Long term variations of monthly mean sea level and its relation to atmospheric pressure in the Mediterranean Sea

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Abstract

The records of the monthly mean sea level at 19 stations and the monthly mean atmospheric pressure at 15 stations in the Mediterranean Sea are analysed to find out the trend of the sea level and to identify the significant oscillations from the power spectral estimates.

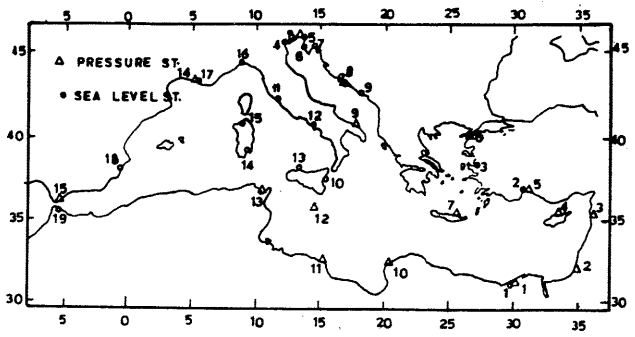

Figure 1. Positions of stations of sea level and atmospheric pressure in the Mediterranean (see Table 1, 2).

The results show that from the present data at Marseille, Triesta and Genova, it is expected, the sea level tends to increase by 13 cm/100 years, which will affect the water budget of the area.

The power spectral analysis of the pressure could explain most of the oscillations in the sea level time series at 12, 6 and 4 months periods, except in the Adriatic and Aegean Sea where the steric effect has an important contribution.

Table 1. Mediterranean stations where monthly mean sea level was taken, and Spectra characteristics.

Region	Station	position Lat. N	position Long. E	period	No. of points	No. of c.f.	period of sign. peaks
Levantine	1-Alexandria	31° 12'	29° 53'	1938-1972	180	10	12,6,4
	2-Ayalim	34°33'	32° 49'	1929-1938	240	13	12,6,2,7
Aegean	3-Izmir	38°24'	27° 10'	1937-1961	300 (60 Lags)	10	6,5,4.1
Adriatic	4-Bakar	45°16'	13° 32'	1933-1967	180	10	12,6,2,4
	5-Trieste	45°39'	13°45'	1937-1956	180	10	12,6,2,1
	6-Ancona	43°37'	13°30'	1936-1970	168	10	12,6
	7-Ortona	42°22'	14°24'	1955-1969	180	10	12,6
	8-Split	43°30'	16°26'	1955-1969	180	10	12,6,3.1,2.4
	9-Stončica	43°19'	16°04'	1936-1970	168	10	3,5
Ionian	10-Catania	37°30'	15°05'	1960-1971	144	8	12,4.8,3.3
Tyrrhenian	11-Civitavecchia	42°05'	11° 48'	1888-1916	240	13	12,6
	12-Amalfi	40°34'	14° 36'	1897-1916	240	13	12,6,4
	13-Palermo	38°08'	13° 22'	1901-1930	240	13	12
	14-Cagliari	39° 12'	09° 10'	1897-1916	240	13	12,3,1,2.4
	15- La Maddalena	41° 24'	09° 22'	1920-1941	144	8	12,4,2.3
Western Basin	16-Genova I	44°24'	08° 54'	1884-1899	180	10	20,12,6
	Genova II	44° 24'	08° 54'	1931-1960	360	20	
	17-Genova II a I	43° 18'	08° 21'	1906-1935	600	20	12,6,3,4
	Marseille II	43° 18'	05° 21'	1938-1957	240	13	12,6
	18-Alicante	38° 20'	00° 29'	1960-1974	180	10	12,6,3.6,2.1

Table 2. Mediterranean station where monthly mean pressure was taken and some spectral characteristics.

Region	Station	Position Lat.	Position Long.	period	No. of points	No. of c.f.	period of significant peaks
Levantine	1-Alexandria	31° 12'	29° 53'	1963-1973	180	10	12,6,4.3,4 (3.8 .....2.0
	2-Beirut	33° 54'	35° 54'	1955-1974	240	13	12,6
	3-Latakia	35° 31'	35° 47'	1956-1973	240	13	12,6,4.3,6,..2.4
	4-Mersin	36° 48'	34° 38'	1955-1966	180	10	36,12,6,4.3,6
	5-Antalya	36° 53'	30° 44'	1955-1974	240	13	12,6,4,(3.6..3-1
Aegean Sea	6-Canakkale	40° 09'	26° 24'	1955-1974	240	13	12,6,4.3,2.4
	7-Izmir	38° 25'	27° 11'	1955-1974	240	13	7
Adriatic	8-Trieste	45° 39'	13° 45'	1955-1966	180	10	4
	9-Ancona	43° 37'	13° 31'	1955-1966	180	10	4
Ionian Sea	10-Bengazi	32° 05'	20° 16'	1963-1973	144	8	12,6,4
	11-Tobruk	32° 05'	23° 58'	1963-1973	144	8	12,6,3,4
	12-Luxor	25° 41'	32° 39'	1955-1974	240	13	7
Western Mediterranean	13- Tunis	36° 50'	10° 14'	1955-1974	240	13	4.4
	14-Marseille	43° 27'	05° 21'	1955-1974	240	13	4.4, 4
	15-March Front	36° 09'	05° 21'	1955-1974	240	13	12,6

Seasonal variations of oceanographic properties in the Middle Adriatic

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Data from six stations of the Split-Gargano profile (Fig.1) were processed for the period 1971-1983 and partly for the earlier period, as well.

