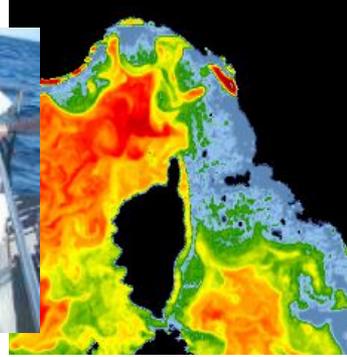
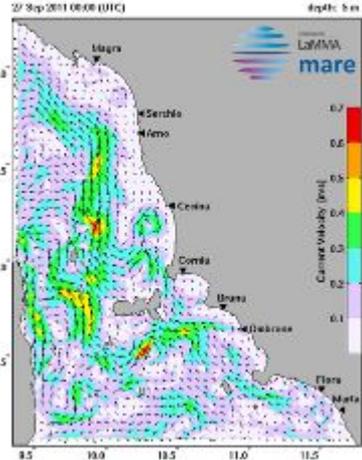
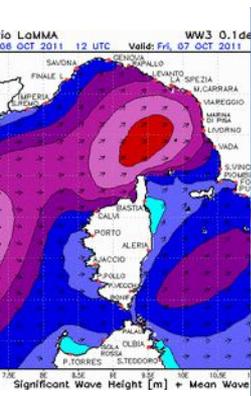




COSMEMOS

The upcoming sensor network in the North Tyrrhenian and Ligurian sea for waves and oceanography



Carlo Brandini - Consorzio LaMMA

Livorno, 23 Ottobre 2013



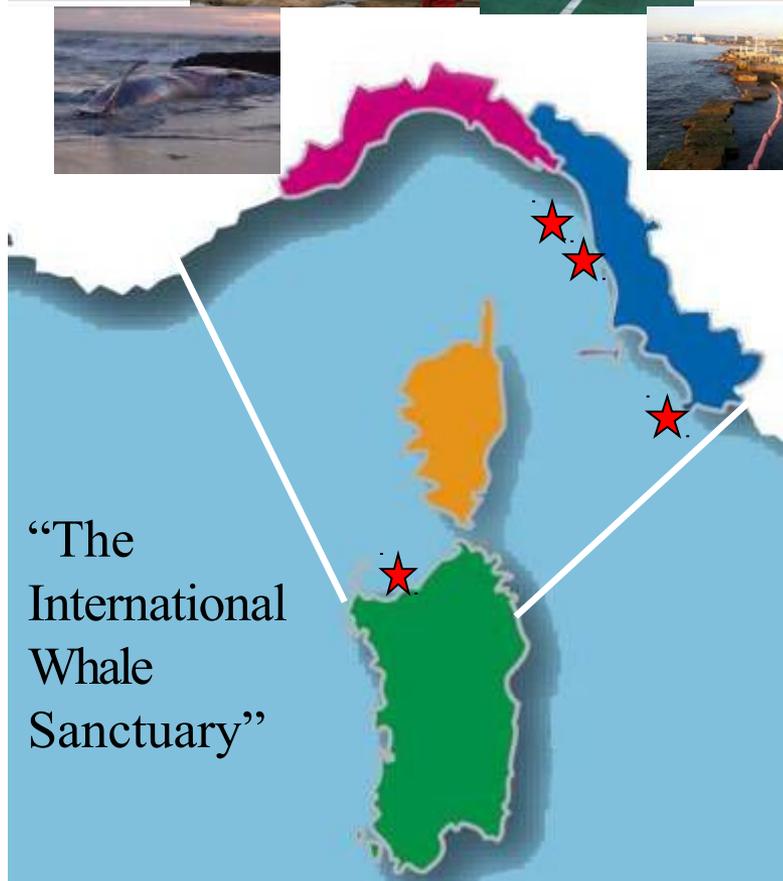


From MOMAR to SICOMAR

The Directive 2008/56/EC recognizes the sea monitoring as a fundamental tool for environmental protection and for contributing to the definition of common policies through the use of integrated control systems for the transnational marine space.



Maritime emergencies



“The International Whale Sanctuary”

Objective: define a common path for the creation of an integrated system for monitoring marine and coastal environment in the regions bordering the North Tyrrhenian / Ligurian sea area

