MEDITERRANEAN SEA PRIMARY PRODUCTIVITY SIMULATED BY OPATM-BFM MODEL

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Abstract

We present an analysis of the primary productivity estimation for the Mediterranean Sea carried out by the numerical tool OPATM-BFM. Annual budget of primary productivity is quantified and compared with other estimations based on satellite observations and in-situ measurements. Model results are discussed and summarized considering the main biogeochemical properties and their inter-annual variability (period 1999-2004) at the sub-basins level with a particular interest to primary productivity (PP).

Keywords: Primary Production, Models, Pelagic

Introduction

Scenarios analyses indicate that the anthropogenic pressure on the Mediterranean Sea environment will significantly increase in the next decades. Optimal management of this rapid change requires a quantitative knowledge of the Mediterranean Sea functioning based on an integrated view that may include in-situ remote measurements and modelling projections. Models represent the only system able to quantitatively estimate with high space/time resolution the biogeochemical processes at basin scale. We applied a model developed in the framework of the operational short-term forecast [1] for a multi-annual simulation of plankton productivity.

Model

OPATM-BFM is a three-dimensional transport-reaction model developed to simulate the evolution of the marine biogeochemistry. It is designed to resolve the seasonal cycle of primary producers on the Mediterranean basin spatial scale. The model in its current version has an horizontal resolution of 0.125 degrees with 43 vertical levels. The system is forced with physical parameters produced by an external high- resolution Ocean General Circulation Model (OGCM) according to the off-line approach. Advection, diffusion and sinking are implemented by a modified version of OPATM code, OPA Tracer Model version v8.1 [2]. The reaction term is implemented by the BFM model version 2.0 [3]. The physical parameters are computed by the MED16 OGCM forced by the atmospheric fields of the ECMWF reanalysis for the period 1998-2004. Photosynthetic Available Radiance (PAR) is modulated by a satellite-estimated extinction parameter. Initial and boundary conditions (for the Gibraltar Strait input) are obtained from the nutrient climatological dataset MEDAR MEDATLAS 2002.

Result and Discussion

Table 1 shows the annual averages (as arithmetic means) of PP estimated by OPATM-BFM model, SeaWiFS, and by data synthesis of in situ measurements for different sub basins of the Mediterranean Sea, Fig. 1. Overall there is a good correspondence among different estimations for all the sub-basins, with an average productivity around 94 mgC m^{-2} y^{-1} for the whole Mediterranean Sea basin. The western Mediterranean is characterized by an higher average productivity level, around 127 mgC m^{-2} y^{-1} , including Alboran Sea, while the eastern Mediterranean average productivity is lower and around 72 mgC m^{-2} y^{-1} . A seasonal cycle is evident for each year considered in the present simulations, both in the western and eastern sub-basins. The maxima of primary production occur always during the winter period while the minima occur in late autumn, as shown in the time series of the period 1999-2004, Fig. 1. In the ALB sub-basin, the seasonal cycle is super-imposed to the high frequency peaks related to the highly dynamical regime of this area. The NWM area has a dominant seasonal cycle with an evident maximum of the productive peak in 2003 (around 1 gC m^{-2} d^{-1}). LEV area shows maxima of productivity in April and very low values during summer and autumn periods, even below 50 mgC m^{-2} d^{-1}. In summary, our model gives full spatial/temporal coverage for the period considered, providing an estimate of the biogeochemical properties not measured experimentally.

Tab. 1. Horizontal averages of vertical integrated primary productions (gC.m^{-2}.y^{-1}) for the period 1999-2004. On parenthesis (average of the annual variance, variance of the annual average). Western basin includes Alboran Sea, North and South Western Mediterranean, Thyrrenian Sea. Eastern basin includes Ionian and Levantine sub-basins. [5] Crispi et al., 2002; [6] Simone Colella Phd Thesis; In situ data: [7] Sournia et al., 1973; [8] Bethoux et al.,1989; [9] Conan et al.,1998, Moutin e Raimbault, 2002; [10] Dugdale and Wilkerson, 1988; [11] Boldrin et al., 2002; [12] Moutin and Raimbault, 2002.

NPP	OPATM-BFM	Other Model[5]	Satellite model[6]	In Situ
Mediterranean	94 (±84/±4)	*	90 (±50/±3)	80-90[7]
Western Med	127 (±103/±5)	120	112 (±67/±6)	120[8]/140-150[9]
Eastern Med	73 (±61/±4)	56	76 (±24/±3)	20[10]/62-97[11]/99[12]

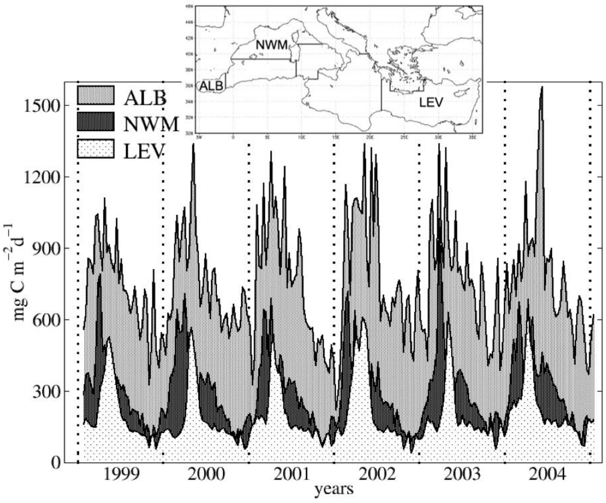

Fig. 1. Six years (1999-2004) time series of vertically integrated primary productivity horizontally averaged on three sub-basins: Alboran Sea (ALB), North Western Mediterranean (NWM), Levantine Basin (LEV). Sub-basin map is shown in top panel.

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