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What can we know from the rise time of geomagnetic sudden commencements?

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The geomagnetic sudden commencement(SC) observed in low latitudes shows a monotonous increase of the H-component. The time to reach the maximum value is called rise time and takes 2-10 min. There are two different analyses about relationship between the rise time and amplitude of geomagnetic sudden commencement(SC). One [Chapman and Bartels, 1962] shows no relationship between them but the other [Pisharoty et al., 1962] an inverse relationship. Since it is now clear that the SC is caused by a collision of an interplanetary shock with the magnetosphere, it will be reasonable to assume that the rise time is primarily determined by a direct interaction between the solar wind and the magnetosphere. The effects of the direct interaction is modified, however, by electric currents secondary induced in the magnetosphere and ionosphere. Thus it is important to minimize these secondary effects in the analysis of the rise time of SC. Previous analyses have not paid attention to this point.

We analyzed the rise time by the use of geomagnetic H-component observed in the nighttime at a low latitude station, Guam, because the secondary induced current effects is considered to be minimized in night side low laitudes. The rise time and amplitude were measured from rapid-run magnetograms for 18 years from 1957 to 1975. The result shows that the data points in the plot of the amplitude versus rise time scatters but shows a clear upper envelope which decreases with increasing rise time. If we assume that the rise time, dT, is determined by a sweeping time of an interplanetary shock over the geo-effective magnetopause length L, we have a relationship dT = L/Vshock, where Vshock = Vsw + Ma * Vf (Vsw: solar wind speed, Ma: Alfven Mach No., Vf :fast mode HM wave speed). Now we have an empirical relationship between dH and a jump in the square root of solar wind dynamic pressure (Pd), dH = a* (Pd2**0.5 - Pd1**0.5) where 'a' is an empirical constant and Pd1 and Pd2 are the dynamic pressure in front of and behind the shock, respectively. When L, Ma and solar wind parameters in front of a shock are given, Pd2 can be calculated by using the shock relations and one data point (dH, dT) is determined. Changing Ma and solar wind parameters in front of the shock, we searched a value of L which gives calculated data points fitting with the data analysis and found about 30Re is best. The assumption above and calculated results are checked by in situ shock observations and SC rise time produced by it.