Velocity distribution of asteroids and larger meteoroids and impacting Earth

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Most data sets which include ground-based observational data of meteors are affected by biases. The larger and faster the entering meteoroid, the brighter is the produced meteor. This bias of meteor observations towards faster meteoroids has to be considered when quantitative population and flux models are derived. In this work the velocity distribution of objects in space is analysed by using different data sets that should not be affected by this velocity bias since they include only large objects. These data sets include objects in the near-Earth object (NEO) risk list of ESA's near-Earth object Coordination Centre (NEOCC) [1], and the fireballs in NASA's CNEOS (Center for near-Earth object studies) JPL fireball database [2]. Additionally, when only the largest objects recorded with the CILBO (Canary Island Long-Baseline Observatory) camera setup [3] were analysed, a very similar distribution was found.

The three data sets analysed in this work are all for objects impacting Earth but they cover different size ranges. The NEOCC data are for known asteroids in space which span a size range of a few metres to several hundred metres. The fireball data from the JPL database are for objects between about 1 m in size and a maximum of ca. 20 m (the Chelyabinsk object). The CILBO data are for meteoroids large enough to be recorded by the video cameras at all velocities (ca. larger than 1 g in mass).

These velocity distributions all peak at relatively low velocities around 13 - 15 km/s. This is in good agreement with a widely used theoretically velocity distribution for smaller sporadic meteoroids in free space which was adopted as reference by the ECSS (European Cooperation for Space Standardisation) Space Environment Standard [4].

[1] SSA, ESA (2018) http://neo.ssa.esa.int/risk-page
[2] CNEOS, JPL, NASA (2018) https://cneos.jpl.nasa.gov/fireballs/, accessed: 01. November 2018
[3] Koschny, D., Drolshagen, E., Drolshagen, S., Kretschmer, J., Ott, T., Drolshagen, G., and Poppe, B. (2017). Flux densities of meteoroids derived from optical double-station observations. Planetary and Space Science, 143(Sept.), 230-237.
[4] ECSS (2008). European Cooperation for Space Standardization, Space Engineering, Space Environment, ECSS-E-ST-10-04C. Noordwijk, Netherlands: ESA Requirements and Standards Division.