Algorithmic Identification of STEVE-SAID Events in Swarm Data

H. Panwar[1], G.W. Perry[1], A. Gyakobo[1], L.V. Goodwin[1], W.E. Archer[2]

Email: hp56@njit.edu, (1) Center for Solar-Terrestrial Research, New Jersey Institute of Technology, Newark, New Jersey, USA, (2) The Canadian Space Agency

Background

- Strong Thermal Emission Velocity Enhancement (STEVE) is an optical phenomenon
- Observed as a purple band of light equatorward of auroral oval (Archer et. al 2019)

Left: Photograph by Dave Markel Photography, National Geographic Your Shot. Available at: https://www.nationalgeographic.com/science/article/odd-aurora-named-steve-revealed-to-be-two-different-sky-shows-in-one

Right: Photograph of STEVE emissions and a green picket fence taken by Robert Downie. Figure taken from Archer et. al. (2019a)

- STEVE found to be associated with intense Subauroral Ion Drift (SAID) under following conditions (Archer et. al 2019): (1) High electron temperature (2) Low plasma density (3) High peak ion velocities
- **Motivations: Provide an algorithmic approach to identify coupled STEVE and SAID events**

Methodology

- Create spike finding routine for electron temperature that matches SWARM A spikes identified in Archer et. al 2019

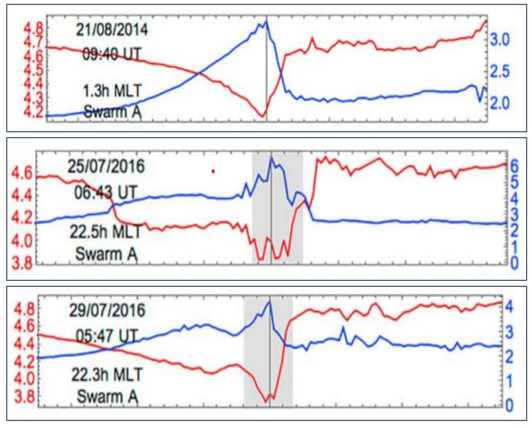

Figure 1: 3 Swarm A temperature spikes as identified in Fig. 1 from Archer et. al 2019

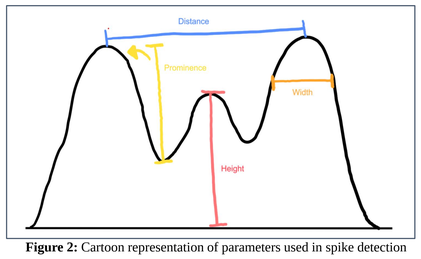

Figure 2: Cartoon representation of parameters used in spike detection route

- Parameters: Height (3000 - 2000 K), Distance (100 samples), Width (4 – 40 samples), Prominence (1250 – 5000 samples)
- Run all available data through spike finding routine
- Apply cross-correlation filtering with respect to plasma density

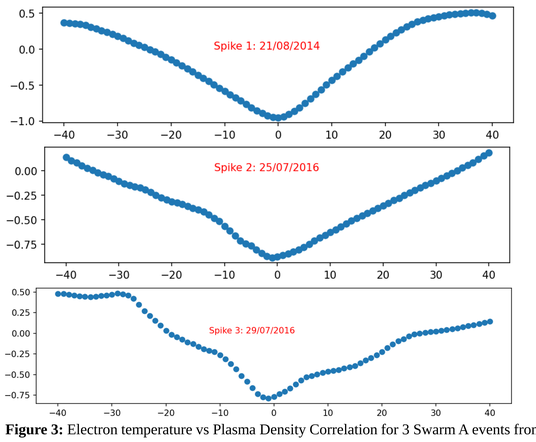

Figure 3: Electron temperature vs Plasma Density Correlation for 3 Swarm A events from Fig.1

- Filter all identified electron temperature spikes using minimum cross-correlation factor (-.8)
- Identify visual patterns

