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SANDSTORMS ON THE NORTHERN COASTS OF LIBYA AND EGYPT

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SANDSTORMS ON THE NORTHERN COASTS OF LIBYA AND EGYPT

By E. A. Lunson, B.A.

This memorandum discusses the sandstorms of the Western Desert and Cyrenaica east of the Tunisian border. The note is in two parts. Part I gives a general account of the conditions leading to sandstorms. Part II describes the weather of a recent typical khamsin depression which illustrates the conclusions reached in Part I very closely.

PART I—THE ORIGIN OF THE SANDSTORM

Introduction.—The best known feature of the weather of the Western Desert is the sandstorm. Anyone who has lived, even for a comparatively short time, among these sandy wastes and not experienced a sandstorm is very fortunate, and must be one of a small minority.

For the purpose of this note the Western Desert is taken to include the territory from the Suez Canal to Tunisia, and the conclusions are based on experience gained in forecasting for, and living in, the region for three years during the World War 1939–45.

A sandstorm occurs when a strong wind raises and carries along with it dust and sand "in suspension", reducing visibility usually to 80–100 yd. and often to less than 10 yd.; the temperature may or may not be abnormal, and the storm may blow by night as well as by day. The more vigorous storms blow for 2 or 3 days and often move across the continent from west to east, reaching their maximum intensity during the middle of the day and subsiding somewhat by night.

The origin and nature of such storms depend on,

(*a*) the general synoptic situation,

(*b*) the local conditions,

(*c*) the season of the year and time of day.

Synoptic situation.—The worst sandstorms are frontal, and occur any time between October and early June. When a depression moves eastwards along the Mediterranean within 100 miles or so of the African coast, or forms in central Tripolitania and moves along the coast to the Nile Delta, there is a very strong indraught of air from the Sahara, which is followed after the centre has passed, by cold unstable air from the north. On these "khamsin"* depressions the fronts, both warm and cold, and a "warm sector" are very well marked and give rise to severe sandstorms. These depressions usually develop in spring, and to a lesser degree in autumn, when the contrasts in temperature and stability of the air masses over the Sahara and Europe are most marked; if, in addition, the ridge of high pressure over the Balkans is long in breaking down before the onset of the disturbance, then the southerly winds in front are very strong, both by day and night. This was the case on March 24, 1942, when Tobruk reported SE., S., or SW. winds of between 22 and 40 m.p.h. and visibility less than 1,000 yd. at the routine observations taken at 0400, 0600, 0900, 1200 and 1800 G.M.T.

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* The khamsin is the dry, hot, southerly wind that blows in Egypt and Libya in spring, bringing with it sandstorms, dust haze and high temperatures. These winds are most frequent in March and April, but also occur in February, May and June. The Arabic name "khamsin" refers to the fifty days after the Coptic Easter, revealing the season at which they are most frequent.

