



HF radar “Dardanos”: measuring the outflow of the Black Sea in the Aegean

**Vassilis Zervakis¹, Zoi Kokkini^{1,2}, Emmanuel Potiris^{1,3} E and
Alkiviadis Kalampokis^{1,3}**

¹Department of Marine Sciences, University of the Aegean, Mytilene, Greece

²Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy

³Institute of Oceanography, Hellenic Centre for Marine Research, Heraklion, Greece



The Department of Marine Sciences, University of the Aegean

Location – Premises - Infrastructure





The Department of Marine Sciences, University of the Aegean

The Department of Marine Sciences:

- Covers all the disciplines of the Marine Sciences
- Is the single University Department in Greece offering B.Sc. Degree in Marine Sciences.
- Offers M.Sc. Degree in Coastal Zone Management
- Offers Ph.D. degrees in oceanography and related sciences

Still: a “*poor*” University Department of a bankrupted country





Our immediate vicinity and area of interest: The North Aegean Sea

The North Aegean Sea: area of first inflow of Black Sea Waters into the Mediterranean

**The Black Sea:
Dilution basin, mesotrophic environment**

**The Aegean Sea (and the Med):
Concentration basin, oligotrophic environment**

Black Sea Waters outflow into the Mediterranean forms a surface layer that:

- *hinders dense-water formation and*
- *Fertilizes the North Aegean*





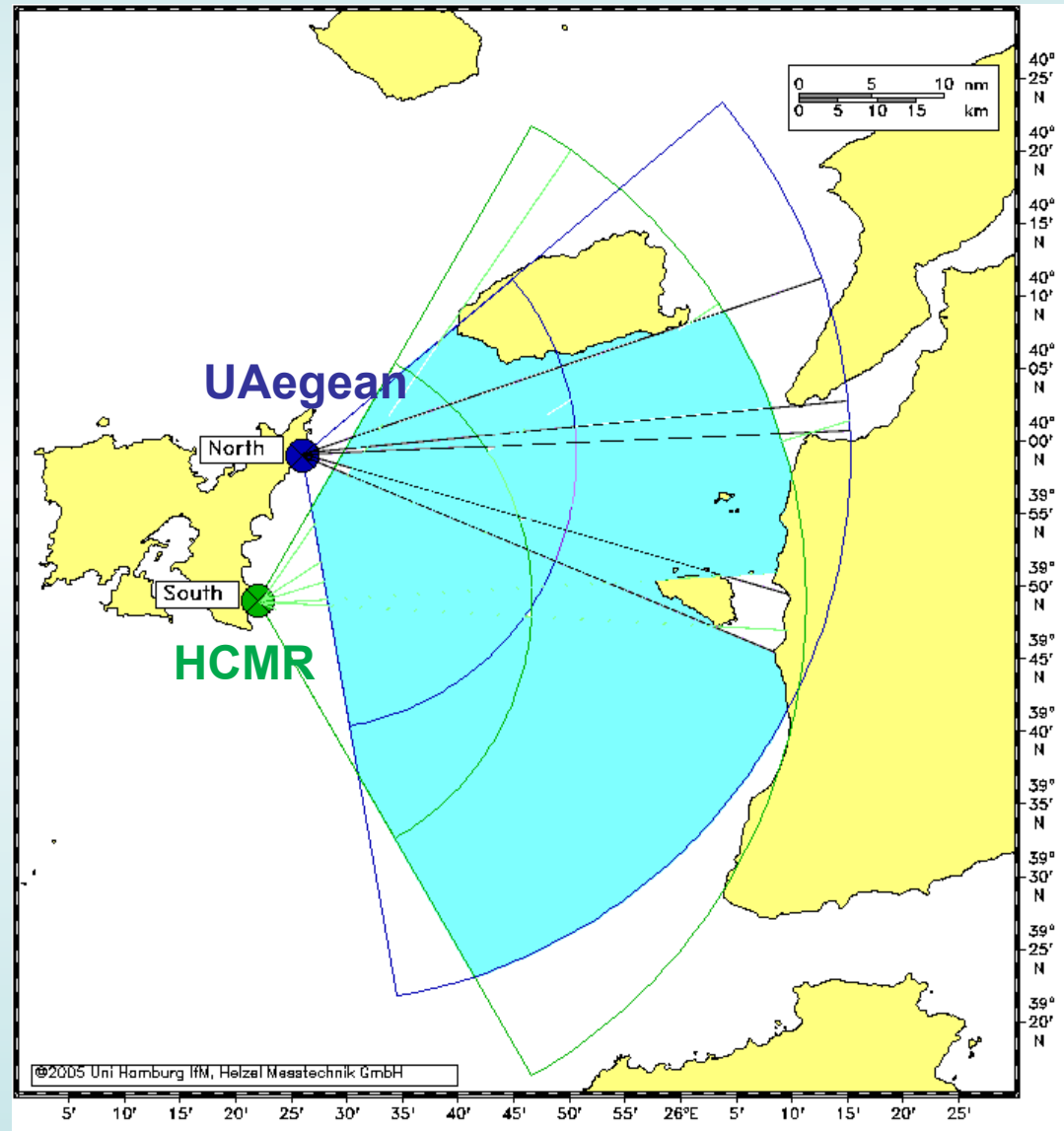
The Department of Marine Sciences: Research Strategy of Physical Oceanography Group

Since 2004 that we joined the University of the Aegean, we chose to seek low-cost solutions for collecting large amounts of information.

Concentrated on:

- Lagrangian measurements and
- Coastal HF radars

Concentrating on the Dardanelles role as a potential point-source of pollution, we got two HF radar sites funded (...), one for the UAegean and one for the Hellenic Centre for Marine Research





The Department of Marine Sciences: WERA radar purchase, installation and operation

Two parallel calls for bid took place, each for a “HF radar measuring the radial current component....”, by UAegean and HCMR.

Helzel Messtechnik GmbH was the sole bidder.

We purchased a WERA HF radar (two sites), operating at 13.4 MHz. Each receiver has only 4 antennas (Direction Finding technique).

Communication was via GSM in the southern site (HCMR), satellite internet at the northern site (UAegean).

