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## Concerning the impact of deorbiting spacecraft to the upper atmosphere

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The increasing activities in space due to more and more countries with space programs, advancing commercialization, and large satellite constellation projects lead to a rising number of human-made objects in space. While many of those stay in orbit at high altitudes, objects in low Earth orbit reenter the atmosphere mostly disintegrating and injecting material into the atmosphere. The growing concern about space debris has led to policies encouraging deorbiting of satellites at the end of their lifetime. All that will increase the annual mass influx into the atmosphere by human-made (anthropogenic) objects in the future. We compare the influx of those objects to the natural mass influx of entering meteoroids of asteroidal, cometary, and planetary origin into Earth's atmosphere. We look at the mass and the elemental composition of the entering bodies also incorporating different ablation of those objects. This way, a quantitative assessment of the annual injection of aerosols and atomic remnants into the atmosphere is possible. Today, anthropogenic material makes up way less than 1 % of the overall injected mass. However, future large spacecraft constellations could increase the anthropogenic influx significantly, then contributing 4 % or more of the whole injection. As spacecraft have a high abundance of metal elements, the metal mass portion of the injection can reach up to 15 %. For some elements, the anthropogenic injection may even prevail the natural injection. This implies for future large satellite constellations that the anthropogenic injection can become significant with unknown effects on the upper atmosphere and the terrestrial habitat.