The National Spatial Reference System Modernization

May 2024 SCPLS Chapter Meeting

May 21, 2024

Brian Shaw
brian.shaw@noaa.gov

Brian Shaw
Rocky Mountain Advisor
brian.shaw@noaa.gov

NSRS Modernization Delay

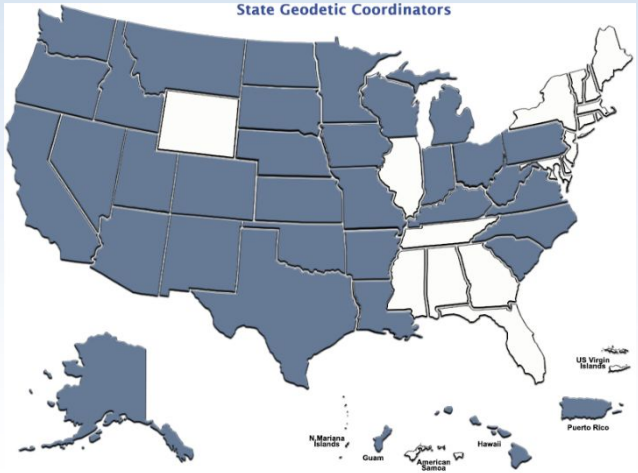
Operational, workforce retention and other issues have delayed NSRS Modernization

SPCS2022 zones will be finalized in 2024 but will not be rolled out until all of the NSRS is modernized.

Beta rollout planned for 2025, full rollout in 2026

https://geodesy.noaa.gov/datums/newdatums/delayed-release.shtml
https://geodesy.noaa.gov/datums/newdatums/FAQNewDatums.shtml

Importance of Coordination



39 Coordinators

NGS Resources

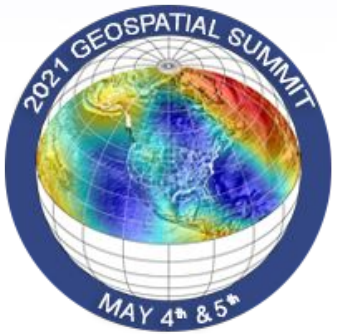
NGS Training Center
https://geodesy.noaa.gov/web/science_edu/training/

Educational Videos
https://geodesy.noaa.gov/datums/newdatums/WatchVideos.shtml

NGS Webinar Series
https://geodesy.noaa.gov/web/science_edu/webinar_series/

Geospatial Summit (2021, 2019 recorded sessions)
https://geodesy.noaa.gov/geospatial-summit/

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



NGS Resources – Educational Videos

Video Library

NGS, in partnership with **The COMET Program**, has developed short videos about topics related to geodesy and mapping. View or download our featured video or previous videos. Please visit the **COMET YouTube Channel** to view the **entire playlist**.


What are Geodetic Datums?


How Were Geodetic Datums Established?

What Is the Status of Today's Geodetic Datums?


Geospatial Infrastructure for Coastal Communities: Informing Adaptation to Sea Level Rise


Best Practices for Minimizing Errors during GNSS Data Collection


The Importance of Accurate Coastal Elevation and Shoreline Data

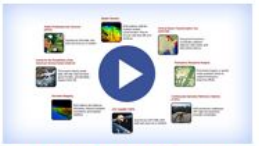

What's Next for Geodetic Datums?


Precision and Accuracy in Geodetic Surveying


Two Right Feet? U.S. Survey Feet vs. International Survey Feet


NOAA's VDatum Tool: Transforming Heights Between Vertical Datums


Geodetic Control in Land Surveying: Active vs. Passive


Location Science Improves Everyday Life

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

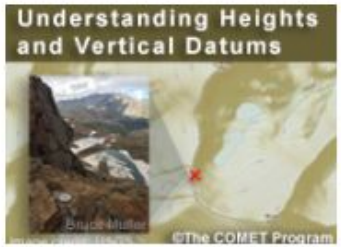
NGS Resources – Online Lessons

Online Lessons

NGS, in partnership with **The COMET Program**, has developed a series of self-paced lessons on geodetic and remote sensing topics. **Create a free user account** to gain access to the courses below and **many others that may be of interest**. You will have the option of printing out a certificate upon successful completion of the quiz at the end of each lesson.

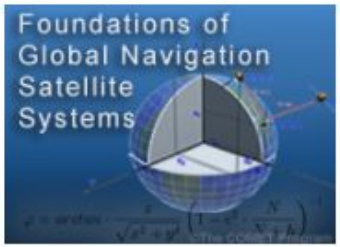
These lessons are rated by skill level:

- **0** = Suitable for non-scientists
- **1** = Requires basic scientific literacy
- **2** = Requires some prior knowledge of the topic

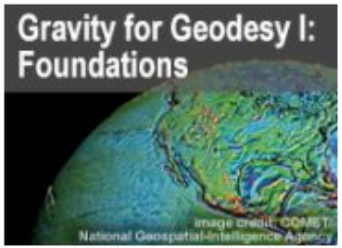


Understanding Heights and Vertical Datums
Skill Level: 0

GNSS Positioning: Survey Planning and Data Acquisition
Skill Level: 1



Foundations of Global Navigation Satellite Systems
Skill Level: 2



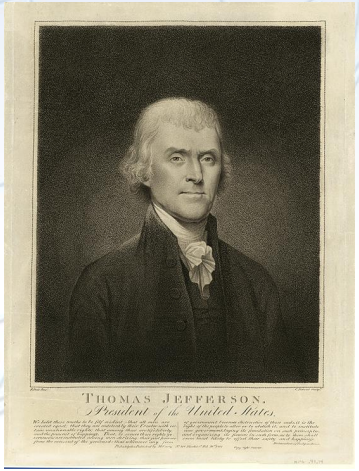
Gravity for Geodesy I: Foundations
Skill Level: 2

Gravity for Geodesy II: Applications
Skill Level: 2

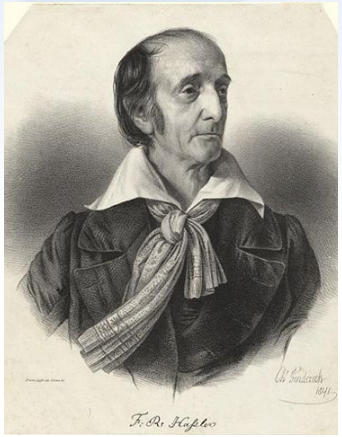
https://geodesy.noaa.gov/web/science_edu/online_lessons/index.shtml

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

NGS's Mission

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

.....

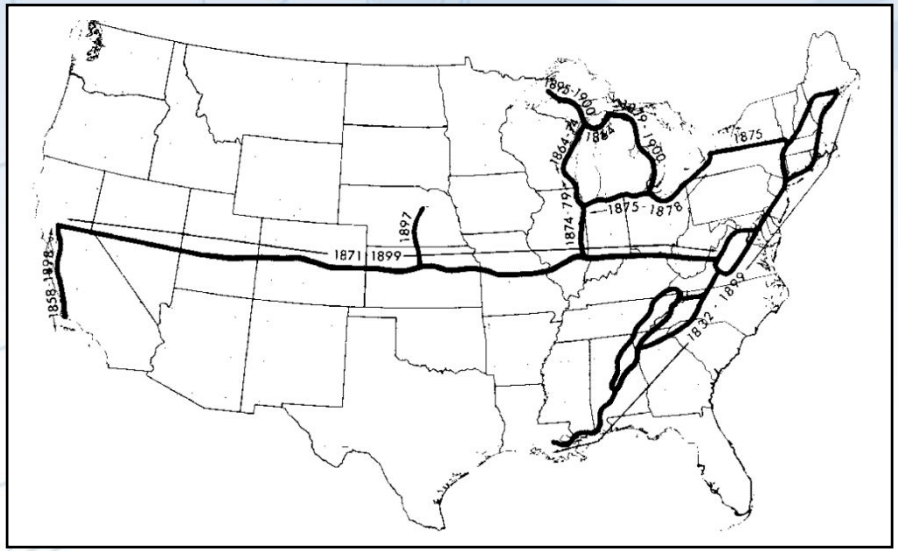
.....

The **NSRS** is a consi

that defines latitude, longitude, height, scale,

Sectors that Rely on Geodesy

NGS's Historical Horizontal Networks



US Standard Datum 1900

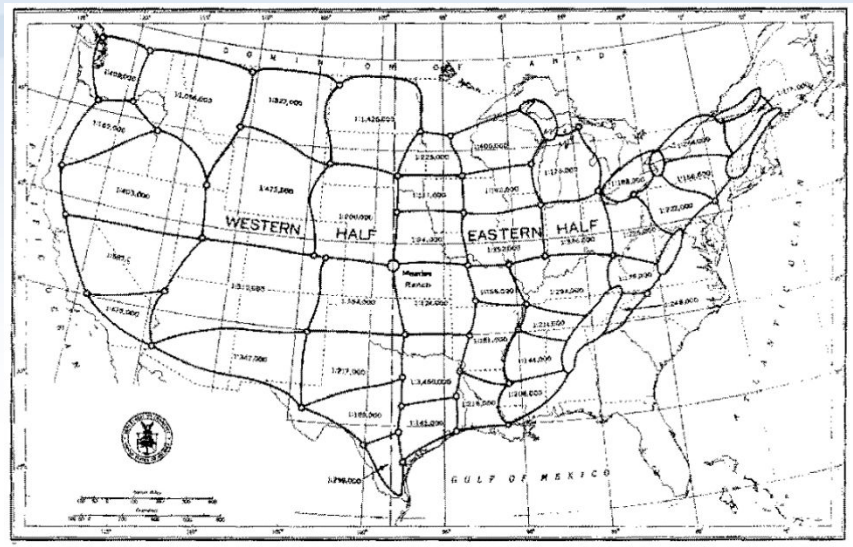
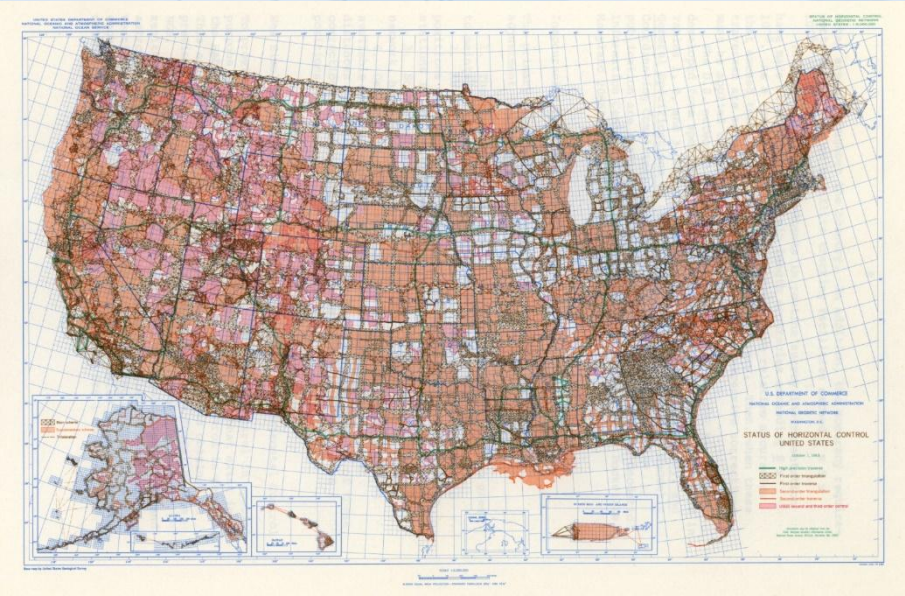


Figure 2.1. Adjustment closures for the North American Datum of 1927.

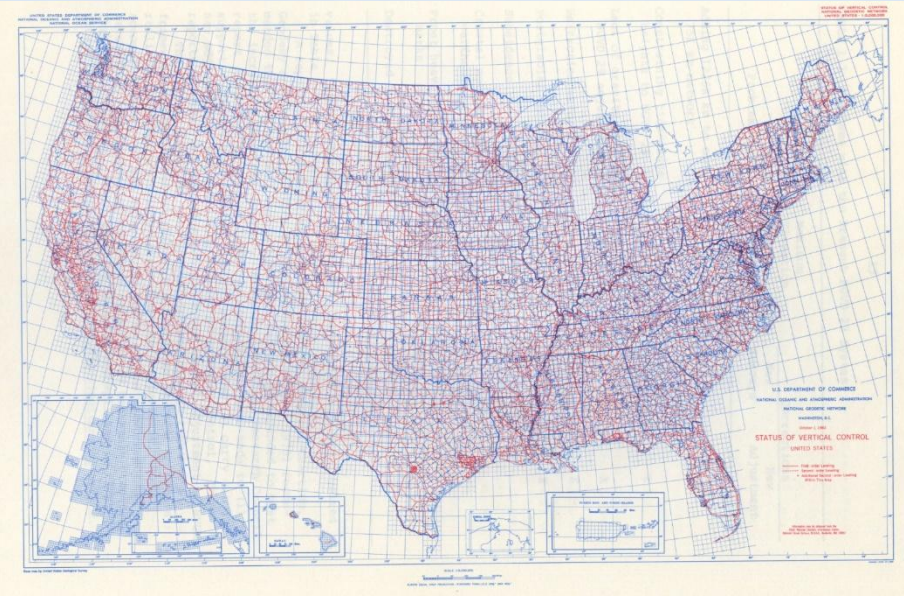
North American Datum of 1927 (NAD 27)

http://www.geodesy.noaa.gov/PUBS_LIB/NADof1983.pdf

1983 Control Networks



Status of Horizontal Control 1983



Status of Vertical Control 1983

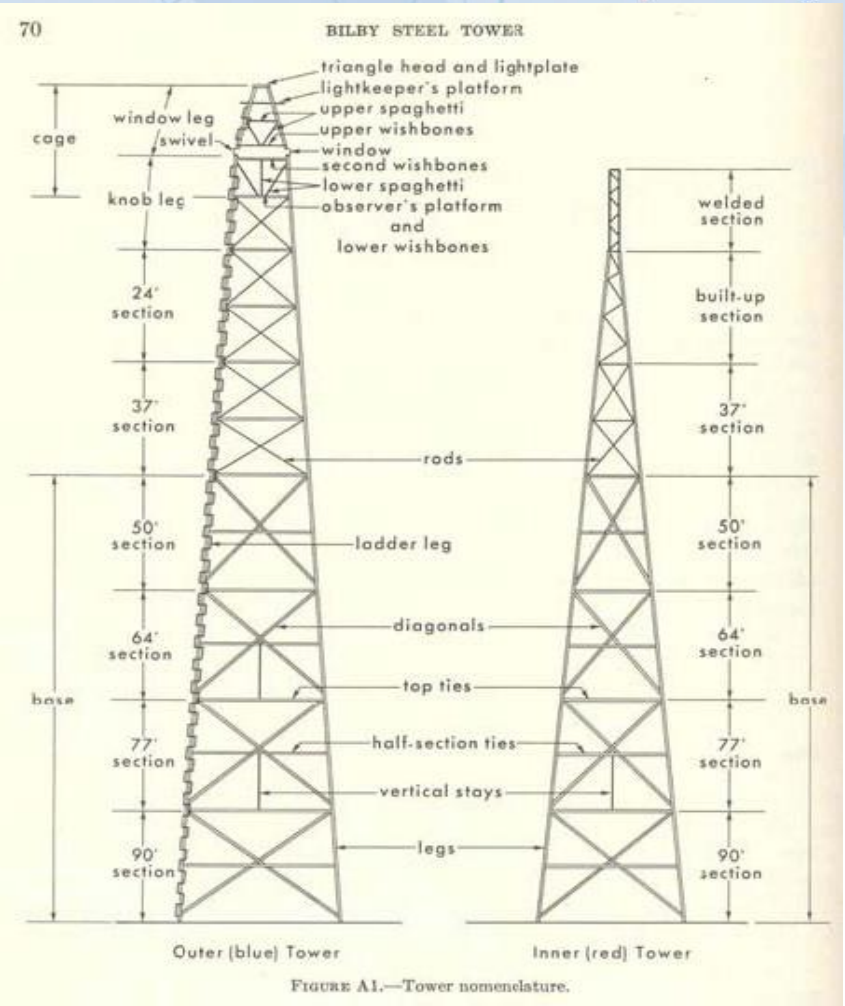
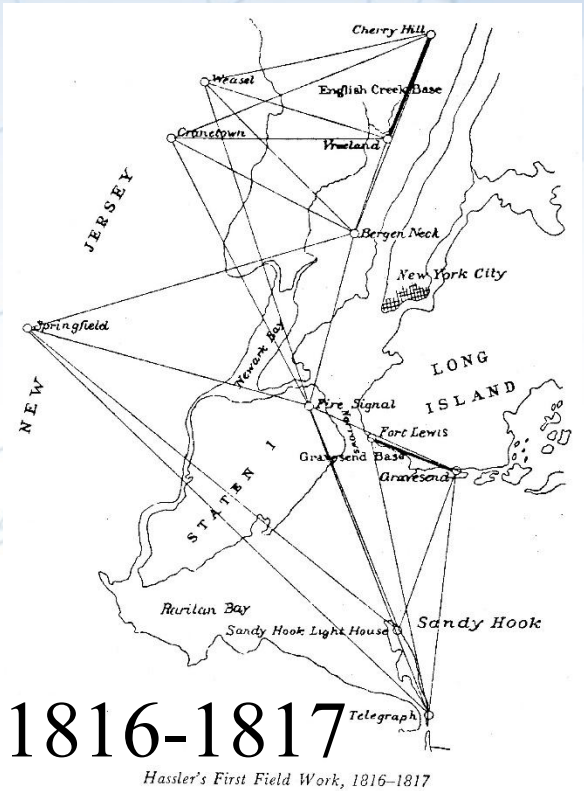


FIGURE A1.—Tower nomenclature.

