

Pomen določanja geoida v geodeziji

- Določanje geometrije površine Zemlje.
- Redukcija terestričnih geodetskih meritev na elipsoid.
 - Popravek, ki ga moramo upoštevati pri redukciji dolžine S (dolžine reducirano na ničelno nivojsko ploskev) na elipsoidno ploskev:

$$\delta S = -\frac{N}{R} S$$

Splošno velja, da neupoštevanje vsakih 6,0 m geoidne višine povzroči relativni sistematični pogrešek velikosti 1 ppm (1×10^{-6}), reducirane elipsoidne dolžine.

- Višinski datum za geodetsko izmero.
- Povezava terestrične izmere z meritvami opravljenimi s satelitskimi merskimi tehnikami $\Rightarrow$ transformacija koordinat.
- GNSS-višinomerstvo.
- Raziskave v geodinamiki in geofiziki.
- Oceanografske raziskave.

Določitev geoida (kvazigeoida)

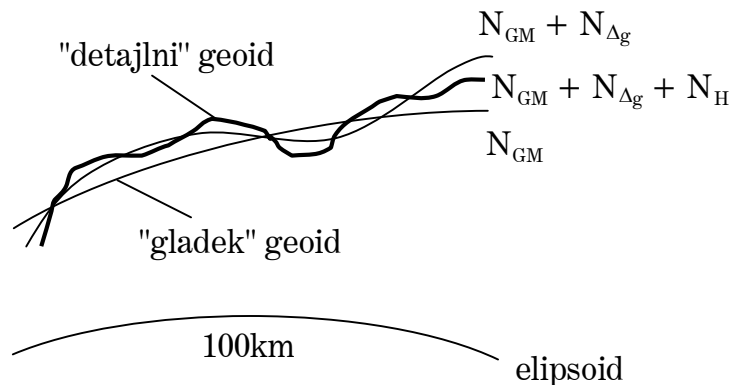
- Podatki za izračun:
 - meritve težnosti (na kopnu, morju in v zraku), $\rightarrow \Delta g$;
 - astronomska opazovanja $(\Phi, \Lambda) \rightarrow \xi, \eta$;
 - Koordinate točk določene z metodami satelitske geodezije: $(\phi, \lambda, h) \rightarrow N = h - H$ ($\zeta = h - H^N$).
 - Opazovanja do umetnih zemeljskih satelitov in med njimi $\rightarrow$ geopotencialni model.
 - Meritve satelitske altimetrije $\rightarrow \Delta g$.
 - Podatki o topografiji, reliefu, DMV (digitalni model višin), DMR (digitalni modeli reliefa).

Metode določitve

Metode določitve geoida (kvazigeoida):

- gravimetrična,
- astrogeodetska,
- satelitska,
- integrirana.

Danes se uporabljajo izključno integrirane metode → vključujejo vse razpoložljive podatke.



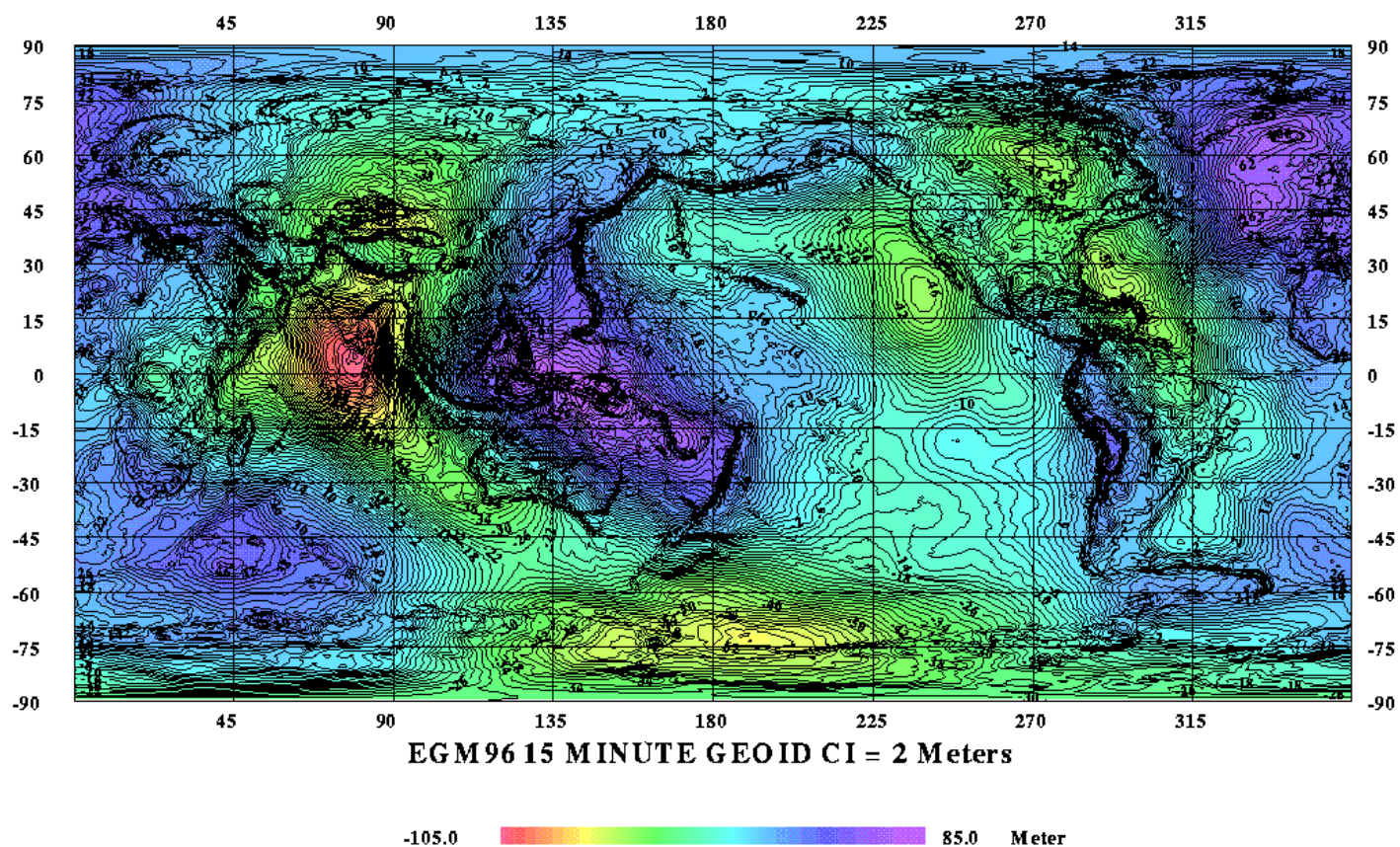
N_{GM} podatki globalnega geopotencialnega modela
 N_{Ag} terestrični podatki
 N_H podatki o topografiji (DMV)

Prikaz izračunanega geoida

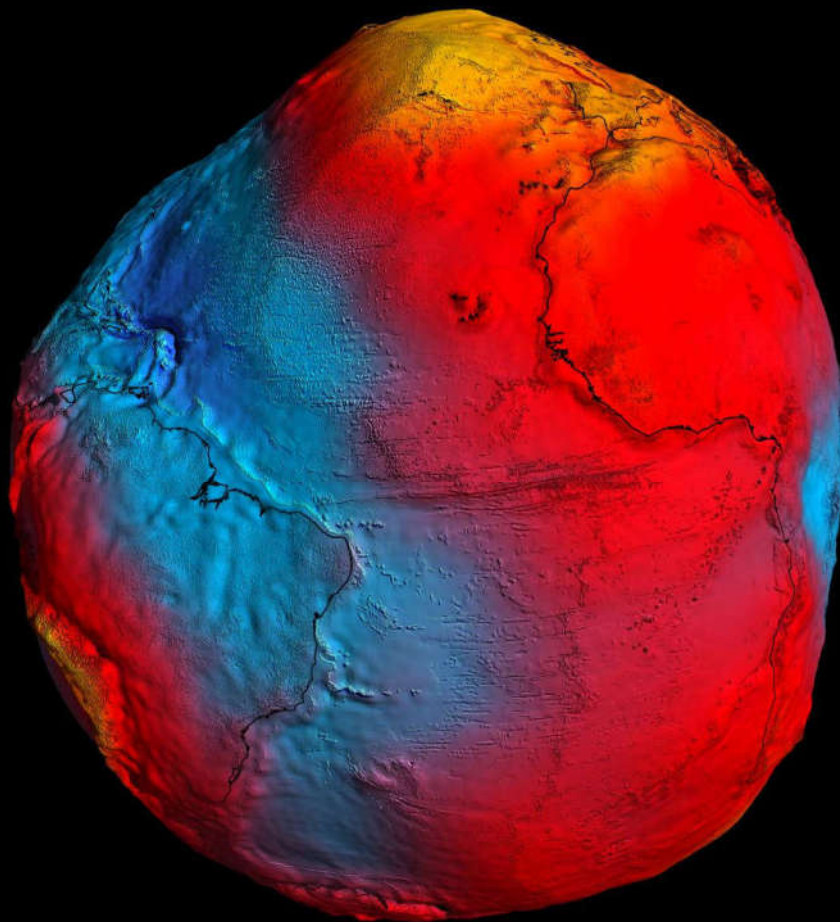
Geoid je določen z vrednostmi N (geoidnih višin) oz. ζ (anomalij višin) v neki obliki:

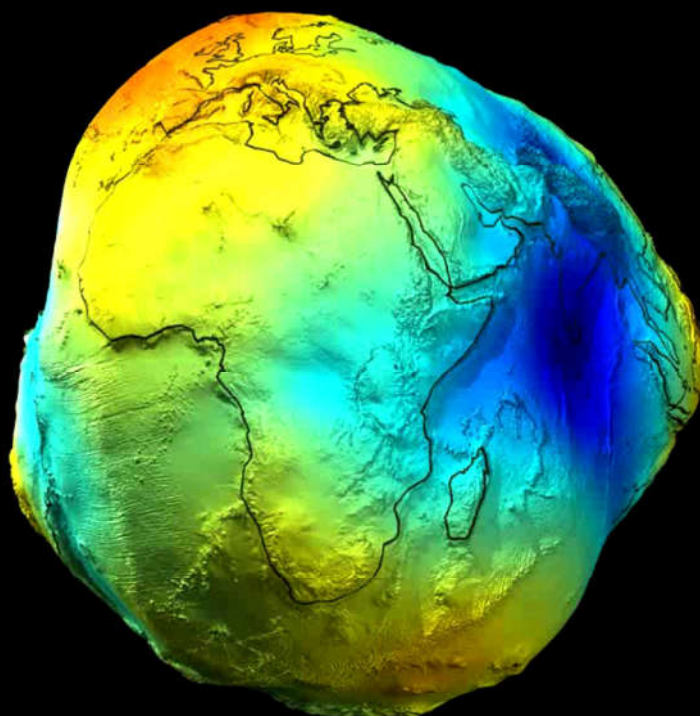
- neskončna matematična vrsta (zajema celotno Zemljino oblo), razvoj potenciala težnosti v vrsto po sfernih funkcijah → **globalni geopotencialni model**.
- Mreža diskretnih točk z znanim položajem in geoidno višino,
- Enostavna funkcija (polinom) → aproksimacija na lokalnem območju.
$$N(y,x) = Ay + Bx + C$$
- Grafična predstavitev (plastnice).

EGM96 – globalni geopotencialni model



Globalni geoid





IGFM



Global Gravity Field Models

We kindly ask the authors of the models to check the links to the original websites of the models from time to time. Please let us know if something has changed.

The table can be interactively re-sorted by clicking on the column header fields (Nr, Model, Year, Degree, Data, Reference).

In the data column, the datasets used in the development of the models are summarized, where **A** is for altimetry, **S** is for satellite (e.g., GRACE, GOCE, LAGEOS), **G** for ground data (e.g., terrestrial, shipborne and airborne measurements) and **T** is for topography.

