



US Country Briefing: Modernization of the United States National Spatial Reference System

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USA Representative

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**SIRGAS Symposium Rio de Janeiro:
November 11-14, 2019**

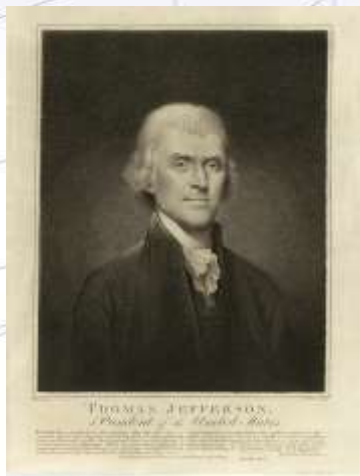


SIRGAS
Sistema de Referencia Geocéntrico
para las Américas

2019
Rio de Janeiro,
Brasil

NOAA and NGS

Our Nation's First Civilian Science Agency



1807
Thomas Jefferson
Survey of the Coast



1811
Ferdinand Hassler
Superintendent



1878
U.S. Coast and
Geodetic Survey

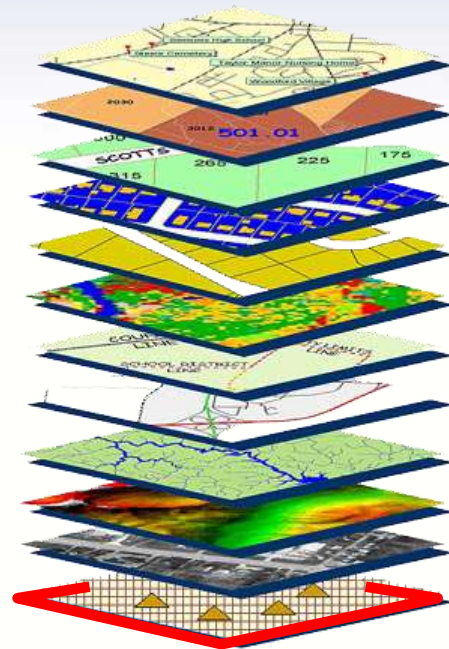


1970
NOAA is established

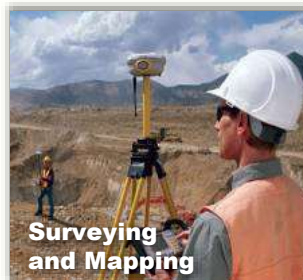
Mission Statement

To define, maintain and provide access to the **National Spatial Reference System (NSRS)** to meet our Nation's economic, social, and environmental needs.

The **NSRS** is a consistent coordinate system that defines latitude, longitude, height, scale, gravity, orientation, and shoreline throughout the United States.



NGS Provides the Geospatial Infrastructure Critical to Our Economy through the NSRS



The NSRS Supports:



National Oceanic and Atmospheric Administration

NSRS positioning data provides the reference for **NOAA's nautical charts**, among many other geospatial applications.



Federal Emergency Management Agency

FEMA uses NSRS elevations to **determine flood zones** for the National Flood Insurance Program.



United States Army Corps of Engineers

USACE uses NSRS elevations to **determine levee heights** and positions in their Levee Safety Program.



United States Geological Survey

USGS uses the NSRS to geospatially reference their **Topographic Maps and interior water data** for the nation.



National Geospatial Intelligence Agency

NSRS gravity data contributes to **NGA's geospatial mission**.

The National Geodetic Survey Strategic Plan

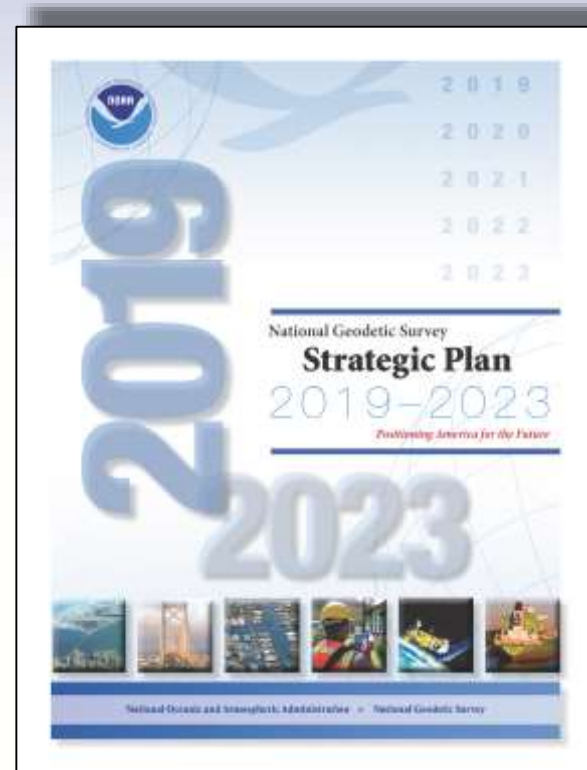
Support the users of the National Spatial Reference System.

Modernize and improve the National Spatial Reference System.

Expand the National Spatial Reference System stakeholder base through partnerships, education, and outreach.

Develop and enable a workforce with a supportive environment.

Improve organizational and administrative functionality.



NSRS Modernization



Revolutionize professional surveying

- No more need for installing and locating bench marks
- Absolute, consistent positioning autonomously, anywhere

Vastly improve flood plain mapping

- Water “sees” and flows due to differences in gravity. These are mapped directly using GNSS.
- Critical importance in low-lying, flat communities

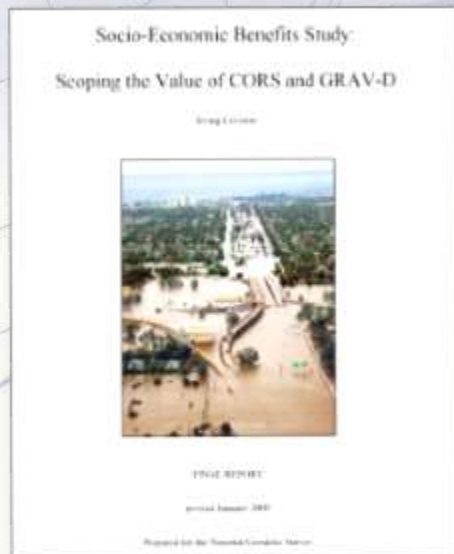
Impacts on infrastructure

- Any application requiring precise positioning - bridges, tunnels, railways, agriculture, navigation - will be easier and more accurate

Fundamental support for new technologies

- “Smart Highways” for autonomous vehicles

Socio-Economic Benefits



NSRS worth \$2.4 billion per year,
\$22 billion over 15 years at a discounted rate.

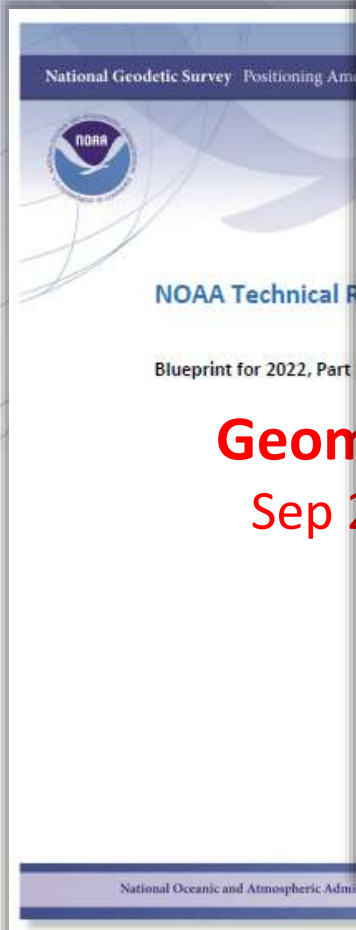
CORS worth \$758 million per year;
\$6.9 billion over 15 years at a discounted rate.

GRAV-D worth \$522 million per year
through implementation of a new national
vertical datum; \$4.8 billion over 15 years at a
discounted rate, including \$2.2 billion for
improved floodplain management alone.

