANNEL PSS #6 Identification of Observational Gaps

Objectives: Based on a census of existing monitoring programmes (low and high resolution strategies, incl. ecosystemic/scientific cruises, fixed stations, buoys and FerryBox/SOP, observational gaps will be analysed in both regions, especially related to biological and biogeochemical (including carbon cycle) variables (link to EOV, EBV concept). Analysing needs for institutional interactions will aim to improve regional integration of observations in forthcoming Supersites.

Action Lead and other Partners (with contact persons): Hereon (Brix, Möller, Voynova), IFREMER (Lefebvre, Verney), CEFAS (Creach, Greenwood), Deltares (Blauw, van Kessel, Gwee), RBINS (Vanderzande, Fettweis), VLIZ (Debusschere), CNRS (Artigas, Lizon, Claquin), AWI (Fischer), NIVA (King), IMR (Wehde).

JS3 Platforms included: not relevant for this action.

Other data sources and external partners for implementation: Definition of data will be completed in the first half of 2022.

Overall timetable of action: Jan 2021-Nov 2022.

Description of action: As gap analyses have so far only been done in a very local and not coordinated approach (if at all), a shared gap analysis will be undertaken taking the entire NSEA and CHANNEL PSS regions into consideration. In particular, the national partners will create an inventory of existing measurements of biological, biogeochemical and carbon cycle quantities, including riverine input data. Efforts will be made to begin investigating these inventories and recommendations will be formulated on how to fill the gaps.

Best practices used or developed: not relevant for this action.

Data flows: Topic will not collect new observation data but provide means for improved observation and data collection.

Data QC routines: not relevant for this action.

Data management issues: not relevant for this action.

Expected results: Overview of observational gaps in the EC and NSEA PSS, recommendations on how to address these gaps.

Users of results: scientific community, stakeholders, policy makers, RIs.

Dissemination of results: specific reports, oral communications and posters during working groups and colloquia/symposium during the course of the project.

Links: Links to other PSS (joint studies, shared best practices, merging data for pan - European products, shared use of tools for identification of gaps).

WP1 (feed into scientific concept), WP2 (connection to other RIs), WP3 (IRS), WP9 (design).

Links outside JS3: Links with scientific projects: CPER MARCO (Fr), CPER ROEC (Fr), CPER ObsOcean (Fr), InterReg S3 EUROHAB (Fr, UK), CPER Vallée de la Seine Phresque2 (Fr), GIP Seine Aval (Fr), ANR CO2COAST (Fr).

Links with EU Directives and Regional Sea Conventions working groups (focus on monitoring program's needs).

NSEA and CHANNEL PSS #7 Cross-regional communication between PSSs (North Sea and Channel)

Objectives: The aims of a cross-regional communication in the PSS are to highlight in situ technology innovation and implementation, investigate the possibility of transfer to each region of the PSSs (North Sea and Channel) as well as the platforms, and investigate how to share approach/tools and knowledge from experience between partners to be applied at the regional scales for scientific and societal purposes.

Action Lead and other Partners (with contact persons): CEFAS (Creach), Hereon (Brix), IFREMER (Lefebvre), Deltares (Blauw), RWS (Enserink), VLIZ (Debusschere), NIVA (Frigstad).

Other data sources and external partners for implementation: not relevant for this action

Overall timetable of action: Jan 2021 - Nov 2022.

Description of action: communication will consist in:

- informing partners on status for actions #1, #2, #3 and #4 by the action leaders and possibility of closer collaboration with partners interested in the actions during webinars (workshops not being possible) to facilitate exchanges between the partners of the two sites in the PSS.
- Involve partners from the Channel and SE North Sea together for the specific actions below
- action #1 & 2 (Riverine input to the North Sea): IFREMER (Lefebvre, Devreker), VLIZ (Debusschere), CEFAS (Greenwood, Graves).
- Involve all partners and particularly agencies and organisations in charge of national water quality, biodiversity and food webs monitoring in action #8 (Support to EU directives and ecosystem management.): CEFAS (Graves).
- identify the users and their needs in the PSS area in collaboration with the subtask 9.2.
- common surveys on research vessels and ships of opportunity.

Best practices used or developed: not relevant for this action.

Data flows: not relevant for this action.

Data QC routines: not relevant for the action.

Data management issues: not relevant for the action.

Expected results: Definition of an optimised organisation in connecting between PSSs and with the users from other PSSs and RIs and JERICO-RI in general when developing PSS concept further.

Users of results: not relevant for the action

Dissemination of results: this action will use the communication channel of JERICO-S3 (WP10) for highlighting the main achievements in the PSS. Annual workshops during the GA of J-S3 and virtual workshops will be established.

Links: link to WP1, WP2, WP9.

