Observations and modelling of a shallow baroclinic anticyclonic eddy off Cape Bojador

Simón Ruiz[1], Mikhail Emelianov[2], Josep Lluís Pelegrí[2], Ananda Pascual[1], Evan Mason[2]
[1]IMEDEA (CSIC-UIB), Mallorca, Spain, email: simon.ruiz@uib.es
[2]ICM-CMIMA (CSIC), Barcelona, Spain

1. Introduction

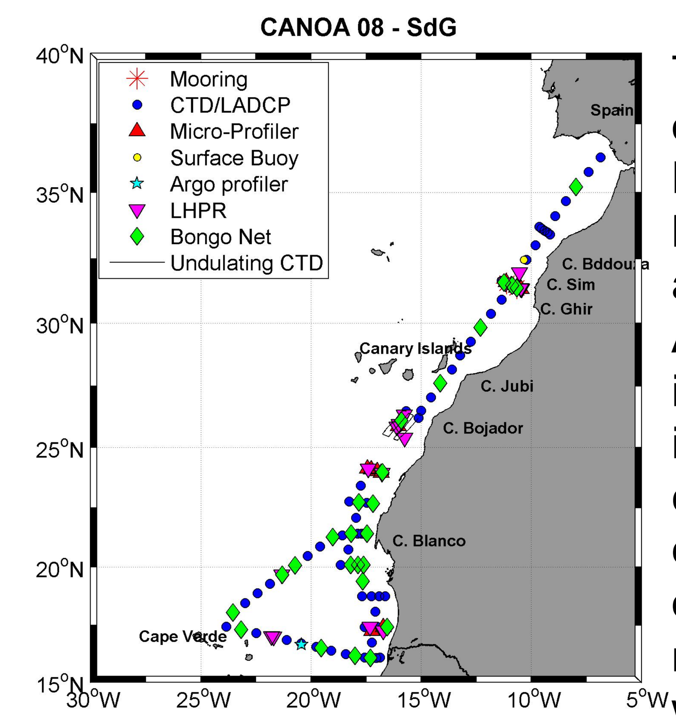
Understanding the role of the mesoscale and sub-mesoscale structures in the variability of the general ocean patterns circulation is essential to have a better comprehension of the exchanges of energy between coastal and the open ocean. Moreover, the associated ageostrophic motion associated to these structures plays a key role on the vertical exchanges between the upper layers and the ocean interior. Dynamics of (sub)mesoscale processes drive many ecosystem processes in the upper layer such as the carbon pump (Willem et al., 2007), plankton blooms (McGillicuddy et al., 2007) and heat transport (Wolfe et al., 2008) among others.

OBJECTIVE OF THIS STUDY

1. 3D characterization of a mesoscale anticyclonic eddy from a multi-parametric sampling approach and the estimation of its associated secondary circulation (quasi-geostrophic vertical velocities).

2. Investigate the potential mechanisms for the generation and evolution of the eddy sampled using numerical simulations from ROMS.

The CANOA PROJECT



This work has been done in the framework of the CANOA project (CTM2005-00444/MAR) which aims to improve our knowledge on the characterization of fronts and currents in the region off Northwest Africa, from Gibraltar to Cape Verde islands. A key aspect of the project is to investigate the influence of the African coast, the Canary Islands, and the exchanges with the Mediterranean waters on the large/mesoscale circulation in the region and the vertical structure of the water column from surface to 2000 meters.

