Preliminary 250-m resolution surface gravitational maps of the Moon from GRAIL gravity, LOLA topography and 3D crustal density [P13D-2252]

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What is LGM2026?

LGM2026 are Lunar Gravitational Maps 2026

- LGM2026 shows the lunar gravitational field at the lunar surface and on its circumscribing sphere
- Depicted is the gravitational potential, vector and tensor at the spatial resolution of 128 pixels per degree (~ 250 m at the equator)
- The gravitational field is expanded into spherical harmonics up to degree $11{,}519$ (Fig. 1)

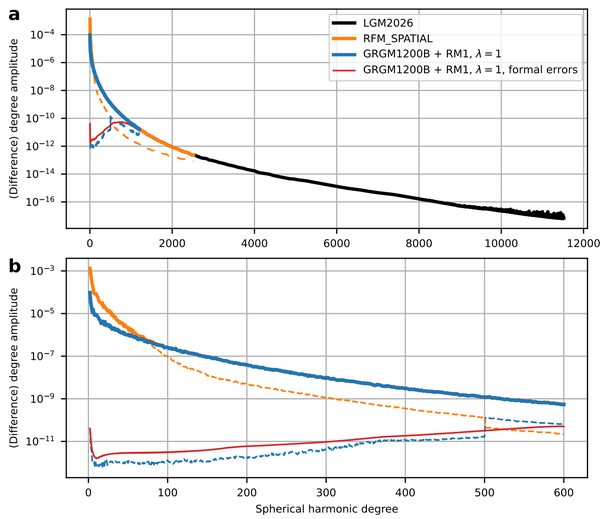

Figure 1. (a) Comparison of LGM2026 with respect to GRGM1200B + RM1, $\lambda = 1$ and RFM_SPATIAL [1]. Harmonic degrees 0 and 1 are omitted for better visualisation. (b) Zoom-in to harmonic degrees 2 – 600.

LGM2026 constituents

- **Long wavelengths** (up to degree 500, ∼11 km): Kaula-constrained GRGM1200B [2]
- **Short-scale signals** (beyond degree 500): gravity-forward modelling of topography [3] and 3D crustal density [2] following the residual terrain modelling:
  - Masses up to 10° from evaluation points were gravity-forward modelled by tesseroids with radially variable density
  - Beyond the integration radius of 10°, spherical harmonic technique of [4] was used to gain efficiency

LGM2026 at Artemis III Candidate Landing Sites

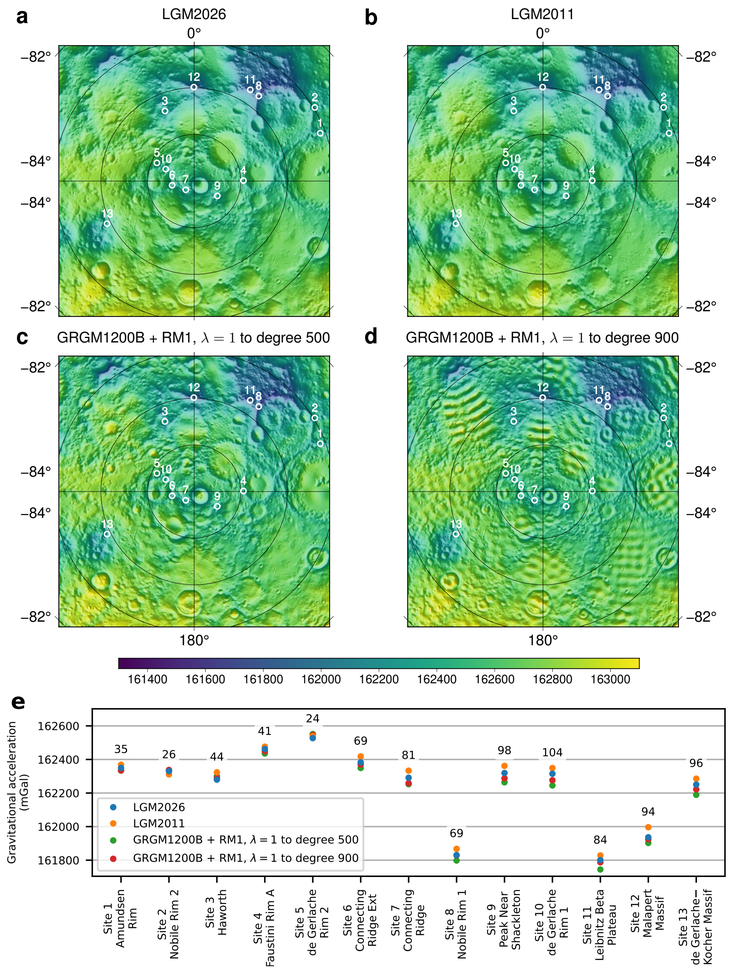

Figure 2. Magnitude of the gravitational vector over the south polar region (a to d). The panel (e) shows predictions of the gravitational acceleration at the 13 candidate Artemis sites that have been identified for possible human landing. The values above the dots show the range of the discrepancies between the predictions. All values in mGal.

Video Visualisation

Scan the QR code for a video visualisation of LGM2026 and a comparison to LGM2011

Accuracy

- Gravitational potential: $13\ \mathrm{m^2\ s^{-2}}$ (2 to 3 orders of magnitude better for the disturbing potential)
- Gravitational vector: 2 mGal
- Gravitational tensor: 220 E for the diagonal elements, a few tens of E for the off-diagonal elements

Applications

- Gravitational potential: physically meaningful height system, study of gravity-driven mass movements and basalt flow direction
- Gravitational vector: gravity predictions at prospective landing sites, verification/calibration of accelerometer readings, inertial navigation
- Gravitational tensor: autonomous navigation of spacecraft based on gravity gradient measurements, upward/downward continuation of the gravitational potential and vector in mass-free space
- Spherical harmonic expansion: spectral-domain analyses at fine spatial scales, study of convergence/divergence of spherical harmonic at the lunar surface

Final Notes

- LGM2026 will be released by mid-2026 under the CC BY 4.0 license
- Developed methodology for high-resolution gravity field modelling with 3D variable densities at planetary bodies (applicable also to the Earth)

References

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