Radar and drifter measurements for rapide response to marine accidents: the TOSCA network

Annalisa Griffa (CNR-ISMAR)

- Motivation and strategy for a radar and drifter monitoring system
- Results from the preliminary MREA/POET experiment in the Gulf of La Spezia
- The TOSCA project: A network for better response to marine accidents.
  Leading PI, Anne Molcard.

Motivation and strategy

- Prediction of transport of substances released in the ocean is very challenging because it is highly sensitive to the correct knowledge of the velocity field. Even small errors in the velocity field can cause significant errors
- Appropriate measurements should be taken in order to improve transport prediction.
- HF coastal radar are very useful since they allow continuous monitoring of surface velocity in extended areas (of the order of 10-80 km) at time intervals of half an hour.
- Floating instruments like drifters are very useful since they follow the current and provide direct transport measurements.

Motivation and strategy

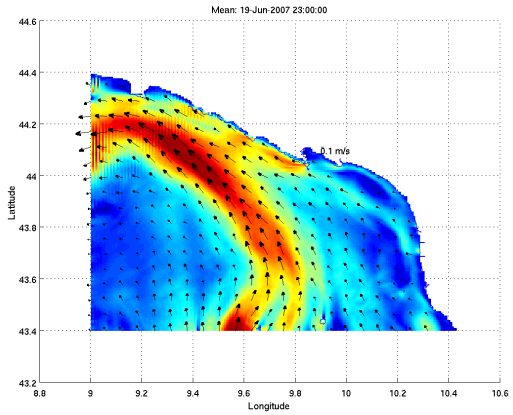
- Radar and drifter platforms are extremely useful but they have limitation (as any other platform):
  - HF radar velocity has typical errors of 5-10 cm/sec;
  - drifters provide limited geographical coverage;
  - both systems provide information only at the ocean surface and they cannot provide forecast…

- General strategy: use information from radar and drifters together with modelling information through assimilation or fusion techniques in order to enhance transport prediction

The MREA07/POET experiment in the Gulf of La Spezia

The POET experiment (Pilot Oceanographical and Environmental Trial) has been held in the Gulf of La Spezia in June 2007, with the collaboration of a number of national and international laboratories (CNR, LSEET, NURC, ENEA, OGS, RSMAS: Molcard et al., 2009; Haza et al., 2010).

Measurements have been performed from various platforms, complemented by the analysis of numerical model results.



