Response of the Mediterranean to the Oceanographic/Meteorological Conditions of the North Atlantic

by

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One of the most striking features of the Eastern Mediterranean is the presence of the eastern (Levantine) water type of very high salinity. This water spreads out at intermediate depths of the whole basin but not always at the same rate. The long term fluctuations in the rate of penetration on this water have been first recognised in the Adriatic Sea [BULJAN, 1953]. On the other hand, the Adriatic Sea as the most northern part of the Eastern Mediterranean is the main source region of its deep water. The more intensive water exchange between the Adriatic and the neighbouring basins is manifested in the Adriatic by the inflow of the larger quantity of the very saline Levantine water that results in the higher average salinity of its water on the whole. So the long term variation of salinity of the Adriatic water could be taken as an indicator of the rate of water exchange between the Adriatic and the other basins of the Eastern Mediterranean, or more precisely, as the indicator of the water circulation intensity in the whole region.

Some attempts have already been made to connect the circulation intensity with some inner and outher factors. It has been shown that the formation of larger quantities of the heavier (colder or more saline) water in the North Adriatic in winter could result in the more intensive water exchange within the neighbouring basins [ZORE-ARMANDA, 1968]. Seasonal variation is also to a great extent due to the sea water density distribution and on the whole it has been better understood from the year to year variation. On the other hand, atmospheric pressure gradient over the Eastern Mediterranean plays a role in the seasonal as well as in the long term variation [ZORE-ARMANDA, 1969 *a*, 1969 *b*]. In Fig. 1 are shown

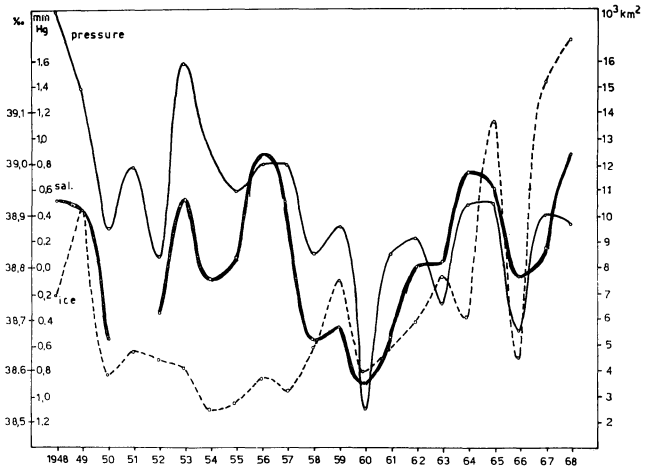

FIG. 1. — Average annual values of the sea surface covered by ice in km² in the Iceland region (cca within 20 nautical miles) — dotted line — (data after Sigtryggsson, 1969), annual salinity maximums in the middle Adriatic (6 stations considered) — thick full line — (data after BULJAN & MARINKOVIĆ, 1956; BULJAN & ZORE-ARMANDA, 1966) and annual air pressure differences between Trieste and Athenai — thin full line — (data after Ist. sperim. talassogr., 1958-1969; Polli, 1950-1954; U.S. Weather Bureau, 1948-1968), all for the 21 year period.

Rapp. Comm. int. Mer Médit., **21**, 4, pp. 203-205, 2 fig. (1972).

the annual air pressure differences between Trieste and Athenai for 21 years as well as the annual salinity maximums in the middle Adriatic, the first ones representing the average air pressure gradients over the Adriatic and the Ionian Sea and the later ones the water exchange intensity between these basins. It is seen that between two curves exists very good relationship showing that the air pressure distribution has definite influence on the water exchange between the basins of the Eastern Mediterranean, but that its long term fluctuations could partly be due to some other factor as well.