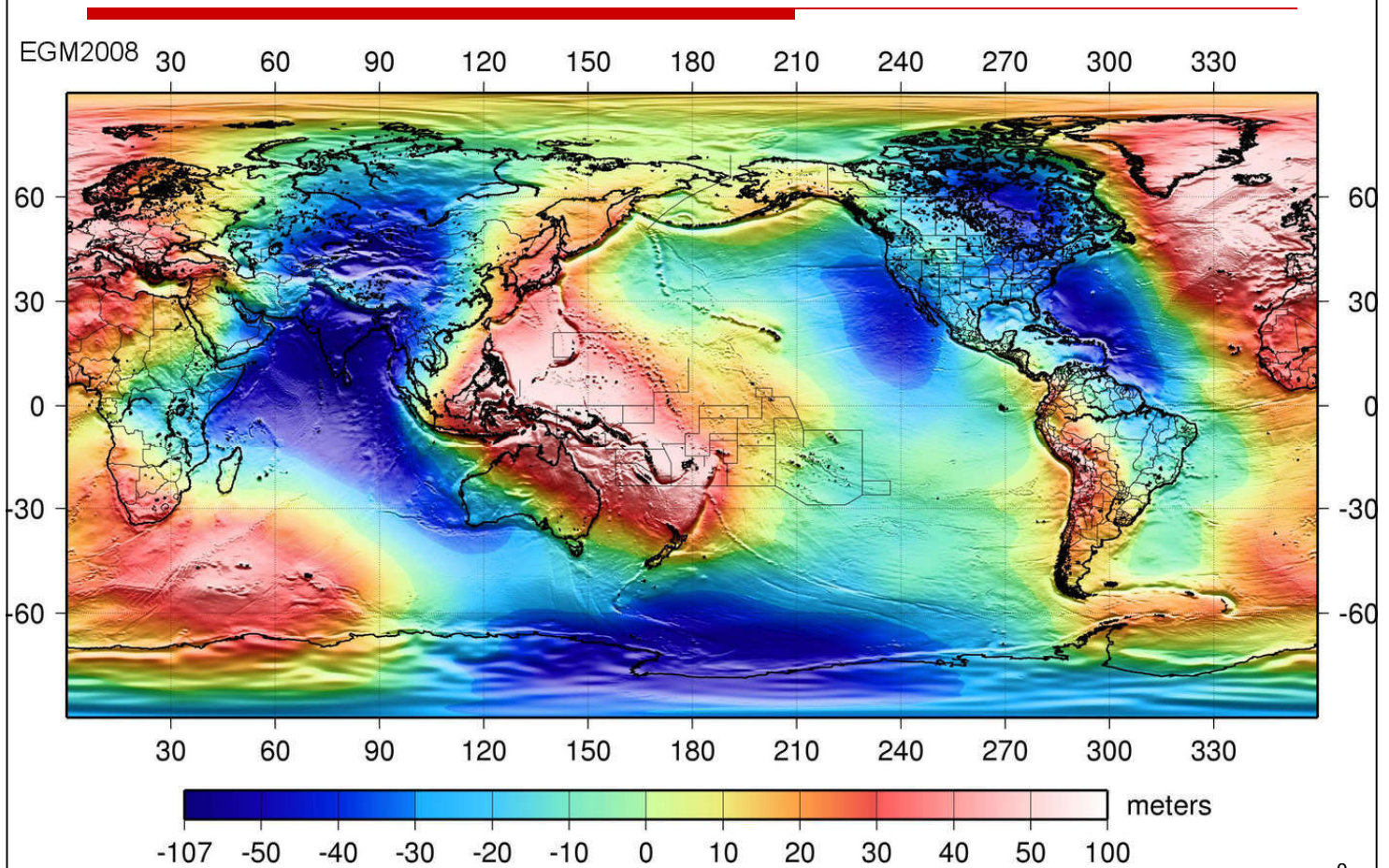
The links **calculate** and **show** in the last columns of the table directly invoke the Calculation Service and Visualization page for the selected model.

For models with a registered **doi** ("digital object identifier") the last column contains the symbol , which directly opens the page on "http://dx.doi.org".

If you click on the reference, the complete list of references can be seen.

Nr	Model	Year	Degree	Data	References	Download	Calculate	Show	DOI
176	XGM2019e_2159	2019	2190 5540 760	A, G, S(GOCO06s), T	Zingerle, P. et al, 2019	gfc zip gfc zip gfc zip	Calculate	Show	✓
175	GO_CONS_GCF_2_TIM_R6e	2019	300	G (Polar), S(Goce)	Zingerle, P. et al, 2019	gfc zip	Calculate	Show	✓
174	ITSG-Grace2018s	2019	200	S(Grace)	Mayer-Gürr, T. et al, 2018	gfc zip	Calculate	Show	✓
173	EIGEN-GRGS.RL04.MEAN-FIELD	2019	300	S	Lemoine et al, 2019	gfc zip	Calculate	Show	✓
172	GOCO06s	2019	300	S	Kvas et al., 2019	gfc zip	Calculate	Show	✓
171	GO_CONS_GCF_2_TIM_R6	2019	300	S(Goce)	Brockmann, J. M. et al, 2014	gfc zip	Calculate	Show	✓
170	GO_CONS_GCF_2_DIR_R6	2019	300	S	Bruinsma, S. L. et al, 2014	gfc zip	Calculate	Show	✓
169	IGGT_R1C	2018	240	G, S(Goce), S(Grace)	Lu, B. et al., 2019	gfc zip	Calculate	Show	✓
168	Tongji-Grace02k	2018	180	S(Grace)	Chen, Q. et al, 2018	gfc zip	Calculate	Show	✓
167	SGG-UGM-1	2018	2159	EGM2008, S(Goce)	Liang, W. et al., 2018 & Xu, X. et al. (2017)	gfc zip	Calculate	Show	✓
166	GOSG01S	2018	220	S(Goce)	Xu, X. et al., 2018	gfc zip	Calculate	Show	✓
165	IGGT_R1	2017	240	S(Goce)	Lu, B. et al, 2017	gfc zip	Calculate	Show	✓
164	HE_GOC05s	2017	250	S	Wu, H. et al, 2017	gfc zip	Calculate	Show	✓
163	GO_CONS_GCF_2_SPW_R5	2017	330	S(Goce)	Gatti, A. et al, 2016	gfc zip	Calculate	Show	✓
162	GAO2012	2012	360	A, G, S(Goce), S(Grace)	Demianov, G. et al, 2012	gfc zip	Calculate	Show	✓
161	XGM2016	2017	719	A, G, S(GOCO05s)	Pail, R. et al, 2017	gfc zip	Calculate	Show	✓
160	Tongji-Grace02s	2017	180	S(Grace)	Chen, Q. et al, 2016	gfc zip	Calculate	Show	✓
159	NULP-02s	2017	250	S(Goce)	A.N. Marchenko et al, 2016	gfc zip	Calculate	Show	✓
158	HUST-Grace2016s	2016	160	S(Grace)	Zhou, H. et al, 2016	gfc zip	Calculate	Show	✓
157	ITU_GRACE16	2016	180	S(Grace)	Akyilmaz, O. et al, 2016	gfc zip	Calculate	Show	✓
156	ITU_GGC16	2016	280	S(Goce), S(Grace)	Akyilmaz, O. et al, 2016	gfc zip	Calculate	Show	✓

EGM08 – globalni geopotencialni model

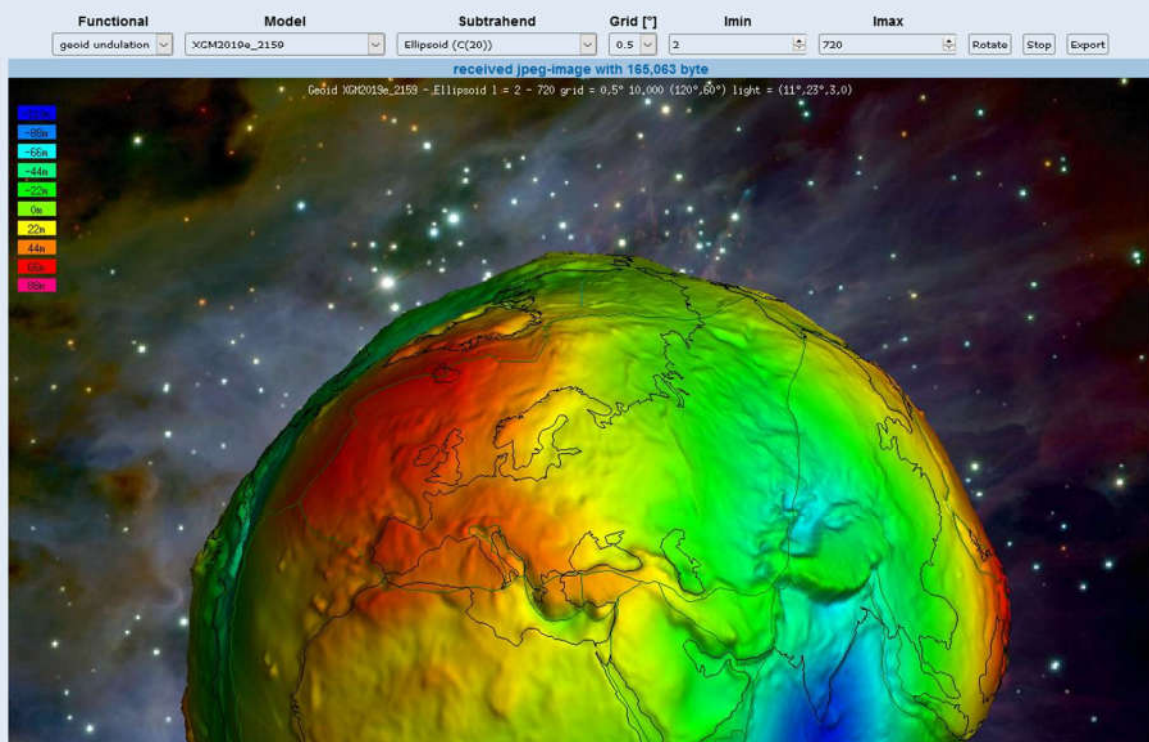


M. Kuhar - Referenčni sistemi

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Visualization of Gravity Field Models and their Differences

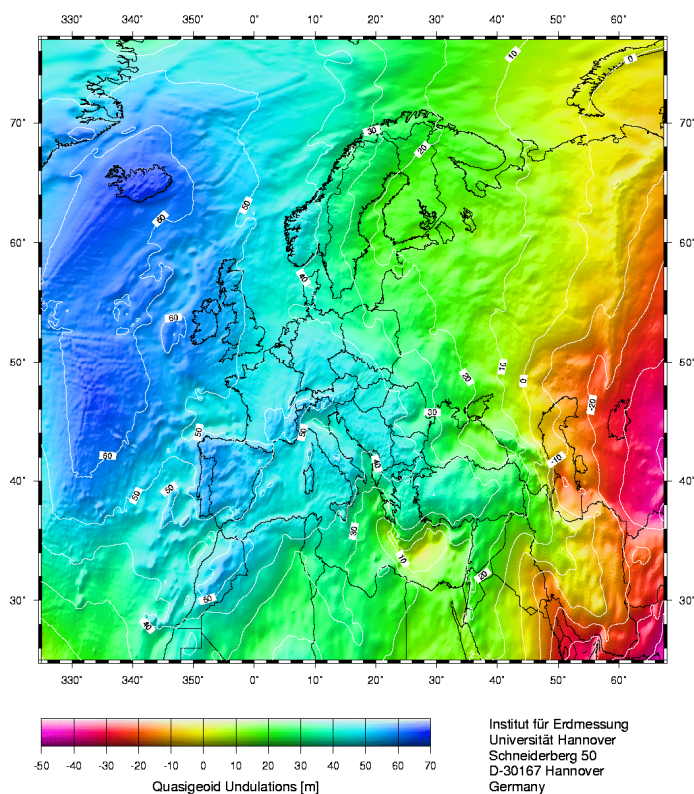
This is an interactive web site (based on Javascript) to visualize the Geoid and other gravity functionals of the Earth. Please have some seconds patience for generating the image on the server.
The Geoid undulations are multiplied with a so-called radial 'boost factor' (initial value: $b = 10,000$) to make them visible.
You can select another Functional, gravity Model and Subtrahend model (to display model differences).
The option Grid defines the resolution of the view: smaller values show more details, but require more computing time (on the server).



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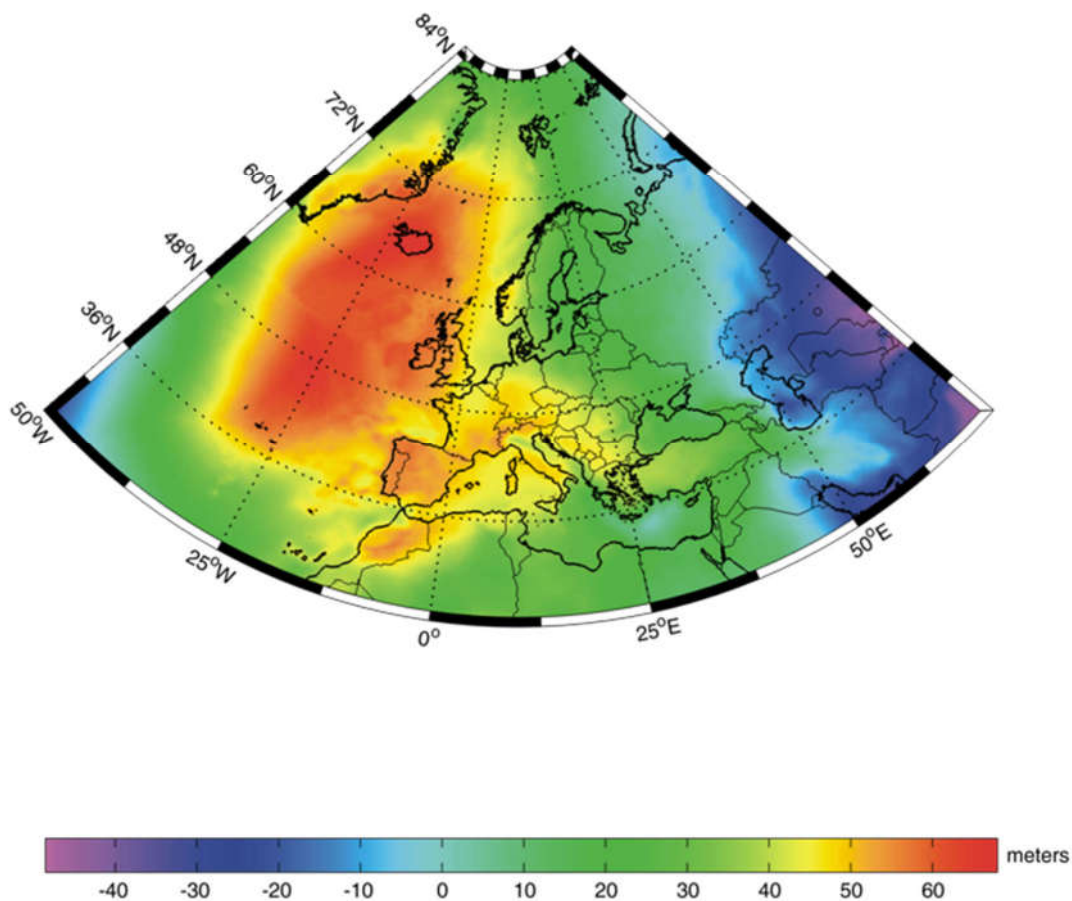
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Quasigeoid Model EGG97

