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

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  - 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 (NA2011)**
  - 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)**

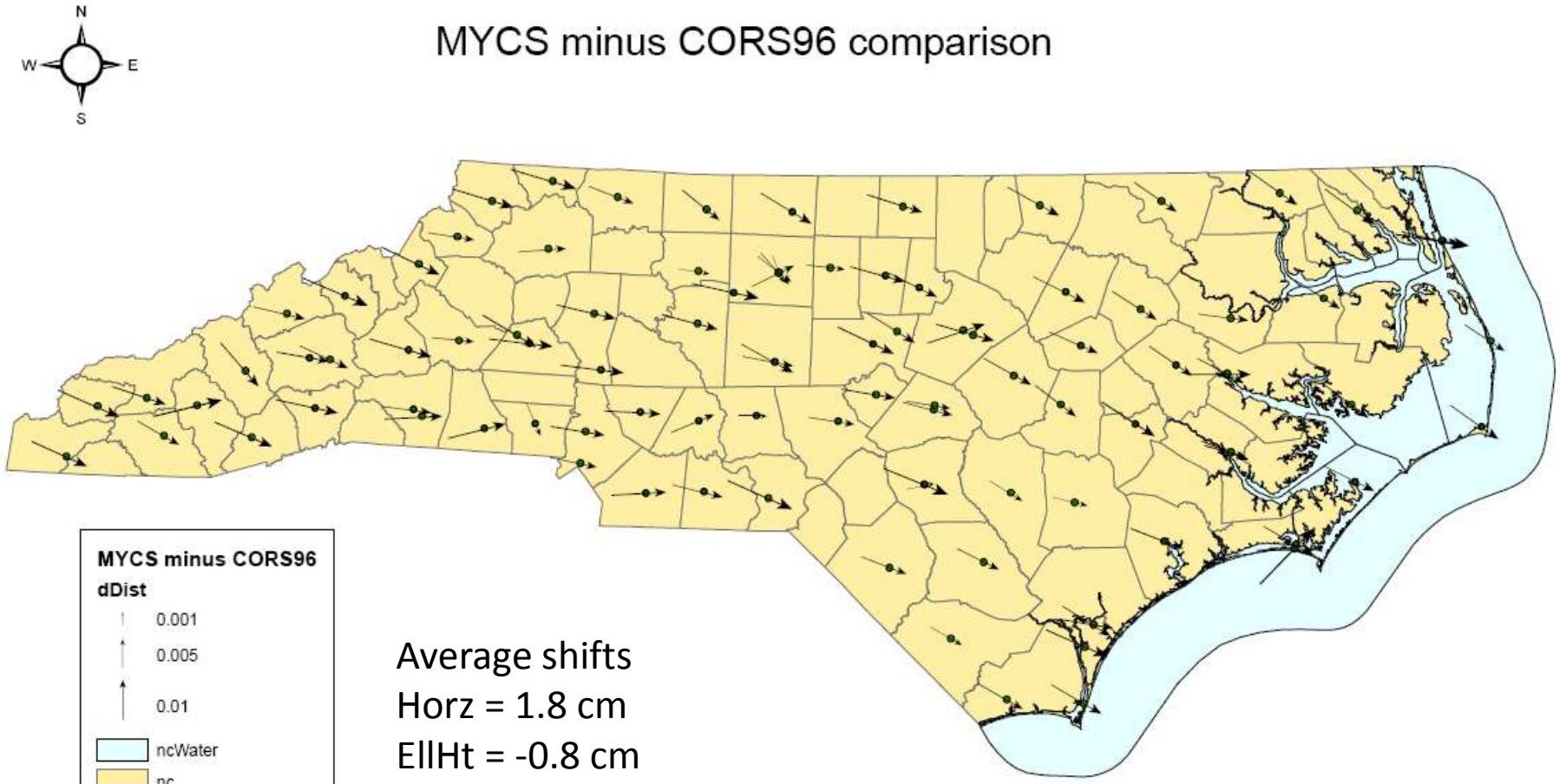
Why a new NAD 83 realization?

- 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 *B*est *A*vailable *M*ethods**
  - ***Needed because CORS network is foundation of NSRS***

New Adjustment

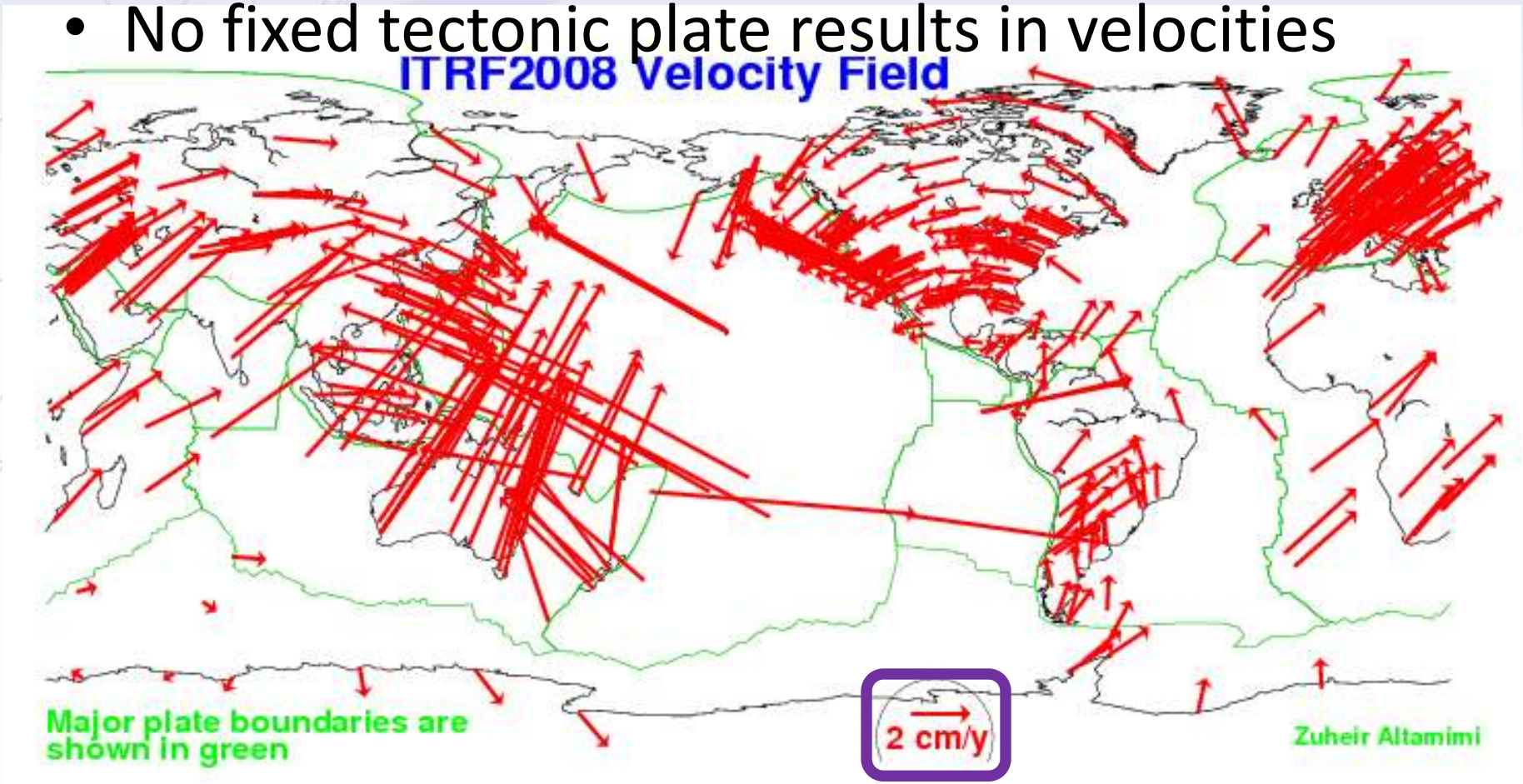
- Name: **NAD83(2011) epoch 2010**.
- Expected Release June
  - Delayed due to technical difficulties and new data inclusion
- Based on re-computation of all CORS 1994 to present to align with world wide effort.
- NC Shifts (based on CORS shifts)
  - @ 1.8cm generally ESE
  - @-0.8cm (mainly due to computational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

Shift From CORS96 to NAD83(2011)

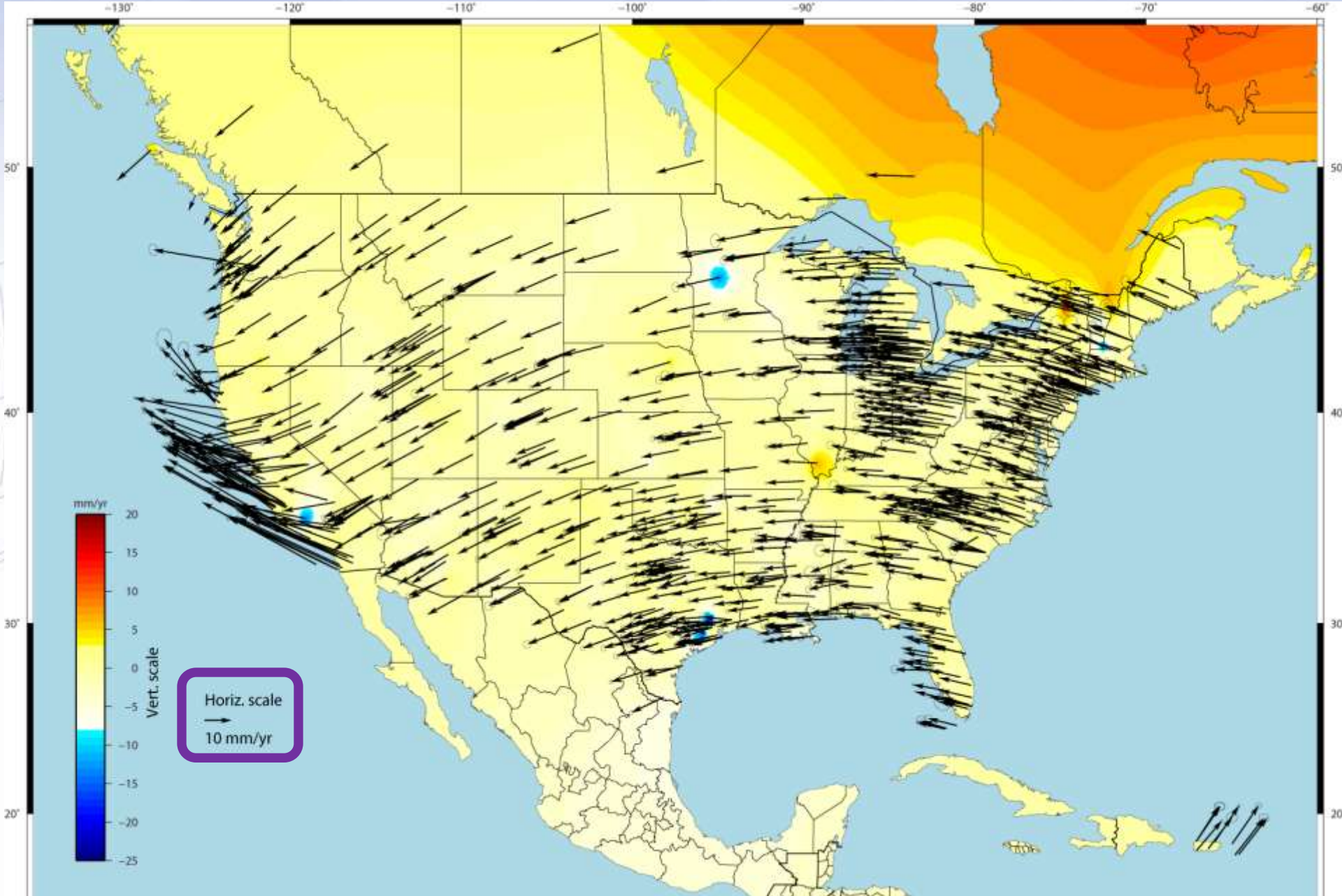


Rationale for Updating the NSRS (CORS)

