Long-lasting differences between population of eastern and western coronal mass ejections

Marta Skirgiello

Space Research Center of Polish Academy of Science, Poland

Introduction

Various phenomena of solar activity are not uniformly distributed with heliographic longitudes. Analysis of solar data, such as daily sunspot numbers, parameters of solar wind, synoptic maps of photospheric magnetic fields etc., indicates that some solar longitudes are especially active. Also the CME occurrence rate reveals longitudinal dependence (Hildner et al., 1976; Skirgiello, 2005). The active longitudes in CME data manifest itself in such a way that during some part of solar rotation statistically more events appear at one limb, and during another part, more events are observed at opposite limb.

However, the detailed examination of CME occurrence rate for eastern and western limb separately shows much more complex pattern. CMEs are commonly considered to be related to the solar surface activity. Therefore, one should not expect any significant differences between eastern and western population on time-scales longer than the Carrington rotation period. That is not the case yet. In this study, SOHO LASCO 1996-2004 data has been examined and large "autonomy" of CME activity at both limbs has been found. Here, some outstanding examples will be presented.

Examples of long-lasting East-West differences in CME activity

During all the 9-year period of SOHO LASCO operation, the western events generally dominate. There were about 4% more events at western than at eastern limb. It is difficult to explain, considering an orbital revolution of the Earth about the Sun. Probably it could be explained by observational and instrumental effect (Skirgiello, 2005).

East-west asymmetry of CME occurrence rate calculated in 3-month time periods shows alternate domination of one and another limb (see Figure 1). Note that persistent domination of one limb is sometimes followed by domination of another limb after half a year (see for example 1996 – early 1998 and 2004 in Figure 1). Taking into account an annual revolution of the Earth it proves that increased activity persists in the same place, fixed in space (i.e. not undergoing Carrington rotation), which is observed from opposite

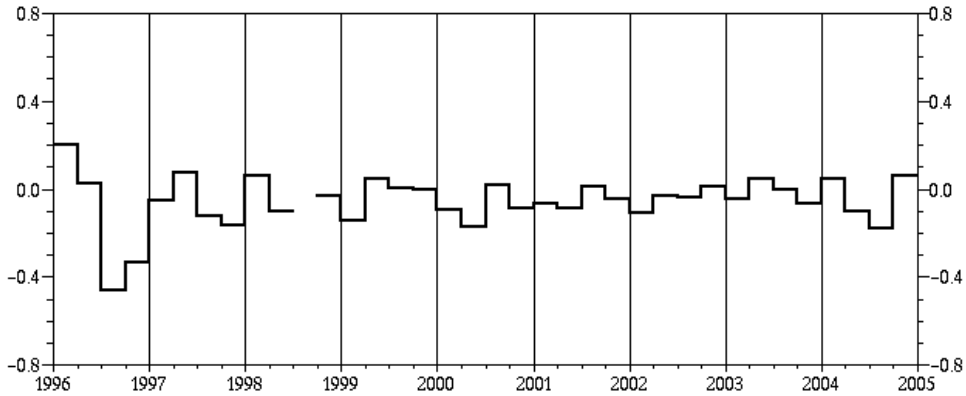

Figure 1. *East-west asymmetry of CME occurrence rate (defined as (N_E - N_W)/ (N_E + N_W), where N_E is the number of events observed at the eastern limb, N_W is the number of events observed at the western limb), calculated for 3-month periods of SOHO LASCO observations.*

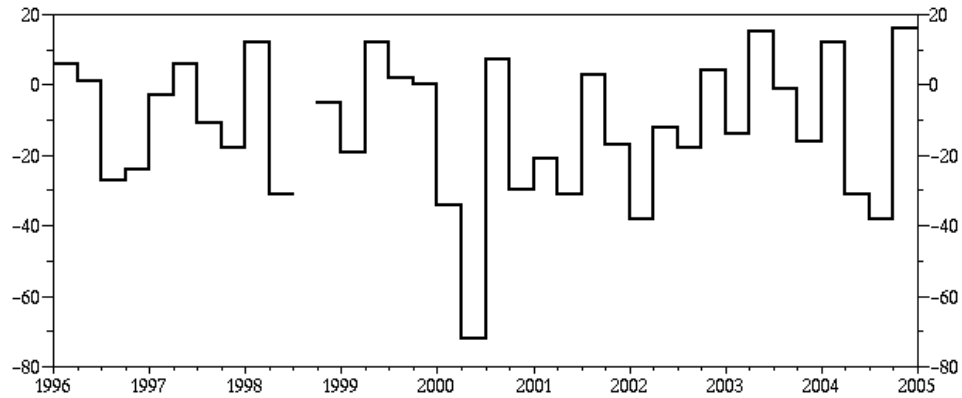

Figure 2. *The differences between the numbers of eastern and western CMEs calculated for 3-month periods of SOHO LASCO observations.*

