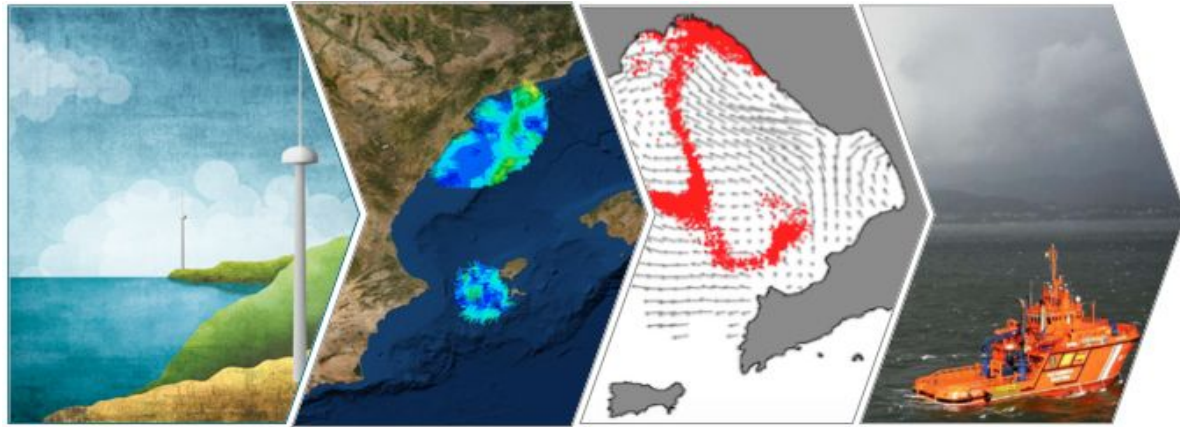


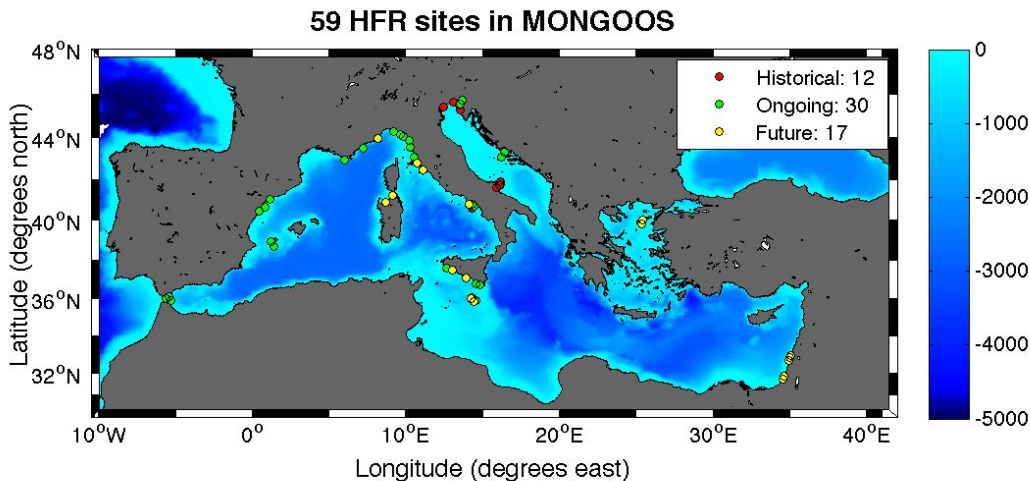
# Unlocking HF radar data potential for scientific and societal applications



E. Reyes, P. Lorente and MONGOOS HFR (speaker: Catalina Reyes)

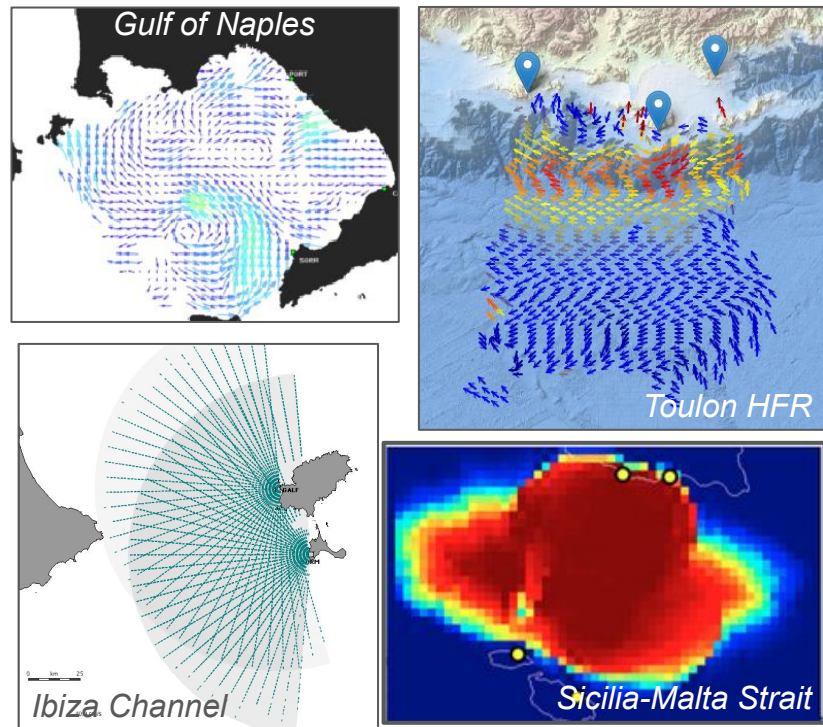
# HF radar in the MedSea

- > 55% HFR sites of EU
- > 50% operational
- > 86% permanent installations



Map of HF radar systems (>55% in EU) deployed in the Mediterranean  
(from the last updated EU HFR node inventory)

- 2D surface currents maps
- High spatial resolution (0.2- 6 km)
- High temporal resolution (30'-1h)
- Wide coastal coverage (> 200 km)



