INTERPRETATION OF THE TIME-INTENSITY PROFILE OF THE 15 MARCH 2013 SOLAR ENERGETIC PARTICLE EVENT WITH GLOBAL MHD SIMULATION

Drs. Chin-Chun Wu[1], Kan Liou[2], Angelos Vourlidas[1], Simon Plunkett[1], Murray Dryer[3], S. T. Wu[4], Richard A. Mewald[5]

[1]Space Science Division, Naval Research Laboratory

[2]Space Department, Applied Physics Laboratory

[3]Emeritus, NOAA, Boulder, CO, USA

[4]CSPAR, University of Alabama, Huntsville, Alabama, USA

[5]California Institute of Technology, Pasadena, CA, USA

ABSTRACT

The coronal mass ejection (CME) event on March 15, 2013 is one of the few solar events in cycle 24 that produced a large solar energetic particle (SEP) event and severe geomagnetic activity. SEP observations from the ACE spacecraft show a complex time-intensity profile that is not easily understood with current SEP theories. In this study, we employ a global three-dimensional (3-D) magnetohydrodynamic (MHD) simulation to help interpret the observations. The simulation is based on the H3DMHD code and incorporates extrapolations of photospheric magnetic field as the inner boundary condition at 2.5 solar radii (Rs). A Gaussian-shaped velocity pulse is imposed at the inner boundary as a proxy of the CME. It is found that the time-intensity profile of the high-energy (> 10MeV) SEPs can be explained by the evolution of the CME-driven shock and its interaction with the heliospheric current sheet and the non-uniform solar wind. Specifically, we demonstrate that the shock Mach number at the well-connected shock location is correlated ($r \geq 0.8$) with the concurrent proton SEP fluxes with energies greater than 10 and 30 MeV. This study demonstrates that global MHD simulation, despite the limitation implied by its physics-based ideal fluid continuum assumption, can be a useful tool for SEP data analysis.