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Successive Impacts Of The Earth by Several Halo CMEs From Active Region NOAA 652

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Abstract. Several Halo CMEs hit the Earth in the second half of July 2004. They were produced by the very large complex active region NOAA 652 (Yousef *et al.* 2005). For CME details consult the web (ftp://lasco6.nascom.nasa.gov/pub/lasco/status/LASCO_CME_List_004).

We focus on the 26^{th} -27^{th} of July CME hit. This CME was associated with the long-duration M1 flare at 25/15:14. It made a very fast Sun to Earth transit - just over 31 hours (SGAS 27 July 2004). A greater than 10 MeV proton event began at 25/18:55. Solar wind speed remained elevated from 500 to over 700 km/s. A Severe Geomagnetic storm was observed and the aurora was seen as far as California.

A strong shock impacted the ACE spacecraft at 26/22:28. A sudden impulse (SI) of 96 nT was observed on the Boulder magnetometer at 22:51. The IMF Bz component was turned negative (-18 nT). Generally speaking, according to de Pater and Lissauer (2001), since a strong CME disturbance in the solar wind is usually preceded by an interplanetary shock followed by an enhanced density and velocity, the field strength first increases when the disturbance hits the magnetosphere, inducing an increase in the ring current. Several hours(up to over 25 hrs) the field strength Dst decreases dramatically during the storm main phase which typically lasts for a day The main phase is caused by an increase in the ring current, resulting from an enhanced particle flow towards the Earth. It is well known that geomagnetic storms tend to occur when IMF is directed southward. Magnetic reconnection occurs between the negative IMF and the magnetosphere thus opens the field lines with one end connected to the Earth (Dungey 1963). This magnetic reconnection allowed the protons and electrons to leak in. The proton and electron flux maximums occurred around the time of geomagnetic storm commencement which lasted for about 27 h (fig. 1). This is in agreement with the statement of Robinson (2003) that large numbers of energetic protons are constrained to occupy the region around the IP shock. The IMF Bz component dropped to -20 nT on 27 of July at 12:00 UT as measured by ACE satellite while Kp reached a maximum of 9 around 15:00 UT at the storm maximum as seen in fig. 2.

Keywords. Sun: coronal mass ejections (CMEs), solar-terrestrial relations

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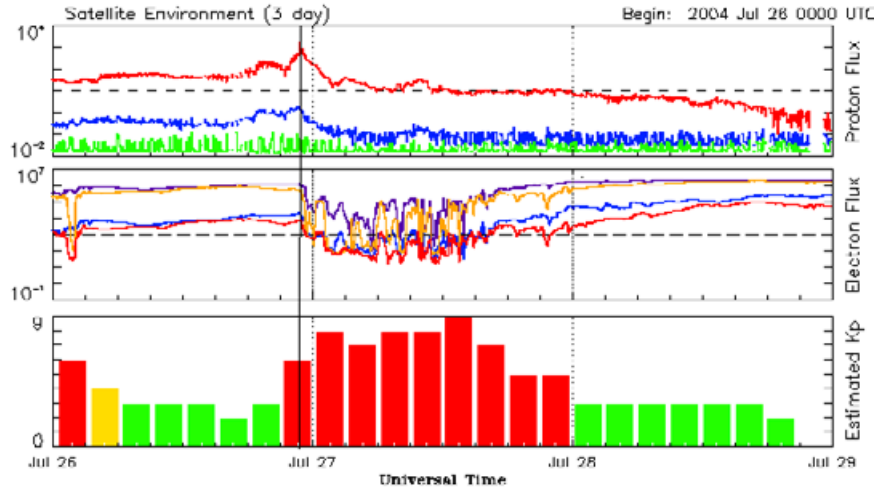

Figure 1. Three day plots of the 26-27 of July 2004 halo CME hit of the Earth. Top is the proton flare (Goes 11 proton flux 5 minutes data in three energy domains 10, 50 and 100 MeV from top to bottom). Middle is the Goes 10 and 12 electron flux (>2, > 0.6 MeV) . Lower curve is the Kp index showing the magnetic storm that started around 26d 23h ,maximum Kp was 9 on the 27th of July around 15:00. There is a coincidence of the maximums of proton and electron fluxes with the start of the magnetic storm. Plots are from the web site http://sec.noaa.gov/ftpmenu/plots/2004_plots/satenv.htm

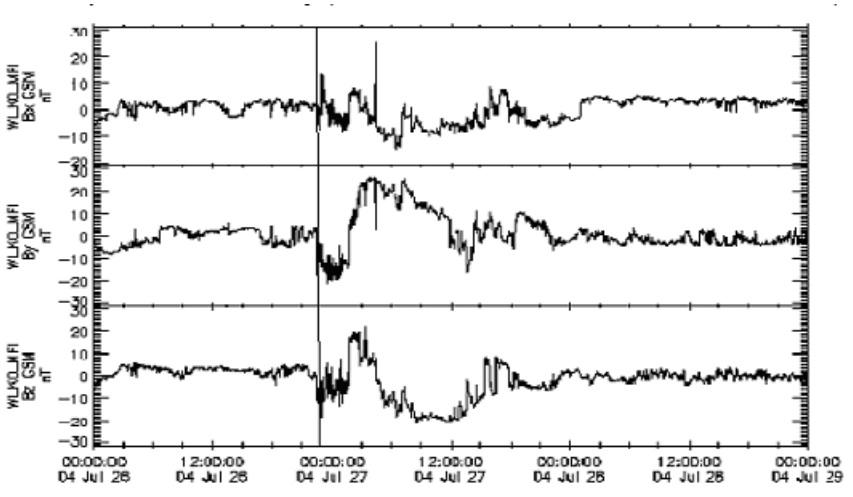

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Figure 2. The three IMF components. Note that Bz dropped to negative value of -18nT. The CME shock arrived ACE satellite at 26/22:28. The Bz component stayed negative for few hours before it was switched to positive also for few hours and then back to negative. Data is provided by R.Lepping at NASA/GSFC and CDAweb

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