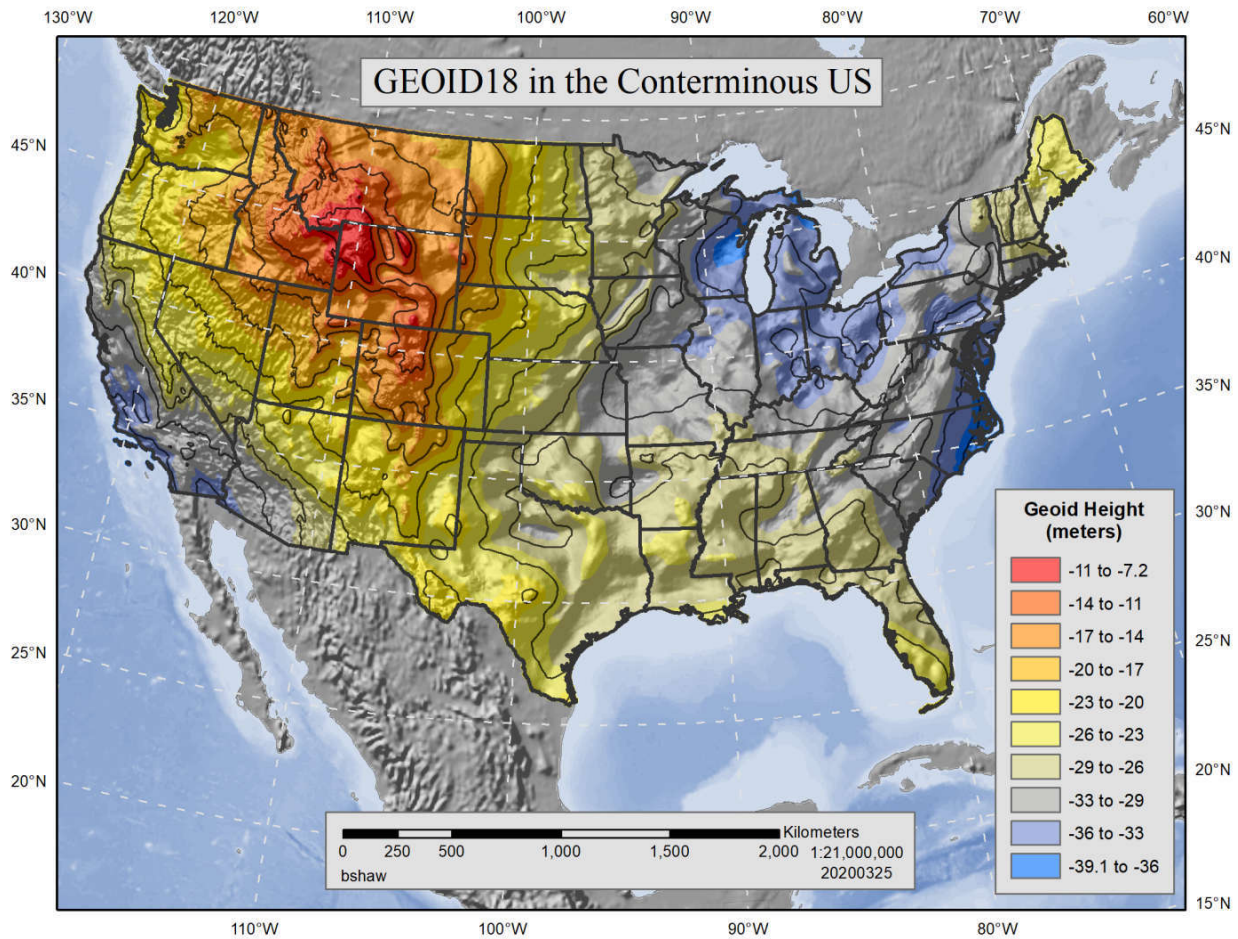


Evropski gravimetrični
geoid 1997

EGG2015

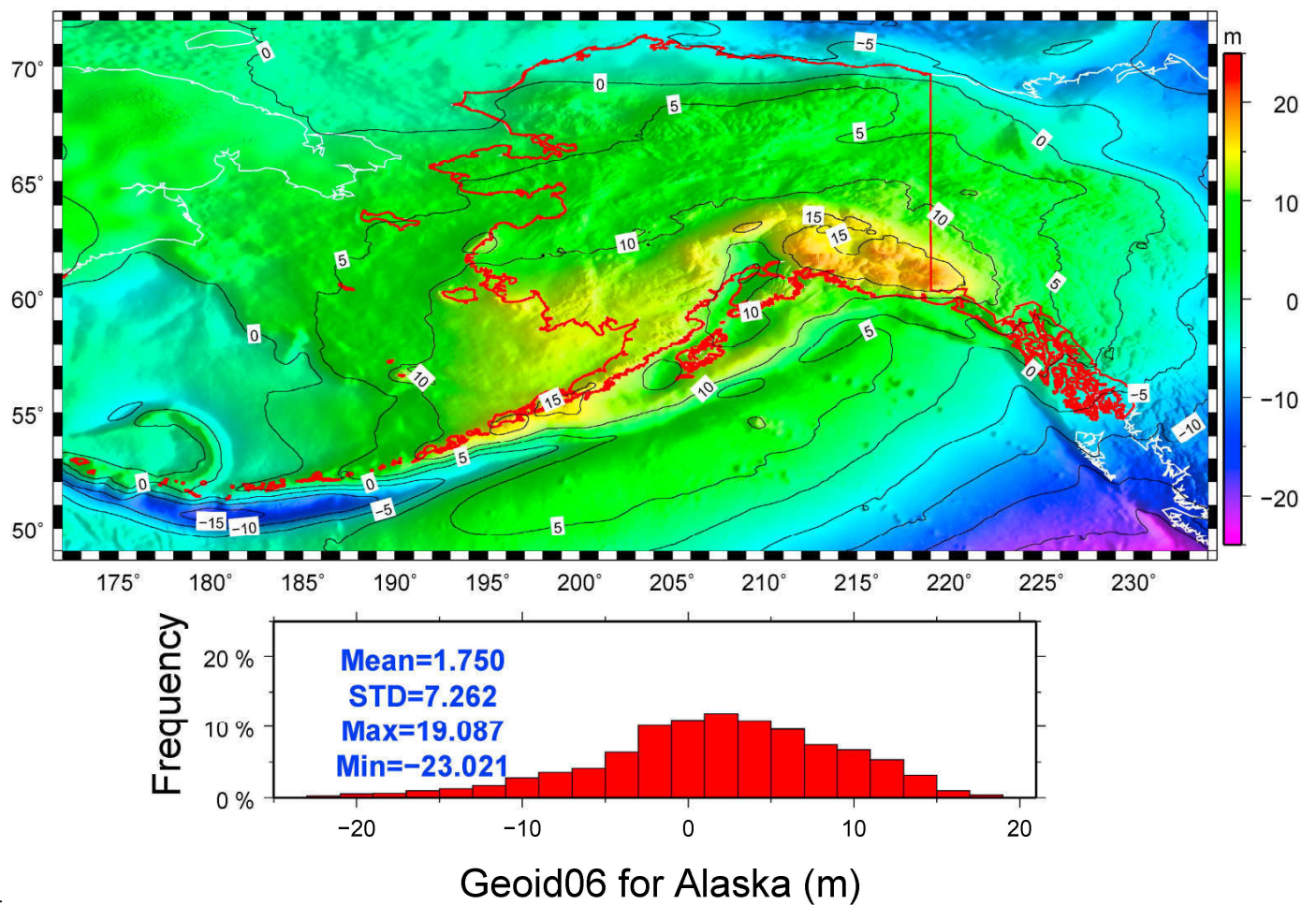


Nacionalni geoidi



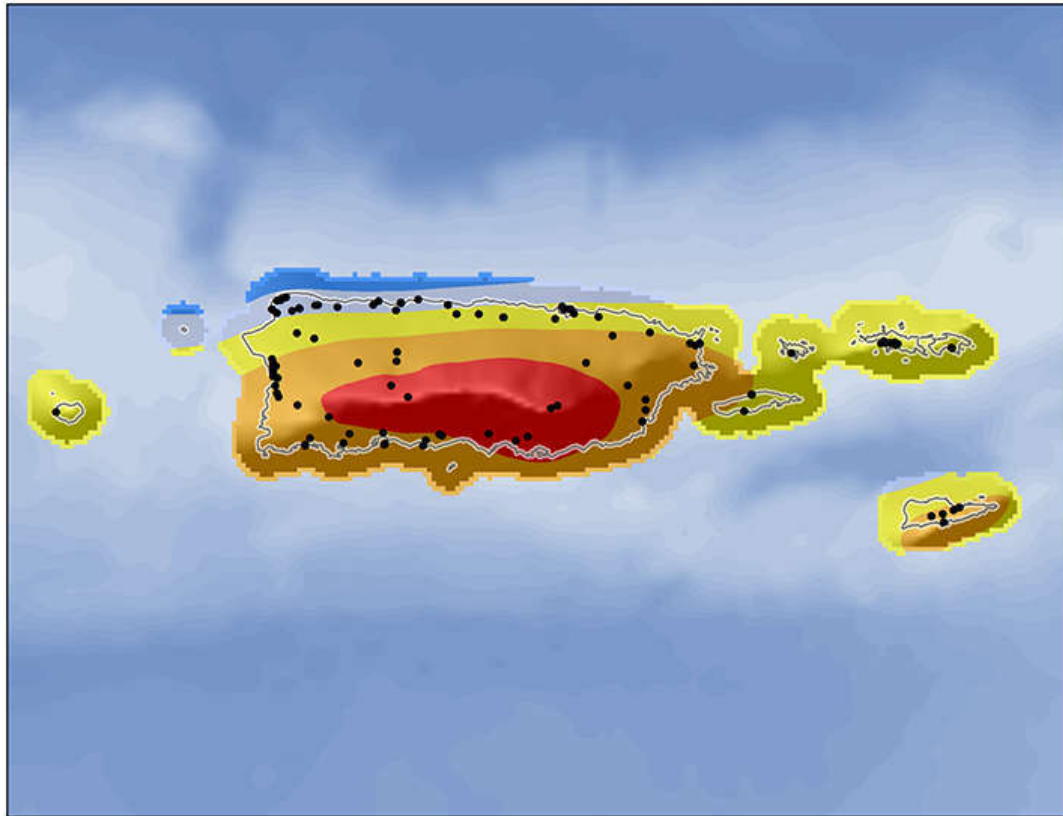
M. Ku

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M.

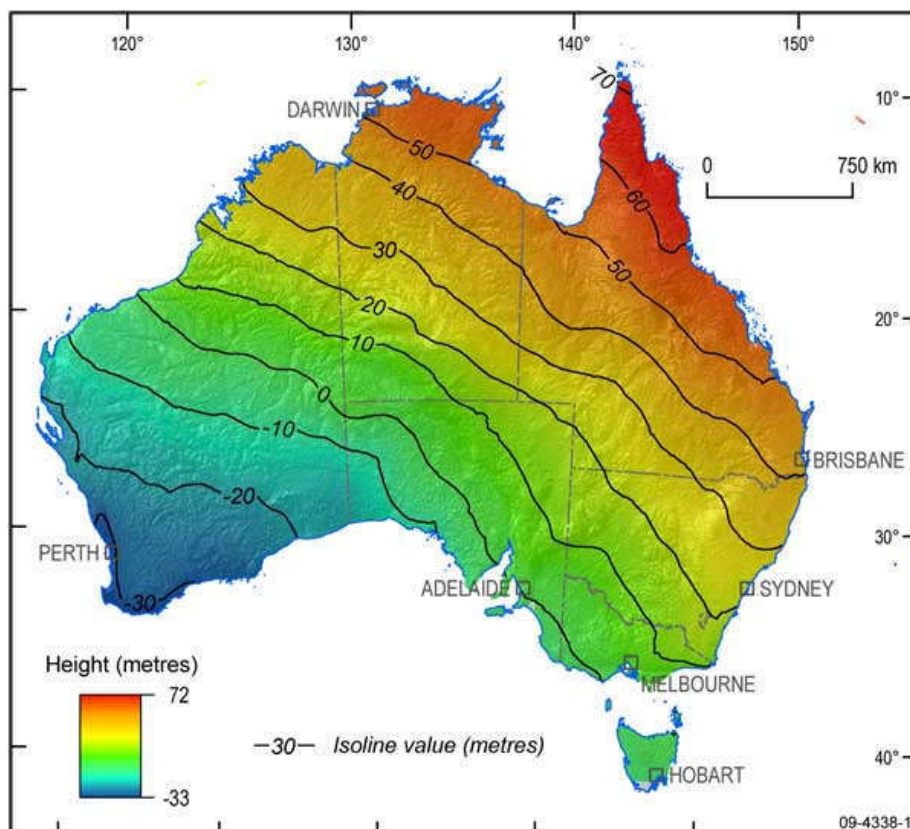
Portoriko (ZDA)



