Building strong foundations towards the pan-European High Frequency Radar network

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High Frequency Radar (HFR) is a land-based remote sensing technology offering a unique insight to coastal ocean variability, as it maps coastal ocean surface currents over wide areas (reaching distances from the coast of over 200 km) with high spatial (a few kms or higher) and temporal resolution (hourly or higher). HFR products are directly used in different sectors, such as Search and Rescue, renewable energy, fishery management and monitoring of pollutants and biological quantities, offering an unprecedented potential for the integrated management of coastal zones. Moreover, in the next years it is expected that HFR surface current data will be systematically ingested in Data Assimilation (DA) processes necessary for predictive model adjustment. It is then crucial to promote and distribute high quality HFR data for scientific, operational and societal applications.

HFR technology is rapidly expanding in Europe, where the number of systems is growing at a rate of 6 new sites per year, with over 58 systems currently deployed and operational and a number in the planning stage. Since the European HFR systems are playing an increasing role in the overall operational oceanography marine services, many initiatives are now active in Europe aiming at building an operational pan-European HFR network based on a coordinated data management. In 2014, EuroGOOS launched the HFR Task Team to achieve the harmonization of system requirements and design, data quality and standardization of HFR data access and tools. In 2015, a pilot action coordinated by EMODnet Physics, begun to develop a strategy for assembling HFR metadata and data products within Europe in a uniform way to make them easily accessible, and more interoperable. The SeaDataCloud (SDC) project, launched in 2016, is contributing to the integration and long-term preservation of historical time series from HFR into the SeaDataNet infrastructure by defining standard interoperable data and Common Data Index (CDI) derived metadata formats and Quality Control (QC) standard procedures for historical data. Recently, the Copernicus Marine Environment Monitoring Service (CMEMS) Service Evolution Call supported the INCREASE project, which set the bases for the integration of existing European HFR operational systems into the CMEMS-INSTAC (In Situ Thematic Assembly Center). In parallel, EU project JERICO-NEXT is working to provide procedures and methodologies to enable HFR data to comply with the international standards regarding their quality and metadata, within the overall goal of integrating the European coastal observatories.

The results of these integrated efforts are significant and promising. The European common data and metadata model for real-time surface current HFR data has been defined and implemented, compliant with Climate and Forecast Metadata Convention version 1.6 (CF-1.6), OceanSITES convention, CMEMS-INSTAC requirements and INSPIRE directive. Furthermore, the list of the QC tests to be applied to HFR data has been defined according to the DATAMEQ working recommendations on real-time QC and building on the Quality Assurance/Quality Control of Real-Time Oceanographic Data (QARTOD) manual produced by the US Integrated Ocean Observing System (IOOS).

Thanks to these achievements, the inclusion of HFR data into CMEMS-INSTAC and into SDC Data Access was decided to ensure the improved management of several related key issues as Marine Safety, Marine Resources, Coastal & Marine Environment, Weather, Climate & Seasonal Forecast.

CMEMS-INSTAC and SDC operate through a decentralized architecture based on National Oceanographic Data Centres (NODC), Production Units (PUs) organized by region for the global ocean and the six European seas and a Global Distribution Unit (DU). In particular, CMEMS-INSTAC implements the functions of data acquisition, QC, validation/assessment and distribution. The core of CMEMS-INSTAC and SDC is to guarantee that for the users the quality of the product delivered is equivalent wherever the data are processed.

HFR data are in situ gridded data in time (big data), therefore the standard in situ data management infrastructures have to be organized and adapted to allow INSTAC PUs, other CMEMS Thematic Centres (TAC) and Marine Forecasting Centers (MFC) to efficiently manage this type of data. The establishment of the HFR data stream has to be organized in the coordinated framework formed by the existing main European infrastructures and actors. Given the importance of the data type and the diversity with the already available data streams and quality check procedures, the implementation of the HFR data stream has to come together with the development of a centralized European competence centre.

Thus, the development of a centralized HFR node goes towards three additional main steps:

i) to set up a data centre dedicated to link all the available data providers and collect and process HFR data;

ii) to develop and upgrade the software tools for the harmonization of data and metadata of HFR data coming from different sources;

iii) to apply data processing, both in real time and delayed mode, and create catalogues of HFR data compliant with the requirements of CMEMS-INSTAC and SDC.

Its implementation should be based on a hierarchical infrastructure to facilitate management and integration of any potential data provider according to a simple and very effective rule: if the data provider can set up the data flow according the defined standards, the HFR central node only has to link and include the new catalogue and data stream. If the data centre cannot setup the data flow (because of lack of experience, technical capacity, etc.), the HFR node will work on harvesting the data from the provider, harmonize and format these data and make them available.

The integration and assessment of the HFR data in a centralized data system will allow a second harmonized level of quality check assessment, interoperable data products and a more efficient implementation of tools for downstream services. For all these reasons the establishment of a centralized HFR node should be the cornerstone of the operational European HFR network.