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Geomagnetic response to solar activity: summary for the last ten years and analysis of selected cases

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The main sources of geomagnetic disturbances are either coronal mass ejections (CMEs), which are usually connected with eruptive flares, or high-speed streams of solar wind from coronal holes.

Development of an eruptive flare and ejection of coronal mass is accompanied by magnetic reconnection. The evidence of reconnection can be found in a broad spectrum of observations. The observations of X-rays and radio bursts were used in our study. The geoeffectiveness of solar X-ray flares was initially analysed on data from the period 1996 – 2004 [1]. It was shown that the probability of geomagnetic response depends on the solar flare class and its position on the solar disc. The flares in the central region were found to be more geoeffective. The probability further increased if the flare was accompanied by Type II and/or Type IV of solar radio bursts. In the next step a neural network model was developed to determine the probability, with which flares will be followed by the geomagnetic response of a particular intensity. Enhancement of solar energetic particle flux was added to the set of input parameters. The results indicated that X-ray flares accompanied by solar radio bursts represent a good proxy of CMEs [2, 3]. This conclusion was now confirmed by the data from the period 2005 – 2012.

Coronal holes are stable formations that can survive over several solar rotations. Corotating interaction regions (CIRs) between fast and slow solar wind can thus periodically pass over the Earth and cause recurrent geomagnetic storms. This periodicity makes the forecasts of the geomagnetic disturbances much easier [4] than in the case of eruptive phenomena.

Our analysis confirmed that the strongest magnetic storms are caused by CMEs. Nevertheless, many geomagnetic disturbances in the active part of solar cycle are influenced by sequences of CMEs and CIRs, which increase their strength.

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