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VARIATIONS OF WIND VELOCITY WITH TIME AND SPACE ALONG ALEXANDRIA AND ABUKIR COASTAL ZONE OF EGYPT.

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ABSTRACT

The hourly values of wind velocity in the period from January, 1976 to December, 1979 at Ras Eltin station (Alexandria) as well as at Abukir station from February to December, 1979 were analysed. The monthly as well as the annual variations of the variance and the spectrum were studied and the coherence between Ras Eltin and Abukir winds was determined. The kinetic energy of wind is minimum in summer and maximum in december. The most important variance of wind is found in the low ferquency range with period up to 24 h. The normal to the shore component of the wind (relative to Alexandria coast), in 1979 was significantly coherent between the two stations, nearly all the year, in the periods equal or greater than 20.57 hours. The longshore component was coherent only up to 28.80 hours, in February, March, May, June, November and December. The limited coherence of the longshore component could be explained by the influence of the land.

The linear equations relating the daily mean longshore components (and the normal to shore components) at the two stations were calculated and the correlation coeffecients were significant at all months.

INTRODUCTION

The wind force is one of the most important factors affecting currents, waves and surge generation in the sea. The objectives of this paper is to understand its variability in the Alexandria coastal zone.

The positions of the meteorological stations at Ras Eltin and Abukir are shown by Fig. (1). The distance between the two stations is about 22 km and Ras Eltin station is better exposed than Abu-kir one which is more sheltered by the high land on the western side. The recording instrument at Ras Eltin station is fixed at about 10.1 m above mean

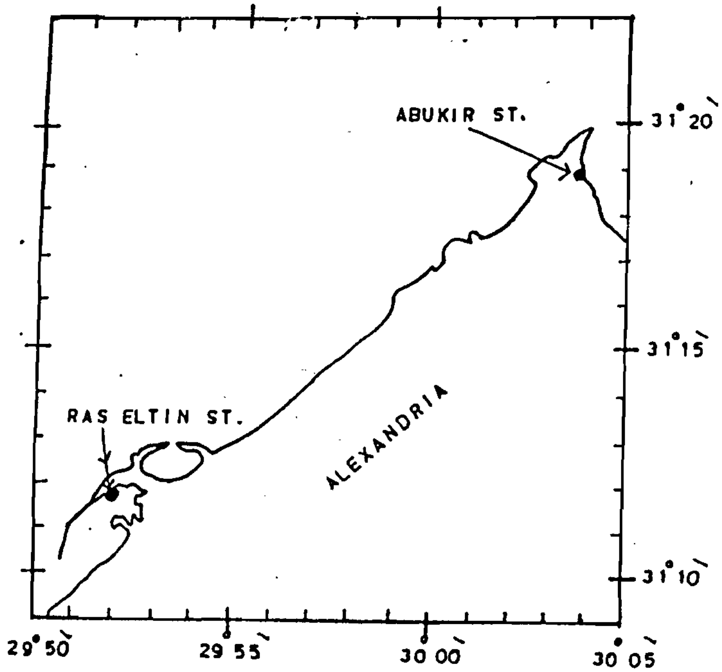

Fig. (1)
A map showing the positions of Ras Eltin and Abukir meteorological stations.

sea level (MSL), while that at Abu-kir is at about 9.31 m above MSL. The hourly value was taken as the conventional method in meteorology, i.e., the mean direction and speed over the last ten minutes of the hour.

Data and Method of Analysis:

The hourly values of wind velocity were taken at Ras Eltin station in the period from January 1976, to December 1979, while at Abukir one data analysed were from February 1979, to December 1979. The wind velocity was analysed into two components; one parallel to Alexandria coast and the other one normal to that coast. The monthly mean of the kinetic energy of wind was estimated using the equation (Seung, 1979):

$$K.E. = 1/2\,(\sigma_u^2 + \sigma_v^2)$$

where, σ_u^2 and σ_v^2 are the variances of the longshore and the normal to shore components, respectively.

The spectral analysis was applied on the time series of both wind components. The number of points in each time series was 720, corresponding to a record length of 720 hours (1 month). The highest frequency is 0.5 cycle/hour, corresponding to 2 hours period. To determine the variance at each frequency, the spectral density was multiplied by the frequency.