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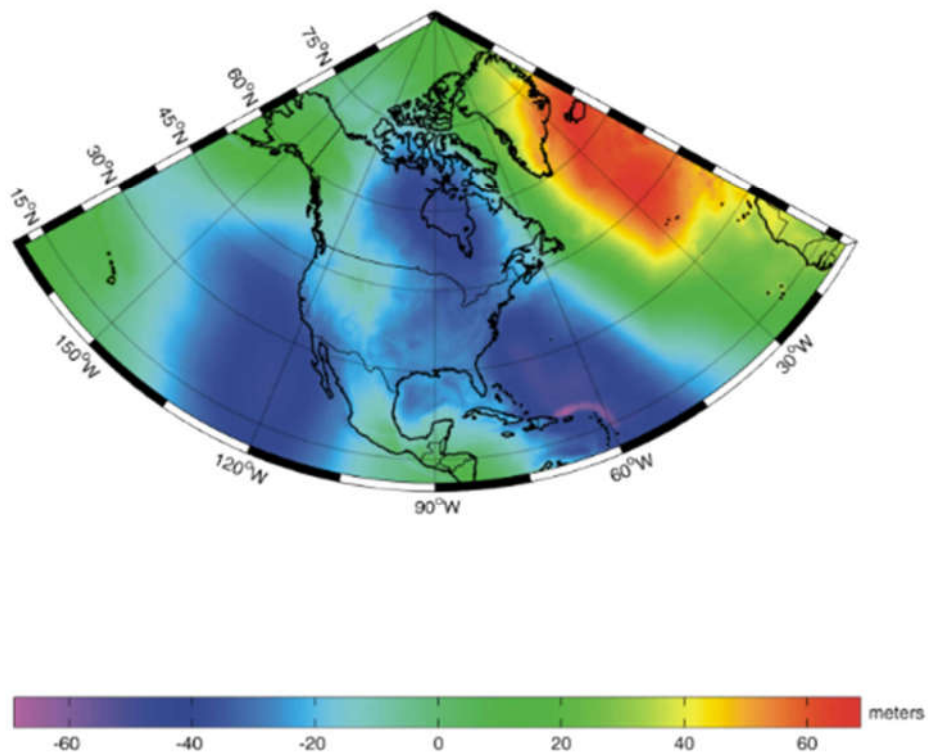
Avstralija (2009)



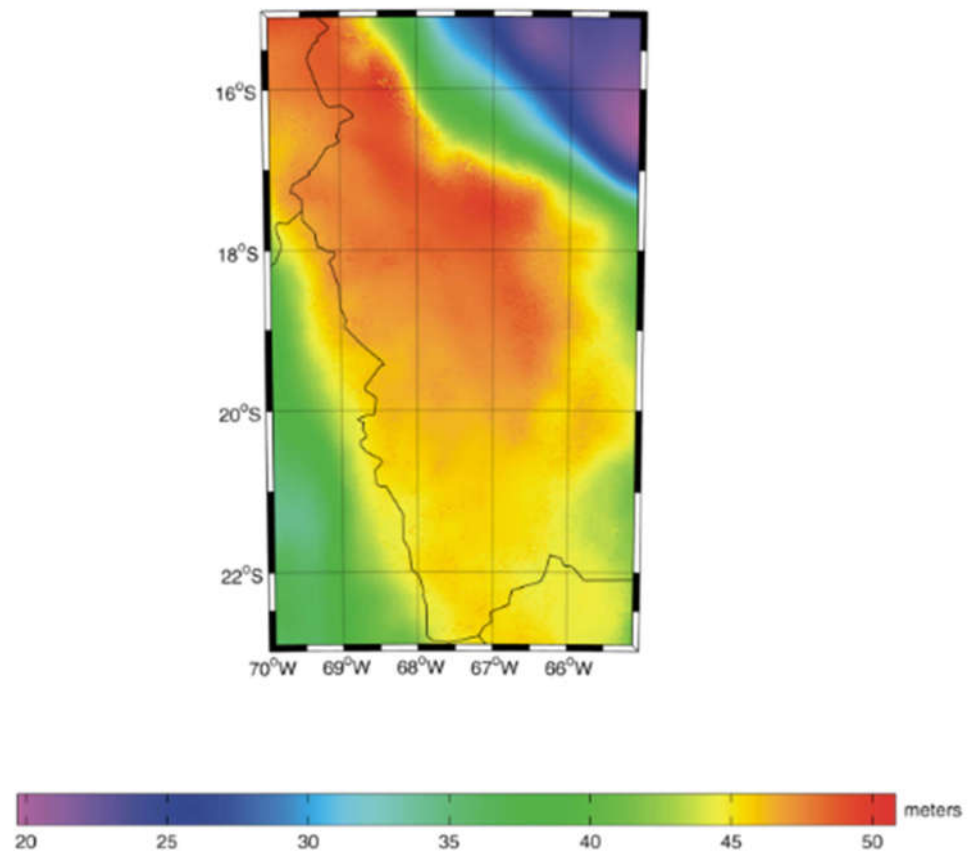
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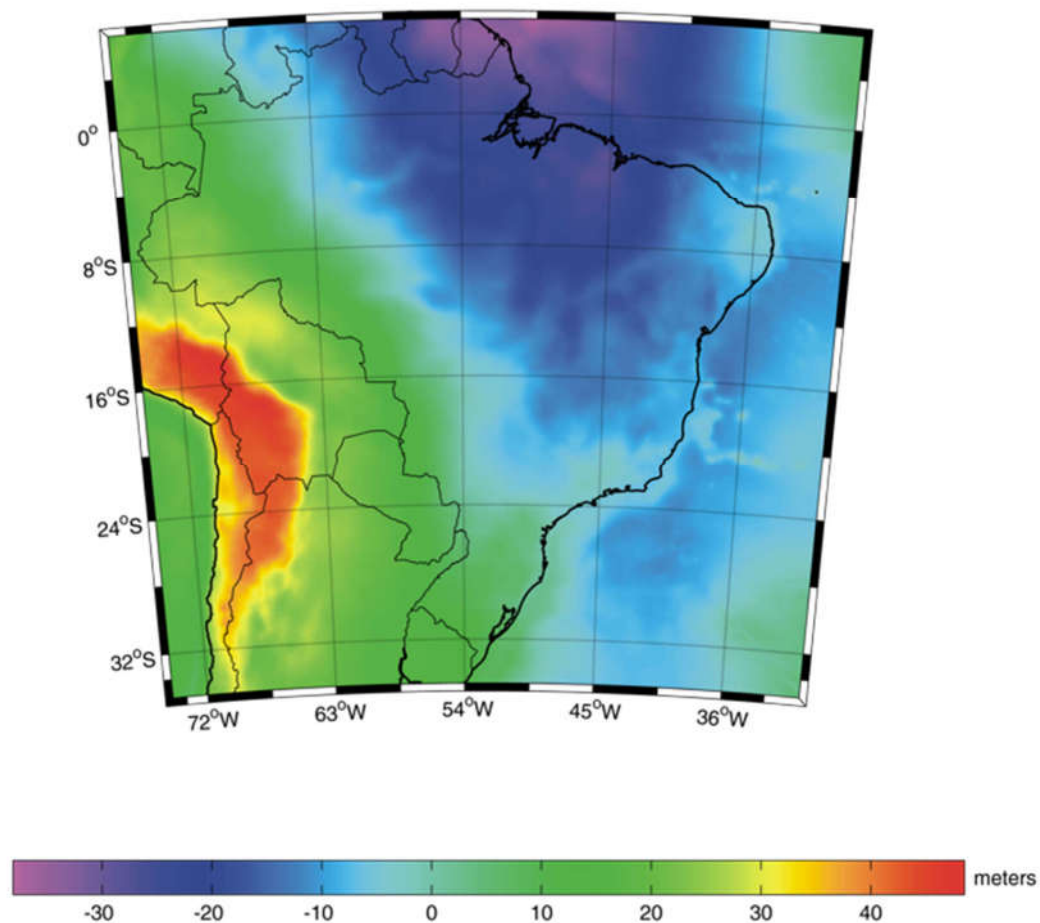
Kanada (2010)



Bolivija (2006)



Brazilija (2015)



Iran (2004)

Filipini (2017)

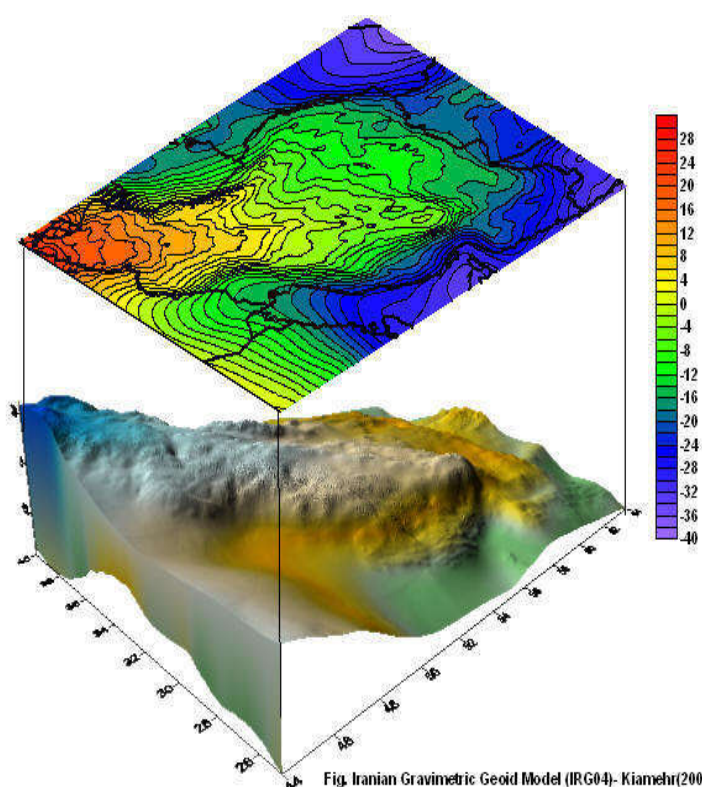
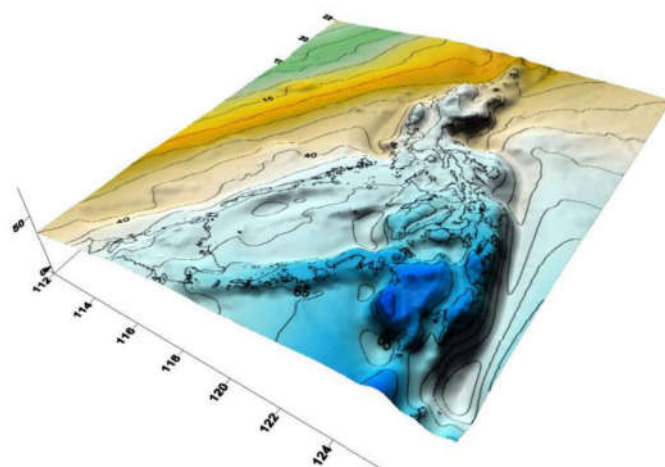
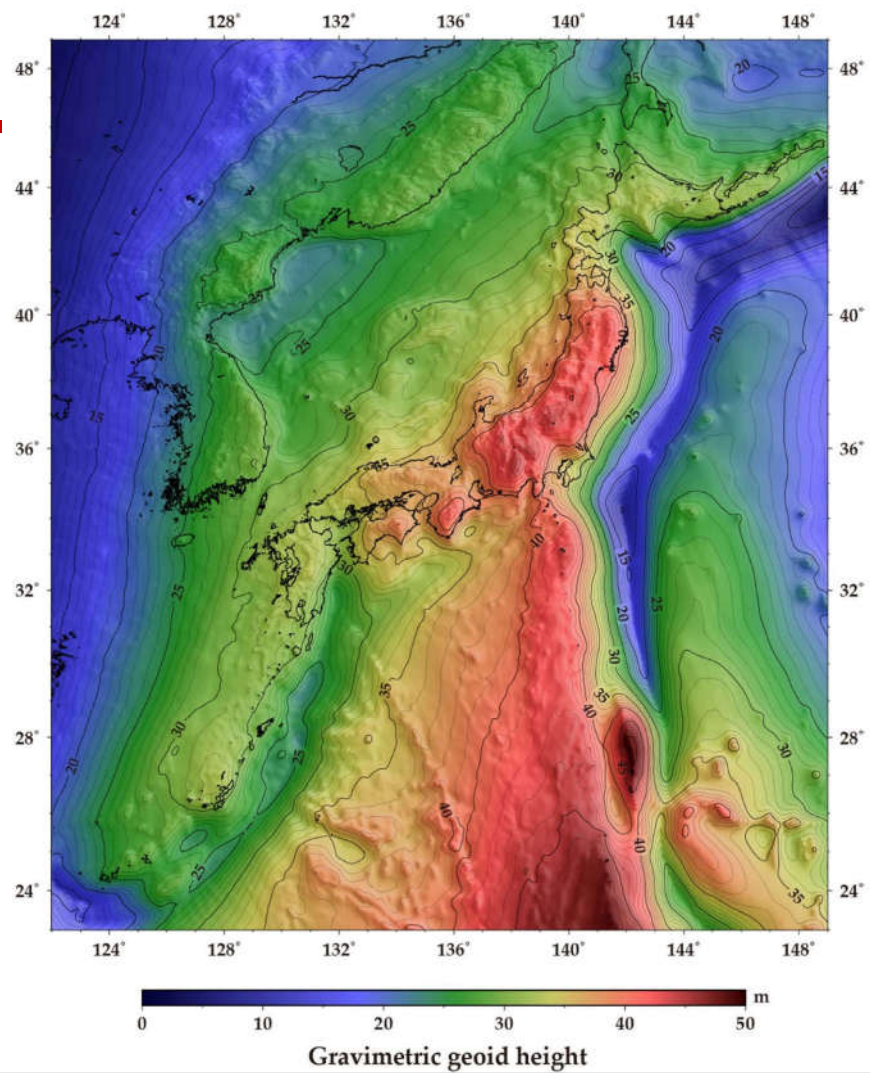