2. Study area

The CANOA-08B cruise took place on board R/V Sarmiento de Gamboa from 2 to 29 November 2008. The campaign consisted in a multi-parametric in-situ sampling (CTD from ship and Nu-Shuttle undulating platform, Argo profiles, surface drifters and water samples) complemented with remote sensing data (SST and altimetry). The study area covers the Northwest African Coast, from Cadiz to Cape Verde Islands. In this work we present results from data collected South of Canary Island

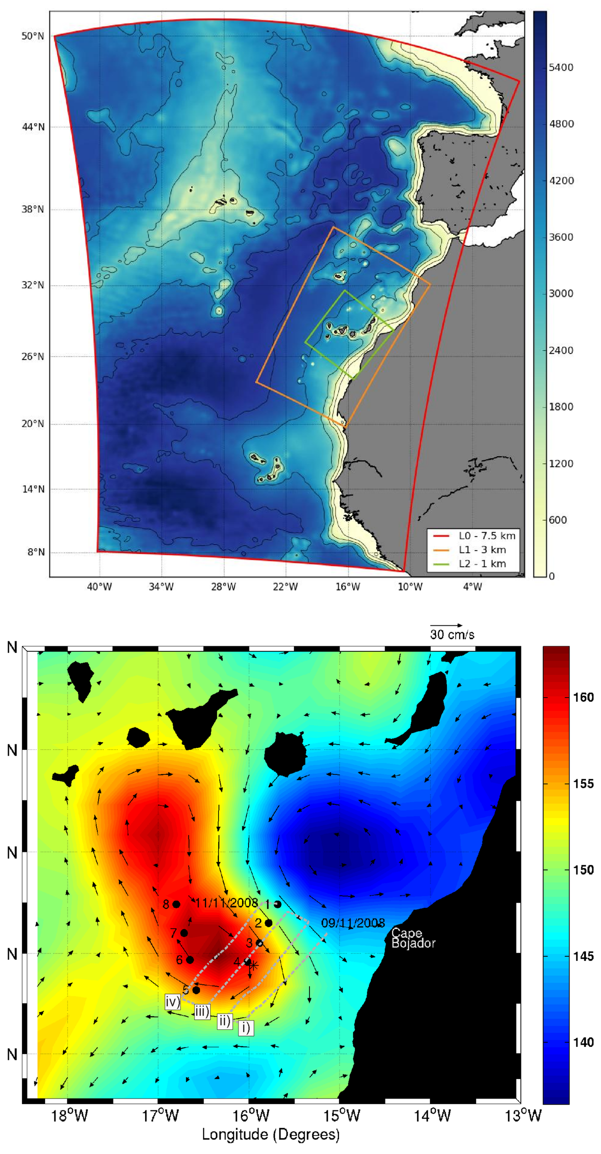


Figure 1. Top: Domain for model simulations. L2, L1 and L0 correspond to the 1-, 3- and 7.5-km solutions respectively. Bottom: Study area south of Canary Islands. Dashed line corresponds to the four Nu-Shuttle legs (i to iv). Dots correspond to deep CTD-rosette casts performed just after the Nu-Shuttle survey (1 to 4) and two weeks after the Nu-shuttle sampling (5 to 8). Asterisk indicates the launch position of a surface drifter buoy. Vectors are absolute geostrophic velocity derived from absolute dynamic topography (background colour) altimetric data for 10 November 2008.

Figure 1.

