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The HESPERIA real-time Solar Energetic Particle prediction tools

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Solar Energetic Particles (SEPs), ranging in energy from tens of keV to a few GeV, constitute an important contributor to the characterization of the space environment. SEP radiation storms may have durations from a period of hours to days or even weeks and have a large range of energy spectrum profiles. They pose a threat to modern technology strongly relying on spacecraft and are a serious radiation hazard to humans in space, and are additionally of concern for avionics and commercial aviation in extreme cases. The High Energy Solar Particle Events forecasting and Analysis (HESPERIA) project, supported by the HORIZON 2020 programme of the European Union, has furthered our prediction capability of high-energy SEP events by developing new European capabilities for SEP forecasting and warning, while exploiting novel as well as already existing datasets. The HESPERIA UMASEP-500 tool makes real-time predictions of the occurrence of >500 MeV and Ground Level Enhancement (GLE) events from the analysis of soft X-ray flux and high-energy differential proton flux measured by the GOES satellite network. Regarding the prediction of GLE events for the period 2000-2016, this tool had a Probability of Detection (POD) of 53.8% and a False Alarm Ratio (FAR) of 30.0%. For this period, the tool obtained an Advanced Warning Time (AWT) of 8 min taking as reference the alert time from the first NM station; using the time of the warning issued by the GLE Alert Plus tool for the aforementioned period as reference, the tool obtained an AWT of 15 min (Núñez et al. 2017). Based on the Relativistic Electron Alert System for Exploration (REleASE) forecasting scheme (Posner, 2007), the HESPERIA REleASE tools generate real-time predictions of the proton flux (30-50 MeV) at the Lagrangian point L1, making use of relativistic electrons (v>0.9c) and near-relativistic (v<0.8c) electron measurements provided by the SOHO/EPHIN and ACE/EPAM experiments, respectively. Analysis of historic data from 2009 to 2016 has shown the HESPERIA REleASE tools have a low FAR (∼30%) and a high POD (63%). Both HESPERIA tools are operational through the project's website (http://www.hesperia.astro.noa.gr) at the National Observatory of Athens and presented in the recently published book on 'Solar Particle Radiation Storms Forecasting and Analysis, The HESPERIA HORIZON 2020 Project and Beyond', edited by Malandraki and Crosby, Springer, Astrophysics and Space Sciences Library, 2018, freely available at https://www.springer.com/de/book/9783319600505.