# National Geodetic Survey

## Continuously Operating Reference Station (CORS) Network Update

## CGSIC US & Local Gov Subcommittee Regional Meeting - Seattle

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NOAA's National Geodetic Survey
geodesy.noaa.gov

# U.S. Department of Commerce
# National Oceanic & Atmospheric Administration
# **National Geodetic Survey**

*Mission*: To define, maintain & provide access to the

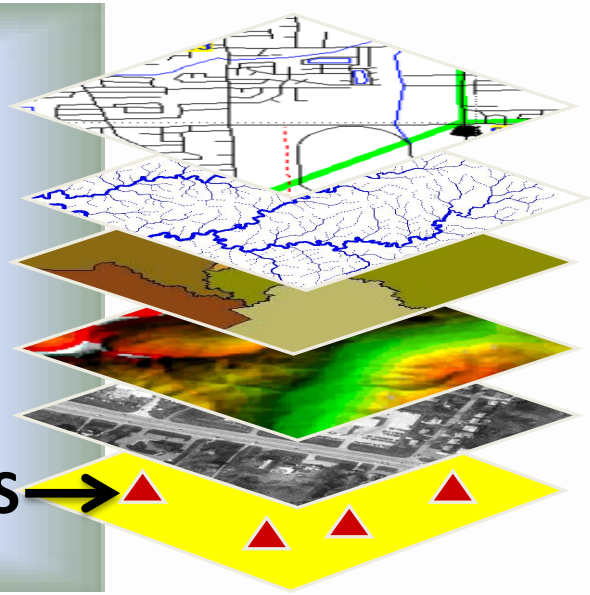
***National Spatial Reference System (NSRS)***

to meet our Nation's economic, social & environmental needs

## National Spatial Reference System

- Latitude
- Longitude
- Height
- Scale
- Gravity
- Orientation

***& their time variations***



# Continuously Operating Reference Stations (CORS)

Help

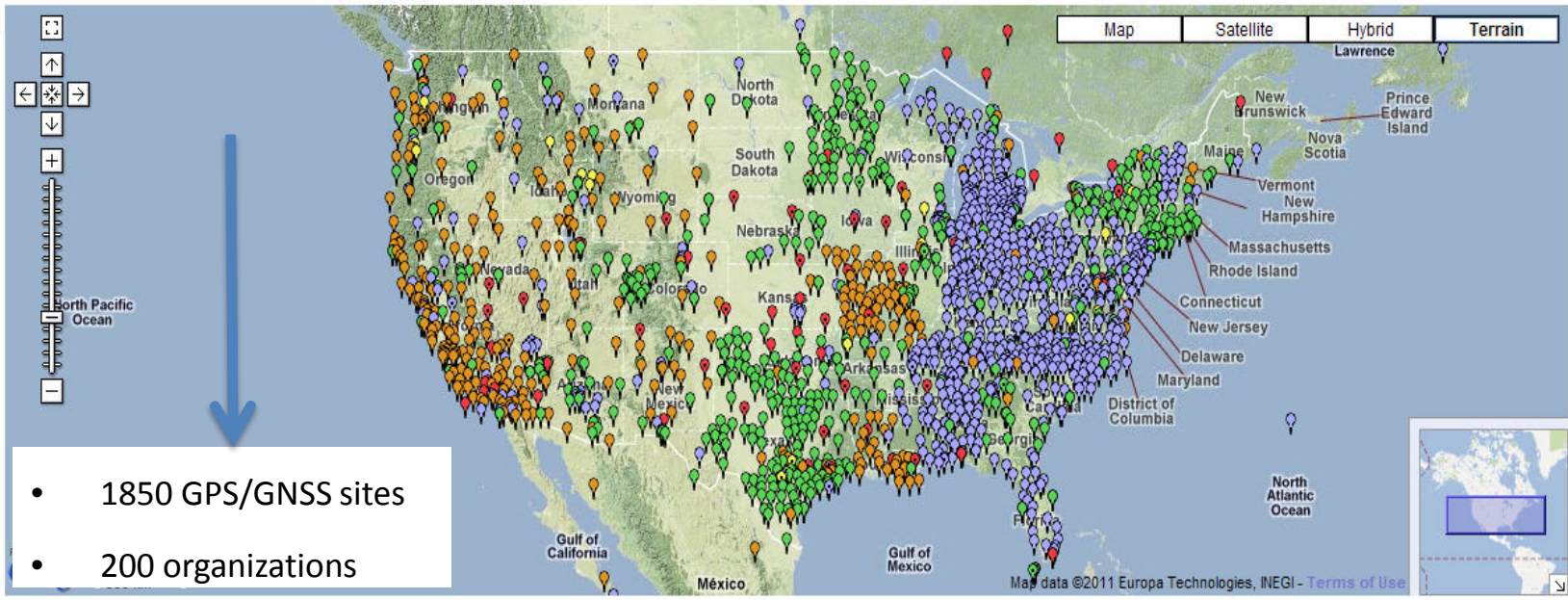
Zoom to CORS:
Site ID: Go

Cursor Lat/Lon :
28.30438 , -139.39453
Three Nearest Sites :
HILR 1854.10 km
PAH5 1859.04 km
PAH6 1859.07 km

Enter a location Go

Place X

Sampling Rate (clickable legend icons) Non-Operational 250 km radius
1 sec 5 sec 10 sec 15 sec 30 sec All Active Decom




- 1850 GPS/GNSS sites
- 200 organizations

## User Friendly CORS

Version 3.6

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

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

UFCORS Page Info | Trimble Products Configuration | UFCORS Problem/Comment Form

Starting Day: Feb 2, 2012 - 033 Get Older Data
Start Time of the field observation: 00:00 Day and Time Info
Time Zone relative to observation location: UTC (GMT) Time Zone Info
Number of hours of data you wish to receive: 1 Please LIMIT requests for 1-second sampling rate data to 2 hours.

CONTINUE CLEAR

# CORS Discussion Bullets

- Global Reference Frame Coordinates are: IGS08 epoch 2005
- NSRS Coordinates are: NAD 83(2011,MA11,PA11) epoch 2010.00
- Change in antenna calibrations: IGS08 Absolute Ant. Calib.
- CORS positions are computed by the: Multi-Years CORS Solution
  - Published CORS positions and velocities require a min. of 130 weekly solutions (+2.5 year) of data and are computed for stacked solution.
  - Newer CORS with less that 130 weekly solutions have computed positions but modeled velocities using HTDP

# Background - Relative vs. Absolute Antenna Models

**Background**

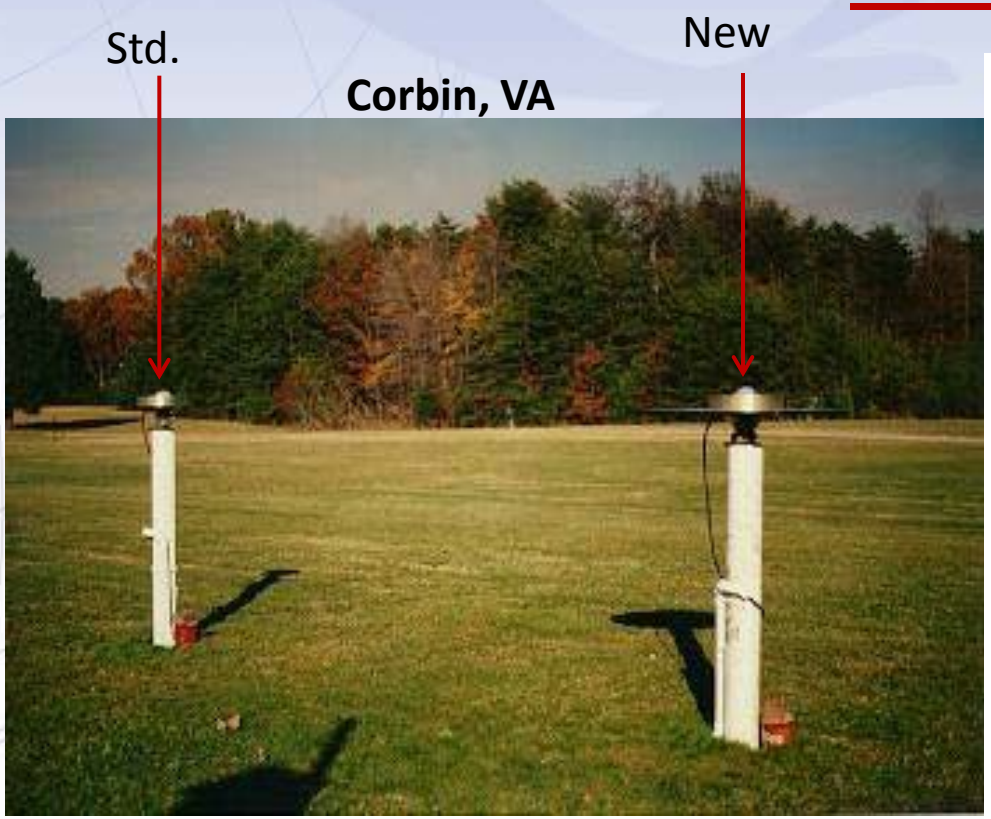
The IGS started to use absolute antenna phase center variation (PCV) patterns with GPS week 1400.

