8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

Numerical Modeling of Particle Dynamics during Dipolarization Events

Kirolosse M. Girgis[1], Tohru Hada[1], Kaiti Wang[4], Fumiko Otsuka[2], Akimasa Yoshikawa[3]
[1]International Research Center for Space and Planetary Environmental Science (i-SPES), Kyushu University, JAPAN, [2]Department of Earth System Science and Technology (ESST), Interdisciplinary Graduate School of Engineering Sciences (IGSES), Kyushu University, [3]Department of Earth and Planetary Sciences, Graduate School of Sciences, Kyushu University, [4]Department of Aerospace Engineering, Tamkang University, TAIWAN
e-mail (speaker): girgiskirolosse@esst.kyushu-u.ac.jp, girgiskirolosse@i-spes.kyushu-u.ac.jp

Abstract
We developed a hybrid test particle simulation code to examine particle dynamics during three dipolarization events detected by the THEMIS mission during substorm time in 2008 and 2009. We evaluated the trajectories of electrons, protons, and oxygen ions within an energy range from 0.1 keV to 1 MeV, considering various initial pitch angles and *L*-shells. Our code incorporates two particle tracing methods: the Tao-Chan-Brizard guiding center model and the full Lorentz particle motion, with an assessment of the adiabaticity criterion. We applied the Tsyganenko TS05 model and the IGRF-12 model to reproduce the time-varying magnetic field, including the corresponding inductive and polarized electric fields.
Our preliminary simulation results confirmed that particle energies were enhanced in the nighttime magnetosphere during dipolarization events. We suggest that the increase in magnetic field strength during dipolarization events, along with the corresponding induced and polarized electric fields, energizes and transports particles earthward. This process may explain the mechanism behind the enhanced particle flux in the inner magnetosphere.

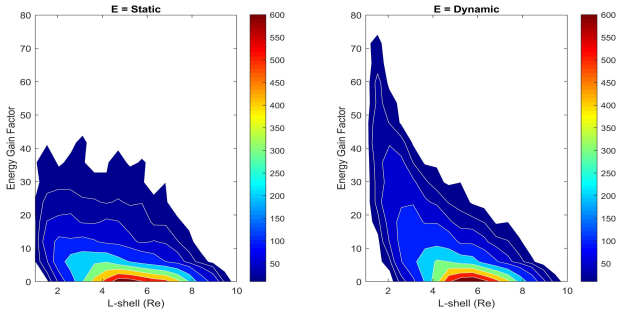

Fig. 1: Electron distribution of the energy gain from the magnetotail region to the Earth's vicinity by test particle simulations [Girgis et al., JpGU (2020)].

References

[1] Girgis et al., "*Geomagnetic Storm Effects on the LEO Proton Flux During Solar Energetic Particle Events*", Space Weather 21 (2023) https://doi.org/10.1029/2023SW003664
[2] Girgis et al., "*Inner radiation belt simulations of the proton flux response in the South Atlantic Anomaly during the Geomagnetic Storm of 15 May 2005*", J. Space Weather Space Clim. 11 48 (2021) https://doi.org/10.1051/swsc/2021031
[3] Ozturk K., "*Trajectories of charged particles trapped in Earth's magnetic field*", American Journal of Physics, (2011) https://doi.org/10.48550/arXiv.1112.3487
[4] Delcourt D. C. et. al., "*Dynamics of single-particle orbits during substorm expansion phase*", JGR 95(A12)(1990) https://doi.org/10.1029/JA095iA12p20853
[5] Heikkila W. J., Pellinen R. J., "*Localized induced electric field within the magnetotail*", JGR 82(10) (1977) https://doi.org/10.1029/JA082i010p01610