The Bilby Tower

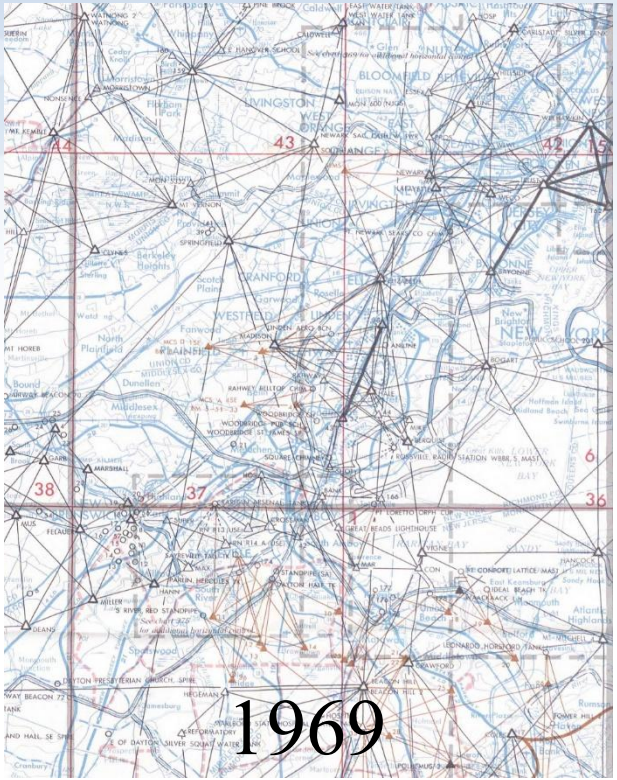
Horizontal Network

The Importance of Geodesy

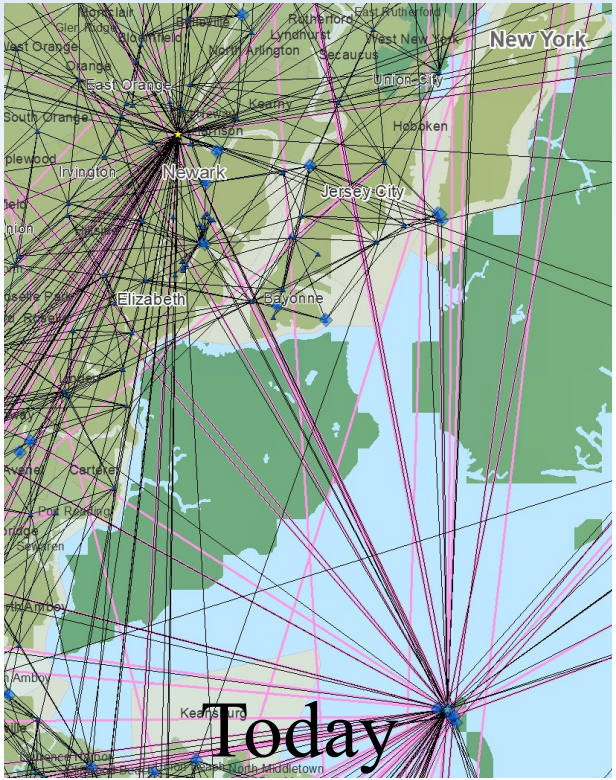


1816-1817

Hassler's First Field Work, 1816–1817

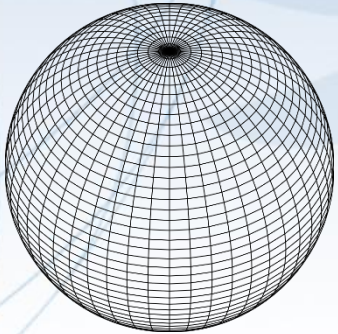


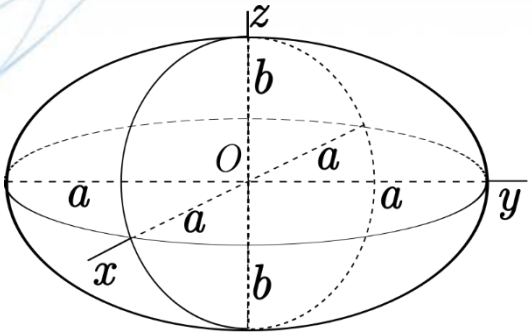
1969

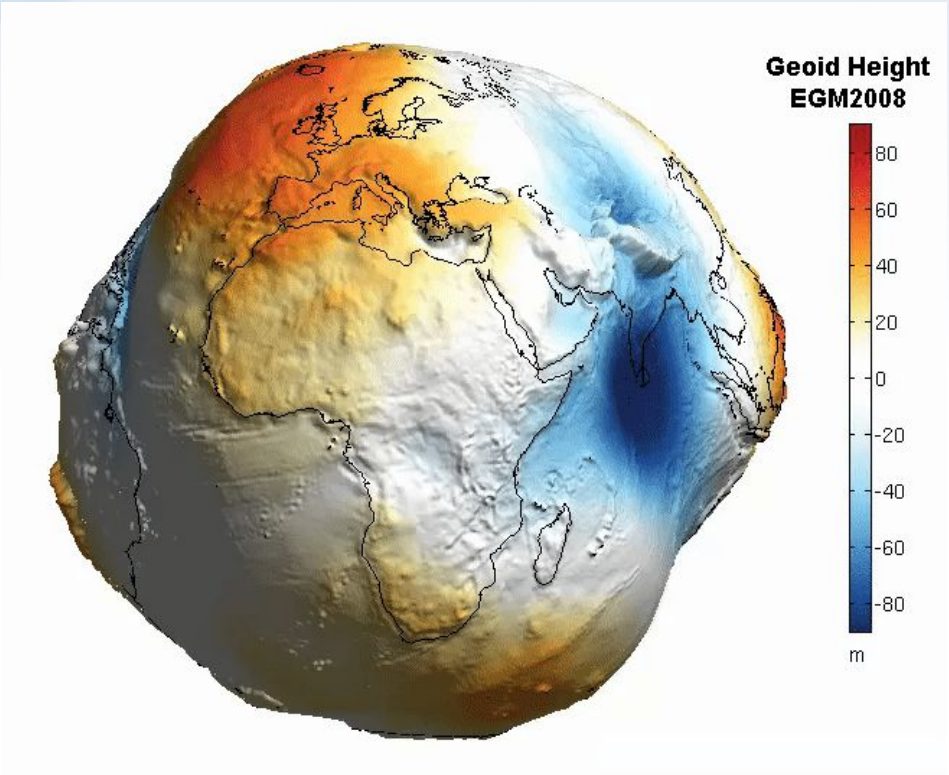


Today

The Earth is Infinitely Complex

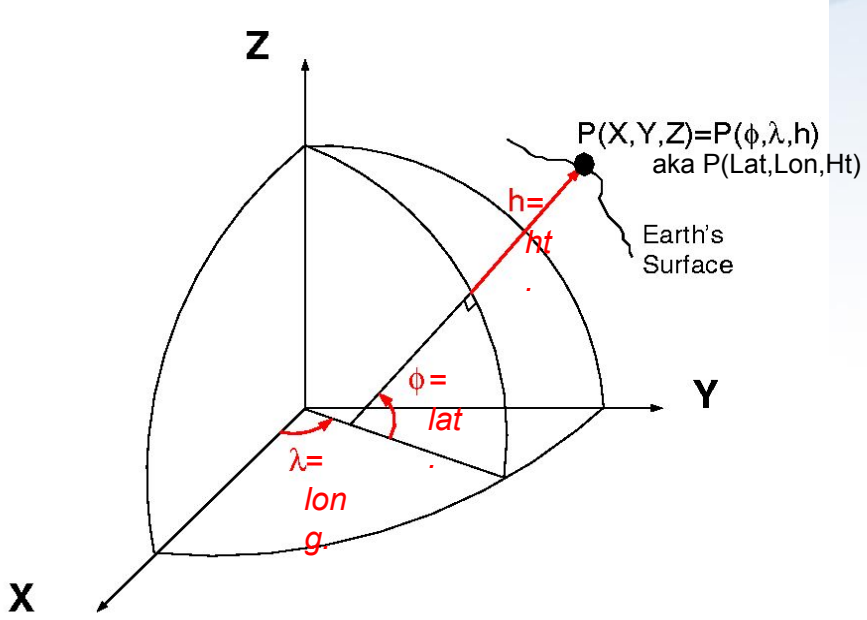




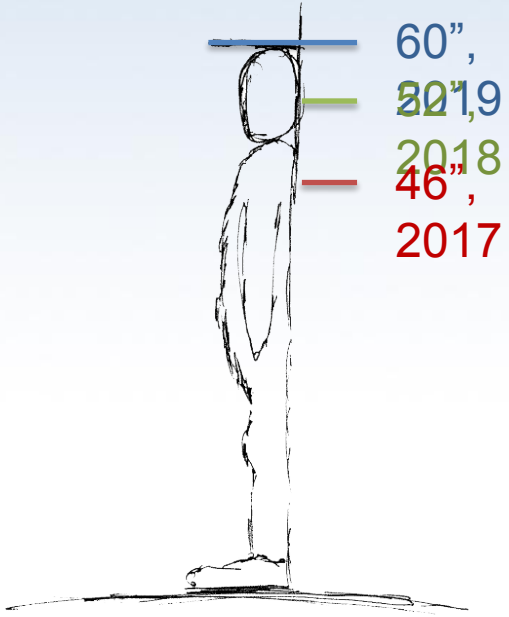


Build Models to Simplify

Datums and Reference Frames



X,Y,Z vs Lat, Lon, Ht



A reference surface or framework to reference your data to for consistency

Gravity is Fundamental

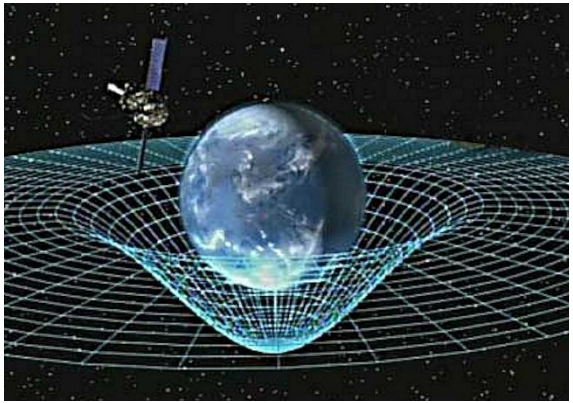
Aristotle (350BC)
- Objects fall proportional to mass

Al-Khazini (1121)
- Gravitational potential energy

Galileo (1590)
- Terminal velocity

Newton (1687)
- Gravity inverse-square law

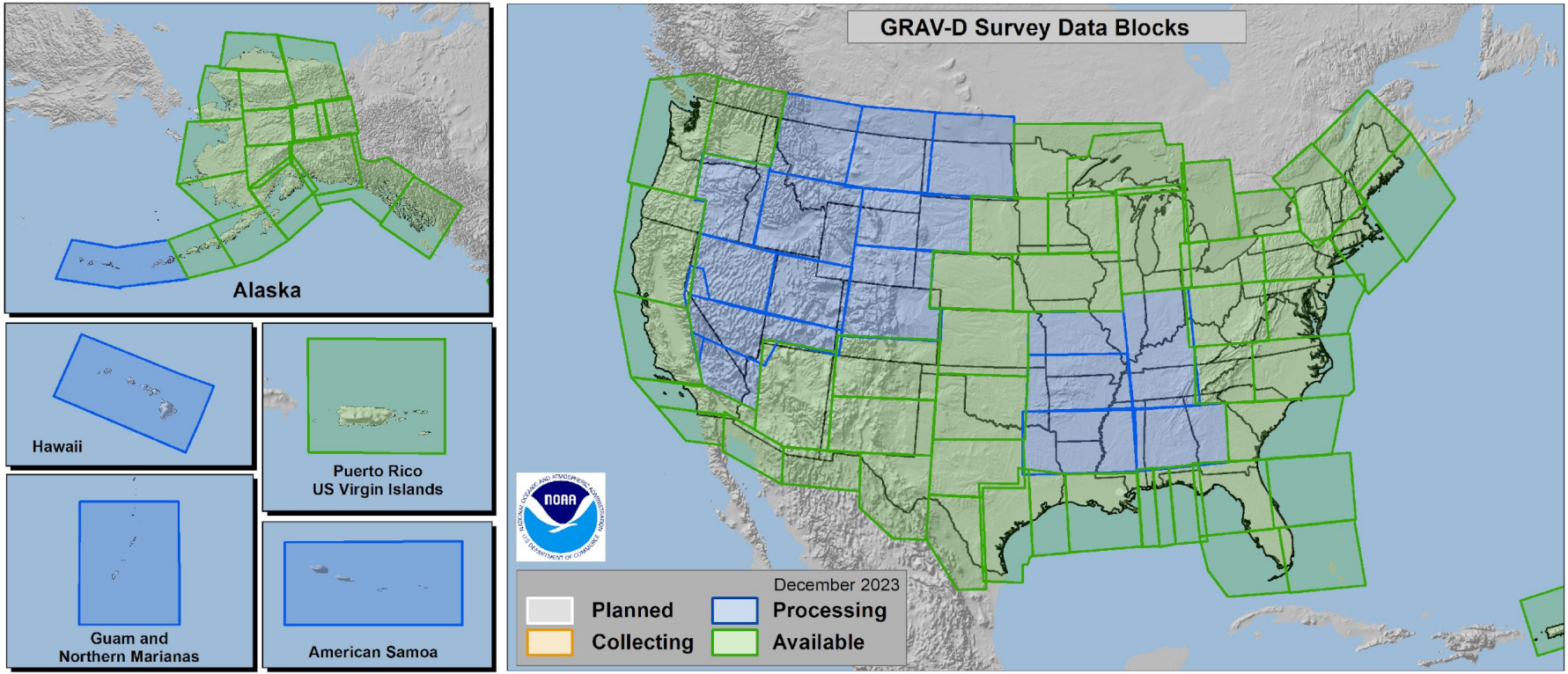
Einstein (1913)
- Theory of general relativity



Gravity of the Redefinition of the American Vertical Datum

GRAV-D

100% Complete (12/2023)



Why Modernize the NSRS

Current models built on old technology

- 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

Main Benefits of Modernized NSRS

Fast, Accurate, Consistent Elevations Everywhere

Improved Public Safety

- Flood Plain Maps
- Emergency Route Planning

Accurate Positioning

- Autonomous vehicles, BIMs, Smart Cities

Best ways to determine coordinates in Modernized NSRS

1. **Resurvey**: Return to the field and collect new observations, relying upon geodetic control that has coordinates in the new datum

2. **Readjust**: Using existing observations, re-compute new coordinates based upon geodetic control (CORS) that has been defined in the new datum

3. **Transform**: Take finished products which have coordinates in the old datum and use transformation software to estimate coordinates in the new datum

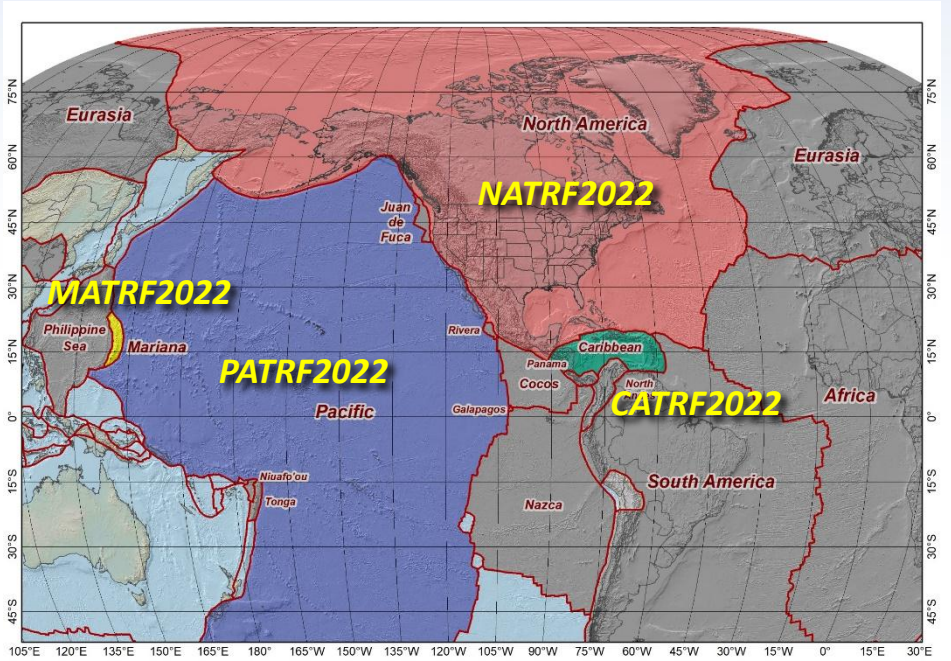
The Future Reference Frames

Tectonic Plate based

Each Plate is based on the same densified ITRF model

North America	NATRF
Caribbean	CATRF
Pacific	PATRF
Mariana	MATRF

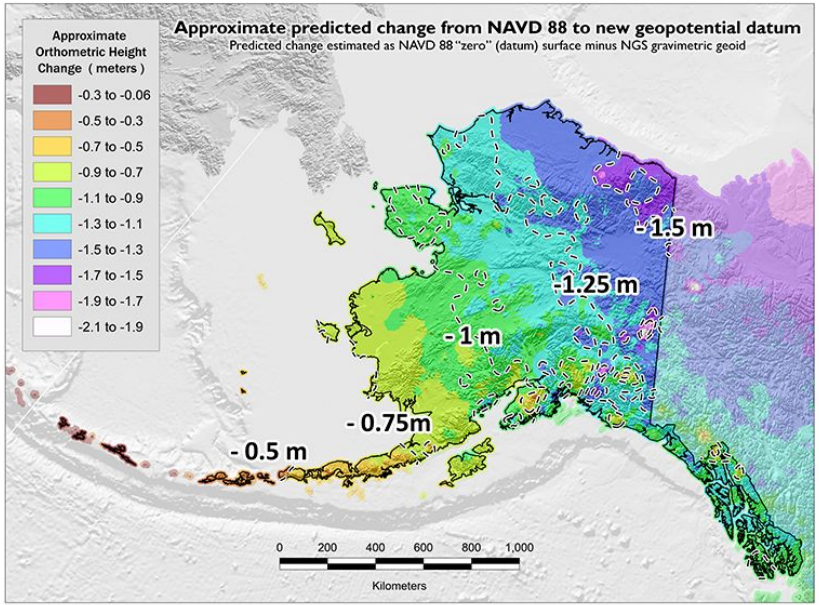
The tectonic plates "fixed" for the 2022 Terrestrial Reference Frames