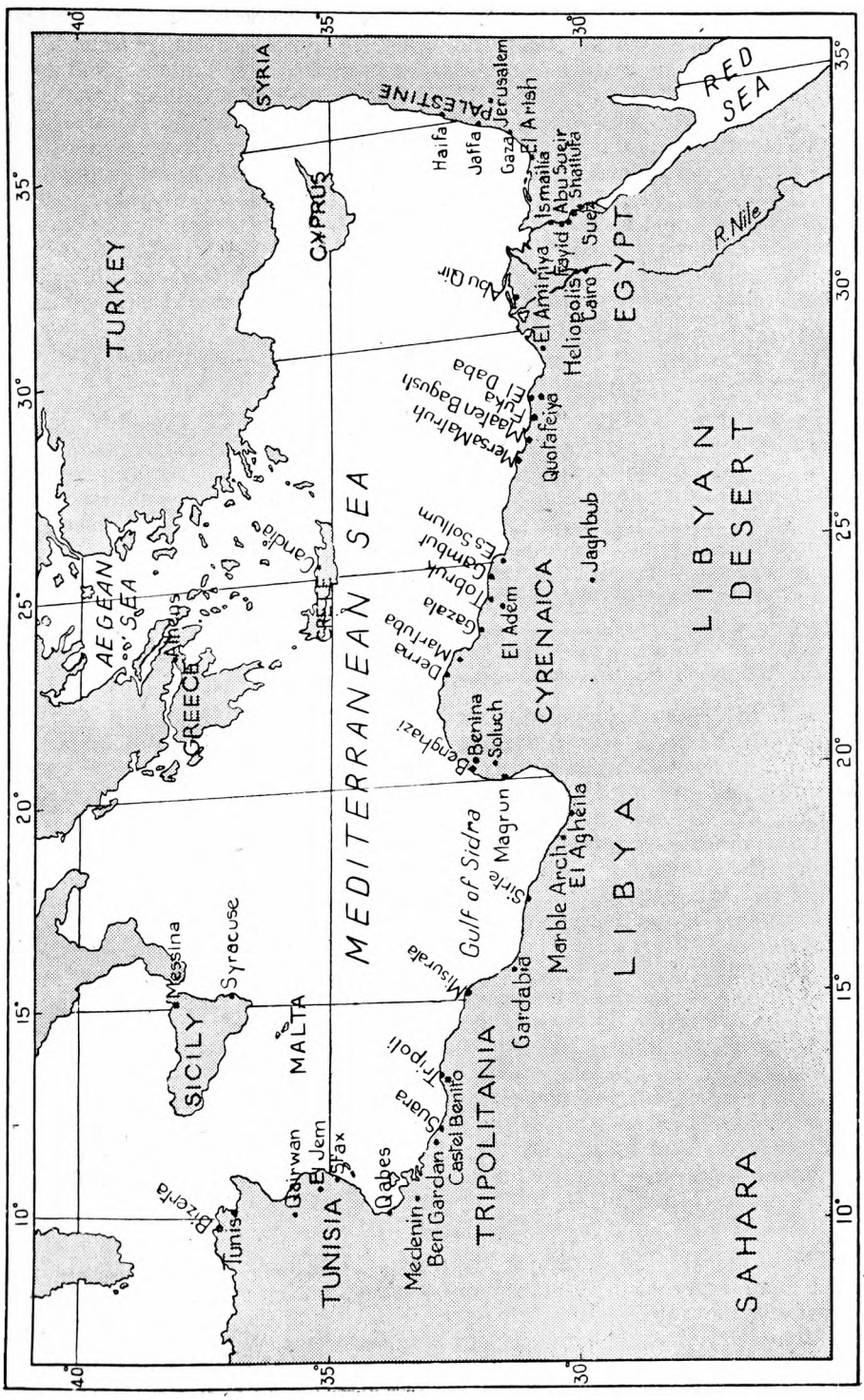

FIG. 1.—NORTHERN COASTS OF LIBYA AND EGYPT

As these depressions move across an area, the wind veers from SE. through SW. to W. or NW. at the cold front, and the wind and turbulence are strong enough to produce sandstorms. The worst storms are usually from the southerly quarter; they last longer, are more persistent if less intense, and are accompanied by high temperatures. These are the really hot, stifling khamsin winds. As the cold front passes—often after a short lull in the storm—the humidity increases, the temperature drops, the wind changes to a gusty north-wester, and the sand blows again. Behind the front the sandstorm gradually degenerates to " occasional rising sand ". Inland this wind might give rise to sandstorms, but near the coast, where it has not travelled long over the land, very little sand is raised and none is lifted to any great height. The later in the spring the depressions occur the more marked is the improvement behind the cold front; for in February or March the air from the Balkans and south-east Europe, which reaches the Western Desert behind such a depression, is sufficiently unstable to cause vigorous sandstorms for some hours after the passage of the cold front.

In the winter months the " Cyprus low " deepens from time to time, and there is a burst of cold air from south Russia over the Balkans to the northern coast of Egypt. As these waves of very cold air cross the Mediterranean they become unstable, and on striking the coast cause either heavy showers or sandstorms and sometimes both. These fronts affect the coast as far west as the Derna Hills, except under very stormy conditions when north-easterly gales may extend as far west as Benghazi; but normally the fronts moving south and south-east from Greece and the Aegean Sea that cause the sand-storms or showers in Egypt are weaker in the area west of Es Sollum. On these fronts there are no hot S. winds; the winds are SW.–W. before the front reaches the coast and NW.–N. afterwards.

Apart from these major disturbances sandstorms can be caused by a freshening of the wind provided there is sufficient instability in the lower layers to " lift " the sand. But a better designation for such phenomena would be " rising sand " (see below). As a general rule it can be said that, apart from the type of depression discussed in the preceding paragraph, any unstable air mass causes minor sandstorms when the wind reaches Beaufort force 4 during the day. The prevailing wind along the Western Desert coast is north-westerly, and this can blow from 5 up to 20–22 m.p.h. without any great synoptic change becoming apparent. When this does occur over a soft-sand area, *i.e.* where the surface is loose and light, either by nature or through the movement of aircraft or vehicles, the sand is lifted and visibility reduced at times to 500–1,000 yd. This north-westerly wind, the normal daylight wind, usually decreases by sundown, within 2 hours falls away altogether and later gives way to the night land breeze. This decrease in wind strength occurs at the same time as the decrease in convection and the sand rising ceases. In average summer conditions a sandstorm or a wind from between SW. and NE. through N. is a hindrance to flying for the period from 3 hours before to 4–5 hours after local noon. Outside these hours the sand lifts only on a 20–25 m.p.h. wind—and if the wind is so strong there is some departure from average summer conditions.

