

# On the utility of correcting Barometric tendencies for normal diurnal variations for forecasting in India

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*(Received 7 April 1949)*

**ABSTRACT.** Forecasting offices in India are at present preparing a chart showing 24 hour pressure change and using the same to indicate pressure tendencies for forecasting purposes. As a period of 24 hours is rather too long to give a reliable indication of pressure changes that would follow, it is considered that a chart showing pressure changes during a shorter period corrected for normal diurnal variation would give a more reliable indication of the present tendencies. It has been shown that the corrected pressure changes since the last hour of observation can be obtained by subtracting pressure departures from normal at the hour of observation from the corresponding value at the previous hour. This procedure automatically takes into account the diurnal correction which is appropriate for the individual stations and also for the season or period under observation and thereby eliminates the error which would otherwise come in in using a mean correction for the diurnal variation.

The utility of such a chart is illustrated in the case of typical weather situation during week ending 3 October 1948. The inferences that could be drawn on the basis of the corrected pressure changes for shorter period and those on 24 hour pressure changes have been compared day to day with reference to actual development of weather during the period.

## 1. Introduction

The barometric tendency plays an important part in the technique of forecasting in the temperate zone. The utility of barometric tendency for forecasting in India has been discussed by A.K. Roy in Technical Note No. 22 published by the India Meteorological Department. It is true, as observed by Roy, that in countries like India where variations of pressure, associated with the travel of weather system, are as a rule comparatively of a small order and are liable to be masked by large diurnal

variation, the observed barometric tendencies are often of no material help in the analysis of weather charts, unless these are carefully corrected for the diurnal variation factor. The corrections as are ordinarily attempted by allowing for the mean variation of pressure from one hour to another, however, do not always give the true barometric tendency in any given period, as the diurnal variation factor varies appreciably from station to station and also with the types of air mass conditions prevailing at a station. That the normal variation of pressure appreciably varies from station to

station and from season to season in India can be seen from Technical Note No.15 published by the India Meteorological Department. It is indeed a very intricate matter to make due allowance for the diurnal variation factor to the extent it is influenced by the weather factors at a station, but in order that the pressure tendencies may be of reasonable value in forecasting, it is at least necessary that the observed pressure changes in any given period should be corrected for the normal diurnal variation in the same period for that particular station.

## 2. Construction of Pressure change charts

24 hour pressure changes, being independent of the diurnal variation, are plotted by all Forecast Centres in India with a view to utilise these for the prognosis of pressure systems. It is, however, obvious that the total pressure change during the past 24 hours at a station does not always give a correct indication of the barometric tendency in the immediate past and, as such, often does not throw any light on the trend of pressure change in the immediate future. The inferences drawn with regard to movement of pressure systems on the basis of 24 hour pressure changes may thus often be misleading. In this respect corrected pressure changes for shorter intervals would be much more useful than the 24 hour pressure changes. As the normal diurnal variation varies from station to station and from season to season, the same average value cannot be used for working out the corrected pressure changes at all stations and on all days. These uncertainties can be largely eliminated if pressure changes corrected for diurnal variation are worked out for different stations between two synoptic hours, for which 5-day normal pressure values are available. The corrected pressure change at a station can then be readily obtained from the change in the value of pressure departure from normal since the last synoptic observation. Suppose  $p_m$ ,  $N_m$ ;  $d_m$  and  $p_e$ ,  $N_e$ ,  $d_e$  be the pressures, normal values of pressure and pressure departures for a station corresponding to the morning and evening synoptic hours, i.e., 0800 and 1700 IST.

Then

$$d_m = p_m - N_m$$

$$\text{and } d_e = p_e - N_e$$

$$\begin{aligned} \text{Therefore, } d_m - d_e &= (p_m - p_e) - (N_m - N_e) \\ &= (\text{Actual pressure change}) - \\ &\quad (\text{normal diurnal variation}) \\ &= \text{Corrected pressure change.} \end{aligned}$$

The corrected pressure change at 0800 IST since last 1700 IST can thus be readily obtained by algebraic subtraction of the evening departure from the morning departure values. The difference can be directly read from the relevant departure charts and plotted on a separate chart meant for the corrected changes. A chart so prepared can be utilised while analysing the morning charts. Similarly corrected changes at 1700 since 0800 IST of the same day can be utilised while analysing the evening charts. When normal pressure values for other synoptic hours are available the same procedure can be extended to work out barometric tendencies corresponding to periods between any other consecutive synoptic charts.

Although the procedure suggested above does not allow for the diurnal variation correction in so far as it is influenced by weather, *viz.*, cloudiness, prevailing airmass at the station etc., actual experience has shown that the tendency charts prepared on the lines indicated in the preceding paragraph are more useful in forecasting than either the 24 hour change charts or charts showing pressure changes in any given period corrected for the mean diurnal variations as given in Table 6 of 'Tables for the reduction of meteorological observations'.

An additional chart showing the barometric tendency since the 1700 IST of the previous day was accordingly started as a routine at Calcutta for study along with the 0800 IST synoptic charts, and has been found to be of material help in anticipating future movements of pressure systems.

