Alpine-Carpathian Gravimetry Workshop

AlpArray´s gravity team that crossed frontiers

H.-J. Götze (CAU Kiel) and the AlpArray Gravity Research Group

OUTLINE:

- AAGRG`s mission
- Very short review of data & problems
- Products, publication, error estimation

Bratislava, 22 May 2024

AAGRG´s Mission (2017)

The gravity research group focuses on compiling a homogeneous surface-based gravity dataset across the Alpine area, on creating related gravity products and using them *for high resolution interdisciplinary studies* from small to regional to continental scales, as well as for *joint inversion* with other datasets.

The first pan-Alpine gravity data map, will be homogeneous regarding *input data sets, applied methods and all corrections* as well as common *reference frames*, which are not available yet.

All 10 countries around the Alps have agreed to contribute with *point /gridded gravity data and/or gravity data processing techniques* to a recompilation of the Alpine gravity.

The AAGRG decided to present a first data set of the new gravity fields (BA, FA, and mass corrections) on a *2km x 2km (internal use) and 4km x 4km grid* for the public.

The first pan-Alpine surface-gravity data compilation, a modern up-to-date compilation that crosses frontiers

Pavol Zahorec, Juraj Papčo, Roman Pašteka, Miroslav Bielik, Sylvain Bonvalot, Carla Braitenberg, Jörg Ebbing, Gerald Gabriel, Andrej Gosar, Adam Grand, Hans-Jürgen Götze, György Hetényi, Nils Holzrichter, Edi Kissling, Urs Marti, Bruno Meurers, Jan Mrlina, Alberto Pastorutti, Matteo Scarponi, Josef Sebera, Lucia Seoane, Peter Skiba, Eszter Szűcs, Matej Varga

Earth System Science Data, Volume 13, issue 5, ESSD, 13, 2165–2209, 2021

https://doi.org/10.5194/essd-13-2165-2021

Supplement

https://doi.org/10.5194/essd-13-2165-2021-supplement

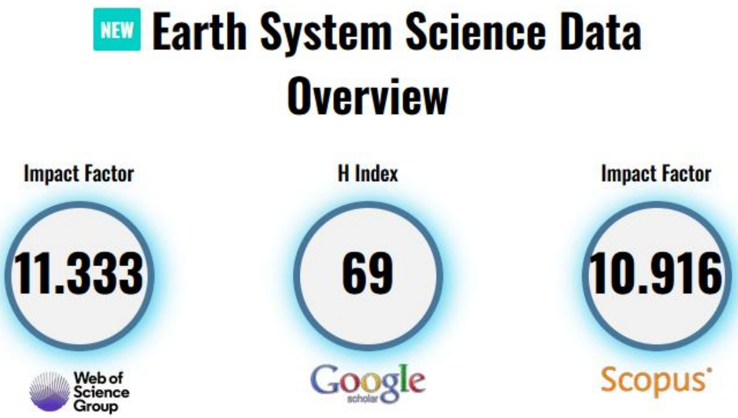
Data sets

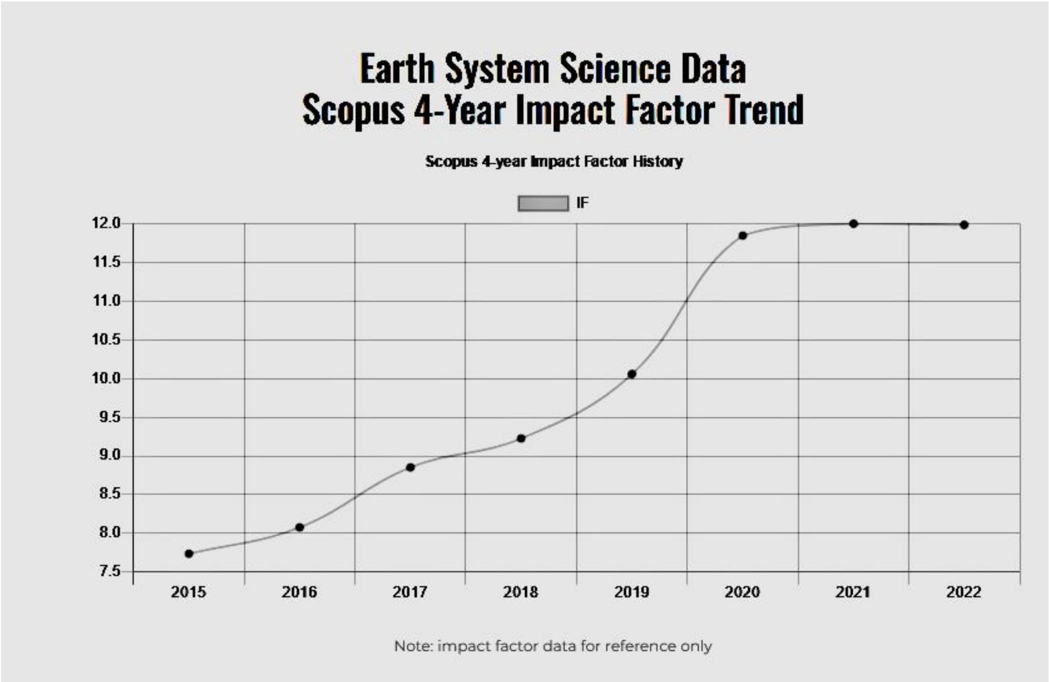
The Pan-Alpine gravity database 2020

Zahorec, Pavol; Papčo, Juraj; Pašteka, Roman; Bielik, Miroslav; Bonvalot, Sylvain; Braitenberg, Carla; Ebbing, Jörg; Gabriel, Gerald; Gosar, Andrej; Grand, Adam; Götze, Hans-Jürgen; Hetényi, György; Holzrichter, Nils; Kissling, Edi; Marti, Urs; Meurers, Bruno; Mrlina, Jan; Pastorutti, Alberto; Scarponi, Matteo; Sebera, Josef; Seoane, Lucia; Skiba, Peter; Szűcs, Eszter; Varga, Matej

https://doi.org/10.5880/fidgeo.2020.045

Scientific Recognition (I - journal)





https://www.scijournal.org/impact-factor-of-earth-system-science-data.shtml?utm_content=cmp-true

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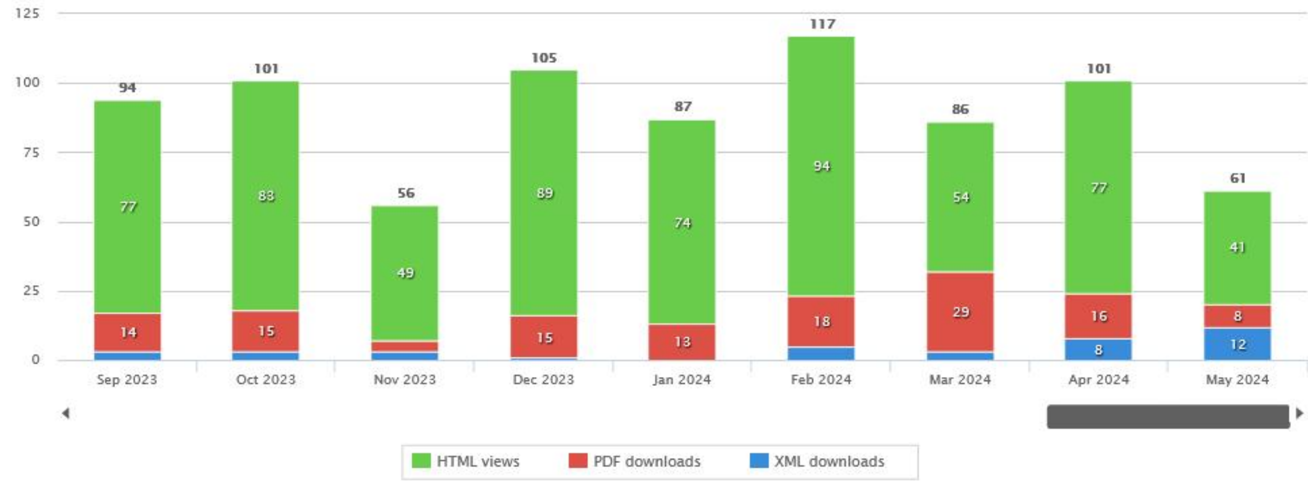
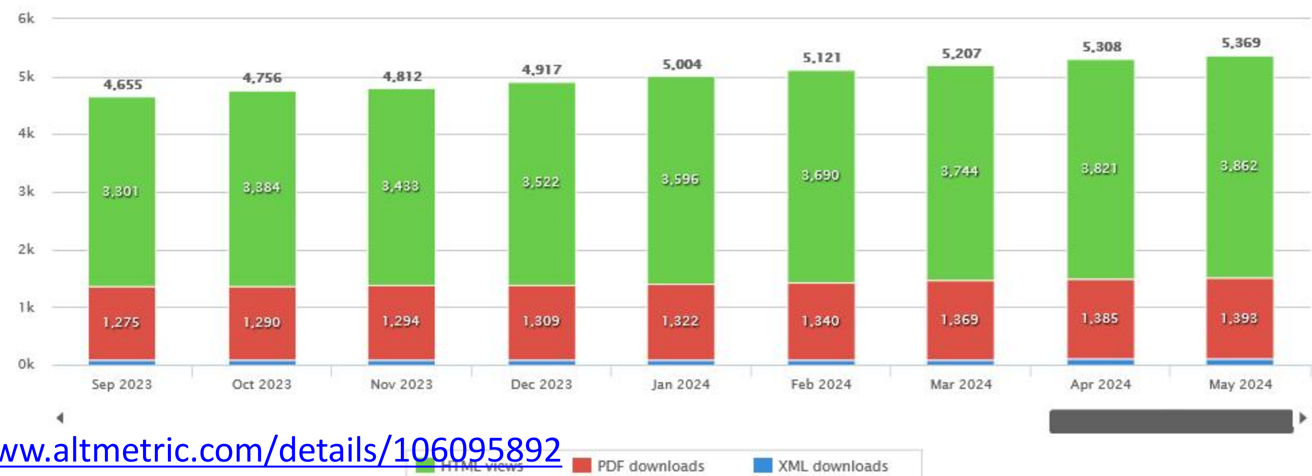
Total article views: 5,369 (including HTML, PDF, and XML)

