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FORECASTS OF SOLAR AND GEOMAGNETIC ACTIVITY

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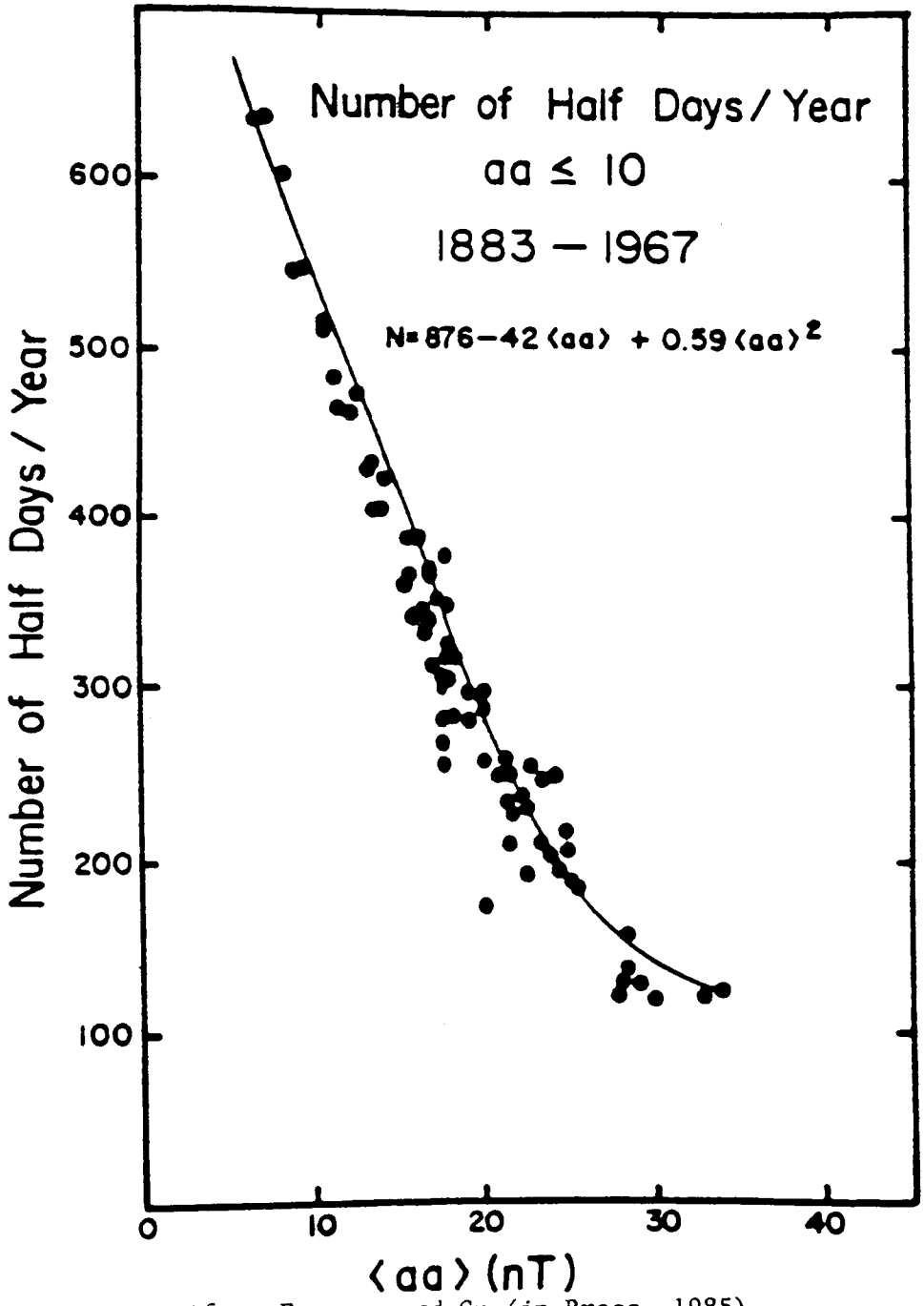
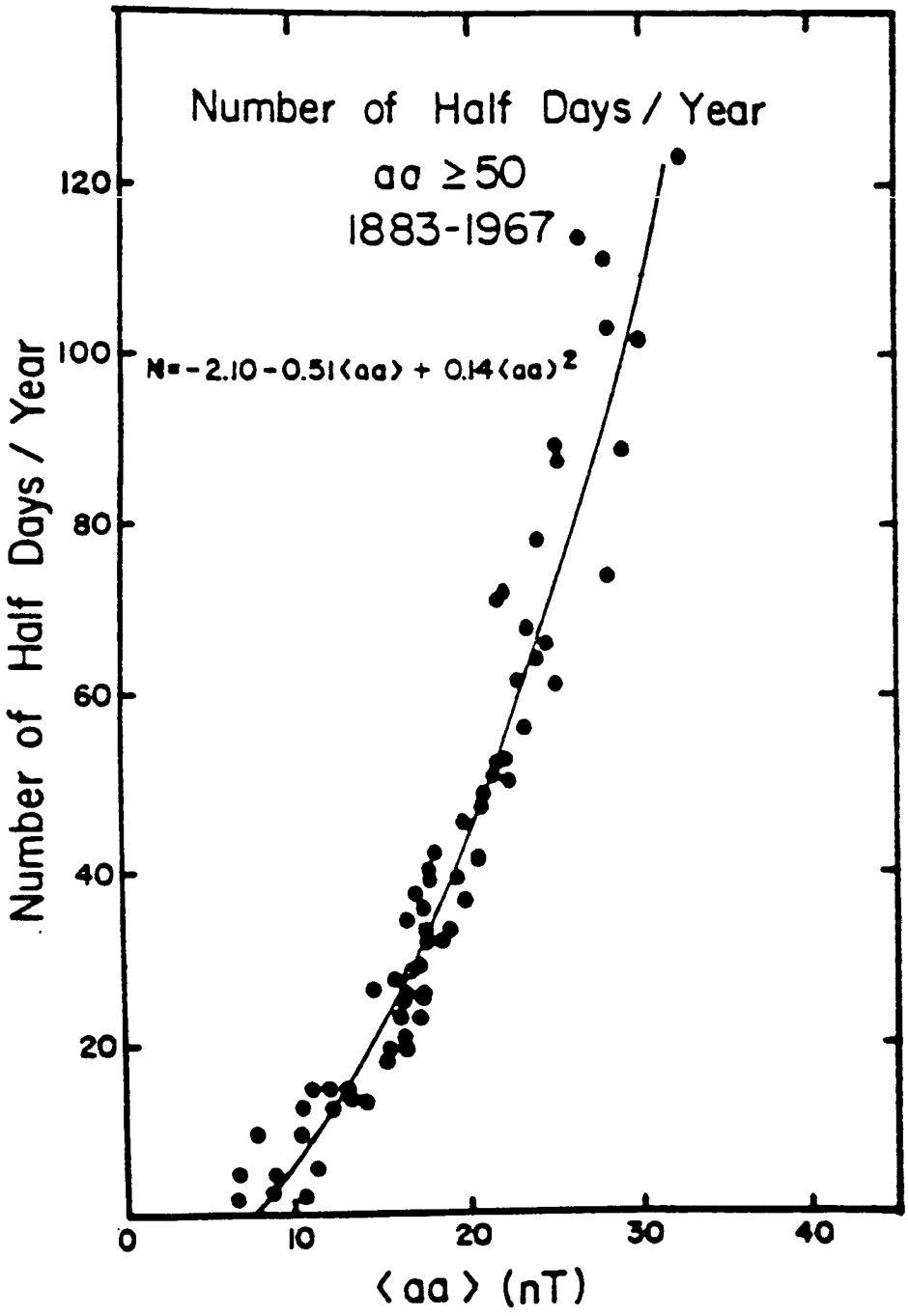
Forecasts of solar and geomagnetic activity are critical since these quantities are such important inputs to the thermospheric density models. At the moment, a key question is "When will the next solar maximum be, and how large will it be?" At this time in the history of solar science there is no way to make such a forecast from first principles. Physical theory applied to the sun is developing rapidly, but is still primitive. Techniques used for forecasting depend upon the observations over about 130 years, which is only twelve solar cycles. (The solar sunspot cycle period is about eleven years, but shows considerable variability. The number of cases available for study is too small for a reliable statistical analysis.) It has been noted that even-numbered cycles systematically tend to be smaller than the odd-numbered ones by about 20 percent. Another observation (Sargent) is that for the last 12 cycle pairs, an even-numbered sunspot cycle looks rather like the next odd-numbered cycle, but with the top cut off. These observations are examples of approximate periodicities that forecasters try to use to achieve some insight into the nature of an upcoming cycle. Another new and useful forecasting aid is a correlation that has been noted between geomagnetic indices and the size of the next solar cycle.

