A self-consistent synthesis formulation for the evolution of ionospheric conductances within an M-I coupling scheme

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Abstract

We develop a self-consistent, synthesis equation for the ionospheric conductivity evolution within an M-I coupling scheme. This procedure takes into account the parallel potential drop at the auroral acceleration region and the current-carrier transition process from electrons to ions at a finite field-aligned current (FAC) region. In our equation, the ionization ratio by monoenergetic electron precipitation is calculated from the upward FAC amplitude. In the case of low energy electron precipitation below several tens of eV, the electron flux divergence plays a crucial role for the plasma transportation, production, and evacuation effect. While the case of high-energy electron precipitations over ~keV, the ionospheric current divergences activated by the precipitation effect becomes a non-linear driver of the plasma transportation. Using our new equation, we find that the plasma density does not transfer to the ExB direction as predicted by previous model, but it rather advects against the diverging (converging) current from (into) the FAC region. The propagation speed of the plasma density increases proportionally with the increase of the upward FAC, and the propagation direction is strongly controlled by the converging Cowling current into the upward FAC region. The results deduced from this synthesis equation for the ionospheric conductivity evolution may explain the self-organized evolution of the westward-traveling surge during an auroral substorm.