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29 JUNE – 1 JULY 2022
EuroSea/OceanPredict
Workshop on Ocean Prediction and Observing

EuroSea

Assimilation of gliders in the Western Mediterranean

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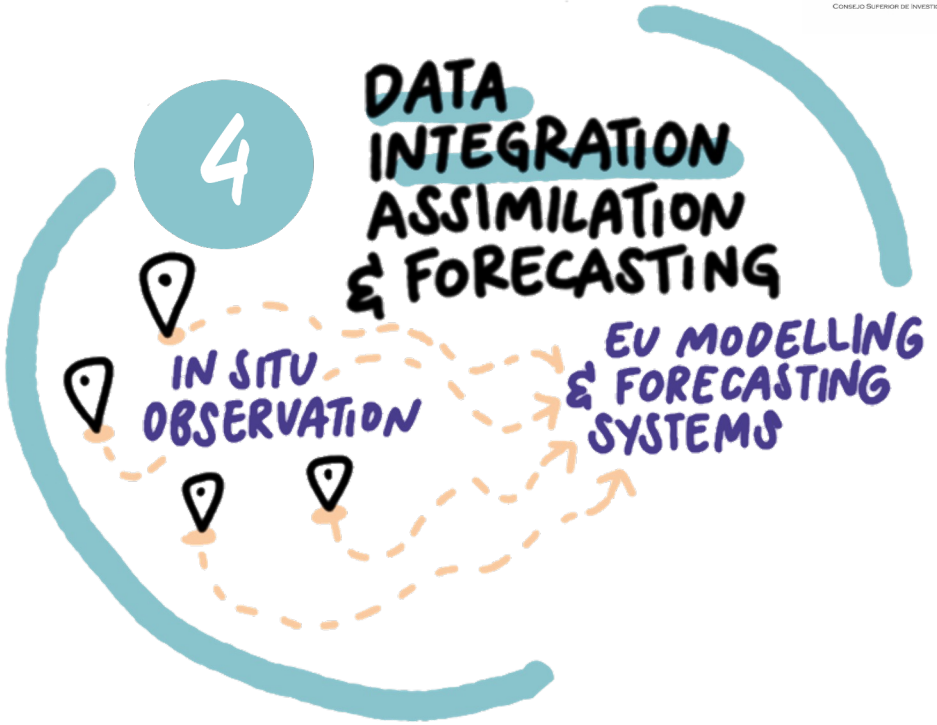
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862626.

Data Integration, Assimilation & Forecasting



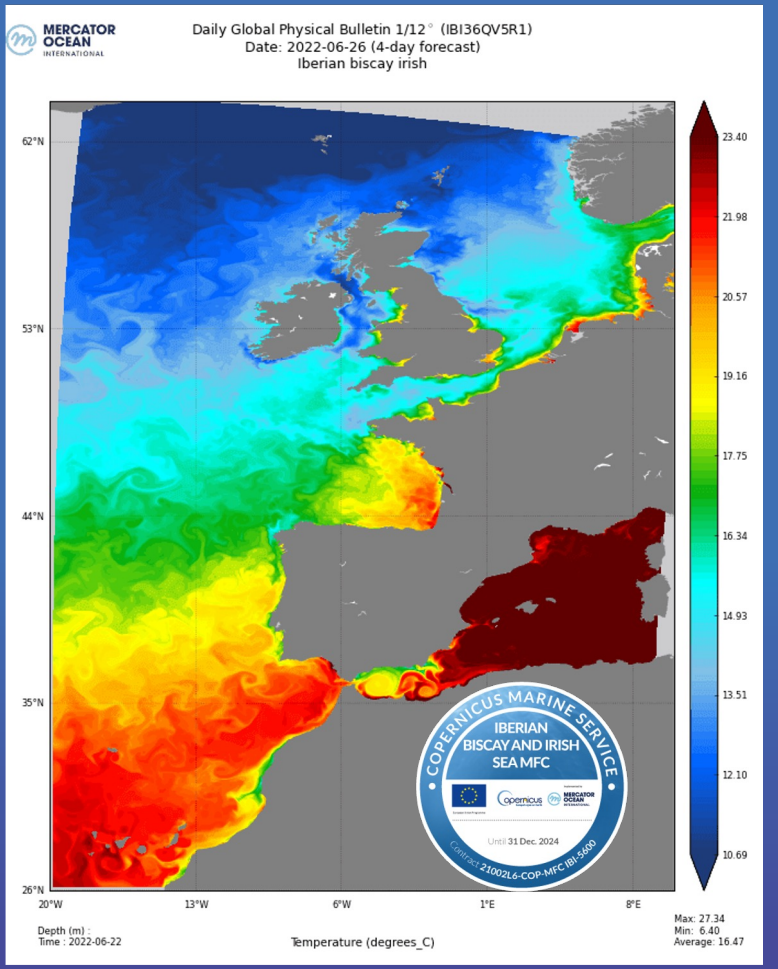
Task 4.1 Assimilation in the IBI: analysis/forecast quality assessment

Impact of glider and floats assimilation

Goal of the OSEs with the IBI system:

- Understand the impact of high frequency / high resolution glider observations on the IBI 1/36° regional analysis
- Improve the data assimilation strategy of HF/HR in situ profiles
- Assess the efficiency of gliders for routine monitoring of coastal environment. Focus on specific physical feature: transport through key section (Canary Islands), eddy reconstruction (Bay of Biscay).

In the Mediterranean sea, multi system experiments comparison for the 2017 OSEs

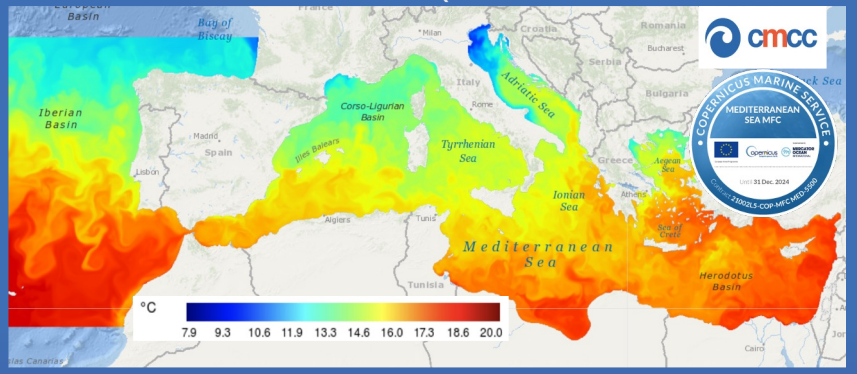


Task 4.2 Assimilation in the Mediterranean: analysis/forecast quality assessment

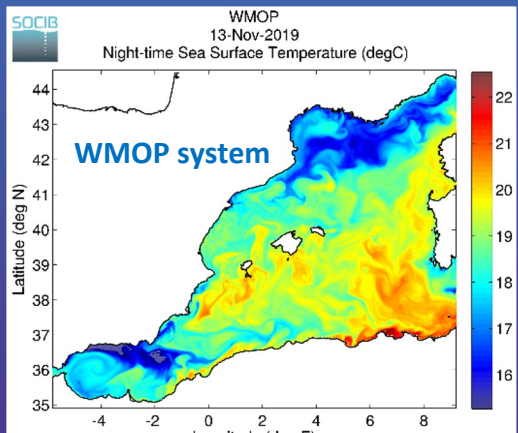
Impact of glider and floats assimilation

- the future configurations of the CMEMS MED-PHY (*Clementi et al., 2021*) system
- coordinated experiments using the CMEMS Med-PHY and WMOP (*Juza et al., 2016, Mourre et al., 2018*) systems

