# SEASONAL RELATION BETWEEN NORTH AMERICA, SOUTHERN MONSOON AND WINTER RAIN IN NORTH-WEST INDIA

By S. L. MALURKAR

(*Poona* 5)

THE south-west monsoon is dependent on the incursion of equatorial maritime air (Em) from the south. A series of low pressure area or 'pulses' moving westwards just south of the equator cross into the northern hemisphere and give rise to Em there.[1] These low pressure areas or 'pulses' could be traced to the high pressure area over South America[2] in southern winter. Climatic charts show that the winds in S.E. Pacific Ocean west of North Chile and of Peru are steady and moderate to strong during that period. If the northern or north-western portions of the high pressure area about this region are considered, the resulting wind stream would be easterly.

During the pre- and post-monsoon months in India, the northward passage of the 'pulses' is necessary for the formation and maintenance of tropical cyclonic storms or depressions.[3]

In southern summer, fresh 'pulses' from the north cross over to the southern hemisphere to form and maintain tropical cyclonic storms and depressions and help to intensify the seasonal low pressure area there. These 'pulses' can also be traced to the east of the place where they crossed over into the South Indian Ocean along the corridor of low pressure just north of the equator and south of the winter Asiatic high. The climatic charts show that the winds in the north tropical region of East Pacific (west of California and Mexico) are steady and moderate to strong due to the high pressure area over the United States of America and North Mexico in the northern winter. The arguments of advection of air from this region to the South Indian Ocean would be similar to that used for the Indian Monsoon and the time lag of 30 to 45 days would be equally applicable.[4] The 'pulse' that enters the South Indian Ocean would be one of the secondaries of the low pressure area originating from the southern or south-western portions of the North American high. The main factor that controls the monsoon in the South Indian Ocean with a positive relation should be the pressure of the south or south-western portions of the North American high a month or a month and a half before the epoch considered. The regions that can be expected to modify the passage of the 'pulse', once it has left North America, are :

(*a*) The low pressure area over the North Pacific Ocean should not be too marked or extend to too southerly latitudes.

(*b*) The winter high pressure area over Asia should not extend too far south in the pacific as then the 'pulse' would move into the S. Pacific.

(*c*) The seasonal high pressure area over the S. Pacific should be well developed and this prevents a premature crossing of the 'pulse' into the S. Pacific.

(*d*) The seasonal high pressure area over the western regions of Asia should be well developed to allow the 'pulse' to cross into the S. Indian Ocean.

(*e*) The seasonal low pressure area in the S. Indian Ocean must be normal in position and intensity.

(*f*) The general circulation (also wind speed) north of the equator must be adequate.

The time lag between these factors and the epoch of the southern monsoon decreases successively so that the time between the crossing of the equator by the 'pulse' and strengthening of the monsoon low in the south may be about three to four days.

The southern monsoon low pressure stretches over the South Indian Ocean and a foreshadowing of the seasonal weather there has not a great practical value and would not be quite exciting as in the case of the Indian monsoon which affects a considerable portion of the world population.

An indirect effect of the southern monsoon over N.W. India is important from the point of view of wheat crop there. The winter rain over N.W. India is due to 'western disturbances' which are often diffuse secondaries of extra-tropical depressions moving from west to east. The rainfall and movement of these diffuse and complex low pressure areas become clear if they are separated out into successive secondaries all of which move (with varying speeds) in an east-north-easterly direction.[5] In the absence of tropical cyclonic storms or depressions south of the equator, the western disturbances give a good distribution of rain in N.W. India, occasionally reminding one of a 'monsoon day'. If there be a tropical cyclonic storm or a depression south of the equator (but not too far south) in the Indian Ocean, the lower secondaries of the western disturbances are either not formed or at best ill-defined over N.W. India and produce scanty rain.[6] The winter rain in N.W. India should be negatively indicated with the monsoon in S. Indian Ocean and hence negatively correlated with the North American pressure with the necessary time lag. This was an important point that could be checked.

