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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-4-10. Cosmic Ray Modulation and Geomagnetism

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Years ago we published a paper[1] showing that a severe magnetic storm in July 1946 produced a Forbush decrease, the recovery phase of which exhibited a remarkable correlation between the depression of the horizontal magnetic force at equatorial stations (known as ring current field) and the depression of cosmic ray intensity. Both recovered with a time constant of 2.5 days and the regression was -17.8γ in magnetic horizontal force per -1% in cosmic ray meson intensity at Manchester. This storm was not followed by another throughout the full recovery time. At that time this result looked like favouring the idea that ring currents round the earth have to do with modulation of cosmic ray intensity. Meanwhile it was shown[2),3),4)] that this modulation is quite the same far outside the earth's magnetic field and that it can be described in all its consequences by the variation of a single parameter with time[2)] (only the relatively small diurnal variations are of other nature).

This parameter has the dimension of an electric tension of the earth against the far space whence cosmic rays come. The corresponding electrically acting field acts round the sun and equipotential surfaces (=surfaces of constant cosmic ray intensity) are pulled outwards by solar wind and especially by solar plasma beams, that cause more local deformations and bring the earth into zones of higher decelerating potential. In this picture the correlation of cosmic rays depression with the ringcurrent field means that both are controlled by the solar wind and certain differences are expected with respect of the narrower local excitement of ringcurrents and the presumably much wider influence of solar beams on cosmic rays.

Fig. 2 shows by the thick line the variation of cosmic rays at Weissenau over two years in terms of percent variation and of decelerating potential of the earth. The thin line shows the magnetic horizontal force at Huancayo[5)] in the night hours round midnight, that means 0.00 till 5.00 GMT. after a correction that is given by the difference of the thin dashed line and the thin dashed-pointed line. Both scales are in a ratio corresponding to that in Fig. 1. This upper dashed line tries to give a smooth variation corrected for the individual Forbush decreases. These have in mean a recovery going exponentially with time like the less steep recovery curve drawn at the left side of

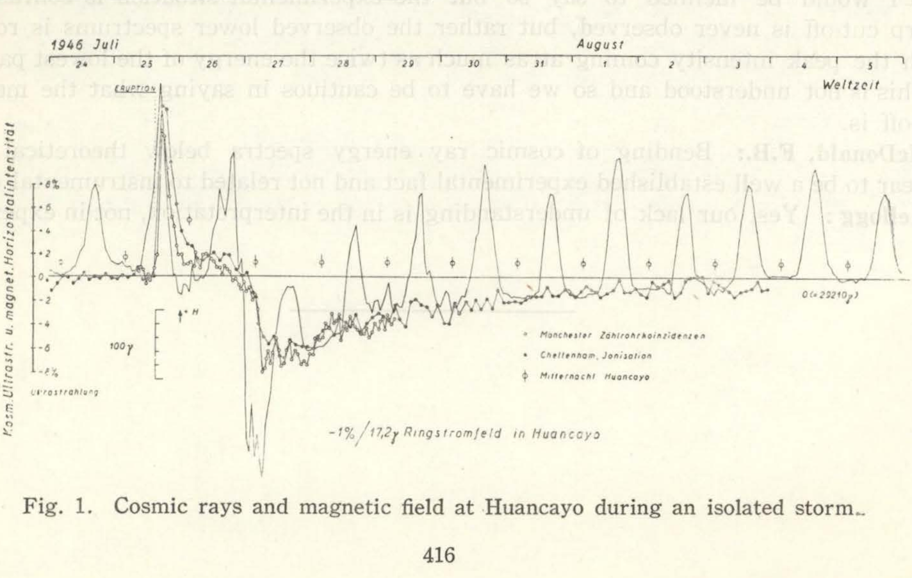

Fig. 1. Cosmic rays and magnetic field at Huancayo during an isolated storm.

Fig. 2, in so far as no further storm disturbes the recovery. By applying this curve to the variations a number of single points of the dashed line are found.

The same procedure by applying the steeper recovery curve as drawn left side in Fig. 2 to the magnetic data drawn without correction (not drawn in Fig. 2), one gets the dashed-pointed line. Fig. 3 repeats these two lines for the variations corrected for the individual storms and shows the difference that exhibits a semi-annual wave that obviously belongs to a component of the magnetic field variation that does not influence cosmic rays. The maximum field depressions occur during the equinoxes when the sun is in the zenith of the station at noon. This is reasonable enough to assume that indeed the other component in the smooth variation of the magnetic field continues to have a strong correlation with cosmic rays respective with the decelerating potential of the earth.

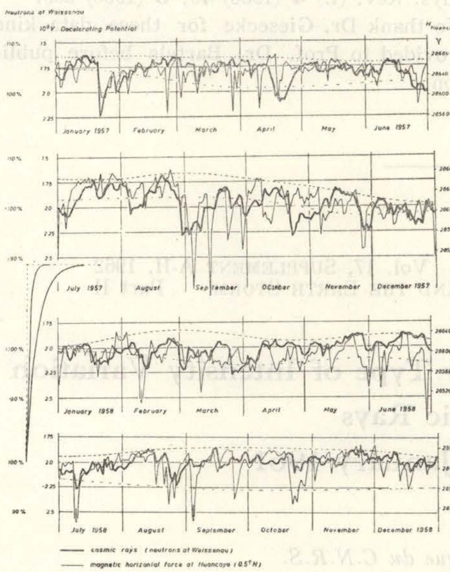

Fig. 2. Cosmic ray intensity at Weissenau and magnetic field at Huancayo.