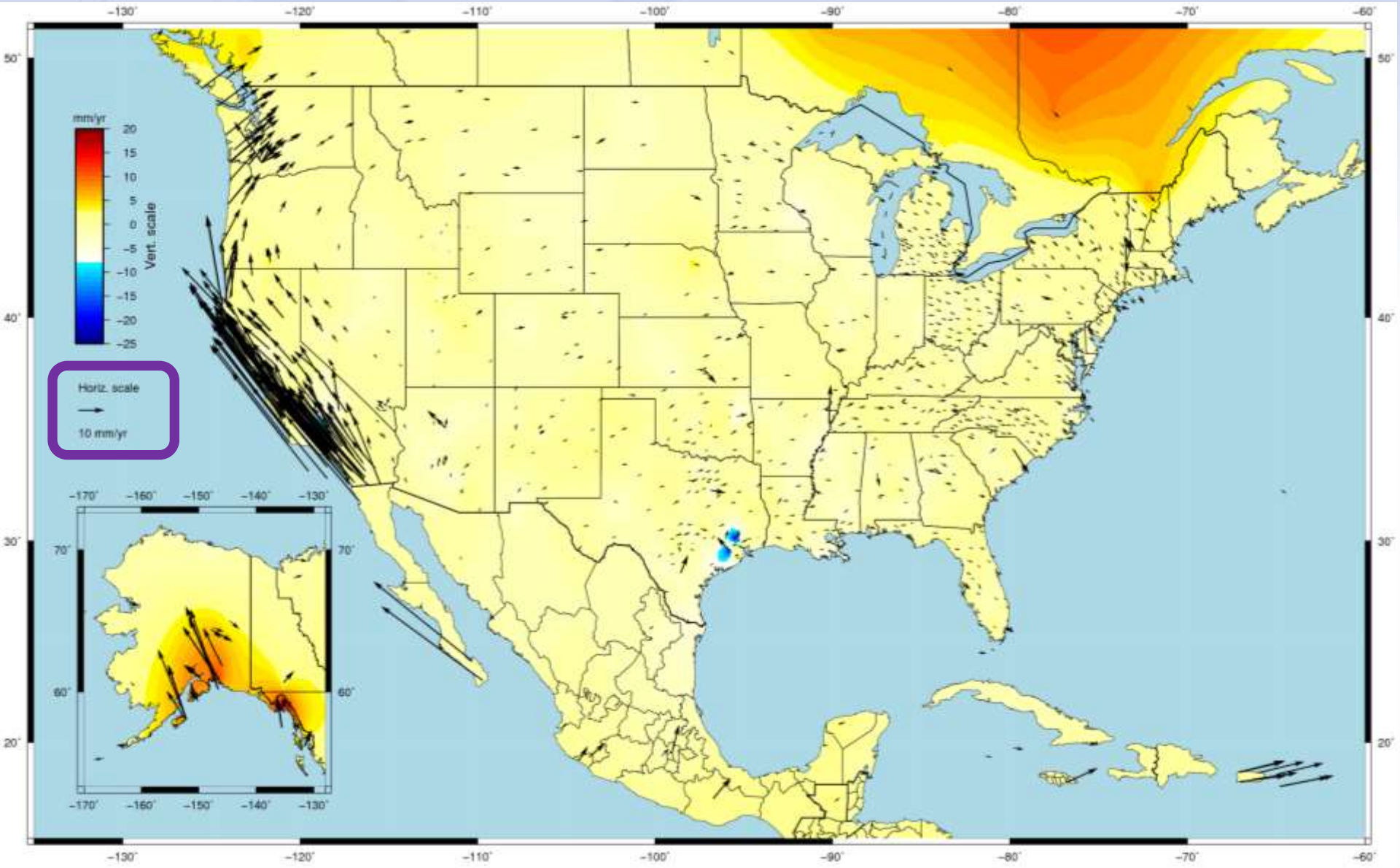
- Definition starts with a global RF: ITRF##
- No fixed tectonic plate results in velocities



U.S. CORS Velocity Field – ITRF2008



U.S. CORS Velocity Field - NAD83(2011) epoch 2010.0



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

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 tentative)	2005.0	Abs IGS08 ANTEX	1994.0-2010.5 (ongoing)
NAD 83(2011) (tentative)	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

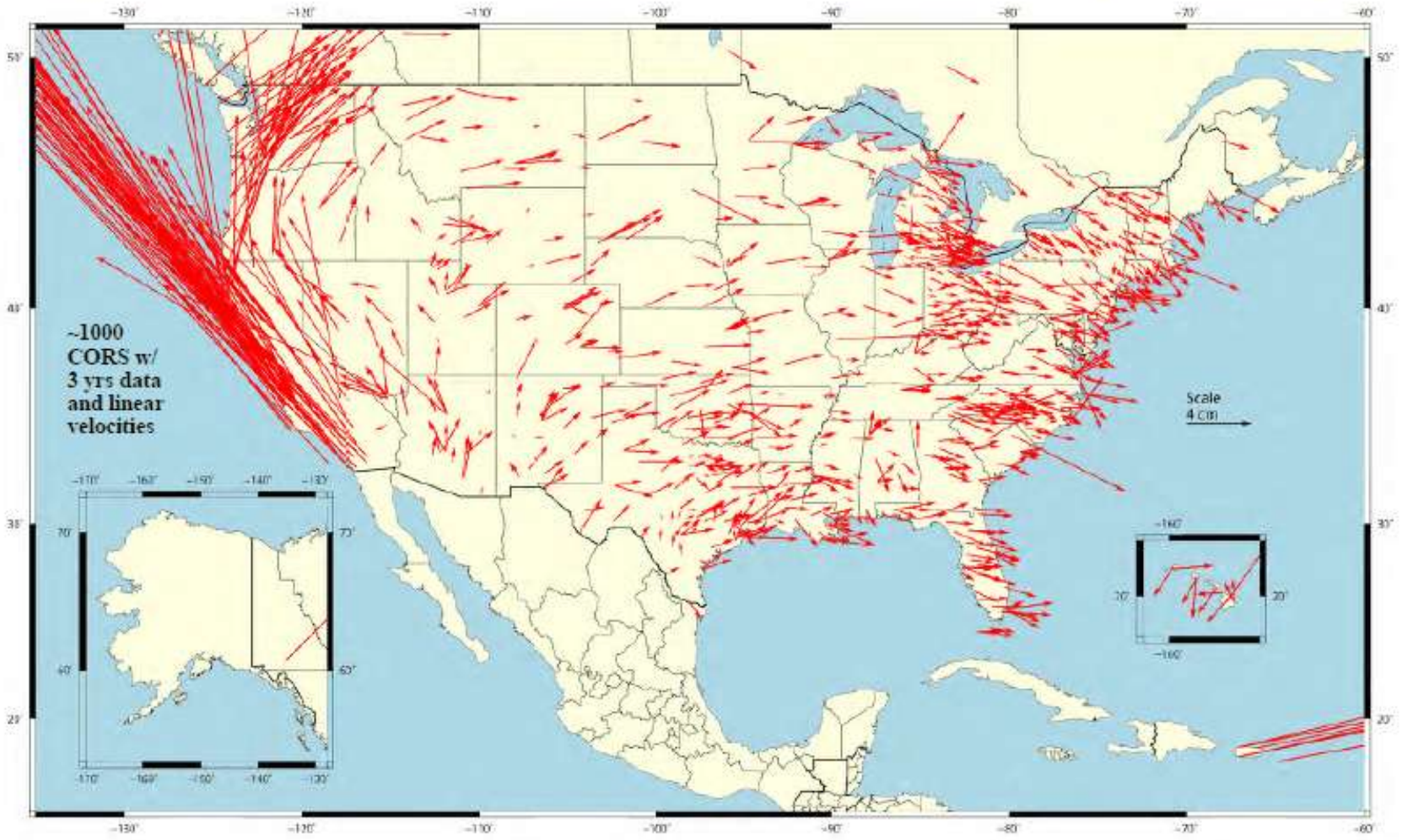
On to NAD83(2011)
When will it all be done?

- National Adjustment of 2011
  - Goal: Complete May 2012, publish ***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
    - Plan release same time as NA2011
  - 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)

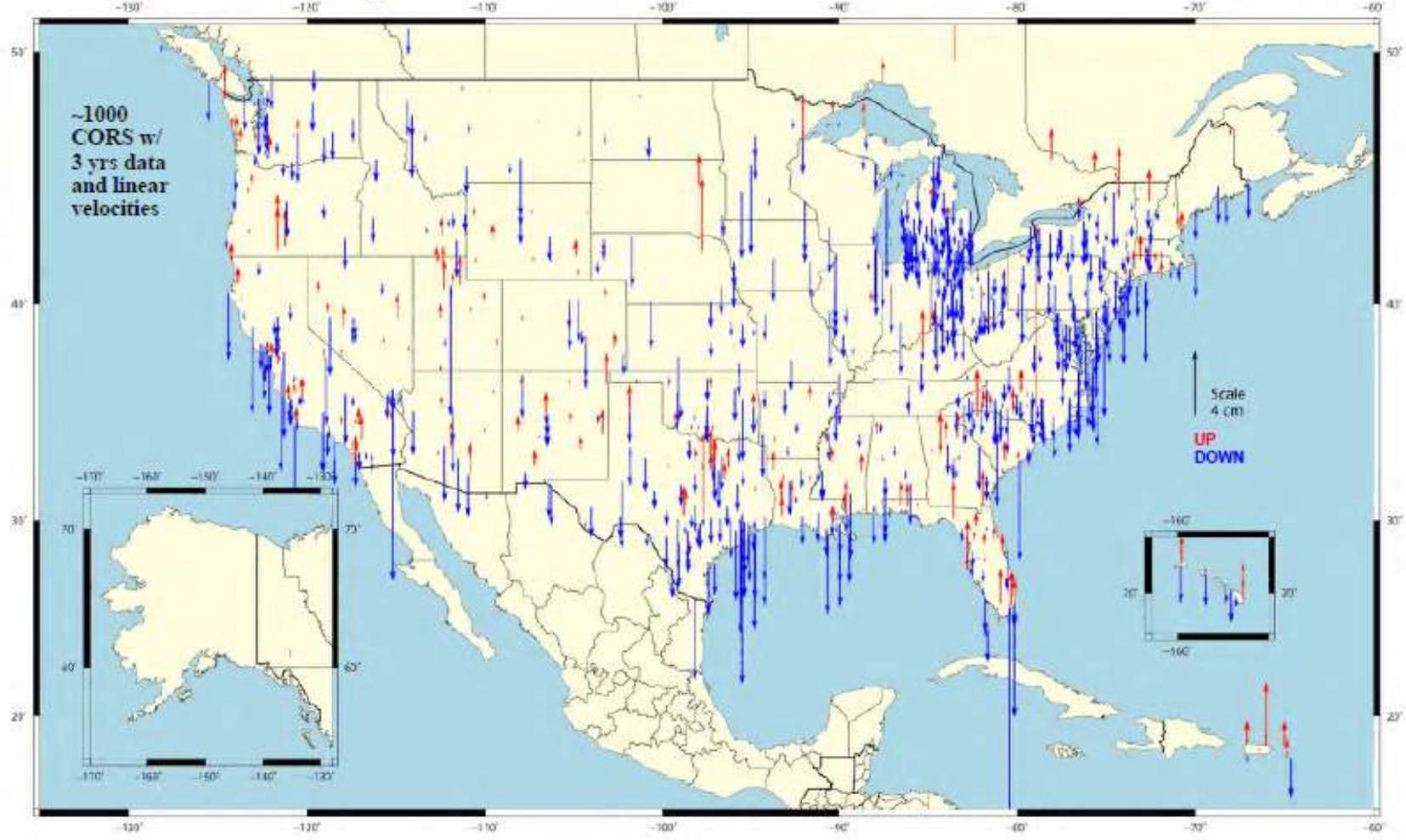
- **avg. shifts:** $\Delta E = 0.20 (\pm 5.85)$ cm; $\Delta N = 1.95 (\pm 6.42)$ cm
  - large shifts in western U.S. due to crustal deformation
  - apparent rotation in "stable" U.S. likely due to errors in NUVEL-1A (used in HTDP)



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

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

- **avg. shift: = -0.92 cm (± 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(CORS96), i.e. local vertical motion



Why a new national adjustment?

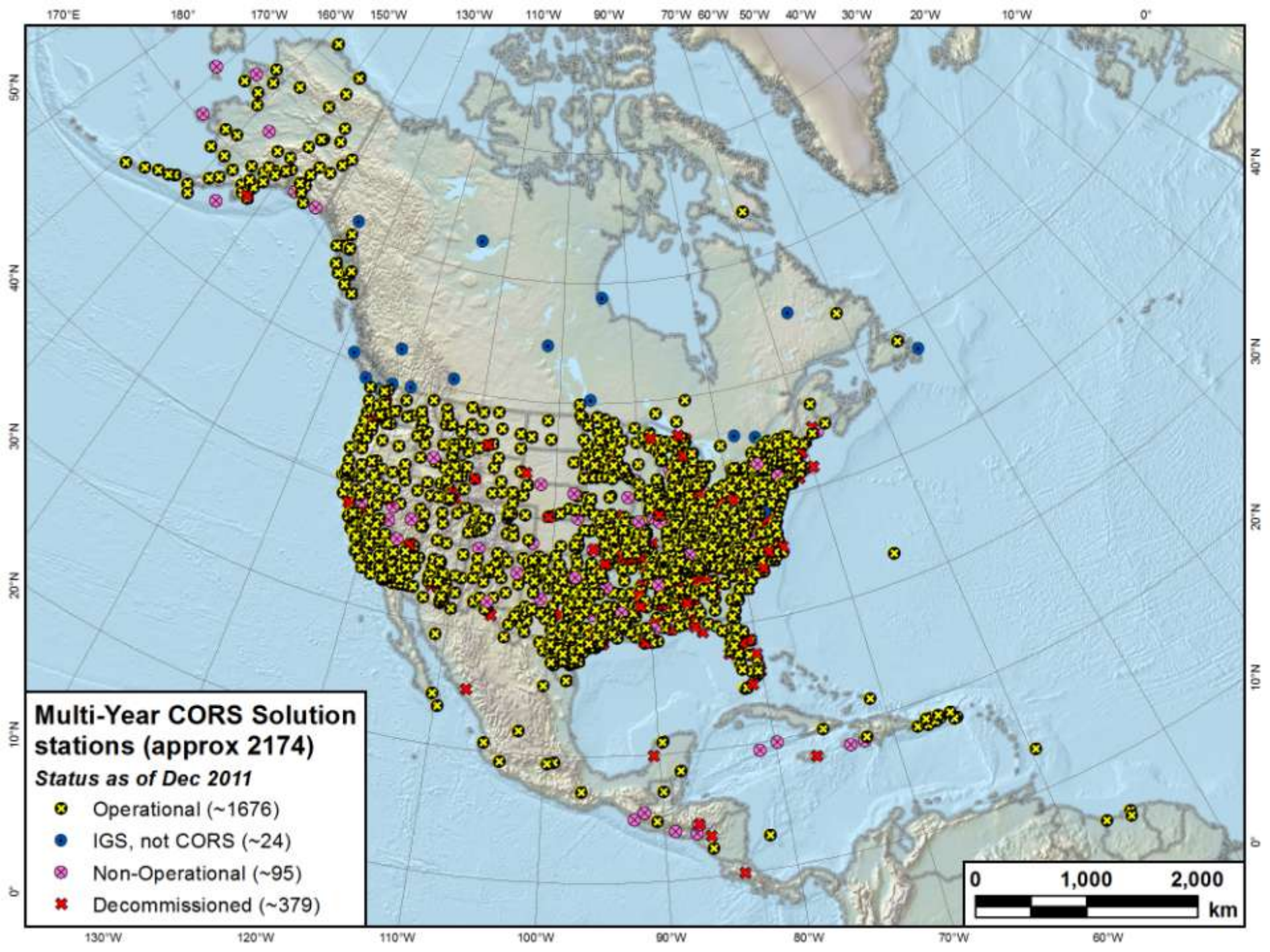
- Optimally align passive control with new CORS
- Over 700 projects submitted since 2007 project
  - Also observations for Hawaii, other Pacific islands
- Determine network and local accuracies on all stations
  - Including future submitted projects
- More consistent results in tectonically active areas
  - 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

