MONSOON SEASON RAIN PREDICTION FOR THE YEAR 2015 FOR TELANGANA, INDIA BASED ON TELANGANA'S HISTORICAL RAIN DATA

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ABSTRACT

In this work the prediction of rain is based on average of two methods. In these methods, historical rain data of Telangana between 1981 to 2012 are selected for projection. These methods take into account the trends in rain pattern also.

Among the results are the effects of El Nino and La Nina which for Telangana are not as significant as compared to higher frequencies on annual rainfall basis. The period of these combined effects (El Nino and La Nina) is 10.67 years. The average rainfall of Telangana is 27.559 inches. The normal range of rain varies between minus 19% of the mean to plus 0.19 % of the men value as per the Indian Meteorological Department (IMD).

The forecast is being made in November 2014 for the Year 2015 that the rain will be normal in the month of June whereas some excess rain will take place in later months as shown in tables here.

The advantage of this approach is that it gives farmers far more time than they get presently when preliminary predictions are announced by Indian Meteorological Department in April for each monsoon.

KEYWORDS: Monsoon rain prediction**,** annual rainfall**,** rainfall frequency spectrum, El Nino and La Nina influence on rainfall, drought and famine, crop failure

1. **RAIN AND AGRICULTURE**

India is primarily dependent on its agricultural output which constitutes its major fraction of GDP. Majority of Indians still live in villages where agriculture is their mainstay. The agriculture sector is highly dependent on rain which India gets from South –West monsoon rains (from the Arabian Sea) and from the Bay of Bengal. These rains occur during the months between June to September.

Higher energy costs such as Diesel fuel used in pumps - have added to the country's foreign exchange needs and India is highly deficient in energy sources. This requires that the information about the amount of rain to be expected in coming season be known as accurately as possible.

Another factor which is playing havoc in the rainfall is the global warming which has introduced increased uncertainty in preparing for planting crops. This planting period is very sensitive and critical otherwise the farmers would have to wait for another year where these people do not have alternate means to earn their living. Such crop failures lead to large scale migrations from the villages to cities where people can earn some money to survive. This migration causes increased load on city's services and it increases slum areas in the cities.

Vidarbha, Telangana, and Marathawada lie in the Central and Southern India as shown in Fig. 1 where its location is away from both the Western Ghats and the Eastern Ghats from where the monsoon approaches the Indian subcontinent. It rains heavily between the Ghats and the sea but these Ghats act as a barrier for smooth rainfall transition between the coast and inland. Therefore, a steep gradient in rainfall exists between the coasts and these three areas. To the south of Vidarbha is the Telangana region and on the southwest is the Marathwada region, and all of these regions suffer from droughts from time to time.

In history, Daulatabad near Aurangabad in Marathawada, starting in 1327, it famously remained the capital of Tughlaq dynasty, under Muhammad bin Tughluq (r. 1325-1351). He forcibly moved the entire population of Delhi here, for two years, before it was abandoned due to lack of water [6].

The news about farmers suicides is wide spread ; the author was drawn to such news and wanted to understand the problem closely [1-5]. Bihar is another region where droughts take place but not much news about suicides is published in the newspapers [7] .

2. **RAIN PREDICTION IN INDIA**

India's primary information about rain comes from India Meteorological Department (IMD) [8] . India has emphasized fair amount on research on rain predictions and many scientists are quite actively pursuing research in this respect. It is known that monsoon is predicted either by statistical models based on analysis of historical data to determine the relationship of Indian Summer Monsoon Rainfall (ISMR) , to a variety of atmospheric and oceanic variables over different parts of the world prior to the summer monsoon season, or by dynamical models based on the laws of physics [9,10]

Irrespective of methods used above, their validity over large tract of land area cannot be held as reliable because of their dependence merely on atmospheric and ocean parameters. The convective conditions over the land areas are entirely different. India is a vast country with widely different topography.

In view of the above argument, there is a need to have an alternate and reliable method of prediction for places like Vidarbha, Telangana etc because the agriculturists are mainly of lower income group and un-reliability of rainfall causes intense hardships to them. Not only this, the country as a whole is quite cautious about grain production and has been quite hesitant to sign agreement in the World Trade Organization (WTO) over the storage or having buffer grain stock.