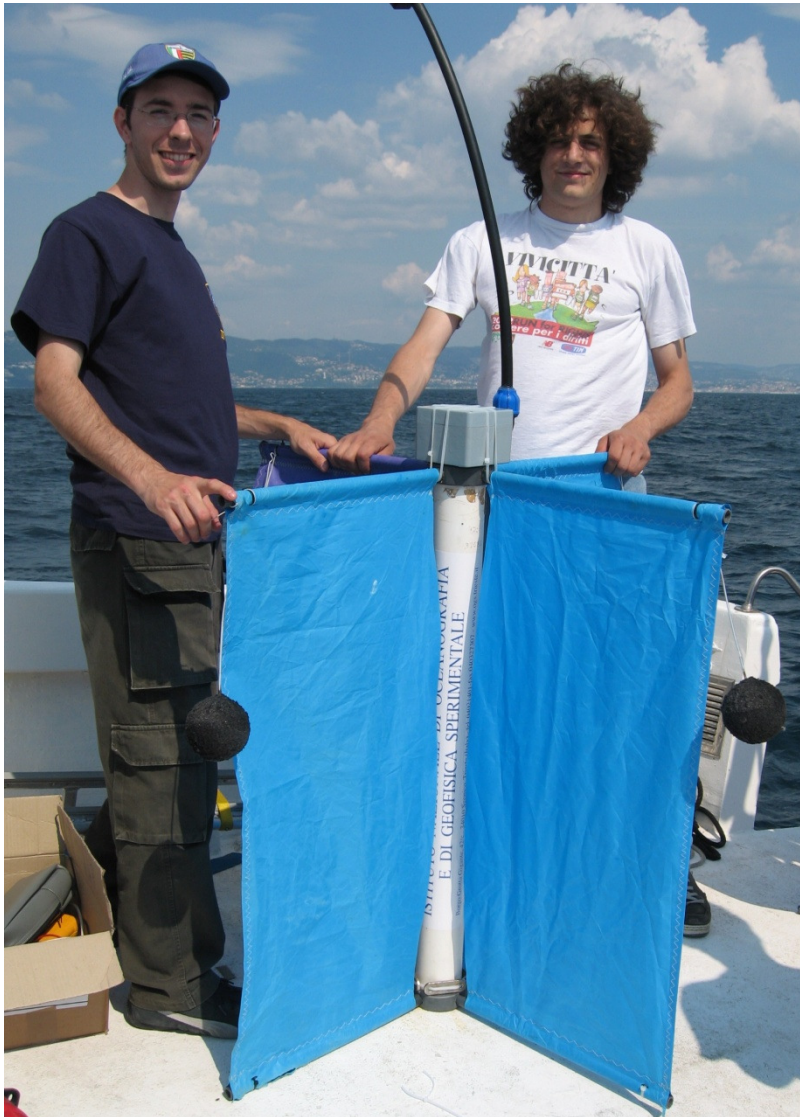
Current measurements from a Very High Frequency (VHF) coastal radar by LSEET- Toulon University (Fr).

