SEE Bulletin

NASA's Space Environments and Effects Program October 2003

Due to planning activities for the 8th Spacecraft Charging Technology Conference, this edition of the *SEE Bulletin* will be in electronic format only. We will resume normal, quarterly distribution starting January 2004.

JIMO

By: Donna Hardage
NASA's Space Environments and Effects Program

The Space Environments and Effects (SEE) Program received funds from the Jupiter Icy Moons Orbiter (JIMO) Project to manage technology development activities in the area of space environments. The JIMO mission will orbit three planet-sized moons of Jupiter – Callisto, Ganymede, and Europa, to investigate their makeup, history, and potential for sustaining life. This mission will enhance space exploration by the use of electric propulsion powered by a nuclear fission reactor.

In FY03, the SEE Program managed a task that resulted in EP plume data and models for JIMO. This task takes the initial steps to take in-situ chamber measurements to characterize the observed plume environment to understand sputtering material effects and degradation. Two and three-dimensional models will then be developed and validated in terms of these data. A critical component of the JIMO effort will be the ability to predict the thruster plume environment and its effects on the mission. By being able to model and predict this environment in advance, mitigation methods can be developed to limit any mission-limiting effects early in the design when cost effects are minimal.

These activities will be continued in FY04 as well as new tasks initiated. These tasks are: 1) Jovian Ionizing Radiation Environmental Modeling, 2) Thruster Plume and Effects Models for JIMO, 3) Internal Electrostatic Discharge (IESD), Spacecraft Charging, and Environmental Effect on High Voltage System, 4) Interactions Between Nuclear Power and Propulsion and Spacecraft Systems (Contamination), 5) Jovian Meteoroid Environment Definition, and 6) Plume Measurements.

Surveying and Examination of Eroded Returned Surfaces (SEERS) Project

Evaluating Yesterday's Flight Hardware for Tomorrow's Missions

By: Billy Kauffman
NASA's Space Environments and Effects Program

The understanding of the different space environments and their effects on spacecraft components and systems is vital to all future space missions, particularly as the emphasis for spacecraft development is placed on more compact, longer-life systems that contain enabling technologies. An understanding of these environments and establishment of techniques to mitigate the effects from these environments is essential to the advancement of new technologies. The Surveying and Examination of Eroded Returned Surfaces (SEERS) Project was initiated to provide leadership in the analysis of flight hardware returned from space.

The SEERS Project is managed by NASA's SEE Program. The Project will include comprehensive efforts toward the analysis of returned spacecraft hardware (not primary science mission objectives) to understand environmental effects due to solar UV, ionizing radiation, plasmas, neutral contamination, meteoroids, and other conditions experienced during the mission.

The Project will initially concentrate efforts toward the return of the Genesis spacecraft (currently scheduled to return September, 2004) while long range plans include the Stardust spacecraft (currently scheduled to return January, 2006). Genesis will be the first spacecraft returned from Lagrangian Point (L1) and Stardust will be the first spacecraft to return contemporary comet grains and possibly interstellar dust to Earth.

The SEERS Project will provide the ability to study space exposed materials for degradation and contamination as well as investigate system level effects of radiation degradation to microelectronics, mechanisms, and associated hardware. Knowledge gathered from this initiative will provide excellent risk mitigation for future missions.

A second SEERS workshop is currently being planned for the 2nd quarter of FY04 to refine technical activities toward the Genesis return capsule and begin identifying technical activities for the Stardust return capsule. The SEE Program Office is currently attempting to secure resources for FY05 and beyond.

For more information, please visit the website at:

http://see.msfc.nasa.gov/seers

Empirical Low Energy Ion Flux Model for the Terrestrial Magnetosphere

By: Joe Minow
Jacobs Sverdrup

The Space Environments and Effects (SEE) Program, in partnering with Marshall Space Flight Center's Space Environments Team, was awarded a two year effort through the Living With a Star (LWS) Targeted Research and Technology Program to develop an empirical model of ion flux environments in the Earth's magnetosphere. Incorporating ion flux observations from multiple satellites, the model will yield statistical flux estimates of the ion environment required to mitigate harmful effects on human technologies. A secondary objective of work will be to enable cost-effective design of scientific spacecraft and subsystems by providing improved engineering design tools for use in minimizing space environmental effects and damage. Finally, the proposed technique to incorporate ion flux observations from multiple spacecraft into a single statistical flux model yields a simple and cost-effective technique for assimilating data from multiple research spacecraft.

Charged particle flux models are required by engineers and space environments analysts to determine spacecraft vulnerability to space environments and assess the impact of ionizing radiation on spacecraft design, instrument operation, as well as providing estimates of the space environment for use in investigations of anomalies in spacecraft systems. The standard AP-8 and AE-8 trapped proton and electron environment models are the most widely used models for providing time independent models of the radiation environments for either solar maximum or solar minimum conditions. The standard models find wide use in mission analysis and spacecraft design as long as the limitations are understood and the codes are not misused. For example, the AP-8/AE-8 models are most useful for estimating particle fluence accumulated over many orbits in the inner magnetosphere.