The farmers need fair bit of advance information to plan for seeds, and other necessities like finance to negotiate from the banks or other lenders. The uncertainties in rain cause hardships even suicides amongst the farmers [1-5]. They borrow money at high interest rate and crop failure puts them in awkward position where they could lose their houses or other assets by defaulting on payments.

The crops can fail if (a) there is scanty rain in June or (b) the total rain is not sufficient in the rainy season between June to September. In other words, based on (a) timeliness of rain is also extremely important and is discussed in [7] .

3. **RAIN DATA AND ANALYSIS**

Figs. 2 to 5 show plots of yearly rains starting from 1981 to 2012 for the, months of June to September whereas Fig. 6 shows rains for all these months in combined form. This shows a slightly but not much increasing trend after regression analysis from year to year. This record (Fig. 6) has on an average or the mean value of 27.559 inches of rain. Indian Meteorological Department defines normal rain if the values lie between plus or minus 19% of the mean value. Although in absolute sense, this mean varies from region to region. One can clearly see that the plot has many ups and downs. However, low amount of rain causes drought conditions such as in 2009 in Fig. 6.

What is strange about Telangana's rain history is that the rain amount is very erratic – it has very wide swing from year to year which is very detrimental in crop planning.

The first important factor which ought to be emphasized is the timeliness of rain for planting crop as stated earlier [7]. If the rain is delayed too much then the hardship is going to be there. Fig. 2 shows the variation in rain in the month of June starting from the year 1981. It shows that there exists history of deficient rain i.e. rain below lower limit. The lower or upper limits are 19% of the mean value. In these years, the farmers have difficulties in planting the crop.

Fig. 3 also shows that in the past many years the rainfalls were deficient in July. Fig. 2 also shows deficient rains in many years- more than July months. The rains in Fig. 4 in August were below the lower limit much more than those in July. As far as the months of September (refer to Fig. 5) are concerned, the rains have been either above or near the upper limit or below or near the lower limit.

Fig. 5 shows rain in September and it also shows that the rains have been, of late, been quite frequently below the lower limit which were bad for agriculture. In this figure only, the results obtained by Maple software which computed the rain amount based on the frequency

and amplitude data in accordance with the Fourier series. The frequency and amplitude information was obtained using Fast Fourier Transforms (FFT) using Excel software. The results here show slightly different values from the actual rain data,

To get better insight into the total amount of rain over the years one can see Fig. 6.   The same data was analyzed in the frequency domain using Fast Fourier Transforms (FFT), and the results are shown in Fig. 7 [11,12]. It shows frequency numbers which are quite significant are 1, 3, 4, 6, 12, and 13. The number 3, points out the frequency corresponding to the El Nino or its counterpart La Nina effect which occur every 10.67 years. Remarkable fact is that numbers 12, and 13, which have much higher frequencies with greater amplitudes. This shows that the change in rain amount will be very rapid from year to year. This rapid fluctuation in the amount of rain throws off the planning for the crops

This rainfall data's statistical distribution was plotted and the result is shown in Fig. 8 which shows slight difference from a normal distribution curve especially at higher value of rain. This was further checked using chi squared test using software called MATLAB.

All figures – 3 to 7 show plots of the actual data and the results of FFT method i.e. after obtaining Fourier coefficients using FFT; the time dependent results were calculated using the Fourier series. It shows a very close match between the two (actual and its FFT model).

4. **RAINFALL PREDICTION**

It was not possible for the author to obtain data beyond 2012. For year 2013 onwards, the rain data were not posted on its (IMD's) web i.e. region by region data on IMD website.

India is a country which depends upon agriculture as one of its main component of the Gross Domestic Product (GDP). Therefore, the government ought to be current in providing information in the public domain for better productivity in the agriculture sector. The information should not be kept a secret but it should be widely available in the IMD's regional offices as well as state governments offices in full public view.

Similarly, IMD's monsoon predictions should be reliable - region by region. For example the farmers of these areas should know the amount of rainfall that is predicted for next year as

early as possible with sufficient lead time . This is for possible planning of the crops and the prediction should also be as accurate as possible. This is not the case presently unfortunately.

Table 1 shows the results for June for years 2013 onwards. Here the results of the Time Series method were arrived at using regression analysis where the monthly variations were averaged out over the span between 2001 to 2012. It showed ascending trend but yielded conservative results.

