Mineral Resources Program

The Feasibility of Using Lidar-Derived Digital Elevation Models for Gravity Data Reduction

Open-File Report 2025–1019
Version 1.1. July 2025

U.S. Department of the Interior
U.S. Geological Survey

The Feasibility of Using Lidar-Derived Digital Elevation Models for Gravity Data Reduction

By Jacob T. Murchek, Benjamin J. Drenth, James J. Reitman, Eric D. Anderson, Benjamin P. Magnin, and James M. DeGraff

Mineral Resources Program

Open-File Report 2025–1019
Version 1.1. July 2025

U.S. Department of the Interior
U.S. Geological Survey

U.S. Geological Survey, Reston, Virginia: 2025
First release: 2025
Revised: July 2025 (ver. 1.1)

Suggested citation:
Murchek, J.T., Drenth, B.J., Reitman, J.J., Anderson, E.D., Magnin, B.P., and DeGraff, J.M., 2025, The feasibility of using lidar-derived digital elevation models for gravity data reduction (ver. 1.1, July 2025): U.S. Geological Survey Open-File Report 2025–1019, 33 p., https://doi.org/10.3133/ofr20251019.

ISSN 2331-1258 (online)

Acknowledgments

The authors would like to thank Dr. Snehamoy Chatterjee of the Michigan Technological University for his helpful discussion of statistical data analysis; Joshua Nimetz of the U.S. Geological Survey (USGS) for his helpful discussion on lidar data acquisition, processing, and formats; and Anji Shah and Phil Brown of the USGS for their thorough reviews of our manuscript. Val Chandler of the Minnesota Geological Survey was an early proponent of using lidar-derived digital elevation models for gravity work and challenged us to undertake this study.

Contents

Figures

Tables

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
meter (m)	1.094	yard (yd)
	Area	
square meter (m^2)	10.76	square foot (ft^2)
square kilometer (km^2)	0.3861	square mile (mi^2)

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

Abbreviations

3DEP	3D Elevation Program
ASPRS	American Society for Photogrammetry and Remote Sensing
cm	centimeter
CO–WM	Wet Mountains of Colorado
DEM	digital elevation model
dGNSS	differential global navigational satellite system
GLONASS	Globalnaya Navigazionnaya Sputnikovaya Sistema [Global Navigation Satellite System]
GNSS	global navigation satellite system
GPS	Global Positioning System
IDW	inverse distance weighted
IMU	inertial measurement unit
km	kilometer
km^2	square kilometer
lidar	light detection and ranging
m	meter
mGal	milligal
MI–HR	west-central Upper Peninsula of Michigan
MI–KP0	Keweenaw Peninsula of Michigan
MI–TM	central Upper Peninsula of Michigan
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NPD	nominal pulse density
NPS	nominal pulse spacing
QL	quality level
RMSEz	root mean square error in the vertical (z) direction
TIN	triangulated irregular network
UP	upper peninsula
USGS	U.S. Geological Survey
WY–MB	Medicine Bow Mountains of Wyoming

The Feasibility of Using Lidar-Derived Digital Elevation Models for Gravity Data Reduction

By Jacob T. Murchek,[1,2] Benjamin J. Drenth,[1] James J. Reitman,[1] Eric D. Anderson,[1] Benjamin P. Magnin,[1] and James M. DeGraff[2]

Abstract

Gravity data require submeter elevation accuracy for data processing, and differential global navigation satellite system (dGNSS) equipment is commonly used to acquire three-dimensional positional data to achieve such accuracy. However, lidar (light detection and ranging) data are commonly used to develop digital elevation models (DEMs) of Earth's surface. Therefore, using elevations from lidar-derived DEMs for gravity-data acquisition and reduction may improve field efficiency and reduce cost. This study examines the feasibility of using DEMs for gravity-data reduction by comparing dGNSS elevation data from 435 gravity stations in Michigan, Wyoming, and Colorado with their respective DEM elevations. The results show that the average difference between DEM and dGNSS elevations is 13 centimeters (cm) and that 93 percent of those differences are less than 50 cm, even in areas with steep terrain. Because an elevation discrepancy of 50 cm corresponds to an error of roughly 0.1 milligals (mGal) in the simple Bouguer gravity anomaly, the results suggest that lidar-derived DEMs are a viable source for acquiring the elevation data needed to process gravity data, thus improving both the cost and efficiency of data collection for regional surveys where an accuracy of less than 1.0 mGal is desired.

Introduction

The gravity geophysical method is a useful, often essential, tool for mapping subsurface geology. Gravity data reduction (processing) relies heavily on accurate and precise elevation measurements, which are often achieved using high-precision (submeter) differential global navigation satellite system (dGNSS) equipment that can determine gravity-station elevations within less than 1 meter. This sort of "surveying grade" dGNSS equipment typically costs tens of thousands of dollars and requires the daily setup of a local base station that must be secured. If the requirement for expensive dGNSS equipment and the corresponding need for a local base station can be eliminated, gravity data acquisition would become less expensive and more efficient. This report examines the feasibility of using elevations taken from lidar-derived DEMs for use in the reduction of gravity data as a possible replacement for measurements that require the use of expensive dGNSS equipment. The assessment involves comparing gravity-station elevations acquired using high-precision dGNSS equipment with elevations sampled from lidar-derived DEMs at the same locations. Nondifferentially corrected horizontal coordinates provided by the dGNSS measurements were used to simulate the effect of data acquisition without using a GNSS base station.

Gravity Data Acquisition and Reduction

Gravity data are acquired using gravimeters, which are usually spring-type balances that measure relative gravity by the change of strain (length) on an internal spring (for example, Hinze and others [2012]). A change in gravity causes the displacement of a test mass within these devices that can be nullified by adjusting the spring length to compensate for the test mass displacement. The spring length needed to nullify the balance is then used to calculate the gravity at a specific location. Gravity measurements are taken relative to a base station, where the absolute value of the gravity field intensity is typically known to within 0.1 milligal (mGal). Measurements of variations in the Earth's gravity field (anomalies) are produced by lateral variations of density within the subsurface (as in Hinze and others [2012]). The measured gravity field is affected by multiple factors, including time-varying factors (such as tides and instrument drift), latitude, elevation, the terrain surrounding the measurement locations (stations), and the density of the Earth. To isolate anomalies produced by local density variations relatable to geology, a series of corresponding corrections must be applied to the observed gravity (for example, Longman [1959] and Blakely [1995]). Accurate elevation measurements are crucial for calculating the free-air and Bouguer gravity anomalies. So, the quality of a gravity survey is heavily dependent on precise elevation control, as an elevation error of 50 centimeters (cm) results in a 0.1 mGal error in the simple Bouguer anomaly.

[1]U.S. Geological Survey.

[2]Michigan Technological University.

Lidar Acquisition and Processing

Lidar is a remote-sensing method that uses light as a pulsed laser to measure distances to the Earth from an airborne platform (for example, National Oceanic and Atmospheric Administration [NOAA], [2023]). Data are collected from an aircraft with three main components: a laser scanner unit, a global navigation satellite system (GNSS) unit, and an inertial measurement unit (IMU) (Habib and others, 2005; Hollaus and others, 2005; Reutebuch and others, 2005; Webster and Dias, 2006; Pfeifer and Briese, 2007; Liu, 2008). The laser scanner emits pulses around 1,000 nanometers at a near-infrared wavelength (for example, Elaksher [2016]) and contains a receiver that detects the time it takes for the pulsed laser to reach the Earth and return (fig. 1). These reflections are recorded as individual points that define a point cloud, which can be processed to represent locations on the surface of the Earth (Sugarbaker and others, 2014). The recorded reflections occur from vegetation, the ground surface, and even human-made objects (see Barber and Shortrudge [2004] and Stoker and others [2006]). Therefore, a critical step in lidar processing is ensuring that unwanted artifacts (nonground) are extracted from the data before DEM construction (Liu, 2008).

The GNSS unit records the aircraft's trajectory, and the IMU measures the aircraft's altitude; both directly influence the accuracy of the lidar points (Webster and Dias, 2006). Analysts supplement and validate the lidar data with ground-control checkpoints having known horizontal and vertical positions to ensure horizontal and vertical accuracy. Table 1 gives the minimum number of checkpoints recommended by the American Society for Photogrammetry and Remote Sensing (ASPRS) based on the area of the DEM being constructed; however, these checkpoints may be altered based on the desired quality level (QL) of the DEM (ASPRS, 2023).

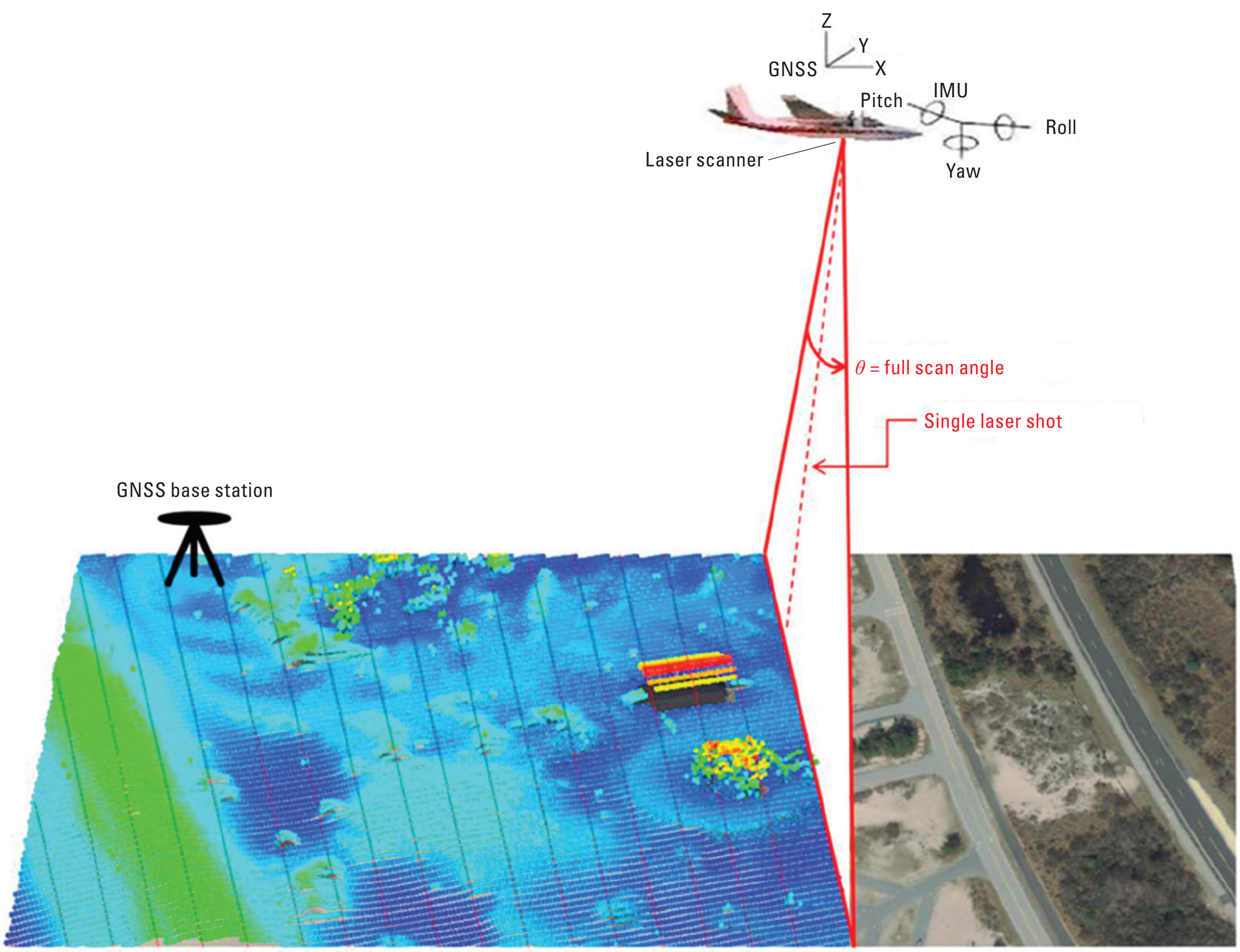

Figure 1. A schematic of light detection and ranging (lidar) data acquisition, modified from National Oceanic and Atmospheric Administration (2012), showing an aircraft scanning the Earth's surface with lidar and revealing lidar topography information while simultaneously receiving global navigation satellite system (GNSS) and inertial measurement unit data. The full scan angle (θ) from the aircraft and a single laser shot within that scan are shown. A GNSS base station is shown on Earth's surface.

The quality level (QL) of a lidar survey is determined by the nominal pulse spacing (NPS) and the vertical positional accuracy, as specified in table 2 (U. S. Geological Survey [USGS], undated.). QL2 lidar-derived DEMs were used for this analysis.

Table 1. The minimum number of checkpoints recommended per square kilometer (km^2) of a light detection and ranging survey from the American Society for Photogrammetry and Remote Sensing (2023).

[≤, less than or equal to]

Area (km^2)	Number of checkpoints
≤ 500	30
501–750	35
751–1,000	40
1,001–1,250	45
1,251–1,500	50
1,501–1,750	55
1,751–2,000	60
2,001–2,250	65
2,251–2,500	70

Table 2. The requirements for different quality level (QL) light detection and ranging (lidar) data; quality level 2 (QL2) data are used in this report.

[This table is modified from the U.S. Geological Survey (USGS) 3D Elevation Program (3DEP) (USGS, undated). cm, centimeter; DEM, digital elevation model; m, meter; NPD, nominal pulse density; NPS, nominal pulse spacing; pts per m^2, points per square meter; RMSEz, root mean square error in the vertical (z) direction, QL; quality level; ≤, less than or equal to; ≥, greater than or equal to]

Quality level[1]	Data source	Vertical accuracy RMSEz (cm)	Nominal pulse spacing (m)	Nominal pulse density (pts per m^2)	DEM cell size (m)
QL0	Lidar	5	≤ 0.35	≥ 8	0.5
QL1	Lidar	10	≤ 0.35	≥ 8	0.5
QL2	Lidar	10	≤ 0.71	≥ 2	1
QL3	Lidar	20	≤ 1.41	≥ 0.5	2

[1]Quality levels are explained in U.S. Geological Survey (undated).

