The features of vertical component of daily geomagnetic field during geomagnetic storm

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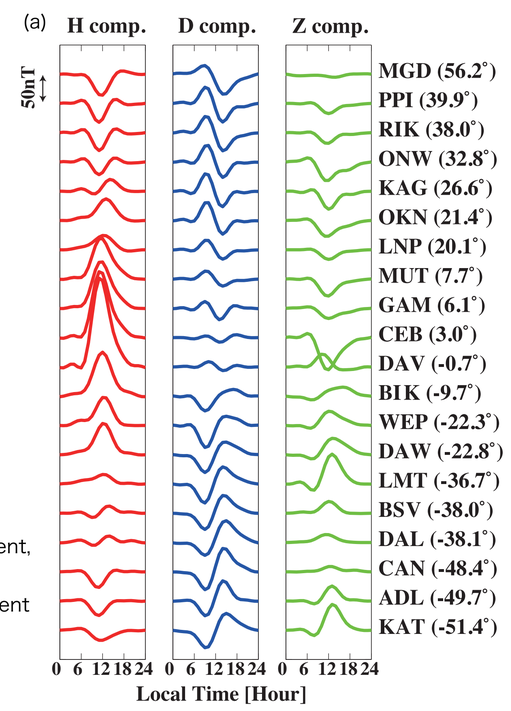
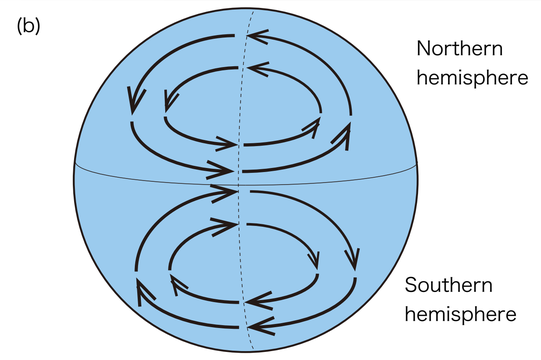
1. Introduction

Sq variation :
Sq variation can be observed during geo magnetically quiet time, and this variation is produced by two vortices current (Fig. 1(a)), which are counter clockwise in northern hemisphere and clockwise in southern hemisphere in the ionosphere. This current is formed by combination between inductive electric field and eastward electric field at dip equator. Global feature of Sq variation is also shown in Fig.1(b).

Sq focus :
The location of Sq focus can be assumed by the feature of magnetic field change produced by two vortices in both hemisphere, which horizontal component of magnetic field become nearly zero and the vertical component become minimum (maximum) in northern hemisphere (southern hemisphere). (see fig.1(c))

Objectives of this paper
- To clarify the effect of global geomagnetic activity on Sq focus time
- To investigate the effect of the storm on no-Sq B_Z variation





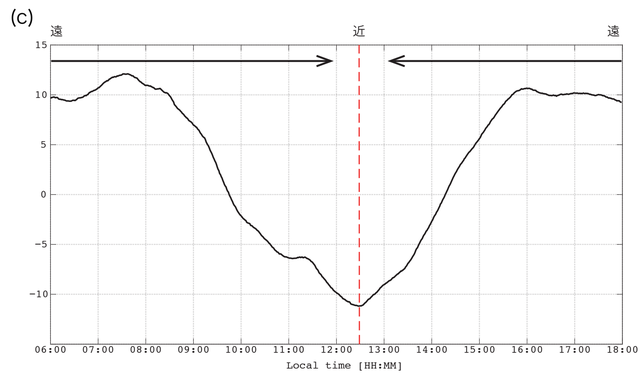


Fig.1(a): Sq variation of each component, B_H(red), B_D(blue) and B_Z(green)
Fig.1(b): Schematic picture of Sq current
Fig.1(c): Daily variation of vertical component of magnetic field. Red broken line indicate the focus of Sq

2. Analysis

Data set
- Geomagnetic field data from ONW, KUJ, LMT (Fig.2).
- Kp index, F10.7, sunspot number are derived from OMNI web(http://omniweb.gsfc.nasa.gov/)

Determination of Sq focus time (Fig.3)
1. Apply average value of daily B_Z variation as the base line of the B_Z variation.
2. Subtract the base line value from daily B_Z variation, and find maximum(minimum) value in the day.
3. The time which has maximum or minimum value is defined as Sq focus time at the observatories.

Estimation of no-Sq B_Z variation
1. Calculate ideal Sq variation of B_Z in the day by averaging same local time variation of B_Z from -15days to +15 days.
2. Subtract derived ideal Sq variation from raw data of daily B_Z variation.