HTML	PDF	XML	Total	Supplement	BibTeX	EndNote
3,862	1,393	114	5,369	378	99	85

Views and downloads (calculated since 15 Jan 2021)



Cumulative views and downloads (calculated since 15 Jan 2021)



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Scientific Recognition (III - article)

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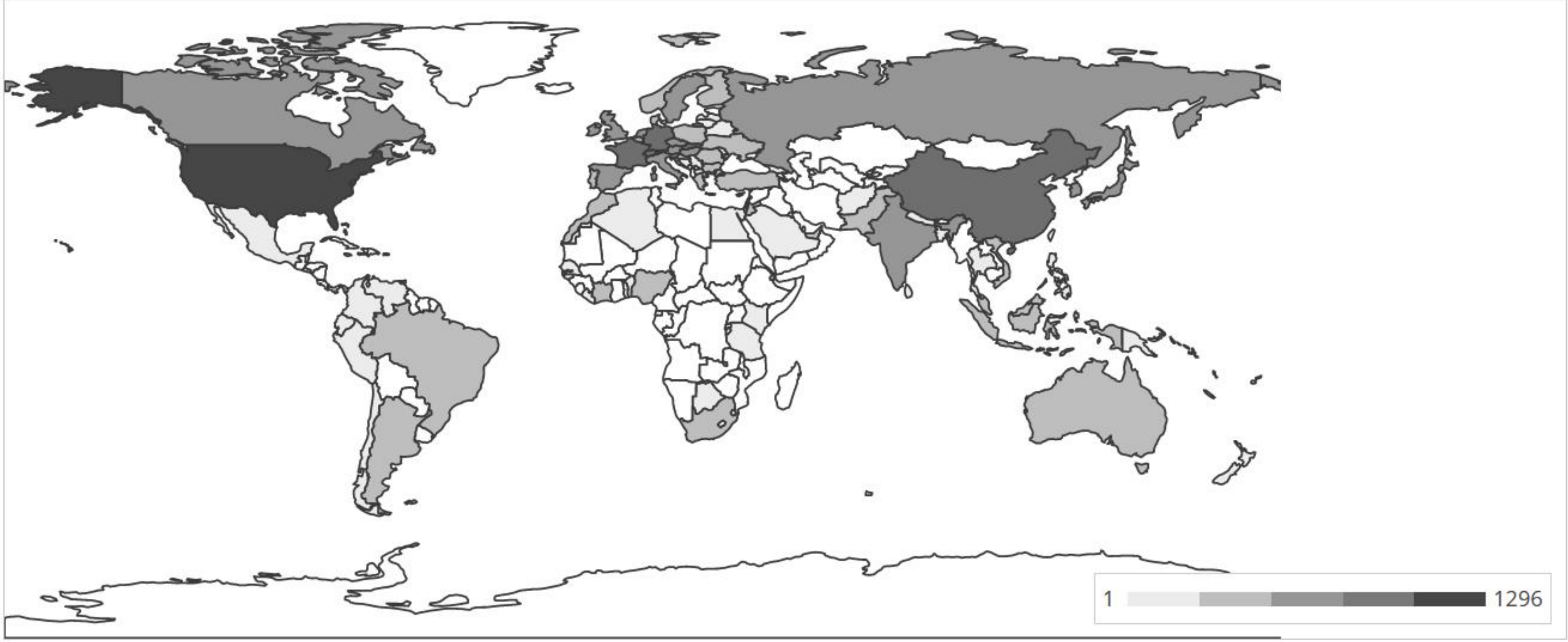
Total article views: 5,369 (including HTML, PDF, and XML)

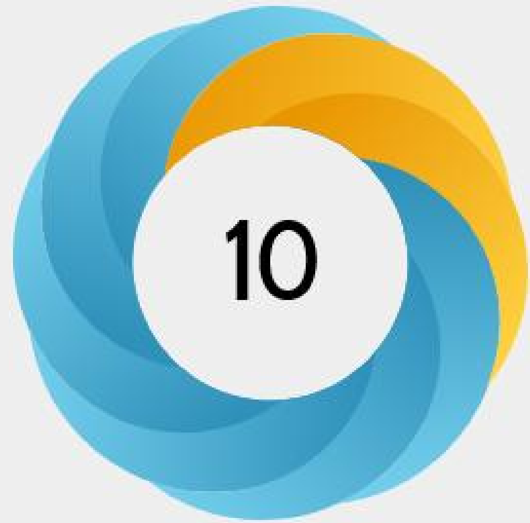
Thereof 4,905 with geography defined and 464 with unknown origin.

Country	#	Views	%
United States of America	1	1296	24
Germany	2	845	15
China	3	280	5
Switzerland	4	259	4
Slovakia	5	255	4



https://www.altmetric.com/details/106095892

Scientific Recognition (IV - article)



Demographic breakdown

Readers by professional status	Count	As %
Researcher	8	40%
Student > Ph. D. Student	3	15%
Professor	2	10%
Student > Master	1	5%
Unknown	6	30%

Readers by discipline	Count	As %
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Social Sciences	2	10%
Computer Science	1	5%
Mathematics	1	5%
Unknown	6	30%

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AAGRG 2021

AAGRG 2021

Data & Problems

- ***Gravity***

  Local-national gravity reference system vs. absolute reference systems, coverage

- ***Positions***

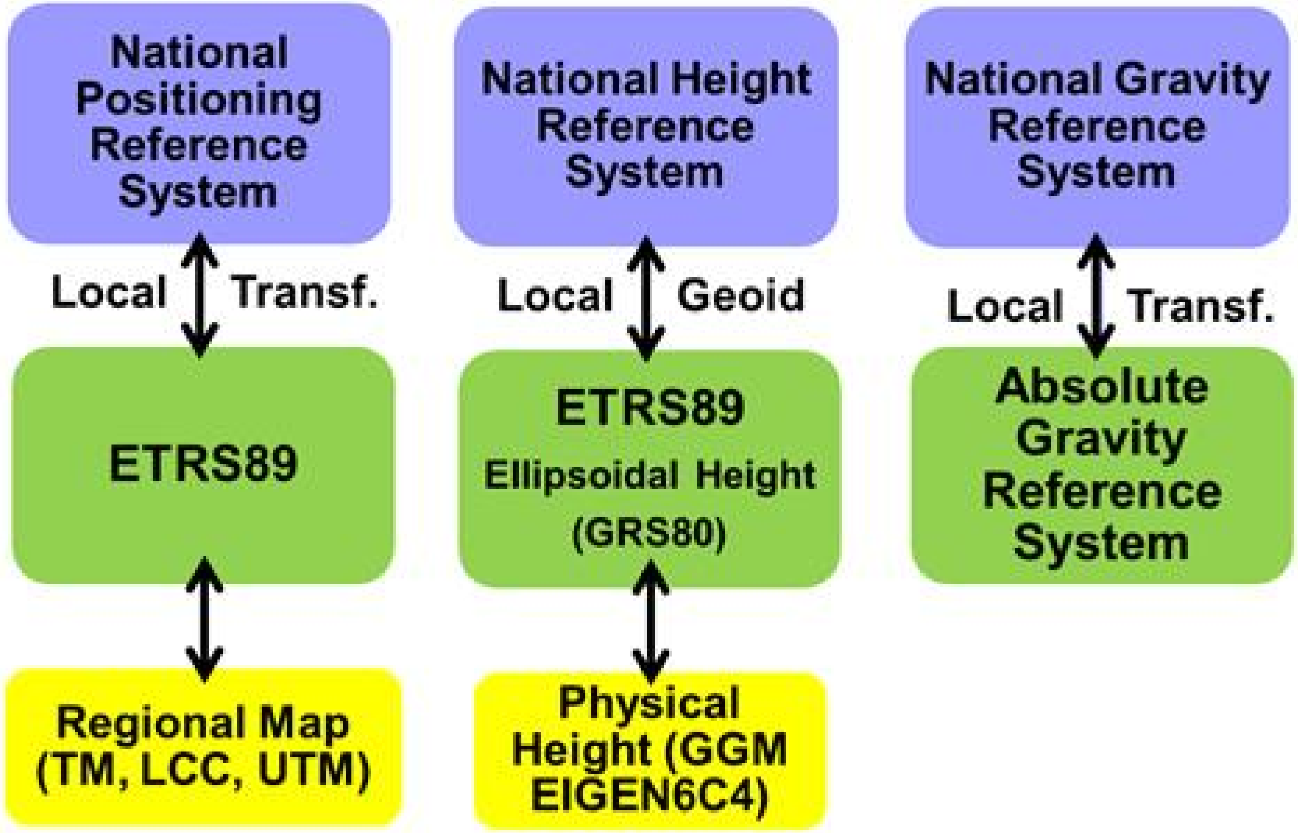
  Homogenization of data point positions. Local vs. global systems.

