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Statistical analysis of NICT magnetosphere MHD simulation (solar wind and IMF dependences of ionospheric potential distribution)

Manabu Kunitake[1]; Shinichi Watari[1]; Hiroyuki Shinagawa[1]; Hironori Shimazu[1]; Tsutomu Nagatsuma[1]; Tomoaki Hori[2]; Takashi Tanaka[3]

[1] NICT; [2] Solar-Terrestrial Environment Laboratory, Nagoya Univ.; [3] Kyushu University

[Introduction]

National Institute of Information and Communications Technology (NICT) has been running the real-time magnetohydrodynamic (MHD) simulation of the solar wind-magnetosphere-ionosphere (S-M-I) coupling system (Tanaka 1995, Tanaka 2000, Tanaka 2003, and Den et al. 2006). The simulation uses the solar wind data actually observed by the ACE spacecraft as input parameters. The 2-D ionospheric electric potential distribution can be reproduced by the real-time run of the simulation. The calculated results have been archived. We extracted parameters, such as, the locations (MLT and latitude) of the potential MAX and MIN and the magnitude of potential MAX (Potmax) and the magnitude of potential MIN (|Potmin|), and the cross polar cap potential from the 2-D ionospheric potential distribution, then made statistical analysis about the dependence of these parameters on the solar wind and IMF. When IMF Bz is positive, it would be expected that the potential distribution would be complicated and would be hard for us to extract these parameters. Therefore, we use only the cases that IMF Bz is negative. An interesting result is shown below. Other detailed results will be shown at the meeting.

[Result]The dependence of the difference between Potmax and |Potmin|on IMF clock angle

In the cases that IMF Bz is negative, the ionospheric convection usually appears as two cell convection. The potential MAX is located at the focus of the dawn side cell. The potential MIN is located at the focus of the dusk cell. We calculated the difference between Potmax and |Potmin|, and then analyzed how the difference depends on the clock angle. When the clock angle is from 90 degree to nearly 180 degree, that is, IMF By is positive, the difference is negative, that is, Potmax is smaller than |Potmin|. When the clock angle is from nearly 180 degree to 270 degree, that is, IMF By is negative, the difference is positive, that is, Potmax is larger than |Potmin|.

[Discussion]

The statistical analysis by using the archive of our simulation outputs shows the dependence of the difference between Potmax and |Potmin|on the IMF clock angle as follows. When By is positive, Potmax is smaller than |Potmin|. When By is negative, Potmax is larger than |Potmin|. However, the statistical model based on the SuperDARN observation shows that Potmax is smaller than |Potmin|, regardless of the polarity of IMF By (Ruohoniemi and Greenwald 1996). Ridley et al. (2004) show that a steep day-to-night gradient in Hall conductance in their simulation results in that Potmax is smaller than |Potmin|. The comparison of our result with the results of Ruohoniemi and Greenwald (1996) and Ridley et al. (2004) would imply that the day-to-night gradient in Hall conductance in our simulation would be not so steep as the value in the actual ionosphere. In our simulation, the conductance is calculated from three sources: (1)solar EUV flux, (2)diffuse precipitation modeled by the pressure and temperature, and (3)discrete precipitation modeled by the upward FAC (Tanaka 2000). While the conductance distribution by (1) generates the day-to-night gradient in Hall conductance, the conductances by (2) and (3) contribute to the reduction of the day-to-night gradient in Hall conductance. Therefore, it is concluded that the conductances by (2) and (3) in our simulation would be larger than the value in the actual ionosphere. It is desirable to perform the simulation with smaller conductances due to (2) and (3) and to examine whether the situation that Potmax is smaller than |Potmin|occurs or not regardless of the polarity of By.