

National Geodetic Survey's (NGS) Modernization of the National Spatial Reference System (NSRS): What You Can Do To Prepare

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Idaho Geodetic Control-Technical Working Group (GC-TWG)

Jan. 27, 2022

Accurate maps begin with accurate coordinates!

Geodetic control (NSRS) is the foundation layer for all geospatial products.

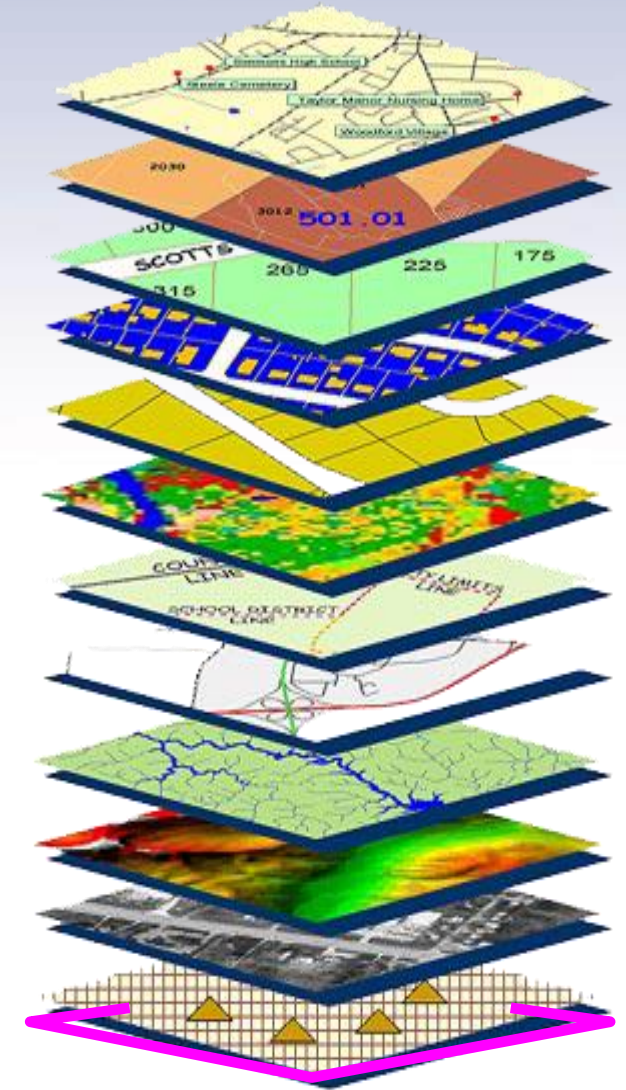
Easiest way to think of “geodetic control”:

Points with Coordinates

****Soon to be Coordinates as a function of time*

Without a geodetic control “base map” layer, GIS applications will not align properly!

Geodetic control needs to be more accurate than any survey or map which builds upon it

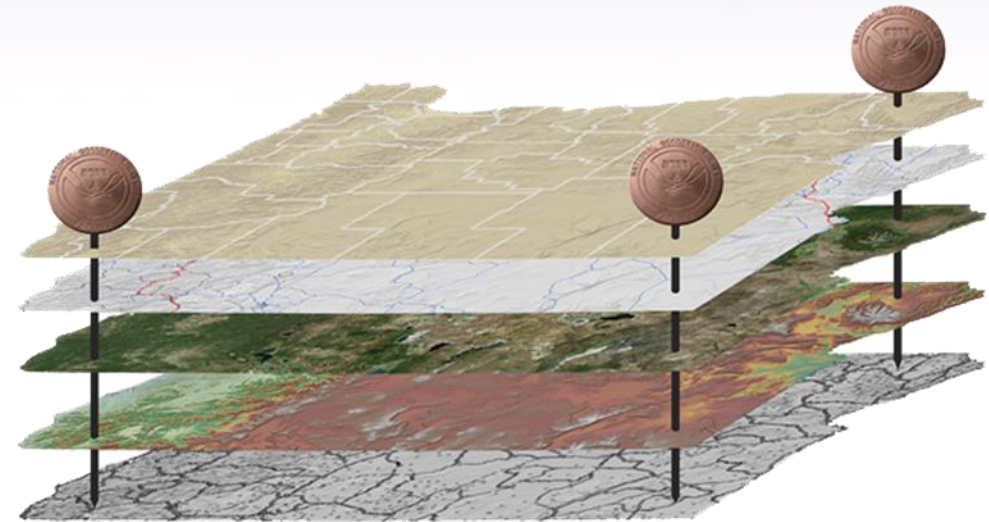


The National Spatial Reference System (NSRS)

NGS defines, maintains and provides access to the NSRS to meet our Nation's economic, social & environmental needs

Latitude • Longitude • Elevation •
Gravity • Shoreline Position
+ changes over time

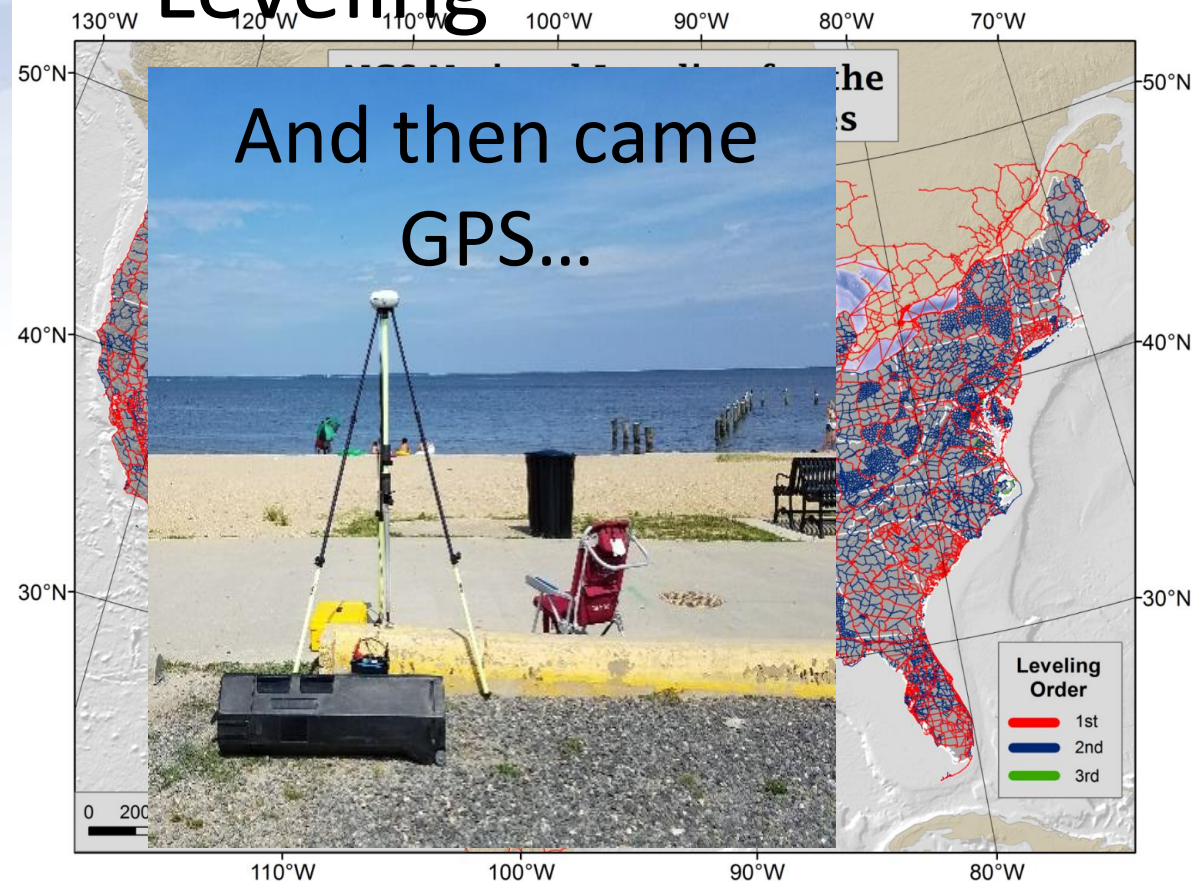
- North American Datum of 1983 (**NAD 83**)
- North American Vertical Datum of 1988 (**NAVD 88**)