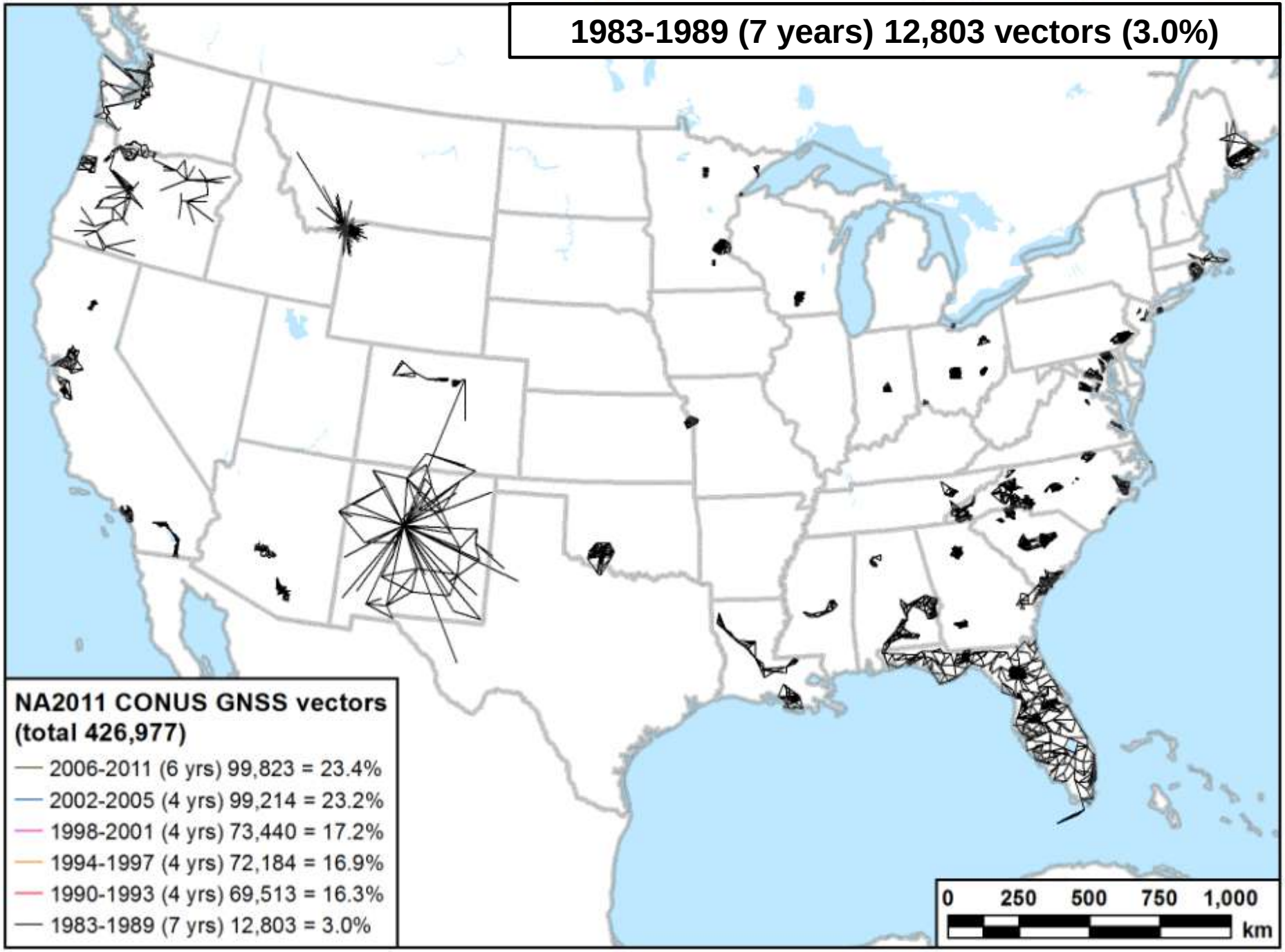
NA2011 project status

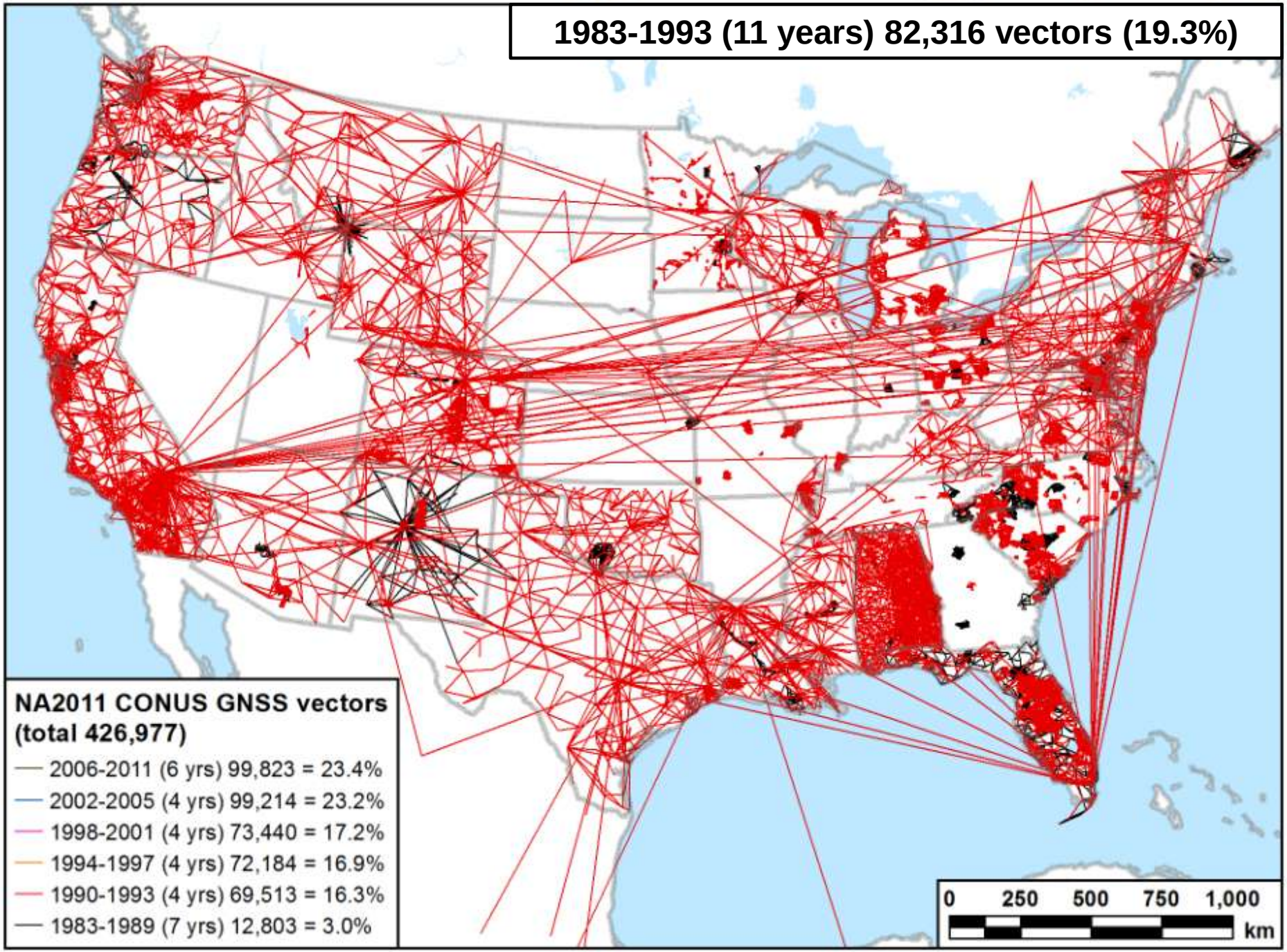
- Last database pull on December 14, 2011
- CONUS and the Caribbean (plus Alaska)
  - 4197 GPS projects
  - 80,244 stations
  - 429,747 vectors total (approximately **407,000** enabled)
  - All referenced to North American tectonic plate
- Comparison to NSRS2007 network
  - 3418 projects → ***23% more in NA2011***
  - 67,693 stations → ***19% more in NA2011***
  - 283,691 vectors enabled → ***43% more in NA2011***


Multi-Year CORS Solution stations (approx 2174)
Status as of Dec 2011
Operational (~1676)
IGS, not CORS (~24)
Non-Operational (~95)
Decommissioned (~379)
0
1,000
2,000
km
170°E
180°
170°W
160°W
150°W
130°W
110°W
90°W
70°W
60°W
50°W
40°W
30°W
20°W
10°W
0°
50°N
40°N
30°N
20°N
10°N
0°
130°W
120°W
110°W
100°W
90°W
80°W
70°W
60°W

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?


1983-1989 (7 years) 12,803 vectors (3.0%)
NA2011 CONUS GNSS vectors
(total 426,977)
2006-2011 (6 yrs) 99,823 = 23.4%
2002-2005 (4 yrs) 99,214 = 23.2%
1998-2001 (4 yrs) 73,440 = 17.2%
1994-1997 (4 yrs) 72,184 = 16.9%
1990-1993 (4 yrs) 69,513 = 16.3%
1983-1989 (7 yrs) 12,803 = 3.0%
0 250 500 750 1,000
km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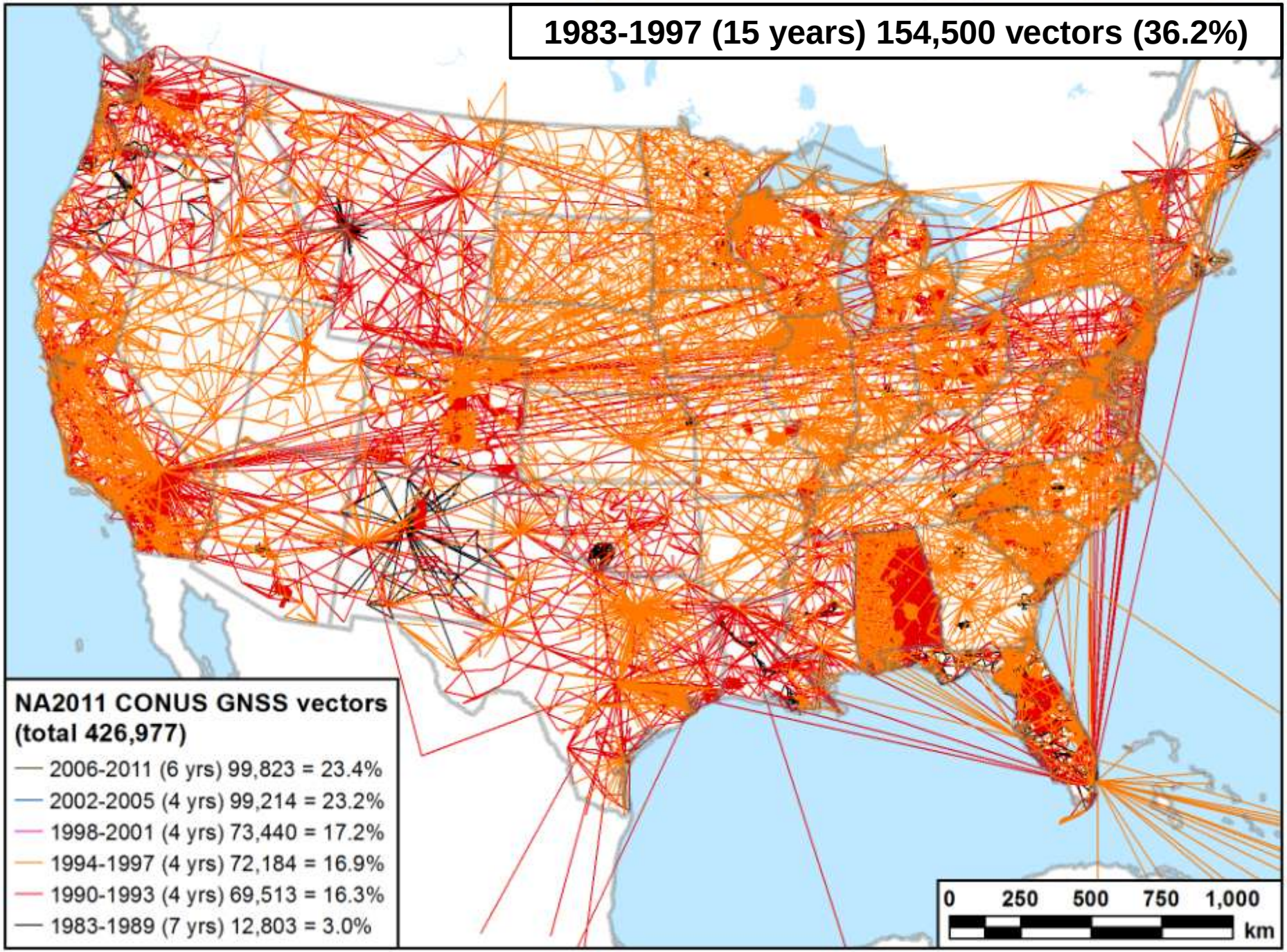
0 250 500 750 1,000
km


