Forecasting Solar Energetic Ion Events with Relativistic Electrons: Statistical and Superposed Epoch Analyses

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The sudden and prompt occurrence of solar energetic particle events poses a hazard to manned space activities and interferes with robotic space science missions. This study analyses the possibility of forecasting the appearance, duration, and intensity of solar ion events by means of relativistic, near light-speed electrons with data from the SOHO/COSTEP instrument. A list of the most severe particle events measured by GOES-8 in the years 1996-2002 serves as a basis to derive the forecasting potential of this method. This list contains all solar proton events (SPEs) with fluxes exceeding 10 pfu. SOHO/COSTEP provides relativistic electron and $<$50 MeV proton observations at 1 AU. With a superposed epoch analysis subset of solar energetic particle (SEP) events where the location of the associated flare on the Sun has been determined, we find that (1) relativistic electrons always arrive ahead of non-relativistic SPEs allowing their forecasting; (2) the early electron intensity can be utilized to forecast the upcoming proton intensity by means of a high correlation between the two; and (3) the intensity increase of both, electrons and protons alike, depends on the magnetic connection, i.e. the magnetic longitude difference between the observer and the flare.