

# Mesoscale and Sub-Mesoscale structures observed during High resolution surveys in Western Mediterranean Basin

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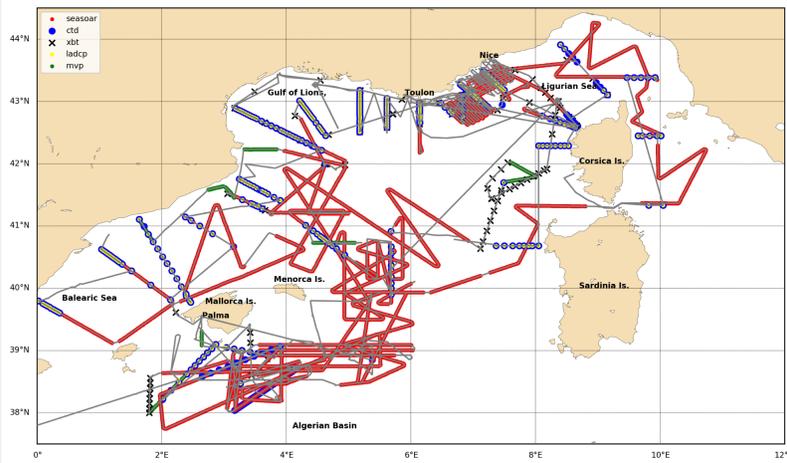
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## Introduction

From 2015 to 2018 four field experiments (7 legs) have been performed in the Western Mediterranean Basin during winter or early spring, observing mesoscale dynamics (slope current and its instabilities, anticyclonic eddies, sub-mesoscale coherent vortices, frontal dynamics convection events, strait outflows) and sub-mesoscale processes like stirring, mixed layer or symmetric instabilities.



## 4 Surveys and 7 legs

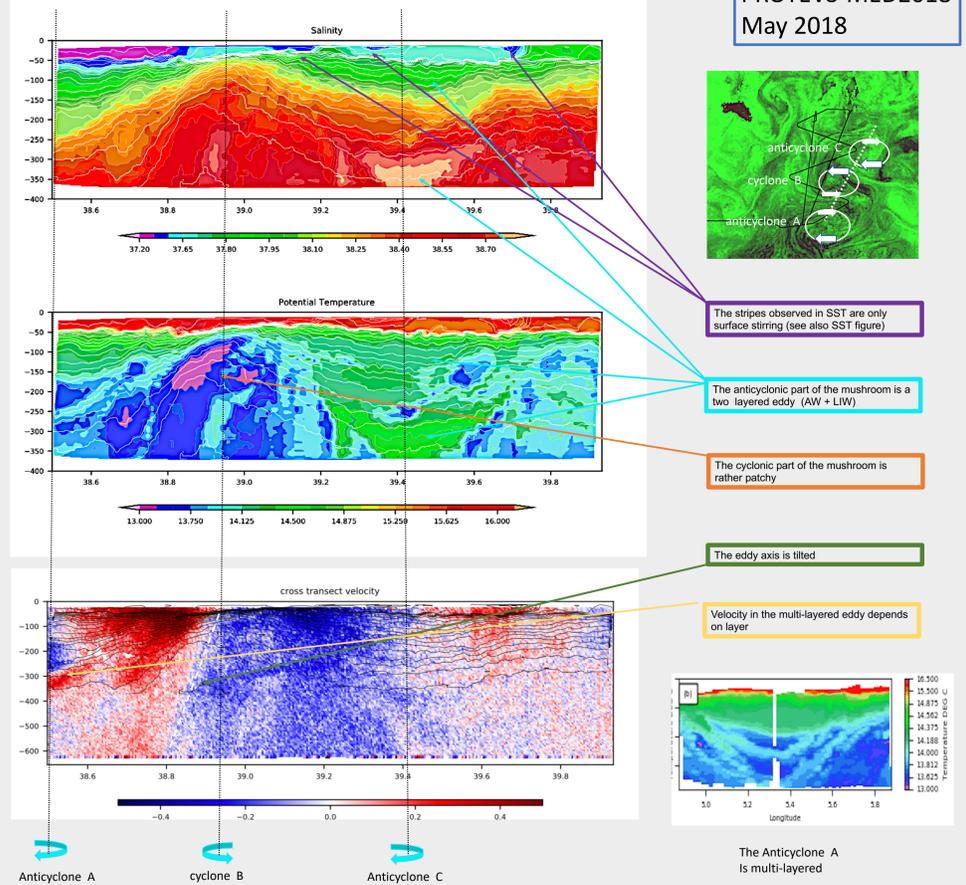


The horizontal resolution is about 1 nautical mile  
The depth range is nominally 0-400m  
The ship velocity is 9 knots, close to its transit velocity.

