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The Unusual Widespread Solar Energetic Particle Event on 2013 August 19: Solar origin, CME-driven shock evolution and particle longitudinal distribution.

Context: Late on 2013 August 19, STEREO-A, STEREO-B, MESSENGER, Mars Odyssey, and L1 spacecraft, spanning a longitudinal range of 222¡ in the ecliptic plane, observed an energetic particle flux increase. The widespread solar energetic particle (SEP) event was associated with a coronal mass ejection (CME) that came from a region located near the far-side central meridian from Earth's perspective. The CME appeared to consist of two eruptions, and was accompanied by a ∼M3 flare as a post-eruption arcade, and low-frequency (interplanetary) type II and shock-accelerated type III radio bursts. Aims: The main objectives of this study are two, disentangling the reasons of the different intensity-time profiles observed by MESSENGER and STEREO-A, longitudinally separated by only 15¡, and unravelling the single solar source related with the SEP event. Results: The solar source associated with the widespread SEP event is the shock driven by the two-stage CME, as the flare observed as a posteruptive arcade is too late to explain the estimated particle onset. The different intensity-time profiles observed by STEREO-A, located at 0.97 au, and MESSENGER, at 0.33 au, can be mainly interpreted as enhanced particle scattering beyond Mercury's orbit. The longitudinal extent of the shock does not explain by itself the wide spread of particles in the heliosphere. The particle increase observed at L1 may be attributed to cross-field diffusion transport, and this is also the case for STEREO-B, at least until the spacecraft is eventually magnetically connected to the shock at ∼0.6 au. The CME-driven shock may have suffered distortion in its evolution in the heliosphere, such that the shock flank overtakes the shock nose at 1 au.

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