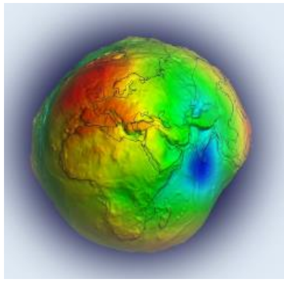


ICGEM

International Centre for Global Earth Models

http://icgem.gfz-potsdam.de/home

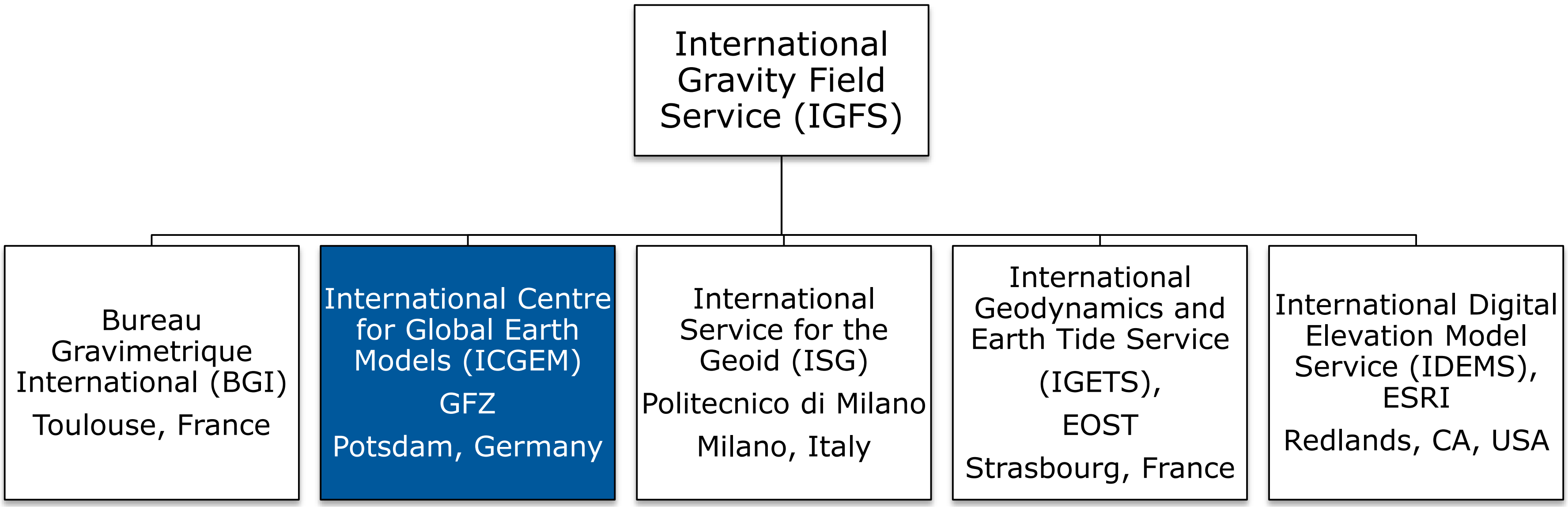
E. Sinem Ince, Sven Reißland,
Franz Barthelmes (retired) and Kirsten Elger

1- Department 1: Geodesy
2- Library and Information Services
GFZ-Potsdam

icgem@gfz-potsdam.de

ICGEM – Service of IAG

15 years of service to the Gravity Field related activities



Hosted and supported by GFZ.

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Objectives of ICGEM

- Collecting and archiving of all existing global gravity field models (e.g. static)
- Making them available in a standardized format (.gfc format)
- Interactive visualisation of the models, their differences, and their time variation
- Web interface to calculate gravity field functionals from the spherical harmonic models on freely selectible grids
- Evaluation of the static gravity field models
- **Online discussion forum**

ICGEM Homepage

ICGEM Home

Gravity Field Models
- Static Models
- Temporal Models
- Topographic Gravity Field Models

Calculation Service
- Regular grids
- User-defined points

3D Visualisation
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- Temporal Models
- Trend & Amplitude
- Spherical Harmonics

Evaluation
- Spectral domain
- GNSS Leveling

Documentation
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- Latest Changes
- Discussion Forum

Other Celestial Bodies (Moon,Venus, Mars)
- Table of Models
- 3D Visualization
- Calculation Service

I C G E M

International Centre for Global Earth Models (ICGEM)

ICGEM Service New Publication:

Our new paper has been puplished in Earth System Science Data (ESSD), data publishing journal.
The paper is open access and can be reached at:https://www.earth-syst-sci-data.net/11/647/2019/essd-11-647-2019.pdf

The paper is intented to be the main reference for the ICGEM Service and its activities that include model downloads, and calculation and visualisation services. See below how to cite.

Appointment of the new director:

The longtime director of the ICGEM service, Franz Barthelmes retired on December 31st 2017. We would like to acknowledge the invaluable contributions he provided to ICGEM service and GFZ family.
As of January 1st 2018, E. Sinem Ince has been appointed as the new director of the ICGEM service.

ICGEM is one of five services coordinated by the International Gravity Field Service (IGFS) of the International Association of Geodesy (IAG).
The other services are:

- BGI (Bureau Gravimetrique International), Toulouse, France
- ISG (International Service for the Geoid), Politecnico di Milano, Milano, Italy
- IGETS (International Geodynamics and Earth Tide Service), EOST, Strasbourg, France
- IDEMS (International Digital Elevation Model Service), ESRI, Redlands, CA, USA

Services of ICGEM

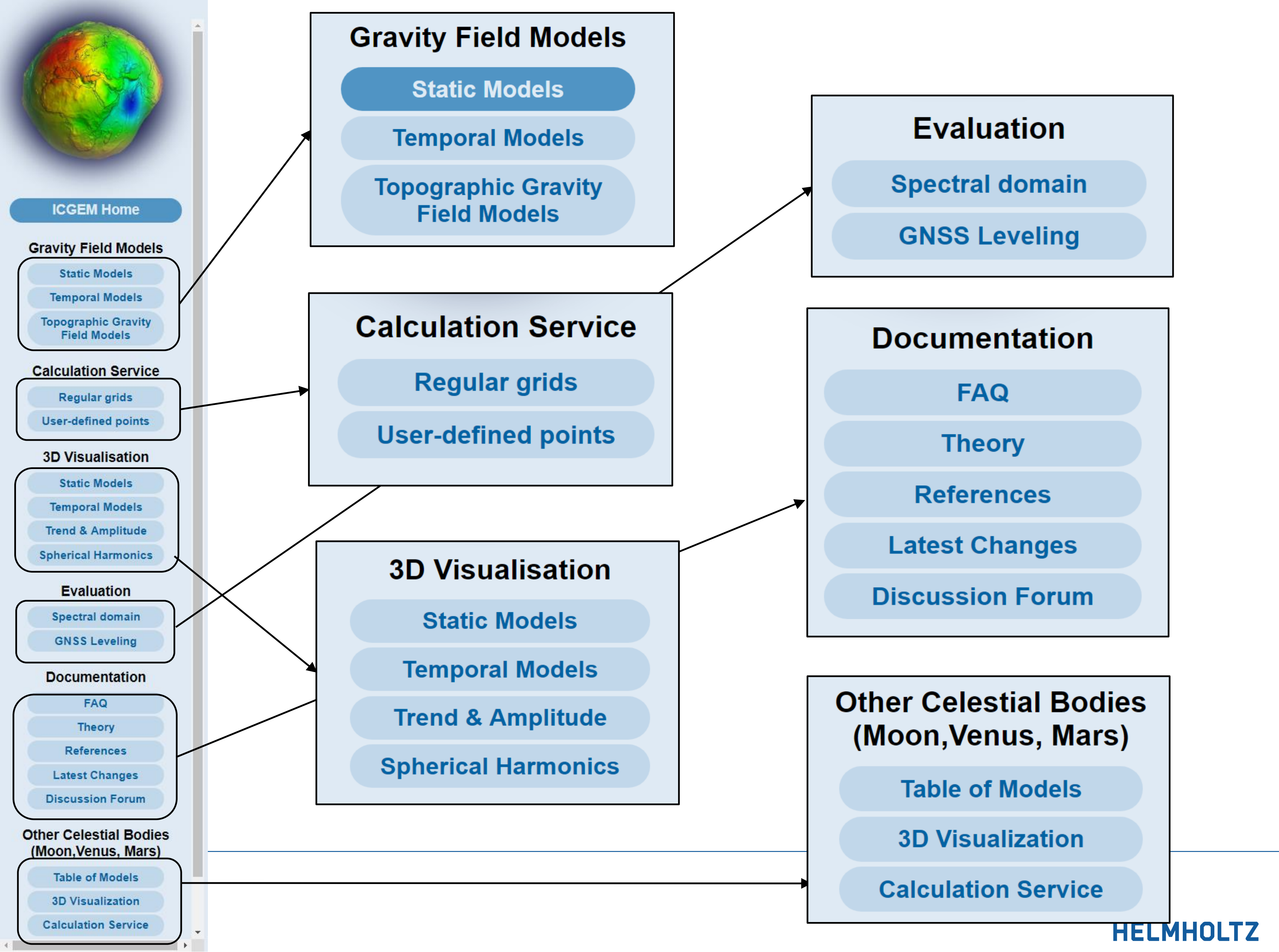
- collecting and archiving of all existing global gravity field models
- web interface for getting access to global gravity field models
- web based visualization of the gravity field models their differences and their time variation
- web based service for calculating different functionals of the gravity field models
- web site for tutorials on spherical harmonics and the theory of the calculation service
- *new service since 2016:* providing a Digital Object Identifier (DOI) for the data set of the model (the coefficients)

Some ICGEM related documents

- Definition of Functionals of the Geopotential and Their Calculation from Spherical Harmonic Models
- Article about Global Models
- Description of the ICGEM-format
- IGFS and ICGEM in Geodesists Handbook 2016
- ICGEM-Report 2003-2007
- ICGEM-Report 2007-2011
- ICGEM-Report 2011-2015
- ICGEM-Report 2015-2017
- ICGEM Poster 2018

icgem@gfz-potsdam.de

http://icgem.gfz-potsdam.de/home



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- IDEMS (International Digital Elevation Model Service), ESRI, Redlands, CA, USA

Other IGFS services

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- ICGEM-Report 2015-2017
- ICGEM Poster 2018

Our references

Static Gravity Field Models

ICGEM

GFZ Helmholtz Centre POTSDAM

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 **S** is for satellite (e.g., GRACE, GOCE, LAGEOS), **A** is for altimetry, and **G** for ground data (e.g., terrestrial, shipborne and airborne measurements).

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
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	IfE_GOCE05s	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	✓

List of static gravity field models

Nr	Model	Year	Degree	Data	References	Download	Calculate	Show	DOI
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	IfE_GOCE05s	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	✓
11	WGS72	1972	28	G, S	Seppelin, T.O. and WGS Committee,, 1974	gfc zip	Calculate	Show	
10	GEM4	1972	16	G, S	Lerch, F.J. et al, 1972	gfc zip	Calculate	Show	
9	GEM3	1972	12	S	Lerch, F.J. et al, 1972	gfc zip	Calculate	Show	
8	GEM2	1972	22	G, S	Lerch, F.J. et al, 1972	gfc zip	Calculate	Show	
7	GEM1	1972	22	S	Lerch, F.J. et al, 1972	gfc zip	Calculate	Show	
6	KOCH71	1971	11	G, S	Koch, Karl-Rudolf and Witte, Bertold U., 1971	gfc zip	Calculate	Show	
5	KOCH70	1970	8	G, S	Koch, Karl-Rudolf and Morrison, Foster, 1970	gfc zip	Calculate	Show	
4	SE2	1969	22	G, S	Gaposchkin, E.M. Lambeck, K., 1970	gfc zip	Calculate	Show	
3	OSU68	1968	14	G, S	Rapp, Richard H., 1968	gfc zip	Calculate	Show	
2	WGS66	1966	24	G	WGS Committee, 1966	gfc zip	Calculate	Show	
1	SE1	1966	15	S	Lundquist, C.A. et al, 1966	gfc zip	Calculate	Show	

Which models are accepted/published?

- The ultimate aim is to collect and make available the **static** gravity field models
- Any model from any institution is accepted as long as they are consistent with other already “reliable” models based on our evaluation results in spectral domain and w.r.t. GNSS/levelling-derived geoid undulations
- For other models (temporal, other celestial bodies and topographic) we do not apply any evaluation scheme but observe the consistency among models

Link to calculation Service

DOI # assignment

Release year

Data used

References

Download option

Model expansion

Link to visualization

Model

Nr	Model	Year	Degree	Data	References	Download	Calculate	Show	DOI
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	IfE_GOCE05s	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	✓
155	EIGEN-6S4 (v2)	2016	300	S(Goce), S(Grace), S(Lageos)	Förste, C. and Bruinsma, S.L., 2016	gfc zip	Calculate	Show	✓
154	GOCO05c	2016	720	(see model), A, G, S	Fecher, T. et al, 2016	gfc zip	Calculate	Show	✓
153	GGM05C	2015	360	A, G, S(Goce), S(Grace)	Ries, J. et al, 2016	gfc zip	Calculate	Show	✓
152	GECO	2015	2190	EGM2008, S(Goce)	Gilardoni, M. et al, 2016	gfc zip	Calculate	Show	
151	GGM05G	2015	240	S(Goce), S(Grace)	Bettadpur, S. et al, 2015	gfc zip	Calculate	Show	
150	GOCO05s	2015	280	(see model), S	Mayer-Gürr, T. et al, 2015	gfc zip	Calculate	Show	

THE EXPERIMENTAL GRAVITY FIELD MODEL XGM2016
===

XGM2016

When using the data please cite is like:

Pail, Roland; Fecher, Thomas; Barnes, Daniel; Factor, John; Holmes, Simon; Gruber, Thomas; Zingerle Philipp

Model information

The experimental gravity field model XGM2016 is an outcome of TUM's assessment of a 15'x15' data grid excerpt provided from NGA's updated and revised gravity data bas

Contact: R. Pail, roland.pail@tum.de
Contributing institutions:
* TU Muenchen, Institute of Astronomical and Physical Geodesy
  Roland Pail, Thomas Fecher, Thomas Gruber, Philipp Zingerle
* National Geospatial-Intelligence Agency
  Daniel Barnes, John Factor
* SGT Inc
  Simon Holmes

References

Reference - GOCO05s (XGM2016 satellite base):
Mayer-Guerr T, et al. (2015): The combined satellite gravity field model GOCO05s. Presentation at EGU 2015, Geophysical Research Abstracts Vol. 17, EGU2015-12364, Vienna.