HF radar systems in the Med Sea

# HF radar: Applications

## Ibiza Channel HFR system (ereyes@socib.es)

### Model assessment

- HFR data for WMOP model operational validation

### Model improvement

- HFR data assimilation

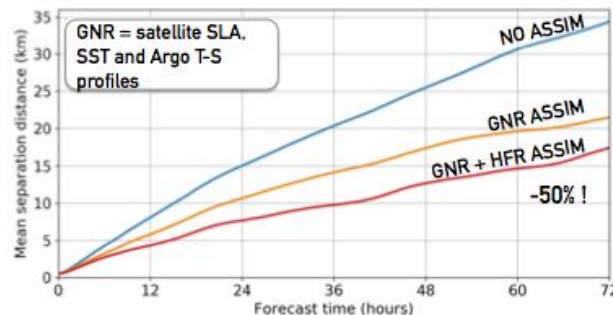
### Extreme events monitoring

- Impact of extreme river discharges

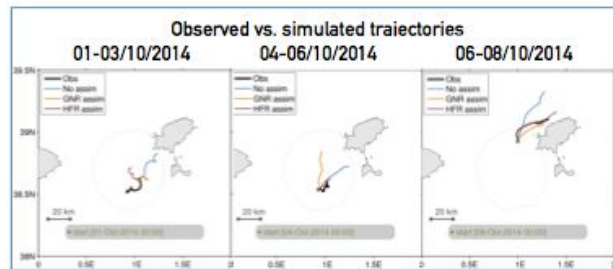
### Data downstream services

- HFR data integration in Search & Rescue services

- HFR data assimilation improves the prediction of Lagrangian trajectories.



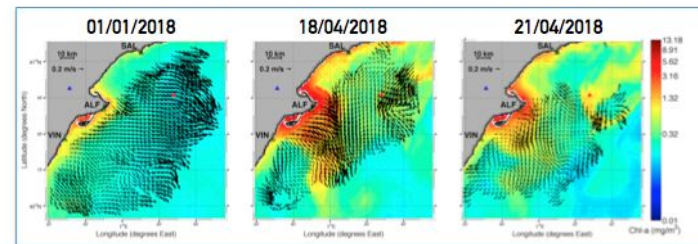
Mean separation distance (km) over the time between real and simulated trajectories for different DA simulations. Validation performed with 14 drifters during 10 days.



Multi-platform data assimilation improves the model performance on average, though not on a systematic basis.

Hernández-Lasheras J. et al, 2019

- Impact of the last extreme Ebro river discharge event on the surface circulation.



Maps of HFR surface currents and surface Chlorophyll-a concentration for reference conditions (left) and extreme discharge events (middle and right).

Ruiz et al, 2019.

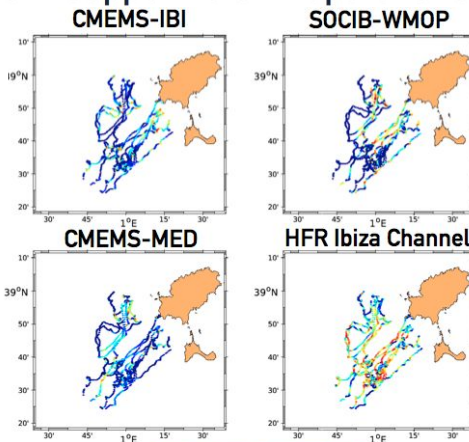
- IBISAR service in support to SAR operations

HFR observations outperforms models in most scenarios

[www.ibisar.es](http://www.ibisar.es)

Spatial distribution of skill scores in the Ibiza Channel

Reyes et al., 2019





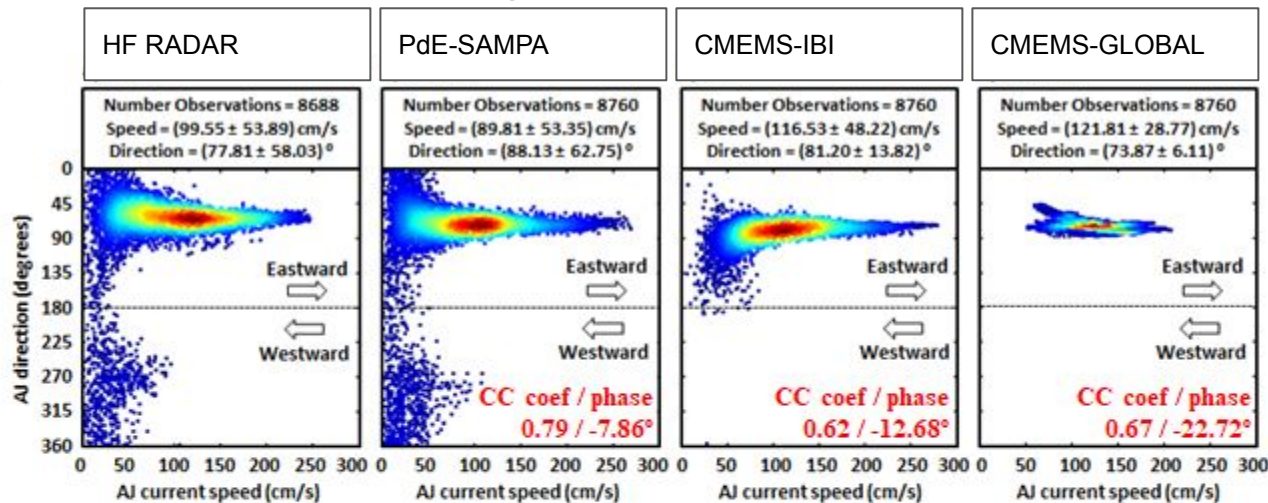
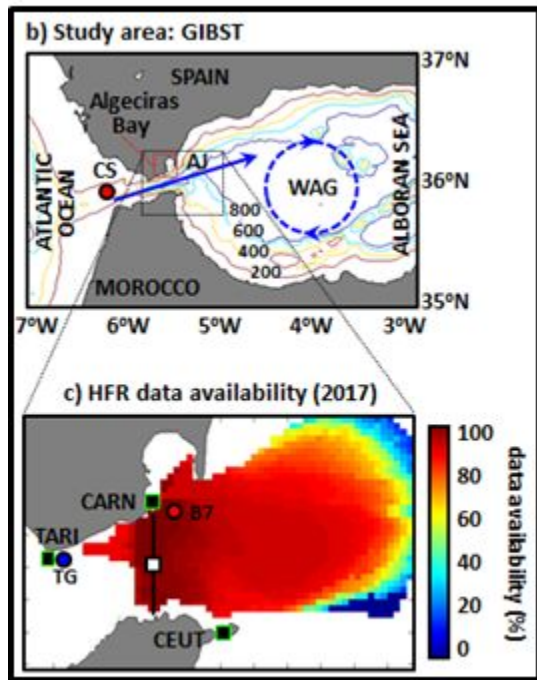
# HF radar: Applications

