Actually – it’s a new adjustment AND a new Geoid…
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
**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.
1. Multi-Year CORS Solution (MYCS)
2. NAD 83(2011) epoch 2010.00
3. GEOID12a
4. Datasheet format changes
5. OPUS
   - NAD 83(HARN) ↔ (NSRS2007/CORS96) ↔ (2011)

2022 - Estimated completion of entirely new geometric and geopotential datums along with completion of GRAV-D
NGS Update
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
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
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 → NAD 83(2011) epoch 2010.00

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

1. \( H + V \)
   
   27, 29

2. \( H + V \)
   
   2 + 1
   
   83(86), 88

3. \( H + V_E + V_o \)
   
   2 + 1 + 1
   
   83(92), 88

+ VELOCITIES (time)

4. \( H + H_t + V_E + V_o \)
   
   2 + 2 + 1 + 1
   
   83(11), HTDP, 88

5. \( H + H_t + V_E + V_{Et} \)
   
   2 + 2 + 1 + 1
   
   ITRF08 (2010.00)

GPS

+ GRAVITY

(geoid model)

GEOMETRIC

GEOPOTENTIAL
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
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)
Absolute vs. Relative: What does it really mean?
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.
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]
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/
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
Please choose the coordinate you want to use.

**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](geodesy.noaa.gov/CORS/coords.shtml)
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 HNY DIST 5 CORS ARP
DK3320 CORS_ID - KYTE
DK3320 PID - DK3320
DK3320 STATE/COUNTY - KY/JEFFERSON
DK3320 COUNTRY - US
DK3320 USGS QUAD - ANCHORAGE (1987)

*CURRENT SURVEY CONTROL

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 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 ELLIP ORDER - SPECIAL (CORS)
The ellipsoidal height was determined by GPS observations and is referenced to NAD 83.

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

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>East</th>
<th>Units</th>
<th>Scale Factor</th>
<th>Converg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DK3320;SPC KY1Z</td>
<td>-1,215,687.021</td>
<td>1,513,265.245</td>
<td>MT</td>
<td>0.999992928</td>
<td>+0 05 35.1</td>
</tr>
<tr>
<td>DK3320;SPC KY1Z</td>
<td>-3,988,466.50</td>
<td>4,964,771.06</td>
<td>sFT</td>
<td>0.999992928</td>
<td>+0 05 35.1</td>
</tr>
<tr>
<td>DK3320;SPC KY N</td>
<td>-87,069.117</td>
<td>382,022.013</td>
<td>MT</td>
<td>0.99996759</td>
<td>-0 50 19.6</td>
</tr>
<tr>
<td>DK3320;SPC KY N</td>
<td>-285,659.26</td>
<td>1,253,350.55</td>
<td>sFT</td>
<td>0.99996759</td>
<td>-0 50 19.6</td>
</tr>
</tbody>
</table>

- Elev Factor x Scale Factor = Combined Factor
- 0.999997523 x 0.99992928 = 0.99990452
- 0.99997523 x 0.99996759 = 0.99994283

SUPERSEDED SURVEY CONTROL

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

Superseded values are not recommended for survey control.

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

See file dsdata.txt to determine how the superseded data were derived.
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

NONE no antenna selected
Antenna type - choosing wrong may degrade your accuracy.

0.00 meters above your mark.
Antenna height of your antenna's reference point.

* Email address - your solution will be sent here.

Options to customize your solution.

Upload to Rapid-Station Upload to Station
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.
KYCORS Update

- KYCORS
  - NAD83(CORS96)
  - Relative Antenna Calibrations
  - Geoid09

- KYCORS2011
  - NAD83(2011)
  - Absolute Antenna Calibrations
  - Geoid12a
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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