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COST Action ES1402: Evaluation of Ocean Syntheses

Measurement of ocean currents in the Bay of Calvi (Corsica, France)

Scientific report

Currents modelling remains essential in order to approach any environmental study in oceanography. The most difficult part of current modelling remains to establish boundaries and initial conditions (Norro, 1995).

In this idea, the GeoHydrodynamic and Environmental Research Group (GHER) from the Université de Liège developed 3D nested models for the western part of the Mediterranean sea (Beckers, 1991). A first model, covering the entire Mediterranean Sea, with a resolution of 1/4°, was implemented. Inside this grid, a second model, thinner, was inserted, with a resolution of 1/20°, covering the Ligurio-Provencal Basin. Finally, within this second grid, a third model was nested, with a resolution of 1/60°, over the Ligurian Sea. Boundary conditions of nested models are thus interpolated based on the coarser model results. Inversely, the solutions obtained for the finer offer then a feedback to the coarser model. The purpose of my master thesis is to add a further layer to this nesting, and evaluate currents at a more local scale.

The bay of Calvi represents therefore an interesting location. Indeed, situated in the North-West of Corsica, it covers an area of 22.26 km², with a lateral open-boundary of 6.3 km between the Punta de la Revellata and the Punta Spano. The bay of Calvi is included in the 1/60° model.

The model resolution should be increased at 1/300° or 1/420°, depending on the computing power. The boundary conditions would then be interpolated from the Ligurian Sea model. As the Figure 1 shows, this zone is mainly influenced by the Western Corsican Current, joining the Eastern Corsican current at the Capo Rosso (Barth et al., 2005). However, this model is built at a too large scale to observe local influences. Indeed, as it is supposed, the Bay of Calvi hydrodynamic is influenced by the submarine canyon, located a few kilometres away from the coast. There, the slopes are steep, and can cause up- and downwelling waters, relevant in those oligotrophic waters. The presence of this submarine canyon just outside of the bay, and shallow waters along the coasts inside the bay might play an important role on the circulation. The 3D currents are therefore highly important and can play a role, even if it cannot be seen at the larger scale. As the model presents a two-way nesting, this local scale would later be implemented in the coarser models, in order to approach the potential feedback.

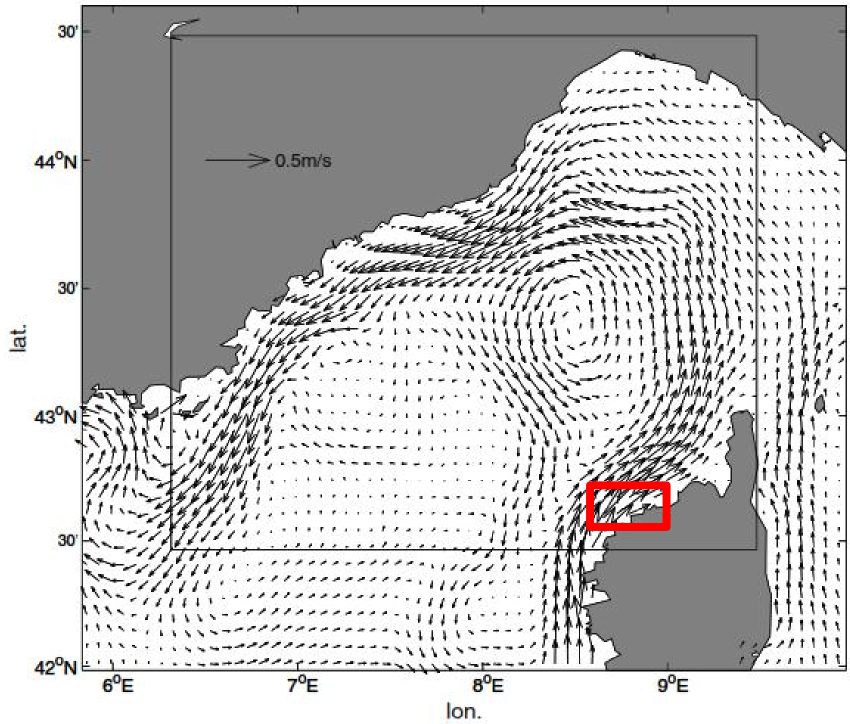

Figure 1: Mean velocity in winter at the surface of the Ligurian Sea, and boundary limits of the fin grid models. The study zone is also displayed (adapted from Barth et al., 2006).

To validate this model, physical measurements have to be collected. This is the reason why this field trip was organized. It took part of a series of campaigns, to also assess the temporal variability of the circulation. The same scenario is conducted every months, to get a yearly panel of the possible seasonal effects, which would later help in the modelling of the current in the bay of Calvi. Among 9 measurements points across the bay, 5 presented a depth of 30 m, whereas 4 points were above a 60 m water column height.

The objective of this field campaign was to approach the field work of current data collection. Therefore, I joined the responsible, Michèle Leduc. The current was measured thanks to a current meter, placed at 10 m from the seawater surface, during 10 minutes. This current meter is an Acoustic Doppler Currents profiler (ADCP). This machine records the direction and the strength of current every 30 second, in order to build the profile at each location. The depth of 10 m was chosen because it is considered as the depth at which the influence of waves can be neglected, and only the current itself is recorded. Indeed, as the machine recording is based on the Doppler Effect, it is impossible to dissociate the influence of waves compared to the influence of the current on the movement of a particle. Therefore, selecting conditions in which the part of the wave becomes insignificant is a great asset. Unfortunately, because of atmospheric conditions relatively windy that produced important waves in the bay, only one campaign could be conducted during the week, on October 16th. That day, wind velocity was close to zero, and the free surface of water was like a mirror, nearly without waves.

