Topics (T)
Earth Observing Missions and Systems to Address Climate Change and Its Impacts [3] (3C)

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CONSTELLATION OF SMALL SATELLITES FOR A COST-EFFECTIVE AND LONG-TERM OBSERVATION OF GLACIERS

Abstract

Glaciers' evolution throughout the years is one of the major indicators of climate change. To date, glacier remote sensing missions are limited in spatial coverage, temporal resolution and long-term data acquisition capability. With this work, we show how to exploit recent advancements in various areas of space technology (sensors, edge computing, propulsion) to design a high performance, long duration glacier monitoring mission aimed at enhancing our present understanding of worldwide glacier evolution. To this end, this paper presents a Pre-Phase A feasibility analysis of a mission capable of overcoming the above-mentioned shortcomings, featuring an operating life of 12 years so to guarantee long-term, consistent data acquisition. All technology used is at high TRL and readily available on the market. The mission consists of six spacecraft in the 250 kg mass range, equally spaced in true anomaly on two Sun-synchronous circular orbits at 550 km. The two orbital planes are symmetrically located around the terminator and separated by 30 deg in RAAN. Such arrangement minimizes the revisit time over a multi-latitude glacial spread while maintaining dawn-dusk illumination, so to have ideal observation conditions and a stable thermal environment. This provides high temporal resolution ranging between 1 and 7 days from polar to equatorial regions, respectively. Constellation spacecrafts are equipped with a multispectral optical sensor, a SAR and a GNSS receiver for reflectometry measurements. Significant reduction in data downlink requirements is achieved by adopting AI-enhanced onboard processing to discard low-quality data (e.g., cloud-covered images). A distinctive feature of the selected architecture is the capability to change the orbital parameters to get a better point of view over a chosen area. To this end, the spacecraft embark a 100 W Hall propulsion system. The electric thruster is used to perform periodically a perigee lowering maneuver, bringing the spacecraft to an elliptical orbit with a minimum altitude of 300 km centered over the area of interest. It is therefore possible to "zoom-in" on selected glaciers, enhancing

the quality of the remote observations, during the yearly peak ice ablation season. Closer monitoring of this important phenomenon provides useful information to researchers studying the dynamics of glacier melting. The design of the satellites is carefully tuned to facilitate easy disposal at EOL for space debris mitigation. Our preliminary cost analysis shows that the mission financial budget is under 200 MEur, with considerable cost reduction with respect to past missions of similar scope.