PREDICTION OF WET PERIODS IN EGYPT FOUR TO SIX DAYS IN ADVANCE

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ABSTRACT

An attempt is made to predict the occurrence of wet periods in the Middle East 4 to 6 days in advance. Such a forecast is of great value for cotton cultivation in Egypt during the cold season (December to March).

Generally, wet periods in the Middle East are known to be associated with the development of low pressure systems (the so-called Cyprus lows) over the eastern Mediterranean Sea. Such systems have been observed at upper levels, particularly at 500 mb, and have been found to originate as upper lows further west or west-southwest over northwest Africa, south of latitude 30°N, where they usually first appear on our charts.

These upper lows move east-northeastward, and after an average time of five days they give rise to active Cyprus depressions. At this stage their displacements are frequently checked either by the blocking effect of higher pressures in advance, or by the introduction of extremely cold air currents from northern and central Russia.

Rainfall has been observed to be heavy and to extend to southern Egypt during wet periods with the passage, at the 500-mb level, of troughs extending from northern or central Russia southwards to Egypt or the northern Sudan.

1. Intensity and distribution of precipitation

1. Wet periods are associated with intense depressions near Cyprus;
2. The main mechanism underlying the development of these depressions is the regeneration of shallow lows in the eastern Mediterranean area by the inflow of cold polar air from high pressure systems covering the Balkans; and
3. In Egypt rainfall is usually heavier and extends to greater distances inland than usual when the center of the low is nearer to the Egyptian coast and the isobars run almost north-south for a fair distance inland.

Through further study of these conditions the following conclusions have been recently reached by the present writer.

1. The amount of precipitation associated with a Cyprus low does not necessarily depend on the intensity of that low. For example, on 1 February 1950 (fig. 2), a deep Cyprus low covered the eastern Mediterranean area with a central pressure of about 1000 mbs, but no rain was reported in Egypt on that day except for drops at Port Said and El Arish.

2. Moderate, rather widespread rain extending inland to upper Egypt has sometimes been found to be associated with shallow Cyprus depressions. An example occurred on 16 January 1950 (fig. 3), when pressure at the center was as high as 1015 mb, while precipitation extended southward to Minia, in middle Egypt. Another example occurred on 11 February 1951, when a remarkably shallow center of low pressure, 1021 mb, gave rise to widespread rain (fig. 4). Over Egypt, fronts were absent on the surface charts for that day.

3. Depressions over the eastern Mediterranean region sometimes become weaker in spite of the flow of cold air from eastern Europe and the Balkans, where high pressure is established.

An example of this type took place on the 10 February 1951 (fig. 5), when the eastern Mediterranean area was occupied by a depression, having a central pressure of 1009 mb, west of Cyprus. The pressure was then high over the Balkans and southern Russia, and an east to northeast stream of cold air was blowing from there toward the eastern Mediterranean region.

The depression had filled rapidly by the next day (fig. 4); the pressure at the center rising to 1021 mb in 24 hours, although the winds were still coming from eastern Europe and the Balkans where the high pressure cell was stationary and now more intense.

From these examples, it can be deduced that the existence and characteristics of the Cyprus depression are not particularly relevant to the prediction of rainfall in middle or upper Egypt. Thus the surface distribution of pressure is not the only factor affecting the rainfall. Other factors, such as the wind distribution (and associated contour patterns) at upper levels are believed to be much more influential.

2. Extended upper troughs

According to Riehl (1950), the air currents at middle and upper troposphere levels (600–200 mb) over the low latitudes are not steady but highly variable, with trains of well developed waves or vortices present. When these disturbances combine with troughs in the polar westerlies of the middle and high latitudes,

the resulting extended troughs often reach from pole to equator. To the east of these trough lines heat is injected into the polar zone in a few narrow strips of longitude. To some extent therefore, changes of flow configuration and intensity at higher latitudes must depend on the availability of low latitude disturbances to form extended troughs.

Cressman (1948) demonstrated that the amplitudes of high and low latitude disturbances and the intensity of the associated bad weather and rainfall increase wherever these disturbances join to form extended upper troughs.

3. Shape of contour lines at 500-mb level during rainy periods in winter

Scully (1951) stated that the most useful upper air map appeared to be that for the 500-mb level. An appearance of a cold low at this level is accompanied by a change in the surface map within 24–36 hr; and well developed troughs aloft are accompanied by increased middle and high cloud cover, as observed frequently in connection with thunderstorm formation and shower activity in the western and central Mediterranean area.