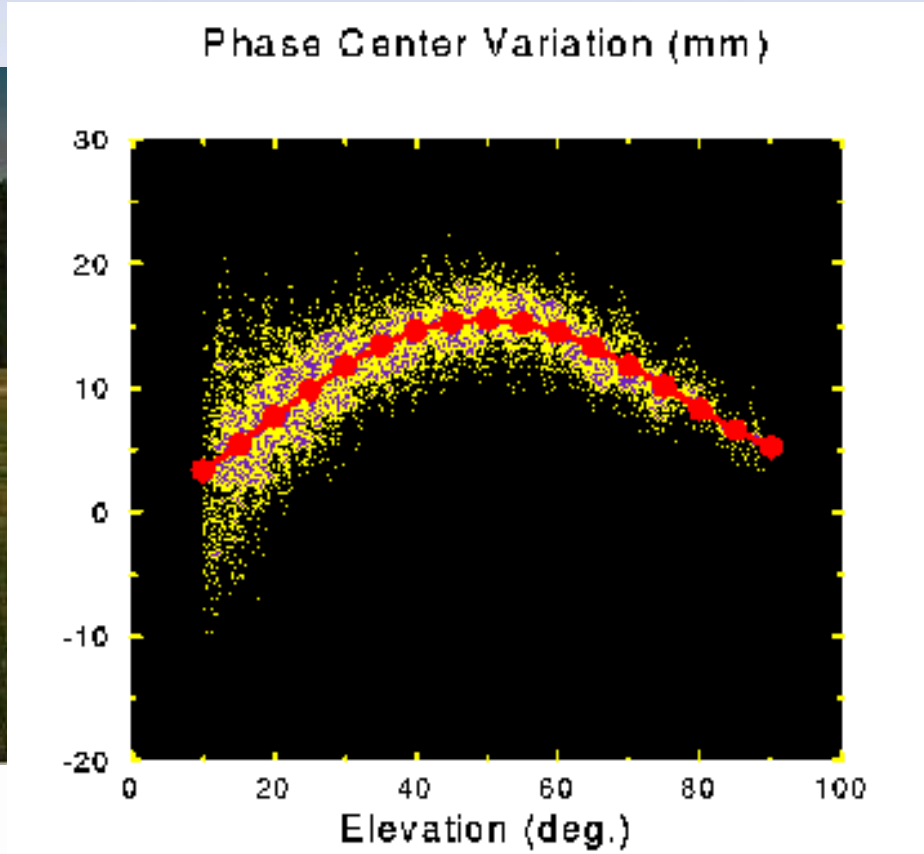
Coordinates of IGS reference stations are consistently based on the official IGS absolute PCVs.

As a consequence, a user should use the identical pattern for these sites as used by the IGS in order to get a consistent tie to the reference frame.

# Relative vs. Absolute GNSS Antenna Calibration

## RELATIVE




Relative means all new antennae compared with the standard reference antenna Dorne Margolin Type, e.g. AOAD/MT. The standard being the "ZERO" fixed mean offset.

# Relative vs. Absolute GNSS Antenna Calibration

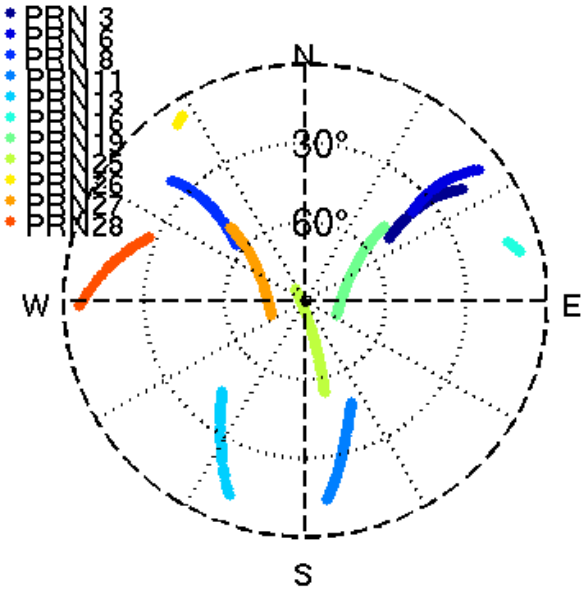
## ABSOLUTE

**Robotic Arm**

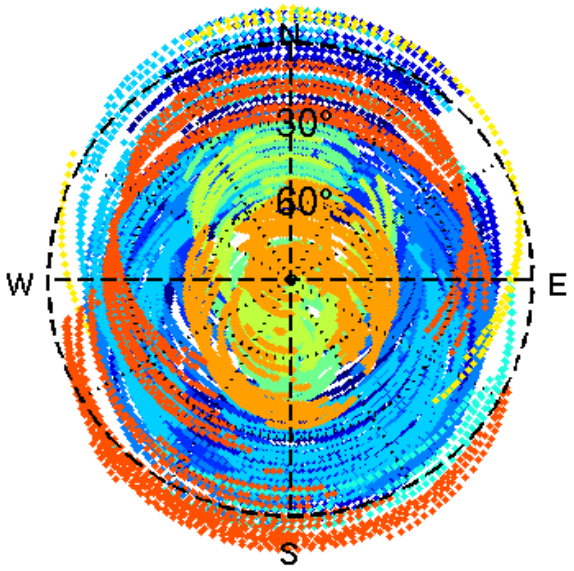
rotation introduces angle changes for time difference of single difference (TDSD) phase observables.

**Speeds up the process!**

static antenna




moving antenna



# Advantages of the absolute antenna calibration

- The robot carries out fast rotations on different axes
- Saves time

– absolute 3D-offset and PCV

– high resolution and precision (sub mm)