Currents were measured at Stončica station (9) every month in the period 1967-1974 and seasonally in other years, always in 24-hour series from the anchored ship. Monthly mean values of the NW and NE components, i.e. directions along-shore and onshore to the eastern coast were calculated. In the first half of the year the NW direction is dominant in all layers and in the second part of the year the NE direction. This pattern may be due to the corresponding pattern in the geostrophic current field (Fig.1). In winter the incomming current over the Palagruža Sill, i.e. in the profile area, is pushed towards the western coast. On the contrary, in summer it is pushed towards the eastern coast.

Such changes in the current pattern in the course of the year could also be connected to the seasonal distribution of salinity on the profile Split-Palagruža. In March (Table 1) the highest value of the average salinity is at Palagruža (station 12) i.e. closer to the western coast. In spring (June) maximum average salinity appears at station 11 i.e. in the central part of the profile. High value appears also at Stončica station, but only in the bottom layer. At the same station, i.e. closer to the eastern coast, the highest values of the average salinity appear in September in the whole layer from 10-100 m, and in December the highest values appear at surface, as well. Observing from the eastern coast, the highest salinities at the profile are most distant in winter and therefrom they approach the eastern coast, first in the bottom layer (spring) and finally (autumn) in the whole layer. A comparison between average monthly surface salinity and current component normal to the coast at Stončica station (Fig. 2) shows well the dependence of annual salinity variations on the current regime.

Table 1. Longterm average salinities (1971-1983) at the profile Split-Gargano.

	March					June				
0	35.68	37.66	38.22	38.46	38.47	38.18	35.67	37.53	38.04	38.38	38.21	38.11
10	36.69	38.04	38.25	38.52	38.53	38.30	37.09	37.81	38.11	38.45	38.36	38.23
20	37.18	38.14	38.30	38.54	38.55	38.46	37.53	38.11	38.31	38.54	38.55	38.43
30	37.60	38.19	38.37	38.56	38.57	38.51	37.74	38.32	38.49	38.58	38.54	38.52
50		38.32	38.43	38.58	38.57	38.54		38.49	38.56	38.63	38.59	38.56
75		38.45	38.46	38.58	38.59	38.55		38.55	38.59	38.63	38.59	38.55
100			38.51	38.57	38.60	38.56			38.64	38.64	38.64	38.53
	September					December				
0	36.56	36.27	38.32	38.34	38.26	37.85	35.09	37.96	38.37	38.38	38.32	38.18
10	37.35	38.35	38.38	38.42	38.43	38.27	36.53	38.13	38.39	38.39	38.33	38.29
20	37.93	38.42	38.45	38.47	38.49	38.37	37.51	38.21	38.42	38.41	38.37	38.35
30	38.28	38.50	38.52	38.54	38.56	38.46	37.95	38.26	38.43	38.43	38.40	38.36
50		38.56	38.59	38.56	38.58	38.53		38.36	38.50	38.48	38.43	38.41
75		38.61	38.64	38.58	38.66	38.53		38.46	38.54	38.54	38.55	38.51
100			38.66	38.62	38.65	38.55			38.67	38.60	38.62	38.56

Temperature regime on the profile also depends on the current system, even though less clear. Maximum average temperatures are closer to the western coast in the upper layers and closer to the eastern coast in the lower layers. This is due to the advection of warmer water from the south, which is more efficient at the eastern coast of the profile in summer during the vertical stratification. In winter during the vertical homogeneity, it is more efficient on the western coast of the profile.

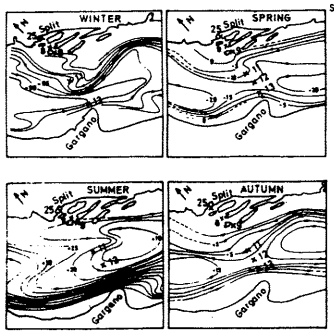

Fig. 1. Profile Split-Gargano and geopotential topographies for the region (after Zore, 1956).

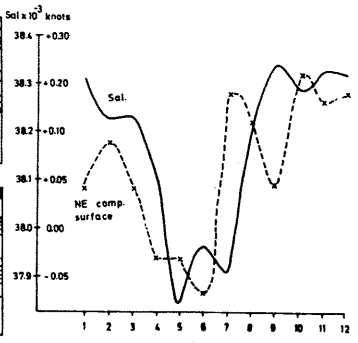

Fig. 2. Annual variation of average monthly values of NE current component in the surface layer and the same for monthly salinities for station 9 (Stončica).