Vertical motion of a polar cap patch and its contribution to the electron density profile

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We investigate how a plasma patch survives for a long time during its journey across the polar cap. Polar-cap patches are embedded in the convection flow in the high latitude ionosphere. Their motion has an upward component on the day side and a downward component on the night side due to a small inclination of the Earth's main field in the polar cap. In addition, the meridional neutral wind pushes the ions down (on the day side) and up (on the night side) along the magnetic field lines. These motions of the patch plasmas, as well as the ionization loss rate, determine the electron density profile of a polar cap patch. It is well known that the electron density profile above the F-region peak altitude (hmF2) is controlled by the vertical transport (diffusion) of plasmas while the bottom-side profile is determined by loss (decay) process. To clarify the effect of the vertical motion on the electron density profile of polar cap patches we observed the vertical motion of the F-region plasma in the night-side polar cap using EISCAT Svalbard Radar. The observation showed that a typical downward speed of a patch was about 50 m/s while the horizontal speed was about 500 m/s. The observation also revealed that there was an almost continuous upward field-aligned ion motion throughout the observation period, which suggests the existence of an equatorward neutral wind. From this observation, combined with the observed electron density and the ionization loss rate derived from the MSIS atmosphere, we calculated the electron density profile of a polar cap patch at its exit from the polar cap. Our result shows that, in the polar cap, the electron density profile below hmF2 is also controlled by the vertical transport of plasmas.