Several methods can be used for extracting nonground points from the raw lidar point-cloud, such as triangulated irregular network (TIN) filtering, slope-based filtering, mathematical morphological filtering, interpolation-based filtering, and machine-learning-based filtering (Cai and others, 2020). The USGS 3D Elevation Program (3DEP) typically requires TIN filtering to assess both the vegetated and nonvegetated vertical accuracy of lidar data (USGS, 2024). TIN filtering uses a triangulation algorithm to create a surface model from the point-cloud data. The height of each point is compared with its neighbor within the triangle, and points having a significantly higher height than their neighbors are removed (Peucker and others, 1976). After extracting nonground points from the lidar data, a DEM is interpolated based on the remaining ground points. Interpolation is predicting values at an unsampled location using the measured values nearby (for example, Burrough and McDonnell [1998]). DEM interpolation typically uses inverse distance weighted (IDW), spline-based, or geostatistical methods (such as kriging) (Liu, 2008). Once the interpolation method is chosen, a DEM grid is constructed based on the QL of the data.

Study Design

To study the feasibility of using lidar-derived elevations for gravity-data reduction, we acquired dGNSS elevation data for 435 gravity stations in the Upper Peninsula of Michigan (237 stations, fig. 2*A*–*C*), the Wet Mountains of Colorado (59 stations, fig. 3*A*), and the Medicine Bow Mountains of Wyoming (139 stations, fig. 3*B*). For each station, Leica Viva GS16 GNSS equipment or a Trimble Geo7x handheld GNSS receiver was used to determine differentially corrected locations (latitude and longitude) and elevations, typically accurate to within 10 cm. To compute differential corrections for the Leica Viva GS16, a GNSS base station located within 25 kilometers (km) of the stations was used. For the Trimble Geo7x, the NOAA Continuously Operating Reference Stations located within 65 km of the gravity stations were used to correct the data differentially. Additionally, GNSS-derived locations were recorded without applying differential corrections to simulate data acquisition conditions without using a GNSS base station.

For the lidar comparisons, 1-meter DEM tiles (QL2) were obtained using the USGS LidarExplorer (USGS, 2022; USGS, 2023), the Michigan Technological University Geospatial Research Facility DEM downloader (Sanborn Map Company, Inc., 2020), or the Colorado Hazard Mapping & Risk MAP Portal (Merrick & Company, 2016; Quantum Spatial, Inc., 2020) and were “mosaiced” together in the ArcGIS Pro software package to encompass the entirety of each gravity survey.[3] The nondifferentially corrected gravity station coordinates (North American Datum of 1983) were added to ArcGIS Pro, and the DEM was sampled at each station for comparison with the differentially corrected elevation provided by the dGNSS equipment. The flowchart shown in figure 4 describes each data acquisition, processing, and interpretation step. However, it should be noted that the lidar data were acquired and processed before this study.

[3]Datasets are “mosaiced” or merged using the “Mosaic” tool in the ArcGIS Pro software package.

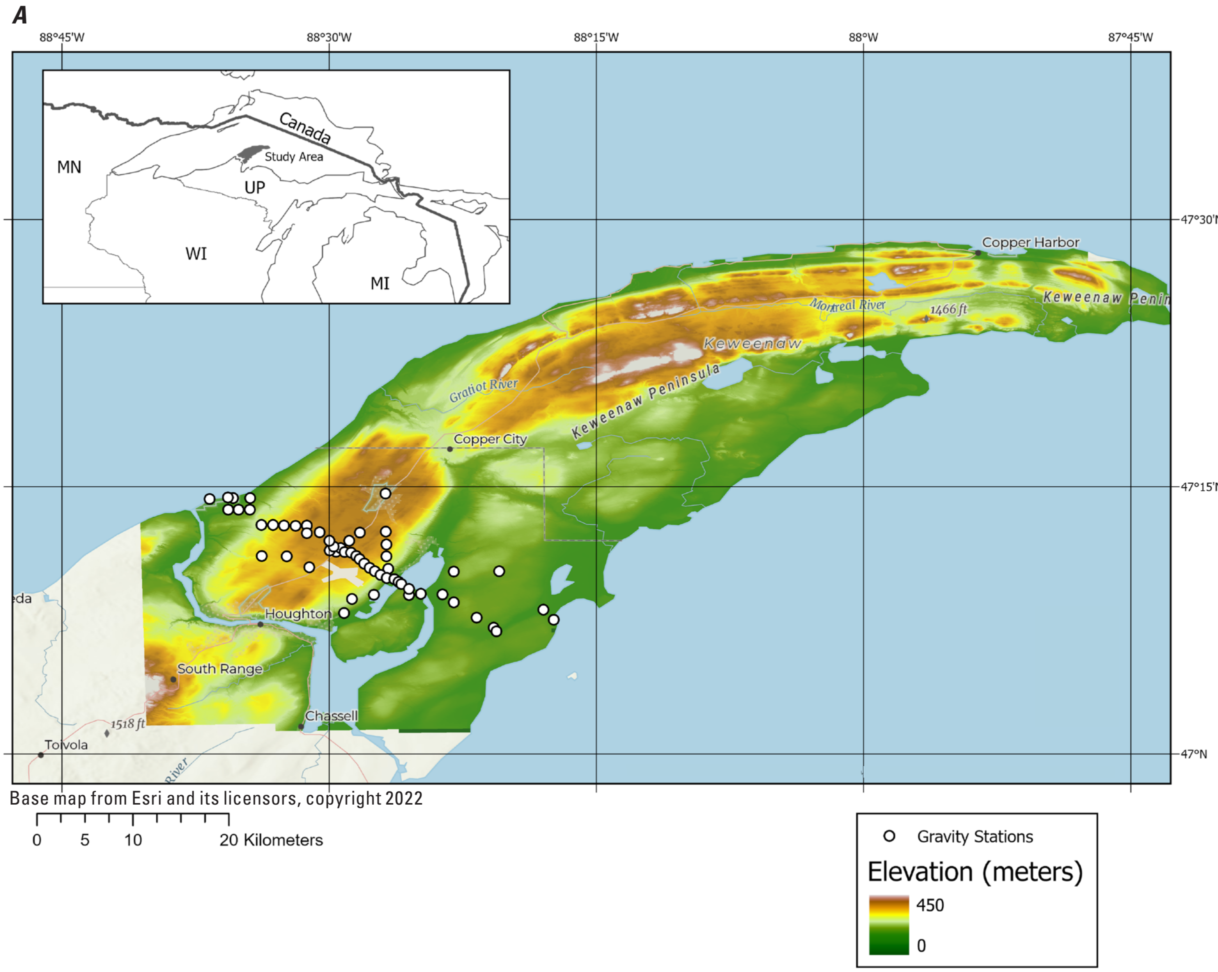

Figure 2. Three maps (*A*–*C*) showing the 237 gravity stations in the Upper Peninsula of Michigan for which location information was collected as part of regional gravity surveys. The stations overlay the mosaiced 1-meter (m) digital elevation model (DEM) rasters obtained from the U.S. Geological Survey (USGS) 3D Elevation Program (3DEP) light detection and ranging (lidar) data in the National Map Downloader (USGS, 2022) or the Michigan Technological University Geospatial Research Facility DEM tool (Sanborn Map Company, Inc., 2020). (*A*) Map showing the 56 gravity stations in the Keweenaw Peninsula of Michigan (MI–KP0) where location data were collected with a Global Navigational Satellite System (GNSS) receiver. Elevation data are from 0 to 450 m. (*B*) Map showing the 94 gravity stations in the west-central Upper Peninsula of Michigan (MI–HR) where location information was collected with GNSS equipment. Elevation data are from 400 to 600 m. (*C*) Map showing the 87 gravity stations in the central Upper Peninsula of Michigan (MI–TM) where location information was collected with GNSS equipment. Elevation data are from 150 to 300 m. The prefixes discussed here—MI–KP0, MI–HR, and MI–TM—represent the location aspect of the gravity station numbers in tables 3, 4, and 7 (at the end of this report). ft, foot.

