Statistical Properties of Curtain Electron Precipitation Derived with AeroCube-6

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Key Points:

- We used the dual AeroCube-6 CubeSats to identify stationary, narrow, and persistent > 30 keV precipitation in low Earth orbit
- A single low Earth-orbiting spacecraft can easily misidentify curtains as microburst precipitation
- A few curtains locally precipitated for at least six seconds

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Abstract

1 Plain Language Summary

2 Introduction

Outline

1. Introduce various particle loss mechanisms
2. Introduce microbursts and their effect on atmospheric chemistry. Maybe mention how there is an unexplained source of HOX and NOX?
3. Introduce curtains and the prevailing hypothesis linking curtains to microbursts
4. Our goal is to study three statistical properties of curtains: location, spatial width, and preferred geomagnetic conditions. Lastly we will use the SAA to determine if some curtains were drifting around the Earth or locally precipitating

3 Instrumentation

Outline

1. Basically same as AC6 microburst paper
2. Mention separation confirmed with GPS and in-track lag can be readily calculated

4 Methodology

4.1 Curtain Identification

Outline

1. Shifted the AC6B time series by the in-track lag and looked for times when the following two conditions were met:
2. a one second running correlation was greater than 0.8 and
3. the correlated counts were bursty - defined as greater than two standard deviations (assuming Poission statistics) above a ten second-long running mean.
4. Events were automatically identified and checked by an author to catalog 1634 curtains. Examples shown in Fig. 1.

5 Results

Outline

1. Show curtain width and comment how narrow they are. Whether they are drifting or locally precipitating, they must have a very filamentary structure that persists for multiple seconds
2. Figure out how the detection bias affects the width distribution
3. Show, and comment on the Auroral electroject strengths when each curtain was observed. Curtains are more likeliy to be observed during disturbed times.
4. Discuss the SAA, BLC, and show the curtains the the BLC plot. Mention how these electrons must have been precipitating for multiple seconds, over an order of magnitude longer than typical microbursts.

In the spirit of brevity, we limited the scope of these results to answer the following three questions:
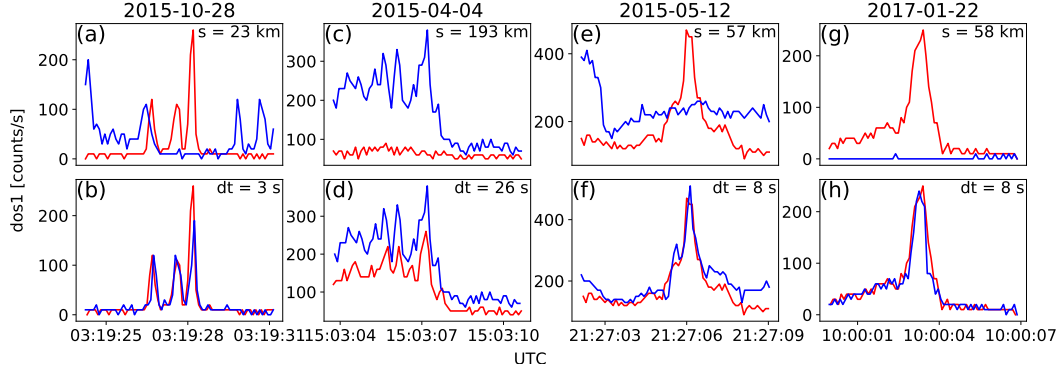
Figure 1. Four examples showing the AC6 > 30 keV electron data taken by AC6 at the same time in the top row and at the same position in the bottom row. To show the data at the same position the time series data from one spacecraft was shifted by the in-track lag and annotated by dt. These examples show curtain precipitation that was highly correlated for up to 26 seconds.
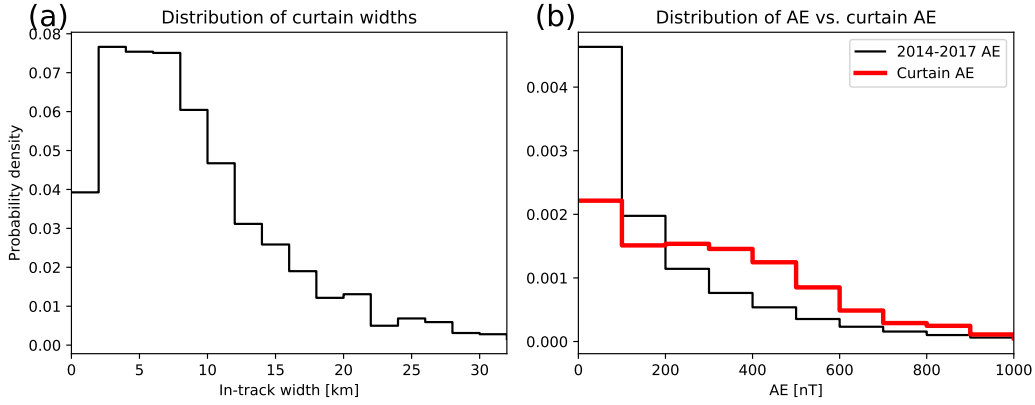

