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A climatological study of storms and depressions in the Arabian Sea *

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1. The paper presents a climatological study of storms and depressions in the Arabian Sea based on the data of 61 years, 1890—1950. A similar study for the Bay of Bengal has been made by Rai Sircar (1956).

2. During the 61-year period, the total number of disturbances in the Arabian Sea was 140, out of which the number of cyclonic storms† was 63, the rest (77) being depressions. It is noted that the number of disturbances in the Arabian Sea is very much smaller than in the Bay of Bengal, being only 1/6th of that in the Bay of Bengal. Unlike those in the Bay of Bengal, as much as half the disturbances in the Arabian Sea develop into cyclonic storms. Table 1 gives the total number of disturbances — (*a*) of all intensities and (*b*) of cyclonic storms, month by month, during the period under study.

3. It will be seen that disturbances are practically absent in February, March and August and are relatively few in January, April, July, September and December. In April, although the total number of disturbances were not many, all of them developed into cyclonic storms. The most important feature in the Arabian Sea is the virtual absence of mid-monsoon milder disturbances of July and August, which are a special feature of the north and adjoining central Bay of Bengal. Thus the disturbed periods in the Arabian Sea are mostly confined to the months of May, June, October and November.

4. There were 7 years when no disturbances developed and 17 years when only one disturbance developed. The maximum number of disturbances developing in any one year was 6. The occurrence of more than one disturbance in a month is rather uncommon; in the 61-year period under consideration such occurrence was observed only once in the months of May, September and December, thrice in the month of November, 4 times in the month of June and 5 times in the month of October. In other months there is no record of more than one disturbance. Again, cases of more than two disturbances in a month were only 2, one in September and the other in November. Cases of two cyclonic storms developing during a month are only three, one each in June, September and October. There are no cases of more than two cyclonic storms in a month.

5. The average annual frequency of disturbances of all intensities is a little over 2 and of cyclonic storms alone about 1. The number of disturbances of all intensities varied from a minimum of 0, *i.e.*, no disturbance occurring, in 7 years to a maximum of 6 in 3 years. In respect of cyclonic storms alone, the number varied from a minimum of 0 in as many as 23 years to

* A short resume of a paper which is being published separately as a Memoir of the India Meteorological Department

† A disturbance was classified as a cyclonic storm if at least one ship in the field of disturbance reported wind force of 8 B.F. or more

TABLE 1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					(*a*) Disturbances of all intensities							
Total number	6	1	2	4	16	25	4	2	9	34	27	10
Percentage of total	4	1	1	3	12	18	3	1	7	24	19	7
					(*b*) Cyclonic storms							
Total number	1	—	—	4	10	11	2	1	4	15	12	3
Percentage of total	2	—	—	6	16	17	3	2	6	24	19	5

a maximum of 5 in one year (1962). The year 1902 is of special interest in view of the fact that all the disturbances that occurred developed into cyclonic storms. An examination of histograms (not reproduced here) showing the number of disturbances that formed in each successive 5-year period has not shown any significant secular trend.

6. An examination of monthly frequency of disturbances crossing each one degree square has shown that in January there are two distinct areas of disturbances—one in the southeast Arabian Sea off Ceylon and the other in the extreme north Arabian Sea in the Gulf of Oman and off the Mekran coast. The disturbances off Ceylon are the residuals of the disturbances in the south Bay of Bengal which moved westwards. The disturbances in the extreme north Arabian Sea are obviously the western disturbances with a southerly track. Disturbances are rare in February and March, but are not completely absent, one forming off the Konkan coast in each of these months and one in the Ceylon area in March. In April, the disturbances are practically confined to the east Arabian Sea, but the scatter over the east Arabian Sea by itself is wide. The scatter of disturbances in May (Fig. 1) would indicate that the north Arabian Sea is more or less free from disturbances, but any other part of the Arabian Sea is liable to be affected. There is a definite shift northwards of the area of disturbances during the month of June (Fig. 2), the south Arabian Sea being practically free, but the scatter is otherwise wide, affecting both the eastern and western parts. The number of disturbances in July and August are also few and they are more or less confined to the coastal areas off Saurashtra and the north Konkan. In September there is a definite increase in the number of disturbances and they are mostly confined to the northeast and east central Arabian Sea, the former being more susceptible. The post-monsoon months of October and November (Figs. 3 and 4) are the real storm period and the areas affected are very much spread out. In October, the northwest and most parts of the southwest Arabian Sea are free from disturbances, while in November the northwest and the west central Arabian Sea are free. The worst affected areas appear to be the area east of 70°E. There is again a decrease in the number of disturbances in December as northeast monsoon gets established.

