

Meteoroid environment modeling: the Meteoroid Engineering Model and shower forecasting

Althea V. Moorhead
NASA Meteoroid Environment Office,
Marshall Space Flight Center, Huntsville, Alabama 35812

The meteoroid environment is often divided conceptually into meteor showers plus a sporadic background component. The sporadic complex poses the bulk of the risk to spacecraft, but showers can produce significant short-term enhancements of the meteoroid flux. The Meteoroid Environment Office (MEO) has produced two environment models to handle these cases: the Meteoroid Engineering Model (MEM) and an annual meteor shower forecast. Both MEM and the forecast are used by multiple manned spaceflight projects in their meteoroid risk evaluation, and both tools are being revised to incorporate recent meteor velocity, density, and timing measurements.

MEM describes the sporadic meteoroid complex and calculates the flux, speed, and directionality of the meteoroid environment relative to a user-supplied spacecraft trajectory, taking the spacecraft's motion into account. MEM is valid in the inner solar system and offers near-Earth and cis-lunar environments. While the current version of MEM offers a nominal meteoroid environment corresponding to a single meteoroid bulk density, the next version of MEMR3 will offer both flux uncertainties and a density distribution in addition to a revised near-Earth environment. We have updated the near-Earth meteor speed distribution and have made the first determination of uncertainty in this distribution. We have also derived a meteor density distribution from the work of Kikwaya et al. (2011).

The annual meteor shower forecast takes the form of a report and data tables that can be used in conjunction with an existing MEM assessment. Fluxes are typically quoted to a constant limiting kinetic energy in order to comport with commonly used ballistic limit equations. For the 2017 annual forecast, the MEO substantially revised the list of showers and their characteristics using 14 years of meteor flux measurements from the Canadian Meteor Orbit Radar (CMOR). Defunct or insignificant showers were removed and the temporal profiles of many showers were improved. In 2016 the MEO also adapted the forecast to the cislunar environment for the first time. We plan to make additional improvements to the model in the next two years using optical meteor flux measurements and mass indices.