# Even-odd solar-cycle differences of corona brightness

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Received: December 1, 1994

**Abstract.** Distribution of the green emission corona FeXIV 530.3 nm in the period from 1943 to 1993 is analysed. If the variability of its brightness inside heliographic latitudinal belts is considered, a nearly 22-year periodicity, supporting systematic even-odd solar-cycle differences, emerges. In addition, it seems that a prevailing source of this long-term feature is the alternating behaviour of the minimum values of the 530.3 nm spectral line intensities measured in the middle-latitudinal belt (+/− 20-40 deg.), similar to that one observed in the sunspot-number cycles on a semi-annual basis. The peak value in each odd cycle is higher than that attained in the previous even cycle (the well-known Gnevyshev/Ohl rule). Moreover, activity in the southern hemisphere is more involved in this long-term trend than that in the northern one.

**Key words:** solar corona – solar cycle – variability and periodicity

## 1. Introduction

The possibility that a different heliolatitudinal coronal control of the 3-dimensional interplanetary space exists during successive sunspot-number cycles is being investigated in the frame of the international collaboration between the Astronomical Institute of SAV and the Istituto di Fisica dello Spazio Interplanetario of CNR. For this purpose green emission line corona data seems to be very appropriate from several points of view:

(a) There exist more than half a century of patrol measurements of the coronal intensity in this line, made by a small world-wide network of high-altitude coronal observatories;

(b) The measurements are performed with sufficient time- and space-resolutions at least once per day and in steps of five degrees around the sun's limb;

(c) In contrast with many other coronal lines the green line is detectable and measurable during each observation;

(d) At the same time, the green coronal line is highly sensitive to the solar activity beneath the solar corona. This is because its intensity is proportional

Contrib. Astron. Obs. Skalnaté Pleso **25**, (1995), 90– 108.

to the density, as well as to the temperature of the medium in which this line originates. In fact, the ratio of the intensities of the green-line corona originating in the active and in the quiet regions (as well as that of the maxima and minima of the solar activity cycles) is about five times greater than that for the white-light corona.

Our preliminary results (Storini et al., 1994) have shown that, during the ascending phases of even cycles (18, 20, 22):

- the minimum green-line intensity, on a semi-annual basis, attains values smaller than those observed in odd cycles (19, 21) in the middle-latitudinal belt (+/− 20-40 deg.).

- the commencements of the green corona cycle, evaluated on the basis of six-monthly averaged data, closely coincidence in both the equatorial and middle-latitudinal belts, while in odd cycles there is first a sudden increase in the middle-latitudinal intensity, followed by a later increase in the equatorial zone.

In this paper we shall deal with the first item in more detail, analysing separately the hemispheric activity of the green corona. The second item has been investigated elsewhere for the period 1947-1976 (Storini and Sýkora, 1995), using the continuous monthly-averaged set of data published by Kulčár et al. (1991).

## 2. Green corona brightness

The green corona data (spectral line: Fe XIV 530.3 nm), described by Sýkora (1992) and Storini et al. (1994; 1995) has been updated to 1993. The final set is a grid made up of 37x102 points, being the coronal brightness determined at steps of 5 degrees in latitude on a semi-annual basis. Values both from the east and west (14 days later) limbs were averaged to derive the central meridian data. The Pic du Midi photometric scale has been maintained over the years, although the continuous patrol service at this observatory was terminated in 1974 (see, Sýkora, 1971 and 1992, for problems connected with corona source data and their summary utilization from different observatories). After July 1991 only the data from the Kislovodsk Observatory were used, hence data at the end of our period should be regarded somewhat preliminary. To exemplify the available data set, Figure 1 shows the green-line intensity during sunspot cycle No. 21. The upper panels refer to the coronal ascending phase (left panel displays the average brightness during the January-June intervals and right panel presents that one during the July-December intervals of each year), while the lower panels show the same during the descending phase of the 21st solar cycle.

To obtain a global view of the green corona brightness distribution, a 3D-grid conversion was applied to the original data set, similarly as for the smaller time interval reported by Storini et al. (1995). In the present case, however, the chosen conversion is somewhat different. To emphasize the large-scale impulsive character of the green corona brightness (Sýkora and Storini, 1995), we applied

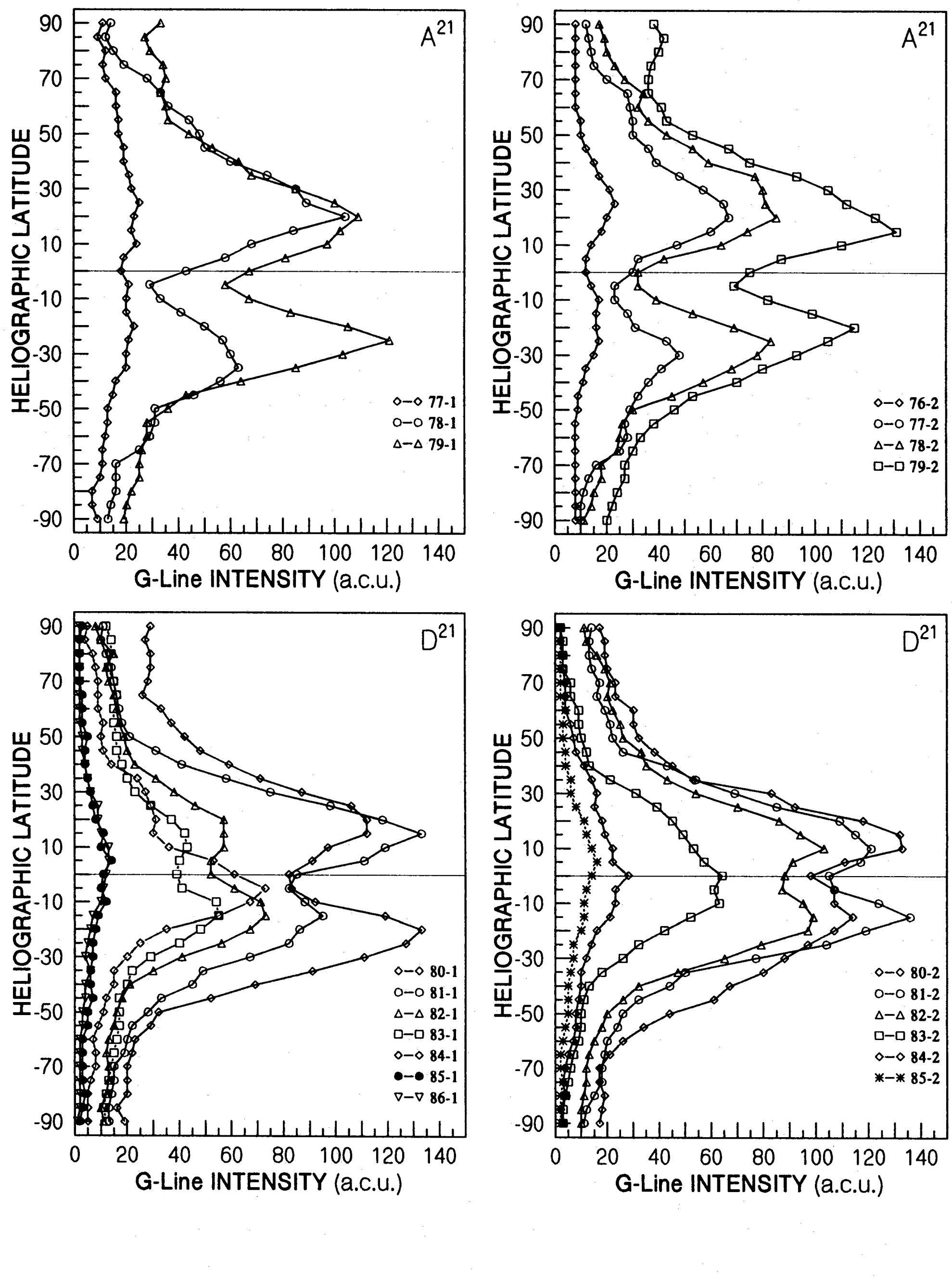


**Figure 1.** Green-line corona brightness during sunspot-number cycle No. 21, determined in steps of 5 degrees of heliolatitude on a semi-annual basis. The left-hand panels give values for the first half of each year of the ascending (up) and descending (down) cycle phases, while the right-hand panels present the same for the second half of each year.