7. An examination of the direction and speed of motion of storms and depressions across the different one degree squares during the different months has shown that the movement of disturbances in the Arabian Sea is more uncertain than in the Bay of Bengal and this makes the forecast of movement on the basis of climatological study alone difficult. The areas affected in the most disturbed post-monsoon months also show a rather wide scatter, although, in

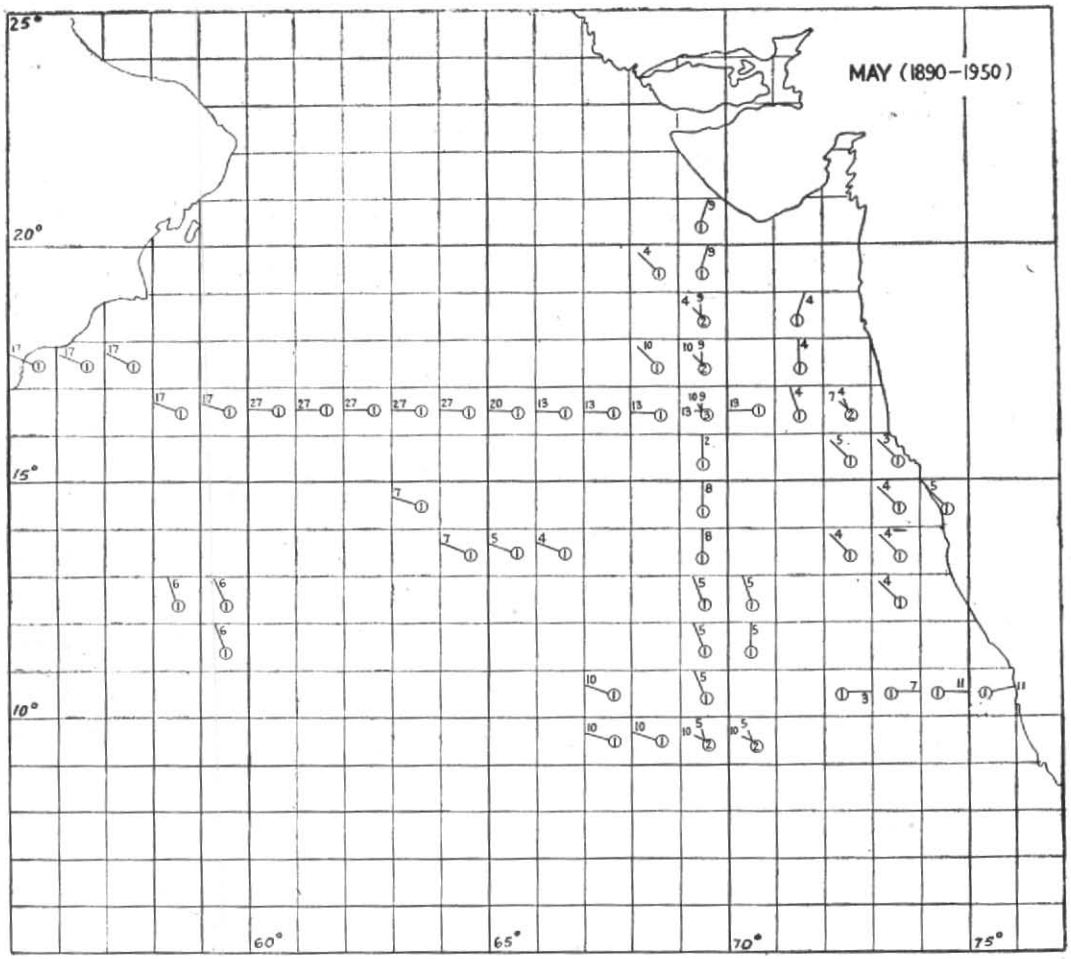

Fig. 1. Percentage frequency distribution of direction of motion of tropical disturbances in various one degree squares. Figures inside circles represent number of disturbances. Length of vector gives percentage frequency of disturbances moving in one particular direction (Scale 100 %—, 50 %—, 10 %–). Figure at end of each vector gives average speed in m.p.h.