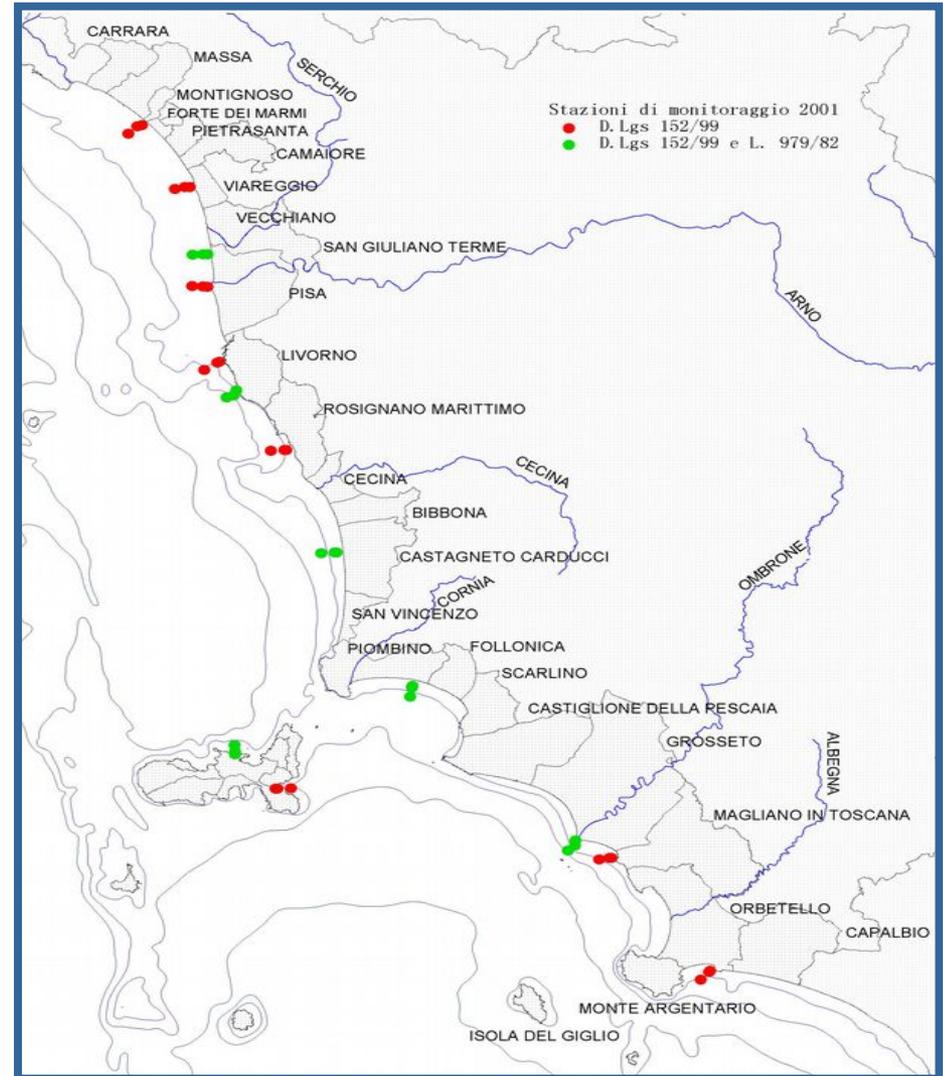


Environmental monitoring of coastal waters

Directive 2000/60 /CE e DM 131/08

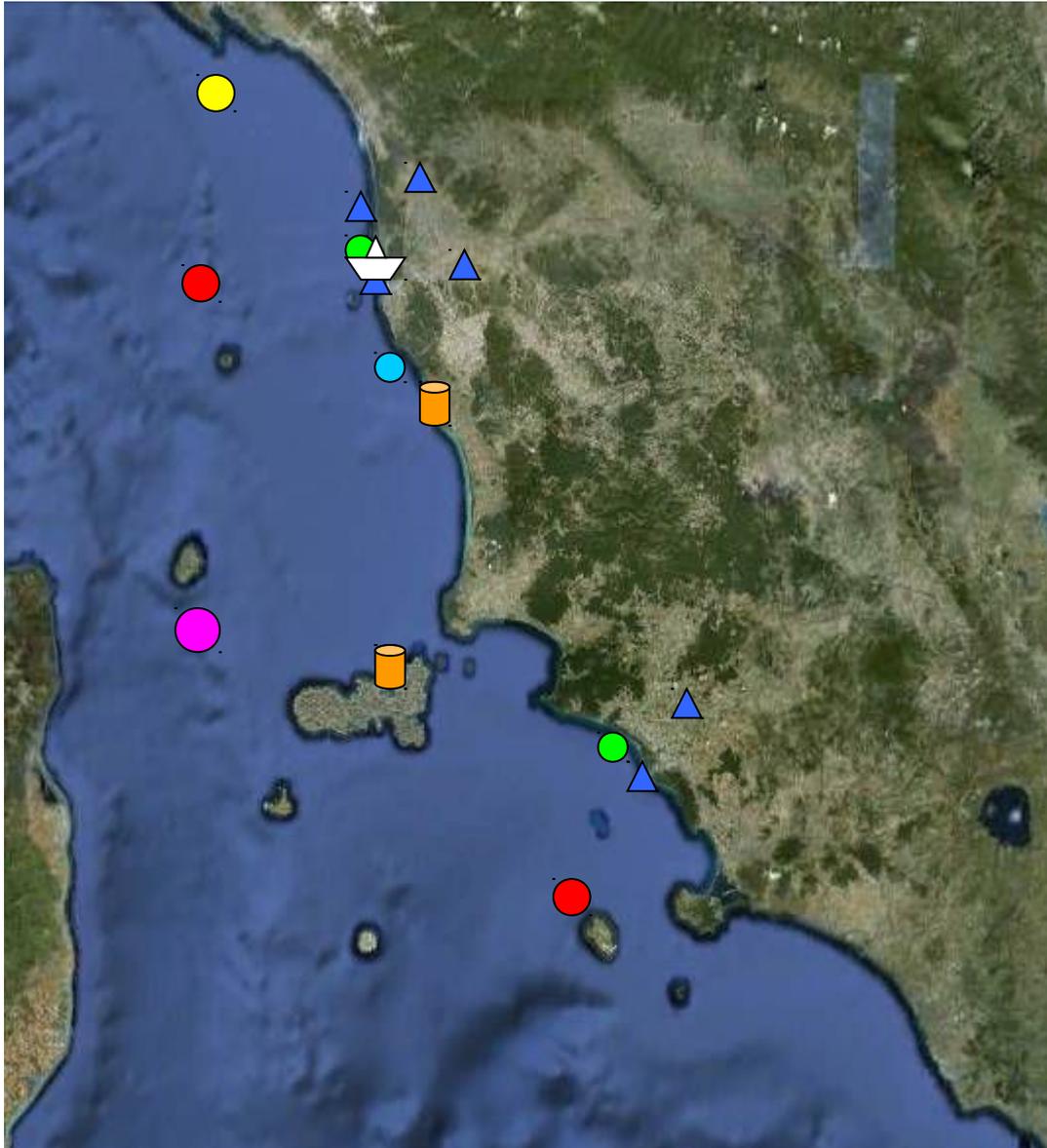
Water bodies

Costa della Versilia	Costa di Punta Ala
Costa del Serchio	Costa dell'Ombrone
Costa Pisana	Costa dell'Uccellina
Costa Livornese	Costa dell'Albegna
Costa del Cecina	Costa dell'Argentario
Costa di Piombino	Costa di Burano
Costa di Follonica	Arcipelago toscano





Need for improving sea monitoring procedures



The Tuscany Region marine measurement network



Oceanographic vessel



Wave buoys



ADCPs



Oceanographic buoy



Tide gauge

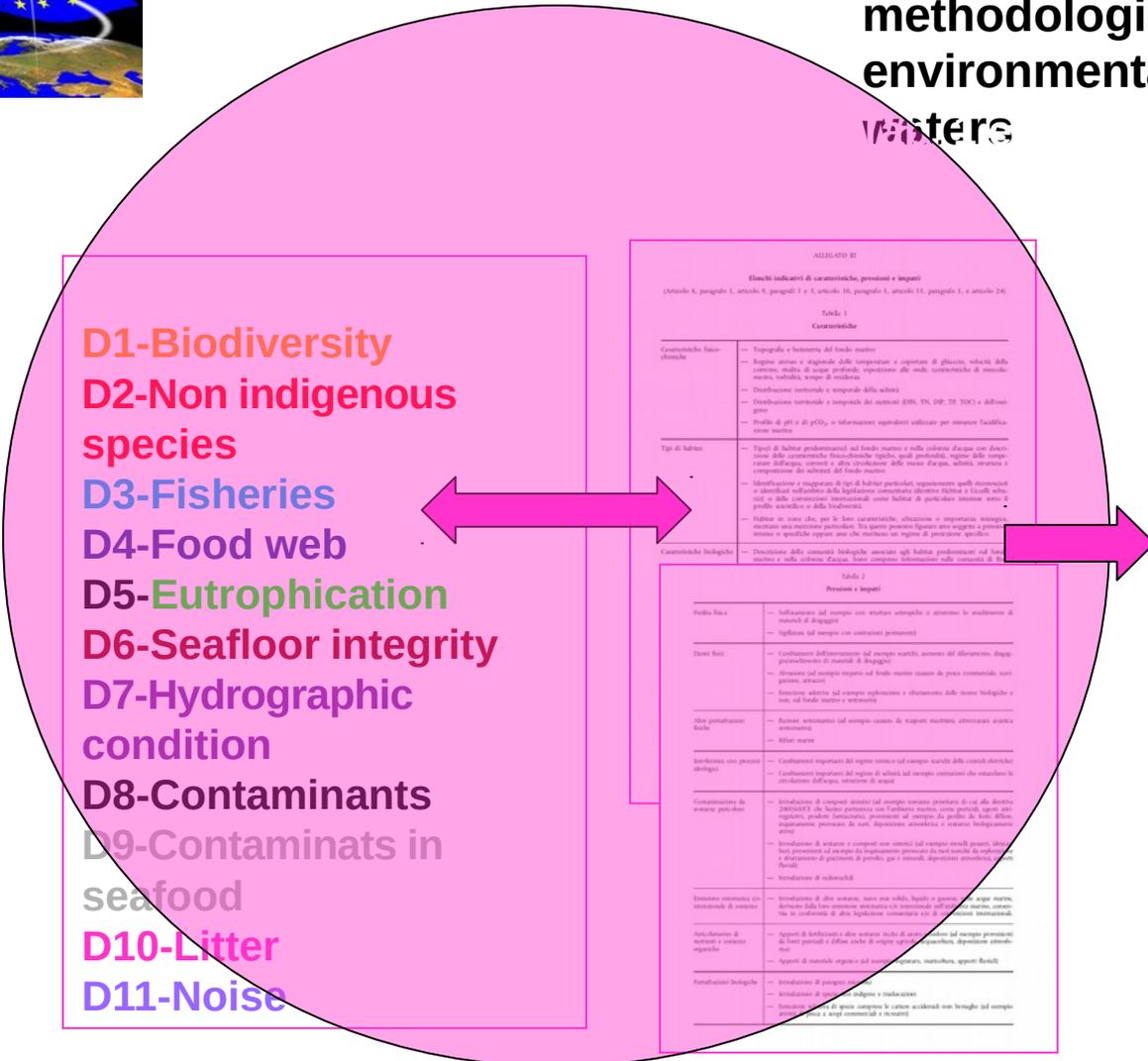


Hydrometer

The Marine Strategy Framework Directive



Commission decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters



ALLEGATO III
 Elenco indicatori di caratteristiche, processi e impatti
 (articolo 8, paragrafo 1, articolo 9, paragrafi 1 e 2, articolo 10, paragrafo 1, articolo 11, paragrafo 1, e articolo 24)

Tabella 1
 Caratteristiche

Caratteristiche fisico-chimiche	<ul style="list-style-type: none"> Topografia e batimetria del fondo marino Regime termico e stagionale delle temperature e spessore di ghiaccio relativi alla corrente, modo di essere profondo, spessore delle varie caratteristiche di mesoclima, turbidità, tempo di risalita Distribuzione termica e temporale della salinità Distribuzione termica e temporale dei nutrienti (DIN, TN, DIP, TP, TDIC) e dell'ossigeno Profilo di pH e di pCO₂, e informazioni riguardanti l'efficienza per ossigeno (efficienza ossigeno)
Tipi di habitat	<ul style="list-style-type: none"> Tipi di habitat predominanti nel fondo marino e nella colonna d'acqua con descrizione delle caratteristiche fisico-chimiche tipiche, quali profondità, regime delle temperature dell'acqua, correnti e altre condizioni delle maree d'acqua, salinità, struttura e composizione dei sedimenti del fondo marino Identificazione e mappatura di tipi di habitat particolari, soprattutto quelli riconosciuti o identificati nell'ambito della legislazione comunitaria relativa alla pesca e all'acquicoltura e della legislazione comunitaria come habitat di particolare interesse sotto profilo scientifico o della biodiversità Habitat di zona che, per le loro caratteristiche, situazione o importanza strategica, meritano una protezione particolare. Tra questi possono figurare una laguna o un'isola protetta o specifiche zone che meritano un regime di protezione specifica
Caratteristiche biologiche	<ul style="list-style-type: none"> Descrizione delle comunità biologiche associate agli habitat predominanti nel fondo marino e nella colonna d'acqua. Sono comprese informazioni sulle comunità di fitoplancton e zooplancton

