

There's a New Datum in Town!

Actually – it's a new adjustment
AND a new Geoid...

NGS Update

Brief History of NAD83

- ◉ **Original realization completed in 1986**
 - Consisted (almost) entirely of classical (optical) observations
- ◉ **“High Accuracy Reference Network” (HARN) and FBN/CBN realizations**
 - Most done in 1990s, state-by-state
 - Based on GNSS but classical stations included in adjustments, pre-dates CORS
- ◉ **National Re-Adjustment of 2007**
 - NAD 83(CORS96), epoch 2002.00 active monuments and (NSRS2007) passive monuments
 - Simultaneous nationwide adjustment (GNSS only)
- ◉ ***NAD83(2011) epoch 2010.00 realization July 2012***
 - *Active and Passive monuments*

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Brief History of Geoid Models

Geoid Models: To transform between ellipsoidal height (h) and orthometric height (H) systems, one requires *geoid height* (N). These height systems are related by the equation: $H = h - N$.

Geoid 96: low of -51.6 meters in the Atlantic to a high of -7.2 meters in the Rocky Mountains.

Geoid 99: low of -50.97 meters in the Atlantic Ocean to a high of 3.23 meters in the Labrador Strait

Geoid 03: low of -50.97 meters in the Atlantic Ocean to a high of 3.23 meters in the Labrador Strait

Geoid 06: built largely on the [USGG2003](#) gravimetric geoid

Geoid 09: low of -50.68 meters in the Atlantic Ocean to a high of 3.44 meters in the Labrador Strait.

Geoid 12: low of -50.71 meters in the Atlantic Ocean to a high of 3.31 meters in the Labrador Strait.

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New Products

1. **Multi-Year CORS Solution (MYCS)**
2. **NAD 83(2011) epoch 2010.00**
3. **GEOID12a**
4. **Datasheet format changes**
5. **OPUS**
6. **New Coordinate Transformation tools for NAD 83(2011)**
 - **NAD 83(HARN) \leftrightarrow (NSRS2007/CORS96) \leftrightarrow (2011)**

2022 - Estimated completion of entirely new geometric and geopotential datums along with completion of GRAV-D

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When will it all be done?

- **Multi-Year CORS Solution**
 - Officially released coordinates September 2011
 - Published in NGS database simultaneously with NA2011
- **National Adjustment of 2011**
 - Final data added to NA2011 network mid-Dec 2011
 - Released in July 2012
- **OPUS (Online Positioning User Service)**
 - Dual solutions (CORS96 and MYC) availability ended late July 2012
 - NAD83(2011) Reference Frame, Geoid 12a, Absolute Antenna Calibrations
- **Coordinate transformation tool**
 - NAD83(HARN) \leftrightarrow (NSRS2007/CORS96) : Error of the transformation greater than magnitude of shifts
 - Beta testing NAD83(HARN) \leftrightarrow (NSRS2007/CORS96) \leftrightarrow (2011) tool
 - Prelim high res (1 arc-minute) grids completed for HARN / NSRS2007
 - Includes error grid to give users estimate of accuracy
- **New hybrid geoid model (GEOID12)**
 - Use NAD 83(2011) ellipsoid heights on leveled NAVD 88 benchmarks
 - Geoid12 Released July 2012 (busts in Wisconsin, Oklahoma, Texas and northern Gulf Coast)
 - Geoid12a (beta) Released August 2012 - open for comment until September 10, 2012

NGS Update

Why a Multi-Year CORS Solution?

- Consistent coordinates and velocities from combined solution
 - Previous a mix of station and velocity sources, few ties to global frame
 - Previous vertical velocities of zero for most CORS
- Aligned with most recent realization of global frame (IGS08)
 - **IGS08 epoch 2005.0** (previous aligned at epoch 1997.0)
 - **NAD 83 epoch 2010.0** (previous epochs of 2002.0 and 2003.0)
- Major processing algorithm, modeling, metadata improvements
 - Conformance with current international conventions (IERS)
- Absolute phase center antenna calibrations
 - Both ground (receiving) and satellite (transmitting) antennas
 - Previous (CORS96) used relative calibrations (significant change)
- **Highly accurate *and* consistent CORS coordinates *and* velocities determined using *Best Available Methods***
 - *Needed because CORS network is foundation of NSRS*

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How much change in coordinates?