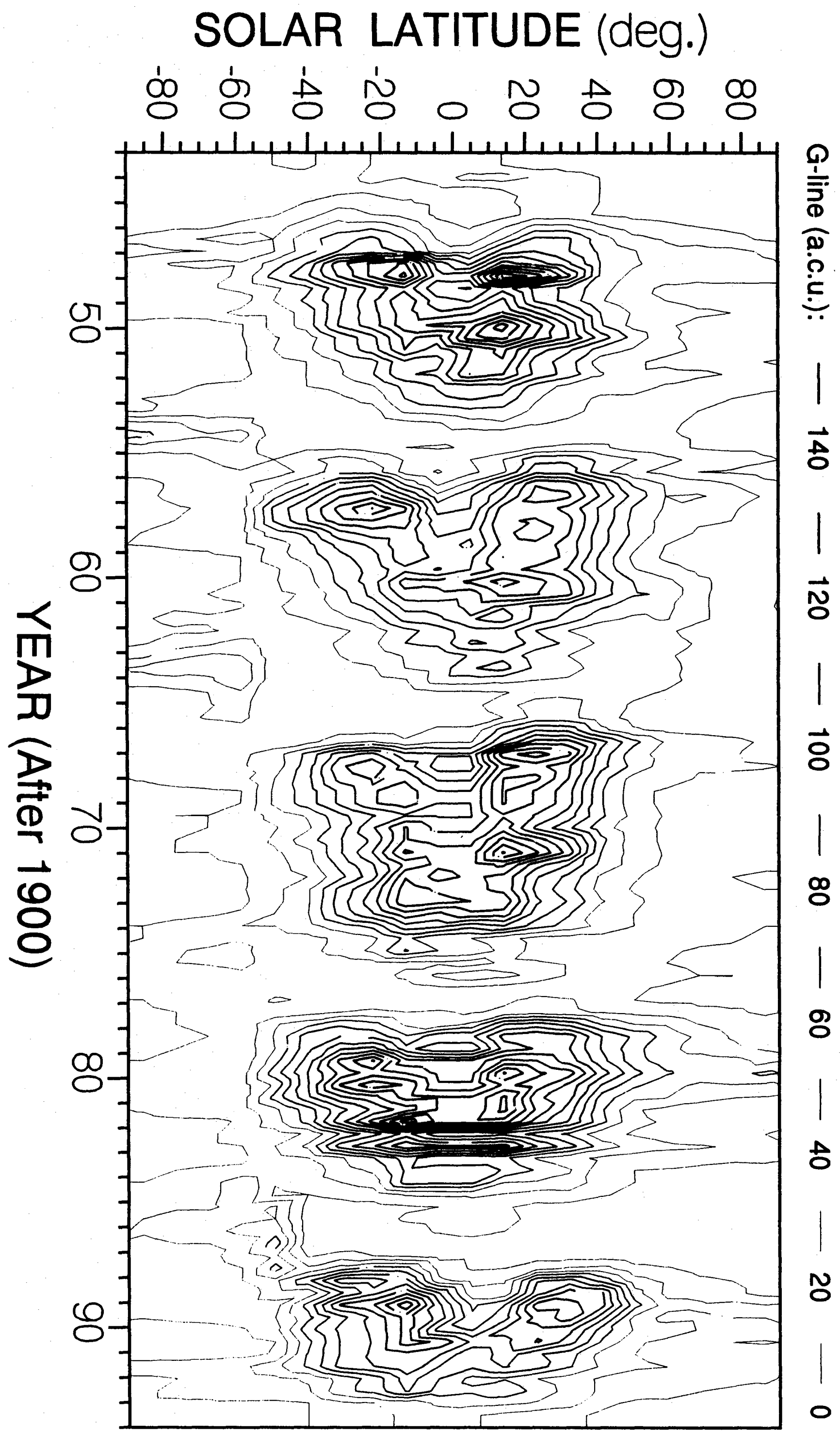


**Figure 2.** Isophotes of the green-line intensity from 1943 to 1993 plotted in steps of 10 a.c.u. (see the text for details).

to every grid point a nearest-neighbour-type of search with a weighting function equal to the inverse of the distance squared and scaled. Figure 2 shows the obtained time-space evolution of the green corona brightness (isophotes are in steps of 10 absolute coronal units - a.c.u.) in the period 1943-93. The contour distribution shows that, in each green-corona cycle:

- there are several large and well-isolated impulses of brightness (c.f. coronal activity);
- there is no close coincidence between the impulses appearing in the northern and southern solar hemispheres.

Hence, it seems very appropriate to investigate green corona extreme values in different heliographic latitudinal belts, because they can give us a better idea of the extent of green-corona variability. Moreover, it could be interesting to check if the hemispheric behaviour is the source of some even-odd cyclic trends in the green-corona parameters (see also Sýkora et al., 1994).

## 3. High and low coronal brightness inside heliolatitudinal belts

As in our previous investigations devoted to long-term features and trends of the solar-terrestrial parameters, we have considered three latitudinal belts of the solar corona: +/− 0-15 deg. (equatorial Eq-belt), +/− 20-40 deg. (middle-latitudinal Md-belt) and +/− 45-90 deg. (high-latitudinal H-belt). Here the global solar hemispheric activities have not been considered because, due to the yearly earth's excursion around the solar equator, the near-ecliptic environment is influenced from both hemispheres (with prevailing influence of the southern latitudes during the first half of the year and of the northern ones during the second half). Hence, in some studies based on large-scale data the absolute coronal variability in each belt could be sufficient to quantify solar-induced effects in the near-ecliptic region, disregarding hemispheric activity. That is why, in each data subset (Eq-belt made up of seven, Md-belt of ten, and H-belt of twenty values in each semi-annual sequence) we have looked for absolute maxima (the highest intensities) and minima (the lowest intensities). Table 1 reports these data series, together with the sunspot numbers (2nd column) and the total green-line intensity, i.e. the average intensities estimated from −90 to +90 deg. of latitude (3rd column). The maximum values are presented in the 4th, 6th and 8th columns, while the 5th, 7th and 9th columns display the minimum values.

Figure 3 shows the time trends of the maximum and minimum values, and the dashed area represents the variability of the green-line intensity within each belt. Examination of the even and odd cycles clearly shows the above-mentioned particular behaviour of the minima curve in the green-corona Md-belt. Moreover, a similar feature can be observed in the maxima of the coronal H-belt. Certainly, the green-line intensities measured in the H-belt have larger random

**Table 1.** Solar parameters from 1943 to 1993 on half-yearly basis. 'Rz' stands for sunspot number and 'Tgl' for total green-line intensity (+/− 90 deg.). 'H-Hgl'; 'H-Mgl'; 'H-Egl' and 'L-Hgl'; 'L-Mgl'; 'L-Egl' refer to the maximum and minimum values in the +/− 45-90 deg.; +/− 20-40 deg. and +/− 0-15 deg. belts, respectively.

