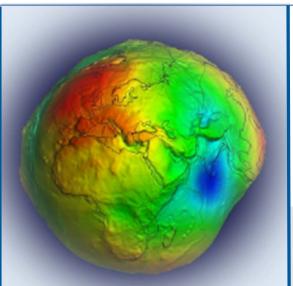


Helmholtz Centre POTSDAM

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The International Centre for Global Earth Models (ICGEM) E. Sinem Ince, Franz Barthelmes, Sven Reißland, Kirsten Elger, Christoph Förste and Frank Flechtner (contact us at icgem@gfz-potsdam.de)



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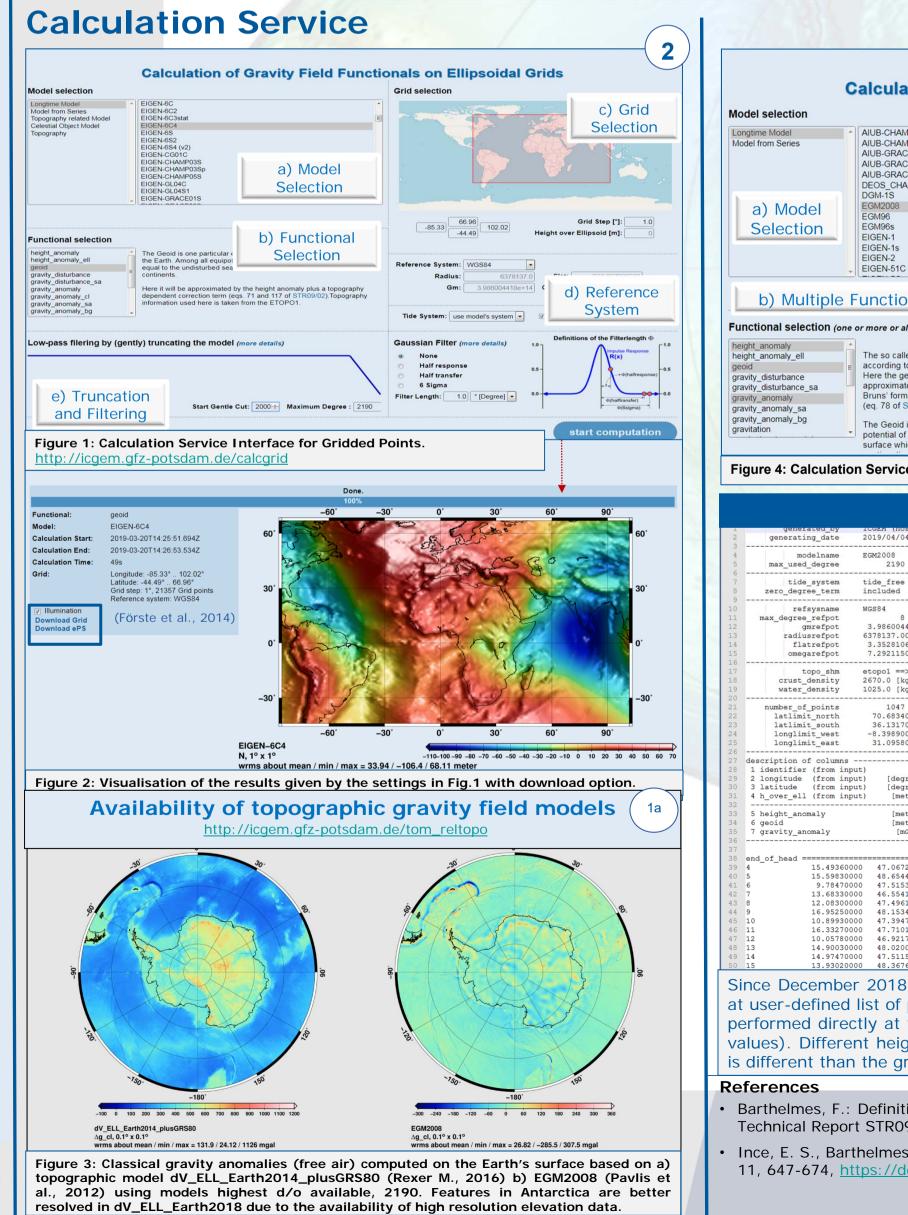
3D Visualization