The writer believes that the findings of Riehl,

FIG. 1. Egypt.

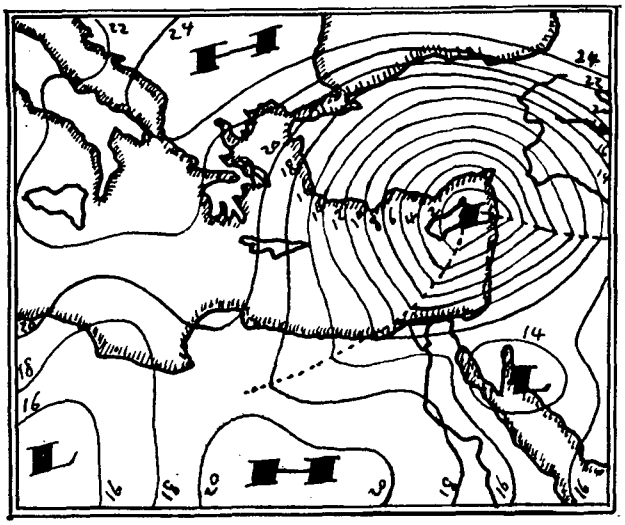

FIG. 2. Surface chart, 0600 GCT 1 February 1950.

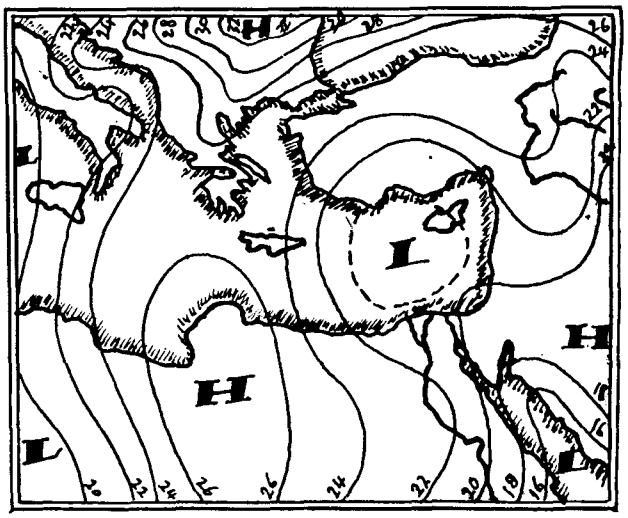

FIG. 4. Surface chart, 0600 GCT 11 February 1950.

Cressman and Scully are this applicable, to some extent, to the eastern Mediterranean area. Cyprus depressions are not associated with rainfall over Egypt, unless they are observed at the 500-mb level. It has been observed that a necessary and sufficient condition for the occurrence of rainfall over lower Egypt is the existence of a trough at the 500-mb level, extending from central or northern Russia to the eastern Mediterranean region including Egypt. Most of the rainfall takes place in the vicinity of the trough line.

Showers have frequently been observed over the extreme west coast when a trough line reaches Cyrenaica. Rain spreads eastward with the movement of the trough line in that direction. As soon as that trough line moves east of Transjordan, precipitation ceases abruptly in Egypt.

Sometimes a trough line may then return westward to Transjordan while the trough deepens due to the inflow of very cold polar air from northern Russia. Moderate rain then starts to fall again over lower Egypt, and may even extend to middle Egypt.

A selected example of these observations is given in figs. 6, 7, 8, 9 and 10, which show the position of the trough and trough line during the period 7–11 January 1950.

The trough line was at about longitude 23°E on the 7th (fig. 6), when rain fell at Salloum and Sidi-Barrani only. On the 8th (fig. 7), the trough line moved to the Alexandria area, while the showers spread to the coast to include Port Said, the Delta and the Cairo area; and to middle Egypt to include Fayoum.

Precipitation ended west of Matruh on the 9th (fig. 8), but extended to El Arish which the trough line passed on that day. No rain took place over Egypt on the 10th (fig. 9), when the trough line moved to western Iraq. On the 11th (fig. 10), the trough line receded westward to Palestine, and the trough deepened with a stream of colder air in the rear. Showers started to fall again over many places in lower Egypt.

