

National Geodetic Survey

NGS-CDOT Annual Visit

**Region 3
Grand Junction
January 31, 2012**



National Oceanic and Atmospheric Administration

Agenda

- OPUS Programs
 - OPUS – DB – Key to heights
 - OPUS- Projects
- CORS/OPUS Team Efforts
- NAD83 (2011), MultiYear CORS Solution
- Geoid12
- New Data Sheets
- CBLs
- NGS Advisor Program

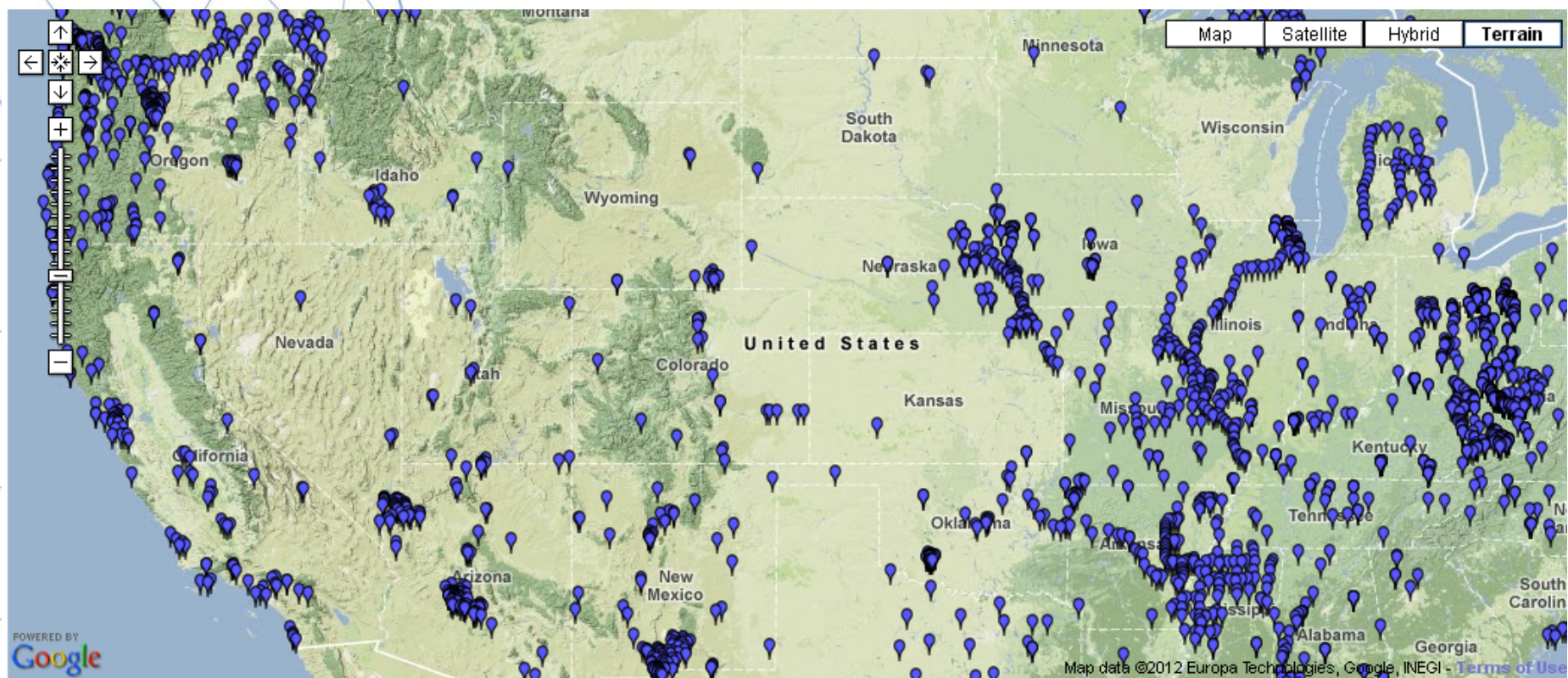


OPUS

- OPUS – S (2 hrs)
- OPUS – RS (15 minutes)
- OPUS – DB (Publish)
- OPUS – Projects (Network)



OPUS-DB Published Solutions



Website Owner: National Geodetic Survey / Last modified by NGS.OPUS Tuesday, 24-Jan-2012 09:30:10 EST



Sample OPUS DataSheet

SURVEY DATASHEET (Version 1.0)

PID: KIM0446
Designation: GNAT
Stamping:
Stability: Most reliable; expected to hold position well
Setting: In rock outcrop or ledge
Mark: G
Condition:
Description: Station mark remains a standard U.S. Geological tablet cemented in rock, almost flush with ground. Access from an existing wellsite named Horseshoe Canyon # 1-28 located in the SW1/4 SE1/4 of Sec. 28, T.9S., R.97W. can be done with an ATV. From the east side of the wellsite follow a existing trail road suitable for ATV and follow for approximately 0.3 mi. and a quick right turn thru cedar timber 500 ft. to monument.
Observed: 2010-10-06 T17:37:00Z [See Also 2010-10-06](#)
Source: OPUS - page5 1009.28



Close-up View

REF FRAME:	EPOCH:	SOURCE: NAVD88 (Computed using	UNITS:	SET	
NAD_83(CORS96)	2002.0000	GEOID09)	m	PROFILE	DETAILS
LAT 39° 14' 22.66405" ± 0.020 m		UTM 12 SPC 502(CO C)			
LON: -108° 12' 50.71816" ± 0.034 m		NORTHING: 4347068.286m 464409.887m			
ELL HT: 1823.020 ± 0.031 m		EASTING: 740440.278m 680134.403m			
X: -1546574.618 ± 0.044 m		CONVERGENCE: 1.76311413° -1.71174719°			
Y: -4700038.101 ± 0.025 m		POINT SCALE: 1.00031188 0.99993883			
Z: 4014109.597 ± 0.011 m		COMBINED FACTOR: 1.00002586 0.99965291			
ORTHO HT: 1839.428 ± 0.059 m					

CONTRIBUTED BY

[preidpls](#)
 Paul Reid, PLS



Horizon View



N

The numerical values for this position solution have satisfied the quality control criteria of the National Geodetic Survey. The contributor has verified that the information submitted is accurate and complete.

OPUS-DB

<http://www.ngs.noaa.gov/>



OPUS DB Requirements

Field Procedures

- GPS [data file](#) \geq 4 hour duration
- quality [mark setting](#)
- experienced observer
- fixed height tripod recommended
- brace tripod legs with sandbags or chain
- verify [antenna height](#) and plumb



OPUS DB Requirements

High-Quality OPUS Solution

- $\geq 70\%$ observations used
- $\geq 70\%$ ambiguities fixed
- ≤ 3 cm RMS
- ≤ 4 cm peak-to-peaks, lat. & lon.
- ≤ 8 cm peak-to-peak, el. hgt.
- properly identify antenna type
- precise or rapid orbits (avail. next day)



OPUS DB Requirements

Mark Attributes

- photos of mark & equipment
- details (name, type, stability, etc.)
- description to aid mark recovery
- preview [mark description form](#) & [help file](#)



OPUS-DB Requirements



Help File: Mark Descriptions

National Geodetic Survey

A good description helps surveyors appraise a mark's fitness for use and aids in mark recovery. To help you in writing good descriptions, the primary metadata elements are illustrated below.

descriptive elements:	Publishing Methods:			
	DSWORLD *	Mark Recovery *	OPUS	WinDesc
accuracy	†	†	automated	uses all these, & more
visibility	visibility	†	automated	
position	position	†	automated	
condition	condition	condition	condition	
notes	notes	notes	notes	
photos	photos	†	photos	
stamping	stamping	†	stamping	
designation	†	†	designation	
type	type	†	type	
setting	setting	†	setting	
rod depths	†	†	rod depths	
application	†	†	application	
magnetic	magnetic	†	magnetic	
stability	stability	†	stability	
equipment IDs	†	†	equipment IDs	

* use these methods only for marks already published.
is mine published? **Search our database** to find out.

† to revise this element, use **WinDesc**.



Why OPUS-DB

- A new easier way to capture data and have it in an NGS database
- Help populate Ellipsoidal Heights on Bench Marks, help with Geoid models and future vertical datums



Work to be Done (Ht Modernization) *Big Picture*

- Assessment of Vertical Issues in CO
- Gap Analysis of Where we need better vertical measurements, whether orthometric or ellipsoidal
- Collect Data in those Key areas, using OPUS-DB, and determine what other means (leveling)
- In the meantime, collect what you can using OPUS-DB
- Write a report capturing all of this



OPUS-Projects

Dave Newcomer's Presentation
can be found at
<ftp://ftp.ngs.noaa.gov/dist/pamfrom/CDOT>



OPUS Projects



OPUS-Projects BETA

National Geodetic Survey

[NGS Home](#)

[About NGS](#)

[Data & Imagery](#)

[Tools](#)

[Surveys](#)

[Science & Education](#)



OPUS-Projects gives users web-based access to simple management and processing tools for projects involving multiple sites and multiple occupations.

- Data uploading through OPUS.
- Customizable data processing via the PAGES software suite.
- Visualization and management aids.

Create a new project.

[Create](#)

RESTRICTED to trained project managers.

Create

After completing OPUS-Projects training, you are registered and may create a new project.

Configure, edit, and process individual network sessions.

[Session](#)

Project Identifier:

Session Keyword:

Your Email:

Session

Manage, edit, process, and publish the project.

[Manage](#)

Project Identifier:

Manager Keyword:

Manage

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[Published Solutions](#)

[<-- back](#)

OPUS-Projects

Any questions ???



CDOT CORS/OPUS Team

- To incorporate CORS and OPUS into the CDOT Survey Manual
- Present to the SAC on Feb 15, 2012
- Proposed Addendum
- Recommendations



CDOT CORS/OPUS Team

Proposed Addendum

Surveying and mapping work, upon which all planning, studies and engineering designs are based, shall use the established CDOT project datum. Unless otherwise determined and approved by CDOT Region Survey Coordinator, the horizontal datum shall be the most recent realization of the North American Datum of 1983 (NAD83) as defined by the National Geodetic Survey (NGS). The horizontal control may utilize accepted CDOT and NGS ground based monuments (such as former HARN) and CORS (Continuous Operating Reference Stations).