Calculation Service

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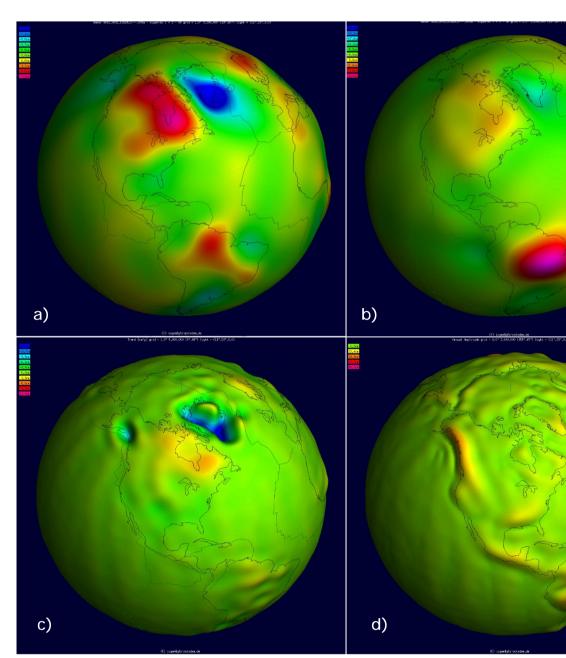
3D Visualisation Service Abstract The more than 15-year-old ICGEM is one of the five services coordinated by the International Gravity Field Service (IGFS) of the International Association of Geodesy (IAG). It is hosted by GFZ German Research Centre for Geosciences in Potsdam, Germany. The aim of the ICGEM service is to provide the scientific community with a state-of-the-art archive of static and time variable global gravity field models of the Earth in a standardized format with a possibility to assign DOI number. Furthermore, ICGEM contains an interactive calculation and visualization service of gravity field functionals. Development and maintenance of such a unique platform is crucial for the scientific community in geodesy, geophysics, oceanography and climatology and has a positive impact in governmental institutions and industrial practice. This poster covers the maintenance, recently established new features and future plans of the ICGEM Service. New features include the calculation of gravity field functionals at a list of user-defined distributed points and new topographic gravity field models, whereas the future plans aim to meet the needs of the scientific community. As an add-on, ICGEM provides also access to the gravity field models of some other celestial bodies (Mars, Venus, and Earth's moon). **Gravity Field Models** The datasets available via the ICGEM Service are the spherical harmonic coefficients, which together with the spherical harmonic functions, approximate the real gravitational potential of the Earth and/or its variations. ICGEM collects all available static and most of the temporal and topographical global gravity field models (GGMs) recently from different institutions under one umbrella and makes these models freely available to the public. ICGEM currently (April 30th, 2020) provides access to 176 static, variety of temporal and 10 topographic GGMs New features: The temporal models generated by the International Combination Service for Time-variable Gravity Field (COST-G) are available at ICGEM since July 2019. Since April 2020, the GAX products associated to the GRACE and Grace-FO solutions from the Science Data System centers CSR, GFZ and JPL are available at ICGEM as well **Calculation of Gravity Field Functionals on Ellipsoidal Grids** Calculation of Gravity Field Functionals on User-Defined Points **Aodel selection** c) Grid Model selection **User-Defined Points** Selection c) Point Selection AIUB-CHAMP01 Longtime Model AIUB-CHAMP03S AIUB-GRACE01S lodel from Serie AIUB-GRACE a) Model AIUB-GRACE03 Selection DEOS CHAMP-0 a) Model Grid Step [°]: Selection Height over Ellipsoid [m]: b) Functional Selection d) Reference b) Multiple Functional Selection System Tide System: use model's system Functional selection (o Figure 5: Snapshot of Visualisation Service for temporal gravity field models w-pass filering by (gently) truncating the model (more detail height anomaly height_anomaly_ell The so called "height anomaly" is an approxim a) EWH in January 2009 b) EWH in May 2009, note that the EWH difference b according to Molodensky's theory. It is equal to the select the format of the coordinates in your data file: Lon Lat Height Half response Here the generalised height anomaly at the given p and upload your file: Choose File europe dat two months represents the mass change, c) trend, note the strong effect d d models: gravity disturbance 6 Sigma ravity_disturbance_sa Hudson Bay area, Canada and ice melting in Greenland and Alaska d) annual a Bruns' formula: disturbance_potential(h, λ, φ) / norm \Rightarrow up to 1000 randomly selected points of your set are shown in the map e) Truncatior gravity anomaly Start Gentle Cut: 2000 Maximum Degree : 219 the large signal amplitude in the Amazon region is noticeable gravity_anomaly_sa and Filtering gravity_anomaly_bg The Geoid is one particular equipotential surface of the gravi (EWH - Equivalent Water Height) potential of the Earth. Among all equipotential surfaces, geoid is the surface which is equal to the undisturbed sea surface and its Tide System: use model's system 🔽 🛛 Zero Degree Term Figure 1: Calculation Service Interface for Gridded Points <u> http://icgem.gfz-potsdam.de/calcgrid</u> Figure 4: Calculation Service Interface for User-defined Points. <u> http://icgem.gfz-potsdam.de/calcpoints</u> An online interactive 3D Visualisation Service of the static models (geoid undulations and gravity anomalies), temporal models (geoid undulation and equivalent water column or height), trend and annual amplitude of GRACE gravity time variations, and spherical harmonics as illuminated projection on a freely rotatable sphere are available on the ICGEM Service. Static model visualisation enables also the demonstration of differences between two Output models with a selected grid interval and spherical harmonic degree expansion. Users of this service can select the functional, the model, the grid interval and the spherical harmonic degree expansion of the model to demonstrate Functional: d) Input Format Model: EIGEN-6C4 the results on the 3D visualization. 