Leveraging the multi-system glider data assimilation experiments within EuroSea to the international level

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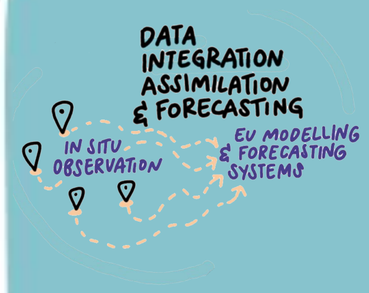
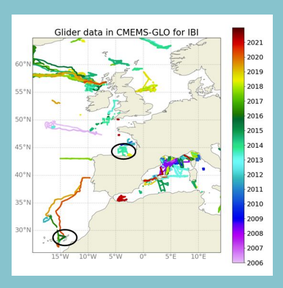
29 JUNE – 1 JULY 2022
EuroSea/OceanPredict
Workshop on Ocean Prediction and Observing

This poster aim at enhancing the cooperation between the ocean operational community and ocean observing community to:

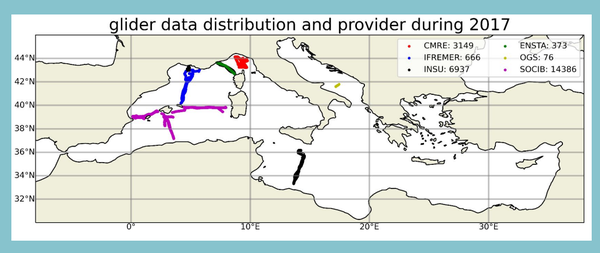
- *Advocate for sustainability of in situ observations*
- *Show the role and potential of gliders data in improving the ocean estimates*
- *Discuss future needs and requirements from an operational perspective*
- *A better understanding of the observation information content, data treatment and quality content*
- *Disseminate results acquired during EuroSea*
- *Highlight the diversity of studies and the need for joint perspectives from each communities to leverage disseminated efforts*

Assimilation of gliders in EuroSea





Glider observations available in different years in the IBI domain (top) and providers in the Mediterranean Sea in 2017 (below).

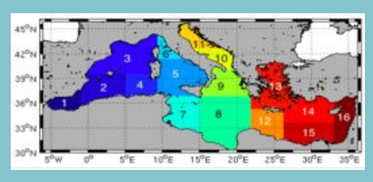


⇨ Gliders are sampling permanently every region of the European Seas (IBI, North Seas, Baltic, Arctic and Mediterranean Sea), supported by 12 European countries and coordinated internationally (OceanGliders) and regionally (EuroGOOS)

⇨ Gliders contribute significantly to the number of observations in the Western Mediterranean

⇨ Gliders are used routinely along regular lines producing a long term time serie of high resolution data set available in real time

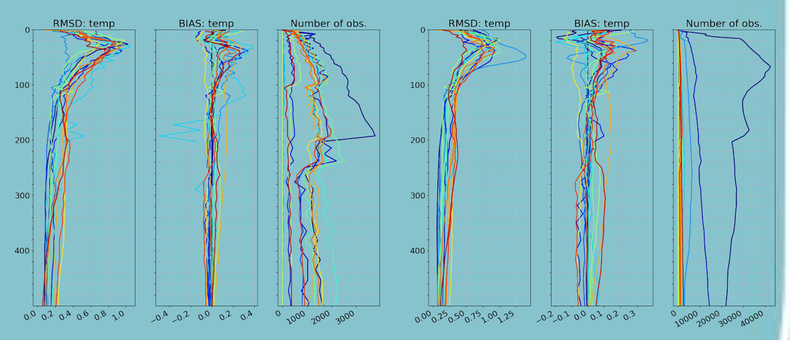
⇨ It is crucial to understand how to benefit the best way from this sustained coordinated ocean observing effort by improving the quality control, subsampling schemes and uncertainty representation of the assimilation systems.



⇨ In WP4, task teams 4.1 and 4.2 are working together to develop capacity for the assimilation of the glider observations and demonstrate best practices for the intercomparison of the impact on different systems.

