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

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USA Representative

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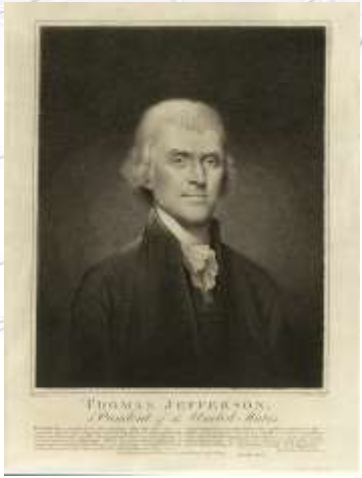
SIRGAS Symposium Rio de Janero:
November 11-14, 2019

SIRGAS 2019
Sistema de Referencia Geocéntrico para las Américas
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

1836
U.S. Coast
Survey

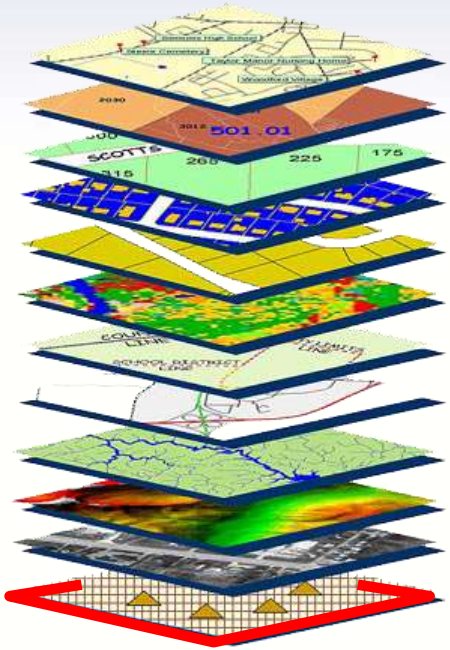
1878
U.S. Coast and
Geodetic Survey

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

Satellite Operations

Personal Navigation

Survey Marks

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

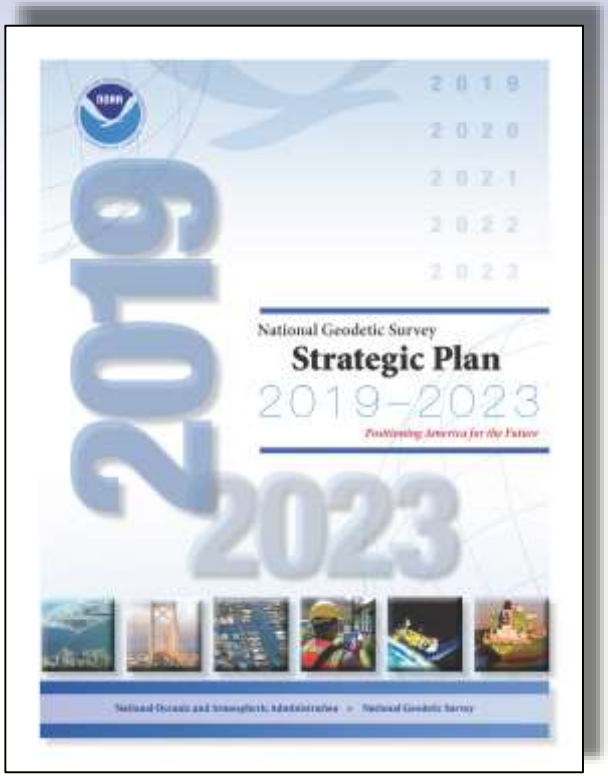
Support the users of the National Spatial Reference System.

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.



https://www.ngs.noaa.gov/web/about_ngs/info/documents/ngs-strategic-plan-2019-2023.pdf

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

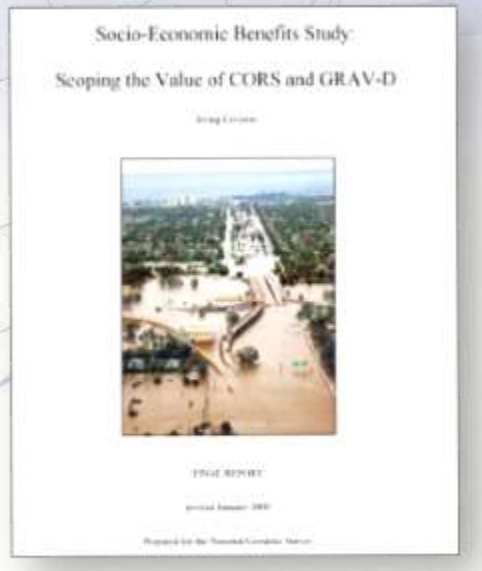
Impacts on infrastructure

- 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



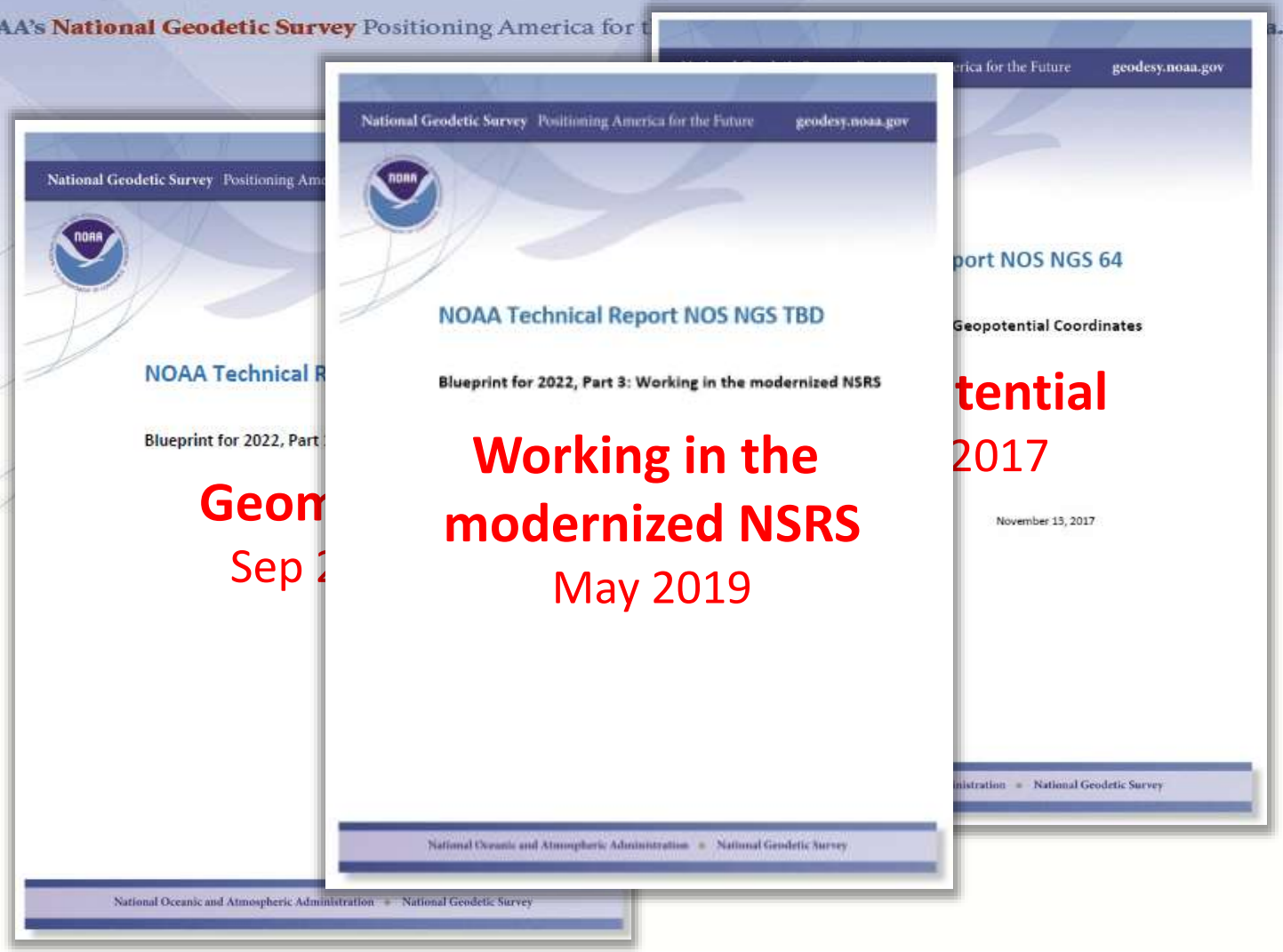
NSRS worth $2.4 billion per year,
$22 billion over 15 years at a discounted rate.