NSEA and CHANNEL PSS #8 Support to EU directives and ecosystem management

Objectives: Strongly interface with WP2, task 2.5., this action will contribute to identifying new tools and products developed or optimised within the EC PSS to address WFD/MSFD/OSPAR water quality assessment needs. EC PSS tools and products will be used as proof of concept (from the sensors to the data, from the data to the indicators then, from the indicators to the environmental status assessment). Action #8 results should contribute to EU Directives and Regional Sea Convention monitoring programmes definition and implementation and, to coastal ecosystem assessment and management improvement (IFREMER, Hereon, Deltares, RWS).

Action Lead and other Partners (with contact persons): RWS (Enserink), IFREMER (Lefebvre, Devreker), CNRS-LOG (Artigas), VLIZ (Debusschere), Hereon (Brix), DELTARES (Blauw).

JS3 Platforms included: Not relevant for this task, as this is a networking activity.

Other data sources and external partners for implementation: networking activity including participation to MSFD, OSPAR, NOOS working groups => new partners and collaborations to be identified during the course of the project.

Overall timetable of action: Jan 2021- Nov 2022.

Description of action: The EC-PSS is part of the OSPAR Region II (Greater North Sea). One of OSPAR's tasks is to develop Quality Status Reports (QSR) in a 6-year cycle. These reports form the joint basis for OSPAR contracting parties that are also EU member states for their MSFD reporting. Eutrophication (MSFD Descriptor 5), Biodiversity - Pelagic habitats (Descriptor 1) and Food webs (Descriptor 4) are the main themes that link with the actions in this PSS.

For the next QSR 2023 an attempt will be made to involve tools that are currently used for the assessment of eutrophication (i.e., Satellite, buoys and ferry box observations, hydrodynamic modelling) in the assessments of eutrophication and biodiversity, notably pelagic habitats. This is also supported by a newly started EU project (NEA PANACEA). Some contributors to action #8 are also involved in this project and can thereby make a good link with the EC PSS.

Any new tools and products developed in the EC PSS may not be in time to contribute to the QSR 2023 but can be useful for the next cycle of assessments. Iterations with the relevant OSPAR groups will improve the suitability of the tools for the work of OSPAR. This will be done through the meetings of the relevant OSPAR groups, where members of this action's team are regular participants.

Best practices used or developed: networking activity.

Data flows: Topic will not collect new observation data but provide means for improved observation and data collection

Data QC routines: not relevant for the action.

Data management issues: not relevant for the action.

Expected results: Integration and implementation of new tools and products from the EC PSS (and NS PSS, through active collaboration via action #7) into EU Directives and Regional Sea convention assessment procedures.

Users of results: MSFD, OSPAR, JRC, EEA, NOOS, government authorities, stakeholders, policy makers.

Dissemination of results: Participation to and interaction with MSFD, OSPAR Regional Sea Convention and North West European Shelf Operational Oceanographic

System (NOOS) Working Groups according to their own schedules (Example: OSPAR Intersessional Group on Eutrophication in January each year) ; specific networking activities via Virtual Meetings ; specific contributions such as Meeting Document or communications during MSFD/OSPAR/NOOS meetings to highlight main results and share experiences.

Links: Links to WP2, Task 2.5 (Interfacing with monitoring programmes, non-European OOS and the political realm).

Link to products and services prototyped in WPs 3, 4 & 9.

Links to WP4 Bay of Biscay, GoF PSS (shared products => contribution to a pan - European approach as needed for Directives and Regional Sea Convention implementation).

External partners/networks identified are MSFD, OSPAR, NOOS working groups and relevant projects, notably NEA PANACEA.

NSEA and CHANNEL PSS #9 Interaction with other RIs on ecosystem studies, eutrophication, coastal management and carbon fluxes

Objectives: PSSs will interface with other RIs (DANUBIUS-RI, EMBRC-ERIC, ICOS ERIC, LifeWatch-ERIC) by cooperating on key competences of PSSs and RIs on coastal ecosystem studies and data related to carbon cycling and eutrophication (nutrients particularly) which will advance the interaction with DANUBIUS-RI in resolving land-sea carbon and nutrients fluxes and to facilitate forthcoming collaborations. Particularly, the creation of a network of scientists is sought to be constructed that will allow for better coordination of shared research interests.

Action Lead and other Partners (with contact persons): Hereon (Brix), VLIZ (Deneudt), IFREMER (Lefebvre).

JS3 Platforms included: Not relevant for this task, as this is a networking activity.

Other data sources and external partners for implementation: All RIs as listed in WP2, task 2.2, are identified where present and established contacts will be used to connect to these partners and establish mutual data access.

Overall timetable of action: Jan 2021-Nov 2022

Description of action: The Action will connect to other RIs within the PSS region to discuss data and information sharing, coordinate campaigns, identify overlap and gaps in measurement programs. Action will develop a roster of activities and people and develop shared sampling strategies. In addition, the Action will investigate data and technology sharing opportunities, compare approaches to data processing, storage and dissemination, use of FAIR principles and develop strategy to facilitate access to data, merge where possible. Action will share knowledge about existing dissemination and outreach efforts. The above will be actualized where added value can be found and existing connections can be exploited.