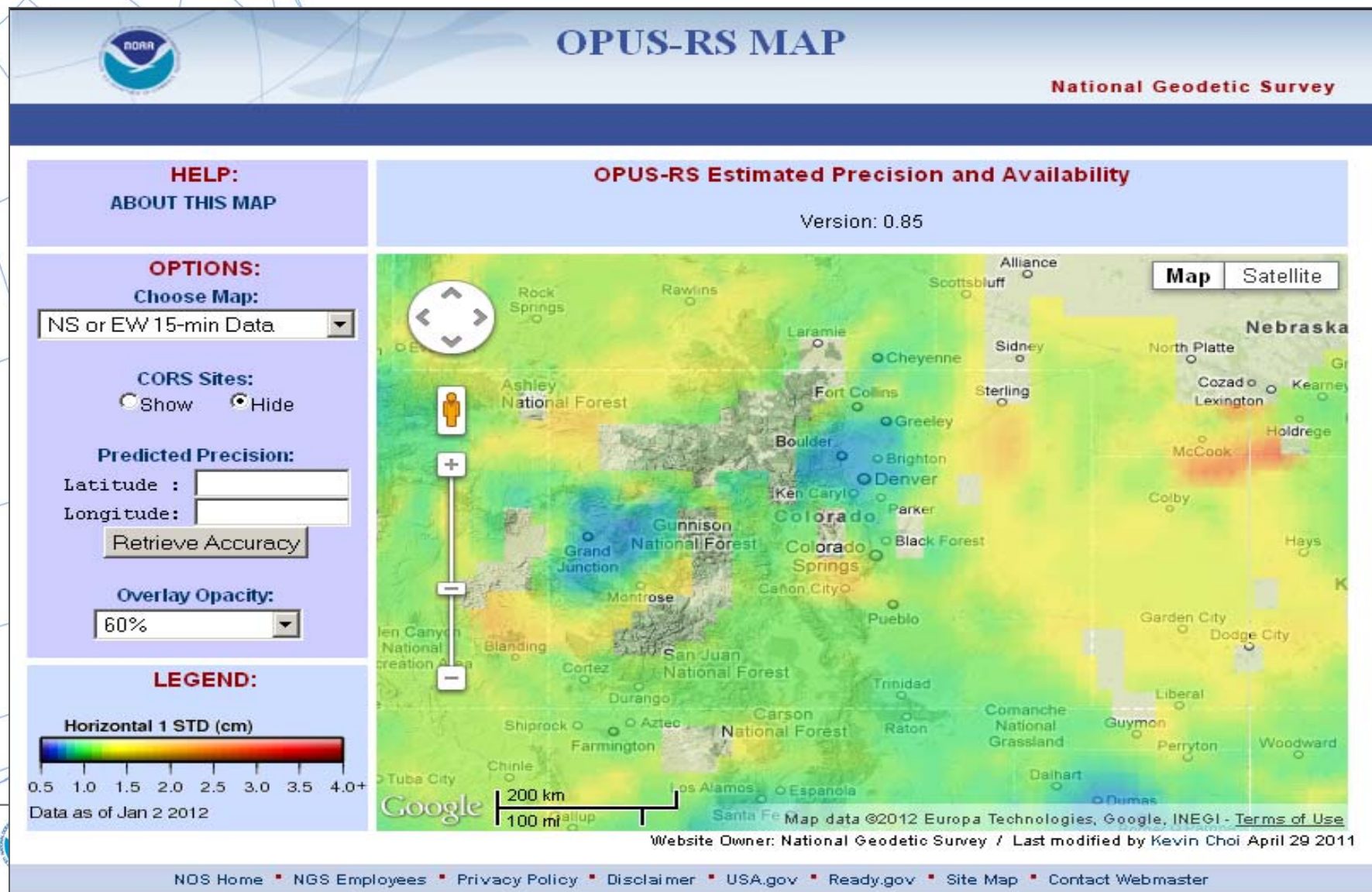
CDOT CORS/OPUS Team

Recommendations

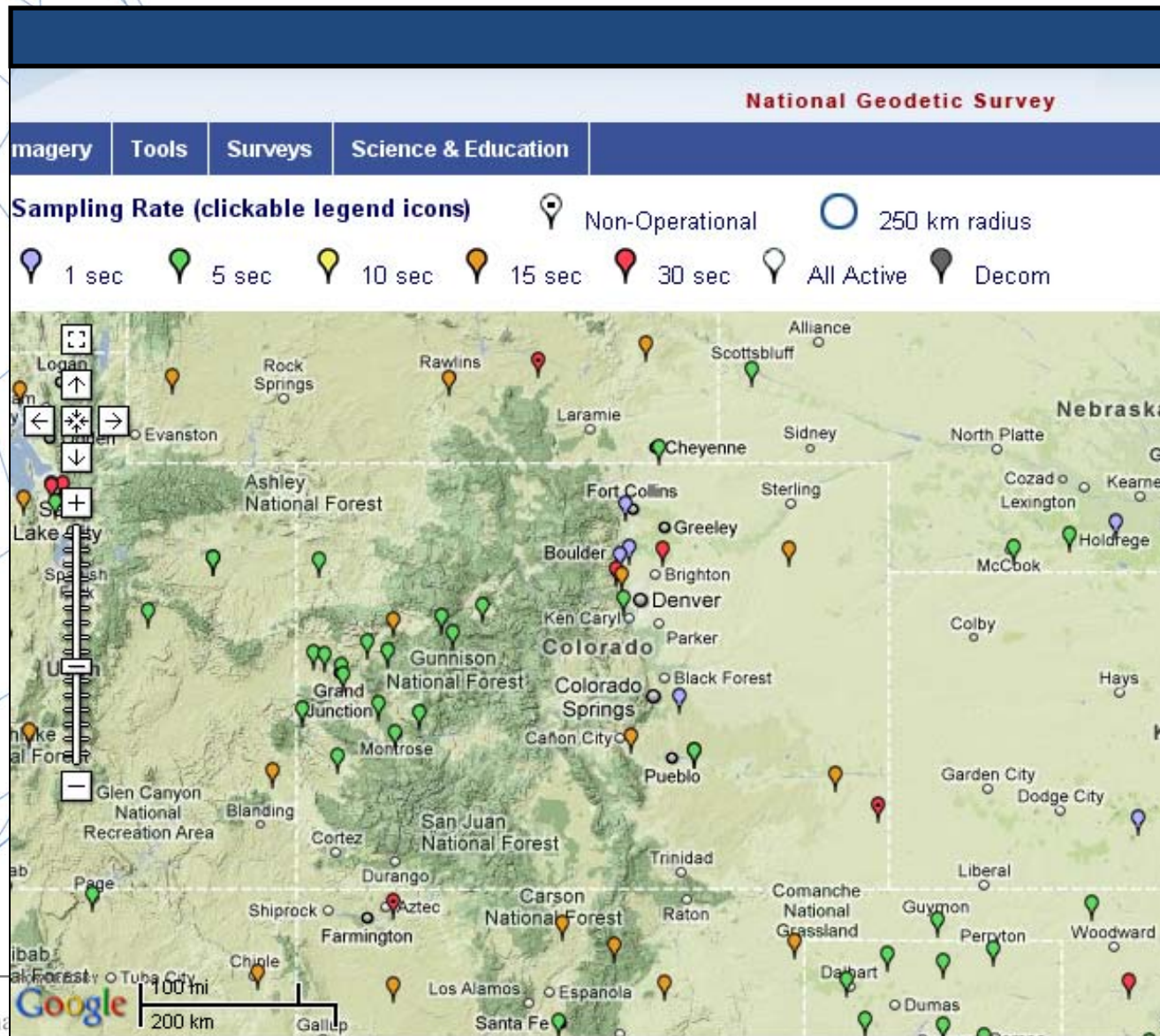
1. OPUS tools are valuable and use of them should be further explored and encouraged where appropriate and incorporated into re-write of Chapter 3.
2. Encourage publishing of control using OPUS-DB especially on NGS vertical marks to prepare the vertical datums for the future.
3. Additional CORS should be added in Colorado
4. Microstation control diagrams be edited to reflect the language in the proposed (approved) Addendum
5. Training to Support these Changes



OPUS-RS Coverage in Colorado



CORS in CO



Recommendation	Reason	Annual Cost Savings to CDOT	NGS Programs/Tools
Immediately end CDOT's future "blue book" surveys to replace existing, or set new, horizontal and/or vertical marks as part of the national network.	By 2022, horizontal and/or vertical marks will no longer be part of the national network. NGS is encouraging states to transition away from these marks.	~ \$300K	New Datums; MYCORS; GRAV-D; Geoid 12; new datasheets;
Immediately implement "Use It Until You Lose It" post-processes to use Continuous Operating Reference Stations (CORS), in conjunction with existing marks to reference CDOT surveys to the national network until 2022 (at which time only CORS will be used).	By 2022, CORS will be the national network. NGS is encouraging states to transition to CORS.	~ \$200K	OPUS-DB; OPUS-RS; vertical
Immediately update CDOT's Survey Manual per FHWA Federal Lands Project Development and Design Manual (PDDM) Chapter 5 – Surveying and Mapping to allow full use of CORS.	FHWA is the lead federal agency in transportation design and construction surveys; their PDDM was updated and published in 2011 and readily available for CDOT's use.	~ \$100K	CORS; OPUS
Immediately implement NGS OPUS by submitting to NGS one CDOT control monument referenced to the national network for every 30 miles surveyed via "Publish Your OPUS Solutions".	NGS OPUS provides simplified processes for data submission to NGS, which eliminates the additional cost to CDOT of "blue booking" data.	~ \$100K	OPUS-DB; OPUS-Projects; LOCUS; Tracking System
Immediately implement a transition period for the Colorado NGS Advisor to a regional NGS Advisor with full implementation by the expiration of the current agreement on December 31, 2015, at which time CDOT's funding of the advisor program will end.	NGS is transitioning the state sponsored advisor program to a regional program to allow greater use of the advisor in multiple states. This will further support and sustain the national network presence in Colorado and surrounding states.	~ \$70K starting 2016	Five Year Implementation Period; Training Modules
Immediately update CDOT's Basis of Elevation statements to read: "with an approximate NAVD 88 elevation... for transportation purposes only", with a goal of dropping the language by 2022, when the new national network is fully implemented.	Marks that are part of the national network are no longer an accurate representation of NAVD 88.	Cost neutral	GRAV-D; Vertical plan for CO; Capture local knowledge; infrastructure for transformation models
Assist NGS in performing a "Gap Analysis" of the CORS network in Colorado over the next two years to determine if Colorado's portion of the national network is sufficient to support the new national network.	NGS will perform a "Gap Analysis" of the CORS network over the next two years.	Cost neutral	National CORS; GRAV-D;
Continue working with local agencies and private partners to expand CDOT's use of their real time CORS networks in Colorado.	Mesa County, Trimble and Leica all operate real time CORS networks in Colorado, each are available for CDOT's use.	Cost neutral	Guidelines, Best Practices

Other State Use - CORS

<u>Montana</u>	Observation times at a mark, to a certain extent, are a function of baseline length. Table 8-1 indicates suggested occupation times for dual frequency receivers for various baseline lengths		
	Baseline Distance	Number of SVs	Time (minutes)
	Less than 20 km (12.4 miles)	4	20
		5	15
		6 or more	9
	20 to 35km (12.4 to 21.7 miles)	4	40
		5	30
		6 or more	16
	35 to 60 km (21.7 to 37.2 miles)	4	60
		5	12
		6 or more	30
	Greater than 60 km (37.2 miles)	4	180
		5	135
		6 or more	95



Other State Use - OPUS

Ohio DOT *	3 sessions; at least 4 hours per session	
Michigan DOT **	2 static observations of no less than 2 hrs and no more than 4 hrs as a minimum	
	Dist. from farthest CORS (mi)	Horizontal only
	Under 25	2 hours
	25 – 43	3 hours
	44 and over	4 hours
North Dakota	occupy each PRIMARY CONTROL point for a MINIMUM of 4 hrs	
Montana	Observations submitted to NGS for an OPUS solution should adhere to their recommended observation times	
TEXAS	Any stations that contain 2 or more hrs of raw GPS data can be processed at this (<i>OPUS</i>) Web site.	
Georgia	<i>a minimum occupation time of 2 hrs</i> during peak satellite cover	
California	OPUS solutions shall not be used for producing final coordinates or elevations	

- * Use the same 3 base stations when processing; manually select base stations to be used in OPUS processing.
- ** Processing of vectors for the Primary Horizontal control must be done using OPUS.

