



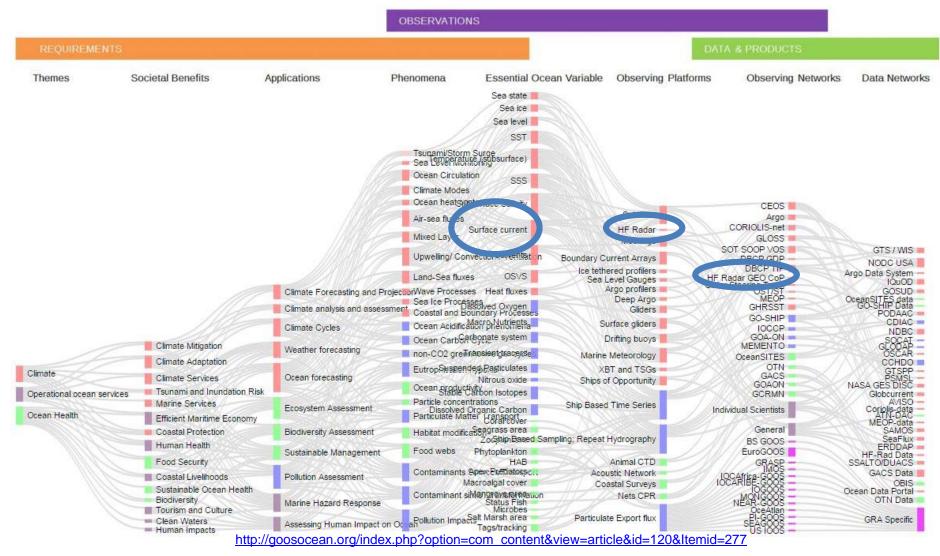




# The Global High Frequency Radar Network

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# **GOOS Strategic Mapping**





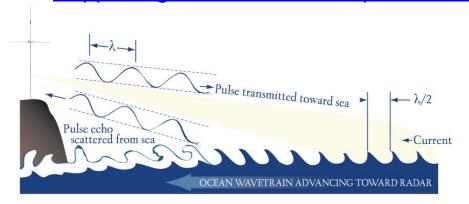


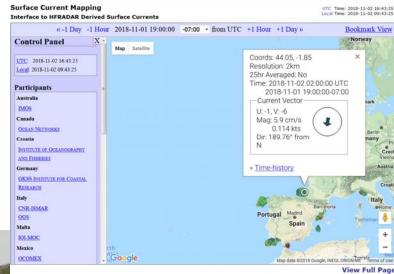


### **HFR Technology Overview**

"High-Frequency Radar:

Supporting Critical Coastal Operations with Real-time Surface Current Data"









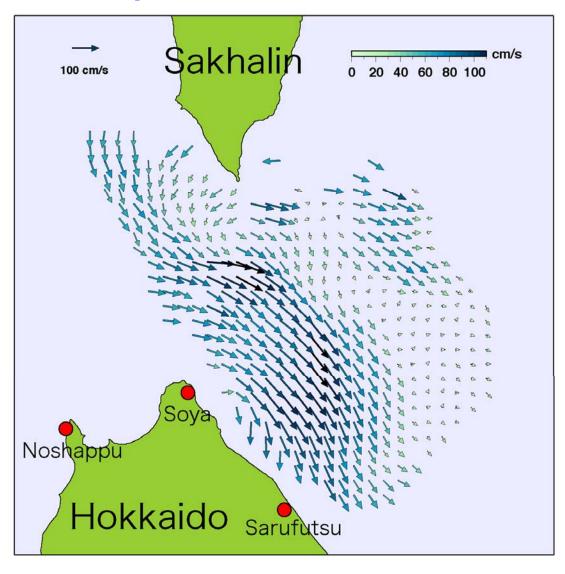








# **Example of Observed Snapshot**

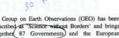


17h20m (JST) 3 Aug 2003

Real-time current maps are available from our web site. http://wwwoc.lowtem.hokudai.ac.jp/hf-radar/index.html

### The Global HF Radar Network

Editoria



described at Science without Borders' and brings together, 87 Governmens) and the European Commission and efficiency extended, and regional organisations to provide access to timely data, new analytical tools, and forecasts about emerging threats that will enable wise choices in an uncertain world.