Tabella 2
 Processi e impatti

Produttività	<ul style="list-style-type: none"> Mantenimento del tempo con strutture atrofiche o strutture in via di smantellamento di sistemi di dragaggio Efficienza del tempo con strutture permanenti
Scambi fisici	<ul style="list-style-type: none"> Condizioni dell'atmosfera sul tempo variabile, aumento del disseccamento (dragaggio) di sistemi di dragaggio Aumento del tempo rispetto del fondo marino causato da pressioni costanti, navigazione, attracco Intensità relativa del tempo di sedimentazione e sbiancamento delle maree biologiche e non, nel fondo marino e sedimenti
Altre perturbazioni fisiche	<ul style="list-style-type: none"> Risorse sottomarine (al tempo causate da rapporti marittimi, estrazione sottomarina sottomarina) Effetti maree
Habitat con processi abiotici	<ul style="list-style-type: none"> Condizioni importanti del regime termico (al tempo variabile delle correnti circolari) Condizioni importanti del regime di salinità (al tempo variabile che influenzano la circolazione dell'acqua, variazioni di salinità)
Contaminazione di sostanze pericolose	<ul style="list-style-type: none"> Introduzione di composti tossici (al tempo variabile) di cui alla direttiva 2002/41/CE che tutela l'ambiente con l'obiettivo marino, come pesticidi, agenti anticorrosivi, prodotti farmaceutici, prodotti al tempo da prodotti di fatto difficili, inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino Introduzione di sostanze e composti non tossici (al tempo variabile) per il clima, come i prodotti di inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino Introduzione di nutrienti
Distruzione o alterazione dei sistemi di sedimentazione	<ul style="list-style-type: none"> Introduzione di altri sedimenti, come sabbia, ghiaia o gesso, che, se non sono, possono alterare la composizione chimica e fisica dei sedimenti marittimi Introduzione di altri sedimenti, come sabbia, ghiaia o gesso, che, se non sono, possono alterare la composizione chimica e fisica dei sedimenti marittimi
Accumulo di rifiuti e rifiuti sottomarini	<ul style="list-style-type: none"> Accumulo di rifiuti e altri materiali ricche di nutrienti (al tempo variabile) di fatto difficili, inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino Accumulo di materiali organici (al tempo variabile, metano, rifiuti plastici)
Perturbazioni biologiche	<ul style="list-style-type: none"> Introduzione di parassiti e patogeni (al tempo variabile) di fatto difficili, inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino Introduzione di specie aliene (al tempo variabile) di fatto difficili, inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino Introduzione di specie aliene (al tempo variabile) di fatto difficili, inquinamento prodotto da navi, inquinamento sottomarino e inquinamento biologico marino

Defines criteria and methodological rules to define the good ecological status (Commission decision)





Centro Interuniversitario di
Biologia Marina ed Ecologia
applicata



Dipartimento di Sanità Pubblica
Università di Cagliari



Laboratorio di Meteorologia e
Modellistica Ambientale



Istituto Oceanografico Francese
Centro per il Mediterraneo
Laboratorio Ambiente e Risorse

Main issues :

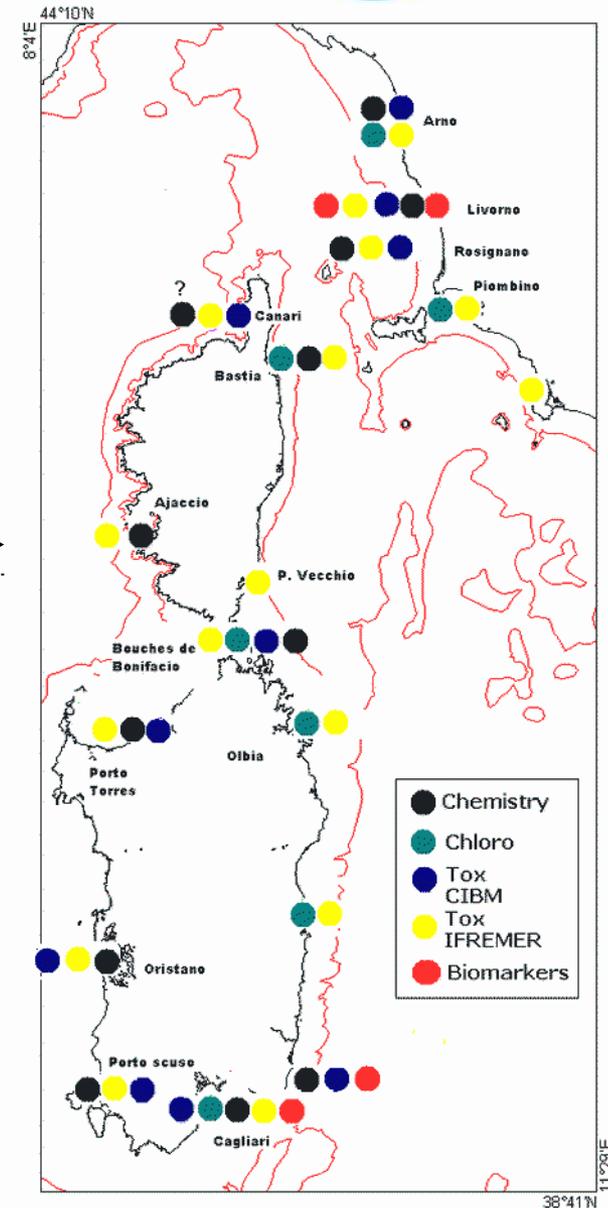
- Sea pollution monitoring by chemical and eco-toxicologic analysis

Water and sediment samples



- Remote sensing monitoring of marine coastal environment and EO products calibration/validation

- Hydrodynamic analysis of the potential diffusion/dispersion of pollutants



Oceanographic campaigns



MILONGA
Misure Lagrangiane
OceaNoGrafiche al largo
dell'Arcipelago toscano

MELBA

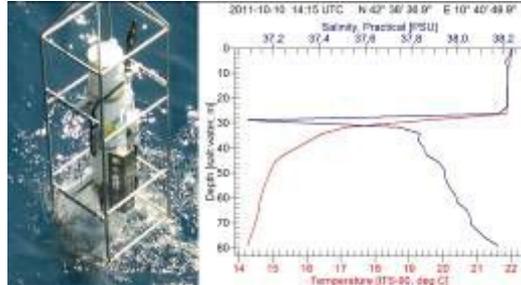
In-situ measurements in use



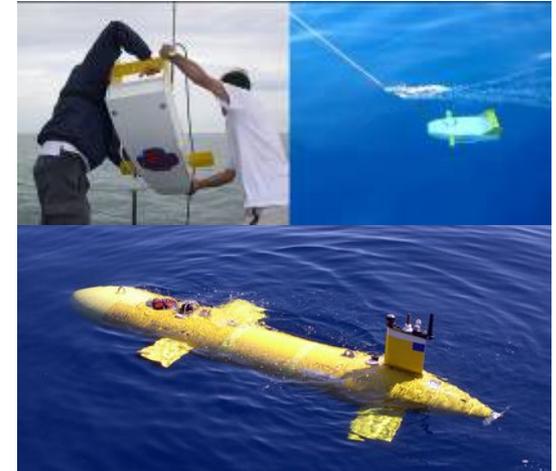
Water sampling/analysis



Temperature and salinity (CTD/floats)



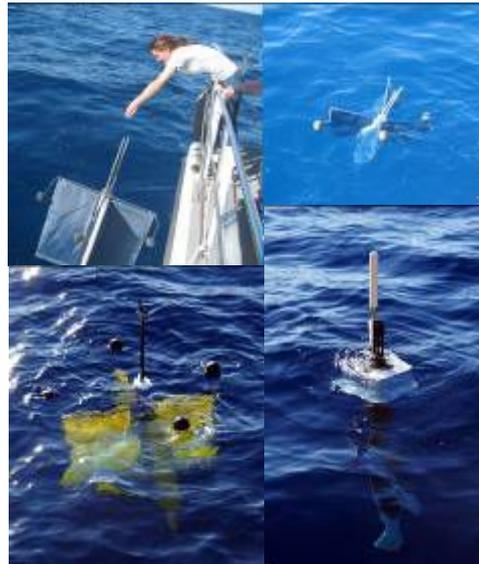
Currents (ADCP)



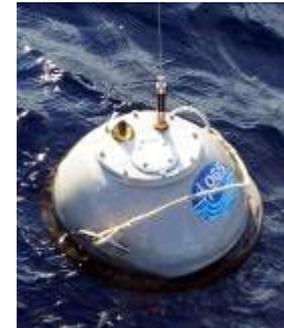
Sediments



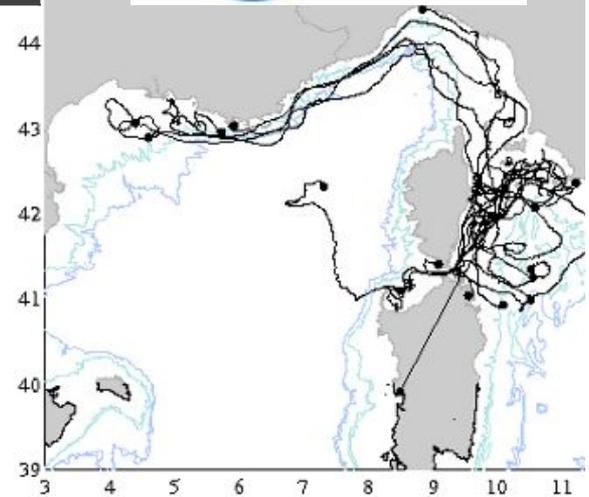
Currents (drifters/floats)