This field trip also allowed me to understand the machine, the ADCP, and to get familiar with the software. Moreover, data of salinity, temperature, pressure, oxygen and conductivity were recorded during the week, to complete the picture. Finally, the journey allowed me to see the bay, and understand the physical and geomorphology features of the bay.

As it can be seen on Figure 2 here below, the currents in the bay appear to follow the coastline, clockwise, from the Punta Spano to the Punta de la revellata. On the western side of the bay, the currents seem to be stronger, probably due to the shape of the rocky coastline.

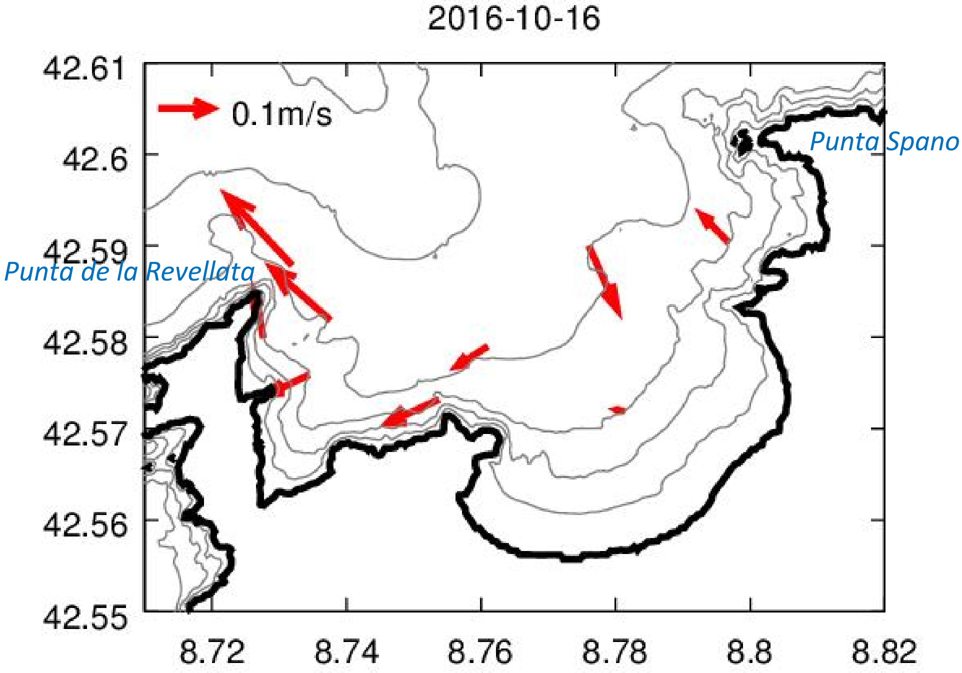

Figure 2 : Hydrodynamic measurements by ADCP in the bay of Calvi on October 16th, 2016.

The topic of hydrodynamic currents was already studied. Indeed, in 1995, Norro established a first model, based on climatological forcing, as the proximity of the meteorology station is an asset. However, studying the golf of Florida, Barth et al. proved that a nested model was more reliable than a model based on climatological forcing (2008). This study could be another opportunity to assess this purpose, by comparing both types of models on the bay of Calvi.

The host institution, STARESO, is a privileged partner of the Université de Liège, as a lot of studies have been carried in association. Therefore, the Bay of Calvi is well studied, particularly concerning its ecology. Major variables, such as sea temperature, salinity, chlorophyll content or meteorological variables have been monitored in the bay for years.

On its western side, the bay is nearly a pristine nature. As hydrodynamic have an impact on a lot of processes, having a clear, reliable model of the current in the bay could be a real asset in order to understand the logic hidden behind certain phenomena, or part of it. For example, a highly investigated topic today concerns microplastic particles. Having a hydrodynamic model of the bay could benefit, and help to understand the distribution of those particles. Moreover, the collaboration between STARESO and the ULg has also the aim of studying the ecology of *Posedonia oceanica*, a seagrass species found in the Mediterranean Sea. Our model could help to understand how the meadow is influenced by hydrodynamism. Furthermore, the Mediterranean Sea is considered as an oligotrophic area, poor in nutrients, and subsequently presenting a poor productivity. The proximity of the canyon offers an alternative source of nutrients, as it promotes an upwelling of cold, denser, richer water along the slope, with potentially a Eckman cell when northern wind are dominant. This latter assumption, suggested by Norro (1995), has still to be proven though, and could be approached thanks to our model.

Therefore, I have no doubt that this research could sustain future projects, carried by STARESO and/or the ULg, and that these two institutions will keep on collaborating. This model could act as a tool for any possible articles published concerning this bay, and nested models at a local scale. Moreover, in the idea of shared knowledge of the EOS-COST, this work could be an additional contribution, in the *Working group 4*, downscaling issues from global to regional scale.

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