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ORIGINAL ARTICLE

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Effect of the SRTM global DEM on the determination of a high-resolution geoid model: a case study in Iran

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Abstract Any errors in digital elevation models (DEMs) will introduce errors directly in gravity anomalies and geoid models when used in interpolating Bouguer gravity anomalies. Errors are also propagated into the geoid model by the topographic and downward continuation (DWC) corrections in the application of Stokes's formula. The effects of these errors are assessed by the evaluation of the absolute accuracy of nine independent DEMs for the Iran region. It is shown that the improvement in using the high-resolution Shuttle Radar Topography Mission (SRTM) data versus previously available DEMs in gridding of gravity anomalies, terrain corrections and DWC effects for the geoid model are significant. Based on the Iranian GPS/levelling network data, we estimate the absolute vertical accuracy of the SRTM in Iran to be 6.5 m, which is much better than the estimated global accuracy of the SRTM (say 16 m). Hence, this DEM has a comparable accuracy to a current photogrammetric high-resolution DEM of Iran under development. We also found very large differences between the GLOBE and SRTM models on the range of −750 to 550 m. This difference causes an error in the range of −160 to 140 mGal in interpolating surface gravity anomalies and −60 to 60 mGal in simple Bouguer anomaly correction terms. In the view of geoid heights, we found large differences between the use of GLOBE and SRTM DEMs, in the range of −1.1 to 1 m for the study area. The terrain correction of the geoid model at selected GPS/levelling points only differs by 3 cm for these two DEMs.

Keywords Digital elevation model (DEM) · Geoid · Iran · Shuttle Radar Topography Mission (SRTM)

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1 Introduction

A digital elevation model (DEM) is a computer representation of the Earth's surface; it provides a base dataset from which topographic parameters can be digitally generated. DEMs are used, e.g., to determine the terrain correction and downward continuation (DWC) corrections in geoid modelling, geo-morphological simulation and classification and hydrological run-off modelling.

However, a DEM is only a *model* of the elevation surface, and like other models, it is subject to errors (e.g., Hilton et al. 2003). Like any other source of data in geoid determination (e.g., global geopotential models and gravity data), it is important to evaluate the accuracy of the DEM in the area of interest before using it. The accuracy of DEMs usually is not uniform because they use various data sources in their construction. To make such an assessment, users must first be aware of the impact of errors of the DEM (e.g., Merry 2003).

The error can be directly estimated by comparing the heights extracted from a DEM and their values interpolated from GPS/levelling data (where GPS is used for the horizontal control). However, because of the presence of datum problems among different types of heights, in particular in the determination of heights by levelling, this effect must be eliminated before any detailed discussion.

There have been a few studies on DEM-error effects in geoid modelling. Merry (2003) compared the effect of some regional and global DEMs according to Molodensky's theory for computing the G1 term and the influence of the grid size of DEMs on quasi-geoid in a small part of South Africa. Based on his work, an error in height of 120 m introduces a RMS error in the height anomaly (ζ) and G1 term in the order of 7 and 2 cm, respectively. After the release of the high-resolution Shuttle Radar Topography Mission (SRTM) DEM, it is of interest to investigate the quality and effect of this new data source versus regional and global DEMs in geoid modelling.

The test area that we have chosen for this purpose is in Iran, bounded by $25^\circ N < \varphi < 40^\circ N$ and $44^\circ E < \lambda < 64^\circ E$