

# Preliminary applications of the ROMS 4D-Var data assimilation to a Tyrrhenian Sea coastal region

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SANTA CRUZ

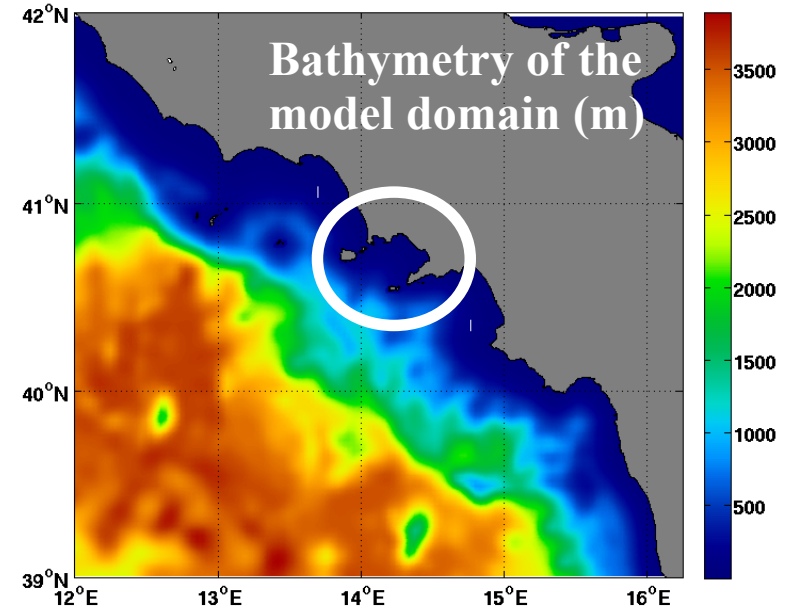


- Tyrrhenian Sea coastal area (& the Gulf of Naples)
- HF Radar
- Coastal modelling
- Preliminary applications of ROMS I4D-Var
- Discussion & Ongoing

# Tyrrhenian Sea coastal area (& the Gulf of Naples)

A particularly interesting area influenced by numerous environmental, socio-economic and interacting cultural factors

- strong anthropogenic impact
- intense maritime traffic
- presence of the polluted Sarno river
- relevant tourist and economic activities
- four marine protected areas



# HF Radar

One of the very few sites along the Italian coasts that can benefit from the availability of real-time surface velocity data provided by a system of high frequency (HF) coastal radars.

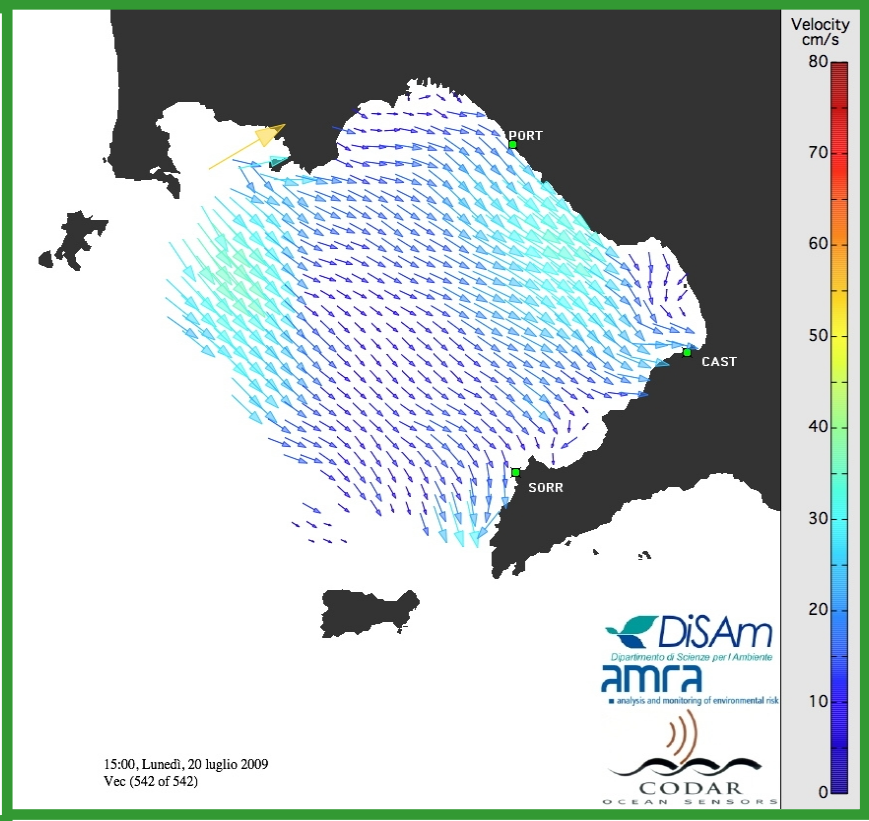
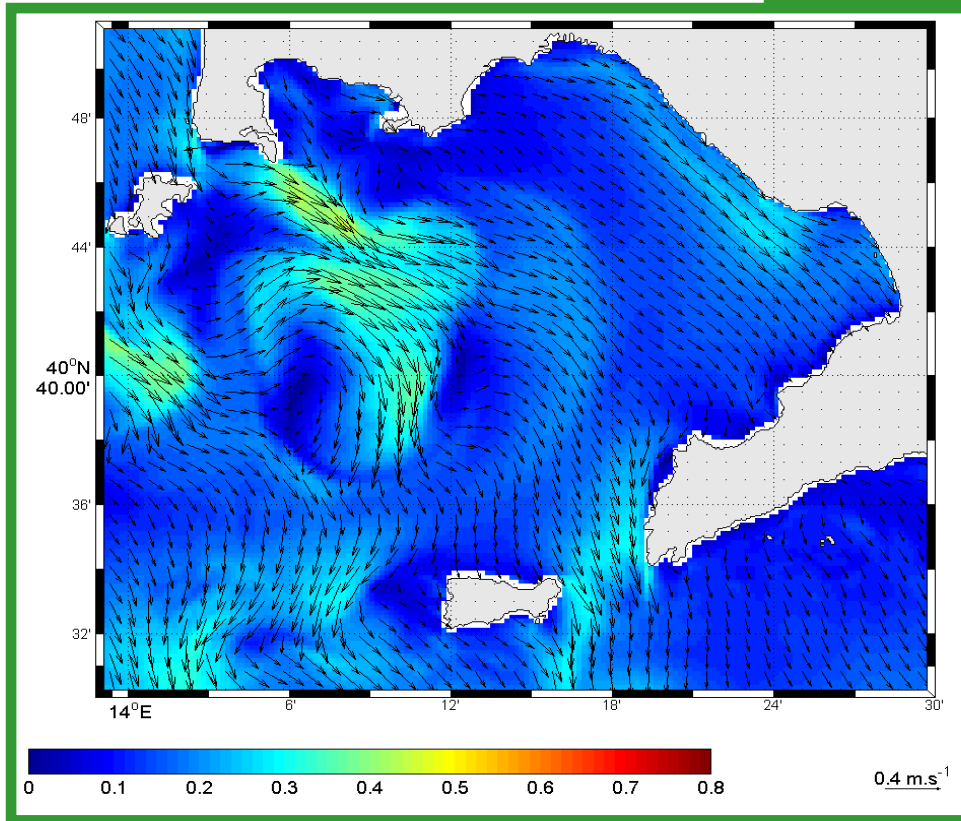
CODARs been operating in the GoN since 2004 providing real-time (hourly data) surface current fields with a resolution of 1.0 x 1.0 km over almost the entire GoN while the range is approximately 35 km from the coast.



Sea Sonde type  
manufactured by CODAR  
Ocean Sensors (Mountain  
View, California, USA).

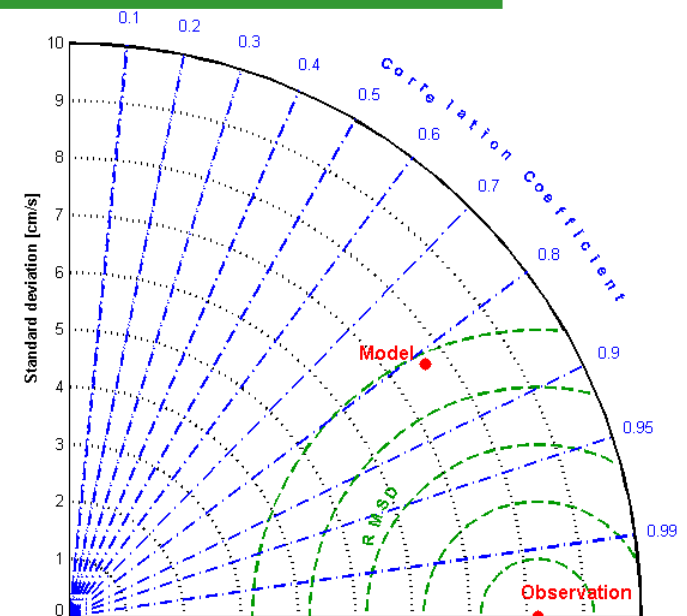
it works in the 25 MHz  
band

# Coastal modelling : Calibration /Validation



HF Radar already used to validate “ex-post” in a semi-quantitative way an implementation of ROMS model in the region.

ROMS model outputs vs HF radar data during summer of 2009



# Why 4D-Var?

ROMS is the only open-source, ocean community-modelling supporting three different 4D-Var data assimilation methodologies (Moore et al., 2011a, b).

improve the model match to the observations (HF Radar)

assess the sensitivity of assimilating surface velocities from surface downwards

establish an useful and efficient starting point for a high-resolution implementation of 4D-Var in the coastal area of GoN

The 4D-Var of HF radar data in high resolution coastal ocean models represents an innovative and novel approach within the Italian scientific community

# I4D-Var: Non-linear ROMS model

Adjusting initial conditions, boundary conditions, and atmospheric forcing fields for a case studies of December 2009

Single cycle – 7 days assimilation window

ECMWF forcing  
(ERA at  
 $0.125 \times 0.125$ )

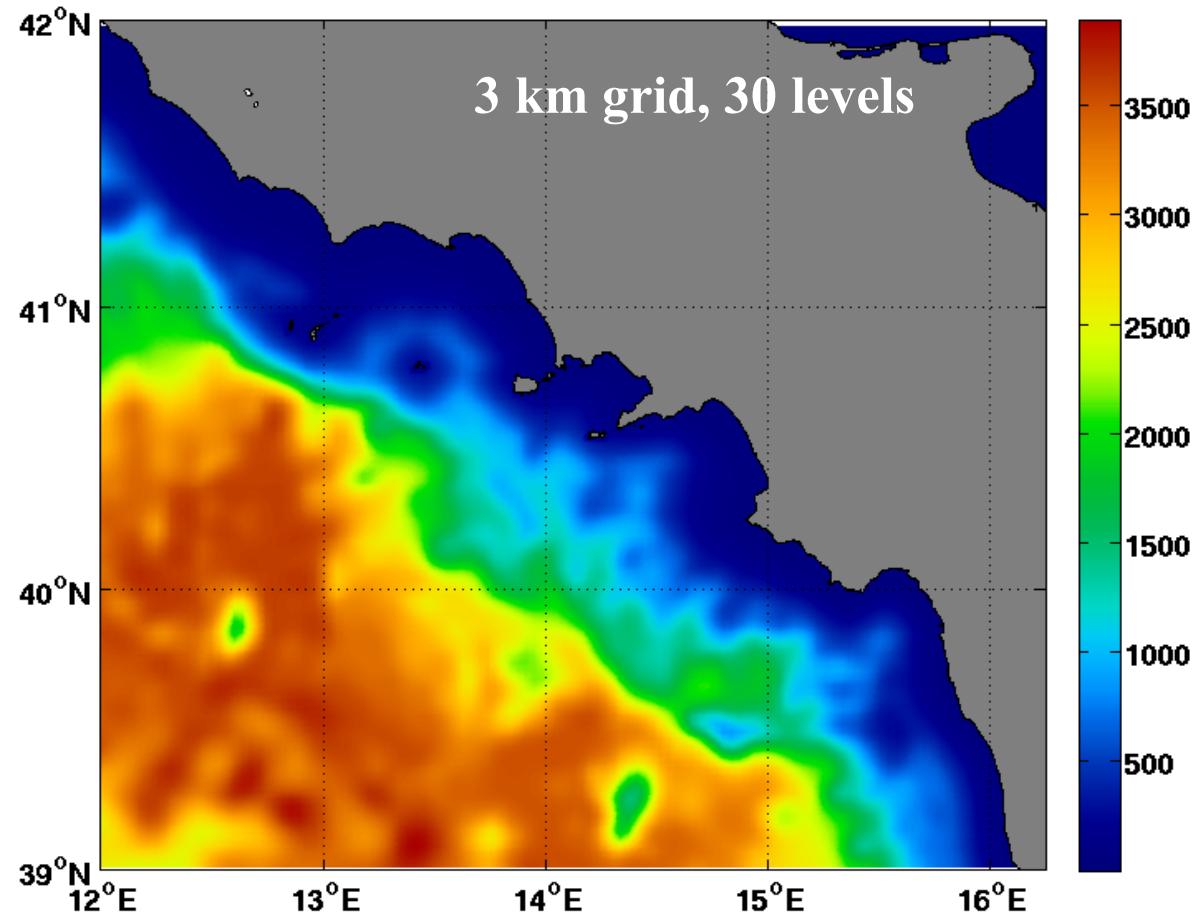
$$\mathbf{f}_b(t), \mathbf{B}_f$$

HR Atlantic and  
Mediterranean  
MERCATOR dataset  
Open boundary  
conditions ( $1/12^\circ$ )