3. Altimetry

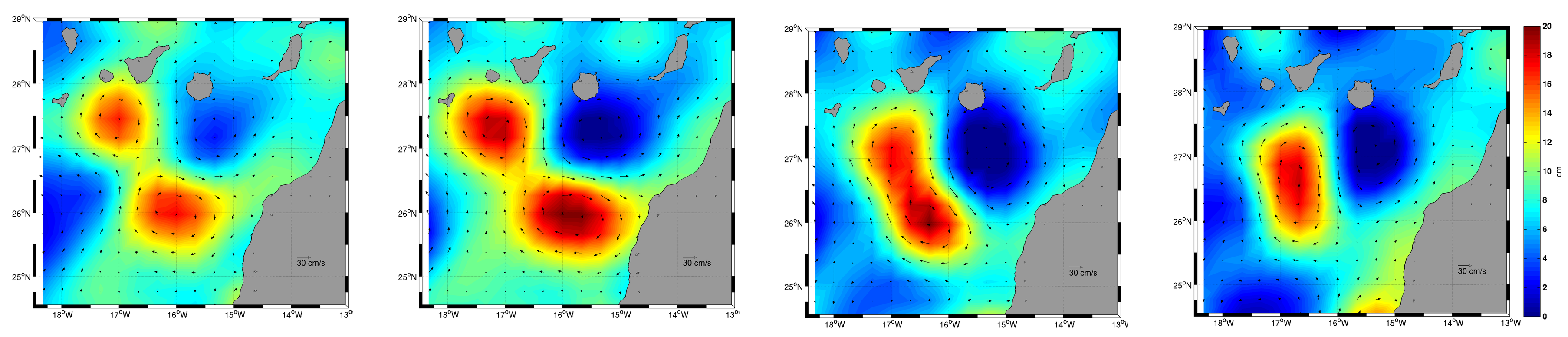
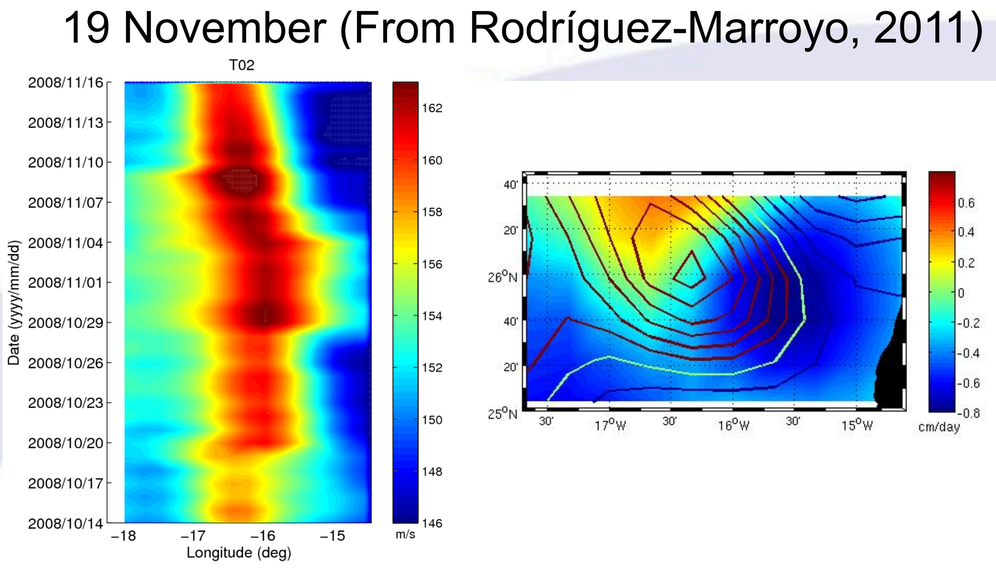


Figure 2. Sea Level Anomaly (SLA). From left to right: 15 and 29 October and 12 and 19 November (From Rodríguez-Marroyo, 2011)



Tendency is defined here as: $\chi = \left(\frac{\partial \phi^{ADT}}{\partial t}\right)$

It has been computed for 10th November (using data from 5th and 15th November). Tendency map shows negative values of 0.8 cm s^{-1} at the Southeast part of eddy sampled while in the northwest area there are positive values of 0.4 cm day^{-1} (Figure 3).

Figure 3. Hovmöller diagram for Absolute Dynamic Topography at 26ºN (left) and tendency computed form altimetry maps (right).

