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A brief report of a discussion on "Western Disturbances" held at New Delhi

At the suggestion of the Chairman of the Atmospheric Research Committee a discussion on "Western Disturbances and Indian Weather" was arranged in the Meteorological Office, Lodi Road, New Delhi, on Saturday the 8th October 1955. The following 7 papers were tabled for discussion:

(1) "The study of the variation of ozone content in the upper atmosphere over India in relation to Western Disturbances"

(2) "Studies in Western Disturbances and Cold Waves" by L. A. Ramdas, S. P. Venkiteshwaran, S. Yegnanarayanan, V. Venkateswarlu and K. Sethumadhavan

(3) "General Survey of the present position regarding Western Disturbances and Indian Weather" by B. N. Desai and P. R. Pisharoty

(4) "A study of Western Disturbances and 'breaks' in the S.W. Monsoon (1934-1940)" by S. B. Kulkarni

(5) "Have Western Disturbances any influence on the weather over North-east India in the monsoon months?" by K. C. Chakravortty and S. C. Basu

(6) "Western Disturbances and thunderstorm rain over Gangetic West Bengal in the years of 1949 and 1955" by R. C. Bhattacharjee

(7) "Western Disturbances and Indian Weather" by D. A. Mooley

Shri S. Basu, Director General of Observatories, opening the meeting, referred to the western disturbances as constituting one of the major weather phenomena in the meteorology of India and to the appropriateness of having a general discussion on the subject on an occasion when a number of meteorologists happened to assemble at Delhi in connection with the other meetings. He then invited Prof. K. R. Ramanathan to take the Chair.

Prof. Ramanathan in his introductory remarks stressed the part played by western disturbances in shaping the winter weather over northern India and said that a more systematic study of these disturbances should be undertaken. He then invited the authors to present the papers and each paper was followed by a short discussion.

Paper No. 1

Prof. Ramanathan introduced the first paper describing the results of recent studies in progress at the Physical Research Laboratory, Ahmedabad, regarding day to day variation in the ozone content of the higher levels of the atmosphere and its relation to western disturbances. The following interesting features were explained with the help of diagrams and charts:

(i) Day to day variation of ozone content has a larger dispersion in the lower levels of the atmosphere than at higher levels,

(ii) the 300-mb level appears to be the most suitable level for studying ozone content variation in the atmosphere,

(iii) there is a significant seasonal variation in the ozone content of the upper atmosphere (300-mb level). Three distinct types (*viz.*, summer, monsoon and winter) can be seen in the variation of ozone content as we go from south to north across the latitudes,

(iv) during winter, there is a sharp rise in the ozone content of the upper atmosphere between Ahmedabad and Delhi as we go from south to north,

(v) day to day variation of the ozone in the upper atmosphere during winter over northern India seems to be associated with passage of western disturbances; and

(vi) a day's lag in the variation of the ozone content was observable between Quetta and New Delhi on plotting day to day values for the two stations.

These studies are based on data collected during 1952-53 and Prof. Ramanathan said that the studies are being continued with further data that had accummulated since then.

DISCUSSION

S. P. VENKITESHWARAN suggested that the larger dispersion of ozone observed in the lower levels of the atmosphere may be due to the effect of Himalayan mountain ranges.

K. R. RAMANATHAN: We cannot say so definitely. It requires more observations.

A. K. ROY wished to know whether the difference of one day in the occurrence of peaks in ozone contents of Quetta and Delhi has any forecasting value.

S. MULL observed that the one day peak difference between Quetta and Delhi is not seen in all cases. There are some cases of disagreement also.

K. R. RAMANATHAN replying to these points said that the studies are in progress and attempts have to be made to reconcile the disagreements in the peak values and that it has not been possible to determine the time sequence of ozone changes definitely. But the indications are that the time sequences are not related to the physical transport of air at those levels. The question is being further looked into.

Paper No. 2

Dr. L. A. Ramdas presented a statistical study of the number of western disturbances which affected northern India during the period of 50 years and showed that how the graph of the number of western disturbances, as counted from the records, showed an increasing trend. He explained that the introduction of upper air observations in 1920 might have resulted in ability to locate more such disturbances from upper air circulation than in the period before. A similar graph of the eastern depressions did not reveal any such trend. The monthly series of western disturbances from November—April have also been studied separately and it was found that the number of western disturbances during November-December together was correlated with the number of disturbances during the second part of the season *i.e.* January-April, thereby indicating that there was a seasonal characteristic in regard to the sequence of western disturbances. There was, however, no correlation between the number of western disturbances and the series of eastern depressions in the same year.

