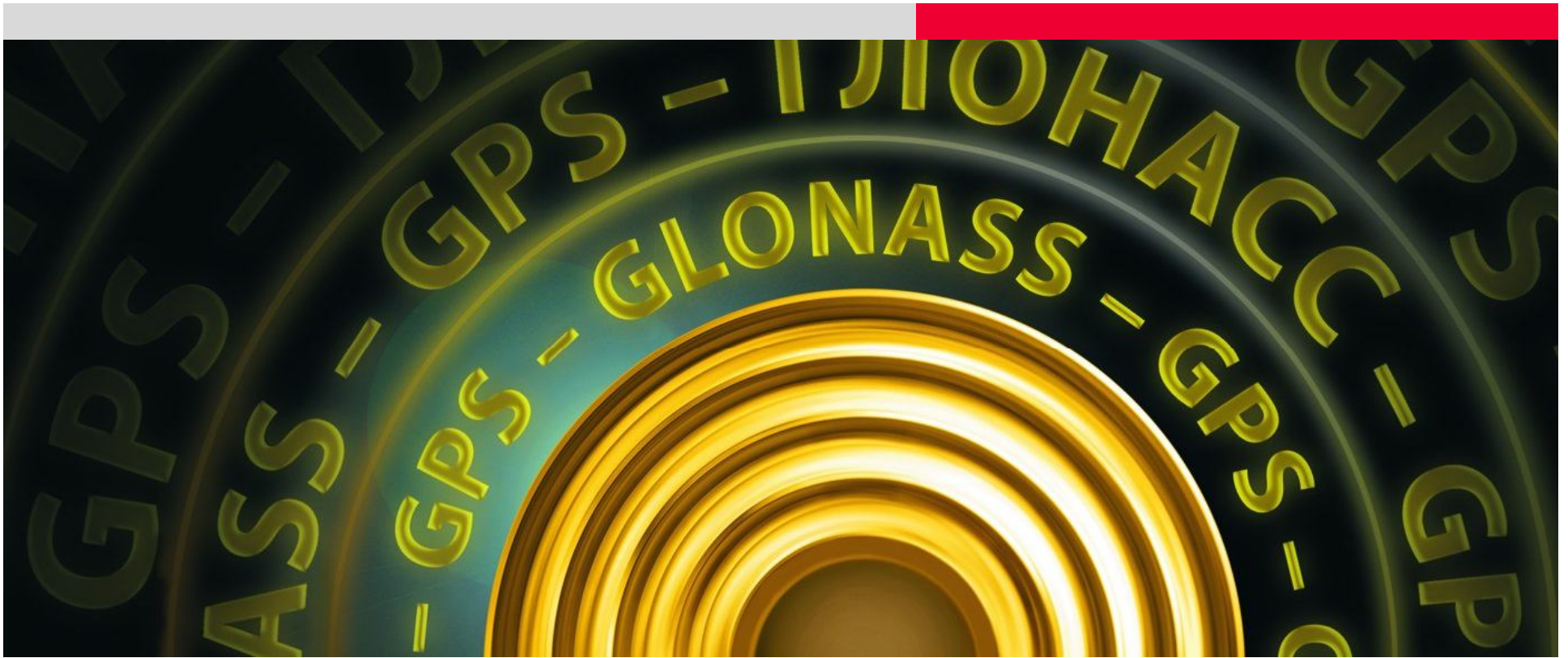




NGS NAD83(2011)2010.0000 and the Indiana Real-Time Network (INCORS)

Jill Johnson, PLS

¹ NRS Project Engineering

- when it has to be **right**

Leica
Geosystems

Outline

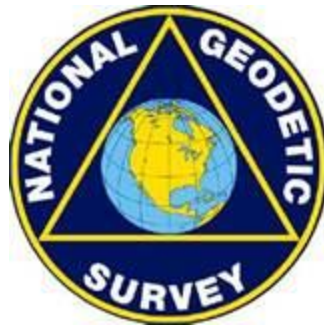
1. The NGS and NAD83(2011)2010.0000

1. Why reprocess?
2. How did they reprocess?
3. What has changed?

2. The INCORS RTN and NAD83(2011)2010.0000

1. Why reprocess?
2. What data was reprocessed?
3. What were the adjustment results?
4. What were the position changes in NAD83?
5. How was alignment with NGS confirmed?
6. What is the Impact to end-users?

The NGS and NAD83(2011)2010.0000



all excerpts taken from:

<http://www.ngs.noaa.gov/CORS/coords.shtml>

FAQ 1: Why Did NGS Reprocess?

