

## Wide energy electron precipitation associated with the pulsating aurora and its impact on the middle atmosphere

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The pulsating aurora are caused by intermittent precipitations of tens keV electrons. It is also expected that not only tens keV electrons but also sub-relativistic/relativistic electrons precipitate simultaneously into the ionosphere owing to whistler-mode wave-particle interactions. We analyzed the pulsating aurora event in November 2012 using several ground-based observation data; EISCAT, riometer, and sub-ionospheric radio waves, and the Van Allen Probes satellite data. The electron density profile obtained from EISCA Tromso VHF radar identify the electron density enhancement at >68 km altitudes. The electron energy spectrum derived from the inversion method indicates the wide energy electron precipitations from 10 keV ? 200 keV. The riometer and network of subionospheric radio wave observations also showed the energetic electron precipitations during this period. During this period, the footprint of the Van Allen Probe-A satellite was very close to Tromso and the satellite observed rising tone emissions of the lower-band chorus (LBC) waves near the equatorial plane. Using the satellite observed LBC and trapped electrons as an initial condition, we conducted a computer simulation of the wave-particle interactions. The simulation showed simultaneous precipitation of electrons at both tens of keV and a few hundred keV, which is consistent with the energy spectrum estimated by the inversion method using the EISCAT observations. This result revealed that electrons with a wide energy range simultaneously precipitate into the ionosphere in association with the pulsating aurora. We also discuss the possible impacts on the middle atmosphere due to precipitations of wide energy electrons during the pulsating aurora.

Keywords: energetic electron precipitation, Geospace, middle atmosphere