Space Ionization Radiation Environment and Effects (SIRE2) Model for Satellite Applications

SEESAW Workshop

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Overview

• Why develop SIRE2?
• Tour of the Graphic User Interface (GUI)
• Example satellite calculations
• Future updates for SIRE2
Why Develop SIRE2?

• CREME96, SPENVIS, etc.
  – State of the art in their day
  – Environment models updates needed
• Address environments of space vehicles, UAV, and aircraft in arbitrary trajectory
  – Plans to incorporate atmospheric transport and address neutron environments
• Address needs for operation on corporate networks and desktop computers
• This work is being performed in support of a Phase III SBIR
Space Ionizing Radiation Environments and Effects (SIRE2)

CREME 86/96
- Calculates satellite environments
- Environments models from mid 90’s.
  - Geomagnetic Fields (CRÈME96-C96)
  - Trapped Radiation (AP8)
  - Cosmic Rays (C96)
  - Solar Particles (C96)
  - Radiation Shielding (C96+)
- Effects models also from the 80’s/90’s (C96)

SIRE2
- Calculates satellite, rockets, space vehicles, and other trajectory environments
- Environments models from mid 90’s.
  - Geomagnetic Fields (C96+, SS06)
  - Trapped Radiation (AP8/AE8 & AP9/AE9 soon)
  - Cosmic Rays (C96/BON14)
  - Solar Particles (C96, RA17)
  - Radiation Shielding (C96+)
- Effects models also from the 80’s/90’s (C96 + plans for further upgrades)

1. All CREME96 legacy environment models were updated in SIRE2 for space vehicles in flight.
2. New SIRE2 environments models apply to interplanetary space, satellite, space vehicles, and other trajectories.
3. SIRE2 user interface designed to maximize productivity and documentation. Results link with Microsoft Office via Visual Basic for Applications (VBA)
4. Batch Model processing allows for a series for a variety of environment conditions and for large sets of piece parts
SIRE2 Capability

- Environments
  - GTF
    - CREME-96
    - Smart-Shea 2006
  - Nymik Cutoff
    - Min, Max, Ave
  - Magnetic Field Conditions
    - Stormy
    - Quiet
  - Trapped Belt
    - AP8 Min/AP8 Max
    - AP9 TBD
    - AE9 TBD (dose only)
- Flux Models
  - CREME96 Cosmic Rays
  - BON2014 Cosmic Rays
  - CREME96 Solar Particles
  - Robinson/Adams Solar Particles (Fall 2017)
- Batch mode processor always for a series of calculation
SIRE2 Capability

- **Environments**
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- **Batch mode processor always for a series of calculation**
Custom Satellite Orbital Parameters

Name Of Satellite Orbit GTRN Output File: GTRNFilename

- Apogee: 300 km
- Perigee: 200 km
- Inclination: 10 Degrees

Geomagnetic Cutoff Model:
- CREWE96
- Smart-Shea 2006

Magnetospheric Field Condition:
- Quiet
- Stormy

Kp Index: 0

Starting Time (UT):
- Year: 2017
- Month: 3
- Day: 29
- Hour: 11
- Minute: 21:58

Advanced Parameters:
- Initial Longitude Of Ascending Node: 0 Degrees
- Initial Displacement From Ascending Node: 0
- Displacement Of Perigee From Ascending Node: 0
- Number Of Days To Average: 7
- Number Of Steps Per Orbit: 200
- Number Of Orbits To Display: 1

Create Close
2000 Kilometer Circular Orbit

Latitude: Min = -10.00 deg, Max = 10.00 deg
Longitude: Min = 0.00 deg, Max = 326.60 deg
Altitude: Min = 2000.00 km, Max = 3000.00 km, Period = 127.19 min, Average Over 7 Days
2000 Kilometer Circular Orbit

Satellite/Legacy: Circular.gtf
Magnetic Field: Quiet, CREME96 Solar Quiet (Minimum), Al Shield: 100.00 mils
Apogee = 2000.00 km, Perigee = 2000.00 km, Inc = 10.00 deg, Advanced = 0.00, 0.00, 0.00 deg, Period = 127.19 min, Ndays = 7

Geomagnetic Transmission

Integral LET Spectrum

Free-Field Differential Flux
Average Date = 2.025e-06 (2012), 7.55e-6 (2013)

Shielded Differential Flux
Average Date = 2.025e-06 (2012), 7.55e-6 (2013)
SIRE2 Capability

- Electronic Upset models (legacy)
  - HUP
    - 2 Column
    - Weibull
    - Critical Charge
  - PUP
    - 2 Column
    - Bendel 1
    - Bendel 2
    - Weibull

- Updated Interface with Batch Mode Processor (SIRE2)
  - Excel or text input
  - Electronics Parts Template
  - Results saved in Excel and text format for later review
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Single Event Upsets

- Orbit averaged and/or time dependent upset rates recorded for each part including model parameters and environmental conditions
Future Updates to SIRE2

- Probabilistic Model
- AE9/AP9
- Increase calculation speed using callable DLL’s and multiple core processing
How to Become Beta Tester

• Fill out contact information and make a request in the comments box

http://www.5thgait.com/contact/index

• Or email zachary@5thgait.com
References