S. Teresa site

La Rocchetta site

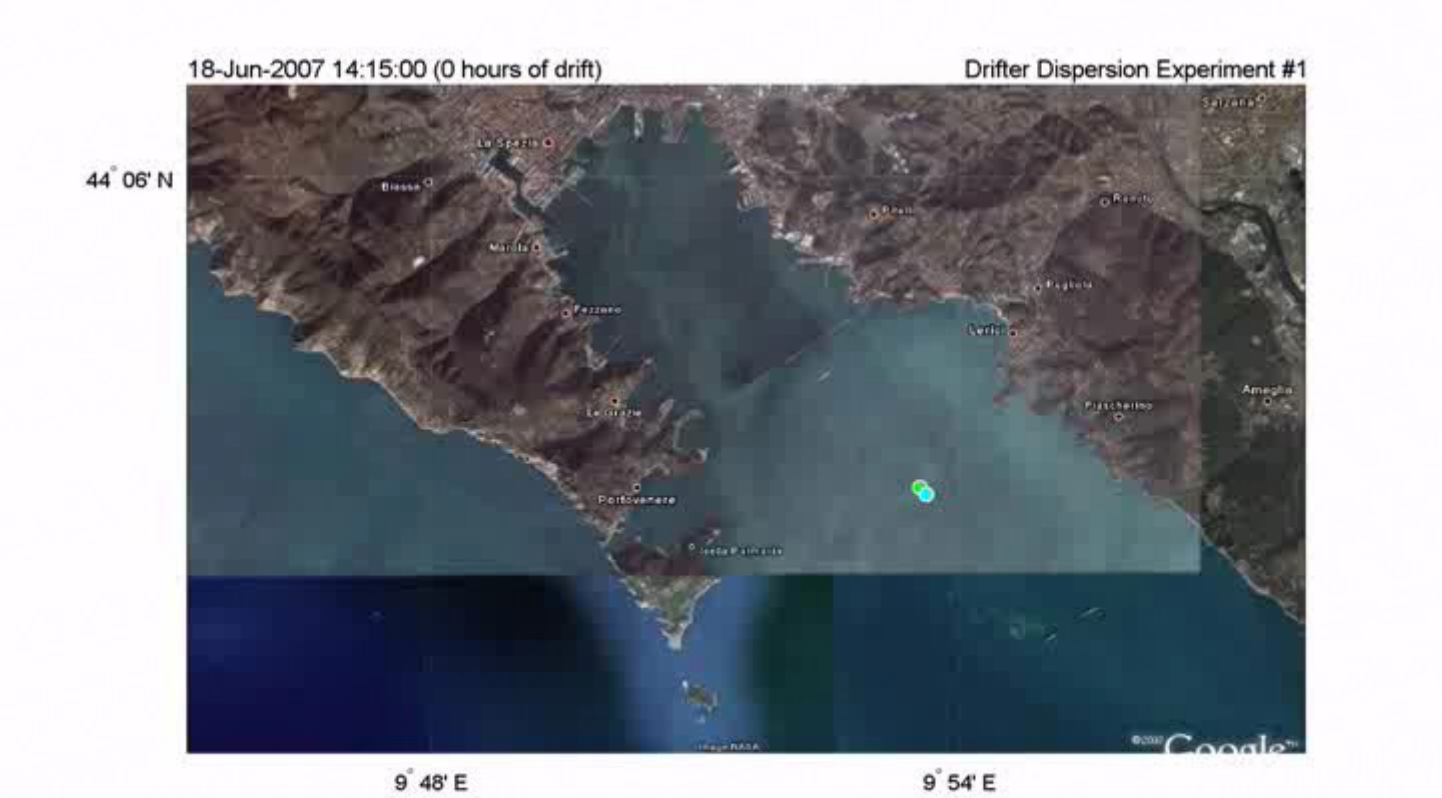
Coverage

Transport measurement with surface floating buoys (drifters) with OGS.

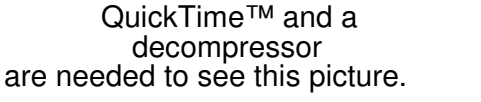


- Three main cluster releases have been performed
- The first two releases of 5 drifters show very distinct patterns of dispersion
- They are satisfactorily depicted by the radar fields: velocity errors are less 5cm/sec and drifter trajectories fall in the ensemble of synthetic trajectories from the radar fields
- The last release of 3 drifters is less satisfactory, with errors of 6-7 cm/sec and synthetic trajectories diverging from the in-situ ones

