



CORS and CORS Products Update

CGSIC US States and Local Government
Subcommittee Regional Meeting

April 27, 2011

Daniel Martin

NOAA/NGS

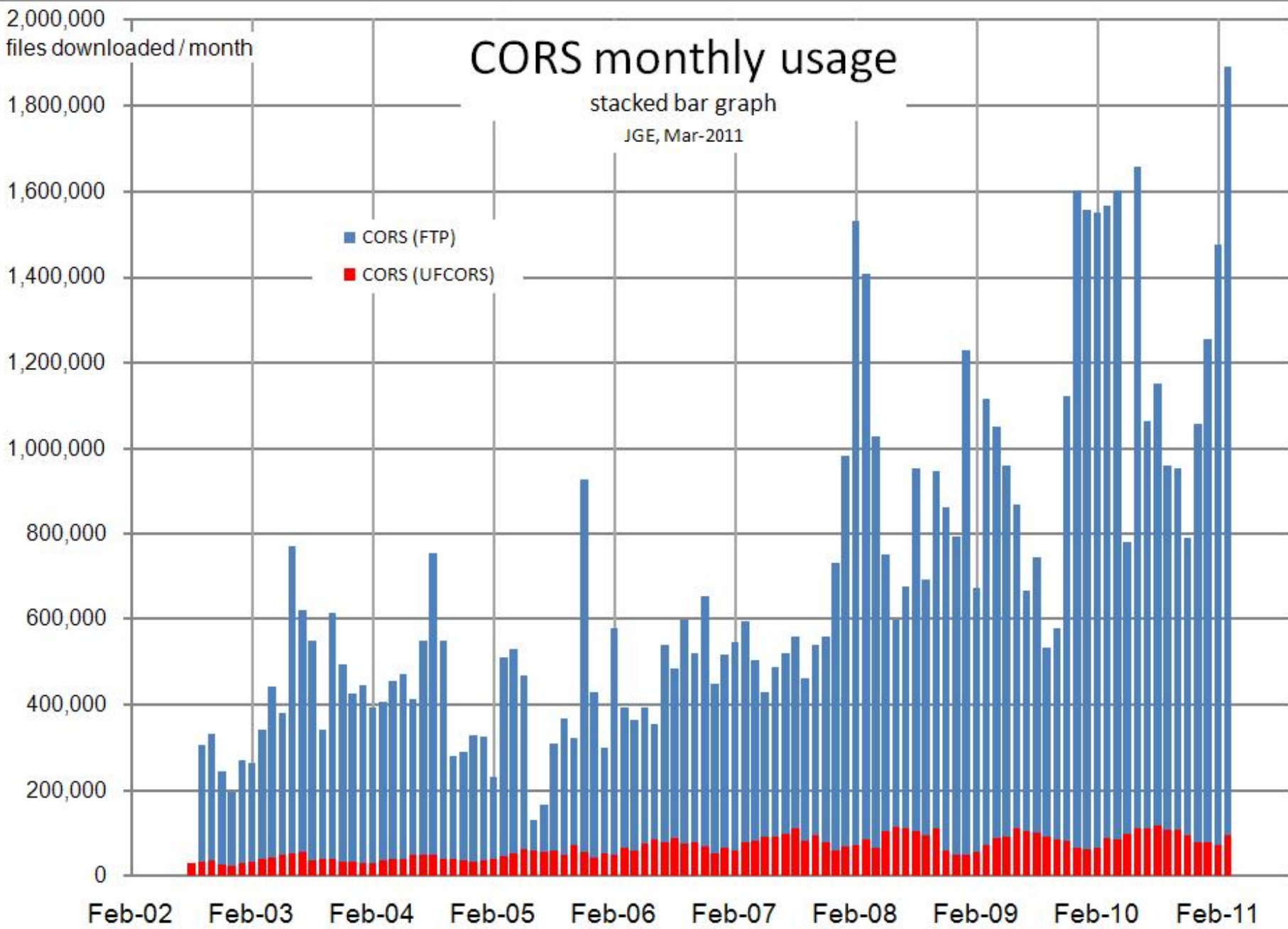
Vermont State Geodetic Advisor

CORS monthly usage

stacked bar graph

JGE, Mar-2011

- CORS (FTP)
- CORS (UFCORS)



FLAVORS OF OPUS

OPUS Tool Box



OPUS-S
\$\$ Receivers
2 Hours of data
Results not shared

OPUS-RS
\$\$ Receivers
15 Minutes of data
Results not shared

OPUS-DB
\$\$ Receivers
4 Hours of data
Results shared

OPUS-Projects
\$\$ Receivers
2-4 Hours of data
Multiple Receivers
Network Solution
Results shared or not

OPUS-Net
\$\$ Receivers
?? Hours of Data
Replace OPUS-S?

LOCUS
Digital Bar-Code Leveling
Integration with GPS?
Results shared or not



OPUS: Online Positioning User Service

National Geodetic Survey

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



OPUS-RS is currently experiencing a higher than normal failure rate and it may not be able to be fixed until Monday April 18. OPUS-S is affected to a much smaller degree. We are sorry for the inconvenience.

Upload your data file.

Tie your GPS observation to the National Spatial Reference System.

What is OPUS? FAQs

* **Email address** - your solution will be sent here.

 No file chosen

* **Data file** of dual-frequency GPS observations. **sample**

 no antenna selected ▼

Antenna type - choosing wrong may degrade your accuracy.

 meters above your mark.

