THE BASIC CYCLE OF SOLAR ACTIVITY AND THE GLOBAL MAGNETIC FIELD AND ACTIVE PHENOMENA DISTRIBUTION*

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Abstract. We have compared the latitudinal distributions of polar faculae, green coronal emission maxima, prominences and of a new index of enhanced geomagnetic recurrence with the distribution of magnetic fields during the cycles Nos. 20 and 21.

We did not find a distinct high-latitude initial stage of an extended cycle in the corona, prominences and polar faculae distribution. On the contrary, it seems that the polar faculae and their following polarity magnetic fields represent the last evolutionary phase of a magnetic activity cycle lasting 15–17 years. The enhanced recurrent geomagnetic activity seems to be related to the old cycle fields.

All studied phenomena clearly display two types of latitudinal distribution: the polar belts, into which the old following polarity fields have been transported from the equatorial belt where both the polarities develop in situ simultaneously, but in which the leading polarity fields only remain, crossing the equator during the minimum of activity, to play the same role on the opposite hemispheres in the new cycle.

1. Introduction

Recently, we have intensively studied the relations of globally distributed solar magnetic fields and activity phenomena to the cyclic activity changes. The greatest attention was paid to an extended cycle of activity, especially to the concept of its high-latitude origin (Wilson et al., 1988; Makarov et al., 1987; Howard and LaBonte, 1981; Snodgrass, 1987; etc.).

We compared the newly constructed graphs of latitudinal distribution of polar faculae (Makarov and Makarova, 1986; Khusainov, 1988), unified data of the green coronal emission maxima (Rybansky, 1975), maximum prominence areas and numbers (Rušín et al., 1988) and of our newly constructed index of recurrence of enhanced geomagnetic activity (Bumba and Hejna, 1990a) with the same distribution of solar magnetic fields (Howard and LaBonte, 1981; Snodgrass, 1987; Topka et al., 1982) for the last two 11-year activity cycles (Nos. 21 and 21).


2. Polar Faculae and Polar Magnetic Fields

The polar magnetic fields represent (Bumba and Růžičková-Topolová, 1969; Topka et al., 1982) the following polarity fields expelled successively from the magnetic active longitudes formed in the main equatorial body of the background fields.

If we compare the detailed latitudinal distribution of polar faculae (Makarov and Makarova, 1986; Khusainov, 1988) with the distribution of weak solar fields, we see that the polar faculae fill in exactly the areas covered by the mentioned following polarity unipolar magnetic fields (Bumba, 1990). This distribution is emphasized by the distribution of maximum prominence areas coinciding with the magnetic field boundaries.

All this indicates that the polar magnetic fields and the polar faculae represent the last phase of a magnetic activity cycle which had started with the formation of the first active regions around latitudes ±40°. The lifetime of such a magnetic activity cycle ending with a polar field reversal is about 15–17 years.

3. Green Coronal Maxima and Magnetic Field Latitudinal Distribution

The most characteristic feature of our unified coronal data is the existence of well-defined main zones running equatorwards, extending from enlarged regions of points almost homogeneously dispersed around the poles during the sunspot minimum. One edge of these regions seems to be the only better defined feature running from the polar regions continually equatorwards, while the other edge shifts from about ±45° polewards (Bumba et al., 1989, 1990).

All the main coronal zones border the leading polarity equatorial zones at their poleward rims. But in polar regions we see no unambiguous relation of the green coronal emission maxima to the polar magnetic fields.

4. Prominence and Magnetic Field Latitudinal Distribution

In our graphs of the latitudinal distribution of maximum prominence areas and numbers during 1967–1986 (Bumba et al., 1989, 1990), we see the same two main latitudinal zones: the polar zones formed as extensions of one of the secondary equatorial branches oriented slightly poleward, bridging the period of low and maximum sunspot activity over several years and, at the same time, connecting the main low-latitude prominence zones with the polar zones. Their full durations are 9 (without) or 15 (with the main zones) years. The equatorial prominence zones of the new 11-year cycles seem to be detached from the long polar prominence zone of the old cycle at the latitudes ±45°.

The two main latitudinal belts without prominences and, therefore, also without substantial magnetic activity have developed the polar belt filled in by the following polarity fields of the old cycle and by their polar faculae and the equatorial belt. In the equatorial belts without prominences the leading polarities of magnetic fields produced by the active regions and shifting equatorwards seem to cross the equator at the times of sunspot minima to start their activities again as leading polarities of new cycles in the opposite hemispheres.