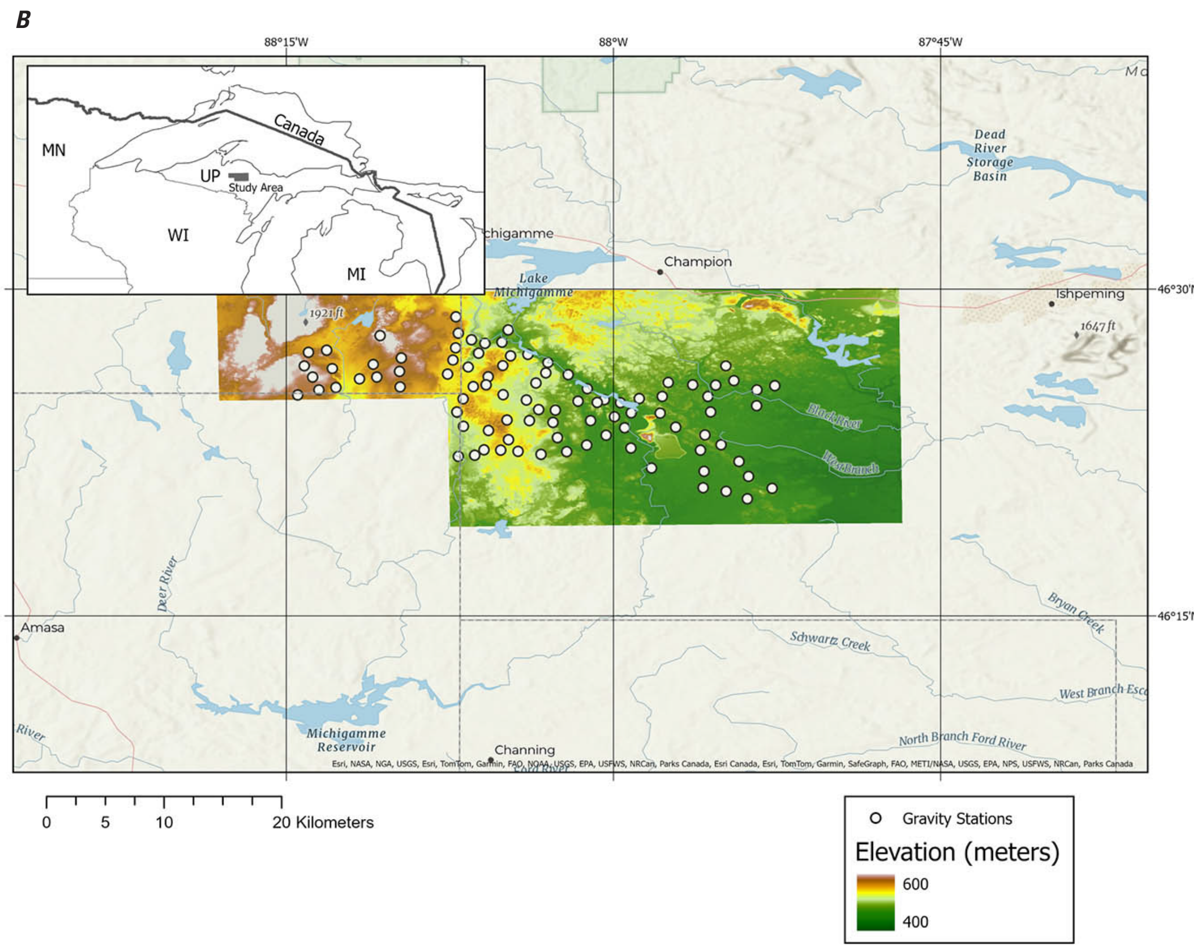

Figure 2.—Continued

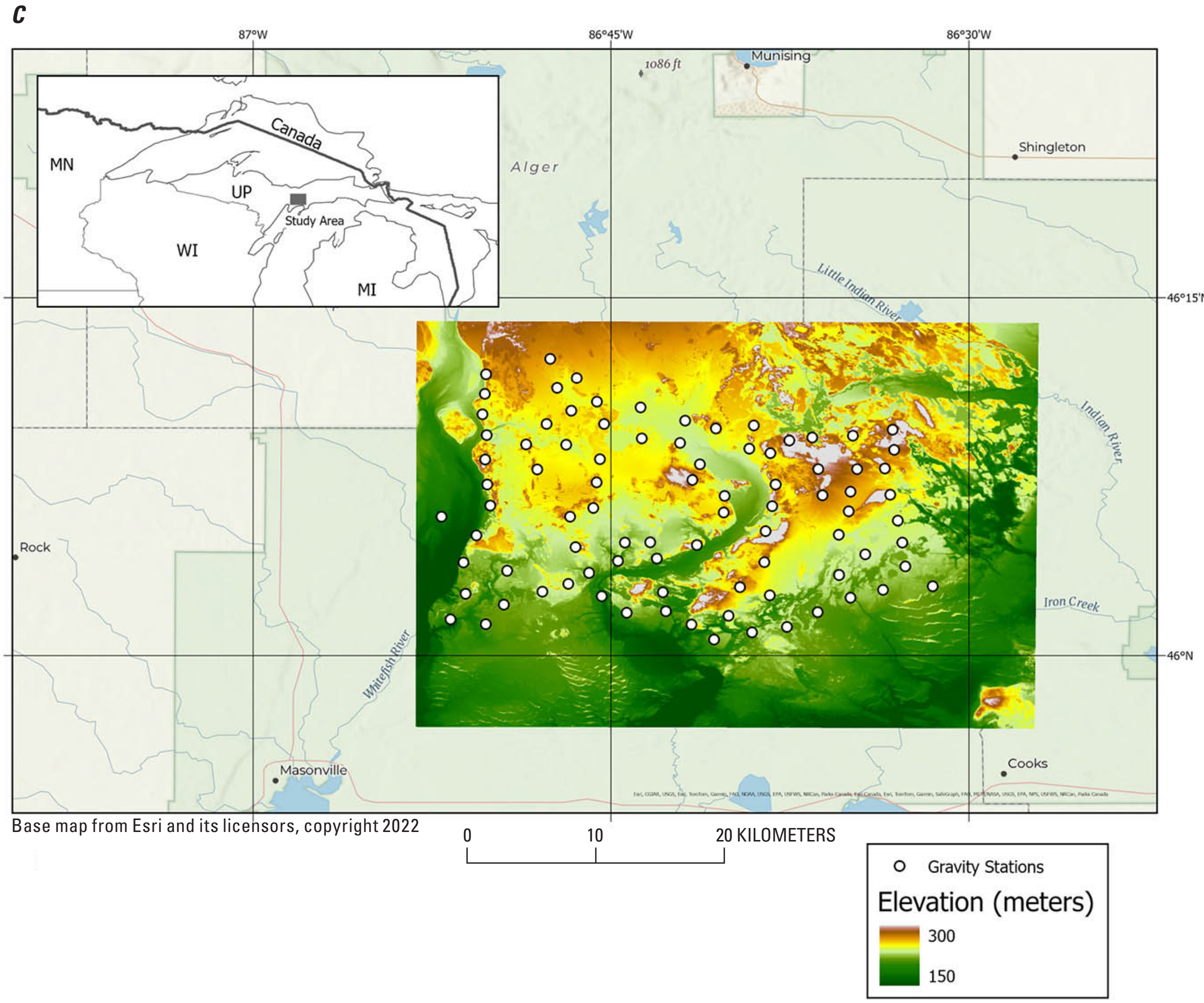

Figure 2.—Continued

A

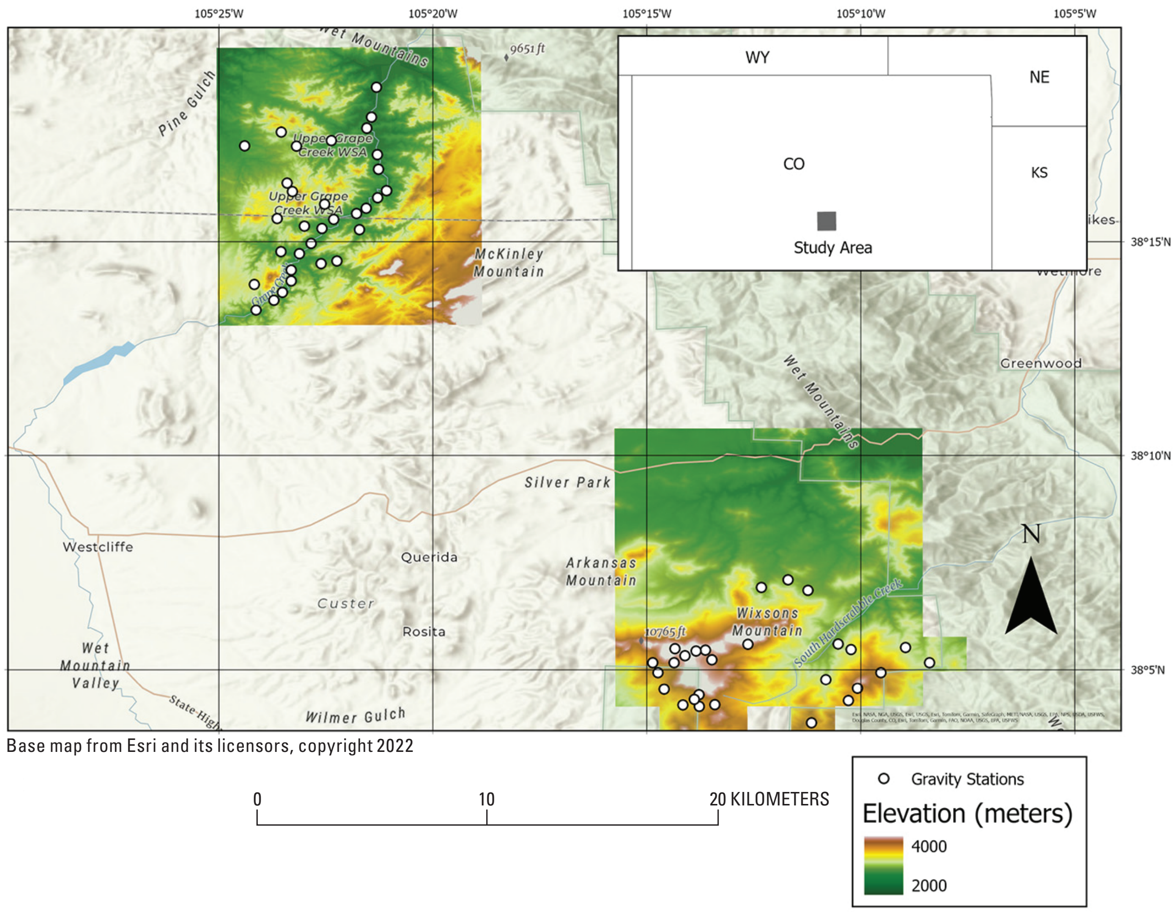

Figure 3. Two maps (*A*, *B*) showing the 198 gravity stations in the western United States (Wyoming and Colorado) for which location information was collected as part of regional gravity surveys. The stations overlay the mosaiced 1-meter (m) digital elevation model (DEM) rasters. Light detection and ranging (lidar) data were obtained from two sources. U.S. Geological Survey (USGS) 3D Elevation Program lidar data were retrieved from the USGS National Map Downloader (USGS, 2024). Lidar data from Merrick & Company (2016) and Quantum Spatial, Inc. (2020) were retrieved from the Colorado Hazard Mapping & Risk MAP Portal (Merrick & Company, 2016). (*A*) Map showing the 59 gravity stations in the Wet Mountains of Colorado (CO–WM) where location information was collected with Global Navigational Satellite System (GNSS) equipment. Elevation data are from 2,000 to 4,000 m. (*B*) Map showing the 139 gravity stations in the Medicine Bow Mountains of Wyoming (WY–MB) where location information was collected with GNSS equipment. Elevation data are from 2,000 to 4,000 m. The prefixes discussed here—CO–WM and WY–MB—represent the location aspect of the gravity station numbers in tables 5 and 6 (at the end of this report). ft, foot.

B

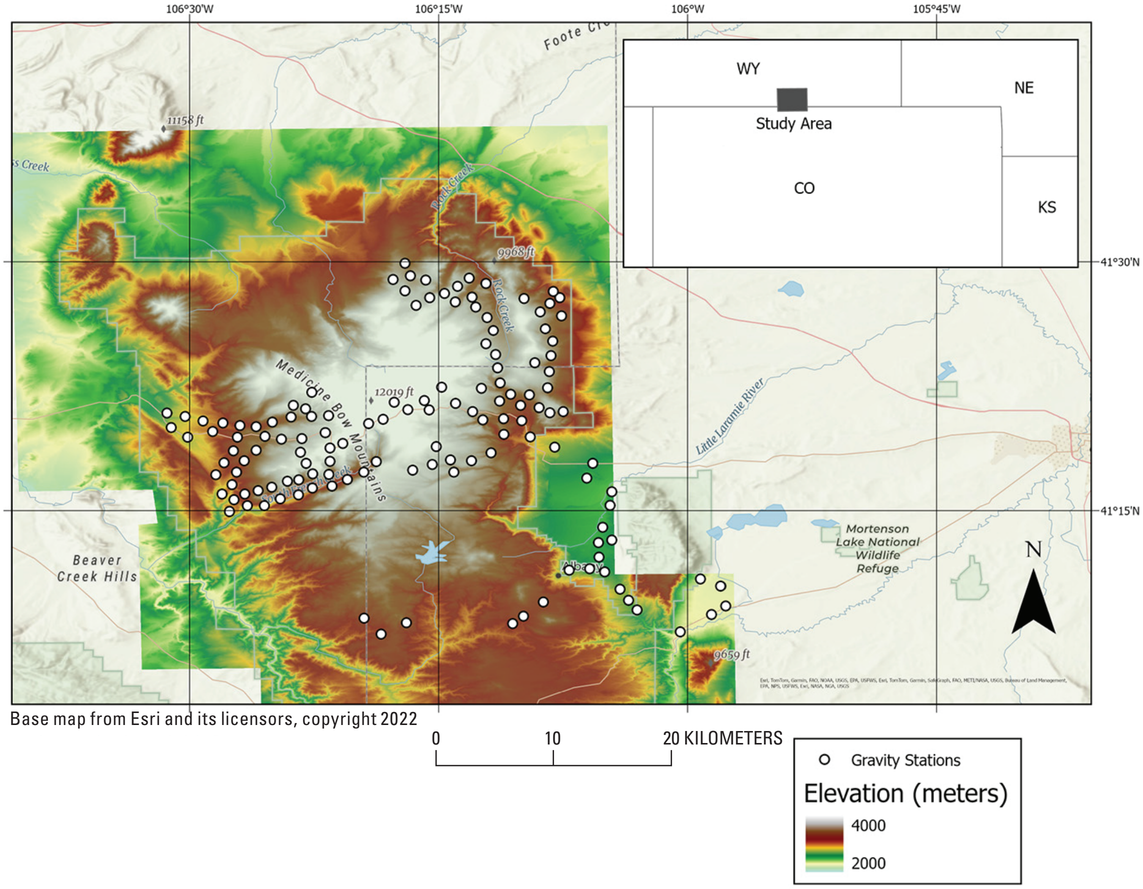

Figure 3.—Continued

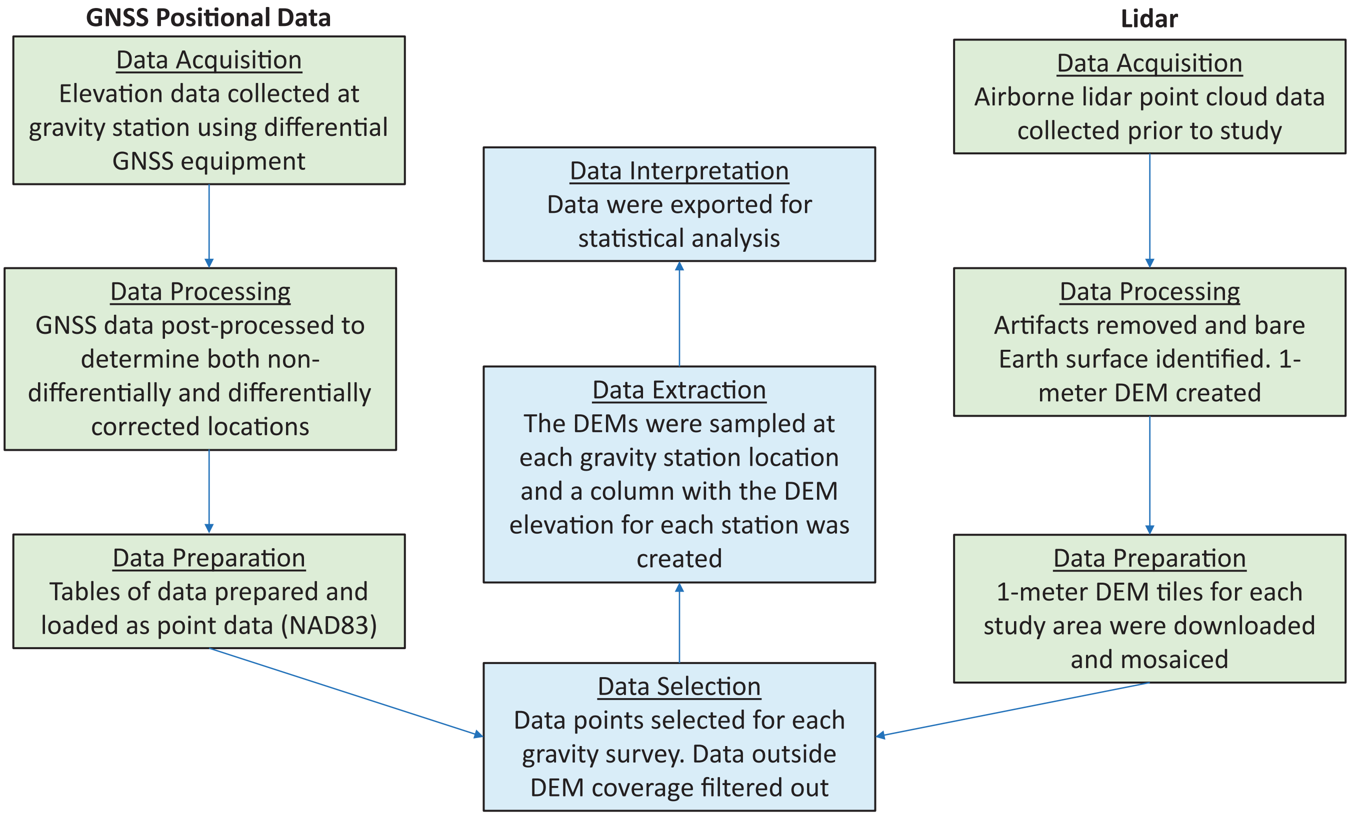

Figure 4. A flowchart showing how global navigational satellite system (GNSS) positional data and light detection and ranging (lidar) data were acquired, processed, and prepared and then how the resulting data for both sets were selected, extracted, and interpreted. DEM, digital elevation model; NAD 83, North American Datum of 1983.

Results

The elevation differences between the dGNSS measurements and DEMs were consistently (93 percent) less than 50 cm, corresponding to a 0.1 mGal error in the simple Bouguer gravity anomaly. Horizontal and vertical positions for all 435 gravity stations are shown in tables 3–7 (at the end of the report) with their respective lidar-derived elevation and the differences between the GNSS and lidar-derived elevations. The distribution of differences between DEM and GNSS elevations is shown in figure 5*A*, and the distribution of their absolute differences is shown in figure 5*B*.

The mean difference between the GNSS and DEM-derived elevations is 13 cm with a standard deviation of 46 cm. Approximately 93 percent (N = 406) of the data points fall within 1 standard deviation of the mean (minimum –33 cm; maximum 59 cm). The lower limit for the 95 percent confidence interval is 9 cm, and the upper limit is 17 cm. A maximum positive difference of 3.9 meters (m) and a maximum negative difference of –2.1 m occur in the central Upper Peninsula. However, the mean elevation difference in the Upper Peninsula is 8 cm, a measure less than the average in Colorado and Wyoming (20 cm), which contain steep terrain. Overall, 97 percent (N = 423) of the 435 stations exhibit an elevation difference of less than 1 m. The statistical breakdown for each study area is shown in table 8.

