57 # 2917. Seasonal dependence of geomagnetic field variations on the ground associated with geomagnetic sudden commencements

IUGONET
Inter-university Upper atmosphere
Global Observation NETwork

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1. Introduction

1.1 Waveform and amplitude of geomagnetic sudden commencement and its current system during the main impulse

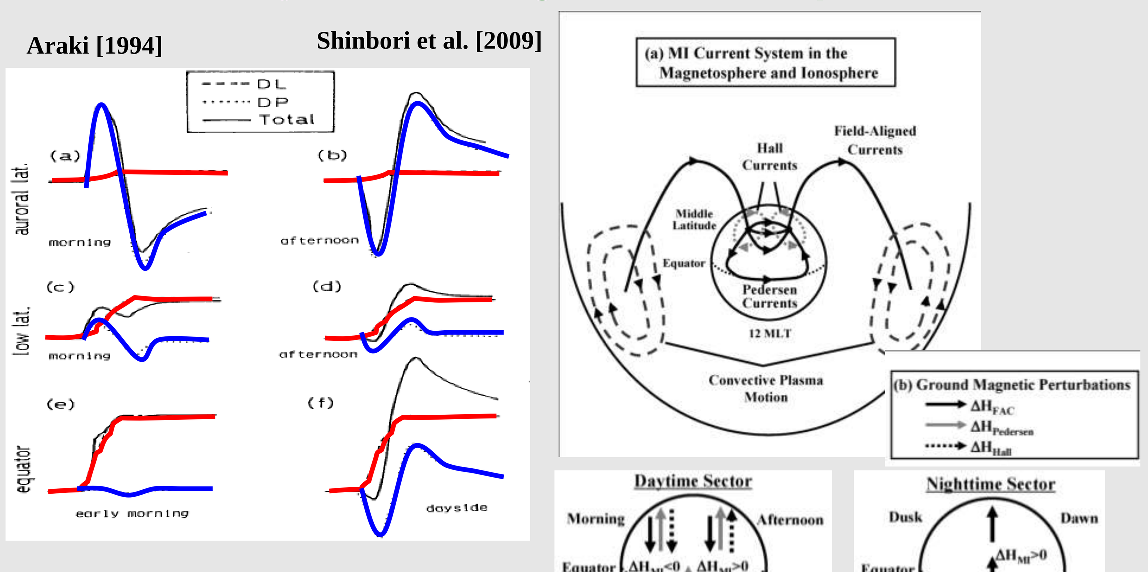

Fig 1. Schematic pictures of SC waveform and large-scale current system during the main impulse

- The SC waveform and amplitude on the ground depends strongly on both the magnetic latitude and local time.
- The second pulse observed at the auroral latitude and magnetic equator, which is called the main impulse (MI), is due to the magnetic effect produced by the region-1 type of the ionospheric and field-aligned currents.

1.2 Seasonal variation of the SC-MI amplitude

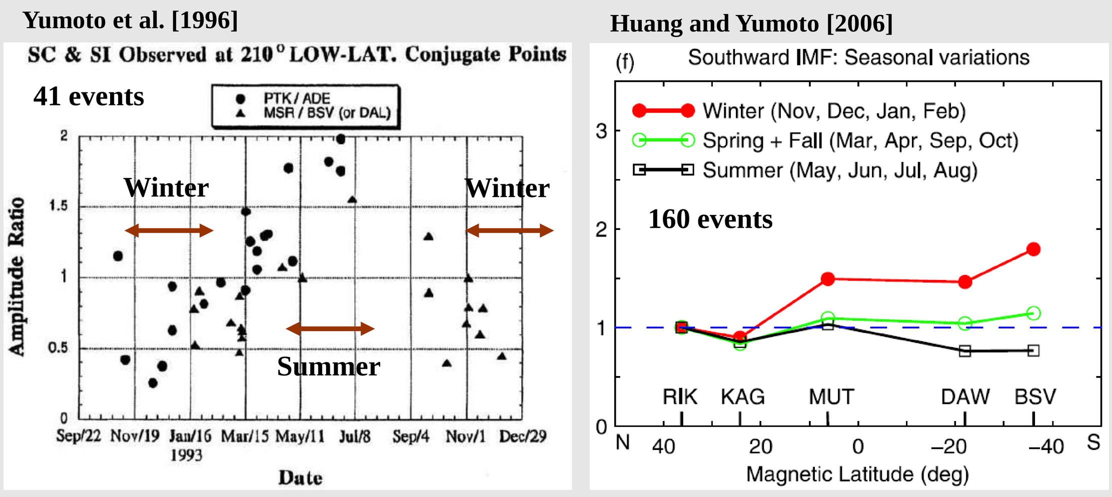

Fig 2. Time-series plot of the SC-MI amplitude ratio of the northern to southern hemispheres during Sep. 22 , 1993 – Dec. 29, 1994, and its latitudinal dependence of the north-south asymetory in the winter, spring + fall and winter.