⇨ In the study, WMOP (SOCIB), Copernicus Marine Service MED-MFC (CMCC) and IBI-MFC (MOi) blue ocean components are included. For the assessment of the impact on the green ocean, MED-MFC (OGS) BGC system is employed.

⇨ An intercomparison experiment is designed to assess the impact of the same dataset of glider profiles in the common domains (Western Mediterranean).



RMSD, BIAS and number of observations without (left) and with (right) glider observations in different regions of the Mediterranean Sea show on the map (bottom).

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

⇨ To discuss the practices in use of glider and floats observations by operational forecasting systems.

⇨ To discuss the accessibility to the glider / Argo floats observations in NRT and DT mode.

⇨ To discuss the quality control (QC) in the assimilation systems

Outcome : A set of needs and requirements …

⇨ 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.

⇨ For a universal solution in the data flow, format and QC to standardize access to the glider observations

⇨ 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.

A perspective from OceanPredict

Regular lines and dedicated fleet of gliders are operated worldwide to monitor the coastal environment (California Underwater Glider Network, Mediterranean Ocean Observing System for Environment, Canales Lines, Ellet Line), improve the understanding and foreacts of hurricanes (NOAA Hurricane Underwater Gliders), and observe the deep water convection area (Labrador Sea, Gulf of Lion, Adriatic Sea)

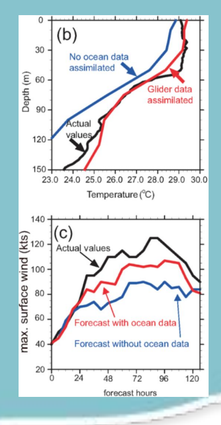
Ocean gliders data from some of those regional monitoring systems routinely assimilated in different ocean/coupled operational system have shown that:

- Glider assimilation can improve coupled hurricane forecast (Goni G. J. et al., 2017)
- Underwater gliders are well suited for sustained observations of boundary currents and their low-frequency variability (Zaba K. D. et al., 2018).
- Glider vertical profile data need to be supported by surface observations when assimilated in a high-resolution coastal ocean model (Pasmans I. et al., 2019, Levin J., et al., 2021)
- Coordinated glider fleet networking is beneficial for the prediction (Alvarez and Mourre, 2014), as well as adaptive sampling strategies (Mourre and Alvarez, 2012)
- The assimilation of data from a fleet of gliders provides a similar performance as that of a dense CTD survey for local predictions (Hernández-Lasheras and Mourre, 2018)

Dedicated efforts are needed to continue to improve the efficiency of glider assimilation and better understand their complementarity with other observing networks when use in operational monitoring and forecasting systems.

Future works include:

- Coordinated glider dives targeting assimilation experiments
- Collaboration on real-time quality check (RTQC) procedures
- Intercomparison experiments among DA systems
- Investigating the assimilation of correlated observations in the water column



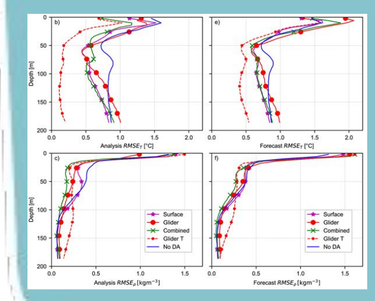
Further studies on the glider assimilation

Storm forecasting

Towards Better (Intensity) Predictions of Atlantic Tropical Cyclones (Goni et al., 2019).
While Tropical Cyclone (TC) trajectory forecasts have improved constantly since 1970, short term intensity forecast haven't progressed much in the last 20 years (b).
Ocean stratification is an decisive element of storm intensification (or collapsing). Monitoring the upper ocean temperature and salinity are key to improve hurricane intensity forecasts. Gliders have the capacity to measure and transmit the real time data directly under any category of storms. Assimilation of T and S data to reproduce ocean stratification is essential to improve TC intensity forecasting (c).

