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THE FIRST SUPER GEOMAGNETIC STORM OF SOLAR CYCLE 24: "THE ST. PATRICK DAY (17 MARCH 2015)" EVENT

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The first super geomagnetic storm of solar cycle 24 occurred on the "St. Patrick's day" (17 March 2015). Notably, it was a two-step storm. The source of the storm can be traced back to the solar event on March 15, 2015. At ~2:10 UT on that day, *SOHO/LASCO* C3 recorded a partial halo corona mass ejection (CME) which was associated with a C9.1/1F flare (S22W25) and a series of type II/IV radio bursts. The propagation speed of this CME is estimated to be ~668 km/s during 02:10 – 06:20 UT (Figure 1). An interplanetary (IP) shock, likely driven by the CME, arrived at the *Wind* spacecraft at 03:59 UT on 17 March (Figure 2). The arrival of the IP shock at the Earth may have caused a sudden storm commencement (SSC) at 04:45 UT on March 17. The storm intensified (Dst dropped to -80 nT at ~10:00 UT) during the crossing of the CME sheath. Later, the storm recovered slightly (Dst ~ -50 nT) after the IMF turned northward. At 11:01 UT, IMF started turning southward again due to the large magnetic cloud (MC) field itself and caused the second storm intensification, reaching Dst = - 228 nT on March 18. We conclude that the St. Patrick day event is a two-step storm. The first step is associated with the sheath, whereas the second step is associated with the MC. Here, we employ a numerical simulation using the global, three-dimensional (3D), time-dependent, magnetohydrodynamic (MHD) model (H3DMHD, Wu et al. 2007) to study the CME propagation from the Sun to the Earth. The H3DMHD model has been modified so that it can be driven by (solar wind) data at the inner boundary of the computational domain. In this study, we use time varying, 3D solar wind velocity and density reconstructed from STELab, Japan interplanetary scintillation (IPS) data by the University of California, San Diego, and magnetic field at the IPS inner boundary provided by CSSS model closed-loop propagation (Jackson et a., 2015). The simulation result matches well with the in situ solar wind plasma and field data at *Wind*, in terms of the peak values of the IP shock and its arrival time (Figure 3). The simulation not only helps us to identify the driver of the IP shock, but also demonstrates that the modified H3DMHD model is capable of realistic simulations of large solar event. In this presentation, we will discuss the CME/storm event with detailed data from observations (*Wind* and *SOHO*) and our numerical simulation.

***Key words**: Realistic 3D MHD simulation, coronal mass ejection, interplanetary shock, super geomagnetic storm

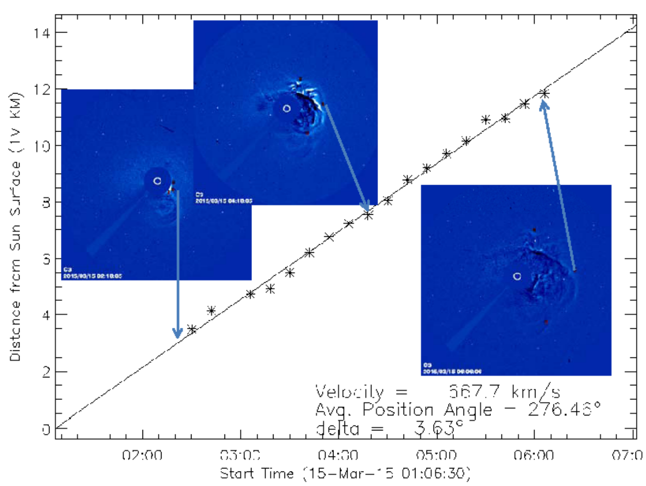

Figure 1. *SOHO/LASCO* C3 recorded a partial halo corona mass ejection (CME) during 02:10-0620UT on 15 March 2015. The propagation speed of this CME is estimated to be ~668 km/s during 02:10 – 06:20 UT.

