Multi-Wavelength Investigations of Solar Activity
Proceedings IAU Symposium No. 223, 2004
A.V. Stepanov, E.E. Benevolenskaya & A.G. Kosovichev, eds.

DOI: 00.0000/X000000000000000X

Review of experimental results on geoeffectiveness of solar and interplanetary events

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Abstract. We present a brief review of published results on the geomagnetic storm effectiveness of CMEs and solar flares as well as of interplanetary events. Attention is drawn to the fact that the published values of storm effectiveness are in conflict with one another. Possible reasons of their differences are discussed.

Keywords. Sun: coronal mass ejections and flares, Solar wind, Geomagnetic storms

1. Introduction

At the present time the quantity of publications on solar event – geomagnetic storm connections has steadily grown. However, attention is drawn to the fact that these publications contain strongly diverging estimations of geoeffectiveness of those or other solar phenomena. For example, estimations of CME geoeffectiveness change from 35-45% up to 83-100% (see, for instance paper by Yermolaev & Yermolaev (2003b) and references therein). The aim of our paper is to compare different methods of solar-terrestrial physics and to explain exiting discrepancies in published results.

2. Results and conclusions

We made a review of published results and found that different results arise due to differences in the methods used to analyze the data: (1) the direction in which the events are compared, (2) the pair of compared events, and (3) the methods of the event classifications (see preliminary version of study by Yermolaev & Yermolaev (2003b)). We selected papers (see Fig.1) using (1) the analysis on direct and back tracing of events, and (2) solar (coronal flares and CMEs), interplanetary (magnetic clouds and ejecta) and geomagnetic disturbances (storms on Dst and Kp indices). The classifications of magnetic storms by the Kp and Dst indices, the solar flare classifications by optical and X-ray observations, and the classifications of different geoeffective interplanetary events are compared and discussed by Yermolaev and Yermolaev (2003b). Taking into account this selection, all published results on the geoeffectiveness agree to each other in each subset: $CME \rightarrow Storms$ – 35-50%, $CME \rightarrow MC, Ejecta$ – 60-80%, $MC, Ejecta \rightarrow Storm$ – 50-80%, $Storm \rightarrow MC, Ejecta$ - 30-70%, $MC, Ejecta \rightarrow CME$ - 50-80%, $Storm \rightarrow CME$ – 80-100%, $Flare \rightarrow Storms$ – 30-40% and $Storms \rightarrow Flare$ - 50-80%. Higher values of correlations were obtained by back tracing, that is, by method, in which they were defined as the probability of finding candidates for a source of geomagnetic storms among CMEs and flares, and, strictly speaking, these values are not true estimates

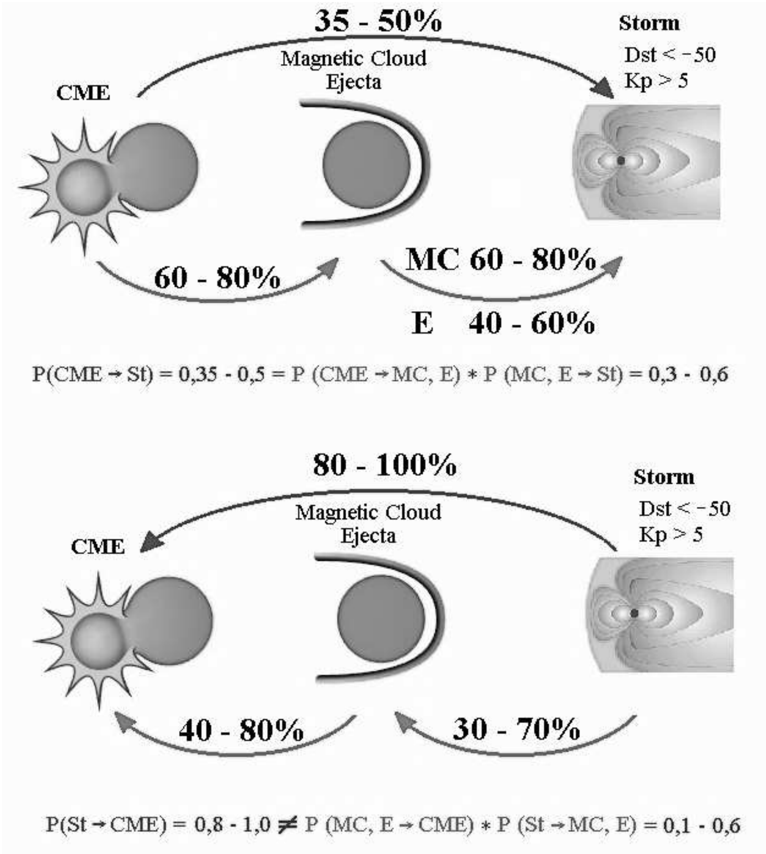

Figure 1. Schematic view of correlations between CME, MC/ejecta and magnetic storms for direct (top panel) and back (bottom panel) tracings. Relations of probabilities for 1– and 2–step tracings are shown below each panels

of the geoeffectiveness. The latter results are also in contrast with the results of the two-stage tracing of the events: first a storm - an interplanetary disturbance, and then an interplanetary disturbance - a CME/flare (see Fig.1).

Estimations of CME (35-50%) and solar flare (30-40%) geoeffectiveness are close to each other and can be partially a result of random processes (Yermolaev and Yermolaev (2003a)) and, therefore, the forecast of geomagnetic conditions on the basis of observations of the solar phenomena can contain high level of false alarm. To increase reliability of the forecast, the further analysis of the solar data and revealing of characteristics which would allow us to select the phenomena among CMEs and/or flares with higher geoeffectiveness are required.

Acknowledgements

Paper is supported in part by Physical Department of Russian Academy of Sciences, Program N 18, and RFBR, grant 04-02-16131-a.

References

Yermolaev, Yu. I., Yermolaev, M. Yu. 2003a *Cosmic Research* **41**, 105–109.
Yermolaev, Yu. I., Yermolaev, M. Yu. 2003b *Cosmic Research* **41**, 539–549.