216: Time dependent - 3D geomagnetic cutoffs in an LFM simulation with and without electric fields

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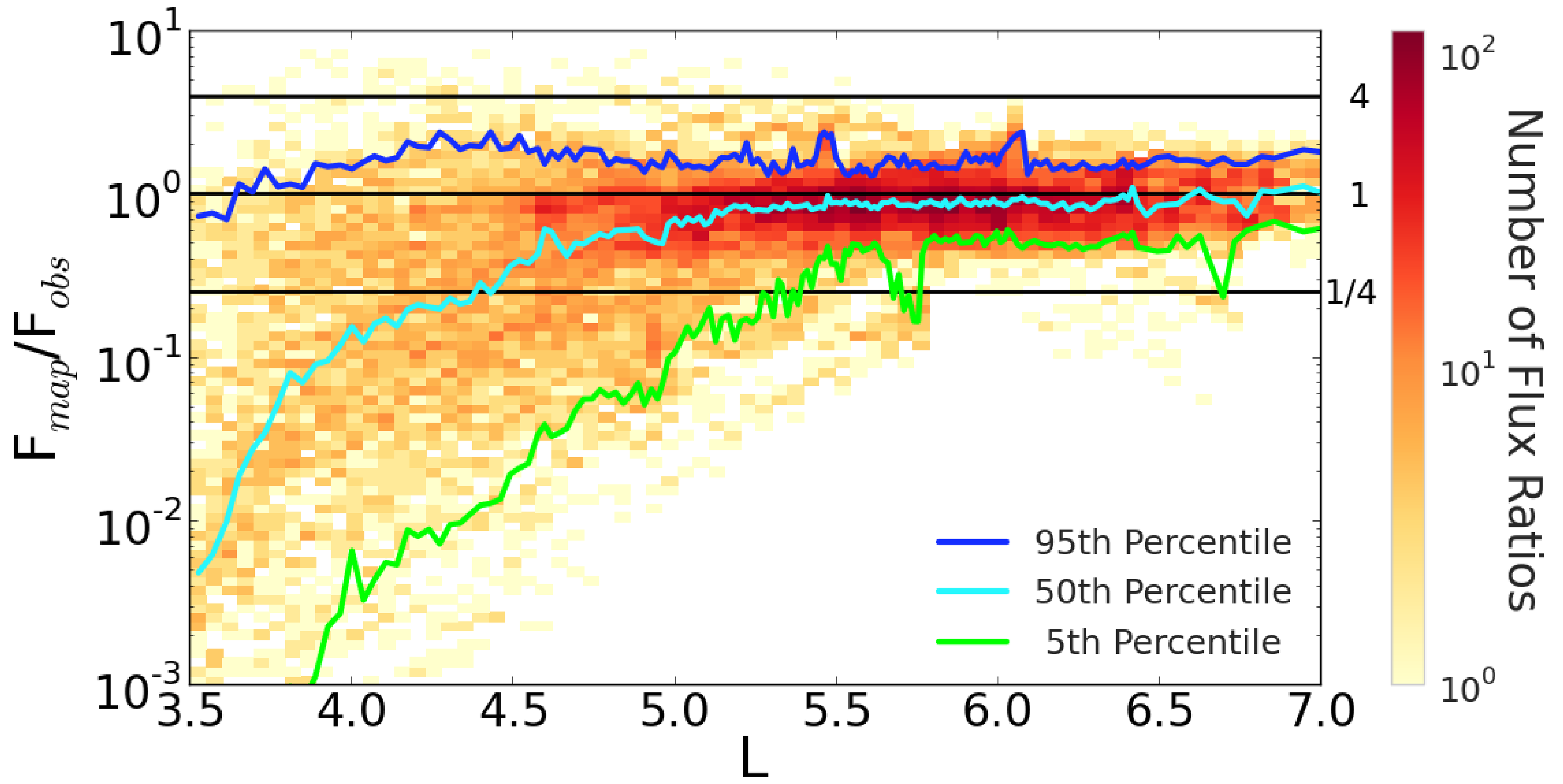
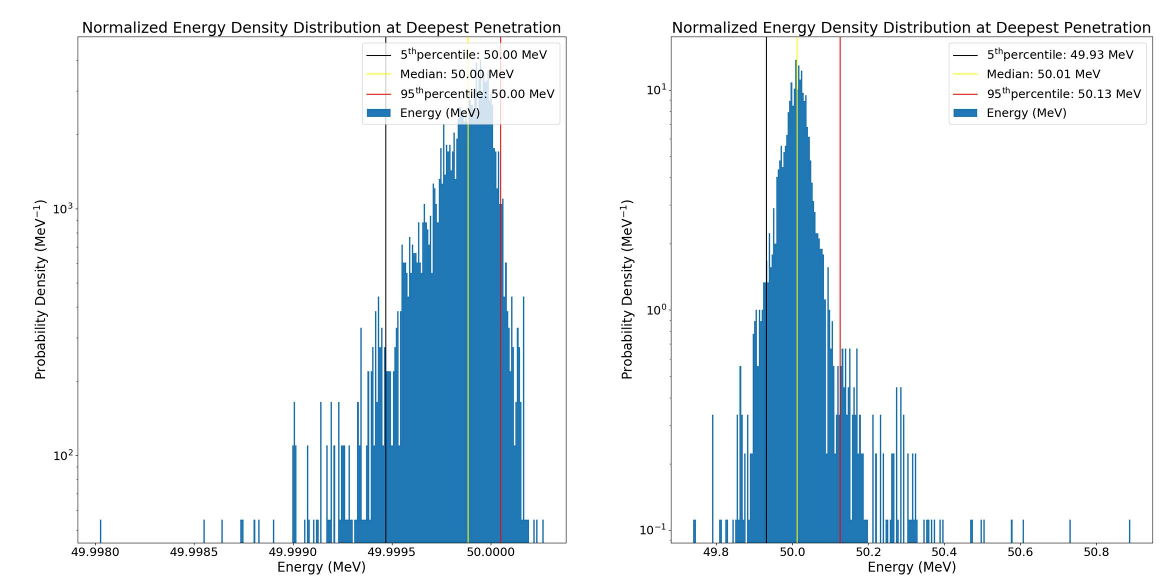


