ISSN 0252-1075
Research Report No. RR-067

Contributions from
Indian Institute of Tropical Meteorology

THE INSTRUMENTAL PERIOD RAINFALL SERIES OF THE INDIAN REGION : A DOCUMENTATION

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PUNE - 411 008
INDIA

MARCH 1996

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Abstract: For studying climate variability of the tropical country like India long period rainfall series can provide the information of greatest value. The summer monsoon circulation and the associated rainfall occurrences during June through September dominate the climatic conditions of the country. The time series of June-to-September total rainfall for the country as one unit has been prepared and analysed extensively to understand summer monsoon/climatic variability. Due to large spatial variability in rainfall the representation of the monsoon rainfall series for the entire country is limited, so its scientific and practical value. In order to develop an effective system for the monsoon rainfall studies the country has been divided into six zones named as North West India (NWI), North Central India (NCI), North East India (NEI), West Peninsula India (WPI), East Peninsula India (EPI) and South Peninsula India (SPI). Fluctuation, empirical orthogonal function (EOF) and cluster analyses of the summer monsoon rainfall of the period 1871-1984 of ubiquitous 306 raingauges are carried out for this classification. Updating the different zonal rainfall series on a real-time basis after getting data from all the gauges is a difficult task. In the present study by applying an objective technique 'selecting a subset of a few gauges whose mean showed the highest correlation with the all gauges mean series' a total of 116 raingauge stations (19 for NWI, 27 for NCI, 15 for NEI, 18 for WPI, 14 for EPI and 23 for SPI) maintained by the India Meteorological Department (IMD) have been identified for updating the different zonal series. The IMD gauges are better known for timely availability of data. Using the same set of the IMD gauges the winter (J-F), the summer (M-A-M), the summer monsoon monthly (J,J,A and S), the post-monsoon (O-N-D) as well as the annual rainfall series of the respective zone have also been reconstructed and updated. The different zonal series are extended maximum possible backward (prior to 1871) by applying the objective technique on the yearwise limited available gauges.

It is shown that the representative all-India monsoon rainfall series from 1871 onwards can be reconstructed/updated from the area-weighted mean of the six zones. In the same way the all-India rainfall series for the other three seasons, the four summer monsoon months and the annual total have been reconstructed and updated. The different all-India series are also extended maximum possible backwards by applying the objective technique on the available gauges. The different reconstructed series for the longest instrumental period are reported.

Key words: *Area-averaged rainfall series, reconstruction, optimization of raingauges, delineation of rainfall zones, monitoring rainfall variations*

1. Introduction

In recent years earth, atmospheric and social scientists alike have become increasingly more concern about the problem of climatic variability. Anthropogenic environmental modification and reported fluctuations in the observed climatic parameters from different parts of the globe are the main causes of the concern. Over the tropical region rainfall variability is of reatest concern, since it is an end product of a series of complex interactions among the atmospheric processes, so any fluctuation in atmospheric circulation and processes are expected to be reflected in the rainfall fluctuation. The Asian monsoon during four months of its period June-to-September contributes 75-to-90% to the annual rainfall over major parts of India. The monsoonal rainfall exhibits large spatial and temporal variability, and has been the main theme of several studies. Sporadic studies of rainfall of other periods of the year are also available. Analysis of rainfall data was found to be directly useful in agriculture, hydrology, industry and other areas. Reliability of inferences from empirical studies largely depend on the length of data. Attempts have been made to reconstruct the long period climatic series (mostly temperature and precipitation) using proxies viz. isotopic, palynological, dendrological, study of chronicles etc. as well as historical records. In the proxy reconstruction error is considerably large, and often impossible to judge. Reconstruction can be treated relatively reliable even done using few available instrumental records. Some of the studies which made such attempts are Craddock, 1976; Kraus, 1955; Manley, 1974; Smith, 1974; Tyson et al, 1975; Willett, 1950 and others.

To understand large-scale interannual variability of the summer monsoon over India preparing representative long period series of June-to-September analysis of total rainfall for the entire country was felt a suitable approach. For British India (comprised of the present India, Pakistan, Bangala Desh and Myanmar), Sir Gilbert T. Walker (1910, 1914, 1922) prepared the southwest (or summer) monsoon rainfall series for the period 1841-1908 using all available observations which varied from 40 to 2000. Annual rainfall series of British India for a 19-year period 1867-1885 was first prepared by Blanford (1886). For independent India annual/summer monsoon rainfall series for different periods (of different lengths) prepared using data from different raingauge networks are reported in Parthasarathy and Dhar, 1976; Parthasarathy and Mooley, 1978; Mooley and Parthasarathy, 1979 and 1984; Parthasarathy et al, 1987. These studies were restricted to the periods for which data for large number of stations was available. Updating such series is a difficult task due to non-availability of data for all the gauges that were involved in preparing them.

Some recent studies have attempted to demonstrate the adequacy of limited observations for the large scale precipitation and temperature series. Sontakke et al (1992) have reconstructed the summer monsoon rainfall series of India for the period 1813-1991 by applying correlation and regression approaches on a few chosen gauges, the number of gauges used in this case was between 1 and 36 inclusive, and the multiple correlation coefficient (CC) between 0.3959 and 0.9558 inclusive. In purely an objective approach it is shown that about 35 well spread observations are adequate to get a reliable estimate (CC exceeding 0.99) of mean monsoon rainfall over India (Singh, 1994; Sontakke et al 1993). Wales-Smith (1971) constructed the monthly and annual rainfall for Kew observatory (U.K.) for the period 1697-1970 using few available ephemeral records from sporadic raingauges in the nearby areas. Mather (1975) estimated monthly area average precipitation in Salem and Cumberland counties in southern New Jersey (U.S.A.) by three different methods- simple arithmetic averaging of station values, weighting of point observations by construction of Thiessen polygons, and weighting of point values by evaluating isohyetal patterns. He found little difference in values of areal average precipitation whether a 10-station, a 27-station or a combined 37-station network was used. Flohn (1976) identified drought and flood years over India during 1853-1972 using only 22 stations data. Landsberg et al (1978) attempted to reproduce the annual temperature series (1899-1975) of the northern hemisphere by fitting multiple linear regression on 9 chosen stations (multiple CC= 0.81). Later Groveman and Landsberg (1979) applied multiple linear screening technique on 20 chosen stations, 8 stations entered the regression, and the estimated series showed the CC of 0.882 with the actual annual northern hemisphere temperature series (1881-1975). They have also extended the series backward to 1579 using scanty available observations. Wigley et al (1984b) have extended the monthly and annual precipitation series of England and Wales combined back to 1766 by applying multiple regression approach on an evenly-distributed records from the sites maintaining the longest precipitation records. Nicholls and Lavery (1992) have identified ten raingauge stations, one from each of the ten zones delineated based on a cluster analysis, to monitor the rainfall fluctuations across Australia. Owing to non- availability of data from all the gauges, Christopher et al (1992) have prepared the monsoon rainfall series for western Sahel by the method of Kraus (1977) using only five gauges, which are in operation and have relatively continuous records back to the beginning of this century. They found that this five-gauge index shared 83% of its variance with the larger 38-gauge index series for the common period of 1949-1990. Over smaller river catchments objectively determined sparser raingauge network giving reliable estimates of daily rainfall can be seen in Nicks (1965), Hall and Barclay (1980) and others.

Singh et al (1991) have shown that the areal representation of the all-India summer monsoon series is limited, and it can't be improved by changing the method of preparing the series. In this paper we attempted the following:

1. Divide the country into an optimum number of zones (not necessarily homogeneous rainfall zones according to some pre-fixed criteria), so that an effective system for summer monsoon rainfall studies for the country can be developed;
2. Identify an optimum set of gauges for routine updating of the different regional, as well as the all-India summer monsoon rainfall series; and
3. Reconstruct the longest possible instrumental seasonal, summer monsoon monthly and annual rainfall series for each of the zones as well as for the whole country using the objective technique suggested elsewhere (Singh, 1994; Sontakke et al, 1993 and Wigley et al, 1984a).

2. Raingauge network considered

Monthly rainfall data from a network of 306 raingauge stations well spread over contiguous and relatively plain areas (excluding mountainous terrain in the extreme northern parts and the Islands in the Bay of Bengal and the Arabian Sea) of India is used in the study. The study area is 2880324 km^2 which is about 88% of the total geographical area of the country, and hereafter this will be referred to as the country or all-India. For the period 1871-1984 the data for different gauges is obtained from Dr.B.Parthasarathy. Missing observations in the dataset which account for less than 2% of the total number of rainfall figures were filled by the ratio method as suggested by Rainbird (1967)- details are given in Mooley et al (1981), Mooley and Parthasarathy (1984) and Parthasarathy et al (1987). An examination revealed that filling of missing data was done mostly for the periods 1871-1900 and 1981-1984.

Prior to 1871 the data for this network is available but its density decreases abruptly back in time (Eliot, 1902). The oldest data is available from 1813 for the lone station Madras. Available number of gauges from each year are given in Table 1.

The reliability and trustworthiness of the data of the 19th century is discussed in relevant records. (Blanford, 1886; Eliot, 1902 and Walker, 1910).

For the period 1985-1994 the data for 116 selected IMD (India Meteorological Department) gauges has been collected from the relevant records of the IMD, Pune.

After applying the Swed-Eisenhart run test (WMO, 1966) it is found that the monsoon rainfall series for the different stations considered in the study is homogeneous. Plots of individual series from earliest available year through 1994 also did not suggest abrupt shift or change type inhomogeneity in any of the series. Longest monsoonal rainfall series for six selected stations from different parts of the country are given in Figure 1.

3. An optimum division of the country for effective studies of summer monsoon rainfall variations

In an attempt to provide the best possible representative summer monsoon rainfall series of India Singh et al (1991) have prepared the series for the period 1871-1984 by nine methods using data of the same presenthly used 306 gauges (see Section 2). In different methods the spatial mean of the following is calculated,

1. actual rainfall,
2. area weighted rainfall (Mooley and Parthasarathy, 1984),
3. ratio of actual and the respective series mean rainfall (Winstanley, 1973),
4. standardized rainfall (actual minus mean divided by standard deviation) (Kraus, 1977),
5. normalized-weighted standardized rainfall (Katz and Glantz, 1986),
6. rank of the actual rainfall amount in the respective station series (Rasmusson and Carpenter, 1983),
7. estimated non-exceedance probability from the maximum likelihood fitted two-parameter gamma distribution to the station rainfall series (Bradley et al, 1987),
8. standardized rainfall using parameters of the gamma distribution (Singh et al, 1991),and
9. normalized-weighted standardized rainfall using gamma parameters (Singh et al, 1991).

Singh et al (1991) have also suggested an 'Index of Areal Representativeness' to quantify the areal representation of the area-averaged series. The IAR is defined as,

$$IAR = \frac{S_R^2}{1/M \sum_{i=1}^{M} s_i^2} * 100 \quad \ldots\ldots(1)$$

where S_R^2 is the variance of the area-averaged rainfall series, s_i^2 that of the individual series and M number of series averaged. Larger the value of IAR greater is the spatial representation of the series. For the all-India monsoon rainfall series prepared by the nine methods the IAR varied between 7 and 14 percent. It was the highest for the series prepared by averaging non-exceedance probability derived from a maximum likelihood fitted 2-parameter gamma distribution to the individual station series. From the experiment it was inferred that by changing the method it was not possible to enhance the areal representation of the all-India series considerably. Moreover, the rainfall index series prepared by the method of Bradley et al (1987) is difficult to interpret (Vinnicov et al, 1990). Indices suggested by Katz and Glantz (1986) and Singh et al (1991) are also not simple to interpret. Therefore, without much loss of information and computational simplicity in the present study the representative area-averaged rainfall series will be prepared by calculating yearwise arithmetic mean of the station rainfall amounts. To give a feel of the areal representation the isopleth of the correlation coefficient (CC) between the all-India monsoon rainfall series (1871-1984) prepared by simple arithmetic mean of the 306 gauges (IAR= 10.95%) and the individual gauges is given in Figure 2. The CC exceeds 0.6 over parts of the western Ghats and decreases to 0.1 over southern parts and to zero over eastern parts of the country. For having an effective system of assessing/monitoring/predicting summer monsoon rainfall over India it was then felt essential to divide the country into certain zones.

Walker (1924) divided the British India for the first time into three regions namely Northwest India, Peninsula and Northeast India following administrative boundary of the provinces (or states) for long range forecasting of the summer monsoon. For independent India the boundaries of these regions were slightly modified by the India Meteorological Department (IMD) in 1949 and 1961 due to reorganization of the states. In recent years, while Shukla (1987) divided the country into four broad regions Northwest India, Peninsular India, Southern India and Northeast India, Gregory(1989) divided into ten the so-called macro-regions and Parthasarathy and Yang (1995) into five zones. In these classifications some neighbouring meteorological subdivisions of different sizes are combined by taking into consideration characteristics of the area-averaged monsoon rainfall series of the subdivisions. In the present study the country has been divided into an optimum number of zones based on similarity in the summer monsoon rainfall fluctuations at individual stations. As stated previously for the network of 306 gauges minimum filling of missing observations has been done for the period 1901-1980. It is felt legitimate to involve only this period for examination of critical features of rainfall. The following four objective analyses which are expected to provide some useful guidance for delineating the zones have been carried out:

i. Percentage difference in the mean monsoon rainfall from first to second half of the period 1901-1980 at different stations;
ii. Empirical orthogonal function (EOF) analysis;
iii. Cluster analysis based on the correlation coefficient (r_{ij}) between the different gauges; and
iv. Cluster analysis based on distance coefficient (d_{ij}) between the gauges

$$r_{ij} = \frac{COV_{ij}}{\sqrt{s_i^2 s_j^2}} \quad \ldots\ldots\ldots(2)$$

s_i indicates standard deviation of i series and s_j that of j series;
and COV_{ij} covariance of the i and j series.

$$d_{ij} = \left[\frac{\sum_{k=1}^{N}(X_{ik} - X_{jk})^2}{N}\right]^{1/2} \quad ....(3)$$

where X_{ik} represents the standardized (actual minus mean divided by standard deviation) summer monsoon rainfall series for the raingauge i and X_{jk} that for the gauge j; N is the length of the rainfall series; and d_{ij} the distance between gauge i and gauge j. As one expects, a small distance would indicate the two gauges are "close together" that is the difference between the corresponding elements of the two standardized monsoon rainfall series is small, whereas large distance would indicate they are wide apart.

Change in mean rainfall: The plot of the percentage difference in the mean monsoon rainfall during the second half subperiod (1941-1980) compared to the first half (1901-1940) at the 306 locations did not display systematic spatial pattern which enables drawing isolines. However, the gauges with positive/negative difference were geographically continuous. The negative areas are shaded in Figure 3. From this result we initiated a preliminary classification as follows:

a. The contiguous area east of longitude 80°E and north of latitude 21°N with decreasing trend in rainfall;
b. The area south of 15°N again with decreasing rainfall; and
c. The remaining parts of the country with increasing rainfall trend.

The EOF analysis: The S-mode EOF analysis of the summer monsoon rainfall of the 306 stations is carried out through the computation of the correlation matrix of the size 306 by 306 using first the data of the period 1901-1980, and then its two subperiods 1901-1940 and 1941-1980, and the full period 1871-1984 to see the variation in the loading pattern of the eigenvalues. The eigenvalues and eigenvectors have been calculated as follows:

Let **[X(N,P)]**, where N is number of observations and P number of variables, be the data matrix. Using respective mean and standard deviation every column of the data matrix is standardized (actual minus mean divided by standard deviation) and denoted as **[X(N,P)]** or simply **[X]**. The square matrix **[S(P,P)]** of the product-moment correlation coefficient is calculated as,

$$S_{jk} = \frac{1}{N-1}\sum_{i=1}^{N} X_{ji}\ X_{ik} \quad ....(4)$$
$$j,k = 1,2,3............P$$

The characteristic roots λ of the square matrix **S** is obtained by solving the following equation for other than the trivial case of **A**=0.

$$[\,S - \lambda I\,]\,A = 0 \qquad \text{..........(5)}$$

Where **A** is the characteristics vector and **I** the identity matrix with diagonal elements equal to one and the off-diagonal elements equal to zero. Number of roots of λ is equal to the degree of the matrix **S**. The characteristics roots are arranged in descending order. For each value of λ the Eq 5 is solved subject to the constraint

$$\sum_{k=1}^{P} a_k^2 = 1 \qquad \text{.........(6)}$$

to get the characteristic vectors with P elements.

In the present case raingauge stations are the variable **P** and number of years of data **N**.The first four eigenvalues computed involving the data 1901-1980 explain about 36% (16.78, 7.82, 6.23 and 4.88 percent respectively) of the total system variance. Their eigenvectors are displayed in Figure 4. The maximum loading of the first EOF occurs over northwest India with vector values greater than 0.08. The loading is -ve over northeast India, less than 0.08 over south Peninsula India and between 0.0 and 0.06 over remaining parts of the country. This is in agreement with the results of Bedi and Bindra (1980). To know the stability of this pattern the analysis is repeated for the two equal subperiods 1901-1940, 1941-1980, and the full period 1871-1984, and the loadings are presented in Figure 4. There are variations in the magnitude and organization of the eigenvector pattern, but overall picture remained essentially the same. Keeping in view the loading pattern of the first eigenvalue and its variations the country can be divided into the following five zones:

a. Area north of 21°N and west of 80°E;
b. Area north of 21°N and between the longitude 80°E and 88°E;
c. Area north of 21°N and east of 88°E;
d. Area between the latitudes of 15°N and 21°N; and
e. Area south of 15°N.

The loading pattern for the second eigenvalue is presented in Figures 4(E) to 4(H) for the four periods respectively. The special feature in this case is the heavy loading (with -ve sign) that occurs over northcentral India. This makes an important point to identify this area as a separate zone. There is change in the sign of the loading over major parts of the country when data of the period 1871-1984 was used in the analysis compared to the other three periods. This we could not understand. The loading patterns of the third and fourth eigenvalues did not display any systematic spatial pattern (Figures 4(I)-4(P)). This EOF analysis was repeated considering randomly selected data of 100 stations of the period 1871-1984 and the loading pattern of the first four eigenvalues for three sets of the 100 stations is presented in Figure 5. Further this was done using 80-year (1901-1980) data of 60 stations (Figure 6). In essence for the first two eigenvalues results similar to that reported here based on data of 306 stations were found in every case. Large variations were seen in the loading pattern of the third and fourth eigenvalues when the density and location of the raingauges, and the period and length of the rainfall data were changed. Therefore, higher order eigenvalues were not found useful for the purpose of classification.

The cluster analysis: A cluster analysis of the 306 raingauges is also carried out based on similarity in the monsoon rainfall fluctuations. Each group will identify a zone over the country. A parallel analysis has been conducted for the two measures of variability that is the correlation coefficient (CC) and the distance coefficient (DC) considered in the study. The analysis is carried out in a sequential manner by repeating certain processes at different levels. The stations are first arranged into a hierarchy so that those with the highest mutual similarity are placed together. Further groups or clusters of stations are associated with other group which they most closely resemble and so on until all of the stations have been placed into a complete classification scheme. A 'weighted pair-group method with arithmetic averages' has been used for clustering the stations into groups and groups into larger groups. The final matrix of similarities will be a 2 by 2 matrix between the last remaining two clusters. The end-product is a dendrogram, showing the successive fusions of individuals, which culminates at the stage where all the individuals are in one group. Summarily the complete process can be realized in the following five steps (Davis, 1973):

a. Compute the CC and the DC matrix from all the gauges, and consider one of the matrices at a time.
b. Cluster the stations showing the highest similarities first, and calculate a new correlation/distance coefficient matrix by averaging rows and columns corresponding to the gauges showing highest similarities.
c. Now fuse the groups or clusters of gauges showing most close resemblance by computing the similarity matrix again by averaging rows and columns of the corresponding groups or clusters. Continue the process until all the gauges are exhausted.
d. Prepare the dendrogram showing the entire clustering process step by step.
e. Depending upon the purpose isolate the groups of gauges or clusters from the dendrogram.

Demarcation of the cluster is made at the station where there is a sudden drop (increase in case of DC)in the plot of the measure of variability in the dendrogram. But the drop/increase was ignored if it was not considerable and the following stations were part of the contiguous area. This decision is subjective and can vary from individual to individual. Zones delineated from the clusters of the 306 gauges first using data of the period 1901-1980, and later its two subperiods 1901-1940 and 1941-1980, and the full period 1871-1984 are shown in Figures 7(A)-7(H) for both the measures. From large variations in the shape, size and orientation of the clustered zones at first glance one may get the impression that the classification is dependent upon the measure of variability used and the data period. But a close examination would reveal that there is a general consensus between the two measures for the same data set. For variations with change in the data period our understanding is that these are due to long term spatial and temporal monsoon rainfall fluctuations. Over northern India long term spatial monsoon rainfall fluctuations with rising trend over western parts and declining trend over eastern parts are reported in Singh et al (1992).

Even from this fluid information of the cluster analysis it is possible to delineate the area east of the longitude 88°E and the area south of the latitude 15°N as distinct zones. Over remaining parts further division of the zones suggested in the previous subsection can be seen. North West India is divided into three to four subzones. It is felt intuitively that for regional studies of the summer monsoon variations the entire area north of 21°N and west of 80°E can make one zone. Over northwest and northeast the summer monsoon rainfall fluctuations are negatively correlated (Subbaramayya, 1968; Singh et al, 1992). Over the same zonal belt that is north of 21°N emergence of a third zone (North Central India) between two large zones North

West India and North East India is a natural one. The noticeable features of the North Central India are: decrease in monsoon rainfall from 1901-1940 to 1941-1980; organized variation with a gentle E-W gradient in the loading of the first EOF; and maximum loading of the second EOF.

Finally the decision about division of the zonal belt between the latitudes of 15°N and 21°N into two parts along the longitude of 79°E is made after closely examining the variations in clustered-zones with the change in the data period. The western part has been named as West Peninsula India (WPI) and the eastern part East Peninsula India (EPI). Over WPI the loading of the first eigenvalue is much higher compared to the EPI. Thus by applying judgemental subjective approaches on the results of the quantitative analyses of the rainfall fluctuations we arrived at the following six zones classification of the country for effective studies of the summer monsoon variations.

North West India (NWI) : north of 21°N and west of 80°E
North Central India (NCI) : north of 21°N and between 80°E and 88°E
North East India (NEI) : north of 21°N and east of 88°E
West Peninsula India (WPI) : between 15°N and 21°E and west of 79°E
East Peninsula India (EPI) : between 15°N and 21°E and east of 79°E
South Peninsula India (SPI) : south of 15°N

These boundaries are superimposed on the Figures 2 to 7, including the different panels for visual comparison of the results of different analyses and the final classification of the zones.

For the period 1871-1984 the representative zonal monsoon rainfall series is prepared by calculating arithmetic mean of the gauges in the particular zone. For the individual series an optimum set of the IMD (India Meteorological Department) has been identified for its updating on a real time basis. The series is also extended maximum possible backward. The procedural details are given in the following sections for the North West India series as an example. For other series they are briefly described thereafter. Important statistics about the different zones, their gauges and the representative rainfall series are given in Table 2.

The importance of the zonal series over the all-India series is demonstrated in Figure 8 which presents the correlation between the zonal monsoon series and its individual gauges based on the data period 1871-1984. The correlation spatial pattern provides a balanced and comparable representation of the area in all the six cases. The variation in CC is between 0.4 and 0.6 over NCI, NEI, WPI and SPI, and around 0.6 for the other two zones. The CC of 0.4 and 0.6 is significant at 0.1% and better level. The correlation of the all-India monsoon series is high with the stations over northwest India and it decreases outward in all sides (Figure 2). Thus to achieve some reasonable correlation structure for the area-averaged monsoon rainfall series division of the country into six zones is felt essential.

4. Selecting an optimum set of the IMD raingauges to reconstruct and update the representative NWI summer monsoon rainfall series

The representative monsoon rainfall series (1871-1984) of North West India is the simple arithmetic mean of a maximum of 116 gauges in the zone. Updating the series on a real-time basis after getting data from all the 116 gauges is a difficult task. Published work and our own experience tell that a subset of limited gauges can be identified that would be adequate for the purpose. The objective technique that is 'selecting a few gauges whose mean showed the highest correlation with the all gauges mean series' applied to select the gauges is given in Singh (1994) and Sontakke et al (1993).

In the country the India Meteorological Department (IMD) maintains its own network of raingauge stations and the different states agencies their own. Getting data from the states is particularly difficult and time-consuming. On the other hand the IMD gauges are better known for timely availability of data. So for updating only IMD gauges have been optimized. Of the 116 raingauges in the North West India (NWI) 84 are by the IMD and the remaining 32 by the states. The selection is done one by one in a manner similar to the forward selection of independent variables in the multiple linear regression. To begin with the product-moment correlation coefficient (CC) is calculated between the representative rainfall series of NWI (mean all the 116 raingauges) and the rainfall series of each of the 84 IMD gauges using the data 1871-1980. The first gauge is identified which showed the highest CC with the representative series. Now mean of two gauges that is the `first' selected gauge and one additional gauge, successively selected from the remaining 83 IMD gauges, is correlated with the representative series. The two-gauge set is identified which showed the highest CC. Further, mean series of three gauges that is the mean of the two selected gauges and one additional gauge, successively selected from the remaining 82 gauges, is correlated, and the group showing the highest CC identified. This is to continue as long as the CC increases due to inclusion of an additional gauge. Bundi (an IMD station in Rajasthan state) which showed the CC of 0.7011 was the first gauge to enter for the NWI series. In all 19 IMD gauges entered the selection and the highest CC achieved was 0.99. The sequence in which the gauges entered the selection is given in Table 3, and their location is marked in Figure 8. Interesting to note is that the gauges from different parts of the area entered the selection. The least-squares estimated linear regression of the 19 IMD-gauges mean rainfall (R_{19}) on the representative North West India series (Y_{NWI}) is as follows:

$$Y_{NWI} = 61.63 + 0.8787\,\overline{R_{19}} \quad \ldots\ldots(7)$$

where Y_{NWI} andR_{19} are in mm. The standard deviation and the standard error of the estimated series (1871-1980) from Eq.(7) are 128.9mm and 18.1mm respectively. A biased RMSE on the independent sample of 4 years (1981-1984) is 43.3mm.

Wigley et al (1984a) have derived an expression which shows that the CC between m-gauge mean series and M-gauge mean series (where m is a subset of M) is dependent upon m, the standard deviation of m-gauge mean series s(m), the standard deviation of each of the m series s_i and the CC of the individual m gauges with the M-gauge mean series $r_{i,M}$. The expression is as follows:

$$R_{m,M} = \frac{1}{m\,s(m)} \sum_{i=1}^{m} s_i\, r_{i,M} \quad \ldots\ldots(8)$$

In the selection process of the gauges the CC achieved at each step is found equal to that calculated using Eq.(8). Hence the results of the objective technique are consistent with the theoretical expectations.

5. Reconstruction and update of the representative time series of the three other seasonal, the four monsoon monthly and the annual rainfall over the North West India

Using the same set of the IMD gauges identified for the monsoon rainfall series the representative series of the rainfall during each of the other three seasons e.g. winter Jan-Feb, summer Mar-Apr-May and post-monsoon Oct-Nov-Dec; during each of the four monsoon months June, July, August and September; and the whole year over North West India have been reconstructed from 1871 onwards. The representative series (1871-1984) of the rainfall total of different periods is prepared by averaging all the gauges (116) in the zone. The CC between the 19 selected IMD gauges and the representative series based on data of 1871-1980 is given in Table 4 against the year 1871. It is interesting to note that the CC is comparable with the summer monsoon series in different cases except for the winter rainfall series in which case CC is somewhat low. The intercept and the slope of the least-squares fitted regression of the type Eq.7 are given in Table 2.

6. Backward extension of the NWI summer monsoon rainfall series

As stated previously, density of the raingauge network over the country decreases abruptly as one goes back in time prior to 1871. Over the North West India unbroken records for 27 gauges are available from 1844. From 1845 the available gauges increased to 29. Upto 1970 available number of gauges from each year are given in Table 1. From the years 1869-1870 the number of available gauges are 64 and during 1871-1984 116. The estimated NWI series using Eq. 7 is treated as reference, and is extended backward to 1844 by applying the objective technique on the available limited gauges. For each year of the period 1844-1970 the data is first screened for the available gauges. The technique is applied based on data of the common period (1871-1980) to select the gauges so that the explained variance of the reference series is maximized. No limit is prescribed that is the gauge with more than zero variance contribution can enter the regression. Available number of gauges, the number that entered the selection, the highest CC achieved and the standard deviation of the estimated series from the developed regression are given in Table 1. Using mean of the selected gauges in the regression the NWI rainfall for the particular year is estimated. Since the CC is less than 1.0 the NWI rainfall amount will be underestimated. The underestimation will be different in every case as the CC is different. In order to achieve homogeneity the rainfall estimates for the years prior to 1871 are brought to the variance level of the reference series by inflating them by a factor of p. The variance inflating factor (VIF) p is defined as (Klein et al, 1959);

$$p = \frac{s'}{s} \quad ......(9)$$

where s' is the standard deviation of the estimated series (1871-1980) from the regression developed for the particular year (prior to 1871) with mean of the selected gauges as independent parameter and s that of the reference series. In Table 1 s' is given against the particular year and s against 1871. This is achieved in two steps. The estimated rainfall amount of the particular year is standardized using mean and standard deviation of the corresponding estimated series (1871-1980). The standardized value is again converted into the rainfall amount using mean and standard deviation of the reference series. Of course, in this variance inflating treatment mean will be the same. With this treatment the individual element of the final reconstructed series would belong to the same population with mean 697.7mm and standard deviation 128.9mm. The reason to adjust the variance to the level of the estimated series using Eq. (7) rather than the actual representative series is to remind the limitation of the present reconstruction (CC=0.99), as well as the reliability of the future rainfall estimates. The reconstructed yearly rainfall amount for the period 1844-1994 is given in Table 3, and the time series alongwith a 9-point Gaussian low-pass filter (WMO, 1966) is presented in Figure 8. Notable features are rising trend in the series from the beginning of this century upto 1978 and declining trend afterwards.

7. Backward extension of the other NWI rainfall series prior to 1871

The other seasonal, the monsoon monthly and the annual rainfall series of North West India (NWI) are also extended back to 1844 following the same procedure as for the monsoon rainfall series. The number of available gauges, the number that entered the selection, the highest CC achieved and the standard deviation of the estimated series are given in Table 4 for each year of the period 1844-1870. The standard deviation of the reference series is given in the table against the year 1871. The reference series is the estimated series (1871-1980) using mean of the 19 selected IMD gauges as independent variable in the regression whose intercept and slope are given in Table 2. For the region the reconstructed rainfall amount for the four seasons, for the four monsoon months and the whole year are given in the Table 5 for the period 1844-1994. The time series of the seasonal rainfall are presented in Figure 9, of the monsoon monthly rainfall in Figure 10 and the annual rainfall in Figure 11 (a), each alongwith a 9-point Gaussian low-pass filter for having feel of the fluctuations in the low-frequency mode.

8. Reconstruction and update of the longest summer monsoon rainfall series for the other five zones

Like NWI for each of the other five zones that is North West India (NWI), North Central India (NCI), North East India (NEI), West Peninsula India (WPI), East Peninsula India (EPI) and South Peninsula India (SPI) the representative monsoon rainfall series (1871-1984) is first prepared by calculating arithmetic mean of the gauges in the respective zone, an optimum set of the IMD gauges is identified using the objective technique based on the common data period 1871-1980 for its reconstruction/update from 1871 onwards and then it is extended maximum possible backward. The number of available gauges and that entered the selection are given in Tables 6 to 10 for the different zones respectively. The regressions for the 1871 onwards reconstruction as well as the future update are as follows:

$$Y_{NCI} = 76.95 + 0.9487\,\overline{R_{27}} \qquad (10)$$

$$Y_{NEI} = 113.45 + 0.9343\,\overline{R_{15}} \qquad (11)$$

$$Y_{WPI} = 47.22 + 0.8921\,\overline{R_{18}} \qquad (12)$$

$$Y_{EPI} = 48.91 + 0.9527\,\overline{R_{14}} \qquad (13)$$

$$Y_{SPI} = 33.92 + 0.8920\,\overline{R_{23}} \qquad (14)$$

Y_{NCI}, Y_{NEI}, Y_{WPI}, Y_{EPI} and Y_{SPI} are the rainfall (in mm) of the zone indicated by the subscript; andR the mean rainfall (in mm) of the selected IMD gauges, the subscript denotes the number. Location of the selected IMD gauges is marked in Figure 8. The gauges are well spread. Total number of the IMD gauges in different zones, the multiple CC and the standard deviation of estimated series (1871-1980) from the regression are given in Tables 6 to 10 against the year 1871. The biased RMSE of the regressions on the independent sample of 1981-1984 is given in Table 2. In total 116 IMD observations will be required to update the rainfall series of the six zones. Data for these stations is generally available by the middle of November of the same year, and thus the different series can be updated easily.

Important information related to backward reconstruction of the monsoon rainfall series of the five zones are given in Tables 6 to 10 respectively. The NEI and the EPI monsoon series are extended back to 1848, the NWI to 1844, the NCI to 1842, the WPI to 1817 and the SPI to 1813. In the backward extension the prescribed lowest limit of CC was 0.1874, which is the 5% significant value for the 108 (actual period 1871-1980 minus 2). To maintain homogeneity in the variance it is possible that we have to deflate the variance of some of the estimates. The reconstructed monsoon series for the longest period are given in Tables 11 to 15. They are displayed in Figures 12 to 16 for the five zones in the order alongwith a 9-point Gaussian low-pass filter (WMO, 1966) for visual examination. In the low frequency mode the NCI series shows large fluctuations; the NCI series declining trend from about 1910; the WPI series excess rainfall activities in the last four decades; the EPI series rising trend from about 1970 and the SPI series homogeneous characteristics from 1870 onwards.

9. Longest reconstruction and update of the other rainfall series of the five zones

The representative series for the period 1871-1984 of the other seasonal rainfall, the monsoon monthly rainfall and the annual rainfall for the five zones are prepared by calculating arithmetic mean of the gauges in the particular zone. Using mean rainfall of the IMD-gauges selected for the monsoon series the different rainfall series of the particular zone are reconstructed from 1871 onwards. The data of the common period 1871-1980 was involved in the reconstruction process. The multiple CC and the standard deviation of the estimated series are given in Tables 6 to 10 against the year 1871, and the intercept and the slope of the regression in Table 2 which also contain the biased RMSE of the regression on the independent sample of 1981-1984.

The different reconstructed series using limited IMD observations are extended maximum possible backward by applying the objective technique on the available gauges. Important information related to backward reconstruction of the diffeent series are given in Tables 6 to 10 for the five zones respectively. Yearwise rainfall amount for the longest possible period is given in Tables 11 to 15 for the different zones. The seasonal rainfall series are presented in Figures 12 to 16, the monsoon monthly series in Figures 12 to 16 and the annual series in Figure 11. The different series are smoothed by a 9-point low-pass filter.

10. Reconstruction and update of the longest all-India summer monsoon rainfall series

1. For the period 1871 onwards

Areal representation of the rainfall series for the entire country is limited and so its practical value. But it does provide some useful information for large scale climate variability studies, particularly those attempting to understand teleconnections and the earth system dynamics using General Circulation Models (GCMs). The representative all-India series (1871-1984) is the arithmetic mean of the 306 raingauges. If interest is directly with the rainfall of the country as one unit it is possible to optimize the network of the 306 gauges for updating the series. An excellent set of 35 IMD gauges has already been identified and reported in Singh (1994). But once the updated zonal rainfall estimates are obtained the all-India estimate is a matter of simple calculation which requires no additional information. The correlation between the representative all-India series (306-gauge mean series) and the area-weighted mean of the six zonal reconstructions based on data of 1871-1980 is 0.9931, and the estimated regression,

$$Y_{AI} = 7.15 + 1.1036\,\overline{R_Z} \qquad \text{........(15)}$$

The all-India rainfall amount (Y_{AI}) and the six zone mean rainfall (R_Z) are in mm. Since at this stage we are using mean rainfall of the six zones of different sizes, for technical reasons it is essential to weight the individual zonal rainfall amount by the respective area in calculating their mean. On the independent sample of 4 years (1981-1984) the biased RMSE) of Eq. (15) is 26.2mm which is about 30% of the standard deviation of the representative series. Thus the mean of the zonal rainfall provides a reliable estimate of the all-India rainfall. Ignoring the intercept (=7.15mm), the slope of Eq. (15) brings out an important point that the area-weighted mean rainfall of the six zones is less by about 10% compared to the arithmetic mean of the 306 gauges. This is because the largest weight was assigned to the lowest rainfall amount of North West India. From hydrological view point the difference between the mean rainfall by the two methods may be of concern. But the CC of 0.9931 suggests that for climatological purposes both Y_{AI} andR_Z convey almost identical meaning.

Researchers have tried different approaches to prepare representative area-averaged rainfall series for climatological studies (Bradley et al,1987; Katz and Glantz, 1986; Kraus, 1977; Mooley and Parthasarathy, 1984; Rasmusson and Carpenter, 1982; Singh et al 1991 and others). In order to have the best possible one Singh et al (1991) have prepared the all-India monsoon rainfall series by nine methods. The difference between the means of the all-India monsoon rainfall series (1871-1984) prepared by the district-area-weighted mean of the 306 gauges (Mooley and Parthasarathy, 1984) and that by the simple arithmetic mean is about 50mm, being higher in the later case. District is a small administrative unit in India. The geographical shape of most of the districts is more or less like a polygon. The Head Quarter of the district and the raingauge station are generally located in the centre of the district. The CC between the all-India series prepared by the two methods is 0.975 (Singh et al, 1991). The choice of the series prepared by simple arithmetic mean as representative in the present study was dictated by the higher value of the IAR (10.95%). The IAR for the district-area-weighted series is 9.45%. The greatest advantage with the simple arithmetic mean series is that a theoretical justification from a study published elsewhere can be provided to the results of the optimization technique employed to reconstruct the longest rainfall series. Recently Parthasarathy et al (1993) reported a monsoon rainfall series (1871-1990) for a homogeneous India (which is more or less the present North West India (NWI) and West Peninsula India (WPI) combined). The correlation of the series with the area-weighted mean series of the NWI and the WPI is 0.9556. Hence, a reliable estimate of the homogeneous India monsoon rainfall (Parthasarathy et al, 1993) can be obtained from the mean of the NWI and the WPI rainfalls.