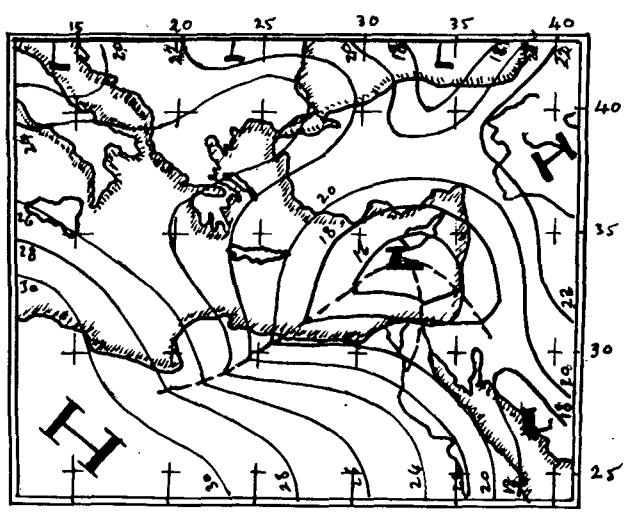

FIG. 3. Surface chart, 0600 GCT 16 February 1950.

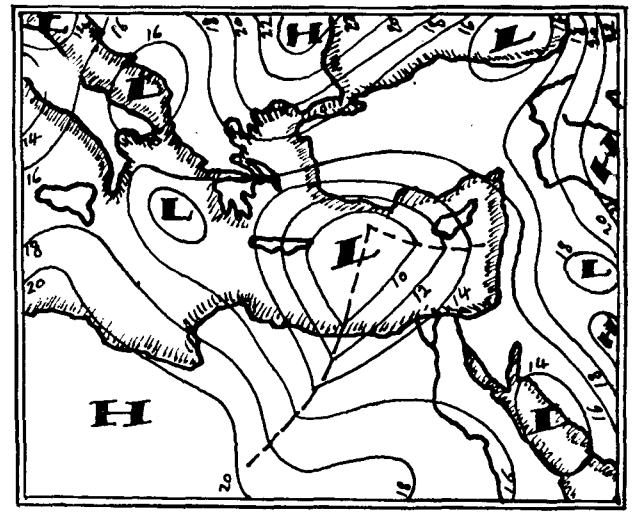

FIG. 5. Surface chart, 0600 GCT 10 February 1950.

4. Relation between intensity of rainfall and characteristics of contour lines at 500 mb

Observations showed that the intensity of rainfall and its extension further southward to middle Egypt are greater:

1. the nearer the trough line is to the north-south direction;
2. the smaller the angle between the northwesterly cold and the southwesterly warm streams;
3. in the absence of closed centers of low pressure in the trough from southern and central Russia to Egypt, *i.e.*, in the absence of easterly winds which cut across the flow of southwesterly winds to decrease heat transfer from low to high latitudes;
4. the more parallel isotherms are to contour lines;
5. the lower the temperature is at the trough line;
6. the deeper the trough, as a result of the inflow of very cold air from northern Russia in the rear. The trough then becomes stationary and may move westward. As soon as the flow of very cold air is cut off, to be replaced with a flow from the northwest Atlantic area, the trough starts to move eastward again;
7. the more extensive the trough is in the north-south direction.

5. Development of the trough at 500 mb

The trough extending from central Russia to Egypt is a combination of the trough in the polar westerlies that approach Europe, and a low latitude disturbance. This upper tropical low usually is complex, and is first observed over northwest Africa. It remains stationary for some days in the early stages of formation and then starts to move. A low pressure center appears near the coast of Morocco or Algiers, while another center becomes located over the Sahara south of latitude 30°N.

