Abstract. The long-term distribution of the Green Corona Low Brightness Regions (GCLBR*) on the solar surface is investigated. The frequency curves of the GCLBR follow the solar cycle, but are displaced considerably relative to the curve of the sunspot number cycle. The observed displacement increases with the size of the GCLBR and reaches up to 4–5 years for the largest regions. It is, however, interesting that the displacement in the equatorial zone is opposite to that in the higher-latitude zones.

An older idea on the physical affinity between GCLBR and coronal holes led us to study the frequency of GCLBR and the properties of High-Speed Plasma Streams (HSPS*) in the solar wind. Maximum velocity and duration of the coronal-hole-related HSPS seem to be well correlated with the number and size of GCLBR located in the N60–N20 and S20–S60 latitudinal zones. This is particularly evident at the end of the solar cycle.

Geophysical Kp and aa indices are used to demonstrate a possible genetic dependence of geoactivity on the size, position on the Sun’s surface and frequency of the GCLBR. In this sense, the most pronounced period is 1973–1976.

1. Introduction

The Atlas of the Green Corona Synoptic Charts for the Period 1947–1976 (Letfus and Sýkora, 1982a; hereinafter referred as ‘Atlas’), has been used to analyse the long-term distribution of the Green Corona Low Brightness Regions (GCLBR*), which are regions of weak emission in the Fe XIV 530.3 nm spectral line. It is evident that the GCLBR are not exactly-defined physical phenomena, but they are sure to be of physical origin. We are interested in investigating these regions because the GCLBR have, so to speak, a certain affinity to coronal holes. This had been suggested earlier by Waldmeier (1975, 1981) and was later demonstrated for example by us, for particular periods of the Skylab mission and the solar eclipse of July 31, 1981 (Letfus, Kulčár, and Sýkora, 1980; Sýkora et al., 1986). The physical reason for such an affinity is that the intensity of the green coronal line, 530.3 nm, decreases greatly in regions of low plasma density and temperature which are, of course, also the most pronounced properties of coronal holes. In any case, all the GCLBR, which we define in our ‘Atlas’ as the areas limited by dashed isolines only, represent certain ‘concavities’ of the brightness profile on the Sun’s surface, are characterized very probably by a quasi-open configuration of the magnetic field lines of force. Hence, escape of solar particles into interplanetary space from such regions is more probable and easier than from the more active neighbourhood surrounding them. When we speak of an affinity between GCLBR and coronal holes, it is necessary to note a certain bias of this relationship. We have found that, while each X- and EUV-coronal hole can be attributed to some low brightness region of the green

* The abbreviations GCLBR and HSPS should be read in the plural throughout this paper.
corona, the opposite does not necessarily apply, i.e., that each GCLBR becomes evident as a coronal hole, though observations in X or EUV exist at the given time.

In a number of papers (lateley, for example, Lindblad, 1990; Xanthakis, Petropoulos, and Mavromichalaki, 1990), it has been proved beyond doubt that High-Speed Plasma Streams (HSPS) originate in coronal holes on the Sun. According to the above-mentioned affinity, the GCLBR should possess the same property, realizing, however, that not all the regions emit detectable amounts of particles (namely not those of the smallest size). We have analysed a catalogue of HSPS compiled in three parts by Lindblad and Lundstedt (1981, 1983) and Lindblad, Lundstedt, and Larsson (1989) to study the time changes of some characteristics of the solar wind. In comparison with some other HSPS catalogues, this one emphasizes the velocity gradient of HSPS and seems, therefore, to be particularly convenient for solar-terrestrial studies. Besides this, the data gaps in the original Interplanetary Medium Data Book (see Figure 1 in King, 1977, showing the composite data set coverage), in particular in parts of 1968, 1971, and 1972, have been carefully (as far as possible) eliminated by Lindblad and his colleagues.

The responses of HSPS in geoactivity have also been frequently investigated in the past. Two types of the streams were classified clearly: the first, which are flare-related and less numerous, and the second, which are evidently emitted by long-lived corotating regions on the Sun, known as M-regions or coronal holes or, as we believe, also by formations referred to as GCLBR in the present paper. We demonstrate the far greater geoeffectivity of the second type of stream by correlating the GCLBR with the geomagnetic $Kp = 4$ to 9 and $aa$ indices. (For an explanation of the indices see Bartels, 1963, and Solar-Geophysical Data. We have also used a special digigraph 'Monthly mean sunspot numbers, $Kp$-frequencies and average $Ap$ for the years 1932–1986' produced and distributed by Institut für Geophysik, Göttingen.)

2. Distribution of the GCLBR in the ‘Atlas’

The ‘Atlas’ was compiled by using the intensity measurements of the coronal emission line Fe XIV 530.3 nm, regularly performed in the last decades by fewer than ten high-altitude observatories, concerned with observations of the solar corona. The raw data were transformed to a common photometric scale (in our case to the scale of the Pic du Midi Observatory). In this process, most of the systematic errors in the data of the different observatories were removed (Sýkora, 1971). Many regularities and properties were found in studying the longitudinal and latitudinal distribution of active features in the green coronal emission (see, for example, Sýkora, 1980; Letfus and Sýkora, 1982b).

For the purpose of the present study we had to determine the positions (the heliographic longitude and latitude of the centres of gravity) and size of the low-intensity features on the synoptic charts of the ‘Atlas’, defined quite conventionally as the regions outlined by dashed isophotes and called here the GCLBR (see example in Figure 1). The size of each area was estimated in certain non-physical units as its dimension in days