- Both the previous studies showed that the SC amplitude is more enhanced in the summer, compared with that in the winter.
- However, the seasonal dependence of the diurnal variation of the SC amplitude from the high latitude to the magnetic equator remains unknown.

2. The purpose of this study

2.1 Problems of previous works

Due to the shortage of the integrated analysis of the long-term geomagnetic field data with high time resolution obtained from many observation points and their data accessibility, the previous works could not systematically investigate magnetic latitude and local time variations of the SC-MI amplitude and its seasonal variation from high latitudes to the magnetic equator. Then, as several major problems,

1. Global features of the SC-MI amplitude remains unknown.
2. Detailed features of seasonal dependence of the diurnal variation have not been clarified yet as function of magnetic latitude and local time.
3. Understanding the nature of SC-MI current system is insufficient.

2.2 The purpose of this study

◎In order to clarify the magnetic latitude and local time variations of the SC-MI amplitude and its seasonal variation, we analyzed geomagnetic field data with high time resolution of 1 second in a long period of 1996/01-2010/07.

◎In this analysis, we took advantage of the metadata search system and integrated analysis software developed in the IUGONET project.

3. Data analysis and method

2.1 Observation points of ground magnetometer and list of number of SC event

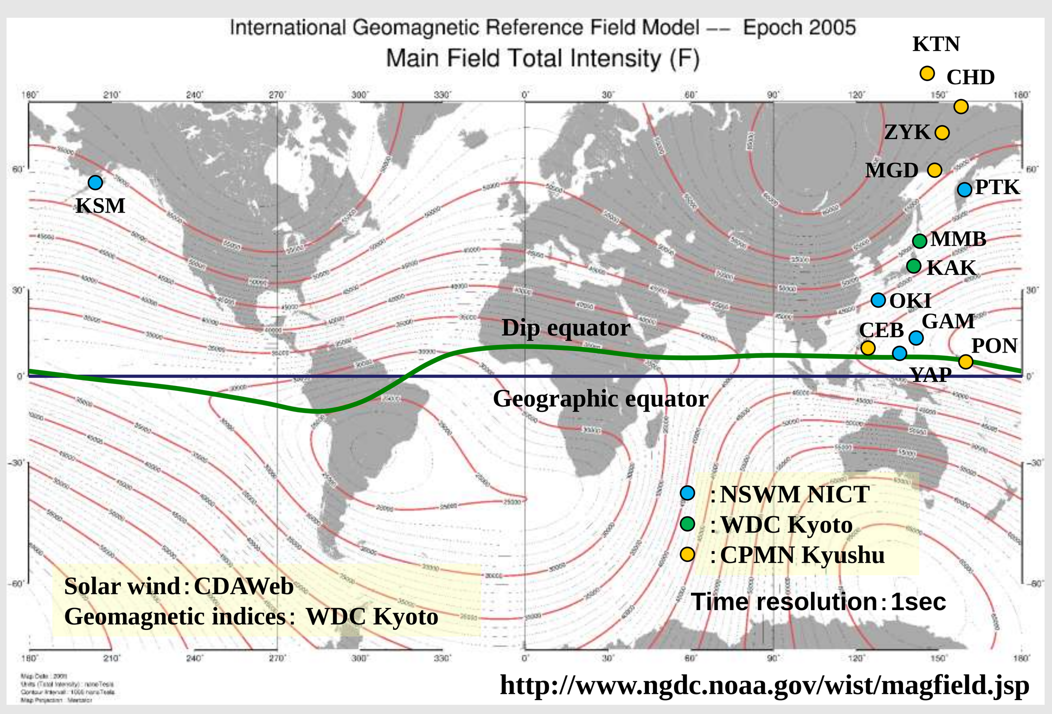

Fig 3. Location of the used geomagnetic observatories.