Best practices used or developed: Build on existing connections to inquire about best practices used and work toward.

Data flows: N/A

Data QC routines: N/A

Data management issues: N/A

Expected results: list of cooperation possibilities and facility overlap / synergies.

Users of results: scientists, public administrations, etc.

Dissemination of results: Report of Actions; Dissemination to other RI through, for example, activities in TNAs, reports at regional meetings; also as part of WP2 activities and deliverables.

Links. Links to other RIs (DANUBIUS-PP, EMBRC-ERIC, ICOS-ERIC, LifeWatch-ERIC) and all J-S3 PSS and IRS sites (mainly during J-S3 GAs).

Links to other WPs in JS3 (e.g. citizen science, D2PTS ...).

5.4. Implementation strategies: Cretan Sea Pilot Supersite

JERICO-S3 Subtask 4.3.4. Pilot Supersite at Cretan Sea; CRETAN PSS (Lead HCMR, partners CNRS, NIVA, SYKE)

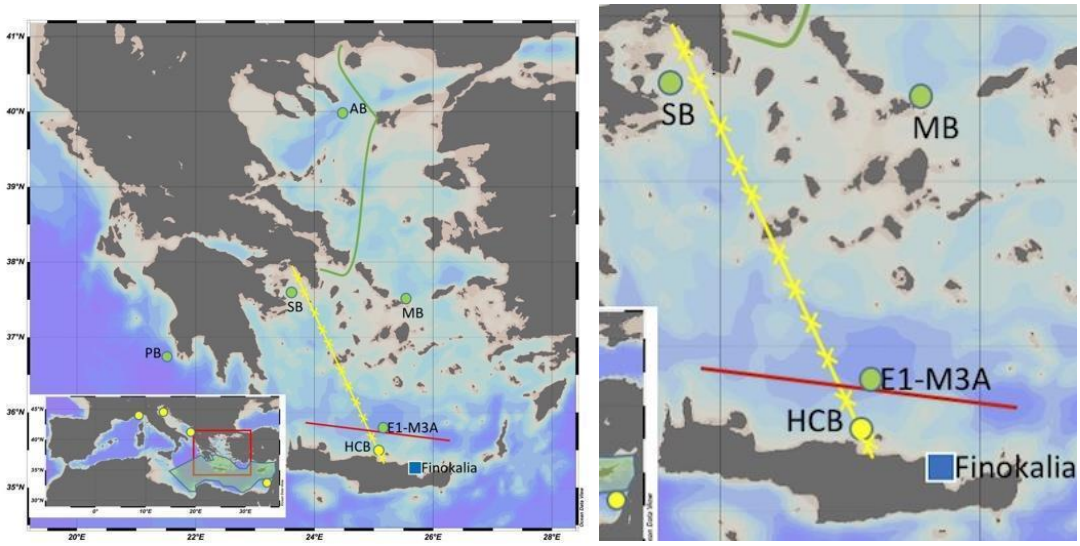


Figure 5.4. Map showing the location of the POSEIDON system platforms at CRETAN PSS (AB: Athos Buoy, MB: Mykonos Buoy, PB: Pylos Buoy, SB: Saronikos Buoy, E1-M3A Buoy), glider endurance line (red line) and Ferrybox routes (yellow and green line).

Table 5.4. Platforms in CRETAN PSS

Operational observation systems & platforms in the region	Operational status	Parameters
Ferrybox PFB	Interrupted due to upgrade. Planned to be back on in late spring 2022	T, S, Fluo, O2 +CO2 planned +sampler planned
Fixed platform HCB,	Operational	meteo; SSS, SST; pH (sensorlab) air+water CO2 (ProOceanus)
Fixed platform E1-M3A	Operational	meteo; SSS, SST; T, S, Chl-a, O2 at 20, 50, 75, 100 m; T, S at 250, 400, 600, 1000 m
Fixed platform -MB	Operational	meteo; SSS, SST;

Glider PG	Operational	T,S, O2 every 1m down to 1000m Seasonal transects
Argo floats	OK (if available in the area)	T, S (O2)
Calibration Lab	Operational	T, S, O2, pH, Fluorescence
Monitoring by R/V	Operational	Monthly visits at HCB Biannually visits at E1-M3A -CTD cast (T, S, O2, Fluo, Turbidity, PAR, Phycoerythrin) -Niskin 2,10,20,50,75,100,120m (pH, CT&AT, inorganic nutrients, Chla, bacteria to phytoplankton) -zooplankton net

CRETAN PSS #1 Solubility and biological pumps

Objectives: Study air-sea CO_2 fluxes and pH using several tools/approaches to understand their variability and main drivers in an area where there is a sparseness of carbonate system data, pH trends are unknown and the existing AT-S relationships are inadequate. The action targets an optimum strategy in the area to understand its role as source or sink of CO_2 as well as the links between carbon, nutrients cycles and primary productivity.