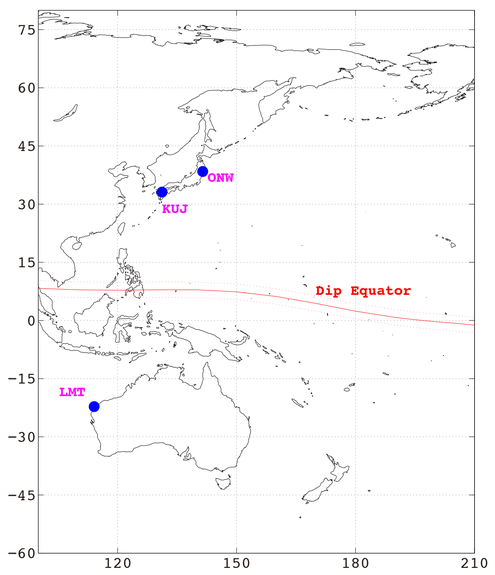


Fig.2: The map of the station which is used in this paper. The blue dots and 3-code indicate the location and name of the observatories respectively.

	地理緯度 [度]	地理経度 [度]	磁気緯度 [度]	磁気経度 [度]
ONW	38.43	141.47	31.15	212.63
LMT	-22.22	114.10	-33.59	185.11
KUJ	33.10	131.20	26.03	202.90

Table1: Location information of each observatories

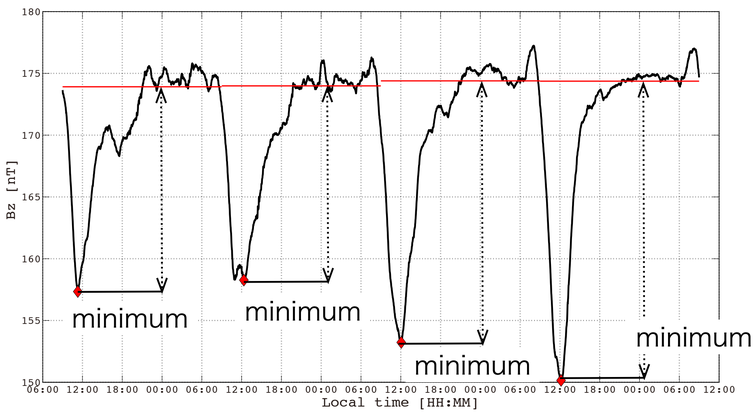


Fig.3: How to determine the Sq focus time

3. Results

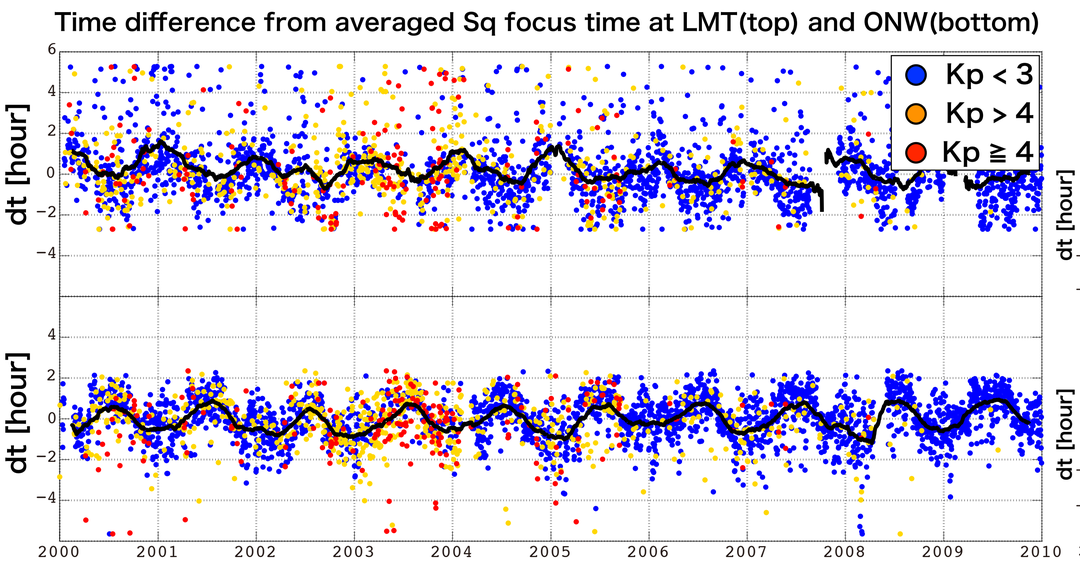


Fig.4: Differences between daily Sq focus time and averaged Sq focus time (dots), running averages of the differences (black line). The difference of the color of the dots in this figure shows different Kp index value. The top panel and the bottom one are the value at LMT station and ONW station from 2000 to 2010 year.