Reference - GOCO05c (combination methodology as for XGM2016):
Fecher T, et al. (2017): GOCO05c: A New Combined Gravity Field Model Based on Full Normal Equations and Regionally Varying Weighting. Surveys in Geophysics, Vol. 38, Nr. 3, pp

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radius                       0.63781363000D+07
max_degree                 719
errors                    formal
norm                      fully_normalized
tide_system               zero_tide
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Coefficients

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gfc	1	0	+0.000000000000000E+00	+0.000000000000000E+00	+0.000000000000000E+00	+0.0[illegible]
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gfc	2	2	+2.439360668495790E-06	-1.400308589410540E-06	+3.484023464432440E-13	+3.469907389581660E-13
gfc	3	0	+9.571897323556379E-07	+0.000000000000000E+00	+2.430153890723960E-13	+0.000000000000000E+00
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gfc	3	2	+9.047645014176970E-07	-6.190036839518900E-07	+2.560665614556440E-13	+2.610593334202640E-13
gfc	3	3	+7.212945271678900E-07	+1.414385774916610E-06	+2.858095830008700E-13	+2.864273001049410E-13
gfc	4	0	+5.399925774145787E-07	+0.000000000000000E+00	+1.713102172592780E-13	+0.000000000000000E+00
gfc	4	1	-5.361789608196520E-07	-4.735741349788470E-07	+1.765972592216480E-13	+1.570708311151830E-13

DOI Request

Metadata ▾ | Dataset ▾ | Publication ▾ | About/Help ▾

DataCite Metadata

Resource Information

DOI (will be generated in the publishing process)	Year

Resource Type	Title	Version	Language of dataset

Licenses and Rights

Licence	

Authors (Persons and/or Institutions)

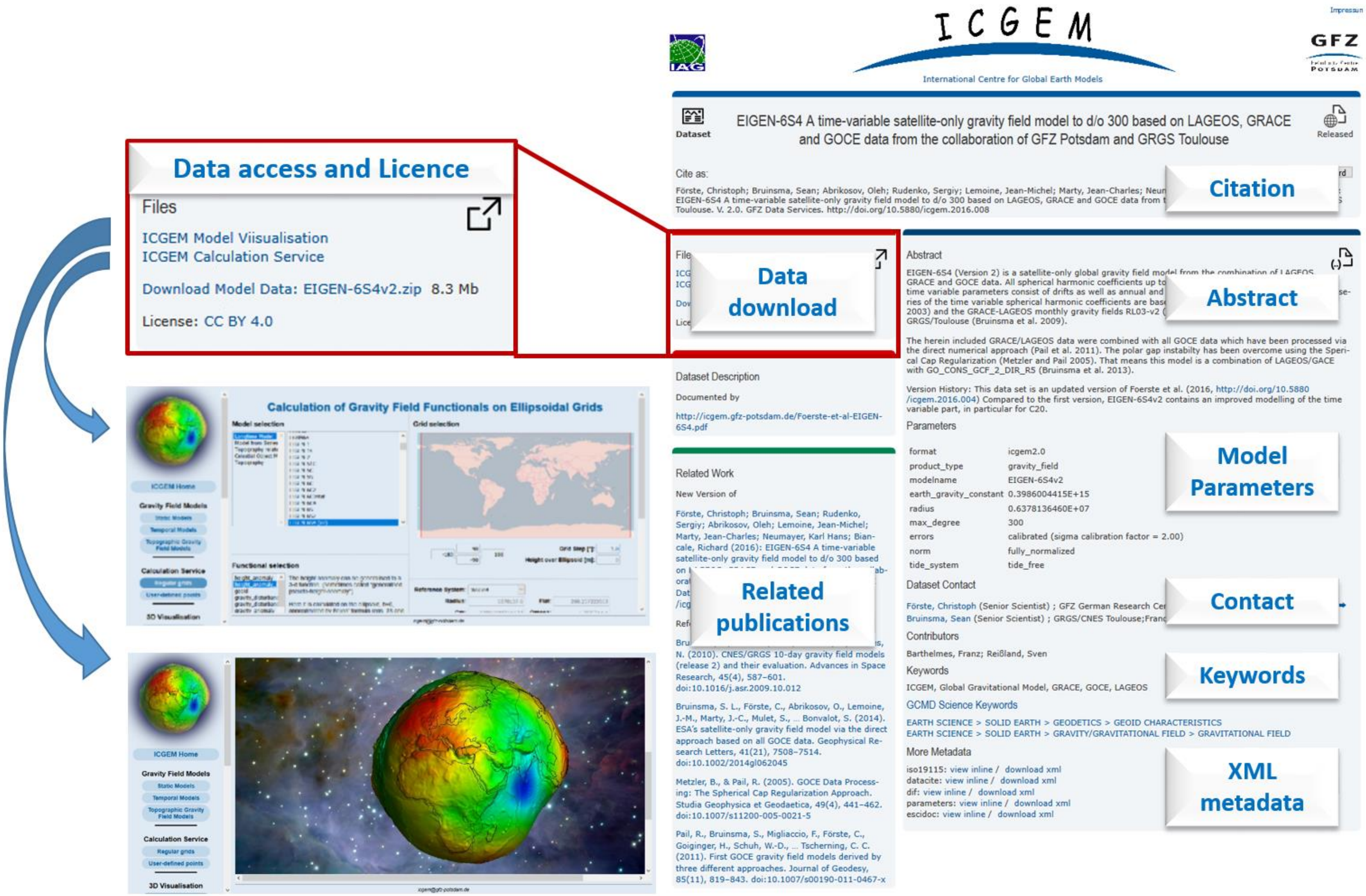
Lastname	Firstname	Role	Author ID Type	Author Identifier (...	Affiliation	

Contact Person(s) / Point of Contact

Author (Lastname, First...	Position	Email	Website	Affiliation	

http://pmd.gfz-potsdam.de/panmetaworks/metaedit/

DOI# Assignment



Evaluation w.r.t. GNSS/Levelling

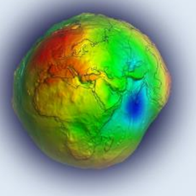
Root mean square (rms) about mean of GPS / levelling minus gravity field model derived geoid heights [m]

The following table shows a comparison of quasigeoid heights derived from the models with GPS / levelling derived geoid values from USA, Canada, Europe, Japan and Brazil. Note that the differences also contain the cut-off error of the models, i.e. the unmodelled short wavelength part of the gravity field. The GPS / levelling data sets are from:

- USA; Milbert, 1998
- Canada; Veronneau, personal communication 2003; National Ressources Canada, GPS on BMs file, update February 2003
- Europe; Ihde et al., 2002
- Australia; Gary Johnston, Geoscience Australia
- Japan; Tokuro Kodama, Geospatial Information Authority of Japan
- Brazil; Denizar Blitzkow and Ana Cristina Oliveira Cancoro de Matos, Centro de Estudos de Geodesia (CENEGEO), the data belongs to the Laboratory of Topography and Geodesy/University of Sao Paulo (LTG/USP) and the Brazilian Institute of Geography and Statistics (IBGE)

The table is interactively re-sortable for all columns by clicking in the header cells.

Nr	Model	Nmax	Australia (201 points)	Brazil (1112 points)	Canada (2691 points)	Europe (1047 points)	Japan (816 points)	USA (6169 points)	All (12036 points)
176	**XGM2019**	760	0.217 m	0.44 m	0.151 m	0.14 m	0.125 m	0.264 m	0.2494 m
176	**XGM2019e**	5,540	0 m	0 m	0 m	0 m	0 m	0 m	0.0 m
176	**XGM2019e_2159**	2,190	0.215 m	0.438 m	0.128 m	0.127 m	0.09 m	0.248 m	0.2361 m
175	**GO_CONS_GCF_2_TIM_R6e**	300	0.318 m	0.502 m	0.29 m	0.34 m	0.431 m	0.396 m	0.3832 m
174	**ITSG-Grace2018s**	200	0.404 m	0.545 m	0.387 m	0.504 m	0.573 m	0.496 m	0.4837 m
173	**EIGEN-GRGS.RL04.MEAN-FIELD**	300	0.327 m	0.507 m	0.298 m	0.345 m	0.447 m	0.404 m	0.391 m
172	**GOCO06s**	300	0.318 m	0.503 m	0.292 m	0.341 m	0.43 m	0.398 m	0.3847 m
171	**GO_CONS_GCF_2_TIM_R6**	300	0.317 m	0.501 m	0.29 m	0.34 m	0.431 m	0.396 m	0.383 m
170	**GO_CONS_GCF_2_DIR_R6**	300	0.313 m	0.503 m	0.292 m	0.339 m	0.432 m	0.396 m	0.3838 m
169	**IGGT_R1C**	240	0.388 m	0.529 m	0.427 m	0.457 m	0.574 m	0.464 m	0.4689 m
168	**Tongji-Grace02k**	180	0.432 m	0.592 m	0.475 m	0.587 m	0.661 m	0.525 m	0.5357 m
167	**SGG-UGM-1**	2,159	0.217 m	0.446 m	0.13 m	0.121 m	0.076 m	0.245 m	0.2353 m
166	**GOSG01S**	220	0.359 m	0.518 m	0.373 m	0.426 m	0.526 m	0.442 m	0.4392 m
165	**IGGT_R1**	240	0.317 m	0.513 m	0.348 m	0.387 m	0.483 m	0.412 m	0.4111 m
164	**IfE_GOCE05s**	250	0.337 m	0.512 m	0.329 m	0.385 m	0.48 m	0.414 m	0.4081 m



ICGEM Home

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POTSDAM

GRACE monthly solutions from the 3 processing centers CSR, GFZ and JPL

CSR Release 05	(UTCSR Level-2 Processing Standards Document, Rev 4.0 May 29, 2012)
CSR Release 06	
GFZ Release 05	(GFZ ... uary 2013)
GFZ Release 06	
JPL Release 05	(PL ... 05.1 November 3, 2014)
JPL Release 06	

CSR, GFZ, JPL

3 Processing centre

The processing standards to generate the GRACE Level-2 products of CSR, GFZ and JPL are also available in the Document Section of the GRACE archives at GFZ ISDC or JPL PO.DAAC

GRACE / CHAMP monthly solutions from other groups

Other groups

AIUB Release 02		(more information can be found here)
CNES_GRGS_RL03		GRACE monthly solutions from the CNES_GRGS ; more information can be found here here)
CNES_GRGS_RL04		GRACE monthly solutions from the CNES_GRGS ; more information can be found here here)
DMT-1		(More information can be found here)
EGSIEM		(GRACE monthly combined solutions from the EGSIEM project, more information can be found here)
geo_Q		(Time-variable gravity fields from Leibniz Universität Hannover. More information can be found here)
QuantumFrontiers		(Time-variable gravity fields from Leibniz Universität Hannover. More information can be found here)
HUST-Grace2016	DOI	(GRACE monthly solutions from the Huazhong University of Science and Technology, Wuhan, PR China)
IGG_RL01		(GRACE monthly solutions from the Institute of Geodesy and Geophysics, Chinese Academy of Sciences, China)
ITG		(More information can be found here)
ITSG-Grace2014		(GRACE monthly solutions from the ITSG, TU Graz; more information can be found here)
ITSG-Grace2016	DOI	(GRACE monthly solutions from the ITSG, TU Graz; more information can be found here)
ITSG-Grace2018	DOI	(GRACE monthly solutions from the ITSG, TU Graz; more information can be found here)

COST-G (International Combination Service for Time-variable Gravity Field)

Combined solutions

GRACE	(M... l Combination Service for Time-variable Gravity Field (COST-G),
Swarm	(M... be found here here and here)

Combination!

GRACE weekly solutions

Monthly
Weekly
Daily

GFZ Release 05	(GFZ GRACE Level-2 Processing, Revised Edition, January 2013)

GRACE daily solutions

ITSG-Grace2014	(more information can be found here)
ITSG-Grace2016	(more information can be found here)
ITSG-Grace2018	(more information can be found here)

SLR_monthly

SLR-only monthly solutions from AIUB

GRACE-FO solutions coming soon…

Non-isotropic smoothing

AIUB Release 02	(more information can be found here)
CSR Release 05	(UTCSR Level-2 Processing Standards Document, Rev 4.0 May 29, 2012)
GFZ Release 05	(GFZ GRACE Level-2 Processing, Revised Edition, January 2013)

Which (temporal) gravity field model is the best?

Which center or institution provides the best solutions?

- Depends on the application
- Depends on the area
- Depends on the post processing, background models, assumptions, regularisation
- …

For temporal models new product service since July, 2019

COST-G: Combination Service for Time Variable Gravity Field

https://cost-g.org/index.php?p=introduction

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Gravity Field Solutions for dedicated Time Periods

GFZ Release 05

You can download all the models in this set as zip (151.8 MiB) or you can find subsets and single model files below.
It can take a moment to generate the zip file for you.
You can also find these files at ftp://icgem.gfz-potsdam.de/01_GRACE_monthly/GFZ Release 05.

DDK1	zip (17.1 MiB)
DDK2	zip (17.1 MiB)
DDK3	zip (17.0 MiB)
DDK4	zip (17.0 MiB)
DDK5	zip (17.0 MiB)
DDK6	zip (17.0 MiB)
DDK7	zip (17.0 MiB)
DDK8	zip (17.0 MiB)
unfiltered	zip (15.5 MiB)

DDK1	zip (17.1 MiB)
kfilter_DDK1_GSM-2_2002094-2002120_0024_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002122-2002137_0013_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002213-2002243_0031_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002244-2002273_0021_EIGEN_GK2-_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002274-2002304_0030_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002305-2002334_0027_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2002335-2002365_0029_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
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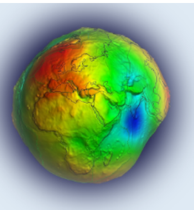
kfilter_DDK1_GSM-2_2003305-2003334_0030_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2003335-2003365_0031_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2003353-2004014_0027_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004035-2004060_0026_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004061-2004091_0031_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004092-2004121_0030_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004122-2004152_0031_EIGEN_G---_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004153-2004182_0030_EIGEN_GK2-_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004183-2004213_0031_EIGEN_GK2-_005a.gfc	gfc (330.3 KiB)
kfilter_DDK1_GSM-2_2004214-2004244_0031_EIGEN_GK2-_005a.gfc	gfc (330.3 KiB)

Filtered or unfiltered coefficients

Topographic gravity field models



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Topographic 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.

More information on the Topographic Gravity Field Models can be found here.