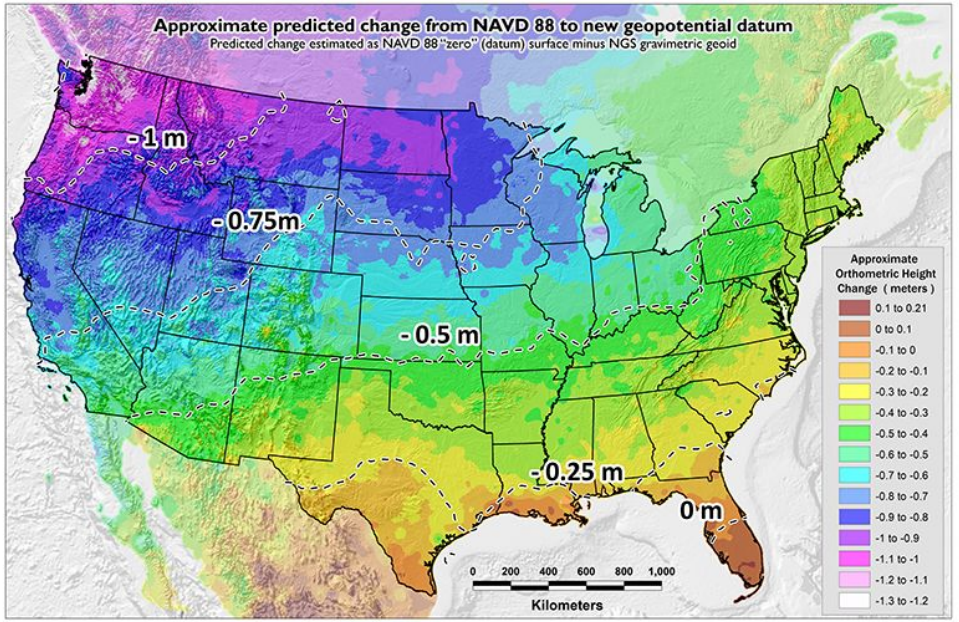


NAVD 88 Issues

NAVD 88 suffers from *a known bias* and *tilt*

(about 1 meter across CONUS) relative to the gravimetric geoid

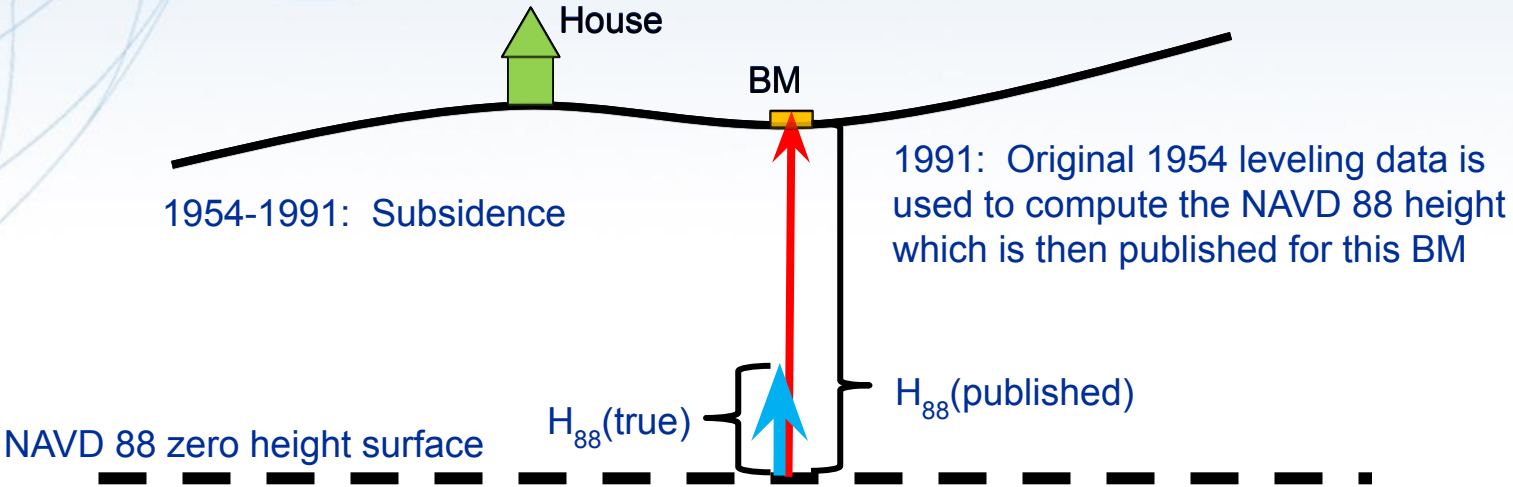




NAVD 88 Issues

NAVD 88 suffers from ***unknown movements*** before, during and after its original adjustment

A hypothetical example…
1954: Leveling Performed to bench mark



The true height relative to the NAVD 88 zero surface is not the published NAVD 88 height

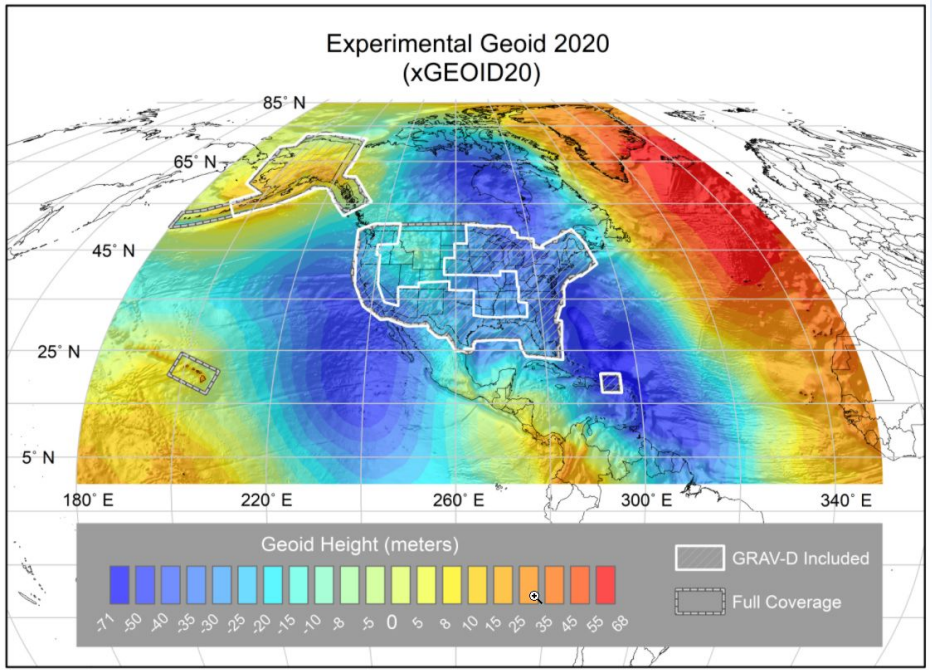
NAPGD2022 Geopotential Datum

North American-Pacific Geopotential Datum of 2022

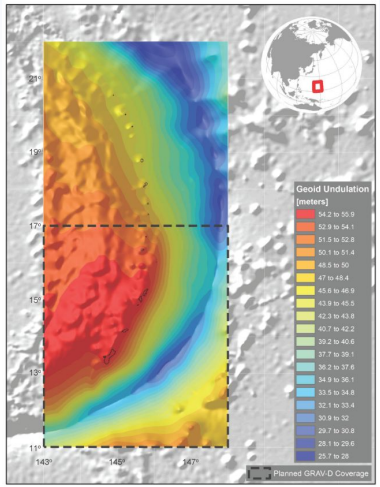
Not a vertical datum, it is more than just heights.

Models included:

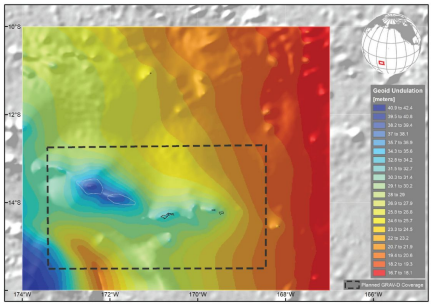
- Geopotential
- Deflection
- Gravity
- Geoid



¼ Earth's Surface



Guam/CNMI



American Samoa

NSRS Modernization Catch Phrase

Shift and Drift

Not the Fast and Furious

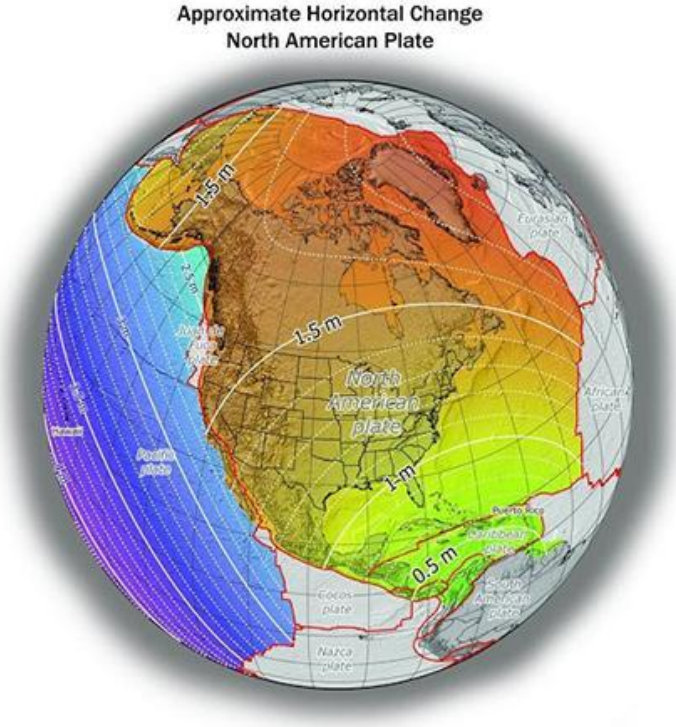
Shift and Drift

- A sudden ***shift***
  - Horizontal change: **0.5 to 4 m (1.5 to 13 ft)**
  - Ellipsoid height change: **±2 m (±6 ft)**
  - Elevation change: **-0.5 to +2 m (-1.5 to +6 ft)**

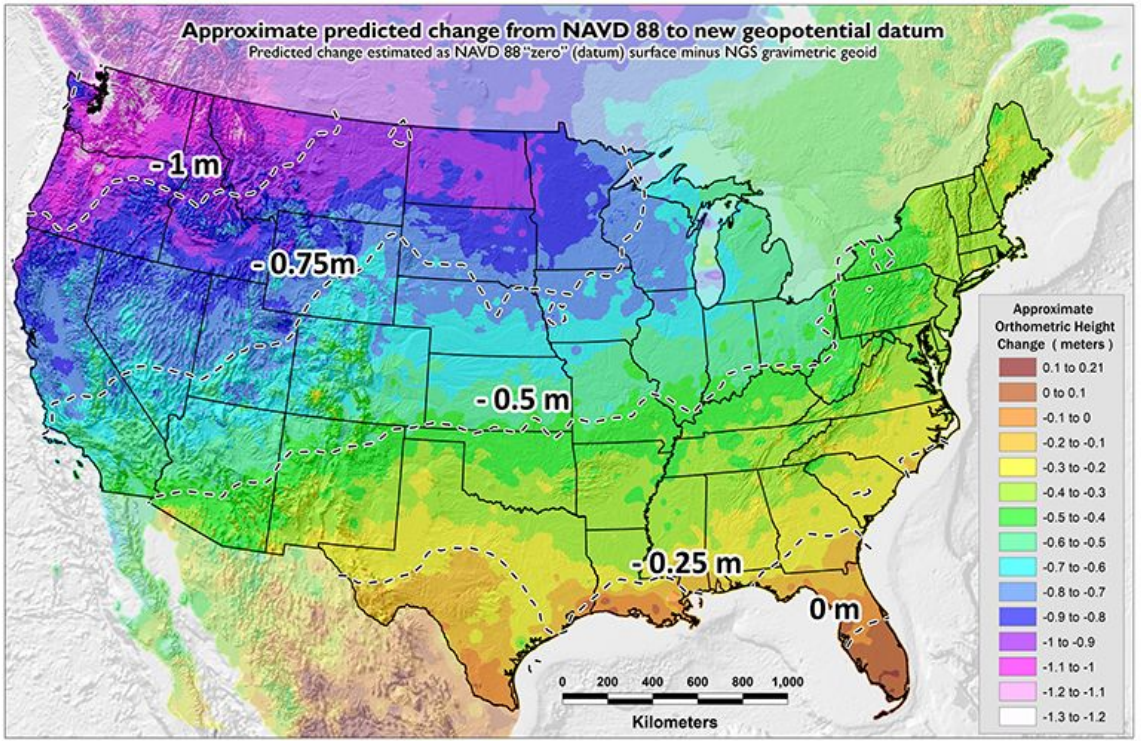
- A continuous ***drift***
  - Coordinates associated with specific dates

- Two components of drift:
  - Tectonic plate rotation (easy to model, 2D only)
  - All other residual motion (hard to model, 3D)