2. Backward extension to 1813

Sontakke et al (1991) have extended the Mooley-Parthasarathy series (Mooley and Parthasarathy, 1984) backward to 1813 and updated to 1991 using few selected observations. There are two main limitations of this reconstruction:

a. Areal representation of the Mooley-Parthasarathy series is comparatively lesser (IAR= 9.45%); and
b. For extending the series backward prior to 1871 the gauges were chosen subjectively.

The representation of the 306-gauge mean all-India series is more than the Mooley-Parthasarathy series, and a reliable estimate of the series for the period from 1871 onwards can be obtained from the area-weighted mean rainfall of the six zones (Eq. 15). Therefore, the all-India estimated series using Eq. (15) is extended backward to 1813. Objective selection of the gauges and the estimation of the regression have been done based on data of the common period 1871-1980. The objective technique is operated as long as the CC showed increase due to selection of an additional gauge. For every year of the period 1813-1870 important parameters related to the reconstruction process are given in Table 1. To get the final reconstruction the variance of the estimated rainfall is inflated by a factor of p (Eq. 9), here s the standard deviation of the reference series is 89mm.

For the years 1813 to 1843 the highest CC is achieved is between 0.4046 and 0.6280, and standard deviation of the estimated series is less than the standard error. Therefore, care must be exercised in utilizing these rainfall figures. The reconstructed all-India monsoon rainfall series for the period 1813-1994 is given in Table 16. It is presented in Figure 22 alongwith a 9-point Gaussian low-pass filter (WMO, 1966) for visual examination and having a feel of the same. Two points require clarification. First, the variance of the estimated amount was not inflated to the level of the actual representative all-India series. Secondly, this will provide some quantative information in the absence of any other.

11. Longest reconstruction and update of the other all-India rainfall series

For the period 1871-1994 the all-India series of the three other seasonal (winter, summer and post-monsoon) rainfall, the monsoon monthly rainfall and the annual total rainfall are reconstructed by fitting regression of the area-weighted mean of the reconstructed rainfall of the six zones on the representative all-India series based on data of 1871-1980. The representative series is the arithmetic mean of the 306 gauges. The CC is appreciable for the different rainfall series and are given in Table 1 against the year 1871. The intercept and the slope of the regression are given in Table 2. The individual all-India series is extended maximum possible backward by applying the reconstruction technique based on data of the reference period (1871-1980). The entire reconstruction process would require the following:

i. Screening the data yearwise prior to 1871 for the available gauges;
ii. Selecting the gauges from the available one by applying the objective technique based on data of the period 1871-1980;
iii. Developing a regression of the mean of the selected gauges on the reference period all-India series;
iv. Estimating the rainfall amount for the particular year prior to 1871 using mean of the selected gauges in the regression; and
v. Inflating the estimated rainfall amount by a factor of p (Eq. 9).

In selecting the gauges the technique was operated as long as the CC showed increase due to inclusion of an additional gauge. For the different rainfall series yearwise number of available, the number that entered the selection, the highest CC achieved and the standard deviation of the estimated series from the fitted regression are given in Table 1. The winter and the annual rainfall series could be extended back to 1826, the July and the September series to 1817 and the summer, the June, the August, the summer monsoon and the post-monsoon series to 1813. For the period 1813-1816 the July and the September series were not constructed due to weak correlation (< 0.1874). The different reconstructed all-India series are reported in Table 16. The seasonal all-India series are presented in Figure 22, the monsoon monthly in Figure 23, and the annual in Figure 11(b).

12. Correlation matrix for the regional and all-India monsoon rainfall series

The correlation matrix for the monsoon rainfall series of the six regions as well as the entire country based on the period 1871-1984 is given in Table 17. The NWI is highly positively correlated with WPI; and the WPI with EPI and SPI. The NEI is negatively (but weakly) correlated with WPI, EPI and SPI. The all-India series is most highly and positively correlated with NWI (CC=0.8955) followed by WPI (CC=0.7210), NCI (CC=0.5412), EPI (CC=0.5212) and SPI (CC=0.5086). But features of the all-India rainfall series are independent to that of the North East India. This brings out the important point for the division of the country for monsoon rainfall studies.

Part of this study concerned with the summer monsoon rainfall is reported in (Sontakke and Singh, 1995).

13. Summary and concluding remarks

1. The areal representation of the summer monsoon rainfall series for the entire country is limited. In order to develop a system for an effective study of the summer monsoon rainfall the country has been divided into an optimum of six zones NWI, NCI, NEI, WPI, EPI and SPI keeping in view the similarity in the monsoon rainfall fluctuations at the 306 gauge stations. The zonal rainfall series (1871-1984) prepared by the simple arithmetic mean of the gauges in the particular zone is considered as representative in the study.

2. The raingauge stations maintained by the India Meteorological Department (IMD) are better known for the timely availability of data. By applying an objective technique a total of 116 IMD raingauges have been identified for the reconstruction/update of the representative monsoon rainfall series of the six different zones from 1871 onwards.

3. The IMD gauges selected for the reconstruction/update of the representative monsoon rainfall series provided an excellent estimate of the other seasonal rainfall, the monsoon monthly and the annual rainfall series of the respective region from 1871 onwards.

4. The individual regional series has also been extended maximum possible backward by applying the objective technique on the available limited gauges. For the NWI the different series were extended back to 1844; for the NCI to 1842; for the NEI the August and the summer monsoon series to 1848 and others to 1829; for the WPI the winter, the summer, the post-monsoon and the annual series to 1841 and the monsoon monthly and the monsoon series to 1817; for the EPI the different series to 1848; and for the SPI the June series to 1837 and the others to 1813.

5. The area weighted mean of the six zonal estimates provided an excellent estimate for the reconstruction/update of the representative all-India seasonal, monsoon monthly and annual rainfall series. The all-India winter and the annual series were extended back to 1826, the July and the September to 1817, and the summer, the June, the August, the monsoon and the post-monsoon to 1813.

The present reconstruction is a quantitative information based on actual observation, but the reliability of the individual estimates prior to 1871 is different so care must be excercised in treating them at par with the representative series in the analysis. The reconstructions updated to the year 1994 documented in this report are expected to provide useful information in the following areas.

i. To better understand the summer monsoon variability over the Indian region over the longer period in the past.
ii. In the long term planning and management of the natural water resources.
iii. In issuing and assessing the long range monsoon forecast in an effective manner.
vi. In making reliable estimate of the recurrence interval between extreme events (droughts/floods) associated with the summer monsoon circulation, and in knowing recent changes in them if any.
v. In cross comparisons of the climatological proxies such as tree rings, micro-organisms in marine cores, lake sediments, preserved pollens, ice cores etc.

Acknowledgements

The authors are extremely grateful to Dr.R.N.Keshavamurty, Director of the Institute for necessary facilities; to the India Meteorological Department for the rainfall data used in the study; and to Dr.G.B.Pant, Head of the Climatology and Hydrometeorology for his keen interest and encouragement as well as for editing the final version of the manuscript.

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TABLE 1: Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc ($*10^{-4}$) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated periods from 1813-1870 for the whole country. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.

YEAR	JF				MAM				JUNE			
	1	2	3	4	1	2	3	4	1	2	3	4
1813-16	WEAK				1	1	3309	7	1	1	1940	8
1817-25	CC				1	1	3309	7	2	2	3697	14
1826-28	3	2	5327	6	3	3	5095	10	4	3	5419	21
1829	4	3	6525	8	4	4	6775	14	6	4	6455	25
1830	5	3	6525	8	5	5	7038	15	6	4	6455	25
1831	5	3	6433	8	5	5	7232	15	6	5	6512	26
1832	4	3	4962	6	4	4	6740	14	5	4	6122	24
1833	3	2	4641	6	3	3	6194	13	3	3	5561	22
1834	2	1	4086	5	2	2	5537	11	3	3	5561	22
1835	3	2	4940	6	3	3	6085	12	4	3	5561	22
1836	4	3	5238	6	4	4	6274	13	5	3	6564	26
1837	7	6	6262	8	7	6	6546	13	8	5	6704	26
1838-40	7	4	5839	7	7	5	6855	14	8	4	5865	23
1841	8	4	5839	7	8	5	7014	14	9	4	6699	26
1842	12	3	6886	8	11	6	7516	16	13	6	7223	29
1843	12	3	6886	8	12	7	7821	16	14	7	7747	31
1844	20	13	9029	11	20	14	8492	18	57	13	9368	37
1845	55	14	9384	12	55	24	8819	18	59	27	9630	38

YEAR	JULY				AUGUST				SEPTEMBER			
	1	2	3	4	1	2	3	4	1	2	3	4
1813-16	WEAK CC				1	1	3654	16	WEAK CC			
1817-25	2	2	3269	13	2	2	5719	24	2	1	5288	21
1826-28	4	3	4025	16	4	4	6413	27	4	2	6432	26
1829	6	5	4782	19	6	5	6786	28	6	3	6718	27
1830	6	5	4782	19	6	5	6786	28	6	3	6718	27
1831	6	6	5202	20	6	4	6663	28	6	3	7047	29
1832	5	4	4579	18	5	4	6101	26	5	2	6047	25
1833	3	3	3793	15	3	3	5954	25	3	2	5752	23
1834	3	3	3793	15	3	3	5954	25	3	2	5752	23
1835	4	4	3834	15	4	3	5954	25	4	2	5752	23
1836	5	4	5116	20	5	4	6661	28	5	2	5752	23
1837	8	1	4347	17	8	4	6369	27	8	2	5752	23
1838-40	8	5	5105	20	8	5	6581	28	8	2	5752	23
1841	9	6	5996	24	9	6	6803	29	9	2	5752	23
1842	13	7	6367	25	13	6	7230	30	13	3	6115	25
1843	14	10	6766	27	14	8	7731	32	12	4	6259	25
1844	58	18	9239	37	59	22	9574	40	59	21	9403	39
1845	59	13	9170	36	59	27	9622	41	58	11	9278	38

YEAR	JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4
1813-16	1	1	4046	36	1	1	2140	8	WEAK			
1817-25	2	2	4890	44	1	1	2140	8	CC			
1826-28	4	4	5819	52	3	2	6134	21	3	2	6192	66
1829	6	6	5970	53	5	4	7457	26	4	2	6192	66
1830	6	6	5970	53	5	4	7457	26	5	2	6192	66
1831	6	4	6034	54	5	4	7119	25	5	2	5215	56
1832	5	4	5307	47	4	3	6143	21	4	2	2929	31
1833	3	2	4890	44	2	1	4376	15	2	1	1466	15
1834	3	2	4890	44	2	1	4376	15	2	1	1466	15
1835	4	4	5020	45	3	2	5970	21	3	1	3204	34
1836	5	5	5629	50	4	3	6324	22	4	2	5270	56
1837	8	6	5611	50	7	5	6558	23	7	5	4275	46
1838-40	8	5	5281	47	7	3	6336	22	7	5	4275	46
1841	9	5	5601	50	8	3	6336	22	8	5	5054	54
1842	13	9	5993	53	12	5	7886	28	11	4	5895	63
1843	12	7	6280	56	12	5	8030	28	11	4	6084	65
1844	56	30	9366	84	56	15	9460	33	20	11	8644	93
1845	58	13	9387	84	55	15	9460	33	55	25	9495	102

contd.............

TABLE 1 contd.....

YEAR	JF				MAM				JUNE			
	1	2	3	4	1	2	3	4	1	2	3	4
1846	56	14	9384	12	56	24	8819	18	60	27	9630	38
1847	58	19	9417	12	59	18	8912	19	63	27	9624	38
1848	58	20	9507	12	58	25	9055	19	68	16	9466	38
1849	71	23	9514	12	71	29	9181	19	72	13	9394	37
1850	73	22	9504	12	63	28	9065	19	64	23	9505	38
1851	68	26	9532	12	68	27	9152	19	69	26	9646	38
1852	74	23	9515	12	67	7	8174	17	66	28	9625	38
1853	71	22	9463	12	68	9	8451	18	72	34	9642	38
1854	73	26	9537	12	67	30	9364	19	75	41	9684	38
1855	54	20	9424	12	53	27	9087	19	54	25	9466	38
1856	32	18	9337	12	32	23	9160	19	32	22	9191	36
1857	34	20	9376	12	34	18	8992	19	34	23	9098	36
1858	35	25	9392	12	35	18	8992	19	35	20	9096	36
1859	41	23	9357	12	41	24	9389	20	42	15	9343	37
1860	79	35	9601	12	79	32	9492	20	79	11	9521	38
1861	100	43	9632	12	99	3	7426	15	100	39	9808	39
1862	108	37	9641	12	107	38	9609	20	107	28	9771	39
1863	136	27	9665	12	137	47	9711	20	137	20	9762	39
1864	139	19	9581	12	139	39	9639	20	139	20	9762	39
1865	142	29	9644	12	142	39	9639	20	142	43	9904	39
1866	146	29	9644	12	146	39	9639	20	146	33	9868	39
1867	168	19	9596	12	168	47	9703	20	168	33	9868	39
1868	177	24	9634	12	177	51	9715	20	178	37	9887	39
1869	179	37	9677	12	179	51	9715	20	179	26	9836	39
1870	190	30	9670	12	190	43	9638	20	190	26	9841	39
1871	232	116	9610	12	232	116	9574	20	232	116	9913	39

YEAR	JULY				AUGUST				SEPTEMBER			
	1	2	3	4	1	2	3	4	1	2	3	4
1846	60	13	9170	36	60	29	9624	41	59	11	9278	38
1847	63	22	9334	37	63	24	9642	41	62	25	9471	39
1848	69	14	9195	36	69	30	9684	41	69	27	9591	39
1849	72	26	9405	37	72	23	9598	40	73	23	9603	39
1850	64	16	8944	35	63	15	9116	38	63	15	9224	38
1851	69	16	9030	36	68	21	9496	40	70	18	9511	39
1852	65	19	9033	36	66	18	9433	40	70	21	9451	39
1853	72	20	9381	37	74	20	9456	40	70	17	9525	39
1854	73	18	9363	37	73	22	9529	40	75	26	9623	39
1855	52	20	8998	36	53	17	9130	38	53	11	9315	38
1856	32	20	8942	35	32	15	9253	39	32	12	9333	38
1857	34	20	9007	36	34	16	9282	39	34	15	9421	39
1858	35	20	8995	36	35	15	9179	39	35	16	9433	39
1859	42	18	9067	36	42	15	9229	39	42	20	9581	39
1860	79	20	9646	38	79	31	9702	41	79	27	9743	40
1861	100	25	9655	38	100	41	9799	41	100	36	9857	40
1862	108	20	9626	38	107	42	9819	41	108	24	9782	40
1863	137	24	9769	39	136	32	9839	41	136	29	9876	40
1864	139	46	9866	39	139	28	9830	41	139	33	9902	41
1865	142	23	9723	39	141	28	9830	41	142	33	9902	41
1866	146	23	9723	39	146	28	9830	41	146	35	9906	41
1867	168	34	9823	39	168	30	9878	42	168	32	9900	41
1868	178	34	9823	39	178	30	9878	42	178	19	9810	40
1869	179	34	9823	39	179	31	9869	42	179	19	9810	40
1870	190	30	9804	39	190	35	9900	42	190	19	9810	40
1871	232	116	9851	39	232	116	9880	42	232	116	9910	41

YEAR	JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4
1846	59	14	9414	84	56	15	9460	33	56	25	9495	102
1847	62	14	9414	84	61	14	9526	33	58	18	9453	101
1848	68	13	9373	84	68	18	9597	34	57	25	9592	103
1849	72	13	9373	84	72	29	9614	34	70	18	9493	102
1850	63	21	9198	82	62	20	9435	33	62	22	9381	101
1851	68	23	9378	84	66	15	9296	33	63	27	9444	101
1852	65	24	9431	84	65	20	9546	33	63	23	9518	102
1853	68	16	9350	84	69	20	9600	34	63	23	9468	102
1854	72	30	9553	86	66	22	9616	34	61	21	9457	101
1855	52	15	9196	82	29	20	9509	33	29	21	9193	99
1856	32	19	9255	83	32	21	9527	33	31	18	9258	99
1857	34	22	9345	84	34	20	9518	33	34	15	9311	100
1858	35	22	9345	84	35	20	9518	33	35	15	9311	100
1859	42	21	9404	84	42	23	9646	34	41	16	9393	101
1860	79	32	9776	88	78	25	9731	34	78	34	9813	105
1861	100	30	9731	87	98	35	9817	34	97	40	9852	106
1862	107	20	9671	87	108	38	9833	34	107	34	9820	105
1863	136	16	9661	87	136	33	9853	35	135	30	9844	106
1864	139	16	9661	87	139	23	9774	34	139	30	9844	106
1865	141	16	9661	87	142	23	9774	34	141	28	9803	105
1866	146	16	9661	87	146	38	9870	35	146	31	9863	106
1867	168	18	9693	87	168	27	9808	34	168	32	9842	106
1868	178	26	9771	88	178	33	9862	35	177	34	9872	106
1869	179	35	9909	89	179	32	9886	35	179	43	9903	106
1870	190	38	9910	89	190	29	9894	35	190	16	9728	104
1871	232	116	9934	89	232	116	9915	35	232	116	9602	103

TABLE 2 : Some important statistics about the study area and the area averaged rainfall series of each of the six zones North West India (NWI), North Central India (NCI), North East India (NEI), West Peninsula India (WPI), East Peninsula India (EPI), and South Peninsula India (SPI).

	JF	MAM	JUNE	JULY	AUGUST	SEPT	JJAS	OND	ANNUAL
NWI	*Area (km2) = 997525; Percentage area of the study = 34.63; Number of Gauges = 116*								
Mean (mm)	25.88	25.69	91.32	250.87	224.83	130.69	697.70	35.30	784.41
Interseries cc (r)	.3274	.3159	.3590	.2101	.2905	.3759	.2863	.3690	.2963
Mean cc (R)	.4947	.5079	.6013	.4622	.5438	.6162	.5395	.6078	.5476
IAR (%)	3.3	3.8	33.0	19.7	28.3	35.9	27.3	33.5	24.1
Intercept (a)	2.3898	.2142	3.7760	16.6773	12.1643	5.4373	41.6262	.8373	47.4073
Slope (b)	.8768	.9840	.9131	.8715	.8717	.9072	.8787	.9408	.8817
Rmse (mm) 1981-198	1.8	3.2	11.4	18.5	20.1	8.4	43.3	5.9	48.4
NCI	*Area (km2) = 586187; Percentage area of the study = 20.45; Number of Gauges = 65*								
Mean (mm)	36.55	65.53	164.65	336.85	325.87	209.84	1037.21	79.08	1218.35
Interseries cc (r)	.4391	.4113	.3648	.2221	.1447	.2592	.2255	.4169	.2617
Mean cc (R)	.6650	.6386	.6110	.4832	.3964	.5195	.4864	.6516	.5222
IAR (%)	39.8	34.1	35.7	23.1	15.6	26.4	24.1	40.2	27.1
Intercept (a)	.9291	6.1256	7.3837	39.6827	45.4811	14.0399	76.9452	6.6483	86.4812
Slope (b)	.9741	1.0038	1.0080	.8974	.8745	.9580	.9487	.9654	.9569
Rmse (mm) 1981-1984	5.4	9.4	18.9	16.5	9.7	23.8	48.3	5.3	60.1
NEI	*Area (km2) = 229002; Percentage area of the study = 7.95; Number of Gauges = 25*								
Mean (mm)	41.21	430.76	406.12	425.60	377.05	298.58	1507.36	170.29	2149.60
Interseries cc (r)	.3764	.2556	.1653	.1537	.1437	.1815	.1285	.3994	.1758
Mean cc (R)	.6303	.5214	.4355	.4218	.4116	.4552	.3951	.6493	.4507
IAR (%)	36.8	25.4	17.6	18.0	17.4	19.6	15.7	39.0	19.5
Intercept (a)	3.0844	16.3427	22.7164	43.5963	39.0475	29.3948	113.4502	11.4001	84.4854
Slope (b)	.9272	.8794	.9313	.9025	.9164	.9340	.9343	.9551	.9514
Rmse (mm) 1981-1984	4.6	19.7	10.5	24.8	7.6	8.8	31.5	9.2	44.3

contd...

TABLE 2 contd....

	JF	MAM	JUNE	JULY	AUGUST	SEPT	JJAS	OND	ANNUAL
WPI	*Area (km2) = 414202; Percentage area of the study = 14.38; Number of Gauges = 37*								
Mean (mm)	8.81	54.99	207.76	309.98	216.63	190.50	924.87	107.18	1095.32
Interseries cc (r)	.2999	.3347	.2698	.2997	.3811	.3022	.3679	.3854	.3917
Mean cc (R)	.5594	.3921	.5182	.5448	.6223	.5561	.6109	.6329	.6286
IAR (%)	27.9	4.3	24.2	25.0	34.7	30.7	32.7	38.9	26.6
Intrcept (a)	.1495	3.2380	5.9496	15.4883	14.7640	12.9943	47.2167	5.5872	65.4709
Slope (b)	.9464	1.0187	.8705	.8792	.9008	.9203	.8921	.9721	.8970
Rmse (mm) 1981-1984	2.9	3.7	4.8	11.7	11.4	4.9	14.3	3.7	14.7
EPI	*Area (km2) = 319184; Percentage area of the study = 11.08; Number of Gauges = 22*								
Mean (mm)	20.90	80.57	157.53	248.91	235.42	200.31	842.18	203.46	1147.08
Interseries cc (r)	.3740	.4027	.2896	.2356	.2252	.1981	.2402	.3871	.3108
Mean cc (R)	.6312	.6539	.5536	.5126	.5003	.4832	.5191	.6344	.5844
IAR (%)	38.7	41.8	31.1	26.1	25.4	23.6	26.5	36.1	33.4
Intercept (a)	.4439	4.0909	12.3302	14.3037	17.4796	11.1821	48.9113	-4.5891	37.6201
Slope (b)	.9824	.9388	.9390	.9584	.9381	.9413	.9527	.9066	.9528
Rmse (mm) 1981-1984	2.7	7.8	8.3	7.2	10.9	13.2	16.9	10.9	17.5
SPI	*Area (km2) = 334224; Percentage area of the study = 11.60; Number of Gauges = 41*								
Mean (mm)	24.25	204.03	269.81	289.31	202.02	156.45	917.58	394.81	1540.64
Interseries cc (r)	.3056	.2746	.1277	.2238	.2297	.2776	.2479	.3740	.2398
Mean cc (R)	.5539	.5253	.3072	.4101	.4477	.5304	.4674	.6180	.4870
IAR (%)	27.9	28.3	18.1	20.7	22.1	28.0	22.3	34.8	22.3
Intercept (a)	.7864	10.5359	.7630	5.4157	12.7484	8.9407	33.9159	12.9519	43.9436
Slope (b)	1.0888	.9361	.9039	.8878	.8911	.9172	.8920	1.0266	.9408
Rmse (mm) 1981-1984	12.6	11.3	14.3	11.2	15.6	15.3	21.2	21.08	39.9
AI	*Area (km2) =2880324; Percentage area of the study =100.00; Number of Gauges = 306*								
Mean (mm)	26.76	98.63	175.37	295.57	255.44	176.91	903.28	124.58	1153.11
Interseries cc (r)	.1890	.1676	.1673	.0780	.1012	.1173	.1243	.2036	.1441
Mean cc (R)	.4200	.3596	.4050	.2791	.3198	.3451	.3537	.4343	.3809
IAR (%)	4.3	3.1	12.8	7.5	10.0	12.1	11.1	12.5	11.2
Intercept (a)	.4287	4.2761	-4.5120	-8.5581	-4.3651	-6.6161	-17.1241	.5366	-2.2161
Slope (b)	1.0098	.9728	1.0217	1.0309	1.0195	1.0227	1.0166	.9874	1.0012
Rmse (mm) 1981-1984	2.1	3.5	6.0	12.6	9.7	8.1	26.2	3.7	28.4

TABLE 3: The sequence of the selected IMD-raingauges for the reconstruction from 1871 onwards of the rainfall series of each of the six zones (NWI, NCI, NEI, WPI, EPI and SPI) of India. The 'cc' shows the highest correlation coefficient achieved at each step in the selection process by applying the objective optimization technique.

S	NWI		NCI		NEI		WPI		EPI		SPI	
No	*Station*	*cc*	*Station*	*cc*	*Station*	*cc*	*Station*	*cc*	*Station*	*cc*	*Station*	*cc*
1	Bundi	.7011	Lucknow	.7658	Tura	.6263	Alibag	.8354	Hanumkonda	.6537	Cannanore	.8190
2	Delhi	.8108	Ballia	.8427	Malda	.7606	Nanded	.9016	Bhawanipatna	.8351	Fort Cochin	.8796
3	Pratapgarh	.8840	Sidhi	.8828	Haflong	.8061	Akola	.9305	Masulipatnam	.8682	Tumkur	.9154
4	Baroda	.9070	Jaunpur	.9100	Krishnanagar	.8584	Kolhapur	.9465	Gopalpur	.8904	Salem	.9332
5	Nowgong	.9315	Jamui	.9259	Jalpaiguri	.8789	Bidar	.9616	Chandrapur	.9110	Palghat	.9449
6	Bhopal	.9408	Fatehpur	.9375	Berhampur	.9064	Bijapur	.9649	Phulabani	.9313	Cuddapah	.9566
7	Ludhiana	.9564	Keonjargarh	.9466	Tezpur	.9229	Amraoti	.9664	Ongole	.9472	Madras	.9619
8	Aligarh	.9624	Gorakhpur	.9521	Sibsagar	.9298	Pune	.9685	Puri	.9527	Chikmagalur	.9659
9	Jodhpur	.9672	Purulia	.9596	Calcutta	.9389	Goa/Panjim	.9705	Kakinada	.9616	Bangalore	.9682
10	Patiala	.9709	Mandla	.9643	Silchar	.9497	Bulsar	.9751	Khammam	.9692	Punalur	.9713
11	Radhanpur	.9742	Arrah	.9669	Goalpara	.9594	Gulbarga	.9813	Koraput	.9740	Mangalore	.9750
12	Bareilly	.9794	Hardoi	.9718	Darjeeling	.9660	Aurangabad	.9839	Nalgonda	.9754	Anantapur	.9797
13	Sawai Madhopur	.9821	Naya Dumka	.9735	Agartala	.9714	Mahbubnagar	.9861	Cuttack	.9797	Ootacamund	.9828
14	Seoni	.9857	Sultanpur	.9750	Imphal	.9730	Parbhani	.9870	Vishakhapatnam	.9813	Vellore	.9841
15	Udaipur	.9868	Panna	.9769	Guwahati	.9740	Belgaum	.9880			Shimoga	.9856
16	Meerut	.9874	Varanasi	.9782			Buldhana	.9887			Kozhikode	.9861
17	Indore	.9881	Bahraich	.9792			Bombay(Colaba)	.9897			Mysore	.9876
18	Damoh	.9889	Chaibassa	.9816			Hyderabad	.9911			Coimbatore	.9883
19	Nagpur	.9900	Allahabad	.9825							Tanjavore	.9887
20			Bhagalpur	.9838							Hassan	.9889
21			Raipur	.9863							Cuddalore	.9890
22			Gaya	.9865							Thiruvananthapuram	.9893
23			Kanpur	.9872							Karwar	.9905
24			Gonda	.9880								
25			Midnapore	.9892								
26			Sambalpur	.9895								
27			Azamgarh	.9904								

TABLE 4: Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc($*10^{-4}$) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4); in the reconstruction of the rainfall of the indicated periods from 1844-1870 for North West India. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.

YEAR	JF				MAM				JUNE				JULY				AUGUST			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1844	3	3	7393	12	3	3	7427	13	27	9	9211	43	28	11	8761	54	29	9	9246	66
1845-47	29	7	8451	14	29	8	8666	15	29	10	9313	44	29	12	8845	54	29	9	9246	66
1848	29	7	8451	14	29	8	8666	15	28	10	9313	44	29	12	8845	54	29	9	9246	66
1849	29	7	8451	14	29	8	8666	15	29	10	9313	44	29	12	8845	54	29	9	9246	66
1850	30	7	8451	14	22	10	8487	15	23	9	9026	42	22	5	7868	48	22	7	8275	59
1851	27	9	8427	14	27	8	8650	15	27	14	9413	44	27	12	8845	54	26	9	9189	65
1852	26	8	8469	14	26	7	8519	15	26	10	9274	43	25	9	8242	51	26	9	9050	64
1853	24	7	8422	14	24	7	8519	15	25	12	9232	43	25	8	8449	52	25	8	8945	64
1854	25	7	8422	14	22	7	8519	15	24	13	9297	44	24	11	8684	53	24	8	9078	64
1855	22	6	8333	13	22	10	8487	15	22	11	9160	43	22	8	8112	50	22	7	8355	59
1856	8	7	8016	13	8	5	8128	14	9	8	8885	42	9	7	8694	53	9	6	8796	62
1857	12	8	8129	13	12	6	8327	14	12	6	9100	43	12	8	8886	55	12	7	8881	63
1858-59	13	9	8191	13	13	6	8327	14	13	7	9170	43	13	9	8900	55	13	8	8985	64
1860	31	12	8565	14	31	8	8886	15	31	14	9650	45	31	12	9302	57	31	14	9456	67
1861	39	15	8602	14	38	8	8886	15	39	21	9774	46	39	16	9461	58	39	20	9644	69
1862	44	15	8624	14	44	9	9000	16	44	22	9830	46	44	16	9551	59	44	19	9678	69
1863	51	16	8682	14	51	15	9182	16	51	23	9880	46	51	21	9734	60	51	20	9834	70
1864-65	54	10	8661	14	54	13	9238	16	54	25	9893	46	54	25	9771	60	54	23	9853	70
1866	55	10	8661	14	55	13	9238	16	55	19	9863	46	55	25	9771	60	55	19	9836	70
1867	57	10	8661	14	57	14	9256	16	57	23	9880	46	57	22	9791	60	57	23	9892	70
1868	63	15	8737	14	63	9	9215	16	63	17	9880	46	63	27	9861	61	63	25	9900	70
1869-70	64	15	8737	14	64	9	9195	16	64	17	9880	46	64	24	9852	61	64	25	9900	70
1871	84	19	8526	14	84	19	8708	15	84	19	9757	46	84	19	9703	60	84	19	9826	70

YEAR	SEPTEMBER				JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1844	29	12	9442	67	27	14	8955	116	29	4	9255	27	3	3	8126	113
1845-47	29	12	9442	67	29	13	9138	118	29	4	9255	27	29	13	9245	129
1848	29	12	9442	67	28	13	9138	118	29	4	9255	27	28	13	9245	129
1849	29	12	9442	67	29	13	9138	118	29	4	9255	27	29	13	9245	129
1850	22	6	9041	64	22	7	8557	111	22	6	9115	26	22	8	8706	121
1851	27	10	9518	67	26	12	9083	118	23	9	9241	27	23	8	8977	125
1852	26	6	9433	67	25	9	8887	115	25	9	9279	27	24	11	9006	126
1853	25	6	9433	67	25	9	8998	117	25	8	9288	27	24	9	9043	126
1854	24	6	9433	67	24	13	9120	118	23	4	8929	26	22	8	8972	125
1855	22	6	9262	66	22	9	8761	114	8	7	8896	26	8	7	8627	120
1856	9	7	9267	66	9	7	9030	117	9	6	9145	27	8	6	8833	123
1857	12	8	9346	66	12	9	9129	118	12	7	9281	27	12	8	9088	127
1858-59	13	8	9346	66	13	9	9157	119	13	7	9281	27	13	10	9093	127
1860	31	12	9677	69	31	15	9562	124	31	8	9646	28	31	15	9530	133
1861	39	16	9805	70	39	11	9517	123	39	12	9744	28	38	19	9637	134
1862	44	11	9713	69	44	21	9704	126	44	18	9835	29	44	20	9666	135
1863	51	23	9891	70	51	25	9851	128	51	15	9867	29	51	28	9845	137
1864-65	54	16	9867	70	54	28	9867	128	54	17	9912	29	54	27	9856	137
1866	55	16	9867	70	55	27	9866	128	55	17	9912	29	55	27	9856	137
1867	57	15	9871	70	57	27	9875	128	57	17	9912	29	57	26	9865	138
1868	63	8	9794	69	63	22	9875	128	63	15	9904	29	63	17	9825	137
1869-70	64	18	9907	70	64	27	9902	128	64	15	9904	29	64	28	9903	138
1871	84	19	9866	70	84	19	9900	128	84	19	9867	29	84	19	9868	138

TABLE 5: The reconstructed seasonal, the monsoon monthly and annual rainfall (in mm) of the North West India for the longest instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1844	26.0	24.4	47.4	220.0	182.3	52.7	510.7	7.7	597.6
1845	35.5	38.3	112.1	294.6	263.1	23.0	664.5	9.1	725.1
1846	5.6	12.9	237.4	251.7	92.5	158.3	709.2	7.4	747.6
1847	28.6	17.9	129.8	213.0	203.5	133.0	662.9	50.6	731.4
1848	10.6	26.6	75.2	127.5	155.7	67.9	414.2	17.9	437.5
1849	40.0	11.3	116.4	167.6	193.3	158.4	663.3	38.0	776.3
1850	60.7	16.8	79.1	168.8	199.7	116.0	590.3	32.2	675.6
1851	36.6	16.6	40.9	269.1	152.1	91.7	576.0	12.1	652.9
1852	5.5	84.4	121.8	146.5	264.5	123.0	759.7	12.9	867.9
1853	18.3	29.4	136.5	290.1	92.0	57.3	577.7	89.2	685.8
1854	19.4	7.4	121.4	224.1	167.8	133.3	622.9	120.6	804.7
1855	21.7	55.7	78.3	340.8	54.1	122.8	580.5	19.5	676.6
1856	11.9	11.2	113.6	324.4	238.2	114.7	777.9	22.6	816.9
1857	42.2	19.5	95.2	155.1	289.2	176.4	725.1	26.7	809.2
1858	24.2	4.0	61.8	312.3	144.9	165.0	650.0	10.6	694.8
1859	26.8	42.6	111.1	181.3	190.0	139.4	622.7	14.8	721.8
1860	25.0	27.2	41.4	273.6	202.6	93.4	590.2	5.0	618.9
1861	17.4	16.2	152.9	273.6	251.2	95.7	867.5	11.3	864.8
1862	9.3	29.8	129.1	338.0	197.2	177.9	784.3	68.8	928.4
1863	20.7	21.4	172.9	361.3	184.7	55.7	804.4	38.1	861.0
1864	24.0	35.5	45.2	222.9	208.1	92.7	545.7	2.6	626.8
1865	31.7	58.5	38.3	182.6	324.2	107.4	625.6	16.9	786.6
1866	24.1	12.2	89.7	261.1	295.9	42.1	699.1	5.9	736.6
1867	9.0	34.0	103.4	267.0	311.1	118.3	807.7	47.5	935.2
1868	26.4	27.7	70.6	197.5	163.3	58.1	442.4	2.0	479.1
1869	19.9	45.6	44.9	270.0	148.1	249.6	658.6	65.9	792.6
1870	5.8	41.0	189.2	269.1	180.2	106.8	717.0	36.1	796.3
1871	23.9	35.9	199.1	281.9	173.1	109.6	760.1	23.9	843.5
1872	20.5	24.9	100.6	258.6	313.8	98.5	773.0	9.9	830.0
1873	20.2	30.0	47.8	271.4	209.1	197.1	725.0	16.3	792.2
1874	16.5	13.3	139.9	300.6	232.5	126.6	798.3	1.1	832.7
1875	23.3	18.0	59.9	310.0	175.6	305.7	847.1	16.3	907.0
1876	6.0	27.9	42.6	323.7	157.7	161.7	686.7	15.0	736.2
1877	59.1	36.1	73.6	106.7	65.2	69.1	314.7	128.5	530.2
1878	29.7	48.9	51.1	299.8	313.7	130.7	797.9	10.2	886.0
1879	17.1	19.0	155.5	192.3	326.4	112.3	785.0	43.9	865.3
1880	16.1	8.5	88.5	280.0	135.5	185.1	686.9	45.4	757.9
1881	12.6	46.2	95.9	336.2	266.5	70.1	771.4	9.5	839.2
1882	21.6	16.8	149.7	376.5	135.4	120.1	780.2	9.9	831.1
1883	33.1	40.4	102.0	228.1	80.0	187.2	593.8	24.2	690.2
1884	15.1	9.1	117.1	257.7	267.1	299.0	935.0	36.2	997.6
1885	33.7	39.6	126.8	251.6	288.1	31.0	699.9	63.3	833.2
1886	16.6	44.5	150.6	283.0	194.8	56.9	685.4	73.5	815.3
1887	26.3	4.1	107.3	329.5	272.9	113.5	824.1	34.0	891.1
1888	36.2	9.8	60.0	224.0	273.9	120.3	679.8	14.7	743.2
1889	39.4	26.1	120.8	235.9	330.0	39.5	728.6	17.4	812.7
1890	4.2	19.8	154.5	283.6	206.9	90.8	734.7	16.6	776.9
1891	28.8	36.4	28.7	243.3	261.6	211.5	745.1	20.3	830.4
1892	23.9	12.4	77.7	273.6	278.4	209.2	837.7	25.6	901.8
1893	61.7	58.9	201.8	227.4	194.8	213.6	830.4	49.1	996.3
1894	42.6	16.7	208.8	278.7	203.2	165.9	851.2	105.7	1013.2
1895	40.7	18.6	150.4	194.7	199.9	52.9	597.5	8.4	667.2
1896	12.0	5.0	137.8	235.3	225.7	19.3	619.7	25.3	664.3
1897	16.6	14.7	77.3	240.5	239.9	124.6	683.1	9.0	725.9
1898	52.2	9.7	90.9	273.4	186.1	127.8	678.2	16.6	759.4
1899	6.3	20.2	163.4	146.0	49.9	19.7	377.5	2.4	407.6
1900	17.4	24.5	30.9	194.6	324.5	249.7	798.7	19.1	860.9
1901	46.5	23.5	27.7	194.0	249.6	45.8	521.9	6.6	599.9
1902	8.9	12.8	50.9	255.8	144.7	148.0	599.9	32.8	655.3
1903	11.7	20.8	36.7	238.8	219.4	175.6	671.0	53.5	756.1
1904	15.5	55.0	58.4	230.0	164.9	89.2	544.3	30.0	641.4
1905	29.4	17.2	27.7	222.1	90.7	93.1	435.8	3.1	487.4