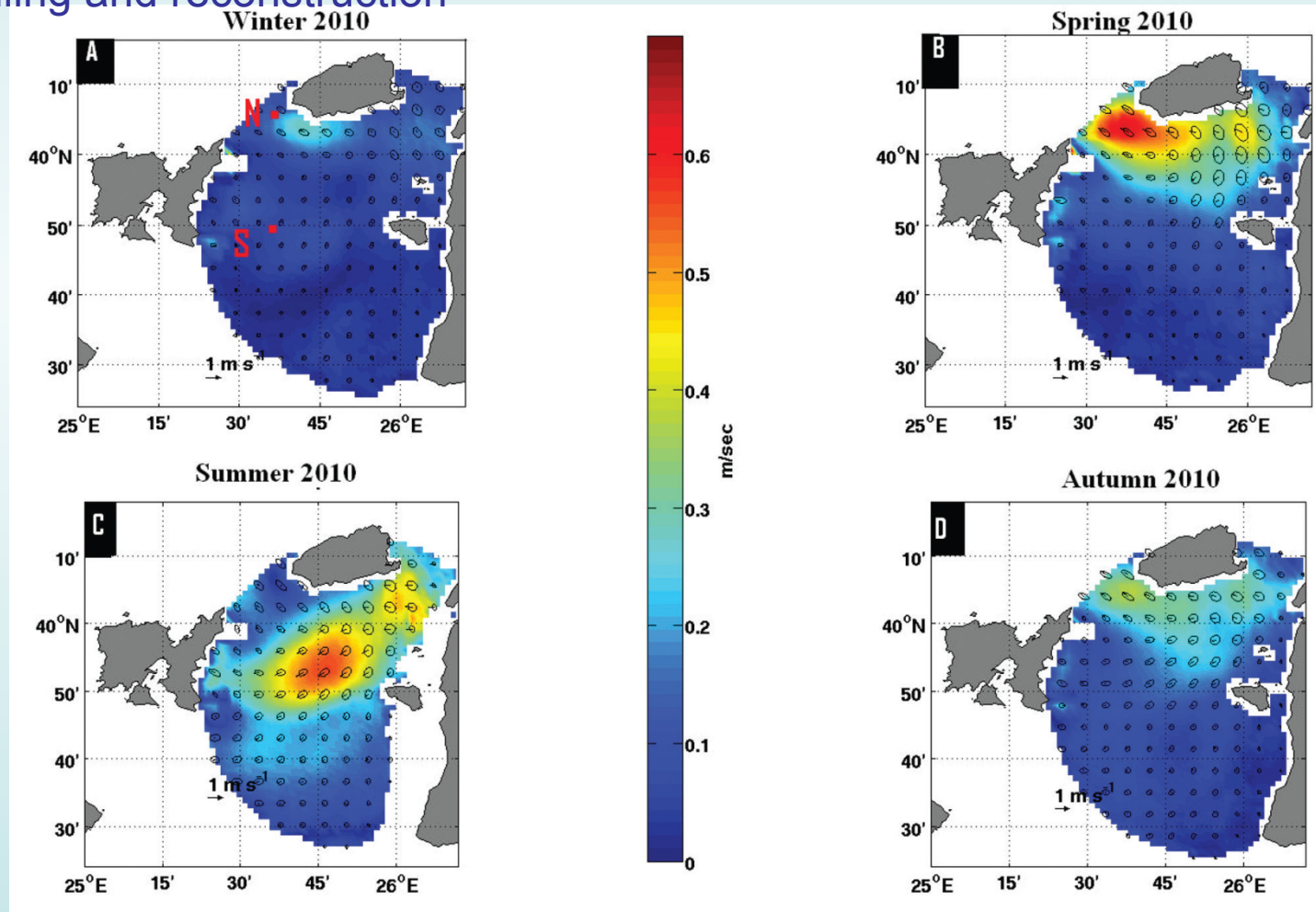
Operation has been continuous from November 2009 until June 2011, intermittent since then due to various causes.

The HF radar has been used by the UAegean in the projects:
MedEx (EU project, nationally-funded), TOSCA (EU-funded), AegeanMarTech (Greek-funded)



The “Dardanos” HF radar system: Quality Control and Gap-Filling procedures

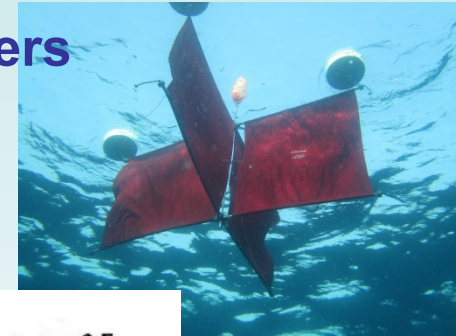
- The standard WERA quality-control software was used at a first level.
- Temporal filtering and despiking followed
- DINEOF analysis provided further spatio-temporal low-pass filtering as well as data gap-filling and reconstruction



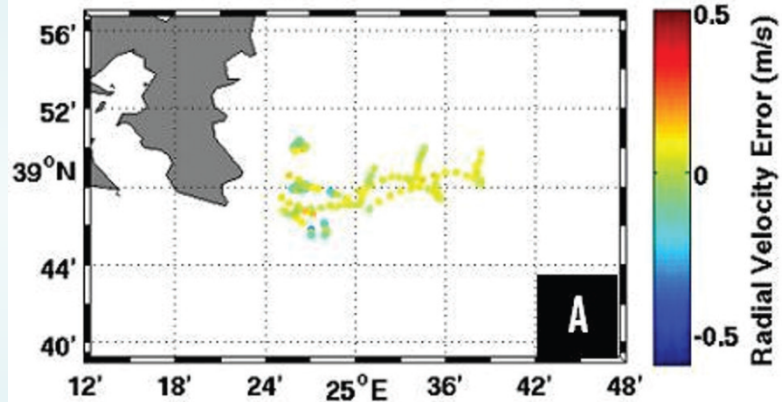


The “Dardanos” HF radar system: Validation: Comparing radial velocities

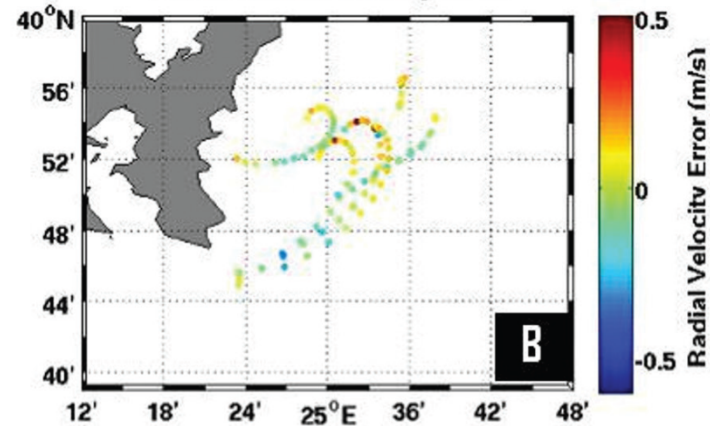
Used our-own design and construction CODE-type drifters



