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STUDY OF MONSOON RAINFALL IN RELATION TO THE MOVEMENT OF UPPER AIR ANTICYCLONE

BY

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has been accepted as satisfactory in partial fulfillment for the degree of Master of Philosophy in Physics and certify that the student demonstrated a satisfactory knowledge on the field covered by this thesis in an oral examination held on 14 December, 2006.

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This is to certify that this thesis which the candidate has presented for M. Phil degree has been done by the candidate himself and does not contain any material extracted from elsewhere or from a work published by any body else. The work of this thesis has not been presented for another degree or diploma in any other University or Institute. No other person's work has been used without due acknowledgement.

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TO

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Abstract

Using the Constant Pressure (C.P) chart upper air anticyclonic axis position at 200 and 300 hPa levels were studied. The anticyclonic axis position has been drawn on C.P. chart and location of the axis has been determined along 85^0, 90^0 and 95^0 E longitude. Using these locations a best-fitted straight line have been fitted. The latitudes of the best fitted straight line w.r.t. the particular stations have been determined at regular basis in the monsoon season of 1998, 2000, 2001 and 2002. The anomalies of the axis positions have been also investigated from the monthly mean position. Then we have tried to identify how the monsoon rainfall is correlated with the movement of the upper air anticyclonic axis position. In this study we have considered 10 stations of different quadrant covering whole Bangladesh.

We have found from the analysis that rainfall occurred over Dhaka, Barisal, Chittagong, Comilla, Dinajpur, Khulna, Mymensingh, Rajshahi, Seemangal and Sylhet station when the upper air anticyclonic axis of 200 and 300 hPa levels were close to the stations. In the 2^{nd} half of July and 1^{st} half of August the anticyclonic axis was away from the stations but rainfall occurred over the stations at that duration. When the anticyclonic axis of 200 and 300 hPa levels moved continuously from north to south or south to north rainfall occurred over all of the stations either in that duration or at the end of that duration in the monsoon season.

In the 1^{st} half of June the anomalies of anticyclonic axis position was below the mean position and in the 2^{nd} half the axis was above the mean position for 200 and 300 hPa levels. In July and August it was oscillatory about the mean position and in September it was above the mean position during 1^{st} half and below the mean position during 2^{nd} half with some exceptions for both the levels.

The average rainfall of 34 meteorological stations of Bangladesh has been computed on regular basis during the monsoon season of 1998, 2000, 2001 and 2002. The correlation co-efficient between the daily average rainfall in the monsoon season and the upper air anticyclonic axis position have been studied and we observed that the correlation co-efficient between them is not significant for 200 and 300 hPa levels.

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Chapter I: INTRODUCTION

Weather is the state of atmosphere at any given time denoting the short-term variations of atmosphere in terms of temperature, pressure, wind, moisture, cloudiness, precipitation and visibility. Climate, on the other hand, is the sum total of the variety of weather conditions of an area or a place from day to day.

Of all the factors of our physical environment which influence the life of man inhabiting the planet earth the most important and the most fundamental is the climate. Its influences are so varied, so subtle and all pervading as to defy complete identification and analysis. According to the climate in Bangladesh there are four seasons, which are (a) Pre-monsoon (March-May), (b) monsoon (June-September), (c) post-monsoon (October-November and (d) winter (December-February). Of them monsoon season is important for rainfall in Bangladesh. Most of the annual rainfall occurs in this season.

Monsoon, which is also termed as Summer Monsoon season in the Indian subcontinent, is the most important and vital one for the people who live in the subcontinent. The East Asian summer monsoon has complex space and time structures that are distinct from the South Asian monsoon. On an average, the onset of monsoon occurs in the first week of June in Bangladesh and mid May in India when heavy convective rainfall occurs. The elongated rain belt during the monsoon season normally moves northward direction. The impact of Indian sub-continental rainfall is tremendous in monsoon season. In this season sometimes huge amount of rainfall occurs in the upper catchment area (Nepal, Northeast India) of Bangladesh, which causes flood in the Northeast India and Bangladesh. Almost all the rain water, falling in the upper catchment area flow over Bangladesh and the country faces heavy flood. The flood that occurred in the recent past 1987, 1988, 1998 and 2004 are of remembrance. Sometimes it is also observed that when flood is occurring in the Northeast India and Bangladesh, at the same time drought are occurring in the west part of India.

Studies of rainfall characteristics of Bangladesh are a few. A preliminary investigation of spatial and temporal variability of rainfall by Samad and Islam (1993), aspects of hydrological regions with reference to agriculture by Shamsuddin and Alam (1990) and correlation between winter temperature and monsoon rainfall over Bangladesh

by Alam (2002) are among those which made the significant contributions towards understanding of rainfall characteristics and distribution of Bangladesh.

The southwest monsoon (as it comes from southwest, hence the term) enters Bangladesh through the southeastern region, i.e., Cox's Bazar, then moves north wards up to shillong plateau across Sylhet region and finally moves westward (Ahmed and Karmakar 1993). The mean arrival dates of the summer monsoon in the extreme southeastern coastal part and in the extreme northwestern part of Bangladesh are 2 June and 15 July respectively. Mean withdrawal dates of the summer monsoon from the extreme northwestern part and extreme southeastern part of the country are 30 September and 17 October respectively (Ahmed and Karmakar, 1993). During the southwest monsoon, Bangladesh receive about 75-80% of the total annual rainfall.

The variations of rainfall in different seasons are well known. However, it is generally expected that direct correlation may exist between the rainfall and temperature. Though the southwest monsoon is the major rainfall season for Bangladesh, the post monsoon or northeast monsoon is also important. The followings are some investigations made in terms of correlation's with the rainfall of different seasons: Raj, (1989) has shown that the August – September 150 hPa mean zonal wind of Trivandrum is capable of giving satisfactory forecasts for the post monsoon rainfall of Tamilnadu. Upadhyay et al., (1990) and Kanaujia et al., (1992) determined the rainfall correlation structure over India and concluded that space rainfall correlation decreases exponentially with distance. Banerjee et al., (1978) showed that the total monsoon rainfall over India is significantly correlated with the latitudinal position of the subtropical ridge of the mean circulation of April at 500 hPa level.

The analysis of annual rainfall for the Bangladesh region for the period 1870-1991 showed no discernible long- term trend in mean- annual rainfall. Karmakar and Nessa, (1997) studied climate change and its impacts on natural disasters and southwest monsoon in Bangladesh and the Bay of Bengal. They found that the decadal mean annual temperature over Bangladesh have shown increasing tendency especially after 1961-1970. They also predicted that the rainfall during the southwest monsoon season is likely to increases by 12.74 mm and 23.36 mm by 2050 and 2100 respectively.

1.1 Monsoon

The monsoons are seasonal winds that bring torrential rains in the summer and sunny and dry weather in the winter. These winds blow in response to differences in temperature between air over the land and air over the sea. The monsoons influence the climates of India, Bangladesh, Southeast Asia, and, to a lesser extent, northern Australia and Central Africa.

At the beginning of winter, the subcontinent cools rapidly, while the Indian Ocean is still remain warm because the temperature of water takes longer time to change than does the temperature of land. The warm water heats the air over the oceans, forcing the air to rise. This movement draws cool air from the Himalayas and northern India to the Indian Ocean. These northeast winter monsoon winds bring cool, sunny, and dry weather to India during the winter.

As summer returns, the pattern reverses. The temperature in southern Asia rises faster than that of the Indian Ocean. Some areas of northern and central India reach temperatures of more than 40°C (100°F). Hot air rises over the land, drawing masses of cool, damp air from the ocean towards the land. These southwest winds mark the return of the summer monsoon rains. Moisture blown in by these winds condenses, resulting in sustained, heavy rains, which normally begin in June and last until September.

The Himalayas form a barrier that forces the warm air to drop its moisture over southern Asia. The southern flanks of the Himalayas receive large amounts of precipitation, while the northern slopes receive small amounts. This orographic effect also occurs along the southwestern coast of India as a result of the Western Ghats Range. Thus, certain areas of the subcontinent receive tremendous amounts of rain during the summer monsoon season. Cherrapunji, in northeastern India, receives about 10,920 millimeters (430 inches) of rain each year, most of that during the summer.

Monsoon normally reaches the coastal districts of Bangladesh by the last week of May to first week of June and progressively engulfs the whole country through June. Generally heavy to very heavy rain with overcast skies characterizes the season. On the average there are 20-25 rainy days per month during June to August, decreasing to 12-15 days in September. More than 75% of the total annual rainfall occurs in this season. The rainfall is greater over the northeastern, the southern and the southeastern districts than over the central, western and northwestern districts. During the first two months of the

season the rainfall is between 450-600 mm per month over the northern and southern districts and it is 700-850 mm per month over the district of Sylhet and the southeastern districts of Chittagong and Chittagong Hill Tracts. Over the central districts, the rainfall is 250-380 mm per month in the two months. The rainfall over the country decreases gradually as the season advances. In September the rainfall is 200-250 mm over the country except in the district of Sylhet and the coastal districts of Barisal, Noakhali, Chittagong and Chittagong Hill Tracts, where the rainfall is 300-450 mm [WMO/UNDP/BGD/79/013, 1986]

Summer monsoon rains cause widespread flooding in Bangladesh and other monsoon regions. Many people in these regions build their homes on stilts in preparation for the annual floods. Yet the summer rains are essential for crops. In some years, summer monsoon rains are not plentiful, leading to drought and crop failure. The monsoon rains are essential for the annual replenishing of freshwater supplies for many countries in southern Asia.

On the subseasonal timescale, the summer monsoon undergoes periods of enhanced and reduced rainfall activity over a large region and these intraseasonal variations are termed "active" and "break" monsoon phases. During an inactive or break phase, the monsoon trough is found to shift northward from its normal position to the foothills of the Himalaya (Ramamurthy, 1969; Rao, 1976).

Sir Gilbert Walker knew that the Southern Oscillation (SO) and the Indian summer monsoon are intimately linked (Walker and Bliss, 1937), and he hoped that knowledge of the SO would permit accurate prediction of the monsoon (Normand, 1953). Since then, numerous studies have shown the influence of the Indian monsoon on tropical circulation (Normand, 1953 ; Troup, 1965 ; Yasunari, 1990 ; Yasunari and Seki, 1992) or, conversely, the impact of the El Niño–Southern Oscillation (ENSO) on the monsoon (Walker and Bliss, 1937 ; Shukla and Paolino, 1983 ; Joseph et al., 1994).

The strength of the monsoon and the occurrence of warm or cold ENSO events depend on the location and magnitude of western Pacific SSTs and on tropical convection (Soman and Slingo, 1997). A strong monsoon [heavy rains, low sea level pressure (SLP), strong easterlies] tends to inhibit warm events and favor cold events (Yasunari, 1990). Conversely, a warm ENSO event (decreased convection and high SLP in the west Pacific, weak easterlies) tends to suppress the monsoon (Webster, 1995).

1.2 Rainfall

Rain is a form of precipitation, other forms of which include snow, sleet, hail and dew. Rain forms when separate drops of water fall to the Earth's surface from clouds. Rain plays a major role in the hydrologic cycle in which moisture from the oceans evaporates, condenses into clouds, precipitates back to earth, and eventually returns to the ocean via streams and rivers to repeat the cycle again. There is also a small amount of water vapor that respires from plants and evaporates to join other water molecules in condensing into clouds.

The amount of rainfall is measured using a rain gauge. It is expressed as the depth of water that collects on a flat surface, and can be measured to the nearest 0.27 mm or 0.01 in. It is sometimes expressed in liters per square meter (1 liter/m^2 = 1 mm).

Ahmed and Kim (2003) studied the results of the statistical analyses of daily rainfall at 19 weather stations in Bangladesh, for the months of May through October, for the 35-yr. period 1964–1998. They emphasized on the patterns of daily rainfall during the wettest and driest summer monsoon seasons at three stations. The summer monsoon in Bangladesh prevails from early June to mid-October, with an average duration of 110 days in the west to 134 days in the southeast, and an average number of rain days of 60 days in the west to 100 days in the northeast and southeast. Average summer monsoon rainfall ranges from 1200 mm in the west to 3000 mm in the northeast and southeast. During the wettest monsoon season at three stations the periods of consecutive rain days range from 8–10 days in the west to 30–40 days in the northeast. During the driest monsoon season at these stations the periods of consecutive rain days vary from 3–6 days in the west to 20– 30 days in the northeast. Frequency of consecutive rain days of various duration's at these stations in the 35-yr. period shows that episodes with duration of 1–3 days are most common. However, episodes of much longer consecutive rain days also occur, ranging from 10–19 days in the west to 18–35 days in the southeast, and 20–44 days in the northeast.

Remote sensing data are now widely used for different purposes, and the use of satellite data for rainfall prediction has increased markedly. There has been an attempt to estimate the rainfall in Bangladesh from satellite data in a joint research project carried out by Japan International Corporation Agency (JICA) and Bangladesh University of Engineering & Technology (BUET). As a result, a Geostationary Meteorological Satellite

5 (GMS-5) receiving station was installed at the Institute of Water and Flood Management (IWFM), BUET in 1996. Using GMS-5 data, Wahid and Islam (1999) calculated the amount of rainfall by the Gross Precipitation Index (GPI) technique. They calibrated the GPI value with the raingauge rainfall recorded for Sylhet district of Bangladesh and suggested further study. Because much of the precipitation in both the mid-latitudes and tropics emanates from meso-scale convective systems (Houze and Beets, 1981), it is necessary to distinguish between the convective and stratiform components of these cloud systems as the physics and dynamics of air motion and precipitation growth in the convective and stratiform regions differ fundamentally (Goldenberg et al., 1990). The GPI method can not differentiate the convective and stratiform regions of clouds, therefore it gives the average instead of the componential actual rainfall. The amount of the componential rainfall from the convective and stratiform cloud components also determined by Liu et al., (1995) and Islam et al., (1999).

Kripalani et al., 1996 have used the monthly rainfall data for 14 stations over Bangladesh for the period 1901-1977 were used to investigate and understand the interannual variability of the summer monsoon rainfall. They have presented monthly, seasonal, and annual spatial rainfall patterns, and the spatial patterns of variability. Dominant structures of seasonal rainfall are determined through the empirical orthogonal functions. It was observed that the standardized rainfall for this series shows random fluctuations up to 1963, thereafter the standardized values are much above the normal values. Further the rainfall variations over Bangladesh are not related to large-scale variables such as the Northern Hemisphere surface temperature, Darwin pressure tendency, and the subtropical ridge over the Indian region. However, the rainfall variations over Bangladesh are related well with rainfall variations over north-east India. Similar analysis is done for the Nepal region by examining the monthly rainfall data over Katmandu for a 105 year period (1851-1900, 1921-1975). Results reveal that Nepal rainfall is well related with rainfall variations over northern and central parts of India.

Characteristics of rainfall over Bangladesh during the monsoon season of 1995 were investigated by Ohsawa et al. (1998) using surface meteorological data, aerological data, raingauge data, GMS-4/5 infrared data and 700 hPa isobaric charts. The monsoon rainfall in 1995 was normal over Bangladesh. The monsoon season over Bangladesh can be divided into BAM (Bangladeshi Active Monsoon) phase, BBM (Bangladesh Break

Monsoon) phase and transient phase. 4 periods of BAM phase and 3 periods of BBM phase were selected. By comparing the features of BAM and BBM phase, it was found that the positions of the monsoon trough and the vertical wind profiles were obviously different, but the vertical thermodynamic structures were not different between both phases. The temporal variation such as BAM and BBM phase were interpreted, to some extent, in terms of the spatial structure of monsoon circulation relative to the monsoon trough and the variation of rainfall over Bangladesh depended on the movement of the deep convective area located to the south of the monsoon trough with strong southwesterly wind in its lower layer.

The rainfall over Bangladesh during the 1995 summer monsoon season has been investigated by Ohsawa et al., (2000) in terms of the intraseasonal variation of monsoon activities. The rainfall over Bangladesh is basically dominated by the north-south oscillation of the monsoon trough. The rainfall increases when the monsoon trough is located at the foot of the Himalayas, because synoptic-scale convective activity is much more vigorous to the south of the monsoon trough axis than to the north of it. In addition, the strong southwesterly wind to the south of the monsoon trough intensifies local convective activity owing to the effects of the orography to the north and east of the country. It is also found that the monsoon rainfall over Bangladesh in 1995 varies with a periodicity of 20 days, and this rainfall variation is closely associated with synoptic-scale monsoon activities spreading over South and Southeast Asia. The active/break cycle of the rainfall variation during the 1995 summer monsoon season can be mostly explained by the northward propagation of what is called the 10-20 day variation of monsoon activities.

Japanese Geostationary Meteorological Satellite 5 (GMS-5) data were used to estimate rainfall in Bangladesh over a period of 61 days from June 1, 1996. The 3-hourly digital data over 33 ground-truth stations throughout Bangladesh obtained from GMS-5 were analyzed. Satellite rainfall was estimated by the Convective Stratiform Technique (CST) algorithm. The amount of rainfall calculated by the CST was compared with that calculated from the ground-truth data. That calculated by the CST was 1.1 times larger than that of the ground-truth rainfall. The average daily rainfalls were 15 mm as calculated from satellite and 14.3 mm from the ground-truth data. The correlation between the satellite and the ground-truth rainfall was significant at coastal stations but not at inland ones. Satellite and ground-truth data were used to derive a linear regression

equation for estimating the amount of surface rain from satellite data. Data from stations throughout the country that showed good correlations gave a slope term of 0.84 and intercept constant of – 0.1 in the regression equation.

Bangladesh is one of the heaviest rainfall regions in South Asia. Climatic rainfall over Bangladesh is about 6000 mm during summer monsoon in some regions. Especially northeastern Bangladesh has much rainfall, where the late night-early morning maximum rainfall was observed by rain gauges and the radar in Dhaka (Ohsawa et al., 2000, 2001; Terao et al., 2002; Islam et al., 2005). They suggested that the late night-early morning maximum is associated with the Shillong Plateau, east-west elongated mountainous range whose highest peak is about 2000 m located right in the north of the late night-early morning maximum rainfall region.

From the coast of west Bengal and the hills of Orissa, rainfall decreases inland. Further westwards, the Chota Nagpur hills, the Maikala Range and the Mahadeo hills cause an increase of rainfall, with lesser amounts in the valleys in between. The Gir hills in Kathiawar have more rainfall than the neighborhood. Mount Abu in Aravallis has a rainfall of 169 cm while the surrounding plains have only 60 to 80 cm.

A line of rainfall minimum runs from 28.5°N, 75°E to 25°N, 88°E that is paradoxically close to the monsoon trough across northern India. Area to the south of this rainfall minimum falls in the track of monsoon depressions, which are responsible for much of the rainfall. In tracts further to north, there is probably the influence of the Himalayas in increasing the rainfall. Apart from this, there is also a decrease of rainfall from east to west, from about 1200 mm in West Bengal to less than 200 mm in the Great Indian Desert in west Rajasthan. In the northwestern parts of the subcontinent rainfall progressively decreases westwards, from 40 cm in Rajasthan to 5 cm in Baluchistan. Southwest Srilanka and the hills get good rains at this time but not the other parts of the island.

Rainfall measured in river valleys may not be representative of the hill slopes. Between the Great Himalayan Range and the plains, there are the Pir Panjal. the Siwalik and the Mahabharat Ranges. Most of the available observations are from these ranges. Rainfall increases up the slopes of these foot hills, presumably decreases on their northern slopes and increases again on the Himalayan slopes. Annual rainfall at Chaunrikharka (2,700 meters) is 228 cm and at Namche Bazar (3,300 metres) only 94 cm (Dhar and

Narayanan, 1965). Both are in Nepal and the distance between the two is hardly 16 km. Therefore, we can tentatively conclude that above some elevation near 3 km, rainfall may decrease with height on the Himalayan Range. In the eastern Himalayas, rainfall is more than in the western portions. In the east, annual rainfall of 400 cm has been recorded but less than 200 cm in the west.

The coefficient of variation of rainfall, which is the ratio of the standard deviation of the season's rainfall to the mean amount, varies from 60 per cent in the western desert to 20 per cent or less in the most rainy areas. In the southeastern tip of the Peninsula where this is not the rainy season, it is 100 per cent. The coefficient of variation decreases with increasing rainfall up to about 100 cm and then does not vary, as pointed out by Rao et al, (1972). Standard deviations of rainfall are generally comparable over the whole country but the wide differences in variability are due to the differences in mean rainfall. These fluctuations in rainfall affect economic activities, more so in areas of poor rainfall.

Arabian Sea Islands get more rain in June than in July, while Kerala has about the same in the two months, both areas being more rainy in May. In Greater Assam and sub-Himalayan West Bengal, June and July are equally rainy, decreasing thereafter. Some parts of Assam get slightly less rain in July. In Bihar, Uttar Pradesh, Gangetic West Bengal, east Madhya Pradesh and parts of Orissa, Julyand August have the same amounts. In the Peninsula between 19^0N and 16^0N and east of 76^0E, an increase in September is noticed, apparently due to the effect of depressions and lows forming at lower latitudes, Coefficient of variation of rainfall of individual months is more than for the whole season, as may be expected. For July alone, the coefficient is 30 per cent in the more rainy parts and 100 per cent in the Rajasthan desert.

A possible explanation for the improvement of forecast is suggested by the study of D'Amato and Lebel (1998) which demonstrated that interannual variability of Sahel rainfall is linked to the number rather than the magnitude of the rainfall events. The square root transformation can also be beneficial for forecasts over either smaller regions or shorter periods, such as statistical predictions of regional rainfall (Feddersen et al. 1999). The square root transformation gives less weight to anomalies in large rainfall amounts and can be considered as equivalent to using a non-Euclidean positively curved measure of forecast skill (Stephenson, 1997).

The spatial relationships of the seasonal rainfall with the Subtropical Ridge (STR) position over the Indian and the west Pacific regions, the Darwin Pressure Tendency (DPT) and the Northern Hemisphere Surface Temperature (NHST) - reveal that within the Asian monsoon regime, not only are there any regions which are in-phase with Indian monsoon rainfall, but there are also regions which are out-of-phase (Kripalani and Kulkarni, 1998).

Hills and mountain ranges cause striking variations in rainfall distribution. On the southern slopes of the Khasi-Jaintia hills rainfall is over 8000 mm while to the north, in the Brahmaputra valley, it drops to about 1200 mm. Cherrapunji's annual rainfall of 11420 mm (at elevation of 1313 m) is obviously due to orographic lifting but its magnitude requires that to be quantitatively explained. From the West Coast, rainfall increases along the slopes of the Western Ghats and rapidly decreases on the eastern lee side. In the higher reaches of the Western Ghats, there are places with seasonal rainfall of 5000 mm. Within 80 km on the lee side, rainfall is only 400 mm (Rao, 1976).

1.3 Anticyclone

The rotation about the local vertical opposite to that of the earth's rotation; that is clockwise in the Northern Hemisphere, counter-clockwise in the Southern Hemisphere and undefined at the equator is called anticyclone. It is opposite of cyclone. The anticyclone has a major influence on weather and climate. The Northern Hemispheric anticyclone is somewhat more intense and well organized than its southern counterpart. The structure of the pair of anomalous anticyclones resembles that of a symmetric Rossby wave (Matsuno, 1966 ; Gill, 1980)

Krishnamurti and Subrahmanyam (1982) showed that the circulation anomalies on the 30-50 days timescale manifest in the form of meridionally propagating trains of lower-tropospheric cyclonic and anticyclonic flow patterns from the equatorial regions toward the Himalaya. They observed that the passage of these cyclonic and anticyclonic wind anomalies coincided with the occurrence of wet and dry spells over India and neighboring Indochina suggesting a strong coherence between the wind oscillations and the precipitating patterns. Hartmann and Michelsen (1989) noted a spectral peak with periodicity around 40 days by examining 70 yr of daily precipitation data over the Indian subcontinent. In a comprehensive review, Madden and Julian (1994) have discussed

several other important studies related to 40–50 day fluctuations over the summer monsoon region.

In the upper troposphere the strong southerly wind anomalies over India indicate a weakening of the tropical easterly jet. The Tibetan high is displaced eastward from its normal position and is located over eastern China. This shift of the Tibetan anticyclone during inactive periods of monsoon has been noted in observations (Krishnamurti et al, 1989 ; Raman and Rao, 1981).

The beating of the Tibetan Plateau which is at mid-tropospheric level, produces an anticyclone aloft. The effect of this cell is the reversal of the normal temperature and pressure gradients in the layers between 600 and 300 mb. This reversal acts like a switch for the atmospheric circulation over the southern half of Asia and produces nearly simultaneously in the first half of June. Ananthakrishnan (1965) has emphasized that the first onset of monsoon over Kerala has no relation with the Tibetan Plateau acting as a heat source in middle troposphere. At that time, the sub-tropical anticyclone in the upper troposphere lies over north Indian between 20^0 and 25^0N, well to the south of the Tibetan Plateau. It takes five to six weeks for the monsoon to be fully established over India and only then the sub-tropical ridge shifts to about 50^0N. Flohn (1960) observes that in years with a high hemispherical zonal index (35^0-55^0N) in June, the onset of monsoon in Delhi occurs on the average on June 28, but in years with low index on July 4. No similar relationship could be found for latitudes south of 25^0N. While Mooley (1957) regards western disturbances moving across northernmost parts of India as favourable for at least temporary extension of monsoon current into Punjab, west Uttar Pradesh and Kashmir, Chakravorty and Basu (1957) find them having a retarding effect on the advance of monsoon into northeast India.

Even when the monsoon trough is along the Himalayas and favourable for monsoon activity in the neighbourhood, rainfall over north Assam and sub-Himalayan West Bengal is more when a middle latitude westerly trough is extending upto Tibet. The case of 7 to 11 July 1967, the passage of a middle latitude westerly trough on a break-type of situation (Srinivasan et al., 1972). Between 5 and 6 July, the monsoon trough shifted progressively northwards and the eastern half lay close to the foot of the Himalayas. A feeble north-south oriented trough lay over sub-Himalayan west Bengal on 7^{th} upto 850 mb. At 500 mb and above, a trough in mid-latitude westerlies had taken place at least a day earlier. As this upper trough lay near Long. 86^0E on 8^{th} and 9^{th}, rainfall in northeast

India increased right up to Head Bay. This is not a case of break situation being caused by a westerly trough but rainfall being enhanced in a break situation by a westerly trough extending right into the plains.

Miller and Keshavamurthy (1968) have computed divergence, vorticity and vertical motion from streamline analysis using the cyclone center at 500 mb as the origin. Increase in relative vorticity with height upto 500 mb and slope of the line of maximum vorticity towards south and west are seen. A comparison of streamlines with contours showed that a nonsteady state existed within 250 km of center. The streamlines spiralling into the center of the low pressure cut the contours at a sharp angle, especially in the southern half between 700 mb and 500 mb. This is explained as due to constant state of flux of the thermal field, due to changing intensities of rainfall, horizontal wind speeds and vertical motions, as in tropical cyclones. The maximum convergence at the centre is at 500 mb and the level of non-divergence at 300 mb. At north of 23^0N, convergence is seen at 300 mb and 200 mb, marked divergence between 700 mb and 400 mb (almost two- thirds of the convergence at the center of the cyclone) and again convergence below. Vertical velocity (ascent) near the center is maximum at 300 mb and continues well above 200 mb explaining the rainfall intensities. In the descent at the periphery, velocities reach 15 cm sec^{-1} in upper troposphere near 64^0E, about 40% of the rate of ascent at center.

Some works have been done on rainfall and some on anticyclone but so far no study is available to find the influence of upper air anticyclone on the monsoon rainfall over Bangladesh. But it is expected that anticyclone has its influence on the monsoon rainfall in Bangladesh and it is important to investigate that. In this research we have tried to find the relation between upper air anticyclonic axis movement and the rainfall over Bangladesh during the summer monsoon season.

In this study we have tried to find the day to day variation of rainfall during the monsoon season of 1998, 2000, 2001 and 2002 and also the position of the upper air anticyclonic axis at 200 and 300 hPa level. These have been done stationwise (over Dhaka, Barisal, Chittagong, Comilla, Dinajpur, Khulna, Mymensingh, Rajshahi, Sreemangal and Sylhet stations throughout Bangladesh). Then we have tried to develop the relation between the monsoon rainfall and the upper air anticyclonic axis position of different stations over Bangladesh.

We also tried to investigate the anomaly of the position of upper air anticyclonic axis for different month of the monsoon season at the considered levels. Our study also includes the computation of the correlation coefficient (CC) between the daily average rainfall of different stations over Bangladesh in the monsoon season and the position of the upper air anticyclonic axis at that considered levels.

1.4 Monsoon trough

A line in weather map showing the locations of minimum sea level pressure in a monsoon region. Several regions worldwide qualify as a monsoon region: western Mexico, the far western north Pacific Ocean and north Indian Ocean near southeast Asia, the far western south Pacific Ocean near Australia, central South America, and occasionally near the west coast of Africa. If the trough is in its normal orientation, tropical cyclones along its periphery will move with a westward motion. If it is reverse oriented, tropical cyclones will move more poleward. Tropical cyclone tracks with S shapes tend to be associated with reverse-oriented monsoon troughs. The South Pacific convergence zone and South American convergence zones are generally reverse oriented.

It reaches its zenith in latitude during the late summer when the wintertime surface ridge in the opposite hemisphere is the strongest, with the monsoon trough reaching as far as the 40th parallel in the Northern Hemisphere in August. Likewise, in the Southern Hemisphere, it is at its greatest extent in February. On the charts on the left and right, the areas of convergence in the streamline field mark the climatological position of the monsoon trough for those respective months. Movements in the monsoon trough location can mark the beginning/ending of the wet or dry season.

Increase in the relative vorticity of the monsoon trough is normally a product of increased wind convergence. Wind surges can lead to this increase in convergence. A strengthening or equator ward movement in the subtropical ridge can cause a strengthening of the monsoon trough as a wind surge moves southward towards its location. As fronts move through the subtropics of one hemisphere during their winter, wind surges can cross the equator in oceanic regions and enhance the monsoon trough in the other hemisphere's summer. A key way of detecting whether a wind surge has reached the monsoon trough is the formation of a burst of thunderstorms within the feature.

Worldwide, the monsoon trough is the main genesis region for tropical cyclones. Vorticity-rich low level environments lead to a better than average chance of tropical

cyclone formation. This is because a pre-existing near-surface disturbance with sufficient vorticity and convergence is one of the six requirements for tropical cyclogenesis. The monsoon trough is one such area of strong low-level vorticity. There appears to be a 15-25 day cycle in thunderstorm activity associated with the monsoon trough, which is roughly half the wavelength of the Madden-Julian Oscillation, or MJO. This mirrors tropical cyclone genesis near these features, as genesis clusters in 2-3 weeks of activity followed by 2-3 weeks of inactivity. Indeed, tropical cyclones can form in outbreaks around these features under special circumstances, tending to follow the next cyclone to its north and west. This is different than the Atlantic Ocean, where tropical cyclones mainly form from tropical waves, which move offshore Africa. Eastern Pacific Ocean tropical cyclone formation shows a hybrid of these two mechanisms [http://en.wikipedia.org/wiki/Monsoon_trough].

Chapter II: METHODOLOGY

2.1. Constant Pressure Chart

A constant pressure analysis chart is an upper air weather map where all the information depicted is at the specified pressure of the chart, which is termed as constant pressure (CP) chart. The analyses are referred to as specific millibar (mb) charts or in metric nomenclature, hectapascal (hPa) charts. Twice daily, six computer-prepared constant pressure charts (850, 700, 500, 300, 250, and 200 mb/hPa) are transmitted over the facsimile circuits. The valid times of these charts are the same as the radiosonde time, 0000UTC and 1200UTC.

Data from each observation station are plotted around a station circle on each constant pressure chart. The circle identifies the station position. The data plotted on each chart are temperature, temperature-dew point spread, wind, height of the surface above sea level and height change of the surface over the previous 12 hour period. The temperatures are in degree Celsius, wind direction is related to true north, wind speed is in knots and height and height changes are in meters. All charts contain contours, isotherms and some contain isotachs. Contours are lines of equal heights, isotherms are lines of equal temperature, and isotachs, are lines of equal wind speed.

Heights of the specified pressure for each station are analyzed through the use of solid lines called contours. This contour analysis gives the charts of a height pattern. The contours depict highs, lows, troughs, and ridges aloft in the same manner as isobars on the surface chart. On an upper air chart, then, we speak of "high or low height centers" instead of "high or low pressure centers". Comparing a height analysis to a pressure analysis note that a contour high, low, trough or ridge is analogous to a pressure high, low, trough or ridge. Also note that the two terms may be used interchangeably as height and pressure analyses are just two ways of describing the same features.

2.1.1 300 hPa level

The 300 hPa chart is in the vicinity of the tropopause, at the top of the troposphere. Only 30 percent of the mass of the atmosphere lies above this level. The altitude of the 300 mb surface is near 9000 meters (30,000 ft) - at a level where many long-distance commercial jet aircraft fly. This level also corresponds the level of the

upper tropospheric jet stream, a region of very fast winds that move across the country. Inspection of the isotach patterns at these levels not only reveal the location of the jet streams, but aid the meteorologist in locating the regions of largest acceleration, deceleration and wind shear (rapid changes in wind speed and/or direction); these regions contribute to the upper level horizontal divergence and convergence patterns that influence surface weather systems.

The primary features of the 300 hPa chart are the permanent and semipermanent highs and lows, certain dynamic lows, long waves, the polar jet stream in winter, and the tropopauses, especially the arctic and mid-latitude tropopauses in winter. Its primary uses are in forecasting; determining the characteristics of long waves; analyzing and forecasting jet streams; analyzing the tropopause in winter; determining vorticity distribution; and in the case of tropical lows that do not show a closed circulation at this level, steering currents. It is also an indispensable tool in planning jet aircraft operations. The contour interval of 300 hPa level is normally 120 meters, but a 60-meter interval may be used in areas where a finer degree of declination is required.

2.1.2 200 hPa level

The altitude of the 200 hPa surface is near 12,000 meters (39,000 ft) The 200 hPa chart are the same as those of 300 hPa chart for the operational use and contour interval. In fact, the 200 hPa chart is used as an adjunct to the 300 hPa analysis. In summer, it plays the same role, with respect to the jet stream, that the 300 hPa chart does in winter. In winter, its principal use is in estimating changes in the temperature advection pattern in the stratosphere.

2.2 Curve Fitting

Individual judgment can be used to draw an approximating curve to fit a set of data. This is called a free hand method of curve fitting. If the type of equation of this curve is known, it is possible to obtain the constant in the equation by choosing as many points on the curve as there are constants in the equation. The different methods for curves are as follows.

2.2.1 The Straight Line

The simplest type of approximating curve is a straight line, whose equation can be written

$$Y = a_0 + a_1 X \tag{1}$$

Given any two points (X_1, Y_1) and (X_2, Y_2) on the line, the constants a_0 and a_1 can be determined. The resulting equation of the line can be written

$$Y - Y_1 = \left(\frac{Y_2 - Y_1}{X_2 - X_1}\right)(X - X_1)$$

or $$Y - Y_1 = m(X - X_1) \tag{2}$$

where $$m = \frac{Y_2 - Y_1}{X_2 - X_1}$$

is called the slope of the line and represents the change in Y divided by the corresponding change in X.

When the equation is written in the form (1), the constant a_1 is the slope m. The constant a_0, which is the value of Y when $X = 0$, is called the Y intercept.

2.2.2 The Method of Least Squares

If the data points are given by (X_1,Y_1), (X_2,Y_2),..... (X_N,Y_N), for a given value of X, say X_1, there will be a difference between the value Y_1 and the corresponding value of it. We denote this difference by D_1, which is sometimes referred to as a deviation and may be positive, negative or zero. Similarly, corresponding to the values X_2,.....X_N we obtain the deviations D_2,.....D_N. Of all curves approximating a given set of data points, the curve having the property that $D_1^2 + D_2^2 + ... + D_N^2$ is a minimum is called a best-fitting curve.

A curve having this property is said to fit the data in the least-squares sense and is called a least-squares curve. Thus a line having this property is called a least-squares line.

