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Anomalous occurrence features of the preliminary impulse of geomagnetic sudden commencement (SC) in the SAA region

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A sudden increase in the solar wind dynamic pressure can generally cause a geomagnetic sudden commencement (SC) which shows a step-like increase in the H component in low latitudes. The global distribution of SC waveform strongly depends on both magnetic latitude and local time. At middle and subauroral latitudes in the afternoon sector and dip equator in the daytime sector, the SC waveform shows a preliminary reverse impulse (PRI) followed by a main impulse (MI) [e.g., Araki, 1977]. The PRI amplitude tends to decrease with decrease of magnetic latitude, and the occurrence probability becomes almost zero near 20 degrees (geomagnetic latitude) [e.g., Matsushita, 1962; Araki, 1977, 1994; Kikuchi and Araki, 1985]. However, in the present data analysis, it is found that the PRI phenomena are frequently observed at the SMA station located near the center of the South Atlantic Anomaly (SAA) region. Then, in the present study, we investigated 3163 SC events identified in the SYM-H index within a period from January 1996 to December 2008 in order to reexamine the occurrence probability of the PRI phenomena in low latitudes and to clarify difference of magnetic field variations during SC in between the SAA and other low-latitude regions.

In the present analysis, we used geomagnetic field data with time resolution of 1 second obtained from 8 stations (OKI (37.97 degrees: dip latitude), YAP (3.29 degrees), PON (1.01 degrees), CEB (5.79 degrees), ANC (1.43 degrees), SLZ (-2.96 degrees), EUS (-11.99 degrees), SMA (-34.35 degrees)) belonging to the NICT NSWM [Kikuchi et al., 2008] and CPMN [Yumoto and the CPMN group, 2001] magnetometer networks. Here, SC events have been identified from the following two criteria: (1) a rapid increase of the SYM-H value with the amplitude of more than 5 nT within 10 minutes, and (2) no Pi 2 phenomena around the onset time. We also referred solar wind data obtained from the IMP-8, Geotail, Wind and ACE satellites in order to identify a sudden enhancement of solar wind dynamic pressure.

As a result, the occurrence rate of the low-latitude PRI signature became the maximum around noon in both the Pacific Ocean (OKI) and SAA (SMA) regions. This distribution was almost the same tendency as that in the equatorial region. This result implies that the PRI magnetic signature is produced by the ionospheric currents driven by the dusk-to-dawn polar electric field. Moreover, the occurrence rate at SMA was enhanced significantly with its peak value of about 80 %. This peak value was twice as large as that at OKI in the Pacific Ocean region. The distribution of the low-latitude PRI amplitude at SMA showed a significant enhancement in the daytime sector (06-1 8 h, MLT), compared with that at OKI. The peak value around noon at SMA was 3.0 times larger than that at OKI. This result suggests that the PRI amplitude tended to be enhanced near the center of the SAA region.

The calculation result of the IRI-2007 and NRLMSISE-00 models showed a significant enhancement of the ionpsheric conductivities in the SAA region, where the ambient magnetic field is a half value of the Pacific Ocean region. The ratio of the height-integrated conductivities (SMA/

OKI) was nearly the same as that of the PRI amplitude ratio. The difference value was 0.5 of 3.0 around the noon sector (08-16 h, MLT). The difference value corresponds to 3-8 % of the conductivity ratio for each magnetic local time. This result suggests that the weakness of the ambient magnetic field intensity in the SAA region leads to the significant enhancement of the ionospheric conductivities.

Keywords: geomagnetic sudden commencement, the South Atlantic Anomaly region, preliminary reverse impulse, ionospheric conductivity, magnetic field intensity, occurrence rate