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JERICO-S3 DELIVERABLE

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

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1. EXECUTIVE SUMMARY

This deliverable D4.2 assesses and refines D4.1 JERICO-S3 Pilot Supersite monitoring strategies after one year of implementation. The final version of D4.1 describing the PSSs implementation plan was released in May 2021, but the draft version was available already at the start of 2021 and the actual implementation of PSS actions started in January 2021. Thus, D4.2 assesses and refines one year of implementation, i.e. all activities happening in 2021. Practically all of 30 PSS actions have been started, although parts of some actions (e.g. modelling, dissemination, partnership building) will peak in 2022.

2. OVERALL DEVELOPMENTS AND ANALYSIS OF FIRST YEAR OF IMPLEMENTATION

2.1. Overall developments within JERICO-S3 Pilot Supersites during the first year of implementation

Implementation of JERICO-S3 Pilot Supersites (PSSs) started in January 2021, following the implementation plan provided by D4.1 *JERICO-S3 Pilot Supersite monitoring strategies*. The actual progress report of implementation will be provided by D4.3. *Progress report on PSS implementation*, giving detailed insight on the development of 30 different PSS Actions. The purpose of the current deliverable D4.2 is to provide analyses of PSSs implementation and consider if the original plan needs to be adjusted, to meet the objectives set for PSSs.

Based on the experience gained in 2021, all PSSs will be better able to define their organisational and observational challenges. A main organisational challenge was that some PSS platforms were fully or partly inactive in 2021. Covid-19 added operational complexity. All this provided lessons to PSSs on maintenance procedures under societal restriction as well as on the importance of sharing and exploring additional platforms and data sources. Another common challenge among PSSs is the low level of funding for implementation, allowing only demonstration studies. The experience gained during the first year showed that this may be balanced by new funding opportunities coming in the future via the dissemination of results and the increased partnership building.

To tackle various scientific challenges the multiplatform in situ approach coupled with modelling and satellite data, was expressed as an important benefit for all PSSs. However, it increased the challenge of merging and harmonising observations, to meet all demands of coastal ecosystem BGC data. A shared PSS view facilitated the transfer of knowledge through partnerships between different competencies and specialisations.

Some Actions were given more emphasis in certain PSS than others. NSea/EC and CS PSSs gave focus on carbonate system and phytoplankton observations in 2021, NW Med PSS to adopt a coastal multi-platform approach that feeds 3D model of current transport and GoF PSS focused more on phytoplankton observations. NSea/EC PSS focused on eutrophication assessment status as well as processing complex multivariate/multisource/multiscale data sets with machine learning. CS PSS explored new methods to improve primary production estimates in oligotrophic areas.

Several, mainly virtual, meetings were used in 2021 to communicate and coordinate activities at several levels: six WP4 leads meetings, four PSS leads meeting, three to four meetings by each PSS and one WP4 all partners meeting (with participation of other WP leads and interested JericoS3 partners). In addition, during ARW #2 JERICO-week, WP4 was represented in various sessions (e.g. modelling), and during a JERICO-DS GA workshop all PSSs presented their objectives and experiences from multiplatform observations. Some more specific workshops were also organised: by GoF PSS an harmonisation workshop for sensors and calibration practices (with participants also outside JERICO community) and by NSea/EC PSS a workshop on data mining for integrated observations systems. Finally, the overall concept of JERICO Pilot Supersites was presented in various national, regional and global meetings.

All PSSs started or improved their partnership building via connections with other communities and users, and disseminated their activities through the JERICO-S3 web page and social media. Existing or new interaction with other ERIC, EU projects and industry was used by all PSSs allowing planning of common benefit activities as for example early adoption of data QC procedures, and availability of data in portals. Of particular benefit are the joint actions with AQUACOSM-RI. In NW-MED PSS, a mesocosm experiment was conducted in 2021 to study responses of phytoplankton communities to extreme events, while similar experiments are planned in 2022 in the Cretan Sea and GoF PSSs. In 2022 all PSSs will give emphasis to dissemination activities, partnerships and relations with other RIs and user communities. This will also be the case for transfer of knowledge between PSSs and towards other WPs.

2.2. Summary of overall developments and analysis for 2021 per PSS

GoF PSS: Summary of overall developments and analysis for 2021

The overall scientific aims of GoF PSS were related to understanding how external human pressures affect the state of the sea, how to improve knowledge on key processes and how to advance the observations to meet these goals. Several GoF PSS Actions already improved the harmonisation of the observations among partners for various target variables (e.g. phytoplankton, oxygen, carbonate system). Partnership was created to include different competencies and specialisations and subsequently the transfer of knowledge within partnership has been a particularly desirable activity. Transnational harmonisation and sharing datasets are seen as beneficial to all parties and strengthening the joint knowledge base.

The Actions including components of ocean colour and modelling are demonstrating the added value of making harmonised and consistent observations and merging multiplatform measurements. Given the short timeframe of Pilot Supersite studies, the adjustments in sampling strategies (e.g. changing location or timing of observations, adding variables) may not take place immediately, but we already foresee advances of integration and further joint multiplatform studies are planned. Overall, the multiplatform approach has been seen as important for various scientific challenges (like carbonate system) and products (like algae reviews).

GoF PSS has also specific organisational challenges as objectives, for example, to study joint management of platforms and data, how to share and manage platforms jointly, and connecting to user communities. Though partners already have a long history of

collaborations, PSS brings up the needs for better streamlining of their individual data value chains and provides a longer time perspective and motivation for joint developments. As well, PSS brings a better sense of togetherness and promotes sharing at various levels.

PSS status has also provided a feeling of better credibility and authority within the region. As regional key marine institutes join their forces, they will provide regional (and beyond) leadership in their activities, like in quality of data, products and services, and such a consortium is listened to better than an individual actor.

The key challenges in GoF PSS operations during 2021 were very practical ones. Several of the PSS platforms were fully or partly inactive during 2021, due to covid-19. FerryBox systems onboard Silja Serenade and Silja Europa had discontinuities in operation as Ferry lines had to stop passenger traffic. Profiling buoys at Utö and Keri had interruptions in operation due to maintenance issues and recovery of Utö buoy for maintenance was fully prevented as no external persons were allowed at Coast Guard vessel used for lifting the buoy. But as unfortunate the situation with covid is, there is also a bright side: we have learned how some observations can be maintained even during periods of societal restrictions, and how important is the sharing especially during such periods. As well, need to note, the relatively low level of funding for PSS implementation just allows some demonstrations studies, picking low hanging fruits, but not to open new avenues for transnational multiplatform studies. But based on the experience of the first year of GoF PSS, the new study plans roll over and new funding opportunities are being sought.

GoF PSS links to various other RIs and several user communities. If nothing else, this is the development point for 2022. We need to better disseminate our activities, starting from our own institutes and countries, and include the key regional actors. The overall transfer of knowledge between other PSSs and towards other J-S3 WPs need to be improved as well.

NW Med PSS: Summary of overall developments and analysis for 2021

The NW Mediterranean Sea PSS aims to observe and understand the impacts of climate change and anthropogenic pressure on the coastal marine ecosystem, which are already visible due to the dynamics of the North Current and the influence of riverine inputs. The NW Mediterranean Sea system has already adopted a multi-platform and multi-disciplinary approach through two permanent observing systems (SOCIB, ILICO) and a few regional networks oriented to science and society needs.

In 2021, the PSS focused on adopting this approach in the coastal system and its strong interactions with ERICs (EMSO, EURO-ARGO, EMBRC). Through advanced operational networks, in situ observations were used to feed models to reconstruct the 3D northern current transport from the Ligurian Sea to the Balearic Channel.

The integration of BGC data into observation systems is essential in coastal waters if the main challenges (acidification, CO_2 fluxes at the air-sea interface, nutrient and organic matter inputs from rivers...) are to be addressed. To this end, and because spatial and temporal dynamics are complex to understand and model in coastal waters, the PSS strives to combine both the multi-platform in situ approach, coupled modelling and neural network to provide quality BGC data. During this period and despite COVID restrictions, the PSS has been able to maintain the provision of physical and BGC data through the deployment of marine robots (Argo floats, gliders) throughout the region.

The PSS also benefits from the strong involvement of its observing systems in ERICs and many European projects towards operational oceanography and marine science, which allowed the early adoption of data quality control procedures and the availability of data in the GDAC and EU portals.

The main remaining challenges of the PSS are the implementation of algorithms for satellite observations in coastal areas (e.g., ocean colour, turbidity), better cooperation with the DANUBIUS network, and the long-term sustainability of BGC measurements throughout the PSS region.

NSEA/EC PSS: Summary of overall developments and analysis for 2021

The overall scientific aims of the English Channel and the North Sea PSSs were respectively related to refine the regional carbon budget including terrestrial inputs, coastal carbon cycling, and biological carbon fluxes as well as, to assess regional eutrophication status, phytoplankton biodiversity and productivity, and their modulations. Jointly, this twin PSS is identifying gaps in observations and interactions that hamper regional studies of carbon cycle and eutrophication. These objectives rely on nine actions related to the following main themes: carbon cycling and regional carbon budget, phytoplankton dynamics and biodiversity, as well as eutrophication processes. Whereas some actions aim to improve the harmonisation of the observations among partners for various target variables, others are to identify observational gaps and enhance cross-regional communication as well as interaction with other RIs. Beyond organisational challenges, products resulting from these actions such as optimised monitoring strategy, best practises and numerical tools will help to support EU Directives and ecosystem management needs (e.g., MSFD and OSPAR environmental assessment).

In 2021, the NSea PSS focused on carbonate system observations thus allowing for high-resolution carbon flux estimates and quantifying recent changes in carbonate chemistry. A large part of the available pCO_2 measurements from FerryBox observations produced by Hereon has now been post-calibrated, quality controlled and published

As a support to eutrophication assessment status in the EC and NSea areas, we experiment with different approaches for the calculation of daily river loads to better quantify nutrients pressures from riverine inputs. Moreover, based on available and optimised monitoring programmes and data streams, some partners were able to contribute within OSPAR to the development of the new eutrophication assessment common procedure (COMP). This COMP should also be the main pillar for offshore waters assessment within the EU MSFD Descriptor 5 on eutrophication.

Throughout the year 2021, the long-term monitoring of hydrology, phytoplankton and zooplankton (low and high resolution in time and/or in space) has continued even though Covid-19 issues added to operational complexity. Analytical procedures and best practises based on imagery and multispectral fluorescence were further improved and were tested in situ during cruises and during deployment on instrumented station (MAREL Carnot) as well as cabled observatories.