2.2.3 The Least-Squares Line

The least-squares line approximating the set of points (X_1,Y_1), (X_2,Y_2),.....(X_N,Y_N) has the equation

$$Y = a_0 + a_1 X$$

Where the constants a_0 and a_1 are determined by solving simultaneously the equations

$$\sum Y = a_0 N + a_1 \sum X$$
$$\sum XY = a_0 \sum X + a_1 \sum X^2 \qquad (3)$$

Which are called the normal equations for the least-squares line (1). The constants a_0 and a_1 of equations (3) can be found from the formulas

$$a_0 = \frac{(\sum Y)(\sum X^2) - (\sum X)(\sum XY)}{N\sum X^2 - (\sum X)^2}$$
$$a_1 = \frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2} \qquad (4)$$

The equation (3) are easily remembered by observing that the first equation can be obtained formally summing on both sides of (1), i.e.,

$$\sum Y = \sum (a_0 + a_1 X) = a_0 N + a_1 \sum X ,$$

while the second equation is obtained formally by first multiplying both sides of (1) by X and then summing, i.e.,

$$\sum XY = \sum X(a_0 + a_1 X) = a_0 \sum X + a_1 \sum X^2$$

The labor involved in finding a least-squares line can be shortened by transforming the data so that $x = X - \overline{X}$ and $y = Y - \overline{Y}$. If $\sum x = \sum (X - \overline{X}) = 0$ and $\sum y = \sum (Y - \overline{Y}) = 0$ the equation of the least-squares line can then be written

$$y = \left(\frac{\sum xy}{\sum x^2}\right)x \quad \text{or} \quad y = \left(\frac{\sum x(Y - \overline{Y})}{\sum x^2}\right) = \frac{\sum xY - \overline{Y}\sum x}{\sum x^2} = \frac{\sum xY}{\sum x^2} \qquad (5)$$

In particular, if X is such that $\sum X = 0$ (i.e., $\overline{X} = 0$), this becomes

$$Y = \overline{Y} + \left(\frac{\sum XY}{\sum X^2}\right)X \qquad (6)$$

Equation (5) implies that $y = 0$ when $x = 0$; thus the least-squares line passes through the point $(\overline{X}, \overline{Y})$, called the centroid, or center of gravity, of the data.

If the variable X is taken to be the dependent instead of the independent variable, we write equation (1) as $X = b_0 + b_1 Y$. Then the above results hold if X and Y are interchanged and a_0 and a_1 are replaced by b_0 and b_1, respectively.

2.3 Mean

The arithmetic mean or simply the mean, is the central value of the items in a series. It is obtained by dividing the total value of the items in a series by the number of items. It is computed by taking into consideration all the values in the series and cannot be located by studying the position of the values in the series.

Let variables be denoted by X and $X_1, X_2, X_3, \ldots\ldots X_n$ denote the values which X may assume. These values may or may not be different. The sum may be written as

$$\sum X = X_1 + X_2 + X_3 + \ldots\ldots + X_n$$

$$\text{Then, } \overline{X} = \frac{\sum_{i=1}^{n} X_i}{n} \qquad (7)$$

where, X_i = Individual observation

n = Number of observation

$\overline{X}$ = Mean or average of observation.

In the formula for the arithmetic mean as given in equation (7) each X_1 is counted once. The possibility that some of the X_i's are equal is deliberately ignored. Now suppose, there are k distinct values $X_1, X_2, \ldots\ldots, X_k$ in the set consisting of n values (some of which may be alike). Let these values occur with frequencies $f_1, f_2, \ldots\ldots f_k$ respectively, such that

$$f_1 + f_2 + \ldots\ldots + f_k = \sum_{i=1}^{k} f_i$$

Then an alternative formula for the arithmetic mean is

$$\overline{X} = \frac{f_1X_1 + f_2X_2 + \ldots\ldots + f_kX_k}{\sum_{i=1}^{k} f_i} \quad \text{or} \quad \overline{X} = \frac{\sum_{i=1}^{k} f_iX_i}{\sum_{i=1}^{k} f_i} \qquad (8)$$

It should be noted that $\sum_{i=1}^{n} X_i$ in equation (7) is numerically equal to $\sum_{i=1}^{k} f_iX_i$ in equation (8). Again n refers to the total number of observations in the set and k refers to the number of distinct values in the set or the number of groups in a frequency distribution.

2.4 Deviation

It is quite important to know whether the individual values closely around the average or they are widely scattered. In other words we need know to what extent the average is typical of the whole set. This information is provided by a measure of dispersion. Dispersion is an important characteristic of a frequency distribution; it tells us how compactly the individual values are distributed around the average.

If $X_1, X_2, \ldots\ldots\ldots, X_n$ denote n observations and A is a fixed arbitrary value of the variable X, then $d_i = X_i - A \quad (i = 1, 2, \ldots\ldots\ldots n)$ is called the deviation of X from A. The dispersion of a set of values clearly depends on the amounts by which the individual values deviate from the average i.e. on the deviations measured from the average.

The deviation of a set of n numbers $X_1, X_2, X_3, \ldots\ldots\ldots\ldots X_n$ from the arithmetic mean is $X_i - \overline{X}$.

Where, $\overline{X}$ = the arithmetic mean of the numbers

2.5 Coefficient of Correlation

The ratio of the explained variation to the total variation is called the coefficient of determination. If there is zero explained variation (i.e., the total variation is all unexplained), this ratio is 0. If there is zero unexplained variation (i.e., the total variation is all explained), the ratio is 1. In other cases the ratio lies between 0 and 1. Since the ratio is always nonnegative, we can denote it by r^2. The quantity r, called the coefficient of correlation or briefly correlation coefficient, is given by

$$r = \pm\sqrt{\frac{Explained\ \ Variation}{Total\ \ Variation}} = \pm\sqrt{\frac{\sum(Y_{est} - \bar{Y})^2}{\sum(Y - \bar{Y})^2}} \qquad (9)$$

and varies between –1 and +1. The + and – signs are used for positive linear correlation and negative linear correlation, respectively. r is a dimensionless quantity; that is, it does not depend on the units employed.

The total variation of Y is defined as $\sum(Y - \bar{Y})^2$; that is, the sum of the squares of the deviations of the values of Y from the mean $\bar{Y}$. This can be written

$$\sum(Y - \bar{Y})^2 = \sum(Y - Y_{est})^2 + \sum(Y_{est} - \bar{Y})^2 \qquad (10)$$

The first term on the right of equation (10) is called the unexplained variation, while the second term is called the explained variation.

Here Y_{est} represent the value of Y for given values of X as estimated from equation $Y = a_0 + a_1 X$ and a measure of the scatter about the regression line of Y on X is supplied by the quantity

$$s_{Y.X} = \sqrt{\frac{\sum(Y - Y_{est})^2}{N}} \qquad (11)$$

and the scatter about the regression line of X on Y is

$$s_{X.Y} = \sqrt{\frac{\sum(X - X_{est})^2}{N}} \qquad (12)$$

By using the equations (10) and (11) and the fact that the standard deviation of Y is

$$s_Y = \sqrt{\frac{\sum(Y - \bar{Y})^2}{N}} \qquad (13)$$

We find that equation (9) can be written, disregarding the sign as

$$r = \sqrt{1 - \frac{s_{Y.X}^2}{s_Y^2}} \qquad (14)$$

or $$s_{Y.X} = s_Y\sqrt{1 - r^2} \qquad (15)$$

Similar equations exist when X and Y are interchanged.

2.6 Data collection and Analyzed stations

We have collected CP charts from Bangladesh Meteorological Department (BMD) and using free hand we have drawn axes on every chart which we call the upper air anticyclonic axis. Then from the CP chart we have computed the values of latitudes of the axis of the upper air anticyclone along 85°, 90° and 95°E longitude, i.e. three values for every anticyclonic axis location of every chart and using the computed values best-fitted straight lines (axis) are drawn. The perpendicular distances of the axes from the particular

Table 2.1: The stations considered calculating the average rainfall

Sl. No.	Index(BMD)	Station name	Index(WMO)
1	11111	Dhaka	(41)923
2	10609	Mymensingh	(41)886
3	41909	Tangile	(41)909
4	11505	Faridpur	(41)929
5	11513	Madaripur	(41)939
6	11921	Chittagong	(41)978
7	11916	Sandwip	(41)964
8	11912	Sitakunda	(41)965
9	12007	Rangamati	(41)966
10	11313	Comilla	(41)933
11	11316	Chandpur	(41)941
12	11809	M.Court	(41)953
13	11805	Feni	(41)943
14	11814	Hatiya	(41)963
15	11927	Cox's Bazar	(41)992
16	11925	Kutubdia	(41)989
17	11929	Teknaf	(41)998
18	10705	Sylhet	(41)891
19	10724	Srimangal	(41)915
20	10320	Rajshahi	(41)895
21	10910	Ishwardi	(41)907
22	10408	Bogra	(41)883
23	10208	Rangpur	(41)859
24	10120	Dinajpur	(41)863
25	41858	Shyedpur	(41)858
26	11604	Khulna	(41)947
27	41958	Mongla	(41)958
28	11610	Satkhira	(41)946
29	11407	Jessore	(41)936
30	41926	Chuadanga	(41)926
31	11704	Barisal	(41)950
32	12103	Patuakhali	(41)960
33	12110	Khepupara	(41)984
34	11706	Bhola	(41)951

stations have been calculated. The stations considered are Dhaka, Barisal, Chittagong, Comilla, Dinajpur, Khulna, Mymensingh, Rajshahi, Sreemangal and Sylhet. The monthly mean of the axis position is also computed.

The mean of the rainfall over 34 stations (Table 2.1) in Bangladesh has been calculated on daily basis in the monsoon season of Bangladesh. The classification of rainfall used by the BMD is tabulated in Table 2.2. We have calculated the correlation coefficient between the daily average rainfall and the corresponding axis positions by using ***Instat+*** Software.

Table 2.2: BMD/WMO Classification of rainfall

Type of rain	Range in mm/Day
Light rain	4.57 – 9.64
Moderate rain	9.65 – 22.34
Moderately heavy rain	22.35 – 44.19
Heavy rain	44.20 – 88.90
Very heavy rain	≥88.90

Chapter III: RESULTS & DISCUSSION

3.1 Distribution of rainfall in monsoon season

In this section we have discussed the day to day variation of rainfall over different stations during the monsoon season of 1998, 2000, 2001 and 2002. The stations considered are Dhaka, Barisal, Chittagong, Comilla, Dinajpur, Khulna, Mymensingh, Rajshahi, Sreemangal and Sylhet.

3.1.1 Distribution of rainfall at Dhaka station

There was no rain up to 9 June but at 10 June the rain was about 20 mm in the monsoon season of 1998 as shown in Fig. 1(a). Light rainfall occurred during 23-28 June over the station and moderately heavy rainfall occurred during 3-22 July and 2-7 August and very heavy rainfall is observed during 11-17 August. From 23 August to 12 September moderate rainfall observed but heavy rainfall observed on 13-22 September over Dhaka station.

In the monsoon season of 2000 we have observed moderate rainfall to occur on every day during 6-24 June except 12-15 June over Dhaka station as shown in Fig. 1(b). During 6-26 July the rainfalls were moderate and frequently except on 10, 11, 16 and 25 July. Very heavy rainfall occurred on 1, 2 and 31 August. During 7-20 September the rainfall was moderately heavy and frequent except 11-13 and 16 September over the station.

Moderately heavy to heavy rainfall observed from 2 June to 20 June during the monsoon season of 2001 as in Fig. 1(c). Again during 26-30 June and 10-13 July the rainfall was significant and moderately heavy on 30 June. From 20 July to 8 August the rainfall occurred every day and sometimes moderately heavy to heavy rainfall observed. From 10 August to 1 September the rainfall was not heavy but continued almost every day over the station. Again during 7-18 September the observed rainfall was moderate to moderately heavy. In this year rainfall occurred maximum days of the season.

From Fig. 1(d) we observed that in the year 2002 the rain started from the very beginning of the monsoon season and it continued daily up to 28 August over Dhaka station. In this long duration we observed moderately heavy to heavy rainfall on 2 June,

12-14 June, 30 June to 4 July and 21 July over the station. From 29 August to 20 September there was no rain except 3, 6 and 15 September over the station. During 21-30 September there was significant rainfall over Dhaka station.

3.1.2 Distribution of rainfall at Barisal Station

In the monsoon season of 1998 we observed there was no rain during 1-12 June except 3 June as shown in Fig. 2(a). From 13th June to 18th August the rainfall occurred almost every day. During 2-16 July the rainfall was moderately heavy to heavy except on 6 and 7 July. Also very heavy rainfall was observed on 11 July and 5 August and moderately heavy rainfall was observed on 8-11 and 27-30 September over the station.

The rainfall occurred daily from 6th to 25 June except 13-17 June over Barisal station in the year of 2000 as shown in Fig. 2(b). In this duration heavy rainfall occurred on 22 June over the station. Almost no rain occurred during 25 June to 7 July. We observed rainfall daily from 8 July to 2 August and also heavy rainfall occurred on 8 and 18 July over the station. Again during 10-15 August, 28 August to 8 September and 17-21 September the rainfall occurred every day over Barisal station. Heavy rainfall observed on 1 September during this period.

In the monsoon season of 2001 the rainfall was about the whole of season over Barisal station and only few days were rainless as in Fig. 2(c). We observed moderately heavy to heavy rainfall during 5-19 June except 9-11 June and very heavy rainfall observed on 14 June. During 26 June to 2 July there was moderate rainfall over the station. During 9-12 July the rainfall was moderate to heavy and 4-6, 14 and 30 August, 17, 18 and 30 September there was moderate rainfall but on 11 September it was heavy over the station. Also very heavy rainfall was observed on 27 and 28 August over the station.

The rain occurred daily from 7 June to 22 July of 2002 which was moderately heavy to very heavy except little anomalies over Barisal station as shown in Fig. 2(d). From then up to 7 September we observed light to moderate rainfall almost every day. Again during 8-10 and 22-28 September moderate to heavy rainfall occurred over the station.

3.1.3 Distribution of rainfall at Chittagong Station

During 1 June to 1 July of 1998 moderately heavy rainfall observed on 3, 9 and 21 June and in other days the Chittagong station is almost rainless as in Fig. 3(a). We observed moderately heavy to very heavy rainfall from 2 July to 31 August except few days over the station. Very heavy rainfall observed on 4-6, 12, 13 and 15 July and 3, 4, 11-13 and 29 August and heavy rainfall observed on 11 and 16 July and 2 and 30 August over Chittagong station. Light to moderate rainfall observed during 1-30 September except few days during the period where the station is rainless.

Moderately heavy to very heavy rainfall observed from the starting days of monsoon to middle of July of 2000 over Chittagong station as in Fig. 3(b). Very heavy rainfall observed on 11, 12 and 24 June, 17, 18 and 23 July and 3and 4 August and heavy rainfall observed on 4, 8 and 23 June, 19 and 24 July and 1, 2, 15 and 16 August over the station. From 29 August to 8 September moderately heavy rainfall observed over the station except little anomaly.

We observed heavy rainfall from the very beginning of the monsoon season of 2001 i.e. on 3 June there was about 75 mm rain and 2-8 June the rain was moderate and heavy to very heavy rainfall occurred during 14-19 June over Chittagong station as in Fig. 3(c). Very heavy rainfall observed on 16 June and heavy rainfall observed on 14, 15, 17, and 19 June. Again on 30 June and 1 July the rainfall was moderately heavy and heavy respectively. From 9th July to 14 August there was rainfall almost daily over the station. In this time on 20 and 31 July the rainfall was heavy and on 13, 19, 25 and 30 July and 1 August the rainfall was moderately heavy over the station. Then from 24 August to 2 September and 11-30 September the rainfall was observed to occur on every day over the station in which heavy rainfall occurred on 17 September.

We observed rainfall to occur daily from the beginning of the season to 23 August of 2002 over Chittagong station except only few days as shown in Fig. 3(d). In this duration very heavy rainfall observed on 29 June and 4, 20 and 21 July, heavy rainfall observed on 7, 13, 21 and 30 June, 22, 23 and 29 July and 9, 16 and 22 August and moderately heavy rainfall observed on 31 June, 10 and 19 July, 2-5 and 14 August and 5 and 21 September over the station. Rest of the days of the season there was light to moderate rain over the station except few days.

3.1.4 Distribution of rainfall at Comilla Station

In the month of June of 1998 rainfall observed for 10 days in which 10 June it was moderately heavy as shown in Fig. 4(a) over Comilla station. But for the month of July we observed rainfall daily during 1-24 July in which on 12, 14, 15 and 22 July it was very heavy, 13 and 17 July it was heavy and 1, 4, 11, 16, 21 and 24 July the rain was moderately heavy over the station. From 9 August to 20 September we observed rainfall to occur every day over the station. In this duration very heavy rainfall observed on 19 September, heavy rainfall on 13, 18 and 29 August and moderately heavy rainfall on 11 and 28 August over the station. Rest of the days we observed light to moderate rainfall over the Comilla station. During 1-10, 16-20 and 26-30 June, from 25 July to 7 August and 21-26 September there was almost no rain over the station

We observed rainfall daily during 5-27 June, 12-24 July, from 30 July to 16 August and 25-31 August, over Comilla station in the monsoon season of 2000 as shown in Fig. 4(b). We observed heavy rainfall on 10 and 24 June and 2 August and moderately heavy rain on 16, 23 and 25 June, 12, 18, 19 and 24 July, 1, 3, 13 and 15 August and 18 and 24 September over Comilla station.

We observed in the monsoon season of 2001 that very heavy rainfall occurred on 5 and 14 June and 18 September over Comilla station as in Fig. 4(c). There was heavy rainfall on 6 and 15 June and 26 August and moderately heavy rainfall on 1, 3, 18, 19 and 27 June, 28 and 29 July, 5 and 29 August and 1, 9, 16 and 19 September over the station. During 1-8 and 13-20 June, from 26 June to 8 August, from 24 August to 11 September we observed rainfall to occur every day over Comilla station. Light to moderate rainfall observed in other days of the season over the station.

In 2002 we observed rainfall all through the monsoon season from the very beginning of the season over Comilla station as shown in Fig. 4(d). Very heavy rainfall observed on 13 June and 22 July, heavy rainfall on 1, 3, 4, 10, 20-21 and 24 July and moderately heavy rainfall on 1, 7, 12, 15, 28 and 30 June, 6-8, 16 and 29 July, 11, 14, 17 and 26 August and 27 September over the station. For rest of the days of the season light to moderate rainfall occurred over the station.

3.1.5 Distribution of rainfall at Dinajpur Station

From Fig. 5(a) during 1-18 June of 1998 there was no rain over Dinajpur station. From 19 June to 5 September rainfall occurred daily over the station in which very heavy

rainfall occurred only on 2 August, heavy rainfall on 21 and 27 June, 5, 6, 13, 17 and 22 July and 13, 15 and 29 August and moderately heavy rainfall on 20 and 29 June, 12, 15 and 24 July, 14 and 17 August and 1, 2 and 5 September. During 6-30 September we observed rainfall on very few days i.e. heavy rain on 27 September and moderate rainfall on 9, 17 and 28 September over the station.

Heavy rainfall occurred on 9, 13 and 22 June and 1 August, moderately heavy rain on 1, 6 and 23 June, 29 July, 11 and 31 August and 10, 17 and 19 September over Dinajpur station in the monsoon season of 2000 as shown in Fig. 5(b). We observed rainfall to occur on every day during 1-28 June, from 26 July to 15 August and from 30 August to 22 September over the station except very few days where no rainfall occurred.

From the very beginning of the monsoon season of 2001 we observed very heavy rainfall up to 8 June as in Fig. 5(c) over Dinajpur station. This year very heavy rainfall observed on 2, 3 and 19 June and 27 August, heavy rainfall on 5 and 6 June, 24 August and 5-7 and 10 September and moderately heavy rain on 17 June, 29 July, 23 and 25 August and 3, 4, 8 and 11 September over the station. Rainfall occurred daily during 1-8 and 14-20 June, from 8 July to 5 August and from 22 August to 17 September. But from 21 June to 7 July and during 18-28 September the rainfall was about zero over the station.

The rainfall occurred daily almost all through the monsoon season of 2002 over Dinajpur station except from 25 August to 13 September as shown in Fig. 5(d). In this year very heavy rainfall occurred on 18 and 19 June and 24 and 25 September, heavy rainfall occurred on 1, 12, 17, 21 and 30 June, 4, 14, 19, 22, 24, 29 and 30 July, 12 August and 27 September and moderately heavy rain on 2 and 29 June, 3, 7, 8, 16, 20 and 23 July, 10 and 18 August and 14 and 28 September over the station. Light to moderate rainfall occurred in other days of the season over the station

3.1.6 Distribution of rainfall at Khulna Station

In the monsoon season of 1998 at the beginning of the season i.e. 1-9 June and at the end of the season i.e. 14-30 September there was no rain over Khulna station except 3 June and 23 and 27 September as shown in Fig. 6(a). Rest of the days of the season the rain falling every day over the station in which very heavy rainfall observed on 11 July, heavy rain on 24 June, 12 July and 9 September and moderately heavy rain on 10 June, 4 and 15 July, 4 August and 27 September over the station. In other days light to moderate rain observed over the station.

We observe from Fig. 6(b) that the rain has occurred in most of the days from 4 June to 24 July, from 31 July to 2 August, 8-17 August and from 27 August to 22 September of 2000 over Khulna station. In this season very heavy rainfall occurred on 23 and 24 July, 30 August and 19 September, heavy rain occurred on 21 June, 31 August and 18 September and moderately heavy rain on 6 June, 18 July, 1, 11, 13 and 15 August and 4 September over the station. No rain observed in 44 days through the season.

In 2001 from the beginning of the monsoon season rainfall started and it continued daily up to 19 September except only few days over Khulna station as in Fig. 6(c). From then the rainfall was totally zero up to the end of the season except the last day of the season over the station. We observed heavy rainfall on 14 June and 17 September and moderately heavy rain on 3, 5, 13, 18, 19 and 30 June, 10 and 12 July, 16 and 26 August and 6 and 8 September and light to moderate rainfall observed in other days of the season over the station.

From Fig. 6(d) the rainfall occurred almost all through the monsoon season of 2002 except during 16-20 June, 7-10 and 23-28 July, 5-7 August and 17-21 September over Khulna station. In this year very heavy rainfall observed on 12, 13 and 22 June, heavy rainfall observed on 4, 9 and 21 June, 1, 2 and 11 July, 3, 12, 17, 23 and 27 August and 10, 11 and 23 September and moderately heavy rainfall on 2, 11, 25 and 29 June, 29 July, 13 and 16 August and 9, 22 and 26, 27 September over the station. Light to moderate rainfall observed in other days of the season over the station.

3.1.7 Distribution of rainfall at Mymensingh Station

In the monsoon season of 1998 rainfall occurred daily during 2-25 July and from 1 August to 20 September over Mymensingh station as shown in Fig. 7(a). We observed very heavy rainfall during 13, 14 and 20 July, heavy rainfall occurred on 1 and 19 June, 12, 15 and 22 July, 17 and 25 August and 5 and 16 September. Also moderately heavy rainfall observed on 19 July, 1, 4, 5, 12, 15, 16, 18, 25, 28 and 29 August and 2, 14, 19 and 20 September over the station. In other days of the season light to moderate rainfall occurred over the station.

In the monsoon season of 2000, rainfall occurred daily over Mymensingh station from 4 June to 1 July, from 7 July to 17 August and from 28 August to 26 September as shown in Fig. 7(b). In these duration's heavy rainfall observed on 5, 14, 23 and 25 June, 1 August and 18 and 23 September and moderately heavy rainfall observed on 8, 13 and 29

June, 2-4, 11, 15, 30 and 31 August and 3, 9, 11, 17 and 26 September over the station. No rainfall occurred during 1-3, 15-17 June, 2-4, 23-27 July 5-10, 18-27 August and 27-30 September. In other days light to moderate rainfall occurred over the station.

Rainfall occurred every day from 1 June to 14 August and from 25 August to 18 September 2001 over Mymensingh station As shown in Fig. 7(c). During these time we observed very heavy rain on 4 June, 26 August and 16 September, heavy rain on 3 and 20 June and 18 September and moderately heavy rain on 2, 5, 6, 15 and 18 June, 29 July, 29 August and 7 and 17 September over the station. Light to moderate rainfall occurred in other days of the season over the station.

In 2002 rainfall started from the beginning of the monsoon season and it continued daily up to 2 August over Mymensingh station as shown in Fig. 7(d). Again during 10-26 August and 20-30 September rainfall occurred daily over the station. During 3-9 August and a long duration from 27 August to 19 September the rainfall was about zero over the station. In this season very heavy rainfall occurred only on 14 and 15 June, heavy rainfall on 12 June, 7 July and 23 and 24 September and moderately heavy rain on 3, 13, 16 and 30 June, 1, 2, 14 and 24 July, 12, 22 and 23 August and 22, 27, 28 and 30 September over the station.

3.1.8 Distribution of rainfall at Rajshahi Station

There was no rain during 1-12 June of 1998 over Rajshahi station as shown in Fig. 8(a). From then upto end of the season rainfall occurred daily over the station with few exceptions. This time heavy rainfall observed on 12, 13 and 19 July, 3 and 24 August and 17 September and moderately heavy rain on 13 and 21 June, 6-8 and 22-23 July, 18 and 31 August and 6, 8, 10, 11, 21 and 28 September over the station. Light to moderate rainfall occurred in other days of the season over the station.

In the monsoon season of 2000 we observed very heavy rainfall on 31 August and 18 and 19 September, heavy rain on 1 August and 20 September and moderately heavy rain on 4, 16 and 26 June, 23 July, 2 and 15 August and 1 September over Rajshahi station as shown in Fig. 8(b). From 27 June 17 July and 24-30 September there was almost no rain over the station. Light to moderate rainfall occurred maximum days of the season over the station.

As in Fig. 8(c), during 18-30 September there was no rain over Rajshahi station but for rest of the days the rainfall was observed to occur almost every day with few

exceptions. In the monsoon season of 2001 we observed very heavy rainfall on 19 June and 14 July, heavy rainfall on 3 June, 29 July and 1 August and moderately heavy rain on 15, 16 and 18 June, 16 and 19 July, 15, 27 and 30 August and 9 September over the station.

In the monsoon season of 2002 heavy rainfall observed on 9 June, 2 July, 14 August and 4 and 24 September and moderately heavy rain on 7, 22 and 30 June, 1, 3, 16, 21 and 28 July, 3, 12, 16 and 27 August and 10, 22 and 23 September over Rajshahi station as shown in Fig. 8(d). During 7-12 July, 5-10 August and 12-19 September there was no rain over the station and for the rest of the days of the monsoon season the rainfall was light to moderate.

3.1.9 Distribution of rainfall at Sreemangal Station

In 1998 rainfall started from the very beginning of the monsoon season and continued daily up to 16 September except very few days where no rain observed over Sreemangal station as shown in Fig. 9(a). In these duration very heavy rainfall occurred on 22 July, heavy rainfall on 8 June, 13, 14, 21 and 28 July and 3 August and moderately heavy rainfall on 1, 2 and 5 June, 1,12 27 and 31 July, 9 and 24 August and 6,10 and 16 September over the station. During 17-27 September no rain observed over the station.

The rainfall occurred all through the monsoon season of 2000 over Sreemangal station as shown in Fig. 9(b). We observed very heavy rainfall on 1 August, heavy rainfall on 25-27 June, 6 July, 9 August and 17 September and moderately heavy rain on 1, 5, 10 and 19 June, 1 and 30 July, 4, 6, 7, 10, 12, 13, 27 and 31 August and 3, 15 and 16 September over the station.

In the monsoon season of 2001 rainfall occurred every day all through the season over Sreemangal station with little anomaly as shown in Fig. 9(c). This year very heavy rainfall occurred on 4, 10 and 22 June, heavy rainfall on 5-6 June, 17 and 30 July, 29 August and 18 and 19 September and moderately heavy rainfall on 1, 2 and 7 June, 7 and 31 July, 1, 4, 5, 8, 9, 19, 20, 27 and 29 August and 3 September over the station. From 30 July to 9 August moderately heavy rainfall was observed to occur about daily and during 8-20 June moderate rainfall was about to occur daily except little anomaly.

We observed rainfall all through the season in the year 2002 over Sreemangal station as shown in Fig. 9(d). In this season very heavy rainfall occurred on 16 July, heavy rainfall on 3, 4, 6 and 15 June, 7, 15 and 22 July, 2, 5, 6 and 26 August and 23

September and moderately heavy rainfall on 8, 9, 13, 16 and 20 June, 4, 10, 25 and 29 July, 12, 28 and 30 August and 2, 3, 21, 24, 26 and 27 September over the station.

3.1.10 Distribution of rainfall at Sylhet Station

In the monsoon season of 1998 we observed rainfall to occur every day almost all through the season over Sylhet station as shown in Fig. 10(a). Very heavy rainfall observed on 1, 2 and 8 June and 20, 22 and 23 July, heavy rainfall observed on 4 and 14 June, 14, 15, 21, 24 and 26 July, 15, 16, 24, 25 and 30 August and 4 and 20 September and moderately heavy rainfall on 6, 17 and 20 June, 3, 12, 13, 17, 19 and 25 July, 3, 6, 14, 17, 18, 22, 23 and 26 August and 2, 10, 14 and 23 September over the station.

From Fig. 10(b) we observed that rainfall occurred almost all through the season in the monsoon season of 2000 over Sylhet station. This year very heavy rainfall occurred on 12 and 24 June, 1, 4 and 12 August and 10 and 25 September over the station. On 12 June we observed excess rainfall which was about 370 mm. Heavy rainfall observed on 10, 13 and 26 June, 3, 7, 8, 11, 14 and 18 August, 4 and 14-18 September over the station. In other days of the season moderate to moderately heavy rainfall observed over the station.

In the monsoon season of 2001 rainfall occurred almost all through the season over the Sylhet station as in Fig. 10(c). We observed very heavy rainfall on 4, 5 and 30 June and 31 July, heavy rainfall on 3, 17 and 23 June, 29 and 30 July, 1, 18 and 20 August and 13, 17 and 19 September and moderately heavy rainfall on 6, 9, 15 and 20 June, 1, 12, 16, 18, 23 and 26 July, 6, 9-11, and 30 August and 4 and 25 September over the station. Moderate rainfall observed in other days of the season over the station.

As in Fig. 10(d), starting from the very beginning of the monsoon season of 2002 rainfall continued daily upto 1 September over the Sylhet station. We observed very heavy rainfall on 6 and 14 June, 12 and 23 July, 2 August and 28 September, heavy rainfall on 30 June, 6, 7, 13 and 29 July, 20 August and 15 and 29 September and moderately heavy rainfall on many days over the station. Excess rainfall occurred on 2 August, which was 450 mm over the station.

3.2 Anticyclonic axis position at 200 hPa level

3.2.1 Anticyclonic axis position w.r.t. Dhaka Station

The position of the upper air anticyclonic axis in the monsoon season of 1998 w.r.t. Dhaka station is shown in Fig. 1(a). We observed that on 1-10 and 13 June the anticyclonic axis position was south of the Dhaka station. From then up to 4 September the axis was north and far away from the station with few exceptions. The exceptions are on 23 and 27 June, 13 July 14 August and 2 September when it was close to the station. During 5-8, 10 and 14 September the axis was south of the station. From 15 to 30 September the anticyclonic axis was north of the station.

The axis position of the upper air anticyclone in the monsoon season of 2000 w.r.t. Dhaka station is shown in Fig. 1(b). From Fig. we observed that up to 23 June the axis position of the upper air anticyclone was oscillatory towards north-south direction. From then up to 15 September the axis was north of the station except on 9 July and 10 September when the axis was south of the station. The upper air anticyclonic axis was situated south of the station during 16 to 30 September.

The upper air anticyclonic axis position for the monsoon season of 2001 w.r.t. Dhaka station is shown in Fig. 1(c). During 1-15 June the position of the anticyclonic axis was south of the station. Then from 16 June to 23 September the axis was north of the station except 3 July and 17 September when it was south of the Dhaka station. From 4 July to 21 August the anticyclonic axis was north and far away from the station. During 24-30 September the axis was near but oscillatory about the north-south direction.

In the monsoon season of 2002 the position of the upper air anticyclonic axis w.r.t. Dhaka station is shown in Fig. 1(d). During 1-8 June the 200 hPa level anticyclonic axis was south of the Dhaka station. During 9-21 June the axis position was moving in the north-south direction. From 22 July to 13 September the axis position was north of the station. During 14-25 September the axis position was south of the Dhaka station except on 15 and 20 September when it was about over the station. The rest of the days of the season the axis position were oscillatory about the Dhaka station as center. From 27 June to 3 July, 16-21 July, 7-10 August and 9-17 September the movement of the anticyclonic axis was continuously from north to south but it was still north of the station.

3.2.2 Axis position w.r.t. Barisal Station

The axis position of the upper air anticyclone in the monsoon season of 1998 is shown in Fig. 2(a). The anticyclonic axis at 200 hPa level was south of the Barisal station at the beginning of the monsoon season i.e. during 1-9 June. From then the axis was north of the station up to the end of the season only except 5-8 and 10 September. For whole the season the movement of the anticyclonic axis was oscillatory; only from 26 August to 7 September it was moving continuously from north to south but it still becomes north of the station.

In the year 2000 the upper air anticyclonic axis of 200 hPa level was north of the Barisal station from 2 June to 17 September except on 5 and 14 June and 9 July when it was very close to the station as shown in Fig. 2(b). After 17 September the axis was south of the station. During 27-30 July and 14-19 September the axis was moving from north to south continuously over the station.

The position of the upper air anticyclonic axis in the monsoon of 2001 is shown in Fig. 2(c). During 1-11 June the anticyclonic axis at 200 hPa level was south of the Barisal station. Then From 16 June to end of the season the axis was north of the station except 27 and 30 September.

In the year 2002 during 1-4 June the axis was south of the station and 5-21 June it was near but north about the Barisal station as shown in Fig. 2(d). From 22 June to 16 September the axis was north of the station and for rest of the days of the season the axis was near but oscillatory about the station. From 27 June to 3 July, 17-22 July, 7-10 August and 9-14 September the axis moved from north to south towards the station.

3.2.3 Axis position w.r.t. Chittagong Station

The position of upper air anticyclonic axis at 200 hPa level w.r.t. Chittagong station in the monsoon of 1998 is shown in Fig. 3(a). During 1-9 June the anticyclonic axis was south of the station except 6 June. After then the axis was north of the station almost whole of the season except on 5-8 and 10 September when it came south of the station. The axis position was always oscillatory but from 26 August to 7 September the axis moved from north to south continuously.

From the beginning of the season of 2000 the anticyclonic axis at 200 hPa level w.r.t. Chittagong station was north of the station up to 17 September except on 1 June and

9 July when it was very close to the station as shown in Fig. 3(b). Starting from 18 September to the end of the season the axis was south of the Chittagong station. During 27-31 July and 11-19 September the axis was moving from north to south continuously.

The position of the upper air anticyclonic axis at 200 hPa level w.r.t. Chittagong station in the monsoon season of 2001 is shown in Fig. 3(c). This year during 1-11 June the axis of anticyclone was almost near and south of the Chittagong station. During 12-14 June the axis was oscillatory about the station as center. From 16 June to the end of the season the axis was north and far from the station except on 27 and 30 September when it was at south but near the Chittagong station.

In the monsoon season of 2002 on 1-4, 6th and 13th June the axis of upper air anticyclone at 200 hPa level was south of the Chittagong station as shown in Fig. 3(d). After then up to 16 September it was north of the station. From 27 June to 3 July, 16-21 July, 6-10 August and 8-14 September the axis of upper air anticyclone was moving from north to south continuously.

3.2.4 Axis position w.r.t. Comilla Station

The position of the upper air anticyclonic axis at 200 hPa level w.r.t. Comilla station in the monsoon season of 1998 is shown in Fig. 4(a). During 1-9 June the axis was south of the station. During 10 to 13 June it was oscillate towards north-south over the station. After then up to 4 September the axis was north of the station. During 5-8 and 10 September this anticyclonic axis was south of the station. Again during 11-30 September the axis was north of the station except on 14 September. From 26 August to 7 September the axis moved continuously from north to south.

In the monsoon season of 2000 from the beginning of the season the anticyclonic axis at 200 hPa level was north of the Comilla station and continued up to 15 September except on 1, 5 and 14 June and 19 July when it was south but close to the station as shown in Fig. 4(b). During 16-30 September the upper air anticyclonic axis was south of the station. It was important that most of the time of the monsoon season of 2000 the axis was near the Comilla station. During 27-31 July and 14-19 September the axis moved from north to south continuously.

The position of the upper air anticyclonic axis at 200 hPa level w.r.t. Comilla station in the monsoon of 2001 is shown in Fig. 4(c). During 1-15 June the anticyclonic axis was south of the station except on 12 and 14 June. From 16 June to 25 September the

axis was north of the station except only on 2 July when it was at south but very close to the station. Again on 26-27 and 30 September the axis was south of the station. From 3 July to 20 August the axis was far from the station.

In the year 2002 during 1-8 June the upper air anticyclonic axis at 200 hPa level was south of the station and from then up to 21 June the axis was oscillatory about the Comilla station as shown in Fig. 4(d). From 22 June to 13 September it was north of the station. Again 14-30 September most of the time the axis was south of the station. From 27 June to 3 July, 16-21 July and 8-14 September the axis moved continuously from north to south.

