Transitioning AMPS to the CCMC

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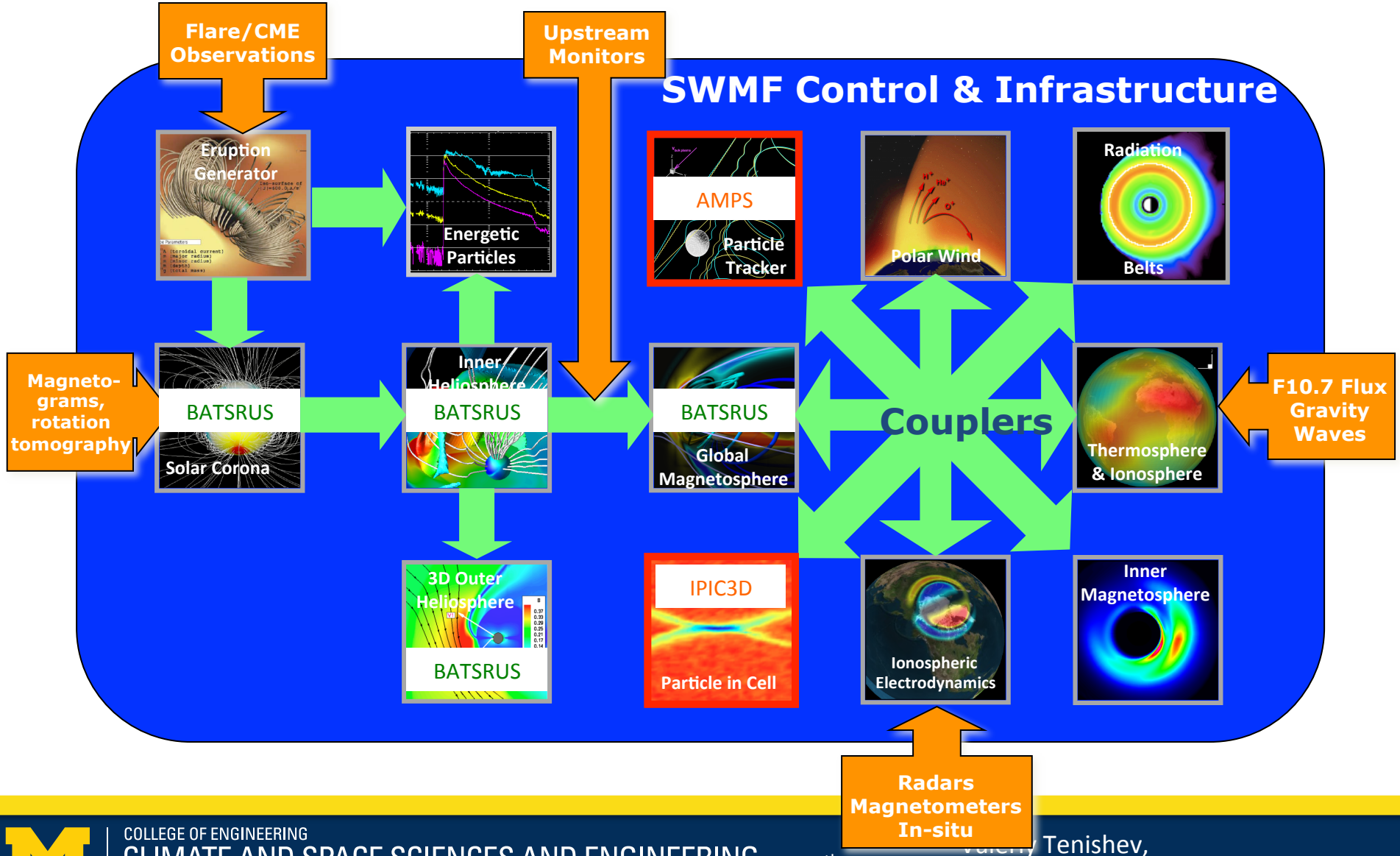
Particle Based Modeling

1. Non thermal component of the simulated environment
   - Energetic particle radiation environment in Earth's magnetosphere
   - Charged dust, etc…