During the GBO-VIII Plenary the GBO 2012-2015 workplan was accepted that includes a focus on the importance of ocean observing under the Blue Planer Societal Benefit Area (SBA). One component of this SBA is the operational systems for monitoring marine and coastal ecosystems. There are many systems ranging from buoys and gauges to autonomous underwater and surface vehicles to satellites and animal tagging that must work in a complementary fashion to provide the three dimensional observing needed to answer pressing questions, such as: Can we efficiently and safely move commerce; how will we adapt to, and mitigate, a changing climate; is the water safe to swim in; will we continue to sustain the world's need for food from the ocean?

Just as measuring winds in the atmosphere is fundamental to weather forecasting, ocean currents determine the movement of surface waters, providing critical information to support pollutant tracking, search and rescue, harmful algal bloom monitoring, navigation, and ecosystem based management and coastal and marine spatial planning. One system that has proven to effectively measure surface currents along the coast is high frequency (HP) radar.

A number of countries have used HF radar operationally in the areas of navigation, oil spill monitoring, search and rescue and harmful algal bloom forecasting but in many cases this is done on a case-by-case basis. Within the United States, the Coast Goad uses this data in their operational Search and Rescue Program and has shown that the search area can be decreased by 60% in 96 hours, and that means saving lives. HF radar information was used by the National Oceanic and Atmospheric Administration for oil track predictions during the Deepwater Horizon oil spill. Emerging uses include ecosystem-based studies, vessel tracking and, most recently, HF radar picked up the signal from the March 2011 Pacific Tsunami — see Journal of Remote Sensing — http://www.mdoj.com/2072-429/38/16/33/19

The United States has been working for many years to transition its HF radar network of over 100 radars to an operational system and has succeeded in moving from individual radars to clusters of radars to a comprehensive national network tied together through common data architecture, set of practices and a national plan. Many other nations have begun to deploy HF radars and there is a tremendous amount of informal coordination and collaboration taking place. But to truly make a difference on a global scale we need to unite under a single worldwide network to make these critical measurements available into ocean and ecosystem modelling.

Towards a global HF radar network

Therefore, under GEO we have set forth a bold task to develop a global HF radar network. We will kick off this task at a meeting during Oceanology International in March 2012. The goals of this effort are to increase the numbers of coastal radars, ensure that HF radar data is available in a single standards, as et of easy to use standard products, assimilate the data into ocean and ecosystem modelling and develop the emerging uses of HF radar. This is an exciting initiative and if you would like to be part of this global effort, please contact the oc-chairs: Jack Harland Nosa (St HF radar, Project Manager, Jack Harlandenoas gov or Enrique Fanjul, Spain Puetros del Estado, enrique@poettos.

Zdenka Willis Director, US 100S Program Office National Oceanic and Atmospheric Administration

- Established in March 2012
- Meetings Held
  - 2012 England
  - 2013 Norway
  - 2014 Taiwan
  - 2015 Greece
  - 2016 United States
- Presentations available here

http://global-hfradar.org/meetings.html

Journal of Operational Oceanography Vol 5 No. I 2012







### Goals for Global HF Radar Network

- 1) Increase the number of coastal radars
- 2) Ensure HFR data is available in a single standardized format in near-real-time,
- 3) Assimilate data into ocean and ecosystem models
- 4) A set of easy to use standard products
- 5) Worldwide Quality Standards
- 6) Develop emerging uses of HF radar