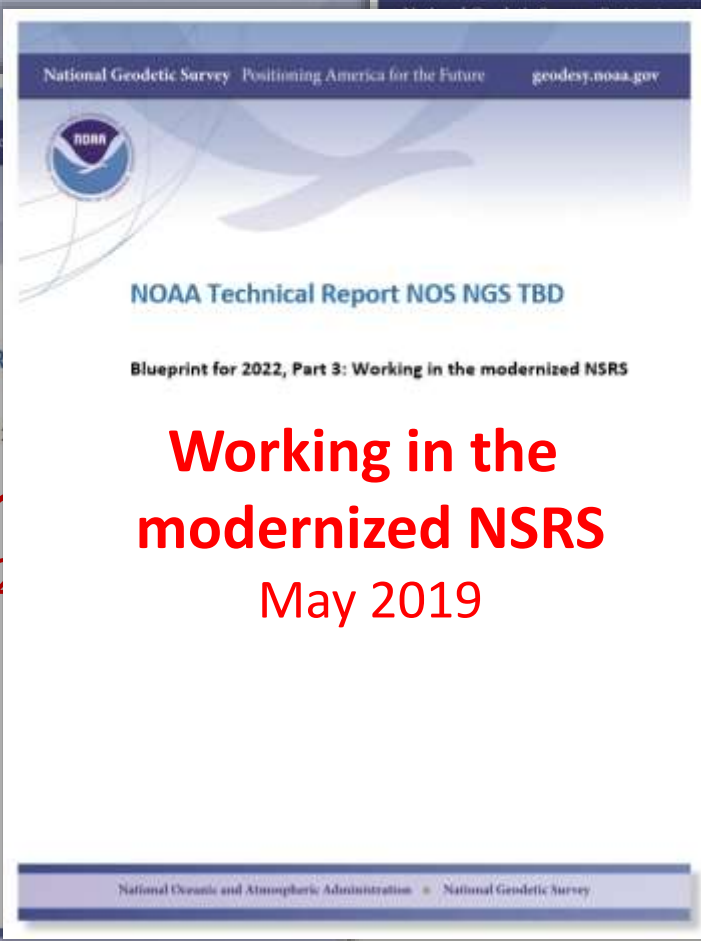


https://geodesy.noaa.gov/PUBS_LIB/Socio-EconomicBenefitsofCORSandGRAV-D.pdf

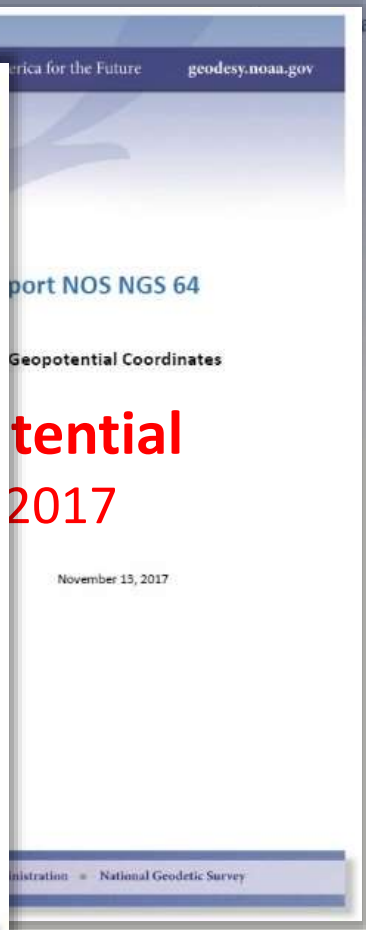
One-page handout available at: https://geodesy.noaa.gov/INFO/OnePagers/socio_eco_handout.pdf



Geopotential
Sep 2017



Working in the
modernized NSRS
May 2019



Report NOS NGS 64
Geopotential Coordinates
November 15, 2017

Recent Publications

Blueprint Documents for 2022

[Part 1: Geometric Coordinates](#)

[Part 2: Geopotential Coordinates](#)

[Part 3: Working in the modernized NSRS](#)

**The State Plane Coordinate System History, Policy,
and Future Directions**

[NOAA Special Publication NOS NGS 13](#)

The Future Reference Frames

Will be based on a densified ITRF model (Eg. SIRGAS)

Tectonic Plate based

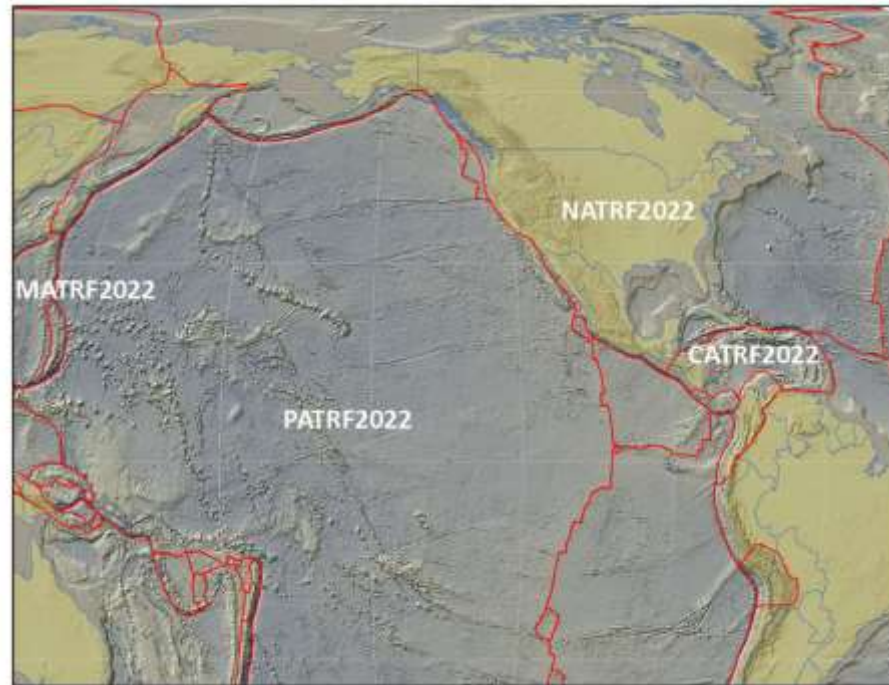
Each Plate is based on the same densified ITRF model

North America [NATRF]

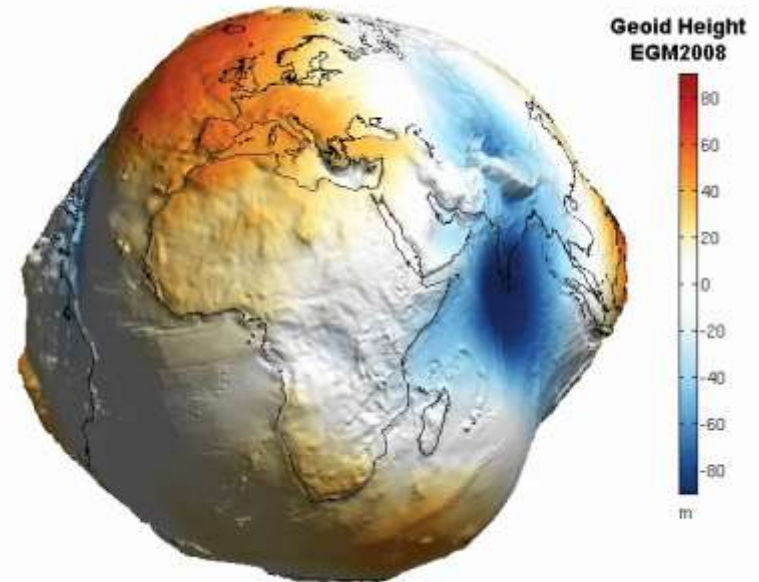
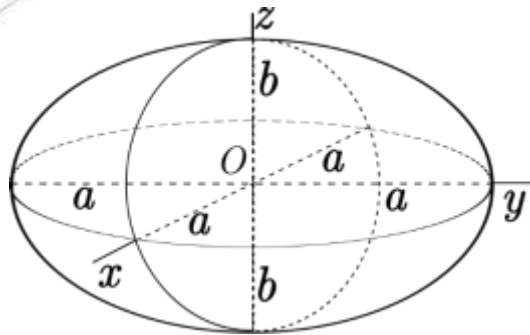
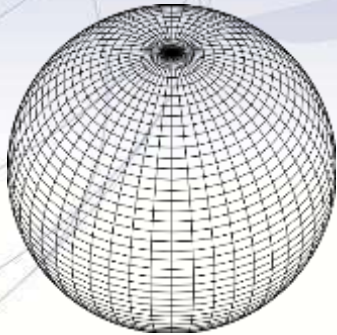
Caribbean [CATRF]