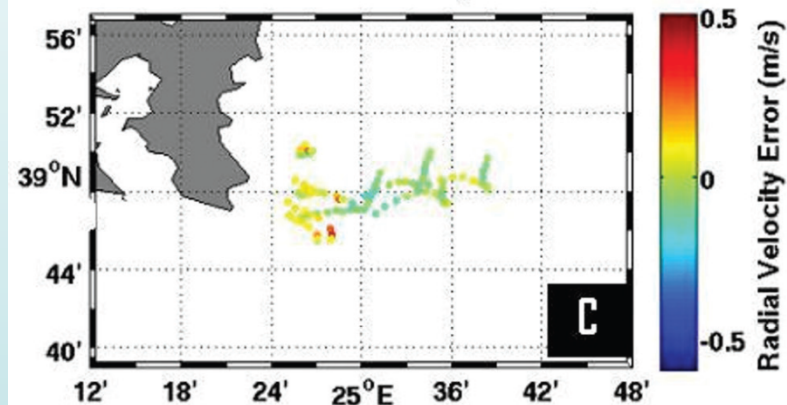
Fissini - Radial Velocity Error



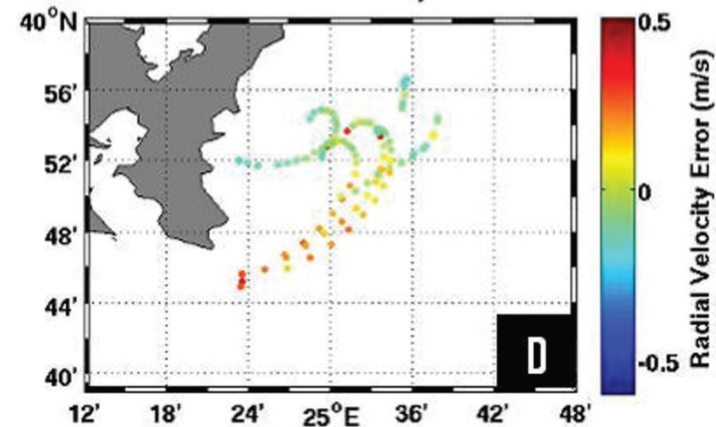
Fissini - Radial Velocity Error



Plaka - Radial Velocity Error



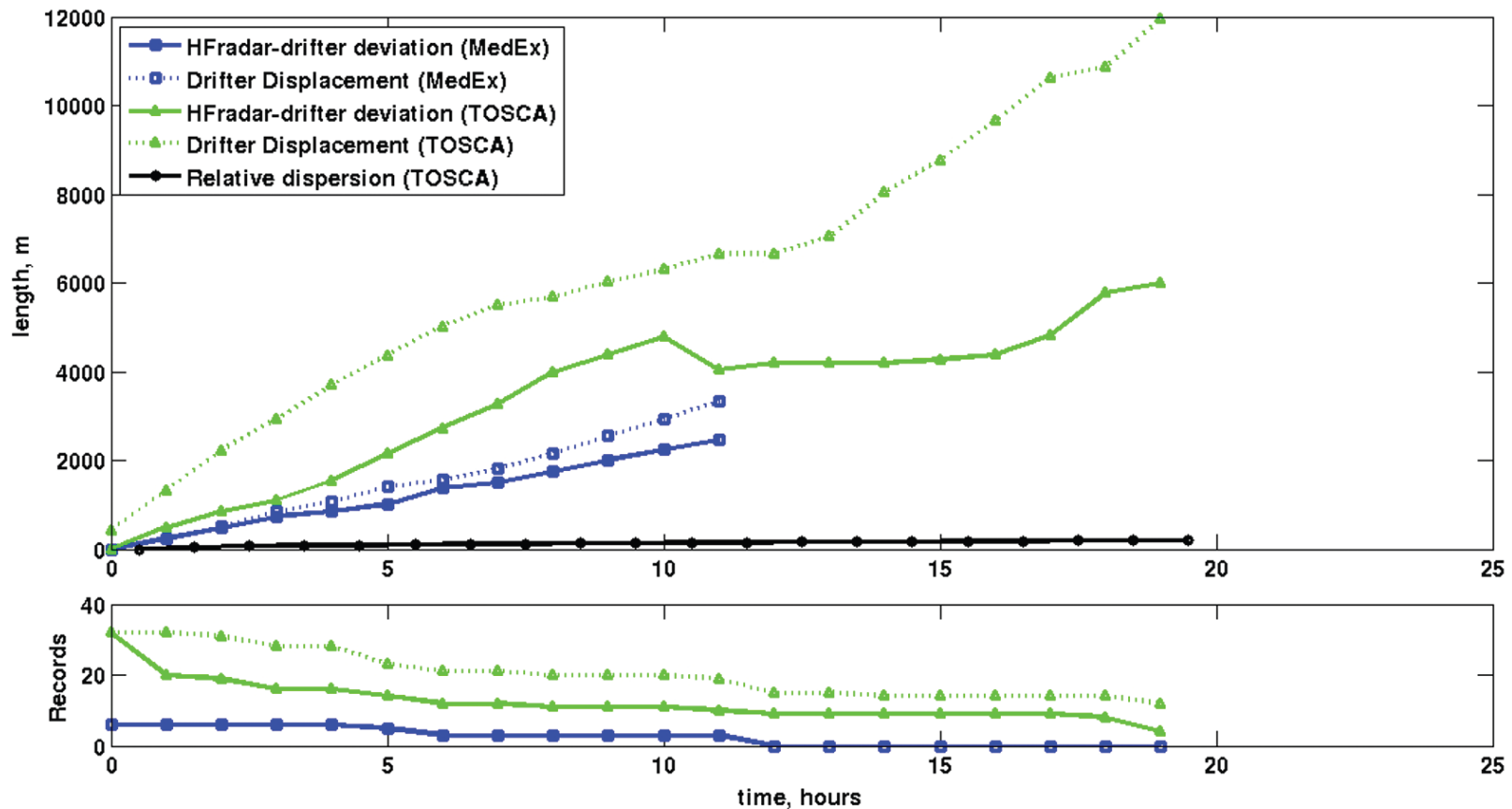
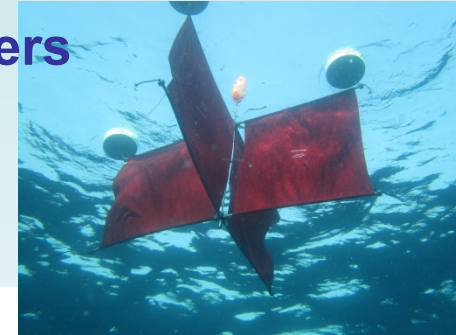
Plaka - Radial Velocity Error





The “Dardanos” HF radar system: Validation: Comparing real and synthetic trajectories

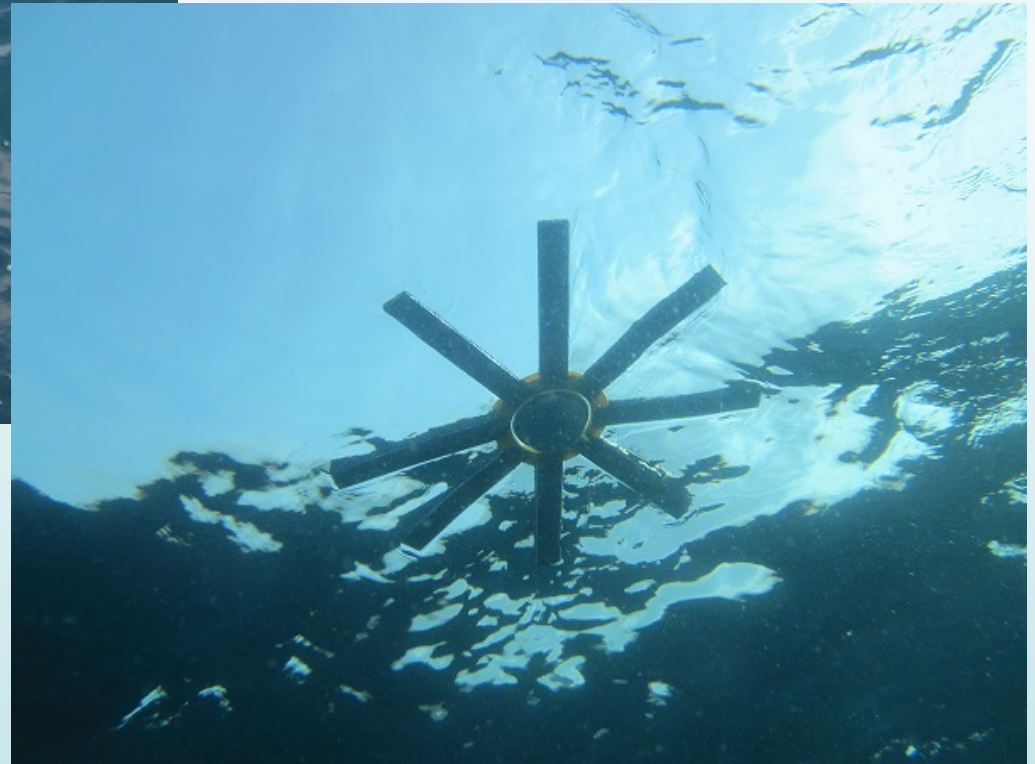
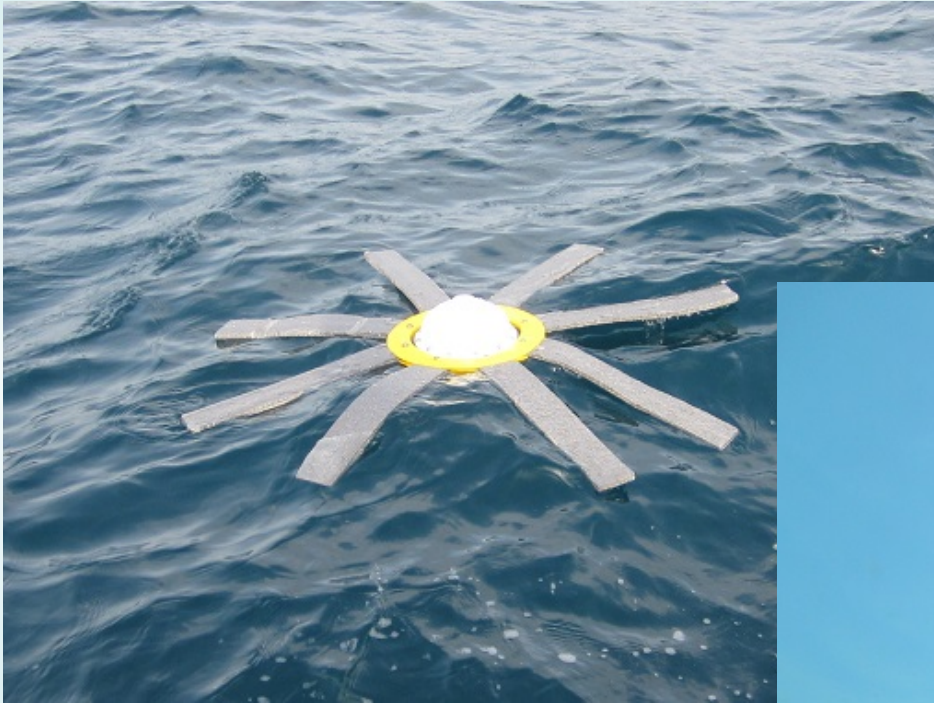
Used our-own design and construction CODE-type drifters