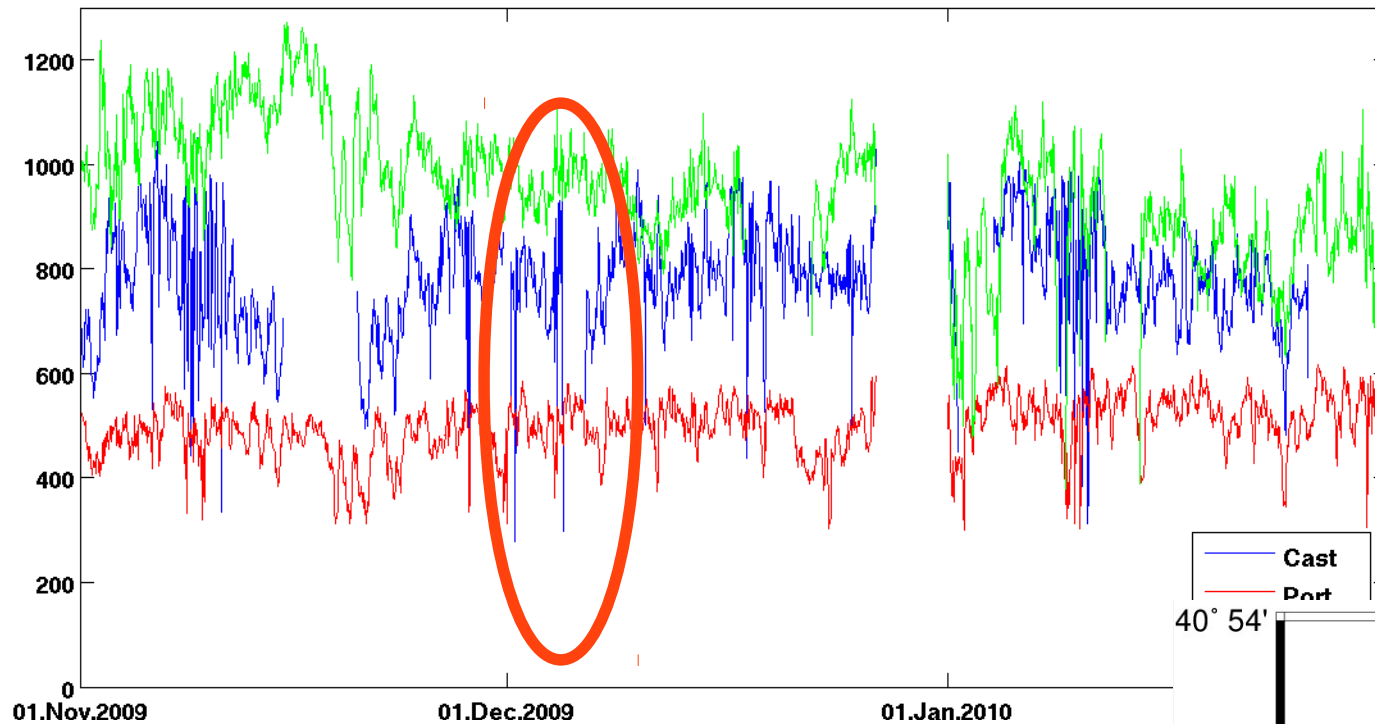
$$\mathbf{b}_b(t), \mathbf{B}_b$$

$$\mathbf{x}_b(0), \mathbf{B}_x$$

↑  
prior  $\mathbf{D}_x$  (initial conditions): from  
a single interannual run that spans  
from January 2007 to December 2010

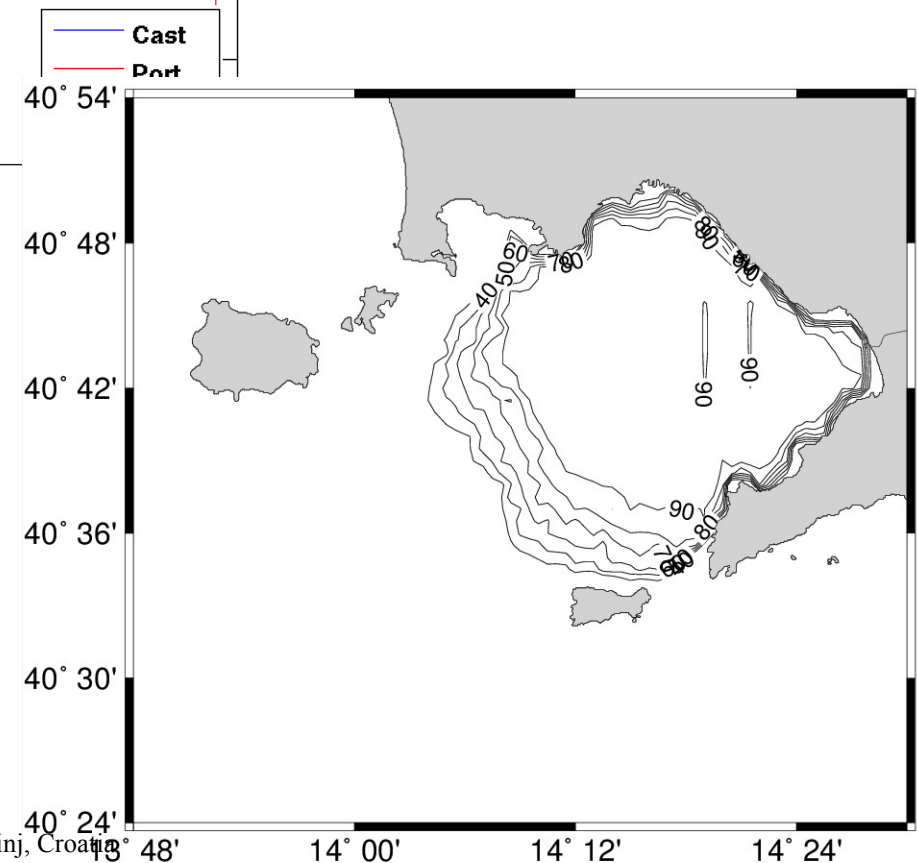


Hourly Number of Data from Each Radar



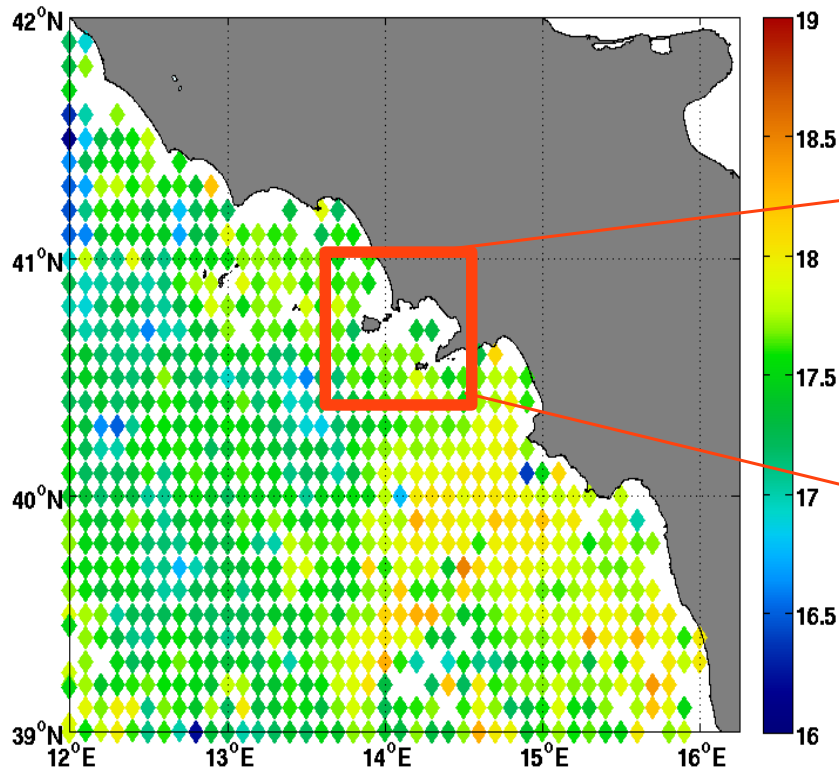
Hourly count of data from the three radars deployed at S1, S2 and S3 along the GoN coast. Assimilation experiments were performed over 7-day periods in December.

The lines denote the coverage area by three high-frequency radar sites in the year 2009.

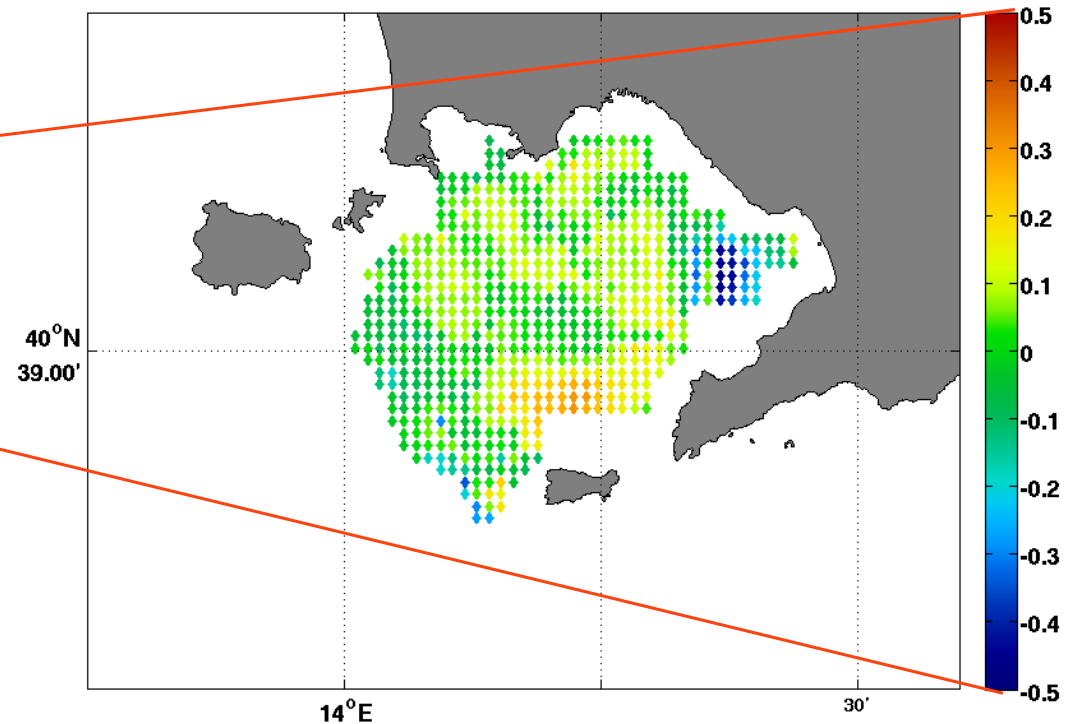




## Blended SST



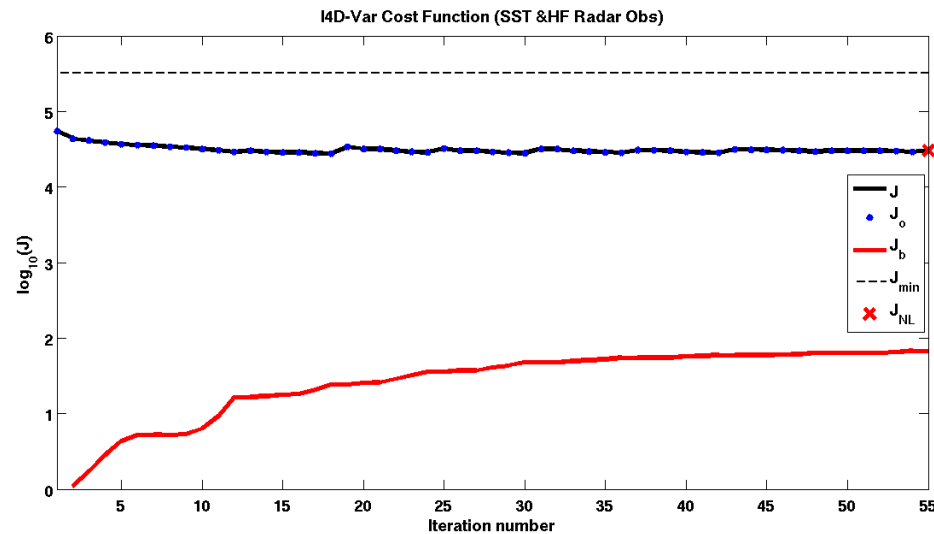
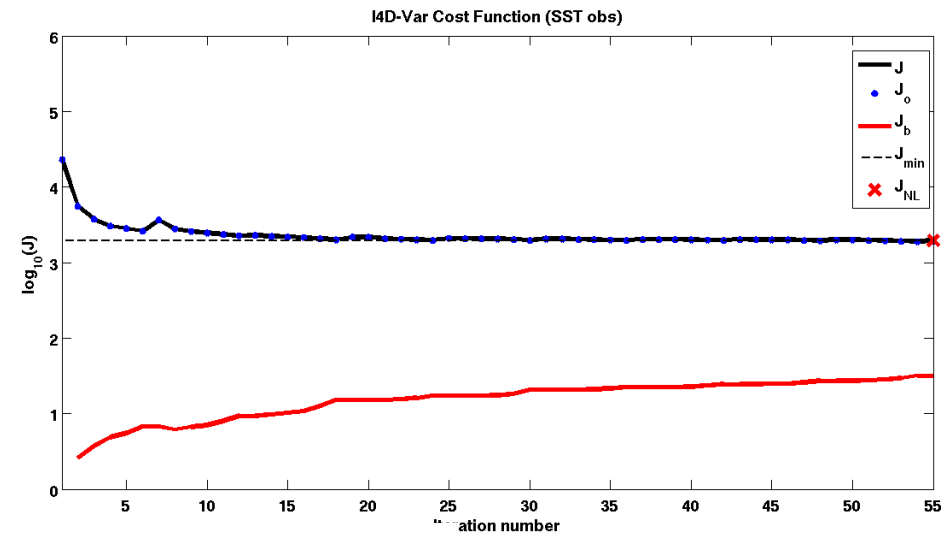
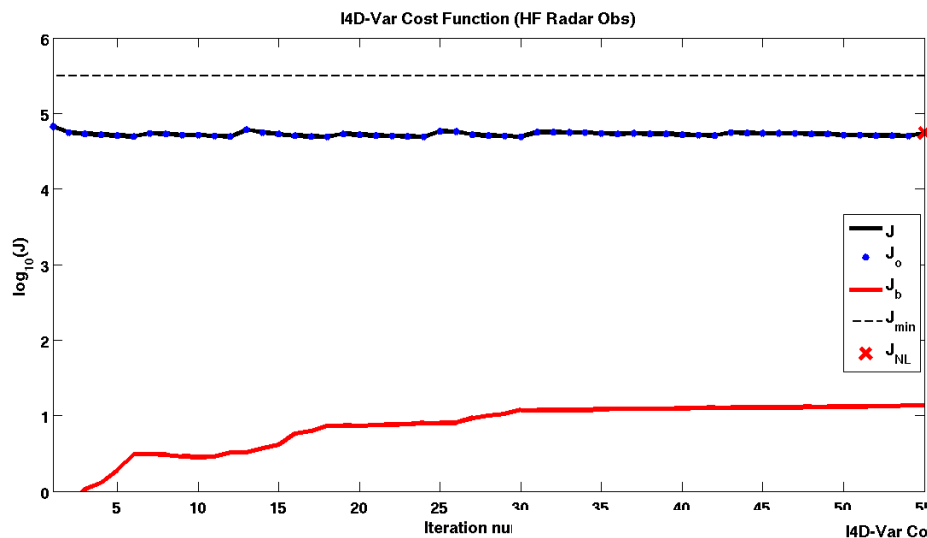
## HF Radar data



I4D-Var implemented in Tyrrhenian Sea, assimilating blended SST (global at 0.1degrees) and HF Radar hourly data at 1km resolution .