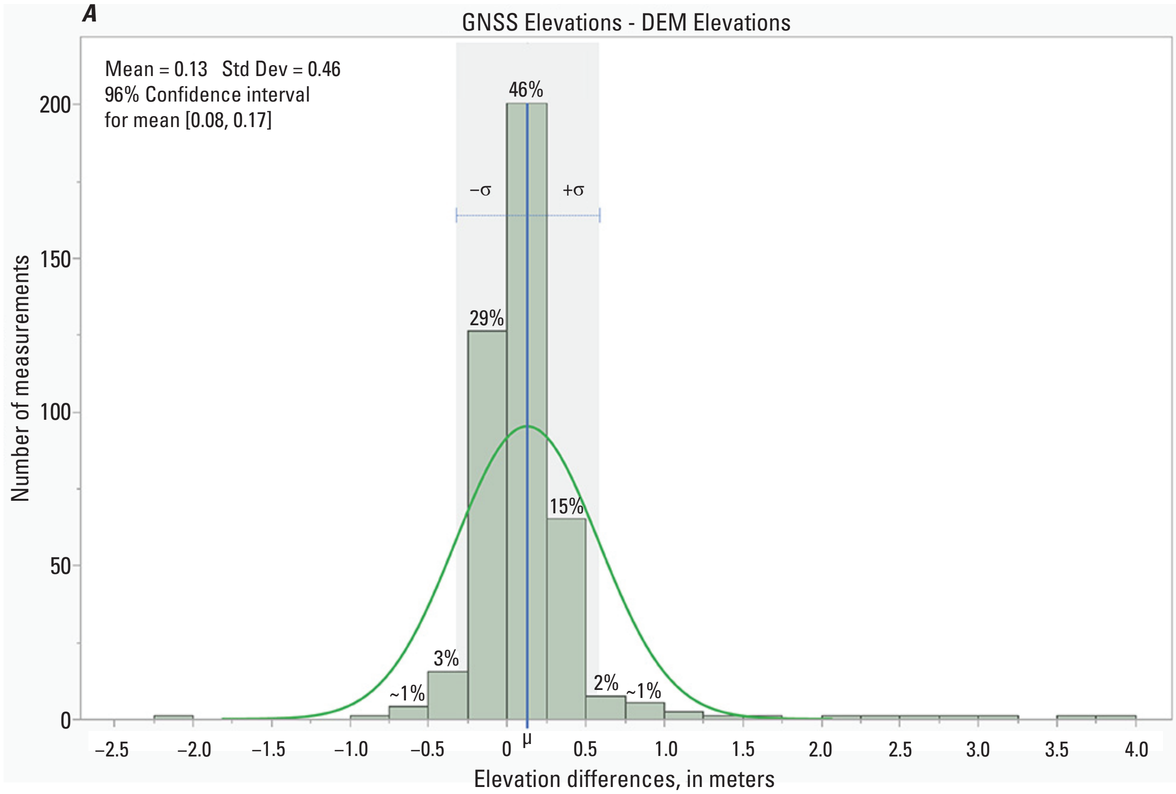

Figure 5. Two bar graphs (*A*, *B*) showing elevation distributions. (*A*) Bar graph that shows the distribution (mean = 0.13, standard deviation = 0.46) of elevation differences (global navigational satellite system minus light detection and ranging [GNSS – lidar]) and indicates that 93 percent of the data fall within 1 standard deviation (σ) of the mean (μ) (13 centimeters [cm]). (*B*) Bar graph that shows the distribution (mean = 0.22, standard deviation = 0.42) of the absolute value of the elevation differences (|GNSS – lidar|) and a mean difference of 22 cm in the absolute differences observed within the data. %, percent; m, meter.

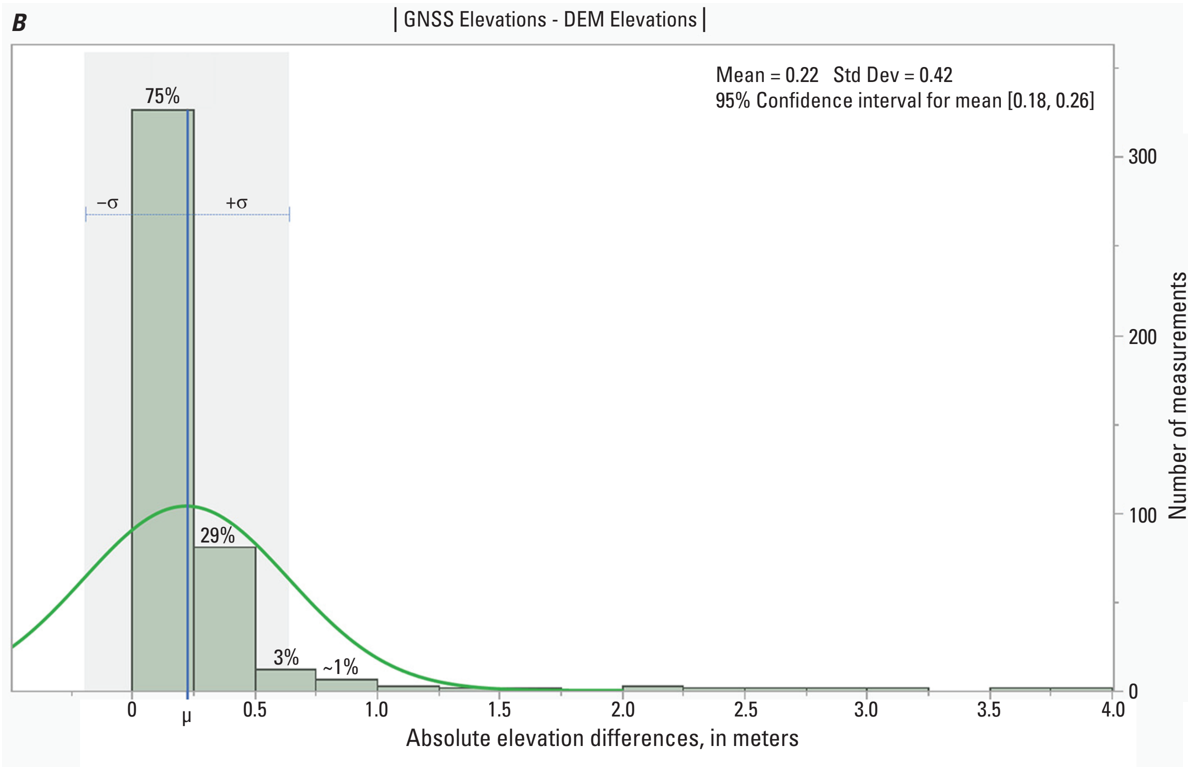

Figure 5.—Continued

Table 8. A statistical breakdown of each study area in this project that shows the average elevation difference observed and the number of points with a difference greater than 1 meter (m).

[UP, upper peninsula ; > greater than]

Location	Mean elevation difference (m)	Standard deviation	Minimum (m)	Maximum (m)	No. of points >1 m elevation difference
Medicine Bow Mountains, Wyoming	0.25	0.37	–0.39	3.1	4
Wet Mountains, Colorado	0.11	0.53	–0.93	3.7	1
Keweenaw Peninsula, Michigan	0.26	0.47	–0.07	2.7	2
West-central UP, Michigan	–0.07	0.17	–0.66	0.54	0
Central UP, Michigan	0.11	0.62	–2.1	3.9	5
Regional totals					
Total UP, Michigan (less-steep terrain)	0.08	0.44	–2.1	3.9	7
Total Wyoming and Colorado (steep terrain)	0.20	0.42	–0.93	3.7	5

Discussion

Of the 435 gravity stations, 406 (approximately 93 percent) lidar-derived elevations fall within ±50 cm of the dGNSS elevations, meaning that their use would produce an error of less than 0.1 mGal in the simple Bouguer anomaly. Regional gravity surveys commonly focus on mapping anomalies greater than 1 mGal, so an error of 0.1 mGal is not a cause for concern in most cases. Moreover, most absolute base (reference) stations used for gravity-data reduction have an uncertainty of ±0.1 mGal (for example, Morelli and others [1972]). Therefore, this study shows that lidar-derived elevations are sufficiently accurate for regional gravity-data reduction, and, in most cases, their use produces errors comparable to the inherent absolute accuracy of standard regional gravity surveys. For detailed gravity surveys focused on smaller anomalies—those with an accuracy of less than 0.1 mGal—dGNSS equipment may be necessary.

Only 12 gravity stations (less than 3 percent) had elevation differences greater than 1 m between dGNSS and lidar-derived elevations. Seven were in the Upper Peninsula of Michigan, four were in the Medicine Bow Mountains of Wyoming, and one was in the Wet Mountains of Colorado. To identify the sources of these discrepancies, we examined the elevation differences between the lidar-derived elevations and dGNSS elevations using the differentially corrected horizontal coordinates in the Medicine Bow Mountains. The average elevation difference between the measurements was roughly 1-cm less than when the nondifferentially corrected coordinates were used, and the same four stations showed an elevation difference of greater than 1 m. This observation indicates that the four largest elevation discrepancies are not likely related to the lack of differential processing for the horizontal coordinates. Instead, these discrepancies may result from dense vegetation causing a multipath in the GNSS signal, a locally steep elevation gradient, or an unknown error in the dGNSS-derived elevations.

Recommended Field Practices

The use of several recommendations may optimize positional data acquisition for gravity data processing and yield acceptable uncertainty in simple Bouguer gravity values. GNSS equipment (for example, a handheld, non-dGNSS unit) with the ability to detect both Global Positioning System (GPS) and Globalnaya Navigatsionnaya Sputnikovaya Sistema (GLONASS)[4] satellites is recommended for obtaining the best possible horizontal position data, especially at higher latitudes where GPS readings are less accurate. Horizontal positional errors may result in the gravity station being mislocated by more than several meters, thus producing elevation inaccuracies. For this reason, placing gravity stations in areas more than 5 m away from steep topographic slopes (such as a locally flat surface) is recommended.

The reduction or elimination of multipaths is also necessary for optimizing positional accuracy during data acquisition. A multipath can result from the primary GNSS signal reflecting off buildings, vegetation, or mountains, or from atmospheric scattering. A reduction of this effect can be achieved by placing the GNSS antenna in an elevated position, such as on the roof of a vehicle or a range pole and away from areas with dense vegetation. Placing stations on small platforms above the ground's surface can also cause inaccuracies in the lidar-derived elevation and should be avoided.

Conclusion

This study evaluated whether lidar-derived DEMs could serve as elevation control for gravity surveys to reduce cost and improve field efficiency. Elevation data from 435 gravity stations in the Upper Peninsula of Michigan, the Medicine Bow Mountains of Wyoming, and the Wet Mountains of Colorado were compared with elevations from a 1-m horizontal-resolution DEM for each station. An average difference of 13 cm between dGNSS and DEM elevations was observed, with a standard deviation of 46 cm. Over 93 percent of the DEM data were within 50 cm of GNSS data, corresponding to a simple Bouguer gravity error of approximately 0.1 mGal.

These results indicate that lidar-derived DEMs provide acceptable elevation control for gravity data reduction, particularly for regional gravity surveys where anomalies of interest are usually greater than 1 mGal in amplitude. In detailed surveys requiring greater accuracy and precision, other means of determining elevations may be required. Twelve stations exhibited elevation differences between dGNSS and DEM data greater than 1 m. The source of this relatively rare discrepancy is unknown but may be related to dense vegetation cover, locally steep elevation gradients, or an unknown error in the dGNSS elevations. This study suggests that using QL2 lidar-derived DEMs for gravity-data reduction is acceptable for most regional surveys.

[4]The "Global Navigation Satellite System" is a Russian satellite-based navigation system that provides position information.

Tables 3–7

Table 3. Location information for the 94 gravity stations located at west-central Upper Peninsula of Michigan (MI–HR) from Drenth and Others (2024).

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–HR209	46.42494	–88.16299	46.42493	–88.16300	523.87	523.74	0.13	0.13
MI–HR210	46.43683	–88.16355	46.43681	–88.16355	538.11	538.10	0.01	0.01
MI–HR211	46.44739	–88.16216	46.44738	–88.16216	531.44	531.10	0.35	0.35
MI–HR212	46.46448	–88.17829	46.46448	–88.17830	544.78	544.73	0.04	0.04
MI–HR213	46.43243	–88.18091	46.43242	–88.18092	525.93	525.81	0.12	0.12
MI–HR214	46.43118	–88.19405	46.43117	–88.19406	514.27	514.27	0.00	0.00
MI–HR215	46.42438	–88.21213	46.42439	–88.21215	515.77	515.53	0.24	0.24
MI–HR216	46.42267	–88.22513	46.42266	–88.22513	536.88	536.80	0.09	0.09
MI–HR217	46.41882	–88.24124	46.41881	–88.24127	534.57	534.72	–0.15	0.15
MI–HR218	46.43243	–88.22989	46.43243	–88.22991	543.09	543.01	0.08	0.08
MI–HR219	46.44121	–88.23626	46.44121	–88.23627	540.62	540.19	0.43	0.43
MI–HR220	46.45163	–88.23310	46.45164	–88.23311	534.12	534.74	–0.62	0.62
MI–HR221	46.45329	–88.21923	46.45330	–88.21922	525.97	525.43	0.54	0.54
MI–HR222	46.43917	–88.21494	46.43918	–88.21494	528.55	528.60	–0.05	0.05
MI–HR223	46.44226	–88.18349	46.44227	–88.18349	529.38	529.38	0.00	0.00
MI–HR239	46.44133	–88.08456	46.44131	–88.08455	510.37	510.46	–0.10	0.10
MI–HR240	46.44881	–88.07866	46.44879	–88.07865	511.92	511.90	0.02	0.02
MI–HR241	46.46879	–88.08052	46.46877	–88.08051	478.68	478.89	–0.21	0.21
MI–HR242	46.45943	–88.08535	46.45941	–88.08534	472.61	472.67	–0.06	0.06
MI–HR243	46.45848	–88.09835	46.45848	–88.09833	479.39	479.48	–0.09	0.09
MI–HR244	46.46113	–88.10863	46.46113	–88.10862	498.09	498.04	0.06	0.06
MI–HR245	46.46627	–88.11848	46.46626	–88.11848	521.55	521.60	–0.05	0.05
MI–HR246	46.47889	–88.12047	46.47888	–88.12046	525.69	525.75	–0.06	0.06
MI–HR247	46.45086	–88.10303	46.45085	–88.10303	492.13	492.27	–0.14	0.14
MI–HR248	46.44016	–88.11112	46.44014	–88.11112	486.16	486.13	0.02	0.02

