THE INFLUENCE OF HYDRODYNAMIC PROCESSES ON ZOOPLANKTON TRANSPORT AND DISTRIBUTIONS IN THE NORTH WESTERN MEDITERRANEAN SEA ESTIMATED FROM A LAGRANGIAN MODEL.

François Carlotti [1]*, Zhongfeng Qiu [1] and Andrea Doglioli [1]
[1] Laboratoire d'Ocanographie et de Biogochimie Station Marine d'Endoume, Observatoire des Sciences de -
francois.carlotti@univmed.fr

Abstract

A Lagrangian module has been developed and coupled with the 3D circulation model Symphonie to study the influence of hydrodynamic processes on zooplankton transport and distributions in the North Western Mediterranean (NWM) sea. Forward and backward procedures are used to simulate trajectories of planktonic organisms. The individuals are released from March to October from different places of the NWM to study their transport and tracked for 40 days either as passive particles or with a simple diel vertical migrations (DVM) pattern. Teleconnectivity between different regions of the NWM sea are proposed. The model used backward procedure to study the origin of organisms drifted to the coastal line all around the NWM sea. The patterns of distribution of the jellyfish Pelagia noctiluca are discussed.

Keywords: Models, Zooplankton , Western Mediterranean, Circulation Models, Life Cycles

Zooplankton transport in a variety of physical conditions can be considered as the combination of two closely linked aspects. The first involves zooplankton transport by non-stationary flow field and the second involves the behavioral response of the zooplankton organism, mainly swimming, to changes of environmental conditions. Lagrangian particle-tracking models coupled with hydrodynamic models are particularly efficient tool to examine the role played by various physical processes, to study transport processes over an entire basin and to simulate complex and interactive processes acting at different scales.. The North Western Mediterranean (hereinafter NWM) is a favorable area to study the influence of water circulations and estuarine inputs on biological activity and distributions. In the NWM, large scale circulation is dominated by the Northern Current The NWM sub-basin is one of the most productive areas in Mediterranean owing to important river discharges from the Rhône and Ebre rivers and strong wind mixing on the shelf, and in the open sea the central divergence zones of the Liguro-Provençal and Catalano-Balearic Seas, gyres, upwellings and vertical mixing. In this study, we investigate the influence of the hydrodynamic processes on zooplankton transport and distributions in the NWMS. The model is fully described by Qiu et al. (submitted). We simulate the trajectories of passive particles and vertically migrating organisms in the region by using a lagrangian-particle algorithm driven by velocity fields from a three-dimentional (3D) hydrodynamic model. The model will be used in forward and backward procedures for different objectives. The model domain extends between longitude 1.75°W and 10.90°E and latitude 38.28°N and 5.61°N In order to classify different zones of the NWM as aggregative or dispersive, we divide the model domain into 9 sectors. Sectors 1 and 2 correspond to shelf areas delimited by the isobath of 200m in the GoL and in the Catalan Sea, respectively; sector 3 marks the shelf area around the Balearic islands; sectors 4, 5 and 6 represent the Ligurian Sea (Here sectors 5 and 6 represent di_erent ecosystems in the Ligurian Sea); sector 7 bounds the center of the NWM gyre; sector 8 is the shelf slope where The modeled domain extends between longitude 1.75° W and 10.90° E and latitude 38.28° and 5.61° N (Fig. 1). In order to classify the different zones of the NWM as aggregative or dispersive, we divided the modelled domain into 9 sectors Sectors 1 and 2 correspond to shelf areas delimited by the isobath of 200m in the GoL and in the Catalan Sea, respectively; sector 3 marks the shelf area around the Balearic islands; sectors 4, 5 and 6 represent the Ligurian Sea (sectors 5 and 6 represent different ecosystems in the Ligurian Sea); sector 7 bounds the center of the NWM gyre; sector 8 is the shelf slope where the main branch of the NC passes; sector 9 represents the offshore zone in the Catalan Sea. In a first part, the model is used in forward procedure to study transport from source region to target regions in the way to study connectivity of zooplankton populations between regions in the NWM. Particles are released at D point and R point (Fig. 2) every 3 days from March 1st to August 31, 2001. During the simulations, the particles are simulated as passive zooplankton individuals. The final distributions of the particles are shown in Fig. 3 and 5. The particles released in one month are plotted in one figure. Here Fig. 3 shows the final locations of the particles released at D point and Fig. 5 at R point. The release locations are also included. The percentages of the particles distributions in different sectors are shown in Table 1 and 2. The particles released in one month have been considered as a whole. After 40 days being released at D point, the particles could almost spread anywhere in the NWM (Table 1 and Fig. 1). After being released at D point, the particles are divided into two parts resulting from the currents. One part follows the anticlockwise circulation, first drifts southern and then eastern along the WCC. After reaching the area northeast to the Corsica Island, the particles flow northern along the continental slopes, then return in the NC and go back at D point again. At the end of simulations, this part remains in the sector 4 and 5, i.e. the Ligurian Sea. Another part of the particles follow the NC westward. From the sector 6, the main particles trap in the NC (the sector 8) along the continental slope and then flow into the Catalan Sea (the sector 2 and 9), a part moves more offshore into the sector 7 and a few particles enter in the sector 1 with the intrusion of the NC at the eastern side of the GoL. In the Catalan Sea, the particles reach as far as the Channel of Ibiza where it splits in two parts. The main part re-turn into the Northwestern Basin and some particles enter in the sector 3 (Fig. 1). Strong seasonal patterns in the transport and distributions of the particles are observed (Table 1, Fig. 1). Only 17% of the particles, which released in May and June, maintain in the Ligurian Sea (the sectors 4-6) while the maximum, over 60% in March. On the contrary, only 9% enter in the Catalan Sea (the sectors 2-3 and 9) in March while 46% in May (Table 1). The distributions of the particles in the path areas of the NC are more offshore in July and August than in other months (Fig. 1). At the end of the simulations, the particles scatter in the northeastern part of the Catalan Sea, which released in March and April. The main particles released in July and August concentrate in the path of the NC. And the particles released in May and June distribute mainly similar with the cases in July. However, comparing to only a few particles locate in the northeastward re-turn branch in July, more particles are in the path of the re-turn branch in May and June, even some flow to the areas east to the Balearic Island in May. Moreover, different patterns appear in the final distributions of the particles with different released depths. At the end of the simulations, the main parts of the particles locate in the path of the NC, which release at -100m. The particles released at -5m distribute more complex than those released at -100m, which scatter in the whole areas of the NWM, and the patterns are different in different months. Moreover, along the path of the NC, the particles released at -5m locate further than the particles released at -100m, and only a few of the latter particles reach the open boundary. Others simulations with launched particles from different origins will be presented and zooplankton connectivity between regions will be discussed The model will be used backward procedure to study the origin of organisms drifted to the coastal line all around the NWM sea. This backward procedure is particularly interesting to investigate the patterns of distribution of the jellyfish *Pelagia noctiluca* from the area where coastal jellyfish invasion have been observed, i.e. on the French Riviera, the Gulf of Lions and the Catalan and Balearics seas. The simulations offer a tool to suggest potential pathways of jellyfish transports in the NWM sea.

References

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