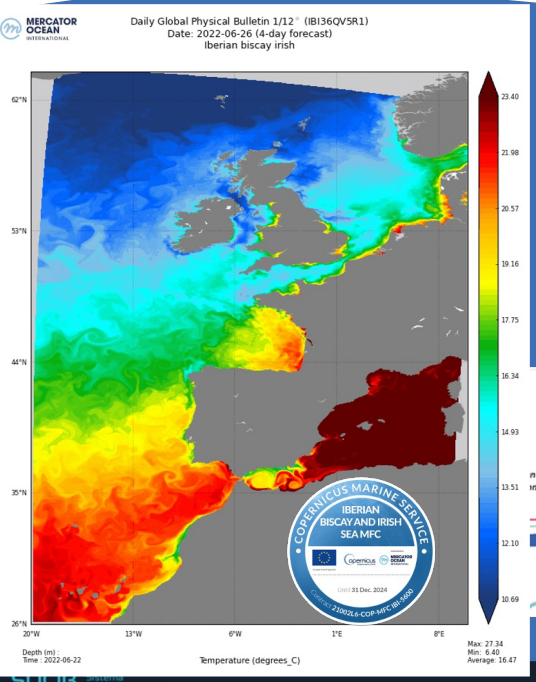
  in the Western Mediterranean

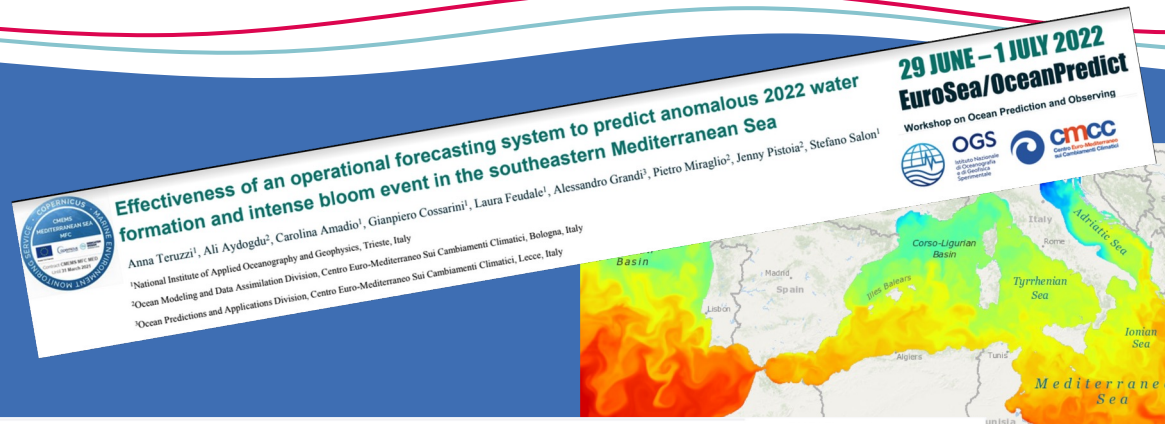


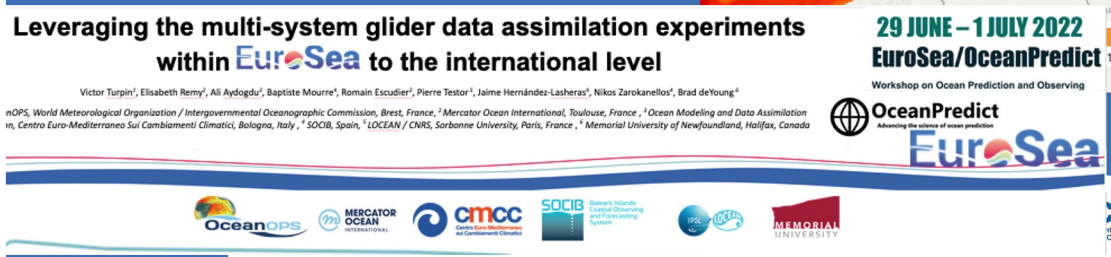
- build knowledge in the use of BGC glider data
- evaluate the impact of the assimilation of glider T,S observations on the MED-MFC BIO (*Salon et al., 2019, Feudale et al., 2021*)
- BGC multiplatform and multivariate assimilation (*Teruzzi et al., 2021*)

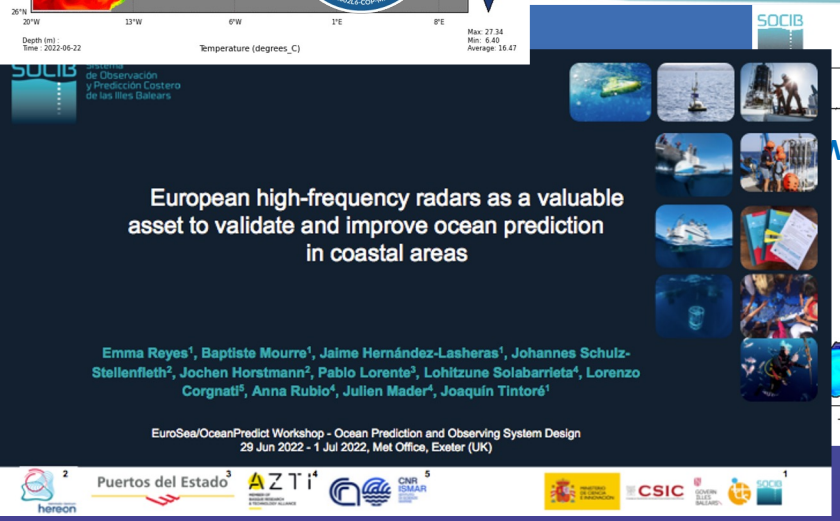


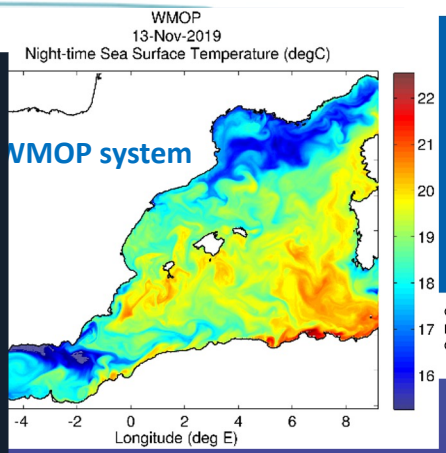
Some other contributions in the workshop using