1983-1997 (15 years) 154,500 vectors (36.2%)
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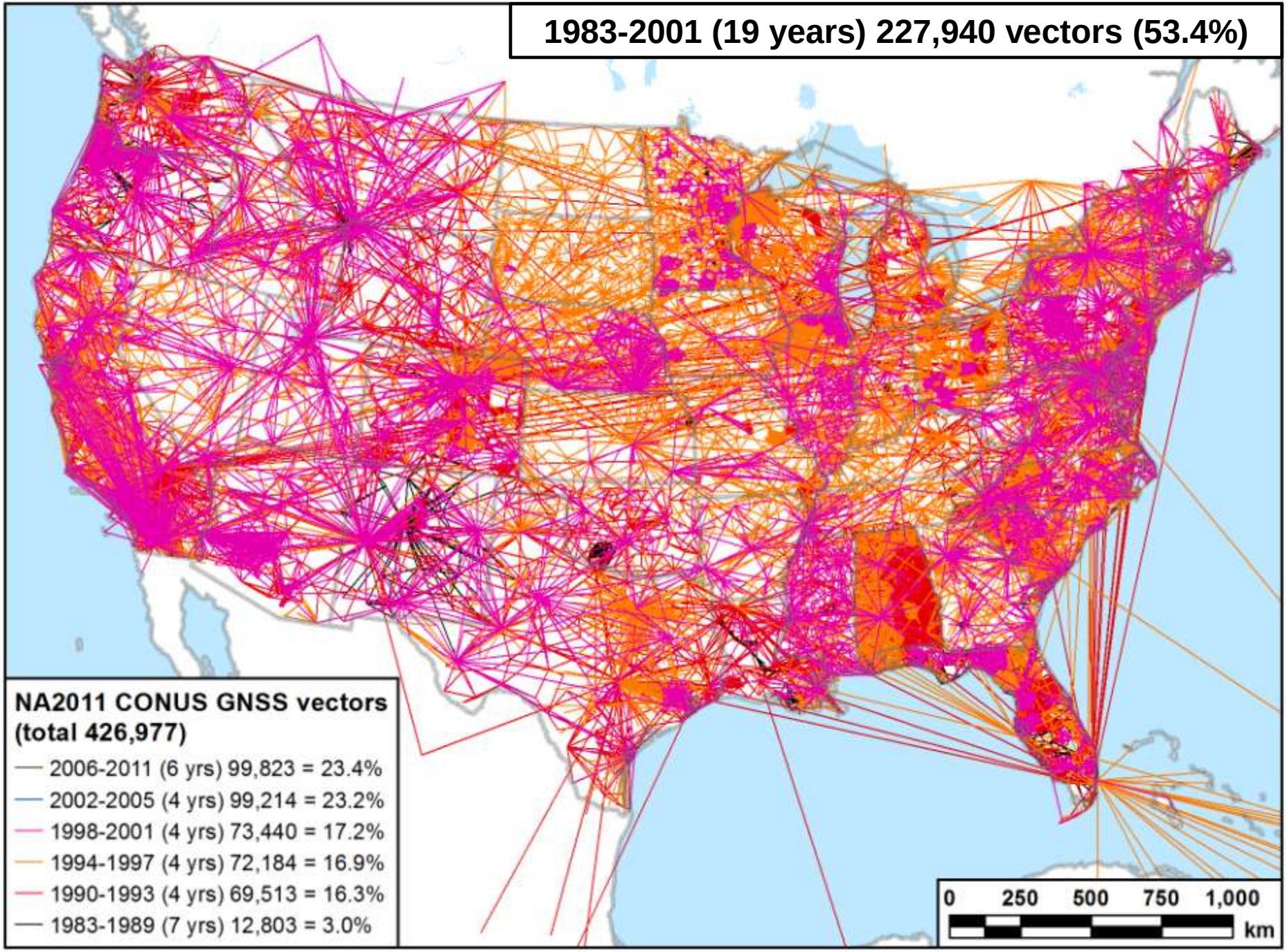
1983-2001 (19 years) 227,940 vectors (53.4%)
NA2011 CONUS GNSS vectors
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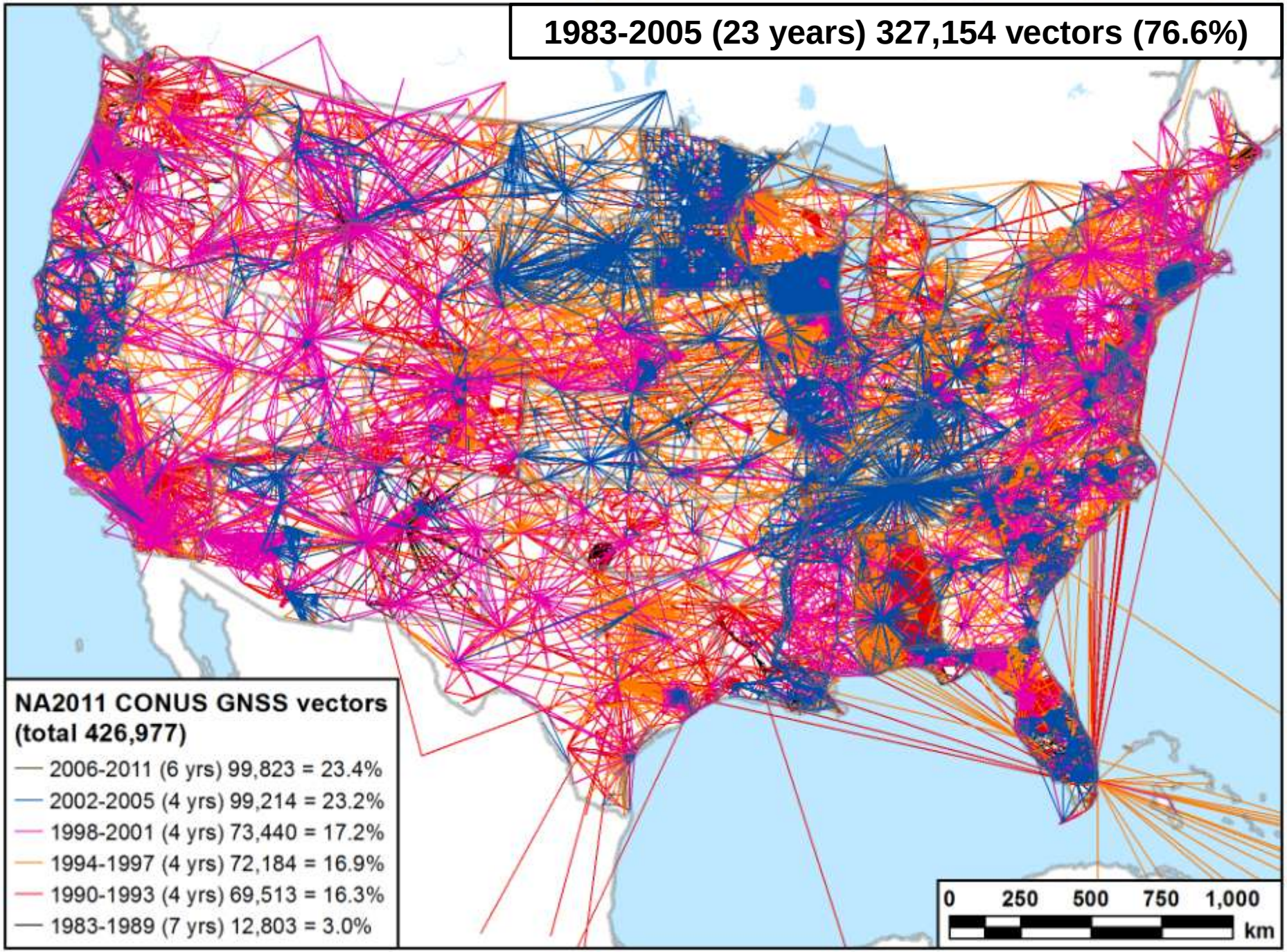
km


1983-2005 (23 years) 327,154 vectors (76.6%)
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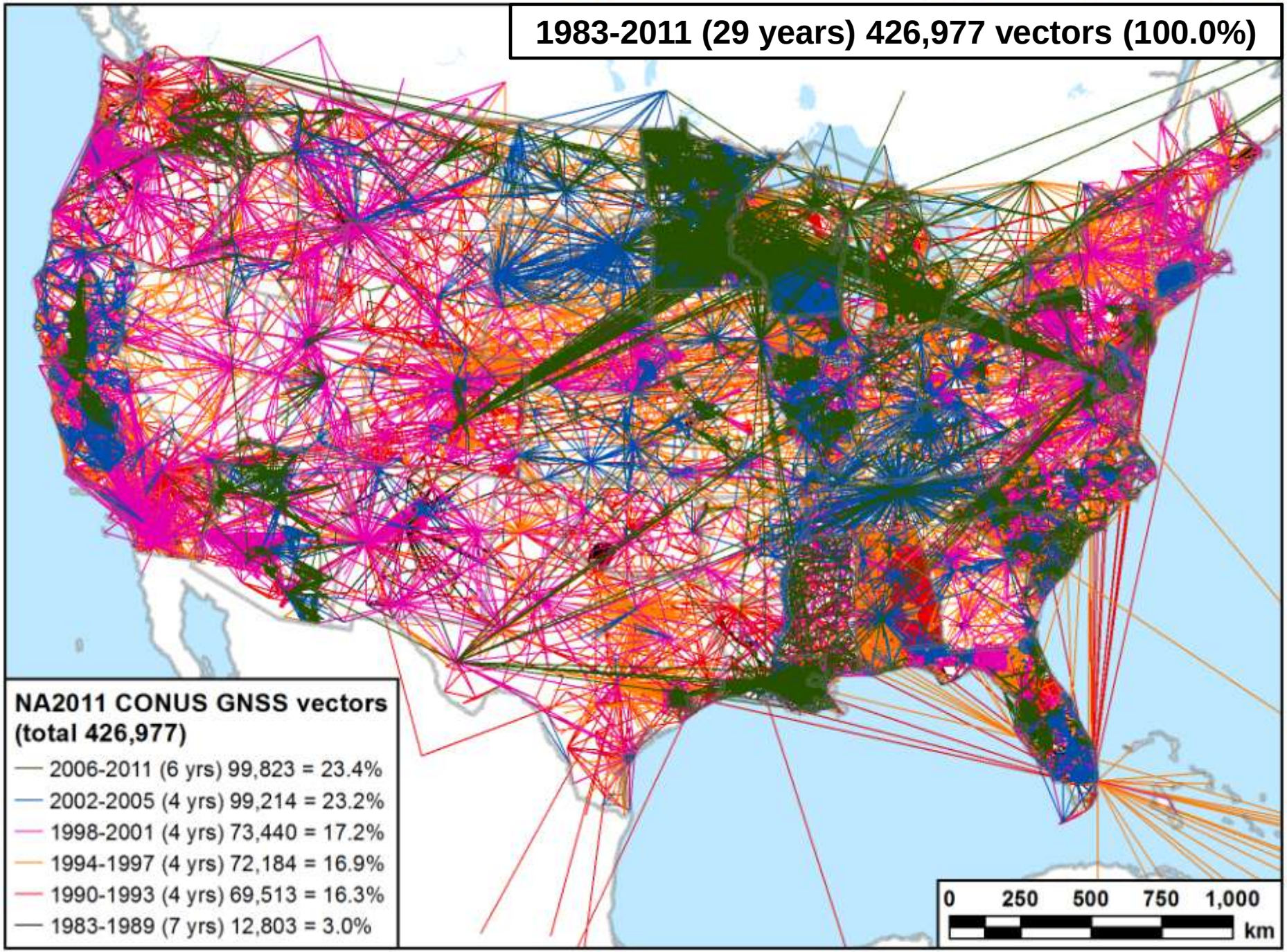
0 250 500 750 1,000
km