First release

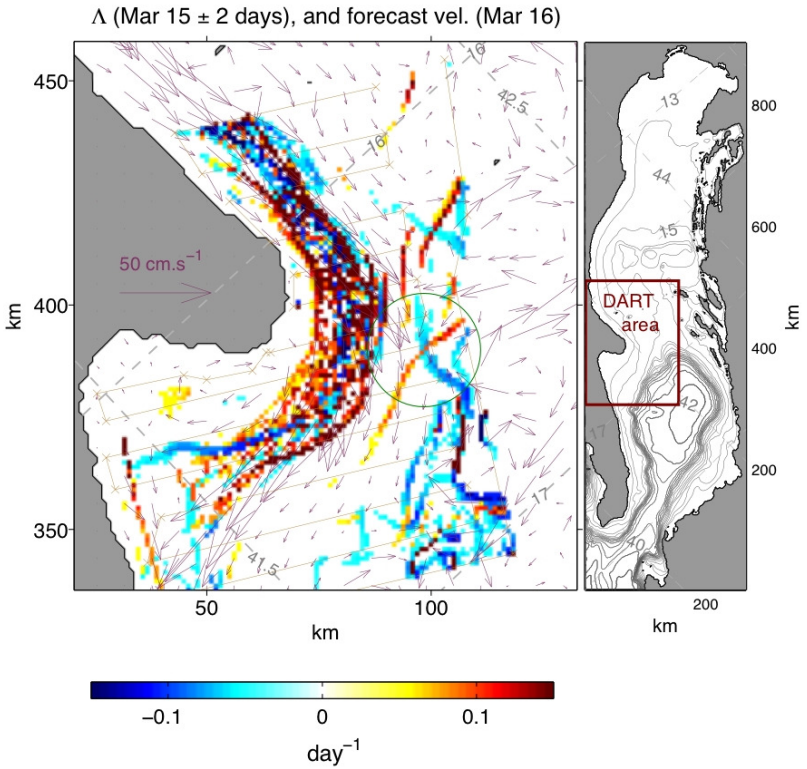


Second release



FSLE diagnostics to visualize transport barriers

- FSLEs (Finite Size Lyapunov Exponents) are a diagnostics that measures relative dispersion. They highlight the main flow structures (eddies, jets, boundary currents)
- Input: Velocity fields from numerical models or HF radars
- FSLEs are computed seeding particles in clusters in the velocity fields and advecting them forward and backward. How quickly do they diverge and converge?



Example from NRL NCOM model during DART06 (Haza et al., 2007)

- Red lines = concentration lines
- Blue lines = dispersion lines
- Ridges indicate transport barriers between different flow regions
- Crossing of red and blue lines indicate hyperbolic points

FSLEs and radar and drifter analysis during MREA07-POET in the Gulf of La Spezia (Molcard et al., 2009; Haza et al., 2010)

QuickTime™ and a
Microsoft Video 1 decompressor
are needed to see this picture.

Tracking Oil Spills & Coastal Awareness network **http://www.tosca-med.eu**

Programme cofinanced by European Regional Development Fund (ERDF)
Programme cofinancé par le Fonds Européen de Développement Régional (FEDER)

TOSCA Partners

Programme cofinanced by European Regional Development Fund (ERDF)
Programme cofinancé par le Fonds Européen de Développement Régional (FEDER)

