16th Observation Coordination Group (OCG-16)

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High Frequency Radar OCG-16 Report

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1. Highlight the key network successes

Europe

The European High-Frequency Radar Node REST-API streamlines M2M discovery of updated metadata from European HFR stations. Publication of the FAIR Implementation Profile of the European HFR community for assessing the FAIRness level of the community (https://w3id.org/np/RAxgSL7swwOsqo4RZC3OPE5FJjxBQikDFG-QwMEH0_Wb0).

United States

The Florida Institute of Technology and UGA Skidaway Institute of Oceanography recently installed four high frequency radars on the east coast of Florida. HFR stations operating once again in Hillsboro, Florida and Nantucket, Massachusetts.

On May 30, 2024, the U.S. IOOS Office and South Fork Wind, LLC have signed an MOU for the mitigation of mission degrading offshore wind turbine interference to oceanographic high-frequency radar by the South Fork offshore wind farm (SFWF). This wind farm, off the coast of New England, will potentially impact eight HFR systems. If the wind farm interferes with the HFR signal, the MOU requires South Fork Wind to share data from a nearby met-ocean buoy and a wave and current radar on the SFWF Offshore Sub Station (wave height, direction, period, current speed and direction, and visibility data) that can be used to mitigate the interference to the radar signal. On July 9, 2024, the U.S. IOOS Office and Revolution Wind, LLC fully executed a memorandum of agreement (MOA) for the wind turbine radar interference mitigation (WTRIM) of mission-degrading offshore wind (OSW) turbine interference to IOOS oceanographic high-frequency (HF) radars by the Revolution Wind Farm.

A new version of the community open-source software “hfradarpy” containing tools for working with coastal high frequency radar (HFR) data has been released through a collaboration between Teresa Updyke (ODU/MARACOOS), Lorenzo Corgnati (Italian CNR Institute of Marine Science/European HFR Network) and Michael Smith (Rutgers University). Teresa Updyke led the effort to consolidate code improvements and

additions made in recent years into a shared repository hosted on the Radiowave Operators Working Group webpage on GitHub (www.github.com/rowg). Lorenzo Corgnati created the initial merge of MARACOOS and European versions of code and Mike Smith provided guidance throughout for updates and testing procedures. Version 1.0.0.0 was made available on the website on January 22, 2025. This release incorporates contributions from the European HFR network including updated parsing to handle more HFR file formats, additional radial and total QC tests and a least squares method for computation of total vectors. The hfradarpy toolbox is written in the open-source language of Python. Future releases can be built from this code base to promote sharing of processing methods among the HFR community.

Canada Ocean Networks Canada (ONC) continues to manage one WERA radar and ten CODARs (two of them belonging the federal Department of Fisheries and Oceans) on the west coast of British Columbia. ONC is also archiving data from two CODAR stations, SCOV and MEDH, which are co-owned by Dalhousie University and Defence Research and Development Canada (DRDC) and operated by Dalhousie. Dalhousie's new CLMH site is expected to be operational within the next month, at which point ONC will begin archiving its data as well.
ONC is conducting field trials of a low-power CODAR housed in an off-grid (solar and wind-powered) enclosure manufactured by APRS World LLC. The site, LPR1, is co-located with ONC's 16.15-MHz VJOR radial site, allowing cross-comparisons between the two systems. In the long term, the off-grid system is expected to be deployed at a remote site, possibly in Canada's high arctic. ONC's sole WERA system has suffered a serious setback caused by the installation of high fencing around the entire airport where it is located. Testing is ongoing, but it is not clear that the WERA will be able to produce valid current data in such proximity to the metal fence poles. It is possible the WERA will need to be moved, but no obvious candidates for a new site have been identified.

2. How has the network advanced across the OCG Network Attribute areas[1]
    - ***a. Europe***
        - i. Integration of new networks in the operational workflow for the distribution of Near Real Time and Delayed Mode surface current datasets: HFR-ICATMAR (Catalunya), HFR-GoS (Tyrrhenian Sea, Italian coast), HFR-MedTln (NW Med, Southern French coast).
        - ii. Periodic revision/update of the documentation of the European standard HFR data model (available on the OBPS repository at https://doi.org/10.25607/10.25607/OBP-944.2).
    - b. Sustained Observation
        - i. **Taiwan's** ocean radar observation network is a major national initiative within the country's marine science community and has been actively promoted for many years by the Taiwan Ocean Research Institute (TORI) of the National Institutes of Applied Research (NIAR). Since 2016, Taiwan has established a radar network based on the CODAR system, covering more than 19 observation stations. Between 2019 and 2025, various government agencies in Taiwan have continued to expand and operate more than 44 oceanographic radar stations, including 22 high-frequency (HF) radars and 22 marine microwave radars. These include: Central