3D Visualisation of temporal gravity field models displays computation of geoid undulation and equivalent water height from different daily and monthly series with an option of using filtered or Calculation Start: 2019-03-20T14:25:51.694Z enerating date Calculation End: 2019-03-20T14:26:53.534Z unfiltered model coefficients. The visualisation tool can also be used for animation purposes for different monthly series. modelname max_used_degree Index Lat Lon Height EGM2008 Model Calculation Time: 49s Longitude: -85.33° .. 102.02° Latitude: -44.49° .. 66.96° Grid step: 1°, 21357 Grid poin Reference system: WGS84 Grid: Index Lon Lat Height Information tide system tide free ICGEM provides a gravity field discussion forum (http://icgem.gfz-potsdam.de/guestbook) which provides users with a platform to communicate with the ICGEM team and other scientists working on similar topics. Apart from Index Lat Lon fulfilling the requirements of the service, this platform has also been used as a tool for educational purposes in which undergraduate or graduate students communicate with the ICGEM team directly. The updated version of the WGS84 Index Lon Lat (Förste et al., 2014) max degree refpot forum in 2016 should give the users the opportunity to discuss any topic related to gravity field among themselves or answer each other's question and probably share data in the future. gmrefpot radiusrefpot 3.98600441 3.98600441800E+14 [m**3/s**2] 6378137.000 m Pavlis et al., 2012) Lat Lon Height Reference 3.352810664747480E-03 (1/298.25722356300 flatrefpo Lon Lat Height system omegarefpot 7.29211500000E-05 1/s etopo1 ==> for Bouguer anomaly and geoid 2670.0 [kg/m**3] ==> for Bouguer anomaly and geoid 1025.0 [kg/m**3] ==> for Bouguer anomaly Lat Lon **User Interaction** Lon Lat water_density number_of_points
latlimit_north
latlimit_south Input **Gravity Field Discussion For** 36.13170000000 Information longlimit west -8.398900000000 longlimit_east 31,09580000000 EIGEN-6C4 The details of the 10-100-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 7 Dear ICGEM User, N, 1° x 1° ription of columns wrms about mean / min / max = 33.94 / -106.4 / 68.11 meter calculation procedure identifier (from input) Output Velcome to the Gravity Field Discussion Forum! This platform has been created to assist scientists, students, and anyone who is in longitude (from input) latitude (from input) h_over_ell (from input) Figure 2: Visualisation of the results given by the settings in Fig.1 with download option. applied in the Format Please post your questions, comments or critics here and ICGEM team will try to respond as soon as possible Calculation and Availability of topographic gravity field models Moreover, other users are very welcome to actively join the discussion or answer the questions as well. Discussions of general interest can 5 height_anomaly [meter] T(h)/normal gravity(h [meter] h_anomaly_ell + Topo-Term [mGal] gravity(h) - gamma(h-h_anomaly Visualisation Services http://icgem.gfz-potsdam.de/tom_relt List of Before submitting your question, please take a look at our Frequently Asked Questions (FAQs) since your question might have already been gravity_anomaly can be found in points Barthelmes, 2014, 15.49360000 47.06720000 4.737000E+01 4.789712829572E+01 4.7880716 15.59830000 48.65440000 4.649000E+01 4.700905667443E+01 4.6996853 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 Technical Report. Names are limited to 60 characters and the comment must not have less than 10 or more than 4000 characters, otherwise it is rejected. 47.51530000 4.709000E+01 4.763468386405E+01 4.758578310597E+01 -3.699127075141E-Your posting will appear on the top of the guest book listing after it is confirmed by our syster 13.68330000 46.55410000 4.879000E+01 4.940242953026E+01 4.931591019585E+01 2.415306593218E 12.08300000 47.49610000 4.756000E+01 4.816963831508E+01 4.810882479117E+01 -4.912342087682E 16.95250000 47.15340000 4.396000E+01 4.442349463971E+01 4.44207603028E+01 2.10630464959E+01 10.89930000 47.39470000 4.959000E+01 5.037250149187E+01 5.010013391707E+01 6.967311579622E+01 http://icgem.gfz-You may also contact us per email potsdam.de/str-0902 16.33270000 47.71010000 4.585000E+01 4.637105522744E+01 4.635005874251E+01 3.383642956454E+01 10.05780000 46.92170000 5.110000E+01 5.183489340493E+01 5.127182263482E+01 7.589000406671E+0
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 <u>revised.pdf</u> Your Name: Your E-Mail 3.93020000 48.36760000 4.559000E+01 4.606614805377E+01 4.604723903670E+01 -1.821698019384E+0 Since December 2018, ICGEM makes available also the calculation of gravity field functionals Users comments or questions are welcome! at user-defined list of points that are given in one of the input formats and the calculations are performed directly at those given points using model coefficients (not an interpolation to grid