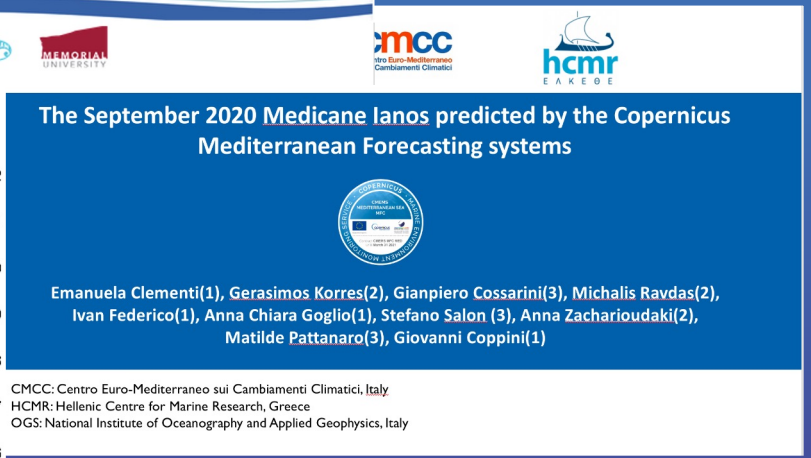








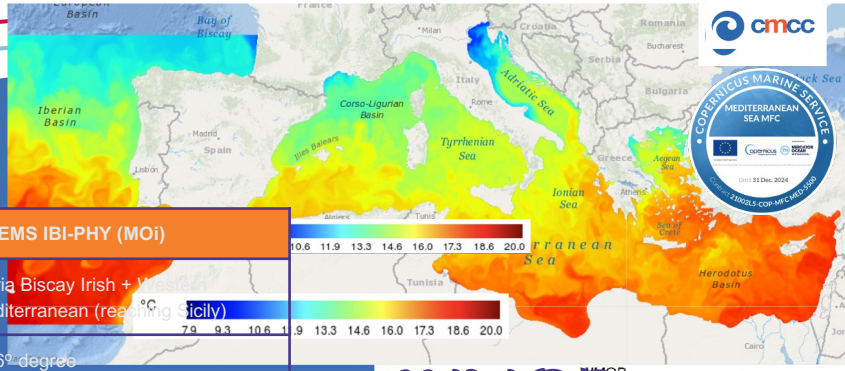




System descriptions

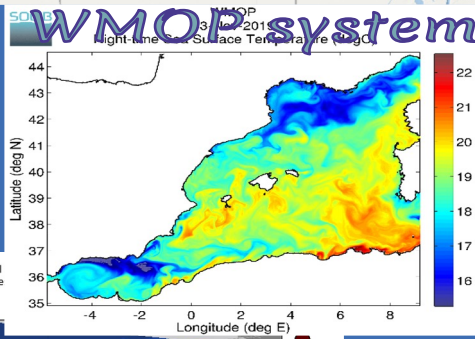
EuroSea

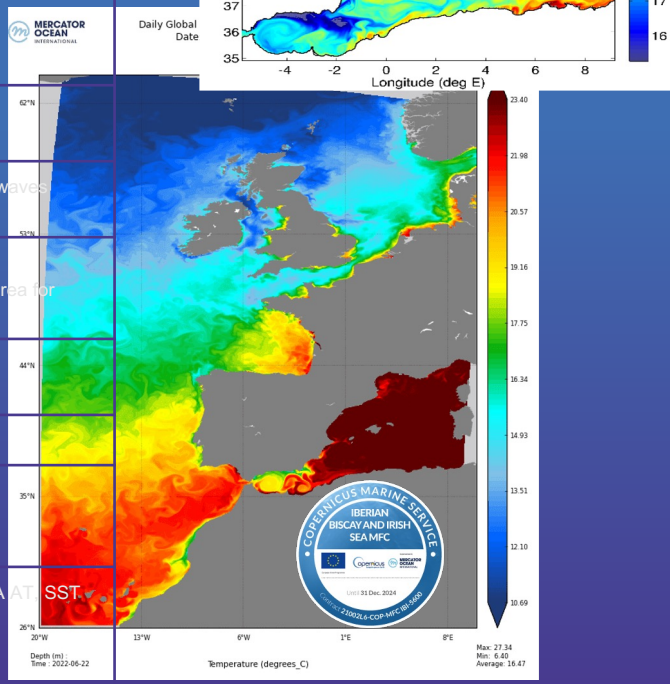
MED-MFC systems



	CMEMS MED-PHY (CMCC)	WMOP (SOCIB)	CMEMS MED-BIO (OGS)	CMEMS IBI-PHY (MOi)
Domain	Mediterranean Sea (+ Atlantic box)	Western Med. Gibraltar to Corsica-Sardinia	Mediterranean Sea (+ Atlantic box)	Iberia Biscay Irish + W Mediterranean (reaching Sicily)
Resolution	1/24° degree (~4.5km) 141 z* vertical levels	~1/50° degree (2km) 32 vertical sigma-levels	1/24° degree (~4.5km) 125 vertical levels	1/36° degree 50 z* vertical levels
Numerical model	NEMO v3.6 < - > WW3 v3.14	ROMS v3.4	MedBFM (OGSTM-BFM)	NEMO v4.2
Time step	120 sec (Barotropic step 2.4sec)	120 sec (Barotropic step 6sec)		150 sec (Barotropic step 5sec)
Parameterizations	Tides, atmospheric pressure	No tides, No atm. pressure	plankton functional types: 4 phytoplankton groups, 4 zooplankton groups, 1 bacteria group Describes the biogeochemical cycle of N, P, C, Si and O. It includes the carbonate system dynamics	Tides, atmospheric pressure
	climatological inputs from 39 rivers.	climatological inputs from 6 major rivers.	climatological inputs from 39 rivers.	33 rivers climatology
	Richardson number-dependent vertical diffusion	Generic model of two-equations GLS turbulent closure.		GLS k-epsilon - Internal waves parametrization
	Flather for barotropic currents and SSH. Orlanski for baroclinic currents	Flather for 2-D momentum. Chapman for surface elevation. Mixed radiation-nudging for 3-D.		Flather for barotropic Prescribed + relaxation area for baroclinic
Atmospheric forcing	ECMWF HR 10km, 6hr resolution	AEMET (Spanish meteo agency) HARMONIE 2.5km 1hr		ECMWF IFS (3h)
Ocean forcing			MED-MFC PHY	
Lateral open boundary condition	From CMEMS GLO-MFC NRT system	From CMEMS MED-MFC		CMEMS GLO-MFC
Data Assimilation	**OceanVar**: SLA along tracks, ARGO vertical T/S profiles	**EnOI**: SLA along-track, ARGO vertical T/S profiles, SST L4 satellite product, HF-Radar (Ibiza Channel)	**3DVarBio**: surface chlorophyll concentration from satellite observations	**SAM2** (SEEK Filter): SLA AT SST L3s, ARGO profiles