Table 3. Location information for the 94 gravity stations located at west-central Upper Peninsula of Michigan (MI–HR) from Drenth and Others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–HR249	46.43465	–88.12686	46.43464	–88.12685	508.44	508.33	0.11	0.11
MI–HR250	46.44574	–88.12259	46.44573	–88.12259	508.40	508.40	0.00	0.00
MI–HR251	46.45507	–88.12062	46.45507	–88.12063	512.48	512.41	0.08	0.08
MI–HR252	46.45011	–88.06530	46.45011	–88.06529	471.30	471.16	0.14	0.14
MI–HR253	46.44357	–88.05018	46.44357	–88.05017	465.11	465.32	–0.21	0.21
MI–HR254	46.42801	–88.05931	46.42801	–88.05930	497.72	497.72	0.00	0.00
MI–HR255	46.43435	–88.03451	46.43434	–88.03450	457.50	457.70	–0.20	0.20
MI–HR256	46.42357	–88.02001	46.42358	–88.02000	457.56	457.47	0.09	0.09
MI–HR257	46.41524	–88.00702	46.41523	–88.00701	461.07	461.20	–0.13	0.13
MI–HR258	46.43268	–88.09584	46.43266	–88.09583	519.07	519.20	–0.13	0.13
MI–HR259	46.42517	–88.10726	46.42517	–88.10726	509.49	509.43	0.06	0.06
MI–HR260	46.41580	–88.11487	46.41580	–88.11487	511.05	511.11	–0.07	0.07
MI–HR261	46.40543	–88.11949	46.40543	–88.11949	503.56	503.58	–0.02	0.02
MI–HR262	46.40569	–88.11962	46.40569	–88.11961	503.74	503.75	0.00	0.00
MI–HR263	46.39486	–88.11466	46.39486	–88.11466	490.43	490.56	–0.13	0.13
MI–HR265	46.42661	–88.09738	46.42660	–88.09738	524.72	524.96	–0.24	0.24
MI–HR266	46.41892	–88.08438	46.41892	–88.08436	508.71	508.78	–0.07	0.07
MI–HR267	46.43559	–88.05164	46.43558	–88.05165	499.46	499.57	–0.11	0.11
MI–HR268	46.41399	–88.02718	46.41398	–88.02718	475.55	475.52	0.04	0.04
MI–HR269	46.41310	–88.01249	46.41309	–88.01248	472.11	472.25	–0.13	0.13
MI–HR270	46.41278	–87.99475	46.41277	–87.99474	457.07	457.03	0.04	0.04
MI–HR271	46.40503	–87.98644	46.40502	–87.98643	456.36	456.40	–0.04	0.04
MI–HR272	46.39359	–87.99155	46.39358	–87.99154	462.14	462.16	–0.01	0.01
MI–HR273	46.39923	–88.01748	46.39922	–88.01748	457.80	457.90	–0.10	0.10
MI–HR274	46.38052	–88.02036	46.38051	–88.02037	461.31	461.31	0.00	0.00
MI–HR275	46.38799	–88.00558	46.38799	–88.00558	456.66	456.70	–0.04	0.04
MI–HR276	46.39172	–88.09548	46.39171	–88.09546	505.30	505.39	–0.09	0.09
MI–HR277	46.39956	–88.08134	46.39956	–88.08134	514.50	514.63	–0.12	0.12

Table 3. Location information for the 94 gravity stations located at west-central Upper Peninsula of Michigan (MI–HR) from Drenth and Others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–HR278	46.39919	–88.06436	46.39920	–88.06434	498.56	498.47	0.09	0.09
MI–HR279	46.40759	–88.05725	46.40758	–88.05723	488.88	488.88	0.01	0.01
MI–HR280	46.41484	–88.06662	46.41484	–88.06661	493.27	493.31	–0.04	0.04
MI–HR281	46.40704	–88.04444	46.40703	–88.04443	477.41	477.68	–0.27	0.27
MI–HR282	46.38617	–88.04290	46.38617	–88.04290	474.39	474.54	–0.15	0.15
MI–HR283	46.39784	–88.04632	46.39783	–88.04632	476.50	476.69	–0.18	0.18
MI–HR284	46.38457	–88.08025	46.38456	–88.08025	507.73	507.89	–0.16	0.16
MI–HR285	46.37563	–88.07300	46.37561	–88.07301	501.87	502.09	–0.22	0.22
MI–HR286	46.37335	–88.05530	46.37333	–88.05530	482.75	482.83	–0.08	0.08
MI–HR287	46.37545	–88.03577	46.37543	–88.03578	471.54	471.62	–0.08	0.08
MI–HR288	46.37665	–88.08606	46.37664	–88.08606	507.56	507.64	–0.08	0.08
MI–HR289	46.37673	–88.09903	46.37672	–88.09903	495.34	495.37	–0.03	0.03
MI–HR290	46.37274	–88.10606	46.37273	–88.10606	488.82	488.87	–0.05	0.05
MI–HR291	46.37188	–88.11852	46.37187	–88.11853	479.97	480.05	–0.08	0.08
MI–HR301	46.41593	–87.98031	46.41594	–87.98032	482.42	482.41	0.01	0.01
MI–HR302	46.41762	–87.96272	46.41761	–87.96274	474.48	474.78	–0.30	0.30
MI–HR303	46.42835	–87.95810	46.42835	–87.95812	466.70	466.94	–0.24	0.24
MI–HR304	46.42658	–87.93938	46.42657	–87.93940	465.76	465.84	–0.08	0.08
MI–HR305	46.42620	–87.92179	46.42620	–87.92181	462.74	462.75	0.00	0.00
MI–HR306	46.42973	–87.90791	46.42970	–87.90793	461.32	461.42	–0.11	0.11
MI–HR307	46.44103	–87.91421	46.44099	–87.91423	477.03	476.99	0.04	0.04
MI–HR308	46.42258	–87.89031	46.42254	–87.89032	456.78	456.92	–0.14	0.14
MI–HR309	46.42578	–87.87663	46.42575	–87.87665	459.60	459.74	–0.15	0.15
MI–HR310	46.41063	–87.89066	46.41060	–87.89066	457.74	457.91	–0.17	0.17
MI–HR311	46.41775	–87.92782	46.41772	–87.92783	460.52	460.70	–0.18	0.18
MI–HR312	46.40566	–87.92574	46.40565	–87.92576	464.99	465.32	–0.33	0.33
MI–HR313	46.40483	–87.96428	46.40484	–87.96430	465.96	466.39	–0.43	0.43
MI–HR314	46.39421	–87.95238	46.39421	–87.95241	467.12	467.40	–0.27	0.27

Table 3. Location information for the 94 gravity stations located at west-central Upper Peninsula of Michigan (MI–HR) from Drenth and Others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–HR315	46.38814	–87.93001	46.38815	–87.93003	465.65	465.94	–0.29	0.29
MI–HR316	46.38068	–87.91778	46.38070	–87.91779	459.97	460.14	–0.16	0.16
MI–HR317	46.36793	–87.90407	46.36795	–87.90407	454.28	454.45	–0.17	0.17
MI–HR318	46.35638	–87.89669	46.35640	–87.89667	456.48	457.15	–0.66	0.66
MI–HR319	46.34743	–87.87883	46.34744	–87.87881	451.22	451.53	–0.31	0.31
MI–HR320	46.33948	–87.89772	46.33949	–87.89771	454.00	454.09	–0.09	0.09
MI–HR321	46.34497	–87.91396	46.34498	–87.91394	458.56	458.65	–0.09	0.09
MI–HR322	46.34791	–87.93149	46.34791	–87.93146	452.12	452.42	–0.30	0.30
MI–HR323	46.36046	–87.93067	46.36046	–87.93065	455.94	456.20	–0.26	0.26
MI–HR324	46.37647	–87.93349	46.37646	–87.93346	460.19	460.06	0.14	0.14
MI–HR325	46.40201	–87.99925	46.40202	–87.99923	481.08	481.11	–0.03	0.03
MI–HR326	46.37824	–87.98663	46.37825	–87.98662	451.77	451.76	0.01	0.01
MI–HR327	46.36282	–87.97087	46.36284	–87.97084	447.92	448.19	–0.27	0.27

Table 4. Location information for the 87 gravity stations located on the central Upper Peninsula of Michigan (MI–TM) from Drenth and others (2024).

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–TM001	46.05761	–86.76523	46.05760	–86.76523	228.46	228.55	–0.10	0.10
MI–TM002	46.05005	–86.77984	46.05004	–86.77984	237.26	237.29	–0.04	0.04
MI–TM003	46.04471	–86.79793	46.04470	–86.79792	235.38	235.29	0.09	0.09
MI–TM004	46.03561	–86.82491	46.03561	–86.82492	231.49	231.54	–0.05	0.05
MI–TM005	46.05917	–86.82250	46.05919	–86.82249	231.44	233.53	–2.09	2.09
MI–TM006	46.10298	–86.76241	46.10298	–86.76243	240.67	240.74	–0.07	0.07
MI–TM007	46.12079	–86.75999	46.12079	–86.76001	250.59	250.52	0.07	0.07
MI–TM008	46.13699	–86.75775	46.13700	–86.75778	243.03	243.05	–0.01	0.01
MI–TM009	46.14718	–86.78123	46.14719	–86.78124	240.63	240.60	0.02	0.02
MI–TM010	46.14721	–86.80917	46.14722	–86.80918	242.80	242.83	–0.02	0.02
MI–TM011	46.15373	–86.83689	46.15373	–86.83691	237.25	237.29	–0.04	0.04
MI–TM012	46.13682	–86.83782	46.13683	–86.83782	248.12	247.11	1.01	1.01
MI–TM013	46.11941	–86.83631	46.11941	–86.83633	243.01	243.11	–0.10	0.10
MI–TM014	46.10464	–86.83439	46.10466	–86.83442	228.64	228.71	–0.07	0.07
MI–TM015	46.09690	–86.86844	46.09690	–86.86845	214.65	214.68	–0.04	0.04
MI–TM016	46.08374	–86.84393	46.08374	–86.84394	231.24	231.25	–0.02	0.02
MI–TM017	46.06476	–86.85307	46.06475	–86.85306	232.13	231.87	0.26	0.26
MI–TM018	46.04313	–86.85153	46.04314	–86.85154	230.66	230.67	–0.01	0.01
MI–TM019	46.02522	–86.86199	46.02522	–86.86200	224.94	225.03	–0.09	0.09
MI–TM020	46.02190	–86.83746	46.02190	–86.83748	228.33	228.41	–0.08	0.08
MI–TM021	46.09679	–86.77856	46.09679	–86.77857	243.10	242.94	0.16	0.16
MI–TM022	46.07565	–86.77473	46.07564	–86.77473	237.34	237.23	0.11	0.11
MI–TM023	46.04142	–86.75639	46.04141	–86.75639	215.18	215.18	0.00	0.00
MI–TM024	46.02985	–86.73892	46.02984	–86.73893	231.27	231.18	0.09	0.09
MI–TM025	46.03102	–86.71163	46.03102	–86.71163	229.00	228.94	0.06	0.06
MI–TM026	46.04420	–86.71386	46.04421	–86.71387	230.28	230.34	–0.07	0.07
MI–TM027	46.02166	–86.69368	46.02168	–86.69369	230.49	230.47	0.02	0.02
MI–TM028	46.01128	–86.67806	46.01129	–86.67808	230.95	230.94	0.01	0.01

Table 4. Location information for the 87 gravity stations located on the central Upper Peninsula of Michigan (MI–TM) from Drenth and others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–TM029	46.01631	–86.65150	46.01633	–86.65150	229.18	229.18	0.00	0.00
MI–TM030	46.02011	–86.62713	46.02013	–86.62713	238.58	234.70	3.89	3.89
MI–TM031	46.03034	–86.60562	46.03034	–86.60562	232.86	232.85	0.01	0.01
MI–TM032	46.04037	–86.58267	46.04037	–86.58268	233.50	233.46	0.04	0.04
MI–TM033	46.04585	–86.56003	46.04586	–86.56004	233.23	233.06	0.17	0.17
MI–TM034	46.04844	–86.52518	46.04844	–86.52518	231.52	231.51	0.01	0.01
MI–TM035	46.06206	–86.54437	46.06206	–86.54437	234.53	234.51	0.02	0.02
MI–TM036	46.07869	–86.54662	46.07871	–86.54663	237.41	237.31	0.10	0.10
MI–TM037	46.09413	–86.54977	46.09414	–86.54978	239.60	239.56	0.04	0.04
MI–TM038	46.11218	–86.55485	46.11219	–86.55486	244.43	244.38	0.05	0.05
MI–TM039	46.13041	–86.55865	46.13043	–86.55866	247.42	247.39	0.02	0.02
MI–TM040	46.14352	–86.55224	46.14354	–86.55226	255.16	255.02	0.13	0.13
MI–TM041	46.15762	–86.55333	46.15763	–86.55333	253.88	253.87	0.01	0.01
MI–TM042	46.15343	–86.58112	46.15343	–86.58114	242.02	242.12	–0.10	0.10
MI–TM043	46.15213	–86.60946	46.15214	–86.60948	240.03	240.05	–0.02	0.02
MI–TM044	46.07875	–86.74031	46.07874	–86.74032	237.59	236.63	0.95	0.95
MI–TM045	46.07712	–86.69008	46.07711	–86.69009	278.00	278.33	–0.32	0.32
MI–TM046	46.09977	–86.67117	46.09976	–86.67117	249.36	249.29	0.07	0.07
MI–TM047	46.11141	–86.67072	46.11143	–86.67073	239.36	239.24	0.11	0.11
MI–TM048	46.06748	–86.71794	46.06747	–86.71797	231.27	231.28	0.00	0.00
MI–TM049	46.07899	–86.72260	46.07900	–86.72261	235.34	235.34	0.00	0.00
MI–TM050	46.06587	–86.74520	46.06587	–86.74521	223.32	223.30	0.02	0.02
MI–TM051	46.02779	–86.66780	46.02781	–86.66781	242.08	242.04	0.04	0.04
MI–TM052	46.04770	–86.65981	46.04770	–86.65981	249.52	249.51	0.01	0.01
MI–TM053	46.04221	–86.63906	46.04224	–86.63907	240.68	240.27	0.41	0.41
MI–TM054	46.06501	–86.64277	46.06502	–86.64278	245.66	245.55	0.11	0.11
MI–TM055	46.08670	–86.64203	46.08671	–86.64204	248.09	248.09	0.00	0.00
MI–TM056	46.10423	–86.63742	46.10425	–86.63741	253.69	252.71	0.98	0.98

