INCREASE
HF Radar
Users
Workshop

26th
September 2017

INCREASE HF Radar Users Workshop

HF radar applications

Outline

1. General view of HF Radar applications
2. Examples of HFR applications
3. HFR data uses and users in Europe
4. Final remarks

Courtesy of L. Wyatt and E. Zambianchi

CMEMS Service Evolution 21-SE-CALL1
Lot5: INCREASE project
Innovation and Networking for the integration of Coastal Radars into European mArine SErvices

General view of HFR systems applications

HFRs being used worldwide for several applications… and growing number

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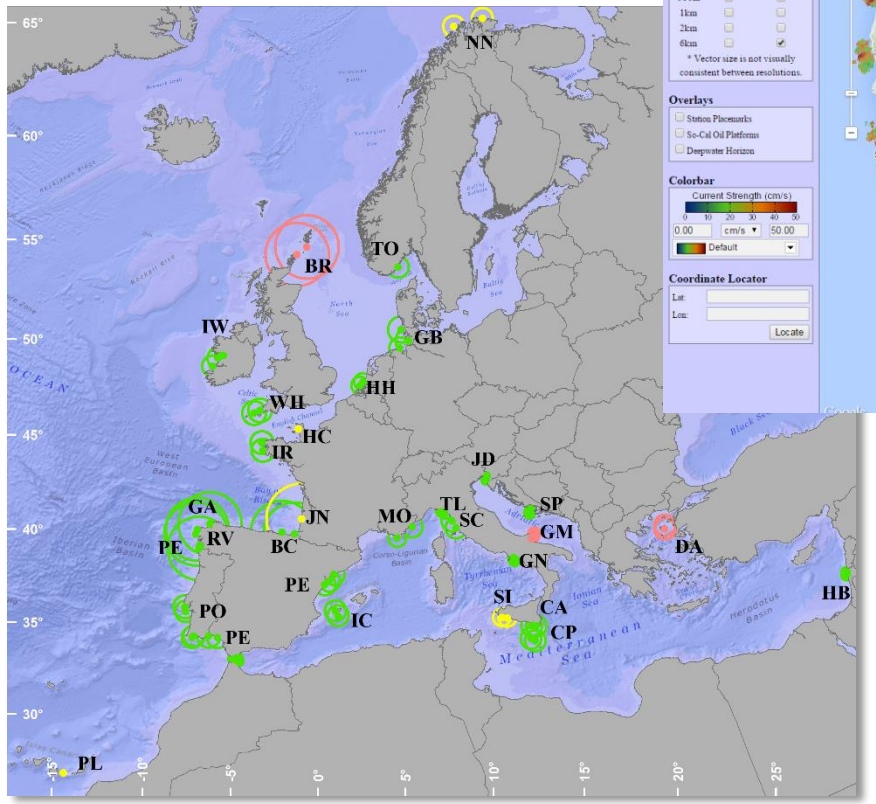
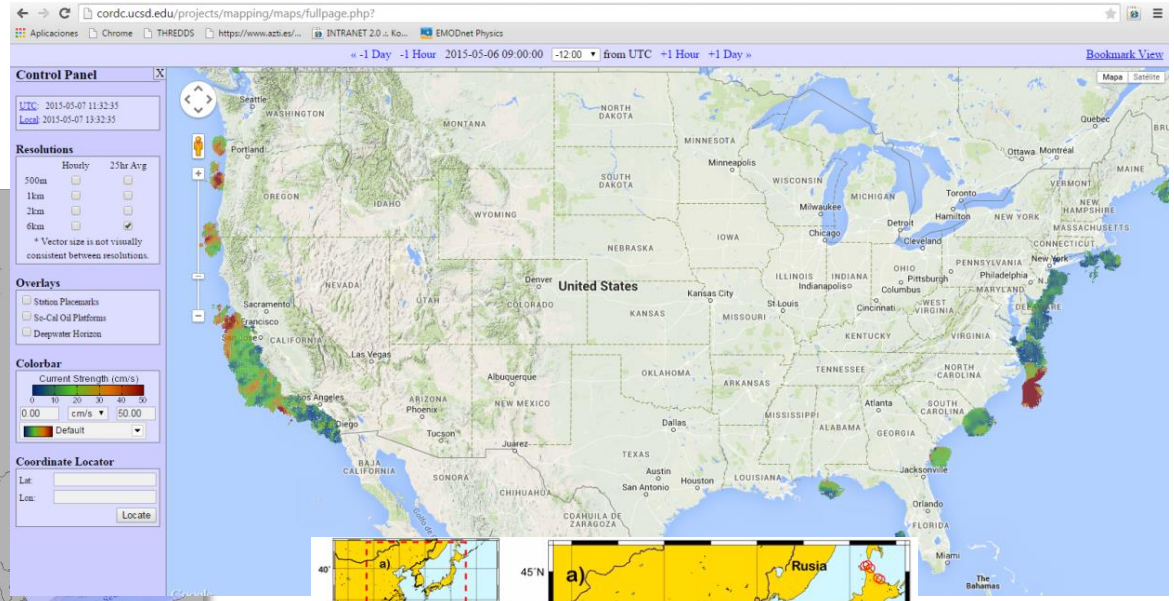
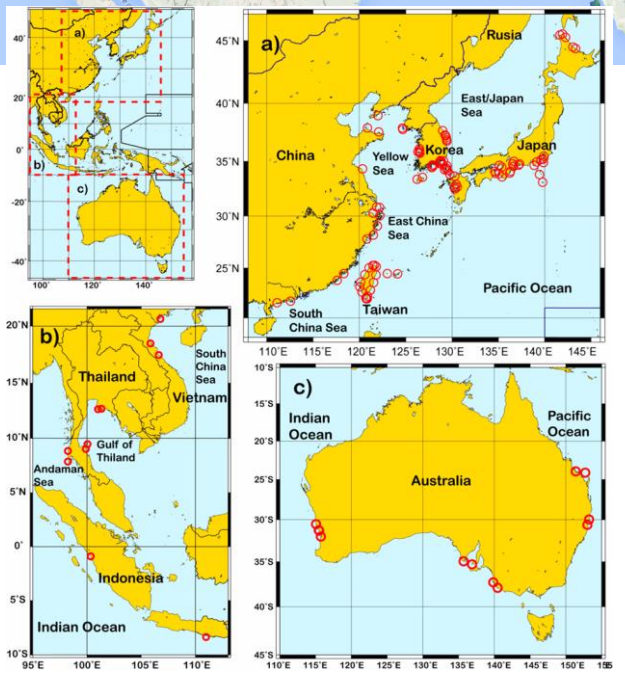