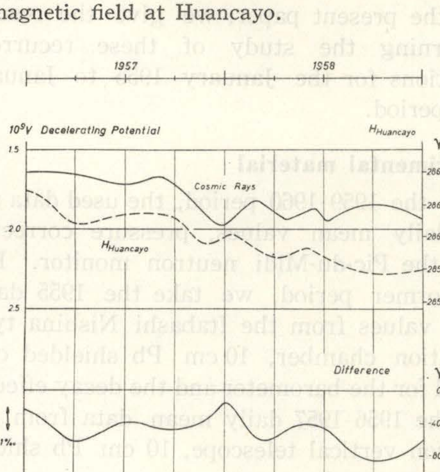

Fig. 3. The difference of cosmic rays and magnetic field exhibits a semi-annual variation with $\pm 30\gamma$ amplitude.

We corrected now the magnetic data by this difference in Fig. 3 and these corrected data are drawn in Fig. 2 as thin line to have a better comparison for studying the storm variations themselves. It is evident that:

1. there exist extreme strong ringcurrent fields of short duration with only very weak influence on cosmic rays, especially if the preceding storm has not yet recovered. (24.2.57; 10.4.57; 12.9.57; 10.3.58; 4.9.58; 13.5.58; 6.6.58; 24.9.58.) In these cases a beam touched the earth and excited a ringcurrent, but modulation of cosmic rays was exhausted in before. These real ringcurrents themselves do not influence cosmic rays markedly.

2. Modulation can precede the formation of ringcurrents (14.-18.4.57; 22.-25.7.57) as modulating beams pass at first aside the earth. This confirms the wider modulating range of these beams.

3. Field generations without modulation effect at all (14.4.58; 12.5.58; 25.5.58; 19.6.58) or field generation preceding the modulation (20.10.58; 2.11.58). In most of these cases the magnetic recovery is as slow as in general for cosmic rays. This may indicate another mechanism in producing these field variations.

The decelerating potential varied from 1 GV in 1954 to 2.7 GV in July 1959. For the horizontal component of H at Huancayo a variation results from 28400γ at maximum activity to 28820γ at minimum activity. If we assume that even at sunspot minimum a deceleration exists as is indicated by the spectra of cosmic rays[2] and if we further assume that the same regression holds within this region, we find for Huancayo an extrapolated earth magnetic horizontal force of 29000γ. The actual depression reached in this cycle at least 500γ, that are 5% of the extrapolated value for totally quiet sun.

In any case we see from this analysis

that the general ringcurrent field contains at least three components of different nature: One caused by actual ringcurrents set up by the storms, one by the interference of the solar plasma flow with the earth's magnetic field in a larger scale and a semi-annual wave of the last one by the varying angle of attack of this flow against the earth's dipole axis. On behalf of the isotropy of cosmic rays this wave is only seen in magnetic on the earth and not in cosmic rays. Its mean amplitude of -40γ indicates that the pure earth magnetic field is at Huancayo close to the value of 29000γ extrapolated above and that the assumptions for this extrapolation are widely correct. This value itself may underly final corrections not yet known at the moment as we used preliminary magnetic data just to show the method, that must be extended to much longer periods regarding secular variations.

References

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5) We thank Dr. Giesecke for these data kindly provided to Prof. Dr. Bartels before publication.

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-4-11. Phases Changes in the 27 Day Type of Intensity Variation of Primary Cosmic Rays from January 1955 to January 1961

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It is well known that 27 day recurrent variation of cosmic-ray presents long periods of stability in correlation with long life high activity regions of the sun, these variations mainly providing from modulation effects of solar plasmas on the cosmic-ray galactic flux.

In previous works[1)2)3)] these variations have been studied during the last solar activity maximum, from the October 1956 to December 1958 data of two neutron monitors located at Pic-du-Midi, France and Port-aux-Francais, Kerguélen Island. During the whole period of observations a constant period of 27.40±0.06 day was found for the cosmic-ray variation and a corresponding constancy for the integral distribution of ≥ 2+ solar flares (Carrington coordinates) was put into evidence[4)].

In the present paper, we give the results concerning the study of these recurrent variations for the January 1955 to January 1961 period.

Experimental material

For the 1959–1960 period, the used data are the daily mean values, pressure corrected from the Pic-du-Midi neutron monitor. For the former period, we take the 1955 daily mean values from the Itabashi Nishina type ionization chamber, 10 cm Pb shielded corrected for the barometer and the decay effects, and the 1956–1957 daily mean data from the Mawson vertical telescope, 10 cm Pb shielded, uncorrected.

Computation method

The used method has been formerly de-