Table 4. Location information for the 87 gravity stations located on the central Upper Peninsula of Michigan (MI–TM) from Drenth and others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–TM057	46.16162	–86.75468	46.16161	–86.75469	245.85	245.96	–0.12	0.12
MI–TM058	46.17326	–86.72937	46.17326	–86.72939	241.60	241.64	–0.04	0.04
MI–TM059	46.15155	–86.72839	46.15156	–86.72840	241.30	241.38	–0.09	0.09
MI–TM060	46.12253	–86.69312	46.12254	–86.69314	258.60	258.57	0.04	0.04
MI–TM061	46.13349	–86.68783	46.13351	–86.68784	239.11	239.13	–0.02	0.02
MI–TM062	46.14831	–86.70171	46.14833	–86.70173	237.16	237.11	0.05	0.05
MI–TM063	46.16396	–86.69830	46.16397	–86.69831	238.12	238.16	–0.04	0.04
MI–TM064	46.15843	–86.67672	46.15844	–86.67673	255.73	255.73	–0.01	0.01
MI–TM065	46.16060	–86.65028	46.16063	–86.65029	245.13	245.13	0.01	0.01
MI–TM066	46.14994	–86.62531	46.14995	–86.62532	259.00	259.06	–0.06	0.06
MI–TM067	46.12999	–86.60514	46.13001	–86.60516	259.66	258.78	0.88	0.88
MI–TM068	46.13003	–86.57811	46.13004	–86.57811	251.35	251.37	–0.02	0.02
MI–TM069	46.11426	–86.58261	46.11428	–86.58263	248.29	248.27	0.02	0.02
MI–TM070	46.11179	–86.60224	46.11181	–86.60225	252.11	252.11	0.00	0.00
MI–TM071	46.10062	–86.58400	46.10063	–86.58401	245.12	245.04	0.09	0.09
MI–TM072	46.08423	–86.59097	46.08424	–86.59097	240.72	240.70	0.02	0.02
MI–TM073	46.07043	–86.57232	46.07044	–86.57232	236.64	236.62	0.02	0.02
MI–TM074	46.05627	–86.59073	46.05627	–86.59074	235.12	235.84	–0.71	0.71
MI–TM075	46.11936	–86.63511	46.11935	–86.63514	243.36	243.68	–0.32	0.32
MI–TM076	46.14429	–86.65346	46.14430	–86.65349	243.00	242.59	0.41	0.41
MI–TM077	46.14126	–86.63864	46.14127	–86.63868	252.68	251.23	1.45	1.45
MI–TM078	46.12989	–86.80151	46.12989	–86.80151	245.00	245.02	–0.02	0.02
MI–TM079	46.16822	–86.83967	46.16821	–86.83969	239.68	239.76	–0.08	0.08
MI–TM080	46.18263	–86.83808	46.18263	–86.83810	251.87	248.97	2.90	2.90
MI–TM081	46.19654	–86.83722	46.19654	–86.83725	247.93	247.95	–0.03	0.03
MI–TM082	46.16161	–86.79492	46.16161	–86.79493	246.17	246.19	–0.02	0.02
MI–TM083	46.17095	–86.77776	46.17096	–86.77777	245.68	245.66	0.02	0.02
MI–TM084	46.18688	–86.78758	46.18689	–86.78760	245.01	245.08	–0.07	0.07

Table 4. Location information for the 87 gravity stations located on the central Upper Peninsula of Michigan (MI–TM) from Drenth and others (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–TM085	46.17720	–86.75986	46.17722	–86.75988	241.53	241.41	0.12	0.12
MI–TM086	46.19373	–86.77394	46.19374	–86.77395	245.13	245.18	–0.05	0.05
MI–TM087	46.20733	–86.79234	46.20736	–86.79234	248.92	248.74	0.19	0.19

Table 5. Location information for the 139 gravity stations located on the Medicine Bow Mountains of Wyoming (WY–MB) from Brown and others (2025).

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
WY–MB501	41.19046	–106.11896	41.19047	–106.11896	2460.88	2460.79	0.09	0.09
WY–MB502	41.19209	–106.09834	41.19209	–106.09833	2429.51	2429.49	0.02	0.02
WY–MB503	41.18895	–106.08313	41.18895	–106.08313	2437.69	2437.67	0.02	0.02
WY–MB504	41.17132	–106.06800	41.17133	–106.06801	2500.66	2500.68	–0.02	0.02
WY–MB505	41.16023	–106.05934	41.16023	–106.05934	2472.42	2472.48	–0.06	0.06
WY–MB506	41.15066	–106.05078	41.15065	–106.05078	2442.59	2442.57	0.02	0.02
WY–MB507	41.12864	–106.00738	41.12862	–106.00738	2275.38	2275.50	–0.12	0.12
WY–MB508	41.14603	–105.97609	41.14602	–105.97608	2262.97	2263.02	–0.05	0.05
WY–MB509	41.15448	–105.96188	41.15447	–105.96188	2258.65	2258.61	0.03	0.03
WY–MB510	41.17454	–105.96686	41.17453	–105.96686	2247.40	2247.43	–0.03	0.03
WY–MB511	41.18156	–105.98720	41.18155	–105.98720	2282.29	2282.41	–0.12	0.12
WY–MB512	41.20351	–106.08888	41.20350	–106.08889	2410.12	2410.13	–0.02	0.02
WY–MB513	41.21824	–106.08941	41.21823	–106.08941	2391.92	2391.99	–0.07	0.07
WY–MB514	41.15853	–106.14494	41.15853	–106.14494	2795.83	2795.68	0.15	0.15
WY–MB515	41.14441	–106.16480	41.14441	–106.16481	2779.63	2779.50	0.13	0.13
WY–MB516	41.13696	–106.17559	41.13695	–106.17559	2758.67	2758.61	0.06	0.06
WY–MB517	41.14246	–106.32488	41.14245	–106.32489	2753.32	2753.25	0.07	0.07
WY–MB518	41.13765	–106.28225	41.13764	–106.28225	2858.08	2857.98	0.09	0.09
WY–MB519	41.12641	–106.30779	41.12640	–106.30779	2750.82	2750.57	0.25	0.25
WY–MB520	41.23346	–106.08523	41.23346	–106.08524	2390.43	2390.38	0.06	0.06
WY–MB521	41.25531	–106.07788	41.25530	–106.07789	2398.72	2398.82	–0.10	0.10
WY–MB522	41.26883	–106.07623	41.26882	–106.07624	2377.67	2377.53	0.14	0.14
WY–MB523	41.37340	–106.14062	41.37340	–106.14062	2992.11	2991.83	0.28	0.28
WY–MB524	41.38964	–106.13893	41.38964	–106.13892	3011.35	3011.26	0.09	0.09
WY–MB525	41.39842	–106.15353	41.39843	–106.15353	3011.69	3011.50	0.19	0.19
WY–MB526	41.40553	–106.13729	41.40554	–106.13730	2993.47	2993.19	0.28	0.28
WY–MB527	41.42013	–106.13554	41.42014	–106.13554	2948.85	2948.73	0.13	0.13
WY–MB528	41.43273	–106.14276	41.43274	–106.14277	2951.91	2951.76	0.16	0.16

Table 5. Location information for the 139 gravity stations located on the Medicine Bow Mountains of Wyoming (WY–MB) from Brown and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
WY–MB529	41.44584	–106.12669	41.44585	–106.12670	2859.09	2858.94	0.15	0.15
WY–MB530	41.45834	–106.13831	41.45835	–106.13831	2819.46	2819.35	0.11	0.11
WY–MB531	41.46409	–106.12843	41.46408	–106.12843	2728.25	2726.51	1.74	1.74
WY–MB532	41.47037	–106.13498	41.47037	–106.13499	2712.18	2711.95	0.22	0.22
WY–MB533	41.44986	–106.14798	41.44985	–106.14799	3003.16	3002.90	0.26	0.26
WY–MB534	41.46325	–106.16424	41.46323	–106.16423	3002.84	3000.83	2.01	2.01
WY–MB535	41.35344	–106.14914	41.35343	–106.14915	3004.88	3004.53	0.36	0.36
WY–MB536	41.34814	–106.13838	41.34813	–106.13839	2988.23	2988.12	0.11	0.11
WY–MB537	41.34938	–106.12493	41.34936	–106.12494	2934.99	2935.39	–0.39	0.39
WY–MB538	41.36627	–106.15873	41.36628	–106.15873	2911.80	2911.48	0.33	0.33
WY–MB539	41.35579	–106.16766	41.35579	–106.16765	2783.06	2782.97	0.09	0.09
WY–MB540	41.34026	–106.16665	41.34026	–106.16665	2715.32	2715.31	0.01	0.01
WY–MB541	41.32412	–106.15787	41.32412	–106.15788	2591.96	2591.90	0.06	0.06
WY–MB542	41.28275	–106.10119	41.28275	–106.10119	2398.06	2398.07	–0.01	0.01
WY–MB543	41.22071	–106.07606	41.22071	–106.07605	2424.21	2424.16	0.04	0.04
WY–MB544	41.29736	–106.09520	41.29734	–106.09519	2421.13	2421.07	0.06	0.06
WY–MB545	41.31386	–106.13360	41.31385	–106.13360	2503.76	2503.76	0.00	0.00
WY–MB546	41.30799	–106.19738	41.30798	–106.19738	2918.25	2918.09	0.16	0.16
WY–MB547	41.30010	–106.21714	41.30009	–106.21715	3031.58	3031.27	0.31	0.31
WY–MB548	41.30087	–106.23800	41.30087	–106.23801	3051.26	3050.86	0.40	0.40
WY–MB549	41.31434	–106.25226	41.31435	–106.25228	3175.54	3175.29	0.26	0.26
WY–MB550	41.29642	–106.25626	41.29643	–106.25626	3037.98	3037.74	0.24	0.24
WY–MB551	41.29071	–106.27609	41.29071	–106.27609	3074.98	3074.79	0.18	0.18
WY–MB552	41.28869	–106.23471	41.28869	–106.23470	2960.95	2960.86	0.09	0.09
WY–MB553	41.36680	–106.17763	41.36680	–106.17764	2863.04	2862.91	0.13	0.13
WY–MB554	41.37821	–106.18809	41.37821	–106.18811	2961.79	2961.66	0.13	0.13
WY–MB555	41.39324	–106.19073	41.39322	–106.19074	3036.08	3035.80	0.28	0.28
WY–MB556	41.40661	–106.19289	41.40661	–106.19292	3071.54	3071.25	0.29	0.29

Table 5. Location information for the 139 gravity stations located on the Medicine Bow Mountains of Wyoming (WY–MB) from Brown and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
WY–MB557	41.41760	–106.20245	41.41760	–106.20246	3053.63	3053.41	0.22	0.22
WY–MB558	41.43099	–106.19507	41.43097	–106.19507	2995.17	2994.94	0.23	0.23
WY–MB559	41.44403	–106.20143	41.44402	–106.20143	2984.57	2984.45	0.12	0.12
WY–MB560	41.45465	–106.21267	41.45464	–106.21267	2990.60	2990.29	0.31	0.31
WY–MB561	41.47833	–106.20236	41.47833	–106.20237	2948.91	2948.56	0.35	0.35
WY–MB562	41.46460	–106.21658	41.46458	–106.21659	2981.29	2980.69	0.60	0.60
WY–MB563	41.45965	–106.23325	41.45964	–106.23326	2973.63	2972.78	0.84	0.84
WY–MB564	41.47559	–106.23098	41.47558	–106.23098	3071.38	3071.14	0.24	0.24
WY–MB565	41.48384	–106.21930	41.48382	–106.21931	3006.00	3005.99	0.01	0.01
WY–MB566	41.46829	–106.24426	41.46830	–106.24427	3078.87	3078.57	0.30	0.30
WY–MB567	41.46409	–106.25900	41.46410	–106.25901	3077.83	3077.51	0.32	0.32
WY–MB568	41.45625	–106.27278	41.45626	–106.27279	3073.55	3073.28	0.28	0.28
WY–MB569	41.47083	–106.28379	41.47083	–106.28379	3055.43	3055.10	0.33	0.33
WY–MB570	41.48219	–106.29583	41.48219	–106.29583	3035.92	3035.62	0.30	0.30
WY–MB571	41.48175	–106.26286	41.48175	–106.26286	3049.84	3049.53	0.31	0.31
WY–MB572	41.48593	–106.27830	41.48593	–106.27829	2946.91	2943.84	3.07	3.07
WY–MB573	41.49861	–106.28389	41.49859	–106.28388	2940.61	2940.15	0.46	0.46
WY–MB574	41.35981	–106.18889	41.35980	–106.18890	2905.54	2905.28	0.26	0.26
WY–MB575	41.37285	–106.20701	41.37284	–106.20703	3062.39	3062.32	0.06	0.06
WY–MB576	41.34232	–106.18478	41.34233	–106.18479	2782.28	2782.24	0.04	0.04
WY–MB577	41.32670	–106.18456	41.32671	–106.18457	2715.24	2715.07	0.17	0.17
WY–MB578	41.34118	–106.20559	41.34119	–106.20560	2889.53	2889.33	0.19	0.19
WY–MB579	41.34941	–106.21585	41.34942	–106.21586	2987.38	2987.24	0.14	0.14
WY–MB580	41.37390	–106.24701	41.37391	–106.24702	3225.84	3225.55	0.28	0.28
WY–MB581	41.35780	–106.23310	41.35781	–106.23311	3095.83	3095.61	0.21	0.21
WY–MB582	41.35124	–106.25958	41.35124	–106.25958	3194.78	3194.64	0.15	0.15
WY–MB583	41.35149	–106.28097	41.35150	–106.28097	3232.63	3232.42	0.21	0.21
WY–MB584	41.36052	–106.26446	41.36051	–106.26446	3218.29	3218.16	0.14	0.14

Table 5. Location information for the 139 gravity stations located on the Medicine Bow Mountains of Wyoming (WY–MB) from Brown and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
WY–MB585	41.35868	–106.29448	41.35868	–106.29448	3284.27	3283.91	0.36	0.36
WY–MB586	41.34155	–106.30579	41.34154	–106.30579	3297.49	3297.19	0.30	0.30
WY–MB587	41.33727	–106.32016	41.33726	–106.32014	3217.13	3216.98	0.15	0.15
WY–MB588	41.31288	–106.35900	41.31287	–106.35901	3193.29	3193.05	0.24	0.24
WY–MB589	41.32837	–106.36387	41.32837	–106.36388	3101.15	3100.74	0.40	0.40
WY–MB590	41.31746	–106.34631	41.31745	–106.34631	3237.34	3237.02	0.32	0.32
WY–MB591	41.34466	–106.37755	41.34466	–106.37756	2967.09	2966.92	0.17	0.17
WY–MB592	41.36871	–106.37738	41.36872	–106.37738	3165.50	3165.29	0.21	0.21
WY–MB593	41.35236	–106.38354	41.35238	–106.38354	3051.39	3051.08	0.31	0.31
WY–MB594	41.35572	–106.39594	41.35571	–106.39594	3062.38	3062.04	0.35	0.35
WY–MB595	41.34407	–106.39819	41.34405	–106.39819	2891.16	2890.84	0.32	0.32
WY–MB596	41.33876	–106.41694	41.33875	–106.41695	2813.67	2813.49	0.18	0.18
WY–MB597	41.33429	–106.43329	41.33428	–106.43327	2760.35	2759.99	0.37	0.37
WY–MB598	41.33547	–106.44952	41.33545	–106.44952	2710.88	2710.85	0.03	0.03
WY–MB599	41.33790	–106.46655	41.33789	–106.46655	2655.43	2655.29	0.14	0.14
WY–MB600	41.33987	–106.48643	41.33986	–106.48643	2594.88	2593.65	1.23	1.23
WY–MB601	41.34448	–106.50441	41.34447	–106.50442	2532.86	2532.66	0.20	0.20
WY–MB602	41.34786	–106.52291	41.34786	–106.52291	2473.84	2473.60	0.24	0.24
WY–MB603	41.33354	–106.51849	41.33353	–106.51850	2501.09	2500.91	0.18	0.18
WY–MB604	41.32386	–106.50193	41.32386	–106.50194	2542.62	2542.48	0.13	0.13
WY–MB605	41.32934	–106.47678	41.32934	–106.47679	2651.04	2651.03	0.01	0.01
WY–MB606	41.32362	–106.45199	41.32361	–106.45200	2795.31	2795.19	0.11	0.11
WY–MB607	41.32444	–106.42427	41.32445	–106.42427	2924.09	2923.92	0.17	0.17
WY–MB608	41.34529	–106.36044	41.34529	–106.36044	3139.11	3138.94	0.17	0.17
WY–MB609	41.32228	–106.38720	41.32226	–106.38721	3002.52	3002.33	0.20	0.20
WY–MB610	41.32165	–106.40788	41.32164	–106.40789	2963.94	2963.83	0.12	0.12
WY–MB611	41.30854	–106.38885	41.30853	–106.38886	3091.15	3090.82	0.33	0.33
WY–MB612	41.29757	–106.38299	41.29756	–106.38301	3145.04	3144.82	0.23	0.23

