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Monsoon Onset and Everest Expeditions

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ABSTRACT. The paper presents the results of a study of the daily precipitation, temperature at 6 km and winds between 6 and 9 km a.s.l. over the Everest area during the months of May and June for the period 1952 to 1962. The indications are that there is no well marked 'monsoon lull' or a 'monsoon onset' over the Everest. The transition from the strong and steady westerlies between 6 and 9 km a.s.l. of the pre-monsoon season to the steady easterlies of the monsoon season occurs over a period highly variable in duration and can occasionally extend over the whole of May and June. Winds over Everest during this period can be moderate or weak westerlies or weak easterlies. With weak westerlies precipitation can occur practically every day and in most of the years it is not possible to distinguish the onset of the monsoon rains as distinct from the 'pre-monsoon thundershower activity'. The temperature of the strong and steady westerlies at 6 km a.s.l. over Everest increases gradually from — 10°C in early May to about 0°C by the time the variable winds set in. From a consideration of the weather features that were obtained by the successful and unsuccessful expeditions to the Mount Everest since 1952 it is considered more profitable for future expeditions to get to the high reaches of the Everest by early May instead of late May.

1. Introduction

There are three critical factors facing any mountaineering expedition which sets out to climb the highest peaks of the Himalayas; they are the altitude effect on the human system, the climbing difficulties of the slopes and the weather conditions (Hunt 1953). With sufficient development of the techniques in human physiology to overcome the effect of altitude and in negotiating difficult terrain and slopes one may be able to meet successfully the first two aspects but weather is something one has to put up with. Since the first attempt at climbing Mount Everest (Lat. 27° 59′ N and Long. 86° 56′ E, 8848 metres a.s.l.) in 1921 by Mallory no less than 12 major expeditions have been organised with the aim of reaching the top of Everest. Many of them reached within 300 metres of the summit but were forced back by adverse weather conditions. Heavy snowfalls and strong winds that occur at the time of the final assault of the peak have been the main deciding factors for the success or failure of such expeditions.

The activity of the strong sub-tropical westerly jet stream in winter and the heavy monsoon precipitation in summer permit a successful assault on Mount Everest only during the two periods of transition. These are the pre-monsoon period May-June and the post monsoon period October-November. Koteswaram and Parthasarathy (1953) studied the daily upper wind observations over Everest area for 6, 7·2 and 9 km during the months March to June and September to November 1952. The winds in the post monsoon period were shown to be comparatively stronger than those in the pre-monsoon period. The number of lulls with less strong

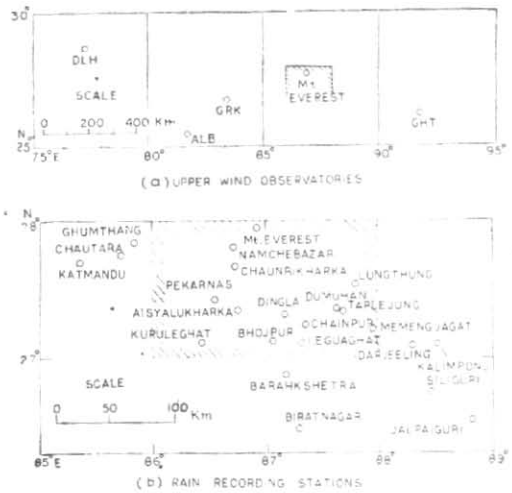

Fig. 1. Disposition of observatories about the Mount Everest

(Data of stations within the area enclosed by hatching are taken to represent rainfall in Everest area)

winds were more in the pre-monsoon period than in the post monsoon. The post monsoon period was considered more stable in its weather conditions since the wintery sub-tropical jet is dominated by large scale subsidence. The short pauses between passage of relatively weak jet maxima during the early parts of this season may bring unexpectedly clear and calm weather on the wind-swept sides of the peak and the risk of avalanches is greatly reduced during calm periods. But towards the end of October and early in November the westerly gales blow with unceasing fury and chances for success of a mountaineering expedition are very little. The only expedition which has succeeded to climb a major Himalayan peak in the post monsoon period is the 1954 Austrian Expedition to Cho-Oyu (8189 metres) lying approximately 30 km to the northwest of Mount Everest and the climbing was done during a short pause on 18 to 19 October which fell between two jet maxima. The meteorological conditions which prevailed during this expedition have been discussed in detail in relation to the retreat of the monsoon by Reiter and Henbuger (1960).

The most favourable period for an assault on Mount Everest, therefore, remains the pre-monsoon period when one is ahead of the monsoon snow-storms and avalanches. This is considered to be a period when the westerly jet stream is replaced over the Nepal Himalaya by the relatively weak easterly moist air flow in association with the monsoon. There is the common conception among mountaineers that there is a period of lull over Everest area lasting 7 to 10 days between the westerly and easterly regimes when conditions are most favourable for a successful assault on the summit of Everest. According to them the monsoon breaks over Everest in a well marked manner and thereafter the weather is characterised by long period of crumbling ice walls, thundering avalanches, furious squalls, heavy thunderstorms and precipitation. It is, however, difficult to make out from the descriptions of mountaineering expeditions the exact nature of the 'monsoon lull' and 'the burst of the monsoon', factors which are considered very important for a successful assault on Mount Everest. In the last 10 to 12 years a great increase in the meteorological observations in the neighbourhood of Everest has been effected and it was considered useful to examine the available data for a better understanding of these aspects.