3.2.5 Axis position w.r.t. Dinajpur Station

In 1998 during 1-13 June the upper air anticyclonic axis at 200 hPa level was south of the Dinajpur station as shown in Fig. 5(a). From then up to 25 June position of the axis was oscillatory about the Dinajpur station as center. From 26 June to 31 August the axis was north and near the station except on 13 July and 14 August. During 1-16 September the axis was south of the station except on 4, 13 and 15 September. Again during 17-30 September the anticyclonic axis was north and near the station except on 20 and 28 September. From 27 August to 6 September the upper air anticyclonic axis moved from north to south continuously.

The position of the upper air anticyclonic axis at 200 hPa level w.r.t. Dinajpur station in the monsoon season of 2000 is shown in Fig. 5(b). From the beginning of the season the upper air anticyclonic axis was oscillatory up to 14 September about Dinajpur station as center with some exceptions. During 15-30 September the axis was south of the station. During 27-31 July and 14-19 September the anticyclonic axis moved from north to south continuously.

During 1-15 June the upper air anticyclonic axis at 200 hPa level in the monsoon season of 2001 was south of the Dinajpur station as shown in Fig. 5(c). From then up to 21 August the axis was north of the station except on 24, 27 and 29 June and 1 and 3 July when it was south but very close to the station. From 22 August to 23 September the axis position was oscillatory about the station as center. Again during 24-30 September the axis was south but near to the station.

During 1-24 June of 2002 the axis of upper air anticyclone at 200 hPa level was south of the Dinajpur station except on 22 June when it was just north of the station as

shown in Fig. 5(d). From 25 June to 10 September the anticyclonic axis was north but near to the station except on 11 and 29 July and 14 August when it was at south but very close to the station. During 11-30 September the axis was south of the station. From 27 June to 3 July, 16-21 July, 25-29 July and 9-14 September the axis moved from north to south continuously.

3.2.6 Axis position w.r.t. Khulna Station

The position of the upper air anticyclonic axis w.r.t. Khulna station at 200 hPa level in the monsoon season of 1998 is shown in Fig. 6(a). During 1-9 June except 6th June and 6-10 September except on 9 September the upper air anticyclonic axis was south of the Khulna station. Rest of the days of the season the axis was north and far from the station. From 26 August to 6 September the axis moved from north to south continuously.

In 2000 from the beginning of the season the upper air anticyclonic axis at 200 hPa level was north of the Khulna station up to 17 September except on 1, 5 and 14 June, 9 July and 16 September when the axis was south but very close to the station as shown in Fig. 6(b). During 18-30 September the axis was south of the Khulna station. From 20 to 30 July the axis was north and far from the station.

The position of the upper air anticyclonic axis w.r.t. Khulna station at 200 hPa level in the monsoon season of 2001 is shown in Fig. 6(c). During 1-11 June the upper air anticyclonic axis was south of the Khulna station except 2 June and 12-15 June the axis position was oscillatory about the station as center. Then from 16 June to the end of the season of the year 2001 the axis was north of the station except on 26, 27 and 30 September. Figure also shows that the axis was north and far from the station during 3 July to 22 August.

During 1-4 June of 2002 the upper air anticyclonic axis at 200 hPa level was south of the Khulna station as shown in Fig. 6(d). During 5-16 June the axis was oscillatory about the station. From 17 June to 16 September the axis was north and some times far from the station. During 17-30 September the axis was oscillatory keeping the station as center. From 27 June to 3 July, 16-21 July and 9-15 September the moved from north to south continuously.

3.2.7 Axis position w.r.t. Mymensingh Station

The position of the upper air anticyclonic axis w.r.t. Mymensingh station at 200 hPa level in the monsoon of 1998 is shown in Fig. 7(a). During 1-11 June the upper air anticyclonic axis was south of the station. From 12 June to 4 September almost all the time the axis was north of the station but on 18, 23 and 25 June, 2 and 4 September the axis was just over the station and on 13 and 23 June and 13 July the axis was at south but very close to the station. During 5-14 September the axis position was oscillatory about the station as center. During 17-30 September the axis was again north of the station. From 26 August to 2 September the anticyclonic axis moved continuously from north to south.

In 2000 from the beginning of the season the position of the upper air anticyclonic axis 200 hPa level was oscillatory about the Mymensingh station as center and up to 23 June it continued as shown in Fig. 7(b). From 24 June to 15 September the axis was north of the station except 9 July, 30 August and 8-10 September. During 16-30 September the axis was south and away from the station. During 25-31 July and 14-19 September the axis of anticyclone moved continuously from north to south.

During 1-15 June and 24-30 September of 2001 the axis of upper air anticyclone of 200 hPa level was south of Mymensingh station as shown in Fig. 7(c). From 16 June to 23 September the axis was north of the station except on 29 June, 3 July, 26 and 27 August, 10 and 17 September. From 3 July to 21 August the axis was north and far from the station.

The position of the upper air anticyclonic axis w.r.t. Mymensingh station at 200 hPa level in the monsoon season of 2002 is shown in Fig. 7(d). During 1-10 June the upper air anticyclonic axis was south of the station. From then up to 21 June the axis position was oscillatory about the Mymensingh station as center. From 22 June to 12 September the axis was north of the station. During 13-30 September the anticyclonic axis was south of the station except 27 and 28 September. From 27 June to 3 July, 16-21 July and 9-14 September the anticyclonic axis moved from north to south continuously.

3.2.8 Axis position w.r.t. Rajshahi Station

In 1998 during 1-13 June the upper air anticyclonic axis of 200 hPa level was south of Rajshahi station except on 10 June as shown in Fig. 8(a). From 14 June to 4 September the axis was north of the station except on 23 June and 13 July. During 5-16

September the axis position was oscillatory about the Rajshahi station as center. During 17-30 September the axis was again north of the station. From 26 August to 6 September the anticyclonic axis moved from north to south continuously.

In the monsoon of 2000 during 1-23 June the position of upper air anticyclonic axis at 200 hPa was oscillatory about the Rajshahi station as shown in Fig. 8(b). From 24 June to 7 September the axis was north of the station except on 9 July and 30 August. During 8-16 September the axis position was oscillatory about the axis as center and from then up to the end of the season the axis was south of the Rajshahi station.

The position of the upper air anticyclonic axis w.r.t. Rajshahi station at 200 hPa level in the monsoon of 2001 is shown in Fig. 8(c). During 1-11 June and 24-30 September the upper air anticyclonic axis was south of the station. From 16 June to 16 September the axis was north of the station except on 3 July and 26 and 27 August when it was very close to the station.

The position of the upper air anticyclonic axis w.r.t. Rajshahi station at 200 hPa level in the monsoon of 2002 is shown in Fig. 8(d). During 1-10 June the upper air anticyclonic axis was south of the station. During 11-21 June the axis was oscillatory about the Rajshahi station. From 22 June to 13 September the axis was north and far from the station. During 14-30 September the axis was again south of the station except on 27 and 28 September. From 27 June to 3 July, 16-21 July and 9-14 September the axis moved from north to south continuously.

3.2.9 Axis position w.r.t. Sreemangal Station

In the monsoon of 1998 during 1-10 June the upper air anticyclonic axis at 200 hPa level was south of the Sreemangal station as shown in Fig. 9(a). From 14 June to 4 September the axis was north of the station except on 23 June and 13 July. Again during 15-30 September the axis was north of the station. From 26 August to 2 September and 3-7 September the anticyclonic axis at 200 hPa level moved from north to south continuously. From 5-14 September the axis was oscillatory about the station.

The position of the upper air anticyclonic axis w.r.t. Sreemangal station at 200 hPa level in the monsoon season of 2000 is shown in Fig. 9(b). This year during 1-23 June the position of upper air anticyclonic axis was oscillatory about the Sreemangal station. From 24 June to 15 September the axis was north of the station except on 9 July, 30 August and 10 September. During 16-30 September the anticyclonic axis was south of Sreemangal

station. During 27-31 July and 14-19 September the axis moved from north to south continuously.

In 2001 during 1-15 June the upper air anticyclonic axis at 200 hPa level was south of the Sreemangal station as shown in Fig. 9(c). From 16 June to 23 September the axis was north of the station except on 2 July, 26 August and 17 September. During 24-30 September the anticyclonic axis was south of the station except on 25 September.

In the monsoon of 2002 during 1-21 June the upper air anticyclonic axis w.r.t. Sreemangal station at 200 hPa level was south of the station except on 11, 14 and 17 June. From 22 June to 12 September the anticyclonic axis was north of the station as in Fig. 9(d). During 13-30 September the axis was south of the station except on 27 September. From 27 June to 3 July, 15-20 July, 6-10 August and 8-14 September the anticyclonic axis was continuously moved from north to south.

3.2.10 Axis position w.r.t. Sylhet Station

The position of the upper air anticyclonic axis w.r.t. Sylhet station at 200 hPa level in the monsoon season of 1998 is shown in Fig. 10(a). During 1-13 June the upper air anticyclonic axis was south of the Sylhet station except 12 June. From 14 June to 1 September the axis was north of the station. During 2-14 September the axis position was oscillatory about the station as center. During 15-30 September the axis was again north of the station. From 26 August to 2 September the anticyclonic axis moved from north to south continuously. In this year the anticyclonic axis was near the station.

In the monsoon season of 2000 during 1-25 June and 28 August to 15 September the axis was oscillatory about the station as center as shown in Fig. 10(b). From 26 June to 27 August the upper air anticyclonic axis at 200 hPa level was north of the station except on 9 July. During 16-30 September the axis was south of the station.

In 2001 during 1-15 June the upper air anticyclonic axis w.r.t. Sylhet station at 200 hPa level was south of the station as shown in Fig. 10(c). From 16 June to 21 August the axis was north of the station except 24 and 29 June and 3 July. After one week from 28 August to 16 September again the axis was north of the station and 24-30 September it was south of the Sylhet station.

The position of the upper air anticyclonic axis w.r.t Sylhet station at 200 hPa level in the monsoon season of 2002 is shown in Fig. 10(d). During 1-21 June the upper air

anticyclonic axis was south of the Sylhet station except on 14 and 17 June. From 22 June to 12 September the axis was north of the station. During 13-30 September the axis was south of the station except on 27 September. In this year the axis was also very close to the station.

3.3 Anticyclonic axis position at 300 hPa level

3.3.1 Anticyclonic axis position w.r.t. Dhaka Station

The position of the upper air anticyclonic axis in the monsoon season of 1998 w.r.t. Dhaka station is shown in Fig. 11(a). During 1-12 June the upper air anticyclonic axis at 300 hPa level was south of Dhaka station. From 13 June to 2 September except 13 July the axis was at north of the station. During 3-20 September the axis position was oscillatory about the station as center. During 21-28 September the axis was again north of the station.

In the monsoon season of 2000 starting from 2 June up to 15 September except on 13, 23 and 25 June, 3 and 30 August and 12 September the upper air anticyclonic axis at 300 hPa level was north of the Dhaka station as shown in Fig. 11(b). During 16-30 September the axis was south of the station. Maximum shifting of upper air anticyclonic axis was occurred during 10-15 July from Dhaka.

In the monsoon season of 2001 during 1-11 June the anticyclonic axis at 300 hPa level was south of station except on 3 June as shown in Fig. 11(c). From 12 June to 2 July the axis position was oscillatory about the Dhaka station. From 3 July to 25 August the axis was north of the station. From then the axis position was again oscillatory about the Dhaka station as center up to the end of the season.

During 1-7 June of 2002, the anticyclonic axis at 300 hPa level was south of the station as shown in Fig. 11(d). During 8-13 June the anticyclonic axis position was oscillatory about the Dhaka station as center. During 14-24 June the axis was south of the station. From 22 June to 11 September sthe axis was north of the station except on 1, 2, 11 and 22 July, 13 and 17 August. During 16-30 September the axis of anticyclone was south of the Dhaka station.

3.3.2 Axis position w.r.t. Barisal Station

In the monsoon season of 1998 the upper air anticyclonic axis w.r.t. Barisal station at 300 hPa level are discussed as in Fig. 12(a). During 1-9 June the anticyclonic axis was

south and far from the station. From 12 June to 30 September the axis was north of the Barisal station except on 5, 7, 13 and 16 September. Maximum shifting of upper air anticyclone occur in 9 September.

The position of the upper air anticyclonic axis in the monsoon season of 2000 w.r.t. Barisal station is shown in Fig. 12(b). From 2 June to 15 September the anticyclonic axis at 300 hPa level was north of the Barisal station except on 13 June and 30 August. During 16-30 September the axis was south of the station. Shifting of anticyclonic axis was maximum at 21 July.

The upper air anticyclonic axis position in the monsoon season of 2001 w.r.t. Barisal station is shown in Fig. 12(c). During 1-19 June the anticyclonic axis position was oscillatory about the Barisal station as center. From 20 June to 30 September the axis was north of the station except on 6, 17, 20, 26 and 27 September.

The position of the upper air anticyclonic axis in the monsoon season of 2002 w.r.t. Barisal station is shown in Fig. 12(d). During 1-7 June the anticyclonic axis at 300 hPa level was south of the Barisal station. From 22 June to 15 September the axis was north of the station except on 2 July and 12 September. Again on 16-30 September the axis came south of the station except on 28 September.

3.3.3 Axis position w.r.t. Chittagong Station

During 1-8 June of 1998 the anticyclonic axis position at 300 hPa level was south of the Chittagong station as shown in Fig. 13(a). From 12 June to 30 September the axis was north of the station except on 5, 7, and 13 September.

The position of the upper air anticyclonic axis in the monsoon season of 2000 w.r.t. Chittagong station is shown in Fig. 13(b). From 2 June to 15 September the anticyclonic axis at 300 hPa level was north of the station only except on 30 August. During 16-28 September the axis was at the south of the station. From 27 July to 3 August the axis moved from north to south continuously.

During 1-19 June of 2001 the anticyclonic axis position was oscillatory about the Chittagong station as center as shown in Fig. 13(c). From 20 June to 30 September the axis was north of the station except on 17, 20 and 26 September.

The position of the upper air anticyclonic axis in the monsoon season of 2002 w.r.t. Chittagong station is shown in Fig. 13(d). During 1-7 June the upper air

anticyclonic axis was south of the Chittagong station. From 22 July to 15 September the axis was north of the station except on 2 July. During 16-30 September the axis was south of the station except 19 and 28 September. During 16-22 July and 7-13 August the anticyclonic axis moved from north to south continuously.

3.3.4 Axis position w.r.t. Comilla Station

In the monsoon season of 1998 during 1-11 June the upper air anticyclonic axis at 300 hPa level was south of the Comilla station as shown in Fig. 14(a). From 12 June to 2 September and 17-30 September the axis was at the north of the station. During 3-16 September the axis was oscillatory about the Comilla station as center.

The position of the upper air anticyclonic axis at 300 hPa level in the monsoon season of 2000 w.r.t. Comilla station is shown in Fig. 14(b). From 2nd June to 15 September the upper air anticyclonic axis was north of the station except on 18 June and 30 August. The axis was north and far away from the station during 3rd and 4th week of July. Rest of the days of the season the axis was south of the station. From 27 July to 1 August the axis moved continuously from north to south.

In the monsoon season of 2001 the upper air anticyclonic axis w.r.t. Comilla station at 300 hPa level is shown in Fig. 14(c). During 1-19 June and from 26 August to 30 September the upper air anticyclonic axis position was oscillatory about the station as center. For rest of the days of the season the axis was north of the station, and from 2nd week of July to 2nd week of August the axis was far from the station.

The position of the upper air anticyclonic axis w.r.t. Comilla station at 300 hPa level in the monsoon of 2002 is shown in Fig. 14(d). During 1-7 June the upper air anticyclonic axis was south of the station. From 8th June to 2 July the axis position was oscillatory about the station as center. From 2 July to 11 September the axis was north of the station except on 12 July and 13 and 17 August. During 16-30 September the axis was south and near to the station.

3.3.5 Axis position w.r.t. Dinajpur Station

In the monsoon season of 1998 during 1-13 June the upper air anticyclonic axis at 300 hPa level was south of the Dinajpur station as shown in Fig. 15(a). From 14 June to 20 July the axis was oscillatory about the Dinajpur station as center. From 21 July to 12 August and 16-31 August the axis was north of the station. During 1-20 September the

axis position was oscillatory about the station and 21-29 September it was north of the station. In this year the anticyclonic axis was near the station.

The position of the upper air anticyclonic axis w.r.t. Dinajpur station at 300 hPa level in the monsoon season of 2000 is shown in Fig. 15(b). During 1-5 June and 16-30 September the upper air and anticyclonic axis was south of the station. From 29 June to 31 July and 5-22 August the axis was north of the station. For rest of the days of the season the axis position was oscillatory about the Dinajpur station as center. Except 3rd week of July the anticyclonic axis was more or less near the station.

Fig. 15(c) shows that during 1-12 June of 2001 the upper air anticyclonic axis at 300 hPa level was south of the Dinajpur station. From 13 June to 3 July and from 18 August to 11 September the axis was oscillatory about the station as center. From 4 July to 17 August the axis was north of the station and 12-30 September the axis was south of the station. During 1st and 2nd week of August the axis was north and far from the station.

The position of the upper air anticyclonic axis in the monsoon of 2002 is shown in Fig. 15(d). During 1-21 June the upper air anticyclonic axis at 300 hPa level was south of the Dinajpur station except on 10 June. From 22 June to 25 July the axis was oscillatory about the station as center. From 31 July to 12 August and from 22 August to 8 September it was north of the station. During 15-30 September the axis was south of the station. Most of the time the axis was near the station.

3.3.6 Axis position w.r.t. Khulna Station

The position of the upper air anticyclonic axis w.r.t. Khulna station at 300hPa level in the monsoon season of 1998 is shown in Fig. 16(a). During 1-9 June the upper air anticyclonic axis was south of the station. From 12 June to 4 September and 17-30 September the axis was north of the station. Most of the time the axis was north and far from the station.

In the monsoon season of 2000 from 2 June to 15 September the axis of anticyclone at 300 hPa level was north of the Khulna station except on 13 June and 30 August as shown in Fig. 16(b). During 16-30 September the axis was south of the station. The axis was north and far away from the station during 3rd and 4th week of July.

The position of the upper air anticyclonic axis w.r.t. Khulna station at 300hPa level in the monsoon season of 2001 is shown in Fig. 16(c). During 1-26 June the upper

air anticyclonic axis was oscillatory about the Khulna station as center. For rest of the days of the season the axis of anticyclone was north of the station except only few days.The anticyclonic axis was north and far from the station during 5 July to 15 August and near the station during 16 August to 30 September.

During 1-7 June in the monsoon season of 2002 the upper air anticyclonic axis at 300 hPa level was south of Khulna station as shown in Fig. 16(d). From 3 July to 11 September it was north of the station. During 16-30 September it was south of the station. The anticyclonic axis was also oscillatory during 8 June to 2 July.

3.3.7 Axis position w.r.t. Mymensingh Station

The position of the upper air anticyclonic axis w.r.t. Mymensingh station at 300hPa level in the monsoon season of 1998 is shown in Fig. 17(a). During 1-12 June the upper air anticyclonic axis was south of the Mymensingh station. From 14 June to 31 August the axis was north and near to the station except few days. During 1-20 September the axis position was oscillatory about the station as center and 21-29 September it was north of the station.

In 2000 from 26 June to 28 August the upper air anticyclonic axis at 300 hPa level was north of the Mymensingh station except on 3 August as shown in Fig. 17(b). During 16-30 September the axis of anticyclone was south of the station. For rest of the days of the season the axis was oscillatory about the station as center. From 27 July to 1 August the axis moved from north to south continuously. The anticyclonic axis was north and far from the station during 3rd and 4th week of July.

The position of the upper air anticyclonic axis w.r.t. Mymensingh station at 300hPa level in the monsoon of 2001 is shown in Fig. 17(c). During 1-12 June the upper air anticyclonic axis was south of the station. From 13 June to 2 July it was oscillatory about the station as center. From 3 July to 17 August the axis was north and far from the station. For the rest of the days the axis of anticyclone was oscillatory about the Mymensingh station as center.

In the monsoon of 2002 during 1-21 June the axis was south of the Mymensingh station except on 10 June as shown in Fig. 17(d). From 26 July to 12 August and from 20 August to 8 September the axis was north of the station. During 14-30 September the axis was south of the station. For rest of the days the axis was oscillatory about the Mymensingh station as center.

3.3.8 Axis position w.r.t. Rajshahi Station

During 1-12 June of 1998 the upper air anticyclonic axis at 300 hPa level was south of the Rajshahi station as shown in Fig. 18(a). From 13 June to 31 August the axis was north of the station except 25 June, 11, 13 and 20 July and 13 August. During 1-20 September the axis of anticyclone was oscillatory about the station as center and 21-29 September it was again north of the station.

The position of the upper air anticyclonic axis w.r.t. Rajshahi station at 300hPa level in the monsoon of 2000 is shown in Fig. 18(b). During 1-25 June and 30 August to 15 September the upper air anticyclonic axis was oscillatory about the Rajshahi station as center. From 26 June to 29 August the axis was north of the station except 3 August. During 16-30 September it was south of the station. Most of the time the anticyclonic axis was near the station except 3rd and 4th week of July when the axis was north and far from the station.

The upper air anticyclonic axis position w.r.t. Rajshahi station at 300hPa level in the monsoon of 2001 is shown in Fig. 18(c). From 4 July to 17 August the upper air anticyclonic axis was north and far from Rajshahi station. For rest of the days of the season the axis position was oscillatory about the Rajshahi station as center.

The position of the upper air anticyclonic axis w.r.t. Rajshahi station at 300hPa level in the monsoon of 2002 is shown in Fig. 18(d). During 1-7 June and 15-30 September the axis was south of the Rajshahi station. During 3-21 July, 25 July to 12 August and 22 August to 8 September the axis was north and far from the station. Rest of the days of the monsoon the axis position was oscillatory about the station as center.

3.3.9 Axis position w.r.t. Sreemangal Station

In the monsoon of 1998 during 1-12 June the upper air anticyclonic axis at 300hPa level was south of the Sreemangal station as shown in Fig. 19(a). From 13 June to 31 August it was north of the station except on 11 and 13 July. During 1-20 September it was oscillatory about the station as center and during 21-29 September the axis was north of the station.

The position of the upper air anticyclonic axis w.r.t. Sreemangal station at 300 hPa level in the monsoon of 2000 is shown in Fig. 19(b). During 1-25 June and 8-15 September the upper air anticyclonic axis position was oscillatory about the station as

center. From 26 June to 7 September the axis was north of the station except on 3 and 30 August. During 16-30 September the axis was south of the station.

During 1-12 June of 2001 the upper air anticyclonic axis at 300 hPa level was south of the Sreemangal station as shown in Fig. 19(c). From 3 July to 25 August it was north and far from the station. During 13 June to 2 July and 26 August to 30 September the axis was oscillatory about the Sreemangal station as center.

The position of the upper air anticyclonic axis w.r.t. Sreemangal station at 300 hPa level in the monsoon of 2002 is shown in Fig. 19(d). During 1-21 June and 15-30 September the upper air anticyclonic axis was south of the Sreemangal station. Form 22 July to 12 August and from 18 August to 11 September the axis was north of the station. Rest of the days of the monsoon season the axis was oscillatory about the station.

3.3.10 Axis position w.r.t. Sylhet Station

In 1998 during 1-13 June the upper air anticyclonic axis of 300 hPa level was south of the Sylhet station as shown in Fig. 20(a). From then up to 31 August the axis was north of the station except little anomaly. During 1-7 September the axis was south of the station and 8-20 September the axis of anticyclone was oscillatory about the Sylhet station as center.

The position of the upper air anticyclonic axis w.r.t. Sylhet station at 300 hPa level in the monsoon season of 2000 is shown in Fig. 20(b). During 1-2 June the upper air anticyclonic axis was south of the Sylhet station. From 26 June to 29 August the axis was north of the station except little anomaly. During 15-30 September the axis was south of the station. From 27 July to 1 August and 13-17 September the axis moved from north to south continuously. During 1-25 June and 30 August to 14 September the axis was oscillatory about the station as center.

In the monsoon season of 2001 during 1-12 June the axis of upper air anticyclone at 300 hPa level was south of the Sylhet station as shown in Fig. 20(c). From 13 June to 2 July and 18 August to 30 September the axis was oscillatory about the station. From 3 July to 17 August the axis was north and far from the station.

The position of the upper air anticyclonic axis w.r.t. Sylhet station at 300 hPa level in the monsoon season of 2002 is shown in Fig. 20(d). During 1-21 June the axis of upper air anticyclone was south of the Sylhet station except on 10 June. From 22 June to

14 September the axis was north and far from the station for most of the time. During 15-30 September the upper air anticyclonic axis was again south of the station.

3.4 Relation between rainfall and anticyclonic axis position at 200 hPa level

3.4.1 Relation between rainfall and axis position w.r.t. Dhaka Station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Dhaka station are shown in Fig. 1(a). The upper air anticyclonic axis was very close to the Dhaka station on 6, 10-13, 15 and 18 June and rainfall occurred on 10 and 13 June over the station. When the axis was close to the station then the rainfall occurred during 23-28 June. The anticyclonic axis was far away from the station from 29 June to 1 September but heavy rainfall is observed during 12-21 July and very heavy rainfall is observed during 11-17 August except on 13 July and 14 August when the axis was close to the station. From then the axis was more or less near the station and also rainfall is observed.

Anticyclonic axis position at 200 hPa level and the daily rainfall in the monsoon of 2000 over Dhaka station are shown in Fig. 1(b). The axis position was not so far away from the Dhaka station during 6-24 June but moderate to moderately heavy rainfall occurred during the mentioned time. During 27-31 July the axis was continuously moving from north to south and rainfall occurred for next two days i.e. on 1-2 August. Again during 14-19 September the axis of anticyclone was moving continuously from north to south and at that time moderately heavy rainfall was observed.

The distribution of upper air anticyclonic axis position at 200 hPa level and the daily rainfall in the monsoon season of 2001 over Dhaka station are shown in Fig. 1(c). During 1-20 June moderately heavy rainfall occurred over the station and this time the axis was around the station. From 4 July to 22 August the anticyclonic axis was far away from the Dhaka station and almost all this time moderate to moderately heavy rainfall occurred. Rest of the days of the season the axis was more or less around the station and rainfall also occurred this time over the Dhaka station.

The positions of anticyclonic axis at 200 hPa level w.r.t. Dhaka station and the daily rainfall in the monsoon season of 2002 is shown in Fig. 1(d). First 4 days of the season the axis was at the south and away from the station but this time moderately heavy rainfall occurred over the station. During 5-21 June the axis was more or less near the station and also moderate to moderately heavy rainfall occurred over the station. From 27

June to 3 July the 200 hPa level anticyclonic axis moved from north to south continuously and heavy rainfall occurred from 30 June to 4 July. Again during 16-21 July and 7-10 August the movement of the axis was continuously from north to south and heavy rainfall occurred on 21 July and on 10 August over the Station. During 24-27 September the axis moved from south to north continuously and moderately heavy rainfall occurred on 27 September over the station.

From the above discussion we can say that in the monsoon season of 1998, 2000, 2001 and 2002 rainfall occurred over Dhaka station when the anticyclonic axis was close to the station. But in August of 1998 and 2nd half of July and 1st half of August of 2001 the axis was away from the station then also rainfall occurred over the station. When the axis moved towards the station continuously from north to south or from south to north the rainfall occurred at that time and also at the end of that duration over Dhaka station.

3.4.2 Relation between rainfall and axis position w.r.t. Barisal Station

Anticyclonic axis position at 200 hPa level and the daily rainfall in the monsoon season of 1998 over Barisal station are shown in Fig. 2(a). During 1-12 June there was no rain and the position of the anticyclonic axis was south of the station. During 13-30 June rainfall occurred over the station and this time the axis was near and north of the station. During 2-16 July there was moderate to heavy rainfall and this time the axis was north and far away from the Barisal station except on 13 July when it was near the station. During 2-18 August we observed moderately heavy to heavy rainfall but the axis of upper air anticyclone was north and far away from the station. On 9 and 27 September rain was moderate but axis was far away from the Barisal station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2000 over Barisal station are shown in Fig. 2(b). During 1, 2, 5 and 14 June the axis was very close to the station whereas we observed no rain at that day over the station. During 6-12 June there was moderate rainfall observed when the axis was away from the station. But from 26 June to 6 July and 16-27 August there was no rain when the anticyclonic axis was clearly away from the Barisal station. From 8 July to 2 August the rainfall was continuous and moderately heavy and the axis was far away most of the time except on 9 July when it was very close to the station. From 26 July to 2 August the axis moved continuously from north to south and the rainfall was significant on 30 July and 1, 2 August. On 31 August rainfall was heavy over the station and axis

position was near the station. During 14-19 September the anticyclonic axis moved continuously from north to south and 17-21 September there was moderate to moderately heavy rainfall occurred over the Barisal station.

The upper air anticyclonic axis positions at 200 hPa level and the daily rainfall in the monsoon season of 2001 over Barisal station are shown in Fig. 2(c). During 1-15 June heavy to very heavy rainfall occurred and this time the anticyclonic axis was not so far away from the station. From 16 June to 3 July the axis was also not so away from the station except on 3 July when it was close to the Barisal station and this time rainfall was moderately heavy to heavy. From 4 July to 21 August the anticyclonic axis of 200 hPa level was clearly far away from the station but we observed moderate to moderately heavy rainfall in this time. For rest of the days of the monsoon the axis was close to the station but signification rainfall observed over the Barisal station.

The positions of anticyclonic axis at 200 hPa level and the daily rainfall in the monsoon season of 2002 over Barisal station are shown in Fig. 2(d). During 5-21 June the axis position was close to the station and the rainfall was heavy to very heavy over the station. From 22 June to 13 September the axis was far away from the station and the rainfall occurred almost all this time over the Barisal station and very heavy rainfall observed on 30 June and 1 July and heavy rainfall observed on 21 July. During 20-28 September the rainfall occurred everyday over the station and this time the anticyclonic axis was more or less near the station.

From the above discussion we can conclude that in the monsoon season of 1998, 2000, 2001 and 2002 the rainfall occurred when the axis came close to the Barisal station except in 2nd half of July of 2000 and 1st half of September of 2002 when the anticyclonic axis was away from the station but rainfall occurred over the station. When the anticyclonic axis continuously moved from north to south then there was rain in that duration over the Barisal station.

3.4.3 Relation between rainfall and axis position w.r.t. Chittagong Station

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 1998 over Chittagong station are shown in Fig. 3(a). During 2-22 June the axis came near the station many times but rainfall was about zero in that duration but moderately heavy rainfall occurred on 3, 9 and 21 June and for each of the three days the axis was away from the station. From 2 July to 31 August rainfall was moderately heavy,

heavy and very heavy over the station but this time the axis was clearly away from the Chittagong station except on 13 July when it came close to the station. The anticyclonic axis moved continuously from north to south from 26 August to 7 September and very heavy rainfall occurred on 29 August. Throughout the month of September the axis was not so far away from the station but light to moderate rainfall occurred this time over the Chittagong station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2000 over Chittagong station are shown in Fig. 3(b). During 2-12 June the rainfall was moderately heavy, heavy and very heavy but the axis of anticyclone on 1 and 5 June was very close to the Chittagong station. We observed heavy rainfall on 4 and 8 June and very heavy rainfall on 11, 12 June but in that days the axis was away from the station. On 14 and 15 June the axis was just over the station but there was no rain over the station. On 24 June the rainfall was very heavy and the axis was near the station but during 17-20 and 23, 24 July and 1-4 August the rainfall was moderately heavy, heavy and very heavy and the axis was far away from the station in this time. The anticyclonic axis moved continuously from north to south during 27-31 July and heavy to very heavy rainfall occurred on 1-4 August. During 15, 16 August the rainfall was heavy over the Chittagong station but the axis was far away from the station. The axis moved continuously north to south from 11 to 19 September but we observed moderate rainfall on 17 September.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2001 over Chittagong station are shown in Fig. 3(c). During 2-8 June there was continuous rainfall over the station in which on 2 June the axis was over the station and on 6 and 10 June the axis was very close to the station. During 14-21 June the rainfall was moderately heavy, heavy and very heavy and this time the axis crosses the station from south to north and always away from the station. We observed heavy rainfall on 1 July and at that time the anticyclonic axis moved north to south and on 3 July it came close to the Chittagong station. From 9 July to 14 August rainfall occurred everyday in which on 20 and 31 July heavy rainfall but the anticyclonic axis of 200 hPa level was far away from the station. From 24 August to 3 September we observed rainfall everyday and this time the axis was near the station. During 11-30 September also there was rainfall occurred everyday but only on 24, 26, 27 and 30 September the axis was near the Chittagong station.

The upper air anticyclonic axis positions at 200 hPa level and daily rainfall in the monsoon of 2002 over Chittagong station are shown in Fig. 3(d). During 3-13 June rainfall was moderate and heavy and the axis of anticyclone was not so far from the station and on 5, 7, 10 and 13 June the axis was close to the station. During 19-21 June the axis was close to the station and on 21 June the rainfall was heavy. From then up to 24 August there was moderately heavy, heavy and very heavy rainfall occurred but the anticyclonic axis was away from the station. From 27 June to 3 July the axis was shifted from north to south continuously and from 29 June to 5 July the rainfall was moderately heavy, heavy and very heavy. During 16-21 July the axis moved from north to south continuously and 19-23 July there was also moderately heavy, heavy and very heavy rainfall. During 6-10 August again the axis continuously moved from north to south and on 9 August heavy rainfall occurred over the station. Also during 8-14 September the movement of the anticyclonic axis was continuously from north to south and on 15 September we observed moderately heavy rain over the Chittagong station. During 14-23 September the rainfall was light to moderate and the axis was near the station.

According to the above discuussion we can say that rainfall occurred over the station in every monsoon season of 1998, 2000, 2001 and 2002 when the anticyclonic axis was near the station except 2nd half of July of 2000, last half of July and 1st half of August of 2001 and 1st half of September of 2002 when the axis was away from the station but rainfall occurred. Also when the anticyclonic axis moved from north to south continuously then we observed rainfall at the end of that duration over the station.

3.4.4 Relation between rainfall and axis position w.r.t. Comilla Station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Comilla station are shown in Fig. 4(a). During 1-9 June there was no rain over the Comilla station except on 3 June but on 6 June the anticyclonic axis was very close to the station. On 10, 13 and 23 June the axis was over the station and the rainfall was moderately heavy, light and moderate respectively on those days. Rest of the days of the month of June many times the anticyclonic axis came near the station but rain was about zero. On 13 July the axis came very close to the station and heavy to very heavy rainfall occurred during 12-17 July. During 1-24 July the rain was moderately heavy, heavy and very heavy though the -anticyclonic axis at 200 hPa level was away from the Comilla station. We observed daily rainfall from 8 August to 20 September and

in this duration the axis was near the Comilla station on 14 August, 2, 4, 11 and 14 September. On 19 September the axis of anticyclone was far away from the station but the rainfall was very heavy which was about 170 mm. During 21-26 September the axis was clearly away from the station and there was no rain at that time.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2000 over Comilla station are shown in Fig. 4(b). During 5-27 June the axis was more or less near the station and rainfall occurred on everyday out of which heavy rainfall was observed on 10 and 24 June. From 28 June to 6 July there was no rain over the station and this time the axis was clearly away from the Comilla station. Though during 9-11 July the axis was near the station and this time there was no rain but rainfall occurred everyday during 12-24 July and in which time the axis was away from the Comilla station. From 27 July to 3 August the upper air anticyclonic axis moved from north to south continuously and on 1-3 August moderately heavy, heavy rainfall occurred over the Comilla station in the year 2000. During 25-31 August rainfall occurred on 30 August when the axis came very close to the station. During 8-10 September the axis was close to the station and 9-10 September rainfall occurred over the Comilla station. During 14-19 September axis moved continuously from north to south and on 18 September the rainfall was moderately heavy over the station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2001 over Comilla station are shown in Fig. 4(c). During 1-8 June the rainfall was moderately heavy, heavy and very heavy over the station and the axis was at the south but more or less near the station. During 13-20 June also the rainfall was moderately heavy, heavy and very heavy but only on 12 and 14 June the axis was near the station. The rainfall occurred everyday from 26 June to 8 August and this time the axis was far away from the station except on 29 June and 3 July when it was close to the station. During 24-29 August the axis was more or less near the station and this time the rainfall was moderate, moderately heavy and heavy over the station. During 14-17 September the anticyclonic axis moved from north to south and on 17 September it came very close to the station and during 16-19 September there was moderately heavy to very heavy rainfall occurred over the Comilla station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2002 over Comilla station are shown in Fig. 4(d). The axis of anticyclone was

near and sometimes very close to the station from 5 to 21 June but moderately heavy rainfall occurred on 1, 7, 12 and 15 June and very heavy rainfall occurred on 13 June. During 19-21 June the axis was very close to the station but this time it was about rainless. The axis moved from north to south continuously from 27 June to 3 July and moderately heavy to heavy rainfall occurred from 27 June to 10 July over the Comilla station. During 16-21 July also the axis moved continuously from north to south and we observed moderately heavy, heavy and very heavy rain during 19-25 July. During 9-23 August the axis was more or less near the station and the rainfall occurred everyday with few exceptions. From 24 August to 10 September the axis was clearly far away from the station but rainfall also occurred during this time. During 11-30 September more or less the axis was close to the station but no significant rain was there over the station.