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


National Geodetic Survey Positioning America for the Future geodesy.noaa.gov
NOAA Technical Report NOS NGS TBD
Blueprint for 2022, Part 3: Working in the modernized NSRS
Working in the modernized NSRS
May 2019
National Oceanic and Atmospheric Administration • National Geodetic Survey
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Geopotential Coordinates
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2017
November 15, 2017
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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

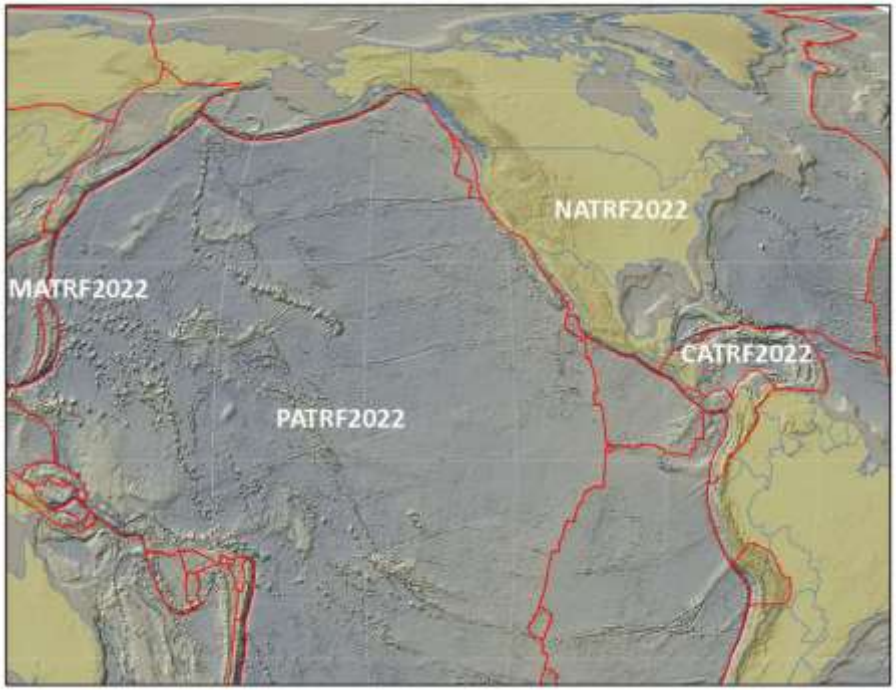
The Future Reference Frames

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

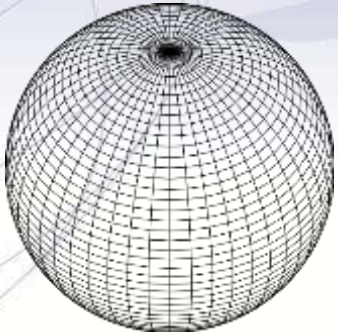
Tectonic Plate based

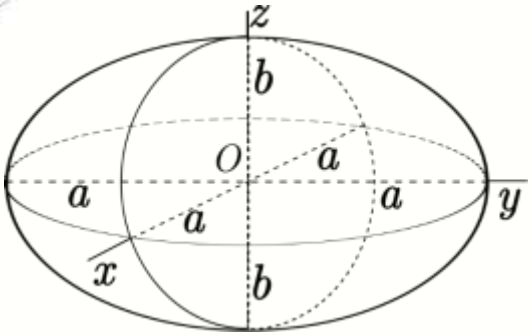
Each Plate is based on the same densified ITRF model

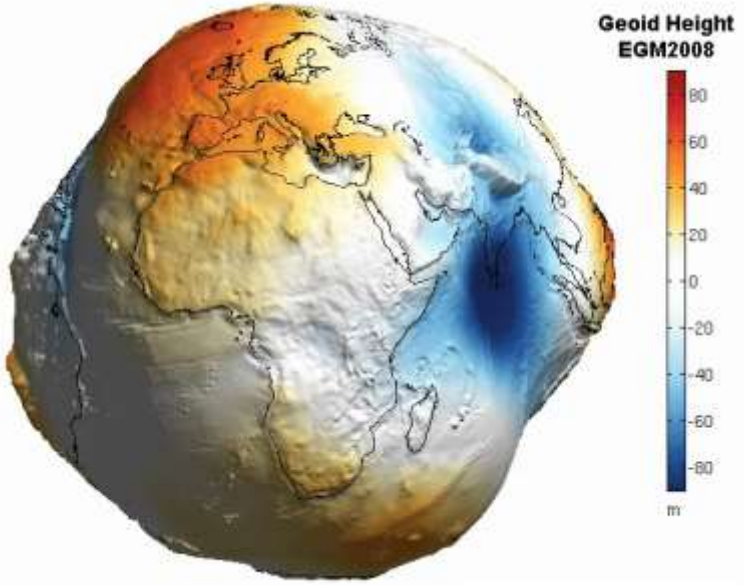
North America [NATRF]
Caribbean [CATRF]
Pacific [PATRF]
Mariana [MATRF]



The Earth is Infinitely Complex



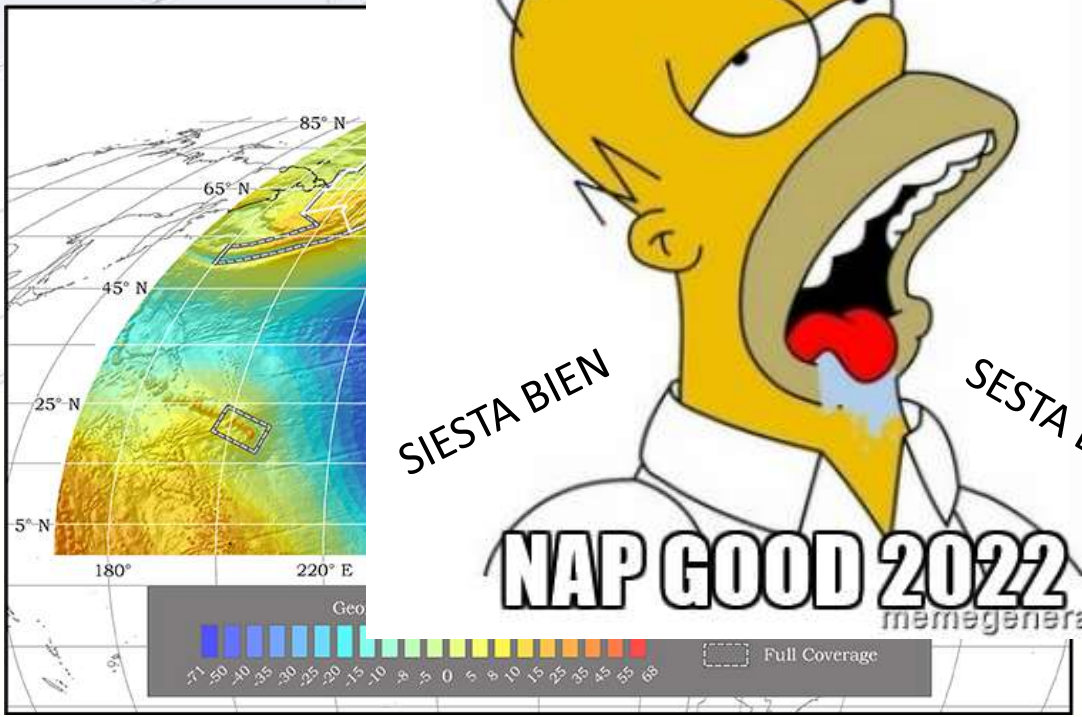




Build Models to Simplify

NAP[illegible]ntial Datum

Not a vertical [illegible]nts.