- Mixed coordinates from an earlier solution (1994-2002) that used only 3-8 ITRF reference frame sites to align to the global frame
- Mixed horizontal velocities: modeled vs. computed
- Mixed vertical velocities, which for many of the NAD 83(COR96,MARP00,PACP00) epoch 2002.00 stations were assigned a value of 0 mm/yr
- NGS's global frame was ITRF00 epoch 1997.00; projecting positions 13 years to the present was unrealistic
- NGS's plate-fixed frame was NAD 83(CORS96,MARP00,PACP00) epoch 2002.00; projecting positions 8 years to the present was also questionable
- Implemented significant changes to existing processing algorithms and models including compliance with IERS conventions (i.e. software changes)
- Switched from using relative antenna calibration to absolute antenna calibrations
- The current state-of-the-art full (~230 stations) global reference frame: IGS08 epoch 2005.00

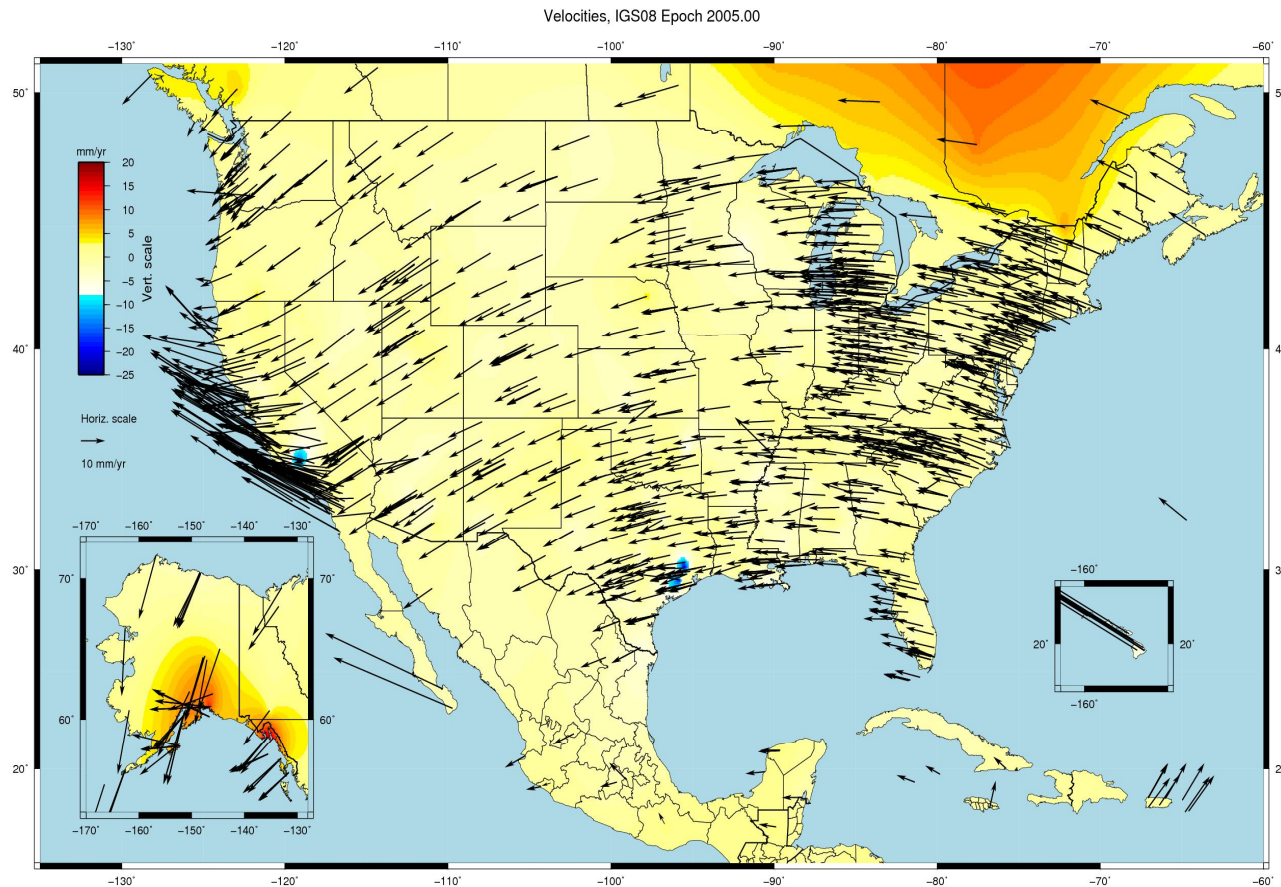
Given these major inconsistencies and changes, NGS elected to reprocess all its CORS data to provide a single consistent set of coordinates for all sites computed using the best available methods.

FAQ 2: How did NGS reprocess the data?

- RINEX observations from the set of global sites were reduced to obtain weekly sets of station positions, satellite orbits, and Earth Orientation Parameters, using the latest version of the NGS PAGES software.
- These weekly "global" solutions were submitted to the IGS for their IG1/reprop1 data reprocessing campaign.
- Then, CORS data were tied to the framework of the global solution on a weekly basis at the normal equation level resulting in weekly SINEX files containing the positions and full variance-covariance information for CORS plus global stations.
- Regularized positions and secular velocities were obtained by stacking the SINEX files with the CATREF software from Institut Géographique National (IGN), Paris, France.