1983-2011 (29 years) 426,977 vectors (100.0%)
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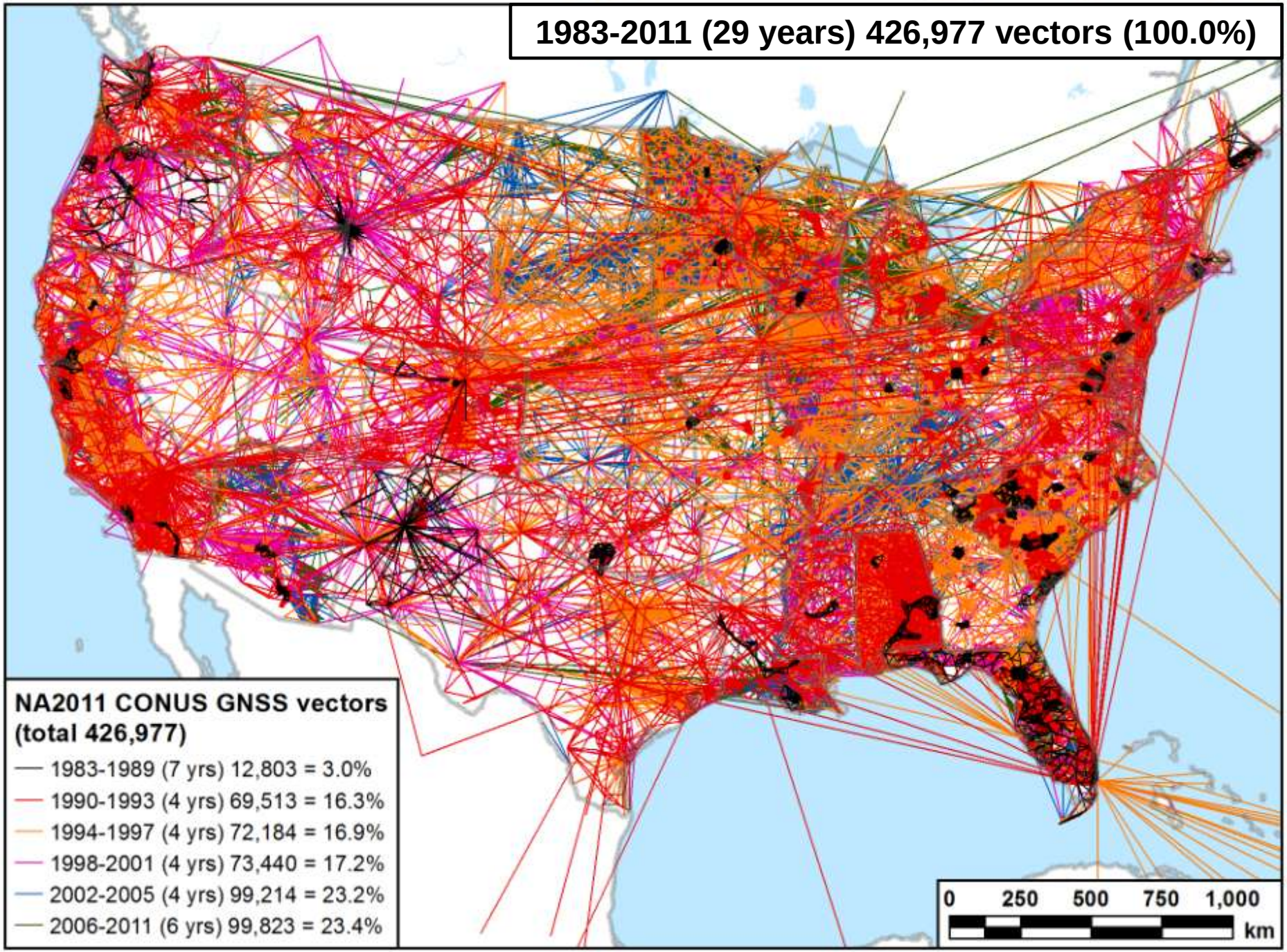
0 250 500 750 1,000
km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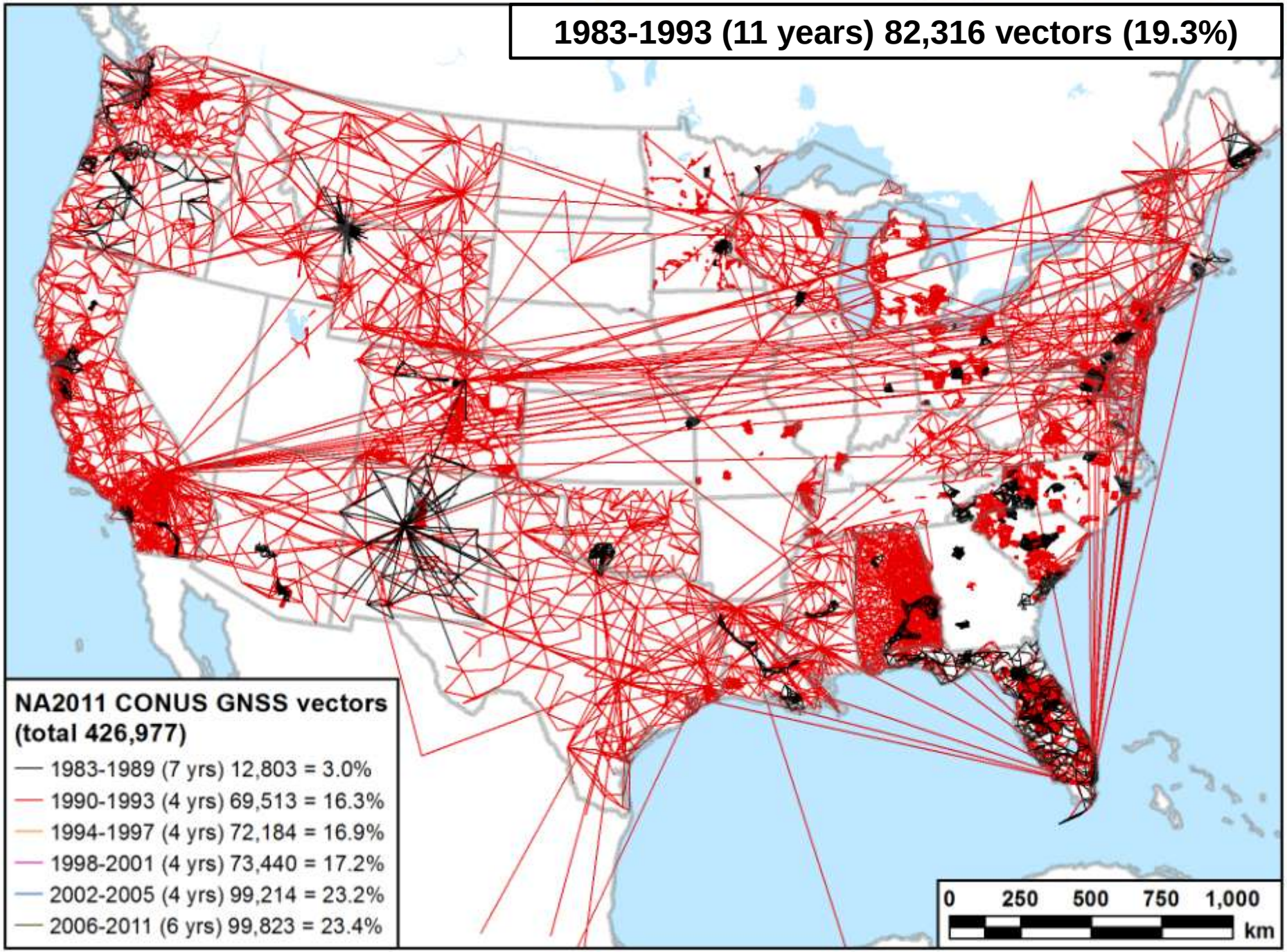
km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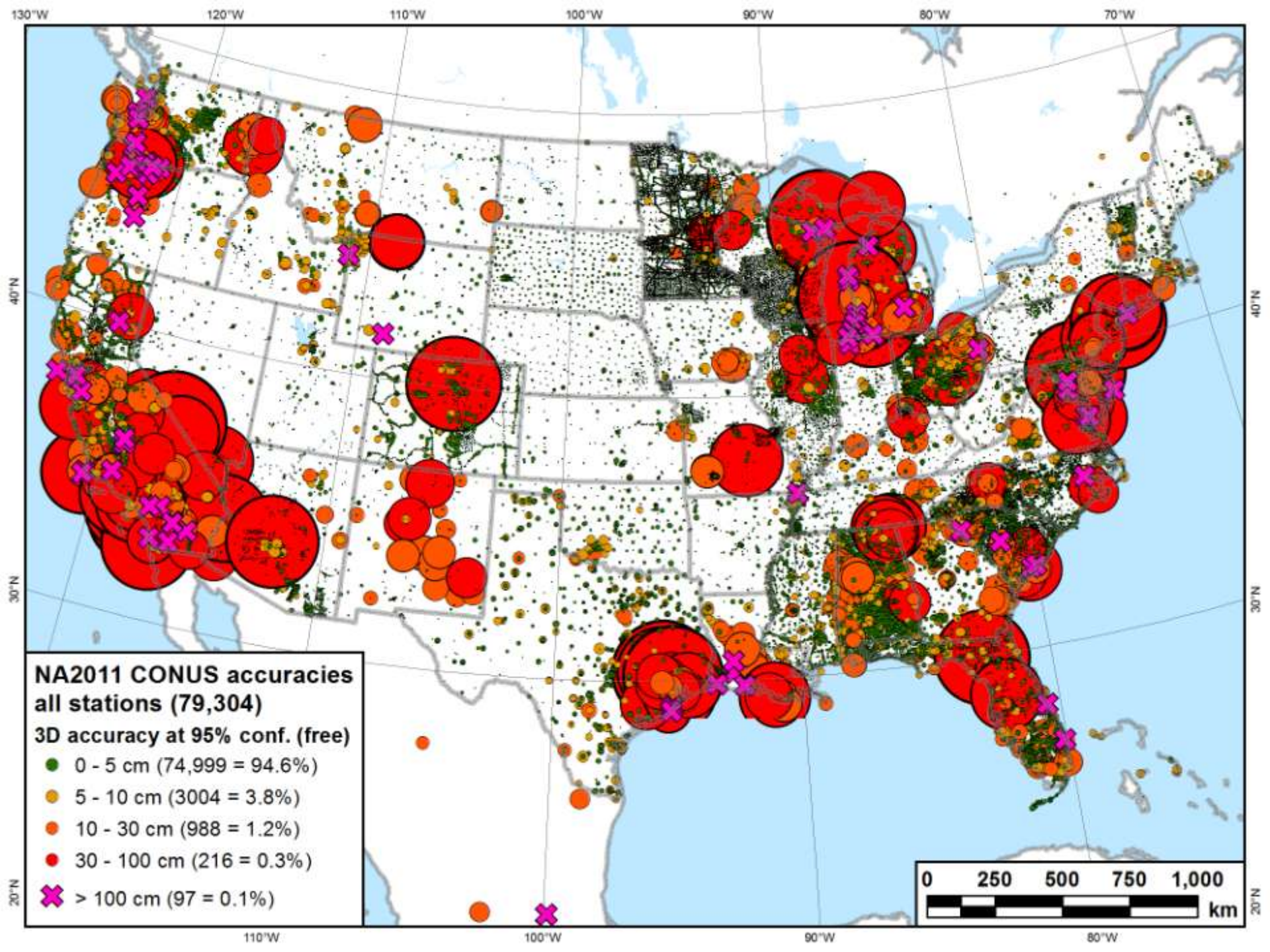
0 250 500 750 1,000
km

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


130°W
120°W
110°W
100°W
90°W
80°W
70°W
40°N
30°N
20°N
NA2011 CONUS accuracies
all stations (79,304)
3D accuracy at 95% conf. (free)
0 - 5 cm (74,999 = 94.6%)
5 - 10 cm (3004 = 3.8%)
10 - 30 cm (988 = 1.2%)
30 - 100 cm (216 = 0.3%)
> 100 cm (97 = 0.1%)
0
250
500
750
1,000
km

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)

How fixed should fixed control be?

