Geoid modelling in South America

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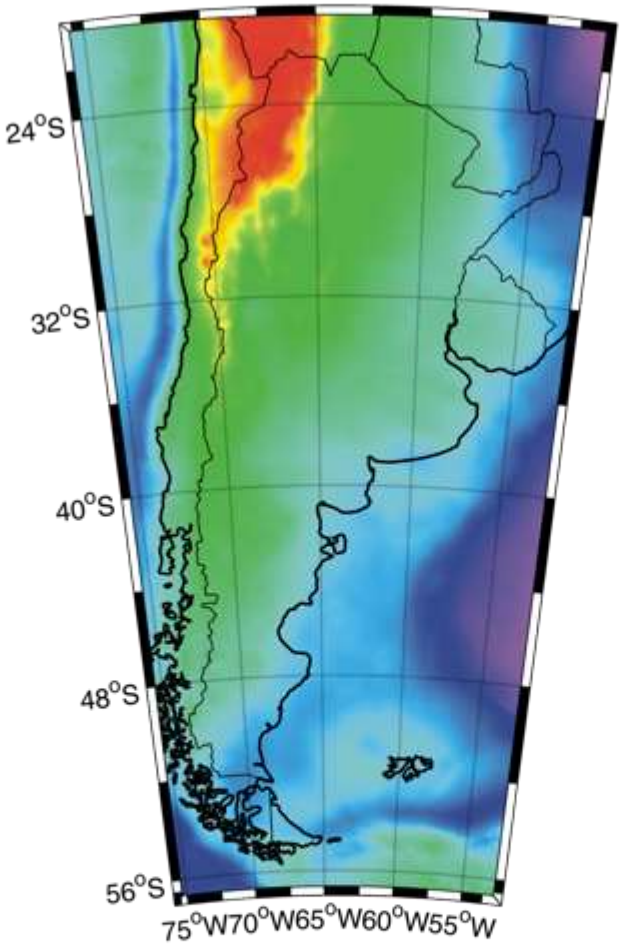
Most of the attempts for geoidal models presented here have their grids available on the International Service for the Geoid (ISG) website.

website: http://www.isgeoid.polimi.it/index.html

ISG image

Argentina Geoid models
1998 (ARG98),2005 (ARG05), 2006 (GAR) and 2016 (GEOIDEAR16)



ARG05

Tocho C, Font G, Sideris MG (2007) A new high-precision gravimetric geoid model for Argentina. In: Tregoning P, Rizos C (eds) ***Dynamic planet: monitoring and understanding a dynamic planet with geodetic and oceanographic tools IAG Symposium*** Cairns, Australia 22–26 August, 2005. Springer, Berlin Heidelberg

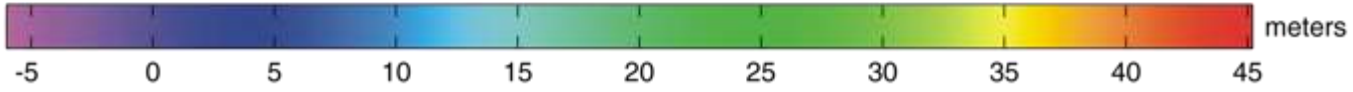
GAR

V. Corchete, M.C. Pacino (2007). The first high-resolution gravimetric geoid for Argentina: GAR. ***Physics of the Earth and Planetary Interiors***, 161, pp. 177-183.

GEOIDEAR16

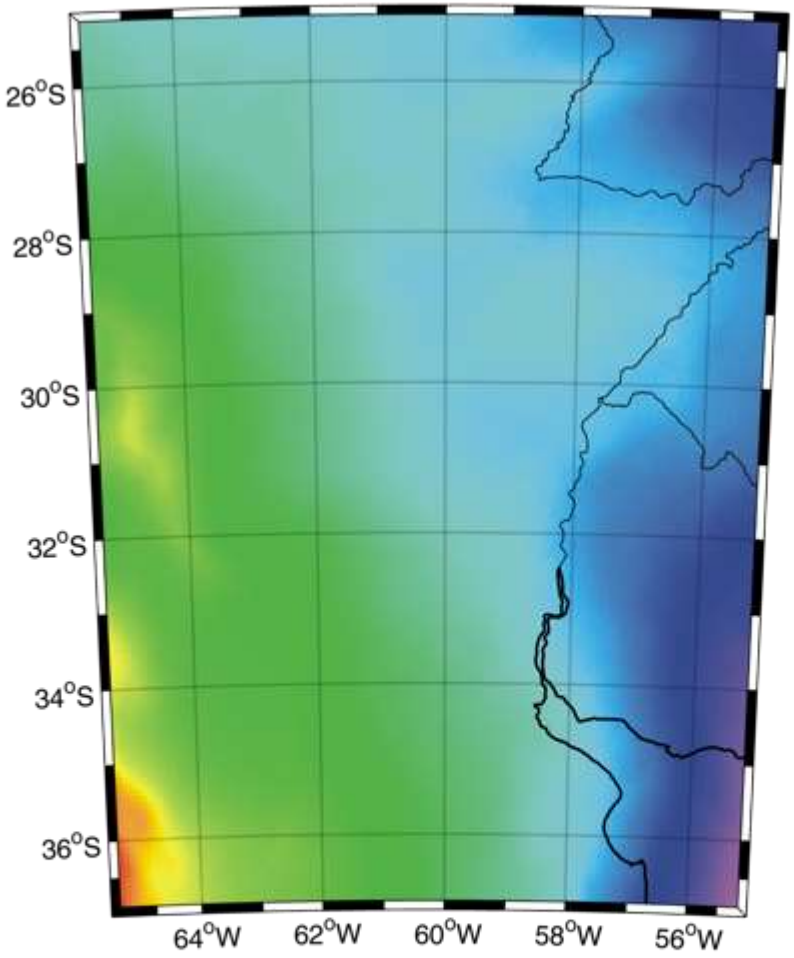
Piñon, Diego & Zhang, Kefei & Wu, Suqin & Cimbaro, Sergio. (2017). A New Argentinean Gravimetric Geoid Model: GEOIDEAR. International Symposium on *Earth and Environmental Sciences for Future Generations: Proceedings of the IAG General Assembly*, Prague, Czech Republic, June 22-July 2, DOI:201510.1007/1345_2017_267.

