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TRANSPORT AND VERGENCE OF THE EASTERN MEDITERRANEAN DRIFT CURRENT FROM THE AVERAGE PRESSURE DISTRIBUTION

TRANSPORT I VERGENCIJA STANJA UZROKOVANIH VJETROM U ISTOČNOM MEDITERANU RAČUNATIH IZ SREDNJIH RASPODJELA TLAKA ZRAKA

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7300 surface synoptic charts were used to study the wind, the transport and the vergence field of wind drift current over the eastern Mediterranean sea during the period January 1971 to December 1975. During winter and spring seasons, the eastern Mediterranean is affected by depression. The transport of the wing drift current gives souththe northern extension of the Azores high, Lee and Sudan monsoon depressions.

During autumn, it is affected by depression activities as well as the northern extension of the Sudan monsoon depression. The transport of the wind drift current gives southwest transport at the Egyptian coast except Sinai coasts during winter and spring seasons. During summer the transport along the western coasts becomes westerly while over the remaining ones they are southwesterly. During the autumn season, the western coasts of Egypt as well as Sinai are affected by the northwest transport. From the study of the vergence field of the wind drift current, the Eastern Mediterranean is affected by divergence more than convergence during winter and spring seasons. During summer surface convergence is pronounced over the southern part of the eastern Mediterranean, while divergence is more effective over the northern part. The late autumn vergence field resembles that of early winter.

INTRODUCTION

The direct use of surface synoptical charts can give reasonably approximate value close to the observed wind. The synoptical charts of the Mediterranean were collected for a period of five years; four daily surface charts were collected from January 1971 to December 1975. Isobars were drawn every 2.5 mb and pressure systems were determined. From these analyzed charts geostrophic wind has been estimated and surface wind has been calculated over regions of 1° latitude by 1° longitude. Surface winds were used to calculate drift current, current transport and vergence field of current in the eastern Mediterranean every month.

The direction of the drift current is taken to be 54° to the right of the wind as Ekman first stated. The current speed is calculated from the formula given by Ekman (1905).

$$V = \frac{1.27\,w}{\sqrt{\sin \varnothing}} \quad \text{cm/sec} \; \ldots\ldots\ldots \; (1)$$

where V is the surface wind-drift current speed, W is the surface wind speed in meters/sec and Ø is the latitude.

The transport of the wind drift current is taken 90° to the right of the wind from surface to the depth of friction. The amount of wind drift transport is calculated from the formula given by Brooks (1939):

$$T = \frac{2.6\,p\,W^2}{2\,w\,\sin\varnothing} \quad \text{ton /m/sec} \; \ldots\ldots\ldots \; (2)$$

where T is the transport and p is the air density.

The wind drift current vectors are resolved into x and y components, in the east and in the north respectively. Using these components, the vergence field is calculared from the equation given by Knauss (1978).

$$\text{div (a)} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \quad \ldots\ldots\ldots \; (3)$$

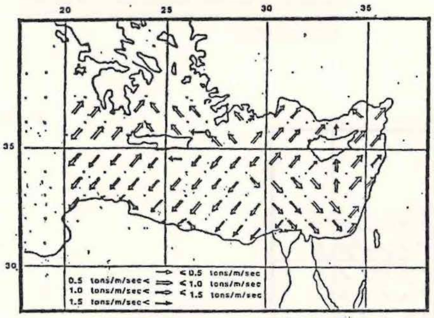
if the numerical value is negative, there will be convergence and if it is positive there will be divergence.

The numerical calculation for the stationary wind currents in the central and eastern Mediterranean were carried out by Meskalenko (1968). This was originally used by Shtockman (1946). Ovchinnikov (1966) calculated the geostrophic current relative to 1000 db. Gerges (1976) calculated the pure drift current from the air pressure distribution over the sea surface at different levels during winter season.

