Statistics of Ground-Based Elve Photometry

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A transient luminous event (TLE) observation campaign was conducted at Langmuir Laboratory near Socorro, New Mexico from July 4, 2008 to August 1, 2008. One of the instruments involved was the photometric imaging instrument called PIPER (Photometric Imaging of Precipitation of Electron Radiation), and one of the major emphases of the campaign was to make ground-based observations of elves. Hundreds of elves were observed with PIPER over the course of the campaign, including over 100 from a single storm. In this paper, we present a statistical summary of these observations.

The PIPER instrument consists of four multi-anode photomultiplier tubes (PMTs) arranged in pairs, with one pair operating behind a 437.8 nm optical filter and the other pair operating behind a 630.0 nm optical filter. The 16 anodes of each PMT are arranged in a line, and each pair of PMTs consists of a PMT with anodes arranged horizontally and a PMT with anodes arranged vertically. Thus, horizontal and vertical spatial resolution of the field of view is obtained at the high frame rates (25000 frames per second) typical of photometers. In this kind of imaging mode, elves have a characteristic signature that make them easy to identify. Moreover, although the frame rate is high, the number of measurements made per frame (64, one for each anode) is low enough that PIPER can record continuously for hours, removing the need to trigger the instrument each time an event is thought to have occurred. The combination of these factors makes PIPER ideal for an aggregate study of elves.

In this paper, we present a brief overview of the PIPER instrument and examples of recorded elves. We then present a statistical summary of the body of PIPER elve recordings made to date, including elve association with a variety of important parameters like causative CG peak current, VLF early/fast events, storm sprite production, and storm size. We also present examples of elves occurring in doublets and triplets—that is, in rapid (< 20 ms) succession of each other—and investigate why these events occur commonly for some types of storms and not at all for others.