2. Illustration of the particle dynamics on a kinetic level

AMPS in the SWMF

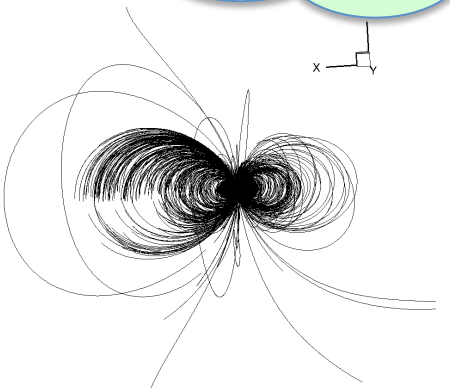


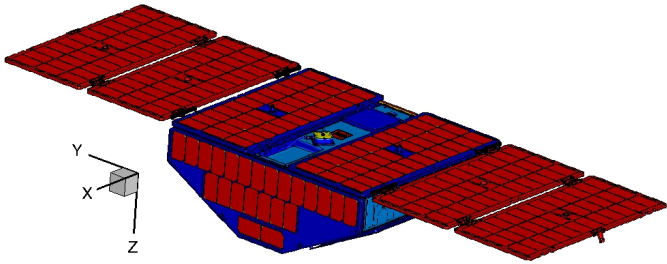
Adaptive Mesh Particle Simulator (AMPS)

