A new explanation for the asymmetries of equatorial east-west electric field based on the global polarization effect

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The longitudinal profile of the east-west electric field in the equatorial region shows characteristic such as morning-evening asymmetries with pre-noon peak and localized enhancements around the dusk sector (pre-reversal enhancement, PRE). Although these structures have been discussed in terms of the neutral wind dynamo, we propose that it is also possible to explain them, at least qualitatively, purely by ionospheric effects.

Our study is based on the idea of the global Cowling Channel (or the global polarization theory) [Yoshikawa, JpGU, 2011]. So far, we have specified one-to-one relationship between some characteristic inhomogeneities of conductivity and characteristic deformations of electric potential based on model calculations. For example, considering a dawn-dusk symmetric R1-FAC distribution for simplicity and defining its primary field as Phi_0, (a) equatorward conductivity enhancement yields positive/negative Hall polarization field ($\mathrm{dPhi}_{Hall,eq}$) around pre-noon/pre-midnight sectors and rotates the two-cell potential pattern clockwise, (b) day-night conductivity difference shifts the potential maximum and minimum toward night due to the Pedersen polarization effect (in other words, current continuity), and (c) sharp conductivity gradients across dawn/dusk terminators result in positive/negative Hall polarization field ($\mathrm{dPhi}_{Hall,t}$) and convex/concave of potential along the terminators.

Guided by the above exercise we seek to understand the east-west electric field structure in the equatorial region. The morning-evening asymmetry with pre-noon peak is naturally produced by the effect (a). PRE like structure can be produced basically by (c), but its sharpness is determined by the total balance of (a), (b), and (c), which can be attributed to the relative distributions of background and auroral zone conductivities. In this talk we will also discuss the possibilities to distinguish ionospheric polarization effects from atmospheric effects.