Figure 2. Distribution of curtain in-track width (AC6 in-track separation mostly in latitude) in panel a. Panel b shows the distribution of the Auroral Electroject (AE) index from 2014 to 2017 in black, and the AE index when curtains were observed by the thicker red curve.

1. how narrow are curtains,
2. when and where are curtains observed, and
3. are curtains drifting or locally precipitating?

5.1 Local Atmospheric Precipitation

6 Discussion

Outline

1. Curtains are spatially small and must be around a few hundred km at the equator
2. curtain phenomena originates in the outer radiation belt, and observed relatively more in the evening than morning regions. Limited AC6 coverage prevents a complete MLT distribution
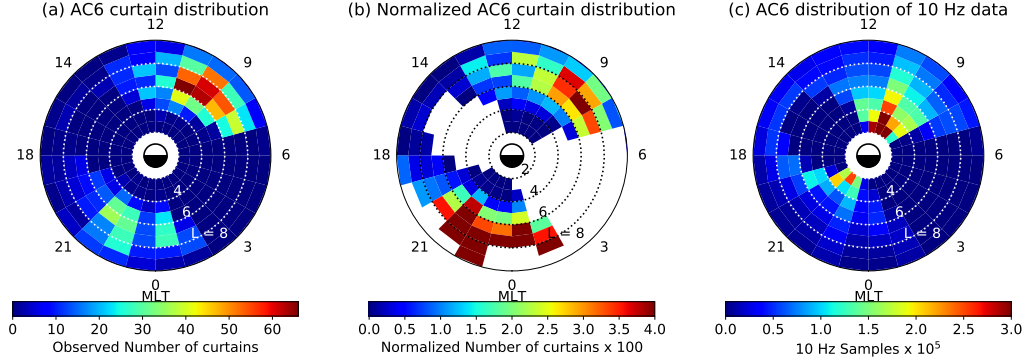
Figure 3. Distribution of curtains as a function of L and MLT. To avoid noisy normalization scaling, bins with less than 10,000 10 Hz samples were not normalized in panel b. Check that there is no bug interpolating MLT between 24 and 0 hours.
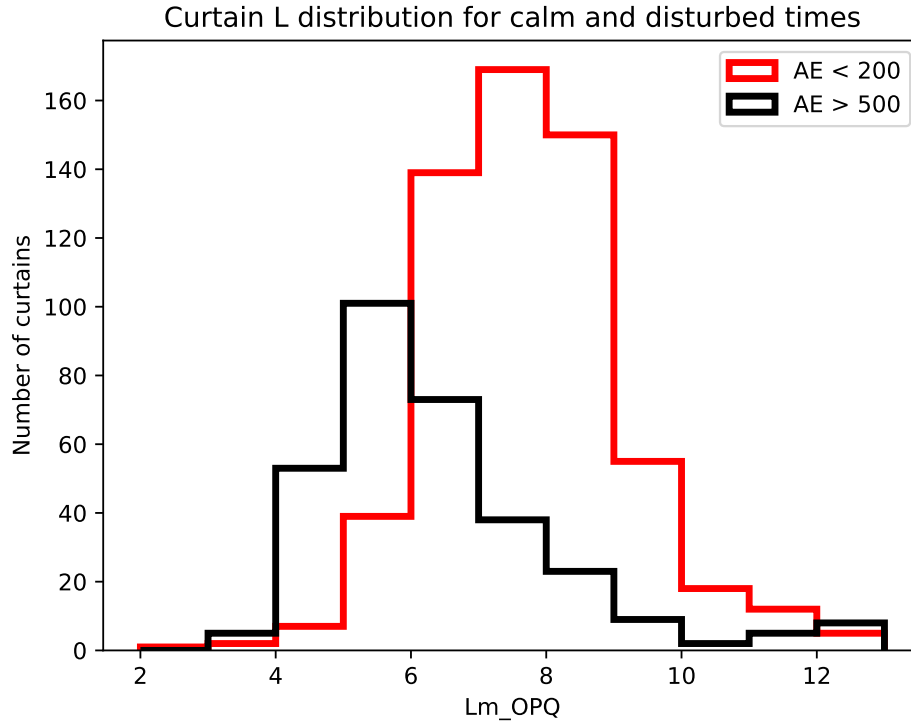

