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ENHANCING AURORA MODELING THROUGH DISTRIBUTED SPACE SYSTEMS TECHNOLOGY

Abstract

The Aurora, with its dazzling display of lights, presents a complex atmospheric phenomenon that has intrigued scientists for decades. Its dynamic nature and expansive spatial coverage pose significant challenges for in-depth study and understanding using traditional monolithic satellite systems. These challenges stem from the need for simultaneous measurements at various locations within the Aurora to capture its multidimensional characteristics accurately. This paper proposes a novel approach to Aurora study through the design of a distributed space system, harnessing the synergy of CubeSat and PocketQube technologies. We introduce a system, composed of a CubeSat acting as communication relay and a command center, and PocketQubes (Developed in University of Luxembourg) functioning as dedicated measurement units. This architecture allows for the deployment of a swarm of satellites directly into the Aurora, enabling synchronous data collection from multiple points within the phenomenon. Such a distributed system overcomes the limitations of single-satellite measurements by providing a comprehensive, three-dimensional model of the Aurora's behavior and properties. The CubeSat in this system serves a dual purpose. Primarily, it acts as the backbone for communication, relaying data from the PocketQubes to ground stations, ensuring timely and efficient data transmission. Secondly, it serves as a command center, orchestrating the operation of the PocketQube swarm, including deployment, navigation, and data collection protocols. The PocketQubes, on the other hand, are equipped with specialized sensors and instruments tailored for Aurora research. These small satellites penetrate the Aurora, performing in-situ measurements of electromagnetic fields, charged particles, and other relevant parameters. This paper details the Phase 0/A design considerations for such a distributed system, including satellite swarm management, communication architecture, data integration techniques, and the scientific instruments employed. By adopting this distributed satellite approach, we aim to open new avenues for space research and atmospheric studies, showcasing the potential of CubeSat and PocketQube integration in addressing complex scientific challenges.