- Overall coordinate change approx same as MYCS

- Horizontal: Mean ~ 2 cm (± 8 cm), median ~ 0 cm
- Vertical: Mean ~ -1 cm (± 2 cm), median ~ -1 cm
- This is for change in realization **and** reference epoch
 - NAD 83(CORS96) epoch 2002.00 \rightarrow NAD 83(2011) epoch 2010.00

- In Kentucky?

Evolution of Geodetic Datums: from NAD27/NGVD29 to NAD83/NAVD88 to ?/ ?

$$\begin{array}{l}
 H + V \\
 2 + 1 \\
 27, 29
 \end{array}$$



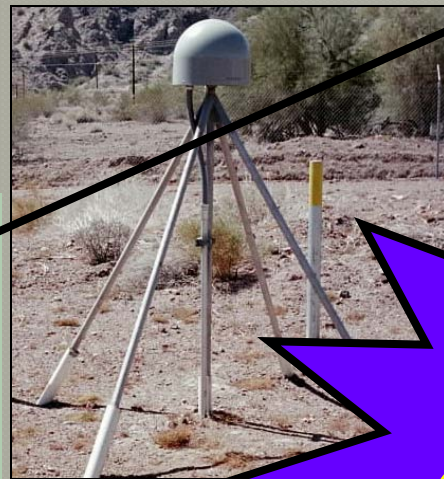
$$\begin{array}{l}
 H + V \\
 2 + 1 \\
 83(86), 88
 \end{array}$$



$$\begin{array}{l}
 H + V_E + V_O \\
 2 + 1 + 1 \\
 83(92), 88
 \end{array}$$

+VELOCITIES (time)

$$\begin{array}{l}
 H + H_t + V_E + V_O \\
 2 + 2 + 1 + 1 \\
 83(11) + HTDP, 88
 \end{array}$$



$$\begin{array}{l}
 H + H_t + V_E + V_{Et} \\
 2 + 2 + 1 + 1 \\
 ITRF08 (2010.00)
 \end{array}$$



+ GRAVITY
(geoid model)



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Rationale for New Datums

- What?
 - Horizontal becomes GEOMETRIC
 - Vertical becomes GEOPOTENTIAL
- When?
 - 2022, if GRAV-D program is complete
- Why?!
 1. Need a better vertical datum for height data (geoid, ortho ht) not obtained by traditional leveling
 - Geodetic Data collection relies upon GNSS satellites orbiting around the mass center (geocenter) of the Earth
 - NAD83 reference frame/datum is not geocentric
 2. NAD83 is not defined to include vertical velocities
 - Earth is not stable; reference frame must account for this to be as geodetically accurate as possible

What to look out for...

○ Don't mix adjustments

- If using the KYCORS network
 - Pick the correct server
- If using OPUS
 - Use NAD83(2011) and Geoid12a otherwise download raw CORS data and use post-processing software
- Transform NAD83(2007)/(CORS96) data?
 - Re-compute coordinates using original observations for new adjustment & geoid (at least until NGS tool released)
- Antenna calibrations: Absolute vs. Relative
 - Won't see a difference unless baselines are very long (>200km)

Antenna Calibrations???

Absolute vs. Relative: What does it *really mean*?

Antenna Calibrations

- Differences from using relative to absolute antenna models can produce another "several" cm in absolute height difference
- Most rovers have always used the relative calibrations in their firmware and applied them from their ARP for their positions.
- It is possible that the difference in time/distance of the signal at the speed of light could vary from the absolute modeled position to the relative modeled position, and might therefore yield different corrections
- However, when using a rover position relative to a fixed station, the relative vertical differences from point to point should be similar in the project area - within the precision of RTK
- Most users are probably still calibrating their sites to passive control, which would naturally provide heights relative to what they hold.

Why Go to Absolute?