– free of multipath

– PCV from 0°-90° elevation, also azimuthal PCV

– site and location independent

# Influence of the antenna dome

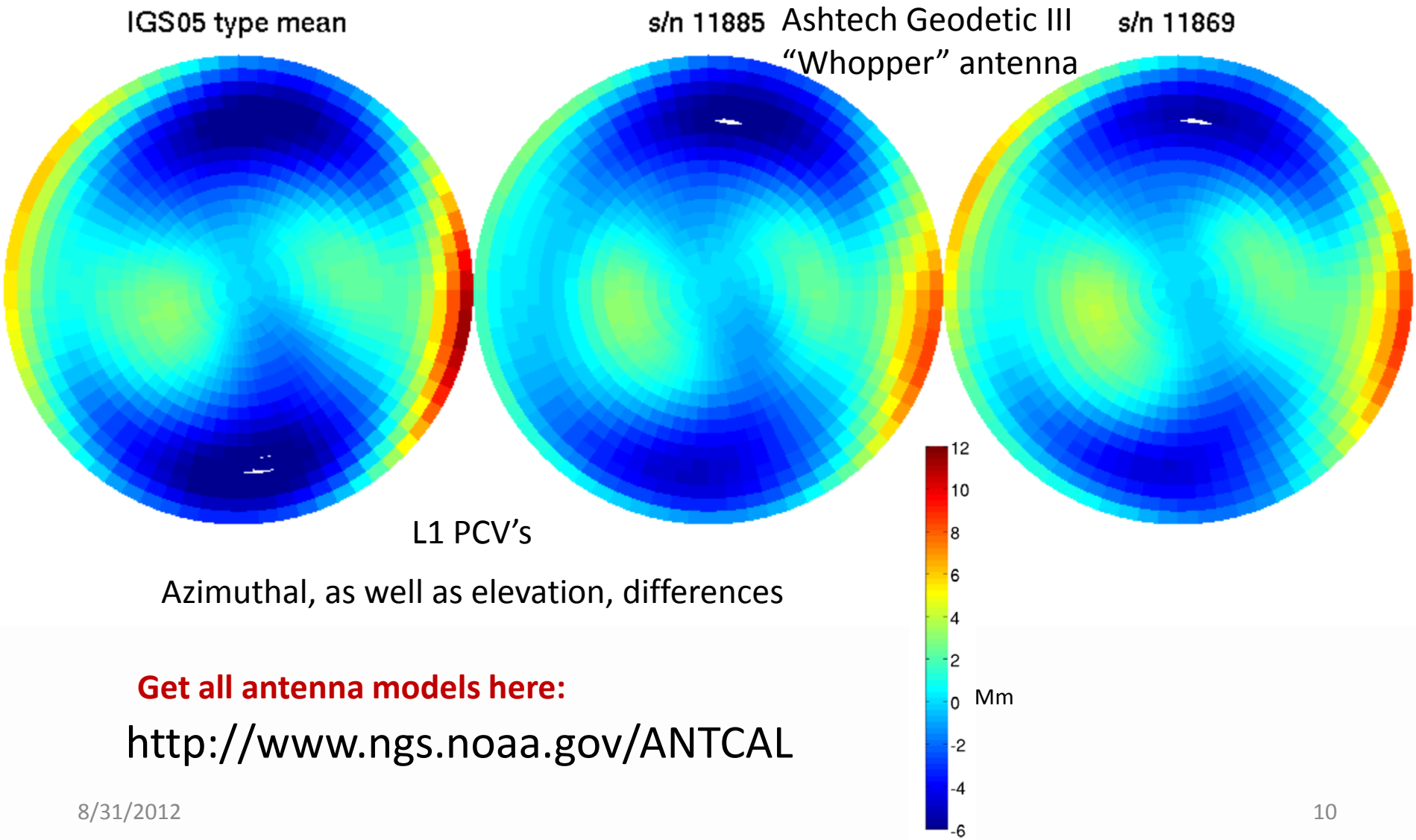
Site AB24 - Alaska

1st model antenna without dome. (absolute)
2nd model with dome and compare.

Studies have shown that domes can affect network horizontal change in position < 5 mm… and vertical network changes can be as large as < 3 cm.

**The position error caused by domes is not a constant but depends on the satellite geometry observed at the specific site.** **(CH. Volken, F. Menge, Impact of Differenent GPS Antenna Calibr Models on EUREF)**

# NGS Calibrations compared to IGS type mean




L1 PCV's

Azimuthal, as well as elevation, differences

**Get all antenna models here:**

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

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

- Change to absolute antenna calibrations
  - Use absolute cal. in your processing: DON'T MIX!

- Better because 8 more years of data:
  - International IGS sites
  - CORS data: about 1600 total, ~1000 w/ >2.5 yrs
  - Orbit determination sophistication
  - CORS velocity data
  - Better HTDP modeling for those w/ <2.5 yrs
  - Better processing algorithms

Called COMPUTED CORS

Called MODELED CORS

# CORS Reference Frame Changes Due to MYCS –

## new coordinates / velocities available now

## *Also with OPUS*

```
        Antenna Reference Point(ARP): RED BUTTE CORS ARP
        ------------------------------------------------
                          PID = AF9633
```

OLD

```
ITRF00 POSITION (EPOCH 1997.0)
Computed in Aug. 2007 using 1244 days of data.
    X =  -1797278.745 m     latitude    =  40 46 51.82884 N
    Y =  -4491525.887 m     longitude   = 111 48 31.53360 W
    Z =   4145132.622 m     ellipsoid height = 1667.743   m

ITRF00 VELOCITY
Adapted in Aug. 2007 using 1244 days of data.
    VX =  -0.0133 m/yr      northward =  -0.0087 m/yr
    VY =  -0.0008 m/yr      eastward  =  -0.0121 m/yr
    VZ =  -0.0066 m/yr      upward    =   0.0000 m/yr
```

**NEW!**

> IGS08 epoch 2005.0

IGS08 = International GNSS Service 2008
(GPS-only realization of ITRF2008)

**NEW!**

> NAD83 (2011) epoch 2010.00

```
NAD_83 (CORS96) POSITION (EPOCH 2002.0)
Transformed from ITRF00 (epoch 1997.0) position in Aug. 2007.
    X =  -1797278.172 m     latitude    =  40 46 51.80741 N
    Y =  -4491527.168 m     longitude   = 111 48 31.49063 W
    Z =   4145132.591 m     ellipsoid height = 1668.462   m

NAD_83 (CORS96) VELOCITY
Transformed from ITRF00 velocity in Aug. 2007.
    VX =   0.0041 m/yr      northward =   0.0020 m/yr
    VY =   0.0002 m/yr      eastward  =   0.0037 m/yr
    VZ =   0.0012 m/yr      upward    =  -0.0005 m/yr
```

NAD83 (2011) = North American Datum 1983
(2011 Realization)

# How do I find the coordinates?

- Individual CORS Coordinate page, as before

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

- TWO basic divisions:
  - One with COMPUTED velocities, one MODELED
- TWO basic Ref Frames: IGS08, NAD83
- Two types of coordinates/vel for each of those:
  - X,Y,Z *AND* lat/long/ht (N,E,U)

- Recommend using only CORS w/ **computed** velocities when performing network adjustments.

# Lists of CORS Coord. & Velocities

- LETS LOOK AT THE LISTS….
  - As of September, 3rd, 2011
  - GO TO:

http://www.geodesy.noaa.gov/CORS/coords.shtml

# IGS08

**Computed**

**IGS08 epoch 2005.00**
**x, y, z; $V_x$, $V_y$, $V_z$**

**IGS08 epoch 2005.00**
**lat, lon, height; $V_n$, $V_e$, $V_u$**

**Modeled**

**IGS08 epoch 2005.00**
**x, y, z; $V_x$, $V_y$, $V_z$**

**IGS08 epoch 2005.00**
**lat, lon, height; $V_n$, $V_e$, $V_u$**

**Note: Vu = 0 as HTDP can only model Horiz vel. At this time**

# NAD 83

**Computed**

**NAD 83 (2011) epoch 2010.00**
**x, y, z; $V_x$, $V_y$, $V_z$**

**NAD 83 (2011) epoch 2010.00**
**lat, lon, height; $V_n$, $V_e$, $V_u$**

**Modeled**

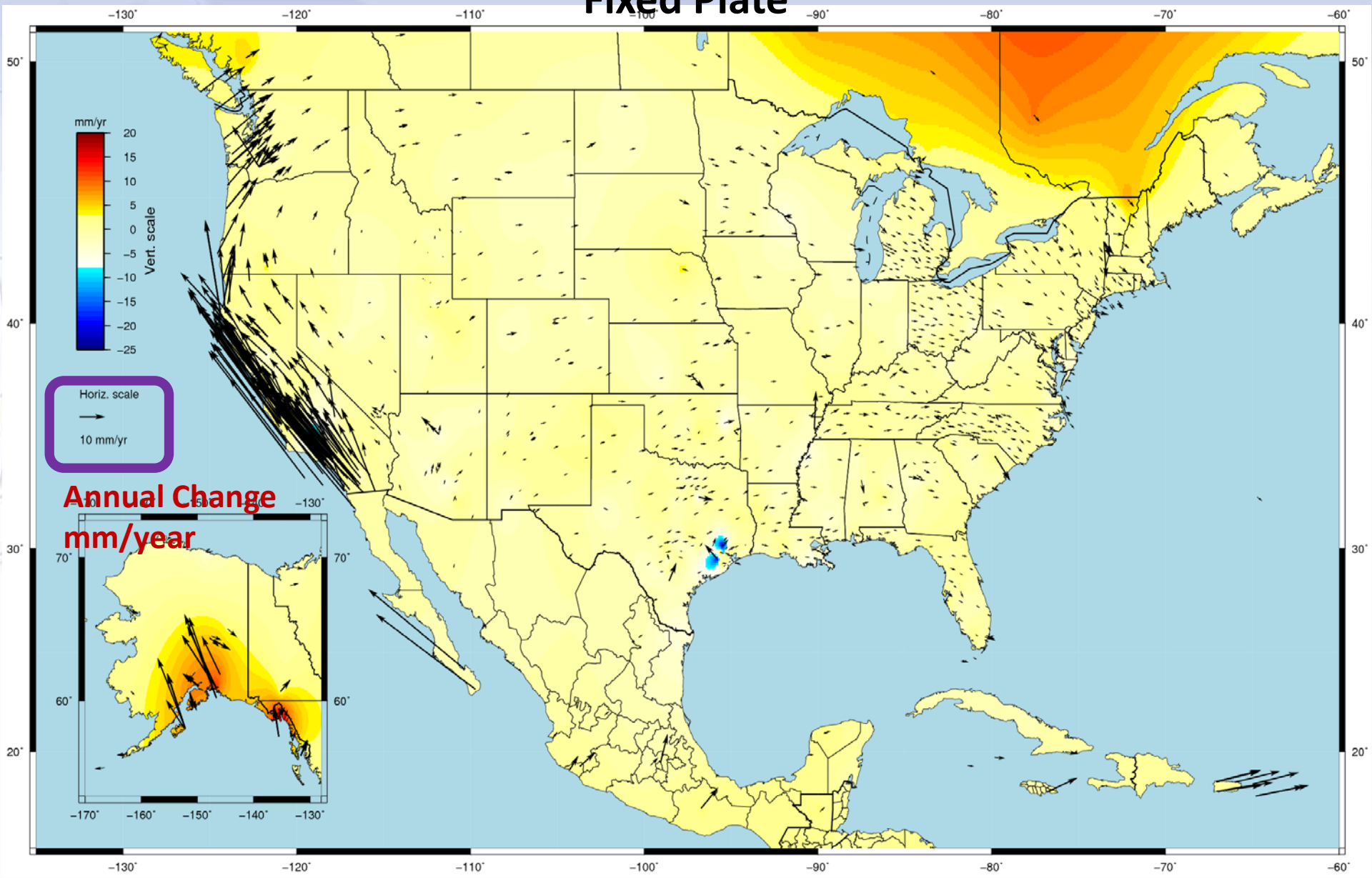
**NAD 83 (2011) epoch 2010.00**
**x, y, z; $V_x$, $V_y$, $V_z$**