## 3. Utility of pressure change charts

By way of illustration, the charts for the week ending 3 October 1948 during which a depression from west central Bay of Bengal moved northwest, crossed Orissa coast and then recurved as a low pressure wave northeastwards into Gangetic West Bengal and finally emerged again at the head Bay

of Bengal are given in Figs 1-7. These contain for each day four charts showing respectively,

- (i) 24 hour pressure changes at 0800 IST
- (ii) Corrected pressure change since last 1700 IST
- (iii) Isobaric chart at 0800 IST together with rainfall during past 24 hours
- (iv) Morning upper winds at 2000 ft.

Inferences that one would draw on the basis of the corrected pressure changes, the advantages over those drawn on the 24 hour pressure change chart and the actual subsequent development of the synoptic situation are explained below date-wise.

#### 27 September 1948 (Fig. 1)

It is significant that although the 24 hour pressure change chart indicates a rather uniform fall of pressure over the area east of Longitude 82°E except for a small rise in pressure over Eastern Pakistan, the corrected pressure changes since last 1700 IST indicate fall of pressure only over Orissa and along and near the Circars coast while appreciable rise is indicated over the rest of northeast India and to the northwest of Orissa and Circars coast. Thus the steeper isallobaric gradient indicated by the corrected pressure change chart would suggest possible intensification of the depression. The slightly concentrated falls along Orissa-north Circars coast on the corrected change chart would also suggest movement of the depression in a westnorth-westerly direction but the values of the pressure changes are rather low to be of sufficient significance. The isallobaric gradient or rather the isallobaric wind as seen on the corrected change chart would suggest increased cyclonic vorticity of moist air over Orissa-Circars area and hence supports immediate increase of rain over that area as could be seen on the rainfall chart of the 28th.

#### 28 September 1948 (Fig. 2)

The morning isobaric chart showing extension of the trough northwestwards and the 24 hour pressure change chart showing almost a flat negative area to the northwest of the depression centre would suggest a northwesterly movement of the depression without appreciable intensification. The corrected change chart on the

other hand reveals a fresh feature regarding the pressure tendency in so far as there appears a ridge of relatively larger positive change along the belt from Raipur to Anantapur whereas concentrated negative changes appear over Orissa-north Circars coast. This configuration of pressure tendencies would suggest that movement of the depression northwestwards, if any, would be small and slow. This consideration would also give hint for a possible eventual recurvature of the depression. The isobaric chart of the next morning (29th) shows that the depression did remain practically stationary since 28th morning.

#### 29 September 1948 (Fig. 3)

The corrected change chart of this morning provides a very good illustration of its advantage over the usual 24 hour change chart from the point of view of forecasting the movement of the pressure systems. It will be seen that while the 24 hour pressure change chart indicates a practically uniform fall of pressure ( $\frac{1}{2}$  to 1 mb), the corrected change chart reveals a well-defined area of falling pressure over southwest Bengal and neighbourhood, surrounded by areas of rising pressure. This provided a reliable clue that the depression which was crossing Orissa coast might recurve northeastwards towards southwest Bengal. One would also infer that while the northwestward movement of the depression across south Orissa coast would have led to a general decrease in rainfall over northeast India, the recurvature of the depression as indicated by the corrected change chart would not only result in the persistence of rain in northeast India but might even cause increased rain over there. A study of the charts of 29th and 30th morning would reveal that the inferences drawn on the basis of the corrected change chart were in good agreement with the actual developments by the 30th. The isobaric chart of the 30th indicated that the depression had crossed coast and lay as a trough of low with the region of lowest pressure near Midnapore. The upper air charts for 2000 ft of the 29th and 30th show more clearly the movement of the low. Rainfall chart of the 30th morning also indicates the correctness of the inference drawn in this respect.

#### 30 September 1948 (Fig. 4)

The 24 hour pressure change chart gave a practically uniform fall of pressure

over the whole of northeast India whereas the corrected pressure change chart indicated a comparatively larger pressure fall over south Bengal and north Orissa. The corrected pressure change would thus suggest that the shallow low over north Orissa and adjoining southwest Bengal would move further into southwest Bengal and might intensify and that this would be associated with a general increase of rainfall over northeast India, particularly over Assam and south Bengal. The inferences so drawn agree remarkably well with what was actually realised by the next morning vide isobaric and rainfall chart of 1st October morning. Widespread and locally heavy rain occurred in Assam and south Bengal during the 24 hours ending at 0800 IST of 1 October 1948.

*1 October 1948 (Fig. 5)*

The 24 hour change chart showed small uniform fall of pressure over northeast India. The corrected change chart also indicated a general fall of pressure over northeast India but with a small area of slightly larger fall to the east of Calcutta. In this case both the 24 hour and the corrected change charts would indicate that the low over southwest Bengal and adjoining north Orissa might persist causing further widespread and locally heavy rain over Assam and Bengal. Assam and Bengal did get widespread and locally heavy rain in the subsequent 24 hours vide 2 October chart.