EUROPE

(Rubio et al., 2017 – Frontiers in Marine Systems)



Asia and Oceanie

(Fujii et al. 2013 – Ocean Science Journal)

USA

(Paduan and Washburn, 2013 - Annual Review of Marine Science)

General view of HFR systems applications

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Near real time or operational use of the data:

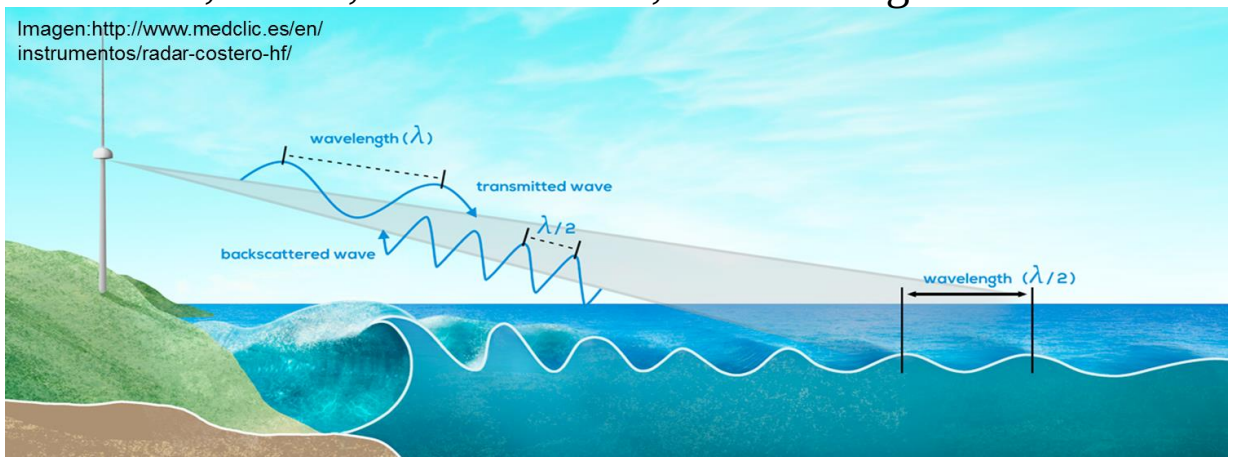
- -study of surface drift of floating objects
- -statistical methods for short term prediction
- -model-data comparisons or data assimilation in models…

Long term data series and/or data exploitation:

- - study of ocean processes: inertial oscillations, tidal variability, (sub)mesoscale coastal processes,
- - connectivity between marine areas
- -air-sea interactions…

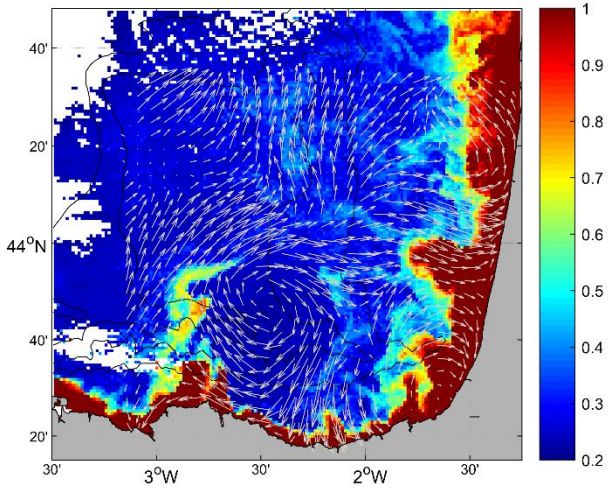
Direct use of data:

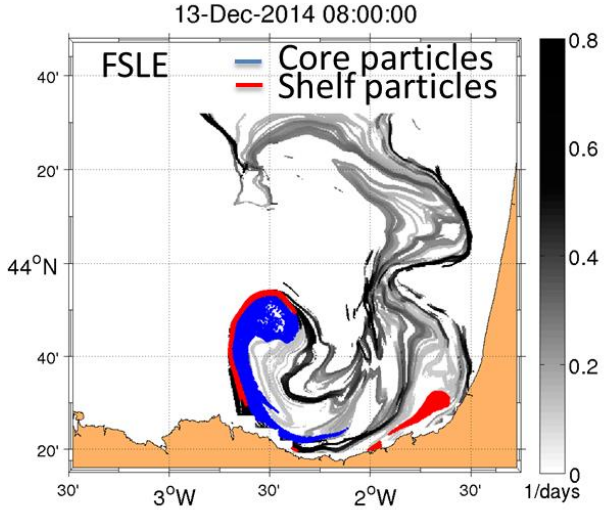
- UV fields, waves, wind direction, discrete targets



Derived products:

-Lagrangian models, gap-filled data…





Rubio et al. Under review for RSE

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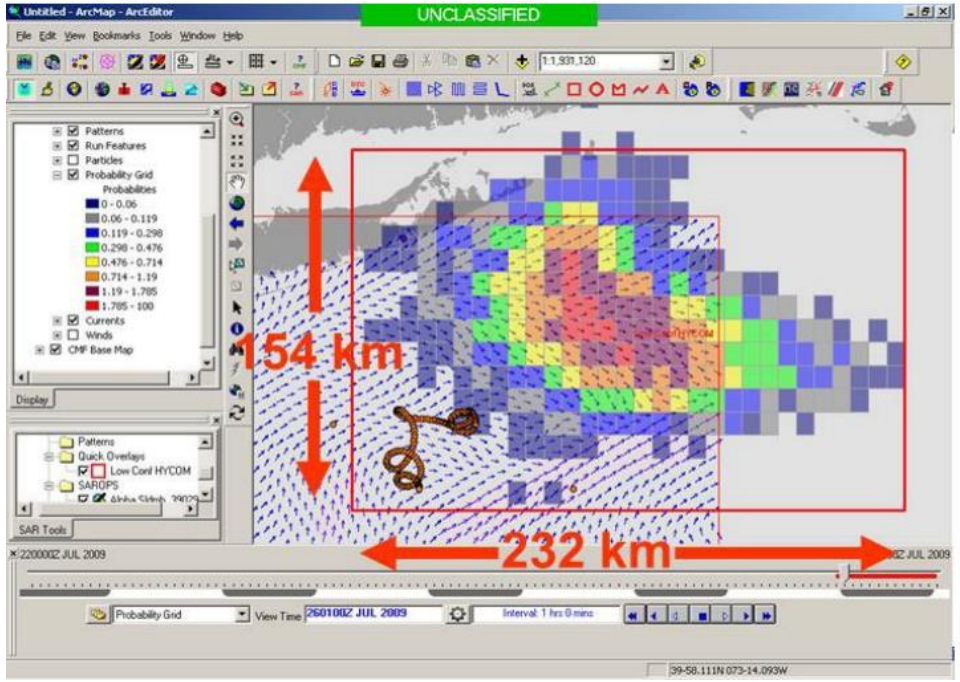
Near real time applications

