Dynamical model for the toroidal sporadic meteors

P. Pokorný[1], D. Vokrouhlický[1,2], D. Nesvorný[2], M. Campbell-Brown[3], and P. Brown[3]

[1]Institute of Astronomy, Charles University, V Holešovičkách 2, CZ–18000 Prague 8, Czech Republic
[2]Department of Space Studies, Southwest Research Institute, 1050 Walnut St., Ste 300, Boulder, CO 80302, USA
[3]Department of Physics and Astronomy, University of Western Ontario, London, ON, N6A 3K7, Canada

The sporadic meteoroid complex (SMC) represents a major part of the meteoroid population in near-Earth space. Studies conducted over the past decades have identified six apparent SMC sources on the sky: (i) north/south apex source, (ii) helion/anti-helion source, and (iii) south/north toroidal source. Nesvorný et al. (2011a) presented a steady-state dynamical model for the north/south apex source with Oort-cloud comets being the main source of these dust particles. Similarly, Nesvorný et al. (2011b) modeled the helion/anti-helion source using a steady-state population of dust released from Jupiter-family comets. The parent population of the toroidal dust particles has not previously been identified. Here we overcome this problem and present a consistent dynamical steady-state model for the toroidal source of the SMC. In particular, we show that sub-mm to mm particles released from Halley-type comets (HTCs), are able to explain all observed properties of the background average of the toroidal component of the SMC, including their typically small eccentricities. Interestingly, the toroidal component of the SMC shows the largest yearly variations. We show that the major variations may be due to prolific activity of periodic sources such as comet 96P/Machholz. Our steady-state model includes the following parts: (i) dust particles with sizes in the 0.1–5 mm range released from a synthetic population of HTCs consistent with the Levison et al. (2006) model, (ii) dynamical evolution of these particles tracked by a numerical integrator taking into account gravitational and radiative forces, and at the same time allowing them to be dynamically swept out of the Solar System, thermally or collisionally destroyed, and (iii) evaluation of the collision probability with the Earth using our new code appropriate for impactors with high eccentricity and inclination orbits (Pokorný & Vokrouhlický 2013). Figure shows results from our model that are compared and calibrated to the observations of Canadian Meteor Orbit Radar (CMOR). We also perform additional consistency checks, such as the contribution of the HTC dust particles to the other SMC sources and their contribution to the IR flux of the zodiacal cloud observed by the IRAS spacecraft.

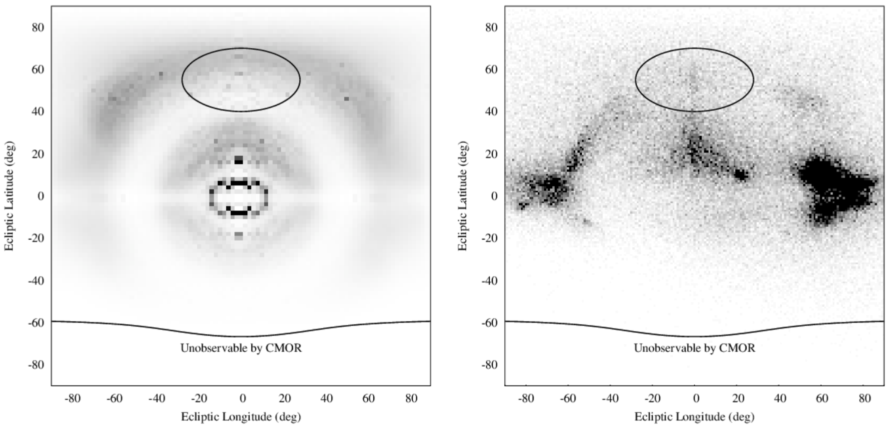

Figure: Distribution of radiant positions of our modeled population of micrometeoroids released from HTCs (left panel) and distribution of radiant positions of CMOR 2012 observations restricted to 50–90° solar longitude (right panel).

Acknowledgements: This research was supported by Czech Grant Agency and the Grant Agency of the Charles University (grants P209-13-01308S and GAUK 602213). The work of DN was supported by NASA's PGG Program. CMOR measurements were supported by funding from NASA's Meteoroid Environment Office through co-operative agreement NNX11AB76A. The work of MCB and PB were supported by the Natural Sciences and Engineering Research Council of Canada and the Canada Research Chairs program.

References: Levison, H. F., Duncan, M. J., Dones, L., & Gladman, B. J. 2006, Icarus, 184, 619; Nesvorný, D., Vokrouhlický, D., Pokorný, P., & Janches, D. 2011a, ApJ, 743, 37; Nesvorný, D., Janches, D., Vokrouhlický, D., et al. 2011b, ApJ, 743, 129; Pokorný, P., & Vokrouhlický, D. 2013, Icarus, 226, 682.