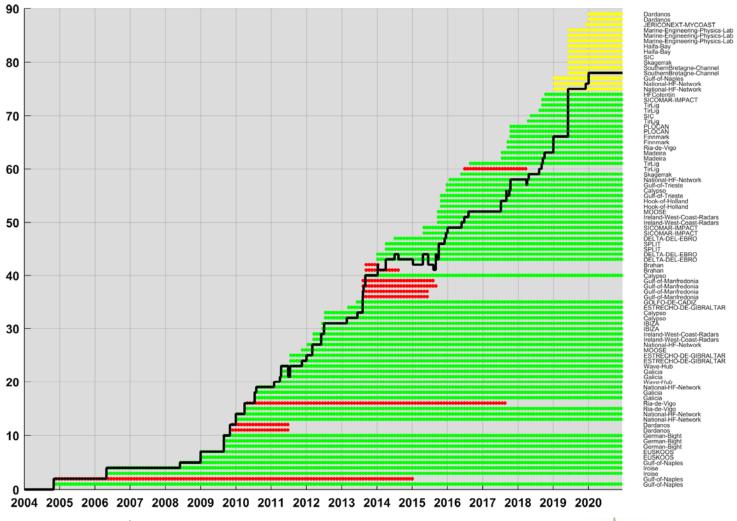
### Growth in the United States

### HFRadar Network Site Growth



WMO OMM

# Growth in Europe

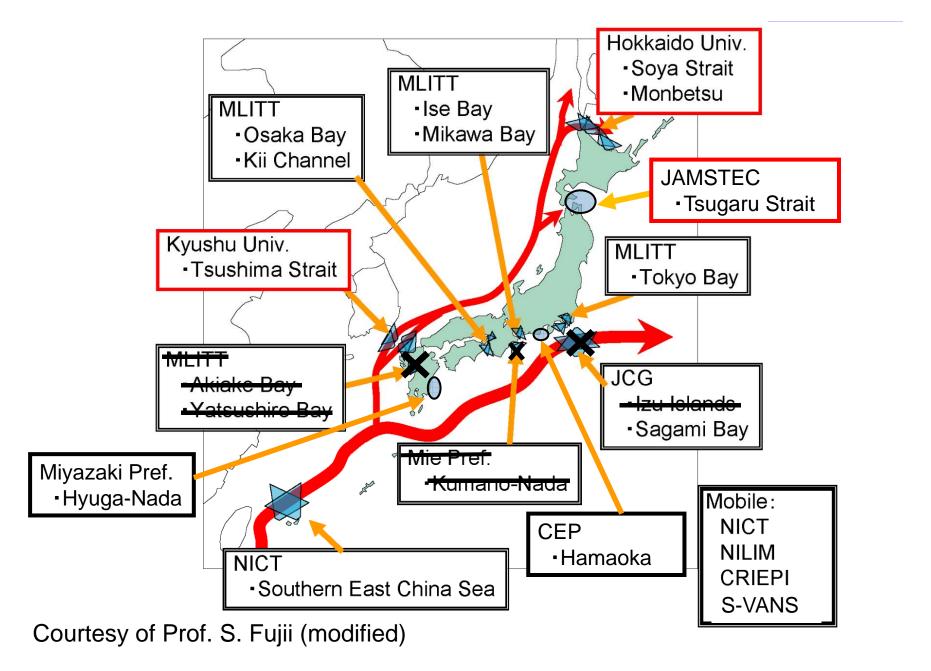




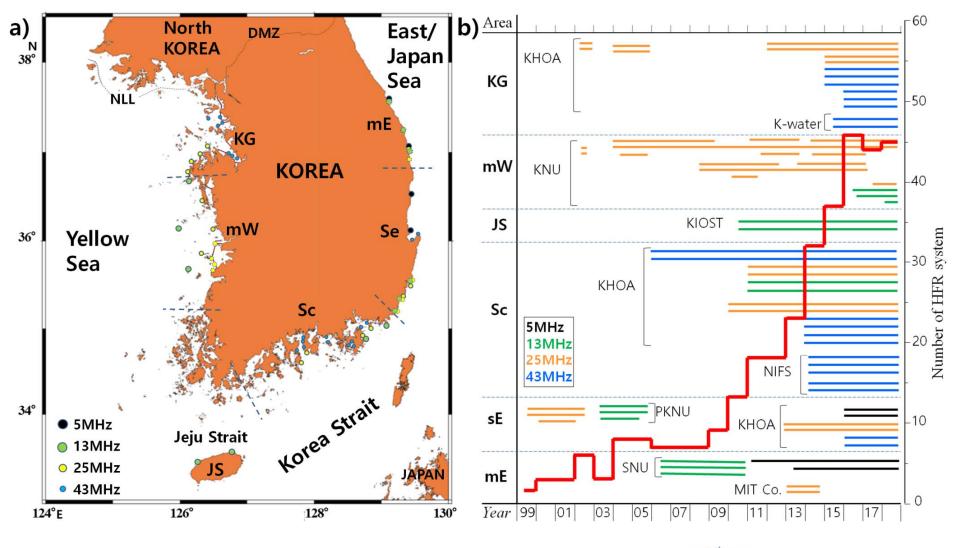




# HFR in Japan



### Growth in Korea

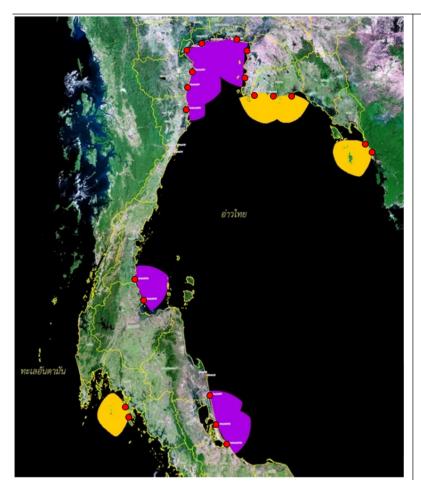








## HFR in Thailand



Coastal radar stations (Purple is phase 1 and yellow is phase 2)