# I4D-Var: preliminary experiments

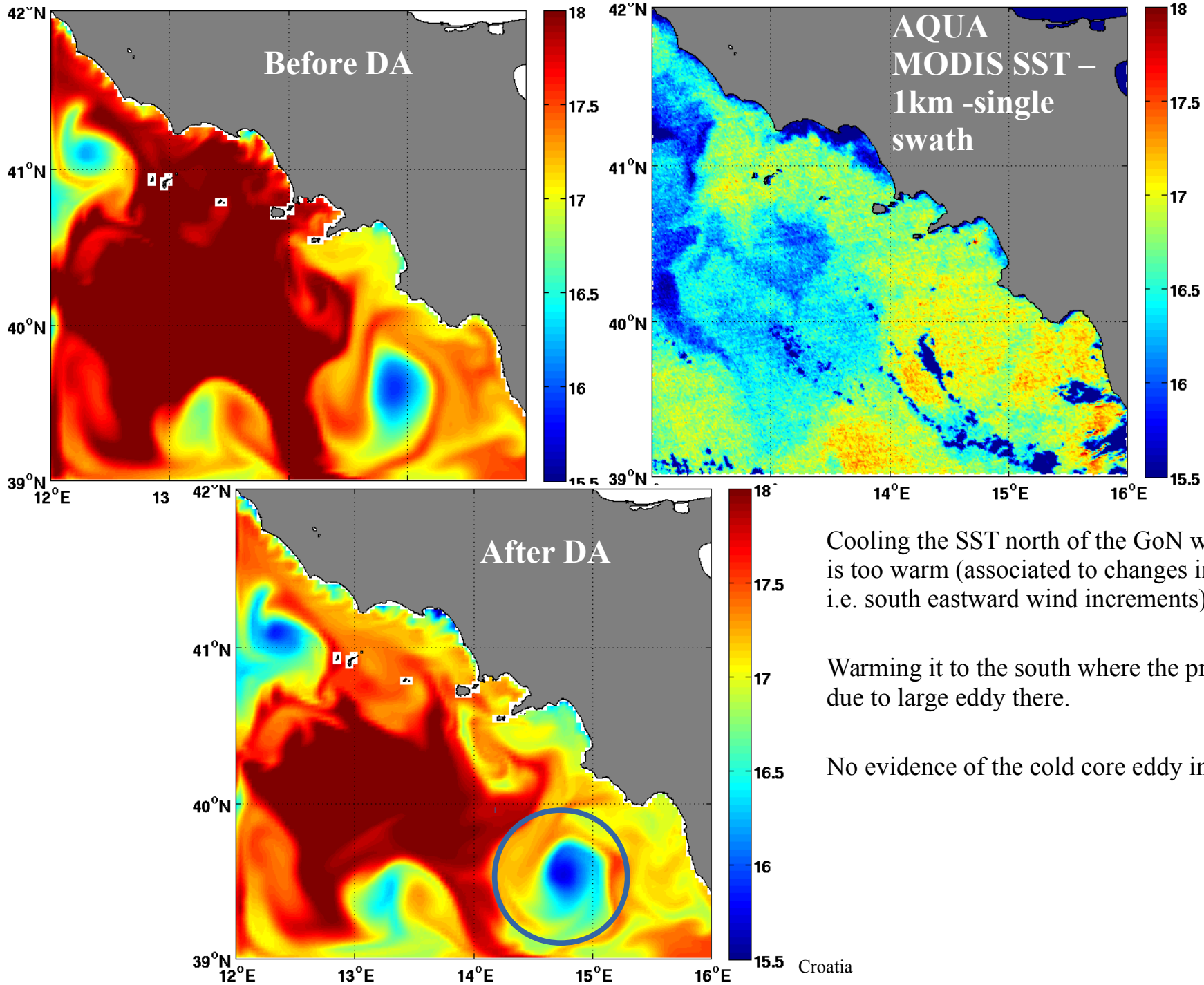
4D-Var technique	I4D-Var	I4D-Var	I4D-Var
OBS type	HF Radar	SST	SST + HF Radar



**Parameters for the prior error covariance matrix**

**Default values: 30 km in the horizontal and 200m in the vertical**

# I4D-Var: HF Radar data



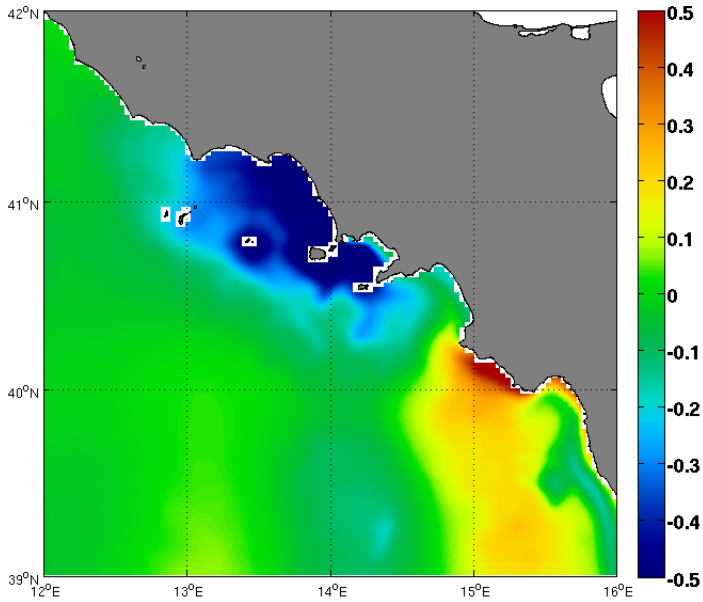
Cooling the SST north of the GoN where the prior SST is too warm (associated to changes in the wind stress; i.e. south eastward wind increments)

Warming it to the south where the prior SST is too cold due to large eddy there.

No evidence of the cold core eddy in the SST obs

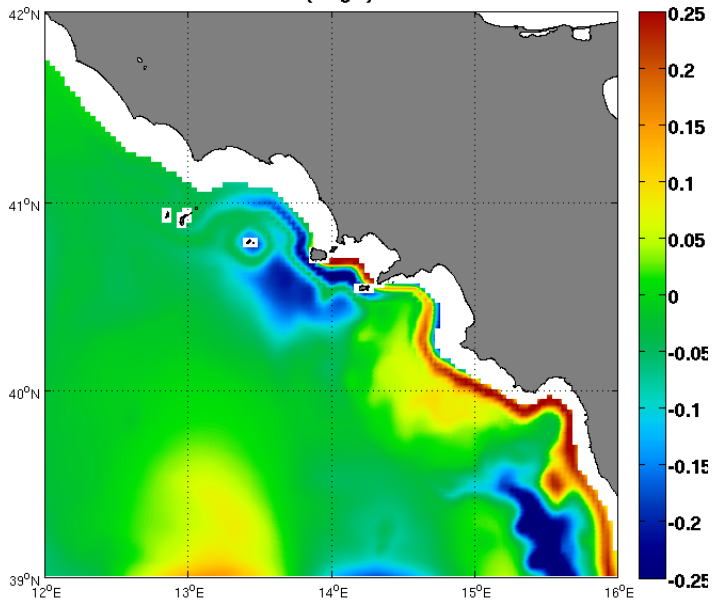
# I4D-Var: HF Radar data

I4D-Var T-increment

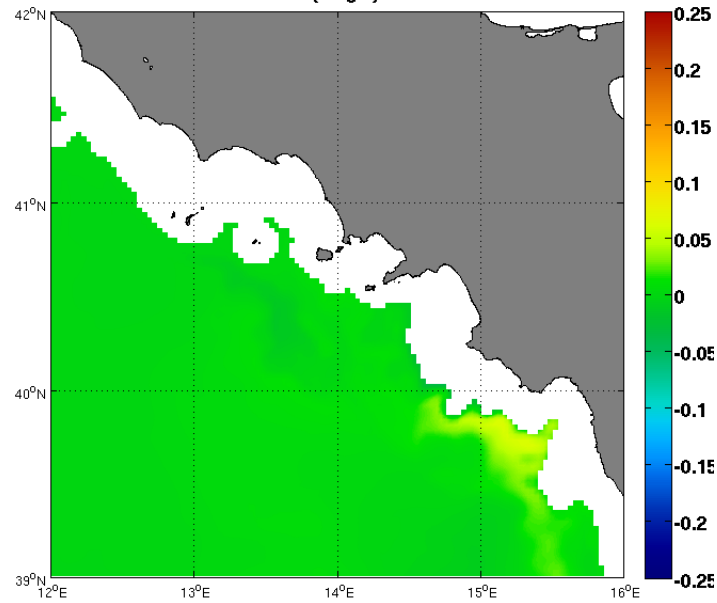


Increments (posterior-prior) also remote from the Gulf of Naples where the HF radar obs are concentrated