Data from several EC and NSea PSSs actions were secured and made available to be used in models (e.g., DELTARES, ECOMARS3D) and in environmental quality assessments. Models have been used in an ensemble modelling exercise in the context of OSPAR working group for ecological modelling. Data pre-processing and processing numerical tools based

on Machine Learning were also developed or improved for unsupervised clustering or supervised classification of complex multivariate/multisource/multiscale datasets. Contrasted environmental states highlighted with such ML-based tools will help to optimally define the environmental statuses and to put together a learning base via a deep approach. Supervised learning will lead to the development of a model which will be the basis for an expert forecasting, warning and decision-making system.

In 2022, partnership and relations with other RIs and additional research establishments in our focus areas should be improved to include additional competencies and specialisations and subsequently the transfer of knowledge within partnerships. This will help to reach the ultimate goal of providing an integrated observation system dealing with physics, biogeochemistry and biology focusing on a specific geographic area with the primary scope to generate knowledge via optimised monitoring strategies and data synthesis and thereby addressing scientific, societal and economic challenges. Recognition of the benefit of such an integrated system as well as outreach activities should pave the way for new collaborations and opportunities that could allow proposing new projects and new funding opportunities.

CS PSS: Summary of overall developments and analysis for 2021

The Cretan Sea (CS) PSS scientific aims are to study air-sea CO_2 fluxes and pH trends to understand their variability and main regional drivers. The PSS looks also to ways to improve primary productivity estimates in oligotrophic waters as well as to improved ways to analyse effects of extreme events on phytoplankton communities.

To achieve these goals the CS PSS uses several tools such as multiplatform observations, mesocosms, modelling, designs new and optimum sampling strategies, evaluates novel technologies, tests/improves estimation algorithms, and revisits best practices. It also uses partnerships at multiple levels: within PSS, with other PSSs, with other environmental RIs, with regional initiatives, as well as with industry and technology-related projects.

In 2021 the scientific objectives were met for the carbonate system by setting up the: acquisition of data, best practices, QA, QC, and submission to database (SOCAT). In addition, new methods for primary production estimates were tested successfully and logistic plans were made for a mesocosm experiment in 2022 to analyse effects of extreme events on phytoplankton communities using a large set of sensors. In these 2021 activities the benefits of a PSS were the support by partners participating also in other PSSs (CNRS-MIO: phytoplankton, NIVA: carbonate chemistry, SYKE: optics), the enhanced collaboration with other RIs (ICOS, AQUACOSM+, EMBRC). Finally, a TA action with an industry partner was beneficial to the CS PSS as well as to other PSS.

The organisational challenges that the Cretan Sea PSS faces in general are the continuity in operation of infrastructures (mainly related to maintenance of national funding), the strengthening of trans-institutional collaboration, the establishment of platforms with endurance in neighbouring countries and the expansion of spatio-temporal coverage.

On the other hand, the observational challenges are the design of new sampling strategies, the evaluation of novel technologies and establishing best practices to promote the carbonate and biological measurements in this oligotrophic, low-biomass area, where concurrent technologies fail.

In 2021 the challenges encountered were mostly observational, related to non or poor operation of platforms. One buoy was lost at sea, the FerryBox line reactivation was postponed several times and the glider transects were fewer than planned. Covid-19 issues added complexity in operation and increased delays.

Some refinements and adjustments are proposed below in each PSS action to overcome the above setbacks, and to generally improve the achievement of the goals set. The refinements are mostly related to an expansion to additional data sources such as satellite data, model reanalysis products and improved estimations via algorithms that could complete the picture of observational data collected. The low level of funding (especially national funding) remains an important challenge giving uncertainty for continuation beyond the PSS implementation period. However, the PSS outreach activities, the new products (e.g. CO_2, pH data delivery) created additional contacts and opportunities that could allow in the future to open new funding opportunities. Links via contacts with RIs have been established, and in several cases joint actions have been initiated (AQUACOSM+, ICOS, EMBRC, industry). There is a need to strengthen and expand these linking activities in 2022. This also is the case for PSS outreach that has been initiated in 2021, however the larger outreach part is expected in 2022.

3. REFINEMENTS OF MONITORING STRATEGY

3.1 Overall refinements requested by PSS as whole

In 2021 there has been good progress in all PSSs, so the initial objectives for all actions will remain broadly the same. Still, actions targeting communication had difficulties to progress and some delays were experienced on platform operation, both partly due to covid restrictions. These will be covered in 2022, or alternative plans will be given, so that the objectives are attained. Modelling related actions will be mostly active in 2022 in most PSSs as planned, although some (NW Med PSS) have already well progressed. A merging of two partnership building actions (#5 and #6) was requested by NW Med PSSs with all objectives kept as initially. Partners within each PSS remain the same. External partners for implementation are to be further developed and refined in some actions (NSea/EC #6).

The experience gained using several platforms in 2021, stressed even more the added value of the multiplatform approach. Some of the initial JS3 platforms had limited or no observations in 2021 (often due to covid). Delays were experienced with Ferryboxes operation (CS, GoF, NSea/EC), as well as decreases in glider operation (NW Med, CS). However overall, there is no need to modify the list of platforms. The majority of them are expected to be functional in 2022, otherwise data flow will be compensated by another platform. Emphasis on data collection will be given to some platforms, while others will be used as complementation of primary datasets. In specific cases data from previous years may be used to complement if data gap is important in 2022.

Among data sources other than JS3 platforms, additional ones will be explored that were not originally considered (e.g. additional satellite sources in CS, additional river load database in NSea/EC, transnational river input database in NW Med, automated nutrient analysis in GoF PSS). As refinement in the type of data provided, partners were asked to provide the list the EOV and EBV variables as well as MSFD descriptor covered by the PSSs and related tables 1 and 2 gathering the info is provided. Partners were also asked if they also use citizen science as a source. Citizen science is used in limited actions (NSea/EC #3, GoF#4).

Table 1. List of Essential Biodiversity Variables covered by PSSs during their implementation (only EBVs covered by PSSs are shown)

	EBV	GoF PSS Actions	NW-MED PSS Actions	NSEA & CHANNEL PSS Actions	Cretan PSS Actions
Species populations	Species distributions	4		3	
	Species abundances	4, 8	3	3	
Species traits	Morphology			3	
	Phenology			3	
	Movement	3, 4		3	
Community composition	Community abundance	3, 4, 8	3	3	3, 6
	Taxonomic/phylogenetic diversity	3, 4, 8	3	3	3, 6
	Trait diversity	3, 4, 8	3	3	3
	Interaction diversity			3	
Ecosystem functioning	Primary productivity	8	3	3, 5, 8	2, 3, 5
	Ecosystem phenology	3, 4	3	3, 4, 5, 8	
	Ecosystem disturbances	3, 4, 8		3, 4, 5	3
	Ecosystem Vertical Profile			5	

Table 2. List of Essential Ocean Variables covered by PSSs during their implementation (only EOVs covered by PSSs are shown) (Real time (RT) or delayed mode (DM))

	EOV	**GoF PSS Actions**	**NW-MED PSS Actions**	**NSEA & CHANNEL PSS Actions**	**Cretan PSS Actions**
Physics	Sea surface temperature	1,6 (RT) 2,8,9(DM)	1 (RT&DM)	3,4,5 (RT&DM)	1,2 (RT)
	Subsurface temperature	2,5 (DM)	1 (RT&DM)	3,4,5 (RT&DM)	1,2 (RT)
	Surface currents		1 (RT&DM)		
	Subsurface currents		1 (RT&DM)		
	Sea surface salinity	1,6 (RT) 2,9 (DM)	1 (RT&DM)	3,4,5 (RT&DM) 8	1,2 (RT)
	Subsurface salinity	2,5 (DM)	1 (RT&DM)	3,4,5 (RT&DM)	1,2 (RT)
Biochemistry	Oxygen	1,2,5,9 (DM)	4 (DM)	3,4,5 (RT&DM) 8	2 (RT)
	Nutrients	1,2,8 (DM)	4 (DM)	2,3,4,5(RT&DM) 8	1 (DM), 3 (DM)
	Inorganic carbon	1,6 (RT&DM)	4 (DM)	5 (DM)	1,4 (RT&DM)
	Particulate matter	3,8 (RT&DM)	4 (DM)	3,4,5 (RT&DM)	3 (DM)
	Dissolved organic carbon	1,3,8(RT&DM)			3 (DM)
Biology and Ecosystems	Phytoplankton biomass and diversity	1,3,4(RT&DM) 9 (DM)	1(DM), 4(DM)	3,4,5 (RT&DM), 8	2 (RT) 3,5 (DM)
	Zooplankton biomass and diversity	8 (DM)	4 (DM)	8	
	Microbe biomass and diversity (*emerging)	8 (DM)			3 (DM)
Cross-disciplinary	Ocean colour	3,4 (RT&DM)	4 (DM)	3,4,5 (RT&DM) 8	
	Ocean sound				

Table 3 List of Marine Strategy Framework directives covered by PSSs during their implementation (only MSFD descriptors covered by PSSs are shown)

MSFD descriptor	GoF PSS Actions	NW-MED PSS Actions	NSEA & CHANNEL PSS Actions	Cretan PSS Actions
Descriptor 1. Biodiversity is maintained	8		3,4,8	3
Descriptor 2. Non-indigenous species do not adversely alter the ecosystem			3,4	
Descriptor 4. Elements of food webs ensure long-term abundance and reproduction			8	2
Descriptor 5. Eutrophication is minimised	1, 2, 3, 4, 5, 8, 9	2, 4	2,3,4,5,8	2,3
Descriptor 7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem			5	
Descriptor 11. Introduction of energy (including underwater noise) does not adversely affect the ecosystem			5	

In general, there was no request to modify the description of the various actions besides describing Transnational Access projects that have contributed or are expected to contribute in 2022 to the objectives of actions. An extension of the end of implementation period from August to November 2022 is requested, to compensate for the delay in starting PSS and in order to collect more data, to allow more detailed analysis of data, to expand interactions with other communities and to have more disseminations opportunities.

Data practices, flows, QC and management have shown overall good progress, with some data flows improved earlier than expected (NW Med). Several practices are already established (many common with other RIs), while for others the focus to improve them will be given in 2022, based on 2021 experiences. New data flows and new best practices are to be added including new methods for gap filling and data analysis tools. For some variables, practises are to be improved (e.g. QA and QC of T and S for carbonate system observations) especially in harmonization (e.g. river databases) and calibration (e.g. for ocean colour related sensors). On the other hand, the importance of actual exchange in written best practises documents, SOPs and QC scripts has been stressed (e.g. for oxygen observations).

Several dissemination activities occurred in 2021 but dissemination will essentially be in 2022. Concerning foreseen results, their users and ways of dissemination, some PSSs will propose additional ones (GoF, CS) or give precisions, otherwise they will remain as originally planned. Planning of participation in specific workshops, conferences, meetings is now better known and will be used as refinement. The exact method and/or possibility of sharing of results through JERICO e-infrastructure is still to be established.

