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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-4-3. Time Variation of Cosmic Ray Intensity from North and South Directions at Low Latitudes

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Following the interesting results which emerged from a study by Rao and Sarabhai[1,2] of the time variations of cosmic ray muon intensity for East and West directions at Ahmedabad (Long. 75°E, Geomag. lat. 14°N, sea level), we have conducted an investigation, with the same apparatus, of variations of South and North intensities. We present here some preliminary results of data obtained during 1959 and 1960 with telescopes of semi-angle $20\times45°$ inclined at 45° to the zenith.

§1. The average daily variation for South and North.

In Fig. 1 we show the mean daily variation for South and for North for 93 days of operation during 1959, for 169 days of operation during 1960 and for the combined period of 252 days during 1959-1960. The average daily variation has been corrected for the

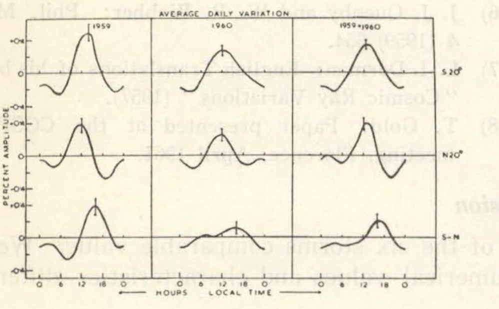

Fig. 1.

daily variation of atmospheric pressure and of temperature in the atmosphere at different levels. For the latter, the procedure described by Rao and Sarabhai[1] has been adopted. The daily variation for (S-N), being the difference of the average daily variations for South and North directions, is also shown in the figure. It would be observed that during each year individually and for the combined period, the average daily variation for South is consistently greater than the average daily variation for North. This is more pronounced in 1959 than in 1960. The times of maxima of the variations for South and North are not very different, and in consequence the average (S-N) daily variation is approximately similar in form to the average daily variation in either direction.

§2. The distribution of (S-N) bihourly intensity at 8 and 16 hours on individual days.

The average (S-N) variation has a minimum at 8 hours and a maximum at 16 hours. In order to test whether the (S-N) difference that is observed in the average daily variation is present on a statistically significant basis for changes occurring at the particular hours on individual days, we have considered the per cent bihourly deviations for North and South directions for 8 hours and 16 hours. In Fig. 2 we show the histograms of (S-N) bihourly intensities at 8 and 16 hours. The histograms at the two hours have been compared with each other for 1959 and 1960 and for the combined period 1959-1960. Applying the χ^2 test to the histograms, we have verified that the histogram for (S-N) intensity at 8 hours is different from the histogram at

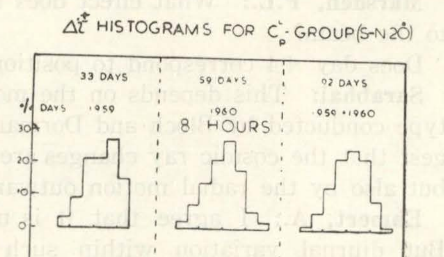

Fig. 2.

16 hours for the combined period of 1959-1960 at a 5% level of significance. During 1959, the level of significance is even higher, but the histograms are not significantly different during 1960.

Since Rao and Sarabhai have shown that the daily variation can be attributed to an anisotropy of primary radiation on days of low or moderate geomagnetic disturbance indicated by a value of $C_p<1$, we have conducted the analysis for days which are not geomagnetically disturbed. We find that during 1959 as well as 1960, the histograms at the two hours are different at a 5% level of significance. We thus conclude that the features seen in the average daily variation, indicative of the daily variation for South being larger than the daily variation for the North, are present on individual days, particularly those which are not geomagnetically disturbed.

§ 3. The (S-N) daily variation on individual days.

We have conducted harmonic analysis of daily variation for South and for North on each individual day and vectorically determined the characteristics of the harmonic component of the (S-N) variation. We show in Fig. 3 the histograms of the diurnal amplitude r_1(S-N) and its time of maximum

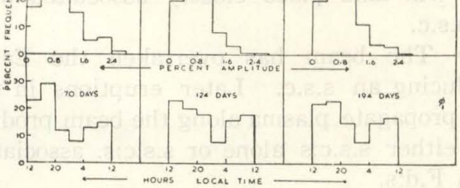

Fig. 3.

