Identification of meteorite source regions in the Solar System

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Over the past decade there has been a large increase in the number of automated camera networks that monitor the sky for fireballs. One of the goals of these networks is to provide the necessary information for linking meteorites to their pre-impact, heliocentric orbits and ultimately to their source regions in the Solar System. We re-compute heliocentric orbits for the 25 meteorite falls published to date from original data sources. Using these orbits, we constrain their most likely escape routes from the main asteroid belt and the cometary region by utilizing a state-of-the-art orbit model of the near-Earth-object population, which includes a size-dependence in delivery efficiency. While we find that our general results for escape routes are comparable to previous work, the role of trajectory measurement uncertainty in escape-route identification is explored for the first time. Moreover, our improved size-dependent delivery model substantially changes likely escape routes for several meteorite falls, most notably Tagish Lake which seems unlikely to have originated in the outer main belt as previously suggested. We find that reducing the uncertainty of fireball velocity measurements below about 0.1 km/s does not lead to reduced uncertainties in the identification of their escape routes from the asteroid belt and, further, their ultimate source regions. This analysis suggests that camera networks should be optimized for the largest possible number of meteorite recoveries with measured speed precisions of order 0.1 km/s.