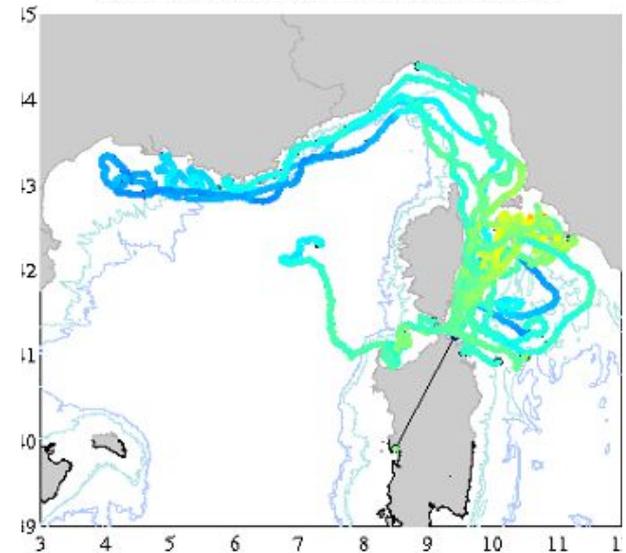
Waves (Buoy)



Lagrangian measurements



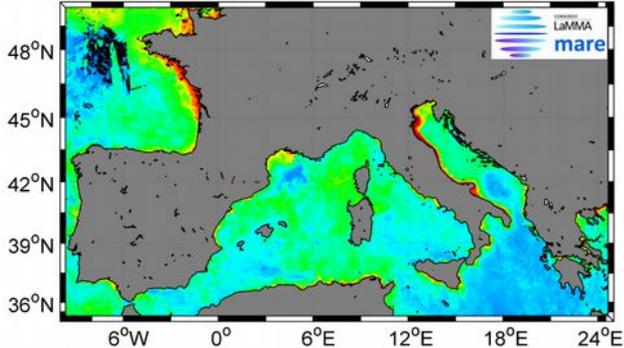
DRIFTER TRAJECTORIES AS OF 05-Dec-2011



Data integration → the Operational Oceanography activity



Satellite
data



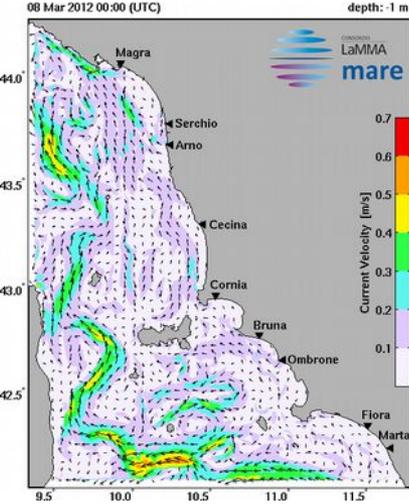
Towards an integrated monitoring system ?



In-situ
measur
ements



Models





Marine Services → impact on Society



Navigation



Litter, spills, contamination



Energy



Tourism



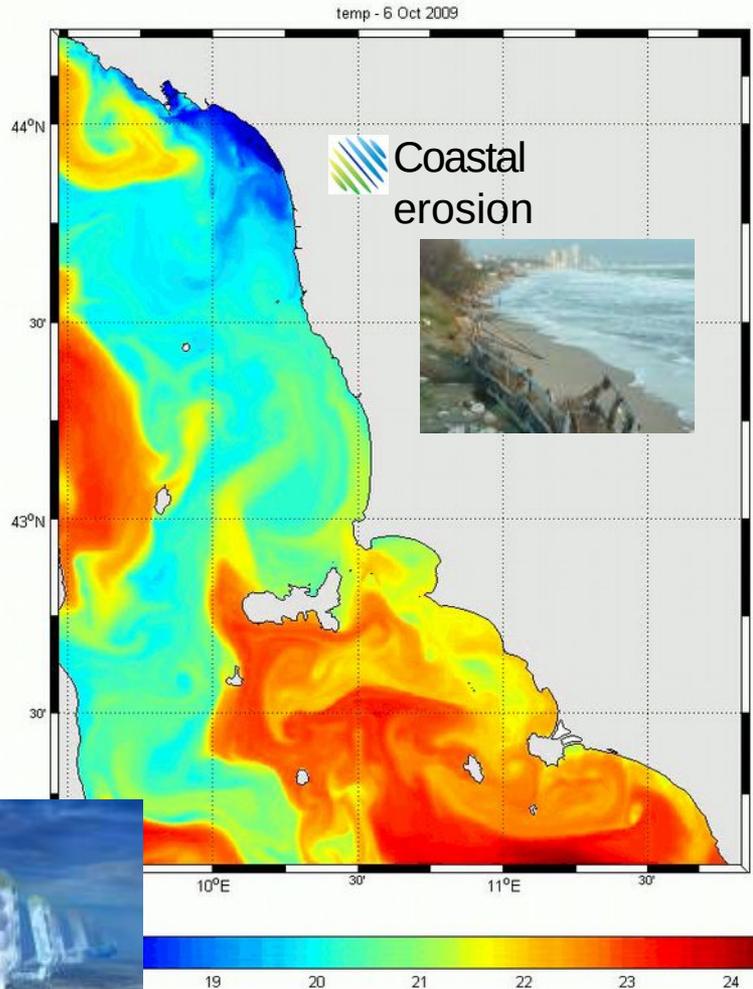
Marine Technologies



Biodiversity



Fishing, aquaculture



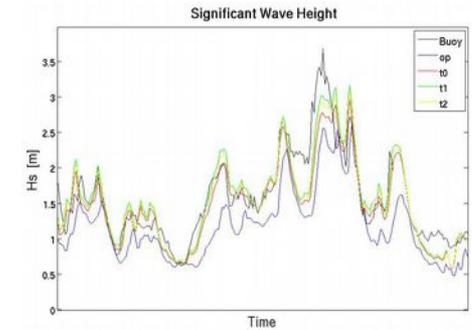


Data & models

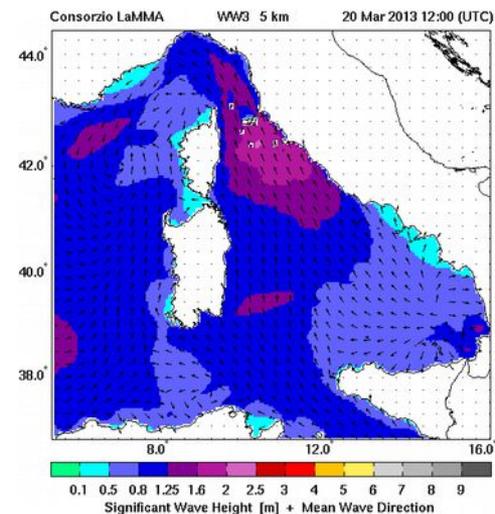
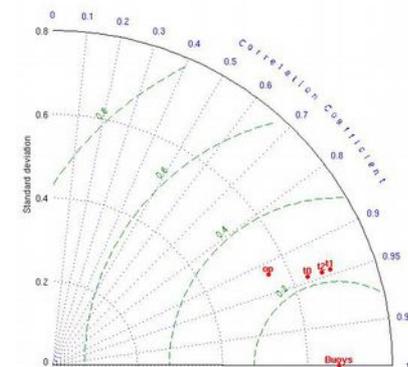
Validation: how good is my model when compared to measured data?

Calibration / configuration: how can model parameters be improved so that we can have better forecast?

Assimilation: how can I use my data, in a dynamical way, ingesting them into models to improve their reliability?

