URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Constraining the Size and Duration of Microburst-producing Chorus Regions: A Statistical Study of Low- and High-Altitude Observations

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Microbursts are impulsive injections of energetic (few keV to MeV) electrons into the atmosphere, primarily caused by nonlinear scattering by whistler mode chorus waves. These electrons can deposit their energy at altitudes as low as the stratosphere and thus may represent an important driver of magnetosphere, ionosphere, and atmosphere coupling. However, the importance of microburst precipitation as a loss process from the outer radiation belt has not been properly quantified, though many studies have suggested that it may at times be a major loss source.

To better quantify the spatial extent and temporal duration of microburst loss during active times, we utilize a database of magnetic conjunction observations from 2015–2019 containing high-rate burst particle data from the low Earth orbit FIREBIRD II CubeSats and waveform observations from the near-equatorial orbiting Van Allen Probes (RBSP). This conjunction dataset is supplemented with observations of energetic electron precipitation from POES, the AC-6 CubeSats, and BARREL balloons, and waves from Arase, THEMIS, and ground-based VLF receivers. From this combined dataset we can estimate the spatial extent and duration of both individual microburst enhancement events and statistically over many events. Results indicate that microburst enhancements can be spatially extensive (hours in magnetic local time and multiple L-shells) and long-lasting, suggesting that they represent an important component of electron loss from the outer belt.

However, achieving sufficient spatial coverage of the microburst region typically requires integrating observations over hours, meaning we cannot resolve important source dynamics on relevant timescales (e.g. tens of minutes to hours associated with substorm injection events). This highlights the heliophysics community need for an increased number of observational platforms and well as imager-type missions to properly quantify energetic electron loss.