



**Better Positions *and***

**Improved Access *to the***

# **National Spatial Reference System**

***The National Adjustment of 2011***

***and related National Geodetic Survey***

***products & services***

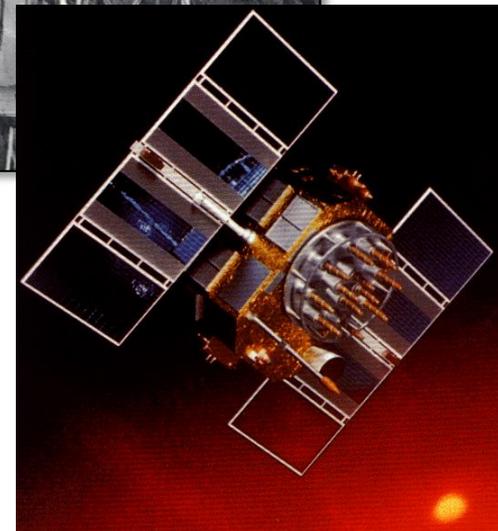
**Scott Lokken**  
**NGS State Advisor (NC)**  
**[scott.lokken@noaa.gov](mailto:scott.lokken@noaa.gov)**

# Contents:

- *The National Spatial Reference System*
  - A (very) brief history of NAD 83
  - The latest realization: NAD 83(2011) epoch 2010.00
- Related and dependant NGS products & services
  - The Multi-Year CORS Solution (MYCS)
  - OPUS
  - A new hybrid geoid model (GEOID12)
  - New NAD 83 coordinate transformations
  - New NGS Datasheet format
  - Subsequent Development of GEOID12 (In progress, waiting on NAD83(2011) heights)

# A (very) brief history of NAD 83

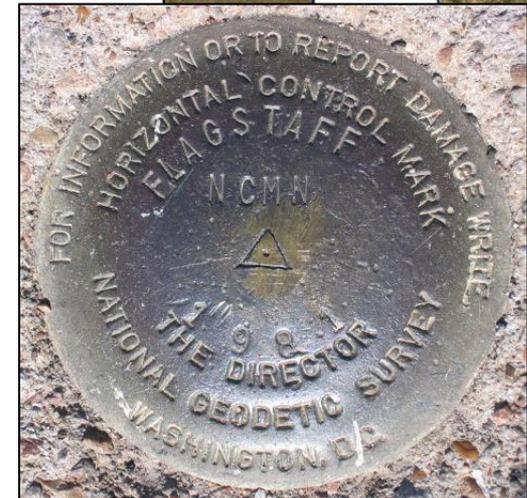
- Original realization completed in 1986
  - Consisted (almost) entirely of classical (optical) observations
- “High Precision Geodetic Network” (HPGN) and “High Accuracy Reference Network” (HARN) realizations
  - Most done in 1990s, essentially state-by-state
  - Based on GNSS but classical stations 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***



# 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-- NAD83(2011)**
  - New adjustment of GNSS passive control
  - GNSS vectors tied (and constrained) to CORS NAD 83(2011) epoch 2010.00
  - Approximately 80,000 stations and 400,000 GNSS vectors
- **Realization SAME for CORS and passive marks**
- **This is *NOT* a new datum! (still NAD 83)**



# Why a new NAD 83 realization?

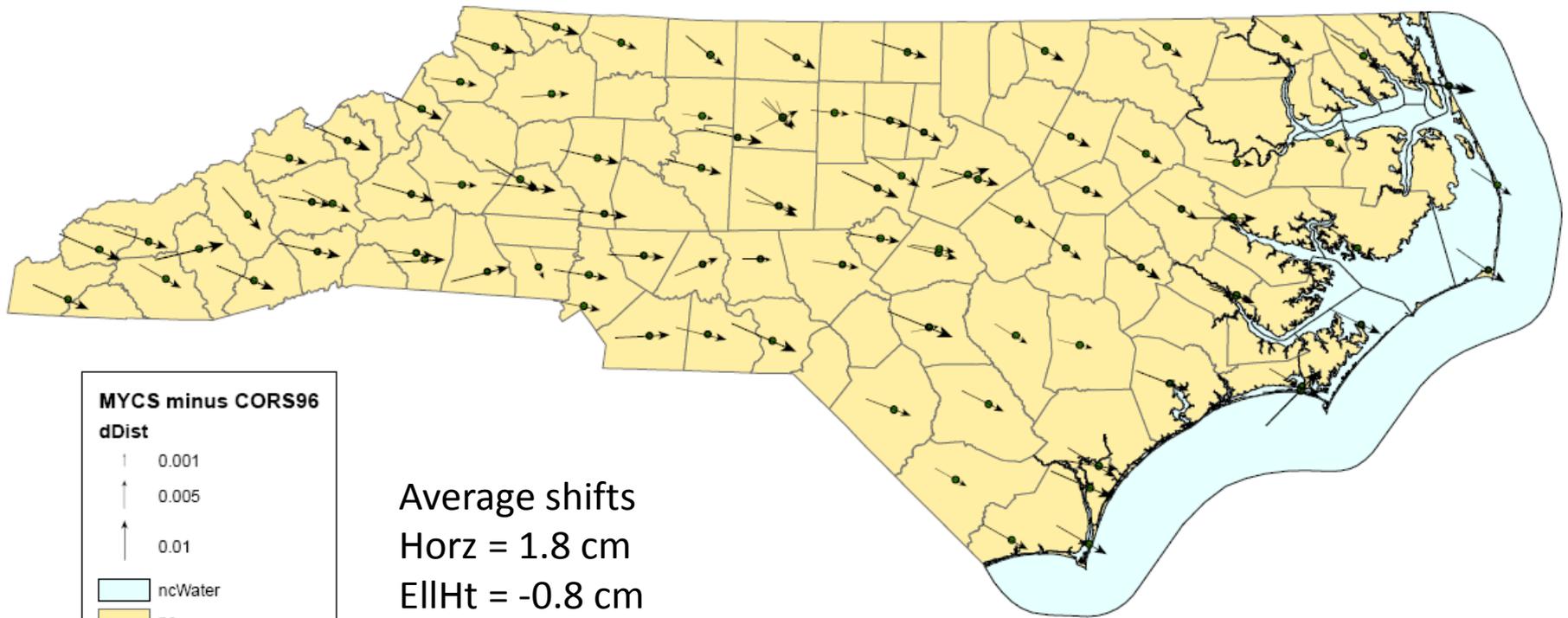
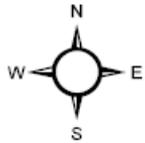
- Previous NAD 83(CORS96) needed many improvements
- NSRS improvements achieved with the MYCS include:
  - Consistent coordinates and velocities from combined solution
  - Aligned with most recent realization of global frame (IGS08)
    - IGS08 epoch 2005.0 (previous aligned at epoch 1997.0)
    - NAD 83 epoch 2010.0 (previous epochs of 2002.0 and 2003.0)
  - Major processing algorithm, modeling, metadata improvements
  - Absolute phase center antenna calibrations
- **Highly accurate *and* consistent CORS coordinates *and* velocities determined using Best Available Methods**
  - *Needed because CORS network is foundation of NSRS*

# New Adjustment

- Name: **NAD83(2011) epoch 2010.**
- Released end of June 2012
  - Delayed due to technical difficulties and new data inclusion
- Based on re-computation of all CORS 1994 to present to align with world wide effort.
- NC Shifts (based on CORS shifts)
  - @ 1.8cm generally ESE
  - @ -0.8cm (mainly due to computational change)

# Shift From CORS96 to NAD83(2011)

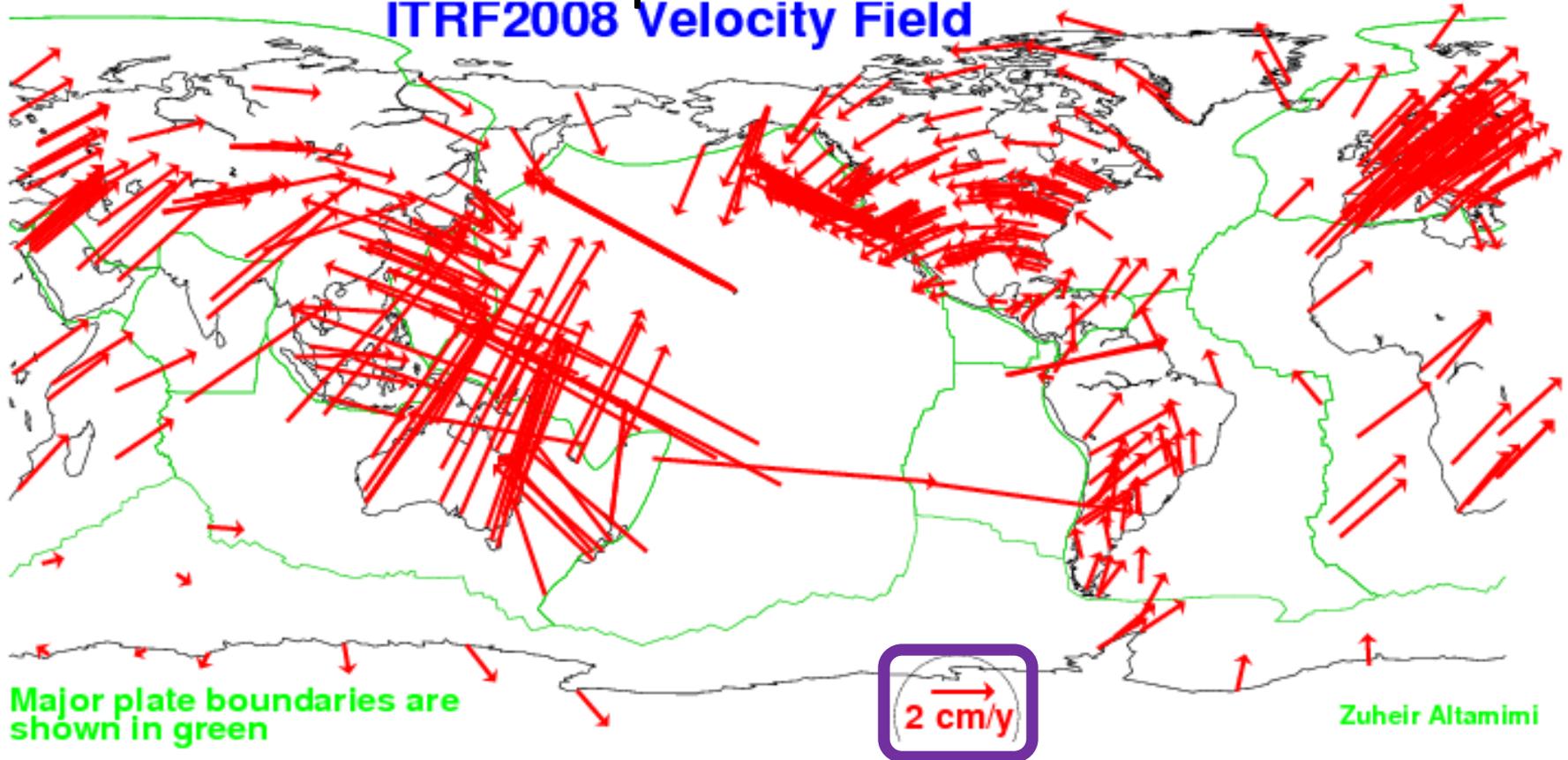
MYCS minus CORS96 comparison



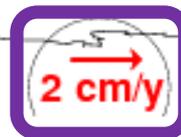
# Rationale for Updating the NSRS (CORS)

