HESPERIA REleASE+: Improving Solar Proton Event Forecasting by Means of Automated Recognition of Type-III Radio Bursts

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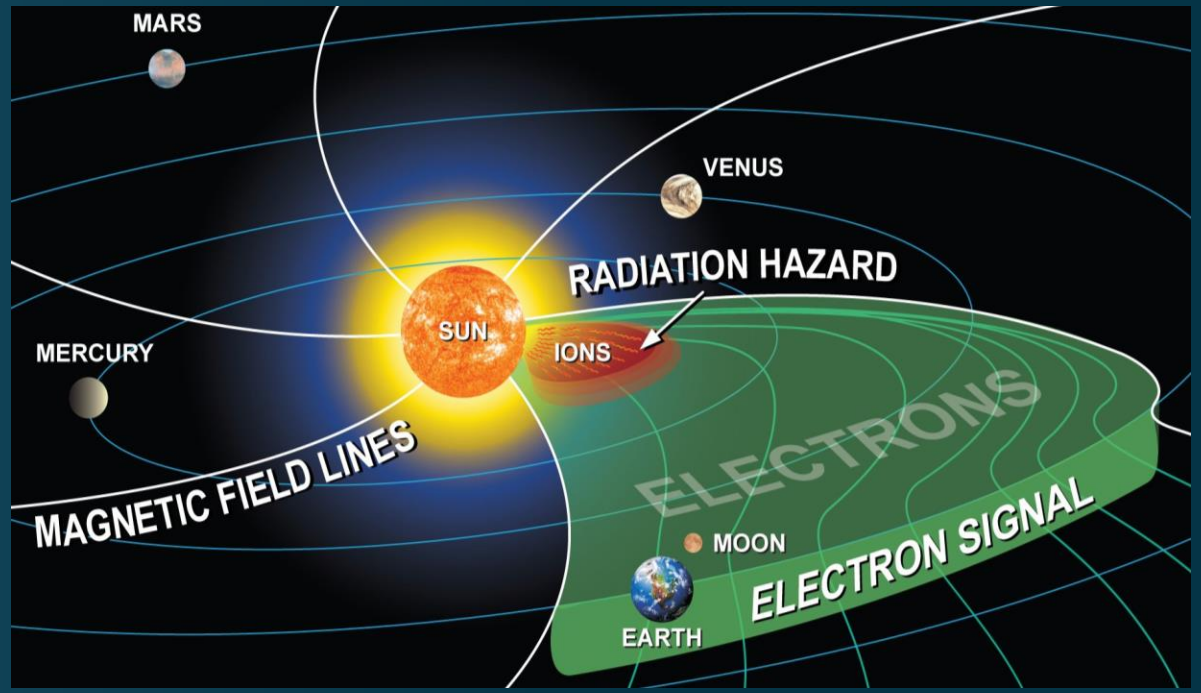
Background

Solar Energetic particles (SEPs) can have a major impact on human and robotic space exploration activities.

The chief hazards come from energetic ions, which move at a good fraction of the speed of light. However, relativistic electrons travel faster than ions so that the electrons arrive at the Earth-Sun L1 point (1.5 million km sunward from Earth) 30 to 90 minutes before the slower protons. Thus, measurements of these energetic electrons can be used to increase warning times of the arrival of the more dangerous ions.

The Relativistic Electron Alert System for Exploration (REleASE) forecasting scheme (Posner 2007) uses this effect to predict the proton flux by utilizing electron flux measurements and had been in use for forecasting since 2008. It utilizes data from SOHO/COSTEP and ACE/EPAM.

Used by NASA's Community Coordinated Modeling Center and Space Radiation Analysis Group and the ESA Space Weather Service Network.

