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HARMFUL DEBRIS FIELDS PRODUCED BY LOW ALTITUDE ANTI-SATELLITE AND BALLISTIC MISSILE DEFENSE TESTING

Abstract

Over the past two years, the international community has recognized the growing threat posed by the orbital debris from destructive anti-satellite weapons tests. With 37 countries having made pledges to stop destructive, direct-ascent anti-satellite (DA-ASAT) weapons testing, and the passing of a UN General Assembly resolution calling on countries to halt DA-ASAT tests, much of the conversation has focused on the threat of "long-lived debris" in Low Earth Orbit (LEO). With the goal of preventing the generation of debris with very long deorbit times, Liemer & Chyba (2010) proposed a verifiable limited test ban for ASATs, in which they suggested that ASAT testing be limited to an altitude ceiling of 250-300 km.

In this paper, we suggest that the primary concern with ASAT testing should not just be how long the debris is in orbit, but rather what kinds of orbits it is in. Through detailed modeling of the collisions and resulting satellite breakup, we show that ASAT impacts are extremely energetic events, which will result in the production of debris in highly elliptical orbits. Even if the ASAT test is conducted at an altitude lower than 300 km, such that a large fraction of debris is contained to low altitude orbits where it will deorbit relatively quickly, there will be a significant tail in the debris distribution that extends to high apogees. The debris in these highly elliptical orbits will pass through dense shells of satellite constellations, e.g. around 500 km, posing a serious collision threat. We estimate this collision threat, and the potential for collisional cascades, using simulations that propagate the orbits of ASAT test debris particles in a realistic satellite field, resulting in quantitative predictions for the harm caused by ASAT testing at various altitudes and impact angles.

Finally, we extend this modeling to the debris fields produced by ballistic missile defense (BMD) testing, and show that these also have the potential to pose significant collision threats to LEO satellites, especially as the very low earth orbit (vLEO) satellite population grows over the next few years. These detailed simulations show the urgency of adopting an international and total ban on destructive ASAT testing, and the need to seriously reconsider the practice of BMD testing. Such measures are critical for safeguarding the interests of every nation and ensuring continued access to space and space capabilities for all humankind.