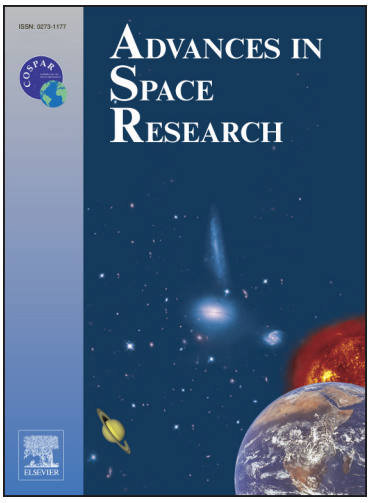

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Satellite constellation design algorithm for remote sensing of diurnal cycles phenomena

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Abstract

This paper proposes an algorithm to find the smallest satellite constellation satisfying a given set of Earth observation requirements. This methodology is exemplified with the Satellites Observing Lakes and Vegetation Environments (SOLVE) study, which aims at deploying a fleet of small satellites carrying miniaturized hyperspectral spectrometers. A key requirement of this mission is a high temporal resolution through which the ground target can be observed several times a day. Hourly observations are required in this mission in order to capture diurnal changes in water quality and vegetation environments. Given sensor specifications and observation requirements, the proposed algorithm determines orbital parameters of an optimal constellation design via a semi-analytical approach. This approach reveals trade-offs amongst performance metrics and deployment cost, providing better physical intuition for decision-making compared to stochastic optimization.

Key Words: Hyperspectral spectrometer, Remote sensing, Satellite constellation, Diurnal cycles, Ecosystems

1. Introduction

Space-based remote sensing has been playing a crucial role in advancing Earth science. For example, SeaSat, the first satellite dedicated to ocean research launched in 1978, could acquire more information than collected by shipboard surveys for the preceding 100 years during its 105-day lifetime (Fu and Holt, 1982; Logan et al., 2014). A number of satellites have been launched since then and more missions are being planned, but most of them are only able to observe targets at weekly scales or daily at best. The SOLVE (Satellites Observing Lakes and Vegetation Environments) is a hyper-spectral remote sensing mission intended for observing vegetation and water processes on Earth at hourly scales (Ivanov et al., 2016). The mission aims to monitor Earth's changing environment by revisiting target areas several times a day. The hourly revisits are essential for studying diurnal variability of vegetation and fresh water environments. This revisit requirement is the key element of SOLVE, implying the need of a constellation with multiple satellites and orbital planes. The purpose of this paper is proposing an algorithm to

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