TABLE 5 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1906	39.7	21.7	126.8	257.6	153.8	204.1	738.2	9.6	811.3
1907	59.2	39.8	36.8	162.6	295.7	13.1	513.7	2.8	615.4
1908	22.9	13.1	54.4	303.1	348.6	78.6	789.2	4.3	832.8
1909	21.4	55.3	134.0	273.7	175.6	122.1	703.9	32.3	809.9
1910	12.6	8.0	132.4	154.5	247.9	162.8	694.4	78.1	792.0
1911	40.5	28.9	93.6	79.3	113.5	175.9	458.4	39.1	565.5
1912	22.5	15.7	39.2	281.6	223.1	118.1	664.6	27.9	731.9
1913	27.4	50.5	150.8	188.1	152.5	50.4	541.0	16.6	633.5
1914	7.6	38.0	101.4	290.8	154.4	172.3	717.1	21.7	783.8
1915	63.7	48.3	68.0	154.0	162.6	99.1	484.3	59.2	651.1
1916	14.2	12.2	118.7	197.5	355.1	175.3	844.9	54.3	926.1
1917	23.9	96.9	159.3	244.7	269.0	295.4	961.0	115.0	1185.1
1918	5.4	34.0	75.8	73.1	177.6	29.5	357.9	7.7	404.5
1919	52.9	23.7	66.9	277.8	367.2	65.4	781.6	35.7	894.4
1920	24.5	42.8	112.9	261.2	105.5	34.9	515.7	1.2	583.8
1921	26.2	2.6	72.3	199.9	200.0	202.4	672.3	10.6	715.3
1922	26.1	5.1	79.1	250.6	172.2	204.0	703.6	29.7	766.8
1923	30.4	20.2	11.5	301.6	276.5	94.3	688.8	32.4	772.4
1924	32.1	13.7	34.7	254.5	223.6	224.3	736.2	44.9	827.6
1925	4.5	15.4	151.5	274.1	129.5	43.7	598.7	26.5	646.0
1926	14.9	66.8	19.1	223.9	329.2	190.7	764.2	24.3	866.7
1927	18.8	32.7	65.1	293.7	250.1	60.3	673.0	103.2	822.4
1928	48.9	10.4	71.9	269.8	166.4	65.4	576.0	80.4	713.9
1929	15.1	13.5	81.0	249.6	198.5	49.9	581.7	25.9	637.4
1930	27.8	18.6	91.8	314.0	140.2	89.4	636.6	41.5	724.5
1931	16.6	17.2	30.3	228.6	310.8	154.7	726.4	80.5	838.6
1932	9.1	21.9	43.1	297.5	141.9	188.9	671.0	13.3	716.8
1933	15.3	61.4	198.5	223.3	311.4	205.2	932.4	40.1	1045.9
1934	14.3	19.9	149.9	192.2	337.3	139.5	816.8	20.9	873.6
1935	33.1	18.6	53.8	291.1	153.5	155.9	654.7	28.2	735.6
1936	18.6	29.6	184.1	206.5	165.2	143.2	694.3	54.2	794.9
1937	42.4	24.0	105.8	343.0	121.8	136.9	706.8	28.6	802.3
1938	29.3	16.0	166.5	228.2	149.8	42.4	586.1	38.1	669.8
1939	27.3	19.6	83.3	196.2	181.9	94.4	556.5	3.0	608.4
1940	42.3	19.6	86.7	237.3	247.0	45.0	618.9	39.7	720.6
1941	31.4	16.6	71.6	177.4	224.9	72.9	548.7	8.9	607.6
1942	59.2	15.5	69.3	425.7	290.2	127.1	915.2	15.5	1008.5
1943	32.9	27.0	70.2	321.7	161.3	124.5	678.7	19.6	758.8
1944	48.4	53.3	68.9	349.4	303.4	76.1	801.8	32.8	933.8
1945	30.8	15.8	111.8	315.7	204.4	230.6	859.0	17.3	925.5
1946	16.0	19.2	157.7	249.6	313.3	71.6	792.3	81.3	906.7
1947	25.8	16.0	33.1	213.9	229.7	279.9	753.8	24.1	821.4
1948	47.5	17.2	73.2	231.6	251.2	130.1	687.0	39.9	792.1
1949	22.1	16.3	46.7	316.5	165.8	152.3	682.3	36.6	757.9
1950	20.9	24.3	36.6	356.9	196.9	179.3	770.8	7.4	825.3
1951	14.7	42.1	56.5	167.6	167.5	82.3	475.7	22.4	552.9
1952	21.0	20.5	123.9	272.5	243.9	27.9	670.5	6.3	720.2
1953	28.1	11.6	70.5	263.3	260.3	82.9	679.7	6.4	728.7
1954	50.4	12.0	65.0	269.1	158.6	275.9	764.7	50.2	878.0
1955	35.7	17.2	119.6	144.3	331.5	232.1	823.3	136.7	1007.6
1956	17.9	36.7	81.0	355.7	272.2	82.8	794.8	142.7	984.4
1957	35.8	38.4	64.1	248.0	211.6	119.0	644.0	26.9	744.1
1958	11.2	10.6	60.2	292.5	226.0	249.4	825.9	62.3	910.1
1959	29.6	29.1	64.9	284.2	259.9	191.9	800.5	61.2	918.6
1960	13.7	22.9	76.7	244.2	297.9	55.0	677.2	69.5	781.2
1961	39.3	17.9	85.8	336.9	289.6	256.7	966.5	66.0	1089.5
1962	31.4	28.7	25.2	228.0	187.2	252.2	690.7	26.7	777.5
1963	15.4	25.2	82.4	178.3	325.7	159.9	745.8	32.4	819.0
1964	4.9	26.0	70.9	309.8	274.3	161.1	816.8	7.5	857.0
1965	17.8	33.8	19.2	219.0	150.5	96.5	488.1	12.8	552.2
1966	15.5	21.1	139.2	168.2	196.9	77.1	580.4	19.8	637.7
1967	3.7	65.8	97.4	223.7	297.7	153.7	771.9	63.9	899.4
1968	22.7	15.9	39.8	295.7	205.6	58.2	603.6	15.9	659.7
1969	10.8	18.1	33.8	273.0	229.6	160.3	698.2	20.4	748.9
1970	44.4	25.1	124.9	147.2	317.8	172.8	760.0	5.5	837.1

TABLE 5 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1971	20.5	46.0	155.8	269.5	204.0	158.0	783.9	47.5	895.1
1972	20.0	10.0	59.2	152.6	251.5	58.5	524.7	22.7	579.1
1973	21.4	12.2	69.0	294.8	320.1	169.1	853.7	37.1	925.9
1974	4.0	15.3	52.0	244.7	213.1	39.6	553.6	61.5	633.0
1975	18.8	9.4	130.6	270.5	281.2	192.8	872.3	51.9	953.4
1976	22.5	27.5	100.6	258.2	326.3	121.7	807.6	44.0	901.0
1977	22.0	41.9	128.3	315.0	209.4	151.4	802.5	54.7	918.4
1978	31.7	30.4	133.6	297.2	322.4	110.2	863.7	30.1	956.2
1979	59.2	33.0	70.9	203.2	161.7	28.5	467.4	68.1	624.2
1980	11.3	18.9	142.0	255.8	235.1	55.8	689.2	37.4	757.2
1981	21.2	31.9	85.7	232.0	184.0	95.5	598.0	54.7	703.4
1982	38.9	99.9	61.2	197.0	321.5	57.4	640.9	72.1	841.5
1983	25.5	79.5	71.1	270.8	269.3	176.6	787.6	38.9	925.8
1984	32.3	7.1	68.9	182.4	329.6	79.1	662.8	2.3	708.2
1985	17.9	24.7	71.1	273.6	221.7	98.5	666.8	129.0	832.3
1986	44.4	45.3	92.1	254.5	179.6	54.7	582.9	24.7	695.5
1987	32.2	38.2	46.5	120.4	189.6	64.4	423.2	44.1	534.8
1988	12.5	21.0	100.8	306.3	246.4	137.8	791.3	27.1	853.0
1989	19.1	23.6	67.9	178.9	255.8	94.9	599.2	11.8	672.7
1990	35.4	39.5	105.8	249.9	304.0	217.2	874.3	45.5	993.1
1991	12.5	28.6	72.4	219.5	238.8	48.7	582.6	19.6	643.3
1992	19.5	13.6	37.6	193.5	251.7	129.9	614.5	34.0	682.5
1993	15.8	37.8	103.9	304.6	124.5	179.8	710.4	11.0	775.1
1994	34.9	22.6	121.4	325.3	322.1	107.0	876.6	4.2	941.2

TABL 6: Yearwise the number of anvailable gauges (1); the number that entered the selection (2); the highest cc (*10^{-4}) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated period from 1842-1870 for the North Central India. Against the year 1871 that details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.

YEAR	JF				MAM				JUNE				JULY			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1842-43	1	1	7440	17	1	1	6981	21	1	1	6023	40	1	1	4573	32
1844	3	3	8340	19	3	3	8186	25	12	7	8990	59	12	9	9271	64
1845-46	12	5	9084	21	12	8	9020	27	12	8	9283	61	12	10	9343	65
1847	12	5	9084	21	13	8	9020	27	13	8	9283	61	13	10	9427	65
1848	13	5	9084	21	13	8	9020	27	19	10	9667	64	19	12	9626	67
1849	22	12	9797	22	22	17	9707	29	23	10	9696	64	23	11	9605	67
1850	22	11	9794	22	21	13	9660	29	22	9	9556	63	22	10	9516	66
1851	21	10	9676	22	21	13	9660	29	22	9	9556	63	22	10	9516	66
1852	22	7	9681	22	16	11	9464	29	16	9	9369	62	16	9	9388	65
1853	17	4	9385	21	14	10	9192	28	17	14	9457	62	16	10	9439	66
1854	18	8	9540	22	17	13	9521	29	20	14	9513	63	19	11	9475	66
1855	12	5	8622	20	12	6	8961	27	12	7	8990	59	12	9	9271	64
1856-5	3	3	8340	19	3	3	8186	25	3	3	7858	52	3	3	7443	52
1859	7	5	8888	20	7	7	8933	27	7	6	8857	58	7	4	7856	54
1860	22	7	9653	22	22	18	9757	30	22	15	9620	63	22	11	9376	65
1861	23	7	9746	22	23	18	9750	30	23	12	9732	64	23	17	9575	66
1862	23	7	9746	22	23	18	9750	30	23	12	9732	64	23	17	9575	66
1863	26	12	9854	22	26	26	9860	30	26	13	9814	65	25	19	9691	67
1864	25	12	9854	22	25	25	9854	30	25	13	9814	65	25	19	9691	67
1865	25	12	9854	22	25	25	9854	30	25	13	9814	65	25	19	9691	67
1866	26	6	9743	22	26	24	9880	30	26	24	9872	65	26	19	9745	68
1867	43	12	9861	22	43	20	9902	30	43	21	9893	65	43	24	9878	69
1868	44	12	9861	22	44	20	9902	30	44	21	9893	65	44	19	9859	68
1869	45	12	9861	22	45	20	9902	30	45	21	9898	65	45	23	9888	69
1870	49	16	9908	23	49	19	9902	30	49	23	9905	65	49	25	9896	69
1871	50	27	9909	23	50	27	9858	30	50	27	9902	65	50	27	9814	68

YEAR	AUGUST				SEPTEMBER				JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1842-43	1	1	2840	16	1	1	3513	22	1	1	4578	61	1	1	7528	39	1	1	4724	73
1844	12	11	8705	47	13	10	9256	57	12	8	9250	123	13	6	9257	47	3	3	8135	125
1845-46	12	10	8888	48	12	11	9228	57	12	10	9431	126	12	6	9257	47	12	8	9399	144
1847	13	10	8888	48	13	10	9256	57	13	8	9450	126	13	6	9257	47	12	8	9410	144
1848	19	14	9349	51	19	14	9627	59	19	12	9583	128	18	7	9678	50	13	8	9410	144
1849	23	14	9350	51	23	16	9622	59	23	11	9561	128	22	12	9742	50	21	13	9602	147
1850	22	12	9181	50	22	11	9490	59	22	15	9428	126	21	13	9712	50	21	10	9407	144
1851	22	12	9181	50	22	11	9490	59	22	15	9428	126	22	5	9546	49	21	10	9407	144
1852	16	9	8832	48	16	9	9326	58	16	9	9366	125	15	5	9209	47	15	9	9270	142
1853	18	10	8978	49	14	5	9132	56	14	9	9394	125	15	5	9416	48	12	9	9144	140
1854	20	11	9106	49	20	11	9497	59	19	11	9442	126	15	6	9538	49	14	8	9246	142
1855	12	11	8705	47	12	9	9148	56	12	8	9250	123	3	3	8920	46	3	3	8135	125
1856-5	3	2	6471	35	3	2	7435	46	3	3	8037	107	3	3	8920	46	3	3	8135	125
1859	7	4	7143	39	7	5	8487	52	7	4	8338	111	7	4	9461	48	7	4	8537	131
1860	22	12	9169	50	2	14	9546	59	22	15	9495	127	21	14	9831	50	21	17	9545	147
1861	23	12	9320	51	23	18	9661	60	23	15	9557	128	22	15	9857	50	22	13	9560	147
1862	23	12	9320	51	23	18	9661	60	23	15	9557	128	23	15	9857	50	23	15	9576	147
1863	25	20	9533	52	25	19	9757	60	25	15	9679	129	25	16	9854	50	25	18	9762	150
1864	25	20	9533	52	25	19	9757	60	25	15	9679	129	25	16	9854	50	25	18	9762	150
1865	24	20	9533	52	25	19	9757	60	24	13	9630	129	25	16	9854	50	24	14	9719	149
1866	26	20	9533	52	26	20	9783	60	26	19	9748	130	26	16	9874	51	26	14	9732	149
1867	43	20	9727	53	43	23	9880	61	43	30	9887	132	43	16	9898	51	43	26	9909	152
1868	44	26	9810	53	44	23	9880	61	44	30	9887	132	44	18	9905	51	44	26	9909	152
1869	45	27	9803	53	45	23	9880	61	45	25	9879	132	45	17	9909	51	45	25	9892	152
1870	49	31	9855	54	49	28	9900	61	49	26	9893	132	49	14	9903	51	49	27	9904	152
1871	50	27	9726	53	50	27	9829	61	50	27	9903	132	50	27	9883	51	50	27	9901	152

TABLE 7: Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc (*10^{-4}) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated periods from 1829-1870 for the North East India. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.

YEAR	JF				MAM				JUNE			
	1	2	3	4	1	2	3	4	1	2	3	4
1829-36	1	1	6058	13	1	1	4067	34	1	1	4294	30
1837	2	2	7359	15	2	2	5016	41	2	2	5601	38
1838-47	1	1	6058	13	1	1	4067	34	1	1	4294	30
1848	2	2	8169	17	2	2	7449	62	7	7	7875	54
1849	9	7	9578	20	9	7	8995	74	9	8	8781	60
1850	11	8	9597	20	10	9	9121	76	9	9	9022	62
1851	10	8	9597	20	10	8	9214	76	10	10	8997	61
1852	11	8	9597	20	10	8	8942	74	9	9	9008	61
1853	8	6	9222	19	8	6	8828	73	8	8	8939	61
1854	8	7	9528	20	5	4	8476	70	8	6	8362	57
1855	5	5	8643	18	4	3	7850	65	5	5	7735	53
1856	4	4	8532	18	4	3	7850	65	3	3	6504	44
1857-58	2	2	8169	17	2	2	7449	62	2	2	5571	38
1859	3	2	8490	18	3	2	7503	62	3	2	6086	41
1860	6	5	8967	19	6	4	8263	68	6	5	7443	51
1861	7	5	8967	19	7	4	8272	68	7	5	7614	52
1862	9	6	9310	20	8	8	8638	71	8	6	7641	52
1863	9	9	9595	20	9	8	8751	72	9	9	8048	55
1864	9	9	9595	20	9	8	8751	72	9	9	8048	55
1865	10	9	9595	20	10	10	8811	73	10	9	8048	55
1866	11	9	9682	20	11	11	9058	75	11	9	8471	58
1867	13	9	9682	20	13	12	9162	76	13	9	8824	60
1868	15	12	9727	21	15	11	9443	78	16	10	9295	63
1869	16	9	9685	20	16	14	9579	79	16	13	9522	65
1870	18	11	9748	21	18	16	9756	81	18	15	9617	66
1871	20	15	9838	21	20	15	9776	81	20	15	9698	66

YEAR	JULY				AUGUST				SEPTEMBER			
	1	2	3	4	1	2	3	4	1	2	3	4
1829-36	1	1	2004	14	WEAK				1	1	2126	14
1837	2	2	4266	30	CC				2	2	5174	33
1838-47	1	1	2004	14					1	1	2126	14
1848	7	5	7521	52	7	6	7482	47	7	7	8291	53
1849	9	6	8695	61	9	6	8460	53	10	9	8966	57
1850	10	9	8774	61	9	7	8660	54	9	8	8993	57
1851	10	8	8737	61	10	8	8857	55	11	11	9178	55
1852	9	7	8542	60	9	4	8423	53	10	9	9016	57
1853	9	9	8597	60	9	5	8517	53	9	8	8861	56
1854	8	6	8226	57	8	5	7655	48	9	5	8444	54
1855	4	4	6649	46	5	2	7128	44	5	5	7797	50
1856	3	3	6155	43	3	2	4204	26	3	3	6346	40
1857-58	2	2	4799	33	2	1	2925	18	2	1	5703	36
1859	3	2	5881	41	3	2	5643	35	3	2	6893	44
1860	6	5	7251	50	6	3	7734	48	6	5	7855	50
1861	7	6	7387	51	7	3	7734	48	7	6	7892	50
1862	9	7	7867	55	8	5	7293	46	9	8	8369	53
1863	10	9	8336	58	9	8	8038	50	9	7	8347	53
1864	9	7	8290	58	9	8	8038	50	9	7	8347	53
1865	10	7	8290	58	10	8	8038	50	10	7	8370	53
1866	11	8	8911	62	11	8	8489	53	11	9	8569	55
1867	13	9	8973	63	13	9	8769	55	13	10	8980	57
1868	16	10	9290	65	16	10	9137	57	16	5	8954	57
1869	16	11	9597	67	16	8	9285	58	16	10	9520	61
1870	18	15	9746	68	18	15	9727	61	18	14	9743	62
1871	20	15	9676	68	20	15	9632	60	20	15	9704	62

YEAR	JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4
1829-36	WEAK				1	1	7263	52	1	1	2471	44
1837	CC				2	2	7339	52	2	2	4825	85
1838-47					1	1	7263	52	1	1	2471	44
1848	7	7	7399	95	7	5	9156	65	2	2	4861	86
1849	9	6	8357	107	10	8	9561	67	9	7	8651	153
1850	9	8	8577	110	9	8	9609	68	9	8	8791	155
1851	10	8	8743	112	11	8	9636	68	9	8	8914	157
1852	9	8	8570	110	10	8	9636	68	9	7	8755	155
1853	7	6	8274	106	9	7	9551	67	7	5	8426	149
1854	8	7	7542	97	7	5	9249	65	4	4	7366	130
1855	4	4	6084	78	4	3	8770	62	4	4	6765	119
1856	3	3	5085	65	3	3	8770	62	3	3	5841	103
1857-58	2	1	3519	45	2	2	8515	60	2	2	4861	86
1859	3	2	5878	75	3	3	8555	60	3	2	6361	112
1860	6	5	7242	93	6	4	9072	64	6	5	7303	129
1861	7	6	7516	96	6	5	9128	64	6	5	7453	132
1862	8	6	7657	98	9	8	9316	66	8	7	7889	139
1863	9	7	7905	101	9	9	9447	67	9	9	8164	144
1864	9	7	7905	101	9	9	9447	67	9	9	8164	144
1865	10	7	7905	101	10	10	9468	67	10	9	8227	145
1866	11	4	8118	104	11	10	9553	67	11	7	8614	152
1867	13	8	8790	113	13	11	9707	68	13	8	8877	157
1868	16	9	9197	118	16	14	9788	69	15	10	9275	164
1869	16	12	9387	121	16	12	9767	69	16	11	9483	167
1870	18	14	9617	124	18	15	9837	69	18	16	9681	171
1871	20	15	9739	125	20	15	9855	69	20	15	9713	172

TABI Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc (*10^{-4}) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated periods from 1817-1870 for the West Peninsula India. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.

YEAR JF 1	JF 2	JF 3	JF 4	MAM 1	MAM 2	MAM 3	MAM 4	JUNE 1	JUNE 2	JUNE 3	JUNE 4	JULY 1	JULY 2	JULY 3	JULY 4	AUGUST 1	AUGUST 2	AUGUST 3	AUGUST 4	SEPTEMBER 1	SEPTEMBER 2	SEPTEMBER 3	SEPTEMBER 4	JJAS 1	JJAS 2	JJAS 3	JJAS 4	OND 1	OND 2	OND 3	OND 4	ANNUAL 1	ANNUAL 2	ANNUAL 3	ANNUAL 4
1817-:								1	1	7148	43	1	1	7549	62	1	1	8303	68	1	1	6937	48	1	1	7460	125								
1826-:	NO			No				2	2	7844	47	2	2	7963	64	2	2	8542	70	2	2	7796	54	2	2	7922	132	NO				NO			
1831-:	DATA			DATA				1	1	7148	43	1	1	7549	62	1	1	8303	68	1	1	6937	48	1	1	7460	125	DATA				DATA			
1836								2	2	7831	47	2	2	8122	66	2	2	8454	69	2	2	7669	53	2	2	7748	129								
1837-:								1	1	7148	43	1	1	7148	43	1	1	8303	68	1	1	6937	48	1	1	7460	125								
18411	1	6058	13	1	1	5346	25	2	2	7732	46	2	2	7732	46	2	1	8302	68	2	2	7591	52	2	2	7781	129	1	1	5743	31	1	1	4974	96
18422	2	6316	6	2	2	5450	25	3	3	8183	49	3	3	8183	49	3	2	8542	70	3	3	7985	55	3	3	8007	133	2	2	7602	40	2	2	6510	125
18432	2	6046	6	2	2	5443	25	3	3	8256	49	3	3	8256	49	3	2	8737	71	3	3	8564	59	3	3	8409	140	2	2	7393	39	2	2	6934	133
1844-5	3	7851	7	5	2	4926	22	9	9	9420	56	9	7	9320	75	9	8	9390	77	8	6	9070	63	8	7	9259	154	5	3	8976	47	5	3	7813	150
18478	5	8720	8	8	3	6457	30	12	9	9420	56	12	8	9385	76	12	9	9420	77	11	7	9073	63	11	8	9295	155	10	5	9395	50	8	6	8952	172
18485	4	8639	8	5	2	4289	19	5	4	8450	50	5	4	8724	70	5	3	8972	73	5	3	8660	60	5	4	8724	145	5	4	9120	48	5	4	8778	169
18493	3	8211	8	3	2	4289	19	3	3	8332	50	3	3	8473	68	3	3	8972	73	2	2	8279	57	3	3	8574	143	3	3	9033	48	3	3	8552	164
185(2	2	7432	7	2	2	3542	16	2	2	7840	47	2	2	8261	67	2	2	8737	71	2	2	8279	57	2	2	8301	138	2	2	8134	43	2	2	8211	158
185 2	2	7432	7	2	2	3542	16	2	2	7840	47	2	2	8261	67	2	2	8737	71	4	3	8348	58	2	2	8301	138	2	2	8134	43	2	2	8211	158
185:4	4	7969	8	4	3	3866	17	4	3	7900	47	4	3	8460	68	4	3	8774	72	5	3	8580	59	4	4	8667	144	4	3	8464	45	4	4	8686	167
1853-5	5	8274	8	5	1	5817	27	5	4	8271	49	5	4	8470	68	5	3	8774	72	5	3	8580	59	5	5	8749	146	5	4	8747	46	5	5	8811	169
185 3	3	8032	8	3	1	5817	27	3	3	8253	49	3	3	8340	67	3	3	8745	71	3	3	8580	59	3	3	8579	143	3	3	8525	45	3	3	8606	166
1856-6	5	8928	9	6	3	6516	30	6	5	8872	53	6	4	8997	73	6	6	9109	74	6	4	8783	61	6	6	8946	149	6	4	9092	48	6	6	9010	173
185 7	7	9188	9	7	3	7068	32	8	7	9198	55	8	6	9395	76	8	8	9509	78	8	7	9345	65	8	8	9464	158	8	7	9570	51	7	7	9326	179
1869	9	9495	9	9	4	7215	33	9	7	9198	55	9	6	9395	76	9	9	9545	78	9	9	9407	65	9	8	9464	158	9	8	9591	51	9	8	9463	182
1869	11	9678	9	19	4	7393	34	19	12	9703	58	19	16	9669	78	19	17	9796	80	19	12	9662	67	19	13	9721	162	19	15	9751	52	19	14	9626	185
1860	13	9701	9	20	4	7393	34	20	19	9768	58	20	14	9692	78	20	18	9807	80	20	10	9645	67	20	18	9765	163	20	12	9823	52	20	18	9659	186
186321	13	9757	9	21	4	7393	34	21	20	9780	58	21	15	9717	78	21	19	9834	80	21	10	9755	68	21	14	9779	163	21	15	9876	52	21	19	9691	186
186522	12	9760	9	22	5	7431	34	22	14	9775	58	22	17	9762	79	22	16	9841	80	22	10	9763	68	22	14	9803	163	22	18	9891	52	22	14	9672	186
18732	18	9780	9	32	18	6526	30	32	18	9854	59	32	18	9835	79	32	18	9904	81	32	18	9845	68	32	18	9910	165	32	18	9849	52	32	18	9756	188

TABLE 9: Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc ($*10^{-4}$) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated periods from 1848-1870 for the East Peninsula India. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series, from 1871 onwards as well as for the real time update.

YEAR	JF				MAM				JUNE			
	1	2	3	4	1	2	3	4	1	2	3	4
1848-51	1	1	6371	12	1	1	6823	28	1	1	5806	32
1852-62	2	2	7856	15	2	2	8561	35	2	2	6640	36
1863-65	6	5	8744	17	6	5	9438	39	6	4	8707	47
1866	7	5	8877	17	7	6	9525	39	7	4	8707	47
1867-69	8	5	9218	18	8	8	9585	39	8	6	9048	49
1870	9	5	9218	18	9	8	9585	39	9	6	9081	49
1871	15	14	9863	19	15	14	9883	41	15	14	9881	54

YEAR	JULY				AUGUST				SEPTEMBER			
	1	2	3	4	1	2	3	4	1	2	3	4
1848-51	1	1	5644	31	1	1	5635	30	1	1	4783	23
1852-62	2	2	6778	36	2	2	6987	36	2	2	6389	30
1863-65	6	4	8304	45	6	4	8475	44	6	4	8031	38
1866	7	4	8430	45	7	4	8475	44	7	4	8522	40
1867-69	8	6	8859	48	8	6	9052	47	8	6	8788	41
1870	9	7	8900	48	9	6	9052	47	9	6	8810	42
1871	15	14	9798	53	15	14	9828	51	15	14	9687	46

YEAR	JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4
1848-51	1	1	5207	57	1	1	7218	59	1	1	5752	89
1852-62	2	2	6765	74	2	2	8759	71	2	2	7686	118
1863-65	6	4	8177	90	6	5	9368	76	6	5	8814	136
1866	7	4	8394	92	7	6	9535	78	7	5	8814	136
1867-69	8	6	8794	96	8	7	9743	79	8	7	9219	142
1870	9	6	8794	96	9	7	9743	79	9	7	9219	142
1871	15	14	9813	108	15	14	9921	81	15	14	9866	152

TABLE 10: **Yearwise the number of available gauges (1); the number that entered the selection (2); the highest cc ($*10^{-4}$) achieved (3); and the standard deviation (in mm) of the estimated series (1871-1980) from the fitted regression (4) in the reconstruction of the rainfall of the indicated periods from 1813-1870 for the South Peninsula India. Against the year 1871 these details are based on the IMD gauges for the reconstruction of the respective series from 1871 onwards as well as for the real time update.**

YEAR	JF				MAM				JUNE				JULY				AUGUST				SEPTEMBER				JJAS				OND				ANNUAL			
	1	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*
1813-28	1	1	6148	13	1	1	3630	24		WEAK			1	1	2394	18	1	1	2958	18	1	1	3453	19	1	1	3145	44	1	1	7329	79	1	1	3756	66
1829	1	1	6148	13	1	1	3630	24		CC			2	2	5794	42	2	2	5191	31	2	2	6306	34	2	2	5485	76	2	2	8284	88	1	1	3756	66
1830	2	2	8064	16	2	2	5862	38					2	2	5794	42	2	2	5191	31	2	2	6306	34	2	2	5485	76	2	2	8284	88	2	2	5541	97
1831	2	2	8064	16	2	2	5862	38					2	2	5794	42	2	2	5191	31	2	2	6306	34	2	2	5485	76	2	2	8284	88	2	2	5541	97
1832	2	2	8064	16	2	2	5862	38					2	2	5794	42	2	2	5191	31	2	2	6306	34	2	2	5485	76	2	2	8284	88	2	2	5541	97
1833	2	2	8064	16	2	2	5862	38					1	1	2394	18	1	1	2958	18	1	1	3453	19	1	1	3145	44	1	1	7329	79	1	1	3756	66
1834	1	1	6148	13	1	1	3630	24					1	1	2394	18	1	1	2958	18	1	1	3453	19	1	1	3145	44	1	1	7329	79	1	1	3756	66
1835	2	2	6547	13	2	2	5250	34					2	2	2741	20	2	2	4256	26	2	2	6890	37	1	1	3145	44	2	2	8166	87	2	2	5059	89
1836	2	2	6547	13	2	2	5250	34					2	2	2741	20	2	2	4256	26	2	2	6890	37	2	2	4796	66	2	2	8166	87	2	2	5059	89
1837	5	4	7678	16	5	5	6671	44	5	2	4428	27	5	3	6321	46	5	3	6891	42	5	3	7474	40	5	4	6649	92	5	4	8617	92	5	4	6534	115
1838	6	5	8289	17	6	5	8406	55	6	3	8186	49	6	4	7921	58	6	4	8420	51	6	5	8529	46	6	4	8449	117	6	5	9225	99	6	5	8218	144
1839	6	5	8289	17	6	5	8406	55	6	3	8186	49	6	4	7921	58	6	4	8420	51	6	5	8529	46	6	4	8449	117	6	5	9225	99	6	5	8218	144
1840	6	5	8289	17	6	5	8406	55	6	3	8186	49	6	4	7921	58	6	4	8420	51	6	5	8529	46	6	4	8449	117	6	5	9225	99	6	5	8218	144
1841	6	5	8289	17	6	5	8406	55	6	3	8186	49	6	4	7921	58	6	4	8420	51	6	5	8529	46	6	4	8449	117	6	5	9225	99	6	5	8218	144
1842	8	7	9185	19	7	6	8980	59	8	5	9110	55	8	6	8900	65	8	5	9345	57	8	6	9204	50	8	6	8985	125	8	7	9565	102	7	6	8938	157
1843	8	7	9185	19	8	7	9181	61	8	5	9110	55	8	6	8900	65	8	5	9345	57	7	6	9204	50	7	6	8985	125	8	7	9565	102	7	6	8938	157
1844	8	7	9185	19	8	7	9181	61	8	5	9110	55	8	6	8900	65	8	5	9345	57	8	6	9204	50	8	6	8985	125	8	7	9565	102	8	6	8938	157
1845	8	7	9185	19	8	7	9181	61	8	5	9110	55	8	6	8900	65	8	5	9345	57	8	6	9204	50	8	6	8985	125	8	7	9565	102	8	6	8938	157

Contd.....

TABLE 10 CONTD.......

