



Roughness map for the equatorial region of Mercury and its implication to surface evolution

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Analyses of topographic roughness at various baselines are useful for studying surface evolution on airless bodies. Using data from the Mercury Laser Altimeter (MLA) onboard Space ENvironment, Geochemistry, and Ranging (MESSENGER) mission, roughness distribution on Mercury has been investigated at baselines down to sub-km scale [e.g., 1]. However, due to the eccentric orbit of MESSENGER and the limited ranging distance of MLA, laser ranging observations are limited to the north polar region. In addition, previous image-based digital elevation cannot be used to quantify roughness at km scale due to limited spatial resolution [2]. Therefore, roughness at km-scale baselines has not been mapped below 45°N latitude on Mercury.

To complement the lack of roughness data in the equatorial region, this study analyzes the latest global DEM (version 20240927) produced as described in Preusker et al. [3]. The effective resolution of this DEM has been estimated to be 5 km [e.g., 3]. Focusing on topographic curvatures at baselines of 5–10 km and their interquartile ranges at each latitude and longitude, we mapped roughness distribution at latitudes of 66°N–66°S to examine correlations between roughness and geologic features.

Our new roughness map shows several anomalous features correlated with Mercury's geology. The most obvious feature is a clear distinction between smooth plains and rough intercrater plains. Our roughness map shows roughness differences similar to those reported by previous works for the northern hemisphere [1]. In addition, our analysis shows a certain variation in roughness among the smooth plains. For example, the Caloris smooth plains show higher roughness than other smooth plains due to superposing grabens in the Caloris basin. Another characteristic is high-roughness anomalies around young basins. The areas of continuous ejecta have higher roughness than the surroundings due to their freshness. The roughness values do not simply decrease with increasing distance from the basin centers but show local minima adjacent to their rims, originating from coverage of impact melt and/or deficit of secondary craters.

Furthermore, a comparison with the latest catalog of tectonic landforms [4] shows an absence of contractional landforms at high roughness anomalies. The lobate scarps and ridges tend to be distributed outside rough regions like the young basin ejecta. This correlation may suggest superposition of younger basin ejecta on older tectonic features, difficulty of tectonic landform

detection on rough terrains, and/or less efficient formation of contractional landforms due to possibly high crustal porosity. These possibilities imply that the extent of Mercury's radial contraction may have been underestimated due to the obscuration of old contractional landforms. In the presentation, we will discuss possible extent of corrections to global contraction estimates to account for the roughness effect.

References:

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