Although the slightly larger fall to the east of Calcutta noticed in the corrected pressure change chart might be considered as too small a contrast to be of significance, it apparently provided a clue in this case to the subsequent eastward movement of the low encroaching into the head Bay.

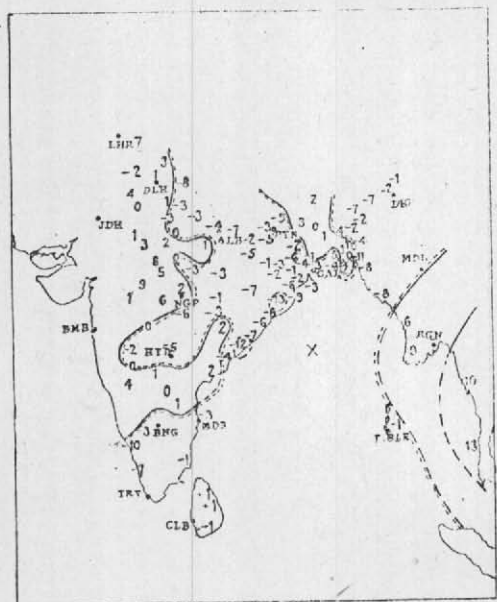
*2 October 1948 (Fig. 6)*

Both the 24 hour and the corrected pressure change charts on this day showed practically uniform fall in pressure over Bengal suggesting the persistence of the low over south Bengal and further rain over Assam and Bengal. By the next morning (3rd), the low moved slightly to the north and widespread rain continued in Assam and Bengal during the period.

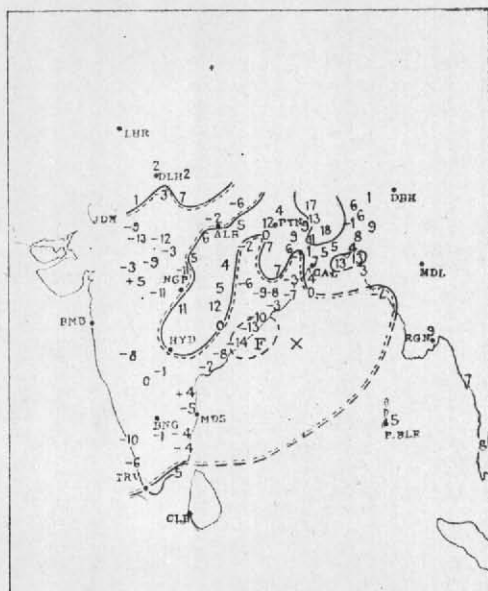
*3 October 1948 (Fig. 7)*

Both the change charts, particularly the corrected change chart indicated a movement of the low over southwest Bengal towards north or northeast. The trough actually elongated towards northnortheast by the same evening and by the next morning (4th) it caused widespread rain with few heavy falls in Assam and north Bengal.

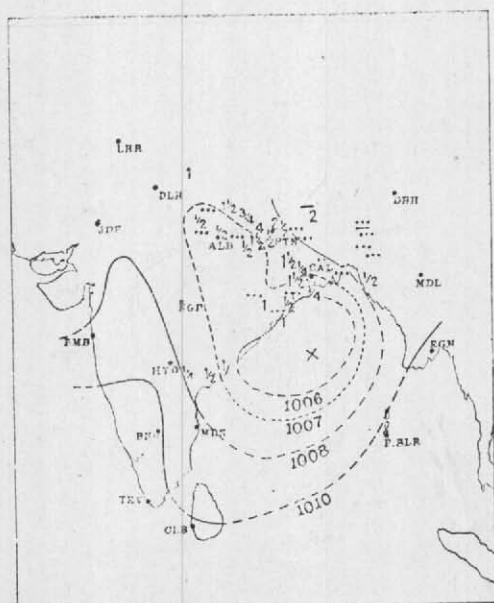
By the 4th morning, pressure started rising rapidly over northeast India and during the next 24 hours, the low became unimportant and rainfall decreased in northeast India.



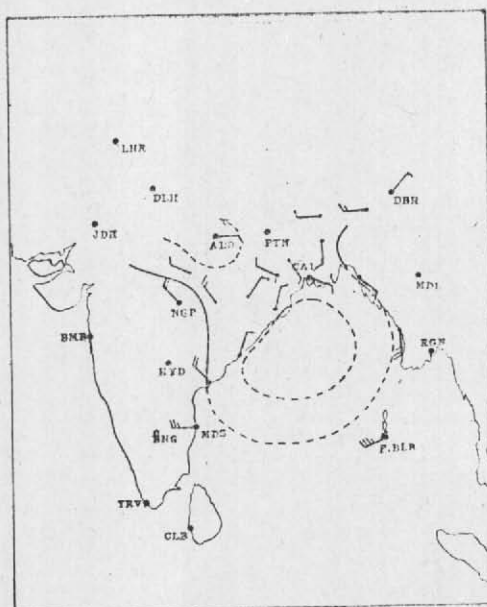
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar



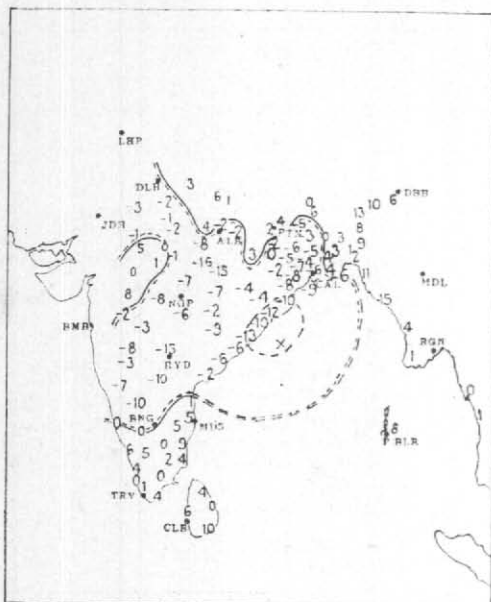
(iii) Isobar and Rain



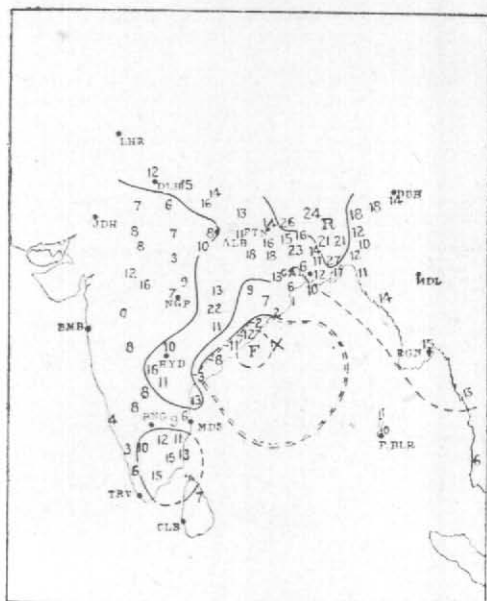
(iv) Upper winds  
2000'

× indicates the centre of the depression

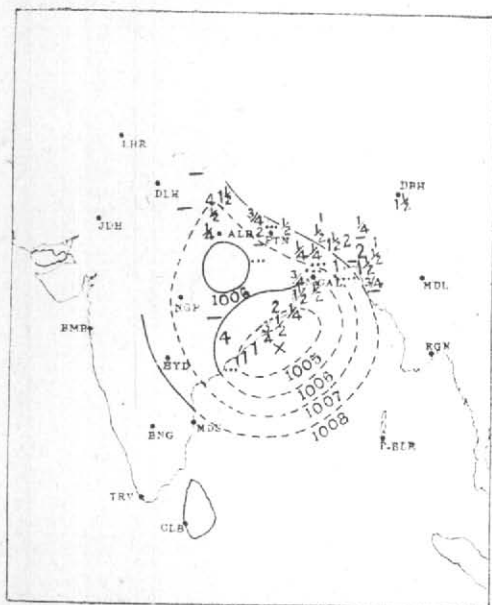
Fig. 1. Charts for 0800 IST on 27 September 1948



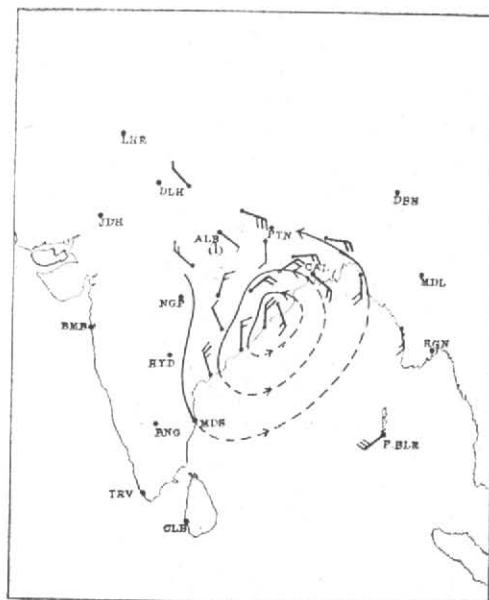
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar



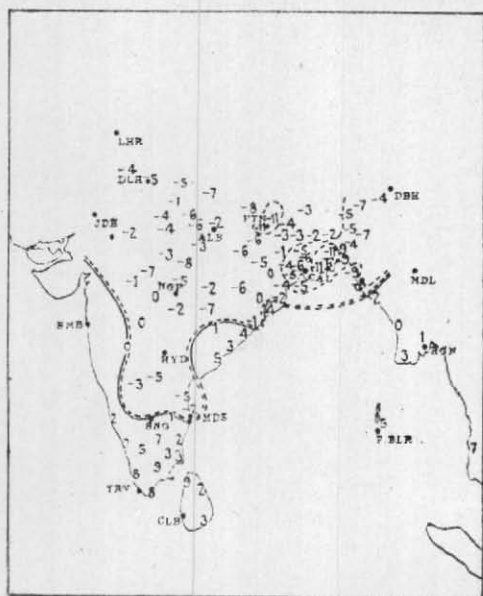
(iii) Isobar and Rain



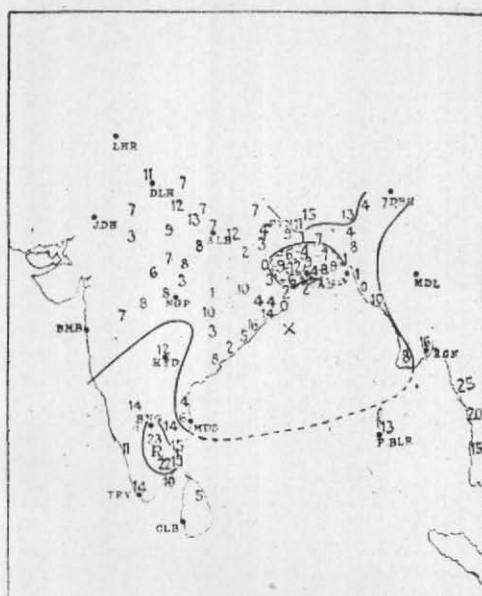
(iv) Upper winds  
2000'

× indicates the centre of the depression

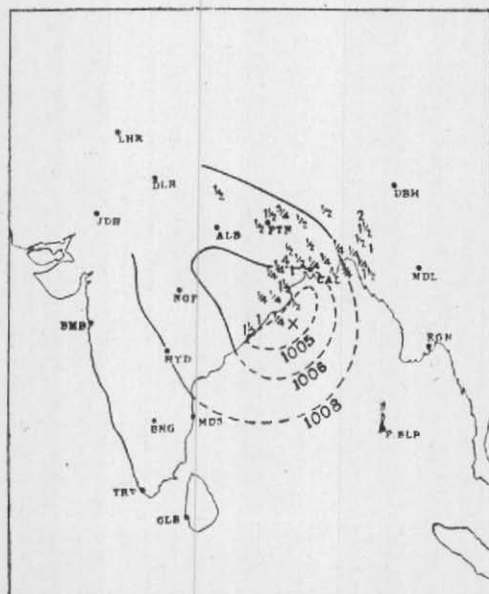
Fig. 2. Charts for 0800 IST on 28 September 1943



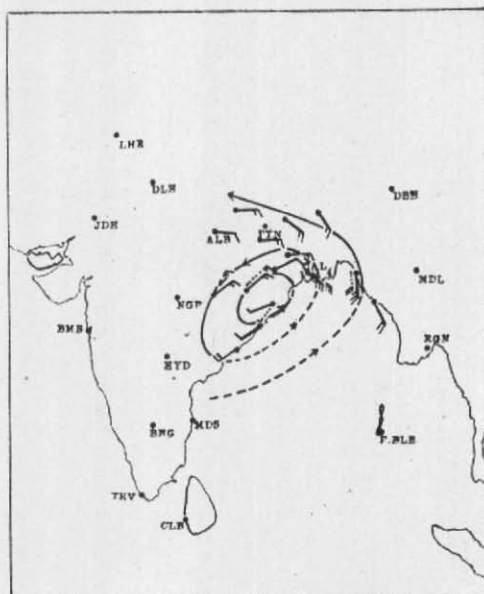
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar



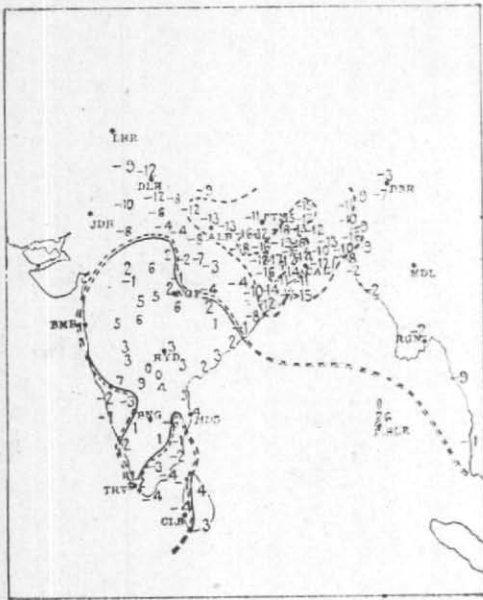
(iii) Isobar and Rain



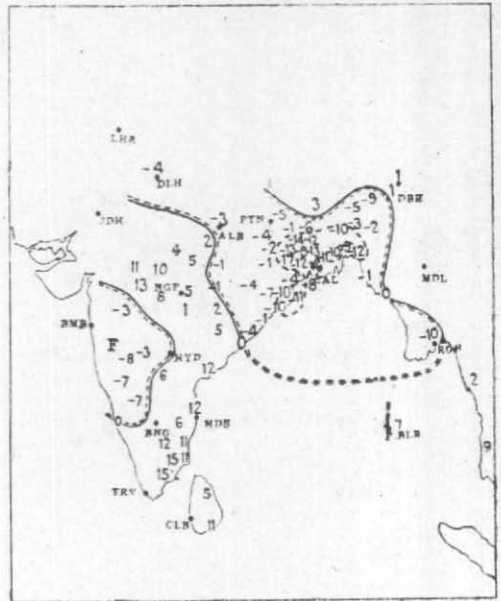
(iv) Upper winds  
 —————> 2000'  
 .....> 3000'

