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FORECASTING SOLAR ENERGETIC PARTICLE RADIATION EFFECTS

Abstract

Radiation hazards by intense solar energetic particle events (SEPs) pose a serious threat to satellite systems, astronauts and aircraft crews. To help better understanding the dependence of intense SEP fluxes on the location of the onset site of their solar drivers, a specific study has been carried out taking into account the magnetic connection to the associated CME and its plane of the sky speed. The NOAA solar proton event list "Solar Proton Events Affecting the Earth Environment", classified by the NOAA space weather scales was investigated for the time period after launch of ACE in order to be able to analyze the solar wind plasma and IMF conditions measured near Earth orbit at SEP event onsets. The time period with information on major SEP events provided by the list, together with the solar wind data, spanning the period November 1997 to March 2012, had 105 SEP entries. These events were then compared with information on CMEs and flares listed in the SOHO LASCO CME catalogue. Taking into account times with missing SOHO data and events without determined CME speeds, the established SEP event list includes 81 proton events and a total of 100 associated CMEs. For these events the proton flux data for energies ¿10 MeV measured by the GOES satellites were used to determine the characteristic proton event parameters, such as peak flux, event duration and the number of total measured protons per event. The parameters of solar activity were compiled from the SOHO/LASCO CME catalogue. The source regions of the CMEs were identified using images and movies of the SOHO/LASCO/EIT and MDI, SDO/AIA and HMI, and STEREO/SECCHI instruments. Solar wind data from the ACE and in a few cases as substitutes, from the WIND satellites were used to determine the two-dimensional (in longitude) and three-dimensional magnetic connection (the real solar wind source region) to the Sun at the onset of the solar proton events. The results of this study demonstrate that the peak SEP intensities depend on the location of the CME onset sites with respect to the observer, their lateral expansions and outward plane of the sky propagation speeds. The implications of the results for the development of state-of-the-art forecast capabilities are discussed.