Local conditions.—The nature of the surface, whether rock or light sand, whether there is any scrub vegetation or occasional native crops, whether there has been any movement of aircraft or vehicles over any of the neighbouring areas, often determines the intensity of the sandstorms. With a deep khamsin depression sandstorms are severe and widespread since the sand and dust are transported from afar, and the local conditions are not strong enough to cause

anything but slight changes from the prevailing conditions. On the other hand with conditions such as those discussed in the preceding paragraph the local factors often make the difference between local sandstorms and normal good visibility.

On any aerodrome a wind of 18–20 m.p.h. lifts the sand, and if the surface of the landing ground and the surrounding area is light by nature the result may well be a local sandstorm. This is the case in the El Amiriya district. On the other hand on the Gambut plateau in the more rocky area there may only be local sand rising, which does not seriously hinder the working of aircraft. Permanent runways do something to mitigate the dangers of landing in bad visibility due to sandstorms ; there is a smaller area of loose sand, and the runway can be seen more easily and clearly than a " sand " runway.

For the Canal Zone airfields the Delta acts as an excellent shelter and windbreak for the sandstorms from the west. Even with the strong winds that develop locally the incidence of sandstorms is lower in the Canal Zone than in the Western Desert.

Season of year and time of day.—In the settled conditions of mid June to mid September north-westerly winds prevail, and neither southward moving fronts or khamsin depressions occur. Real sandstorms are very rare, but on a freshening of the wind or with an increase in the instability of the lower layers there is " sand rising " ; this probably extends over large areas, but bad visibility occurs only where the terrain is light and loose. Between these areas visibility is good. Owing to the drought over the whole of the area in these months, a wind which in winter would not raise even dust causes local deteriorations. In winter crops give slight protection and a binding of the sand and the dampness of the sand caused by showers neutralises the lifting power of the wind.

Sandstorms are worst during the day. The hot southerly wind, reaching gale force at times, can of its own accord cause a sandstorm ; but during the day it is helped by the vigorous convection of the desert, and visibility is often nil. This same wind at night may be just as strong but the sand is then not so thick, nor is it carried so high. In areas of very loose sand, or where there has been much movement the sandstorm still rages, but away from the landing grounds there is considerable improvement in the day-time conditions. Nevertheless, these " depression sandstorms ", moving as they do, may cease in the middle of the day, the storm passing eastwards and leaving local flurries of sand blowing across the landing grounds. This was the case at Maaten Bagush in mid October 1940, when the airfield was unserviceable from dawn until 1330 G.M.T., when visibility improved to 5–8 miles. Thus these " depression sandstorms " can and do blow by day and by night and are liable to die down at any time. On the other hand where there is no khamsin depression but only instability in the northerly air stream, the sandstorm or rising sand is worst during the hottest part of the day, decreases in intensity towards sunset and does not blow at night. As a general rule such storms can be said to cause conditions in which landing is difficult for about 7 hours in the day, from 3 hours before to 4 hours after local noon ; these are outside times and apply to severe cases.

It is suggested that the phrases " sandstorm " and " rising sand " should be standardised with the following meaning :—

	Sandstorm	Rising sand
Cause	Khamsin depression ; or cold front lying east-west along the coast.	Local instability or increase in strength of surface wind.

	Sandstorm	Rising sand
Wind	Severe with both northerly and southerly winds; also at frontal changes.	Mainly from between SW. through N. to NE.
Area affected..	Large areas, often belt of severe sandstorms 100 miles wide; moves from west to east with depression, or affects whole coastal area from the Delta to Es Sollum on front lying east-west.	Local in character, poor visibility on landing ground or where much movement; areas between clear.
Time	Blows both by night and day.	Day only; from 3 hours before to 4 hours after local noon.
Season ..	Khamsin type spring and autumn; those on cold fronts from Balkan area in winter; can occur between September and mid June.	All seasons; most frequent spring and summer.
Intensity ..	Intense and continuous for periods up to 3 days.	Intermittent, severe in gusts.
Landing conditions	Always dangerous and usually impossible.	Difficult but not prohibitive; possible to land in temporary lull and always in late afternoon.
Visibility ..	Reduced to nil–50 yd.	Reduced to 200–500 yd.
General ..	Disturbance too strong to be neutralised by local conditions.	Intensity depends largely on local terrain, *e.g.* 15 m.p.h. wind will produce " rising sand " at El Amiriya but not at Benina.