Antenna height of your antenna's reference point.

 to **customize** your solution.

for data > 15 min. < 2 hrs. for data > 2 hrs. < 48 hrs.

* required fields

We may use your data for internal evaluations of OPUS use, accuracy, or related research.

Station Name	Station ID	Station Type	Station Class	Station Status	Station Description
...

[Sample Solutions](#)

OPUS Menu

- [Upload](#)
- [About OPUS](#)
- [Published Solutions](#)

Prefer the old OPUS?

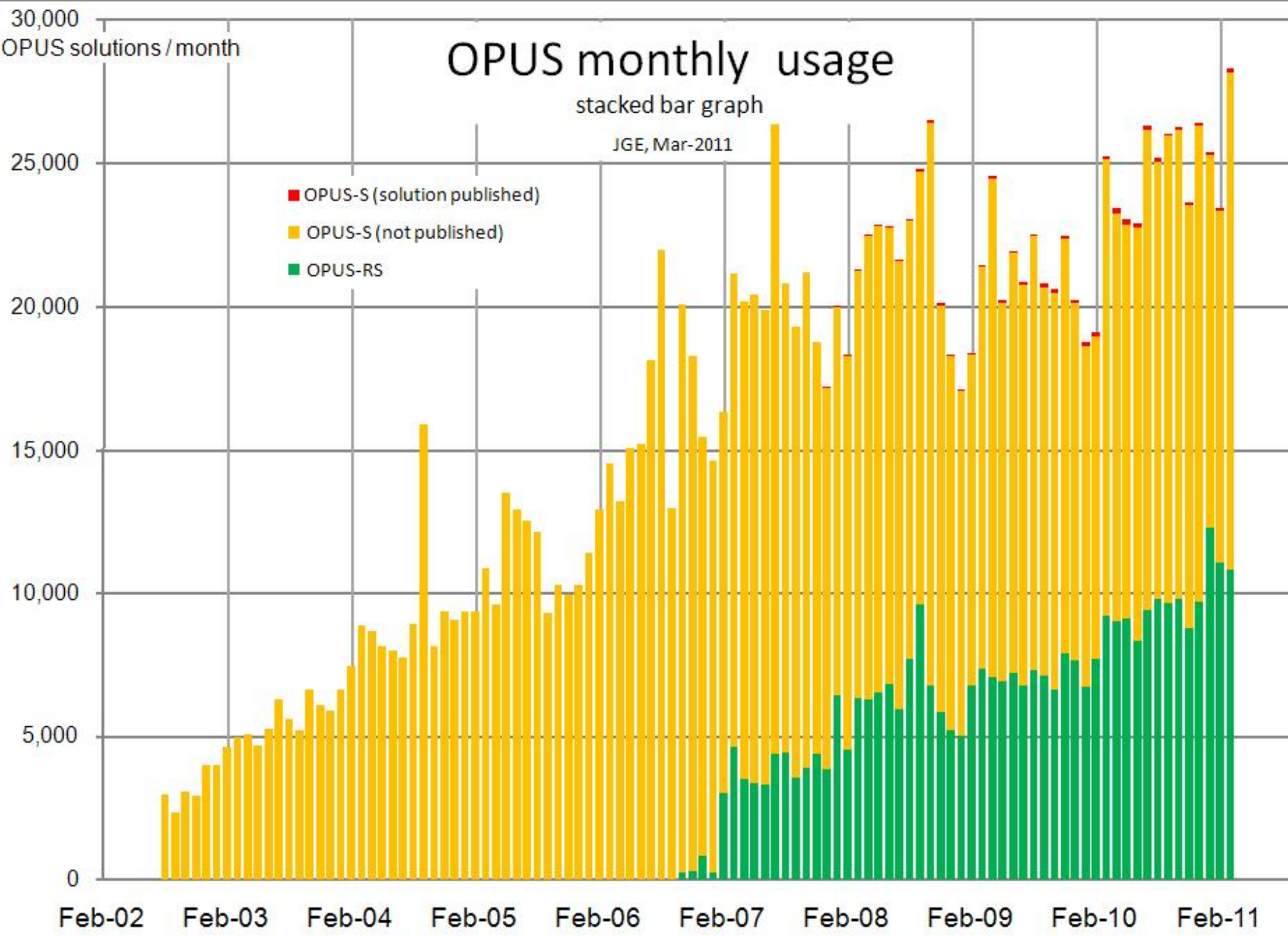


revert to OPUS v1.2 and **tell us why**.

OPUS monthly usage

stacked bar graph

JGE, Mar-2011





OPUS-RS MAP

National Geodetic Survey

HELP:

ABOUT THIS MAP

OPTIONS:

Choose Map:

NS or EW 15-min Data

CORS Sites:

Show Hide

Predicted Accuracy:

Latitude :

Longitude:

Overlay Opacity:

60%

LEGEND:

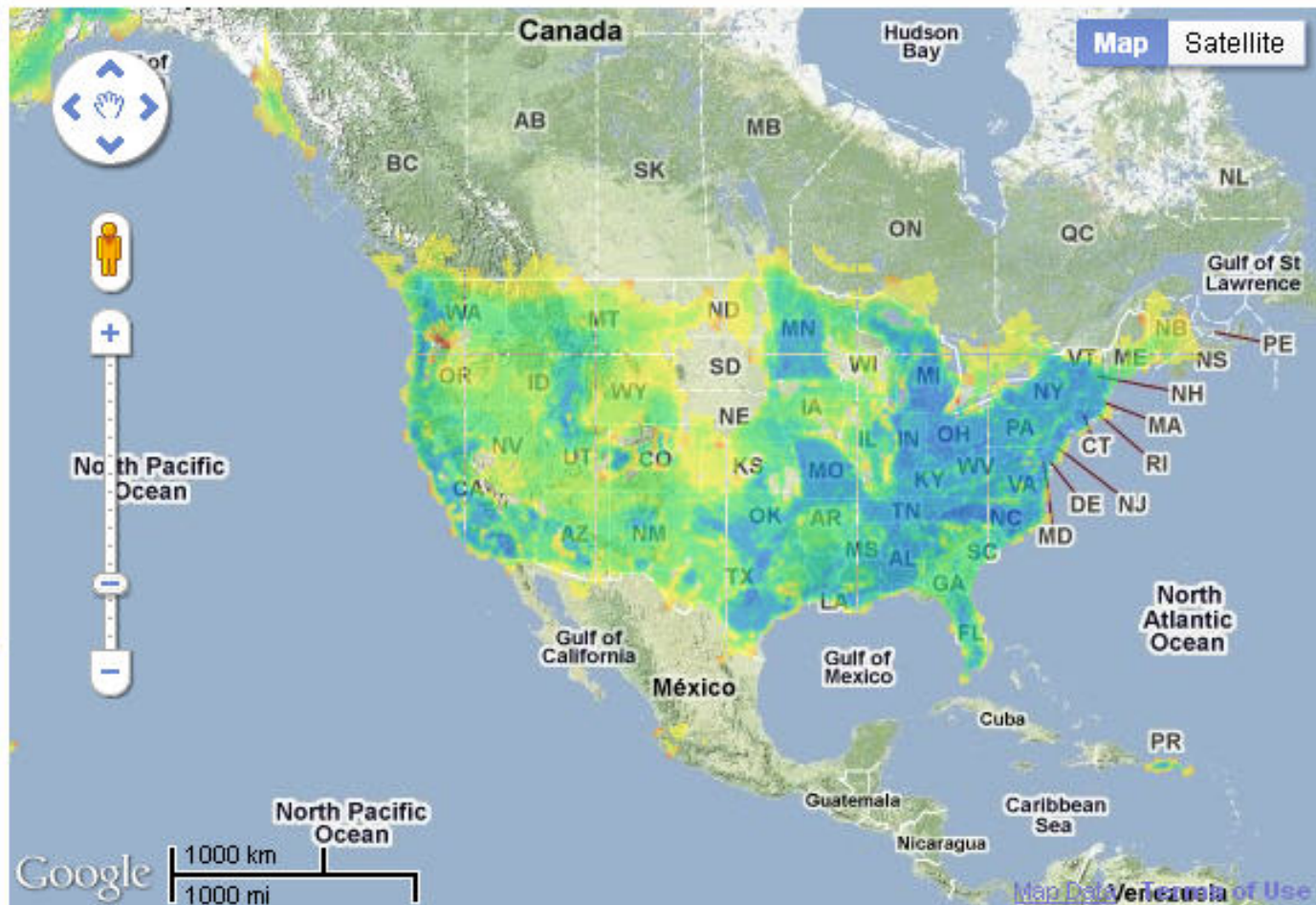
Horizontal Standard Error (cm)



Data as of Apr 11 2011

OPUS-RS Accuracy and Availability

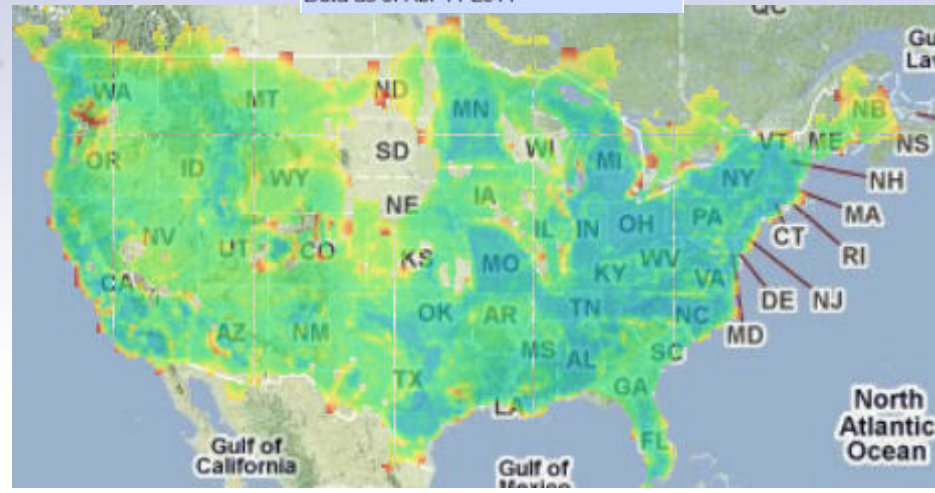
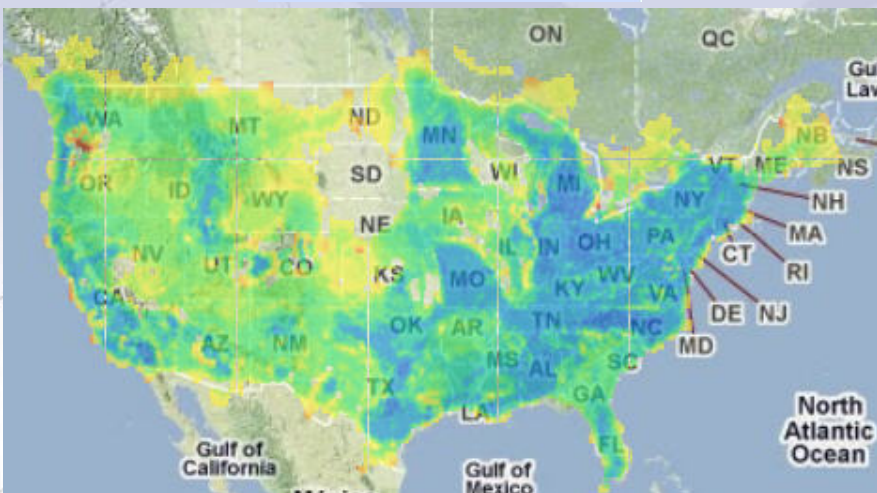
Version: 0.82



