



# SPENVIS Tutorial: mission concept

M. Kruglanski  
Belgian Institute for Space Aeronomy



# Last and near-future SPENVIS features

- 4.6.1 (June 2009)

- RB: IGE2006/POLE (e<sup>-</sup> geostationary orbit)
- SEP: Rosenqvist et al. update of JPL-91
- GCR: ISO-15390, Nymmik et al 1996
- Surface charging: Burke's equation, Auroral environment
- DICTAT v3
- Orbit generator: Martian and Jovian orbit
- Jovian Radiation belts

- 4.6.2 (December 2009)

- java-based geometry definition tool → Laszlo H.
- ECSS space environment standard ← Eamonn D.
- SPENVIS Kernel, Help pages (broken links)



# Last and near-future SPENVIS features

- 4.6.3 (February 2010)
  - Mars Energetic Radiation Environment Models → Wednesday
  - Relative Damage Coefficient converter (Tada et al 1982)
  - Magnetocosmics and Planetocosmics → Neophytos M.
  - Ionospheric NeQuick model
  - PSYCHIC model (Solar Energetic Particle)
  - MC-SCREAM model for solar cell degradation (???)
  - Upgrade of Single Event upset rates → Erwin DD.
  - Geant4 tools (user interface) → Neophytos M.
  - index page (help), Result export facility
- Near future (4.6.4, 4.6.5)
  - Spacecraft trajectory: new upload, hyperbolic
  - SEP flux and GCR fluence separated from LETORB → Erwin DD.
  - SEP & GCR for other planets → Erwin DD.
  - Update of magnetic shielding based on Magnetocosmics
  - Outgasing contamination analysis tool
  - ODI, JoveRem → Wednesday



# Models in SPENVIS

- Grouped by packages
- Grouped by planets
- Grouped by types
  - Spacecraft trajectories
  - Coordinate grids (single point, profile, maps)
  - Other
- Model dependencies

▲ UP	<b>Coordinate generators</b>
	<u>Spacecraft trajectories</u>
	or
	<u>Geographical coordinate grids</u>
	or
	<u>Switch to another planet</u>
	<b><u>Radiation sources and effects</u></b>
	<b><u>Spacecraft charging</u></b>
	<b><u>Atmosphere and ionosphere</u></b>
	<b><u>Magnetic field</u></b>
	<b><u>Meteoroids and debris</u></b>
	<b><u>Miscellaneous</u></b>
	<b><u>Geant4 Tools</u></b>
	<b>ECSS Space Environment Standard</b>

Planet: Earth
<b>Coordinate generators</b>
<b>Radiation sources and effects</b>
Trapped particle flux maps and profiles Geomagnetic cutoff maps and profiles
<b>Spacecraft charging</b>
<b>Atmosphere and ionosphere</b>
<b>Magnetic field</b>
<b>Meteoroids and debris</b>
<b>Miscellaneous</b>
<b>Geant4 Tools</b>
<b>ECSS Space Environment Standard</b>

Planet: Earth
<b>Coordinate generators</b>
<b>Radiation sources and effects</b>
<b>Radiation sources</b>
Trapped proton and electron fluxes Trapped proton flux anisotropy Solar proton fluences
<b>Solar cell radiation damage</b>
Damage equivalent fluences for solar cells (EQFLUX) NIEL based damage equivalent fluences for solar cells (MC-SCREAM)
<b>Radiation doses</b>
Ionizing and non-ionizing dose models for simple geometries
<b>Single event effects</b>
Ion energy and LET spectra Single event upset rates
<b>Spacecraft charging</b>
<b>Atmosphere and ionosphere</b>
<b>Magnetic field</b>
<b>Meteoroids and debris</b>
<b>Miscellaneous</b>
<b>Geant4 Tools</b>
<b>ECSS Space Environment Standard</b>

