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HIGHLY DISTRIBUTED CHIPSATS TO PROVIDE IN-SITU MEASUREMENTS OF THE MAGNETIC FIELD FOR SPACE WEATHER MONITORING

Abstract

Distributed space systems can acquire scientific data from numerous sample points in multiple locations simultaneously. As technology continues to miniaturize and improve, satellites are getting smaller and constellations are becoming larger. CubeSat constellations have been successful in the commercial Earth observation sector and are expected to be used more for communications and interplanetary science missions in the near future. The next step in this evolution could be the inexpensive, cracker-sized satellites known as ChipSats.

ChipSats have a mass under 10 grams and this allows many hundreds of units to be launched aboard a single CubeSat. Due to their size, small payloads providing in-situ measurements are most suitable for these satellites. Once deployed, ChipSat clusters can collect scientific data through their on-board sensors and relay this data back to their CubeSat mothership. Due to the low mass-to-area ratio of ChipSats, the satellites will deorbit within days or weeks after release from the CubeSat. To be effective, this necessitates multiple releases of ChipSats from the mothership to capture particular events of interest.

This paper presents a novel application of ChipSats as a distributed sensor system to obtain in-situ magnetic field measurements. ChipSats would be released during intense solar events to better quantify the correlation between space weather events and changes to the Earth's magnetic field. This relationship is important to understand because space weather can impact technological systems on the ground, and can also be hazardous to spaceborne astronauts and spacecraft.

The proposed mission requires input from existing space and ground-based solar observation methods and networks to relay the onset of a solar event to a collection of CubeSats, each containing hundreds of ChipSats, distributed in Low Earth orbit. These CubeSats would then release a select number of ChipSats to gather magnetic field measurements as a cluster during the solar event. These magnetic field measurements can be combined with solar and ground-based measurements from other sources to better calibrate space weather forecasting models for improved accuracy. Altogether, this data would be of interest to both public and private entities interested in and affected by severe space weather occurrences and would assist in developing deterministic mitigation techniques in the case of space weather-related disaster management.