Pacific [PATRF]

Mariana [MATRF]



The Earth is Infinitely Complex



Build Models to Simplify

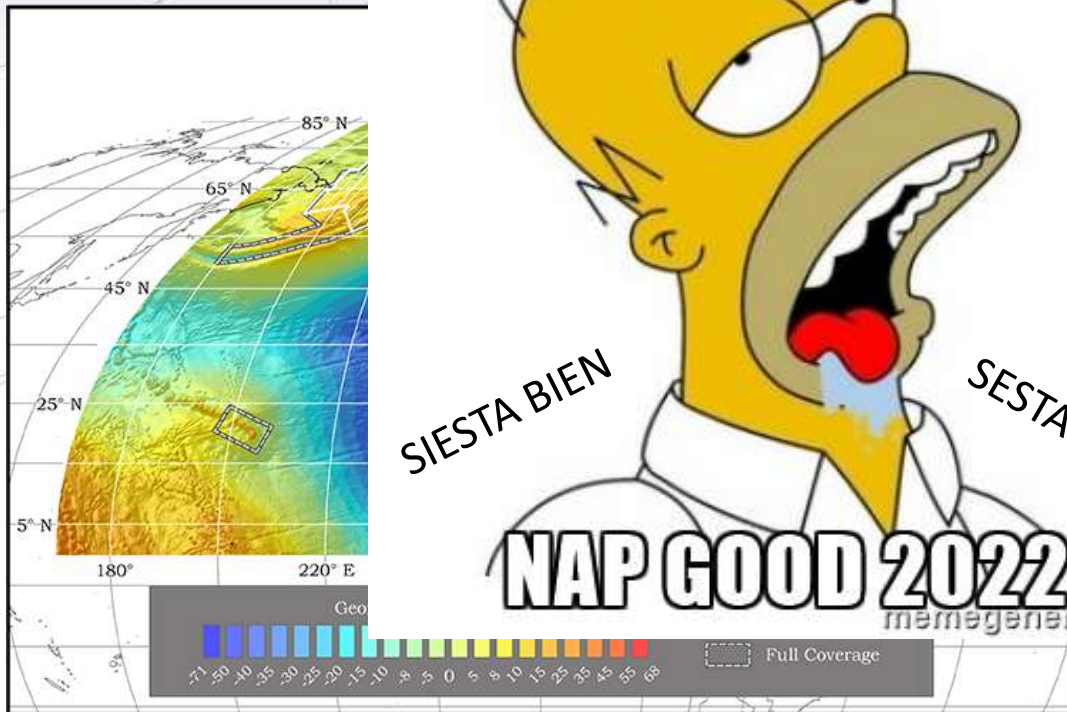
NAPGOOD 2022 Geopotential Datum

Not a vertical

nts.

Models included:

- Geopotential
- Deflection
- Gravity
- Geoid

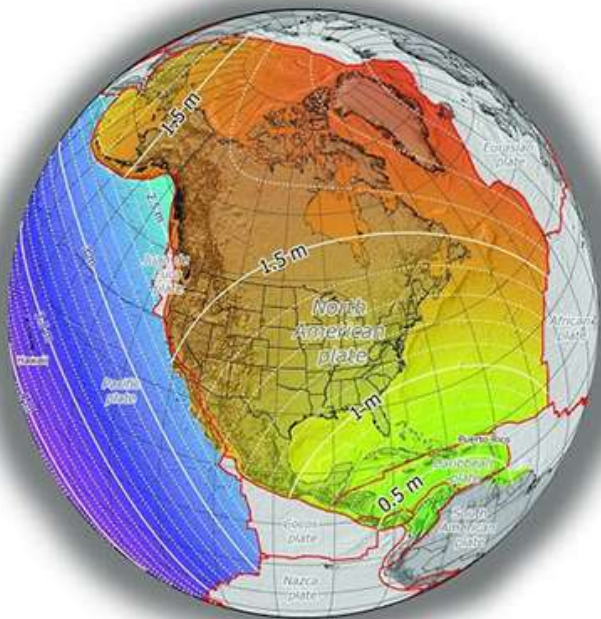


Guam/CNMI

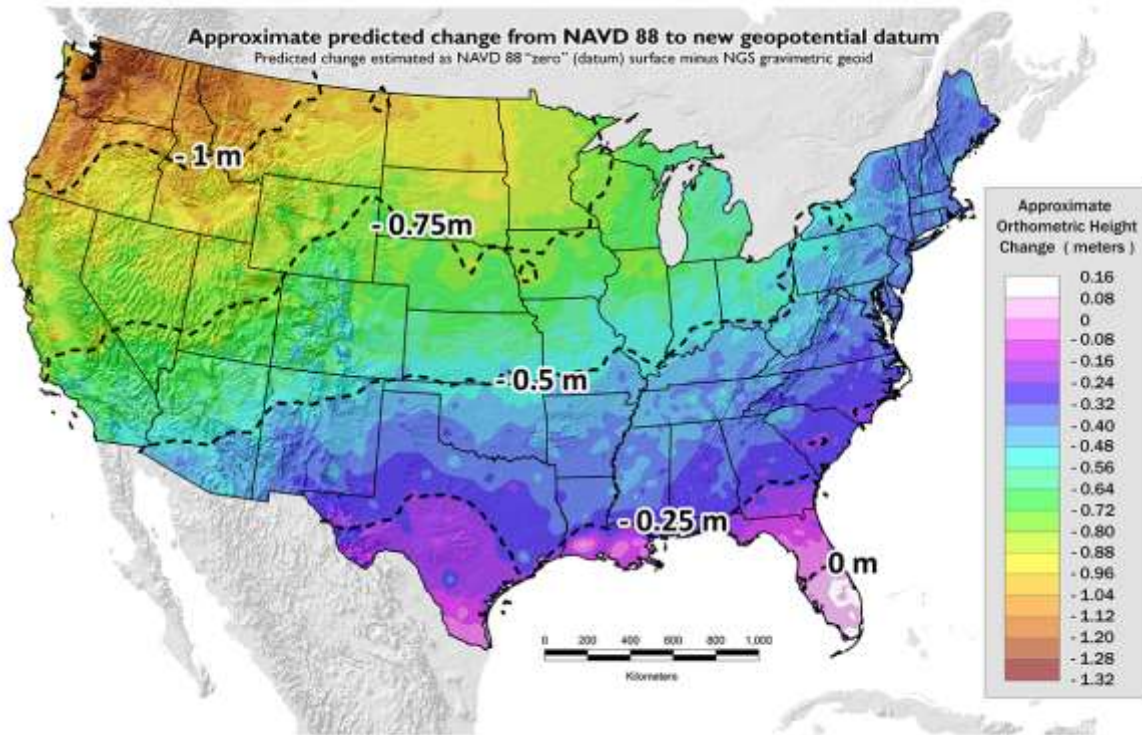
American Samoa

Once we get to 2022: What to Expect?