FHWA

FHWA

Federal Lands
Highway
Project
Development
and Design
Manual

5.3.1.1 Horizontal Datum

All surveying and mapping work, planning, studies and engineering designs must be based upon a common well-understood horizontal datum. **Unless unique circumstances prescribe use of an alternate reference system, the horizontal datum standard for all mapping, planning, design, right-of-way and construction on FLH projects shall be the North American Datum of 1983 (NAD83) as defined by the National Geodetic Survey (NGS).** Use of the most current realization of NAD83, from High Accuracy Reference Networks (HARN), Continuous Operating Reference Stations (CORS) or both is encouraged. Use of the [NGS Online Positioning User Service \(OPUS\)](#) is a convenient and efficient method of establishing the required horizontal control datum. Project coordinates (northings and eastings) for mapping and design shall be expressed in terms of the State plane coordinate system zone in which the project exists. Definition of the State plane coordinate projections can be found in *NGS publication* [NOS NGS-05](#).



CDOT Comparison Between HARN, CORS and OPUS

Comparison of Static Solution with HARN Stations to Static Solution with CORS Stations Coordinates are State Plane Colorado Central Zone Coordinates

<u>Solution</u>	<u>Station</u>	<u>Northing</u>	<u>Easting</u>	<u>Delta N</u>	<u>Delta E</u>	<u>Vector</u>	<u>Remarks</u>
Static Survey	KOEPSSELL	485019.8310	692784.1960				Held Fixed NGS Coordinates
Static (CORS)	KOEPSSELL	485019.8280	692784.1940	0.003m (0.010 ft)	0.002m (0.007 ft)	0.004m (0.012 ft)	Static Solution from CORS
Static Survey	72.30E	484813.4910	692714.6750				
Static (CORS)	72.30E	484813.4880	692714.6740	0.003m (0.010 ft)	0.001m (0.003 ft)	0.003m (0.010 ft)	
Static Survey	72.30E	484813.4910	692714.6750				
OPUS-RS Solution	72.30E	484813.4960	692714.6800	-0.005m (-0.016 ft)	-0.005m (-0.016 ft)	0.007m (0.023 ft)	
Static Survey	72.45E	485172.0020	692900.1110				
Static (CORS)	72.45E	485171.9980	692900.1090	0.004m (0.013 ft)	0.002m (0.007 ft)	0.004m (0.015 ft)	
Static Survey	72.30W	485091.9840	692644.0670				
Static (CORS)	72.30W	485091.9790	692644.0650	0.005m (0.016 ft)	0.002m (0.007 ft)	0.005m (0.018 ft)	
Static Survey	72.45W	485367.7120	692756.3640				
Static (CORS)	72.45W	485367.7060	692756.3630	0.006m (0.020 ft)	0.001m (0.003 ft)	0.006m (0.020 ft)	

	<u>Sta to Sta</u>	<u>Dist m</u>	<u>Dist ft (mi)</u>
Static Survey	72.30W to MCCARY	9614.917m	31544.9 ft (5.97 mi)
	72.30W to FABER	8901.729m	29205.1 ft (5.53 mi)
	72.30W to KOEPSSELL	157.613m	517.1 ft (0.10 mi)
Static (CORS)	72.30W to GSC1	65708.007m	215577.0 ft (40.83 mi)
	72.30W to MC07	17084.257m	56050.6 ft (10.62 mi)
	72.30W to MC08	23088.460m	75749.4 ft (14.35 mi)



CDOT Comparison Between HARN, CORS and OPUS

Comparison of Static Solution with HARN Stations to Static Solution with CORS Stations Coordinates are State Plane Colorado Central Zone Coordinates

Project control is located in Sections 23 and 24, T 19 S, R 69 W, Fremont County CO.

<u>Solution</u>	<u>Station</u>	<u>Northing</u>	<u>Easting</u>	<u>Delta N</u>	<u>Delta E</u>	<u>Vector</u>	<u>Remarks</u>
Static Survey	32	366101.7520	952018.7510				Held Fixed NGS Coordinates
Static (CORS)	32	366101.7577	952018.7723	-0.006m (-0.019 ft)	-0.021m (-0.070 ft)	0.022m (0.072 ft)	Static Solution from CORS
Static Survey	32	366101.7520	952018.7510				Held Fixed NGS Coordinates
OPUS-RS Solution	32	366101.7580	952018.7520	-0.006m (-0.020 ft)	-0.001m (-0.003 ft)	0.006m (0.020 ft)	
Static Survey	5	366251.7970	951640.9540				Held Fixed NGS Coordinates
Static (CORS)	5	366251.8055	951640.9737	-0.008m (-0.028 ft)	-0.020m (-0.065 ft)	0.021m (0.070 ft)	Static Solution from CORS
Static Survey	5	366251.7970	951640.9540				Held Fixed NGS Coordinates
OPUS-RS Solution	5	366251.8090	951640.9670	-0.012m (-0.039 ft)	-0.013m (-0.043 ft)	0.018m (0.058 ft)	

	<u>Sta to Sta</u>	<u>Dist m</u>	<u>Dist ft (mi)</u>
Static Survey	32 to Newlin	7105.143m	23310.8 ft (4.41 mi)
	32 to J 430	5666.143m	18589.7 ft (3.52 mi)
	32 to N 349	5716.130m	18753.7 ft (3.55 mi)
Static (CORS)	32 to P037	5130.697m	16833.0 ft (3.19 mi)
	32 to AMC2	66407.796m	217872.9 ft (41.26 mi)
	32 to PUB5	64224.086m	210708.5 ft (39.91 mi)
Static Survey	5 to Newlin	7084.652m	23243.6 ft (4.40 mi)
	5 to J 430	5915.067m	19406.3 ft (3.68 mi)
	5 to N 349	5352.682m	17561.3 ft (3.33 mi)
Static (CORS)	5 to P037	4787.821m	15708.0 ft (2.98 mi)
	5 to AMC2	66571.079m	218408.6 ft (41.37 mi)
	5 to PUB5	64621.140m	212011.2 ft (40.15 mi)



NGS NSRS Improvements

<u>NETWORK</u>	<u>TIME SPAN</u>	<u>NETWORK ACCURACY</u>	<u>LOCAL ACCURACY</u>
NAD 27	1927-1986	10 meters	(1 part in 100,000)
NAD83(86)	1986-1990	1 meter	(1 part in 100,000)
NAD83(199x) HARN	1990-1997	0.1 meter	B-order (1 part in 1 million) A-order (1 part in 10 million)
NAD83(NSRS2007) (CORS)	1996 -	0.01 meter	0.01 meter



"PASSIVE" NETWORK
National Spatial Reference System
(NSRS), *marks in the ground.*

1.5 million marks in the
National Geodetic Survey database.

These marks provide:

- Horizontal position, or
- Horizontal position and ellipsoid height, or
- Orthometric Heights, or
- Both Horizontal and Vertical values
- Tidal Information



“ACTIVE” Geodetic Network

This is the Geodetic Network
of

Continuously **O**perating **R**eference **S**tations

known as **CORS**



CORS "Data Products" Page

CORS

National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

CORS Data Products

GPS data collected at CORS sites are available to download for "post-processing."
[Data Availability and Retention Policy](#)

Methods of Obtaining NGS CORS Data

1. Customized
[User Friendly CORS \(UFCORS\)](#) ← **Obtain Static Data Files for CORS Here**
2. Standard
[standard1.shtml](#)
3. FTP <ftp://www.ngs.noaa.gov/cors/> - Directory Tree
See also alternate FTP <ftp://alt.ngs.noaa.gov/cors/> - Directory Tree

NGS published Coordinates and Velocities Explained
[Coordinates and Velocities](#)
Predict horizontal displacements with [HTDP](#)

Metadata / Station Logs
Station/site log files contain all the historical equipment (receiver/antenna) used at that site, approximate location, owner and operating agency, etc. We must stress that the the position/coordinates listed in the log file like that in the RINEX header files should be considered APPROXIMATE. When a user downloads data they should at the same time download the official NGS position/coordinate and velocity file for that site. You can find that file [here](#).
[Show Directory of All Logfiles](#)

Antenna Calibrations

List and Sort Sites
[CORS Site List \(kml \)](#) The coordinates listed in this KML file are for reference frame ITRF00, epoch 1997.1

CORS

[Enter SiteID](#)

Enter 4-char SiteID

[Enter String](#)

Enter partial string to find SiteID, Site Name, or City

[CORS Home](#)
[Data Products](#)
[CORS Map](#)
[Newsletter](#)
[General Information](#)
[CORS Site Guidelines](#)
[GPS Links](#)

Provide Information about your Project

User Friendly CORS Version 3.5.9 - Windows Internet Explorer

http://www.ngs.noaa.gov/UFCORS/

File Edit View Favorites Tools Help

User Friendly CORS Version 3.5.9

User Friendly CORS

Version 3.5.9

This utility allows you to obtain a specific block of Global Positioning System (GPS) data for a continuously operating reference station (CORS) contained in the network of GPS sites managed by the National Geodetic Survey.

The GPS data will be in "receiver independent exchange" (RINEX) format, version 2.10.

[UFCORS Page Info](#) [Trimble Products Configuration](#) [UFCORS Problem/Comment Form](#)

Starting Day: Jul 14, 2011 - 195 [Get Older Data](#)

Start Time of the field observation: 00:00 [Day and Time Info](#)

Time Zone relative to observation location: UTC (GMT) [Time Zone Info](#)

Number of hours of data you wish to receive: 1 Please LIMIT requests for 1-second sampling rate data to 2 hours.

[CONTINUE](#) [CLEAR](#)

[NOS Home](#) | [Contact Us](#) | [Privacy Policy](#) | [Disclaimer](#) | [Document Viewers](#)

Web site owner: [National Geodetic Survey \(NGS\)](#), [National Oceanic & Atmospheric Administration \(NOAA\)](#)

start

Microsoft... WI Monthly... Microsoft P... Google Earth 4 Internet... Survey Software

Internet 100% 1:34 PM

User Friendly CORS

Version 3.5.9

GPS data are available for the following sites for your specified time interval:

1lsu

[Site Info](#), [Site Map](#), [Data Availability](#), [Time Series](#)

This utility will [interpolate or decimate](#) the GPS data.

How many seconds do you want between individual data points?:

As Is

Please LIMIT requests for 1-second sampling rate data to 2 hours.

Would you like the corresponding files?

Coordinate File: no

[Coordinate File Info](#)

Met File: no

[Met File Info](#)

NGS data sheet: no

IGS Orbits in SP3 format: no

[Orbit File Info](#)

Please choose the compression format.

Files can be compressed using pkzip

[Compression Info](#)

Processing will take place within a minute. A window will appear after processing that allows you to select where on your hard drive to save the transmitted files.

Also, a window displaying icons for several directories (folders) and files may appear. You may use this window to view the transmitted files. This feature is browser dependent and may not work on your browser.