The first center, accompanied by bad weather,

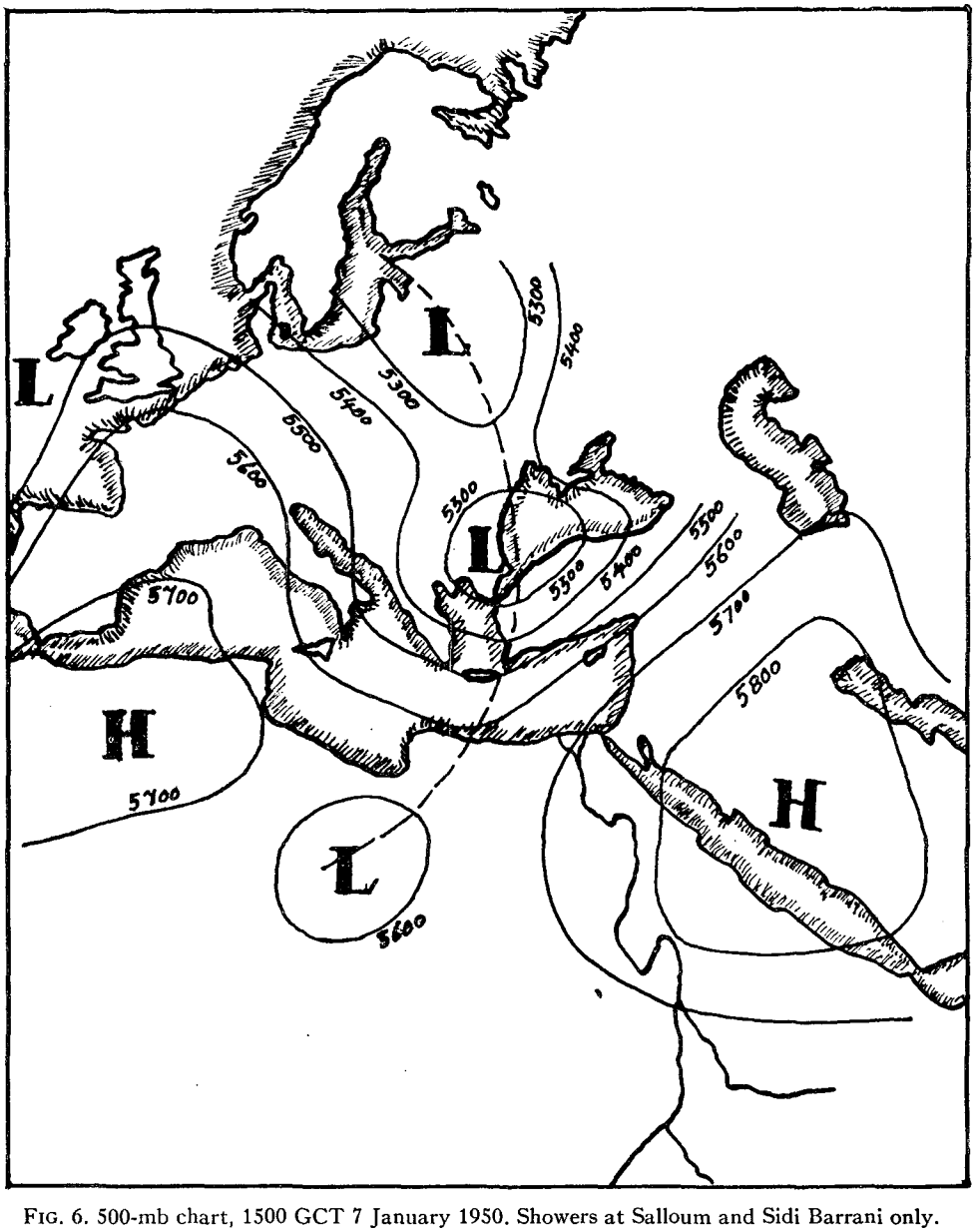

FIG. 6. 500-mb chart, 1500 GCT 7 January 1950. Showers at Salloum and Sidi Barrani only.

moves northeastward to Italy, the Adriatic Sea and then to the Balkans. The second one moves to southern Tunisia and then along or near the African coast until it reaches the southeastern Mediterranean sea. There it amalgamates with the trough which lies further north, to form a combined trough that extends sometimes as far south as central Sudan.

The initial movement of the second vortex may be controlled by another vortex developing in the eastern Atlantic area near Africa. This hypothesis needs further investigation and study; but once the depression starts to move, it continues to follow the track just described.

6. The blocking effect

The anticyclone following the extended trough at 500 mb, may occupy quite a considerable area and extend from Scandinavia to the central Mediterranean Sea and Libya. This anticyclone is usually associated with a warm anticyclone at the surface to form a block of high pressure. Once this block is established, it remains almost stationary for a week or more, while the advanced trough dominates the Mediterranean Sea and Egypt. Showers continue to fall over lower and middle Egypt. The trough deepens, and may even move westward if the trough line has already passed east of Egypt.

As soon as the surface anticyclone starts to weaken, the upper one weakens also, and both are displaced eastward along with the trough in advance. At once, precipitation decreases in intensity and extension inland, and finally stops when the 500-mb trough line reaches Iraq. The eastern Mediterranean area is then dominated by high pressure.

