A COMBINED APPROACH TO STUDY INTERANNUAL VARIABILITY OF PIGMENTS IN THE FIRST OPTICAL LENGTH IN MEDITERRANEAN SEA

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Abstract

The aim of this work is to provide evidence of the interannual variability of the pigments in the upper ocean up to the first optical length. The approach is twofold: a 3D eco-hydrodynamical model describing the nitrogen cycle in the Mediterranean Sea has been integrated for the period 1980-86 to obtain estimates of monthly mean chlorophyll concentrations. Seasonal cycles are computed both from model results and CZCS monthly means obtained from JRC. The analysis of normalized relative anomalies show that in both cases the seasonal signal usually accounts for more than 80% of the energy of total signal.

Keywords: nitrogen cycle, interannual variability, chlorophyll content, CZCS.

Introduction

The interannual-to-decadal variability of circulation of upper and intermediate layer over the Mediterranean Sea has been appraised by many authors. Variability studies of the pelagic biogeochemical cycles on multiannual scales is instead hampered by the scarcity of the data sets. These studies are mainly located in selected areas such as the NW Mediterranean [1]. Here a coupled eco-hydrodynamical model is used to capture a basin-wide multiannual variability in the Mediterranean Sea. An estimate of relative importance of interannual variability versus seasonal cycle for the chorophyll content in the first optical length in Mediterranean area. Independently, the same estimates are obtained from the analysis of pigments concentration as derived by CZCS images. The comparison of satellite images with the model diagnosed chlorophyll fields demonstrates the robustness of the estimates.

Materials and methods: model experiments and remotely sensed chlorophyll concentration field processing.

Here the model protocol is firstly presented, and then the analysis of chorophyll concentration as derived from CZCS optical sensor.

The model is composed by two modules: a 1/4 degreee 31 level MOM 1.0 OGCM plus Nitrogen-Phytoplankton-Detritus-Chlorophyll (NPD-Chl) nitrogen cycle described through a set of advection-diffusion-reaction non-linear equations. Details on the functional forms of the equations, parametrization, numerics and forcings of the coupled model are provided in [2,3].

The model is in this case forced with NMC/NCEP annually varying monthly means along the period 1980-86. Chlorophyll-a was diagnostically computed from model outputs using an empirical non-linear model [4].The pheopigments concentration (ugChl/dm^3) in the first optical length was detected by CZCS sensor in the period 1979-1985. The original data set used here, reanalyzed by EU Joint Research Center of Ispra, was converted and regridded to a 2kmx2km resolution. A bathymetric mask was applied to regions shallower than 200m to wipe out coastal signals from the pelagic region both in model outputs and images.

Results

To obtain a synthetic estimate of the relative importance of interannual variability, the Hovmoller diagram of meridionally integrated (between 30.5N and 45N) chlorophyll fields are computed from both model and images. In this way, the well known zonal trophic gradient (presentet also in chlorophyll concentration), is preserved.

Both model and images show that the response of the basin is locked to the seasonal cycle all over the Mediterranean except for Alboran Sea which seems instead controlled by permanent upwelling conditions combined with baroclinic dynamics. The clear west-to-east negative gradient in chlorophyll concentration indicates the averaged increasing oligotrophy of the surface waters. Permanent maxima are connected to subbasin scale circulation, more evident in the western areas. Weaker signals are evident in the Eastern Mediterranean where the fertilization effects of Rhodes Gyre are barely visible at surface. Chlorophyll content shows energetic maxima in 1981 and 1983 years in Western Mediterranean. The model exibits stronger relative variability in the Eastern Mediterranean where winter maxima appear overestimated. Seasonal anomalies found in the Western Mediterranean during Autumn 1981 and 1982 are present both in images and model outputs (but not 1982 winter anomaly) as well as the 1983 winter peak (more spread in the CZCS). Summer deep chlorophyll maxima (in particular in the eastern basin) are too deep to be capture by satellite images but are well represented by the model.

The explanation of the normalized variance of the signal integrated over the East and West Mediterranean Sea is shown in Fig. 1: the seasonal cycle explains about 80% of the variance, except for January where the model only predicts slightly higher variability. Interestingly, similar figures were obtained in East Mediterranean from an EOF analysis of SST diagnosed from AVHRR radiometer [5].

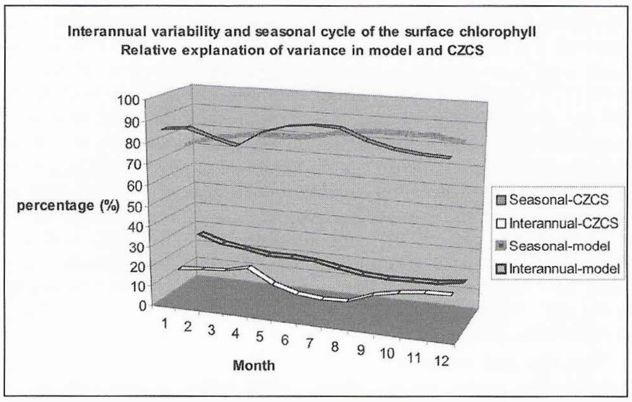

Fig.1. Breakdown of normalized chlorophyll variance expressed in terms of seasonal and interannual variability along the climatological year calculated in the period 1980-86. CZCS results are shaded while model outputs are plotted with thicker lines.

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