RuDTM2014: New digital terrain model for Russia and its effect on the prediction of mean gravity anomalies

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Data sources and methods

The RuDTM2014 (Russian Digital Terrain Model) has been derived from two different data sets. The main source was the Digital Elevation Model from digitized 1:100 000 topographic maps with 1´´resolution (DEM100k). The elevations were determined using not only contour lines, but also all the additional information from the maps. The DEM100k covers the whole territory of Russia except several data gaps near the borders and the islands.

Three global digital elevation models were evaluated and used to fill–in the gaps in DEM100k inside the country and outside its borders: SRTM (versions 2, 3 and 4)[2, 4], ASTER GDEM version 2 [5] and DEM from J. de Ferranti's PathfinderPanorama web site [1].

Resolution and coverage of all the sources are listed in the following table

	SRTM	ASTERv2	DEM3	DEM100k
Resolution	3´´	1´´	3´´	1´´
Coverage	lat $< 60°$	World	World	Russia–only
Datum	WGS84	WGS84	WGS84	Pulkovo 1942

The Geospatial Data Abstraction Library (GDAL) v1.11 [3] was used for all the calculations (interpolation, regridding, transformation) with the digital terrain models, save the evaluation (see the next section).

Evaluation and results

Evaluation of the digital terrain models have to be done before and after any operations with the raster files. It helps to catch large errors in the model and to examine its quality.

All the global data sources as well as DEM100k were evaluated in order to obtain their statistical characteristics and to choose the best one. In the future this information can be used for the error propagation analysis in the computation of gravity anomalies and other gravity quantities.

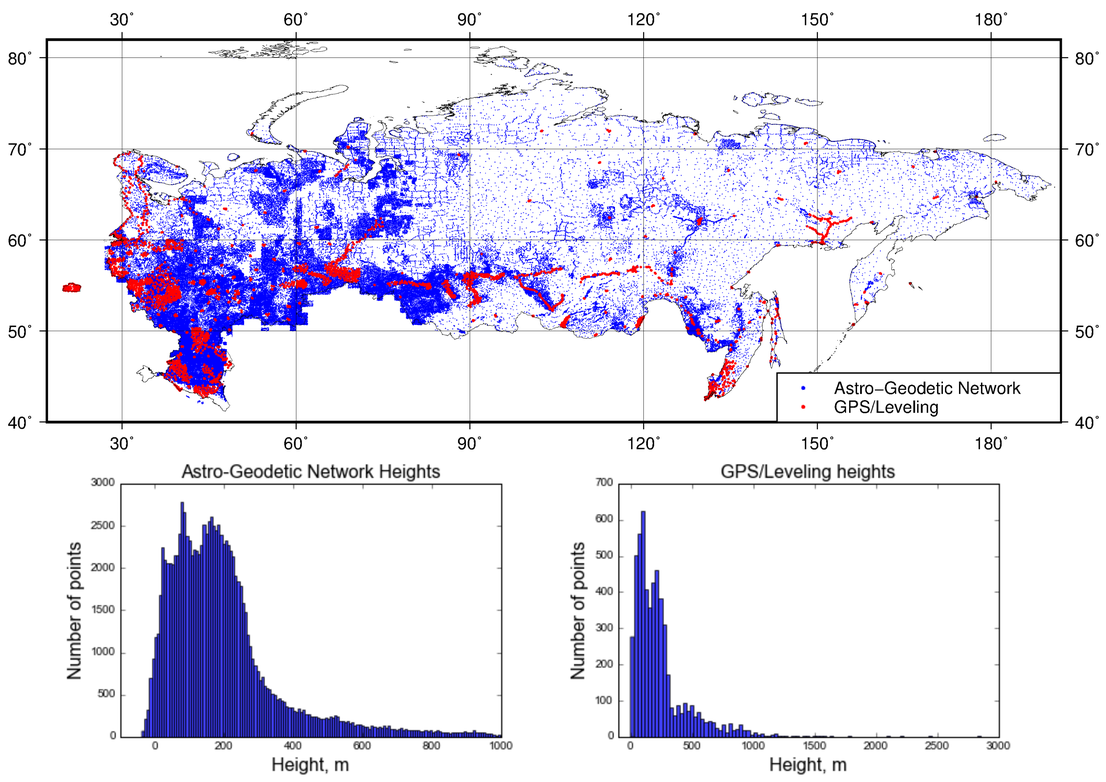
Control data set on Russian territory consists of two parts:

1. Astro–Geodetic Network with known Baltic (normal) heights from differential leveling (not trigonometric), number of points is **105021**
2. GPS/Leveling points with both geodetic and normal heights are known, number of points is **5661**

The evaluation of each DEM sources and the final model were done with the bicubic interpolation by GMT software [6].