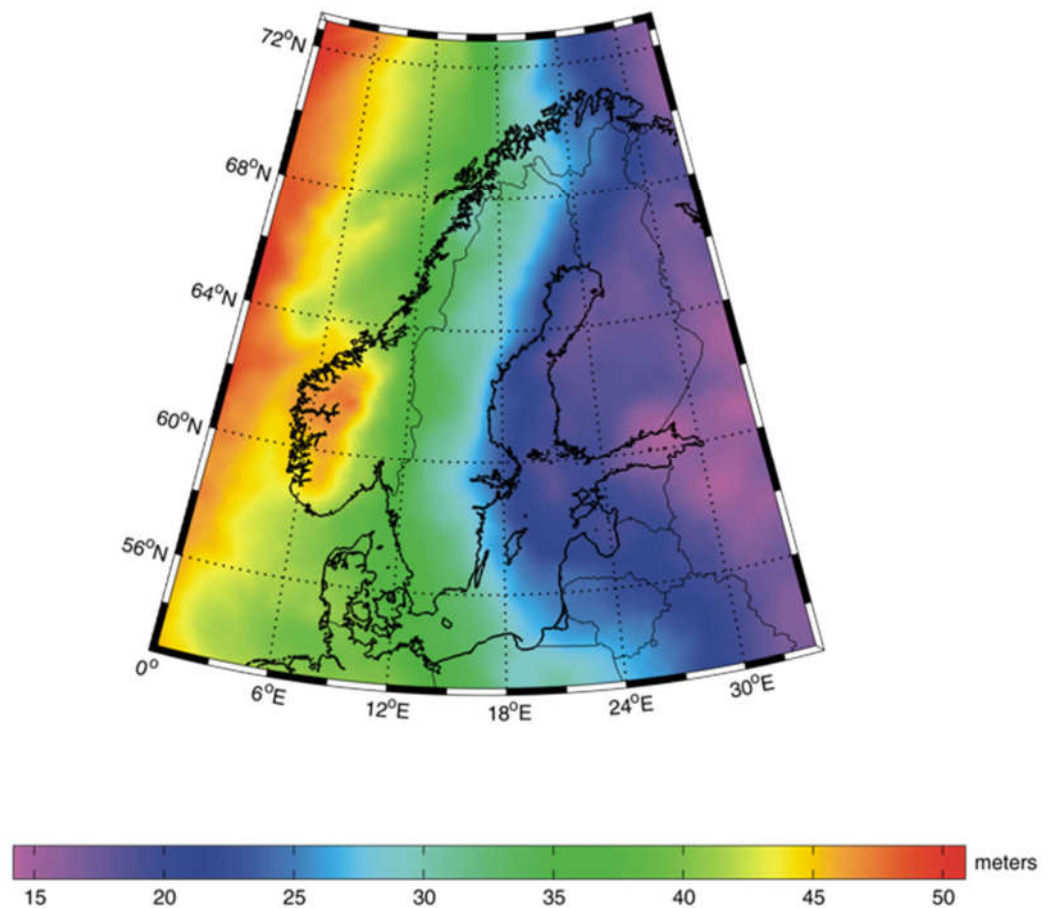
Fig. Iranian Gravimetric Geoid Model (IRG04)- Kiamehr(2006)



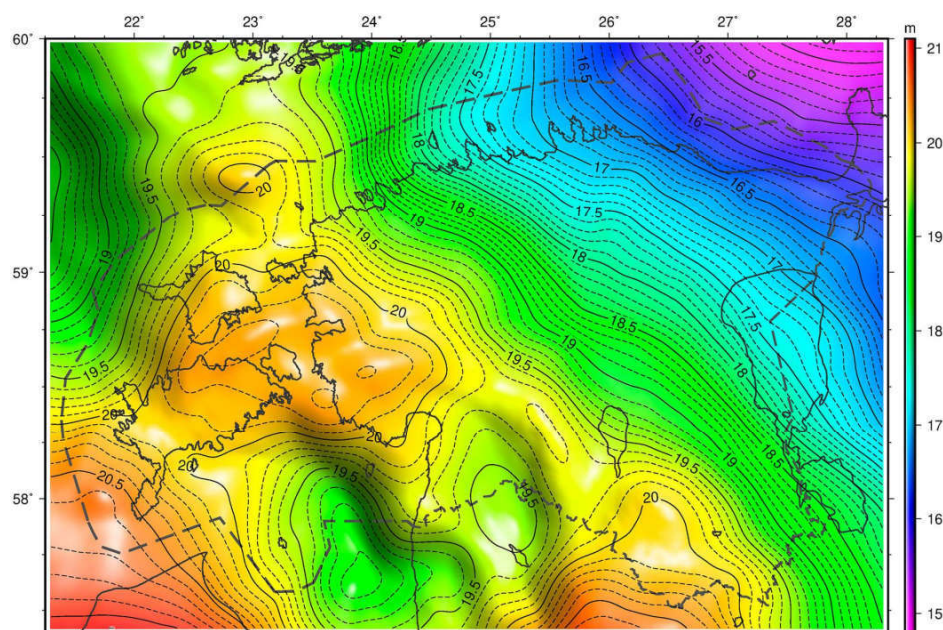
Japonska (2020)



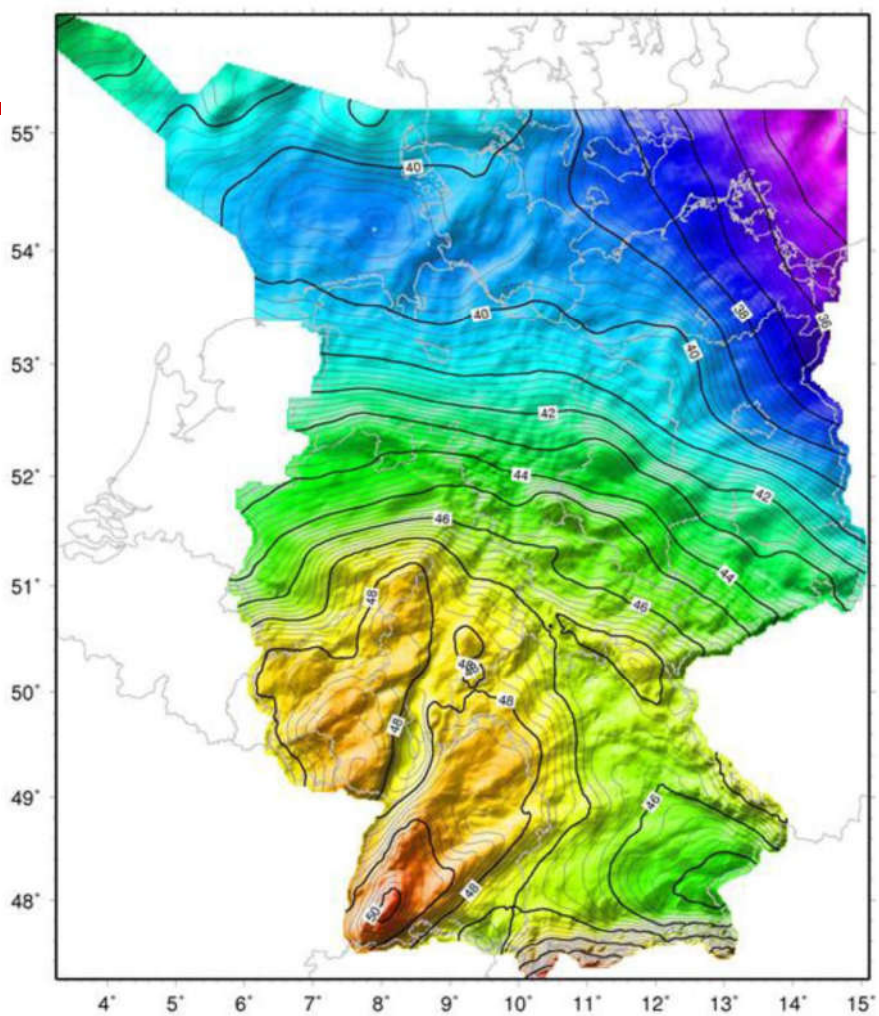
Skandinavija (2015)



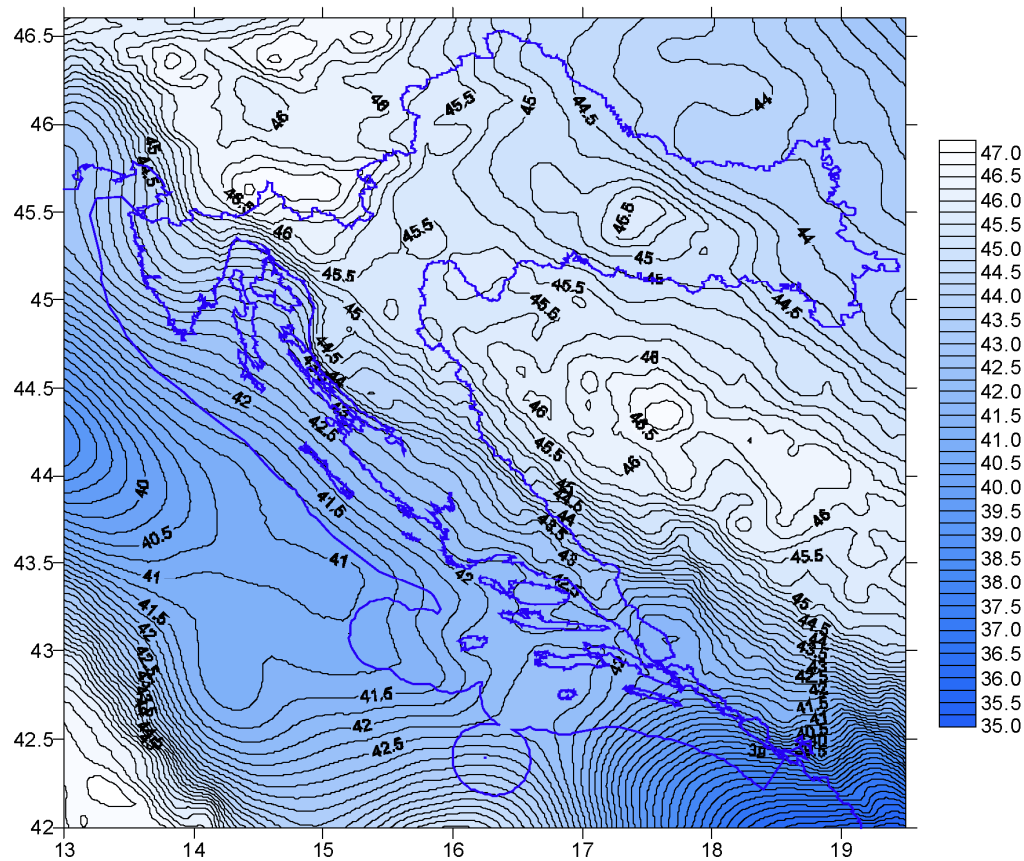
Estonija (2017)



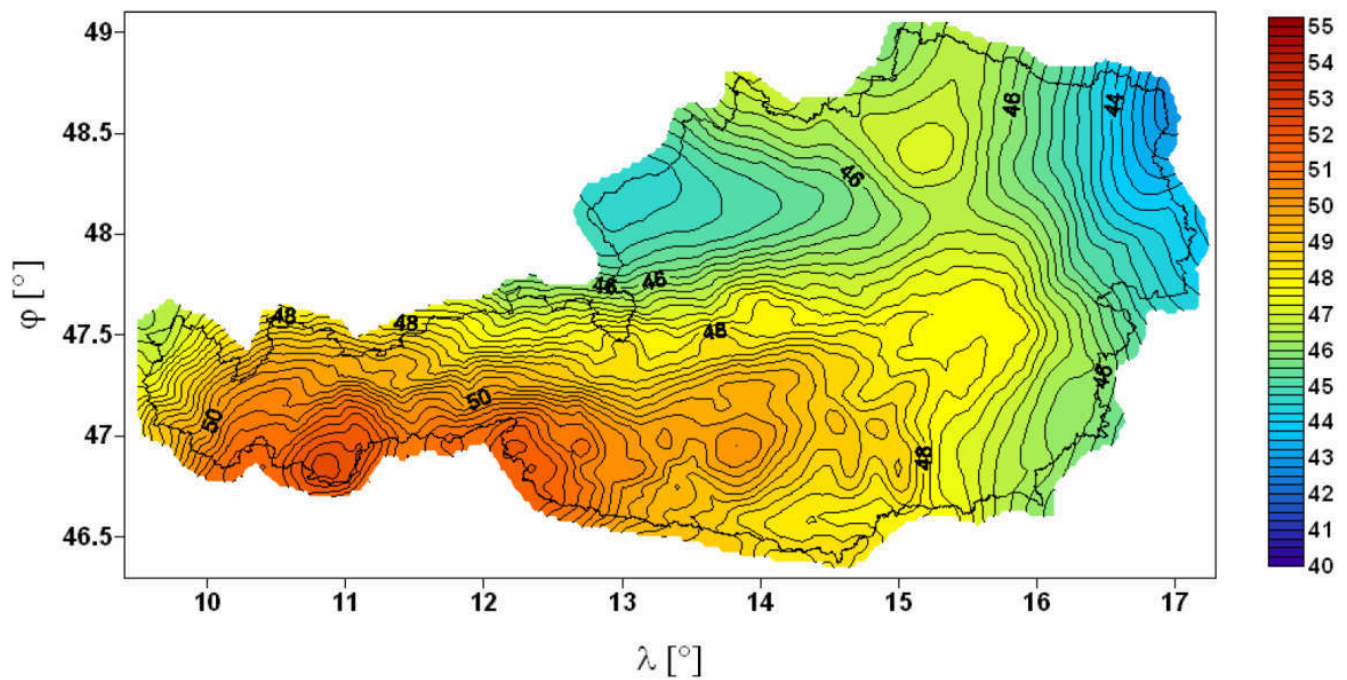
(German Combined QuasiGeoid 2016)