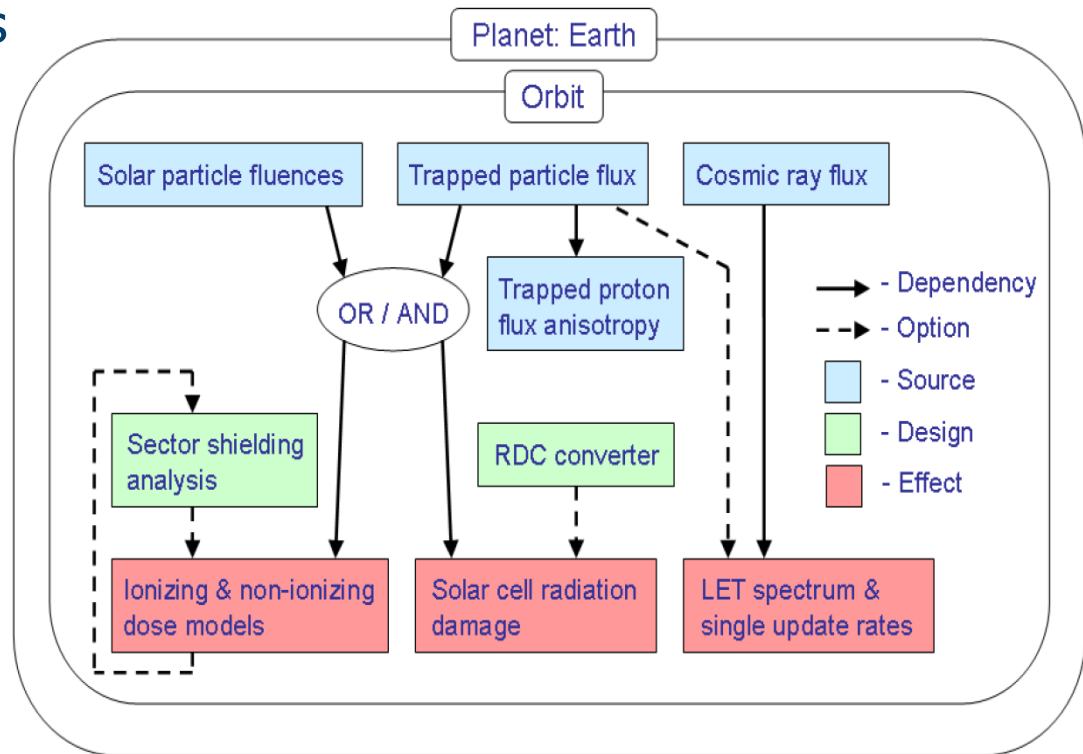
Planet: Earth
<b>Coordinate generators</b>
<b>Radiation sources and effects</b>
<b>Radiation sources</b>
<u>Trapped proton and electron fluxes</u> Trapped proton flux anisotropy <u>Solar proton fluences</u>
<b>Solar cell radiation damage</b>
Damage equivalent fluences for solar cells (EQFLUX) NIEL based damage equivalent fluences for solar cells (MC-SCREAM)
<b>Radiation doses</b>
Ionizing and non-ionizing dose models for simple geometries
<b>Single event effects</b>
<u>Ion energy and LET spectra</u> Single event upset rates
<b>Spacecraft charging</b>
<b>Atmosphere and ionosphere</b>
<b>Magnetic field</b>
<b>Meteoroids and debris</b>
<b>Miscellaneous</b>
<b>Geant4 Tools</b>
<b>ECSS Space Environment Standard</b>

Planet: Jupiter
<b>Coordinate generators</b>
<b>Radiation sources and effects</b>
<b>Radiation sources</b>
<u>Trapped proton and electron fluxes</u> <b>Solar cell radiation damage</b> Damage equivalent fluences for solar cells (EQFLUX) NIEL based damage equivalent fluences for solar cells (MC-SCREAM)
<b>Radiation doses</b>
Ionizing and non-ionizing dose models for simple geometries
<b>Miscellaneous</b>
<b>Geant4 Tools</b>
<b>ECSS Space Environment Standard</b>



# Model dependencies

- Type: spacecraft trajectories
- Logic of the dependencies:
  1. Orbit generator
  2. Space environment
  3. Design (optional)
  4. Environment effects
- First step = Orbit generator