- Better/fuller description of phase behavior
 - 0-10° elevation coverage
 - Azimuthal variations
 - Multipath removed/negated
- The way of the future
 - International GNSS Service (IGS) standard
 - Used in OPUS
 - Used in CORS multiyear [IGS08 epoch 2005.0 and NAD 83(2011) epoch 2010.0]

Antenna Calibrations

- http://www.ngs.noaa.gov/CORS/coord_info/myear_FAQ.shtml
-
- **FAQ 8: How does the change in antenna calibration values from relative to absolute impact users?**
- The new coordinates IGS08 epoch 2005.00 and NAD 83(2011) epoch 2010.00 were established using IGS08 absolute antenna phase center patterns. If a user processes data using relative antenna phase center values instead of absolute antenna phase center values they may get positions that differ by up to a few centimeters as compared to processing using absolute antenna phase center values. Users must therefore change the antenna phase center values they use when processing data. NGS has established a beta website with IGS08 consistent absolute antenna phase center values that users can download to test in conjunction with the coordinates listed on this page.
- <http://www.ngs.noaa.gov/ANTCAL/>

NGS Update Data Sheet Format

- **Update to new Datasheet version (8.00)**
 - Changed location, length, and text for many fields
 - Added new fields, deleted fields, augmented existing fields
- **Summary of content changes**
 - Added country (e.g., USA) where control station located
 - Hyperlinked vertical datum designation to datum web page
 - Ortho height epoch date, if applicable (e.g., subsidence areas)
 - Note for geoid model used on Ht Mod stations if not current geoid
 - Network and (median) local accuracies
 - Horizontal and ellipsoid height accuracy at 95% confidence (per FGDC)
 - Includes link to detailed accuracy info, list of all local accuracies
 - Superseded Ht Mod ortho heights indicate geoid model used

NGS Update Data Sheet Format

KYTE
KY HWY DIST 5
Louisville, KY
USA

National Geodetic Survey - CORS



Site operated by:
[KYTC](#)

Please choose the coordinate you want to use.

Coordinates

[SiteLog](#)

[Photographs](#)

[Data Availability](#)

[Standard Files](#)

[Custom Files \(UFCORS\)](#)

[Time Series \(60-day\)](#)

[Time Series \(longterm\)](#)

[Google Map kyte only](#)

[Google Map all CORS](#)

New Coordinates: In IGS08 epoch 2005.00 and NAD 83(2011,MA11,PA11) epoch 2010.00

These coordinates were computed using absolute [antenna calibrations](#) and should only be used when processing data with absolute antenna calibrations.

[Position and Velocity](#)

[Data Sheet for Position at ARP](#)

[Data Sheet for Position for Both ARP and Monument \(if exists \)](#)

Old Coordinates: In ITRF00 epoch 1997.00 and NAD 83(CORS96,MARP00,PACP00) epoch 2002.00

These coordinates were computed using relative [antenna calibrations](#) and should only be used when processing data with relative antenna calibrations.

[Position and Velocity](#)

For additional information on the differences between IGS08, NAD 83(2011,MA11,PA11) and ITRF00, NAD 83(CORS96,MARP00, PACP00) consult: geodesy.noaa.gov/CORS/coords.shtml

Enter SiteID

[CORS Home](#)

