Coronal index of solar activity for 1998

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Abstract. We present the Fe XIV 530.3 nm ("green line") coronal index (CI) of solar activity for 1998. A systematic increase of CI was observed from January to October 1998. Toward the end of the year the rate of increase slowed remarkably. A comparison of CI with similar indices of solar activity (2800 MHz radio flux, the Wolf sunspot number and the SUSIM Mg II index) shows a good correlation.

Key words: green corona – solar activity – cycle maximum

1. Introduction

Solar activity may be expressed with many indices; e.g., the Wolf sunspot number (R), 2800 MHz radio flux, and various X-ray and Extreme Ultraviolet data. Each of them reflects different physical conditions in the solar atmosphere. These indices allow us to estimate the influence of solar activity on the heliospheric state and processes on Earth. The effect of solar activity on these indices is without doubt, even though we are not able to say which index tells us the most about the physics of the solar cycle. One index that is used to study solar-terrestrial relations is the coronal index of solar activity, CI, introduced by Rybanský (1975). This index is based on the irradiance of the "green" corona (Fe XIV 530.3 nm) as observed by ground-based coronagraphs. At present, CI has been derived over the period 1939-1997 (cf. Rybanský et al., 1996, and Altrock et al., 1999). A plot of monthly means of CI over this period is shown in Figure 1.

As follows from Figure 1, the cycle-maxima of CI have monotonically increased since cycle 18 by almost a factor of two. This behavior is quite different from that of R or 2800 MHz radio flux. We note that the green corona irradiance reflects different physical conditions than these indices.

On the other hand, the root source of the variation of these indices is the same: magnetic fields (probably local) and their development during the cycle. The time-latitude development of the green corona intensities has already been

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discussed many times by Altrock (1997), Minarovjech et al. (1998), Rušin et al. (1998, and references therein).

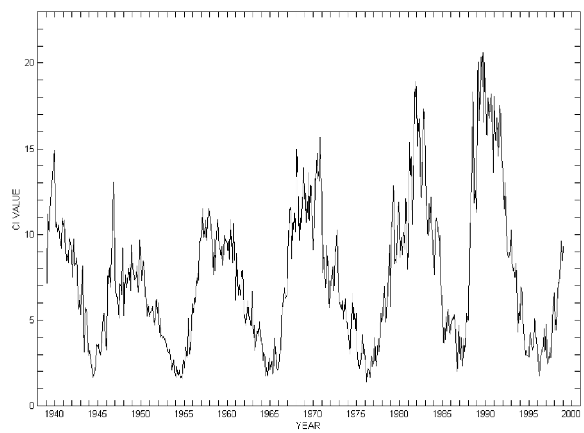

Figure 1. Monthly averaged CI for 1939-1997

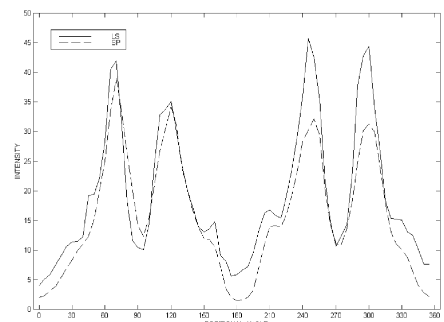

Figure 2. Average relative intensities on the common observational days for SP and LS in 1998. The SP data are nearly one order of magnitude lower than the LS data due to the different heights of observation above the limb.

We present daily values of 1998 CI in this paper. CI is computed from daily observations of the green corona, and the results are compared with other solar indices.

2. Observations

Regular daily observations of the green corona intensities at present are made only at two coronal stations: Sacramento Peak (SP) and Lomnický Štít (LS). CI

