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Largest geomagnetic sudden commencement (SC) and interplanetary shock

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The long term variation of amplitude of geomagnetic sudden commencements (SCs) is examined by checking old magnetograms at Kakioka (27.5 deg. geomagnetic latitude) and Alibag (10.3 deg.) and SC lists prepared by both stations. We found that the SC occurred on March 24, 1940 was largest since 1868. The amplitude is 310 nT at Alibag and larger than 273 nT at Kakioka. The magnetogram of Cape Town (-33.3 deg) was also available for this event which shows 164 nT amplitude. This SC occurred during the main phase of a large magnetic storm which has been interested as one of space weather events.

The statistical analysis shows that the occurrence probability is less than 5 % for SCs with amplitude larger than 50 nT and less than 1 % for SCs larger than 100 nT at both Kakioka and Alibag. Large amplitude SCs tend to occur in the declining phase of the sun spot cycle as is reported for magnetic storms.

Siscoe et al. (1968) firstly proposed the relationship for the solar wind dynamic pressure P and SC amplitude, dH as dH = C*d(P^0.5) where d(P^0.5) shows a jump of the square root of P associated with interplanetary shocks. If we take the proportionality constant C as 15 nT/(nPa)^0.5 and the 300 nT SC amplitude (dH) needs pressure jump from 2 nPa (assumed dynamic pressure in front of the shock) to 460 nPa.

If the non-linear effect for magnetospheric compression is taken into account, a larger dynamic pressure will be needed for this large amplitude SC. On the other hand, the proportionality constant, C, might become larger for larger amplitude SC because C includes effects of electric currents induced in the earth. Larger amplitude SCs have larger time variation rate by which C becomes larger and the required dynamic pressure increase becomes smaller. We do not know which of the two competing processes is dominant but we consider that the linear estimation of the required dynamic pressure described above may be valid as the first order approximation.