On the basis of the foregoing an attempt has been made to classify the airfields and landing grounds between the Canal Zone and Tunisia according to their tendency to become unserviceable through reduction of visibility due to sandstorms. This can be only tentative, but will serve as a guide, and it must be borne in mind that the number of aircraft or squadrons using a landing ground is among the most important of the local factors discussed above; for the more movement on and around a landing ground the more is it affected by rising sand.

Classification of airfields.—The classification used in this report is as follows:—

Good	Subject only to the worst of the depression sandstorms and seldom put unserviceable for long by rising sand.
Moderate	Affected by depressions and by rising sand but not unserviceable through rising sand for long periods or on winds of moderate strength.
Poor	Visibility reduced for many days at a time through gusty 15–18 m.p.h. winds.

Airfield	Classification	Airfield	Classification
Canal Zone	Good. Abu Sueir and Ismailia less reliable than Fayid and Shallufa	Derna	Good
		Benghazi area	Good
		Soluch	Moderate
		Magrun	Moderate
Heliopolis	Good		
Cairo West	Moderate to good	El Agheila area	Poor
El Amiriya area	Poor	Marble Arch	Poor
El Daba area	Poor to moderate	Gardabia to Misurata	Moderate
Fuka area	Poor	Castle Benito	Moderate
Maaten Bagush	Moderate	Suara	Moderate
Mersa Matruh	Moderate	Ben Gardan	Poor
Gambut area east	Moderate	Medenin	Poor
Gambut area west	Poor	Qabes	Poor
Tobruk area	Poor	Sfax	Moderate
El Adem	Poor to moderate	El Jem	Good
Gazala area	Moderate	Qairwan area	Good
Martuba area	Moderate	Tunis area	Good

PART II—KHAMSIN DEPRESSION OF MARCH 23–25, 1942

It is during spring that khamsin depressions, the last of those which bring rain to the Mediterranean in the winter months, can move the length of the Libyan and Egyptian coasts, before the almost static conditions of summer have settled over the northern Sahara, the Balkans and the eastern Mediterranean. In spring the contrast between the temperatures near the coast and inland is great, and thus the khamsin reaches the Mediterranean shores as a hot and stifling wind.

The khamsin depression of March 1942 moved from south of Malta to a position between Haifa and Cyprus in 48 hours. Accurate analysis of the synoptic charts is difficult as so little meteorological information is available from near-by areas owing to the difficult circumstances at the time. Some information from widely spaced areas is however available.

At 1800 G.M.T. on March 23 (Fig. 2) the depression was centred south-south-east of Malta; during the day Malta's surface wind had backed to E. from S., bringing with it haze and, by nightfall, 9 tenths low stratus. The southerly wind off the Tunisian and Tripolitanian deserts had reached Malta as a "scirocco"—the dry and dusty "chili" of Tunisia or "ghibli" of Tripolitania (the equivalent of the khamsin of Egypt) now warm and humid after crossing the sea. Pressure was high over the eastern Mediterranean, with a steep gradient between Malta and Tobruk which was giving strong south-easterly winds and rising sand at Tobruk. By 0400 on the 24th the barometer was falling fast, and a sandstorm blowing with a 20 m.p.h. SE. wind. At 0600 (Fig. 3) the depression appeared to have moved towards the Gulf of Sidra, there was sand rising as far east as Quotafeiya, and severe sandstorms at Es Sollum and Tobruk. Sandstorms are very rare so early in the day and occur only at the passage of a vigorous cold front (when they are short-lived) or in front of a well marked depression (and are then likely to continue). At 0900 Tobruk reported severe sandstorm with sky obscured, visibility nil and a gusty S. wind of 30 m.p.h. The change in wind direction to SW. at 0600 is difficult to account for, but it made little difference to the weather. By 1200 sandstorms had spread eastwards to Quotafeiya, which was recording a