We can say from the above discussion that during the monsoon seasons of 1998, 2000, 2001 and 2002 rainfall occurred over the station when the axis was near the station except the month of July of 1998, 2000 and 2001 and August of 2000 when the axis was away from the station but rainfall occurred over the station. The duration's when the anticyclonic axis moved continuously from north to south then rainfall also occurred in that duration's over Comilla station.

3.4.5 Relation between rainfall and axis position w.r.t. Dinajpur Station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Dinajpur station are shown in Fig. 5(a). During 1-18 June no rainfall occurred over the station in which on 1-10 June the axis of anticyclone was at the south and moves towards the Dinajpur station. From then up to 25 July the axis was more or less near the station and often it was very close to the station, this time we observed moderate to heavy rainfall. Though on 2 August there was very heavy rainfall but on that day the axis was moving away and at the north of the station. On 14 August the anticyclonic axis was very close to the station and moderate, moderately heavy and heavy rainfall occurred during 10-17 August over the station. From 27 August to 6 September the axis moved from north to south continuously and also from 29 August to 3 September it was very close to the station and we observed moderate, moderately heavy and heavy rainfall from 29 August to 5 September over the Dinajpur station. Again on 27 and 28 September the axis of anticyclone was very close to the station and moderate and heavy rainfall occurred respectively over the station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 2000 over Dinajpur station are shown in Fig. 5(b). During 1-28 June the rainfall was moderate, moderately heavy, and heavy and this times the axis was more or less close to the station. From 30 July to 12 August the axis of anticyclone was close to the station and we observed moderate and moderately heavy rainfall from 26 July to 15 August. During 16-30 September the axis was at the south and far away from the Dinajpur station but we observed moderate and moderately heavy rainfall during 17-21 September over the station. Also during 27-31 July and 14-19 September the movement of the anticyclonic axis was continuous from north to south and this time moderate to moderately heavy rainfall occurred over the Dinajpur station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2001 over Dinajpur station are shown in Fig. 5(c). During 1-8 June the rainfall was moderate, heavy and very heavy and this time the axis was at the south and away from the Dinajpur station. During 14-20 June we observed moderate, moderately heavy and very heavy rain and this time the anticyclonic axis was near the station. Though from 21 June to 7 July it was about rainless but this time the axis was also near the station. From 8 July to 5 August the axis was away from the station except on 15 July and light to moderate rainfall occurred over the station. Again from 22 August to 17 September the rain was moderate to very heavy and the anticyclonic axis was near the station during this time. During 29-30 September moderate rainfall occurred and the axis was at the south and away from the Dinajpur station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2002 over Dinajpur station are shown in Fig. 5(d). During 1-4 June the upper air anticyclonic axis was at the south and moving towards the station but this time moderate to heavy rainfall occurred over the Dinajpur station. From 11 June to 24 August the axis was more or less close to the station when moderate, moderately heavy, heavy and very heavy rainfall occurred frequently over the station. From 25 August to 13 September there was no rain over the station and this time the axis of anticyclone was clearly away from the station. For all the duration of continuous movement from north to south of the anticyclonic axis there was significant rainfall over the station. During 24-25 September very heavy rainfall occurred over Dinajpur station but this time the axis was not near the station. On 27 September the axis was over the station and heavy rainfall occurred on that day over the station.

From the above discussion we can say that in the monsoon seasons of 1998, 2000, 2001 and 2002 rainfall occurred when the anticyclonic axis was near the station except 1st week of June of 2001 and 2002 when rainfall occurred but the axis was away from the station. Also we observed rainfall during the continuous movement of the axis from north to south.

3.4.6 Relation between rainfall and axis position w.r.t. Khulna Station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Khulna station are shown in Fig. 6(a). During 1-19 June we observed rainfall only on 3, 10 and 15 June in which the rain was moderately heavy at 10 June and on 15 June it was moderate over the station and the anticyclonic axis was near the station on those days. From 20 June to 13 September moderate to moderately heavy rainfall occurred frequently over the station and heavy to very heavy rainfall occurred on 11 and 12 July but the axis came close to the station only on 25 June, 13 July, 14 August and for some days in the 1st half of September. The axis moved continuously from north to south from 26 August to 6 September and moderate to heavy rainfall occurred at that time.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 2000 over Khulna station are shown in Fig. 6(b). The axis was very close to the station on 5, 13, 14 and 23 June and 9 July and the frequent rainfall occurred from 4 June to 24 July. For rest of the days in this duration the axis was away and far away from the station. During 21-24 July we observed moderate to very heavy rainfall over the station and this time the axis was far away from the station. From 26 July to 1 August the anticyclonic axis moved from north to south continuously and moderately heavy rainfall occurred on 1 August. During 18-26 August there was no rain over the station and this time the axis was clearly away from the station. On 30 August the axis was near the station and on 30-31 August there was very heavy and heavy rainfall respectively over Khulna station. During 8-10 September the axis was close to the station but light rainfall occurred at that time. During 14-19 September the axis moved from north to south continuously and 18, 19 September there was heavy and very heavy rainfall respectively over the station. During 23-30 September there was no rain and this time the anticyclonic axis was at the south of Khulna station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2001 over Khulna station are shown in Fig. 6(c). During 3-6 June we observed light to moderately heavy rainfall over the station and this time the anticyclonic axis was at the south and near the station. During 12-15 June the axis was oscillatory about the station and was not so near the station but this time moderate, moderately heavy and heavy rainfall occurred over the station. From 4 July to 21 August the anticyclonic axis was clearly away from the station but this time light to moderate rainfall occurred frequently over the Khulna station. During 22-28 August the axis was near the station and we also observed moderate and moderately heavy rainfall in that time over the station. From 30 August to 4 September again the axis went away and the rainfall was about zero at that time. On 17 September the axis was very close to the station and we observed very heavy rainfall on that day. During 20-30 September the axis was more or less near the station but this time there was no rain over the Khulna station except on 30 September when light rain occurred.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2002 over Khulna station are shown in Fig. 6(d). We observed moderate, moderately heavy and heavy rain during 2-4 June and this time the axis was at the south and away from the station. During 7-13 June the rainfall was moderate, moderately heavy, heavy and very heavy and this time the axis was at the north and near the station. During 15-21 June the axis was at or near the north but no rain occurred during 16-20 June over the station. From 22 June to 10 September the axis was not near the station but moderate, moderately heavy and heavy rain occurred frequently over the station at that time. The axis moved from north to south continuously from 27 June to 3 July and this time the rainfall was moderate, moderately heavy and heavy over the station. Also on 9-15 September we observed that the axis was moving continuously from north to south and moderate, moderately heavy and heavy rainfall occurred over the station at this time.

From the above discussion we can say that except 2nd half of July of 1998 and 2000 and 1st half of August of 2001 rainfall occurred over the Khulna station when the anticyclonic axis was near the station for every monsoon season of 1998, 2000, 2001 and 2002. Also we observed that when the axis moved from north to south continuously the rainfall occurred at the ends of that duration's over the station.

3.4.7 Relation between rainfall and axis position w.r.t. Mymensingh Station

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 1998 over Mymensingh station are shown in Fig. 7(a). On 1 June the rain was heavy but the axis was at the south and far away from the station. During 2-25 July the rainfall was moderate, moderately heavy, heavy and very heavy over the station and this time the axis was not so far away from the station. During 26-31 July there was no rain over the station and this time the axis was clearly away from the station. From 1 August to 20 September there was frequently moderate, moderately heavy and heavy rain over the station and this time the axis of anticyclone was not so far away from the station. From 26 August to 2 September the axis moved continuously from north to south and also this time the rain was moderate and moderately heavy over the station. During 27-30 September the axis came close to the station but no rain occurred over the station at that time. It is also observed that when the axis was close to the station or moves towards the station then heavy to very heavy rainfall occurred at that time.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2000 over Mymensingh station are shown in Fig. 7(b). From 4 June to 1 July frequently we observed moderate, moderately heavy and heavy rain over the station and the axis was more or less near the station. During 18-27 August there was no rain over the station and this time the axis was clearly away from the station. During 16-30 September the axis was clearly away and at the south of the station but we observed moderate, moderately heavy and heavy rain during 16-26 September over the station. During 25-31 July the axis moved continuously from north to south and we observed moderate rainfall at that time over the station. Also during 14-19 September the axis of anticyclone moved from north to south continuously and moderate, moderately heavy and heavy rainfall occurred over the station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 2001 over Mymensingh station are shown in Fig. 7(c). During 1-7 June the rainfall was moderate, moderately heavy, heavy and very heavy over the station but the axis was at the south and away from the station. During 11-20 June the rainfall was moderate, moderately heavy and heavy and the axis was more or less near the station. Rainfall occurred frequently from 6 July to 14 August but the axis was away from the station except on 15 July. From 25 August to 18 September there was moderate, moderately

heavy, heavy and very heavy rainfall over the Mymensingh station and the axis was more or less close to the station at that time.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2002 over Mymensingh station are shown in Fig. 7(d). From the starting day of the monsoon season to 2 August we observed moderate, moderately heavy, heavy and very heavy rainfall frequently over the station for this long duration the anticyclonic axis was near the station except very few days. From 27 June to 3 July the axis moved from north to south continuously and this time moderate and moderately heavy rainfall occurred over the station. During 3-9 August there was no rain and the axis was clearly far away from the station. From 27 August to 19 September also there was no rain and we see that during 27 August to 9 September the anticyclonic axis was at the north and far away from the station but on 10–16 September it was close to the station. During 20-30 September we observed moderate, moderately heavy and heavy rainfall and this time the upper air anticyclonic axis was at the south and also close to the station. During 16-25 July the axis moved continuously from north to south and this time there was light and moderate rain over the station and again on 9-14 September the axis also continuously moved from north to south but this time no rain was there over Mymensingh station.

From the above discussion we conclude that for every monsoon season of 1998, 2000, 2001 and 2002 rainfall occurred over the station when the axis was near the station only except 2nd half of July of 2001 when rainfall occurred over the station but the axis was away from the station. When the axis moved continuously from north to south then rainfall occurred over the station at that duration's.

3.4.8 Relation between rainfall and axis position w.r.t. Rajshahi Station

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 1998 over Rajshahi station are shown in Fig. 8(a). During 1-10 June the axis was at the south and away from the station and this time there was no rain over the station. During 12-25 June the anticyclonic axis was more or less near the station and we observed moderate and moderately heavy rainfall on 13 and 19-27 June over the station. From 27 June to 22 August the axis was away from the station except on 14 August but during 3-23 July and from 29 July to 18 August the rainfall was moderate, moderately heavy and heavy and continuous over the station. From 26 August to 6 September the anticyclonic

axis moved continuously from north to south and this time we observed moderate and moderately heavy rainfall over the Rajshahi station. On 24 August the rainfall was heavy but on that day the axis was far away from the Rajshahi station. We observed moderate, moderately heavy and heavy rainfall from 28 August to 21 September and most of this time the axis position was oscillatory about the station and only few days the axis was close to the station. In the duration of 22-30 September only on 28 September the axis was close to the station and moderate rainfall occurred only on that day over the Rajshahi station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2000 over Rajshahi station are shown in Fig. 8(b). During 4-26 June moderate and moderately heavy rainfall occurred frequently over the station and this time the anticyclonic axis was more or less close to the station. From 9 July to 19 August light, moderate and moderately heavy rainfall occurred sometimes but during this period only during 9-11 July, 12-31 July and 1-12 August the axis was near the station, away from the station and more or less near the station respectively. On 30 August the axis of anticyclone was very close to the station and we observed very heavy rainfall on 31 August. From then up to 23 September there was moderate, heavy and very heavy rainfall occurred frequently over the station and this time from 30 August to 17 September the axis was more or less close to the station. During 24-30 September there was no rain over the station and this time the anticyclonic axis was at the south and away from the Rajshahi station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2001 over Rajshahi station are shown in Fig. 8(c). On 2 June the axis was at the south but close to the station and heavy rainfall occurred on 3 June. Moderate, moderately heavy, and very heavy rainfall occurred during 14-20 June and this time the axis was near the station. From 21 June to 8 July the axis was close to the station but except on 30 June there was no significant rain over the Rajshahi station. During 9-23 July moderate, moderately heavy, and very heavy rainfall occurred and this time the upper air anticyclonic axis was far away from the station except on 15 July when the anticyclonic axis was near the station. Also moderate and heavy rainfall occurred from 28 July to 2 August and this time the anticyclonic axis was far away from the station. From 25 August to 12 September the axis was near the station and rainfall was moderate and

moderately heavy over the station. During 18-30 September the rainfall was zero but on 24, 25, 28 and 29 September the axis was very close to Rajshahi station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2002 over Rajshahi station are shown in Fig. 8(d). From 7 June to 6 July moderate, moderately heavy and heavy rainfall occurred frequently and the anticyclonic axis was close to the station. During 7-12 July the axis was near the station but there was no rain over the station whereas during 13-20 July the axis was far away but moderate and moderately heavy rainfall occurred at that time. On 21 and 28 July moderately heavy rainfall occurred and on that days the axis were close to the station whereas on 1-9 August the axis was far away but only 3-4 August we observed rainfall over the station. During 10-23 August the anticyclonic axis was near and moderate, moderately heavy and heavy rainfall occurred this time over the station. From 24 August to 9 September the axis was far away but on 27 August and 4 September the rainfall was moderately heavy and heavy over the station respectively. During 12-19 September there was no rain occurred but this time axis was near the station. During 22-29 September the axis was near and moderate, moderately heavy and heavy rainfall occurred over the station. From 27 June to 3 July, 16-21 July and 9-14 September the anticyclonic axis moved from north to south continuously and significant rainfall occurred during this period over the station.

For Rajshahi station in the monsoon season of 1998, 2000, 2001 and 2002 we observed that when the axis was near the station then rainfall occurred over the station with some exceptions. The exceptions are the month of August of 1998, 2nd half of July of 2000 and July and August of 2001 when the axis of anticyclone was away from the station but rainfall occurred over the Rajshahi station at that duration's. When the anticyclonic axis moved continuously from north to south then significant rainfall occurred in that duration's.

3.4.9 Relation between rainfall and axis position w.r.t. Sreemangal Station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Sreemangal station are shown in Fig. 9(a). During 1-10 June we observed moderate, moderately heavy and heavy rainfall over the Sreemangal station but this time the anticyclonic axis was not so near whereas on 11-19 June the axis was near and no rainfall occurred this time over the station. From 22 June to 16

September moderate, moderately heavy, heavy and very heavy rainfall occurred frequently and during 22-28 June, 12 and 13 July, 16 August and from 31 August to 16 September the upper air anticyclonic axis was near the station. During 17-27 September there was no rain over the station and this time the axis was away from the station only except on 20 September. On 28 September the anticyclonic axis was very close to the station and moderate rainfall occurred on that day. From 26 August to 2 September and 3-7 September the axis moved continuously from north to south and these times more or less rainfall occurred over Sreemangal station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2000 over Sreemangal station are shown in Fig. 9(b). From 1 June to 8 July there was moderate, moderately heavy and heavy rain, which was frequent and this time the axis was more or less near the station. During 27-31 July the anticyclonic axis moved from north to south continuously and on 1 August we observed very heavy rainfall over the station. From 30 July to 13 August the anticyclonic axis was near and moderate, moderately heavy, heavy and very heavy rainfall occurred frequently over the station. During 14-26 August the axis was clearly away and this time there was light rain over the station. From 27 August to 18 September the axis was near the station when moderate, moderately heavy and heavy rainfall occurred over Sreemangal station. During 14-19 September the axis moved continuously from north to south and this time we observed moderate, moderately heavy and heavy rainfall over the station. During 19-30 September it was about rainless except on 26 September and this time the axis was at the south and away from the station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2001 over Sreemangal station are shown in Fig. 9(c). During 1-11 June the anticyclonic axis was at the south but this time we observed moderate, moderately heavy, heavy and very heavy rainfall over the station. From 12 June to 3 July the position of anticyclonic axis was more or less near and north of the station and this time light to moderate rainfall occurred over the station in which on 22 June it was very heavy. From 4 July to 21 August the axis was far away except on 15 July and 17 August but this time moderate, moderately heavy and heavy rainfall occurred frequently over the station. From 22 August to 30 September the axis was near and moderate, moderately heavy and heavy rainfall occurred but during 6-16 and 21-28 September the rainfall was

light over the station. In the monsoon season of 2001 light to heavy rainfall occurred 72 days and 30 days were rainless over the station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 2002 over Sreemangal station are shown in Fig. 9(d). During 3-24 June there was moderate, moderately heavy and heavy rain observed and this time the axis of anticyclone was near the station. From 3 July to the end of the season we observed moderate, moderately heavy, heavy and very heavy rainfall frequently with few exceptions and in this long duration most of the time the axis was more or less near the station except 12-18 July, 1-8 August and from 30 August to 9 September when it was far from the Sreemangal station. From 27 June to 3 July, 15-20 July, 6-10 August and 8-14 September the anticyclonic axis moved from north to south continuously but for every of this duration there was rain over the Sreemangal station.

For the Sreemangal station in the monsoon season of 1998, 2000, 2001 and 2002 rainfall occurred over the station when the anticyclonic axis was near except 2nd half of august of 1998 and 1st half of September of 2002 when rainfall occurred over the station but the axis was away from the station. In 2001 we see that 1st half of June and from 16 July to 16 August rainfall occurred but the axis was away from the station at that time.

3.4.10 Relation between rainfall and axis position w.r.t. Sylhet station

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 1998 over Sylhet station are shown in Fig. 10(a). During 1-8 June the rainfall was moderate, moderately heavy, heavy and very heavy and this time the axis was at the south and far from the station except on 6 June. From 9 June to 14 July the axis was near the station and moderate, moderately heavy and heavy rainfall occurred almost everyday over the station. We observed moderately heavy, heavy and very heavy rainfall during 20-25 July and this time the axis was near the station. During 23-27 August the axis was far from the station but moderate, moderately heavy and heavy rainfall occurred this time over the Sylhet station. During 6-9 September the rainfall was about zero and this time the axis was away from the station. This year the anticyclonic axis was more or less near the Sylhet station and 85 days light to very heavy rainfall occurred and only 17 days were rainless over the station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon season of 2000 over Sylhet station are shown in Fig. 10(b). From 1 June to 14 July the

axis was near the station and moderate, moderately heavy, heavy and very heavy rainfall occurred almost regularly over the station in which very heavy rainfall observed on 12 June. During 20-29 July the axis was away and light rain occurred at that time over the station. From 30 July to 20 August also moderate, moderately heavy, heavy and very heavy rainfall occurred and this time the axis was near the station. During 22-30 September the axis was at the south and clearly far from the station but very heavy rainfall occurred on 25 September over the Sylhet station.

The positions of anticyclonic axis at 200 hPa level and daily rainfall in the monsoon season of 2001 over Sylhet station are shown in Fig. 10(c). During 1-9 June there was moderate, moderately heavy and very heavy rainfall occurred but this time the anticyclonic axis was at the south and far from the station. From 10 June to 2 July the axis was near and moderate, moderately heavy and very heavy rainfall occurred frequently over the station. From 5 July to 21 August the axis was at the north and far from the station except on 15 July and 17 August but this time we observed moderate, moderately heavy, heavy and very heavy rainfall over the station. Rest of the days of the season the axis was more or less near the station and we observed moderate, moderately heavy and heavy rainfall over the Sylhet station.

Anticyclonic axis position at 200 hPa level and daily rainfall in the monsoon of 2002 over Sylhet station are shown in Fig. 10(d). During 1-7 June the axis was at the south and far from the station and in this time on 6 June we observed very heavy rain over the station which was about 180 mm. During 12-18 July and 1-8 August the axis was at the north and far from the station but moderate, moderately heavy, heavy and very heavy rainfall occurred this time over the Sylhet station in which on 2 August the rainfall was about 450 mm. From 24 August to 9 September the axis was at the north and far from the station and rainfall was about zero except on 30 August and 1 September. From 10 September to the end of the season the axis of anticyclone was near the station but rainfall occurred during 15, 16 and 21-30 September which were moderate, moderately heavy, heavy and very heavy over the station. On 16 and 27, 28 September the upper air anticyclonic axis was very close to the station and moderate rainfall occurred at that time over the Sylhet station.

From the above discussion for the Sylhet station the 1st half of June of 1998, 2001 and 2002 the axis was far from the station but rainfall occurred over the station in that

duration's. For rest of the time of every monsoon season of 1998, 2000, 2001 and 2002 we observed rainfall over the station when the anticyclonic axis was near the Sylhet station. For all the duration's when the axis moved continuously from north to south we observed rainfall at that duration's. We also observed some exceptional rainfall over the Sylhet station, which are, on 12 June of 2000 when the rainfall was about 360 mm and on 2 August of 2002 when it was about 450 mm over the station.

3.5 Relation between rainfall and anticyclonic axis position at 300 hPa level

3.5.1 Relation between rainfall and axis position w.r.t. Dhaka Station

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 1998 over Dhaka station are shown in Fig. 11(a). During 1-9 June the axis was at the south and away from the station and rainfall was about zero over the station at that time. On 10 and 12 and 13 June the axis of anticyclone was near the station and moderate rainfall observed on 10 and light rain on 13 June over the station. During 14-22 June there was no rain and also the axis was away from the station. During 4-20 July the anticyclonic axis was more or less near the station and this time we observed moderate, moderately heavy and heavy rainfall frequently over the station. From 21 July to 12 August the axis was away from the station but this time we observed moderately heavy rainfall on 2 August and moderate rainfall on 10 August. During 11-17 August we observed very heavy rainfall on 12,13 and 17 August over the station and these time the axis was more or less near the station. During 18-31 August the axis was away from the station and heavy rainfall observed on 23 August over the station. During 1-20 September the axis came close to the station and we observed moderate and moderately heavy rainfall frequently over the station. During 22-26 September there was no rain and this time the axis was clearly away from the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2000 over Dhaka station are shown in Fig. 11(b). During 1-25 June the axis was near the station and rainfall occurred at 6-11 and 16-24 June over the station. We observed moderate, moderately heavy and heavy rainfall during 6-26 July over the station but this time the anticyclonic axis at 300 hPa level was away from the station. During 1-4 August the axis was near the station and 1 and 2 August the rainfall was very heavy over the station. During 5-30 August the axis was not so near the station and this time we observed light rain over the station except 13 and 14 August when it was moderately heavy. During 14-20 September there was moderate and moderately heavy rainfall the station and this

time the anticyclonic axis was not so away from the station. During 24-29 September there was no rain over the station and this time the axis was at the south and away from the Dhaka station except 29 September.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2001 over Dhaka station are shown in Fig. 11(c). During 2-20 June the rainfall was moderate, moderately heavy and heavy everyday but this time only few days the upper air anticyclonic axis was near the station. From 5 July to 17 August the anticyclonic axis at 300 hPa level was at the north and far away from the station but 11-13 July there was moderate rain and from 20 July to 17 August the rainfall was moderate, moderately heavy and heavy over the station. From 18 August to the end of the season the anticyclonic axis was more or less near the station and also moderate, moderately heavy and heavy rainfall occurred over the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2002 over Dhaka station are shown in Fig. 11(d). During 1-7 June the anticyclonic axis was at the south and away from the station but moderate, moderately heavy and heavy rainfall occurred this time over the station. From 8 June to 12 July the axis position was more or less near the station and this time there was moderate, moderately heavy and heavy rainfall occurred frequently over the station. During 13-20 July the axis was at the north and far away from the station and this time we observed light rain over the station. During 21-31 July the axis was near the station and heavy, moderate and moderately heavy rainfall occurred on 21, 24 and 28 July respectively. During 3-9 August the axis was also at the north and far away from the station and daily rainfall was about zero over the station. During 12-21 August the axis was near the station and moderate and heavy rainfall occurred this time over the station. From 22 August to 8 September the axis was at the north and far away form the station and only few days light to moderate rainfall occurred over the station.

From the above discussion we can say that in 1998 rainfall occurred when the anticyclonic axis was near the station except last week of July and 1st week of august. In 2000 except in the month of July rainfall occurred over the station when the axis was near the station. In 2001 during the last half of July and 1st half of August there was rain over the station but the anticyclonic axis was away from the station. Rest of the time of the monsoon of 2001 rainfall occurred when the axis was near the station. In 2002 except the

1st week of September rainfall occurred over the Dhaka station when the axis was near the station.

3.5.2 Relation between rainfall and axis position w.r.t. Barisal Station

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 1998 over Barisal station are shown in Fig. 12(a). During 1-12 June we observed no rain when the axis was at the south and away from the station except on 10 June. We observed moderate, moderately heavy, heavy and very heavy rainfall frequently from 13 June to 18 August and this time only during 13-19 June, 4-14, 20th July and 13-15 August the anticyclonic axis was near the station. During 19-28 August we observed light rain when the axis was clearly away and at the north of the station. During 1-12 September the axis was more or less near the station and this time light to moderate rainfall occurred and heavy rainfall occurred on 9 September over the station. During 13-26 September the station was about rainless when the axis was at the north and away from the station except on 16 and 20 September.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2000 over Barisal station are shown in Fig. 12(b). During 6-25 June we observed moderate, moderately heavy and heavy rainfall over the station when the axis position was north and near the station. From 26 June to 7 July there was no rain over the station and the axis was clearly away and at the north of the station. From 8 July to 2 August again we observed moderate, moderately heavy and heavy rainfall frequently over the station when the axis was at the north and far away from the station. During 16-27 August the station was about rainless when the axis was clearly away and at the north of the station. During 8-30 September the axis was more or less near the station but light to moderate rainfall occurred during 17-20 September over the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2001 over Barisal station are shown in Fig. 12(c). From 1 June to 4 July the axis position was oscillatory and near the station and this time we observed moderate, moderately heavy and heavy rainfall over the station. From 5 July to 17 August the anticyclonic axis was at the north and far away from the station but from 9 July to 8 August we observed moderate to moderately heavy rainfall except 10, 28 and 29 July where heavy to very heavy rainfall over the station. From 23 August to 30 September the axis was more or less close to the station and also light to moderate rainfall occurred this time over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Barisal station are shown in Fig. 12(d). During 1-6 June we observed light rain over the station when the anticyclonic axis was at the south of the station. From 7 June to 23 August we observed moderate, moderately heavy and heavy rainfall except 30 June and 1 July where very heavy rainfall over the station and this time during 13-18 July and 1-9 August the axis position was far away from the Barisal station when the rain was moderate and moderately heavy. From 22 August to 8 September the axis was at the north and clearly away from the station but light to moderate rainfall also occurred over the station this time. During 22-28 September we observed light to moderately heavy rainfall over the station when axis was at the south but near the station.

We observed that in 1998 when the anticyclonic axis at 300 hPa level was near the station then rainfall occurred over the station except 1st half of August when moderate to very heavy rainfall occurred over the station but the axis was away from the station. In 2000 during 8-31 July we observed moderate to heavy rainfall but the anticyclonic axis was far away from the station. In 2001 for the month of July and 1st half of August rainfall occurred when the axis was away from the station. In 2002 we observed all through the season that when the axis came closer to the station then rainfall occurred.

3.5.3 Relation between rainfall and axis position w.r.t. Chittagong Station

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 1998 over Chittagong station are shown in Fig. 13(a). From 1 June to 1 July most of the days were rainless in which only on 3, 7, 9 and 18-21 June we observed light to moderately heavy rainfall over the station and in this duration only 5, 10 and 12 June the axis was close to the station and during 14-20 June it was away from the station. From 2 July to 31 August we observed moderate to very heavy rainfall frequently over the station and during 4-15 July the anticyclonic axis was more or less near the station and from 25 July to 12 August the axis was far away from the station. During 1-30 September most of the days the axis was near the station and light to moderate rainfall occurred for most of the days over the station and moderately heavy rainfall occurred only on 29 September.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2000 over Chittagong station are shown in Fig. 13(b). During 1-25 June the upper air anticyclonic axis was more or less near the Chittagong station and the

rainfall was moderate, moderately heavy, heavy and very heavy over the station. During the period from 17 July to 4 August also we observed moderate, moderately heavy, heavy and very heavy rainfall frequently over the station but this time the axis was far away from the station except on 1-4 August. This time from 27 July to 3 August the anticyclonic axis moved from north to south continuously and 1-4 August the rainfall was heavy to very heavy over the station. During 18-28 August there was no rain over the station and this time the axis was at the north and clearly away from the station. From 29 August to 30 September the axis was more or less near the station but only from 29 August to 8 September we observed moderate to moderately heavy rainfall over the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 2001 over Chittagong station are shown in Fig. 13(c). During 2-8 June we observed moderate rainfall in which only on 3 June it was heavy over the Chittagong station and this time the anticyclonic axis at 300hPa level was near the station. During 14-21 June the rainfall was moderate to very heavy but this time the axis was away from the station. Again from 9 July to 14 August we observed moderate to heavy rainfall frequently over the station and this time the axis was at the north and far away from the station. From 24 August to 30 September the anticyclonic axis was more or less near the station and also moderate to heavy rainfall occurred frequently over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Chittagong station are shown in Fig. 13(d). From 2 June to 2 July the anticyclonic axis was near the station and this time on some day moderate to very heavy rainfall occurred over Chittagong station. From 3 July to 12 August the axis was at the north and away from the axis except on 12 and 22 July but on 19-23 July moderately heavy to very heavy rainfall occurred over the station. During 16-22 July the axis moved from north to south continuously and 19-23 July the rainfall was moderately heavy to very heavy. During 13-19 August the axis was near the station and moderate to heavy rainfall occurred over the station. From 23 August to 30 September the rainfall was light to moderately heavy for few days only and in this duration from 23 August to 8 September the axis was at the north and far away from the station and rest of the days it was more or less near the station. During 7-13 August the axis moved continuously from north to south but we observed heavy rainfall 14-17 August over the Chittagong station.

According to the above discussion every monsoon season of 1998, 2000, 2001 and 2002 rainfall occurred most of the days over the station when the upper air anticyclonic axis was near the station with some exceptions. The exceptions are: the 1st half of August of 1998 when the axis was away from the Chittagong station but we observed for few days very heavy rainfall over the station, the month of July of 2000 when the axis was far away from the station but in this time moderate to very heavy rainfall occurred over the Chittagong station, most of the days of July and 1st half of August of 2001 when we observed moderate to heavy rainfall occurred over the station but the axis was away from the station and 1st week of August of 2002 when moderate to heavy rainfall occurred over the station but the axis was not near the station.

3.5.4 Relation between rainfall and axis position w.r.t. Comilla Station

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 1998 over Comilla station are shown in Fig. 14(a). During 1-9 June the anticyclonic axis was at the south and away from the Comilla station and this time the rainfall was about zero over the station. During 10-15 June when the axis was near the station light to moderate rainfall occurred on 12-14 June over the station. During 1-24 July the rainfall was moderate, moderately heavy, heavy and very heavy over the station when the axis was more or less near the station. From 25 July to 8 August there was no rainfall over the station when the axis was clearly away from the station. From 13 August to 20 September the rainfall was moderate, moderately heavy and heavy when the axis of anticyclone at 300 hPa level was more or less near the station except during 18-28 August. During 21-26 September there was no rain over the station when the axis was clearly away from the Comilla station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2000 over Comilla station are shown in Fig. 14(b). During 5-25 June the rainfall was moderate, moderately heavy and heavy over the Comilla station when the anticyclonic axis was close to the station. From 28 June to 11 July the rainfall was about zero over the station when the axis was at the north and clearly away from the station. During 12-24 July we observed moderate and moderately heavy rainfall over the station when the axis was far away from the station. From 27 July to 1 August the anticyclonic axis moved continuously from north to south and we observed moderately heavy to heavy rainfall during 1-4 August. From 17 August to 30 September we observed light to

moderate rainfall for few days and in this duration 1-16 September the anticyclonic axis was more or less near the Comilla station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 2001 over Comilla station are shown in Fig. 14(c). During 1-20 June we observed moderate, moderately heavy, heavy and very heavy rain over the Comilla station when the anticyclonic axis position was oscillatory and near the station. From 5 July to 17 August the axis was at the north and far away from the station but this time we observed moderate and moderately heavy rain over the station except 9-17 August. From 23 August to 19 September the anticyclonic axis was close to the station and we observed moderate, moderately heavy, heavy and very heavy rainfall over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Comilla station are shown in Fig. 14(d). During 1-7 June we observed moderate and moderately heavy rainfall over the Comilla station when the anticyclonic axis was at the south and away from the station. During 11-15 June the rainfall was moderate and very heavy over the station when the axis was close to the station. During 16-20 June there was no rain over the station but this time the axis was near the station. From 28 June to 31 July the axis was more or less near the station except during 13-20 July and this time we observed moderate, moderately heavy, heavy and very heavy rainfall over the station. During 1-10 August the axis was at the north and far away from the station but moderate rainfall occurred. During 13-19 August the axis was close to the station and moderate to moderately heavy rainfall occurred at that time. From 22nd August to 8 September the axis was at the north and far away from the station but light to moderate rainfall also occurred frequently over the station. During 9-30 September the anticyclonic axis was more or less near the station but light rain occurred frequently during 16-28 September in which moderately heavy rainfall observed only on 27 September.

According to the above discussion we can say that when the anticyclonic axis was near the station then rainfall occurred over the station and when it was far away from the station the rainfall was about zero over the station. But for 2nd and 3rd week of July of 2000 the axis was away from the station but we observed moderate rainfall. In the month of July of 2001 rainfall occurred frequently over the station but the axis was not so near the station. In 2002 in 1st and last week of August and 1st week of September the axis was

away from the station but rainfall occurred over the station at that time. Except these exceptions in every monsoon season of 1998, 2000, 2001 and 2002 we observed rainfall over the Comilla station when the axis was near the station.

3.5.5 Relation between rainfall and axis position w.r.t. Dinajpur Station

The upper air anticyclonic axis positions at 200 hPa level and daily rainfall in the monsoon of 1998 over Dinajpur station are shown in Fig. 15(a). During 1-18 June the rainfall was about zero over the station though 13-18 June the axis was near the station. From 18 June to 26 July we observed moderate, moderately heavy and heavy rainfall everyday over the station when the anticyclonic axis was more or less near the station. On 2 August we observed very heavy rainfall (180mm) over the station though the axis was not so near the station. The anticyclonic axis position was near but south from 1 to 5 September but heavy rainfall occurred during the period over the station. Where as 6-26 September the anticyclonic axis position was oscillatory and more or less close to the Dinajpur station but the rainfall was about zero over the station but heavy rainfall occurred on 27 September.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2000 over Dinajpur station are shown in Fig. 15(b). During 5-28 June we observed moderate, moderately heavy and heavy rainfall frequently over the Dinajpur station when the anticyclonic axis was more or less close to the station. From 29 June to 25 July the rainfall was about zero over the station when the axis was away from the station. From 26 July to 15 August also the rainfall was moderate, moderately heavy and heavy over the station when the axis was near the station. During 16-25 August there was no rain over the station but this time the axis was not far away from the station. From 30 August to 21 September moderate and moderately heavy rainfall occurred when the axis of anticyclone was more or less near the Dinajpur station. During 22-30 September there was no rain over the station when the axis was at the south and far away from the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2001 over Dinajpur station are shown in Fig. 15(c). During 1-8 June the rainfall was heavy and very heavy over the Dinajpur station when the axis of anticyclone was at the south and away from the station. During 14-20 June the rainfall was also moderate, moderately heavy and very heavy when the axis was not so far away from the station. From 21 June to 14 July the rainfall was about zero but this time the axis

was not so away from the Dinajpur station except 5-10 July. From 20 July to 5 August light to moderate and moderately heavy rainfall occurred over the station when the axis was at the north and away from the station. From 22 August to 12 September we observed moderate to very heavy rainfall over the station when the axis position was close to the station. During 18-28 September there was no rain over the station when the axis was at the south of the station but not so away from the Dinajpur station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 2002 over Dinajpur station are shown in Fig. 15(d). From 1 June to 24 August we observed moderate, moderately heavy, heavy and very heavy rainfall frequently over the station and this time the axis was more or less close to the station except 1-7 June and 1-9 August. From 25 August to 8 September the axis was at the north and away from the station except 3 September and at that time the rainfall was about zero over the station. During 20-30 September the anticyclonic axis was at the south and away from the Dinajpur station but we observed moderate to very heavy rainfall over the station.

From the above discussion we can say that rainfall observed over the Dinajpur station when the axis was near the station except 1st week of June and last week of September of 2002 when the axis was away from the station. Also in the 1st week of July of 2000 the axis was near the station but no rainfall observed at that time over the station.

