



## **FORECASTING SPACE WEATHER: USING ACE DATA TO PROVIDE REAL-TIME PREDICTIONS OF HIGH-INTENSITY ENERGETIC STORM PARTICLE EVENTS**

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Geo-effective interplanetary (IP) shocks are often accompanied by Energetic Storm Particle (ESP) events, during which the intensity of charged particles can increase by several orders of magnitude. Such high intensities of incident ions present a radiation hazard to astronauts and electronics in Earth orbit. Observations by NASA's Advanced Composition Explorer (ACE) spacecraft indicate that these events are usually preceded by characteristic signatures in the ion intensities, thus providing an opportunity for predicting the events before they arrive.

We have developed an algorithm that can forecast the arrival of ESP events. Using historical ion data from ACE, we trained an artificial neural network to detect the characteristic signals that warn of an impending event. The network predicts the time remaining until the maximum intensity is reached. We trained the network on 37 events, from 1997 to 2002, and tested it on a separate set of 18 events from the same time period. Initial performance of the network is very encouraging; the average uncertainty in predictions made 24 hours in advance is 9.4 hours, while the uncertainty improves to 4.9 hours when the event is 12 hours away.

Recently, we have integrated our predictive algorithm in a system that uses real-time ACE data provided by the NOAA Space Environment Center. This system continually processes the latest ACE data and reports whether or not there is an impending ESP event. After detecting an event, our algorithm predicts the time remaining until the peak intensity occurs.

For example, on November 25, 2002, our real-time system successfully detected an upcoming event and steadily produced predictions until the corresponding IP shock

hit, at 9:45 p.m. on November 26, 2002. By providing a significant amount of lead-time, as well updated predictions every five minutes, this system can be a crucial source of information to mission planners, satellite operations controllers, and scientists.