Study of surface drift of floating objects: SEARCH AND RESCUE

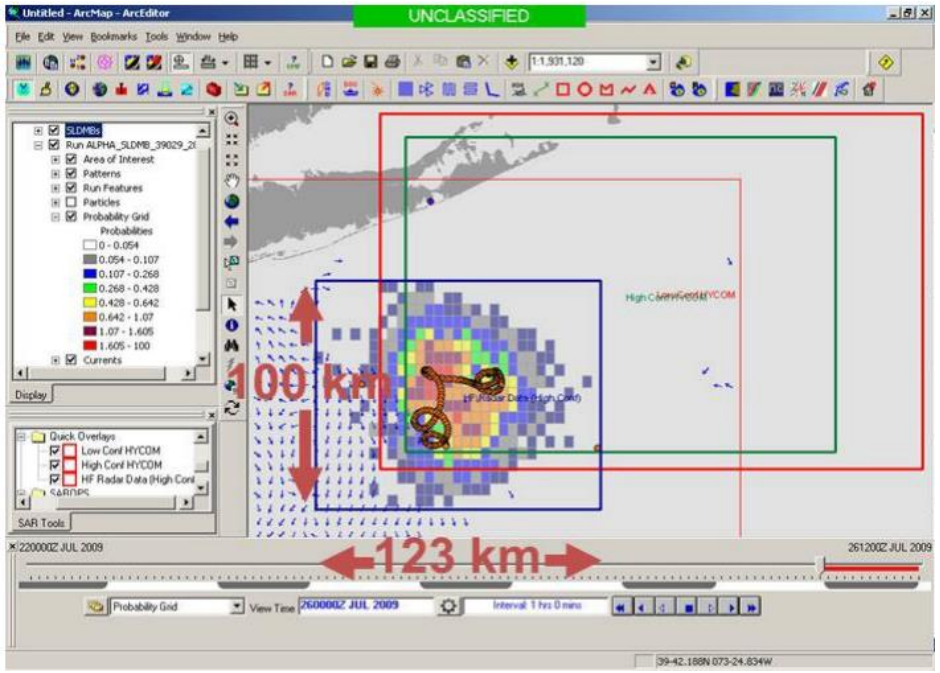
HF Radar in SAROPS (US Coast Guard SAR tool)

Source: http://www.ioos.noaa.gov/hfradar/sarops_hfr_info2012.pdf

HYCOM



HF RADAR



Near real time applications

Model-data comparisons or data assimilation in models

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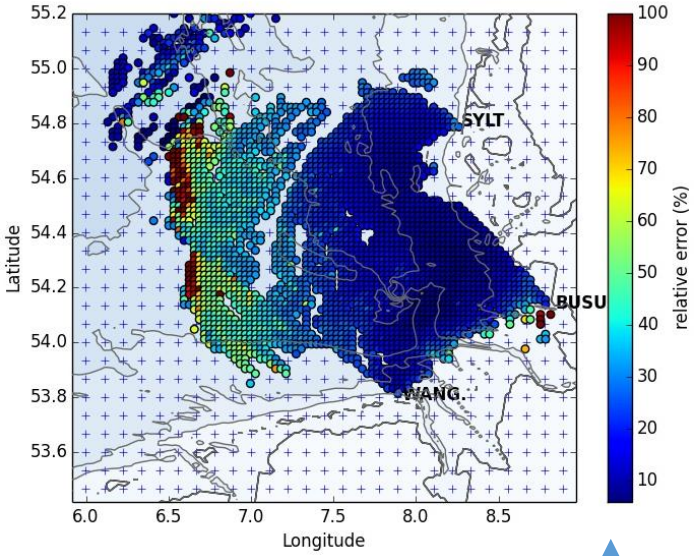
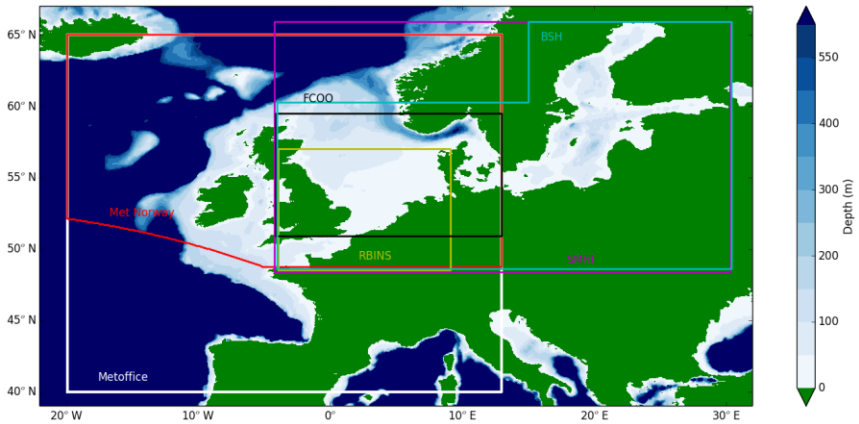
Surface currents forecast operational verification using HF radar

Christine Pequignet, Jan Maksymczuk,
Met Office Ocean forecast verification team

- **Verification of Met Office operational ocean surface currents forecast using HF radar data is being developed**
- In parallel, a multi-model verification of European models on the European North West shelf is implemented, initially using the German Bight COSYNA data.
- **The work will be extended to include more European HF radar datasets**
- Plans for verification of 5 day forecasts for the overlapping area of IBI, Mercator PSY4 and Met Office FOAM-AMM7



3 month average of relative error of surface current magnitude from COSYNA HF radar (German Bight)