2. Analysis of data

The main climbing problems of the expeditions arise only above 6 km a.s.l. The favourable weather conditions for Everest climbing apparently are (*i*) winds should be weak, say 20 knots or less, (*ii*) little or no snow should be occurring at the time of climbing and (*iii*) the slopes should be clear of large accumulation of freshly fallen loose snow. The available observations are examined from these aspects.

In the absence of routine observations from the great heights of Everest area those of stations as near to it as possible have been taken. Fig. 1 (*a*) shows the relative positions of the stations Allahabad and Gauhati which are only 600 km from Mount Everest and

TABLE 1

Year	Weakening of westerlies from 40/50 kt to 15/20 kt on	Duration of weak westerlies/ easterlies	Setting in of steady monsoon easterlies	Starting of continuous or heavy ppt. over Everest area approximately on
1962	Jun 3	33 days	Jul 6	Jun 6
1961	May 28	21	Jun 18	May 20
1960	May 14	37	Jun 20	May 14
1959	May 30	30	Jun 29	May 23
1958	Jun 6	20	Jun 25	Jun 6
1957	May 27	33	Jun 29	May 30
1956	Apr 24	60	Jun 24	May 24
1955	Apr 30	57	Jun 26	May 18
1954	May 17	32	Jun 18	May 17
1953	Jun 10	8	Jun 18	May 30
1952	May 26	22	Jun 17	May 17

also Gorakhpur which is 350 km away. There are sometimes observable variations between the winds over these stations but on an average they may be taken to represent to a fair degree of approximation the winds over Everest. Delhi lies about 1000 km to the west and its characteristics of westerly winds should, therefore, be related to those over the Everest. The daily winds observed at 6·0, 7·2 and 9·0 km in May and June over the above stations have been plotted for 11 years 1952 to 1962 in Figs. 2 to 12. Radio wind observations mostly 00 GMT of Delhi, Allahabad and Gauhati were used from 1956 to 1962 and the rest of the winds were derived from pibals. Fig. 1(b) shows the 13 raingauge stations (average height 2500 metres a s.l.) situated in the area Long. 86° to 88°E and Lat. 27° to 28°N and which have been functioning since 1952 for hydrological purposes. The mean daily rainfall over these stations have been worked out and given in Figs. 2 to 12 as a step diagram and these can reasonably be taken to represent at least qualitatively the spells of heavy precipitation in the high reaches of Mount Everest.

The weather forecaster for Everest expeditions in India has to depend upon the telegraphic rainfall reports from stations in Sub-Himalayan West Bengal (*i.e.*, Darjeeling—Siliguri area) to get an idea of the precipitation over Everest. The daily mean rainfall worked out from the records of stations in Sub-Himalayan West Bengal (average height about 1 km a.s.l.) for May and June for these years have also been incorporated in the diagrams for purposes of comparison with that over the foot-hills to the south of Mount Everest.

The daily temperatures at 6 km a.s.l. during the same period over Delhi, Allahabad and Gauhati were examined (for the years 1956 to 1962) to find out their relation with the winds and precipitation. Daily temperature plots for some typical years, *viz.*, 1962, 1957 and 1956 shown in Fig. 13 serve to illustrate the nature of the temperature variations.

3. Results

The salient features of winds and precipitation of the different years have been mentioned in the legends of Figs. 2 to 12. The approximate dates of the more marked changes of wind and weather are also collected in Table 1. The following provisional conclusions have been drawn from a scrutiny of these.

(*i*) Before the arrival of the monsoon season, the prevailing steady westerlies 40/50 knots over Everest decrease to 15/20 knots fairly rapidly within a period of 1 to 3

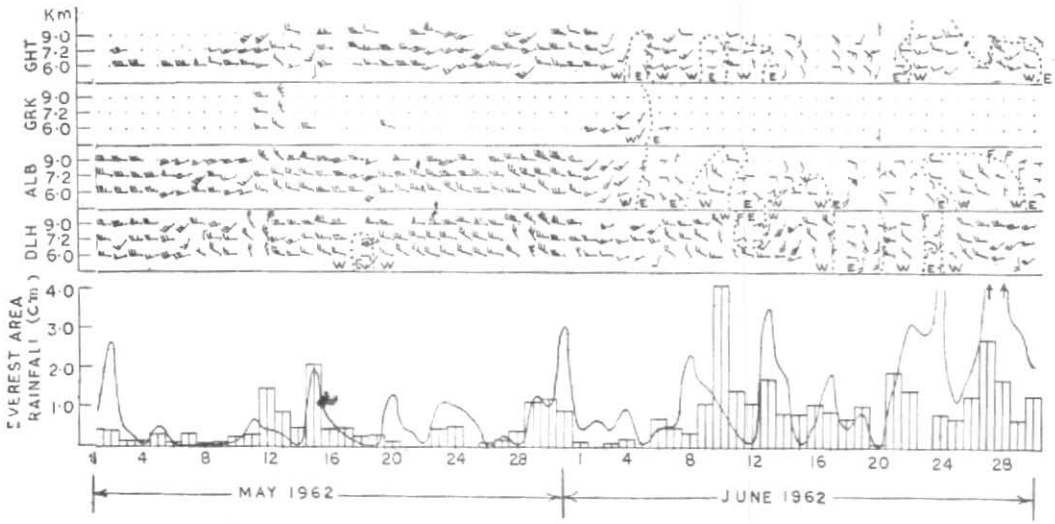

Fig. 2. A well-marked and rapid weakening of relatively strong and steady westerlies occurred over Everest area at about 3 June. Though similar weakening took place at Delhi also west winds were occasionally strong there till the end of June. Marked increase of precipitation commencing from 6 June may be noted.