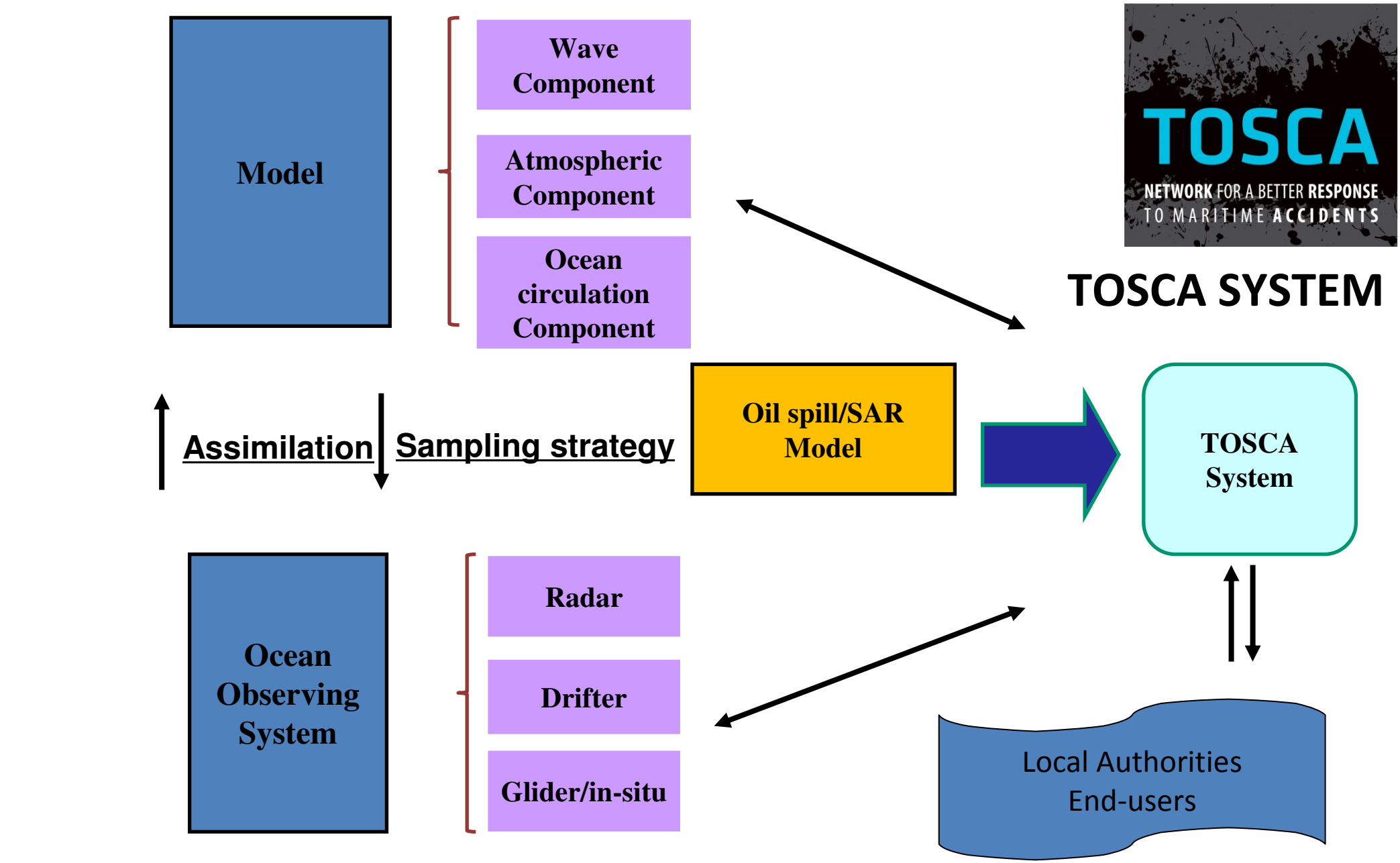
Objectives

✓ **develop** a long-lasting **network** of policy makers & scientists for observation & forecasting of marine accidents (oil pollution, Search And Rescue (SAR) operations …), in the Mediterranean Sea.

✓**monitor** in real time and predict the **transport** of marine currents with an observational **network** based on coastal-radar and Lagrangian platforms coupled with a forecasting circulation oil-spill dispersion model.

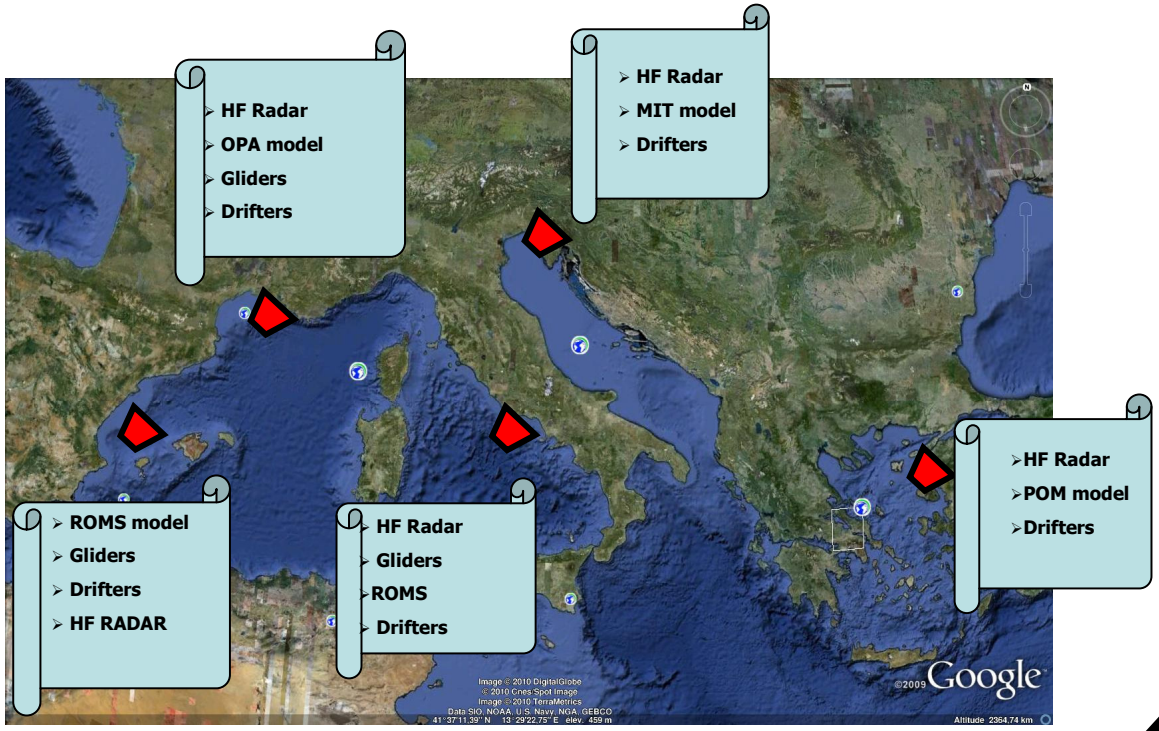
✓Develop assimilation methods to improve oil spill dispersion and SAR forecast skill

