Geophysical Research Abstracts
Vol. 18, EGU2016-10338, 2016
EGU General Assembly 2016

Simulation of Theoretical Most-Extreme Geomagnetic Sudden Commencements

Daniel Welling (1), Jeffrey Love (2), Michael Wiltberger (3), Erin Rigler (2), and Tamas Gombosi (1)

(1) University of Michigan, Dept. of Climate and Space, Ann Arbor, MI, United States (dwelling@umich.edu), (2) Geomagnetism Program, U.S. Geological Survey, Denver, CO, United States, (3) National Center for Atmospheric Research High Altitude Observatory, Boulder, CO, United States

We report results from a numerical simulation of geomagnetic sudden commencements driven by solar wind conditions given by theoretical-limit extreme coronal-mass ejections (CMEs) estimated by Tsurutani and Lakhina [2014]. The CME characteristics at Earth are a step function that jumps from typical quiet values to 2700 km/s flow speed and a magnetic field magnitude of 127 nT. These values are used to drive three coupled models: a global magnetohydrodynamic (MHD) magnetospheric model (BATS-R-US), a ring current model (the Rice Convection Model, RCM), and a height-integrated ionospheric electrodynamics model (the Ridley Ionosphere Model, RIM), all coupled together using the Space Weather Modeling Framework (SWMF). Additionally, simulations from the Lyon-Fedder-Mobarry MHD model are performed for comparison. The commencement is simulated with both purely northward and southward IMF orientations. Low-latitude ground-level geomagnetic variations, both B and dB/dt, are estimated in response to the storm sudden commencement. For a northward interplanetary magnetic field (IMF) storm, the combined models predict a maximum sudden commencement response, Dst-equivalent of +200 nT and a maximum local dB/dt of $\sim$200nT/s. While this positive Dst response is driven mainly by magnetopause currents, complicated and dynamic Birkeland current patterns also develop, which drive the strong dB/dt responses at high latitude. For southward IMF conditions, erosion of dayside magnetic flux allows magnetopause currents to approach much closer to the Earth, leading to a stronger terrestrial response (Dst-equivalent of +250 nT). Further, high latitude signals from Region 1 Birkeland currents move to lower latitudes during the southward IMF case, increasing the risk to populated areas around the globe. Results inform fundamental understanding of solar-terrestrial interaction and benchmark estimates for induction hazards of interest to the electric-power grid industry.