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Interplanetary Solar Wind and Magnetosphere-Ionosphere Drivers of Localized Geomagnetic Field Variations

C. M. Ngwira[1,2]
(1) The Department of Physics, Catholic University of America, Washington, DC, USA, e-mail: chigomezyo.ngwira@nasa.gov
(2) Space Weather Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD, USA

Interaction of solar wind with the Earth's magnetosphere-ionosphere coupled system is a critical component in the space weather chain. Understanding this interaction is a basic aspect of space weather research. One of the most interesting and important features of this interaction is the production of localized rapid geomagnetic variations (dB/dt) on the ground, which are important for geomagnetically induced currents (GICs). Not only are these localized events a major space weather target but they are also a reflection of the fundamental magnetospheric and ionospheric complex processes.

A key aspect of these localized events that continues to challenge our understanding pertains to their mechanism of production. In this study, we analyze over 20 identified localized events during the period 2000 to 2023 to address the science question above. These events are distributed at different times of the day, latitude, and longitude. Firstly, explore their interplanetary solar wind drivers. A superposed epoch study of these events was performed for different solar wind and IMF parameters. Results show that the localized dB/dt instances appear to be consistent with some form of solar wind fluctuation. This suggests that these events are externally driving by some solar wind processes. This result is different to the finding in prior studies. However, it is important to emphasize here that our events were particularly selected to be during activity geomagnetic periods and do not include non-storm periods, whereas prior work was more focused on non-storm periods. Secondly, we investigate their magnetosphere and ionosphere related processes using a multi-instrument approach. We focus on understanding the type of processes (e.g., substorms, streamers, injections, sudden commencement) that are associated with these events.