- ***Heights***

  Local-national height systems vs. European systems;
  Ellipsoidal vs. geoidal heights

- ***National DEM*** (Digital Elevation Models)

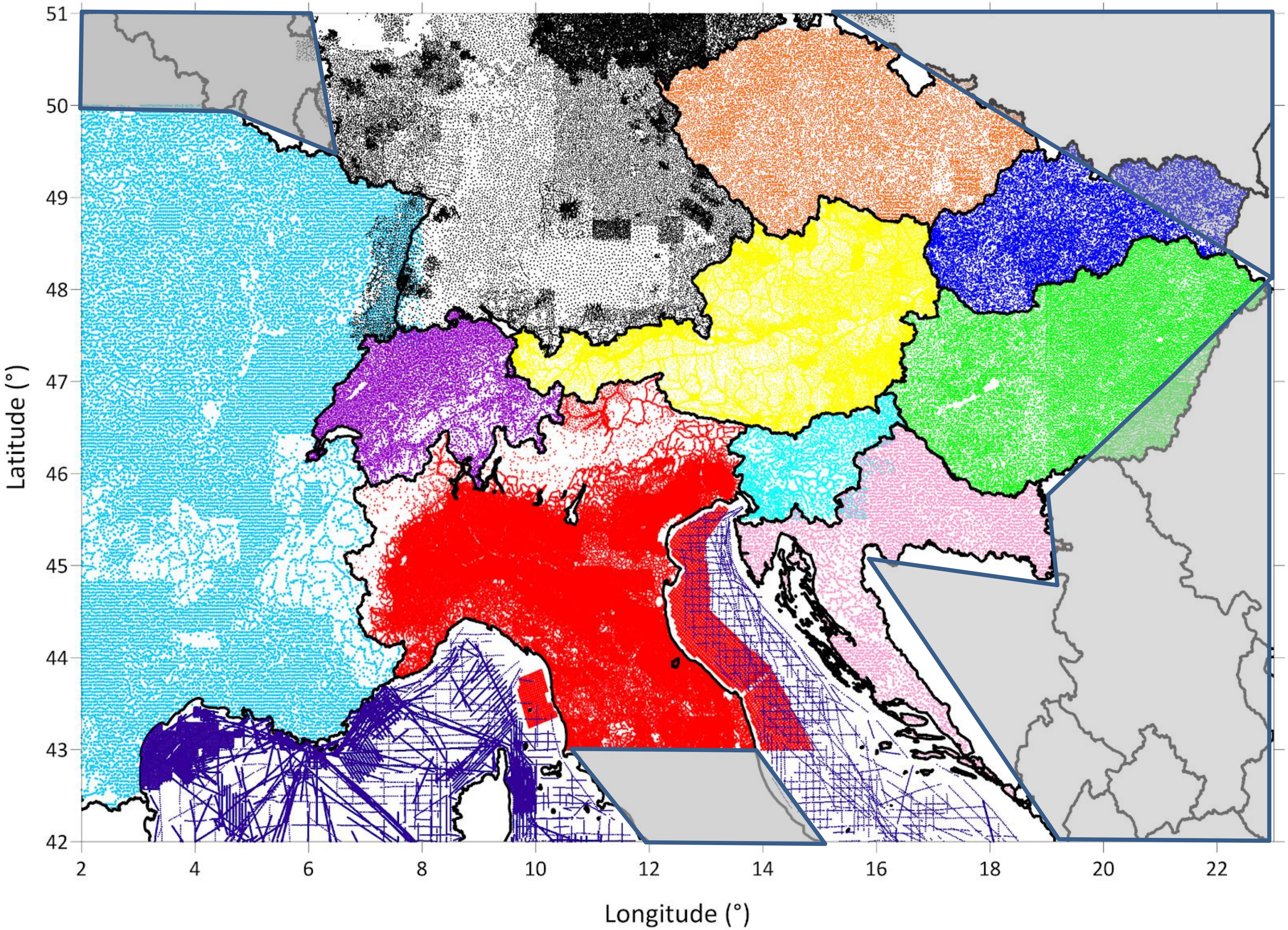
  National vs. global DEMs



Transformation scheme for unification of the national positioning, height and gravity reference system.

