GAIA Simulations of Electric Potential Variations in the Equatorial Evening Ionosphere after a Severe Solar Flare

Mitsuru MATSUMURA(1), Kazuo SHIOKAWA(1), Hiroyuki SHINAGAWA(2), Yuichi OTSUKA(1), Hidekatsu JIN(2), Yasunobu MIYOSHI(3), and Hitoshi FUJIWARA(4)

(1) Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan

(2) National Institute of Information and Communications Technology, Koganei, Japan

(3) Kyushu University, Fukuoka, Japan

(4) Seikei University, Musashino, Japan

It has been known that intense solar EUV and X-ray radiation by flares increases the electron density in the dayside ionosphere. The density distribution depends on chemical factors such as the ionization rate determined by the solar zenith angle and the loss rate related to the density of molecular nitrogen and oxygen. In addition, recent satellite measurements and modelling studies have shown that flares vary the zonal electric field to further disturb the electron density. The mechanism of the electric field variations by flares is still unknown. One possible mechanism is the conductivity changes by the enhanced ionization. Another candidate is the neutral wind dynamo developed by solar heating. In order to understand how each candidate varies the zonal electric field, we implemented the Flare Irradiance Spectral Model (FISM) to the GAIA model, a coupled model of whole atmosphere-ionosphere system. We performed three simulation runs for the X17 flare on October 28, 2003: one with the ionization enhancement and without the solar heating enhancement, another with the heating and without the ionization, and the other with both enhancements. The first run showed that the ionization enhancement steepens the westward gradient of the conductance around the sunset terminator to create the positive electric potential in the pre-sunset sector. The positive potential accompanies the plasma drift around the terminator, which sustains the steep conductance gradient and the positive potential itself. The second run indicated that the heating enhancement creates the negative potential in the post-sunset sector. The negative potential accompanies the plasma drift in the post-sunset sector, which changes the conductance distribution and transports the negative potential eastward. The third run showed that both enhancements intensifies the positive eastward electric field in the after noon sector for more than four hours. The electric field variations are most significant around the terminator, which could encourage the growth of plasma bubbles.