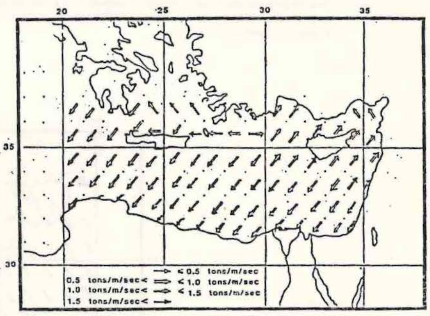
RESULTS AND DISCUSSION

Monthly variation of the transport of wind drift currents using wind velocity and equation of mass transport

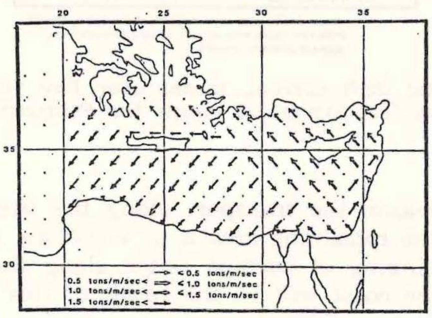
During winter season the Egyptian coasts except Sinai coasts are affected by southwest transport which causes coastal convergence, coastal sinking of surface water and bottom currents away from the coast. Sinai coasts are affected by the northwest and the northeast transport in early and late winter respectively which causes coastal divergence, coastal upwelling of subsurface cold water and bottom currents towards the coast (Fig. 1).



TRANSPORT OF WIND DRIFT CURRENT FOR JANUARY OVER FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.



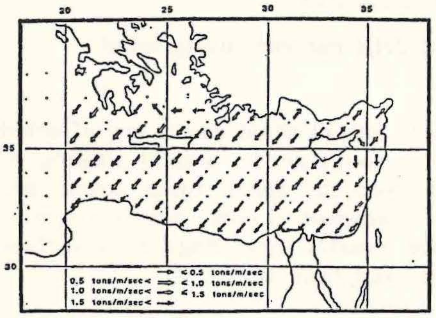
TRANSPORT OF WIND DRIFT CURRENT, MEANS FOR MARCH FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.



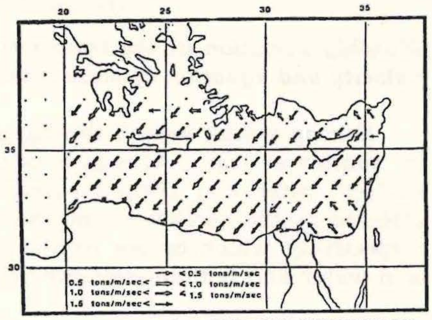
TRANSPORT OF WIND DRIFT CURRENT, MEANS FOR DECEMBER OVER FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.

Fig. 1. Transport of wind drift current, means over five year period (1971—1975) computed from surface synoptical charts for December, January and March.

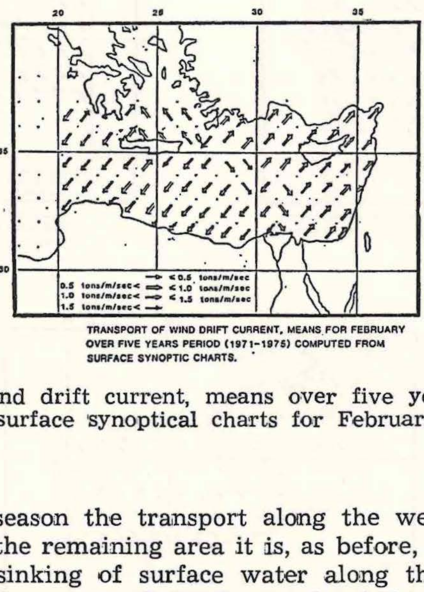
During spring season the Egyptian coasts are affected by the strong southwest transport which causes coastal convergence, downwelling and bottom currents away from the coasts. By the end of spring season, the transport along the Sinai coasts changes into northwest which means that coastal divergence and upwelling will take place again (Fig. 2).



TRANSPORT OF WIND DRIFT CURRENT, MEANS FOR APRIL OVER FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.



TRANSPORT OF WIND DRIFT CURRENT, MEANS FOR MAY OVER FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.



TRANSPORT OF WIND DRIFT CURRENT, MEANS FOR FEBRUARY OVER FIVE YEARS PERIOD (1971-1975) COMPUTED FROM SURFACE SYNOPTIC CHARTS.