Action Lead and other Partners (with contact persons): HCMR (Frangoulis), NIVA (King, Marty)

JS3 Platforms included: a) For carbonate variables: Core platforms: HCB, Ferrybox or R/V (In case the Ferrybox cannot provide data during 2022, some transects with an R/V on part of the track of the Ferrybox will be made to collect carbonate data as demo of the capacity of the Ferrybox.), Additional platforms: monitoring by R/V at HCB, Calibration lab (for pH analysis), lab for CT/AT analysis. b) For carbonate associated/interpretation variables. Core platforms: HCB, E1-M3A, Glider, Mykonos buoy or Saronikos Buoy. Additional platforms: Argo float data (when available in the area), satellite data

Other data sources and external partners for implementation: Other data includes, a) simulated sea surface pH, pCO_2 and PP from HCMR 3-D coupled model, b) nearby atmospheric station Finokalia (air pCO2) and nearest ICOS marine stations ~~and~~ c) estimates of carbonate system variables from temperature and salinity using existing or improved (see action #5) regional algorithms, d) satellite derived pCO2 from CMEMS etc and e) analysis or reanalysis carbonate products from satellite data from CMEMS etc

Overall timetable of action:

Jan 2021 to Nov 2022: Carbonate system data collection from HCB (fixed platform + RV visits).

Jan 2022: Submission of CO_2 data to SOCAT

June 2022 to Nov 2022: Carbonate system data collection activities expanded to Ferrybox.

June 2022 to Nov 2022: estimates of carbonate system variables from optimum algorithms

Description of action:

Key PPS features: capacity to provide additional EOVs at required resolution. Multi-interface coverage. Collaboration elements: i) transfer of knowledge from other partners, ii) connecting with other regional initiatives measuring carbon parameters and iii) linking observations with modelling

Measurement of carbonate variables using the complementarity of a fixed platform (HCB, with regular RV visits) and FB (In case the FB cannot provide data at all during 2022, some transects with an R/V on the part of the track of the FB will be made to collect carbonate data as demo of the capacity of the FB.). In addition, measurement of associate variables in all platforms, to allow interpretation of carbonate system variability and to test (improve) empirical algorithms providing estimates of carbonate variables (input of Action #5).

Best practices used or developed: Follow up WP6 activities related to carbonate system data management such as workshops (MS34), workshops planned for early 2022, from which contribution could be given to D6.8 delivered in 2023 from T6.3.3. Exchange of practices with/from JERICO-S3 partners, ICOS, colleagues working in the

Mediterranean Sea. A carbonate theme workshop carbonate is planned summer 2022 with participation of all PSSs and invitation of WP6.

Data flows: (i) Carbonate system associated variables (T, S, meteo, O_2, Chl-a) handled, by CMEMS In Situ Thematic Assembly Center (INS TAC), (ii) CO2 system variables are sent to SOCAT), (iii) Additional databases (GLODAP, SDG 14.3.1 data portal) are considered for non CO2 carbonate variables. Some submissions cannot be in 2022 (GLODAP will be January 2023).

Data QC routines: QC procedures for carbonate system associated variables collected from POSEIDON platforms comply with the CMEMS INS TAC. Carbonate variables QC defined during the first year, will be used to create regional routines. Improved QC for NRT pH will be developed. Strategy for CO2 data delivery in NRT will be defined (but probably not applied) in 2022.

Data management issues: None expected ~~at this stage~~

Expected results: Carbonate system data available via related databases (e.g. SOCAT). Improved understanding of the CO_2 solubility and biological pump functioning; creation of reference carbonate system database in the Eastern Med. New collaborative schemes for sustained carbonate system observations. Results on optimum sampling strategy (maximum number of variables, best platforms, data minimum frequency) (common with action #5).

Users of results: Scientists, ERICs (ICOS), Databases (SOCAT), educators, students, media, Regional Sea Conventions, Ministries, local authorities, UN Sustainable Development goals.

Dissemination of results: Beginning 2022, progress disseminated via tweets and JERICO-S3, POSEIDON websites. First results shown in D4.3. After the first year of data collection communication of the annual cycle results in meetings, related initiatives (e.g ICOS ERIC, SOLAS, SOCAT, EuroGOOS ~~coastal group~~) and conferences. A post and a paper resulting from ICOS 2021 OTC pCO2 inter-comparison workshop are planned, with participation of partners from other PSSs.

Links: to carbonate system actions in other PSS; to ICOS ERIC, SOCAT, MonGOOS, ACTRIS and/or SOLAS (via action #6 and T2.2), contribution from/to Guidelines for carbonate system data management (T6.3.3), VA of carbonate system data (WP11). Consideration of contact with EuroGOOS working groups (coastal, biology, FerryBox) jointly with other PSSs. Actions taken to strengthen links with WP6 (see data management section above). A carbonate theme workshop is planned summer 2022 with participation of all PSSs and invitation of IRS and all interested WPs.