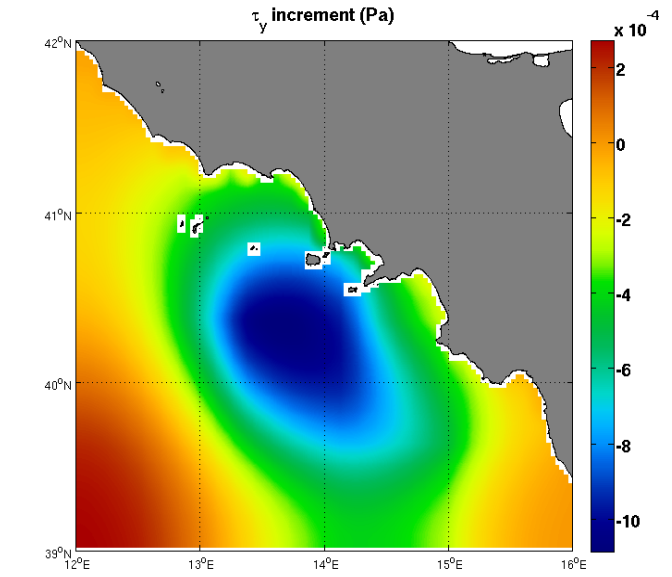
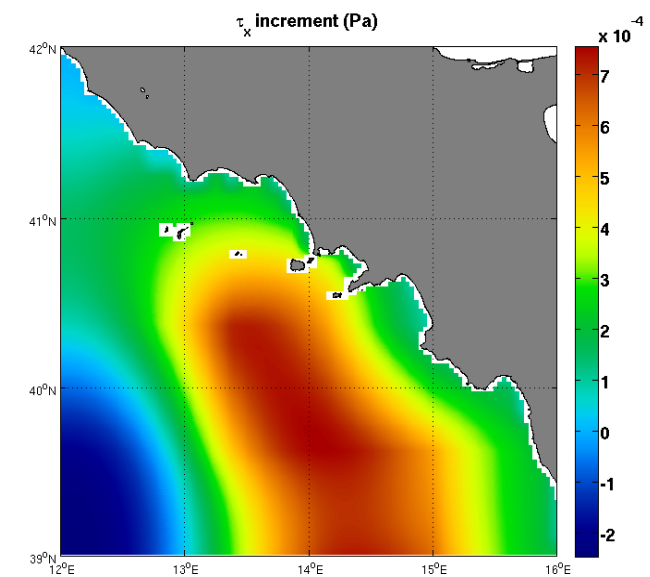
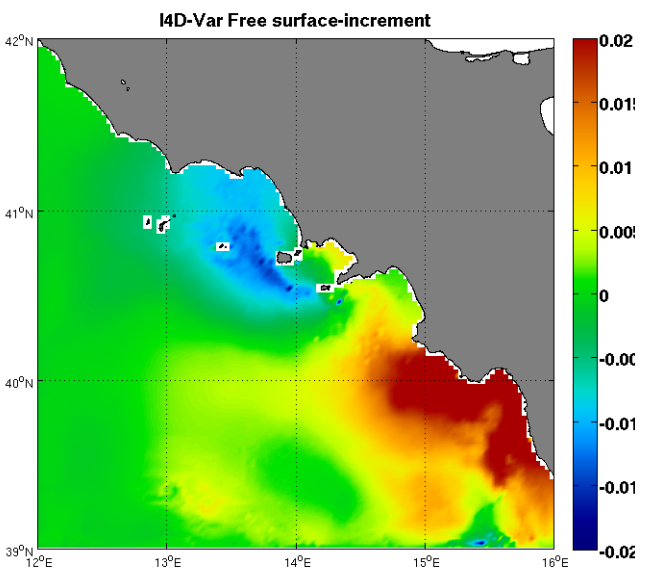
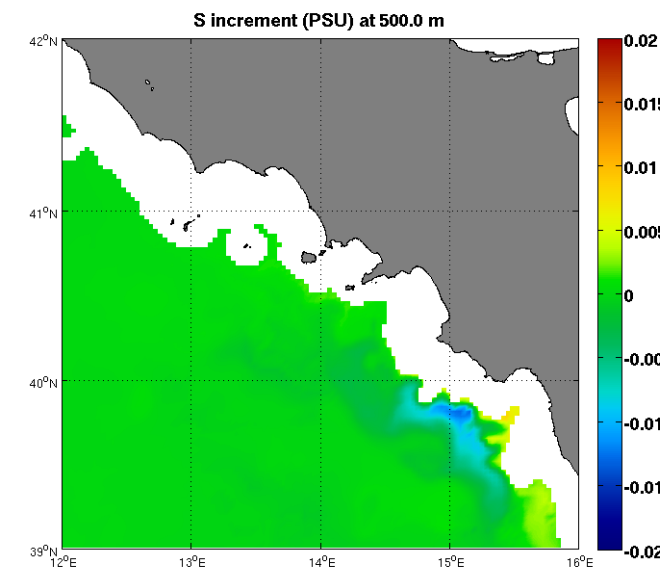
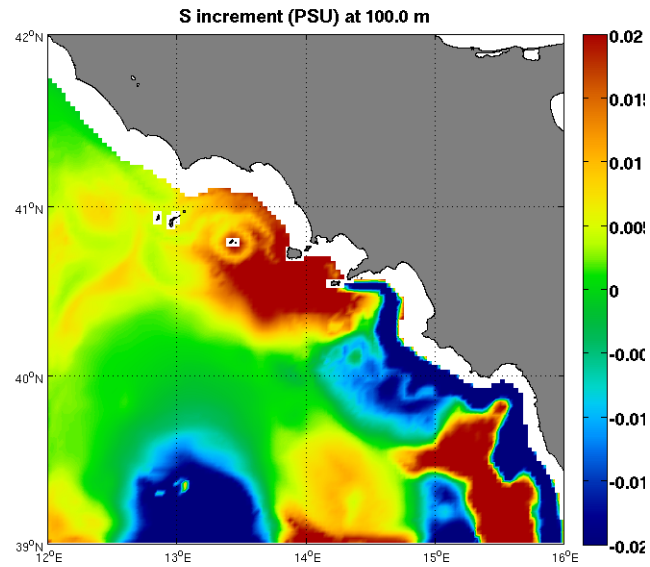
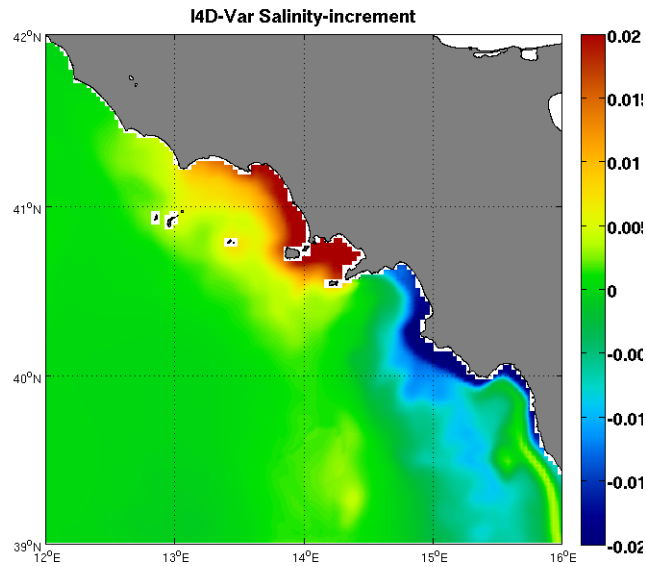
T increment (DegC) at 100.0 m



T increment (DegC) at 500.0 m



# I4D-Var: HF Radar data

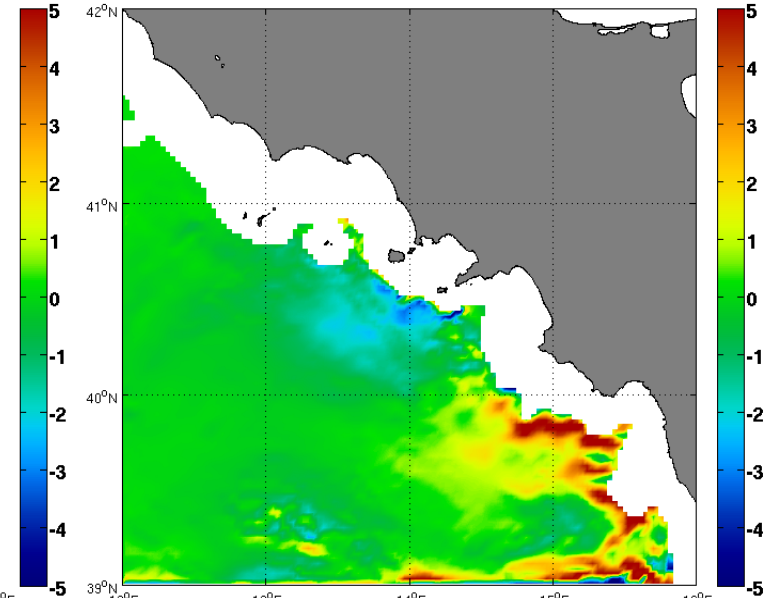
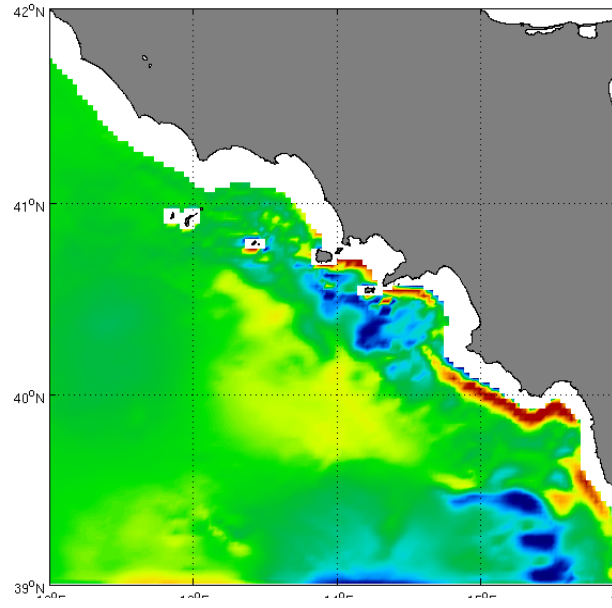
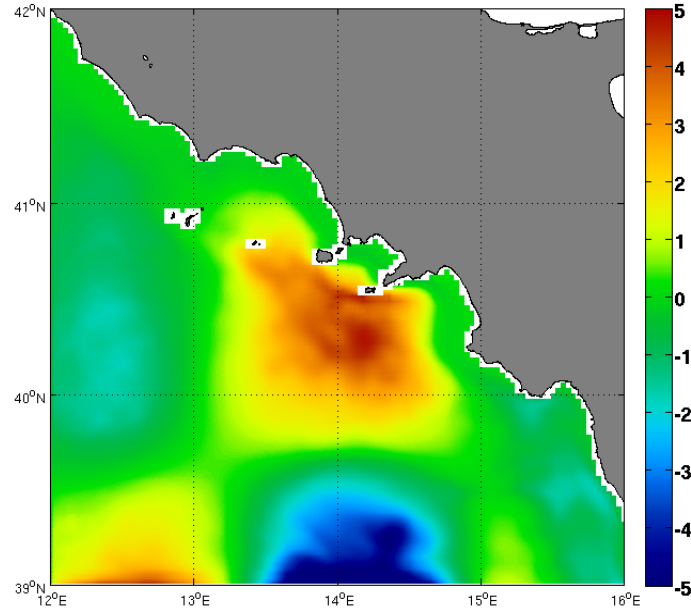


# I4D-Var: HF Radar data

I4D-Var Total U-velocity increment (cm/s)

U-momentum increment (cm/s) at 100.0 m

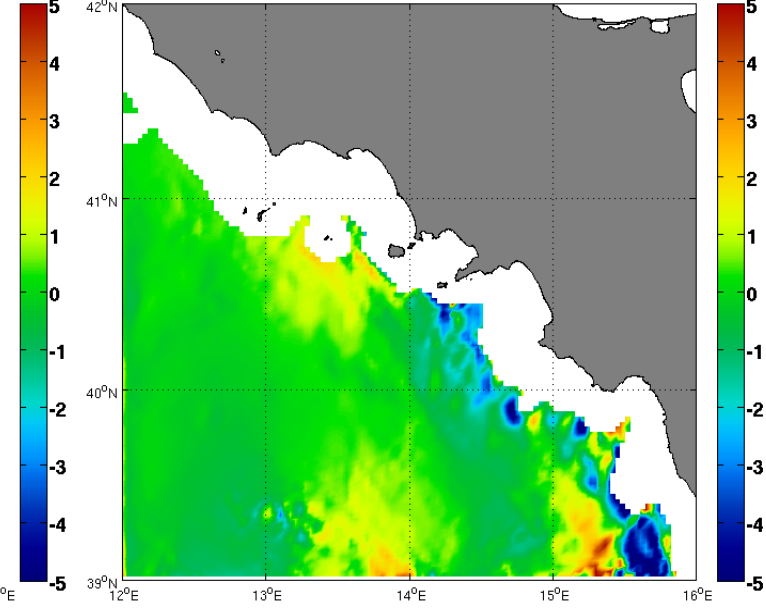
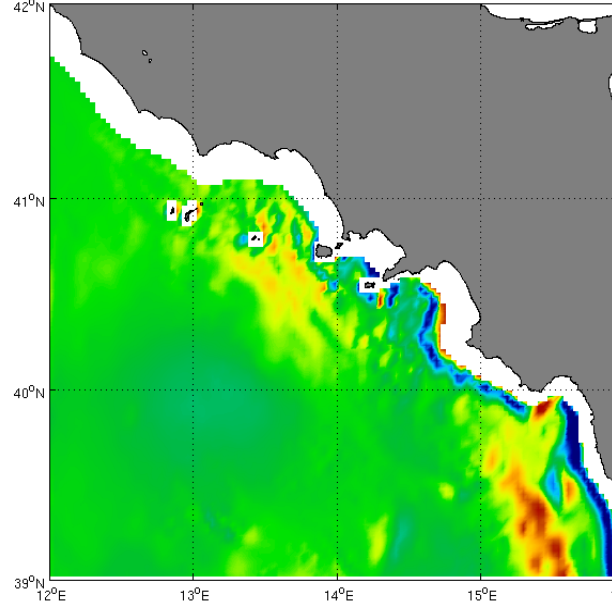
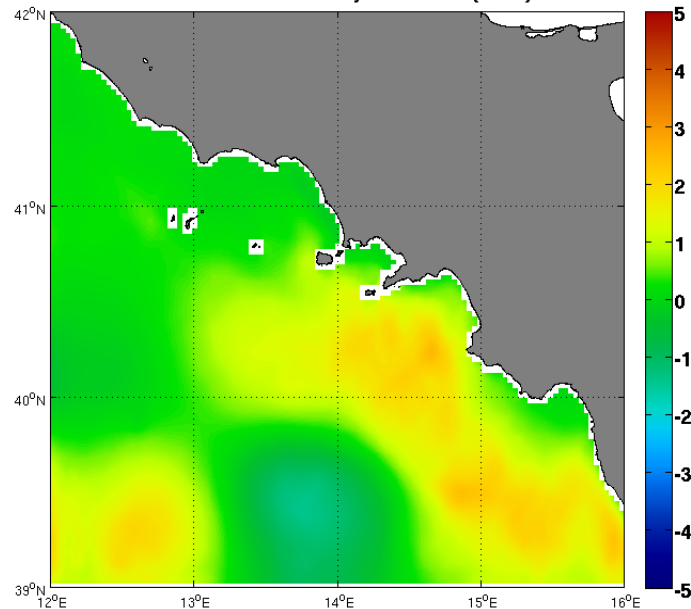
U-momentum increment (cm/s) at 500.0 m