HR in BiH

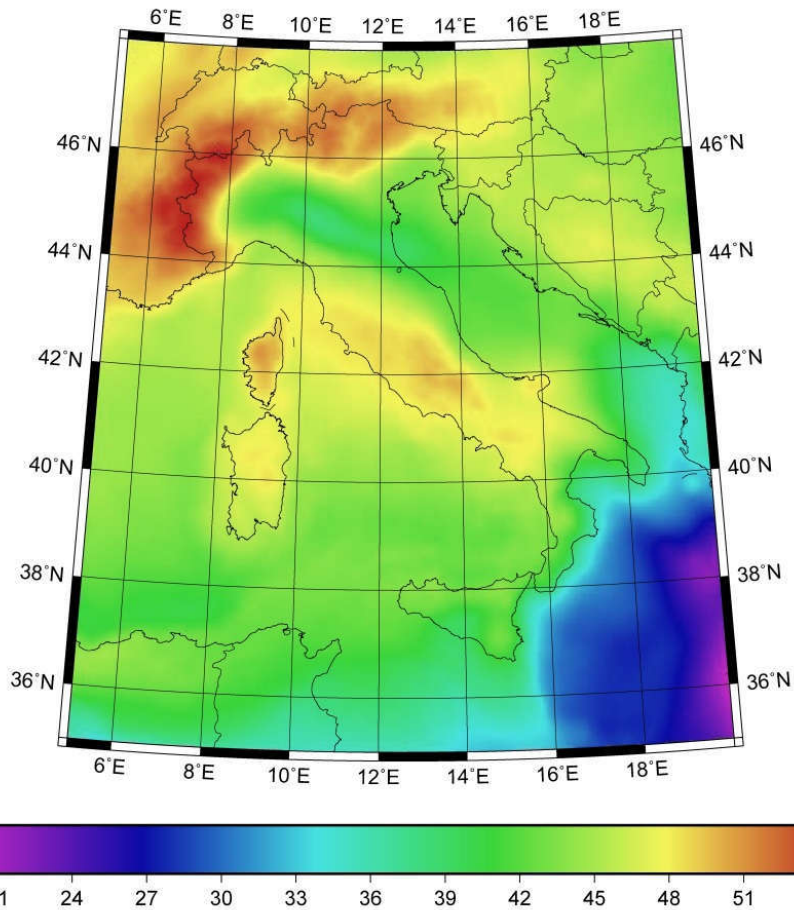


Avstrija



Italija

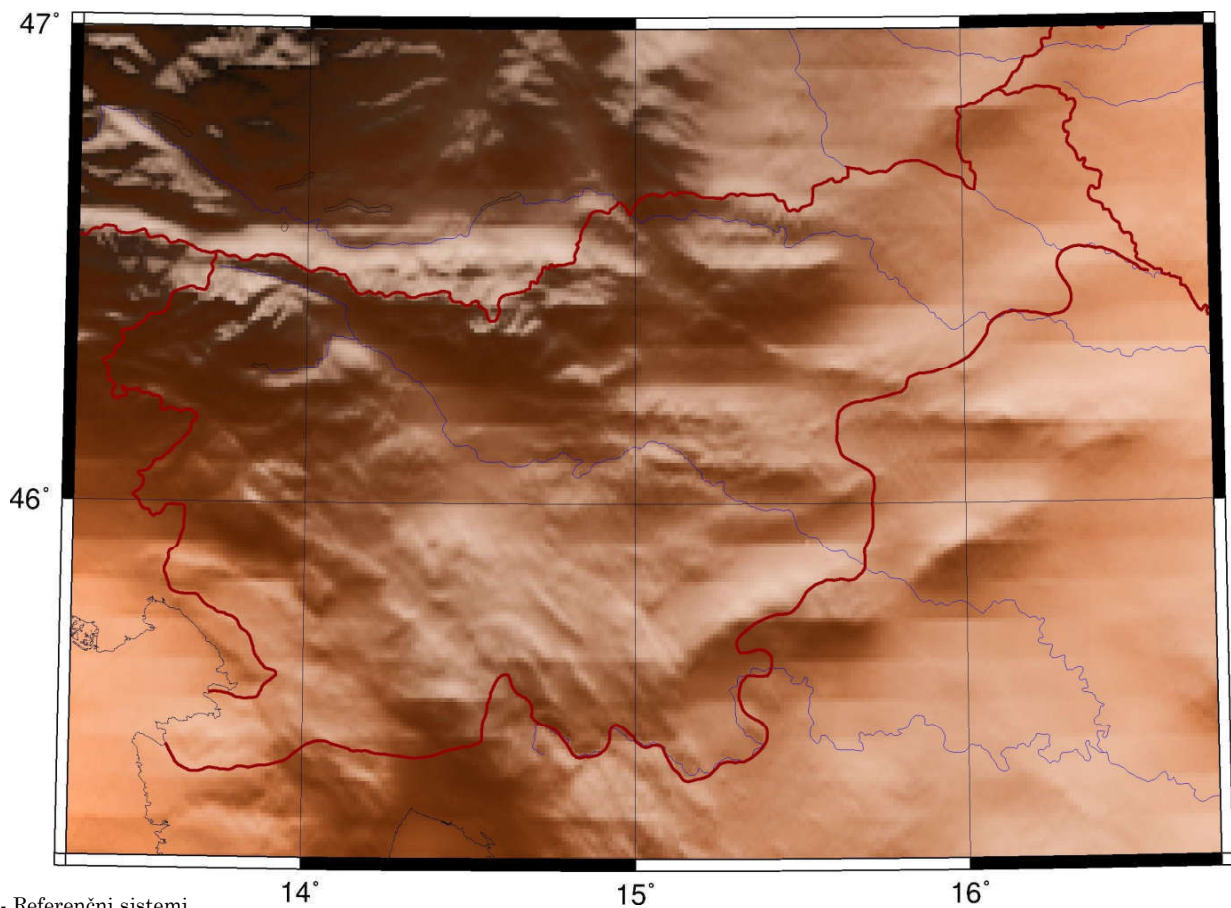
Italgeo05



M. Kuhar - Referenčni siste

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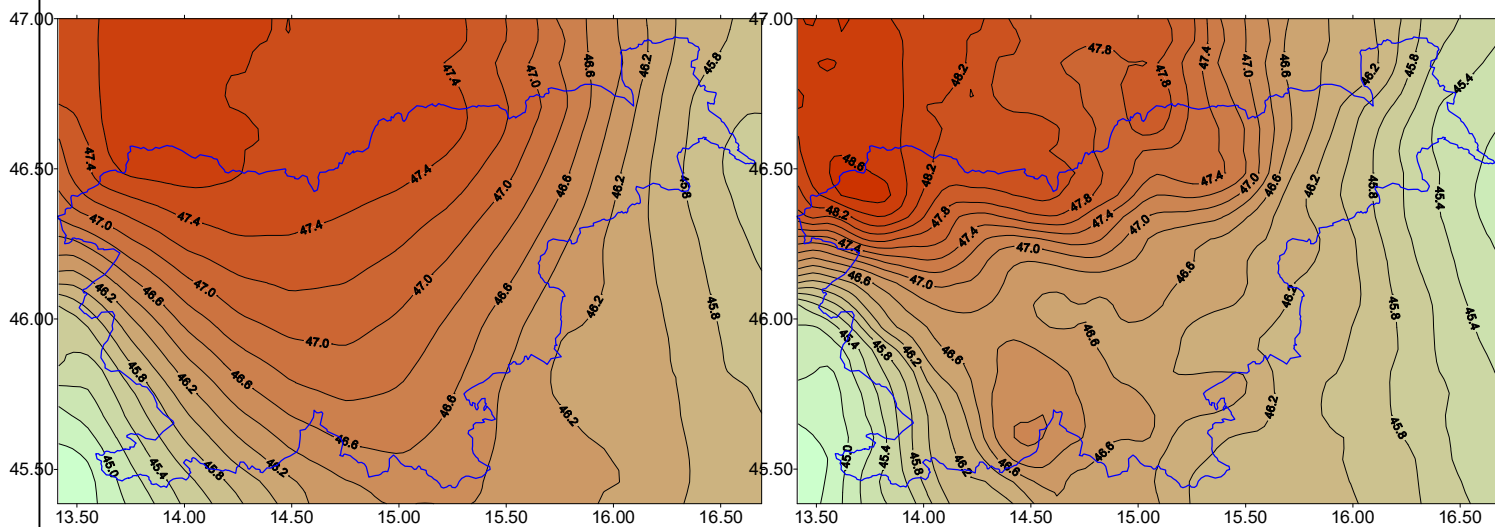
Geoid na območju Slovenije (senčen prikaz)



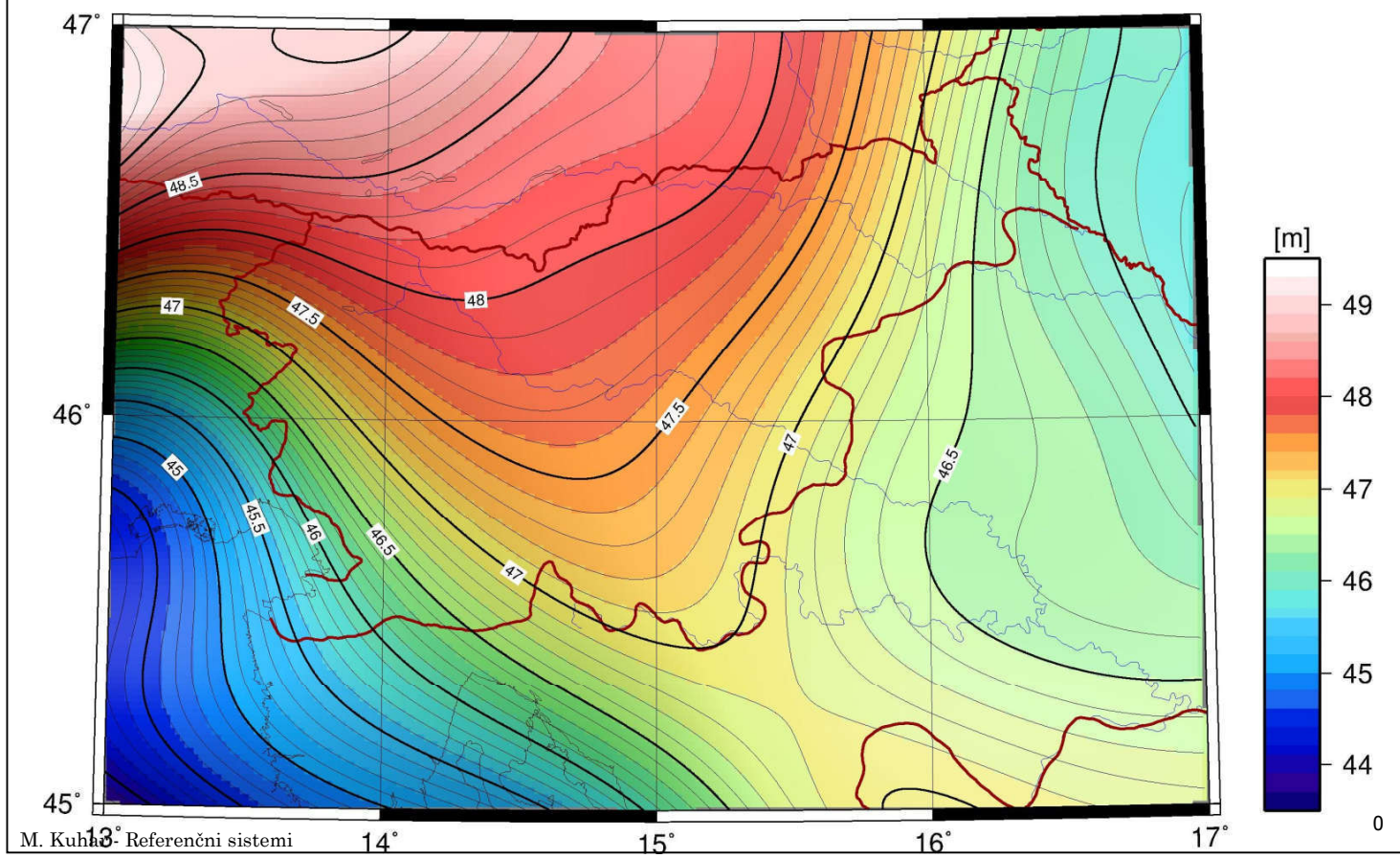
M. Kuhar - Referenčni sistemi

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Globalni in evropski geoid na območju Slovenije