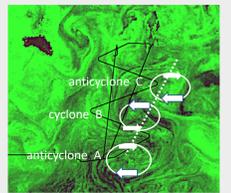
Thanks to the intensive use of a towed vehicle undulating in the upper oceanic layer between 0 and 400 meter depth (a SeaSoar), a large amount of very high resolution hydrographic transects (about 10.000 km) have been performed,



## Across a mushroom in Algerian Basin



PROTEVS-MED2018  
May 2018



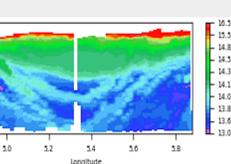
The stripes observed in SST are only surface stirring (see also SST figure)

The anticyclonic part of the mushroom is a two layered eddy (AW + LIW)

The cyclonic part of the mushroom is rather patchy

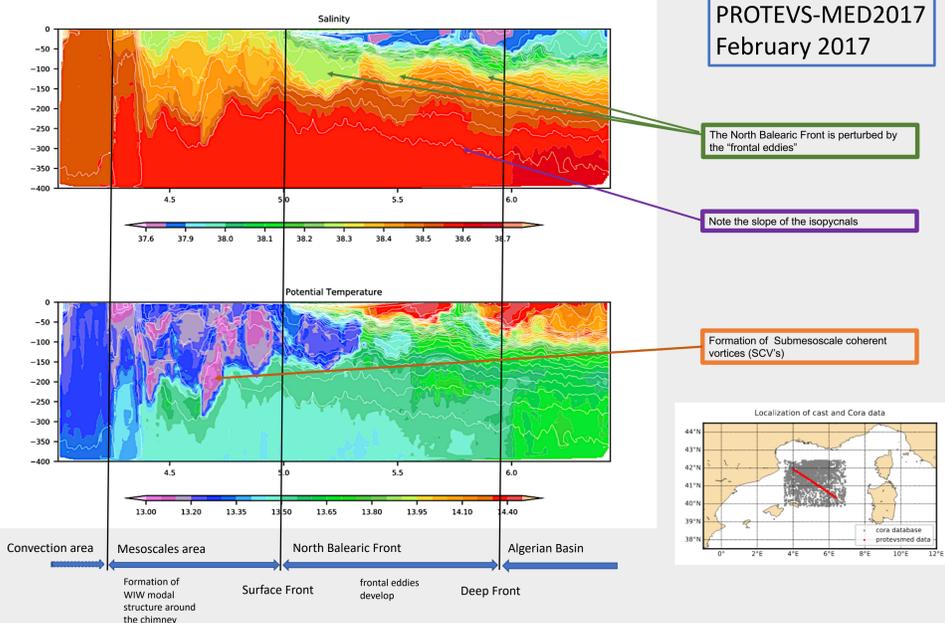
The eddy axis is tilted

Velocity in the multi-layered eddy depends on layer



The Anticyclone A is multi-layered

## From the convection area to the NBF

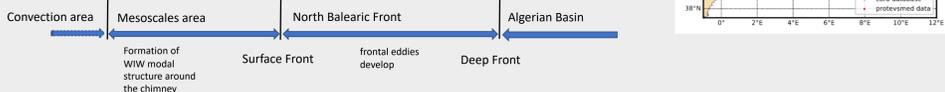
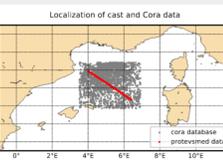


PROTEVS-MED2017  
February 2017

The North Balearic Front is perturbed by the "frontal eddies"

