ON THE POSSIBILITY OF FORECASTING CORONAL HOLES

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ABSTRACT. The possibility is studied of forecasting coronal holes based on observations of the corona or radio emissions (2800 MHz) above the eastern limb of the Sun on the Earth. It was found that a) a coronal hole is characterized by a substantial decrease of the 530.3 nm line intensity; b) the ratio of intensities 530.3/637.4 nm in coronal holes is 1.5, but 5.5 in their neighbourhood; c) coronal holes could not be localized on E-W scanning interferograms although the behaviour of the radio emissions (2800 MHz) and coronal intensities in the 530.3 nm line was nearly the same in the course of solar cycle 20. The analysis indicates that it is possible to forecast coronal holes on the basis of coronal observations, but not on the basis of radio emissions.

О ВОЗМОЖНОСТИ ПРОГНОЗА КОРОНАЛЬНЫХ ДЫР. На основании наземных наблюдений эмиссионной короны или радиоизлучения на частоте 2800 МГц над восточным лимбом Солнца в работе исследуется возможность прогноза корональных дыр. Показалось, что а) корональная дыра является продолжительным понижением яркости зеленой корональной линии (530.3 нм); б) отношение интенсивностей корональных линий 530.3/637.4 достигает значений 1.5 в корональной дыре и 5.5 в окрестной короне; в) корональные дыры не удалось идентифицировать из радиоинтерферограмм (2800 МГц) в направлении В-З хотя в течение цикла № 20 ход интенсивностей этого излучения и зеленой короны почти одинаков. Из этого анализа следует, что пока возможность прогноза корональных дыр из наземных наблюдений короны существует, для радиоизлучения на этой частоте нет.

О MOŽNOSTI PREDPOVEDÍ KORONÁLNYCH DIER. V článku študujeme možnosti

predpovedí koronálnych dier na základe pozorovaní emisnej korony alebo rádiového žiarenia (2800 MHz) nad východným limbom Slnka, ktoré sa robia na Zemi. Zistilo sa, že a) v časovom priebehu intenzít v čiare 530,3 nm koronálna diera sa prejavuje výrazným znížením jej intenzity; b) pomer intenzít koronálnych čiar 530,3/637,4 nm v koronálnych dierach je 1,5, kým pre ich okolie 5,5; c) z interferogramov E-W skanovania sa koronálne diery lokalizovať nepodarilo, hoci v priebehu cyklu 20 priebeh rádiového žiarenia (2800 MHz) a intenzít koronálnej čiary 530,3 nm mal temer rovnaký priebeh. Z prevedenej analýzy vyplýva, že možnosť predpovedí koronálnych dier z pozorovaní korony existuje, kým z rádiového žiarenia nie

1. INTRODUCTION

It is no considered as nearly proved that coronal holes and Bartels' M-regions on the Sun, which are responsible for geomagnetic disturbances, are identical. We refer to regions of the corona with a lower density and temperature and with a faster escape of coronal plasma, which is boosted by the open configuration of the magnetic field, as coronal holes. The statistical comparisons, based on the observation material obtained during the manned Skylab mission (Nolte et al., 1976), have shown that every equatorial coronal hole is connected with a high-velocity solar wind stream. This stream is the source of geomagnetic disturbances, which it generates as it passes the Earth's magnetosphere.

This relationship can be used to forecast geomagnetic activity. The problem is in identifying coronal holes from ground-based observations. In this paper, we present several possibilities of determining the presence of a coronal hole at the eastern limb of the Sun from ground-based non-eclipse observations of the corona.

2. RESULTS AND DISCUSSION

The first possibility follows from the paper by Lukáč (1985). In the day-to-day determination of the average intensity of the green coronal line (530.3 nm) at the solar limb, the coronal hole is manifest as a longer decrease of its intensity. In the referenced paper, the analysis was carried out by means of the method of superimposed epochs. The zero day was the day in which a recurrent storm occurred. Only storms which re-occurred at least 5 times were considered. There were 235 of these storms in the period 1965-1976. In Fig. 1, the average intensities of the green coronal line at heliographic latitudes of $+10^{\circ}$ to -10° for corresponding day are depicted in the neighbourhood of the zero day. The first curve represents the result for the period being investigated as a whole, the second and third curves refer to the pe-

riod of increase and decrease of solar activity in the 20th cycle. The last curve displays a marked decrease 8 days prior to the commencement of recurrent geomagnetic storm. On the second curve this decrease is not conspicuous.