Domains from models used in the multi-model verification over the European NWS

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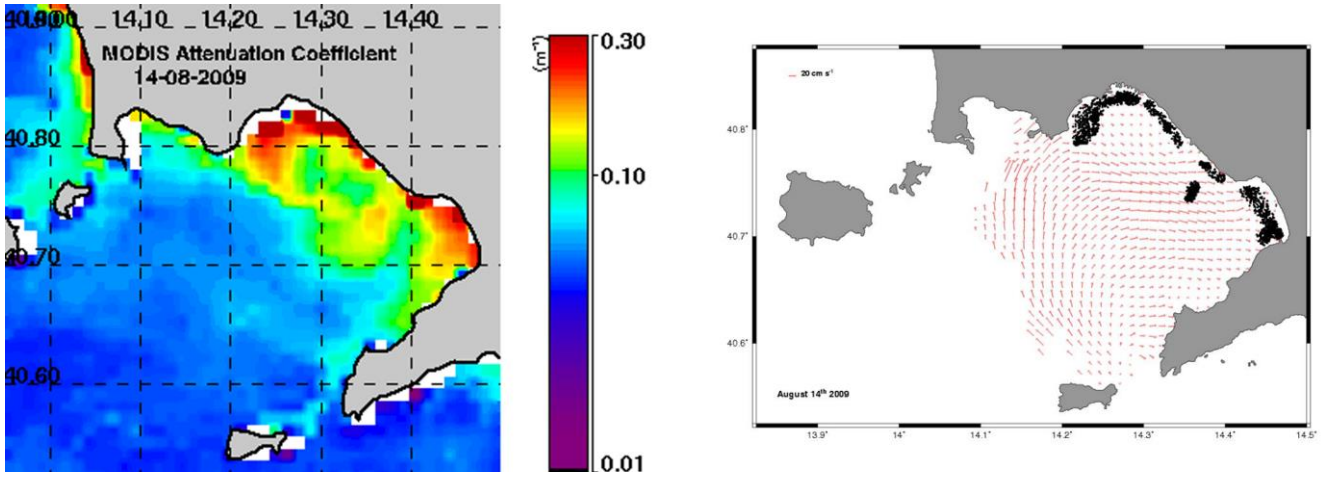
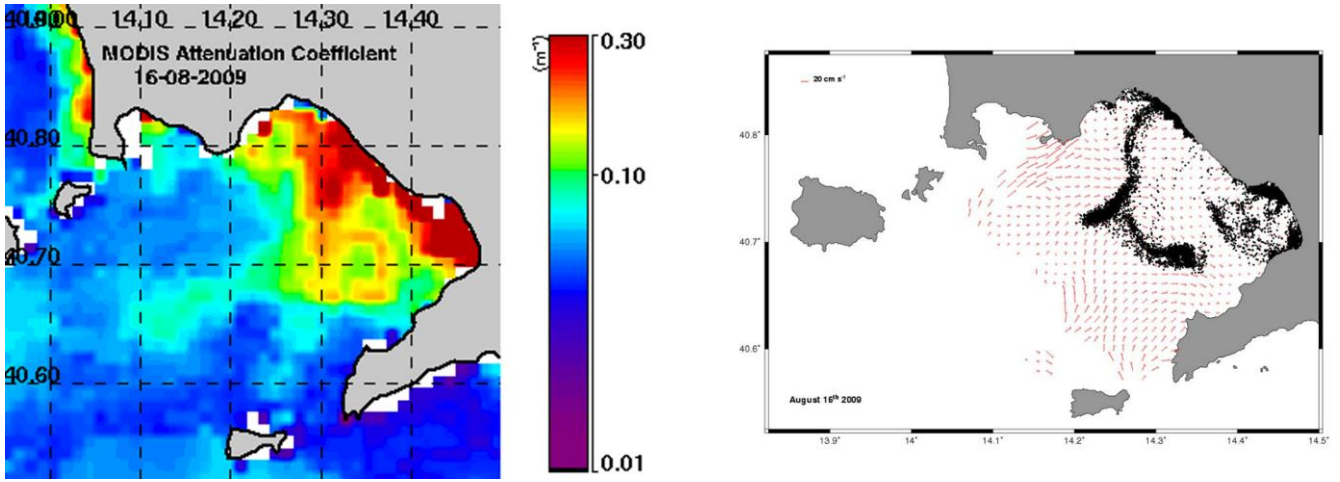
Long term data applications

Lagrangian studies and connectivity between marine areas

Combined use of HF radar and satellite data to study the dynamics in the Gulf of Naples. Enrico Zambianchi et al. (DiSAm, Parthenope University of Napoli)



2 days later…



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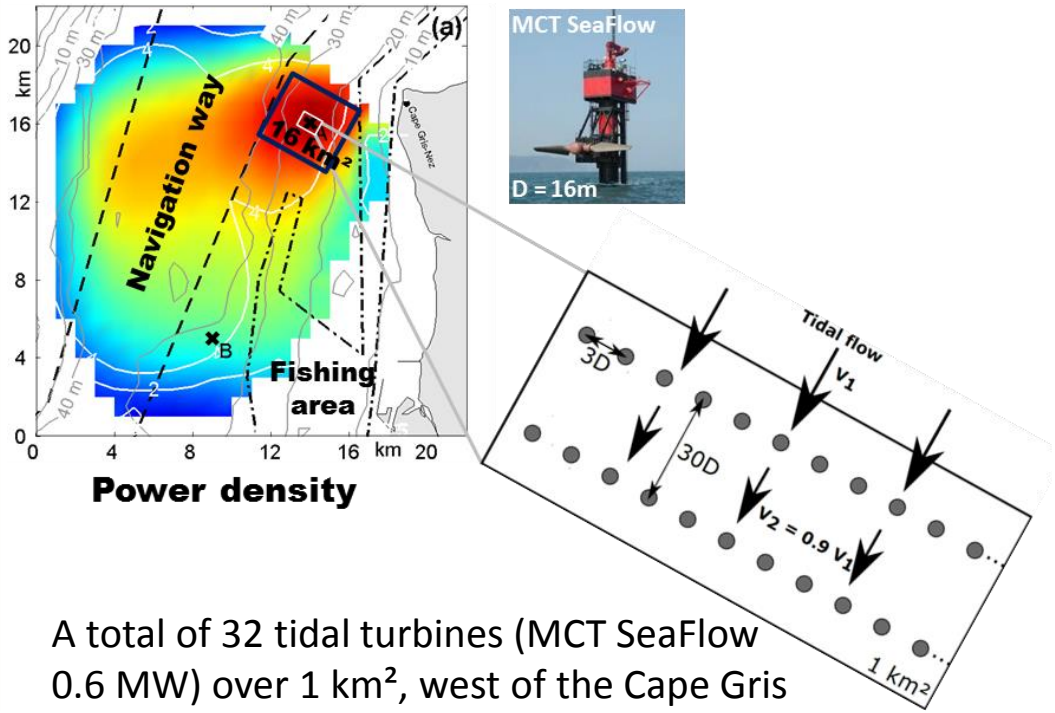
Long term data applications

Ocean processes

THE USE OF HF RADARS FOR MONITORING STRONG TIDAL CURRENTS IN STRAITS AND ASSESSING TIDAL STREAM RESOURCE
A new way of resource assessment

Alexei Sentchev, Maxime Thiébaut (Lab. Oceanology & Geosciences - LOG, Université du Littoral, FRANCE