other seasons, localisation over certain areas can be noticed. It would appear that the west Arabian Sea is much less affected than the east, but it is possible that, in view of the difficulty of locating disturbances in the west Arabian Sea, some disturbances in that area might have gone undetected. Nevertheless, speaking qualitatively, the west Arabian Sea would appear to be comparatively free from disturbances. The average speed of movement of disturbances also shows a wide variation and it is difficult to make any generalisation in regard to the speed of movement over different areas, except that the disturbances travel faster when far out at sea than when near the coast. Speeds as low as 2 mph and as high as 30 mph have been noted, although the most common speed appears to be between 7 and 15 mph. There does not also appear to be any regular seasonal variation in the speed of movement. A slowing down of the

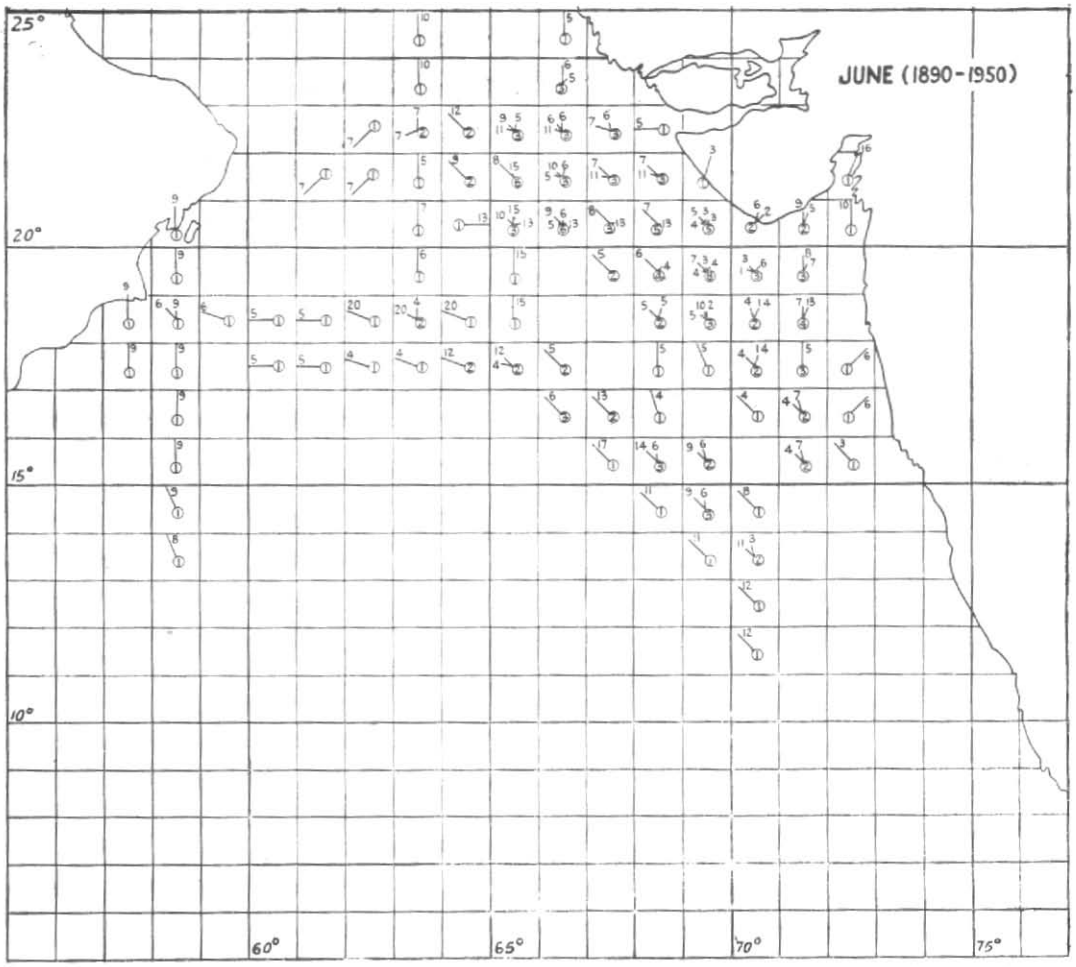

Fig. 2. Percentage frequency distribution of direction of motion of tropical disturbances in various one degree squares. Figures inside circles represent number of disturbances. Length of vector gives percentage frequency of disturbances moving in one particular direction (Scale 100% —, 50% —, 10% –). Figure at end of each vector gives average speed in m.p.h.