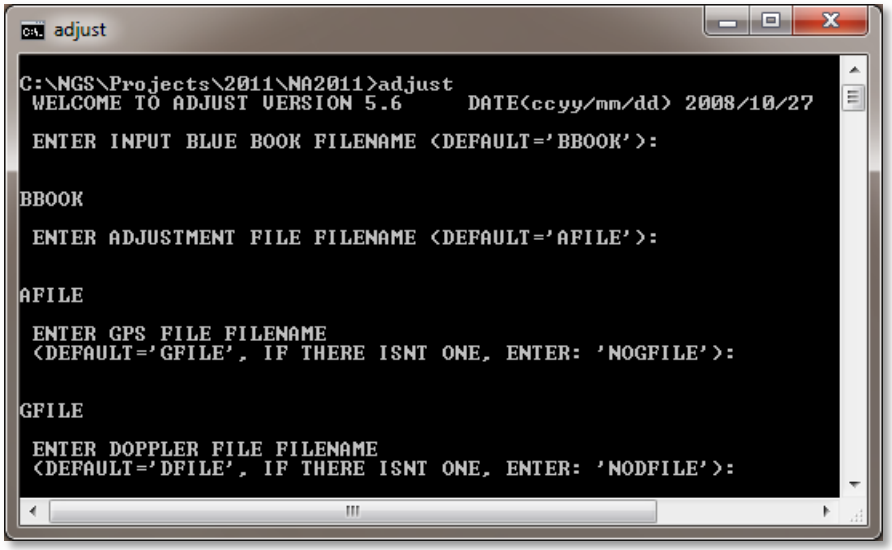
- Question: Use rigid or variable weighted constraints?
  - For variable, use MYCS ***σ*** values directly, or scale them?
    - Concern: Actual MYCS ***σ*** values may be too "loose" as constraints
- Rigid vs. weighted constraints: How much do they move?
  - Max ~7 cm horiz and ~5 cm vert; mean ~0 cm (±1 cm)
  - 185 have shift > 3 cm (half of these in CA)
- Expect overall coordinate change about same as MYCS
  - Horizontal: Mean ~2 cm (±6 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

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×delta time → 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

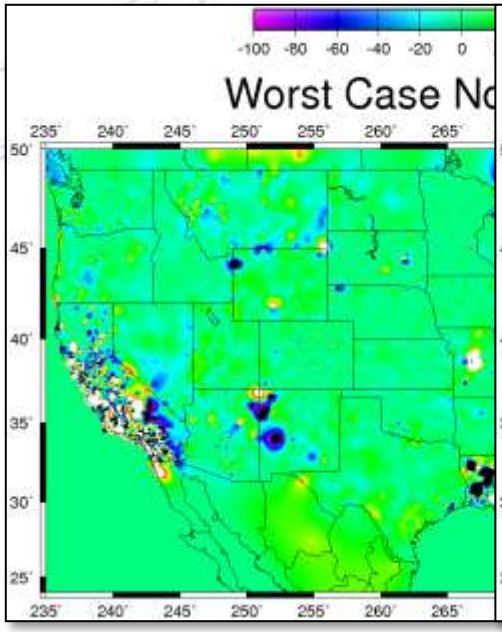
Related Tasks, Products & Deliverables

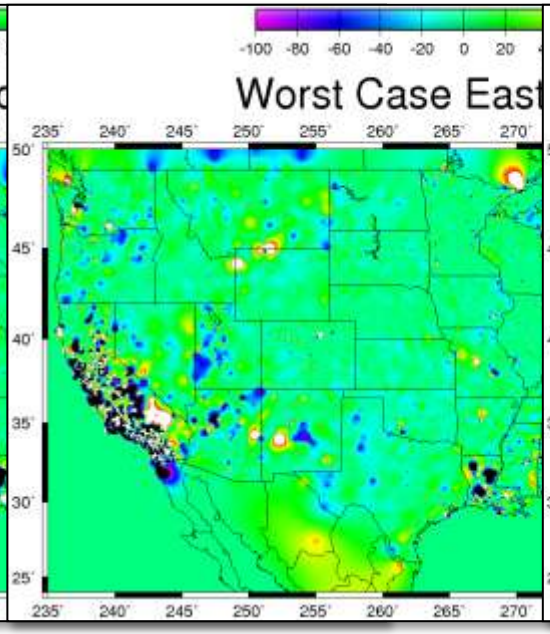
- Release NA2011 results in "Readjustment Distribution Format" (RDF)
  - aka "Bluebook" format (b-files)
  - Includes positions, ellipsoid heights, and accuracies
    - Accuracies as N, E, U sigmas and horizontal correlations
- New version of NGS program "ADJUST"
  - Network and local accuracies
  -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

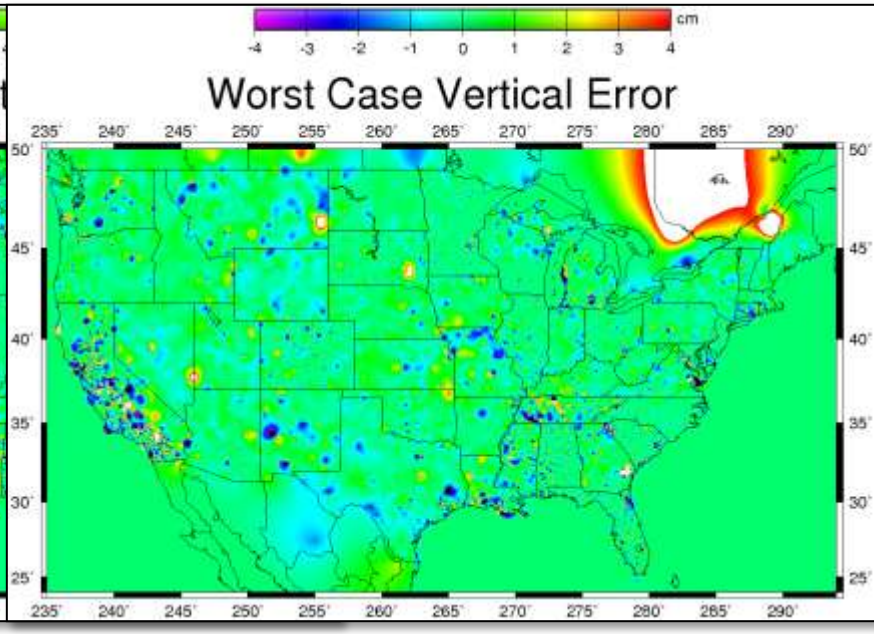


Related Tasks, Products & Deliverables

- New NAD 83 coordinate transformations
  - NAD 83 "HARN" ←→ NAD 83(NSRS2007/CORS96)
    - Algorithm for this tool already created
  - NAD 83(NSRS2007/CORS96) ←→ 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







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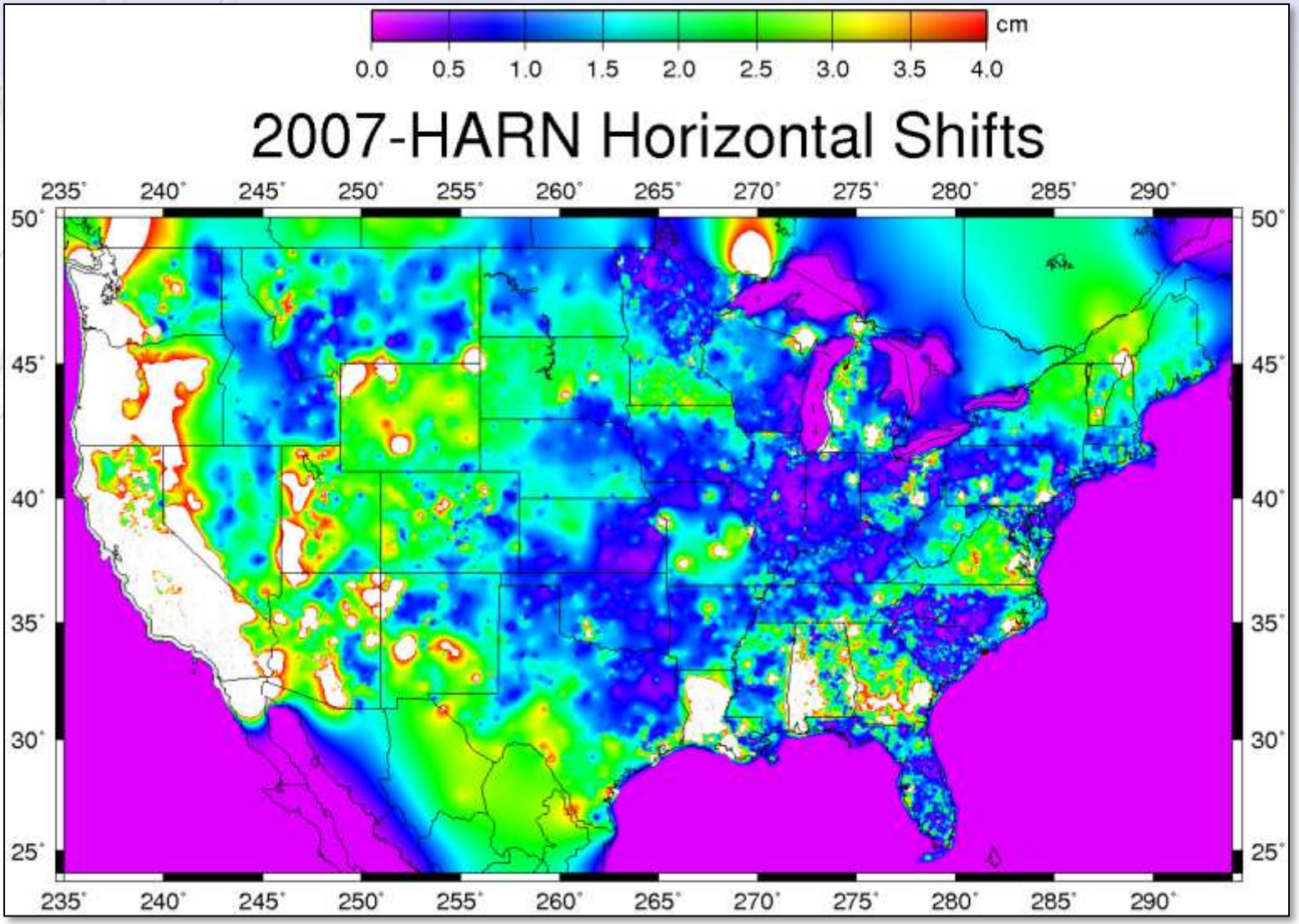
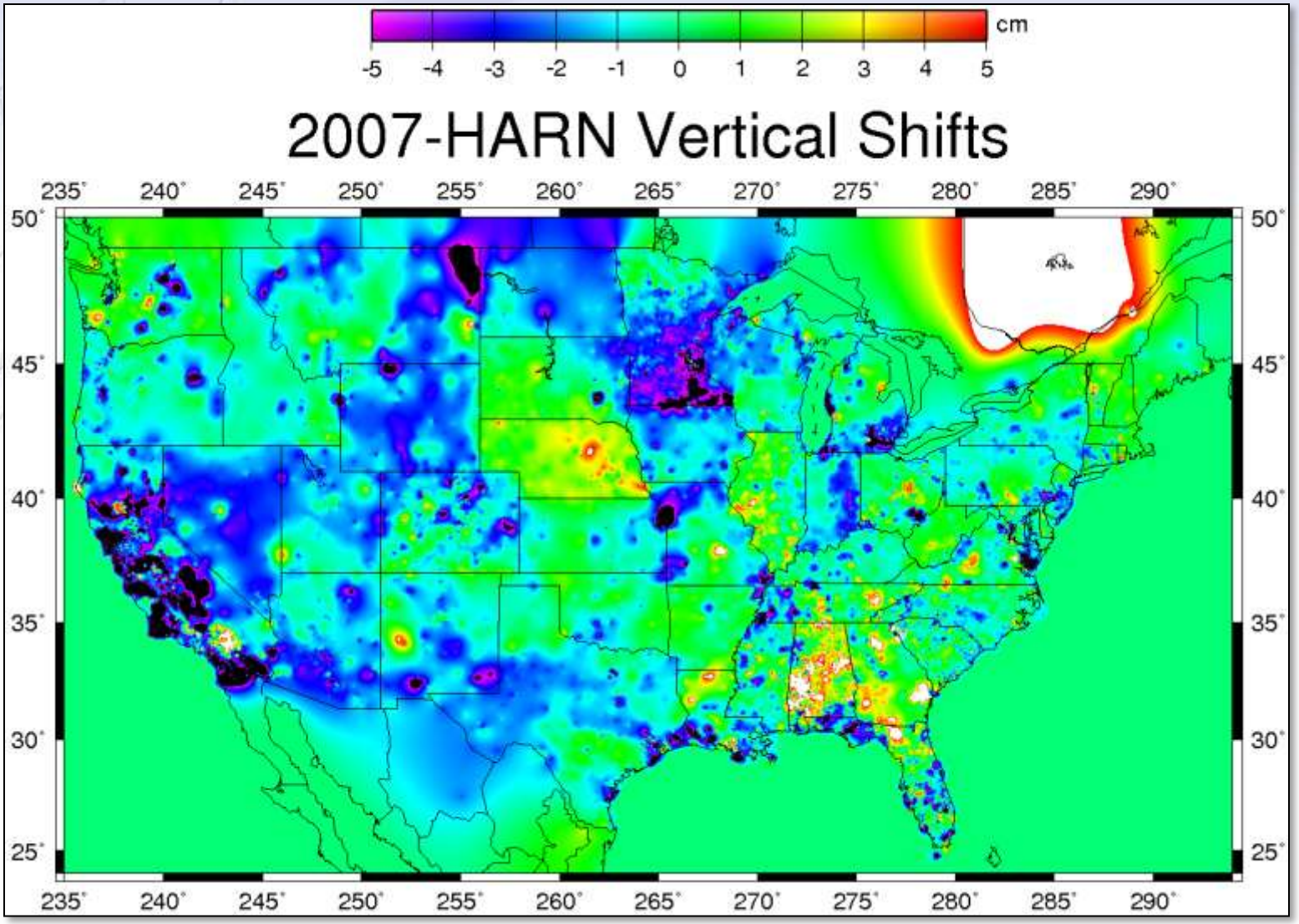