YEAR	JF				MAM				JUNE				JULY			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1846	9	8	9357	19	9	8	9231	61	9	5	9110	55	9	6	8900	65
1847-48	8	8	9357	19	8	7	8828	58	8	3	8186	49	8	4	7921	58
1849-51	7	6	8882	18	7	6	8666	57	7	3	8186	49	7	4	7921	58
1852	9	8	9161	19	9	7	8705	57	9	3	8186	49	9	4	7921	58
1853	15	12	9488	19	15	15	9737	64	15	9	9514	58	15	13	9650	71
1854	15	15	9670	20	16	16	9754	64	16	12	9539	58	15	13	9639	71
1855	10	9	9386	19	10	9	9311	61	10	7	8850	54	9	6	8883	65
1856-60	9	8	9130	19	9	9	9311	61	9	6	8819	53	9	6	8883	65
1861-62	10	10	9514	19	10	10	9451	62	10	7	8715	53	10	6	8883	65
1863	23	13	9779	20	24	20	9811	65	24	16	9709	59	24	15	9740	71
1864	24	13	9779	20	24	20	9811	65	24	16	9709	59	24	15	9740	71
1865-68	25	13	9779	20	25	21	9823	65	25	12	9713	59	25	20	9786	72
1869	24	13	9779	20	24	21	9807	65	24	12	9713	59	24	19	9809	72
1870	28	15	9788	20	28	21	9839	65	28	11	9732	59	28	17	9748	71
1871	31	23	9775	20	31	23	9848	65	31	23	9868	60	31	23	9827	72

YEAR	AUGUST				SEPTEMBER				JJAS				OND				ANNUAL			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1846	9	5	9345	57	9	6	9204	50	9	6	8985	125	9	7	9565	102	9	6	8938	157
1847-48	8	4	8420	51	8	5	8529	46	8	4	8449	117	8	6	9437	101	8	5	8218	144
1849-51	7	4	8420	51	7	5	8529	46	7	4	8449	117	7	6	9290	99	7	5	8218	144
1852	9	4	8420	51	9	5	8529	46	9	4	8449	117	9	6	9290	99	9	4	8278	146
1853	15	9	9729	59	15	6	9541	51	15	14	9688	134	13	12	9698	104	13	11	9494	167
1854	14	8	9725	59	15	6	9541	51	14	13	9642	134	14	14	9701	104	14	12	9541	168
1855	9	6	9202	56	9	6	9196	50	9	6	9141	127	9	7	9402	100	9	7	9148	161
1856-60	9	6	9202	56	9	6	9196	50	9	6	9141	127	9	7	9402	100	9	7	9148	161
1861-62	10	5	9242	56	10	7	9300	50	10	6	9099	126	10	8	9507	102	10	7	9148	161
1863	24	9	9729	59	24	16	9828	53	24	19	9804	136	24	20	9868	105	23	16	9698	171
1864	24	9	9729	59	24	16	9828	53	24	19	9804	136	24	20	9868	105	24	15	9722	171
1865-68	25	9	9729	59	25	19	9846	53	25	10	9695	134	25	19	9879	106	25	19	9786	172
1869	24	9	9729	59	24	14	9785	53	24	10	9695	134	24	18	9875	106	24	18	9784	172
1870	28	12	9822	60	28	19	9868	53	28	10	9707	135	28	17	9873	106	28	17	9769	172
1871	31	23	9869	60	31	23	9886	53	31	23	9904	137	31	23	9852	105	31	23	9838	173

TABLE 11: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the North Central India for the longest instrumental period

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1842	9.3	62.3	176.1	374.4	323.9	226.5	1092.5	157.6	1323.3
1843	16.1	59.2	150.9	213.6	247.9	143.9	755.8	91.7	906.3
1844	42.5	101.3	113.1	328.5	343.7	145.5	930.5	21.1	1001.5
1845	34.2	49.9	164.4	392.0	320.2	98.3	995.1	27.5	1116.7
1846	32.2	86.5	195.5	301.1	280.6	240.3	1024.0	26.0	1169.7
1847	33.9	55.3	88.2	329.2	348.0	163.2	939.7	226.2	1283.2
1848	6.2	59.2	228.9	249.7	259.5	138.8	841.5	60.2	1006.7
1849	40.8	24.4	161.4	181.7	295.0	129.0	784.9	112.2	986.1
1850	48.5	24.4	253.1	258.8	286.1	226.7	1077.1	72.2	1323.8
1851	65.3	22.6	123.9	284.6	222.6	183.6	891.0	100.5	1111.9
1852	23.0	149.4	206.8	395.5	224.9	167.8	915.4	29.1	1075.9
1853	43.9	29.8	139.3	349.8	206.2	170.0	887.3	63.7	1061.5
1854	26.5	51.3	255.2	224.5	353.3	276.1	1103.4	128.6	1284.2
1855	17.3	110.6	145.9	406.0	186.1	317.8	1025.4	29.3	1130.5
1856	34.0	79.2	221.7	303.8	301.8	173.0	1008.6	157.9	1272.7
1857	18.4	64.2	154.7	399.6	299.1	201.0	1079.6	40.7	1212.7
1858	42.3	59.0	130.2	405.9	344.3	208.0	1056.4	77.8	1237.4
1859	38.9	111.6	223.2	295.0	338.0	175.6	1035.9	190.9	1303.5
1860	21.8	62.7	64.9	346.4	249.2	168.5	827.6	69.5	1014.5
1861	39.4	101.3	319.4	414.9	242.5	244.3	1192.0	157.4	1517.9
1862	21.3	68.3	134.4	418.3	339.2	211.0	1083.7	121.3	1282.7
1863	23.1	42.7	230.3	370.2	335.7	229.6	1166.4	89.0	1295.9
1864	28.8	58.9	72.3	212.4	248.4	156.8	669.3	64.2	816.6
1865	26.0	161.6	110.3	362.1	281.5	153.7	922.7	20.9	1146.3
1866	66.7	52.8	165.7	341.8	297.6	202.0	1031.1	44.1	1211.7
1867	54.4	94.3	246.7	390.1	292.3	254.5	1184.4	77.7	1386.7
1868	33.7	64.4	246.3	217.7	218.1	195.8	864.8	13.1	954.1
1869	4.4	58.1	140.4	320.0	234.5	242.1	994.7	179.5	1197.2
1870	12.6	46.8	199.0	375.5	366.5	229.1	1161.1	137.7	1366.4
1871	18.4	127.3	239.8	427.8	297.0	338.9	1300.6	32.6	1479.0
1872	41.2	44.3	205.2	339.3	329.8	193.0	1065.7	70.2	1222.6
1873	6.5	60.8	76.0	407.3	265.6	146.5	900.1	22.3	989.7
1874	42.1	38.4	327.8	317.1	362.7	222.9	1222.7	84.5	1390.4
1875	32.0	59.9	208.7	343.0	331.8	207.3	1089.0	34.0	1216.0
1876	2.2	50.7	119.4	319.8	274.8	235.4	946.6	102.4	1102.1
1877	101.1	124.1	133.4	213.5	224.2	113.9	672.0	113.9	1003.7
1878	47.8	107.7	86.0	253.9	314.0	200.5	853.4	50.9	1056.3
1879	14.8	36.1	175.4	365.4	365.2	264.2	1174.0	99.8	1327.4
1880	42.5	72.0	162.0	373.3	253.5	145.2	930.7	72.0	1116.0
1881	4.1	104.4	211.2	364.7	359.1	121.2	1058.8	81.9	1248.0
1882	11.3	76.4	235.0	276.5	313.1	122.6	939.4	101.7	1127.7
1883	53.5	52.2	230.8	361.4	196.7	156.5	932.5	31.2	1069.2
1884	9.2	39.2	168.3	321.8	319.2	252.0	1059.2	80.9	1190.4
1885	26.8	57.9	225.6	381.2	384.7	181.3	1177.0	95.6	1358.8
1886	7.5	88.6	213.1	360.4	267.4	228.8	1063.1	157.5	1315.6
1887	31.4	106.2	145.7	321.5	368.6	163.3	1003.3	77.2	1216.0
1888	40.7	48.5	92.7	416.5	453.5	175.0	1157.7	27.7	1276.7
1889	57.8	43.9	242.4	365.5	318.2	211.2	1133.7	67.8	1304.7
1890	2.0	56.9	318.8	424.7	303.7	211.3	1252.5	58.1	1372.5
1891	35.7	142.5	99.9	231.2	406.5	257.7	999.4	56.3	1230.2
1892	25.0	27.5	158.0	390.4	342.9	151.4	1048.1	44.1	1147.1
1893	81.2	156.2	272.5	330.9	251.5	292.0	1133.1	116.6	1482.5
1894	37.6	22.3	251.4	386.0	397.3	204.0	1242.6	311.7	1615.9
1895	32.9	64.5	249.4	291.8	290.6	159.5	981.2	30.6	1109.3
1896	3.1	34.5	222.5	318.2	309.3	79.1	924.6	27.9	991.5
1897	37.4	74.4	190.2	295.3	396.7	180.8	1065.4	108.5	1285.3
1898	44.8	43.0	188.0	371.5	436.3	251.1	1256.5	39.4	1386.8
1899	26.3	87.6	252.5	472.6	261.4	117.0	1101.4	29.0	1244.3
1900	65.8	63.1	132.9	293.7	292.5	320.8	1035.3	75.6	1239.3
1901	109.4	63.7	52.2	269.7	349.9	214.3	890.9	32.4	1094.4
1902	7.9	72.9	63.8	399.7	234.5	280.5	979.6	32.3	1092.8
1903	17.1	46.9	100.8	191.7	346.5	245.6	881.5	280.8	1224.5

TABLE 11 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1904	13.8	78.7	235.3	400.6	322.9	127.5	1086.3	83.1	1262.1
1905	58.6	99.1	38.6	366.6	336.1	238.4	989.4	18.0	1163.2
1906	95.2	55.7	181.0	366.2	288.4	179.4	1012.8	49.4	1212.5
1907	70.1	90.9	156.6	208.0	346.6	124.6	831.5	16.2	1005.6
1908	41.0	35.6	121.9	300.1	358.0	129.9	913.8	23.6	1014.7
1909	22.7	108.1	294.4	384.5	277.5	200.8	1148.3	41.9	1320.6
1910	13.3	53.3	201.2	257.6	363.0	228.5	1046.5	130.2	1243.9
1911	21.9	67.9	224.5	145.7	402.8	319.5	1083.5	149.1	1322.4
1912	31.8	67.2	94.0	370.6	326.4	128.7	926.6	72.3	1097.0
1913	61.0	110.2	240.8	282.0	315.7	151.7	982.4	69.6	1220.3
1914	17.6	131.5	86.8	457.3	333.8	125.2	1016.1	26.7	1189.4
1915	54.6	75.3	125.2	314.0	348.1	321.6	1110.7	116.5	1356.6
1916	18.1	30.9	287.1	285.1	360.1	233.9	1158.7	140.7	1350.9
1917	43.4	109.0	243.0	342.5	277.6	291.3	1145.2	132.7	1428.6
1918	3.4	60.5	250.9	169.0	352.3	164.8	925.0	13.5	1002.8
1919	81.1	69.5	197.2	390.5	332.2	214.1	1135.6	81.9	1368.0
1920	15.7	78.4	110.1	536.6	237.0	161.3	1052.6	17.2	1164.3
1921	40.7	23.8	194.8	275.8	420.5	253.0	1146.5	33.0	1247.1
1922	32.3	29.3	216.7	424.9	414.0	280.4	1344.9	36.5	1447.7
1923	45.2	31.6	85.3	327.5	398.6	194.5	1016.3	81.8	1176.1
1924	25.4	27.8	92.7	478.7	282.3	273.6	1135.4	92.0	1283.3
1925	9.3	79.7	174.3	453.6	267.9	227.4	1124.3	59.5	1273.5
1926	18.4	110.8	41.6	393.7	350.8	278.7	1076.8	61.3	1266.0
1927	54.7	78.0	114.3	352.5	322.8	156.4	950.1	113.1	1193.9
1928	79.8	63.4	191.4	346.2	197.2	109.1	832.9	122.8	1096.0
1929	55.8	41.2	175.6	400.7	378.6	101.6	1065.0	156.5	1318.8
1930	21.7	40.3	108.2	392.5	284.2	262.7	1050.0	90.3	1203.7
1931	46.0	29.4	80.6	326.1	319.0	282.5	1011.2	122.4	1209.9
1932	16.2	39.5	113.8	280.5	303.7	174.7	870.9	72.8	999.6
1933	54.8	127.7	187.2	280.1	335.1	201.2	999.9	85.8	1264.5
1934	35.0	30.1	163.6	350.3	315.5	273.2	1102.0	41.9	1211.6
1935	42.3	30.6	103.3	302.2	355.3	200.7	965.6	15.0	1055.0
1936	34.3	73.7	251.7	466.4	332.0	311.9	1363.8	102.8	1576.7
1937	74.4	72.6	154.6	359.3	337.5	168.6	1023.2	108.8	1277.5
1938	42.8	73.4	305.4	361.2	400.9	225.7	1292.5	55.6	1466.1
1939	44.3	39.3	187.2	354.9	323.9	238.6	1103.9	59.6	1249.0
1940	34.1	95.0	112.1	336.5	384.5	148.8	990.6	48.5	1166.8
1941	30.7	38.9	209.7	238.4	328.3	174.2	942.9	78.9	1091.9
1942	93.3	40.3	105.5	375.4	373.5	256.8	1120.5	38.2	1293.5
1943	59.2	58.2	105.5	327.5	430.2	285.4	1159.6	39.0	1317.4
1944	75.3	99.0	109.7	327.5	376.0	177.2	997.7	77.6	1247.0
1945	56.6	63.7	113.8	289.6	252.3	294.6	943.5	129.0	1191.2
1946	20.9	118.2	186.9	402.4	302.5	213.0	1105.2	140.9	1383.0
1947	33.9	47.8	103.0	402.4	282.8	241.6	1033.2	58.3	1174.2
1948	38.6	52.1	147.8	352.3	386.5	281.9	1174.9	134.5	1401.2
1949	37.0	105.1	143.5	359.0	382.4	248.9	1140.8	94.7	1376.4
1950	35.4	68.1	222.9	321.1	353.9	133.0	1029.6	49.3	1182.5
1951	27.7	86.2	164.1	254.3	272.9	191.7	874.1	52.8	1038.8
1952	13.5	74.2	219.1	283.7	351.7	202.2	1052.8	35.1	1176.1
1953	40.2	33.6	154.2	418.2	368.4	274.0	1223.0	40.1	1340.3
1954	44.5	26.8	107.8	284.4	286.7	212.9	888.8	33.2	994.2
1955	37.8	30.8	198.2	406.3	294.4	245.5	1143.4	129.4	1343.5
1956	32.6	98.4	231.6	283.6	327.3	305.1	1139.8	198.0	1467.1
1957	64.0	38.4	103.7	345.0	295.6	180.0	926.2	25.5	1054.3
1958	28.3	41.4	76.6	311.4	331.3	234.8	958.1	126.5	1154.4
1959	55.2	67.5	96.4	308.5	302.0	170.6	878.3	176.4	1174.7
1960	11.4	61.6	104.0	363.3	372.9	203.6	1052.9	108.3	1234.7
1961	64.0	34.0	185.6	305.2	371.5	248.7	1111.4	188.4	1398.5
1962	27.9	52.0	104.9	247.2	351.9	237.3	941.6	67.4	1089.0
1963	18.1	71.8	138.4	337.7	302.9	205.3	984.0	81.0	1154.4
1964	11.3	63.3	138.8	379.0	253.4	268.4	1036.9	62.6	1174.7
1965	7.2	61.2	68.1	262.5	246.4	195.0	766.9	46.6	880.6
1966	26.0	28.8	213.0	198.5	264.4	70.4	731.7	65.2	851.0
1967	11.3	86.9	87.8	278.5	415.0	213.5	1003.4	43.2	1144.2
1968	42.6	27.5	174.8	328.0	298.6	103.3	902.3	56.5	1029.6

TABLE 11 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1969	10.6	88.1	116.9	383.3	329.5	211.5	1046.9	43.9	1189.3
1970	70.1	73.3	217.5	279.4	276.8	328.8	1090.7	56.4	1290.3
1971	40.2	149.3	268.3	396.1	421.8	213.3	1304.9	125.0	1617.3
1972	38.3	16.6	68.2	211.5	324.6	213.6	816.3	72.0	943.6
1973	28.5	51.5	147.7	316.1	330.5	271.6	1065.6	178.3	1324.0
1974	7.8	44.8	82.9	339.7	310.2	153.7	890.6	55.0	998.6
1975	22.9	45.9	199.7	369.4	304.6	202.9	1074.7	63.2	1208.3
1976	17.6	58.9	88.8	284.3	300.3	277.6	949.5	20.6	1047.1
1977	21.3	73.0	155.5	371.9	315.5	150.2	995.4	109.9	1198.9
1978	58.1	73.1	206.0	294.4	293.9	300.8	1086.6	84.6	1302.0
1979	57.7	35.5	128.7	309.0	176.7	90.1	693.6	72.8	857.8
1980	15.6	68.5	221.0	470.0	364.2	250.4	1312.7	50.6	1450.2
1981	41.4	119.9	111.6	433.4	267.3	247.8	1063.5	26.3	1249.1
1982	55.6	111.6	155.3	239.6	376.4	257.3	1027.4	55.5	1247.8
1983	30.7	87.4	118.8	279.9	265.5	315.2	972.8	103.5	1192.6
1984	67.5	39.6	343.4	327.8	334.3	215.7	1210.9	36.7	1357.2
1985	28.8	51.1	120.1	357.6	291.2	285.2	1054.3	173.5	1307.7
1986	47.6	86.3	178.6	324.5	254.1	149.0	899.1	130.2	1160.4
1987	32.8	54.5	70.2	303.2	297.0	302.2	972.8	102.7	1162.6
1988	28.8	78.0	175.7	308.3	351.7	135.4	971.8	59.2	1136.9
1989	14.9	67.2	224.4	324.5	253.2	224.0	1015.6	53.7	1151.8
1990	35.9	115.9	201.9	411.1	276.5	281.2	1168.0	82.9	1401.4
1991	24.7	54.7	172.9	237.8	384.8	220.6	1014.8	60.8	1155.6
1992	15.9	56.3	103.9	274.3	307.0	173.1	857.0	50.1	978.9
1993	9.7	110.4	219.0	221.7	288.6	304.0	1019.4	39.9	1178.1
1994	55.7	49.7	205.7	358.0	371.5	196.7	1134.7	55.3	1296.9

TABLE 12: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the North East India for the longest possible instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1829	24.1	367.8	493.3	374.0		281.2		200.0	2102.1
1830	19.8	665.4	408.5	392.6		250.0		145.2	2149.5
1831	41.8	436.4	500.7	342.0		242.6		150.2	2058.9
1832	42.5	445.7	326.9	311.7		238.3		232.8	1971.1
1833	26.9	595.1	312.6	428.2		273.7		179.7	2110.9
1834	26.0	427.8	463.6	337.9		258.4		322.5	2227.0
1835	19.8	656.0	440.3	523.7		289.2		231.1	2465.2
1836	49.5	360.9	337.8	412.2		331.7		60.3	1928.2
1837	45.2	373.4	405.0	357.3		287.4		187.4	2061.5
1838	21.3	346.6	415.0	390.5		273.4		194.7	2003.4
1839	41.3	456.6	383.9	453.1		389.0		87.5	2173.5
1840	19.8	453.2	430.1	370.0		238.9		90.4	2094.5
1841	34.7	454.1	359.4	443.3		310.1		115.1	2106.4
1842	19.8	453.7	585.0	378.6		229.7		147.0	2332.0
1843	51.5	446.4	378.3	386.8		305.9		112.5	2164.5
1844	23.8	483.0	419.3	437.9		239.8		148.5	2299.9
1845	43.7	444.6	402.0	424.7		237.4		179.1	2115.5
1846	55.8	375.2	419.4	529.6		292.8		295.0	2336.5
1847	19.8	410.1	417.9	466.4		303.3		267.2	2278.5
1848	25.3	455.0	357.8	297.3	352.5	247.3	1251.9	183.8	2237.9
1849	82.4	462.1	351.8	402.1	320.5	281.2	1338.2	216.4	2129.9
1850	46.6	358.2	334.5	493.0	427.4	351.1	1565.6	190.0	2167.1
1851	63.6	402.9	451.6	335.8	315.8	228.3	1341.0	248.1	2046.1
1852	25.6	548.7	387.1	439.5	286.4	383.9	1444.9	116.4	2148.5
1853	30.1	241.1	427.1	414.2	383.4	393.6	1467.7	122.7	1944.0
1854	30.4	339.9	456.5	275.3	339.2	228.0	1302.5	148.4	1869.6
1855	49.4	521.9	348.9	320.5	349.7	321.2	1264.8	102.5	1920.1
1856	40.7	459.9	436.5	418.3	293.9	248.9	1401.5	198.0	2084.0
1857	24.4	419.5	386.3	574.2	284.9	254.9	1566.2	112.9	2200.5
1858	23.1	537.8	430.2	429.6	524.4	331.6	1690.5	211.9	2384.9
1859	16.2	410.4	354.9	618.8	420.8	342.0	1734.9	158.3	2350.8
1860	16.6	418.7	441.9	472.2	472.3	308.5	1677.7	180.8	2339.5
1861	14.8	553.9	503.0	505.9	360.1	312.5	1652.6	306.2	2460.9
1862	33.9	413.9	424.1	413.1	480.3	344.2	1584.4	320.6	2379.3
1863	23.9	362.4	416.1	325.2	349.2	259.5	1353.4	96.5	1866.3
1864	36.8	339.0	367.5	474.4	304.0	272.8	1407.1	203.3	2046.5
1865	39.6	533.1	414.9	537.6	311.6	194.0	1496.0	93.0	2116.4
1866	128.8	428.2	473.8	421.9	381.1	326.6	1550.6	145.2	2457.1
1867	60.1	404.5	365.7	495.3	308.3	362.0	1543.4	232.7	2272.0
1868	53.7	374.6	440.7	414.9	536.7	351.2	1815.5	80.5	2306.7
1869	83.0	411.8	459.4	369.6	401.9	377.0	1536.4	109.1	2110.5
1870	20.9	321.2	562.2	455.2	333.7	379.0	1744.8	233.2	2299.4
1871	26.6	449.5	367.3	435.5	386.2	305.7	1495.1	122.3	2094.6
1872	40.4	371.2	363.4	414.4	348.6	381.9	1507.3	210.3	2124.1
1873	25.5	319.9	344.7	353.0	305.7	211.3	1210.5	55.7	1597.1
1874	98.6	461.3	350.2	372.4	281.1	427.3	1427.1	261.6	2250.7
1875	55.3	464.1	516.9	397.8	495.5	200.9	1612.7	61.1	2198.7
1876	25.2	429.5	483.2	410.6	358.5	253.7	1505.4	170.0	2129.6
1877	75.5	466.1	233.4	476.4	354.5	353.9	1419.0	105.0	2068.1
1878	41.3	422.4	394.9	472.7	469.0	461.7	1801.8	148.7	2419.0
1879	24.4	370.1	470.3	526.3	459.5	344.9	1806.4	140.4	2341.5
1880	82.1	503.6	539.4	391.3	424.6	254.8	1610.3	208.0	2412.7
1881	13.5	523.8	366.8	328.3	402.3	426.0	1520.3	113.2	2178.1
1882	61.2	390.2	421.0	296.8	439.2	287.2	1441.1	343.5	2231.3
1883	27.4	480.6	367.0	348.6	410.7	249.5	1373.6	107.6	1990.7
1884	41.0	442.6	333.2	313.8	365.1	174.6	1182.3	152.9	1813.7
1885	29.6	386.9	390.9	464.7	362.7	406.7	1626.1	131.1	2172.1
1886	17.1	394.6	359.7	509.2	440.6	436.5	1750.1	104.8	2267.8
1887	46.7	492.1	495.1	309.2	353.3	288.1	1441.4	97.6	2082.0
1888	49.6	534.6	326.8	442.2	416.9	227.0	1413.9	86.7	2092.2
1889	64.6	372.0	522.6	417.5	281.2	340.6	1560.2	148.0	2141.5
1890	24.7	358.0	490.8	523.5	403.3	289.5	1711.3	215.1	2306.2

TABLE 12 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1891	54.7	479.6	280.5	401.0	303.8	209.8	1192.5	85.6	1811.3
1892	34.8	586.8	345.2	462.6	439.4	251.9	1501.4	147.6	2283.1
1893	79.7	476.6	478.8	491.7	381.3	311.8	1666.4	150.6	2381.0
1894	41.5	443.3	409.5	340.6	416.9	364.0	1528.7	296.8	2311.4
1895	14.6	435.7	262.3	525.5	387.9	277.4	1456.3	124.3	2029.8
1896	52.2	454.2	300.0	366.4	276.9	303.0	1241.9	35.6	1781.7
1897	18.0	426.7	368.9	390.0	401.9	340.5	1500.5	200.1	2144.1
1898	56.2	282.7	404.0	399.9	416.4	369.4	1589.6	170.5	2088.9
1899	58.4	431.3	466.3	495.4	398.3	345.9	1709.0	141.1	2344.1
1900	49.2	424.1	388.0	463.9	258.0	345.8	1454.8	52.9	1980.2
1901	36.8	302.4	406.4	390.3	384.0	280.5	1460.1	190.9	1978.6
1902	8.2	487.1	438.7	411.3	398.5	437.6	1686.1	110.8	2299.4
1903	33.2	281.1	473.1	267.4	441.5	303.4	1481.3	205.9	1988.4
1904	55.0	616.1	318.1	426.6	373.4	233.1	1350.8	145.3	2180.0
1905	44.7	477.2	356.4	484.5	553.6	305.3	1705.2	193.7	2428.3
1906	89.1	404.6	344.7	398.8	541.7	301.4	1588.6	170.9	2253.9
1907	60.4	401.2	429.4	445.4	276.2	292.3	1442.1	47.2	1948.2
1908	38.6	317.3	365.1	404.7	304.8	333.1	1405.5	80.7	1831.1
1909	17.8	354.8	534.0	344.4	459.1	238.5	1575.2	202.1	2144.2
1910	27.3	384.9	432.7	548.9	361.4	289.5	1636.6	194.9	2241.7
1911	50.0	515.1	442.2	426.3	349.2	354.7	1572.0	211.7	2357.0
1912	42.3	490.7	355.3	468.1	382.8	172.9	1380.6	223.0	2138.9
1913	73.4	523.3	508.7	424.4	336.2	260.1	1528.9	230.7	2364.9
1914	66.9	461.3	287.0	413.9	434.3	256.4	1391.9	88.3	2009.8
1915	45.4	595.7	403.5	478.0	415.7	228.6	1528.4	125.2	2308.8
1916	27.6	380.5	405.0	401.7	386.5	374.2	1566.8	269.6	2240.7
1917	60.1	304.2	442.6	435.4	318.9	344.9	1541.2	305.3	2201.1
1918	11.0	456.1	539.3	520.4	549.6	300.9	1917.2	59.2	2452.8
1919	28.9	314.6	414.3	418.6	302.3	322.1	1455.7	172.1	1960.5
1920	37.7	431.1	359.5	340.9	400.1	416.1	1513.9	139.6	2122.6
1921	44.5	538.5	457.3	501.6	383.4	284.4	1629.7	116.5	2340.5
1922	15.9	288.3	504.6	368.8	401.3	294.3	1567.9	111.9	1973.0
1923	48.8	414.0	438.8	415.1	305.2	284.5	1442.0	128.8	2031.4
1924	24.6	363.5	370.4	525.0	397.7	321.2	1618.0	215.0	2216.9
1925	34.9	602.9	286.8	407.1	351.4	371.7	1415.4	146.7	2212.1
1926	46.6	424.2	393.7	520.1	388.4	232.8	1538.5	165.5	2174.9
1927	89.4	431.0	381.1	404.3	343.8	420.0	1547.8	131.4	2201.8
1928	32.1	391.6	396.2	434.6	402.3	261.3	1495.2	297.4	2212.2
1929	53.8	589.1	439.6	399.1	339.2	273.4	1449.7	300.0	2404.4
1930	37.8	320.7	495.7	339.6	381.6	256.2	1470.4	215.3	2034.3
1931	27.7	423.1	371.9	522.3	283.5	298.6	1477.7	191.3	2118.1
1932	39.8	449.4	437.6	356.6	366.0	287.4	1445.1	206.1	2140.7
1933	36.9	407.7	408.8	395.3	479.1	239.4	1523.5	131.8	2098.4
1934	75.6	454.7	497.2	437.8	335.0	262.7	1532.6	251.6	2317.4
1935	43.2	298.9	449.0	329.1	476.5	305.7	1558.9	46.5	1938.2
1936	44.7	477.4	377.8	479.2	348.0	358.5	1564.7	172.2	2263.9
1937	68.8	342.9	365.3	360.8	462.3	269.4	1456.9	220.3	2081.3
1938	32.5	478.7	452.1	421.5	413.7	327.8	1615.8	149.6	2282.4
1939	29.0	337.3	433.1	470.8	341.0	354.4	1600.3	198.5	2158.6
1940	46.3	464.3	391.5	393.0	315.7	323.4	1421.2	90.1	2023.5
1941	32.9	540.6	463.6	367.9	400.3	285.7	1516.1	191.9	2290.2
1942	24.7	509.5	420.6	306.8	394.4	427.5	1545.6	139.0	2225.7
1943	80.9	519.5	424.2	396.6	354.4	331.3	1505.1	104.9	2218.9
1944	54.0	455.2	358.0	392.8	373.9	327.2	1450.6	81.4	2042.9
1945	61.4	412.8	401.8	409.1	395.0	276.5	1482.2	226.1	2180.9
1946	21.9	446.2	404.9	430.3	273.7	299.4	1406.5	349.7	2222.5
1947	8.6	427.2	431.7	473.4	338.7	341.9	1586.6	187.6	2210.2
1948	49.0	661.0	398.6	463.1	382.8	269.4	1515.3	294.3	2538.3
1949	26.8	583.3	462.3	387.1	407.3	327.8	1584.0	153.0	2360.5
1950	43.6	313.2	550.1	373.4	439.4	231.6	1594.4	207.6	2150.7
1951	6.2	359.0	414.8	473.1	331.0	208.8	1428.4	248.2	2033.2
1952	12.7	543.7	344.9	487.2	382.6	329.8	1546.5	242.6	2354.4
1953	37.9	458.8	399.6	479.9	293.4	383.2	1556.4	110.1	2166.7
1954	49.6	397.2	454.9	445.3	343.3	206.8	1450.6	161.1	2055.0
1955	12.8	424.6	402.4	532.3	380.9	261.1	1580.5	217.3	2235.1

TABLE 12 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1956	25.7	549.2	566.6	372.4	377.1	244.5	1559.1	223.5	2367.5
1957	111.0	358.5	366.4	415.2	349.2	250.4	1380.3	110.9	1954.4
1958	55.2	443.4	309.0	328.8	458.0	268.5	1362.1	151.2	2010.8
1959	81.1	437.8	364.5	353.9	307.1	321.7	1343.2	378.1	2237.9
1960	6.0	319.5	327.0	523.6	374.1	407.6	1635.6	117.6	2071.1
1961	43.1	451.7	346.4	347.2	366.5	254.0	1311.1	144.4	1948.6
1962	36.3	345.9	442.0	319.9	364.3	183.3	1305.6	128.5	1805.7
1963	9.3	418.6	450.5	444.2	434.1	244.5	1575.2	209.2	2211.5
1964	21.2	448.5	401.8	591.4	305.7	314.5	1617.9	189.5	2279.9
1965	50.4	363.5	430.0	446.0	427.5	279.2	1584.5	127.1	2121.7
1966	37.7	348.5	478.8	437.7	440.5	276.6	1635.4	193.1	2210.0
1967	49.4	404.7	315.8	405.6	275.2	328.7	1322.3	111.3	1882.7
1968	26.9	353.2	460.3	486.6	372.5	220.5	1542.1	203.1	2119.2
1969	13.0	375.0	429.1	366.4	422.8	252.1	1469.3	122.5	1973.9
1970	72.6	378.0	427.2	501.5	335.4	311.2	1577.2	226.0	2251.4
1971	29.9	431.7	408.0	420.7	392.1	250.9	1471.7	270.5	2202.5
1972	38.4	390.2	347.1	395.3	286.8	247.8	1273.9	85.1	1780.3
1973	55.7	497.6	460.4	329.8	317.6	346.7	1450.1	294.6	2302.3
1974	21.9	462.0	396.1	654.1	429.5	280.4	1769.2	196.0	2455.9
1975	21.4	349.2	310.9	531.8	259.2	294.2	1397.3	197.6	1956.2
1976	46.2	429.7	460.6	432.5	393.3	206.8	1493.9	87.8	2057.7
1977	28.0	612.5	420.5	453.1	393.5	202.0	1470.4	239.6	2364.0
1978	11.2	373.7	392.2	380.3	311.3	328.7	1409.6	136.3	1923.6
1979	20.7	253.8	245.6	545.4	289.6	273.9	1356.4	233.3	1846.2
1980	40.7	464.2	338.9	441.4	377.1	233.2	1391.1	197.8	2094.2
1981	47.2	478.6	232.2	476.7	325.5	254.4	1289.1	88.3	1903.6
1982	26.6	375.5	308.2	353.2	314.9	230.7	1202.9	97.1	1691.9
1983	42.4	427.2	318.7	459.3	345.2	336.1	1459.7	234.8	2162.6
1984	25.4	422.7	475.0	439.1	346.2	358.6	1619.0	153.0	2221.2
1985	38.7	430.8	406.9	459.6	277.2	310.4	1453.5	108.9	2030.9
1986	16.7	375.3	286.8	382.7	299.2	358.7	1324.0	317.1	2024.0
1987	28.6	349.2	375.6	490.0	463.6	379.2	1712.3	133.6	2220.5
1988	38.7	431.5	318.1	466.0	481.3	288.3	1556.9	271.1	2298.7
1989	38.6	373.9	356.7	535.4	287.8	438.7	1620.6	195.7	2226.0
1990	50.5	487.9	361.1	467.5	264.2	307.6	1399.6	189.4	2130.3
1991	41.7	515.6	398.8	287.4	313.1	368.5	1361.7	286.1	2208.9
1992	54.6	314.2	312.8	436.9	262.7	266.7	1276.9	136.3	1768.7
1993	100.7	418.9	467.4	489.6	397.2	316.3	1673.5	119.0	2315.9
1994	64.6	439.6	395.7	306.2	326.4	200.8	1224.0	147.5	1871.9

TABLE 13: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the West Peninsula India for the longest possible instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1817			377.2	294.9	166.5	307.8	1210.2		
1818			224.6	251.1	349.0	184.1	992.6		
1819			181.2	353.0	270.5	181.7	982.1		
1820			200.1	329.3	263.4	186.4	977.2		
1821			176.1	272.4	349.7	251.6	1023.8		
1822			271.3	316.3	400.4	284.6	1286.6		
1823			219.5	238.4	265.4	131.9	838.4		
1824			101.8	180.6	247.8	110.6	571.3		
1825			237.2	305.9	200.8	178.0	931.9		
1826			187.9	326.5	141.7	257.5	917.7		
1827			427.7	183.5	167.0	180.0	1001.5		
1828			211.6	479.4	233.0	287.2	1255.1		
1829			255.2	257.6	192.3	109.7	817.1		
1830			219.5	341.3	165.9	130.6	870.8		
1831			222.1	321.6	341.2	286.2	1173.4		
1832			166.0	473.5	121.7	156.0	942.6		
1833			158.5	281.2	204.7	296.4	922.6		
1834			169.4	281.4	249.6	202.5	881.8		
1835			142.0	152.8	418.8	199.3	842.8		
1836			220.3	279.5	386.1	138.3	1009.1		
1837			159.2	300.2	291.5	139.3	864.0		
1838			271.7	185.3	147.4	138.4	741.5		
1839			196.5	357.3	253.5	135.5	944.2		
1840			241.1	299.1	117.4	159.8	832.4		
1841	4.7	32.3	249.1	292.0	273.3	100.6	885.0	157.3	1074.4
1842	7.4	32.0	188.3	382.6	468.6	226.1	1233.2	49.2	1349.1
1843	17.8	101.9	119.1	360.7	235.8	193.4	901.7	84.1	1247.7
1844	3.6	35.9	236.9	238.3	149.6	173.0	823.3	76.1	1012.6
1845	5.5	134.1	225.1	201.1	164.7	146.0	747.3	57.1	839.4
1846	8.3	78.8	375.7	330.8	176.7	181.0	1108.5	66.0	1138.6
1847	7.5	129.0	291.8	217.8	166.3	143.6	886.3	193.9	1147.7
1848	2.7	203.4	282.1	209.1	157.5	79.1	797.2	139.5	1060.5
1849	7.4	36.0	257.5	445.4	214.3	322.1	1279.7	51.6	1403.9
1850	5.7	23.3	181.5	252.3	134.0	143.1	699.8	181.0	893.8
1851	2.8	32.4	225.3	486.0	261.7	97.3	1092.8	127.4	1267.5
1852	2.5	72.5	205.4	270.0	211.7	151.0	878.8	105.0	1105.3
1853	19.6	62.9	281.5	190.1	174.4	139.4	778.1	62.1	964.4
1854	2.7	42.2	163.9	452.9	142.4	199.5	957.3	204.0	1201.5
1855	8.5	31.4	204.1	179.0	128.5	104.7	606.2	79.2	739.8
1856	2.0	138.5	239.7	255.7	207.2	109.8	803.5	98.2	1002.9
1857	9.7	123.2	172.2	168.4	225.0	190.1	679.3	144.4	969.2
1858	2.6	84.2	155.2	248.0	98.3	232.3	688.8	111.2	908.9
1859	.6	115.0	198.3	278.1	248.4	146.4	887.6	46.2	1032.8
1860	1.9	29.2	274.0	265.2	176.1	222.8	913.9	64.1	968.5
1861	18.3	37.5	190.2	385.8	383.8	126.3	1114.0	59.0	1264.7
1862	4.0	18.3	233.8	116.9	199.5	281.9	847.8	126.4	1011.5
1863	2.3	53.1	230.3	289.0	160.8	170.4	806.8	61.8	978.6
1864	6.8	42.0	271.0	231.9	185.9	120.5	842.5	40.6	879.9
1865	18.9	97.6	165.4	230.0	405.7	73.8	849.8	84.9	1081.7
1866	.7	22.5	152.0	362.8	254.3	121.1	795.6	100.3	937.3
1867	1.3	33.6	230.9	245.7	254.2	180.3	881.3	156.7	1129.3
1868	13.4	53.0	265.2	270.4	245.8	108.7	909.7	18.1	989.2
1869	.5	19.6	197.7	233.1	293.0	207.9	876.4	126.4	1063.7
1870	8.1	55.5	259.0	388.1	176.3	187.7	1032.3	165.1	1236.7
1871	37.2	38.1	154.8	182.2	127.0	117.7	581.5	71.2	728.9
1872	.2	42.1	252.6	361.2	173.5	240.1	1028.1	93.7	1167.2
1873	9.9	66.3	181.2	231.5	220.3	184.1	815.5	55.1	948.3
1874	.9	46.4	241.9	410.3	151.0	259.5	1063.6	68.1	1183.6
1875	3.9	35.9	274.7	341.9	202.4	269.6	1088.5	63.1	1197.6
1876	.7	16.1	146.0	280.2	168.1	98.2	693.7	11.6	732.7
1877	24.1	57.0	224.3	113.6	151.9	180.7	668.9	190.8	931.4
1878	.8	35.5	199.7	451.9	433.7	296.2	1378.0	167.2	1581.5