The prediction was based on weighted average ratio of 3:1 between the results obtained by FFT and Time Series methods. For example in Table 1 in the year 2013 , the value of 6.209990447as prediction was arrived at as (3 x6.94095+ 4.017111789) /4 .

The results show that in the month of June, it is projected as normal in the year 2013 but deficient in the other two projected years.

Table 2 shows that the rains are expected to be normal in these years in the month of July.

In the month of August (Table 3) , it would be deficient only in the year 2014 whereas in Table 4, it would be greater than the upper limit of the normal range in two of the three years.

The total rain values are shown in Table 5 which shows that if the total values are considered then it would be normal.

This clearly shows the fallacy in coming to the conclusion based on the total values because if the rain is deficient when the crops are planted in June, then farmers would lose their crop even if the deficient rain is made up in latter months.

6 CONCLUSIONS

In this work, at first a brief review of the drought or famine in Telangana area was carried out. It was found that Telangana has had severe drought conditions in the past.

The historical rain data showed that Telangana has had slight increasing trend in rainfall (Time Series method).

At first a suitable model was searched for and it was found necessary to analyze the possible causes of the rainfall variations by looking at the frequency spectrum. The identified frequencies included the El Nino and La Nina effects amongst the others. The dominant frequencies were 1, 3, 4, 6, 12 and 13 – of these the latter two are the higher frequencies. These higher frequencies give rise to rapid changes in rainfall about the mean value.

The rainfall predictions were made using Fourier series method and Time Series which uses Moving Average Method of rainfall and linear regression analysis. The weightage ratio of 3:1 between the two methods was selected because the FFT method fitted the actual rain data very well.

Based on this analysis, the prediction for the Year 2015 is that there will be excess rain in later months but normal in June.

5. **REFERENCES**

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TABLE 1 PREDICTED RESULT FOR THE MONTH OF JUNE FOR YEARS 2013 TO 2015

JUNE	2013	2014	2015
TIME SERIES	4.017111789	3.078702089	3.090573255
FFT	6.94095	4.70854	5.48427
PREDICTION	6.209990447	4.301080522	4.885845814
AVERAGE	4.753813976	4.753813976	4.753813976
LOWER	3.850589321	3.850589321	3.850589321
UPPER	5.657038632	5.657038632	5.657038632
CLASSIFICATION	EXCESS	NORMAL	NORMAL

TABLE 2 PREDICTED RESULTS FOR THE MONTHS OF JULY FOR YEARS 2013 TO 2015

JULY	2013	2014	2015
TIME SERIES	7.662202695	4.032649298	4.048186807
FFT	9.52652	11.9933	9.69945
PREDICTION	9.060440674	10.00313732	8.286634202
AVERAGE	8.348302165	8.348302165	8.348302165
LOWER	6.845607776	6.845607776	6.845607776
UPPER	9.934479577	9.934479577	9.934479577
CLASSIFICATION	NORMAL	EXCESS	NORMAL

TABLE 3 PREDICTED RESULTS FOR THE MONTHS OF

AUGUST FOR YEARS 2013 TO 2015

AUGUST	2013	2014	2015
TIME SERIES	8.065626435	8.096774724	8.127923012
FFT	8.28175	7.10807	15.0107
PREDICTION	8.227719109	7.355246181	13.29000575
AVERAGE	8.38238189	8.38238189	8.38238189
LOWER	6.789729331	6.789729331	6.789729331
UPPER	9.975034449	9.975034449	9.975034449
CLASSIFICATION	**NORMAL**	**NORMAL**	**EXCESS**

TABLE 4 PREDICTED RESULTS FOR THE MONTH OF SEPTEMBER FOR YEARS 2013 TO 2015

SEPTEMBER	2013	2014	2015
TIME SERIES	6.907936424	6.934593291	6.961250159
FFT	12.8709	6.05243	9.53124
PREDICTION	11.38015911	6.272970823	8.88874254
AVERAGE	6.07480315	6.07480315	6.07480315
LOWER	4.920590551	4.920590551	4.920590551
UPPER	7.229015748	7.229015748	7.229015748
CLASSIFICATION	**EXCESS**	**NORMAL**	**EXCESS**