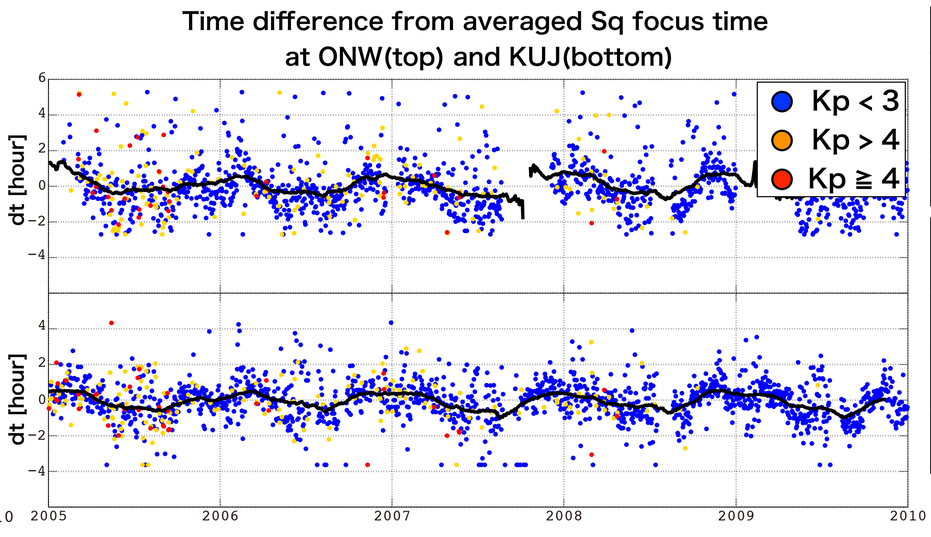


Fig.5: Differences between daily Sq focus time and averaged Sq focus time at ONW station and KUJ station from 2005 to 2010 year. Other format of the figure is same as figure 4.

	Corr coef (LMT)	Corr coef (ONW)
Kp	-0.07	0.10
SSN	-0.04	0.10
F10.7	-0.08	0.13

Table2(a): Correlation coefficient between Sq focus time difference from averaged Sq focus time and some indices

	Std [hour] (seasonal variation is removed)
ONW	±0.85
LMT	±0.73
KUJ	±0.75

Table2(b): Standard deviation of Sq focus time (removed seasonal variation)

4. Discussion & Conclusion

1. Less correlation of Sq focus time difference with geomagnetic activity (Fig.4, 5, Table2)
---> There is large day to day variability, but few effect of geomagnetic activity
---> This may indicate the Sq vortices exist also during storm time

2. Seasonal variation of Sq focus time (Fig.4, 5)
---> Sq focus time has maximum(minimum) value in summer(winter) hemisphere.
---> It is possible that IHFAC(Inter Hemispherical FAC) cause this seasonal variation, which are upward FAC in winter hemisphere and downward FAC in summer hemisphere [Fukushima, 1979, Takeda, 1982, 1989].

3. The extremely large difference of Z component of Sq variation during storm time (Fig.6, 7)
---> There may be the effect of ground induced current(GIC) on B_Z during geomagnetic storm time, which is called coastal effect (ex, [Parkinson, 1959], [Parkinson and Jones, 1979], etc). Two days lags of the peak values of correlation coefficient between the amplitude of no-Sq part of B_Z and AE(Dst) might indicate that disturbance dynamo [Blanc and Richmond, 1980] cause this large differences during the recovery phase of the storm in Fig.6.

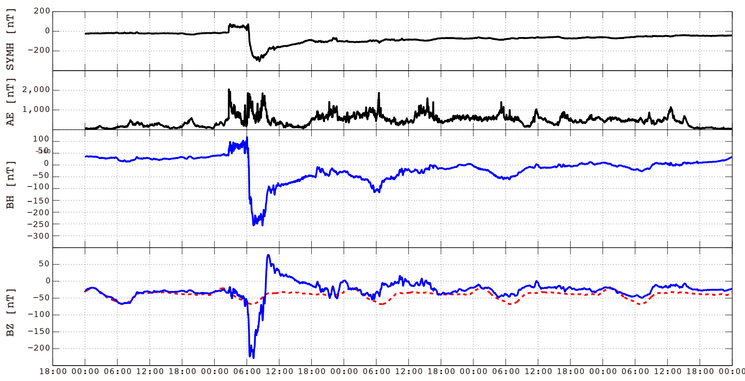


Fig.6: SYMH(top), AE(middle-top), B_H at LMT(middle-bottom), B_Z at LMT(bottom). The broken red line in bottom panel shows ideal Sq variation derived by averaging B_Z from 15 days before to 15 days after.

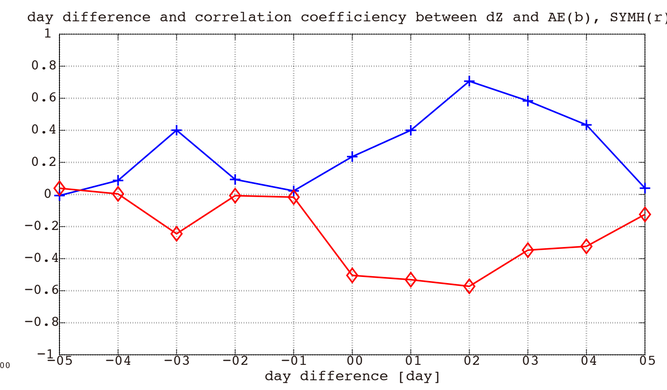


Fig.7: Correlation coefficient between the amplitude of B_Z and AE(blue), SYMH(red) with time shift of per day.

Conclusion
Sq vortices may exist also during storm time although the magnetic field change by the ring current or AEJ cause the vortices apparently disappear in horizontal component of magnetic field change, which is less effect on vertical component of magnetic field change.
However, there still be much effect of day to day variability to Sq focus time, and it is needed to investigate more about day to day variability of Sq variation to clarify the real effect of the storm.

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