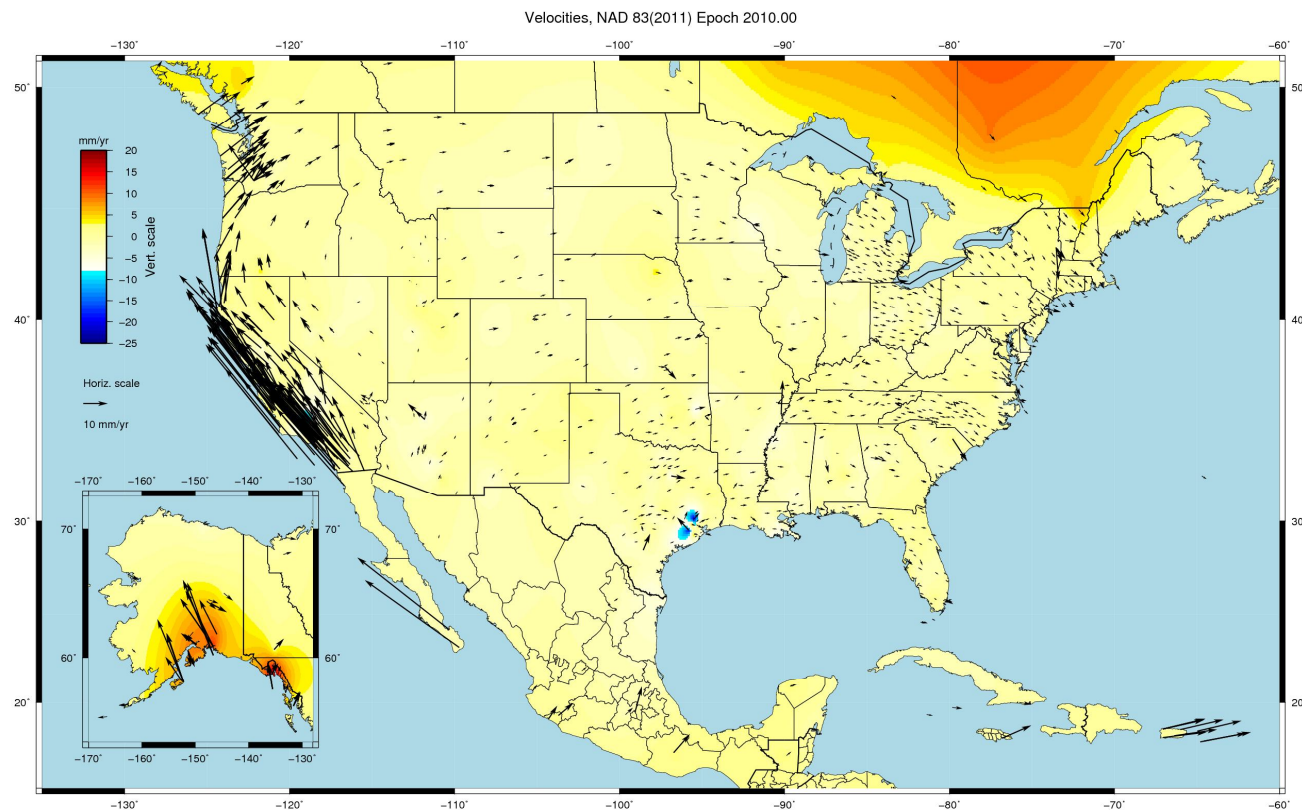
These new coordinates form the basis for NGS's realization of IGS08, and thus NAD 83(2011).

The solutions obtained from the processing were first aligned to IGS08(2005.00).



(Horizontal velocities are shown as black vectors. Vertical velocities are shown as colored surface.)