The “Dardanos” HF radar system: Use with oil-spill models and floats

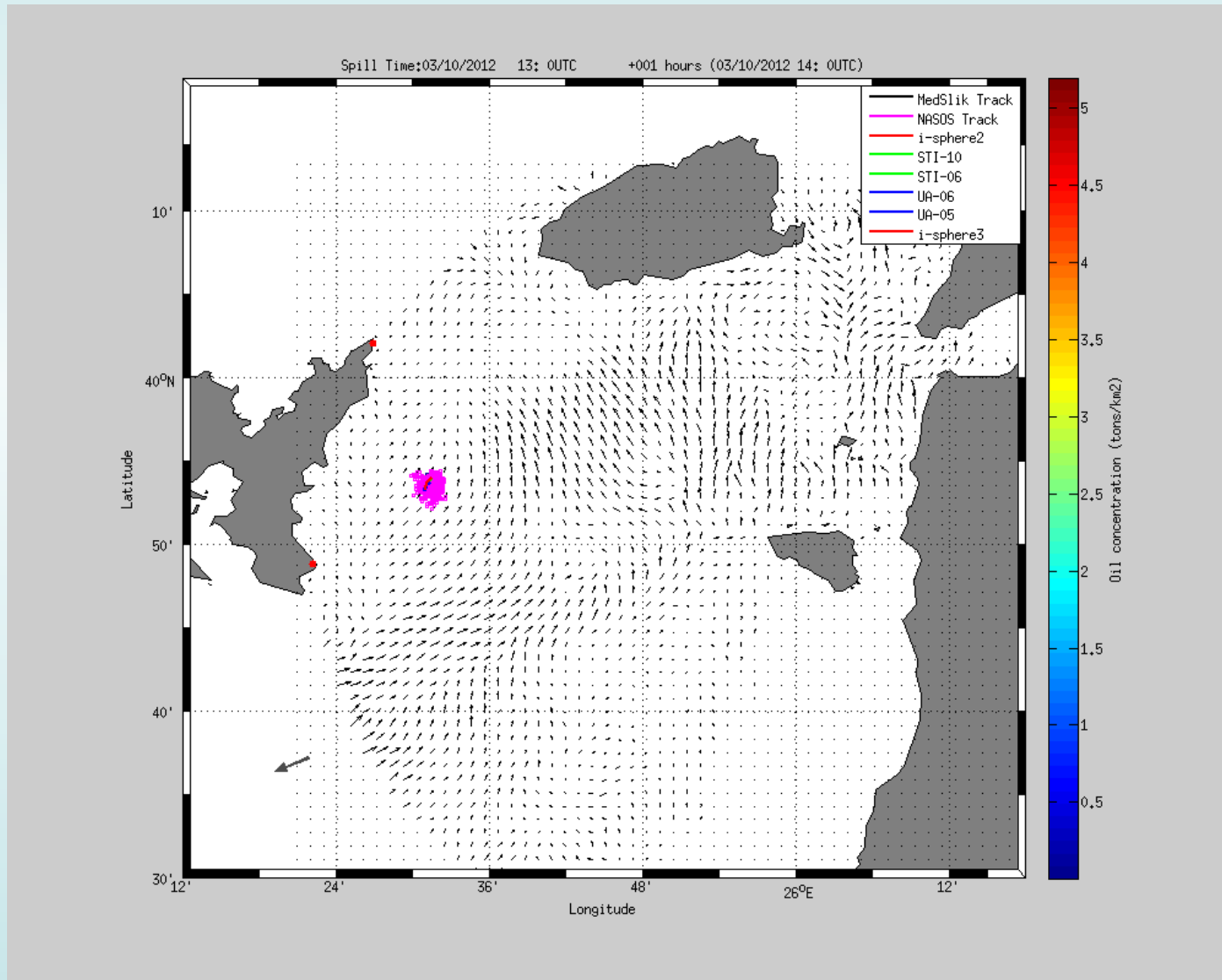
Used our-own design and construction CODE-type drifters and COSTA oil-spill drifters