To find out the relation between wind velocity at Abu-kir and Ras Eltin stations, the coherence at different fequencies for both components was calculated using the standard spectral method (Bendat and Piersol, 1980). The linear regression equations between longshore components and normal to shore components, at the two stations have been determined using the least square method.

Monthly and Annual Variations of Wind Kinetic Energy:

The monthly mean kinetic energy of the wind in the different years (in knot^2/unit mass) is represented on Figure (2). This figure shows that the K.E. is minimum (10 knot^2) during the period from June to September, with little variations from one year to another, while the maximum energy (50 to 85 knot^2) is always found in December, with important year to year variations. This monthly evolution is obviously related to the cyclonic activity variations; the lowest energy exists when stable high pressure system is found over the Eastern Mediterranean region during summer. The yearly significant variations in K.E. in December and January may be related to the deepness and the tracks of the depressions passing over the area.

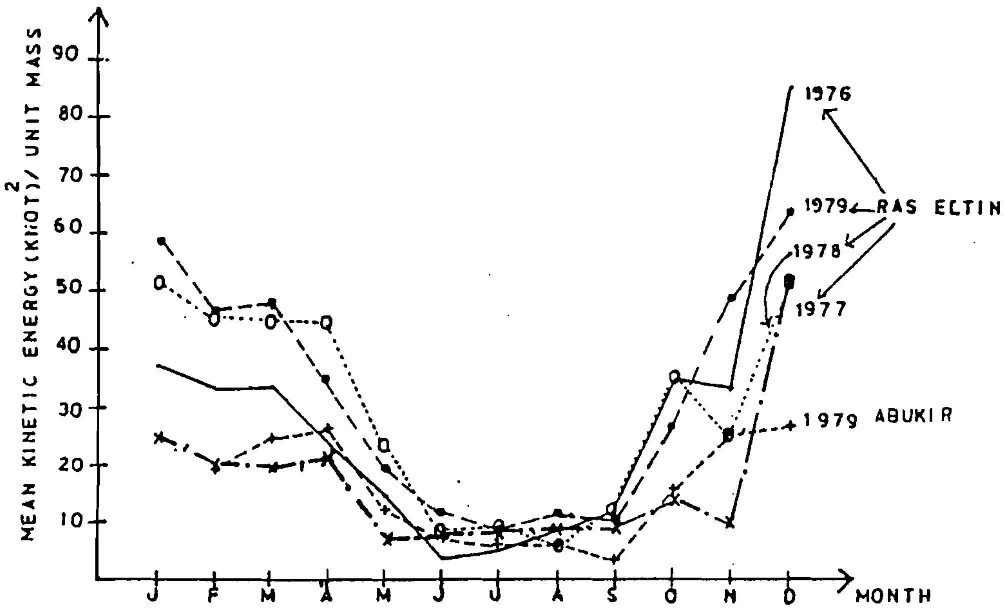

Fig. (2)

Monthly mean K.E. of wind at Ras Eltin and Abukir stations, $[1/2\ (\sigma_u^2 + \sigma_v^2)]$. σ is the standard deviation.

It is also observed that the K.E. at Ras Eltin station is much higher than that at Abu-kir station. This evidence is due to the position of Abu-kir station which is relatively shelterd and surrounded by land.

Monthly Variations of Variance:

The variances at the different frequencies can be represented as a function of the frequency (cycles/month); the variance axis with a linear scale and the frequency with a logarithmic scale.

At Ras Eltin station, Figure 3, the mean variance of the long shore component of the wind in December and January is mostly related to the low frequency range, with periods greater than 12 hours. From February, two peaks start to appear at the periods of 72 and 24 hours. In February, March, April and June the variance contained in the 72 hours period oscillation is more important than that in the 24 hour oscillation. However, in May, July and August, the variance at the 24 hours period is clearly dominating with a well defined peak. At last, in October and Novemer, the situation gradually changing to the winter conditions. The year to year variations in the same month at each frequency are marked by dashed vertical lines indicating the standard deviation values. This standard deviation is sometimes significantly important as in the case of September and April.