Today's NSRS

North American Vertical Datum of 1988 is Based on Continental Scale Geodetic Leveling

Orthometric
Heights tell you
which way water
will flow



NAVD 88 consists of about 800,000 bench marks connected by about 2.2M km of leveling observed over a span of 80+ years and all adjusted together.

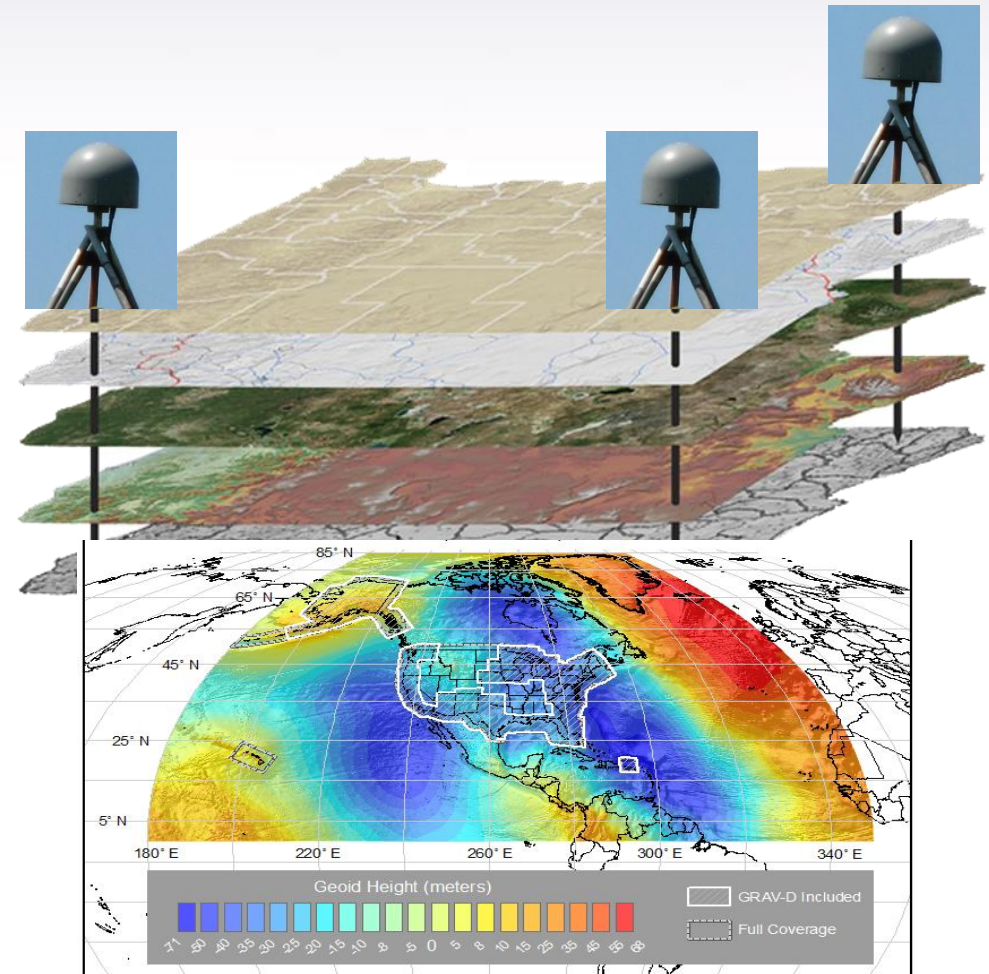
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Latitude • Longitude • Elevation • Gravity • Shoreline Position
+ changes over time

- North American Terrestrial Reference Frame (NATRF 2022)
- Caribbean Terrestrial Reference Frame (CATRF 2022)
- Pacific Terrestrial Reference Frame (PATRF 2022)
- Marianas Terrestrial Reference Frame (MATRF 2022)

North America and Pacific Geopotential Datum (NAPGD 2022)



July 24, 2020- Federal Register Notice Published

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44865

DEPARTMENT OF COMMERCE**National Oceanic and Atmospheric Administration****Consideration of Potential Age-Limiting Observations To Be Used To Compute 2020.00 Reference Epoch Coordinates in the National Spatial Reference System**

AGENCY: The Office of the National Geodetic Survey (NGS), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), Department of Commerce (DOC).

ACTION: Request for information.

SUMMARY: The National Geodetic Survey (NGS) is considering imposing age limits on the observations that will be used in the creation of 2020.00 Reference Epoch Coordinates (RECs), as part of the modernization of the National Spatial Reference System (NSRS). Due to expected uncertainties in the vertical component of the Intra-Frame Velocity Model (IFVM), the age limits cannot be determined until well-structured, data-driven experiments have been conducted. Such experiments are expected to occur during the 2020 reference epoch adjustment projects (geometric, orthometric, and gravimetric), which are scheduled for calendar year 2022. Therefore, NGS requests that users take new Global Navigation Satellite System (GNSS) observations on geodetic control marks of interest, especially those marks that have not been surveyed since January 1, 2010, and share them with NGS before December 31, 2021.

DATES: The effective date of this announcement is upon publication of this notice. Submission of GNSS observations on geodetic control marks of interest are requested before December 31, 2021.

ADDRESS: National Geodetic Survey, 1315 East-West Highway, Silver Spring, MD 20910.

FOR FURTHER INFORMATION CONTACT: Dr. Dru Smith, NSRS Modernization Manager, by email at dru.smith@noaa.gov, by phone at (240) 533-9654, or by mail at NOAA/NGS 1315 East-West Highway, Silver Spring, MD, 20910.

SUPPLEMENTARY INFORMATION: In 2017, the National Geodetic Survey (NGS) announced its plans to estimate RECs on a five-year cycle in NOAA Technical Report NOS NGS 67, 2019, starting with the first reference epoch at 2020.00, as part of the modernization of the NSRS.