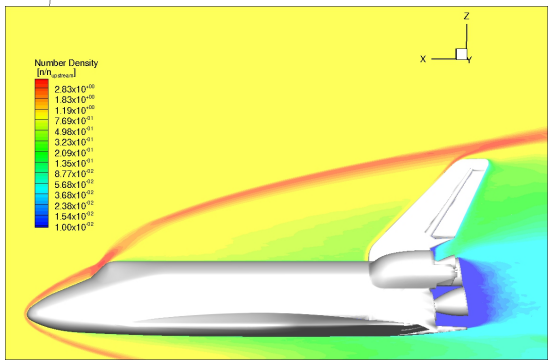
SWMF Component

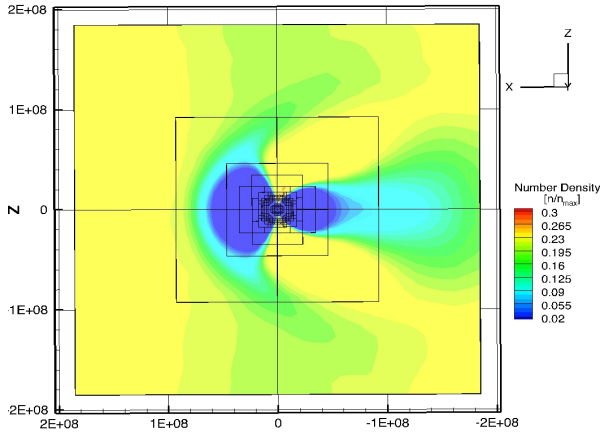
Stand along code

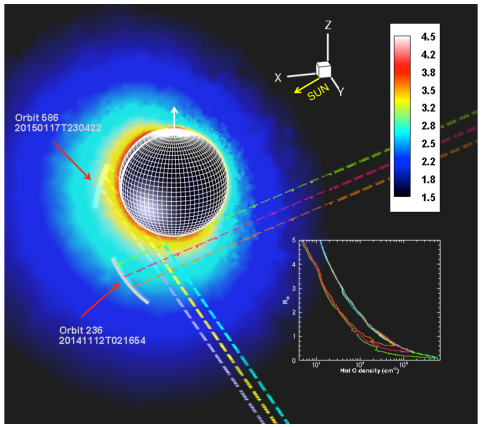
AMPS





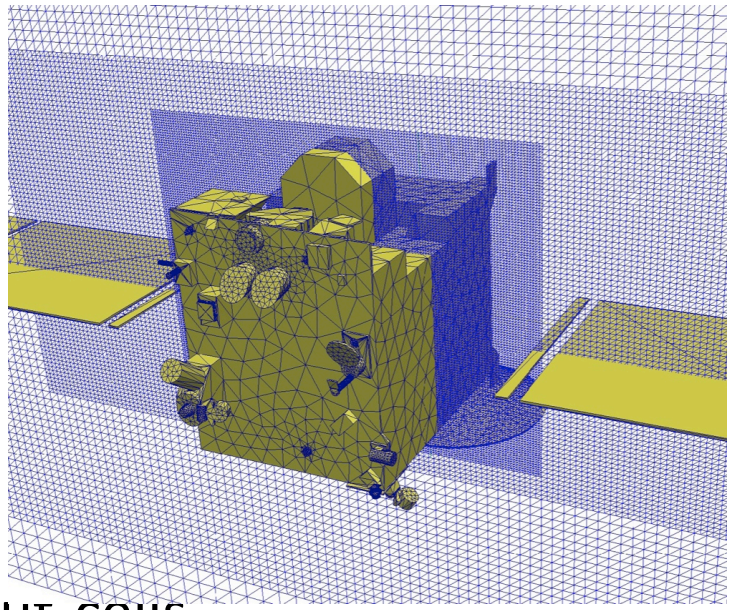






Adaptive Mesh Particle Simulator (AMPS)

- Applications
  - Comets, planetary satellites and exospheres
  - Tracking of the ions and charged dust
- Integrated with SPICE and SWMF
- Optimizations
  - Local time step and particle weight
  - Individual particle weight correction
- Adaptive Mesh Refinement (AMR) with cut-cells
- Parallel implementation
  - Domain decomposition
  - Static (volume, cell number) and dynamic load balancing (particle number, execution time)
  - Hybrid implementation: MPI (between nodes) + OpenMP (within each node)



Recent Development

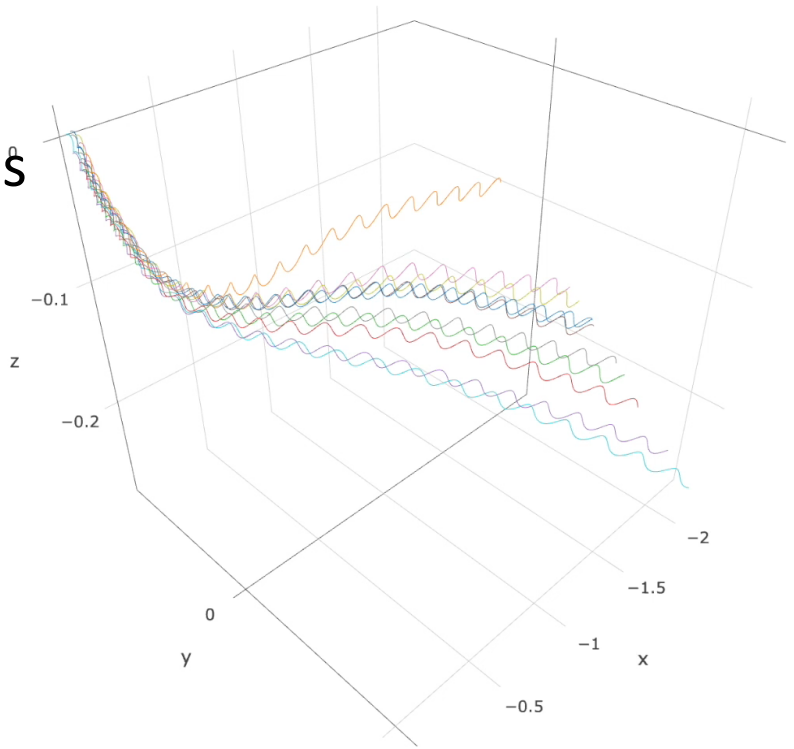
1. Backward particle tracking
2. Calculation of the cutoff rigidity, energy spectra, and flux of the energetic particles

Under construction:

1. Field solver for adding implicit PIC capabilities

Transitioning to the CCMC

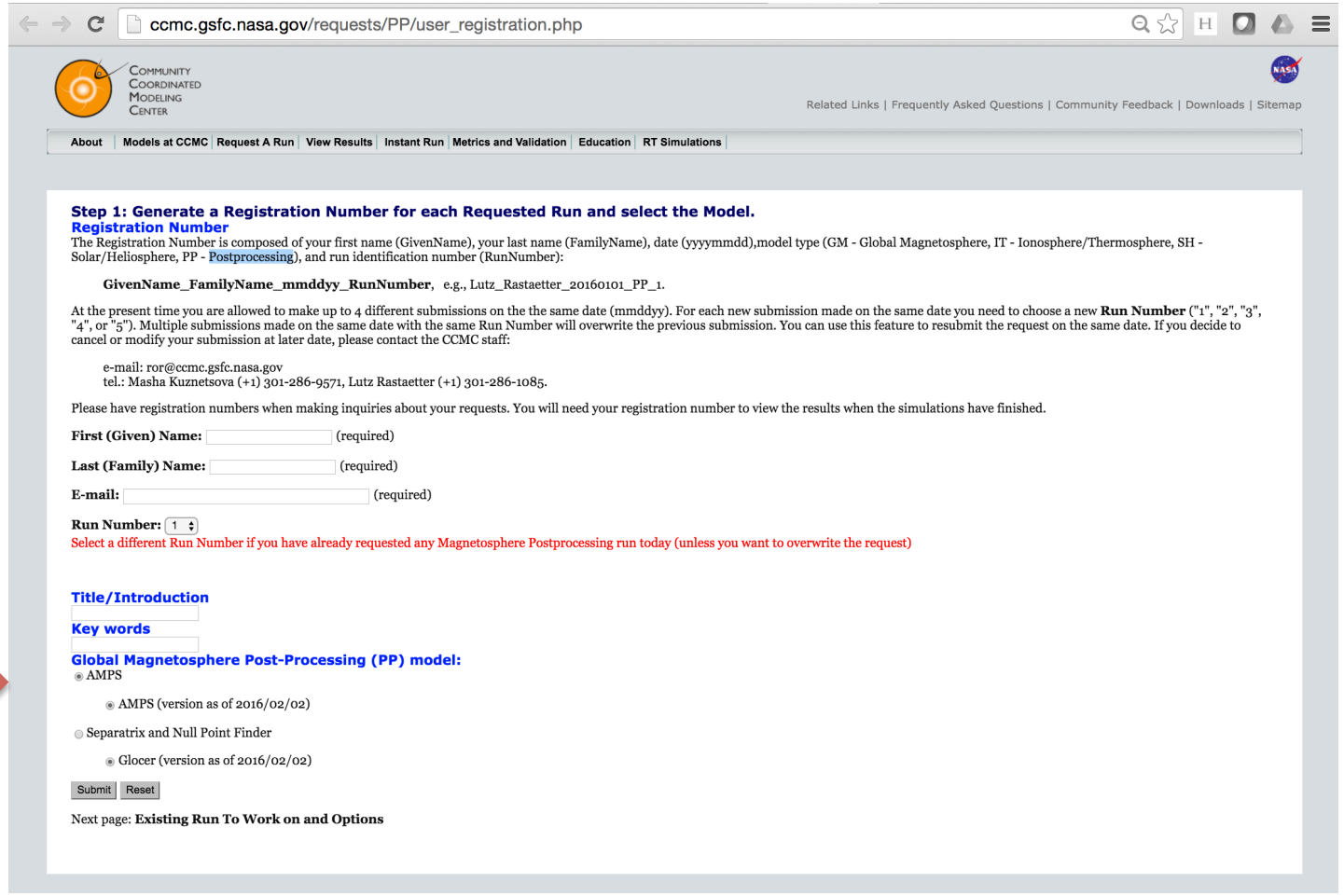
- Analyze charged particle trajectories moving in plasma
  - Post processing tool: use pre-calculated plasma and magnetic field
- Import of the plasma flow simulations into AMPS
  - Time-dependent results of the plasma modeling is saved in files
- Output
  - Individual particle trajectories
  - Samples of the distribution functions
  - Energy spectra
  - Flux