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

Nr	Model	Year	Degree	Data	References	Download	Calculate
1	dV_ELL_RET2012	2014	2190	Topography	Claessens, S.J. and C. Hirt (2013)	gfc zip	
2	dV_ELL_RET2012_plusGRS80	2014	2190	Topography	Claessens, S.J. and C. Hirt (2013)	gfc zip	Calculate
3	RWI_TOPO_2012	2014	1800	Topography	Grombein et al., (2014)	gfc zip	
4	RWI_ISOS_2012	2014	1800	Isostasy	Grombein et al., (2014)	gfc zip	
5	RWI_TOIS_2012	2014	1800	Isostasy, Topography	Grombein et al., (2014)	gfc zip	
6	RWI_TOPO_2012_plusGRS80	2014	1800	Topography	Grombein et al., (2014)	gfc zip	Calculate
7	RWI_ISOS_2012_plusGRS80	2014	1800	Isostasy	Grombein et al., (2014)	gfc zip	Calculate
8	RWI_TOIS_2012_plusGRS80	2014	1800	Isostasy, Topography	Grombein et al., (2014)	gfc zip	Calculate
9	RWI_TOPO_2015	2015	2190	Topography	Grombein et al., (2016)	gfc zip	
10	REQ_TOPO_2015	2015	2190	Topography	Grombein et al., (2016)	gfc zip	
11	RWI_TOPO_2015_plusGRS80	2015	2190	Topography	Grombein et al., (2016)	gfc zip	Calculate
12	REQ_TOPO_2015_plusGRS80	2015	2190	Topography	Grombein et al., (2016)	gfc zip	Calculate
13	dV_ELL_RET2014	2016	2190	Topography	Rexer et al., (2016)	gfc zip	
14	dV_ELL_RET2014_plusGRS80	2016	2190	Topography	Rexer et al., (2016)	gfc zip	Calculate
15	dV_ELL_Earth2014	2016	2190	Topography	Rexer et al., (2016)	gfc zip	
16	dV_ELL_Earth2014_plusGRS80	2016	2190	Topography	Rexer et al., (2016)	gfc zip	Calculate
17	dV_ELL_Earth2014_5480	2017	5480	Topography	Rexer et al., (2017), Rexer, M. (2017)	gfc zip	
18	dV_ELL_Earth2014_5480_plusGRS80	2017	5480	Topography	Rexer et al., (2017), Rexer, M. (2017)	gfc zip	Calculate

New set of models on the ICGEM service

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Topographic gravity field models

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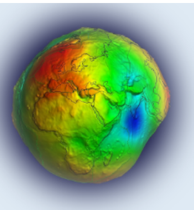
3	RWI_TOPO_2012	2014	1800	Topography
4	RWI_ISOS_2012	2014	1800	Isostasy
5	RWI_TOIS_2012	2014	1800	Isostasy, Topography
6	RWI_TOPO_2012_plusGRS80	2014	1800	Topography
7	RWI_ISOS_2012_plusGRS80	2014	1800	Isostasy
8	RWI_TOIS_2012_plusGRS80	2014	1800	Isostasy, Topography
9	RWI_TOPO_2015	2015	2190	Topography
10	REQ_TOPO_2015	2015	2190	Topography
11	RWI_TOPO_2015_plusGRS80	2015	2190	Topography
12	REQ_TOPO_2015_plusGRS80	2015	2190	Topography
13	dV_ELL_RET2014	2016	2190	Topography
14	dV_ELL_RET2014_plusGRS80	2016	2190	Topography
15	dV_ELL_Earth2014	2016	2190	Topography
16	dV_ELL_Earth2014_plusGRS80	2016	2190	Topography
17	dV_ELL_Earth2014_5480	2017	5480	Topography
18	dV_ELL_Earth2014_5480_plusGRS80	2017	5480	Topography

New set of models on the ICGEM service

Other Celestial Bodies



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Gravity Field Models of other Celestial Bodies

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 **S** is for satellite (e.g., GRACE, GOCE, LAGEOS), **A** is for altimetry, and **G** for ground data (e.g., terrestrial, shipborne and airborne measurements).

It is not planned to offer the complete service of ICGEM also for non-Earth gravity field models. Nevertheless, we think it could be useful to compile also some gravity field models of other celestial bodies for downloading and for use in our visualisation and calculation service.

Object	Model	Year	Degree	References	Download	Calculate
Mars	ggm1025a	2002	80	F.G. Lemoine et al, 2001	gfc zip	Calculate
Mars	jgm85f01	2002	85		gfc zip	Calculate
Mars	ggm2bc80	2000	80		gfc zip	Calculate
Mars	ggm50a01	1998	50		gfc zip	Calculate
Mars	ggm50a02	1998	50		gfc zip	Calculate
Mars	jgm50c01	1998	50		gfc zip	Calculate
Moon (of the Earth)	STU_MoonTopo720	2019	2160	Bucha, B. et al., 2019	gfc zip	
Moon (of the Earth)	STU_MoonTopo720_plusNormalField	2019	2160	Bucha, B. et al., 2019	gfc zip	Calculate
Moon (of the Earth)	GrazLGM420b	2018	420	Wirnsberger H. et al, 2018	gfc zip	Calculate
Moon (of the Earth)	GrazLGM420b+	2018	420	Wirnsberger H. et al, 2018	gfc zip	Calculate
Moon (of the Earth)	RFM_Moon_2520	2018	2520	Sprlak et al., (2018)	gfc zip	Calculate
Moon (of the Earth)	GrazLGM420a	2017	420	Wirnsberger H. et al, 2017	gfc zip	Calculate
Moon (of the Earth)	dV_MoonTopo_2160	2017	2160	Hirt, C. and M. Kuhn (2017)	gfc zip	Calculate
Moon (of the Earth)	GrazLGM300c	2016	300	Krauss, S. et al, 2016	gfc zip	Calculate
Moon (of the Earth)	AIUB-GRL200A	2015	200	Arnold D. et al, 2015	gfc zip	Calculate
Moon (of the Earth)	AIUB-GRL200B	2015	200	Arnold D. et al, 2015	gfc zip	Calculate
Moon (of the Earth)	GL0660B	2013	660		gfc zip	Calculate
Moon (of the Earth)	GRGM660PRIM	2013	660		gfc zip	Calculate
Moon (of the Earth)	JGL150Q1	2000	150		gfc zip	Calculate
Moon (of the Earth)	JGL165P1	2000	165		gfc zip	Calculate
Moon (of the Earth)	JGL100J1	1999	100		gfc zip	Calculate
Moon (of the Earth)	JGL100K1	1999	100		gfc zip	Calculate
Moon (of the Earth)	JGL075D1	1998	75		gfc zip	Calculate
Moon (of the Earth)	JGL075G1	1998	75		gfc zip	Calculate
Moon (of the Earth)	GLGM-2	1995	70	F. G. Lemoine et al, 1995	gfc zip	Calculate
Moon (of the Earth)	GLGM-1	1994	70	F. G. Lemoine et al, 1994	gfc zip	Calculate
Venus	shgj180ua01	1997	180		gfc zip	Calculate
Venus	shgj120pa01	1996	120		gfc zip	Calculate

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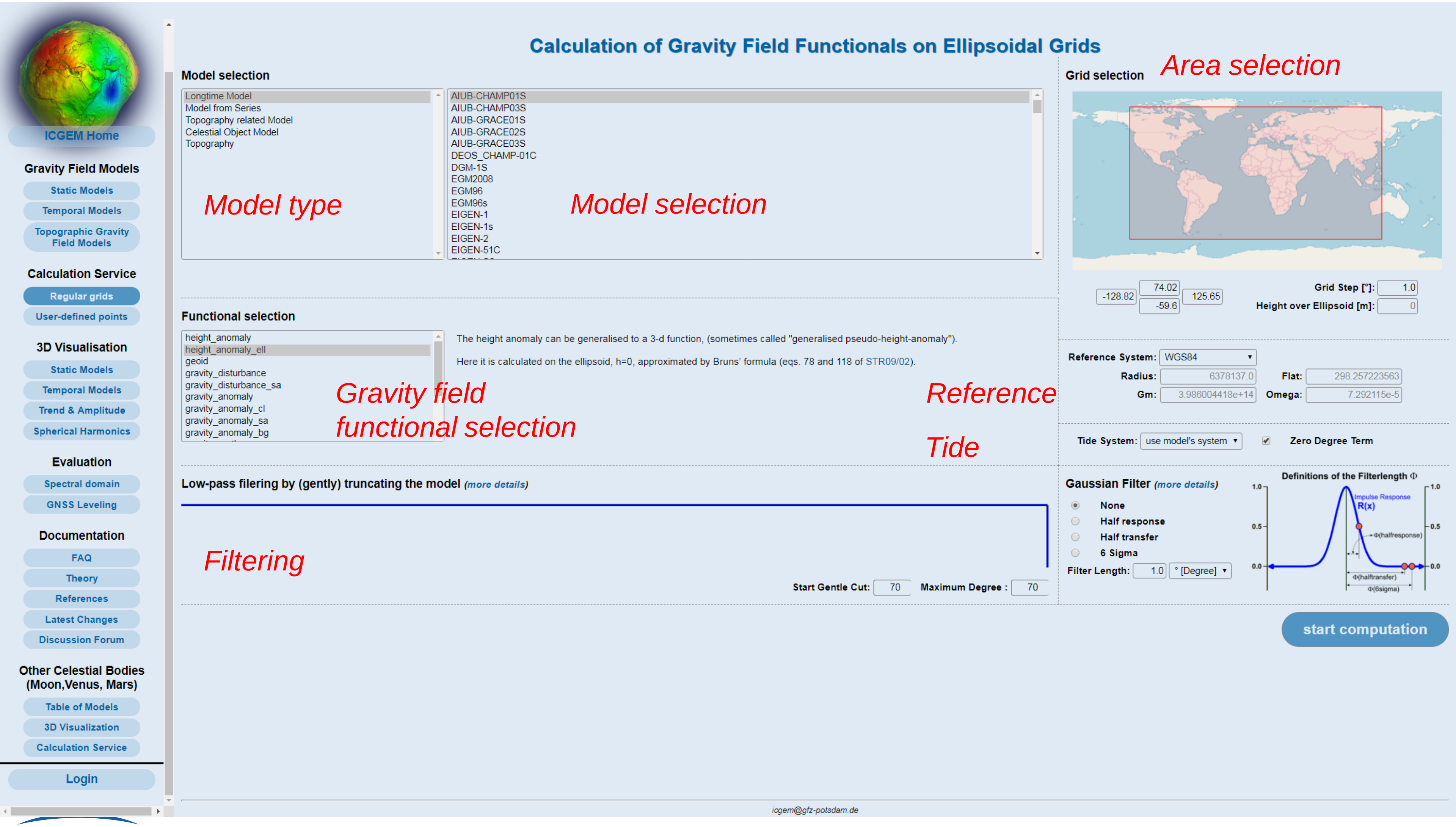
Calculation Service
Regular Grid



Model selection

Longtime Model
Model from Series
Topography related Model
Celestial Object Model
Topography

...on Service
...ar Grid

...y Field Functionals on Ellipsoidal Grids

...tion

Grid selection

Area selection

-128.82 | 74.02 | -59.6 | 125.65

Grid Step [°]: 1.0
Height over Ellipsoid [m]: 0

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Spherical Harmonics

height_anomaly_ell
geoid
gravity_disturbance
gravity_disturbance_sa
gravity_anomaly
gravity_anomaly_cl
gravity_anomaly_sa
gravity_anomaly_bg

The height anomaly can be generalised to a 3-d function, (sometimes called "generalised pseudo-height-anomaly").

Here it is calculated on the ellipsoid, h=0, approximated by Bruns' formula (eqs. 78 and 118 of STR09/02).

Gravity field functional selection

Reference

Tide

Reference System: WGS84
Radius: 6378137.0
Flat: 298.257223563
Gm: 3.986004418e+14
Omega: 7.292115e-5

Tide System: use model's system
Zero Degree Term

Functional selection

height_anomaly
height_anomaly_ell
geoid
gravity_disturbance
gravity_disturbance_sa
gravity_anomaly
gravity_anomaly_cl
gravity_anomaly_sa
gravity_anomaly_bg

Gaussian Filter (*more details*)
None
Half response
Half transfer
6 Sigma
Filter Length: 1.0 ° [Degree]

Definitions of the Filterlength Φ
Impulse Response R(x)
Φ(halfresponse)
Φ(halftransfer)
Φ(6sigma)

Start Gentle Cut: 70
Maximum Degree: 70

start computation

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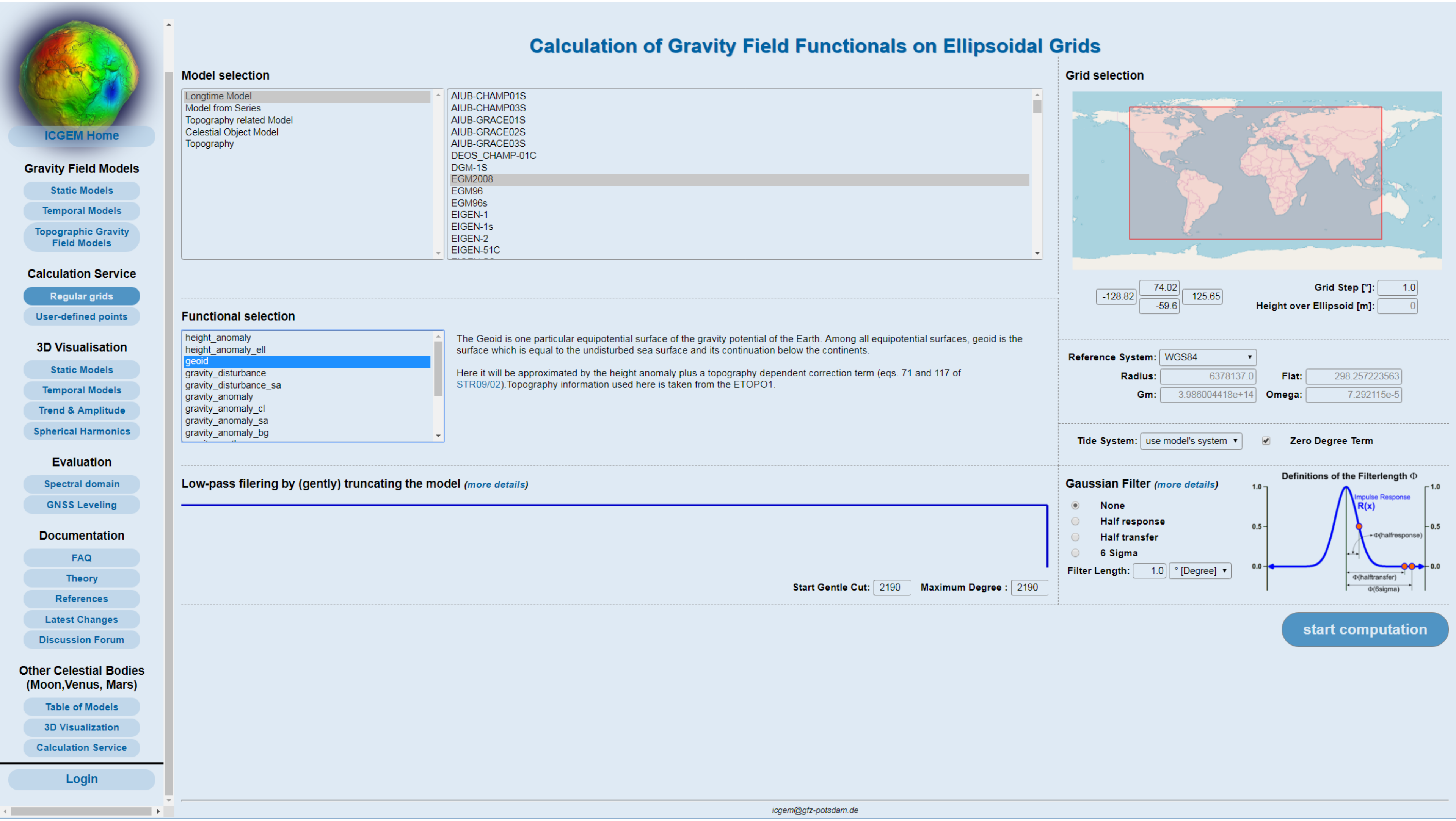
Calculation Service