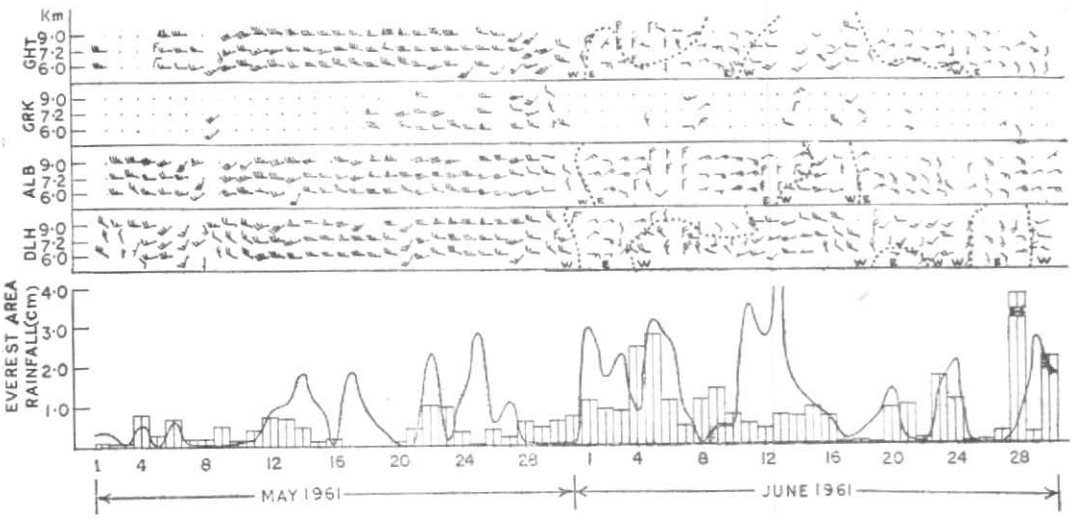

Fig. 3. Note the rapid weakening of steady strong westerlies by 28 May and the setting in of fairly steady and weak easterlies by 18 June over Everest area. Rainfall activity increased markedly from 20 May.

Explanation of Figs. 2 to 12

The step diagrams show the daily average rainfall over the Everest area. The continuous line shows the average rainfall over Sub-Himalayan West Bengal. The winds are plotted with the usual convention, one barb indicating 10 kts and a pendant indicating 50 kts. The dotted lines separate Easterlies from Westerlies. A dot (.) indicates that no observation is available.

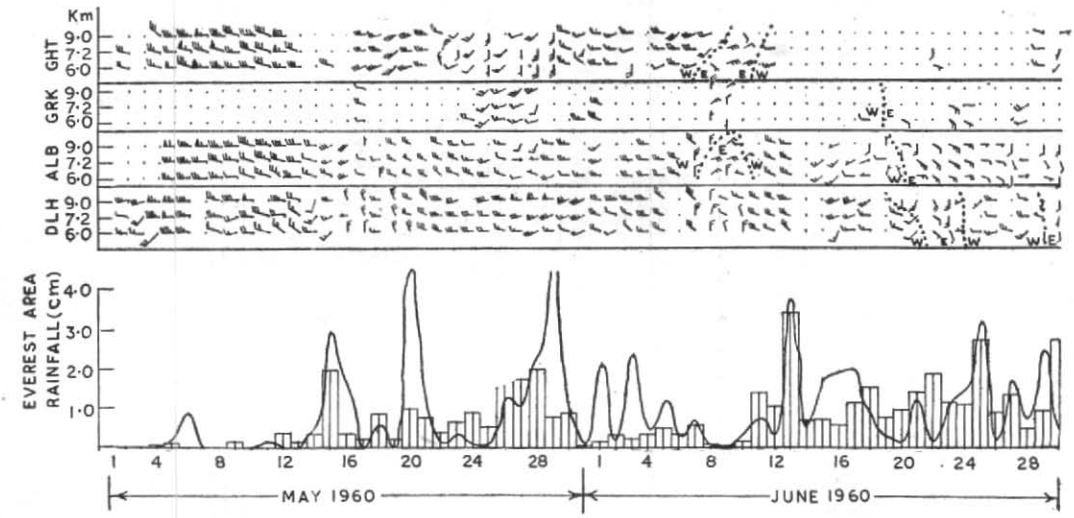

Fig. 4. Note the marked weakening of steady westerlies over Everest by 14 May and the simultaneous increase in rainfall activity. Westerlies fluctuated in speed thereafter and reached even 50 kts at times till 20 June after which fairly steady easterlies set in. Strong westerlies persisted over Delhi till about 20 June.