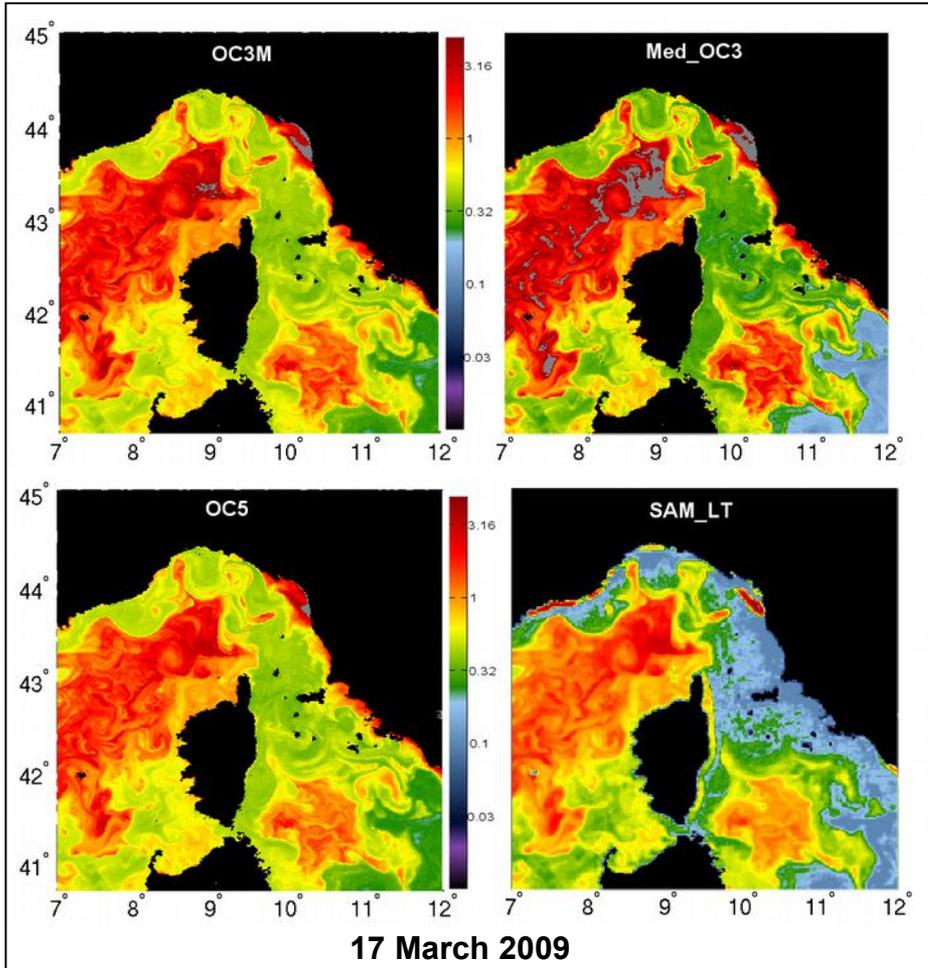


Significant Wave Height Taylor Diagram



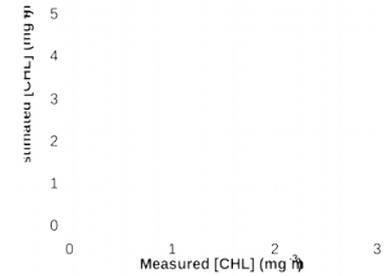
Integration of observed data : remote sensing

Clorofilla-a

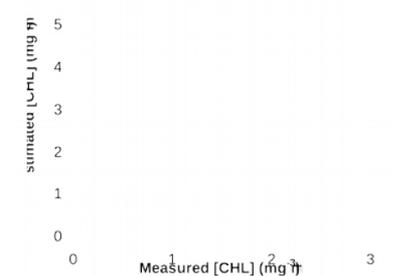


Campaign	Period	Number of	
MOMAR	April 2010 July 2011	28	CIBM
MELBA	May 2011	11	LaMMA, Ifremer, CIBM
MILONGA	September October 2011	18	LaMMA, Ifremer, CIBM, ARPAT

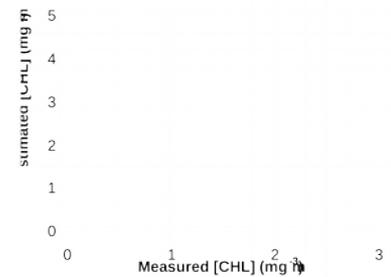
Measured vs estimat $R^2 = 0.367$
OC3M Chl_a RMSE = 0.599 mg³
 %MBE = 21.641
 $y = 0.7128x + 0.11$



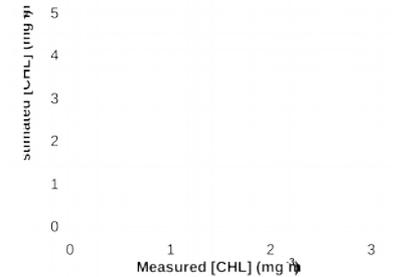
Measured vs estimat $R^2 = 0.272$
MedOC3 Chl_a RMSE = 1.104 mg³
 %MBE = 41.606
 $y = 1.1139x + 0.11$



Measured vs estimat $R^2 = 0.411$
OC5 Chl_a RMSE = 0.498 mg³
 %MBE = 8.489
 $y = 0.594x + 0.18$



Measured vs estimat $R^2 = 0.398$
SAM_LT Chl_a RMSE = 0.472 mg³
 %MBE = -4.771
 $y = 0.4287x + 0.18$



Applications and case studies



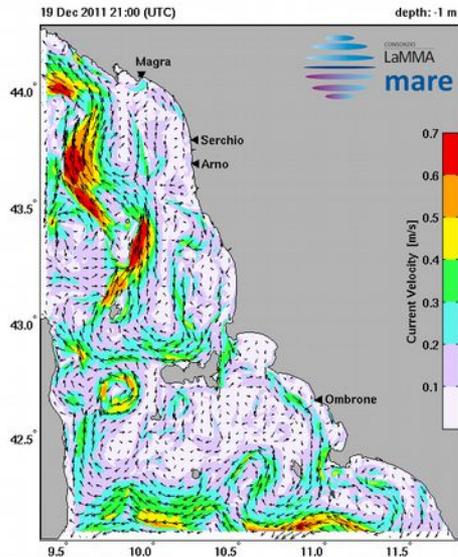
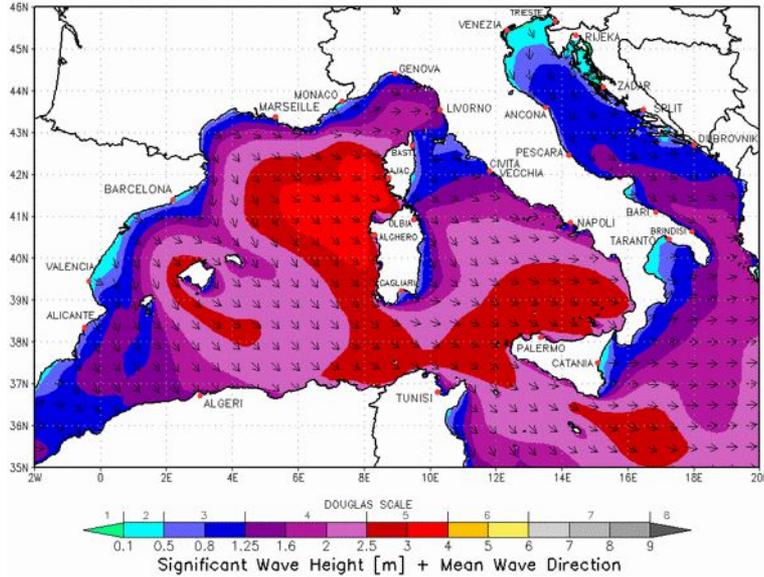
**Pollutant dispersion at sea:
paraffin dispersed offshore Livorno
towards Livorno.**



Simulation of paraffin spill (Livorno, 28/02/2012)

Applications & case studies

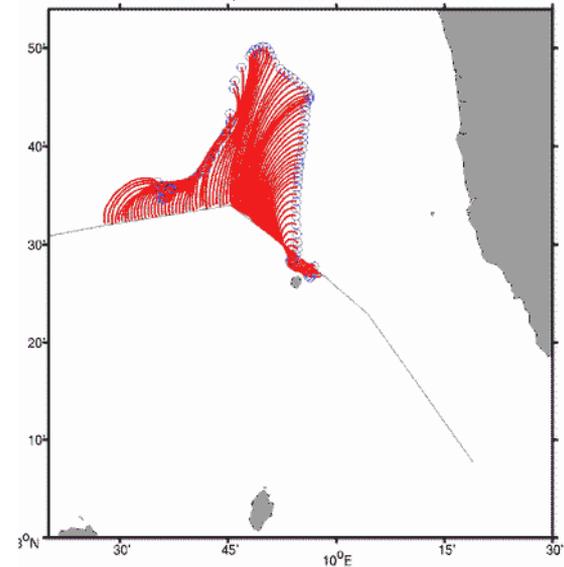
Consorzio LaMMA WW3 0.1deg - NMM 0.1deg
 Init.: Thu, 15 DEC 2011 12 UTC Valid: Sun, 18 DEC 2011 00 UTC T=+60h



Drums containing heavy metals and hazardous materials, fallen off the Gorgona.



Punti di deposito - sedimentation time: 720min





The challenges of operational oceanography: observe, analyze, predict, provide services to society



Oceanic deformation radius $O(10-200)$ km \ll Atmospheric $O(1000s)$ km, \rightarrow significantly higher resolution is needed to resolve ocean “weather”



The observing network should be as comprehensive as possible in order to resolve time and space scales of motion and number of field state variables



The system of observations be available in real time, consistent with the analysis/prediction system (the prognostic component).



The diagnostic/analysis component should be developed to bring observations into a ‘regular grid’ representation consistent with the prognostic component (objective analysis and data assimilation techniques)



Development of downstream services and value-added applications to:

- allow better knowledge of uncertainty limits
- ensure the presence of data of great impact to society (for example, planning of activities at sea, security, search and rescue, etc.)



