Quasi-periodic variation in electron density, conductance and electric field during pulsating aurora

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We report simultaneous radio and optical observations of pulsating aurora (PsA) in Tromsoe (69.60N, 19.20E), Norway, using an all-sky TV camera (ATV) and the EISCAT UHF/VHF systems. During an interval within this campaign period, PsA with periods of 8-17 s was observed by the ATV in the morning local time sector (approximately 05 MLT). In this interval, quasi-periodic oscillations were identified in the raw electron density obtained by the EISCAT UHF system. The electron density at the lower part of the E region (95-115 km) was enhanced by a factor of 3-4 immediately after the optical pulsation became "on". The height-integrated Hall conductance was also elevated by a factor of 1.5-2 almost in harmony with the electron density variation. Interestingly, the remote antenna at Kiruna observed systematic redirection of the horizontal electric field when the PsA was "on". We propose a model in which the enhancement of the Hall conductance within patches of PsA caused charge accumulation at the edges of the patches, and the electric field was then modified by the resulting polarization electric field. An estimation of the electric field modulation based on this model well reproduced the actual electric field variation measured by EISCAT, which implies that the ionization caused by high-energy electron precipitation associated with PsA has a significant effect on the ionospheric current system. During the same interval of PsA, a significant ionization was observed by the EISCAT VHF system not only in the E region but also in the upper part of the D region (80–95 km). An altitude profile of the Pedersen conductance derived from EISCAT exhibited two distinct layers of enhanced conductance. The upper one occurred at ~120 km altitude which corresponded to the normal Pedersen current layer carried by the ions. The lower one appeared as a thin layer between 80 and 95 km in altitude, which was mainly carried by the collisional motion of electrons. Such an electron Pedersen layer is detectable only when the electron density is sufficiently high for allowing an appreciable current to flow in the D region. The electron Pedersen current flows exactly in the altitudes where the pulsating ionization occurs; thus, it would play more important role in the closure of electric current associated with patches of PsA.