Approximate Horizontal Change
North American Plate



Approximate predicted change from NAVD 88 to new geopotential datum
Predicted change estimated as NAVD 88 "zero" (datum) surface minus NGS gravimetric geoid



~1 to 1.5 meters North America

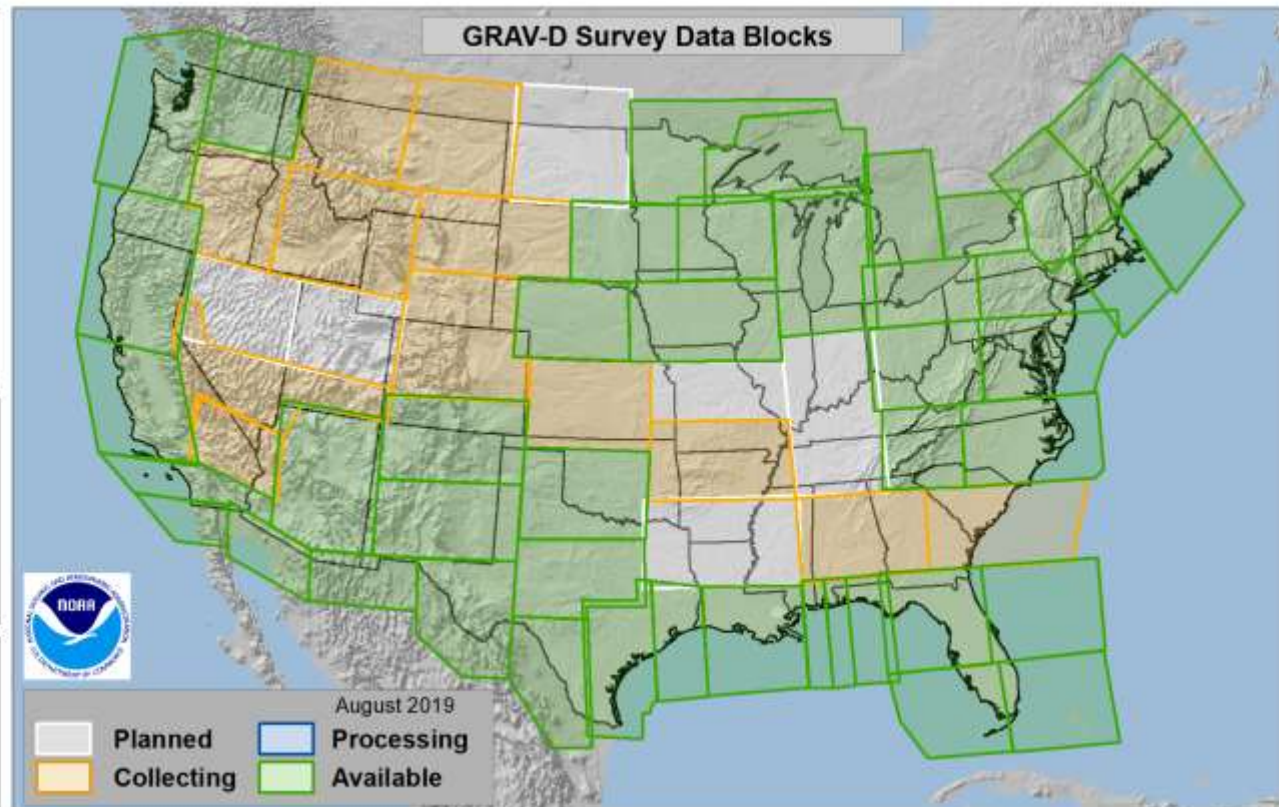
~2.5 to 4 meters in Pacific

0 to 1.3 meters CONUS

Gravity for the Redefinition of the American Vertical Datum

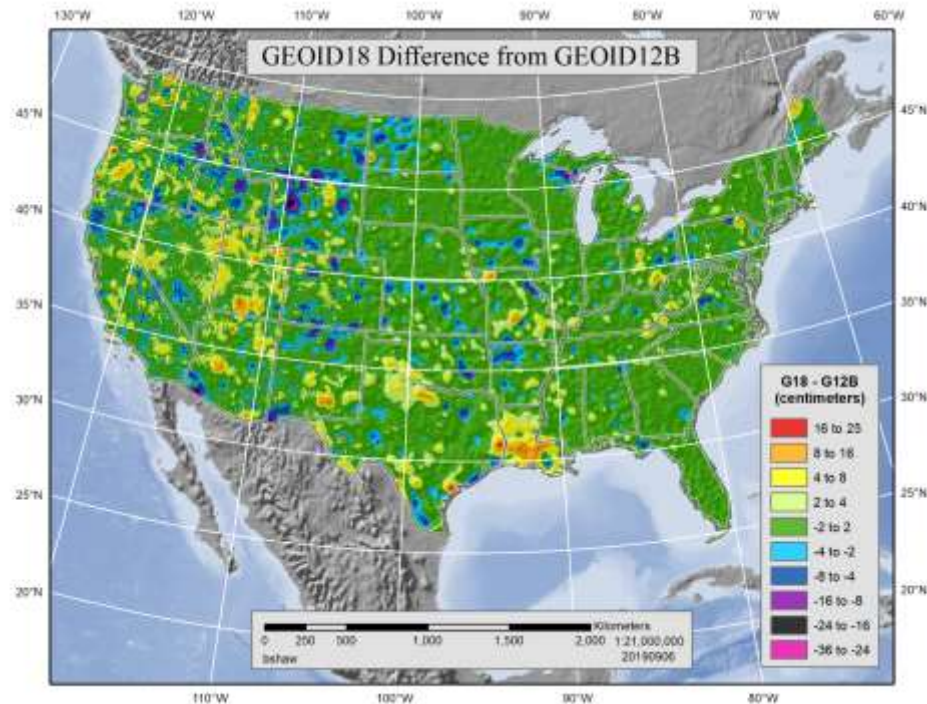
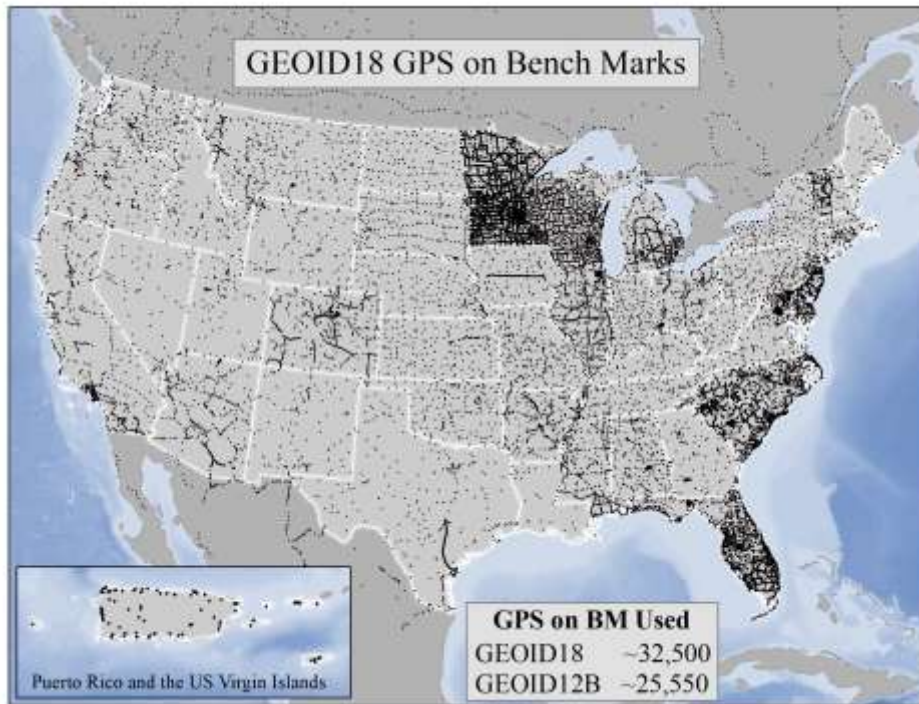
GRAV-D

GPR 78.5%



GEOID18

Released:
September 11, 2019



<https://geodesy.noaa.gov/GEOID/GEOID18/>

Prototype AGOL Dashboards

GPS on Bench Marks 2018



Leveling Dashboard

GPS on Bench Marks For the Transformation Tool



Priority List

- > 90,000 bench marks total
- ~45,000 Priority A
- ~70,000 at 10 km resolution
- ~9,000 Done