SICOMAR, at a glance

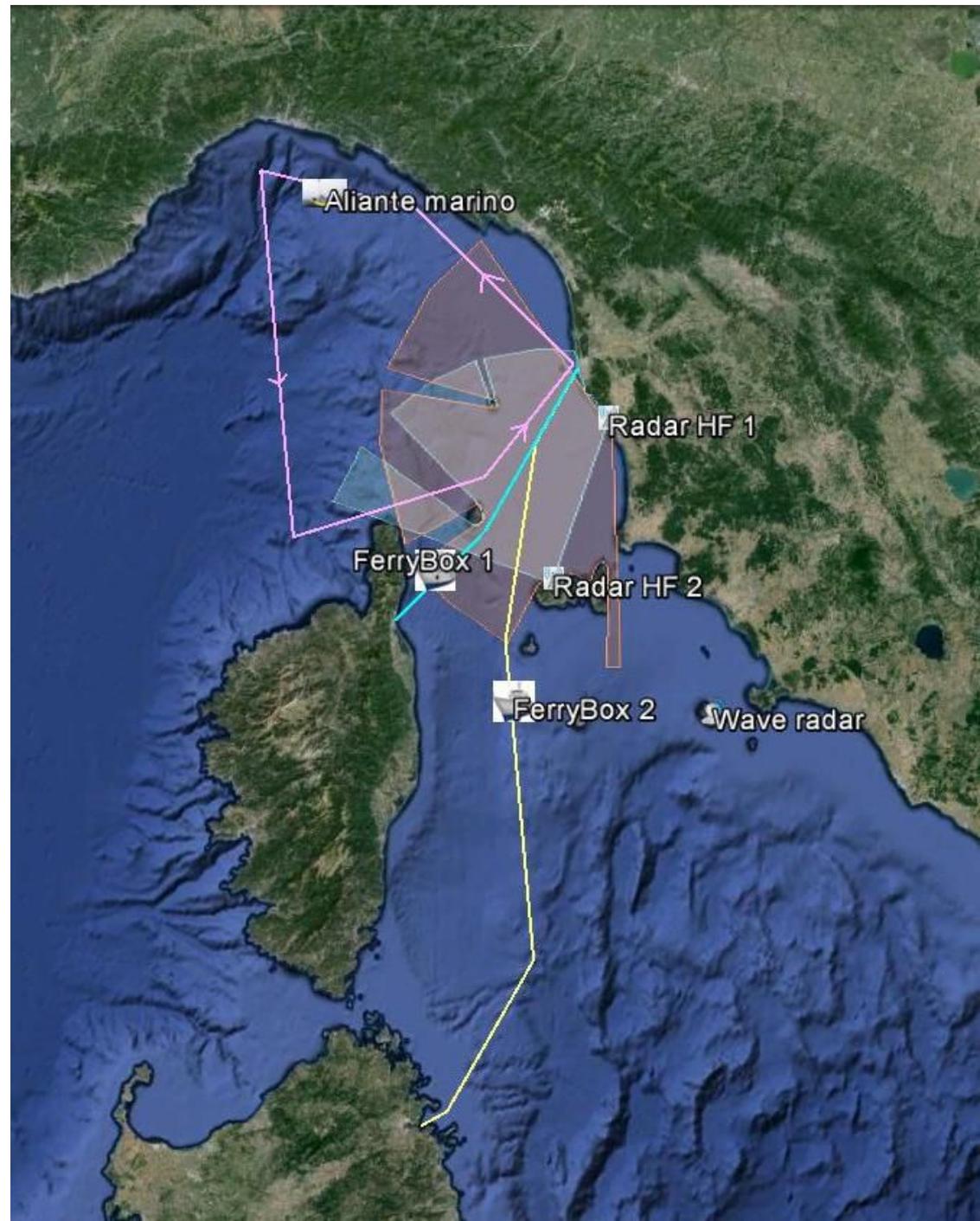
Distributed information, in space and time

A “fully” integrated system: for integrated marine monitoring (multiplatforms) + that can be integrated with a minimal effort with further sensors and instruments

Complementary tools and platforms, even compared to the existing measurement networks

Data immediately usable by itself, with real time transmission, to improve the reliability of the models for sea state analysis and forecast

Sustainability





FerryBox

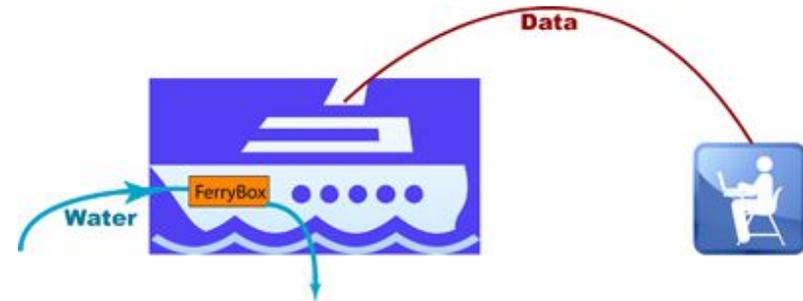
Ferry ships operate regular routes in many areas of the world

Boxes of sensors that work automatically can be installed

To collect physical, chemical and biological data using commercial ships

Cost effective data collection

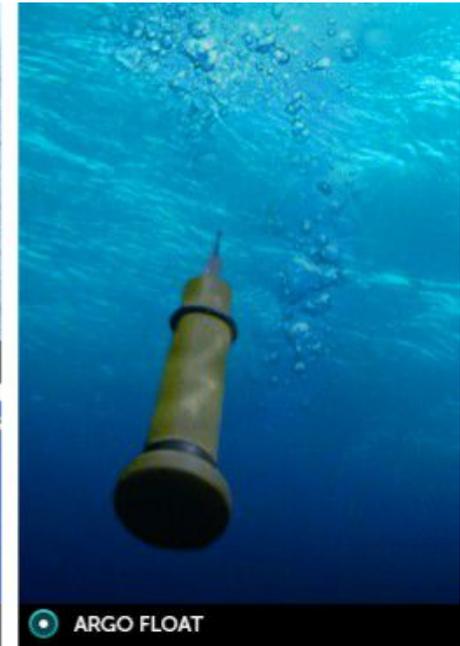
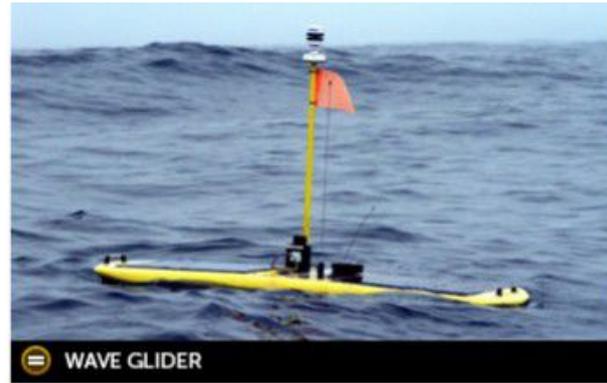
Voluntary Observing Ships → Cooperative data collection



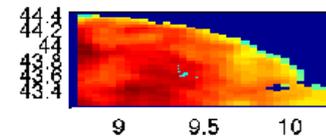
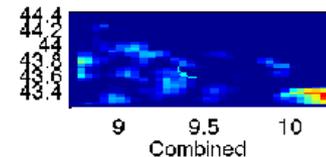
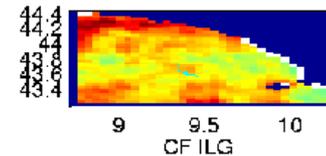


Ocean Robots

- Tools easy to deploy, significantly more affordable than multi-million dollar moorings
- Suitable for environmental monitoring (capability for host multiple sensors)
- Different mechanisms for propulsion: electric motor fed by rechargeable batteries, buoyancy, wave power
- The most interesting aspect is that you can drive the tool remotely and, in particular, trying to capture data where the model uncertainty is greater