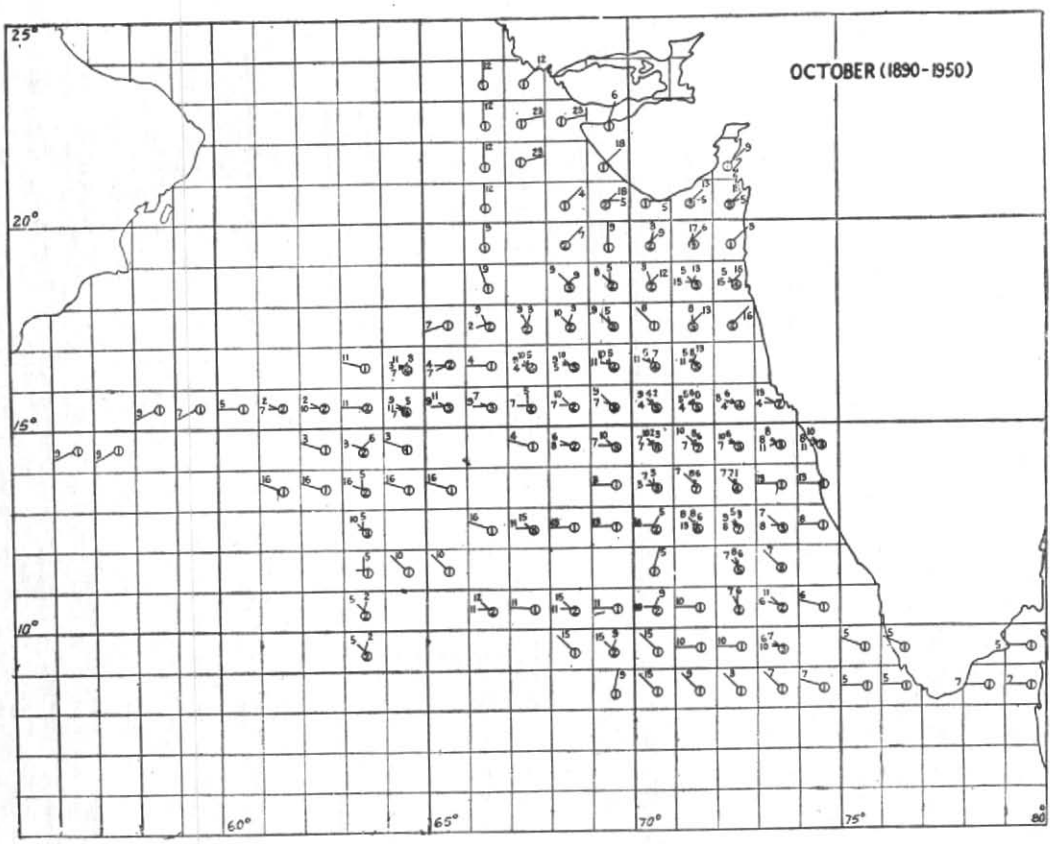

Fig. 3. Percentage frequency distribution of direction of motion of tropical disturbances in various one degree squares. Figures inside circles represent number of disturbances. Length of vector gives percentage frequency of disturbances moving in one particular direction. (Scale 100% —, 50% —, 10% –). Figure at end of each vector gives average speed in m.p.h.

speed of movement at the time of recurvature is, however, clearly noticeable.

8. It is seen that during the months of January to March, the disturbances above Lat. 20°N generally move west to east and those below Lat. 20°N generally move east to west. In April and May the dividing line between disturbances moving west and those moving east may be taken roughly as Lat. 18°N, although there are a number of exceptions, particularly in the case of disturbances to the west of Long. 60°E. During the monsoon months June to September, the disturbances generally move towards the west with only a few exceptions in the months of June and July. In the months of October and November the recurvature usually takes place between the latitudes 18°N and 20°N and in the month of December, when very few disturbances affect areas north of 18°N, disturbances usually move from east to west. Taking all the seasons together, the latitudes at which recurvature takes place may be taken roughly as 18°–20°N.

