



The Ohio Department of Transportation Office of Research & Development Executive Summary Report

Performance of GEOID09 for Height Conversion in Ohio

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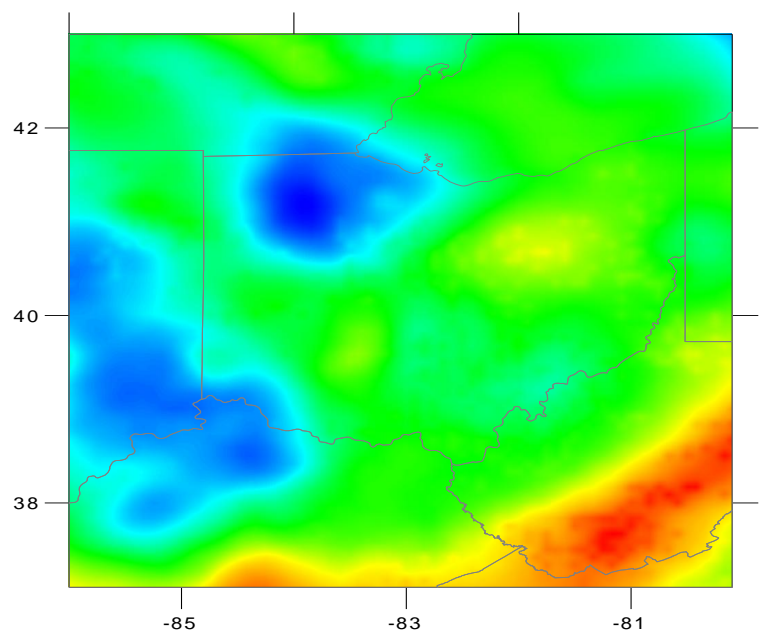
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Problem

This study evaluates Height Modernization issues related to NGS hybrid geoid performance (specifically GEIOD09 and GEOID03) for height conversions between NAVD88 and NAD83 for the state of Ohio and quality of gravity and height data needed to produce a cm-accurate gravimetric geoid. The hybrid geoid is of particular significance in this study, because an accurate hybrid geoid would support both accurate height conversions as well as improve orthometric (MSL) height determination, facilitating the almost-total replacement (except in GPS-antagonistic environments) of traditional leveling exercises by GPS leveling, a much more cost- and labor-efficient heighting technique than its traditional counterpart.



Objectives

In this study, a significant objective is to use geometric geoid undulations in Ohio in order to evaluate the extent to which the hybrid geoid models (GEOID09 and GEOID03) agree with the geoid inferred by the GPSBMs. In so doing, the goal is to enumerate the accuracy with which these models can truly be used for statewide height conversion needs. In addition, a local gravimetric geoid model was developed using publicly available gravity and DEM data. This model was used as the basis of a study, the objective of which was to determine the quality of gravity and height data needed to produce a cm-accurate geoid in Ohio.

Description

This study consists of 3 sections, namely:

1. *Performance of NGS hybrid geoids in Ohio* - The height conversion precision of GEOID03 and GEOID09 is evaluated at GPSBMs (collected by ODOT at pre-existent BMs using 15secs of 1Hz VRS GPS data) **not** included in the GEOID03 and GEOID09 model development.
2. *Gravimetric geoid development for Ohio using publicly-available PACES relative gravity data and the GTOPO30 DEM.*
3. *Random error influence on gravimetric geoid solution* - Zero

mean Gaussian-distributed random errors of various standard deviations were imposed on the data used to develop the aforementioned gravimetric geoid. Error-prone gravimetric geoid solutions were then computed using these data sets and compared to the original gravimetric solution developed from the “clean” data set. Analysis of the data combinations which facilitate cm-accurate geoid development was performed.

Conclusions & Recommendations

The results of this study confirm that:

- Overall GEOID09 performs better than GEOID03 in tested areas of Ohio
- If VRS techniques are used along with the current GEOID09 model to perform GPS leveling, the orthometric height will have an inherent error of about $\pm 5\text{cm}$ (1σ) – hence a more precise geoid over the Ohio region is needed for higher accuracy leveling.

ODOT would be well-advised to engage in a collaborative NGS / ODOT gravity data densification campaign (with special focus on the Lake Erie region) in support of improved geoid modeling for the state.

Implementation Potential

GEOID09 performance in Ohio needs to be improved to facilitate precise GPS leveling. To avoid, implementation of a separate state-based geoid model for Ohio, ODOT is strongly encouraged to communicate hybrid geoid performance to NGS and to collaborate with them to improve the model. Gravity densification will likely be needed. Re-leveling of GPSBMs in Ohio to ensure the integrity of Ohio level lines will also likely be needed.