Mean Spread Temp over time 100m





HF radar

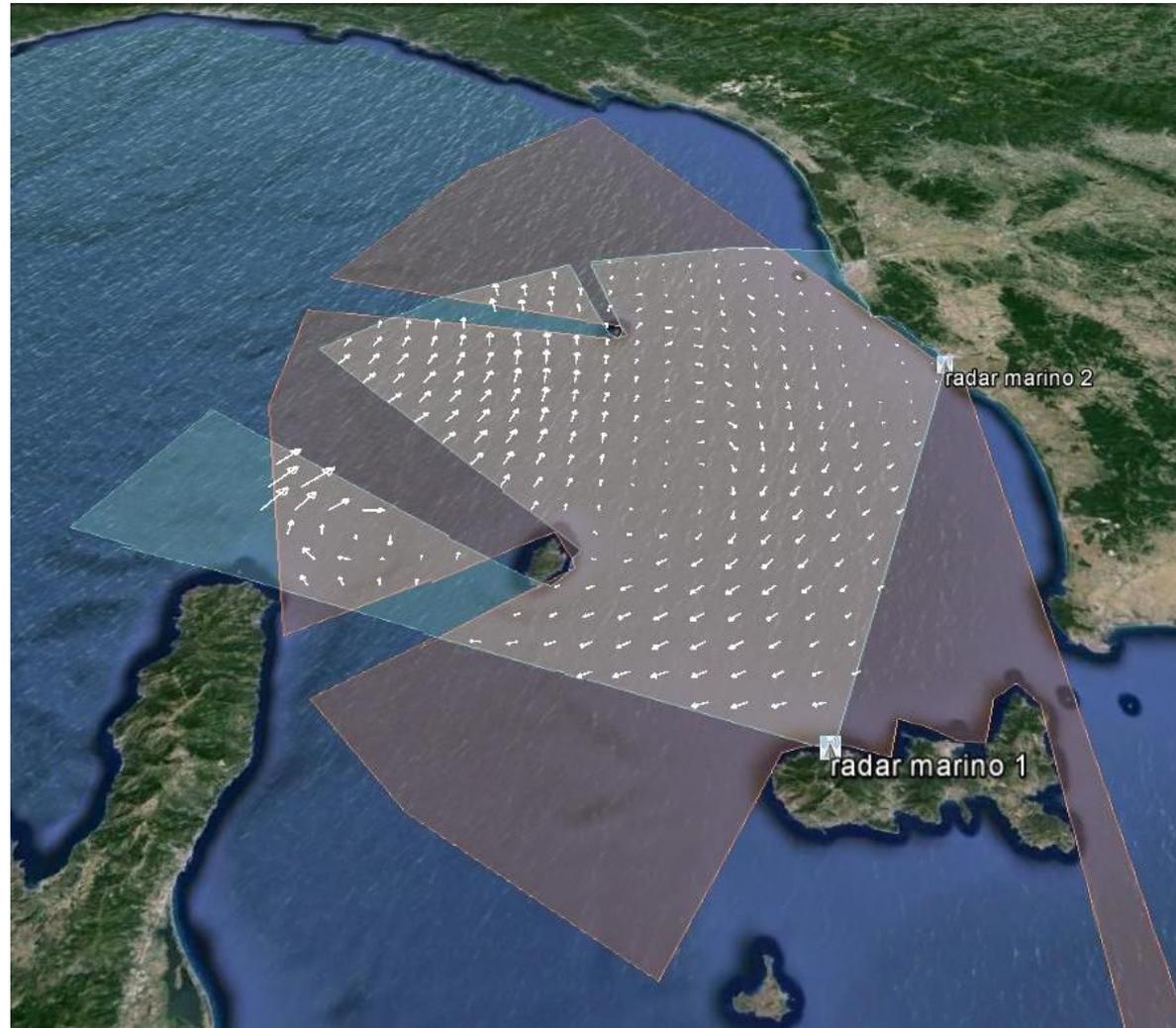
Wide cross-border area covered

Reduced environmental impact

Integration with existing monitoring network

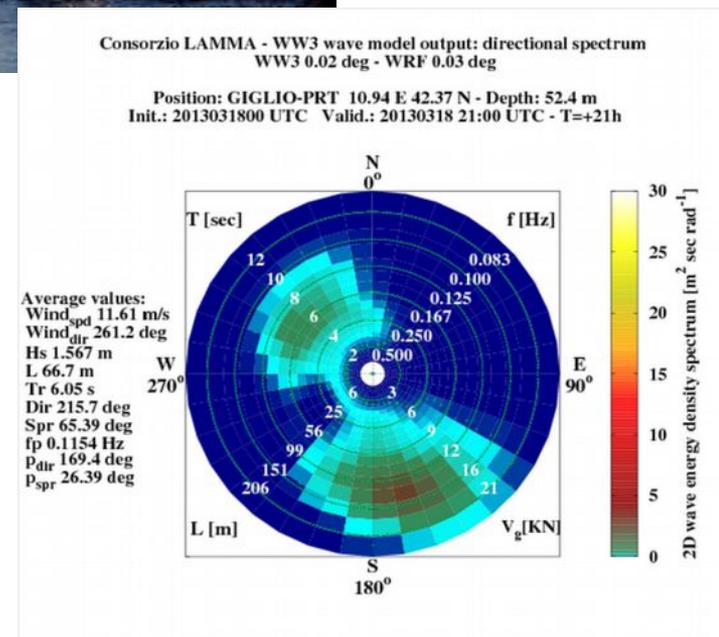
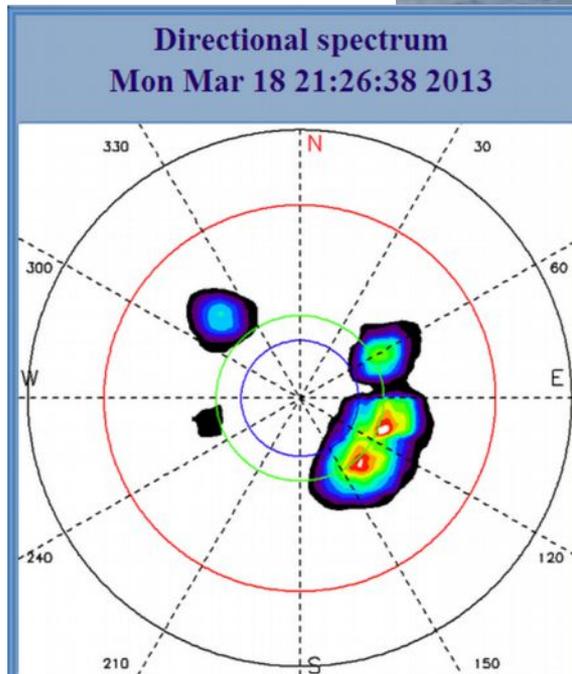
Multi-purposes data: surface currents (on a wide range), waves (on a reduced range) + research development

Sustainability

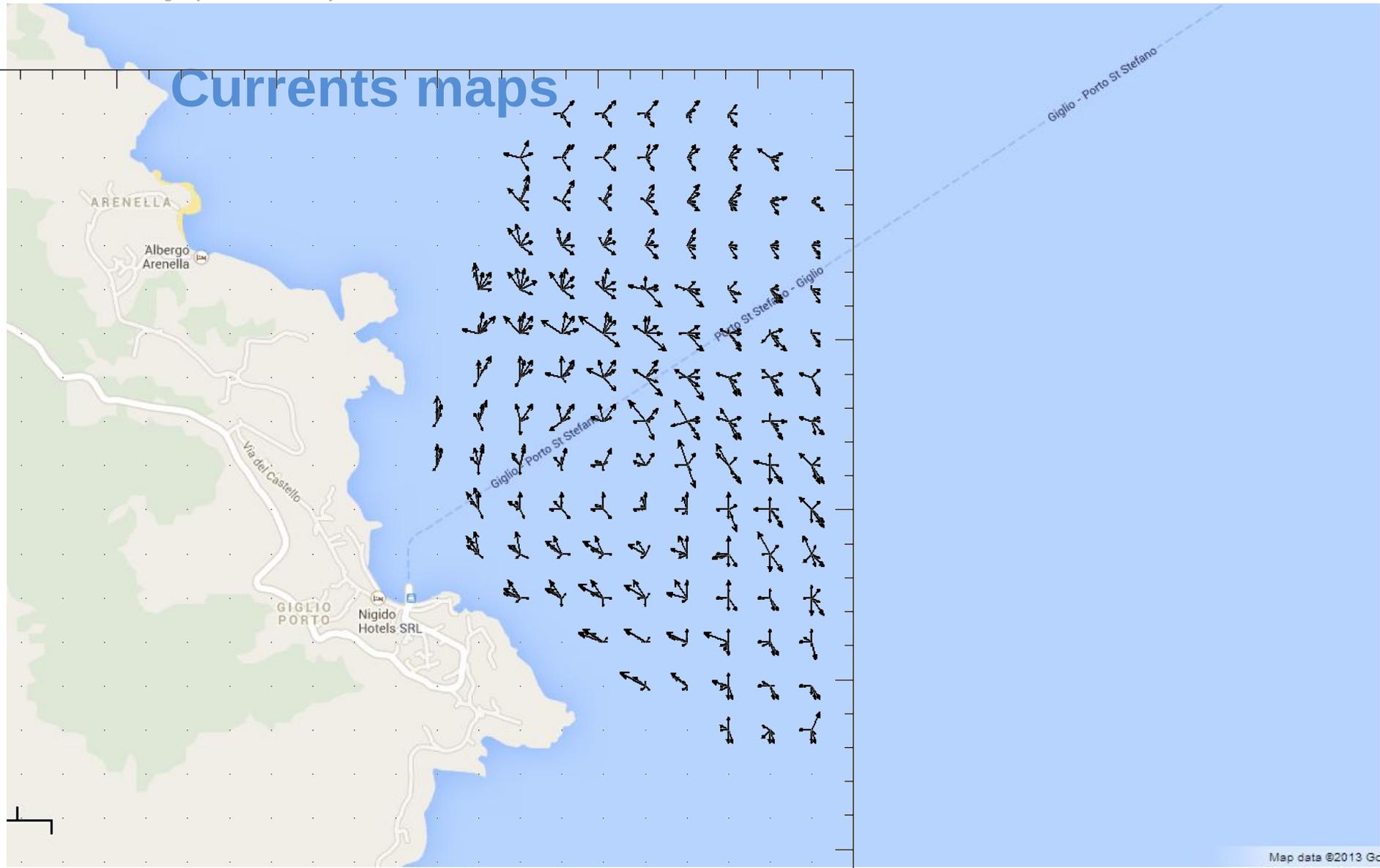




The Giglio wave radar, a tool for emergency support and work planning.