ϕ_1(S-N), the latter for those days on which the amplitude r_1(S-N) is greater than the standard error of 0.6%. The histograms show that in 1959 and in 1960 there are large numbers of days on which the daily variations for South and North are significantly different. Moreover, the (S-N) variation has a time of maximum for the diurnal component which is not randomly scattered. The ϕ_1(S-N) histograms for 1959, 1960 and for 1959-1960 have been statistically tested for lack of randomness and at a better than 5% level significance the preponderance for the occurrence of (S-N) maximum at 16 hours is established in each case. Thus the study made on the basis of individual days confirm the existence of significant difference between South and North daily variations which was seen in the average daily variation.

§ 4. Discussion.

By consideration of the geomagnetic drift for primary particles responsible for intensity for South and North telescopes, we find that at Ahmedabad, South looks almost along the plane of the ecliptic while North looks at a region of the celestial sphere with declination greater than 30°. Thus, a comparison of daily variation for South and North on individual days when the daily variation can be associated with an anisotropy of primary rays helps us to study change of strength of source of daily variation with declination. The smaller amplitude for North compared to South is in agreement with conclusions in this regard from a comparison of the global distribution of the amplitude of the daily variation made by Dorman[3] and others.

Work is in progress to study the solar and terrestrial relationships of days when the daily variation for South has a large amplitude and the daily variation for North is in one case similar to South and in another case dissimilar to it, *i.e.* r_1(S-N) is large or small simultaneously with r_1(S) being large. We are also examining the data to look for evidence for change in the orientation of the trapped magnetic field in solar streams according to the suggestion of Dorman[3].

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References

1) V. A. Sarabhai, S. P. Duggal, U. R. Rao, H. Razdan, T. S. G. Sastry and R. Palmeira: Proc. IUPAP Moscow Conf. **4** (1959) 231.
2) V. A. Sarabhai and U. R. Rao: Sent for publication in Proc. Roy. Soc. (1961).
3) L. I. Dorman: Cosmic ray variations published by State Publishing House, Moscow. (1957).

Discussion

Parsons, N. R.: Are the asymptotic longitudes scanned by N and S telescopes approximately the same?

Sarabhai, V.A.: This is nearly so at the latitude of Ahmedabad. For the diurnal component the difference in time of maximum due to this would be insignificant.

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-4-4. An Attempt of Analyzing Cosmic Ray Storms

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It is being shown that a beam model can explain the sequences of Forbush decreases and storm sudden commencements characteristic of cosmic ray storms. It also explains why there does not exist regular 27-day period in the appearance of cosmic ray storms associated with the return of active regions.

According to Steljes *et al.*[1] the unusual series of events in November 1960 are to be ascribed to one and the same plasma beam covering a considerable part of the Earth's orbit.

Apart from a plasma beam serving as a carrier of a flow of cosmic ray particles emitted from the sun it modulates the normal cosmic radiation by decreasing the intensity, *i.e.* creating a C.R.S. It has been shown that only 45–50 per cent of all observed s.s.c:s appear to be associated with an F.d. On the other hand very few F.d : s have been observed which were not accompanied by an s.s.c. The same beam being responsible for both phenomena it appears as if the plasma has to have special characteristics to be able to generate a C.R.S.

Maintaining the picture introduced by Steljes *et al.* an F.d. might be due to a new burst of plasma travelling along a beam already enveloping the Earth. It is also possible that the beam overtakes the Earth. If it is already filled with plasma having the characteristics necessary for the production of an F.d., a C.R.S. will develop. In both cases an s.s.c. also takes place, associated with the F.d. However, if in the latter case the latter case the beam does not contain any plasma, able to produce an F.d. there can still be an s.s.c. An F.d. will not appear until a new eruption on the sun propagates plasma of the right kind along the beam. The events can be classified as follows:

A) A beam, lacking the properties to produce a C.R.S. is overtaking the Earth. An s.s.c. will take place but no F.d.

B) The beam has also the properties necessary for the production of a C.R.S. An F.d. will take place closely associated with an s.s.c.

C) The beam has overtaken the Earth producing an s.s.c. Later eruptions in the sun propagate plasma along the beam producing either s.s.c:s alone or s.s.c:s. associated with F.d:s.

In the first two cases the time interval between the events on the sun and the correlated s.s.c. or F.d. will vary within wide limits. As concerns the third case observations show that there is a considerable variation as to the time interval between the full development of a C.R.S. and the s.s.c.[2].

Usually an F.d. appearing during the later stages of a C.R.S. is insignificant as compared to the initial one[3]. As the initial F.d. results from the removal of C.R. particles the later plasma stream cannot give rise to an