In the Technical Report, the exact observations to be used for this estimation were listed as "To Be

Determined." Now, NGS is considering imposing age limits upon the observations that will be used, particularly because of expected uncertainties in the vertical component of the IFVM. These age limits cannot be determined until additional well-structured, data-driven experiments are conducted. Such experiments are expected to occur during the 2020 reference epoch adjustment projects (geometric, orthometric, and gravimetric), which are scheduled for calendar year 2022.

However, since the cut-off for new observations to enter those adjustment projects is December 31, 2021, any decision to age-limit input observations will come too late for submissions to impact the 2020 REC. While the cut-off for age-limited observations is unknown, certain assumptions are safe to make. For instance, it is unlikely that such an age-limit will be fewer than 10 years. Older observations may be used in the estimation of 2020 RECs, but this cannot be guaranteed. As such, NGS requests that users take new GNSS observations on geodetic control marks of interest that have not been surveyed since January 1, 2010, and asks the users to submit the observations to NGS before December 31, 2021. Users may either (a) submit existing unsubmitted observations through the OPUS-Share tool or (b) conduct new GNSS observations and submit the data to NGS via the OPUS-Share tool.

In order to increase the submission of GNSS observations on marks, NGS is prioritizing the finalization of an expanded OPUS-Projects tool, which will allow real-time kinematic and real-time network (RTK/RIN) observations to be submitted, rather than the standard four-hour observations required in OPUS-Share. Initial roll-out of this new tool is expected to occur during calendar year 2020.

This action is designed to increase both the number and the coordinate accuracy of geodetic control points, which in the modernized NSRS will have an estimated 2020.00 REC. Historically, NGS has combined data across multiple decades to estimate geodetic coordinates, yet such efforts have not fully accounted for the lack of information about vertical motion of geodetic control points throughout the years. Since height information is critical to the understanding of floods, failure to compute heights accurately can have negative impacts on property and lives. NGS views periodic re-surveys of geodetic control points, rather than the estimation of coordinates from observations that are years (or even decades) old, as the most effective way

to maintain accurate and up-to-date knowledge of geodetic coordinates, including heights. As such, this announcement provides users of the NSRS with advance notice that geodetic control points of interest to them should be re-surveyed for the most accurate representation of geodetic coordinates, including heights.

(Authority: Coast and Geodetic Survey Act of 1947, 33 U.S.C. 833a et seq.)

Juliana P. Blackwell,
Director, National Geodetic Survey, National Ocean Service, National Oceanic and Atmospheric Administration.
(FR Doc. 2020-16164 Filed 7-23-20; 8:45 am)
BILLING CODE 3510-JE-P

COMMITTEE FOR PURCHASE FROM PEOPLE WHO ARE BLIND OR SEVERELY DISABLED**Procurement List; Proposed Deletions**

AGENCY: Committee for Purchase From People Who Are Blind or Severely Disabled.

ACTION: Proposed Deletions from the Procurement List.

SUMMARY: The Committee is proposing to delete products and services on the Procurement List furnished by nonprofit agencies employing persons who are blind or have other severe disabilities.

DATES: Comments must be received on or before August 23, 2020.

ADDRESSES: Committee for Purchase From People Who Are Blind or Severely Disabled, 1401 S. Clark Street, Suite 715, Arlington, Virginia, 22202-4149.

FOR FURTHER INFORMATION CONTACT: For further information or to submit comments contact: Michael R. Jurkowski, Telephone: (703) 603-2117, Fax: (703) 603-0655, or email CMTPedBuy@AbilityOne.gov.

SUPPLEMENTARY INFORMATION: This notice is published pursuant to 41 U.S.C. 8503 (a)(2) and 41 CFR 51-2.3. Its purpose is to provide interested persons an opportunity to submit comments on the proposal actions.

Deletions

The following products and services are proposed for deletion from the Procurement List:

Products

NSN(s)—Product Name(s):
8415-01-387-983—Drawers, Underwear, Midweight Flw Retardant, F7EE, Army, Desert Sand, X55
8415-01-387-985—Drawers, Underwear, Midweight Flw Retardant, F7EE, Army, Desert Sand, X5R

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Set the framework of what NGS required for passive station coordinates to be considered 'current' for 2022 datum and be used in the forthcoming transformation tool.

- Said there must be two consistent GNSS observations on a station with at least one since 2014.

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AS SUCH, THIS ANNOUNCEMENT PROVIDES USERS OF THE NSRS (NATIONAL SPATIAL REFERENCE SYSTEM) WITH NOTICE THAT PASSIVE GEODETIC CONTROL POINTS OF INTEREST SHOULD BE RE-SURVEYED FOR THE MOST ACCURATE REPRESENTATION OF GEODETIC COORDINATES, INCLUDING HEIGHTS.

GPS on Bench Marks - What & Why?

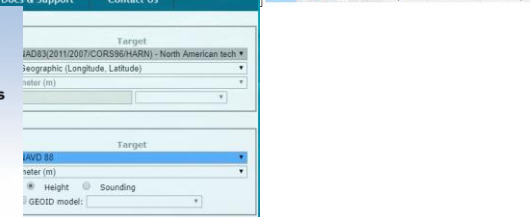
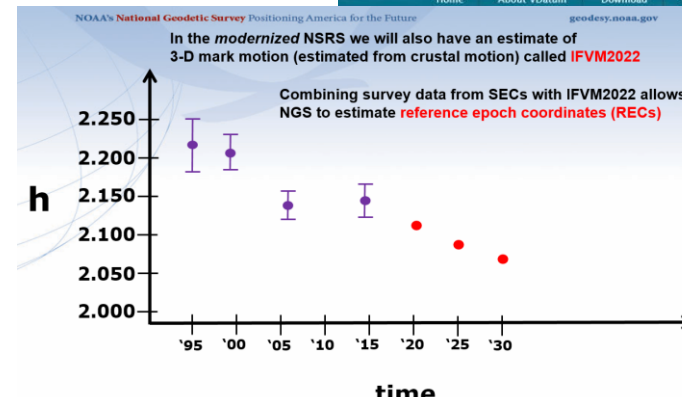
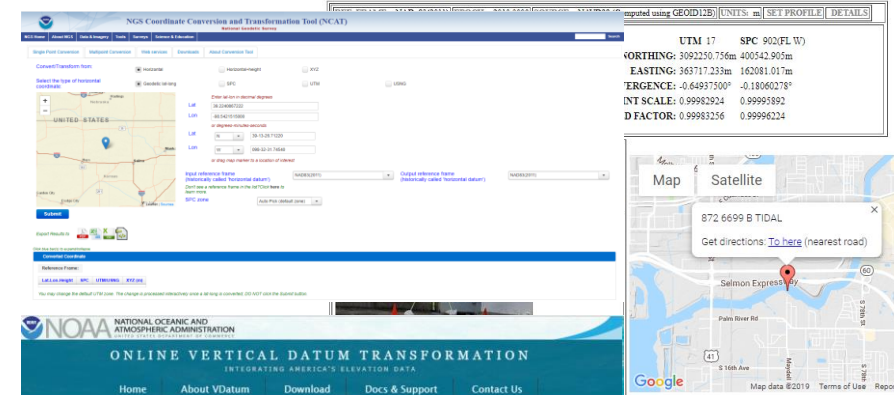
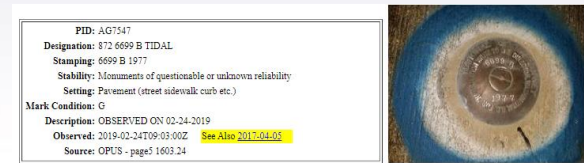
GPS on Bench Marks is about preparing the country and our communities to take full advantage of the benefits of the Modernized NSRS, by collecting new GPS observations on bench marks with published NAVD 88 heights.

