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# Local time distribution and activity dependence of extreme electron densities in the auroral D-region as an image of energy-dependent energetic electron precipitation

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Although electron density Ne in the auroral ionospheric D-region is formed by solar radiation and energetic particle precipitation, the highest observed densities are definitely produced by intense precipitated fluxes of energetic electrons (EE, here 30-300keV) and solar flare protons. Therefore, studying the most intense Ne episodes may provide valuable information about spatial distribution, spectral changes, and drivers of intense EE precipitation, which have important space weather implications. By combining EISCAT-Tromso UHF observations in different modes made in 2001-2021 (with polar cap absorption events being excluded), we survey Ne occurrence distributions and study statistical properties of EE precipitation producing the highest 10%, 5%, and 1% of Ne values at the altitudes between 100 and 75 km (corresponding to EE energies of ~20 to ~300keV), and found two different patterns of spatial distribution of the extreme ionization. The largest Ne values occur in the nightside-early morning local time sector in the upper D-region (H>85km) and in the morning-noon sector at low altitudes (75-85 km). This bimodal pattern could partly be contributed by the suppressed Ne in the dark ionosphere where negatively charged ions may appear in large amounts. However, by analyzing measurements in the twilight conditions at all MLTs together with published statistical patterns of EE precipitation at different energies, we got indications that a dominance of pre-noon maximum at low altitudes in the D-region reflects the enhanced precipitation of >100keV electrons in this local time sector. Statistically, at all altitudes (especially below 80/90km) the appearance of the highest Ne values favors enhanced auroral activity (not necessarily storms as revealed by SymH index) and shows a strong preference for high solar wind velocity (>550 km/s). These properties copy the known driver properties of energetic electrons. We discuss the advantages of exploring Ne data at specific altitudes (against direct measurements of EE precipitation) to investigate statistically the effects of specific precipitated energy components and the evolution of EE energy spectra.