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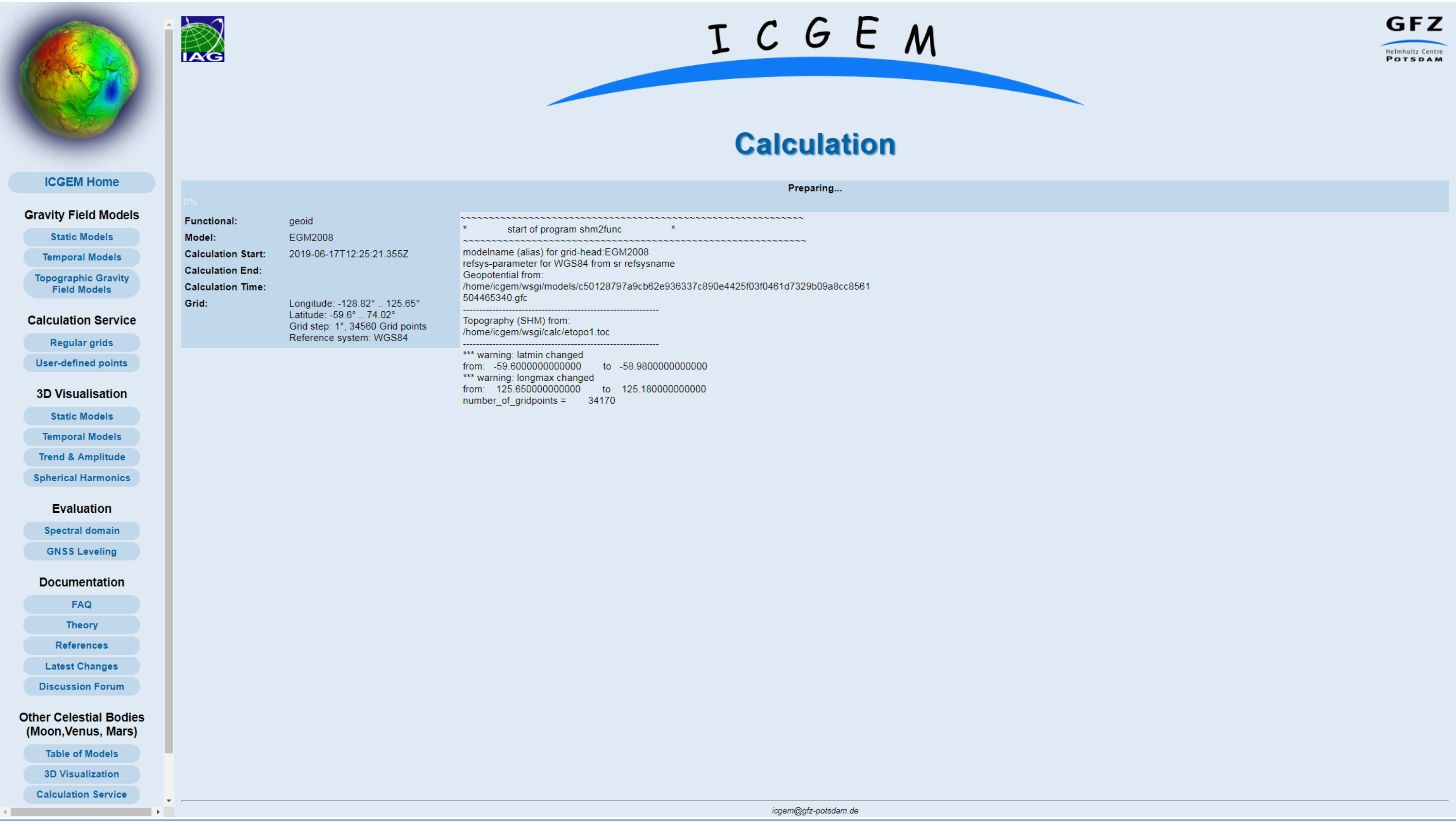
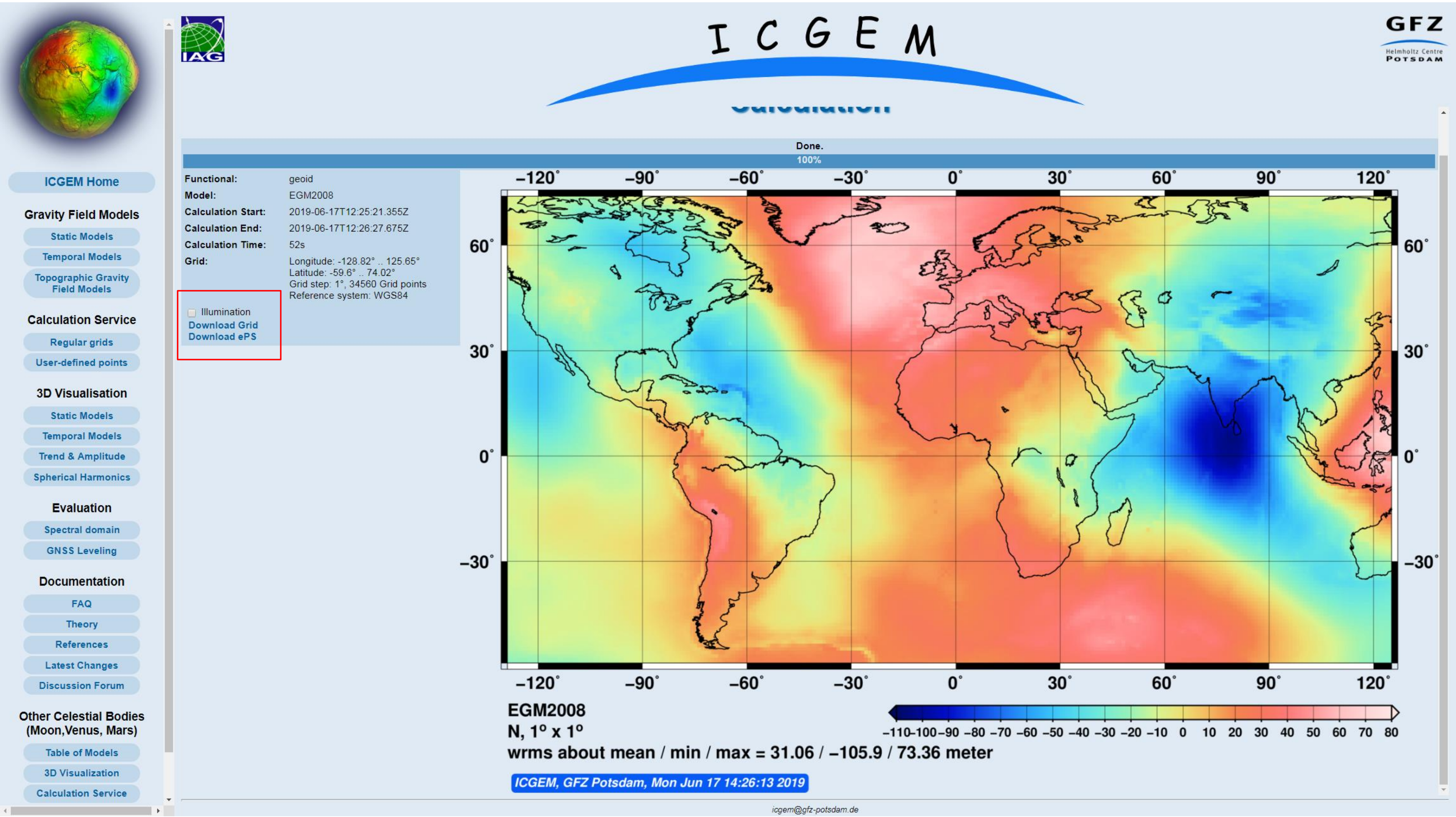
Calculation Service



Calculation Service



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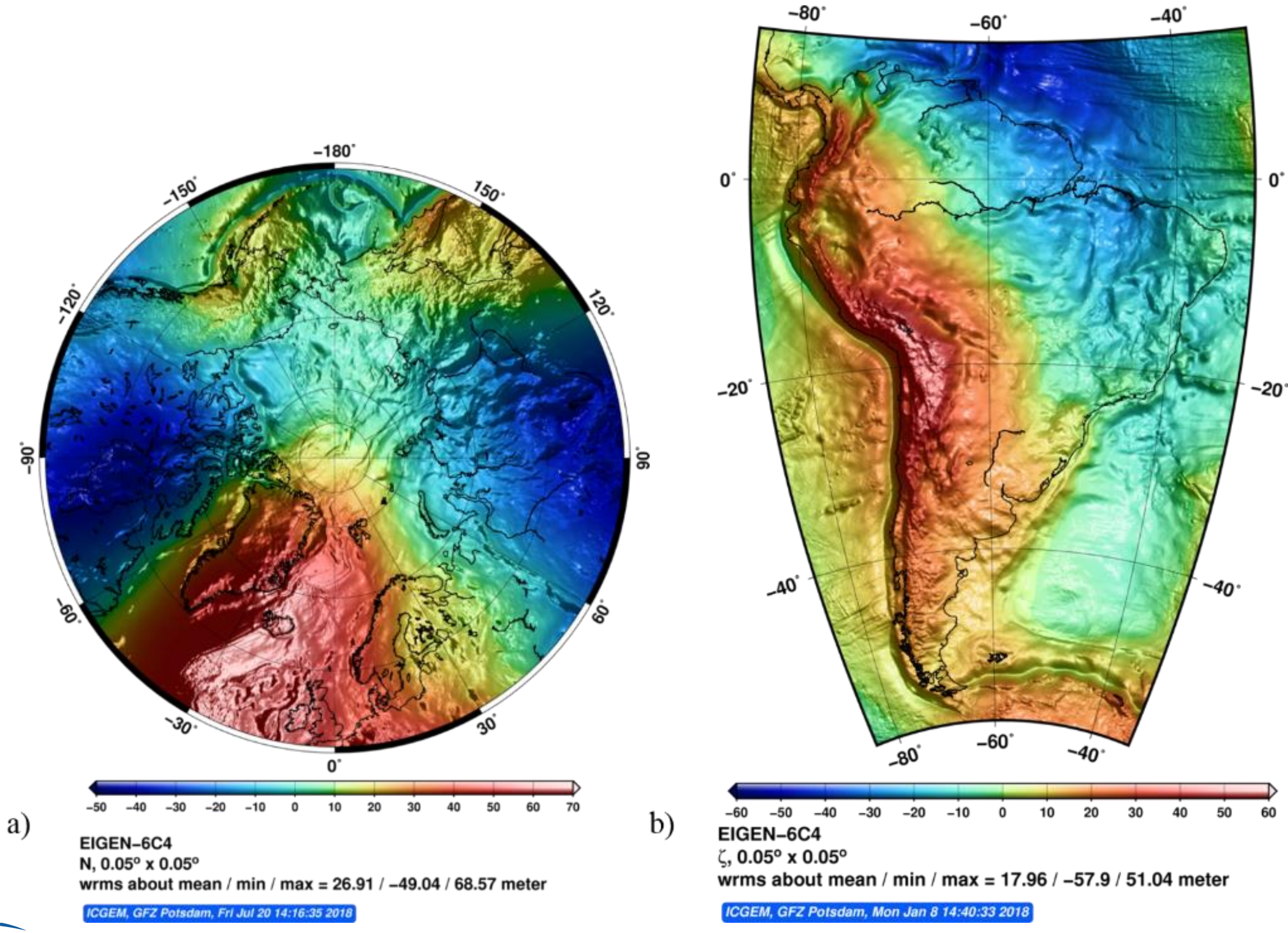
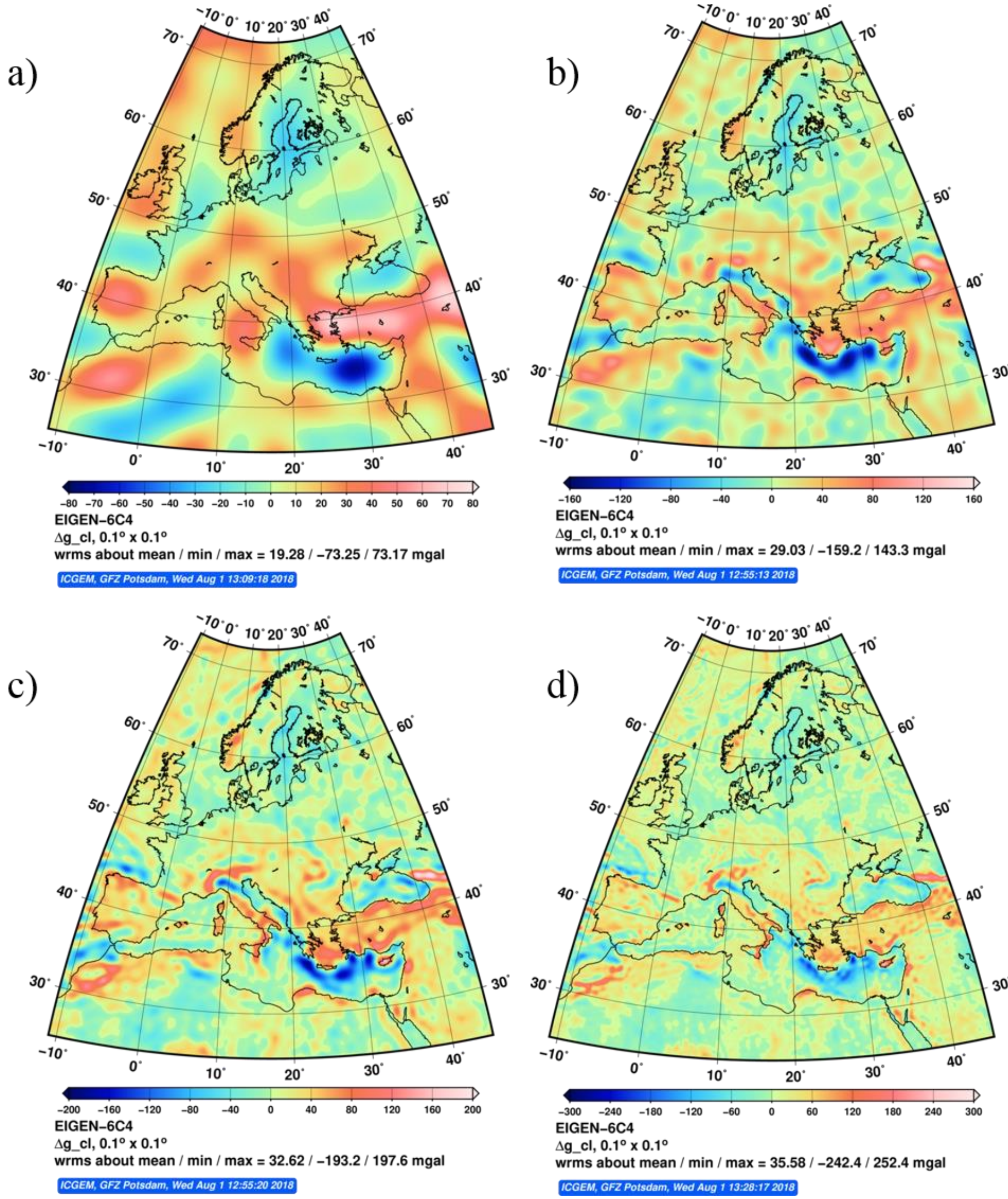
Different areas – different projection