Geomagnetic activity tends to correlate with solar activity. There appears to be an 88 year periodicity (the Gleissberg Cycle). Other quasi-periodicities can be partially accounted for by noting that during even cycles, high aa is primarily due to coronal holes, while during odd cycles it is due to solar flare activity. Based on these and similar considerations, in the mid 1990's we expect that aa<10 70-145 days per year (quiet), 10<aa<50 22-55 days/year with K's 5 or greater. As a function of season of the year, on the average there is more geomagnetic activity during the equinoxes than during the solstices.

Now to forecasts: We think that it is very unlikely that the next solar minimum will occur before June, 1986. Our best guess is July, 1987. We are unwilling to say when the next maximum will occur, but the best estimate for the time of the next maximum would probably be July of 1991. The next solar maximum looks like around 150 for F10.7.



After Feynman and Gu (in Press, 1985)



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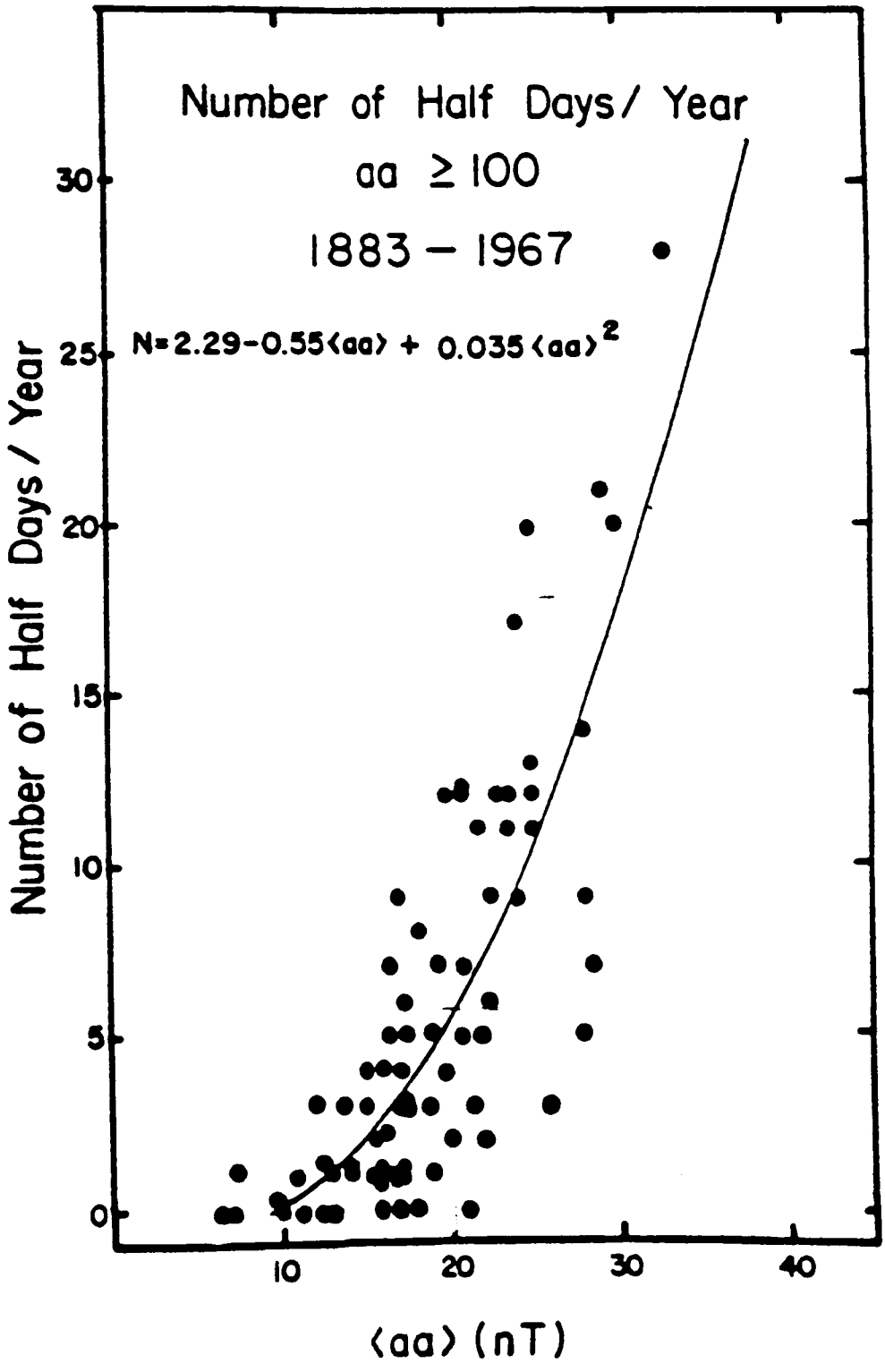