ISG image



GEOIDEAR16	IGN Official geoid model
RESOLUTION	1’
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	GOCO05S (280)
INTEGRATION	Stokes' integral using the spherical multi-band FFT approach and the deterministic kernel modification proposed by Wong and Gore
DTM	SRTM_v4.1 and SRTM30_Plus_v10
GRAVITY MODEL	DTU13
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	Yes
CONSISTENCY WITH GPS/BENCHMARKS	5 centimeters (1891 points)

Argentina Geoid models 2017 (Santa Fé province)

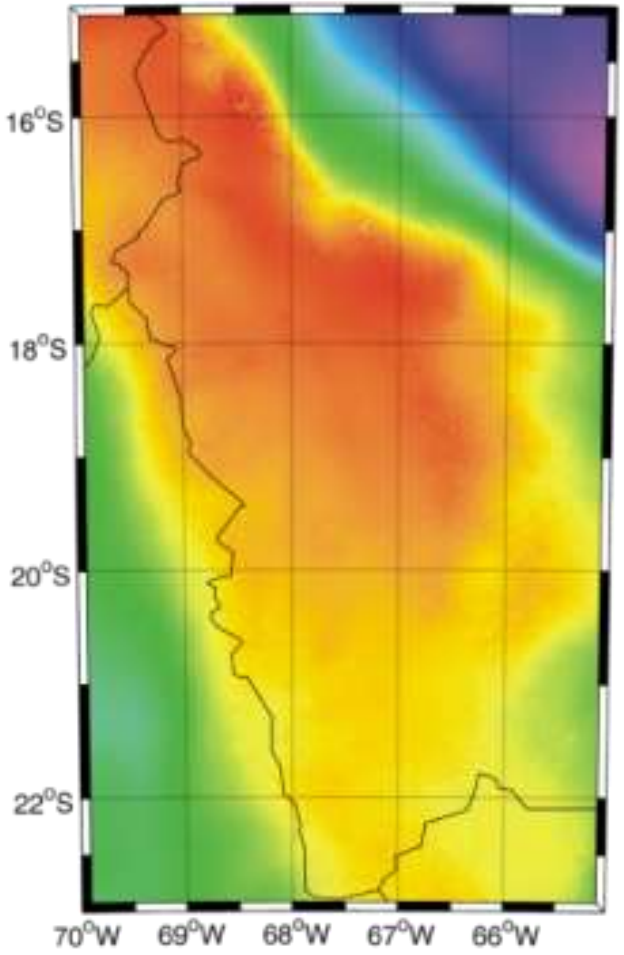


C. Cornero, A. Pereira, M. Varela Sanchez, A.C.O.C. De Matos, D. Blitzkow, M.C. Pacino (2017). Modelado del geoide gravimetrico estatico para la provincia de Santa Fe, Argentina. ***Geoacta,*** 42(2), pp. 82-95 (in Spanish).

ISG image

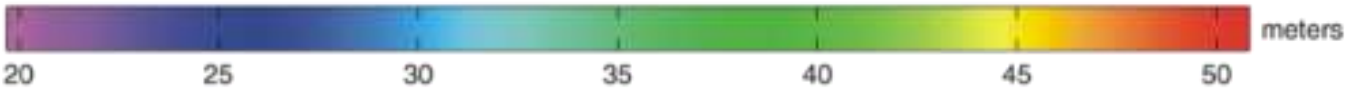
Santa Fé geoid	
RESOLUTION	5’
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	GO_CONS_GCF_2_**DIR_R5** (300)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification
DTM	SAM3s_v2
GRAVITY MODEL	DTU10
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	22 centimeters (100 points)

Bolivia Geoid model 2006 (BOLGEO)