TABLE 13 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1879	5.6	110.7	215.6	191.2	374.0	126.8	906.4	85.2	1102.6
1880	.3	33.6	224.3	254.1	89.6	276.5	842.7	132.3	1009.0
1881	.4	45.2	171.3	283.6	206.0	143.1	804.3	121.8	970.9
1882	6.9	45.5	306.5	390.9	133.3	230.7	1064.7	74.8	1196.0
1883	1.7	38.1	281.3	344.9	269.7	260.5	1156.1	164.0	1358.5
1884	6.3	31.3	114.9	358.2	192.8	286.1	947.7	156.1	1140.3
1885	1.1	71.7	111.5	291.8	213.4	192.9	806.8	192.2	1062.4
1886	.2	67.1	302.8	374.8	197.3	94.2	975.7	205.8	1239.9
1887	1.0	45.0	262.7	373.8	245.0	201.4	1084.7	159.7	1288.2
1888	30.4	44.7	205.3	307.7	175.3	108.0	799.2	88.3	962.9
1889	.8	44.8	236.6	342.0	179.6	199.9	959.3	152.1	1154.8
1890	.2	38.6	277.5	325.5	202.6	178.7	986.8	129.5	1155.5
1891	19.1	38.7	91.6	331.3	172.0	231.8	823.3	65.8	950.4
1892	2.0	64.1	221.5	341.5	431.4	330.0	1318.9	199.9	1578.6
1893	17.0	160.8	293.2	205.6	287.0	172.2	958.5	177.1	1294.5
1894	6.1	37.0	195.6	336.2	186.7	289.8	1005.7	116.0	1166.3
1895	10.6	41.6	174.4	286.3	202.0	247.0	906.9	115.5	1075.0
1896	.3	33.2	238.0	345.8	256.1	50.0	895.1	51.7	986.9
1897	5.2	41.1	154.4	337.9	216.6	238.0	944.5	74.4	1069.1
1898	11.6	51.2	212.6	335.7	122.9	234.4	905.6	70.2	1041.2
1899	1.4	71.3	206.8	68.9	100.2	118.2	493.9	14.6	583.8
1900	2.2	30.5	174.8	346.7	299.7	161.0	982.0	25.1	1049.1
1901	26.9	103.9	255.5	270.9	236.7	92.1	858.8	75.6	1059.9
1902	1.3	20.0	142.9	270.9	193.0	248.2	851.3	170.3	1041.6
1903	4.1	83.5	145.0	421.2	273.3	180.4	1019.8	146.1	1247.2
1904	1.6	37.9	220.8	206.5	96.5	207.1	730.4	75.0	848.3
1905	3.8	35.7	99.6	207.6	146.8	133.8	586.1	64.6	693.6
1906	22.8	19.8	223.8	324.2	233.5	115.1	899.3	77.6	1024.6
1907	16.3	76.0	192.0	367.1	284.8	99.5	946.0	20.2	1061.9
1908	1.3	25.7	155.9	370.0	232.2	229.7	986.1	20.4	1043.8
1909	5.2	42.7	244.7	337.7	158.4	204.8	947.1	51.0	1051.5
1910	.2	18.7	279.7	189.7	263.1	284.7	1013.9	109.4	1146.8
1911	7.7	26.5	147.8	218.6	204.1	77.5	648.6	54.8	743.0
1912	11.3	37.8	157.5	403.9	204.6	81.7	851.3	94.7	997.1
1913	2.4	45.6	299.2	335.4	129.8	106.9	877.3	63.6	993.0
1914	4.9	31.0	265.4	399.8	278.6	276.2	1219.5	43.5	1307.9
1915	22.6	89.3	306.0	248.4	152.1	238.3	945.4	135.8	1185.8
1916	2.3	62.1	227.0	360.1	231.4	320.7	1136.3	258.2	1447.4
1917	36.7	55.8	236.7	192.8	311.5	281.9	1018.2	211.3	1312.4
1918	6.2	163.6	102.9	120.0	138.9	97.9	457.8	60.4	675.9
1919	14.5	42.4	199.0	284.6	171.2	195.4	849.8	120.2	1026.3
1920	25.9	36.0	140.4	212.1	117.6	114.8	585.1	32.4	684.2
1921	1.2	22.8	231.8	372.0	161.6	155.7	924.2	81.8	1035.6
1922	41.6	31.3	226.9	317.8	103.4	170.7	821.1	140.6	1032.0
1923	7.7	56.5	68.9	465.7	141.4	236.9	911.1	11.9	993.8
1924	5.1	31.7	124.0	281.3	216.8	184.9	804.6	82.7	927.8
1925	.3	77.2	226.3	180.6	164.9	100.7	674.2	116.5	863.4
1926	42.6	45.2	85.9	336.0	320.1	203.8	941.7	21.1	1056.4
1927	2.1	36.7	265.5	278.2	115.1	161.9	823.5	145.0	1005.9
1928	24.6	27.9	217.3	284.9	189.0	224.4	914.7	101.0	1070.5
1929	25.1	45.2	248.5	226.3	119.3	162.3	757.9	100.7	928.3
1930	1.2	33.1	258.7	182.8	129.0	329.9	896.4	111.6	1044.2
1931	.6	32.8	143.6	459.4	253.8	196.9	1053.7	255.5	1334.3
1932	8.6	60.4	140.0	431.5	185.1	183.7	940.8	155.4	1160.4
1933	8.4	135.5	264.0	280.0	245.1	247.4	1035.4	149.4	1315.9
1934	2.2	22.7	248.5	299.2	307.7	146.8	1003.6	94.0	1127.5
1935	12.1	24.3	225.8	313.1	193.6	189.8	923.1	94.2	1057.6
1936	22.4	55.6	291.0	170.0	150.6	151.7	765.1	138.0	976.6
1937	14.8	101.1	213.8	359.2	79.4	209.7	863.6	126.6	1097.9
1938	5.5	79.5	339.2	281.7	236.8	214.1	1073.7	128.3	1283.0
1939	.7	26.8	127.8	284.5	253.5	96.6	762.6	74.1	869.1
1940	4.9	54.7	254.7	301.5	297.5	143.4	998.8	136.5	1192.7
1941	21.7	22.2	118.3	241.4	126.3	133.3	618.7	41.7	710.5
1942	20.6	38.3	300.8	372.0	255.7	142.2	1075.0	58.5	1197.8
1943	16.2	118.1	243.3	304.4	89.6	242.6	880.3	150.7	1153.3

TABLE 13 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1944	11.4	59.0	156.3	400.8	227.9	148.9	935.1	115.7	1119.4
1945	6.4	21.4	206.6	383.9	252.5	197.4	1040.9	50.9	1128.3
1946	7.8	60.7	250.6	303.8	243.4	163.0	962.4	156.0	1182.2
1947	21.4	60.4	102.5	290.5	324.6	256.5	968.2	57.9	1110.1
1948	18.4	33.6	192.4	294.2	207.1	194.0	887.1	211.6	1144.0
1949	3.5	79.2	170.2	328.8	178.4	432.8	1102.6	77.7	1263.0
1950	9.3	37.8	103.9	371.5	137.9	278.8	888.4	74.0	1013.3
1951	2.3	64.0	203.6	355.6	142.1	101.5	806.9	128.4	998.1
1952	7.2	69.1	210.4	282.3	141.9	98.1	736.0	91.8	902.2
1953	.5	32.8	255.6	406.8	248.7	172.6	1086.7	143.0	1263.6
1954	1.1	37.9	206.8	460.1	301.2	299.3	1265.4	45.7	1358.6
1955	4.6	58.2	249.9	276.1	386.2	234.5	1144.3	145.9	1350.5
1956	4.0	108.2	222.3	450.2	211.0	225.3	1110.1	155.6	1368.5
1957	1.4	87.9	177.2	285.3	300.1	105.9	869.1	107.4	1061.5
1958	1.5	85.2	217.8	405.5	452.8	168.5	1244.7	90.8	1421.5
1959	1.2	53.6	269.3	405.0	243.4	282.6	1200.1	151.6	1404.6
1960	9.6	107.9	267.5	289.5	143.7	199.1	901.5	84.6	1098.3
1961	6.9	145.7	197.8	447.6	191.5	165.9	1005.6	180.5	1322.2
1962	5.9	116.1	124.3	330.8	232.5	266.2	949.6	168.1	1227.5
1963	7.5	63.0	204.1	339.3	458.0	103.9	1106.0	120.7	1295.8
1964	2.1	26.9	220.0	313.7	288.0	254.2	1073.6	110.0	1216.4
1965	9.3	30.8	187.4	397.4	202.9	108.9	900.0	38.2	985.7
1966	9.7	94.6	123.7	383.7	141.2	193.6	841.8	119.5	1059.0
1967	3.2	41.7	237.7	401.9	162.9	172.6	978.4	101.5	1126.8
1968	17.2	55.3	128.9	301.9	138.1	171.1	739.2	90.9	901.9
1969	1.0	33.8	188.1	311.6	194.4	238.6	931.1	70.7	1041.8
1970	2.2	75.0	286.4	247.5	432.2	204.1	1168.8	70.8	1318.3
1971	2.0	71.0	261.1	151.8	218.9	167.2	798.7	88.4	958.7
1972	2.1	40.8	194.1	187.4	132.2	93.9	609.3	43.7	700.7
1973	2.9	27.0	165.5	293.4	319.9	174.7	951.8	139.8	1122.2
1974	1.1	97.5	130.2	319.5	233.8	162.2	844.5	158.4	1091.9
1975	12.5	44.2	246.9	318.7	299.2	304.2	1165.8	176.9	1396.0
1976	.3	34.7	189.9	371.3	269.6	150.5	982.5	72.8	1095.6
1977	1.5	61.7	208.5	344.1	166.5	147.6	869.0	163.4	1090.0
1978	24.7	92.5	303.5	295.3	239.4	146.6	988.1	120.7	1219.5
1979	27.0	48.3	231.0	214.4	283.0	226.1	951.9	125.5	1150.9
1980	2.0	35.1	306.3	223.9	308.3	110.2	951.6	46.7	1042.4
1981	11.9	53.3	208.9	320.8	250.6	336.0	1111.8	78.0	1257.7
1982	19.8	65.0	176.9	337.4	203.0	159.9	877.9	93.0	1054.3
1983	.4	15.8	196.6	368.7	458.0	333.7	1350.8	117.4	1490.5
1984	21.7	24.0	188.9	333.2	167.1	153.5	844.2	115.7	1007.0
1985	7.5	41.2	290.4	247.7	170.8	84.6	798.4	128.5	974.4
1986	27.5	32.4	223.9	180.4	208.3	82.4	696.9	62.2	822.4
1987	12.4	45.0	212.7	233.3	306.2	69.4	823.5	206.0	1079.1
1988	4.4	38.9	182.1	428.0	293.3	370.3	1268.7	79.7	1397.3
1989	.8	57.2	218.7	352.7	228.8	176.4	977.9	42.7	1083.4
1990	2.9	139.8	304.7	197.7	372.7	180.2	1054.9	160.0	1344.0
1991	2.4	44.9	310.0	418.4	170.8	76.1	983.4	36.2	1073.7
1992	.2	36.1	210.6	199.9	340.7	153.2	902.8	99.7	1041.5
1993	2.7	76.9	185.5	316.7	202.6	198.0	902.2	189.0	1161.8
1994	8.2	48.2	243.6	407.8	209.7	143.2	1008.1	138,9	1201.7

TABLE 14: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the East Peninsula India for the longest instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1848	21.5	82.6	157.7	218.5	196.5	120.4	700.8	251.9	1032.2
1849	21.5	41.7	162.6	185.3	205.9	172.2	729.3	254.7	1031.3
1850	9.3	40.4	166.5	284.7	144.0	167.5	769.2	228.0	1037.4
1851	10.6	54.3	129.4	290.1	197.6	139.9	760.6	244.4	1058.5
1852	7.4	164.5	136.1	255.2	230.5	314.0	929.6	196.9	1304.9
1853	17.5	40.4	110.9	233.7	250.8	147.3	743.6	120.1	898.9
1854	18.9	60.0	109.8	344.8	279.1	261.4	982.7	225.6	1302.0
1855	47.6	85.1	117.6	260.9	229.2	239.4	843.9	118.9	1085.1
1856	13.8	101.4	173.3	213.7	230.9	156.6	779.3	349.6	1261.8
1857	6.1	147.6	140.3	229.8	234.6	204.1	809.2	127.1	1074.7
1858	10.6	46.3	142.9	256.0	217.4	172.9	791.2	168.7	1005.2
1859	11.1	71.8	128.4	180.6	296.7	169.6	774.8	127.4	966.0
1860	6.1	29.7	191.1	282.5	291.5	298.3	1053.6	105.3	1194.1
1861	15.0	70.9	114.6	195.5	419.9	204.2	921.6	230.8	1248.5
1862	32.1	60.0	163.8	216.6	207.1	240.4	830.0	340.0	1283.6
1863	20.7	121.8	153.2	214.8	186.7	212.9	780.1	203.9	1090.4
1864	32.6	226.1	136.7	168.5	121.1	139.3	602.9	209.3	1045.0
1865	76.8	183.8	128.2	147.4	219.8	160.8	605.1	45.6	935.1
1866	33.6	63.5	89.9	224.2	315.6	194.1	863.3	228.2	1077.4
1867	13.3	101.9	188.0	199.7	243.9	270.8	951.0	201.1	1244.7
1868	2.8	76.4	276.3	227.2	199.4	149.4	816.4	39.2	978.0
1869	10.6	58.0	173.8	221.8	186.4	197.2	797.2	171.5	1028.6
1870	45.0	35.7	139.7	257.0	180.0	208.8	813.9	263.0	1200.0
1871	20.3	143.7	133.7	225.2	116.3	206.5	679.7	55.1	892.1
1872	4.0	37.6	276.3	229.4	211.7	196.1	914.9	328.4	1291.1
1873	.5	69.6	79.4	195.1	220.9	153.2	646.9	236.6	955.7
1874	20.7	57.3	191.8	226.2	225.4	227.5	871.7	259.4	1211.6
1875	19.6	73.4	157.8	282.1	176.4	253.0	868.8	174.8	1135.1
1876	.9	54.1	84.8	195.4	206.9	174.1	659.8	102.4	812.1
1877	47.6	194.0	90.3	162.0	140.5	175.5	566.0	125.3	929.8
1878	2.2	93.8	91.7	283.5	299.0	200.8	874.8	346.8	1325.6
1879	6.5	149.4	127.2	165.8	298.0	170.1	761.7	230.5	1150.9
1880	13.5	71.7	208.7	251.7	240.0	205.8	907.0	284.7	1281.1
1881	1.4	78.7	205.0	204.7	214.6	199.6	824.5	136.9	1038.6
1882	7.2	73.4	96.2	301.1	181.7	242.1	819.7	245.3	1147.9
1883	6.1	58.6	283.7	248.1	220.4	203.8	957.7	258.6	1283.9
1884	30.3	47.0	190.2	277.0	220.8	246.7	935.4	166.5	1176.6
1885	30.6	94.1	160.0	213.1	147.8	163.0	682.3	233.1	1041.4
1886	2.6	110.4	215.9	256.2	267.7	201.7	942.9	379.2	1444.9
1887	3.0	49.5	173.8	269.9	244.4	142.5	830.1	177.0	1058.3
1888	24.7	74.6	86.5	203.7	261.3	124.2	674.5	172.6	944.6
1889	1.9	40.4	206.4	248.7	297.4	211.4	965.6	344.6	1359.6
1890	.7	60.3	222.5	276.7	199.5	242.8	942.3	207.2	1211.0
1891	16.4	110.2	57.2	208.9	267.8	274.4	808.4	97.7	1027.9
1892	1.7	23.6	175.6	237.4	260.4	271.7	946.7	285.5	1261.3
1893	57.9	239.8	146.0	228.2	277.0	345.0	998.6	321.0	1624.5
1894	10.0	43.5	181.1	259.2	185.9	207.6	833.4	257.5	1146.9
1895	5.3	63.8	242.9	244.7	278.8	193.7	961.9	162.4	1191.6
1896	.9	41.6	200.8	261.0	305.6	134.7	903.0	69.3	1007.9
1897	22.1	86.7	103.6	233.0	253.4	245.1	835.2	176.4	1119.0
1898	27.2	57.8	162.8	268.8	195.2	192.0	817.9	236.8	1140.8
1899	2.7	130.9	119.4	139.0	160.3	105.4	521.9	88.2	739.0
1900	3.3	85.7	130.4	231.7	275.0	277.6	916.1	119.3	1120.7
1901	97.8	74.9	76.3	207.8	217.3	154.7	654.3	217.4	1042.8
1902	3.0	78.5	73.9	254.5	251.5	183.3	762.1	190.3	1033.7
1903	17.0	73.2	144.8	346.7	245.7	225.7	962.5	295.3	1352.7
1904	11.5	95.2	218.2	194.9	195.4	157.0	765.5	144.8	1014.5
1905	23.0	140.5	98.7	159.8	211.1	238.1	707.4	43.3	906.8
1906	39.8	44.9	227.9	237.8	236.9	161.8	865.0	169.0	1115.9
1907	14.0	118.0	208.4	160.4	319.7	145.9	836.3	81.8	1044.8
1908	52.8	47.1	145.3	227.5	347.6	300.7	1023.9	53.4	1168.1
1909	5.1	114.3	157.6	325.5	191.2	179.2	852.1	70.6	1036.4

TABLE 14 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1910	6.9	42.2	207.3	285.3	284.1	225.3	1003.5	264.5	1320.0
1911	1.9	59.4	234.6	163.0	243.6	169.9	812.5	154.6	1026.2
1912	37.9	38.7	73.8	285.6	313.4	183.9	856.3	133.1	1061.4
1913	26.2	59.8	141.2	317.8	212.6	134.3	804.1	196.4	1085.6
1914	10.6	142.6	225.2	277.8	214.7	251.9	970.7	32.7	1149.0
1915	44.1	119.9	165.1	213.5	278.5	191.3	849.2	322.9	1342.1
1916	12.6	43.6	190.6	263.0	256.0	163.3	873.3	327.3	1262.8
1917	50.4	95.0	208.5	236.6	222.4	255.4	924.2	324.9	1399.9
1918	17.3	129.3	219.2	179.9	221.4	149.3	770.2	99.6	1012.0
1919	62.5	87.6	190.1	200.0	281.2	127.6	799.5	295.5	1248.6
1920	13.5	69.3	108.4	269.2	159.8	142.9	677.7	112.2	868.0
1921	41.9	30.6	160.6	233.1	176.0	267.3	837.1	148.9	1054.3
1922	21.8	31.6	134.7	302.7	210.2	240.0	886.9	185.9	1124.7
1923	44.5	50.7	58.5	204.3	179.5	213.7	654.1	298.9	1051.9
1924	23.8	62.4	68.4	170.8	217.2	268.9	725.0	298.4	1113.9
1925	1.9	136.0	239.9	303.8	276.5	151.3	972.3	267.5	1382.3
1926	37.8	146.8	71.6	226.7	333.8	183.0	815.4	60.4	1053.6
1927	23.9	38.7	234.3	261.4	282.7	197.0	977.2	172.5	1210.1
1928	8.7	84.6	153.7	288.5	171.3	228.6	841.1	254.9	1192.3
1929	36.9	42.1	190.2	239.2	252.2	196.9	879.2	204.0	1161.2
1930	19.2	95.3	190.1	253.0	186.1	191.8	820.7	308.9	1249.8
1931	3.4	56.2	144.0	202.4	252.2	202.6	801.7	344.1	1212.7
1932	31.4	75.4	91.3	350.7	167.5	216.3	823.5	214.8	1145.3
1933	27.8	95.2	227.8	239.0	329.7	228.8	1028.1	232.0	1384.7
1934	1.3	21.2	156.8	283.1	295.3	228.0	964.4	148.5	1132.2
1935	4.8	41.6	96.6	366.7	139.0	213.2	812.7	89.8	942.9
1936	90.8	146.9	307.5	290.0	283.4	172.9	1056.2	287.6	1584.6
1937	69.8	136.7	121.9	262.8	194.7	178.5	756.5	122.5	1080.7
1938	27.9	99.0	195.2	222.2	232.6	215.3	866.1	226.4	1220.6
1939	4.0	49.8	130.5	260.1	223.1	168.9	781.6	326.9	1168.6
1940	12.0	223.5	225.6	345.9	278.1	123.5	973.2	200.5	1411.4
1941	18.7	55.7	223.1	178.2	138.4	185.2	724.5	221.8	1021.3
1942	19.7	46.8	174.0	245.9	275.3	174.3	870.0	178.5	1113.3
1943	33.6	100.9	163.5	281.9	189.9	231.7	866.5	162.4	1161.3
1944	54.0	139.2	113.5	342.0	273.6	159.0	887.1	250.2	1332.8
1945	8.2	67.4	101.2	299.5	220.2	253.2	873.3	185.4	1133.5
1946	10.4	94.2	156.4	257.8	240.8	136.6	790.9	253.5	1152.0
1947	29.9	26.2	145.0	309.0	291.9	190.0	936.1	241.0	1233.9
1948	38.1	72.0	100.6	225.2	241.8	206.4	773.6	210.2	1093.6
1949	7.1	82.9	111.6	258.9	235.0	259.6	865.1	278.0	1237.3
1950	21.2	82.0	154.1	247.2	193.0	216.5	810.3	184.8	1097.4
1951	1.0	112.1	156.8	312.2	239.2	148.6	855.8	148.8	1116.0
1952	8.7	83.2	124.9	209.5	213.8	181.5	728.9	217.5	1039.4
1953	26.4	33.1	194.9	184.6	342.0	220.2	944.5	203.9	1207.0
1954	4.2	42.0	145.2	237.9	226.8	321.0	932.2	201.2	1179.3
1955	1.3	121.5	148.7	175.0	309.6	239.5	874.7	341.0	1346.6
1956	14.0	87.2	237.1	376.5	251.1	259.7	1125.9	274.6	1505.6
1957	17.2	64.7	149.7	190.4	326.3	163.6	831.3	75.8	982.4
1958	28.3	44.6	94.5	327.0	254.2	231.7	906.7	345.7	1331.8
1959	29.5	63.9	161.6	320.6	281.9	206.4	971.1	155.8	1217.4
1960	1.2	63.7	161.1	257.3	184.3	208.9	810.9	121.3	993.2
1961	55.0	48.7	204.0	272.2	254.0	249.9	981.5	233.5	1318.7
1962	24.8	75.6	119.8	313.9	227.7	248.3	909.3	282.4	1295.9
1963	1.8	87.8	198.5	229.9	262.7	180.7	872.8	219.4	1183.1
1964	16.2	46.1	98.0	278.5	305.6	286.4	969.7	104.7	1131.2
1965	14.1	79.1	98.9	304.8	178.4	196.9	777.0	83.9	948.2
1966	44.6	53.2	139.3	313.2	179.9	177.7	808.3	201.1	1105.9
1967	25.9	113.7	160.1	298.0	221.0	169.2	847.5	81.2	1062.4
1968	41.6	58.3	109.5	219.6	113.9	256.7	698.0	275.6	1076.1
1969	.7	148.0	122.9	343.6	184.7	188.5	837.7	303.3	1296.3
1970	47.7	125.8	221.8	190.5	273.1	137.8	824.3	143.0	1137.6
1971	46.1	162.9	229.5	138.8	226.7	154.1	750.1	162.3	1119.7
1972	18.8	33.6	108.2	214.8	154.3	211.2	686.9	252.3	993.3
1973	1.8	60.7	107.3	272.9	259.2	126.6	764.6	250.1	1079.7
1974	5.2	66.6	104.8	121.9	191.8	166.1	583.5	232.2	889.1

TABLE 14 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1975	16.6	39.1	191.1	214.7	228.6	255.7	891.4	204.9	1151.6
1976	5.4	40.0	76.0	336.7	311.5	103.6	826.1	213.5	1085.4
1977	6.5	111.8	127.2	227.8	259.0	165.9	779.6	217.8	1117.3
1978	42.1	51.4	181.5	283.7	317.7	144.5	928.1	140.6	1157.9
1979	24.7	73.6	158.7	162.8	146.4	200.4	667.4	165.8	929.3
1980	13.2	50.2	237.9	265.2	235.5	204.6	944.3	159.0	1164.2
1981	27.6	118.2	140.5	215.5	273.6	232.8	863.4	118.4	1123.6
1982	15.3	74.9	130.3	203.8	309.7	165.6	810.1	146.2	1043.5
1983	30.4	64.6	137.2	247.7	298.1	245.1	929.3	173.4	1195.7
1984	16.7	68.1	164.7	262.7	239.9	120.1	786.5	87.3	952.7
1985	39.2	40.9	136.9	214.1	277.2	192.7	821.4	232.4	1134.2
1986	64.3	83.0	191.8	245.0	340.3	136.4	914.8	279.1	1343.9
1987	20.1	91.2	81.6	239.9	201.7	105.7	626.1	348.9	1093.8
1988	14.6	93.3	134.4	349.4	247.7	272.1	1003.7	90.2	1196.4
1989	.6	65.6	243.9	322.9	298.6	200.5	1067.6	44.9	1170.9
1990	62.1	337.8	170.1	193.7	349.2	177.1	892.1	298.7	1598.1
1991	27.9	48.3	183.3	335.7	331.1	203.5	1055.1	214.6	1345.7
1992	23.2	76.8	148.2	297.4	343.8	157.9	948.1	201.0	1248.8
1993	1.7	93.3	157.0	231.8	255.3	182.6	827.0	156.7	1077.0
1994	23.2	55.6	193.4	326.9	307.9	174.4	1003.5	263.2	1348.0

TABLE 15: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the South Peninsula India for the longest possible instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1813	10.1	170.7		204.2	108.4	109.9	687.6	450.4	1479.0
1814	10.8	158.5		215.4	198.3	232.5	906.2	285.7	1319.7
1815	25.6	158.5		386.4	107.7	120.3	771.8	508.7	1616.3
1816	17.8	161.9		337.6	206.6	244.5	1044.5	309.9	1429.7
1817	13.3	161.9		215.4	167.9	216.9	850.5	557.6	1711.2
1818	10.1	168.8		571.9	234.8	171.4	1173.5	567.5	1870.8
1819	10.1	202.5		274.4	114.5	361.6	1033.9	260.2	1369.1
1820	10.1	580.1		303.9	164.4	97.3	768.0	436.9	1792.3
1821	43.9	193.3		201.3	161.2	209.5	846.8	379.6	1504.6
1822	31.7	169.1		178.5	240.4	112.0	809.3	517.1	1661.5
1823	23.7	179.1		259.9	160.6	151.4	838.1	236.2	1246.9
1824	22.0	159.3		167.9	149.3	72.9	594.2	378.3	1336.1
1825	11.6	231.8		267.0	262.2	133.4	930.5	439.2	1616.9
1826	10.1	176.5		232.9	305.2	109.8	1100.7	456.0	1675.6
1827	91.5	560.8		331.3	140.7	152.2	899.1	488.5	2023.5
1828	25.3	253.0		277.5	253.9	177.8	952.4	259.2	1388.4
1829	42.3	199.1		239.7	184.9	125.0	883.3	344.7	1375.7
1830	8.7	242.8		308.1	160.9	103.8	889.8	342.8	1462.1
1831	16.5	172.8		209.3	251.6	258.3	979.8	333.9	1462.8
1832	7.1	166.5		232.4	99.4	255.9	834.0	167.0	1128.0
1833	7.6	198.7		200.3	249.6	142.0	872.0	331.4	1378.7
1834	10.6	224.9		407.9	181.9	160.8	1007.8	278.7	1402.5
1835	8.2	286.0		356.0	158.5	215.6	1004.2	321.9	1538.0
1836	13.7	178.9		306.2	263.8	112.3	920.5	379.5	1486.6
1837	6.7	174.0	202.7	166.8	138.6	125.7	697.0	500.2	1484.0
1838	11.9	116.9	240.6	160.6	142.9	135.1	682.4	305.2	1145.0
1839	29.9	233.7	248.6	318.1	220.4	164.4	1002.0	313.1	1425.1
1840	2.5	165.1	251.1	263.0	133.9	143.9	786.3	363.1	1263.7
1841	16.2	222.6	259.9	197.8	201.4	177.4	917.1	453.5	1636.0
1842	49.3	226.4	244.9	200.2	211.2	202.8	878.5	228.3	1331.3
1843	68.0	378.3	304.4	223.4	93.5	142.9	763.1	378.6	1548.9
1844	11.4	174.0	232.7	230.8	154.4	134.8	766.8	463.2	1416.5
1845	40.3	168.6	277.7	175.2	122.6	147.9	717.1	301.1	1308.0
1846	18.4	229.6	333.2	275.6	184.8	95.2	859.6	524.0	1709.4
1847	60.7	306.0	234.3	198.6	146.4	118.2	807.1	602.0	1791.5
1848	4.9	291.0	194.1	231.8	175.4	139.4	839.8	291.5	1433.9
1849	33.7	242.8	232.9	212.6	323.4	104.9	926.7	327.0	1460.1
1850	46.8	170.2	240.8	277.4	214.7	141.9	935.7	369.9	1561.5
1851	2.4	304.3	256.5	328.7	136.1	117.2	828.6	393.7	1531.4
1852	11.9	369.3	275.6	419.1	211.9	228.5	1042.4	534.4	1843.6
1853	55.6	288.0	318.4	250.4	176.2	110.3	861.8	260.5	1487.7
1854	5.2	115.7	215.5	261.2	205.1	129.3	799.5	404.0	1338.3
1855	39.7	99.6	246.8	149.1	166.9	119.8	672.2	261.2	1103.4
1856	6.8	439.7	257.6	263.3	281.7	72.7	849.9	324.0	1656.5
1857	8.4	363.6	225.7	152.5	168.8	117.6	672.8	411.5	1468.3
1858	4.1	413.1	168.0	247.6	89.5	160.1	627.3	529.8	1546.0
1859	12.6	257.2	309.3	304.0	205.8	164.9	969.6	339.4	1620.4
1860	5.0	131.8	188.9	179.8	194.5	131.5	656.8	248.1	1062.2
1861	5.4	251.6	298.6	265.1	262.7	138.3	909.7	190.2	1423.7
1862	39.5	132.1	247.7	180.1	276.2	182.4	876.4	428.8	1510.9
1863	9.1	301.9	337.9	303.0	211.4	70.9	958.7	370.6	1617.6
1864	2.3	153.0	352.8	324.1	220.5	107.9	990.0	273.5	1457.7
1865	6.1	238.6	267.4	324.8	185.7	82.4	972.3	301.0	1393.5
1866	13.8	77.8	198.4	260.2	148.4	111.6	700.6	418.6	1202.4
1867	8.7	186.1	222.2	239.5	186.7	99.6	754.6	232.8	1168.0
1868	57.3	129.3	449.7	221.5	105.8	126.5	923.0	232.9	1262.3
1869	10.0	135.2	288.1	286.0	193.5	206.6	1036.0	421.3	1538.7
1870	27.0	113.2	238.4	260.7	186.1	159.7	890.7	431.6	1482.0
1871	91.8	208.5	284.0	317.3	119.1	168.4	888.4	364.4	1544.9
1872	8.5	203.1	278.2	320.1	207.6	196.2	1001.0	389.7	1609.4
1873	67.2	193.8	269.4	247.1	143.4	115.8	776.5	339.1	1367.6
1874	11.3	316.6	346.8	328.9	164.5	247.4	1084.1	352.0	1779.0

TABLE 15 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1875	3.8	157.5	307.3	260.3	184.7	109.5	862.4	220.0	1257.8
1876	1.3	138.9	229.9	308.1	152.2	85.7	778.5	98.0	1036.5
1877	3.6	170.8	315.7	113.5	218.3	235.5	879.4	555.4	1596.3
1878	5.0	188.4	334.9	246.8	396.7	290.3	1264.1	305.4	1791.8
1879	23.1	339.9	214.1	285.9	209.5	111.6	823.0	337.7	1524.0
1880	17.4	226.6	264.1	249.4	134.6	113.7	762.9	476.2	1468.7
1881	5.9	134.5	135.5	134.6	279.4	151.7	702.4	298.2	1139.5
1882	35.2	218.4	331.0	435.0	206.2	157.3	1129.4	418.5	1809.6
1883	6.4	196.9	266.2	325.6	226.3	80.6	901.0	512.0	1607.9
1884	11.6	114.0	169.8	173.6	239.4	149.3	733.1	556.1	1392.5
1885	2.4	110.5	348.2	318.2	161.2	127.3	954.8	511.3	1573.7
1886	7.4	246.5	257.2	313.6	160.9	149.1	881.2	333.0	1473.7
1887	2.9	145.6	361.6	226.5	145.7	142.0	874.6	561.9	1571.2
1888	7.1	207.9	376.0	229.0	203.6	126.1	933.9	373.8	1527.7
1889	5.7	169.7	353.5	259.3	235.3	286.6	1129.9	351.1	1674.0
1890	11.3	223.1	258.1	268.3	147.6	107.1	782.4	286.1	1306.5
1891	29.7	165.6	251.5	238.2	135.5	75.7	703.1	429.4	1312.1
1892	11.2	258.1	194.2	394.0	320.9	113.0	1024.9	303.3	1613.1
1893	29.0	233.9	299.4	227.9	131.5	113.9	773.0	483.1	1503.2
1894	27.7	210.5	214.4	219.5	244.9	117.0	797.4	304.5	1340.7
1895	2.9	176.4	272.5	294.1	178.5	138.4	883.9	396.0	1459.9
1896	9.2	160.8	351.6	253.2	259.8	117.5	981.9	390.2	1547.8
1897	35.1	165.0	353.6	318.8	292.6	270.0	1231.0	235.3	1695.1
1898	15.7	160.4	265.1	263.2	124.2	243.7	893.7	529.9	1588.0
1899	21.0	280.6	258.2	97.9	95.1	165.5	615.6	265.9	1178.2
1900	15.3	158.1	303.6	323.8	196.8	175.8	999.1	267.3	1455.9
1901	56.4	170.8	305.4	249.6	167.0	156.6	877.9	458.3	1551.4
1902	30.7	159.7	188.0	406.7	159.0	235.8	988.8	528.8	1699.6
1903	26.2	186.7	230.5	392.9	211.6	243.7	1077.2	483.0	1774.1
1904	20.6	217.9	371.0	292.6	122.2	119.6	905.0	226.5	1383.9
1905	17.0	189.3	282.8	200.8	193.8	91.2	769.7	373.9	1344.5
1906	50.7	103.6	193.8	327.9	251.5	118.1	893.6	439.5	1478.1
1907	10.9	176.9	298.3	290.5	299.0	152.6	1040.1	368.1	1606.6
1908	28.5	159.0	228.1	376.5	181.5	140.3	927.8	261.6	1387.8
1909	81.0	359.1	269.5	325.8	231.1	155.7	982.3	226.6	1659.7
1910	17.6	132.4	289.4	263.1	241.7	151.4	945.4	443.4	1536.8
1911	3.9	165.0	304.3	256.1	115.8	87.5	764.9	409.8	1336.5
1912	13.7	145.4	326.9	314.2	242.2	150.0	1032.9	487.9	1679.5
1913	5.8	156.9	209.0	277.0	109.4	150.4	746.6	483.5	1378.3
1914	5.7	115.9	236.6	353.4	236.1	164.8	991.4	428.3	1544.6
1915	55.9	185.5	306.6	328.2	128.4	237.2	997.8	371.0	1612.2
1916	3.9	172.4	328.8	276.5	210.8	205.6	1019.5	448.3	1647.8
1917	55.8	133.1	319.5	187.7	225.2	253.2	981.8	421.5	1588.8
1918	49.0	347.3	181.5	94.8	151.6	90.9	520.7	446.6	1334.9
1919	28.6	198.7	225.8	301.0	192.0	224.4	941.9	474.7	1638.0
1920	71.0	147.0	374.8	298.6	146.2	146.9	965.3	459.6	1633.4
1921	81.1	167.5	204.0	286.5	293.7	104.6	891.1	364.6	1497.5
1922	46.8	198.2	270.8	392.6	149.1	97.8	912.3	505.0	1649.6
1923	54.1	137.0	258.3	387.1	306.0	168.8	1120.6	273.2	1601.7
1924	20.6	188.2	352.5	531.2	220.5	197.2	1300.3	290.5	1829.6
1925	12.6	244.9	274.7	262.7	247.2	102.4	888.3	471.7	1611.2
1926	43.6	153.2	231.8	295.2	220.3	174.1	921.5	264.3	1390.8
1927	27.5	184.7	256.6	326.9	142.6	202.0	927.2	231.2	1384.3
1928	65.2	138.9	228.6	228.5	235.8	64.3	759.9	444.3	1389.6
1929	48.2	227.9	392.1	275.2	136.2	193.5	994.3	401.0	1671.9
1930	50.7	292.0	249.5	165.5	123.1	200.8	737.2	579.4	1630.8
1931	7.7	165.0	230.7	287.7	367.1	147.9	1034.3	414.5	1628.3
1932	24.0	324.0	166.4	261.2	224.6	161.2	814.6	575.2	1717.7
1933	4.5	436.7	308.9	320.5	248.9	193.6	1070.5	419.3	1941.1
1934	44.8	130.8	347.5	186.9	166.8	53.0	755.4	363.3	1284.9
1935	23.0	114.3	213.9	268.7	217.3	131.9	833.1	392.6	1358.3
1936	26.5	290.5	292.7	269.6	160.2	173.2	894.8	347.9	1562.6
1937	20.8	236.8	196.1	401.0	137.9	114.0	851.6	441.3	1543.6
1938	31.1	178.0	260.2	269.2	218.5	177.2	924.5	164.0	1316.2
1939	19.7	200.3	257.7	257.0	186.2	122.4	824.2	483.1	1515.3

TABLE 15 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1940	1.6	218.5	258.1	325.1	298.9	112.2	995.8	534.4	1746.0
1941	21.1	226.3	298.2	185.6	185.1	181.1	848.5	456.6	1544.1
1942	4.9	202.6	332.9	302.5	181.0	108.9	925.9	345.1	1485.6
1943	83.3	402.6	296.5	279.4	111.6	166.1	852.8	553.7	1868.5
1944	40.5	207.2	246.1	280.9	130.6	127.3	785.9	528.5	1541.5
1945	14.6	133.0	231.1	334.8	183.4	108.2	859.6	323.8	1334.7
1946	10.6	215.2	353.7	282.8	298.3	156.4	1090.1	709.7	2010.7
1947	51.3	154.6	237.6	297.8	304.8	206.5	1045.9	211.9	1482.0
1948	32.5	202.7	329.7	268.4	230.8	115.4	944.6	329.1	1514.6
1949	2.7	269.1	235.6	343.4	215.7	179.6	974.4	244.3	1509.4
1950	38.0	168.6	247.1	365.2	202.7	218.8	1032.7	299.4	1550.9
1951	4.9	228.9	298.8	286.4	111.8	173.3	869.3	336.5	1444.5
1952	37.3	194.9	242.4	205.2	181.1	49.9	681.4	356.2	1258.3
1953	14.9	141.7	184.9	474.1	142.6	119.8	924.4	456.1	1533.2
1954	32.1	251.7	288.5	318.2	230.5	102.1	940.7	333.0	1563.1
1955	20.7	387.1	306.9	192.0	171.1	237.0	903.8	394.6	1706.9
1956	17.5	268.0	308.5	217.5	137.7	137.5	800.9	494.5	1567.3
1957	15.3	250.4	330.0	298.0	175.7	53.8	859.5	421.0	1542.2
1958	19.5	254.9	297.0	250.8	251.6	106.2	906.6	341.5	1527.3
1959	23.0	215.9	316.4	382.8	185.8	202.4	1085.8	322.0	1662.2
1960	12.6	312.0	208.2	297.7	139.0	234.3	877.9	481.3	1676.4
1961	43.4	299.7	401.7	447.8	300.2	223.8	1370.9	298.1	2042.7
1962	41.1	311.9	133.1	329.8	280.9	200.9	945.6	470.9	1762.9
1963	38.8	185.4	186.9	269.5	275.8	136.6	870.4	373.8	1465.6
1964	3.2	126.2	174.8	322.9	270.3	215.1	982.8	409.0	1526.0
1965	11.6	156.0	231.1	214.4	194.9	103.6	745.6	352.0	1260.8
1966	12.9	157.5	220.8	267.6	144.9	219.3	851.4	586.9	1590.2
1967	30.7	168.9	250.8	387.3	220.6	105.7	966.6	329.0	1502.2
1968	16.5	173.8	265.8	436.3	148.3	193.2	1043.2	271.9	1523.4
1969	5.0	187.0	212.8	290.7	168.2	119.6	793.0	479.2	1452.7
1970	22.9	250.9	239.6	267.5	289.9	143.6	941.3	369.0	1588.0
1971	32.1	242.0	314.8	277.7	225.2	202.7	1018.5	295.4	1600.9
1972	7.4	279.3	205.3	267.3	133.1	156.2	762.6	501.8	1536.3
1973	2.1	135.3	258.0	251.0	286.8	109.6	906.7	323.7	1375.8
1974	5.6	204.0	135.6	411.3	215.4	262.9	1024.5	210.6	1468.5
1975	15.5	197.1	384.5	300.3	306.5	251.4	1238.7	427.4	1894.7
1976	1.9	146.5	127.7	271.3	203.2	92.5	698.3	424.0	1258.9
1977	9.4	255.8	252.6	295.2	157.5	146.3	852.1	599.7	1698.5
1978	19.3	250.2	324.5	306.7	213.2	161.8	1005.5	491.6	1764.3
1979	36.3	132.7	288.5	273.6	175.0	201.4	936.9	465.0	1564.0
1980	2.6	164.3	293.3	268.6	208.2	130.0	900.4	364.3	1435.9
1981	18.2	177.1	376.6	238.4	265.3	234.7	1111.3	347.9	1669.7
1982	1.1	161.8	273.3	239.1	257.7	82.8	854.7	283.9	1310.3
1983	1.2	95.2	176.3	282.7	329.8	291.0	1077.4	358.0	1546.1
1984	105.8	230.9	284.8	267.1	128.8	145.2	825.9	315.1	1468.4
1985	46.1	166.4	315.1	187.2	193.8	147.3	842.5	373.3	1422.8
1986	56.8	127.9	266.3	150.8	204.6	173.7	794.4	294.3	1270.2
1987	4.0	119.1	267.7	155.6	235.3	122.6	781.4	501.6	1392.1
1988	7.0	205.1	267.5	311.0	281.2	252.5	1109.8	184.9	1537.2
1989	6.4	153.8	306.2	296.1	163.6	200.8	964.9	307.7	1444.9
1990	21.6	287.4	187.5	242.5	199.9	110.8	742.9	395.4	1438.4
1991	14.5	162.2	421.5	317.3	239.0	89.0	1066.8	398.8	1651.2
1992	5.5	146.9	357.2	299.5	272.6	178.9	1106.6	449.2	1716.2
1993	11.4	149.5	249.5	336.5	174.5	112.9	875.0	648.5	1662.2
1994	40.8	171.6	329.6	366.4	210.6	108.0	1015.6	468.9	1693.5

TABLE 16: The reconstructed seasonal, the monsoon monthly and the annual rainfall (in mm) of the whole country for the longest possible instrumental period.