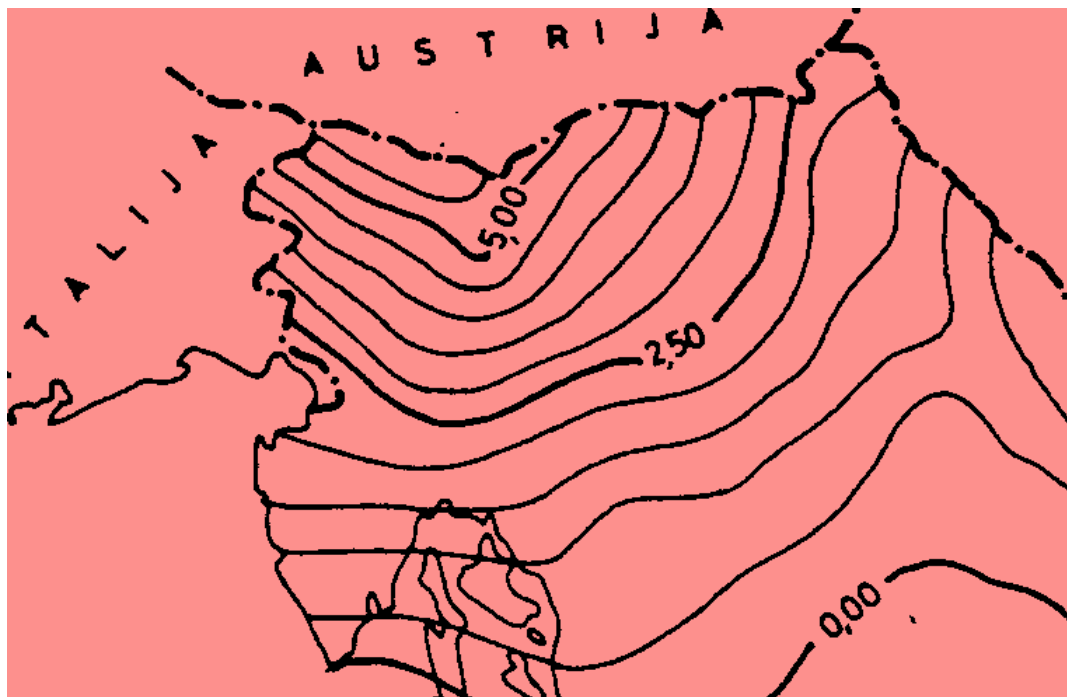


EGM96 na območju Slovenije



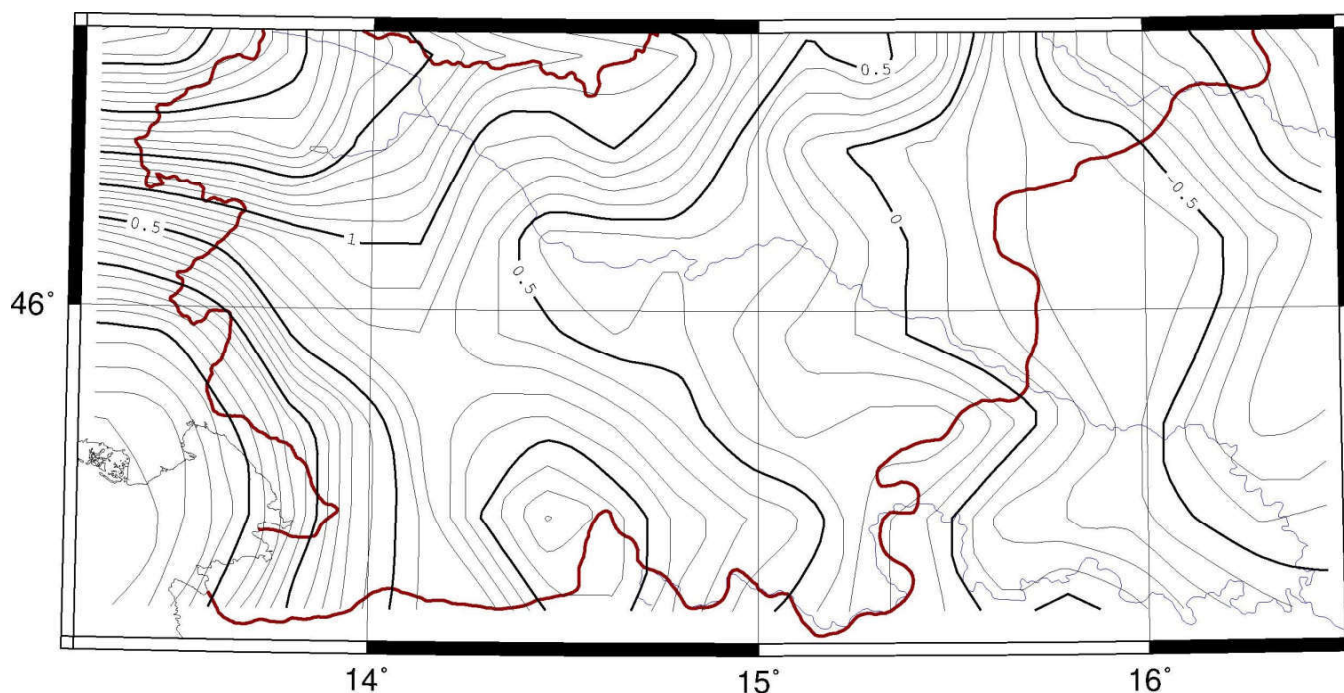
Raziskave ploskve geoida v Sloveniji (1)

- Prof. A. Muminagić (1974), astrogeodetska rešitev (Besselov elipsoid).



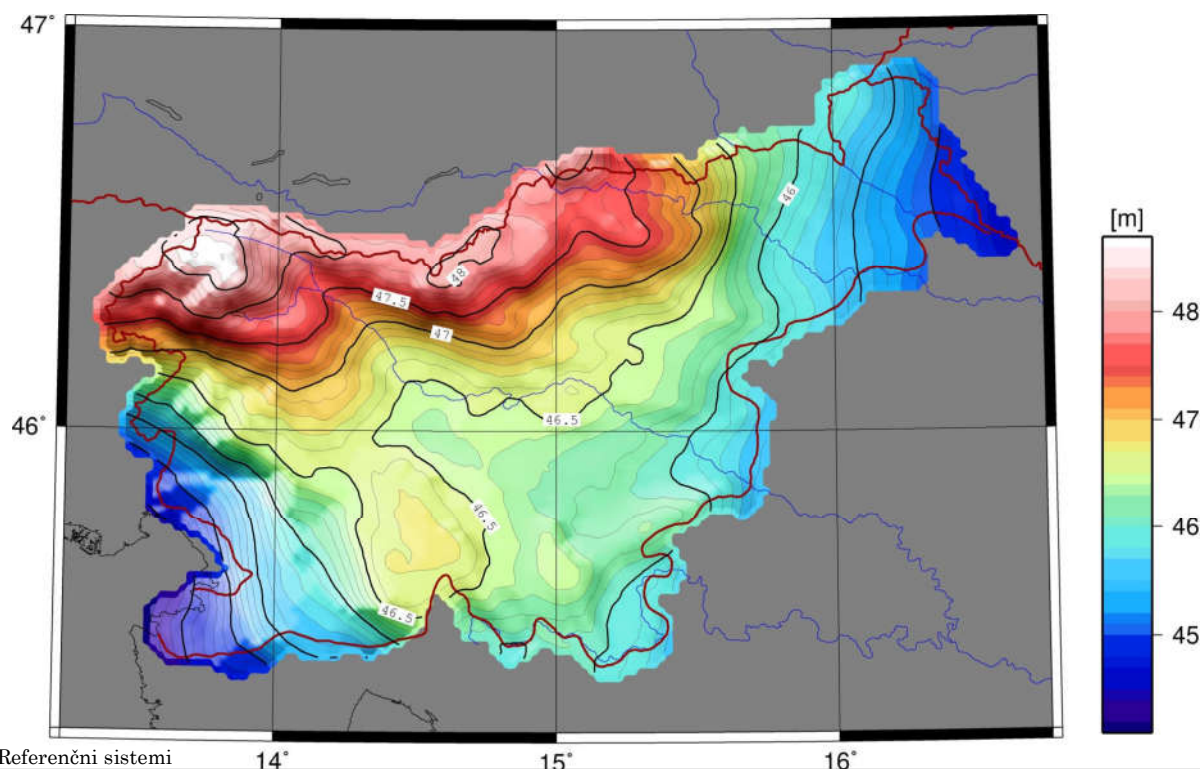
Geoid v Sloveniji (2)

- Prof. dr. T. Bašić, (GF Zagreb), 1993, astrogeodetska rešitev (Besselov elipsoid).



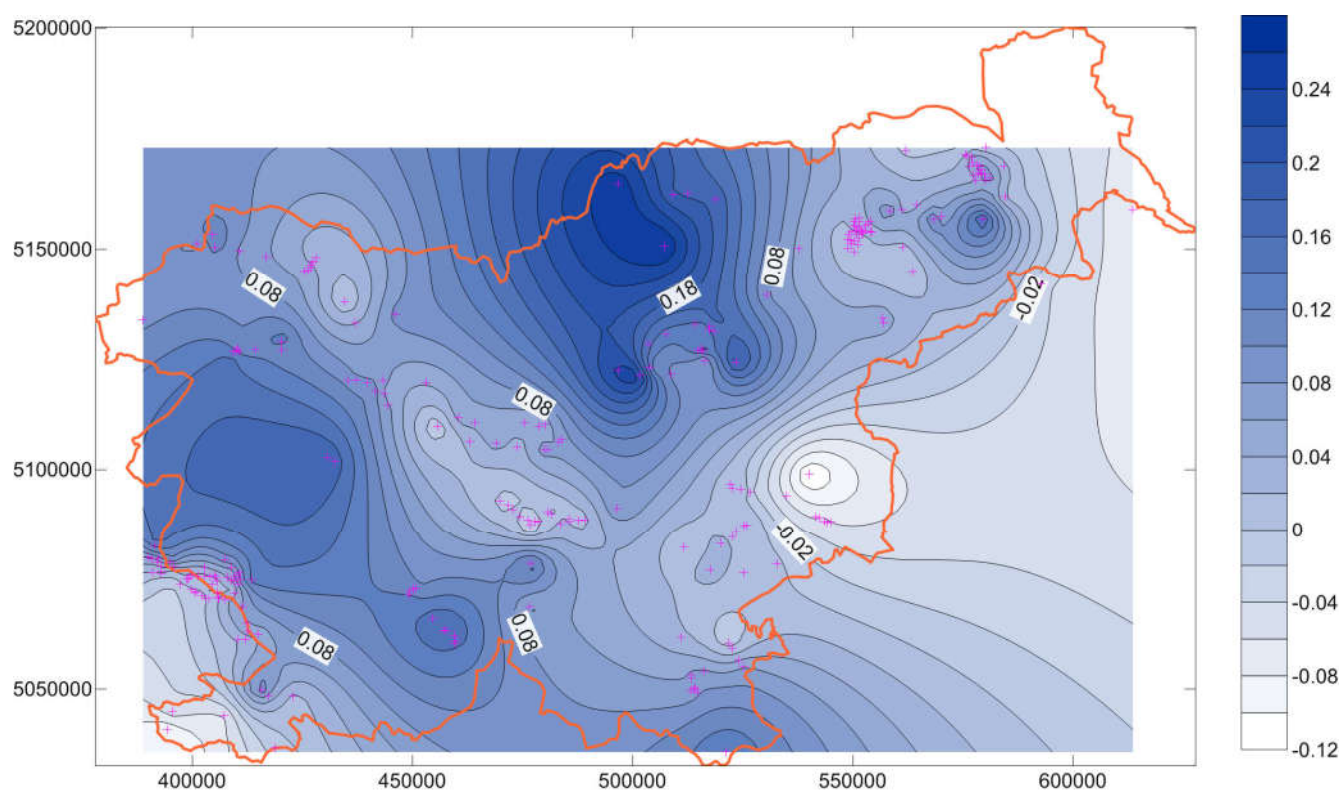
Geoid v Sloveniji (3), trenutno v uporabi

- Prof. dr. B. Pribičević (GF Zagreb), 2000, kombinirana rešitev, kolokacija MNK (elipsoid GRS-80).



