Substorm 開始時における夜側 poleward expansion aurora 近傍の下部熱圏変動

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Lower-thermospheric variations in the vicinity of night-side poleward expansion aurora around substorm onset

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At high latitudes, electromagnetic and particle energies are transferred from the magnetosphere to the ionosphere and the thermosphere. The polar ionosphere and thermosphere act as an energy and particle sink, where the energy is transformed into both heated and accelerated plasmas and neutral particles. The former and latter processes can be regarded as thermal and mechanical energy transformation, respectively. These processes result in wind acceleration of the polar lower thermosphere. In this paper, wind acceleration in the lower thermosphere and magnetospheric energy inputs were studied using data from the European Incoherent Scatter (EISCAT) radar and a Fabry-Perot interferometer (FPI; 557.7 nm) at Tromsoe, Norway. In particular, this presentation focuses on geomagnetically active periods around substorm onset. The onset time was decided by the EISCAT-derived electron density at 110 km height or FPI fringe count, which showed abrupt increases due to auroral particle precipitation coinciding with auroral passing over the zenith at Tromsoe. Please note that the onset time adopted in this study is different from so-called substorm onset time determined from the magnetometer data. A superposed epoch analysis method was applied on the EISCAT-derived ionospheric parameters for +/-1 hour at the center of the onset time. The ion temperature at 110 and 250 km heights and the electron temperature at 110 km height showed clear enhancements before the electron-density enhancement by a few tens of minutes. These increases suggest enhancements of the perpendicular electric field, which induces frictional and Joule heating and Farley-Buneman instability, at the outside adjacent to poleward edge of the poleward-moving aurora. The FPI-derived neutral wind data were also analyzed by the superposed epoch analysis method. Vertical component of the neutral wind velocity increased for periods of enhancements of the ion and electron temperature. At the same time, the horizontal wind velocity changed the direction from southwestward to southward decreasing its magnitude, which means northeastward acceleration. Since presumable directions of the Hall and Pedersen currents around the onset time are westward and southward, respectively, the total ionospheric current is southwestward. In this case statistical result of the southward neutral wind gives positive **U**.(**J**x**B**), which is equal to **J.E - J.E'**. The positive value suggests that the electromagnetic energy flux (**J.E**) originated in the magnetosphere is converted to both Joule heating (**J.E'**) and Lorentz force (**J**x**B**/rho) in the ionosphere/thermosphere. It is thus concluded that both Joule heating process and the Lorentz force come into play for accelerating the horizontal wind in the lower thermosphere at the onset. However, Joule heating must be a predominant mechanism for the vertical-wind perturbations because Lorentz force acts almost horizontally. Role of the Lorentz force gradually increases with time after the onset.