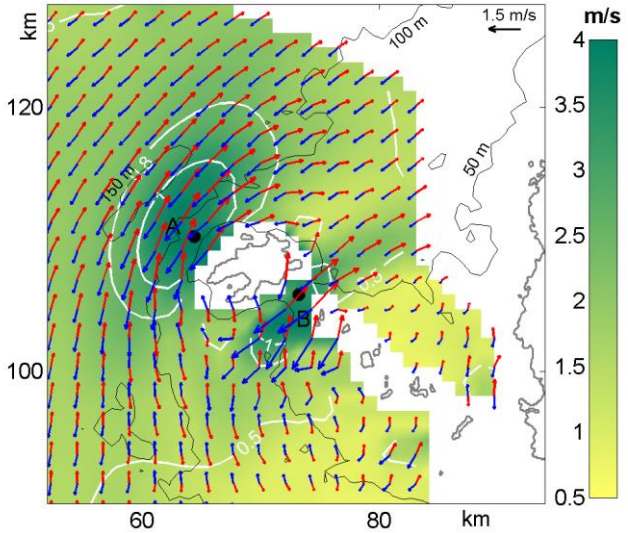


A total of 32 tidal turbines (MCT SeaFlow 0.6 MW) over 1 km², west of the Cape Gris Nez (Hauts de France), facing the flow (e.g. *Blunden & Bahaj, 2007*)

Fromveur Strait

Expected technically expoitable potential:

- **One MCT SeaFlow device: P_{tech} = 0.6 GWh**
- **An array of 32 tidal turbies : P_{tech} = 15 GWh**
- **Array location is very important beacause the variation of current asymmetry is strong**



Flood/Ebb tidal HFR currents in Fromveur area

Other applications

Ship detection

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Map of ship detections in the German Bight resulting from fusion of HFRs at Wangerooge and Büsum covering the German Bight of the southern North Sea. *(J. Horstmann in Rubio et al. 2017, FMS)*

Other applications

Wind and wave data

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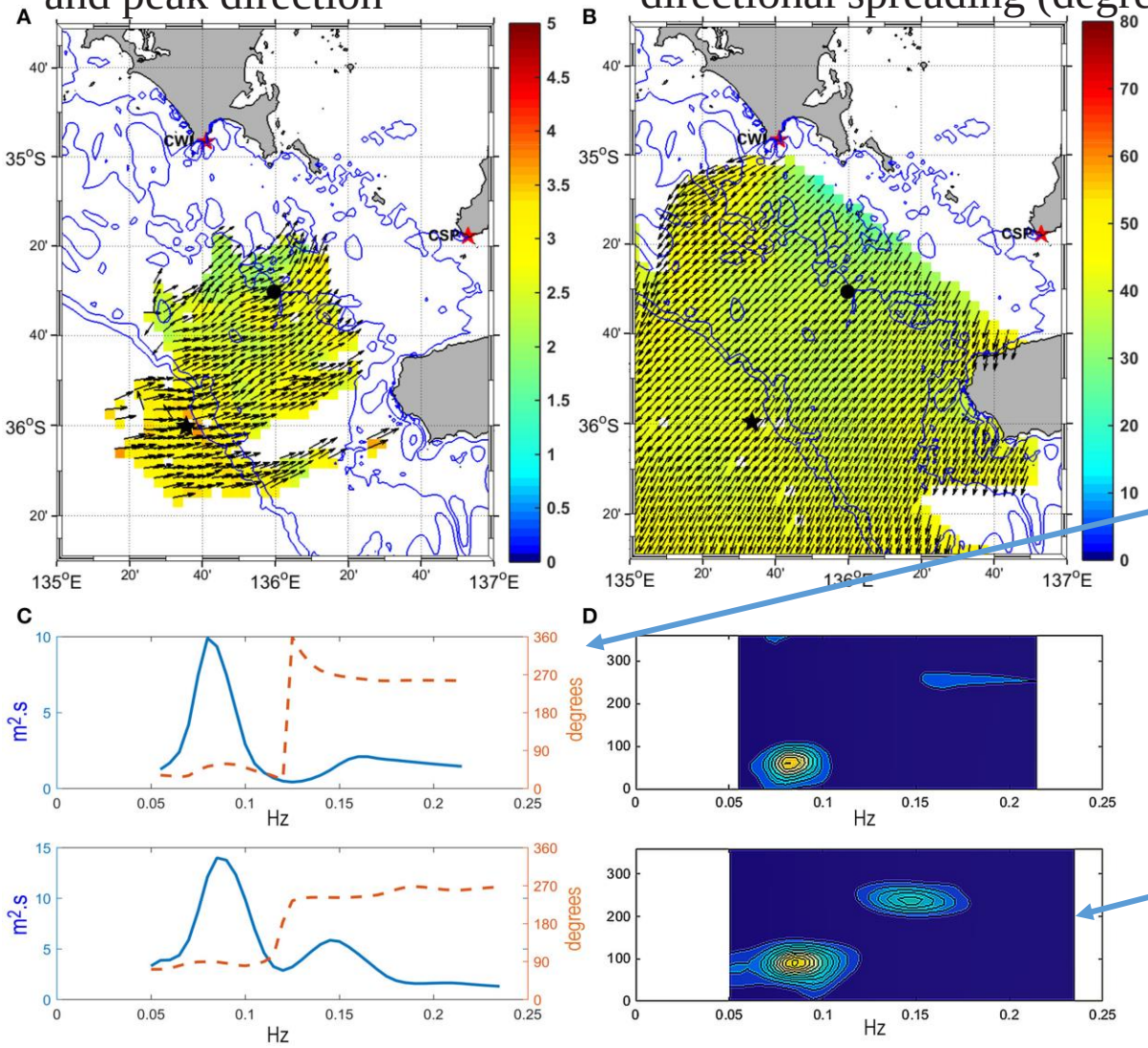
Significant wave height (m) and peak direction

Wind direction and directional spreading (degrees)



Example of HFR-derived wave data (28/06/2011 02:00) in South Australia showing a bimodal sea state (SW swell from and local sea from the E and winds from NE)

Frequency spectrum (blue) and mean direction at each frequency (red) at two locations,
one in shallower seas (top, black dot on the maps A,B) and the other (bottom, black star on the maps A,B) near the shelf edge

Directional spectra (spectral density, in m2.s.radian-1).
(L. Wyatt in Rubio et al. 2017, FMS)

HF Radar applications in Europe

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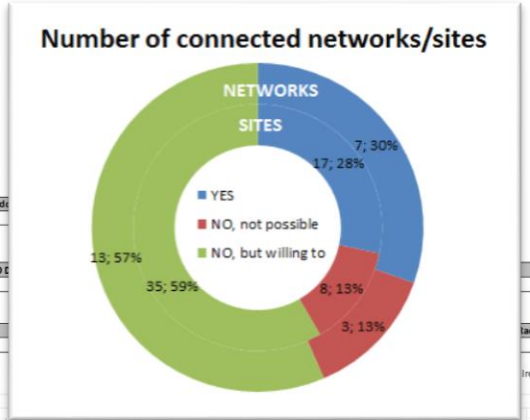
July 2016

HFRadar Task Team | EuroGOOS European Global Ocean Observing System | JERICO next

28 institutions, 23 operators of ongoing or past HFR networks.
72 sites (28 networks), 51 operational (20 networks).