ICGEM

values). Different heights for different points can be introduced in the point calculation which is different than the grid calculation where the height is assumed same for all the grid points.



Barthelmes, F.: 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). Scientific Technical Report STR09/02, Revised Edition, January 2013. Deutsches GeoForschungZentrum GFZ, http://doi.org/10.2312/GFZ.b103-0902-26, 2013

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.

EGU General Assembly 2020, Online 4th – 8th May 2020 <u>https://doi.org/10.5194/egusphere-egu2020-3511</u>



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

4	I C G E M G F Z International Centre for Global Earth Models				DOI Service was developed as a re community in cooperation with GFZ To reduce the heterogeneity in da for static global gravity field mod		
EIGE	and GOCE data fro as: e, Christoph; Bruinsma, Sean; Abrikosov, Oleh; Ru	atellite-only gravity field model to d/o 300 based on LAG om the collaboration of GFZ Potsdam and GRGS Toulou udenko, Sergiy; Lemoine, Jean-Michel; Marty, Jean-Charles; Neumayer, Karl n todel to d/o 300 based on LAGEOS, GRACE and GOCE data from the collabor \$880/icgem.2016.008	Ise Released Citation tans; Biancale, Richard (2016):	metadata developed DOIs are Attributio	a templates for describin d. At the moment, all ma e published under the on 4.0 International Licen s implementation in lat	ng oc Cr	
Files ICGE ICGE Down		Abstract EIGEN-6S4 (Version 2) is a satellite-only global gravity field model from the GRACE and GOCE data. All spherical harmonic coefficients up to degree/ord time variable parameters consist of drifts as well as annual and semi-annua ries of the time variable spherical harmonic coefficients are based on the LA 2003) and the GRACE-LAGEOS monthly gravity fields RL03-v2 (August 200 GRGS/Toulouse (Bruinsma et al. 2009).	ler 80 are time variable. Their Il variations per year. The time se- AGEOS-1/2 solution (1985 to	gravity fi	DOIs to 23 static and ield models, mostly time ication via ICGEM.		
Docu	Data download	The herein included GRACE/LAGEOS data were combined with all GOCE di the direct numerical approach (Pail et al. 2011). The polar gap instability h cal Cap Regularization (Metzler and Pail 2005). That means this model is i with GO_CONS_GCF_2_DIR_RS (Bruinsma et al. 2013). Version History: This data set is an updated version of Foerste et al. (2016, /icgem_2016.004) Compared to the first version, EIGEN-6S4v2 contains an variable part, in particular for C20. Parameters			I DE CALLAR In the data colume, the datasets used in the development of the models are summarize atimetry, and 6 for ground data (e.g., terrestrial, shipborne and aitborne measurement The links calculate and show in the last columns of the table directly invoke the Calcu	zed, whe	