CRETAN PSS #2 Improved approximations of Primary Production

Objectives: Improve primary productivity estimates in oligotrophic waters where a large part of primary production is held most time of the year at depths that are not at satellite reach. Reliable measurements of PP are critical for understanding the carbon cycle and ecosystem function. Estimates will be done by optimising the quality of current datasets feeding model PP predictions and by going through innovative observation systems.

Action Lead and other Partners (with contact persons): CNRS-MIO (Thyssen), HCMR (Frangoulis, Stamataki, Tsiaras), NIVA (King, Marty), SYKE (Seppälä, Ylöstalo)

JS3 Platforms included: Core platforms: E1-M3A and HCB fixed platforms, glider. Additional platforms: RV visits at HCB and E1-M3A. Bio-Argos could contribute if providing O2 and Chla data. Ferrybox, if available, could provide Chla, O2. If not enough glider data collected in 2022, glider data from a previous data rich period will be used.

Other data sources and external partners for implementation: Simulated Primary Production (PP) from HCMR 3-D coupled model (POM-ERSEM-HALTAFALL), supported/validated by in situ data from platforms (T, Chla, O_2, nutrients, plankton). Other model (CMEMS) reanalysis products and satellite images will be used also. Additional variables to be considered: those that could explain the spatiotemporal variability and/or that constrain the model PP: e.g. light attenuation (from CTD casts).

Overall timetable of action:

Jan 2021 to November 2022: In situ data collection for model improvement

Feb 2022 to November2022: Upgrading model with data collected

Description of action:

Key PSS features. Collaboration elements: i) transfer of knowledge from other partners, ii) linking observations with modelling, iii) linking with industry on PP sensing devices

Upgraded model PP predictions tuned and validated against the collected data from several platforms: E1-M3A fixed platform (T, Chla, O_2 at 20, 50, 75, 100 m); HCB fixed platform (SST; pH, pCO2); glider (T, S, O_2 every 1m down to 1000m), RV visits at HCB (T, S, O2, Chla, light attenuation), ~~and~~ E1M3A (nutrients, plankton from subsurface until 120m) and available Bio-Argos (O2, Chla). Focus will be given to improve quality of Chl-a data (better QA of fluorescence sensors- see Action #5). Links between in situ variables and remote sensing products will also be examined. Eventually also PP estimation data from sensors applied in situ (depending on outcome of Actions #3 and #5). Ferrybox Chla and O2, if available, will be used to check consistency with model sea-surface spatial output. A comparison with other (than that of HCMR) model reanalysis products and satellite PP products is planned (from CMEMS).

Best practices used or developed: Follow activities (workshops, MS, DL) of WP6 occurring in 2022 and in particular those of T6.3.2 related to data management, best practices of biological sensor of phytoplankton communities: workshop on best practices for data management for biological sensors and their reports (MS33) as well as D6.5 Data Management Best practices report for biological optical sensors. Practices for measuring PP at ultraoligotrophic areas are compared/developed and several will be tested during the mesocosm experiment in 2022, linking #2, #3 and #5. In particular, the novel PP sensors LabSTAF and AutoSTAF (Chelsea Technologies Ltd) are tested for the first time in the region.

Data flows: in situ data handled by CMEMS INS TAC

Data QC routines: QC procedures comply with CMEMS INS TAC.

Data management issues: None expected at this stage

Expected results: improved understanding of primary production, prospecting deep layers (Deep Chlorophyll maximum) and of the implications to C export and trophic status. Evaluation of innovative sensors for trial and validation under oligotrophic conditions (joint activity of Actions #2, #3 and #5).

Users of results: Scientists (biologists, modelers), educators, students, EU directives (MSFD).

Dissemination of results: During the first year, progress disseminated via tweets and JERICO-S3, POSEIDON websites (common with in action #1). First model upgrade will be shown during a JS3 (preferably) event in autumn 2022. Dissemination to modelling community workshops/conferences.

Links: Link to T2.4 for the coupling of observations and modelling communities. In particular discussion with the modellers on how to better include phytoplankton data in PP models will be conducted. Direct links with WP5 and WP6 for data management and best practices for optical sensors. The use and testing of the elaborated best practices will be implemented especially after feedback from mesocosm experiment (action #3), and new technology tests (action #5) in particular with Chelsea technologies new PP sensors.

CRETAN PSS #3 Extreme events affecting phytoplankton - AQUACOSM collaboration III

Objectives: The Action identifies the extreme events in the CRETAN PSS area. It studies the improved ways to analyse effects of extreme events on phytoplankton communities with existing systems, via multiple sensors, multiple platforms and mesocosms. In parallel, improved calibration practices for sensors used in oligotrophic conditions are examined. A joint mesocosm experiment is planned with AQUACOSM-plus, aiming to provide support in the continuous monitoring of phytoplankton responses in mesocosms. The Action improves regional synergies between experimental and observational marine communities studying the same ecological questions

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Ylöstalo), HCMR (Frangoulis, Stamataki), CNRS-MIO (Thyssen), NIVA (King, Marty)

JS3 Platforms included: Poseidon Calibration Lab (PCL). Non JERICO-S3 platforms: HCMR mesocosm, HCMR underwater biotechnological park (UBPC). Other platforms like fixed platforms and FerryBox will be examined if they can provide evidence on extreme events effects on phytoplankton communities. Data from the above platforms from previous years (before 2021) will be also explored in case a more evident extreme event with effect on phytoplankton communities can be found.