Primary GPSONBM Campaign Benefits:

- 2020.0 Reference Epoch Coordinates (REC's)
- Data for NAVD 88 – NAPGD2022 Transformation Tools
- Build time series of observations in areas of motion

Added benefits:

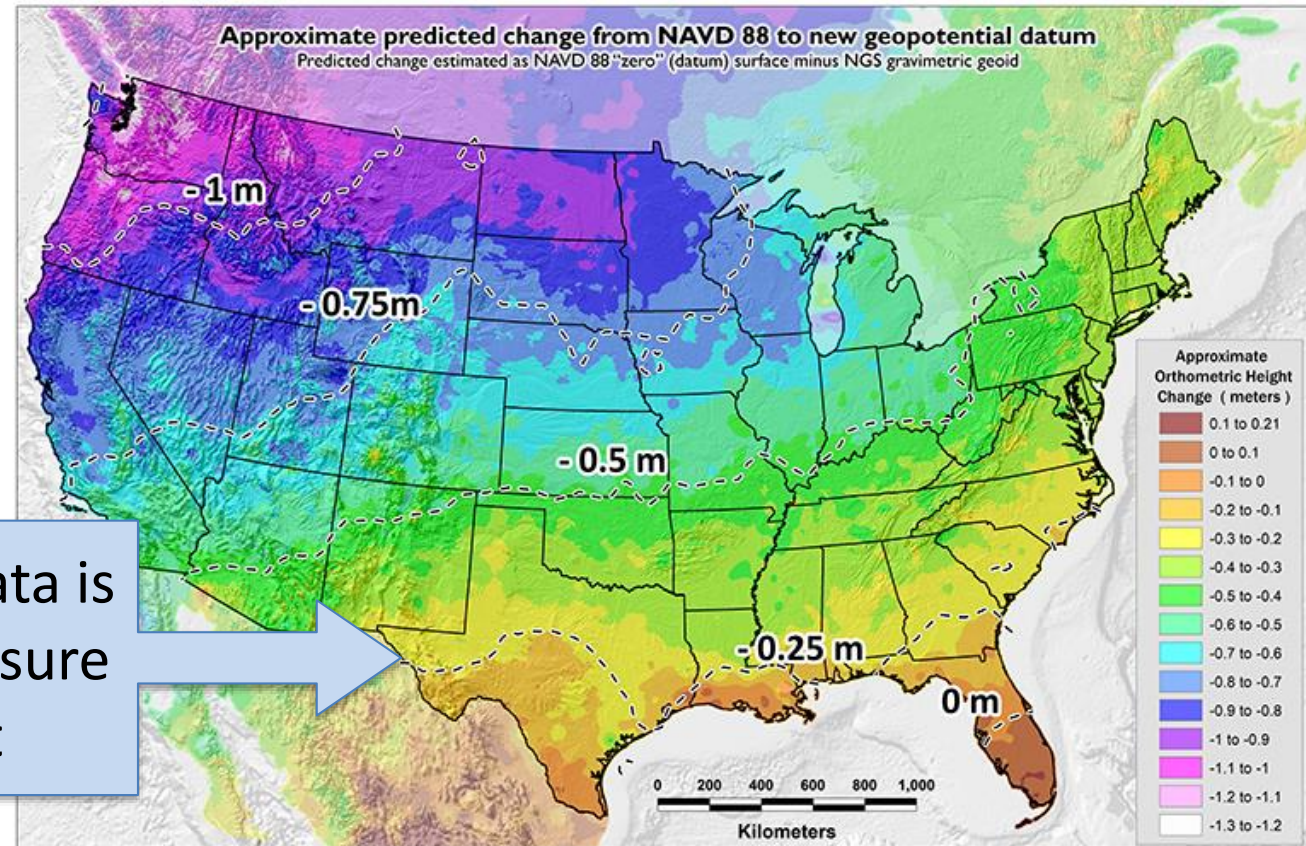
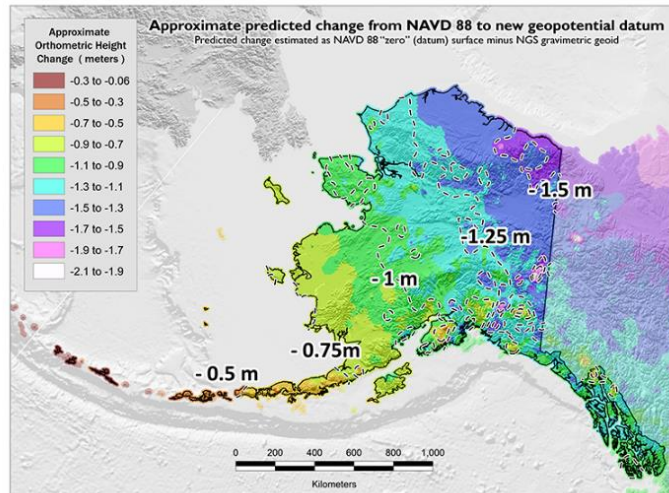
- Evaluate gravimetric geoid models
- Check your RTN results
- Update and maintain passive control marks
- Identify marks suspected of movement



GPSonBM Measurements Connect Current and Future Datums

The relationship between the old and new datums vary by location. GPSonBM data is used to measure that relationship. The accuracy of the transformations in any particular place will be directly related to the density of GPSonBM data available in that area.

In moving from NAVD 88 to NAPGD2022, there will be a Shift: A one-time 0 to 2 meter jump in orthometric heights
 -From fixing biases and/or tilts in NAVD 88



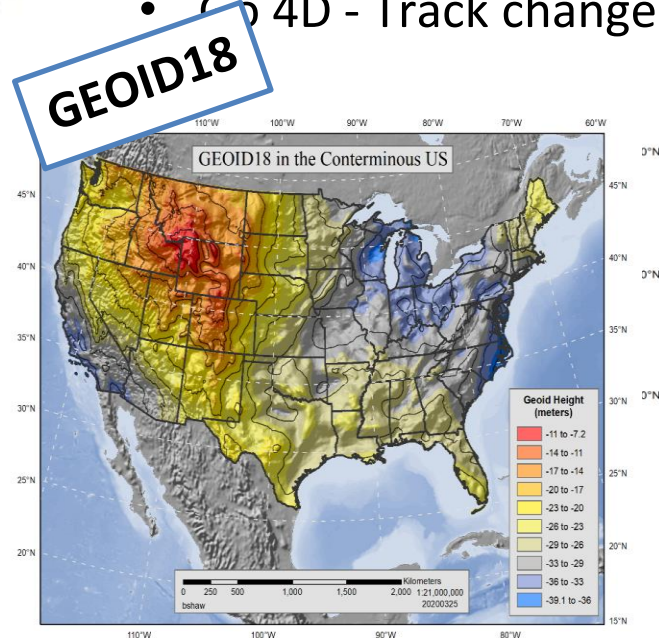
GPSonBM data is used to measure the Shift

