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Lomnický Peak Observatory - weather and astroclimate

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Abstract. This contribution presents statistical results on observations of the solar corona and solar prominences using coronagraphs at the Lomnický Peak Observatory of the Astronomical Institute of the Slovak Academy of Sciences in the epoch 1963 – 2009. The mean frequency of the observing days in this epoch was 34,93% while the maximum long-term mean frequency of the observing days was found to be in the period from August to October. The mean frequency of the observing days suitable for observations of prominences was 34,0%, that of the observing days suitable for observations of the emission corona was 20,03%. The mean frequency of the observing days in which weather conditions allowed observations of the emission corona longer than 2 hours was 13,69%.

Key words: Sun – astroclimate – Lomnický Peak Observatory

1. Introduction

Since 1962 the astronomical observatory of the Astronomical Institute SAS at the Lomnický Peak (2634 m a.s.l.) has been in operation. It is devoted exclusively to observations of the solar corona and prominences using a coronagraph (Lexa, 1963). Such observations require not only a high-latitude position of the observatory and usage of a coronagraph, whose optical layout minimizes the instrumental scattered light, but also meteorological conditions allowing this kind of observations. Status of the Earth's atmosphere has to be of a kind to cause the scattered light in the atmosphere as small as possible. Only under these conditions a very weak intensity of the emission lines originating in prominences and the corona is possible to observe in a close vicinity of the bright limb of the solar disk. Such observations led to creation of a catalogue of the solar prominences (Rušin et al., 1988, 1994), construction of a homogeneous data set of intensities of the green coronal emission line (Rybanský a Rušin, 1994), and to the coronal index of the solar activity (Rybanský, 1975, Rybanský et al., 2005).

This work contains basic information on statistics of observations at the Lomnický Peak Observatory during which conditions for a low scattered light level in the Earth's atmosphere were fulfilled. The analyzed epoch covers 47 years. Statistics of the astroclimate at the Skalnaté Pleso Observatory of the

Astronomical Institute SAS were published already after a decade of its existence (Šáškyová, 1955).

2. Data

For each observing day information on the beginning and end of different types of observations carried out at the observatory was extracted from the observing record books from the epoch from 1963 to 2009 (in total 17167 days). These data were handled in a way that for each day of observations the length of the temporal interval of observations of prominences and that of the temporal interval of observations of the emission corona were calculated. Division of observations into these two different types was introduced due to the fact that those types require a different level of inevitable observing conditions for their performance. The former type of observations suffices worse scattering observing conditions comparing to the latter one. Such temporal data are just low estimates of the length of the temporal interval of observing conditions as the observing program for a particular day could be completely executed already before the actual degradation of the weather conditions causing either an interruption of observations or at least an increase of the light scattering above the inevitably required level.

A typical observing program in the epoch under study consisted of patrol observations of prominences at the beginning of the observing day and it continued by observations of the emission corona until the end of the patrol observations of the emission coronal lines. Since 1991 till now a photoelectric method of the data acquisition has been used for observations of the corona (Minarovjech and Rybanský, 1992) which allowed observations of a longer time series of the coronal emission. These observations were usually continued until the end of favorable observing conditions for an observation of the emission corona.

Statistical research, performed in this work, is not corrected for influence of interruptions of regular patrol observations caused by different technical or management reasons. This fact only strengthens the statement that the derived statistical results are only a low estimate of the mean frequency of the observing days favorable for observations of prominences and the emission corona at the Lomnický Peak Observatory.

3. Results

The basic statistical result is the mean frequency of the observing days at the observatory. We derived that for the whole epoch under study observations of the Sun were carried out in 34,9 % of days. For comparison, measurements of sunshine using a meteorological heliograph at the station of the Slovak Hydrometeorological Institute at the Lomnický Peak in the particular epoch show that only 25 % of the days are completely cloudy (Bochníček a Horecká, 2010). Significant difference between 25 % of the completely cloudy days and 65,1 % of days when it was impossible to perform observations of the Sun is due to the fact that the heliograph actually records sunshine also through relatively dense high-altitude clouds or foggy cloudiness.

As in 1991 the photoelectric observations of the solar corona were introduced (and moreover in this year also the observing program was broadened) we have analyzed the statistical results not only for the whole epoch under study but also for the period since 1991. For the whole studied epoch the mean frequency of the observing days was 34,0 % of days. For the period since 1991 the mean frequency reached 33,9 %. Observations of the solar corona were performed in 22.3 % of days, and in 20.0 % of days in the period since 1991 respectively.

We can assume that in days when an observation of the emission corona was possible to perform, conditions for observations of the solar corona were favorable also during previous observations of prominences in the particular day. Therefore, we have focused on the statistical mean frequency of days with observing conditions favorable for observations of the emission corona. Temporal intervals were split into length intervals shorter than 0.5 hour, between 0.5 and 1.0 hour, 1.0 and 2,0 hour, and separately also for the length longer than 2 hours (Table 1). We found that observations of the emission corona longer than 2 hours were possible to acquire in 13,7 % (14.0 %) of days.

