Wo determination for Argentinean height system unification

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Abstract

The estimation of the zero-height geopotential level plays a fundamental role in the definition and realization of a global reference surface that allows the integration of the existing Local Vertical Datums in a global one.

The main objective of this study is to obtain a representative estimate of the zero-height geopotential value over the continental part of Argentina using Mader orthometric heights, GPS measurements over a network of benchmarks (BMs) and a high-accuracy GGM (Global Geopotential Model), containing data only from the satellite mission GOCE (Gravity field and steady-state Ocean Circulation Explorer) or from a GOCE/GRACE (Gravity Recovery and Climate Experiment) combined GGM. Within the present work the Argentinean LVD zero-level geopotential value is determined from the latest GOCE and GOCE/GRACE GGMs determined by the time-wise and direct approaches (TIM-R5 and DIR-R5, respectively) by estimating directly the gravitational potential at available trigonometric BMs that belong to the country's national network.
A Least-Squares based adjustment is also employed to remove any possible dependencies with height. Our previous results, computed with information from EGM2008, show that the best possible estimate at present is 62 636 853.9 m^2s^{-2}; however, improvements are sought employing the latest GOCE and GOCE/GRACE GGMs along with a more extensive network of GPS/Levelling benchmarks.

Keywords: ZERO-HEIGHT GEOPOTENTIAL LEVEL, ARGENTINA, LOCAL VERTICAL DATUM

Data used

❖ GPS/Levelling data

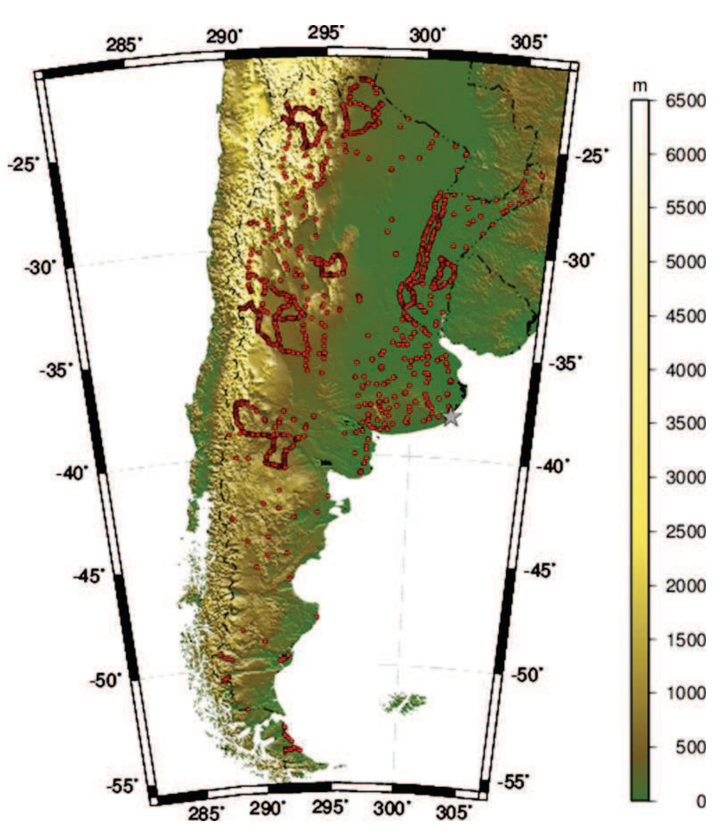
The data available for this study consist of a total of 1485 co-located GPS/Levelling data.
In principle, physical heights in the Argentinean Vertical Datum (AVD) were modelled as Mader orthometric heights.
Mader orthometric heights are based on mean gravity given by Mader in (1954).
According to the definition of orthometric heights, the Mader orthometric heights were computed as:

$$H = \frac{C}{\bar{g}^M} = \frac{C}{g + 0.0424H + \frac{C_T}{2}}$$

where CT is the classical planar terrain correction.

The origin of the Argentinean Vertical Datum (AVD) was defined in 1923, based on an analysis of short time series observations of the Tide Gauge station located at Mar del Plata city, where local MSL was computed from sea level measurements. In1950, its physical realization was transferred to Tandil. The physical heights in the AVD were modelled as Mader orthometric in the Zero-Tide (ZT) system, an uncertain in the type of system is still unknown, heights. A zero-height geopotential value was not originally associated with the AVD and hence is also considered as unknown.
All the ellipsoidal heights (h) are referred to the POSGAR 07 (POSiciones Geodesicas ARgentinas 2007) national reference frame, which was linked to the ITRF2005 (epoch t=2006.632, Tide-Free (TF) system) international reference frame. The horizontal and vertical accuracy of their GPS derived spatial positions are at ±0.02 m and σ_z=±0.05, respectively.

Distribution of GPS/LEVELLING BMs over Argentina



Methodology

$$C^{CVD} = W_0^{CVD} - W_i$$
$$C_i^{LVD} = W_0^{LVD} - W_i,$$

The differences between the local and global vertical datum can be described by the next formula:

$$\Delta C_i^{CVD/LVD} = W_0^{CVD} - W_0^{LVD},$$
$$W_0^{LVD} = \frac{\sum_{i=1}^{m} W_0^{LVD}}{m} = W_0^{CVD} - \frac{\sum_{i=1}^{m} \Delta C_i^{CVD/LVD}}{m}.$$

where $\Delta C_i^{CVD/LVD}$ is given by: $\bar{g}_i^{Mader} = g_i + 0.024\, H_i + \frac{CT}{2}$

