Revamping data system and portal in the Basque Operational Oceanography

2022 IEEE International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea) | 978-1-6654-9942-2/22/$31.00 ©2022 IEEE | DOI: 10.1109/METROSEA55331.2022.9950947

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Abstract— *The Basque Operational Oceanography System named EuskOOS is a multiplatform system composed by coastal stations, ocean buoys, high frequency radars, videometry systems and wave and ocean models, operating since 2001. EuskOOS system carries out an exhaustive monitoring of different ocean parameters, allowing the evolution analysis of weather, storms, gales, etc. A good management of the delivery, formatting and dissemination of the monitored ocean data is crucial for the usefulness and impact of*

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the generated datasets. EuskOOS has recently developed two main elements of the data centre (backend and frontend) upgrading to an interoperable open data management ERDDAP server (backend), followed by the generation of a user-friendly portal (frontend) for data visibility and accessibility. These new steps would allow EuskOOS to get a joint double achievement: (i) reach higher impact in the Basque society while (ii) contributing to the European Ocean Observing System Portals with interoperable datasets, which are directly available in the ERDDAP and can be extracted by any user.

Keywords — operational oceanography, datasets, data interoperability, EuskOOS, ERDDAP, Basque Country

I. INTRODUCTION

Acquiring knowledge and information for the different uses of the marine environment, for the exploitation of its resources and its sustainable management, requires advanced observation technologies. In addition, the prediction of extreme events, marine spatial planning, rescue operations, as well as ecosystem and climate modelling, depend on ocean observations and the existence of efficient operational oceanography systems. The European Global Ocean Observing System (EuroGOOS) defines Operational Oceanography as the activity of systematic and long-term routine measurements of the seas and oceans and atmosphere, and their rapid interpretation and dissemination. An operational oceanography system comprises five essential components. These are: the observation networks, data management and monitoring, prediction and assessment, service delivery and dissemination, and uptake of products by end users/clients [1].

In the late 20th century, the Basque Meteorological Agency (Euskalmet) started to set up an observation network in the Basque coast in order to provide local metocean information [2,3,4]. Later, during the first decade of the 21st century, an operational metocean system was implemented in the Basque Country with six coastal stations and two deep water buoys [5]. Since then, other technologies were added to this system, such as the HF Radar [6] and coastal videometry [7], enhancing its scope and becoming the Basque Operational Oceanography System named EuskOOS (https://www.euskoos.eus/). The observing platforms contained nowadays in EuskOOS are described in TABLE 1 and their geographical location is shown in Fig 1.

In addition, two numerical models complete the EuskOOS system: WAM wave model and CROCO ocean model, both implemented in the Basque Coast, providing forecast data for a 3-day horizon.

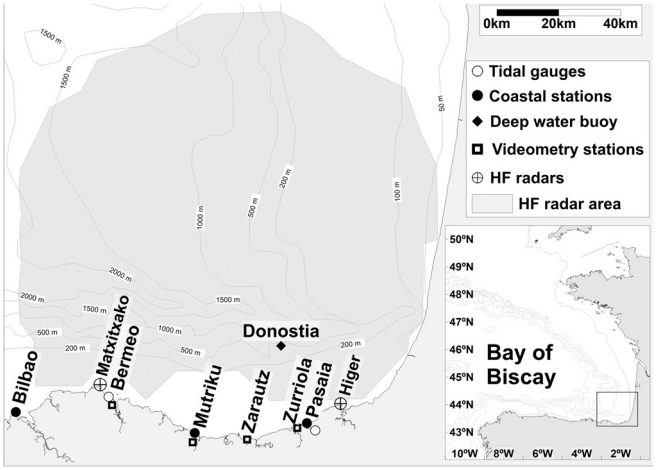


Fig 1: Location of EuskOOS platforms in SE corner of the Bay of Biscay (Spain)

Data from these platforms are sent in real time (by satellite and other means of communication) to the facilities of Euskalmet where exhaustive monitoring is carried out at the precise moment, thus allowing the evolution analysis of the weather, storms, gales, etc. However, the delivery and dissemination to users, until now, was disperse, complex, and mainly focused on the operational needs of the Emergency Department of the Basque Government.

In order to (i) reach a higher impact both in the Basque society and as contribution to the European Ocean Observing System landscape, (ii) offer an easier way to access datasets in Near Real Time (NRT) and, (iii) provide final users a better visualization of datasets, EuskOOS aims to implement innovative tools to progress on its interoperability, making easier the access to scientific data and improving their uptake in the Basque Country and beyond in the European framework.