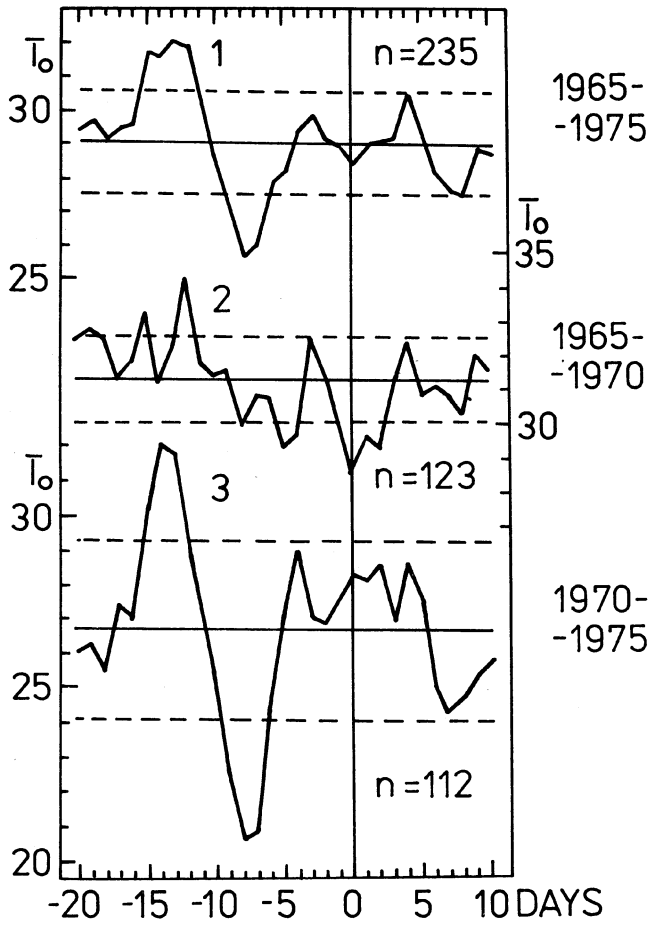

Fig. 1 Average intensities of the green coronal line vs magnetic storms. For details refer to text.

Drawing on Fig. 1, we can claim that: 1) roughly 8 days after the decrease in the time variation of the average intensity of the green coronal line has passed the eastern limb of the Sun, a magnetic storm commences on the Earth; 2) this decrease is more distinct in the descending branch of solar cycle 20. A smaller number of solar flares occurred at this time.

To be able to exploit this possibility, it is necessary to have a continuous series of observations of the corona at the eastern limb of the Sun. This is usually hindered by poor weather. To circumvent this obstacle, we attemped to replace the average intensities of the corona at the eastern limb

by radio interferogram E-W data on 2800 MHz (Rybanský and Rušin, 1983). To verify this hypothesis, we have used the data from the Sacramento Peak Observatory (USA) and the radio emission data from Algonquin (Canada) for the 1981 year (Solar-Geophysical Data, 1981, 1982). The result is illustrated in Fig.2.

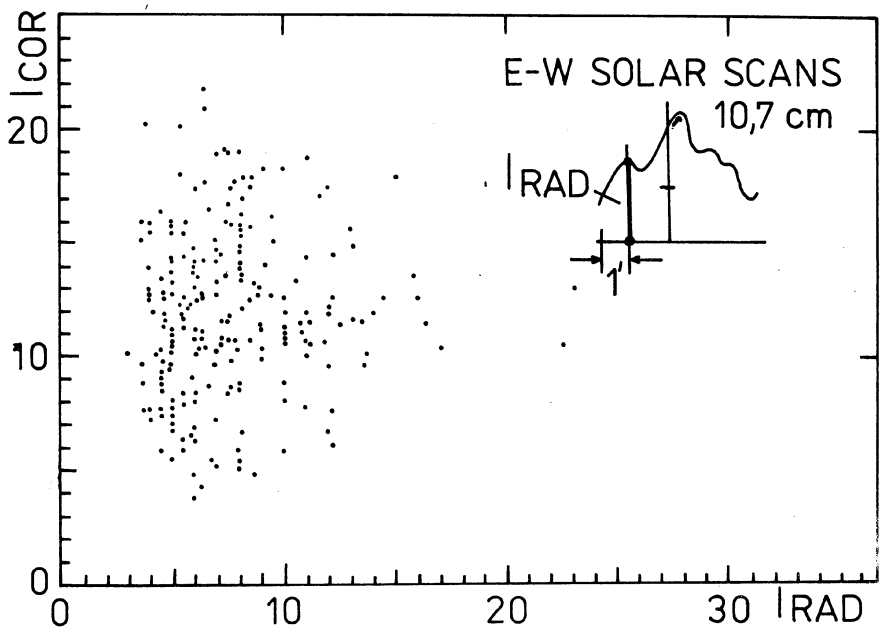

Fig. 2 Comparison between the intensities of the 530.3 nm corona and solar flux at 2800 MHz.

It was found that the correlation is practically zero (r = 0.02, N=221) so that the original intention could not be realized. The reason for the disagreement is not clear. It may possibility be that the solar flus is anisotropic.

Another possibility is to determine the ratio of the intensities of the green and red coronal lines. Theoretical studies (Pecker and Thomas, 1962, Fort et al., 1973) indicate that regions which emit the green line have a density 5 times higher than the regions which emit the red line. This, and also the lower ionization temperature indicate, that the ratio of the green-to-red intensity should be smaller in coronal holes than in the neighbouring corona.

This hypothesis was verified using the coronal data from the observatories of Kislovodsk and Lomnický Štít, and the data on coronal holes from the papers by Underwood and Broussard (1977) and by Bohlin and Rubenstein (1975). These materials were used to evaluate the data for 19 cases of coronal holes and their neighbourhood. The ratio of intensities was determined on both sides of the holes. It was found that the mean value of the ratio of the green-to-red coronal line intensities was of about 1.5 inside the coronal holes and

5.5 in the neighbourhood of the holes. After this fact has been verified using more extensive material, it may prove to be very valuable for forecasting.

To be able to put these results to practical use, it is necessary to improve the organization of coronal observations in order to decrease the number of gaps in the observation series.

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