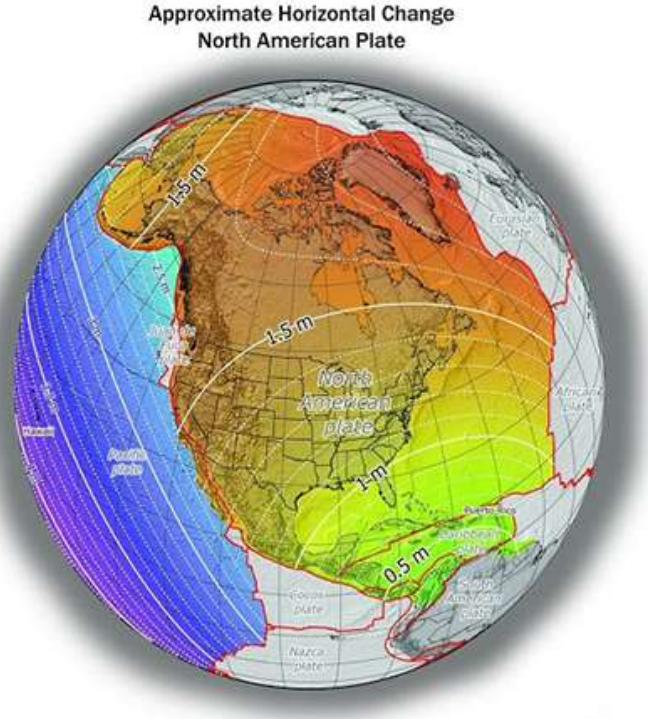
Models included:

- Geopotential
- Deflection
- Gravity
- Geoid

Guam/CNMI

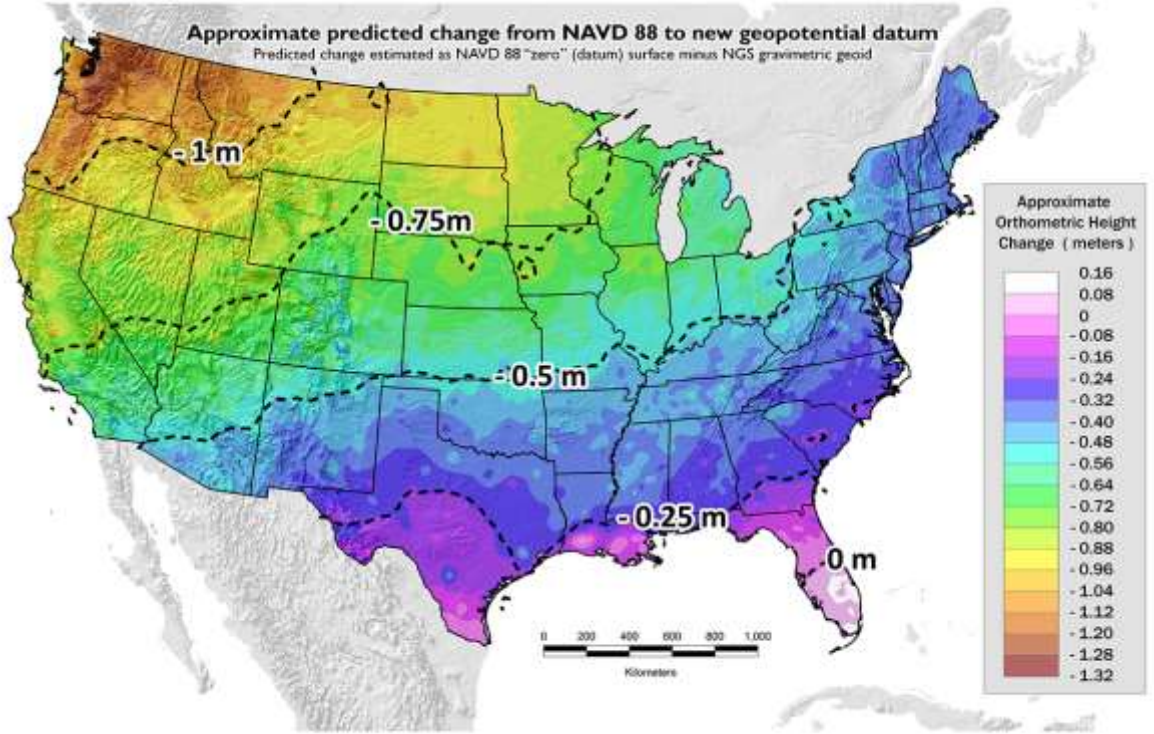
American Samoa

Once we to get to 2022:What to Expect?



