Ev-005 Room: C510 Time: June 8 10:10-10:25

Global magnetic perturbations during an SC caused by a 3-D current circuit in the magnetosphere and ionosphere

Takashi Kikuchi[1], Satoru Tsunomura[2], Kumiko Hashimoto[3], Kenro Nozaki[3]

[1] Communications Res. Lab., [2] JMA, [3] CRL

The SC was preceded by a PPI at noon mid latitudes, and by a PRI at the magnetic equator. We subtracted the step-like SC at a lower latitude from the SC at mid and equatorial latitudes, to identify the magnetic fields caused by the FACs and ionospheric currents. We found that the mid-latitude PPI was composed of a positive impulse (true-PPI) and a succeeding negative impulse. Analysis of 46 well-defined PPI events showed that they occurred in afternoon hours as well as in morning hours. The afternoon PPIs occurred exclusively in winter. Model calculations indicate that the FACs played a predominant role at mid latitudes in the winter hemisphere. Consequently, the true-PPIs and succeeding negative impulses were dominated by the magnetic effects of the FACs.

The geomagnetic sudden commencement (SC) beginning at 0246UT on February 18, 1999 was preceded by a preliminary positive impulse (PPI) at noon (1146 LT) mid latitudes, Memambetsu (34.9 geomagnetic latitude (GML)) and Kakioka (26.9 GML), and by a preliminary reverse impulse (PRI) at the magnetic equator, Yap (-0.3 GML) and Guam (4.9 GML), in the same local-time sector. The ground magnetic perturbations are a result of an integration of magnetic fields caused by the Chapman-Ferraro currents, field-aligned currents (FACs) and ionospheric currents. By assuming that the step-like SC at a lower latitude (Okinawa (14.5 GML)) was entirely caused by the Chapman-Ferraro currents, we subtracted this magnetic field from the SC at mid and equatorial latitudes, to identify the magnetic fields caused by the FACs and ionospheric currents. We found that the mid-latitude PPI was composed of a positive impulse (true-PPI) with a time scale of less than 1 min and a succeeding negative impulse (several min), with their amplitudes decreasing with decreasing latitudes. The true-PPI occurred simultaneously with the equatorial PRI, and the succeeding negative impulse occurred with the DP2-type ionospheric current component of the main impulse of the SC (DP (MI)). Analysis of 46 well-defined PPI events detected at Memambetsu over the period 1971-1995 showed that they occurred in afternoon hours as well as in morning hours. The afternoon PPIs occurred exclusively in winter, while there was no significant seasonal dependence in the morning PPIs. The morning PPIs could have been explained by the conventional SC model basing on the Chapman-Ferraro currents and the DP2-type ionospheric currents, but none of the afternoon PPIs fit this model. To interpret the afternoon PPIs, we apply the Biot-Savart law to a three-dimensional current circuit including field-aligned currents (FACs) in addition to the Chapman-Ferraro currents and DP2-type ionospheric currents. Model calculations were made for the ground H-component magnetic fields caused by the FACs and ionospheric currents by taking into account a seasonal asymmetry in the ionospheric conductivity. The results indicate that the FACs played a predominant role at mid latitudes in the winter hemisphere, while the ionospheric currents played a predominant role in the summer hemisphere as well as at the dayside dip equator. Consequently, the true-PPIs and succeeding negative impulses were dominated by the magnetic effects of the FACs that carry the electric fields responsible for the PRIs and DP (MIs), respectively. The FACs may have been associated with transient Alfvén waves generated inside the dayside magnetopause (< 1 min) and with an enhancement of the magnetospheric convection in the equatorial plane of the magnetosphere (> 1 min).