INTERANNUAL SALINITY FLUCTUATIONS IN THE MIDDLE ADRIATIC SEA

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Abstract

In order to explain interannual salinity fluctuations the data series for the open middle Adriatic were subjects to the principal component analysis. Results were compared to the meteorological factors leading to the conclusion that salinity fluctuations in the surface layer were correlated with the water flux while the intermediate layer responded to the pressure gradient between the northern and the southern Adriatic. To describe the advection mechanism additional attention was payed to the pressure field, analysing frequency of cyclones and anticyclones over the larger area (from 70W-40E and 20N-80N).

Key-words: salinity, Adriatic Sea

Introduction

The transect Split-Gargano laying over the Palagruža Sill in the middle Adriatic is a region with a strong temporal variability of thermohaline structure as being exposed to the influences both from the northern and the southern Adriatic. The dynamics on the investigated transect is controlled also by the topographic constraint on the Palagruža Sill (1). In winter, in the northern Adriatic, very cold dense water is formed, which sinks to deep layers of the Jabuka Pit, and is advected across the Palagruža Sill (2). The transect area is also under the influence of saltier water advected from the southern Adriatic. The most important feature of the Mediterranean waters advected into the Adriatic (in the intermediate layer) is their high salinity (3). This high salinity is a property of the Levantine Basin, which has one of the highest salinities of the world ocean (>39 psu) (4). Intensification of the inflow of Mediterranean water, called "ingression" (5), result in transient increase in salinity in the middle Adriatic. Since the temperature of the Levantine intermediate water (LIW) is higher than that of the Adriatic water, "ingressions" are observed in the temperature as well (3). The most important factor enhancing the water exchange between the two basins is the horizontal pressure gradient over the eastern Mediterranean (2;6). The location of the Iceland cyclone and the Siberian anticyclone centers were found responsible for this pressure gradient (7). It was observed that such changes could be related to the pressure conditions of a wide area of the north Atlantic and Europe.

Therefore, interannual salinity changes in the whole water column in the middle Adriatic depend on the three different processes: advection from the north Adriatic, advection from the south Adriatic (and/or Mediterranean) and atmospheric input. The principal goal of this paper is to analyse long-term salinity changes in order to distinguish layers influenced by different processes.

Materials and methods

Data used in this work span the time interval from January 1961 to December 1980 (8) and were collected on the regular monthly basis at oceanographic station Stončica.

For the analysis of a wide area pressure conditions, mean monthly surface maps (9) from 1956-1981 were analysed. In the region between 70°W-40°E and from 20°N-80°N spatial grid was defined of 10^0 x 10^0 gridpoint distance. Spreading of local minimum and maximum of surface pressure centers were determined within such grid and their frequency counted from each monthly map in each year.

The evaporation rates were calculated for the station Hvar (Fig. 1), for the same period (1961-1980), on the basis of the monthly mean meteorological data (10). Air pressure data were taken from Trieste and Palagruza station.

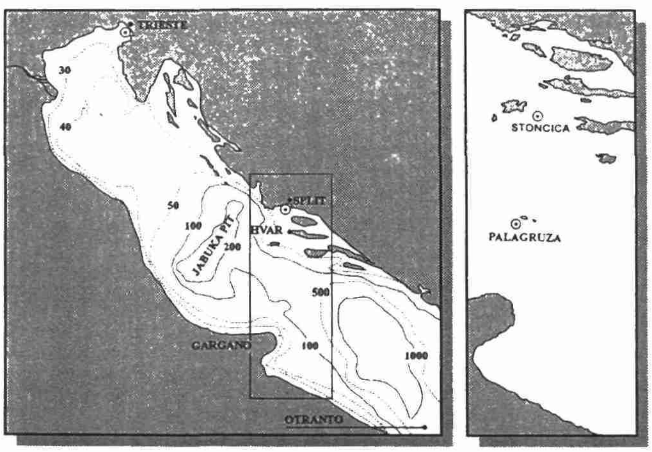

Figure 1.The transect Split-Gargano in the middle Adriatic Sea.