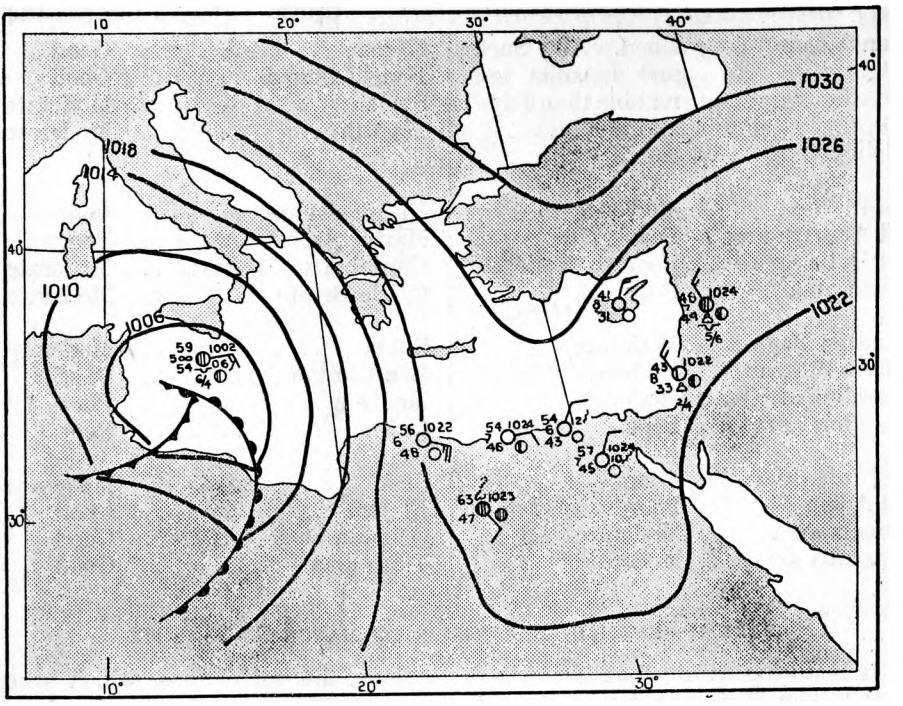

FIG. 2.—SYNOPTIC CHART, 1800 MARCH 23, 1942

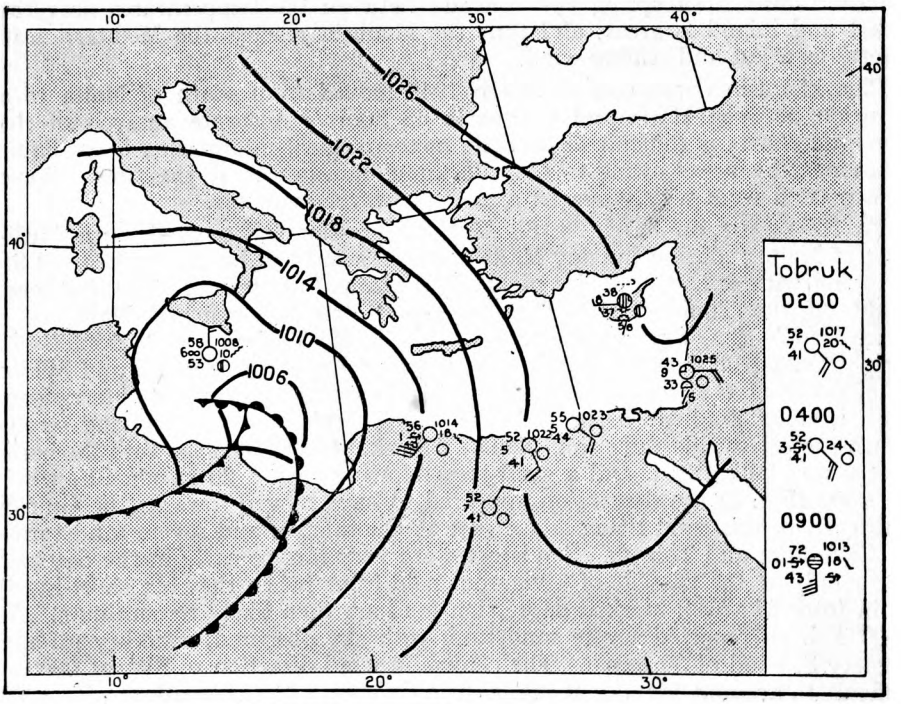

FIG. 3.—SYNOPTIC CHART, 0600 MARCH 24, 1942

temperature of 76° F. ; Tobruk's temperature had risen to 85° F., the visibility was nil and the wind had increased to a gusty Beaufort force 8. Sandstorms continued throughout the day in the Western Desert between Gazala and Maaten Bagush, but by 1800 had subsided at Quotafeiya although still continuing at Tobruk, which was by now within 130 miles of the centre of the depression (Fig. 4). The high pressure area in the eastern Mediterranean was