**NAD 83 (2011) epoch 2010.00**
**lat, lon, height; $V_n$, $V_e$, $V_u$**

**Note: Vu is not 0 as transformation to NAD 83 yields a Vu value – Not Reliable**

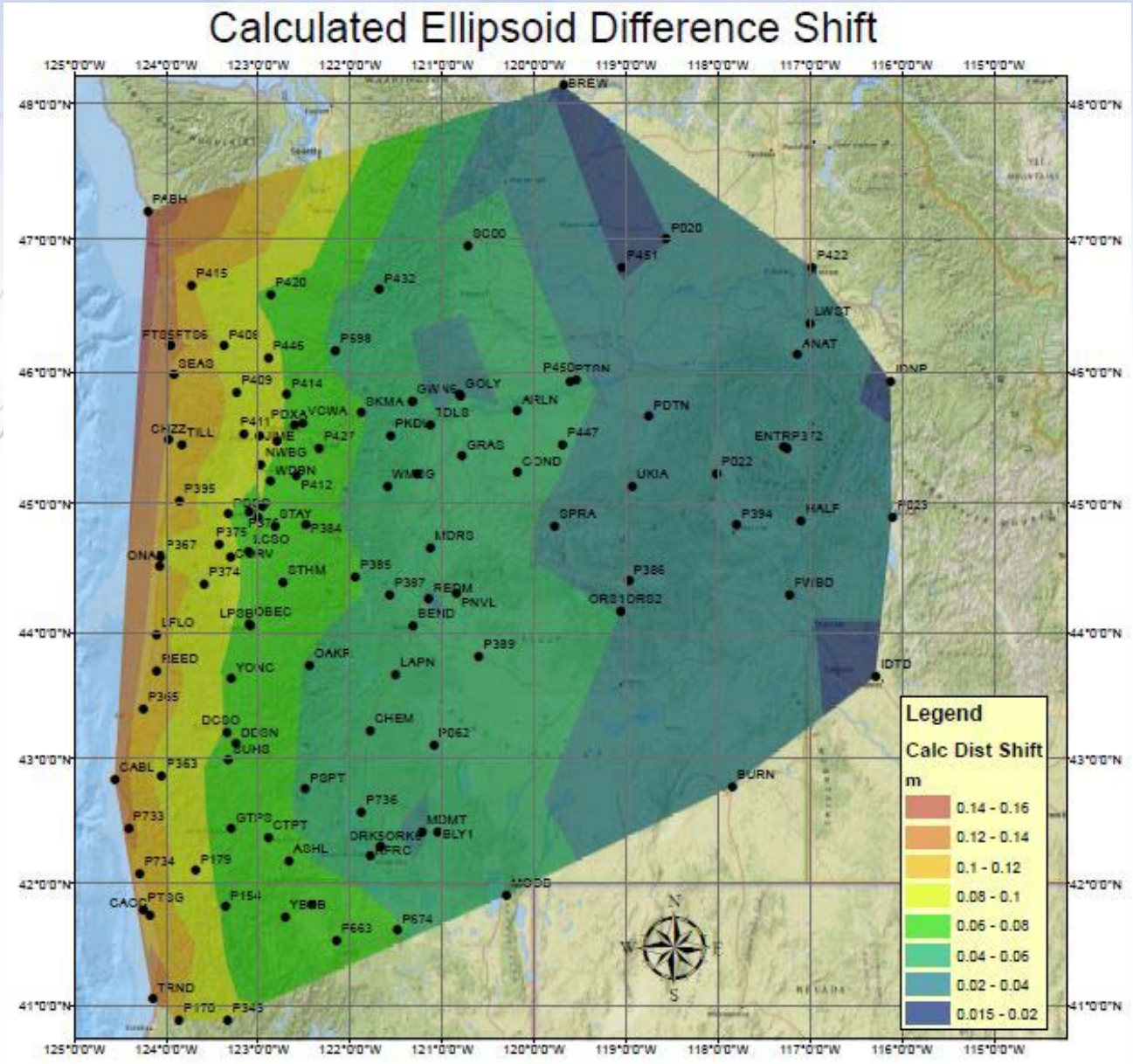
# U.S. CORS Velocity Field: **NAD83(2011) epoch 2010.00**