✓ supply **forecast models, risk maps & action plans** developed by the scientists in collaboration with the local authorities (includes the high risk regions of oil pipeline outlets in the Eastern Mediterranean, as well as high traffic areas in the Western Mediterranean)



Programme cofinanced by European Regional Development Fund (ERDF)
Programme cofinancé par le Fonds Européen de Développement Régional (FEDER)

TOSCA experimental sites and strategy



In situ observations (cruises, drifters, gliders, new drifters, …)

HF Radars

Modeling System – Validation/calibration (past– new experiments) Different models

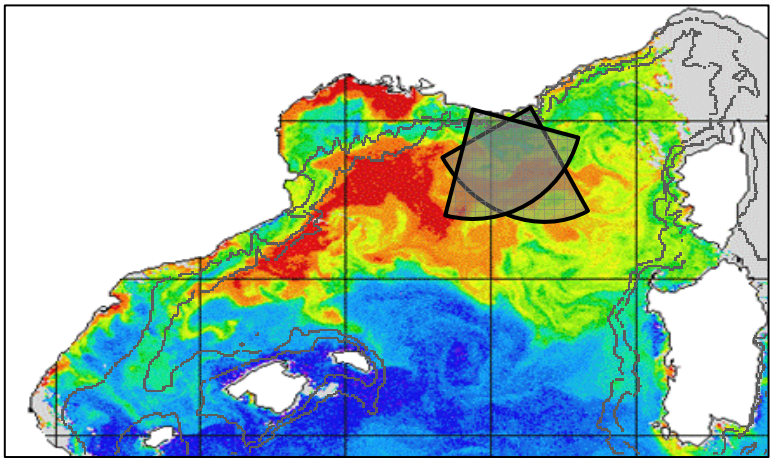
Improved assimilation of HF Radar and Lagrangian observations

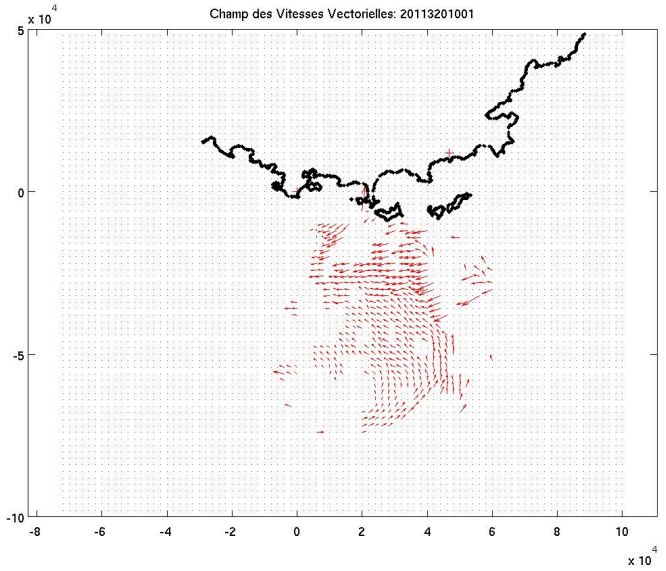
Improve response strategies with local authorities