| Year | Rz | Tgl | H-Hgl | L-Hgl | H-Mgl | L-Mgl | H-Egl | L-Egl |
|---|---|---|---|---|---|---|---|---|
| 43-1 | 19.4 | 7.7 | 14 | 3 | 13 | 4 | 15 | 10 |
| 43-2 | 13.2 | 10.2 | 11 | 2 | 20 | 7 | 25 | 10 |
| 44-1 | 3.8 | 5.8 | 8 | 1 | 12 | 5 | 10 | 4 |
| 44-2 | 15.4 | 7.4 | 8 | 1 | 13 | 10 | 11 | 5 |
| 45-1 | 25.3 | 8.3 | 10 | 1 | 25 | 9 | 17 | 4 |
| 45-2 | 40.9 | 17.1 | 18 | 5 | 37 | 22 | 29 | 9 |
| 46-1 | 74.1 | 25.4 | 29 | 8 | 53 | 35 | 40 | 14 |
| 46-2 | 110.9 | 30.4 | 34 | 9 | 60 | 35 | 54 | 22 |
| 47-1 | 149.0 | 48.8 | 41 | 20 | 108 | 40 | 112 | 48 |
| 47-2 | 154.0 | 58.9 | 46 | 23 | 136 | 39 | 130 | 67 |
| 48-1 | 136.8 | 39.8 | 32 | 15 | 82 | 34 | 87 | 52 |
| 48-2 | 135.6 | 42.2 | 35 | 14 | 93 | 31 | 99 | 61 |
| 49-1 | 139.0 | 44.9 | 34 | 9 | 91 | 34 | 102 | 77 |
| 49-2 | 131.3 | 49.3 | 31 | 8 | 123 | 34 | 135 | 88 |
| 50-1 | 101.6 | 45.3 | 45 | 8 | 111 | 24 | 124 | 76 |
| 50-2 | 66.3 | 36.7 | 33 | 6 | 82 | 27 | 93 | 60 |
| 51-1 | 79.6 | 30.8 | 24 | 8 | 74 | 20 | 89 | 54 |
| 51-2 | 59.2 | 33.4 | 26 | 9 | 70 | 20 | 90 | 59 |
| 52-1 | 29.1 | 26.1 | 24 | 10 | 47 | 20 | 57 | 43 |
| 52-2 | 33.8 | 21.3 | 18 | 6 | 41 | 13 | 51 | 40 |
| 53-1 | 17.1 | 17.9 | 18 | 6 | 32 | 13 | 40 | 32 |
| 53-2 | 10.6 | 13.8 | 17 | 6 | 26 | 11 | 29 | 17 |
| 54-1 | 2.4 | 12.2 | 15 | 8 | 15 | 13 | 17 | 13 |
| 54-2 | 6.4 | 12.5 | 19 | 7 | 22 | 12 | 11 | 9 |
| 55-1 | 20.1 | 22.9 | 35 | 8 | 48 | 25 | 30 | 16 |
| 55-2 | 55.7 | 19.9 | 27 | 6 | 57 | 23 | 28 | 9 |
| 56-1 | 113.3 | 35.9 | 51 | 8 | 89 | 39 | 58 | 17 |
| 56-2 | 170.1 | 46.2 | 55 | 18 | 94 | 57 | 68 | 27 |
| 57-1 | 165.5 | 52.8 | 64 | 15 | 110 | 58 | 92 | 40 |
| 57-2 | 214.2 | 51.2 | 60 | 17 | 93 | 58 | 89 | 47 |
| 58-1 | 183.5 | 45.1 | 35 | 14 | 98 | 43 | 86 | 52 |
| 58-2 | 185.7 | 41.3 | 30 | 11 | 86 | 36 | 82 | 52 |
| 59-1 | 175.0 | 40.7 | 28 | 10 | 92 | 34 | 90 | 64 |
| 59-2 | 142.5 | 37.9 | 31 | 10 | 81 | 28 | 84 | 59 |
| 60-1 | 117.7 | 45.1 | 40 | 10 | 103 | 26 | 105 | 80 |
| 60-2 | 106.8 | 42.5 | 43 | 10 | 91 | 21 | 93 | 69 |
| 61-1 | 57.8 | 35.8 | 35 | 8 | 62 | 23 | 73 | 64 |
| 61-2 | 50.0 | 32.8 | 31 | 10 | 70 | 20 | 75 | 54 |
| 62-1 | 44.5 | 23.2 | 23 | 6 | 50 | 13 | 58 | 37 |
| 62-2 | 30.8 | 26.3 | 24 | 8 | 54 | 16 | 63 | 40 |

**Table 1.** - Continued

| Year | Rz | Tgl | H-Hgl | L-Hgl | H-Mgl | L-Mgl | H-Egl | L-Egl |
|---|---|---|---|---|---|---|---|---|
| 63-1 | 28.3 | 22.0 | 24 | 8 | 41 | 16 | 51 | 31 |
| 63-2 | 27.5 | 22.8 | 25 | 9 | 42 | 14 | 57 | 30 |
| 64-1 | 12.8 | 19.1 | 25 | 9 | 31 | 13 | 35 | 19 |
| 64-2 | 7.6 | 15.0 | 23 | 8 | 27 | 11 | 19 | 14 |
| 65-1 | 15.0 | 15.2 | 21 | 7 | 36 | 10 | 25 | 14 |
| 65-2 | 15.1 | 14.4 | 20 | 7 | 33 | 12 | 20 | 11 |
| 66-1 | 36.6 | 19.1 | 26 | 6 | 59 | 12 | 44 | 12 |
| 66-2 | 57.2 | 30.2 | 56 | 7 | 85 | 17 | 59 | 18 |
| 67-1 | 89.9 | 43.1 | 44 | 10 | 117 | 43 | 106 | 34 |
| 67-2 | 97.4 | 42.3 | 44 | 9 | 97 | 45 | 86 | 34 |
| 68-1 | 107.4 | 44.0 | 38 | 12 | 111 | 44 | 100 | 43 |
| 68-2 | 104.4 | 44.3 | 37 | 14 | 102 | 41 | 101 | 56 |
| 69-1 | 115.6 | 38.4 | 34 | 12 | 89 | 31 | 89 | 55 |
| 69-2 | 95.5 | 38.9 | 29 | 11 | 87 | 28 | 95 | 66 |
| 70-1 | 114.8 | 44.2 | 32 | 10 | 110 | 36 | 114 | 78 |
| 70-2 | 95.1 | 46.7 | 31 | 9 | 129 | 27 | 131 | 83 |
| 71-1 | 68.4 | 40.3 | 31 | 9 | 93 | 25 | 106 | 83 |
| 71-2 | 65.0 | 36.8 | 23 | 9 | 83 | 20 | 99 | 84 |
| 72-1 | 77.0 | 39.3 | 22 | 9 | 89 | 26 | 111 | 87 |
| 72-2 | 60.9 | 42.5 | 26 | 10 | 97 | 28 | 114 | 98 |
| 73-1 | 45.5 | 37.7 | 25 | 11 | 83 | 24 | 91 | 78 |
| 73-2 | 31.0 | 29.6 | 22 | 10 | 55 | 26 | 69 | 53 |
| 74-1 | 31.8 | 18.6 | 16 | 8 | 41 | 16 | 42 | 23 |
| 74-2 | 37.0 | 19.6 | 17 | 8 | 40 | 11 | 51 | 27 |
| 75-1 | 11.2 | 12.9 | 15 | 6 | 25 | 13 | 22 | 15 |
| 75-2 | 19.7 | 17.4 | 16 | 7 | 31 | 14 | 38 | 22 |
| 76-1 | 12.9 | 12.1 | 14 | 7 | 16 | 11 | 20 | 16 |
| 76-2 | 12.1 | 11.9 | 12 | 8 | 23 | 11 | 18 | 12 |
| 77-1 | 19.7 | 16.3 | 19 | 7 | 25 | 16 | 24 | 18 |
| 77-2 | 35.3 | 31.0 | 36 | 10 | 67 | 31 | 60 | 23 |
| 78-1 | 83.3 | 43.1 | 50 | 12 | 104 | 50 | 84 | 29 |
| 78-2 | 94.9 | 43.5 | 53 | 11 | 85 | 57 | 74 | 32 |
| 79-1 | 137.9 | 56.5 | 53 | 19 | 121 | 63 | 102 | 58 |
| 79-2 | 172.6 | 64.4 | 67 | 20 | 123 | 70 | 131 | 69 |
| 80-1 | 157.0 | 60.1 | 52 | 16 | 133 | 59 | 112 | 82 |
| 80-2 | 152.3 | 58.3 | 61 | 17 | 118 | 45 | 133 | 98 |
| 81-1 | 127.6 | 48.4 | 33 | 10 | 118 | 41 | 133 | 82 |
| 81-2 | 153.3 | 52.6 | 32 | 11 | 119 | 43 | 136 | 105 |
| 82-1 | 123.9 | 30.0 | 20 | 8 | 67 | 21 | 73 | 52 |
| 82-2 | 108.7 | 43.4 | 33 | 10 | 97 | 32 | 103 | 87 |
| 83-1 | 78.8 | 24.0 | 17 | 11 | 48 | 18 | 55 | 39 |
| 83-2 | 54.5 | 21.9 | 12 | 2 | 45 | 13 | 64 | 49 |
| 84-1 | 69.7 | 20.8 | 12 | 4 | 35 | 14 | 73 | 30 |
| 84-2 | 22.0 | 10.5 | 9 | 2 | 18 | 10 | 28 | 19 |
| 85-1 | 19.6 | 5.6 | 7 | 2 | 8 | 4 | 14 | 9 |
| 85-2 | 16.3 | 5.9 | 5 | 2 | 11 | 4 | 16 | 11 |