9. The average life period of storms and depressions in each month is shown in Table 2. It will be seen that the life period varies from 3 to 5 days, the only exception being the month of April when the average life

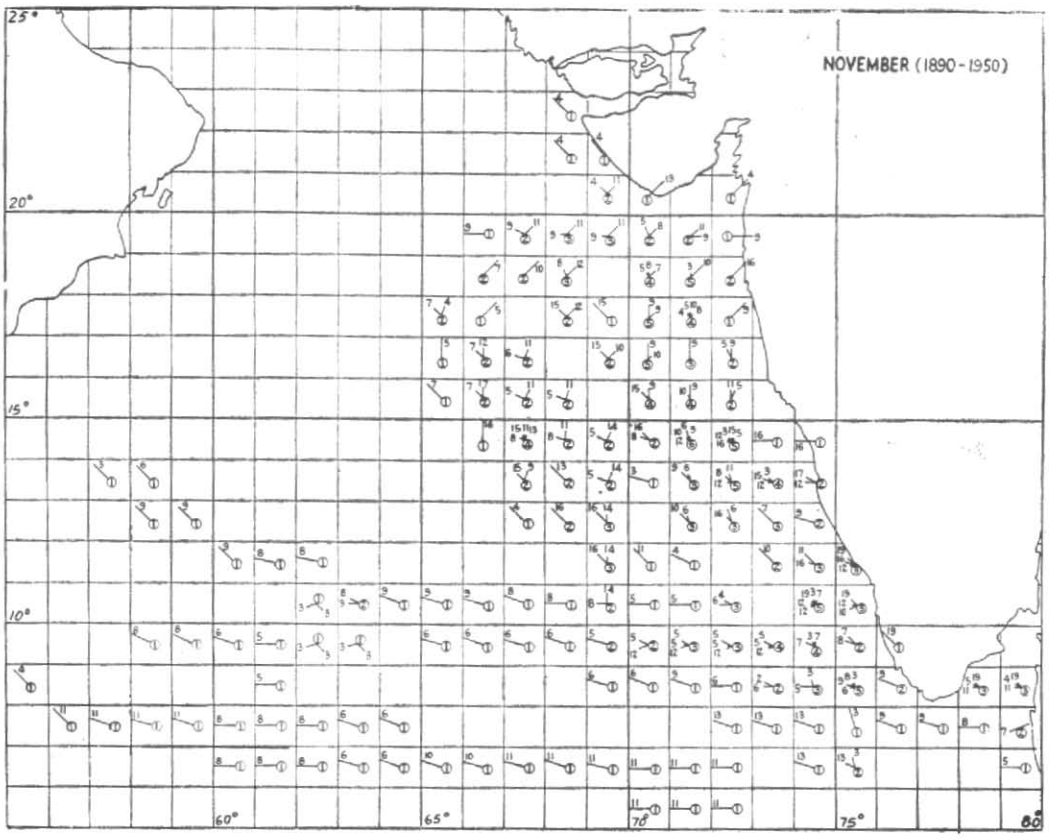

Fig. 4. Percentage frequency distribution of direction of motion of tropical disturbances in various one degree squares. Figures inside circles represent number of disturbances. Length of vector gives percentage frequency of disturbances moving in one particular direction (Scale 100 %——, 50 %—, 10 %–). Figure at end of each vector gives average speed in m.p.h.

TABLE 2

Average life period (from the day of formation or emergence in the Arabian Sea to the day of filling up) of storms and depressions originating in the Arabian Sea

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average life period in days	3	3	3	9	5	4	4	4	5	5	5	4

is 9 days. In January, February, March and August the average life is 3 days; the average life period is 4 days in June, July and December and 5 days in May, September, October and November and 9 days in April. For disturbances whose formation is in the Bay of Bengal, the life period has been calculated only from the date of entry into the Arabian Sea.