The mean variance of the normal to shore component at Ras Eltin station, Figure (4) shows the same features of the longshore one. In November, December, January, February and March, the variance is mostly due to low frequencies. In April the variances at the oscillations with 72 and 24 hours have nearly the same value, while the 24 hours period becomes quite important from May to Septemper. The year to year variations are pronounced in October which is a transitory month between summer and autumn.

The monthly evolution of the variance discussed above indicates the dominance of low frequency oscillations, which are due to large pressure systems in the Eastern Mediterranean basin associated with active winds in the period from November to the next March, while the daily variations, due to land-sea breezes, become more obvious in the period from May to September.

The variance at Abu-kir station showed the same evidence as at Ras Eltin, but variances are less than that at Ras Eltin station.

Coherence of Winds at Ras Eltin and Abukir Stations:

The coherences of wind between the longshors components at the two stations and also between the normal to shore components in 1979 are shown by Tables (1, A) and (1, B), respectively. From these tables it can be concluded that the normal to shore components are, in most ases,

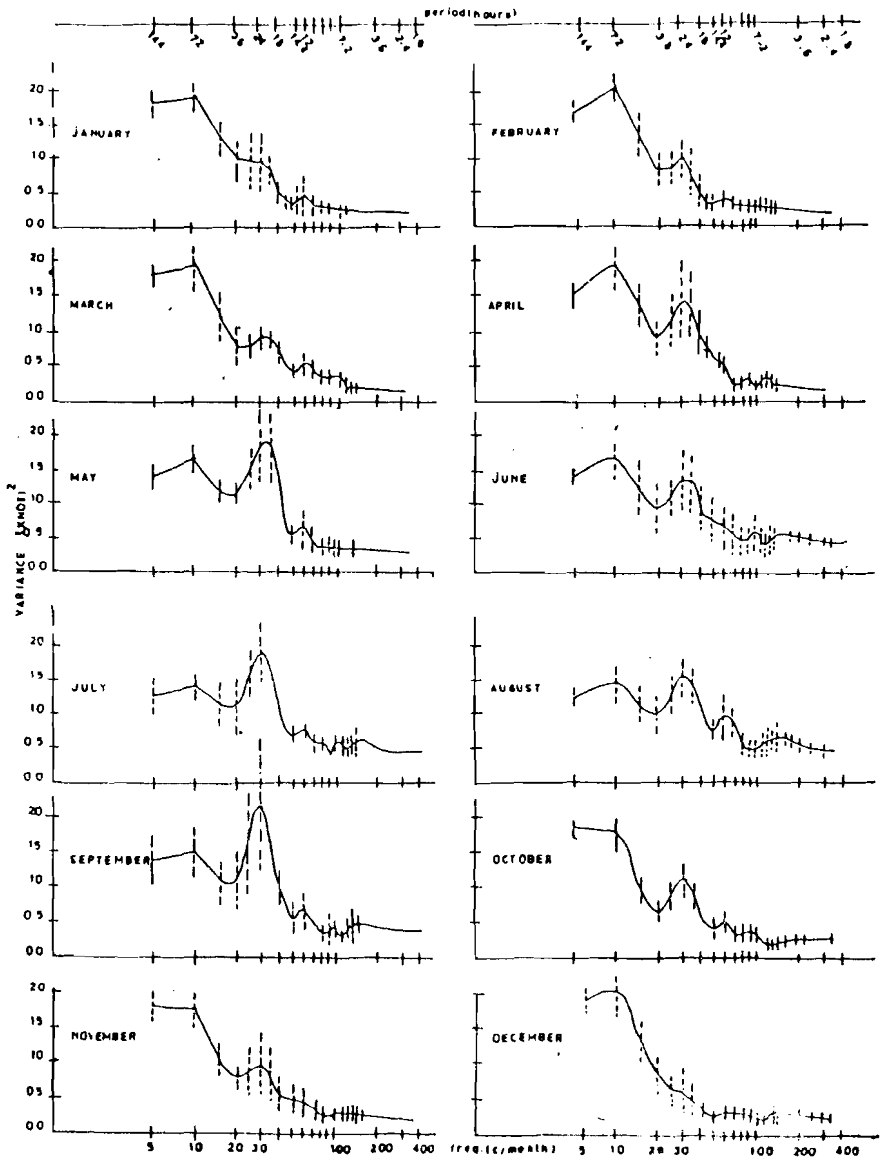

Fig. (3)
Monthly variance of wind component along Alexandria shore at different frequencies (Data is taken at Ras Eltin from 1976 to 1979).
Vertical lines indicate the standard deviations.