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1813		88.2	198.2		190.1		754.0	143.1	
1814		84.4	117.8		252.9		895.9	88.2	
1815		84.4	117.8		189.7		808.7	162.5	
1816		85.5	131.1		258.7		985.7	96.3	
1817		85.5	279.1	281.1	225.5	247.1	1032.1	178.9	
1818		87.6	181.3	295.6	323.3	173.1	975.5	182.2	
1819		98.1	150.1	314.5	263.2	171.6	949.0	79.7	
1820		215.9	165.6	306.2	269.7	174.5	905.9	138.6	
1821		95.3	151.0	269.1	309.1	213.5	940.7	119.5	
1822		87.8	216.5	287.6	348.2	233.3	1063.0	165.4	
1823		90.9	183.6	258.8	269.9	141.8	849.0	71.7	
1824		84.7	99.3	222.4	259.5	129.0	681.5	119.1	
1825		107.3	192.8	291.4	260.0	169.4	908.7	139.4	
1826	35.4	94.4	304.1	288.4	263.7	196.4	959.9	111.9	1193.3
1827	42.9	187.8	232.0	256.0	216.2	208.1	946.8	122.3	1208.6
1828	27.9	111.9	145.9	360.7	261.9	228.8	1032.6	178.1	1170.9
1829	16.8	92.0	214.1	263.6	219.8	144.4	840.1	152.6	1109.7
1830	10.6	142.1	186.8	292.5	207.7	138.7	802.8	138.3	973.9
1831	23.2	89.3	237.8	245.8	319.0	244.9	1082.9	204.3	1364.7
1832	22.8	98.2	120.4	332.9	202.5	156.9	886.5	99.3	1067.0
1833	14.8	121.4	116.5	273.7	257.6	218.5	895.2	129.3	1129.1
1834	17.8	102.5	173.8	272.6	280.8	167.2	896.1	201.3	1201.2
1835	12.6	153.8	145.2	258.1	339.7	177.6	922.5	125.8	1269.0
1836	28.8	80.4	141.0	275.3	339.7	163.1	921.2	103.7	1127.1
1837	23.1	87.8	143.8	235.6	258.0	149.3	788.6	147.8	1016.3
1838	12.6	70.0	197.6	203.4	206.7	142.0	739.5	84.9	833.7
1839	24.7	107.4	155.3	331.5	260.8	185.2	945.5	90.8	1045.6
1840	11.9	90.1	197.0	272.7	229.7	139.1	845.9	86.6	967.8
1841	18.3	108.5	168.3	273.8	267.9	140.6	904.0	128.5	1137.9
1842	21.4	100.2	225.8	263.0	358.8	153.9	1077.0	93.9	1265.7
1843	13.9	141.1	130.3	239.5	237.3	172.7	801.4	144.7	1105.6
1844	21.6	116.1	153.3	246.5	237.2	124.0	757.4	94.8	1004.2
1845	32.7	102.1	185.3	329.3	230.0	86.9	857.0	70.2	1073.3
1846	20.4	91.2	268.8	354.5	179.3	160.7	928.4	120.2	1206.3
1847	31.4	120.1	171.8	262.4	212.4	150.1	815.0	173.3	1167.6
1848	9.6	117.9	176.6	205.8	201.4	109.5	681.0	100.6	956.1
1849	44.5	83.7	194.9	226.7	254.6	182.5	849.0	133.9	1074.2
1850	53.0	76.8	192.1	255.6	206.9	151.8	828.8	138.9	1107.0
1851	38.9	92.9	147.7	313.9	190.2	108.4	761.9	104.0	985.3
1852	7.4	172.3	226.4	271.4	255.1	194.4	923.2	110.6	1168.3
1853	30.3	114.5	196.6	280.8	173.4	112.2	759.6	104.4	1044.7
1854	20.5	64.7	205.9	276.5	233.2	200.7	888.4	180.4	1132.1
1855	31.5	97.1	146.9	302.3	142.2	187.7	784.3	94.9	956.2
1856	14.5	145.0	203.7	307.0	247.7	121.7	870.9	146.2	1163.5
1857	26.8	109.4	172.3	215.5	276.9	191.0	856.3	113.6	1144.1
1858	19.2	117.3	137.0	316.1	185.6	198.3	815.7	144.5	1108.8
1859	25.5	124.0	192.8	245.7	250.7	174.2	941.2	129.8	1191.4
1860	17.5	82.8	154.0	273.2	208.2	171.7	773.9	111.8	1022.6
1861	21.4	92.3	225.4	344.7	276.2	143.4	1048.8	98.5	1292.2
1862	16.8	86.6	180.3	303.5	247.9	217.1	961.8	160.7	1149.9
1863	17.5	118.7	261.2	342.0	234.6	141.6	884.0	115.9	1153.5
1864	24.1	123.1	153.8	252.4	194.5	133.4	772.8	77.1	970.1
1865	30.0	167.9	134.2	259.6	308.2	142.1	833.7	83.5	1067.4
1866	38.0	77.7	169.3	295.7	286.0	124.9	851.7	114.6	1107.9
1867	20.2	101.0	219.8	299.8	250.5	171.2	972.3	123.2	1205.3
1868	29.2	85.1	208.2	229.4	213.7	118.1	780.5	54.8	973.7
1869	20.7	92.7	161.1	271.9	214.5	241.1	889.8	151.5	1127.0
1870	15.3	84.9	225.9	314.2	230.4	196.4	975.2	170.9	1193.1
1871	33.1	120.7	217.2	308.2	195.5	188.3	906.8	82.8	1141.8
1872	20.8	83.0	204.7	307.0	277.1	180.3	968.8	128.4	1202.1
1873	20.2	89.8	123.7	288.9	223.6	169.0	805.9	87.5	1002.7
1874	26.5	100.4	240.0	321.8	242.8	212.6	1013.8	116.8	1260.5

TABLE 16 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1875	22.8	88.8	196.7	320.7	238.1	242.5	995.5	71.0	1179.6
1876	5.4	80.7	132.9	308.5	203.4	164.6	809.7	63.6	963.2
1877	57.2	125.2	148.8	162.3	157.9	144.7	612.7	180.0	973.5
1878	24.9	111.1	143.0	319.4	353.8	219.7	1035.1	122.6	1295.8
1879	15.7	116.4	196.6	261.4	337.2	167.4	963.6	122.6	1218.2
1880	25.0	98.4	192.2	298.1	186.6	187.4	862.8	151.3	1138.1
1881	7.7	111.0	167.6	296.5	284.3	139.7	889.8	95.6	1103.9
1882	21.2	94.2	226.7	352.6	208.5	164.8	949.6	136.7	1203.2
1883	26.9	99.3	214.4	295.7	189.2	183.5	879.1	133.8	1138.3
1884	16.6	71.6	157.5	282.2	267.3	253.6	957.2	145.2	1187.1
1885	24.0	91.7	194.8	305.0	273.6	137.1	911.7	163.1	1187.8
1886	10.3	116.4	221.7	332.2	233.8	151.1	938.4	174.4	1239.1
1887	20.7	92.8	205.1	315.2	277.9	153.6	952.4	141.8	1205.7
1888	33.4	96.3	147.1	291.3	299.5	135.8	879.0	92.2	1103.1
1889	32.3	80.3	231.1	296.7	288.7	166.4	982.4	131.3	1227.5
1890	5.7	87.0	252.9	336.7	234.1	159.6	981.8	108.6	1182.9
1891	30.3	117.9	98.9	261.2	268.5	213.2	842.7	94.7	1083.9
1892	18.5	99.9	159.3	333.8	331.3	212.2	1036.4	124.1	1280.6
1893	57.4	166.7	257.5	266.2	236.4	233.1	988.2	168.2	1376.1
1894	31.6	82.2	229.6	305.6	261.0	204.2	998.2	202.1	1313.3
1895	25.1	89.6	207.3	270.8	240.2	142.6	859.2	98.9	1073.4
1896	10.7	75.2	214.3	283.6	264.7	77.9	841.1	77.2	1005.7
1897	22.7	90.7	168.7	286.1	290.2	197.6	942.5	97.9	1157.1
1898	39.0	69.4	180.6	311.7	240.4	206.1	940.1	124.1	1170.9
1899	15.7	117.5	218.2	221.1	143.8	101.8	685.4	60.4	882.2
1900	26.5	89.2	142.0	277.2	290.1	252.7	960.5	73.6	1151.0
1901	63.6	90.1	131.5	243.0	266.5	126.7	771.8	111.3	1034.8
1902	9.9	89.9	114.1	318.2	203.2	225.0	860.0	132.5	1092.8
1903	16.2	83.0	132.9	287.9	273.6	212.4	905.8	199.8	1203.5
1904	17.0	126.2	192.0	280.5	201.8	132.9	808.2	91.3	1046.4
1905	31.4	108.1	101.6	260.4	210.6	158.3	735.0	77.1	953.8
1906	54.7	73.2	187.6	307.4	244.4	176.8	915.1	107.0	1148.6
1907	45.6	110.0	163.1	237.1	307.6	97.0	807.5	62.4	1026.7
1908	29.4	66.9	136.1	321.7	312.5	159.9	932.4	51.8	1080.2
1909	24.8	130.6	233.3	324.3	224.6	166.7	945.9	76.8	1177.6
1910	12.6	69.4	218.2	237.8	287.0	207.5	949.0	164.0	1194.4
1911	24.9	96.0	195.6	166.9	218.7	192.1	772.1	132.1	1027.1
1912	25.7	86.7	128.0	338.2	267.2	126.8	862.9	126.0	1101.8
1913	32.4	114.1	225.0	271.7	198.2	112.8	807.1	124.2	1077.9
1914	14.6	111.6	165.3	358.4	247.6	190.0	962.7	79.1	1167.2
1915	52.3	127.9	178.4	252.0	227.9	198.9	858.3	151.1	1190.7
1916	13.5	76.8	224.0	271.2	314.8	224.7	1031.5	192.4	1312.5
1917	40.0	115.1	234.6	264.4	271.5	287.2	1051.5	204.3	1403.9
1918	12.5	139.0	179.7	145.3	239.3	104.7	670.3	81.2	902.3
1919	50.4	88.2	171.3	307.9	298.3	157.1	936.1	146.5	1219.3
1920	28.8	96.6	164.8	323.2	167.1	123.7	780.3	84.9	991.0
1921	35.9	76.9	175.1	277.8	262.9	206.4	923.1	89.6	1126.3
1922	31.4	64.2	190.2	329.0	231.4	211.8	963.2	125.0	1180.8
1923	36.7	78.2	100.3	340.5	277.9	169.5	891.3	103.9	1112.9
1924	24.7	74.9	124.9	350.5	247.8	237.0	960.5	128.9	1192.5
1925	8.5	125.0	201.6	310.7	210.1	130.5	853.6	132.9	1122.2
1926	28.7	121.0	91.1	307.6	326.8	209.2	937.3	74.0	1160.0
1927	31.6	94.2	169.2	313.6	244.5	151.6	881.4	134.8	1141.4
1928	48.7	79.3	169.3	298.5	202.9	127.1	797.0	169.2	1092.6
1929	34.9	99.1	200.9	291.1	233.8	123.6	852.3	147.0	1135.7
1930	25.9	91.2	179.8	289.5	189.5	194.6	853.6	165.8	1134.7
1931	19.3	77.9	117.9	309.9	303.7	200.7	933.7	189.1	1219.6
1932	17.8	107.4	120.6	321.0	211.0	190.7	842.5	147.3	1114.1
1933	24.9	160.3	239.0	269.5	316.5	212.7	1034.6	136.5	1353.7
1934	24.4	72.3	218.4	268.5	305.5	174.7	966.8	107.1	1169.3
1935	29.2	60.5	141.9	306.2	232.0	183.0	864.0	85.0	1036.8
1936	34.1	122.2	255.9	292.9	224.1	200.6	972.3	144.2	1272.9
1937	48.4	108.9	163.2	350.1	196.1	163.5	873.1	131.4	1159.3
1938	29.6	103.1	257.4	282.6	252.1	159.0	950.8	98.3	1183.5
1939	24.3	76.5	163.2	277.2	239.1	153.2	833.3	130.7	1065.9

TABLE 16 contd...

Year	JF	MAM	JUN	JUL	AUG	SEP	MON	OND	ANN
1940	28.2	122.0	174.8	302.1	298.6	115.0	893.7	133.5	1177.6
1941	28.1	94.0	180.1	213.3	231.6	140.8	765.8	117.0	1008.3
1942	48.1	90.1	179.4	366.8	297.6	180.2	1026.2	91.8	1256.8
1943	46.5	138.0	166.1	318.3	218.4	205.5	910.3	125.9	1217.9
1944	49.6	123.7	136.7	349.2	290.9	138.9	918.2	138.1	1226.4
1945	31.3	79.4	160.6	329.6	235.8	229.4	952.3	114.8	1178.3
1946	15.6	111.6	219.5	308.6	289.4	145.4	962.6	215.3	1302.5
1947	29.6	80.9	123.3	305.0	279.5	254.4	960.7	94.1	1166.7
1948	39.6	106.9	163.2	287.5	280.5	185.7	918.6	155.1	1222.0
1949	19.5	126.1	145.0	330.9	244.7	240.2	960.8	113.5	1223.4
1950	26.7	83.3	161.5	343.8	240.2	194.9	939.1	94.3	1143.9
1951	12.8	110.2	166.4	266.1	199.3	131.7	763.6	111.4	998.4
1952	18.0	108.6	186.6	278.5	252.1	113.1	831.9	106.4	1066.0
1953	26.3	74.5	166.5	350.7	279.7	175.5	975.3	114.3	1190.0
1954	35.6	82.6	158.9	317.1	236.0	244.7	954.2	103.7	1176.4
1955	25.0	113.9	201.6	255.7	316.5	237.7	1009.5	193.6	1341.0
1956	19.7	133.4	214.4	344.2	265.8	185.0	1008.2	215.5	1372.7
1957	38.9	100.1	151.6	286.1	261.6	133.9	834.9	95.3	1067.2
1958	20.3	95.8	135.7	315.7	306.1	216.1	973.0	149.0	1238.5
1959	34.8	100.1	163.5	329.1	264.5	212.0	967.9	162.0	1264.2
1960	11.0	106.1	153.0	305.7	266.8	169.1	898.1	135.7	1148.2
1961	43.0	111.4	192.4	355.2	297.0	236.0	1078.4	157.6	1389.6
1962	28.5	110.6	109.7	275.3	257.3	238.1	879.2	142.0	1158.4
1963	16.1	98.6	164.6	271.2	338.1	164.6	939.1	128.3	1181.1
1964	8.7	83.2	146.2	347.0	278.6	227.2	997.9	104.5	1193.7
1965	16.5	86.3	117.5	280.7	207.5	141.5	748.5	79.2	931.2
1966	22.1	80.8	188.0	253.7	213.9	132.5	785.4	141.8	1028.1
1967	15.0	112.1	156.6	302.9	284.1	176.1	921.7	100.8	1147.3
1968	28.3	76.0	146.1	327.7	211.0	130.6	816.5	107.5	1031.3
1969	8.2	98.6	133.4	319.6	248.6	185.3	888.1	124.1	1119.5
1970	44.5	108.9	215.3	234.2	321.0	211.0	978.4	99.5	1230.7
1971	27.5	137.5	241.2	276.8	271.3	180.2	969.2	127.3	1261.3
1972	21.6	82.0	123.9	207.0	227.6	135.0	695.9	120.8	922.2
1973	19.1	82.7	155.1	294.7	313.1	191.0	953.4	156.4	1213.1
1974	6.6	97.9	110.4	314.2	251.5	136.1	815.1	120.0	1042.7
1975	18.9	76.2	212.0	316.8	285.1	231.4	1042.3	143.0	1279.2
1976	16.5	84.1	138.6	304.7	303.8	155.9	903.5	108.9	1111.8
1977	16.8	129.8	182.4	331.4	239.2	152.6	905.6	175.9	1226.9
1978	34.9	104.6	221.1	303.4	291.9	178.9	993.3	127.4	1256.8
1979	45.6	71.7	153.4	256.6	191.6	124.4	725.4	146.0	986.5
1980	12.9	89.0	225.9	313.2	281.2	139.0	961.3	104.8	1168.6
1981	27.1	116.0	159.1	305.0	241.5	203.1	908.6	95.4	1147.5
1982	32.3	124.5	147.6	242.9	308.0	138.1	838.7	105.7	1098.3
1983	22.7	101.3	136.5	301.3	313.6	260.2	1008.7	129.7	1260.9
1984	45.1	84.0	210.0	272.7	276.3	148.9	907.1	82.8	1118.0
1985	26.6	85.0	174.2	285.4	236.1	164.6	861.9	174.5	1145.9
1986	44.9	93.6	174.7	254.5	229.2	121.1	779.8	133.1	1051.6
1987	25.2	84.5	129.3	218.8	257.3	146.7	754.7	171.6	1035.4
1988	16.9	98.9	167.2	344.2	298.9	209.1	1017.8	85.4	1220.7
1989	14.2	86.9	191.2	291.9	248.4	181.8	912.0	76.9	1096.7
1990	34.1	166.7	190.5	285.7	299.5	213.6	987.8	148.3	1335.2
1991	18.4	94.4	205.7	281.6	275.9	131.3	896.5	116.2	1127.9
1992	18.2	74.2	145.9	253.3	290.5	158.8	849.1	120.5	1062.6
1993	19.3	108.9	190.4	300.5	210.9	209.3	907.4	140.0	1170.9
1994	37.8	87.8	210.1	349.4	303.3	142.2	1005.5	126.9	1256.7

TABLE 17: Correlation matrix for summer monsoon rainfall series of six rainfall zones of India as well as for the entire country based on data of 1871-1984

	NWI	NCI	NEI	WPI	EPI	SPI	INDIA
NWI	1.0000						
NCI	.3244	1.0000					
NEI	-.1731	.2264	1.0000				
WPI	.6233	-.0030	-.1087	1.0000			
EPI	.4763	.1447	-.0715	.5826	1.0000		
SPI	.3297	.0476	-.1504	.4182	.2032	1.0000	
INDIA	.8955	.5412	.0386	.7210	.5212	.5086	1.0000

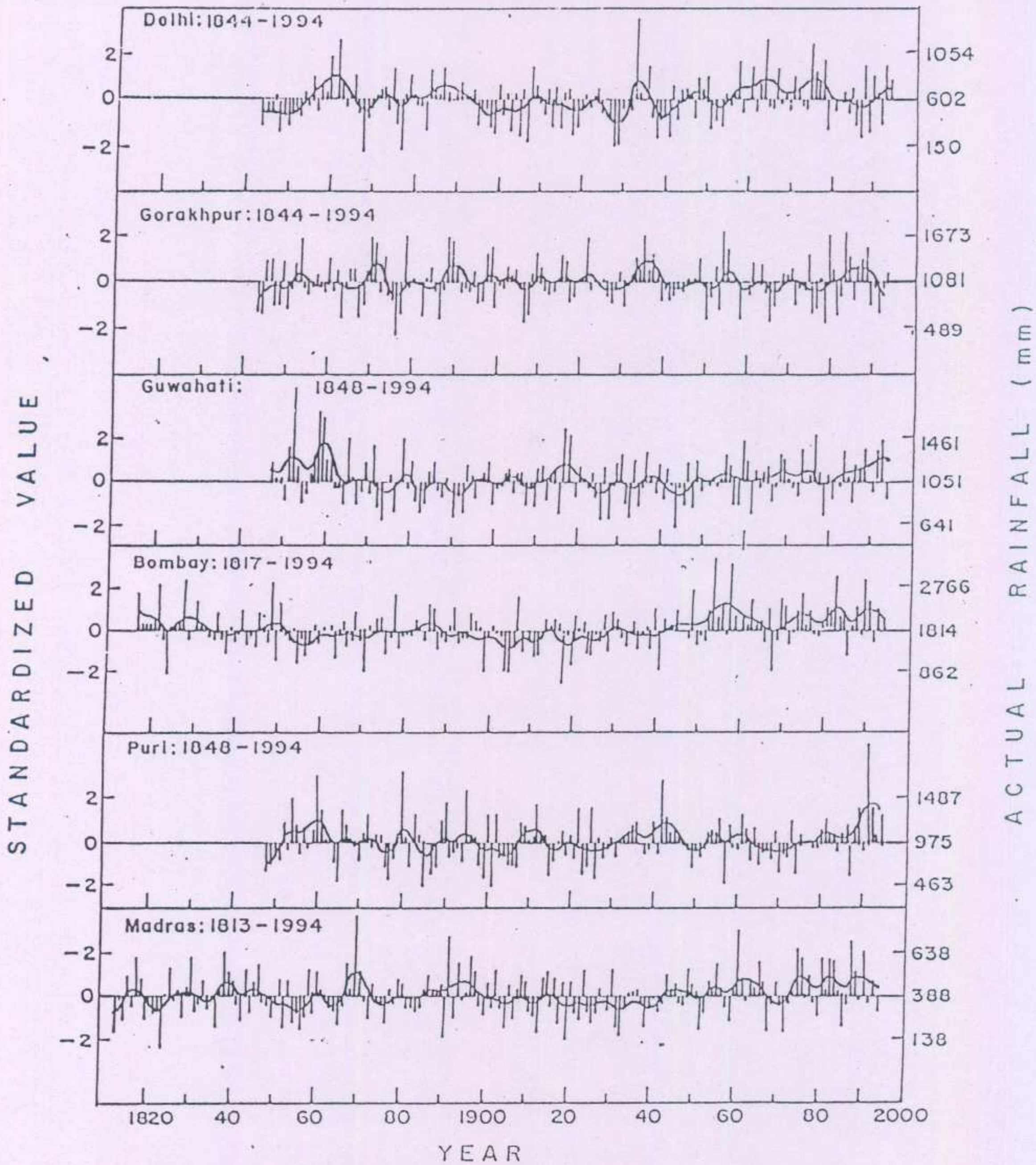

Figure 1 Plots of the longest summer monsoon rainfall series of six selected stations from different parts of the country. Continuous curve shows the 9-point Gaussian low-pass filtered values.

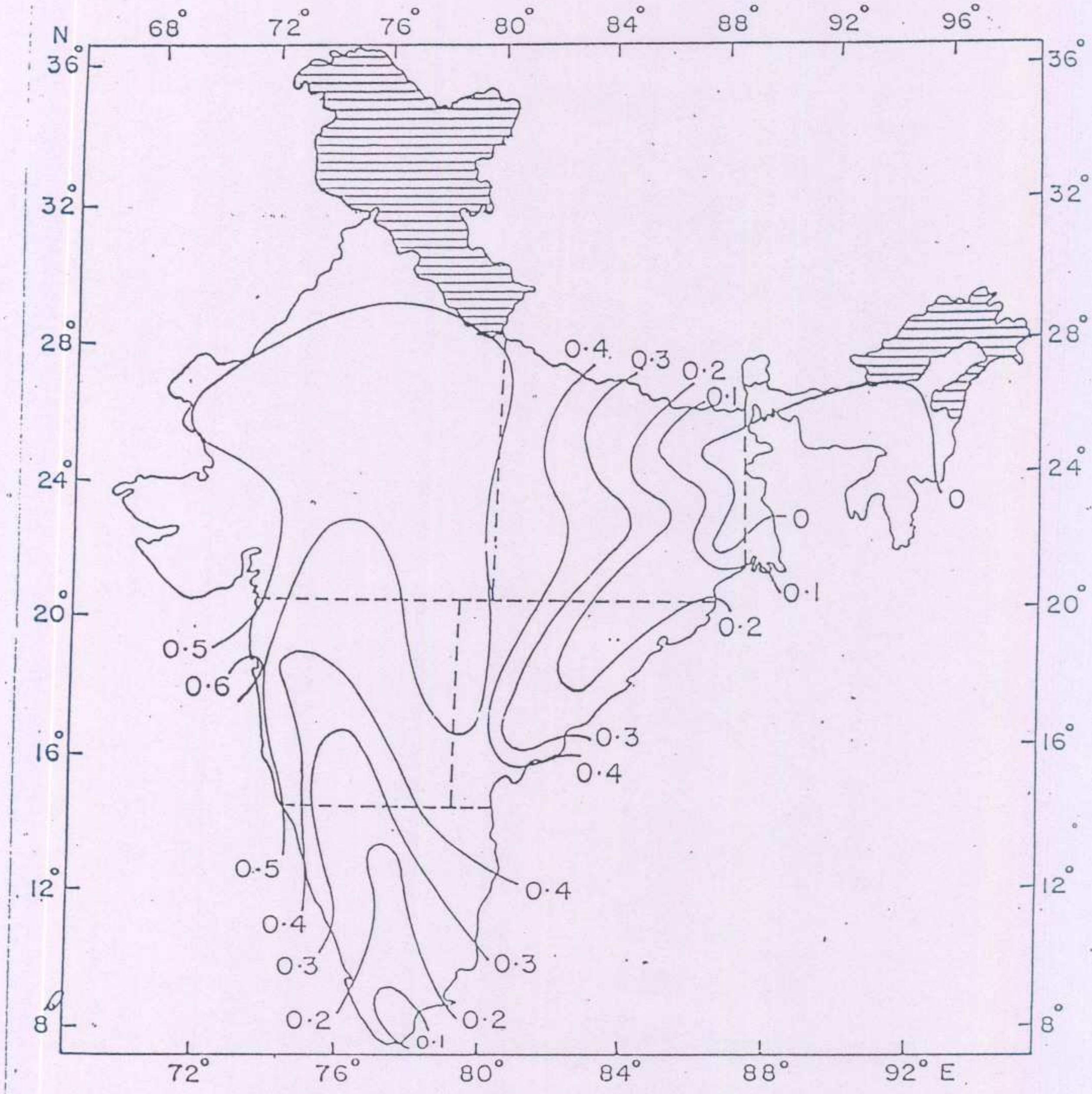

Figure 2 The isopleths of the correlation coefficient (CC) between the representative monsoon rainfall series (1871-1984) of India and the individuals of the 306-raingauge network. Dashed lines show boundaries of the six zones which are delineated later in the paper.

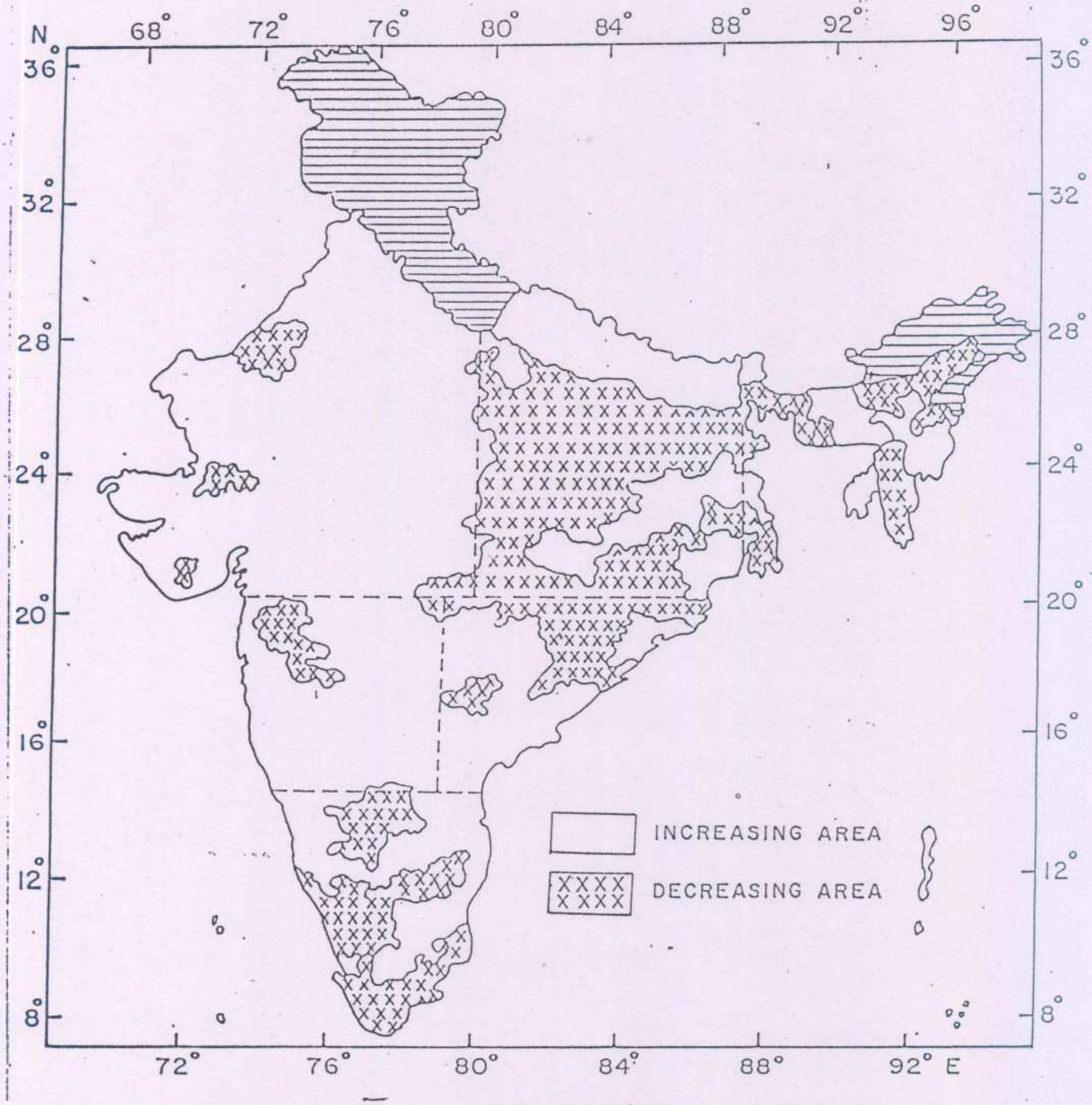

Figure 3. Shaded areas with 'crosses' show decrease in the monsoon rainfall from 1901-1940 to 1941-1980, and the remaining increase. Dashed lines show boundaries of the six zones delineated later in this paper.

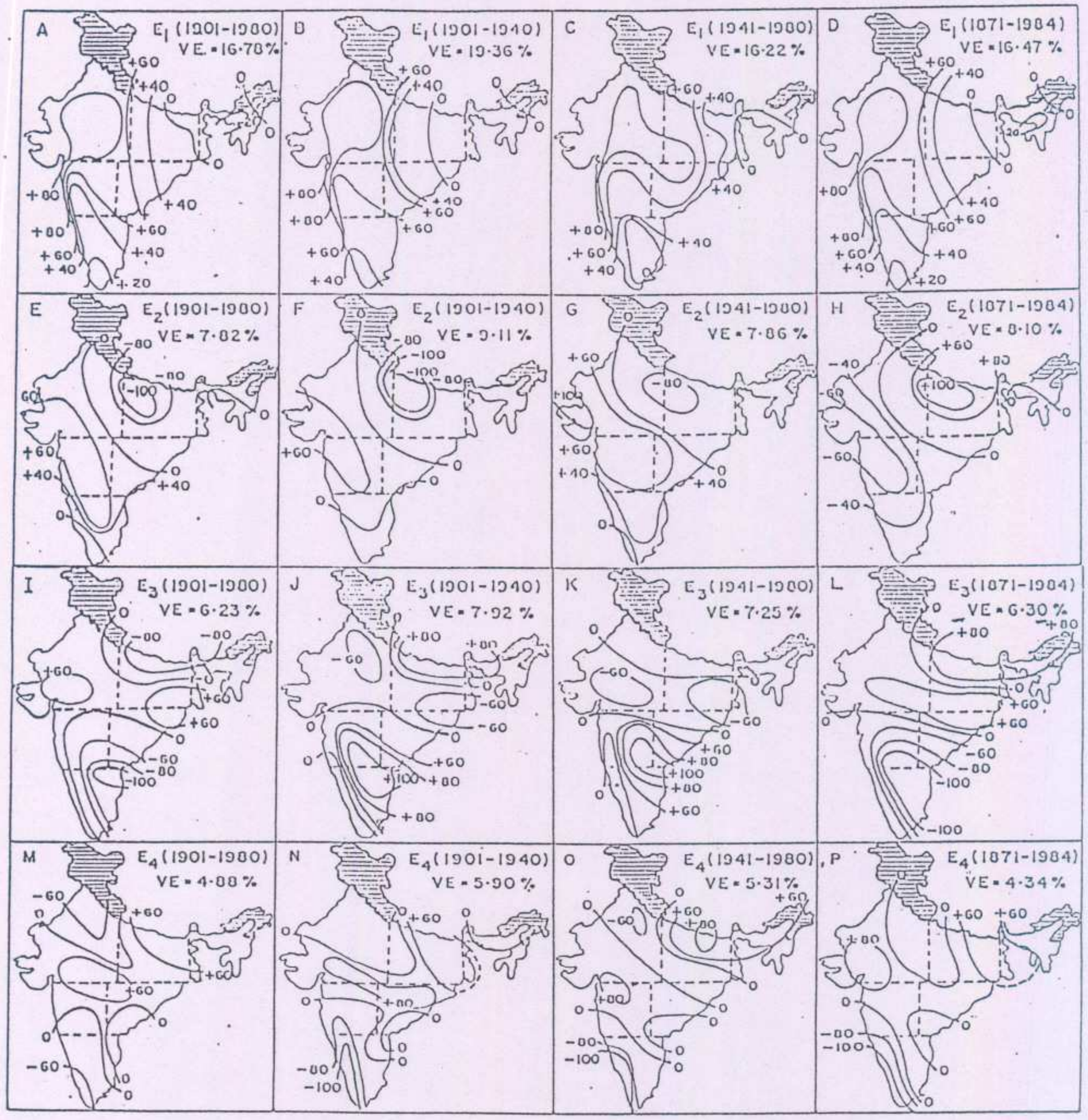

Figure 4. Isopleths of the loading of the first four eigenvalues, the S-mode eigen-analysis is carried out of the correlation matrix of the 306 stations based on the monsoon rainfall of the indicated periods. To get the actual magnitude the plotted figure is to be multiplied by 10^{-3}. VE indicates the variance explained. Dashed lines show the boundaries of the six zones finally delineated.