**Table 1.** - Continued

| Year | Rz | Tgl | H-Hgl | L-Hgl | H-Mgl | L-Mgl | H-Egl | L-Egl |
|---|---|---|---|---|---|---|---|---|
| 86-1 | 12.4 | 4.8 | 4 | 1 | 9 | 4 | 13 | 7 |
| 86-2 | 14.4 | 3.7 | 4 | 1 | 8 | 3 | 6 | 5 |
| 87-1 | 19.6 | 6.1 | 7 | 2 | 14 | 9 | 9 | 7 |
| 87-2 | 38.7 | 15.7 | 20 | 4 | 44 | 13 | 43 | 8 |
| 88-1 | 70.9 | 31.1 | 37 | 6 | 76 | 35 | 63 | 15 |
| 88-2 | 129.2 | 33.7 | 56 | 5 | 91 | 23 | 87 | 17 |
| 89-1 | 153.9 | 48.8 | 60 | 10 | 112 | 44 | 118 | 32 |
| 89-2 | 161.7 | 42.3 | 41 | 10 | 95 | 37 | 97 | 42 |
| 90-1 | 137.7 | 41.3 | 36 | 10 | 88 | 45 | 94 | 42 |
| 90-2 | 146.9 | 39.5 | 31 | 9 | 88 | 38 | 95 | 64 |
| 91-1 | 146.2 | 36.6 | 34 | 15 | 80 | 26 | 78 | 50 |
| 91-2 | 145.3 | 36.2 | 34 | 14 | 76 | 28 | 79 | 51 |
| 92-1 | 109.4 | 24.1 | 18 | 8 | 54 | 18 | 65 | 37 |
| 92-2 | 79.5 | 24.9 | 20 | 8 | 54 | 18 | 61 | 41 |
| 93-1 | 65.6 | 15.4 | 10 | 8 | 29 | 10 | 36 | 25 |
| 93-2 | 43.9 | 12.1 | 8 | 8 | 20 | 8 | 25 | 17 |

errors but a certain systematic trend is present: the peak intensity in the even cycles is always smaller than the one observed in the following odd cycle (the same is also true for the semi-annual sunspot-number averages at least since sunspot cycle 10) in the maximum-values series. However, it is very unlikely that this H-belt affects the near-ecliptic region. Hence, we will concentrate on the two other solar latitudinal belts, but, for completeness, we give in Figure 4 the long-term trend of the difference between the absolute extreme values of the green corona brightness found in each heliolatitudinal belt. There is an opposite even-odd cyclic trend in the Eq-belt, suggesting minor differences in the extreme values during odd cycles and a possible long-term increase of these differences (e.g. Storini, 1995).

For a better understanding of the relationships between the green-line extreme values, correlation plots were constructed, but, due to the small number of points in each phase of the sunspot-number cycles, all the even and all the odd cycles were combined separately. Figure 5 compares values of the same type (maxima or minima) in the two lower-latitudinal belts (A stands for the ascending and D for the descending phases of the cycle) and Figure 6 shows values of the opposite type (maxima vs. minima, or vice versa). From these figures we infer that:

- During the ascending phases the relationship between green-line minima or maxima of both the belts (L-Md vs. L-Eq or H-Md vs. H-Eq) is practically the same for the even and odd cycles;

- During the descending phases a similar relation exits for green-line maxima of both belts, but the relationship for the minima of even cycles is different from

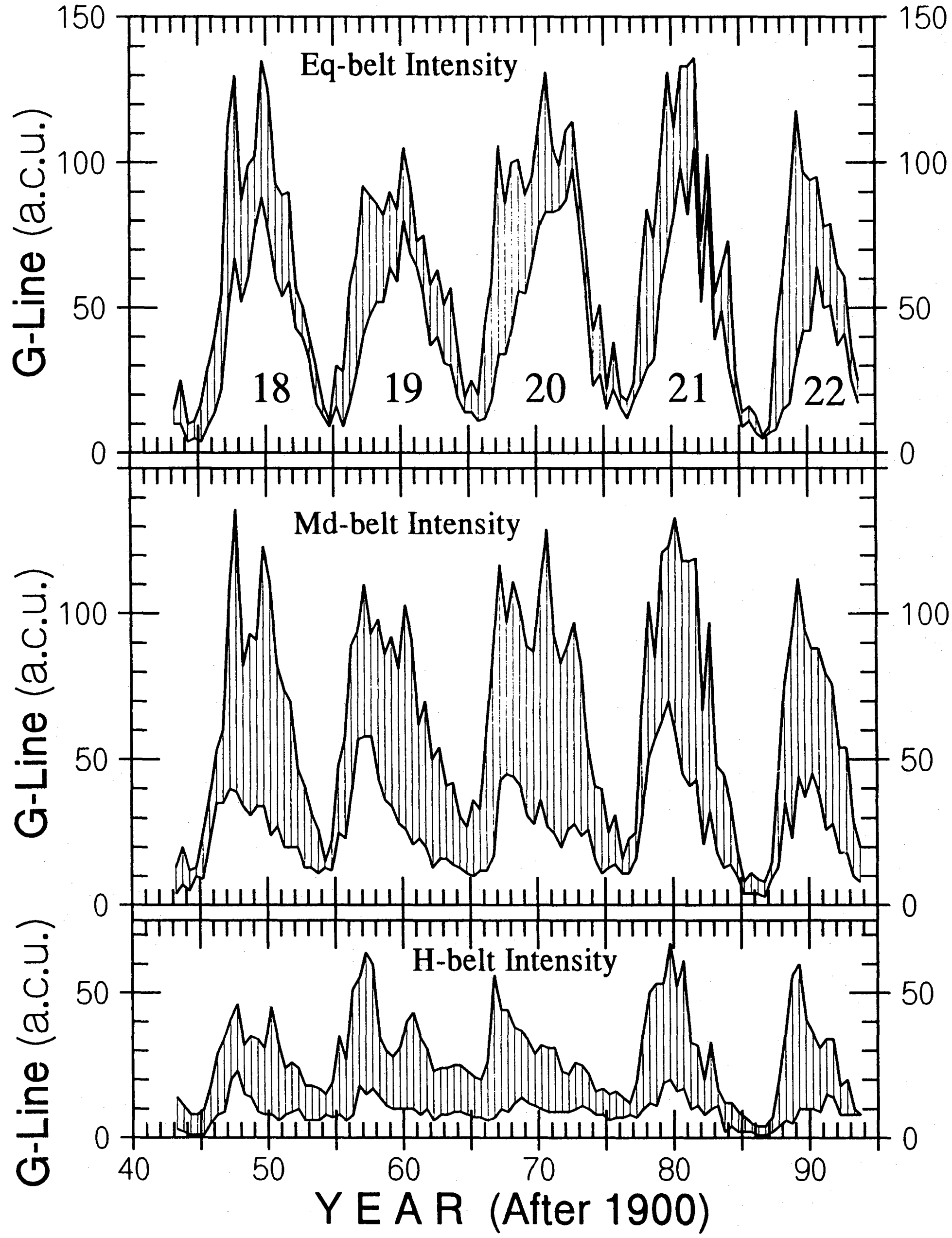


**Figure 3.** Variability of the green-line intensity (dashed area) within three selected heliolatitudinal belts: +/− 0-15 deg. (Eq-belt, upper panel), +/− 20-40 deg. (Md-belt, middle panel) and +/− 45-90 deg. (H-belt, lower panel).