Motivation and Overview

Solar energetic particle (SEP) cutoff calculations are problematic in the outer magnetosphere. This leads to errors in SEP flux specifications as shown to the left where fluxes are mapped from GEO inward using Liouville's theorem and model cutoff calculations. The error in the mapped fluxes increases significantly at distances far away from the GEO observations.

This poster presents first results in an investigation to understand the source of the error in an effort to correct it. Here we investigate the possibility that this is a result of neglecting the electric field during cutoff calculations. It is generally believed that they are to be too weak to have a significant effect on the particle trajectory. We test that hypothesis by calculating two sets of particle trajectories in the LFM MHD model, one set includes the MHD electric field and the other doesn't. In this first set of calculations we are looking at low activity conditions, so the electric fields are weak.

Energy Diffusion



Left: Distribution of final particle energies without electric field. **Right:** Final energy distribution with electric field. .

Setup:

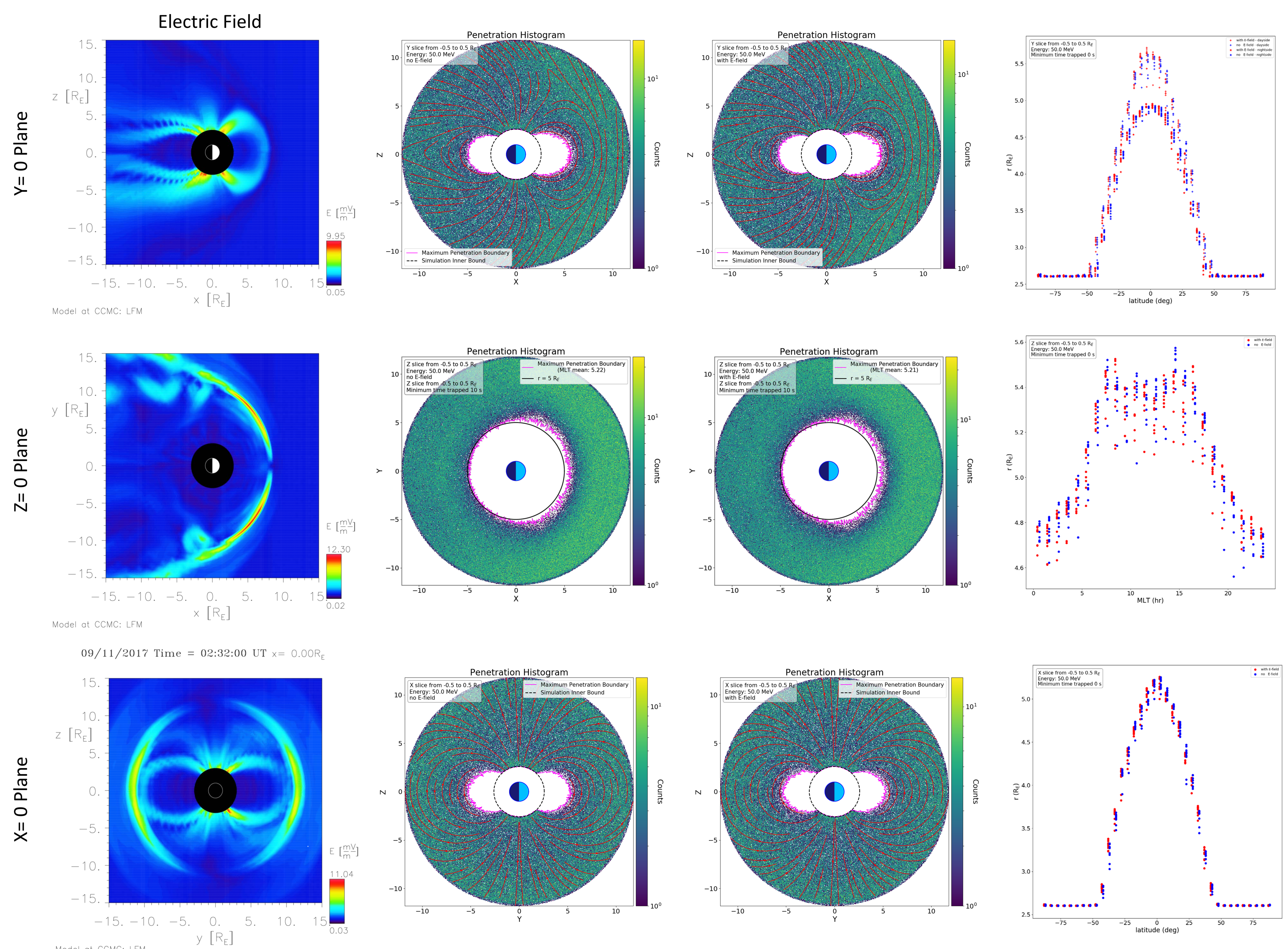
- **MHD model:** LFM, run at Community Coordinated Modeling Center (CCMC)
- **Particle Tracing Code:** Dartmouth-CISM code
- **Simulation Period:** 11 Sep 2017, 0200-0300
- **Particles Trajectories:** 10,000,000 particles were launched at random times during the simulated period. They were launched from a sphere at 11Re and initialized so that in the absence of a magnetic field the distribution inside the sphere would be isotropic.
- **Kp:** 0^+