~1 to 1.5 meters North America

~2.5 to 4 meters in Pacific

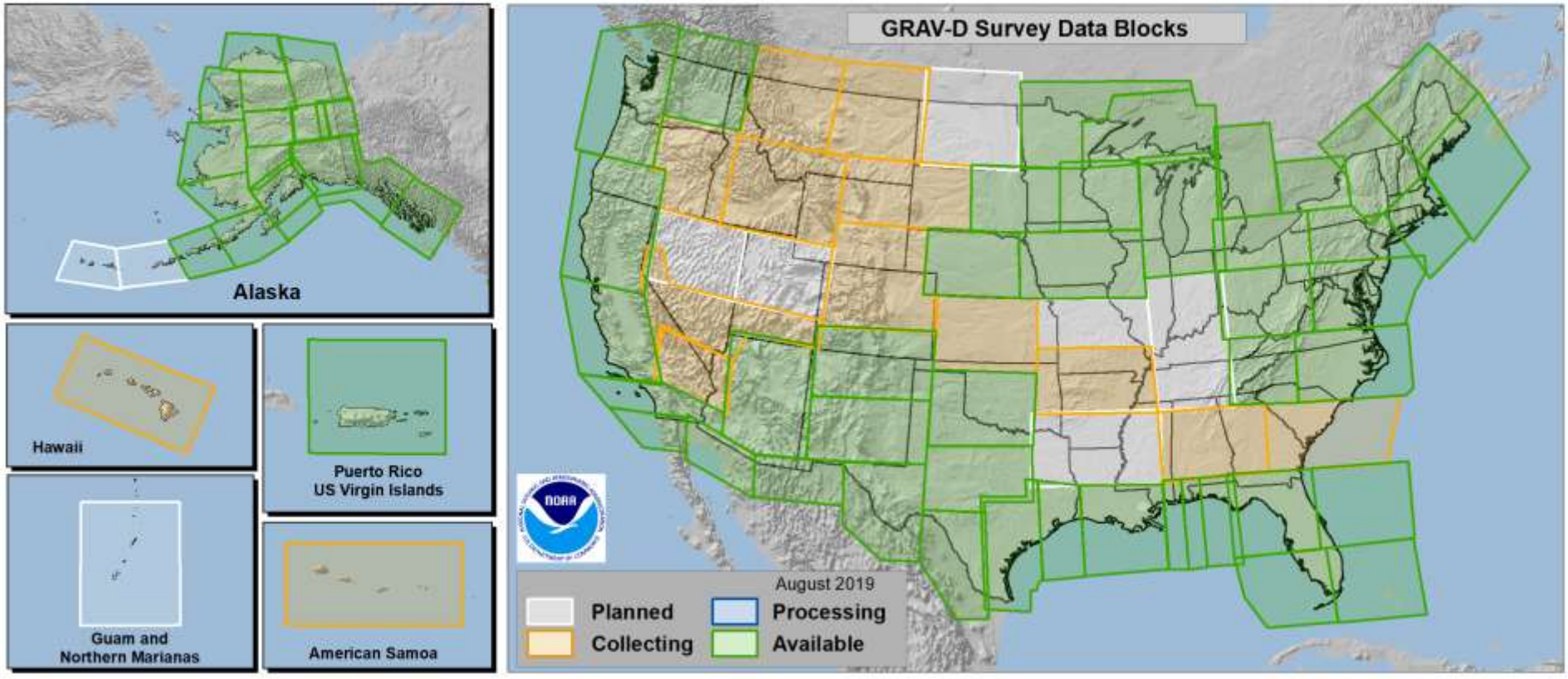


0 to 1.3 meters CONUS

Gravity for the Redefinition of the American Vertical Datum

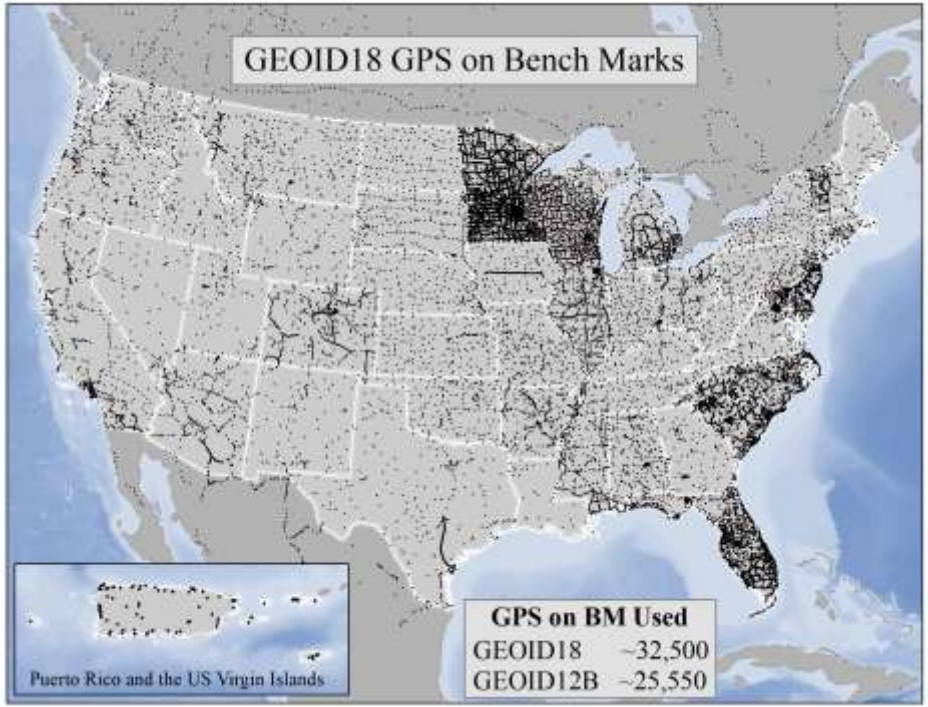
GRAV-D

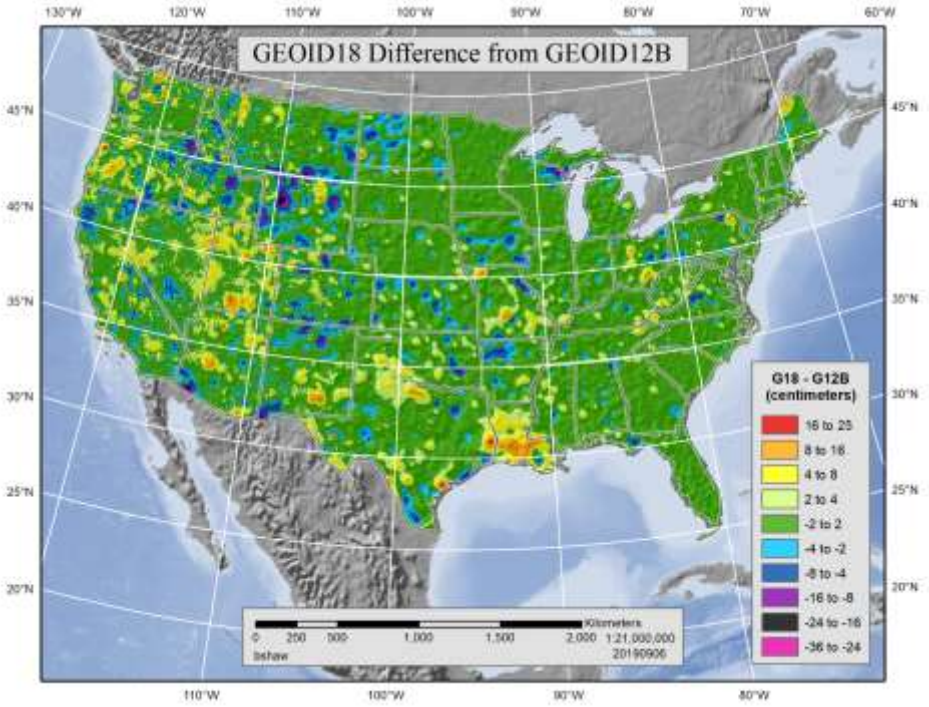
GPRA 78.5%



GEOID18

Released:
September 11, 2019

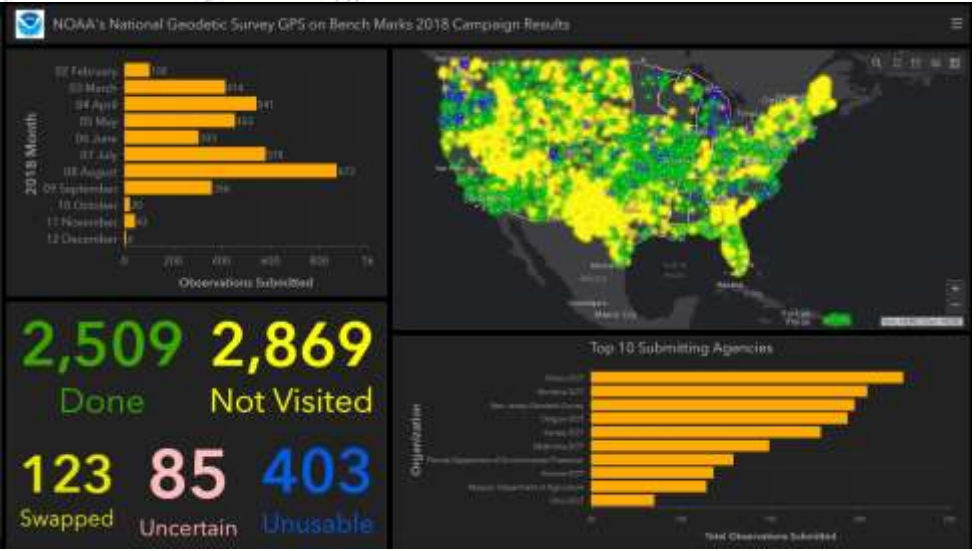




https://geodesy.noaa.gov/GEOID/GEOID18/

Prototype AGOL Dashboards

GPS on Bench Marks 2018