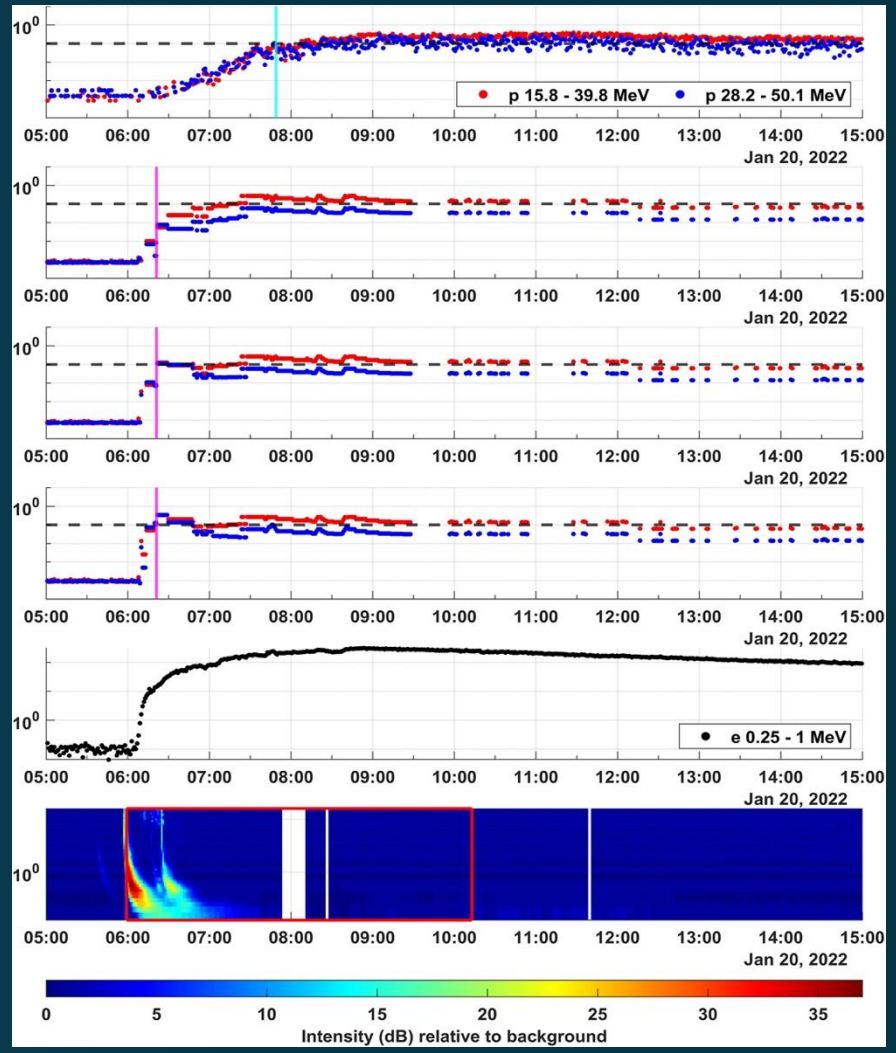


Electrons moving out ahead of energetic ions. Credit: Southwest Research Institute, Posner et al 2009

Analysis

New HESPERIA (High Energy Solar Particle Events foRecastIng and Analysis) REleASE+