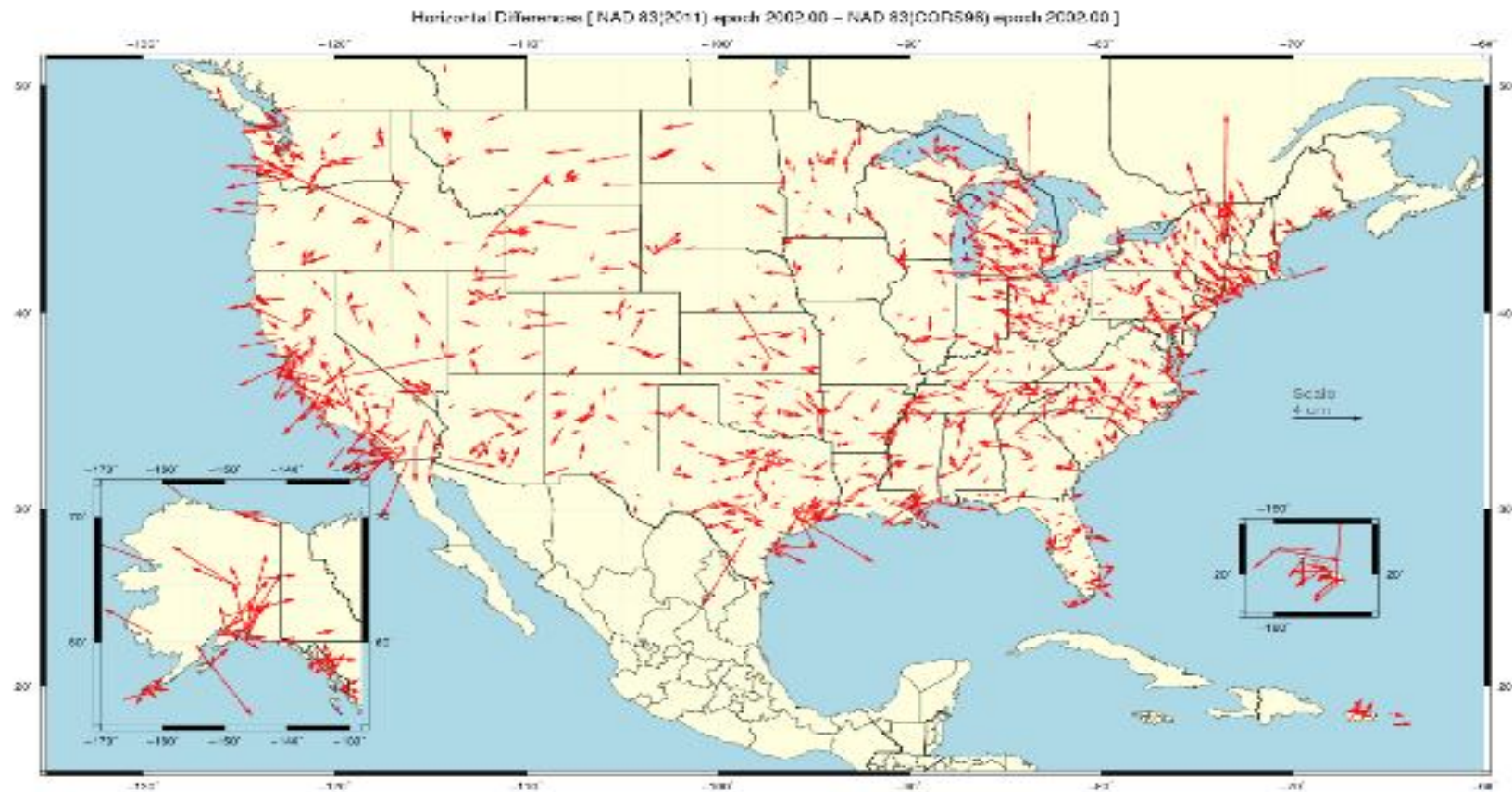
The IGS08 epoch 2005.00 solutions are then transformed to the plate-fixed NSRS consistent frame ... NAD 83(2011) epoch 2010.0000



FAQ 3: What has changed between NAD 83(2011) epoch 2010.00 and NAD 83(CORS96) epoch 2002.00?

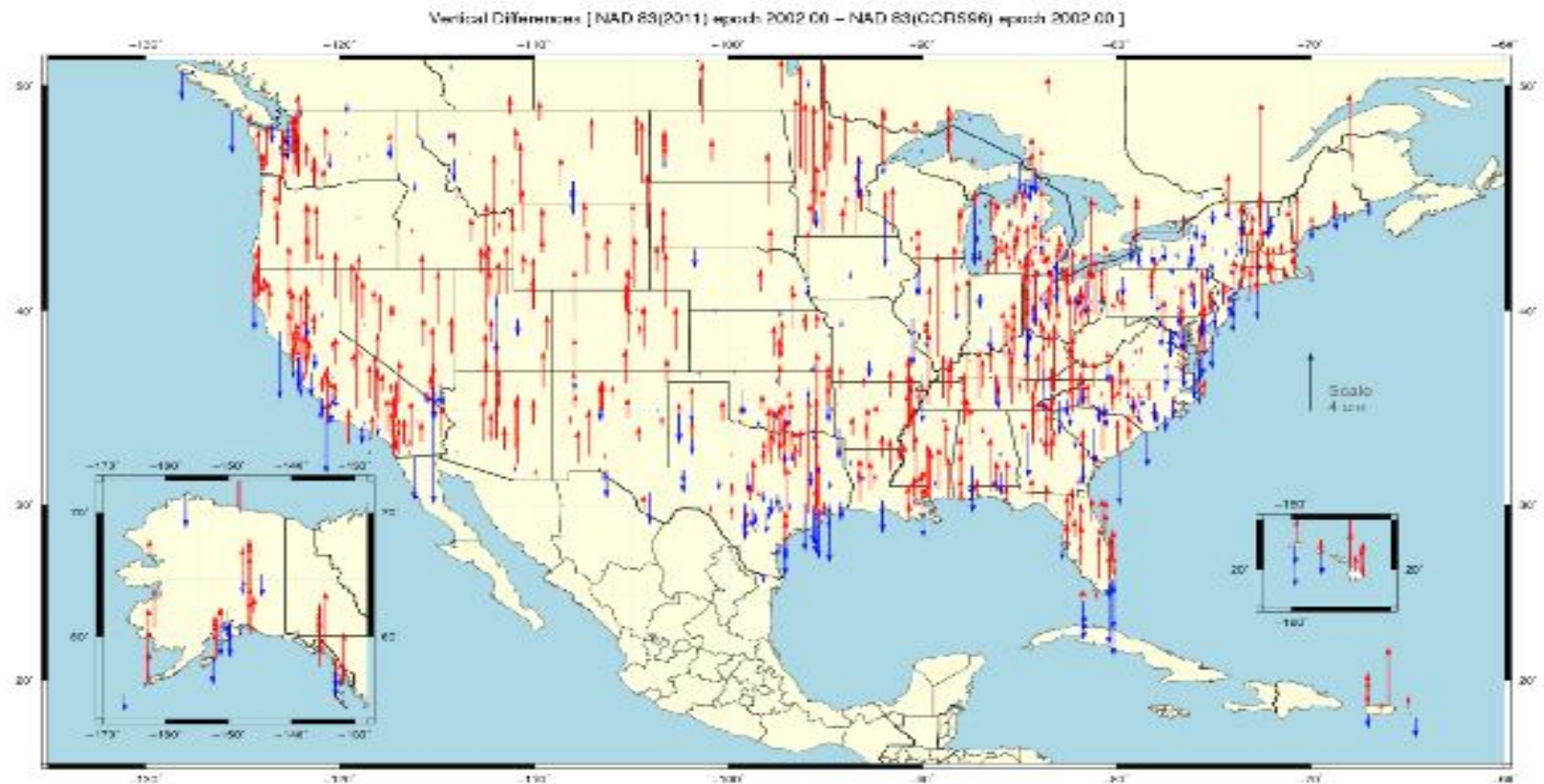
- There has been no datum change, that is, the origin, scale and orientation of NAD 83(2011) are identical to those of NAD 83(CORS96).
- The changes in coordinates are driven by multiple factors including the:
 - switch to absolute antenna calibrations,
 - new/revised processing algorithms,
 - improved discontinuity identification,
 - longer data sets, and
 - improved definition of the global reference frame.
- However for the end user the biggest change is caused by the new reference epoch, which has changed by 8 years from 2002.00 to 2010.00.

