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Modeling of a large SEP event of December 13, 2006 with the PATH code

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We apply the Particle Acceleration and Transport in the Heliosphere (PATH) one-dimensional numerical code to model the SEP event of December 13, 2006. The code is initiated by modeling a quiet-time solar wind and a propagating CME-driven oblique shock. Inner boundary conditions are extrapolated from ACE measurements at 1AU. We assume two energetic particle populations in the modeling, one originating from solar flare particles and the other from solar wind particles accelerated at the traveling shock. Observed shock parameters at 1 AU and flare characteristics are used as input into the code. We assume a diffusive shock acceleration mechanism at the shock and model subsequent transport of particles escaping from the shock through the interplanetary medium to 1 AU. We focus on modeling the spectra of protons, oxygen and iron ions and their time-intensity profiles. Observations indicate that this event is iron-rich with an increase in the Fe/O abundance ratio above 10 MeV/nuc. We numerically estimate this abundance ratio and discuss the underlying physical scenario. Comparison is made with a case of a quasi-perpendicular shock. Our modeling results are compared with in situ measurements by ACE, STEREO, GOES and SAMPEX for this event.