

An Update to the Canadian Vertical Datum

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Abstract:

Orthometric heights form the foundation of accurate topographic mapping in Canada, measuring elevations above the geoid—a reference surface approximating mean sea level. These systems depend on precise geoid models to ensure consistency and reliability in applications such as navigation, infrastructure planning, and environmental monitoring. From a cartographic perspective, the improved vertical consistency enhances the reliability of elevation products, facilitates seamless cross-border data integration, and supports map generalization across national boundaries.

Since 2013, Canada has used the Canadian Gravimetric Geoid Model Ver. 2013a (CGG2013a) within the Canadian Geodetic Vertical Datum of 2013 (CGVD2013). Similarly, the USA has long relied on the North American Vertical Datum of 1988 (NAVD88). However, advancements in geoid modelling have led to the development of the North American-Pacific Geopotential Datum of 2022 (NAPGD2022), marking a significant shift in geospatial accuracy. While the USA is transitioning entirely from NAVD88 to NAPGD2022, Canada will retain CGVD2013 and simply update its realization to use GEOID2022. GEOID2022 was developed collaboratively by the Canadian Geodetic Survey (CGS), the U.S. National Geodetic Survey (NGS), and Mexico's National Institute of Statistics and Geography (INEGI). This represents the first time Canada and the USA will align under a common geoid model, enabling seamless cross-border geospatial integration.

GEOID2022 incorporates improved gravity data, refined computational methods, and harmonized national datasets, addressing limitations in CGG2013a and NAVD88. These advancements reduce height discrepancies, improve alignment with global reference systems, and enhance precision in applications such as GPS surveys, LiDAR-based elevation modelling, flood risk assessments, and precision agriculture. The centimetre-level accuracy achieved by GEOID2022 is particularly critical for industries relying on height data across borders.

In Canada, some provinces have yet to fully adopt CGVD2013, and others, such as British Columbia, are planning to transition directly from CGVD28 to CGVD2013 but with GEOID2022 as the geoid model. For instance, GeoBC is conducting GNSS observations on benchmarks to ensure a smooth transition from CGVD28 to CGVD2013 with GEOID2022 as its realization. This approach ensures consistency and continuity while leveraging the improvements offered by GEOID2022.

This presentation will explore the differences between CGVD28, CGVD2013, and NAPGD2022 in Canada, as well as the shift from NAVD88 to NAPGD2022 in the USA. It will highlight the implications of adopting GEOID2022 for topographic mapping, with a focus on areas of significant height discrepancies and their impact on users working with precise height data. Real-world examples will demonstrate the value of a unified geoid model for applications such as LiDAR, GPS surveys, and cross-border infrastructure projects. The harmonized geoid framework also provides a model for other regions aiming to modernize vertical datums using integrated gravity data and geodetic infrastructure. By unifying the geoid models of Canada and the USA, GEOID2022 sets a new standard for geospatial accuracy and integration across North America.

Figure 1 shows the overall differences between CGG2013a and GEOID2022 in North America. The unit is in centimetres.

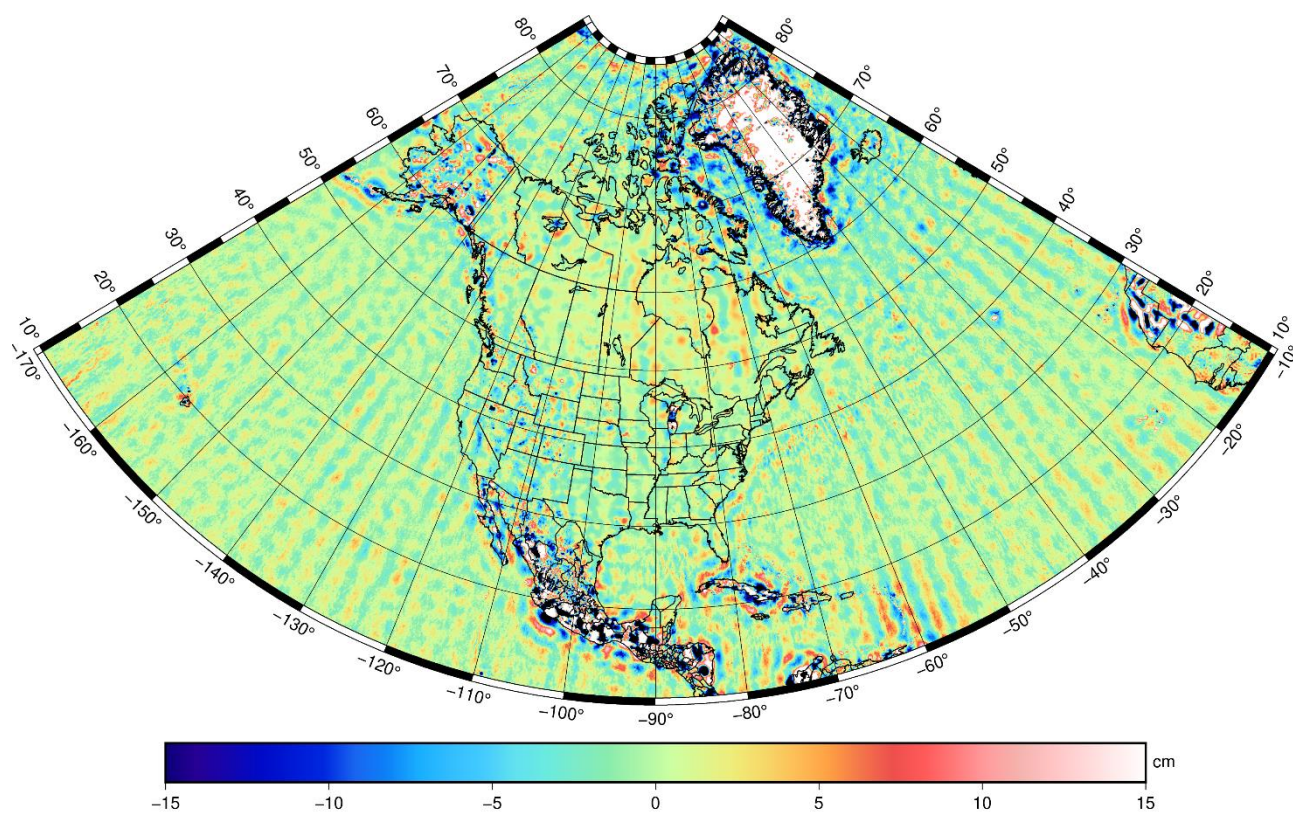


Figure 1. Differences between the current official geoid model and the new proposed geoid model for North America. Units in centimetre