Recent developments in spacecraft and instrument design have led to increased vulnerabilities to particles in energy ranges below which AP-8/AE-8 are applicable. Plans to orbit spacecraft utilizing solar sails for propulsion and sunshields for protection

of sensitive instruments from sunlight have created a need for low energy charged particle environment models to support analysis and testing of thin materials. Modeling of radiation dose in thin materials requires estimates of particle flux at energies below the range covered by the AE-8/AP-8 models where the maximum energy deposition occurs entirely within the thin layers. Finally, use of the models to meet program requirements or to determine regions of geospace where sensitive instruments or materials may be exposed to the space environment require models with information on the variability of the ion flux environment to provide the necessary quantitative statistical information on the instantaneous values of ion and electron flux along the spacecraft orbit.

The effort addresses the need for a low energy ion flux model of the Earth's magnetosphere that can be used in spacecraft design and mission analysis. The product will be an empirical engineering ion flux model applicable over a range of geocentric radial distances of approximately 2 Earth radii (Re) to the magnetopause within a maximum distance of 30 Re in the direction of the magnetotail. The model will provide differential ion energy flux over an energy range from approximately 50 keV to 1000 keV in 10 to15 logarithmic energy steps. A key feature of the proposed model is ion flux values traceable to satellite observations of the ion environment. Data is binned in spatial volume elements and sorted to yield Kp dependent flux estimates that are reported for 50 %, 90 %, or other percentile values in the region, allowing the model to be used for mean or extreme (e.g., 95 % or 99%). Inputs to the model will be location in space, date and time of year, and appropriate interplanetary environment conditions (e.g., interplanetary magnetic field, solar wind density and velocity) and geomagnetic indices (e.g., Dst, Kp) and the software will return values of the ion flux for user selected percentile levels (e.g., the maximum flux value that would be predicted to occur 50% or 90% of the time).

The goal is to provide an alternative to the AP-8 model applicable over an energy range below which the NASA standard models are not applicable and for radial distances that include the outer magnetosphere where strong azimuthal asymmetries in charged particle fluxes are not well described by AP-8. The modeling approach will include the magnetosheath and near Earth solar wind particle flux as well as the magnetosphere in the statistical flux database (because these environments are available in the datasets used to derive the model). Thus, the model provides an integrated charged particle environment definition model useful for a variety of applications including spacecraft design analysis, near real time environment modeling, and dynamic flux estimates for use in on-orbit operations support within 30 Re of the Earth.

The 8th Spacecraft Charging Technology Conference will be held October 20-24, 2003 at the Huntsville Marriott.

The 8th Spacecraft Charging Technology Conference is an international forum to present and discuss spacecraft charging issues and mitigation techniques. As a continuation of previous conferences, this next gathering of the world's leading experts in spacecraft charging looks to further expand the knowledgebase of spacecraft charging information…from identifying specific causes… to the latest in mitigation techniques…to new material characterizations and collaboration opportunities. Co-sponsored by the Air Force Research Lab (AFRL) and the European Space Agency (ESA).

Topics to be discussed include:

- **Models & Computer Simulations**
- **Ground Testing Techniques**
- **On-Orbit Investigations**
- **Environment Specifications**
- **Plasma Propulsion & Tethers**
- **Materials Characterizations**
- **Current Collection and Plasmas Probes in Space Plasmas**
- **Interactions of Spacecraft and Systems with the Natural and Induced Plasma Environment**

More information may be found at: http://see.msfc.nasa.gov/sctc

2003 Spacecraft Contamination & Coatings Workshop

NASA's Goddard Space Flight Center, in conjunction with NASA's Space Environments and Effects (SEE) Program, is sponsoring the 2003 Spacecraft Contamination & Coating Workshop

28-29 October 2003
Martin's Crosswinds
Greenbelt, MD

The objective of the workshop is to provide a forum for exchanging new developments in spacecraft contamination engineering and coatings. This workshop will invite audience participation with each session holding a panel discussion with the presenters. The workshop sessions include:

- Coatings and Films
- Special Topics in Contamination Engineering
- Topics in Mass Transfer
- New Approaches in Environmental Effects

The workshop will be held at Martin's Crosswinds, starting at 8:30 a.m. on Tuesday, October 28th and ending at 5:00 p.m. on Wednesday, October 29th. A block of rooms for attendees has been reserved at the Holiday Inn Greenbelt (adjacent to Martin's Crosswinds), which is located in Greenbelt, Maryland.

For more information, contact the Program Chairs, Ms. Patti Hansen (301) 286-0564 and Ms. Jackie Townsend at (301) 286-6685, or the Conference Coordinator Ms. Kortney Stevens at (800) 634-6326.

The deadline for registration is October 17, 2003.

The SEE Program is continuing to work with NASA Headquarters regarding the potential release of a NASA Research Announcement (NRA) in FY04. More information will be released as it becomes available.

CORRECTION

The May 2003 SEE Bulletin discussed the development of Radiation Environment Array Charge Transport (REACT) Model, which is now available for distribution from the SEE Program website. The SEE Program would like to acknowledge that this model was funded with resources provided by NASA's Living With a Star (LWS) Space Environment Testbed (SET) Program. We regret the omission.

Contact Information

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