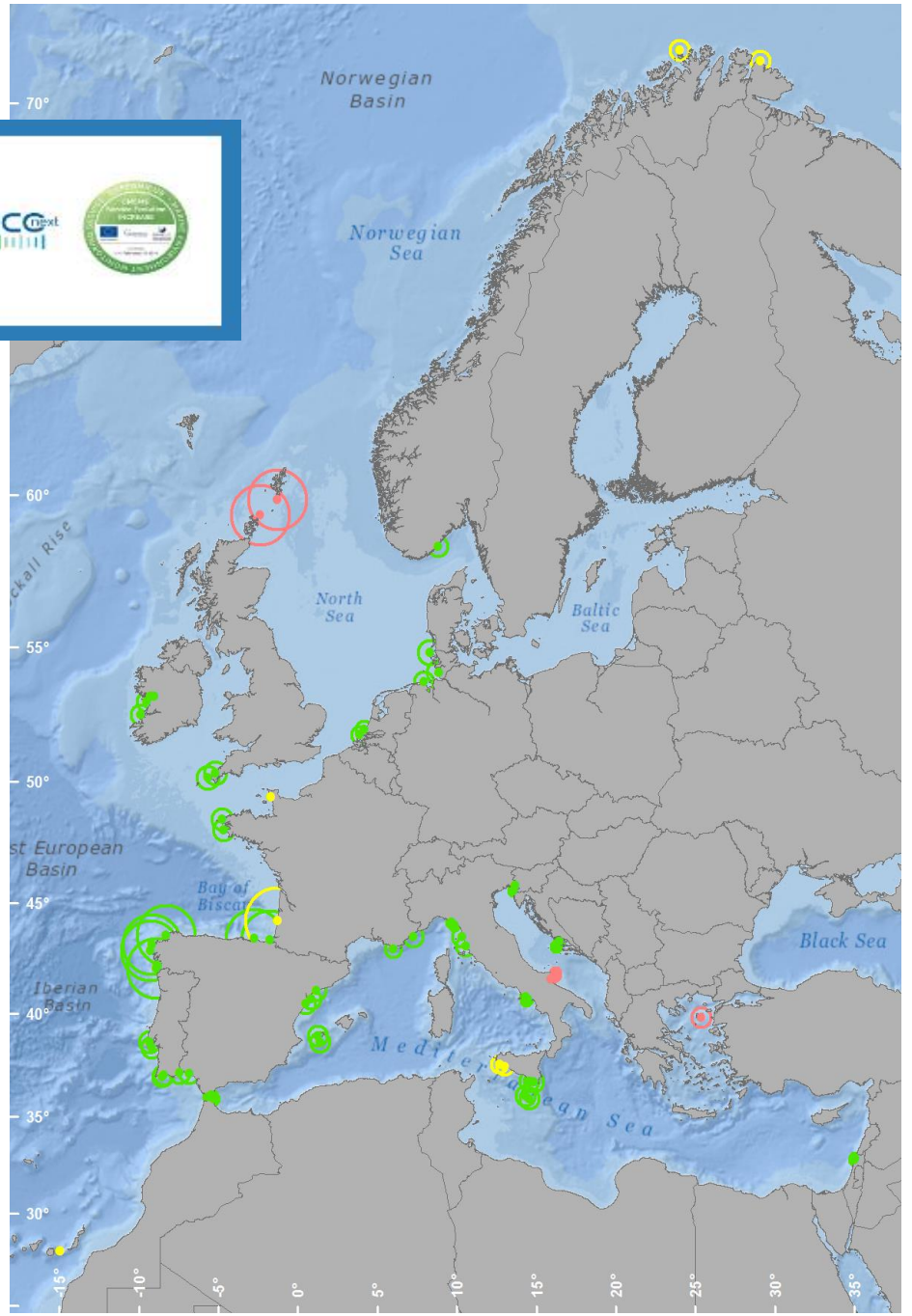
MONGOOS 31 sites (52%)
IBIROOS 17 sites (28%)
NOOS 12 sites (20 %)



HFR NETWORK	Hook of Holland	German Bight	Gulf of Naples	TirLig	Gulf of Manfredo
COUNTRY	THE NETHERLANDS	GERMANY			ITALY
OPERATOR	Rijkswaterstaat	Helmholtz-Zentrum Geesthacht	University of Naples		CNR-ISMAR
Numbser of SITES					
Name of sites	Ter Heijde				
Sites lat , lon coordinates	52,03 4,17				
Date of 1st deployment	01/10				
Status	Ong				
Permanent installation?	Y				
Manufacturer	WE				
Type of radar	P				
Temporal resolution (minutes)					
Spatial resolution of total velocity grid (m)					
Tansmit Fequency (MHz)	16				
Tansmit Bandwidth (KHz)	15				

HFR NETWORK	IBIZA CHANEL	DELTA DEL EBRO	ESTRECHO DE GIBRALTAR	GOLFO D
COUNTRY			SPAIN	
OPERATOR	SOCIB		Puertos del Estado	
Numbser of SITES	2			
Name of sites	FORM	GALF		
Sites lat , lon coordinates	38,67 1,39	38,95 1,22		
Date of 1st deployment	01/06/2012			
Status	Ongoing			
Permanent installation?	yes			
Manufacturer	CODAR			
Type of radar	DF			
Temporal resolution (minutes)	60			
Spatial resolution of total velocity grid (m)	3000			
Tansmit Fequency (MHz)	13,5			
Tansmit Bandwidth (KHz)	90,069			

