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FLIGHT MODEL DESIGN AND DEVELOPMENT OF THE W6U-SIZE PRELUDE FOR INVESTIGATING IONOSPHERIC EARTHQUAKE PRECURSOR PHENOMENA

Abstract

The statistical significance of ionospheric earthquake precursor phenomena has been reported. To elucidate the underlying mechanism of this phenomenon, the authors are developing the W6U CubeSat "PRELUDE", which performs ionospheric observations. PRELUDE selected as JAXA (Japan Aerospace Exploration Agency)'s Innovative Satellite Technology Demonstration Program-4 and is scheduled for launch in 2025. This study presents the design development, versatility, and various tests of the flight model of PRELUDE. Major earthquakes are a threat to humanity, yet a reliable method for predicting them has not been established. One promising phenomenon for earthquake prediction is the reduction of VLF radio wave intensity in the nighttime ionosphere. However, the mechanism behind this phenomenon is unclear, and there is a lack of ionospheric observation data to further analyze its correlation with earthquakes. Therefore, this project aims to increase observation data and realize short-term earthquake prediction in the future. Compared to large satellites, small Earth electromagnetic observations satellites require a design that carefully considers the effects of satellite charging on the surrounding plasma environment. In the observation, the electric field is measured by checking the voltage difference between two sensors with the satellite ground as a reference. Therefore, it is necessary to keep the ground potential stable. To achieve this, a PSEE (electron emitter) is installed. To check if the mission can observe the plasma potential, whether the PSEE operation can reduce changes in the satellite's ground potential, and how the direction of electron emission affects the satellite's charging, tests in a plasma chamber that simulates both vacuum and plasma conditions are needed. This study shows the testing methods and evaluation results. The satellite system is designed for versatile Earth electromagnetic observations with several features:1. Shielding to prevent interference from internal equipment and solar power generation on the mission unit2.Space reserved for a 3U mission unit3A mission processing board that serves as an interface with the bus4A shielded structure for the mission processing board for high-precision analog signal processing. These features show that PRELUDE is a platform for Earth electromagnetic observation. Therefore, the system is designed to perform downlinking only when an earthquake occurs, triggered by a command from the ground station. Additionally, the ground station will use a cloud-based system. In the future, we aim to secure even more data by using multiple ground stations and operating a constellation of satellites.