Terrain correction correction Tasmania – results and implications

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SUMMARY

The terrain correction is a critical component of the complete Bouguer anomaly in Tasmania. New terrain correction values for the entire Tasmanian onshore gravity database have been recalculated using automatic methods. An improved Statewide digital elevation model was produced for this purpose.

The magnitude of the terrain correction adjustment ranges as high as 23 mGal, with the average approximately 2 mGal. The size of this change is such that significant alterations to extant gravity models are indicated.

Key words: gravity, terrain correction, complete Bouguer anomaly, digital terrain models, Tasmania

INTRODUCTION

As Tasmania has the greatest topographic variation of any Australian continental jurisdiction, the terrain correction (TC) is a major component of complete Bouguer anomaly calculation for the State gravity database (currently 84032 stations). TC values > 1 mGal are not uncommon, and may exceed 30 mGal, readily swamping anomalies of exploration and regional geological interest. Accurate determination of the terrain effect is therefore critical.

Most corrections in the Tasmanian database were calculated manually, to 22 km radius. Availability of high resolution elevation models, coupled with high computing capacity, allows revision of these. An earlier pilot project on portions of western Tasmania (Duffett, 2016) indicated that the older TC values may be substantial underestimates. In some areas, automatic corrections (to the standard 167 km radius) exceed the former by > 5 mGal. The pilot also demonstrated that 25-metre DEMs, the best resolution available for the entire State at that time, deliver acceptably low loss of TC accuracy in comparison to 1-metre DTMs from LiDAR.

This paper presents the application of these earlier findings to recalculation of terrain correction values for the entire State gravity database. Production of an improved digital elevation model for Tasmania and the surrounding offshore region, the mainstay of the TC calculation, is also described. The new terrain correction results are presented and discussed.

METHOD AND RESULTS

New elevation model

The earlier work (Duffett, 2016) utilised the Statewide digital elevation model produced by the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) in 2007. This was determined primarily by 10 metre contours, originally obtained photogrammetrically. Though generally adequate for TC calculation (Duffett, 2016), remaining shortcomings from the gravity terrain correction perspective are lack of information in lake areas, and a tendency for ridges to present as plateaus. Lakes including hydroelectric impoundments occupy a significant fraction of Tasmania, some in regions of high mineral prospectivity and gravity station density.

An improved, extended 'bare earth' version of the State DEM was therefore produced (Figure 1). The original 10-metre contours were supplemented with a large fraction of mapped spot heights and a high quality subselection of ground-set State survey control points, together with bathymetry from Tasmania's extensive larger lakes and hydroelectric impoundments. Extension to offshore was via the SeaMap near-shore marine research data (Lucieer, 2007) alongside national bathymetric data (Whiteway, 2009). The latter were found wanting in near-shore areas when compared with the SeaMap data, so where this was absent, sounding data were derived from the hydrographic mapping available at http://fishing-app.gpsnauticalcharts.com. The DTM was also improved in coastal areas by inclusion of low-water-mark mapping in conjunction with tidal range information. Much of this data is freely downloadable via the Land Information System Tasmania (http://maps.thelist.tas.gov.au/listmap/app/list/map), the exception being most lake bathymetry, obtained directly from Hydro Tasmania. Lake St Clair data were digitised after Derbyshire (1971).

The new DEM was created with 20 metre cells (i.e. slightly higher resolution than the older DEM) using the minimum curvature technique as implemented in Mapinfo. The computation, incorporating all source data in a single process, takes just under half an hour on a desktop PC.