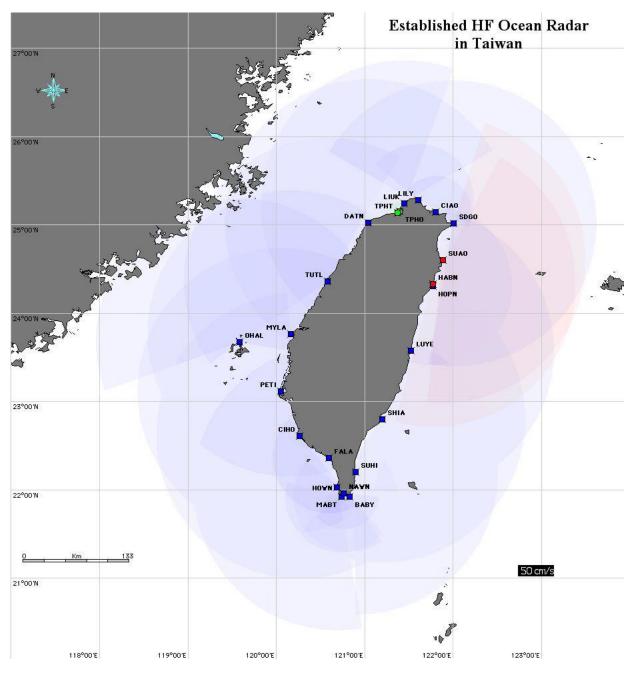


Picture of coastal radar station installed in the area















# Community White Paper on the Global HFR Network



TECHNOLOGY REPORT published: 14 May 2019 doi: 10.3389/fmars.2019.00164



### The Global High Frequency Radar Network

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"Qualitas Remos, Marind, Spain," Phil. Ed. Messtochnik Gmith, Katterkirchen, Germany, "Department of Ocean

