SEA SURFACE TEMPERATURE AND CHLOROPHYLL NON-SEASONAL VARIABILITY IN THE AEGEAN SEA BY MEANS OF EOF ANALYSIS OF SATELLITE DATA

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Abstract

Empirical Orthogonal Function (EOF) analysis is applied to 8-day composite AVHRR-derived Sea Surface Temperature (SST) and SeaWiFS-derived surface chlorophyll (Chl) data (1998-2005) to study the variability of the two parameters in the Aegean Sea from sub-seasonal to interannual time-scales. Results indicate low SST non-seasonal variability, which is controlled by synoptic weather variations and anomalies in the north-south wind-stress component. On the other hand, variations in the Dardanelles chlorophyll inflow and in the riverine nutrient inputs regulate the large intra-annual and interannual variability of Chl.

Keywords: Aegean Sea, Temperature, Chlorophyll-a, Dardanelles

Introduction

The Aegean Sea displays prominent hydrodynamic features involving all time/space scales such as strong baroclinic and topography-induced currents, upwelling regions and frontal zones with important implications on the dynamics of plankton ecosystems. Although the region is often considered to be an oligotrophic environment large gradients of primary productivity have been observed and the highly productive areas are mainly located in the northern basin [1]. In the present study eight years of satellite-measured SST and Chl are analysed in order to capture the dominant space/time features of the Aegean Sea surface variability.

Method

Daily global SeaWiFS ocean colour data (1998-2005) with 1/12° spatial resolution available from the Distributed Active Archive Center at the NASA Goddard Space Flight Center are used. In order to convert ocean colour to chlorophyll-a concentration, all the available SeaWiFS data of the raw measured wavelength bands are re-processed with the MedOC4 bio-optical algorithm, built specifically for the Mediterranean Sea [2]. The construction of SST maps is based on a re-analysis of AVHRR Oceans Pathfinder SST timeseries of the Mediterranean Sea at a 1/16° resolution-grid [3]. EOF analysis (i.e. based on the Singular Value Decomposition method) is applied to the 8-day anomaly time series of the two datasets (i.e. the total harmonic seasonal cycle is removed from the original time series) to study the non-seasonal (intra-annual and interannual) variability of the two parameters.

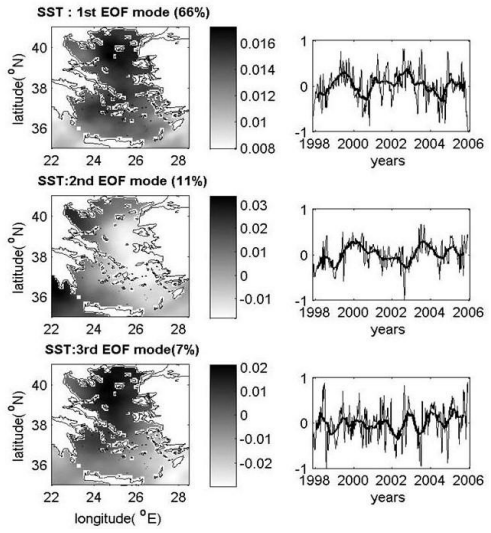

Fig. 1. EOF decomposition of the SST anomaly dataset. Spatial amplitudes (left panels) and temporal modes (right panels). The variance explained by each EOF mode is also depicted. The 22-point (176-day) running mean (dark lines) suppresses signals with timescales less than a year and represents interannual variability.

Results and discussion

Data analysis shows that non-seasonal signals account for the largest part of the Chl total variance (~70%), whereas SST variability is overwhelmed by the seasonal cycle (~98%). EOF results for the SST anomalies (Fig. 1) indicate that non-seasonal variability is induced by synoptic atmospheric weather variations (1st EOF) and anomalies in the north-south wind-stress component mainly occurring during the summer upwelling regime (2nd EOF and 3rd EOF).

EOF analysis of Chl anomalies (Fig. 2) shows large intra-annual variability and clear interannual signals, associated with much larger production during the bloom periods of specific years (i.e. in 1999 and 2004). Results indicate that Chl non-seasonal variability is mainly controlled by variations in the Dardanelles chlorophyll outflow (1st EOF and 3rd EOF), in the position of the hydrological front and the Samothraki anticyclone (2nd EOF), and in the riverine nutrient inputs within the North Aegean Sea. EOF and correlational analysis of the anomaly time-series demonstrate that non-seasonal variations of the two parameters are much less linked than in the global ocean, implying that mixing and upwelling processes play a minor role in controlling surface chlorophyll variability in the Aegean Sea.

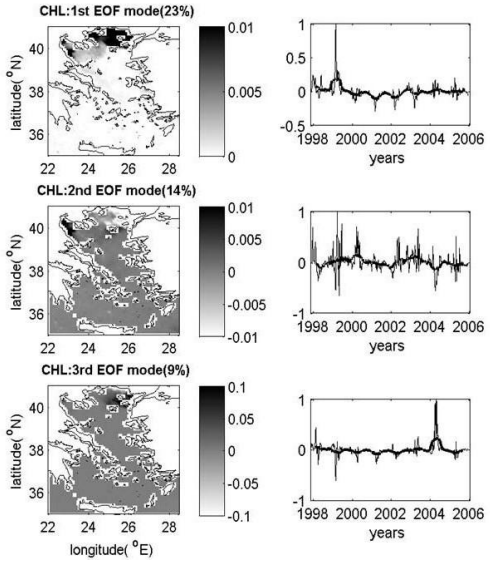

Fig. 2. Same as Fig.1 but for the Chl anomaly dataset.

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