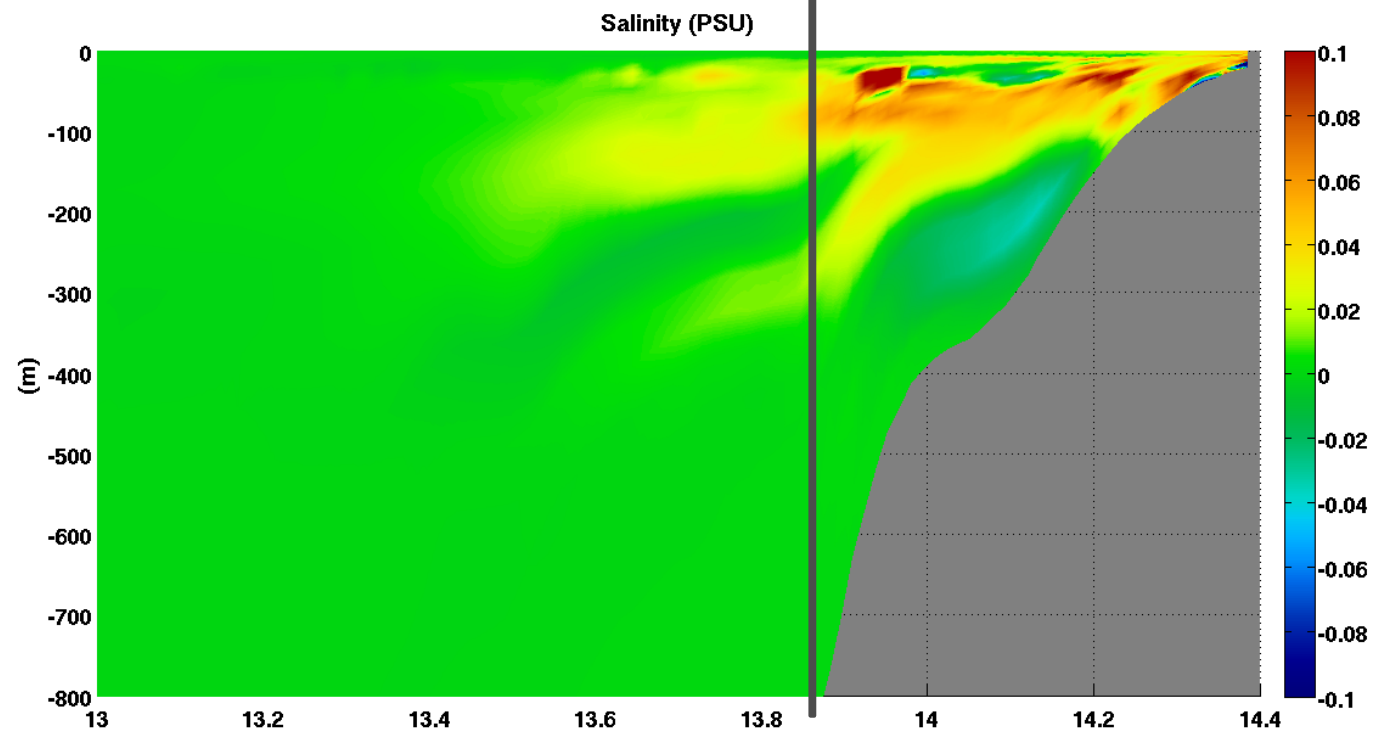
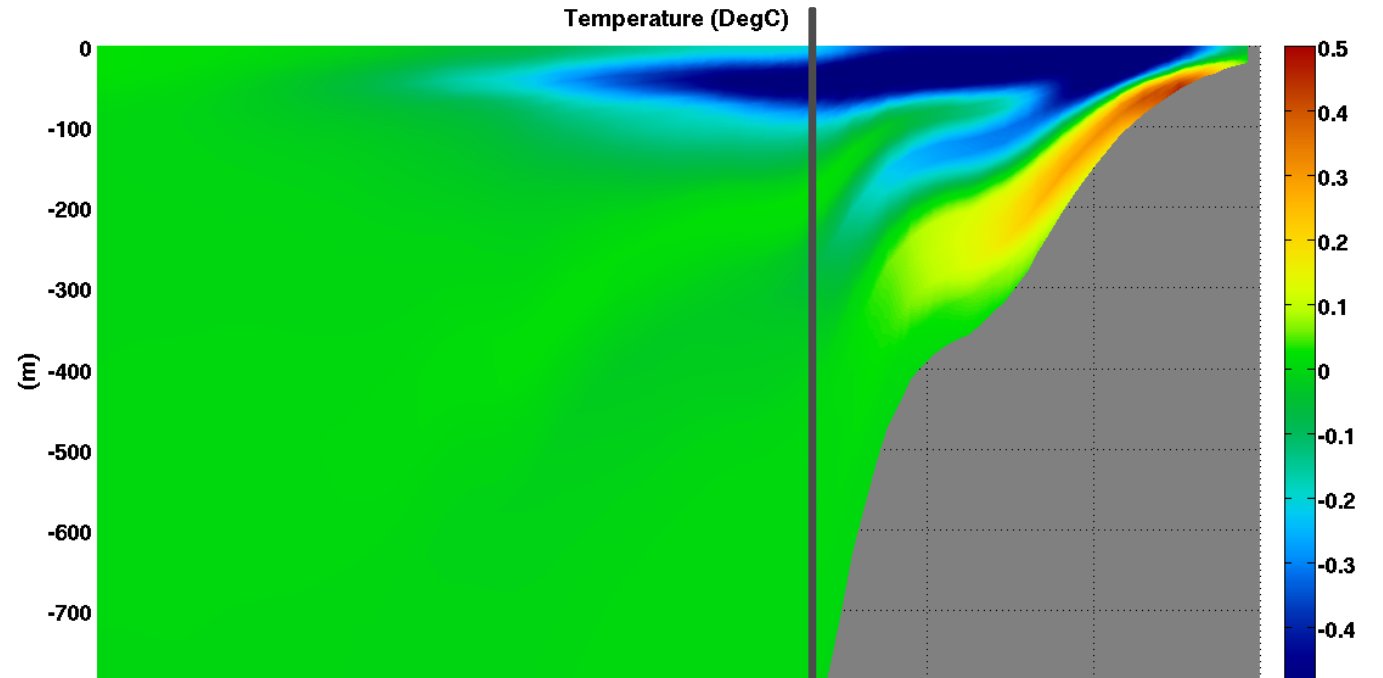
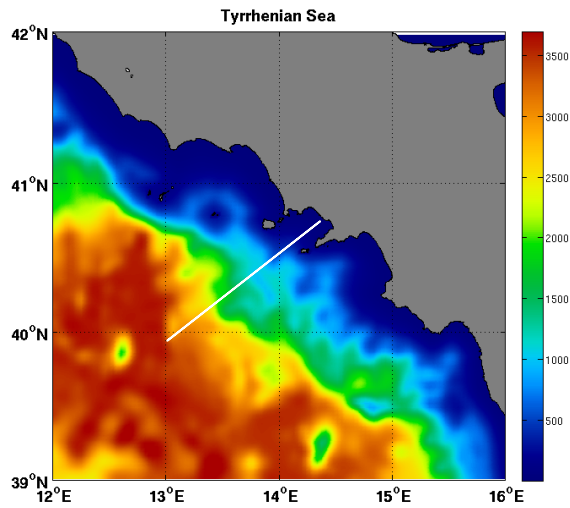
I4D-Var Total V-velocity increment (cm/s)

V-momentum increment (cm/s) at 100.0 m

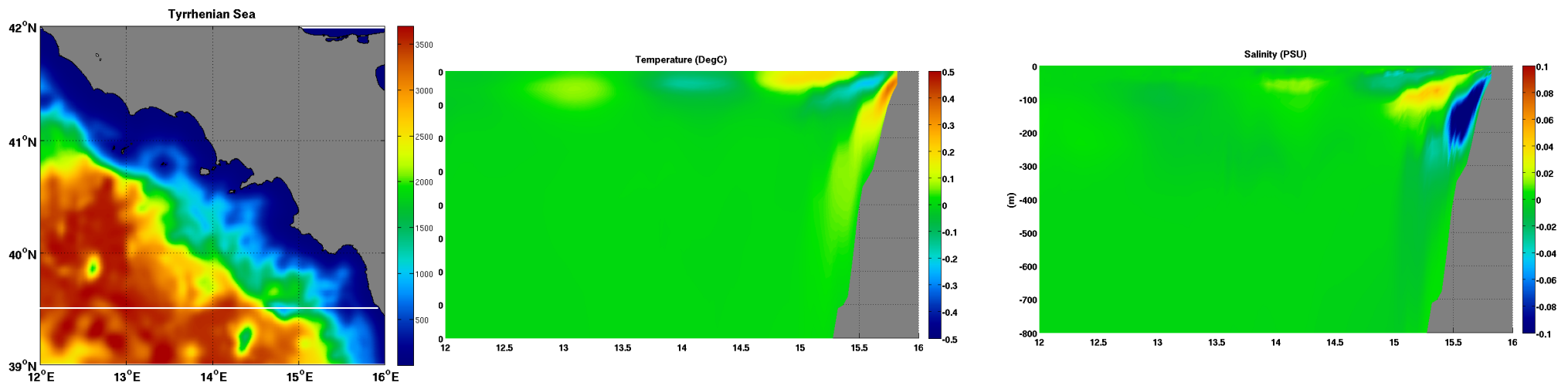
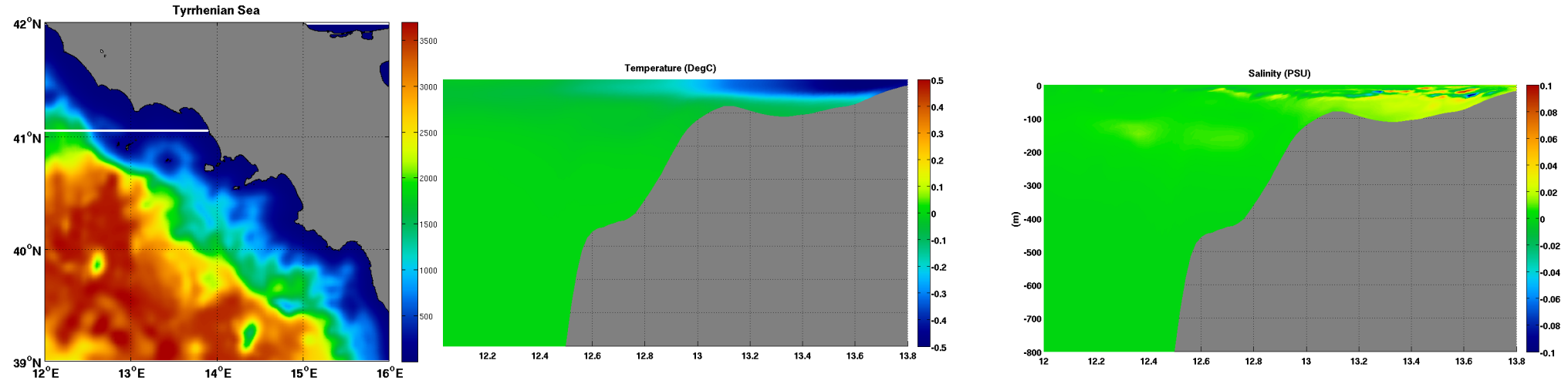
V-momentum increment (cm/s) at 500.0 m



