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STEVE, the mysterious subauroral optical structure (I)

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There has been an exciting recent development in auroral research associated with the discovery of a new subauroral phenomenon called STEVE (Strong Thermal Emission Velocity Enhancement). Although STEVE has been documented by amateur night sky watchers for decades, it is a new upper atmosphere phenomenon. Observed first by amateur auroral photographers, STEVE appears as a narrow luminous structure across the night sky over thousands of kilometers in the east-west direction. In this paper, we present the first statistical analysis of the properties of 28 STEVE events identified using THEMIS ASI and the REGO database. We found that STEVE occurs about one hour after substorm onset at the end of a prolonged expansion phase. On average, the AL index magnitude is larger and the expansion phase has longer duration for STEVE events compared to SAIDs or Substorm. The average duration for STEVE was about one hour and its latitudinal width was ~20km, which corresponds to ~ $\frac{1}{4}$ of the width of narrow auroral structures like streamers. STEVE typically has an equatorward displacement from its initial location of about 50 km and a longitudinal extent of 2145 km. We also analyzed STEVE's seasonal dependence and found that more events were observed during equinox. Finally, we did not find evidence of solar cycle dependence for the events of STEVE analyzed in this study.

In addition, we use data from Meridian Scanning Photometers (MSP, NORSTAR and FESO) that measure brightness of H- β proton auroral emission at 4861Å. This dataset help us to locate STEVE relative to typical auroral arcs. We analyzed in total 12 events in which THEMIS or REGO have a good conjunction with MSP instruments from December 2007 up to May 2017. Our observations suggests that Steve is always located equatorward of the proton aurora (5 mlat on average), and thus is not a traditional electron auroral arc, a feature which is always poleward of the peak in proton auroral brightness.

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