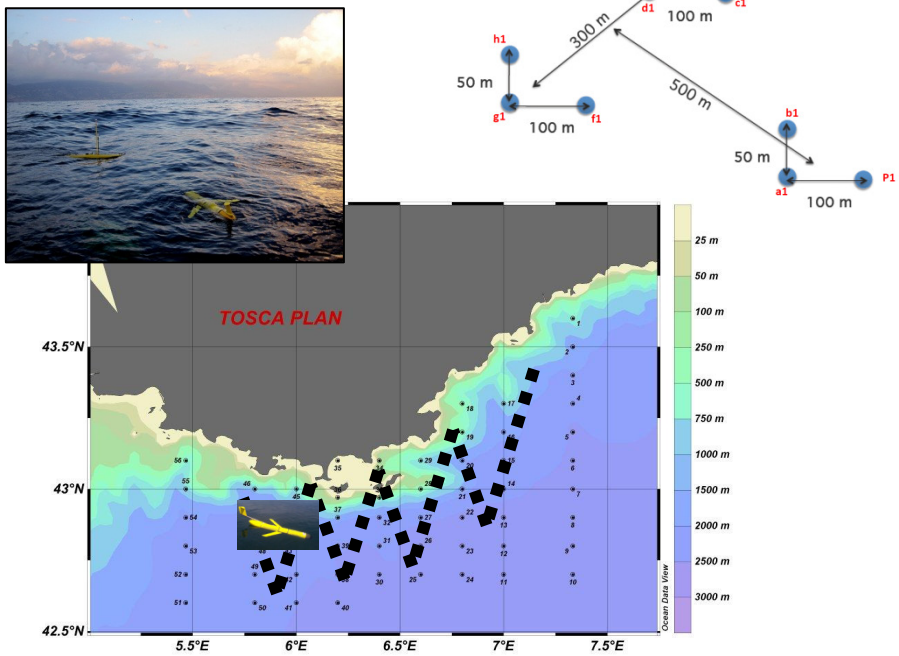
L'Europe en Méditerranée
Europe in the Mediterranean

Programme cofinanced by European Regional Development Fund (ERDF)
Programme cofinancé par le Fonds Européen de Développement Régional (FEDER)

TOSCA CURRENT STATUS







- **Modeling system (ready)**
- **Cal/val with past events (ongoing)**
- **HF Radars (finalizing)**
- **Experiments (started)**
  NW Mediterranean (10-20 December 2011)
- **New algorithms (in progress)**
- **New instruments (finalizing)**

