

Vertical motion and chlorophyll patterns from a high-resolution glider experiment in the Balearic Sea

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SINOCOP EXPERIMENT

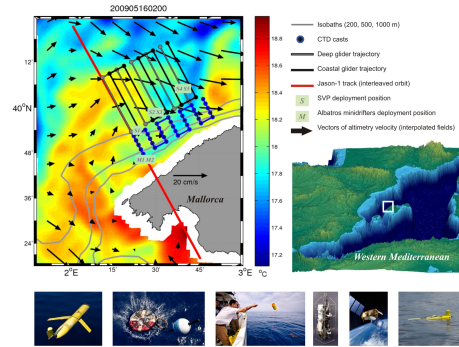


Figure 1. Study area (Balearic Sea, western Mediterranean) and sketch of the sampling design. Vectors correspond to geostrophic velocities from altimetry and colour background represents the sea surface temperature for May 16, 2009.

DATA SET

The SINOCOP experiment was carried out along the north-west coast of Mallorca island, in the Western Mediterranean, from May 11 to 21, 2009.

2 Slocum gliders

811 Hydrographic (temperature and salinity) and biogeochemical measurements (turbidity, oxygen and chlorophyll) were registered in a week. The horizontal resolution along-track is of 0.5 km for the coastal glider and around 1.1 km for the deep glider and about 4 km across-tracks. Final profiles were averaged in the vertical every 1 m.

Coastal ship

24 CTDs casts (SeaBird-19 probe) were performed from IMEDEA coastal ship. The sampling covered the coastal zone between the isobaths of 200 and 1000 m. The distance between stations was 2.5 km along the same transect and 6.5 km between consecutive transects.

5 Surface Velocity Program (SVP) drifters

Each drifter was composed of a surface buoy with subsurface drogue attached and centred at 15 meters depth that guaranteed the flow of the drifter with the ocean currents (minimizing the wind effect).

Remote sensing: altimetry and SST

2D interpolated gridded fields, currently delivered by the AVISO. The gridded fields are specific for the Mediterranean Sea and are computed on a regular 1/8° grid using a suboptimal space/time optimal interpolated analysis.

Regarding sea surface temperature satellite data, raw images at 1.2 km resolution acquired and processed by GOS-ISAC(CNR) as well as 6 hours averaged images at 2 km spatial resolution from EUMETSAT web server were available during the experiment.

SCIENTIFIC OBJECTIVES

To investigate the mesoscale and sub-mesoscale processes associated with the Balearic Current, the main oceanographic feature of the area.

- ✓ To quantify the quasi-geostrophic vertical motion associated with mesoscale processes.
- ✓ To assess the implications on chlorophyll pattern distributions.

METHODS

- ✓ Optimal Statistical Interpolation (OSI)

- ✓ Omega equation:

$$f^2 \frac{\partial^2 \omega}{\partial z^2} + \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} \right) (N^2 \omega) = \nabla_x Q$$

where

$$Q = 2f \left(\frac{\partial v}{\partial x} \frac{\partial u}{\partial y} - \frac{\partial v}{\partial y} \frac{\partial u}{\partial x} \right) - 2f \left(\frac{\partial u}{\partial x} \frac{\partial v}{\partial z} + \frac{\partial u}{\partial y} \frac{\partial v}{\partial z} \right)$$

RESULTS

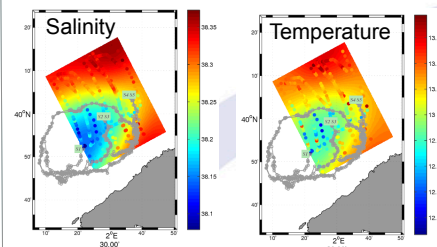


Figure 2. Interpolated salinity and potential temperature (°C) at 150 m from glider data. Colour dots correspond to salinity and temperature from glider at the same depth. Drifters' trajectories are indicated with the gray colour line.