Helmholtz Centre
Potsdam

Ince et al. 2019

ICGEM for educational purposes

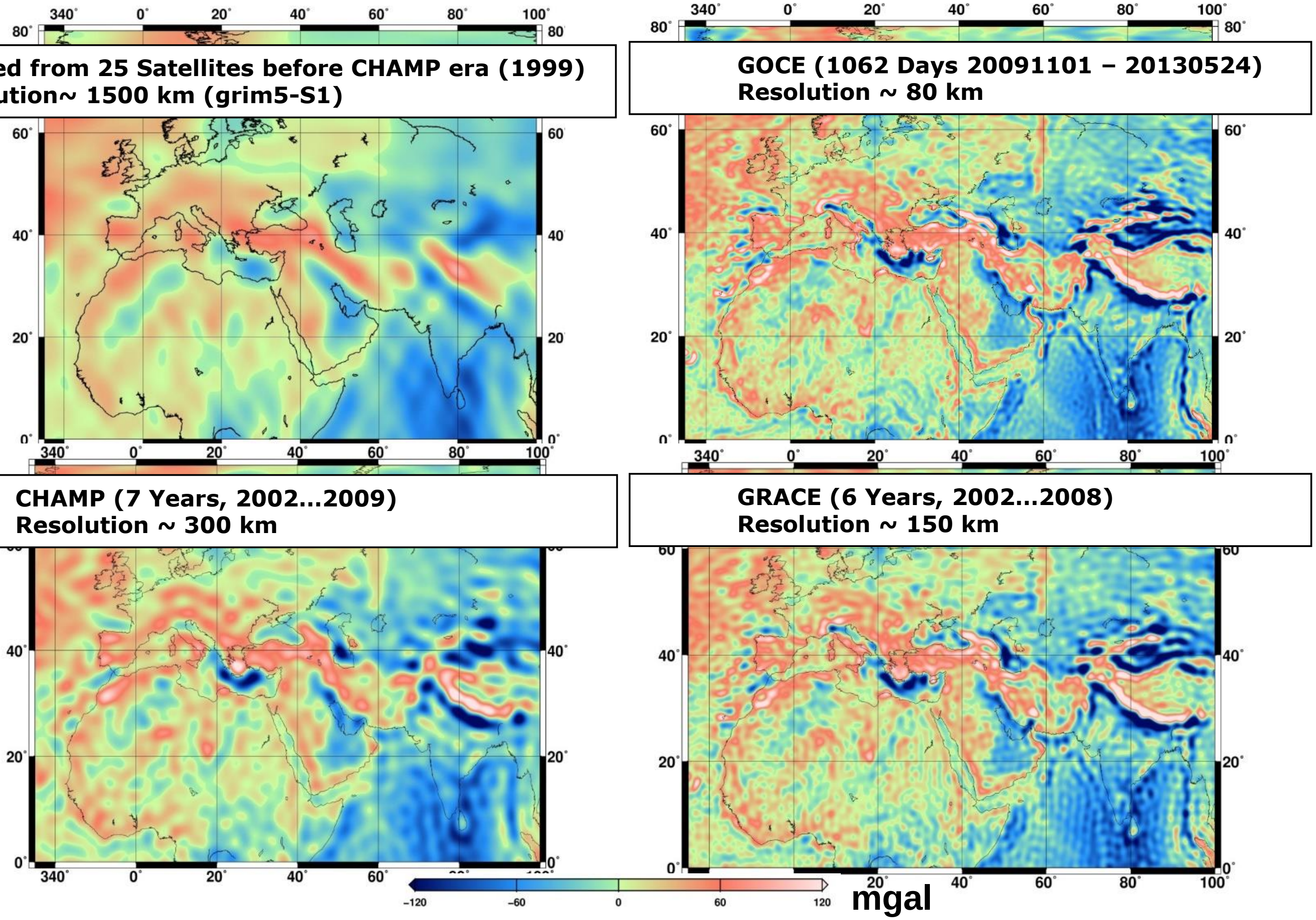


Spherical harmonic degree expansions of the same model: (a) 50, (b) 150, (c) 250, and (d) 500 which correspond to 400, 133, 80, and 40 km half wavelength spatial resolutions.

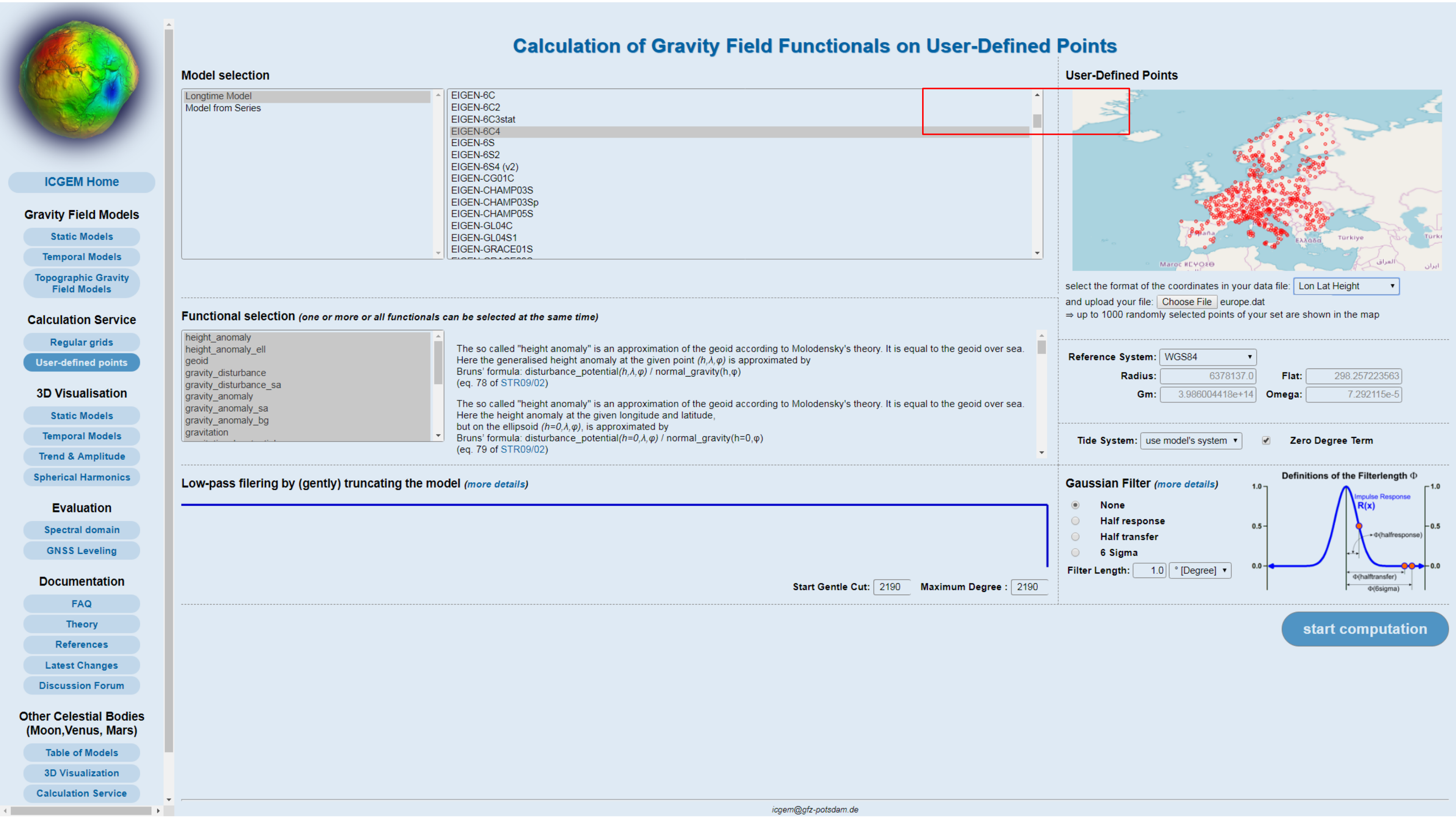
Gravity anomalies in mGal with different spectral and spatial resolution of EIGEN-6C4.

Ince et al. 2019

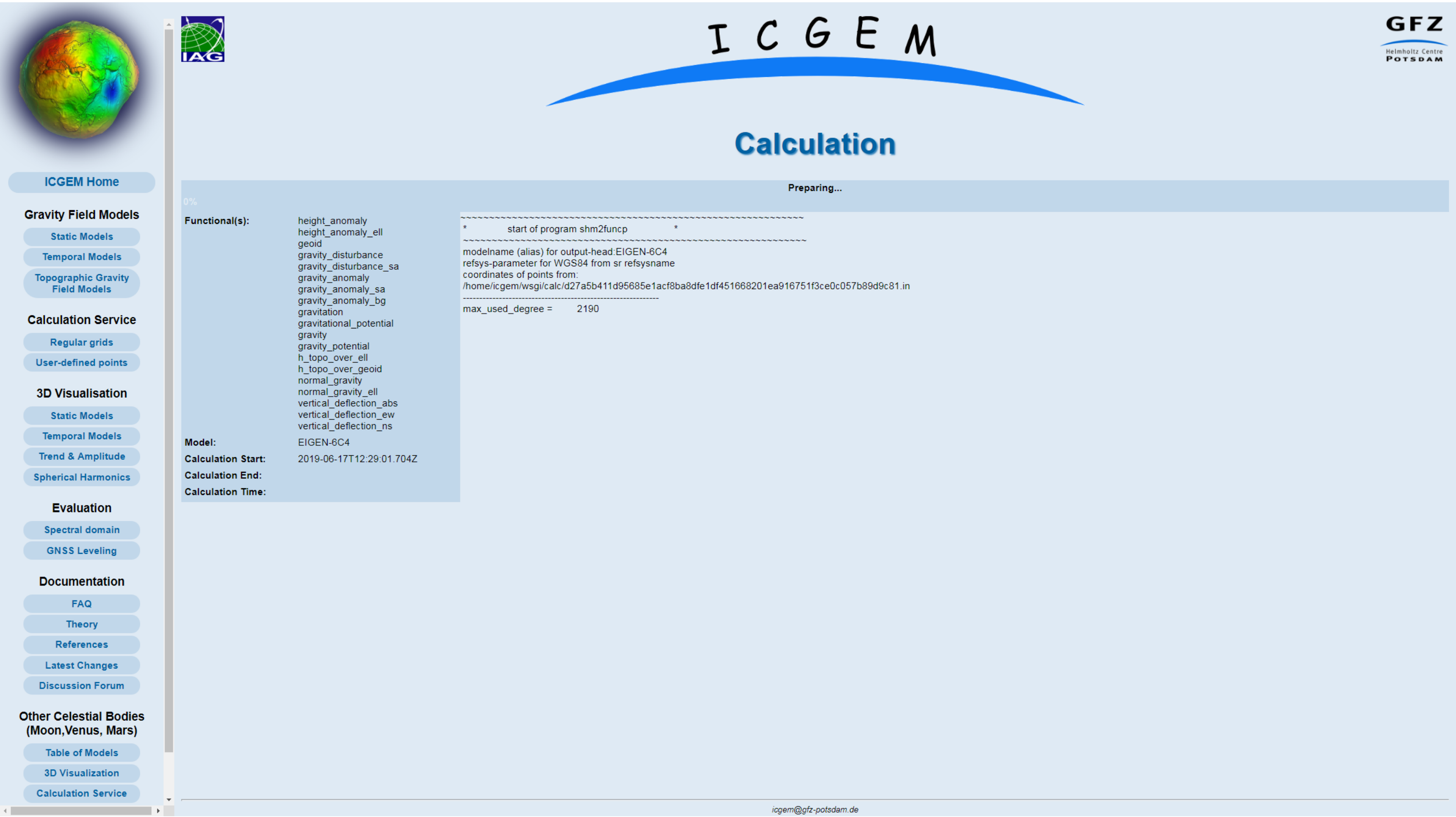
Improvement of spatial resolution in satellite-only Global Gravity Field Models
Example gravity anomalies in Europe



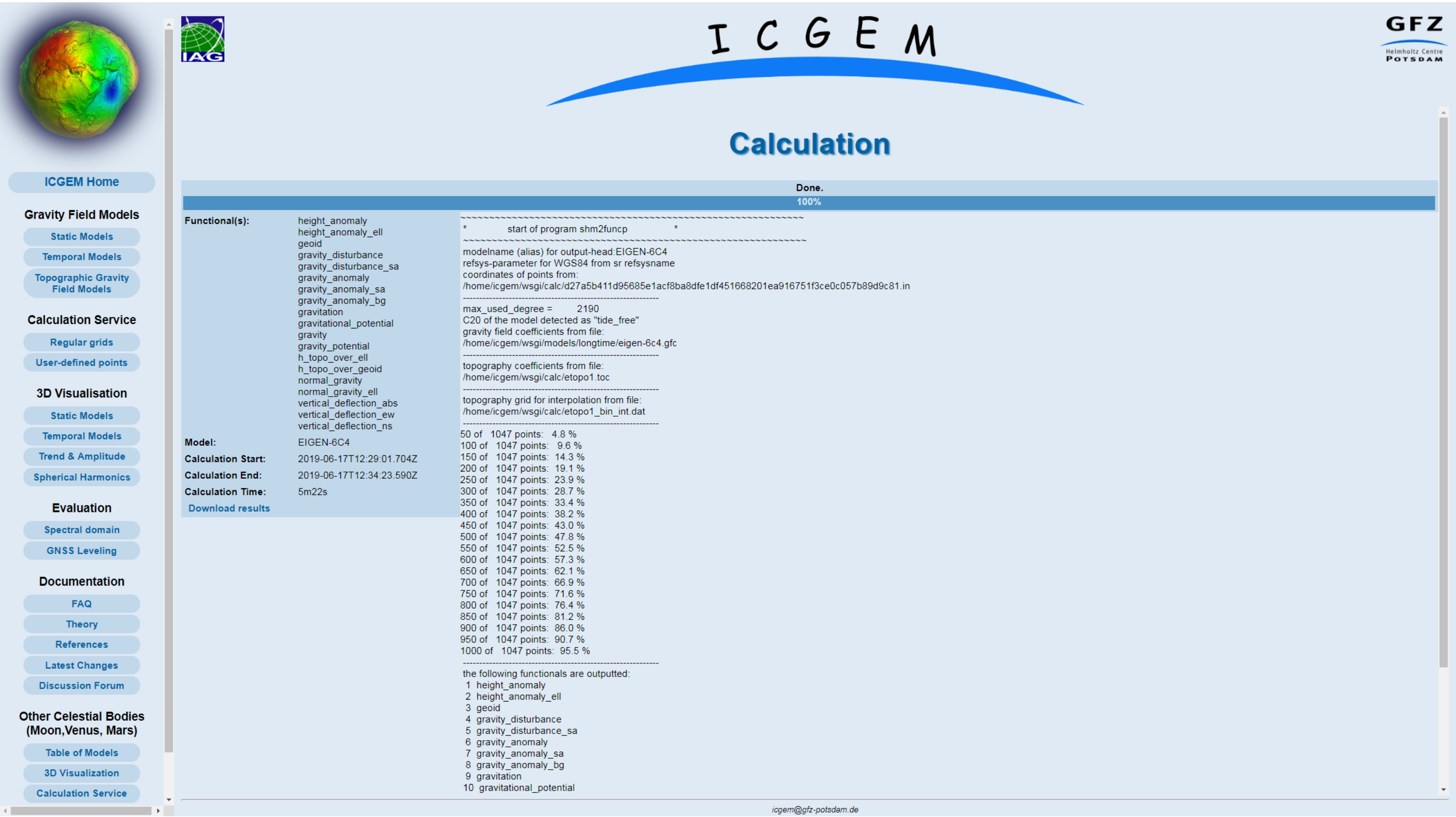
Calculation Service
User-defined points



Calculation Service
User-defined points



Calculation Service
User-defined points



Area

```
    water_density       1025.0  [kg/m**3]  ==> for Bouguer anomaly
-----------------------------------------------------------------------
          topo_grd      etopo1_bin_int  ==> for h_topo_over_geoid
-----------------------------------------------------------------------
   number_of_points          1047
     latlimit_north        70.683400000000
     latlimit_south        36.131700000000
     longlimit_west        -8.398900000000
     longlimit_east        31.095800000000
```

