High Altitude Balloon-Borne X-ray Detector Observations of Impulsive Electron Precipitation Events Associated with Lightning Activity During the 2013/2014 BARREL Campaigns

G. S. Bowers[1], M. McCarthy[2], D. M. Smith[1], R. M. Millan[3], R. H. Holzworth[2]

[1] *Department of Physics, University of California Santa Cruz, Santa Cruz, CA, USA*
[2] *Earth and Space Science, University of Washington, Seattle, WA, USA*
[3] *Physics and Astronomy, Dartmouth College, Hanover, NH, USA*

Broadband VLF emissions from lightning can propagate along the Earth's magnetic field lines as whistler mode waves and alter the pitch angle of electrons trapped in the radiation belts. These scattered electrons can precipitate into the Earth's atmosphere creating regions of increased ionization and x-ray bremsstrahlung [1]. Here we present direct x-ray detector observations of lightning-induced electron precipitation (LEP) made during the 2013/2014 BARREL [2] (Balloon Array for Radiation Belt Relativistic Electron Losses) campaigns. The time profile characteristics of observed x-ray events are presented and comparisons are made to simple LEP Models.

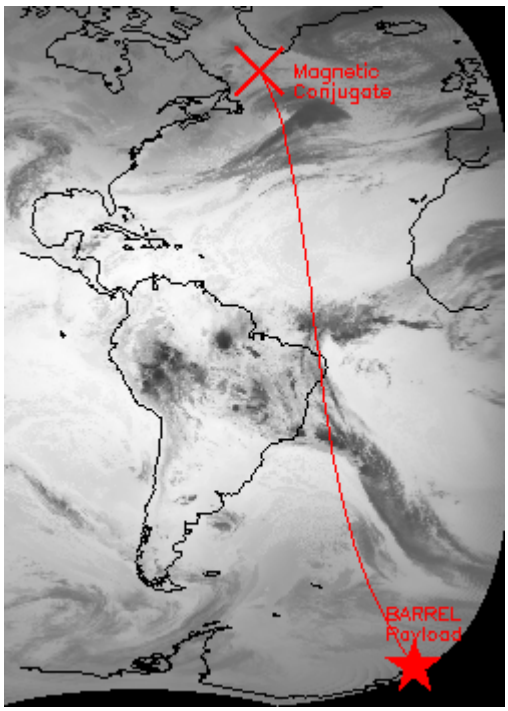

Figure 1. BARREL Payload, field line, and conjugate foot-point poleward of electrically active Arctic storm

1. Background (2013 Event)

During the 2013 BARREL (Balloon Array for Radiation Belt Relativistic Electron Losses) campaign, 20 high altitude balloon payloads equipped with sodium iodide scintillator detectors were launched over several weeks to high altitude (up to 35km) over Antarctica to observe bremsstrahlung from radiation belt electron precipitation.

On a solar-quiet day in January, a payload magnetically conjugate to an electrically active Arctic storm in the North Atlantic (fig 1) saw several isolated bursts of high x-ray counts with energies > 30 keV (fig 2).

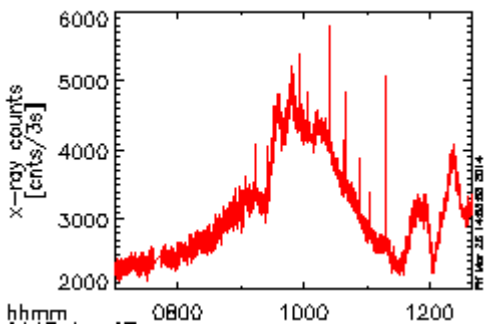

Figure 2. Observed spikes in BARREL x-ray count coincident with Arctic storm

Though the observed spikes are associated with lightning strokes detected by the World-Wide Lightning Location Network (WWLLN), more definitive evidence is sought to establish the cause of these x-ray events.

2. References

[1] H.D. Voss et al, Lightning-induced electron precipitation, (1984) Nature

[2] R.M. Millan, The Balloon Array for RBSP Relativistic Electron Losses, (2013) Space Sciences Reviews