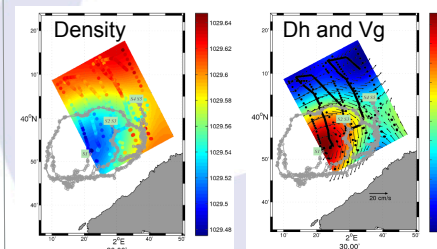


Figure 3. Left: Interpolated density (kg m⁻³) at 150 m, colour dots correspond to density from glider at the same depth. Right: Dynamic height (cm) at 150 m. Vectors correspond to geostrophic velocity (cm s⁻¹; reference level: 570 m). Drifters' trajectories are indicated with the gray colour line.

RESULTS

The relative fresh waters from Atlantic origin (37.4) found in previous studies near the coast were not detected in this experiment. Instead, the signature of the Mediterranean Water (salinity of 38 and higher), typical from open ocean water, was dominant in the study area. It is worth also to mention the presence of Western Mediterranean Intermediate Waters (WIW) characterized by potential temperature lower than 13°C. Furthermore, glider data also gave some insights of Levantine Intermediate Waters (LIW), represented by salinity maxima higher than 38.4.

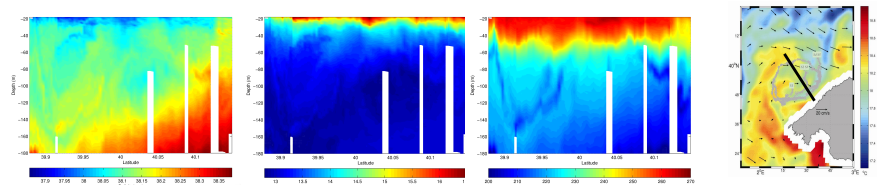


Figure 4. Vertical sections of salinity, potential temperature (°C) and oxygen (umol/kg) from a transect of the coastal glider. Solid black line in the map (right side) indicates the location of the glider transect.

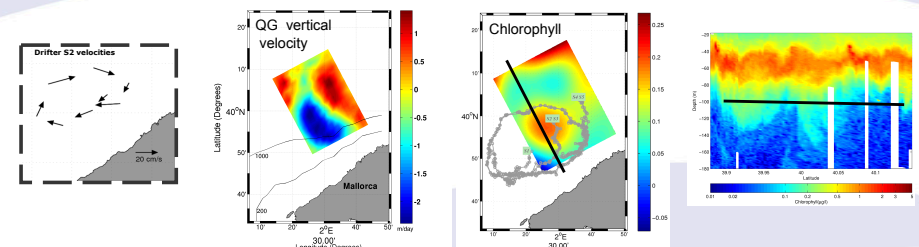


Figure 5. From left to right: Surface velocities derived from drifter S2 (units are cm s⁻¹). QG vertical velocity (units are m d⁻¹) at 100 m. chlorophyll (units are 1e⁶ g l⁻¹) at 100 m. Vertical section of chlorophyll from a transect of the coastal glider (units are 1e⁶ g l⁻¹, log scale).

Maximum horizontal surface velocities of 26 cm s⁻¹ have been measured by drifters (HF signals filtered with low pass filter 36 h). Downward velocities of -3 m day⁻¹ are observed in the southwest part of the sampling area, while positive velocities are dominant in the north and east part of the domain. At 100 m depth a patch of relative high concentration of chlorophyll is observed, the quasi-geostrophic vertical velocities could be the mechanisms responsible for this chlorophyll pattern.

SUMMARY

- ✓ In-situ and remote sensing reveals the presence of an anomalous anticyclonic eddy near the northwest coast of Mallorca island of about 60 km diameter. This structure blocked the usual path of the Balearic Current along the coast, deflecting the main north-eastward flow to the north.
- ✓ This anticyclonic eddy has associated vertical velocities of about +/- 3-4 m/day. Sinking motion in the center of the eddy may indicate an acceleration of the anticyclonic structure (deepening of isopycnals).
- ✓ The patch of relative high concentration of chlorophyll observed at 100 m depth could be explained by the downward vertical velocities diagnosed in that side of the eddy.

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