The original PSS linking ways remain valid for all actions. For some actions additional links came up in 2021 to industry, other RIs, CMEMS, other data portals, EO community and to recently initiated projects. These new links to other communities and to other JS3 WPs (together with some overlooked in D4.1) are now presented in tables 4 and 5 as an update of tables 13, 12 of D4.1. As refinement also, stronger collaborations will be depicted.

An emphasis to links via communication activities will be an important refinement. In fact, several PSSs partners mentioned the need to compensate for the reduction, due to covid, of physical meetings, especially to strengthen partnership outside the JERICO-S3 consortium and the communication between PSSs and with WPs. Common surveys were cancelled or restricted to minimum (e.g. NSea #7), a FerryBox co-trip in 2021 was not realised due to covid restrictions (GoF) and workshops had to be rescheduled, or merged (NSea/EC), or moved to the end of the PSS period (e.g. GoF workshop for pan-European harmonisation of observations) to facilitate participation of other PSSs and WPs.

It is worth mentioning that the large majority of connections to other RIs and projects are informal, as collaboration between colleagues and often based on the fact that PSSs institutes belong to the partnership of those RIs. In some cases, the participation of JS3 community in activities of other RIs (AQUACOSM+ experiments, ICOS calibration workshop) and TA allowed creation of connections with new people. In addition, so far the interactions with RIs have been bilateral while multilateral exchanges may be beneficial and are foreseen for 2022. PSSs partners will propose as refinement additional ways to increase and strengthen links such as: a) sharing experiences of other projects with JS3 Partners, b) more interaction with other PSS by more intensified information flow and workshops with common topics across all PSSs and c) ways to ensuring the co-operative use of data common to several RIs to address various large-scale environmental problems including climate change and eutrophication.

Table 4 (update from D4.1 table 12). Synthesis of links between PSSs implementation actions and JERICO-S3 WPs

	GoF PSS Actions	**NW-MED PSS Actions**	**NSEA & CHANNEL PSS Actions**	**Cretan PSS Actions**
WP1	All	All	All	All
WP2	2, 3, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5,6	1, 2, 3, 5, 6, 7, 8, 9	1, 2, 3, 4, 6
WP3 (with IRS)	1, 10	2, 6	1, 3, 4, 6, 8, 9	6
WP4 (between PSS)	1, 3, 4, 6, 8	2, 3, 6	1, 2, 3, 4, 6, 7, 8, 9	1, 2, 3, 6
WP 5	1, 4, 5	1, 4, 5	1, 3	2, 5
WP 6	1, 4, 6	1, 4	1, 2, 3	1, 2
WP 7	1, 2, 3, 4, 7, 8	1	3	5
WP8	1, 8	3	3	5
WP9	10	1	3, 6, 7, 8	6
WP10	All, especially 9	All, especially 5, 6	All, especially 8, 9	All, especially 6
WP11	3, 4	1	1, 3	1

Table 5 (update from D4.1 table 13). Synthesis of PSSs implementation actions interfaces with: RIs, communities, databases, regional initiatives and directives

		GoF PSS Actions	NW-MED PSS Actions	NSEA & CHANNEL PSS Actions	Cretan PSS Actions
RIs	ACTRIS	10			1, 3
	AQUACOSM+	4, 8, 10	3, 5		2, 3, 5, 6
	DANUBIUS	10	2	1, 2, 9	
	ICOS ERIC	1, 6, 10	5	1, 9	1, 3, 4, 6
	EURO-ARGO	1, 2, 5, 10	4, 5		4, 6
	EMBRC	10	5	9	6
	EMSO		1, 4, 5		6
	EUROFLEETS	1, 5, 10			
	LifeWatch			9	6
	MINKE	1, 3, 10			5
Communities	Modelling	2, 5, 7	1, 4	1, 5	2, 4
	Earth obs	3, 4	1, 2, 4	1, 4, 5	2, 4
	In situ obs	1, 2, 3, 4, 5	1, 2, 3	1, 2, 3, 4, 5, 6	1, 2
	Industry	1			2, 5
Databases & Products	EMODnet	3, 4	4	3, 5	
	SOCAT	6	4	1, 5	1, 4
	CMEMS	2, 3, 4, 5, 9	1, 4, 6	3	1, 2, 3, 4
	ICES	2, 3, 5, 9		3, 4, 5	
	SeaDataNet			3	
Regional Initiatives	MONGOOS	NA	4, 6	NA	1, 6
	UNEP-MAP	NA	6	NA	6
	HELCOM	2, 3, 5, 6, 9, 10	NA	NA	NA
	EUBSR	9	NA	NA	NA
	BOOS	2, 4, 5, 6, 7, 9	NA	NA	NA
	NOOS	NA	NA	8	NA
	OSPAR	NA	NA	3, 4, 5, 8	NA
Directives	MSFD	9	4	2, 3, 4, 5, 8	2
	WFD			2, 3, 4, 8	

3.2 Refinements per PSS action

GoF PSS: Strategy refinement per action

GoF PSS #1 Harmonized observations

GoF #1 Analysis and refinement of objectives

GoF PSS#1 includes all PSS partners and during 2021 they gathered during various workshops and meetings. Partners know each other very well, thus there was no delay in getting together. Despite these several occasions for exchanges, having more physical meetings and discussions would have been useful. Although the online meetings are fine for exchange of information, brainstorming and more strategic and interactive discussions require physical attendance. As well, each partner brought new staff members into the PSS collaboration, and they would have benefited from the physical meetings, to get to know others.

In 2021, the Baltic FerryBox fluorometer calibration workshop was also targeting other platforms, because multiplatform sampling strategies require as consistent sensor observations as possible. Some of the ships and platforms were not fully functional in 2021, and therefore we had a limited number of sensors to be compared and how useful the joint calibration of multiplatform sensors could be was not really demonstrated in 2021.

The original focus on BGC and biological sensors is still valid, but we also noted needs to improve practices for salinity and temperature QA and QC, especially to fulfil the requirements of the carbonate system observations and had related actions. Automated nutrient analysis, not originally considered, may be also dealt with in 2022.

In 2022, we need to better focus on the actual exchange in written best practises documents, SOPs and QC scripts within partnership, communicating with other PSSs and WPs, in detailing the preferred future state of harmonisation, and defining actual actions. Such interactions need to be mentioned in the refined objectives for 2022.

GoF #1 **Refinement of data sources** (both internal i.e. platforms and other-external)

Issues with availability of some platforms due to covid, though annoying and preventing optimal gathering of joint data, did not eventually largely affect GoF PSS#1.

Additional JERICO-S3 partners participated in calibration and harmonisation workshops (SMHI, HCMR), as well as other regional collaborators (University of Helsinki, City of Helsinki, City of Hanko, Estonian Marine Institute).

Overall, there is no need to modify the partnership, platforms or data sources

GoF #1 **Refinement of Description of Action and timetable**

As harmonisation is a process of long duration, Action will continue until the very end of the PSS period, Nov 2022.

Joint workshops for sharing best practices and sensor calibration were conducted as planned and next workshops in Febr-Mar 2022 are already under preparation.

Joint cruise already in autumn 2020 was realised, specific joint cruise for automated measurements in 2022 may be realised as SYKE is offering its research vessel Aranda to TalTech as part of EUROFLEETS+ TA project and FMI has also access to the same cruise.

FerryBox co-trip in 2021 was not realised due to covid restrictions, but instead we had a meeting onboard Ferry (IOW, SYKE, FMI) for joint actions. Also, some additional meetings and actions took place (see D4.3).

We foresee yet one workshop for harmonisation, close to the end of the PSS period, with participation of other PSSs and WPs, to facilitate pan-European harmonisation of observations.

Due to these modest changes in the Action, mostly additions to the original plan, we will modify the Description of Action accordingly.

GoF #1 **Refinement of Data practices, flows, QC, management**

During the first year of the implementation, the best practices and standard operations within partnership were presented during workshops, but they were not agreed upon yet. QC routines were shared with SYKE and FMI, but they have not yet been taken in use for Utö observatory data.

These activities are on the to-do list for 2022 and there is no need to modify this part.

GoF #1 **Refinement of Expected Results, their users and dissemination**

We consider that the results can be achieved as originally planned. As well, the user group is correctly defined. Sharing of results through JERICO CORE (JERICO e-infrastructure) is expected, though the actual method in doing so is yet unknown. Publication of some of the best practices has already started and is expected to continue. Dissemination to other PSSs and WPs, and other communities has been already done, and this needs to be better described in the refined plan.

Accordingly, there need to be slight changes in the "Dissemination of results" to describe the planned actions more in detail.

GoF #1 **Refinement of Links**

Links originally defined to various JERICO-S3 WPs are valid. In addition, GoF PSS#1 will link to WP8, TA activities, as Chelsea Technologies Ltd has received a TA project to test their new fluorometric organic matter sensors at SYKE, and this work matches well when defining practices for various sensors for detection of CDOM. This will also bring a new link to industry. In addition, FMI has created a link to ICOS-OTC for best practices in pCO_2 measurements by participating in their calibration WS.

GoF PSS#1 connections to other RIs (MINKE, ICOS) are not formal but merely based on the fact that institutes (SYKE, FMI, IOW) belong to the partnership of those RIs. Connection to industry (SYKE-Chelsea Technologies Ltd) is based on the JERICO-S3 TA agreement.

GoF PSS #2 The performance of operational forecast models

GoF #2 **Analysis and refinement of objectives**

Despite some setbacks, we have managed to collect the necessary data to conduct the model products performance assessment analysis.

GoF PSS#2 is 1-2 months behind the schedule towards the objective. This is mainly because there have been delays within partnership to deliver data. However, we assume these are to be completed soon, and the overall initial objective remains the same.

The Action initiates and improves the streamlining the observations and modelling within GoF PSS partnership. Further communications on how to optimise sampling strategies to meet the requirements of modelling need to be carried out within the partnership.

GoF #2 **Refinement of data sources** (both internal i.e. platforms and other-external)

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.

Rest of the data sources (gliders, R/V, profiling buoys) will be used only if the primary datasets need extra complementation. In addition, data from the fixed level sensors (moorings) might be used.

GoF #2 **Refinement of Description of Action and timetable**

Not all data have been delivered yet, so the compilation of datasets is not finished. Thus, there is a need to refine the timetable accordingly. No other changes to the activities are expected.

GoF #2 **Refinement of Data practices, flows, QC, management**

This part of the Action does not require any changes

GoF #2 **Refinement of Expected Results, their users and dissemination**

No need for changes.

GoF #2 **Refinement of Links**

Links are updated to include CMEMS and EURO-ARGO. GoF PSS#2 connections to EURO-ARGO is not formal but merely based on the fact that FMI is in partnership with the RI.