Related Tasks, Products & Deliverables



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|-----------------------------------------------------------------------|
AC6803| PID    Reference Object                    Distance      Geod. Az   |
AC6803|                                                          dddmmss.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|---------------------------------------------------------------------|
AC6803| PID    Reference Object                    Distance       Geod. Az   |
AC6803|                                                           dddmmss.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)  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.
```

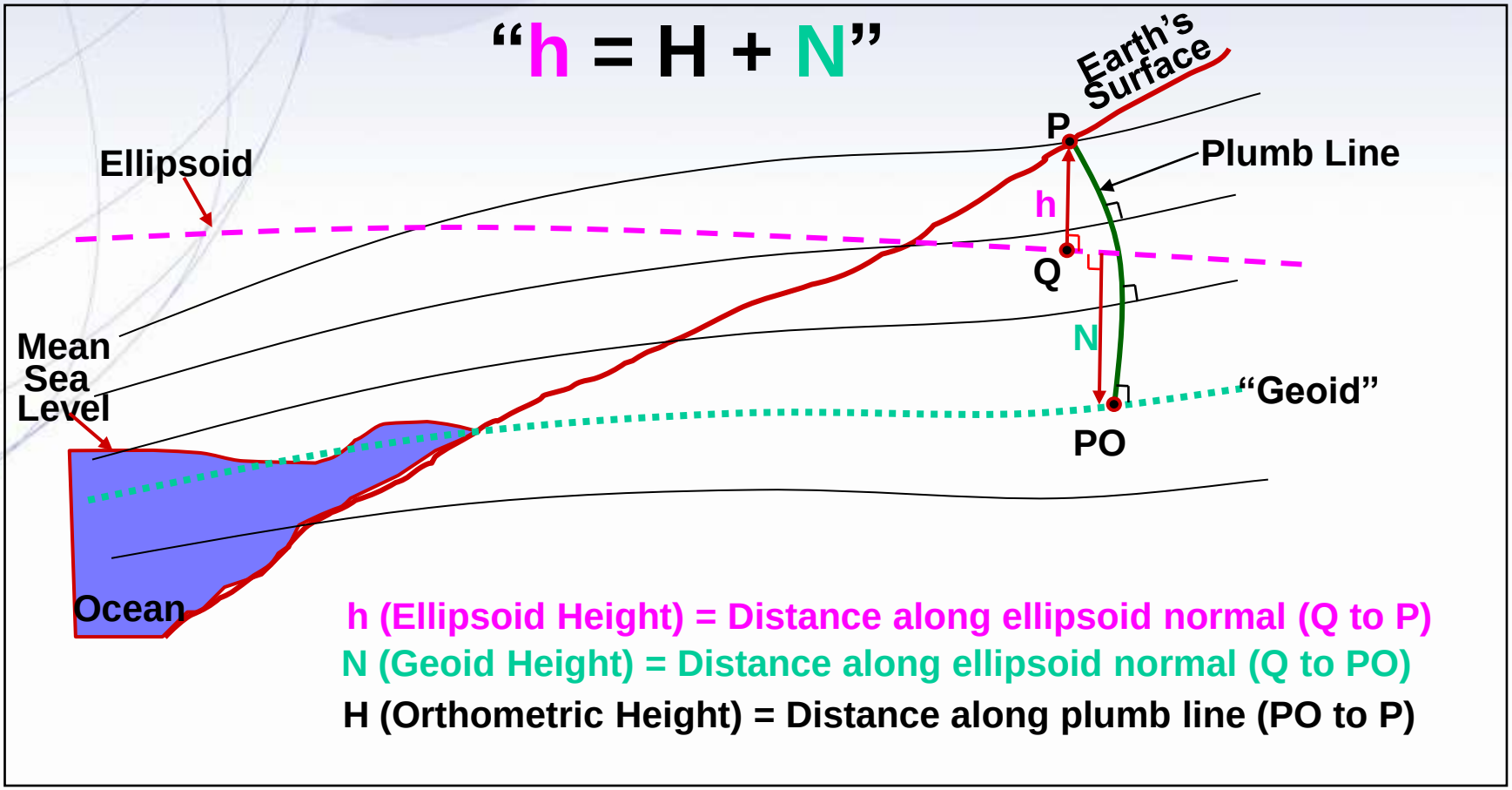
What about orthometric heights?

- 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)?

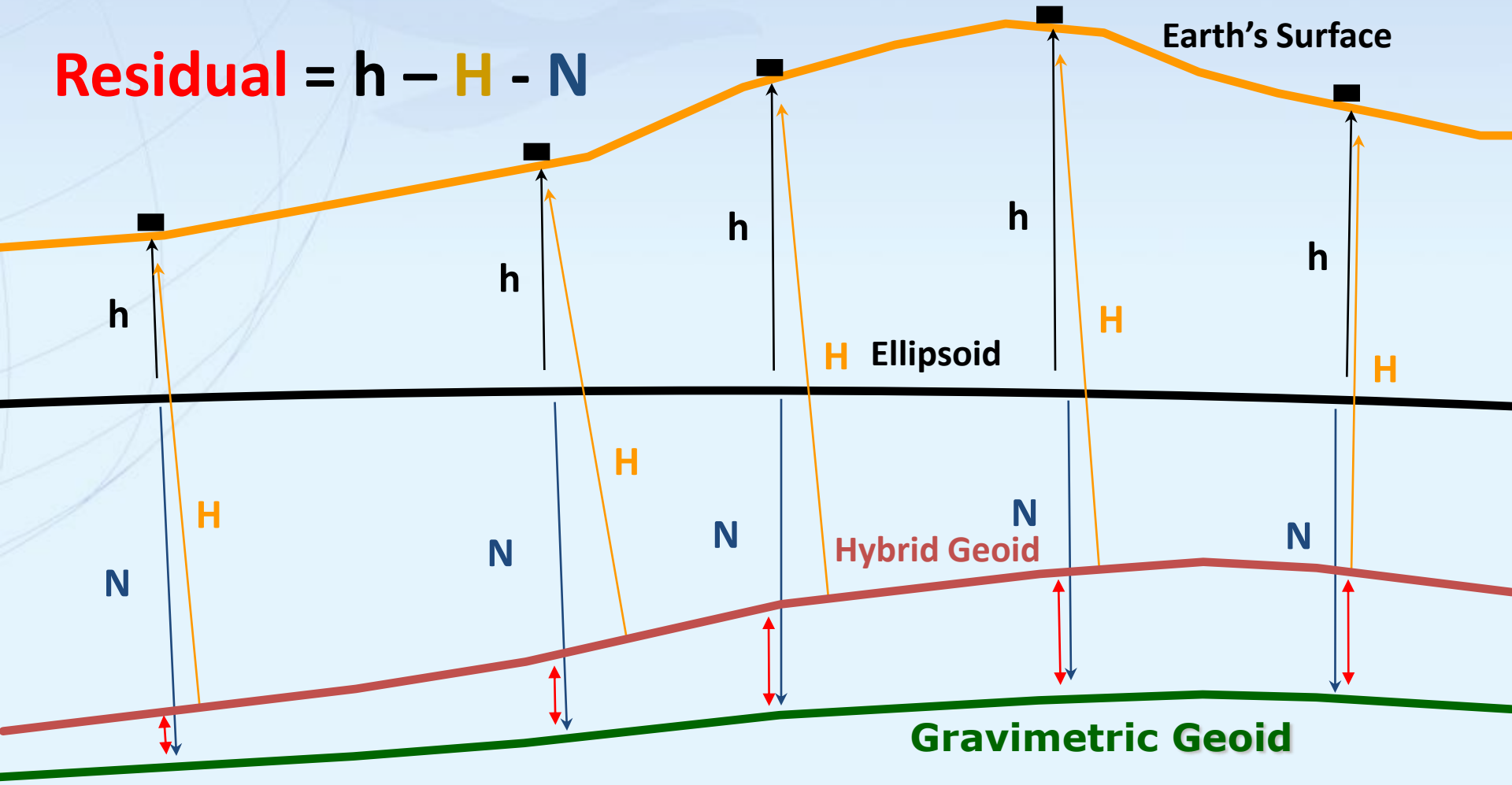
So…GEOID12

- New geoid model compatible with NAD83(2011) ellipsoid heights and NAVD88 bms.
- Release concurrently with ~2011
- We don't expect large slope changes in NC
- GEOID03 is NOT compatible with ~2011, but by localizing to local BMs, the model introduced errors are reduced to cm level

Relationship Between Heights

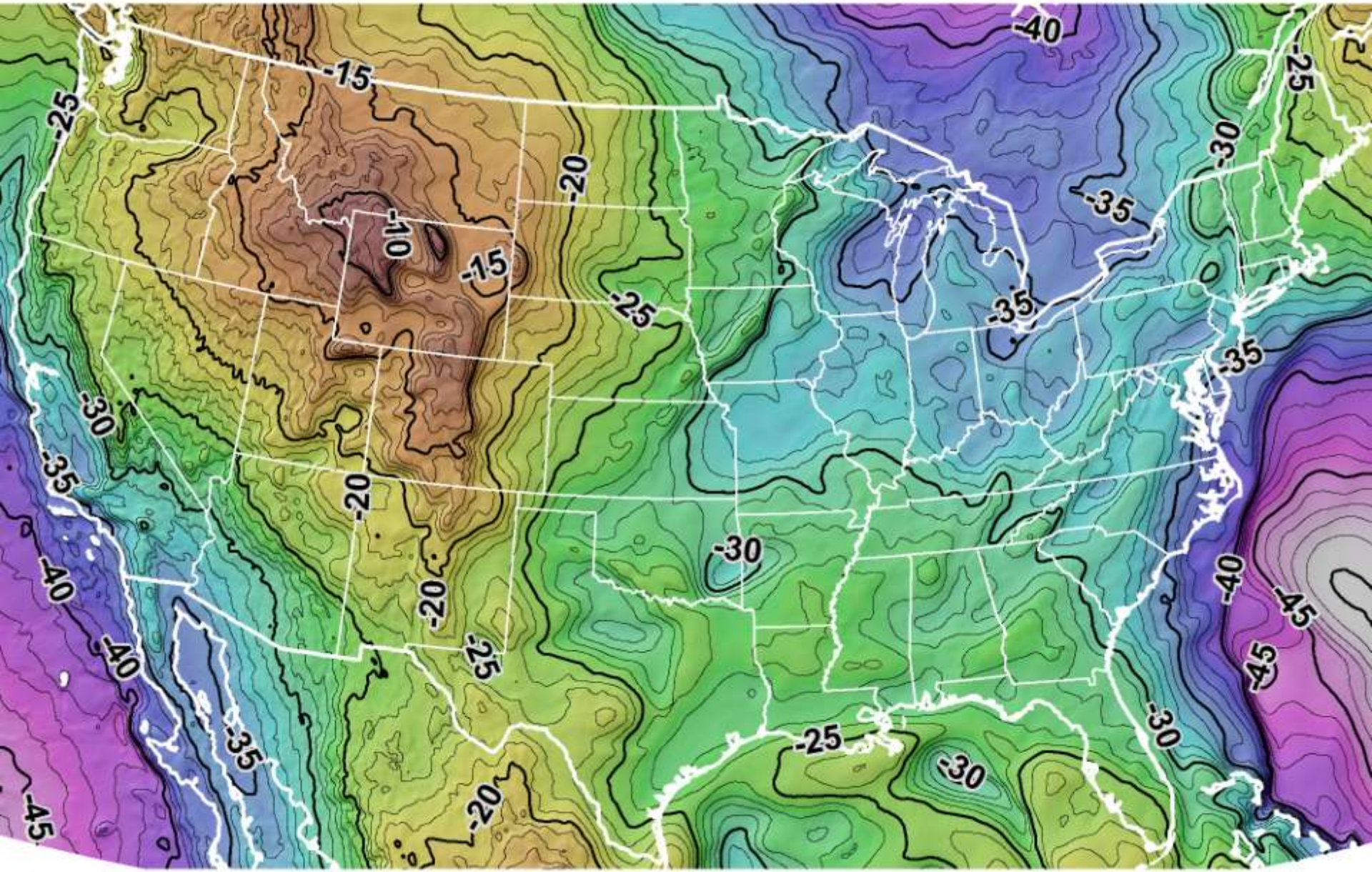


Hybrid Geoid Height Models (e.g., GEOID09) are determined from Gravimetric Geoid Height Models (e.g., USGG2009) and Conversion Surfaces based on GPS on BM data

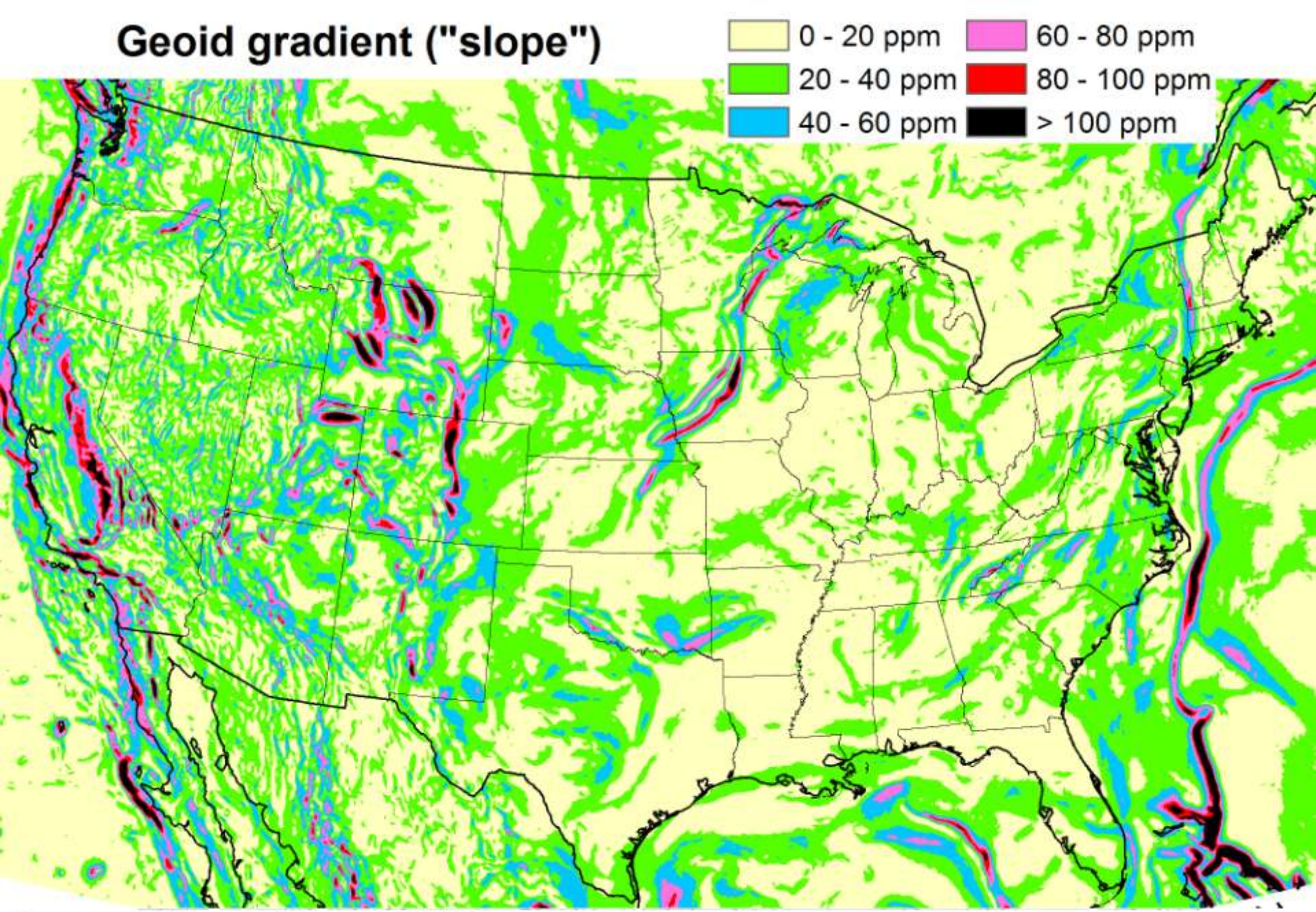


- Gravimetric Geoid systematic misfit to BM's but best fits "true" heights
- Hybrid Geoid "converted" to fit local BM's, so best fits NAVD 88 heights
- Conversion Surface model of systematic misfit derived from BM's in IDB

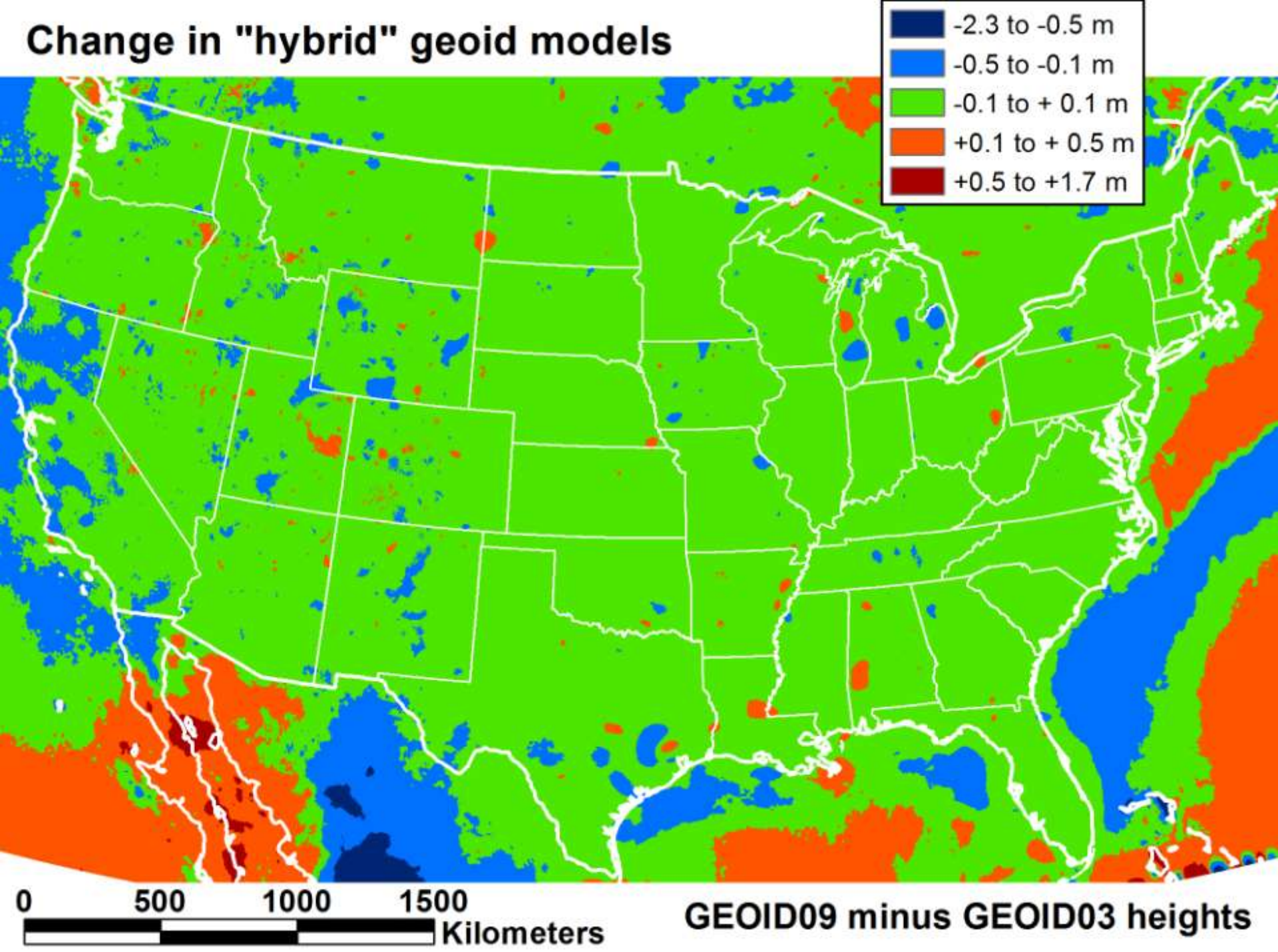
Geoid heights in the United States (contours in meters)



NGS "hybrid" model GEOID09

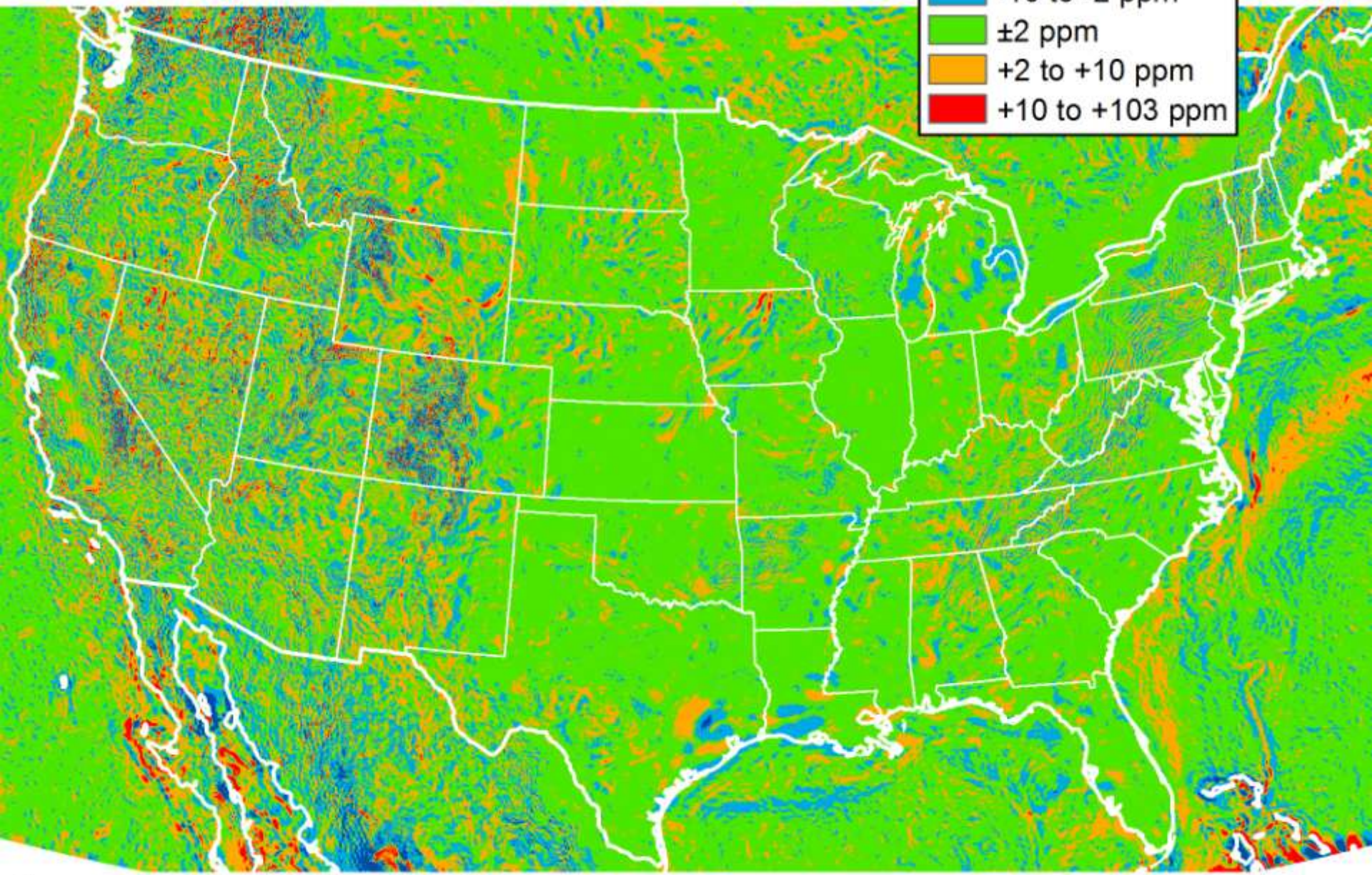

Geoid gradient ("slope")
0 - 20 ppm
20 - 40 ppm
40 - 60 ppm
60 - 80 ppm
80 - 100 ppm
> 100 ppm
0
500
1000
1500
Kilometers