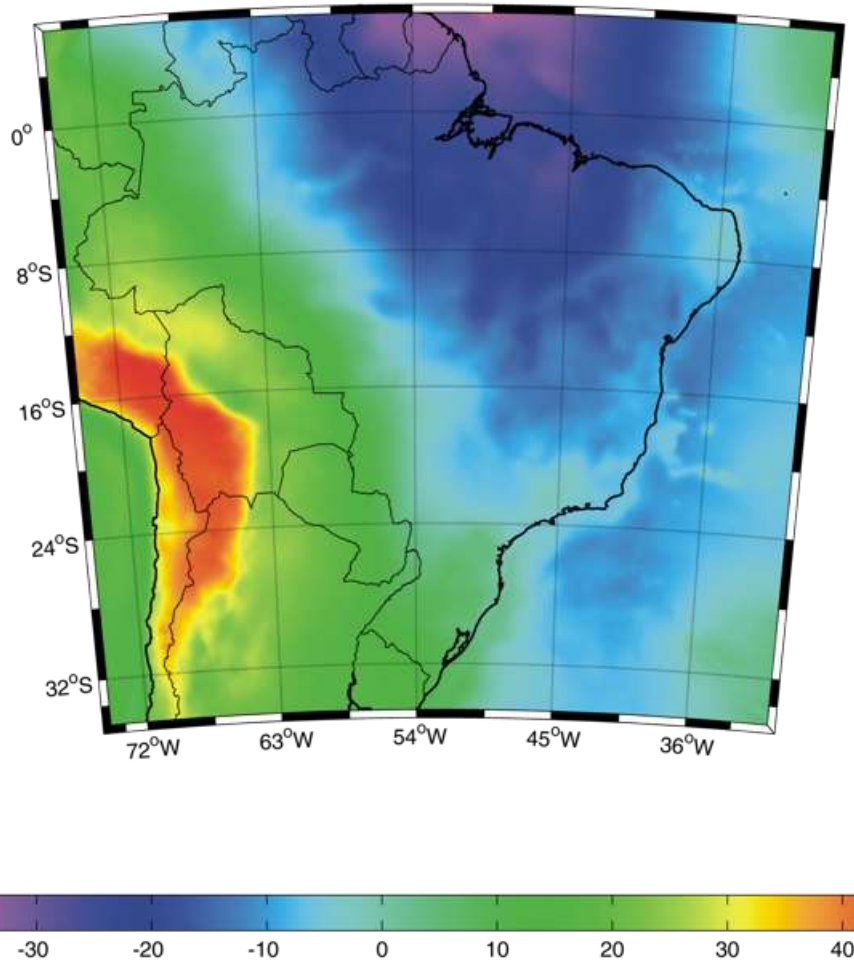
V. Corchete, D. Flores, F. Oviedo (2006). The first high-resolution gravimetric geoid for the Bolivian tableland: BOLGEO. ***Physics of the Earth and Planetary Interiors***, 157, pp. 250-256.

ISG image



BOLGEO	
RESOLUTION	1.5’
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	EIGEN-CG01C (360)
INTEGRATION	FFT of Stokes’ Formula
DTM	SRTM90m
GRAVITY MODEL	-
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	45 centimeters (17 points)

Brazil Geoid models
1992 (MAPGEO1992), 2004 (MAPGEO2004), 2010 (MAPGEO2010) and 2015 (MAPGEO2015)



MAPGEO2004

M.C.B. Lobianco, D. Blitzkow, A.C.O.C. de Matos (2005). O novo modelo geoidal para o Brasil. ***IV Coloquio Brasileiro de Ciencias Geodesicas,*** IV CBCG, 16-20 May 2005, Curitiba, Brazil.

MAPGEO2010

A.C.O.C. de Matos, D. Blitzkow, G.N. Guimaraes, M.C.B. Lobianco, S.M.A. Costa (2012). Validação do MAPGEO2010 e comparação com modelos do geopotencial recentes. ***Boletim de Ciencias Geodesicas,*** 18(1), pp. 101-122. (in portuguese)