Academic, government, and private organizations from around the globe have established High Frequency radar (hereinafter, HFR) networks at regional or national levels. Partnerships have been established to coordinate and collaborate on a single global HFR network (http://global-hfradar.org/). These partnerships were established in 2012 as part of the Group on Earth Observations (GEO) to promote HFR technology and increase data sharing among operators and users. The main product of HFR networks are continuous maps of ocean surface currents within 200 km of the coast at high spatial (1-6 km) and temporal resolution (hourly or higher). Cutting-edge remote sensing technologies are becoming a standard component for ocean observing systems, contributing to the paradigm shift toward ocean monitoring. In 2017 the Global HFR Network was recognized by the Joint Technical WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM) as an observing network of the Global Ocean Observing System (GOOS). In this paper we will discuss the development of the network as well as establishing goals for the future. The U.S. High Frequency Radar Network (HFRNet) has been in operation for over 13 years, with radar data being ingested from 31 organizations including measurements from Canada and Mexico. HFRNet currently holds a collection from over 150 radar installations totaling millions of records of surface ocean velocity measurements. During the past 10 years in Europe, Roarty H.et al., "The Global High Frequency Radar Network." *Frontiers in Marine Science*, 6:164. doi: 10.3389/fmars. 2019.00164, May 2019



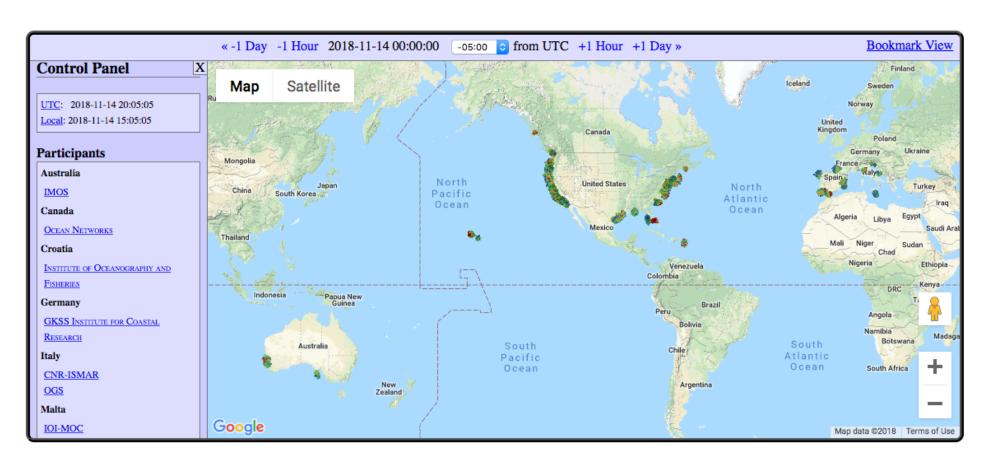


# Operational Integration - United States



# Network Update

- >350 stations operating in
- 35 countries with
- 9 countries sharing surface current data



http://global-hfradar.org







# HF Radar – Surface Currents Data Sharing

	Country	Organization
1	Australia	Integrated Marine Observing System (IMOS)
2	Canada	Ocean Networks
3	Croatia	Institute of Oceanography and Fisheries
4	Germany	Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research
5	Italy	CNR, Consiglio Nazionale delle Ricerche
		OGS, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
6	Malta	University of Malta, Physical Oceanography Unit (PO-Unit), International Ocean Institute-Malta Operational Centre (IOI-MOC)
7	Mexico	Observatorio de Corrientes Oceánicas MEXicanas (OCOMEX)
8	Spain	Puertos del Estado
		SOCIB, Balearic Islands Coastal Observing and Forecasting System
		Meteorological Agency (Euskalmet)
9	United States	Integrated Ocean Observing System (IOOS)

- Republic of Korea Korea Hydrographic and Oceanic Administration (KHOA)

Global Shared Data Repository – European Marine Observation and Data Network (EMODnet)