Shift: datum changes

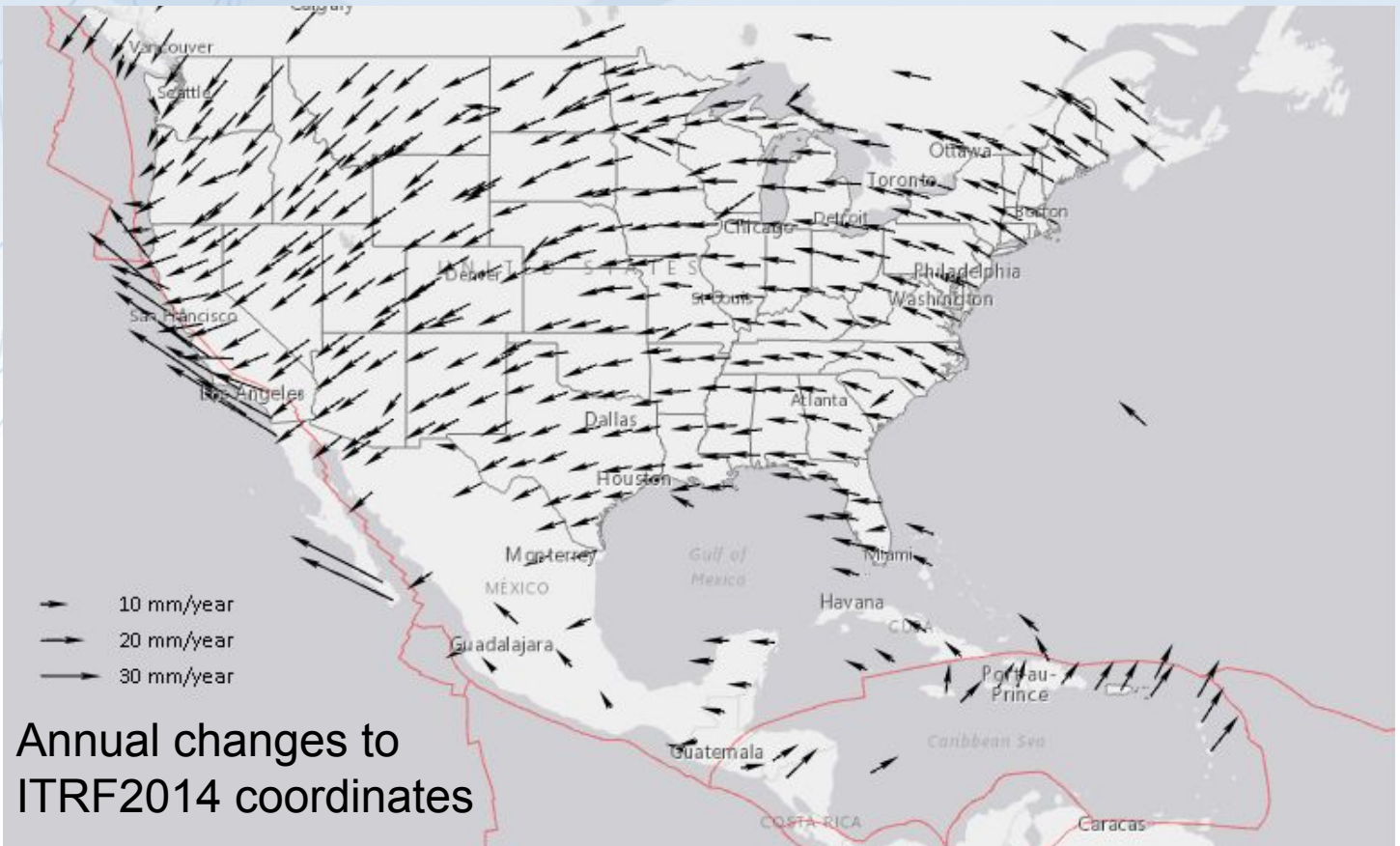


~1 to 1.5 meters North America
~2.5 to 4 meters in Pacific



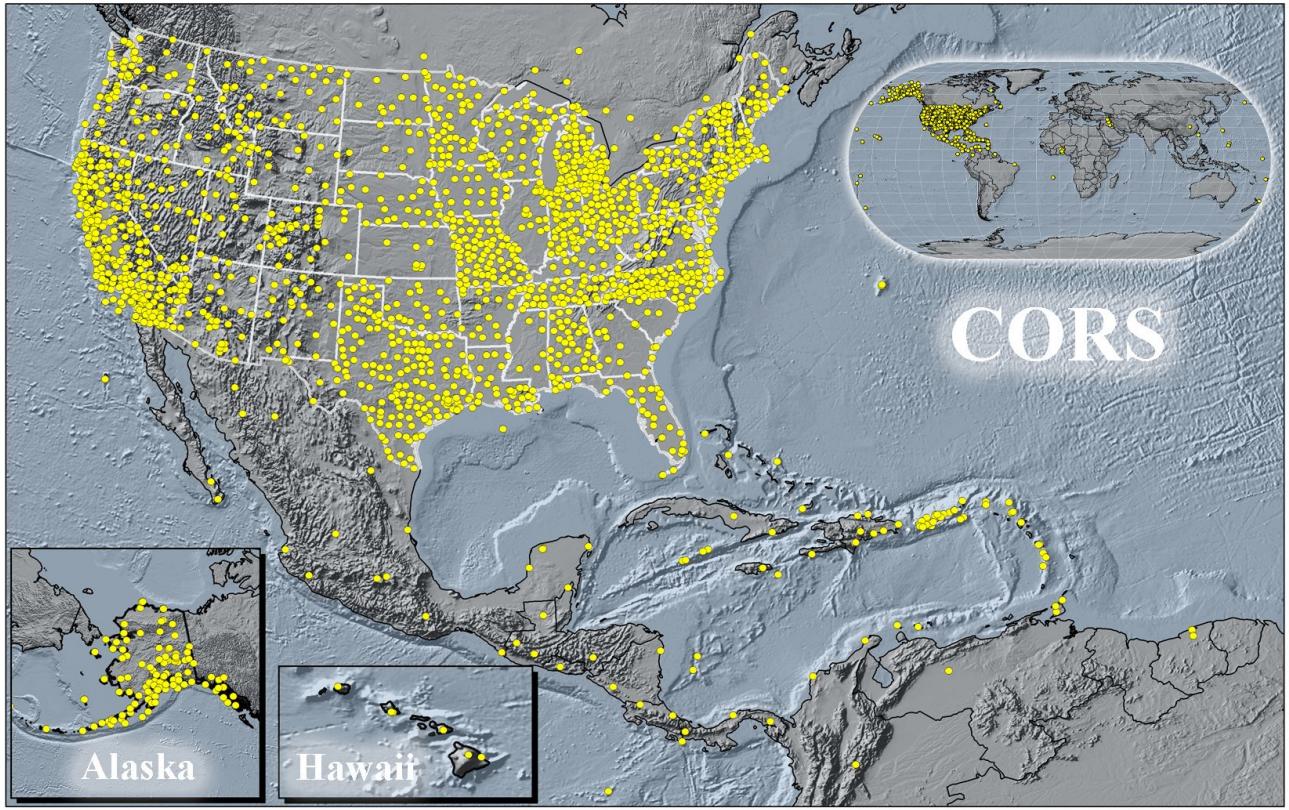
0 to 1.3 meters CONUS

Drift: Plate Tectonics and Velocities



Annual changes to ITRF2014 coordinates

Continuously Operating Reference Stations



P037
Canyon City
Colorado

CTMC
Golden
Colorado

Vertical Motion

Subsidence

Ground fluid withdrawal, sedimentation

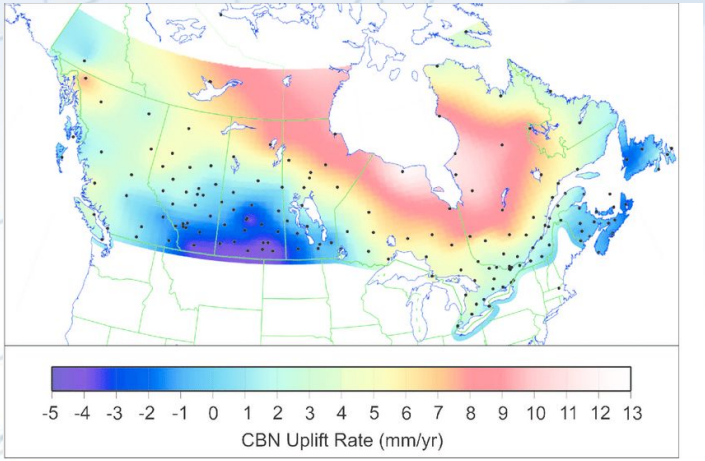
Glacial Isostatic Adjustment (GIA)

Crustal rebound from glaciers (uplift)

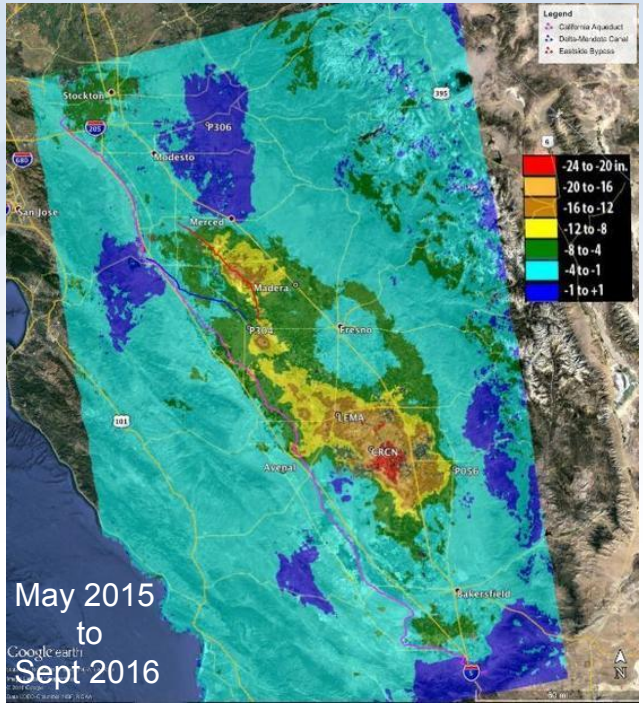
Geophysical Phenomena

Earthquakes, calderas, Earth tides

Vertical Motion

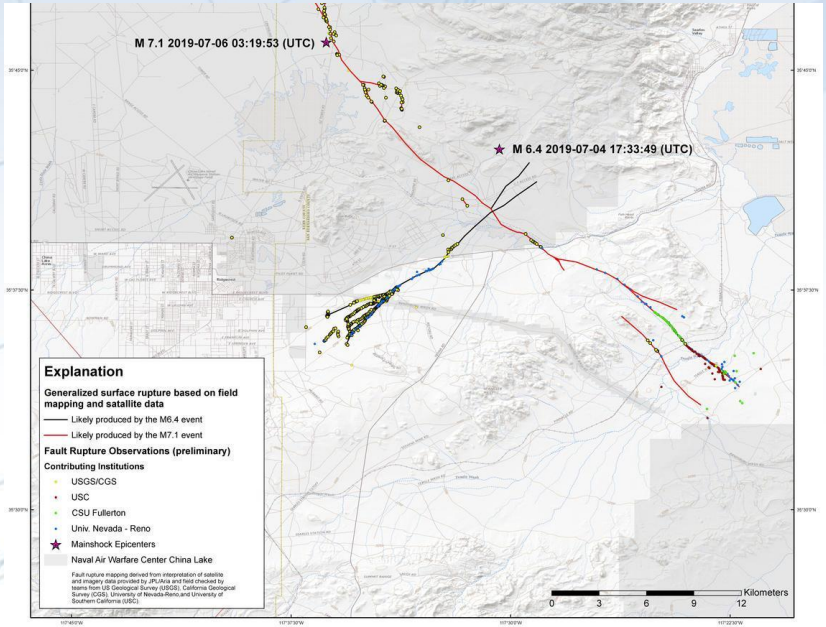


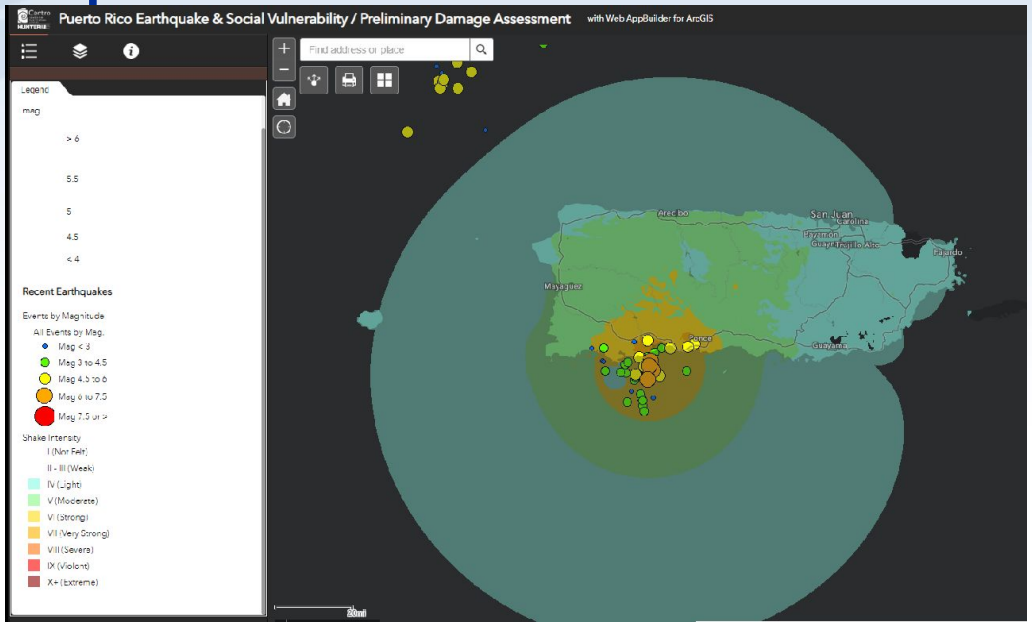
Hudson Bay Uplifting
8 -13 mm/year



San Joaquin Subsiding
20-24" in 16 months

Horizontal and Vertical Motion - Earthquakes

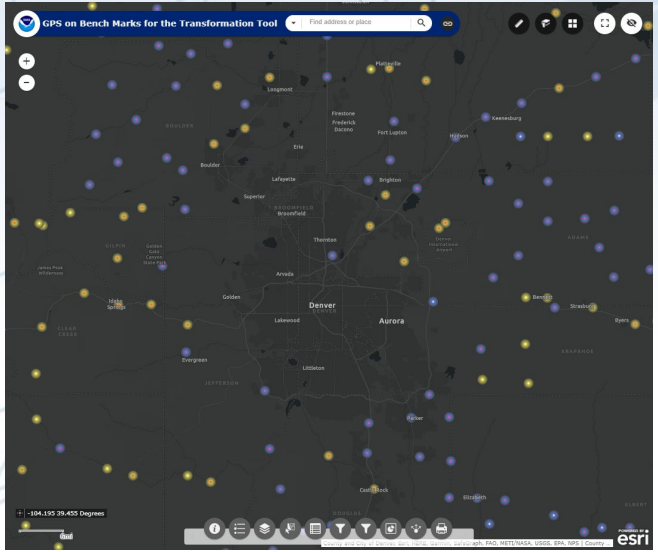


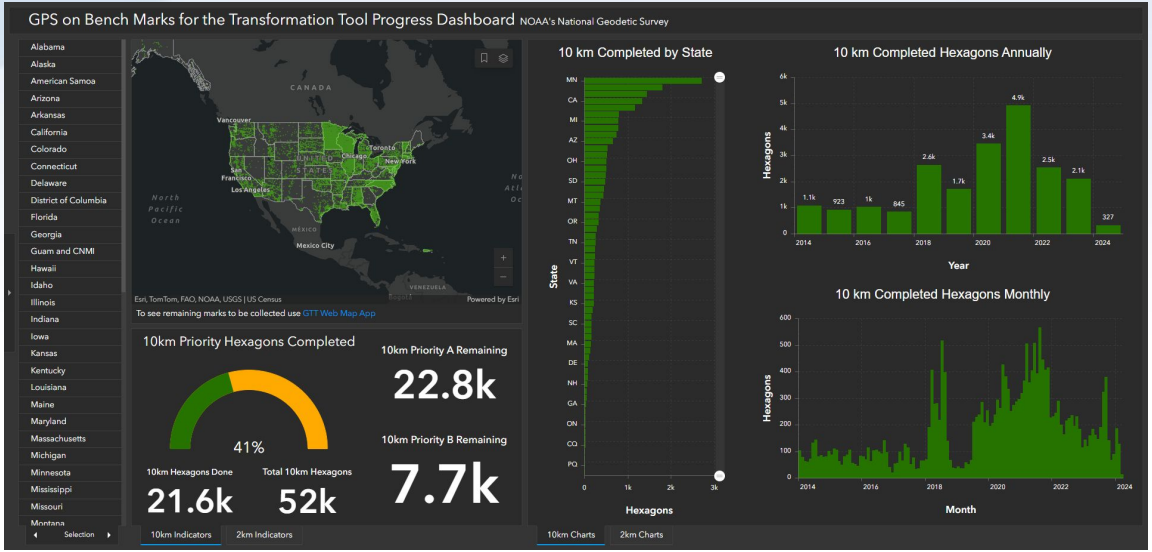


2019 China Lake, CA
6-10 feet Horizontally

2020 Puerto Rico
16 cm Vertically

GPS on Bench Marks





Web Map Application

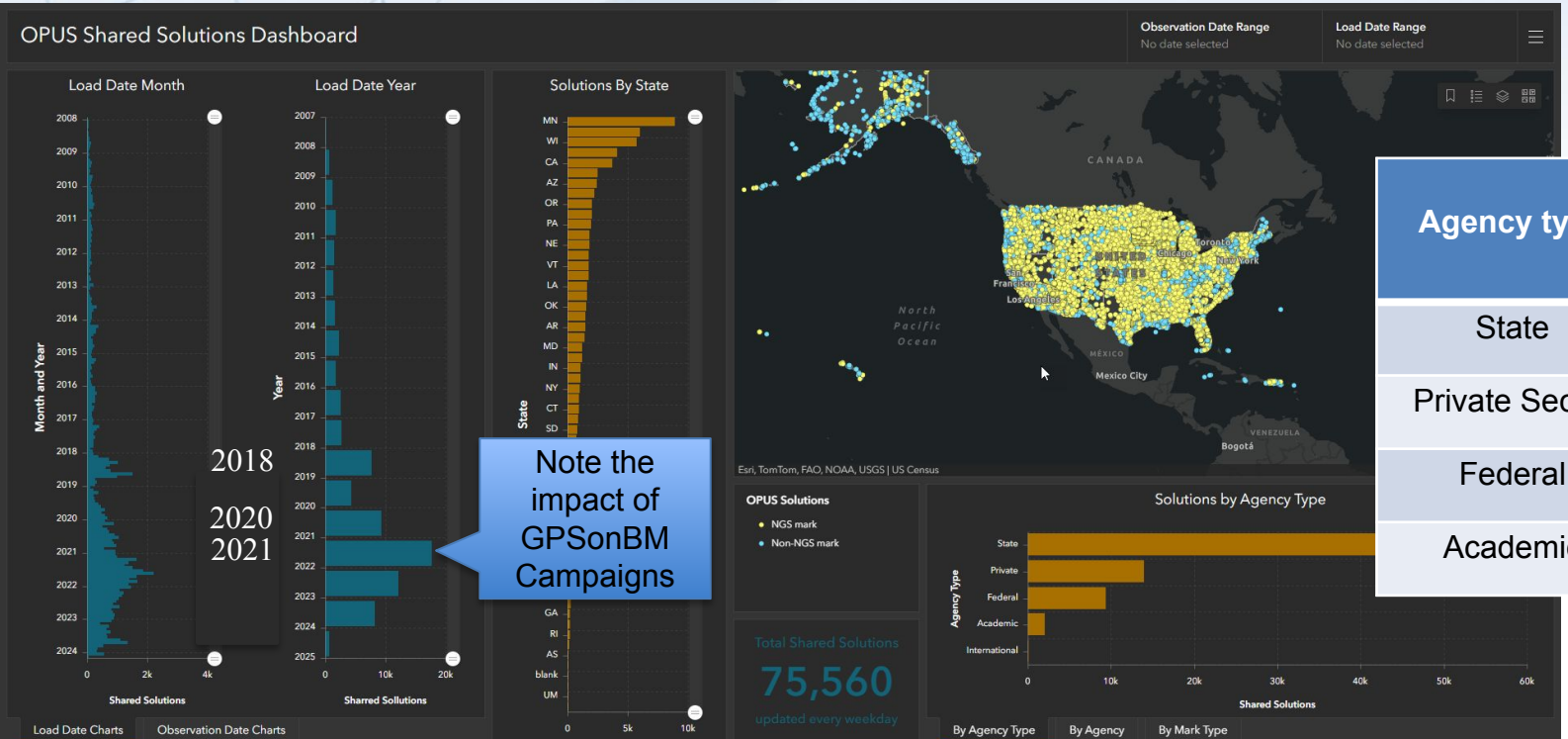
Dashboard

CO 14% Complete
WY 21% Complete

~3,400 Completed in 2020
~4,900 Completed in 2021
~2,500 Completed in 2022
~2,100 Completed in 2023