Results

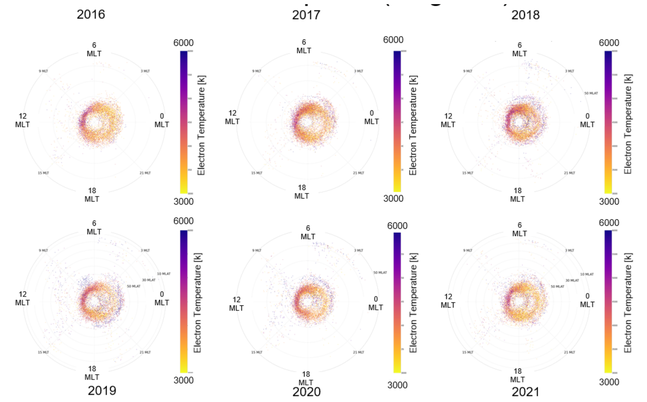

Figure 4: Progression of identified electron temperature spikes using Swarm A data from 2016 to 2021 within Northern Hemisphere

- Similar concentration of hot spikes seen in Southern Hemisphere
- Singular band of hot spikes occurring towards magnetic midnight
- Separation in subauroral zone

- Hotter temperature spikes generally toward magnetic noon
- Bands of hot spikes visible towards magnetic midnight
- Three-band structure separating towards midnight

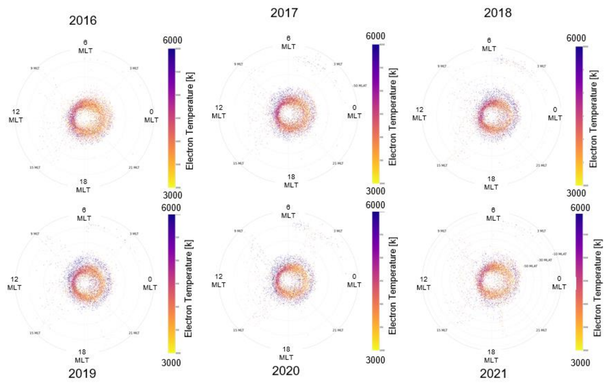

Figure 5: Progression of identified electron temperature spikes using Swarm A data from 2016 to 2021 within Southern Hemisphere

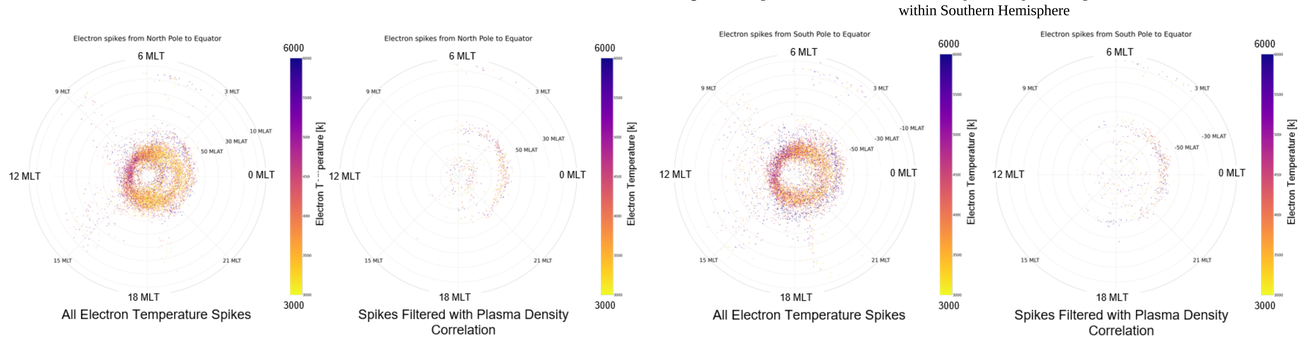

Figure 6: Electron temperature spikes in Northern Hemisphere (left) and Southern Hemisphere (right) after filtering for those with cross-correlation factor less than -.8

- Filtered temperature spikes + plasma drops occur in polar and subauroral zone
- subauroral zone spikes occurring toward magnetic night
- Tighter spread present in Northern Hemisphere in comparison to Southern Hemisphere

Summary

- Algorithm to identify STEVE-SAID coupled events exist under 3 conditions: (1) High electron temperature (2) Low plasma density (3) High peak ion velocities
- Incorporating electron temperatures and plasma density, results show events in polar and subauroral zone
- **Future Works:**
  - Incorporate ion flow
  - Incorporate magnetic field vectors
- **Bibliography:** Archer, W. E., Gallardo-Lacourt, B., Perry, G. W., St.-Maurice, J.-P., Buchert, S. C., & Donovan, E. F. (2019). Steve: The optical signature of intense subauroral ion drifts. Geophysical Research Letters, 46, 6279–6286. https://doi.org/10.1029/2019GL082687