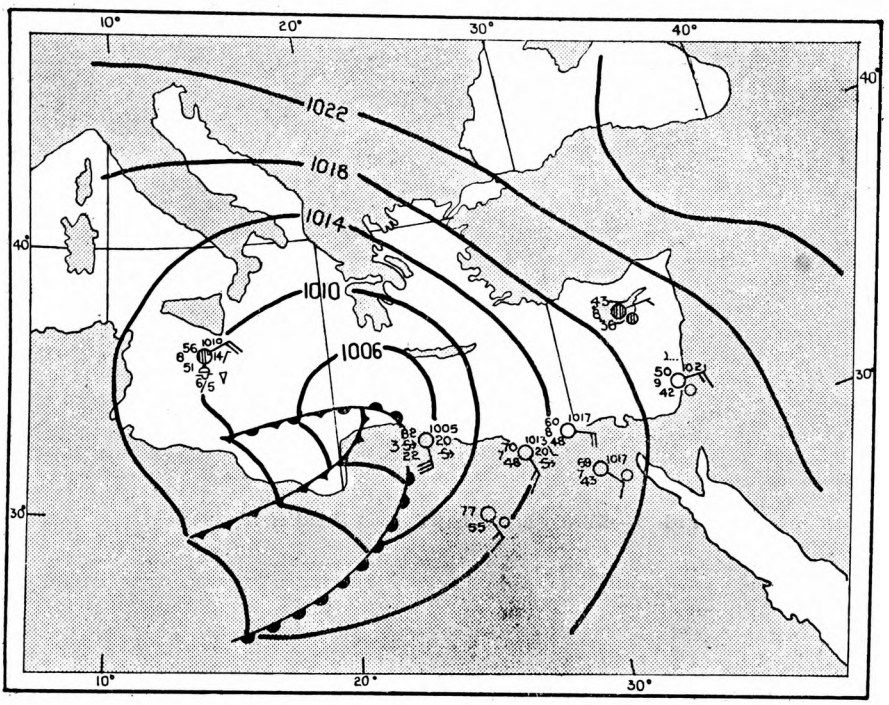

FIG. 4.—SYNOPTIC CHART, 1800 MARCH 24, 1942

rapidly giving way before the depression ; it was clear that it would collapse altogether and allow the low-pressure centre to move eastwards as far at least as the Palestine coast. Behind the depression Malta was reporting showers, large cumulus and stratocumulus and very good visibility. The 0600 chart on the 25th (Fig. 5) shows the depression centred between Crete and Mersa Matruh, the warm front almost at Quotafeiya and the cold front south-east of Tobruk. Between 0530 and 0930 aircraft reported 10 tenths cumulus at 8,000–10,000 ft. on the Cyrenaica hills, sand and dust haze from surface up to 4,000 ft. along the coast from Es Sollum to Tobruk, and bad visibility everywhere. The sandstorm had ceased at Tobruk but was still blowing between Quotafeiya and Es Sollum. During the day the " belt " of sandstorms—an area about 60 miles wide marked by SE. to SW. winds reaching a force of 30–35 m.p.h. and visibility always less than 150 yd. and sometimes nil—moved eastwards, affecting Abu Qir by 1200 and the Canal Zone by the mid afternoon, leaving behind a dust haze reaching up to over 4,000 ft. By 1200 the wind at Maaten Bagush had veered to NNW., force 5, and the worst of the sandstorm was over. In the Canal Zone the warm front was just past Ismailia, where the temperature suddenly rose 6° F. and the relative humidity dropped by 12 per cent. The maximum temperature 97° F. was reached shortly after 1200 ; temperature remained

