PRELIMINARY REFINEMENT OF THE LUNAR PRODUCTION FUNCTION FOR MARE AREAS. A. Oetting, H. Hiesinger, N. Schmedemann, C. H. van der Bogert, Westfälische Wilhelms-Universität Münster, Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (aoetting@uni-muenster.de)

Introduction: A lunar production function (PF) reflects the size-frequency distribution of craters that formed on the Moon and is an important component of the lunar cratering chronology [1, 2, 3, 4]. One frequently used PF was empirically-derived by measuring the crater size-frequency distribution (CSFD) on lunar reference surfaces using Apollo era data for crater diameters of 10 m – 300 km [4]. For crater diameters of 100 m - 200 km, this PF was revised in 2001 [5]. However, the PF of [5] is also suggested to be valid for the diameter range of 10 m – 300 km [6]. Higher resolution images from more recent missions [e.g., 7, 8] can be used to increase the accuracy of CSFD measurements.

Neukum [4, 5] incorporated different mare areas in his PFs, however, the large count areas used in, e.g., Mare Serenitatis and Mare Crisium, likely span several geological units with different formation times [9]. To avoid this type of uncertainty in a new PF, we reduce the count area sizes to omit areas with different compositions and possibly different ages.

Method: We used SELENE Terrain Camera (Kaguya) data with a pixel scale of ~10 m [8] to measure individual CSFDs in a crater diameter range between 100 m to 800 m in selected counting areas that aim to be representative for each mare unit. Thus, the areas were selected to be visually free of resurfacing events, such as secondary crater clusters and rays, and the Clementine ultraviolet-visible color ratio composite map of [10] was used to identify areas with homogeneous compositions. We counted two areas each at Grimaldi and Mare Humorum, and three areas each at Mare Moscoviense and Mare Tranquillitatis (Figure 1). The CSFDs were measured in ArcGIS with the CraterTools add-in of [11] and displayed in CraterStats [12] with pseudo-log binning.

After conducting the CSFD measurements, we normalized the ten individual crater counts. We sorted the measurements by the size of their largest populated crater bin in pseudo-log binning [4] and vertically normalized each of the measurements. The measurement with the largest crater bin size was set as the reference. The adjacent measurement with the second-largest crater bin size was then vertically shifted to remove the offsets in cumulative crater frequencies that are due to different crater retention ages in the overlapping diameter range. A vertical shift of a measurement containing several diameter bins is done by multiplying the cumulative crater frequency of each bin with the same factor. The frequency differences between individual bins within the measurement are not changed by this procedure. After the position with the minimum offset was found, the next measurement with the third largest crater bin was normalized to the previous one until all measurements were normalized. We then calculated the median cumulative crater frequency for each diameter bin. This procedure reduces random noise in each crater bin especially in less populated larger diameter bins.

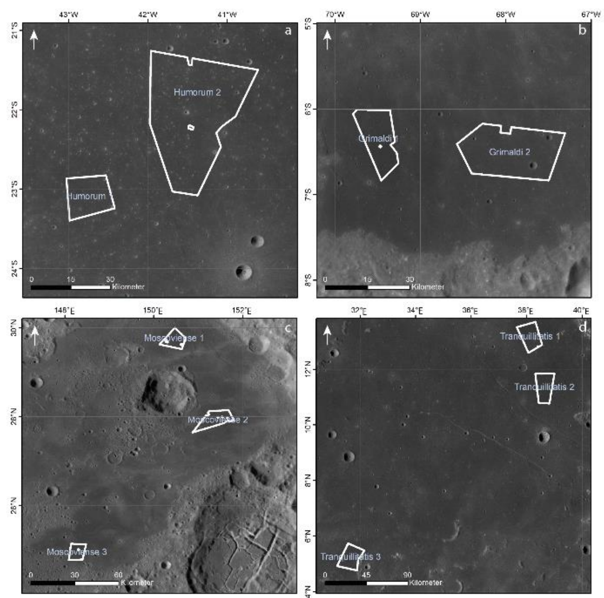

Figure 1: Count areas in (a) Mare Humorum, (b) Grimaldi, (c) Mare Moscoviense, and (d) Mare Tranquillitatis, for which CSFDs were determined.