# Orbit generator



Orbit generator: Mission definition - Mozilla Firefox

SPENVIS DEVELOPER Project: WORKSHOP

Orbit generator  
Mission definition -Earth-

Trajectory generation: use orbit generator

Number of mission segments: 2

Mission end: total mission duration

Mission duration: 1.0 years

Satellite orientation: one axis parallel to the velocity vector

Account for solar radiation pressure: no

Account for atmospheric drag: no

Reset Next>>

Orbit generator: Parameters for segment NULL - Mozilla Firefox

SPENVIS DEVELOPER Project: WORKSHOP

Orbit generator  
Parameters for segment 2

Segment title: segment 2 geostationary

Orbit type: geostationary

Orbit start: end of previous segment

Representative trajectory duration [days]: 1

Longitude [deg]: 0

Output resolution

1.	60.0	s below	20000.0	km
2.	240.0	s below	80000.0	km
3.	3600.0	s elsewhere		

<< Back Next>>

Orbit generator: Parameters for segment NULL - Mozilla Firefox

SPENVIS DEVELOPER Project: WORKSHOP

Orbit generator  
Parameters for segment 1

Segment title: segment 1 general

Orbit type: general

Orbit start: calendar date

01 Jan 2010 00:00:00

Representative trajectory duration [days]: 1

Altitude specification: perigee and apogee altitudes

Perigee altitude [km]: 300

Apogee altitude [km]: 36000

Inclination [deg]: 0.0

R. asc. of asc. node [deg w.r.t gamma50]: 0

Argument of perigee [deg]: 0

True anomaly [deg]: 0

Output resolution

1.	60.0	s below	20000.0	km
2.	240.0	s below	80000.0	km
3.	3600.0	s elsewhere		

<< Back Next>>

Orbit generator: Mission summary - Mozilla Firefox

SPENVIS DEVELOPER Project: WORKSHOP

Orbit generator  
Mission summary

Number of mission segments: 2

Segment 1: segment 1 general

Orbit type: general  
Orbit start: 1/1/2010 0:0:0  
Trajectory duration: 1 day(s)

Segment 2: segment 2 geostationary

Orbit type: geostationary  
Orbit start: end of previous segment  
Trajectory duration: 1 day(s)

<< Back Run Combined Run

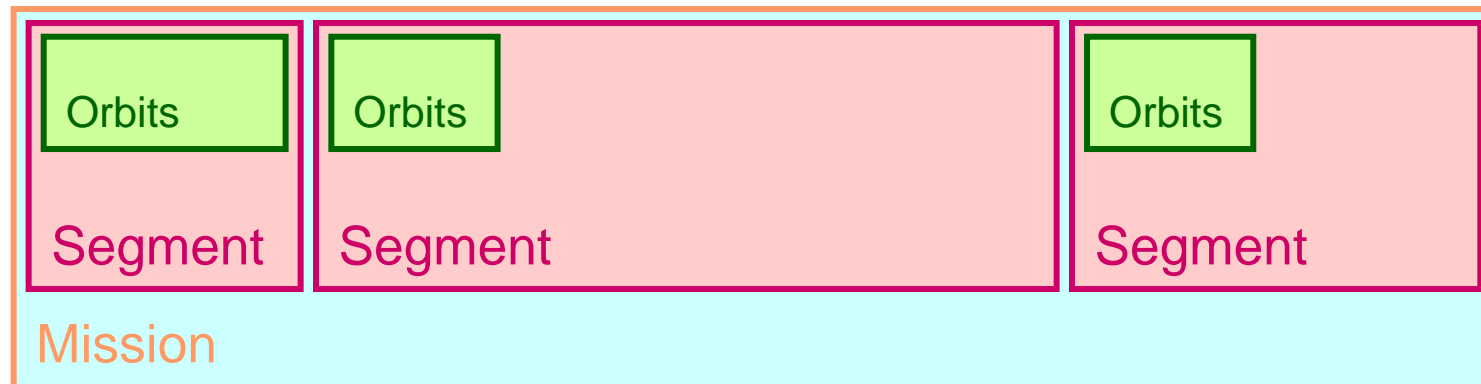
SPENVIS User's Workshop

# SPENVIS Mission concept

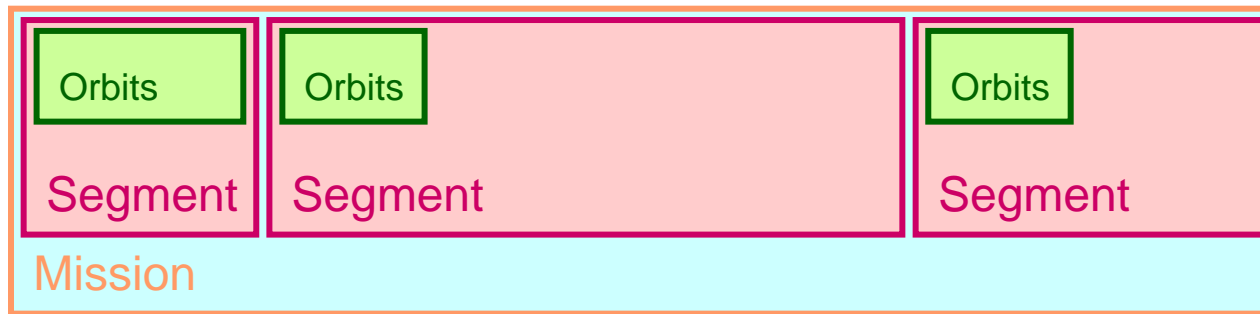
- Number of mission segments
- Mission duration

For each segment

- Orbit start
- Orbit duration
- Segment duration (implicit)