	GMLAT [deg]	Period	SC events
KTN	70.1	96/01-07/02	1670
CHD	64.6	96/01-07/08	2635
ZYK	59.7	96/01-07/06	2502
KSM	58.0	01/11-07/07	1452
MGD	53.6	96/01-07/07	3005
STC		07/07-08/10	
PTK	45.5	97/10-08/09	2256
MMB	35.1	96/01-10/10	3511
KAK	27.1	96/01-10/10	3531
OKI	16.5	96/04-08/10	2028
GAM	5.3	96/08-06/12	2721
CEB	0.8	98/08-05/06	1599
YAP	0.3	98/09-08/08	1442
PON	0.2	97/03-04/05	1631

- We used the long-term geomagnetic field data with time resolution of 1 sec in a period from 1996 to 2010 provided from NICT, WDC Kyoto, and Kyushu Univ.
- In this study, we identified the SC events as an abrupt increase of the SYM-H index with the amplitude of more than 5 nT within 10 minutes.
- We also analyzed solar wind data provided from the CDAWeb in order to identify solar wind dynamic pressure enhancement associated with shock or discontinuity.
- In order to minimize the deviation of the SC-MI amplitude, we normalized this value by the latitudinal corrected SYM-H index.

3. Statistical analysis results

3.1 Magnetic latitude and local time dependence of the SC-MI amplitude

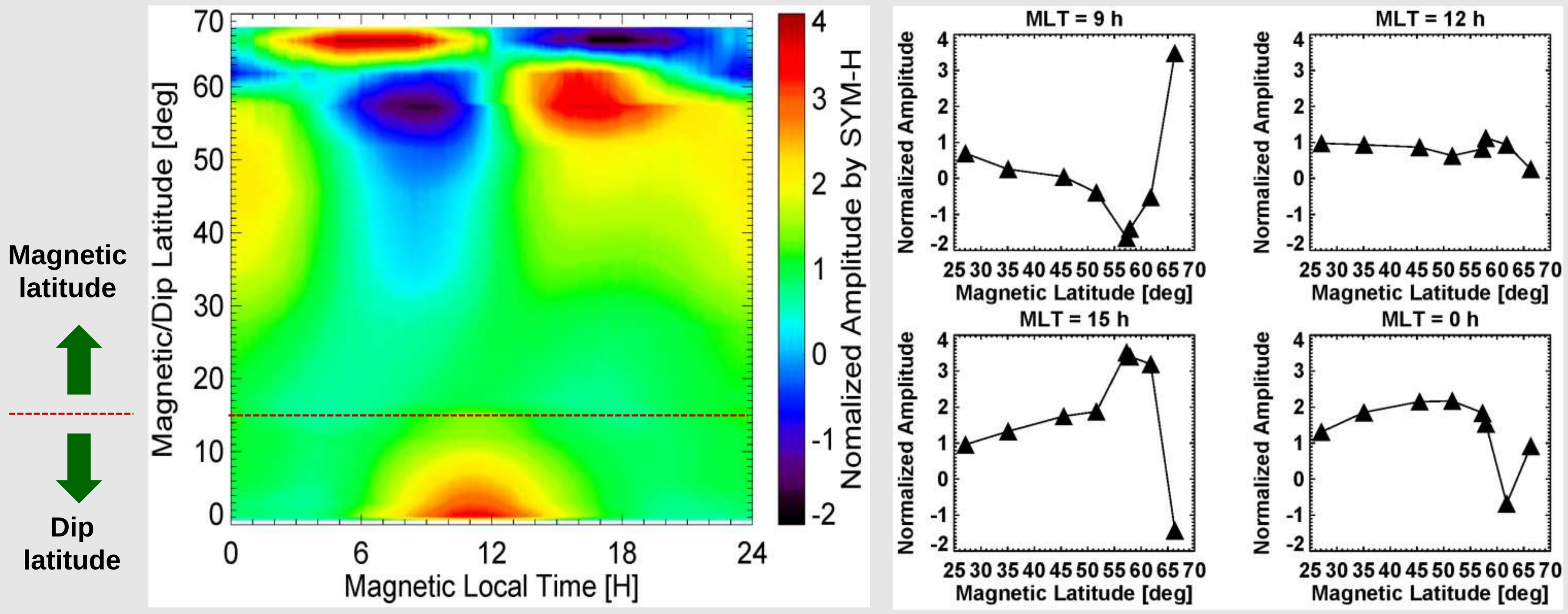

Fig 4. Magnetic latitude and local time dependence of the SC amplitude from the high latitude to the magnetic equator and the latitudinal distribution of the SC-MI amplitude in the morning, noon, afternoon and midnight. The color bar indicates the normalized SC-MI amplitude by the SYM-H. Below the horizontal line, the vertical axis is the dip latitude.