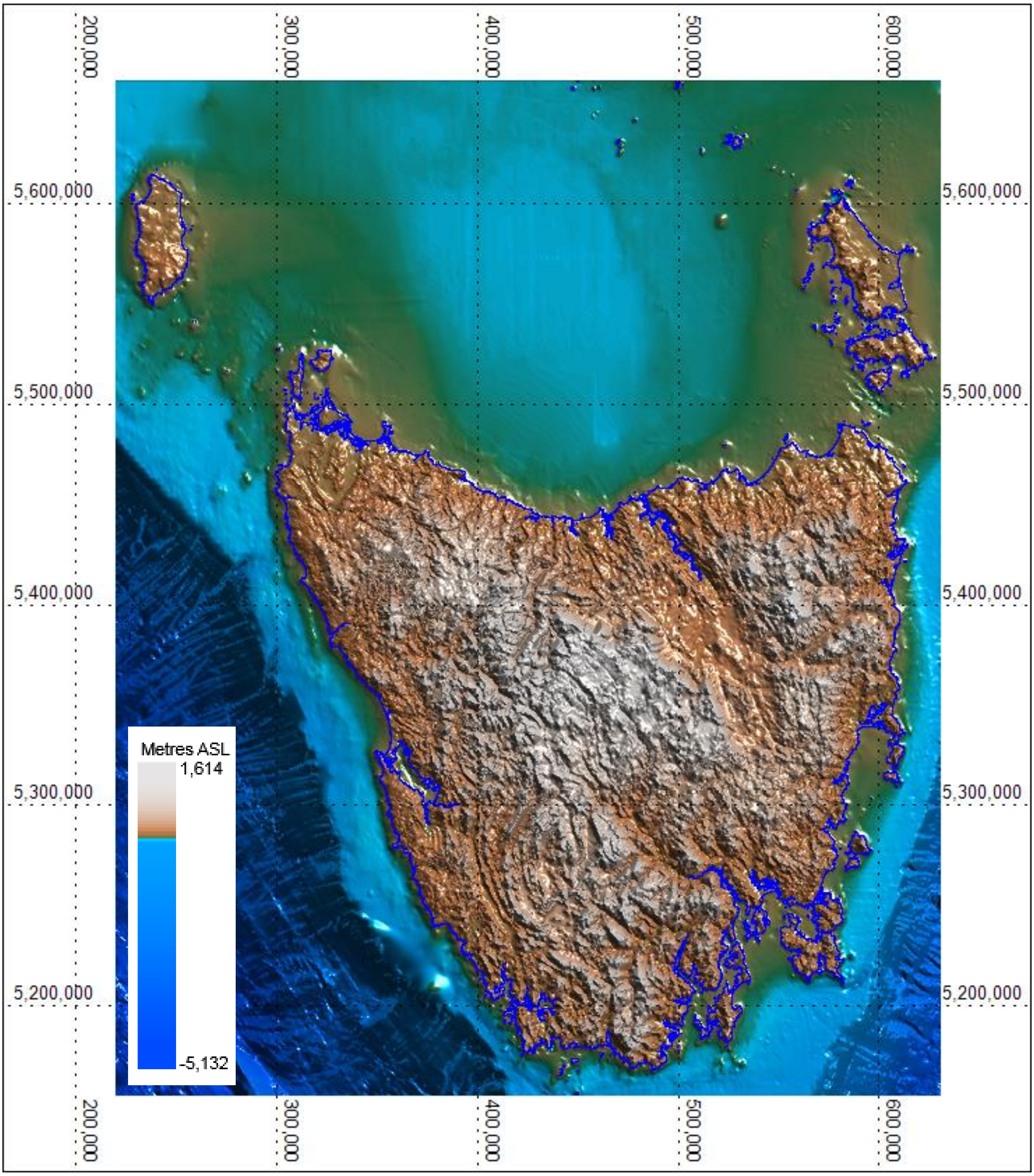

Figure 1: 20 metre-cell bare earth digital elevation model of Tasmania and the surrounding region. This and all subsequent map figures are rendered in the Map Grid of Australia, zone 55.

Terrain correction calculation

As discussed by Duffett (2016), the method adopted in calculating terrain corrections for all Tasmanian onshore gravity stations is that of Cogbill (1990). Three DEMs of varying resolution were used: The 20 metre DEM described above for distances between 2 metres and 4 km of the station, the ~222 metre DEM combining onshore and offshore topography (Whiteway, 2009) from 4 km to 40 km, and a version of the latter subsampled to 1 km cells from 40 km to 166.735 km.