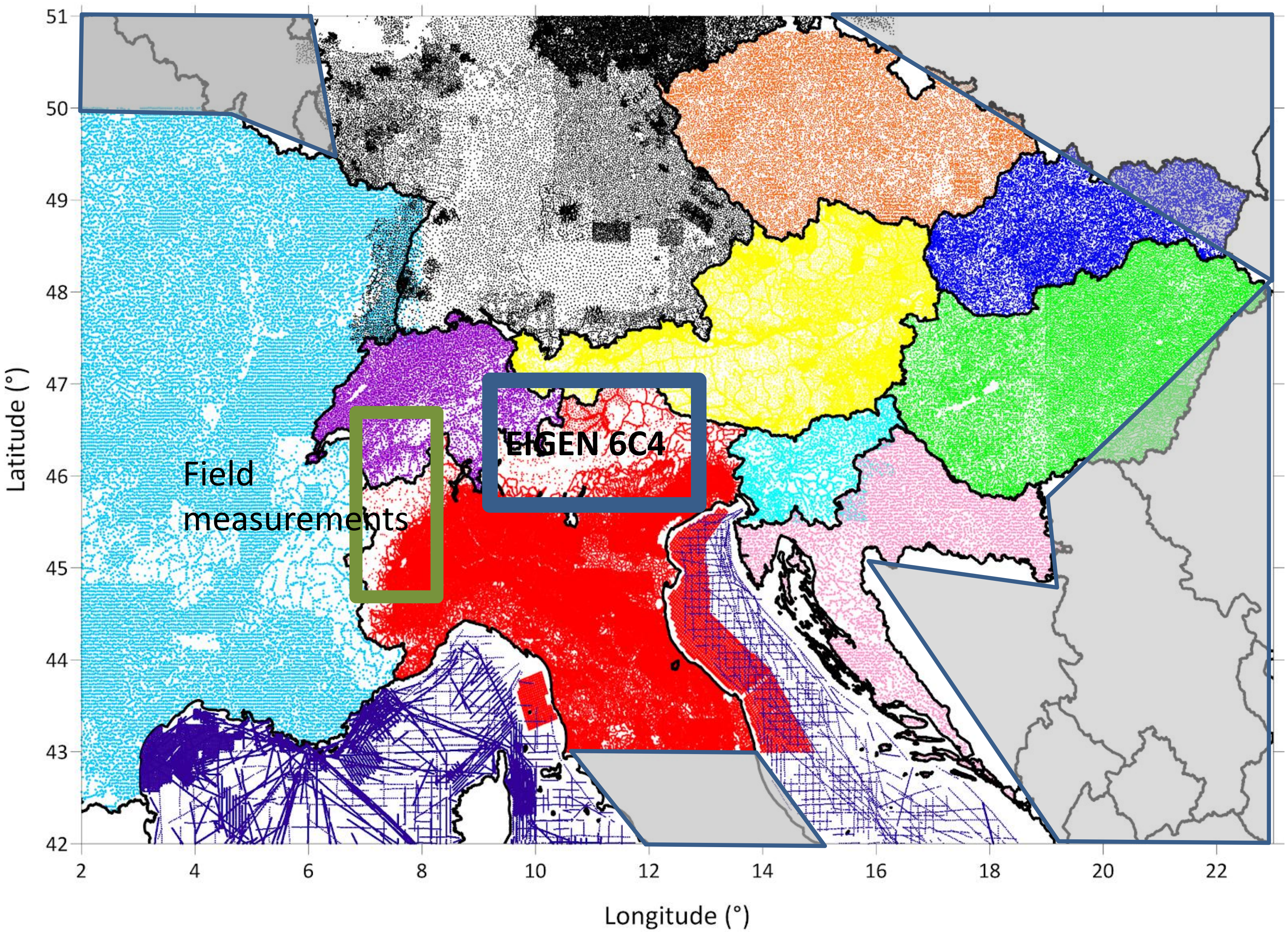
Problem: Data status – gravity

approx. 340 000 point data



Problem: Data status – gravity

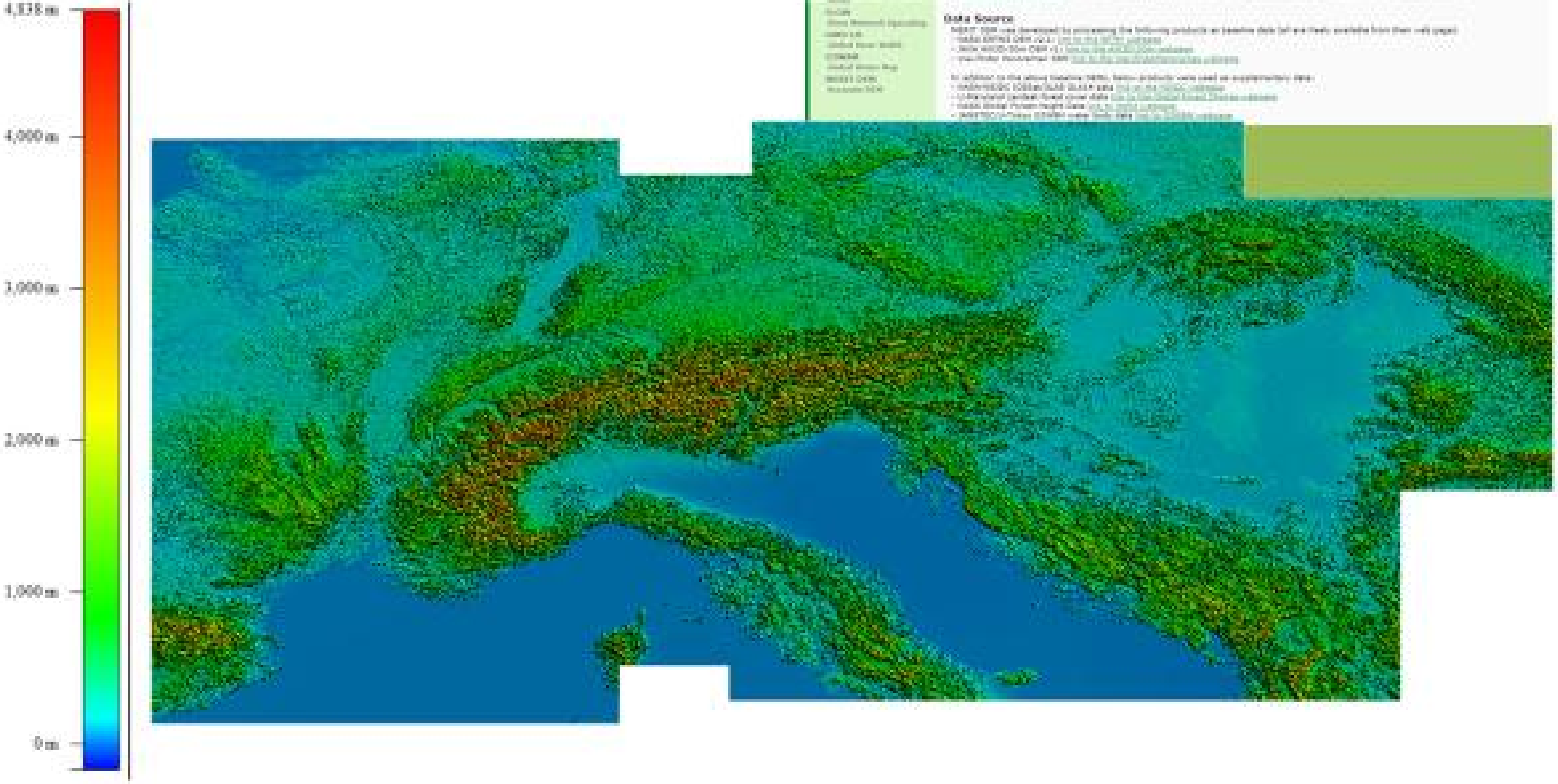
approx. 340 000 point data



Solution: DEM – regional

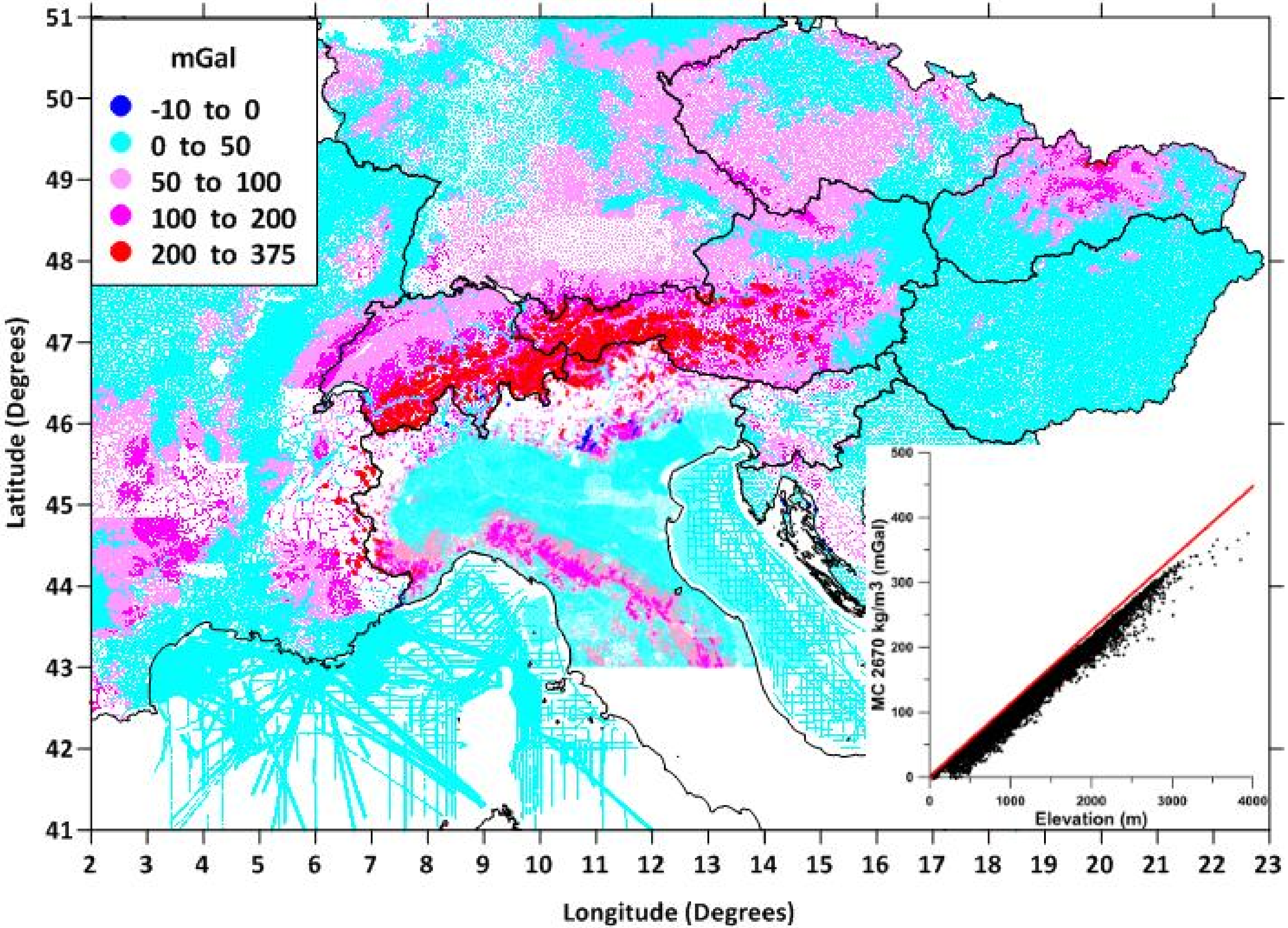
(J. Papčo)

