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The Correspondence between Sudden Commencements and Induced Currents; Insights from New Zealand

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The impact of a solar wind pressure pulse on the Earth's magnetosphere causes rapid changes in the surface geomagnetic field, often termed Sudden Commencements (SCs). Such magnetic field changes can induce potentially damaging currents (GICs) in conducting infrastructure on the ground, and therefore represents a critical space weather hazard. Unfortunately, GICs are not often measured directly. Instead, large GICs are often inferred from easier-to-measure large magnetic perturbations. In this work we examine the coupling between SCs and observed GICs in New Zealand, where both measurements are available.

Overall, we find excellent correlations between the maximum magnetic perturbations and GICs during SCs. Nevertheless, if the SC precedes a geomagnetic storm, then it is associated with 22% larger GICs, controlling for the size of the magnetic deflection. Further, if the SC is observed when New Zealand is on the dayside of the Earth then the associated GICs are 30% greater. We investigate these findings, and attribute them to the full vector directionality of the strongest magnetic field deflection and the full rate of change of the magnetic field of the SC, beyond that recorded in the one minute resolution data.

Finally, we show that based on the properties of the solar wind shock, a skilful prediction can be made as to whether an SC and/or a geomagnetic storm will be observed, which may be used to guide interpretation of the coupling between the magnetic deflection and GICs.