SUBMIT

CLEAR

To Report [UFCORS Problem or Comment Form](#)

Enter your custom requests

NAD83 (2011), MultiYear CORS Solution

New Reference Frame

NAD 83(2011)

Epoch 2010.00

IGS08

Epoch of Observation

Previous Reference Frame

NAD 83(CORS96)

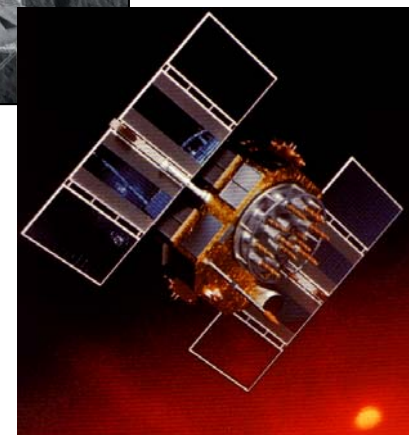
Epoch 2002.00

ITRF00



A (very) brief history of NAD 83

- Original realization completed in 1986
 - Consisted (almost) entirely of classical (optical) observations
- “High Precision Geodetic Network” (HPGN) and “High Accuracy Reference Network” (HARN) realizations
 - Most done in 1990s, essentially state-by-state
 - Based on GNSS but classical stations included in adjustments
- National Re-Adjustment of 2007
 - NAD 83(CORS96) and (NSRS2007)
 - Simultaneous nationwide adjustment (GNSS only)
- ***New realization: NAD 83(2011)
epoch 2010.00***



Multi-Year CORS Solution

- Longer data spans
- Absolute antenna calibrations
 - satellite transmitting and ground receiving antennas
 - most significant change
- New network design—added redundancy
 - Delaunay triangulation over global sites and CORS backbone
 - tie remaining CORS to backbone as stars
- IERS 2003 Conventions generally implemented
- Updated model for station displacements due to ocean tidal loading
- Updated models for troposphere propagation delays
- Use current frame; first attempt to obtain a full history of products in a fully consistent framework

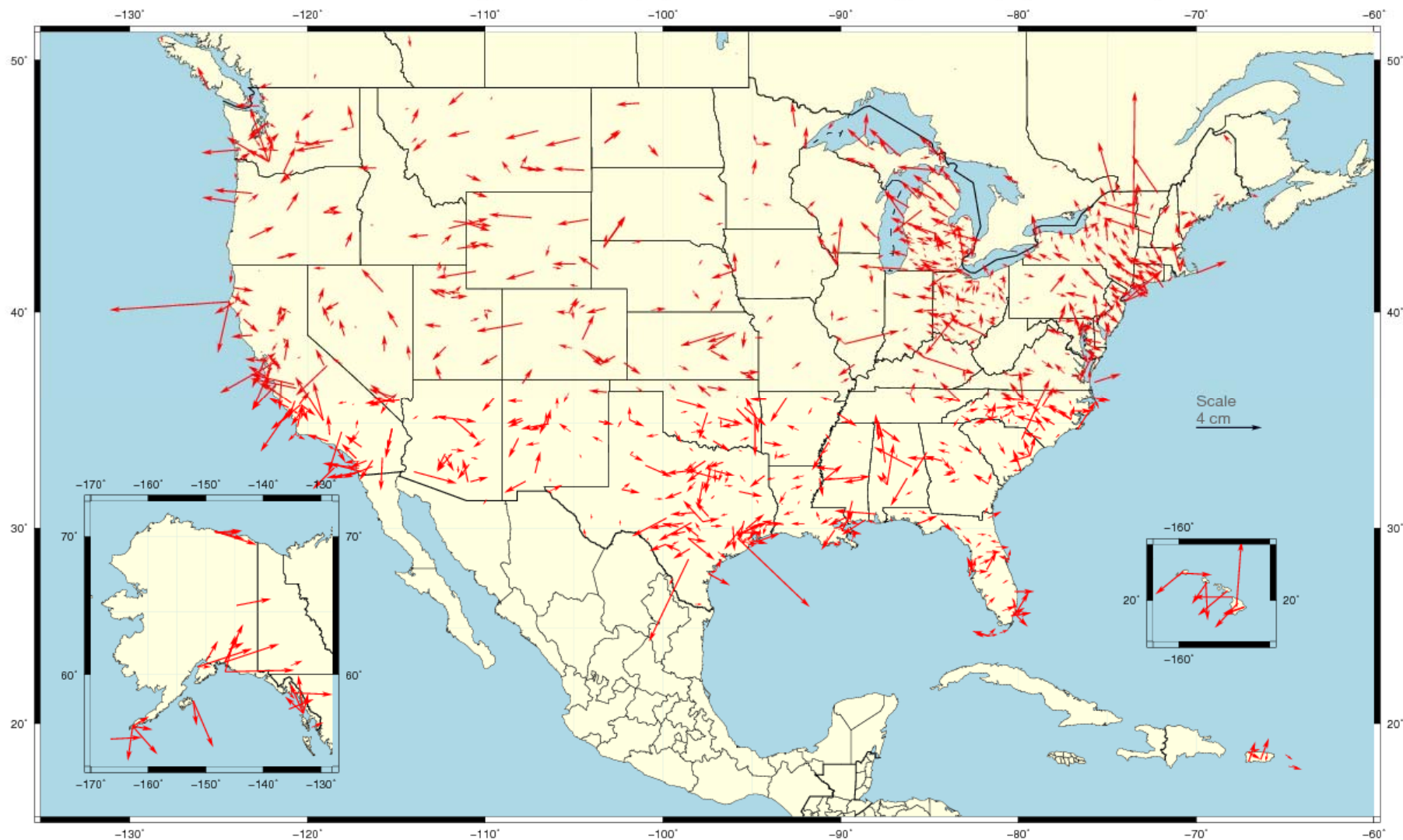


Why a Multi-Year CORS Solution?

- 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***



Horizontal Differences [NAD 83(2011) epoch 2002.0 – NAD 83(CORS96) epoch 2002.0]



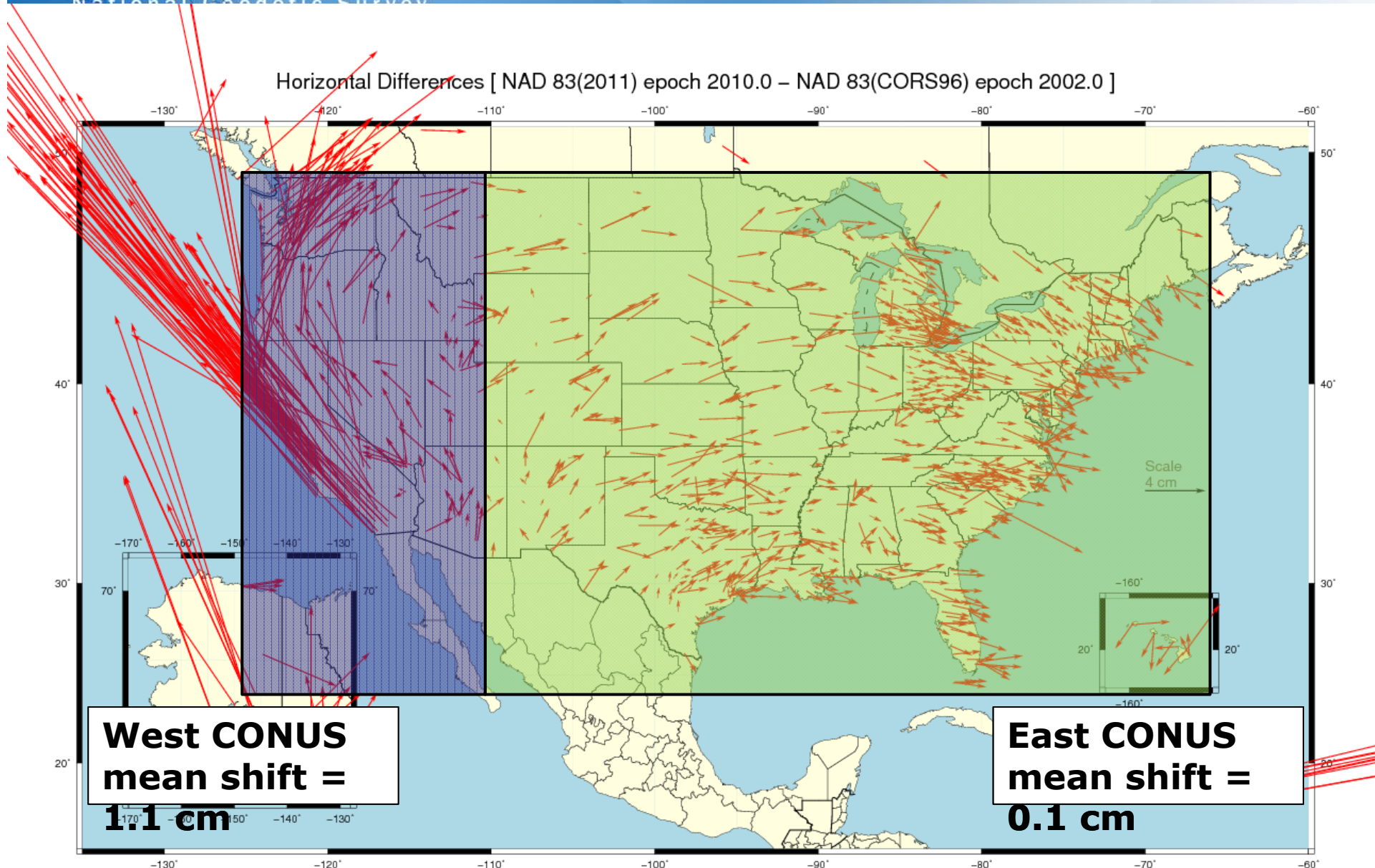
Mean horizontal shift = 0.2 cm (± 2 cm) at epoch 2002.0

©NOAA 2011 Apr 27 07:53:25



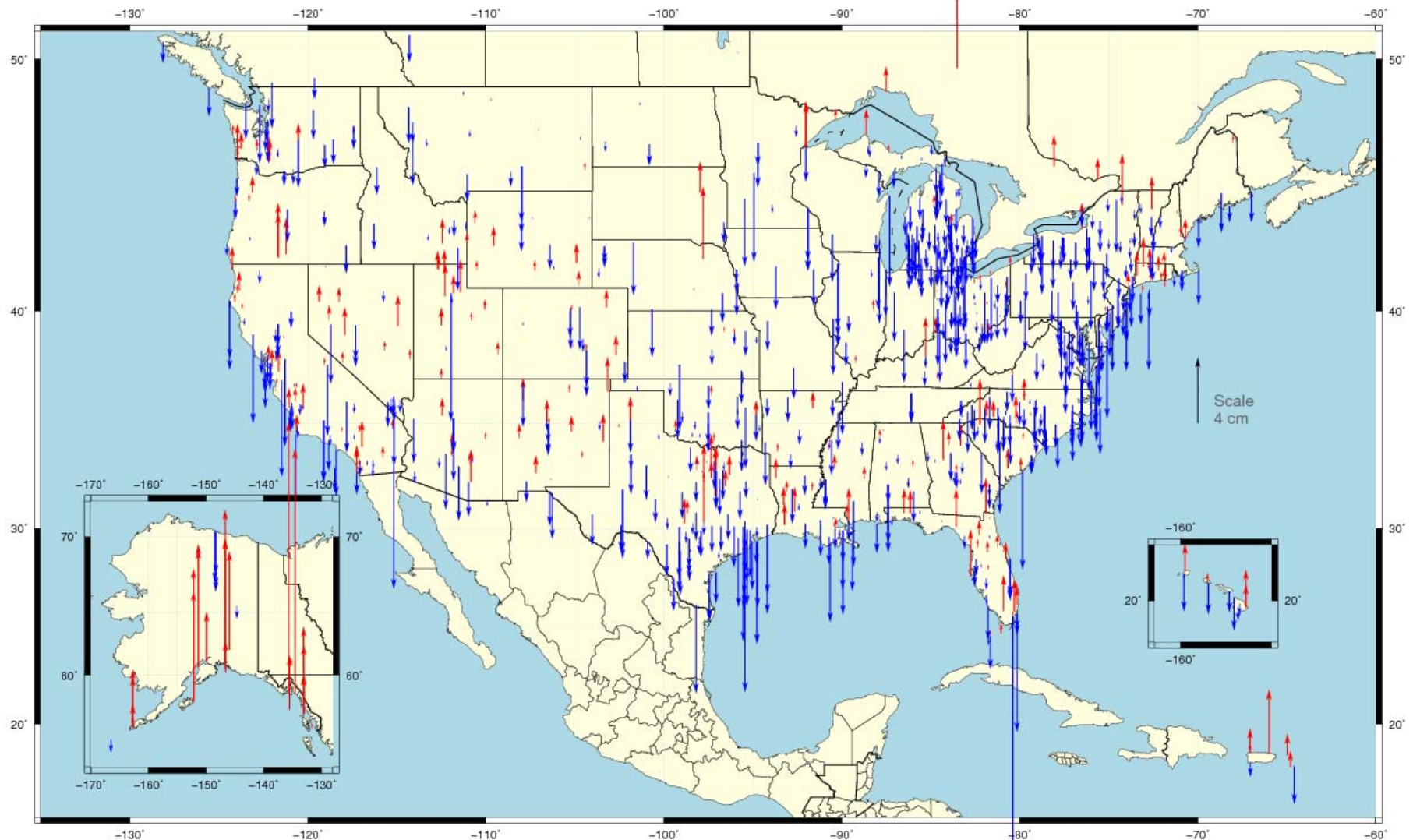
National Oceanic and Atmospheric Administration