side of the Sun. The seasonal variability is getting weak during the time of high solar activity (1999-2002). Figure 2 shows absolute values of differences between numbers of eastern and western CMEs, counted for 3-month periods. Except for the abrupt changes in early part of 2000 (preceding the solar polarity reversal in the solar activity maximum), the amplitude of seasonal variability is roughly constant. It means that the relatively immobile activity has rather constant contribution into overall CME activity. This constant contribution vanishes in abundance of events during high solar activity.

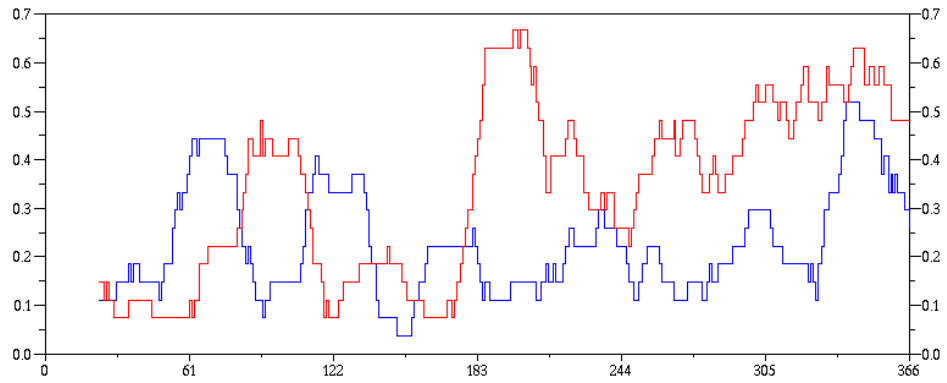

Figure 3a. *Running 27-day average number of CMEs for the eastern (blue) and western (red) limb, for 1996 (solar activity minimum). Note the alternate domination of one and the other limb, particularly conspicuous in early 1996, and persistent domination of western events in latter part of 1996.*

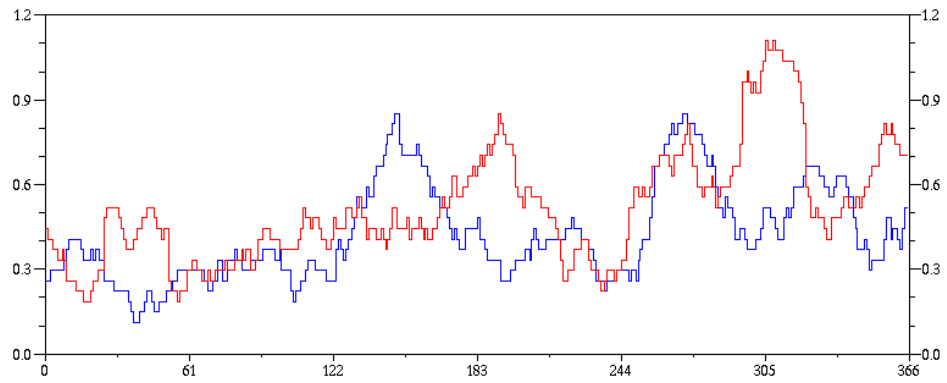

Figure 3b. *Running 27-day average number of CMEs for the eastern (blue) and western (red) limb, for 1997.*