- Definition starts with a global RF: ITRF##
- No fixed tectonic plate results in velocities

ITRF2008 Velocity Field

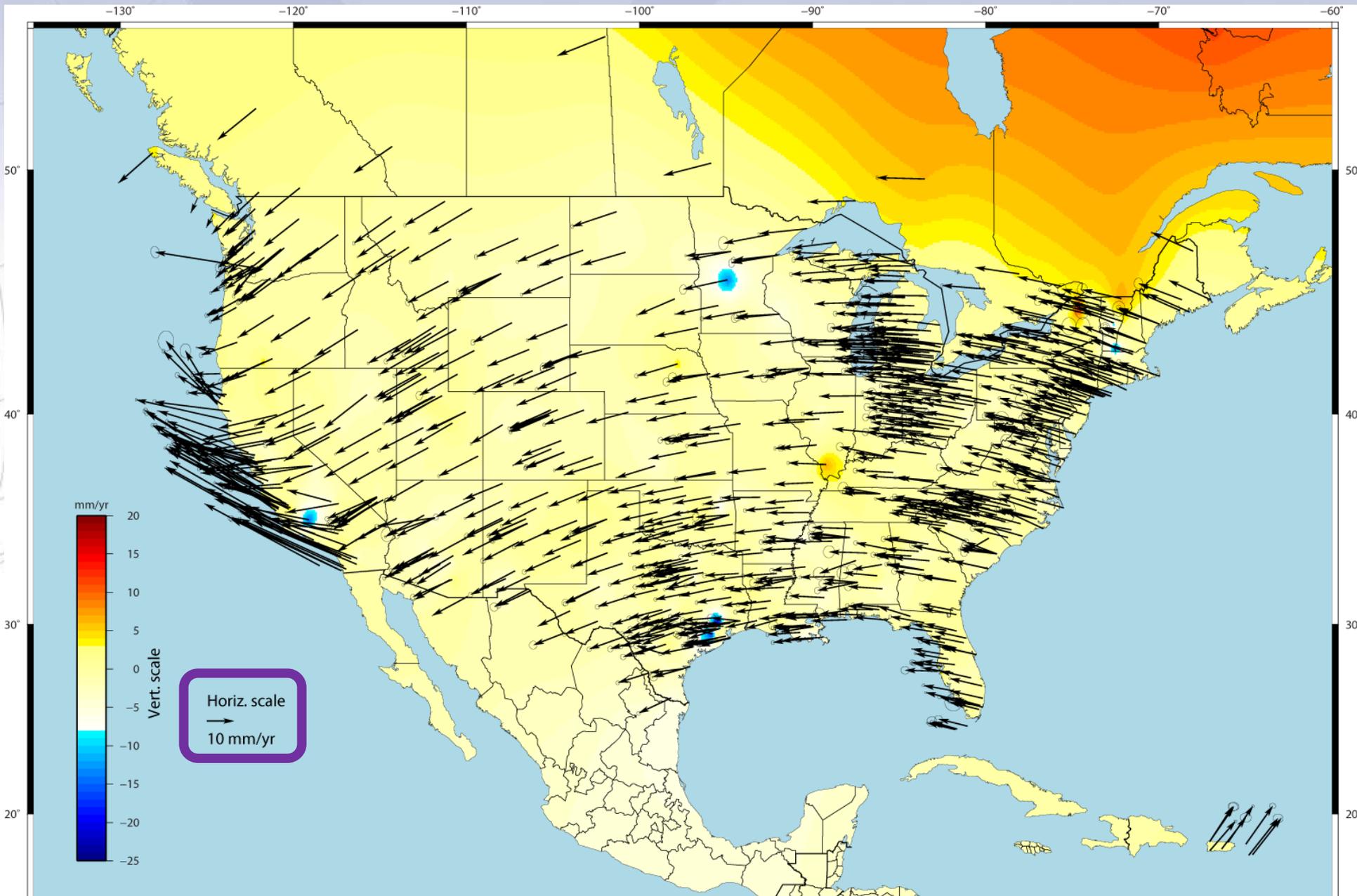


Major plate boundaries are shown in green



Zuheir Altamimi

# U.S. CORS Velocity Field – ITRF2008

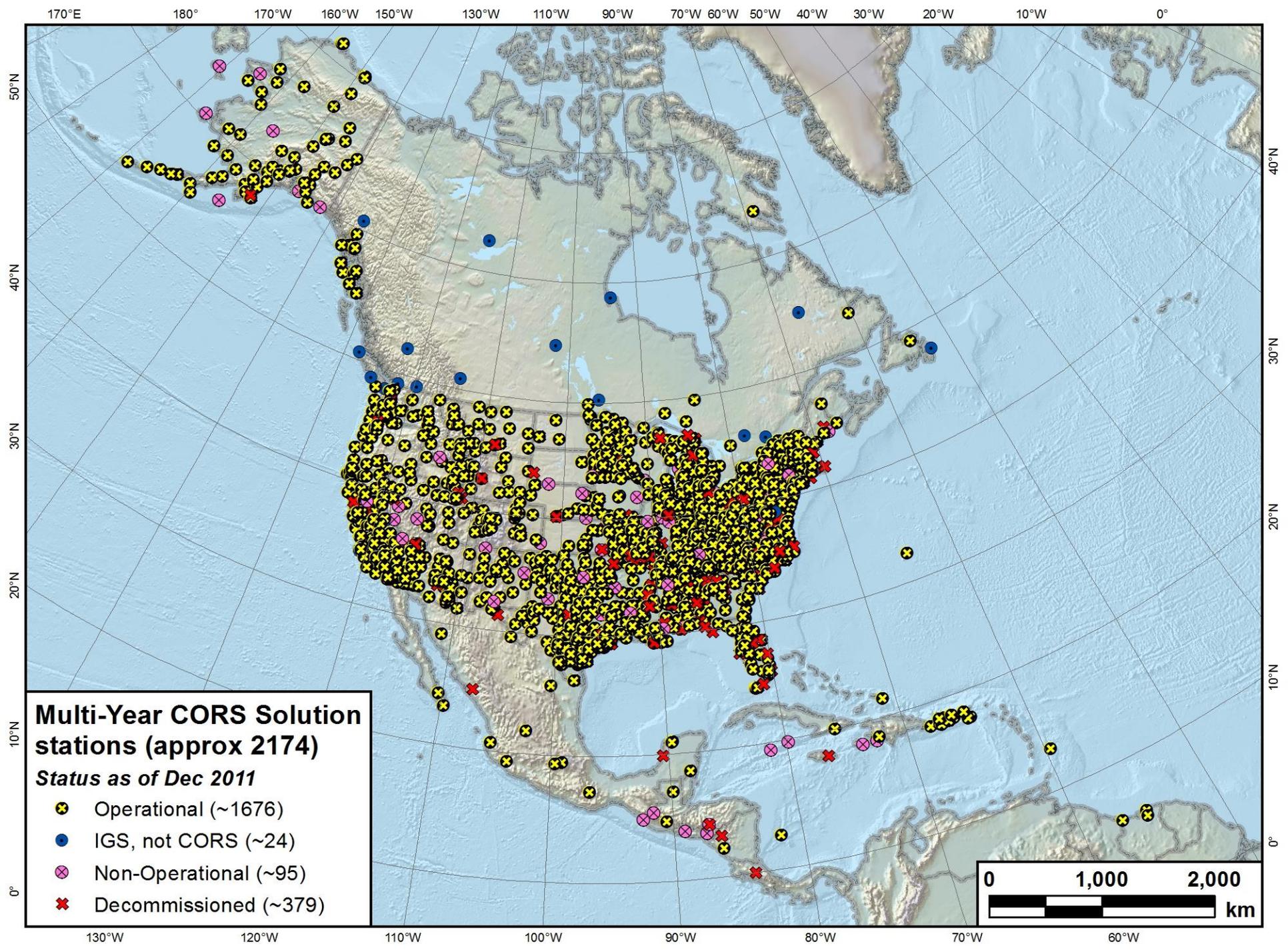


# Rationale for updating CORS RF(MYCS)

- NSRS's global reference frame was ITRF00 epoch 1997.00. Projecting 13 yrs was unrealistic because of velocities; NAD 83(CORS96) epoch 2002.00 projecting 8 yrs was becoming a problem
- Coordinates and velocities were a mixture from last reprocessing (1994-2002) and adjustments using 3 to 8 IGS ref. sites
- Mixture of Computed and HTDP velocities
- Assumed NAD83 vertical vel. = 0 mm/yr
- Change from Relative to Absolute antenna phase center values in ITRF definition
- Metadata issues, eg, discontinuities/offsets
- Significant software changes since 2002

# Multi-year CORS Solution: MYCS

- “Multiyear” effort began 7 years ago
- IGS proposed re-processing all data to re-compute station coordinates, orbits, and EOPs (earth orientation parameters) from 1994-present
- NGS began with a revision of PAGES software and processing strategy driven by weak NGS orbit contributions to IGS
- 860 weekly (full history) CORS+ ~230 global SINEX files containing X,Y,Z positions and full variance-covariance information
- Coordinates published (online) on Sept 6, 2011



## Multi-Year CORS Solution stations (approx 2174)

Status as of Dec 2011

- ⊗ Operational (~1676)
- IGS, not CORS (~24)
- ⊗ Non-Operational (~95)
- ✖ Decommissioned (~379)



# Geodetic Reference Frames

## past and present

- **Critical** to pay attention to **frame tags and epoch dates and antenna calibration values**