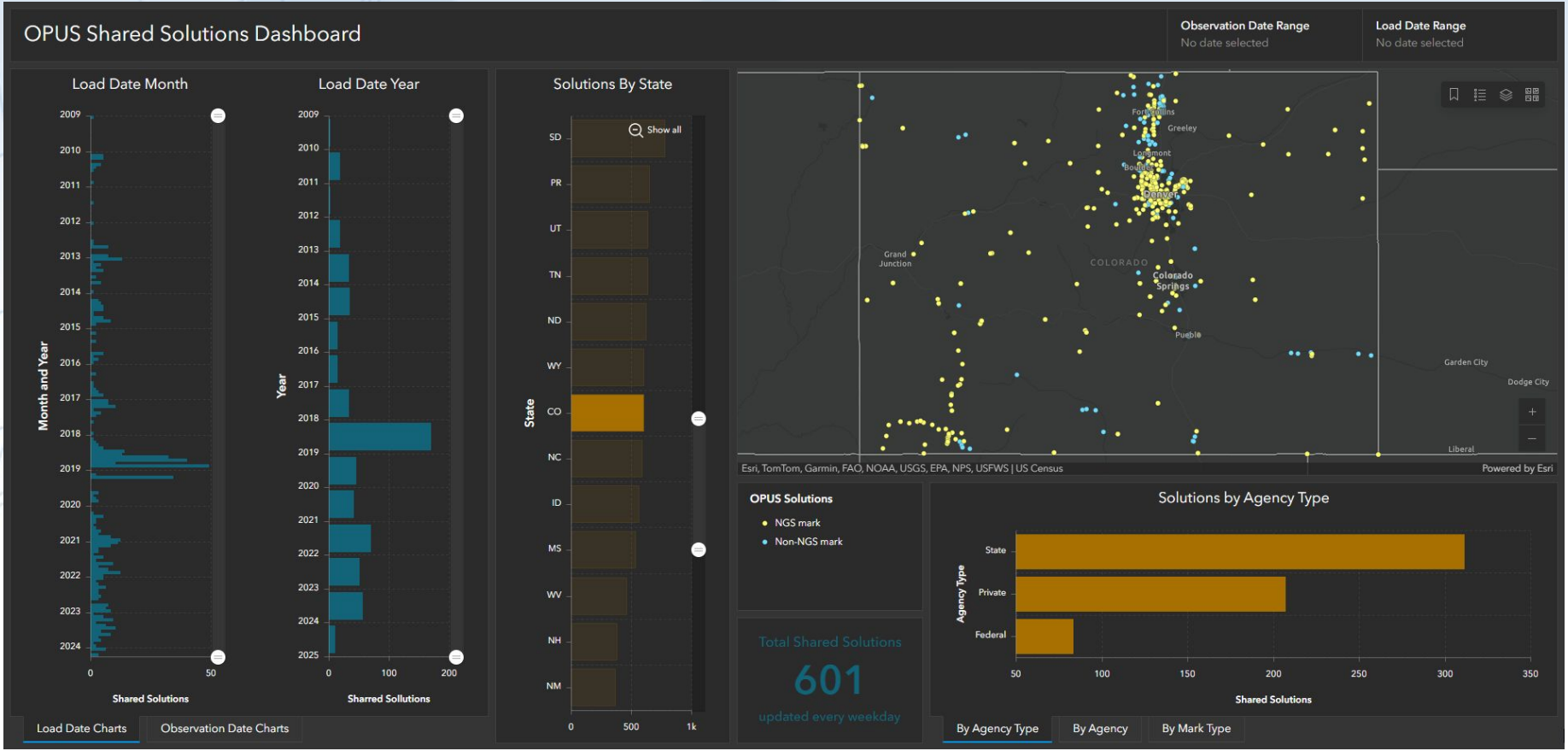
OPUS Shared Solutions Dashboard

Dashboard enables sorting and visualization of Shared Solutions by Month & Year, State, Agency Type, and submitting agency



Agency type	# Shared Solutions on NGS marks
State	~44,900
Private Sector	~7,900
Federal	~4,700
Academic	~1,800

CO OPUS Shared Solutions

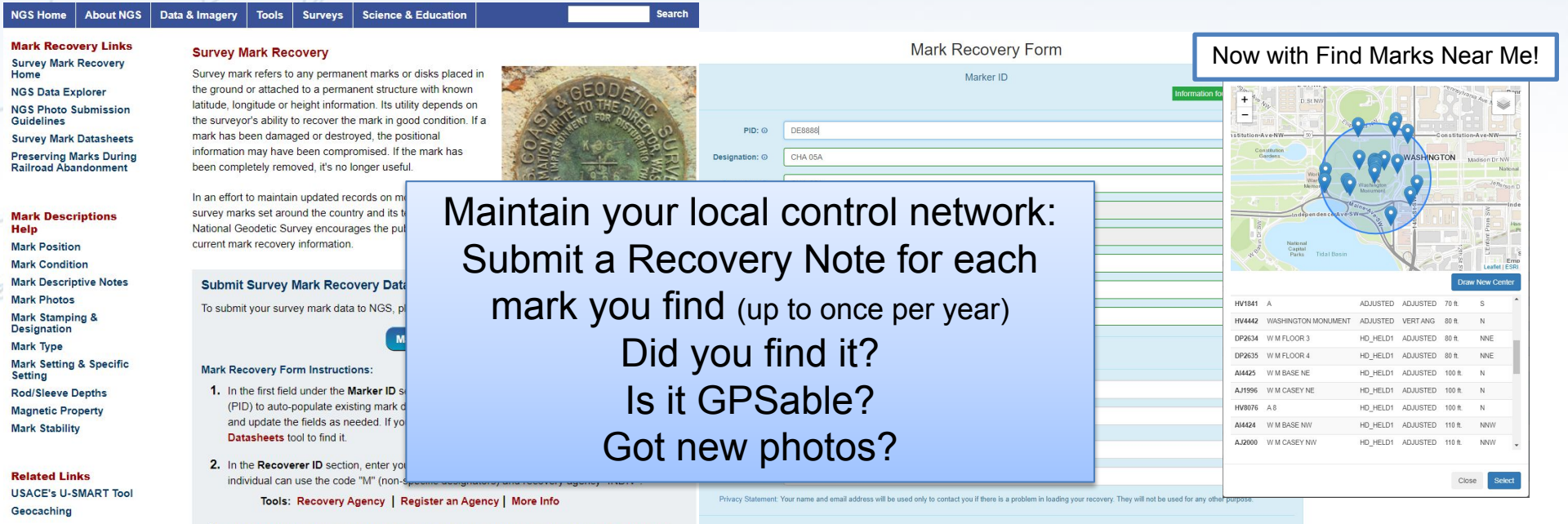


OPUS Shared Solutions Dashboard Demo

NGS Mark Recovery Webpage

Crowd sourced mark recoveries help update the GPSonBM map, let NGS and others know if the mark is still usable, and pictures make it easier to find.

https://geodesy.noaa.gov/surveys/mark-recovery



Maintain your local control network:
Submit a Recovery Note for each mark you find (up to once per year)
Did you find it?
Is it GPSable?
Got new photos?

NAD 83 Overview

Time Assembling Data (1974-1986)

Data from:

Canada, Caribbean, Central America, Greenland, Hawaii, Mexico, United States

Included:

1,785,772 geodetic observations

266,436 stations

NAD 83 Overview

US Portion of NAD 83:

(a) 258,982 horizontal control stations

(b) 1,541,090 1^{st},2^{nd},3^{rd},4^{th} order directions (horizontal angles)

(c) 188,629 geodetic distances

(d) 4,470 astronomic azimuth observations

(e) 666 doppler observations (Navy Navigation Satellite System Doppler)

- 655 observations on 612 stations in Conterminous US and Alaska
- 11 observations at 10 stations in Hawaii

(f) 112 VLBI observations (Very Long Baseline Interferometry)

- 45 stations

(g) 5 GPS (relative position observations) ties to VLBI

NAD 83 Overview

Canada Portion of NAD 83:

(a) 7,454 horizontal control stations

(b) 28,460 directions (horizontal angles)

(c) 10,333 geodetic distances

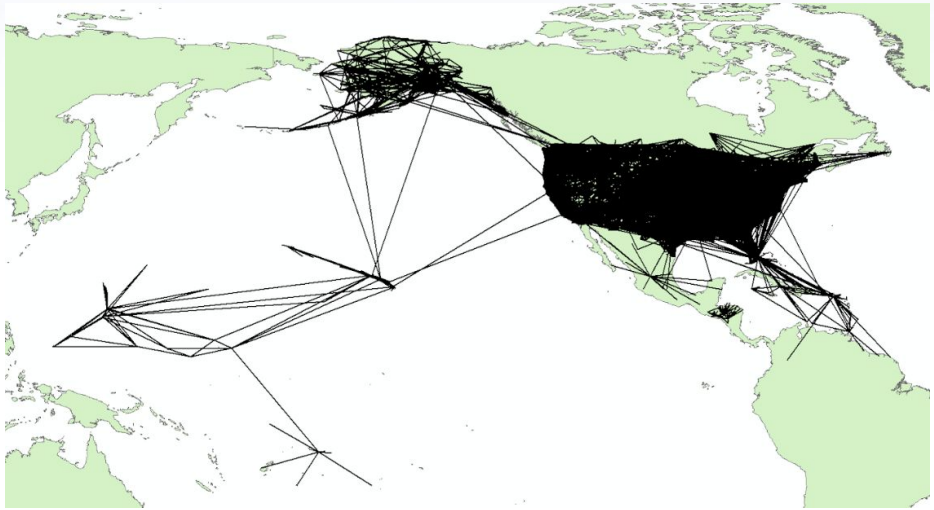
(d) 398 astronomic azimuth observations

(e) 726 doppler observations (Navy Navigation Satellite System Doppler)

National Adjustments

Geometric (approximate numbers)

- Projects: ~5,300
- Stations: ~107,000
- Vectors : ~446,000



National Adjustments

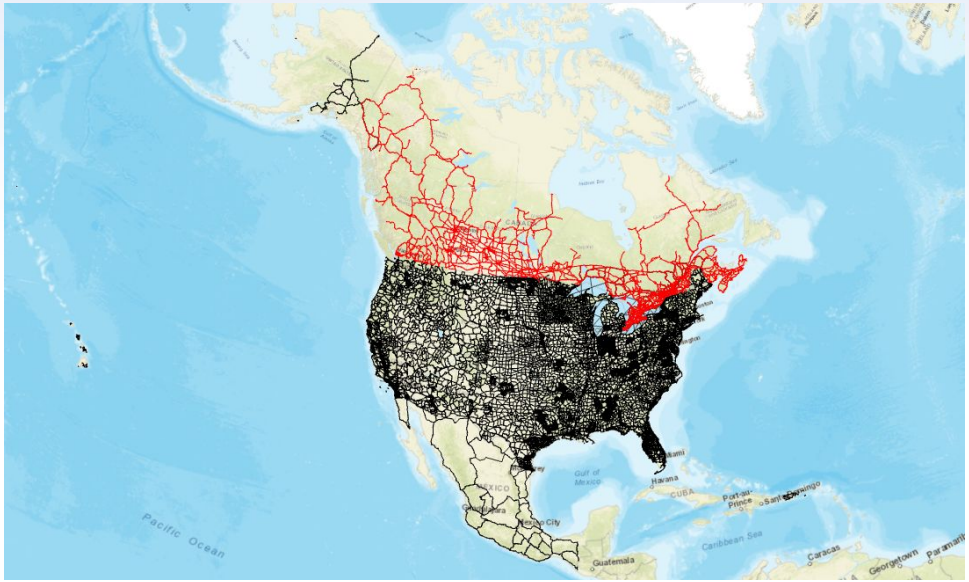
Orthometric (approximate numbers)

USA

- Projects : ~23,900
- Stations : ~1M
- Observations : ~2.1M

Canada

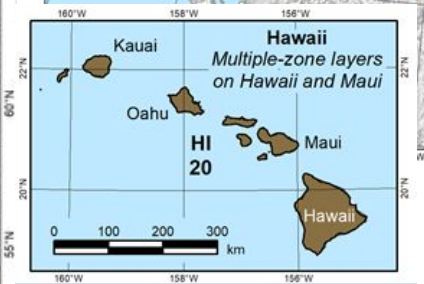
- Projects : ~2,900
- Stations : ~177,000
- Observations : ~204,000



State Plane Coordinate System of 2022 (CONUS, Alaska and Hawaii)

Three territory zones not shown:

- Puerto Rico and U.S Virgin Islands
- American Samoa
- Guam and Commonwealth of the Northern Mariana Islands

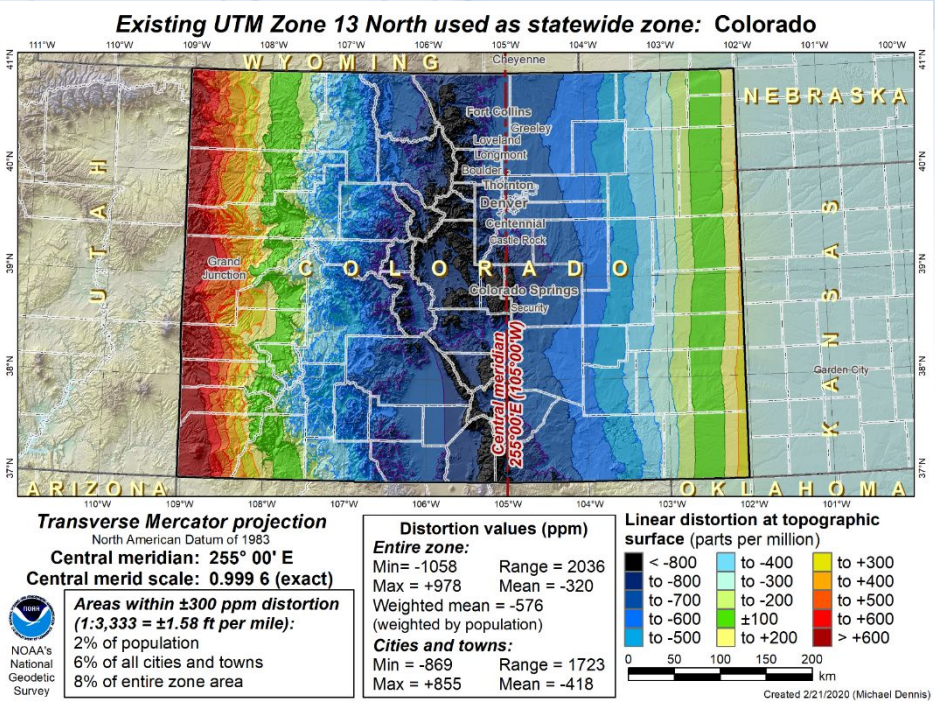


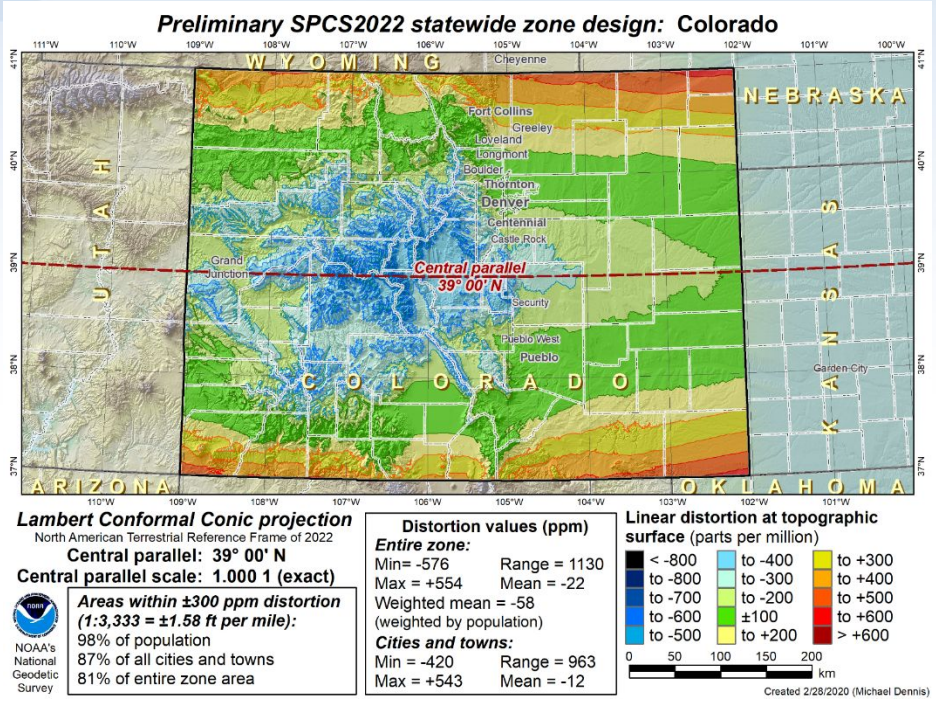
Total 965 zones (12/9/2021)

- 1 zone (18 states)
- 3 - 9 zones (14 states)
- 10 - 19 zones (6 states)
- 20 - 40 zones (11 states)
- 56 - 90 zones (7 states)

