YEAR-TO-YEAR VARIATIONS OF THE PHYTOPLANKTON BIOMASS IN THE SOUTHERN ADRIATIC (SEAWIFS DATA) AND WINTER CLIMATIC CONDITIONS

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Abstract

The high-chlorophyll content patch, which regularly occurs in early spring in the open-sea area of the Southern Adriatic, coincides with the vertically mixed patch formed during the winter deep convection. This spring phytoplankton biomass maximum is highly variable on an interannual time scale. Analysing the SeaWiFS data and air-sea winter heat fluxes, we will show that the spring phytoplankton bloom depends not only on the integrated winter heat loss but also on the high-frequency (weekly) variability of the air-sea heat transfer function.

Key-words: Adriatic Sea, air-sea interaction, remote sensing, phytoplankton

Introduction

Inspection of the available SeaWiFS imagery from the Southern Adriatic area have revealed the regular occurrence of the high-chlorophyll content patch in the centre of the basin in early spring. More detailed analysis for a specific winter (1997/98) and the comparison of the chlorophyll a distribution with the sea surface density field (1) show that the high-chlorophyll content patch coincides with the density maximum and the centre of the South Adriatic Gyre. Similar feature was documented in the Gulf of Lions (2). The occurrence of the chlorophyll patch is due to the local nutrient enrichment of the euphotic layer by winter deep convection processes, which presumably control a local spring phytoplankton bloom. The purpose of this paper is to relate the interannual variations of the spring phytoplankton biomass in the Southern Adriatic to winter climatic conditions and consequently to the intensity of the deep convection.

Discussion and conclusions

The phytoplankton biomass as a function of time is represented by the spatially integrated chlorophyll a on a 40X40 pixel domain centred at the presumable position of the South Adriatic Gyre (Fig. 1) for each cloud-free SeaWiFS image from September 1997 until May 2000. Main features and the shape of the spatially integrated chlorophyll concentration as a function of time did not change appreciably using different integration domains (15X15 pixels, 20X20 pixels and 40X40 pixels

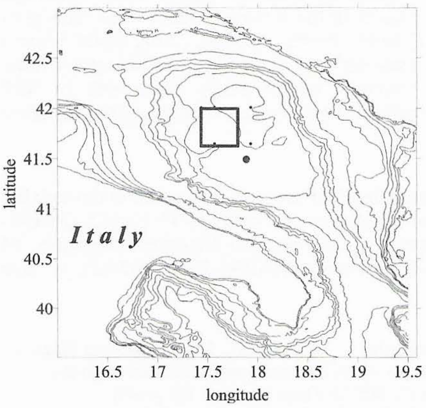

Fig. 1 Adriatic Sea map. The square represents the domain of 40x40 pixels for the integration of the surface chlorophyll content from the Sea WiFS images. The dot denotes the location for which air-sea heat fluxes were calculated.

The presented time-series (Fig. 2) reveals the existence of a prominent seasonal signal in the phytoplankton biomass with a primary maximum in early spring (March/April) reaching as much as 1 mg/m3 which is a rather high value for the Adriatic open-sea areas. A secondary maximum occurs in early autumn (October), while summer is characterized by very low surface chlorophyll a contents. This seasonal signal is modulated on an interannual scale and the most prominent spring phytoplankton biomass maximum occurs in 1999 followed by that in 1998 and in 2000. Earlier evidences (1) suggest that the spring phytoplankton biomass can be related to the intensity of the deep convection which on its turn depends to a major extent on the air-sea heat losses. Therefore, we will try to relate the interannual variability of the spring phytoplankton maximum to winter climatic conditions as represented by either integrated winter heat losses, or high-frequency air-sea heat flux variability.

Air-sea heat losses were calculated from European Center for Medium Weather Forecast (ECMWF) re-analysis six-hourly data for a single point in the centre of the Southern Adriatic using bulk formulas (3). Time-series of daily integrated heat losses for the period January – April for each of the three years in which the SeaWiFS data were available (Fig. 3) shows that the high-frequency variability of the heat-loss as a function of time differs from year to year. More specifically, winter 1998 was characterized by two strong cold events separated by almost a month-long interval of calm weather with slightly positive heat fluxes, in winter 1999 an isolated and strong event of a duration of only few days occurred at the beginning of February followed by almost two months of moderate heat losses, while the winter 2000 was characterized by a continuous and rather strong heat losses for almost entire January-March period. In addition, the interannual variability of the total winter heat loss is very prominent and characterized by its continuous increase from 1998 through 2000.

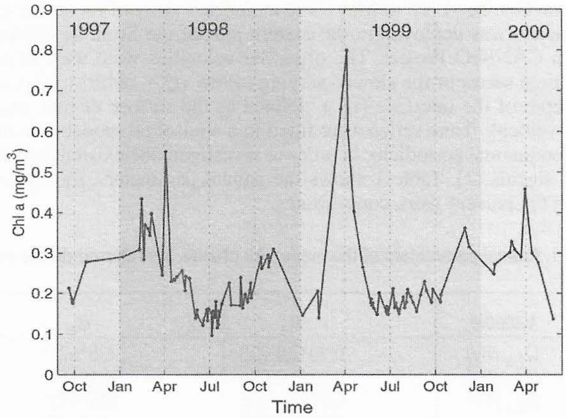

Fig. 2: Spatially integrated chlorophyll *a* concentration as a function of time.

If the winter convection depends only on the integrated winter heat losses and if it determines the spring phytoplankton biomass maximum, winter 2000 would have the most prominent spring maximum of all three years. However, this is not the case and thus we may conclude that the spring phytoplankton biomass is only partially controlled by the winter heat losses. An additional determining factor is probably the high-frequency variability of that function; more efficient in generating a spring phytoplankton bloom is a series of heat loss events, separated by at least a week long periods of calm weather with almost no heat losses.

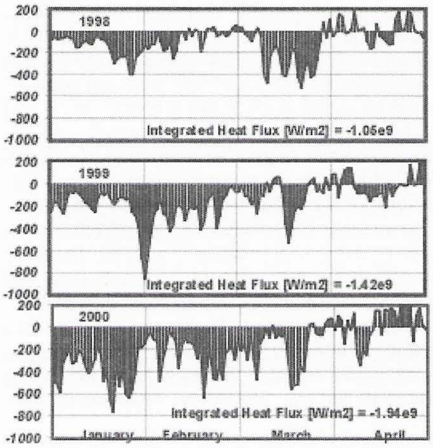

Fig. 3 : Daily integrated air-sea heat fluxes. Negative values denote sea surface heat losses.

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