The “Dardanos” HF radar system: Use with oil-spill models and floats

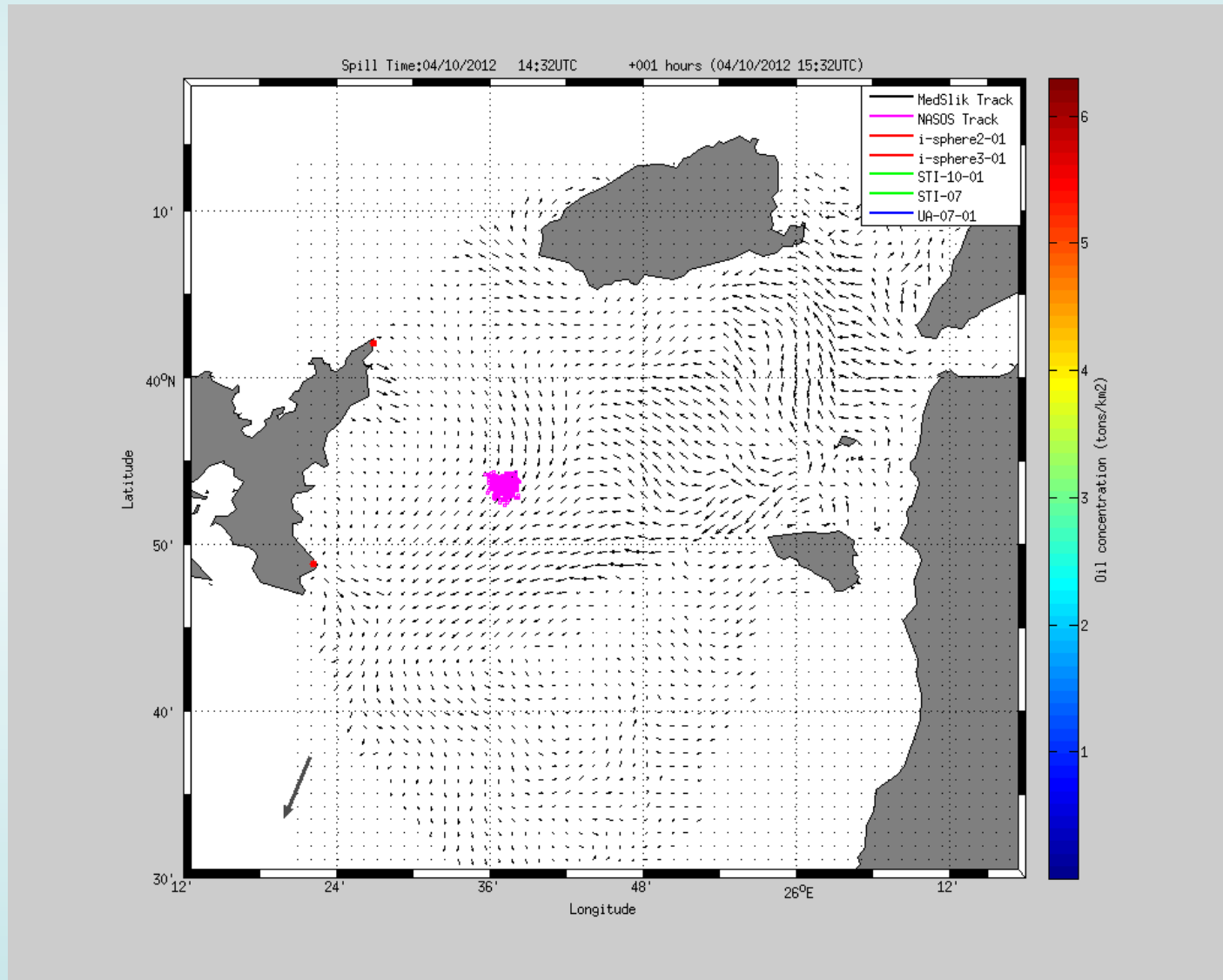
Assess its use for prevention of coastal oil-spill pollution and SAR aid





The “Dardanos” HF radar system: Use with oil-spill models and floats

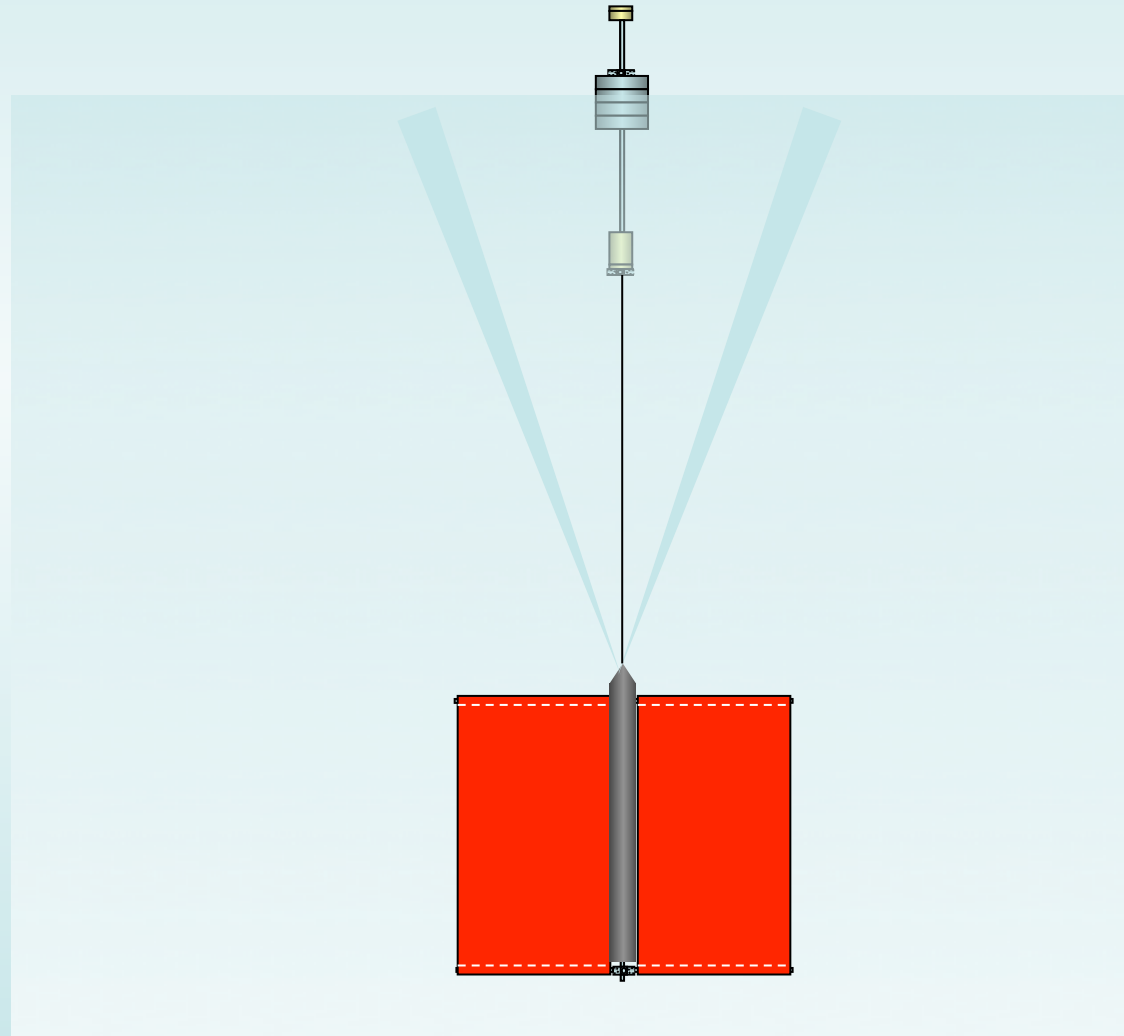
Assess its use for prevention of coastal oil-spill pollution and SAR aid





The “Dardanos” HF radar system: Assessing the role of near-surface shear

We used a drifting platform to measure the near-surface shear within the top 2-m of the water column and assess the windage of typical CODE drifters.