To get as representative a value of the pressure as possible over the high pressure area of the south and west high of the U.S.A., the mean pressure of four stations was taken: Portland (Oregon), St. Louis (Mis.), Galveston (Texas) and San Diego (Cal.), for the period 1876-1930. The pressure for October and November was correlated with rain over N.W. in the succeeding January to March period (the rain in December is small). The value of

**C.C. of North America South and Western portions (Oct.+Nov.) Pressure to N.W. India rain in succeeding Jan. to March was —0.38, the Probable error being 0·09.**

The other important question that arises is the relation between the north-east portion and the winter high over America and the Indian weather. This portion would give rise to westerly winds. It is well known that this region is the starting point of the Atlantic depressions that affect the temperate latitudes, or the extra-tropical depressions one of whose successive secondaries affect India in the winter. A high pressure area over the north-east portion of the high over N. America in winter should help in the formation of extra-tropical depressions and hence in the formation of secondaries that affect India. Other things being equal more secondaries would mean more rain in N.W. India. Hence the rain in N.W. India should be positively correlated with the pressure in the north-east portion of the winter high over N. America. As the speed of the westerlies in temperate latitudes is much greater than the easterlies in the equatorial latitudes. the time lag between N. America and N.W. India would be about 15-20 days only. Hence the contemporary correlation coefficient would have to be tried if a period of about three months is taken for rain. The stations that were chosen to represent pressure were Chicago, Albany (N.Y.) and Washington.

**C.C. of North America (N.E. Portion) Jan. to March pressure to contemporary rain in N.W. India was 0.194 for the same number of years (1876-1930). This is significant to 80% level.**

(The correlation coefficients were calculated by Mr. K. S. Ramamurthy for me.)

It is interesting to notice the behaviour of different portions of the North American winter high towards rain in N.W. India. If the North American high pressure area remained abnormally high throughout the southern winter, it follows that due to the souhern and western portions of it, the winter rain in N.W. India should be defective and due to the influence of the north-east portion of the high pressure the rain in N.W. India should be abundant. Different portions of the same high pressure area exercise opposing influences. In other words, the high pressre area acts as a sort of balancing factor to N.W. India rain. The passage of western disturbances from west to east would pull the 'pulses' or low pressure areas travelling in lower latitudes and may occasionally prevent their crossing of the equator and may create a "break" in the monsoon in the southern hemisphere. Or the high pressure area may also act to a certain extent as a balancing factor for the southern monsoon also.

It appears probable that even for the Indian monsoon, one portion of the southern high near S. America may give rise to 'pulses' moving westwards and ultimately producing the S.W. monsoon in India. A more southerly portion of the high may give rise to extra-tropical depressions, which travel in the southern hemisphere from west to east, may pull down the monsoon pulses and create a "break" in the Indian monsoon.

The high pressure belts away from the equator on either side of it seem to act as stabilising factors on the weather on the two sides of the equator, one being more prominent in northern summer and the other in southern summer.

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1. *Forecasting Weather in and Near India*. S. L. Malurkar. Printed limited number in May 1941, pp. 34. 2. *Ibid.*, 119. 3. *Ibid.*, p. 87. 4. *Ibid.*, p. 120, *et seq.* 5. *Ibid.*, p. 101. 6. *Ibid.*, p. 105.

## RAINIEST SPOT IN THE WORLD

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It was surprising to observe that even the standard books on climatology gave varying data about the rainiest place in the world. H. F. Blanford in his book on *The Climates and Weather of India, Ceylon and Burma*[1] (p. 73), has given the average monthly and total annual rainfall of Cherrapunji as follows:—

W. G. Kendrew in his book on *The Climate of the Continents*[2] (p. 55), has stated that "the west side of Kamerun Peak has 412 inches *per annum* near sea-level, the second highest record in the world, surpassed only at Cherrapunji (India) which has 458 inches", while on p. 131 of the same book 428 inches is given as the annual mean rainfall for Cherrapunji.

| Elevation in feet | Jan. | Feb. | March | April | May | June | July | Aug. | Sep. | Oct. | Nov | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4,455 | 0·6 | 2·6 | 9·0 | 29·6 | 50·0 | 110·0 | 120·5 | 78·9 | 57·1 | 13·6 | 1·8 | 0·3 | 474·0 |

The monthly average of rainy days on p. 74 is given below:—

| Jan. | Feb. | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 4 | 10 | 20 | 25 | 26 | 29 | 28 | 24 | 12 | 3 | 1 | 184 |