GoF PSS #3 Optical data for Ocean Color product validation

GoF #3 **Analysis and refinement of objectives**

Getting reliable sensor data for Ocean Colour product validation requires that issues with sensor calibration and reliability are solved, which is not necessarily yet the case for optical sensors. Therefore, the harmonization and calibration exercises (in GoF PSS#1) are elemental. Still after that there are challenges as various specific optical properties

(fluorescence, absorption, reflectance) are varying and results are not directly comparable between each other or to standard laboratory analysis (and at the same time, EO data is not as well direct measurement of concentrations but based on optics and optimised algorithms). The work started in GoF PSS#3 tries to solve some of these uncertainties and will communicate findings within GoF PSS, but also within other communities as well (including other PSSs).

Connection to the national EO community is well established in Finland and common objectives are found related to data availability, data quality and end products. The platform for displaying various datastreams on top of EO data was incremented with FerryBox data, and joint plans for further piloting the match-ups between sensor data and EO data are created. Such demonstrations of merging multiplatform data will likely attract new users, applications and scientific studies.

Observation data from GoF-PSS has also been made better available through CMEMS and local SYKE databases. We still need to work towards better integration between PSS partners and in communicating with other PSSs and WPs.

There is no need to modify the objectives for GoF PSS#3

GoF #3 **Refinement of data sources** (both internal i.e. platforms and other-external)

There is no need for changes in partners, platforms or data sources to original plan.

GoF #3 **Refinement of Description of Action and timetable**

Timetable is extended until the end of the PSS period, allowing more detailed analysis of data.

As there has already been more connections to EO groups and actions have taken place and planned, these need to be notified in a refined plan. As well, plans between PSS interactions need to be notified.

GoF #3 **Refinement of Data practices, flows, QC, management**

No need for refinements

GoF #3 **Refinement of Expected Results, their users and dissemination**

The first part of the expected results is not necessarily reflecting the actual work carried out, which is merely a demonstration of joint use of observations and EO data. Rather than making actual improvements in uncertainties, this Action provides tools for it. This needs to be better described.

GoF #3 **Refinement of Links**

In the original Action plan, the links observed in tables 12 and 13 have not been optimally analysed and elaborated. There are many more links than originally described.

SYKE connections to other initiatives are formal, as collaborations with MINKE, HELCOM/ICES and CMEMS are based on existing projects, but there is no agreement between those projects and JERICO-S3 or GoF PSS.

GoF PSS #4 Detection of cyanobacterial blooms

GoF #4 **Analysis and refinement of objectives**

The first year of GoF PSS#4 included a lot of practical activities and collaborations improving cyanobacteria imaging observations. New data flows and data analysis tools were created. Results were used in weekly algae reviews by SYKE and disseminated in various scientific meetings, promoting their use.

Challenges to be met in 2022 include improving transnational collaboration within PSS and beyond. To improve multiplatform and transnational integration, demonstration of algae reviews within partnership, improving the between sensor comparability and better visualisation of data need to have high priority in 2022.

Best practices of data collection and data flows have been discussed with WP5 and WP6, and this collaboration needs to be continued. Demonstration of data flows and creation of products with WP7, T7.5 D2PTS is streamlined with GoF PSS#4 and the developments are expected to be finalised in early 2022.

Overall, the original objectives are valid and there is no need for changes. The transnational part of the Action has been delayed as there were lack of observations in some platforms due to covid, and this must be in focus in 2022.

GoF #4 **Refinement of data sources** (both internal i.e. platforms and other-external)

Due to covid, some platforms did not have any or only limited observations on cyanobacteria (Silja Serenade, Silja Europa, Keri Observatory, Profiling buoys). There was no relevant monitoring data from RVs in 2021 either. As they are expected to provide data in 2022, we do not remove them from the list of platforms.

Citizen observations contribute to weekly algae reviews and provide complementary data source for cyanobacteria blooms. However, so far it has not been used for scientific purposes and it plays a very minor role for this Action. Ocean colour data is used along with sensor observations to trace development of cyanobacteria blooms, and methods are complementary. Ocean colour is more dealt in GoF PSS#3.

GoF #4 **Refinement of Description of Action and timetable**

To analyse efficiently the results from the cyanobacteria bloom in 2022 we prolong the Action to the very end of the PSS period, as typically blooms take place in June-August.

As we have already improved the data flows and products for imaging, this may be noted in the Description of Action. Moreover, we need to discuss with other WPs how to store images and data products, as there are no general data aggregators for this available. As well, dissemination of results could be better described.

There is a TA accepted for Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) visiting both SYKE MRC-LAB and FMI Utö Observatory. This work is related to improving harmonisation of imaging between RIs. Visit is preliminary scheduled for late August 2022. In the case there are still abundant cyanobacteria, this TA may contribute to GoF PSS#4. This could be noted in the Description of Action.

GoF #4 **Refinement of Data practices, flows, QC, management**

Issues noted for data flows of phycocyanin fluorescence and imaging data are still valid and need to be kept in the agenda. The local solution for Imaging FlowCytobot data, using cloud computing, should be mentioned as new best practices, though it is not solving the overall data aggregation, but is rather the first step.

There is no need for other changes in this part.

GoF #4 **Refinement of Expected Results, their users and dissemination**

The original lists for expected result, users and dissemination are valid, but need to be amended with scientific results, scientific users and dissemination to scientists.

GoF #4 **Refinement of Links**

The original description needs to be amended with links to WP6 dealing with data flows, to WP5 with best practices in operations and to WP11 for Virtual Access. Link to AQUACOSM-plus has been identified as a TA project for imaging has been accepted.

Contacts are based on informal collaboration between colleagues.

GoF PSS #5 Mapping the deep water oxygen conditions

GoF #5 **Analysis and refinement of objectives**

Despite a slight delay, GoF PSS#5 has progressed as planned and there is no need for refinements.

Oxygen measurements are done by each PSS partner, with various platforms. During GoF PSS#1, we have noted that high quality observations are not always easy to perform due to sensor drifts, as the comparability of various sensors and technologies is not straightforward and as in some platforms (e.g. Argo float) the validation measurements with lab analyses are hard to perform. Although the small uncertainties in the data do not really compromise studies of hypoxia in Gof PSS#5, we have identified a need to improve and share best practices for oxygen observations. This concern is shared among other PSSs.

GoF #5 **Refinement of data sources** (both internal i.e. platforms and other-external)

There will be some refinement in data sources. GoF PSS#5 likely will not use glider and profiler data in mapping. Rest of the platforms will be included. CMEMS product will be used if GoF PSS #2 performance assessment supports it.

GoF #5 **Refinement of Description of Action and timetable**

Prior activities in GoF PSS#5, we have decided to concentrate on the action GoF PSS #2 first (the performance of model products). GoF PSS #2 will give valuable information about

CMEMS products uncertainties in the GoF. When we have learnt about the uncertainties we can decide if CMEMS products can be integrated to the mapping or not. Therefore, we start with the mapping later as planned.

There is only a shift in timeline of actions, no other changes.

GoF #5 **Refinement of Data practices, flows, QC, management**

There are no needs to refine these sections.

GoF #5 **Refinement of Expected Results, their users and dissemination**

There are no changes expected, but the focus of the paper might be slightly modified according to the recent literature. This will not bring any modifications to the original plan though.

GoF #5 **Refinement of Links**

Links to WP5, EURO-ARGO and EuroFleets+ were originally missing; these need to be added. FMI and its Argo floats are part of EURO-ARGO. Otherwise, the connections are not formal.

GoF PSS #6 Biological interplay with the carbonate system

GoF #6 **Analysis and refinement of objectives**

GoF PSS#6 has been efficiently contributing to the transfer of knowledge between the groups. The importance of multiplatform approach to carbonate system measurements has been realised. As well, the need of conducting reliable physical and other biogeochemical and biological observations has been noted, to support calculation of carbon fluxes appropriately and to understand the main factors affecting flux rates. Knowledge on the measurement and data processing has been transferred between the partners, but there is still work to do during the second year of PSS implementation in homogenization, inter-comparability and integrated use of QCed. Collaboration with other WPs and PSSs is expected to be more active in 2022.

Overall, there is no need to refine the description of Objectives.

GoF #6 **Refinement of data sources** (both internal i.e. platforms and other-external)

Despite the issues at some platforms due to covid, data is continuously flowing from FINNMAID and Utö, others contributing occasionally. Though not exactly crossing the GoF PSS, FerryBox Tavastland provides comparative measurements on a cruise track of FINNMAID and also a geographical extension and link to other JERICO partners. Thus, no changes in this part are needed.

GoF #6 **Refinement of Description of Action and timetable**

Timetable will be extended to cover the whole PSS period, until Nov 2022, to allow as complete as possible data analysis.

Description of Action is still valid and no changes needed.

GoF #6 **Refinement of Data practices, flows, QC, management**

There is no need for refinement for the plan. We just need to follow the plan. QCed data is not readily available yet, which needs to be dealt with in 2022. Also, SOCAT flagging needs to be considered in 2022.

GoF #6 **Refinement of Expected Results, their users and dissemination**

These sections are valid, but we like to make one precision in the Users of results, highlighting that our results are applicable especially in directing institutional, national and regional sampling strategies for holistic and efficient carbonate system monitoring in the Baltic Sea.

GoF #6 **Refinement of Links**

The links have been appropriately described. Connections to other RIs are informal.

GoF PSS #7 Forecast models for cyanobacterial blooms

GoF #7 **Analysis and refinement of objectives**

While we had a lot of advances in cyanobacteria observations in 2021 (see GoF PSS#4 for details), the year was challenging due to the covid situation. Maintenance of the profiling buoy was not possible due to the restrictions to enter onboard Coast Guard vessels doing such maintenance cruises, and Silja Serenade & Silja Europa FerryBoxes were not operating until autumn 2021. Additionally, there were unforeseen and sudden issues in staff availability at FMI. These complicated performing the action in full, and the aim is complete the remaining work in 2022.

The in situ vs model comparisons are planned for 2022. Based on preliminary investigations, however, it looks like the current models available do not necessarily provide suitable data for comparisons (see e.g. Munkes et al 2021).

In 2022, we will compare the SYKE algae bloom forecasts to the observations. An efficient way to forecast HAB could be based on meteorological variables instead of sophisticated BGC-models (Kahru et al 2020). Utilising this approach, we could try using a semiempirical approach based on outputs from the NEMO hydrodynamic model and the Harmonie NWP model. Parameters such as SST, solar radiation and winds could be used to forecast the HAB situation. Results of such a semiempirical model may be compared with satellite images and in situ observations, to find out whether we can predict blooms 1…7 days in advance.

GoF #7 **Refinement of data sources** (both internal i.e. platforms and other-external)

In 2021, profiling buoy data was not available, as maintenance was not possible due to covid restrictions. As well, Silja Serenade data was not available due to covid.

We expect that in 2022, data from Silja Serenade will be available. The Utö profiling buoy can be serviced no earlier than winter 2022/23. If the service is successful, the buoy will be redeployed in 2023. However, we have such buoy data from past years, which may be used for model evaluations, and thus we inform no changes in platforms.

