Evolution of the orbital Elements for Objects with high area-to-mass Ratios in Geostationary Transfer Orbits

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A new population of uncatalogued objects near the geostationary orbit (GEO) with a mean motion of about 1 rev/day and eccentricities up to 0.6 has been identified recently. The first observations of this new type of objects were acquired in the framework of the European Space Agency's (ESA) search for space debris in the GEO and the geostationary transfer orbit (GTO) using the ESA 1-m telescope on Tenerife. Earlier studies have postulated that the perturbations due to the solar radiation pressure can lead to such large eccentricities for GEO objects with a high area-to-mass ratio (A/M). The simulations showed that the eccentricities of GEO objects with large A/M exhibit periodic variations with periods of about one year and amplitudes depending on the value of A/M. The findings of these studies could be confirmed by observations from the ESA 1-m telescope on Tenerife.

As opposed to GEO objects, no GTO objects with high A/M have been identified so far. Nevertheless, such objects could also exist. Simulations were performed in order to study the orbital evolution of GTO objects with high A/M. The objective was on the one hand to find a possible explanation why no GTO object with a high A/M has been observed so far, and on the other hand to propose suitable search patterns. The A/M values were assumed to vary from 1 to 20 m^2/kg in our simulations. The semi-major axis and the eccentricity of GTO objects have a correlated decrease (in the sense that a(1-e) $\approx$ const.) with time caused by the air drag, leading to a characteristic line in the (a, e)-diagram. Thus, the initial values of the semi-major axis and the eccentricity were randomly selected along this line. In addition to the evolution of the orbital elements, the dependency of the lifetime on the A/M value was also studied.