Building on the Past to Prepare for the Future

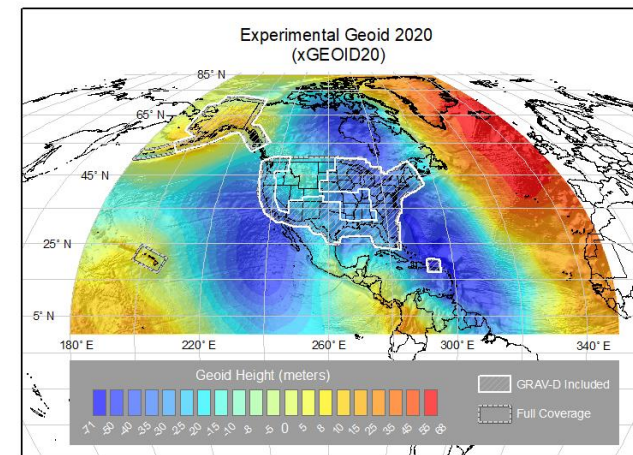
GPS on Bench Marks is about collecting new GPS / GNSS data on existing NGS marks with published NAVD 88 orthometric heights. It's about building the Transformation Tool to connect the past and future Datums and preparing the country and our communities to take full advantage of the benefits of the Modernized NSRS

Benefits of Participating in GPSONBM:

- Improve local results of NAVD 88 – NAPGD2022 Transformation Tools
- Receive 2020.00 Reference Epoch Coordinates (REC's) with initial release of Modernized system
- Go 4D - Track changes over time with Survey Epoch Coordinates (SEC's)



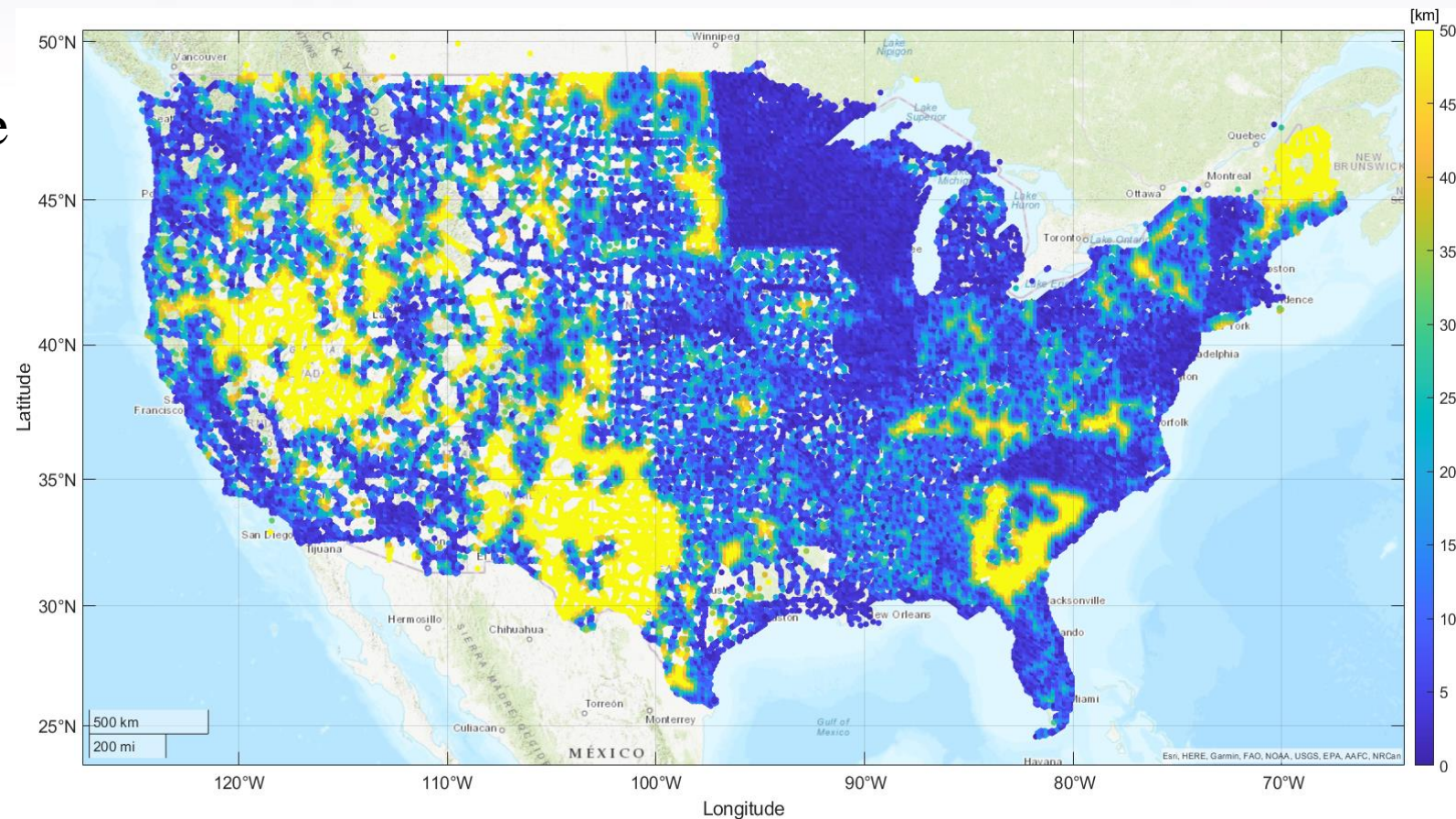
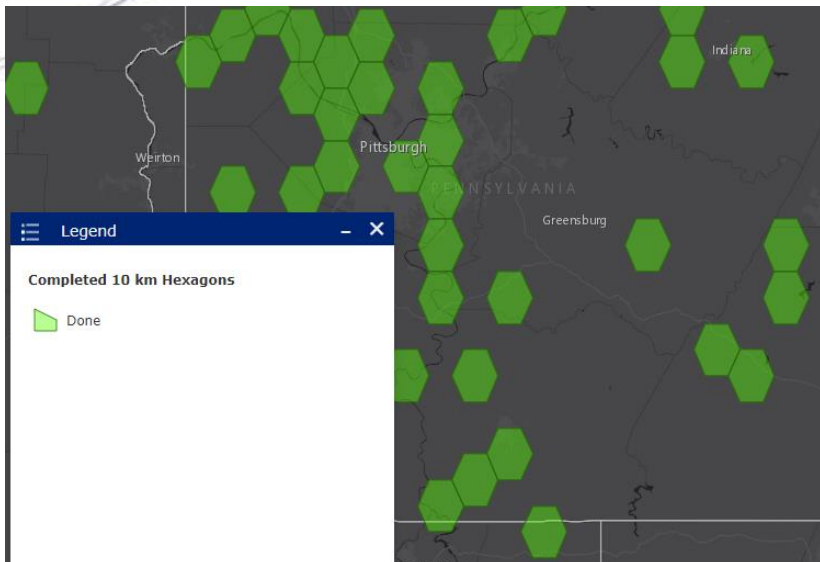
- Update Passive Control Status
- Check your RTN results



2022 Transformation Tool Campaign

NGS will make a **national scale, mapping grade** transformation tool with the data we have in the NGS Database and Shared through OPUS. We must interpolate over areas with data gaps.