<https://geodesy.noaa.gov/GPSonBM/>

GPS on Bench Marks For the Transformation Tool

Web Map Application

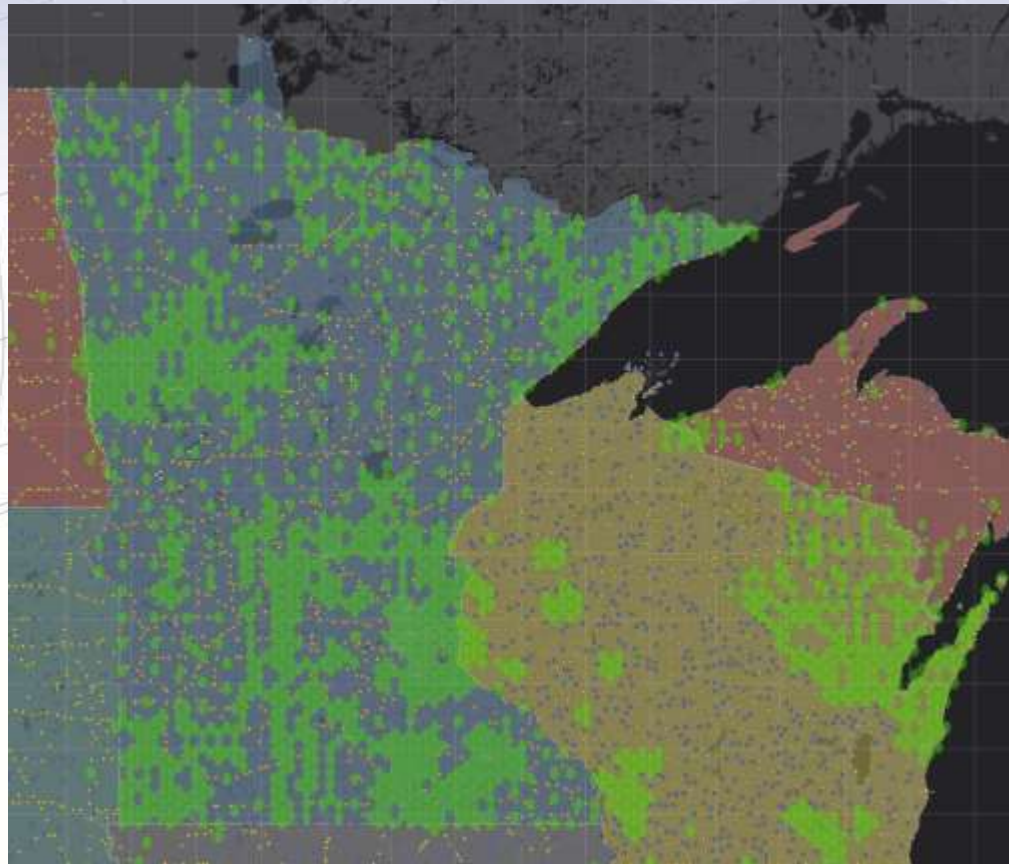
Minnesota Priority Marks

10 km marks - 2787

10 km marks done - 1132 (41%)

Minnesota is 'ALL IN' with GPS on BM for the next few months or until we complete the entire state with the 10km spacing, so expect the submittals from MN to increase.

Good luck to us all! - from MN DOT



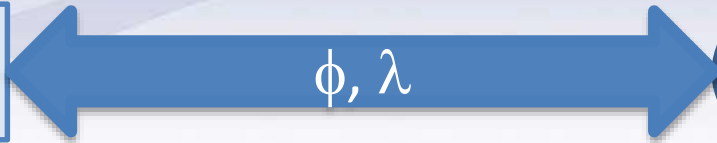
Transformations NCAT/NADCON5

2D

3D

ϕ, λ

ϕ, λ, h



CONUS

UTM
USNG

SPCS

ϕ - Latitude
 λ - Longitude
 h - Ellip. Height

UTM
USNG

SPCS

X, Y, Z

NAD 83

USSD (No SPCS) NAD 27 (1986) (HARN) (FBN) (NSRS2007) (2011) NATRF2022



NGS Products Update - NCAT

The screenshot shows the NOAA National Geodetic Survey website. The header includes the NOAA logo and the text "National Geodetic Survey Positioning America for the Future". A navigation bar contains links for "NGS Home", "About NGS", "Data & Imagery", "Tools", "Surveys", and "Science & Education". A search bar is located on the right. A red banner with a warning icon reads "NOTICE: View NOAA Emergency Information from Hurricane Dorian." Below the navigation bar, there is a "Quick Links" section with various links like "OPUS", "CORS", and "Survey Mark Datasheets". A central menu is open under "Tools", listing options such as "Adjust Leveling (LOCUS)", "Geodetic Tool Kit", "Web Services", "Process GPS data (OPUS)", "Coordinate Conversion and Transformation Tool (NCAT)", "Vertical Conversions (VDATUM)", "Download PC Software", "GEOID12B Toolkit", "GPS Toolbox", "HTDP", and "VERTCON". A pink arrow points to the "Coordinate Conversion and Transformation Tool (NCAT)" option. Below the menu, there are several featured sections: "GNSS & GPS Data", "Remote Sensing", "Land Surveying", and "Geodesy". On the right side, there are sections for "Looking for Bench Marks?", "Product Updates", "In the News", and "Final Releases".

NGS Products Update - NCAT

Single Point Conversion Multipoint Conversion Web services Downloads About Conversion Tool

Convert from: LLh SPC UTM XYZ USNG

Enter lat-lon in decimal degrees

Lat:


Lon:

or degree-minute-second

Lat:

Lon:

or drag map marker to a location of interest




Ellipsoid Height (m):

Input datum: Output datum:

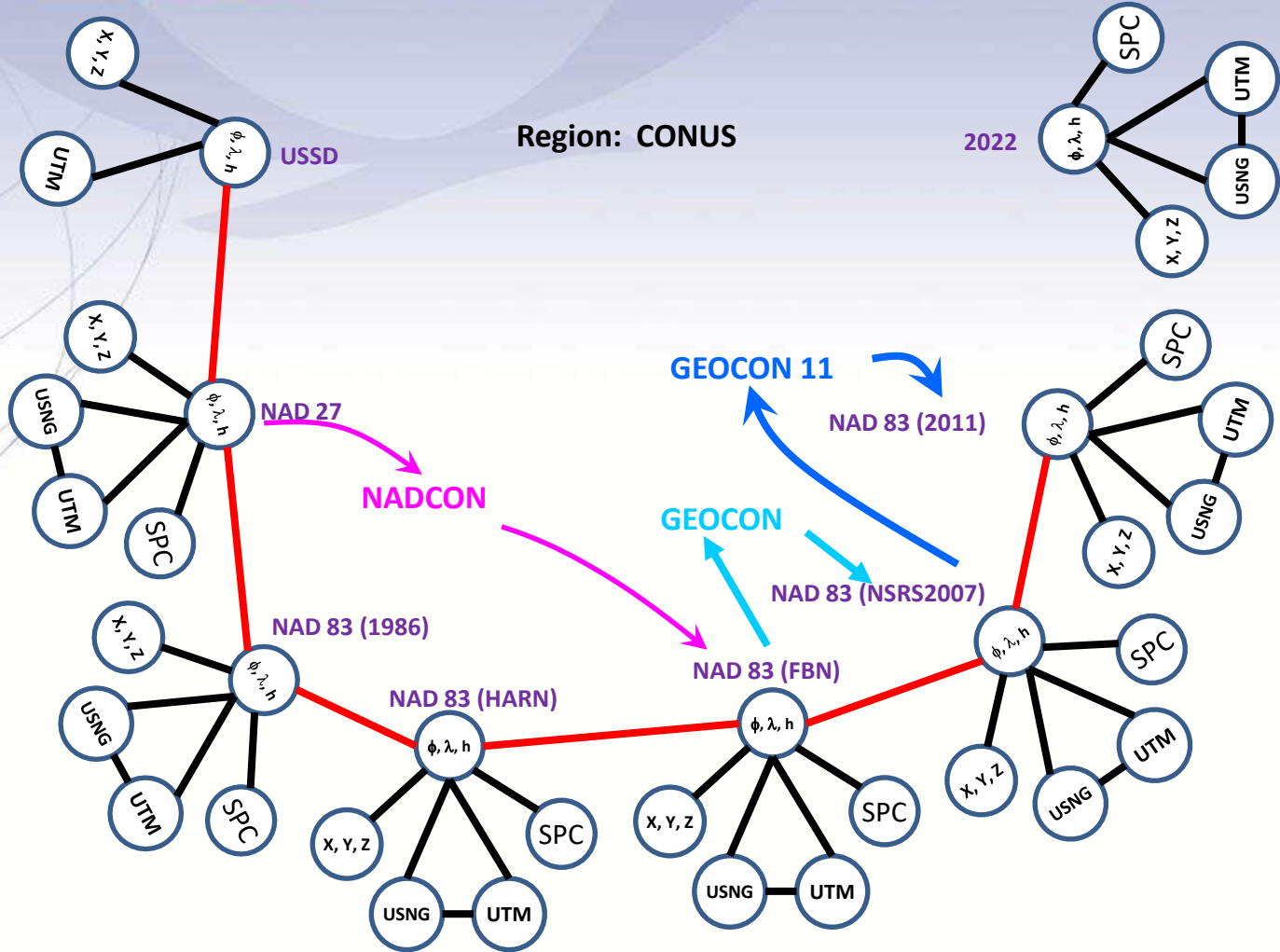
Don't see a datum in the list? [Click here to learn more.](#)

