Statistical study of Ionospheric Conductivity Dependence of the Subauroral Polarization Streams focusing on Solar Zenith Angle using the SuperDARN Hokkaido East HF Radar

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In this study, we investigate characteristics of the subauroral polarization streams (SAPS), focusing on ionospheric conductivity dependence, especially the solar zenith angle(SZA) dependence, using the Super Dual Auroral Radar Network (SuperDARN) Hokkaido East radar, National Oceanic and Atmospheric Administration (NOAA) Polar Operational Environmental Satellites (POES) system and Meteorological Operational Satellite Program of Europe (MetOp) system data. The time span for the present study is from 2008/1/10 to 2016/12/31, which contains over 3180 days, and we limited the time range of the analysis to 3-8 UT (12-17 LT). We found 60 SAPS events over seasons except for summer, and for each event we examined the SZA and the peak Line-of-sight velocity observed in the SAPS, in order to identify the threshold of the possible SZA and illuminated ionospheric altitude for SAPS to be generated. We have determined location of the echo region based on the straight ray path geometry with empirical offset value for multiple-hop paths, whereas in order to investigate the effect of HF propagation geometry and achieve a more precise mapping of scattering locations, we are trying to apply a new empirical virtual height model to the SuperDARN Hokkaido East radar, which uses different coefficients based on range and elevation angle in the model when mapping backscatter targets propagate via different propagation paths. We also took into account the effect of EUV absorption in the atmosphere. As a result of the statistical study, we find that SAPS tend to appear when the SZA is larger than 98.5 degrees, and that the minimal threshold of illuminated ionospheric altitude for SAPS occurrence is estimated to be about 138 km, which is just above the altitude of the peak of Pedersen conductivity. This result suggests that the low background Pedersen conductivity plays an important role in the generation of SAPS through a positive feedback in which the enhanced electric filed drives frictional heating of the neutral atmosphere and thereby lowers the conductivity further. To the best of our knowledge, this is the first detailed study of SAPS-associated SZA, and shows quantitatively the importance of Pedersen conductivity for SAPS generation. We also investigated the seasonal dependence, MLT and MLAT dependence of SAPS, which shows how the solar radiation in different seasons affects SAPS.

Keywords: sub-auroral polarization stream, Pedersen conductivity, solar zenith angle, SuperDARN Hokkaido East radar