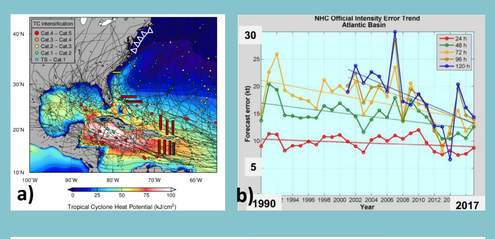
Coastal ocean forecasting and analysis

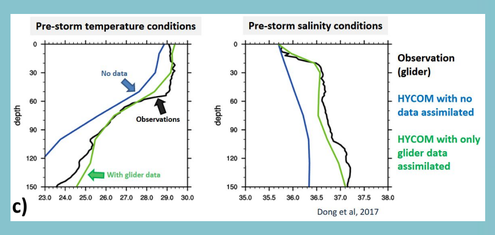
Why Gliders Appreciate Good Company: Glider Assimilation in the Oregon-Washington Coastal Ocean 4DVAR System With and Without Surface Observations, (Kurapov et al., 2019)



This study shows that it can be dangerous to assimilate glider vertical profile data in a high-resolution coastal ocean model if these data are not supported by surface observations.

RMSEs from analyses (b–c) and forecasts (e–f) averaged over the period 21 July 2011 to 11 August 2011 compared to glider salinity observations (first row), glider temperature observations (second row) as functions of depth





a) Compiled TC tracks in the North Western Atlantic over upper ocean heat potential.
b) Trend in the intensity forecast error of hurricane in the Atlantic basin.
c) Temperature and Salinity gliders data assimilation impact on the upper layer of the ocean.

A perspective from OceanGliders

The Storm task team

Storm affects billions of people that live near the coast causing 100s of bilions of dollars in damage annually.

OceanGliders operate unhindered storms in a broad range of water depth.

All OceanGliders provide critical data for assimilation well ahead of the storm to better define essential ocean features impacting storm intensity

Uncertainty in forecast models provide guidance on where and when to deploy OceanGliders to maximize value.

The Boundary current task team

Society feels the effects of ocean variability through boundaries, ecosystems are highly impacted by human activities in these zones and extreme weather and marine events affects billions of people who live and work near the coast.

Gliders connect the coast and open ocean, they capture physical and BGC variability across high gradients and swift currents and integrate effectively with other monitoring system and ocean models.

OceanGliders boundary task team is working to deliver in sustainable manner gliders data in real time, that are essential for forecasting systems and regional products.

What's next ?

Advocate for OceanGliders representatives in the OceanPredict and OceanPredict representatives in the OceanGliders coordination bodies

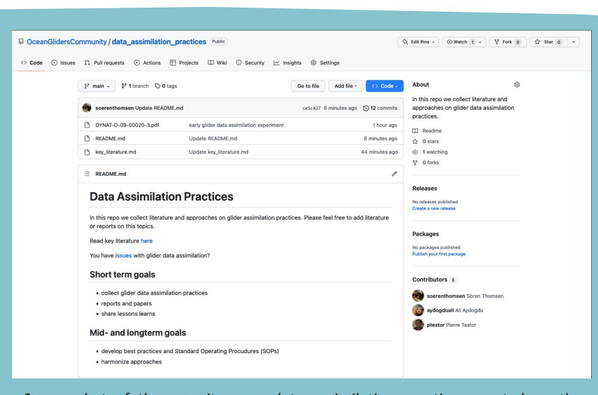
International bodies like OceanPredict and OceanGliders should permanently include representatives of each communities in their coordination body to disseminate progresses and enhance scientific cooperation. This requirement can be extended to any in situ observing system aiming to contribute to ocean forecasting and analysis.

Sharing the data assimilation practices

Ocean data assimilation practices is not very well known by the ocean observing community. This lack of shared knowledge between the two communities, is limiting scientific cooperation that is prejudiciable to achieve the full potential of gliders data assimilation. To overcome this situation, the OceanGliders community has recently open a dedicated repository on his Github page : https://github.com/OceanGlidersCommunity/data_assimilation_practices

Engage in the RTQC Standard Operational Practices

Real Time Quality Control is essential to deliver high quality data to the assimilation community. The standard operational practices for Real Time Quality Control is open to anyone interested in the topic to suggest and improve RTQC for gliders data. Data assimilators are amongst the number one user of the gliders data real time, their feedback and requirement it essential to build efficient RTQC.



Screen shot of the repository on data assimilation practices created on the workspace of the OceanGliders community on Github.