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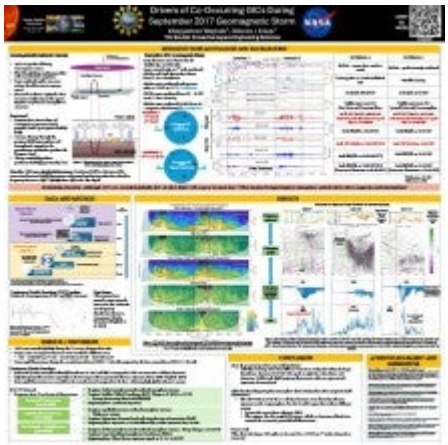
Geomagnetically induced currents (GICs) were globally recorded during the long-duration geomagnetic storm of September 2017. On September 7th, a 30A GIC spike was recorded at the Eastern US station immediately following the shock arrival. Twelve hours later, sustained GICs lasting over an hour were observed across the US, Finland, and New Zealand. Six hours later, a 30A spike occurred at the Mäntsälä pipeline with no identifiable upstream trigger. We investigated the multiscale magnetospheric drivers of these significant GIC events using wavelet analysis and data fusion.

Our analysis revealed three key findings: (1) The 30A spike in the US was driven by shock-induced injection in the duskside magnetosphere, likely amplified by under-shielding conditions due to a weak ring current; (2) the sustained GICs were caused by electric field disturbances in the inner magnetosphere driven by substorm injections; and (3) localized duskside injections drove the 30A spikes in the Mäntsälä pipeline.

This study underscores the importance of considering local time and storm phases to predict significant GIC events and mitigate their impact on infrastructure. Although no damage was reported for the 2017 storm, persistent GICs for a long duration can produce excessive stress on critical ground-based infrastructure, potentially reducing the lifespan of the power grid components. Hence, there is a need to prepare for long-duration storms like the 2017 event as much as the Carrington event.



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