- **MERIT DEM**
  3 sec / resample 1 sec / 25 m

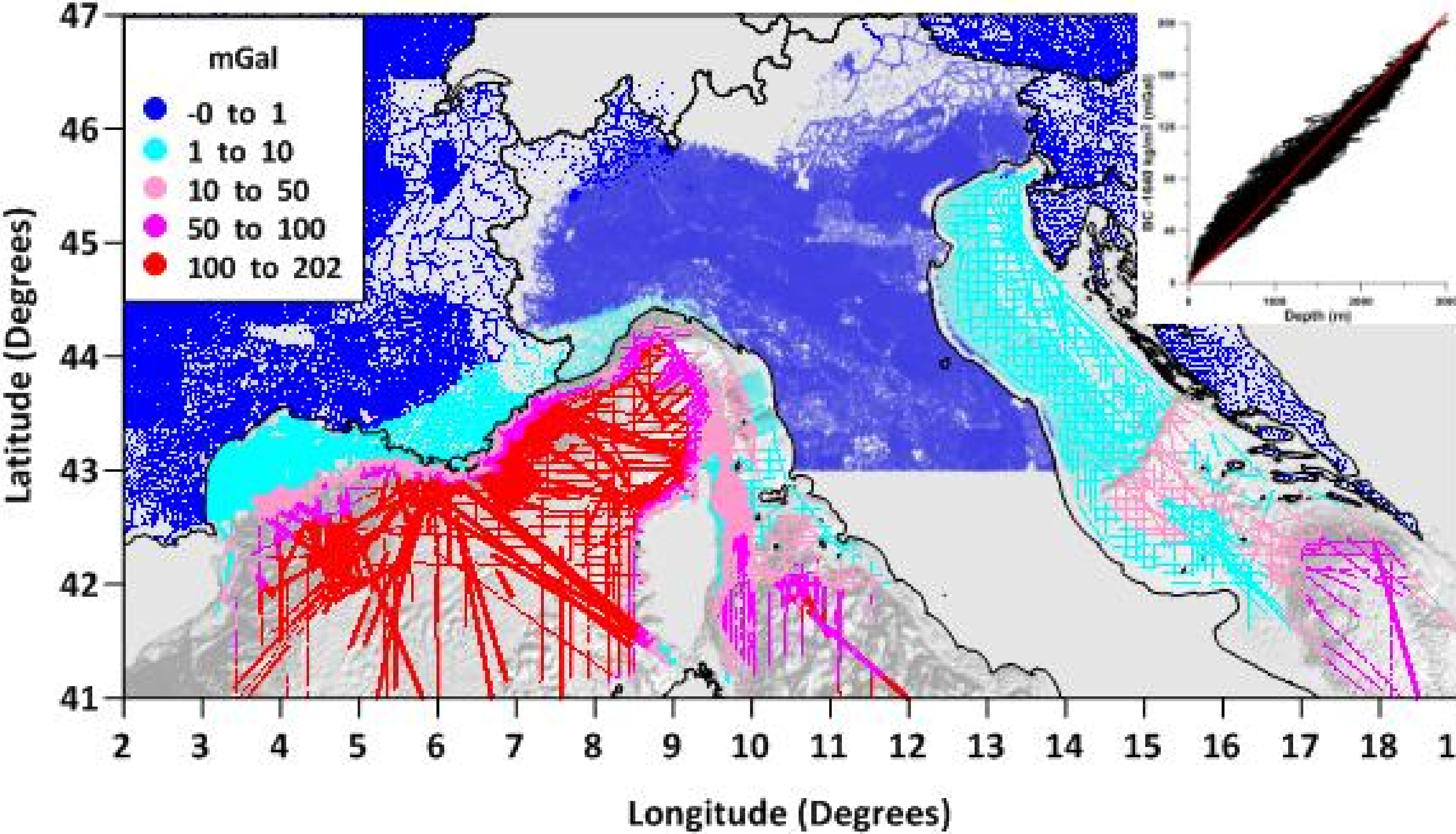


National high resolution DEMs

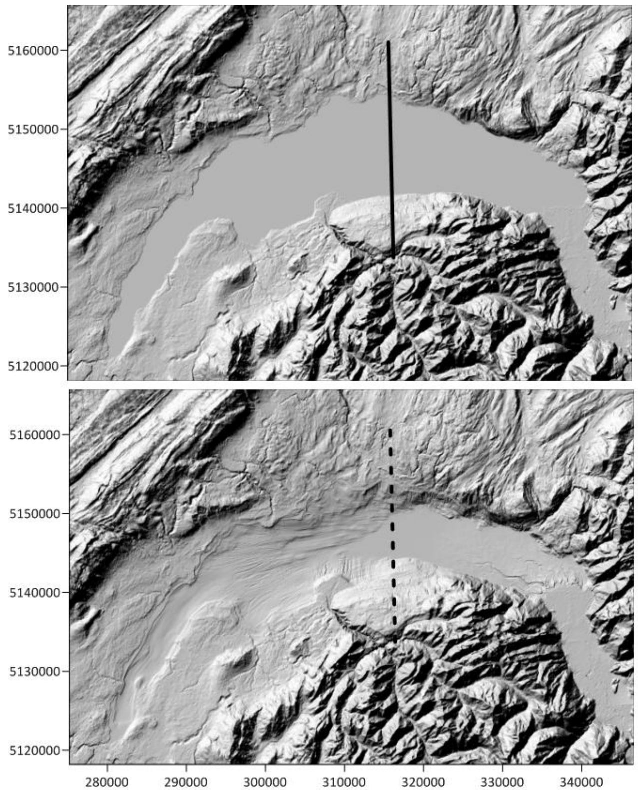
	Source	Grid step (m)	Reference
Austria	L DGM10 Österreich Geoland	10	http://www.geoland.at
Croatia	MERIT	25	http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/
Czech Republic	L DMR5G-V CUZK	5	https://geoportal.cuzk.cz/
France	L/SRTM DTM France Sonny	20	http://data.opendataportal.at/dataset/dtm-france
Germany	L DGM10 BKG	10	http://gdz.bkg.bund.de/
Hungary	TM DDM BFKH	30	http://www.ftf.bfkh.gov.hu/
Italy	MERIT	25	http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/
Slovakia	TM DMR3.5G GKU	10	https://www.geoportal.sk/en/
Slovenia	P/L LIDAR ARSO	12.5	http://www.geoportal.gov.si/eng/ https://gis.arso.gov.si/
Switzerland	L swissALTI3D SwissTopo	5	https://www.swisstopo.admin.ch/

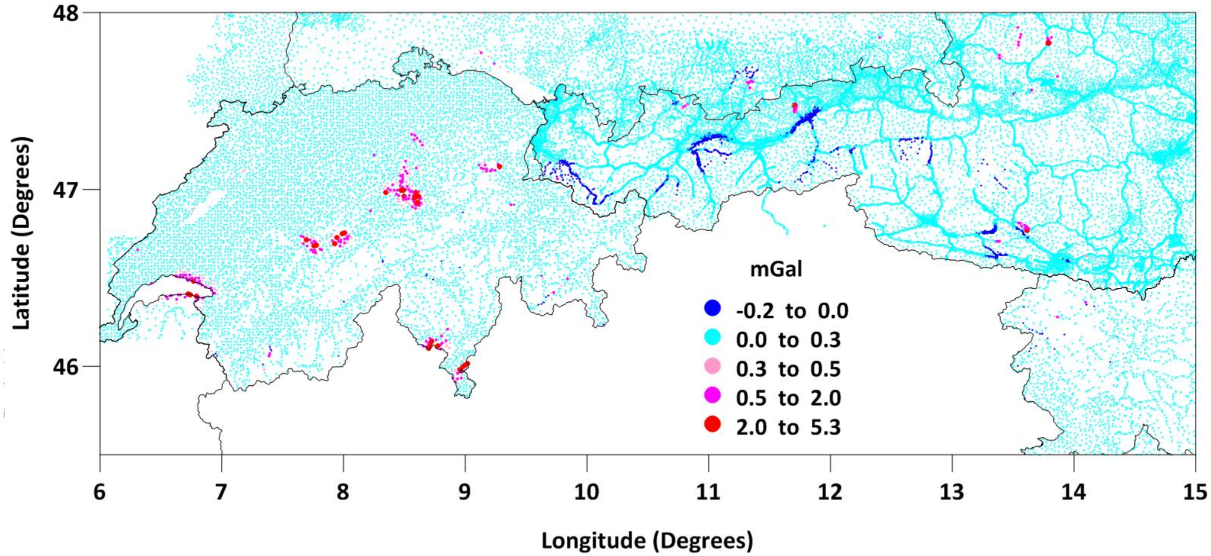


Map of ***mass correction*** (up to the distance of 166.7 km, density 2 670 kg/m^3). Note the negative values of several mGal for a few points (dark blue points), which are mainly near the coast. In the bottom right corner is also a graph showing height dependence of the calculated MC. The red line represents the gravitational effect of the truncated spherical layer (up to the distance of 166.7 km, density 2 670 kg/m^3) for comparison.



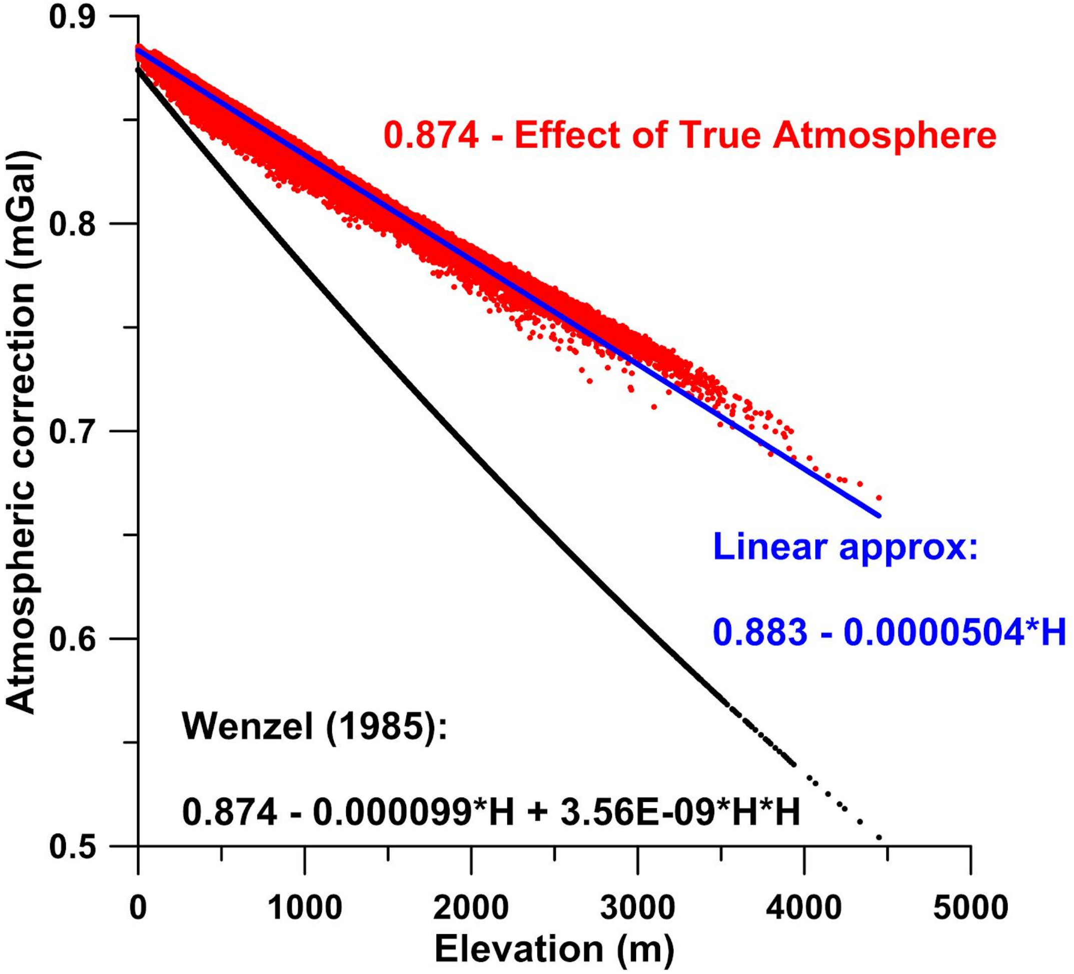
Map of ***bathymetric corrections*** (up to the distance of 166.7 km, density 1 640 kg/m^3). Shaded relief in the background shows the bathymetry of the seabed. In the upper right corner is a graph showing depth-dependence of bathymetric corrections. The red line represents their simple "Bouguer" approximation for comparison.