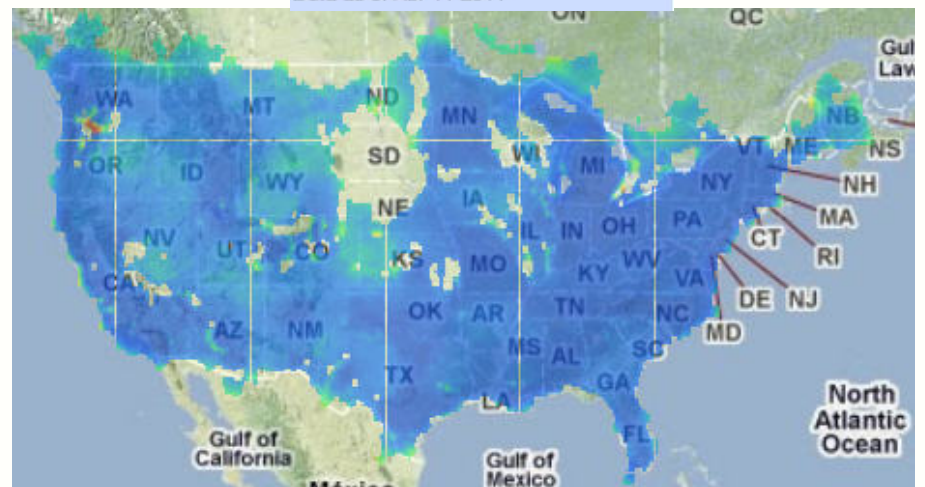
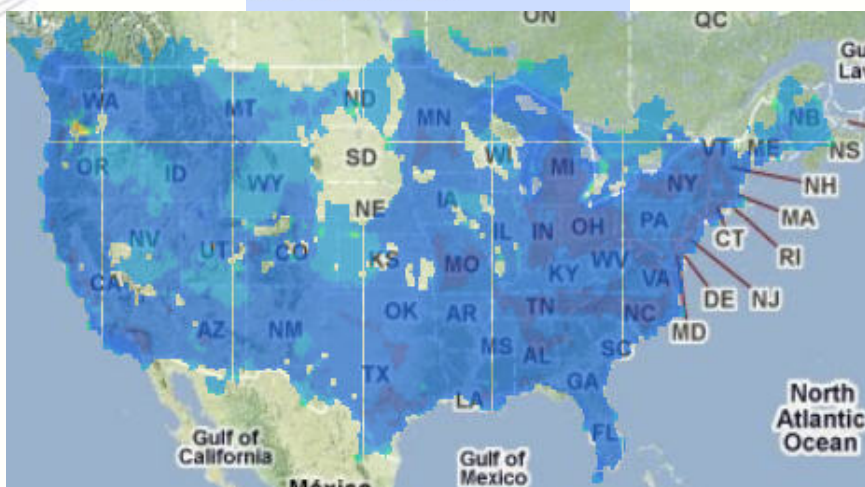
Website Owner: National Geodetic Survey / Last modified by Kevin Choi May 17 2010