× indicates the centre of the depression

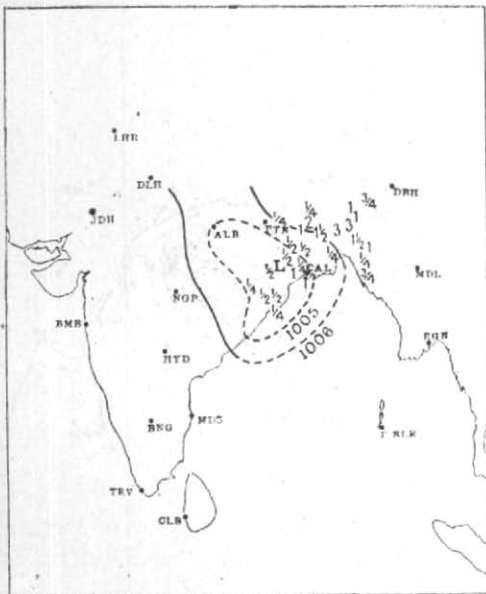
Fig. 3. Charts for 0800 IST on 29 September 1948



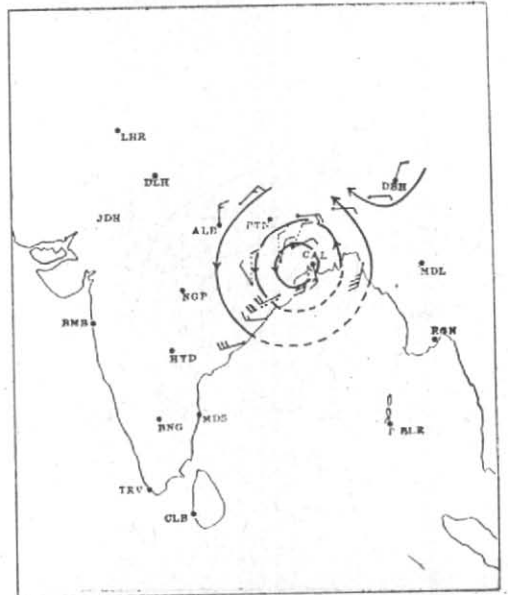
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar



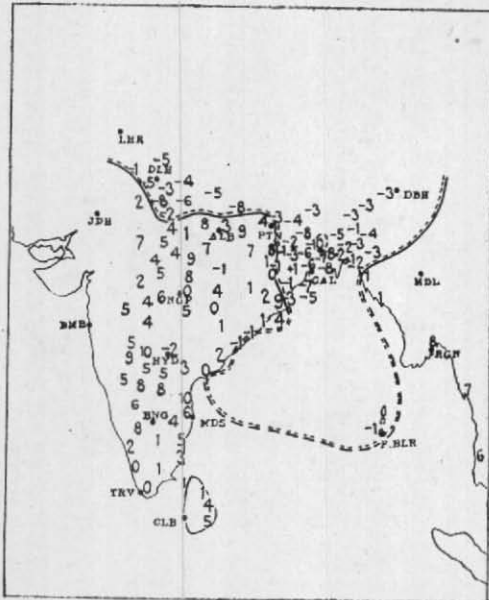
(iii) Isobar and Rain



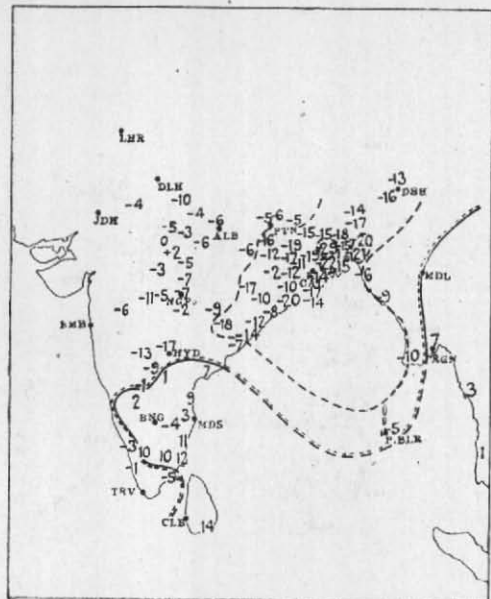
(iv) Upper winds  
 ———→ 2000'  
 .....→ 3000'