## Fixed Plate

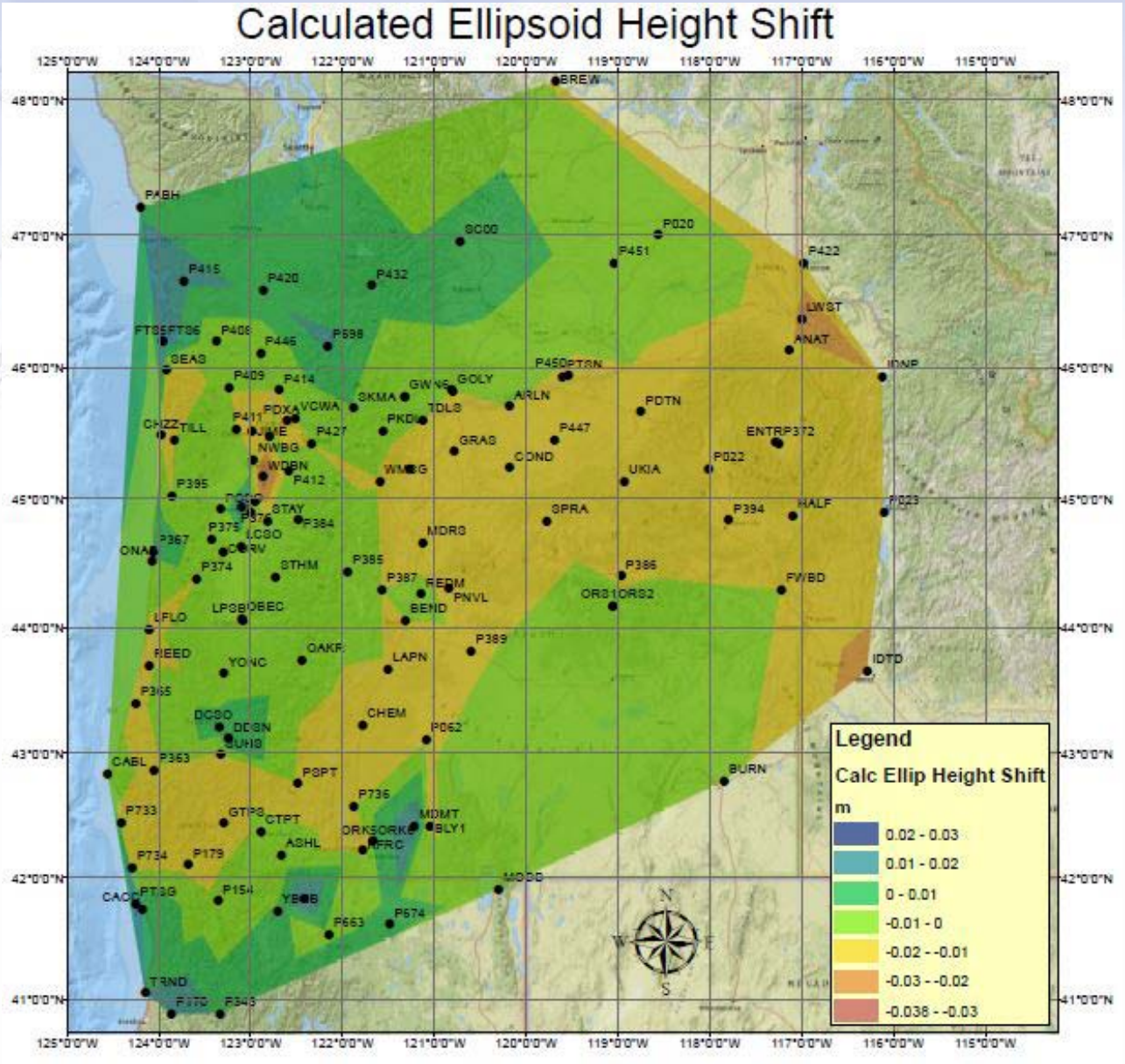


# NAD 83 (CORS96)2002.00 to NAD 83(2011)20100.00

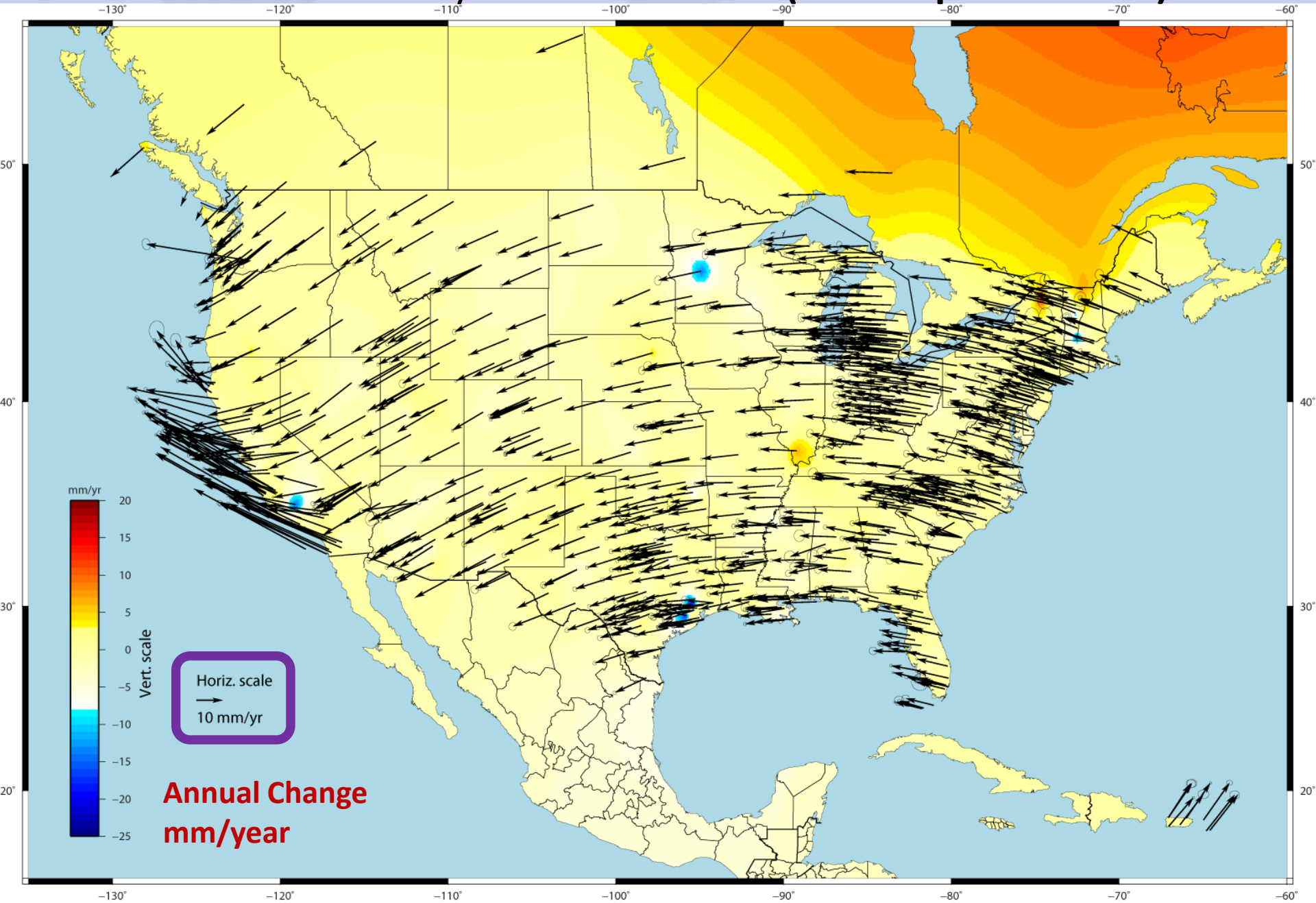
## NW Active Station Horiz. Shift



# NAD 83 (CORS96)2002.00 to NAD 83(2011)2010.00
# NW Active Station Vert. Shift

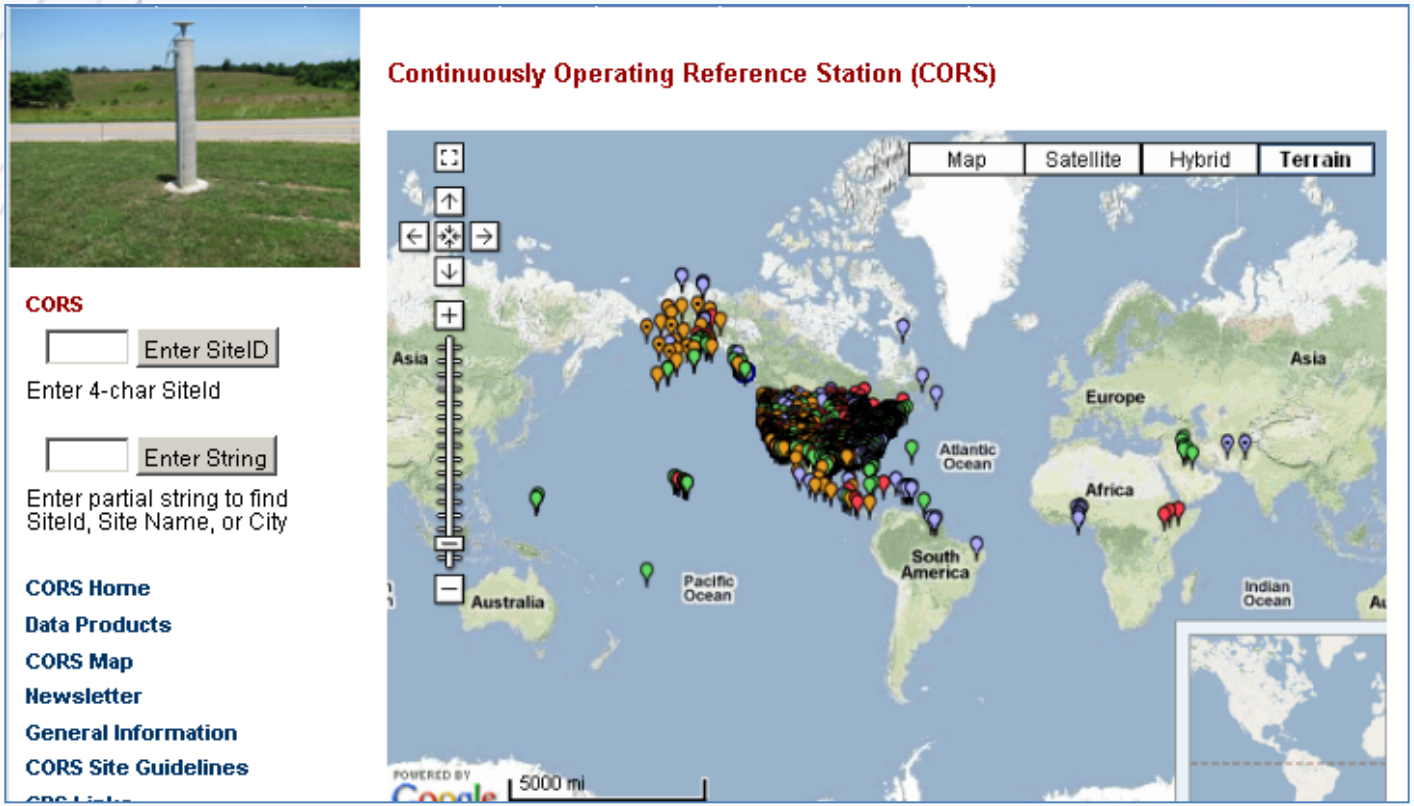