Note the slope of the isopycnals

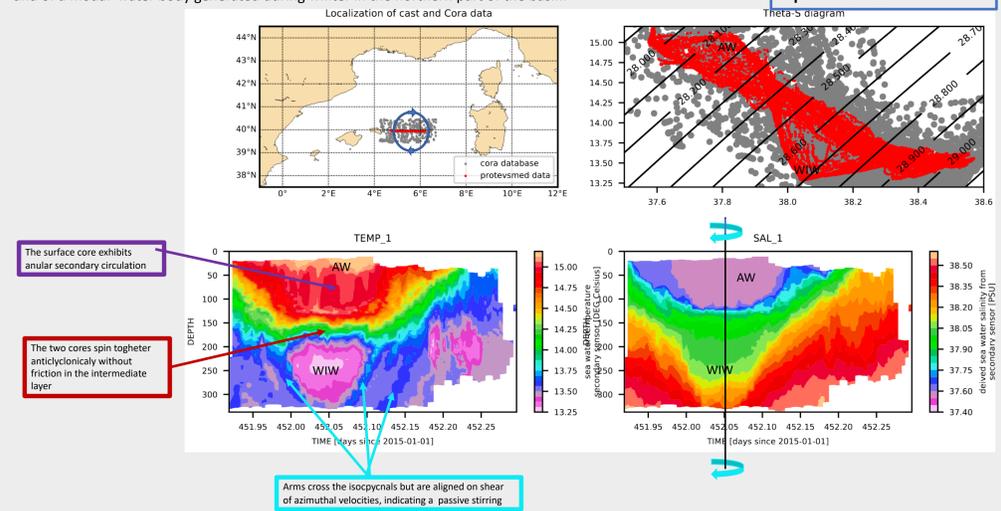
Formation of Submesoscale coherent vortices (SCVs)



## A dual core eddy

The eddy is composed of Atlantic Water (AW) on surface and of Western Intermediate Water (WIW) at 250m depth. It is an example of coalescence of a surface intensified Algerian Eddy generated by the Algerian Current and of a modal water body generated during winter in the northern part of the basin.

PROTEVS-MED2016  
April 2016



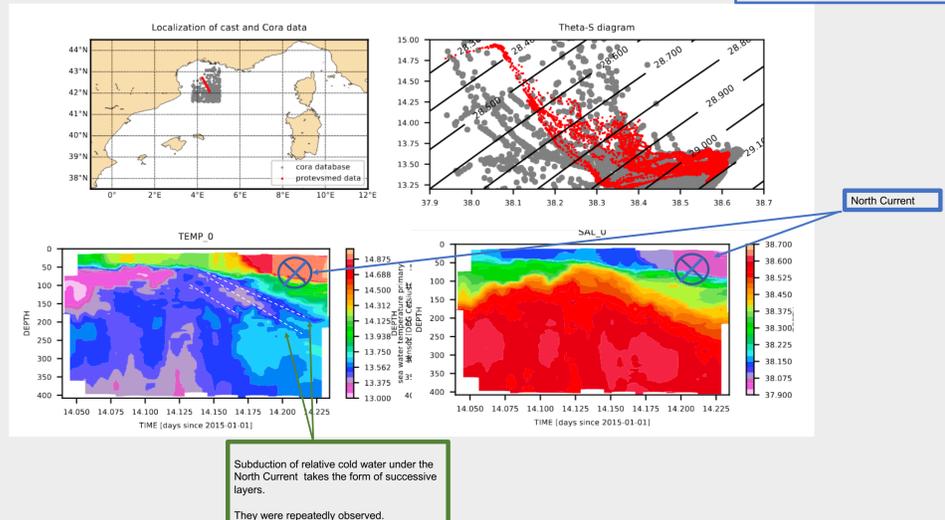
The surface core exhibits anticyclonic secondary circulation

The two cores spin together anticyclonically without friction in the intermediate layer

Arms cross the isopycnals but are aligned on shear of azimuthal velocities, indicating a passive stirring

## Symmetric Instability in the North Current ?

PROTEVS-MED2015  
January 2015



Subduction of relative cold water under the North Current takes the form of successive layers. They were repeatedly observed.

## Conclusions

The PROTEVS-MED dataset available through an unrestricted unique repository is an unprecedented opportunity for the community to approach the very fine scale dynamics in the Western Mediterranean Sea and more largely the sub-mesoscale dynamics associated with strong mesoscale dynamics. It should be useful for modellers (who reduce the grid size below a few hundred meters) and expect to properly catch finer scale dynamics. Likewise, theoretical work could also be illustrated by in situ evidence embedded in this data set.

## A DATA PAPER AND A REPOSITORY

Garreau Pierre, Dumas Franck, Louazel Stephanie, Correard Stephanie, Fercoq Solenn, Le Menn Marc, Serpette Alain, Garnier Valerie, Stegner Alexandre, Le Vu Briac, Doglioli Andrea, Gregori Gerald (2018). PROTEVS-MED field experiments: Very High Resolution Hydrographic Surveys in the Western Mediterranean Sea.

ESSD : <https://doi.org/10.5194/essd-2019-173>

SEANOE : <https://doi.org/10.17882/62352>

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