Day to day sequence of vertical cross-section showing graphically the temperature, wind, humidity etc at Delhi and Jodhpur have been drawn to study the variations in the meteorological elements associated with the passage of western disturbances for a period of 12 years. This study is still in progress.

DISCUSSION

K. R. RAMANATHAN: I would like to know how the western disturbances were counted in these investigations. Were any criteria used for counting a particular phenomena as a western disturbance?

B. N. DESAI: Counting of western disturbances as given in the Monthly Weather Reports is not quite dependable.

A. K. ROY: The counting of western disturbances as described in the paper appears to be very subjective. The counting has to be done on a more objective basis before we can accept any indication from the series of such numbers.

S. BASU: I associate myself with the remarks of the earlier speakers that the counting has been subject to serious limitations. The numbers as reported in the Monthly Weather Reports are subject to personal equations as no specific criteria were laid for ensuring the identification of the passage of western disturbances. It is necessary to make a recount of these numbers after fixing such criteria. We may have to accept the findings shown by Dr. Ramdas with this reservation.

V. SATAKOPAN: Although the part played by subjectivity in counting of western disturbances is very important in accepting other conclusions of this paper, the high inter-correlation between the number of western disturbances during the earlier and later periods of the same season is not so much vitiated by this limitation, as the personal equations may be assumed to have remained the same within each season.

L. A. RAMDAS replying to the points said that although a first count of the disturbances was made, as reported in the Monthly Weather Reports, the working weather charts have also been looked into and counts verified. The study is still in progress and points raised in this discussion will be kept in mind when finalising the paper. He also added that the precipitation caused by western disturbances has also been correlated with other factors in the investigation which is under progress.

K. R. RAMANATHAN winding up the discussion on this paper said that our meteorology having been mostly developed from the observed phenomena such as rainfall etc backwards to the causes of the phenomena, building up theories regarding synoptic meteorology based on objective criteria is a difficult problem. It is hoped that this will be overcome as we proceed further in our studies.

Paper No. 3

Dr. B. N. Desai introduced the paper on the "General survey of the present position regarding western disturbances and Indian Weather". The paper gave a brief summary of the current ideas of the synoptic meteorologists regarding western disturbances. The following were some of the important features:

(i) During the early part of the southwest monsoon period the tracks followed by these westerly waves have a bearing on the retardation, acceleration or the extension of the monsoon into Uttar Pradesh and the Punjab (India).

(ii) during the monsoon period the appearance of these westerly waves cause some heavy rains in the Punjab-Kumaon hills,

(iii) the appearance of these disturbances during the middle of the monsoon period is closely associated with the "break" conditions of monsoon and heavy rains along the Himalayan range.

(iv) towards the end of monsoon period the recurvature of the monsoon depression towards the Himalayas and the possible withdrawal of the monsoon appear to be associated with a more southerly track of some of the western disturbances, and

(v) the westerly waves also appear to have a significant influence in the formation, intensification and recurvature of the post-monsoon storms of the Indian area.

DISCUSSION

P. R. KRISHNA RAO: It is desirable also to study the effect of the passage of the western disturbances on the jet streams over northern India in winter.

S. K. DAS: There is a mention in the paper of the co-existence of the S.W. and N.E. Monsoons in September. Is this possible?

K. PARTHASARATHY: There is a mention that the advance of the monsoon on the west coast depends on the westerly waves. I feel that the advance of the monsoon is more governed by conditions in the equatorial regions than those further north. I would also like to know on what criteria have the presence of westerly waves been fixed.

A. K. ROY: We should arrange for similar discussion on N.E. monsoon also to clarify our ideas about the same.

S. L. MALURKAR: The effect of westerly waves on the track of monsoon depression such as recurvature etc mentioned in this paper have been pointed out by me long ago in my memoirs. At that time it was not accepted by Dr. Desai and others.

B. N. DESAI: Regarding Mr. Das's query, I would say that in the paper it was mentioned that the pressure patterns or oscillations similar to those that prevail during the two monsoons some time show themselves simultaneously in their respective areas in transitional months. This does not mean that the weather conditions associated with the two monsoons simultaneously exist. As regards the

points raised by Mr. Parthasarathy the study has been made with the help of the daily synoptic charts by experienced forcasters. No criterion has been fixed to determine the presence or absence of westerly waves but we do not expect that there will be a large variation in the judgement of synoptic meteorologists in this matter and I trust that I will be able to satisfy any body by going through the charts with them regarding the presence or absence of westerly waves. Moreover, the study presented in the paper is only a collection of current working ideas and some of them may have to be confirmed by detailed investigations and objective analyses in due course.