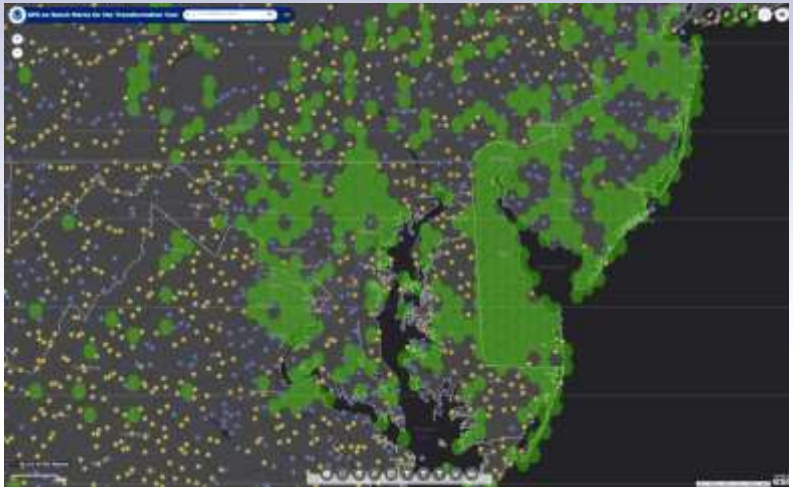


Leveling Dashboard

GPS on Bench Marks

For the Transformation Tool

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



Priority List

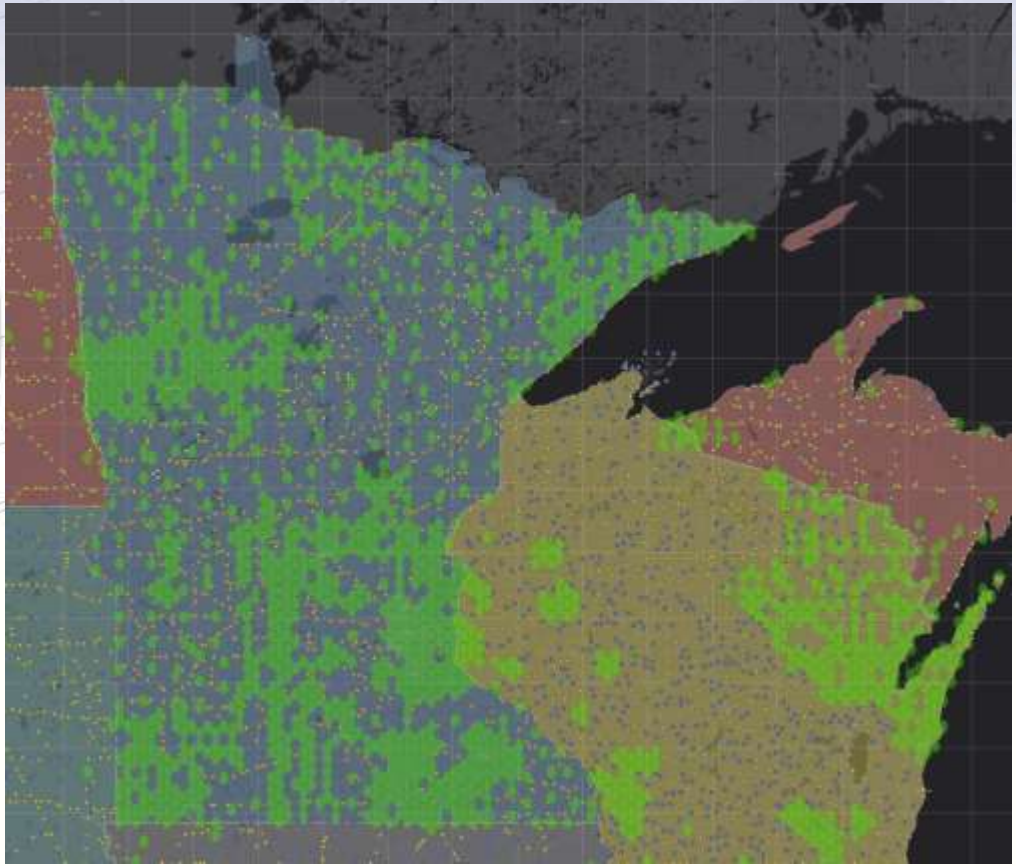
> 90,000 bench marks total

~45,000 Priority A

~70,000 at 10 km resolution

~9,000 Done

GPS on Bench Marks For the Transformation Tool



Web Map Application

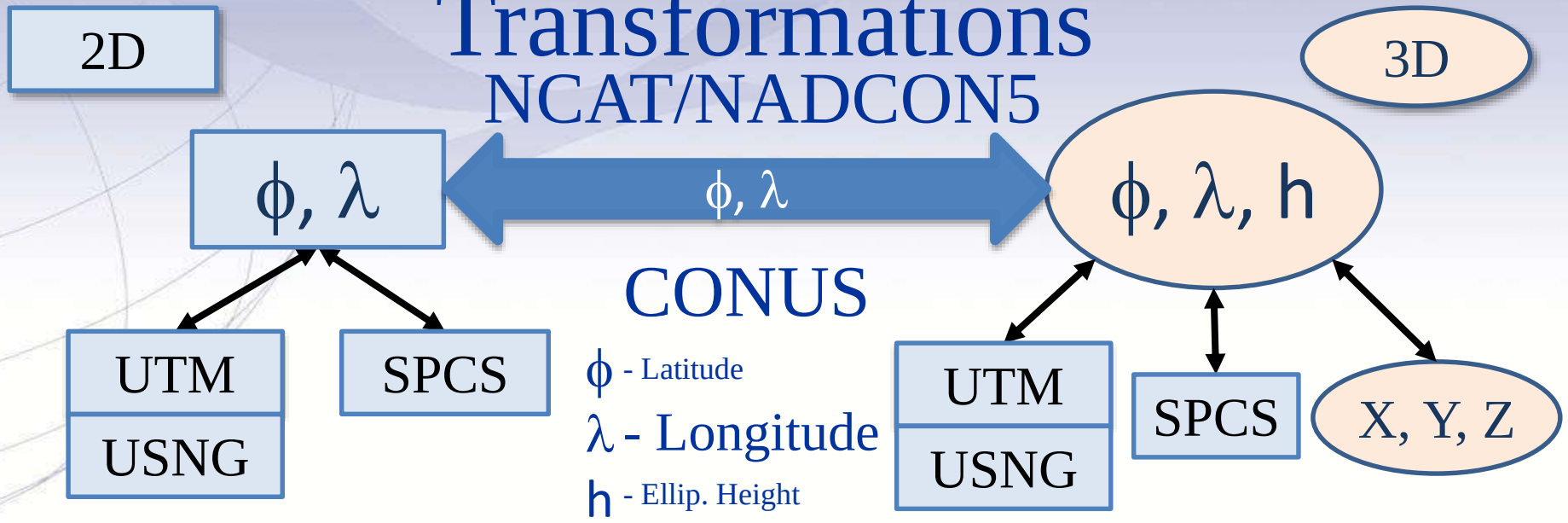
Minnesota Priority Marks

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.