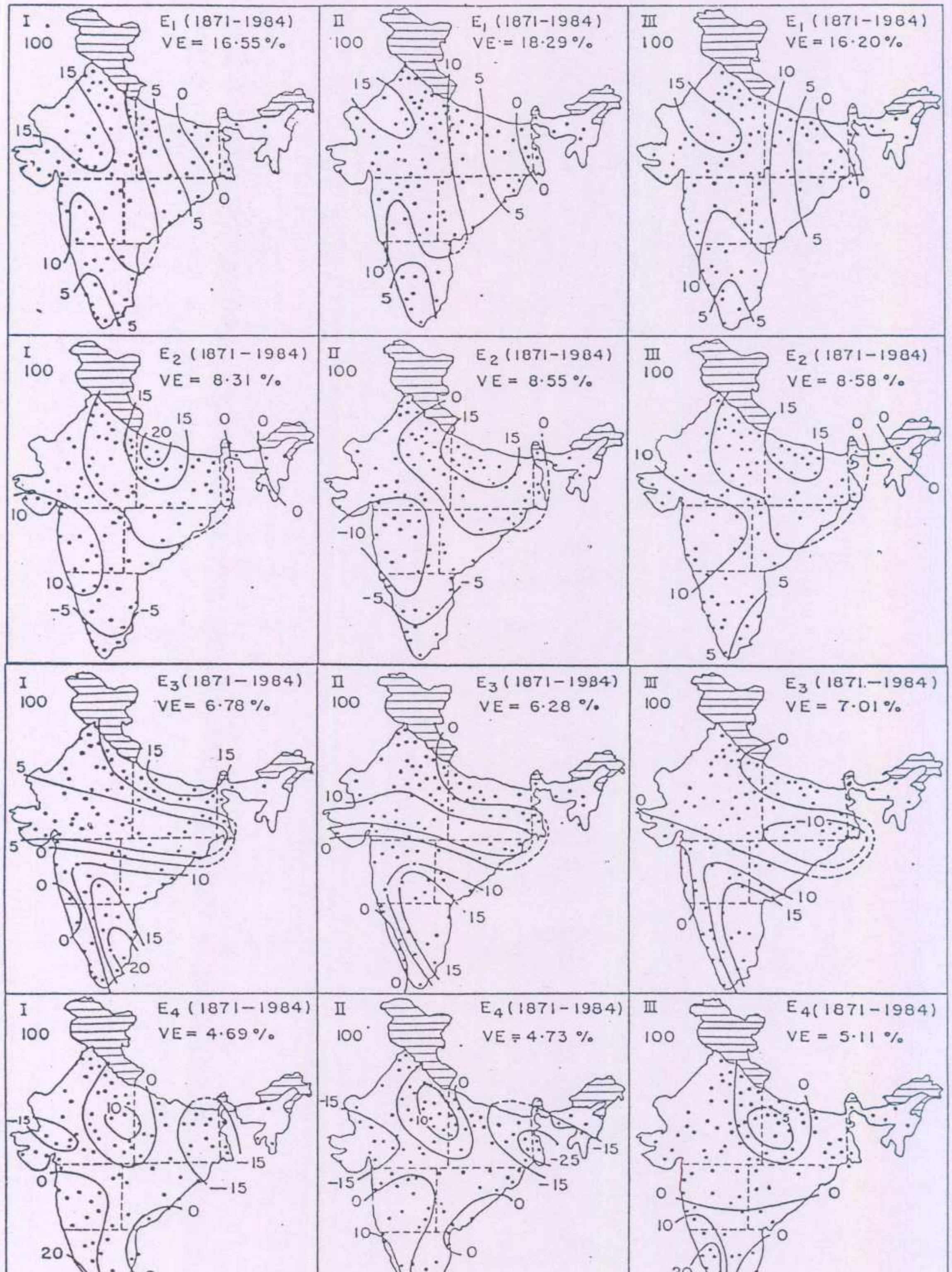

Figure 5. Loading of the first four eigenvalues, the S-mode eigen-analysis is carried out of the correlation matrix for 3 sets of 100 stations based on the monsoon rainfall of 1871-1984. To get the actual magnitude the plotted figure is to be multiplied by 10^{-3}. VE indicates the variance explained. Dashed lines show the boundaries of the six zones finally delineated.

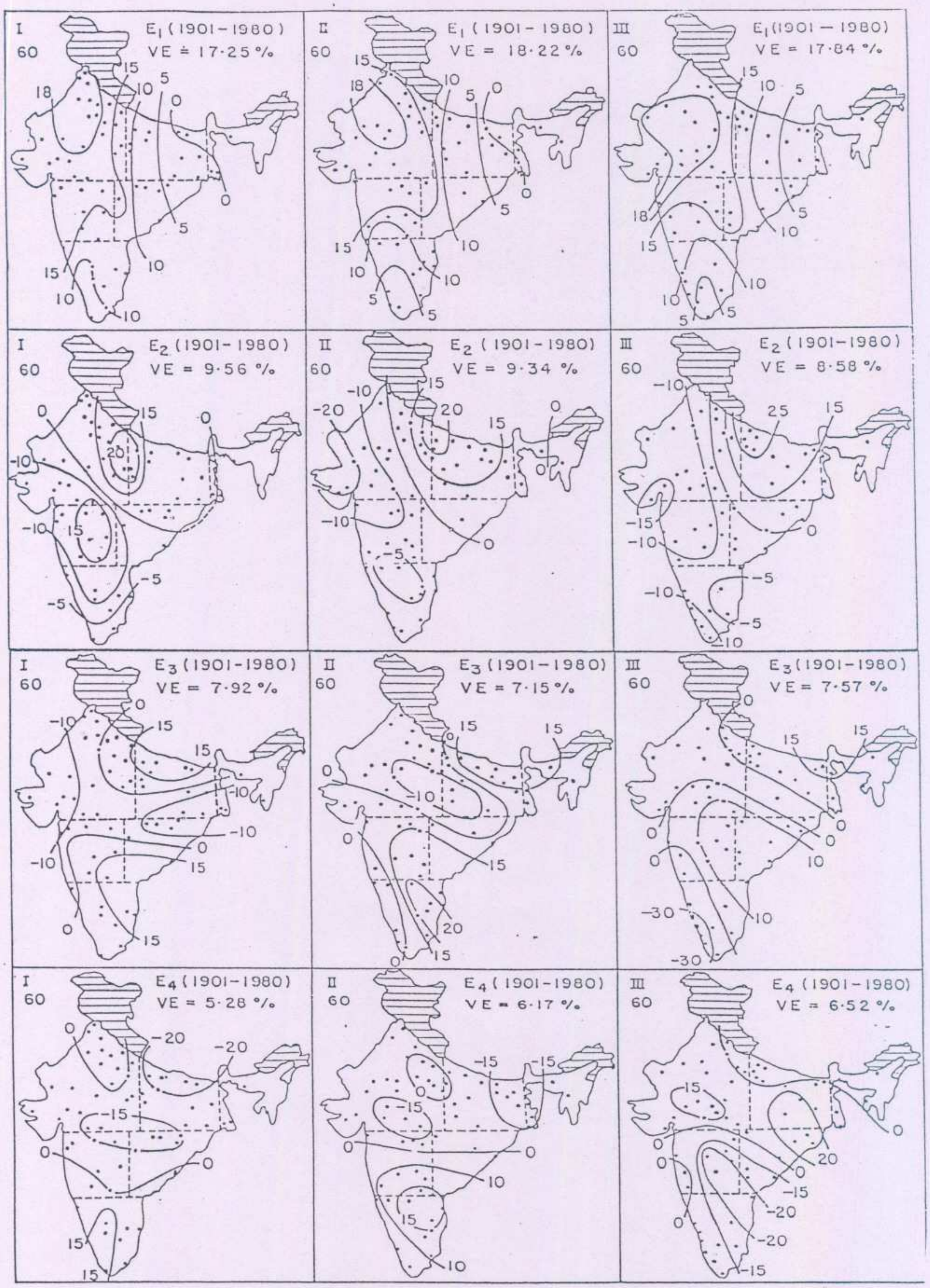

Figure 6. Loading of the first four eigenvalues of the S-mod eigen-analysis of the correlation matrix for 3 sets of 6 stations using the monsoon rainfall of 1901–1980. To ge the actual magnitude the plotted figure is to b multiplied by 10^{-3}. VE indicates the variance explained Dashed lines show the boundaries of the six zones finall delineated.

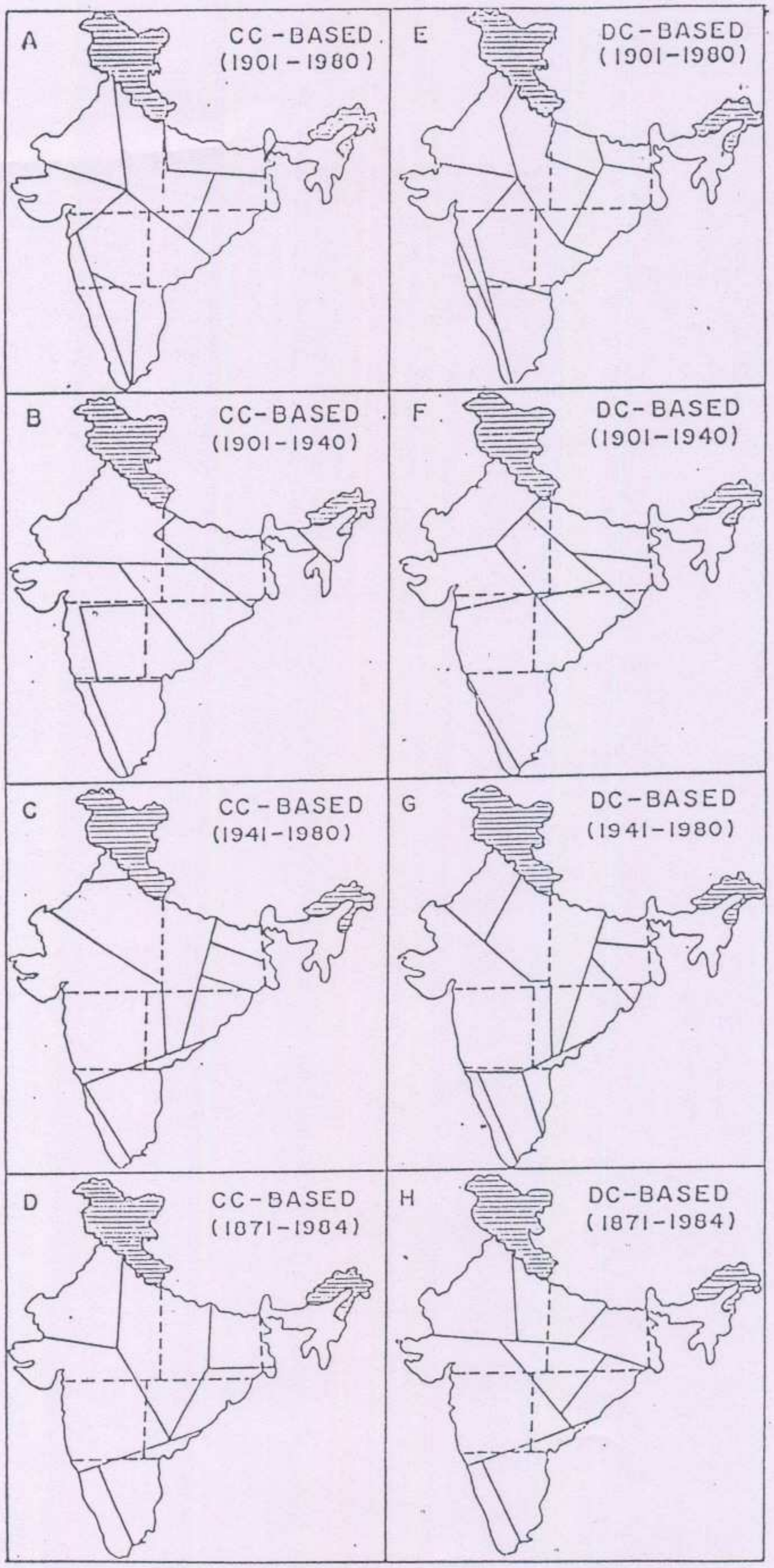

Figure 7. Delineated zones based on cluster analysis of the 306 stations using monsoon rainfall of the indicated periods. The two measures of similarity considered in the study are the correlation coefficient (CC) and the distance coefficient (DC). Dashed lines show the boundaries of the six zones finally delineated.

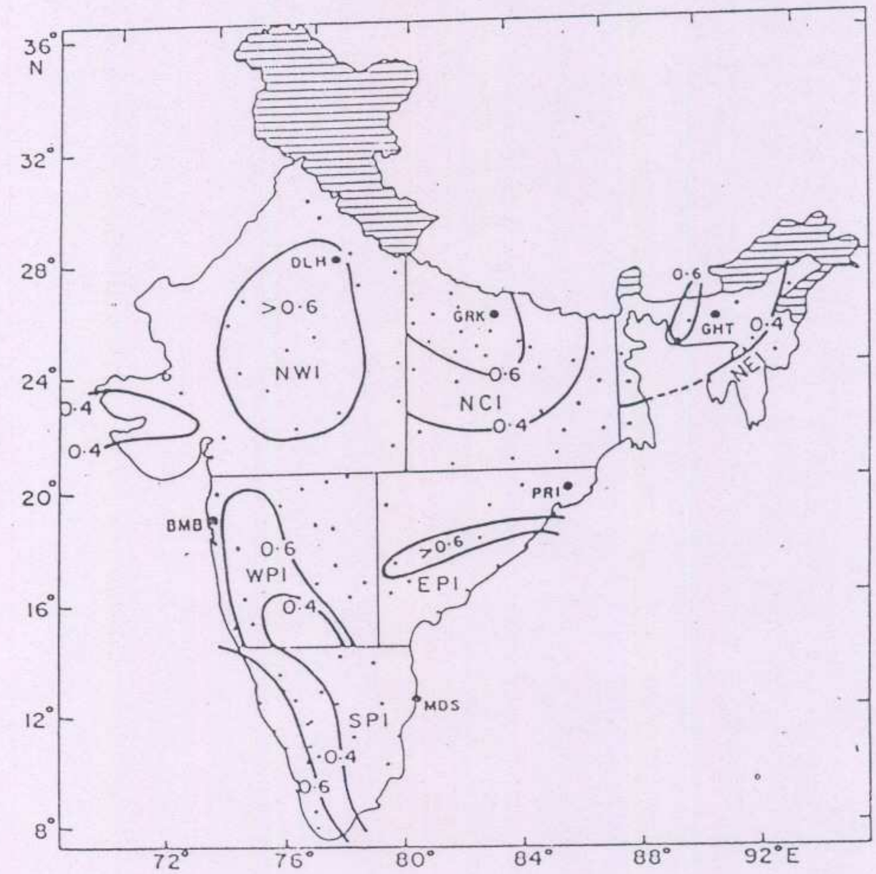

Figure 8. Isopleths of the CC between the zonal monsoon rainfall series (1871-1984) and its individual gauges for the six zones of India. Dots indicate the location of the selected IMD gauges for updating the respective zone monsoon rainfall series.

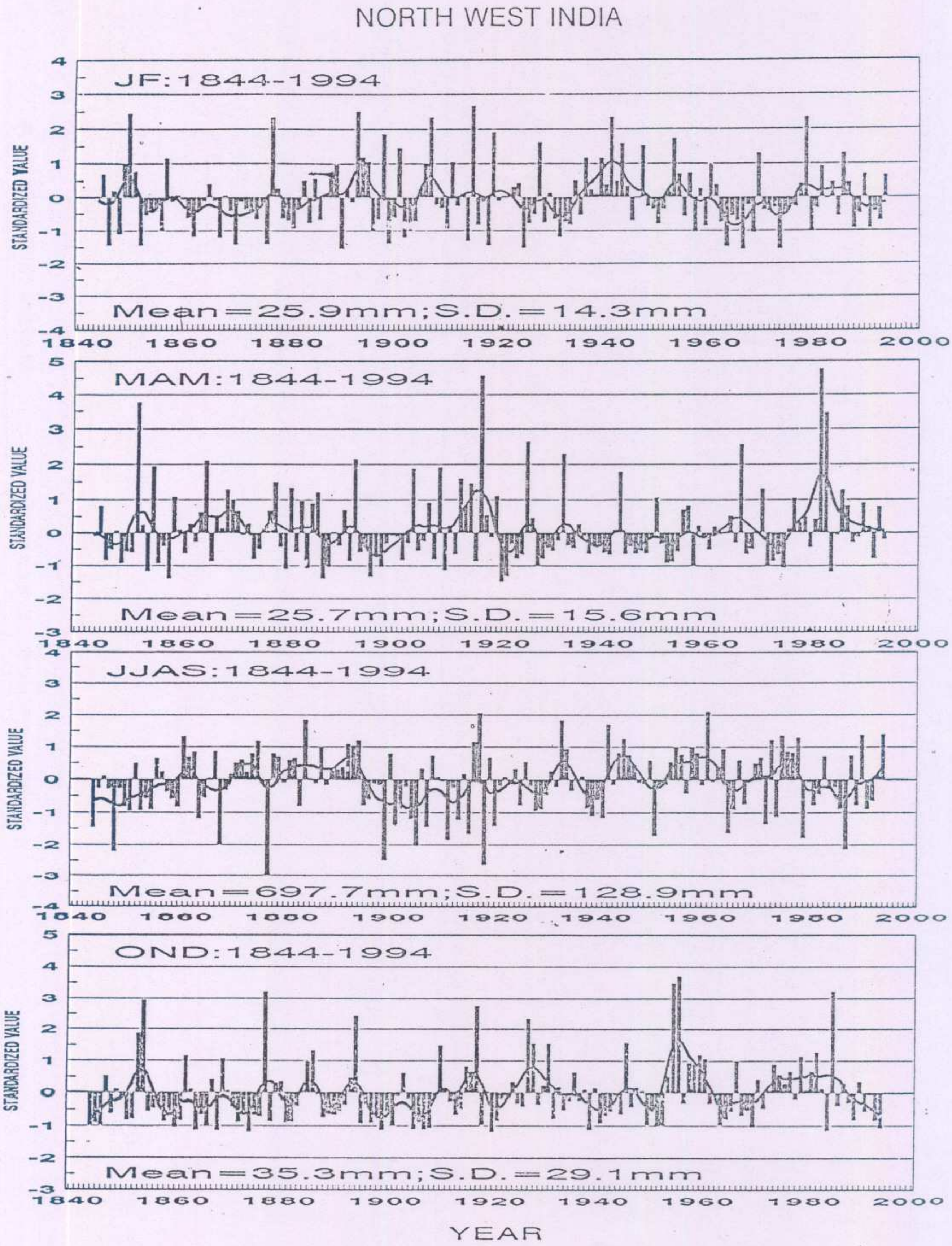

Figure 9. Plots of the reconstructed longest seasonal (winter JF; summer MAM; monsoon JJAS; and post-monsoon OND) rainfall series of the North West India.

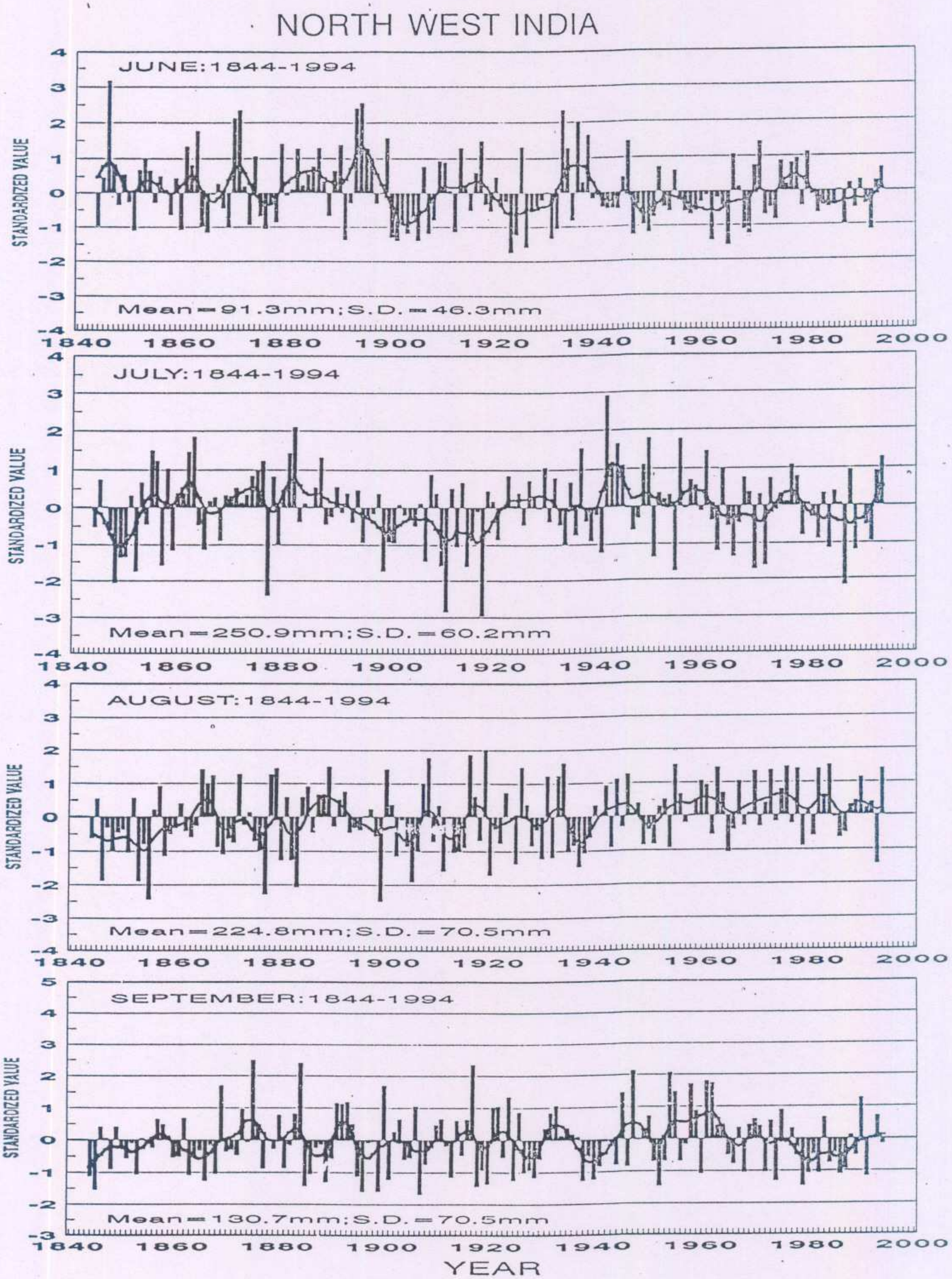

Figure 10. Plots of the reconstructed longest monsoon monthly (June, July, August and September) rainfall series of the North West India.

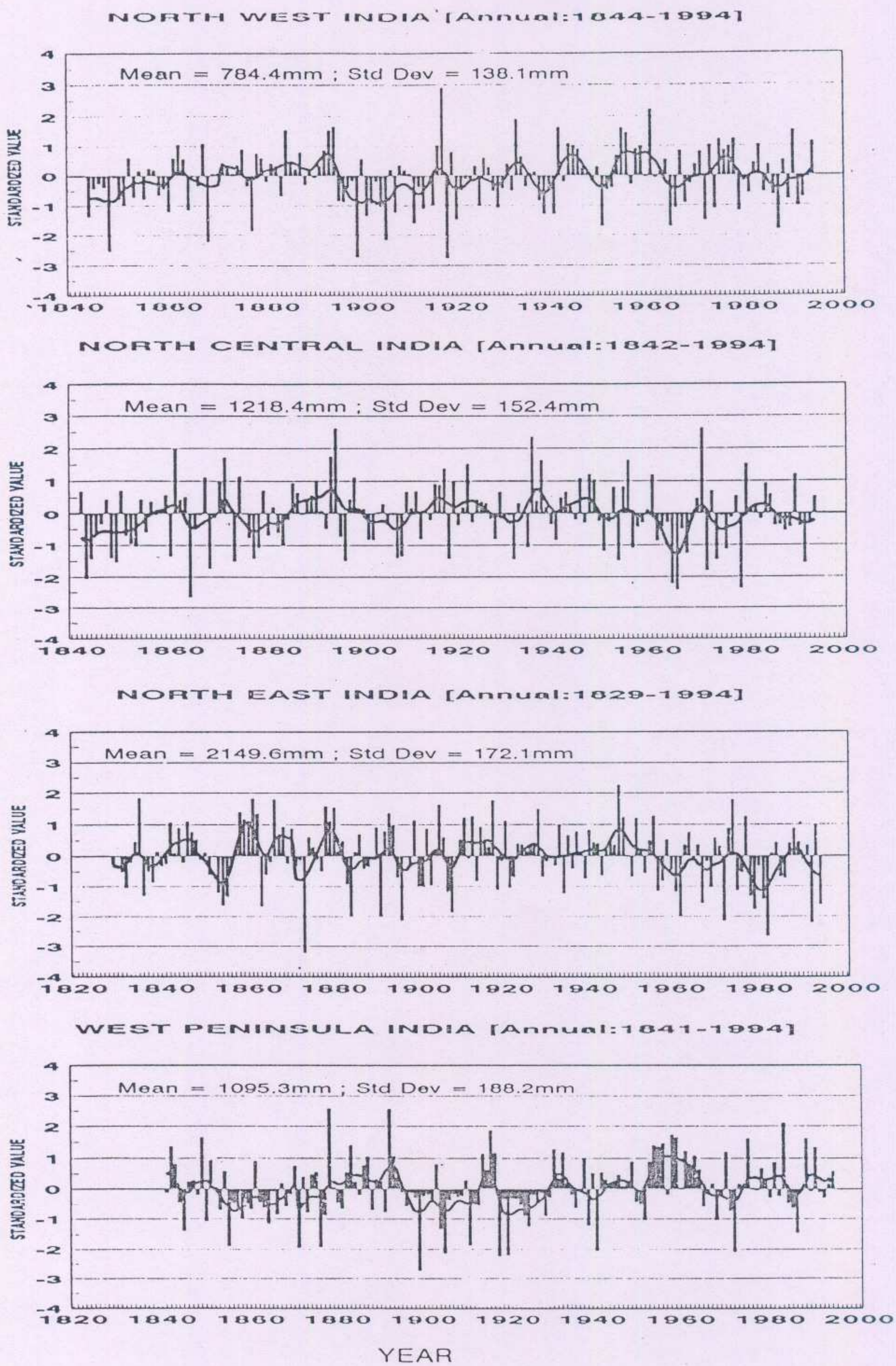

Figure 11 (a): Plots of the reconstructed longest possible annual rainfall series of the North West India, North Central India, North East India and West Peninsula India.

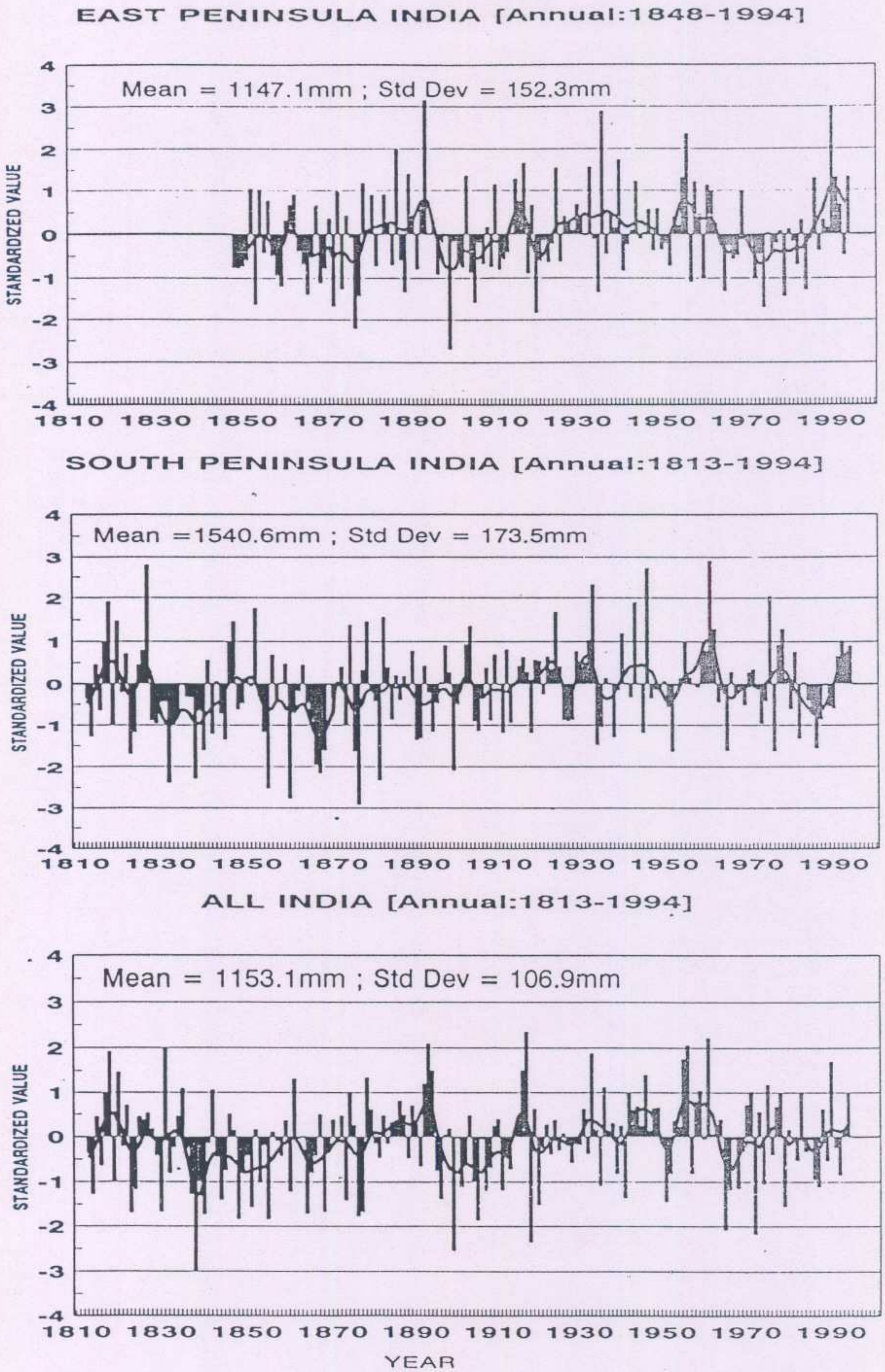

Figure 11 (b). Plots of the reconstructed longest possible annual rainfall series of the East Peninsula India, South Peninsula India and the entire country (all-India).

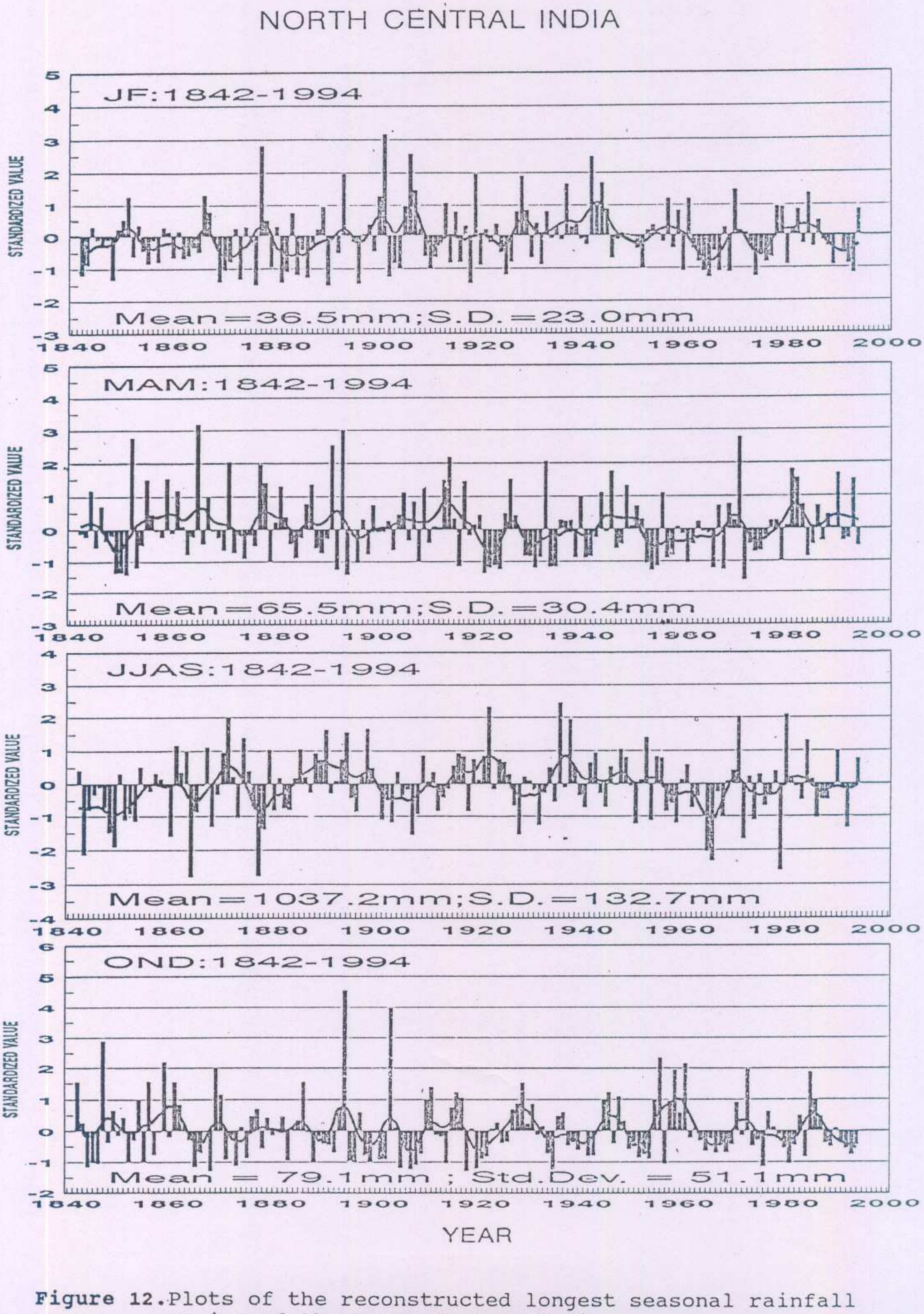

Figure 12. Plots of the reconstructed longest seasonal rainfall series of the North Central India.

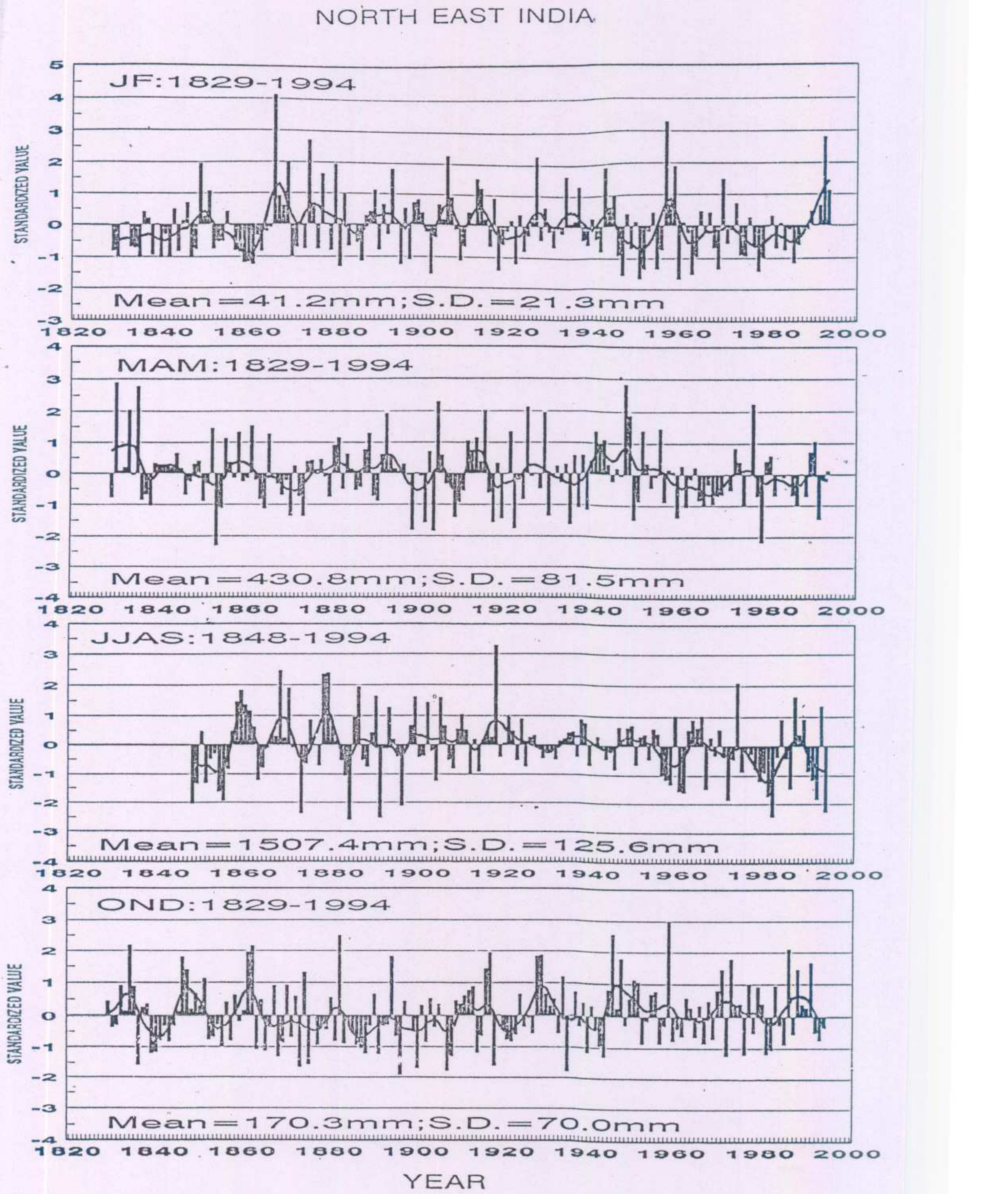

Figure 13. Plots of the reconstructed longest possible seasonal rainfall series of the North East India.