After evaluation, the ERGOM model, originally included, may not be useful for cyanobacteria component, thus it is removed from the list. Aim is to use NEMO ocean model and harmonie NWP model forecasts instead.

GoF #7 **Refinement of Description of Action and timetable**

As a change to the original plan, the model performance analyses will be done in 2022.

Although we have not yet identified the functional operational model, we are making comparisons with static ones which exist and provide an outlook for further developments. This will not require changes in the original description of action.

GoF #7 **Refinement of Data practices, flows, QC, management**

Development of the QC software is still on-going. No changes needed.

GoF #7 **Refinement of Expected Results, their users and dissemination**

As suitable operational forecast models for cyanobacterial blooms were not available, a semiempirical modelling approach will be studied instead. This does not affect the expected results of this Action in general. However, as a consequence it is not certain that model results will be available through JERICO e-infrastructure, but they are disseminated during various workshops and meetings.

GoF #7 **Refinement of Links**

Links to WP7 were not mentioned and need to be added.

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

GoF #8 **Analysis and refinement of objectives**

As the GoF PSS#8 has hardly started the analysis of how the objectives have been met is too early. It seems we are on the right track and having good representation from both JERICO and AQUACOSM communities during the experiment. Marine heatwaves have been selected as a topic for experiment, due to their relevance for plankton dynamics, since actual impact assessment of heatwaves on plankton requires both experimental studies and observations, and such manipulations are feasible to conduct in the SYKE mesocosm facility.

As well we have sorted out the main baseline for surface sea temperature variations using the FerryBox time series. Finally, there is no need to alter the original objectives.

GoF #8 **Refinement of data sources** (both internal i.e. platforms and other-external)

It is likely that data from all platforms listed will not be used, but as this is not currently known in detail, no changes. So far, the analysis is restricted to FerryBox Finnmaid.

The section "other data sources" indicate a possibility to open a TA jointly with AQUACOSM, but it will not realise at least not in time for this Action. However, both projects provide TA separately to participate in mesocosm experiment, to be refined in the text.

GoF #8 **Refinement of Description of Action and timetable**

As the experiment will be carried out late summer, in August, we need to extend the Action until the end of PSS period, to have the possibility to analyse results more in detail.

There are three changes required in the Description of Action, to be modified. First, it is agreed to have a temperature gradient as the main manipulation, mimicking a heat wave. Second, the other manipulation besides temperature will be defined early 2022 after AQUACOSM-plus TA call has been completed. In addition, the TA project already granted, through JERICO-S3 TA call, is related to imaging and this could be highlighted.

GoF #8 **Refinement of Data practices, flows, QC, management**

There are no needs for alterations in these sections.

GoF #8 **Refinement of Expected Results, their users and dissemination**

There is no need to refine the expected results, their users and dissemination.

GoF #8 **Refinement of Links**

Missing link to WP8 (TA) needs to be added.

As a AQUACOSM-plus partner is participating in the experiment through TA, there is an agreement based on it.

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

GoF #9 **Analysis and refinement of objectives**

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.

No changes are foreseen. The only question is regarding communication towards EUBSR that has to be arranged still.

GoF #9 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes in partners, platforms of data sources compared to the original plan. Flow-through data from RV Salme are employed more than planned initially due to some breaks in FerryBox data. Most of the data are gathered in PSS other activities.

GoF #9 **Refinement of Description of Action and timetable**

No need to modify the action plan and timetable, in general. Analysis of applicability of PSS data for indicators to be used in indicator-based assessments is going on and the options/results are shared in the HELCOM expert group (oxygen indicators). An analysis of the use of RV flow-through data for HELCOM Chl a indicator started, not yet discussed at HELCOM EG. Presentation of the impact of using PSS data for indicators/assessment is planned for the coming EG EUTRO and the autumn HELCOM S&C WG meeting (preliminarily on 10-14 October 2022). Presentation/demonstration of PSS products from PSS #2-#8 planned for 2022-2023 (depending on the availability).

GoF #9 **Refinement of Data practices, flows, QC, management**

No refinement needed. Data flows and QS routines are mostly developed/agree in other PSS activities (QC in PSS #1). Input from this PSS activity is mainly provided for collection of additional oxygen profiles (for shallow water oxygen indicator) and handling and use of RV flow-through data (Chl a and potentially pH and/or pCO_2).

GoF #9 **Refinement of Expected Results, their users and dissemination**

No need to refine the results/dissemination, in general. Indicator-based assessment products with confidence estimates when combining conventional data with PSS data are under development. The timeline depends on HELCOM HOLAS III assessment process (but it fits to JERICO timeline, if no delayed will occur).

GoF #9 **Refinement of Links**

No changes. PPS activity #9 is especially directed towards regional (HELCOM and MSFD) environmental assessments. Relevant links are established at national (local authorities) and regional (HELCOM) scales.

GoF PSS #10 Connecting the other RIs in the region

GoF #10 **Analysis and refinement of objectives**

GoF PSS has been collaborating practically with all RIs mentioned in the objectives. The level and intensity of the collaborations has been varying, collaborations with ICOS-ERIC and AQUACOSM-RI being most active. For these RIs, the work between the research infrastructures are daily-basis interactions, with partly the same technical personnel

operating the observations. GoF PSS has also been in contact with other RI, DANUBIUS, not yet active in Baltic Region.

The main objectives remain the same for 2022. Discussions on impact of environmental RI fragmentation will start within the GoF PSS partners. Experiences from GROOM II glider project will be shared between the JERICO GoF partners utilising the gliders.

The Action still needs some structuration of its activities, followed by analysis of potential future interactions, to be disseminated to WP2. This does not, however, require any changes in the objectives, but need to be noted in other parts of Action.

GoF #10 **Refinement of data sources** (both internal i.e. platforms and other-external)

There are no needs for refinements / changes. The other data sources and external are not really relevant here, and may be omitted fully.

GoF #10 **Refinement of Description of Action and timetable**

To follow the RI interactions for the full period of PSS, we need to extend the timetable until Nov 2022.

In 2022, direct discussion between the representatives of regional environmental RIs continues on an almost daily basis. At Utö site, for example, as a bottom-up-approach, instruments part of ICOS, ACTRIS and JERICO are jointly serviced by the same technical personnel. However, there is not much direct overlap between the measurements, so the main aspect should be on data produced by the RI's and ensuring the co-operative use of data to address various large-scale environmental problems including climate change, eutrophication and shipping.

Passing the information from GoF PSS RI collaborations to WP2 needs to be added.

GoF #10 **Refinement of Data practises, flows, QC, management**

Discussions on dataflows produced by ICOS and ACTRIS will be initiated: how does the data produced by these infrastructures is related to EU Copernicus services?

GoF #10 **Refinement of Expected Results, their users and dissemination**

The joint actions and collaborations between RIs have resulted in sharing information, though there may be need for more coordinated actions here. So far the interactions have been bilateral while also multilateral exchanges may be beneficial. WP 2 need to be better informed during the second year of PSS activities.

There are specific examples of bilateral collaborations, like a joint publication combining ICOS and JERICO observations and TA projects from AQUACOSM-plus. In 2022, we are expecting several joint publications combining ICOS, ACTRIS and JERICO observations from GoF PSS.

Scientific community and policy makers as users of between-RI collaborations need to be noted.

GoF #10 **Refinement of Links**

Links to WP3 need to be included. And, of course, this action links to all regional RIs!

NW Med PSS: Strategy refinement per action

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

NW Med #1 **Analysis and refinement of objectives**

Action #1 performed the planned work with some hazards due to COVID which slowed down the physical data flow for assimilation into WMOP. Because of the COVID and the closure of the GNF, the experiment planned in the Ligurian Sea (AMBO) has also been postponed by one year, however this will not affect the overall objectives which remain the same. For the future, face-to-face meetings will have to be planned for several actions of the PSS

This action #1 is the most important in terms of multiplatform integration in the PSS even if we focus here on physical data operated in RT and DM (delayed mode). It also demonstrates the importance of cooperation with others RIs (EMSO, EURO-ARGO).

NW Med #1 **Refinement of data sources** (both internal i.e. platforms and other-external)

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

NW Med #1 **Refinement of Description of Action and timetable**

The modelling efforts to do in 2022 are:

- NC cross-shelf transport and dispersion with SYMPHONIE/SIROCCO (CNRS);
- dispersion modelling with MENOR (IFREMER);
- continue the data assimilation of multiplatform observations in WMOP hydrodynamic model (SOCIB);
- models intercomparison and validation with PSS observations

The above do not affect the initial description of action

Extension to November 2022 is requested in order to collect additional data and for further data analysis

NW Med #1 **Refinement of Data practices, flows, QC, management**

No change

NW Med #1 **Refinement of Expected Results, their users and dissemination**

Dissemination of some results have been reduced to COVID impacts and the limited meetings opportunity

NW Med #1 **Refinement of Links**

The tables 12 & 13 have been updated for action #1. The link with WP7 is finally 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). The links with other RIs do not change (projects H2020 EUROSEA, EA-RISE).

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

NW Med #2 **Analysis and refinement of objectives**

The objectives of this action were mostly achieved in 2021 (uniformisation of river input databases, demonstration action in front of the Ebro delta, and analysis of the impacts of extreme events on coastal ecosystems).

Better integration of river input databases could be done especially to reach the DANUBIUS RI specificities to French and Italian databases and best practices.

NW Med #2 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes in platforms and other data sources

NW Med #2 **Refinement of Description of Action and timetable**

Extension to November 2022 is requested in order to collect additional data and for further data analysis

NW Med #2 **Refinement of Data practices, flows, QC, management**

No change

NW Med #2 **Refinement of Expected Results, their users and dissemination**

No change

NW Med #2 **Refinement of Links**

No change

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

NW Med #3 **Analysis and refinement of objectives**

The action #2 aims to combine two different approaches to investigate the effect of DOC inputs, temperature increase and acidification on plankton shift. It provides a demonstration to integrate two different communities (JERICO & AQUACOSM) which both study the impacts of climate change on plankton species.

In 2021, the experiment had been realised with some delays due to the COVID situation.

NW Med #3 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes

NW Med #3 **Refinement of Description of Action and timetable**

We have a new on-going experiment for this year in the frame of TA-AQUACOSM entitled: Effects of consecutive heat waves on the resistance, resilience and recovery of marine plankton communities (Heat Waves). It could provide a good opportunity to connect between JERICO-S3 and AQUACOSM communities in addition to the experiment already conducted in 2021.

An extension to November 2022 is requested to include the new mesocosm experiment done in 2022 and the related data analysis

NW Med #3 **Refinement of Data practices, flows, QC, management**

No changes

NW Med #3 **Refinement of Expected Results, their users and dissemination**

No changes

NW Med #3 **Refinement of Links**

A new experiment with AQUACOSM II is possible in 2022.