Fig. 2. Transport of wind drift current, means over five year period (1971—1975) computed from surface synoptical charts for February, April and May.

During summer season the transport along the western coasts becomes westerly. While over the remaining area it is, as before, southwesterly. Again, coastal convergence, sinking of surface water along the coasts and bottom currents away from the coast will be the result of this southwesterly transport (Fig. 3).

During autumn season, the western coasts of Egypt as well as Sinai coasts are affected by northwest transport which gives rise to coastal divergence, coastal upwelling of the subsurface cold water and bottom currents towards the coast. The coasts north and northwest from the Nile Delta, as in other seasons, are affected by the southwesterly transport which gives rise to coastal convergence, downwelling and bottom currents away from the coasts (Fig. 4).

The study shows that the highest values of the transport are encountered during spring season while the lowest ones are during autumn. During spring, coastal convergence and downwelling are strongest along the

Egyptian coasts while the coastal divergence and the upwelling are more pronounced during autmn.

Monthly variation of the convergence of wind drift current

During winter season the eastern Mediterranean is affected by divergence more than convergence. The maximum values of divergence (35×10^{-5} sec^{-1}) occur in winter (December) giving strong upward vertical current of subsurface cold water (Fig. 5).

Divergence is still more pronounced phenomenon over the eastern Mediterranean during spring. The strongest surface divergence occurs in early spring where it reaches a value of 35×10^{-5}/sec (March and April). The strongest convergence is, also, encountered in early spring when it reaches a value of -25×10^{-5}/sec (March) giving strong downward vertical current of surface water (Fig. 6).

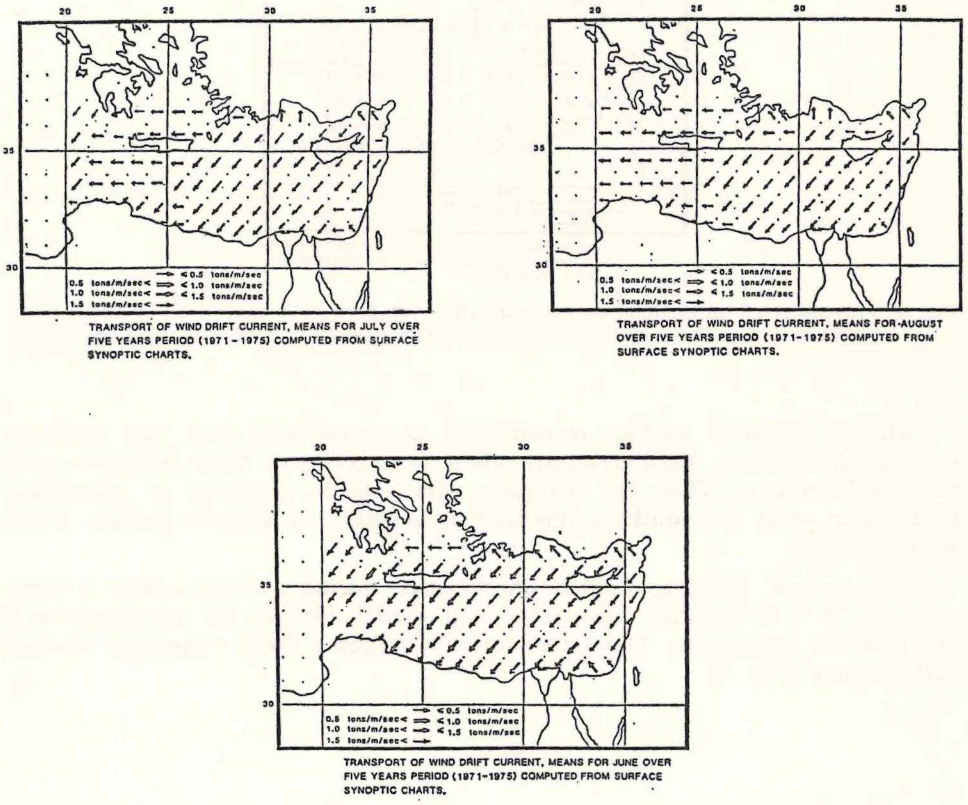


Fig. 3. Transport of wind drift current, means over five year period (1971—1975) computed from surface synoptical charts for June, July and August.

