The Updated Solar Energetic Particle Environment Modelling (SEPEM) Tool

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SEPEM Application Server

The SEPEM (Solar Energetic Particle Environment Modelling) application server is a WWW interface to solar energetic particle (SEP) data and a range of modelling tools and functionalities intended to support space mission design. SEPEM has recently been upgraded including more recent data and a set of new publicly accessible functionalities which are described below.

Use of SEPEM is free of charge, but registration is required and can be done from the homepage:

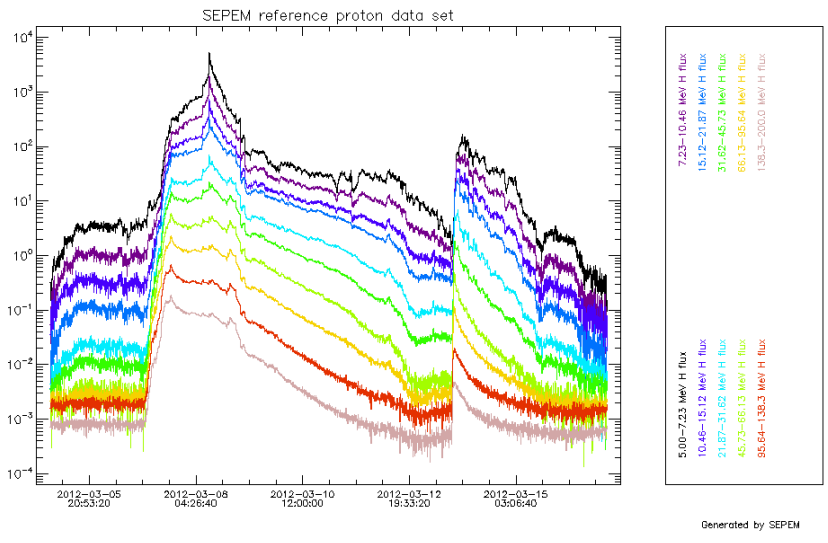
(http://dev.sepem.oma.be/)

The updated SEPEM tool will be shown at the ESWW10 meeting during the Fair on Wed.

(see "The SEPEM model and data server" stand).

SEPEM Reference Proton Dataset and Event List

The SEPEM reference proton dataset ranges from 1973 to 2013 and is comprised of 10 reference energy channels exponentially distributed in range from 5 to 200 MeV. Data processing tools used to build the reference dataset (manual cleaning, gap filling, energy re-binning and cross calibration) and others (median filtering and automatic de-spiking) are available on the SEPEM application server. The current SEPEM reference proton event list is available on the SEPEM application server and includes 250 events.



Statistical Models

Four SEP statistical methods are available on the SEPEM application server: Monte Carlo (JPL method), Worst case ESP method, Cumulative ESP method, and Virtual timelines. The below table lists the SEP parameters that the methods can be applied to. In the new Virtual timelines method, developed under SEPEM, the distribution of waiting times (defined as the time from the end of one event to the onset of the following event) is used as opposed to the event frequency (Jiggens et al., 2012).

Methods	SEP Parameter			
	Fluence analysis	Peak Flux analysis	Duration analysis	Time above threshold
Monte Carlo (JPL method)	X	X		
Worst case ESP method	X	X		
Cumulative ESP method	X			
Virtual timelines	X	X	X	X

For further information

For further information please contact the Project Manager N. Crosby (Norma.Crosby@aeronomie.be).

See also other SEPEM related presentations,

- High-Energy SEP modelling for large solar particle events (P. Jiggens et al., Session 5 - poster)
- Evaluating the effect of proton anisotropies in the inner heliophere: 2006 December 13 SEP event case study (A. Aran et al., Session 9 - poster)
- Updates to the ESA Interplanetary and Planetary Radiation Model for Human Spaceflight (D. Heynderickx et al., Session 5 - oral)

Post-SEPEM

The SEPEM system continues to be hosted at the Belgian Institute for Space Aeronomy.