[1] https://oceanexpert.org/downloadFile/45372

Weather Administration (CWA) under the Ministry of Transportation and Communications: 13 stations (8 HF phased-array radars and 5 microwave radars), Transportation Technology Research Center (TTRC) under the Institute of Transportation, Ministry of Transportation and Communications: 3 stations (2 HF phased-array radars and 1 microwave radar), National Academy of Marine Research (NAMR) under the Ocean Affairs Council: 27 stations (12 HF phased-array radars and 15 microwave radars), and Water Resources Agency (WRA) under the Ministry of Economic Affairs has installed 1 marine microwave radar. Government agencies related to ocean affairs are increasing investments in oceanography radar observation systems and developing data-driven governance initiatives.

ii. **Thailand** The Coastal Radar System has been in operation since 2012. Currently, there are 17 stations, 15 in the Gulf of Thailand and 2 in the Andaman Sea. GISTDA has developed a data service system called http://coastalradar.gistda.or.th. This system has been promoted for use and cooperation with user agencies to utilize the data, such as the Regional Environmental Office in all 23 coastal provinces, the Harbor Department, the Royal Thai Navy, the Marine Police, the Department of Fisheries, the Department of Marine and Coastal Resources, and educational institutions. The data has been applied in various areas, including: Rescue in case of shipwrecks, Oil spills in the sea and garbage, Fisheries warning (daily), Coastal erosion and Education (research/thesis).

c. Community of Practice

i. 2024 International Radiowave Oceanography Workshop (ROW2024): The ROW series of workshops - conducted on a regular basis since 2001, but which had been disrupted since the onset of the COVID-19 pandemic- successfully resumed this week September 3 - 5, 2024 at the University of Plymouth Marine Station, Plymouth, UK. ROW focuses on the oceanographic applications of high-frequency (HF) radar and provides an international forum for discussion of related issues and the direction of future work in the field. A program, book of abstracts, and more information about ROW2024 is available here.

ii. ROWG-13: The 13th Radiowave Oceanographers Working Group hybrid meeting (ROWG-13) was held May 21-23, 2024, at the University of Southern Mississippi's Hardy Hall in Long Beach, Mississippi. More info here: https://ioos.noaa.gov/project/hf-radar/

iii. The 6th Ocean Radar Conference for Asia-Pacific (ORCA2024) was held on December 1-4, 2024, in Zhuhai, China, organized by Sun Yat-sen University. The discussion content of this conference covers all research directions of HF radar for marine observation.

iv. The annual meeting of HFR user communities in Japan was held December 2-3, 2024, in Fukuoka. The theme for the meeting was “Development and Application of Sea State Monitoring System using Ocean Radars”. There were 13 presentations. At present, approximately 40 HF ocean radars are in operation in Japan. You may find the meeting website at https://www.riam.kyushu-u.ac.jp/radar/event/program_file/2024/program2024.htm

d. Delivers data that are free, open and available
    i. United States https://cordc.ucsd.edu/projects/hfrnet/
    ii. Canada https://www.oceannetworks.ca/data/data-dashboards/real-time-surface-currents-data/
    iii. Europe https://www.hfrnode.eu/data-access/
    iv. Thailand https://coastalradar.gistda.or.th/app/map/router.php?page=current
    v. Korea https://www.khoa.go.kr/oceangrid/koofs/eng/observation/obs_real.do

3. Future Plans[2] and Opportunities - at network and/or cross-network OCG level

Europe Contribute to the Global Data Implementation Strategy to the HF Radar network, particularly looking at ERDDAP data services and the m2m exchange of metadata with OceanOPS. Organize in person meeting in October 2025 (possibly 7-8 October 2025 at CNR-ISMAR in Lerici/La Spezia). Contribution to a paper on HFR systems in the Mediterranean Sea, under the coordination of OceanOPS. Endorsement of the European standard data model for HFR current data within OBPS. Design and development of advanced Quality Control procedures based on Artificial Intelligence and non-velocity-based parameters. Preparation of the production of HFR-derived wave data. Enhancement of the FAIRness of the European HFR community by mapping the HFR derived surface current data model to the SOSA ontology and generating the SensorsThing API for implementing the effective M2M accessibility to HFR datasets. The Irish Meteorological Service is looking to establish five coverage areas (Cork, Galway, Shannon Estuary / Tralee Bay, Dublin and Dundalk. We are looking to roll out on a phased basis with potentially Cork and Dundalk being pilot sites. They plan to have approval by May 2025.

