Joint Working Group (JWG) 0.1.1

Vertical Datum Standardisation

Meeting Summary

Date October 11, 2012, 6:30 pm

Place San Servolo Island, Venice. JWG 0.1.1 Meeting in the frame of the International Symposium on Gravity, Geoid and Height Systems GGHS 2012

Attendees

JWG 0.1.1 Members: D. Roman (USA), J. Ågren (Sweden), J. Huang (Canada), L. Sánchez (Germany), R. Čunderlik (Slovakia), V. Vatrt (Czech Rep.), Y.M. Wang (USA), Z. Minarechová (Slovakia), Z. Šíma (Czech Rep.).

Guests: A.P. Falcão (Portugal), C. Tocho (Argentina), D. Avalos-Navarro (Mexico), D. Ruess (Austria), H. Drewes (Germany), H. Wilmes (Germany), J. Mäkinen (Finland), L. Fenoglio (Germany), M. Amos (New Zealand), M. Mojzes (Slovakia), M.C. Pacino (Argentina), P. Holota (Czech Rep.), R. Forsberg (Denmark), R. Grebenitcharsicy (UK), S. Valcheva (Bulgaria), U. Marti (Switzerland), W. Shen (China), Y. Juanguo (China).

Agenda

1. Introduction to the JWG 0.1.1
2. The global vertical reference level W_0
3. Local/regional realisation of the global vertical reference level
4. Website
5. Various

1. Introduction to the JWG 0.1.1

L. Sánchez presents a brief description of the JWG 0.1.1 including (see attached presentations):

- Objectives (Recommendation about the W_0 value to be officially adopted by the IAG, guidelines for realisation and usage of the recommended value)
- Relationship with other IAG components (GGOS, IAG Commissions 1 and 2, geometric Services under the umbrella of the IERS, gravity-related Services under the umbrella of the IGFS, IAS, PSMSL and the GGOS Bureau for Standards and Conventions)
- Interaction with the Working Group "Numerical Standards in Fundamental Astronomy" of the International Astronomical Union due to the dependence of the constant L_G on W_0.
- Present status in the determination of a global W_0 value.

<u>Main conclusion</u>: The JWG 0.1.1 shall support the implementation of the short-term items outlined by the GGOS-Theme 1 (Unified Height system), especially the Item 03 "Establishment of a global vertical reference level". This item explicitly specifies "A formal recommendation about the W_0 value to be

adopted within IAG is a responsibility of the GGOS Working Group on Vertical Datum Standardisation" (see Geodesist's Handbook 2012, Drewes et al. 2012)

2. 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.), Bratislava Group (Čunderlik et al.), Newcastle/Latakia Group (Dayoub et al.) and the Munich Group (Sánchez 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.

In the last months, 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, resulting in 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. (For more details regarding the individual computations please see the corresponding presentations/papers listed at the end of this summary).

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 recommendation on the best estimate for W_0 shall be an agreement between (signed by) the four groups (Burša et al., Čunderlik et al., Dayoub et al., Sánchez et al.).
- 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.
- As a first report of the JWG 0.1.1, the four groups will contribute to a common paper to be published in the GGHS2012 Proceedings.
- 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.

3. 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 if 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.

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

L. Sánchez tries to keep a web site about the JWG 0.1.1 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.)

It was proposed in this meeting to extend the content of the web site including:

- The terms of reference of GGOS-Theme 1 (because they are missing in the GGOS web page)
- 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.

5. Variuos

- New JWG 0.1.1 members after the GGHS2012 Symposium: C. Tocho (Argentina), R. Klees (Netherlands), J. Mäkinen (Finland).

- List of presentations given by JWG 0.1.1 members at the GGHS2012 Symposium:

  Report on the activities of the working group "Vertical Datum Standardisation"
  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.

  Realization of WHS based on the static gravity field observed by GOCE
  Čunderlík R., Mikula K.

Integration of gravity data into a seamless transnational height model for North America
Roman D., Véronneau M., Avalos D., Li X., Holmes S., Huang J.

Wo improved by EGM08 / GRACE geopotential models and Jason 1, 2 altimetry
Burša M., Kouba J., Šima Z., Vatrt V., Vojtiškova M.

High-resolution global gravity field modelling by finite volume method
Minarechová Z., Macak M., Čunderlík R., Mikula K.

Data fusion for geoid computation - numerical tests in Texas area
Wang Y.M., Li X.

Investigations of the requirements for a future 5 mm quasigeoid model over Sweden
Ågren J., Sjöberg L.E.

Impact of the oblique derivative on precise local quasigeoid modelling in mountainous regions
Spir R., Čunderlík R., Mikula K.

A Stokes approach for the comparative analysis of satellite gravity models and terrestrial gravity data
Huang J., Véronneau M.

Assessment of GOCE gravity field models for the new geoid-based vertical datum in Canada
Sinem Ince E., Sideris M.G., Huang J., Véronneau M.

Assessment of GOCE models over Mexico and Canada
Santos M.C., Avalos D., Peet T., Huang J., Vaníček P.

Improving the Swedish quasigeoid by gravity observations on the ice of Lake Vänern
Ågren J., Engberg L.E., Alm L., Dahlström F., Engfeldt A., Lidberg M.

On solving oblique derivative boundary-value problem by the finite volume method
Macak M., Mikula M.

- Selected publications related with the W_0 estimation:

Burša M., S. Kenyon, J. Kouba, Z. Šíma, V. Vatrt, V. Vitek, M. Vojtíšková. (2007a). *The geopotential value Wo for specifying the relativistic atomic time scale and a global vertical reference system*. J. Geod., 81: 103 – 110.

Burša M., Z. Šíma, S Kenyon, J. Kouba, V. Vatrt, M. Vojtíšková (2007b). *Twelve years of developments: geoidal geopotential Wo for the establishment of a world height system - present and future*. In: Proceedings of the 1st international symposium of the International Gravity Filed Service, Istanbul, p. 121-123.

Čunderlík R., K. Mikula, M. Mojzeš (2008). *Numerical solution of the linearized fixed gravimetric boundary-value problem*. J Geod 82: 15 – 29. DOI: 10.1007/s00190-007-0154-0. Springer.

Čunderlík R., K. Mikula (2009). *Numerical solution of the fixed altimetry-gravimetry BVP using the direct BEM formulation*. In: Sideris, M.G. (Ed.), Oberving our changing Earth, IAG Symposia 133:229-236. Springer.

Dayoub N., S.J. Edwards, P. Moore (2012). *The Gauss-Listing potential value Wo and its rate from altimetric mean sea level and GRACE*. J Geod. DOI: 10.1007/s00190-012-1547-6.

Sánchez, L. (2008). *Approach for the establishment of a global vertical reference level*. In: Xu, P., J. Liu, A. Dermanis (Eds.), VI Hotine-Marussi Symposium on Theoretical and Computational Geodesy. Springer, IAG Symposia (132): 119-125.

Sánchez L. (2007). *Definition and Realization of the SIRGAS Vertical Reference System within a Globally Unified Height System*. In: Tregoning, P., Ch. Rizos (Eds.), Dynamic planet. Springer, IAG Symposia (130): 638-645.

Sánchez L. (2009). *Strategy to establish a global vertical reference system*. In: Drewes, H. (Ed.), Geodetic Reference Frames. Springer, IAG Symposia (134): 273-278, doi:10.1007/978-642-3-00860-3-42.

- Annexes to this meeting summary:

  Report on the activities of the working group "Vertical Datum Standardisation"
  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.

  Slides for the JWG 0.1.1 meeting in the frame of the GGHS2012 Symposium.