Frame Name	Epoch	Antenna PCV*	Data Duration
ITRF2000	1997.0	Rel ANTEX	1994.0-2002.0
ITRF00 (NGS's soln)	1997.0	Rel NGS ANTEX	1994.0-present
NAD 83(CORS96)	2002.0	Rel NGS ANTEX	1994.0-present
ITRF2008	2005.0	Abs IGS05 ANTEX	1997.0-2009.5
IGS08	2005.0	Abs IGS08 ANTEX	1997.0-2009.5
IGS08 (NGS's <del>xxxxxxx</del> )	2005.0	Abs IGS08 ANTEX	1994.0-2010.5 (ongoing)
NAD 83(2011) ( <del>xxxxxxx</del> )	2010.0	Abs IGS08 ANTEX	1994.0-2010.5 (ongoing)

\*PCV – phase center value; Abs-Absolute, Rel-Relative

# So, what's different about the CORS coordinates?

- Change to absolute antenna calibrations
  - Use absolute cal. in **your** processing: DON'T MIX!
- Better because 8 more years of data for:
  - International CGPS sites
  - CORS: about 1600 total, ~1000 w/ >2.5 yrs
  - Orbits and sophistication for processing them
  - CORS velocity
- Better HTDP modeling for those w/ <2.5 yrs
- Better processing algorithms

# Antenna calibrations, ANTEX is new

NGS Home	About NGS	Data & Imagery	Tools	Surveys
		<ul style="list-style-type: none"> <li>Survey Mark Datasheets</li> <li>GPS Data (CORS)</li> <li>GPS Data (Real-Time)</li> <li>Aerial Images (Storm)</li> <li>Aerial Images (Coast)</li> <li>Aeronautical Data</li> <li>Antenna Calibration Data</li> <li>GEOID (09,06,03,99)</li> <li>Gravity Data</li> <li>Orbit Data</li> <li>Shoreline Data</li> <li>Storm Imagery (Irene)</li> <li>Storm Imagery (Joplin)</li> <li>Storm Imagery (Tuscaloosa)</li> </ul>		
<p><b>Most Popular</b></p> <ul style="list-style-type: none"> <li>Contact Us</li> <li>CORS</li> <li>Survey Mark Datasheets</li> <li>Geodetic Tool Kit</li> <li>NA2011</li> <li>OPUS</li> <li>Publications</li> <li>Geodetic Advisors</li> <li>Storm Imagery</li> <li>UFCORS</li> </ul>				
<p><b>Upcoming Events</b></p>		<p>...for T version a 90-d isting o LOCUS</p> <p>to Sub eb/sur</p> <p>t for Fl 022 an th Am ely wit</p> <p>...to NGS In response to stakeholder and N several modifications to the forma method for accessing the passive Reference System (NSRS)...more</p> <p>Trial Version of the New NOAA S <a href="http://beta.ngs.noaa.gov/shorelin">http://beta.ngs.noaa.gov/shorelin</a></p> <p>2010 Federal Geospatial Summit</p>		



# On to NAD83(2011)

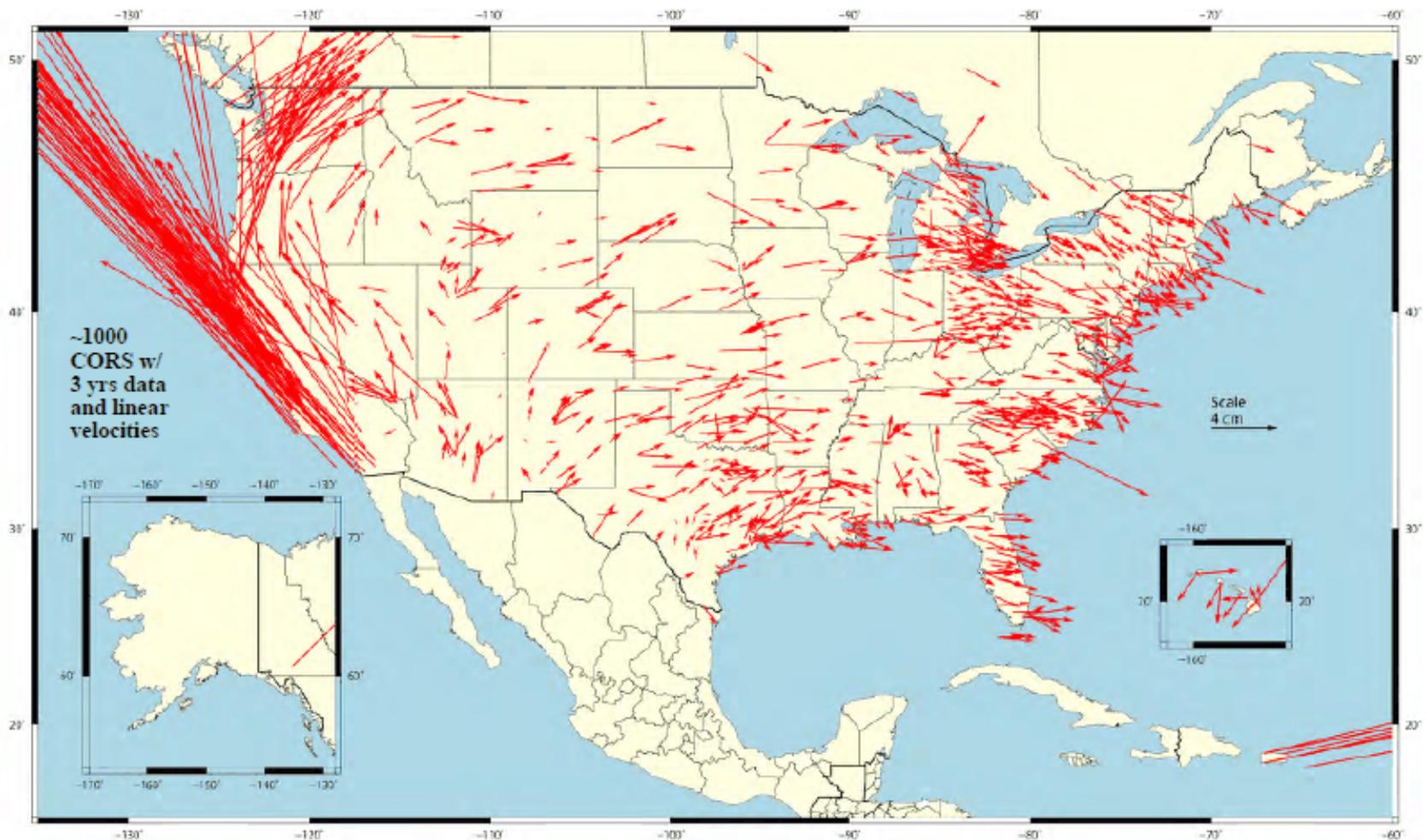
## Timeline

- National Adjustment of 2011
  - Goal: Complete May 2012, published **June 2012**
- Related and dependant products and services
  - Multi-Year CORS Solution
    - Officially released coordinates September 2011
  - OPUS (Online Positioning User Service)
    - Dual solutions (CORS96 and MYCS) available until NA2011 complete
  - New hybrid geoid model (GEOID12)
    - Use NAD 83(2011) ellipsoid heights on leveled NAVD 88 benchmarks
    - Released same time as NA2011
    - Problems detected and revised **GEOID12A** released Sept 11, 2012.
  - New NAD 83 coordinate transformation tools
    - HARN / NSRS2007 / 2011
    - At same time as NA2011 (or soon after)
    - HARN / 2007 algorithm done, just need to implement

# Shift in *Horizontal* Positions due to Change in Ref Epoch

NAD 83 (CORS96A @ 2010.0) – NAD 83 (CORS96 @ 2002.0)

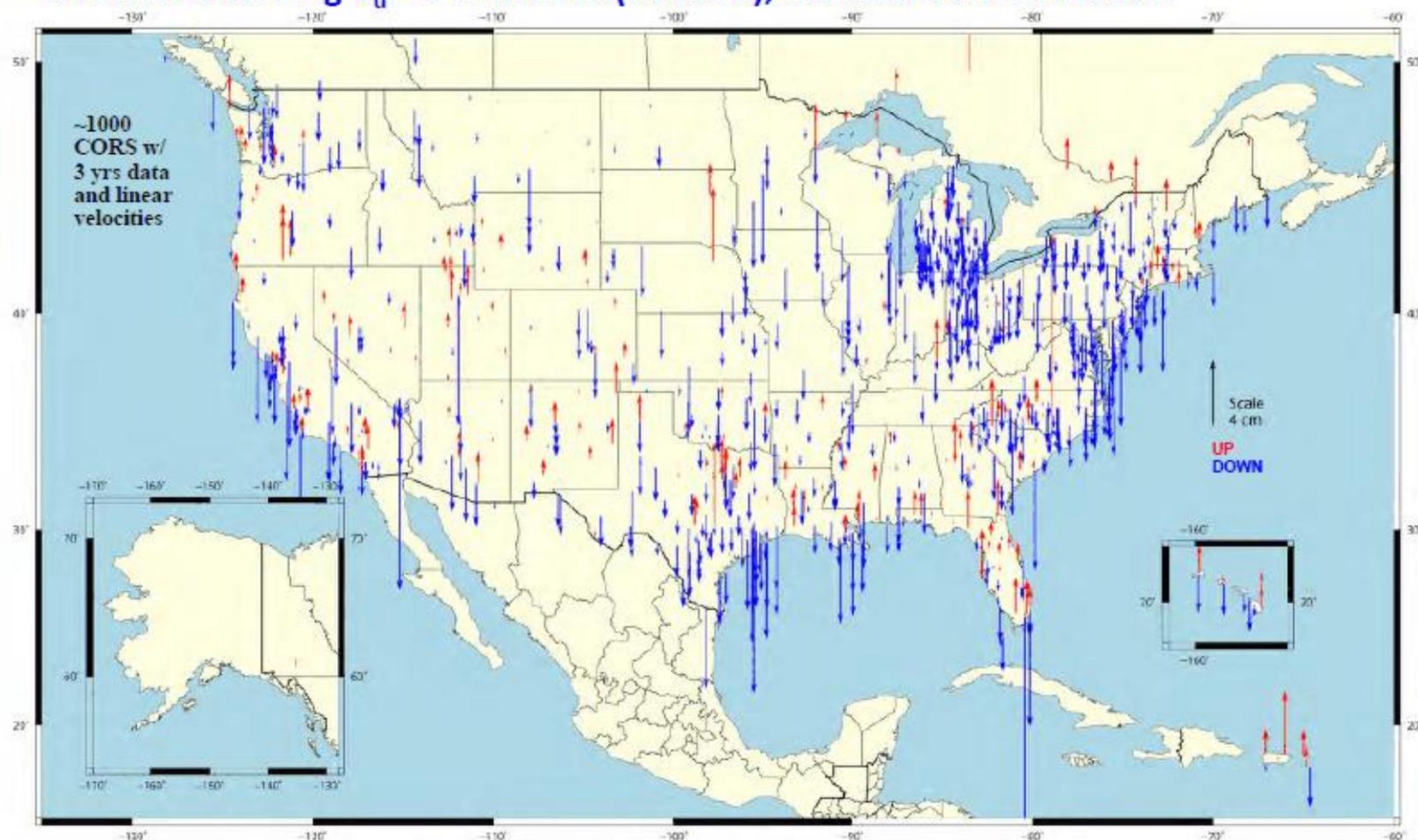
- **avg. shifts:**  $\Delta E = 0.20 (\pm 5.85)$  cm;  $\Delta N = 1.95 (\pm 6.42)$  cm
  - large shifts in western U.S. due to crustal deformation
  - apparent rotation in “stable” U.S. likely due to errors in NUVEL-1A (used in HTDP)