Puertos del Estado



## Multi-model intercomparison in the Strait of Gibraltar from global to local scales:

[plorente\\_externo@puertos.es](mailto:plorente_externo@puertos.es)



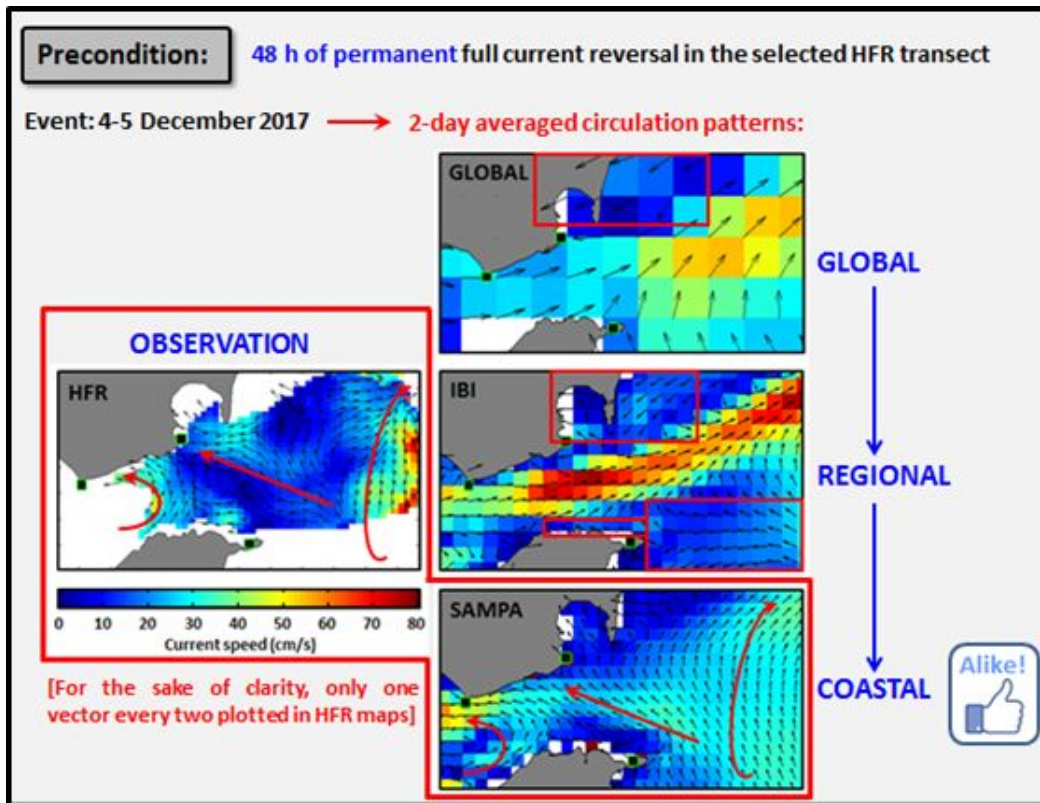
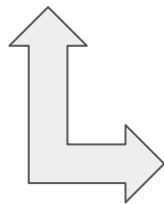
- Scatter of hourly estimations for 2017: speed versus direction (clockwise from North)
- **SAMPA better captured AJ features and flow reversals** → **better skill metrics**
- **GLOBAL & IBI:**
  - i) Eastward flow > 30 cm/s
  - ii) Westward flow never detected

Then... Positive impact of: i) higher model resolution; ii) higher spatio-temporal resolution of atmospheric forcing; iii) tailored bathymetry and iv) barotropic currents

# HF radar: Applications



Extreme event: prolonged inversion of the Atlantic Jet in the Strait of Gibraltar



➤ Added value of downstream services: proved!

➤ HF radars play a key role to evaluate models skill in critical areas!

➤ Focus on models ability to capture extreme coastal events!

## Reference:

Lorente et al., 2019: "Skill assessment of global, regional, and coastal circulation forecast models: evaluating the benefits of dynamical downscaling in IBI surface waters" Ocean Science, 15, 967–996.

# HF radar: Applications

**HFR Gulf of Naples, Mediterranean Sea** ([enrico.zambianchi@uniparthenope.it](mailto:enrico.zambianchi@uniparthenope.it))

◀ **2 x 25-MHz CODAR SeaSonde System**  
**Managed by CoNISMa and Parthenope University of Naples**