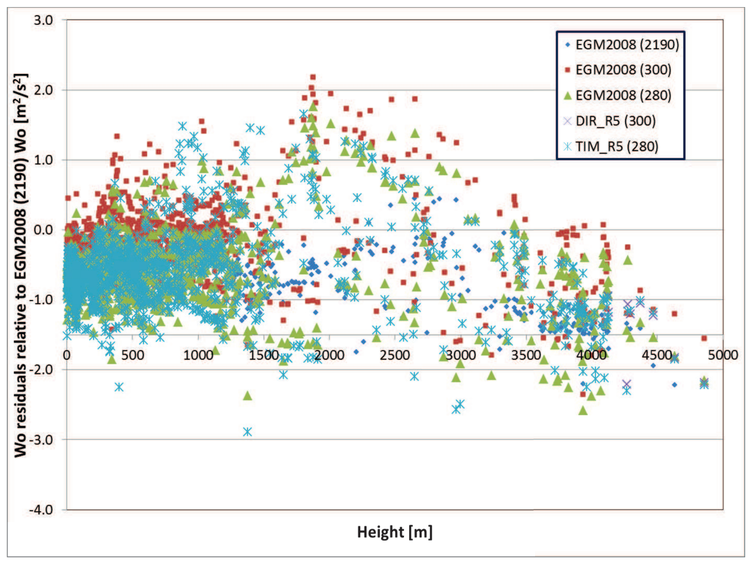
$$\Delta C_i^{CVD/LVD} = (h_i - H_i^{Helmert} - N_i - N_0)\bar{g}_i^{Mader},$$ **from GGM**

where N_o represents the contribution of the zero-degree harmonic to the GGM geoid undulations with respect to a specific reference ellipsoid. It has been computed according to the formula (Heiskanen and Moritz 1967, Eq. 2.182):

The computation of surface gravity (g_i) at each Benchmark (BM) were computed from EGM2008, TIM_R5 and DIR_R5 by:

$$g_i = \gamma_{i(BM)} - \frac{\partial T}{\partial r}$$

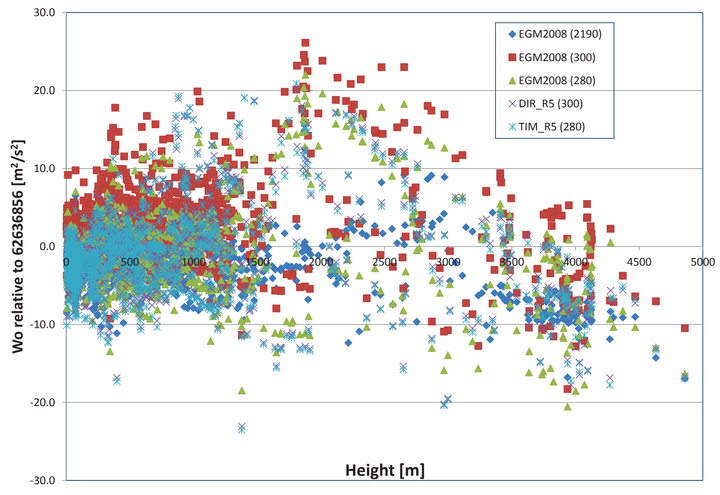
All SHS computations were computed in a Tide-Free system using the *harm_synth* software (Pavlis et al. 2012).



Global Geopotencial Models

Models	Max d/o	Data	ICGEM name	References
DIR_R5	300	S(GOCE, GRACE, LAGEOS)	GO_CONS_GCF_2_DIR_R5	Bruinsma et al., 2013
TIM_R5	280	S(GOCE)	GO_CONS_GCF_2_TIM_R5	Pail et al., 2011
EGM2008	2190	S(GRACE),G, A	EGM2008	Pavlis et al., 2012

(Data: S = Satellite Tracking Data, G = Gravity Data, A = Altimetry Data
GRACE (Gravity Recovery And Climate Experiment)
GOCE (Gravity field and steady state Ocean Circulation Explorer)
LAGEOS (Laser GEOdynamics Satellite)
SST (Sea Surface Topography)



Estimation of the zero-height geopotential value for Argentina

$\bar{W}_0^{LVD}$ [$m^2\,s^{-2}$]

	Un-weighted	Weighted Least Square estimate $p_i=(1/H_i^{Mader})$	Difference	Weighted Least Square estimate $p_i=(1/H_i^{Mader})^2$	Difference	Weighted Least Square estimate $p_i=(1/H_i^{Mader})^{1/2}$	Difference
EGM2008 (2190)	62636853.80±0.02	62636853.73	-0.07	62636853.37	-0.43	62636853.79	-0.01
EGM2008 (300)	62636854.68±0.02	62636854.08	-0.61	62636853.91	-0.77	62636854.32	-0.37
EGM2008 (280)	62636854.75±0.02	62636853.96	-0.80	62636853.79	-0.97	62636854.26	-0.50
DIR_R5 (300)	62636854.70±0.02	62636853.88	-0.82	62636853.42	-1.28	62636854.22	-0.48
TIM_R5 (280)	62636854.70±0.02	62636853.88	-0.82	62636853.42	-1.28	62636854.22	-0.48

Conclusions

We tried to obtain a representative and better (than our publish result) estimate of the zero-height geopotential value over the continental part of Argentina.
How?

- ❑ Working together with the IGN, in order to homogenize the GPS/Levelling data base. We notice that some aspects have to be improved as including more GPS/Levelling data and which is the best way to modelled orthometric heights.
- ❑ Using Mader orthometric heights instead of Helmert orthometric height.
- ❑ The combination of GOCE models (TIM_R5 and DIR_R5 with EGM2008 do not show good results.
- ❑ The best possible estimate from these results is 62 636 853.8 m^2s^{-2}.