Specifying the Solar Energetic Particle Hazard Inside Geosynchronous

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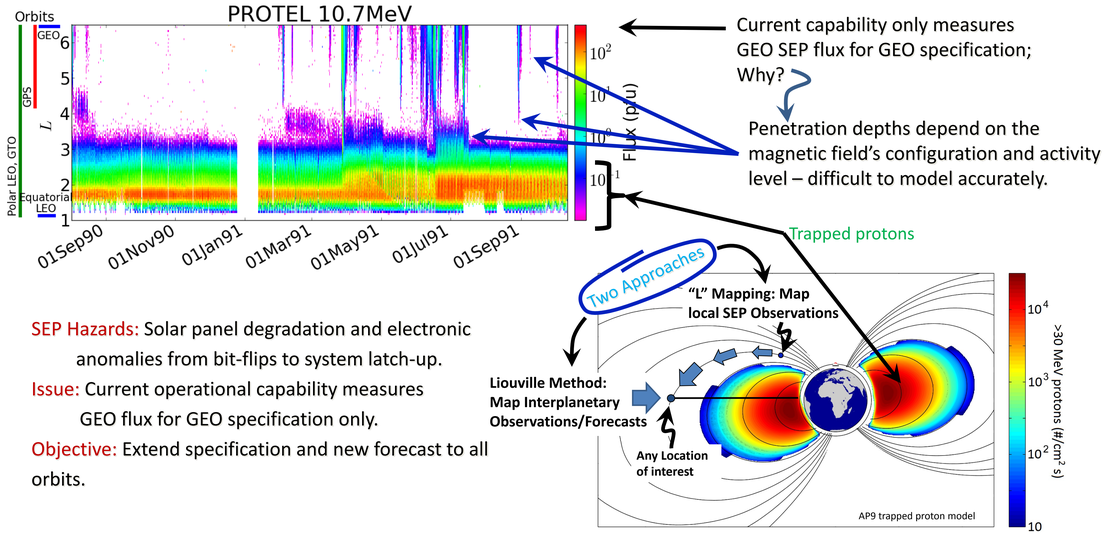
SEP Hazard/Present Capability

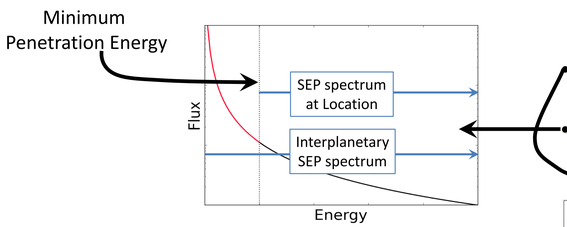


SEP Hazards: Solar panel degradation and electronic anomalies from bit-flips to system latch-up.

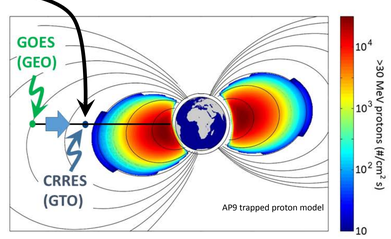
Issue: Current operational capability measures GEO flux for GEO specification only.

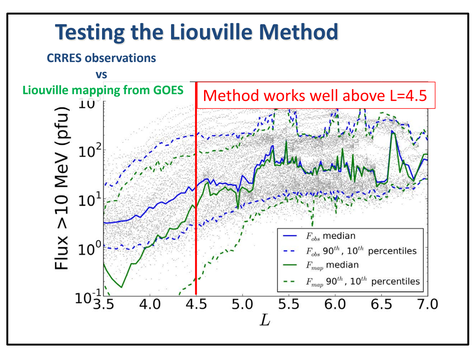
Objective: Extend specification and new forecast to all orbits.

Liouville Method



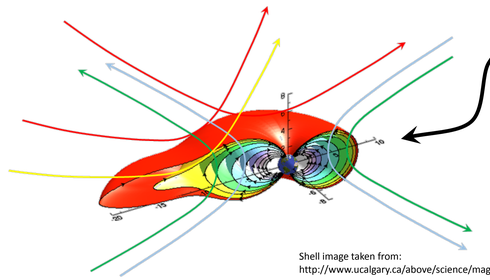
- Use Dartmouth's magnetic shielding code to calculate minimum penetration energy at location of interest.
- Liouville's theory (big simplification!): Interplanetary spectrum above the cutoff has access to the location.





- Liouville mapping is best method for forecasting
- Works well in GPS orbital range.
- Static field models don't provide dynamics necessary to model deep penetrations.

"L" Mapping Method

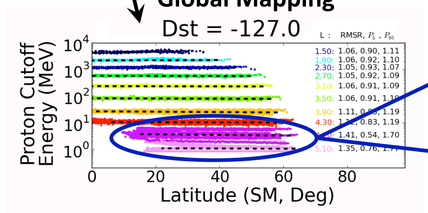


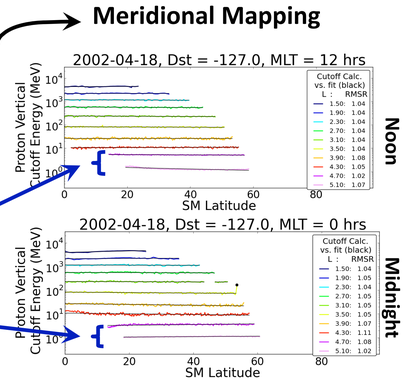
Shell image taken from: http://www.ucalgary.ca/above/science/mag_field

- SEPs penetrate to energy dependent cutoff surfaces.
- Smart and Shea, 1967 (AFGL) – L-shells approximate cutoff surfaces at low altitudes.
- Our study suggests this is valid at higher altitudes.
- Method may bypass need for modelling time dependent fields

1. Numerical Study

- Cutoff energies corresponded well with meridional L curves.
- Cutoff energies are reasonably constant over the L surface.





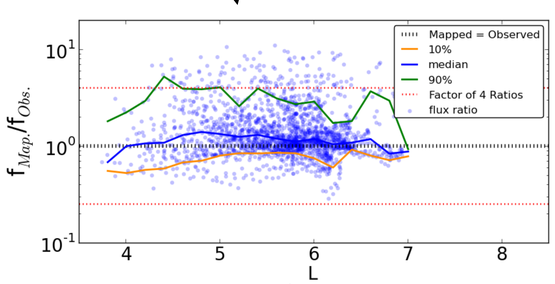
- L mapping method worked well over a range of magnetic conditions.
- Under some conditions mapping may need to be restricted to local observations or supplemented with Liouville method.

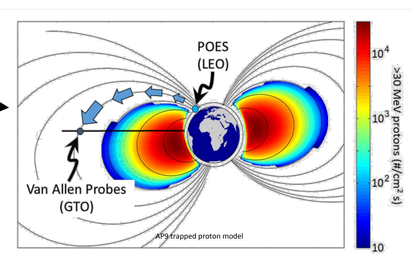
2. Data Study

- Map observations at POES satellite to Van Allen Probes using relation determined by a least squares fit:

$$F_{REPT}(L) = 0.619C_{POES}(L) + 1.85$$

- Compared mapped to locally observed data and found that 90% of mapped observations were within the necessary factor of 4.





- Most mappings were within the targeted accuracy range with simple mapping – even at low L values
- Small number of relevant events – need more events to confirm results and extend study to a larger range of magnetic conditions.

Results: Use "L" Mapping for specification and Liouville Method for high altitude forecast