Uncertainties in the transformed coordinates will grow larger as the distance from a GPSONBM data point increases.



National Coverage and Local Densification

- NGS has a National Coverage goal of 10 km spacing
- 10 km hexagons illustrate this coverage on the map
- Priority marks within each hexagon are selected automatically based on their metadata
- Once the 10 km goal is reached, the opportunity to densify the model and improve local results is unlocked. 2 km hexagons appear along with new priority marks within those hexagons

Priority A Hexagons are Gold



Priority B hexagons are Blue





Hexagons where we have the data we need are marked Done and colored Green



NEW DEADLINE for GPSonBM Data Submittal!!

****Data contributed by Dec 31, 2022 will be considered for use in creating the transformation tool**

Data Contribution Routes

	 <p>via OPUS option "share my solution"</p> <p>share my solution <input type="text" value="Yes, share"/></p>	 <p>via OPUS option "project ID"</p> <p>project identifier <input type="text"/></p>
WHAT DATA?	<p>minimal one receiver, one 4+ hour observation</p>	<p>more; many receivers, redundant sessions, network adjusted by project manager</p>
USE, in transformation tool	<p>Will be used in modeling, existing BMs only (with published ortho heights)</p>	<p>Will be used in modeling, all marks, as projects publish new NGS datasheets with ortho heights</p>
USE, in current generation datasheets	<p>for all marks, results appear as 'shared solutions' = not published geodetic control <i>for existing BM datasheets only, updates "SCALED">"HD_HELD2" coordinates</i></p>	<p>for all marks, results appear as NGS datasheets = published geodetic control</p>
USE, in next generation datasheets	<p>will be published with 2020.00 RECs in the modernized NSRS</p>	

see also, **mark recovery** to update mark descriptions and add photos

State Plane Coordinate System of 2022

SPCS2022

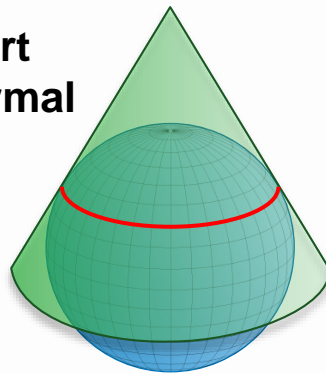
Previous State Plane webinars

- [The State Plane Coordinate System: History, Policy, Future Directions](#) (March 8, 2018)
- [Building a State Plane Coordinate System for the Future](#) (April 12, 2018)
- [State Plane Coordinate System Update](#) (March 7, 2019)
- [The State Plane Coordinate System of 2022: Making It Your Way](#) (May 6, 2019, at Geospatial Summit)
- [Be a Part of the Change: A Guide to Customizing State Plane for 2022](#) (October 10, 2019)

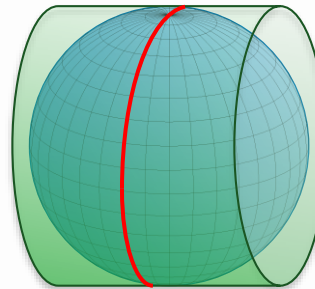
A New State Plane for 2022

- State Plane Coordinate System of 2022 (SPCS2022)
 - Referenced to 2022 Terrestrial Reference Frames (TRFs)
 - Based on same reference ellipsoid as SPCS 83 (GRS 80)
 - Same 3 conformal projection types as SPCS 83 and 27:

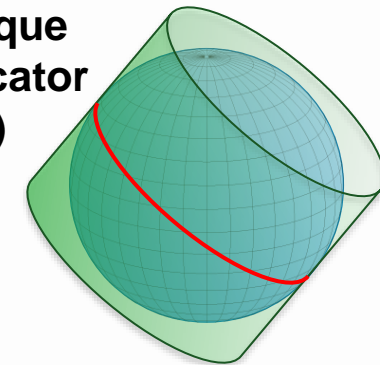
**Lambert
Conformal
Conic
(LCC)**



**Transverse
Mercator
(TM)**



**Oblique
Mercator
(OM)**



We ❤️ projected coordinate systems

SPCS2022
Making the Earth flat again
...one zone at a time

Overall SPCS2022 characteristics

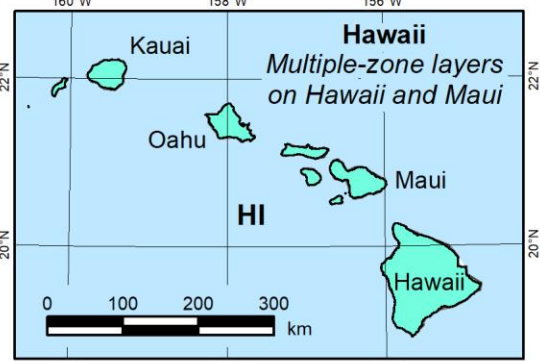
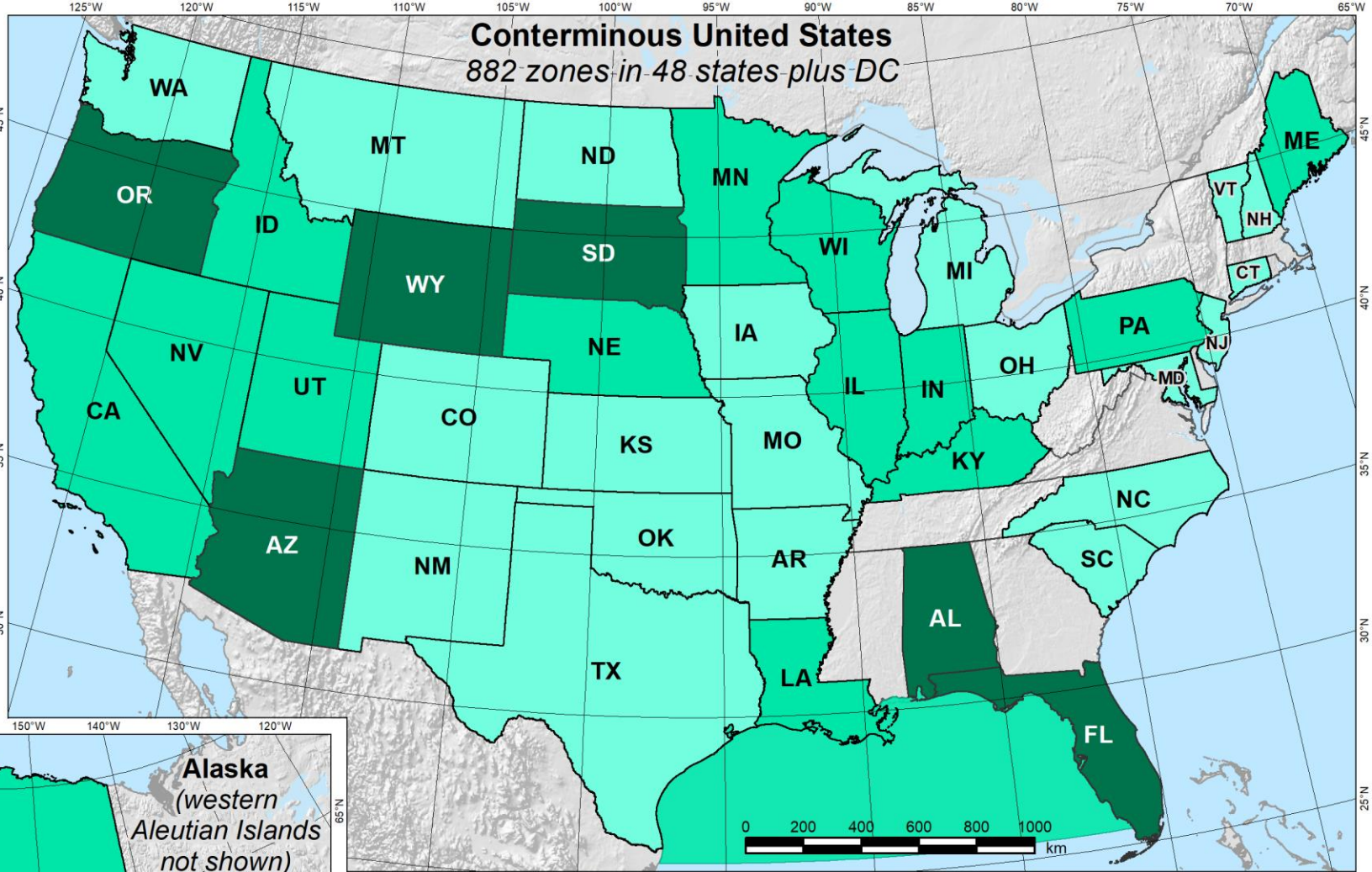
- Minimize distortion at ***topo surface, not*** ellipsoid
- Max of up to **3 zone “layers”** allowed
 - 1 statewide ***plus*** 0, 1, or 2 multiple-zone layers
 - Most states will have total of 2 layers
- Many states made ***requests*** and ***proposals***
 - ***Proposals*** are for zones designed by the states
 - Can include “low-distortion projections” (LDPs)
- NGS will design:
 - ***Statewide*** zone for every state
 - ***Default*** zones if no input from stakeholders (most with same zone extents and projection type as SPCS 83)
 - Zones formally ***requested*** by states

