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HIGH ALTITUDE OBSERVATORY

Solar Research Memorandum No. 25

From: Jean-Claude Pecker and Walter Orr Roberts

Subject: The Role of Active Solar Regions in the Formation of Magnetic Storms

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This memorandum consists of a note on work in progress at High Altitude Observatory which will be submitted as a note to Comptes Rendus in the near future. The research reported in this document has been sponsored in part by the Geophysics Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract AF 19(604)-969.

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1. Numerous researches have brought out evidence for the solar origin of magnetic storms, suggesting particularly that they are due to corpuscular streams emitted from the sun in regions well removed from active centers. The active regions have corresponded to a small diminution of the corpuscular energy. Approximately three days after the CMP of such regions there is a diminution of this corpuscular radiation.

In order to study more precisely these phenomena, we have chosen the period July 1952 - July 1953 when solar activity was very low. The utilized material includes: (1) measures of the green coronal line made at Climax, (2) values of K_p, and (3) the internationally calm (Q) and perturbed (D) days.

2. In order to study the distribution of magnetically quiet or disturbed periods with respect to the time of CMP of an active coronal region, two diagrams have been worked out. On the first, dealing with the corona (Figure 1a) we represent the probability for a quiet day or a disturbed day that it will be found N days after or before CMP of an active zone in terms of strong coronal emission-line maxima (this number has been divided by the probability that any day will find itself at N days from an active coronal region, which we call, hereafter a C-region. The curve is reasonably symmetrical around + 2.5 days, confirming the 3-day lag between CMP and the magnetic effect. The curve presents at the same location 2.5 days after CMP, a maximum for the days Q, a minimum for the days D.

The second diagram (Fibure 1b) represents K_p as a function of the number of days separating the chosen day from the nearest active region (taking account of the roughly 3-day lag). The curve confirms the results of Figure 1a. Moreover we note that the curve is roughly symmetrical its minimum out to an interval of ± 3 days but that it is irregular at greater distances from the minimum.

3. The two curves of Figure 1 seem to indicate a slight simultaneous diminution of both the number of quiet and disturbed days (i.e. days with extremes in K_p) at about four or five days away from the active zone. In order to look at this effect more precisely we have tabulated for each pair of successive active coronal regions of opposed polarity the value of K_p as a function of $\theta = (t - t_1/t_2 - t_1)$, t_1 and t_2 being the days of passage across the central meridian of the two C-regions. The result, shown in Figure 2, is rather surprising: K_p is approximately constant (slightly lower in the vicinity of each C-region, as we have seen); but on the contrary the dispersion of the results varies by a large amount as a function of θ and goes through a minimum at $\theta = 0.5$, and for $\theta = 0$ and $\theta = 1$, as shown in the 2 R_p curve of Figure 2. Figure 2 was made after assuming a three-day lag between the active region and the terrestrial effect.

4. The following interpretation is perhaps suggested: an active coronal region does not affect the production of active corpuscles on the surface of the sun, but it tends to guide the particles into certain directions. Thus it diminishes the corpuscular density in the direction of the axis of the active zones. These therefore tend to be calm. On the other hand the large diversity of the active regions shows up a little distance away from the axial zone by a large dispersion in the values of K_p. Far away from these zones the values of K_p return to the mean values of ordinary K_p days. (Figure 3). These ideas have to be confirmed by measurements dealing with other periods, as will be reported in greater detail elsewhere.