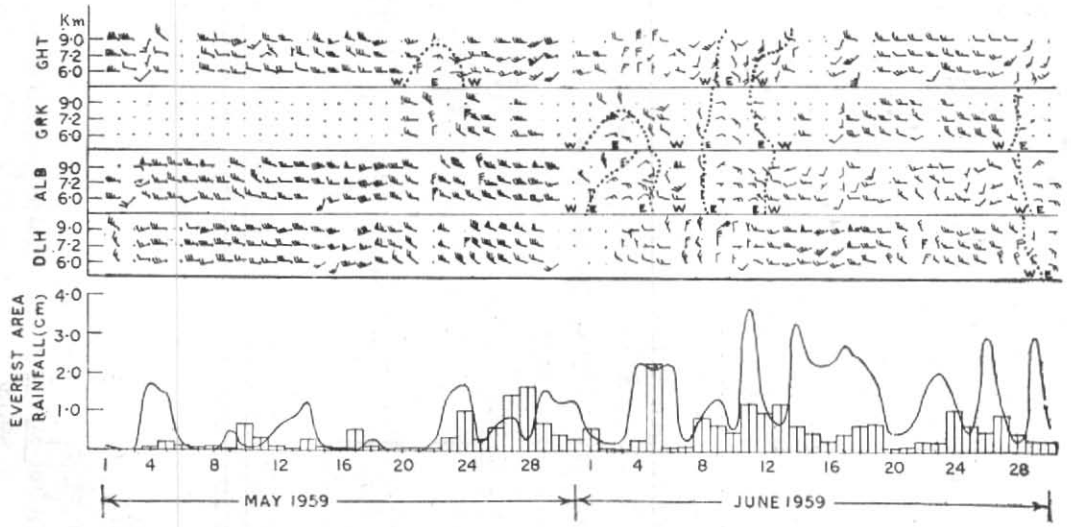

Fig. 5. The weakening of the steady strong westerlies over Everest by 30 May may be noted. Rainfall activity increased markedly from 23 May. After a spell of alternating weak westerlies and easterlies steady westerlies prevailed over Allahabad and Gauhati from 18 to 28 June.

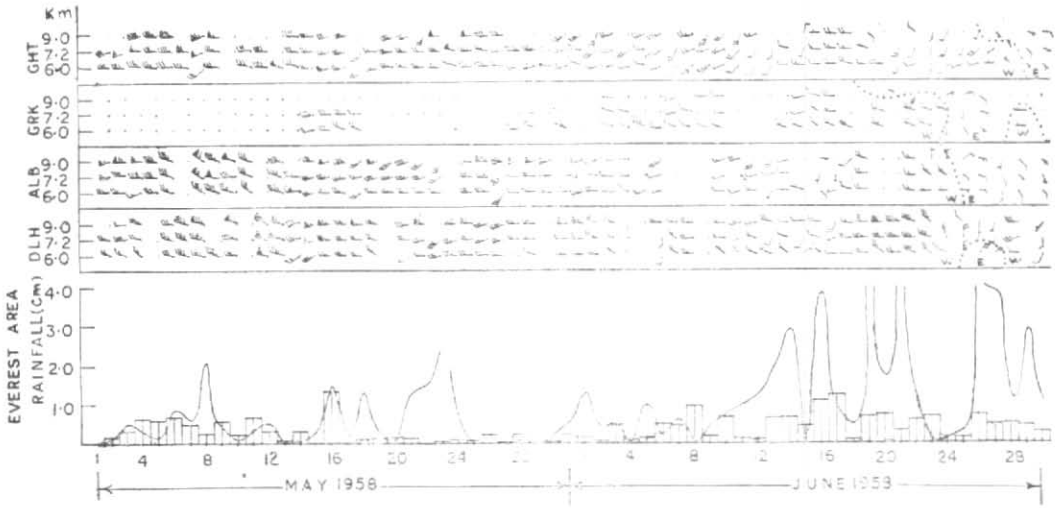

Fig. 6. The weakening of the strong steady westerlies over Everest can be taken as commencing from 6 June and it was simultaneous with increase in rainfall activity. Precipitation over Everest in May and June was light compared to other years. A spell of strong westerlies over Delhi in the third week of June may be noted.

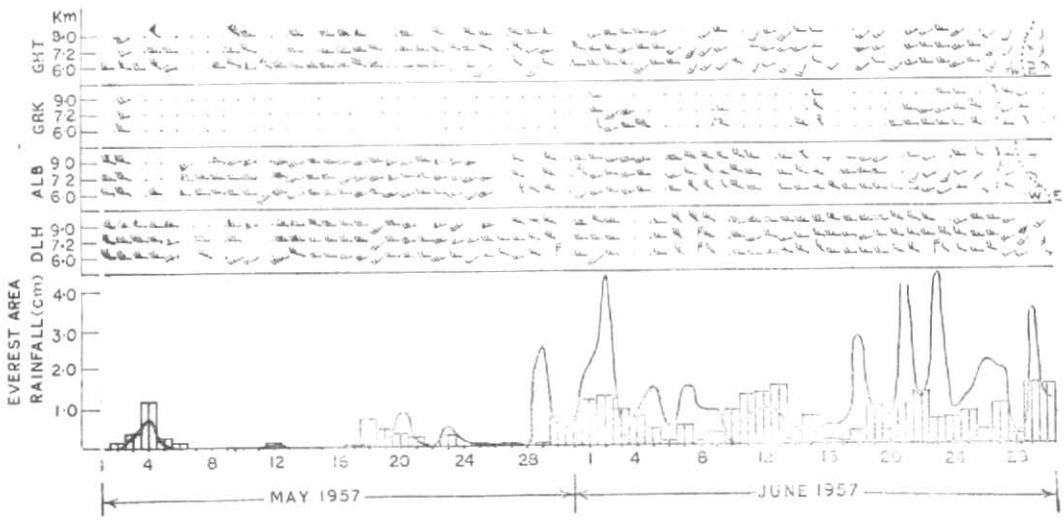

Fig. 7. Though steady and strong westerlies over Everest area weakened noticeably by 27 May the wind remained steady westerlies till practically the end of June with speed occasionally reaching 40 kt. Note that east winds did not reach Delhi even by end of June. Well marked increase in rainfall activity occurred on 30 May. Note the heavy continuous precipitation in association with steady and sometimes moderately strong westerly winds.