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

No forms from four island territories:

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

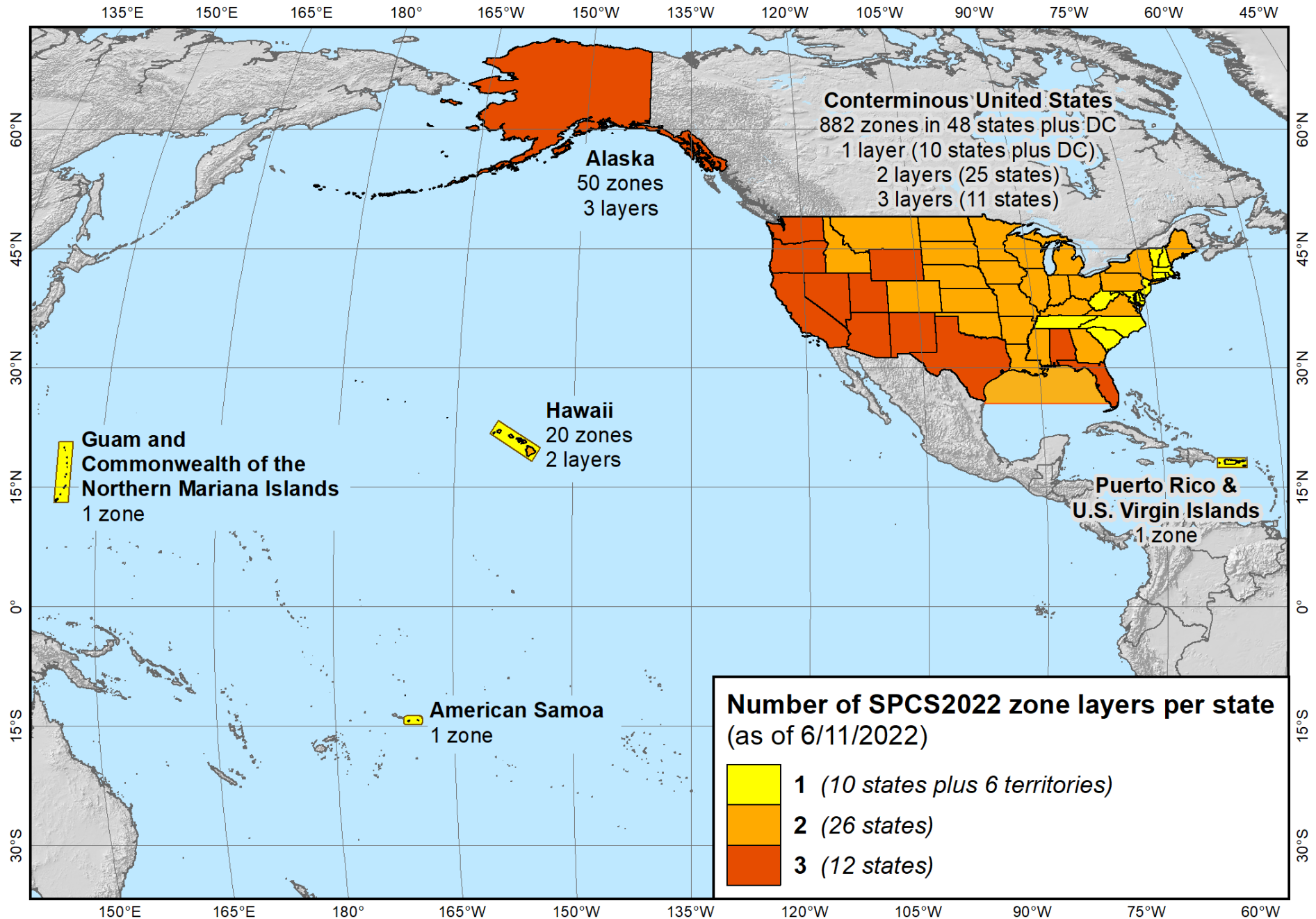
Conterminous United States 882 zones in 48 states plus DC