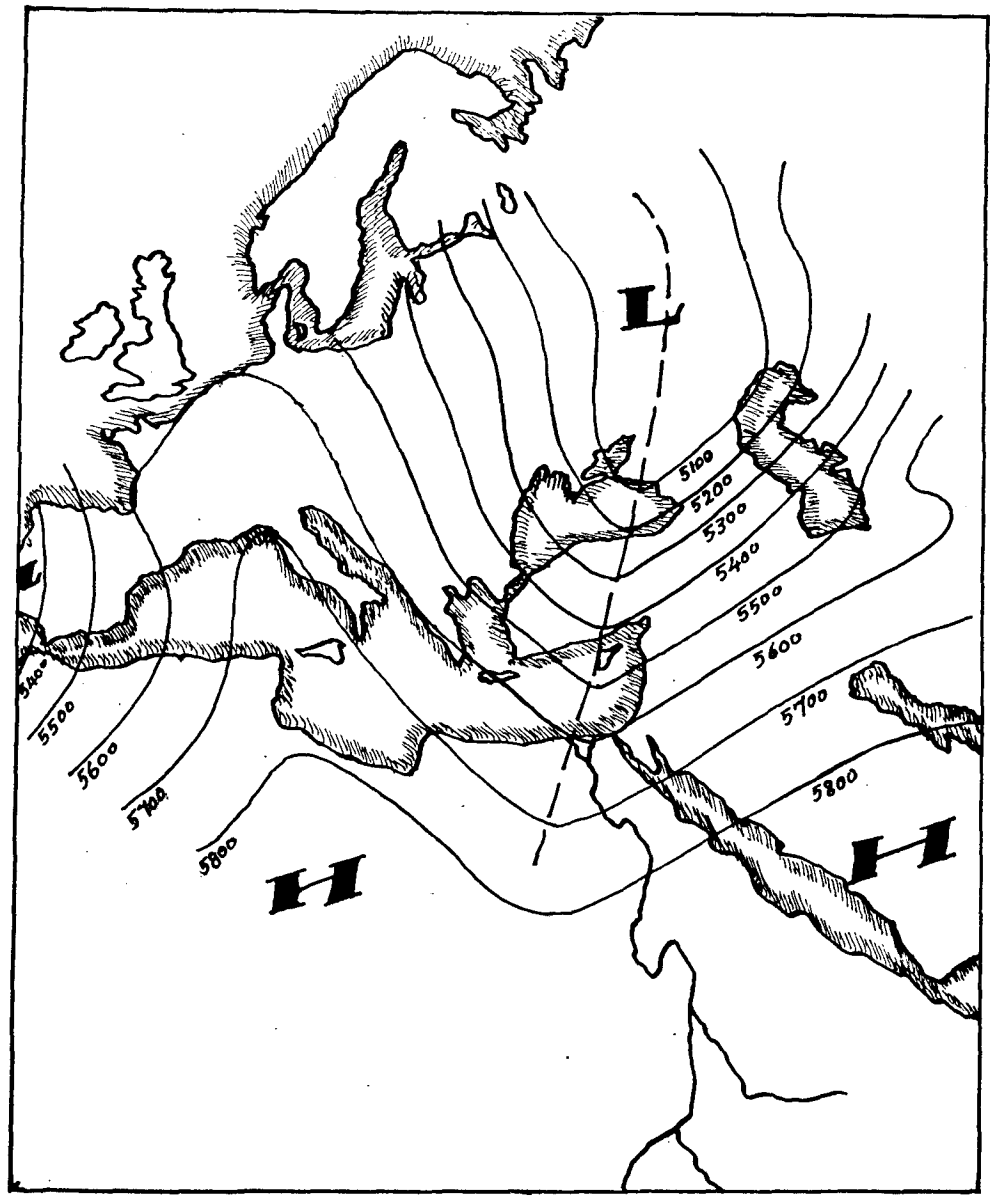

FIG. 7. 500-mb chart, 1500 GCT 8 January 1950. Showers extended to Port Said and to Fayoum.