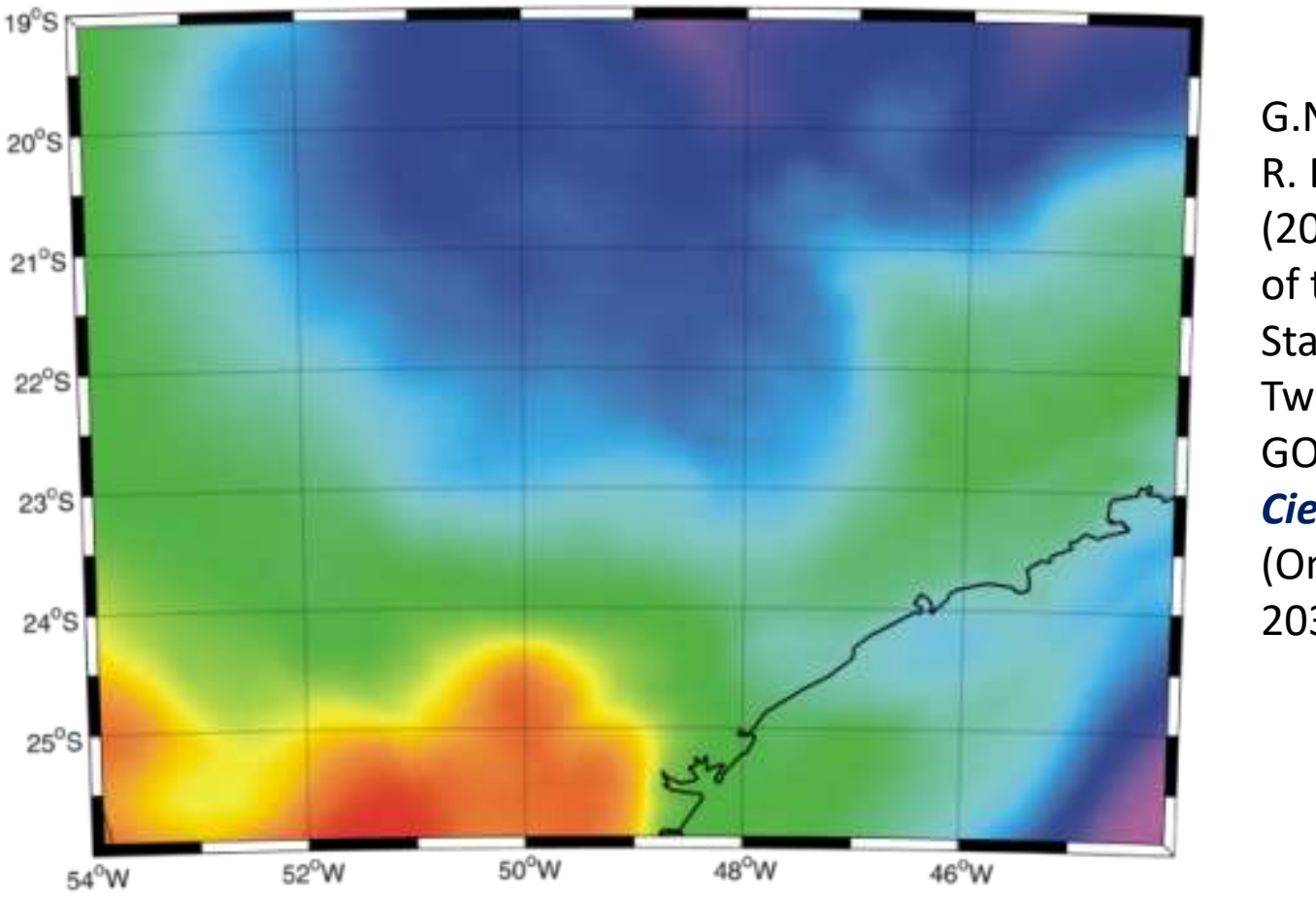
MAPGEO2015

D. Blitzkow, A.C.O.C. de Matos, W.C. Machado, M.A. Nunes, N.V. Lengruber, E.M.L. Xavier, L.P.S. Fortes (2016). MAPGEO2015: the New Geoidal Undulation Model of Brazil. *Revista Brasileira de Cartografia,* 68(10), pp. 1873–1884. (in portuguese)

IGS image

MAPGEO2015	Official geoid model of the IBGE
RESOLUTION	5’
GRAVIMETRY ON THE CONTINENT	Terrestrial
TECHNIQUE	Remove-compute-restore
GGM	EIGEN6C4 (200)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral
DTM	SAM3s_v2
GRAVITY MODEL	DTU10
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	17 centimeters (592 points)

Brazil Geoid models
2014 (GEOID-SP) – São Paulo State

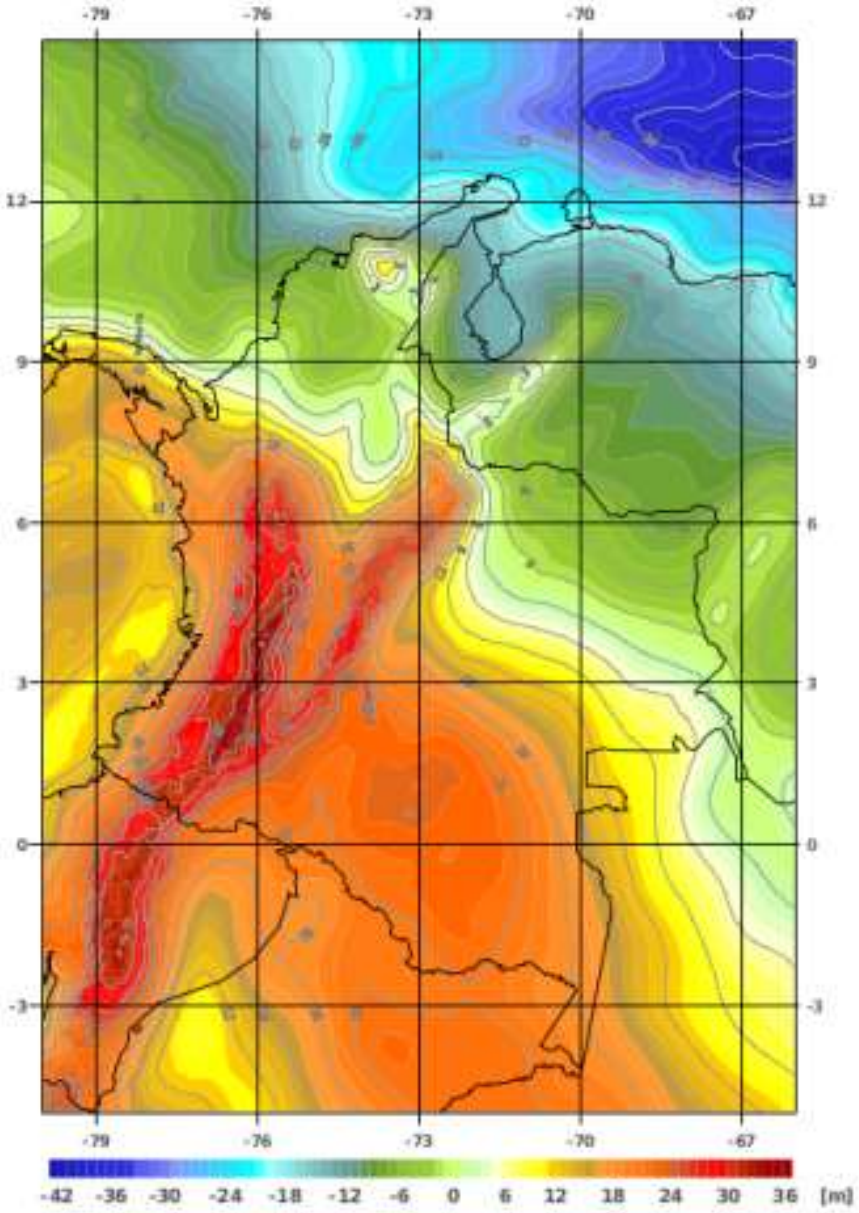


G.N. Guimares, D. Blitzkow, R. Barzaghi, A.C.O.C. Matos (2014). The Computation of the Geoid Model in the State of Sao Paulo Using Two Methodologies and GOCE Models. ***Boletim de Ciencias Geodesicas*** (Online), vol. 20, pp. 183-203.