In this contribution, the "delivery and dissemination" component of EuskOOS, based on the FAIR (Findable, Accessible, Interoperable and Reusable) principles [8], is described.

TABLE 1: description of the EuskOOS platforms

Platforms	Location	Measured variables	Start year	Sampling rate
Coastal stations	Pasaia	Subsurface temperature, Sea surface temperature, Subsurface salinity, Subsurface currents, Air temperature, Wind, Air pressure, Air humidity & Precipitation	2001	10' – 30'
	Bilbao		2003	10'
	Mutriku		2021	10' – 30'
Tidal gauges	Pasaia	Sea surface height (SSH)	2015	10'
	Bermeo		2019	10'
HF radars	Higer	Surface currents & Waves	2009	1 hour
	Matxitxako		2009	1 hour
Videometry stations	Bermeo	Coastal flooding, Wave overtopping, Coastline position, Nearshore bathymetry & Port agitation	2017	30'
	Mutriku		2021	30'
	Zarautz		2016	10'
	Zurriola		2020	30'
Deep water buoy	Donostia	Subsurface temperature, Sea Surface temperature, Subsurface salinity, Subsurface currents, Air temperature, Wind, Air pressure, Air humidity & Precipitation	2007	1 hour

II. REVAMPING EUSKOOS DATA DISSEMINATION

The data acquisition workflow in EuskOOS has been improved since its set up and nowadays fits the common international requirements to obtain adequate and quality controlled data for final users. NRT updated user-friendly visualization site, where a downloading tab of the data was created to facilitate the data understanding and accessibility for users.

In order to offer the final user a better experience with EuskOOS during the visualization and downloading of data, an ERDDAP data server has been deployed to enhance the delivery and dissemination of the EuskOOS datasets. This new data system is a consistent way to download subsets of scientific datasets in several common file formats, allowing new capacities for the integrated dissemination of metocean information. The improvement of the new EuskOOS data system has been performed through the development of two main elements:

- Backend: an upgraded open data management ERDDAP server, interoperable with the main EU ocean data infrastructures (Fig 2)
- Frontend: a friendly portal to give visibility to the data through any platform (smartphone, tablet, computer), represented by graphs, tables and geographical maps.

A. Backend: EuskOOS ERDDAP data server

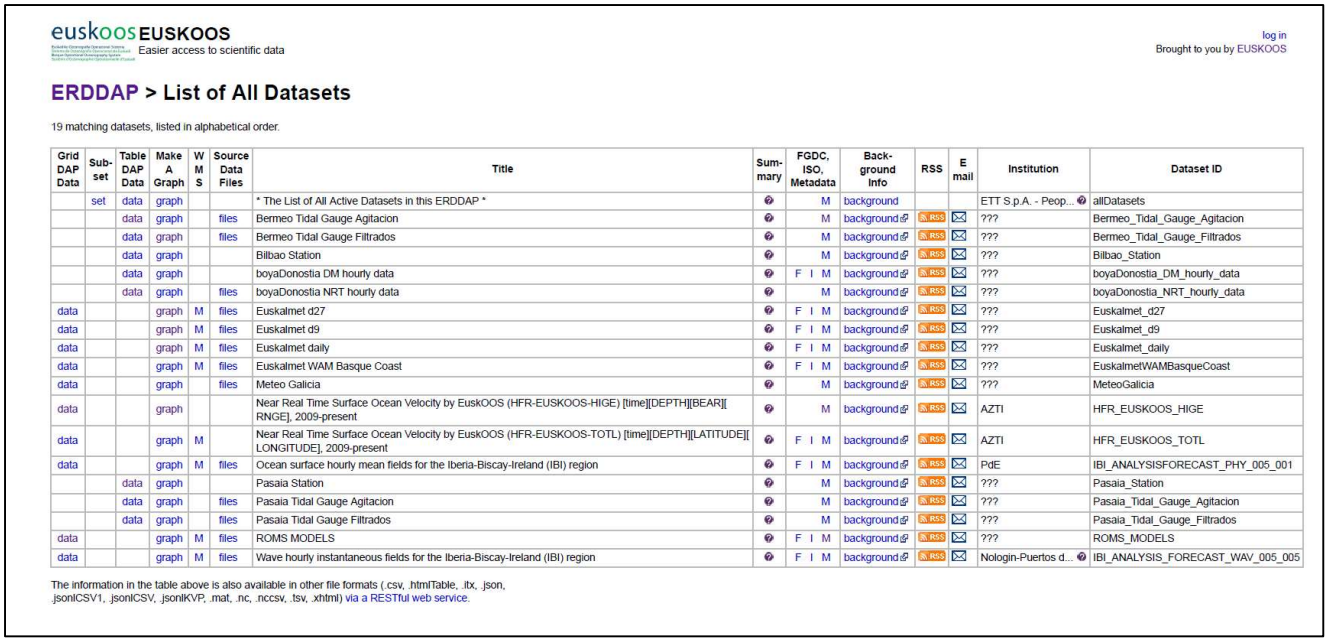
The ERDDAP data server allows to centralize the access to ocean data coming from a high diversity of observing platforms and modelling systems.

