A Global Lunar Crater Database, Complete for Craters ≥1 km, III:
Reassessing the Lunar Crater Production Function, and Lessons Learned Applied to the Global Mars Crater Database

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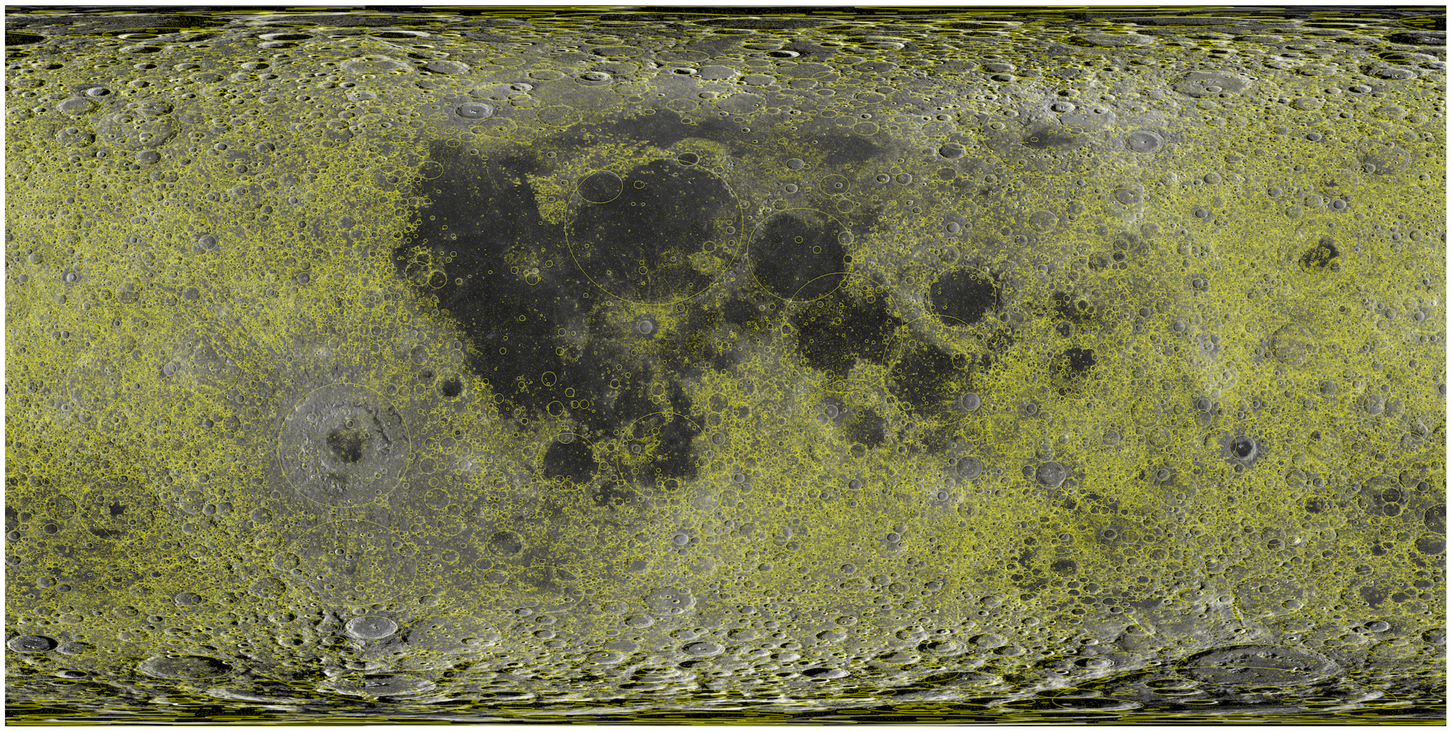
Global Lunar Crater Database (in review with JGR)



Methods

This is a **fully manual** effort because automated detection is not yet good enough for this global work over multiple terrain types.

Craters are **manually** identified and the rims traced in *ArcMap*. Digitized rims are exported in units of decimal degrees and imported to *Igor Pro* where algorithms correct for all projection effects using Great Circles [1] for each rim point.

Both a circle and ellipse are fit. From the circles, location and diameter are saved. From the ellipse, major and minor axes, tilt, ellipticity, and eccentricity are saved.

Stats

All Craters:	2,000,319
# Craters ≥20 km:	6,966
# Craters ≥5 km:	82,987
# Craters ≥1 km‡:	1,296,025
# Craters <1 km*:	704,294

*D<1 km incomplete ~||~ ‡D=1–2 km possibly incomplete

Data Used

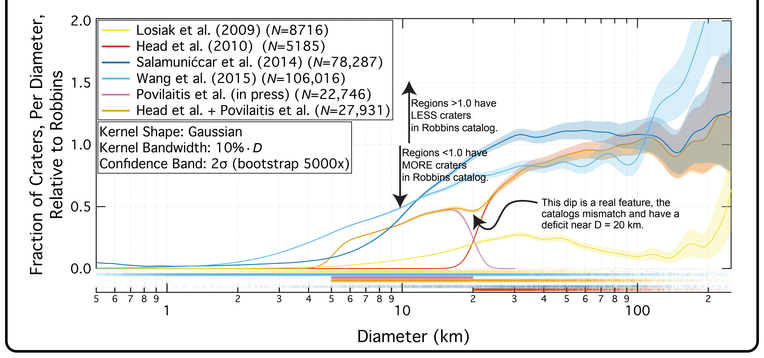
- WAC Morphometric Mosaic
- WAC Dawn/Dusk Mosaics
- WAC Custom Mosaics
- LOLA DTM
- LOLA+Kaguya DTM
- Kaguya TC Mosaics

Comparison with Other Databases: Crater Number versus Diameter

To compare databases, a crater size-frequency distribution (SFD) can be used [2]. This was done with five other recent global databases:

- [3] Named craters and the historic "LPI Catalog"
- [4] Manual $D \geq 20$ km global database
- [5] Automated global database
- [6] Automated global database
- [7] Manual $5 \leq D \leq 20$ km global database

Each SFD is divided by the SFD for this new database to construct the ratio plots below (2σ uncertainty envelopes).