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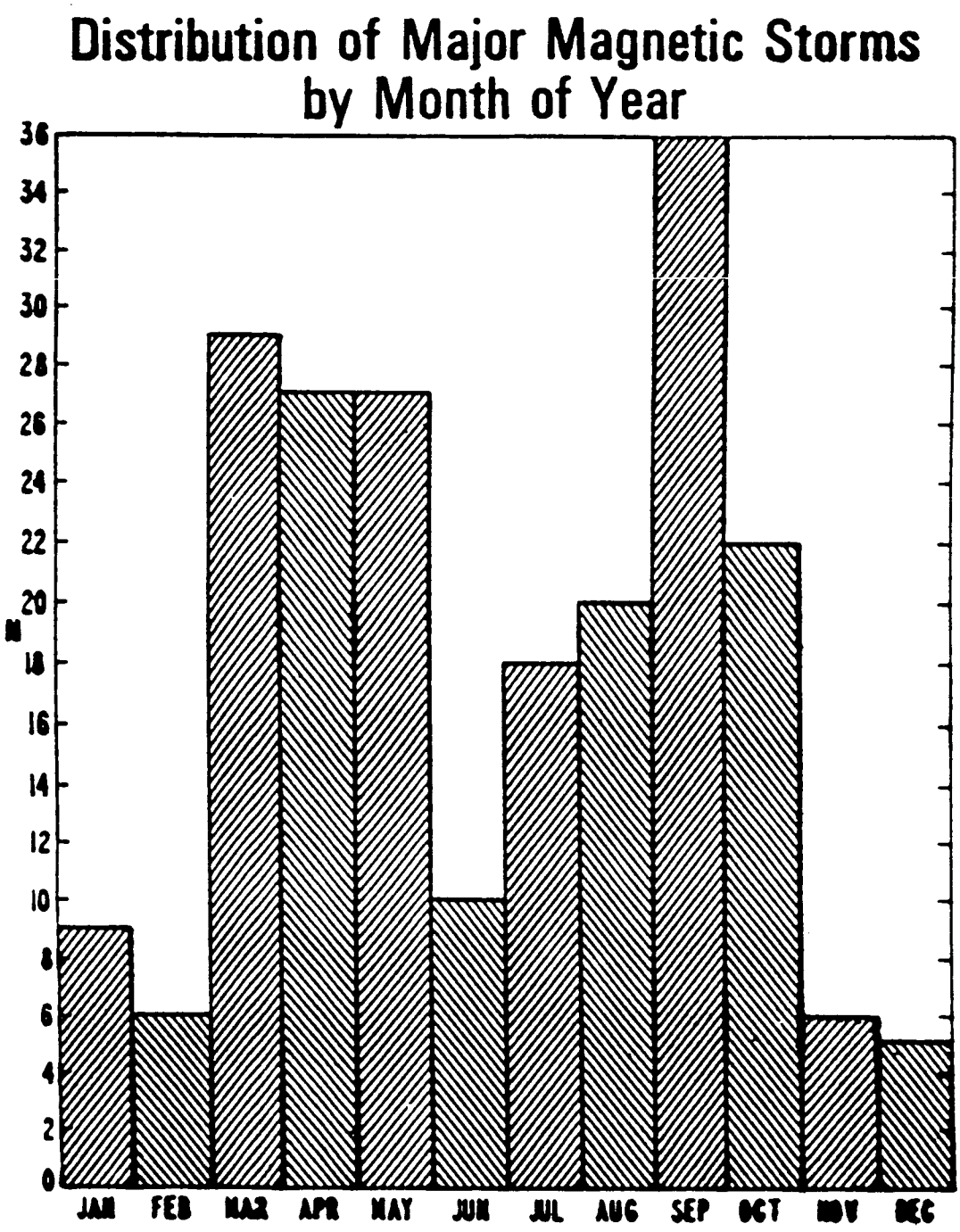