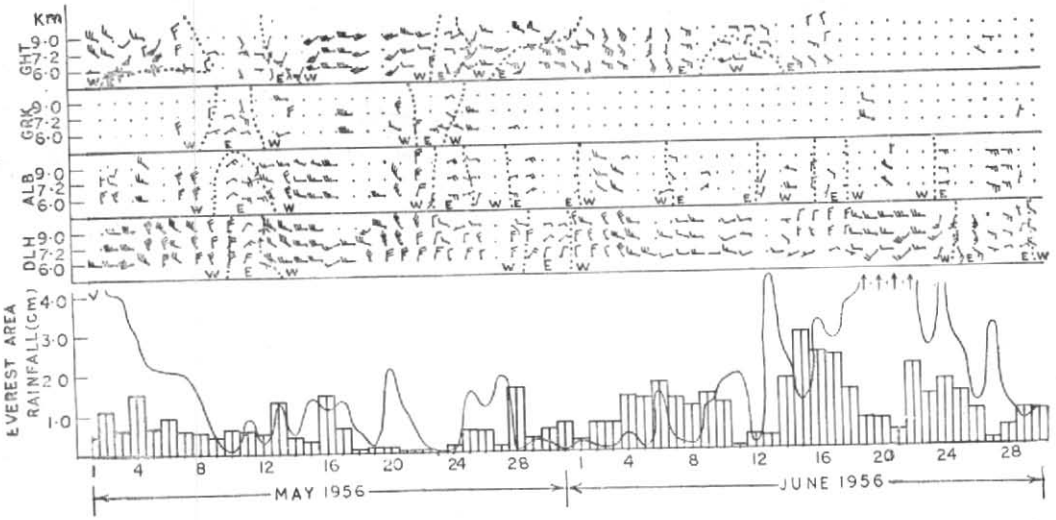

Fig. 8. An extraordinary case when the steady and strong westerlies had disappeared even before the beginning of May (by about 24 April). Till about 22 May northwest winds were occasionally strong in association with passage of well-marked troughs in the westerlies. This was a year of frequent precipitation over Everest in May as well as in June. Heavy precipitation occurred since 24 May, when passage of well-marked westerly troughs ceased.

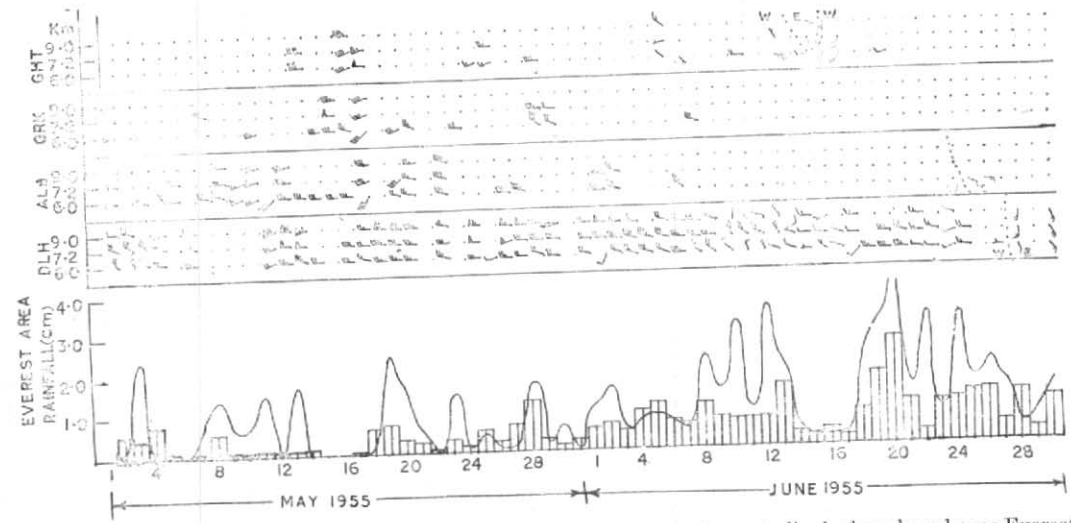

Fig. 9. Upper air observations available are few. Though strong steady westerlies had weakened over Everest even before the beginning of May, 30/40 kt westerlies continued till about 9 June. Note the persistent rains which started by 18 May over Everest were associated with steady moderately strong westerlies.