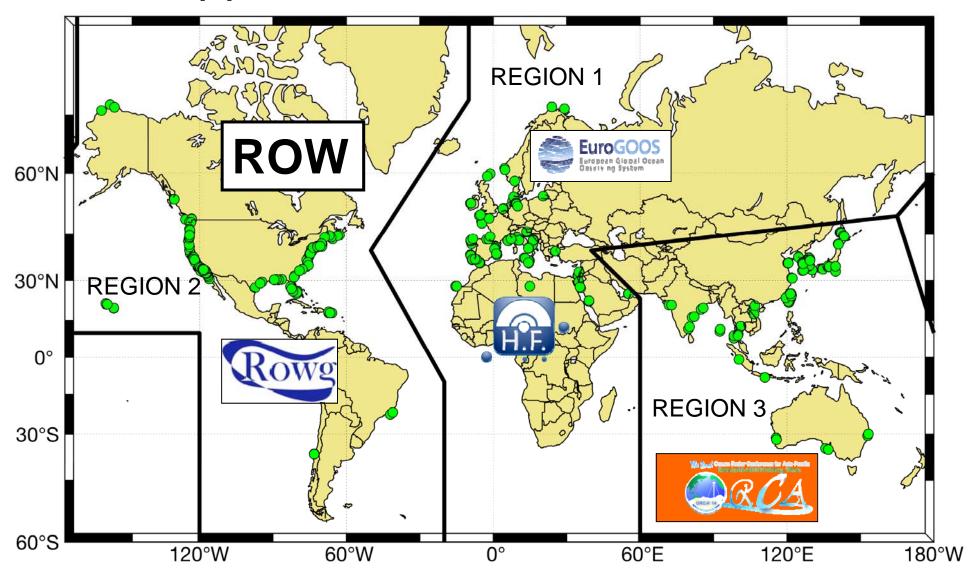
Global Shared Data Visualization – google map visualization







# Opportunities for Coordination











# International Radiowave Oceanography Workshop (ROW)

Homepage for radiowaveoceanography.org

Home Registration Abstracts



#### **ROW 2019**

http://paduan.org/row/

Dear Colleagues:

We are pleased to announce two coordinated scientific meetings based on the use of high frequency (HF) radar for oceanography:

The International Summer School On Radio oceanography (ISSOR; 25-28



August 2019)The Radiowave Oceanography Workshop 2019 (ROW2019; 28-30 August 2019)

These events will take place back-to-back during this period in Victoria, B.C. CANADA. Our hosts will be Ocean Networks Canada at the University of Victoria.







#### Summer school on HF and X-band radars

**⊥** Login

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ISSOR'19

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#### WELCOME <a href="https://radarschool.sciencesconf.org/resource/page/id/5">https://radarschool.sciencesconf.org/resource/page/id/5</a>



In the framework of ANR HYD2M (P.I: A.-C. Bennis) concerning the impacts of wave-current interactions on tidal stream energy estimation, we plan to install four phased array HF radars (operated by Caen University), one VHF radar (operated by Caen University, CNAM-Intechmer and MIO) and one X-band radar (operated by DCNS) in Cap de la Hague to measure surface currents and sea states in Alderney race where the strongest tidal current in Western Europe occurs (up to 12 knots). It is a challenge to operate HF, VHF and X-band radars in such hydrodynamic conditions.

With this in mind, we have organised a summer school on HF and X-band radars.

### Summary

- The Global High Frequency Radar Network is now expanding over 35 countries and 350 radars. 9 countries are sharing data via the global network (http://global-hfradar.org/).
- HFR technology can be found in a wide range of applications: for marine safety, oil spill response, tsunami warning, pollution assessment, coastal zone management, tracking environmental change, numerical model simulation of 3-dimensional circulation, and research to generate new understanding of coastal ocean dynamics.
- The Global HFR Network is an example of national inter-agency and interinstitutional partnerships for improving oceanographic research and operations.
- As global partnerships grow, these collaborations and improved data sharing enhance our ability to respond to regional, national, and global environmental and management issues.
- An active global HFR network is crucial for pushing forward HFR scientific developments, promoting training activities, encouraging the integration of the HFRs into operational maritime monitoring and environmental assessment, and boosting networking toward an integrated, evolving and sustained HFR global network over the next decade.







### Questions?

Send them to Hugh, hroarty@marine.rutgers.edu





