

On Geomagnetic Activity Forecasting

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Abstract

The mean-term forecasting of geomagnetic activity has been carried out at the geomagnetic observatory "Lviv" during 2001-2005. The forecasts are based on 27-day recurrence of solar and geomagnetic activity, their changes during the solar cycles and existence of the so-called "active longitudes on the Sun".

The existence of the "active longitudes on the Sun", especially during the decay phase of solar cycle, allows to improve the forecasting. The successful forecast of geomagnetic storms was in about 65% of cases. An accuracy of the forecast increases with decreasing geomagnetic activity.

Key words: geomagnetic activity, Wolf number, solar cycle.

The magnetic activity forecasting has been performed in the USA (Joselyn 1995). The forecasting was correct at 45%. The qualitative mean-term and long-term forecasting of geomagnetic activity is carried out at magnetic observatory "Lviv" (LVV). The magnetic activity strongly depends on solar activity modulated by daily, seasonal and yearly events in the magnetosphere and ionosphere, i.e., by the daily Earth rotation, the inclination of the Earth to the ecliptic plane and the Earth's rotation around the Sun. The eleven-year solar activity cycle is well known. The duration of solar cycles may change from nine to fourteenth years.

The main characteristics of all experimentally used solar cycles are shown in Table 1, where T is the duration of the cycle, T_1 the duration of the cycle growth phase, T_2 the duration of the cycle decay phase and ΔW the amplitude of Wolf numbers in cycles. A shorter growth phase corresponds to a greater amplitude of Wolf numbers in cycle and a longer decay phase, as shown in Table 1.

Table 1
The main characteristics of solar activity cycles

Cycle No.	T	T ₁	T ₂	ΔW
0	11	6	5	78
1	11	6	5	76
2	9	3	6	95
3	9	3	6	147
4	14	3	11	122
5	12	6	6	44
6	13	6	7	46
7	10	5	5	58
8	10	4	6	130
9	13	5	8	113
10	11	4	7	92
11	11	3	8	132
12	11	5	6	61
13	12	4	8	79
14	12	4	8	61
15	10	4	6	92
16	10	5	5	72
17	11	4	7	108
18	10	3	7	141
19	10	3	7	186
20	12	3	8	96
21	10	3	7	140
22	10	5	7	146
23		5		

Figure 1 shows the dependence of amplitudes ΔW on the ratio T_1/T_2 ; figures mean numbers of cycles. The correlation coefficient between these values is $r(\Delta W, T_1/T_2) = 0.83$ and its dispersion $\sigma_r = 0.06$. The high correlation between the amplitudes of Wolf number in cycles and ratios of duration the growth and decays phases allows to perform forecasting of decay phase duration when we know the growth phase duration and the amplitude. The twenty third solar cycle has the duration of growth phase of five years and its amplitude is $\Delta W = 102$. We have found the duration of decay phase T_2 equal to 6 years, as it seen from Fig. 1. It means that the minimum of 23 solar cycle will be in 2007.

The mean-term activity forecasting is based on 27-days reiteration of magnetic storms because of solar rotation round its axis. Such a forecasting is effective on the decay phase of solar cycles. Forecasting of storms with SSC by such a method is not successful. The storms with SSC may be forecast on solar bursts.

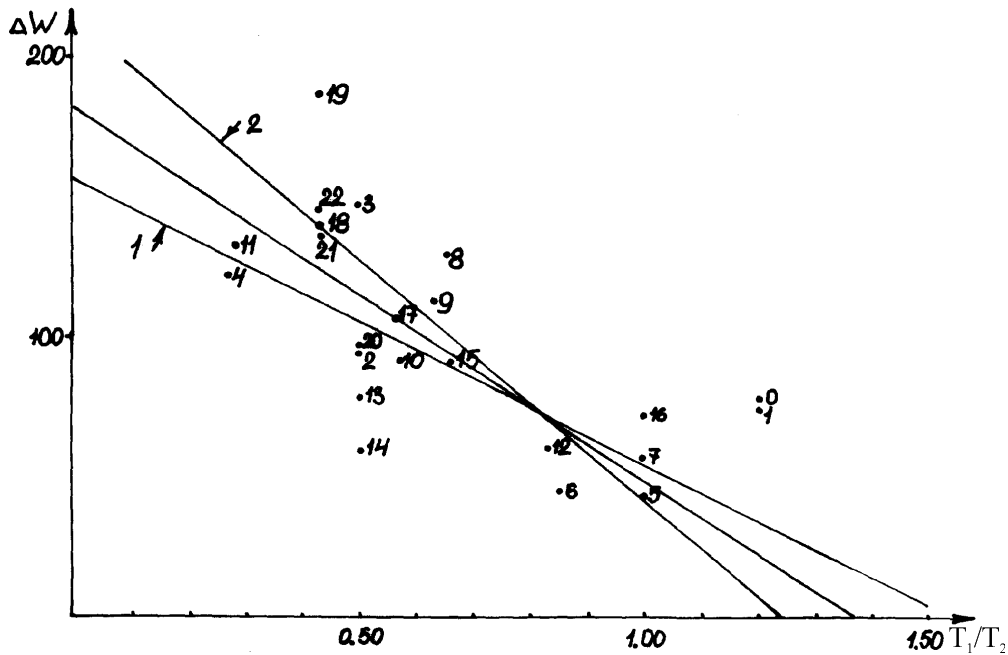


Fig. 1. Dependence of solar cycles amplitudes on relation T_1/T_2 .

The mean-term forecasting is fulfilled from January 2001 till December 2004 at magnetic observatory "Lviv" (LVV). The time interval was 1461 days. The forecast was for 426 disturbed days. In reality we observed 428 disturbed days. The forecasting was correct at sixty five percent of all days, because some days forecast as quiet were disturbed, and vice versa. The quality of forecasting for 2005 year was correct at 89%. This means that for the quietest interval, the forecasting is more successful. The forecasting is most successful if there exist the so-called active longitudes on the Sun. Two such areas existed during 2003-2004.

Conclusion

Long-term and mean-term forecasting of magnetic activity was performed. The minimum activity will be observed in 2007. Forecasting of the magnetic storms was successful at 65% for the observatory LVV.

References

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