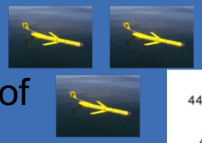
WMOP system

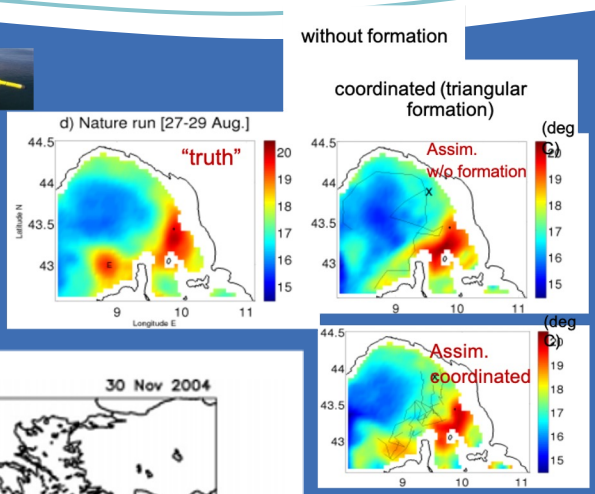




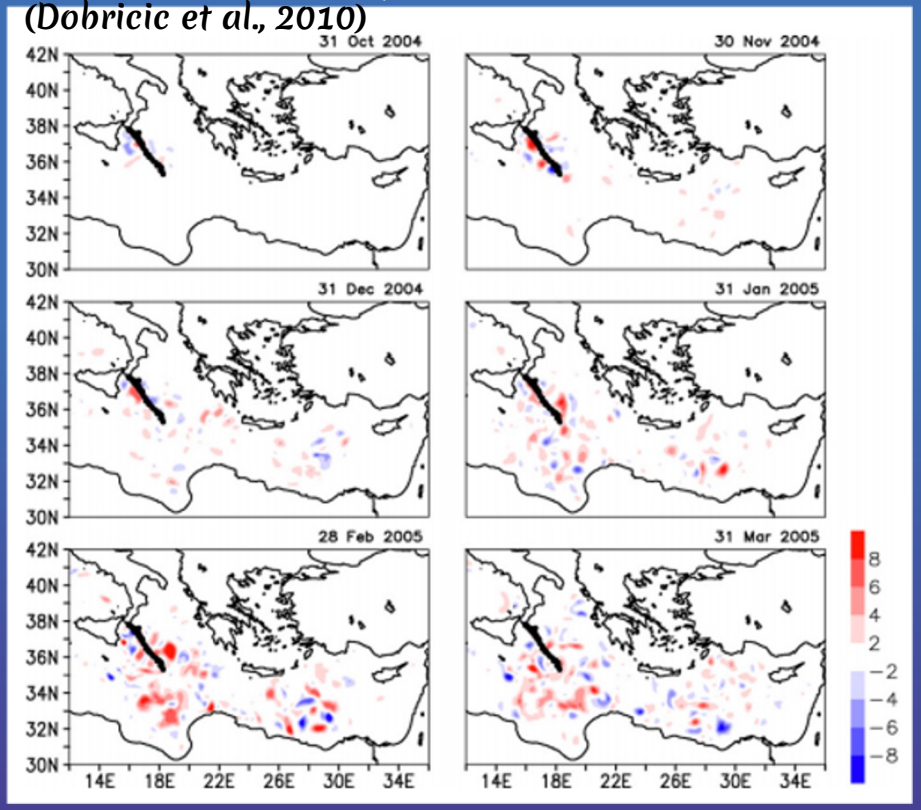
Earlier studies of the task team and systems

Impact of data assimilation of glider observations in the Ionian Sea





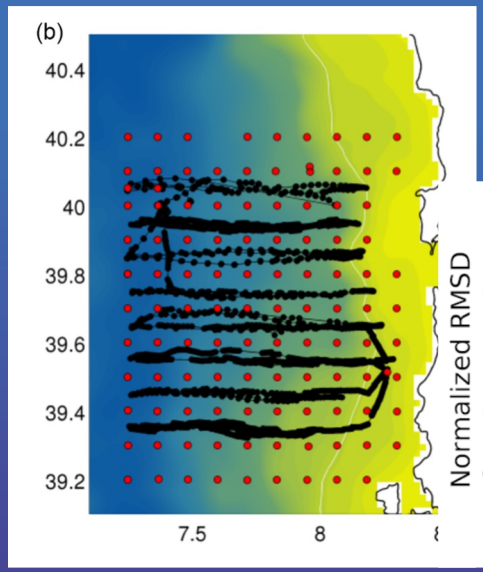
(Dobricic et al., 2010)



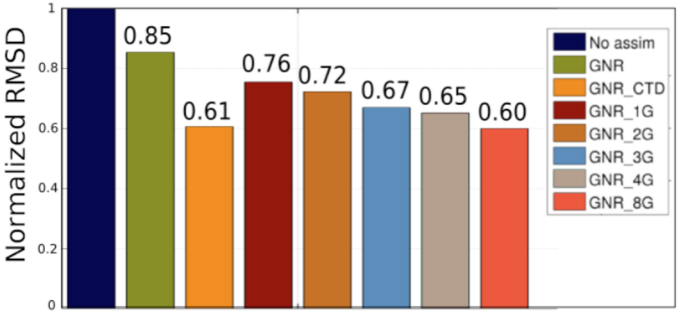
(Alvarez and Mourre, 2014)

Cooperation or coordination of underwater glider networks? An assessment from Observing System Simulation Experiments in the Ligurian Sea

Dense CTD survey versus glider fleet sampling

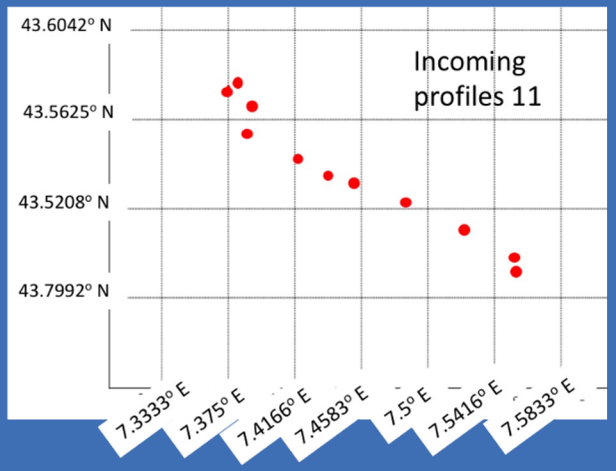


(Hernandez-Lasheras and Mourre, 2018)

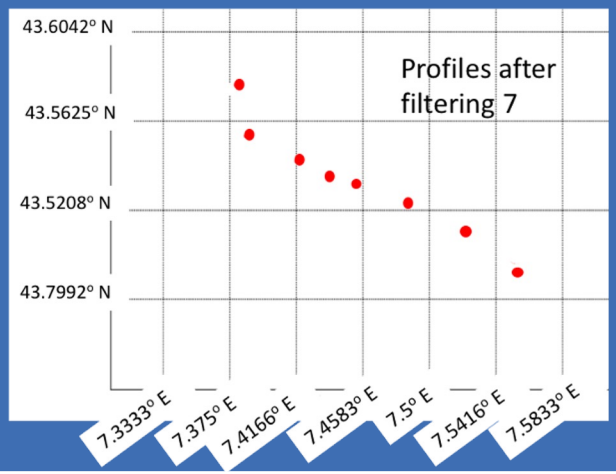


Data preparation and preprocessing

BEFORE SUB-SAMPLING



AFTER SUB-SAMPLING



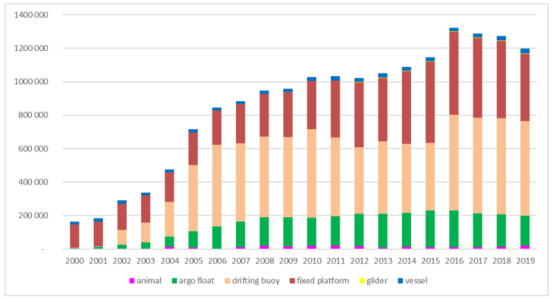
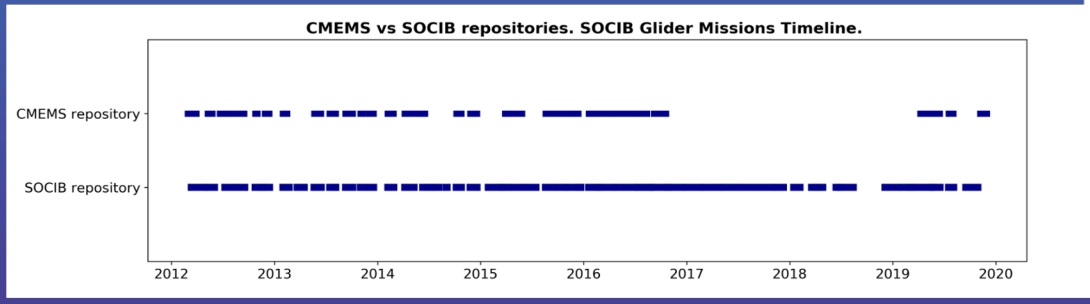
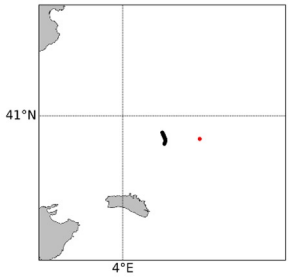


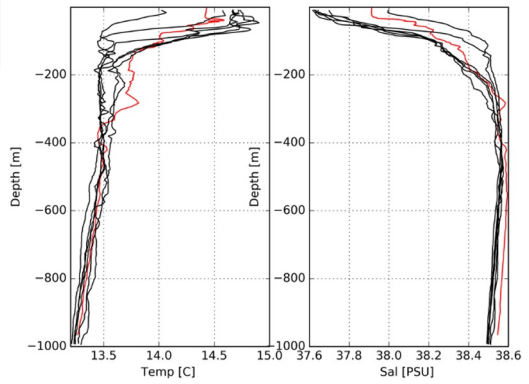
Figure IV.1.3: T&S observations per platform-day, one platform – one day – one or many observations = +1. Years 2000 – 2019.