Figure 4. Or show this figure?
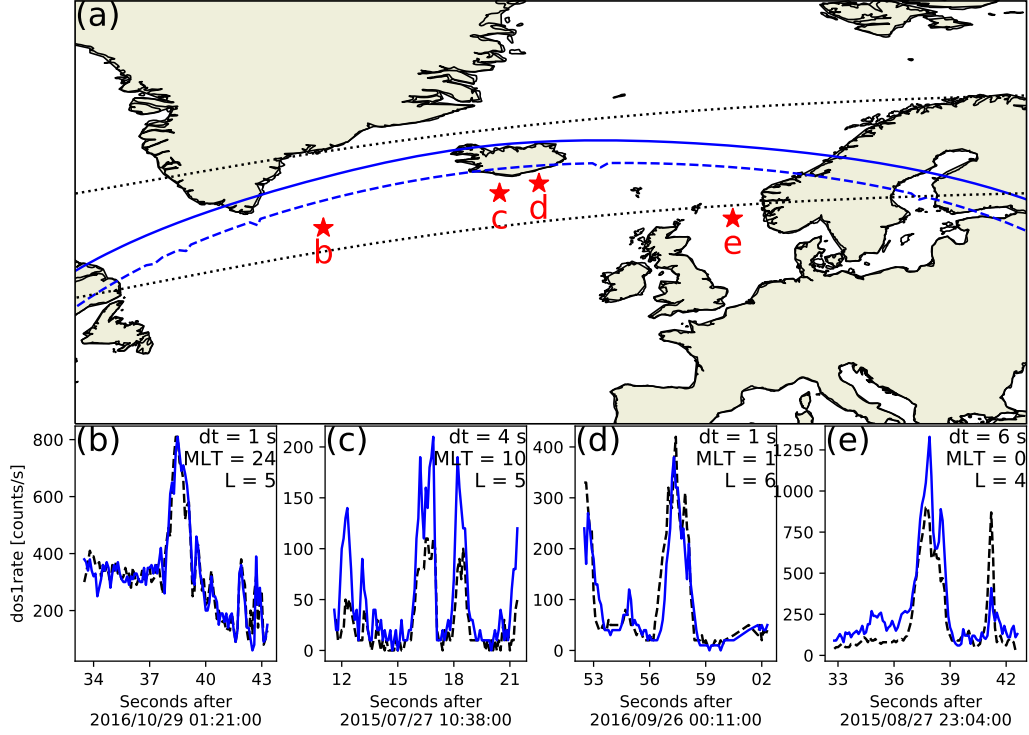
AC6 Curtains in the Bounce Loss Cone

Figure 5. Curtains observed inside the bounce loss cone.

3. preference to disturbed conditions

4. some curtains locally precipitate for an extended period of time. AC6 can't answer this question, but curtains could provide a substantial source of HOx and NOX molecules responsible for destroying ozone. We need AC6 with energy and pitch angle resolution.

7 Conclusions

8 Homeless Words

Title: Statistical Properties of Curtains–Latitudinally-Narrow and Persistent Electron Precipitation Phenomena

This study leverages AC6, a multi-spacecraft mission, to interpret and understand particle precipitation in a way that is impossible with a single spacecraft.

This study leverages the asymmetry in Earth's magnetic field. The asymmetric magnetic field results in the SAA and the BLC, two very related and unique regions

Particles that impact the atmosphere are lost during that bounce motion. We found curtains in the bounce loss cone, a region in the North Atlantic near and above Iceland.

The bounce loss cone is magnetically connected to the SAA, where Earth's magnetic field is weakest near Earth's surface. A particle observed in the blc in the northern hemisphere will descend below 100 km altitude. At sub-100 km altitudes the particle has a high chance of encountering and scattering with the atmosphere and be lost.

We found curtain elections that, when given the chance to execute their cyclical bounce motion, will descend below Earth's surface in the SAA. An election can not survive that trip.

Write the paper and ask the question: "What is this paper really about?" Not just curtains, but uncovering something unexpected that has been observed and overlooked for decades.

Are curtains related to aurora? This is a good question—one that is not pertinent here (idea from The Elements of Style p.68).

Here are two parting questions to consider that are not considered here. Why were some curtains shifted slightly? Perhaps it was due to the movement of the magnetic field lines. Also do curtains have a corresponding visual signature on the ground? The answer to this question will show if curtains are related to the aurora.