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

NW Med #4 **Analysis and refinement of objectives**

Action #4 has partially completed the planned work on the collection of BGC data, with some contingencies due to COVID (cancelled or postponed cruises). Activity on the BGC model is still ongoing with a peer-reviewed paper in preparation. Development of the ocean colour algorithm for coastal waters has progressed slowly. This work should accelerate in 2022. While producing indicators this work should be reviewed. Indeed this activity depends on the work done by third parties not directly involved in JERICO-S3 (OFB). This work will certainly be completed in 2022 but without any guarantee. It would therefore be preferable to revise the initial objectives of this action.

Finally, this action (like Action #1) is a good example to demonstrate the importance of merging deployment and cross-platform strategy to deliver high-quality BGC products. Again here, the PSS is a good place to demonstrate IRs interactions and cross-platform synergy.

NW Med #4 **Refinement of data sources** (both internal i.e. platforms and other-external)

Neural network CANYON-MED products were included as additional data sources (predictions data products)

NW Med #4 **Refinement of Description of Action and timetable**

In the framework of EUROSEA Task 7.1, a deployment of a new glider-pH is planned inside the PSS for 2022

The MOOSE-GE cruise scheduled for 2022 has been delayed (normally the cruise takes place in May-June) due to a technical problem on board the RV Thalassa. The next MOOSE-GE cruise is therefore scheduled for September 2022 (RV Pourquoi Pas). Due to this delay some BGC sampling will be lost or delayed (sediment traps will stop in early June for example).

During this period, new BGC-Argo floats will be deployed and collected (EA-RISE project).

The new pCO_2 module of SYMPHONIE ECO3M-S will be finalised in 2022 (C.Ulses, LEGOS) and the new ACRI algorithm should be developed and tested in the Rhone river site in 2022. The above do not affect the initial description of action

Extension to November 2022 is requested in order to collect additional data and for further data analysis

NW Med #4 **Refinement of Data practices, flows, QC, management**

Additional new best practices under development through EUROSEA WP3 will be included, otherwise no need for changes.

NW Med #4 **Refinement of Expected Results, their users and dissemination**

Additional dissemination is expected via EUROSEA meetings and peer review articles.

NW Med #4 **Refinement of Links**

Tables 12 & 13 have been updated.

Links to MONGOOS and EUROSEA to be considered in addition.

NW-MED PSS #5: RI interactions

NW Med #5 **Analysis and refinement of objectives**

The interaction is a long process and this is not only visible during the JERICO-S3 period. This is the result of the partners participation into different consortia, working groups (such as EUROGOOS) and European projects that aim to demonstrate the need to work jointly with several RIs for key scientific challenges.

NW Med #5 **Refinement of data sources** (both internal i.e. platforms and other-external)

Tables 12 & 13 have been updated

The deployment of benthic crawlers in 2022 is to be added in other data sources

NW Med #5 **Refinement of Description of Action and timetable**

There are strong links between actions #5 and 6 that should be emphasised in the description of action.

Extension to November 2022 is requested in order to collect additional data, for further data analysis and to increase interactions between RIs

In the description of action the deployment of two benthic crawlers near ANTARES site (CNRS) and at Obsea site (UPC) in Spring 2022 and the TALPRO2022 that will occur in May 2022 (GO-SHIP) needs to be added.

NW Med #5 **Refinement of Data practices, flows, QC, management**

No changes.

NW Med #5 **Refinement of Expected Results, their users and dissemination**

As refinement, dissemination of results should include peer reviewed articles

NW Med #5 **Refinement of Links**

Some partners in the PSS participate to the T2.2 and WP5 tasks (KPI)

NW-MED PSS #6: Transnational integration

NW Med #6 **Analysis and refinement of objectives**

The collaboration with UNEP-MAP is not active and it should be removed from the objective

NW Med #6 **Refinement of data sources** (both internal i.e. platforms and other-external)

Tables have been updated

NW Med #6 **Refinement of Description of Action and timetable**

Description slightly modified to describe the work better and change concerning our collaboration with UNEMAP.

NW Med #6 **Refinement of Data practices, flows, QC, management**

No changes.

NW Med #6 **Refinement of Expected Results, their users and dissemination**

No refinement.

NW Med #6 **Refinement of Links**

The tables 12 & 13 have been updated.

NSEA/EC PSS: Strategy refinement per action

NSEA PSS #1 Harmonised observations of regional C fluxes

NSEA #1 **Analysis and refinement of objectives**

The NSea/EC PSS #1 includes mainly partners from the NSea part of this twin PSS. The partners of the NSea PSS gathered virtually approximately every three months to discuss progress and plan further actions. Despite a productive atmosphere at these meetings, the lack of in-person meeting and interactions hampered efforts such as for making progress on strategic topics and for the generation of new ideas and concepts.

The North Sea PSS has been working towards cataloguing and harmonizing measurements from available platforms. Specific attention has been paid to QA/QC efforts. Quality controlled data were shared with partners in NSea PSS (DELTARES, A. Blauw), to include them in datasets to be used in models in other NSea PSS actions. Therefore, data sharing is now well underway, but this is an ongoing collaboration, with expected discussions during upcoming workshops within JERICO.

The work toward improving coherent observations of C-fluxes was mainly successful for air-sea and land-sea fluxes, while pelagic-benthic, and microbial processes still need more attention. Data harmonisation with ICOS ERIC was hampered by lack of personal interactions, but focus of upcoming actions will be centred around this topic.

While the original objectives are still in reach and we will continue working towards them, we somewhat underestimated the effort necessary (especially with regard to human resources involved) to advance overall budgets. As such, we expect to lay the foundation for future efforts after terminating the PSS phase.

NSEA #1 **Refinement of data sources** (both internal i.e. platforms and other-external)

Some issues arose from a lack of in-person interaction due to the pandemic situation with partners outside the JERICO-S3 consortium. The efforts to establish contacts (in particular with British institutions) will need to be intensified to broaden our approach.

NIVA will install a FerryBox system on the ship Norrøna (Denmark to Iceland, NorSOOP), however the installation has been delayed due to COVID-restrictions (planned late 2021/2022). Therefore, there are currently no inorganic carbon measurements in the North Sea proper, however NIVA is operating a FerryBox line between Oslo-Kiel (incl in Skagerrak IRS) that could provide some relevant input data for the North Sea PSS.

Overall, no modification to the initial plan regarding data sources is needed.

NSEA #1 **Refinement of Description of Action and timetable**

With the compilation of databases still ongoing, the analysis of their contents will continue and needs more effort. Thus, there is a need to refine the timetable accordingly and extend the Action until the end of the PSS work, i.e., November 2022. Therefore, and due to the pandemic situation a workshop will be scheduled to intensify collaboration and catch up on missed opportunities. No other changes to the activities are expected.

NSEA #1 **Refinement of Data practices, flows, QC, management**

A SOP for pCO_2 quality control from underway systems is still to be developed and this is one task to be done in 2022 building on the experiences in 2021. No further changes are anticipated.

NSEA #1 **Refinement of Expected Results, their users and dissemination**

No changes are anticipated.

NSEA #1 **Refinement of Links**

No changes are anticipated beyond a more intensified information flow to other PSSs.

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

NSEA/EC #2 **Analysis and refinement of objectives**

The NSea/EC PSS #2 initially included mainly partners from the NSea part of this twin PSS. With the involvement of the Channel part (IFREMER), our work expanded in scope.

We have managed to collect information on existing databases and analysed their content. We also investigated methods to standardise calculations.

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.

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.

NSEA/EC #2 **Refinement of data sources** (both internal i.e. platforms and other-external)

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.

NSEA/EC #2 **Refinement of Description of Action and timetable**

While the compilation of databases has been finished, the analysis of their contents is still ongoing and needs more effort. Thus, there is a need to refine the timetable accordingly. No other changes to the activities are expected.

NSEA/EC #2 **Refinement of Data practices, flows, QC, management**

This part of the Action will need to be refined with regard to the nature of the document of data sources to reflect the diversity of databases. Also, new methods for gap filling developed in JERICO need to be implemented in data QC routines.

Given the distributed nature and large amount of data we need to define protocols for regular data retrieval from different (types of) sources.

NSEA/EC #2 **Refinement of Expected Results, their users and dissemination**

No changes anticipated here.

NSEA/EC #2 **Refinement of Links**

The links specified in the original Action plan are mostly sufficient to fulfil the tasks promised. An intensification of the links to other PSSs is planned.

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

EC #3 **Analysis and refinement of objectives**

Each partner, taken individually or by pair collaborations (i.e. CNRS-IFREMER) has achieved so far its objectives for the implementation of phytoplankton observations and contributed to the work on harmonisation especially but not exclusively by answering the polls set on WP 5.3.3 ST7 and WP 6.2.3 and participating to the first workshop and ongoing discussion within the JERICO consortium.

The year 2022 should be dedicated to pooling (i) this information collected at different levels (from local to EU or even international) and (ii) feedback => SWOT type analysis which will be linked to the action #6 on the observational gap analysis.

EC #3 **Refinement of data sources** (both internal i.e. platforms and other-external)

As a contribution to Phytoplankton data collection, with a focus on Harmful Algal Bloom, IFREMER have decided to extend the citizen science network PHENOMER (https://www.phenomer.org/) from Brittany to the whole French coastal area. Within the EC PSS, IFREMER has been working on the development of a low cost, open access fluorometer in order to extend the list of parameters proposed in this project.

EC #3 **Refinement of Description of Action and timetable**

Two of the three workshops on best practices organised within WP5.3.3-ST7 and WP6.2.3 were delayed and could not take place in 2021. They will be organized in 2022 which means that the corresponding deliverable on data flows (WP6) will be delayed accordingly and an extra-delay will be officially asked about until end of 2022.

EC #3 **Refinement of Data practices, flows, QC, management**

The test, development and application of best practices was delayed accordingly what was written in the previous section. It will be carried out in separate and common workshops and field work during 2022.

EC #3 **Refinement of Expected Results, their users and dissemination**

No refinement needed.

EC #3 **Refinement of Links**

Some formal and informal links with other RIs are still ongoing in discussions and common field work in the Channel and North Sea at a national (i.e. IR ILICO and TGIR FOF in France) and international level (i.e. LifeWatch projects).

CHANNEL PSS #4 Products for Eutrophication Status Assessment

EC #4 **Analysis and refinement of objectives**

All monitoring programmes belonging to the EC PSS area were implemented as initially scheduled. Partners have managed to collect the best available physical, biogeochemical, and biological information from in situ samples and from existing databases. They also developed specific numerical methodologies and tools to further processed high and low resolution data and they analysed their content. Partners also investigated methods to standardise calculations and eutrophication assessment. There is a strong link between the needs from the MSFD and Regional Sea Conventions (i.e. OSPAR) and the work undertaken within the JERICO-S3 project and related ones. The added value of the EC PSS implementation is to propose an innovative approach based on the triptych Observation / Research / Support to public policy. The NS & EC PSS concept need to be further implemented during 2022 in order to further optimise the link between the partners, thus promoting transboundaries integrated studies on the scale of contrasting ecosystems.