Difference in positions of NAD 83(2011) epoch 2002.00 minus NAD 83(CORS96) epoch 2002.00 (Horiz)



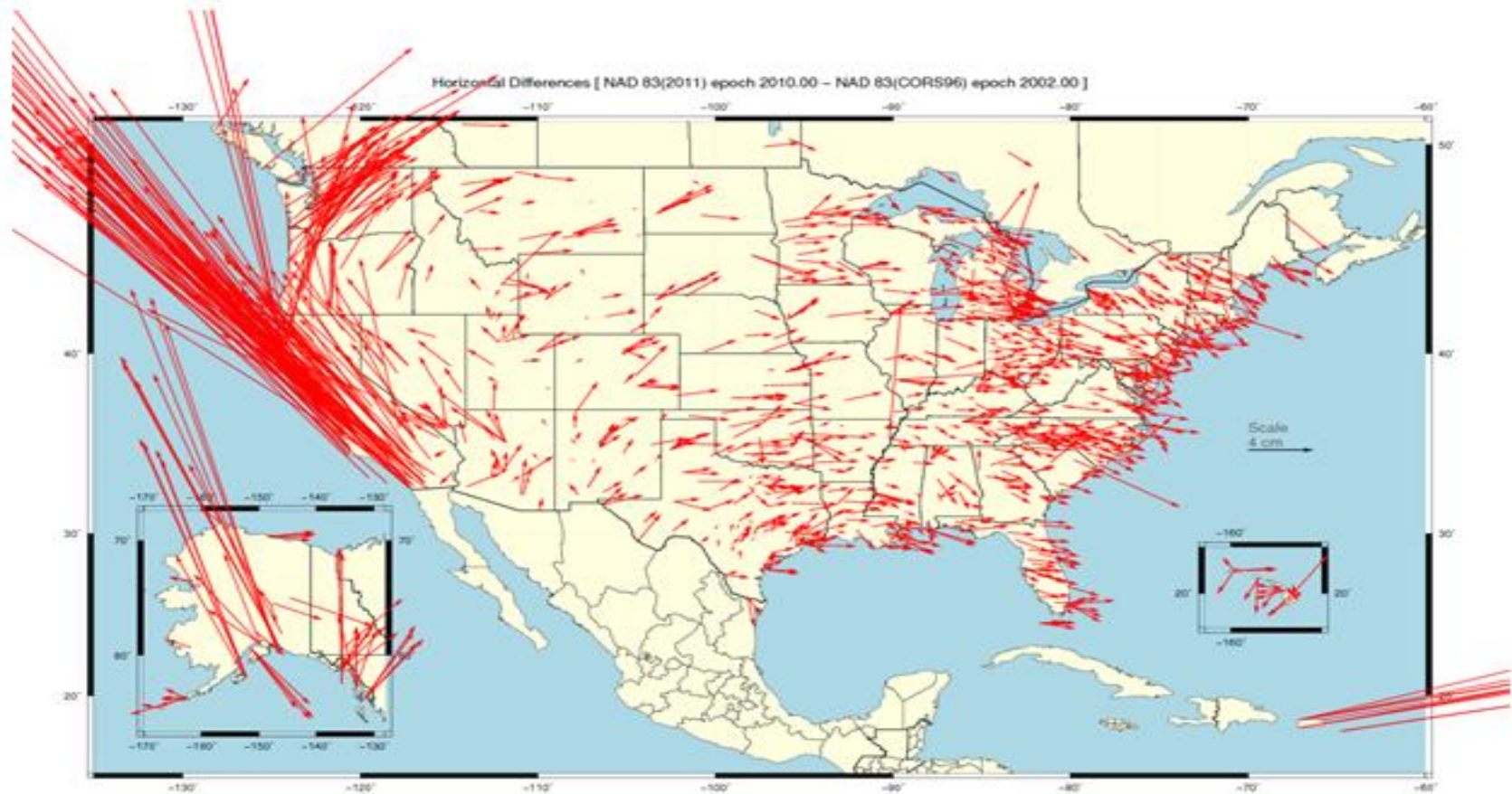
“the horizontal change in reference frames ...”