# Why?



- Generate the trajectory over the full mission
  - Huge files, not real added value
- Mission = set of segments
  - Representative orbits for each segment
  - Start of segment = start of representative orbits
  - End of segment = start of next segment OR end of mission
- Durations: Mission ( $M$ ), Segments ( $S_i$ ), Repr. Orbits ( $T_i$ )
  - Relations:  $T_i < S_i$  and  $M = \sum_i S_i$
- **Orbit mean  $\rightarrow$  Mission average**
  - Along orbit:  $f(t)$ ,  $F^T = \int_{T_i} f(t) dt$ ,  $\langle f^T \rangle_i = F^T / T_i$

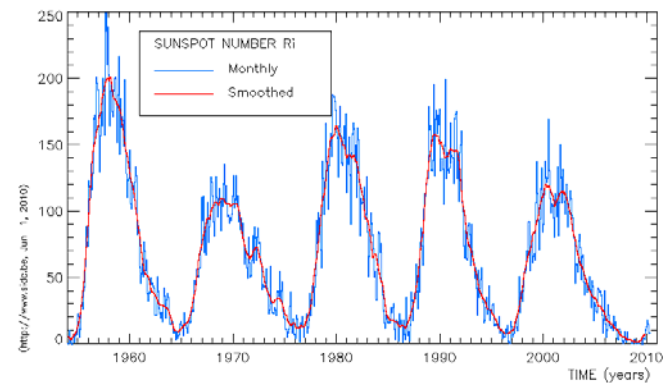
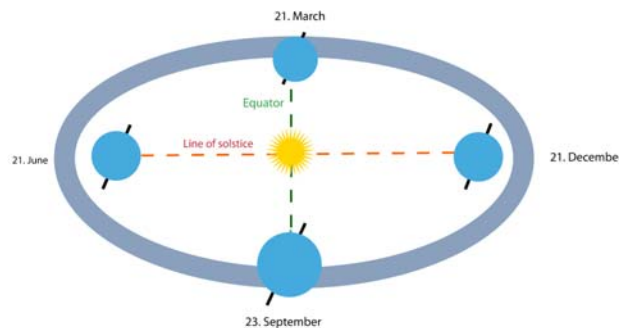
• Mission:

$$\langle f^M \rangle = \sum_i \langle f^T \rangle_i S_i / M$$

# How many segments?

## Criteria

- Spacecraft orbit change, e.g. GTO → GEO
- Precession of the orbital plane, e.g. SAMPEX (near-polar orbit) precession period = 6 months
- Space & time variability of the Space Environment
  - Solar cycle variation
  - Seasonal effect, e.g. tilt of magnetic dipole
- Type of models

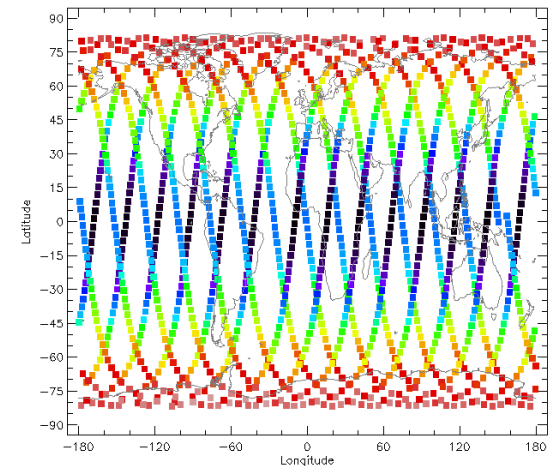
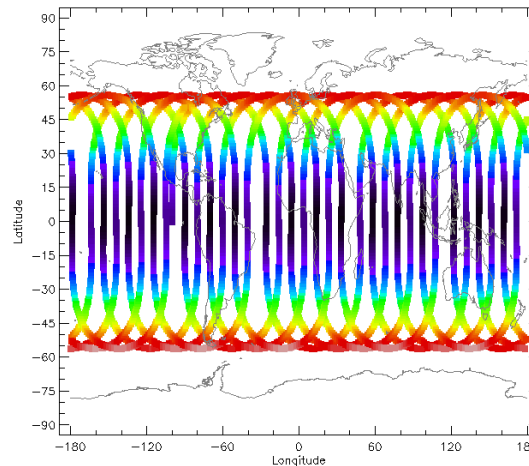


# Which orbit duration?

- Too long: huge files, not real added value
- Too short: missing feature

## Criteria

- Space variability of the Space Environment
  - E.g. South Atlantic Anomaly
- Warning: ascending/descending legs when not circular orbit



# Conclusion: SPENVIS mission concept

Need an adequate selection of

- Mission segments
- Representative orbits

in order to catch all variability  
of the space environment

- SPENVIS provides the tool but its use is user's responsibility
- Type of orbits:
  - General (elliptic), GEO, sun-synchronous;
  - Upload user's trajectory (new format);
  - Earth only: hyperbolic, Two-Line Element

# SPENVIS



The Space Environment Information System



aeronomie.be