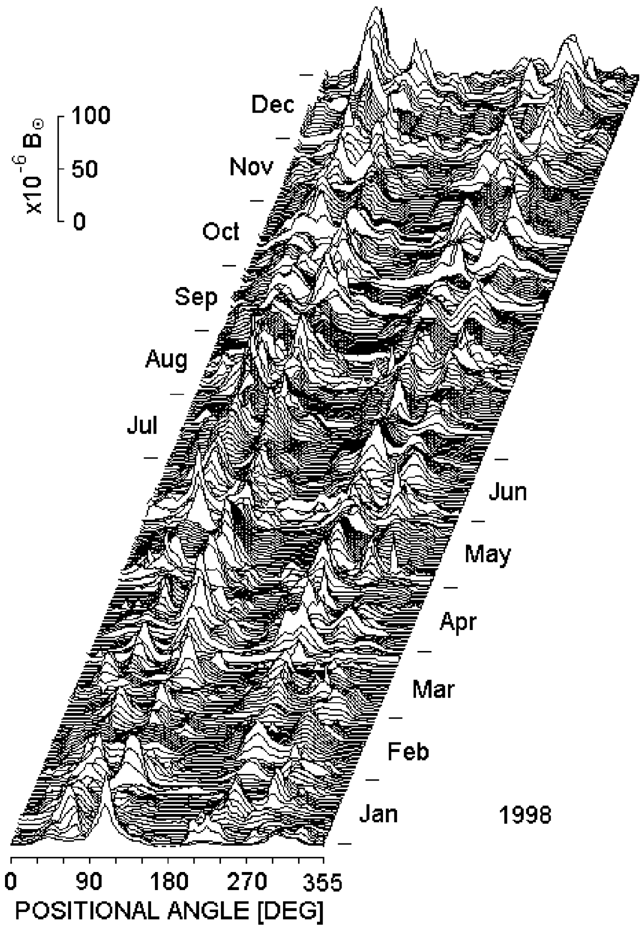

Figure 3. Time-latitude distribution of the green corona intensities

data are interpolated over missing observational days. The longest interpolated period lasted 10 days and occurred from May 16 - 25, 1998. During 1998, observations were obtained on 66 days at Lomnický Štít coronal station and 179 days at Sacramento Peak. There were 25 common observational days. We note that the time difference between the stations is 8 hours, which may cause some differences in the data. However, using the common observational days we prepared a relation to transfer Sacramento Peak intensities to the Lomnický Štít photometric scale. The averages of the common observational days for LS and SP are shown in Figure 2. The values above the E-limb are quite similar, but the W-limb data differ in magnitude, mainly in the two maxima. The resulting green corona intensities create the homogeneous coronal data set (HDS), which is used to compute the CI (see Rybanský, 1975).

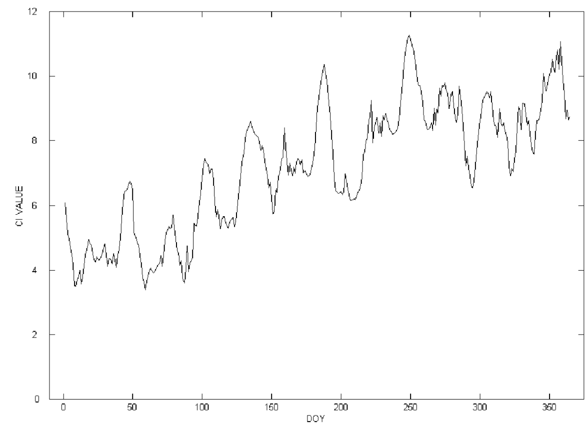

Figure 4. Daily values of CI in 1998 in units of 10^{16} W sr^{-1}

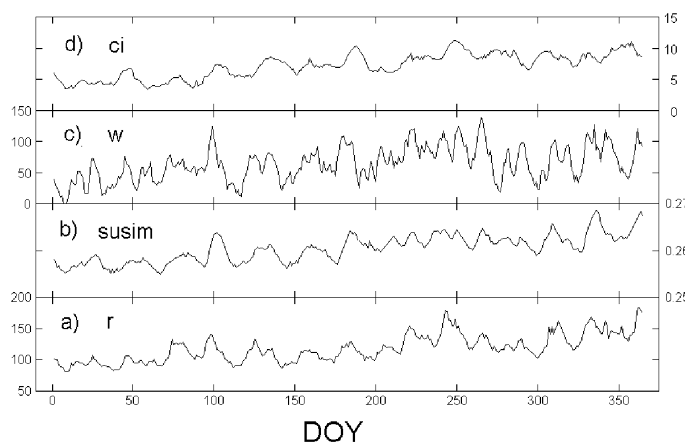

Figure 5. Comparison of daily values of CI on the ascending branch of cycle 23 with some other solar indices for 1998 (*ci = coronal index, w = the Wolf sunspot number, susim = the SUSIM Mg II index, r = 2800 MHz radio flux)*

3. Results

The time-latitude distribution of HDS is shown in Figure 3. As was shown by Altrock et al. (1999), the occurrence of enhanced intensities was sporadic during

Table 1. Daily values of CI.