**Studies of transport by  
submesoscale features**

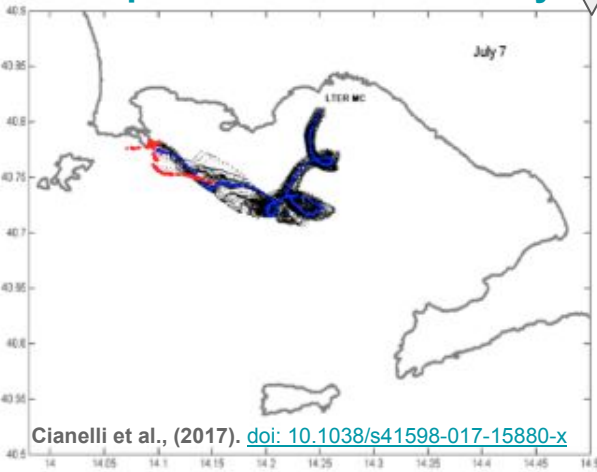
**Eddy detection  
algorithms**

**Wind retrieval** ▶

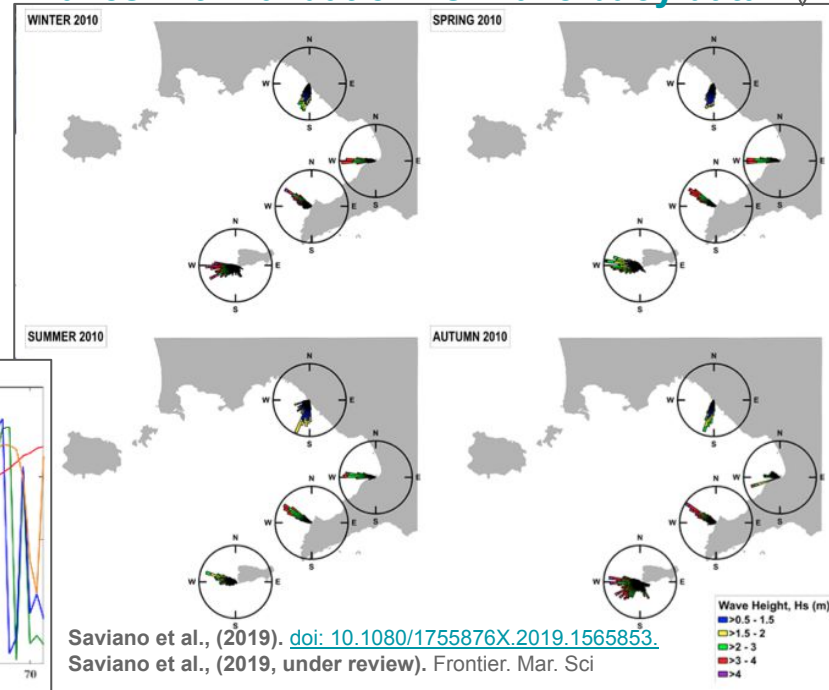
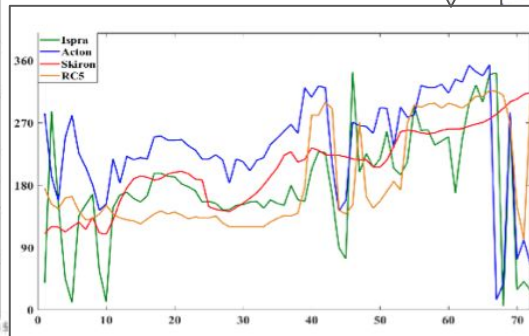
**Waves with validation vs. wave buoy data** ▶



**Transport of biological  
quantities & connectivity** ▶



Cianelli et al., (2017). [doi: 10.1038/s41598-017-15880-x](https://doi.org/10.1038/s41598-017-15880-x)



Saviano et al., (2019). [doi: 10.1080/1755876X.2019.1565853](https://doi.org/10.1080/1755876X.2019.1565853).

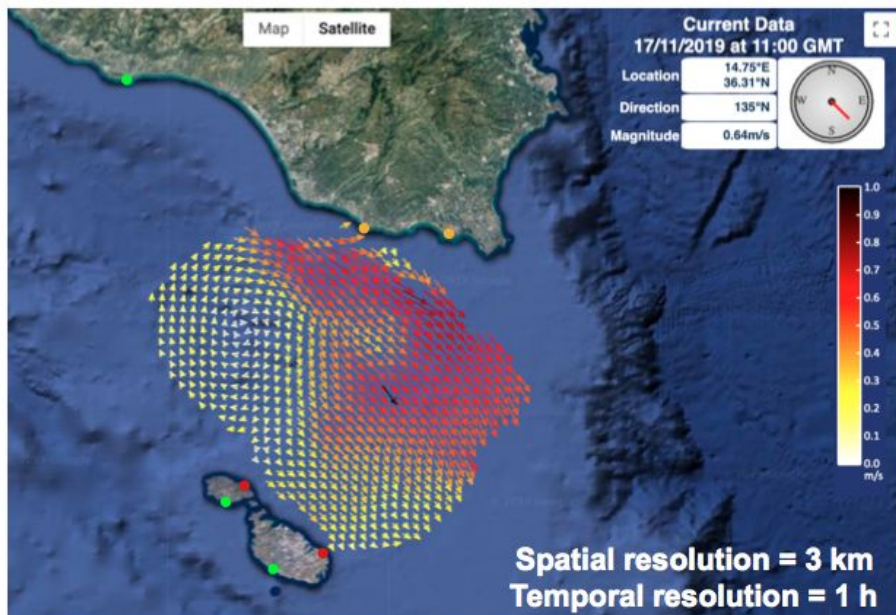
Saviano et al., (2019, under review). *Frontier. Mar. Sci*



# HF radar: Applications

## CALYPSO operational HF Radar system: in the Malta-Sicily Channel

Aldo Drago (Project Leader) | Adam Gauci | Giuseppe Ciraolo | Fulvio Capodici



- Sopu (Gozo) since June 2012
- Barkat (Malta) since June 2012
- Pozzallo (Sicily) since July 2012
- Marina di Ragusa (Sicily) since December 2015
- NEW** Licata (Sicily) from January 2020
- NEW** Ta' Cenc (Gozo) from January 2020
- NEW** Ghar Lapsi (Malta) from January 2020

### Project Research

Gap filling  
using ARMA models  
& Neural Networks

Short Term  
Forecasting

Optimal  
Interpolation

Added value  
products:  
**PORTO & SARWapp**

For more info:

Prof. Aldo Drago: [aldo.drago@um.edu.mt](mailto:aldo.drago@um.edu.mt)

Prof. Giuseppe Ciraolo: [giuseppe.ciraolo@unipa.it](mailto:giuseppe.ciraolo@unipa.it)

**calypsosouth.eu**



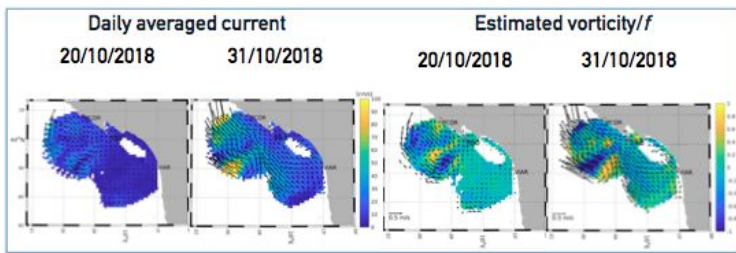
# HF radar: Applications

Ligurian Sea HF Radar system ([carlo.mantovani@cnr.it](mailto:carlo.mantovani@cnr.it))

4 CODAR SeaSonde HFR systems (3 new installations planned by 2021)

## Extreme events monitoring

- Response of submesoscale structures to an extreme wind event in the Ligurian Sea.