Other data sources and external partners for implementation: Meteo, atmospheric data from nearby meteo and atmospheric stations (e.g. Finokalia). Satellite reanalysis products and model output may be used also to explore extreme event effects.

Overall timetable of action:

Jan 2021 to Nov 2022: Collection of field data

Jan 2022 to Nov 2022: Analysis of field data to identify relationships to extreme events.

May 2022: Optimal sensors used in a mesocosm experiment with participation of HCMR, CNRS-MIO, SYKE, NIVA, and other partners from AQUACOSM-plus

Description of action: Key PPS features: Collaboration element between RIs JERICO-S3 - AQUACOSM-plus to address common themes, establish long-term cooperation with co-design actions and priorities setting.

Based on the outcome of various tests of sensors (see Action #5), a set of phytoplankton (and eventually carbonate) JERICO-S3 tested sensors will be used during a mesocosm experiment simulating an extreme event concerning the effect of episodic introduction of airborne microbes into the marine ecosystem. Planning of this activity will be made jointly with other PSSs having similar activities (GoF PSS, NW-MED PSS) and Task 2.2.

In parallel, analyse field data to spot relationships with various extreme events. Communicate outcome of analysis (parameters to monitor) to AQUACOSM-plus.

Based on the outcome of mesocosm tests, some new sensors and/or a different configuration of sensors may be tested afterwards in the field (see Action #5).

Best practices used or developed: exchange of procedures, practices, methodologies with AQUACOSM-plus.

Data flows: in situ data handled by CMEMS INS TAC. Mesocosm data flow following principles set by AQUACOSM-plus.

Data QC routines: QC procedures comply with CMEMS INS TAC. Mesocosm data QC follow principles set by AQUACOSM-plus

Data management issues: Joint data management with AQUACOSM-plus during mesocosm experiments

Expected results: improved calibration of sensors, improved monitoring of mesocosms, feasibility and comparability of methods under oligotrophic conditions

Users of results: Scientists (biologists and modellers), industry

Dissemination of results: During the mesocosm experiment presentations between AQUACOSM-plus and JERICO-S3 participants. In addition, dissemination in AQUACOSM-plus meetings, jointly with GoF PSS and NW-MED PSS. Via tweets and JERICO-S3, AQUACOSM-plus websites.

Links: Strong between PSS-link and link to AQUACOSM-RI community are evident. Additional link to between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged. Between PSS-link to be enhanced by a) participation of SYKE to CS PSS mesocosm experiment and b) HCMR to GoF PSS mesocosm experiment c) mesocosm studies from CS and NW-MED compared for integrated study at the Mediterranean scale.

CRETAN PSS #4 Upscale of Regional Data to a wider area

Objectives: The action aims to more realistically simulate air-sea CO_2 fluxes using a 3D hydrodynamic/BGC/Carbonate ecosystem model (LTL, based on ERSEM). The model will be validated with CRETAN PSS in situ and satellite data via the enhancement of corresponding data acquisition (Action #1) to identify potential biases and necessary modifications (CT/AT initial fields and land-sea inputs, air-sea CO_2 flux parameterisation etc). The final 3D model version will be used to evaluate the representativity ("footprint") of the Cretan Sea solubility pump (air-sea exchanges and carbonate system) in the wider Eastern Mediterranean Sea, to promote the upscaling value of the Regional Data from CRETAN PSS.

Action Lead and other Partners (with contact persons): HCMR (Tsiaras, Stamataki), NIVA (King, Marty)

JS3 Platforms included: Core platforms: HCB fixed platform, E1-M3A fixed platform, Ferrybox or RV, glider; Additional platforms: RV visits at HCB, RV visits at HCB & E1-M3A, Argo floats (see Action #1)

Other data sources: Satellite (SST, Chl-a from CMEMS or other sources). Satellite derived pCO2 from CMEMS etc and analysis or reanalysis carbonate products from satellite data from CMEMS etc.

Overall timetable of action: Feb 2022 to Nov 2022: Upgrading model with data collected (during Jan 2021- Nov 2022 from Action #1)

Description of action: Key PSS features: Delivery of products with added value (upscaling). Collaboration element: linking with modelling and satellite community.

The Action includes: Data collection for model validation (input from Action #1). Comparison of simulations of Cretan Sea with wider eastern Mediterranean Sea. Update of the existing 3D physical-BGC-CO_2 model (POM-ERSEM-HALTAFALL) to more realistically simulate air-sea CO_2 exchanges, based on input from in-situ measurements of atmospheric and seawater *p*CO2, pH. The simulated pH, pCO_2 will be also compared with derived data from algorithms based on satellite (SST, SSS, Chla) and in situ carbonate system-associated variables (links with actions i, ii).