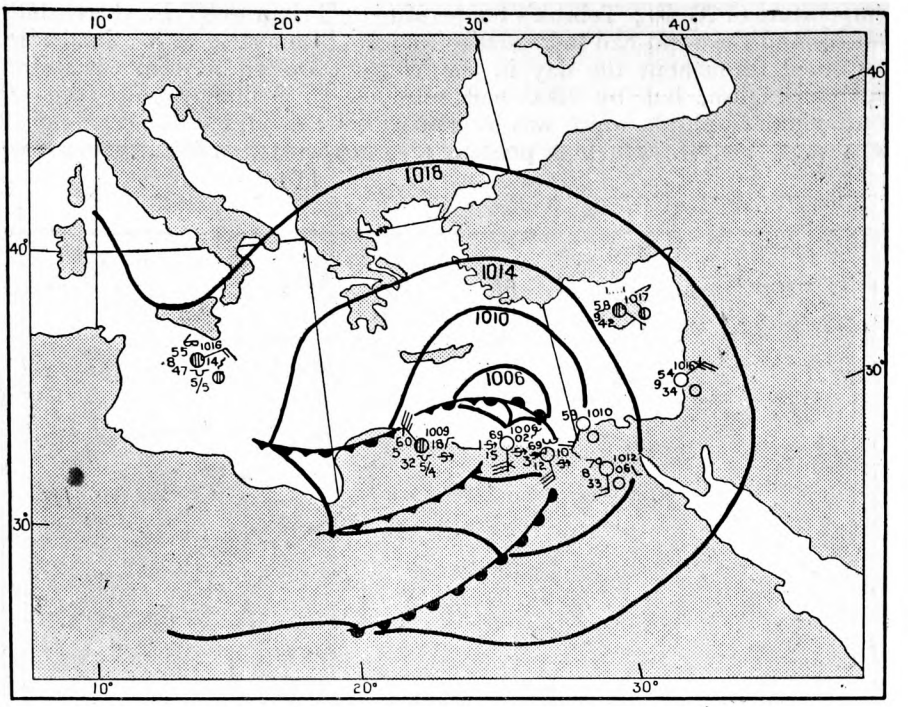

FIG. 5.—SYNOPTIC CHART, 0600 MARCH 25, 1942

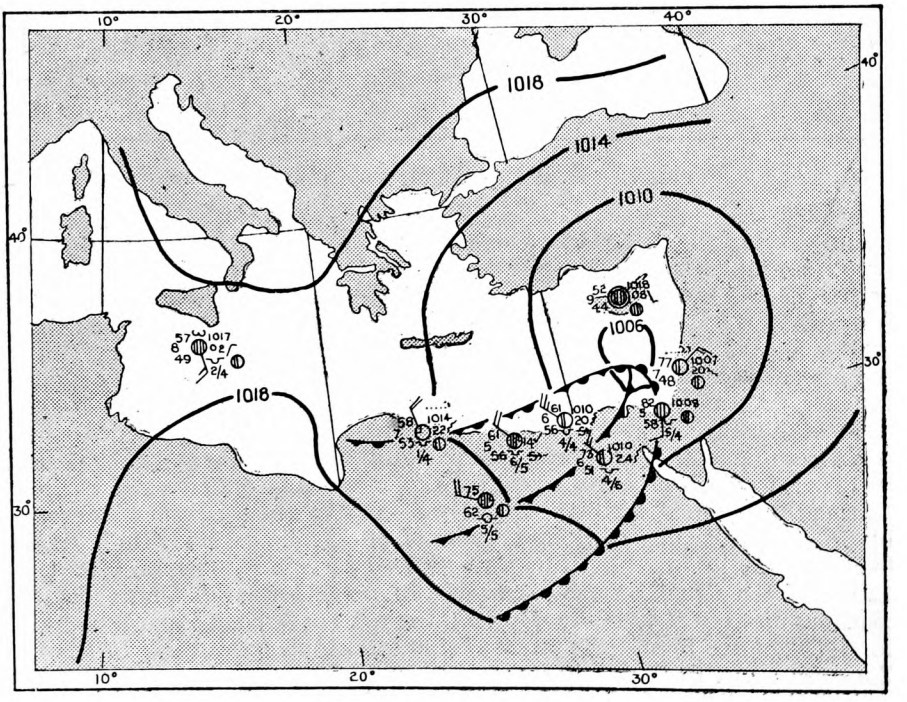

FIG. 6.—SYNOPTIC CHART, 1800 MARCH 25, 1942

above 90° F. until 1610, when it fell sharply 3° and then more gradually. This compares with the average maximum for March 1942 of 76° F.; it was the highest recorded at any station during the period under review. At Quotafeiya the maximum recorded was 82° F., and the average maximum for the whole month was 67° F.

Fig. 6 shows the position at 1800 on the 25th with the depression between Cyprus and Haifa moving east-north-east; the cold front is at Heliopolis and almost on El Arish. There still remained along the Desert coast the hazy visibility, aftermath of the sandstorms, emphasised by the increased humidity of the north-westerly wind. As the cold front passed Ismailia the surface wind veered from SSE. to W. and fifteen minutes later, at 1830, to NNW., 12–15 m.p.h. From 0040 on the 26th the surface wind veered from NW. to SE. and blew at a good 10–15 m.p.h. with gusts of 30 m.p.h. until 1135, when it shifted to SW. and freshened to 20–25 m.p.h. It fell away after 2½ hours to 10 m.p.h. from SSE. The 0900 pilot-balloon ascent revealed a wind from 190° to 210° and 20–30 m.p.h. up to 4,000 ft. By the afternoon the wind up to 8,000 ft. was from 225° to 240° with a speed of 32 m.p.h. at 2,000 ft. and 25–30 m.p.h. from 2,000 to 4,000 ft. The morning ascent on the 26th showed the upper wind back to normal—290° to 310°.

The warm and cold fronts and the occlusion shown on the diagrams were placed as they passed Tobruk, Maaten Bagush and Quotafeiya and then "positioned" on the earlier maps. It was assumed that the depression had moved from the western Mediterranean and was partially occluded when south of Malta. This analysis was continued, and both fronts and occlusion were followed along the north Egyptian coast.