4. In-situ data: CTDs from Nu-shuttle and ship

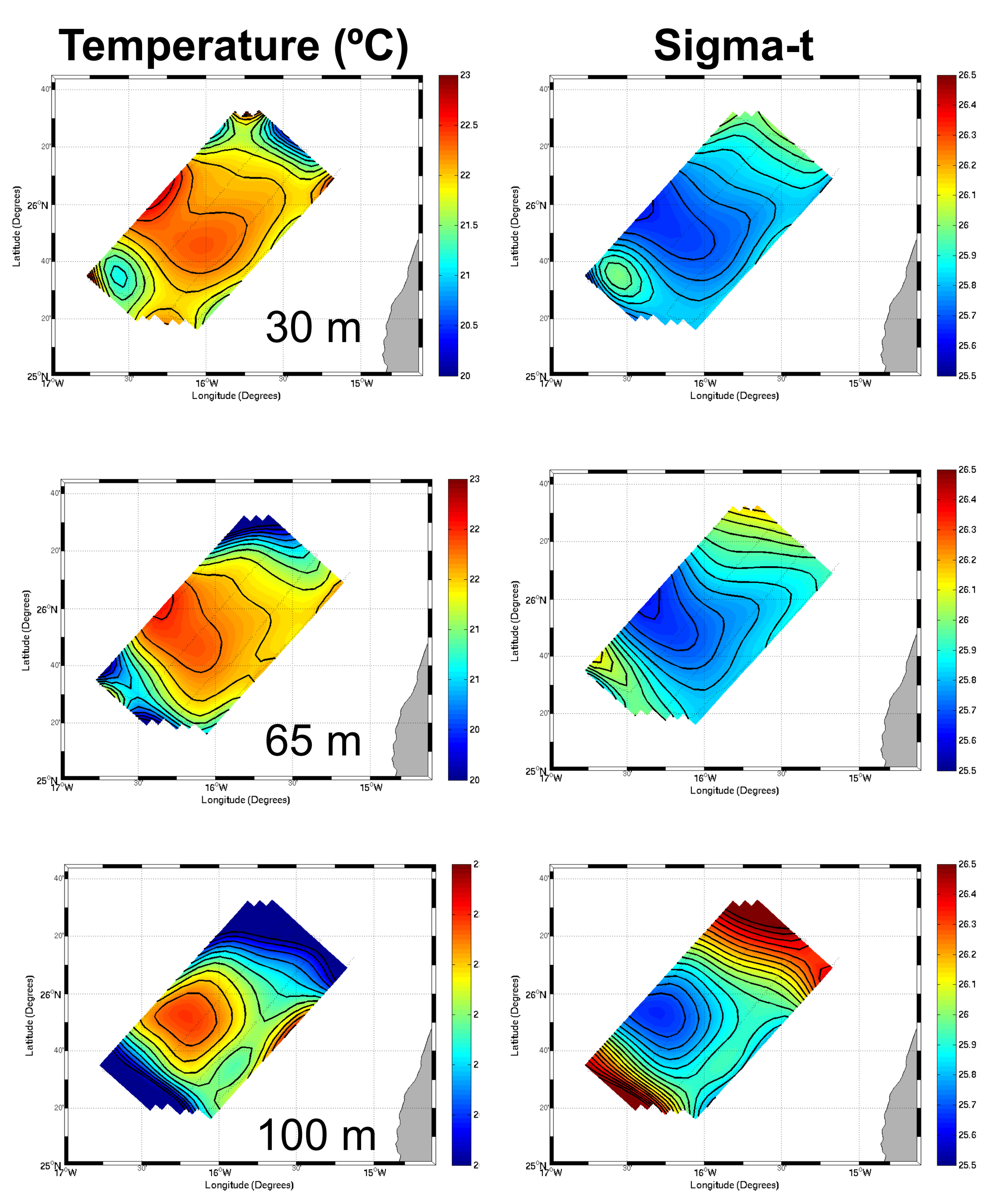
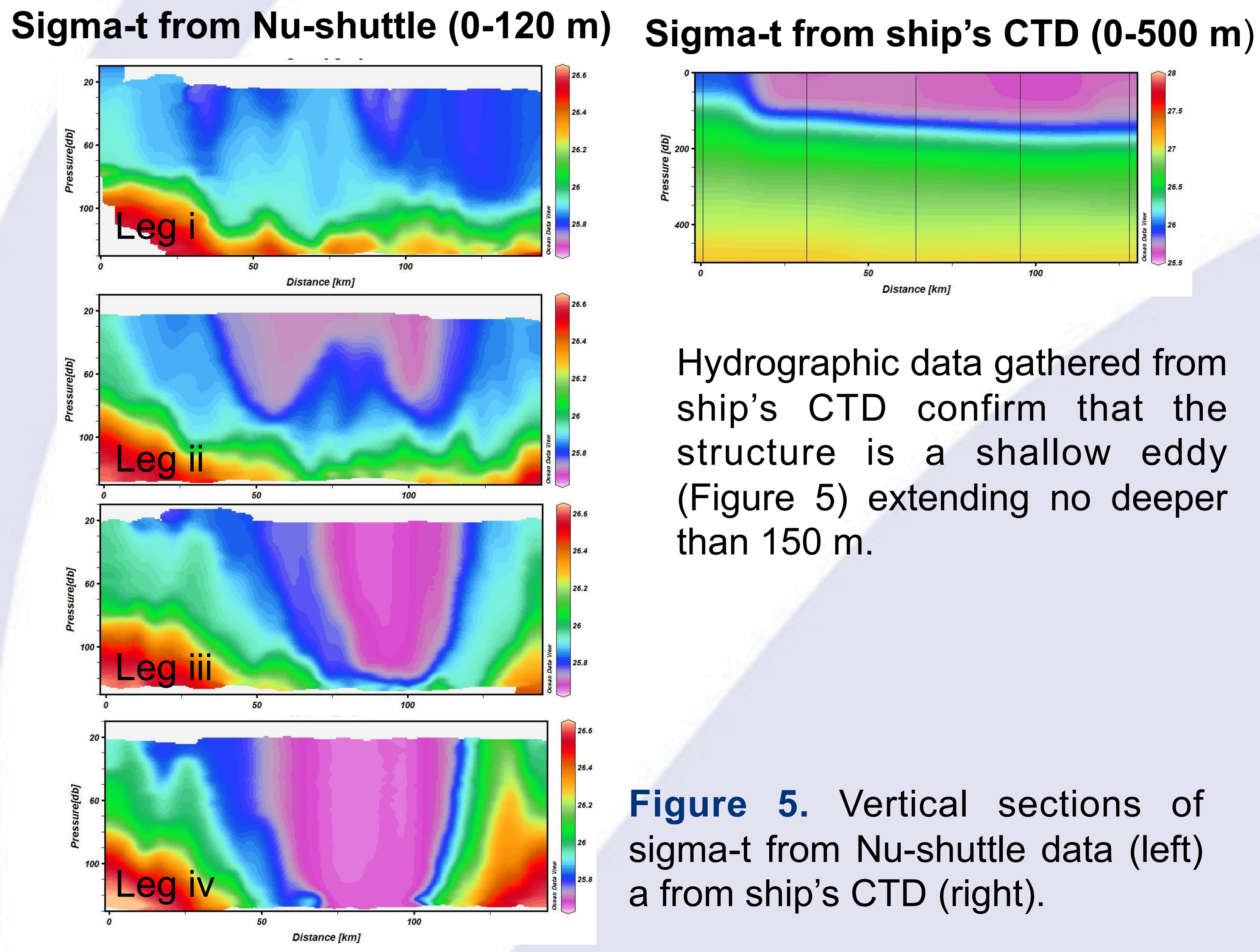