28. Seasonal variation in cumulative number of truly large storms, 1932-1980. (Allen, 1982)

(JGR, 1982)

Feynman: Geomagnetic and Solar Wind Cycles, 1900-1975

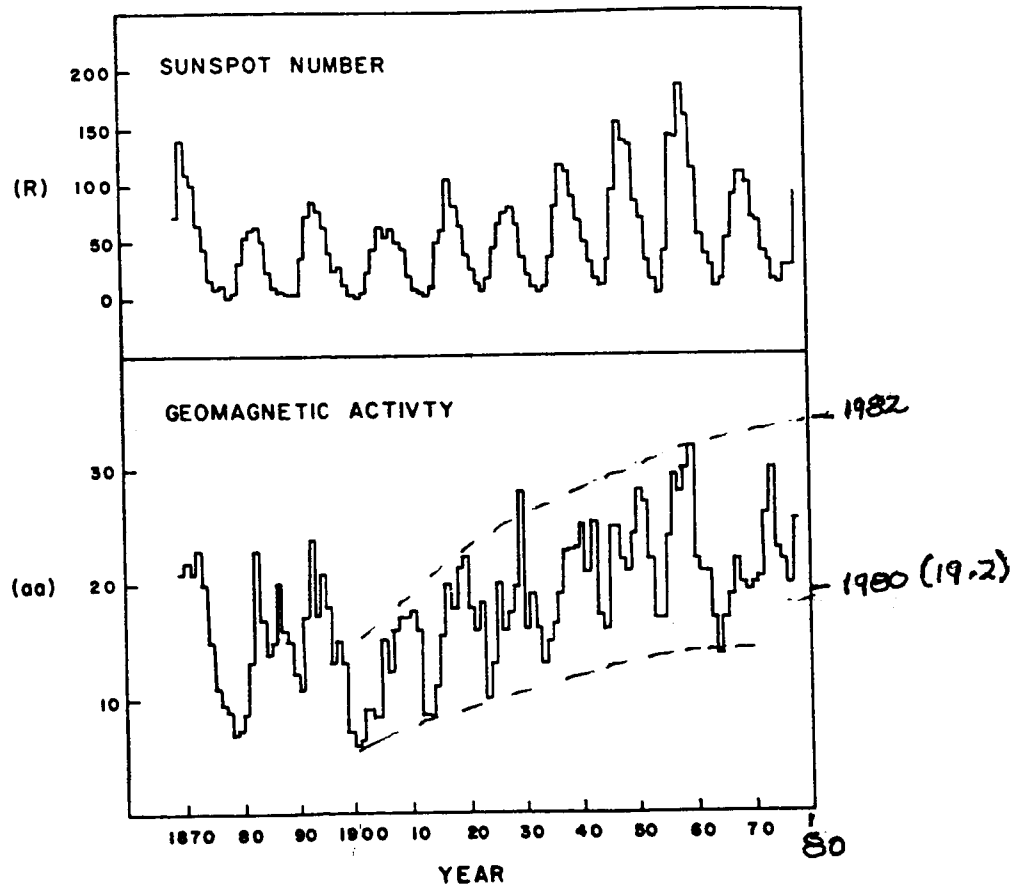

Fig. 1. The annual number, R and the annual average aa index, (aa), from 1868 to 1975. (aa) is measured in units of nanoteslas.

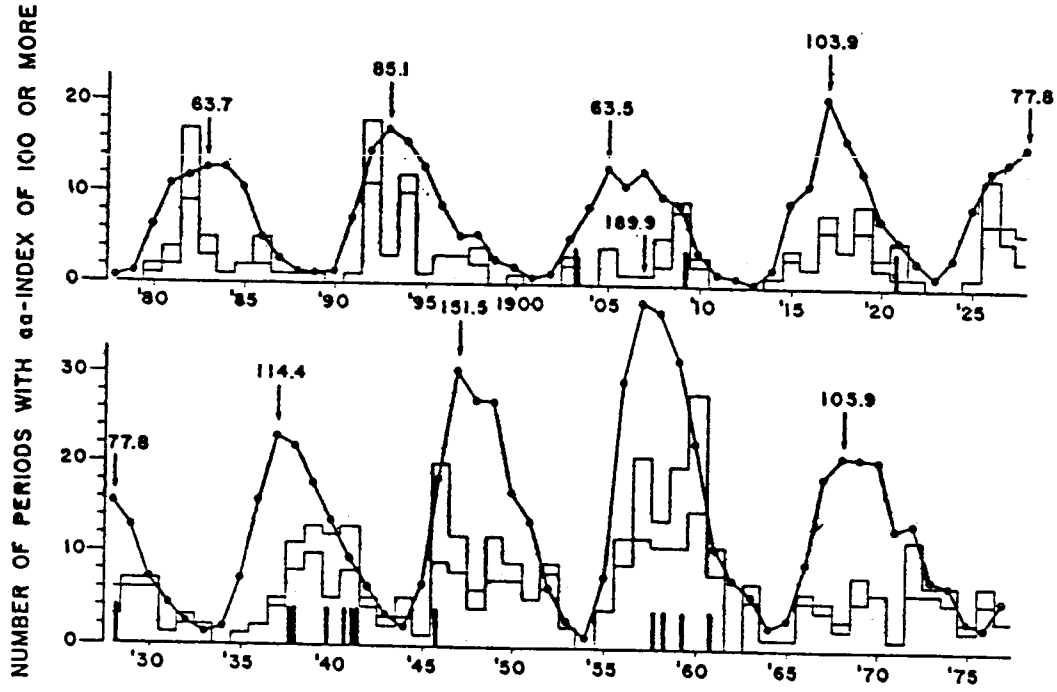

Figure 2. Bar chart showing the number of half-day periods each year when the aa-index equalled or exceeded 100 gammas. Shaded levels indicate the number of separate high-category major geomagnetic storms in a given year (some storms involve several consecutive half-day periods). Heavy vertical lines indicate super storms (where the half-day value equalled or exceeded 350 gammas). Annual mean sunspot numbers are also shown with maximum values specified for each cycle.

