Mars Gravity Field Determination Based on Satellite-to-Satellite Tracking Model

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The Martian gravity field serves as the primary constraint for modeling the interior structure and changes in the surface mass. Currently, the determination of the Martian gravity field relies on ground-based tracking measurements, such as range and Doppler, conducted between Earth stations and Mars orbiters. However, these tracking methods encounter limitations in terms of observation accuracy and signal attenuation. Given the successful application of the satellite-to-satellite tracking technique in determining Earth's gravity field and its time-variable component, as well as improving the resolution of the lunar gravity field, this paper explores its potential application to the determination of the Martian gravity field. The study involves numerical simulations aimed at assessing the improvement in the Mars satellite-to-satellite tracking model for gravity solutions under various conditions, including different observation durations, measurement noises, and orbit altitudes. The findings show that the inter-satellite ranging system considerably enhances the accuracy of the gravity field solution compared to the ground-based tracking method. Extending observation duration proves more beneficial for lower-degree terms of the gravity field. The lower the orbit altitude, the more significant the improvement of the gravity field solution by extending the observation duration. The reduction of Ka-band inter-satellite range-rate noise leads to significant improvement in gravity solution.

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