7. Forecast of rainfall a few days in advance

It has been stated that rain falls in Egypt during winter only if an extended trough is present. The formation of such a trough depends on the location of a low latitude vortex, which originally develops in the Sahara, south of Morocco or Algiers. In the absence of a block, such a center takes 4–6 days to arrive at the eastern Mediterranean region. The initial discovery of the centers is an early indication to expect the formation of an extended trough, with associated rainfall 4–6 days after the Sahara center begins to move. When the center reaches Cyrenaica, rain may start to fall over the extreme western part of the Egyptian coast.

If no vortex is observed over the southern Sahara Desert, a dry spell of at least 6 days duration is to be expected. In this case the African high pressure center oscillates northward; a result which is of great value to agriculture, irrigation and industry.

Continued rainfall would be forecast in each of the following cases:

1. With the introduction at 500 mb, of polar continental air in a northeasterly flow from central Russia, the trough deepens and moves westward. Rain would then be expected to increase in intensity and spread inland.
2. The blocking effect, described in section 6, is present.

When either of these situations terminates, rainfall will diminish in intensity and showers will become light and be restricted to coastal areas. There they may be associated with minor waves forming on the

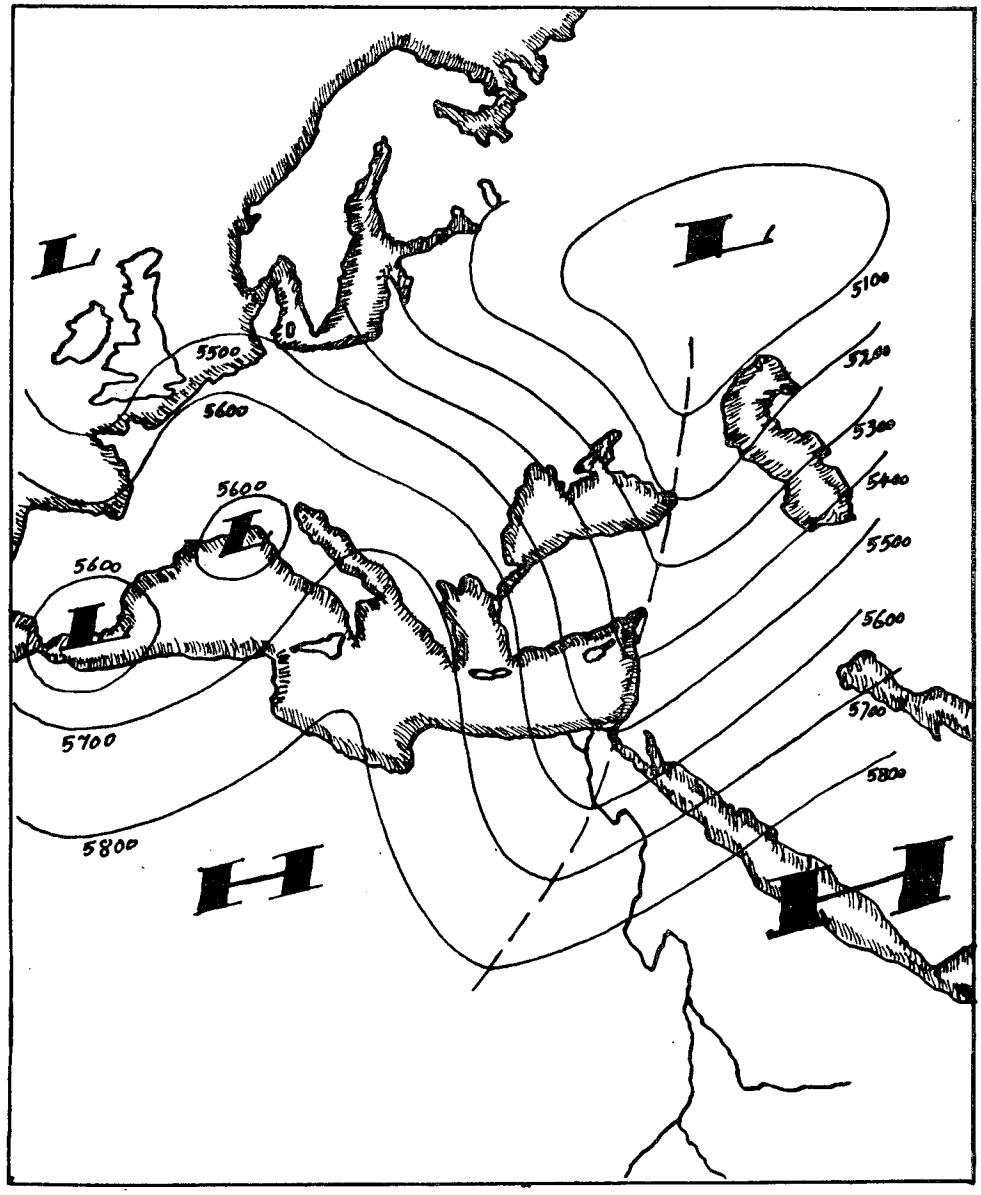

FIG. 8. 500-mb chart, 1500 GCT 9 January 1950. Showers extended to El Arish and to Minya, but stopped west of Matruh.