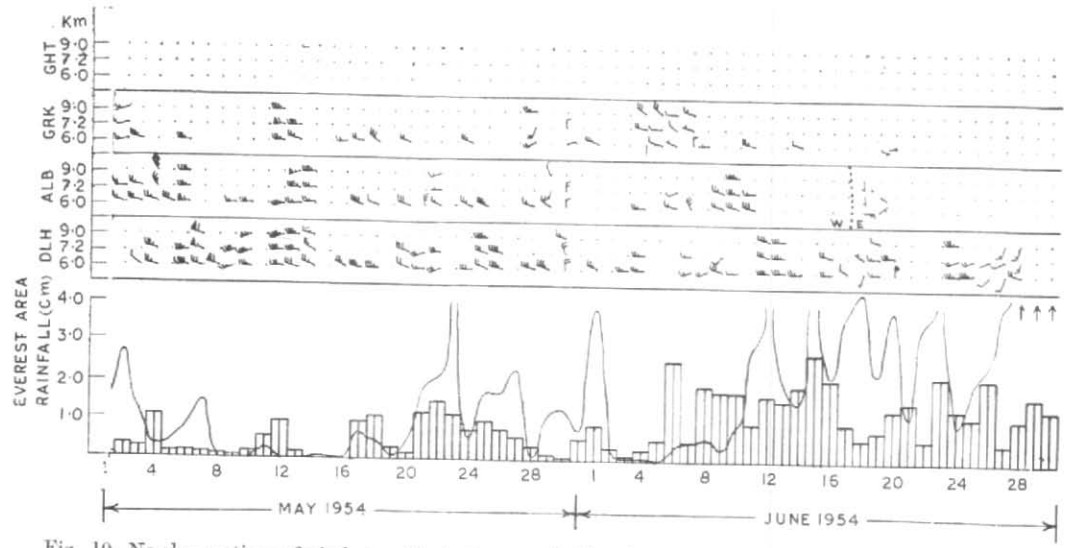

Fig. 10. No observations of winds over Gauhati are available prior to 1955. The strong steady westerlies weakened markedly by 14 May. Daily precipitation started by 17 May. Rains became very heavy from 6 June even when moderately strong westerlies were prevailing over Everest.

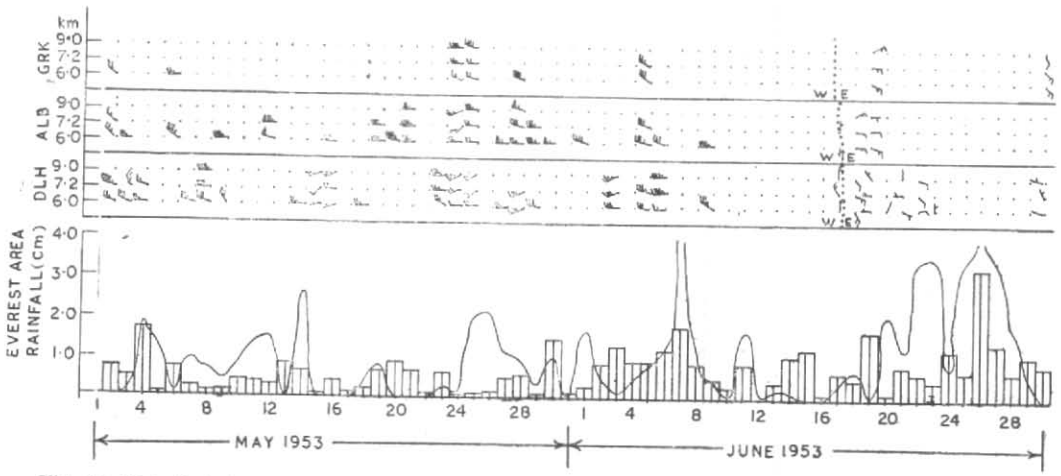

Fig. 11. Note that strong steady west winds persisted over Everest till about 10 June and fairly steady easterlies set in by 18 June. Heavy precipitation occurred commencing from about 30 May.

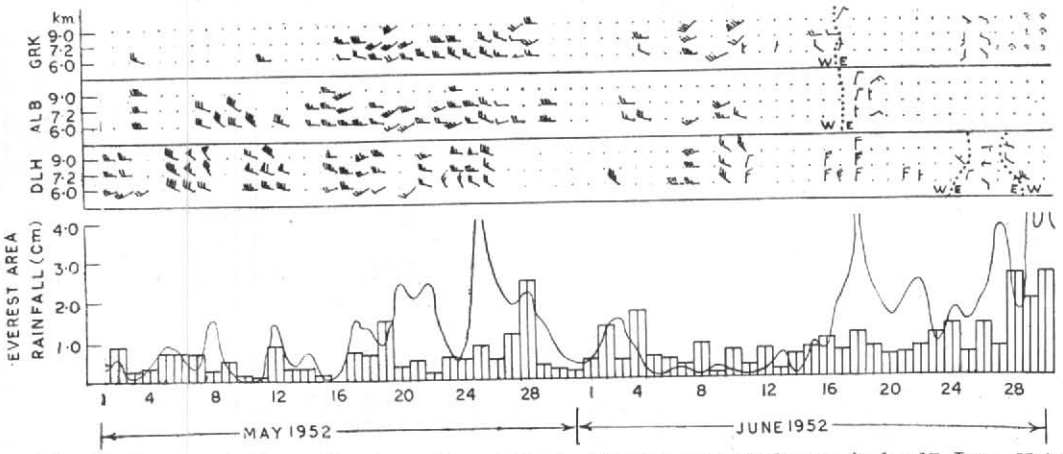

Fig. 12. Strong westerlies continued over Everest till about 26 May and easterlies set in by 17 June. Note the moderately strong westerlies between these dates. Precipitation occurred practically daily throughout May and June. The difficulty in indentifying the monsoon onset as distinct from pre-monsoon thundershowers is obvious.

days. The time of this occurrence is widely variable from year to year and can be on any day between the end of April and 10 June. More often this weakening occurs in the second half of May or the first week of June (*see* years 1962, 1961, 1959 and 1958).

