

Comparative Analysis of Ion and Electron Contributions to Ionospheric Ionization at Subauroral Latitudes from ELFIN-DMSP Conjunctions

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Electron and proton precipitation into the nightside ionosphere is a key process in magnetosphere–ionosphere coupling. Although auroral electron precipitation at $\sim 0.1\text{--}10$ keV has traditionally been regarded as the main driver of auroral emissions, recent studies demonstrate that energetic electrons and protons (>30 keV) can contribute substantially to ionospheric energy deposition, particularly during storm times. While energetic electron precipitation has been studied extensively, the role of energetic proton precipitation remains poorly quantified. Here, we use coordinated ELFIN and DMSP measurements, covering electron and ion precipitation from ~ 30 eV to ~ 6 MeV, to quantify their respective contributions to ionospheric density enhancements. We show that, at subauroral latitudes, energetic protons precipitation in the E-region can contribute comparably to the impact of energetic electrons. These results are further supported by magnetospheric observations from the Arase and THEMIS spacecraft and by ground-based incoherent scatter radar measurements from PFISR.