New Först Sergi Marty cale, satell on L4 oratic Data	ted Work Version of e, Christoph; Bruinsma, Sean; Rudenko, iy; Abrikosov, Oleh; Lemoine, Jean-Michel; iy, Jean-Charles; Neumayer, Karl Hans; Bian- Richard (2016): EIGEN-654 A time-variable lite-only gravity field model to d/o 300 based AGEOS, GRACE and GOCE data from the collab- on of GFZ Potsdam and GRGS Toulouse. GFZ Services. http://doi.org/10.5880 m.2016.004	format icgem2.0 product_type gravity_field modelname EIGEN-6S4v2 earth_gravity_constant 0.3986004415E+15 radius 0.6378136460E+07 max_degree 300 errors calibrated (sigma calibration factor = 2.00) norm fully_normalized tide_system tide_free Dataset Contact Ended to be	Model Parameters Contact	ICGEM Home Gravity Field Models Static Models Temporal Models Topographic Gravity Field Models Calculation Service Regular grids User-defined points 3D Visualisation	Nr Model Year Degre 168 Tongji-Grace02k 2018 180 167 SGG-UGM-1 2018 2159 166 GOSG01S 2018 220 165 IGGT_R1 2017 240 164 IfE_GOCE05s 2017 250 163 GO_CONS_GCF_2_SPW_R5 2017 330 162 GAO2012 2012 360	g g g g g g g g g	
Refer Bruin N. (2 (rele: Rese doi:1 Bruin JM., ESA's appro searc	rences Isma, S., Lemoine, JM., Biancale, R., & Valès, 010). C arch, 45 0.1016 Isma, S. Marty, JC., Mulet, S., Bonvalot, S. (2014). Is satellite-only gravity field model via the direct bach based on all GOCE data. Geophysical Re- th Letters, 41(21), 7508-7514.	Förste, Christoph (Senior Scientist) ; GFZ German Research Centre for Gt Bruinsma, Sean (Senior Scientist) ; GRGS/CNES Toulouse;France; Contributors Barthelmes, Franz; Reißland, Sven Keywords ICGEM, Global Gravitational Model, GRACE, GOCE, LAGEOS GCMD Science Keywords EARTH SCIENCE > SOLID EARTH > GEODETICS > GEOID CHARACTERISTIC EARTH SCIENCE > SOLID EARTH > GRAVITY/GRAVITATIONAL FIELD > GRAVITATIONAL FIELD > GRAVITAT	HERE AND AND AND A COMPANY OF		Liang, W. et al., 2018 & gfo Xu, X. et al. (2017) Xu, X. et al., 2018 gfo Related publications	ink ag	
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	F	Tuture Plans		
um 6		In the near future, the G3 Browser , which showed the time variation of gravity field at any pre-defined basin, will be available again with improved features developed for both advanced		
terested in using ICGEM service and its products.		educational purposes. A specific web interface will be made available for the user to calcul time series of mass variations.	late ai	
sked and answered by our team.	•	• New services, such as the provision of time series of the changes of the gravity field of the Eau flattening retrieved from SLR measurements from different institutions and agencies and the calculation of horizontal gravity gradients in the ICGEM Calculation Service are among our future p		
	•	In the following years, we propose to establish sub-sections for different topics and expand forum to be unique in this field. Anyone without any registration requirement should still comments in the forum which will be publicly available after approval of the ICGEM team.		
efer also to FAQs: 5	•	If requested by the users, data sharing such as terrestrial gravity measurements and GNSS, geoid undulations for GGM evaluation purposes can also be developed under the ICGEM web se		
p://icgem.gfz-potsdam.de/icgem_faq.pdf	•	An e-mail subscription list for the delivery of important updates to the interested users has and will be activated soon.	s beer	
		http://icgem.gfz-potsdam.de/home		

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