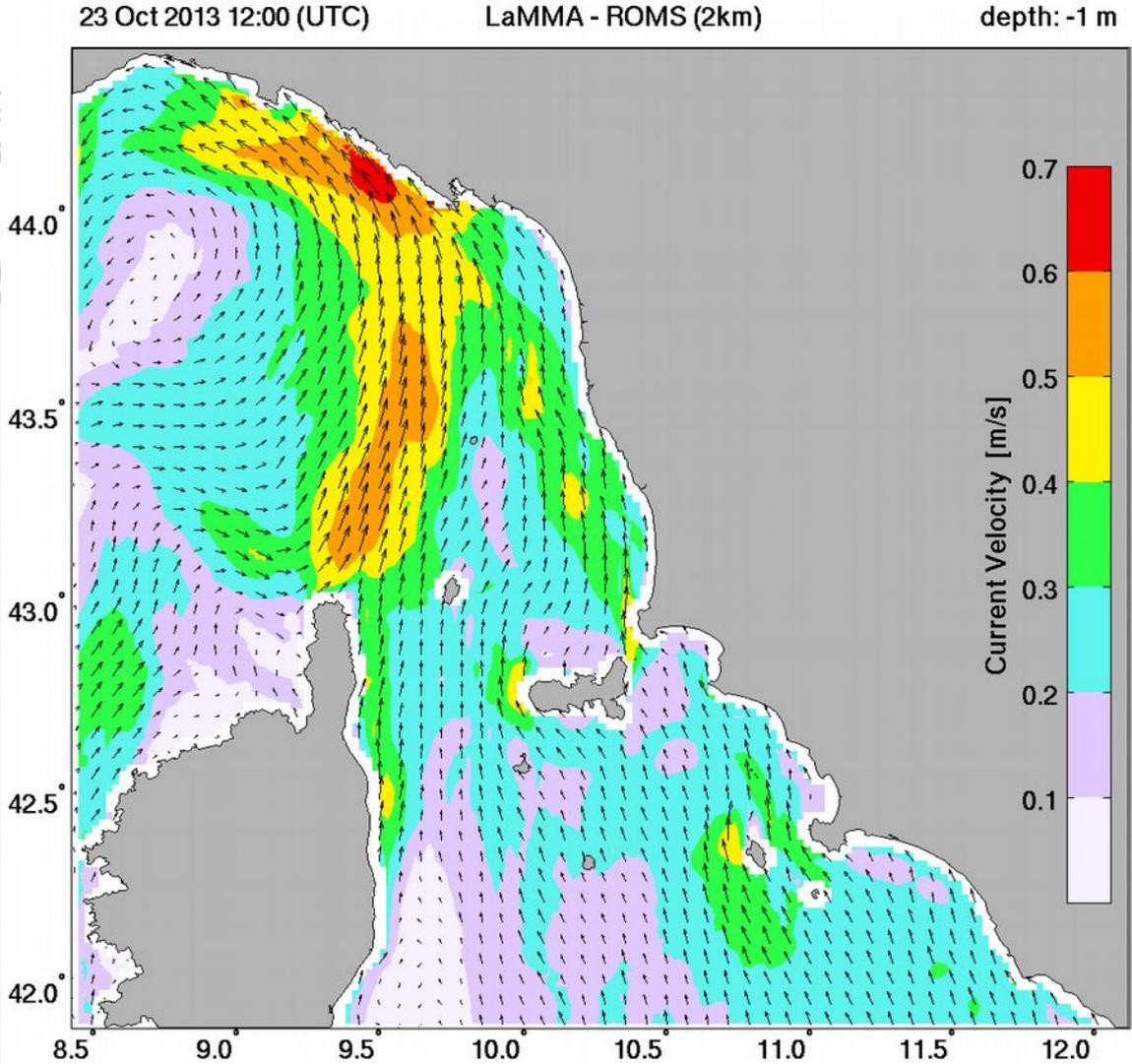


Currents maps



Verification of surface currents

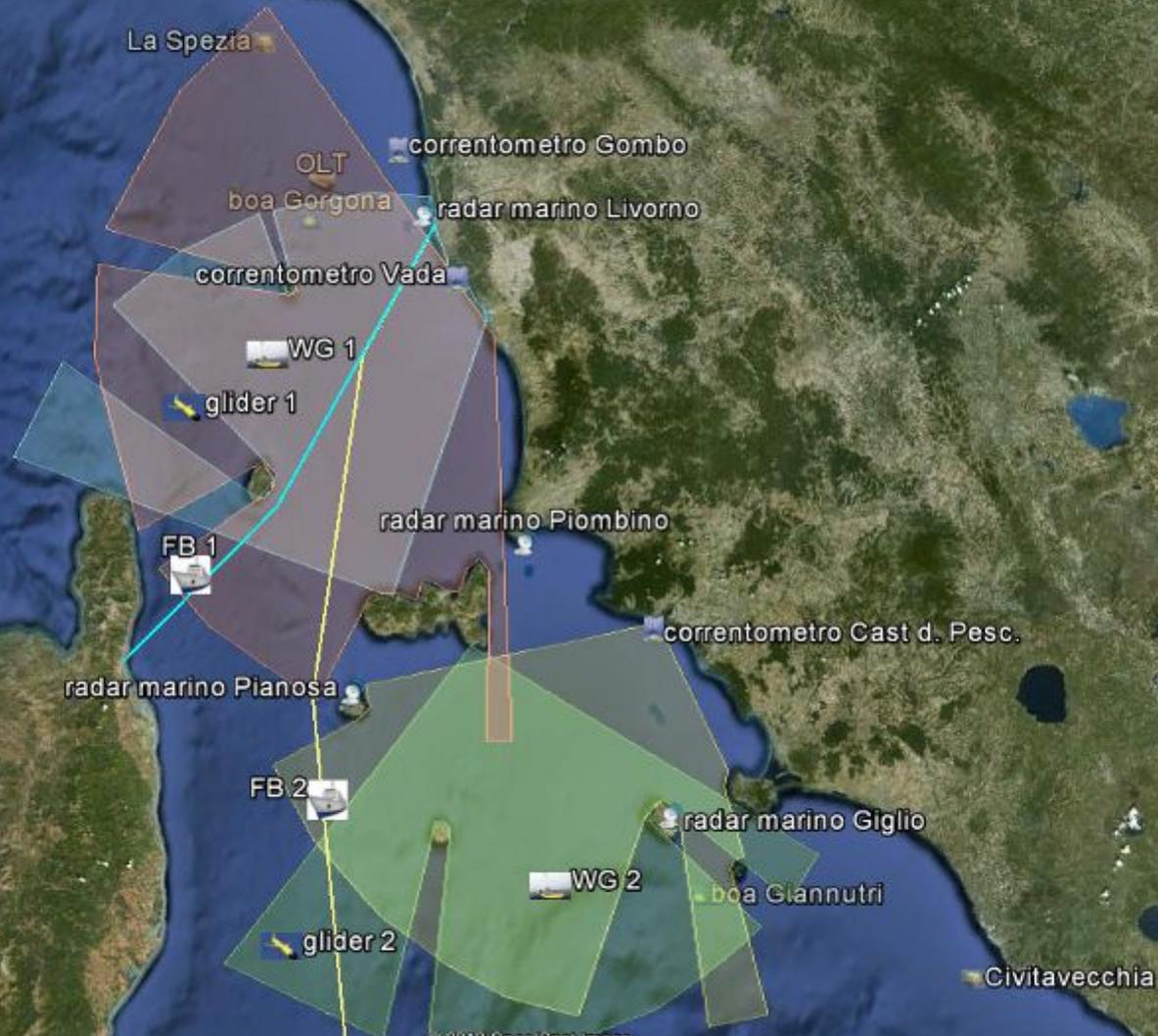
The coastline shape and observation of sub-meso patterns that are challenging observation/forecasting is very significant.





Building a measurement network for sea observation and control

The METOCFAN project (Mediterranean Oceanographic Forecasting Network) started in 2010
.. create OPERATIONAL INSYS systems for a monitoring network





Conclusions

- The design of a state-of-art sea measurement network asks for monitoring methodologies well beyond the traditional concept of sampling → need for approaches to spatial and temporal data integration (eg passive sampling, monitoring of opportunities along the routes, integration with the products of remote monitoring and modeling).
- The information on the physical and biological environment, within and outside the ecosystem point of view adopted by the MSFD, appear inextricably linked → need to improve relations between experts from different sectors but also between institutions and research;
- Need to promote and exploit the opportunities that come from the real economy: marine data (physical, biogeochemical, pollutants), are of great value even for non-public entities (commercial users): they are the basis for the realization of economies of scale, and they can help public (institutions, research organizations) to reach monitoring objectives through cooperative data collection systems.

COoperative Satellite navigation for MEteo-marine
MOdelling and Services



COSMEMOS

Thank you!

REGIONE
TOSCANA



Consiglio Nazionale delle Ricerche