Description of columns

Simplified equations

```
description of columns -----------------------------------------
  1 identifier  (from input)
  2 longitude   (from input)        [degree]
  3 latitude    (from input)        [degree]
  4 h_over_ell  (from input)         [meter]
 ----------------------------------------
  5 height_anomaly                   [meter]   T(h)/normal_gravity(h)
  6 height_anomaly_ell               [meter]   T(h=0)/normal_gravity(h=0)
  7 geoid                            [meter]   h_anomaly_ell + Topo-Term
  8 gravity_disturbance               [mGal]   gravity(h) - gamma(h)
  9 gravity_disturbance_sa            [mGal]   sph. approx. (h=0)
 10 gravity_anomaly                   [mGal]   gravity(h) - gamma(h-h_anomaly)
 11 gravity_anomaly_sa                [mGal]   sph. approx. (h=0)
 12 gravity_anomaly_bg                [mGal]   gravity_anomaly_sa + Topo-Term
 13 gravitation                       [mGal]   gravitation(h)
 14 gravitational_potential    [m**2/s**2]   gravitational_potential(h)
 15 gravity                           [mGal]   gravity(h)
 16 gravity_potential          [m**2/s**2]   gravity_potential(h)
 17 h_topo_over_ell                  [meter]   geoid + topo_over_geoid (model)
```