The quantity of ice in the North Atlantic could be taken as an indicator to have an idea of the oceanographical and meteorological conditions of the area. For example, it could be related to the position of the frontal zone of the North Atlantic current. This Polar Front could be considered as the border between the sub-polar and the sub-tropical water that corresponds to the position of the 10° C isotherm in the 200 m layer [DIETRICH, 1964]. ROSSOV & KISLYAKOV [1969] have shown that this front is not in the same position every year. They have compared its mean position with those in three separate years. The position of the Polar Front in 1958 and 1961 was found to be more northward and in 1968 to be more southward from the mean position. At the same time quantity of sea ice in the Iceland region in the first two years is considerably smaller than in 1968 (Fig. 1, data after SIGTRYGGSSON, 1969). Three years evidently are not enough to come to a definite conclusion, but it seems very probable that the quantity of sea ice in the Iceland region and the position of the oceanic Polar Front are in close relation, i.e., the larger ice quantity corresponds to the more southward penetration of the sub-polar water mass. ROSSOV & KISLYAKOV *(op. cit.)* have also established the hypothesis that « the position of the oceanic Polar Front predetermines to a considerable degree, the paths of the cyclones over the North Atlantic and the intensity of their activity ». To prove this hypothesis, they correlated the position of the oceanic Polar Front with the air temperature over the European part of the U.S.S.R., showing that the air temperatures were higher in the winter of 1958/59 and 1961/62 and lower in the winter of 1968/69, than the average values. If that is so, it could be concluded that in the years in which the sea in the Iceland region is more covered by ice, a higher degree of cyclonic activity as well as more intensive penetration of the cold polar air could be expected over the central Europe. The intensive penetration of such air in the central Mediterranean is followed by a more intensive cyclonic activity [RADINOVIĆ & LALIĆ, 1959] and in consequence by the formation of colder water in the northern part of the Adriatic. All these events influence the dynamics of the Mediterranean though the nature of the actual relationship is not yet completely clear. To prove that a relation exists, the long term variations of the quantity of sea ice in the Iceland region are compared with corresponding long term variations of the salinity of Adriatic water, the later one representing the water circulation intensity in the Eastern Mediterranean. It is easy to observe the relation between the two curves (Fig. 1) though evidently, it is not a striking one. Any way, the highest salinities occur at the same time as the maximum ice quantity and theirs year to year changes most often have the same direction.

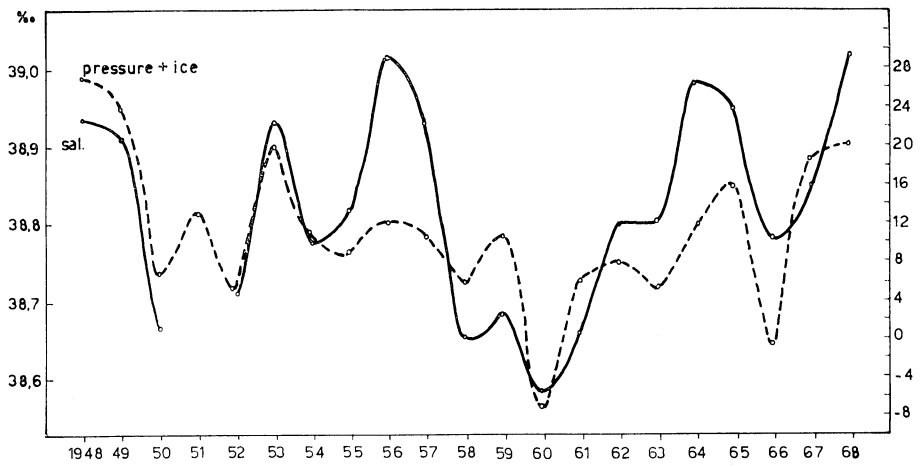

FIG. 2. — Annual salinity maximums in the middle Adriatic as in Fig. 1 — full line — and the curve obtained by superposition of the ice quantity in the Iceland region and the average air pressure difierence betwen Trieste and Athenai (both as in Fig. 1) — dotted line.

In this way the oceanographical conditions of the North Atlantic are related to the Mediterranean not directly but indirectly through the meteorological conditions over the Europe as it is not probable that the water exchange in the Gibraltar Strait itself and its year to year variation could have such conspicuous influence on the Eastern Mediterranean. So, we have here two outer factors influencing the water circulation in the Eastern Mediterranean, the first one being the atmospheric pressure gradient over the region and the second one yet not defined but represented by the higher rate of formation of sea ice in the North Atlantic. If the two factors are added and compared to the long term variation in salinity of the Adriatic water, rather good relationship is observed (Fig. 2) showing that the effects due to the two factors are superimposed.

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