Fig. 4. Charts for 0800 IST on 30 September 1948

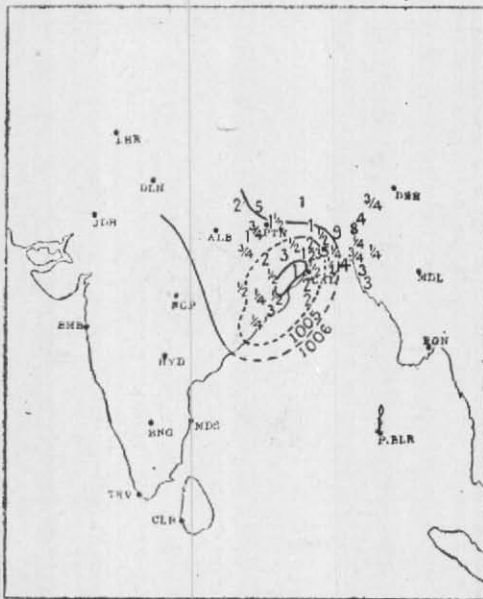




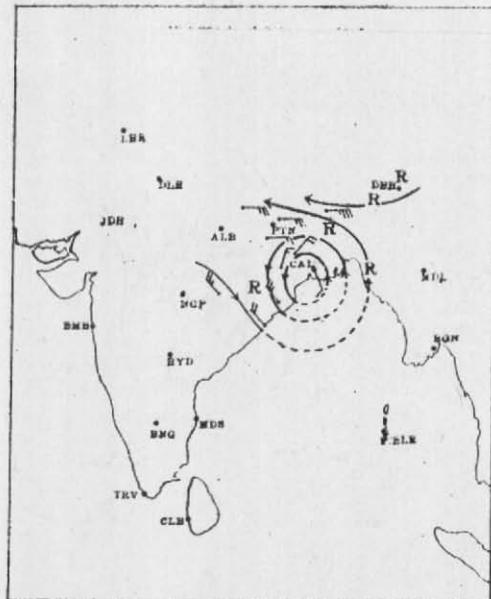
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar

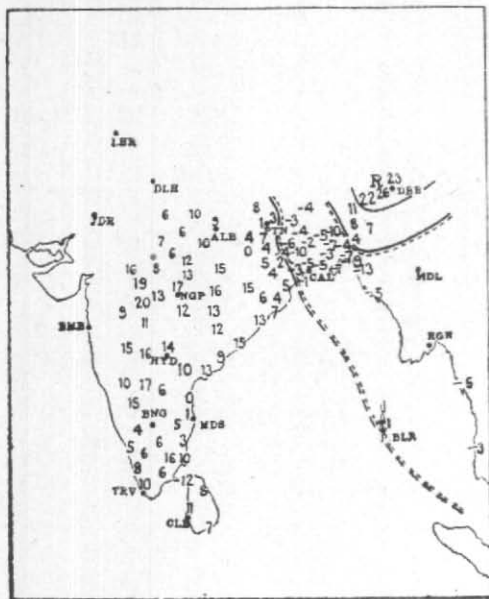


(iii) Isobar and Rain

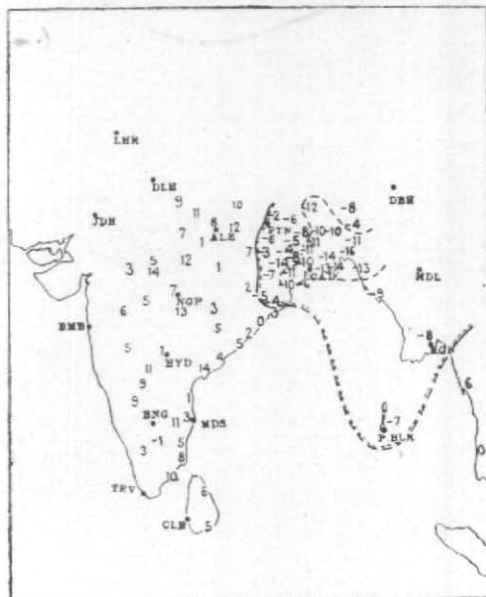


(iv) Upper winds  
2000'

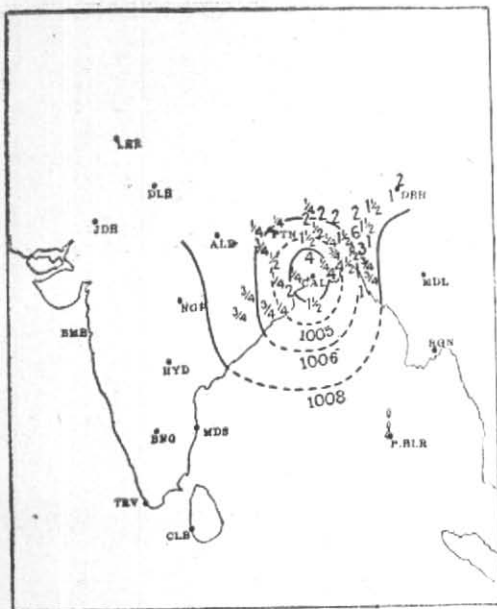
Fig. 5. Charts for 0800 IST on 1 October 1948



