Multi-point Observations of Sudden Impulses and Implications for Signal Travel Time in the Magnetosphere

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The Earth's magnetosphere occasionally experiences sudden movements from localized sources. For example, the impact of the interplanetary shock on the magnetosphere starts from a localized region on the dayside magnetopause, where the perturbations rapidly propagate inside the magnetosphere as the pressure front moves farther away from the Sun. The impulses generated from these sources propagate through the inhomogeneous plasma and can be detected in many corners of the magnetosphere. These impulses often mark the beginning of large-scale reconfigurations in the magnetosphere and the ionosphere, such as magnetic/ionospheric storms and substorms. The propagation of these impulses, such as that through MHD waves, is fast but not instantaneous. The propagation paths in the highly inhomogeneous magnetosphere may not be straightforward. Nonetheless, past studies have demonstrated that the impulse propagation in the dayside magnetosphere can be characterized by the Tamao model.

In this study, we examine the signatures of sudden impulses in the data from a network of spacecraft in the magnetosphere, including THEMIS, Van Allen Probes, MMS, Geotail, and GOES. The ACE and Wind data are also used for solar wind conditions. Observations from Polar, FAST, GOES, Cluster, Swarm, IMP-8, and ground-based magnetometers are also examined whenever they are available. The observations of impulse propagation time will be compared against the modeled Tamao travel time to understand how much the two agree with each other and how the comparison varies with the properties of the solar wind discontinuity.