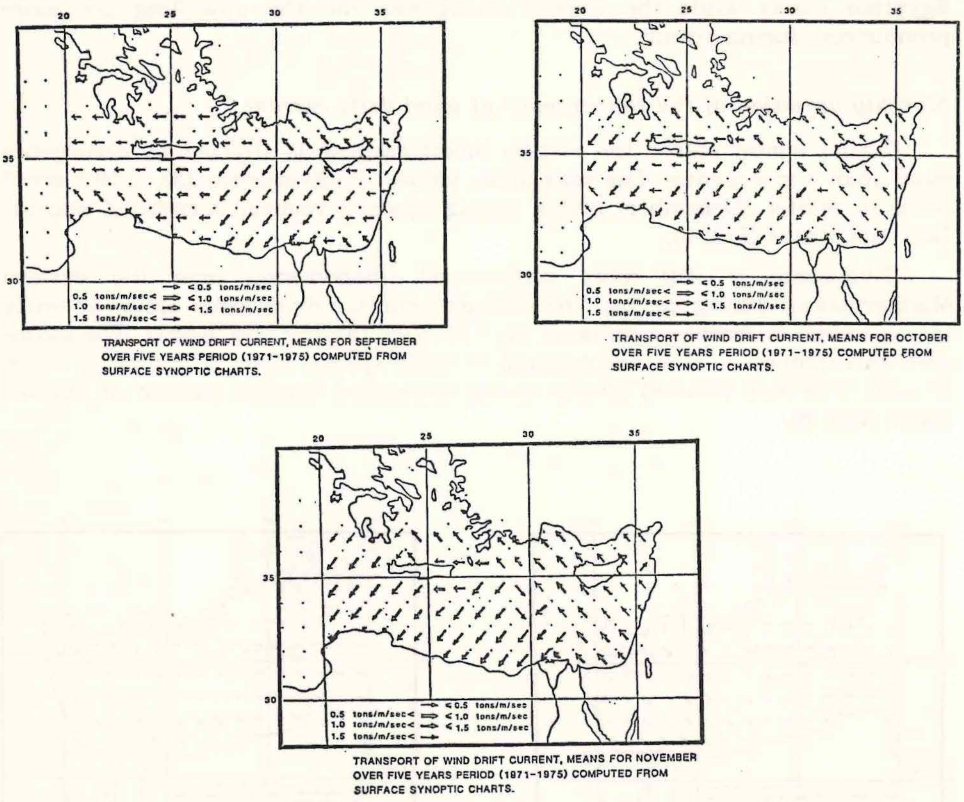


Fig. 4. Transport of wind drift current, means over five year period (1971-1975) computed from surface synoptical charts for September, November and December.

During summer, surface convergence is pronounced over the southern part of the eastern Mediterranean while divergence is more effective over the northern part. Thus the northern part acts as a source of subsurface cold water while the southern one acts as a sink that absorbs surface warm water (Fig. 7).

The poorest vergence field is encountered during autumn where a minimum of 10×10^{-5}/sec for divergence and -10×10^{-5}/sec for convergence is observed in September. The later autumn vergence field resembles that of early winter (Fig. 8).