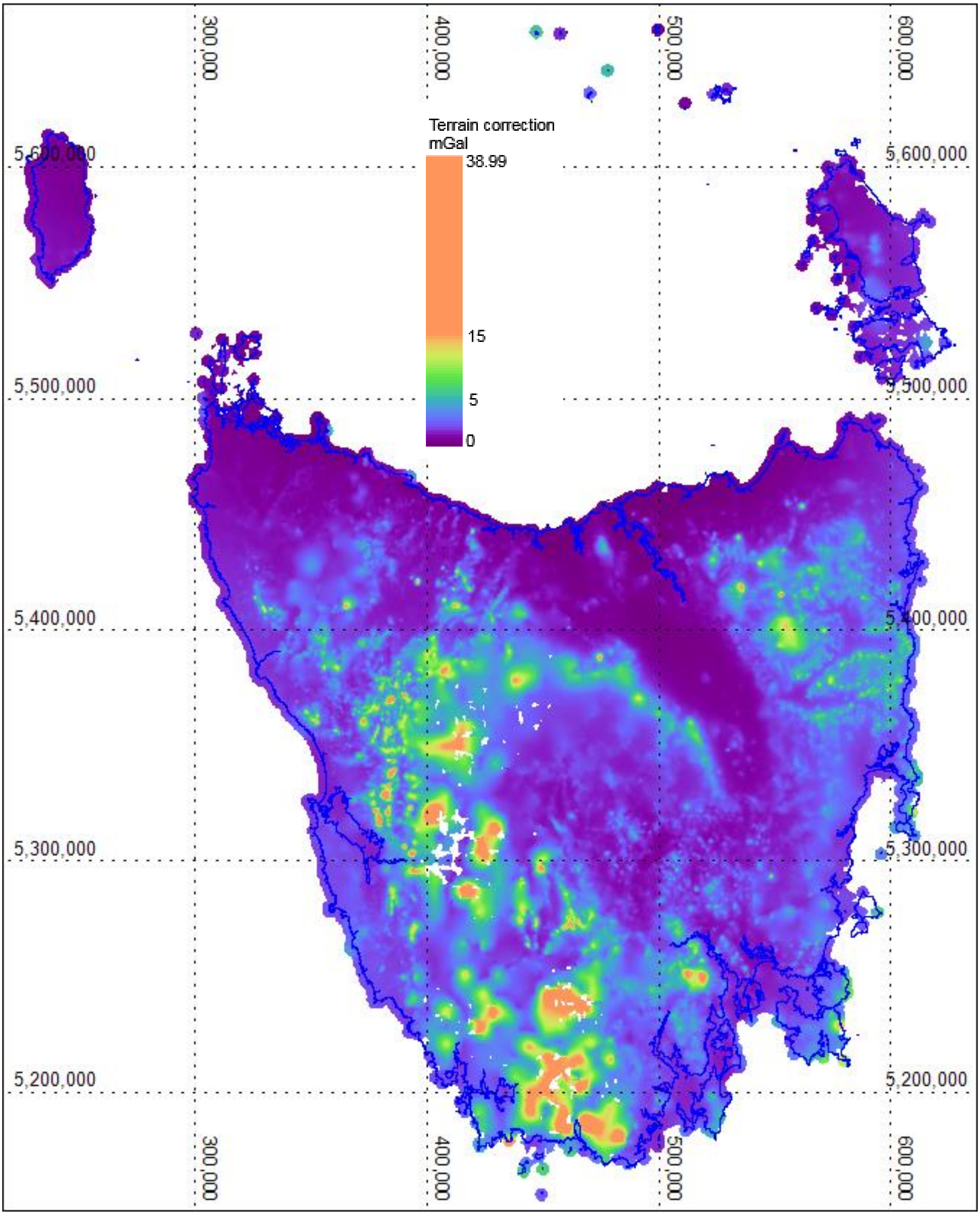

Figure 2: New terrain correction values for Tasmania, gridded on 200 m cells from values calculated at all onshore gravity stations.

In the new terrain correction data set (Figure 2), most of the largest values in Tasmania are observed in western and far southern Tasmania. The very highest, in the vicinity of Mt Murchison, part of the West Coast Range, is 40.6 mGal, an increase of 11.3 mGal over the earlier version.

