The Harang Reversal Generated by Ionospheric Polarization Field by Hall Current Divergence

*Aoi Nakamizo[1], Akimasa Yoshikawa[2,3]

1.Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology, 2.Faculty of Science, Kyushu University, 3.International Center for Space Weather Science and Education, Kyushu University

The ionospheric electric potential shows various asymmetries, localized structures, and so on. Whereas these structures have been mainly interpreted by the IMF polarity and/or magnetospheric convection structure, we have proposed that they can be also recognized purely by the ionospheric effect, the generation of polarization field due to conductivity inhomogeneities. Our study has been based on a part of the M-I coupling theory [e.g., Yoshikawa et al, JGR, 2013a, b] including the idea of Pedersen/Hall divergence/polarization effect [e.g., Yoshikawa et al., JpGU, 2009]. Although the possibility of ionospheric effect had been reported [Wolf, 1970; Atkinson and Hutchison, 1978], we have for the first time addressed and visualized the underlying physics.
By applying a simplified version of 'Hall-conjugate method [Yoshikawa et al., JpGU, 2008]' to a 2D ionospheric potential solver (so-called thin shell model), we separate the total field (Φ, ionospheric total potential) into the primary field (Φ0, including the background and Pedersen polarization field) and secondary field (δΦHall, the polarization field generated by Hall current divergence).
In the previous meetings [Nakamizo et al., SGEPSS, 2012-2014], we have specified one-to-one correspondence between characteristic spatial gradients of conductivity and characteristic deformations of potential, as follows; (a) For simplicity we consider dawn-dusk symmetric R1-FAC as the driving source. As the reference field, we calculate the potential with the uniform conductivity distribution. This reference field is symmetric with respect to both the noon-midnight and dawn-dusk axes. From this condition we gradually add spatial structures on the conductivity distribution. (b) Equatorward latitudinal conductivity gradient generates positive/negative Hall polarization field (δΦHall,eq) around pre-noon/pre-midnight sectors. As the result the total field (Φ) rotates clockwise. (c) Day-night conductivity difference not only shifts the potential centers toward night due to Pedersen polarization effect (in other words, current continuity), but also generates Hall polarization fields (δΦHall,t) along day-night terminators due to sharp conductivity gradients there, resulting in the convex/concave of total field (Φ) along terminators. (d) Auroral conductivity enhancement generates Hall polarization fields (δΦHall,a) around edges of conductivity band. Thus in the total field (Φ) a conspicuous structure appears around the midnight oval, resembling 'Harang reversal.'
This presentation mainly discusses the point (d). Important point is that we get Harang-like structure with simplified distribution of FAC (dawn-dusk symmetric R1-FAC) noted above. Moreover Harang-like structure located in pre-midnight sector, as the same as the observations, where we placed no input FAC. We suggest the possibility of two-ways of the ionospheric control of magnetosphere-ionosphere convection based on the characteristics of the solver used in this study (physically it can be called as 'perfect current confinement solver') and the advanced M-I coupling theory [Yoshikawa et al., JGR, 2013a,b].

Keywords: Hall current divergence and Hall polarization field, Conductivity gradient, Deformation of ionospheric potential, Harang reversal, Magnetosphere-Ionosphere coupling, Ionospheric control on magnetosphere-ionosphere convection

©2016. Japan Geoscience Union. All Right Reserved.

©2016. Japan Geoscience Union. All Right Reserved.