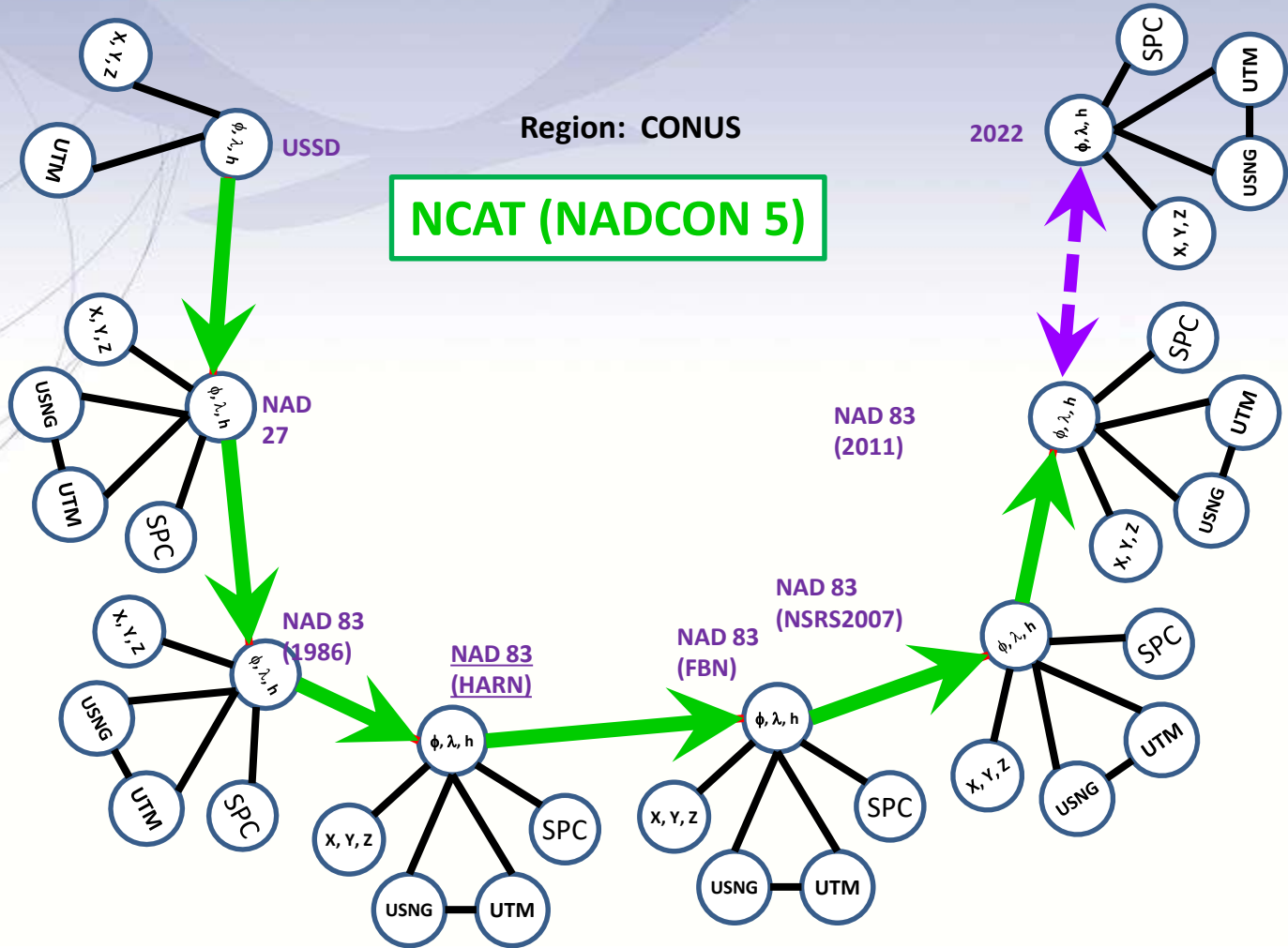
Converted coordinates will be in output datum

Export Results to: 

LLh SPC UTM (m) XYZ (m) USNG

Region: CONUS





Beta Mark Recovery Form

Desktop and Mobile friendly

Mark Recovery Form

Marker ID

FID: ex. AC7026

Designation: ex. ROBERT PACKARD

Stamping: ex. ROBERT PACKARD

Latitude: ex. N343436.8867

Longitude: ex. W1203856.13856

Country:

State:

County:

Recoverer ID

Your Agency Type: Select agency code

Recovery Agency:

Date mark was recovered: YYYYMMDD

Name: ex. John Smith

Email: ex. john.smith@gmail.com

Privacy Statement: Your name and email address will be used only to contact you if there is a problem in locating your recovery. They will not be used for any other purpose.

Mark Recovery Form

Marker ID

FID: ex. AC7026

Designation: ex. ROBERT PACKARD

Stamping: ex. ROBERT PACKARD

Latitude: ex. N343436.8867

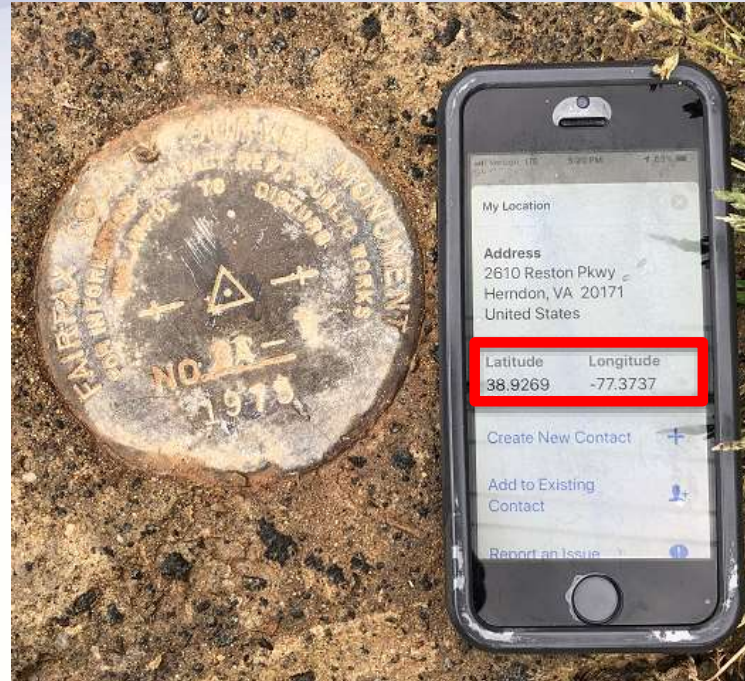
Longitude: ex. W1203856.13856

Country:

State:

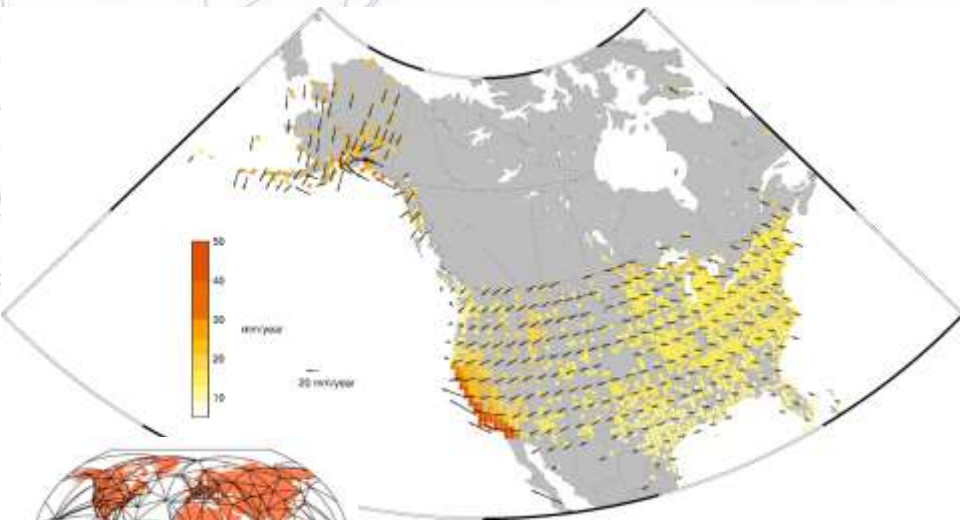
https://beta.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl

Reported Coordinates

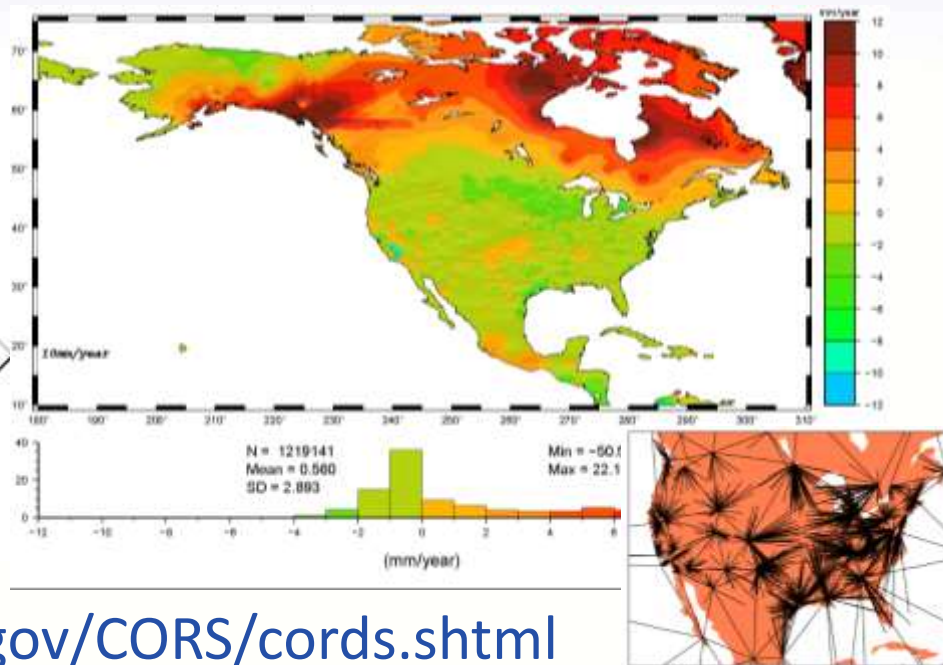


ITRF2014 and MYCS2 CORS Coordinates and Velocities Update

Horizontal Velocities



Vertical Velocities



<https://geodesy.noaa.gov/CORS/cords.shtml>

RTK GVX Format

Requesting Feedback

The screenshot shows a software interface with a map of a region including Kings Valley, Adair Village, and Kings Island. The map displays several green circles representing 'User Marks' and blue lines representing 'Processed Vector (OPUS-Projects)'. Red dashed lines represent 'Uploaded Vector'. A legend in the bottom right of the map area defines these symbols: a yellow triangle for CORS, a green circle for User Mark, a blue line for Processed Vector (OPUS-Projects), and a red dashed line for Uploaded Vector. On the left side, a vertical menu contains various options, with 'Set up Adjustment' and 'Review and Submit to IDB' circled in red.

```

- <SURVEY_SETUP>
  <ID>00000034</ID>
  <SOLUTION_TYPE>NetworkRTK</SOLUTION_TYPE>
  <OPERATOR>John Doe</OPERATOR>
- <PROCESSING_SOFTWARE>
  <NAME>Trimble VRS3Net</NAME>
  <VERSION>3.2</VERSION>
  <SOFTWARE_URL>https://www.trimble.com</SOFTWARE_URL>
</PROCESSING_SOFTWARE>
<CORRECTOR_FORMAT>RTCM 3.1</CORRECTOR_FORMAT>
- <NETWORKRTK>
  <NAME>KeyNetGPS</NAME>
  <MOUNT_POINT>VRS_RTCM3</MOUNT_POINT>
  <TYPE>VRS</TYPE>
  <IP_ADDRESS>209.255.196.164</IP_ADDRESS>
  <IP_PORT>2101</IP_PORT>
</NETWORKRTK>
</SURVEY_SETUP>

```

Figure 5. Example of the SURVEY_SETUP element

<https://geodesy.noaa.gov/data/formats/GVX/>

NGS Resources

NGS Training Center

https://geodesy.noaa.gov/web/science_edu/training/

Educational Videos

<https://geodesy.noaa.gov/datums/newdatums/WatchVideos.shtml>

NGS Webinar Series

https://geodesy.noaa.gov/web/science_edu/webinar_series/

Presentation Library

https://geodesy.noaa.gov/web/science_edu/presentations_library/

A stylized graphic of a globe is positioned on the left side of the slide. It consists of thin, light-colored lines representing the Earth's latitude and longitude, set against a light blue background that features a faint, larger-scale globe pattern.

Oh,
ONE More Thing:

Oh, ONE More Thing:

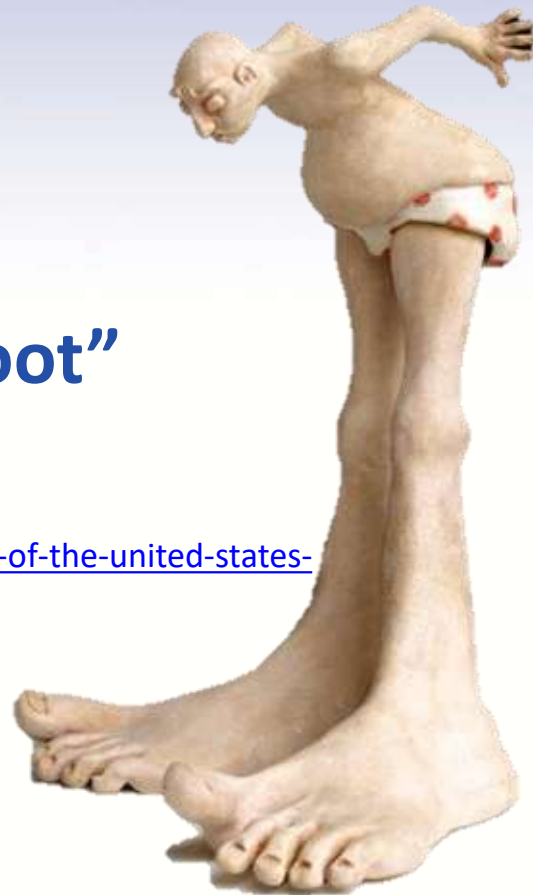
The Federal Register Notice (FRN) on

“Deprecation the U.S. survey foot”

will be published **Today**, Thursday, October 17, 2019

It should be available at

<https://www.federalregister.gov/documents/2019/10/17/2019-22414/deprecation-of-the-united-states-survey-foot>



Thank You !