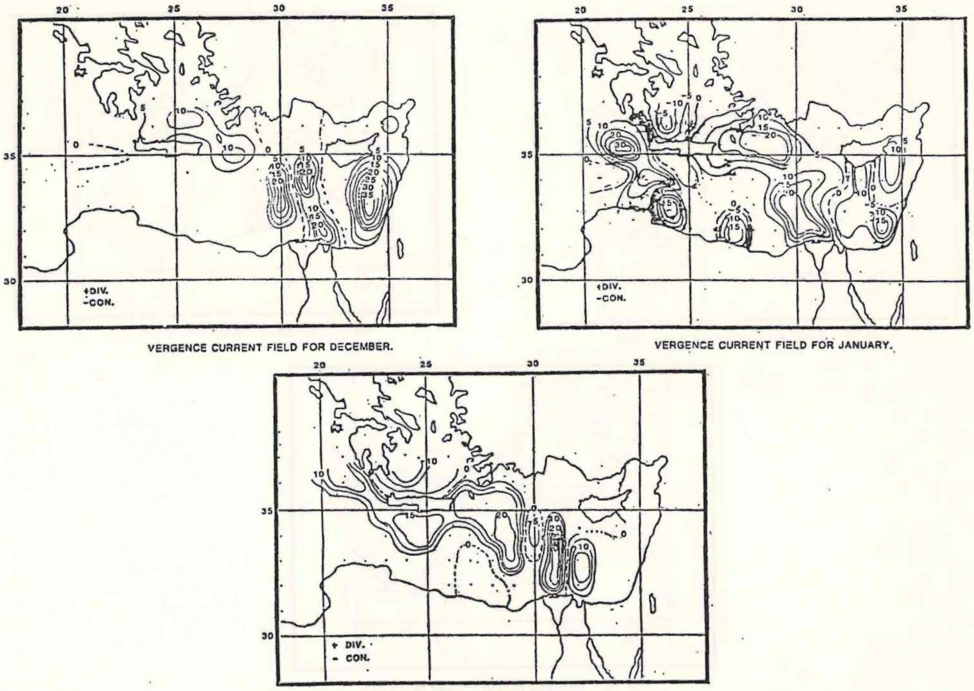


Fig. 5. Vergence current field for December, January and February.

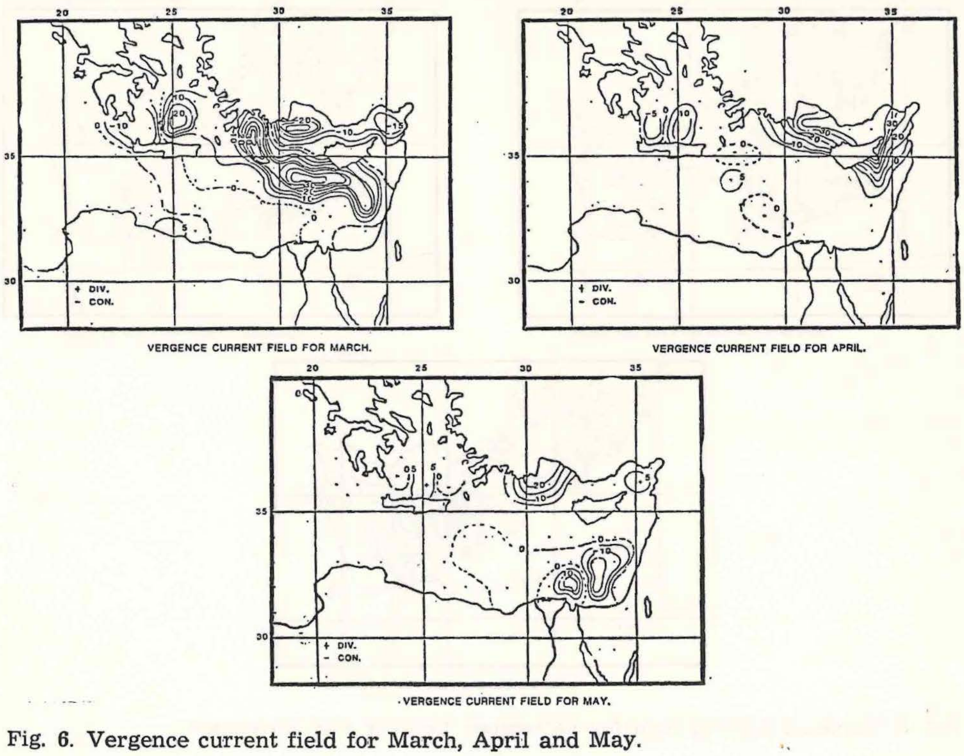


Fig. 6. Vergence current field for March, April and May.