Managing the high-resolution profiles from gliders in the DA systems

- Subsampling? vs Superobbing?
- Vertical? vs Horizontal?
- Consistency in T,S? too different?







Workshop with observation scientists/providers

- the best practices in use of glider and floats in-situ observations by operational forecasting systems
- On the accessibility to the glider / Argo floats observations in NRT and DT mode.
- On the quality control (QC) in the assimilation systems

EuroSea

Internal Milestone #28

Joint workshop between CMCC SOCIB Task 4.2, Task 4.3, Task 4.4 partners and WP3 on sharing best practices on how to use novel sensors (glider, floats) data for assimilation and validation in the CMEMS (global and MED) and SOCIB operational systems (physical and biogeochemical)

Date: *24 June 2021 10:00-12:00 CET*

Goal: EuroSea Task 4.2 aims at evaluating the impact of the glider and BGC Argo observations on marine forecasting systems in the Mediterranean Sea. The question of where and how to access the data in both near-real-time (NRT) and delayed-time (DT) is critical for this task. Several issues have been identified concerning the glider data availability, especially for NRT systems. The objective of this workshop is to bring together European experts on glider data collection, processing and management with the data assimilation experts to open a discussion on this issues and propose solutions to use glider and float observations in operational forecasting systems in the best possible way.

AGENDA

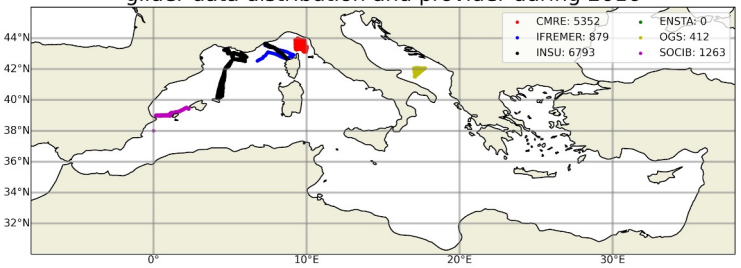
10:00-10:15 Objectives and overview of the status (Ali Aydogdu)
10:15-10:25 Update on SOCIB experience (Jaime Hernandez)
10:25-10:35 NRT and delayed mode data exchange strategy and further opportunities (Victor Turpin / Daniel Hayes)
10:35-10:45 The status of glider observations in the CMEMS (Thierry Carval)
10:45-12:00 Discussion

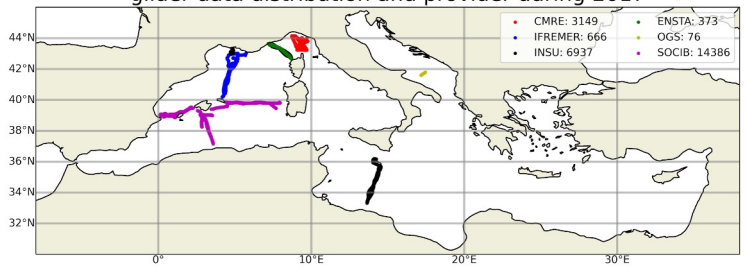
Best practices on how to use novel sensors (gliders and floats) for assimilation and validation

A need…

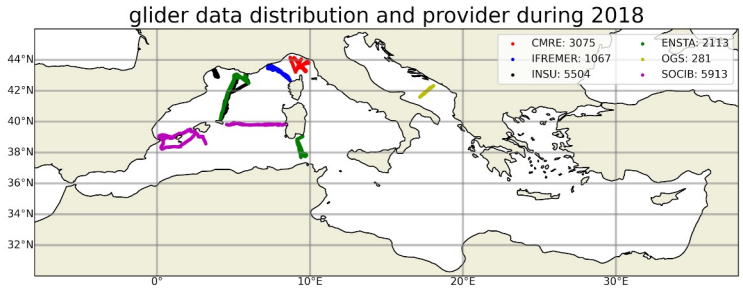
- for more time to assimilate the high-quality glider and BGC-Argo observations in the NRT systems however, DM observations are already high-quality and synchronized to the required repositories.
- to come up with a universal solution. CMEMS (European) and SOCIB (Baleric) systems involved in EuroSea can be taken as a base to detect the need for improvements and propose solutions for every step of the data flow and usage.
- for communication between the communities, e.g., Argo vs. Glider communities to converge on coherent procedure and avoid inconsistencies, Argo + Glider vs. modelling + assimilation communities for the best practices on the use of observations in forecasting and reanalysis systems, e.g., on QC standards.