EC #4 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes.

EC #4 **Refinement of Description of Action and timetable**

MSFD assessment for Descriptor 5 on Eutrophication will be delivered to the French Ministry in charge of the Environment and to stakeholders for June 2022. The timeframe of this action will be extended to November 2022 as some refinements of the results should be needed after national consultancy and in order to have time for some result disseminations.

EC #4 **Refinement of Data practices, flows, QC, management**

No changes.

EC #4 **Refinement of Expected Results, their users and dissemination**

No changes.

EC #4 **Refinement of Links**

EC PSS have informal contacts with other initiatives (InterReg S3, EuroHAB, CPER, IDEAL, EU MSFD, NEA PANACEA, PPR, Riomar) and RIs (IR ILICO, EMBRC).

CHANNEL PSS #5 Intercomparison of phytoplankton distribution using data integration

EC #5 **Analysis and refinement of objectives**

Objectives have not changed. The integrated analysis of observation data from different platforms is underway and will continue. 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 was expanded in 2021. The same model has also been used as part of the ensemble modelling approach by the OSPAR working group on ecological modelling. In this context the model was validated with the ICES assessment dataset.

EC #5 **Refinement of data sources** (both internal i.e. platforms and other-external)

Project is well underway and acquisition for data is underway and will be continued.

EC #5 **Refinement of Description of Action and timetable**

The timeframe of this action will be extended through November 2022 to create a buffer for pandemic related delays.

EC #5 **Refinement of Data practices, flows, QC, management**

No changes.

EC #5 **Refinement of Expected Results, their users and dissemination**

No changes.

EC #5 **Refinement of Links**

Action #5 is not really linking up with other RIs, apart from using ICOS data, downloaded from SOCAT as validation data.

Action #5 partners also improve the 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

NSEA/EC #6 **Analysis and refinement of objectives**

The census of existing monitoring programs is ongoing and not yet finished. The analysis of gaps will only begin (as planned) in 2022, when this census is complete. The analysis of the needs for institutional interactions on a regional level will also be developed based on the census results in 2022.

NSEA/EC #6 **Refinement of data sources** (both internal i.e. platforms and other-external)

The definition of data is somewhat lagging behind schedule and will be completed in the first half of 2022. List of external partners needs to be further developed and refined.

NSEA/EC #6 **Refinement of Description of Action and timetable**

The creation of national inventories is lagging behind schedule. Once completed, the gap analysis will be performed as planned. As of now we are confident to have this action completed by November 2022.

NSEA/EC #6 **Refinement of Data practices, flows, QC, management**

Not relevant for this Action.

NSEA/EC #6 **Refinement of Expected Results, their users and dissemination**

No necessity for changes is anticipated here.

NSEA/EC #6 **Refinement of Links**

No changes and/or refinement anticipated. Links are informal.

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

NSEA/EC #7 **Analysis and refinement of objectives**

The exchanges between the partners were hampered due to covid situation. The common surveys were cancelled or restricted to the minimum. We will achieve the objectives using webinars throughout the year 2022.

NSEA/EC #7 **Refinement of data sources** (both internal i.e. platforms and other-external)

Not applicable.

NSEA/EC #7 **Refinement of Description of Action and timetable**

This task has been very difficult to progress without the possibility of workshops or common surveys or satellite meetings during common conference (ASLO 2021). The webinar is the only option to exchange between the partners. An extension to November 2022 is requested to improve progress.

NSEA/EC #7 **Refinement of Data practices, flows, QC, management**

Not applicable.

NSEA/EC #7 **Refinement of Expected Results, their users and dissemination**

No refinement needed.

NSEA/EC #7 **Refinement of Links**

No changes needed. Link or summary of contacts between partners and particularly agencies and organisations in charge of national water quality, biodiversity and food webs monitoring in will discussed with action #8 later in the year.

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

NSEA/EC #8 **Analysis and refinement of objectives**

The census of information needs concerning the PSS Channel is ongoing and not yet finished. The analysis of where the project can contribute to these needs/gaps will only begin (as planned) in 2022, when this census is complete. Part of the information on information/data needs will be based on an analysis of the OSPAR science agenda and part on newly developed knowledge gaps sections for the OSPAR QSR 2023.

NSEA/EC #8 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes or additions. List of external partners needs to be further developed and refined.

NSEA/EC #8 **Refinement of Description of Action and timetable**

The investigation of OSPAR & MSFD assessment data needs is lagging behind schedule. Once completed, the iteration with other tasks in this PSS will be performed as planned. As of now we are confident to have this action completed by November 2022.

NSEA/EC #8 **Refinement of Data practices, flows, QC, management**

Not relevant for this Action.

NSEA/EC #8 **Refinement of Expected Results, their users and dissemination**

No necessity for changes is anticipated here.

NSEA/EC #8 **Refinement of Links**

External partners/networks identified are MSFD, OSPAR, NOOS working groups and relevant projects, notably NEA PANACEA. Links to additional external partners will be added as they are identified.

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

NSEA/EC #9 Analysis and refinement of objectives

Efforts to create a basis for future collaboration have been initiated. They have been hampered by the lack of opportunities to network at in-person meetings. Local collaboration efforts are well under way (such as with DANUBIUS-RI for the Elbe region), the collaboration on high/executive level was in part hampered by a necessary reorientation of JERICO-RI after the failed JERICO ESFRI roadmap application as the positioning of JERICO in the European research landscape is currently under discussion. Depending on the outcome of this discussion adjustment on how to shape relationships at a management level might be needed.

NSEA/EC #9 **Refinement of data sources** (both internal i.e. platforms and other-external)

N/A, as this is a networking action.

NSEA/EC #9 **Refinement of Description of Action and timetable**

Depending on the outcome of the discussion regarding JERICO's role in the European RI landscape, adjustments might be needed. These discussions are expected to come to a level where the action plan for action #9 can be refined for the remaining project time in March 2022. Extension to November 2022 is requested in order to further develop interactions.

NSEA/EC #9 **Refinement of Data practices, flows, QC, management**

N/A, as this is a networking action

NSEA/EC #9 **Refinement of Expected Results, their users and dissemination**

As of now, no adjustments to the original plans are foreseen here.

NSEA/EC #9 **Refinement of Links**

Links to DANUBIUS-PP, EMBRC-ERIC, ICOS-ERIC, LifeWatch-ERIC have been initiated. These links are mostly informal. The establishment of formal links will be facilitated through actions in WP2.

CS PSS: Strategy refinement per action

CRETAN PSS #1 Solubility and biological pumps

CS #1 **Analysis and refinement of objectives**

The first year of action #1 implementation, focused on collection of in situ carbonate system data 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. In the second year of implementation the enhancement of multiplatform approach and data sources, the communication with additional RIs and other PSS, as well as practices and guidelines released from WP6 could improve the outcome of the action.

CS #1 **Refinement of data sources** (both internal i.e. platforms and other-external)

Concerning the platforms, strong delays are faced with the FerryBox operation. Saronikos buoy was lost at sea and there is no plan for it to be replaced in 2022. Backup platforms or if available an external data source needs to be planned.

Reanalysis carbonate products from physical-biogeochemical models using satellite data may be used as additional data source.

Apart from temperature and salinity, oxygen data would be useful for validating or/and developing regional algorithm.

No citizen science data sources expected.

CS #1 **Refinement of Description of Action and timetable**

Extension of data collection period is desirable to maximise the available dataset to be used, due to less data collected in 2021 due to: the non-operation of FB, the loss of Saronikos buoy, the few glider transects and sending out the HCB CO_2 sensor to ICOS workshop.

Need to adapt description of action in case of non-operation of the FB.

Collaboration with industry via TA to test new pH probes in calibration lab, HCB and FB is planned within 2022.

CS #1 **Refinement of Data practices, flows, QC, management**

As refinement of best practices all WP6 activities (workshops, MS, DL) of carbonate system data management (T6.3.3.) will be followed as well as ways to give/receive contribution.

As refinement of data flows (since SOCAT handles only surface CO_2 data) to other databases is to be identified and used for delivery of non-CO_2 carbonate variables.

As carbonate variables data are delivered in RT almost raw (e.g. with no T, S corrections), an improved RT QC procedure could be developed.

CS #1 **Refinement of Expected Results, their users and dissemination**

Refinement for ways to increase expected results, their users and dissemination to be explored.

CS #1 **Refinement of Links**

Refinement to include collaboration with additional RIs, initiatives to be considered. More concrete actions to be planned to strengthen links. Actions to be taken to strengthen links with WP6.

All collaborations up to now are at informal (contact with colleagues) level besides SOCAT which is with data curator and regional group leader. Action #6 with help from WP2 to take progressively collaboration to a higher level.

CRETAN PSS #2 Improved approximations of Primary Production

CS #2 **Analysis and refinement of objectives**

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 plays a key role in this data collection. TA calls offered by WP8 opened additional possibilities.

During the second period, additional variables and additional data sources that could contribute to goals are also to be examined. A period with maximum density of platforms is to be selected as optimum for demo purposes. Milestones and deliverable on best practices report for biological sensors to be released in 2022 by WP6 will be also crucial.

CS #2 **Refinement of data sources** (both internal i.e. platforms and other-external)

Changes in partnership to include people in HCMR that have started in 2021

The first period of data collection and interaction with partners suggested to consider additional variables and platforms as complementary.

Concerning the platforms included initially, glider transects were very few in 2021. A backup plan is needed in case glider transects remain limited also in 2022. In addition, HCMR calibration lab was used in 2021 during a TA project and joint experiment with Chelsea Technologies Ltd, HCMR and SYKE.

No citizen science data sources expected.

CS #2 **Refinement of Description of Action and timetable**

Extension of data collection (and consequently model upgrade) period is desirable to maximise the available dataset to be used, as some platforms (glider) operated little in 2021 and to include data collection from additional platforms.

As described in the data sources refinement section above, the first period of data collection and interaction with partners suggested to consider additional variables and platforms as complementary as well as a backup plan in case glider transects remain limited also in 2022.

Collaboration among partners was realised as planned and linking to sensor manufacturers was taking place as Chelsea Technologies Ltd had a TA project at HCMR calibration lab.

CS #2 **Refinement of Data practices, flows, QC, management**

As refinement specify activities of WP6 to follow in 2022 related to data management of biological sensors of phytoplankton communities.

CS #2 **Refinement of Expected Results, their users and dissemination**

As D4.3 is due for Feb 2022 (when model upgrade starts), first upgraded model results are to be planned to be shown later.

As refinement, a mention should be added that the evaluation of innovative sensors for trial and validation under oligotrophic conditions is a joint activity of action #2, action #3 and action #5.