Maps of daily averaged HFR surface currents (left) and surface relative vorticity –normalized by  $f$ – (right) before (20/10/18) and after (31/10/18) the extreme wind event. Berta et al, 2019.

### References:

Berta M., et al. (2019, under review). Small scale ocean weather during an extreme wind event in the Ligurian Sea. In: Copernicus Marine Service Ocean State Report, Issue 4, Journal of Operational Oceanography.

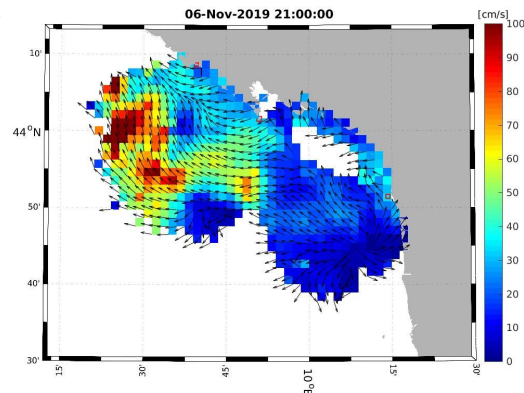
## Virtual particle tracking and biological modelling

- Dispersion maps of larvae and pollutants for Marine Protected Areas management.

## New operational services for a safer navigation

- Wave field parameters and surface currents integration in advance operational service to support navigation.

**NRT data operationally provided to CMEMS INSTAC**





# HF radar: Applications

Dardanos HF Radar system ([alkiviadis.kalampokis@hcmr.gr](mailto:alkiviadis.kalampokis@hcmr.gr))

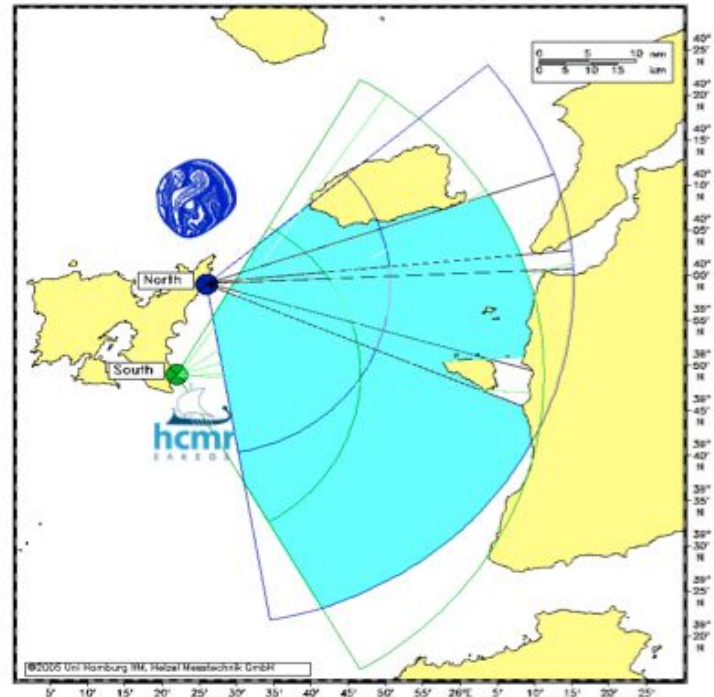
## Basic description of the System

- **Name of the system:** Dardanos
- **Institution:** Hellenic Centre for Marine Research (HCMR) & Univ. Aegean
- **Number of stations:** 2
- **Start of operations:** November 2009
- **End of operations:** December 2012 – currently under maintenance
- **Radar type:** Helzel WERA
- **Radar range:** 70 km
- **Spatial resolution:** 1.5 km
- **Temporal resolution:** 30 minutes
- **Operating frequency:** 13.45 MHz (16 MHz after upgrade)
- **Reception antennas:** 4 (8 after upgrade)
- **Processing Technique:** Direction finding (Beam forming after upgrade)

**Scope:** Monitor the Dardanelles outflow (Black-Sea inflow in the Mediterranean)

**Applications:**

- (a) climatological monitoring
- (b) data assimilation of ocean modelling
- (c) SAR and pollution response



Dardanos HF radar system coverage

# HF radar: Applications

LaMMA Consorzio HFR system ([brandini@lamma.toscana.it](mailto:brandini@lamma.toscana.it))

3 CODAR SeaSonde HFR systems along Tuscany coast

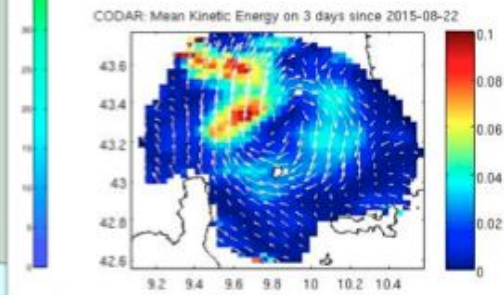
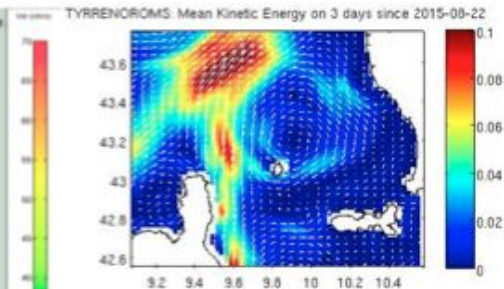
2 more HFR systems planned by 2020