Papers No. 4, 5 and 6

Dr. B. N. Desai introduced the fourth paper on "A study of Western Disturbances and 'breaks' in the S.W. monsoon (1934—1940)". A summary of the paper is given below:—

> The periods of 'breaks' in the S.W. monsoon in July and August which occurred during the seven year period 1934-1940 were studied to find out whether they were related to westerly waves moving eastwards across the Himalayas, as far as these waves could be judged by the 24-hr pressure falls and changes in upper winds. The study indicates that the break conditions were generally preceded by at least *two* westerly waves in rapid succession, whose progressive eastward movement along the Himalayas could be traced on the daily charts. The maintenance of the break conditions needed the continuance of such waves. The break conditions ceased and the axis of the monsoon trough shifted southwards to its normal position soon after a low pressure area from the east arrived over the head of the Bay of Bengal and simultaneously the westerly waves disappeared from the Indian area. Apparently this is associated with the re-establishment of an east-west ridge of high pressure over West China and Tibet.

Mr. S. K. Das then introduced the next two papers (i) " Have Western Disturbances any influence on the weather over Northeast India in the monsoon months?" and (ii) "Western disturbances and thunderstorm rain over Gangetic West Bengal in the years of 1949 and 1955". Summaries of these two papers are given below:

(i) The analysis reveals that although few western disturbances pass across the extreme north of India during this season, instances are available in which these disturbances are responsible for the following significant weather conditions over Northeast India during the period June to September (a) Increased rainfall in the sub-montane districts of Bihar, West Bengal and Assam and a corresponding decrease to the south of these areas, (b) Retarding the progress of southwest monsoon and occurrence of abnormally high temperatures in some areas and (c) Development of conditions unfavourable for the formation of monsoon depressions in the North Bay.

(ii) It is well known that thunderstorm squalls that occur in Gangetic West Bengal in the months of April and May are generally associated with the movement of western disturbances. A vivid contrast was noticed between the thunderstorm activity that occurred in Gangetic West Bengal in the months of April and May in 1949 and that in the corresponding months of the year 1955. An attempt has been made in this note to find out the synoptic conditions that brought about this contrast.

DISCUSSION ON PAPERS (4), (5) *and* (6)

There was a short discussion on these papers during which S. L. MALURKAR stated his view that the phenomena discussed in these papers in association with western disturbances are more in the nature of contemporary variation of weather and it is not perhaps possible to locate any cause and effect of relationship.

L. A. RAMDAS said that it would be better to call these western disturbances as "western depressions".

Paper No. 7

Dr. R. Ananthakrishnan then introduced the paper on "Western disturbances and Indian Weather". A summary of this paper is given below:

> The origin, nature and direction of movement of western disturbances are explained. The activity of disturbances in the various months and over the different parts of India is considered. The weather phenomena associated with western disturbances and the damage caused by them are also considered. The aspects which have been discussed in some detail with suitable instance are:—(i) Widespread and locally heavy rain/snow, (ii) Incidence of cold waves, (iii) Secondaries and the upper air anticyclonic circulation over the central parts of the country and adjoining part of the peninsula during the months from January to April, (iv) Lack of activity of western disturbances and spell of warm weather in winter months, and, (v) The role of western disturbances during the monsoon season.

There was no discussion on this paper.

Concluding of the Session

Prof. Ramanathan winding up the discussion remarked that when he was in Europe earlier this year people were saying that this was an exceptionally dry year for them although the sequence of the weather situations were quite normal. It would appear, therefore, that the sequences of weather situations are more or less similar to ours. He remembered that in 1954, Europe had an exceptionally wet year. It may be worthwhile to study these two seasons alone and compare seasonal features in Europe and elsewhere to see whether the contrast in the two seasons are reflected in another place or country. He added that he hoped there will be more of such discussions in future focussing attention on current problems in Indian Meteorology.

In concluding the proceedings, Shri S. Basu said that he hoped to be able to publish a report of this discussion in the Indian Journal of Meteorology and Geophysics and also such of the full papers as might be presented in suitable form

The meeting ended with a vote of thanks to the Chairman.