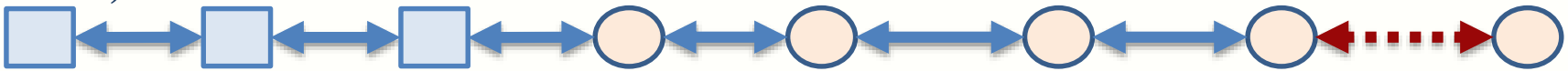
Good luck to us all! - from MN DOT

Transformations
NCAT/NADCON5

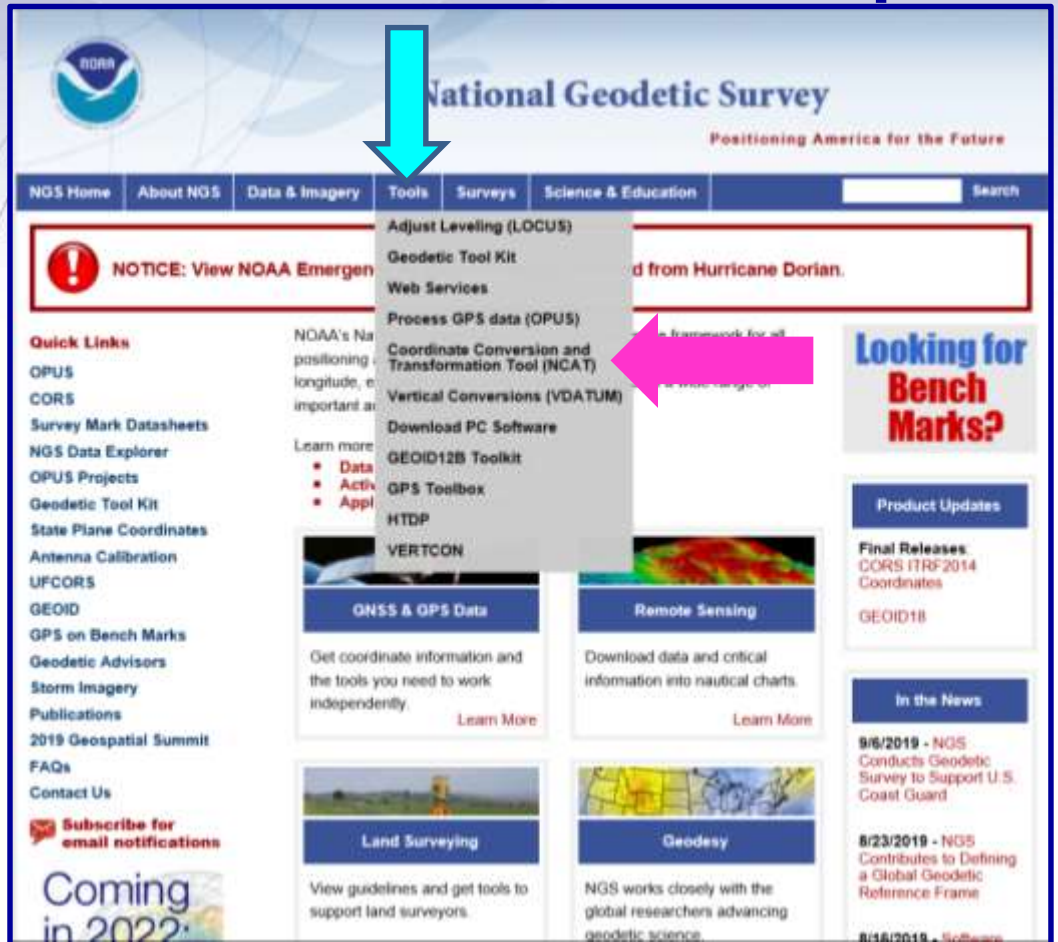


NAD 83

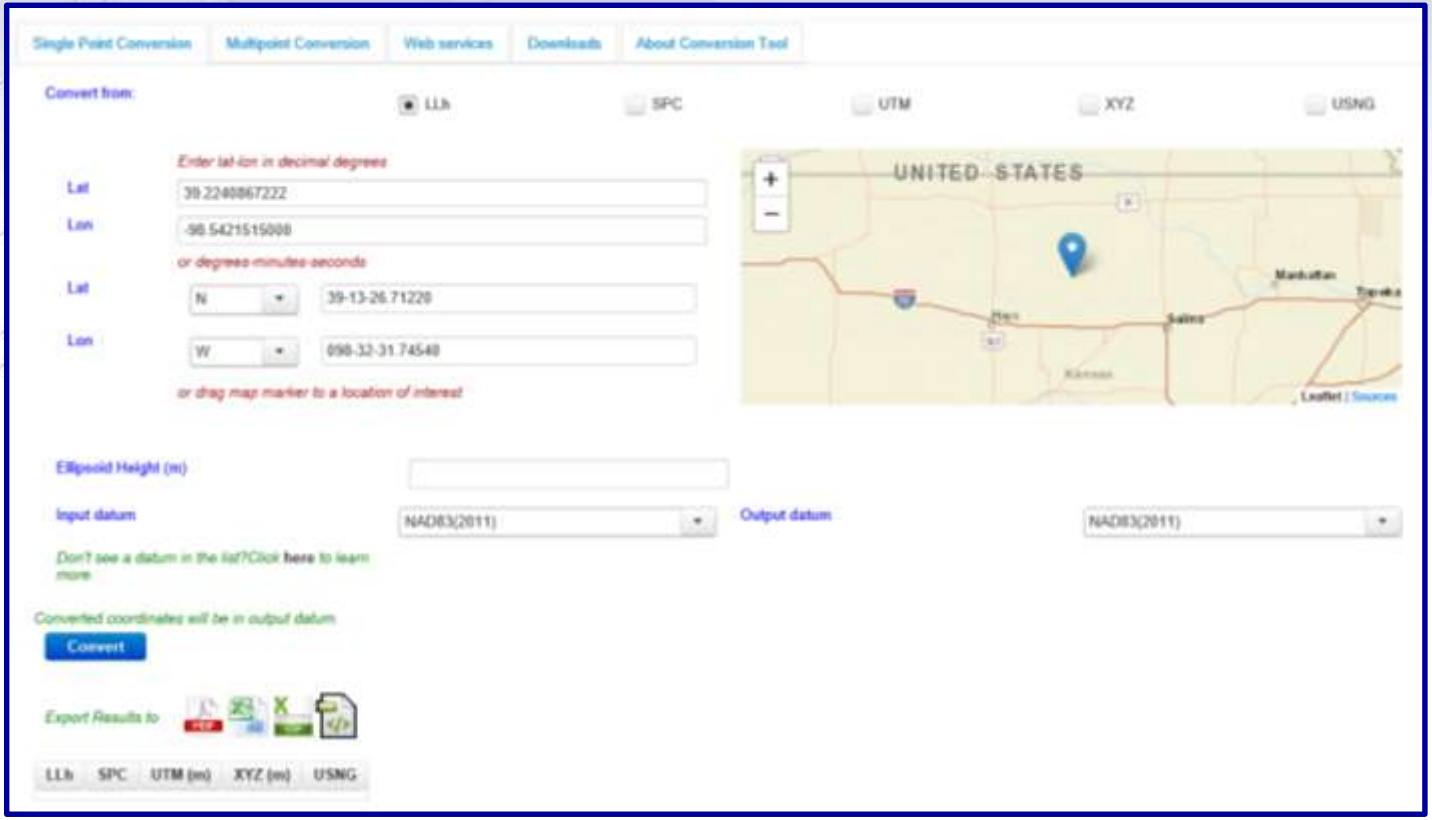
USSD (No SPCS) **NAD 27** **(1986) (HARN) (FBN) (NSRS2007) (2011)** **NATRF2022**