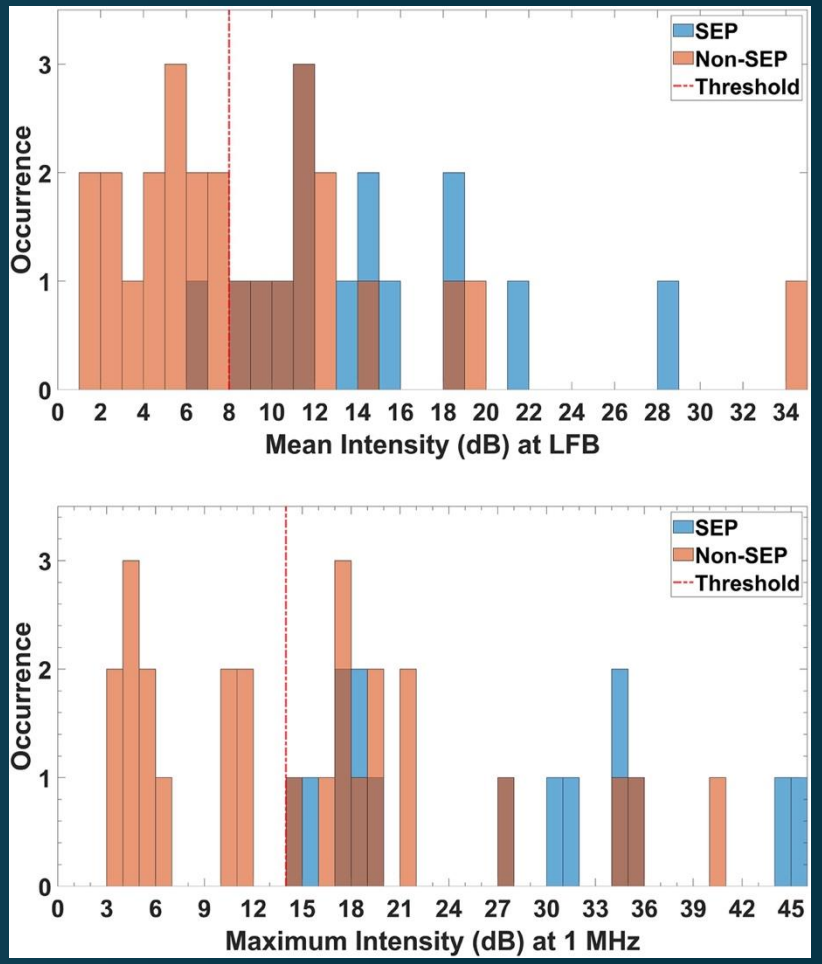
- Uses Stereo-A/WAVES data to verify electron beams using observations of the type III radio bursts produced by these beams and is expected to substantially eliminate false alarms.
- The system uses automated detection of type-III radio bursts in real time in STEREO-A space weather beacon data
- Posner et al. 2024 describes the implementation of the new system and the testing of its performance performance over 2 years



The 20 January 2022, electron and proton event, which has been recorded as another successful forecast for the HESPERIA REleASE+ system. The top four rows show, respectively, the recorded SOHO/EPHIN proton fluxes and the corresponding 30-, 60-, and 90-min forecasted proton fluxes in two energy channels. The horizontal dashed line in all these panels indicates the threshold value, defining significant particle events, while the cyan vertical line on the first panel indicates the time that this threshold value is first surpassed. The purple vertical line in the forecasted proton fluxes indicates the time that the proton alert is issued. The fifth panel shows the corresponding EPHIN electron flux. the bottom panel shows the STEREO-A/WAVES radio flux density. Posner et al. 2024

Findings and Impacts

- The HESPERIA REleASE+ system successfully suppressed false warnings that would have been issued by the previous system.
- STEREO-A's is approaching the Earth Sun L4 point, a side view of the Sun, where its observations are expected to be even more applicable than the current HESPERIA REleASE+ electron-based forecast.
- There are also STEREO-REleASE and STEREO-REleASE+ systems (publications submitted) using STEREO/IMPACT to detect SEPs
- These improvements will enhance a space weather prediction system being used for protection of astronauts and spacecraft.



Histograms of the derived maximum mean STEREO-A/WAVES ow-frequency band intensity values (top panel) as well as the maximum Intensity values at 1 MHz (bottom) for the type-III radio burst events associated with 15 significant (blue and dark brown bars) and 26 non-significant (light and dark brown bars) particle events. All but one significant solar proton event is associated with type III's are above the thresholds shown with the red dotted lines, making the S/WAVES observations a key discriminator between significant and non-significant SEP events. Posner et al. 2024

Additional Info

References:

Posner, A., “Up to 1-hour forecasting of radiation hazards from solar energetic ion events with relativistic electrons”, Space Weather, Vol. 5, S05001, doi:10.1029/2006SW000268, 2007

Posner, A.; Guetersloh, S.; Herber, H.; Rother, O., "A New Trend in Forecasting Solar Radiation Hazards" Space Weather, Vol. 7, S05001, doi:10.1029/2009SW000476, 2009

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