HFR NETWORK	MOOSE HF radar														
COUNTRY	FRANCE														
OPERATOR	MIO, AMU-CNRS-IRD-UTLN														
Numbser of SITES	3														
Name of sites	Vila real de Santo António	ANTARES	DYFAMED	Pointe de Garchine	Pointe de Brézellec	Torungen	Pendeen	Perranporth	SUMB	NRON	Mutton Island	Spiddle	Irish Oirr	Loop Head	
Sites lat , lon coordinates	37,18 -7,44	42,95 6,00	43,50 7,25	48,50 -4,78	48,07 -4,66	58,40 8,79	50,16 -5,67	50,34 -5,18	59,85 -1,28	59,39 -2,38	53,25 9,05	53,24 9,30	53,06 9,52	52,56 9,92	
Date of 1st deployment	01/08/2010	15/11/2011	01/09/2015	01/05/2006		25/05/2016	01/02/2011 and 01/04/2011		01/09/2013		01/03/2012		01/09/2015		
Status	Ongoing	Ongoing	Ongoing	Ongoing		Ongoing	Ongoing		Ended on 09/08/2014	Ended on 09/01/2014	Ongoing				
Permanent installation?	yes	yes	yes	yes		yes	no		no		yes				
Manufacturer	CODAR	WERA*	CODAR	WERA		CODAR	WERA*		CODAR		CODAR				
Type of radar	DF	DF on Brecelving antenna	DF	PA		DF	PA		DF		DF				
Temporal resolution (minutes)	60	60	90	10		60	60		60		60				
Spatial resolution of total velocity grid (m)	1500	3000	0	2000			1000		5000		300		2000		
Tansmit Fequency (MHz)	12,4698	16,175	13,45	12,4		13,5	12		4,5		25		13,5		
Tansmit Bandwidth (KHz)	99,259	50	50	100		75	350	375	36,8		500		49,6		



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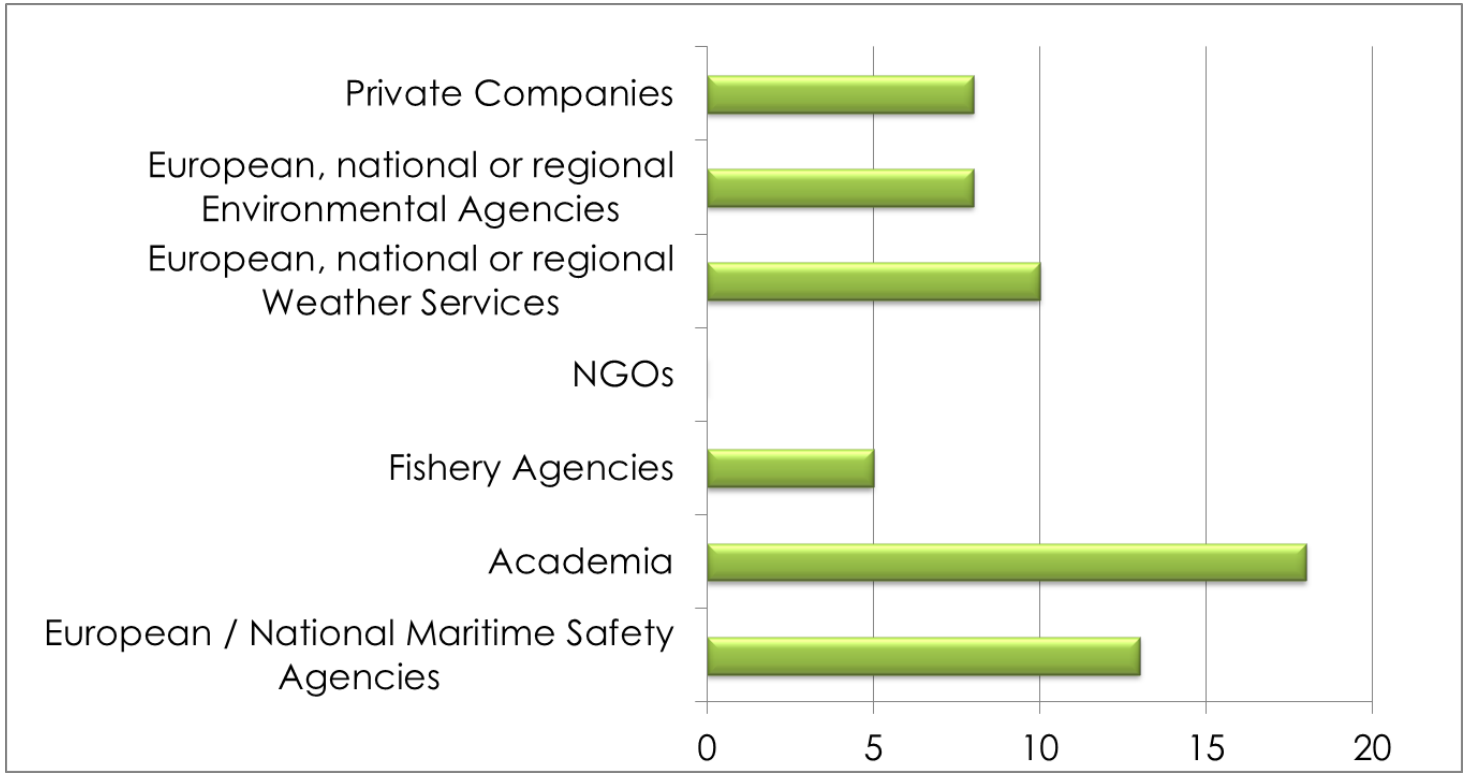
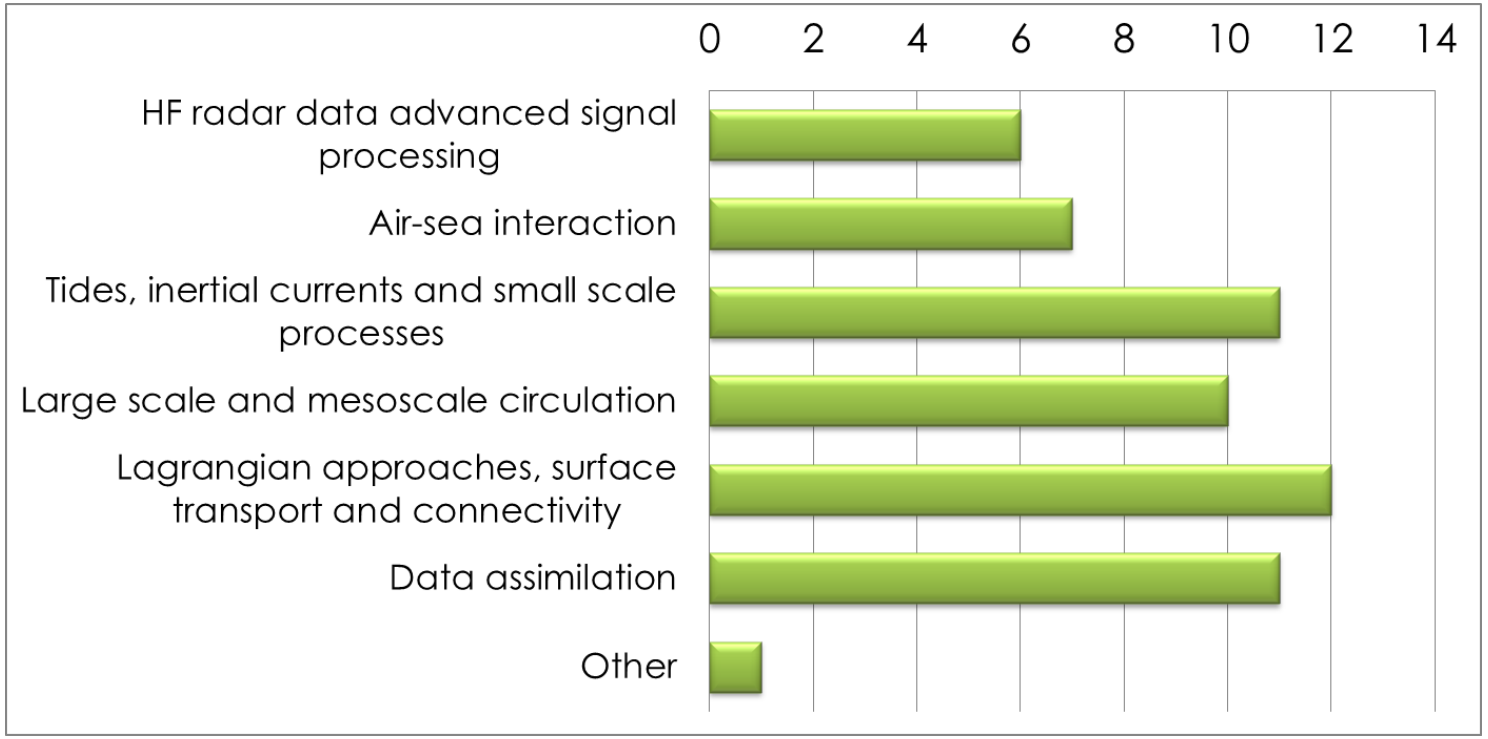
HFR main identified users in Europe



