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What determines the severity of space weather?

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Thanks to the works of a number of scientists it is known that severe space weather can cause extensive social and economic disruptions in the modern high-tech society. It is therefore important to understand what determines the severity of space weather, and whether it can be predicted. We present the results obtained from the analysis of solar-geophysical data during 30 space weather events that occurred since 1957 and produced geomagnetic storms of intensity less than -275 nT, and the Carrington event of 1859. The results seem to indicate that (1) space weather can become severe occasionally (7 since 1957) as experienced by satellite systems, Earth-based systems and Earth's environment. (2) It is the impulsive energy (or power) at the leading edge of the CMEs (coronal mass ejections) mainly due to impulsive leading edge velocity and partly due to density that determines the severity of space weather in the heliosphere; the higher the impulsive velocity (sudden increase by over 275 km s-1 over the background), the more severe the space weather. (3) Such CMEs with IMF Bz also southward from the leading edge cause severe space weather on Earth though the magnitude of southward Bz does not seem important, and the minimum impulsive velocity for severe space weather on Earth seems higher than that for severe space weather in heliosphere. (4) CMEs having northward IMF Bz at the leading edge do not seem to cause severe space weather on Earth though they can lead to geomagnetic storms of long duration main phase with intensity less than even -420 nT. Measurements of the rate of energy release during CME eruption (or measurements of the velocity and density of CMEs as close to the Sun as possible) and orientation of IMF Bz in CMEs may be used for predicting severe space weather.

Keywords: Severe space weather, solar flare, CME, geomagnetic storm