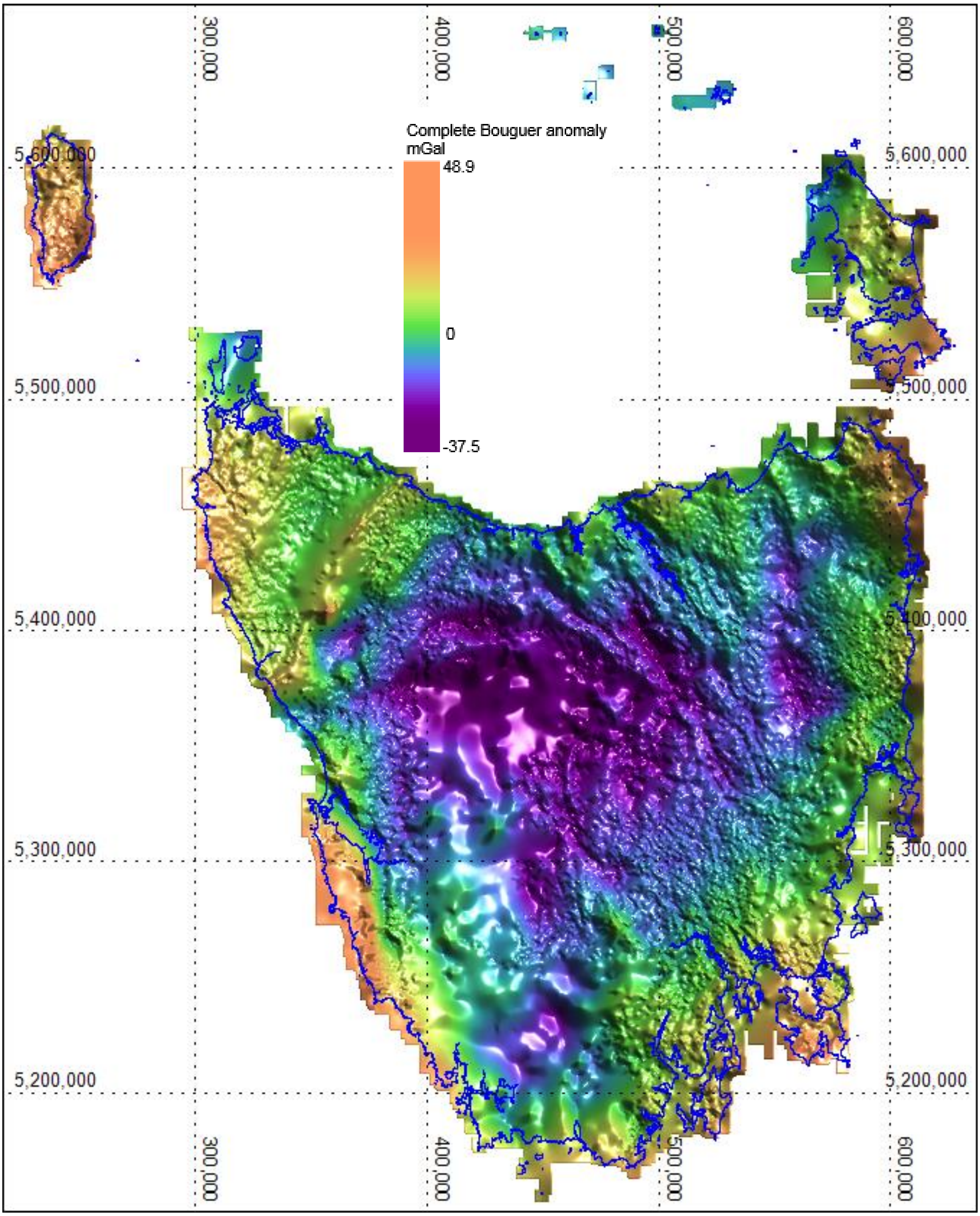

Figure 3: New complete Bouguer gravity anomaly values for Tasmania, gridded on 200 metre cells with minimum curvature from values calculated at all onshore gravity stations. Illumination from north-east.

The resulting new complete Bouguer gravity anomaly for Tasmania is shown in Figure 3, with the difference between this and the older version with more restricted TC in Figure 4. In rare cases the automatically calculated terrain correction value is less than the original, but generally it is greater, by an average of just under 2 mGal. Much of this can be ascribed to extension of the calculation radius from 22 to 167 km (Duffett 2016). The effect of the greater radius of calculation increases with station height, and this is borne out by comparison of Figures 1 and 4.