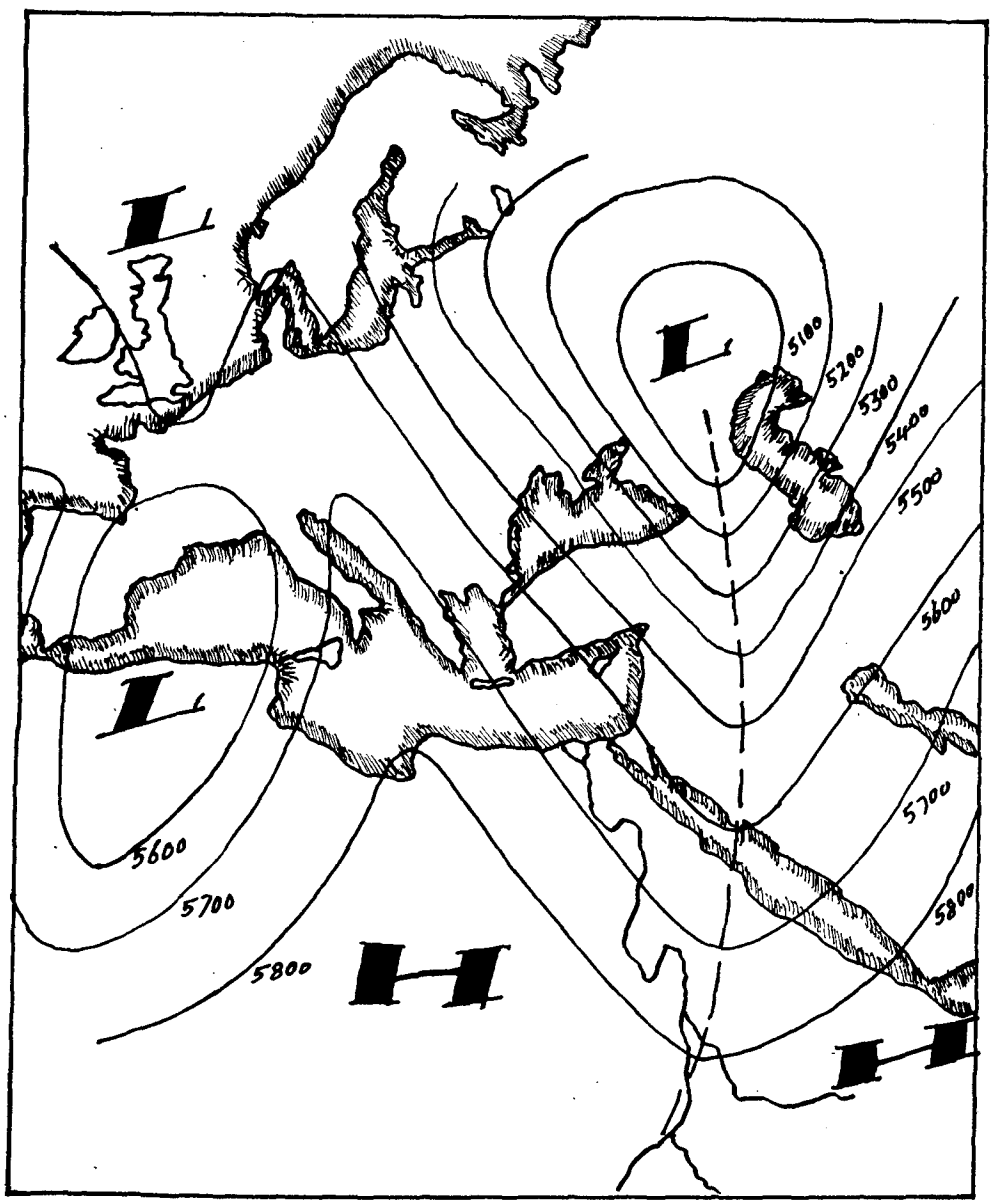

FIG. 9. 500-mb chart, 1500 GCT 10 January 1950. Trough line moved to Western Iraq. No rain over Egypt.