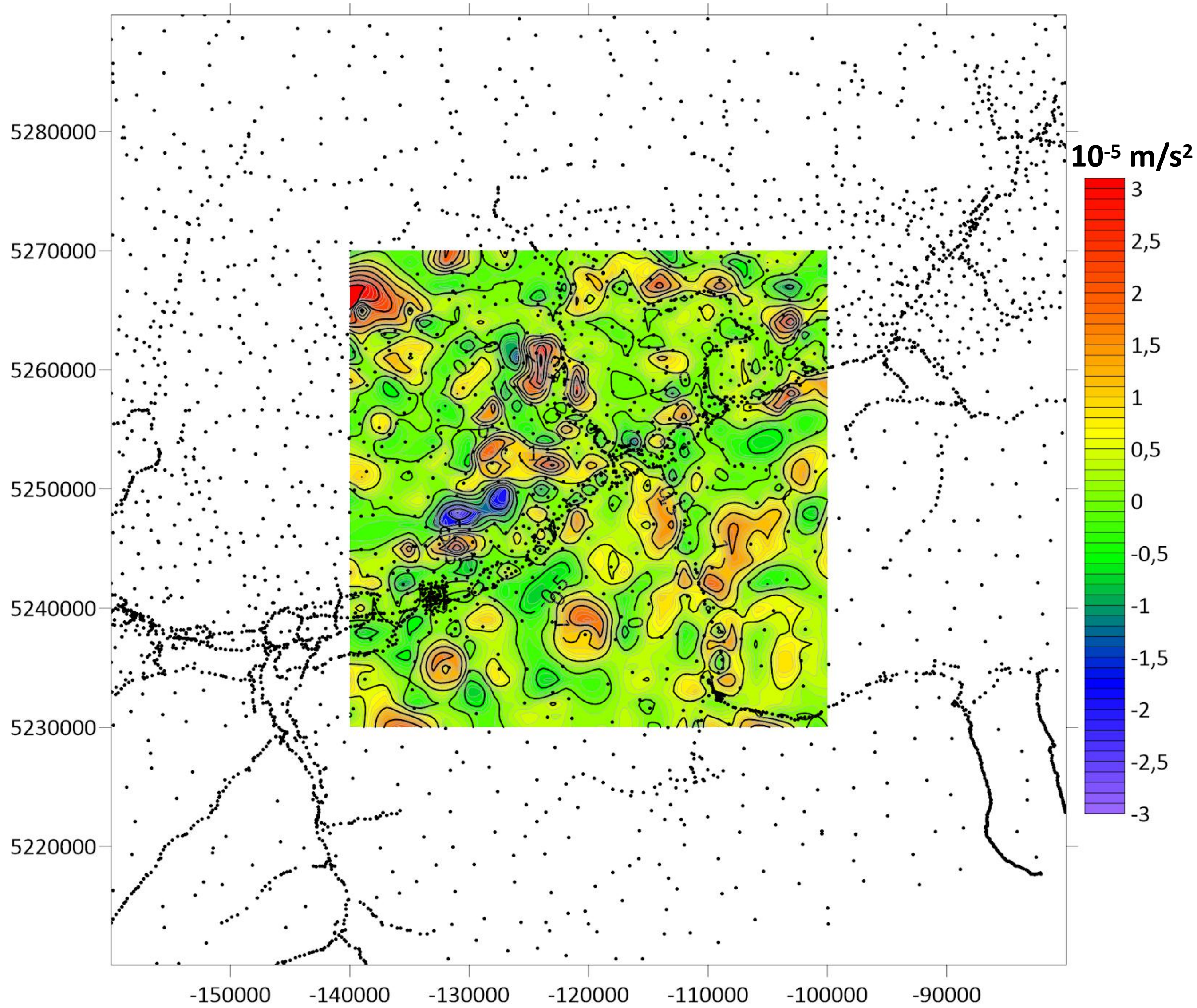


Map of ***lake corrections*** (correction density is 1 670 kg/m^3). Small negative values occur in deep valleys below the level of lakes (dark blue points).

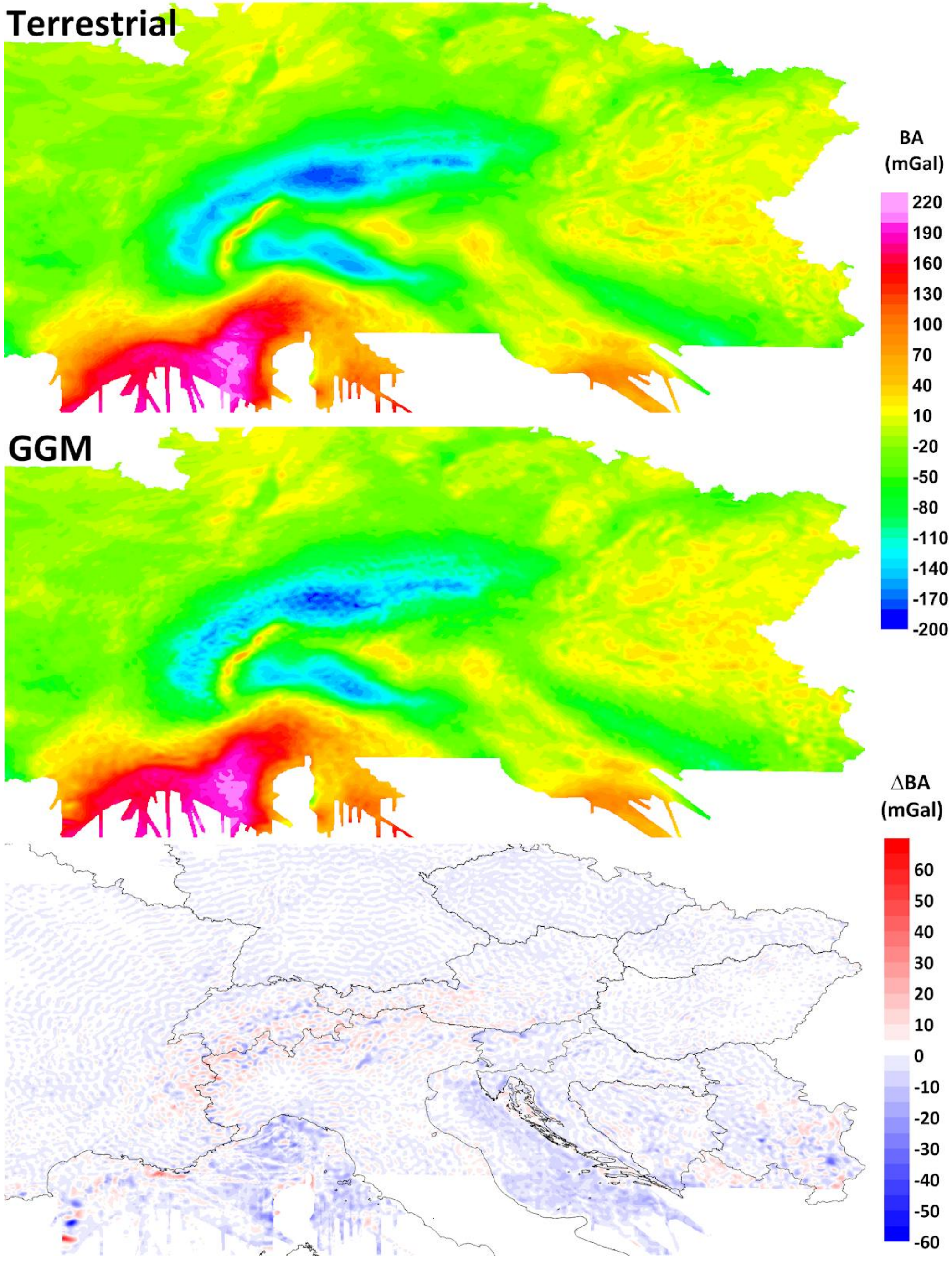
As an example: Lake Geneva



Comparison of ***atmospheric correction*** at selected points covering the whole Alparray area. The black dots represent the atmospheric correction calculated by a simple approximation according to Wenzel (1985). The red dots show the calculation using the effect of true atmosphere (Mikuška et al., 2008) and the blue line is its linear approximation