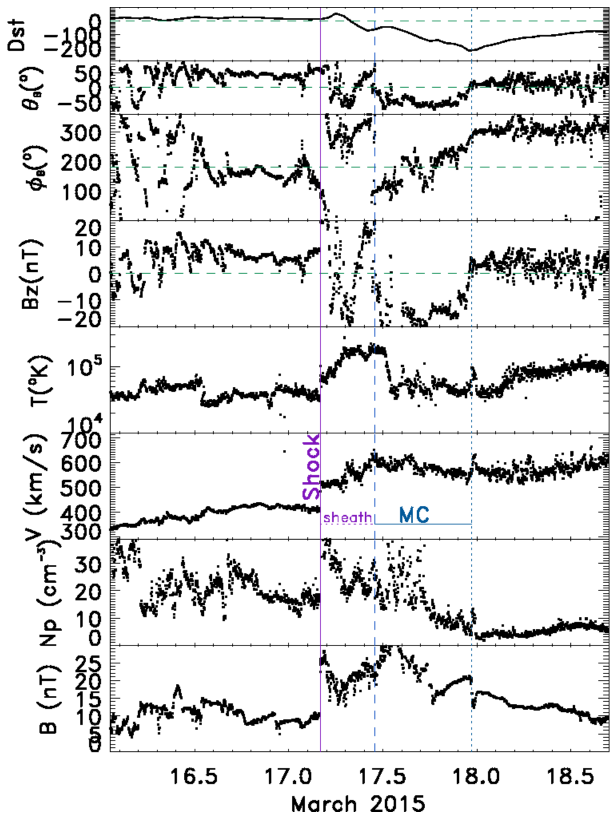

Figure 2: Geomagnetic activity index (Dst: top panel) and *Wind* observed in situ solar wind parameters (1^{st} - 7^{th} panels) during March 16-18, 2015. From Top to Bottom: Dst, latitude (θ_B) and longitude (ϕ_B) in GSE cords., Bz of the field in GSE, proton temperature (T), bulk speed (V), and number density (Np), magnetic field (B) in terms of magnitude. The blue horizontal line in the 3^{rd} panel represents the scheme's identification of the extent of this MC candidate [Lepping et al., 1990]. The purple-solid line and blue-dashed lines represent the IP shock and the front boundary of the MC.

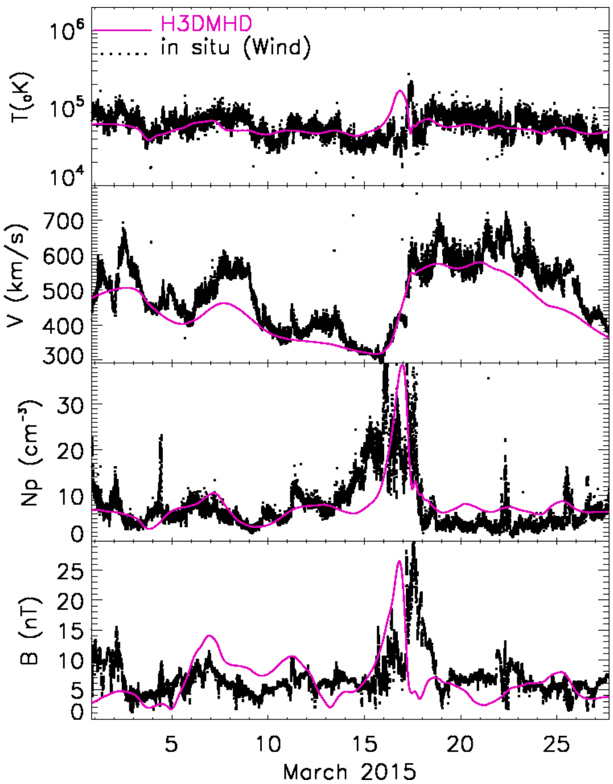

Figure 3: Observation (black-dotted curves observed by *Wind*) and simulation (pink-solid curved simulated by IPS-H3DMHD) of solar wind parameters during 01-27 March, 2015. From Top to Bottom: solar wind temperature (T), bulk speed (V), and number density (Np), magnetic field (B) in terms of magnitude.