Results:
Figure 2 shows the normalized CSFD for craters 110 m to 700 m in diameter in a cumulative plot. The plot follows mainly the PFs of [4, 5], however, in the diameter range between 200 m and 500 m there is bulge towards larger crater diameters.

Contrary to our CSFD measurements at Giordano Bruno, Moore F, and North Ray craters [13], where we combined several individual count areas on the ejecta blankets, here we considere all count areas on mare surfaces separately, since varying mare compositions might reflect different formation ages of different lava flows.

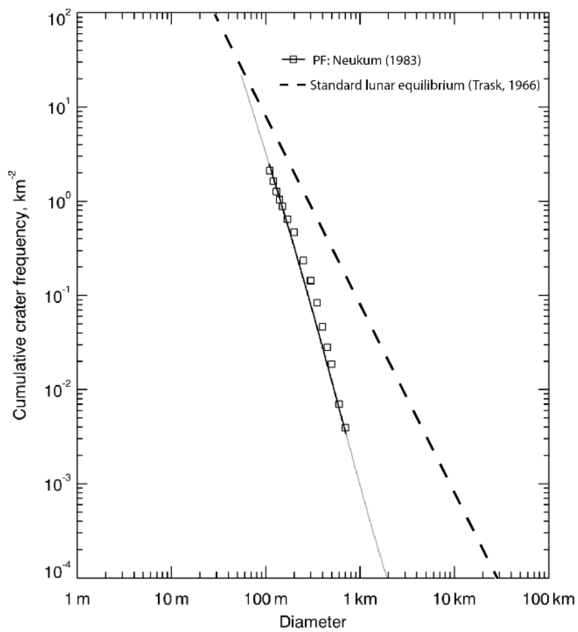

Figure 2: Normalized CSFDs (black squares) of Mare Humorum, Grimaldi, Mare Moscoviense, and Mare Tranquillitatis. The black line represents the PF of [4], the PF of [5] would, however, lie directly on top of it. The black dotted line represents the equilibrium function of Trask (1966) [14].

Discussion: Our preliminary results indicate that both PFs of Neukum [4, 5] generally fit well with our normalized CSFD, consisting of ten individual crater counts including nearly 7000 craters. The crater diameter bins between 200 m and 500 m are, however, higher populated than we would expect from the PFs of [4, 5]. A possible reason for this bulge toward larger crater diameters could be that this expresses the transition from strength to gravity regime. This transition is discussed to occur at ~300 m [15], ~400 m [16] or below 1 km [17]. As well, we have encountered problems due to a high crater density at the areas, which leads to difficulties in distinguishing craters from each other. This high crater density and the CSFD slope, which is shallowing and nearly parallel to the equilibrium function of [14], may indicate that the equilibrium is reached below 200 m. As well, the partially high degradation of craters leads to an imprecise determination of the crater diameter and the initial crater size could not be identified. A combination of a high degradation stage of craters and high crater densities might have resulted in missed craters, especially at smaller diameters.

A CSFD measurement with NAC images [7], which will be carried out in a next step, could resolve, if the smaller craters (110 m – 150 m) exhibit a shallower slope than larger craters.

Since the crater diameter range studied is strength-dominated [e.g., 15, 16], CSFD measurements are performed exclusively on mare units to avoid uncertainties caused, for example, by varying strength and density of the target.

Conclusion: Generally, our normalized CSFD measurements fit well with both PFs of Neukum [4, 5]. Differences are (1) higher populated crater bins in the medium crater bin size (200 m – 500 m) or (2) a flatting in the smaller crater diameter bins, possibly by reaching the crater equilibrium. Problematic in this CSFD measurements were the high degradation stage of some craters and a high frequency, which might have hindered the identification of craters. Nevertheless, it might be possible that the progression of the cumulative CSFD plot reflect the true distribution.

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