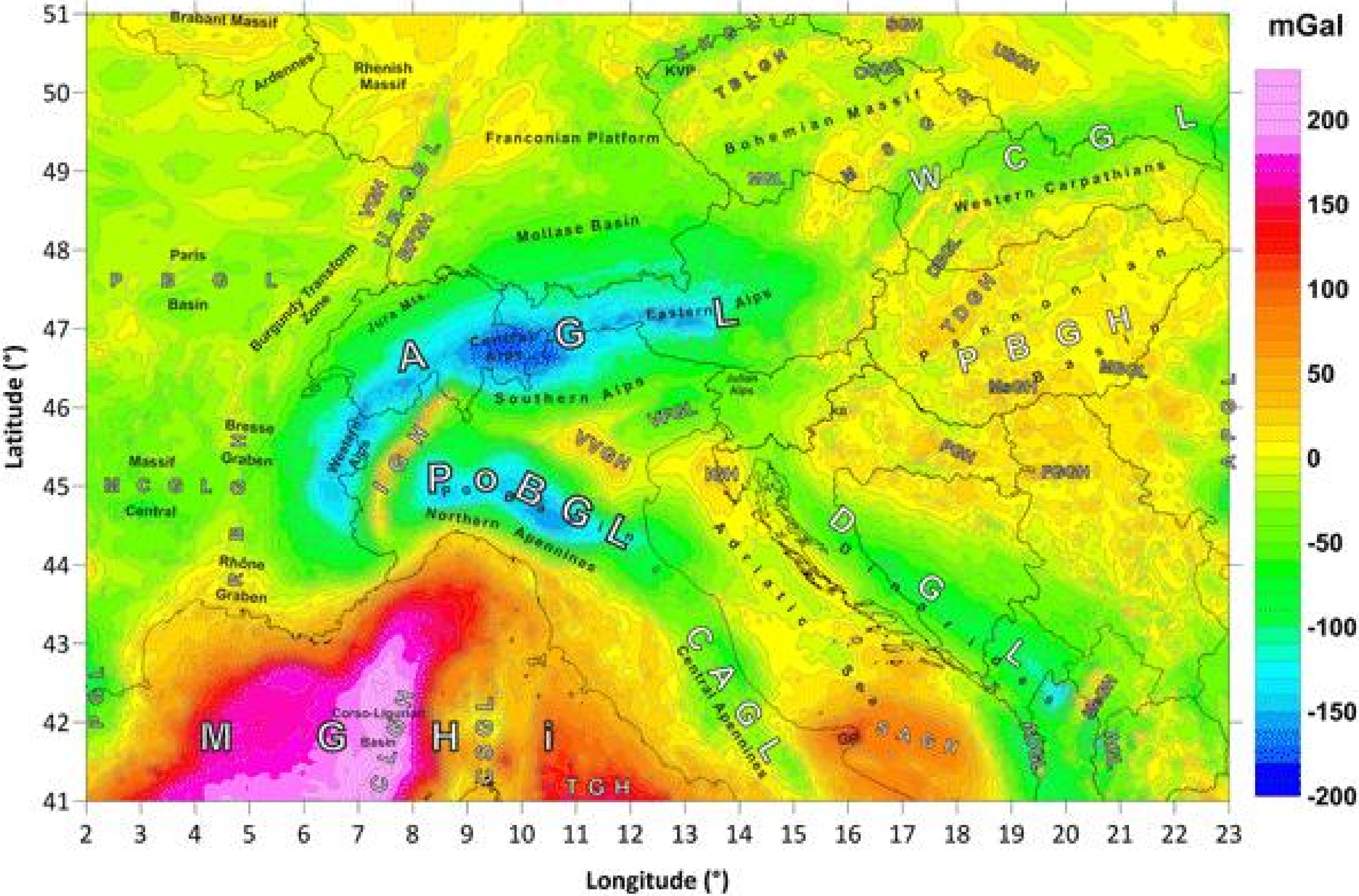


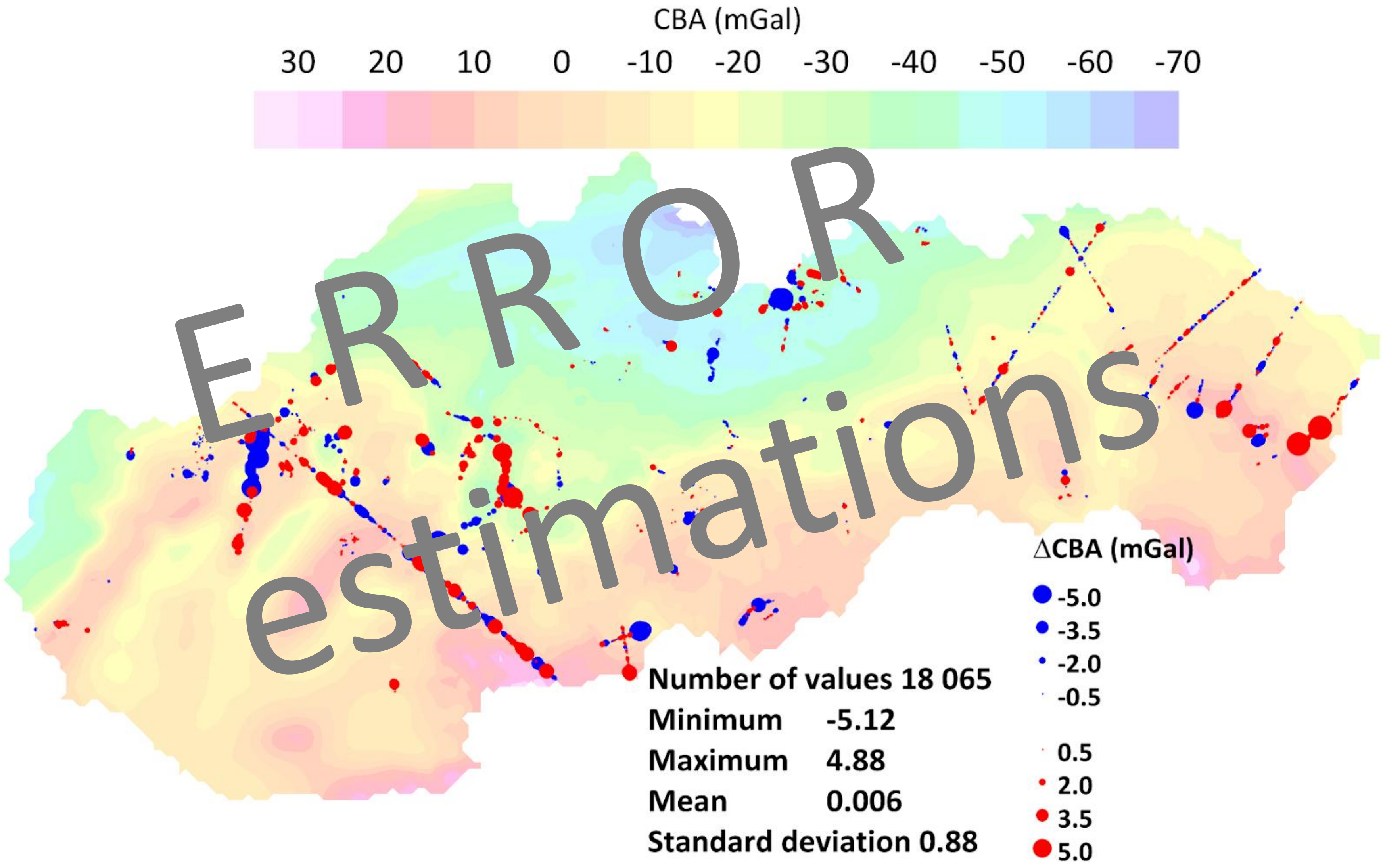
Interpolation error estimate (gravity difference between gravity fields predicted by the EQ-Source-model and by 2D interpolation, after Bruno Meurers); contour interval 0.1 x 10^{-5} m/s^2 , axis coordinates in [m] (Gauss-Krüger projection, N 31).



Comparison of Bouguer anomaly maps (correction density 2 670 kg/m³) derived from terrestrial data (upper) and GGM model EIGEN-6C4 (center). The bottom map shows the difference between both compilations.

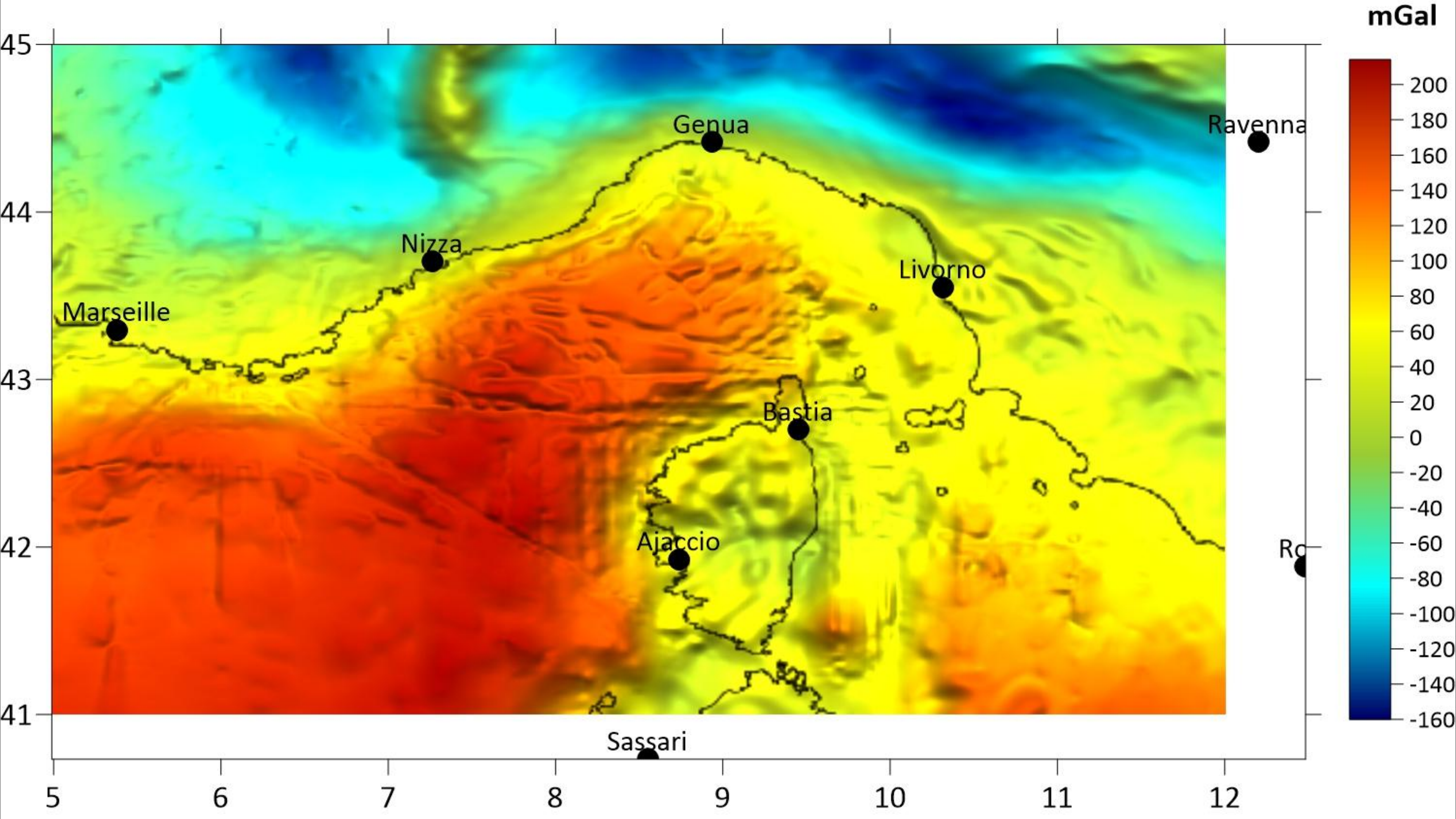
Bouguer anomaly, CBA (May 2021)