3.5.6 Relation between rainfall and axis position w.r.t. Khulna Station

The upper air anticyclonic axis positions at 300 hPa level and daily rainfall in the monsoon of 1998 over Khulna station are shown in Fig. 16(a). During 1-9 June the rainfall was about zero over the station when the axis of anticyclone was at the south and away from the station. From 24 June to 15 July there was moderate to moderately heavy rainfall except 24 June, 12 and 13 July where heavy to very heavy rainfall occurred over the station when the axis was not so away from the Khulna station. From 21 July to 31 August the axis of anticyclone was at the north and far away from the station except 13 August but this time we observed light to moderate rainfall frequently over the station. During 14-30 September the rainfall was about zero except on 27 September when the axis was away from the station except on 16, 20 and 30 September.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2000 over Khulna station are shown in Fig. 16(b). During 1-25 June the axis of anticyclone was near the station and this time we observed light to moderate rainfall

frequently over the station. From 26 June to 2 August the axis was far away from the station but 7-24 July we observed light to very heavy rainfall everyday over the station. During 18-26 August there was no rain when the axis was clearly away from the station. Heavy to very heavy rainfall occurred on 30, 31 August and 18, 19 September when the anticyclonic axis was at the south of the station. During 23-30 September there was no rain when the axis of anticyclone was at the south of the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2001 over Khulna station are shown in Fig. 16(c). From 1 June to 3 July the axis of anticyclone was more or less near the station when frequently light to heavy rainfall occurred over the station. From 4 July to 16 August the axis was at the north and far away from the station but at that time light to moderate rainfall occurred sometimes over the station. From 18 August to 13 September the axis was more or less near the station and frequently light to moderately heavy rainfall occurred over the station at that time. During 18-30 September the rainfall was about zero when the axis was also near the station and on 17 September heavy rainfall occurred when the anticyclonic axis was at the south of the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2002 over Khulna station are shown in Fig. 16(d). During 2-13 June we observed moderate, moderately heavy, heavy and very heavy rainfall over the station when the axis was more or less near the station. During 14-20 June the rainfall was about zero but the axis was close to the station. From 21 June to 4 July there was moderate, moderately heavy, heavy and very heavy rainfall everyday but this time the axis was not so near the station. During 5-10 and 23-28 July there was no rain when the axis was at the north and moving away from the station, whereas during 13-20 July and 1-12 August the axis was away from the station but rainfall occurred at that time also. During 13-21 August the axis was near the station and light to heavy rainfall occurred frequently whereas from 22 August to 8 September moderate and heavy rainfall occurred but the axis of anticyclone was at the north and far away form the station. During 16-30 September the axis was at the south and near the station but moderate to heavy rainfall occurred during 22-27 September over the station.

Most of the time of every monsoon season of 1998, 2000, 2001 and 2002 rainfall occurred over Khulna station when the anticyclonic axis was near the station with some

exceptions. The exceptions are: last week of July and the month of August of 1998, July of 2000 and 2nd half of July of 2001 when rainfall occurred over the station but the axis was away from the Khulna station.

3.5.7 Relation between rainfall and axis position w.r.t. Mymensingh Station

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 1998 over Mymensingh station are shown in Fig. 17(a). During 2-12 June the anticyclonic axis was at the south of the station and the rainfall was about zero at that time over the station. From 18 June to 20 September the rainfall occurred frequently when the axis of anticyclone was more or less near the station except some days. The heavy to very heavy rainfall occurred on 12-14 and 20 July when the anticyclonic axis was near or over the station. During 26-31 July there was no rain over the station and the axis was moving away from the station. During 21-30 September there was no rain when the axis was at the north but not so away from the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2000 over Mymensingh station are shown in Fig. 17(b). During 4-28 June the anticyclonic axis was more or less near the station and we observed moderate, moderately heavy, heavy and very heavy rainfall over the station except some days. From 29 June to 31 July the axis was away from the station and light rainfall occurred at that time over the station. From 27 July to 1 August the axis was moving from north to south continuously and 1-4 August there was moderate to moderately heavy rainfall occurred over the station. During 18-27 August there was no rain when the axis was at the north and away from the station except 23 August. During 16-30 September the axis was at the south but 16-26 September there was moderate, moderately heavy and heavy rainfall occurred frequently over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2001 over Mymensingh station are shown in Fig. 17(c). During 1-7 June the rainfall was moderate, moderately heavy and heavy but only 3 and 7 June the axis was near the station and rest of the days it was at the south of the station. During 11-20 June the rainfall was moderate, moderately heavy and heavy when the axis was oscillatory about the station. From 21 June to 4 July the axis was more or less near the station but the rainfall was about zero over the station. From 5 July to 14 August the axis of anticyclone was at the north and away from the station except 15-16 July and in this

duration we observed frequently light and moderate rainfall over the station. From 25 August to 18 September we observed moderate, moderately heavy, heavy and very heavy rainfall over the station when the axis was close to the station. For rest of the days of the season the axis was close to the station but moderate rainfall was observed only on 30 September over the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2002 over Mymensingh station are shown in Fig. 17(d). From 2 June to 2 August frequently we observed moderate, moderately heavy, heavy and very heavy rainfall over the station in which during 2-7 June the axis was at the south and 13-18 July it was at the north of the station and rest of the days it was more or less near the station. During 3-9 August there was no rain when the anticyclonic axis was far away from the station. During 10-26 August moderate and moderately heavy rainfall observed over the station when the axis was more or less near the station. From 27 August to 19 September also there was no rain when the axis was away from the station except 9-15 September. During 20-30 September moderate to heavy rainfall occurred when the axis was at the south but not so far away from the station.

From the above discussion we can say that the rainfall occurred almost all through every monsoon season of 1998, 2000, 2001 and 2002 over Mymensingh station when the axis was near the station except 2nd half of July of 2001 and last half of September of 2002 when the axis was away from the station but moderate rainfall occurred over the station at that time.

3.5.8 Relation between rainfall and axis position w.r.t. Rajshahi Station

The upper air anticyclonic axis positions at 300 hPa level and daily rainfall in the monsoon of 1998 over Rajshahi station are shown in Fig. 18(a). During 1-12 June no rainfall occurred when the axis was at the south and away from the station. During 19-27 June light to moderate rainfall observed when the anticyclonic axis was near the station. During 5-23 July we observed moderate, moderately heavy and heavy rainfall when the axis was more or less near the station except 15-18 July. From 29 July to 18 August there was rainfall over the station when the axis was away from the station except 13 August. From 28 August to 21 September we observed moderate, moderately heavy and heavy rainfall occurred when the anticyclonic axis was more or less near the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2000 over Rajshahi station are shown in Fig. 18(b). During 4-26 June we observed light, moderate and moderately heavy rainfall when the axis was close to the station. From 29 June to 31 July the axis was at the north and away from the station but light rain occurred for sometimes. From 29 August to 23 September we observed moderate, moderately heavy and very heavy rainfall when the axis was more or less near the station. It was also observed that heavy to very heavy rainfall occurred on 31 August, 18 and 19 September when the axis was at the south of the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2001 over Rajshahi station are shown in Fig. 18(c). On 3 June there was heavy rain over the station and the axis was very close to the station. During 14-20 June we observed moderate, moderately heavy and very heavy rainfall when the axis was not so close to the station but on 19 June very heavy rainfall occurred when the axis was at the south of the station. Again from 9 July to 2 August moderate, moderately heavy, heavy and very heavy rainfall occurred over the station when the axis was at the north and far away from the station except 16 July. During 3-12 August the rain was about zero when the axis of anticyclone was far away from the station. From 23 August to 30 September the anticyclonic axis was close to the station but only from 25 August to 12 September we observed frequently moderate to moderately heavy rainfall over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Rajshahi station are shown in Fig. 18(d). From 7 June to 6 July we observed moderate, moderately heavy and heavy rainfall over the station when the axis was more or less near the station. During 12-20 July we observed frequent rainfall but this time the axis was at the north and far away from the station. During 1-10 August the axis was at the north and far away from the station and in this duration rainfall occurred only during 3-4 August. During 12-16 August there was moderate and moderately heavy rainfall over the station when the axis was near the station. From 22 August to 3 September the axis was at the north and away from the station and only on 27 August we observed rainfall over the station. During 22-30 September the rainfall was light, moderate, moderately heavy and heavy when the axis was at the south of the station but not so away from the Rajshahi station.

When then the anticyclonic axis was near the Rajshahi station then rainfall occurred over the station for every monsoon season of 1998, 2000, 2001 and 2002 except 1st week of August of 1998, last half of July of 2000 and 2001 when the axis was away from the Rajshahi station but we observed significant rainfall over the station at that time. During the continuous movement of the axis from north to south we also observed rainfall at the end of that duration's over the station.

3.5.9 Relation between rainfall and axis position w.r.t. Sreemangal Station

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 1998 over Sreemangal station are shown in Fig. 19(a). During 1-9 June we observed moderate, moderately heavy and heavy rainfall over the Sreemangal station when the axis was at the south and away from the station. From 30 June to 16 September we observed moderate, moderately heavy, heavy and very heavy rainfall time to time when the axis was not so near the station. During 17-27 September there was no rain over the Sreemangal station when the axis was at the north of the station except on 20 September when the axis was at the south of the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2000 over Sreemangal station are shown in Fig. 19(b). From 1 June to 8 July the axis of anticyclone was near the station and this time the rainfall was moderate, moderately heavy and heavy over the station. During 11-29 July there was so light rainfall over the station when the axis of anticyclone was at the north and far away from the Sreemangal station. From 30 July to 13 August we observed moderate, moderately heavy, heavy and very heavy rainfall over the station when the axis was not so away from the station. From 29 August to 15 September the axis was close to the station and this time light to moderately heavy rainfall occurred over the station. During 19-30 September rainfall occurred only on 26 and 30 September when the axis was at the south and away from the Sreemangal station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 2001 over Sreemangal station are shown in Fig. 19(c). During 1-12 June the axis of anticyclone was at the south and not too close to the station but at that time we observed moderate, moderately heavy, heavy and very heavy rainfall regularly over the station. From 12 June to 4 July the axis was more or less near the Sreemangal station and also moderate rainfall occurred over the station. From 5 July to 17 August the axis was at the

north and away from the station except 15-16 July when the rainfall was moderate, moderately heavy, heavy and very heavy for many days. From 18 August to 30 September the axis of anticyclone at 300 hPa level was close to the station and we observed moderate, moderately heavy and heavy rainfall frequently during 27 August to 5 September and during 17-19 September over the Sreemangal station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Sreemangal station are shown in Fig. 19(d). From 3 June to 12 July the axis was more or less near the station and we observed moderate, moderately heavy and heavy rainfall over the station. During 13-18 July the axis of anticyclone was at the north and far away from the Sreemangal station but heavy and very heavy rainfall occurred on 15 and 16 July over he station. During 1-10 August the axis was at the north and far away from the station but we observed heavy rainfall over the station. During 11-21 August the axis was close to the station but we observed light rain over the station. From 22 August to 8 September the axis of anticyclone was at the north and away from the station but moderate, moderately heavy and heavy rainfall is also observed over the station. During 15-30 September the axis was at the south but not so far away from the station when the rainfall was moderate, moderately heavy and heavy over the Sreemangal station.

The rainfall occurred over the station when the axis was near the station for every monsoon season of 1998, 2000, 2001 and 2002 except last week of July and 1st and last week of August of 1998, last half of July and 1st half of August of 2001 and 1st and last week of August of 2002 when rainfall occurred over the station but the axis was away from the Sreemangal station. Also when the anticyclonic axis moved continuously from north to south then rainfall occurred over the station.

3.5.10 Relation between rainfall and axis position w.r.t. Sylhet Station

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon of 1998 over Sylhet station are shown in Fig. 20(a). During 1-10 June we observed moderate, moderately heavy, heavy and very heavy rainfall and at that time the axis of anticyclone was at the south and moving towards the north of the station. From 13 June to 11 July most of the time the axis was close to the station and rainfall was light and moderate over the station. During 12-26 July we observed moderate, moderately heavy, heavy and very heavy rainfall over the station but except on 20 July the axis was at the

north of the station. From 27 July to 28 August also light to heavy rainfall occurred almost everyday but the axis was away from the station. During 6-30 September there was moderate, moderately heavy and heavy rainfall when the axis of anticyclone of 300 hPa level was near the Sylhet station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2000 over Sylhet station are shown in Fig. 20(b). From 1 June to 10 July moderate, moderately heavy, heavy and very heavy rainfall occurred and the axis was near the station. During 11-31 July the axis was far away but moderate and moderately heavy rainfall occurred over the station. From 27 July to 1 August the axis of anticyclone was moved from north to south continuously and we observed very heavy rainfall on 1 to 18 August. During 1-18 August we observed moderate, moderately heavy, heavy and very heavy rainfall over the station when the axis was not so near the station. During 8-15 September the axis of anticyclone at 300 hPa level was near the station and moderate, moderately heavy, heavy and very heavy rainfall was observed over the Sylhet station. During 16-30 September the axis of anticyclone at 300 hPa level way at the south and far away from the station but very heavy rainfall occurred on 25 September over the station.

Anticyclonic axis position at 300 hPa level and daily rainfall in the monsoon season of 2001 over Sylhet station are shown in Fig. 20(c). During 1-9 June we observed moderately heavy to very heavy rainfall when the anticyclonic axis was at the south and away from the station. From 13 June to 2 July the axis was oscillatory about the station where we observed the rainfall was moderate to heavy over the station. From 3 July to 17 August the axis was at the north and away from the station when moderate, moderately heavy, heavy and very heavy rainfall also occurred over the station. From 22 August to 19 September the axis of upper air anticyclone was oscillatory and more or less close to the station and moderate, moderately heavy and heavy rainfall occurred over the station.

The positions of anticyclonic axis at 300 hPa level and daily rainfall in the monsoon season of 2002 over Sylhet station are shown in Fig. 20(d). During 1-7 the axis was at the south and away from the station but we observed moderate rainfall during 2-5 June, very heavy rainfall on 6 June and moderately heavy rain on 7 June. From 10 June to 12 July moderate, moderately heavy, heavy and very heavy rainfall occurred over the Sylhet station when the upper air anticyclonic axis was not so away from the station.

During 13-18 July the axis was at the north and far away from the station and during 19-31 July it was near the station but rainfall occurred in both the duration over the station. During 1-9 August we observed moderate, moderately heavy and very heavy rainfall over the station when the axis of anticyclone was far away from the station. On 2 August we observed 440 mm rainfall when the axis was at the north and far away from the station. From 22 August to 8 September the axis was at the north and away from the station and the rainfall was about zero over the station except on 30 August and 1 September when the rainfall was moderately heavy and moderate respectively. During 15-30 September the anticyclonic axis was at the south and away from the station but during 28-30 September we observed moderately heavy to very heavy rainfall over the station.

From the above discussion it is clear that when the anticyclonic axis was near Sylhet station then rainfall occurred over the station for every monsoon season of 1998, 2000, 2001 and 2002 except 1st week of June of 1998, 2nd half of July of 2000, 1st half of August of 2001 and 1st week of August of 2002 when the axis was away from the station but rainfall occurred over the station. During the continuous movement of the anticyclonic axis from north to south we observed rainfall over the Sylhet station at that time. We also observed some exceptional rainfall over the Sylhet station, which are, on 12 June of 2000 when the rainfall was about 362mm and on 2 August of 2002 when it was about 440 mm over the station.

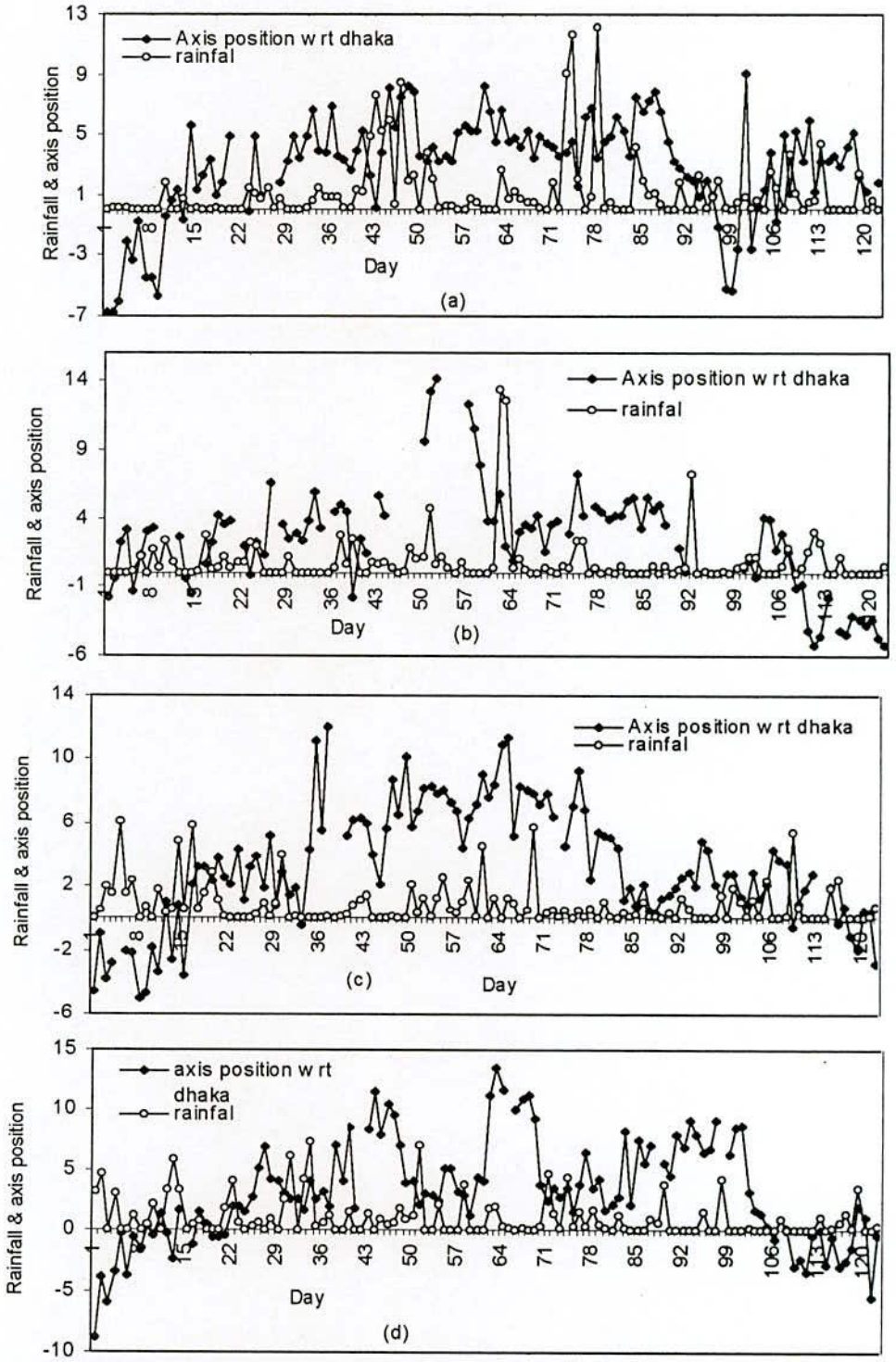

Fig. 1(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Dhaka station respectively

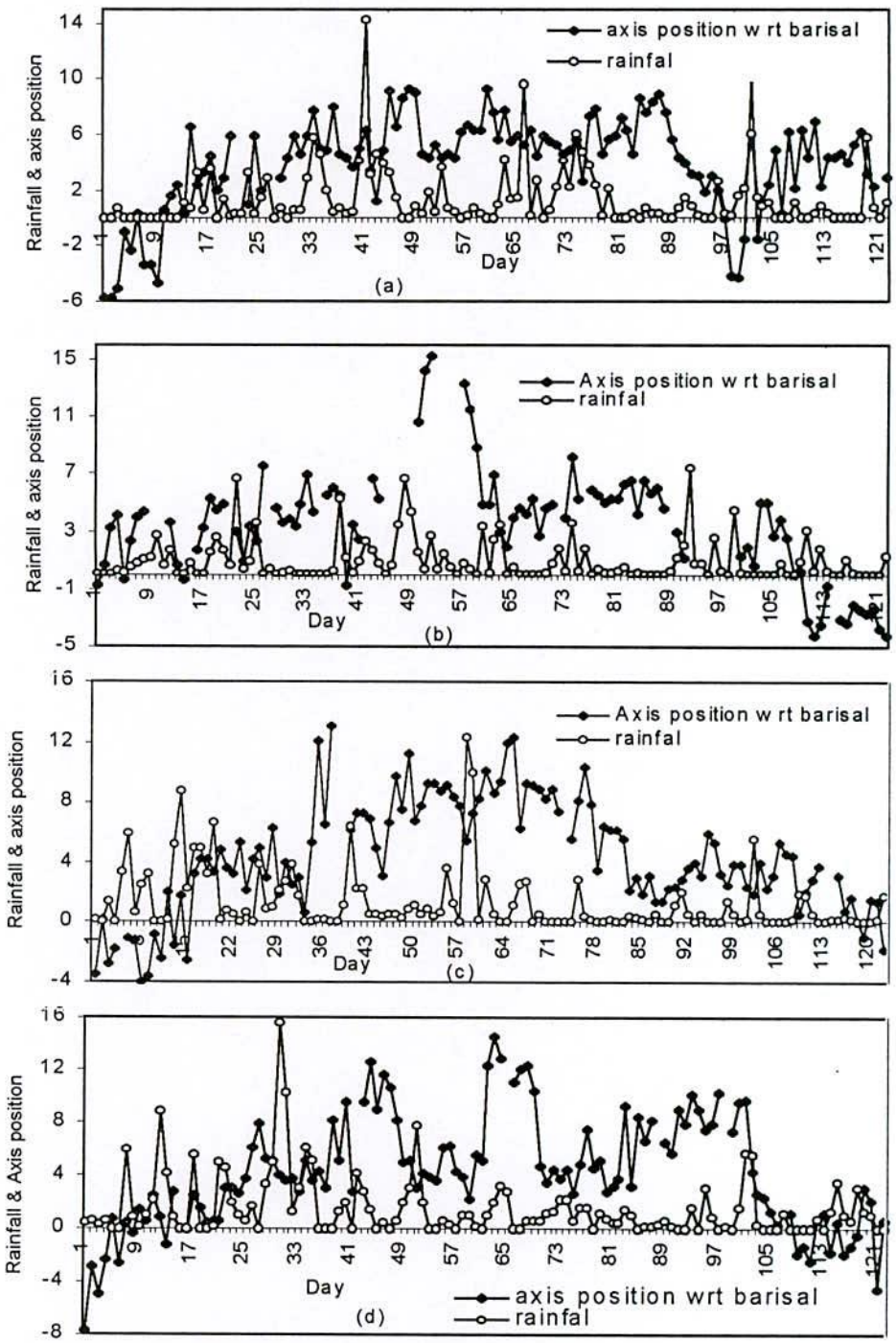

Fig. 2(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Barisal station respectively

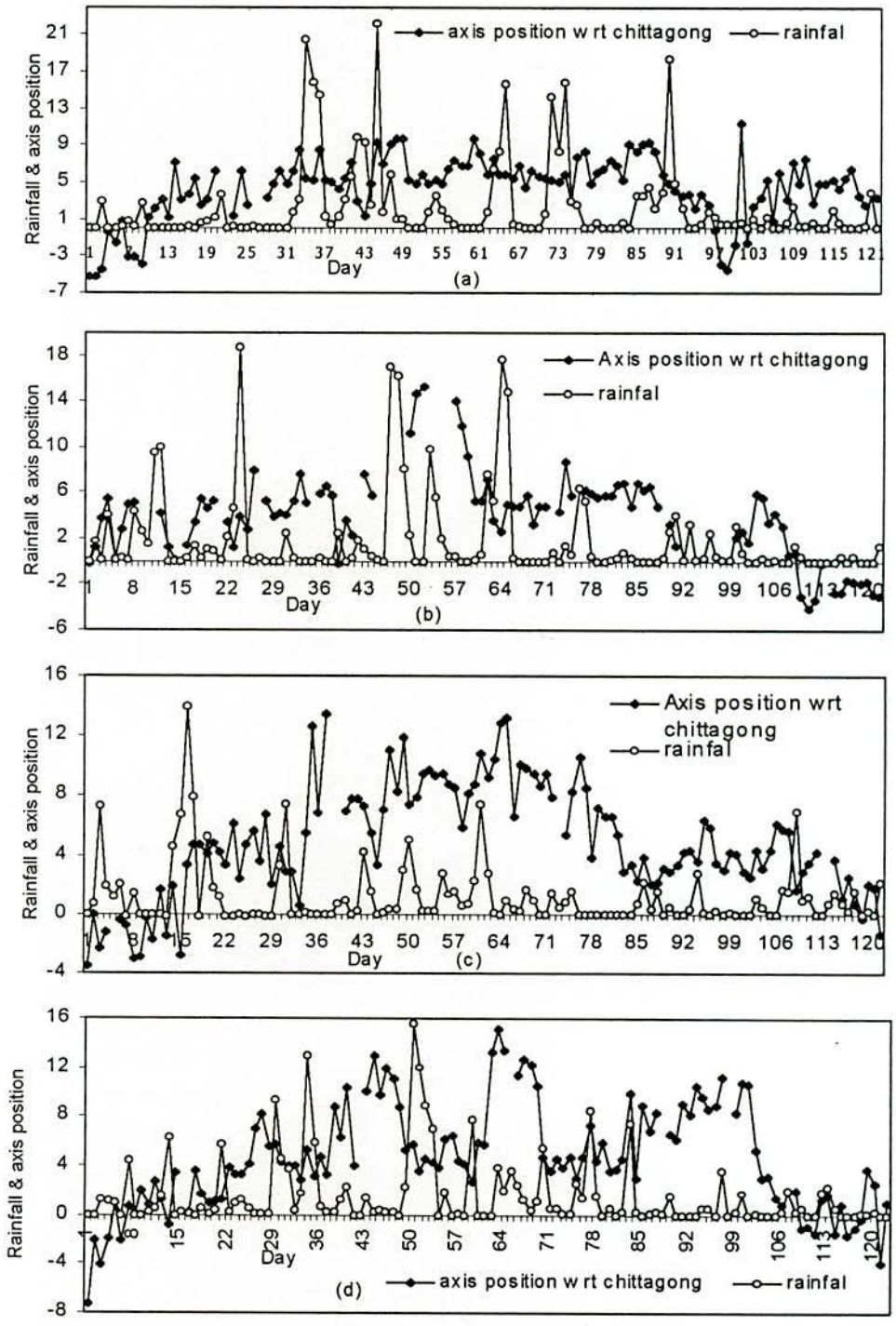

Fig. 3(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Chittagong station respectively

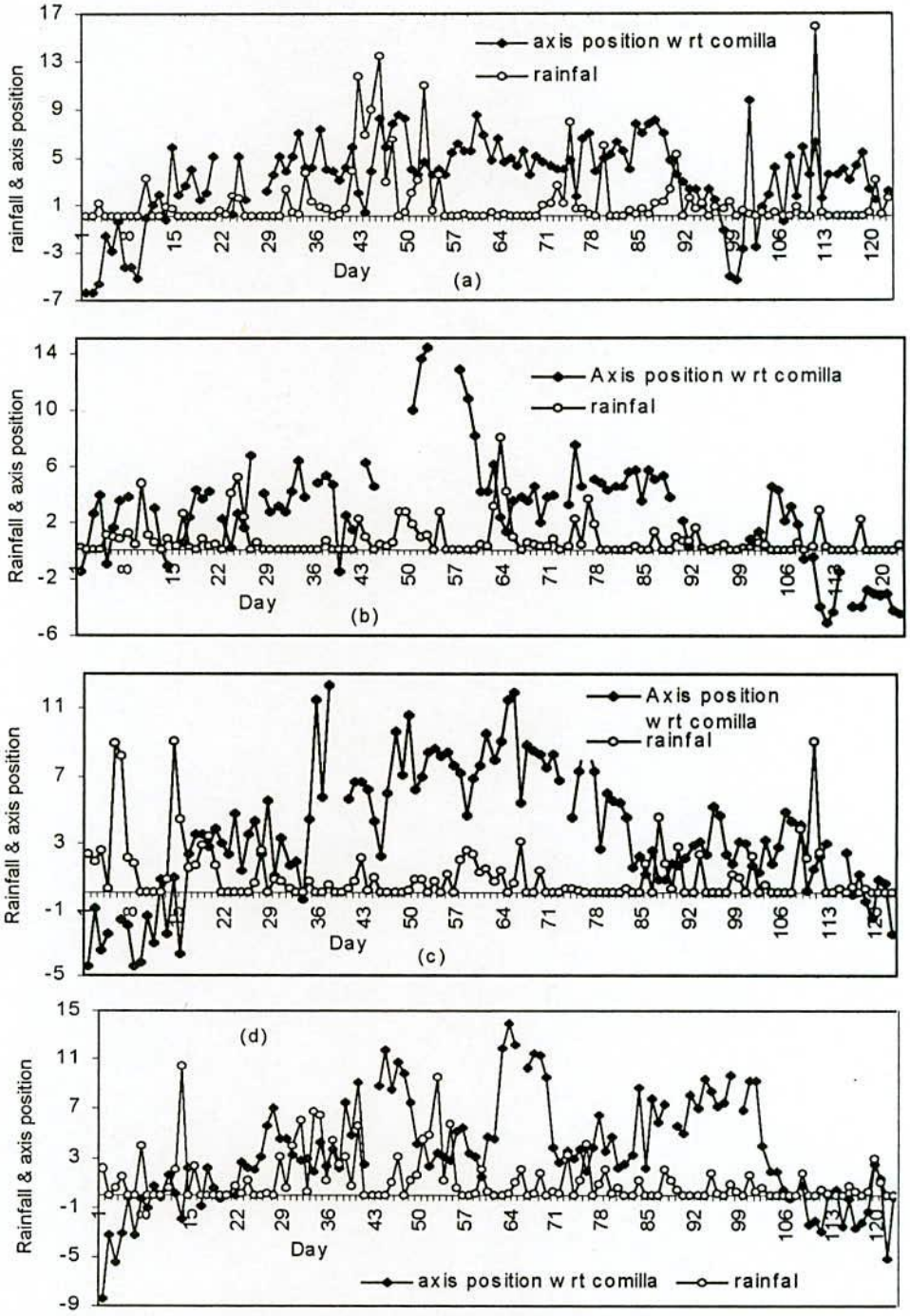

Fig. 4(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Comilla station respectively

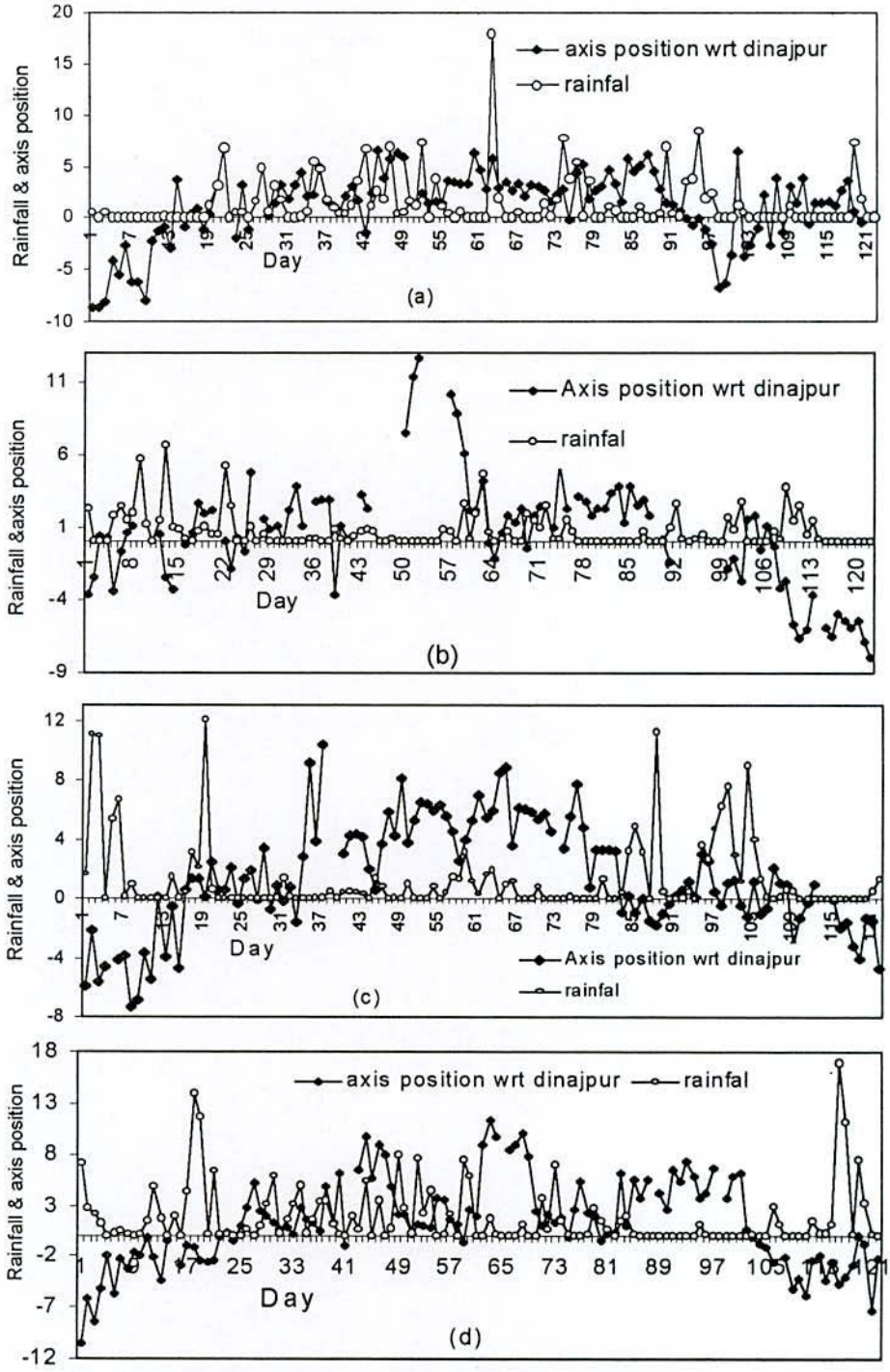

Fig. 5(a-d): Distribution of monsoon rainfall and axis position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Dinajpur station respectively

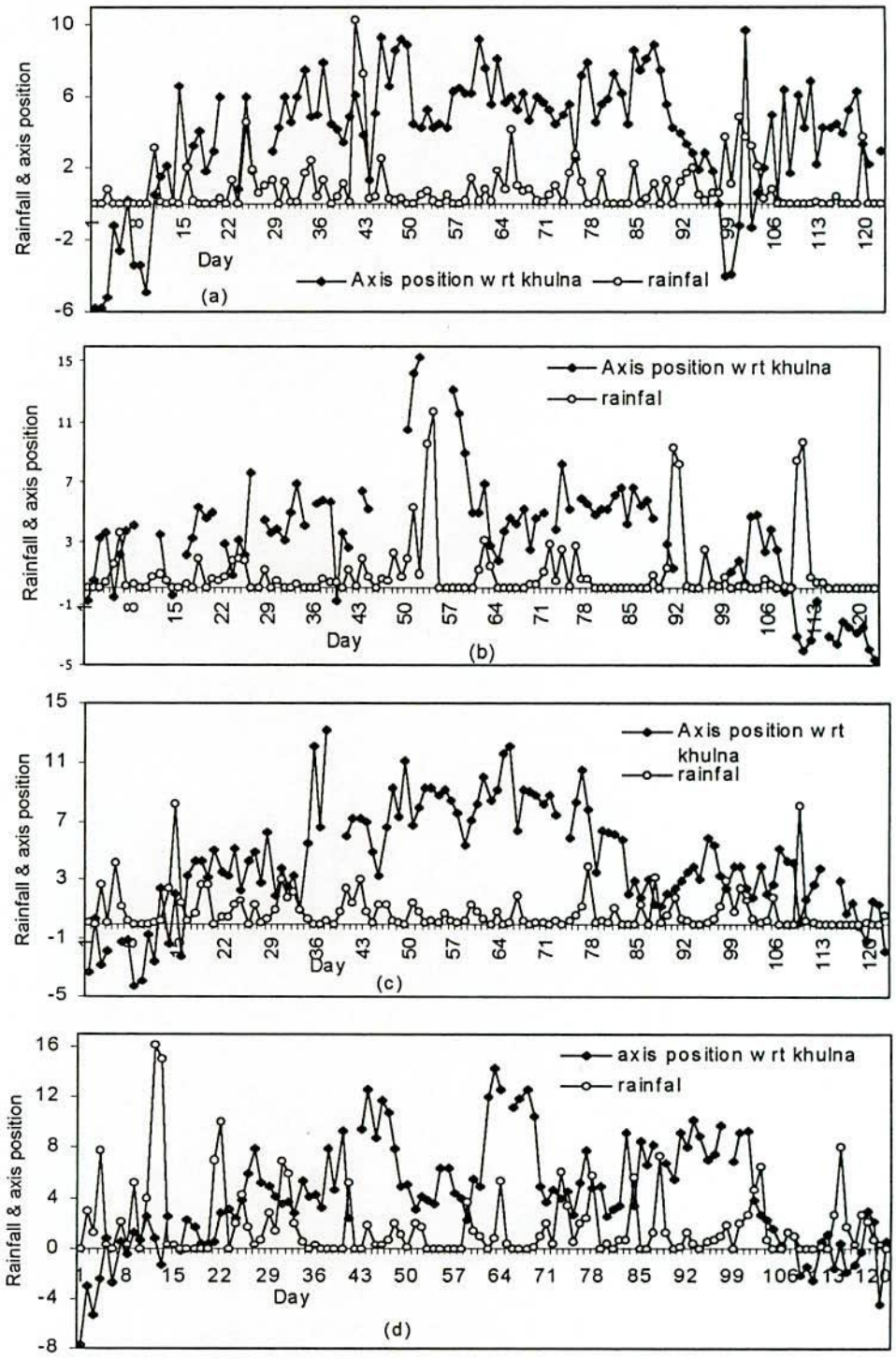

Fig. 6(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Khulna station respectively

