

25th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
19th Workshop on Small Satellite Programmes at the Service of Developing Countries (1)

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TESTING AND OPERATIONS OF A STORE AND FORWARD CUBESAT FOR ENVIRONMENTAL
MONITORING OF COSTA RICA

Abstract

Costa Rica is world-renowned for its environmental conservation and its clean energy generation. The government-led programs such as the Environmental Services Payment Program has resulted in an increase of the country's forest coverage from 21% in 1987 to 51.4% in 2010. Additionally, the country has established an ambitious goal of becoming a carbon neutral entity by 2021. Many efforts have been developed to contribute to this objective, including Irazú, a project consisting of designing, manufacturing,

launching and operating the first Central American satellite to monitor carbon fixation in an experimental forest plantation in Costa Rica. The Irazú project is an initiative of the Central American Association for Aeronautics and Space (ACAE) and the Costa Rica Institute of Technology (TEC), along with many contributors from academia, government, and the private sector. Irazú uses a 1U CubeSat that will act as a Store and Forward system, to collect data from ground sensors in a remote location and forward them to a data analysis and visualization center in TEC. The ground sensors measure tree diameter growth, soil humidity, and meteorological parameters. The data collected is used to estimate the amount of carbon that the trees are absorbing and to observe how this is affected by meteorological variables. Furthermore, this data, along with the spacecraft operating parameters, will be published in a user-friendly website to promote science and technology for Costa Rica's future generations. This paper focuses on the final testing of the spacecraft, which is critical for launch certification, and mission operations. The final testing was performed at the Laboratory of Spacecraft Environment Interaction Engineering of the Kyushu Institute of Technology. Strict requirements set by the launch provider had to be met, which is why this phase included vibration testing, thermal vacuum testing and fit tests of the CubeSat in the JEM Small Satellite Orbital Deployer, among others. Furthermore, the process of obtaining the operating frequency and license of the satellite for a first-time applicant nation is explained. An overview of the operations is presented as well, including a summary of the ground sensor network and how they establish the communication link with the CubeSat, how the satellite stores the data, and how it forwards it to the research center at TEC. The final lessons learned from the project are stated, emphasizing the importance of national and international collaboration for emerging space nations, and recommendations for first-time satellite operators.