High-Altitude Atmospheric Observations with the FaLling Aerogel Re-entry Experiment (FLARE)

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Abstract

FLARE is an Aerospace Engineering Sciences graduate project at the University of Colorado, Boulder in collaboration with the Johns Hopkins University Applied Physics Laboratory (JHUAPL). The project goal is to research and design a novel cost effective solution for performing high-altitude atmospheric research (50-100 km) using lightweight reusable probes. In order to accomplish this, FLARE dropsondes will incorporate off-the-shelf, miniature global positioning system (GPS) transmitting/receiving equipment encapsulated within an extremely low-density polymer aerogel. These probes can be launched using a custom deployer at the apogee of any commercial suborbital spacecraft with an initial focus on Blue Origin's New Shepard rocket. The project goal for the 2022/23 academic year is to mature the technology readiness level (TRL) of a preliminary design for dropsondes and external dispensers, and to develop and deliver a fully-operational system prototype that can be integrated with the JHUAPL developed JANUS system for power and data control.

Dropsonde

To keep the dropsondes as lightweight as possible (low volumetric density), we will use a polymer-based aerogel with a high strength to elasticity ratio as the primary dropsonde structural material. This allows for sufficient protection of the internal electronics from the forces of launch, reentry and landing. Two hemispheres of aerogel are combined to encapsulate the electronics payload within a sphere of 5 inches or less in diameter. Electronics contained within the aerogel structure consist of a GPS receiver and transmitter, along with an onboard power source (battery) and embedded software systems. The dropsonde will be able to communicate with a ground station unit, both for data acquisition redundancy and retrieval of the probe after its descent and landing. After probe procurement, the full dataset will be recovered and analyzed.

Deployer

The deployer is responsible for containing the dropsondes until release at the apogee of a parabolic suborbital flight path or at other predefined timing intervals. Each deployment device is able to hold one dropsonde at a time and utilizes a simple linear actuator ejection mechanism based on cubesat deployer heritage. Multiple deployers can be mounted along the upper ring of New Shepard's propulsion module, allowing for easy configurability and access to the centrally mounted JANUS unit. Having multiple systems allows for the simultaneous deployment of many dropsondes at once, reducing mission risk with multiple modes of data collection existing if one or a few modules fail.

Conclusions

FLARE serves as a demonstration of a low-cost alternative method for taking measurements of the upper atmosphere. The deployer and aerogel dropsondes are designed to be adaptable for integration with multiple commercial suborbital launch platforms, allowing for regular probe flights and more substantial data for future high-altitude researchers.