ISG image

GEOID-SP	
RESOLUTION	5’
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	EIGEN6C (150)
INTEGRATION	1. The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification 2. Least Squares Collocation (LSC)
DTM	SAM3s_v2
GRAVITY MODEL	DTU10
FITTING WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	20 centimeters (363 points)

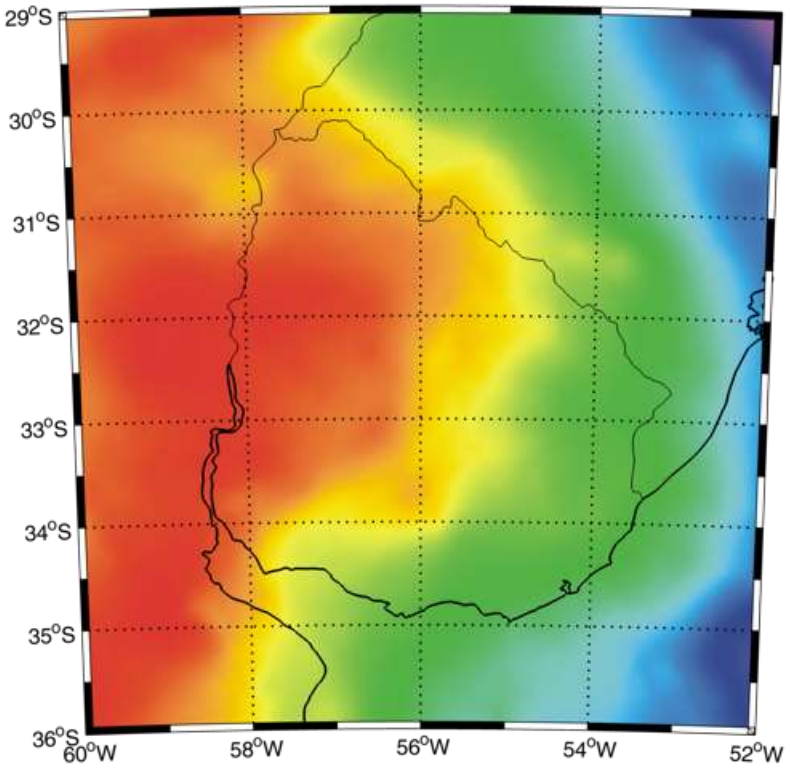
Colombia Geoid model 2004 (QGEOCOL2004/GEOCOL2004)



L. Sánchez (2003). Determinación de la superficie vertical de referencia para Colombia. ***Thesis at Technische Universität Dresden***, Germany (in Spanish and in German).

QGEOCOL2004/GEOCOL2004	Official geoid of the Instituto Geográfico Agustín Codazzi
RESOLUTION	2’
GRAVIMETRY ON THE CONTINENT	Terrestrial and aereo
TECHNIQUE	Remove-compute-restore
GGM	TEG-4 (200)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral
DTM	GTOPO30
GRAVITY MODEL	Sandwell & Smith V.9.1
FITTING WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	55 cm (38 points on leveling line with 300 km of extension) 71 cm (25 points random distribution over the Colombian territory)

Uruguay Geoid models
2000 (URUGEOIDE2000) and 2007 (URUGEOIDE2007)



URUGEOIDE2000

W.H. Subiza Piña, H. Rovera Di Landro, L. Turban (2002). The Vertical Datum and Local Geoidal Models in Uruguay. In: H. Drewes, A.H. Dodson, L.P. Souto Fortes, L. Sanchez, P. Sandoval (eds.), ***Vertical Reference Systems,*** IAG Symposia Series, vol. 124, pp. 169-175, Springer Verlag.