CS #2 **Refinement of Links**

Testing of similar tools with Sea Water Sensing Laboratory @ MIO Marseille is to be removed as this cannot be achieved within 2022. The comparison of study of pulse events at Mediterranean scale was moved to action #3. Links to other PSSs and especially their activities in AQUACOSM-plus will be linked to map challenges in PP estimation (joint with action #3).
Application of best practises defined in WP6 are expected, as well as the SeaDataNet workflow. Discussion with the modellers on how to better include phytoplankton data in PP models will be conducted.
Links up to now with RIs are "informal" contacts with colleagues.

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

CS #3 **Analysis and refinement of objectives**

First year of action #3 was focused on setting the stage: testing sensors in the lab, several preparatory meetings for the joint JERICOS3-AQUACOSM-plus mesocosm experiments to take place in 2022 and collecting field data from multiple platforms. Interaction with AQUACOSM-plus partners showed good progress. 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. TA calls offered by WP8 opened possibilities for testing additional sensors. Objectives per se are expected to be met during the second year where a large effort is planned, especially during mesocosm experiment and for testing sensors in the field.

CS #3 **Refinement of data sources** (both internal i.e. platforms and other-external)

Changes in partnership to include people in HCMR that have started in 2021

Considering platforms and other data sources, additional ones should be explored in case they can provide additional evidence of the effects of extreme events on phytoplankton communities

No citizen science data sources expected

CS #3 **Refinement of Description of Action and timetable**

Extension of all activities to Nov 2022 will increase dataset and probability to encounter additional extreme events. The type of extreme event to be studied in the mesocosm experiment has been decided and concerns the effect of episodic introduction of airborne microbes into the marine ecosystem. This could be added in description of action. As based on this subject, decided by AQUACOSM-plus, no significant changes in carbonate variables between experimental and control of mesocosm treatment is expected, carbonate sensor may not be tested during the mesocosm, or only those directly involved to phytoplankton dynamics.

CS #3 **Refinement of Data practices, flows, QC, management**

No need of refinement.

The novel PP sensor LabStaff (Chelsea Technologies Ltd) has been tested for the first time in the region. Based on that protocols for measuring at ultraoligotrophic areas are jointly developed and will be tested during the mesocosm experiment, linking to #3 and #5.

CS #3 **Refinement of Expected Results, their users and dissemination**

As refinement the scientific users of results could be specified

CS #3 **Refinement of Links**

Refinement with more ways to link between PSSs to be given.
Comparison of studies of pulse events at Mediterranean scale will be explored with NW Med PSS. Links to other PSSs and especially their activities in AQUACOSM-plus will be linked to map challenges in PP estimation (joint with action #2).
Links up to now are "informal" contacts with colleagues.

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

CS #4 **Analysis and refinement of objectives**

The objectives of this action are mainly set for the second PSS year (model upgrade is starting in Feb 2022), so no refinement of this action's objectives is expected. The data

collection needed for this upgrade (activity of Action #1), is on good progress. Modelling activities from other PSSs and any other modelling actions of JericoS3 during the second year are to be followed.

CS #4 **Refinement of data sources** (both internal i.e. platforms and other-external)

Changes in partnership to include people in HCMR that have started in 2021

Concerning the platforms, as two platforms initially planned are not providing data, backup platforms and/or other available external data source needs to be planned in Action #1. In addition, collection of data from other data sources considering a wider Mediterranean area are needed to evaluate the representativity ("footprint") of the Cretan Sea solubility pump.

No citizen science data sources expected

CS #4 **Refinement of Description of Action and timetable**

Extension of activities to Nov 2022 would provide more data for model upgrade

No refinement of description of action (the action per se starts on February 2022)

CS #4 **Refinement of Data practices, flows, QC, management**

For field data collected, refinement for field data flow management is described in action #1

No changes for model data management.

CS #4 **Refinement of Expected Results, their users and dissemination**

No changes for expected results

For users of results additional databases may be included as SOCAT handles only CO_2 and only from subsurface.

For dissemination as D4.3 is due for Feb 2022 (when model upgrade starts), first upgraded model results are to be planned to be shown later.

CS #4 **Refinement of Links**

Refinement of link to Copernicus. Link is only product/data use with no contact.
Refinement with additional links

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

CS #5 **Analysis and refinement of objectives**

Overall, during the first year a large part of the objectives of action #5 were met. Advances were made in new sampling strategies and testing of estimation algorithms, in carbonate system variables. Field sampling strategy for common benefit with EMBRC-ERIC was initiated. In addition, TA calls offered by WP8 opened the possibility to increase linking with industry and test novel technology.

During the second period, besides maintaining the above activities, focus will be given to improvement of practices in phytoplankton biological measurements. For this, milestones

and deliverables on best practices for biological sensors to be released by WP6 are important.

CS #5 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes in partnership is expected

Concerning the platforms, strong delays are faced with the Ferrybox operation. A backup plan for sensors eventually to be tested on Ferrybox needs to be prepared.

No citizen science data sources expected

CS #5 **Refinement of Description of Action and timetable**

Extension of testing period is desirable due to the non-operation of FB and difficulties to obtain optimal setup for sensors to be tested at UBPC in 2021. In addition, the mesocosm experiment in 2022 (action #3) should be included as an additional test bed.

CS #5 **Refinement of Data practices, flows, QC, management**

No changes

CS #5 **Refinement of Expected Results, their users and dissemination**

No changes in expected results and their users

As refinement included means of dissemination to AQUACOSM-plus partners and in all participants of mesocosm experiment.

CS #5 **Refinement of Links**
No need to refine links.
All links are at "informal" contact with colleagues.

CRETAN PSS #6 Partnership building

CS #6 **Analysis and refinement of objectives**

Overall, during the first year the action #6 met the objectives of establishing contacts and planning strategy of common interest activities with other PSS, IRSs, RIs and regional initiatives.

During the second period, focus will be given to meet objectives via joint studies, joint workshops, provision/access to data, demo of collaborations, common promotion activities. The active participation of WP2 and WP10 in these processes is important.

CS #6 **Refinement of data sources** (both internal i.e. platforms and other-external)

No changes in partnership are expected within JERICO-S3. Communication and collaboration with additional RIs and/or other projects will be explored

Concerning changes to platforms see actions #1 to #5

No citizen science data sources expected

CS #6 **Refinement of Description of Action and timetable**

This action being dependent of the previous actions the extension to Nov 2022 is advisable as follow up of other actions

Additional contact with other RIs or projects to be explored

CS #6 **Refinement of Data practices, flows, QC, management**

As refinement of best practices some examples of contexts/frameworks/products that could set basis of partnership practices could be mentioned

CS #6 **Refinement of Expected Results, their users and dissemination**

No changes in expected results and their users

As refinement in dissemination consider also promotion to EuroGOOS working groups

CS #6 **Refinement of Links**

All links up to now are "informal" contact with colleagues.
Refinement with additional links and with ways to make joint actions with other PSSs.

4. JERICO-S3 PILOT SUPERSITE LINKS WITH OTHER WORK PACKAGES DURING FIRST YEAR IMPLEMENTATION PHASE

In addition to linking each PSS Action to some other Work Packages, WP4 has interacted with Work Packages at a higher integrated level. The development of PSSs concept and implementation plan (D4.1) were done in close collaboration with WP1 (JERICO-RI monitoring strategies) and WP3 (Integrated Regional Sites). Some parts of the implementation plan were largely influenced by developments and work in WP2 (linking to other communities), WP5 & 6 (use and development of Best practices), WP7 (technological innovations), WP9 (analysis of users and their needs). Links to Transnational Access (WP8) and Virtual Access (WP11) were also requested by each PSS, and links to communications (WP10) were evident.

Jointly with JERICO-S3 communications team (WP10), Pilot Supersites have communicated and disseminated it's activities through web-pages and social media, e.g. by providing an overview of Pilot Supersites, a series of newsflashes, and various tweets. In addition, PSSs have been presented in numerous presentations and workshops.

In connecting different other communities, PSSs provide regional and national links to other RIs and initiatives. For example, some of the PSS actions collaborate with carbon observing community ICOS or with experimental community AQUACOSM, for very practical tasks, elaborating the same research questions from different perspectives. Such pragmatic RI-RI collaboration will assist WP2 define more specific between-RI strategic guidelines and interfaces.

While developing new innovative technologies, WP7 links to PSSs at many points. First, the design, building and testing an interoperable instrument module is linked to PSSs capacities to provide multiplatform and multidisciplinary sampling strategies. As well, development of e-Infrastructure, and related Virtual Access provision by WP11, links to PSSs capacities. Especially the Data-to-Products Thematic Services pilot studies go largely together with PSS developments.

On September 21, 2021, PSSs organized a special workshop to present their progress to JERICO-S3 community, but also to meet with other Work packages to receive feedback. Briefly, WP1 stressed the importance of identifying the key common scientific objectives, as a first building block for RI. As coastal seas are heterogeneous, regional (transinstitutional and transnational) implementation was noted as a good starting point, but the resulting potentially in the heterogeneity in the developments. WP1 main recommendations for overall PSS work were i) clarifying the basis of the structuration of the future RI (to optimize the outputs) and ii) developing centralized actions (in order to increase the added value of the future pan European RI). When finetuning PSSs actions for the second year of implementation, we consider that enhanced interactions with WP9 and with JERICO-DS project are needed to tackle the first item, while the second point is taken into account while planning more between PSS (and between IRS) activities, which were not originally included (in D4.1). The meeting also presented a proposal for greater involvement of the PSS in the

creation of best practices (WP5), which should be considered when revising the PSS implementation plan. WP11 presented the role of Virtual Access in PSSs activities, highlighting the centralised access to relevant resources.

Besides linking to other JERICO-S3 Work Packages, PSSs link strongly also to JERICO-DS. Specific actions have included a joint workshop for multiplatform observations, including also other communities (EuroGOOS, EuroSea, NAUTILOS, MINKE) and a next session supporting JERICO-RI technical and technology design will take place in spring 2022.

5. REFERENCES

Frigstad, H., Ø. Kaste, A. Deininger, K. Kvalsund, G. Christensen, R.G.J. Bellerby, K. Sørensen, M. Norli, A.L. King (2020). Influence of riverine inputs on Norwegian coastal systems. Frontiers in Marine Science 7 (322), https://doi.org/10.3389/fmars.2020.00332.

Munkes, B., Löptien, U., and Dietze, H. (2021). Cyanobacteria blooms in the Baltic Sea: a review of models and facts, Biogeosciences, 18, 2347–2378, https://doi.org/10.5194/bg-18-2347-2021.

Kahru, M., Elmgren, R., Kaiser, J., Wasmund, N. and Savchuk, O. (2020). Cyanobacterial blooms in the Baltic Sea: Correlations with environmental factors, Harmful Algae, 92, 101739, https://doi.org/10.1016/j.hal.2019.101739.