Transitioning to the CCMC

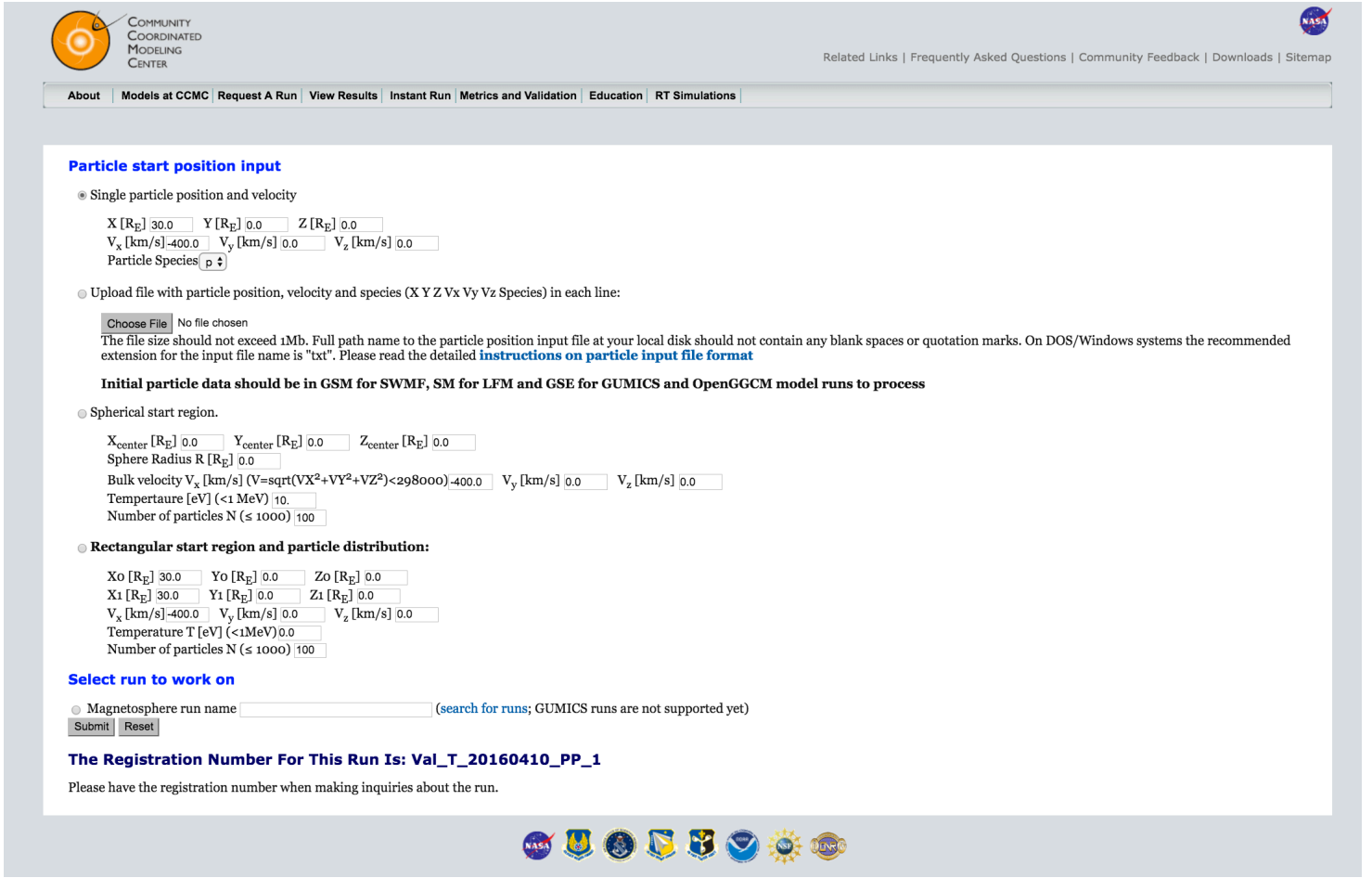
- Web based user interface is under testing