Table 5. Location information for the 139 gravity stations located on the Medicine Bow Mountains of Wyoming (WY–MB) from Brown and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
WY–MB613	41.28690	–106.37650	41.28688	–106.37651	3101.85	3101.70	0.15	0.15
WY–MB614	41.28625	–106.36023	41.28622	–106.36024	3000.34	3000.32	0.02	0.02
WY–MB615	41.29944	–106.35908	41.29941	–106.35908	3041.05	3040.98	0.07	0.07
WY–MB616	41.31065	–106.43329	41.31064	–106.43329	2844.89	2844.62	0.27	0.27
WY–MB617	41.30018	–106.44522	41.30019	–106.44522	2758.25	2757.99	0.26	0.26
WY–MB618	41.28856	–106.45303	41.28856	–106.45302	2683.76	2683.56	0.20	0.20
WY–MB619	41.27598	–106.45759	41.27598	–106.45759	2639.70	2639.35	0.36	0.36
WY–MB620	41.26670	–106.46745	41.26671	–106.46746	2645.14	2645.02	0.12	0.12
WY–MB621	41.26679	–106.44476	41.26681	–106.44476	2736.19	2735.88	0.31	0.31
WY–MB622	41.27006	–106.43131	41.27006	–106.43133	2882.87	2882.68	0.19	0.19
WY–MB623	41.27354	–106.41756	41.27355	–106.41759	2952.08	2951.80	0.28	0.28
WY–MB624	41.27963	–106.40188	41.27964	–106.40189	3063.82	3063.56	0.26	0.26
WY–MB625	41.28087	–106.39031	41.28089	–106.39033	2996.80	2996.54	0.27	0.27
WY–MB626	41.26106	–106.45549	41.26107	–106.45551	2661.72	2661.57	0.14	0.14
WY–MB627	41.24914	–106.46006	41.24914	–106.46008	2630.29	2630.16	0.13	0.13
WY–MB628	41.25510	–106.44214	41.25509	–106.44216	2607.63	2607.44	0.19	0.19
WY–MB629	41.25491	–106.42496	41.25491	–106.42498	2589.58	2589.53	0.05	0.05
WY–MB630	41.26188	–106.40894	41.26187	–106.40896	2607.66	2607.64	0.02	0.02
WY–MB631	41.26583	–106.39063	41.26583	–106.39064	2630.06	2630.01	0.05	0.05
WY–MB632	41.27255	–106.37663	41.27255	–106.37665	2654.22	2654.14	0.08	0.08
WY–MB633	41.27468	–106.35713	41.27467	–106.35714	2709.69	2709.54	0.15	0.15
WY–MB634	41.28110	–106.34158	41.28111	–106.34158	2786.58	2786.38	0.20	0.20
WY–MB635	41.28853	–106.32510	41.28853	–106.32510	2869.34	2869.14	0.20	0.20
WY–MB636	41.29911	–106.31249	41.29912	–106.31250	2944.56	2944.28	0.28	0.28
WY–MB637	41.28596	–106.47379	41.28599	–106.47380	2667.80	2667.65	0.15	0.15
WY–MB638	41.29813	–106.46541	41.29815	–106.46541	2713.53	2712.81	0.72	0.72
WY–MB639	41.30993	–106.45597	41.30994	–106.45597	2781.09	2780.78	0.31	0.31

Table 6. Location information for the 59 gravity stations located on the Wet Mountains of Colorado (CO–WM) from Magnin and Anderson (2024).

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
CO–WM300	38.31006	–105.35527	38.31004	–105.35526	2101.07	2100.79	0.28	0.28
CO–WM301	38.29837	–105.35721	38.29836	–105.35720	2121.65	2121.24	0.41	0.41
CO–WM302	38.29417	–105.35912	38.29414	–105.35911	2129.39	2129.27	0.12	0.12
CO–WM303	38.28391	–105.35495	38.28388	–105.35494	2148.09	2147.80	0.29	0.29
CO–WM304	38.27815	–105.35453	38.27814	–105.35454	2161.73	2161.46	0.27	0.27
CO–WM305	38.26982	–105.35141	38.26981	–105.35141	2179.96	2179.67	0.29	0.29
CO–WM306	38.26719	–105.35480	38.26718	–105.35478	2190.84	2190.52	0.31	0.31
CO–WM307	38.26307	–105.35934	38.26307	–105.35934	2201.92	2201.58	0.34	0.34
CO–WM308	38.26102	–105.36307	38.26101	–105.36307	2205.89	2205.52	0.37	0.37
CO–WM309	38.25873	–105.37197	38.25871	–105.37198	2216.51	2216.19	0.32	0.32
CO–WM310	38.25520	–105.37646	38.25519	–105.37647	2225.66	2225.29	0.37	0.37
CO–WM311	38.24934	–105.38073	38.24933	–105.38074	2234.73	2235.09	–0.36	0.36
CO–WM312	38.24533	–105.38533	38.24530	–105.38534	2243.33	2243.24	0.09	0.09
CO–WM313	38.23901	–105.38846	38.23899	–105.38848	2251.57	2251.65	–0.08	0.08
CO–WM314	38.23475	–105.38846	38.23472	–105.38848	2255.81	2255.86	–0.05	0.05
CO–WM315	38.23029	–105.39197	38.23027	–105.39198	2268.27	2268.04	0.23	0.23
CO–WM316	38.22717	–105.39525	38.22715	–105.39526	2274.55	2274.18	0.37	0.37
CO–WM317	38.22334	–105.40223	38.22333	–105.40227	2283.91	2284.06	–0.15	0.15
CO–WM318	38.23332	–105.40288	38.23332	–105.40289	2408.71	2408.94	–0.23	0.23
CO–WM319	38.24616	–105.39248	38.24616	–105.39249	2265.00	2264.96	0.04	0.04
CO–WM320	38.25602	–105.38334	38.25603	–105.38334	2280.00	2279.92	0.08	0.08
CO–WM321	38.25907	–105.39394	38.25907	–105.39394	2395.34	2395.25	0.09	0.09
CO–WM322	38.26950	–105.38806	38.26949	–105.38806	2398.60	2398.58	0.02	0.02
CO–WM323	38.27286	–105.39011	38.27285	–105.39010	2366.05	2366.03	0.02	0.02
CO–WM324	38.28735	–105.40667	38.28734	–105.40668	2274.35	2274.34	0.01	0.01
CO–WM325	38.29275	–105.39243	38.29273	–105.39243	2380.41	2380.41	0.00	0.00
CO–WM326	38.28718	–105.38645	38.28716	–105.38644	2326.71	2326.70	0.01	0.01
CO–WM327	38.28938	–105.37284	38.28937	–105.37284	2224.21	2224.36	–0.15	0.15

Table 6. Location information for the 59 gravity stations located on the Wet Mountains of Colorado (CO–WM) from Magnin and Anderson (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
CO–WM328	38.26465	–105.37548	38.26464	–105.37548	2345.54	2345.57	–0.03	0.03
CO–WM329	38.25471	–105.36188	38.25469	–105.36189	2257.82	2257.71	0.11	0.11
CO–WM330	38.24246	–105.37071	38.24243	–105.37072	2302.59	2302.50	0.09	0.09
CO–WM331	38.24149	–105.37685	38.24148	–105.37686	2271.77	2271.80	–0.03	0.03
CO–WM332	38.11421	–105.18721	38.11420	–105.18722	2861.52	2861.53	–0.01	0.01
CO–WM333	38.11834	–105.19500	38.11833	–105.19501	2844.62	2844.62	0.00	0.00
CO–WM334	38.11539	–105.20536	38.11538	–105.20537	2851.18	2851.05	0.13	0.13
CO–WM335	38.09331	–105.21065	38.09329	–105.21067	3263.29	3262.77	0.52	0.52
CO–WM336	38.09336	–105.17546	38.09335	–105.17546	2882.04	2881.89	0.15	0.15
CO–WM337	38.09126	–105.17045	38.09125	–105.17046	2955.79	2956.01	–0.22	0.22
CO–WM338	38.08223	–105.15881	38.08223	–105.15881	3160.31	3160.21	0.10	0.10
CO–WM339	38.07603	–105.16797	38.07602	–105.16798	3161.92	3161.82	0.10	0.10
CO–WM340	38.07120	–105.17146	38.07119	–105.17146	3105.18	3105.85	–0.67	0.67
CO–WM341	38.06252	–105.18589	38.06251	–105.18590	3159.78	3159.74	0.04	0.04
CO–WM342	38.07947	–105.18030	38.07944	–105.18029	2925.35	2921.68	3.67	3.67
CO–WM343	38.09203	–105.14929	38.09200	–105.14930	2941.98	2941.82	0.16	0.16
CO–WM344	38.08606	–105.13990	38.08604	–105.13992	2934.02	2934.11	–0.09	0.09
CO–WM345	38.06968	–105.22355	38.06966	–105.22357	3171.49	3171.41	0.08	0.08
CO–WM346	38.07352	–105.22973	38.07349	–105.22974	3189.36	3189.64	–0.28	0.28
CO–WM347	38.07574	–105.24332	38.07573	–105.24332	3115.80	3115.97	–0.17	0.17
CO–WM348	38.06952	–105.23591	38.06952	–105.23593	3068.66	3068.71	–0.05	0.05
CO–WM349	38.06894	–105.22953	38.06894	–105.22955	3119.76	3119.79	–0.03	0.03
CO–WM350	38.07174	–105.23154	38.07174	–105.23155	3142.02	3141.75	0.27	0.27
CO–WM351	38.08607	–105.24776	38.08608	–105.24777	3170.15	3169.97	0.18	0.18
CO–WM352	38.08224	–105.24561	38.08225	–105.24560	3140.92	3140.93	–0.01	0.01
CO–WM353	38.08720	–105.22464	38.08718	–105.22464	3220.52	3220.55	–0.03	0.03
CO–WM354	38.09102	–105.22718	38.09100	–105.22718	3260.35	3260.33	0.02	0.02
CO–WM355	38.09067	–105.23085	38.09065	–105.23085	3287.47	3288.41	–0.94	0.94

Table 6. Location information for the 59 gravity stations located on the Wet Mountains of Colorado (CO–WM) from Magnin and Anderson (2024).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
CO–WM356	38.08886	–105.23514	38.08884	–105.23515	3280.50	3280.75	–0.25	0.25
CO–WM357	38.08606	–105.23944	38.08604	–105.23944	3224.57	3224.24	0.33	0.33
CO–WM358	38.09156	–105.23900	38.09156	–105.23900	3313.85	3313.63	0.22	0.22

Table 7. Location information for the 56 gravity stations located on the Keweenaw Peninsula of Michigan (MI–KP0) from Murchek and others (2025).

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–KP0–1	47.19247	–88.48937	47.19248	–88.48937	357.97	357.83	0.14	0.14
MI–KP0–2	47.2386	–88.61182	47.2386	–88.61181	186.12	185.82	0.31	0.31
MI–KP0–3	47.23998	–88.59468	47.23998	–88.59468	189.02	188.48	0.53	0.53
MI–KP0–4	47.22843	–88.59448	47.22843	–88.59447	198.65	198.31	0.34	0.34
MI–KP0–5	47.23928	–88.59002	47.23927	–88.59001	194.57	194.42	0.15	0.15
MI–KP0–6	47.22849	–88.58479	47.22849	–88.58478	207.38	206.85	0.52	0.52
MI–KP0–7	47.22858	–88.57424	47.22857	–88.57423	221.14	220.83	0.31	0.31
MI–KP0–8	47.23942	–88.57388	47.23942	–88.57387	193.96	193.64	0.32	0.32
MI–KP0–9	47.21424	–88.56344	47.21424	–88.56344	283.33	283.08	0.24	0.24
MI–KP0–10	47.18516	–88.56329	47.18514	–88.56329	318.8	318.72	0.07	0.07
MI–KP0–11	47.21431	–88.55265	47.21431	–88.55265	300.8	300.71	0.09	0.09
MI–KP0–12	47.2138	–88.54236	47.21379	–88.54235	323.6	323.45	0.15	0.15
MI–KP0–13	47.18488	–88.53965	47.18487	–88.53965	333.12	333.07	0.05	0.05
MI–KP0–14	47.21352	–88.53145	47.21351	–88.53145	327.83	327.78	0.05	0.05
MI–KP0–15	47.2067	–88.52091	47.2067	–88.52091	351.73	351.52	0.21	0.21
MI–KP0–16	47.21363	–88.52081	47.21362	–88.52080	351.01	350.86	0.14	0.14
MI–KP0–17	47.17455	–88.51855	47.17455	–88.51855	333.56	333.58	–0.02	0.02
MI–KP0–18	47.20738	–88.50895	47.20738	–88.50894	360.93	360.62	0.3	0.3
MI–KP0–19	47.19935	–88.49976	47.19935	–88.49976	359.46	359.34	0.12	0.12
MI–KP0–20	47.19036	–88.49965	47.19035	–88.49964	353.43	353.33	0.11	0.11
MI–KP0–21	47.19392	–88.49585	47.19391	–88.49584	356.93	356.81	0.13	0.13
MI–KP0–22	47.18917	–88.49367	47.18916	–88.49366	357.74	357.75	–0.01	0.01
MI–KP0–23	47.13179	–88.48612	47.13179	–88.48611	190.49	190.48	0.01	0.01
MI–KP0–24	47.18894	–88.48568	47.18893	–88.48569	365.34	365.31	0.03	0.03
MI–KP0–25	47.19946	–88.48134	47.19945	–88.48133	359.63	359.64	–0.01	0.01
MI–KP0–26	47.18842	–88.47950	47.18843	–88.47950	354.53	354.47	0.06	0.06
MI–KP0–27	47.14506	–88.47867	47.14505	–88.47866	269.47	269.54	–0.07	0.07
MI–KP0–28	47.1853	–88.47486	47.1853	–88.47485	354.27	354.18	0.09	0.09

