# Unlocking HF radar data potential for scientific and societal applications

Emma Reyes[1], Pablo Lorente[2], Nydia Catalina Reyes Suarez[3,4], Aldo Drago[5], Adam Gauci[5], Giuseppe Ciraolo[6], Fulvio Capodici[6], Enrico Zambianchi[7], Pierpaolo Falco[7], Marco Uttieri[7,8], Lorenzo Corgnati[9], Carlo Mantovani[9], Alkiviadis Kalampokis[10], Gerasimos Korres[10], Vassilis Zervakis[11], Carlo Brandini[12], Stefano Taddei[12], Matjaz Licer[13], Branko Čermelj[13], Charles-Antoine Guérin[14], Anne Molcard[14], Vanessa Cardin[3], Enrique Álvarez-Fanjul[2], Joaquin Tintoré[1,15]

[1] SOCIB (Balearic Islands Coastal Observing and Forecasting System), Palma, Spain

[2] Puertos del Estado, Madrid, Spain.

[3] OGS (Istituto Nazionale di Oceanografia e di Geofisica sperimentale), Trieste, Italy.

[4] ICTP (International Centre for Theoretical Physics), Trieste, Italy.

[5] Physical Oceanography Research Group, Department of Geosciences, University University of Malta, Msida, Malta.

[6] Università degli Studi di Palermo, Italy.

[7] Parthenope University of Naples and CoNISMa, Italy.

[8] Stazione Zoologica Anton Dohrn, Naples, Italy.

[9] CNR-ISMAR (National Research Council of Italy, Institute of Marine Sciences), Lerici, Italy.

[10] HCMR (Hellenic Centre for Marine Research), Athens, Greece.

[11] University of the Aegean, Athens, Greece.

[12] Consorzio LaMMA, Florence, Italy.

[13] NIB (National Institute of Biology), Piran, Slovenia.

[14] MIO (Mediterranean Institute of Oceanography), University of Toulon, Toulon, France.

[15] IMEDEA (CSIC-UIB), Esporles, Mallorca, Spain.

The Mediterranean Sea constitutes a first order geostrategic region from both commercial and oceanographic perspectives. With the aim of responding adequately to societal challenges and stakeholder needs, a variety of met-ocean observing platforms have been deployed to efficiently monitor the sea state and deepen the understanding of the ocean circulation in the socioeconomically vital and often environmentally stressed coastal risk-prone areas.

In this context, the use of High-Frequency (HF) radar has been steadily gaining recognition as an effective land-based remote sensing technology to provide reliable near real-time surface currents and directional wave information. Among all existing HF radar systems installed in Europe, more than 50% are operationally monitoring the coastal regions in the Mediterranean, over 80% of which are permanent installations. HF radars are particularly suitable platforms to monitor the variability in semi enclosed seas. They provide 2-D synoptic maps of surface currents for distances up to 200 km offshore over a wide variety of high spatial (0.2-6 km) and temporal (usually between

30-minute and 1-hour averages) scales, enabling the thorough scientific knowledge of small and meso-scales coastal processes. Additionally, HF radar data are also being used for a broad range of science-based societal applications such as, maritime safety, tracking of marine pollutants, water quality monitoring, energy production, fisheries and coastal (e.g. port activity and impact on Marine Protected Areas) management and improvement of numerical circulation models through validation and data assimilation.

The main motivation of this contribution is to showcase the current status of diverse Mediterranean HF radar systems along with the respective ongoing work plans and applications, some of which are aligned with European initiatives (e.g. Copernicus Marine Environment Monitoring Service) and projects (e.g. EuroSea, Jerico-S3, CMEMS-INSTAC, Impact, Sicomar+, Sinapsi, Panoramed, CALYPSO, CALYPSO South, etc). Coordinated efforts between HF radar operators from different multi-disciplinary institutions are mandatory to reach a mature stage at both, national and regional levels, striving to: i) harmonize operational and maintenance practices; ii) standardize data, metadata and quality control tests; iii) centralize data management and access platforms; iv) develop customized visualization tools and added-value products and services fitting to stakeholders needs. It is worth highlighting that many of the Mediterranean HF radar networks contribute to the European HF radar Node, which acts as central focal point for data collection, homogenization, quality assurance and dissemination and promotes networking between EU infrastructures and the Global HF radar network.

Furthermore, challenges and top priority issues linked to the establishment of a long-term, fully integrated, sustainable operational Mediterranean HF radar network are described. This includes aspects related to the setting up of such a system within the broader framework of the European Ocean Observing System (EOOS), and a secured financial support required to preserve the infrastructure core service already implemented. Apart from the technical challenges, the enhancing of the HF radar data discovery and access, the boosting of the data usage as well as the research integration must be achieved by building synergies among academia, management agencies, state government offices, intermediate and end users. This would guarantee a coordinated development of tailored products that meet the societal needs, serving the marine industry with dedicated smart innovative services, along with the promotion of strategic planning and informed decision-making in the marine environment.