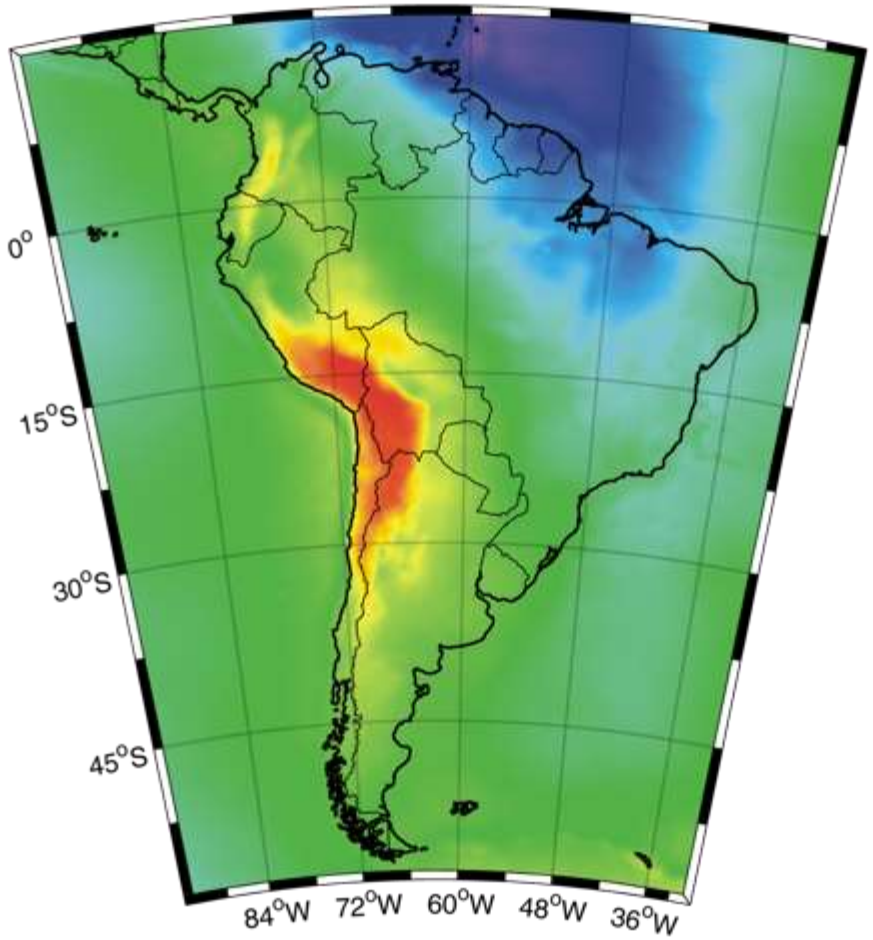
URUGEOIDE2007

Servicio Geografico Militar (2007). Calculo de un nuevo modelo geoidal para Uruguay (UruGeoide-2007). Report of *Servicio Geografico Militar, Montevideo, Uruguay.*

ISG image

UruGeoide-2007	Official geoid model of Servicio Geografico Militar
RESOLUTION	2’
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	GGM02C (200)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral
DTM	SRTM_1s and DNSC05
GRAVITY MODEL	KMS02
FITTING WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	2 centimeters (50 points)

South America Geoid models
2010 (GEOID2010) and 2015 (GEOID2015)



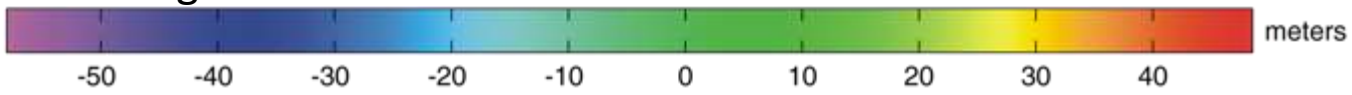
GEOID2010

A.C.O.C. de Matos, D. Blitzkow, G.N. Guimaraes, M.C.B. Lobianco (2014). GOCE and the Geoid in South America. In: C. Rizos, P. Willis (eds.), ***Earth on the Edge: Science for a Sustainable Planet***, IAG Symposia Series, vol. 139, pp. 529-534, Springer Verlag.

GEOID2015

D. Blitzkow, A.C.O.C. de Matos, G. do Nascimento Guimaraes, M.C. Pacino, E.A. Lauria, M. Nunes, C.A. Correia e Castro Junior; F. Flores, N.O. Guevara, R. Alvarez, J.N. Hernandez (2016). Gravity and geoid model for South America. EGU General Assembly 2016, *Geophysical Research Abstracts*, Vol. 18, EGU2016-1626.

ISG image



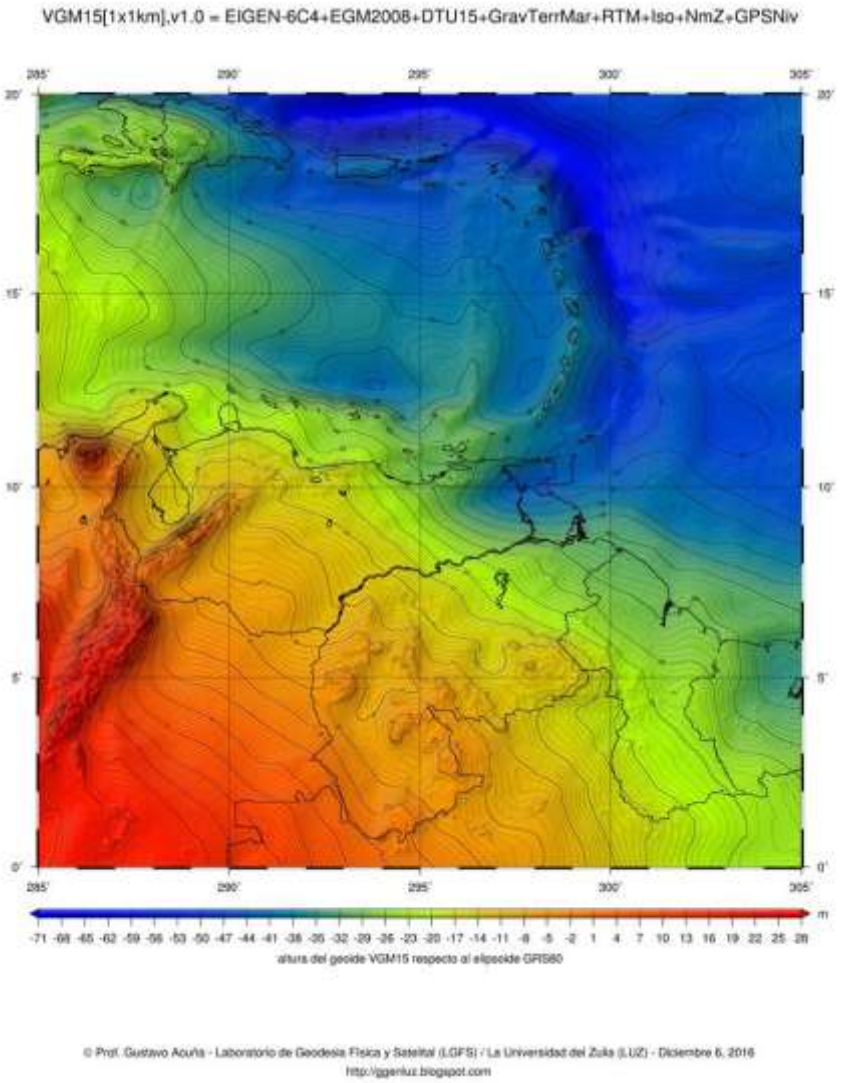
GRAVITY DATA COLECT

Activities going on by different organizations, universities and geographic institutes in South America.

