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Earth Magnetosphere Model Investigations for Coupled Orbit-Attitude Space Debris Perturbations

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ABSTRACT

As more objects are placed into orbit, collisions become increasingly more likely, leading to a so-called Kessler Syndrome: collisions between existing debris creates more debris, causing a cascading effect of larger amounts of debris being put into orbit, even in the absence of launches, making future space fairing difficult or impossible. Natural forces influence the orbit and attitude of uncontrolled debris objects. The natural plasma environment can lead to space object charging. The subsequent orbital movement in the geomagnetosphere induces Lorentz forces that act both on the orbit and attitude of the space object. Those forces have not been investigated thoroughly so far. Current physics-based models of the Earth's magnetosphere examine the influence of the Sun's corona and the Earth's ionosphere on the plasma. This study looks at focusing the magnetosphere models in the near Earth region, specifically from low Earth orbit up to an altitude of 36000 km, to decrease computation time without significantly lowering the accuracy in the region of interest. The models that this study examines are a dipole, multipole, and multipole with plasma dynamics. The position of a charge deviates on the order of micrometers when comparing results from a dipole model and 7^{th} degree multipole model.

KEYWORDS

Geomagnetosphere, plasma dynamics, orbital control