Horizontal Differences [NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0]



Mean horizontal shift = 2.0 cm (± 8 cm) from 2002.0 \rightarrow 2010.0

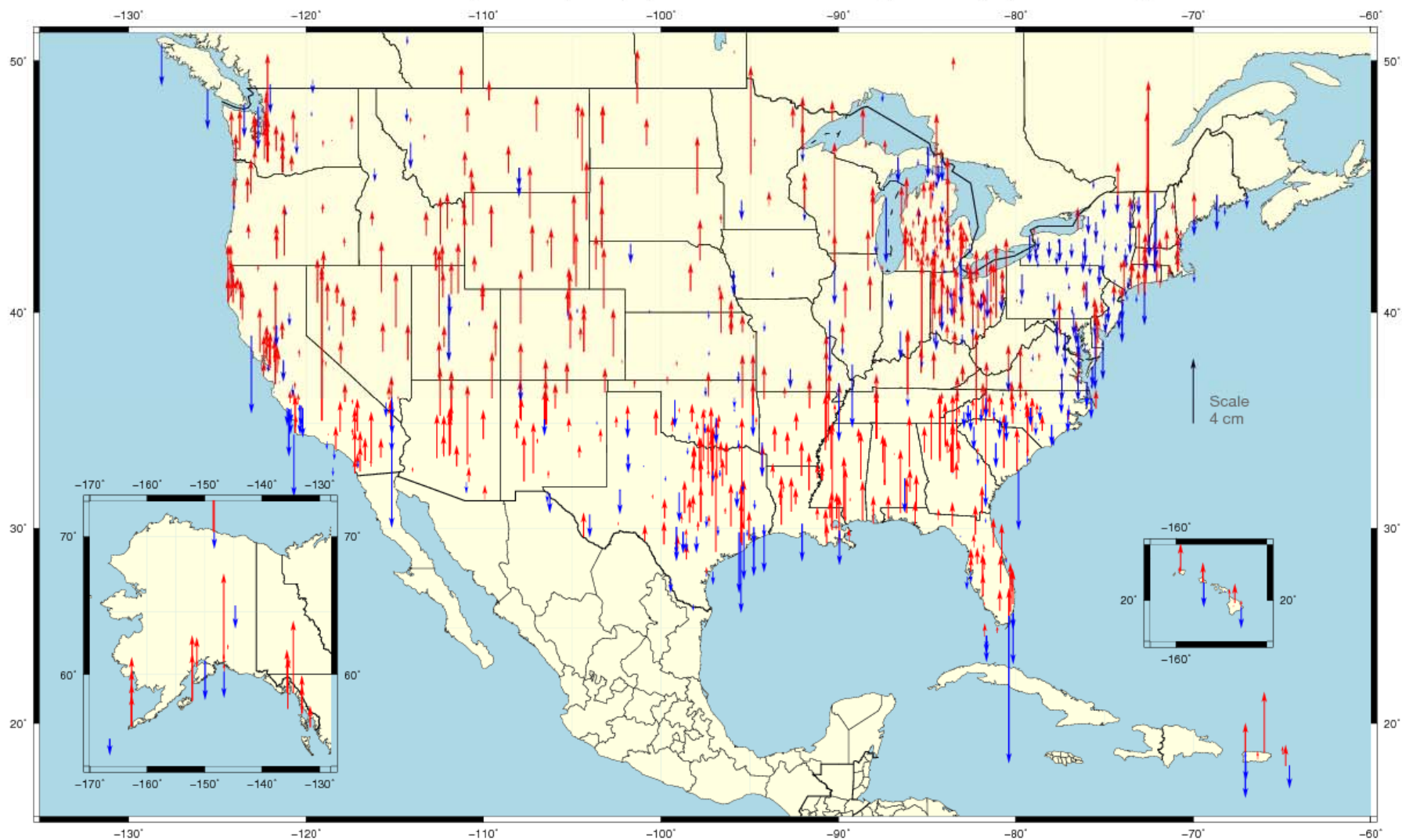
Vertical Differences [NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0]



Mean vertical shift = -0.8 cm (± 2 cm) from 2002.0 \rightarrow 2010.0

Mean vertical shift = +0.7 cm (± 2 cm) at epoch 2002.0

Vertical Differences [NAD 83(2011) epoch 2002.0 – NAD 83(CORS96) epoch 2002.0]



2011 Apr 27 07:54:39



National Oceanic and Atmospheric Administration

Introducing...

NAD 83(2011) epoch 2010.00

- **Multi-Year CORS Solution (MYCS)**
 - Reprocessed all CORS GPS data Jan 1994-Apr 2011
 - 2264 CORS & global stations
 - NAD 83 computed by *transformation* from IGS08
- **National Adjustment of 2011 (NA2011)**
 - New adjustment of GNSS passive control
 - GNSS vectors tied (and constrained) to CO NAD 83(2011) epoch 2010.00
 - Approximately 80,000 stations and more than 400,000 GNSS vectors
- **Realization SAME for CORS and passive marks**
- **This is *NOT* a new datum! (still NAD 83)**



Why a New National Adjustment?

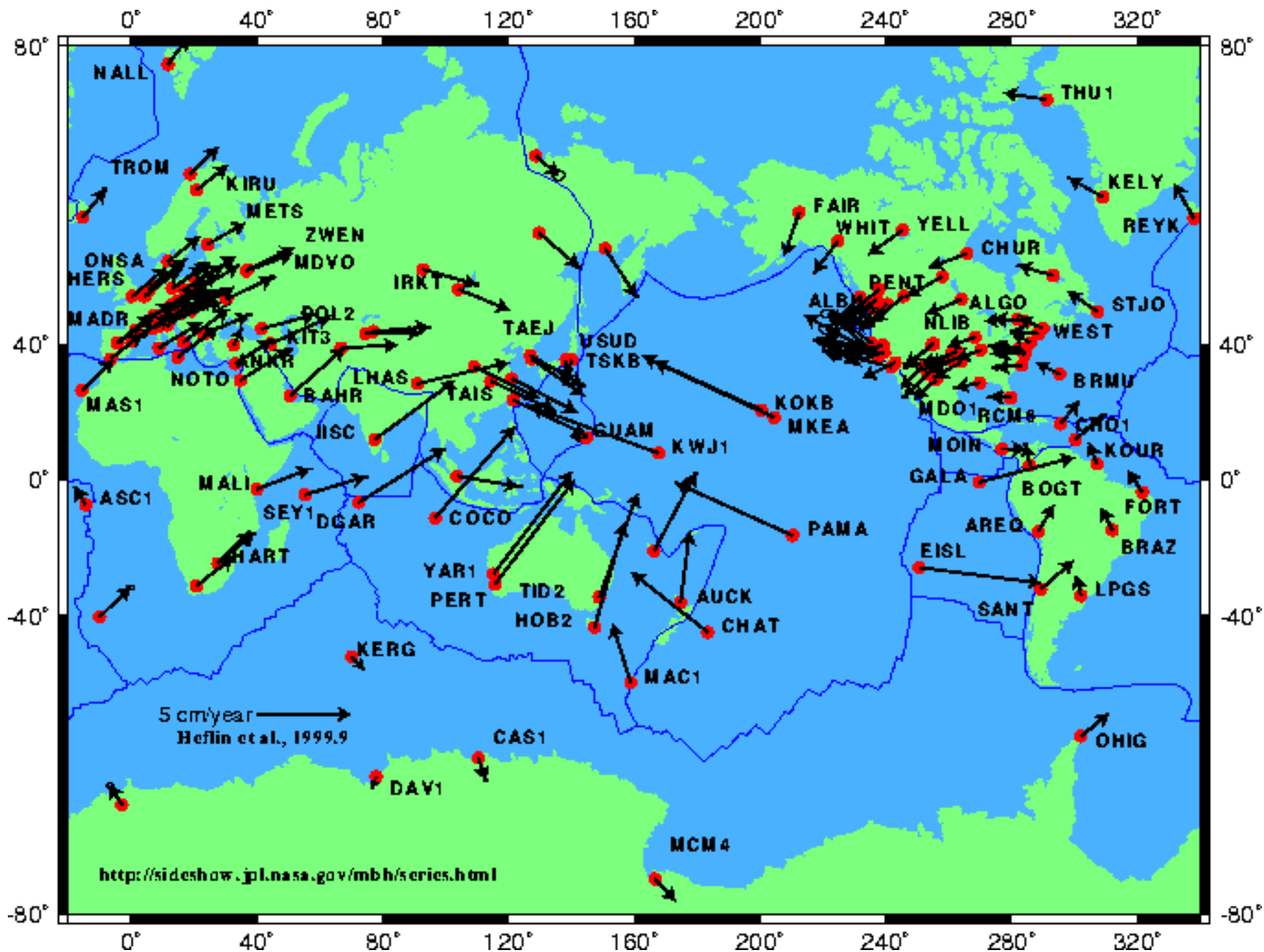
- Optimally align passive control with new CORS
- Add >1000 projects submitted since 2007 project
 - Also observations for Hawaii, other Pacific islands
- Network and local accuracies on all stations
 - Including future submitted projects
- More consistent results in tectonically active areas
 - More current data, better tectonic modeling
- Better computations and analysis techniques
 - E.g., improved outlier detection
 - Incorporation of lessons learned from previous national adjustment



Transformation & Tectonic Complications

- NAD 83(2011) transformation tools?
 - NAD 83(2011) \leftrightarrow (NSRS2007/CORS96) \leftrightarrow (HARN)
 - Under study by NGS
- When is North America not North America?
 - Not all stations on the North American tectonic plate
 - Pacific plate: Hawaii and American Samoa
 - Mariana plate: Guam and CNMI
 - Caribbean plate: Referenced to North American plate
 - Can relate frames (and epoch dates) with HTDP





NAD 83(2011) Epoch:2010.00

Q: Will there be another national adjustment, i.e. a new realization of NAD 83, before the new geometric datum is released?

A: Yes; it's currently underway at NGS HQ; EOY goal.