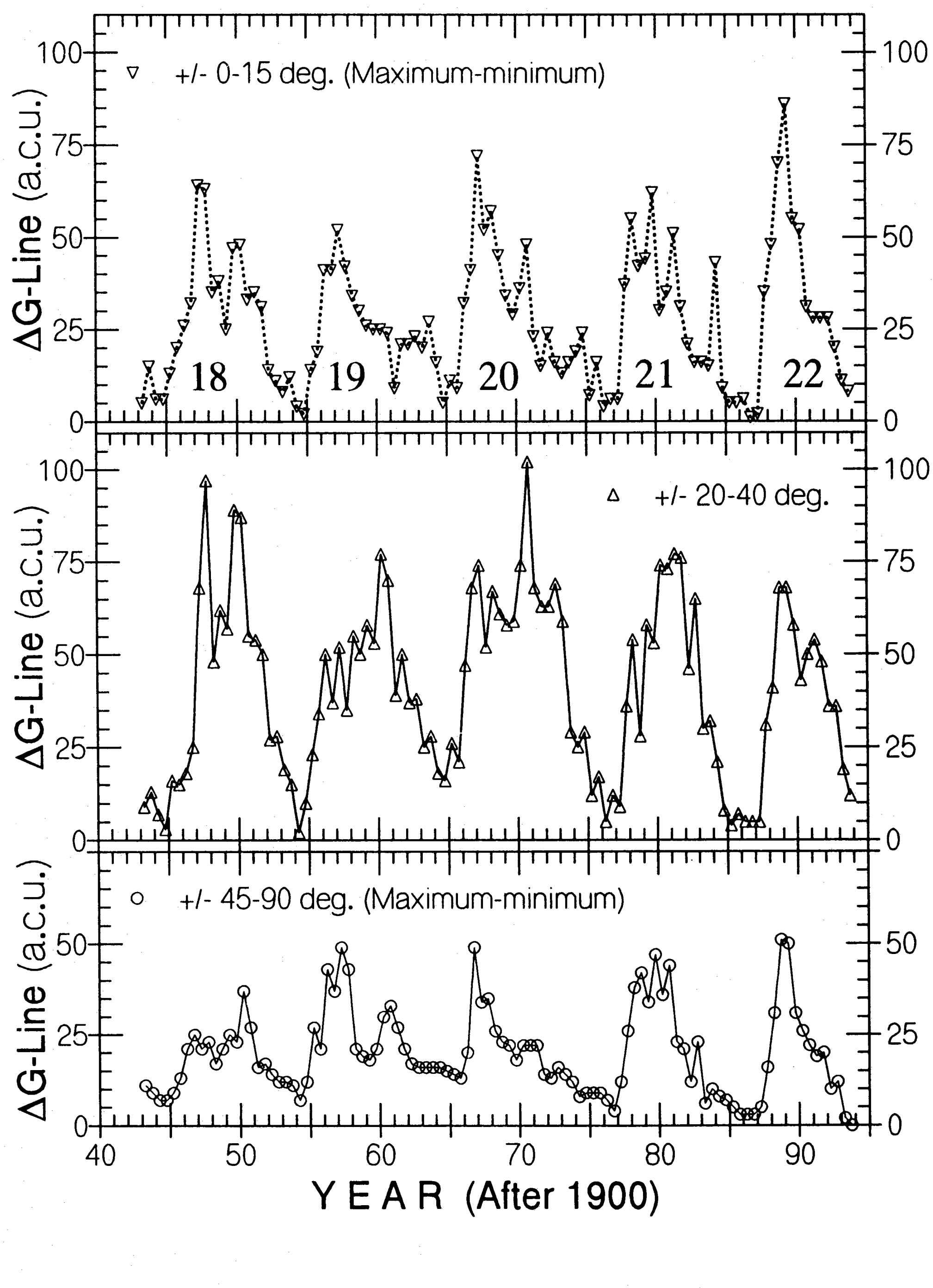


**Figure 4.** Long-term trend of the difference between the absolute extreme values of the green-line intensity found in each heliolatitudinal belt: Eq-belt (upper panel), Md-belt (middle panel) and H-belt (lower panel).

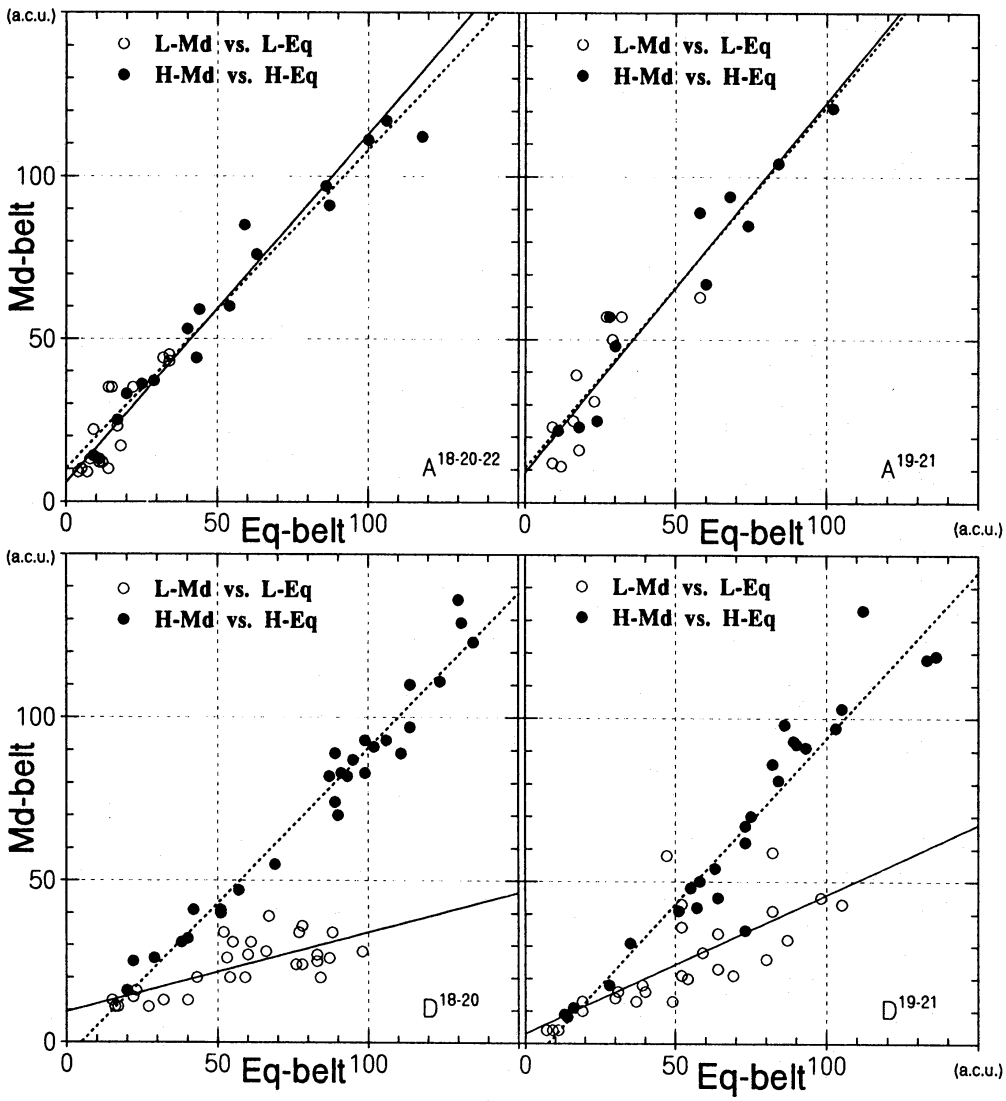


**Figure 5.** Correlation plots for maximum (H) and minimum (L) values of the green-line intensity observed in two adjacent solar belts affecting the near-ecliptic environment (Eq- and Md-belt) in relation to the type (even or odd) of the sunspot cycle. Lines give the best fit obtained (solid line: circles; dotted line: filled circles).