ERDDAP is a NOAA project based on an Apache data server that offers an easy and consistent way to download subsets of gridded and tabular scientific datasets in common file formats and make graphs and maps. The distinctiveness of ERDDAP is that it unifies the different types of data servers, so the user has a consistent way to get the required data in multiple formats. In particular, ERDDAP can reformat the requested data into the required format (.html table, ESRI .asc and .csv, Google Earth .kml, OPeNDAP binary, .mat, .nc, ODV .txt, .csv, .tsv, .json, and .xhtml) by the remote server, It sends the request to the remote server, gets the data, reformats the data into the requested format, and sends the data to requester. ERDDAP has been adopted by many marine data infrastructures (EMODnet, Copernicus Marine Service for the In Situ data, EMSO, etc.) and recently is also promoted by the GOOS Ocean Coordination Group. This ERDDAP file format transformation, together with the upgrade of the datasets into standardized variable and metadata names, help to exchange data and to enable sharing of information, providing the interoperability of data promoted by the FAIR principles [8].

The ERDDAP data server requirements includes the capacity to integrate very diverse sources and data formats in EuskOOS:

- NRT multi-platform observations and forecast from different ocean models.
- Local data from Euskalmet's facilities and available external data in the area of interest.
- 2D fields from remote sensing systems and ocean models and time series from individual stations.

The ERDDAP data server also offers the possibility to visualize the variables before their downloading.


euskoos EUSKOOS
Easier access to scientific data

log in
Brought to you by EUSKOOS

ERDDAP > List of All Datasets

19 matching datasets, listed in alphabetical order.

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	WMS	Source Data Files	Title	Sum-mary	FGDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution	Dataset ID
	set	data	graph			* The List of All Active Datasets in this ERDDAP *		M	background			ETT S.p.A. - Peop...	allDatasets
		data	graph		files	Bermeo Tidal Gauge Agitacion		M	background	RSS		???	Bermeo_Tidal_Gauge_Agitacion
		data	graph		files	Bermeo Tidal Gauge Filtrados		M	background	RSS		???	Bermeo_Tidal_Gauge_Filtrados
		data	graph			Bilbao Station		M	background	RSS		???	Bilbao_Station
		data	graph			boyaDonostia DM hourly data		F I M	background	RSS		???	boyaDonostia_DM_hourly_data
		data	graph		files	boyaDonostia NRT hourly data		M	background	RSS		???	boyaDonostia_NRT_hourly_data
data			graph	M	files	Euskalmet d27		F I M	background	RSS		???	Euskalmet_d27
data			graph	M	files	Euskalmet d9		F I M	background	RSS		???	Euskalmet_d9
data			graph	M	files	Euskalmet daily		F I M	background	RSS		???	Euskalmet_daily
data			graph	M	files	Euskalmet WAM Basque Coast		F I M	background	RSS		???	EuskalmetWAMBasqueCoast
data			graph		files	Meteo Galicia		M	background	RSS		???	MeteoGalicia
data			graph			Near Real Time Surface Ocean Velocity by EuskOOS (HFR-EUSKOOS-HIGE) [time][DEPTH][BEAR][RNGE], 2009-present		M	background	RSS		AZTI	HFR_EUSKOOS_HIGE
data			graph	M		Near Real Time Surface Ocean Velocity by EuskOOS (HFR-EUSKOOS-TOTL) [time][DEPTH][LATITUDE][LONGITUDE], 2009-present		F I M	background	RSS		AZTI	HFR_EUSKOOS_TOTL
data			graph	M	files	Ocean surface hourly mean fields for the Iberia-Biscay-Ireland (IBI) region		F I M	background	RSS		PdE	IBI_ANALYSISFORECAST_PHY_005_001
		data	graph			Pasaia Station		M	background	RSS		???	Pasaia_Station
		data	graph		files	Pasaia Tidal Gauge Agitacion		M	background	RSS		???	Pasaia_Tidal_Gauge_Agitacion
		data	graph		files	Pasaia Tidal Gauge Filtrados		M	background	RSS		???	Pasaia_Tidal_Gauge_Filtrados
data			graph	M	files	ROMS MODELS		F I M	background	RSS		???	ROMS_MODELS
data			graph	M	files	Wave hourly instantaneous fields for the Iberia-Biscay-Ireland (IBI) region		F I M	background	RSS		Nologin-Puertos d...	IBI_ANALYSIS_FORECAST_WAV_005_005