(*ii*) The strong and steady westerlies are followed by a period of weaker winds which lasts for about 30 days on an average and may extend even to as much as 60 days (1956). The winds during this period are westerly or easterly 5/10 knots (1962) or moderately strong and steady or unsteady westerlies.

(*iii*) At the end of period (*ii*), fairly steady easterlies set in. The earliest this has occurred is 17 June. These easterlies may, on rare occasions, get temporarily replaced by weak westerlies in association with feeble troughs in the high latitude westerlies extending to the Everest area during the monsoon season.

(*iv*) The rapid weakening of the strong and steady westerlies over Delhi occurs fairly simultaneously with that over the Everest area but whenever westerlies reappear later they would be stronger at Delhi than over the Everest. This feature is to be expected as the monsoon season generally commences at Delhi only after it commences over Everest.

(*v*) Precipitation occurs over Everest in spells both in pre-monsoon and monsoon seasons. As the pre-monsoon season progresses the rain-spells gradually increase in duration and intensity and the spells are of high intensity during regular monsoon period. There is no sudden increase in precipitation during May and June which can be termed as the 'monsoon onset' in most of the years. A general increase in precipitation activity either simultaneous with or even a few days earlier to the weakening of the strong and steady westerlies and also its persistence can, however, be observed in many years.

(*vi*) Spells of heavy rain can occur throughout the period of relatively weak winds mentioned in (*ii*) above. Heavy precipitation occurs even in association with steady westerlies 25/30 knots (1957, 1953).

(*vii*) The average rainfall amounts over the Sub-Himalayan West Bengal lying to the southeast of Everest are higher than those over Everest area as should be expected in view of the higher elevation of the raingauge stations which have been used to represent precipitation over Everest. Rainfall increase in the Sub-Himalayan West Bengal is accompanied on many occasions but not always with a corresponding increase in the

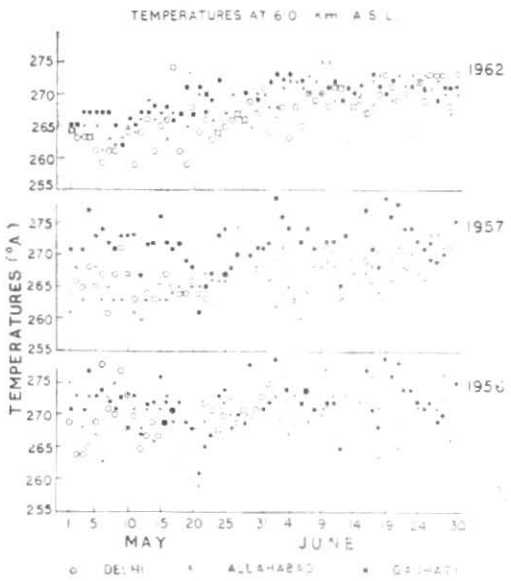

Fig. 13

precipitation over Everest area. This aspect has to be kept in mind by weather forecaster who, while catering to the needs of Everest expeditions, have to judge the intensity of precipitation over Everest from the telegraphic reports of synoptic data received from stations in Sub-Himalayan West Bengal.

Temperatures—The study of the daily temperature variations at 6 km over Delhi, Allahabad and Gauhati shows that temperature fluctuations have no one-to-one correspondence with the changes in wind or precipitation over Everest. However, it is seen that (*a*) the temperatures are generally higher at Gauhati and lower at Delhi than at Allahabad during May and June, (*b*) a temperature of about —10°C over Everest during early May, when strong and steady westerlies prevail, rises gradually to about 0°C in the period of weaker winds. This higher temperature is maintained even in the monsoon easterlies. As can be seen in 1962 the rise mentioned above can take place even when westerlies are strong (*see* Fig. 13), (*c*) temperatures remain —6° to —10°C in the steady westerlies over Delhi and Allahabad but strong steady westerlies over Gauhati can be associated with higher temperatures (1957), (*d*) the temperature over Everest was about 0°C even at the beginning of May in 1956 as a result of early weakening of the strong westerlies in that year. Over the slopes of the Everest temperature must be lower than the free air temperature described above during night on account of the high radiational losses from the snow surface.

4. Discussion of the results

The arrival of the monsoon over the Indian sub-continent has been discussed by Ramanathan and Ramakrishnan (1938). In a detailed study, Yin (1949) has shown that in association with the onset of the monsoon in the Indian sub-continent the sub-tropical high pressure belt shifts rapidly northwards to a position Lat. 30–35°N. Simultaneously the north-south trough line in the westerlies at the 500-mb level lying near Long. 85–90°E rapidly shifts westwards to a Longitude 75°E. This westward shift of the trough is what is seen as the rapid weakening of the steady and strong westerlies above 6 km a.s.l. over the Everest area described here and shown in col. 2 of Table 1. The trough apparently fluctuates in an east-west direction in the neighbourhood of Long. 75°E and accounts for the temporary strengthening of the westerlies over Delhi even after they weaken over Everest. The sub-tropical anticyclonic cell migrating westwards from over China brings in the high level easterlies of the monsoon season over the Everest. From the results presented here it is clear that a relatively long period exists between the weakening of the westerlies and the setting in of the steady easterlies. The mountaineer should normally expect the pre-monsoon strong westerlies above 6 km to weaken fairly rapidly by about the last week of May or the first week of June. Weak westerlies or easterlies will prevail thereafter for about a month before the fairly steady easterlies of the monsoon set in. Very wide divergence from the above situation can,