Observational Datasets

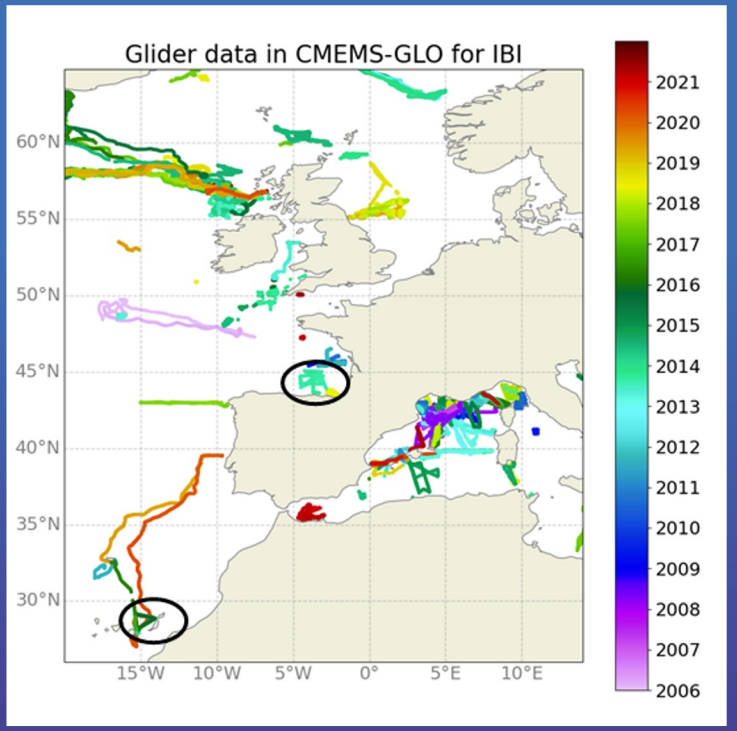




Observations in the MEDSEA



Observations in the IBI domain



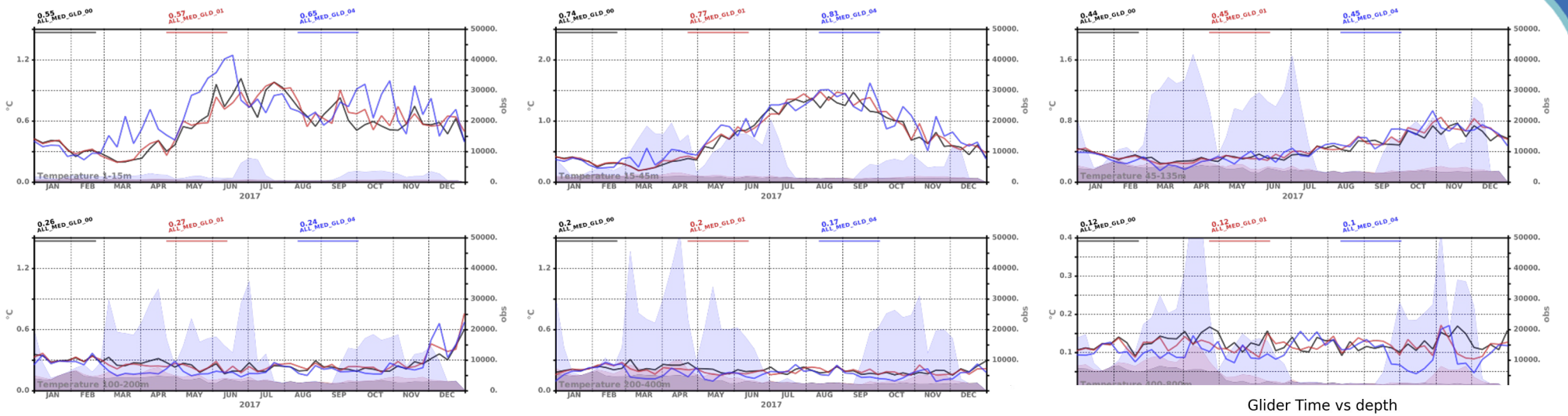
	SOCIB	OGS	IFREMER	INSU	ENSTA	CMRE	Total
2016	1263	412	879	6793	0	5352	14699
2017	14386	76	666	6937	373	3149	25587
2018	5913	281	1067	5504	2113	3075	17953

Assimilation in the Mediterranean Sea

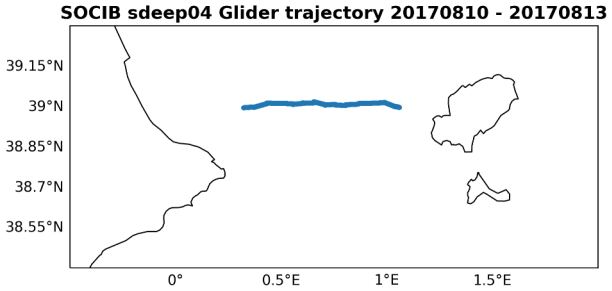
Name	Glider	Subsampling scheme	Status
ALL_MED_GLD_00	✗	----	✓
ALL_MED_GLD_01	✓	last profile of the day for each mission	✓
ALL_MED_GLD_02	✓	Subsampling according the position to have only one profile for grid point	✓
ALL_MED_GLD_03	✓	Superobs (spatial/time average of profiles)	✓
ALL_MED_GLD_04	✓	no subsampling, only ascending profile	✓

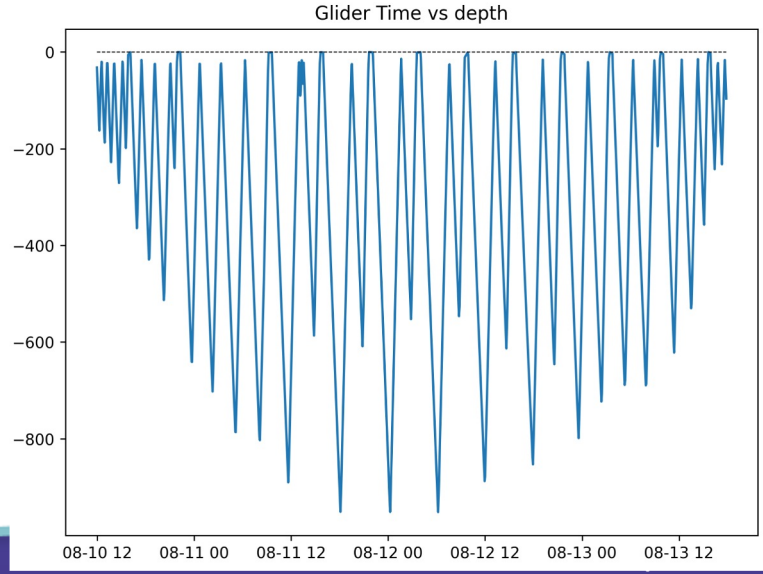
Assimilation in the Mediterranean Sea

no glider | **1 ascending profile** | **all ascending profiles**

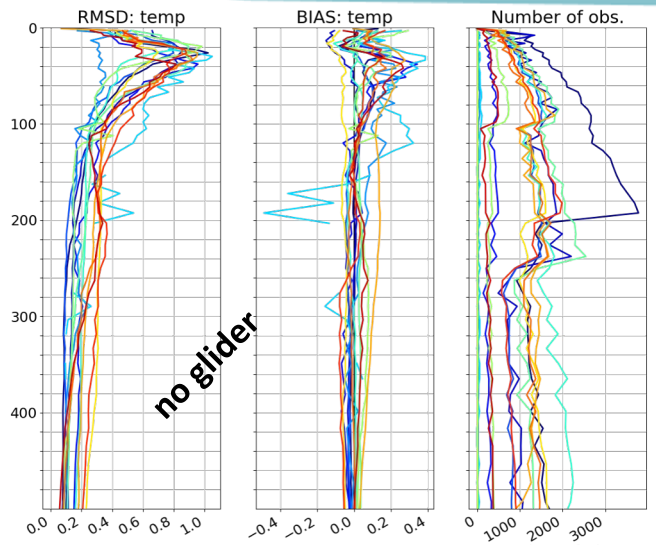


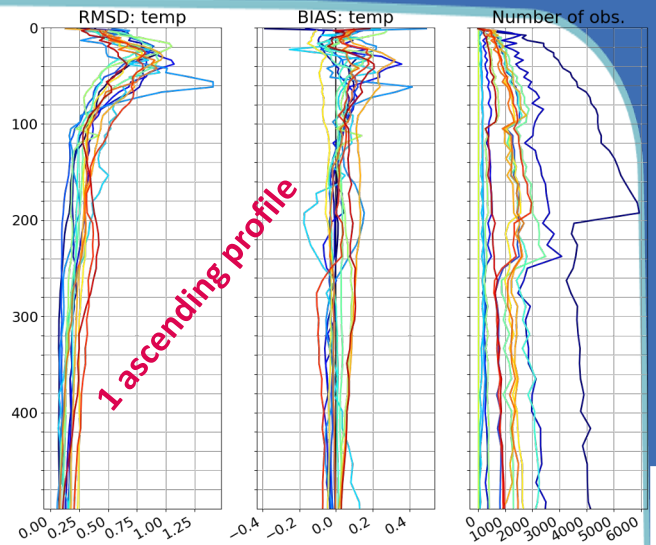
- Significant increase in the number of observations
- Improvement in the deeper layers while a degrading at the surface layers
- Perform experiments with only surfacing profiles

