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Shock Evolution from Sun to Earth during the Halloween 2003 epoch

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During October 28 to November 1, 2003, three shocks generated by solar flares were observed at the L1 libration point by ACE/SWEPAM/SWICS/MAG. Two of these shocks has extremely high solar wind, > 1500 km/s at L1. Two very distinct geomagnetic storms, rank as two of the largest storms of Solar Cycle 23, followed by the arrivals of the shocks at Earth. These two geomagnetic storms are associated with two of these flares (X17/4B and X10/2B). The purpose of this study is to present the use of an adaptive grid 1.5D MHD model that is initiated at the solar surface to study in detail the three shocks observed at L1 that were generated by the solar flares. Accordingly, four separate pressure pulses, at the appropriate times and with different strengths and duration, determined via a trail and error procedure, are introduced on the Sun to mimic the four flares. The model suggests that two shocks, from the first two considered flares, combined into a single shock followed by a directional discontinuity (DD). This latter "DD", as well the shock, was also observed. The results show that the simulated solar wind velocity temporal profiles successfully matched the observations at L1. The propagation speed of shock waves near the Sun also related with the CME observations of SOHO/LASCO. The energy input on the Sun for generating these shocks will be discussed in detail. The major objective, to demonstrate the detailed nature of interacting shocks and some of their products after origination from closely spaced solar events, is achieved. In addition, the MHD model is able to suggest the solar sources that associated specific geomagnetic storms at Earth.

Keywords: shock; solar flare; geomagnetic storms; MHD simulation; discontinuity.