Application: Reassessing Lunar Production Function

Measuring the SFD and comparing to a model of the formation SFD (production function, "PF") is a main tool used in numerous studies, including age modeling, resurfacing, and understanding sub-population components of the emplaced craters.

Two main lunar PFs exist, work headed by W.K. Hartmann [*e.g.*, 10] and G. Neukum [*e.g.*, 11], but they have significant dissimilarities in both model shape (piece-wise power-law versus polynomial) and relative crater spatial densities between one diameter and another. The most significant differences are $D \approx$ 1–10 km, a critical range used for crater analysis.

The original work was completed on early space program data and updates have tended to be tweaks on the model rather than a wholesale new investigation. My effort is that wholesale new investigation of the lunar PF based on modern data and techniques.

Methods

Specific Goal: 0.5–50 km PF

Crater Data: Global database, plus $D \geq 0.5$ km craters identified on 30 m/px Kaguya TC mosaics.

Terrain: Maria for smaller, $0.5 \leq D \leq 5$ km craters. Large crater rims for larger, $1 \leq D \leq 50$ km craters.

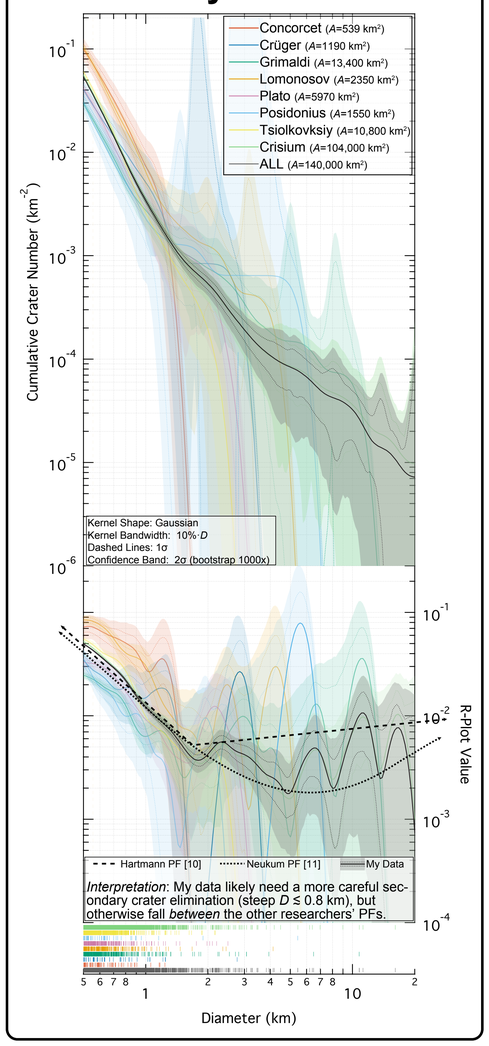
Conservative Mapping: "Clean" surfaces, eliminating secondary craters, graben, rilles, montes, etc. in the maria. Similar approach for large crater rims.

Progress Table

0.5–1 km Craters	Mapping Mare	Mapping Rim	Feature*
—	—	▨	Imbrium
IP	IP	▨	Serenitatis
☑	IP	—	Humorum
☑	☑	▨	Crisium
—	—	▨	Nectarus
☑	IP	▨	Orientale
☑	☑	—	Tsiolkovksiy
☑	IP	—	Moscoviense
☑	☑	—	Plato
☑	☑	—	Lomonosov
☑	☑	—	Crüger
☑	☑	—	Concorcet
☑	☑	—	Grimaldi
☑	☑	—	Posidonius

*Mare in Schichard, Jules Verne, Joliot, and Apollo not yet complete.

Early Results



Lessons Applied to Mars Database [8]

The lunar database benefited from lessons from the martian database, turn-about is fair play. Some issues have arisen about the Mars crater database over the years that I have rectified or am working to rectify:

- ☑ Position/size/ellipse bugs in the code → fixed.
- ☑ Depths of too small craters → fixed by removing.
- ⧅ Inconsistent/incomplete image base → see next panel.
- ☐ Some false positives, false negatives, and duplicates → slowly working on it.
- ☐ Morphology repeatability issues → slowly working on it.

Global CTX Mosaic Effort

The Context Camera (CTX) [9] on *Mars Reconnaissance Orbiter* has imaged >97.4% of Mars at ≥5 m/px at a consistent time of day. Perfect for mosaicking.

I have constructed **uncontrolled** global mosaics, rendered at 20 m/px (1 TB size). These are being used in the new Mars crater database effort to identify and classify features. These mosaics may be publicly released.

I am also leading a pilot effort to fully control CTX and create a public, 11TB mosaic set for Mars.

References & Acknowledgments

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Want to be notified when the lunar crater database is available? Send e-mail to stuart@boulder.swri.edu