**TABLE 5 PREDICTED RESULTS FOR THE MONTHS OF JUNE TO SEPTEMBER COMBINED FOR YEARS 2013 TO 2015**

JUNE-SEPT	2013	2014	2015
TIME SERIES	26.65287734	26.7558332	26.85878907
FFT	35.2823	29.4065	41.8856
PREDICTION	33.12494434	28.7438333	38.12889727
AVERAGE	27.55930118	27.55930118	27.55930118
LOWER	22.32303396	22.32303396	22.32303396
UPPER	32.79556841	32.79556841	32.79556841
CLASSIFICATION	EXCESS	NORMAL	EXCESS

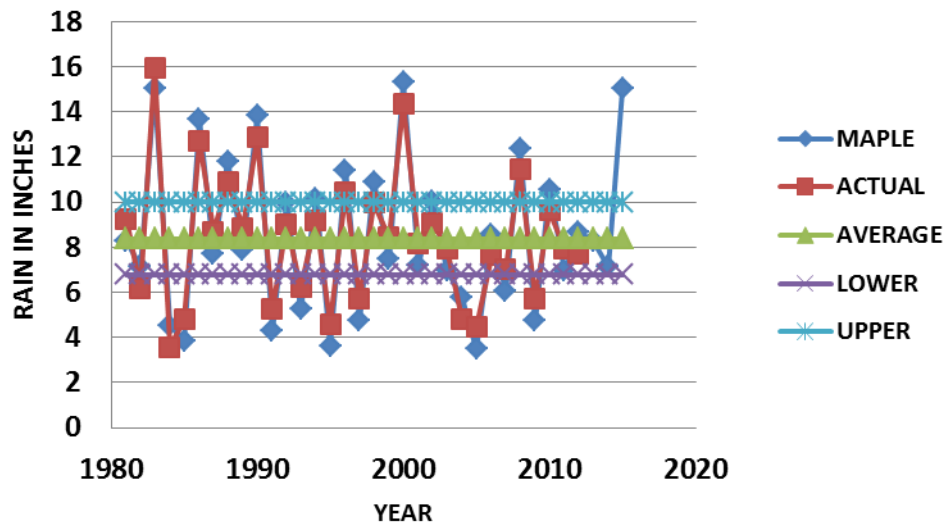**FIG. 1 LOCATIONS OF MARATHAWADA. VIDARBHA. AND TELANGANA BETWEEN WESTERN AND EASTERN GHATS**
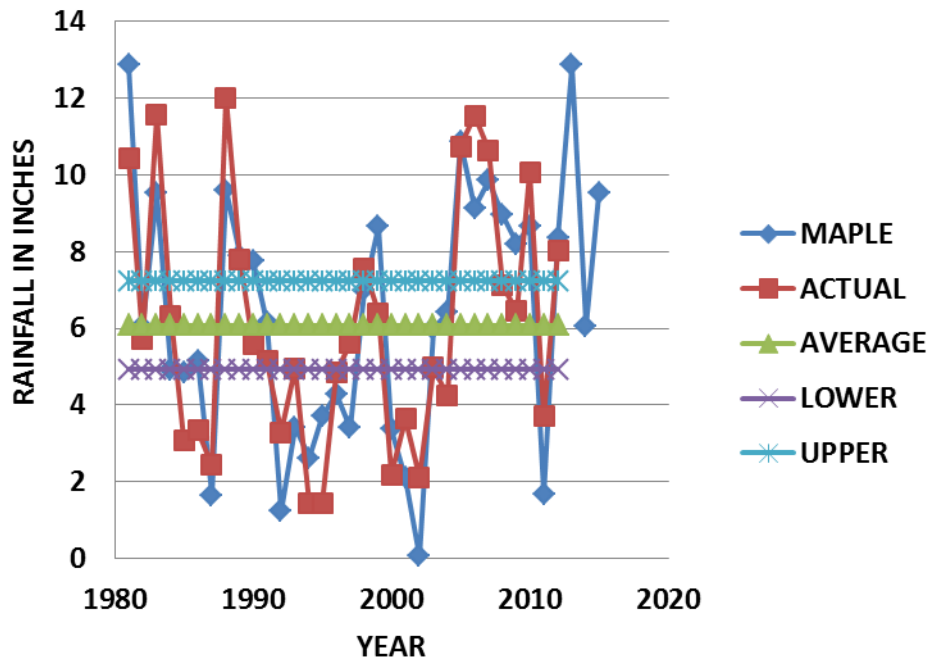
FIG. 2 RAINFALL IN JUNE IN TELANGANA
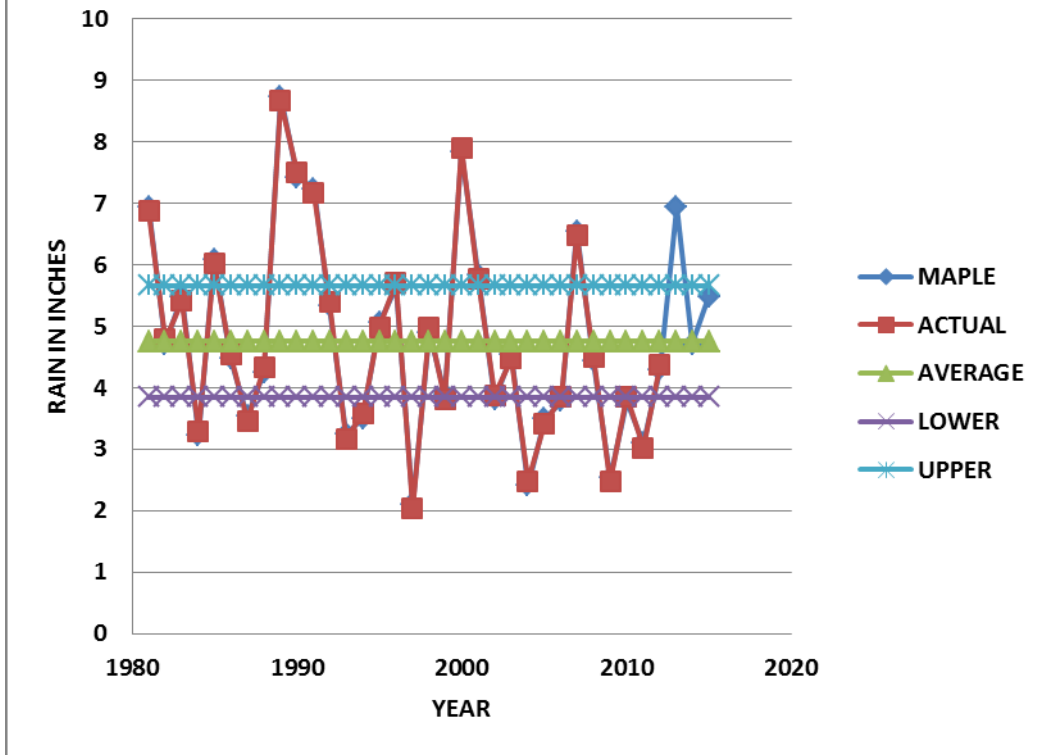
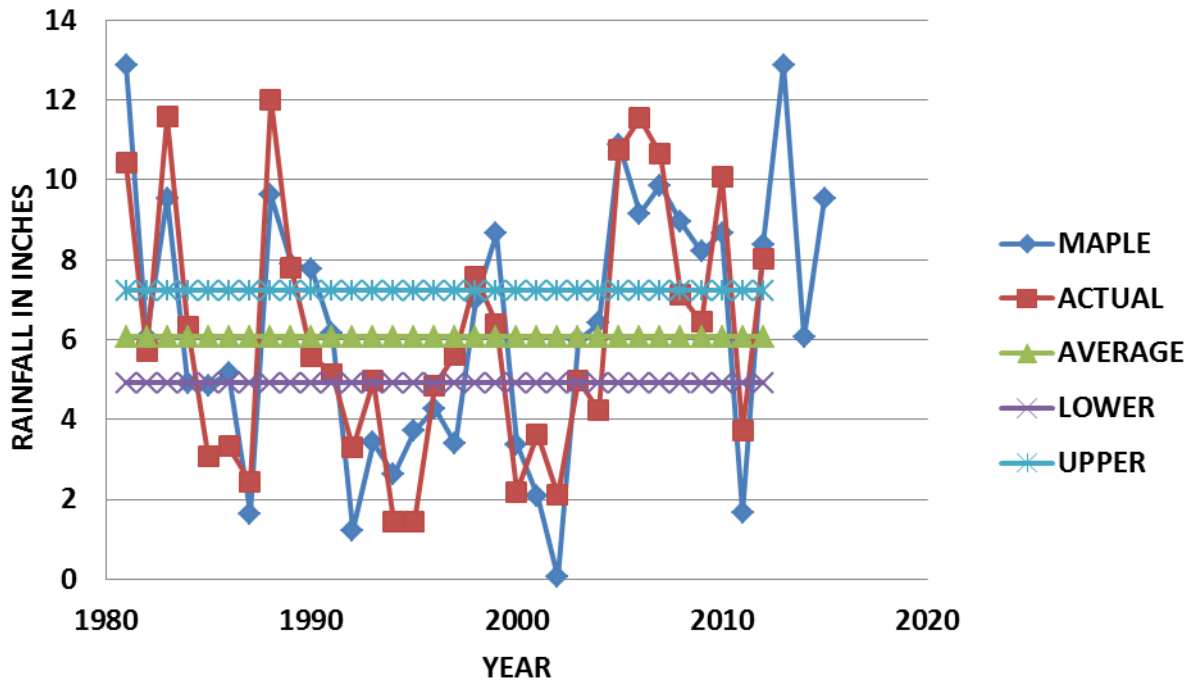FIG. 3 RAINFALL IN TELANGANA IN JULY

