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The improved topographic model from Chang'e-1 mission

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Abstract

Using the precise orbit data based on new developed lunar gravity field model, and considering the drifts of time tag existing in the laser altimeter measurements of Chang'e-1 lunar mission, a new topographic model CLTM-s03 has been developed. In this model, a constant bias about 145m of the altimeter is removed.

1. Introduction

Topography is one of the principle measurements required to quantitatively describe a planetary body [1,2]. In order to obtain the global topography of the Moon, Chang'E-1 lunar orbiter carried two kinds of payloads: the Laser Altimetry Module (LAM) and 3D optical camera. By combining two months effective laser altimeter measurements from Nov. 27, 2007 through Jan. 22, 2008 with early precise orbits and attitudes data, Ping et al. (2008) obtained the lunar global elevations and produced a global topographic model CLTM-s01 of the Moon[1]. Based on the CLTM-s01, Huang et al. (2009) discovered some new features on the surface of the Moon. Also, a number of interesting researches have been carried out by the scientists based on the CLTM-s01 model and other information. Accordingly, the error of early estimated orbit is the main error source of the topography model. And there is a drift of time tag of LAM measurement existing. In this paper, we produce a new topographic model after calibrating the orbit and time drift.

2. Methodology

2.1 The calibration of time drift

During the laser altimeter data processing, an obvious time drift in all pass is found with a value about 10ms/1hour (Figure 1). It came from the two stage of time synchronization between the LAM and ground. This kind of "time" drift error is relatively easy to estimate. Then we calculate the time label again for each measurement using the calibration information of the "time" drift.

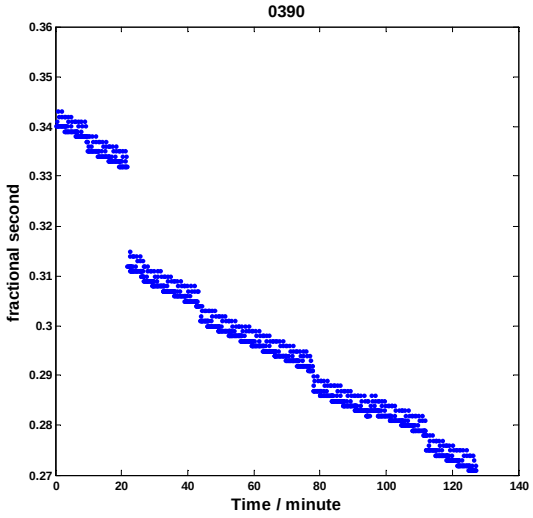

Figure 1: The drift existing on the time label of laser altimeter data from Chang'E-1.

2.2 The improved orbit

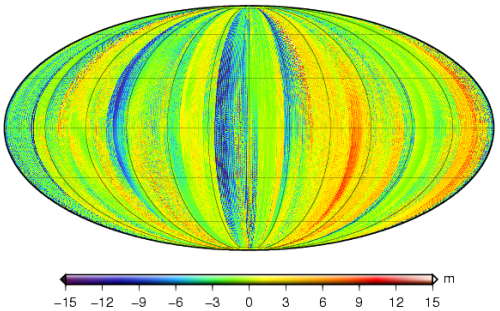

Figure 2: The difference between new and old orbits in radical direction in the RTN coordinate system.

Using the two-way range and range rate data from Chang'E-1, Yan et al. (2010) has estimated a new gravity field and done the precise orbit determination

using the software GEODYNII/SOLVE provided by GSFC/NASA. Then we compared the new orbits with the old ones used in paper [1] in an RTN coordinate system. Figure 2 shows the difference between two groups of orbits in radical direction. There is no obvious systematic bias between the new and old orbits. But an improvement about 10m exists in some belt or strip regions, which will be helpful to improve the topography of these areas.

3. New topographic model

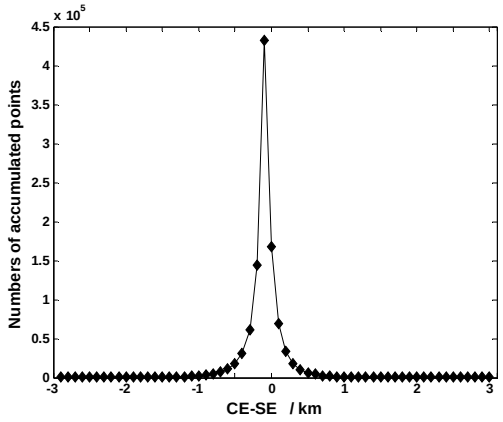

Figure 3: The statistical figure of differences from two topographic models.

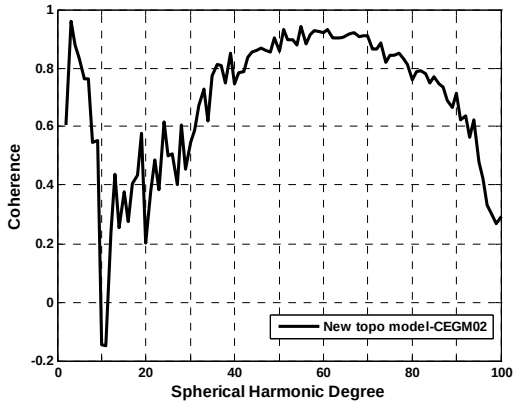

Figure 4: The correlation between the new topographic model and the new gravity field from Chang'E-1.

After calibrating the time drift and orbit error, we obtain a new 360th degree and order spherical harmonic expansion of the lunar radii referenced to a mean radius of 1738km. This topographic model is consistent with the model STM359_grid-02, which is obtained by the SELENE LALT payload team. By statistics, we found that there is a systematic biases about 145m between our model and the topographic model from SELENE, see Figure 3. This bias is due to a non-complete ground calibration of LAM. After removing the bias, we obtained a new topography model CLTM-s03 and its correlation with CEGM-02, see Figure 4.

4. Discussion

This paper gives the detail of calibration during producing topographic model using Chang'E-1 data. It is necessary to check the POD cautiously. Using this new developed lunar topographic model and other high-resolution lunar remote sensing data, as well as the new gravity model, more selenodetic researches can be done, such as mascon, crustal thickness, elastic thickness, and crustal and mantle density, which can further improve the knowledges about the origin of the Moon and its evolution.

Acknowledgements

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