# U.S. CORS Velocity Field: **ITRF2008 (IGS08 epoch 2005.0)**



# CORS Data And Information

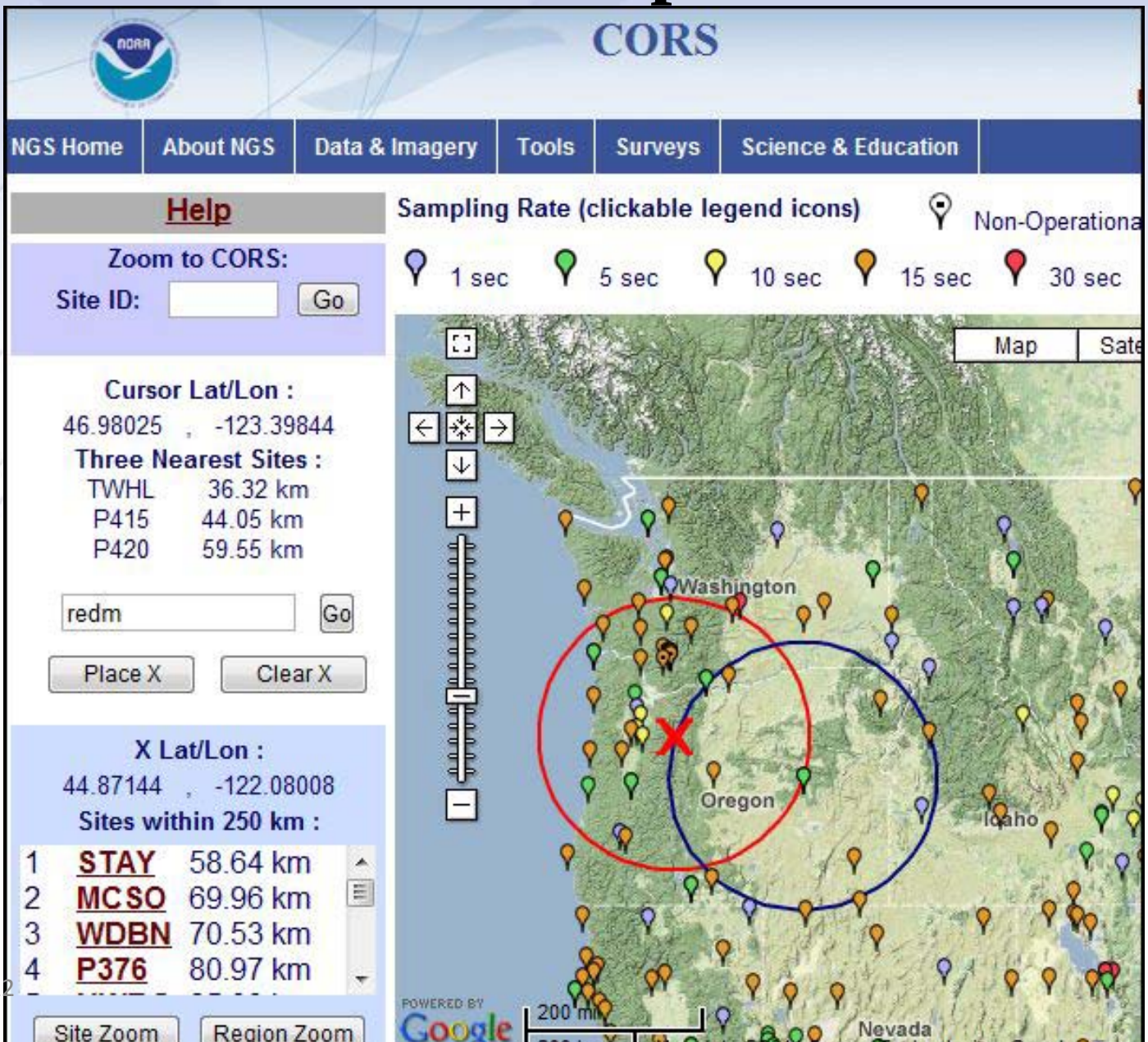
- Many, many CORS partners freely share their GNSS data.
- Data is available with a short latency.
- The NGS acts as a data center offering a newsletter, data, coordinates, site equipment histories, photos and time series.