EU HFR identified users. From the 23 networks 20 chose at least one option. Multiple choice was enabled, so more than one user could be identified by the same operator.

HF Radar applications in Europe

HFR main related research lines



HFR related Research Lines listed by EU operators contributing to the survey. From 23 operators 15 chose at least one of the available options. Multiple choice was enabled, so more than one application within the same or different sectors could be identified by the same operator.

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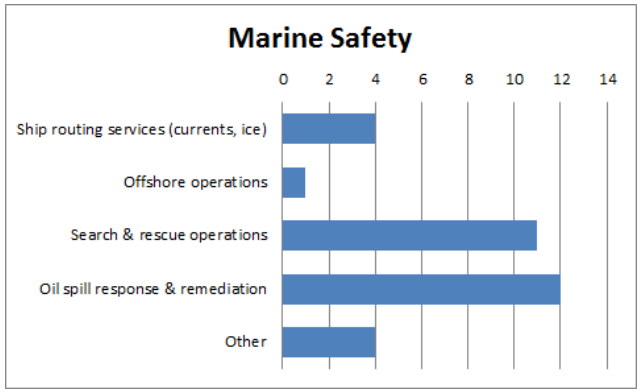
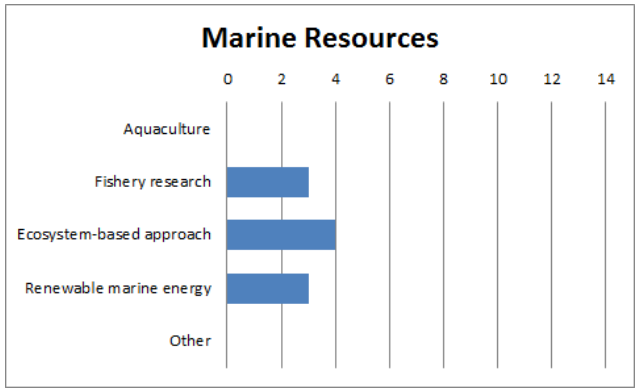
HFR current data uses and users

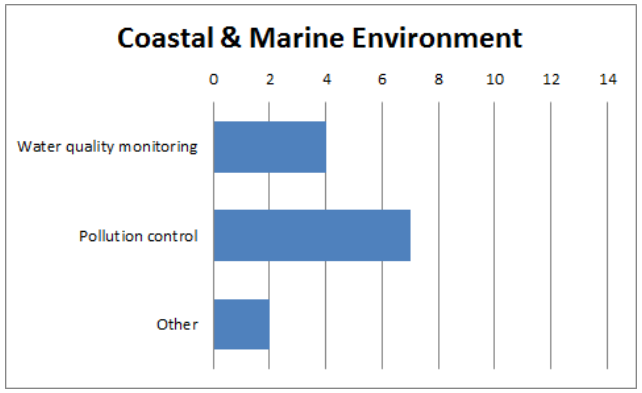
a)



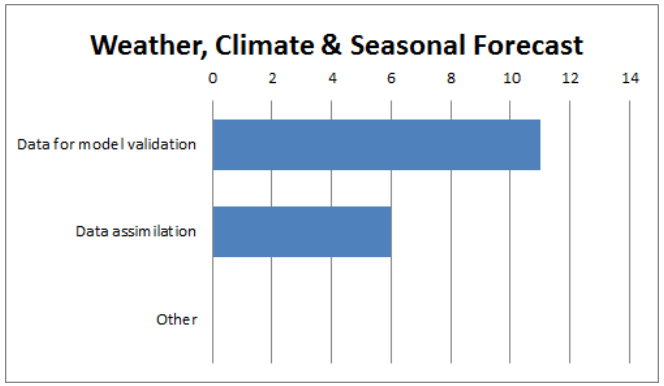
b)



c)



d)



EU HFR applications within four activity sectors. From 23 operators 14,7, 11 and 12 chose at least one of the available options for a), b), c) and d), respectively.

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Final remarks

1 - HFRs offer an unprecedented opportunity to take a step forward in the understanding of coastal ocean processes and transport mechanisms along the European coasts

2- Increasing applications of HFR in notable issues like the Marine Strategy Framework Directive (MSFD), the sustainable development of the Blue economy or the maritime safety (**Most commonly identified users: Academia and Marine Safety agencies)**

3 -To reach the potential that this technology can offer to the European coastal operational oceanography, the HFR and EOOS community need to elaborate a broad plan towards the establishment of a real and effective European HFR Network, in coherence with the existing initiatives at international levels.