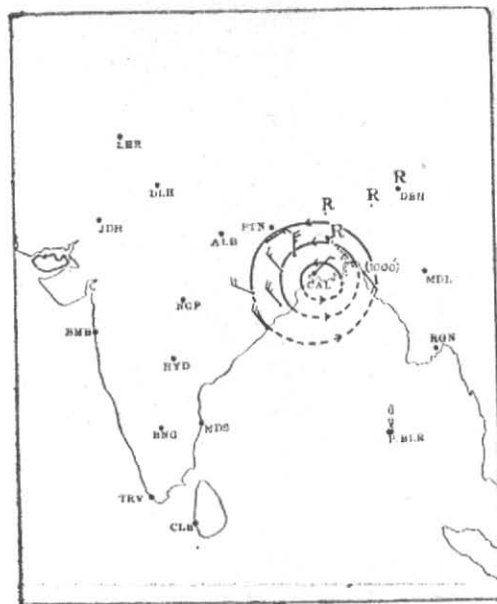
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar

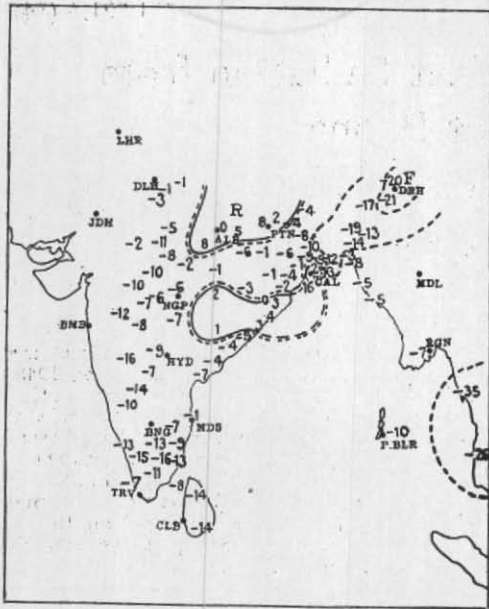


(iii) Isobar and Rain

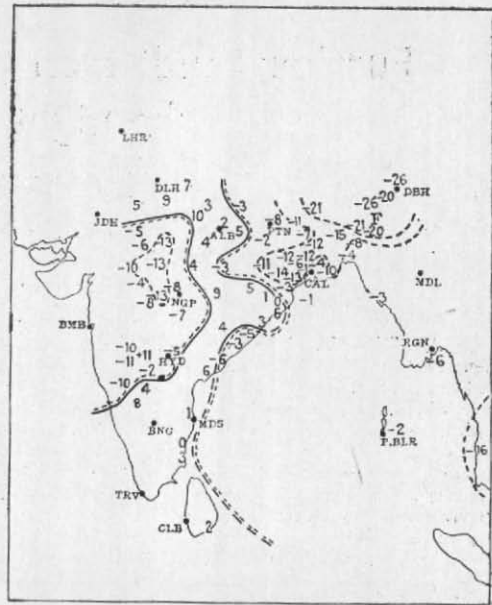


(iv) Upper winds 2000'

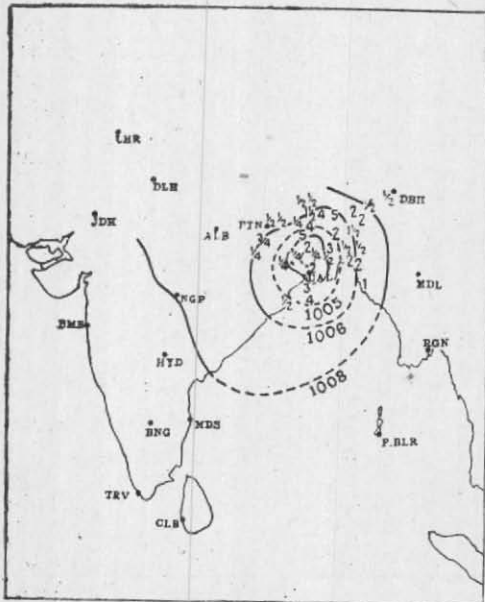
Fig. 6. Charts for 0800 IST on 2 October 1948



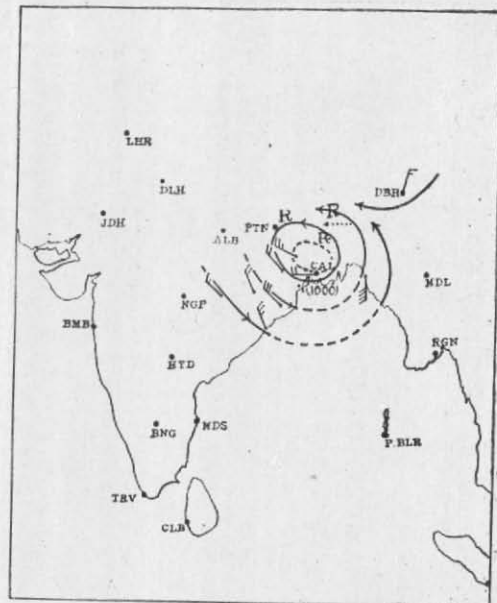
(i) Pressure change since 0800 IST previous day in tenths of millibar



(ii) Corrected pressure change since 1700 IST previous day in tenths of millibar



(iii) Isobar and Rain



(iv) Upper winds  
2000'

Fig. 7. Charts for 0800 IST on 3 October 1948