Comparing proton fluxes and fluences of SEP events with those predicted by SOLPENCO

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Gradual Solar Energetic Particle (SEP) events produced by shocks constitute the largest contribution to the particle radiation experienced in interplanetary space. The characteristics of a SEP event resulting from a CME-driven shock depend on many factors still under debate. At present there is no physical model that quantitatively describes all processes involved in the formation, evolution, and development of individual SEP events. Existing statistical models of fluences and peak fluxes are useful for mission integrated periods but not for forecasting the hazard due to individual SEP events and, moreover, they do not consider the role of the shocks as particle-accelerators. We have developed the first operational code, based on scientific models that can be used for space weather forecasting of SEP events. The SOLar Particle ENgineering COde (SOLPENCO) provides the proton differential flux and cumulated fluence profiles from the onset of the event up to the shock arrival at the observer for a variety of SEP scenarios, including solar longitudes of the parent solar activity ranging from E75 to W90 for observers located at either 1 AU or 0.4 AU, and for proton energies between 0.125 MeV and 64 MeV. We have compared the outputs of the code with proton differential flux measurements of a set of SEP events that fulfill three conditions: (1) the association between the interplanetary shock and the parent solar activity is well established; (2) the event shows a significant proton flux increase at energies below 15 MeV; and (3) the pre-event background is low (i.e., it is an isolated event). We discuss here the results of this validation, paying special attention to: (i) the angular separation between the observer and the solar origin of the SEP event, (ii) the transit velocity of the shock to travel from the Sun up to the observer, and (iii) the proton energy. We draw conclusions on the use of SOLPENCO as a prediction tool, the improvements to be implemented in the code and the requirements that this type of operational models must accomplish to be useful for space weather forecasting.