

Phenomenological approach to GIC risk alert: Large magnetic deflections observed at Memambetsu Japan during major geomagnetic storms

*Shinichi Ohtani¹, Ryuho Kataoka², Shinichi Watari³

1. The Johns Hopkins University Applied Physics Laboratory, 2. National Institute of Polar Research, 3. National Institute of Information and Communications Technology

On 14-15 December 2006 an intense geomagnetic storm took place with a minimum Sym-H of -211 nT, during which a large westward magnetic disturbance was observed at Memambetsu (MMB) Japan (GM Lat: 35.7; GM Lon: 212.2). Watari et al. [2009] found that the associated magnetic variations were well correlated with local GIC signatures, and the event turned out to be the largest GIC event observed during the two-year period of the GIC measurement they conducted at MMB. The event was unique as it was observed in the late morning sector; other GIC events were observed predominantly in the evening-to-midnight sector. Motivated by this original study we examined the 30-years' worth of MMB geomagnetic data along with various data sets available for individual events. The result shows that similar magnetic disturbances were observed almost exclusively in the late morning sector but repeatedly during severe geomagnetic storms. We also found that they can be probably attributed to a large-scale wedge current system formed in the morning sector following nightside substorm activity. Therefore, as preconditions for such extreme geomagnetic disturbances, we suggest (a) major enhancement of the solar wind driver, (b) morning location of the target site, (c) preceding substorm initiation on the night side, and possibly (d) winter season (for a reason to be presented). These conditions may serve as critical elements for warning in advance GIC events such as observed at MMB in the December 2006 event.

Reference: Watari S, Kunitake M, Kitamura K, Hori T, Kikuchi T, Shiokawa K, Nishitani N, Kataoka R, Kamide Y, Aso T, Watanabe Y, Tsuneta Y (2009), Measurements of geomagnetically induced current in a power grid in Hokkaido, Japan, Space Weather 7, S03002, doi:10.1029/2008SW000417.

Keywords: geomagnetically induced currents (GIC), geomagnetic storms, field-aligned currents