The Firefly Mission: An NSF CubeSat to Study the Relationship between Lightning and TGFs

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The Firefly satellite mission is the second in a series of NSF-sponsored CubeSat missions to study Earth's upper atmosphere and the effects of space weather. Scheduled for launch in 2010/2011, Firefly will perform focused observing campaigns over thunderstorms, looking for the signatures of Terrestrial Gamma-ray Flashes (TGFs) and the parent lightning which is thought to produce them. By combining a large-aperture (200 cm^2) gamma-ray detector with sensitive VLF receivers and optical detectors, Firefly will explore the details of the lightning-TGF relationship. Using the first correlative measurements of TGFs and VLF/optical signatures from a single platform, Firefly will make it possible to push the envelope for detection of TGFs that are almost an order of magnitude weaker than previously observed (and probably as much more common). These combined measurements will help to make progress on the following science questions:

1) Are TGFs produced only in association with VLF and optical emissions?
2) What is the relative timing of the VLF, optical, and gamma-ray signatures?
3) What are the characteristics of the lightning flashes that do and do not produce TGFs?
4) How tightly beamed are the gamma rays and how close to the lightning flash are they observed?
5) Is there direct evidence for very energetic electrons accelerated over thunderstorms? – Firefly will have the capability to measure MeV electrons, using a phoswich-style scintillator.
6) What is the attenuation of the low energy portion of the TGF spectrum, and what TGF production height does this suggest?
7) What is the occurrence frequency of very weak TGFs?

We will present the Firefly mission design, and talk about the science objectives and measurement requirements.