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Modeling external magnetic field dynamics during extreme events

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The use of many geomagnetic activity models for examining extreme events can easily lead to incorrect estimates. This is due to the fact that most of these models have been established on the basis of statistical processing of space-age data sets that hardly contained any extreme values of the solar wind velocity and density and interplanetary magnetic field, because the data for extreme magnetic storms is rather scarce. For example, only one super-intense magnetic storm has been recorded (geomagnetic index Dst=-640 nT, March 13, 1989) during the space-age. One of such extreme geomagnetic event is the famous Carrington storm on 2 September 1859. For modeling the magnetic field recorded at the Colaba Observatory during this storm we used a new self-consistent version of a time-dependent magnetospheric paraboloid model PM [Feldstein et al., J. Geophys. Res., 2005, A11, A11214 10.1029/2004JA010584]. The model is valid for storms of any intensity and quantifies the contribution of current on the magnetopause, ring current, and magnetotail current to Dst variation. The result of our modeling suggests rather good agreement with the magnetic storm dynamics, which include a very rapid and big decrease in the horizontal intensity of the geomagnetic field during the main phase, followed by a sharp recovery. The main features of the storm are related to temporal dynamics of the magnetospheric tail current system. It is characterized by the rapid Earthward-directed propagation of the front edge of the plasma sheet in the main phase of the storm to a distance of 2-3 RE from the Earth's center and the subsequent rapid return back to a distance of $\sim 7-8$ RE in the magnetospheric tail.