New algorithms: developing and testing

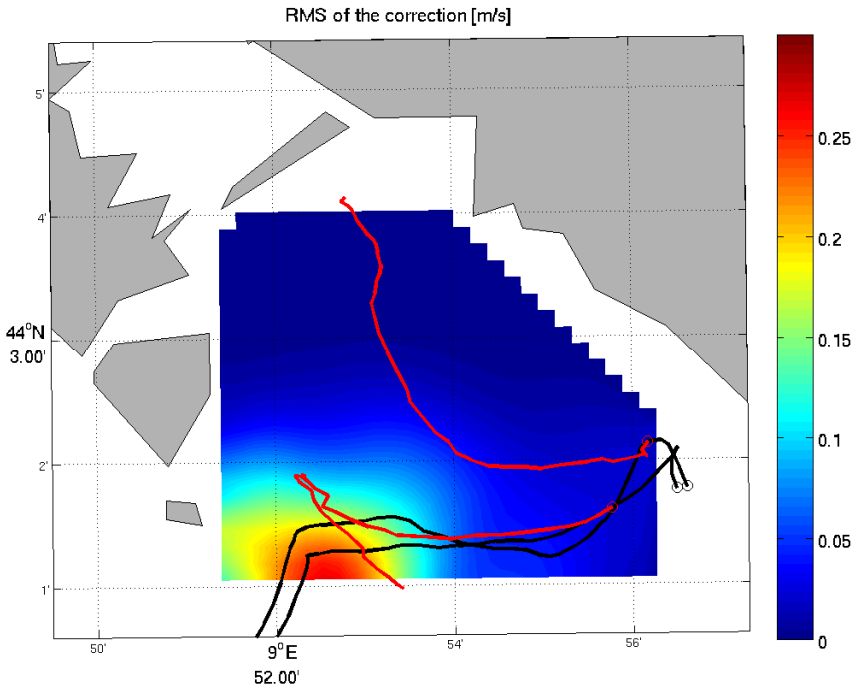
• An algorithm (LAVA) is presently applied to “blend” radar and drifter data to provide optimal velocity fields.

• LAVA is based on a variational approach and was developed in collaboration between CNR-ISMAR, LSEET University of Toulon, LOV CNRS, RSMAS University of Miami (Molcard et al., 2003; Taillandier et al., 2006) and previously applied to model fields

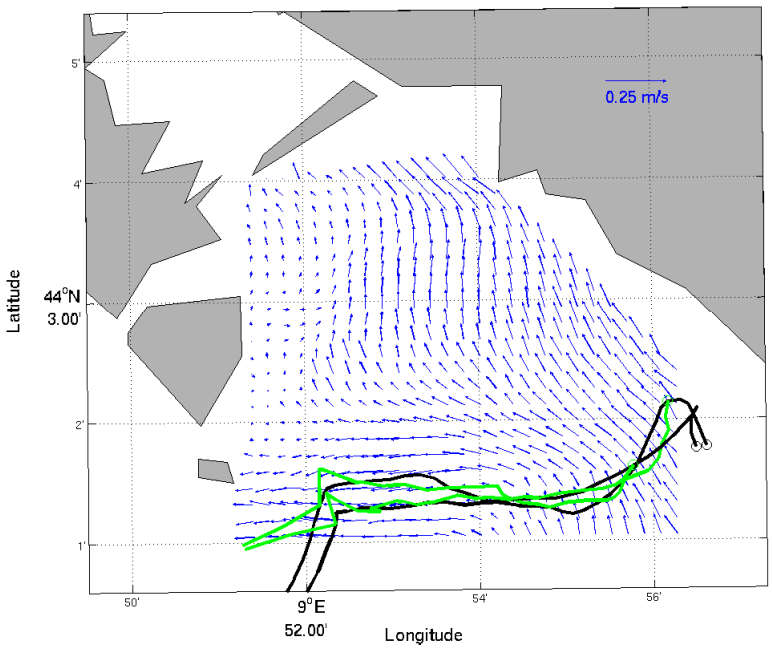
• LAVA has been customized by CNR-ISMAR for TOSCA, tested on the historical POET data set and it is presently made available to all the TOSCA partners.

• Model assimilation: LSEET is presently working on a method by A. Barth to assimilate radar (or drifter blended) surface velocity fields to correct model boundary conditions

Example of LAVA application to POET data



Observed (black) and Radar based (red) trajectories for the third POET cluster, superimposed to the RMS of the correction, i.e. difference between velocity fields with and without LAVA correction



Observed (black) and Radar LAVA corrected based (green) trajectories superimposed the mean Radar velocity

New instruments: finalizing

New types of drifters have been tested and developed by partners

In particular a new “oil spill drifter” has been developed by G. Nicolaides (TEI, Gr) and is now in the process of been tested in in-situ experiments