

31st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Earth Observation Missions (4)

Author: Ms. Nagisa Sone
Nihon University, Japan

Dr. Masahiko Yamazaki
Nihon University, Japan
Prof. Masashi Kamogawa
Japan

DESIGN OF THE PRELUDE CUBESAT FOR OBSERVING ELECTROMAGNETIC
PERTURBATIONS ASSOCIATED WITH SEISMIC ACTIVITY**Abstract**

Despite advances in satellite remote sensing, predicting large earthquakes, often accompanied by tsunamis, remains a significant challenge due to the unpredictable nature of these events. Conventional remote sensing and ground-based observations have yet to contribute effectively to earthquake predictions. To address this challenge, our study, building upon the achievements of the French DEMETER satellite, focuses on atmospheric and space electrical variations as potential indicators of ionospheric precursors to earthquakes. This approach is expected to contribute to the enhancement of short-term prediction capabilities. For this purpose, we would like to introduce our CubeSat "PRELUDE", a tiny satellite dedicated to the EQ precursor detection and propose such CubeSat constellation with the international/global collaboration to elucidate the physical mechanism. PRELUDE is scheduled for launch in FY2025 as part of JAXA(Japan Aerospace Exploration Agency)'s Innovative Satellite Technology Demonstration Program. This study presents the results of the system design, development, and mission planning of the CubeSat PRELUDE, aimed at clarifying the physical mechanisms behind the statistically significant earthquake precursor ionospheric phenomena. PRELUDE is a 6U CubeSat specialized in VLF electromagnetic wave intensity observation, weighing 8 kg. To achieve miniaturization, it incorporates a drive recording function to downlink only the data surrounding the EQ epicenter to ground stations, reducing data storage and transmission requirements. Additionally, it hybridizes the Langmuir and electric field probes, typically found on satellites weighing over 100 kg like DEMETER, into a compact design suitable for CubeSats weighing just a few kilograms. The hybrid sensor unit extends booms bidirectionally by 1.5 m from the satellite using a folding extension mechanism, with each tip hosting a hybrid sensor (spherical electrode) to observe electric potential. The hybrid sensor is a spherical probe of $\phi 40$ mm with a preamplifier inside, similar to the $\phi 60$ mm DEMETER, and the distance between sensors, which is determined by the boom extension length, is 8 m (DEMETER), while the proposed sensor unit is designed with a distance of 3 m. The sensor unit is compact enough to be mounted on a CubeSat, but has a sufficient S/N ratio compared to the on-orbit data of DEMETER. In this presentation, we analyze the data acquired by DEMETER and show the satellite design requirements for elucidating the mechanism of seismic precursor phenomena. The number of seismic data obtained during the operation of PRELUDE will also be analyzed to evaluate the feasibility of the PRELUDE mission and the adequacy of its design.