# Shift in *Vertical* Positions due to Change in Ref Epoch

I NAD 83 (COR96A @ 2010.0) – NAD 83 (COR96 @ 2002.0)

- **avg. shift: = -0.92 cm ( $\pm 2.04$ ) cm**
  - switch to absolute antenna calibrations
  - much of eastern U.S. has downward velocities
  - effect of assuming  $V_u = 0$  in NAD 83(COR96), i.e. local vertical motion



# Why a new national adjustment?

- Optimally align passive control with new CORS
- Over 700 projects submitted since 2007 project
  - Also observations for Hawaii, other Pacific islands
- Determine 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, weighted constraints
  - Incorporation of lessons learned from previous national adjustment

# Approach

- Used a Helmert blocking strategy for CONUS
  - Approx 80,000 points (~240,000 unknowns)
  - Over 400,000 GNSS vectors (> 1.2 million observations)
- Individual projects weighted to account for variable error
  - Horiz and vertical std deviation scale factors computed for all projects
- Outlier detection (for rejecting vectors)
  - Initially using 5 cm threshold, will also check standardized residuals
- Method for vector rejection
  - Rejection by *downweighting vs. removal*
- Challenges:
  - Tectonic tribulations
  - CORS complications
  - Constraint conundrums
  - Subsidence
  - Mixing old and new observations

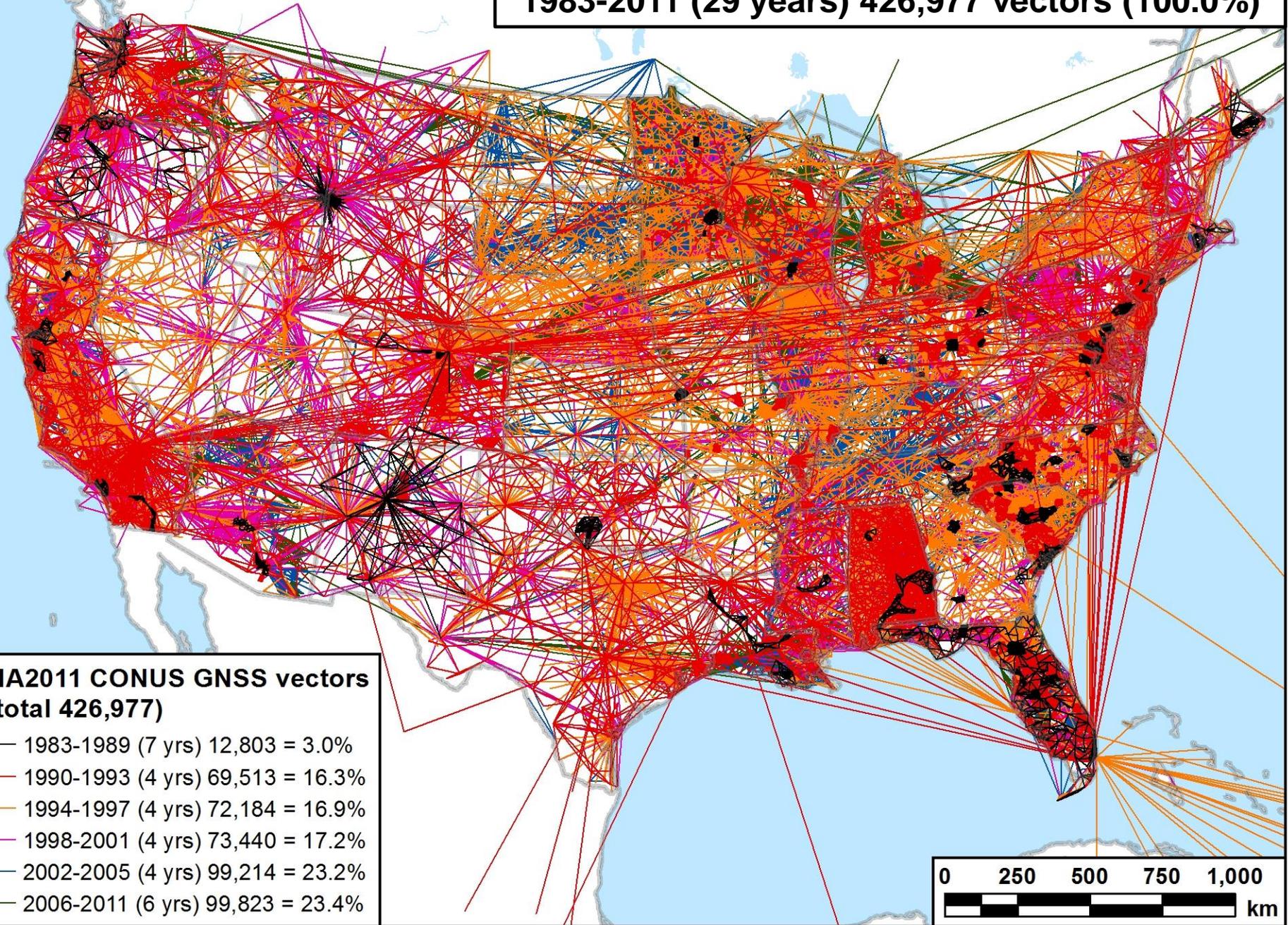
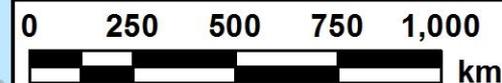
# The building of a network

- Consists of many GPS vectors over time
  - Earliest vectors determined in April 1983
  - Last vectors determined in October 2011
- Vectors prior to ~1993/1994 may be problematic
  - Orbits not accurately determined
  - Poor or no models (e.g., tropo, ocean loading, etc.)
  - Early generation of receivers and antennas (noisier data)
  - Incomplete GPS constellation
  - No antenna phase center models
  - MYCS positions based only on data to 1994
- What should be done about the “old” data...?
  - Was project scaling sufficient? Do additional scaling?
  - Consider removing “old” data from adjustment?

1983-2011 (29 years) 426,977 vectors (100.0%)

**NA2011 CONUS GNSS vectors  
(total 426,977)**

- 1983-1989 (7 yrs) 12,803 = 3.0%
- 1990-1993 (4 yrs) 69,513 = 16.3%
- 1994-1997 (4 yrs) 72,184 = 16.9%
- 1998-2001 (4 yrs) 73,440 = 17.2%
- 2002-2005 (4 yrs) 99,214 = 23.2%
- 2006-2011 (6 yrs) 99,823 = 23.4%



1983-1993 (11 years) 82,316 vectors (19.3%)

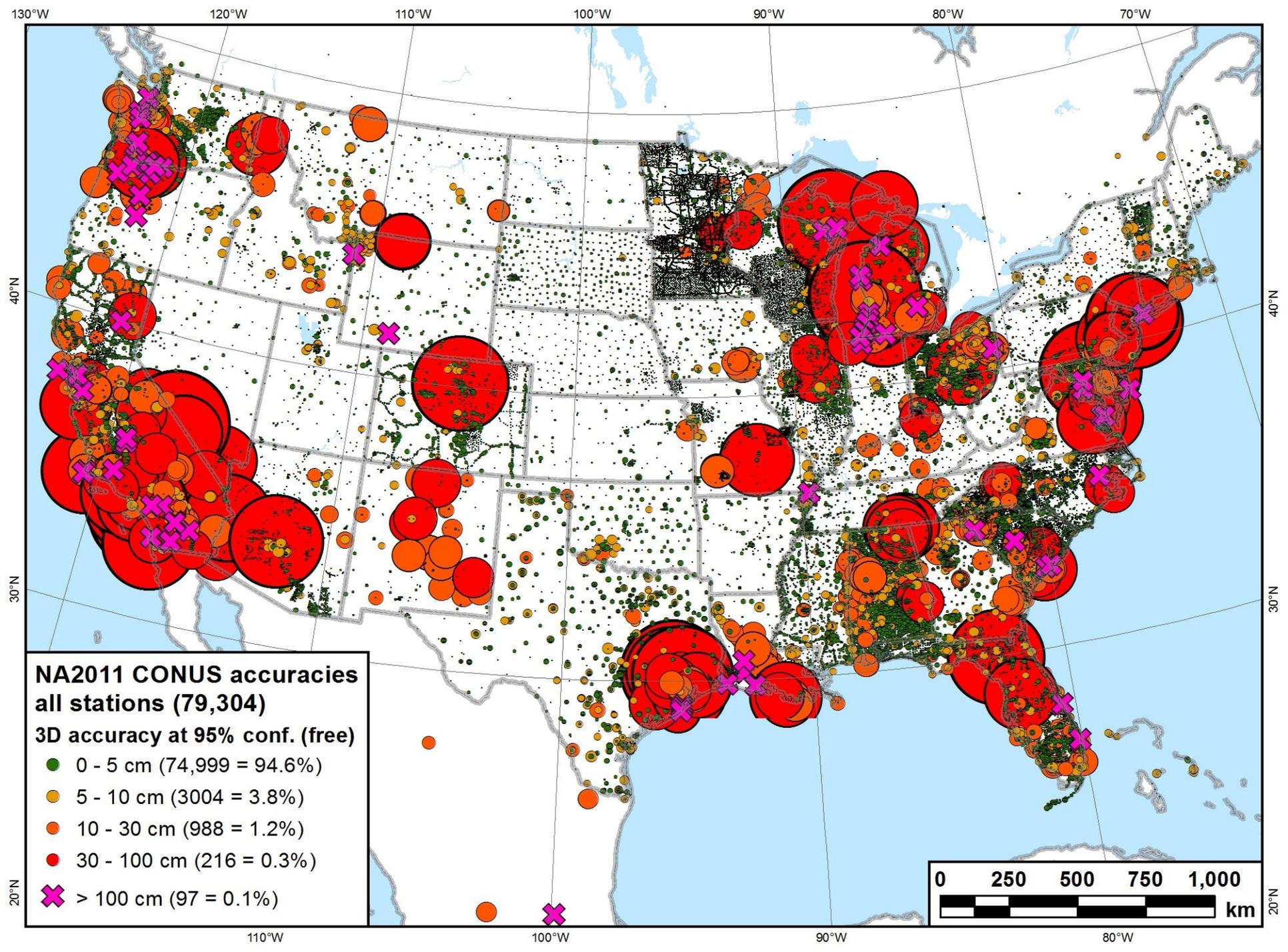
**NA2011 CONUS GNSS vectors  
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- 2006-2011 (6 yrs) 99,823 = 23.4%