Following Henson et al. (2016) methodology, the 3D model simulated CO_2 will be analysed to identify the Cretan Sea (HCB station) footprint in the wider Eastern Mediterranean.

Best practices used or developed: NA

Data flows: Field data (see Action #1). Model data in POSEIDON database

Data QC routines: NA

Data management issues: None expected

Expected results: improved understanding of air-sea CO_2 fluxes, observing effort and observing gaps

Users of results: Scientists (chemists, modelers), ERICs (ICOS ERIC, EURO-ARGO ERIC), Databases (SOCAT, GLODAP, SDG 14.3.1 data portal)

Dissemination of results: First upgraded model results will be shown during a JERICO-S3 (preferably) event in autumn 2022. ~~shown in D4.3.~~ Dissemination to HCMR modelling team which will further disseminate them via modelling community workshops/conferences.

Links: enhanced cooperation with COPERNICUS via improved use of satellite products (T2.3), contribution to linking between scales by upscaling to a wider area (T2.4). Links to SOCAT, ICOS, ACTRIS and/or SOLAS and eventually EURO-ARGO.

CRETAN PSS #5 New sampling strategies, new technologies, best practices

Objectives: Design new sampling strategies, evaluate novel technologies, improve estimation algorithms, and revisit best practices to promote the biological measurements in low-biomass areas. Increase linking with industry and other technology-related projects. Plan with other RI common benefit sampling strategies.

Action Lead and other Partners (with contact persons): HCMR (Frangoulis), CNRS-MIO (Thyssen), NIVA (King), SYKE (Seppälä, Ylöstalo)

JS3 Platforms included: Core platforms: PCL, Ferrybox (If FB is not operational on ship of opportunity, any sensor to be tested on FB will be tested with FB operated in lab), HCB. Additional non JERICO-S3 platforms: UBPC, mesocosms

Other data sources and external partners for implementation: NA

Overall timetable of action:

Jan 2021 to June 2022: Lab tests, tests in mesocosms

Jan 2022 to Nov 2022: Field tests on Ferrybox, UBPC and HCB

Jan 2022 to Nov 2022: Validation of carbonated system regional algorithms (see action #1)

Description of action:

Key PSS features. Benefiting from PSS multiplatform, multisensor approach and experience to test new sampling strategies, technologies, practices. Capacity to support EBVs provision. Capacity to adopt new technology. Collaboration elements: linking with industry, transfer knowledge between PSSs, linking with other technology related projects, linking with other RIs.

The action will screen new technologies of phytoplankton automated observation and PP estimation (considering the review of recent sensor developments task 7.3) with potential application in oligotrophic waters. It evaluates and identifies optimum optical sensors (including optimum combinations) for phytoplankton sensing under low phytoplankton biomass. It aims to test selected phytoplankton and carbonate system related sensors under oligotrophic conditions. These will include phytoplankton abundances and biomass at high frequency and assessment of PP estimates from automated sensors. Outcome will contribute to Actions #2, #3.

In addition, the Action helps in adopting the optimum sampling/deployment strategies for carbonate system, i.e. which variables are need at the least and at what frequency to get description of the system. New regional carbonate algorithms are developed and compared to existing ones (outcome to Action #1, link to WP1).

Best practices used or developed: As in the Actions #1, #2, #3. Action will consider procedures and best practices from T5.3

Data flows: As in the Actions #1, #2, #3

Data QC routines: New QC tests evaluated, e.g. a multi-platform approach QC (neighbour test)

Improved QA practices for sensors

Data management issues: As in the Actions #1, #2, #3

Expected results: Based on the tests done in the Action, one can define best sensors for in situ tests on FerryBox and HCB (outputs to action #2). Action allows improving regional algorithms for estimates of carbonate system variables, using carbonate system

data (output to Action #1). Action provides feasibility and comparability of methods and best practices in oligotrophic conditions (Eastern Mediterranean).

Users of results: scientists (from Mediterranean and other oligotrophic seas), sensor manufacturers

Dissemination of results: Test results will feed the Actions #1 and #2. A publication (white paper) of most successful practices for oligotrophic waters will be considered (e.g. at Ocean Best practices). Dissemination to participants of AQUACOSM-plus Cretan Sea mesocosm experiment and afterwards to AQUACOSM-plus.

Links: action considers the review of recent sensor developments and provides needs of multisensor package (task 7.3) and receives/provides procedures and best practices (T5.3). The Action aims to use TA to improve linkages with industry and to link with other technology related projects to screen all related new technology (e.g. NAUTILOS, MINKE, GROOM II). Action will contribute to tests of new practices for sensor validation using mesocosms linking to the AQUACOSM-plus (see action #3).