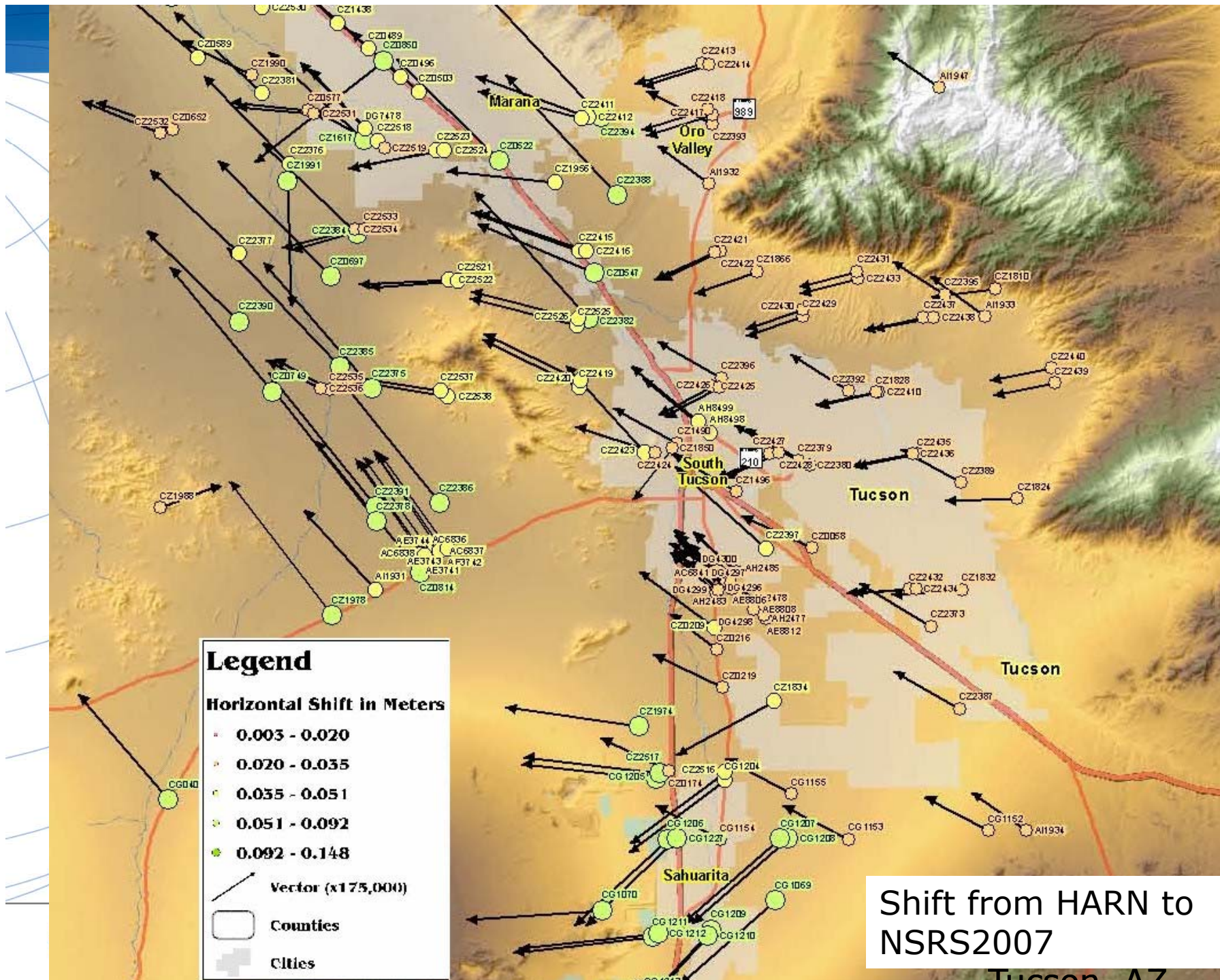
Why?

- Better agreement between CORS and passive control
- Better ellipsoid heights & positions on passive control
- Better transition to new datum(s)

Q: Transformation Tool between NAD 83 realizations?

A: Good question – I'm not sure. NGS is beginning an evaluation of possible solutions.





Future Milestones of the NSRS

1. Multi-Year CORS solution –
 - Completed (for all intents and purposes)
2. National Adjustment (geometric) of passive control
 - 2012
3. Hybrid Geoid Model using new ellipsoid heights
 - 2012
4. National Adjustment (vertical) of GPS passive marks
 - Under consideration
 - This not adjusting the leveling network
5. Adoption of new datums
 - Geometric, could happen any time
 - Vertical, requires completion of GRAV-D



How to Plan for the Future

- Move to a contemporary realization of NAD 83
 - No NAD 83(HARN) <-> NAD 83(NSRS2007) tool
- Obtain precise ellipsoid heights on NAVD 88 bench marks (OPUS, contact NGS Geodetic Advisor(s))
 - Improves hybrid geoid models and provides “hard points” in new vertical datum
- Move off of NGVD 29 to NAVD 88
 - Understand the accuracy of VERTCON in your area
- Move away from passive marks to GNSS
 - Especially move off of classical passive control
- Require/provide complete metadata for all survey/mapping contracts
 - How did they get the positions/heights?
 - Survey Manual/Spatial Data Accuracy and Georeferencing Standards





A Question for You:

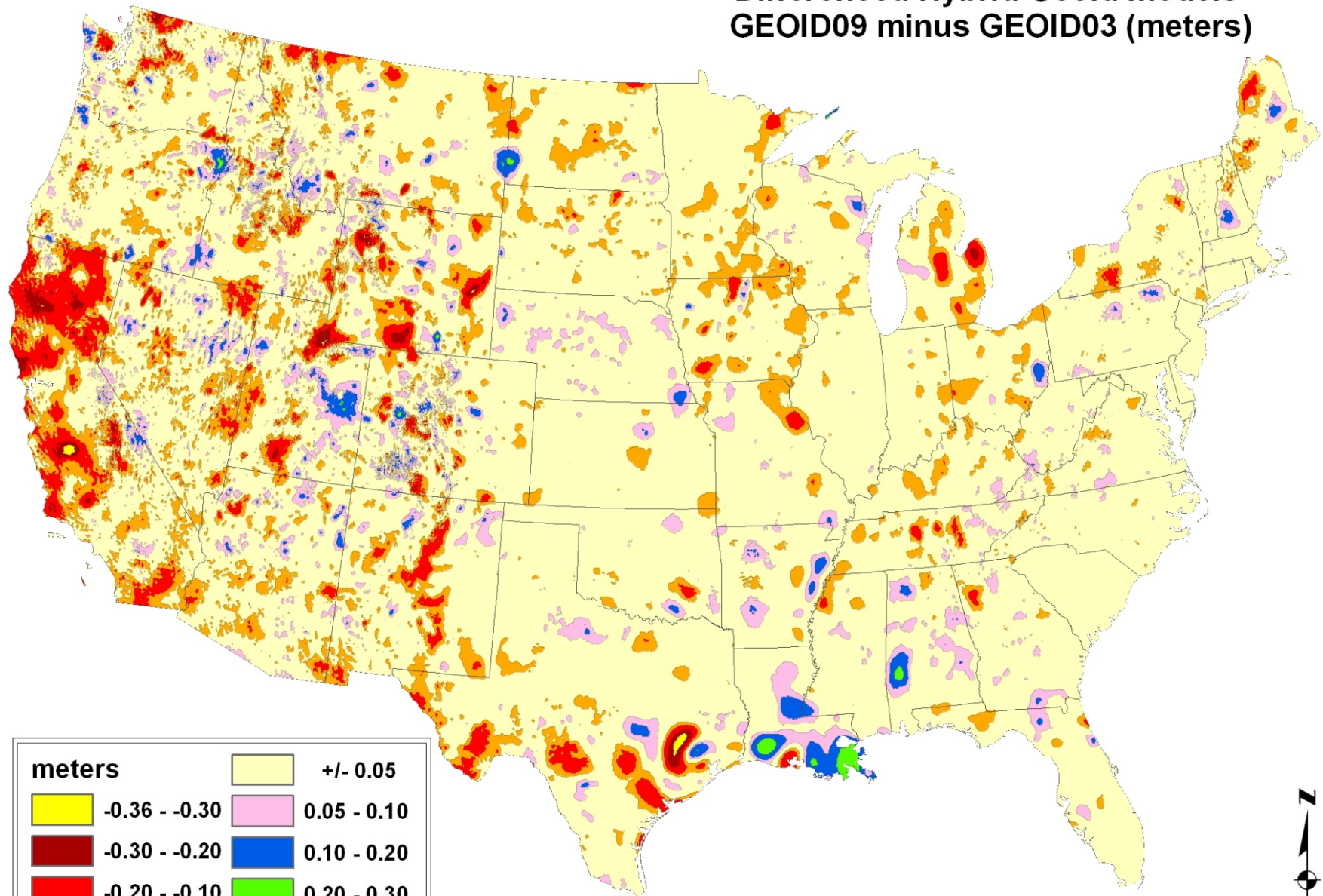
What is good enough with respect to the NSRS,
i.e. have we reached a level of precision and
accuracy where further realizations
(adjustments) are unnecessary?

Near-future plans & possibilities

- **New hybrid geoid model (GEOID12)**
 - Use NAD 83(2011) epoch 2010.00 ellipsoid heights on NAVD 88 benchmarks
 - Might also use OPUS-Database results on NAVD 88 BMs
- **May** perform national vertical adjustment
 - Constrain vertically to NAVD 88 benchmarks
 - Perform as simultaneous nationwide adjustment
 - GNSS-derived orthometric heights
 - NAD 83(2011) ellipsoid heights with GEOID12
 - **NOT** a readjustment of NAVD 88 leveling



Differenced Hybrid Geoid models GEOID09 minus GEOID03 (meters)

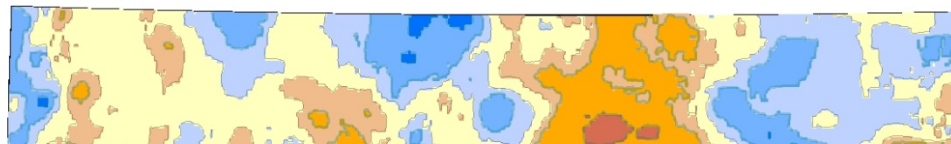


-1.18 ft to +1.28 ft

750 1,000
Kilometers



Geoid Height Differences (m) GEOID03 - GEOID09



GPS-derived orthometric heights Warning #2

$$H \approx h - N$$

The Hybrid GEOID model is defined with respect to a particular realization of NAD 83.

GEOID09 should only be used with NAD 83(NSRS 2007)

GEOID03 should only be used with NAD 83(1992 aka HARN)

NAD 83(HARN) – NAD 83(NSRS2007) in Arizona:
Heights -> min = -20.1 cm, max = 11.5 cm, avg = -2.4 cm

adjusted survey), along with orthometric heights.