# A way to deal with the old & infirm?

- Remove “old” observations from overall network
  - Use cutoff of early 1994 (more or less)
  - Problem: Many projects include data spanning years
  - Solution: Remove projects with **first** observation before 1/1/1994 and **last** observation before 1/1/1995
- Identified 511 projects which will be removed
  - 16,299 stations “posted” (i.e., adjusted afterward)
  - 5491 stations in both overall and posted groups
    - These will get adjusted coordinates in overall adjustment
    - Constrain posted stations to NA2011 coords of these stations



# What's in a name?

*That which we call a datum*

*By any other name would smell as sweet...*

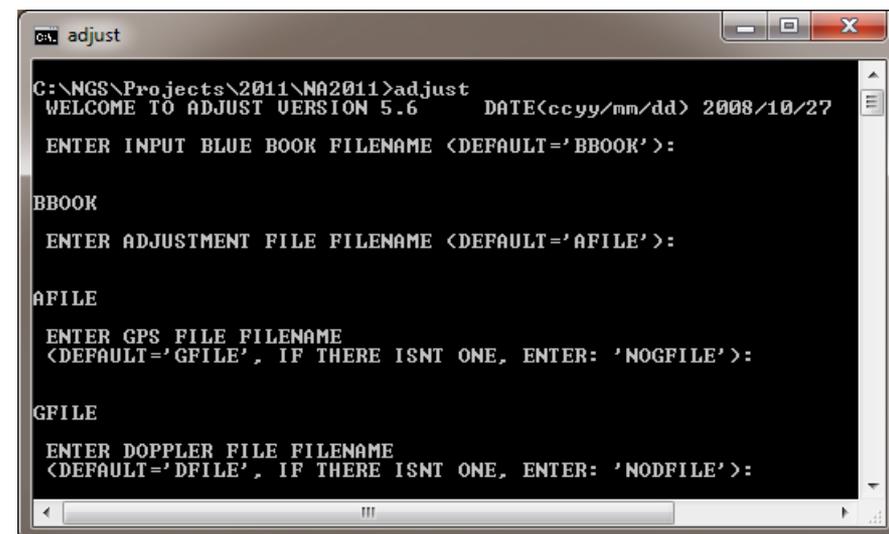
- **NAD 83(2011) epoch 2010.00**
  - “2011” is datum tag → year adjustment complete
  - “2010.00” is “epoch date” (January 1, 2010)
    - Date associated with coordinates of control station
  - Frame fixed to North American tectonic plate
    - Includes California, Alaska, Puerto Rico, and US Virgin Islands
- **NAD 83(PA11) epoch 2010.00**
  - Frame fixed to Pacific tectonic plate (Hawaii and American Samoa)
- **NAD 83(MA11) epoch 2010.00**
  - Frame fixed to Mariana tectonic plate (Guam and CNMI)

# Other NA2011 challenges

- Re-enabled ~20,000 previously rejected vectors
  - Total ~22,600 now rejected (previously ~42,600 rejected)
  - Perform iterative adjustments with new rejection/enabling in each
- HTDP applied to *ALL* GPS vectors
  - Only applied to CA, AZ, NV, OR, WA, and AK in NSRS2007
- Gulf Coast and other subsidence areas
  - Investigating downweighting of up vector components by time
  - Estimated velocities  $\times$  delta time  $\rightarrow$  approximate additional up error
  - Velocities from MYCS, GPS projects, leveling, pub height change, INSAR, etc.
- No-check stations: Reduce number by enabling additional vectors
  - Recommend not publishing accuracies for remaining no-check stations
- Other challenges
  - NETSTAT complexity, larger error estimates, poor network connectivity, duplicate stations, weighting of CORS constraints, CORS with “superseded” antennas

# Related Tasks, Products & Deliverables

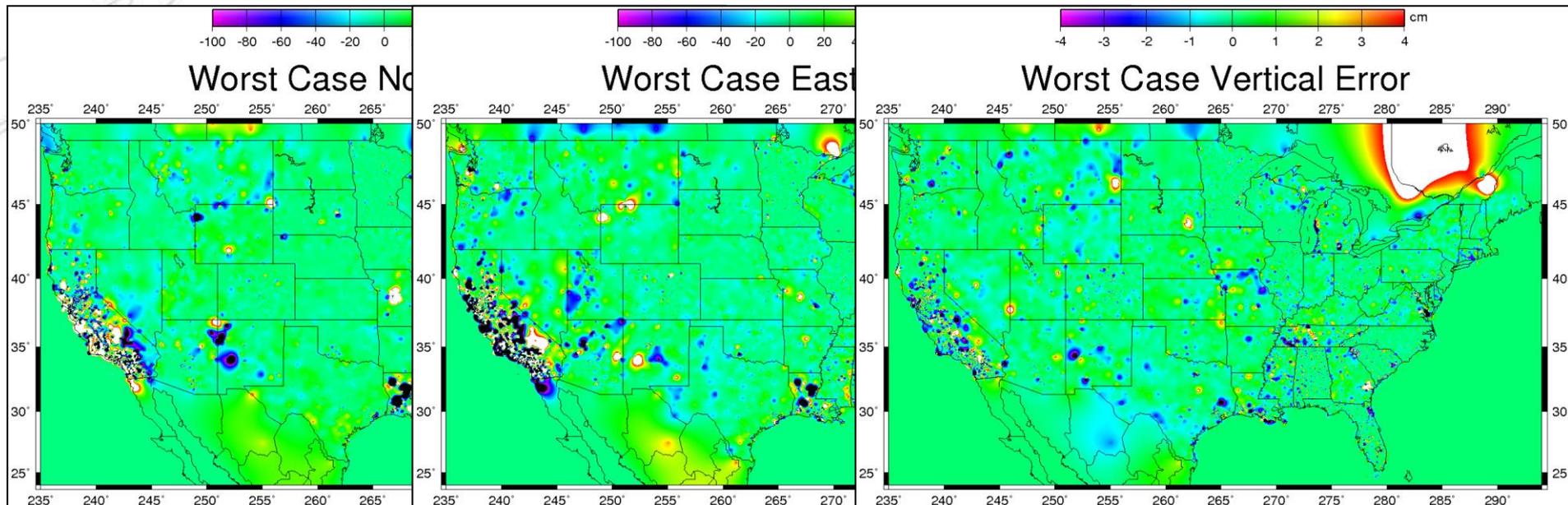
- Release NA2011 results in “Readjustment Distribution Format” (RDF)
  - aka “Bluebook” format (b-files)
  - Includes positions, ellipsoid heights, and accuracies
    - Accuracies as N, E, U sigmas and horizontal correlations
- New version of NGS program “ADJUST”
  - Network and local accuracies
  - Improved output
  - Graphical User Interface!

A screenshot of a Windows command prompt window titled 'cmd adjust'. The window shows the execution of the 'adjust' program. The prompt is 'C:\NGS\Projects\2011\NA2011>adjust'. The program outputs 'WELCOME TO ADJUST VERSION 5.6' and 'DATE(ccyy/mm/dd) 2008/10/27'. It then prompts for 'ENTER INPUT BLUE BOOK FILENAME <DEFAULT='BBOOK'>:', followed by 'BBOOK'. Next, it prompts for 'ENTER ADJUSTMENT FILE FILENAME <DEFAULT='AFILE'>:', followed by 'AFILE'. Then, it prompts for 'ENTER GPS FILE FILENAME <DEFAULT='GFILE', IF THERE ISNT ONE, ENTER: 'NOGFILE'>:', followed by 'GFILE'. Finally, it prompts for 'ENTER DOPPLER FILE FILENAME <DEFAULT='DFILE', IF THERE ISNT ONE, ENTER: 'NODFILE'>:'. The window has standard Windows window controls (minimize, maximize, close) in the top right corner and a scrollbar on the right side.