AMPS



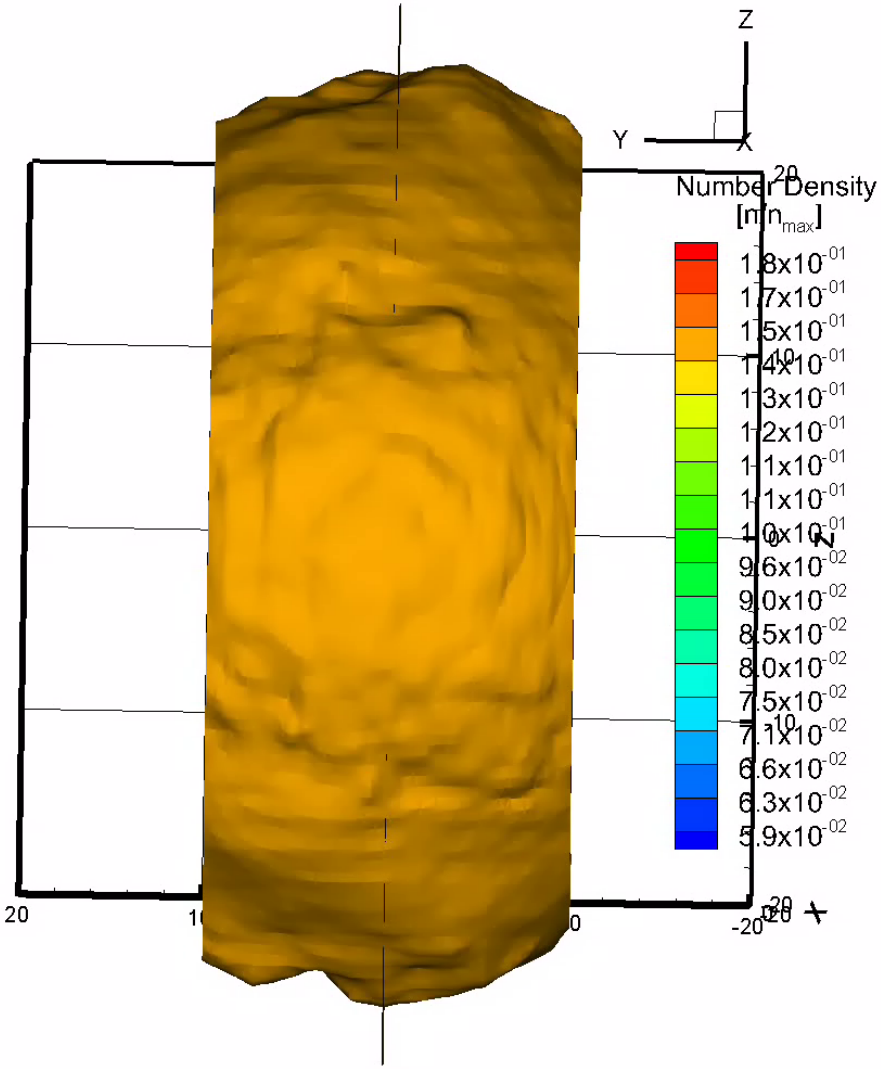
Transitioning to the CCMC

- Initial parameters of the simulated trajectories



GCRs in Earth's Magnetosphere

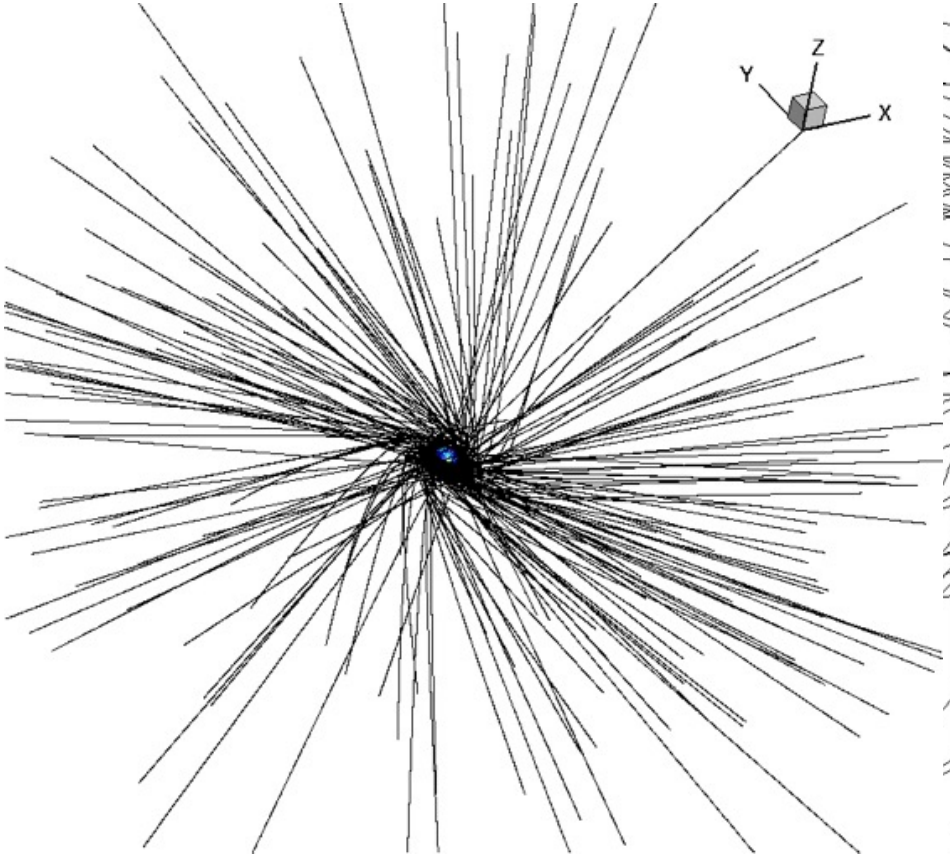
- Energy dependence:
  - Cutoff at low latitudes
  - Shielding by the magnetosphere
- Local time dependence
  - Becomes significant with an increase of the geocentric distance
- Modeling
  - Global modeling of the entire magnetosphere is important

