

Date: September 19, 2024

TO: Geospatial Professionals

FROM: Earl F. Burkholder, PS, PE, F.ASCE
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RE: LinkedIn Post Referencing www.gghs2024.com

I concur with colleagues who applaud the LinkedIn posting on Gravity, Geoid and Height Systems 2024. It is an impressive collection of material from experts all over the world. Is it appropriate to question one or more of the take-aways?

I visited www.gghs2024.com several days ago and downloaded the 171 page file of 126 Abstracts. No way am I able to get my arms around all the concepts, but I fear that some might prematurely associate those research results with continued use of pseudo 3-D when working with 3-D digital spatial data - <http://www.globalcogo.com/true-versus-pseudo.html>. Without being critical of the excellent research material presented at the conference, I invite careful consideration of the needs and activities of the end user.

Last spring I posted an item called Part-I (www.globalcogo.com/Part-I.pdf) with the stated intent of preparing a subsequent Part II item. This memo is strictly a draft and, as appropriate, parts of this memo will be included in the Part II document. The following could be viewed as “shooting from the hip” prior to a careful development of logical arguments.

1. I am a surveying engineer who has been involved in spatial data applications my entire career. When looking at the convergence of abstraction/technology/policy/practice, that includes geodesy and spatial data accuracy.
2. Anyone who knows me is familiar with my view that a 3-D model should be used for 3-D data.
3. In my opinion, the NGS is doing a great job with modernization of the National Spatial Reference System (NSRS). They can take great pride in what is being accomplished. NGS serves more than just surveyors, engineers, and GIS users but, for spatial data application, the primary resource provided by NGS are the X/Y/Zs and covariance matrix of a point. Given past practice it would be premature to abandon separate horizontal and vertical datums – or is it?
4. Looking ahead, two consequences appear to be inevitable for spatial data users . . .
 - a. As a 2-D model, low distortion projections will be replaced by a 3-D model.
 - b. Ellipsoid heights will be used for the third dimension – obviating geoid modeling.
5. But it would be a mistake for scientists to ignore gravity. Research activities are essential.
 - a. Gravity is one of four fundamental physical forces but, for particle physicists, is too small to be included in the Standard Model - [The Standard Model - CERN Document Server](#).
 - b. On the other hand, the force of gravity is infinite in a black hole.
 - c. Humans on Earth live between those extremes and subject to rules of gravity.

6. NGS is to be congratulated for devoting significant resources to understanding gravity and its impact on their mission. Science is essential but what is gravity's impact on "location?"
 - a. The location of any point (X/Y/Z) can be reliably determined without gravity, GNSS. (Yes, yes, satellite orbits and spirit-level instruments are influenced by gravity.)
 - b. But gravity is critical when deciding why a point is where it is or how a point will move in response to external forces – mobile mapping, targeting, collision avoidance, etc.

7. When considering the third dimension the important issue is. . .
 - a. Where is this point with respect to other points?
 - b. Where is this point with respect to where it was yesterday or will be tomorrow.
 - c. That location is referenced to some arbitrary origin. The Earth's center of mass (CM) is. . .
 - i.) Easier to find and
 - ii.) Is more stable than the geoid.

8. Arguments can be made about which origin is "better." Let's use the 4th down measurement in football as an example. The chain is stretched out and the TV audience views the relative position of the football and the head end of the chain – no disputing it. But the audience does not see or verify the zero end of the chain. The stability and integrity of the origin are essential!

9. As I understand it, with publication of the modernized NSRS, the horizontal components and vertical components will be geometrically consistent. What about updates or changes? Is the location of the geoid known sufficiently well (at time of publication) that it will not change? If the geoid is updated, what will it do to the elevation of a stable mark – the origin changes. A study of geoids and elevation of a stable A-order HARN point (Reilly at NMSU) is informative – see www.globalcogo.com/ReilElevA.pdf. It is disconcerting to think that the elevation of a stable point will change with subsequent updates to the geoid model.

10. It is too early to enumerate all of the impacts of AI in the use of spatial data but the integrity and efficiency of performing spatial data computations in 3-D space can be assured more easily if using a 3-D model for 3-D data – using true 3-D rather than pseudo 3-D. Two links are:
 - a. Comparison true 3-D and AI <http://www.globalcogo.com/3D-and-AI.pdf>
 - b. Professional's responsibility using AI <http://www.globalcogo.com/BOLandAI.pdf>

11. A note to those devoted to and painstakingly developing a better geoid model – be open to the possibility that the geoid height may be needed to compute ellipsoid height from orthometric height in addition to the stated intent that geoid height is used to compute orthometric height from ellipsoid height.

12. Other arguments are posted at www.tru3d.xyz/index.html and may be included in the Part II document. See for example, <http://www.globalcogo.com/ImpactOfGravity.pdf>