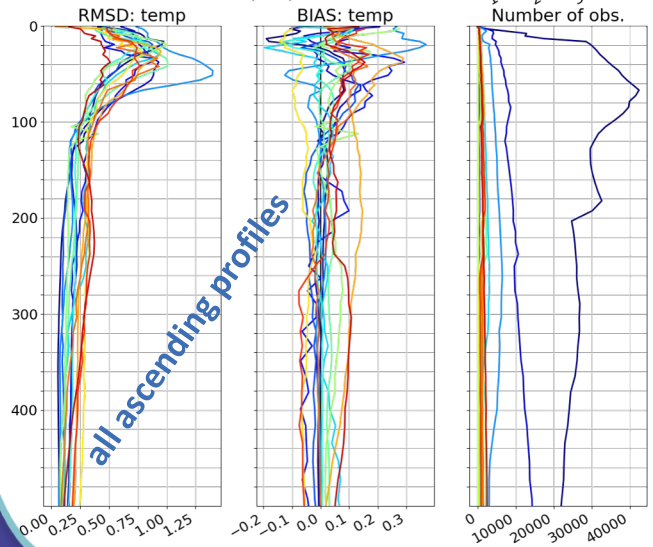


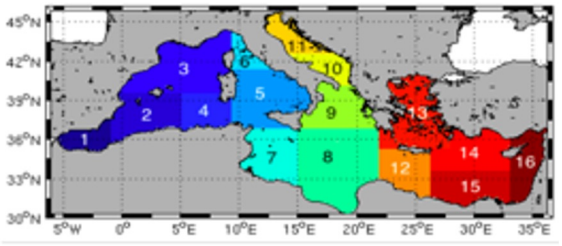


Assimilation in the Mediterranean Sea

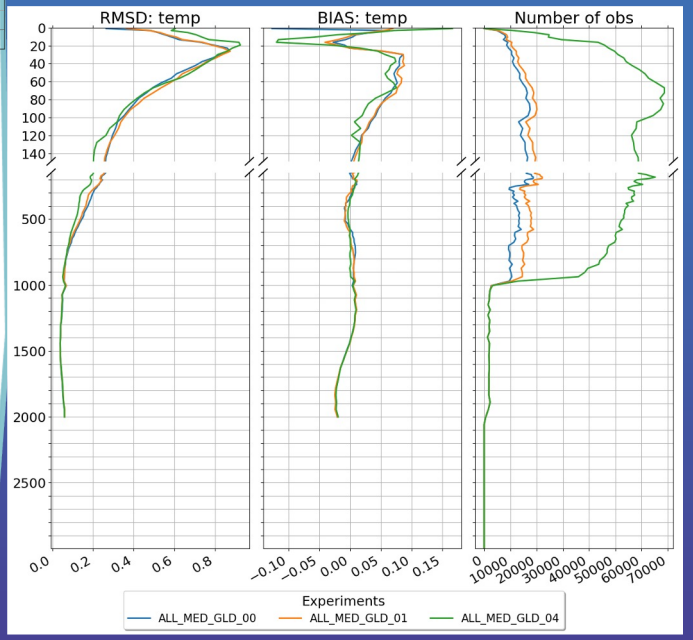








RMSD of temperature in the whole basin



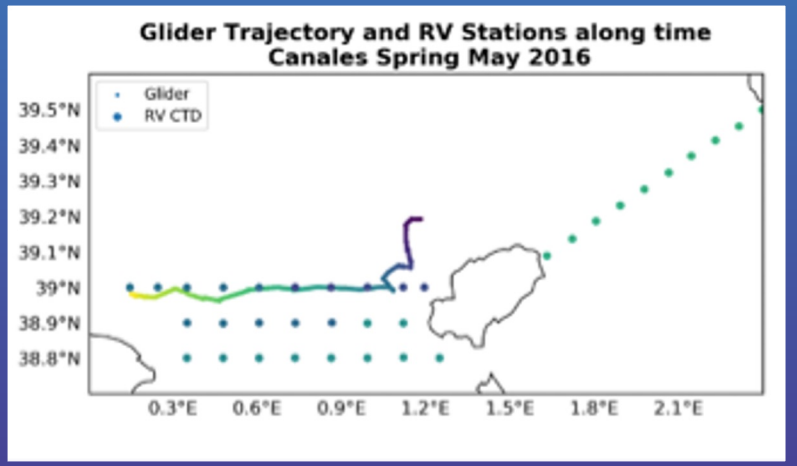
Assimilation in the Western Mediterranean Sea

WMOP. Experiments

- 3 Simulations
- 1 year reanalysis, 2017 (+1 month spin-up)
- 3 day assimilation cycle
- Multimodel local EnOI, with nudging initialization step after analysis

noGLIDERS	GLIDERS	NO ASSIM
(SLA + SST + Argo T-S + HFR)	(SLA + SST + Argo T-S + HFR Gliders)	(Free run)

- CTD data from RV campaign to be used for independent validation.
- Seasonal campaigns in the Ibiza Channel.

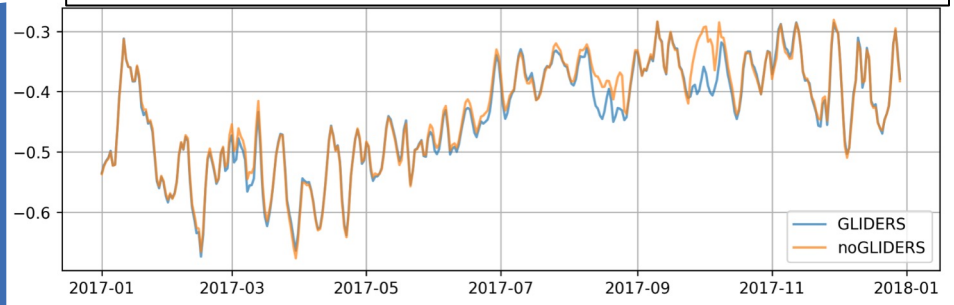


Assimilation in the Western Mediterranean Sea

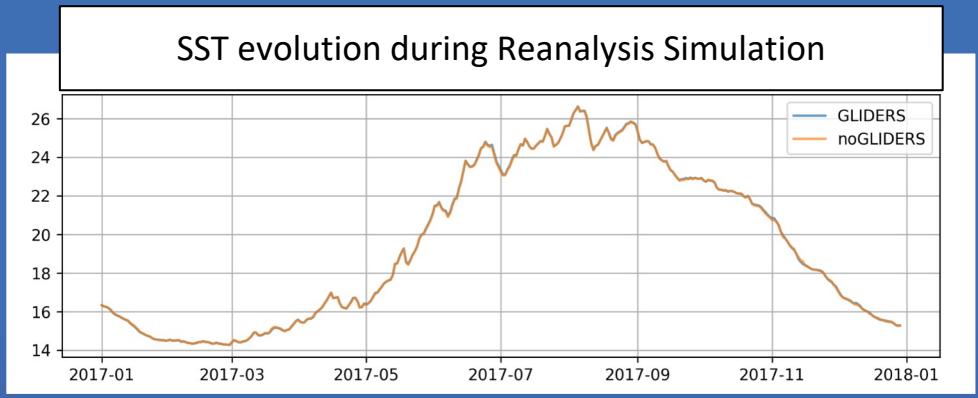
WMOP. First Results

- First analysis show a good agreement between simulations assimilating data, without any anomalous impact of glider observations.
- More comprehensive evaluation in progress

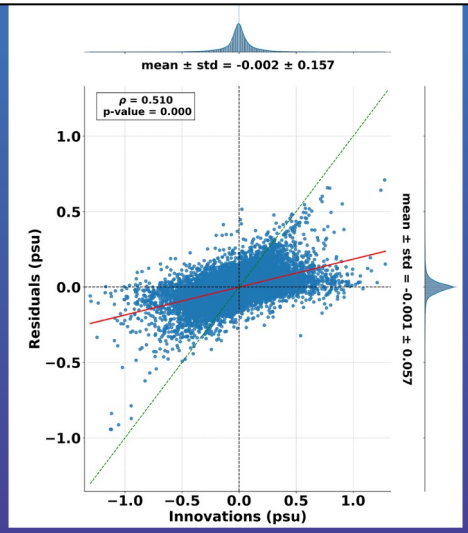
SSH evolution during Reanalysis Simulation



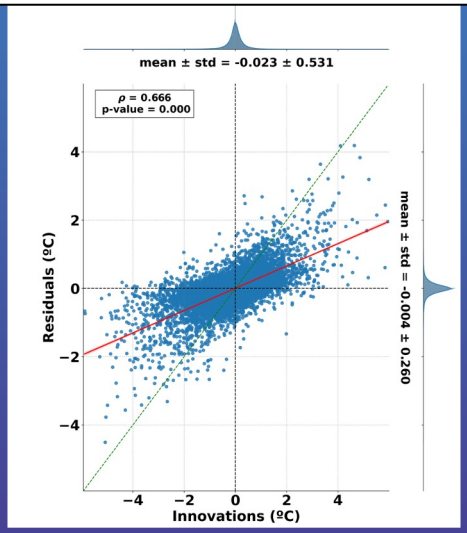
SST evolution during Reanalysis Simulation