15 Minute



60 Minute



HELP:
ABOUT THIS MAP

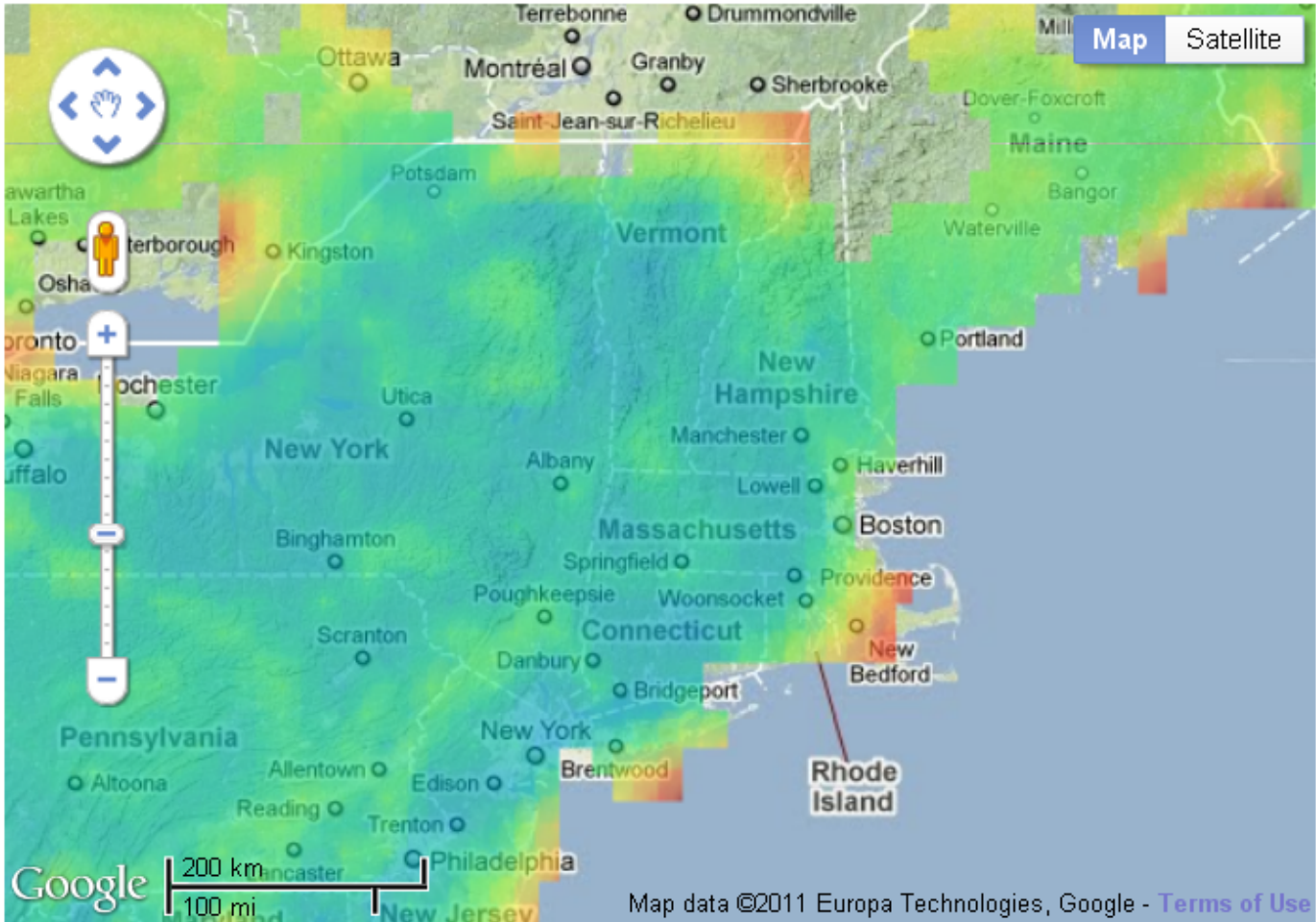
OPUS-RS Accuracy and Availability
Version: 0.82

OPTIONS:
Choose Map:
Ellipsoid Height 15-min Data

CORS Sites:
 Show Hide

Predicted Accuracy:
Latitude :
Longitude:

Overlay Opacity:



LEGEND:

Ellipsoid Height Standard Error (cm)

1 2 3 4 5 6 7 8+

Data as of Apr 11 2011

Map data ©2011 Europa Technologies, Google - [Terms of Use](#)
Website Owner: National Geodetic Survey / Last modified by **Kevin Choi** May 17 2010

OPUS-Static vs. OPUS-Net (engines)

• OPUS-Static

- U.S. CORS Network
- Fixed IGS ephemerides
 - Computes independent double differenced baseline solutions between the unknown and 3 CORS
- Relative antenna models
- Phase ambiguity integer fixing
- Relative troposphere modeling
- ITRF2000 reference frame
- Average position solution
- Peak – Peak error reported



• OPUS-Net

- U.S. CORS Network & IGS Global Network
- Network approach
 - Consists of 3 nearby CORS + up to 12 CGPS from global IGS network
- Absolute antenna models
 - SV & ground
- Ocean tidal loading model
- Satellite weighting
- Relative troposphere modeling
- ITRF2008 reference frame
- Weighted least squares adjustment
- Weighted mean and standard deviations reported at 95%

OPUS-Projects

National Geodetic Survey - OPUS ... Mozilla Firefox Start Page

MARK	ANTENNA	ARP (m)	EPH	OBS (%)	FIXED (%)	RMS (m)	LAT (m)	LON (m)	HGT (m)	UPLOADED
m050	TRM22020.00+GP NONE	2.000	precise	92.5	100.0	0.018	0.009	0.009	0.013	2010-12-15
p050	TRM22020.00+GP NONE	2.000	precise	92.5	100.0	0.024	0.009	0.009	0.013	2010-12-15
r050	TRM22020.00+GP NONE	2.000	precise	93.6	100.0	0.016	0.009	0.009	0.013	2010-12-15
vtd9	TRM22020.00+GP NONE	2.000	precise	93.8	100.0	0.015	0.011	0.009	0.024	2010-12-15

MARK	HUB	CONSTRAINT	HE
<input checked="" type="checkbox"/> m050	<input checked="" type="checkbox"/>	NONE	EL HGT
<input checked="" type="checkbox"/> p050	<input type="checkbox"/>	NONE	EL HGT
<input checked="" type="checkbox"/> r050	<input type="checkbox"/>	NONE	EL HGT
<input checked="" type="checkbox"/> vtd9	<input type="checkbox"/>	NONE	EL HGT
CORS	HUB	CONSTRAINT	HE
<input checked="" type="checkbox"/> nyet	<input checked="" type="checkbox"/>	3-D	EL HGT
<input checked="" type="checkbox"/> nypb	<input checked="" type="checkbox"/>	3-D	EL HGT
<input checked="" type="checkbox"/> vcap	<input checked="" type="checkbox"/>	3-D	EL HGT
<input checked="" type="checkbox"/> vtuv	<input checked="" type="checkbox"/>	3-D	EL HGT

