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The first solar proton event of the current solar cycle recorded by satellites and ground based detectors

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Abstract: On 2012 May 17, the GOES satellites recorded a great and simultaneous increase in the proton flux at different energy channels thereby producing a Solar Proton Event (SPE). These protons had enough energy to be recorded by the ground based worldwide network of neutron monitors, through their secondary, thereby producing first ground level enhancement of solar cosmic rays (GLE71) of the current solar cycle. In this work a combined study of the great solar proton event of 2012 May 17, as it is recorded by the GOES satellites as well as by the ground based network of neutron monitors is presented. The GOES spacecraft recorded a fast rise in the flux of solar protons, followed by a slower decay, which was still ongoing on 2012 May 18. Through this research an attempt to understand the reason for differences with earlier ones is performed. Additionally, a first attempt to derive the characteristics of this recent proton event, by applying an updated version of the NM-BANGLE PPOLA model, already used for modeling past GLEs is presented. The determination of the special characteristics of this event can provide useful information not only about the solar sources that triggered these SEPs, but also for their special impact at interplanetary space.

1 The solar proton event by satellites

At 01:25 UTC of May 17 there was a significant rise in the GOES X-ray flux. The rise quickly reached the M5.1 range at 01:47 UTC coming from around sunspot region 1476 located N12W89. Almost simultaneously at 01:48UTC the SOHO/LASCO satellite observed a Hallo Coronal Mass Ejection having linear speed 1582km/s. Afterwards at ∼02:10 UTC a sharply increase in integral proton channels with energy 10, 30 and 10MeV is observed at EPS of GOES. A more detail analysis of this event using multiple spacecraft observations such as STEREO-A and -B, radio observations from ground-based stations and the WAVES instrument on board the Wind spacecraft and high time-resolution SDO/ AIA imaging and SDO/ HMI vector magnetic field [1], [2], suggested that there were actually two eruptions (both occurring from AR 11476) resulting in two CMEs in the 2012 May 17 event.

2 The solar proton event by neutron monitors

On 2012 May 17, the worldwide network of neutron monitors (NMs) recorded the first Ground Level Enhancement (GLE) of solar cosmic rays of the 24^{th} cycle of solar activity, known as GLE71. On the basis of a preliminary analysis obtained by the application of the NMBANGLE PPOLA model to this GLE, the following information was derived:

The SEP spectrum related to GLE71 was rather soft during the whole period of the event manifesting some weak acceleration episodes only during the initial phase (at ∼01:55-02:00UT) and at ∼02:30-02:35UT and ∼02:55-03:00UT.

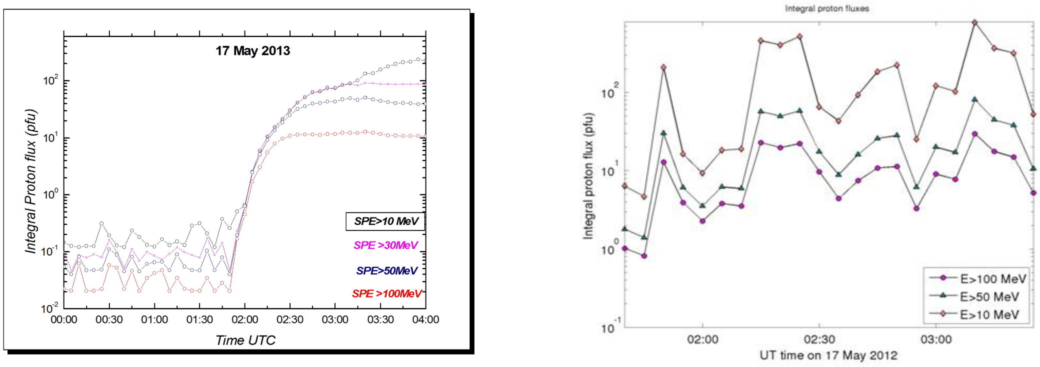

Figure 1: Time profile of the integral proton flux on May 17, 2012 based on data from GOES-15 satellite (left panel) and as derived by extrapolation of the results calculated through the NM BANGLE PPOLA model[4].

The spectral index of the modeled SEP spectrum shows evidence of a CME-shock driven particle acceleration, which is in agreement with the results based on the analysis of satellite measurements [3].

On GLE71 the maximum primary particle rigidities at 1 AU were about 2.4 GV.

The NMBANGLE PPOLA model [4], shows that at 01:50-1:55 UT the maximum primary solar proton flux was centered above the location (59N, -113E, GSE). After 01:55UT the spatial distribution of the primary solar proton fluxes changes and the solar proton source at the top of the atmosphere is moving versus South.

3 Conclusions

From the present analysis the "twin CME" scenario proposed by [3] could be a convincing explanation for the acceleration of the whole particle population of the great Solar Proton Event of May 17, 2012. The derivation of the GLE71 properties through the NMBANGLE PPOLA application is an example of how neutron monitor network data can be efficiently used for space weather modeling and, specifically, for getting information that cannot be directly obtained by space instruments.

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