TESTING CRATER COUNTING ASSUMPTIONS WITH THE CRATERED TERRAIN EVOLUTION MODEL.

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Introduction: Here we explore two problems relating to the interpretion of ages of terrains using crater counting. We use a powerful Monte Carlo code for studying the evolution of cratered terrains called the Cratered Terrain Evolution Model (*CTEM*) [1,2]. CTEM models the crater production and erasure process on a surface and counts craters using the topographic expression of the craters calibrated with a human crater counter [2]. Using this numerical tool, we investigate two issues related to interpreting the ages of a terrain: 1) How close to Poisson-distributed are crater count uncertainties? and 2) How does observed clustering in crater count densities of large craters relate to the changes in the impactor flux?

Quantifying Crater Count Uncertainty: A standard method for estimating uncertainties in crater counts is to assume that the process of crater accumulation is governed by Poisson statistics, and therefore the standard deviation, σ, of the number of craters, N, within some diameter range, $\{b_1,b_2\}$, is equal to $\pm\sqrt{N}$ [3]. However, while the number of impacts that occur onto a planetary surface over time is well characterized by Poisson's distribution, the number of observable craters on the surface may not be. This is because the surface area of a body is finite, and the formation of each new impact crater may destroy pre-existing craters. This process leads to the well-known phenomenon of cratering equilibrium (also known as crater saturation or saturation equilibrium), whereby a surface becomes so heavily cratered that each additional crater erases one old crater, on average [4].

However, even prior to a surface reaching cratering equilibrium, uncertainties in crater counts may be affected by erasure, and because large craters may erase many small craters, the deviations of σ from $\pm\sqrt{N}$ are correlated with crater diameter, and depend on details of the impactor size-frequency distribution.

Here we use a Monte Carlo code called the Cratered Terrain Evolution Model (CTEM) to quantify the estimates of crater uncertainties as a function of crater density and the slope of the production function size distribution. Figure 1 shows the ratio of the calculated standard devation, σ, of a set of 1000 CTEM simulations of the lunar highlands to the estimated standard deviation based on the assumption that counts drawn from a Poisson distribution. The simulated uncertainties are many times higher than the Poisson estimate for small craters.

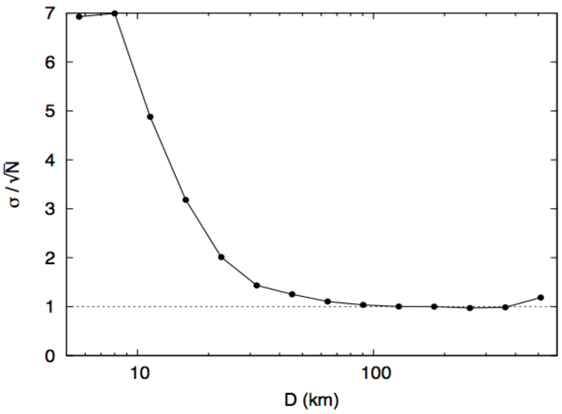

Figure 1. Comparing the estimated and calculated measures of the standard deviation of the number of craters per bin. The number of craters per diameter bin was calculated in 1000 CTEM simulations of the lunar highlands. These simulations are the for the "best fit" case that matches the lunar highlands crater density [2]. The standard deviation in the crater counts per bin, σ, is calculated for the entire set of simulations. The estimate of the standard deviation assuming Poisson statistics is $\sqrt{N}$, where N here is the the median value per bin in each of the ensemble of simulations.

Interpreting crater count ages of large craters: It is common to attempt to obtain ages of large craters (such as basins) by counting superposed small craters [5-7]. However, if the impactors that produce large craters are drawn from the same small body population as the impactors that produce small craters, then no change in the rate of impact may be inferred from any observed clustering the crater densities superposed on large craters. Here we use CTEM to quantify what observed clustering of large crater ages means in terms of changes in the impactor size-frequency distribution.

References:

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