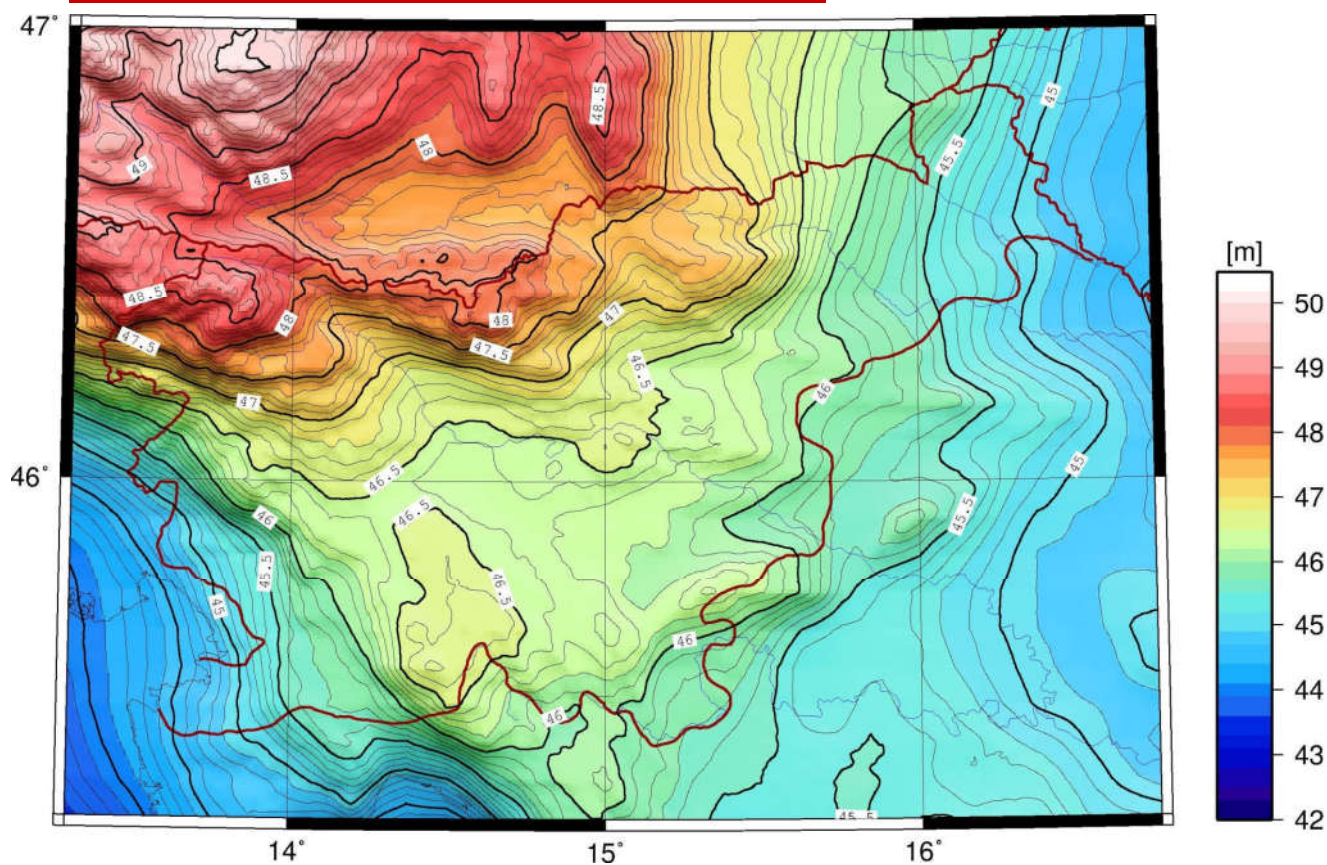
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Rešitev iz leta 2000: odstopanja na "GPS/nivelman" točkah

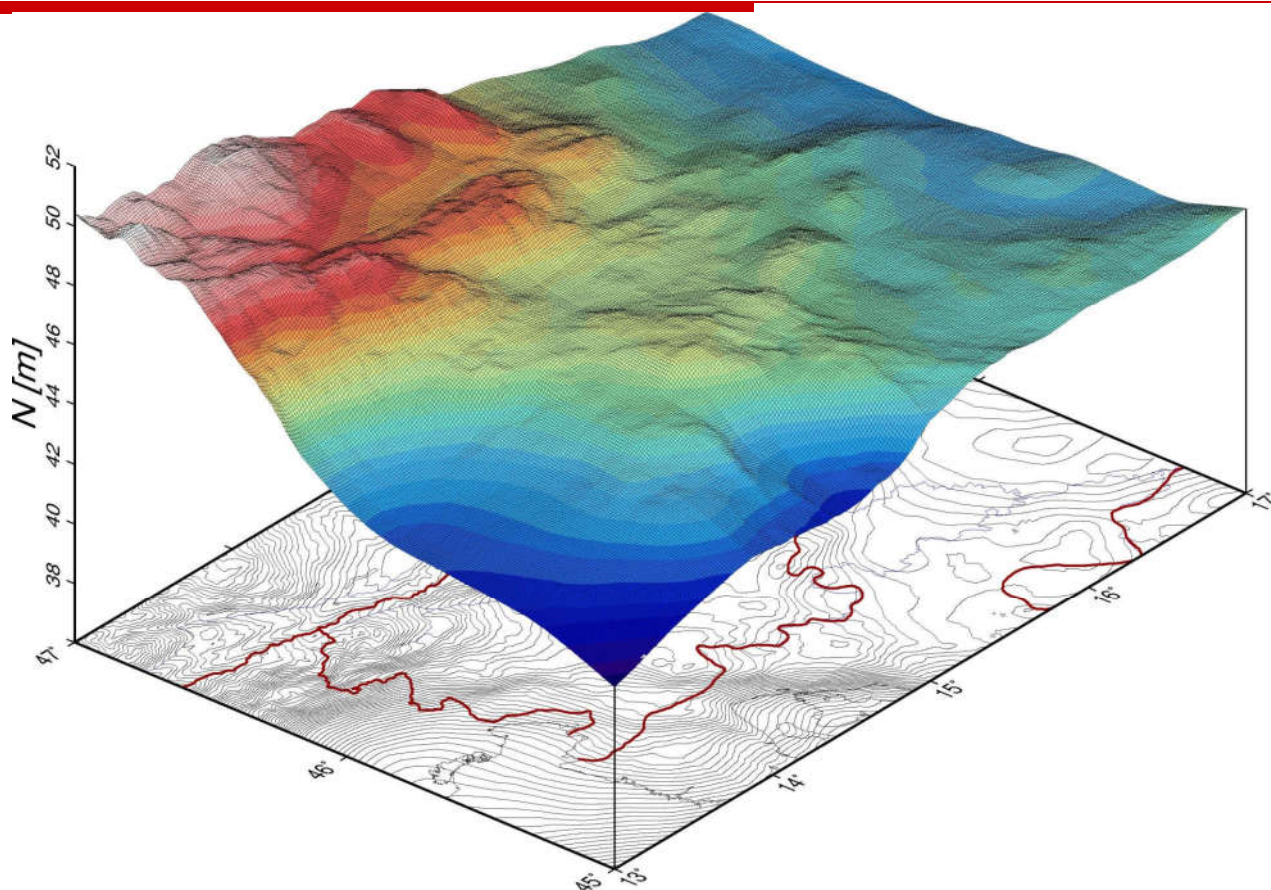


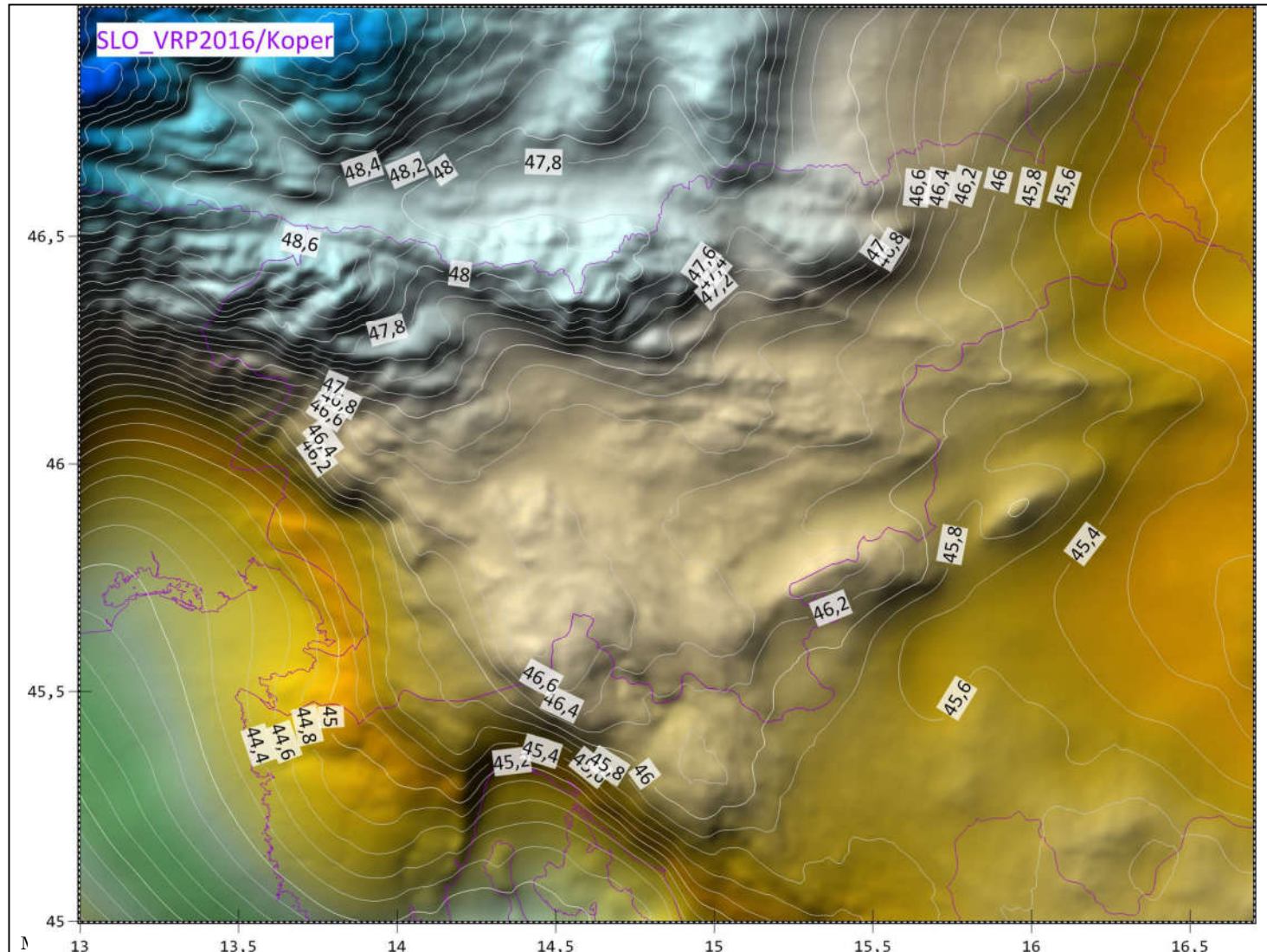
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Testni izračun iz leta 2010 – prikaz 1



Testni izračun iz leta 2010 – prikaz 2

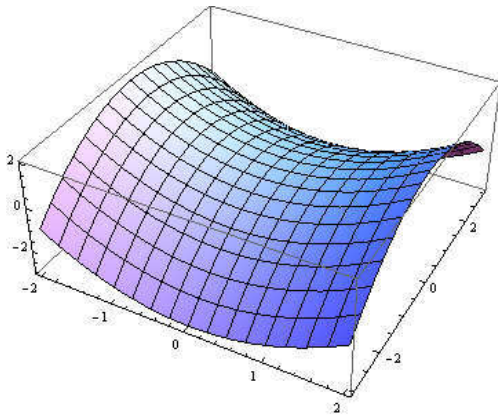
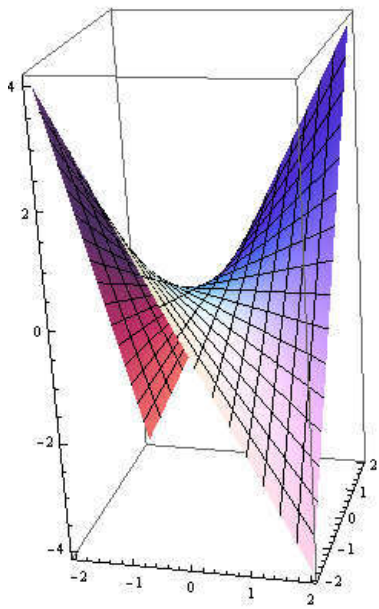




Geoid v digitalni obliki (1)

- ❑ Množica izračunanih točk se preračuna v pravilno točkovno strukturo, celično mrežo točk → **grid**.
- ❑ Predstavitev ploskve s pomočjo grida ima z računalniškega vidika zelo dobro lastnost: ker so horizontalne koordinate točk v gridu podane v enakih presledkih (oddaljenostih) je planimetrični položaj posamezne točke določen z njeno lego v matriki. V računalniškem spominu moramo hraniti samo prostorsko Z koordinato.
- ❑ **Ločljivost grida** ("resolution") pomeni korak s katerim je definirana mreža.
- ❑ Primeri velikosti datotek:
 - EGM96 ločljivost $15' \times 15'$ (ASCII datoteka 9,30 MB).
 - EGG97 ločljivost $1' \times 1,5'$ (binarna datoteka velikosti 32,3 MB).
 - EGM08 ločljivost $1' \times 1'$ (binarna datoteka velikosti 933 MB).

Bilinearna interpolacija – v prostorskem smislu enaka postavitvi hiperboličnega paraboloida skozi štiri točke celice grida.



Bilinearna interpolacija – praktičen primer postavitve ploskve med štirimi točkami celice grida.