-0.10 - -0.05

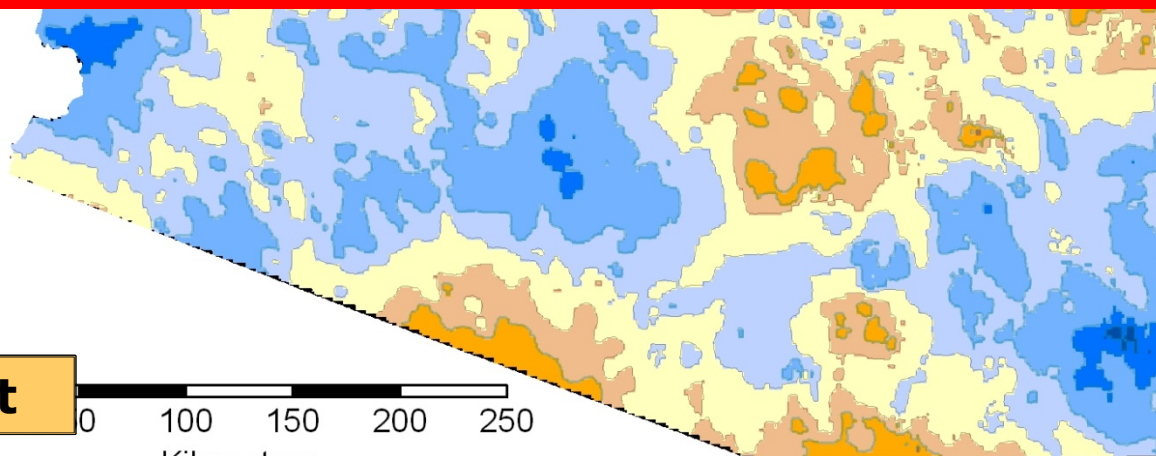
-0.15 - -0.10

-0.17 - -0.15



-0.49 ft to +0.72 ft

0 100 150 200 250
Kilometers



Announcing...

A New NGS Datasheet Format

- **Update to new Datasheet version (8.00)**
 - Changed location, length, and text for many fields
 - Added new fields, deleted fields, augmented existing fields
 - Implemented by end of calendar year 2011
 - Will add announcement and prototype to NGS web site soon
- **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




```

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4
1      National Geodetic Survey,  Retrieval Date = AUGUST 19, 2011
AC6803 *****
AC6803 HT_MOD      -   This is a Height Modernization Survey Station.
AC6803 PACS        -   This is a Primary Airport Control Station.
AC6803 DESIGNATION -   AZC A
AC6803 PID         -   AC6803
AC6803 STATE/COUNTY-   AZ/MOHAVE
AC6803 USGS QUAD   -   LOST SPRING MTN EAST (1988)
AC6803
AC6803                                     *CURRENT SURVEY CONTROL
AC6803
AC6803* NAD 83(2007)- 36 57 59.55377(N)    113 00 32.22917(W)    ADJUSTED
AC6803* NAVD 88      -      1485.56    (meters)    4873.9    (feet)    GPS OBS
AC6803
AC6803 EPOCH DATE   -      2007.00
AC6803 X            -   -1,994,789.496 (meters)                      COMP
AC6803 Y            -   -4,697,388.731 (meters)                      COMP
AC6803 Z            -   3,815,306.819 (meters)                      COMP
AC6803 LAPLACE CORR-      3.37    (seconds)                      DEFLEC09
AC6803 ELLIP HEIGHT-      1462.787 (meters)                      (02/10/07) ADJUSTED
AC6803 GEOID HEIGHT-      -22.80   (meters)                      GEOID09
AC6803
AC6803 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC6803 Type      PID      Designation                      North    East    Ellip
AC6803 -----
AC6803 NETWORK AC6803 AZC A                      0.74    0.61    1.37
AC6803 -----
AC6803
AC6803.This mark is at Colorado City Municipal Airport (AZC)
AC6803
AC6803.The horizontal coordinates were established by GPS observations
AC6803.and adjusted by the National Geodetic Survey in February 2007.
AC6803
AC6803.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC6803 See National Readjustment for more information

```

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 8.00

1 National Geodetic Survey, Retrieval Date = JANUARY 1, 2012

AC6803 *****

AC6803 HT_MOD - This is a Height Modernization Survey Station.

AC6803 PACS - This is a Primary Airport Control Station.

AC6803 DESIGNATION - AZC A

AC6803 PID - AC6803

AC6803 STATE/COUNTY- AZ/MOHAVE

AC6803 COUNTRY - USA

AC6803 USGS QUAD - LOST SPRING MTN EAST (1988)

AC6803

AC6803 *CURRENT SURVEY CONTROL

AC6803

AC6803* NAD 83(2007) POSITION- 36 57 59.55377(N) 113 00 32.22917(W) ADJUSTED

AC6803* NAD 83(2007) ELLIP HT- 1462.787 (meters) (02/10/07) ADJUSTED

AC6803* NAD 83(2007) EPOCH - 2007.00

AC6803* NAVD 88 ORTHO HEIGHT - 1485.56 (meters) 4873.9 (feet) GPS OBS

AC6803* NAVD 88 EPOCH - 2006.81 (for example only, n/a for AC6803)

AC6803

AC6803 NOTE: NAVD 88 ortho height was determined from prior model GEOID03.

AC6803 GEOID03 HEIGHT - -22.75 (meters)

AC6803 GEOID09 HEIGHT - -22.80 (meters)

AC6803 NAD 83(2007) X - -1,994,789.496 (meters) COMP

AC6803 NAD 83(2007) Y - -4,697,388.731 (meters) COMP

AC6803 NAD 83(2007) Z - 3,815,306.819 (meters) COMP

AC6803 LAPLACE CORR - 3.37 (seconds) DEFLEC09

AC6803

AC6803 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)

AC6803 Type Horiz Ellip Dist(km)

AC6803 -----

AC6803 NETWORK ACCURACY 0.86 1.37

AC6803 MEDIAN LOCAL ACCURACY AND DIST (11 points) 0.67 1.22 1.64

AC6803 -----

AC6803 NOTE: Individual local accuracy values and other accuracy information

AC6803 are available [here](#).

AC6803



DATABASE = ,PROGRAM = datasheet, VERSION = 8.00

1 National Geodetic Survey, Retrieval Date = January 1, 2012

AC6803 *****

AC6803 ACCURACIES - Complete network and local accuracy information.

AC6803 HT_MOD - This is a Height Modernization Survey Station.

AC6803 PACS - This is a Primary Airport Control Station.

AC6803 NAME - AZC A

AC6803 PID - AC6803

AC6803

AC6803 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)

AC6803 Type/PID Horiz Ellip Dist(km) Std N Std E Std h Correltn NE

AC6803 -----

AC6803 NETWORK 0.86 1.37 0.38 0.31 0.70 -0.29917912

AC6803 -----

AC6803 MEDIAN LOCAL ACCURACY AND DIST (11 points)

AC6803 AE3181 0.36 0.69 0.07 0.17 0.11 0.35 -0.05276934

AC6803 AC6804 0.22 0.20 0.98 0.10 0.08 0.10 -0.02295189

AC6803 AE3183 0.57 0.90 1.27 0.26 0.19 0.46 -0.24478497

AC6803 AE3184 0.67 1.22 1.35 0.32 0.20 0.62 -0.05253846

AC6803 AE3182 0.66 0.90 1.60 0.30 0.21 0.46 -0.48667427

AC6803 AC6805 0.29 0.24 1.64 0.13 0.10 0.12 -0.07383703

AC6803 HO0112 1.21 2.29 42.91 0.53 0.45 1.17 0.07206508

AC6803 HO0076 0.94 1.71 45.99 0.42 0.34 0.87 -0.05592834

AC6803 AC6806 0.83 1.47 136.10 0.37 0.30 0.75 -0.14246214

AC6803 AC6816 0.82 1.51 139.26 0.33 0.34 0.77 -0.00353532

AC6803 FQ0454 0.86 1.35 230.42 0.38 0.31 0.69 -0.30702358

AC6803

AC6803 MEDIAN 0.67 1.22 1.64

AC6803 -----

AC6803 NOTE: Documentation for the accuracy information is available [here](#).

AC6803

*** retrieval complete.

Elapsed Time = 00:00:00

AC6803.part of the NAVD 88 network.

AC6803

AC6803.The X, Y, and Z were computed from the position and the ellipsoidal ht.

AC6803

AC6803.The Laplace correction was computed from DEFLEC09 derived deflections.

AC6803

AC6803.The ellipsoidal height was determined by GPS observations

AC6803.and is referenced to NAD 83.

AC6803

AC6803.The geoid height was determined by GEOID09.

AC6803

AC6803;

		North	East	Units	Scale Factor	Converg.
--	--	-------	------	-------	--------------	----------

AC6803;SPC AZ W	-	662,036.150	279,346.877	MT	0.99998696	+0 26 44.3
-----------------	---	-------------	-------------	----	------------	------------

AC6803;SPC AZ W	-	2,172,034.61	916,492.38	iFT	0.99998696	+0 26 44.3
-----------------	---	--------------	------------	-----	------------	------------

AC6803;UTM 12	-	4,093,046.689	321,162.779	MT	0.99999401	-1 12 30.2
---------------	---	---------------	-------------	----	------------	------------

AC6803

AC6803!	-	Elev Factor	x	Scale Factor	=	Combined Factor
---------	---	-------------	---	--------------	---	-----------------

AC6803!SPC AZ W	-	0.99977049	x	0.99998696	=	0.99975746
-----------------	---	------------	---	------------	---	------------

AC6803!UTM 12	-	0.99977049	x	0.99999401	=	0.99976451
---------------	---	------------	---	------------	---	------------

AC6803

AC6803	-----				
AC6803	PID	Reference Object	Distance	Geod. Az	
AC6803				dddmss.s	
AC6803	AE3181	AZC CL END RWY 20	68.963 METERS	15655	
AC6803	-----				

AC6803

AC6803

SUPERSEDED SURVEY CONTROL

AC6803

AC6803	ELLIP H (01/12/01)	1462.805 (m)	GP()	4 1
--------	--------------------	--------------	-----	---	-----

AC6803	NAD 83(1992)-	36 57 59.55345(N)	113 00 32.22767(W)	AD() B
--------	---------------	-------------------	--------------------	-----	-----

AC6803	ELLIP H (03/14/97)	1462.873 (m)	GP()	3 1
--------	--------------------	--------------	-----	---	-----

AC6803	NAVD 88 (03/14/97)	1485.51 (m)	4873.7 (f)	GPS OBS	
--------	--------------------	-------------	------------	---------	--

AC6803

AC6803.Superseded values are not recommended for survey control.

AC6803.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

AC6803.[See file dsdata.txt](#) to determine how the superseded data were derived.

AC6803.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC6803

AC6803.The Laplace correction was computed from DEFLEC09 derived deflections.
AC6803

AC6803.The ellipsoidal height was determined by GPS observations
AC6803.and is referenced to NAD 83.
AC6803

AC6803.The geoid height was determined by GEOID09. (remove line)

AC6803

AC6803.The following values were computed from NAD 83(2007).

AC6803

AC6803;		North	East	Units	Scale Factor	Converg.
AC6803;SPC AZ W	-	662,036.150	279,346.877	MT	0.99998696	+0 26 44.3
AC6803;SPC AZ W	-	2,172,034.61	916,492.38	iFT	0.99998696	+0 26 44.3
AC6803;UTM 12	-	4,093,046.689	321,162.779	MT	0.99999401	-1 12 30.2

AC6803

AC6803!	-	Elev Factor	x	Scale Factor	=	Combined Factor
AC6803!SPC AZ W	-	0.99977049	x	0.99998696	=	0.99975746
AC6803!UTM 12	-	0.99977049	x	0.99999401	=	0.99976451

AC6803

AC6803	PID	Reference Object	Distance	Geod. Az
AC6803				dddmss.s
AC6803	AE3181	AZC CL END RWY 20	68.963 METERS	15655

AC6803

AC6803 SUPERSEDED SURVEY CONTROL

AC6803

AC6803	ELLIP H (01/12/01)	1462.805 (m)	GP()	4 1
AC6803	NAD 83(1992)-	36 57 59.55345(N)	113 00 32.22767(W)	AD() B
AC6803	ELLIP H (03/14/97)	1462.873 (m)	GP()	3 1

AC6803 NAVD 88 (03/14/97) 1485.51 (m) GEOID96 model used GP(epoch if appl)

AC6803

AC6803.Superseded values are not recommended for survey control.