Day	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	6.08	4.12	3.64	4.20	5.54	5.79	8.44	6.47	9.77	9.69	9.51	8.63
2	5.60	4.34	3.83	4.28	5.63	6.47	9.01	6.62	10.33	9.80	9.48	8.21
3	5.13	4.32	3.98	4.37	5.33	6.41	9.34	6.86	10.71	9.55	9.34	7.87
4	4.97	4.18	4.05	5.45	5.50	6.89	9.67	7.57	10.94	9.47	9.53	7.66
5	4.69	4.49	3.97	5.39	5.88	7.00	9.94	7.66	11.18	9.00	9.08	7.58
6	4.47	4.29	3.90	5.36	6.28	7.43	10.16	7.99	11.26	9.44	8.61	8.19
7	4.17	4.07	3.96	5.65	6.69	7.48	10.36	8.10	11.13	9.53	8.47	8.63
8	3.52	4.45	4.04	6.11	7.12	8.40	10.11	8.63	10.95	9.10	8.45	8.62
9	3.48	4.64	4.15	6.35	7.47	7.79	9.85	8.75	10.87	8.73	8.11	8.73
10	3.70	4.99	4.20	6.86	7.60	7.36	9.38	9.25	10.59	8.58	8.99	8.95
11	3.80	5.56	4.43	7.26	8.07	6.94	8.78	7.95	10.30	8.82	8.55	9.24
12	4.00	6.09	4.12	7.45	8.27	7.32	8.19	8.41	9.88	9.68	8.44	10.08
13	3.58	6.44	4.46	7.33	8.38	7.10	7.61	8.53	9.71	9.36	8.56	9.73
14	3.78	6.45	4.89	7.28	8.49	6.92	6.83	8.73	9.70	8.97	8.31	9.54
15	4.13	6.49	5.15	6.98	8.60	7.18	6.45	8.24	9.52	8.44	8.17	9.88
16	4.46	6.64	5.24	7.12	8.42	6.99	6.40	8.55	9.17	7.86	7.95	10.04
17	4.71	6.74	5.35	7.12	8.32	7.33	6.36	8.14	8.69	7.23	7.20	10.15
18	4.94	6.69	5.27	6.79	8.22	7.45	6.39	8.78	8.58	7.53	6.91	10.53
19	4.82	6.47	5.32	6.10	8.16	7.40	6.44	8.66	8.35	7.16	7.15	10.22
20	4.78	5.17	5.69	5.66	8.11	7.26	6.32	8.85	8.37	6.90	7.03	10.12
21	4.49	5.00	5.32	5.86	7.96	7.41	6.42	8.66	8.41	6.59	7.42	10.62
22	4.31	4.86	4.95	5.68	7.72	7.02	6.98	8.56	8.56	6.53	7.70	10.83
23	4.24	4.77	4.60	5.28	7.85	7.06	6.75	8.35	8.33	6.75	8.41	10.21
24	4.42	4.45	4.53	5.54	7.70	6.96	6.52	8.31	9.01	7.47	9.06	11.07
25	4.31	4.16	4.14	5.65	7.38	6.89	6.33	8.19	8.50	7.90	8.94	10.46
26	4.30	3.77	4.28	5.65	7.13	6.92	6.16	8.21	8.97	8.28	8.35	9.89
27	4.39	3.63	3.77	5.45	6.91	7.04	6.16	8.25	8.86	8.62	9.17	9.46
28	4.51	3.39	3.60	5.37	6.53	7.20	6.19	8.30	9.62	8.91	9.14	8.68
29	4.66		4.05	5.29	6.72	7.44	6.18	8.38	9.38	9.24	8.80	8.95
30	4.81		4.74	5.49	6.22	7.76	6.28	8.68	9.70	9.34	8.50	8.65
31	4.48		3.96		5.73		6.40	9.16		9.42		8.77
Mean	4.44	5.02	4.44	5.94	7.22	7.15	7.63	8.25	9.64	8.51	8.44	9.36

the minimum period. Now we see that the intensities are consistently enhanced in the main low-latitude activity belts and also in belts at higher latitudes. The poleward migration zone has begun to develop, as was predicted at the 1996 Solar Electromagnetic Radiation Study for Solar Cycle 22 (SOLERS 22) meeting shortly after solar minimum (May 1996) by Minarovjech, Rybanský & Rušin (1998) and confirmed at the 1998 American Geophysical Union meetings by Altrock (1998a, 1998b).

Daily values of CI are given in Table 1 and displayed in Figure 4. The variation of CI is characterized by temporal fluctuations of 10 to 20 days length and a long-term increase during first 9 months of 1998. From October to the end of the year a notable flattening of the long-term trend was observed.

A comparison of CI with similar solar indices (R, the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) Mg II index and 2800 MHz radio flux) is shown in Figure 5. The variation of the individual indices in 1998, is, in general, very similar, even though the amplitude of individual indices at a given period may differ. The differences follow from the different physical conditions required by each index, and a time shift. While R, the SUSIM Mg II index and 2800 MHz radio flux are full-disk observations made each day, CI is computed from all limb observations made 7 days earlier or later.

We derived, from daily values, correlation coefficients *(cc)* between CI and the other indices, which are: *CI:Mg II = 0.77, CI:2800 MHz = 0.68, and CI:R = 0.70.*

We have found, using an FFT method, that the most significant rotational period of CI was 28.5 days. Subsidiary FFT peaks are caused by weaker regions of enhanced intensities that differ from the stronger regions in latitude and longitude.

4. Conclusions

The coronal index of solar activity as defined by the coronal green line irradiance showed a systematic increase in 1998. Similar variations are seen in the Wolf sunspot number, 2800 MHz radio flux and the SUSIM Mg II index. The closest relationship between the indices occurred for the CI and Mg II indices *(cc = 0.77)*. This indicates that the physical conditions required for their origin are most similar for these two indices.

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