https://geodesy.noaa.gov/SPCS/

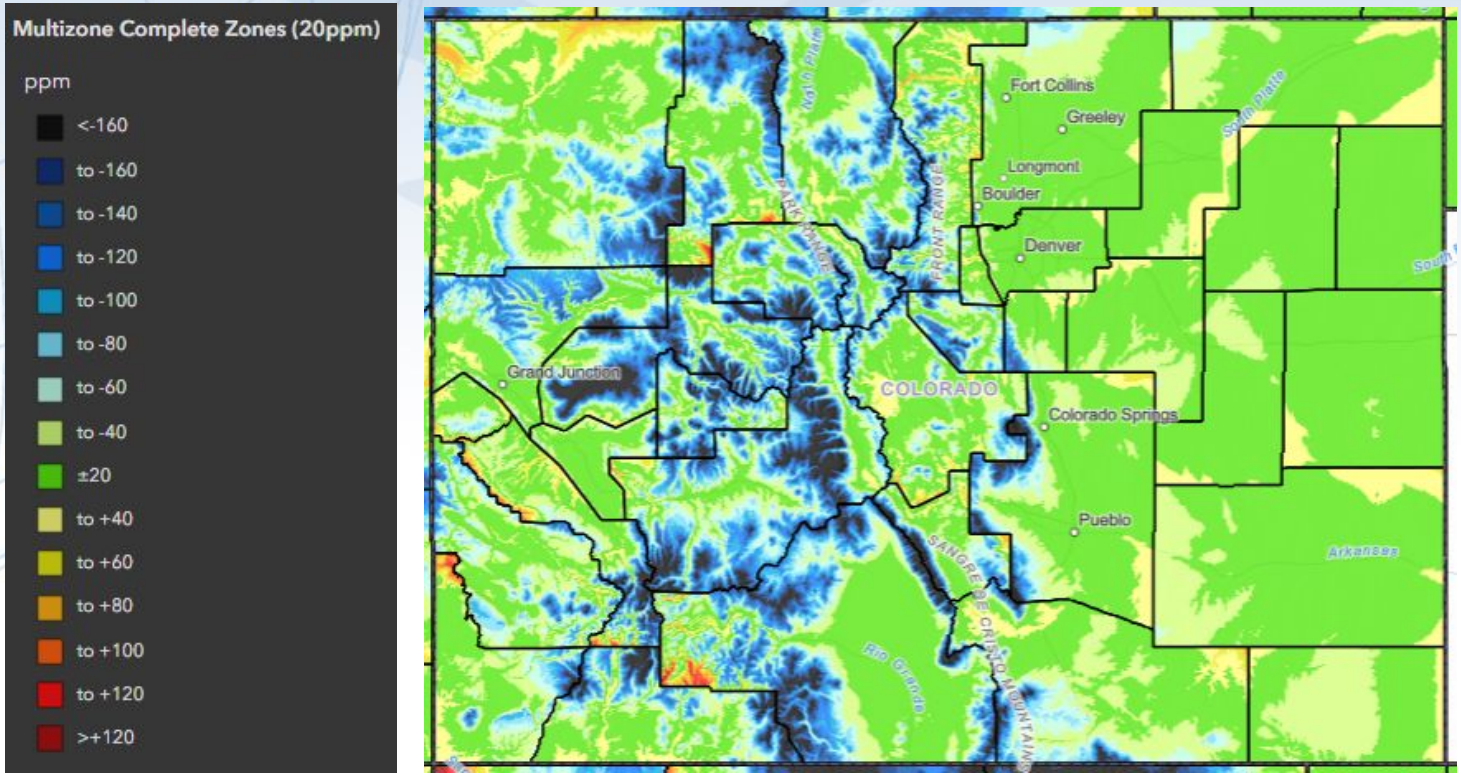
CO SPCS 2022





https://geodesy.noaa.gov/SPCS/

CO SPCS2022 Experience



1 Statewide Zone
35 LDPs

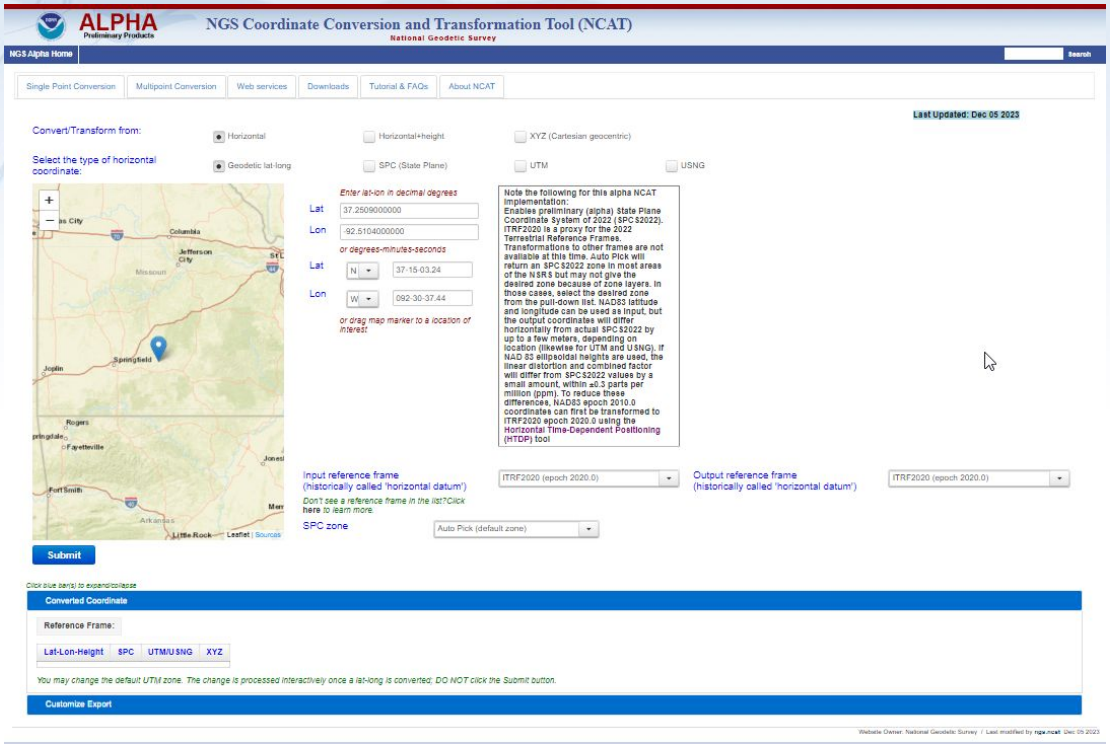
https://experience.arcgis.com/experience/dddb7bc0be6f4e56a1c370c8d529d1a0

Alpha State Plane Coordinate System of 2022 Experience

Demo

https://experience.arcgis.com/experience/dddb7bc0be6f4e56a1c370c8d529d1a0/

Alpha NCAT with SPCS2022



https://alpha.ngs.noaa.gov/SPCS/index.shtml

What is linear distortion and ppm?

Linear distortion is the same as map scale error at the ground surface, given in parts per million (ppm) rather than as a ratio.

Ex:

Distortion of 100 ppm is the same as:

10 cm per km, 0.53 ft per mile, or a ratio 1 part in 10,000

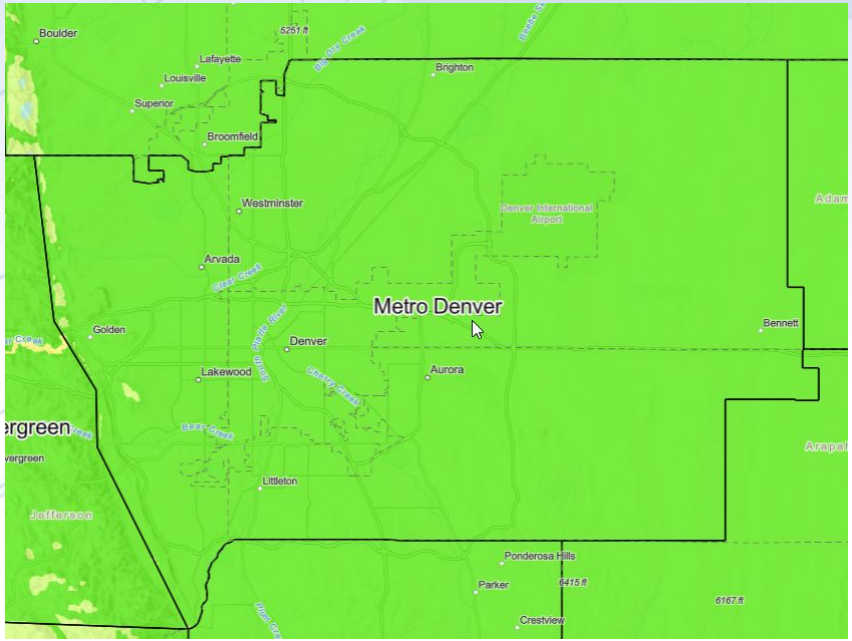
So for an actual horizontal distance of 1 mile, the projected (map grid) distance would be 0.53 ft shorter for negative 100 ppm distortion, and 0.53 ft longer for positive 100 ppm distortion.

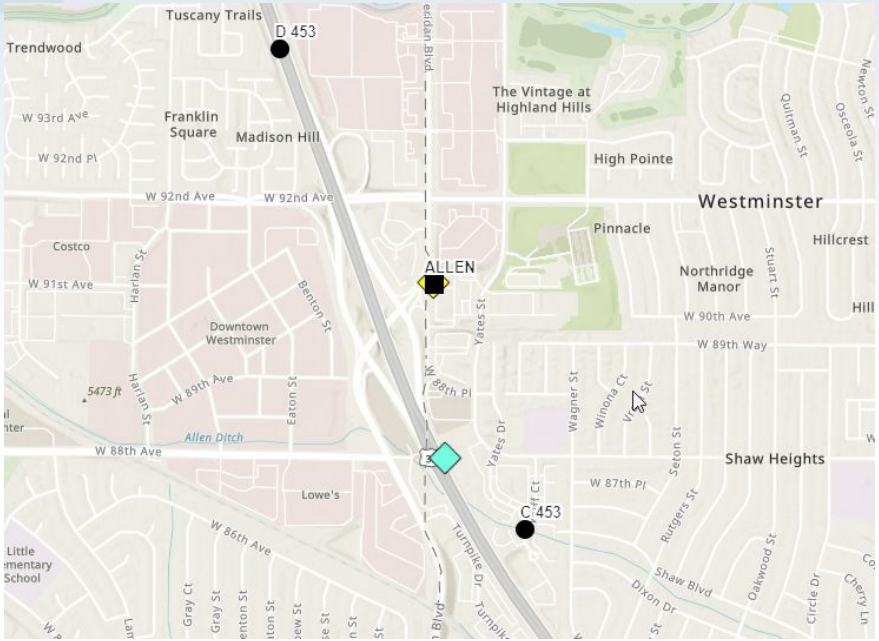
Linear distortion and ppm

Parts per million	Centimeters per kilometer	Feet per mile	Dimensionless ratio	Examples
20 ppm	2 cm/km	0.11 ft/mile	1:50,000	Typical "low distortion projection" limit
50 ppm	5 cm/km	0.26 ft/mile	1:20,000	Minimum distortion for designs by NGS
100 ppm	10 cm/km	0.53 ft/mile	1:10,000	Historic State Plane distortion design limit*
400 ppm	40 cm/km	2.11 ft/mile	1:2,500	UTM distortion design limit*

*For distortion with respect to the ellipsoid, not the topographic surface.

SPCS 83 versus SPCS2022





ALLEN (Westminster, CO)

SPCS 83 versus SPCS2022

ALLEN (Colorado State Zone)

```
KK1753 ***********************************************************************
KK1753  DESIGNATION -  ALLEN
KK1753  PID         -  KK1753
KK1753  STATE/COUNTY-  CO/ADAMS
KK1753  COUNTRY     -  US
KK1753  USGS QUAD   -  ARVADA (2019)
KK1753
KK1753                        *CURRENT SURVEY CONTROL
KK1753 ______________________________________________________________________
KK1753* NAD 83(2011) POSITION- 39 51 40.26600(N) 105 03 10.68534(W)   ADJUSTED
KK1753* NAD 83(2011) ELLIP HT-  1672.849 (meters)        (06/27/12)   ADJUSTED
KK1753* NAD 83(2011) EPOCH   -  2010.00
KK1753* NAVD 88 ORTHO HEIGHT -  1689.919 (meters)     5544.34  (feet) ADJUSTED
KK1753;                    North          East     Units Scale Factor Converg.
KK1753;SPC CO N     -   363,504.220   952,651.856   MT  0.99997982   +0 17 19.8
KK1753;SPC CO N     - 1,192,596.76  3,125,491.96   sFT  0.99997982   +0 17 19.8
KK1753;UTM  13      - 4,412,351.639   495,469.512   MT  0.99960025   -0 02 02.2
KK1753
KK1753!             -  Elev Factor  x  Scale Factor =   Combined Factor
KK1753!SPC CO N     -   0.99973763  x   0.99997982  =   0.99971746
KK1753!UTM  13      -   0.99973763  x   0.99960025  =   0.99933799
```

SPC	
Zone	CO- 080001 (Statewide)
Northing	476,719.044 m 1,564,038.858 ift
Easting	990,758.954 m 3,250,521.504 ift
Convergence	+00° 16′ 52.77″
Scale factor	1.000212990
Combined factor	0.999950566
Distortion	-49.434 ppm

SPCS 83 CO N -282.5 ppm
UTM 13 -662 ppm

SPCS2022 CO -49.4 ppm

SPCS 83 versus SPCS2022

ALLEN (DENVER METRO Zone LDP)

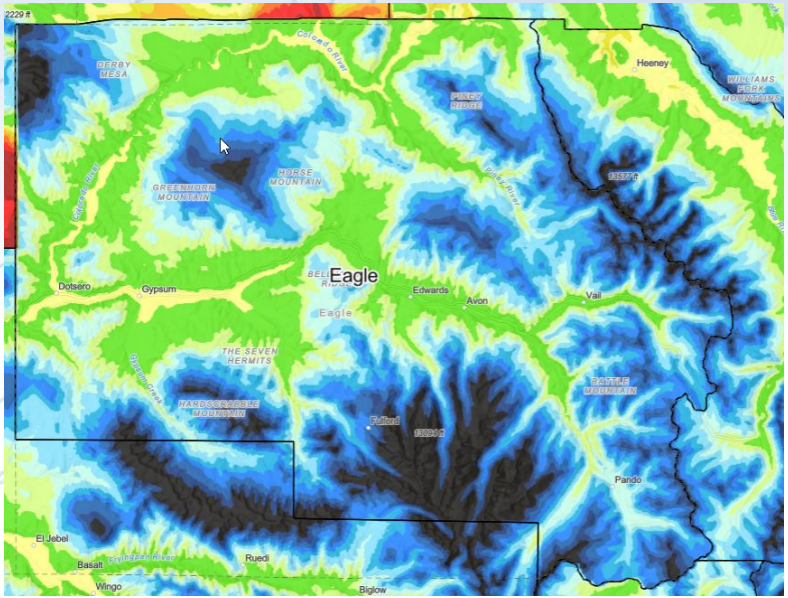
```
KK1753 ******************************************************************************
KK1753  DESIGNATION -  ALLEN
KK1753  PID         -  KK1753
KK1753  STATE/COUNTY-  CO/ADAMS
KK1753  COUNTRY     -  US
KK1753  USGS QUAD   -  ARVADA (2019)
KK1753
KK1753                         *CURRENT SURVEY CONTROL
KK1753  ______________________________________________________________________________
KK1753* NAD 83(2011) POSITION- 39 51 40.26600(N) 105 03 10.68534(W)   ADJUSTED
KK1753* NAD 83(2011) ELLIP HT-  1672.849 (meters)        (06/27/12)   ADJUSTED
KK1753* NAD 83(2011) EPOCH   -  2010.00
KK1753* NAVD 88 ORTHO HEIGHT -  1689.919 (meters)     5544.34  (feet) ADJUSTED
KK1753;                    North          East     Units Scale Factor Converg.
KK1753;SPC CO N     -   363,504.220   952,651.856   MT  0.99997982   +0 17 19.8
KK1753;SPC CO N     - 1,192,596.76  3,125,491.96   sFT  0.99997982   +0 17 19.8
KK1753;UTM  13      - 4,412,351.639   495,469.512   MT  0.99960025   -0 02 02.2
KK1753
KK1753!             -  Elev Factor  x  Scale Factor =   Combined Factor
KK1753!SPC CO N     -   0.99973763  x   0.99997982  =   0.99971746
KK1753!UTM  13      -   0.99973763  x   0.99960025  =   0.99933799
```

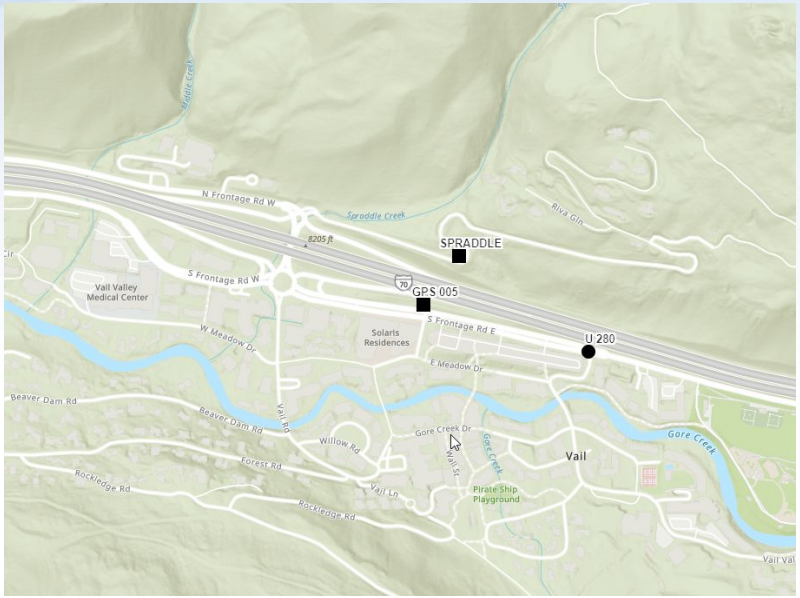
SPC	
Zone	CO DENV-081026 (Multizone complete)
Northing	73,457.466 m 241,002.186 ift
Easting	130,748.971 m 428,966.440 ift
Convergence	-00° 09' 43.69"
Scale factor	1.000255767
Combined factor	0.999993332
Distortion	-6.668 ppm

SPCS 83 CO N -282.5 ppm
UTM 13 -662 ppm

SPCS2022 DENV -6.67 ppm

SPCS 83 versus SPCS2022





SPRADDLE (Eagle County)

SPCS 83 versus SPCS2022

SPRADDLE (Colorado State Zone)

```
AB2083 ********************************************************************
AB2083  HT_MOD      -  This is a Height Modernization Survey Station.
AB2083  DESIGNATION -  SPRADDLE
AB2083  PID         -  AB2083
AB2083  STATE/COUNTY-  CO/EAGLE
AB2083  COUNTRY     -  US
AB2083  USGS QUAD   -  VAIL EAST (2019)
AB2083
AB2083                        *CURRENT SURVEY CONTROL
AB2083 ______________________________________________________________________
AB2083* NAD 83(2011) POSITION- 39 38 38.53766(N) 106 22 25.48745(W)   ADJUSTED
AB2083* NAD 83(2011) ELLIP HT-  2513.514 (meters)        (01/19/24)   ADJUSTED
AB2083* NAD 83(2011) EPOCH   -  2010.00
AB2083* NAVD 88 ORTHO HEIGHT -  2526.04  (meters)     8287.5   (feet) GPS OBS
AB2083;                    North         East     Units Scale Factor Converg.
AB2083;SPC CO C     -   506,167.958   839,405.863   MT  0.99998076   -0 33 03.8
AB2083;SPC CO C     - 1,660,652.71  2,753,950.74   sFT  0.99998076   -0 33 03.8
AB2083;UTM  13      - 4,389,151.814   382,128.671   MT  0.99977105   -0 52 35.7
AB2083
AB2083!             -  Elev Factor  x  Scale Factor =   Combined Factor
AB2083!SPC CO C     -   0.99960582  x   0.99998076  =   0.99958659
AB2083!UTM  13      -   0.99960582  x   0.99977105  =   0.99937696
```

SPC	
Zone	CO-080001 (Statewide)
Northing	452,870.768 m 1,485,796.483 ift
Easting	877,490.352 m 2,878,905.355 ift
Convergence	-00° 32' 59.52"
Scale factor	1.000163124
Combined factor	0.999768884
Distortion	-231.116 ppm

