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Effect of the FACs distribution on the middle and low latitude ionospheric current patterns deduced by a 2-D ionospheric potential solver (GEMSIS-POT)

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As part of the GEMSIS project (Geospace Environment Modeling System for Integrated Studies), we have developed a two-dimensional ionospheric global potential solver. There has been considerable research on the mid-and low-latitude ionospheric system driven by neutral wind [e.g., Richmond, 1973]. However, there are few researches on the relationship between the high-latitude system and middle and low latitude system, which is important for the integrated studies of the magnetosphere-inner magnetosphere system coupled through the ionosphere.

Our model basically follows a methodology provided by Tsunomura [1999]; it solves the Ohm's law under the thin-shell approximated 2-D ionosphere, with FACs in the polar region and height-integrated ionospheric conductivities. The most important extension from previous studies is that our model covers both hemispheres without a boundary at the equator. The values of Pedersen and Hall conductivities are calculated as exactly as possible with the MSIS-2000, IRI-2007, and IGRF-2005 reference models. In addition, we consider the effect of auroral particle precipitation on conductivities with reference to the empirical models [e.g., Hardy et al., 1987]. Although the FACs and ionospheric conductivity are intrinsically related to each other, we set them a priori at present because there is still no theory describing the development of the FACs-conductivity coupled system self-consistently.

By using the solver, we investigate (1) the relationship between the conductivity and electric field in the middle and low latitude ionosphere and (2) how the current density ratio and latitudinal/longitudinal distribution of R1-FAC and R2-FAC affect the electric field distribution and current pattern in the middle and low latitude ionosphere. Here, FACs are distributed with reference to the empirical model by Hori et al. [in preparation] and the location of the conductivity enhancement associated with auroral activities given by empirical models is adjusted according to that of the distributed FACs. As for the point (1), it is confirmed that the difference and gradient between dayside and nightside conductivities are the keys to reproducing the realistic electric field pattern. As for the point (2), the low latitude electric field is reversed when the current density of R2-FAC reaches 0.6-0.7 times that of R1-FAC under the current distribution assumed here, depending on the relative position of FACs and conductivity enhancement. This state is considered to be representing a stationary state during an overshielding by R2-FAC. In this talk, we especially discuss the global ionospheric current patterns both for the R1-dominated case (undershielding) and R2-dominated case (overshielding).