NGS Update Data Sheet Format

The NGS Data Sheet

See file [dsdata.txt](#) for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 7.89.3.1
1      National Geodetic Survey,  Retrieval Date = SEPTEMBER 7, 2012
DK3320 *****
DK3320 HT_MOD      - This is a Height Modernization Survey Station.
DK3320 CORS       - This is a GPS Continuously Operating Reference Station.
DK3320 DESIGNATION - KY HWY DIST 5 CORS ARP
DK3320 CORS_ID    - KYTE
DK3320 PID        - DK3320
DK3320 STATE/COUNTY- KY/JEFFERSON
DK3320 COUNTRY    - US
DK3320 USGS QUAD  - ANCHORAGE (1987)
DK3320
DK3320                                *CURRENT SURVEY CONTROL
DK3320
DK3320* NAD 83(2011) POSITION- 38 16 35.93982(N) 085 35 54.20030(W) ADJUSTED
DK3320* NAD 83(2011) ELLIP HT- 157.839 (meters) (08/??/11) ADJUSTED
DK3320* NAD 83(2011) EPOCH - 2010.00
DK3320* NAVD 88 ORTHO HEIGHT - 191.23 (meters) 627.4 (feet) GPS OBS
DK3320
DK3320 NAD 83(2011) X - 384,778.247 (meters) COMP
DK3320 NAD 83(2011) Y - -4,998,802.108 (meters) COMP
DK3320 NAD 83(2011) Z - 3,929,694.157 (meters) COMP
DK3320 GEOID HEIGHT - -33.35 (meters) GEOID12
DK3320 HORZ ORDER - SPECIAL (CORS)
DK3320 ELLP ORDER - SPECIAL (CORS)
```

NGS Update Data Sheet Format

DK3320.The ellipsoidal height was determined by GPS observations
DK3320.and is referenced to NAD 83.

DK3320

DK3320. The following values were computed from the NAD 83(2011) position.

DK3320

DK3320;		North	East	Units	Scale Factor	Converg.
DK3320;SPC KY1Z	-	1,215,687.021	1,513,265.245	MT	0.99992928	+0 05 35.1
DK3320;SPC KY1Z	-	3,988,466.50	4,964,771.06	sFT	0.99992928	+0 05 35.1
DK3320;SPC KY N	-	87,069.117	382,022.013	MT	0.99996759	-0 50 19.6
DK3320;SPC KY N	-	285,659.26	1,253,350.55	sFT	0.99996759	-0 50 19.6

DK3320

DK3320!	-	Elev Factor	x	Scale Factor	=	Combined Factor
DK3320!SPC KY1Z	-	0.99997523	x	0.99992928	=	0.99990452
DK3320!SPC KY N	-	0.99997523	x	0.99996759	=	0.99994283

DK3320

DK3320

SUPERSEDED SURVEY CONTROL

DK3320

DK3320	NAD 83(CORS)-	38 16 35.93981(N)	085 35 54.20086(W)	AD(2002.00)	c
DK3320	ELLIP H (04/??/08)	157.830 (m)		GP(2002.00)	c c
DK3320	NAVD 88 (09/24/10)	191.19 (m)	GEOID09 model used	GPS OBS	

DK3320

DK3320.Superseded values are not recommended for survey control.

DK3320

DK3320.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

DK3320.[See file dsdata.txt](#) to determine how the superseded data were derived.

NGS Update OPUS



OPUS: Online Positioning User Service

National Geodetic Survey

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GEOID12A (beta) has replaced GEOID12 for NAVD 88 orthometric heights. NAVD 88 heights from the original GEOID12 (used by OPUS in July and early August) may include errors of up to 40 cm in limited areas.

Upload your data file.

Tie your GPS observation to the National Spatial Reference System.

[What is OPUS?](#) [FAQs](#)

[Browse...](#)

* **Data file** of dual-frequency GPS observations. [sample](#)

no antenna selected

* **Antenna type** - choosing wrong may degrade your accuracy.

meters above your mark.

* **Antenna height** of your antenna's reference point.

* **Email address** - your solution will be sent here.

to **customize** your solution.

for data > 15 min. < 2 hrs.

for data > 2 hrs. < 48 hrs.

* **required fields**

We may use your data for internal evaluations of OPUS use, accuracy, or related research.

Field	Value
Station Name	...
Antenna Type	...
Antenna Height	...
Time	...
Latitude	...
Longitude	...
Height	...

[Sample Solutions](#)

KYCORS Update

◎ KYCORS

- NAD83(CORS96)
- Relative Antenna Calibrations
- Geoid09

◎ KYCORS2011

- NAD83(2011)
- Absolute Antenna Calibrations
- Geoid12a

KYCORS Update

- ◉ Does KYTC plan to make the switch?
 - Testing
 - Pilot Project
 - Design Memo

Questions?

<http://kycors.ky.gov>
<http://ngs.noaa.gov>

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