The information in the table above is also available in other file formats (.csv, .htmlTable, .itx, .json, .jsonlCSV1, .jsonlCSV, .jsonlKVP, .mat, .nc, .nccsv, .tsv, .xhtml) via a RESTful web service.

Fig 2: Screenshot of the list of the datasets contained in EuskOOS ERDDAP portal

B. *Frontend: Integrated ocean data portal*

The main targets of EuskOOS are local users performing professional and leisure activities in the coastal area (mainly up to 12 nm from the coast): fisheries, maritime safety, tourism and leisure sectors.

Prior to the revamping of the EuskOOS frontend, the web was platform oriented, i.e.: each platform showed the data measured by its sensors. The analysis of web searches of local users showed that they were demanding a direct access to the ocean variables in different locations of the Basque Coast and not to specific platforms.

Following the interest of the local users, the new EuskOOS data portal aims to integrate all the data available making easier the access to information about recent variability of the ocean variables and short-term forecasts. Thus, the platform-oriented organization of the previous version has been switched to an ocean variable-oriented approach targeting the users' needs.

The web page gives access to information on each variable (eg. wave, wind, currents, sea temperature, sea level) integrating data from all the Backend system. Models data are included in the ERDDAP, as backup solutions, to be shown when a specific EuskOOS source is not available (such as coastal station, buoy, …) or when the user wants to check data from an specific location without *in-situ* instruments (see example in Fig *3*). The graphs shown in the web page provide information of the last 2 days and the 3 foreseen days. There is also a "Download Data" tab with a direct access to the ERDDAP server where all the historical available data can be downloaded.