- IBGE (CGED)
- ANP/PETROBRAS
- NGA
- GETECH
- BGI
- Civil and military institutions in different countries of South America.

GEOID2015	
RESOLUTION	5’
GRAVIMETRY ON THE CONTINENT	Terrestrial and airborne
TECHNIQUE	Remove-compute-restore
GGM	EIGEN6C4 (200)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification
DTM	SAM3s_v2
GRAVITY MODEL	DTU10
FITTING WITH GPS-LEVELLING BENCHMARKS	No
CONSISTENCY WITH GPS/BENCHMARKS	Total = 46 centimeters (1319 points) Argentina 60 cm (296 points) Brazil 17 cm (592 points) Chile 77 cm (173 points) Ecuador 1.17 cm (60 points) Uruguay 65 cm (11 points) Venezuela 47 cm (187 points)

Venezuela Geoid models
MGCV04 (2004) and VGM15 (2015)



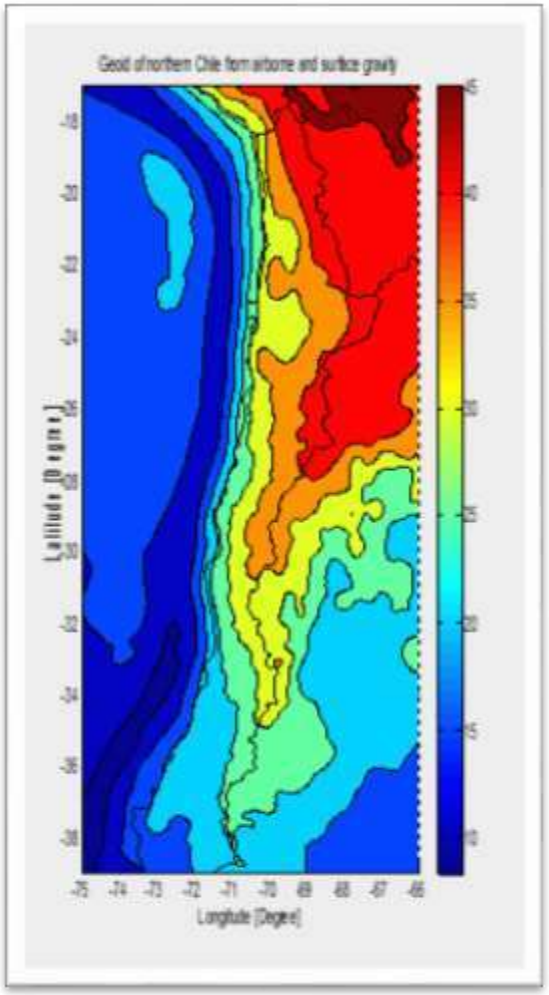
M. Hoyer, Wildermann, E., Suárez, H. y Hernández, J. (2004). Modelo geoidal combinado para Venezuela (MGCV04). ***Interciencia INCI*** v.29 n.12. (in Spanish).

G. Acuña. (2016). VGM15: Venezuelan high-resolution Geoid Model 2015. ***LGFS/DGS – Universidad del Zulia***. (in Spanish).
https://mega.nz/#!MQUkQDbQ!VkBedMi7N-SU4HN25nPLg-F502RFYp4G2BNdc3aOX50

http://ggenluz.blogspot.com/2016/12/vgm15-version-2015-del-geoide.html

VGM2015	
RESOLUTION	90x90m
GRAVIMETRY ON THE CONTINENT	terrestrial
TECHNIQUE	Remove-compute-restore
GGM	EIGEN-6C4(n,m=0-370) + EGM2008(n,m=371-2190)
INTEGRATION	The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification
DTM	SRTM30plusV11.0, SRTM15plusV1.0 and SRTM3v2.1
GRAVITY MODEL	DTU10
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	Yes
CONSISTENCY WITH GPS/BENCHMARKS	12 cm (545 points)

