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The Changing Correlation between Sunspot and Geomagnetic Activity – Link to the Solar System Dynamics

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Since the beginning of the XX century, both the geomagnetic activity as expressed by aa geomagnetic index and the solar activity measured by the sunspot numbers have increased, and their long-term variations are very similar. In the same time, studies of the variations of aa and sunspot number in the 11-year solar cycle show that their short-term correlation has been steadily decreasing, from 0.76 in the period 1868-1890, to 0.35 in the period 1960-1982, while the lag has increased from 0 to 3 years.

Two types of solar agents are mainly responsible for geomagnetic disturbances – long-lived coronal holes, regions of open solar magnetic field and sources of high speed solar wind (HSS) related to recurrent geomagnetic activity, and coronal mass ejections (CME's), regions of closed solar magnetic field and related to sporadic geomagnetic activity. The coronal mass ejections can be additionally divided into magnetic clouds (MC's) and non-magnetic clouds, according to the presence or absence of magnetic field rotation. We compare the geoeffectiveness of HSS's, CME's and MC's. The average geoeffectiveness is highest for MC's and lowest for non-MC CME's. The average geoeffectiveness of MC's is strongly solar cycle dependent, but their number is relatively low, except around sunspot minimum when their geoeffectiveness is small. The geoeffectiveness of HSS's and non-MC CME's practically doesn't change throughout the cycle, however, their relative abundance changes, and so does their cumulative geoeffectiveness. Therefore, the long-term decrease in the correlation between solar and geomagnetic activity is mainly due to the increasing number of HSS's on the declining phase of the sunspot cycle, which in turn is determined by the long-term changes in the tilt angle of the heliospheric current sheet related to the movement of the Sun about the barycentre of the Solar system.

Keywords: solar activity; geomagnetic activity; coronal mass ejections; magnetic clouds, high speed solar wind.