Electron Microbursts from Dawn to Dusk: Investigating Whistler Mode Chorus as a Source of Microbursts

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Abstract

It has been observed that the distribution of whistler mode chorus favors the dawn side of the Earth. Consequently, observed electron microbursts have a significant distribution favoring the dawn side. Previous observation and analysis show more microbursts in this region, however there is still a significant distribution of microbursts present where whistler mode chorus is minimal on the dusk side. This distribution of microburst events on the dusk side and its ratio to whistler mode chorus is the subject of investigation for this project. Data from the Solar Anomalous Magnetospheric Particle Explorer (SAMPEX) satellite, specifically from the Heavy Ion Large Telescope (HILT), is used to analyze microbursts. Algorithmic studies on this data isolated around regions of the subject of investigation, including the South Atlantic Anomaly (SAA), will address ratios of microbursts to whistler mode chorus on the dawn and dusk sides of the Earth. This study approaches characteristics of specific microburst activity to explain known distributions.

Introduction

Relativistic electron microbursts are electron precipitation events known to occur in the earth's magnetosphere. These are important as they are known to be significant contributors to the Earth's radiation belt. Whistler mode chorus is a type of fluctuation in the earth's magnetic field that is known to generate relativistic electron microbursts [1] and

has a distribution that favors dawn side of the earth. Microbursts also experience eastward drifting as a result of the gradient of the earth's magnetic field.

The South Atlantic Anomaly (SAA) is considered to interfere with relativistic electron microburst occurrence due to the abnormal effect on the magnetosphere. Some studies omit data that occurs over this region [1] so here we address it and the surrounding regions specifically.

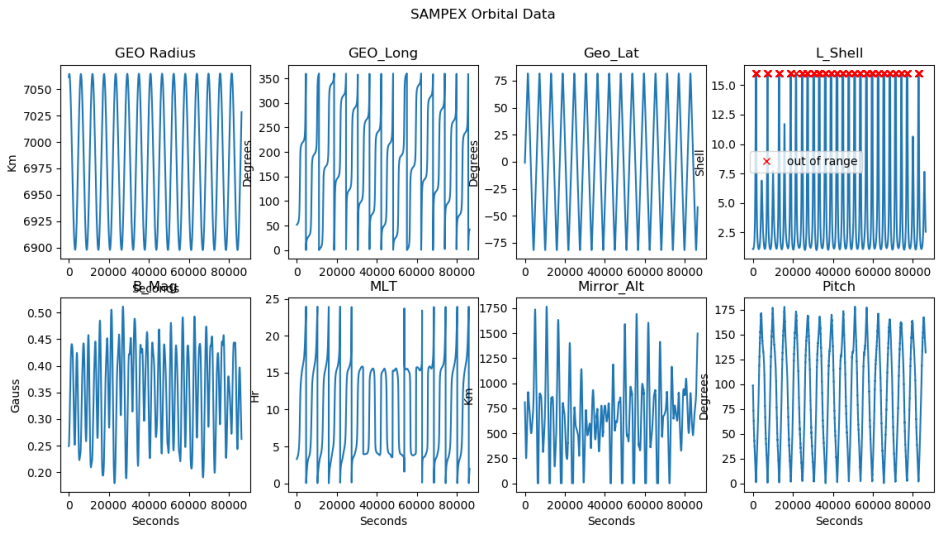
Electron data has been recorded from several satellites. Many studies have collected short-term data but this study focuses on a long term distribution of relativistic electron microbursts. The Solar Anomalous Magnetospheric Particle Explorer (SAMPEX) carried the Heavy Ion Large Telescope (HILT) that recorded a long-term data set that is commonly utilized in studies [1].

Here we utilize O'Brien et al. [3] algorithm to determine relativistic electron microburst events in the SAMPEX HILT data. We follow the same initial process at Douma et al [1] to validate our microburst data. We then investigate microburst data near the SAA and develop distribution models for relativistic electron microbursts across MLT and L values.

Data Set

SAMPEX launched in July 1992 and officially ended June 2004. It continued to operate and record data until it reentered Earth's atmosphere in November 2012 [2]. Throughout it's mission, SAMPEX underwent configuration changes. Data collected during the satellite's "SPIN" modes was neglected, leaving state one and four to analyze. This is because of disturbances to HILT that would not contribute to this study.

During its flight, SAMPEX underwent a polar orbit and the graphs below display orbital information important in this study.



The HILT data set consists of energetic particle count rates from the instrument. Initially, these rates were recorded as counts per 100 milliseconds but over the course of SAMPEX's mission these configurations underwent changes [2]. Event selection from state one and four had to be adjusted to for this.

Event Selection

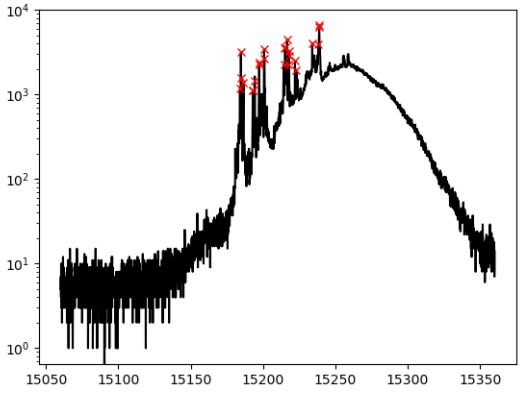
From HILT data, relativistic electron microburst events were selected using the O'Brien formula [3]. This has been done in other studies [1].

$$\frac{N_{100} - A_{500}}{\sqrt{1 + A_{500}}} > 10 \tag{1}$$

N_{100} refers to number of counts per 100 milliseconds while A_500 is the centered running average of N_{100} over five 100 ms intervals (i.e., over 500 ms).

To confirm the consistency of this evaluation with Douma et al. [1], the following graph shows the microbursts juxtaposed with the electron background data over the same time

frame as the article.



This graph depicts microbursts (red crosses) and electron count rates (black) on 17 August 1999 from 04:13:00 to 04:14:30 UT. The horizontal axis specifies seconds and the vertical axis represents count rates.

This time sample is the same used by a previous study [1] and helped validate use of the O'Brien et al [3] formula. This achieved a complete set of relativistic electron mircobursts recorded by HILT and their time of occurrence.

SAA Adjacent Region Events

The SAA is a region where the Earth's inner Van Allen Radiation Belt is closer to Earth's surface. Because microbursts have a distribution that favors the dawn side of the Earth, we specifically need to examine effects of the SAA on the east and west sides of it. An asymmetrical effect over these regions would suggest that drifting electrons are interfered with in this region, effecting the dawn/dusk distribution.

We will use orbit data to find MLT and L values of microbursts in these regions and compare geographic dependencies to MLT and L dependencies.

Next Actions

Relativistic electron microburst activity has been widely investigated but have yet to be fully understood. This study is not yet complete. What remains is analysis of effects from the SAA and gathering a coherent representation of microburst distributions that are corrected for the SAA and electron microburst drift.

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References

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