Figure 4. Temperature (left) and density (right) at 30, 65 and 100 m depth from Optimal Statistical Interpolation (Nu-shuttle data).

The eddy has a homogeneous density core of about 25.5 visible at upper (30 m) and deep levels (100 m) that is determined by its temperature. A coherent warm-core of 22.3ºC is observed at all depths (Figure 4). Salinity fields show a more heterogeneous spatial pattern (not shown).



Hydrographic data gathered from ship's CTD confirm that the structure is a shallow eddy (Figure 5) extending no deeper than 150 m.

Figure 5. Vertical sections of sigma-t from Nu-shuttle data (left) a from ship's CTD (right).

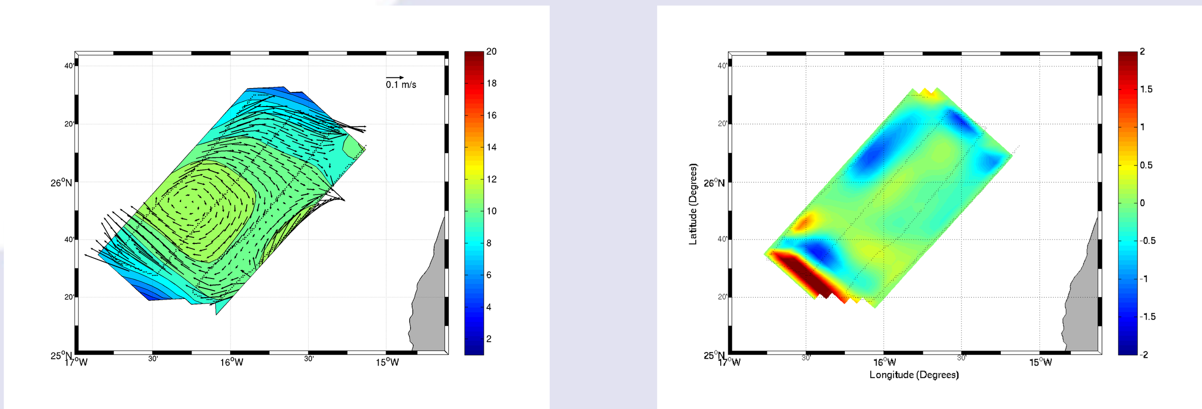
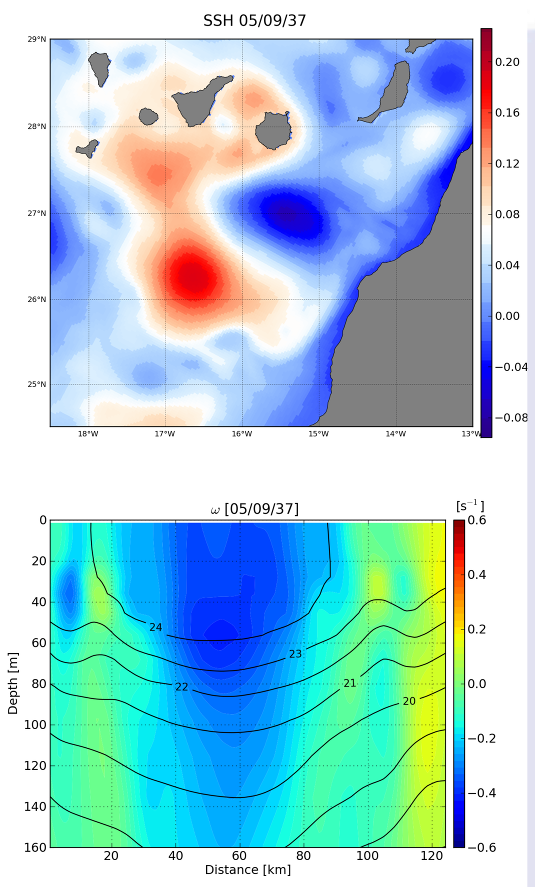


Figure 6. Dynamic height (cm dyn.) and associated geostrophic velocity (m/s) at 65 m depth (left) and quasi-geostrophic vertical velocity at 65 m depth. Units are m/day

5. Modelling: ROMS



ROMS is a free-surface, primitive-equation, curvilinear-coordinate ocean model, where the barotropic and baroclinic momentum equations are resolved separately. See details in Mason (2009) and Mason et al. (2010).

Figure 7. Top: Simulated SSH (m) from ROMS model. Bottom: Vertical section of vorticity from ROMS model (black contours correspond to temperature).

6. Preliminary conclusions

The horizontal and vertical structure of the eddy and its displacement/deformation has been described from a multi-parametric sampling and remote sensing data, then the gesotrohic and ageosrophic circulation has been diagnosed based on the QG omega equation. The anticyclonic eddy observed by altimetry and the in-situ data is well reproduced by the ROMS model in terms of Sea Surface Height (SSH).

For a full list of references used in this poster, please contact Simón Ruiz at simon.ruiz@uib.es