SPCS 83 CO C -413 ppm

UTM 13 -623 ppm

SPCS2022 CO -231 ppm

SPCS 83 versus SPCS2022

SPRADDLE (EAGLE Zone LDP)

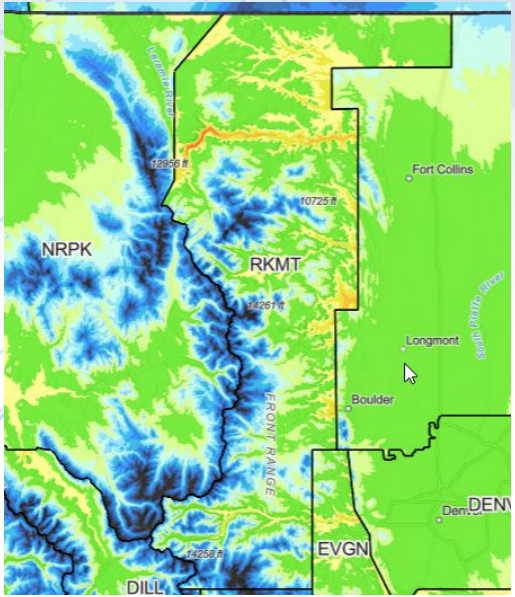
```
AB2083 ************************************************************************
AB2083  HT_MOD      -  This is a Height Modernization Survey Station.
AB2083  DESIGNATION -  SPRADDLE
AB2083  PID         -  AB2083
AB2083  STATE/COUNTY-  CO/EAGLE
AB2083  COUNTRY     -  US
AB2083  USGS QUAD   -  VAIL EAST (2019)
AB2083
AB2083                        *CURRENT SURVEY CONTROL
AB2083 ______________________________________________________________________
AB2083* NAD 83(2011) POSITION- 39 38 38.53766(N) 106 22 25.48745(W)   ADJUSTED
AB2083* NAD 83(2011) ELLIP HT-  2513.514 (meters)        (01/19/24)   ADJUSTED
AB2083* NAD 83(2011) EPOCH   -  2010.00
AB2083* NAVD 88 ORTHO HEIGHT -  2526.04  (meters)     8287.5   (feet) GPS OBS
AB2083;                    North         East     Units Scale Factor Converg.
AB2083;SPC CO C     -   506,167.958   839,405.863   MT  0.99998076   -0 33 03.8
AB2083;SPC CO C     - 1,660,652.71  2,753,950.74   sFT  0.99998076   -0 33 03.8
AB2083;UTM  13      - 4,389,151.814   382,128.671   MT  0.99977105   -0 52 35.7
AB2083
AB2083!             -  Elev Factor  x  Scale Factor =   Combined Factor
AB2083!SPC CO C     -   0.99960582  x   0.99998076  =   0.99958659
AB2083!UTM  13      -   0.99960582  x   0.99977105  =   0.99937696
```

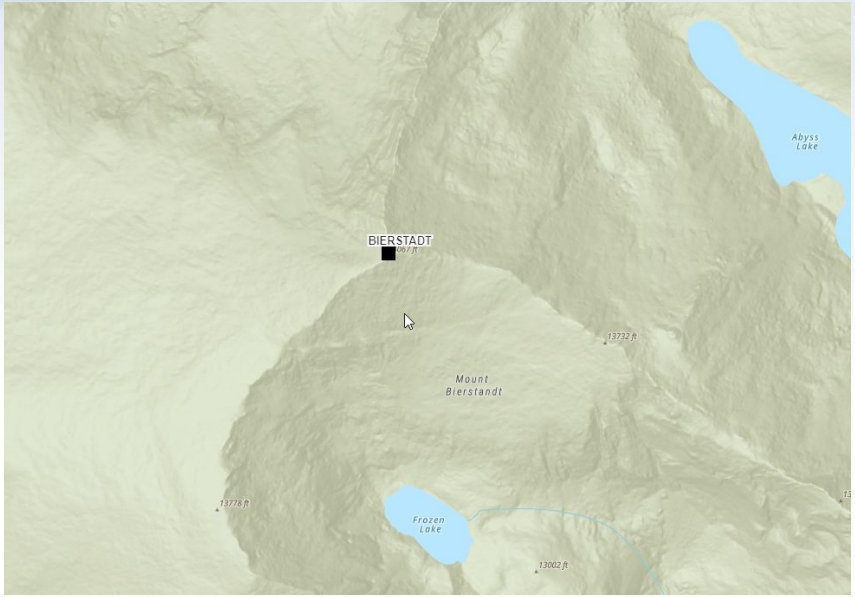
SPC	
Zone	CO EGLE-081014 (Multizone complete)
Northing	60,786.948 m 199,432.246 ift
Easting	151,438.373 m 496,845.056 ift
Convergence	+00° 33' 32.72"
Scale factor	1.000389642
Combined factor	0.999995313
Distortion	-4.687 ppm

SPCS 83 CO C -413 ppm
UTM 13 -623 ppm

SPCS2022 EGLE -4.69 ppm

SPCS 83 versus SPCS2022





BIERSTADT (Clear Creek County)

SPCS 83 versus SPCS2022

BIERSTADT (Colorado State Zone)

```
KK2029 ************************************************************************
KK2029  HT_MOD      -  This is a Height Modernization Survey Station.
KK2029  DESIGNATION -  BIERSTADT
KK2029  PID         -  KK2029
KK2029  STATE/COUNTY-  CO/CLEAR CREEK
KK2029  COUNTRY     -  US
KK2029  USGS QUAD   -  MOUNT EVANS (2019)
KK2029
KK2029                        *CURRENT SURVEY CONTROL
KK2029  ______________________________________________________________________
KK2029* NAD 83(2011) POSITION- 39 34 57.36550(N) 105 40 07.62495(W)   ADJUSTED
KK2029* NAD 83(2011) ELLIP HT-  4274.507 (meters)        (01/18/24)   ADJUSTED
KK2029* NAD 83(2011) EPOCH   -  2010.00
KK2029* NAVD 88 ORTHO HEIGHT -  4286.78  (meters)    14064.2   (feet) GPS OBS
KK2029;                    North         East     Units Scale Factor Converg.
KK2029;SPC CO C     -   498,999.793   899,901.705   MT  0.99997117   -0 06 23.2
KK2029;SPC CO C     - 1,637,135.15  2,952,427.51   sFT  0.99997117   -0 06 23.2
KK2029;UTM  13      - 4,381,645.332   442,566.425   MT  0.99964061   -0 25 34.2
KK2029
KK2029!             -  Elev Factor  x  Scale Factor =   Combined Factor
KK2029!SPC CO C     -   0.99932984  x   0.99997117  =   0.99930103
KK2029!UTM  13      -   0.99932984  x   0.99964061  =   0.99897069
```

SPC	
Zone	CO RKMT-081017 (Multizone complete)
Northing	32,712.343 m 107,323.960 ift
Easting	123,301.076 m 404,531.088 ift
Convergence	-01° 03' 48.65"
Scale factor	1.000443024
Combined factor	0.999772569
Distortion	-227.431 ppm

SPCS 83 CO N -699 ppm

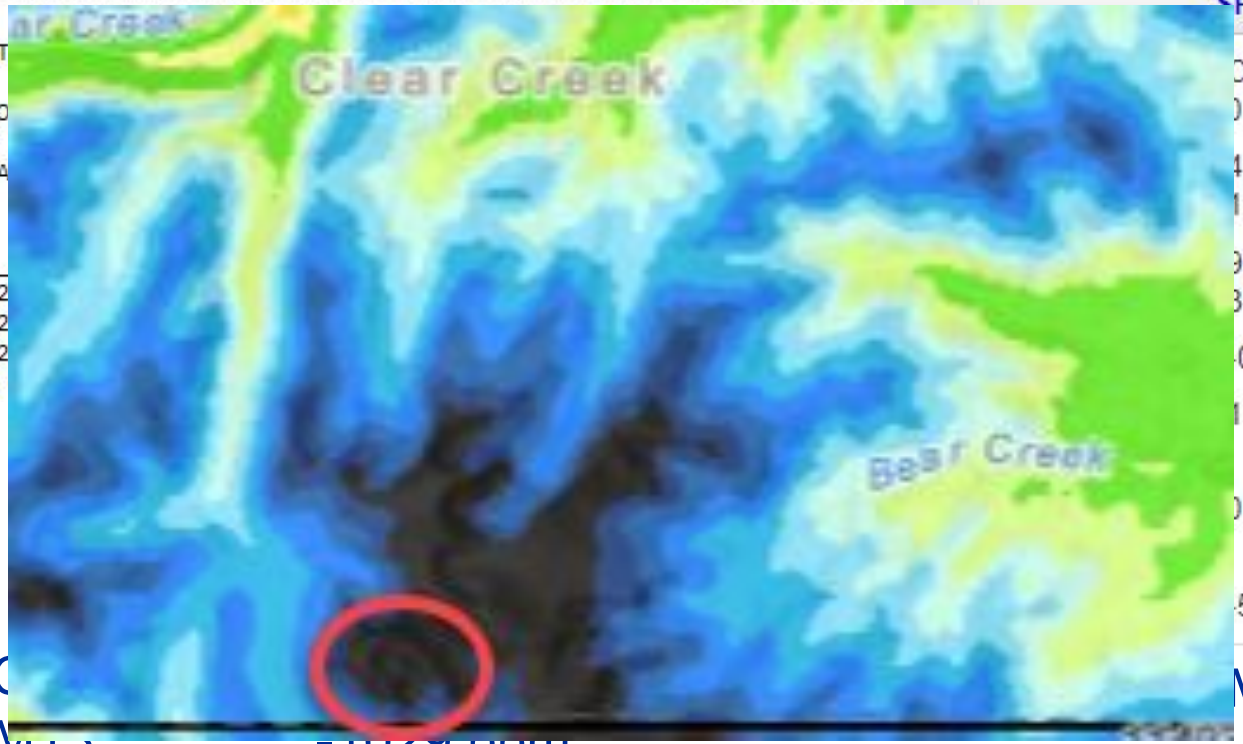
UTM13 -1029 ppm

SPCS2022 CO -227 ppm

SPCS 83 versus SPCS2022

BIERSTADT (Rocky Mountain Zone LDP)

```
KK2029 ********************************************************************
KK2029  HT_MOD
KK2029  DESIGNAT
KK2029  PID
KK2029  STATE/CO
KK2029  COUNTRY
KK2029  USGS QUA
KK2029
KK2029
KK2029  _______
KK2029* NAD 83(2
KK2029* NAD 83(2
KK2029* NAD 83(2
KK2029* NAVD 88
KK2029;
KK2029;SPC CO C
KK2029;SPC CO C
KK2029;UTM  13
KK2029
KK2029!
KK2029!SPC CO C
KK2029!UTM  13
```



SPC

CO-
080001 (Statewide)

445,702.056 m
1,462,277.086 ift

937,997.259 m
3,077,418.829 ift

00° 06' 22.39"

1.000151640

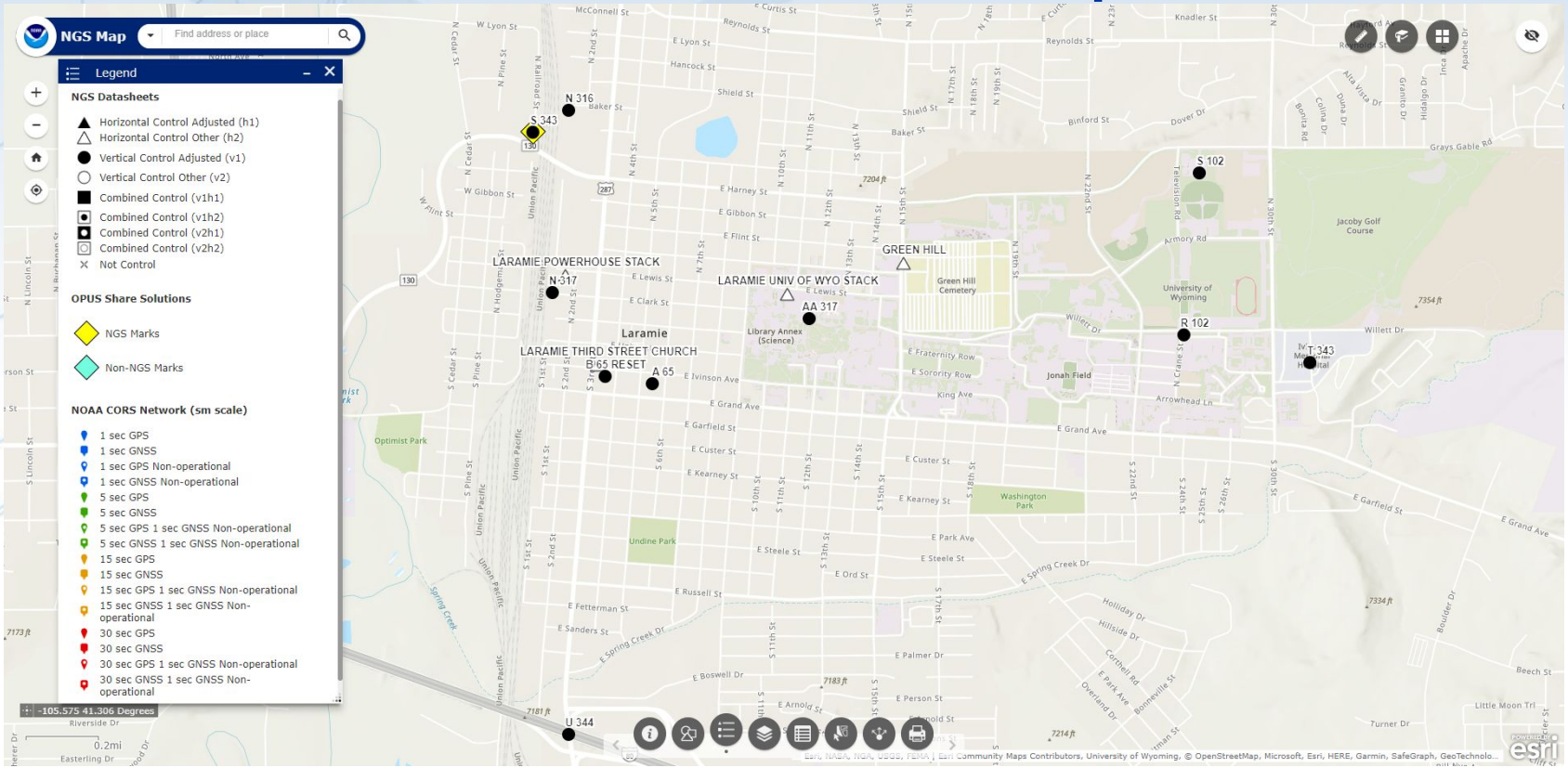
0.999481379

518.621 ppm

SPC … MT -518.6 ppm

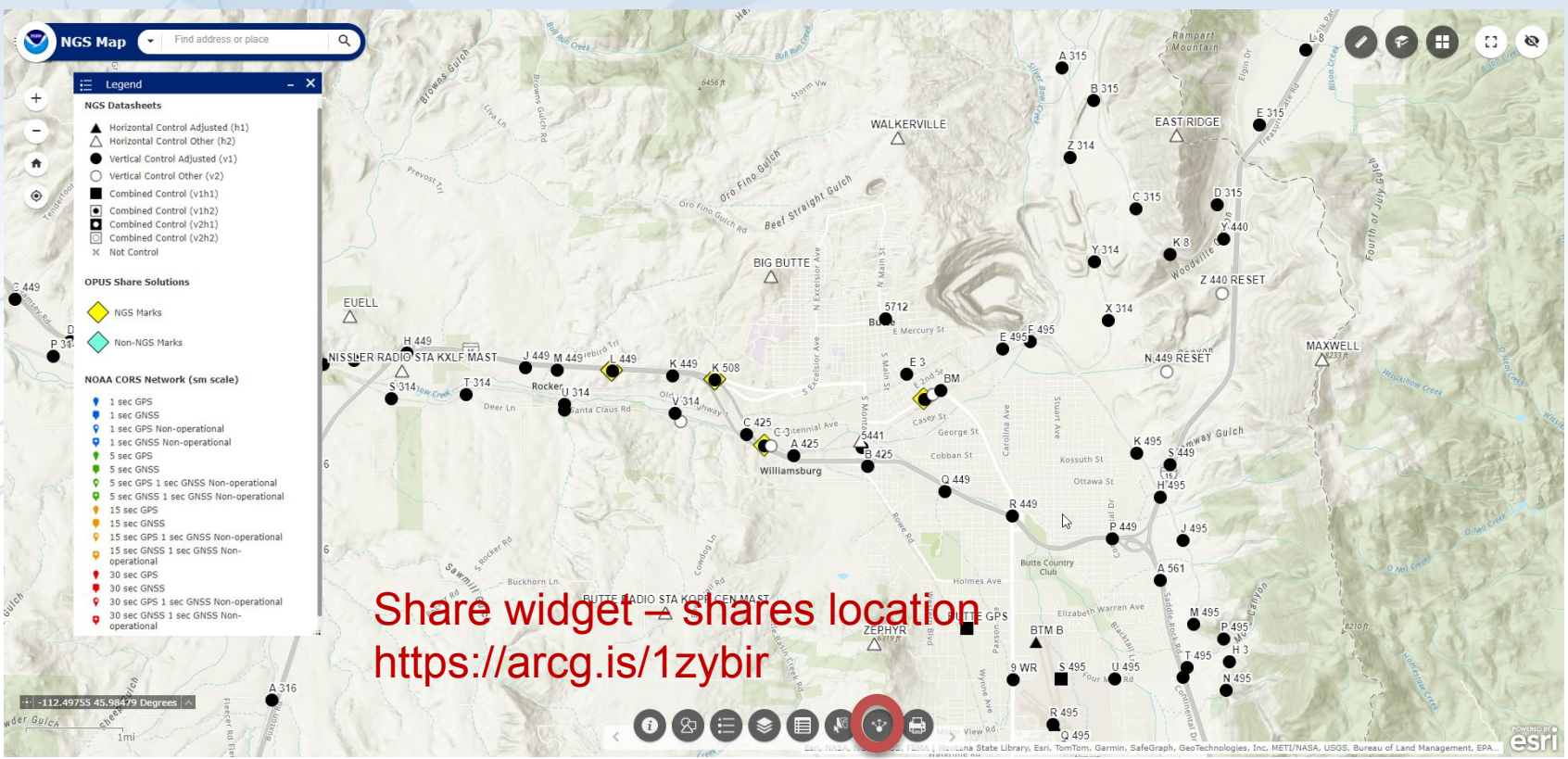
UTM 13 … -1029 ppm

Newish NGS Map



https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db

Newish NGS Map



https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db

NGS Map Demo

NGS ArcGIS Online Resources

Feature Services

NGS Datasheets
NOAA CORS Network
GPS on Benchmarks Priority List
(4 layers - marks, hexagons)
GEOID18 GPS on Benchmarks
GEOID12B GPS on Benchmarks
OPUS Shared Solutions
Mark Recoveries Submitted to NGS