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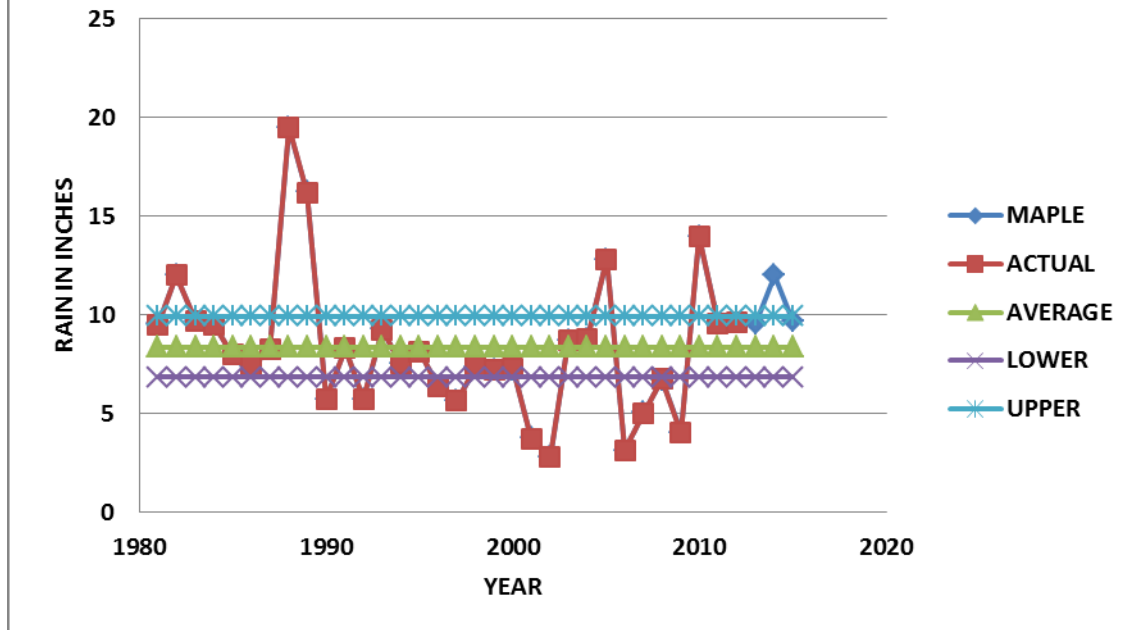
FIG. 4 RAIN IN AUGUST IN TELANGANA

FIG. 5 TAINFALL IN TELANGANA IN SEPTEMBER

FIG. 5 RAINFALL IN TELANGANA IN SEPTEMBER

FIG. 6 RAINFAL BETWEEN JUNE TO SEPTEMBER IN TELANGANA

FIG. 7 AMPLITUDE VERSUS FREQUENCY NUMBER

FIG. 8 PROBABILITY DENSITY FUNCTION OF TOTAL RAIN