- The diurnal variation of the SC-MI amplitude on the dayside shows a DP-2 type magnetic field variations driven by the region-1 type FACs in the middle and auroral latitudes. The diurnal variation is reversed at the auroral latitude, which indicates that the footprint of the FACs is located around 63-65 degrees.
- The SC-MI amplitude on the nightside is enhanced significantly from the middle to low latitudes. This enhancement is cased by the magnetic effect produced by the region-1 type FACs. Moreover, the SC amplitude is depressed steeply around the auroral latitude of 60 degrees due to the enhanced westward auroral electrojet.
- In the equatorial region where the dip latitude is less than 15 degrees, the SC-MI amplitude is enhanced significantly in the daytime associated with the eastward equatorial electrojet current.

3.2 Seasonal dependence of the diurnal variation of the SC-MI amplitude

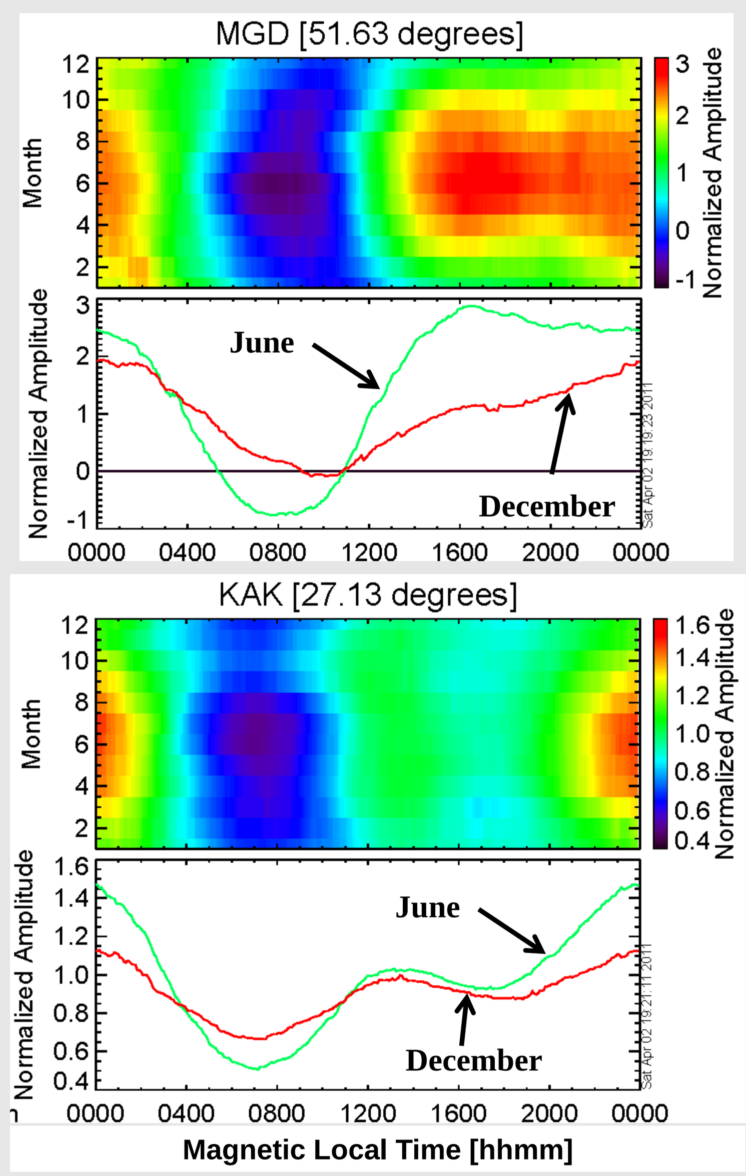

Fig 5. Contour plot of the diurnal variation of the SC-MI amplitude as functions of MLT and month, and line plot of the diurnal variation on June (green) and December (red). The color bar is the SC amplitude normalized by the SYM-H.