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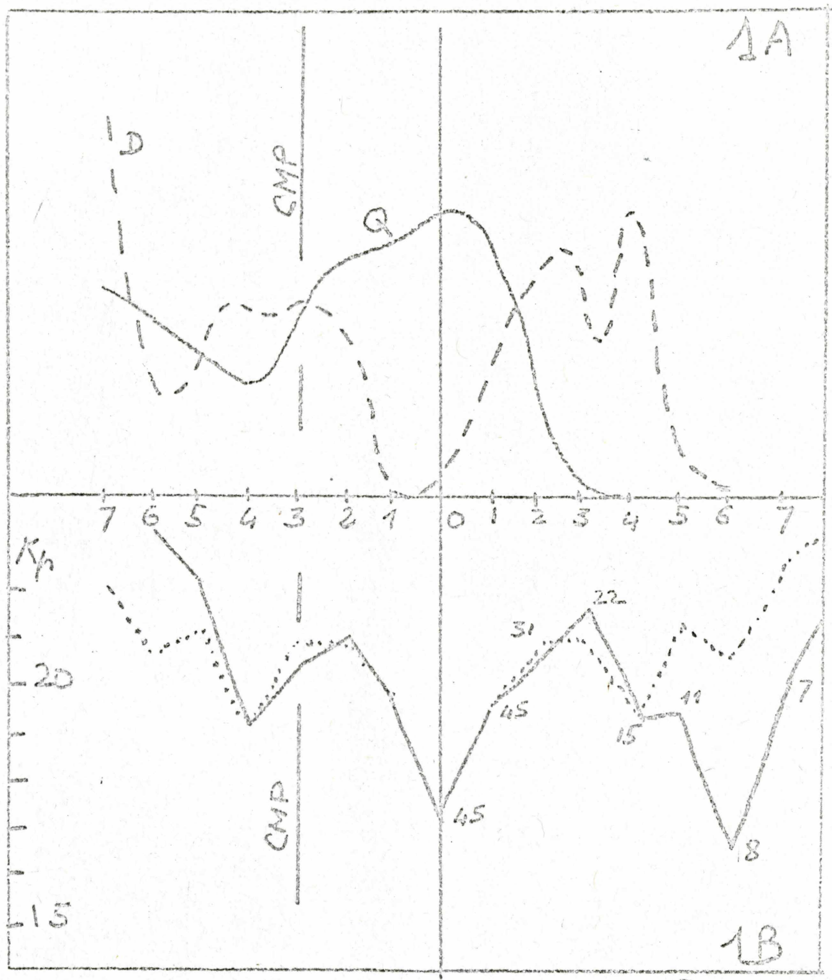

Figure 1

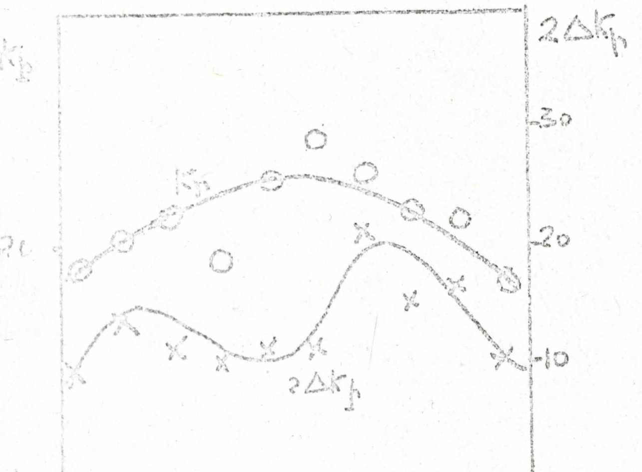

Figure 2

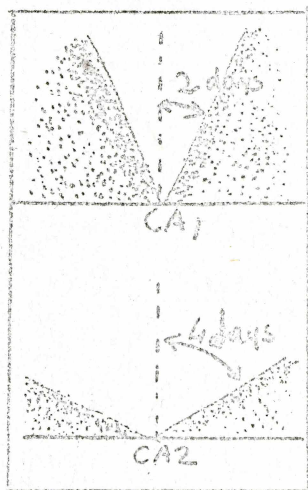

Figure 3

In Figure 1b, the dotted curve represents the mean of K_p before and after the minimum. Numbers correspond to the number of values used to compute each point. Additional information in text.