Results:

The results are organized in the plots to the left as follows:

1st column: LFM Electric field maps (provided by CCMC).
2nd column: Distribution of deepest penetration locations in different slices for calculation without electric field.
3rd column: Same as 2nd column, but includes E-field.
4th column: Compares the 10 deepest penetrating particles as a function of latitude or magnetic local time. Red with E-field, blue without E-field.
Top row: Y=0 plane (1st column), -0.5 < Y < 0.5 (remaining columns)
Middle row: Similar to top row, but for Z.
Bottom row: Similar to top row, but for X.

SEP Penetration



Discussion:

The results for the Kp = 0^+ confirm the expected result for the 50 MeV particles. While the final energy distribution is broadened, the 5th to 95th width only grows to about half a percent of the original energy. This is not enough to make a difference in the macroscopic penetration boundaries as can be seen in the penetration histograms and inner boundary distributions.

Future Work:

This result does not rule out the possibility that cutoffs are influenced by the electric fields at other energies or magnetic field activities. Because of this similar investigations are in progress examining the different energies that are hazardous to spacecraft. We are also working on examining other magnetospheric activity levels.

Because the flux mapping errors demonstrated above occurred when using an index driven climatological magnetic field (Tsyganenko-Sitnov 2005), it is also important to investigate the importance of the dynamics that have been averaged out of such models. A study of this effect is being designed.