AC6803.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

AC6803.[See file dsdata.txt](#) to determine how the superseded data were derived.

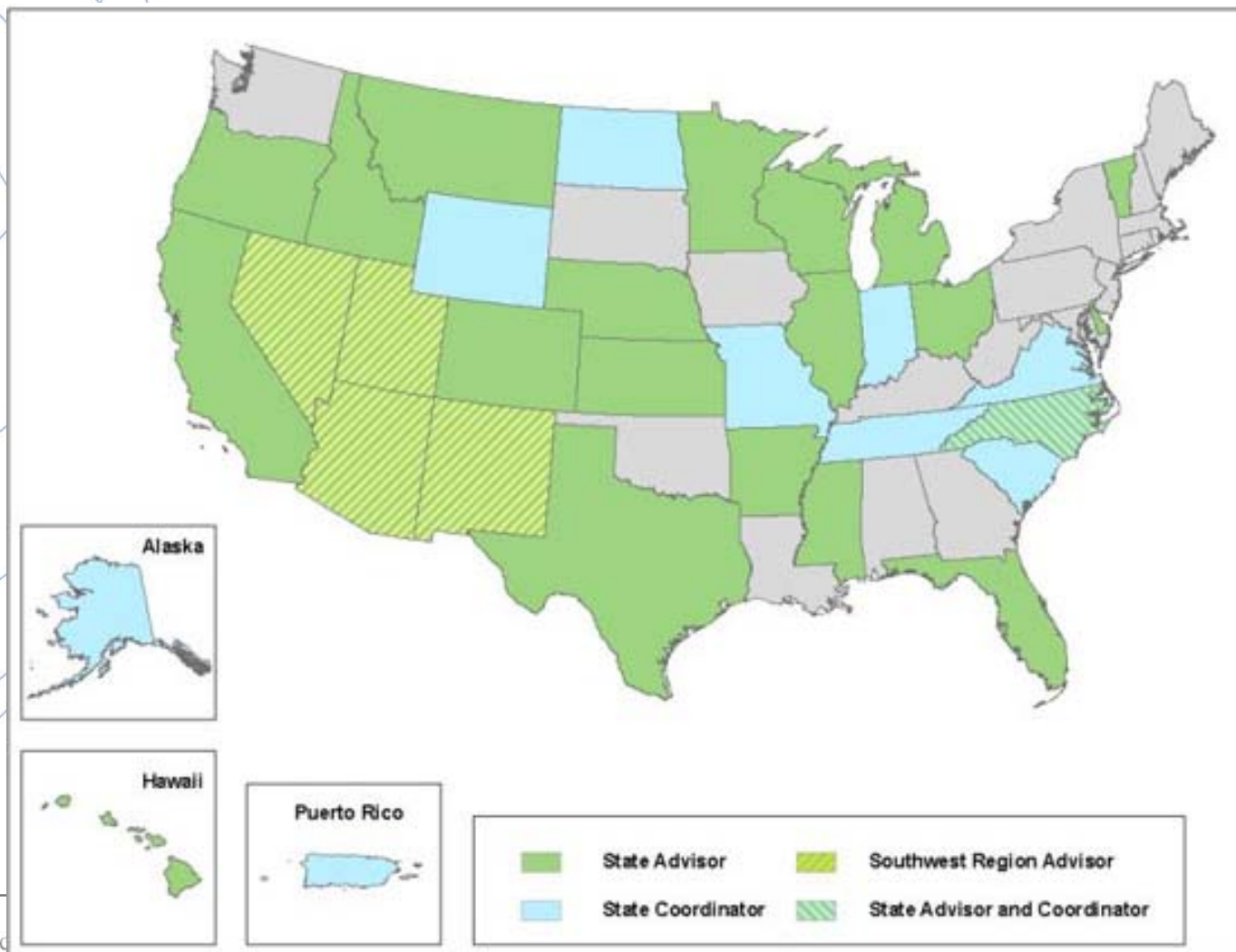
CBLs

STATE OF COLORADO CONTENTS

BASE LINE DESIGNATION	STATE	COUNTY	QUAD
ALAMOSA CBL (2005 REMEASURED)	COLORADO	ALAMOSA	N371053
CHERRY CREEK CBL (UNUSABLE)	COLORADO	ARAPAHOE	N391044
CORTEZ CBL (2004 REMEASURED)	COLORADO	MONTEZUMA	N371083
CRAIG CBL (2004 REMEASURED)	COLORADO	MOFFAT	N401074
DURANGO CBL (2004 MEASURED)	COLORADO	LA PLATA	N371073
EL PASO CBL (2004 MEASURED)	COLORADO	EL PASO	N381044
FORT CARSON CBL (2005 REMEASURED)	COLORADO	EL PASO	N381044
HIGHLINE CBL (2004 REMEASURED)	COLORADO	ADAMS	N391044
KELIM CBL (2004 REMEASURED)	COLORADO	WELD	N401043
LAMAR CBL (2004 REMEASURED)	COLORADO	PROWERS	N381023
LIMON CBL (2004 REMEASURED)	COLORADO	LINCOLN	N391033
MEEKER CBL (2005 REMEASURED)	COLORADO	RIO BLANCO	N401073
MESA (2005 VERIFIED)	COLORADO	MESA	N391083
MONTROSE CBL (2005 REMEASURED)	COLORADO	MONTROSE	N381074
NEW CASTLE CBL (2004 VERIFIED)	COLORADO	GARFIELD	N391074
PINON CANYON CBL (2005 REMEASURED)	COLORADO	LAS ANIMAS	N371041
PUEBLO 2 CBL (2005 VERIFIED)	COLORADO	PUEBLO	N381042
STERLING CBL (2004 VERIFIED)	COLORADO	LOGAN	N401031



Advisor Status In Your State





More information...

National Geodetic Survey

geodesy.noaa.gov

Positioning America for the Future

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August 19, 2011

In The News

2010 Federal Geospatial Summit Proceedings on Improvements to the National Spatial Reference System available:

<http://www.ngs.noaa.gov/2010Summit/proceedings.shtml>

A 2009 independent study shows the benefits to the U.S. economy from NOAA's positioning products and services are in the billions of dollars.

Click [here](#) for a one page overview of the study

Click [here](#) for a copy of the full report

Trial Version of the New NOAA Shoreline Data Explorer Available:

http://beta.ngs.noaa.gov/shoreline_raster

National Geodetic Survey Announces National Adjustment of 2011 Project

As part of the National Geodetic Survey's (NGS) continuing efforts to improve the National Spatial Reference System (NSRS), on May 27, NGS was pleased to announce the National Adjustment of 2011 (NA2011) project...[more](#)

08/11/2011 - NOAA Gravity Survey to Begin in the Great Lakes

The National Geodetic Survey's Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project is working with Fugro Airborne Surveys to begin an airborne gravity survey in the eastern Great Lakes...[more](#)

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Control
Subcommittee
of the **fgdc**

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Questions? Comments?

Multi-Year CORS Solution

National Adjustment of 2011

New NGS Datasheet Format



The NGS Data Sheet

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

```

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 8.00
1 National Geodetic Survey, Retrieval Date = JANUARY 1, 2012
AC6803 *****
AC6803 HT_MOD - This is a Height Modernization Survey Station.
AC6803 PACS - This is a Primary Airport Control Station.
AC6803 DESIGNATION - AZC A
AC6803 PID - AC6803
AC6803 STATE/COUNTY - AZ/MOHAVE
AC6803 COUNTRY - USA
AC6803 USGS QUAD - LOST SPRING MTN EAST (1988)
AC6803
AC6803 *CURRENT SURVEY CONTROL
AC6803
AC6803* NAD 83(2007) POSITION- 36 57 59.55377(N) 113 00 32.22917(W) ADJUSTED
AC6803* NAD 83(2007) ELLIP HT- 1462.787 (meters) (02/10/07) ADJUSTED
AC6803* NAD 83(2007) EPOCH - 2007.00
AC6803* NAVD 88 ORTHO HEIGHT - 1485.56 (meters) 4873.9 (feet) GPS OBS
AC6803* NAVD 88 EPOCH - 2006.81 (feet)
AC6803
AC6803 NOTE: NAVD 88 ortho height was determined from prior model GEOID03.
AC6803 GEOID03 HEIGHT - -22.75 (meters)
AC6803 GEOID09 HEIGHT - -22.80 (meters)
AC6803 NAD 83(2007) X - -1,994,789.496 (meters) COMP
AC6803 NAD 83(2007) Y - -4,697,388.731 (meters) COMP
AC6803 NAD 83(2007) Z - 3,815,306.819 (meters) COMP
AC6803 LAPLACE CORR - 3.37 (seconds) DEFLEC09
AC6803
AC6803 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
AC6803 Type Horiz Ellip Dist(km)
AC6803
AC6803 NETWORK ACCURACY 0.86 1.37
AC6803 MEDIAN LOCAL ACCURACY AND DIST ( 11 points) 0.67 1.22 1.64
AC6803
AC6803 NOTE: Individual local accuracy values and other accuracy information
AC6803 are available here.
AC6803
AC6803 This mark is at Colorado City Municipal Airport (AZC)
AC6803
AC6803 The horizontal coordinates were established by GPS observations
AC6803 and adjusted by the National Geodetic Survey in February 2007.
AC6803
AC6803 The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC6803 See National Readjustment for more information.
AC6803 The horizontal coordinates are valid at the epoch date displayed above.
AC6803 The epoch date for horizontal control is a decimal equivalence
AC6803 of Year/Month/Day.
AC6803
AC6803 The orthometric height was determined by GPS observations and a
AC6803 high-resolution geoid model.
AC6803
AC6803 GPS derived orthometric heights for airport stations designated as

```

Data Sheet

for more information about the datasheet.

```

SIDB , PROGRAM = datasheet95, VERSION = 7.87.4
National Geodetic Survey, Retrieval Date = AUGUST 19, 2011
*****
ID - This is a Height Modernization Survey Station.
DN - This is a Primary Airport Control Station.
GNATION - AZC A
AC6803
E/COUNTY - AZ/MOHAVE
QUAD - LOST SPRING MTN EAST (1988)

*CURRENT SURVEY CONTROL

83(2007)- 36 57 59.55377(N) 113 00 32.22917(W) ADJUSTED
88 - 1485.56 (meters) 4873.9 (feet) GPS OBS

H DATE - 2007.00
- -1,994,789.496 (meters) COMP
- -4,697,388.731 (meters) COMP
- 3,815,306.819 (meters) COMP
ACE CORR- 3.37 (seconds) DEFLEC09
P HEIGHT- 1462.787 (meters) (02/10/07) ADJUSTED
D HEIGHT- -22.80 (meters) GEOID09

--- Accuracy Estimates (at 95% Confidence Level in cm) ---
PID Designation North East Ellip
DRK AC6803 AZC A 0.74 0.61 1.37

```

mark is at Colorado City Municipal Airport (AZC)

Horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in February 2007.

Datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007). See [National Readjustment](#) for more information.

Horizontal coordinates are valid at the epoch date displayed above. Epoch date for horizontal control is a decimal equivalence of Year/Month/Day.

Orthometric height was determined by GPS observations and a high-resolution geoid model.

Derived orthometric heights for airport stations designated as PACS or SACS are published to 2 decimal places. This maintains meter relative accuracy between the PACS and SACS. It does indicate centimeter accuracy relative to other marks which are of the NAVD 88 network.

AC6803
AC6803 The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC6803