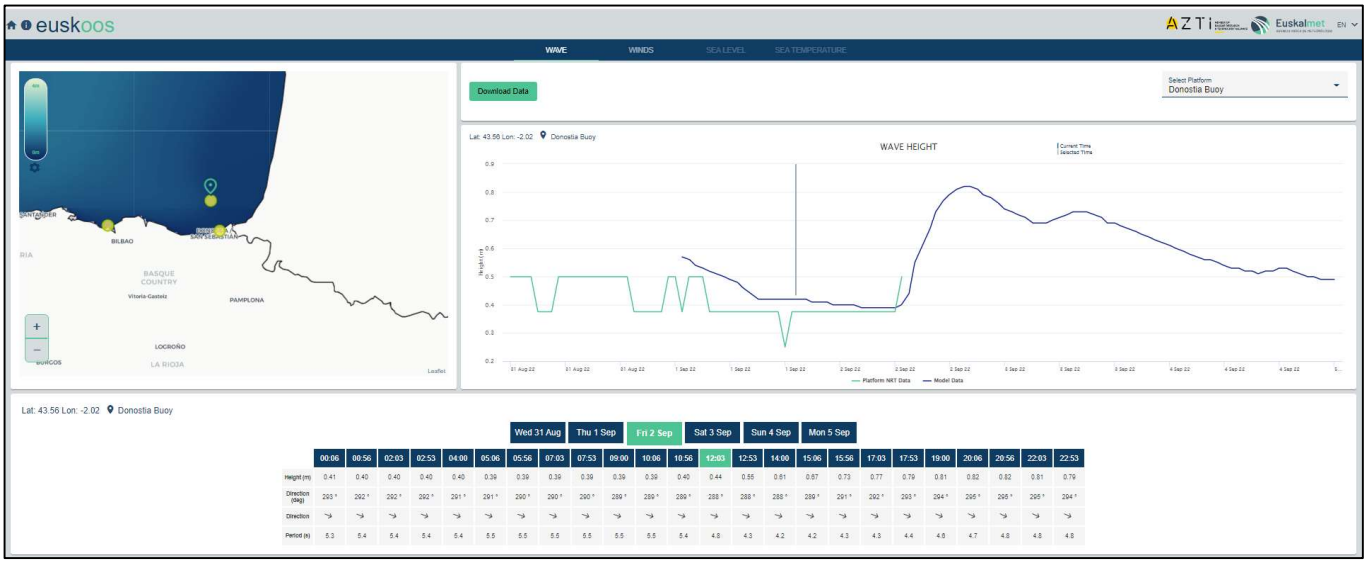


Fig 3: Wave height information in the frontend EuskOOS portal

The EuskOOS web page was built using Angular, the open-source Google framework for building web applications, and Leaflet, the open-source JavaScript library for developing interactive geographic maps. The code behind the map viewer uses HTML, CSS and Typescript, a typed superset of the JavaScript developed by Microsoft. Typescript, normally associated with programming in Angular, offers the advantage of great ease of use. Applications developed in Angular are executed entirely by the web browser after being downloaded from the web server (client-side processing). This means the saving of having to send the web page back to the web-server every time there is a request for action from the user. The code generated by Angular runs on all major modern web browsers such as Chrome, Microsoft Edge, Opera, Firefox and Safari.

III. IMPACT AND PERSPECTIVE

Implementing interoperability capacities with a user-friendly frontend web in EuskOOS opens an important perspective towards developing multidisciplinary ocean observing capacities and nourishing blue economy in the Basque region. In this sense, we are working towards the development of a multidisciplinary super-observatory in the Basque Country [9], inspired on the concept of supersite, adopted in JERICO-RI [10]. This super-observatory aims to better address critical needs linked to: the sustainable management of fisheries, the conservation and recovery of biodiversity and habitats, the challenges of climate and global change, the implementation of policies and directives on the management of the marine environment, in particular, the Directive of the European Marine Strategy (DEME) and, in general, the integrated management of the coastal zone. This augmented observatory is built upon the following requirements: (i) design a multiplatform and multidisciplinary sampling strategy; (ii) provide responses to a wide range of research questions and uses; (iii) ensure continuous and sustained observations over time; (iv) establish clear links with existing activity communities, both technical (for example, numerical modelling community) and sectoral (fishing, tourism...), in order to base the development of

integrated coastal data products and services on a co-design process with the main users of the data; (v) embrace transnational endeavors (given the geographical area covered, which transcend administrative borders).

The setting up of the super-observatory is based on existing observational efforts. Thanks to the participation in several European, national and regional projects, for the last decades the Basque institutions have been playing a key role in the Observation of the Bay of Biscay and the coastal zone of the Basque Country. In addition to EuskOOS, different existing regional observational networks, campaigns, and initiatives (i.e., the Offshore Aquaculture Monitoring system, the Marine Ecological Quality Monitoring network, the Ecosystem Multidisciplinary surveys, the Climate Change Marine Observatory, etc) currently respond to the questions in the aforementioned areas. The super-observatory will capitalize these efforts by ensuring better communication and coordination between the present components for the development and implementation of an integrated scientific, observational, and technological strategy.

The new backend and frontend of EuskOOS are important elements for the adequate design of a multiplatform and multidisciplinary sampling strategy required by the super-observatory of the Basque Country: from one hand, the well classified metocean information of EuskOOS observatory enables its potential application to other disciplines. In the other hand, metocean data gaps or complementary data needs are identified, that can be used to complete or expand EuskOOS system in the framework of the super-observatory.

At European level, to achieve interoperability of the data, EuskOOS ensures (i) a full contribution of all the Basque operational oceanography system datasets to the main European data aggregators like EMODnet or the Copernicus Marine Service, and (ii) a correct synchronization of the local data catalogue in near real time and when changes and upgrades occur.

The ERDDAP scalable data server with harmonized access capacities allows to integrate new observing and modelling platforms in a near future thanks to current initiatives for developing the ocean observing capacities: use of autonomous vehicles, drifters, ferrybox, remote systems, etc.

EuskOOS is intended to be a regional showcase of a multiplatform system with implemented innovative tools to generate interoperable data for the Basque society and European Ocean Observing portals. Moreover, a user-friendly website has been generated to provide an easier access to scientific data in NRT. As far as the authors knowledge, this is the first regional operational multidisciplinary oceanographic system that offers at the same time, FAIR datasets for global data infrastructures (such as EMODnet, Copernicus Marine Service for the In Situ data, EMSO, etc.), and visualization of the data focused on the local (not professional) users.

ACKNOWLEDGMENT

This work has been partially funded by the Directorate of Emergency and Meteorological Services (DAEM) of the Basque Government. The contribution of L. Solabarrieta, J. Mader and A. Rubio has been partially supported by JERICO-S3 project, funded by the European Union's Horizon 2020 Research and Innovation Program under grant agreement no. 871153.This is contribution number xxx of the Marine Research Division of AZTI.

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