Table 7. Location information for the 56 gravity stations located on the Keweenaw Peninsula of Michigan (MI–KP0) from Murchek and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–KP0–29	47.18223	–88.47155	47.18223	–88.47155	337.38	337.18	0.2	0.2
MI–KP0–30	47.20707	–88.47135	47.20707	–88.47134	365.23	365.08	0.16	0.16
MI–KP0–31	47.17804	–88.46743	47.17804	–88.46742	324.81	324.66	0.15	0.15
MI–KP0–32	47.17419	–88.46209	47.17417	–88.46208	314.46	313.5	0.96	0.96
MI–KP0–33	47.14882	–88.45806	47.14882	–88.45805	190.87	190.83	0.04	0.04
MI–KP0–34	47.1709	–88.45737	47.1709	–88.45735	306.2	305.98	0.23	0.23
MI–KP0–35	47.1674	–88.45202	47.16739	–88.45201	273.23	273.09	0.14	0.14
MI–KP0–36	47.20788	–88.44713	47.20787	–88.44713	356.72	356.54	0.18	0.18
MI–KP0–37	47.18497	–88.44653	47.18497	–88.44652	311.7	311.74	–0.04	0.04
MI–KP0–38	47.19592	–88.44639	47.19592	–88.44638	337	337.07	–0.07	0.07
MI–KP0–39	47.16467	–88.44616	47.16467	–88.44616	226.5	226.36	0.14	0.14
MI–KP0–40	47.17307	–88.44471	47.17307	–88.44472	267.49	267.5	–0.02	0.02
MI–KP0–41	47.16355	–88.43915	47.16355	–88.43915	187.27	187.07	0.2	0.2
MI–KP0–42	47.16107	–88.43507	47.16106	–88.43507	184.11	184.01	0.09	0.09
MI–KP0–43	47.15894	–88.43253	47.15893	–88.43253	184.07	183.39	0.68	0.68
MI–KP0–44	47.15447	–88.42535	47.15447	–88.42535	198.16	197.89	0.27	0.27
MI–KP0–45	47.14855	–88.42529	47.14855	–88.42530	216.99	214.63	2.36	2.36
MI–KP0–46	47.14989	–88.41428	47.14988	–88.41427	185.32	185.14	0.18	0.18
MI–KP0–47	47.14911	–88.39405	47.14911	–88.39405	196.15	195.98	0.17	0.17
MI–KP0–48	47.17075	–88.38358	47.17075	–88.38358	226.35	226.3	0.05	0.05
MI–KP0–49	47.14186	–88.38341	47.14186	–88.38341	218.89	218.71	0.19	0.19
MI–KP0–50	47.12744	–88.36215	47.12744	–88.36215	221.22	221	0.22	0.22
MI–KP0–51	47.11808	–88.34597	47.11808	–88.34597	202.97	202.92	0.05	0.05
MI–KP0–52	47.1147	–88.34358	47.11471	–88.34357	195.46	194.97	0.49	0.49
MI–KP0–53	47.17086	–88.34093	47.17086	–88.34092	226.63	226.62	0.01	0.01

Table 7. Location information for the 56 gravity stations located on the Keweenaw Peninsula of Michigan (MI–KP0) from Murchek and others (2025).—Continued

[“Gravity station” refers to a unique identifier that is based on the station number used in the data source for this table. “UC LAT” and “UC LON” refer to the horizontal coordinates before differential correction. “DC LAT” and “DC LON” refer to the differentially corrected horizontal coordinates. “DGNSS ELEV” refers to the elevation data from the differential global navigation satellite system (dGNSS) equipment from the differentially corrected coordinates. “LIDAR ELEV” refers to the light detection and ranging (lidar) derived elevation from the 1-meter (m) digital elevation model (DEM). “ELEV DIFF” refers to the elevation difference (dGNSS – lidar), and “ABS ELEV DIFF” refers to the absolute value of this difference. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988]

Gravity station	UC LAT (NAD 83)	UC LON (NAD 83)	DC LAT (NAD 83)	DC LON (NAD 83)	DGNSS ELEV (m) (NAVD 88)	LIDAR ELEV (m) (NAVD 88)	ELEV DIFF (m)	ABS ELEV DIFF (m)
MI–KP0–54	47.13504	–88.29974	47.13504	–88.29974	192.78	192.76	0.02	0.02
MI–KP0–55	47.12553	–88.29006	47.12553	–88.29006	189.78	187.11	2.67	2.67
[1]MI–KP0–M65	47.2436	–88.44747	47.2436	–88.44747	380.18	379.69	0.49	0.49

[1]The data for this National Geodetic Survey (NGS) station are from NGS (2025). This gravity station identifier was created for use in this report.

References Cited

American Society for Photogrammetry and Remote Sensing [ASPRS], 2023, ASPRS positional accuracy standards for digital geospatial data (2d ed., ver. 1): ASPRS web page, accessed August 20, 2023, at https://publicdocuments.asprs.org/PositionalAccuracyStd-Ed2-V1.

Barber, C.P., and Shortrudge, A.M., 2004, Light detection and ranging (lidar)-derived elevation data for surface hydrology applications: East Lansing, Mich., Institute of Water Resources, Michigan State University, 17 p.

Blakely, R.J., 1995, Gravity anomalies, section 7.3 *in* chap. 7 *of* Potential theory in gravity and magnetic applications: New York, Cambridge University Press, p. 136–146.

Brown, P.J., Reitman, J.J., Drenth, B.J., and Lynds, R.M., 2025, Principal facts of regional gravity data in the Medicine Bow Mountains, Wyoming, 2022–2024: U.S. Geological Survey data release, accessed April 15, 2025, at https://doi.org/10.5066/P1XAVOXP.

Burrough, P.A., and McDonnell, R.A., 1998, Principles of geographical information systems: New York, Oxford University Press, 333 p.

Cai, Z., Ma, H., and Zhang, L., 2020, Feature selection for airborne LiDAR data filtering—A mutual information method with Parzon window optimization: GIScience & Remote Sensing, v. 57, no. 3, p. 323–337, accessed August 20, 2023, at https://doi.org/10.1080/15481603.2019.1695406.

Drenth, B.J., Reitman, J.J., and Brown, P.J., 2024, Principal facts of regional gravity in the central Upper Peninsula, Michigan, 2022–2023: U.S. Geological Survey data release, accessed November 20, 2024, at https://doi.org/10.5066/P9L6KML9.

Elaksher, A.F., 2016, Co-registering satellite images and LIDAR DEMs through straight lines: International Journal of Image and Data Fusion, v. 7, no. 2, p. 103–118, accessed August 20, 2023, at https://doi.org/10.1080/19479832.2015.1075607.

Habib, A., Ghanma, M., Morgan, M., and Al-Ruzouq, R., 2005, Photogrammetric and lidar data registration using linear features: Photogrammetric Engineering and Remote Sensing v. 71, no. 6, p. 699–707, accessed August 20, 2023, at https://doi.org/10.14358/PERS.71.6.699.

Hinze, W.J., Von Frese, R.R.B., and Saad, A.H., 2012, Gravity and magnetic exploration—Principles, practices, and applications: New York, Cambridge University Press, 528 p.

Hollaus, M., Wagner, W., and Kraus, K., 2005, Airborne laser scanning and usefulness for hydrologic models: Advances in Geosciences, v. 5, p. 57–63, accessed August 20, 2023, at https://doi.org/10.5194/adgeo-5-57-2005.

Liu, X., 2008, Airborne lidar for DEM generation—Some critical issues: Progress in Physical Geography—Earth and Environment, v. 32, no. 1, p. 31–49, accessed August 20, 2023, at https://doi.org/10.1177/0309133308089496.

Longman, I.M., 1959, Formulas for computing the tidal accelerations due to the moon and the sun: Journal of Geophysical Research, v. 64, no. 12, p. 2351–2355, accessed August 20, 2023, at https://doi.org/10.1029/JZ064i012p02351.

Magnin, B.P., and Anderson, E.D., 2024, Gravity data in the Wet Mountains area, southcentral Colorado, 2023: U.S. Geological Survey data release, accessed January 16, 2024, at https://doi.org/10.5066/P9KNDYU3.

Merrick & Company, 2016, Arkansas River (partial Fremont) *in* LiDAR download portal: Colorado Hazard Mapping & Risk MAP Portal website, accessed January 24, 2024, at https://coloradohazardmapping.com/lidarDownload.

Morelli, C., Gantar, C., Honkasalo, T., McConnell, R.K., Tanner, J.G., Szabo, B., Uotila, U., and Whalen, C.T., 1972, The International Gravity Standardization Net 1971 (I.G.S.N. 71): Air Force Cambridge Research Laboratories and European Office of Aerospace Research and Development, Special Publication 4, prepared by International Association of Geodesy, Osservatorio Geofisico Sperimentale [Experimental Geophysical Observatory] under contract AF61 (052) 656, 194 p. [Also available at https://apps.dtic.mil/sti/pdfs/ADA006203.pdf.]

Murchek, J.T., DeGraff, J.M., and Drenth, B.J., 2025, Gravity data in the Upper Peninsula, Michigan for geophysical profile modeling of the Midcontinent Rift System and associated structures: U.S. Geological Survey data release, accessed March 6, 2025, at https://doi.org/10.5066/P14BGVCT.

National Geodetic Survey [NGS], 2025, Designation M 65, PID SG0019, State/county MI/Houghton, Country US, USGS quad Laurium: NGS data sheet (datasheet95, ver. 8.12.5.19), accessed May 4, 2025, at https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=SG0019.

National Oceanic and Atmospheric Administration [NOAA], 2012, Lidar 101—An introduction to lidar technology, data, and applications (revised): NOAA Coastal Services Center, Coastal Geospatial Services Division, Coastal Remote Sensing Program report, 72 p., accessed August 20, 2023, at https://oceanservice.noaa.gov/facts/lidar.html.

National Oceanic and Atmospheric Administration [NOAA], 2023, What is lidar?: NOAA web page, accessed April 13, 2023, at https://oceanservice.noaa.gov/facts/lidar.html

Peucker, T.K., Fowler, R.J., Little, J.J., and Mark, D.M., 1976, Digital representation of three-dimensional surfaces by triangulated irregular networks (TIN) (revised): Office of Naval Research, Geography Programs, Technical Report 10, prepared by authors under contract N00014–75–C–0886 {NR 389–171}, 63 p. [Also available at https://apps.dtic.mil/sti/pdfs/ADA094241.pdf.]

Pfeifer, N., and Briese, C., 2007, Geometrical aspects of airborne laser scanning and terrestrial laser scanning *in* Rönnholm, P., Hyyppä, H., and Hyyppä, J., eds., Proceedings of the ISPRS Workshop on Laser Scanning 2007 and SilviLaser 2007, September 12–14, 2007, Espoo, Finland: International Society of Photogrammetry, Remote Sensing Archives, v. XXXVI, part 3/W52, p. 311–319, accessed August 20, 2023, at https://www.isprs.org/proceedings/XXXVI/3-W52/final_papers/Pfeifer_2007_keynote.pdf.

Quantum Spatial, Inc., 2020, 2018 Park, Custer, & Fremont Counties *in* LiDAR download portal: Colorado Hazard Mapping & Risk MAP Portal website, accessed January 24, 2024, at https://coloradohazardmapping.com/lidarDownload.

Reutebuch, S.E., Andersen, H.-E., and McGaughey, R.J., 2005, Light detection and ranging (LIDAR): an emerging tool for multiple resource inventory: Journal of Forestry, v. 103, no. 6, p. 286–292, accessed August 20, 2023, at https://doi.org/10.1093/jof/103.6.286.

Sanborn Map Company, Inc., 2020, Lidar_Houghton_Keweenaw_Ontonagon Hydro-Flattened Bare-Earth DEM *in* MTU GRF DEM Download Tool: Michigan Tech Great Lakes Research Center, Geospatial Research Facility website, accessed January 24, 2024, at https://geospatialresearch.mtu.edu/demindex/.

Stoker, J.M., Greenlee, S.K., Gesch, D.B., and Menig, J.C., 2006, CLICK—The new USGS center for lidar information coordination and knowledge: Photogrammetric Engineering and Remote Sensing, v. 72, no. 6, p. 613–616.

Sugarbaker, L.J., Constance, E.W., Heidemann, H.K., Jason, A.L., Lukas, V., Saghy, D.L., and Stoker, J.M., 2014, The 3D Elevation Program initiative—A call for action: U.S. Geological Survey Circular 1399, 35 p., accessed August 20, 2023, at https://doi.org/10.3133/cir1399.

U.S. Geological Survey [USGS], 2022, 3D Elevation Program 1-meter resolution digital elevation model, MI 13 County C16 *in* TNM Download [The National Map Downloader] version 2.0: U.S. Geological Survey website, accessed June 25, 2023, at https://apps.nationalmap.gov/downloader.

U.S. Geological Survey [USGS], 2023, 3D Elevation Program 1-meter resolution digital elevation model, WY South Central D20 *in* TNM Download [The National Map Downloader] version 2.0: U.S. Geological Survey website, accessed June 25, 2023, at https://apps.nationalmap.gov/downloader.

U.S. Geological Survey [USGS], 2024, Lidar base specification online [LBS 2024 rev. A.]: U.S. Geological Survey website, accessed January 31, 2024, at https://www.usgs.gov/3DEP/lidarspec.

U.S. Geological Survey [USGS], [undated], Topographic data quality levels (QLs): U.S. Geological Survey website, accessed April 13, 2023, at https://www.usgs.gov/3d-elevation-program/topographic-data-quality-levels-qls.

Webster, T.L., and Dias, G., 2006, An automated GIS procedure for comparing GPS and proximal LIDAR elevations: Computers & Geosciences, v. 32, no. 6, p. 713–726, accessed August 20, 2023, at https://doi.org/10.1016/j.cageo.2005.08.009.

For more information about this publication, contact
Director
Energy and Minerals Mission Area
U.S. Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192-0002

For additional information, visit
https://www.usgs.gov/mission-areas/energy-and-minerals

Publishing support provided by the Science Publishing Network,
Reston Publishing Service Center

Murchek and others—**The Feasibility of Using Lidar-Derived Digital Elevation Models for Gravity Data Reduction**—OFR 2025–1019, ver. 1.1.

ISSN 2331-1258 (online)
https://doi.org/10.3133/ofr20251019