# The New NASA Orbital Debris Engineering Model ORDEM 3.0

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The NASA Orbital Debris Program Office (ODPO) has released its latest Orbital Debris Engineering Model, ORDEM 3.0. It supersedes ORDEM 2000, now referred to as ORDEM 2.0. This newer model encompasses the Earth satellite and debris flux environment from altitudes of low Earth orbit (LEO) through geosynchronous orbit (GEO). Debris sizes of 10 μm through larger than 1 m in non-GEO and 10 cm through larger than 1 m in GEO are available. The inclusive years are 2010 through 2035.

The ORDEM model series has always been data driven. ORDEM 3.0 has the benefit of many more hours of data from existing sources and from new sources than past ORDEM versions. The object data range in size from 10 μm to larger than 1 m, and include in situ and remote measurements. The in situ data reveals material characteristics of small particles. Mass densities are grouped in ORDEM 3.0 in terms of 'high-density', represented by 7.9 g/cc, 'medium-density' represented by 2.8 g/cc and 'low-density' represented by 1.4 g/cc.

Supporting models have also advanced significantly. The LEO-to-GEO ENvironment Debris model (LEGEND) includes an historical and a future projection component with yearly populations that include launched and maneuvered intact spacecraft and rocket bodies, mission related debris, and explosion and collision event fragments. LEGEND propagates objects with ephemerides and physical characteristics down to 1 mm in size. The full LEGEND yearly population acts as an a priori condition for a Bayesian statistical model. Specific populations are added from sodium potassium droplet releases, recent major accidental and deliberate collisions, and known anomalous debris events.

This paper elaborates on the upgrades of this model over previous versions. Sample validation results with remote and in situ measurements are shown, and the consequences of including material density are discussed as it relates to heightened risks to crewed and robotic spacecraft.