Difference in positions of NAD 83(2011) epoch 2002.00 minus NAD 83(CORS96) epoch 2002.00 (Vert)



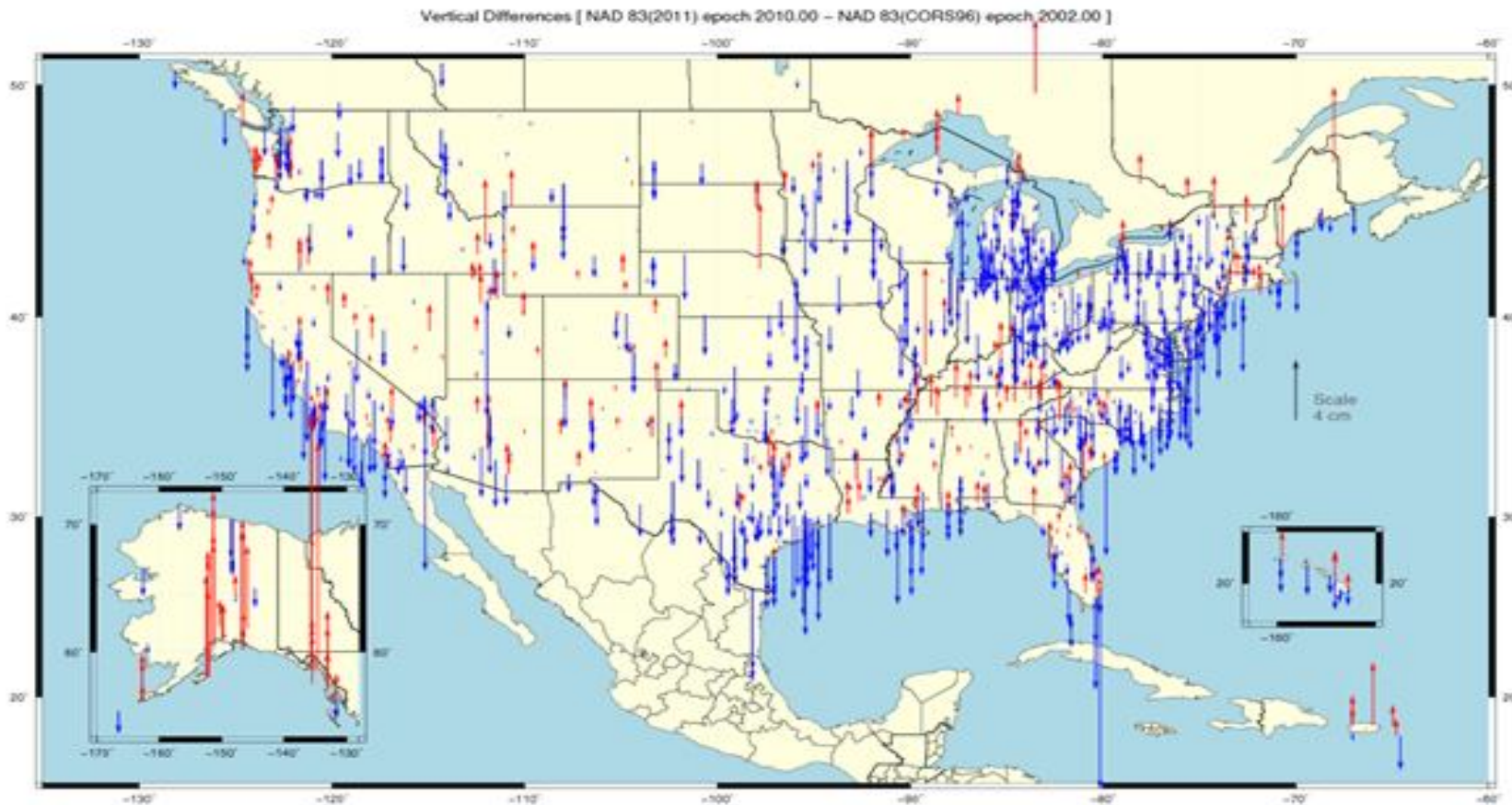
“the vertical change in reference frames ...”