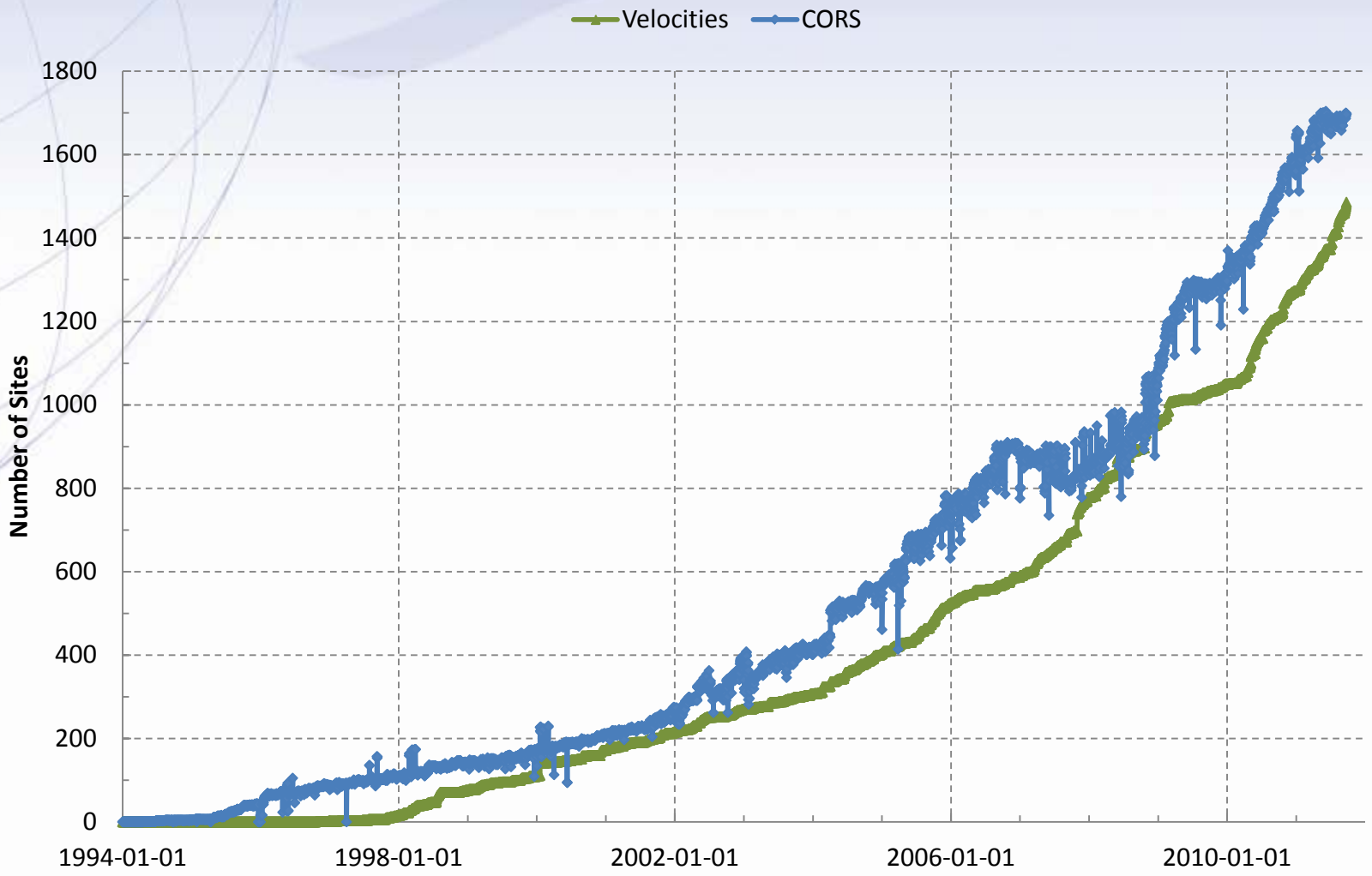

http://www.ngs.noaa.gov/CORS/

# CORS Map Tools



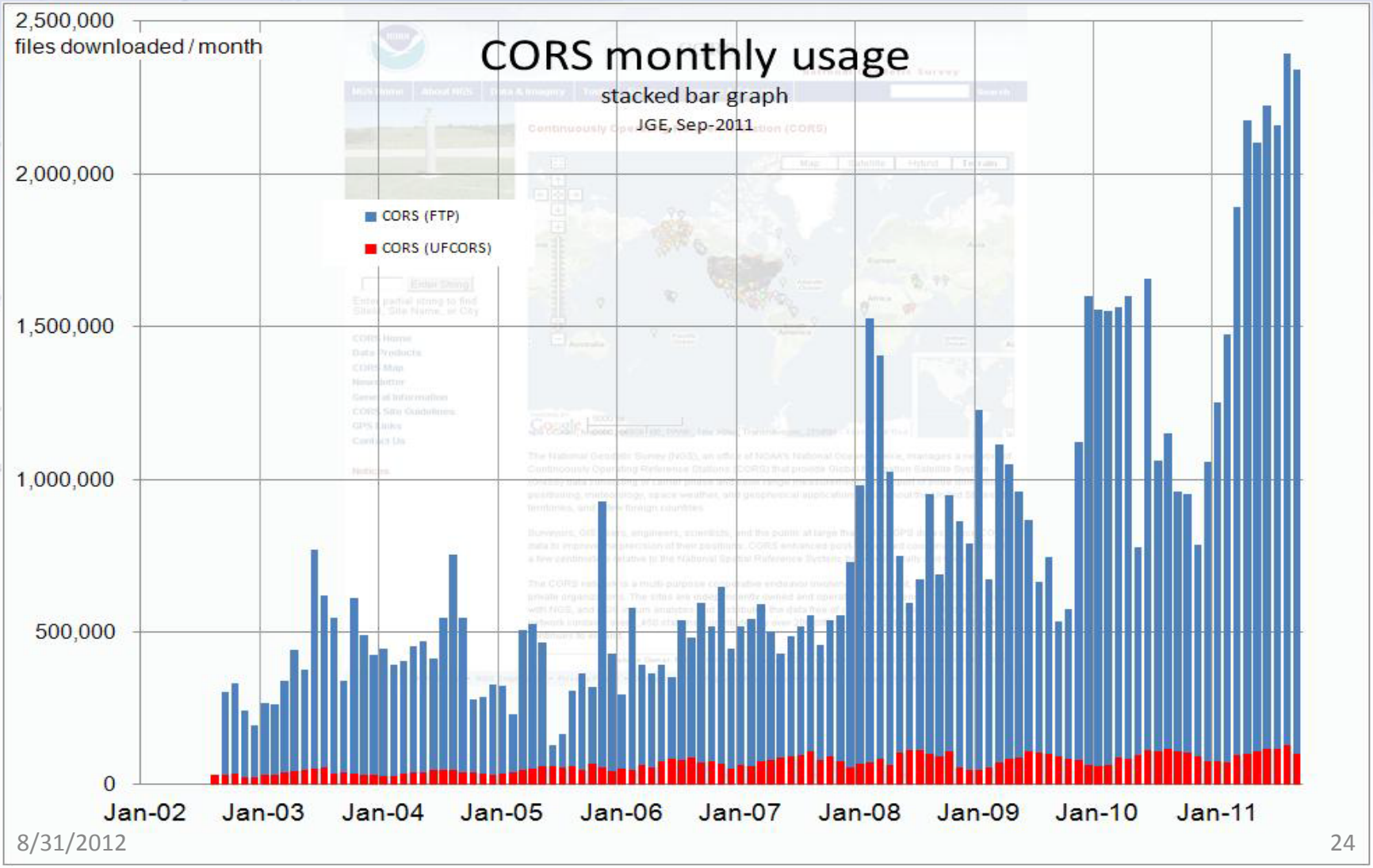
# CORS Network

- Increasing with no end in sight.



# CORS Use

- Increasing with no end in sight.



# CORS Data Availability

AB25
TATALINA__AK2008
McGrath, AK
USA

Site operated by:
UNAVPB

Coordinates

SiteLog
Photographs
Data Availability
Standard Files
Custom Files (UFCORS)

Time Series (60-day)
Time Series (longterm)

Google Map ab25 only
Google Map all CORS

Enter SiteID

CORS Home

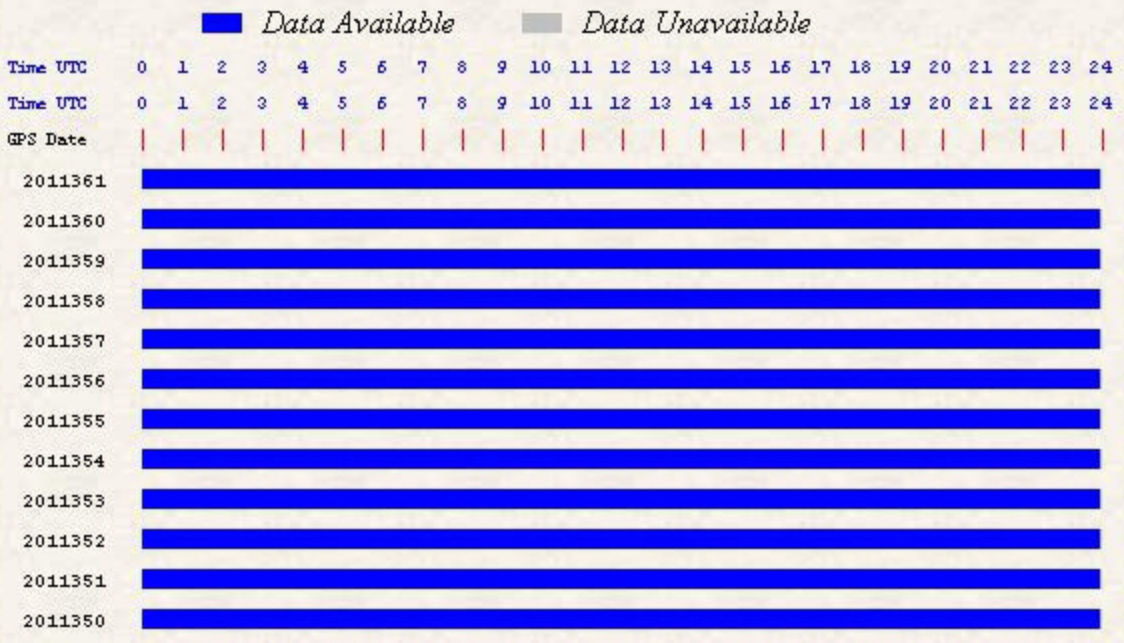
## National Geodetic Survey - CORS

SiteID: ab25 | GPS Date: Tue,Dec 27 2011 – 2011361 | Zone: UTC (GMT) | Days: 7

Submit

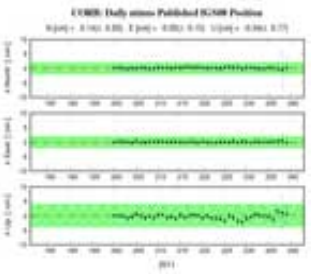
NOTE: Reset options and click "Submit" to view data availability for another time period.

*Data Availability Profile for:* **AB25**



# Look at CORS Repeatability Plots

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



CORS

Enter SiteID

Enter 4-char SiteId

Enter String

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

CORS Home
Data Products
CORS Map
Newsletter
General Information

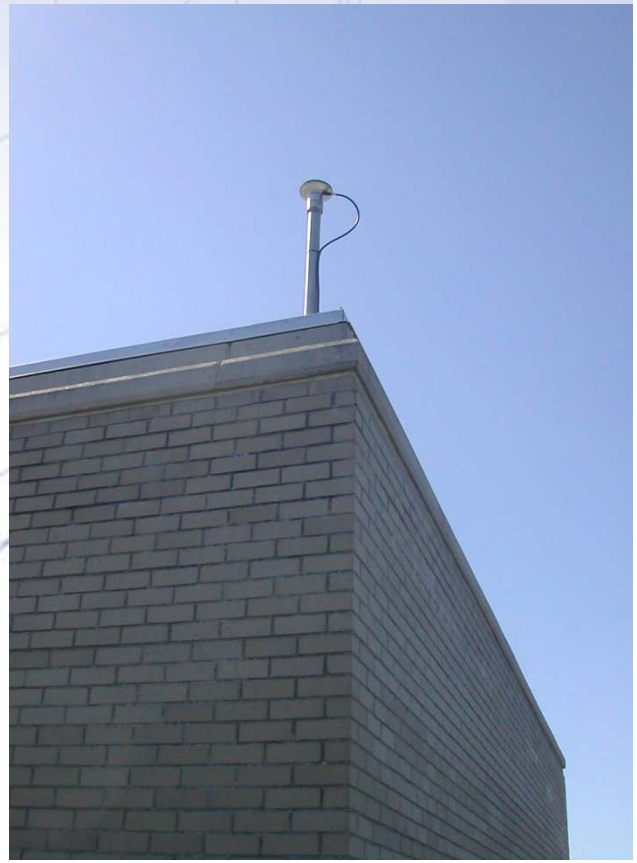
## CORS Repeatability Plots

**60-day plots** show the repeatability of a site for the last 60-days with respect to the published IGS08 position corrected for the effect of the published velocity. These plots are updated daily. For a detailed explanation of these plots go here.