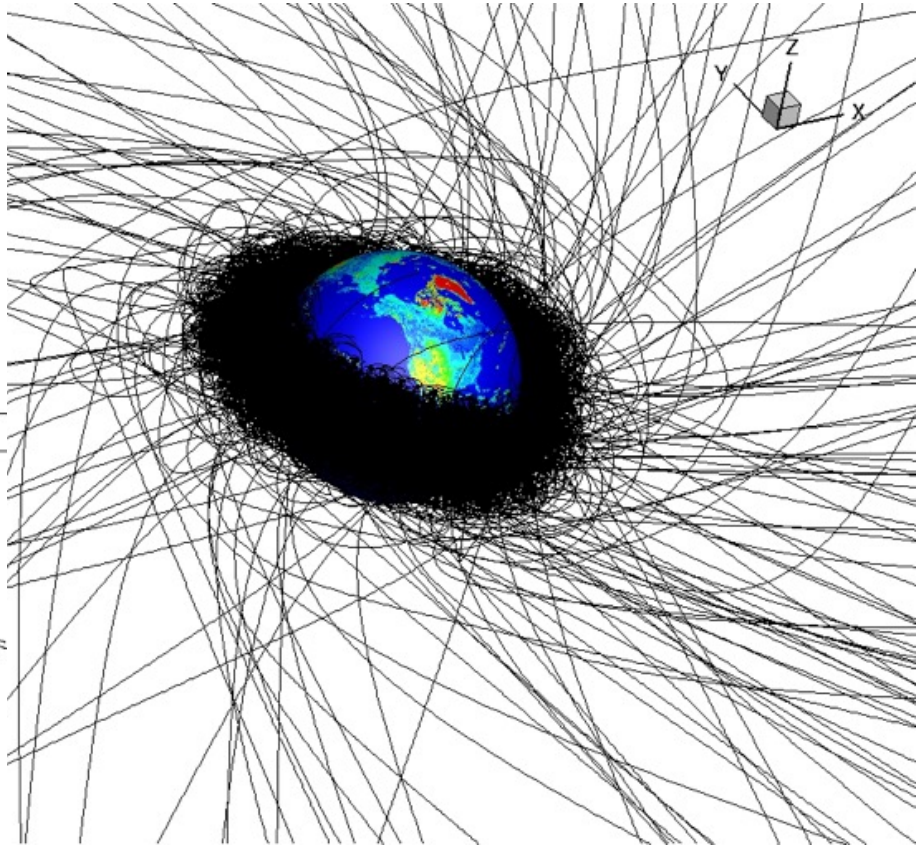


Backward Particle Tracking

Small and Large scale energetic particle trajectory integration

- Radiation environment in the entire Earth's magnetosphere



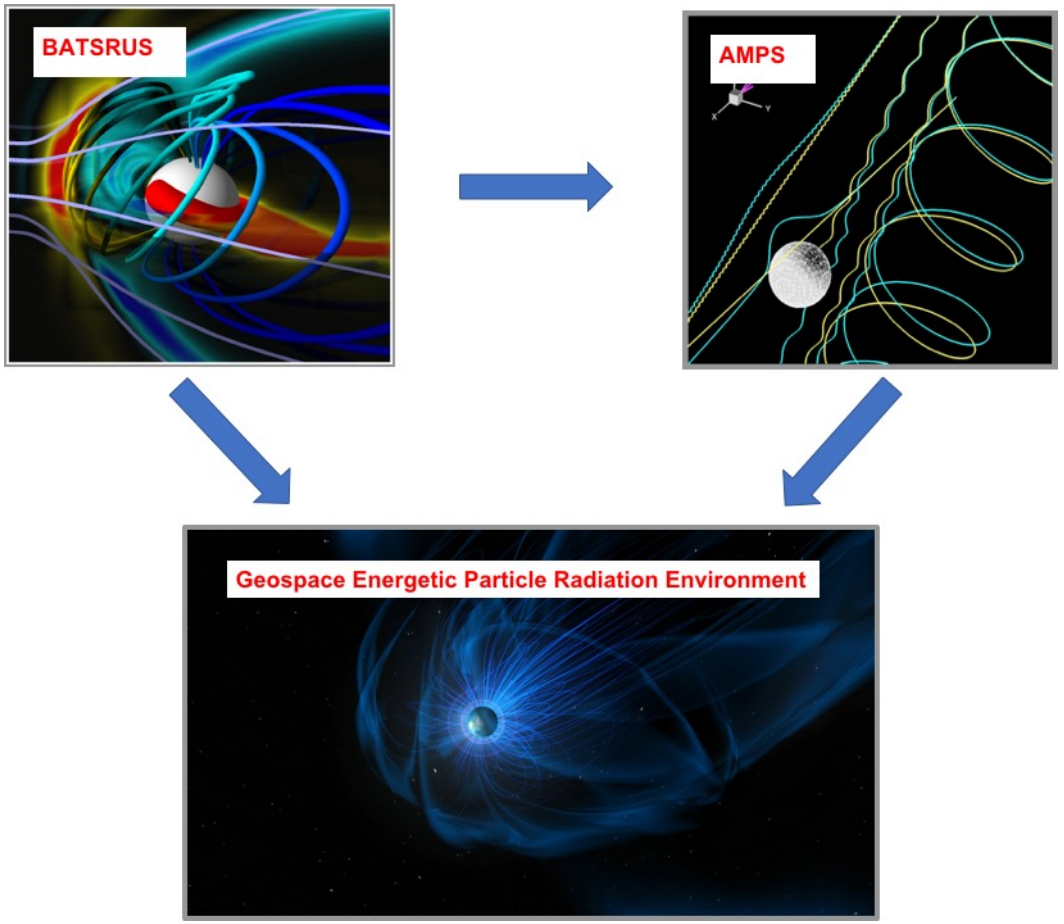


Modeling Geospace Radiation Environment

1. Transport of the energetic particles in a realistic geomagnetic field

2. Results at the top of the atmosphere
   - Cutoff rigidity
   - Energy spectrum
   - Flux

3. Practical applications
   - Radiation environment in Earth's atmosphere, at LEO, MEO, and GEO



Conclusion

- Adaptive Mesh Particle Simulator
  - Self-sufficient Direct Simulation Monte Carlo model
  - A component of SWMF
  - A particle tracking tool in CCMC

- Application
  - Tracking of the charged particle trajectories, and sampling of distribution functions
  - Kinetic modeling of the charge particle dynamics moving in ambient plasma
  - Geospace radiation environment

- Available in the CCMC in a test mode