## Operational monitoring of marine currents

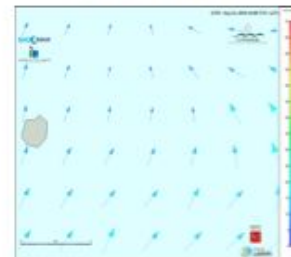


## Model validation and data assimilation

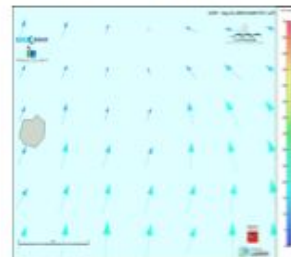


## Intercomparison of radar data

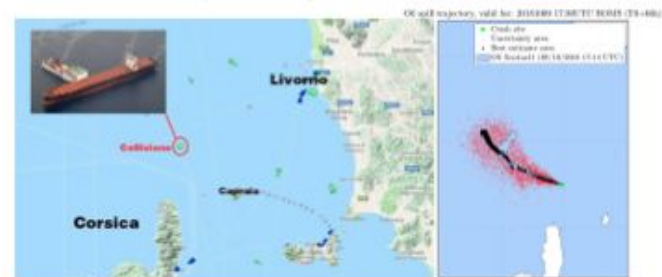
Livorno-Tino



Livorno-San Vincenzo



## Improvement of oil spill trajectory forecast



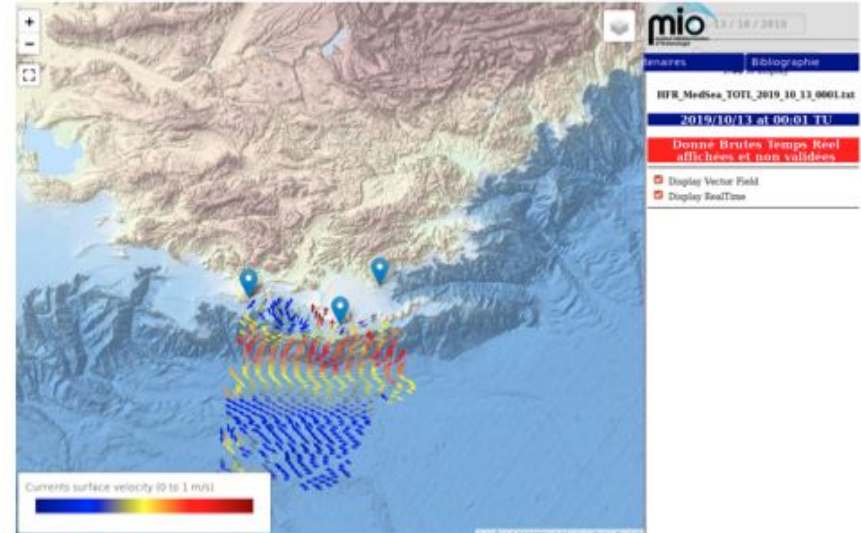
# HF radar: Applications

MIO Toulon HFR system ([guerin@univ-tln.fr](mailto:guerin@univ-tln.fr))

## Basic description of the system

- **Name of the system:** HFR MIO Toulon
- **Institution:** Mediterranean Institute of Oceanography (UTLN/AMU/CNRS/IRD)
- **Number of stations:** 2
- **Start of operations:** May, 2012
- **End of operations:** Operational today
- **Radar type:** Helzel WERA
- **Radar range:** 60-80 Km
- **Spatial resolution:** 1.5 Km
- **Temporal resolution:** 1 h
- **Operating frequency:** 16,175 MHz [100 kHz]

Link to system description/visualization:



*MIO Toulon HF radar system coverage  
(Oct.13, 2019)*

<http://hfradar.univ-tln.fr>

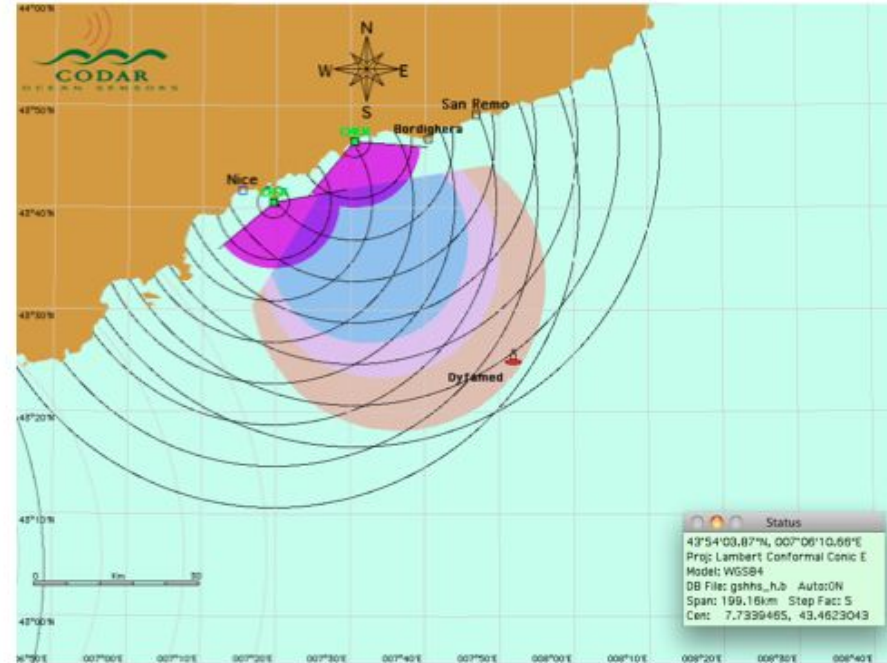


# HF radar: Applications

MIO Nice HFR system ([guerin@univ-tln.fr](mailto:guerin@univ-tln.fr))

## Basic description of the system

- **Name of the system:** HFR MIO Nice
- **Institution:** Mediterranean Institute of Oceanography (UTLN/AMU/CNRS/IRD)
- **Number of stations:** 2
- **Start of operations:** July 2015
- **End of operations:** Operational today
- **Radar type:** CODAR SeaSonde
- **Radar range:** 60-80 Km
- **Spatial resolution:** 1.5 Km
- **Temporal resolution:** 1 h
- **Operating frequency:** 13,5 MHz [100 kHz]