Processing Options

Output Ref Frame: NAD_83(CORS96)

Geoid Model: USGG2009

GNSS: G (GPS-only)

Tropo Model: Piece-wise, Linear

Tropo Interval (s): 7200

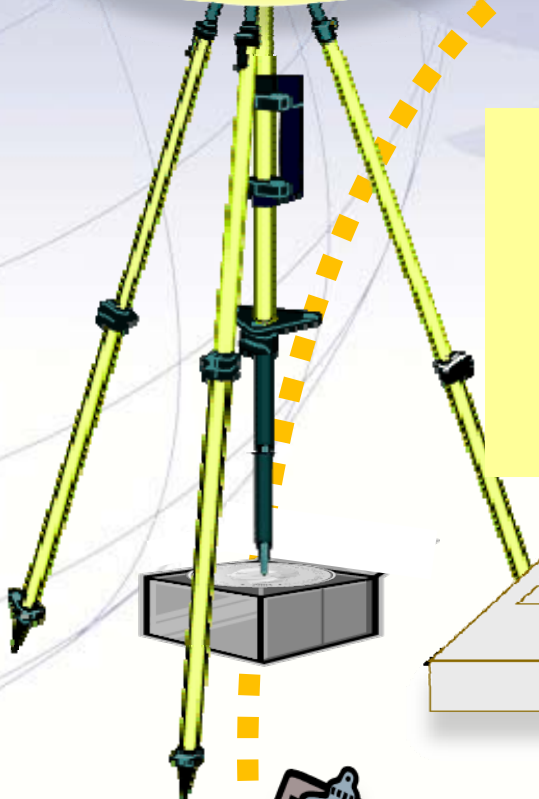
Elevation Cutoff (deg): 15.0

Constraints: Loose Normal Tigris

Network Design: USER CORS MS

**your
GPS data**

**geodetic
standard data**



**3267 points (approx.
3450 solutions) as of
04/14/2011**

- IGS & NGS base stations & site information files
- antenna calibrations
- tellite orbits
- reference frames
- IGS TEC converter
- baseline processor
- geophysical models
- geodetic toolkit



mark description



**your
solution**



**options:
projects &
publishing**



News Item

National Geodetic Survey

Science & Education

Search

Release GNSS Network Guidelines for Real Time

National Geodetic Survey Guidelines for Real Time GNSS Networks



March 2011
v. 2.0

National Geodetic Survey Products and Services Group Leads the effort to release the draft "NGS Guidelines for Real Time GNSS Networks" for public comment. The document was developed by 30 individuals, including NGS staff and external personnel. The document was developed by the following individuals: **William Henning - editor**, **Dan Martin - Site Considerations**, **Gary Thompson - Administration**, **Dr. Richard Snay - Aligning RTN to the NSRS**, **William Henning - Users**, **Group Leads**, **Planning and Design**, **Site Considerations**, **Administration**, **Aligning RTN to the NSRS**, **Users**. The document has evolved in response to the valuable input from our users and other personnel.

Multi-Year CORS Solution

- 'Multi-year' effort began 5 years ago
- IGS proposed re-processing all data to re-compute station coordinates, orbits and EOPs from 1994-present
- MYCS positions were derived from the reprocessing of the full 16 year time series (1994-2010) and a rigorous stacking of weekly estimates in a fully consistent, global framework.
- NAD 83(2011)Epoch2010 is a new realization of NAD 83 based on this NGS Multi-Year CORS Solution (MYCS)

Why Reprocess?

Generally can't continue to live in epoch 2002

- **Generate fully consistent orbits, EOPs and CORS+global station coordinates using latest models and methods—existing history is inadequate for modern realizations of TRFs**
 - longer data spans
 - absolute antenna calibrations
 - satellite transmitting and ground receiving antennas
 - 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
- **Contribute NGS reprocessed orbits, EOPs and global SINEX files to International GNSS Service (IGS) repro1 campaign**
- **Generate CORS coordinates and velocities in global framework using new orbits, EOPs and global station coords**