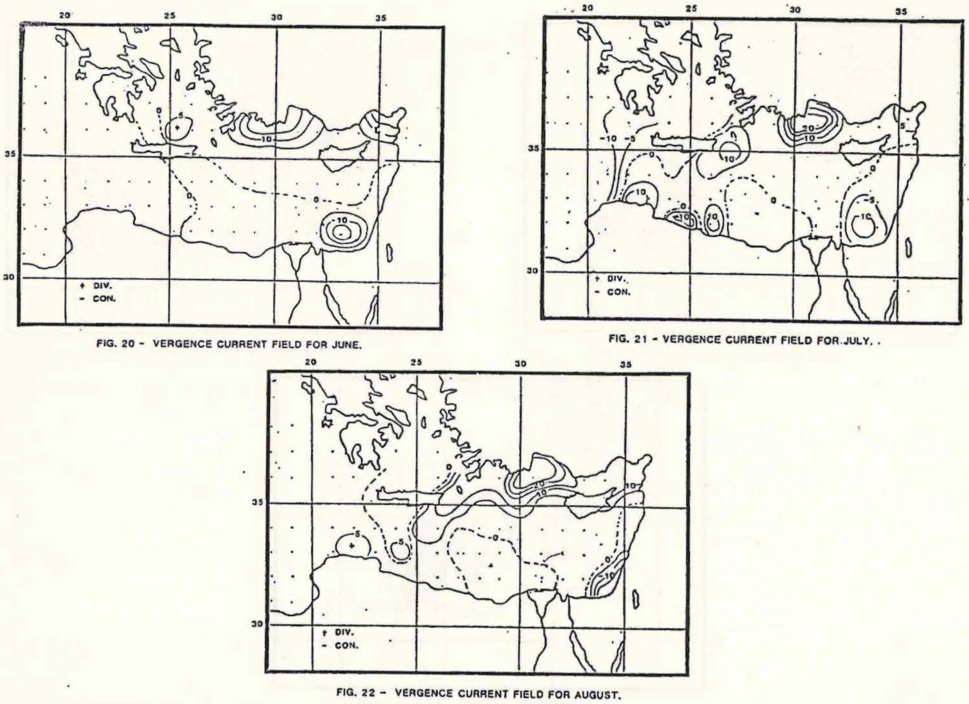
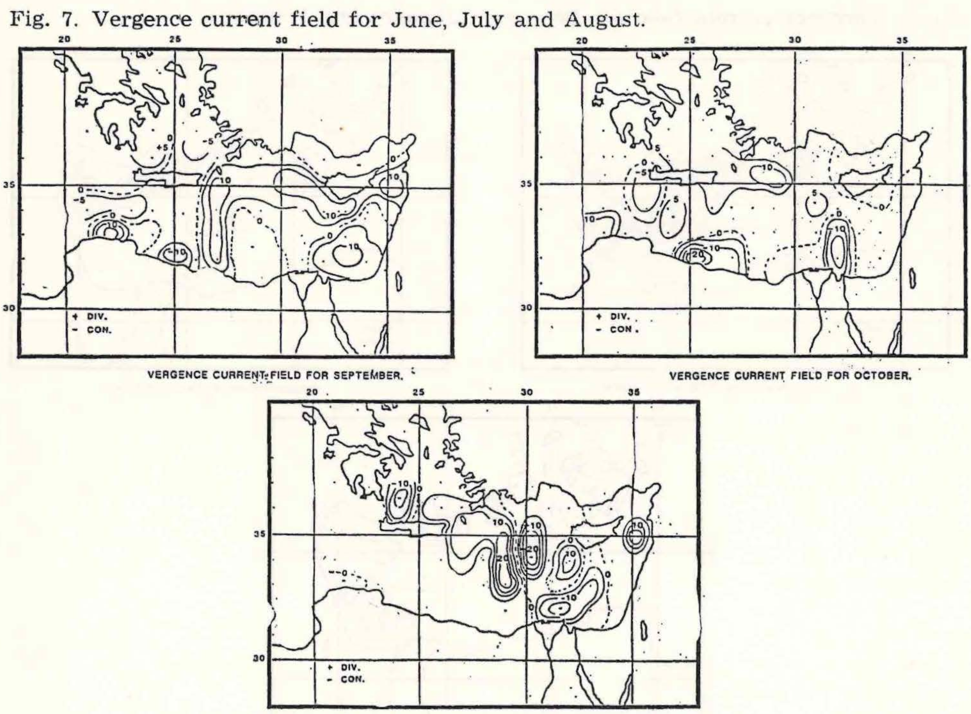


FIG. 20 - VERGENCE CURRENT FIELD FOR JUNE.