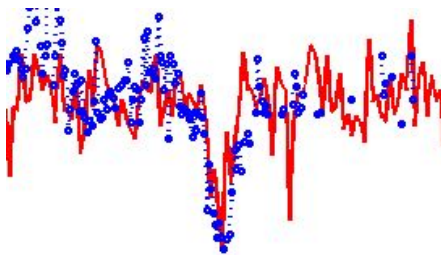
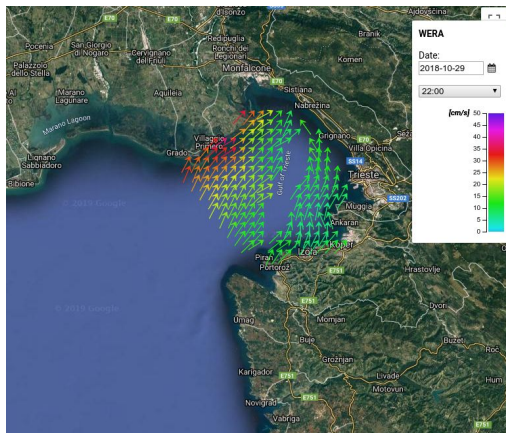
*MIO Nice HF radar system coverage*

**Link to system description/visualization:**

<http://hfradar.univ-tln.fr>

# HF radar: Applications

Gulf Of Trieste HF radar: a WERA system ([matjaz.licer@gmail.com](mailto:matjaz.licer@gmail.com))

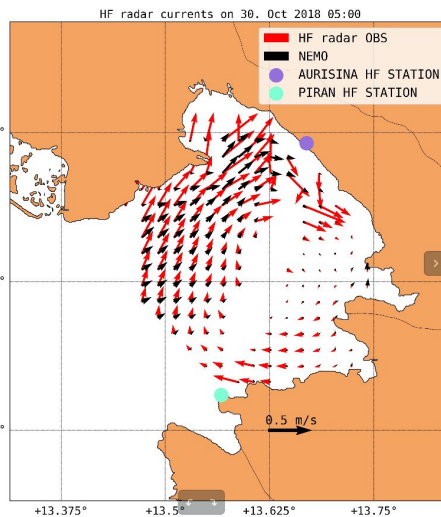
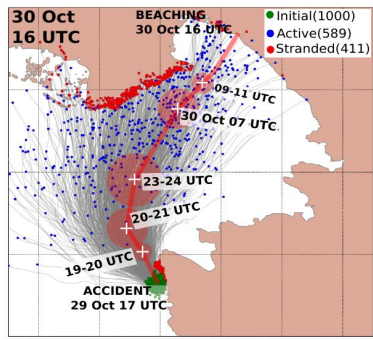


- **Basic specifications:**

- carrier frequency of 25.5 MHz
- 1 km / 1 degree angular resolution every 30 minutes.
- 1.5 km horizontal resolution 22 x 20 regular grid
- Data available in near real time

- **Applications (past and future):**

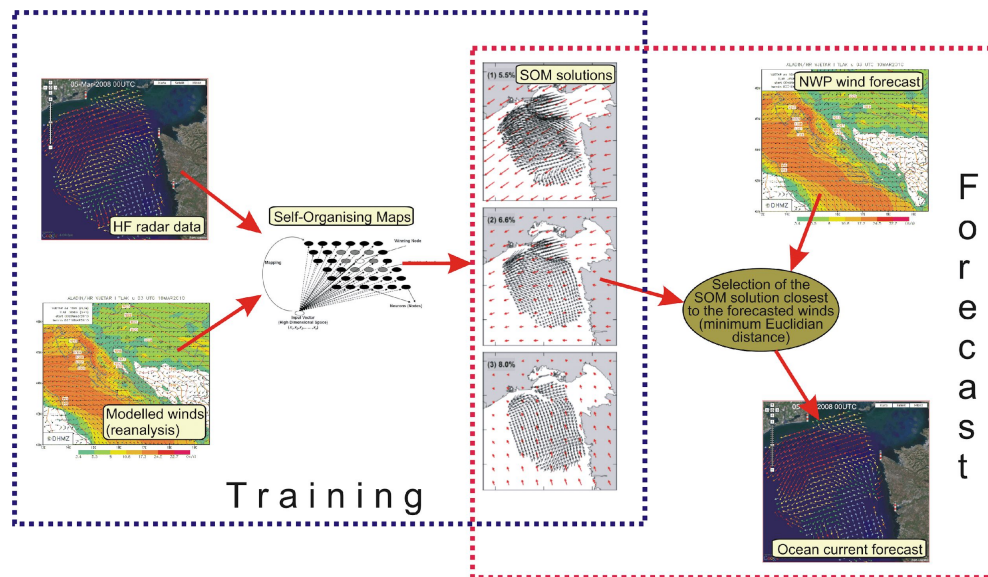
- Model verification (circulation, waves)
- Data assimilation (circulation)
- Lagrangian tracking (oil spills, objects)
- Nowcasting



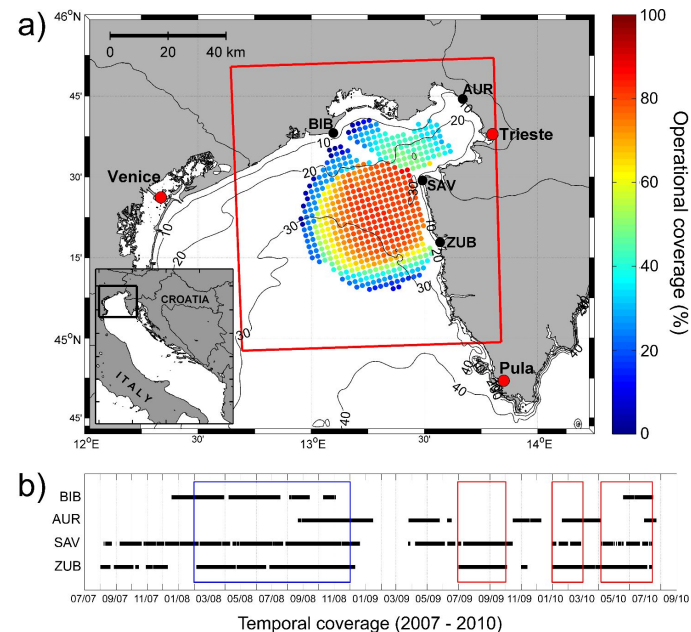
# HF radar: Applications

NEURAL HF-radar based forecasting system ([vilibic@izor.hr](mailto:vilibic@izor.hr))

A prototype of ocean surface current forecasting system, based on HF radar measurements, operational mesoscale weather forecast and neural network algorithms (Self-Organising Maps) has been built in the frame of the NEURAL project ([www.izor.hr/neural](http://www.izor.hr/neural)).



