Forecasting the Radiation Belts in Europe

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Weather forecasting has expanded to space weather. As of 1 March 2012, satellite operators and the general public will be able to obtain forecasts of the Earth's radiation belts, thanks to the SPACECAST project. The opening of the first European system to forecast Earth's radiation belts, part of the SPACECAST project, is funded by the European Union Framework 7 Programme and provides a forecast of high-energy electrons up to 3 hours in advance (updated every hour), as well as a risk index for the satellite operations and service industry.

The SPACECAST project is the result of a growing awareness in Europe, at the government level, that modern society has become dependent on high-technology systems susceptible to space weather. The U.S. National Research Council has estimated that if a Carrington-type storm occurred again, the economic impact from power blackouts and disruption to satellites and other services could be as high as $2 trillion [*Space Studies Board*, 2008]. In Europe the space industry is a key driver of economic growth, and European policy is to use space for the benefit of civilians. Programs based on this commitment include Global Monitoring for Environment and Security (GMES) and the Galileo radio navigation system. SPACECAST is one of several projects now funded by the European Union to help protect these space assets.

Space weather has also gained a special significance in the UK. The volcanic ash cloud that disrupted transatlantic aviation in 2010 prompted a much wider evaluation of natural hazards. Following an inquiry by the House of Commons, space weather was put on the UK national risk register and is now a subject of ongoing research collaboration between the UK and the United States following President Obama's visit to the UK in May 2011 and Prime Minister David Cameron's visit to the United States in March 2012.

The SPACECAST project is an international effort. Led by the British Antarctic Survey, the project includes scientific research and collaboration between eight groups in Europe and four in the United States. Data are collected from satellites and ground-based instruments in real time and combined with a forecast of geomagnetic activity from Sweden to drive two forecasting models, one in France and one in the UK. The forecast results are displayed on a Web site hosted in Belgium. This distributed system enables a much higher level of reliability than a single-point system. A key feature of the SPACECAST forecasts is that they include geostationary and medium Earth orbits together with the slot region in the radiation belts where many new satellites are planned to operate.

One of the advantages of the SPACECAST system is that it uses physics-based models. Research using data from satellites and ground-based experiments in Antarctica has long shown that wave-particle interactions can either increase or decrease the radiation belts under different geomagnetic activity levels and must be included with particle transport across the magnetic field. These wave-particle interactions are included in the SPACECAST forecasting models and are vital for enabling better forecasting. The models can also be used to reconstruct the space radiation environment after a satellite anomaly has occurred.

Over the next 2 years the SPACECAST project will exploit a new database of very low frequency waves to improve high-energy (MeV) electron forecasts and will develop models for lower-energy (keV) electrons that cause satellite surface charging. The project will also use solar wind, MHD, and shock acceleration models to simulate solar energetic particle events in order to better understand and eventually forecast solar energetic particle events in the future.

Details about SPACECAST are available at http://www.fp7-spacecast.eu.

Reference

Space Studies Board (2008), *Severe Space Weather Events—Understanding Societal and Economic Impacts*, Natl. Acad. Press, Washington, D. C. [Available at http://www.nap.edu/openbook.php?record_id=12507&page=1.]

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