Frame Definition and Nomenclature

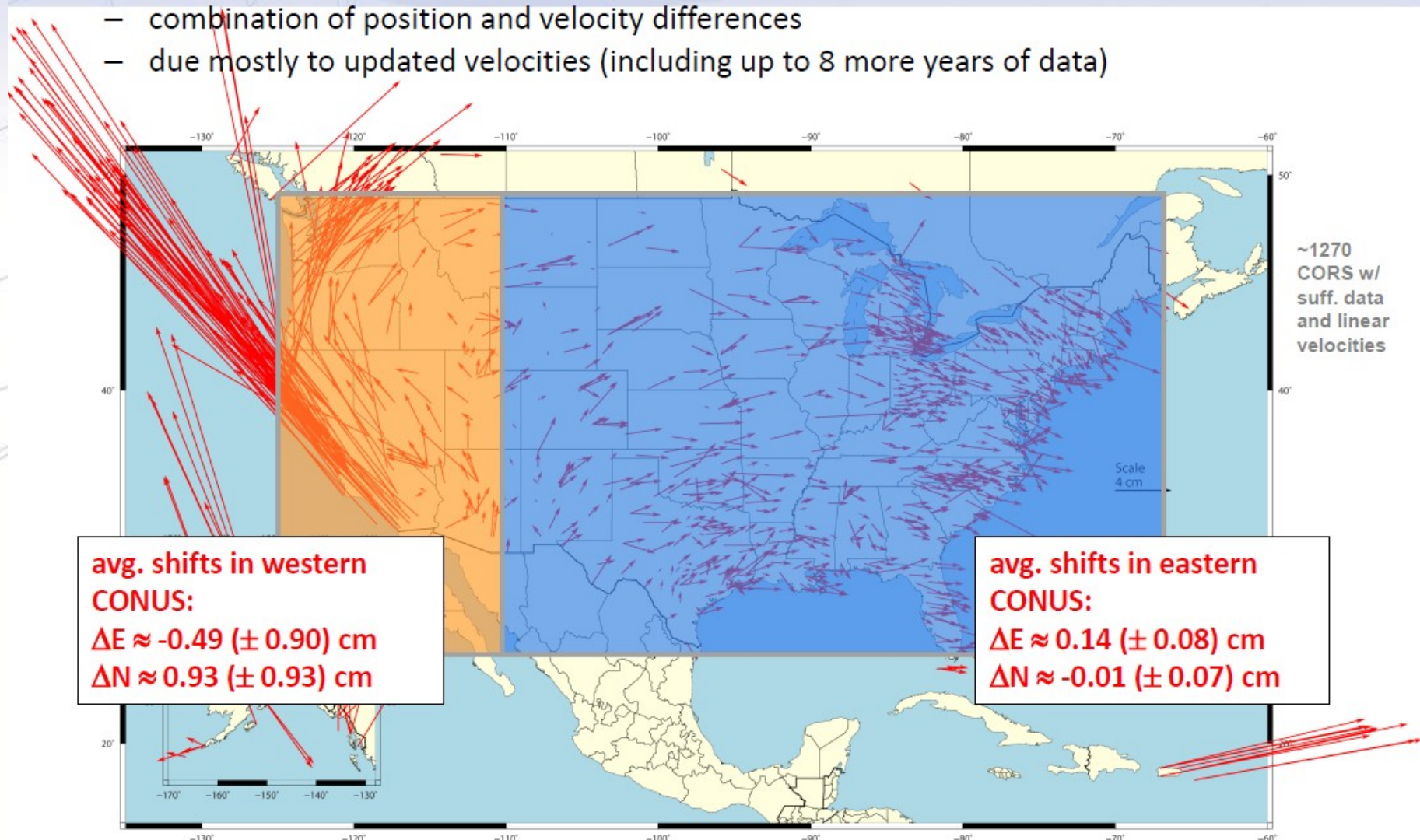
- ITRF frame (global) multi-technique—vlbi, slr, doris, gnss
- IGS frame (global) GNSS only
- NAD frame (plate fixed) related to ITRF
- Critical to pay attention to frame tags and epoch dates and antenna calibration values

<u>Frame Name</u>	<u>Epoch</u>	<u>Antenna PCV*</u>	<u>Data Duration</u>
ITRF2000	1997.0	RelANTEX	1994.0-2002.0
ITRF00(NGS' soln)	1997.0	RelNGS ANTEX	1994.0-present
NAD 83(CORS96)	2002.0	RelNGS 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' 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)