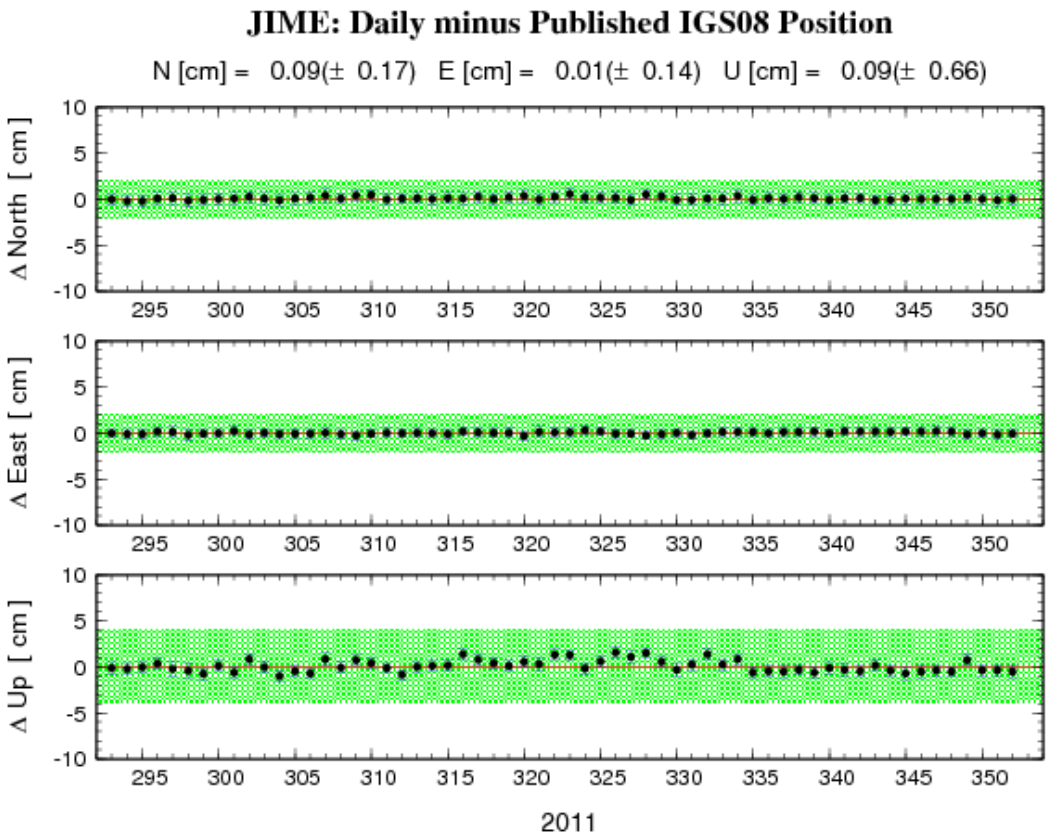
**Long-term plots** show the show weekly residual positions with respect to the published IGS08 coordinates from our stacked solution. Newer sites may not have a long-term plot if they were added after 16 April 2011. For a detailed explanation of these plots go here.

| | | | |
|---|---|---|---|
| 1lsu<br>60-day long-term | 1nsu<br>60-day long-term | 1ulm<br>60-day long-term | ab07<br>60-day long-term |
| ab11<br>60-day long-term | ab12<br>60-day long-term | | |
| ab14<br>60-day long-term | ab15<br>60-day long-term | ab17<br>60-day long-term | ab18<br>60-day long-term |
| ab22<br>60-day long-term | ab27<br>60-day long-term | ab33<br>60-day long-term | |
| ab37<br>60-day long-term | ab39<br>60-day long-term | ab41<br>60-day long-term | ab45<br>60-day long-term |
| ab48<br>60-day long-term | abq5<br>60-day long-term | abq6<br>60-day long-term | |
| abvi<br>60-day long-term | ac07<br>60-day long-term | ac09<br>60-day long-term | |

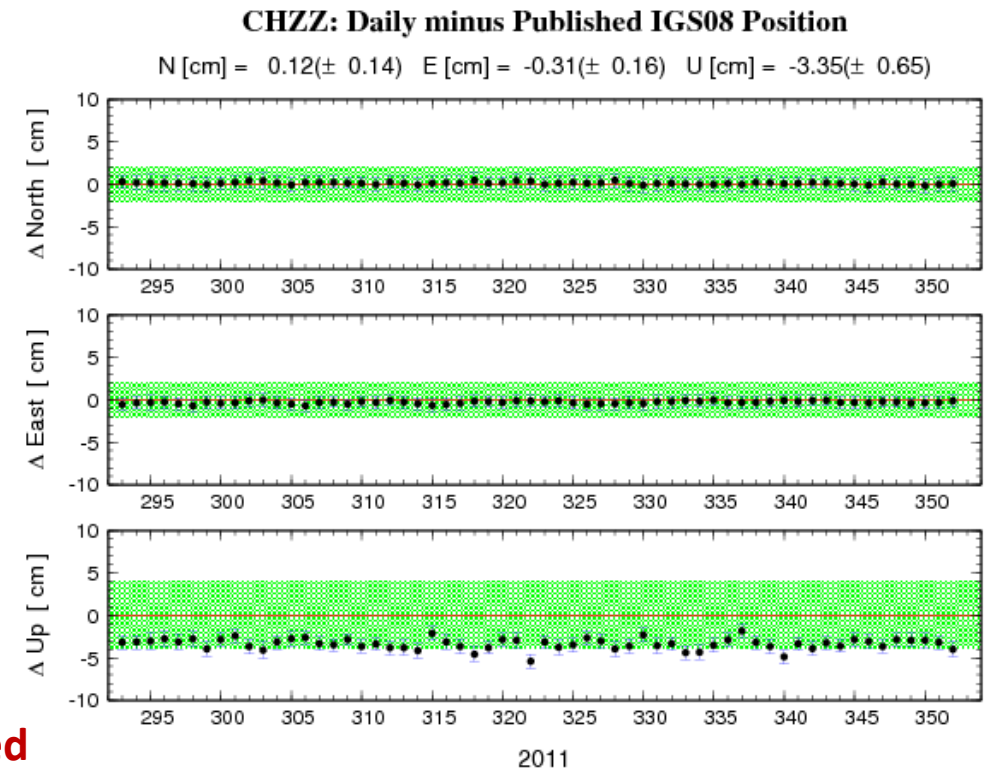
# Review the plots!



60 Day Time Series



# Review the plots!


**Is there an issue here?…**
**Does the Published IGS08 Position need updating?? What caused this? Equipment Change?**

# CORS 'CHZZ'

Equipment change, but owners log file not updated for ~2 years.
New SCIGN mount, antenna, and dome.

# Check the Log File for Accuracy!

- Antenna Type : **TRM59800.80 NONE (????????)**
- Serial Number : 0220373000
- Antenna Reference Point : BPA
- Marker->ARP Up Ecc. (m) : 0.0440
- Marker->ARP North Ecc(m) :
- Marker->ARP East Ecc(m) :
- Alignment from True N : deg
- Antenna Radome Type : NONE
- Radome Serial Number : N/A
- Antenna Cable Type : (vendor & type number) Antenna Cable Length : (m)
- Date Installed : 2010-02-04T12:30Z

# Review the CORS Newsletter

- Provides updates about new CORS
- Changes to CORS Products and Services
- News that impacts the CORS program
- Publications relating to the CORS program
- Statistics and usage maps
- Partners list

**To SUBSCRIBE to the newletter , send an empty email message to:**
**requests@willamette.nos.noaa.gov**
- with subject "Subscribe NGS_CORS_news".

Your name will be added to the list and you will receive all posts

# National Geodetic Survey ***Ten-Year Plan***

- Approved January, 2008
- Refines mission, vision, & strategy for the future of NGS actions
- Emphasis on outside capacity
  - ➢ **Modernize the Geometric ("Horizontal") Datum**
  - ➢ **Modernize the Geopotential ("Vertical") Datum**
  - – Migrate the Coastal Mapping Program >>> Integrated Ocean & Coastal Mapping
  - – Evolve Core Capabilities
  - – Increase Agency Visibility


Available at: geodesy.noaa.gov