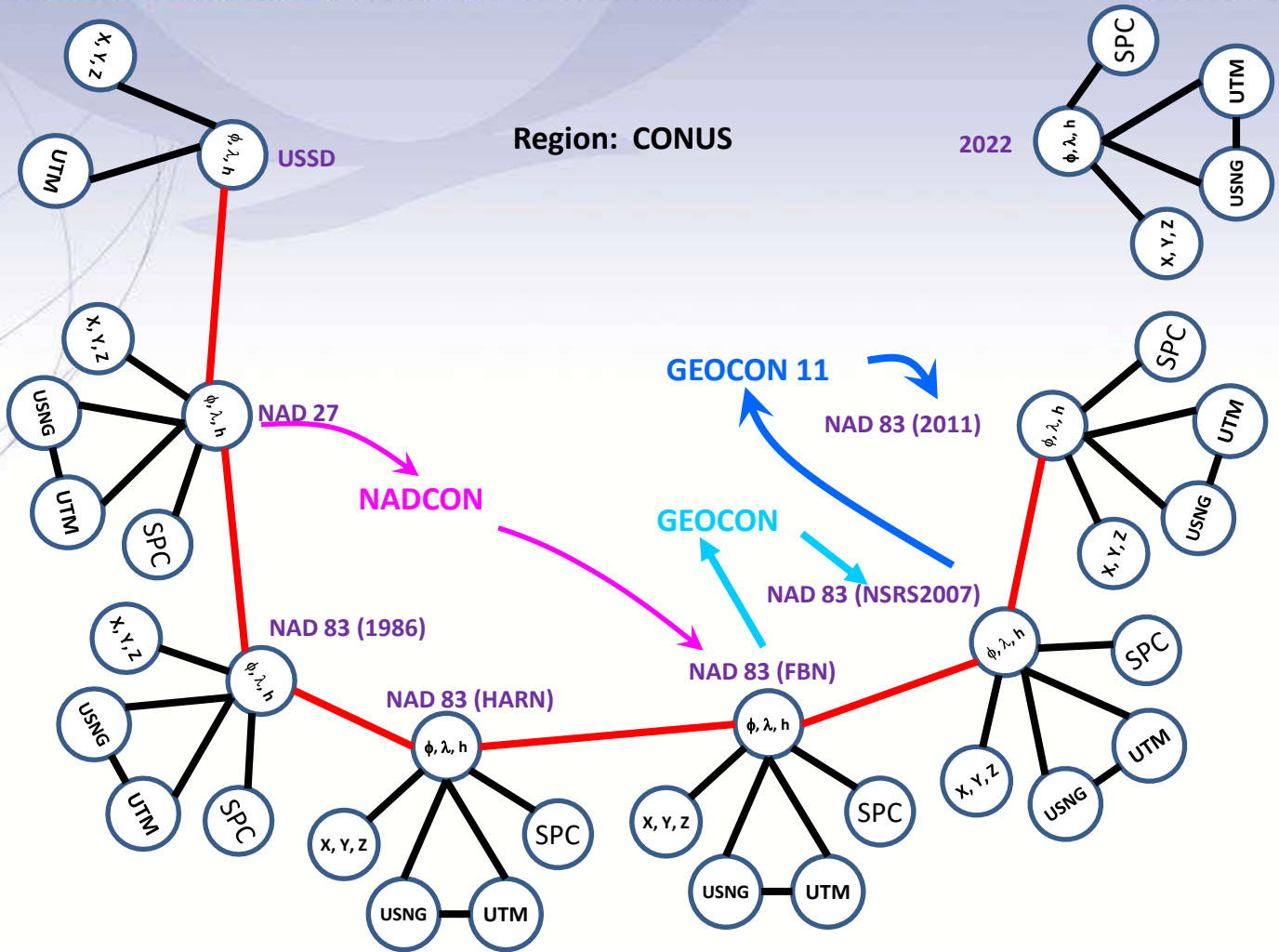


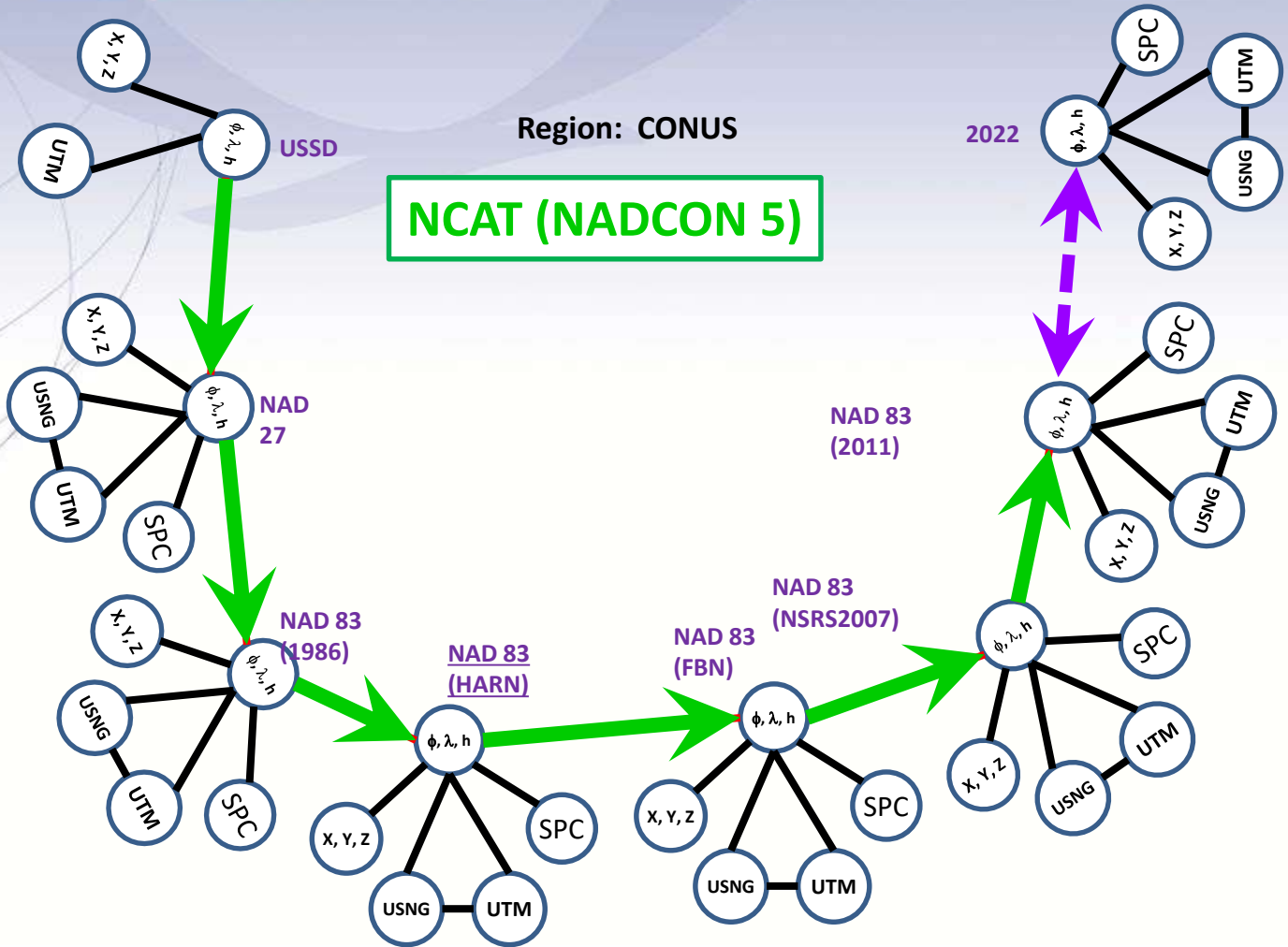
NGS Products Update - NCAT



NGS Products Update - NCAT

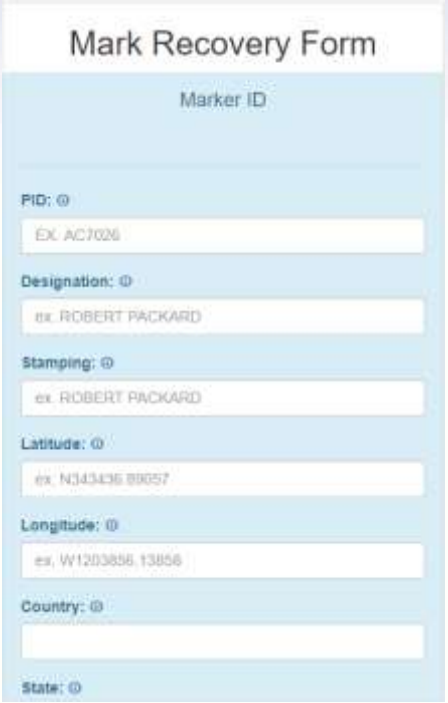



Region: CONUS
USSD
X, Y, Z
UTM
ϕ, λ, h
2022
SPC
UTM
USNG
X, Y, Z
NAD 27
NADCON
GEOCON 11
NAD 83 (2011)
GEOCON
NAD 83 (NSRS2007)
NAD 83 (1986)
NAD 83 (HARN)
NAD 83 (FBN)


Region: CONUS
NCAT (NADCON 5)
USSD
NAD 27
NAD 83 (1986)
NAD 83 (HARN)
NAD 83 (FBN)
NAD 83 (NSRS2007)
NAD 83 (2011)
2022
X, Y, Z
ϕ, λ, h
USNG
UTM
SPC

Beta Mark Recovery Form

Desktop and Mobile friendly



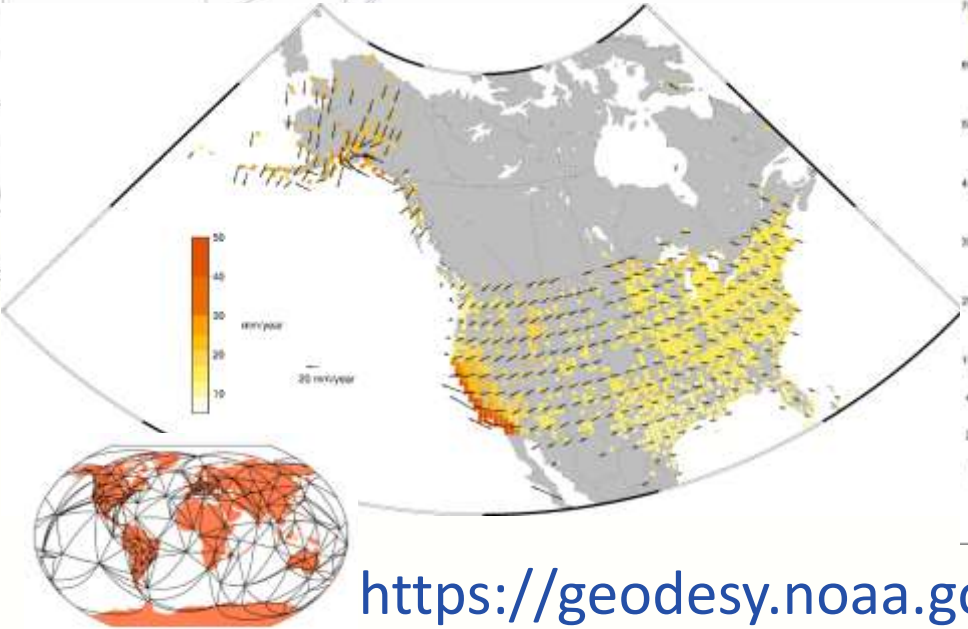
https://beta.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl