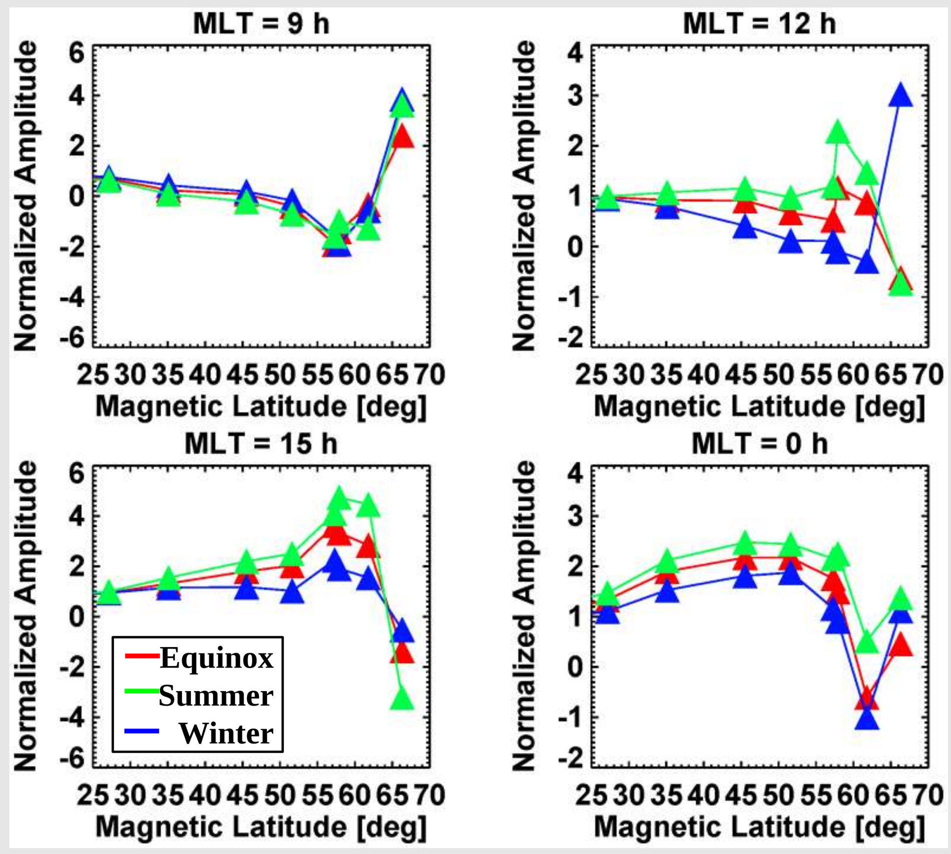

Fig 6. Seasonal dependence of the latitudinal distribution of the SC-MI amplitude from the high to low latitudes in the morning, noon, afternoon and midnight. The red, blue and green lines are the equinox, summer and winter.

- The size of the diurnal variation of the SC-MI amplitude tends to be more enhanced in the summer than in the winter.
- This result suggests that the SC-MI current system is a voltage generator rather than a current generator.

4. Summary and conclusion

(1) Magnetic latitude and local time dependence of the SC-MI amplitude from the high latitude to magnetic equator

- ○The diurnal variation of the SC-MI amplitude on the dayside shows a DP-2 type magnetic field variation produced by the twin vortex of ionospheric currents. .
- ○The nighttime SC-MI amplitude becomes the maximum in the middle latitude (~50 degrees) and steeply decreases around the auroral latitude. The nighttime enhancement and depression are due to the magnetic effects produced by the FACs and westward auroral electrojet, respectively.
- ○In the equatorial region where the dip latitude is less than 10 degrees, the equatorial enhancement of the SC-MI amplitude can be seen in the daytime due to the Cowling effect.

(2) Seasonal dependence of the diurnal variation of the SC-MI amplitude

- ○The size of the diurnal variation of the SC-MI amplitude tends to be more enhanced in the summer than in the winter. This results indicates that ionospheric currents and FACs increases due to the increased ionospheric conductivities.
- ○From the seasonal variation, it can be concluded that a feature of the SC-MI current system is a voltage generator rather than a current generator.
- ○The size of the seasonal variation is larger in the afternoon than in the morning. This weak seasonal variation in the morning suggests that the equivalent current at the ionosphere altitude flows parallel to the H-component. This ionospheric currents produce the east-west magnetic field variations parallel to the D-component.
- ○In the future study, we should investigate the long-term data analysis of the D-component during SCs and its seasonal variations.