FIG. 21 - VERGENCE CURRENT FIELD FOR JULY.

FIG. 22 - VERGENCE CURRENT FIELD FOR AUGUST.

Fig. 7. Vergence current field for June, July and August.



VERGENCE CURRENT FIELD FOR SEPTEMBER.

VERGENCE CURRENT FIELD FOR OCTOBER.

VERGENCE CURRENT FIELD FOR NOVEMBER.

Fig. 8. Vergence current field for September, October and November.

CONCLUSIONS

1. From the study of the transport of wind drift current it can be shown that:

   (a) During winter season the Egyptian coasts, except Sinai coasts, are affected by the southwest transport. Sinai coasts are affected by the northwest and the northeast transport in early and late winter respectively.

   (b) During spring season the Egyptian coasts are affected by strong southwest transport. By the end of spring season, the transport along Sinai coasts changes into northwest.

   (c) During summer season the transport along the western coasts becomes westerly while over the remaining ones they are south-westerly.

   (d) During autumn season, the western coasts of Egypt as well as those of Sinai are affected by the nortwest transport. The coasts north and norhtwest of Delta are affected by the southwesterly transport.

   (e) The highest values of the transport are encountered during spring and the lowest ones during autumn.

2. From the study of the vergence field of the wind drift current it can be concluded that:

   (a) During winter season, the eastern Mediterranean if affected by divergence more than convergence.

   (b) During spring season, divergence is still the most effective phenomenon over the eastern Mediterranean.

   (c) During summer season, surface convergence is pronounced over the southern part of the eastern Mediterranean, while divergence is more effective over the northern part.

   (d) The late autumn vergence field resembles that of early winter.

   (e) The poorest vergence field is during September, with values of $+ 10 \times 10^{-5}$ sec^{-1} for divergence and of -10×10^{-5} sec^{-1} for convergence.

   (f) The maximum values of divergence occur during December, March and April, 35×10^{-5} sec^{-1}.

   (g) The strongest convergence occurs in March, -25×10^{-5} sec^{-1}.

In addition, the analyses showed that the vergence field of the current in the eastern Mediterranean during December and January, gives the dominance of the cyclonic, i. e. + ve vergence. This agrees with the previous results given by Ovchinnikov (1966) and Gerges (1976).

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TRANSPORT I VERGENCIJA STRUJA UZROKOVANIH VJETROM U ISTOČNOM MEDITERANU RAČUNATIH IZ SREDNJIH RASPODJELA TLAKA ZRAKA

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KRATKI SADRŽAJ

Korišteno je 7300 površinskih sinoptičkih karata za studij vjetra, transporta i vergencije struja uzrokovanih vjetrom u istočnom Mediteranu u periodu od siječnja 1971. do prosinca 1975. Tijekom zime i proljeća istočni Mediteran je pod utjecajem ciklonske aktivnosti. Tijekom ljeta on je pod utjecajem sjevernog ogranka Azorske anticiklone, Lee i Sudanske monsunske depresije.

Tijekom jeseni istočni Mediteran je pod utjecajem ciklonske aktivnosti kao i sjevernog ogranka Sudanske monsunske depresije. Uz obalu Egipta, osim uz obale Sinaja tijekom zime i proljeća, transport struja uzrokovanih vjetrom pokazuje se kao jugozapadni. Duž zapadne obale tijekom ljeta imamo

zapadni smjer transporta, a u ostalom dijelu jugozapadni. Tijekom zime je zapadna obala Egipta kao i obala Sinaja pod utjecajem sjeverozapadnog transporta. Iz studija polja vergencije struja uzrokovanih vjetrom slijedi da je istočni Mediteran pretežno područje divergencije tijekom zime i ljeta. Tijekom ljeta površinska konvergencija izražena je iznad južnog dijela istočnog Mediterana, dok je divergencija izraženija iznad sjevernog dijela. Polje vergencije u kasnu jesen podsjeća na ono u ranu zimu.