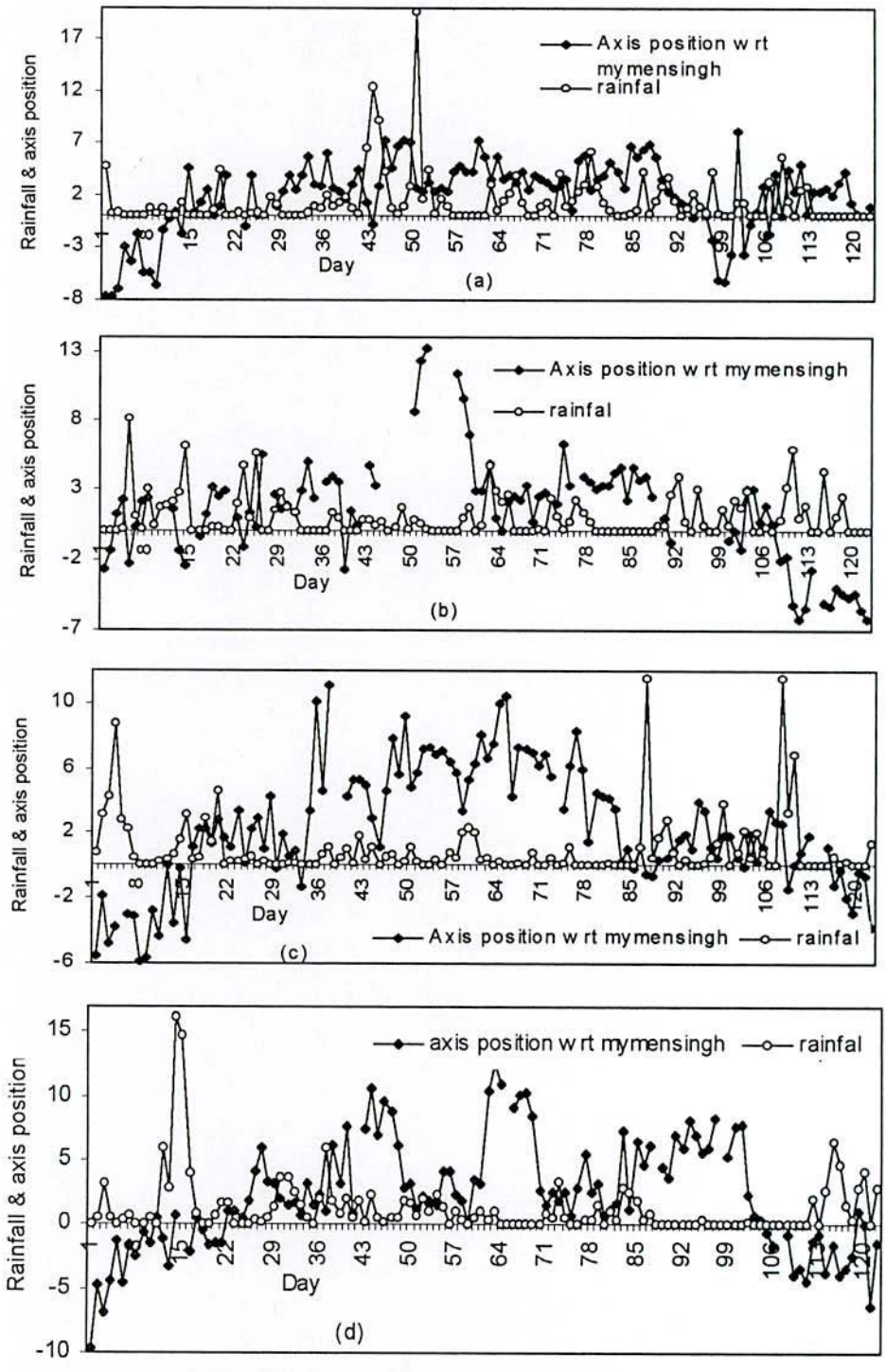

Fig. 7(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Mymensingh station respectively

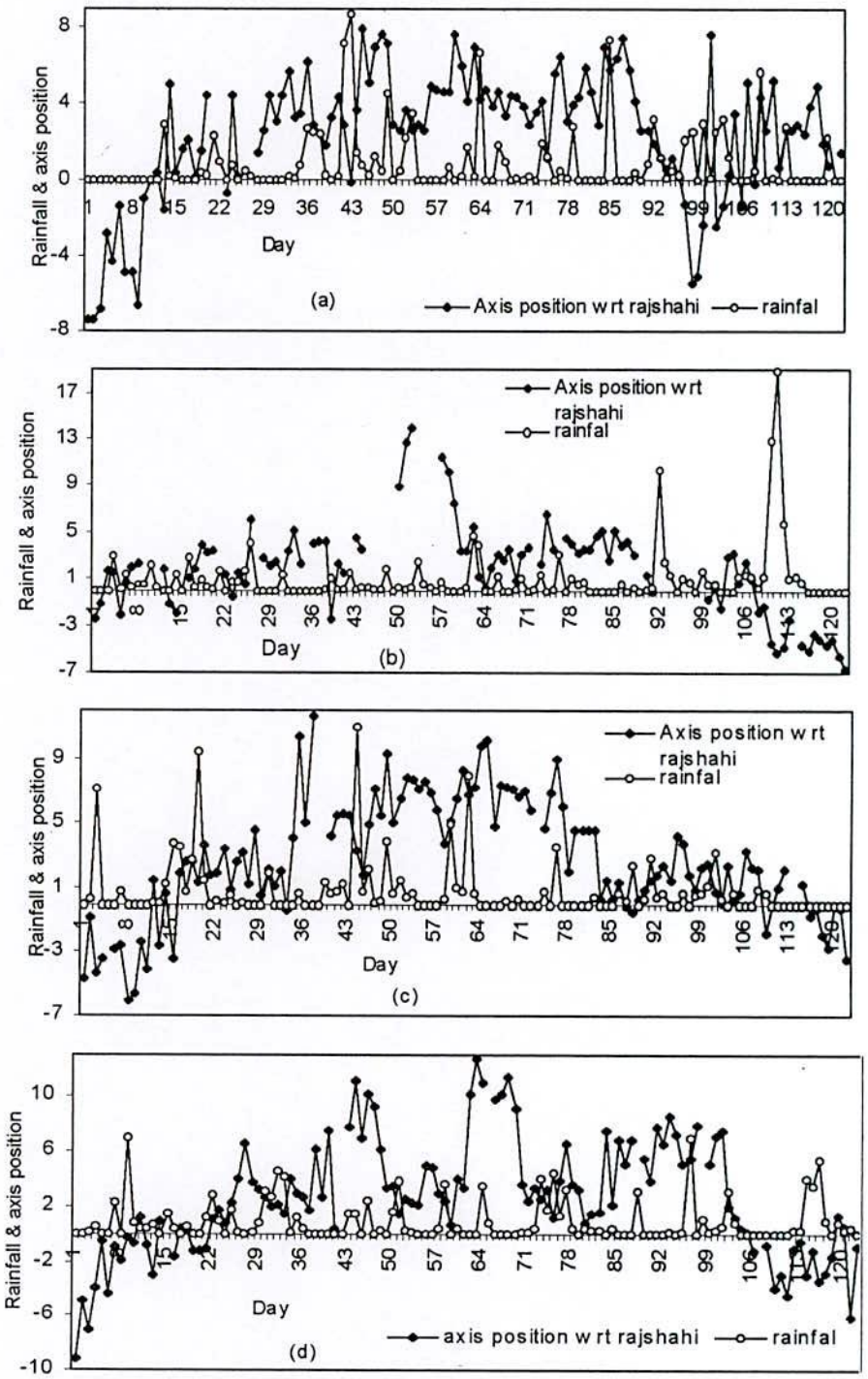

Fig. 8(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Rajshahi station respectively

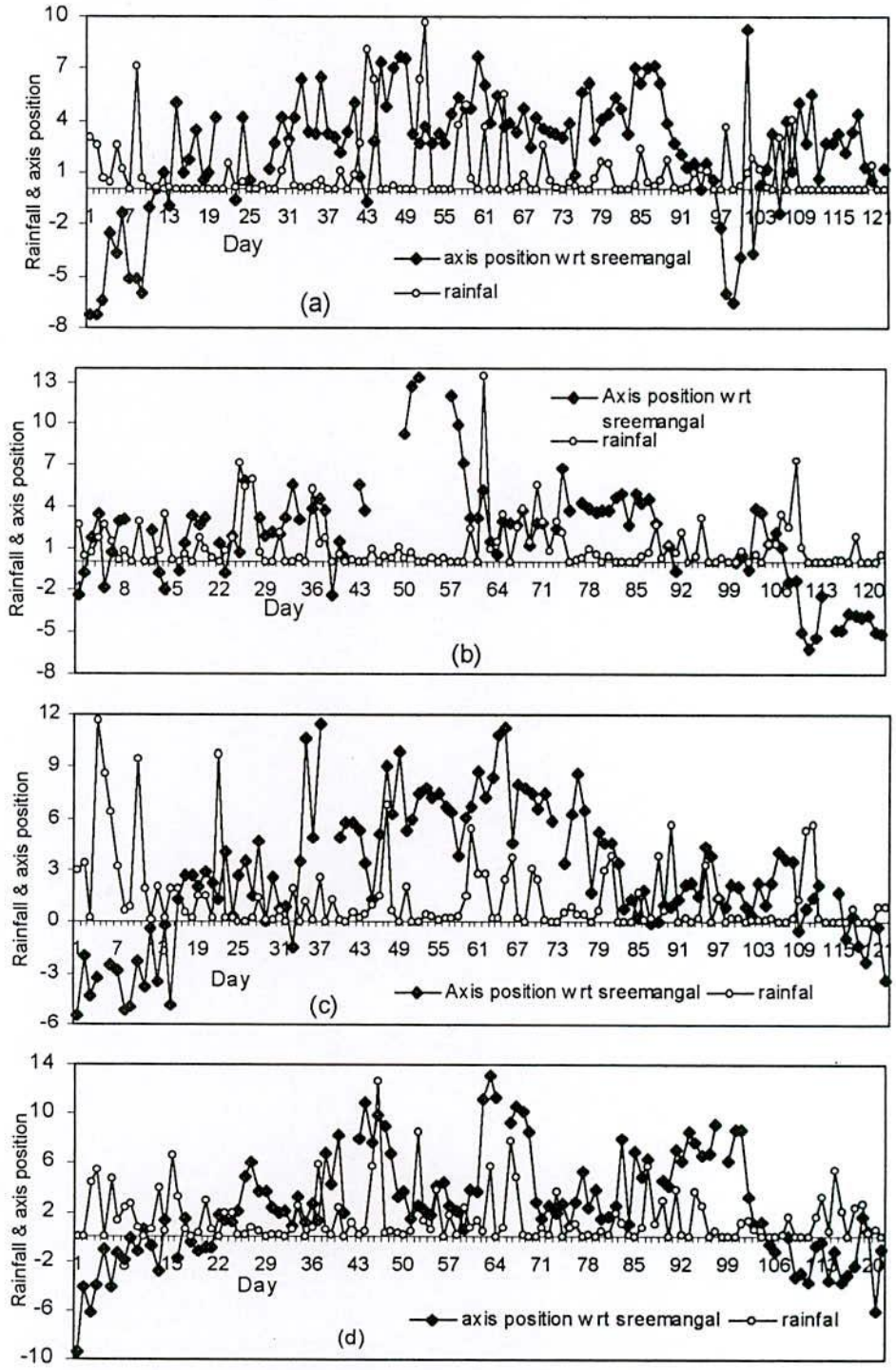

Fig. 9(a-d): Distribution of monsoon rainfall and axis position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Sreemangal station respectively

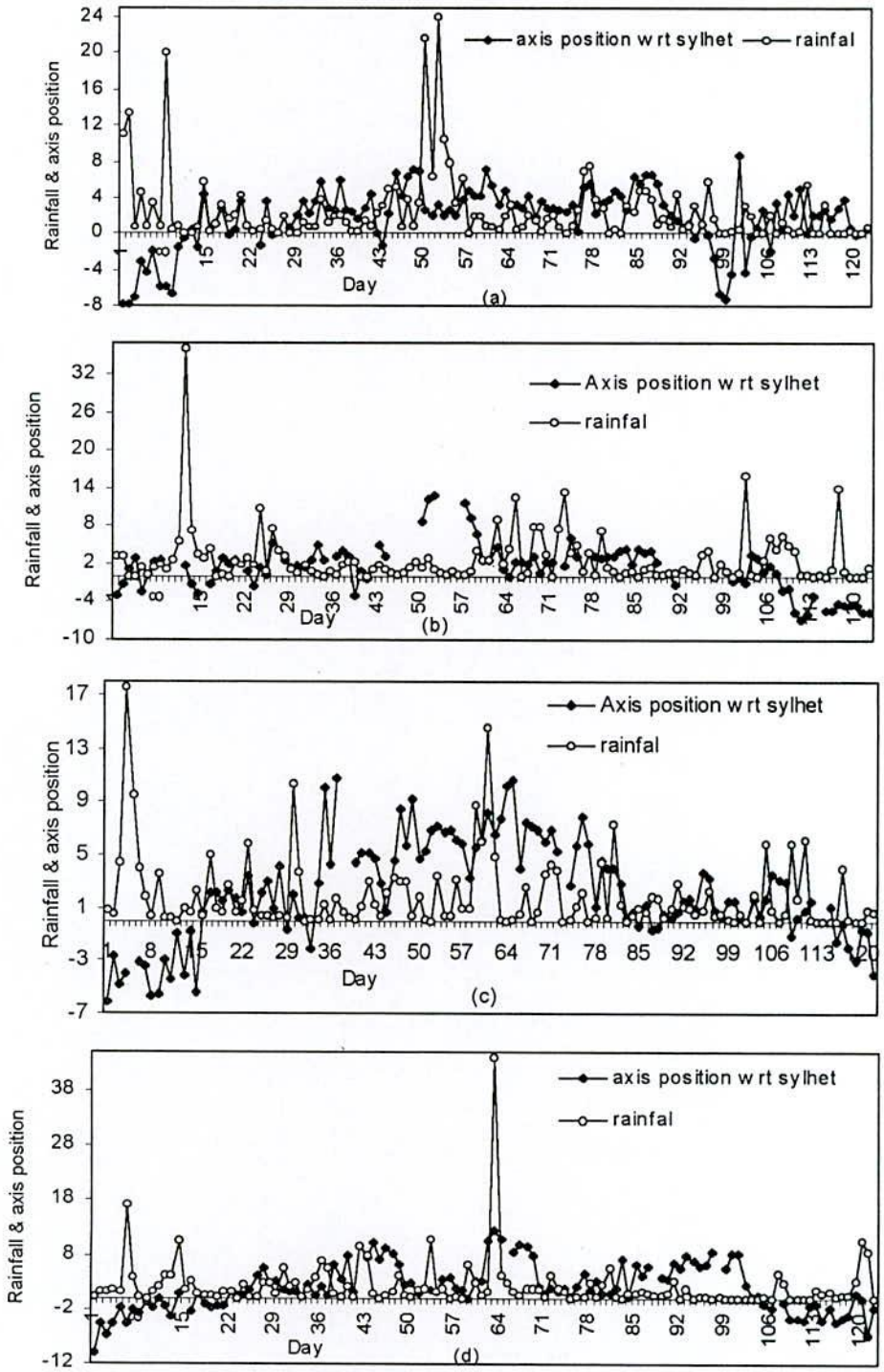

Fig. 10(a-d): Distribution of monsoon rainfall and position of 200 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Sylhet station respectively

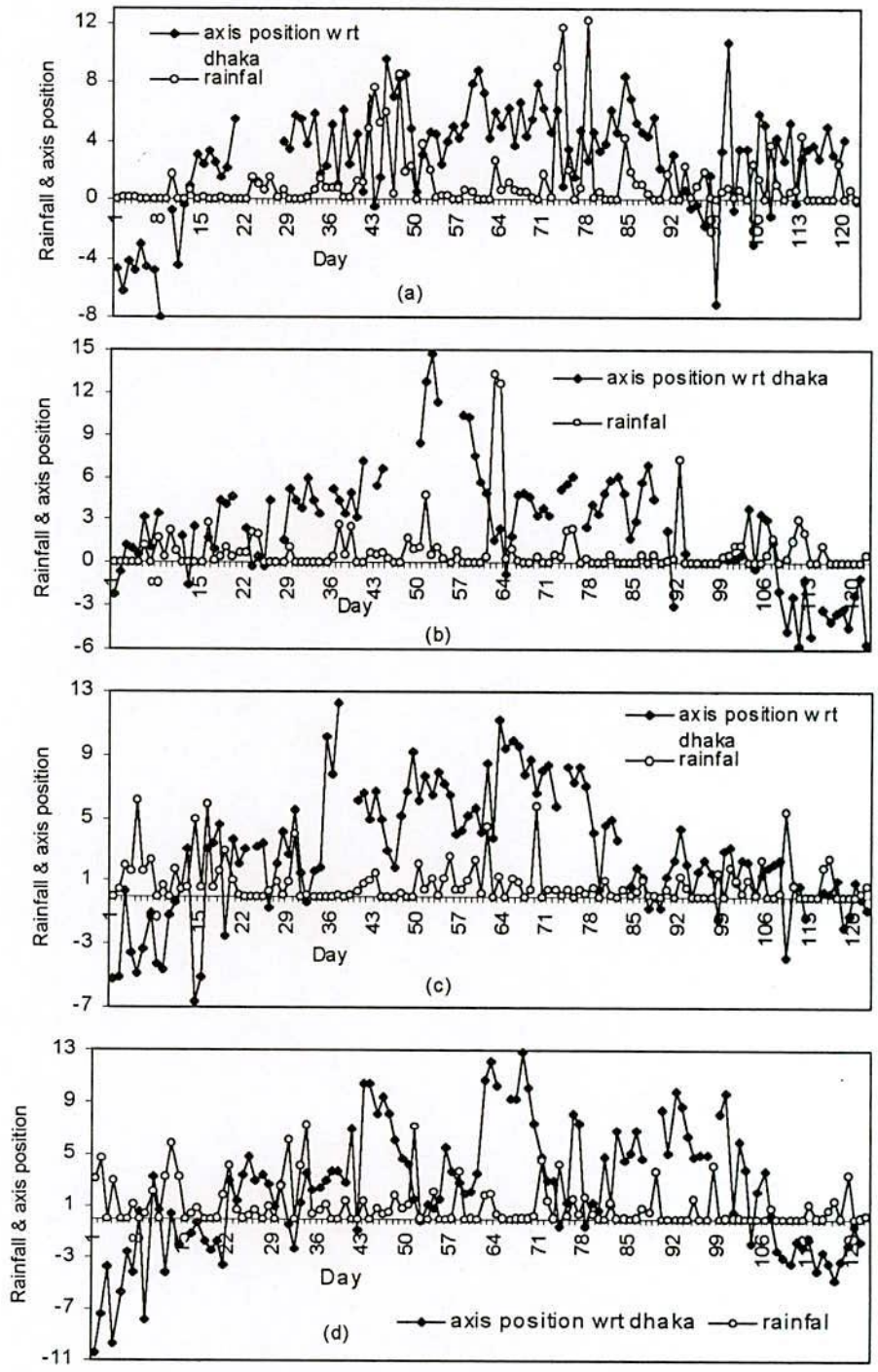

Fig. 11(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Dhaka station respectively

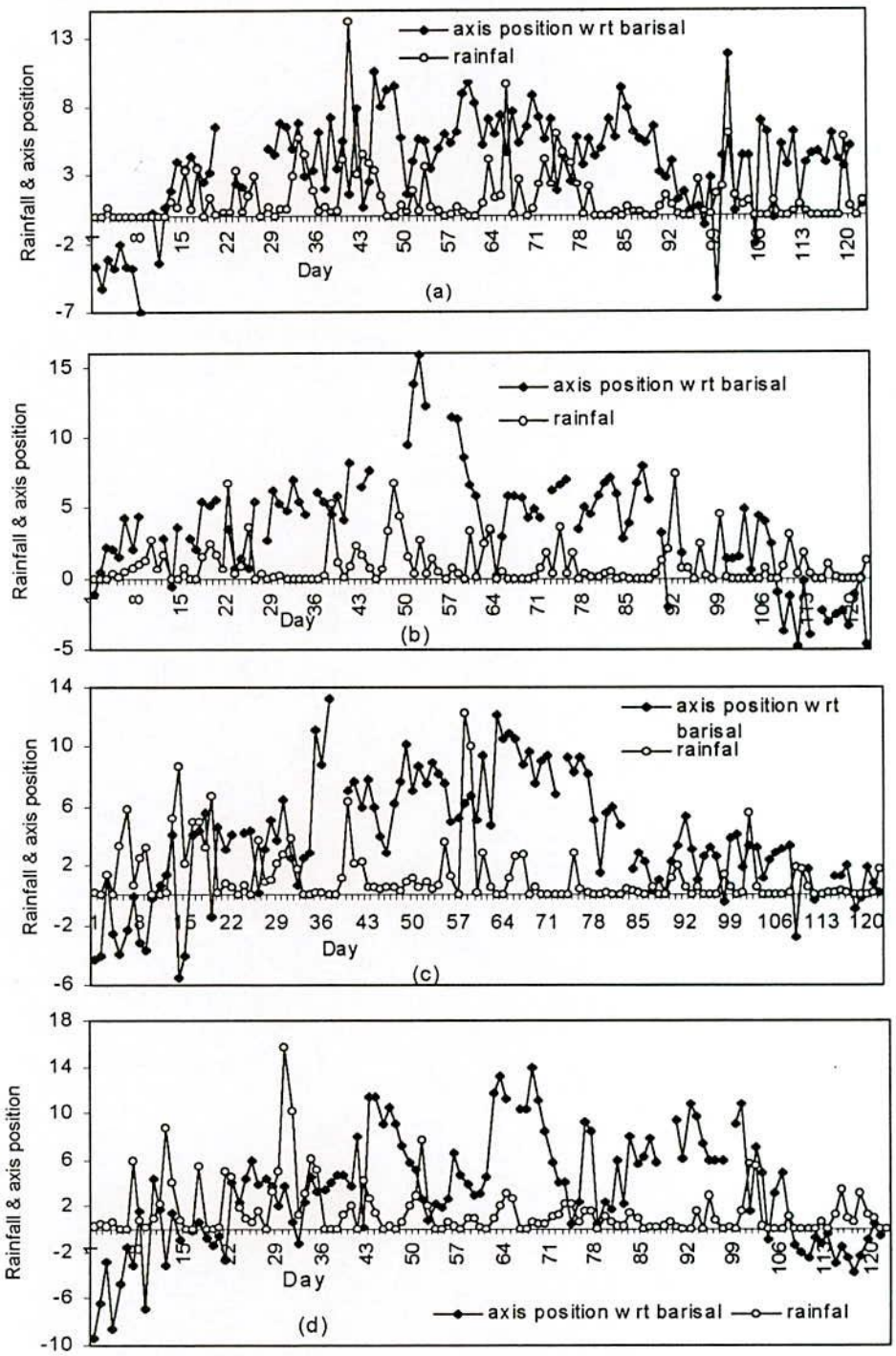

Fig. 12(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Barisal station respectively

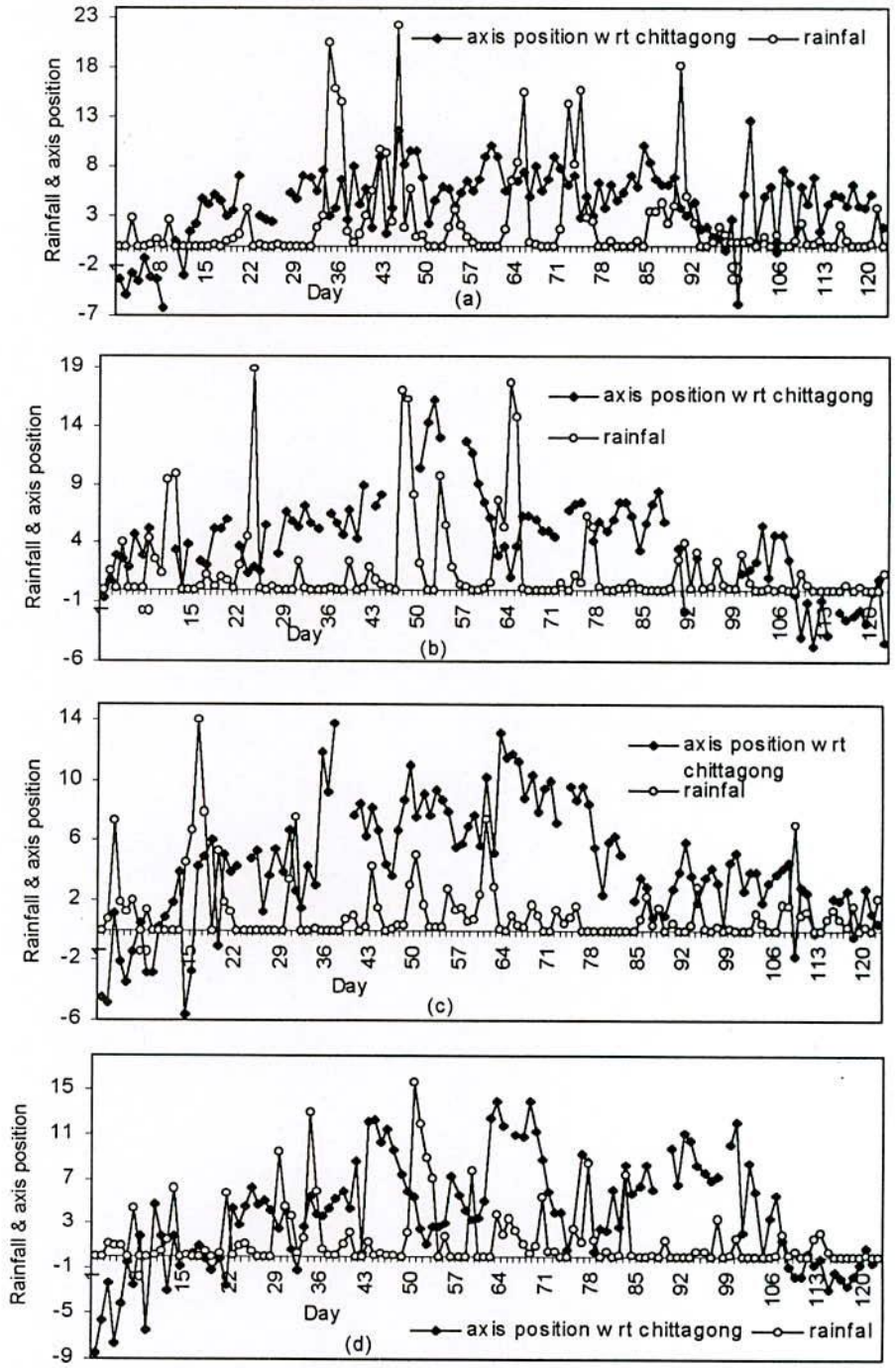

Fig. 13(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Chittagong station respectively

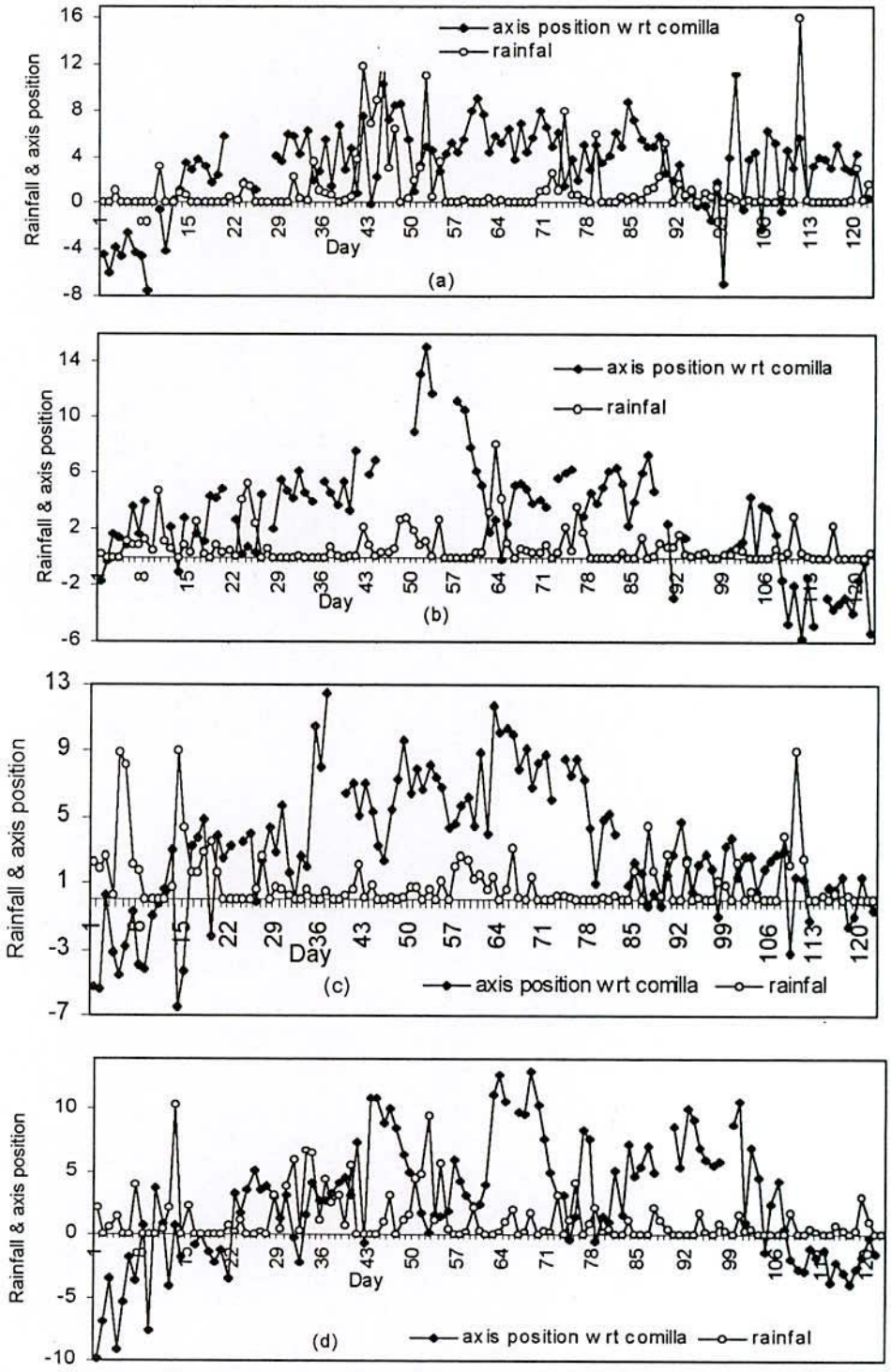

Fig. 14(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Comilla station respectively

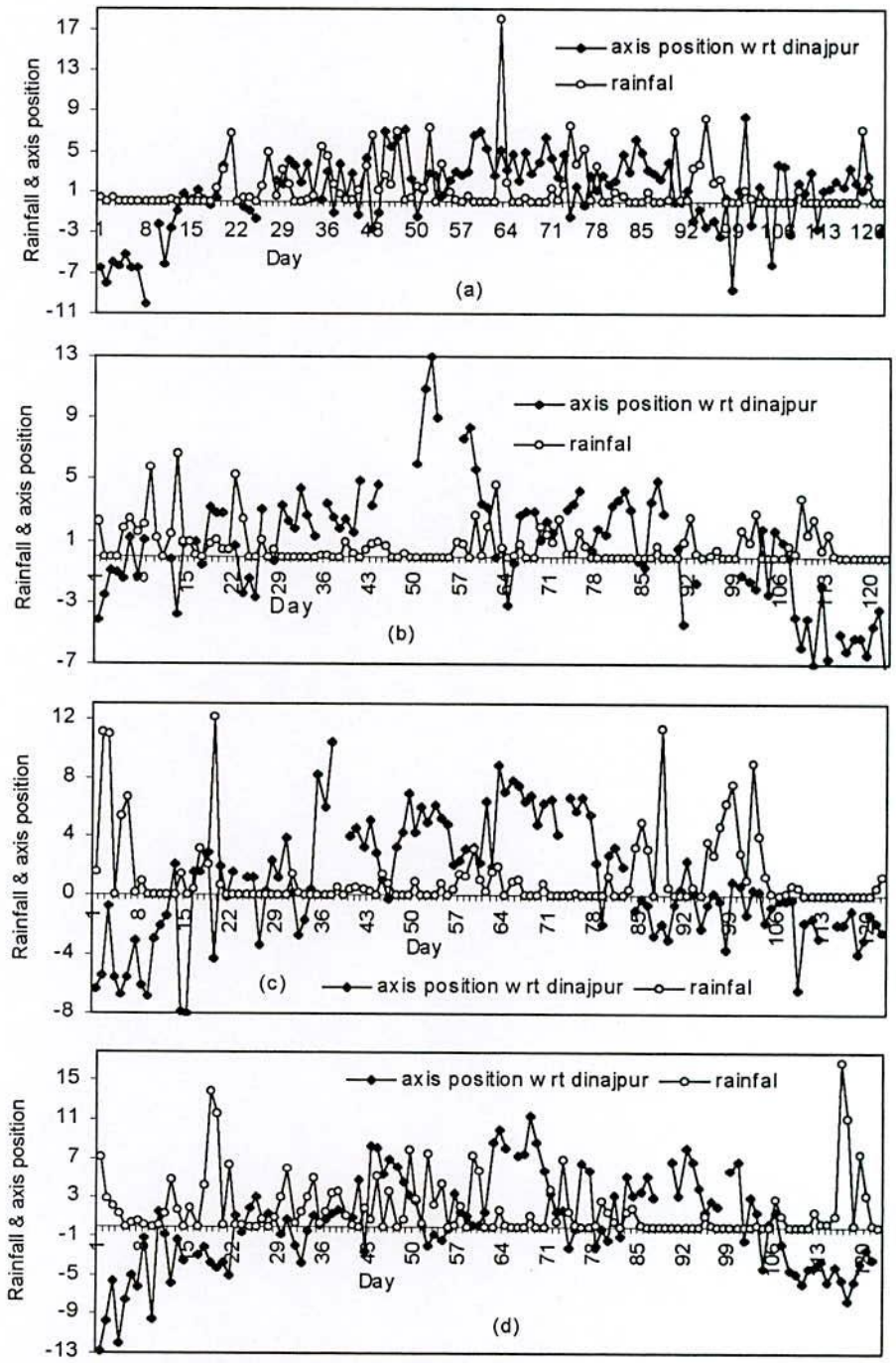

Fig. 15(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Dinajpur station respectively