Note that the control data set doesn't cover territories outside Russia. This will affect the evaluation because the global DEMs are planned to use in the final RuDTM in these areas.

Control points



Comparison with the normal heights of AGN

	SRTM V2	SRTM V4	ASTER	DEM3	DEM100k
Number	76922	76922	104808	104998	104174
Mean, m	-2.1	-2.9	-4.0	-2.1	-0.9
Abs. mean, m	3.9	4.6	8.0	3.7	1.0
Median, m	-2.7	-3.0	-3.9	-2.2	-0.2
Std. dev., m	4.7	5.8	9.9	4.8	2.4

Comparison with the geodetic heights of GPS/Levelling points

	SRTM&DEM3	SRTM V4	ASTER
Number	4965	4965	5661
Mean, m	-4.6	-5.5	-6.5
Abs. mean, m	5.4	6.4	8.9
Median, m	-3.8	-4.1	-6.0
Std. dev., m	6.7	7.8	10.0

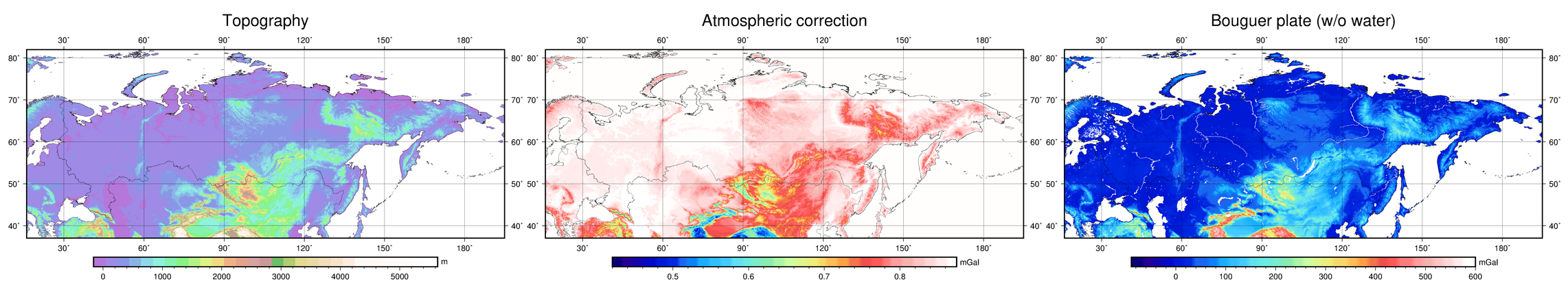
Comparison of the final RuDTM2014 with AGN and GPS/Leveling

After analysis of all the data sources it was decided to use only topographical maps for Russia and to use DEM3 (densified to 1´´) outside its borders.The final RuDTM2014 has the following evaluation results

	AGN	GPS/Levelling
Number	105021	2788
Mean, m	-1.0	-1.6
Abs. mean, m	1.2	1.8
Median, m	-0.3	-0.4
Std. dev., m	2.7	3.6

The horizontal datum of the model is WGS84 and the elevations are referred to Baltic Height System. The digital terrain model has 1´´resolution and covers a large rectangular territory: $16° < \lambda < 195°$, $37° < \phi < 82°$. This also includes the wide mountain region of Central Asia, China, Mongolia and other countries. This is important for calculation of geodetic integrals which requires the height data over the world or at least on a wide area around the computational point (topographical correction, Molodensky's G1 and G2 terms, etc.).

RuDTM2014 and its effect on gravity anomalies



Conclusion

- A new high–resolution (1´´) digital terrain model RuDTM2014 has been created for Russia and surrounding areas: $16° < \lambda < 195°$, $37° < \phi < 82°$.
- The main source of the new model is 1:100 000 topographical maps.
- DEM3, SRTM (v2, v3, v4) and ASTERv2 global digital elevation models were evaluated and tested on Russian territory and the best of them (DEM3) were used to cover surrounding areas and to fill–in the gaps in the topographical maps.

Future work will include the calculation of terrain correction and other reductions in order to compute quasigeoid heights.

References

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GGHS2016, International Symposium on Gravity, Geoid and Height Systems, 19–23 September 2016, Thessaloniki, Greece