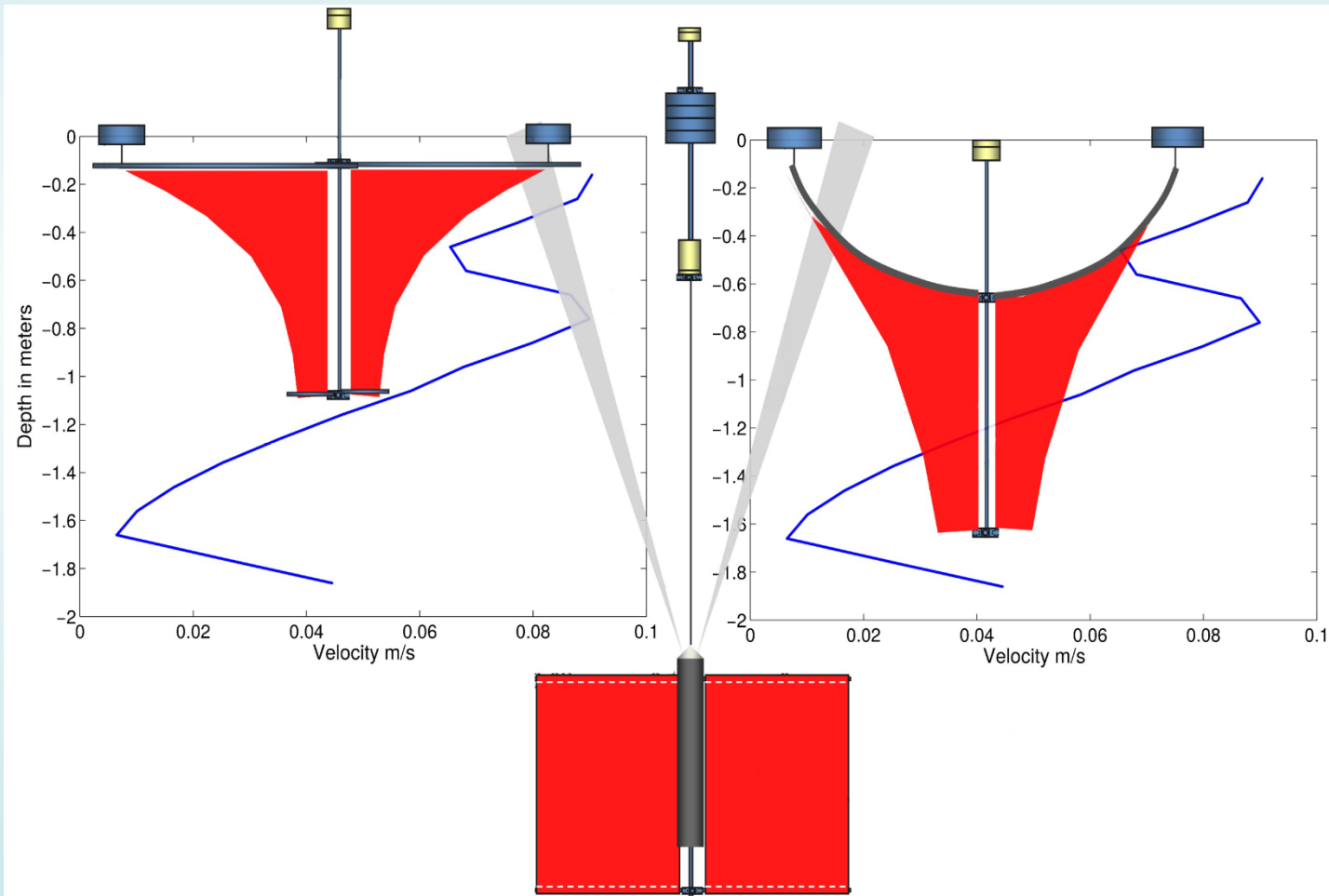
Combination of a

- UAegean drifter in a sub-surface configuration and
- Nortek Aquadopp HR current profiler



The “Dardanos” HF radar system: Developing a drifter specifically-designed for HF radars

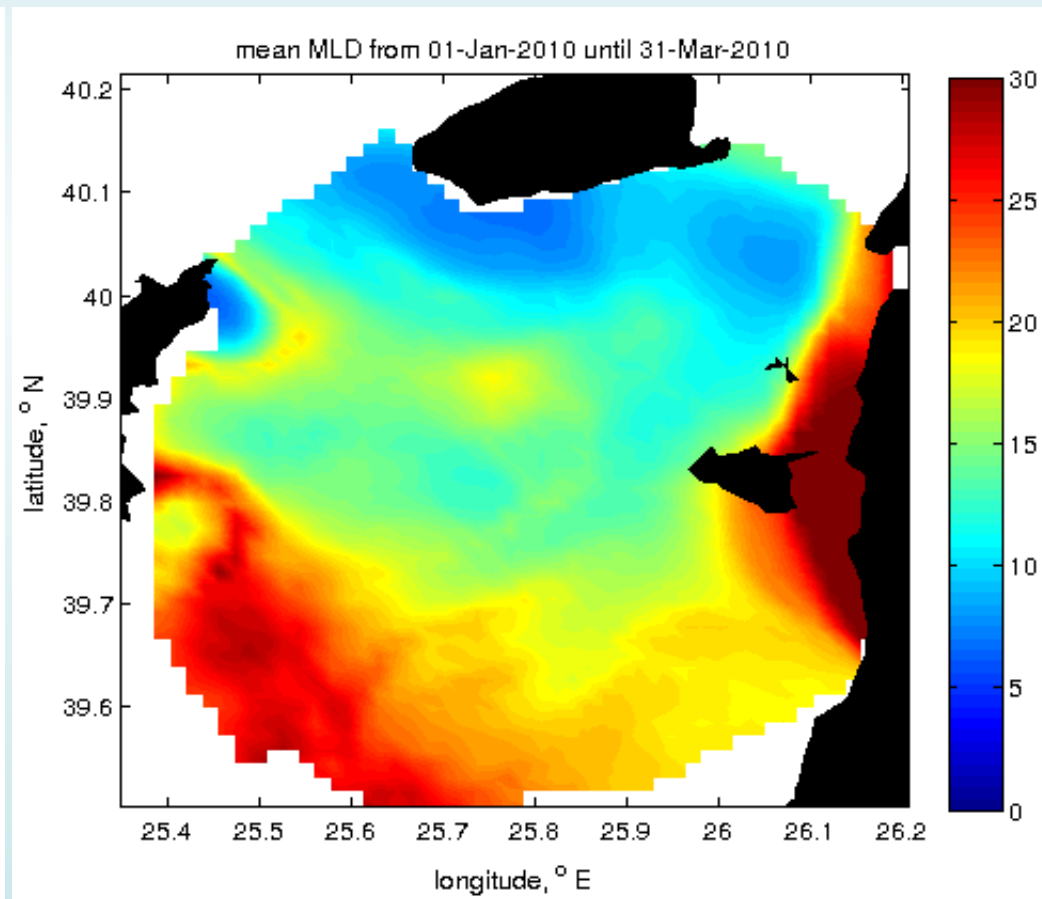
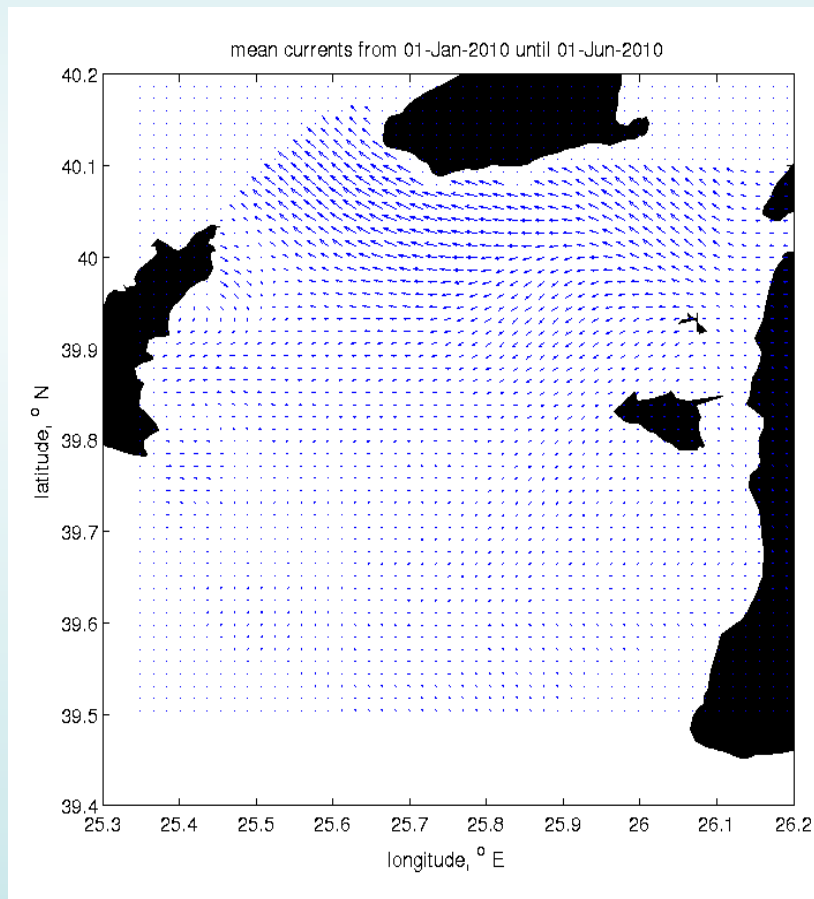
Based on the results of the above-mentioned platform, we developed **STRING**, a CODE-type drifter specially designed for validation of HF radars:





The “Dardanos” HF radar system: Estimating MLD

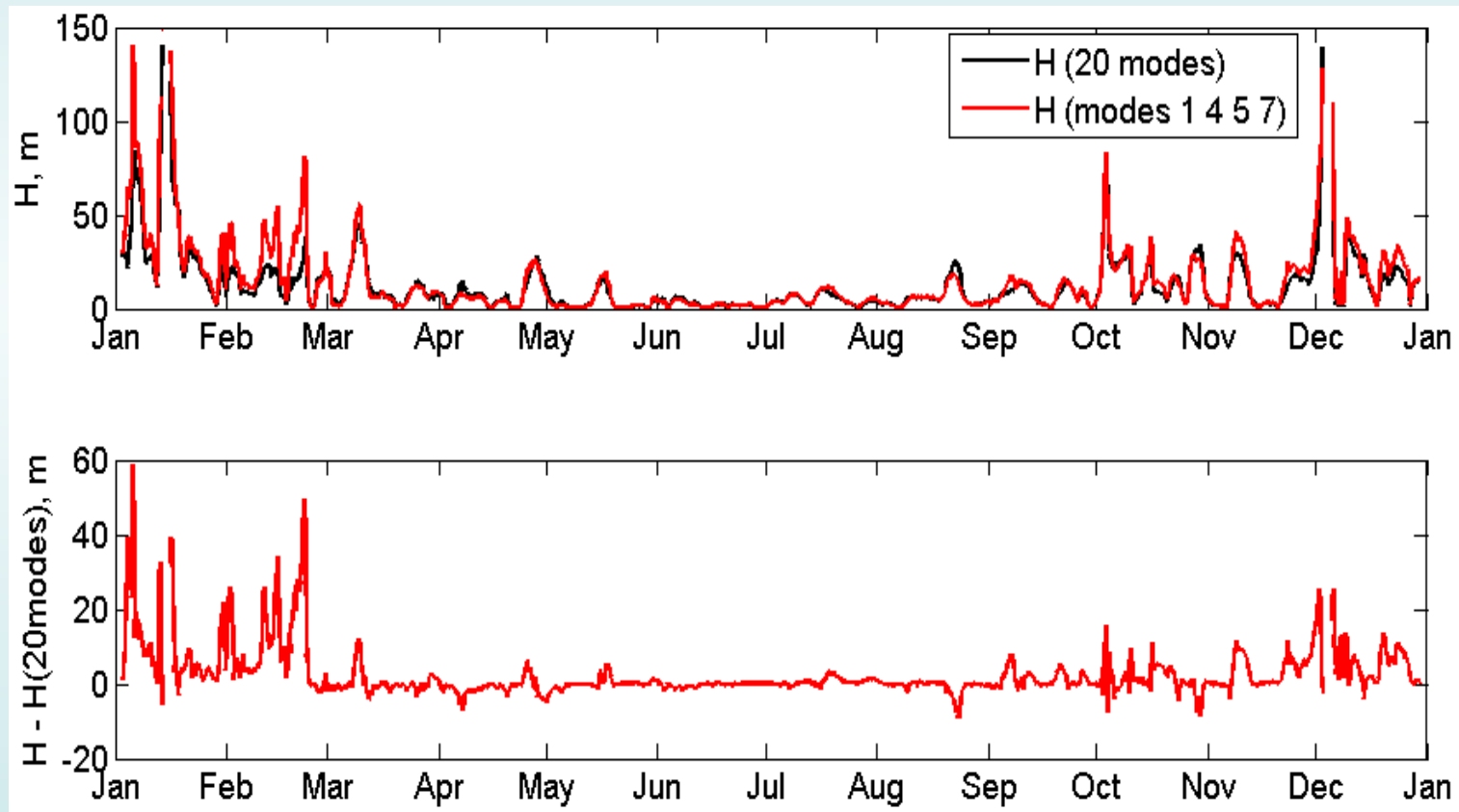
Proceeding towards our aim of quantifying the BSW inflow into the Aegean, we used the slab-layer model assumption to estimate mixed-layer depth:





The “Dardanos” HF radar system: Estimating MLD

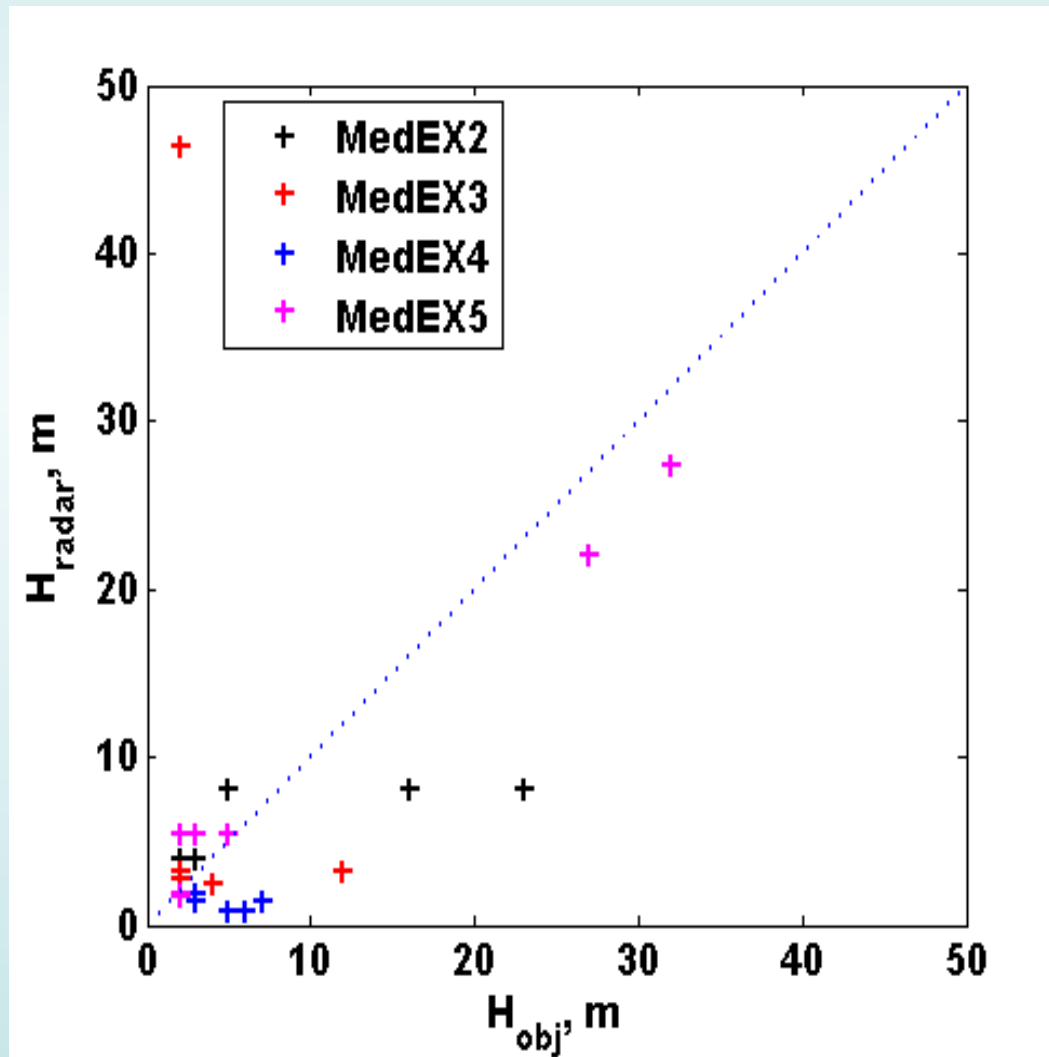
Time-series of the spatial mean of MLD in the coverage region for 2010.