Scheme of the NEURAL operational coastal forecasting system.

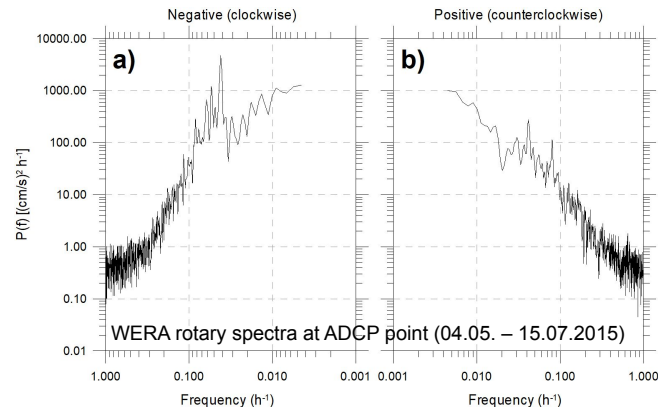
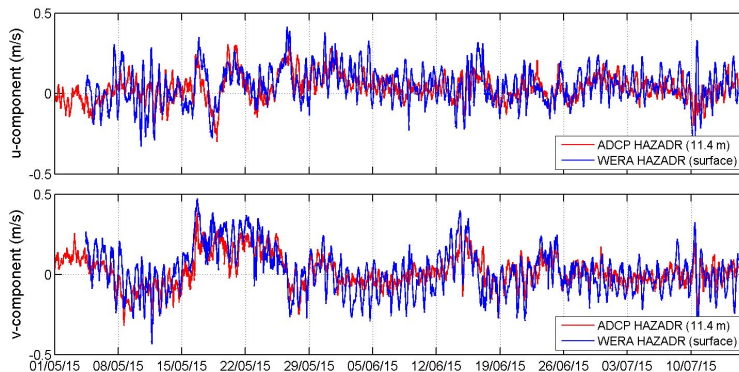
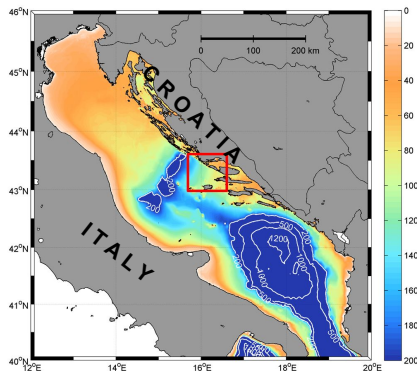


HF radar data used for training and validation of the NEURAL forecasting system.



# HF radar: Applications

Split WERA system ([dadic@izor.hr](mailto:dadic@izor.hr); [hrvoje.mihanovic@izor.hr](mailto:hrvoje.mihanovic@izor.hr))



- **Basic specifications:**

- Operational since March 2014
- carrier frequency 26.3 MHz
- 1 km / 1 degree angular resolution, every 30 minutes
- 1.5 km horizontal resolution
- Data available in near real time

- **Applications (past, present and future):**

- Model verification (currents, waves)
- Data assimilation studies
- Scientific research (currents reversals, inertial and diurnal oscillations)
- Online eddy-detecting
- Nowcasting

Web page: [http://jadran.izor.hr/hazadr/index\\_eng.htm](http://jadran.izor.hr/hazadr/index_eng.htm)

# MedSea HF radar: Coordinated efforts



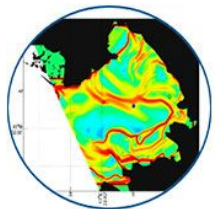
- **Harmonize** operational and maintenance **practices**



- **Standardize** data, metadata and QC tests

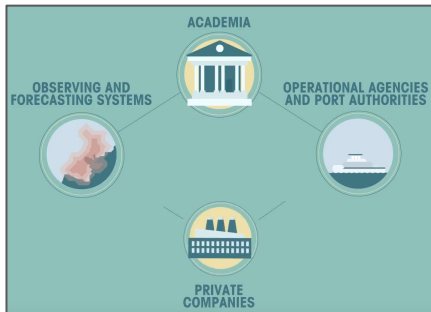
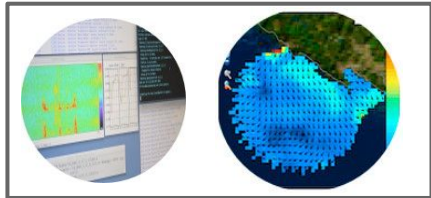
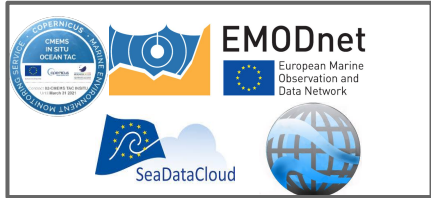
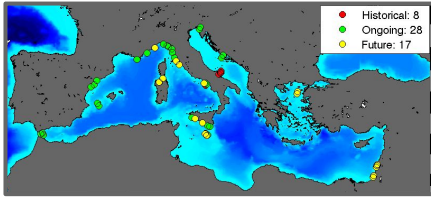


- **Centralize** data management and access (EU HFR node)



- Develop **added-value** products and tools

# MedSea HF radar: Challenges and key issues



- **MedSea HFR network** setting up and funding
- Enhance HFR data **discovery and access**
- Boost HFR data **usage and research**
- **Build synergies** among academia, management agencies, state government offices



Thank you very much for your attention