# I4D-Var: HF Radar data

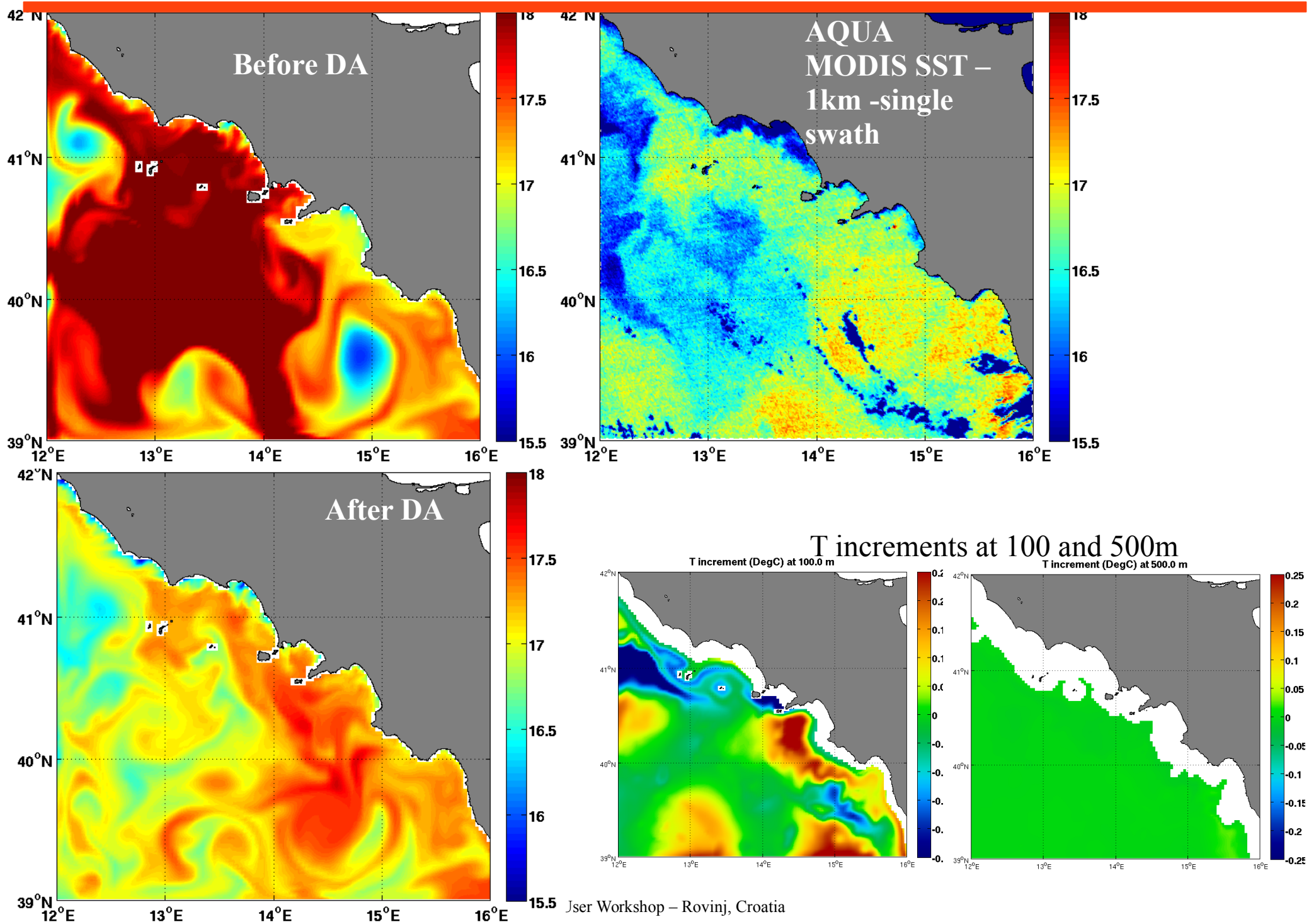


# I4D-Var: HF Radar data

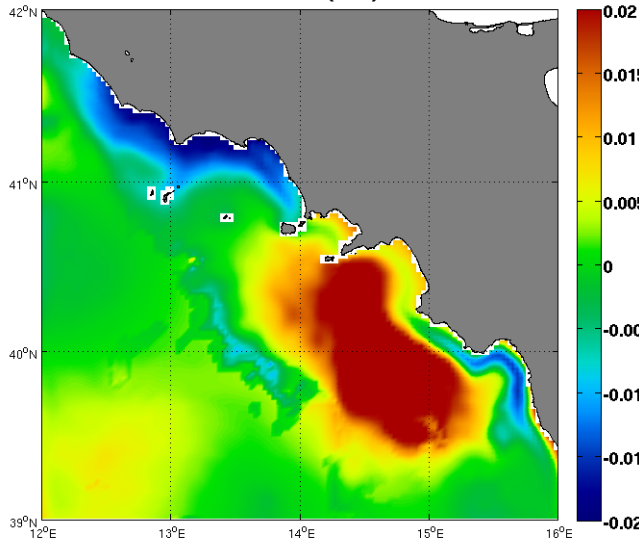




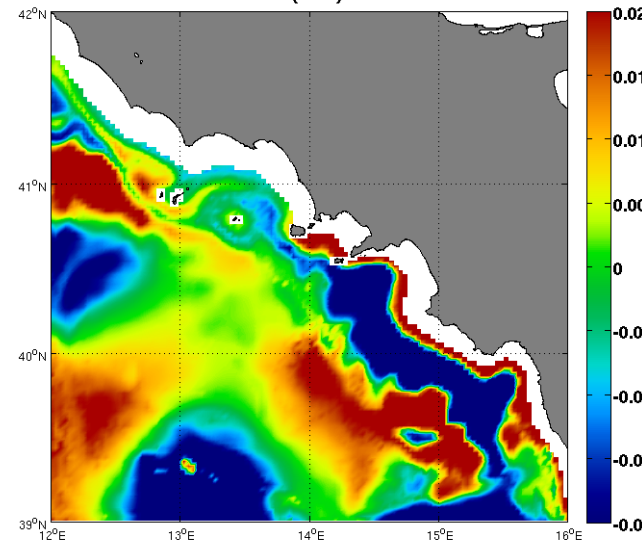
# I4D-Var: SST data



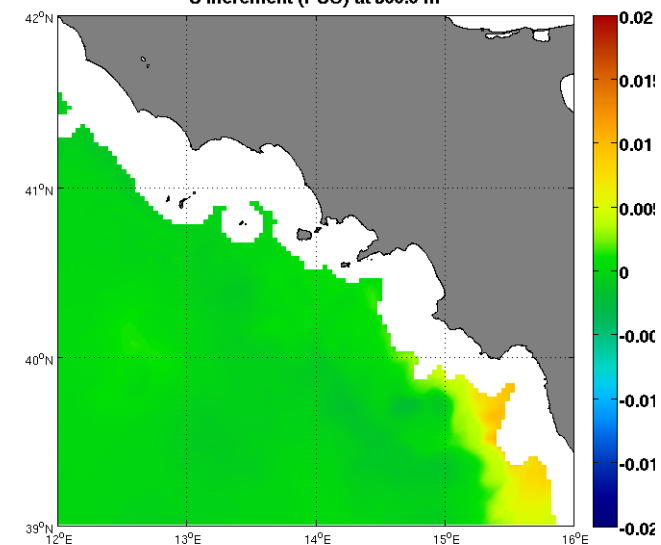
S increment (PSU)



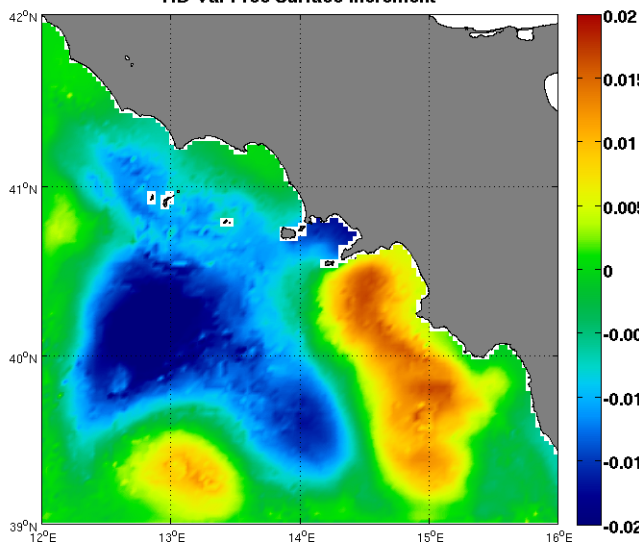
S increment (PSU) at 100.0 m



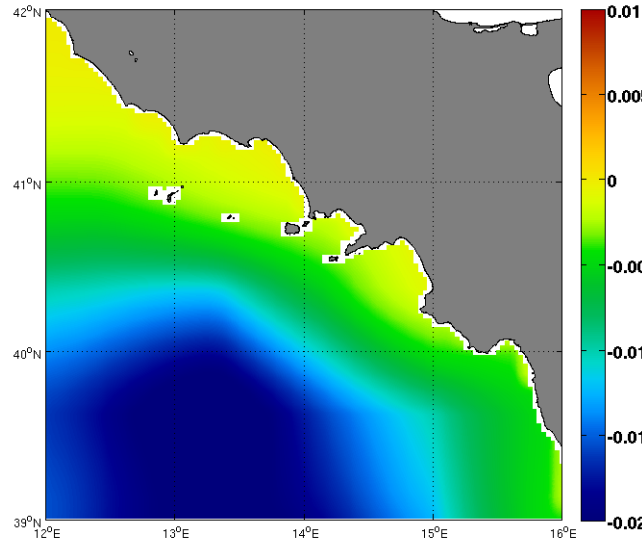
S increment (PSU) at 500.0 m



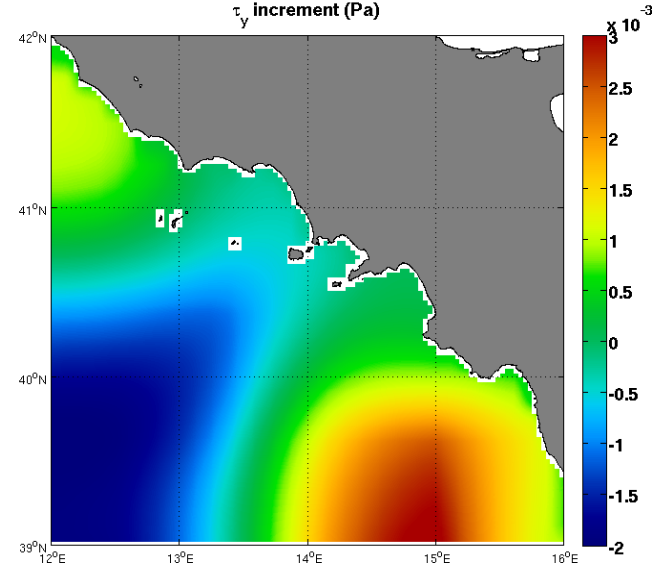
I4D-Var Free Surface-increment



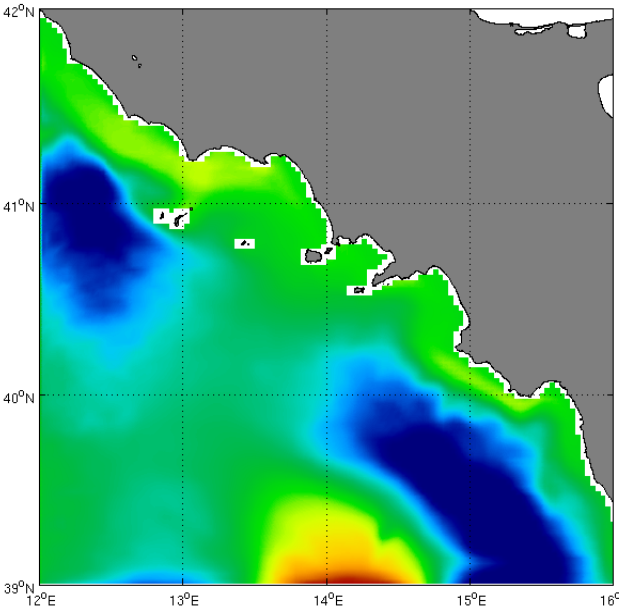
$\tau_x$  increment (Pa)



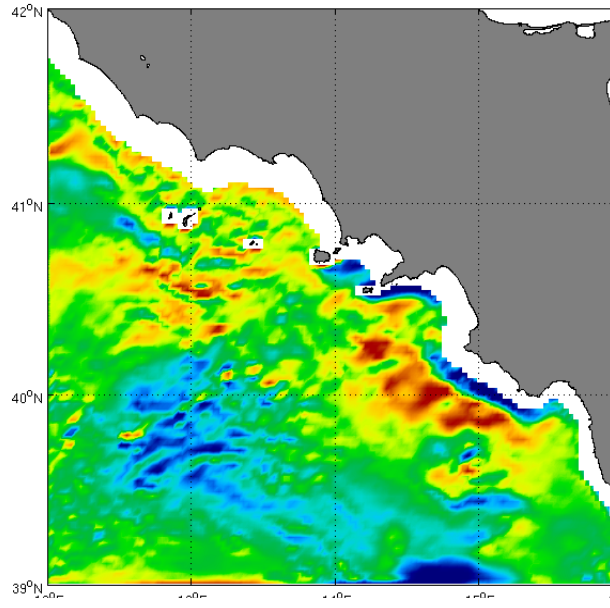
$\tau_y$  increment (Pa)



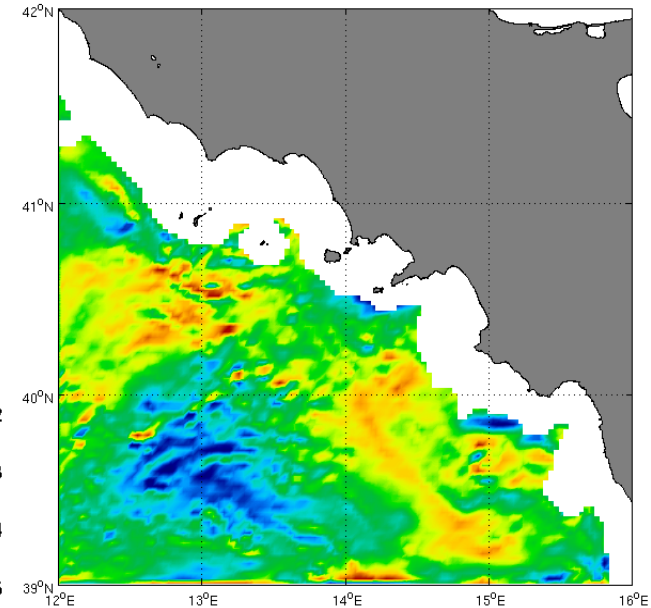
U-momentum increment (cm/s)



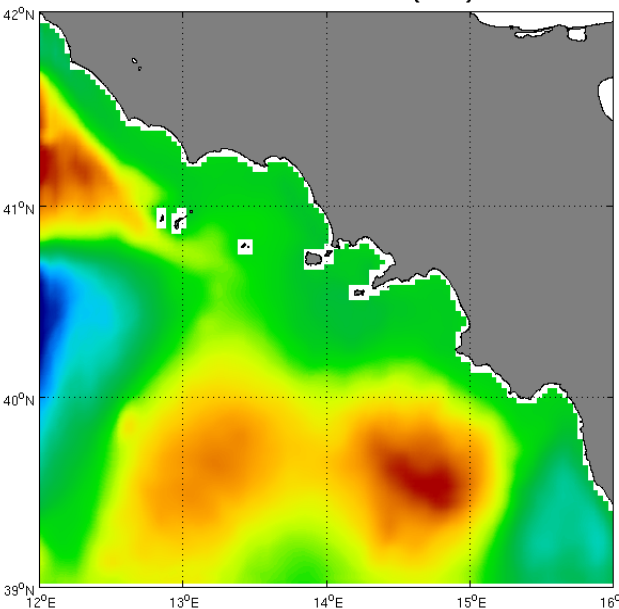
U-momentum increment (cm/s) at 100.0 m



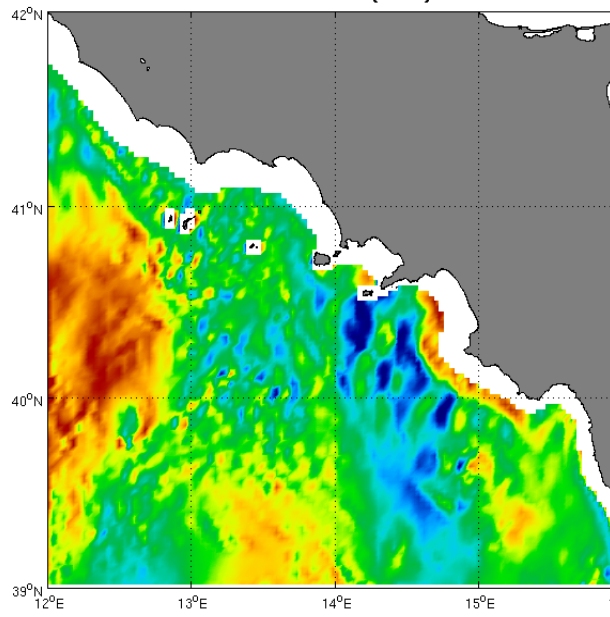
U-momentum increment (cm/s) at 500.0 m



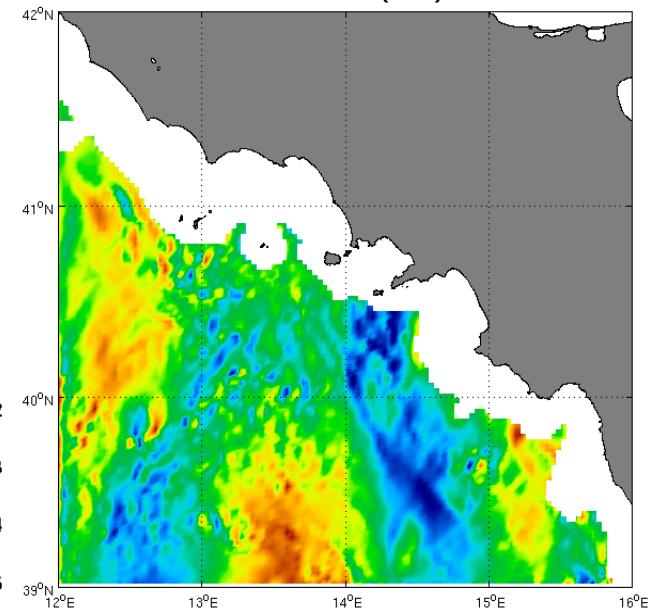
V-momentum increment (cm/s)