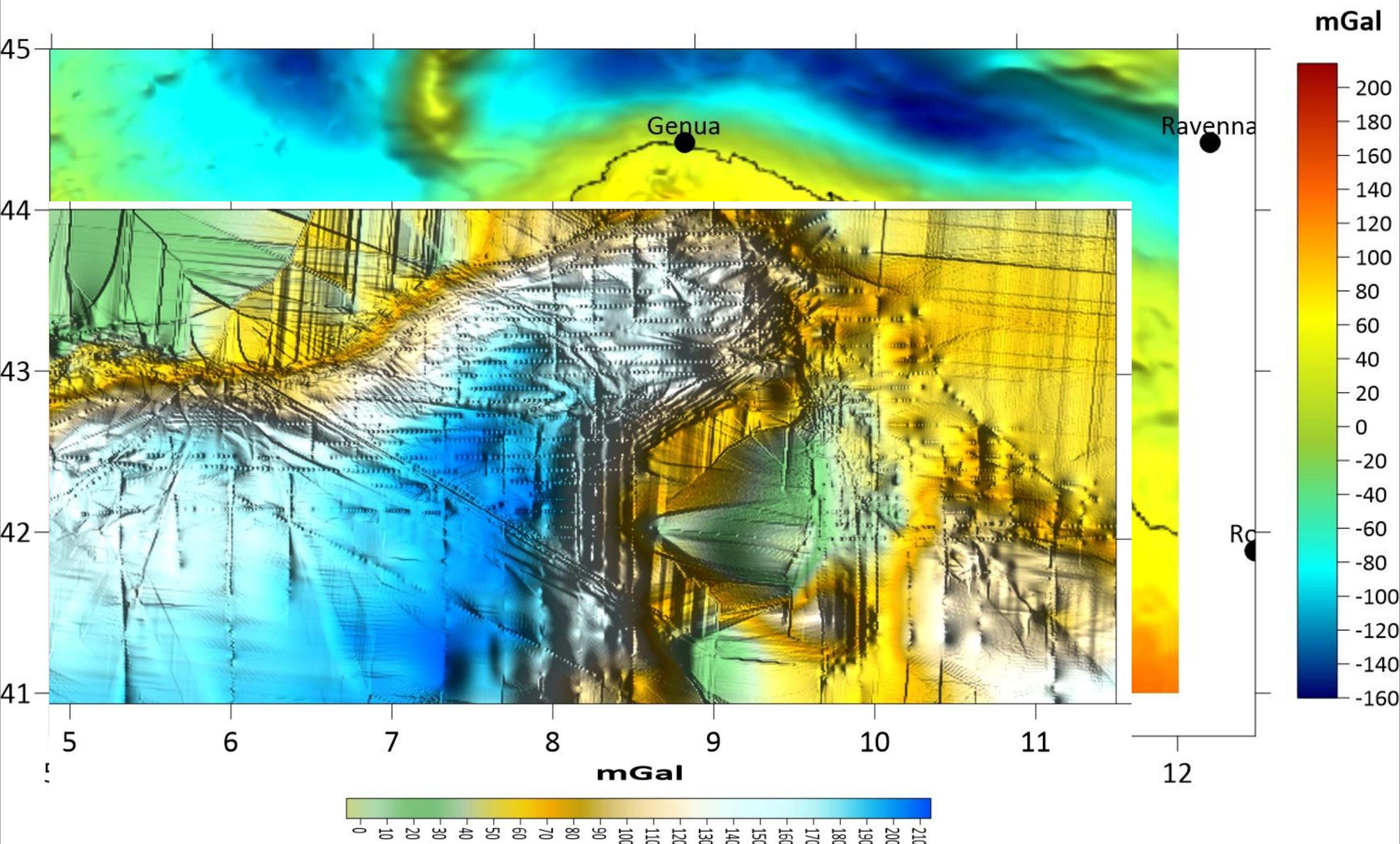


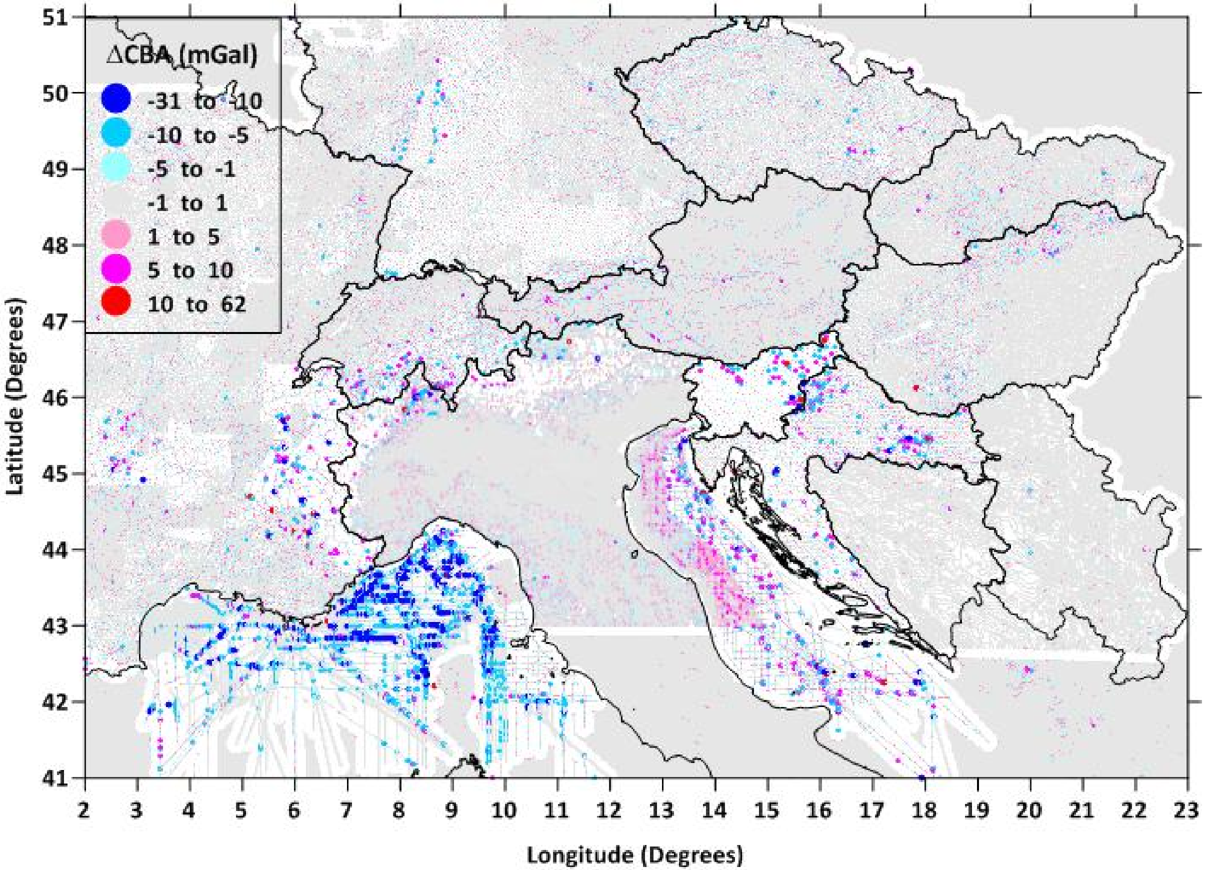
Differences between the CBA grid and the independent gravity points (not used for the Slovakian gravity grid compilation. It was calculated by SURFER´s simple grid-residual procedure and showed that no gravity differences were greater than ∓ 5 mGal.

BOUGUER anomaly, 2 km x 2 km (before correction)



BOUGUER anomaly, 2 km x 2 km (before correction)





Cross validation and simple residuals of the new CBA

To sum up, we can assume that the accuracy of our newly compiled gravity database is between +-5 and at (rare) difficult locations up to +-10 mGal - depending on the area.

2nd publication should focus on the uncertainty of the Bouguer anomaly compilation – still in planning...

Final compilation (May 2021)

- 4 x 4 km Grid (open access)
- DOI for the registration of research data sets;
- 2 km x 2 km für AlpArray members (according to agreement of the
  ten participating countries);
- Digital grid format (ellipsoidal coordinates & heights);
- No distant topo/bath. effects, 2D kriging interpolation;
- Densities: 2 670 – 1 030 – 1 640 kg/m^3.

❑ Bouguer- , Free Air Anomaly
❑ Mass corrections (for recalculation by other correction densities)
❑ Uncertainty/error *estimation*
❑ PDF Map of CBA (high resolution and …..
  nice for office decoration ;-))