ON THE METEOROID FLUX STRIKING THE SOLAR MAX SATELLITE. H. A. Zook[1], B. G. Cour-Palais[1], and J. H. Allton[2]. [1]NASA Johnson Space Center, Houston, TX 77058, [2]Lockheed Engineering and Science Co., 2400 NASA Rd. 1, Houston, TX 77058.

In 1966 Naumann[1] synthesized the somewhat limited spacecraft meteoroid penetration data then available together with the radar and photographic meteor data into a single near-Earth meteoroid flux-mass curve valid for masses in the range 10^{-9} g to 10 g. Zook et al.[2] later fit an analytic function to this curve and showed that it agreed with the impact flux (from one impact) observed on 14 Gemini spacecraft windows. The fit of Zook et al. was also rather closely in agreement with an earlier two-part analytic fit of the meteoroid data by Cour-Palais et al.[3] Grun et al. (1985)[4] noted still later that, if the solar flare track ages of lunar rocks could be ignored and if impact craters on lunar rocks with impact pits smaller than about 10 μm in diameter could also be ignored, the impact crater data obtained from lunar rocks were entirely compatible with the shape of the Zook et al. curve. (The small craters on lunar rocks were mostly thought[5] to be due to pitting by secondary ejecta.) Grun et al.[4] extended the Zook et al.[2] curve with an added analytical function that included additional spacecraft impact data on the very small meteoroids (α and β meteoroids) to obtain an analytical fit valid for meteoroid masses from 10^{-16} g to 10 g.

The return of nearly 3 m^2 of space-exposed surfaces from the Solar Max satellite after 4.1 yrs in space has given us, however, valuable new impact data to work with; the corresponding area-time exposed to space exceeds, by more than one order of magnitude the combined total area-time exposure of all previously returned space experiments and parts that have been examined for meteoroid impacts[6]. This has made it possible to obtain unusually detailed meteoroid impact data and to compare the results with the already mentioned Grun et al. curve. Laurance and Brownlee[7] have already published a meteoroid flux-mass curve derived from impact craters observed on four Solar Max thermal control louvers (totalling 438 cm^2 in area) and found excellent agreement with the Grun et al. curve. The space debris flux was separately delineated. Barrett et al.[8] also analyzed Solar Max surfaces and published separate flux mass curves for meteoroids and for space debris; their results were derived from only the impact holes (and not impact craters) observed on 82 of the Solar Max louvers. Both groups determined, from compositional measurements, which impacts were caused by meteoroids and which were caused by space debris.

In the present work, we endeavor to increase the precision with which the meteoroid flux-mass curve is determined for meteoroid masses between about 10^{-8} and 10^{-5} g. We utilize both the hole and the crater data established by Warren et al.[6] on the Solar Max thermal blankets as well as on the 82 Solar Max louvers. We thereby increase the area-time of exposure considered (which improves the statistical precision) compared to that of Laurance and Brownlee[7] and to that of Barrett et al[8]. We also correct for the local spacecraft shielding as calculated by Warren et al. (2 % for the MEB thermal blanket and 29 % for the aluminum thermal control louvers), as well as for shielding by the earth (31 % at an altitude of 535 km). Finally we attempt to determine a more accurate relation between hole diameter and impacting particle diameter than that given by Carey et al[9] (the latter work was used by Barrett et al. to determine meteoroid and space debris diameters).

The impacting particle diameter to resulting hole diameter relationship for impacts onto a thin target is probably more poorly determined than is the impacting particle diameter to impact crater diameter relationship for impacts onto thick targets. This is partly because more extensive impact work has been done on impacts into targets that are effectively infinitely thick compared to the impacting projectile, and partly because impact work done on thin foils have an additional parameter to consider: namely, the thickness of the foil. Efforts to calibrate hole-particle relationships for Solar Max materials[10,11] have not yet proven definitive,, partly due to scatter in the data. For very thin foils, of course, there is no problem because the hole diameter in the thin foil approximates the projectile diameter.

We attempt to circumvent this problem in the following way: because absolute fluxes can be separately established on the Solar Max MEB thermal blanket and on the thermal control louvers, we can associate, at a given flux, impact craters on the aluminum louvers with impact craters or, depending on size, with impact holes in the relatively thin exterior layer of the thermal blanket. Because part of the data correlates craters in aluminum to craters in Kapton plastic, and another part correlates craters in aluminum to holes in Kapton foil, we are able to establish a hole diameter to impacting particle diameter ratio in Kapton foil for particle diameters determined from impact craters into aluminum. We thereby determine how much less the hole diameter is relative to what a crater diameter would be into a semi-infinite medium. By continuing this process, in a bootstrap fashion, up to the largest holes, we are able to create a new hole penetration relationship that is good for impacting meteoroids and space debris. Preliminary results indicate that the Grun et al. curve[4] may need to be adjusted so that a given flux corresponds to a somewhat larger meteoroid mass, possibly a factor of two larger. More fine-tuning of the bootstrap process is required, however, to establish proper confidence in our new results.

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