however, occur during individual years as exemplified by the highly contrasting years of 1957 and 1956. In 1956, the strong and steady westerlies weakened before the beginning of May and variable winds prevailed till the end of June. In 1957, on the other hand, steady westerlies though with diminished speed continued till the end of June. The period following the sudden weakening of the strong westerlies is associated with frequent and sometimes heavy precipitation. It appears, therefore, that a 'monsoon lull' with little precipitation and weak winds and which lasts for a week as commonly claimed does not exist. Spells of precipitation, at times heavy, often start over Everest simultaneously or even earlier to the weakening of the main steady westerlies. The arrival of the steady easterlies is not a criterion for commencement of heavy monsoon precipitation. The pre-monsoon thundershowers (or the *Chotta Barsat* as the mountaineers call them) apparently merge into the monsoon rains in most of the years.

From the mountaineer's point of view it appears that so long as the westerlies are strong (say 40/50 knots) the snow that accumulates on the slopes resulting from continuous precipitation gets blown off and he will still have a chance for making continued attempts at climbing. If, however, heavy snow occurs in association with weak winds, loose snow accumulates over the slopes in a deep layer and this would result in avalanches. It will be hazardous to make any further attempts at climbing thereafter. The descriptions given by the Everest expeditions of having been caught up by the 'monsoon onset' cannot be always relied upon to fix up any date of monsoon onset over Everest. With the advance of the season and increased moisture incursion in the plains to the south of Everest the frequency and violence of the thunderstorms over Everest increase. A mountaineer while trying to reach the top of Everest by negotiating the last few hundreds of metres is in such a high state of fatigue and tension that he is apt to take any large scale build-up of clouds, snow and squall, even if it be of a temporary nature, as 'the burst of the monsoon'. Instances have occurred when immediately after the expedition gave up the summit attempt, due to the so called 'monsoon onset', spells of very little precipitation in association with weak winds recurred.

Four major expeditions have gone with the definite aim to reach the summit of Everest during the period 1952–1962. The spell of precipitation which occurred between 28 and 31 May forced the Indian Everest Expedition of 1962 to abandon the summit assault on 29 May on account of 'monsoon onset' after reaching within 250 metres of the top. The summit party experienced winds of gale force and driving snow. It may be seen from Fig. 2 that soon after the party abandoned the attempt a spell of little precipitation with the weak winds prevailed between 1 and 6 June. The strong westerly winds that prevailed up to 2 June might have cleared the snow that fell on the slopes between 28 and 31 May and the party might have succeeded if further attempts could be made between 2 and 6 June.

A spell of heavy snow that occurred from 26 to 30 May caused the failure of the first Indian Everest Expedition led by Brig. Gyan Singh in 1960. The summit party gave up the final assault on Everest on 26 May. The statement of the party that heavy snow more than the winds that defeated them is supported by Fig. 4. The period 31 May to 10 June was one of little precipitation and weak winds but it is doubtful whether the expedition could have made any further attempt at climbing during this period. The westerlies were not strong enough to sweep away the heavy snow that accumulated on the slopes between 26 and 30 May.

The conditions under which the two successful expeditions climbed Everest may be seen in Figs. 11 and 8. Hillary and Tenzing of the first successful Everest Expedition led by John Hunt reached the summit on 29 May 1953. Though the progress of the expedition

was hampered by daily fall of snow till the middle of May, there was much less precipitation but accompanied by fairly strong westerlies in the second half of May. The final summit attempt on 29 May was successful in spite of the strong winds. The slight weakening of westerlies and the simultaneous increase in precipitation would have considerably decreased the chances of climbing after 29 May. The success of the party indicates that the climbing parties at these great heights can withstand relatively strong winds. The heavy snow and blizzards constitute a more serious danger to the climbers.

The second successful assault of Mount Everest was made by the Swiss Expedition (1956) on 23 May and again on 24 May. Luck played considerable part in this venture. The strong steady westerlies had weakened at the end of April and it was a year of early as well as heavy monsoon over the Indian subcontinent. Though heavy snowfall had started even from the beginning of May, a spell of 30/40 knots westerlies or northwesterlies prevailed from 16 to 23 May and this must have made the slopes more climbable (*see* Fig. 8). Weak winds and practically no precipitation occurred on the days of the summit assault. The heavy precipitation and weak winds that commenced from 25 May would have made any further attempts futile.

It is fully realised that the exact weather features over the different slopes and valleys at the Everest may deviate somewhat from the free air conditions for which wind data are presented here. Nevertheless, there is little doubt that the broad features seen in the diagrams represent substantially what actually obtain over Everest. In the light of the features discussed above, it appears desirable that mountaineers who want to get to the top of Everest should reach the greatest possible heights much before the onset of the weak winds. The chances of facing heavy snow and blizzards are very high once the steady and strong westerlies weaken. Success at climbing after the westerlies weaken will be too much a matter of luck and a rare occurrence. The steady westerlies in early May are generally only 40/50 knots strong; brief spells of 25/30 knots also occur within this stream occasionally. It is suggested that expeditions should plan to get to heights of the order of 8000 metres a.s.l. by early May with sufficient equipment to enable them, if need be, to wait there for even 10 to 15 days. They will then be able to take advantage of the short pauses in westerlies unassociated with precipitation to make one or more bids to the top. This suggestion would equally well be applicable not only to expeditions to the Everest but also to other peaks not far from Everest.

5. Acknowledgement

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