United States The US data assembly center for HFR data (HFRNet) is transitioning to NOAA. IOOS will transition HFRNet from the Scripps Institution of Oceanography's Coastal Observing Research & Development Center into the NESDIS Common Cloud Framework. The decision to migrate the data assembly center to NCCF was made by the IOOS Office, guided by feedback received from the HFRNet Replacement Request for Information issued in August 2023. Work migrating functionality into the NCCF is underway, with an initial version anticipated to be operational before the end of June 2025.Read more here: https://ioos.noaa.gov/news/high-frequency-radar-data-to-be-hosted-at-noaa/

Taiwan initiated a four-year national project in 2025 to establish a unified, nation-level observation network by integrating the country's four major HF radar operation units. The project aims to enhance marine radar technology, strengthen connections with the international community, and promote the application of radar data in maritime safety affairs such as search and rescue, marine pollution prevention, and marine recreational activities.

[2] Future plans on implementation, instrumentation, data management, test, new sensors, plan for new EOV/ECV observations, capacity development, etc.

4. Challenges and Concerns - at network and/or cross-network OCG level

   Europe Funding the Regional coordination and Node in Europe is still a challenge. Unlock HFR data potential: boost the integration of HFR data in data downstream services, engage end-users, more science-based from HFR observations, enhance the applications development, promote the development and delivery of operational added-value products. Unlock HFR data assimilation, crucial to improve the model performance; use HFR data to assess the SWOT satellite mission.

   United States Funding climate is uncertain with the new presidential administration.

   Australia Our radars continue operations as usual, with plans to upgrade further the hardware. However, major issues impacting on operations are the AUKUS treaty (minor hinder for now) and the particularly strict export legislation towards Europe, when we need to return items for repair and refurbishment. Temporary export permits are required, that take up to 6 months to get or amend, oftentimes having a duration of 6 months or shorter which conflicts with the repair queues at the vendor.

   South Africa CLS southern Africa is currently maintaining HF radar systems at their own costs. They are sharing the data with the Department of Forestry, Fisheries and the Environment and they are in the process of publishing it all on their MIMS data portal (https://data.ocean.gov.za/) with open access to everyone. However, they will be running out of funds in June 2025 and are urgently in need of support to continue those observations.

   Thailand Radio signal interference in the area, which affects the efficiency of data measurement. The cost of spare parts for radar equipment is quite high because they must be imported from abroad. If some parts can be researched and developed and used as replacements, this will reduce costs in this area.

5. Asks from OCG (Exec, networks, OceanOPS, and/or GOOS) and any priority topics that should be addressed at OCG-16

6. Recent publications.

   Mantovani, Carlo, Jay Pearlman, Anna Rubio, Rachel Przeslawski, Mark Bushnell, Pauline Simpson, Lorenzo Corgnati, Enrique Alvarez, Simone Cosoli, and Hugh Roarty. "An ocean practices maturity model: from good to best practices." *Frontiers in Marine Science* 11 (2024): 1415374.

   Corgnati, L., Berta, M., Kokkini, Z., Mantovani, C., Magaldi, M.G., Molcard, A., Griffa, A., 2024. Assessment of OMA Gap-Filling Performances for Multiple and Single Coastal HF Radar Systems: Validation with Drifter Data in the Ligurian Sea. Remote Sens. 2024, 16,2458. https://doi.org/10.3390/rs16132458. WOS:001269639600001

   Roarty, Hugh, Teresa Updyke, Laura Nazzaro, Michael Smith, Scott Glenn, and Oscar Schofield. "Real-time quality assurance and quality control for a high frequency radar network." *Frontiers in Marine Science* 11 (2024): 1352226.

Morales-Márquez, Verónica, Dylan Dumas, and Charles-Antoine Guérin. "HF radar estimation of ocean wave parameters: second-order Doppler spectrum versus Bragg wave modulation approach." *Coastal Engineering* (2025): 104719.

https://www.zotero.org/groups/2601948/eurogoos_hfradar_taskteam