QUESTIONS?



Why Modernize the NSRS

Current models built on old technology and data

NAD 83 not truly Geocentric (~2.2m)

NAVD 88 relies on marks in the ground
and is not easily maintained

Today's technology needs better accuracy

Data is collected exponentially faster

In addition, the US has agreed to adopt the GGRF

NSRS is a Paradigm Shift in Data & Technology

NAD 83

Triangulation (150 years)

TRANSIT/BC-4

DORIS

GRS80 Ellipsoid

NAVD 88

Leveling (150+ years)

Water-Level Transfers

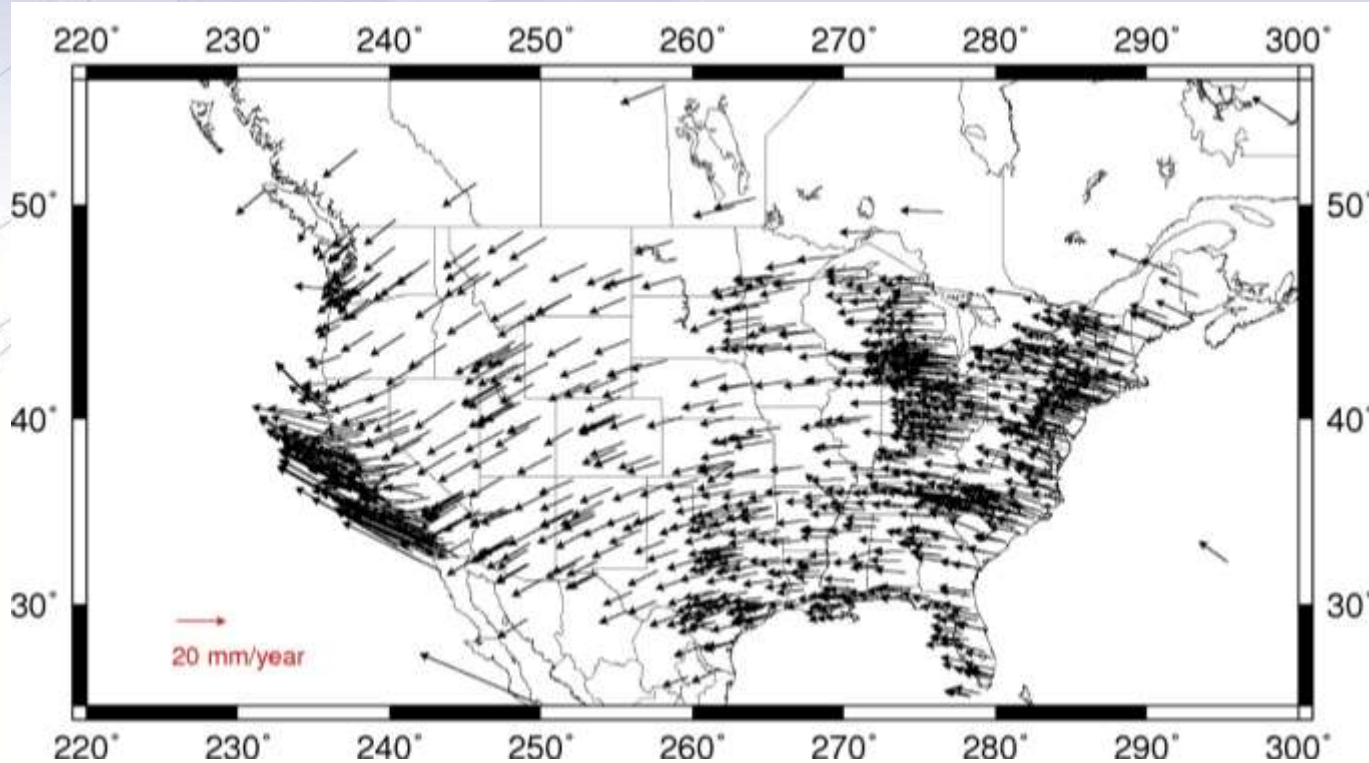
Surface Gravity

Theodolite Vertical Angles

Technology

Main Frames (MB), Theodolites, Dumpy Levels

Plate Tectonics and Velocities



“drift” : Annual changes to ITRF2014 coordinates

NSRS is a Paradigm Shift in Data & Technology

TRFs

GNSS (25 years)

VLBI

SLR

DORIS

Geopotential

Leveling (180+ years) – Now Digital
Satellite, Airborne, Surface Gravity

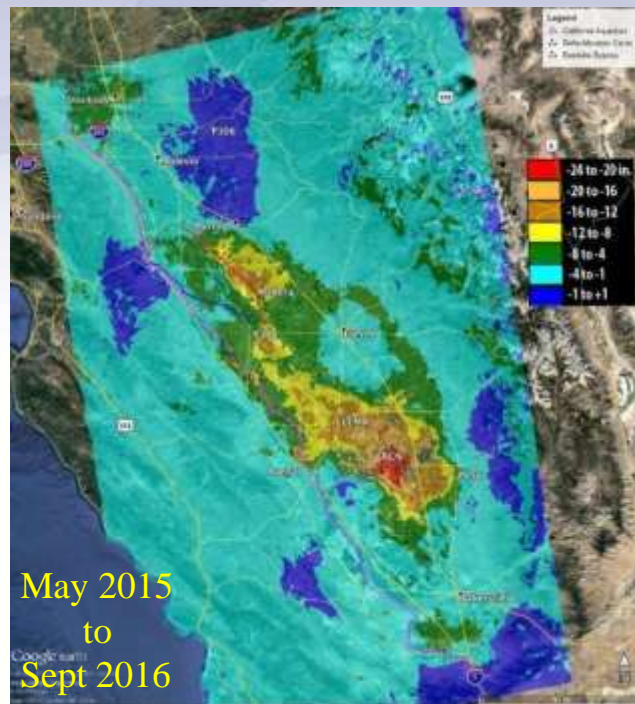
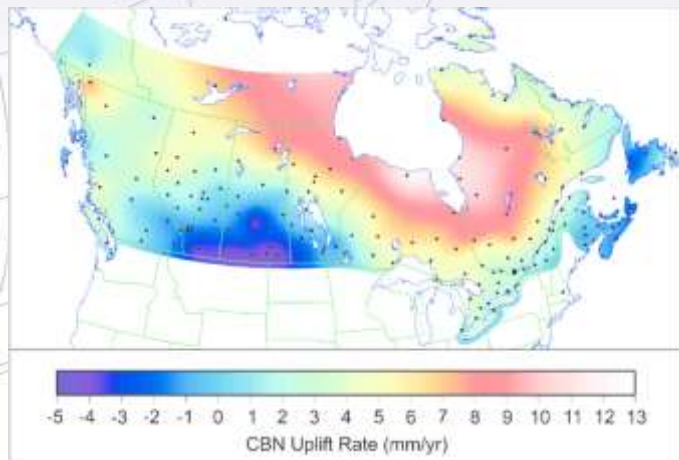
Digital Elevation Models

SRTM, LIDAR, IFSAR

Technology

Cloud/Servers, Satellites, Many new surveying technologies

Vertical Motion



May 2015
to
Sept 2016



Hudson Bay Uplifting
8 -13 mm/year

San Joaquin Subsiding
20-24" in 16 months

State Plane Coordinate Systems of 1927 (134 zones) and 1983 (125 zones)

