Joint Working Group 0.1.1: Vertical Datum Standardisation

Chair: Laura Sánchez (Germany)

Introduction

The main purpose of the joint working group on Vertical Datum Standardization (JWG 0.1.1) is to provide a reliable W_0 value to be introduced as the conventional reference level for the realization of a Unified Global Height System. Although any W_0 value can arbitrarily be chosen, it is expected that this value be consistent with other defining parameters of geometric and physical models of the Earth. In this way, activities developed by JWG 0.1.1 shall be based on the state-of-the-art data and methodologies, especially on the newest available representations of the Earth's surface and gravity field. Computations carried out by JWG 0.1.1 are to be documented in detail in order to guarantee the repeatability and reliability of the results. This documentation shall support the adoption of the obtained W_0 value as an official IAG/GGOS convention. An additional product will be dedicated to provide guidance on the usage of W_0 in practice, in particular for the vertical datum unification.

The global vertical reference level W_0

At present, there are four groups working on the W_0 determination: the Prague Group (Vatrt et al., former Burša et al.), the Munich Group (Sánchez et al.), the Bratislava Group (Čunderlik et al.), and the Newcastle/Latakia Group (Dayoub et al.). When the JWG 0.1.1 was created (during the IUGG General Assembly in Melbourne, August 2011), the W_0 estimations of Čunderlik et al., Dayoub et al., Sánchez et al. were very close to each other (largest discrepancy ~0,2 m^2s^{-2}); while the estimation of Burša et al. was a little far away (about ~2 m^2s^{-2}). According to this, these four groups were invited to participate in the JWG 0.1.1 and they agreed on joining efforts to refine and compare their computations in order to

- evaluate their individual methodologies,
- establish inconsistencies between the input data,
- ensure redundancy between the different computations,
- identify possible discrepancies between the individual results,
- clarify and solve remaining disagreements between the individually computed W_0 values.

During these two years, each group repeated its computations using its own methodology but the same input data, explicitly the same mean sea surface models (CLS11, DUT10) and global gravity models (EGM2008, GOCO03S, EIGEN6C). An exception is the Burša Group, who applied its own mean sea surface model derived from recent satellite altimetry measurements. The new results were presented during the GGHS2012 symposium (International Symposium on Gravity, Geoid and Height Systems, San Servolo Island, Venice, October 2012), being the main conclusion that all the computations are now delivering very close values (including the computation of Burša et al.) and the remaining differences (~0,5 m^2s^{-2}) can be solved by outlining specific standards and conventions.

According to these new results, the JWG 0.1.1 members agreed on the following:

- The W_0 value included in the IERS Conventions (and used by the IAU for the definition of the L_G constant) presents a discrepancy of about ~2 m^2s^{-2} with respect to the recent computations.

- A formal IAG recommendation regarding the best present W_0 estimate shall be outlined to replace the value included in the IERS Conventions and to be introduced as the reference level in the GGOS Unified Height System.
- The outlined recommendation shall be supported by four individual papers describing methodology and input data applied by each group. Based on these four papers, a further common summary paper shall be produced to provide an overview and the main characteristics of the W_0 estimation recommended.
- The next activities to be carried out by the individual groups to refine their estimations and to advance in the definition of required standards and conventions shall include:
- Combination of a "geodetic" sea surface model and an "oceanographic" mean dynamic topography model to reproduce a sea surface closer to an equipotential surface (geoid);
- Integration of polar regions on the Earth's surface representation;
- Differences between W_0 values obtained from a long-term mean sea surface model and yearly mean sea surface models;
- A formal procedure for the error propagation analysis.

Local/regional realisation of the global vertical reference level

One of the main objectives of the JWG 0.1.1 is to provide guidance in the practical realisation of the global W_0 at regional/local level. One possibility is the combination of geometrical and physical heights with (quasi)geoid models of high resolution, i.e. h=H-N. Although this combination is at present widely used for several purposes, it is clear that there are still too many inconsistencies between the different heights and their combination is not reliable enough for the precise realisation of any reference level. To face this inconvenience, it was asked whether the JWG 0.1.1 could try to outline the basic standards to be followed by the three coordinates (h, H, N) to guarantee a consistent combination and, as a consequence, to design an appropriate realisation strategy of the global W_0. This proposal produced many pro and contra comments and it was decided to take up this discussion again once the recommendation on W_0 is ready.

