Paper ID: 64370
student

IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

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# MISSION ANALYSIS AND TRADE-OFF STUDY FOR AURORAL OVAL OBSERVATION MISSION UTILIZING CUBESATS FOR SPACE WEATHER MONITORING

**Abstract**

The auroral lights are a natural phenomenon that occur both in the northern and southern hemispheres at extreme latitudes, caused by energetic particles ejected from the surface of the sun interacting with the Earth's magnetic field and atmosphere. The magnetosphere protects Earth from the majority of solar wind particles, yet some manage to leak in and enter the Earth's atmosphere along the magnetic field lines. This region around the magnetic poles, where the auroral lights are found, is called the auroral oval. Observing the auroral oval can be a means of monitoring space weather and understand its impacts to our infrastructure in space and on ground.

In this work, the orbital analysis and trade-off study concerning a space weather CubeSat mission to complement the Distributed Space Weather Sensor System (D3S) of the European Space Agency (ESA) is presented. The proposed mission utilizes a 24U CubeSat with an imaging payload that covers a 60x60 degrees field of view. The trade-off study assesses: (i) the use of critically inclined orbits, polar orbits, and sun-synchronous orbits; (ii) the implementation of constellations; (iii) the total coverage of the auroral oval at varying altitudes; and (iv) the total radiation dose to the satellite system for a 7-year mission. Orbits of interest are simulated using NASA's General Mission Analysis Tool (GMAT) to evaluate the long-term evolution of the orbits, while accounting for relevant perturbations. To verify the compliance with the orbital debris mitigation guidelines to safely deorbit a satellite system within 25 years, ESA's Debris Risk Assessment and Mitigation Analysis (DRAMA) tool is applied analysing natural decay and the use of a propulsion system. ESA's Space Environment Information System (SPENVIS) is used to assess radiation impacts to the CubeSat system during the entirety of the mission. The trade-off study provides a collection of parameters and highlights constraints for the different investigated orbits, with a set of conclusions and recommendations to help identify the auroral oval observation mission concept best matching the mission requirements.