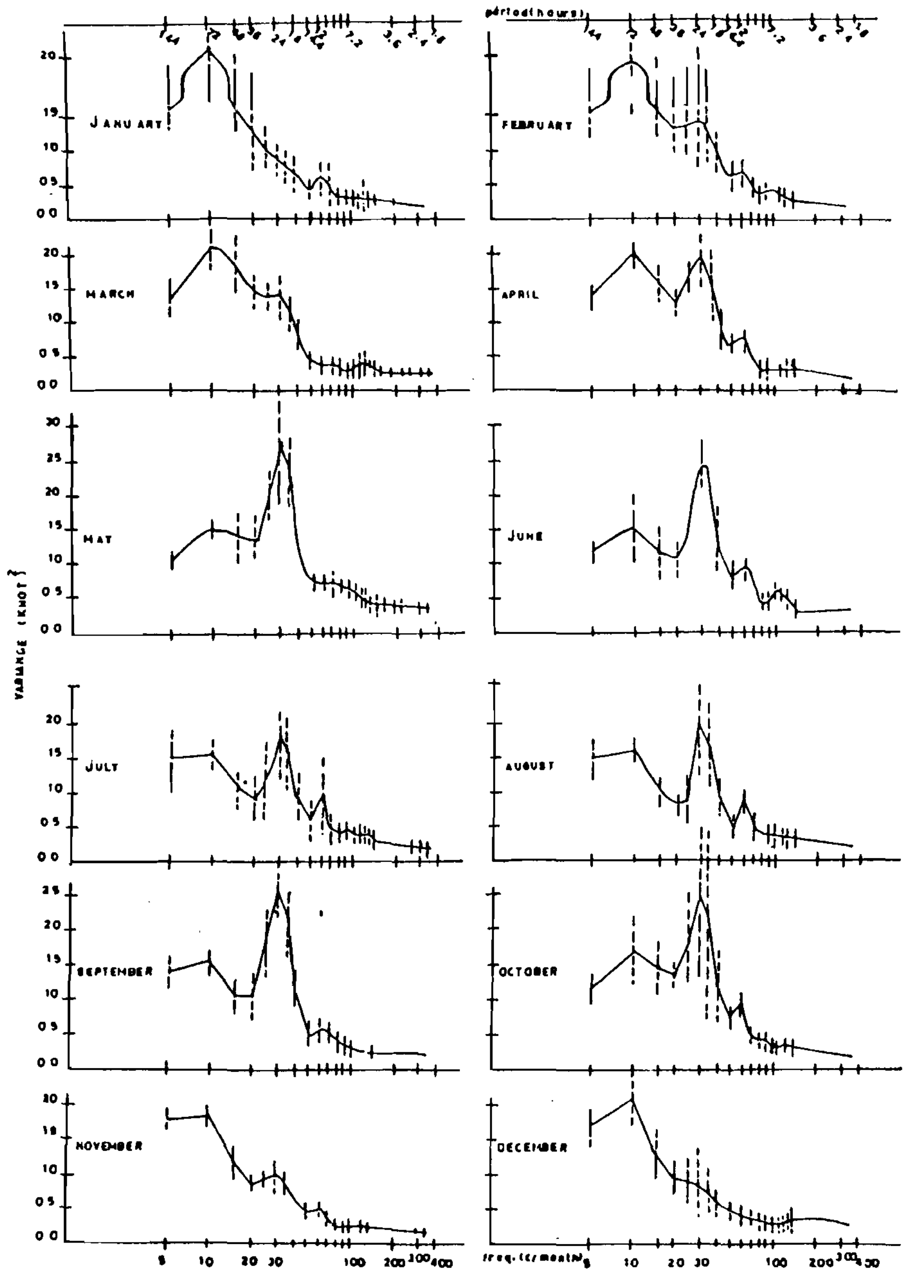

Fig. (4)
Monthly mean variance of wind component normal to Alexandria shore at different frequencies (Data is taken at Ras Eltin from 1976 to 1979). Vertical lines indicate standard deviations.