Innovations vs Residuals
Argo Temp (all period). Gliders exp



Innovations vs Residuals
Argo Sal (all period). Gliders exp

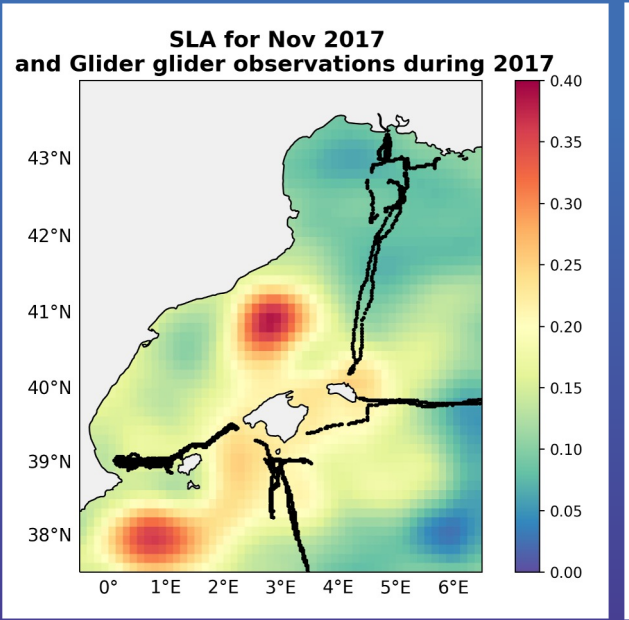


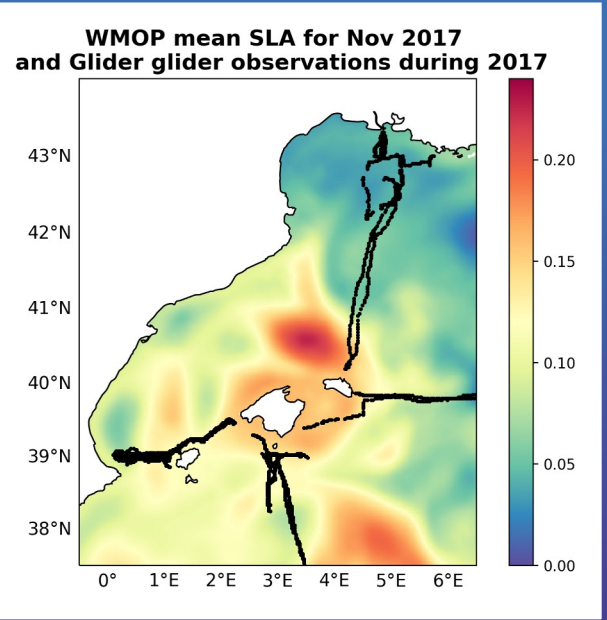
- The DA analysis is systematically closer to observations (for all observing sources, in both simulations), improving the forecast:

Residuals (analysis - obs) **<<** **Innovations** (background - obs)

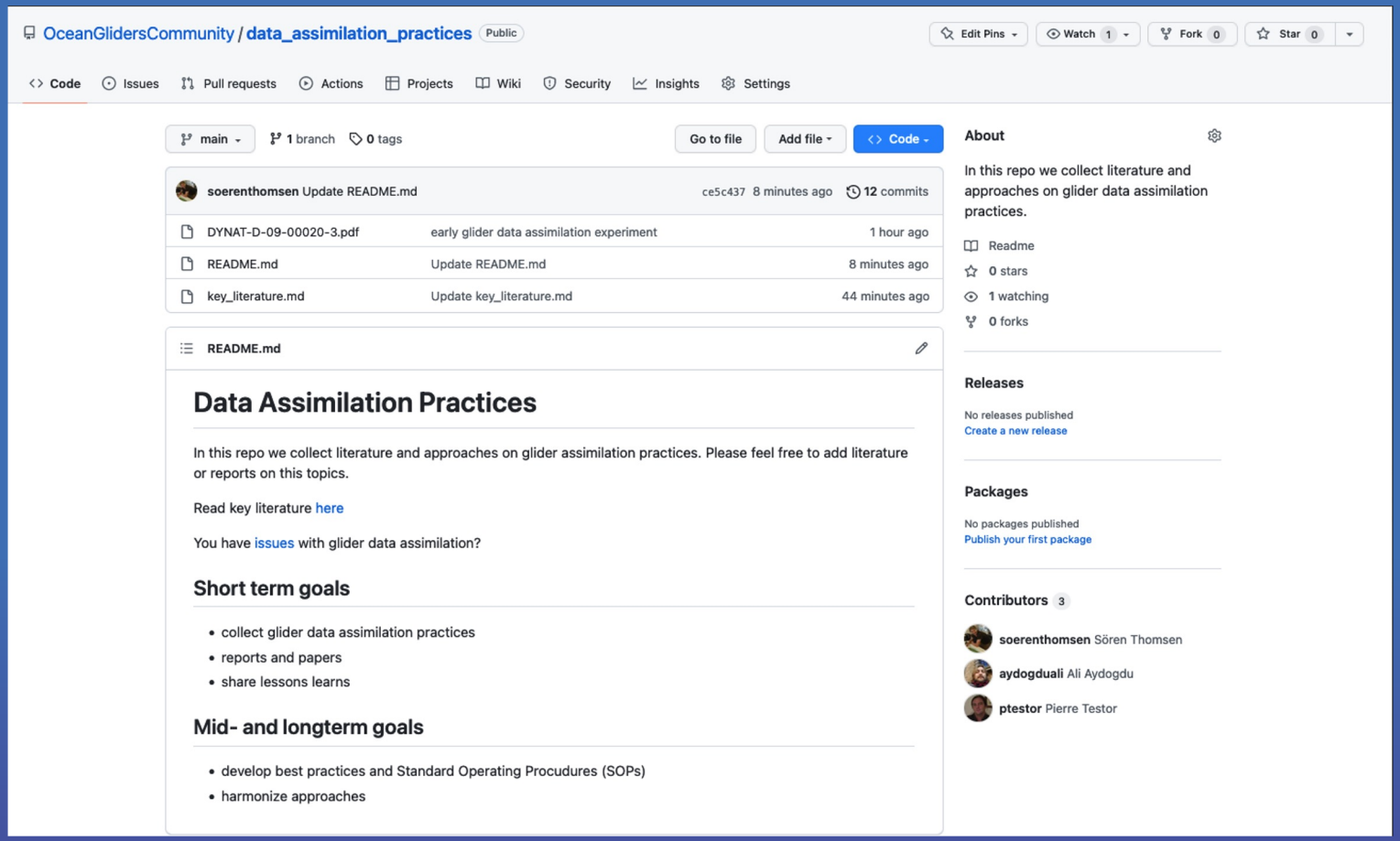
Further steps

- Intercomparison in the Western Mediterranean common domain in the MED-MFC IBI-MFC and WMOP systems
- Statistical improvement will be assessed in the individual systems, some glider data can be left aside for completely independent validation
- Evaluation of the ability of glider DA to correct mesoscale structures (fronts, eddies)
  e.g., intense anticyclonic eddy in the Balearic Sea (Aguiar et al. 2019; OSR3, Aguiar et al. 2022, ,JGR-Oceans)





Engagement with OceanGliders community



Members of OceanPredict community are welcome to contribute to the effort!

Task 4.{1,2} Assimilation in the Mediterranean and IBI Seas

Analysis/forecast quality assessment

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