

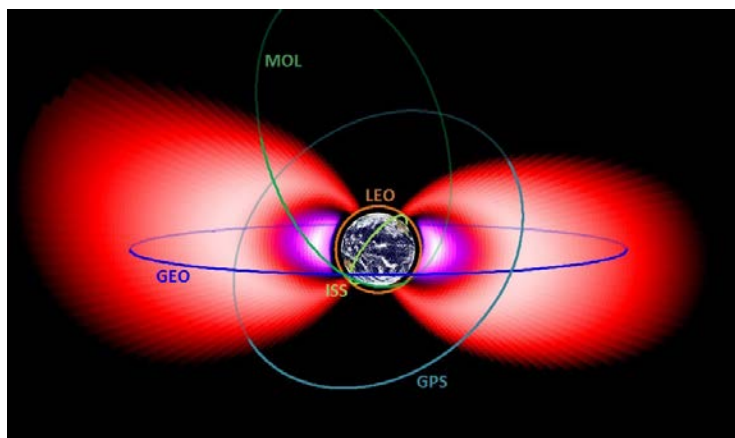


AE9/AP9/SPM-IRENE Radiation Environment Model

AE9/AP9/SPM-IRENE is a suite of models for the fluxes of radiation belt and plasma particles in near-Earth space for use in space system design, mission planning, and other applications of climatological specification. Denoted AE9, AP9, and SPM for energetic Electrons, energetic Protons, and Space Plasma Model, respectively, the models are derived from 45 data sets measured by satellite on-board sensors. Transition to a new name International Radiation Environment Near Earth, or IRENE, marks the coming participation of international collaborators. These data sets have been processed to create maps of the particle fluxes along with estimates of uncertainties from both imperfect measurements and space weather variability. These estimates can be obtained as statistical confidence intervals, e.g. the median and 95th percentile, for fluxes and derived quantities, supporting design trades.

Two methods for interrogating the models are provided, a command-line version and a graphical user interface. Given satellite orbital elements or an ephemeris, the model returns specified quantities of flux, fluence, or dose, and chosen statistics for these quantities from run modes of mean, perturbed mean, or Monte-Carlo scenarios. Both omnidirectional and unidirectional fluxes/fluences are supported. The model is not predictive in terms of providing quantities for a specified solar cycle phase, but the statistics provided encompass the climatology observed over a solar cycle.

The model is available as an executable version for Windows. For developers or for UNIX users, the source code may be requested from AFRL. The distribution package includes the model



software, a user's guide, validation reports, and other general documentation. Full technical documentation will be available as completed.

The initial version, V1.00, was released in 2012. In 2015 V1.20 was released, including new flux maps for AE9, AP9, SPME (electrons) and SPMH (protons) based on new data sets. In 2017 V1.35 introduced support for parallelized processing. Later in 2017 the V1.50 release updated flux maps for AE9 and AP9 with Van Allen Probes data sets, plus other data sets including our first internationally contributed data set, from Azur.

AE9/AP9/SPM is designed with incremental improvements in mind, and forthcoming versions are planned to introduce new features such as: more flexible effects calculations based on pre-computed effects kernels; inclusion of untrapped particle hazards such as solar protons; a sample historical solar cycle fly-through option. The flux maps will also be upgraded with new data sets as they become available. In particular, data from AFRL's Demonstration and Science Experiments (DSX) spacecraft will be included in future versions.

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The AE9/AP9/SPM model is available at:
<https://www.vdl.afrl.af.mil/programs/ae9ap9/>

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