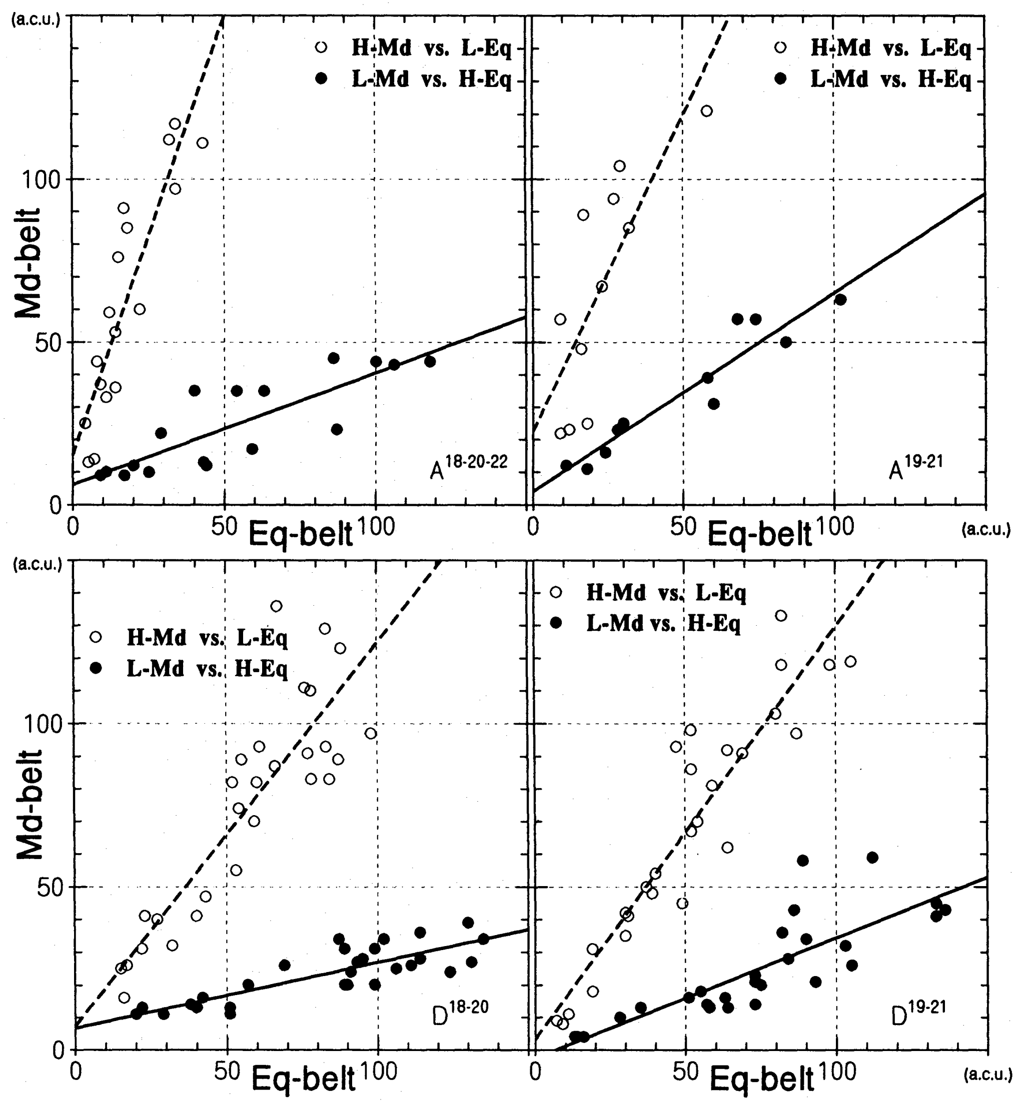


**Figure 6.** Correlation plots for opposite extreme values of the green-line intensity (L stands for minimum and H for maximum values) observed in two adjacent solar latitudinal belts affecting the near-ecliptic environment (Eq- and Md-belt) in relation to the type (even or odd) of the sunspot cycle. The lines give the best fit obtained (solid line: filled circles; dotted line: circles).

that of odd cycles, suggesting higher activity in the Md-belt than in the Eq-belt during the latter cycles.

- During the green-corona ascending phases the relationship between opposite extreme values, picked out in a different belt, is more similar for H-Md vs. L-Eq than L-Md vs. H-Eq, if even and odd cycles are compared. The same holds for the descending phases, but the L-Md intensification in the course of the ascending phases of odd cycles is more significant.

## 4. Hemispheric activity in the middle-latitudinal belt

Solar activity in the middle-latitudinal belt of +/− 20-40 deg. is very important for the physics of heliosphere. We remind, in order to support the above statement, that about 50% of the ground-level enhancements (GLEs), ascribed to solar cosmic rays and recorded by the world-wide network of cosmic-ray detectors, originate in this solar zone. Moreover, GLEs associated with heliographic latitudes above 40 deg. have never been identified. These experimental observations suggest that our division of the solar corona sphere into the 0-15, 20-40 and 45-90 deg. latitudinal belts is convenient for studies in the field of solar-terrestrial physics. Hence, extreme green-line intensities, sorted according to hemispheric activity, have been used to prepare new subsets of data for the Md-belt. Figure 7 shows the time behaviour of green-line maximum and minimum series of the 20-40 deg. belt for the northern (N, upper panel) and southern (S, lower panel) hemispheres. We observe that the even-odd cyclic behaviour discussed above is mainly created by the green-line minima in the southern hemisphere. This feature, of course, is also consistent with the even-odd cyclic behaviour of sunspot numbers, discussed in Section 3. The green-line minima in the northern hemisphere also respect this rule.

The upper panel of Figure 8 depicts the difference of the extreme values in each hemispheric Md-belt, while the lower panel shows that the well-known N–S green-line asymmetry in cycles 18, 19 and 20 (see, for instance, Sýkora, 1980) is clearly present also in the extreme values of the Md-belt.

## 5. Hemispheric activity in the high-latitudinal belt

From the ten data points of each hemispheric green-line H-belt we have chosen the absolute maximum and minimum values in each semi-annually averaged green-line intensity. The selected extreme values are plotted in Figure 9 for the northern (N, upper panel) and southern (S, lower panel) high-latitudinal belts. Again we find that the even-odd cyclic trend observed in this H-belt maximum series is related to southern hemispheric activity.

The lower panel of Figure 10 shows the N-S difference in the green-line extreme values of the H-belt, while the upper one gives the variability of the green-corona brightness of this belt in different hemispheres. This variability