Cumulative histograms of the mean frequency of observing days with the length of prominence observations, the length of the emission corona observations, and the total length of observations with a step of 0.25 hour show a detail distribution of the mean frequency of the observing conditions for observations of prominences, the emission corona and in total for the whole epoch under study (Fig. 1). The cumulative histogram of the total length of observations (Fig. 1, upper panel) shows a distribution with a sharp increase of the number of the observing days shorter that one hours. Reason of this effect can be seen at the cumulative histogram of the length of prominence observations (Fig. 1, middle panel). A narrow distribution of the length of prominence observations is due to a selection effect of the observing program which took place in case of the regular patrol of prominences, performed for the catalogue of the Hα prominences (Rušin et al., 1988, 1994), typically only less that one hour. In the case of the emission corona observations, the cumulative histogram is without any influence of a similar selection effect (Fig. 1, bottom panel).

For investigation of temporal variations of the mean frequency of observations averaged over individual months and individual years, we selected days with conditions favorable for observations of the emission corona. In the plot of the temporal variations of the mean monthly frequency of observations (Fig. 2) it can be seen that the frequency of days without observations varies in a range 65 % – 70 % (November, April). On the contrary, in months from August till October this parameter decreases to minimum values in a range from 55 % to 62 %. The mean frequency of very short observations (less than 1.0 hour) is without a significant seasonal variation. The mean frequency of observations lasting longer than 2 hours is increased in January and February as well as in August and September. Its most significant maximum is in October. Temporal variations of the mean yearly frequency of observations (Fig. 3) do not show any systematic trend. Values of the mean frequency of days without observations change between the extreme values from 50 % up to 77 %. The mean frequency of observations longer than 2 hours is significantly changing from year to year between values from 8 to 22 %.

4. Conclusions

A statistical analysis of the observing records of observations at the Lomnický Peak Observatory for the epoch 1963 – 2009 shows that in the long-term average there was approximately 2/3 of days without possibility for observations of the solar corona and prominences. Observations of prominences were possible in ∼1/3 of the total number of days in this epoch. Only ∼1/5 of the total number of days in the epoch 1963 – 2009 were favorable for observations of the solar emission corona. In ∼1/7 of days from the total number of days in this epoch conditions appropriate for observations of the emission corona lasted at least 2 hours. Based on the long-term statistics, the most favorable months for observations at the Lomnický Peak Observatory are August, September, and October, while probability of good observing conditions rapidly decreases to minimum in November. The derived data on the mean frequency of observations can be considered only as low estimates of existence of the required observing conditions at the observatory as part of days without observations was caused in the given epoch by other than meteorological reasons.

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Table 1. Main statistical results on the mean frequency of the observing days at the Lomnický Peak Observatory.

	1991-2009	1963 – 2009
total number of days	6940	17167
without observations [%]	65.7	65.1
observations of prominences [%]	33.9	34.0
observations of the emission corona [%]	22.3	20.0
coronal conditions (0.0-0.5)hod [%]	0.1	0.1
coronal conditions <0.5-1.0)hod [%]	2.8	1.8
coronal conditions <1.0-2.0)hod [%]	5.3	4.5
coronal conditions <1.0-2.0)hod [%]	14.0	13.7

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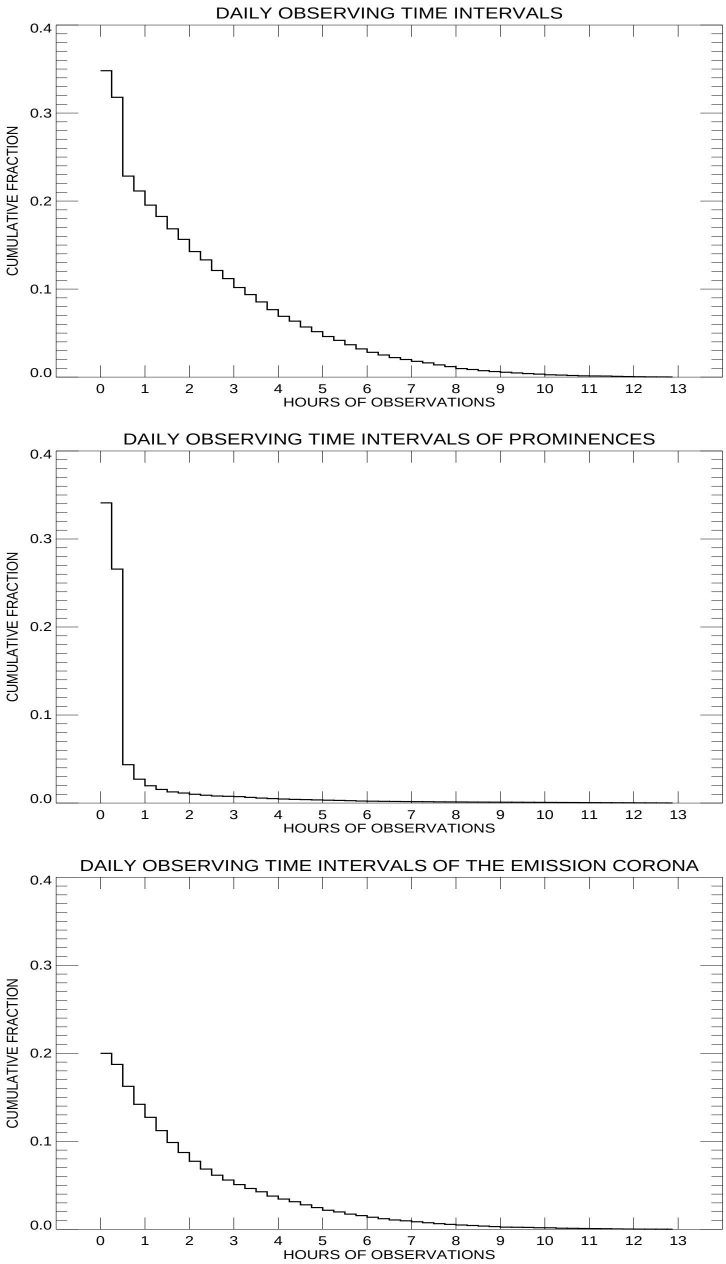

