Geophysical Research Abstracts
Vol. 15, EGU2013-3776, 2013
EGU General Assembly 2013

Possible mechanism of the first ground level enhancement of solar cycle 24

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Solar flare and CME-driven shock are the particle acceleration processes which are believed to cause ground level enhancement (GLE). In this respect, we carried out a study to understand the particle acceleration processes during 17 May 2012 with an aim to comprehend the possible mechanism of the concurrent GLE (GLE71, the first GLE of the solar cycle 24). For this, the cosmic ray intensities registered by neutron monitors at several sites have been analyzed with concurrent solar flare components and CME-driven shock wave. The intensive phases of the solar flare components have been investigated with the solar radio type III burst while the shock wave has been recognized in terms of type II burst. Both type III and II bursts have also been investigated with concurrent electron fluxes and solar radio flux density. On the basis of soft X-ray (1-8 Å) time profile, it is found that the solar flare started at $\sim$ 01:25 UT and reached maximum at 01:47 UT with medium strength (M5.1). The flare originated from the active region 11476 at the western hemisphere (N13W83) of the Sun. To justify the strength of the flare, we also looked into the chromospheric evaporation and recognized that this flare was indeed less powerful than an X-class flare. Since the GLE is the high energy particle event, the responsible flare components are supposed to be the high energy flare components. So, we investigated the high energy flare components ($\sim$0.5-0.002 Å) and found that they have maximum phases at $\sim$01:39 – 01:41 UT which are consistent with the pronounced phases of type III burst. The temporal difference between maximum phases of the high energy flare components and GLE71 is $\sim$>28 minutes indicating that solar flare might not have caused this GLE. We then investigated CME ($\sim$1582 km/s) that onset at $\sim$01:31 UT and started driving the shock wave at $\sim$01:38 UT while showed up first appearance at 01:48:05 UT. For better understanding of the acceleration processes, we studied the spatial evolution of the solar flare and CME-driven shock. To realize whether the GLE71 might have been occurred by the energy released from solar flare or CME-driven shock, we identified the particle injection time in terms of the hardest phase of the spectral indices determined from electron fluxes. The criterion is that if the GLE might have been caused by the energy released from particle acceleration in solar flare, the intensive phase of the flare components representing extreme emissions from the flare should lie within/around the injection time line. Thus, we found that the GLE71 might have been caused by the energy released from particle acceleration in the CME-driven shock wave that has been corroborated by the injection time. However, it is noted that any fractional amount of the energy released from preceding flare components might have contributed to the shock acceleration process. This is in concert with the solar eruption evolution that the flare and CME emission beams are found in the same direction.