10. An examination of the life of individual disturbances in each month shows that it ranges from 1 to 4 days in January, February and March and that in April it varies from 6 to 11 days. In May there is a record of a disturbance with a life of 12 days, otherwise it generally ranges from 2 to 9 days. In the months of June, July, August and September, the life of individual disturbances varies from 1 to 7 days. In the post-monsoon months of October and November the life in individual cases varies from 2 to 8 days generally, although there are exceptions where the life has been as long as 11 to 12 days. In December the life of the disturbance ranges from 1 to 7 days.

11. The probability of a disturbance affecting a particular port has been calculated. Unlike the disturbances in the Bay of Bengal, a large number of disturbances in the Arabian Sea dissipate in the sea itself; as the number of disturbances in the Arabian Sea is also very much less, the probability of a disturbance affecting a port is thus very much less in the case of the Arabian Sea. For example, the port of Bombay is liable to be affected in October, the most disturbed month, only once in 14 years (probability ·07). Ports liable to be most affected are Veraval in June and July, Okha port in June and September, Bombay in October, Mangalore and Cochin in November and Colombo in December.

12. An examination of the areas of development and dissipation shows that a large number of disturbances dissipate in the sea itself or die out on approaching the coast or soon after crossing the coast. In January, when two distinct types of disturbances are observed, the western and the eastern, the western disturbances usually fill up over west Rajasthan or the Punjab (Pakistan) and eastern disturbances which develop off Ceylon or Travancore-Cochin, fill up in and near the Maldive-Laccadive area. There is only one disturbance on record in February and this one originated in the east central Arabian Sea and filled up over Madhya Bharat. In March, one disturbance developed off Ceylon and one off the Konkan coast. Of these the one that developed off Ceylon filled up off the Coromandel coast and the other over Saurashtra. In April, 3 disturbances developed in the southeast Arabian Sea (including Laccadive-Maldive area) and one in the west central Arabian Sea; one disturbance filled up over the east central Arabian Sea far away from the coast, 2 crossed coast near Saurashtra and Kutch and the north Konkan and the remaining one crossed the Mekran coast. In May, out of a total of 61 disturbances, 7 developed in the east central Arabian Sea, 6 in the southeast Arabian Sea (including Laccadive-Maldive area) and 3 in the west central Arabian Sea. Five of the disturbances filled up in the east central Arabian Sea and one in the southeast Arabian Sea. Two of them had long tracks,

one filling up over the Punjab (Pakistan) and the other over East Pakistan after a rather unusually long travel eastwards across the country. The remainder filled up at or near the coast. In June, 24 out of 25 disturbances developed in the east central and the adjoining north Arabian Sea, and only one in the west central Arabian Sea. The majority dissipated in and around the north Arabian Sea, either out at sea or on approaching the coast or soon after crossing the coast. In July, only 4 disturbances are on record and all of them developed off the Saurashtra coast and travelled inland, filling up over Kutch and Sind, or further away over Iran. Both the disturbances that developed in August formed off or near the Konkan coast; one crossed the Saurashtra coast and filled up over the Punjab (Pakistan) and the other travelled to the Gulf of Oman. Except for one, all the disturbances that developed during September formed on and near the Konkan and Saurashtra and Kutch coasts. Three of the disturbances travelled westwards and filled up over the northwest Arabian Sea, 2 filled up near the northeast coast and 2 over Sind. Of the remaining two which crossed the coast, one filled up over north Rajasthan and the other travelled far away towards Iran. As pointed out previously, October is the most disturbed month in the Arabian Sea, there being 34 disturbances on record. The areas where the disturbances developed show a wide scatter and similarly the areas of dissipation also show a wide scatter, quite a large number also moving into the west Arabian Sea and a few travelling as far west as the Persian Gulf. A significant number filled up in and near Saurashtra-Kutch. November, the next most disturbed month, has 27 disturbances on record and all of them, except one, developed in the southeast and the adjoining east central Arabian Sea. Again, like October, majority dissipated in the sea itself, quite a few moving into the southwest and the west central Arabian Sea. No disturbance in November travelled to the Persian Gulf. December has only 10 disturbances on record, with the region of formation mostly in Laccadive, Maldive and Comorin areas. All of them dissipated in the sea itself.

REFERENCE

Rai Sircar, N. C. 1956 *Mem. India met. Dep.*, **30**, Pt. 5.