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Lower-thermospheric wind variations in auroral patches at the substorm recovery phase

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Measurements of the lower-thermospheric wind with a Fabry-Perot interferometer (FPI; 557.7 nm) at Tromsϕ, Norway found the largest wind variations in a night during appearance of the auroral patches at the substorm recovery phase. Taking into account magnetospheric processes of plasma energy accumulation and release in the substorm evolution (i.e., principal part of the energy accumulated in the plasmasheet at the growth phase is released for a short time of the expansion phase), it is an attractive result of the largest amplitude in the measured winds at the latter part of the substorm or the recovery phase. We think that this phenomenon is essentially important for understanding the energy transfer and dissipation processes in the magnetosphere and the upper atmosphere at high latitudes.

Our researching activity is the first detailed investigation regarding the magnetosphere-ionosphere-thermosphere coupled system at the substorm recovery phase using comprehensive data sets of solar wind, geomagnetic field, auroral pattern, and FPI-derived wind. This study selected five events between November 2010 and January 2012, particularly focusing on the wind-variation signatures in the auroral morphology, and detected three clear evidences in all of the events: (1) wind fluctuations were isolated at the edge and/or in the darker area of the auroral patch, and the largest vertical amplitude and the longest oscillation period were about 20 m/s and about 10 minutes, respectively, (2) the convection electric field was smaller than 15 mV/m, and (3) wind fluctuations accompanied the pulsating aurora. These characteristics suggest that the energy dissipation to produce the wind fluctuations is localized in the auroral pattern. Joule heating and Lorentz force are not the principal mechanism because of small electric field. That is a notable characteristics different from the mechanism at the substorm growth and expansion phases. Particle heating must be a minor component in the energy dissipation because of the isolated wind fluctuation in the darker area. Some other mechanisms should play a principal role at the substorm recovery phase; but unknown yet.

Keywords: aurora, substorm, Fabry-Perot interferometer, ionosphere, thermosphere, polar region