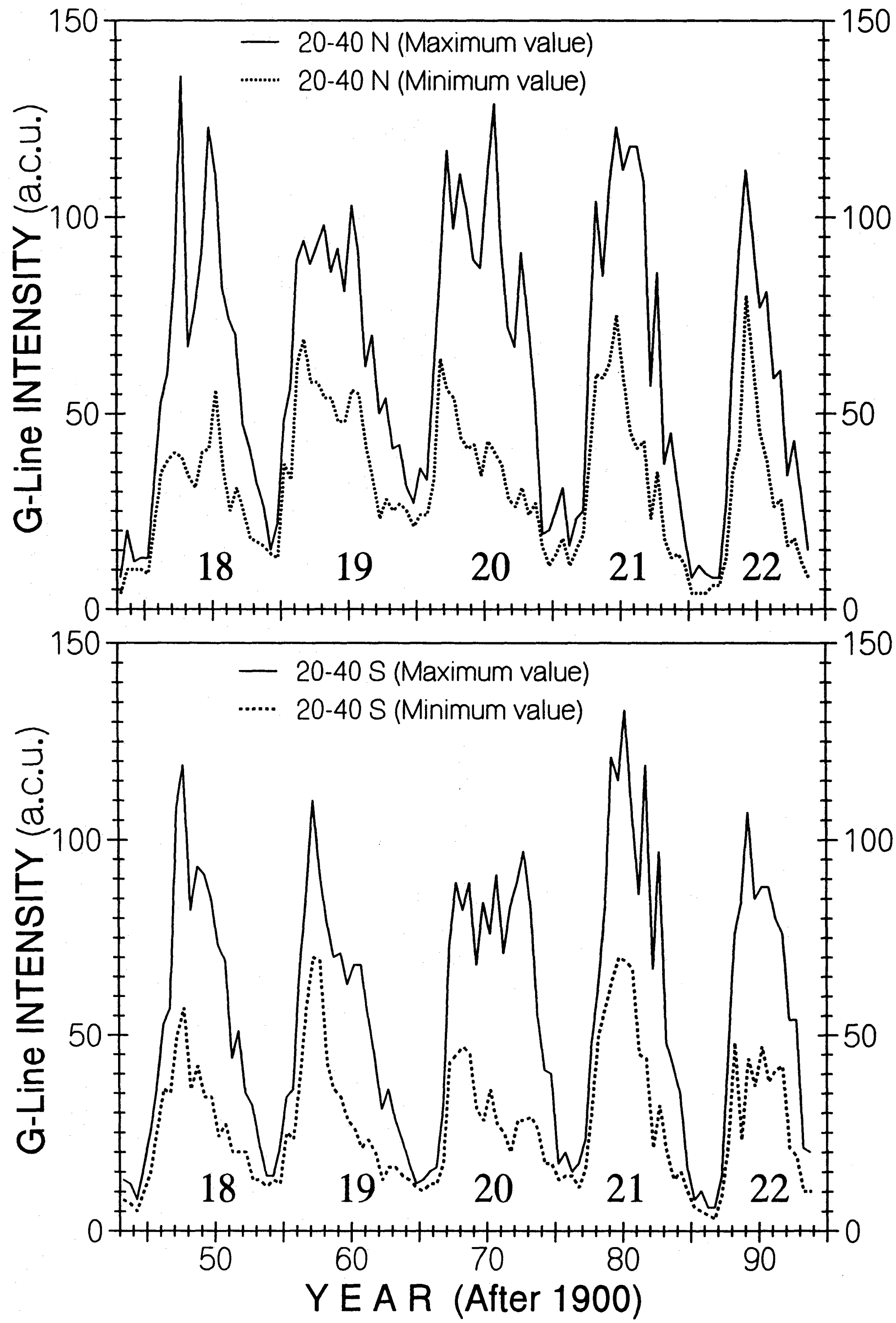


**Figure 7.** Long-term trends of the absolute extreme values of the green-line intensity observed in each hemispheric zone of the Md-belt (North: upper panel; South: lower panel).

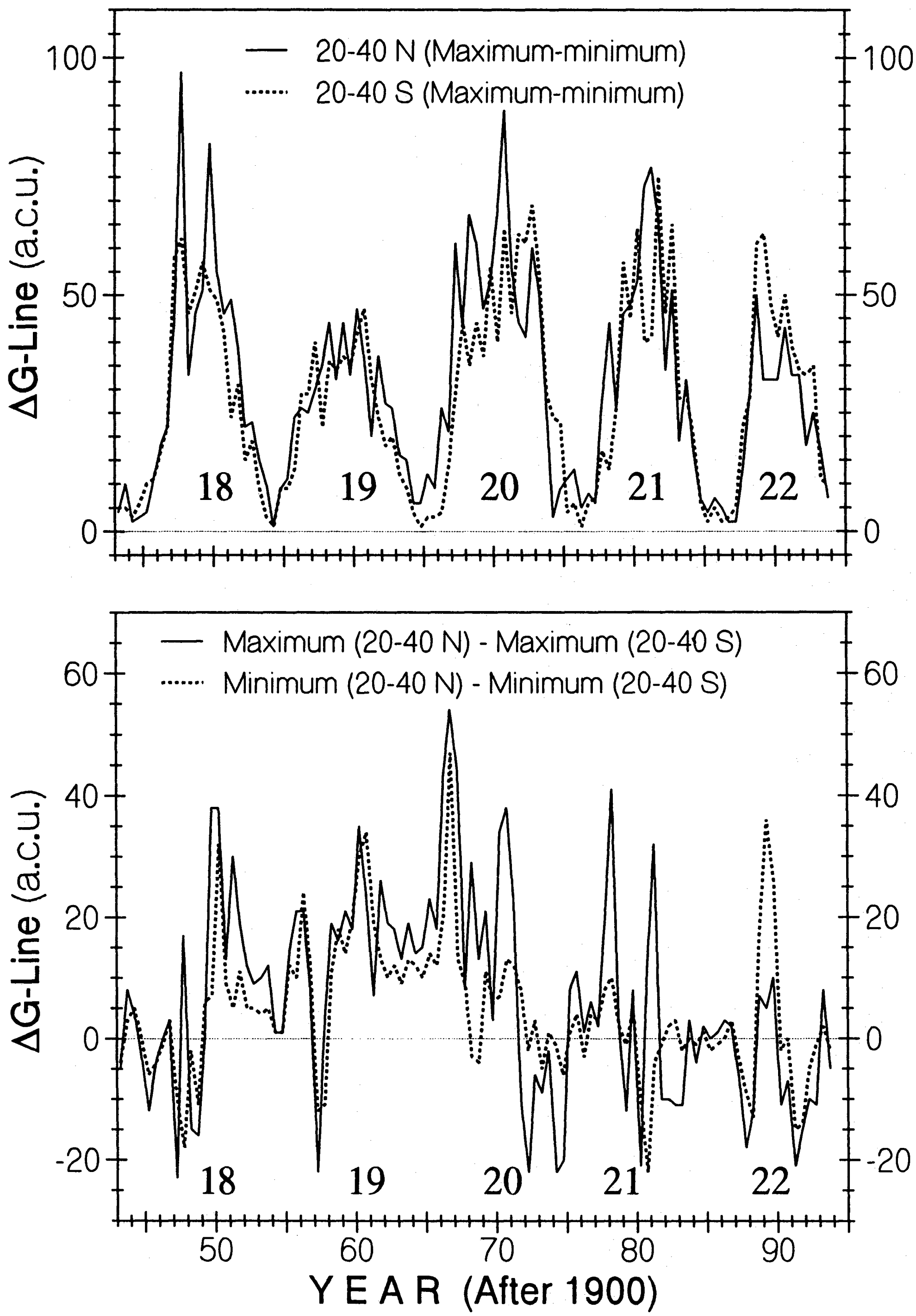


**Figure 8.** Long-term trends of the difference between absolute extreme values of the green-line intensity (upper panel) and absolute maxima or minima (lower panel) observed in each hemispheric Md-belt.