The further development of the SEPEM system to include fully processed solar heavy ion datasets, new effects tools developments, geomagnetic shielding and interface updates is being carried out under the ESA ESHIEM (Energetic Solar Heavy-Ion Environment Models) activity led by Kallisto Consultancy (UK), contract no. 4000107025/NL/AK

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Effects Tools

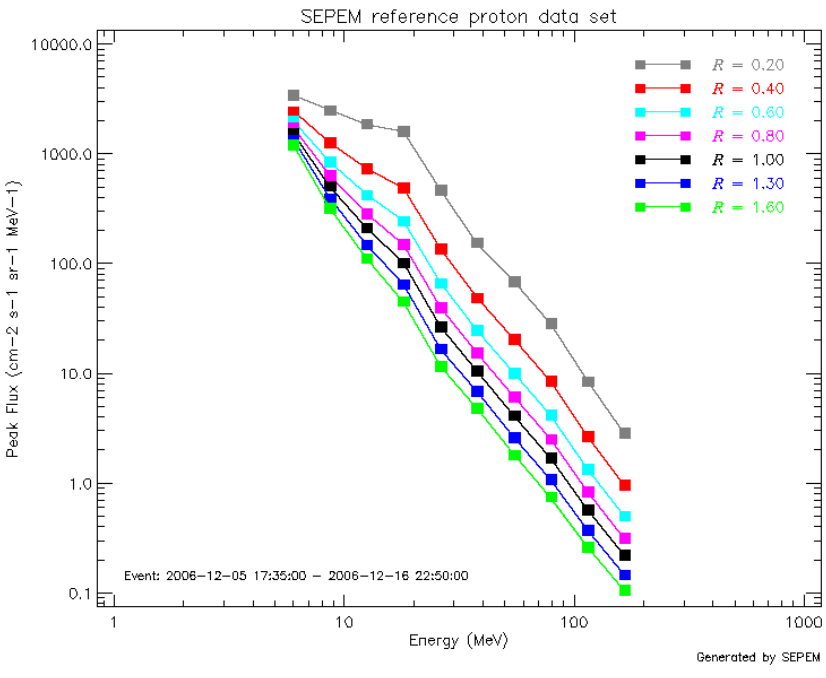
SEPEM has integrated radiation effects analysis tools to allow the calculation of total ionizing dose by SEPs and single event upset (SEU) rates for a variety of engineering scenarios; the statistical methods can also be applied to these effects parameters.

Shielding calculations are performed using the Geant4-based Multi-Layered Shielding Simulation Software (MULASSIS) whilst SEU rates are derived using the Integral Rectangular ParallelePiped (IRPP) method with the Geant4 Microdosimetry Analysis Tool (GEMAT). To use these tools in SEPEM little knowledge of Geant4 is necessary and the user only has to define the data table, the particle species, the device geometry and the device upset cross-section (several standard parameter-based cross-section formulae are available).

Heliocentric Dependence

SEPEM now includes SEP modelling at heliocentric distances greater or less than 1 AU, ranging from 0.2 AU to 1.6 AU using the newly developed SOLar Particle ENgineering COde 2 (SOLPENCO2) tool (built under SEPEM) to simulate particle flux profiles of gradual SEP events. The synthetic derived SEP peak fluxes and fluences provided for the ten SEPEM reference energy channels, are fitted as a function of the distance from the Sun to scaling laws covering the inner Solar System (Aran et al., 2011).

This new method provides the user with a statistical tool to evaluate peak flux and fluence quantities for space missions in the inner Solar System. The scaling is based on physics-based modelling of a small subset of the enhancements seen in the reference event list and, as such, this represents a first step towards development of a comprehensive, statistical model including heliocentric dependence in the absence of sufficient in-situ data at distances from the Sun other than 1 AU.



Peak flux event spectra of the 05-16 Dec 2006 event at the various SEPEM defined radial distances [0.2, 0.4, 0.60, 0.80, 1.0, 1.30, 1.60 AU] based on SOLPENCO2.