HYDRODYNAMIC MODELLING OF THE CASSIDAIGNE CANYON: LIVING CONDITIONS OF COLD-WATER CORALS IN AN UPWELLING AREA

I. Pairaud [1]*, R. Cappelli [1], P. Garreau [2], S. Petton [3], S. Theetten [2], V. Garnier [2], A. Bargain [1] and M. C. Fabri [1]
[1] Ifremer Méditerranée, LERPAC, ZP de Bregaillon, F-83507, La Seyne sur Mer, France - ivane.pairaud@ifremer.fr
[2] Ifremer, Univ. Brest, CNRS, IRD, Laboratoire d'Océanographie Physique et Spatiale, IUEM, F-29280, Brest, France
[3] Ifremer, LPI, F-29840, Argenton en Landunvez, France

Abstract
Canyons are known to be areas of strong cross-shelf exchanges of properties like carbon and nutrients. In the framework of the MSFD, a focus was made on the conditions that favor cold-water corals habitats in the Cassidaigne canyon at the eastern entrance of the Gulf of Lions (NW Mediterranean), and on their vulnerability, after 50 years of red mud release. A high resolution modelling of the canyon hydrodynamics was thus developed. Results confirm the strong influence of the bottom currents (hence bathymetry) on the habitats location. This work contributed to the DISCOREF project and is part of the AMICO-next project.

Keywords: Coastal models, Canyons, Upwelling, Gulf of Lyon

Canyons are areas of complex hydrodynamics, including interactions with the general circulation [1]. The Cassidaigne canyon is located in the area of the strongest upwelling of the Gulf of Lions, with associated cooling of surface water of more than 10 °C. The local hydrodynamics in the canyon interacts with the upwelling and with the general circulation, especially when the Northern Current intrudes over the shelf. Satellite images showed that this area was depleted in Chlorophyll during upwellings [2]. This pattern is unusual as upwellings are mostly associated with high nutrients and hence high productivity in various regions of the world. Associated with the low temperatures at the seabed, cold-water corals were observed at the canyon edges [3]. An accurate modelling of the canyon is thus needed to understand the impact of the physical forcing on biogeochemistry and biology, and to feed the habitat models of cold-water corals.

A high resolution configuration of the MARS3D ocean model was set up in the Cassidaigne canyon area, using a strategy of model nesting (see fig. 1) to increase the horizontal model resolution. The CASCANL configuration horizontal resolution is of 400 m, with 60 vertical generalized sigma levels. The general circulation forcing at open boundaries is provided by the operational MARS3D MENOR model configuration of the NW Mediterranean. Thanks to the use of a refined bathymetry at 10m resolution, a two-way nesting is operated in the CASCANL configuration, with an embedded zoom at 80 m horizontal resolution centered on the canyon (CASCANS configuration). This two-way nesting is necessary to take into account the effect of fine scale bathymetry over bottom currents and retroactions over larger scales. Comparisons of model results with observations were performed following the approach by [4] previously used in the Marseilles area. Comparisons with satellite images (ocean color and sea surface temperature) and *in situ* data (hydrology and current) were first performed in terms of processes through their physical signature patterns. Then statistical comparisons with *in situ* data were performed at fixed stations or along vessels transects to explore the differences in terms of quantitative bias and processes variability. The main features of the area, including the upwelling characteristics, were explored.

The model provides hourly information on the hydrology and dynamics of the area. The first sigma levels near sea bottom (roughly 10 meters) were considered over a period of four months (autumn 2013) for the predictive habitat mapping of cold-water corals. These hydrodynamics variables, together with seafloor characteristics combined with the geographic coordinates of the known occurrences of dense cold-water coral colonies in the canyon (presence-only data), allowed establishing a model using the MAXENT software package to predict the habitat distribution in terms of probability of occurrence [5]. Statistical results confirmed that water temperature followed by current velocity were the most important predictors after seafloor ruggedness.

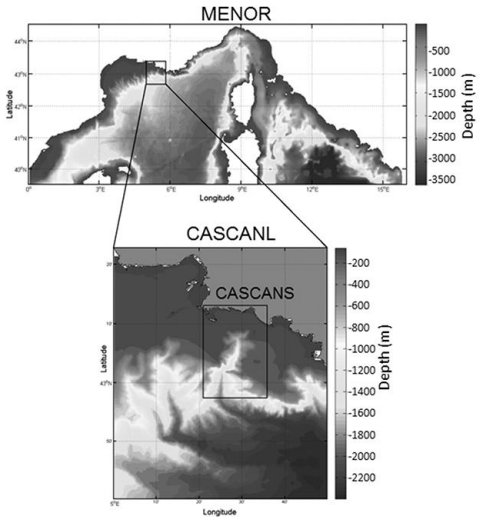

Fig. 1. Bathymetry of the model configurations and nesting strategy: MENOR fields force CASCANL, 2-way nesting between CASCANL and CASCANS using AGRIF.

References
1 - Allen S.E. and Hickey B.M., 2010. Dynamics of advection-driven upwelling over a shelf break submarine canyon, J. Geophys. Res., 115, C08018. doi:10.1029/2009JC005731.
2 - Pinazo C., Fraysse M., Doglioli A., Faure V., Pairaud I., et al., 2013. MASSILIA: Modélisation de la baie de MArSeILLe : Influence des apports Anthropiques de la métropole sur l'écosystème marin. http://archimer.ifremer.fr/doc/00145/25592.
3 - Fabri M.C., Bargain A., Arnaubec A., Pairaud I., Pedel L. and Raugel E., 2015. A case study on Vulnerable Marine Ecosystems in Cassidaigne Canyon - New technologies to track anthropogenic impact. pp. 79-86 In: CIESM Monograph 47 [F. Briand ed.] Submarine canyon dynamics in the Mediterranean and tributary seas - An integrated geological, oceanographic and biological perspective, 232p. CIESM Publisher, Monaco.
4 - Pairaud I.L., Gatti J., Bensoussan N., Verney R. and P. Garreau, 2011. Hydrology and circulation in a coastal area off Marseille: Validation of a nested 3D model with observations, J. Marine Syst., 88:20-33.
5 - Phillips S.J., Anderson R.P. and Schapire R.E., 2006. Maximum entropy modeling of species geographic distributions, Ecol. Model. 190 (3-4): 231-259.