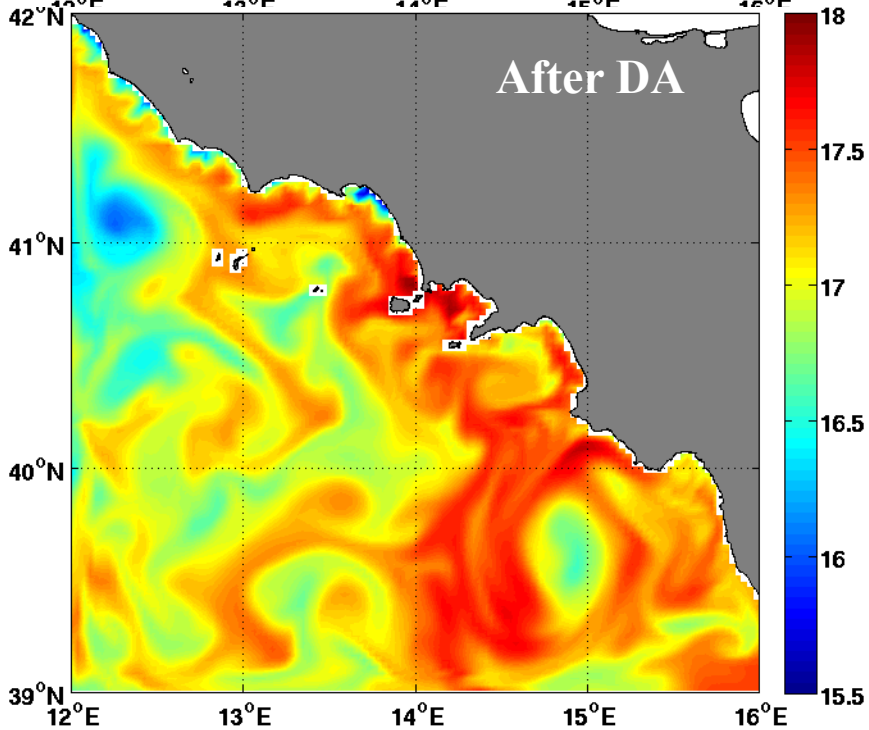
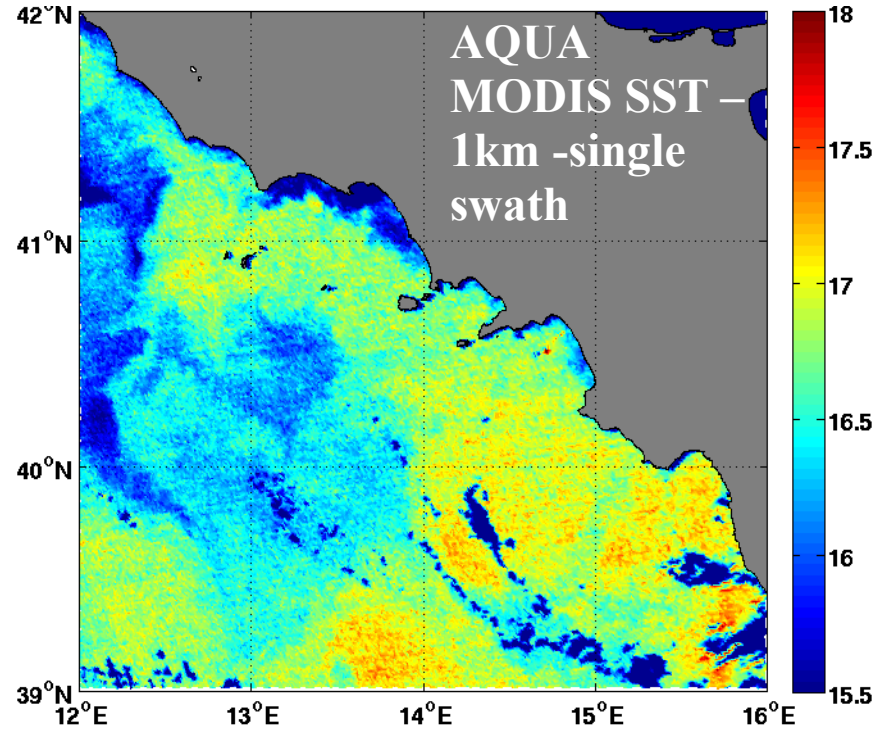
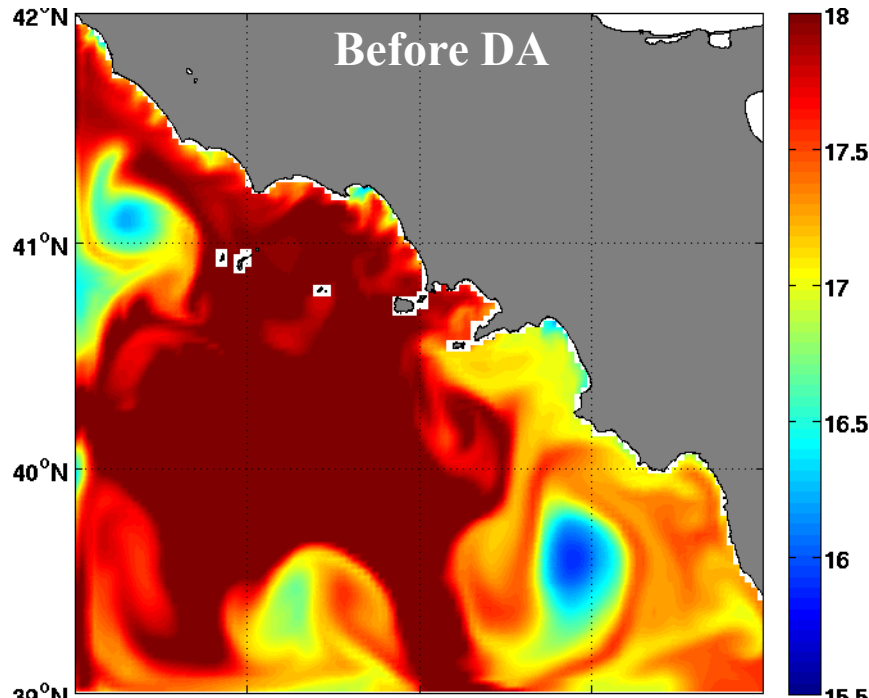
V-momentum increment (cm/s) at 100.0 m



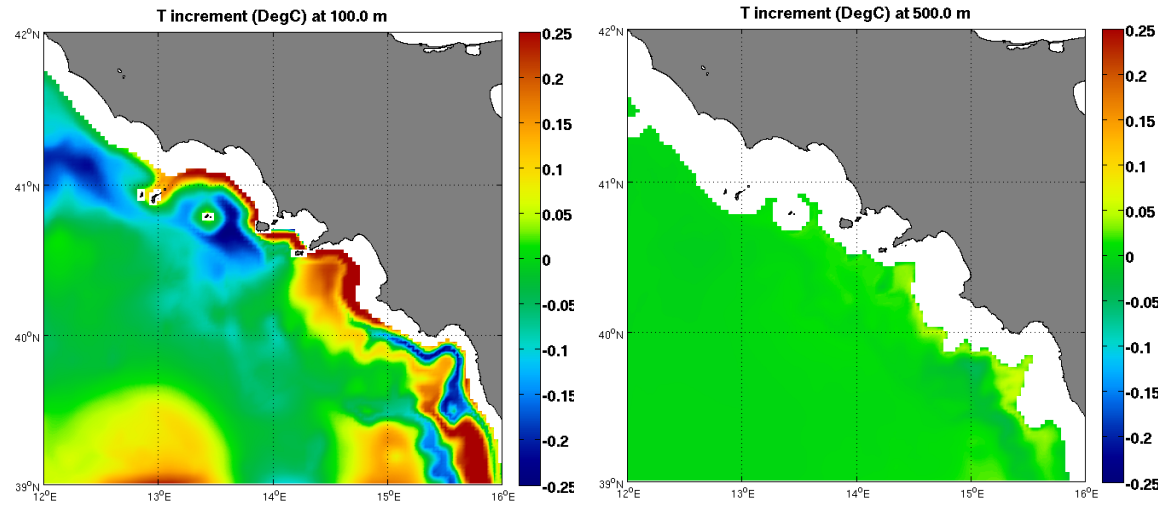
V-momentum increment (cm/s) at 500.0 m



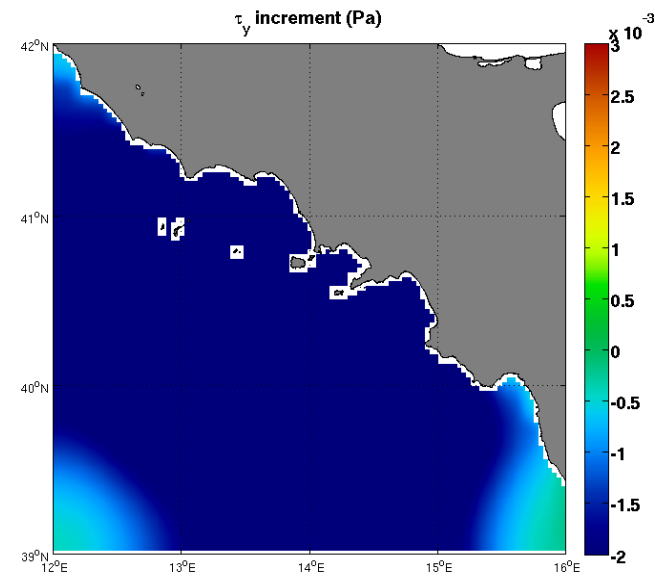
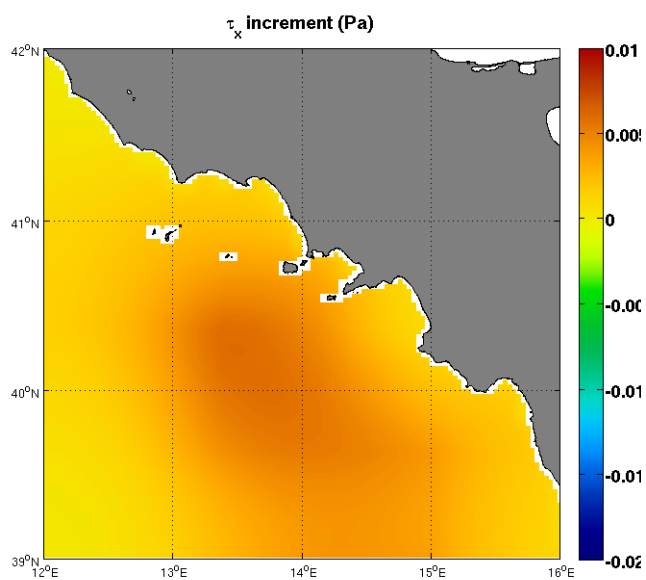
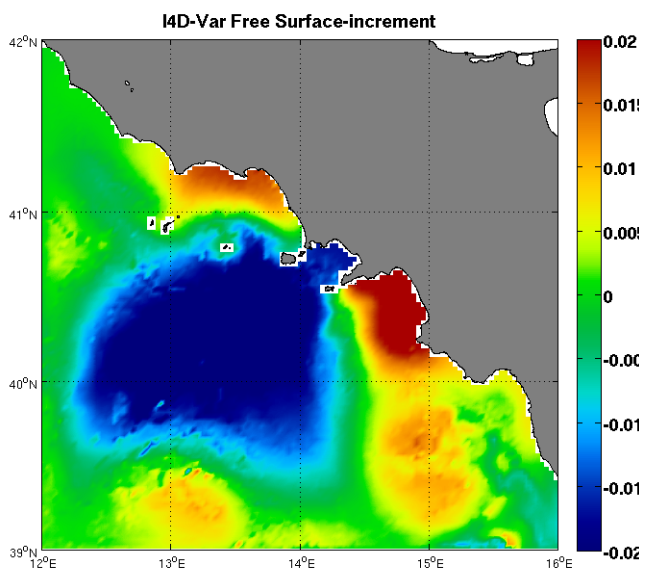
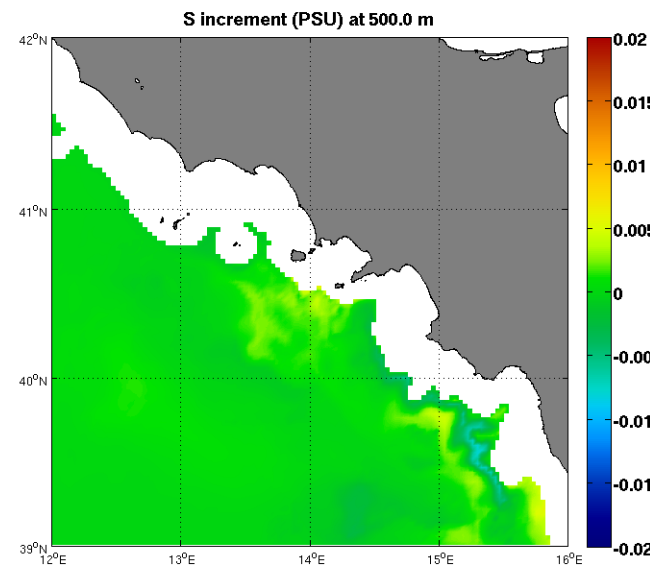
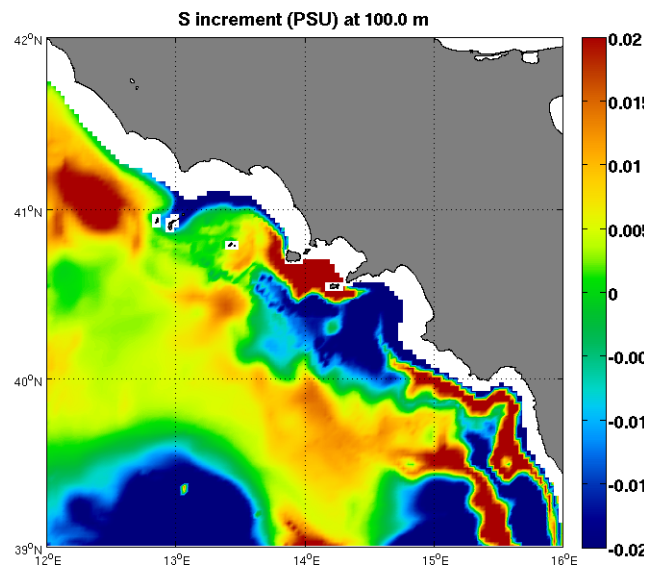
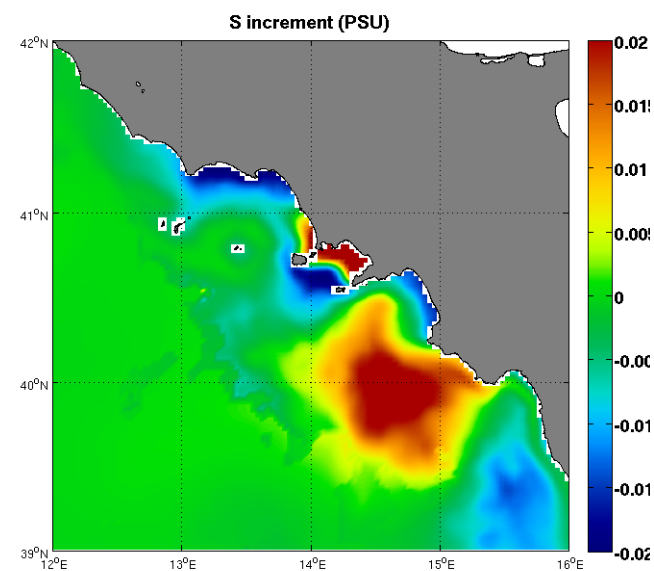
# I4D-Var: SST & HF Radar