SARGENT (1979)

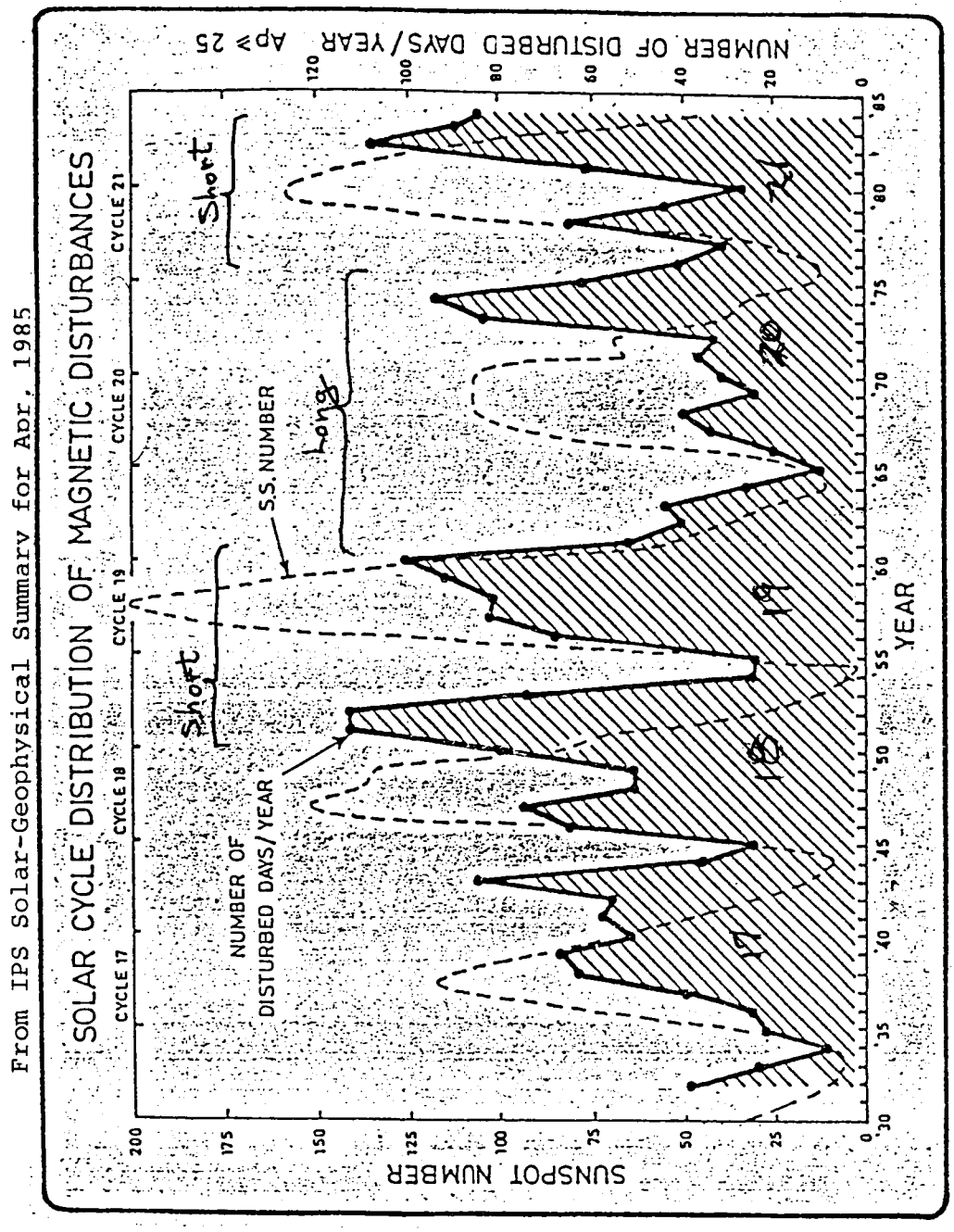

Figure:
The frequency of occurrence of geomagnetic disturbances is not constant but varies from year-to-year in a complicated manner. The figure shows the number of magnetically disturbed days in each year since 1932 (cross-hatched area). For comparison the variation of the sunspot number is also shown (dashed line). It is evident from the figure that there is some tendency for a peak of disturbances to occur near the peak of the solar cycle. However the greatest number of disturbances often occurs during the declining phase of the solar cycle