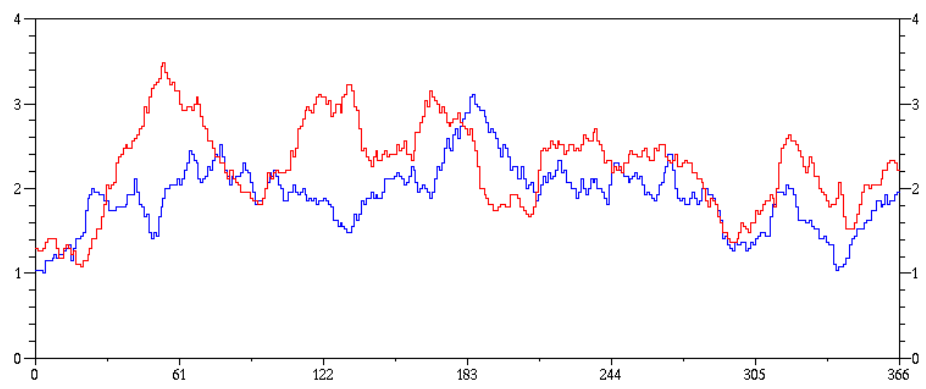

Figure 3c. *Running 27-day average number of CMEs for the eastern (blue) and western (red) limb, for 2000 (solar activity maximum).*

The course of the running 27-day average CME numbers shows noticeable differences in behavior of the CME activity at both limbs (An examples are shown in Figure 3a-c). Sometimes, one can see alternate domination at the eastern and western limb. A space between two consecutive maxima is somewhat over fifty days.

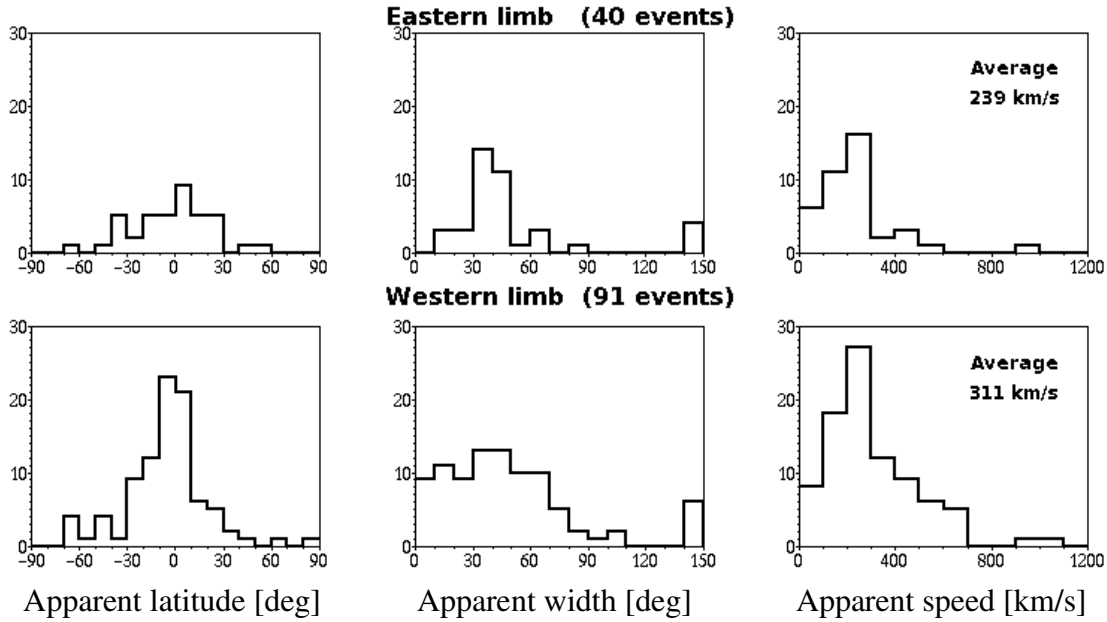

Figure 4. *Distributions of apparent latitudes (left panels), widths (middle panels), and speeds (right panels) for the eastern (blue) and western (red) CME populations in latter part of 1996.*

Long-lasting independence of the eastern and western CME behavior also manifests itself in different characteristics of events. As example, Figure 4 shows distributions of apparent latitudes, widths, and speeds of CMEs for each limb separately, for the period of permanent western domination in second part of 1996. One can see that in comparison with the eastern population at the western limb significantly more events appeared near the equator, there was definitely more events in two intervals of width: 0°-30° and > 50°, and they were on the average faster.

Conclusions

Examination of the 1996-2004 SOHO LASCO CME data for the eastern and western limb separately revealed various significant differences between both populations lasting even several months. It suggests that there must be some additional causes of CME triggering, different from those considered up to now, that is not-related to the solar surface activity. Some possible causes will be discussed in the paper being prepared.

References

Hildner, E., Gosling, J.T., MacQueen, R.M., Munro, R.H., Poland, A.I., and Ross, C.L.: Frequency of coronal transients and solar activity, Sol. Phys., 48, 127-135, 1976.

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