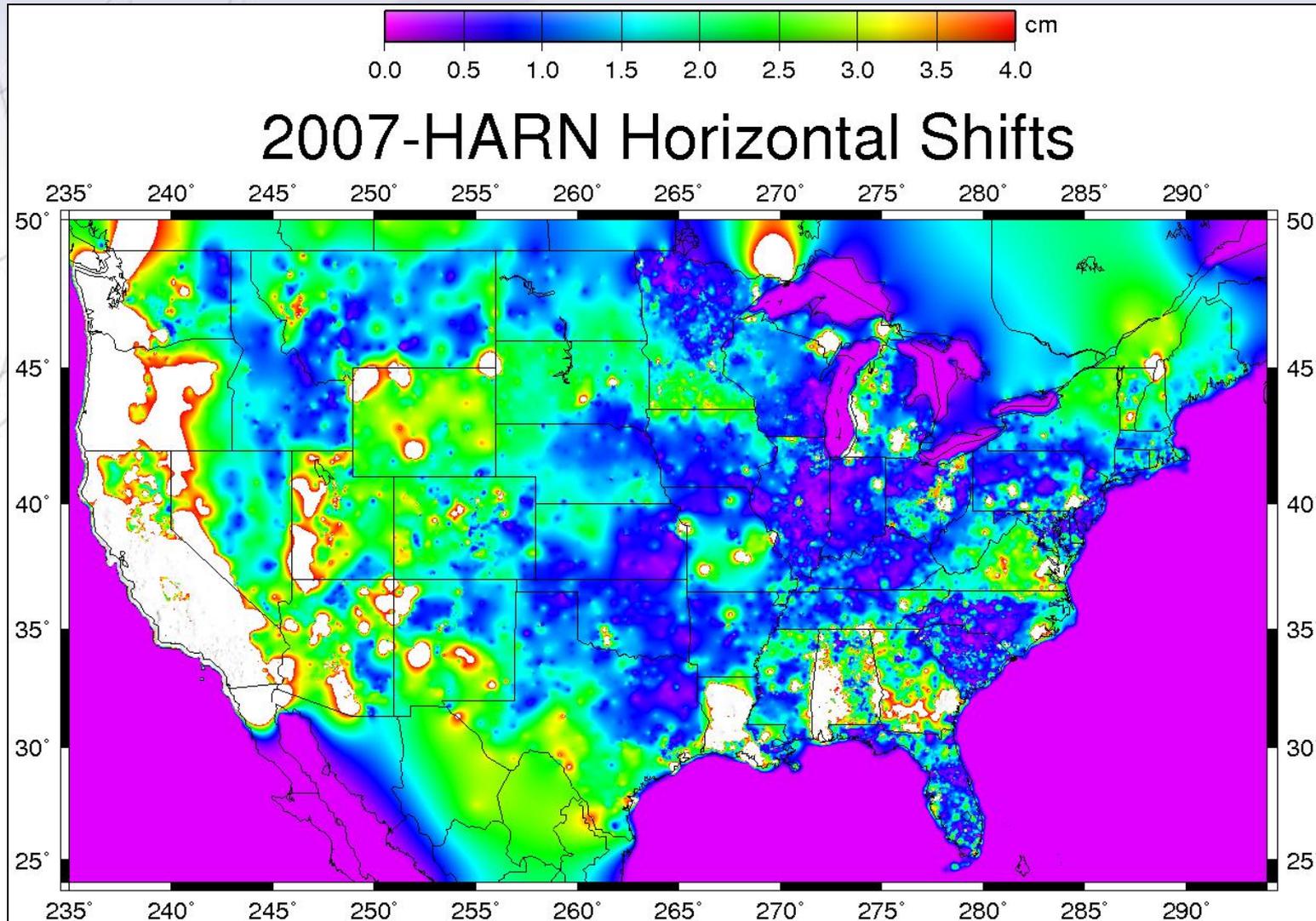
```
cmd adjust
C:\NGS\Projects\2011\NA2011>adjust
WELCOME TO ADJUST VERSION 5.6    DATE(ccyy/mm/dd) 2008/10/27
ENTER INPUT BLUE BOOK FILENAME <DEFAULT='BBOOK'>:
BBOOK
ENTER ADJUSTMENT FILE FILENAME <DEFAULT='AFILE'>:
AFILE
ENTER GPS FILE FILENAME
<DEFAULT='GFILE', IF THERE ISNT ONE, ENTER: 'NOGFILE'>:
GFILE
ENTER DOPPLER FILE FILENAME
<DEFAULT='DFILE', IF THERE ISNT ONE, ENTER: 'NODFILE'>:
```

# Related Tasks, Products & Deliverables

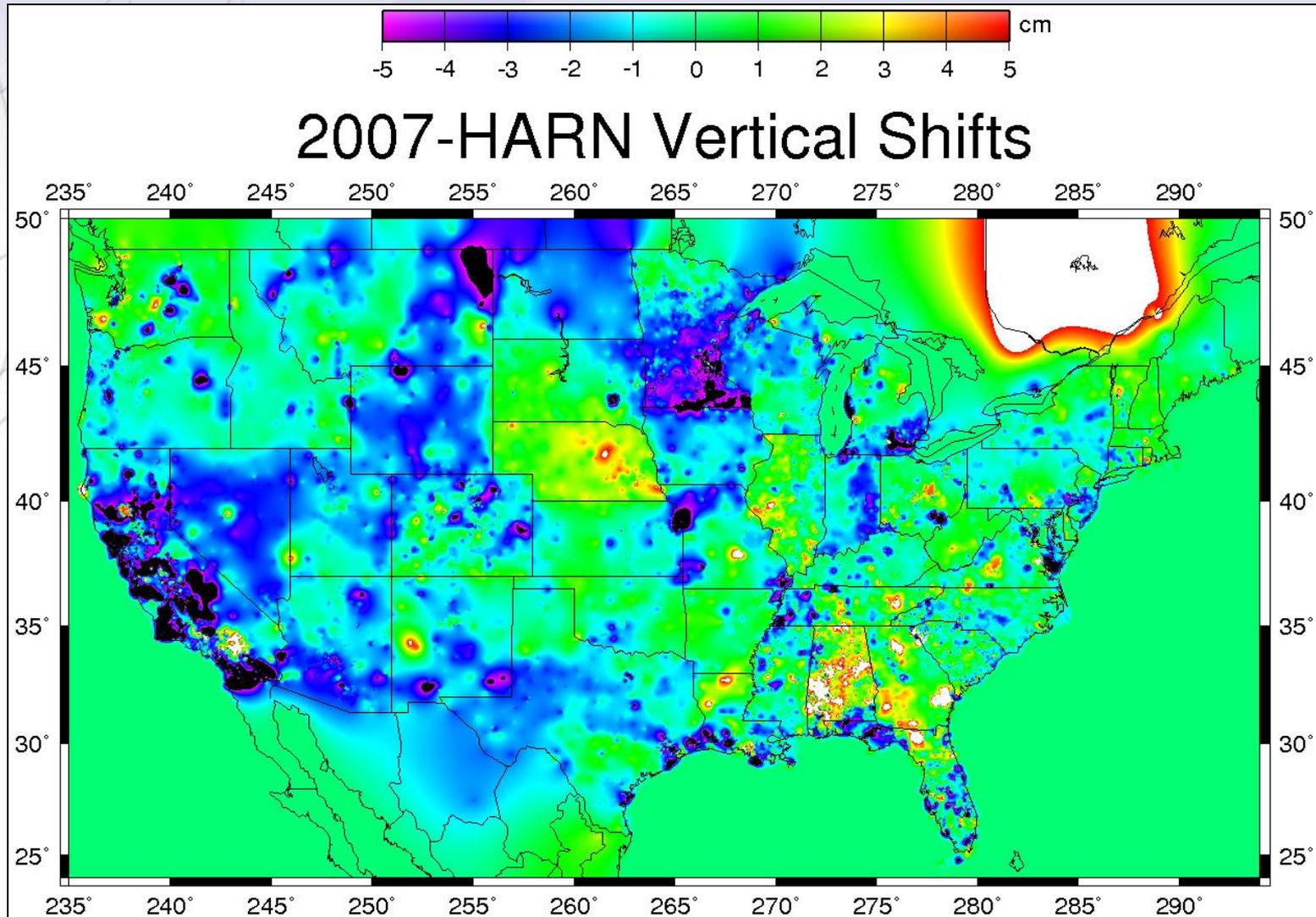
- New NAD 83 coordinate transformations
  - NAD 83 “HARN”  $\leftrightarrow$  NAD 83(NSRS2007/CORS96)
    - Algorithm for this tool already created
  - NAD 83(NSRS2007/CORS96)  $\leftrightarrow$  NAD 83(2011)
    - Will build this tool as soon as NA2011 results available
  - Include output that indicates quality
    - Provided as (conservative) error grids and reports



# Related Tasks, Products & Deliverables



# Related Tasks, Products & Deliverables



# *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
  - Intend to implement ~ same time as NA2011 released
  - Announcement and prototype on NGS web site
- **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 (maybe)

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	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)	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.

# What about orthometric heights?

- NA2011 will yield:
  - NAD 83(2011/PA11/MA11) epoch 2010.00:
    - Latitude, longitude, and ellipsoid height
    - Network and “local” accuracies
- Orthometric heights (“elevations”) will **NOT** be determined in NA2011
  - Question: Will GPS-derived heights based on previous NAD 83 realizations and geoid models be consistent with those based on NAD 83(2011) and GEOID12?
    - i.e., is the **relative** change in ellipsoid heights and/or geoid heights significant (too large to ignore)?

# So...GEOID12

- New geoid model compatible with NAD83(2011) ellipsoid heights and NAVD88 bms.
- Released concurrently with NAD83(2011)
- No large slope changes in NC
- GEOID03 is NOT compatible use **Geoid12!!!**

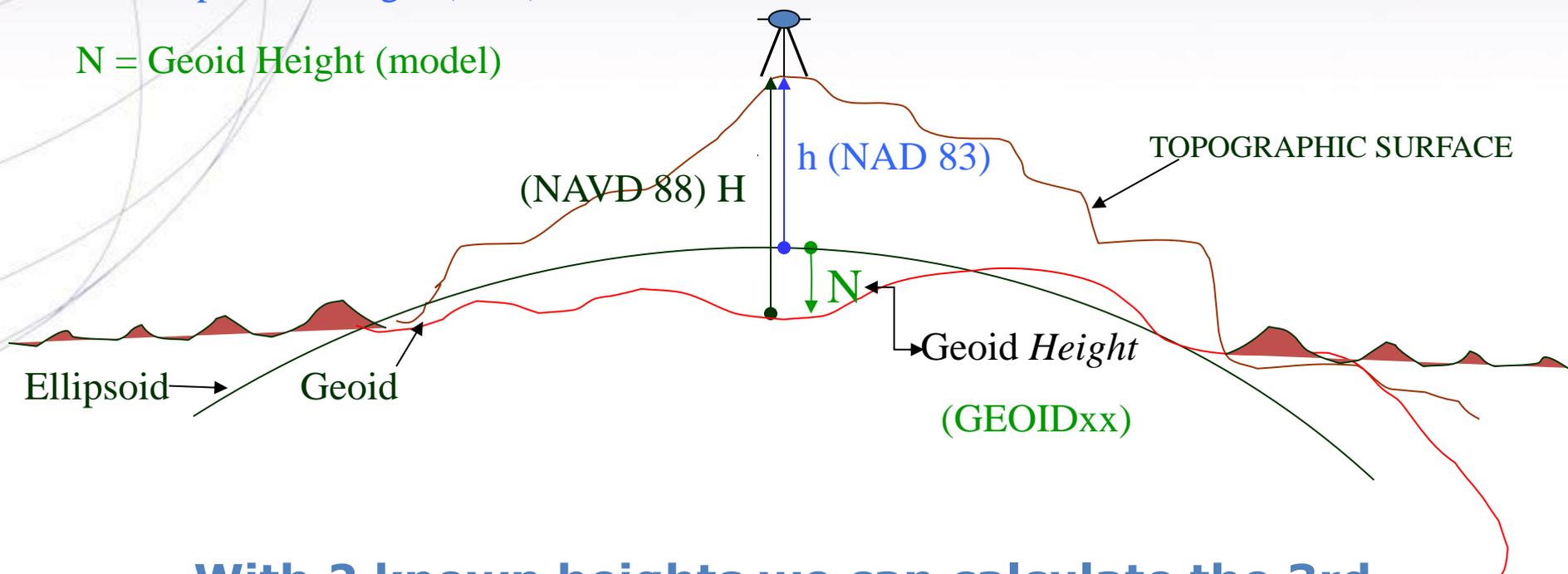
# Ellipsoid, Geoid, and Orthometric Heights