NGS "hybrid" model GEOID09

Change in "hybrid" geoid models



GEOID09 minus GEOID03 heights

Change in geoid gradient ("slope")



GEOID09 minus GEOID03 slope

More information…

geodesy.noaa.gov

National Geodetic Survey

Positioning America for the Future

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

June 11, 2012

Announcements

Trial Version of the New NGS Map Tool is now Available:
http://beta.ngs.noaa.gov/googletest/NGSMap/NGSMap.shtml

2012 Geospatial Summit
NOAA's National Geodetic Survey (NGS) will host the second **Geospatial Summit on Improvements to the National Spatial Reference System** at the Survey Summit and Esri User Conference in San Diego, California in July 2012...more

Notice: The updates to NGS Datasheet Format are now in effect as of 5/01/2012
In response to stakeholder and NGS staff concerns, NGS has developed several modifications to the format of the **NGS datasheet**—the primary method for accessing the passive control network of the National Spatial Reference System (NSRS)...more

NGS Announces New Photo Submission Guidelines:
http://geodesy.noaa.gov/web/surveys/photo_submissions/

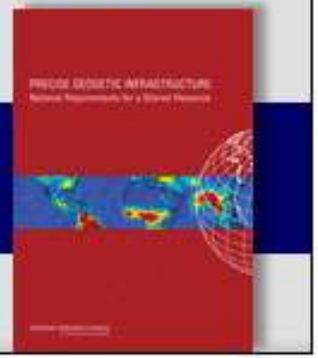
NGS Releases Final Report for Floodplain Mapping Pilot Project
As NGS moves closer to 2022 and replacing the **North American Datum of**

Most Popular

- Contact Us
- CORS
- Survey Mark Datasheets
- Geodetic Tool Kit
- NA2011
- OPUS
- LOCUS
- Publications
- Geodetic Advisors
- Storm Imagery
- UFCORS

Upcoming Events

NRC Highlights Importance of NGS Products...



Federal Geodetic Control Subcommittee of the fgdc

NGS Public

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/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
 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
```

t the datasheet.

```
tasheet95, 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).
t 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.
AC6803
AC6803.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC6803
```