Changes in *Horizontal* NAD 83 Positions Different Epochs

NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0

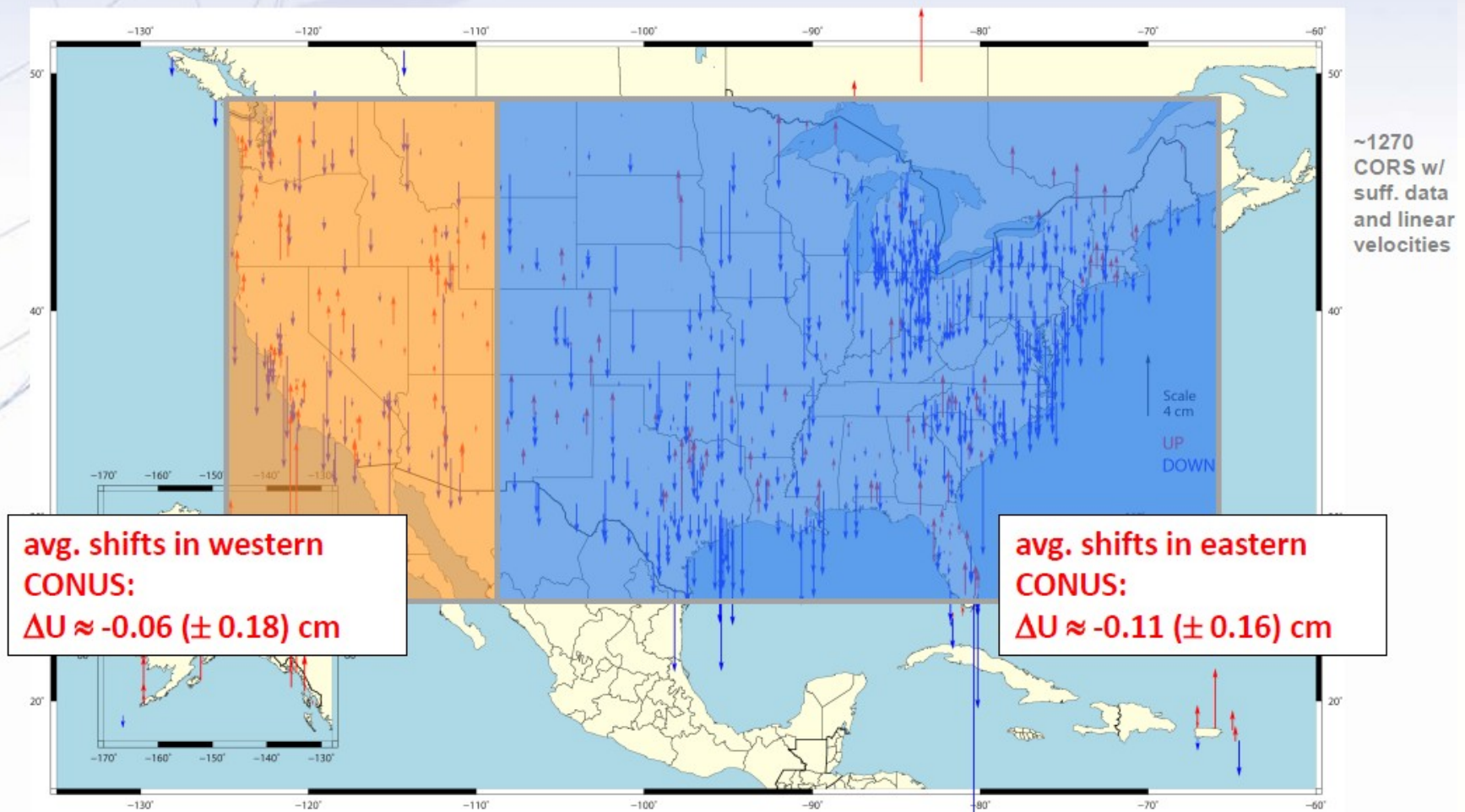
- approx. 2 cm error expected @ 2005.0 (based on σ in old solution)
- overall avg. horizontal shifts: $\Delta E = 0.09 (\pm 5.84)$ cm $\Delta N = 2.03 (\pm 5.98)$ cm
 - combination of position and velocity differences
 - due mostly to updated velocities (including up to 8 more years of data)



Changes in Vertical NAD 83 Positions Different Epochs

NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0

- overall avg. vertical shifts: $\Delta U = -0.79 (\pm 2.09) \text{ cm}$
 - combination of position and velocity differences from additional data, tectonics
 - assuming vertical velocity ≈ 0.00 in NAD 83(CORS96)



Done and To Do

- **Fall 2005:** First discussion and start of software overhaul
- **Mar 2008:** Start of re-analysis of orbits and CORS data
- **Feb 2009:** First results
- **Feb 2010:** NGS submits final solution to IERS
- **Apr 2010:** Full solution and frame discussion begin
- **May 2010:** IERS publishes ITRF2008
- **Jun-Oct:** Verification of time-series for discontinuities
- **Nov-Feb:** Incorporate IGS08 absolute antenna calib., adjust ITRF2008-aligned coordinates for IGS08 calib.
- **Mar-Apr:** Update tools in and out of NGS, and get final IGS08
- **May-Jun:** Coord. beta site, feedback 😊😞, modify?
- **July:** Publish and integrate coord. into NGS prods.

Key Changes

- Change from relative to absolute antenna phase center values (PCV)
- NGS global frame pos/vels are aligned to full global frame (IGS08)
- Distinction between computed and modeled velocities must be maintained and **emphasized** to users
- Ability to robustly/consistently re-compute pos/vels
- More robust discontinuity identification and resolve metadata issues quickly (**site operators are key**)
- Change in pos/vel NAD 83(2011) change epoch from 2002.0 to 2010.0

Changes with New Coordinates

- Coordinates will be rigorously reviewed every 6 months.
- On a weekly basis if a problem with a site is identified, site flagged as problem, e.g. currently do not have an automated way to deal with earthquake offsets/velocity changes, undocumented/unexplained equipment change
- What amount of change/tolerance are permitted?
 - Current 2 cm horizontal, 4 cm vertical
 - Considering 1 cm horizontal, 2 cm vertical
- All users should use IGS08 consistent absolute antenna PCV values (see next slide)

Outstanding Items

tentative timeline

- **Next 1-2 weeks** revise New Coordinates web page
geodesy.noaa.gov/CORS
Click on “Data Products,
Scroll to bottom and follow “Beta Products” links
- **March-April**, Update NGS IDB, test NGS prod. & serv.,
provide beta Antenna Calibration page with IGS08
consistent PCV’s both ANT_INFO and ANTEX format,
final check on coordinates and consistency with IGS08
- **May-June**, Release beta coordinates, update all
coordinates through May 2011, implement HTDP 3.1
- **July** release new coordinates and update NGS products
to be consistent

CORS Questions

Giovanni Sella, Ph.D.
CORS Program Manager,
National Geodetic Survey

For EXISTING CORS e-mail: [ngs.corscollector @ noaa.gov](mailto:ngs.corscollector@noaa.gov)
For PROPOSED CORS e-mail: ngs.proposed.cors@noaa.gov
Tel: 301-713-3198x126

CORS Guidelines:
[www.geodesy.noaa.gov/CORS/Establish Operate CORS.html](http://www.geodesy.noaa.gov/CORS/Establish_Operate_CORS.html)