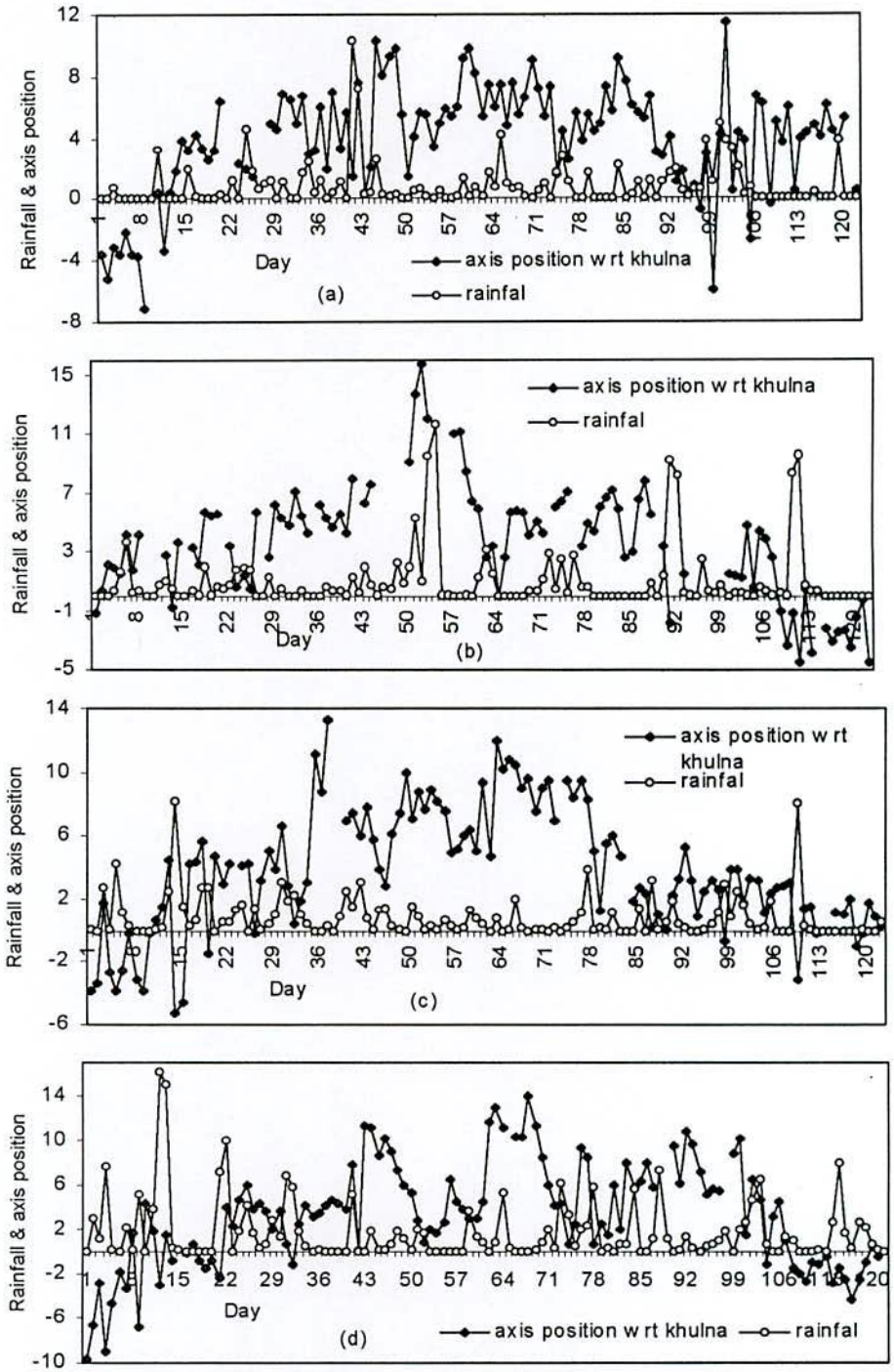

Fig. 16(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Khulna station respectively

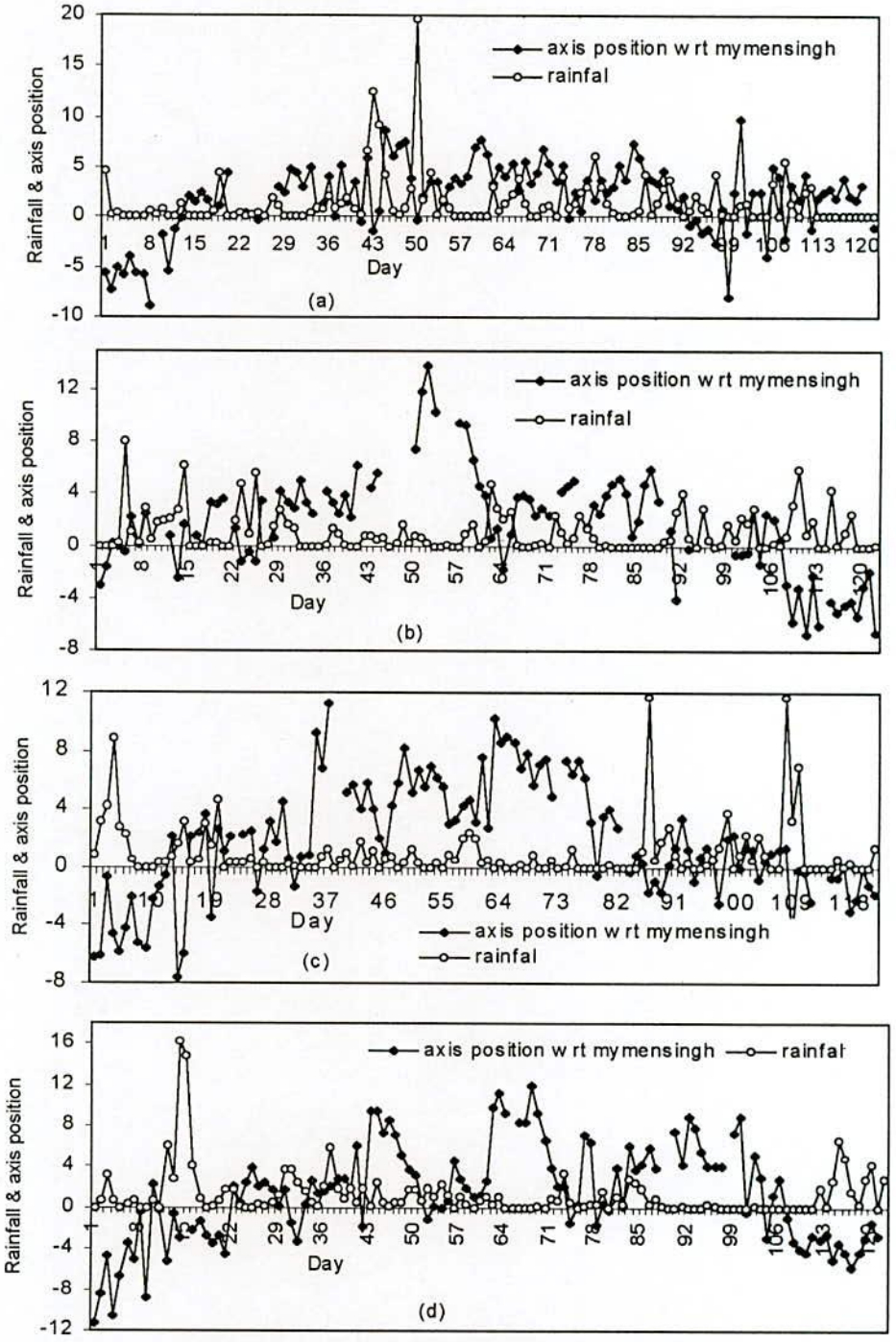

Fig. 17(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Mymensingh station respectively

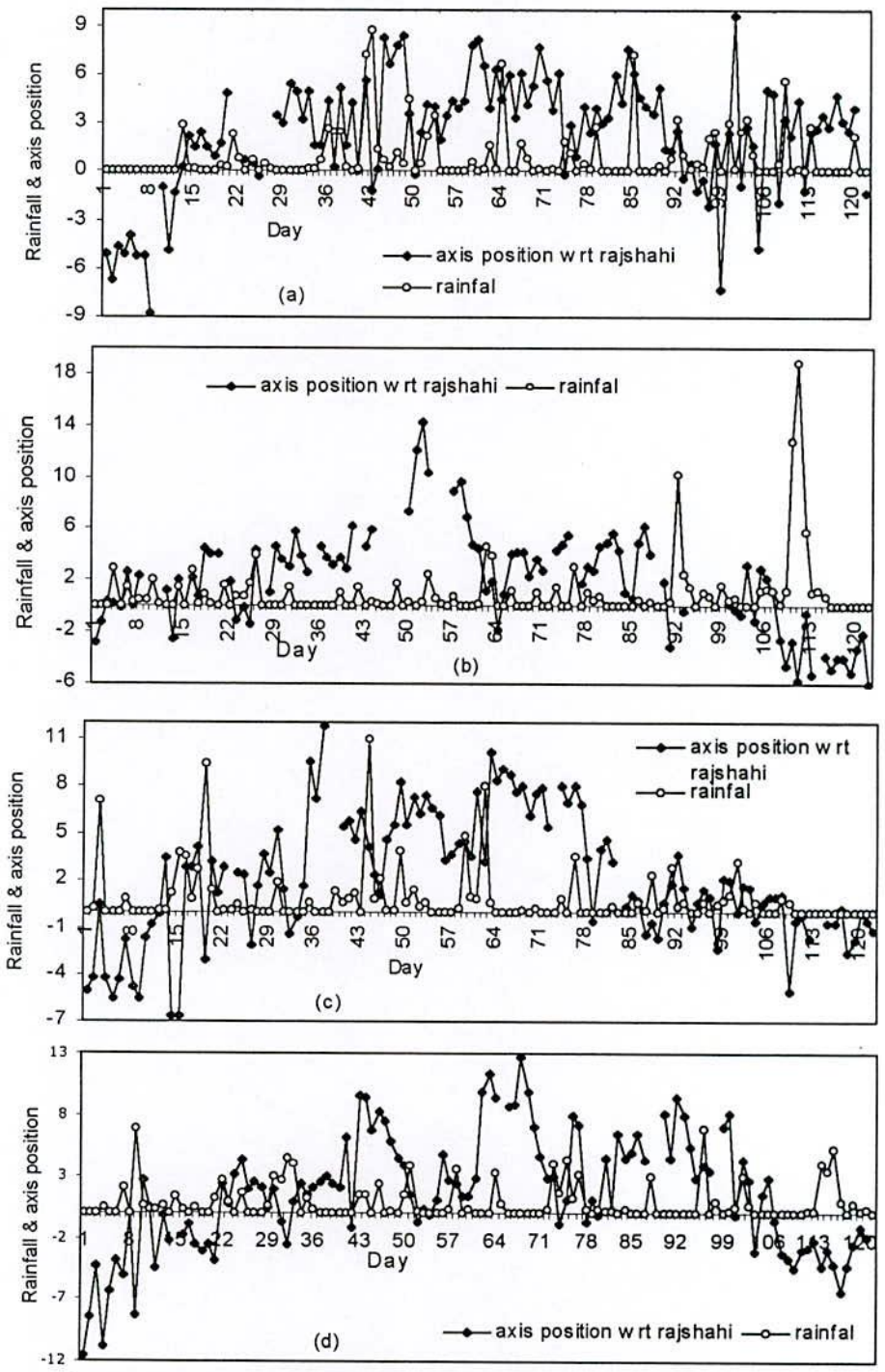

Fig. 18(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Rajshahi station respectively

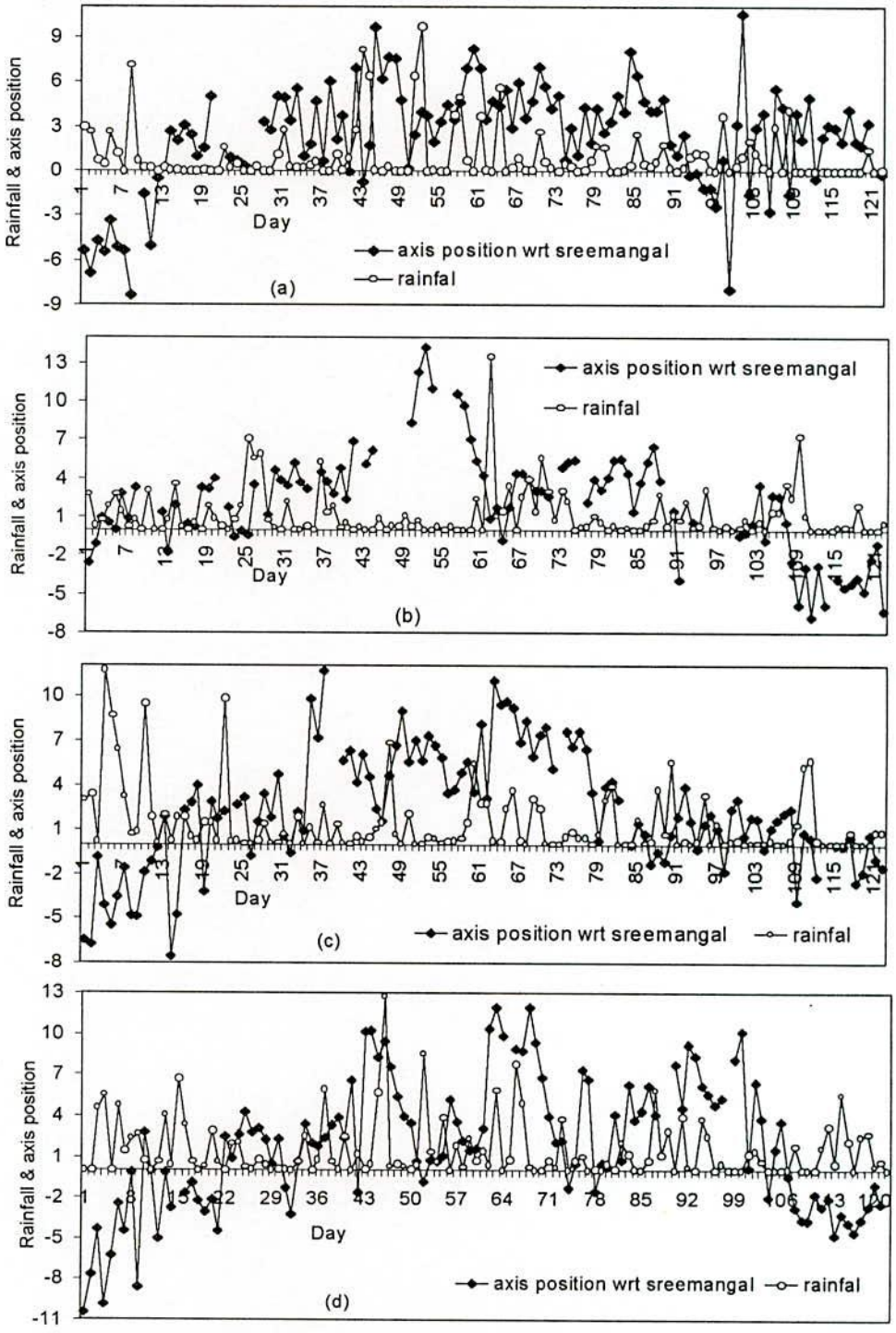

Fig. 19(a-d): Distribution of monsoon rainfall and position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Sreemangal station respectively

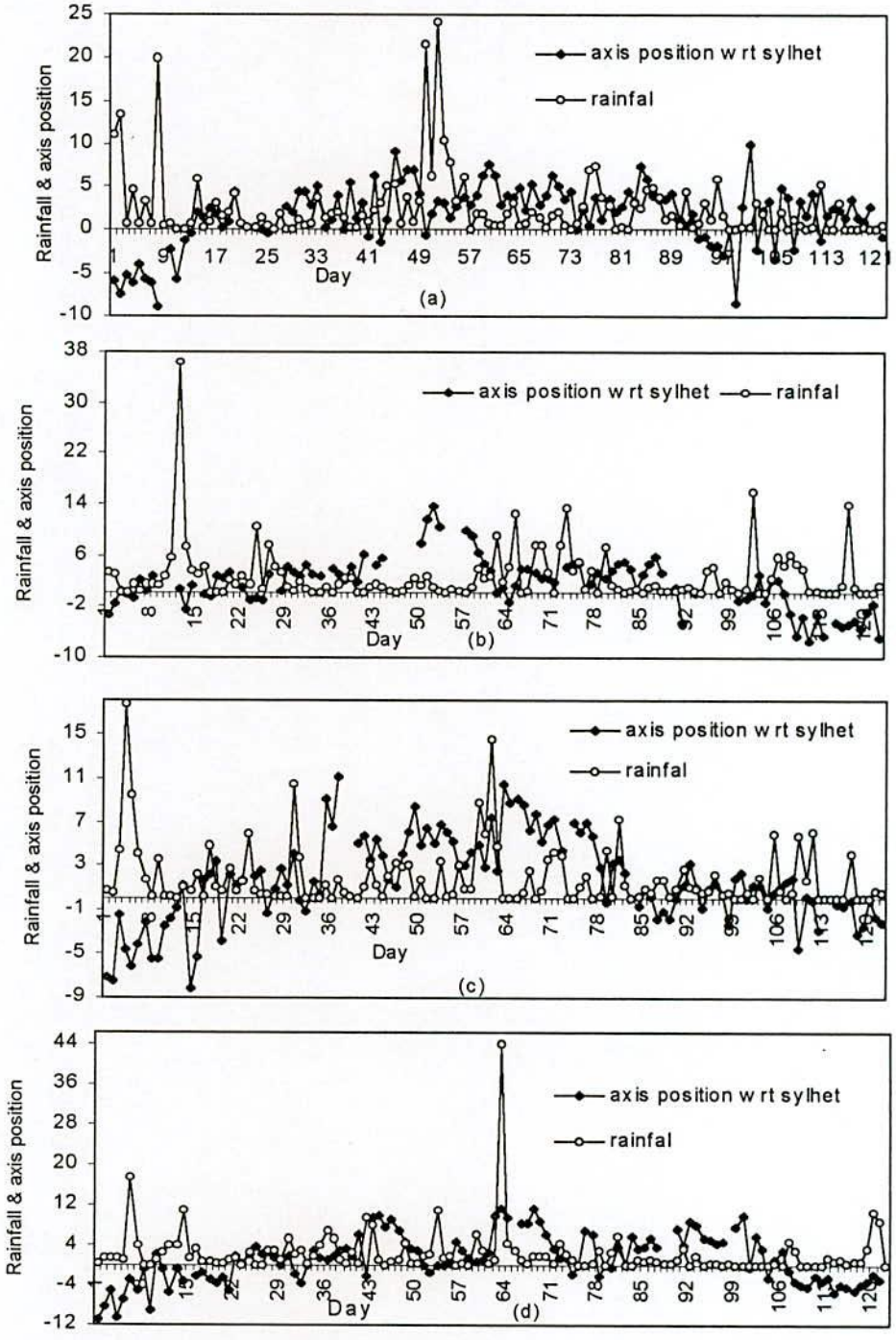

Fig. 20(a-d): Distribution of monsoon rainfall and axis position of 300 hPa anticyclonic axis in the monsoon season of 1998, 2000, 2001 and 2002 over Sylhet station respectively

3.6 Correlation Coefficient

We have calculated the correlation coefficient (CC) between the daily average rainfall of different stations over Bangladesh in the monsoon season and the upper air anticyclonic axis at 200 and 300 hPa level. We have considered different longitudes such as 85°, 90° and 95°E for the different months of monsoon season in the year 1998, 2000, 2001 and 2002.

Table 3.1: The CC between daily average rainfall and the anticyclonic axis position at 200 and 300 hPa level of different longitude.

June								
Axis Position in °E	200 hPa				300 hPa			
	1998	2000	2001	2002	1998	2000	2001	2002
85	0.0105	0.0655	-0.0047	0.0227	0.1350	-0.1641	-0.1975	0.1085
90	-0.0674	0.0389	-0.0622	0.0708	0.1248	-0.1190	-0.2452	0.0396
95	-0.0617	0.1078	-0.1254	0.0650	0.1198	-0.0644	-0.2616	0.0364
July								
	200 hPa				300 hPa			
85	0.0171	0.0577	-0.1581	-0.2438	-0.2875	0.1681	0.0255	-0.3284
90	-0.2023	0.0855	-0.0301	-0.3129	-0.2851	0.1628	-0.0133	-0.2994
95	-0.3170	0.0826	0.0595	-0.3350	-0.0643	0.3591	-0.0437	-0.4686
August								
	200 hPa				300 hPa			
85	-0.1495	-0.2667	-0.1387	-0.0154	-0.3629	-0.3724	-0.2099	-0.1591
90	-0.2531	-0.2307	-0.1362	-0.0617	-0.3756	-0.6161	-0.2208	-0.1387
95	-0.3469	-0.3007	-0.1223	-0.1436	-0.3202	-0.6345	-0.2373	-0.1699
September								
	200 hPa				300 hPa			
85	-0.3883	-0.0481	-0.1976	0.1534	-0.0866	-0.0022	-0.3310	-0.0701
90	-0.2772	-0.2259	-0.1483	0.1540	-0.1173	-0.2300	-0.1562	-0.0454
95	-0.2158	-0.3753	0.0316	0.1599	-0.0945	-0.3514	0.1045	-0.0350

June: The CC between daily average rainfall in the monsoon season and the upper air anticyclonic axis position of June are shown in Table 3.1. The table shows that the maximum values of CC at 200 hPa level is observed along 95°E longitude in 2001 and its value is –0.1254.

The table also shows that the maximum values of CCs observed at 300 hPa level are –0.1975, -0.2452 and –0.2616 along 85°, 90° and 95°E longitudes respectively in 2001 as shown in Table1.

July: The CC between daily average rainfall and the upper air anticyclonic axis position of July shows that the maximum values are –0.2023 and –0.3170 along 90° and 95°E respectively in 1998, -0.2438, -0.3129 and –0.3350 along 85°, 90° and 95°E longitudes respectively in 2002 at 200 hPa level.

At 300 hPa level the maximum values of CC are –0.2875 and –0.2851 along 85° and 90°E longitudes respectively in 1998, 0.3591 along 95°E longitude in 2000 and –0.3284 and –0.4686 along 85° and 95°E longitudes respectively in 2002.

August: The CC between daily average rainfall and the upper air anticyclonic axis position at 200 hPa level shows that the maximum values are –0.2531 and –0.3469 along 90° and 95°E longitudes respectively in 1998, -0.2667 and –0.3469 along 85° and 95°E longitudes respectively in 2000.

At 300 hPa level the maximum values are –0.3629, -0.3756 and –0.3202 along 85°, 90° and 95°E longitudes respectively in 1998, -0.3724, -0.6161 and –0.6345 along 85°, 90° and 95°E longitudes respectively in 2000, -0.2208 and –0.2375 along 90° and 95°E longitudes respectively in 2001.

September: The CC between daily average rainfall and the upper air anticyclonic axis position shows that the maximum values at 200 hPa level are –0.3883 at 85°E in 1998 and -0.3753 at 95°E in 2000.

The table also shows that at 300hPa level the maximum values are –0.3514 at 95°E in 2000 and –0.3310 at 85°E in 2001.

3.7 Position anomaly of upper air anticyclonic axis at 200 hPa and 300 hPa level

In this section we have discussed the anomaly of the position of upper air anticyclonic axis for different month of the monsoon season at longitudes 85°, 90° and 95°E for the years 1998, 2000, 2001 and 2002 at 200 and 300 hPa level. In some days it was not possible to draw the anticyclonic axis at 200 and 300 hPa level constant pressure (CP) chart. In that case we have no data and in the figure the data were absent.

3.7.1 Position anomaly of upper air anticyclonic axis at 200 hPa level

3.7.1.1 Position anomaly of upper air anticyclonic axis of June

3.7.1.1.1 Position anomaly of upper air anticyclonic axis of June along 85°E longitude

The axis position of the upper air anticyclone at 200 hPa level along 85°E longitude in June are presented as in Fig. 21(a). The axis was behind the mean position in the first week of June of 1998. The axis crosses the mean position at 10 June. After then the axis was above the mean position throughout the month. In 2000 the movement of the axis of upper air anticyclone was oscillatory about the mean position all through the month. The upper air anticyclonic axis position of June 2001 was behind the mean position during 1-11 June, during 12-15 June it was oscillatory about the mean position and 16-30 June it was above the mean position. We observed that in 2002 the upper air anticyclonic axis was oscillatory during 3-21 June and the axis was above the mean position during22-30 June.

3.7.1.1.2 Position anomaly of upper air anticyclonic axis of June along 90°E longitude

The upper air anticyclonic axis position at 200 hPa level along 90°E longitude in June are described as in Fig. 21(b). During the first week of June of 1998 the axis was behind the mean position. The axis crosses the mean position at 10 June and after then the axis was above the mean position throughout the month. In 2000 the movement of the axis of upper air anticyclone was oscillatory about the mean position throughout the month. We observed in 2001 that the position of the upper air anticyclonic axis was behind the mean position during 1-11 June, during 12-25 June it was oscillatory about the mean position and 16-30 June it was above the mean position. During 1-8 June of 2002 the upper air anticyclonic axis was behind the mean position. From then up to 21 June the

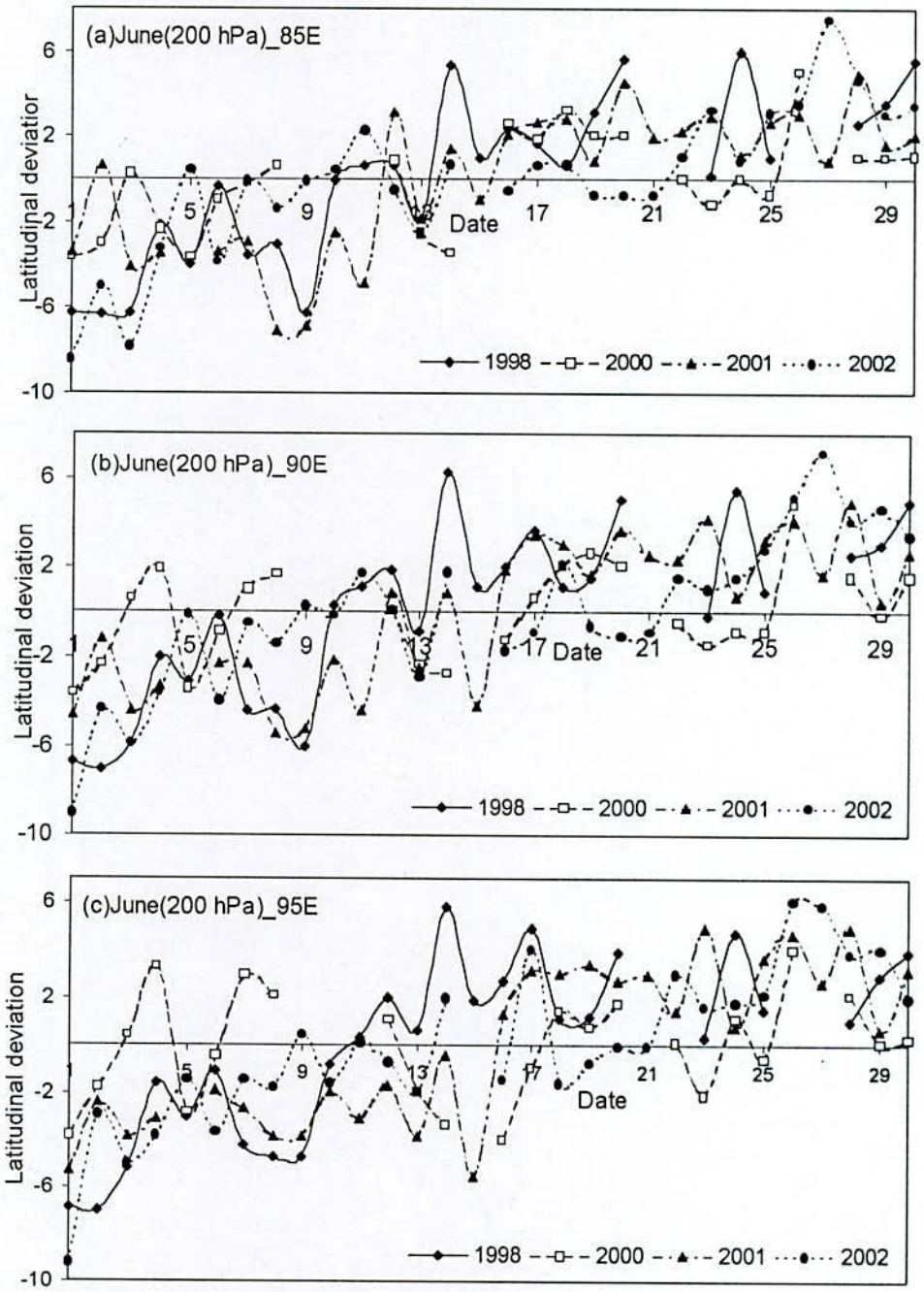

Fig. 21(a-c): Latitudinal anomalies of upper air anticyclonic axis at 200 hPa level for the month of June, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

axis was oscillatory about the mean position and 22-30 June the axis was above the mean position.

3.7.1.1.3 Position anomaly of upper air anticyclonic axis of June along 95°E longitude

The upper air anticyclonic axis position at 200 hPa level along 90°E longitude in June of different year are shown in Fig. 21(c). During 1-11 June of 1998 the axis was behind the mean position. The axis crosses the mean position at 11 June and then the axis was above the mean position throughout the month. In 2000 the movement of the axis of upper air anticyclone was oscillatory about the mean position all through the month. The upper air anticyclonic axis position in the month of June of 2001 was behind the mean position during 1-11 June. During 12-15 June it was oscillatory about the mean position and 16-30 June it was above the mean position. During 1-8 June of 2002 the upper air anticyclonic axis was behind the mean position. From then up to 21 June the axis was oscillatory about the mean position and the axis was above the mean position during 22-30 June.

3.7.1.2 Position anomaly of upper air anticyclonic axis of July

3.7.1.2.1 Position anomaly of upper air anticyclonic axis of July along 85°E longitude

The upper air anticyclonic axis position at 200hPa level along 85°E longitude of July of different year is described as in Fig. 22(a). We observed that during 1-14 July the movement was oscillatory about the mean position. During 15-19 July the axis was above the mean position and 20-25 July it was behind the mean position. During 1-12 July the upper air anticyclonic axis position for the month of July 2000 was behind the mean position and 20-29 July it was above the mean position. The axis position of upper air anticyclone of July 2001 was below the mean position during 1-4 July and 10-16 July. During 17-21 July the axis was oscillatory about the mean position and 22-25 July it was above the mean position. During 1-11 July of 2002 the upper air anticyclonic axis position at 200 hPa level was oscillatory about the mean position. During 13-18 July it was above the mean position and 19-31 July the axis was below the mean position.

3.7.1.2.2 Position anomaly of upper air anticyclonic axis of July along 90°E longitude

The axis position of the upper air anticyclone at 200 hPa level along 90°E longitude in July are presented as in Fig. 22(b). We observed that during 1-14 July of 1998 the movement was oscillatory about the mean position. During 15-19 and 26-31

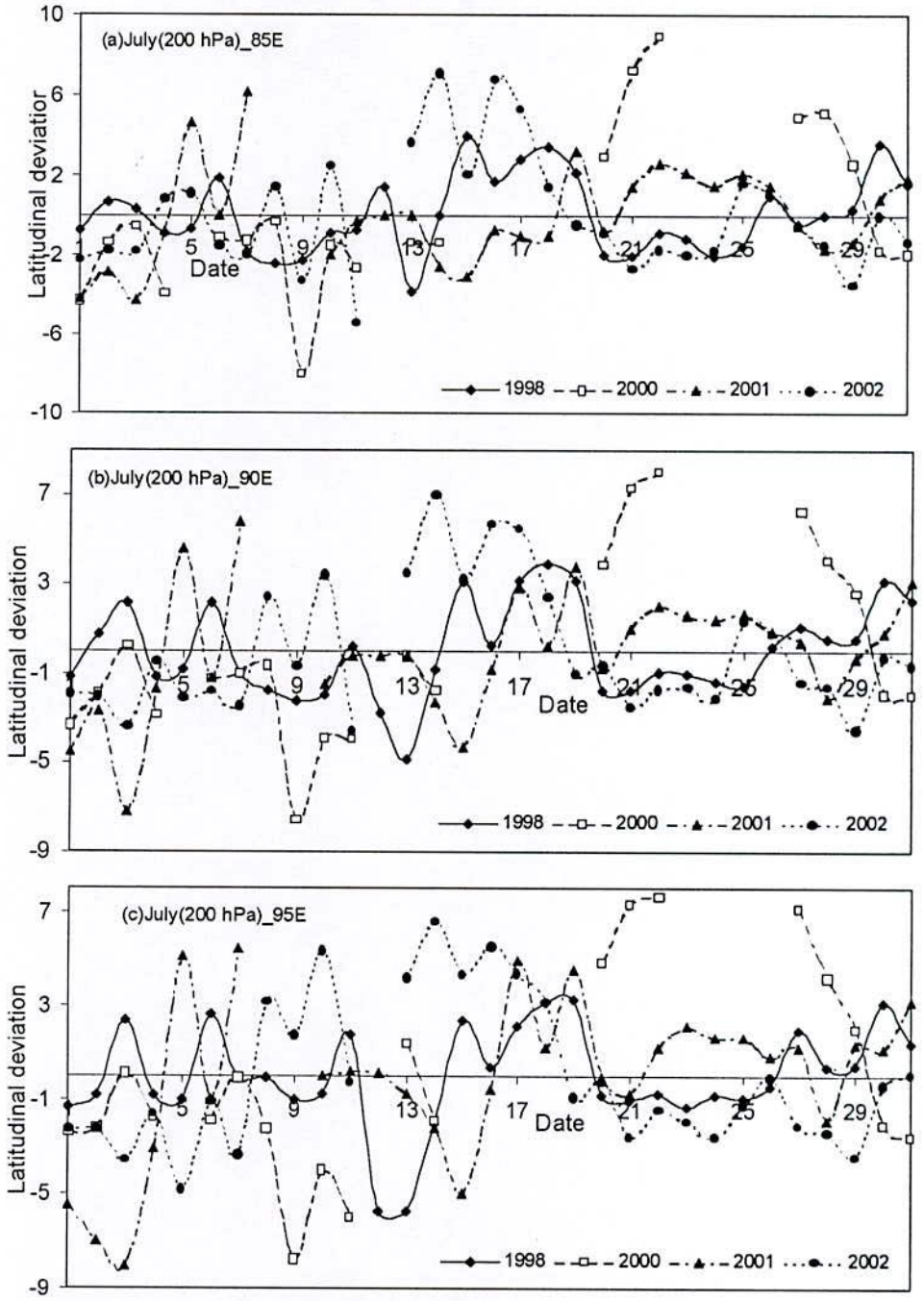

Fig. 22(a-c): Latitudinal anomalies of upper air anticyclonic axis at 200 hPa level for the month of July, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

July the axis was above the mean position and 20-25 July it was behind the mean position. The upper air anticyclonic axis position for the month of July 2000 was behind the mean position during 1-12 July and it was above the mean position during 20-29 July. The position of the axis of upper air anticyclone of July 2001 was below the mean position during 1-4 July and 10-16 July and it was above the mean position during 17-27 July. During 1-7 July the upper air anticyclonic axis was below the mean position of July 2002. During 8-11 July it was oscillatory about the mean position, 13-18 July it was above the mean position and 19-31 July the axis was below the mean position.

3.7.1.2.3 Position anomaly of upper air anticyclonic axis of July along 95°E longitude

The axis position of the upper air anticyclone at 200 hPa level along 95°E longitude in July are shown in Fig. 22(c). In 1998, during 1-14 July the movement of the axis was oscillatory about the mean position. During 15-19 and 26-31 July the axis was above the mean position and 20-25 July it was behind the mean position. The position of the upper air anticyclonic axis for the month of July 2000 was behind the mean position during 1-11 July and it was above the mean position during 20-29 July. During 1-4 July the position of the axis of upper air anticyclone of July 2001 was below the mean position and 22-27 July the axis was above the mean position. For all other days of the month it was oscillatory about the mean position. In 2002 the upper air anticyclonic axis was below the mean position during 1-7 July. During 8-11 July it was oscillatory about the mean position and 13-18 July it was above the mean position and during 19-31 July the axis was below the mean position.

3.7.1.3 Position anomaly of upper air anticyclonic axis of August

3.7.1.3.1 Position anomaly of upper air anticyclonic axis of August along 85°E longitude

The upper air anticyclonic axis position at 200hPa level along 85°E longitude for the month of August is described as in Fig. 23(a). During 1-22 August of 1998 the movement of the axis was oscillatory about the mean position. During 23-27 August the axis was above the mean position and 28-31 it was behind the mean position. In 2000 the movement of the axis of upper air anticyclone was oscillatory about the mean position about all through the month. During 1-16 August of 2001 the upper air anticyclonic axis was above the mean position and 22-31 August it was behind the mean position. The axis position was above the mean position during 1-8 August of 2002. During 9-21 August the

axis was below the mean position and 22-31 August it was oscillatory about the mean position.

3.7.1.3.2 Position anomaly of upper air anticyclonic axis of August along 90°E longitude

The upper air anticyclonic axis position at 200hPa level along 90°E longitude for the month of August are presented as in Fig. 23(b). In 1998, during 1-22 August the axis position was oscillatory about the mean position. During 23-27 August the axis was above the mean position and 28-31 August it was behind the mean position. The position of the axis of August 2000 was below the mean position during 2-6 August. During 7-14 August it was oscillatory about the mean position and 16-26 August it was above the mean position. In 2001, during 1-11 August the upper air anticyclonic axis was above the mean position. During 12-21 August the axis was oscillatory about the mean position and 22-31 August it was behind the mean position. During 1-8 August of 2002 the axis position was above the mean position. During 9-21 August the axis was below the mean position and 22-31 August it was oscillatory about the mean position.

