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Current Status of the GEMSIS Project: Particle acceleration and regional couplings during geospace storms

SEKI, Kanako[1*], KIKUCHI, Takashi[1], KUSANO, Kanya[1], MASUDA, Satoshi[1], MIYOSHI, Yoshizumi[1], IEDA, Akimasa[1], YAMAMOTO, Tetsuya[1], MIYASHITA, Yukinaga[1], NAKAMIZO, Aoi[1], AMANO, Takanobu[1], HORI, Tomoaki[1], SEGAWA, Tomonori[1], UMEDA, Takayuki[1], MINOSHIMA, Takashi[2], SAITO, Shinji[3], EBIHARA, Yusuke[4], HIRAKI, Yasutaka[5], MATSUMOTO, Yosuke[6], NISHIMURA, Yukitoshi[7], GEMSIS project team[1]

[1]STEL, Nagoya University, [2]JAMSTEC, [3]NICT, [4]RISH, Kyoto University, [5]NIFS, [6]Grad. Sch. of Science, Chiba University, [7]UCLA

Human activities in geospace (near-Earth space) have become important since the 20th century. The geospace storms, which often take place during the solar maximum, are drastic variation of the space environment caused by dynamic solar activities such as CMEs. During the geospace storms, enhanced regional couplings in the solar-terrestrial system and dynamic energy and mass transport, resulting in change of Earth's radiation belt and various space weather phenomena, are known to take place. Researches into geospace storms, which can cause various natural and artificial phenomena, such as active auroras, satellite communication blackouts, and spacecraft malfunctions, are getting more international focus in preparation for the solar maximum around 2013. International program CAWSES-II (climate and weather of Sun-Earth System, Part 2) is now underway. RBSP (Radiation Belt Storm Probes) and Resonance missions are being conducted in the US and Russia, respectively, aiming at the launch of geospace exploration satellites around 2013. Japan is also preparing for the ERG (Energization and Radiation in Geospace) project. One of characteristics of the ERG project is close collaboration between three task teams, namely, the satellite, ground-based observation, and theory/simulation/modeling teams.

Aiming at understanding of physical mechanisms of the particle acceleration and regional couplings in solar-terrestrial system during the geospace storms as well as providing efficient study environment for the trinity collaboration in the ERG project, we have conducted the GEMSIS (Geospace Environment Modeling System for Integrated Studies) Phase 2 project from FY2010 at STEL, Nagoya University. The project is based on studies conducted in the GEMSIS phase 1 project in FY2007-2009 that focuses on understanding the high-energy particle environment in geospace and developing basic technologies for geospace modeling. In the GEMSIS project, we develop physics-based as well as empirical models using satellite measurements and global ground-based measurements. Comparisons between models and observational results are essential to improve the models and to eventually understand the dynamics of the geospace. In order to understand physical mechanisms of dynamic phenomena taking place in the complicated Sun-Earth system, the GEMSIS project is carried out by three working teams (WTs): The "GEMSIS-Sun" WT, aiming at understanding of whole processes (energy-storage, trigger, energy-release, and particle acceleration) of solar flare, have developed flare-trigger and particle acceleration models, and carried out researches through comparing them with various kind of observations. Aiming at understanding the dynamics of the inner magnetosphere during the geospace storms, the "GEMSIS-Magnetosphere" WT has addressed the development of new physics-based models for the global dynamics of the ring current (GEMSIS-RC model) and radiation belt (GEMSIS-RB model). Integrated data analysis studies on such as topics as supply mechanisms of ring current ions and relativistic electron accelerations are also conducted using various types of geospace observations from space and from the ground. The "GEMSIS-Ionosphere" WT has implemented models of global distribution of the ionospheric electric potential in order to understand the Sun-Earth system. Combined with observations, the ionospheric electric field as well as energy flow is examined.

Another important task of the GEMSIS Phase 2 project is contribution to the ERG Science Center that facilitates the close collaboration between the satellite, ground-based observation, and theory/simulation/modeling for geospace studies by providing integrated data analysis tools and combined database. Contribution to the Hinode Science Center at STEL has also been made by the project. In this paper, research highlights and strategy of the GEMSIS project will be reported.

Keywords: Geospace Environment, Solar Activity, Particle Acceleration, Inner Magnetosphere, Magnetic Storm