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PLANETARY SUNSHADE FOR SOLAR GEOENGINEERING: PRELIMINARY DESIGN OF A PRECURSOR SYSTEM AND MISSION

Abstract

The objective of this paper is to present the design of a Planetary Sunshade precursor mission in Earth-orbit. This study pioneers the integrated system engineering design and mission scenario definition.

Earth's climate change, driven predominantly by the escalation of greenhouse gases in atmosphere, poses an unprecedented threat to global stability and sustainability, manifesting through increased global temperatures. In response, a space-based geoengineering infrastructure has been previously proposed to reduce the oncoming solar irradiance, by placing a 'solar light umbrella', called Planetary Sunshade System, strategically positioned between the Sun and the Earth.

The proposed Planetary Sunshade precursor mission aims at pushing forward through in-space testing some of the critical enabling technologies for such a space-based climate change mitigation solution.

First, the precursor Planetary Sunshade System and mission requirements are discussed, for the first time to the best knowledge of the authors. Emphasis will be put on the astrodynamics of the mission, analyzing the orbital regimes suitable for maximizing efficacy and stability.

Then, the system design is introduced, based on small satellite components, focusing on its critical subsystems such as solar sail, attitude and orbit control system, deployable structures and mechanisms, thermal, power, telemetry, and on-board data handling, etc. Particular attention will be paid to the choice of solar sail materials, emphasizing their optical properties.

This precursor mission serves not only as a proof of concept but also as a critical testbed for the technologies enabling this geoengineering solution. By demonstrating the feasibility of such a mission, we contribute to a broader discourse on sustainable space-based interventions in climate change mitigation.

Our work aligns with several UN Sustainable Development Goals, notably SDG 13 (Climate Action), by exploring innovative solutions to combat climate change, and SDG 9 (Industry, Innovation, and Infrastructure), by pushing the boundaries of current space technology.