Difference in positions of NAD 83(2011) epoch 2010.00 minus NAD 83(CORS96) epoch 2002.00 (Horiz)



“ now including two reference epochs of 2010.00 and 2002.00“

Difference in positions of NAD 83(2011) epoch 2010.00 minus NAD 83(CORS96) epoch 2002.00 (Vert)



“ now including two reference epochs of 2010.00 and 2002.00 ”

What we see is that the changes for most stations are larger and there are some systematic regional patterns unlike when we compared positions at the same epoch.

The main cause of these differences reflects previous errors in plate fixed (NAD 83) velocity estimates.

The errors however are greater than they seem since we are mixing true plate fixed sites in the Central and Eastern US with sites in the western US that are in the plate boundary zone between the Pacific and North American Plate.

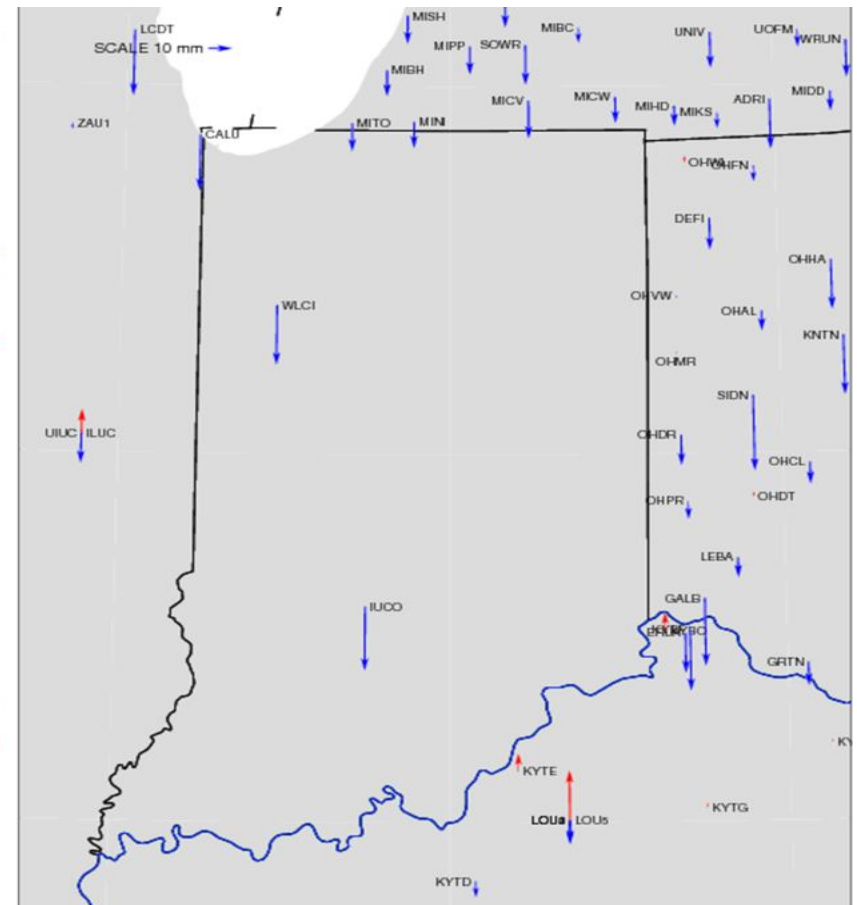
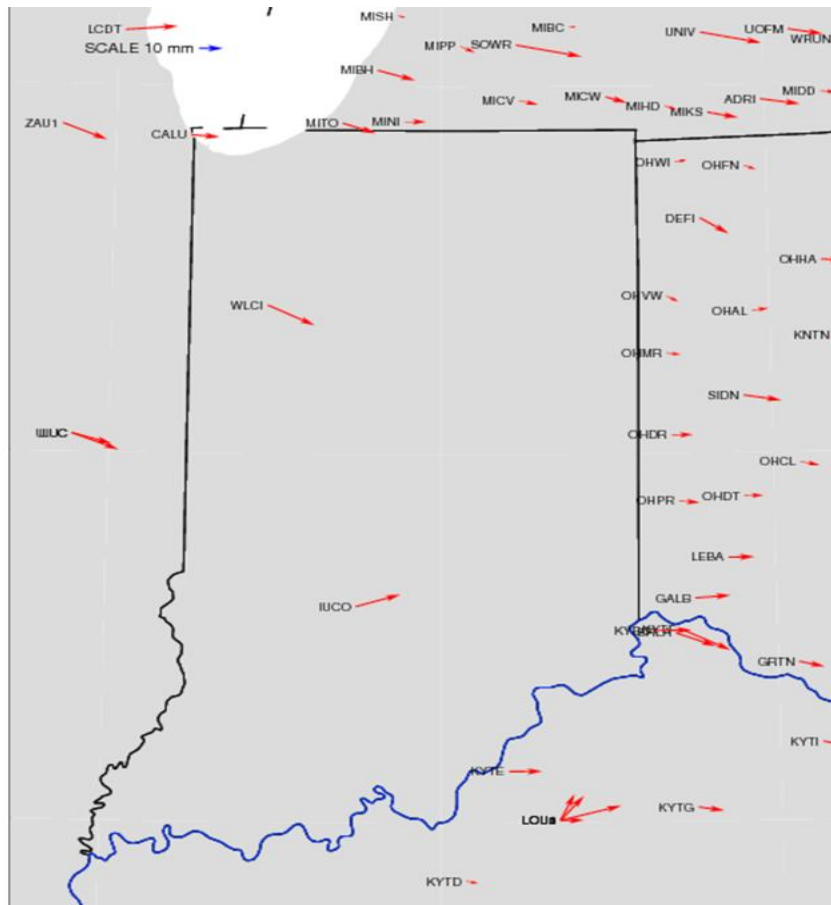
Average differences of NAD 83(2011) epoch 2002.00 minus NAD 83(CORS96) epoch 2002.00