Northern Chile Geoid model



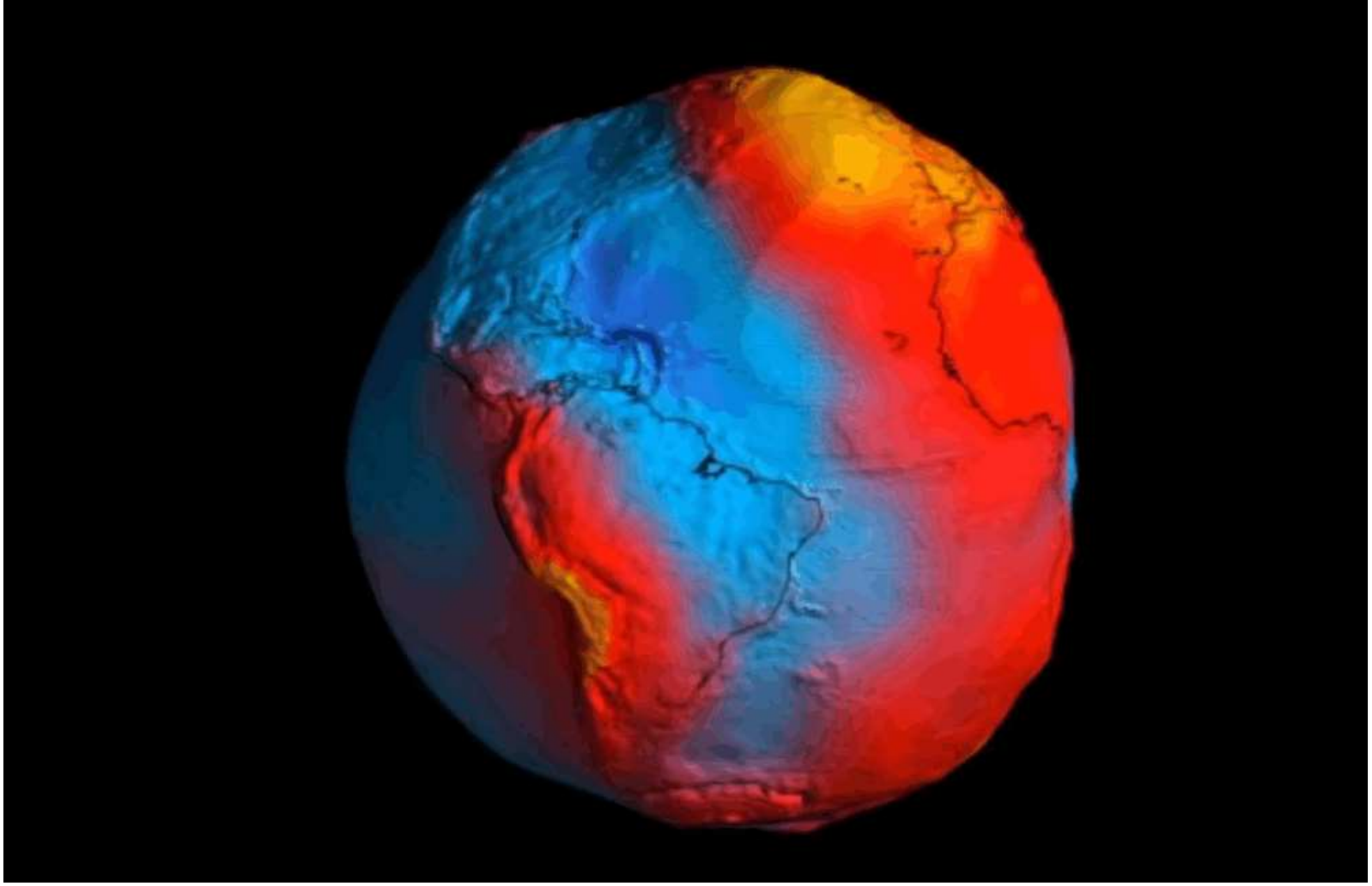
J. Neira and Carrasco, C. (2018). A Geoid Model of Northern Chile from Airborne and Surface Gravity
FIG Congress 2018.
Istanbul, Turkey, May 6–11, 2018

https://www.fig.net/resources/proceedings/fig_proceedings/fig2018/ppt/ts06e/TS06E_neira_carrasco_9189_ppt.pdf

Northern Chile Geoid model	
RESOLUTION	1,2’ x 1,5’
GRAVIMETRY ON THE CONTINENT	Terrestrial and airborne
TECHNIQUE	Remove-compute-restore
GGM	EGM08 + GOCE RL4 satellite data
INTEGRATION	Spherical Fourier Transformation
DTM	SRTM 30” DEM
GRAVITY MODEL	DTU10
FITTING GEOID WITH GPS-LEVELLING BENCHMARKS	no

	Argentina 2017	Bolivia 2006	Brazil 2015	Northern Chile 2018	Colombia 2003	Uruguay 2007	Venezuela 2016
RESOL.	1’	1.5’	5’	1.2’x1,5’	2’	2’	3’’
GRAVIM.	Terrestrial	Terrestrial	Terrestrial	Terr+Air	Terr+Air	Terrestrial	Terrestrial
TECHNIQ	R-C-R	R-C-R	R-C-R	R-C-R	R-C-R	R-C-R	R-C-R
GGM	GOCO05S (280)	EIGEN-CG01C (360)	EIGEN6C4 (200)	EGM08 + GOCE RL4 satellite data	TEG-4 (200)	GGM02C (200)	EIGEN-6C4(370)+ EGM2008 (371-2190)
DTM	SRTM_v4.1 and SRTM30_Plus_ v10	SRTM90m	SAM3s_v2	SRTM 30” DEM	GTOPO30	SRTM_1s and DNSC05	SRTM30plusV11.0, SRTM15 plus V1.0 and SRTM3v2.1
GRAVITY MODEL	DTU13	-----	DTU10	DTU13	Sandwell & Smith V.9.1	KMS02	DTU10
FITTING	Yes	No	No	No	No	No	Yes
CONSIST.	5 cm	45 cm	17 cm	----	55 cm	2 cm	12 cm

Country	Technique
Argentina	Stokes' integral using the spherical multi-band FFT approach and the deterministic kernel modification proposed by Wong and Gore
Bolivia	FFT of Stokes' Formula
Brazil	The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification Least Squares Collocation (LSC)
Chile	FFT of Stokes' Formula
Colombia	The short wavelength component was estimated with FFT technique using the modified Stokes integral
Venezuela	The short wavelength component was estimated with FFT technique using the modified Stokes integral through spheroidal Molodenskii-Meissl kernel modification
Uruguay	The short wavelength component was estimated with FFT technique using the modified Stokes integral



Thanks for your attention