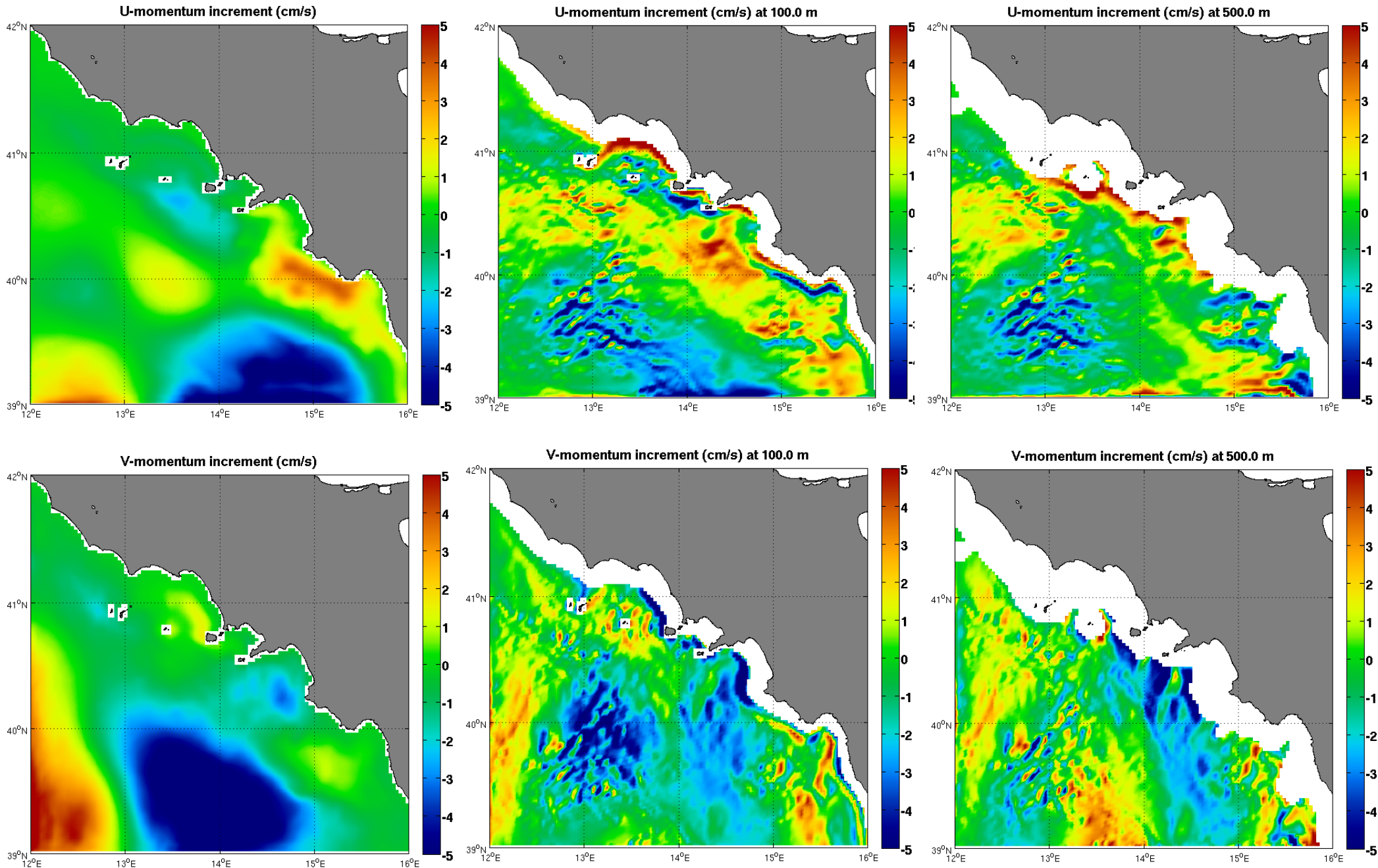
T increments at 100 and 500m



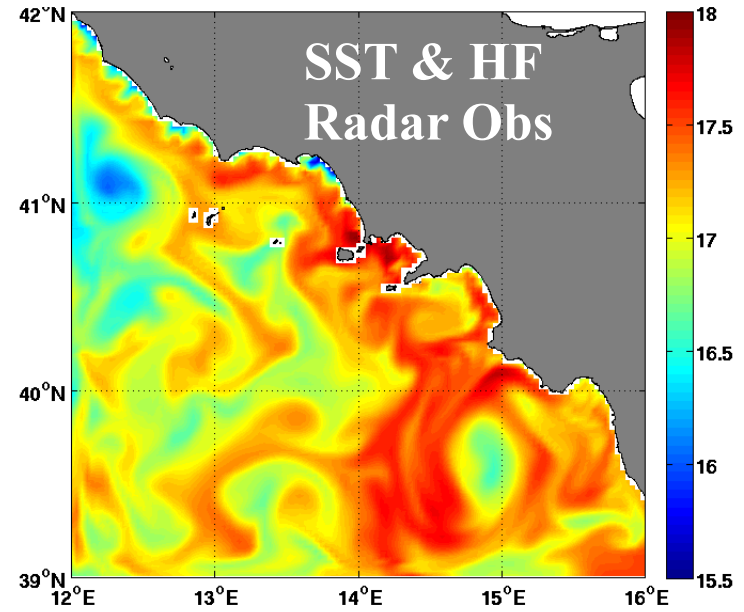
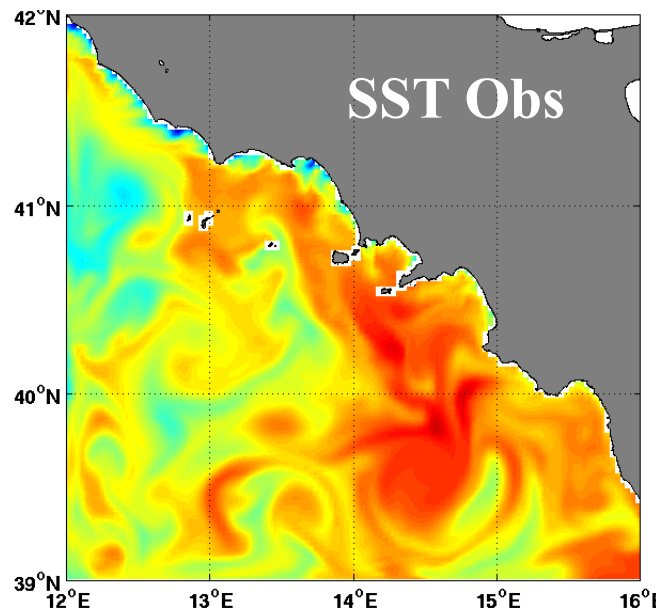
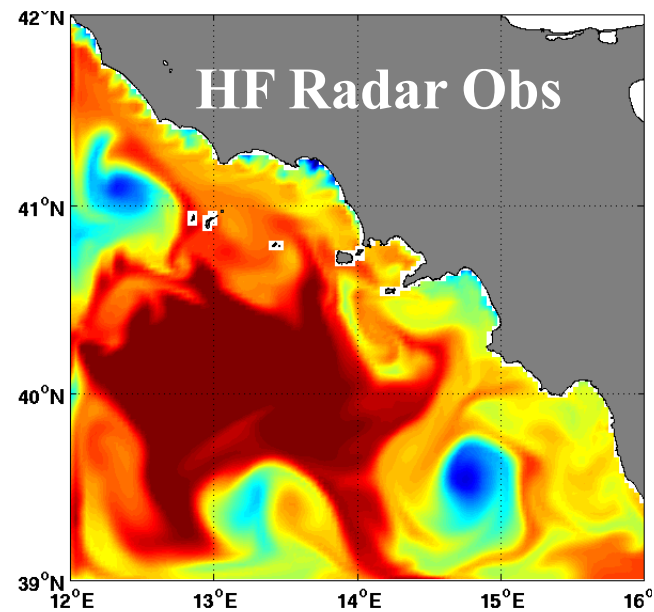
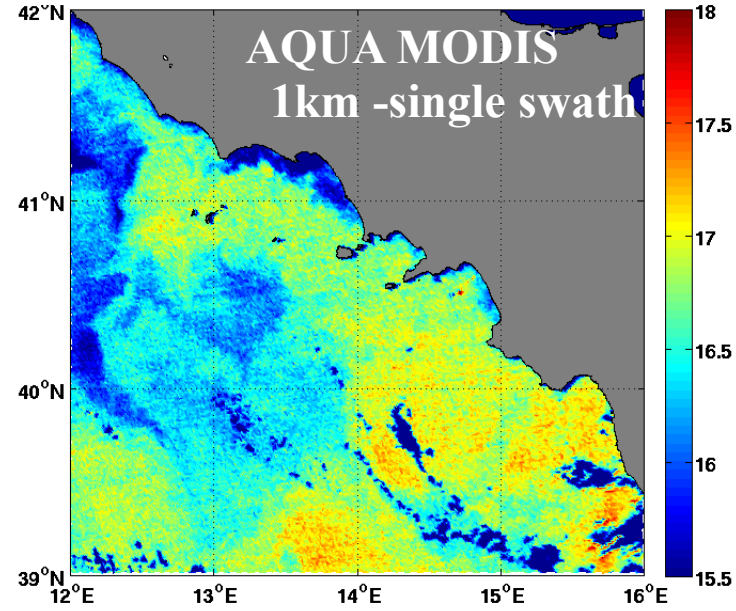
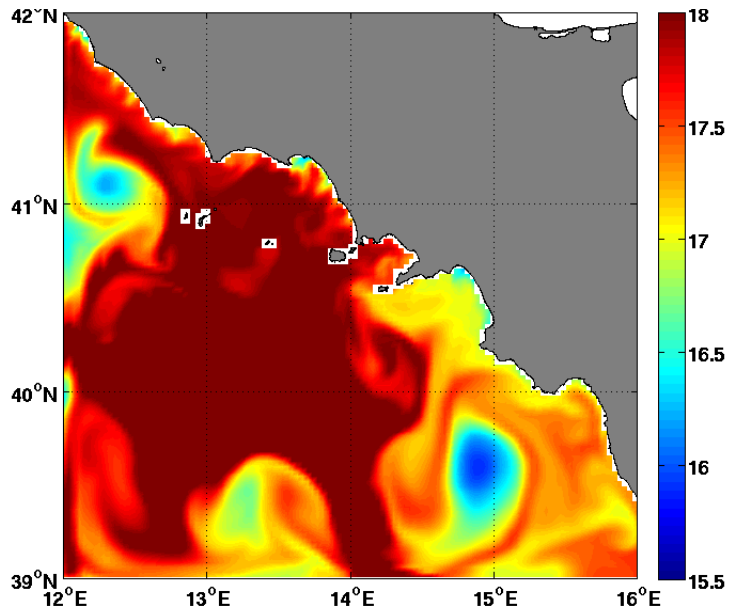
# I4D-Var: SST & HF Radar



# I4D-Var: SST & HF Radar



# I4D-Var: summary



This is a first-cut at developing the assimilation system for this region, but the results are encouraging

The HF radar data is clearly having a large influence on all the other fields.

Using HF radar obs alone 4D-Var is able to make sensible corrections to the SST

The vertical sections showed that information is being transferred from the surface via the vertical correlations and the dynamics. This needs some further analysis

More cycle of data assimilation to assess the performance of the SSH assimilation

Nesting to a high resolution (i.e. 1km as the HF Radar data) focusing of GoN shelf water



Alkiviadis Kalampokis

Pierpaolo Falco

Marco Uttieri

Andrea Bergamasco

Antonio Olita

Roberto Sorgente



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THANKS  
QUESTIONS?

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