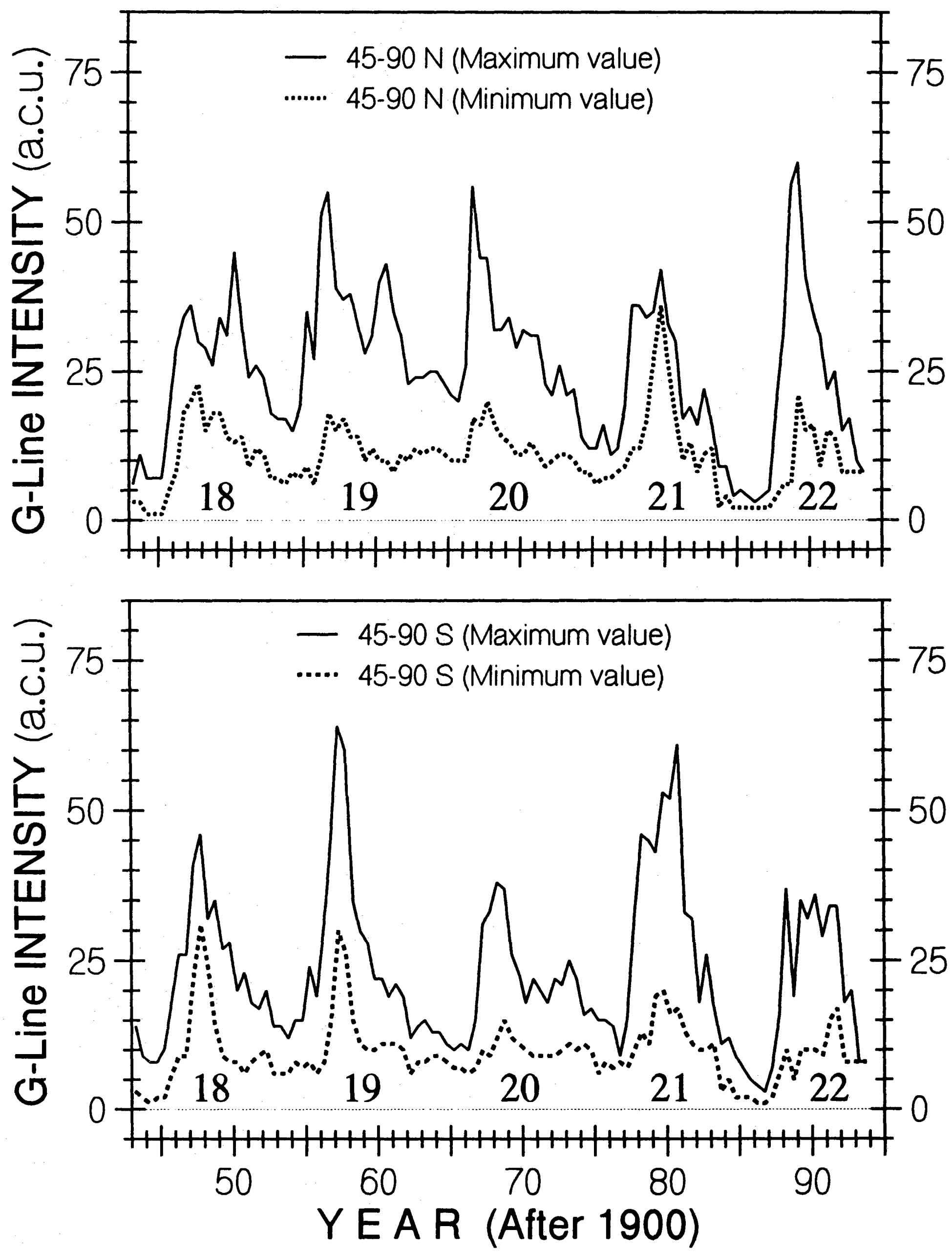


**Figure 9.** Long-term trends of the absolute extreme values of the green-line intensity observed in each hemispheric zone of the H-belt (North: upper panel; South: lower panel).

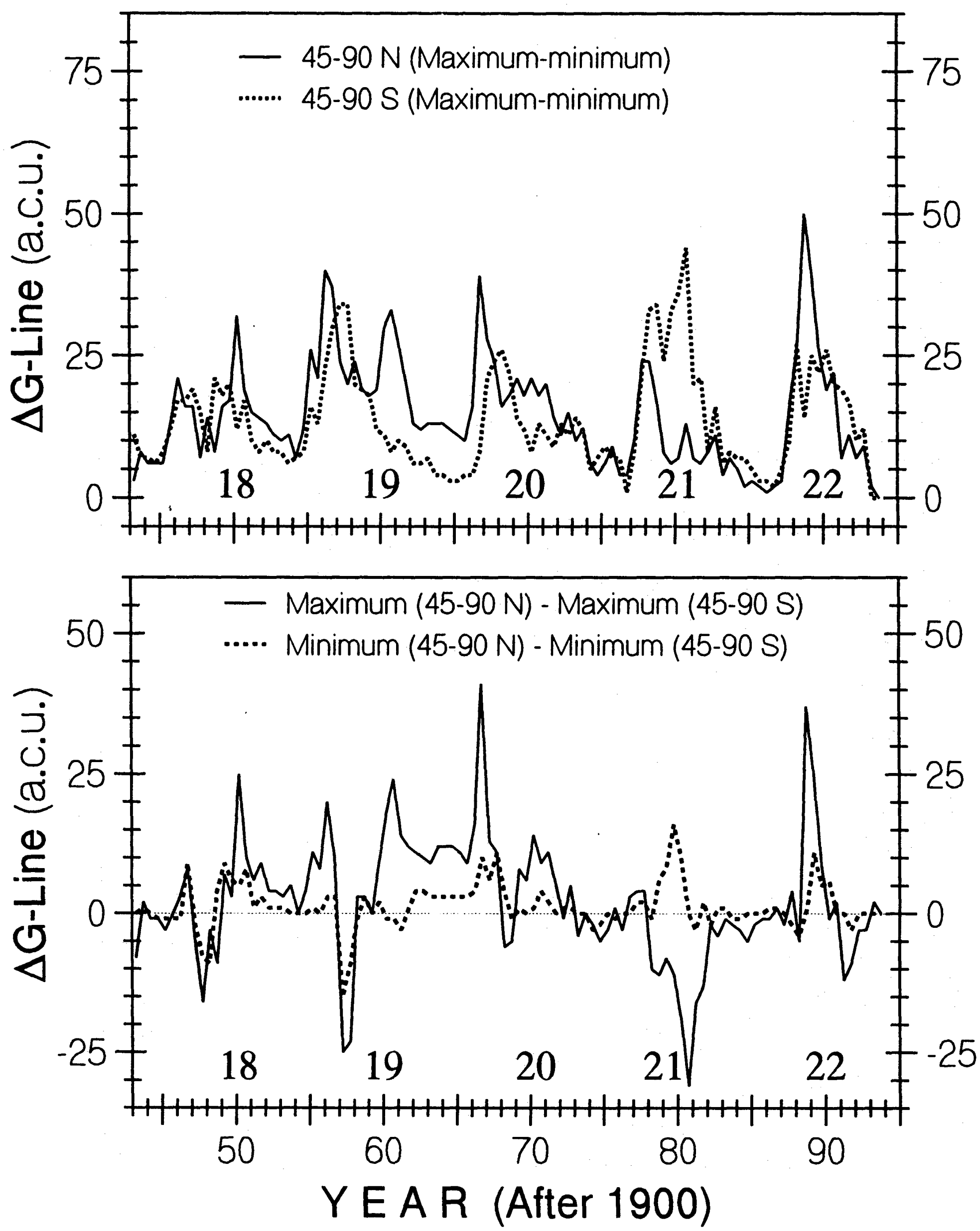


**Figure 10.** Long-term trends of the difference between absolute extreme values of the green-line intensity (upper panel) and absolute maxima or minima (lower panel) observed in each hemispheric H-belt.

shows an even-odd cyclic trend in the southern hemisphere, with even cycles less variable than the odd ones, as one can expect from Figure 9.

## 6. Conclusions

The study of the FeXIV 530.3 nm coronal line during almost five full consecutive solar cycles (1943 to 1993) reveals a nearly 22-year periodicity in the behaviour of the green corona. This is particularly true in terms of the data series made up of the minima and maxima of the green corona brightness observed in the heliographic latitudinal belts of +/− 20-40 and +/− 45-90 degrees (see Figure 3, central and bottom panels). There is a clear peak in excess for odd-cycle coronal activity in the minimum-value series for the former belt and in the maximum-value series for the latter one. This peak behaviour is connected with the ascending phases of the green corona brightness and clearly emerges from the southern hemispheric activity.

Our findings are in agreement with the sunspot-number rule, remarking that peak value in each even Rz cycle is lower than that one attained to the following odd cycle, at least, beginning with solar cycle No. 10 (Storini, 1995).

Swinson et al. (1986), re-examining past work on the north-south asymmetry of solar activity and using sunspot-area and relative sunspot number distributions, pointed out the existence of a 22-year periodicity related to the solar magnetic cycle. More precisely they observed that, in the period 1947-83:

"The northern hemisphere excess activity appears to peak about two years after sunspot minimum" (i.e. during the ascending phase of the sunspot-number cycle), "and the peak is more pronounced in even numbered cycles".

Our results seem to be very similar to those of Swinson et al. (1986), the solar source of these phenomena probably being the same. Hence, we confirm the even-odd cyclic behaviour in sunspot parameters they observed.

Implications of our findings, based on long-term data bases, for solar-terrestrial parameters will be discussed elsewhere. We only remark that our correlative plots (Figures 5 and 6) suggest that the near-ecliptic environment should be different during consecutive sunspot cycles and signatures of this phenomenon should be found in the interplanetary medium.

**Acknowledgements.** M.S. thanks Dr. J. Zverko, Director of the Astronomical Institute, Tatranská Lomnica, for his kind hospitality during the preparation of this paper. The work has been performed under Slovak-Italian collaboration within the scope of the CNR/SAV Agreement (1992-94).

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