Website: http://whs.dgfi.badw.de

The chair of the JWG 0.1.1 tries to keep a web site about these activities updated. This web site was initially established for the IAG Inter-Commission Project 1.2 (Vertical Reference Frames) and at present contains:

- Terms of reference of the JWG 0.1.1 (objectives, plan of activities, members, etc.)
- The ICP1.2 documents (Conventions, presentations, reports, meeting summaries, etc.)
- The terms of reference of GGOS-Theme 1 (because they are missing in the GGOS portal)
- A list of references with recent "vertical datum"-related publications
- Meeting presentations of the JWG 0.1.1 members, when they agree to publish their contributions in the web site.

Members

L. Sánchez (Germany), J. Ågren (Sweden), R. Cunderlík (Slovakia), N. Dayoub (Syria), J. Huang (Canada), R. Klees (The Netherlands), J. Mäkinen (Finland), K. Mikula (Slovakia), Z. Minarechová (Slovakia), P. Moore (United Kingdom), D. Roman (USA), Z. Šima (Czech Republic), C. Tocho (Argentina), V. Vatrt (Czech Republic), M. Vojtiskova (Czech Republic), Y. Wang (USA).

Publications and presentations

Ågren J., Engberg L.E., Alm L., Dahlström F., Engfeldt A., Lidberg M.: Improving the Swedish quasigeoid by gravity observations on the ice of Lake Vänern. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012

Ågren J., Sjöberg L.E.: Investigations of the requirements for a future 5 mm quasigeoid model over Sweden. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012

Burša M., Kouba J., Šima Z., Vatrt V., Vojtiškova M.: Wo improved by EGM08 / GRACE geopotential models and Jason 1, 2 altimetry. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Čunderlík R., Mikula K.: Realization of WHS based on the static gravity field observed by GOCE. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Dayoub N., Edwards S.J., Moore P. (2012). The Gauss-Listing potential value Wo and its rate from altimetric mean sea level and GRACE. J Geod 86: 681 - 694.

Huang J., Véronneau M.: A Stokes approach for the comparative analysis of satellite gravity models and terrestrial gravity data. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Macak M., Mikula M.: On solving oblique derivative boundary-value problem by the finite volume method. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012

Minarechová Z., Macak M., Čunderlík R., Mikula K.: High-resolution global gravity field modelling by finite volume method. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Roman D., Véronneau M., Avalos D., Li X., Holmes S., Huang J.: Integration of gravity data into a seamless transnational height model for North America. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Santos M.C., Avalos D., Peet T., Huang J., Vaníček P.: Assessment of GOCE models over Mexico and Canada. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012

Sánchez, L.: The role of TIGA in the vertical datum standardization. In: Workshop on Geodetic Vertical Monitoring of Tide Gauge Benchmarks, Twelfth Session of the GLOSS Group of Experts. November 9, 2011. Paris, France.

Sánchez L.: Towards a vertical datum standardisation under the umbrella of Global Geodetic Observing System. Journal of Geodetic Science, 2(4): 325 – 342, 2012.

Sánchez, L.: Towards a vertical datum standardisation based on a joint analysis of TIGA, satellite altimetry and gravity field modelling products. In: IGS Workshop 2012 - Olsztyn, Poland - July 23 to 27, 2012.

Sánchez, L.: Towards a Vertical Datum Standardisation. In: AOGS-AGU (WPGM) Joint Assembly, Singapore, August 13-17, 2012.

Sánchez L., Ågren J., Čunderlík R., Dayoub N., Faskova Z., Huang J., Mikula K., Moore P., Roman D., Sima Z., Vatrt V., Vojtiškova M., Wang Y.M.: Report on the activities of the working group "Vertical Datum Standardisation". In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Sánchez L.: Vertical datum standardisation: a fundamental step towards a global vertical reference system. In: AGU Meeting of the Americas, Cancun, Mexico, May 14-17, 2013.

Spir R., Čunderlík R., Mikula K.: Impact of the oblique derivative on precise local quasigeoid modelling in mountainous regions. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Wang Y.M., Li X.: Data fusion for geoid computation - numerical tests in Texas area. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012.

Sinem Ince E., Sideris M.G., Huang J., Véronneau M.: Assessment of GOCE gravity field models for the new geoid-based vertical datum in Canada. In: GGHS2012 Symposium, Venice, Italy, October 9 -12, 2012