地磁気急始変化（SC）の統計的性質

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Statistical properties of geomagnetic sudden commencements.

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We summarize properties of geomagnetic sudden commencement (SC) derived from statistical analysis of the list of SCs observed at Kakioka (gm latitude = 26deg) for 1924-2013 and Colaba/Alibag (16deg) for 1871-1968.

1. [total No. of SC, maximum H-amplitude, No. of SC larger than 50 nT, No. of SC larger than 100 nT] is [2306, 310nT, 136(5.9%), 18(0.78%)] for Colaba/Alibag and [1805, 273 nT, 135(7.5%), 17(0.94%)] for Kakioka.
2. Occurrence frequency (F) and amplitude (A) of SC show a similar time variation with SSN. The peak of A tends to shift to the declining phase.
3. SCs larger than 100 nT occur at the maximum SSN and the declining phase.
4. SC occurred in March 24, 1940 at 15:38 UT seems to the largest SC since 1871.
5. The LT variation of the SC(H) amplitude at Kakioka shows the maximum at midnight, the second maximum near noon and the minimum around 8h LT. The separate plots of the LT variation for summer and winter season show similar LT variations, although the size of it is different (larger in summer). The LT variations are consistent with those calculated by Kikuchi et al. (2001) separately for summer and winter season. We interpret that the midnight maximum of SC(H) is caused by a pair of field aligned currents (FAC) responsible for the main impulse (MI) of SC and the second maximum near noon is due to FAC and FAC-induced IC.
6. The LT variation of the amplitude of SC(D) takes the maximum around 8h LT when SC(H) takes the minimum. A caluculation of global distribution of ICs produced by a pair of high latitude FACs (Tsunomura & Araki; 1984) shows that the current flows in north-south direction near 8h LT. It means that SC(H) is not affected by ICs. Geomagnetic fields due to FACs for MI of SCs is dominant at noon and midnight and weak at the dawn and dusk side. Therefore, we can consider the main source current for SC(H) is the magnetopause current (MC) causing the DL part of SC.
7. Since Siscoe et al. (1968), several workers have been studied the linear relationship between the SC amplitude and the square root of the solar wind dynamic pressure (Pd). The LT variation of SC amplitude, however, is not taken into consideration. Hereafter, we should use SC(H) around 8h LT which is directly related with Pd.
8. The time variation of MC induces currents in the ionosphere and the earth. Although the induced earth current enhances the magnetic field variation on the surface, the current induced in the ionosphere reduces it. Therefore, induction effects may be reduced for SC(H) observed around 8h LT..

Colaba-Alibag (10deg Gm Latitude；1871-1968) と，Kakioka (27deg； 1924-2013) の SC(地磁気急始変化) リストの解析から判る SC の統計的性質をまとめる．

1. [SC 全数，最大振幅，振幅 50nT 以上の SC 数，の振幅 100nT 以上の SC 数] は，Colaba-Alibag が [2306，310nT, 136（5.9 %），18(0.78 %)]，Kakioka が [1805，273nT，135（7.5%），17(0.94%)]
2. 発生頻度 (F），振幅 (A) 共に，太陽黒点数 (SSN) と同様の 11 年周期変化を示す．A のピークは，SSN の下降期にずれる傾向がある．
3. 100nT 以上の大振幅 SC は，SSN 極大期からそれ以後の下降期に発生する．
4. 1940 年 3 月 24 日 15:38 の SC が，1871 年以降の最大振幅 SC（Alibag:310nT, Kakioka：273nT 以上）と推定できる．
5. Kakioka の SC(H）の振幅日変化は，0h 頃に極大，12h 頃に第 2 極大，8h 頃に極小になる．夏冬の季節に分けても，日変化量は変わる（夏が大きい）が，極大・極小の LT は，ほぼ同じである．これは，Kikuchi-Tsunomura（2001）の沿磁力線電流 (FAC) と FAC による電離層電流 (IC）の磁場で，季節変化も含めて説明できる．夜の極大は FAC が，昼の第２極大は FAC ＋ IC が作る．
6. Kakioka の SC(D) 振幅は 8h 頃に極大になる．一方，FAC が作る IC の緯度-LT 分布（Tsunomura & Araki；1884）は，8h 頃に IC の方向が南北になることを示す．これより，8h 頃の SC(H) の極小には IC が寄与していないと解釈できる．FAC の寄与は，0h-12h で最大になり，朝夕では小さいと考えられるから，8h 頃の SC(H) は，主に DL 成分（磁気圏界面電流；MPC）が作ると考えて良い．
７．SC(H) 振幅と（太陽風動圧）**0.5 に線形関係があるとして，その係数を求めた例は，Siscoe et al. (1968) 以来，幾つかあるが，SC(H) の LT 変化は無視されている．8h 頃の SC(H) は，IC・FAC による変形を受けず，直接に太陽風動圧効果を表すから，今後は，これを用いるべきである．
8. SC の誘導電流効果の考察には，源電流として，MPC と IC を考える必要がある．

IC の誘導電流は地球内部に流れて地上磁場を強める．MPC は，電離層と地球内部に誘導電流を流す．地上磁場は地下誘導電流によって強められ，電離層誘導電流によっては弱められる．したがって，電離層源電流の小さい 8h 頃の SC(H) への誘導電流効果は小さいと考えられる．