Salinity time series were subject to the correlation matrix based principal component analysis (PCA) (11). Eigenvalues and eigenvectors were determined, applying the varimax rotation. The significance of principal components were tested with Rule N (11), using Monte Carlo simulation of the random matrix of the same size as the original data matrix.

Results and discussion

PCA was applied to the salinity data from Stončica station at seven available depths (0, 10, 20, 30, 50, 75 and 100m). Eigenvalues and factor matrix of component loadings were determined for the first two components.

On the basis of distribution of PC loadings it was possible to distinguish two layers whose variability contribute with different amount to the total variability in the salinity field. First principal component (87.2%) has significant loadings for layers 30-100m. Second principal component (9.2%) has significant loadings in the surface layer down to 20m (Fig. 2). According to its properties, the layer from 30m to the bottom belongs to the intermediate layer at Stončica station. Salinity fluctuations in these two layers were explained comparing PC scores to atmospheric fluctuations. Significant correlation coefficient (0.31) was found between PC2 (surface layer) of the salinity field and E-P, with three months lag.

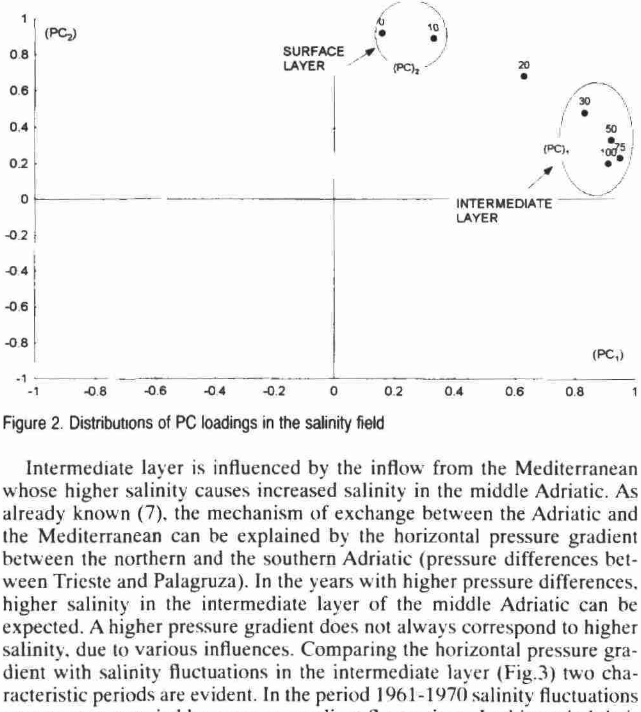

Figure 2. Distributions of PC loadings in the salinity field

Intermediate layer is influenced by the inflow from the Mediterranean whose higher salinity causes increased salinity in the middle Adriatic. As already known (7), the mechanism of exchange between the Adriatic and the Mediterranean can be explained by the horizontal pressure gradient between the northern and the southern Adriatic (pressure differences between Trieste and Palagruza). In the years with higher pressure differences, higher salinity in the intermediate layer of the middle Adriatic can be expected. A higher pressure gradient does not always correspond to higher salinity, due to various influences. Comparing the horizontal pressure gradient with salinity fluctuations in the intermediate layer (Fig.3) two characteristic periods are evident. In the period 1961-1970 salinity fluctuations are not accompanied by pressure gradient fluctuations. In this period their correlation was not significant because salinity in the Mediterranean was mainly increased due to the Assuan damm construction. It caused the fresh water input decrease from 41 to 11 km^3 $year^{-1}$ (12) which reflected upon higher salinity of the eastern Mediterranean. In the period 1973-1980, salinity fluctuations seem to respond to pressure gradient fluctuations and the correlation coefficient between them was 0.55 (significant at the 0.001 level). Besides by higher salinity, the LIW can be also detected in the intermediate layer of the middle Adriatic by higher temperature, so that the Mediterranean influence can also be seen through temperature. Like salinity fluctuations, temperature fluctuations also show two characteristic periods. In the second period, from 1973-1980 temperature fluctuations