$H$  = Orthometric Height (leveling)

$h$  = Ellipsoidal Height (GPS)

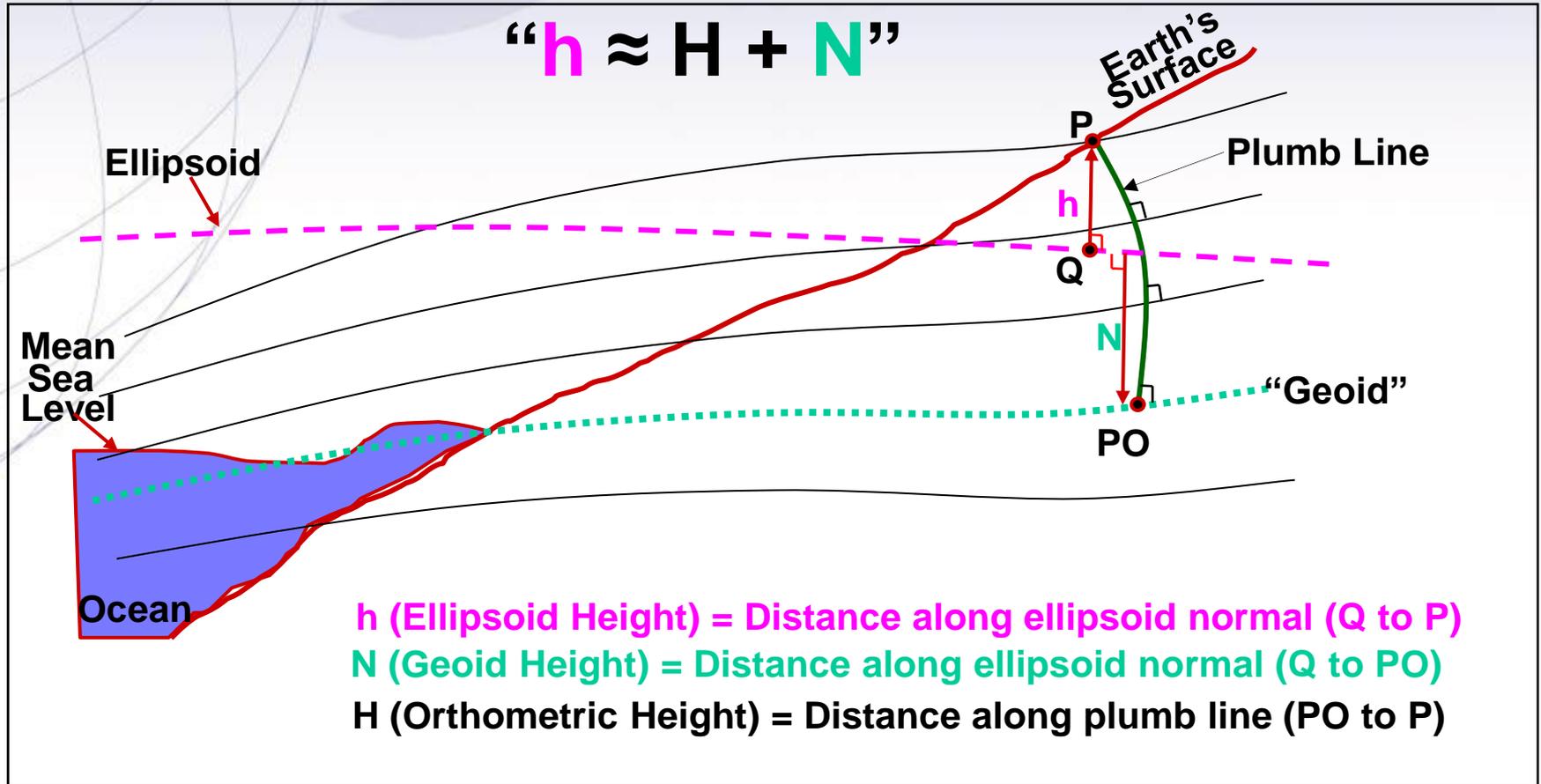
$N$  = Geoid Height (model)

$$H = h - N$$



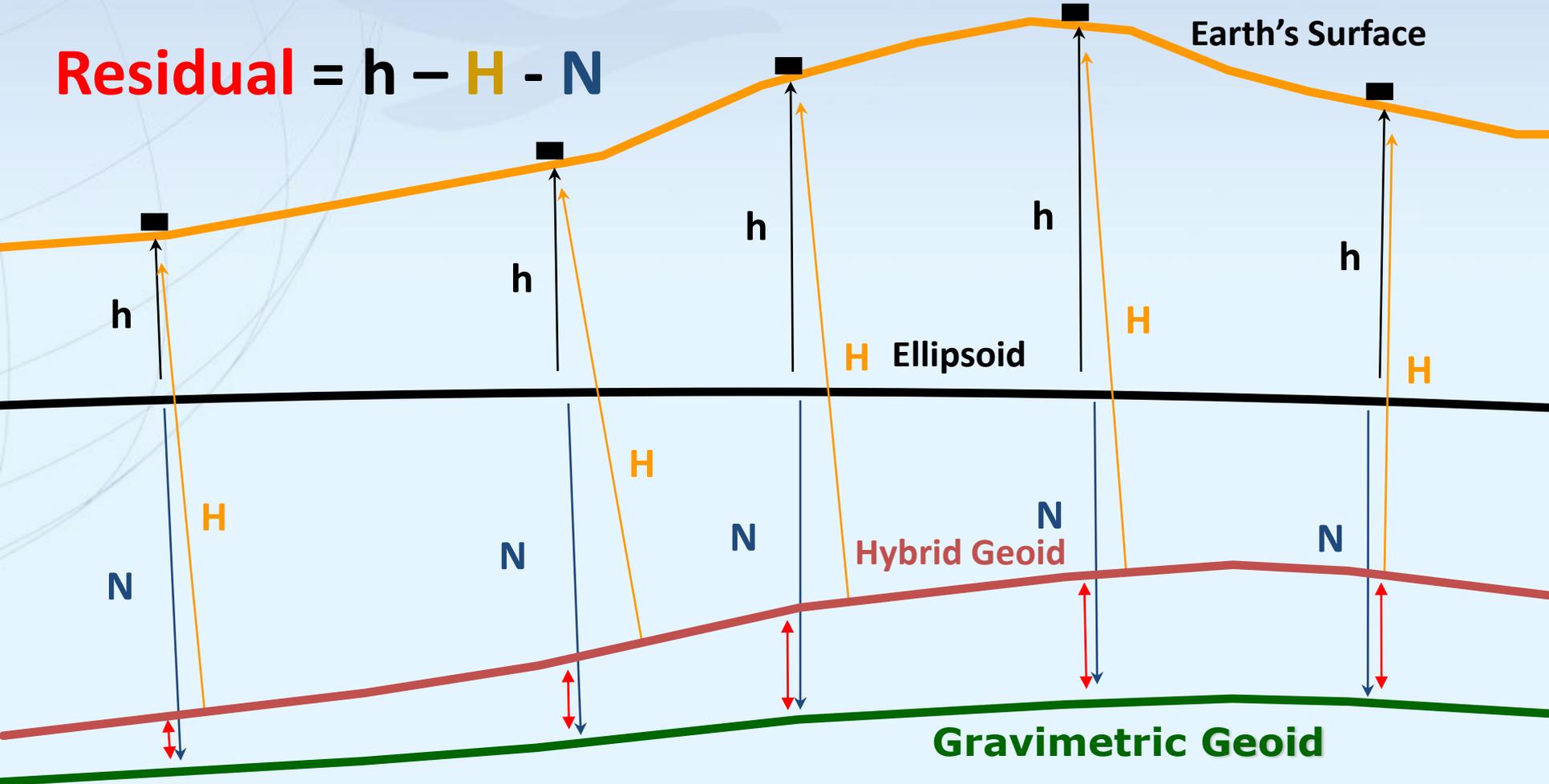
**With 2 known heights we can calculate the 3rd**

# Relationship Between Heights



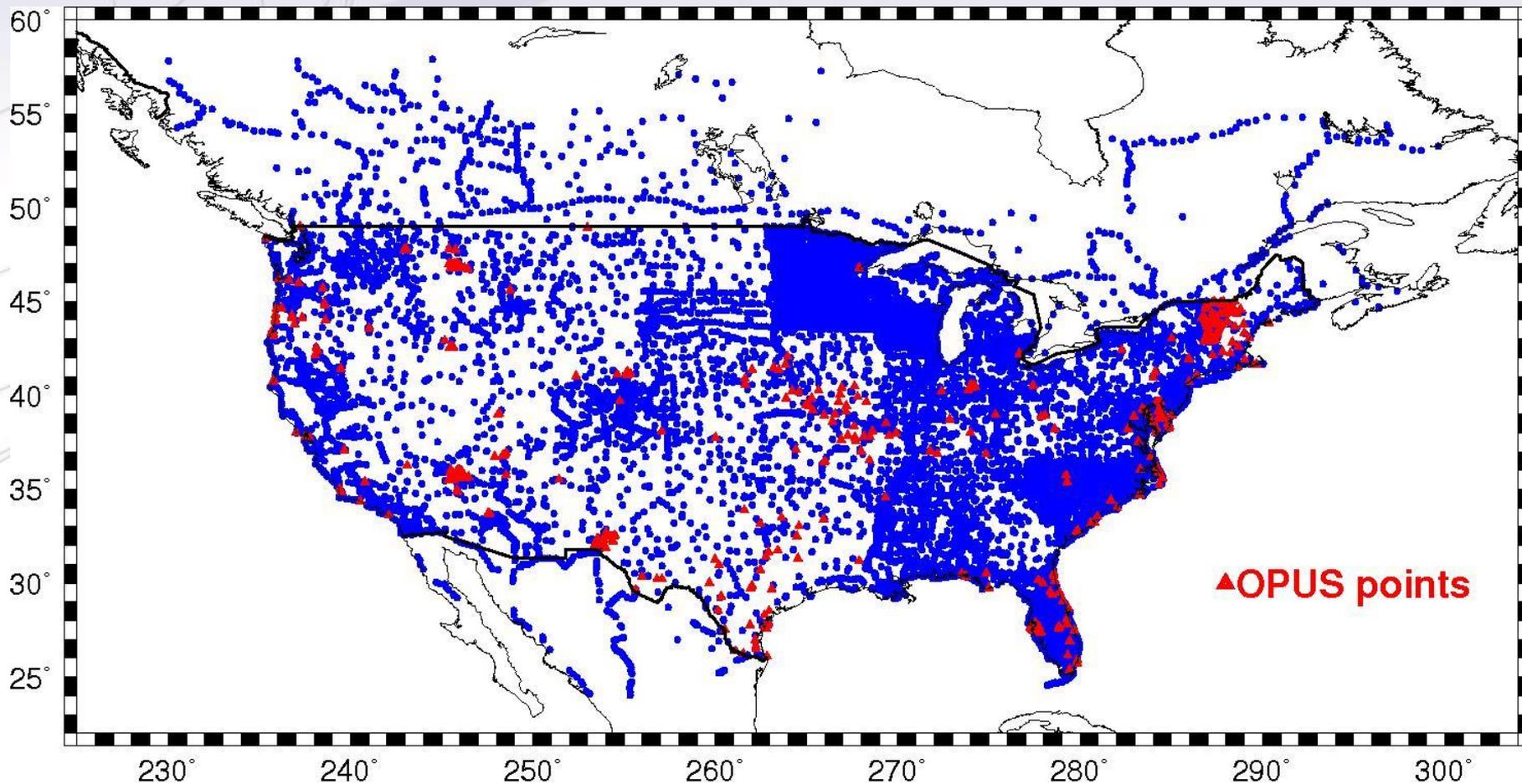
Hybrid Geoid Height Models (e.g., GEOID09) are determined from Gravimetric Geoid Height Models (e.g., USGG2009) and Conversion Surfaces based on GPS on BM data