The fronts of khamsin depressions are marked by wind shifts, sudden changes in temperature and humidity and an increase in gustiness and thus in intensity of the sandstorm; the warm sector air is very dry, but is followed by increased humidity and cloud at the cold front. The most striking phenomenon about these depressions, apart from the dangers and discomforts

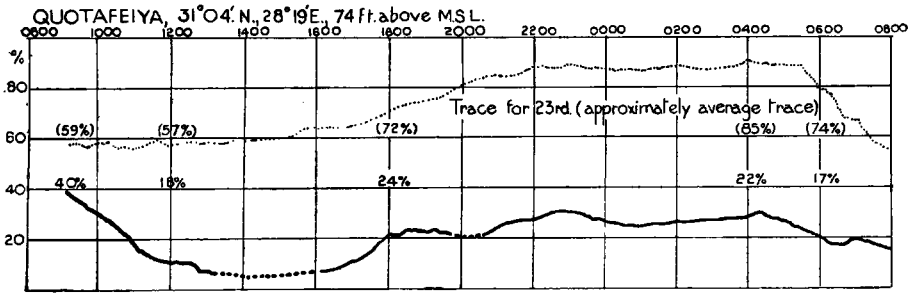

FIG. 7.—HYGROGRAM FOR QUOTAFEIYA, MARCH 24–25, 1942
showing the extremely arid air character of the khamsin air

of the sandstorm, is the sudden change that comes with the cold front; as it passes the gusts increase, the wind suddenly veers and blows cool from NW.; there may be a few drops of rain, but whether there is or not the sandstorm gives way to sudden short-lived whirls of sand, and the cool freshness of the atmosphere is in complete contrast to the hot dust-laden S. wind. Behind the cold front the wind is normally about 10–15 m.p.h. from NW. and causes slight sand rising, but this ceases at dusk and leaves only haze. These depressions are not deep. When pilot-balloon ascents can be carried out before

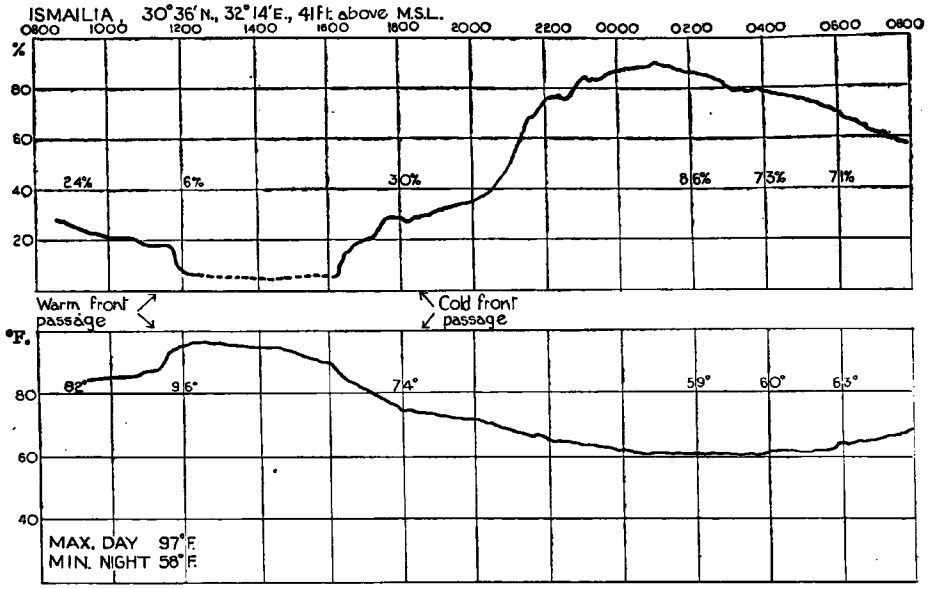

FIG. 8.—HYGROGRAMS AND THERMOGRAM FOR ISMAILIA, MARCH 25–26, 1942
The warm-front passage is clearly marked, but the cold-front passage (defined by wind and tendency change) was preceded by an abrupt fall of temperature inside the warm sector possibly because of the arrival of colder air.

and after the passage of the centre the southerly wind is found only up to 4,000 ft. Above this level the current varies from SW. to W. just in front of, and from W. to NW. just behind the depression. Both surface and upper winds are normally easterly 36 hours before the centre of the depression passes, they veer sharply at the warm front to S.–SW. and to W.–NW. at the cold front. The later in the season these khamsin depressions occur the less is the risk of rain. In February rain is likely on the Cyrenaica hills as the cold front passes and may reach as far as the Egyptian frontier, but by late March or April the air from the south is dry enough to prevent any rain reaching the ground. May or early June is likely to show the maximum temperatures of the season in the Delta or Canal Zone—up to 115°–118° F.—and by mid June summer conditions have settled over northern Egypt.

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