CRETAN PSS #6 Partnership building

Objectives: The Action works at three combined and multiple levels of partnerships:

(i) Collaboration schemes between **PSSs and IRSs**, transfer of knowledge, supply of supporting hardware and human resources, in order to tackle regional and common research questions (feed to WP1, WP3, WP9).

(ii) Alliance with other environmental **RIs,** to enable joint studies and get access/provide supporting data, new technologies. Mapping of environmental RIs in the region (strategy, responsible, etc.) and demonstration of cases of partnership/collaboration

(iii) Promote the added value of integrated coastal observations to **regional initiatives** by providing demonstration of PSS activities. Added value of integrated observations and new products resulting from a PSS approach disseminated to regional initiatives, specifying opportunities, challenges and future needs.

[combination of original topics vi, vii and viii in DoA]

Action Lead and other Partners (with contact persons): HCMR (Petihakis, Frangoulis), CNRS-MIO (Thyssen), NIVA (King), SYKE (Seppälä)

JS3 Platforms included: see Actions #1 to #5

Other data sources and external partners for implementation: Actions #1 to #4

Overall timetable of action:

Jan 2021- March 2022: Contacts for planning strategy of common interest activities (link T2.2). Identification of links, planning of training and collaboration activities

Jan 2022 –Nov 2022: First year dataset distributed, refinement of collaboration strategy, demo of collaborations, promotion activities

Description of action:

Key PSS feature. Collaboration elements: building effective partnerships, linking with regional initiatives, other RIs, other PSSs and IRSs

1) Establish a list of contact points with regional initiatives, other RIs (collaboration with WP2) and other PSSs.

2) Demonstrate a collaboration mechanism that could become common to all PSSs allowing to: spot and tackle common questions, tackle a specific problem in one PSS using knowledge from other PSSs, as well as common dissemination and other products.

A common question of Cretan Sea PSS, with GoF PSS and NW-MED PSSs: "how phytoplankton communities are influenced by extreme coastal events". To tackle this question knowledge, hardware and human resources will be mobilized (CNRS-MIO: phytoplankton, NIVA: carbonate chemistry, SYKE: optics) during field and mesocosm studies (see the Actions #1, #2, #3).

3) Exchange of experience/knowledge for joint promotion plan to regional initiatives of Cretan Sea and NW-MED PSSs activities (action #6 NW-MED PSS)

4) Identify all RIs within the Cretan Sea PSS and explore common ground for collaboration.

Examples of collaboration demonstration cases that will be explored are given below:

- AQUACOSM-plus: access to mesocosm for calibration of sensors //provision of mesocosm monitoring via sensing (see action #3)

- ICOS-ERIC: access to supporting data (CO_2 data in the region), training activities, guidelines best practices / provision of data of carbonate system carbonate in an area with sparseness (see action #1)

- EMBRC-ERIC: access to new technologies providing additional EBV data / provision of samples and access to related physicochemical data

- LifeWatch-ERIC: access to additional EBV data*/* provision of related physicochemical data (e.g. pH)

- EURO-ARGO ERIC: access to supporting data*/* provision of reference data (see actions #1, #2)

- potential collaboration with ACTRIS and/or SOLAS

Contacts with initiatives (e.g. MONGOOS, UNEP-MAP) are established (input from WP2).

Best practices used or developed: develop partnership practices with other PSSs, RIs and regional initiative with: shared vision, common understanding and joint approach to tackle KSC, well defined specificities/differences, performance indicators, joint communication strategy, shared measurement/data systems. Examples of contexts/frameworks/products that could set basis of partnership practices could be described in D.4.4.

Data flows: facilitate data flows between RIs

Data QC routines: exchange of QC procedures between RIs

Data management issues: link of data provided from different RIs and collected at the same infrastructure

Expected results: feasibility and comparability of methods, improved sensor calibration, additional EBVs

Users of results: Scientists, Regional initiatives, Governments, media, environmental managers (e.g. MPA managers), environmental NGOs

Dissemination of results: to meetings/workshops of regional RIs AQUACOSM-plus, ICOS ERIC, EMSO-ERIC, EMBRC-ERIC, LifeWatch-ERIC, EURO-ARGO ERIC, EuroGOOS working groups. Joint promotion plan to regional initiatives (e.g. MONGOOS, UNEPMAP) of Cretan Sea and NW-MED PSS, as well as Northern Adriatic Sea IRS, activities (via WP2). Dissemination of results to regional initiatives with focus on new variables, new products and strategy alignment.

Links: Collaboration ground with several ERICs will be explored together with T2.2 (AQUACOSM-plus, ICOS ERIC, EMBRC-ERIC, LifeWatch-ERIC, EURO-ARGO-ERIC). Demonstration of PSS activities to Regional initiatives with establishment of contact points (MONGOOS, UNEP-MAP). Linking to EuroGOOS working groups and specific promotion of CS PSS activities to EuroGOOS groups (coastal, biology, FerryBox).

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