Figure 1. Cumulative histograms of the mean frequency of the observing days in total (upper panel), observations of prominences (middle panel), and observations of the emission corona (bottom panel) for the epoch 1963 – 2009.

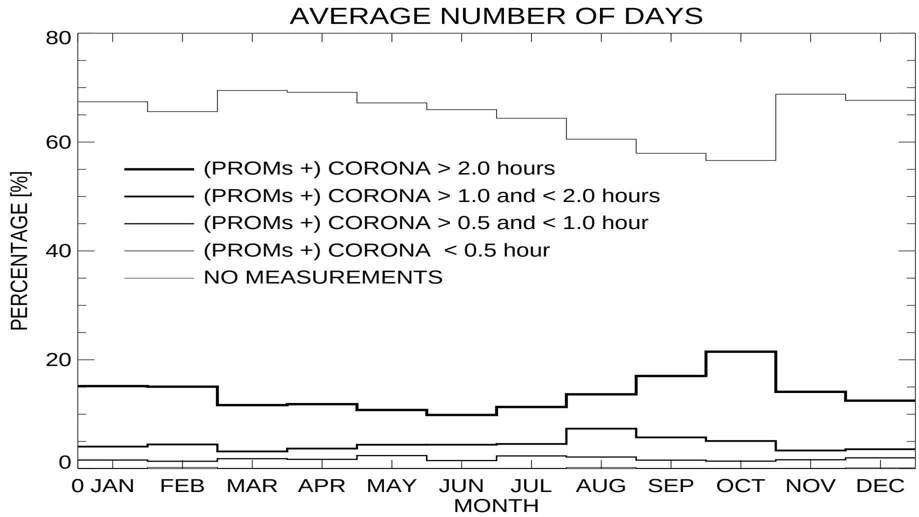

Figure 2. The mean monthly frequency of days without observations and days with observations under coronal scattering conditions for a different total length of observations in individual days for the epoch 1963 – 2009. The line displaying observations shorter that 0.5 hour merges with the lower horizontal axis almost for the whole range of the plot.

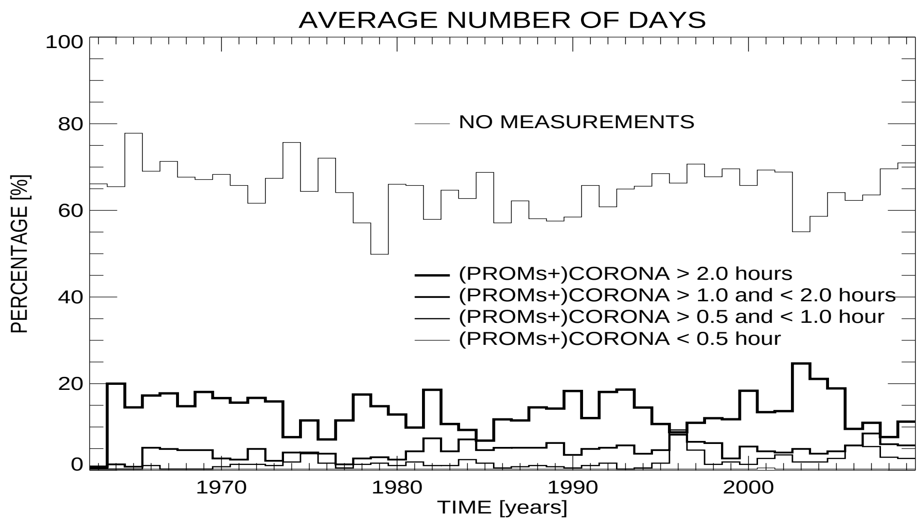

Figure 3. The mean yearly frequency of days withourtobservations and days with observations under coronal scattering conditions for a different total length of observations in individual days for the epoch 1963 – 2009.