Table (1)
Results of Coherence Analysis Between Wind Components at Ras Eltin and Abukir (1979), at different periods. (x sumbol indicates a significant coherence at 95% confidence).

A. Component along Alexandria Coast.

Period Hours	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
144.00	x	x		x	x				x	x	x
072.00	x	x		x	x				x	x	x
048.00	x	x		x	x				x	x	x
036.00		x		x	x				-	x	x
028.80		x		x	x					x	x
024.00		x		x	x						
020.00	x	x		x	x						
018.00		x		x	x						
016.00				x	x						
014.00					x						
013.00					x						

B. Component Normal to the Alexandria Coast.

Period Hours	Feb.	Mar.	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
144.00	x	x	x	x	x	x	x	x		x	x
072.00	x	x	x	x	x		x			x	x
048.00	x	x	x	x	x	x	x			x	x
036.00	x	x	x	x	x		x		x	x	x
028.80	x	x	x	x	x	x	x		x	x	x
024.00	x	x	x	x	x	x	x	x	x	x	x
020.57	x	x	x	x	x	x	x		x	x	x
018.00	x	x	x				x		x	x	x
016.00			x							x	
014.40			x							x	
013.09			x						x	x	
012.00			x				x		x	x	
011.08			x				x		x		

significantly coherent for the oscillations with periods 20.57 and 144 hours, except in September when the wind was fairly weak. The longshore components, (Table 1, B) are less coherent and no coherence was found in April, july, August and September. This evidence might be due to the influence of the land between the two stations on the longshore component.

Relation Between Daily Mean Wind Velocity at the Two Stations:

The monthly correlation coefficients between the longshore wind components, and between the normal to shore components at the two stations were calculated, (Table 2). The correlation coefficients are significant in all months. The constants of the equation,

Speed at Abukir = b + m. Speed at Ras Eltin,

where, the speed is in konts, are shown by Table (2). These equation could be used to calculate the wind speed, at a given direction, at Abukir station from Ras Eltin wind data.

Table (2)
Correlation between daily mean wind components at Ras Eltin and Abukir in 1979 (speed at Abukir = b + m . speed at Ras Eltin).

MONTH	Longshore Component			Normal to Shore Component		
	b	m	r	b	m	r
February	-0.41	0.63	0.86	-0.03	0.53	0.92
March	0.353	0.84	0.93	-0.24	00.51	0.91
April	-1.37	0.40	0.44	-0.41	0.59	0.95
May	0.71	1.09	0.97	-0.63	0.62	0.91
June	0.75	1.04	0.95	-0.76	0.46	0.90
July	1.71	0.63	0.66	-0.76	0.66	0.96
August	1.30	0.65	0.71	0.15	0.60	0.70
September	0.42	0.21	0.50	-1.09	0.45	0.55
October	00.00	0.80	0.95	-0.31	0.58	0.74
November	-0.54	0.74	0.96	-0.40	0.58	0.91
December	-0.25	0.61	0.89	0.43	0.60	0.97

CONCLUSIONS

In the cool season when large number of depressions pass over the Eastern Mediterranean area, the low frequency oscillations contain most of the energy, while the land-sea breezes manifest its influence in the warm season from May to September.

The winds at Ras Eltin and Abukir stations are significantly correlated and predictible one from the other.

REFERENCES

Julius S. Bendat and Allan G. Piersol, (1980). **Engineering Applications of Correlation and Spectral Analysis.** A Wiley-Interscienca Publication.

Seung, Young-HO, (1979). **Mouvment verticaux de basse frequence dans une zone de formation d'eaux profondes.** Thesis of a Third Cycle Doctorate at Paris University-VI.