THE ROLE OF OPTICAL PROPERTIES IN THE KASTELA BAY DYNAMICS

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Abstract

Optical properties in the coastal area of the Adriatic Sea have changed with respect to the conditions that reigned several decades ago. Numerical experiment was performed including different optical conditions for the heat transfer, which resulted in different vertical thermohaline structures for the two water types.

Key words: numerical model, Kastela Bay (Adriatic Sea), optical water types

Introduction

The part of heat energy transfer is affected by optical properties of the sea (transparency), which however in the last decades showed decreased trends, due to the man-made pollution in most of the shelf areas. The hypothesis is that optical conditions of the heat transfer may have significant dynamical effect. Therefore the optical water types (according to Jerlovs' (1) classification) characteristic for the earlier period in the Kastela Bay (coastal area in the Middle Adriatic) and for the type prevailing recently (2) were used in the numerical hydrodynamical model. As the first approximation, the whole Bay was taken to have the same optical type (Ib or III).

The non-linear levels model was used, described in details in the paper by Bone (3). Here, optical water types Ib and III were introduced, by a spectrally simplified representation of a single coefficient for the respective water type. Extinction coefficients were taken for the short-wave (VIS) and long-wave (IR) ranges respectively, according to Paulson and Simpson (4). Heat transport was defined with the "bulk" method, whose empirical coefficients were taken according to Large and Pond (5). Other coefficients in the model were used from Haurwitz (6) and Pyne (7).

Climatological mean value (9 m^3/s) was taken for the Jadro river input. Meteorological conditions are from 23.01.1978 as follows: the eastward wind direction with the speed 10 m/s; air temperature 14°C; relative humidity 70 % and cloudiness 2/10. The control point of the model was in the middle of the Bay, which is the location of the long-term oceanographic station. Horizontal grid step was 300m, and vertical step1m. The tides were taken according to Mosetti and Manca (8) for Split.

Results and discussion

In the numerical simulation, at the surface layer (Fig 1) for the reference point in the Bay, temperature increased when switching from type Ib to III, before the equilibrium state was established, after two days.

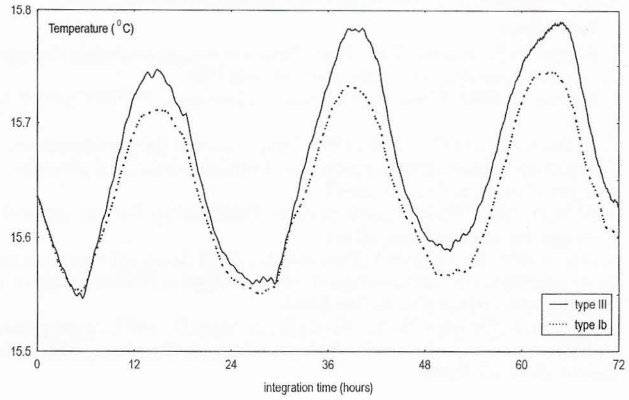

Figure 1. Temperature course with the integration time for the optical water types Ib and III in the surface layer.

The temperature course changed regularly throughout the day but had increased temperature trend with the integration time. Stronger heating in the surface layer was obtained in the optical type III.

The highest temperature differences between the two water types are observed in the vertical temperature profiles (Figure 2) in intermediate layer at the end of the integration period, which demonstrates accumulation of solar energy in the intermediate and surface layer.

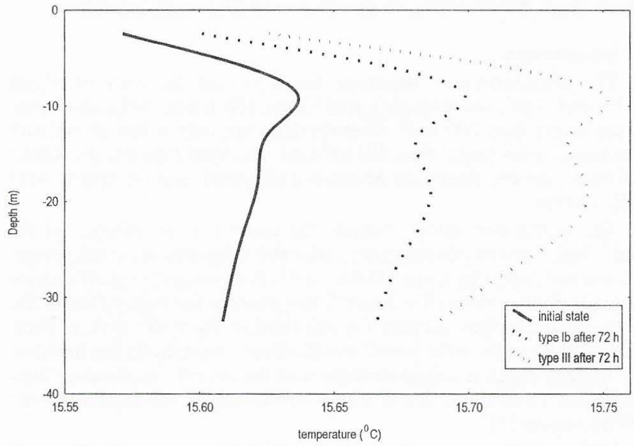

Figure 2. Vertical temperature structures after 72 hours of integration time for optical water types Ib and III.

Vertical salinity profiles does not differ between the two optical water types. Density changes accordingly to increased temperature in the whole layer for the type III, but more in deeper layers. Vertical profile of v current component is stronger in type III relative to the type Ib, while u component remained unchanged.

Conclusions

Long-term trend of decrease in transparency in the last thirty years can be recognized as a change in optical water type. Introducing global radiation and different optical water types in the model, had significant consequences in the Kastela Bay temperature profiles, currents and density, but did not change the salinity field.

The less transparent optical water type (III) kept more thermal energy in the intermediate layer, leading to the more stratified conditions.

Since transparency has decreasing trend in most of the coastal areas, further investigation should include optical water types and all the consequences that they may cause, like the trends of the heat budget, changes in dynamical stability and currents etc.

References

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