Results

```
end_of_head ====================================================================
4          15.49360000   47.06720000  4.737000E+01  4.789167541919E+01  4.789296223378E+01  4.787525389758E+01  4.137726816662E+01  4.141119766980E+01
5          15.59830000   48.65440000  4.649000E+01  4.704454182355E+01  4.704650497386E+01  4.703237385418E+01  5.594845404691E+01  5.592971408380E+01
6           9.78470000   47.51530000  4.709000E+01  4.760861973524E+01  4.760681765294E+01  4.755969505174E+01 -2.280119703482E+01 -2.282168085804E+01
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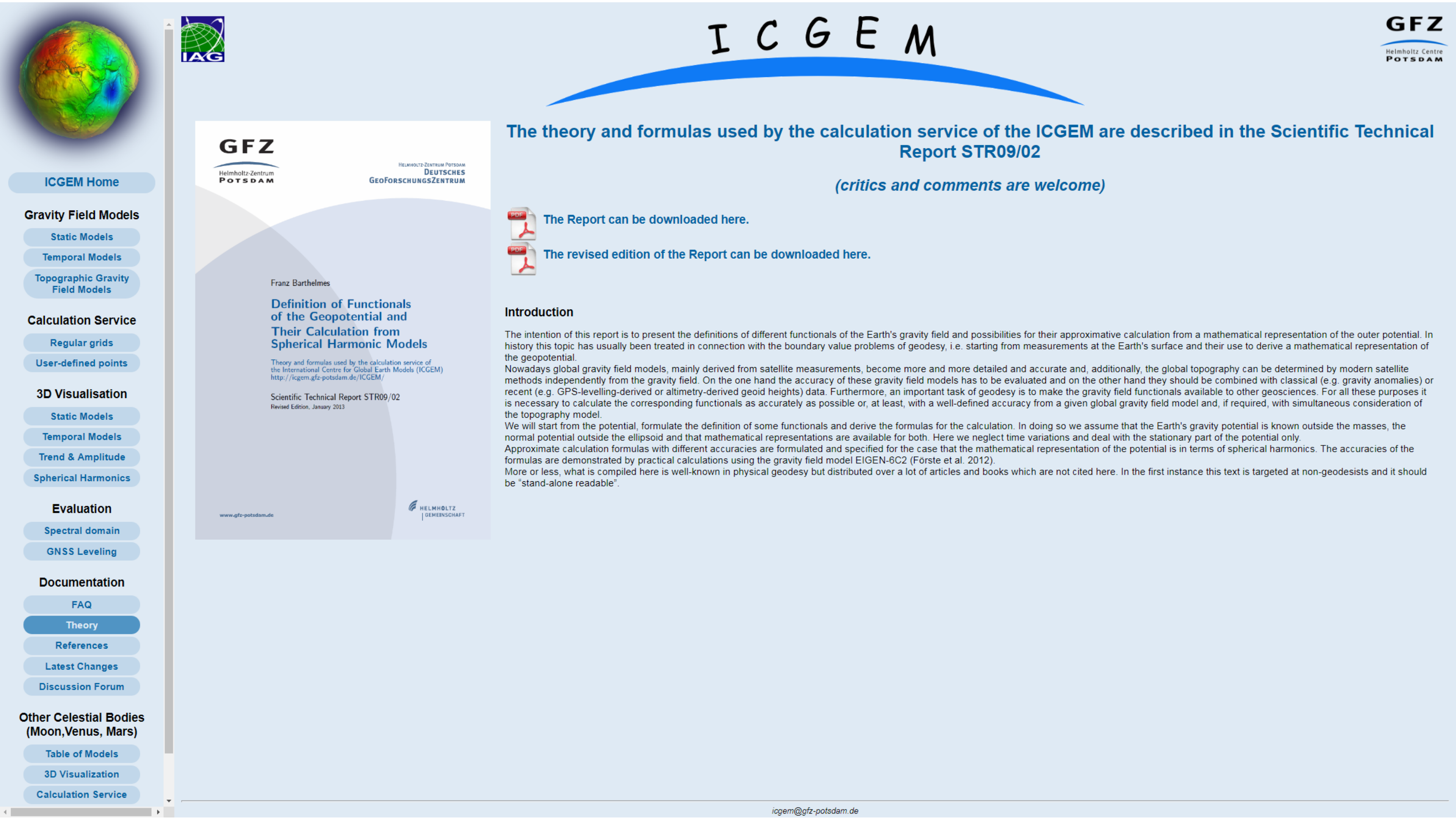
Reference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Franz Barthelmes
Definition of Functionals of the Geopotential and Their Calculation from Spherical Harmonic Models
Theory and formulas used by the calculation service of the International Centre for Global Earth Models (ICGEM) http://icgem.gfz-potsdam.de/ICGEM/
Scientific Technical Report STR09/02
Revised Edition, January 2013
www.gfz-potsdam.de
Helmholtz Gemeinschaft
The theory and formulas used by the calculation service of the ICGEM are described in the Scientific Technical Report STR09/02
(critics and comments are welcome)
The Report can be downloaded here.
The revised edition of the Report can be downloaded here.
Introduction
The intention of this report is to present the definitions of different functionals of the Earth's gravity field and possibilities for their approximative calculation from a mathematical representation of the outer potential. In history this topic has usually been treated in connection with the boundary value problems of geodesy, i.e. starting from measurements at the Earth's surface and their use to derive a mathematical representation of the geopotential.
Nowadays global gravity field models, mainly derived from satellite measurements, become more and more detailed and accurate and, additionally, the global topography can be determined by modern satellite methods independently from the gravity field. On the one hand the accuracy of these gravity field models has to be evaluated and on the other hand they should be combined with classical (e.g. gravity anomalies) or recent (e.g. GPS-levelling-derived or altimetry-derived geoid heights) data. Furthermore, an important task of geodesy is to make the gravity field functionals available to other geosciences. For all these purposes it is necessary to calculate the corresponding functionals as accurately as possible or, at least, with a well-defined accuracy from a given global gravity field model and, if required, with simultaneous consideration of the topography model.
We will start from the potential, formulate the definition of some functionals and derive the formulas for the calculation. In doing so we assume that the Earth's gravity potential is known outside the masses, the normal potential outside the ellipsoid and that mathematical representations are available for both. Here we neglect time variations and deal with the stationary part of the potential only.
Approximate calculation formulas with different accuracies are formulated and specified for the case that the mathematical representation of the potential is in terms of spherical harmonics. The accuracies of the formulas are demonstrated by practical calculations using the gravity field model EIGEN-6C2 (Förste et al. 2012).
More or less, what is compiled here is well-known in physical geodesy but distributed over a lot of articles and books which are not cited here. In the first instance this text is targeted at non-geodesists and it should be "stand-alone readable".
icgem@gfz-potsdam.de

Contents

DOI: 10.2312/GFZ.b103-0902-26

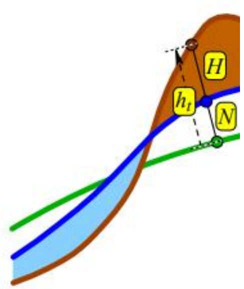
thus W_a is a *harmonic functio*
On the rotating Earth, addit
can be described by its (non-ha

where ω is the angular velocity
Hence, the potential W associa
system) is the sum of the attra

The associated force vector $\vec{g}$ a

and the magnitude

is called *gravity*. Potentials ca
From the theory of harmonic f
sufficient to define the whole h
For the Earth one equipotent
tial surfaces, the geoid is the
equilibrium) and its fictitious
Christou, 1994, Vaníček & Kra



Figure

tential surface, the geoid is a su
equal in magnitude!). To define
has to be chosen:

As usual we split the potential

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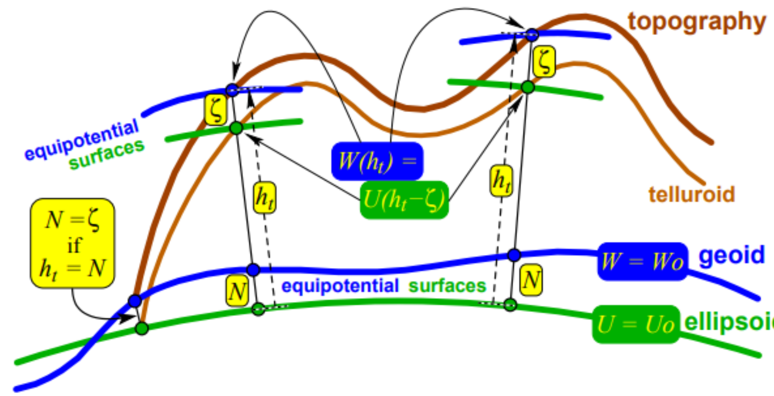

Figure 2: The ellipsoid, the geoid, and the height anomaly ζ

In the history of geodesy the great importance of the height anomaly was that it can be calculated from gravity measurements carried out at the Earth's surface without knowledge of the potential inside the masses, i.e. without any hypothesis about the mass densities.

The definition of eq. (20) is not restricted to heights $h = h_t$ on the Earth's surface, thus a generalised height anomaly $\zeta_g = \zeta_g(h, \lambda, \phi)$ for arbitrary heights h can be defined by:

$$\boxed{W(h, \lambda, \phi) = U(h - \zeta_g, \phi)} \tag{25}$$

2.3 The Gravity Disturbance

The gradient of the disturbing potential T is called the *gravity disturbance vector* and is usually denoted by $\vec{\delta g}$:

$$\vec{\delta g}(h, \lambda, \phi) = \nabla T(h, \lambda, \phi) = \nabla W(h, \lambda, \phi) - \nabla U(h, \phi) \tag{26}$$

The *gravity disturbance* δg is *not* the magnitude of the gravity disturbance vector (as one could guess) but defined as the difference of the magnitudes (Hofmann-Wellenhof & Moritz, 2005):

$$\boxed{\delta g(h, \lambda, \phi) = \left|\nabla W(h, \lambda, \phi)\right| - \left|\nabla U(h, \phi)\right|} \tag{27}$$

In principle, herewith δg is defined for any height h if the potentials W and U are defined there. Additionally, with the downward continuations W_a^c and U_a^c (eqs. 17 and 18), we can define a "harmonic downward continued" gravity disturbance

$$\delta g^c(h, \lambda, \phi) = \left|\nabla W^c(h, \lambda, \phi)\right| - \left|\nabla U^c(h, \phi)\right| \tag{28}$$

With the notations from eqs. (7) and (16) we can write the gravity disturbance in its common form:

$$\boxed{\delta g(h, \lambda, \phi) = g(h, \lambda, \phi) - \gamma(h, \phi)} \tag{29}$$

The reason for this definition is the practical measurement process, where the gravimeter measures only $|\nabla W|$, the magnitude of the gravity, and not the direction of the plumb line.

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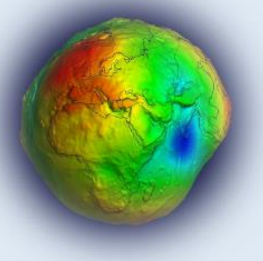
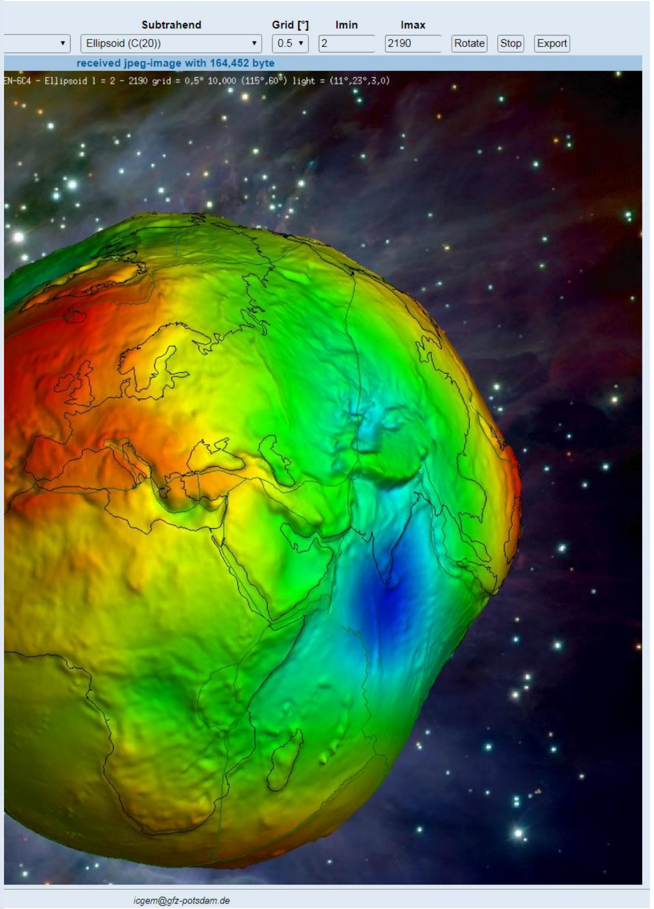
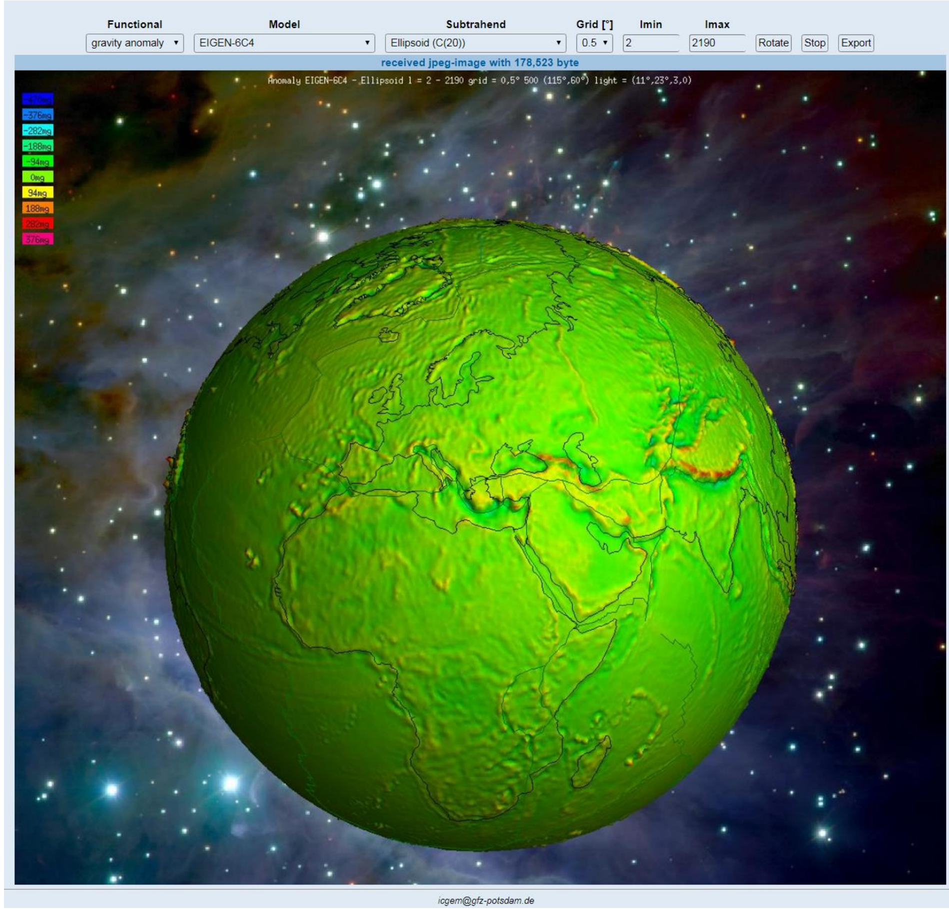


3D Visualisation



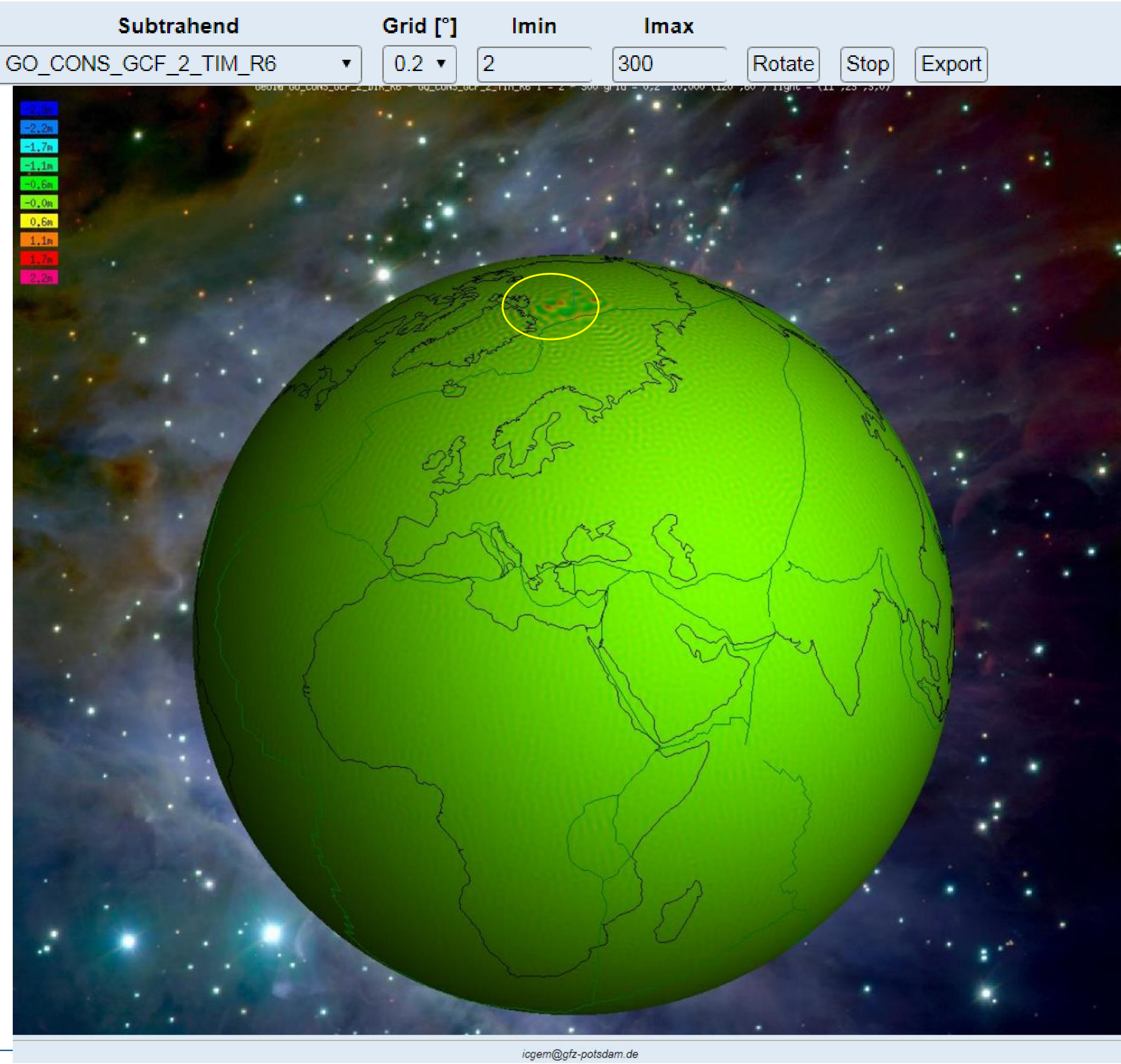
eoid undulation



Gravity anomalies

HELMHOLTZ

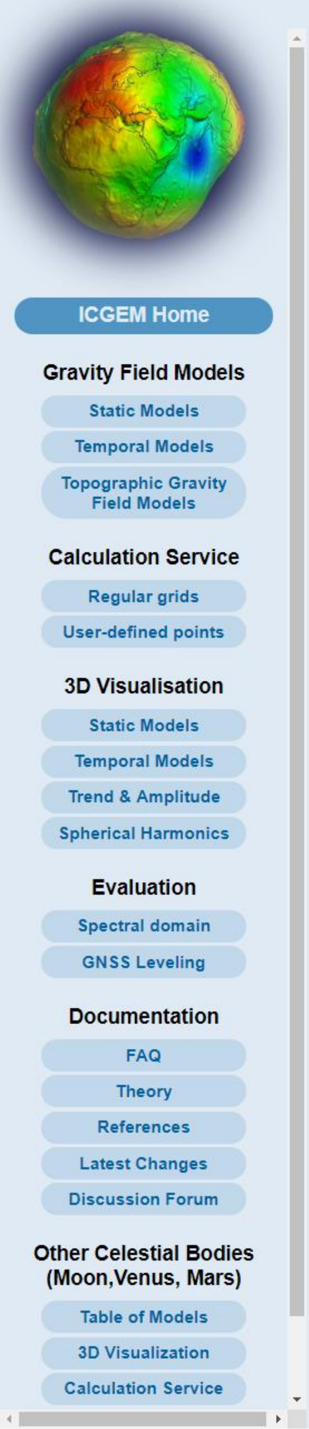
3D Visualisation

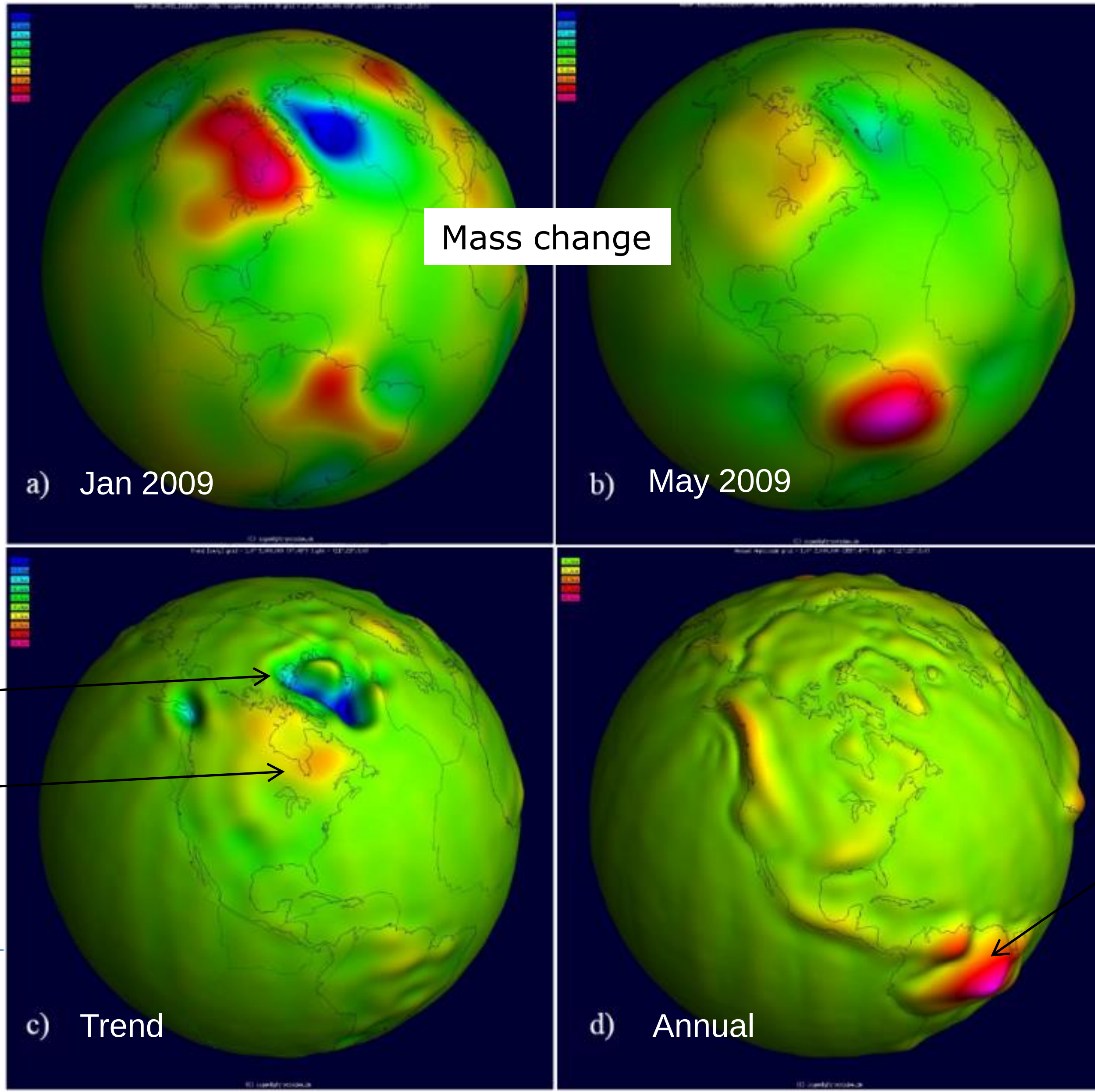


- Differences between two latest GOCE releases
- DIR-R6 and TIM-R6, differences in the polar regions due to different regularisations applied

Geoid undulation differences

3D Visualisation





Large signal

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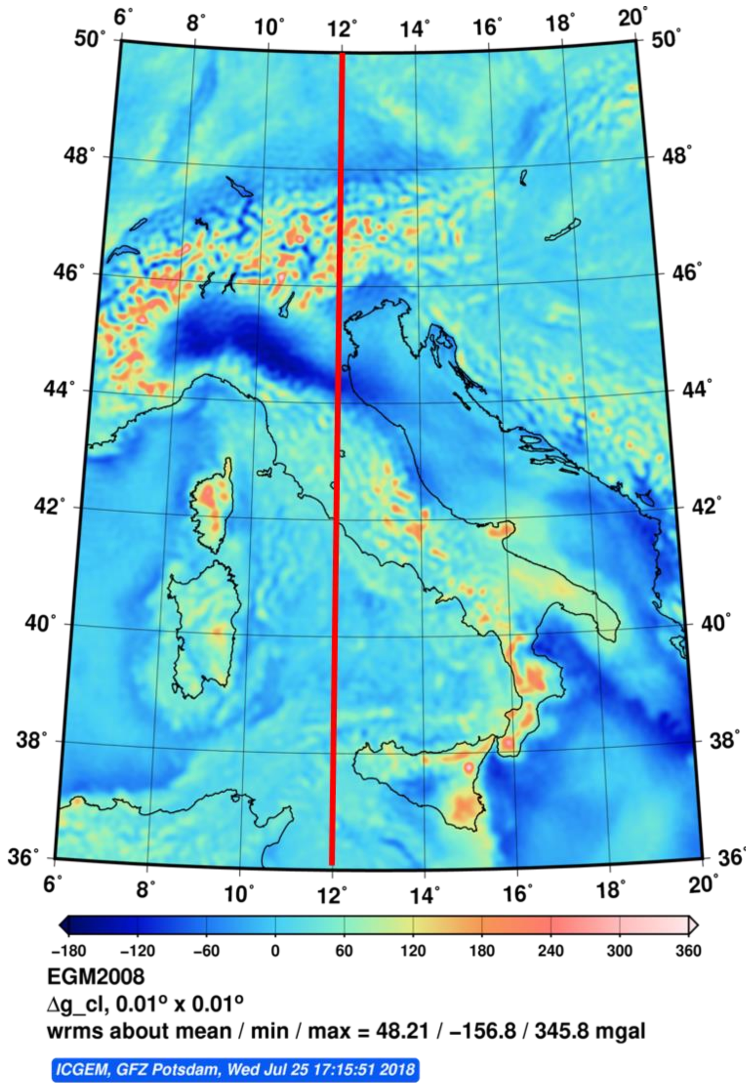
Some other calculations



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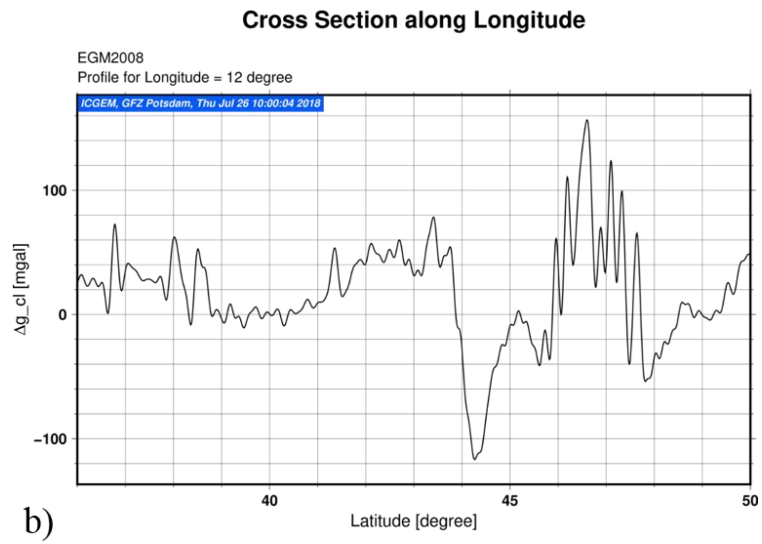

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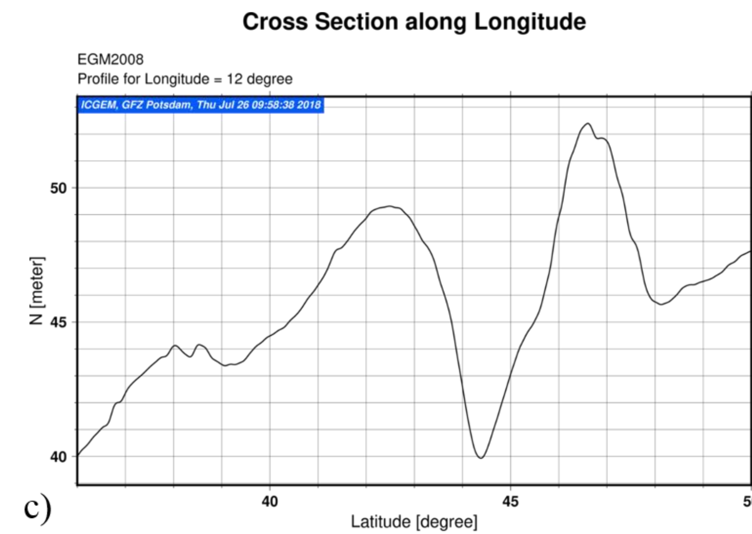


c)

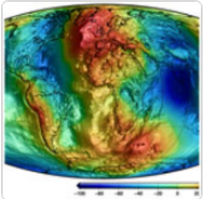
Open access journal paper with examples

Earth System Science Data
The data publishing journal

Earth Syst. Sci. Data, 11, 647-674, 2019
https://doi.org/10.5194/essd-11-647-2019

Research article 15 May 2019

ICGEM – 15 years of successful collection and distribution of global gravitational models, associated services, and future plans



E. Sinem Ince[1], Franz Barthelmes[1], Sven Reißland[1], Kirsten Elger[2], Christoph Förste[1], Frank Flechtner[1,4], and Harald Schuh[3,4]
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[2]Library and Information Services, GFZ German Research Centre for Geosciences, Potsdam, Germany
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Received: 01 Feb 2019 – Discussion started: 05 Feb 2019 – Revised: 03 Apr 2019 – Accepted: 14 Apr 2019 – Published: 15 May 2019

Abstract

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The International Centre for Global Earth Models (ICGEM, http://icgem.gfz-potsdam.de/, last access: 6 May 2019) hosted at the GFZ German Research Centre for Geosciences (GFZ) is one of the five services coordinated by the International Gravity Field Service (IGFS) of the International Association of Geodesy (IAG). The goal of the ICGEM service is to provide the scientific community with a state-of-the-art archive of static and temporal global gravity field models of the Earth, and develop and operate interactive calculation and visualization services of gravity field functionals on user-defined grids or at a list of particular points via its website. ICGEM offers the largest collection of global gravity field models, including those from the 1960s to the 1990s, as well as the most recent ones, which have been developed using data from dedicated satellite gravity missions, CHAMP, GRACE, GOCE, advanced processing methodologies, and additional data sources such as satellite altimetry and terrestrial gravity. The global gravity field models have been collected from different institutions at international level and after a validation process made publicly available in a standardized format with DOI numbers assigned through GFZ Data Services. The development and maintenance of such a unique platform is crucial for the scientific community in geodesy, geophysics, oceanography, and climate research. In this article, we present the development history and future plans of ICGEM and its current products and essential services. We present the ICGEM's data by means of Earth's static, temporal, and topographic gravity field models as well as the gravity field models of other celestial bodies together with examples produced by the ICGEM's calculation and 3-D visualization services and give an insight into how the ICGEM service can additionally contribute to the needs of research and society.

How to cite. Ince, E. S., Barthelmes, F., Reißland, S., Elger, K., Förste, C., Flechtner, F., and Schuh, H.: ICGEM – 15 years of successful collection and distribution of global gravitational models, associated services, and future plans, Earth Syst. Sci. Data, 11, 647-674, https://doi.org/10.5194/essd-11-647-2019, 2019.

1 Introduction

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The determination of the Earth's gravity field is one of the main tasks of geodesy. With the highly accurate satellite measurements a result of today's advancing technology, it is now possible to represent the Earth's global gravity field and its variations with better spatial and temporal resolutions compared to the first-generation global gravity field models derived from the 1960s to 1990s. Global gravity field models provide information about the Earth's shape, its interior and fluid envelope and mass change, which give hints to climate-related changes in the Earth system. The computation of gravity field functionals (e.g. geoid undulations, gravity anomalies) from the model representation is therefore not only relevant for geodesy but also for other geosciences, such as geophysics, glaciology, hydrology, oceanography, and climatology.