**Residual =  $h - H - N$**

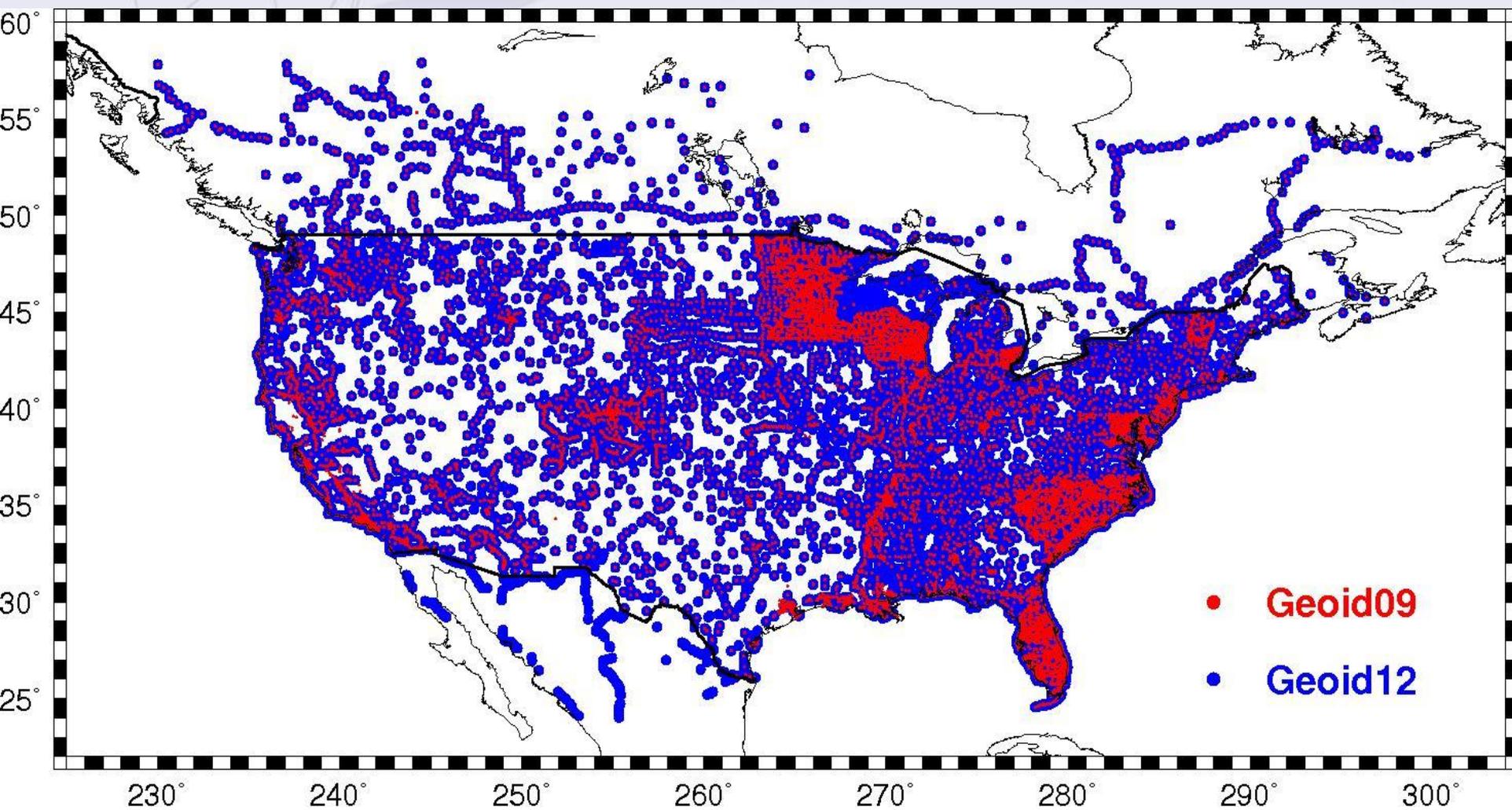


- **Gravimetric Geoid** systematic misfit to BM's but best fits "true" heights
- **Hybrid Geoid** "converted" to fit local BM's, so best fits NAVD 88 heights
- **Conversion Surface** model of systematic misfit derived from BM's in IDB

# Distribution of OPUSDBBM12



# An additional 6,000 points?





# More information...

## National Geodetic Survey

Positioning America for the Future

# geodesy.noaa.gov

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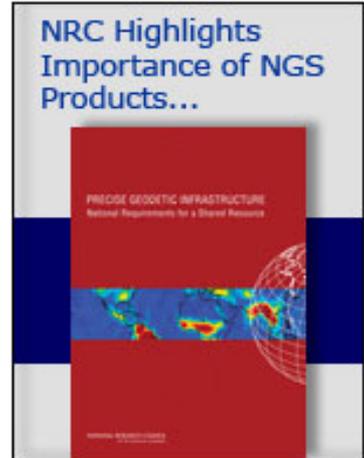
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September 20, 2012

### Announcements

The NGS Database will briefly be unavailable on Saturday, September 22, 2012 from 4:00pm until 4:30pm Eastern time, in order to install additional storage space. This will disable retrievals of data via the web during the upgrade. Thank you for your understanding and cooperation. Please contact the [Database Administrator](#) for additional information about this event.



### Most Popular

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NAD 83(2011) epoch 2010.00

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### Upcoming Events

### NOTICE: September 18, 2012

NGS requests your patience while we update the "bluebooking" process for GPS projects.

While we update the **adjust guidelines**, **submissions for all GPS projects are being postponed** until the new "bluebooking" processes are posted. A notice will be posted here when this is accomplished. Thank you for your cooperation.

### NOTICE: NGS Update, September 11, 2012

#### GEOID12A Model Released

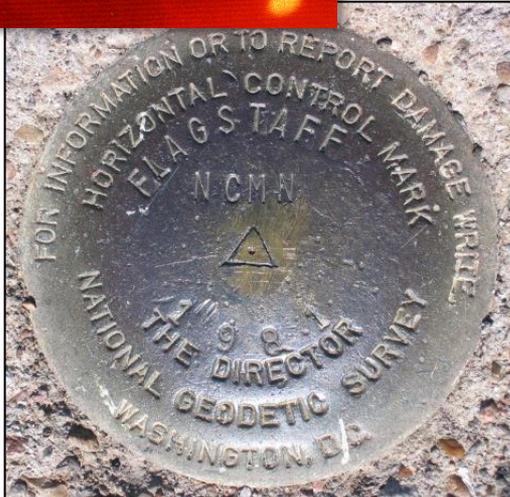
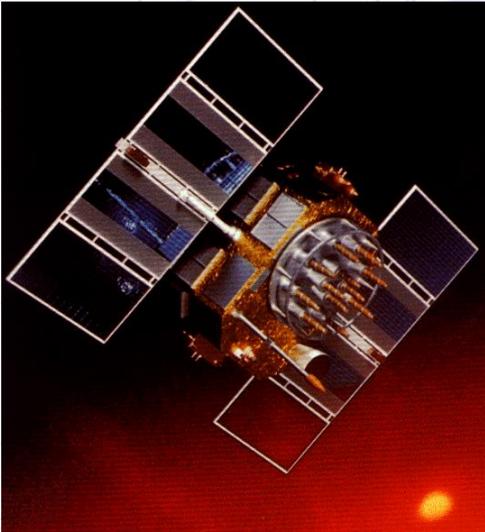
The National Geodetic Survey has released the **GEOID12A model**. Analysis of the underlying control data has been completed and a number of corrections were made to the original data used in making GEOID12. Changes impacted regions in the states of Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Wisconsin. GEOID12A is now available for production and use.



# Questions?

## 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/COUNTRY- AZ/MOHAVE
AC6803 COUNTRY - USA
AC6803 USGS QUAD - LOST SPRING MTN EAST (1988)
AC6803
AC6803
AC6803 *CURRENT SURVEY CONTROL
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
    
```

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

at the datasheet.

```

datasheet95, VERSION = 7.87.4
Y, Retrieval Date = AUGUST 19, 2011
*****
a Height Modernization Survey Station.
a Primary Airport Control Station.
    
```

E  
ING MTN EAST (1988)

\*CURRENT SURVEY CONTROL

```

.55377 (N) 113 00 32.22917 (W) ADJUSTED
.56 (meters) 4873.9 (feet) GPS OBS
    
```

```

07.00
89.496 (meters) COMP
88.731 (meters) COMP
06.819 (meters) COMP
3.37 (seconds) DEFLEC09
62.787 (meters) (02/10/07) ADJUSTED
22.80 (meters) GEOID09
    
```

```

tes (at 95% Confidence Level in cm) -----
ion North East Ellip
-----
0.74 0.61 1.37
    
```

City Municipal Airport (AZC)

es were established by GPS observations  
onal Geodetic Survey in February 2007.

(2007) is equivalent to NAD 83 (NSRS2007) .  
u for more information.

es are valid at the epoch date displayed above.  
ontal control is a decimal equivalence

as determined by GPS observations and a  
del.

heights for airport stations designated as  
ed to 2 decimal places. This maintains  
racy between the PACS and SACS. It does  
accuracy relative to other marks which are  
ork.