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Time-dependent modeling of SEP events: energetic particle acceleration at traveling interplanetary shocks and comparison with ACE measurements

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We present modeling results for the Solar Energetic Particle events (SEPs) which are associated with traveling interplanetary shocks driven by Coronal Mass Ejections (CMEs).

Our model follows shock propagation and evolution from distances of about 0.1 AU near the Sun to the Earth's orbit. The MHD block of the code was adapted from the ZEUS code developed for astrophysical applications. A semi-analytical approach is applied to simulate particle acceleration at a quasi-parallel shock from a seed population (solar wind suprathermals). We adopt diffusive shock acceleration (DSA) as the acceleration mechanism at the shock. Alfven wave turbulence in the shock vicinity is essential for the DSA mechanism and the corresponding parallel diffusion coefficient is calculated from the wave-particle interaction. Finally, a kinetic block of the model is developed to follow transport of energetic particles after they escape from the shock front and reach the Earth's orbit.

The model utilizes solar wind parameters measured in situ by ACE. The output of the model includes energetic particle fluxes, spectra and compositional ratios for protons and heavy ions. We will match our modeling results directly with ACE observations for several large SEP events.