Reported Coordinates

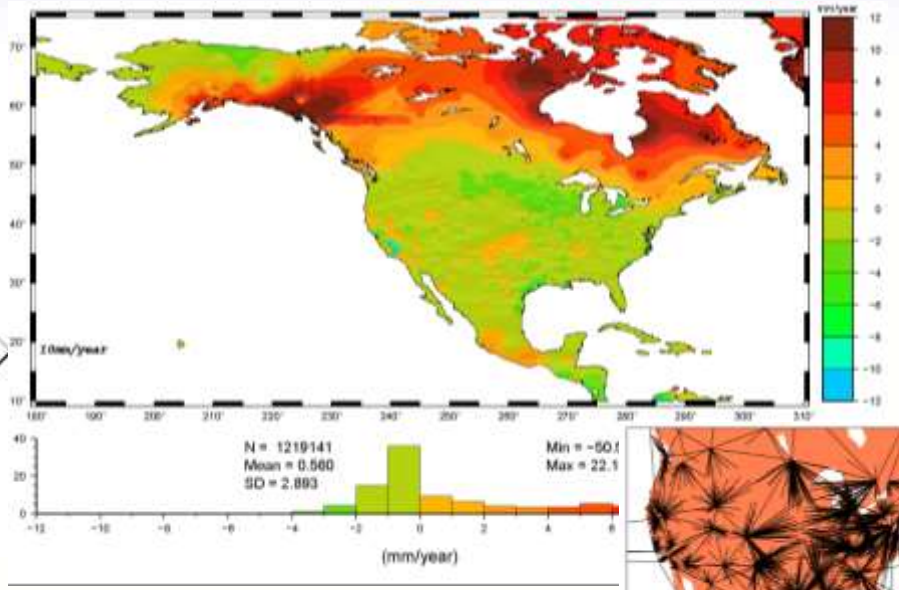
ITRF2014 and MYCS2

CORS Coordinates and Velocities Update

Horizontal Velocities



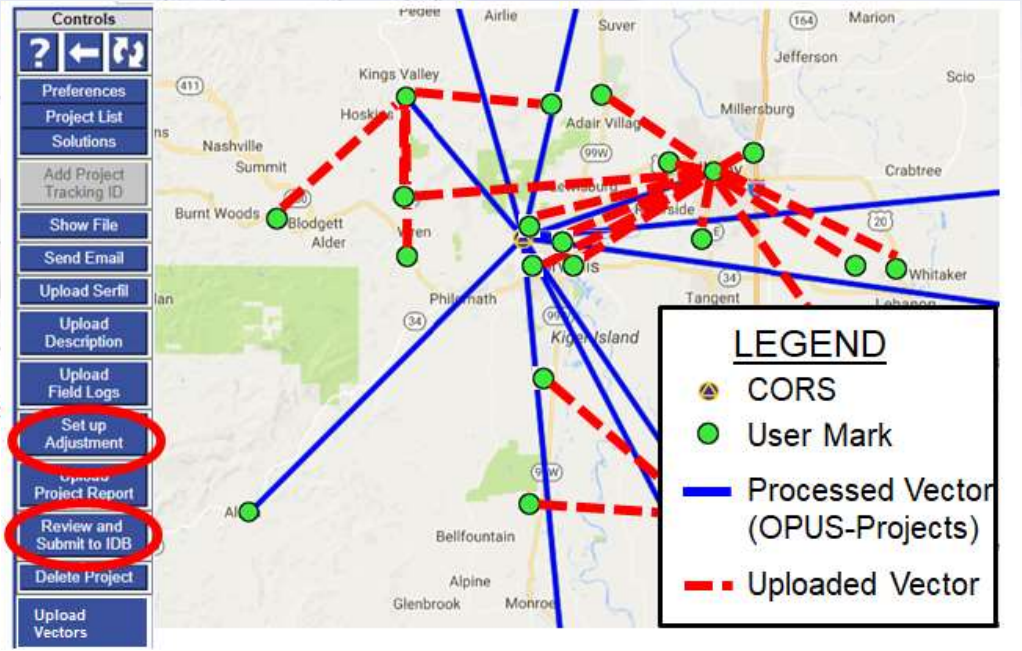
Vertical Velocities



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

RTK GVX Format

Requesting Feedback

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    <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>
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      <IP_PORT>2101</IP_PORT>
    </NETWORKRTK>
  </SURVEY_SETUP>
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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/

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?

IBGE
Instituto Brasileiro de Geografia e Estatística

UERJ
Universidade do Estado do Rio de Janeiro

SIRGAS

IAG

Instituto Panamericano de Geografía e Historia
OEA

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

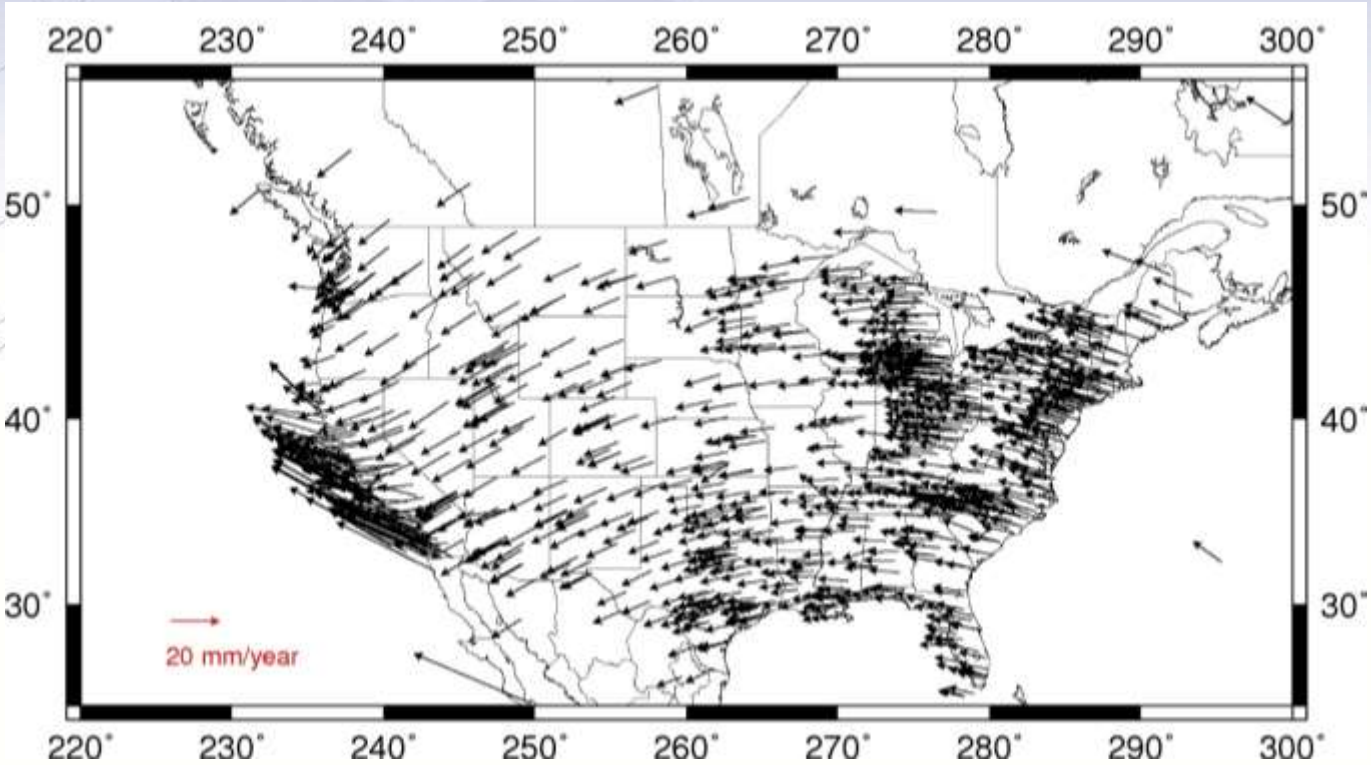
NAVD 88

- 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

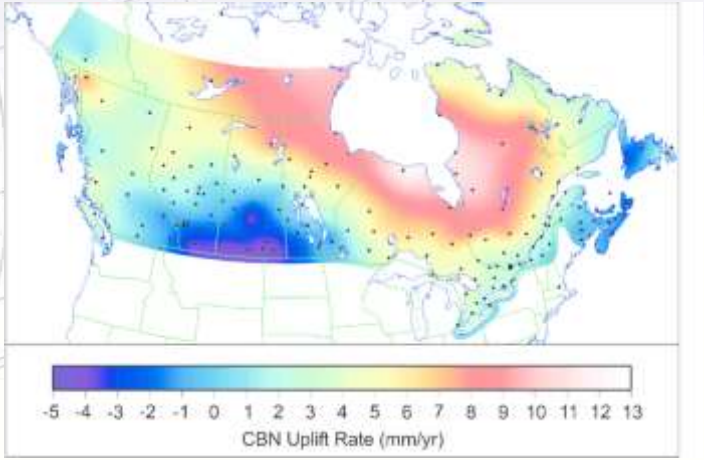
Digital Elevation Models

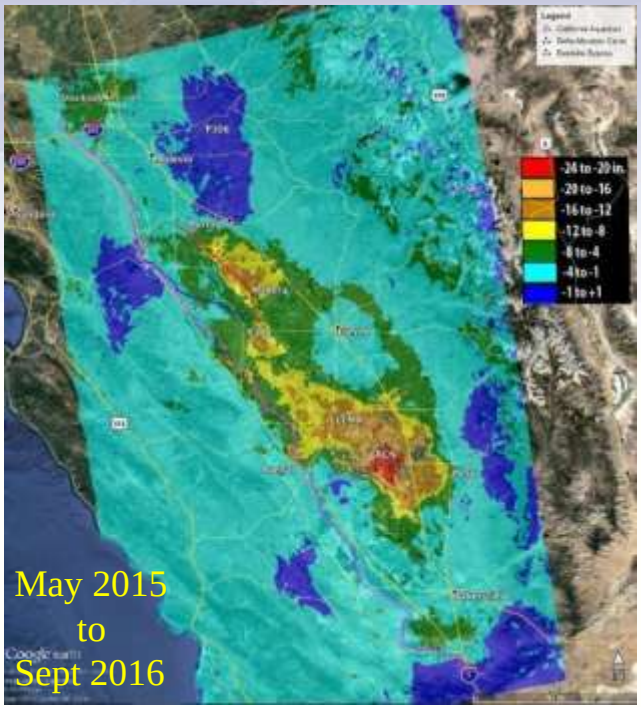
SRTM, LIDAR, IFSAR

Technology

Cloud/Servers, Satellites, Many new surveying technologies

Vertical Motion





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)