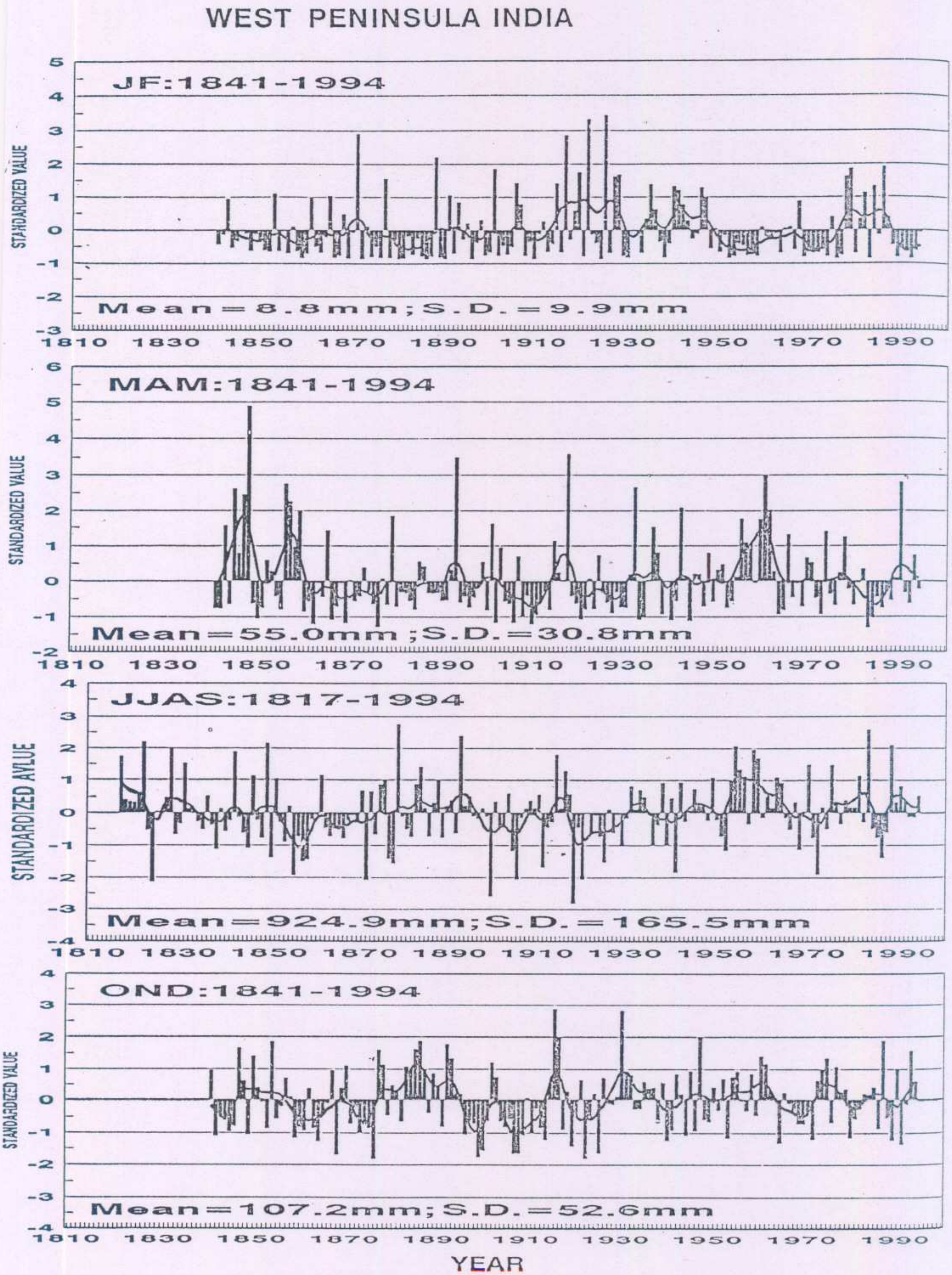

Figure 14. Plots of the reconstructed longest possible seasonal rainfall series of the West Peninsula India.

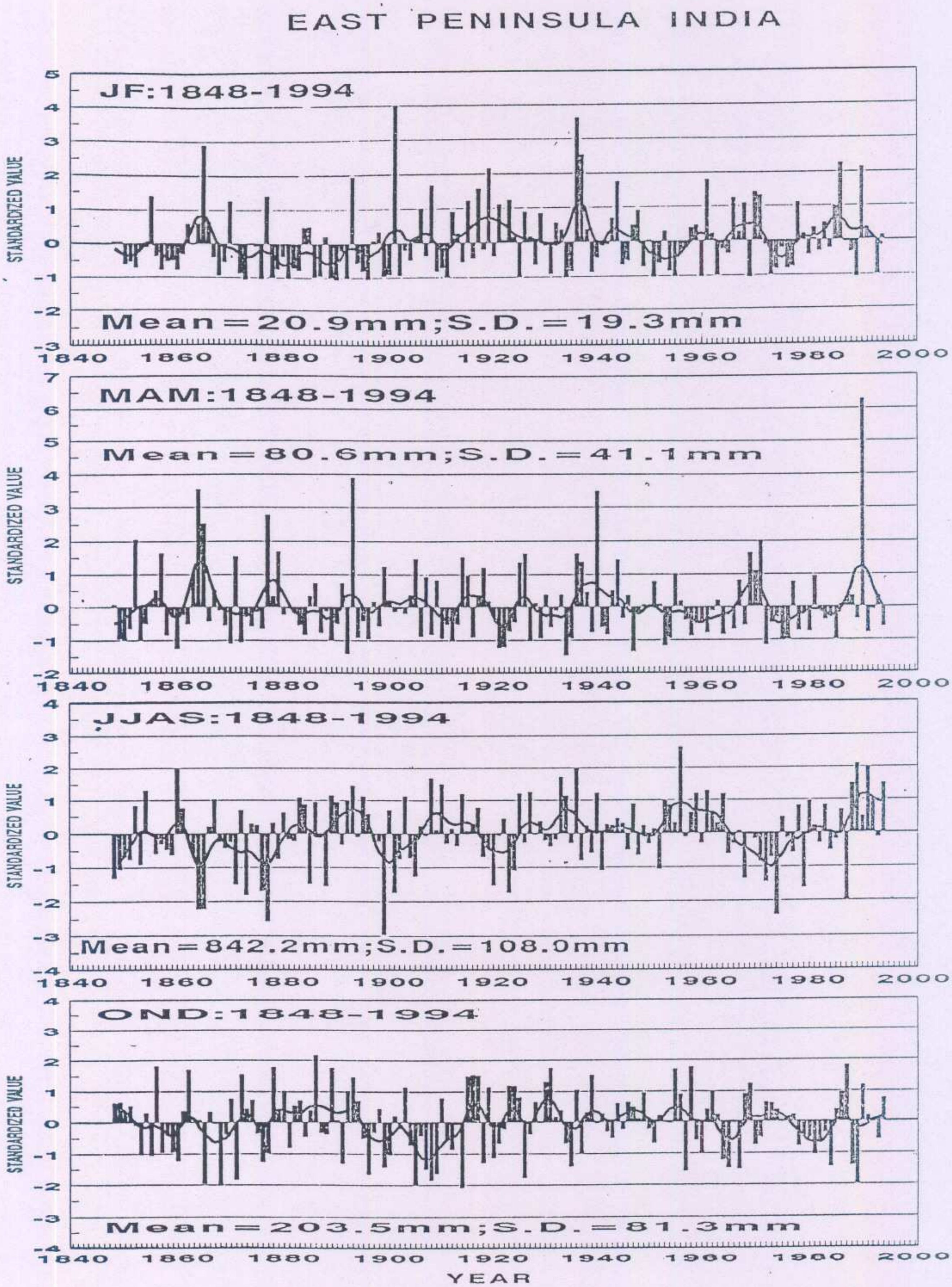

Figure 15. Plots of the reconstructed longest seasonal rainfall series of the East Peninsula India.

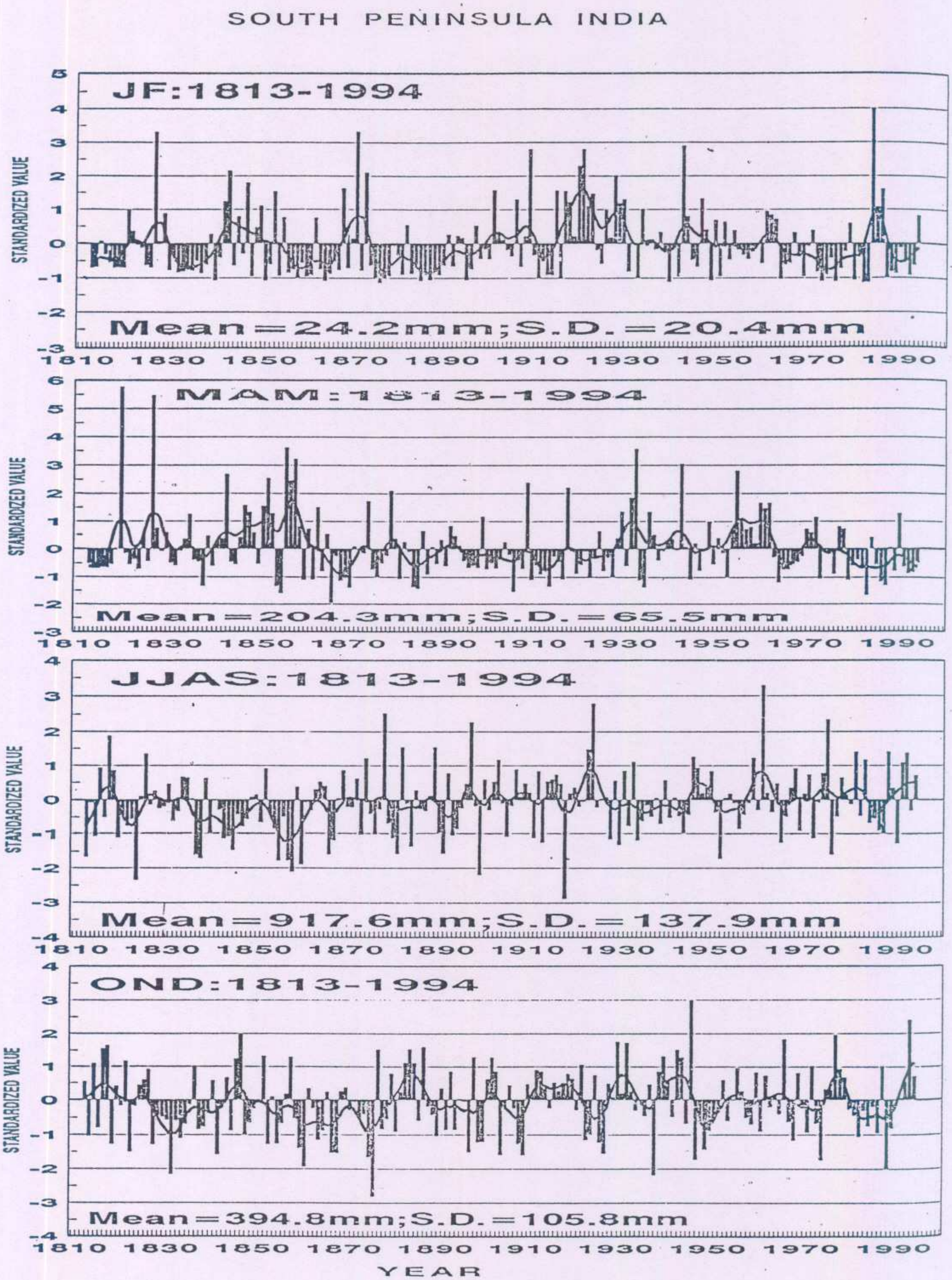

Figure 16. Plots of the reconstructed longest seasonal rainfall series of the South Peninsula India.

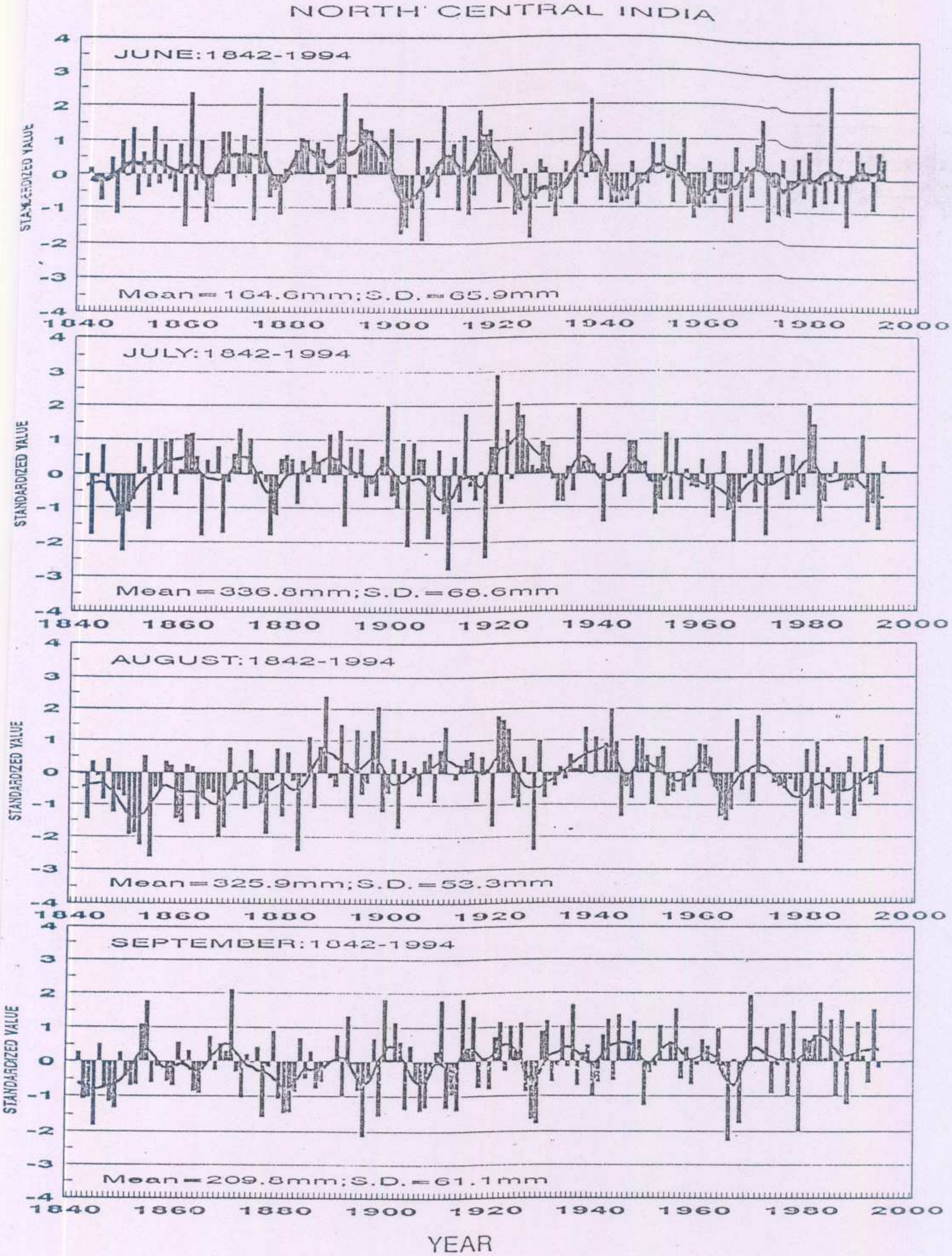

Figure 17. Plots of the reconstructed longest monsoon monthly rainfall series of the North Central India.

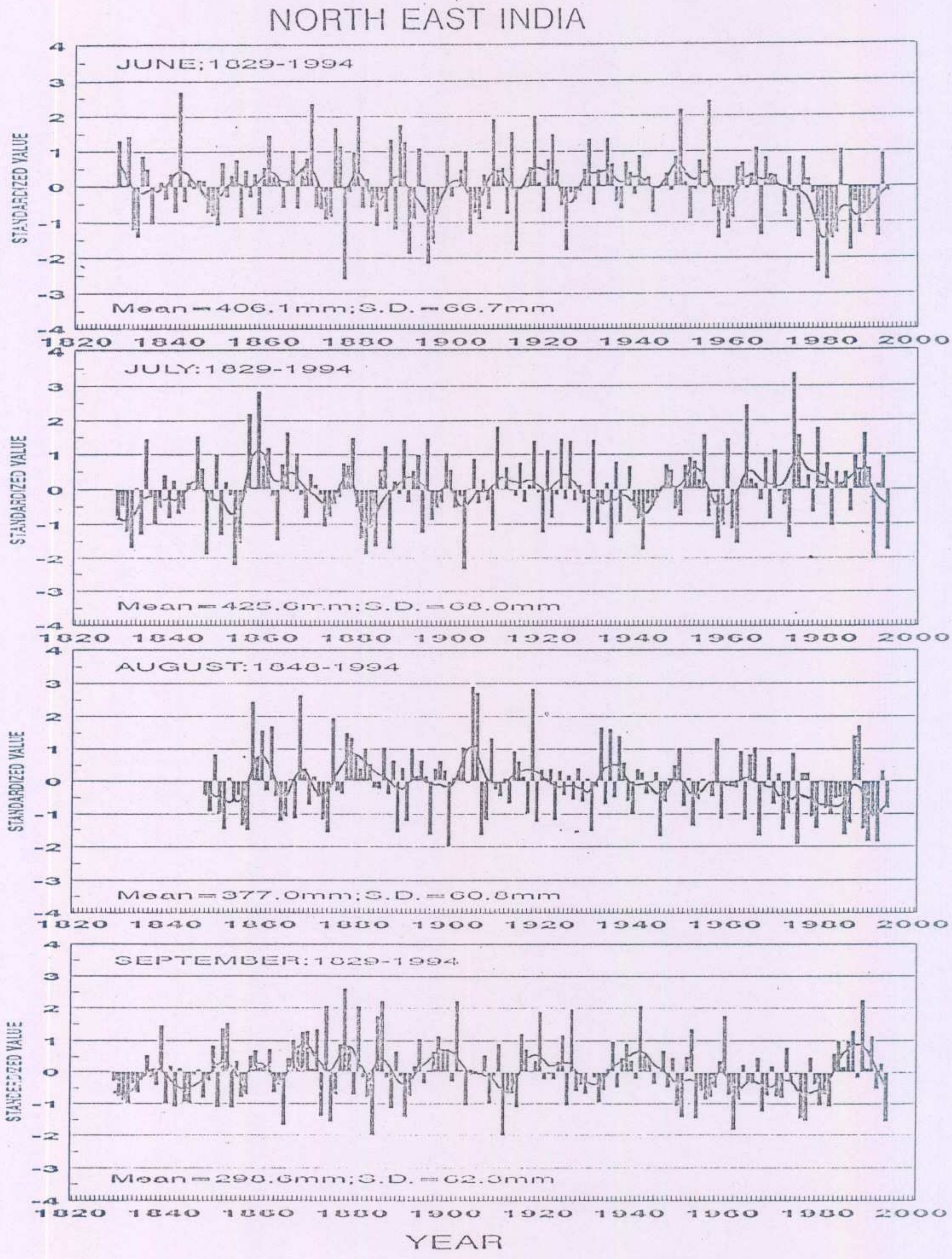

Figure 18. Plots of the reconstructed longest possible monsoon monthly rainfall series of the North East India.

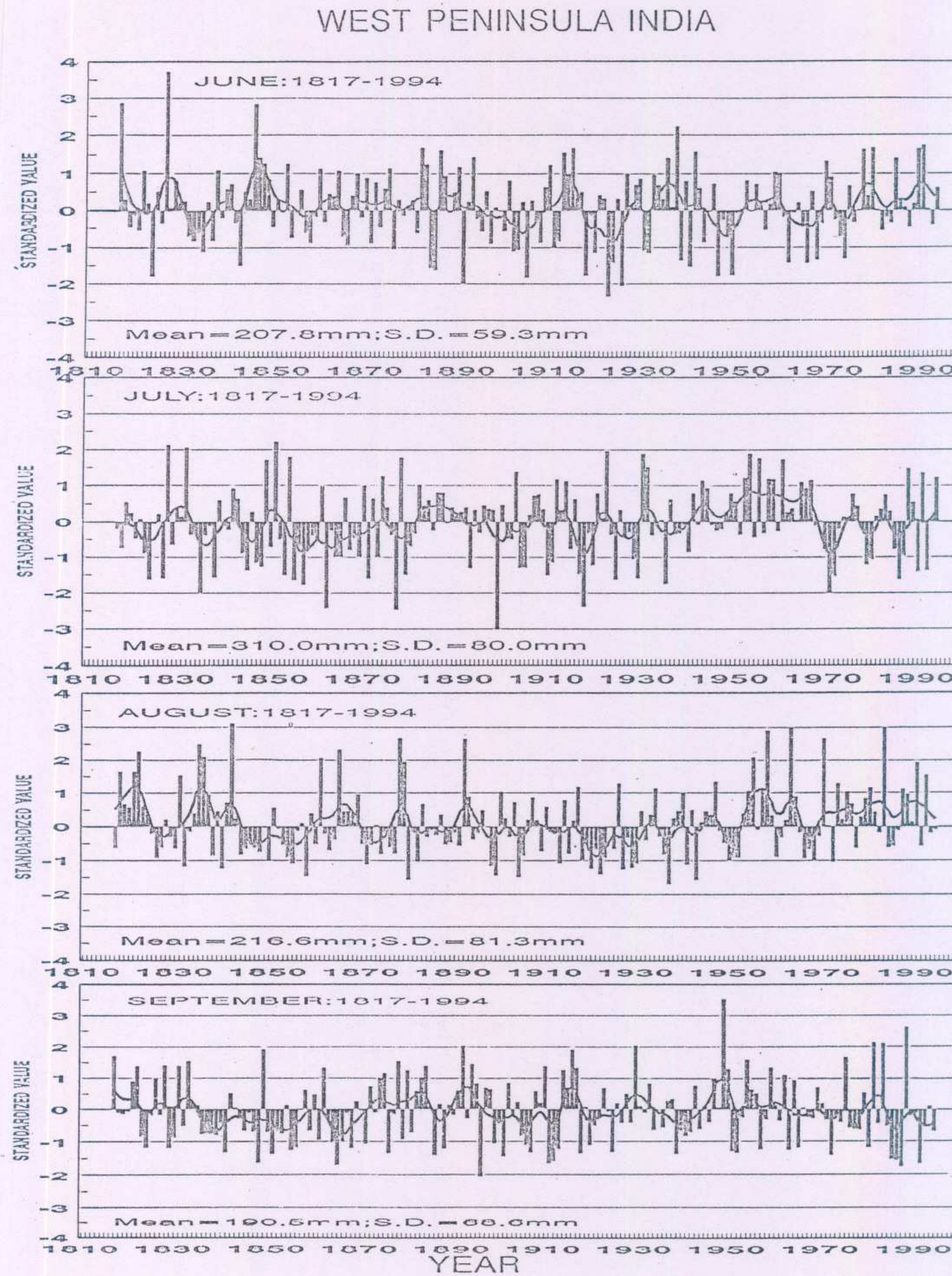

Figure 19. Plots of the reconstructed longest monsoon monthly rainfall series of the West Peninsula India.

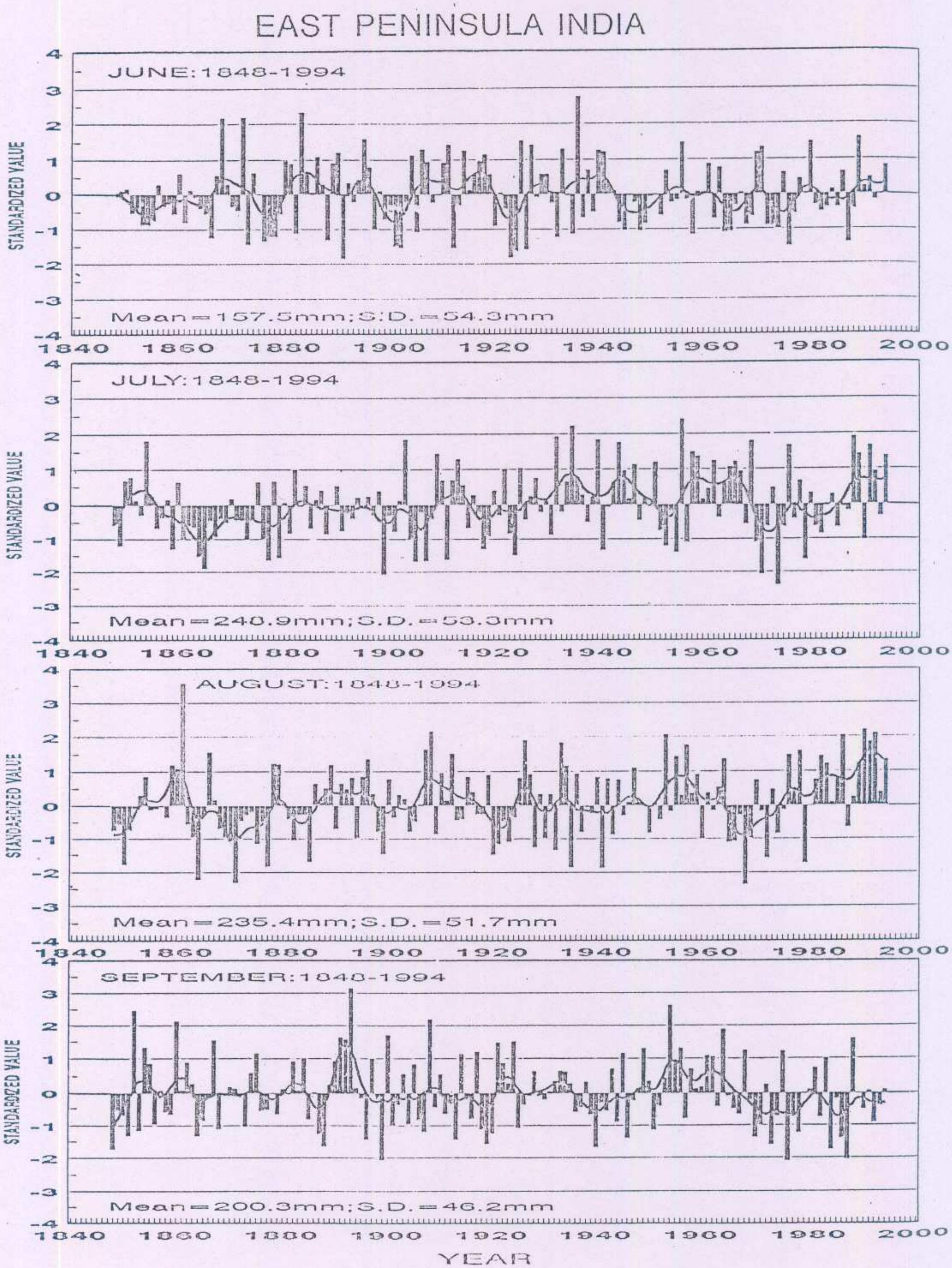

Figure 20.Plots of the reconstructed longest monsoon monthly rainfall series of the East Peninsula India.

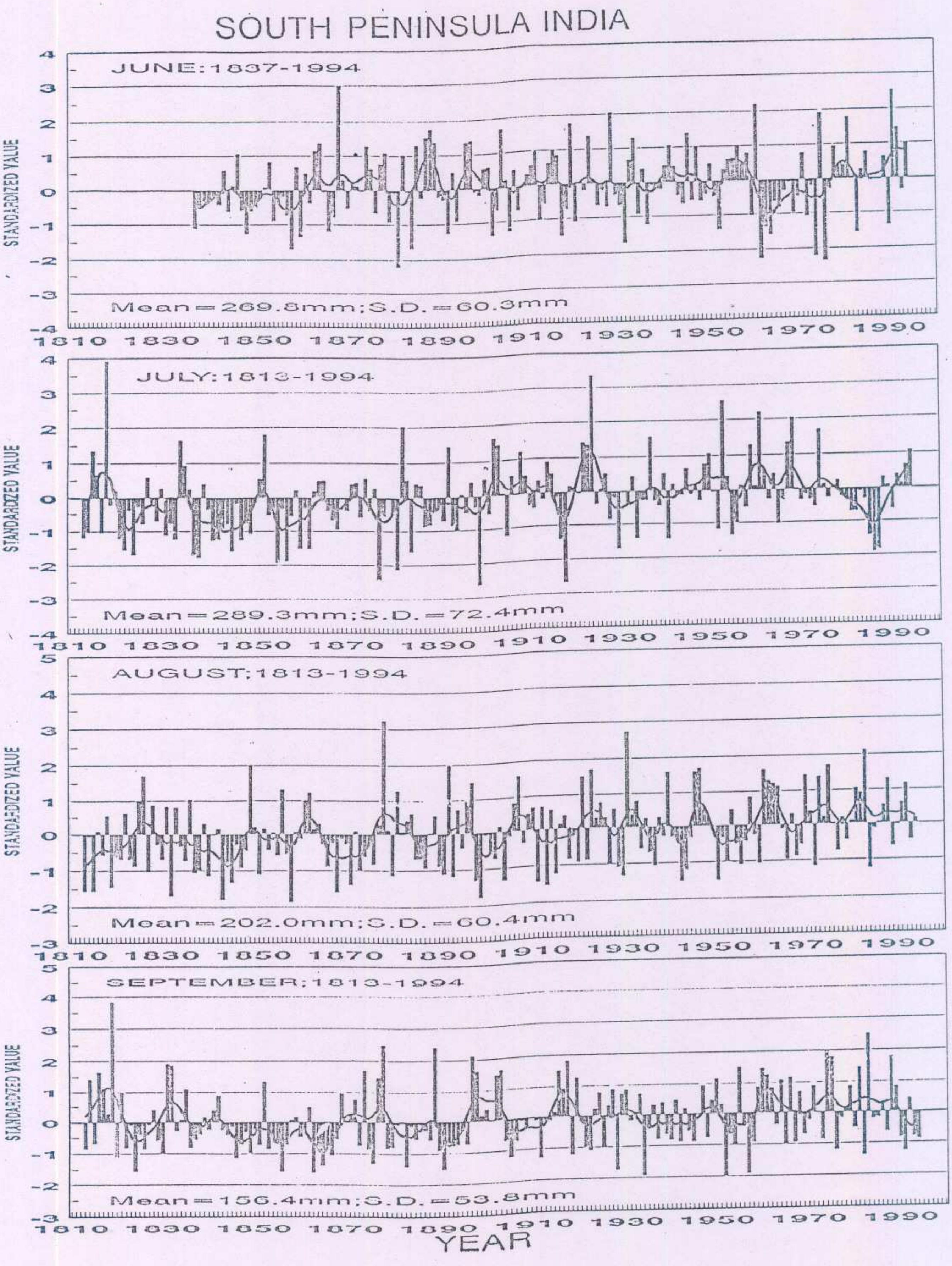

Figure 21. Plots of the reconstructed longest monsoon monthly rainfall series of the South Peninsula India.

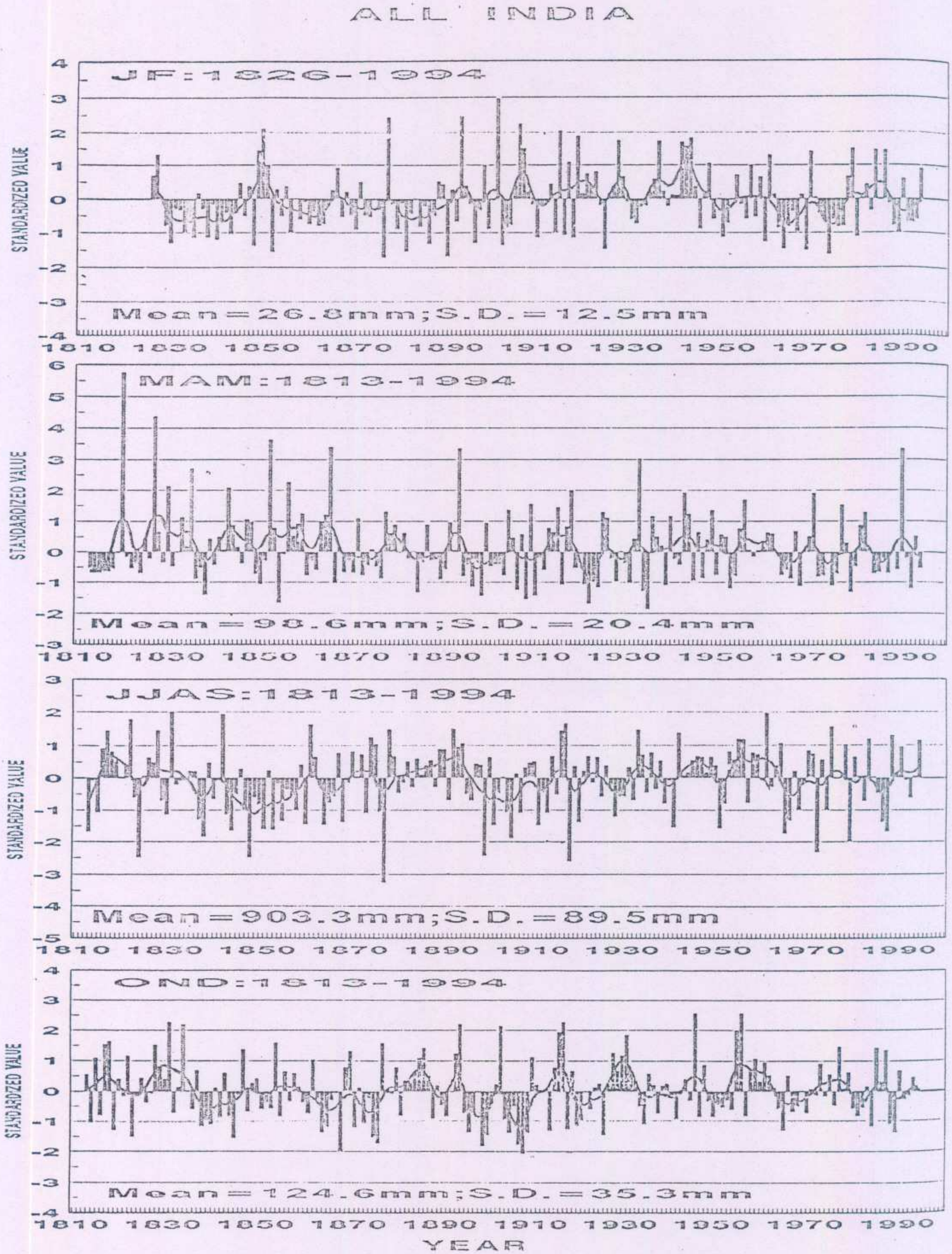

Figure 22. Plots of the reconstructed longest possible seasonal rainfall series of the whole country (India).

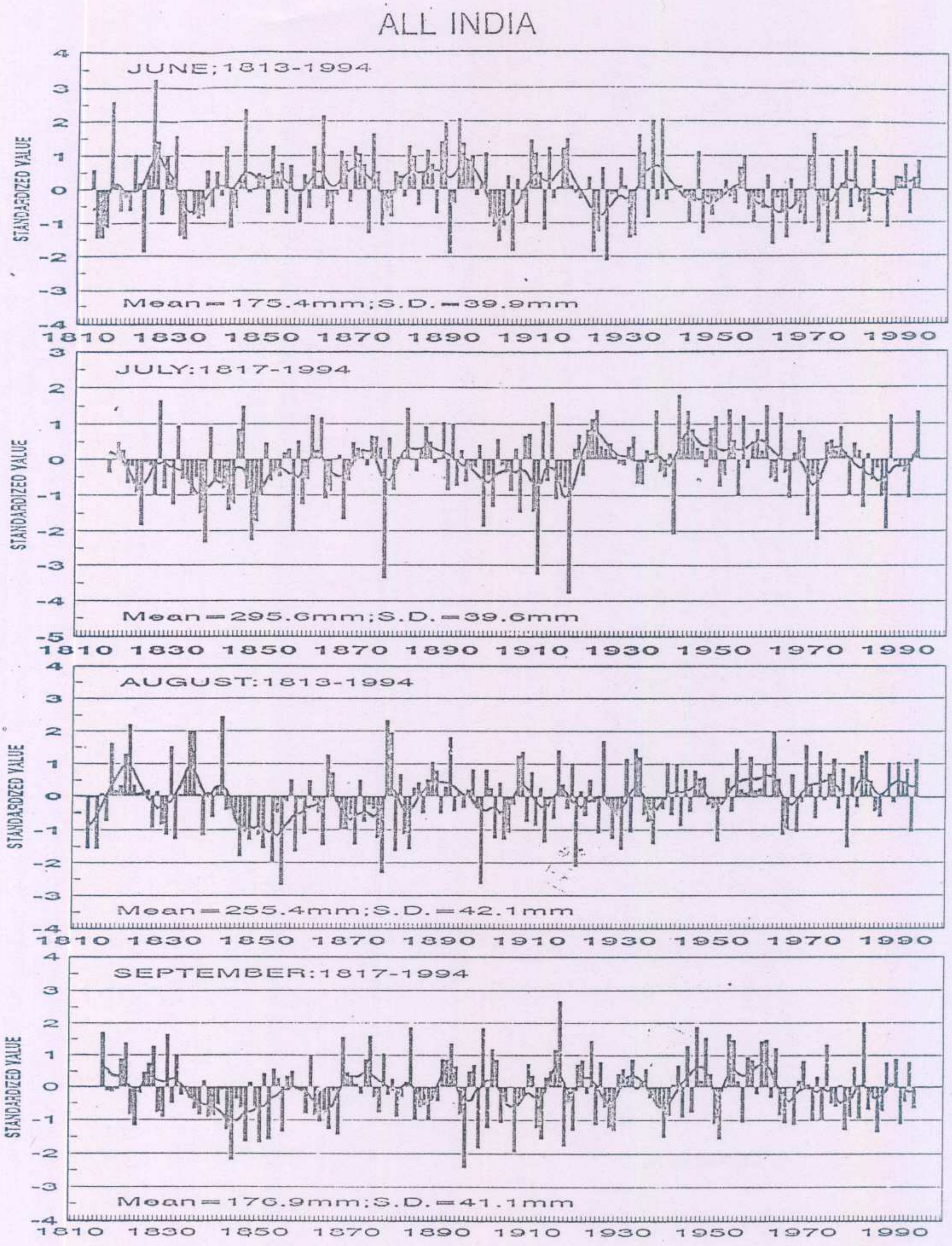

Figure 23. Plots of the reconstructed longest possible monsoon monthly rainfall series of the country (India) as one unit.