3.7.1.3.3 Position anomaly of upper air anticyclonic axis of August along 95°E longitude

The anticyclonic axis position along 95°E longitude for the month of August is described as in Fig. 23(c). During 1-5 August the anticyclonic axis was below the mean position and during 6-22 August it was oscillatory about the mean position. During 23-27 August the axis was above the mean position and 28-31 August it was behind the mean position. During 1-14 August of 2000 the movement of the axis was oscillatory about the mean position and during 16-26 August it was above the mean position. During 1-11 August the upper air anticyclonic axis was above the mean position in 2001 and during 17-31 August the axis was behind the mean position. In 2002 the axis position of upper air anticyclone was above the mean position during 1-8 August. During 9-15 August the axis was below the mean position, 16-23 August it was oscillatory about the mean position and in last week it was above the mean position.

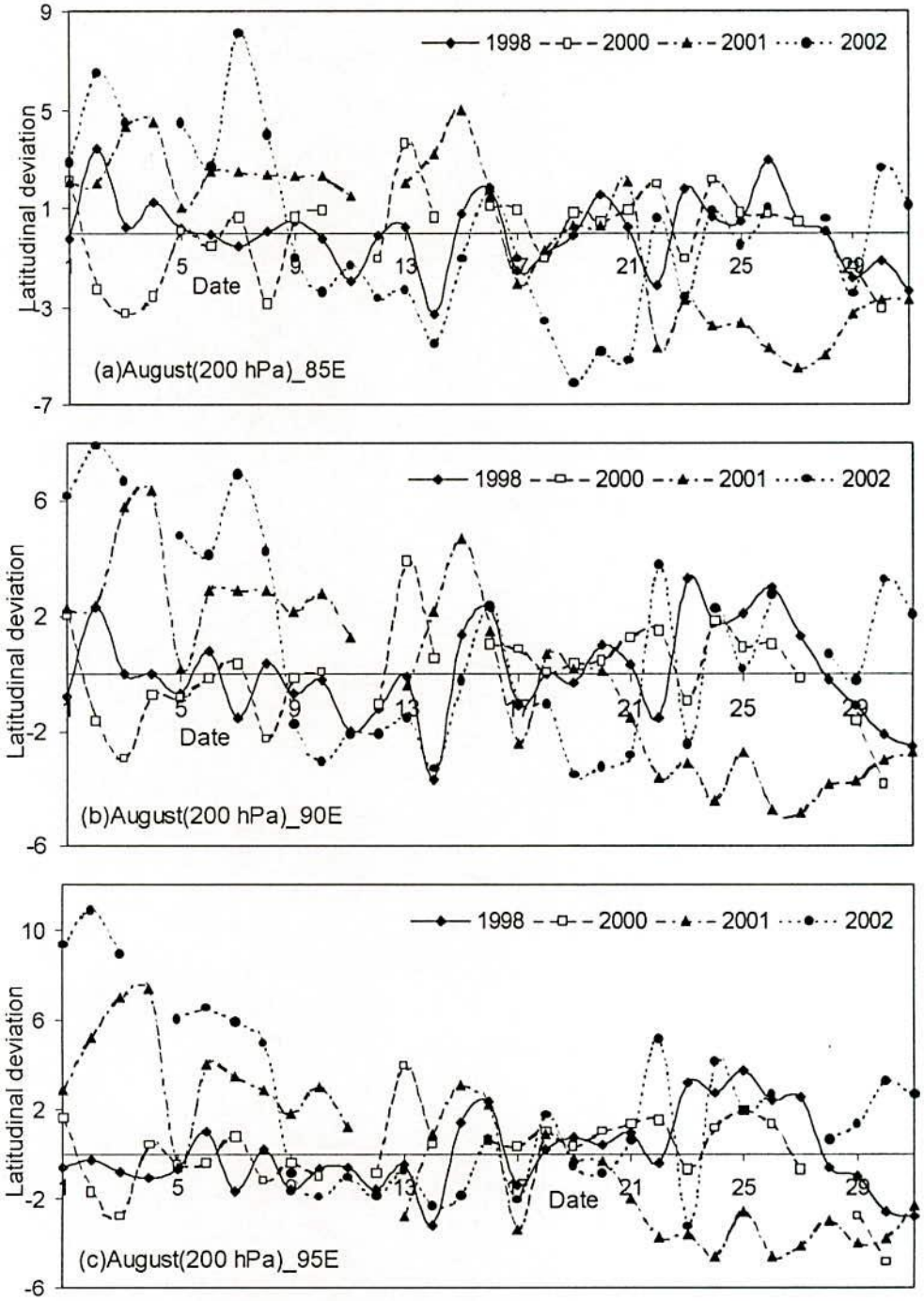

Fig. 23(a-c): Latitudinal anomalies of upper air anticyclonic axis at 200 hPa level for the month of August, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

3.7.1.4 Position anomaly of upper air anticyclonic axis of September

3.7.1.4.1 Position anomaly of upper air anticyclonic axis of September along 85°E longitude

The movement of the axis of upper air anticyclone along 85°E longitude at 200 hPa level of September of different year are presented as in Fig. 24(a). We observed that during 4-12 September of 1998 the anticyclonic axis was behind the mean position and 17-27 September it was above the mean position. During 8-17 September of 2000 the upper air anticyclonic axis was above the mean position and during 18-30 September it was behind the mean position. In 2001 the axis was above the mean position during 1-9 September. From then up to 23 September the movement of the axis was oscillatory about the mean position and 24-30 September it was behind the mean position. During 1-11 September of 2002 the axis of upper air anticyclone was above the mean position and 16-30 September the axis was below the mean position.

3.7.1.4.2 Position anomaly of upper air anticyclonic axis of September along 90°E longitude

The movement of the axis of upper air anticyclone along 90°E longitude at 200 hPa level of September are described as in Fig. 24(b). During 4-12 September of 1998 the anticyclonic axis was behind the mean position and 17-27 September the axis was above the mean position. In 2000, during 8-17 September the upper air anticyclonic axis was above the mean position and 18-30 September it was behind the mean position. The axis position of upper air anticyclone was above the mean position during 1-5 September for the month of September of 2001. From then up to 23 September the movement of the axis was oscillatory about the mean position and 24-30 September it was behind the mean position. During 1-9 September of 2002 the axis of upper air anticyclone was above the mean position and 16-30 September the axis was below the mean position.

3.7.1.4.3 Position anomaly of upper air anticyclonic axis of September along 95°E longitude

The positions of the axis of upper air anticyclone along 95°E longitude of September of different year are shown in Fig. 24(c). In 1998 we observed that during 4-8 September the anticyclonic axis was behind the mean position and during 11-26

September the axis was above the mean position. During 8-17 September of 2000 the upper air anticyclonic axis was above the mean position and 18-30 September it was

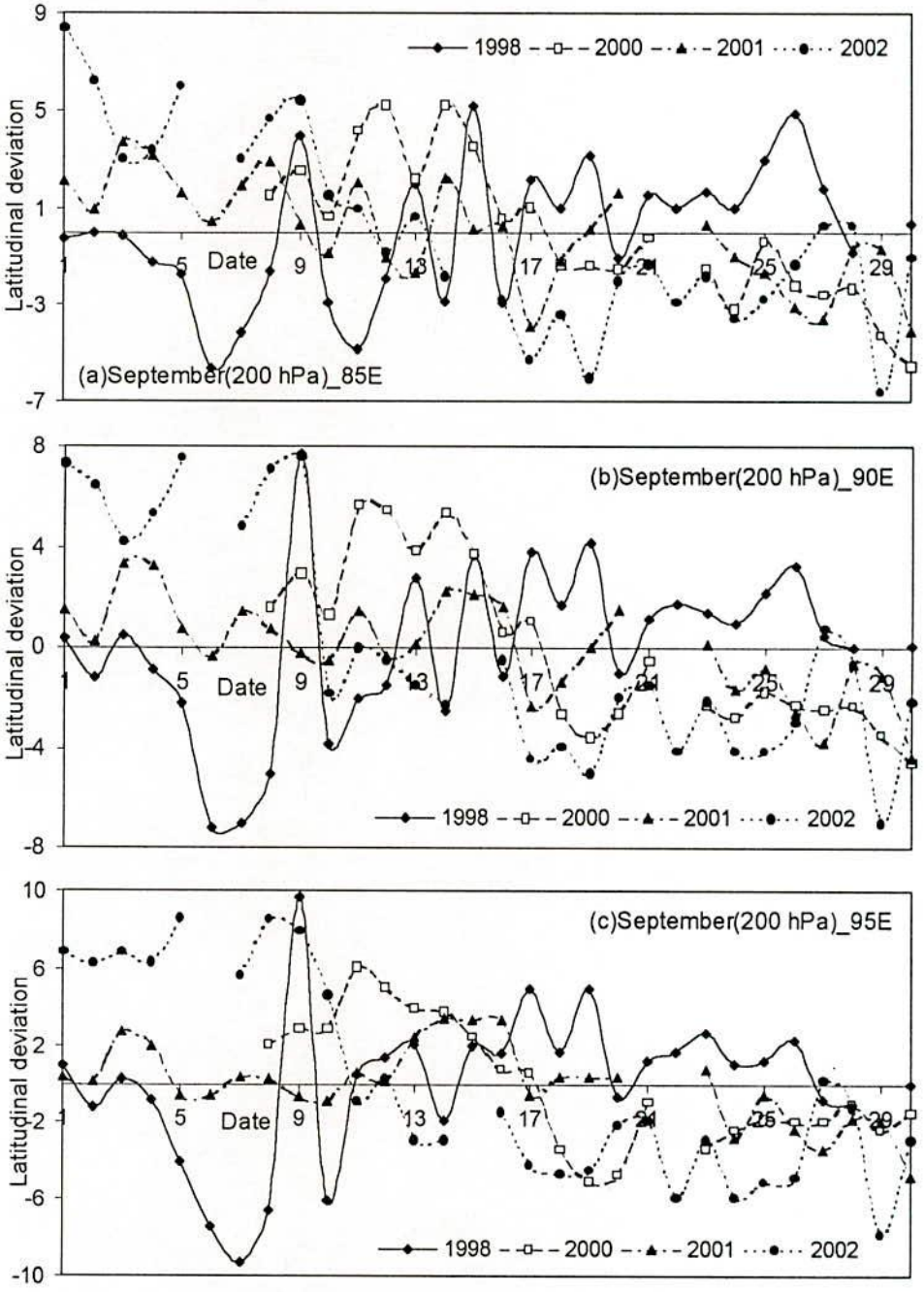

Fig. 24(a-c): Latitudinal anomalies of upper air anticyclonic axis at 200 hPa level for the month of June, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

behind the mean position. In 2001 we observed that the axis position of upper air anticyclone was oscillatory about the mean position during 1-23 September and the axis was behind the mean position during 24-30 September. During 1-10 September of 2002 the axis of upper air anticyclone at 200 hPa level was above the mean position and 16-30 September the axis was below the mean position.

3.7.2 Position anomaly of upper air anticyclonic axis at 300 hPa level

3.7.2.1 Position anomaly of upper air anticyclonic axis of June

3.7.2.1.1 Position anomaly of upper air anticyclonic axis of June along 85°E longitude

The movement of the axis of upper air anticyclone at 300 hPa level along 85°E longitude of June of different year are presented as in Fig. 25(a). In 1998, during 1-8 June the axis was below the mean position and during 13-30 June the axis was above the mean position. The upper air anticyclonic axis for the month of June of 2000 was below the mean position during 1-5 June. For the rest of the days the axis movement was oscillatory about the mean position. In 2001 the axis position of upper air anticyclone was below the mean position during 1-10 June and the axis was above the mean position during 20-30 June. In 2002 we observed that the position of the axis was below the mean position during 1-7 June. During 8-21 June the axis was oscillatory about the mean position and during 22-30 June the axis was above the mean position.

3.7.2.1.2 Position anomaly of upper air anticyclonic axis of June along 90°E longitude

The position of the axis of upper air anticyclone at 300 hPa level along 90°E longitude for the month of June are shown in Fig. 25(b). During 1-8 June of 1998 the axis was below the mean position and during 13-30 June the axis was above the mean position. During 1-5 June of 2000 the upper air anticyclonic axis was below the mean position and for the rest of the days the axis movement was oscillatory about the mean position. In 2001 we observed that during 1-10 June the axis position of upper air anticyclone was below the mean position and during 20-30 June the axis was above the mean position. During 1-5 June of 2002 the position of the axis of upper air anticyclone was below the mean position, during 6-21 June the axis was oscillatory about the mean position and during 22-30 June the axis was above the mean position.

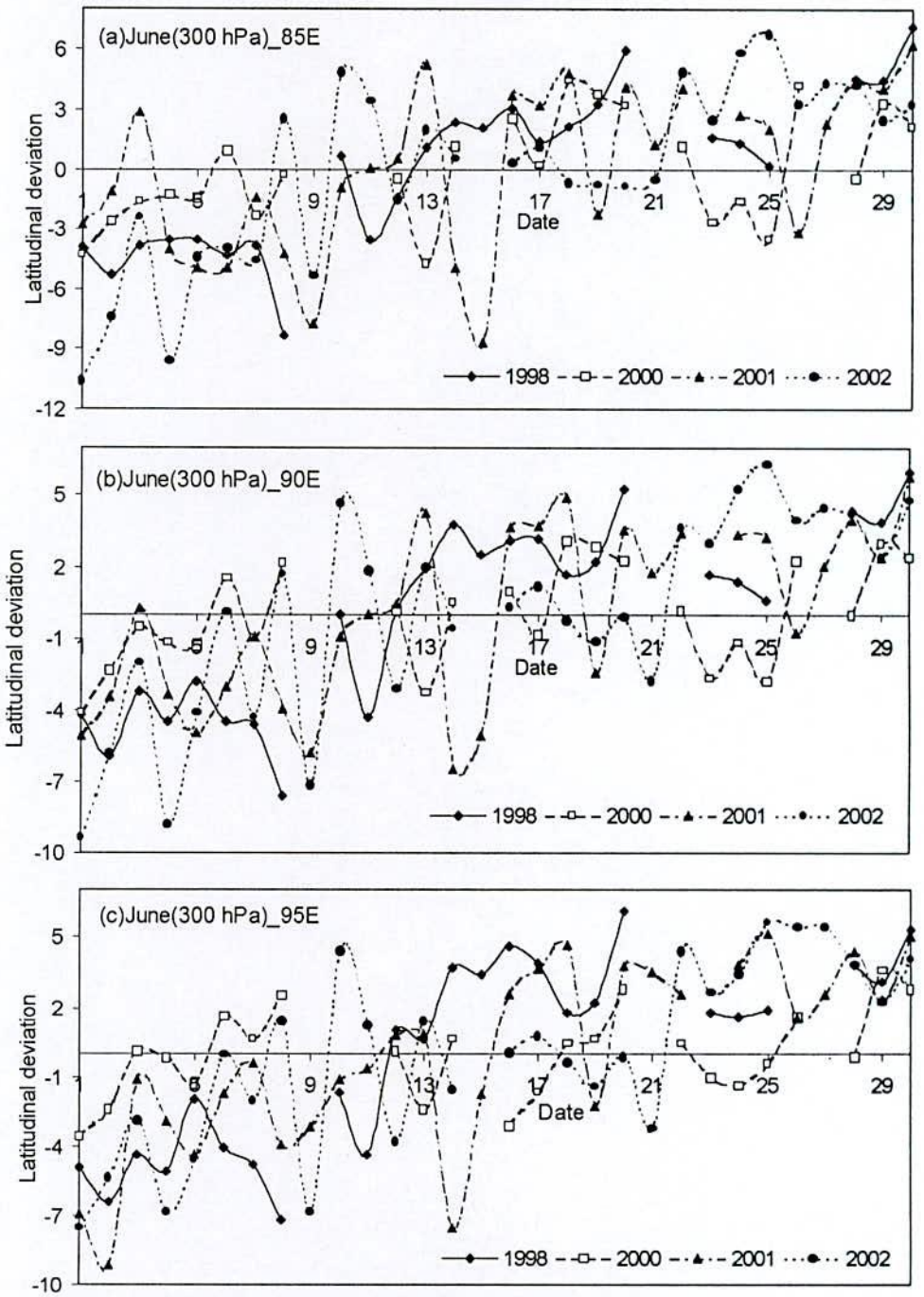

Fig. 25(a-c): Latitudinal anomalies of upper air anticyclonic axis at 300 hPa level for the month of June, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

3.7.2.1.3 Position anomaly of upper air anticyclonic axis of June along 95°E longitude

The movement of the axis of upper air anticyclone along 95°E longitude at 300 hPa level of June of different year are presented as in Fig. 25(c). During 1-8 June of 1998 the axis was below the mean position and during 13-30 June the axis was above the mean position. In 2000 the upper air anticyclonic axis for the month of June was oscillatory about the mean position for whole the month. We observed in 2001 that during 1-11 June the axis position of upper air anticyclone was below the mean position and the axis was above the mean position during 20-30 June. During 1-5 June of 2002 the position of the axis was below the mean position, 6-21 June it was oscillatory about the mean position and 22-30 June it was above the mean position.

3.7.2.2 Position anomaly of upper air anticyclonic axis of July

3.7.2.2.1 Position anomaly of upper air anticyclonic axis of July along 85°E longitude

The upper air anticyclonic axis along 85°E longitude at 300 hPa level for the month of July of different year is described as in Fig. 26(a). In this month of 1998 the anticyclonic axis was oscillatory about the mean position about all through the month. In 2000 the position of the axis of upper air anticyclone of July was below the mean position during 1-11 July and it was above the mean position during 21-29 July. We observed in 2001 that the position of the axis of upper air anticyclone of July was below the mean position during 1-4 July and it was above the mean position during 5-13 and 19-25 July. The upper air anticyclonic axis for the month of July 2002 was below the mean position during 1-9 July. During 13-20 July the axis was above the mean position and during 22-30 July the axis was below the mean position.

3.7.2.2.2 Position anomaly of upper air anticyclonic axis of July along 90°E longitude

The upper air anticyclonic axis at 300 hPa level along 90°E longitude for the month of July is described as in Fig. 26(b). In July 1998 the anticyclonic axis was oscillatory all through the month. During 1-10 July of 2000 the position of the axis was below the mean position and during 20-29 July it was above the mean position. We observed in 2001 that during 1-4 July the axis was below the mean position and 5-11 and 18-25 July it was above the mean position. In 2002 the upper air anticyclonic axis for the

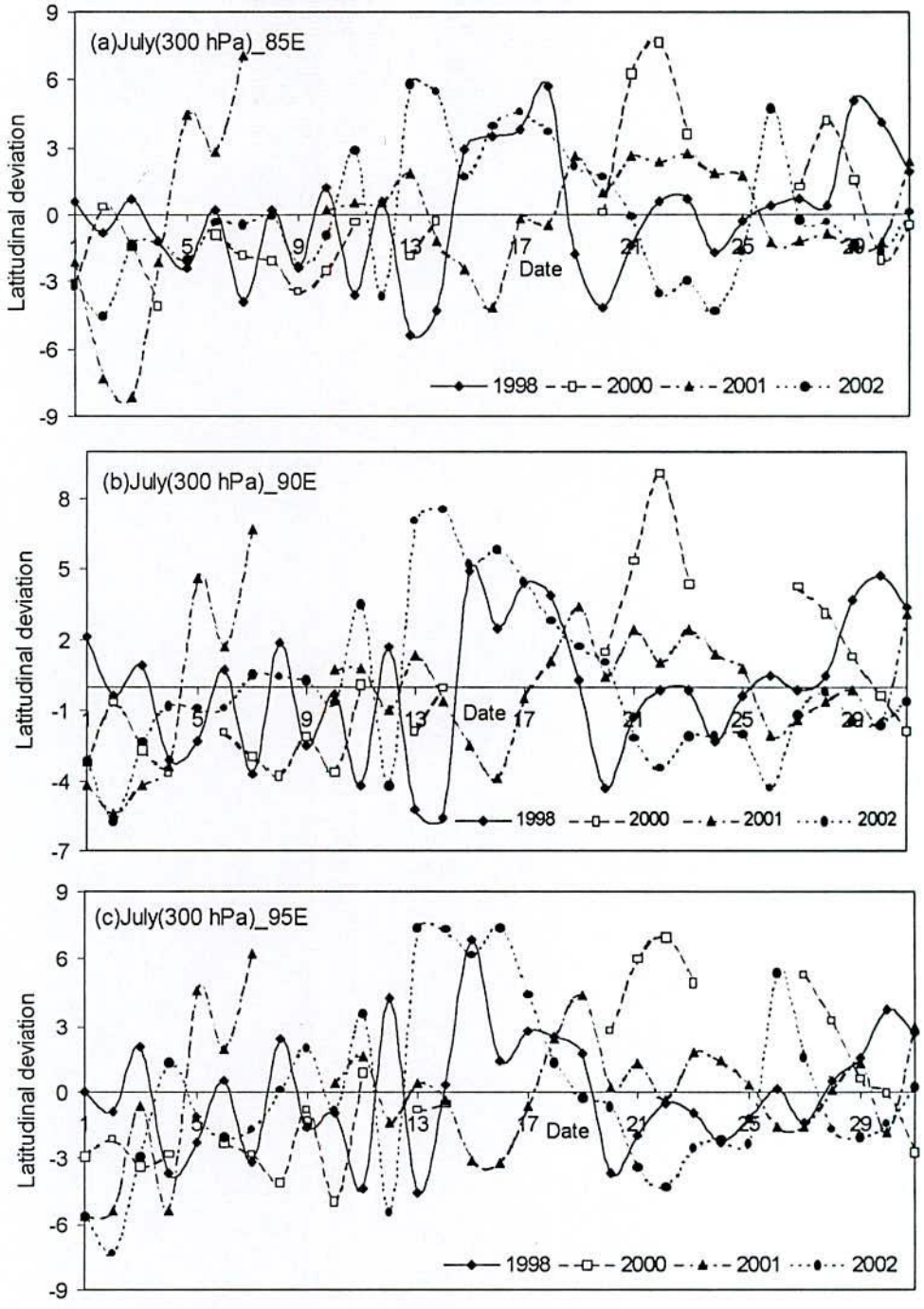

Fig. 26(a-c): Latitudinal anomalies of upper air anticyclonic axis at 300 hPa level for the month of July, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

month of July 2002 was below the mean position during 1-6 July. During 13-20 July the axis was above the mean position and 21-31 July it was below the mean position.

3.7.2.2.3 Position anomaly of upper air anticyclonic axis of July along 95°E longitude

The position of upper air anticyclonic axis along 95°E longitude at 300 hPa level for the month of July of different year is described as in Fig. 26(c). In this month of 1998 the anticyclonic axis was oscillatory about the mean position all through the month. The position of the axis of upper air anticyclone was below the mean position of July 2000 during 1-10 July and it was above the mean position during 20-29 July. During 1-4 July of 2001 the axis of upper air anticyclone was below the mean position. During 10-31 July the axis was oscillatory about the mean position. In 2002 the movement of upper air anticyclonic axis was oscillatory about the mean position during 1-12 July. During 13-18 July the axis was above the mean position and 19-30 July it was below the mean position.

3.7.2.3 Position anomaly of upper air anticyclonic axis of August

3.7.2.3.1 Position anomaly of upper air anticyclonic axis of August along 85°E longitude

The movement of the axis of upper air anticyclone along 85°E longitude at 300 hPa level of August are presented as in Fig. 27(a). In 1998 we observed that the axis was oscillatory about the mean position of August almost all time. In 2000 the movement of the upper air anticyclonic axis was oscillatory about the mean position almost all through the month of August. The position of the axis of upper air anticyclone of August 2001 was below the mean position during 2-16 August and the axis was below the mean position during 21-31 August. In 2002 the axis position of upper air anticyclone for the month of August was above the mean position during 1-9 August and from then up to 31 August the axis was oscillatory about the mean position.

3.7.2.3.2 Position anomaly of upper air anticyclonic axis of August along 90°E longitude

The movement of the axis of upper air anticyclone along 90°E longitude at 300 hPa level of August of different year are presented as in Fig. 27(b). In this month of 1998 the axis was oscillatory about the mean position. We observed in 2000 that the movement of the upper air anticyclonic axis was also oscillatory about the mean position. In 2001 the position of the axis of upper air anticyclone was above the mean position during 2-16

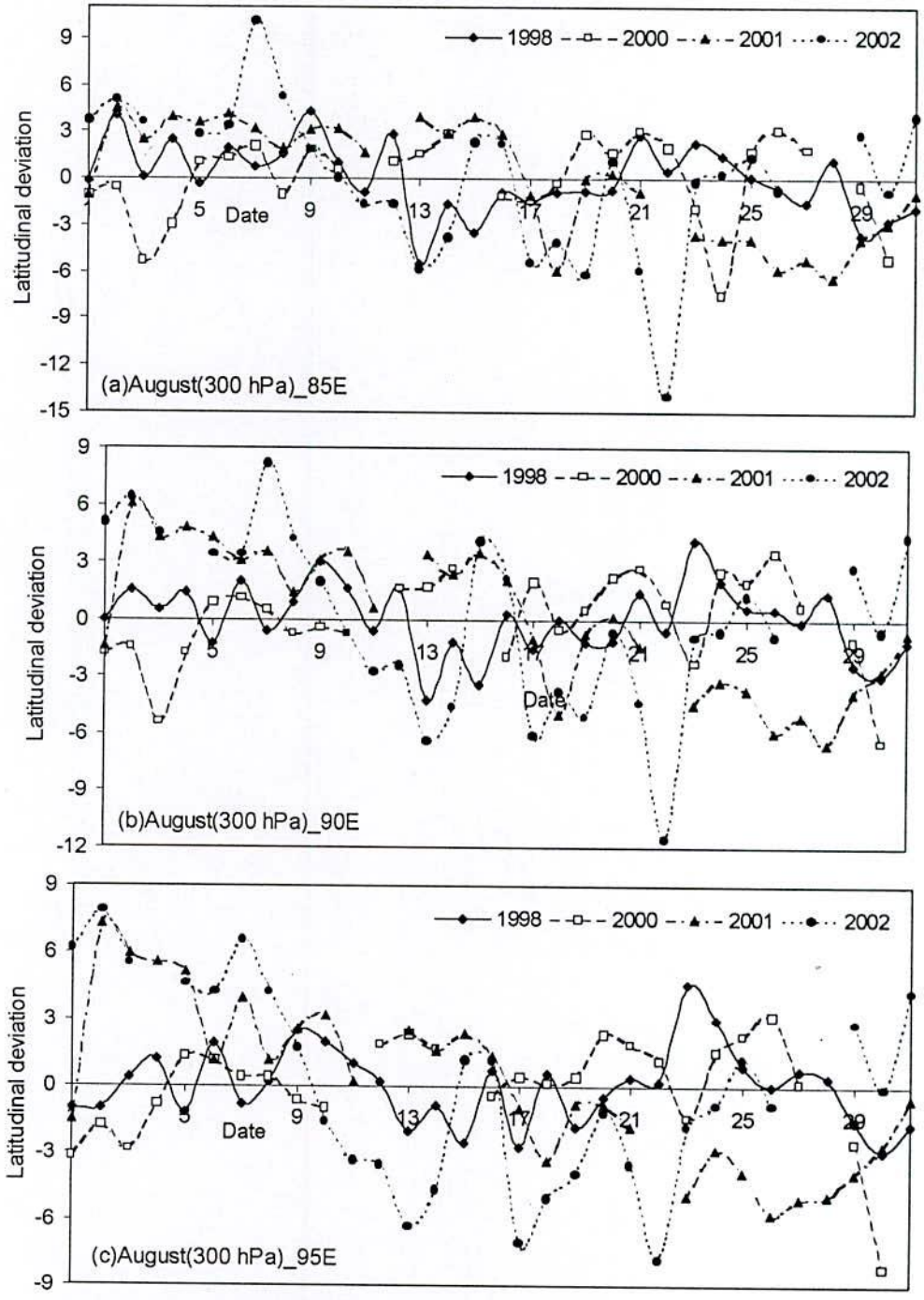

Fig. 27(a-c): Latitudinal anomalies of upper air anticyclonic axis at 300 hPa level for the month of August, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

August and it was below the mean position during 17-31 August. The axis position of upper air anticyclone for the month of August of 2002 was above the mean position during 1-9 August and 10-24 August the axis was below the mean position.

3.7.2.3.3 Position anomaly of upper air anticyclonic axis of August along 95°E longitude

The movement of the axis of upper air anticyclone along 95°E longitude at 300 hPa level of August are presented as in Fig. 27(c). In 1998 the axis was oscillatory about the mean position of August almost all time. The upper air anticyclonic axis for the month of August of 2000 was also oscillatory about the mean position. In 2001 the axis was above the mean position during 2-16 August and it was below the mean position during 17-31 August. In August of 2002, during 1-9 August the axis position was above the mean position and then from 10 to 24 August the axis was below the mean position.

3.7.2.4 Position anomaly of upper air anticyclonic axis of September

3.7.2.4.1 Position anomaly of upper air anticyclonic axis of September along 85°E longitude

The movement of the axis of upper air anticyclone along 85°E longitude at 300 hPa level of September are presented as in Fig. 28(a). During 1-20 September of 1998 the axis was oscillatory about the mean position and from then up to the end of the month it was above the mean position. In 2000 the axis position of upper air anticyclone was oscillatory about the mean position during 8-20 September from then up to the end of the month it was below the mean position. In September of 2001 the movement of the axis was oscillatory about the mean position almost all through the month. During 1-11 September of 2002 the axis was above the mean position and 16-29 September the axis was below the mean position.

3.7.2.4.2 Position anomaly of upper air anticyclonic axis of September along 90°E longitude

The movement of the axis of upper air anticyclone along 90°E longitude at 300 hPa level of September of different year are presented as in Fig. 28(b). During 1-5 September of 1998 the axis was below the mean position and from then up to 20 September it was oscillatory about the mean position. During 8-15 September of 2000 the axis position was above the mean position and from then up to the end of the month it

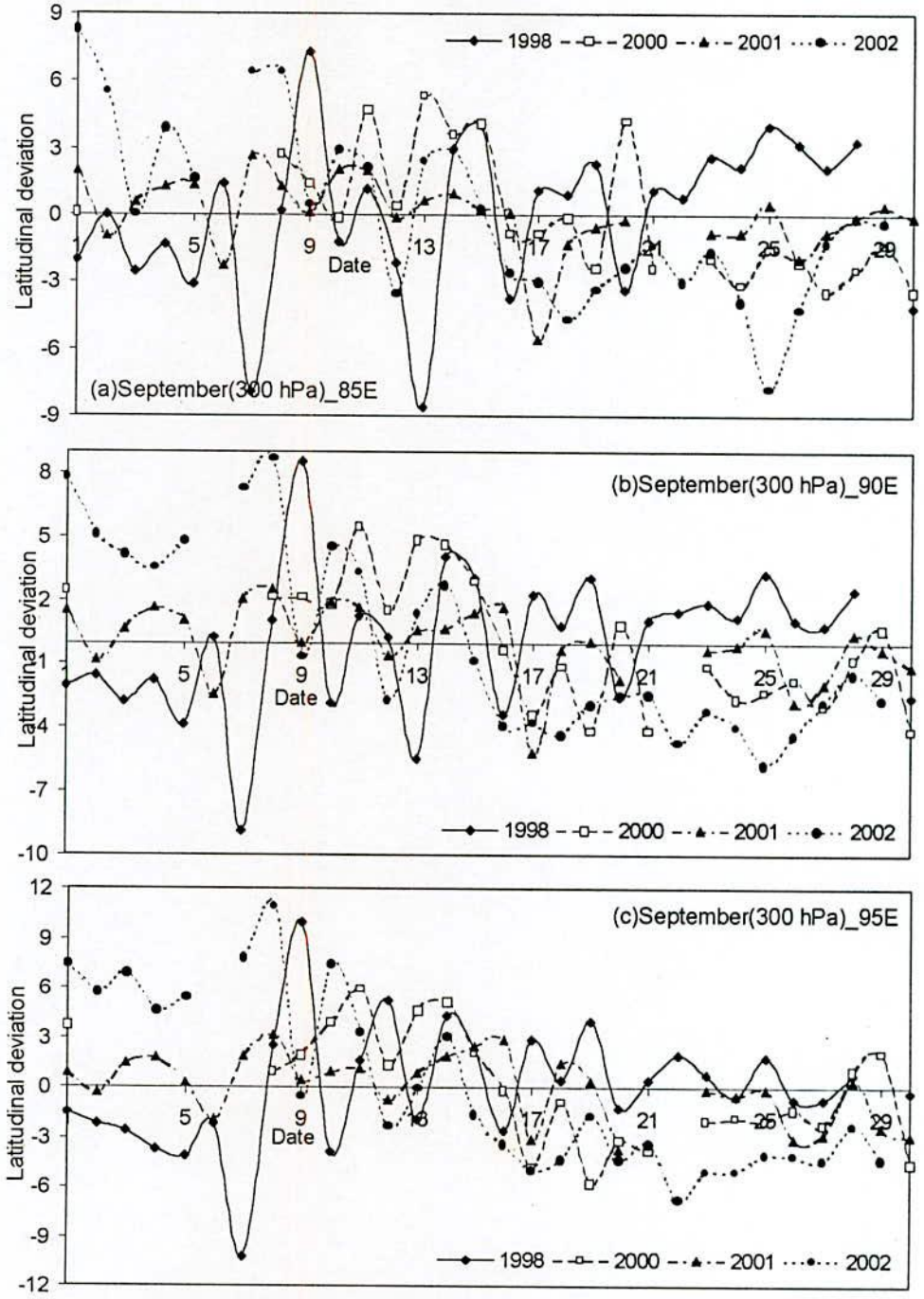

Fig. 28 (a-c): Latitudinal anomalies of upper air anticyclonic axis at 300 hPa level for the month of September, in the year 1998, 2000, 2001 and 2002 along longitudes of 85°, 90° and 95°E respectively.

was below the mean position. In 2001 the movement of the axis was oscillatory about the mean position almost all through the month of September. In September of 2002 the upper air anticyclonic axis was above the mean position during 1-11 September and it was below the mean position during 15-29 September.

3.7.2.4.3 Position anomaly of upper air anticyclonic axis of September along 95°E longitude

The movement of the axis of upper air anticyclone along 95°E longitude at 300 hPa level of September are presented as in Fig. 28(c). During 1-5 September of 1998 the axis was below the mean position and from then up to the end of the month it was oscillatory about the mean position. In 2000 the axis position was above the mean position during 8-15 September and from then up to 27 September it was below the mean position. In September of 2001 the movement of the axis was oscillatory about the mean position almost all through the month. The upper air anticyclonic axis for the month of September of 2002 was above the mean position during 1-8 September and it was below the mean position during 15-29 September.

Chapter IV: CONCLUSIONS

During the monsoon season more rainfall occurs over most of the stations in June, 3rd week of July, 1st half of August and 1st week of September. On the other hand less rainfall occurs in 3rd week of August and last half of September over Bangladesh. It is also observed that lowest amount of rainfall occurred in June 1998, July 2000, August 2001 and September 2002. In the case of stationwise rainfall; more rainfall occurs over Sylhet, Sreemangal and Khulna station and less rainfall occurs over Rajshahi, Dinajpur and Comilla station during the study period.

The upper air anticyclonic axis position is oscillatory but it has no regular trends. In the beginning of the monsoon season the axis is situated at the south of Bangladesh. The anticyclonic axis crosses Bangladesh within 2nd or 3rd week of June and after crossing it remains at the north of the country up to the last week of August. From then the axis stays near or it crosses the stations towards south within 1st or 2nd week of September. In 3rd and 4th week of September the axis stays south of the stations for most of the time.

During the monsoon season rainfall occurs over different stations of Bangladesh in June and September when the upper air anticyclonic axis of 200 and 300 hPa levels lies near the stations. In July when the anticyclonic axis of 200 and 300 hPa levels lies near or away from the stations rainfall occur. In the 2nd half of July rainfall occurs when the anticyclonic axis at 200 hPa level lies away from the station. But for 300 hPa level, rainfall occurs if the axis lies away from the station for the whole month of July. In August rainfall occurs either the anticyclonic axis of 200 and 300 hPa levels lies near or away from the stations. In 1st half of August rainfall occur over the stations even if the axis lies away from the stations. When the anticyclonic axis at 200 and 300 hPa levels moved continuously from north to south or south to north rainfall occurred over all of the stations either in that duration's or at the end of that duration's.

In the 1st half of June the anomalies of the anticyclonic axis position lies below the mean position and 2nd half it lies above the mean position at 200 and 300 hPa levels except in the year 2000. In July and August the axis position become oscillatory about the mean position with some exception. In September the axis lies above the mean position during 1st half and below the mean position during 2nd half with some exception for both the levels in the monsoon season of 1998, 2000, 2001 and 2002.

The correlation co-efficient between daily average rainfall in the monsoon season and the upper air anticyclonic axis position is not significant for 200 and 300 hPa levels.

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