Some application examples in which the precise knowledge of the Earth's gravity field is fundamental are (1) to establish a global vertical datum of global reference systems (Sideris and Fotopoulos, 2012), (2) to monitor mass distributions that are indicators of climate-related changes (Tapley et al., 2004; Schmidt et al., 2006), (3) to simulate the perturbing forces on space vehicles and predict orbits in aeronautics and astronautics (Chao, 2005), (4) to explore the interior structure and geological evolution of our Earth (Wieczorek, 2015), and (5) to

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- Question 5: Why do we need gravity field models? +
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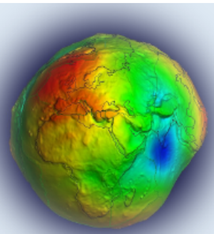

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Question 17: GRS80 and WGS84 are considered to be nearly the same. Then, why are the geoid undulations different?

Answer: The difference between the geoid undulations computed with respect to the two systems is due to the different values GM_1 and GM_2 used in the ellipsoidal model (see question 16). The geoid difference referring to these two reference systems can be computed by:

$$N_{12} = \frac{(GM_1 - GM_2)}{(\gamma R)} \qquad (25)$$

where $GM_{(GRS80)} = 3.986005 \times 10^{14}\ m^2/s^2$ and $GM_{(WGS84)} = 3.986004418 \times 10^{14}\ m^2/s^2$, and the usual values for γ and R, N_{12} is approximately 0.93m.

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2019

- **11. June 2019:**
  CNES-GRGS Release 4 temporal model: New release of temporal global gravity field, CNES.RL04-v1.monthly.NEW_IERS2010_MEAN_POLE_CONVENTION, is available. See also https://grace.obs-mip.fr/variable-models-grace-lageos/grace-solutions-release-04/rl04-products-description/ .
- **7. June 2019:**
  EIGEN-GRGS.RL04.MEAN-FIELD: New release of satellite-only mean global gravity field model from CNES-GRGS is available. See also https://grace.obs-mip.fr/variable-models-grace-lageos/mean-fields/release-04/ .
- **7. June 2019:**
  GOCO06s: New release of combined satellite-only global gravity field model is now available. See also https://www.bgu.tum.de/iapg/forschung/schwerefeld/goco/ .
- **7. June 2019:**
  New release GOCE satellite-only models

- **7. June 2019:**
  New release GOCE satellite-only models

  - **GO_CONS_GCF_2_DIR_R6:** New release of GOCE satellite-only global gravity field model based on Direct solution is available. See also http://earth.esa.int/GOCE/ .,
    GO_CONS_GCF_2_TIM_R6: New release of GOCE satellite-only global gravity field model based on Time-wise solution is available. See also http://earth.esa.int/GOCE/ .

Tongji-Grace2018_n96: New monthly series from Tongji University is available.

- **10. May 2019:**
  IGGT_R1C: Static global gravity field model with the contribution of polar terrestrial gravity data is available.

2018

- **11. December 2018:**
  GFZ Release 06 New release of GFZ GRACE monthly solutions is available.
- **21. November 2018:**
  ITSG-Grace2018 A new time series of monthly and daily GRACE global Earth models from TU Graz are available .
- **17. November 2018:**
  SWJTU-GRACE-RL01 A new time series of GRACE monthly solutions SWJTU-GRACE-RL01 from Southwest Jiaotong University is available.
- **6. September 2018:**
  LUH-GRACE2018 New time series of GRACE monthly solutions, LUH-GRACE2018 from Institude of Geodesy, University of Hannover is available.
- **1. July 2018:**
  Tongji-Grace02k High-precision static GRACE-only global gravity field model derived by refined data processing strategies from Tongji University, China is available.
- **19. April 2018:**
  SGG-UGM-1 Ultra high degree gravity field model SGG-UGM-1 derived combining EGM2008 gravity anomaly and GOCE observation data from Wuhan University, China is available.
- **19. April 2018:**
  GOSG01S A GOCE-only gravity model GOSG01S from Wuhan University, China is available.

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icgem@gfz-potsdam.de

Discussion Forum

ICGEM

Gravity Field Discussion Forum

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Dear ICGEM User,

Welcome to the Gravity Field Discussion Forum! This platform has been created to assist scientists, students, and anyone who is interested in using ICGEM service and its products.

Please post your questions, comments or critics here and ICGEM team will try to respond as soon as possible.
Moreover, other users are very welcome to actively join the discussion or answer the questions as well. Discussions of general interest can help many others and we make all inputs available upon a confirmation by our system.
Before submitting your question, please take a look at our Frequently Asked Questions (FAQs) since your question might have already been asked and answered by our team.

Usage

Please type your name in the upper field, optionally your email address if you want to receive a message when your question is answered. You can add your comment in the textarea, and then press the *send* button.
Names are limited to 60 characters and the comment must not have less than 10 or more than 4000 characters, otherwise it is rejected.
Your posting will appear on the top of the guest book listing after it is confirmed by our system.

You may also contact us per email.

Create a new comment...

300 **Sinem**

Wednesday, May 22. 2019 10:03:28 UTC

Dear Anthony,

GGM refers to Global Gravitational (Field) Model (aka Global Geopotential Model) in general. EGM2008 is a high resolution combined static global gravitational model itself. Please also refer to https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011JB008916 and https://www.earth-syst-sci-data.net/11/647/2019/essd-11-647-2019.html for more information.

Orthometric height is the height difference between the ellipsoidal height and geoid height. The geoid height itself can be computed from a GGM. If you have the ellipsoidal height information at your point of interest, then a simple subtraction will deliver orthometric heights.

Hope it helps.
Best regards,
Sinem

299 **Sinem**

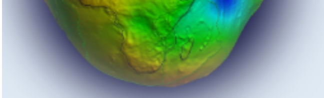
Monday, May 20. 2019 12:52:04 UTC

Dear Afelumo John,

Thank you for contacting our service. You can run the geoid calculation in our calculation service and download the grid values for the area of your interest for free. Therefore you do not need any permission from us but only need to refer to the ICGEM service. We also do not provide separately computed files to the users since this can be done within minutes via the calculation service.
The new reference for the ICGEM service is https://www.earth-syst-sci-data.net/11/647/2019/essd-11-647-2019.pdf in which you can also find an example of the calculation service.

icgem@gfz-potsdam.de

Needs users' contribution to spread the information in the gravity field community!



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255 Sinem

Wednesday, January 17. 2018 13:37:09 UTC

Dear Mustafa Yilmaz,

Thank you for using our service and your question on the isostatic gravity anomalies. Please see below our answer.

Is there any functional selection in the Calculation Service (ICGEM) for computing "free-air gravity anomaly" and "isostatic gravity anomaly"?

-We offer "gravity_anomaly_cl" which is defined as the magnitude of the gradient of the downward continued potential on the geoid minus the magnitude of the gradient of the normal potential on the ellipsoid. Therefore this is technically the free air gravity anomaly defined on the geoidal surface.

We do not offer the calculation of the isostatic gravity anomalies in our service. However, we offer the calculation of the functionals using topography related models which might be useful for this purpose. For more information, the authors of the topography related models can be contacted.

Is the "gravity_anomaly_bg" of the Calculation Service (ICGEM) "refined" or "simple" according to terrain correction?

- The Bouguer gravity anomaly we offer in the Calculation Service is defined based on the description of the simple Bouguer gravity anomaly since only the attraction of the Bouguer plate ($2\pi G\rho H$) is removed. It is calculated by the spherical approximation of the classical gravity anomaly minus $2\pi G\rho H$ (eqs. 107 and 126 of Technical Report STR09/02). The topographic heights $H(\lambda,\varphi)$ are calculated from the spherical harmonic model DTM2006 used up to the same maximum degree as the gravity field model. (For $H \geq 0$ (rock) $\rightarrow \rho = 2670$ kg/m3, and for $H < 0$ (water) $\rightarrow \rho = (2670-1025)$ kg/m3 is used.)

I will be pleased if you give information about the reduction steps of "gravity_earth" to the "gravity_ell" (free-air, bouguer, isostatic, etc.). Which functional(s) of the Calculation Service (ICGEM) can be used in this reduction?

In our calculation service, we use spherical harmonic coefficients that are harmonic outside of the masses. Therefore, we assume that we know the complete information concerning the gravity field. When we compute the gravity functionals at different points (e.g., at the Earth surface or on the geoidal surface), we use the same field information (spherical harmonic coefficients) assuming that the masses are pushed and condensed under the surface that the computation point is referred to. Therefore, we perform the computations at the exact point without applying any reduction. During the calculation process, the mass is already assumed to be condensed and no masses are left outside of the computation point. Based on this, we could tell this is close the definition of t

Why not creating a dynamic platform?

Suggestions are welcome!

Hope it helps.

Best regards,

Sinem

254 Mustafa YILMAZ

Wednesday, January 17. 2018 13:30:07 UTC

Dear ICGEM Editor,
I am updating my entry (253).
Is there any functional selection in the Calculation Service for computing "isostatic gravity anomaly" with respect to long-time models (EGM08 etc.)?
Can "gravity anomaly_cl" be accepted as "free-air" (approximately)?
Kind regards?

253 Mustafa YILMAZ

Sunday, January 14. 2018 08:45:08 UTC

Dear ICGEM Editor,

Users' support
Knowledge exchange

- Contribution to the Discussion Forum
  - Question or answer
- Provision of GNSS/levelling datasets for evaluation purposes
  - To ICGEM, to others?
- Any feedback, comment, and critique is welcome.
  - Some good ideas
  - Some possible improvements

E-mail group

To subscribe:

icgemuser-on@gfz-potsdam.de

Mailing list address:

icgemuser@gfz-potsdam.de

Thank you
for your attention!

References

- Barthelmes F (2013): Definition of functionals of the geopotential and their calculation from spherical harmonic models: theory and formulas used by the calculation service of the International Centre for Global Earth Models (ICGEM); http://icgem.gfz-potsdam.de/ICGEM/; revised Edition, (Scientific Technical Report; 09/02), Potsdam: Deutsches GeoForschungsZentrum GFZ, 32 p. DOI: http://doi.org/10.2312/GFZ.b103-0902-26.
- Ince ES, Barthelmes F, Reißland S, Elger K, Förste C, Flechtner F, Schuh H (2019): ICGEM – 15 years of successful collection and distribution of global gravitational models, associated services, and future plans, Earth Syst. Sci. Data, 11, 647-674, https://doi.org/10.5194/essd-11-647-2019.