AE9/AP9/SPM Radiation Environment Model

Release Notes

Version 1.20.001

The AE9/AP9/SPM model was developed by the Air Force Research Laboratory in partnership with MIT Lincoln Laboratory, Aerospace Corporation, Atmospheric and Environmental Research, Incorporated, Los Alamos National Laboratory and Boston College Institute for Scientific Research.

AE9/AP9/SPM development team: Gregory Ginet[1] (PI), T. Paul O'Brien[2] (PI), Wm. Robert Johnston[3] (PI), Michael Starks[3], Stuart Huston[4], Tim Guild[2], Christopher Roth[4], Paul Whelan[4], Rick Quinn[4], Reiner Friedel[5], Chad Lindstrom[3], Yi-Jiun Su[3], Steve Morley[5], and Dan Madden[6].

Information on AE9/AP9/SPM may be found on line at the NASA SET Radiation Model User Forum (http://lws-set.gsfc.nasa.gov/radiation_model_user_forum.html).

To contact the AE9/AP9/SPM team, email AFRL.RVBXR.AE9.AP9.Org.Mbx@us.af.mil .

V1.00.002 release: 05 September 2012

V1.03.001 release: 26 September 2012

V1.04.001 release: 20 March 2013

V1.04.002 release: 20 June 2013

V1.05.001 release: 06 September 2013

V1.20.001 release: 31 July 2014

In a future release of AE9/AP9/SPM, the model will be renamed to be
"International Radiation Environment Near Earth" (IRENE).

[1] MIT Lincoln Laboratory
[2] Aerospace Corporation
[3] Air Force Research Laboratory, Space Vehicles Directorate
[4] Atmospheric and Environmental Research, Incorporated
[5] Los Alamos National Laboratory
[6] Boston College Institute for Scientific Research

AE9/AP9/SPM Radiation Environment Model
Release Notes

Version 1.20.001
July 31, 2014

Highlights

The AE9/AP9/SPM model software now supports more options for orbital definition, plus expanded options for coordinate systems and the formatting of the input and output files. New options enable the output of the geomagnetic quantities and adiabatic invariants used within the model, and the generation of directional flux results for specified pitch angles. Other changes include the addition of 64-bit Windows support, better performance on Linux machines, and improved error messages. The C++, C and FORTRAN-based API functions have been revised and expanded. The various documents have been updated to include the new and revised software features.

The model databases for AE9, AP9, SPME, and SPMH have been enhanced. The AP9 flux maps now include TacSat-4/CEASE data, and use templates based on Van Allen/RPS data; the latter extends AP9's energy coverage to 2 GeV protons. The AE9 flux maps incorporate corrections to the inter-calibration of several data sets and changes to the template library. The SPME and SPMH flux maps now include THEMIS/ESA data. Adjustments to smoothing between bins have been made for most of these flux maps.

Software Changes

CmdLineAe9Ap9 application

- The available model run parameters for orbit definition were expanded, all of which are now supported by all three propagators.
- New model run parameters were added for the selection and formatting specification of the time field(s), coordinate system and its units, and data delimiter characters used within the input and output files.
- A new model run parameter was added for generation of output files containing the geomagnetic and adiabatic invariant coordinates for each ephemeris position.
- New parameters were added for performing unidirectional flux calculations using a list of pitch angle values, or file containing a time-dependent list of pitch angle values.
- The generated model run output files were enhanced with additional header information and expanded data value accuracy for most parameters.
- Any model run input files that were produced for previous versions will still be able to generate the same form of results, provided that the model database file references are appropriately updated.

Ae9Ap9Gui application

- The GUI application was renamed, removing the 'test' prefix.
- Where possible, support for the newly-added CmdLineAe9Ap9 run parameters were also implemented within the GUI application.

- The interface was enhanced to enable the user to specify the calculation of *specific* percentile flux values of the model (or aggregation).
- The detailed error messages from a failed model run may now be viewed within the GUI application.
- The optional parameters in GUI application configuration file were expanded to include several GUI selection default settings.

General

- The model run error messages were enhanced to be more informative.
- Issues with reading the TLE file orbital parameters when using the SGP4 propagator were resolved.
- The performance of the ShieldDose2 model calculations was improved.
- The internal ephemeris coordinate conversion calculations have been updated to improve their accuracy.
- The default value for the *legacy* model (CRRESELE/PRO, AE8/AP8) parameter for 'SAA Translate' has been changed to 'true'.
- The Linux-based build settings were revised to improve program execution performance.
- Support for 64-bit Windows applications was added.
- The C++, C and FORTRAN application programming interface (API) routines were revised to remove unneeded/unused arguments, change the coordinate system enumerations or string constants, and add new methods for the access to geomagnetic /adiabatic invariant coordinate values. An issue with the data order of multi-dimensional arrays for the FORTRAN interface was resolved.
- The CoordsAe9Ap9 utility was removed, as its capabilities have been superseded by the new 'adiabatic coordinates' features of the CmdLineAe9Ap9 and GUI programs, as well as new methods available in the API.

Documentation Changes

- The AE9/APM/SPM Radiation Environment Model User's Guide was expanded with descriptions of the new software features, and clarifications of existing features. Appendix D was added to describe the internal Ae9/Ap9/SPM model coordinate systems, and the newly- accessible geomagnetic / adiabatic invariant coordinate parameters.
- The Application Program Interface was revised to reflect the expanded features for orbit definition, new options for specifying pitch angles for unidirectional flux calculation, and the new methods to access to the geomagnetic / adiabatic invariant coordinate values.
- The Build Instructions document was updated to include 64-bit Windows compilation options.

Database Changes

AP9V12

- Extended energy grid by adding 700, 1200 and 2000 MeV points, corresponding to new Van Allen/RPS-based templates.
- Added TacSat-4/CEASE proton data.

- Changed K-H_{min} smoothing from 3x3x5 to 3x7x5 (i.e., more K smoothing).
- Added gradient limit: minimum $d\log_{10}j/dH_{min}$ = 1/100 for H_{min} < 100 km.
- Changed minimum flux criterion from 10^{-10} times the maximum to an absolute flux limit of 10^{-3} #/cm^2/s/sr/MeV.
- New K-H_{min} templates incorporating results from Van Allen/RPS data plus improvements to smoothness (see technical documentation for details).
- New K-Φ templates incorporating results from Van Allen/RPS data, plus an additional template representing transient variability observed by CRRES, as well as improvements to smoothness and to spatial gradients near the loss cone (see technical documentation for details).

AE9V12

- Changed K-H_{min} smoothing from 3x3x10 to 3x5x10 (i.e., more K smoothing).
- Removed 95th percentile CRRES K-Φ templates.
- Removed E-3 AE8max and AE8min templates.

SPMEV12

- Added THEMIS/ESA data.

SPMHV12

- Added THEMIS/ESA data.
- Changed to smoothing evenly on 3x3x7 mask (V1.0 was 3x3x3, weighted 0.3 at $|\Delta L_m|$=1 grid point, so V1.2 has more smoothing in L_m).

General

- Added "Perturbed Percentile" to capability list for advanced diagnostic runs in all 'V12' databases. However, this feature is not yet available in the C++ implementation, and has no effect on normal behavior of these runtime tables.
- The previous versions of the model databases are available, if desired. However, it is generally recommended that those be used with the AE9/AP9/SPM model software release in which they are included.

Contact Information

Please send any questions, comments and/or bug reports to
AFRL.RVBXR.AE9.AP9.Org.Mbx@us.af.mil