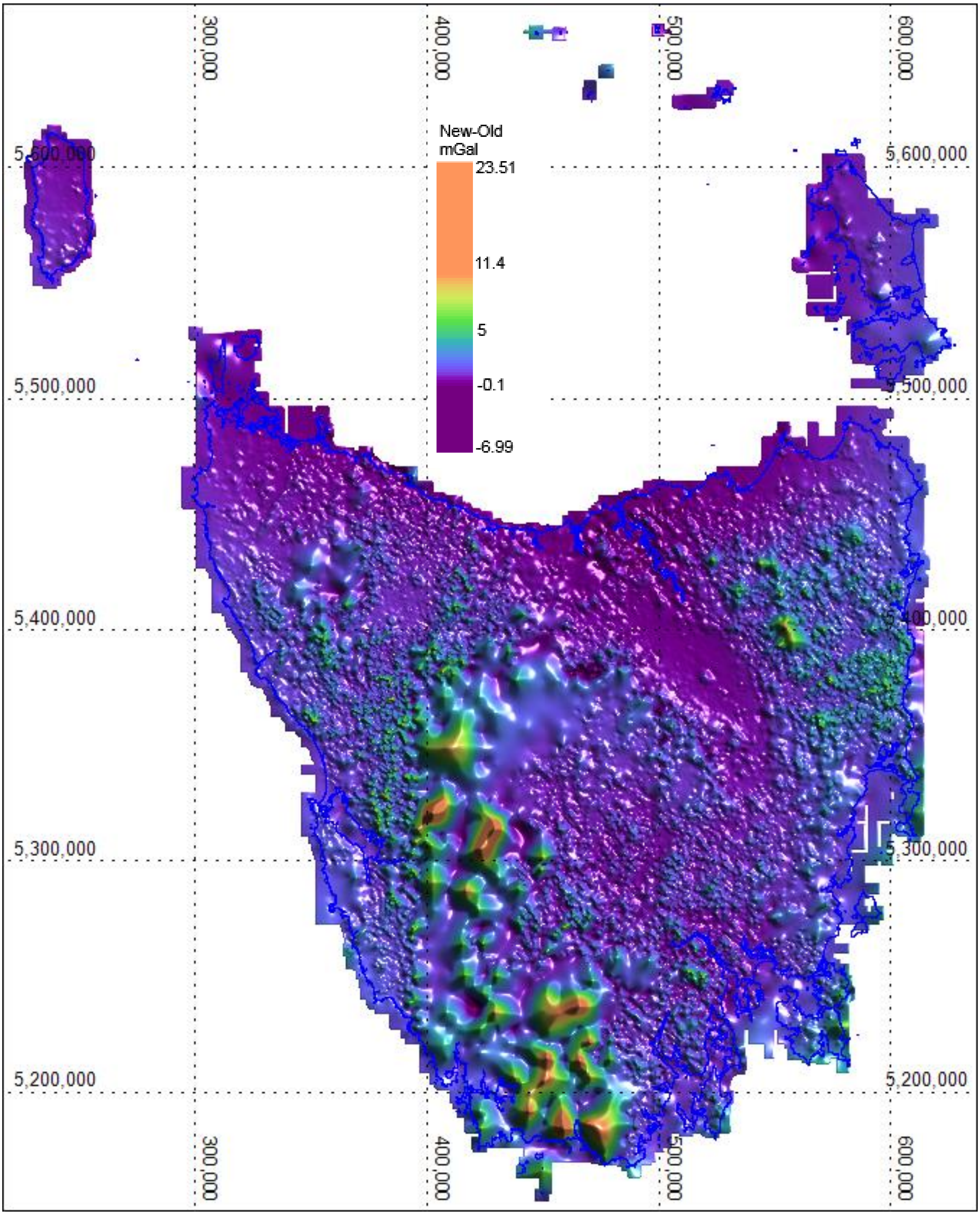

Figure 4: Difference between new and old complete Bouguer gravity anomaly for Tasmania, calculated by subtraction (new-old) after separate gridding. Illumination from north-east.

In addition to the large upward TC adjustments observed in western and southern Tasmania, several large increases are also observed in north-eastern Tasmania (Figure 4). These correspond to Ben Lomond and similarly elevated massifs in that region. These areas have proved problematic in recent 3D gravity modelling projects in that region. It is expected that these issues will be largely resolved by the improvement in complete Bouguer anomaly input data.

Other implications of this work are that granite intrusion in far south and south-western Tasmania is not as extensive as has previously been inferred, similarly in western central Tasmania. Further modifications in understanding of 3D geology at finer scales, including those of near-mine exploration, are likely to emerge as modelling work proceeds.

CONCLUSIONS

The new terrain correction is a major adjustment to the complete Bouguer anomaly calculation in Tasmania, and a significant improvement. The greatest changes are observed in the most elevated stations, consistent with incorporation of a considerably greater terrain correction radius. The magnitude of the adjustments is such that significant changes to extant geophysical interpretations can be expected.

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