The “Dardanos” HF radar system: Estimating MLD

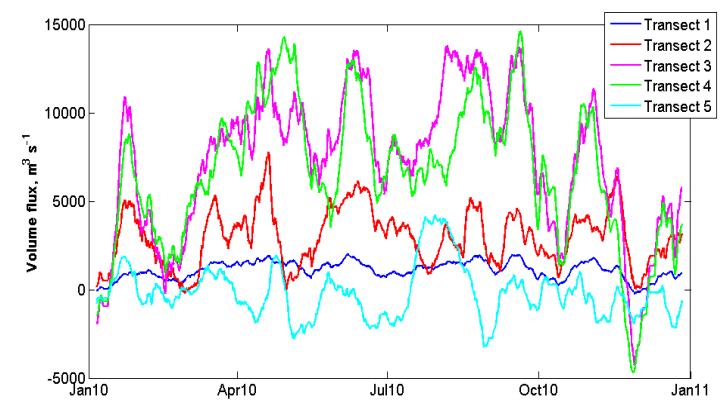
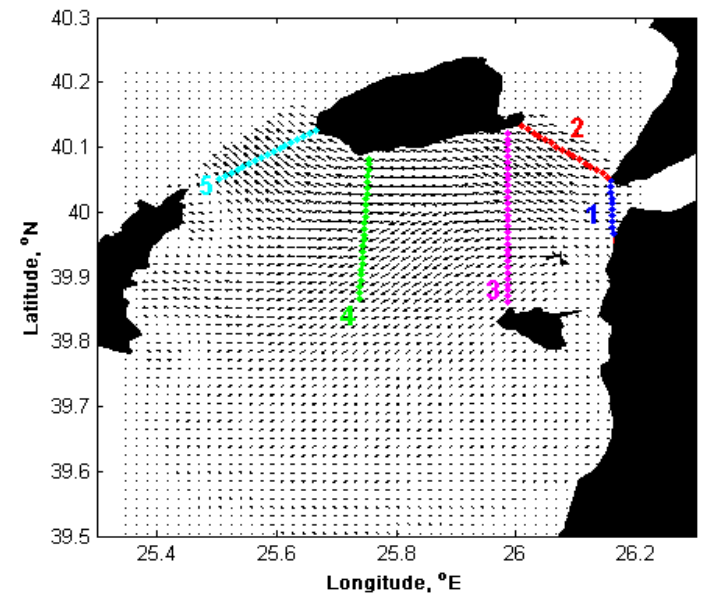
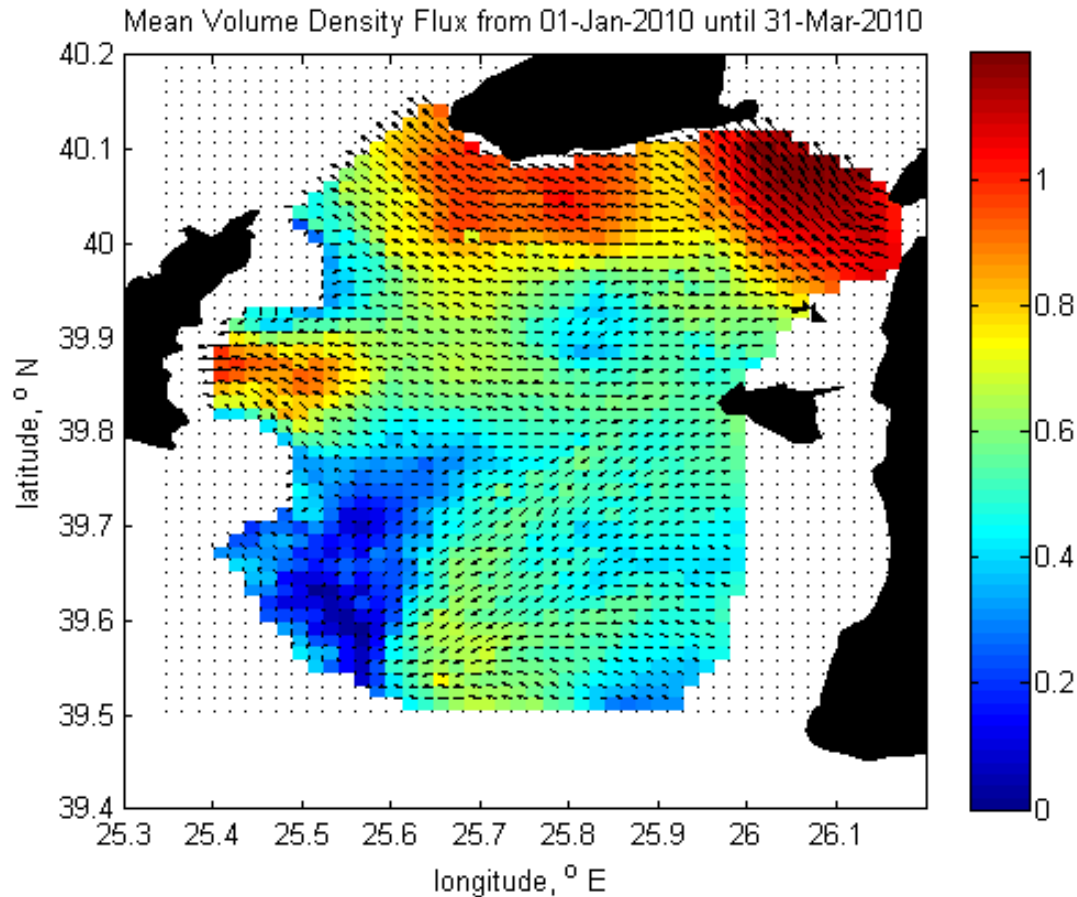
Comparison of HF radar-derived MLD to CTD-derived MLD.





The “Dardanos” HF radar system: Estimating Lateral Volume Fluxes

Using both MLD, surface velocities and the slab-layer assumption, we can estimate volume fluxes.





The “Dardanos” HF radar system: Conclusions / Discussion

- The WERA HF radar “Dardanos” was installed in eastern Lemnos mainly to monitor the inflow of BSW into the Aegean
- Our gradual buildup of expertise involved not only HF radar data processing and analysis, but Lagrangian methodologies and instrumentation as well
- It is possible to estimate MLD using HF radar data
- Thus, for the first time, we can get information along the vertical axis
- The combination of HF radar-derived velocities and MLD provides volume flux estimates..

- Currently, the system is out of order for need of funds.
- We seek closer collaboration with HCMR for use of operational oceanography funds for reviving the system
- We seek partnership with HF radar experts to improve our related knowhow, as HF radar for us is the means, not the target.