Raster Tile Services

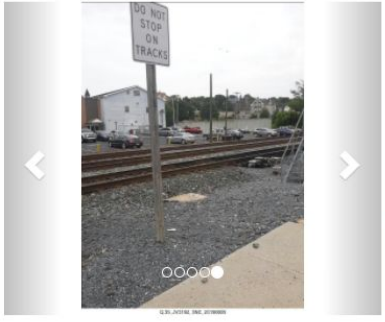
GEOID18 Height (CONUS, PRVI)
GEOID18 Difference (CONUS, PRVI)
GEOID18 Uncertainty (CONUS, PRVI)
GEOID18 Improvements (CONUS, PRVI)

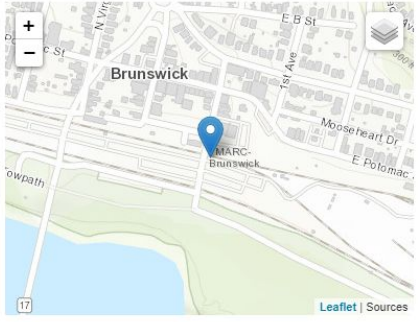
Passive Marks Page

Enter PID: JV3192 [Get Data] [Recover this mark]

Designation:	Q 35
Setting:	36 = SET IN A MASSIVE STRUCTURE
Last Recovery Date/Condition/By:	05/16/2014 - Recovered in good condition - GEOCACHING

PID:	JV3192	State, County:	MD,FREDERICK
Stability:	B	Country:	US
GNSS Useable:	Y	Latitude:	N 39° 18' 42.63"
Orthometric Ht. (m):	75.185	Longitude:	W 077° 37' 37.59"
Vertical Datum:	NAVD 88	Ellipsoid Ht.:	
Vertical Source:	ADJUSTED	Position Datum:	NAD 83(1986)
Order/Class:	1/2	Position Source:	HD_HELD1
Geoid Ht (m).:	-33.056	Network Accuracy Hz (cm):	
Geoid Model:	GEOID18	Network Accuracy Ellip (cm):	





Projects

Leveling Projects

L24378/1

Start Date:	05/07/1979	Order:	1	Agency:	NGS
End Date:	06/06/1979	Class:	2	BM Count:	84

L9532/3

Start Date:	04/10/1942	Order:	2	Agency:	NGS
End Date:	04/21/1942	Class:	0	BM Count:	22

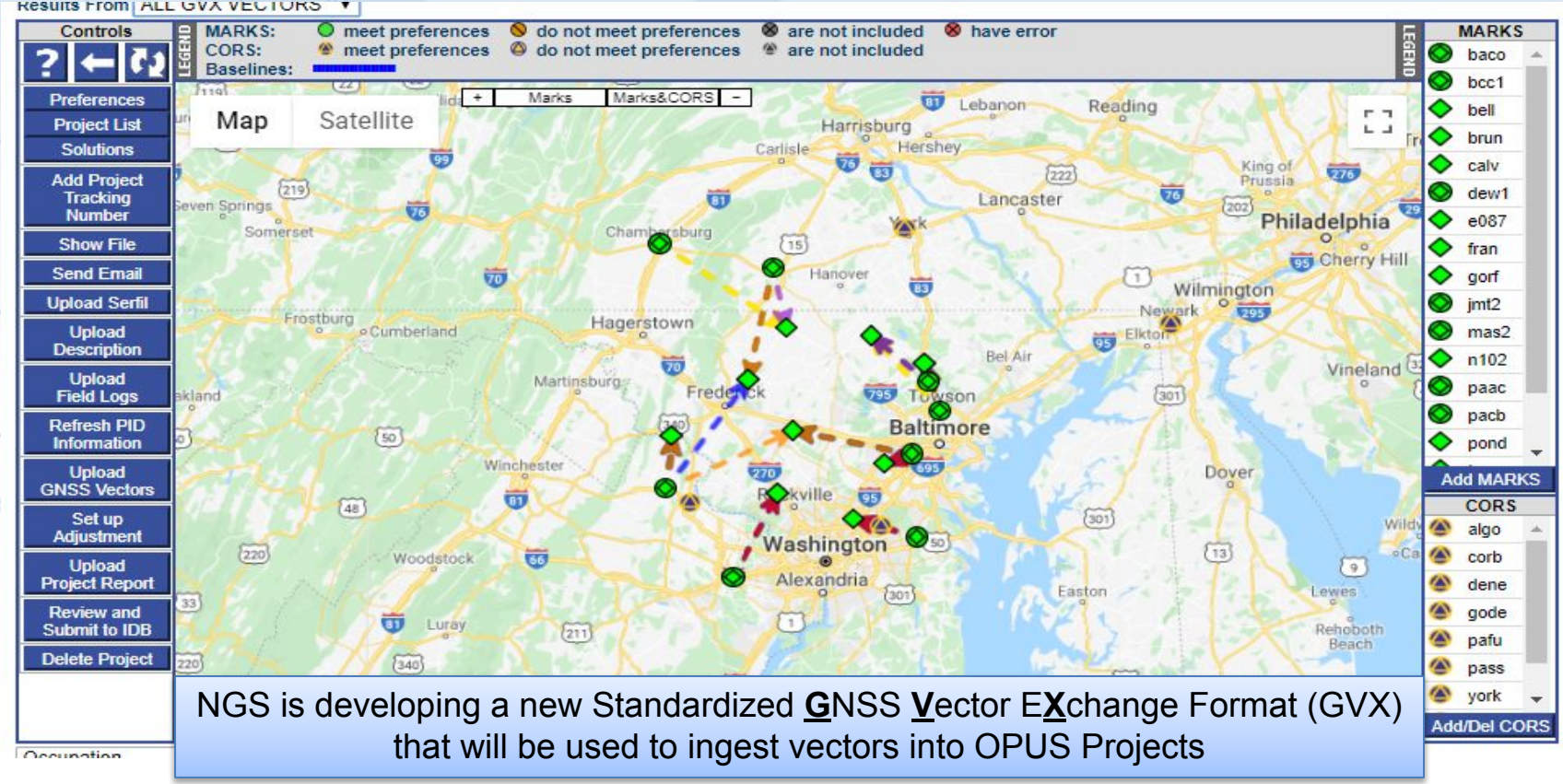
L8007

Start Date:	05/27/1938	Order:	1	Agency:	NGS
End Date:	06/25/1938	Class:	2	BM Count:	71

Descriptive Information

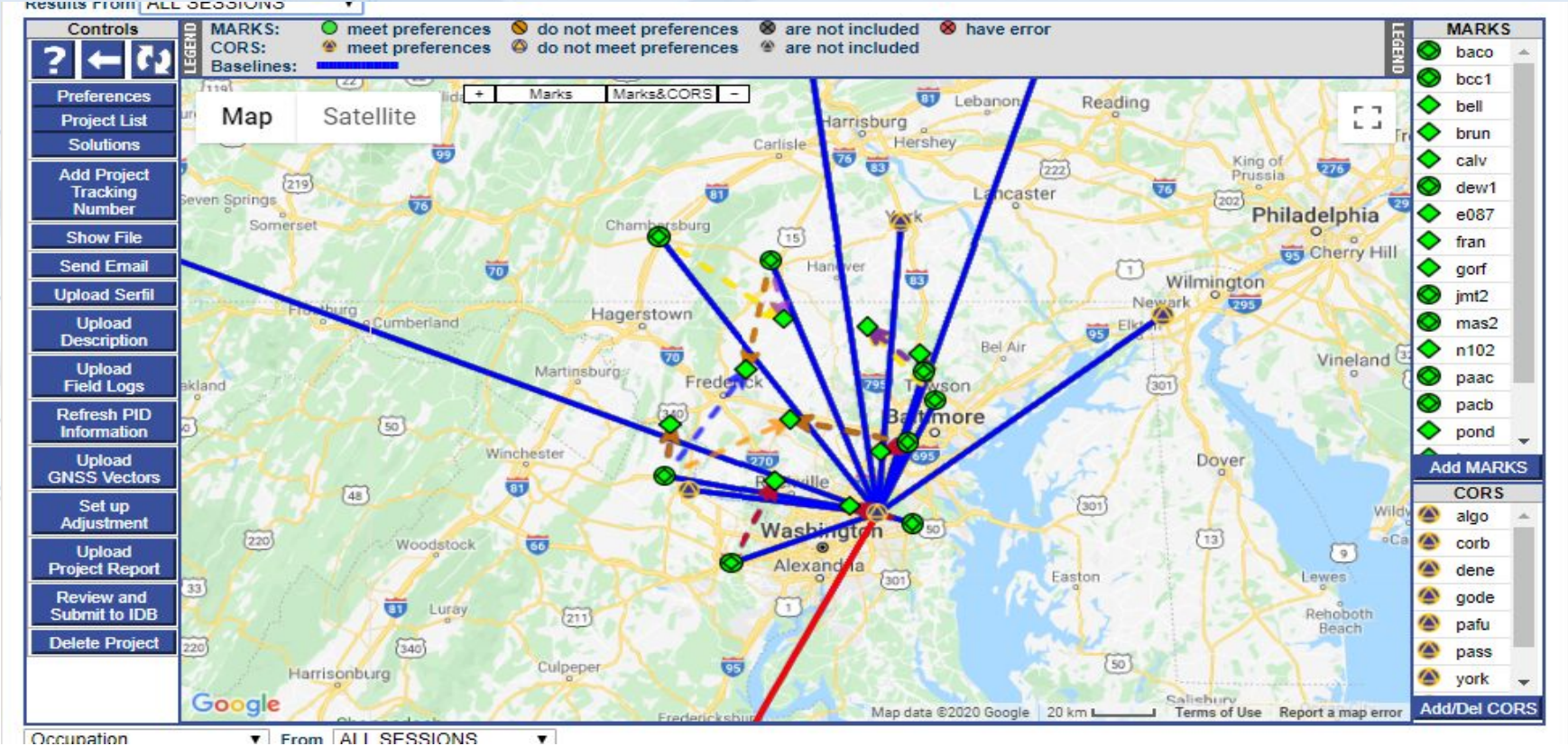
PID:	JV3192	Designation	Q 35
Setting Agency:	CGS	Setting Date:	1938
Marker Type:	DB	Magnetic Code:	
Stability Code:	B	Setting Class:	36
Setting Phrase:	BRIDGE FOUNDATION	Logo:	CGS
Stamping:	Q 35 1938	UDG Mark Type:	
UDG Magnetic Code:		UDG Mark Stability:	
UDG Mark Setting:		UDG Mark Set Date:	
Rod/Pipe Depth:		Sleeve Depth:	
Position Source:	O	Position Quality:	4
Position Technique:	X	Alias:	

OPUS-Projects 5.2 for RTN/RTK Vectors



NGS is developing a new Standardized **G**NSS **V**ector E**X**change Format (GVX) that will be used to ingest vectors into OPUS Projects

OPUS-Projects 5.2 for RTN/RTK Vectors



NOAA Technical Memorandum NOS NGS 92

Classifications, Standards, and Specifications for GNSS Geodetic Control Surveys using OPUS Projects

	Description	PRIMARY	SECONDARY	LOCAL
1.1	Ellipsoid Height (cm) *	2 cm	3 cm	5 cm
1.2	Horizontal (cm) *	1 cm	1.5 cm	2.5 cm
1.3	Orthometric Height (cm) *	3 cm	4 cm	6 cm

** Network and Local Accuracies are stated at the 95% confidence level.*

Classifications of Network and Local Accuracy

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Table 4 - Standards for Observation Requirements by Method

	Requirement	PRIMARY	SECONDARY	LOCAL
4.1	**Requirements for ALL METHODS - Repeat occupations and offset time**	Offset sessions/occupations by 3 to 21 hours.		
4.2	**Requirements for OPUS PP - Required TOTAL Static GNSS Observation Time (T) and Recommended GNSS sessions**	T = 20 hours (for 0 to 200 km) (2) 10 hour sessions or (3) 7 hour sessions or (4) 5 hour sessions Requires at least 2 sessions, with at least 1 session on a different day	T = 8 hours (for 0 to 200 km) (2) 4 hour sessions T = 6 hours (for 0 to 150 km) (2) 3 hour sessions T = 4 hours (for 0 to 100 km) (2) 2 hour sessions Requires at least 2 sessions.	T = 4 hours (for 0 to 200 km) (2) 2 hour sessions Requires at least 2 sessions.

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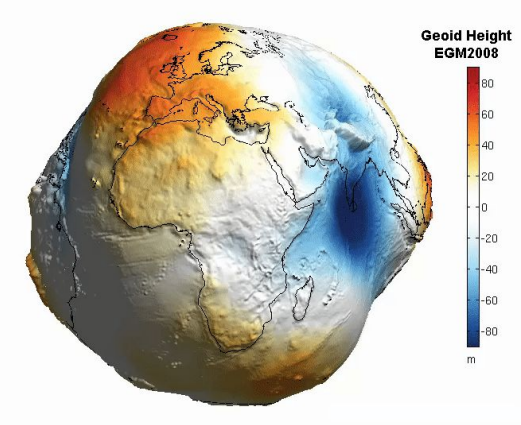
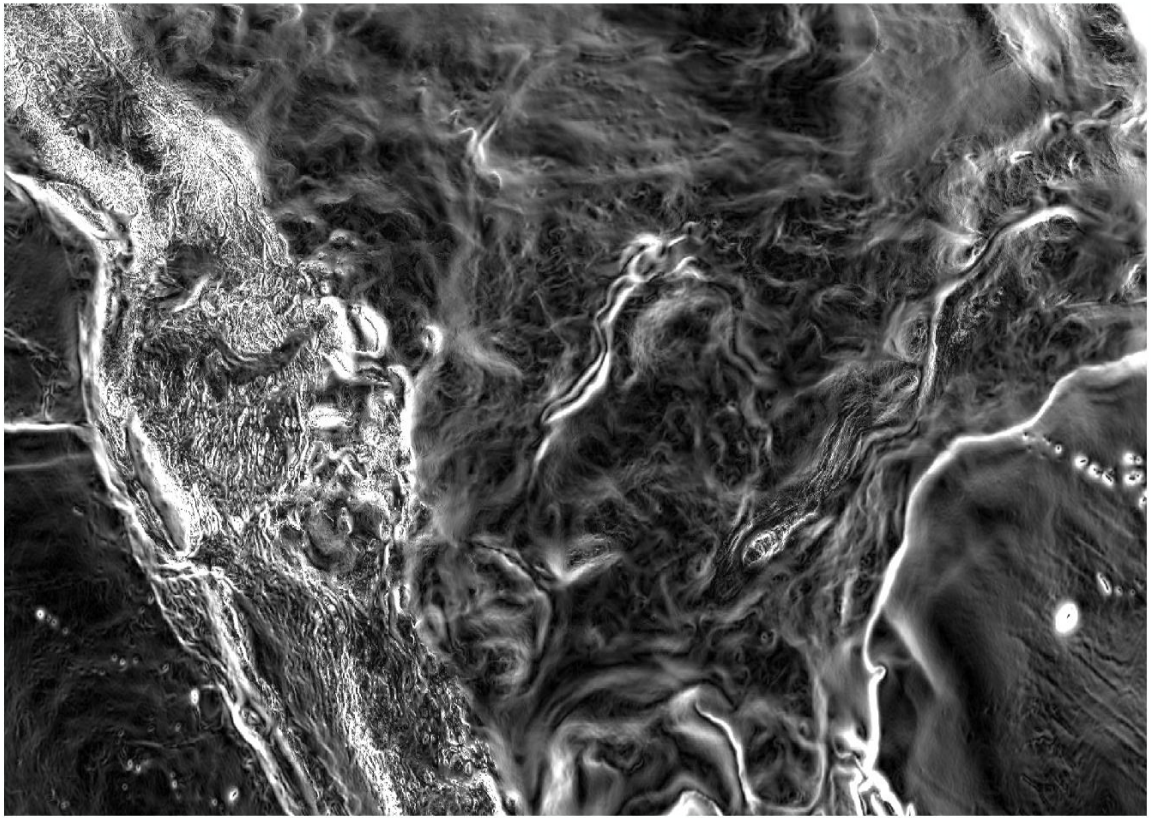
Table 4 - Standards for Observation Requirements by Method

	Requirement	PRIMARY	SECONDARY	LOCAL
4.3	**Requirements for GVX PP - Number and duration of sessions**	3 sessions 60 minutes each (for 0 to 25 km) 90 minutes each (for 25 to 50 km) Requires at least 1 session on a different day.	3 sessions 30 minutes each (for 0 to 25 km) 60 minutes each (for 25 to 50 km)	3 sessions 15 minutes each (for 0 to 25 km) 30 minutes each (for 25 to 50 km)
4.4	**Requirements for GVX NRTK - Number and duration of occupations**	(6) 5 minutes Requires at least 3 occupations on a different day.	(3) 5 minutes	(3) 5 minutes
4.5	**Requirements for GVX SRTK - Number and duration of occupations**	Not allowed	(5) 5 minutes Requires at least 2 occupations on a different day.	(4) 5 minutes Requires at least 1 occupation on a different day.



Magnitude of the Deflection of the Vertical



Questions?

Brian Shaw
brian.shaw@noaa.gov