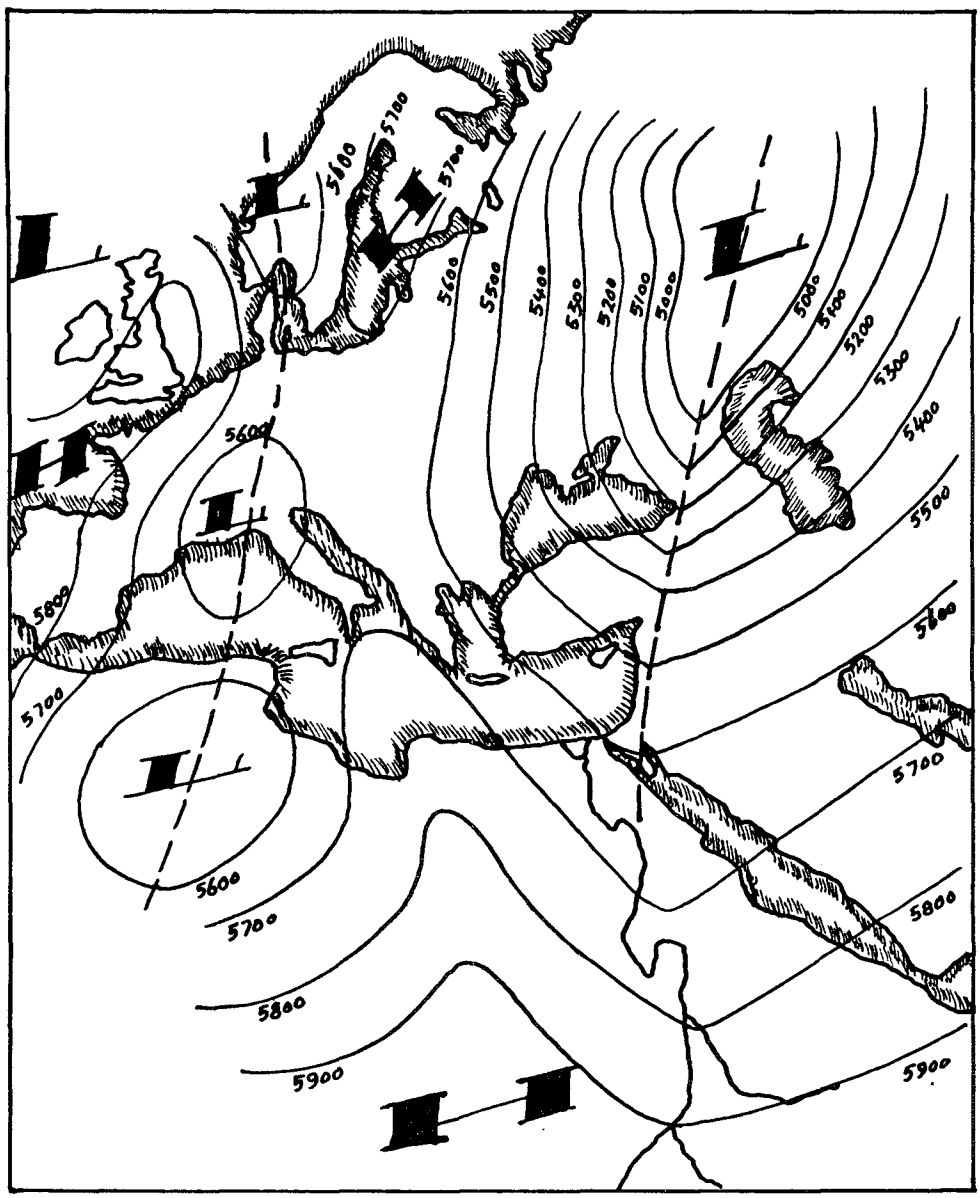

FIG. 10. 500-mb chart, 1500 GCT 11 January 1950. Trough line moved back to Palestine. Showers fell again over Lower Egypt.

wedge of high pressure or with the eastern-European trough extending southward to the eastern Mediterranean region.

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