Average difference of NAD 83(2011) epoch 2010.00 minus NAD 83(CORS96) epoch 2002.00:

Mean values of:
East 0.05 ± 5.25 cm
North 2.12 ± 6.08 cm
Up -0.66 ± 2.24 cm

Median values of:
East -0.12 cm
North 0.00 cm
Vertical -0.80 cm

Detailed maps of difference in horizontal (left) and vertical (right) positions of NAD 83(2011) epoch 2010.00 minus NAD 83(CORS96) epoch 2002.00



- when it has to be **right**

Leica
Geosystems

The INCORS RTN Adjustment and NAD83(2011)2010.0000

FAQ 1: Why Reprocess the RTN?

- Alignment with the current NGS reference frame is of highest importance
- INCORS waited until the NGS had finished all reference frame products including:
 - Passive control coordinates
 - Active control coordinates
 - Geoid12a
 - Absolute Antenna Calibrations
- NGS supports the benefits realized from rigorous network adjustments by RTNs

FAQ 2: How was the RTN data reprocessed?

- Two weeks of 30-second, 24-hr RINEX was collected on all sites
- Baselines were processed with IGS08 reference frame stations in North America using the Bernese Software v5.0
- Least Squares Adjustment was performed using Bernese Software v5.0 resulting in IGS08 coordinate values for all sites
- Transformation of coordinates from IGS08 to NAD83(2011)2010.0000 was accomplished using the NGS software HTDP

FAQ 3: What were the statistical results of the Bernese Adjustment (IGS08) ?

- **Control Sites (IGS Reference Frame Sites):**
 - ALGO, AMC2, DUBO, GODE, MDO1, NRC1
- **Adjustment Sites Included:**
 - All Indiana Sites
All datashare partner sites from Michigan, Ohio and Kentucky
- **Average RMS Error:**
 - U 0.0008m min RMS Error: 0.0001m
N 0.0002m max RMS Error: 0.0012m
E 0.0002m
- **Average 3D Ellipse Axes:**
 - U 0.0008m min length of Axis: 0.0001m
N 0.0002m max length of Axis: 0.0012m
E 0.0002m

- when it has to be **right**



FAQ 4: What were the statistical results after the HTDP transformation (NAD83) ?

Average difference =
NAD 83(2011)2010.00 - NAD 83(CORS96)2002.00

Mean Differences:
Horizontal 0.023m (± 0.006 m 1-sigma)
Vertical 0.002m (± 0.017 m 1-sigma)

Min/Max Differences:
Horizontal 0.011m / 0.046m
Vertical -0.054m / 0.049m

FAQ 5: What were the average difference in position between adjusted NGS values and published NGS values?

Average difference = Adjusted - Published

Mean Differences:

Horizontal 0.006m (± 0.003 m 1-sigma)

Vertical -0.002m (± 0.003 m 1-sigma)

Min/Max Differences:

Horizontal 0.0004m / 0.021m (94% <1cm)

Vertical -0.010m / 0.006m

FAQ 6: How does the new adjustment impact end-users?

New coordinates are scheduled to be loaded into the servers on April 5, 2013:

- Servers are scheduled to go off-line at 9pm
- Full RTN operations are scheduled to returned by midnight

End-users will see horizontal and vertical shifts in their positions by a few centimeters starting on Saturday, April 6.

To continue work on pre-existing projects:

- Perform project transformation, localization, calibration, etc.
- Contact your equipment dealer with any questions regarding operations necessary for completing project transformation, localization, calibration, etc.
- Perform the appropriate checks on projects that you have used GPS on in the past to ensure desired accuracy/precise is being achieved.
- Be sure to use Geoid12a for best Orthometric Heights

Contact the INCORS Network Administrative
team directly with any further questions:

incors@indot.IN.gov

- when it has to be **right**



Thank you for attending!

All written questions that were submitted during this presentation will be answered and forwarded to Dee Baxter for distribution to the presentation attendees.