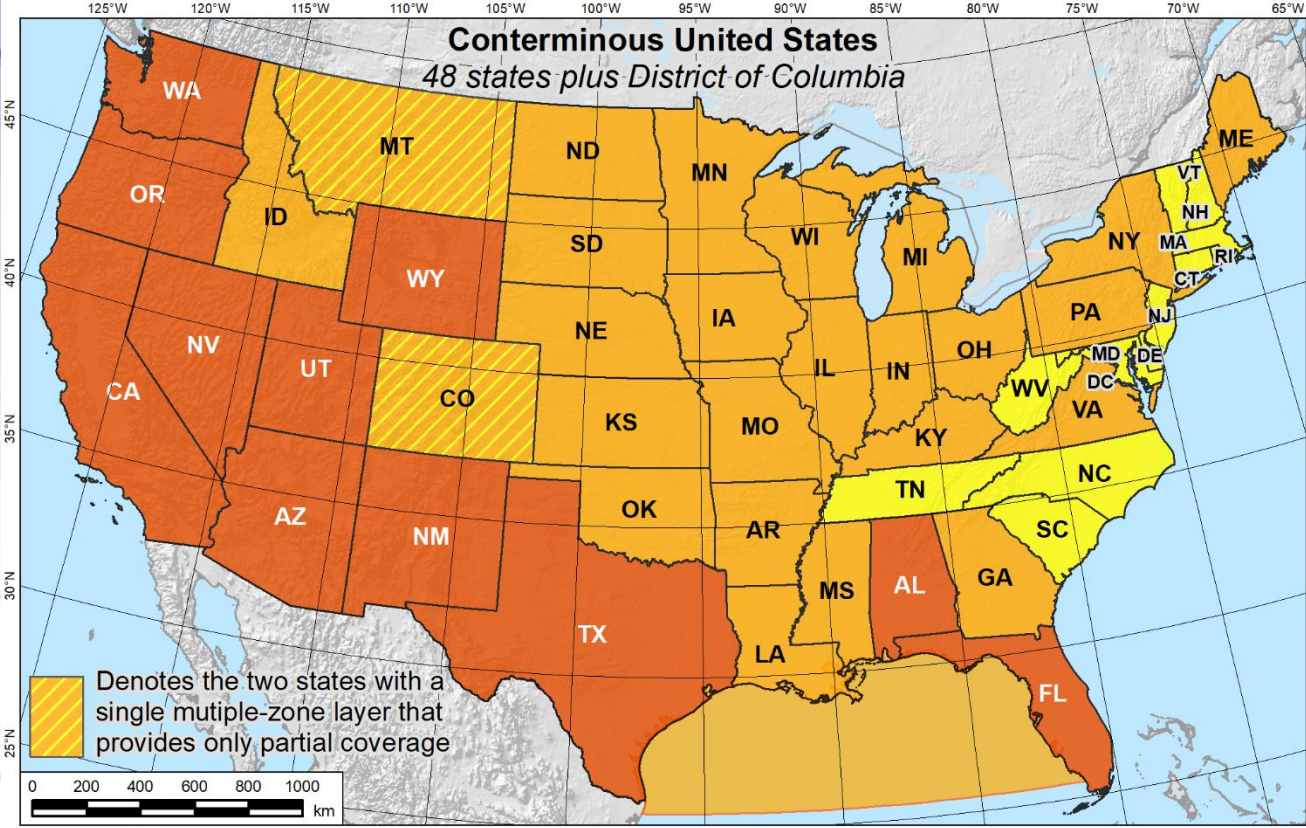


Number of forms per state
Total = 67 from 41 states
(36 requests, 31 proposals)

- 1 (21 states)
- 2 (14 states)
- 3 (6 states)

State Plane Coordinate System of 2022 (955 zones in 56 states and territories)

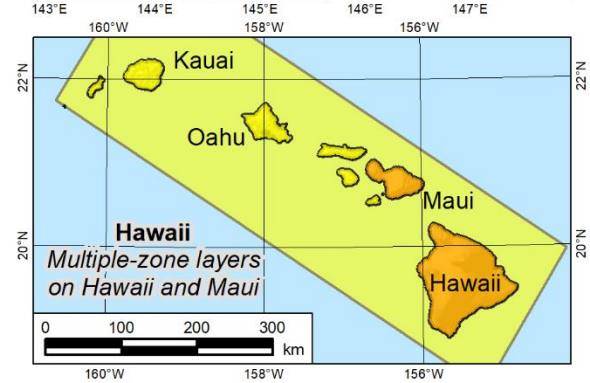
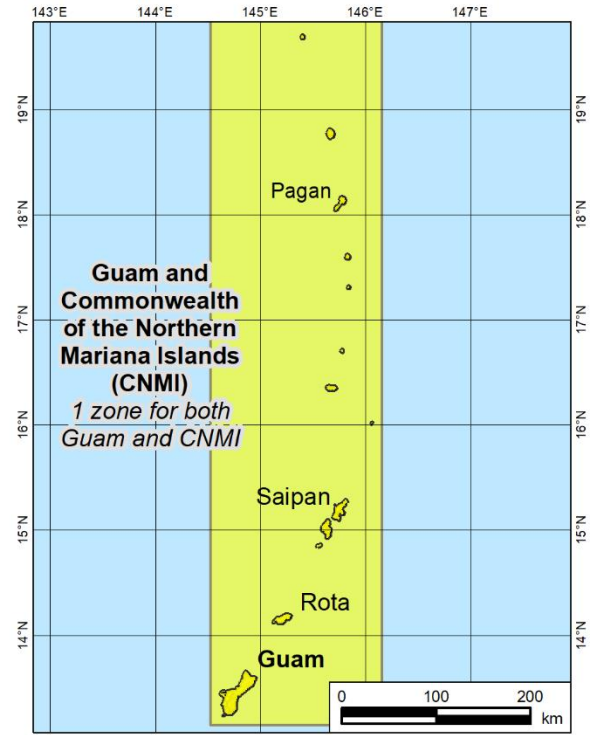
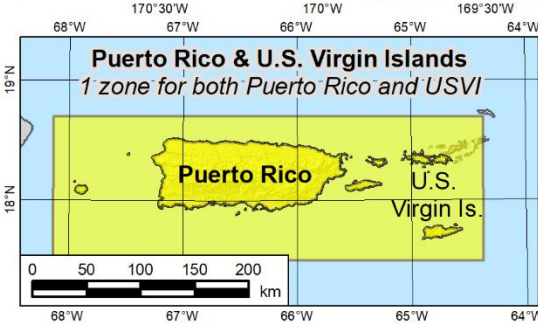
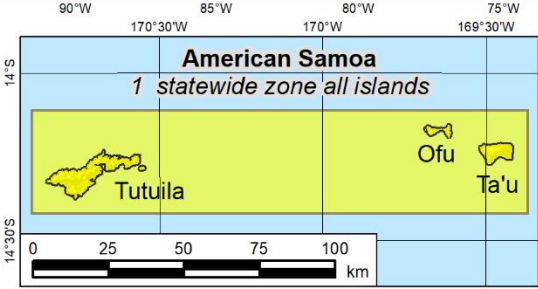




State Plane Coordinate System of 2022

Number zone layers (6/11/2020)

- 1 (10 states plus 6 territories)
- 2 (26 states)
- 3 (12 states)



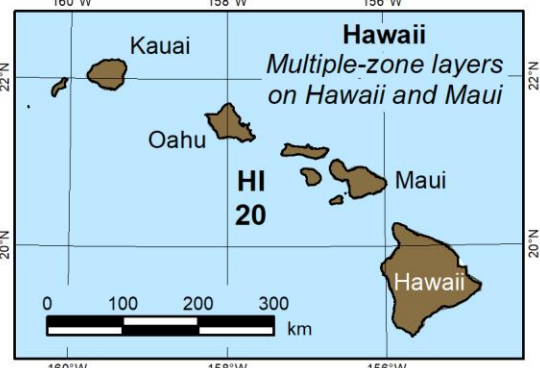
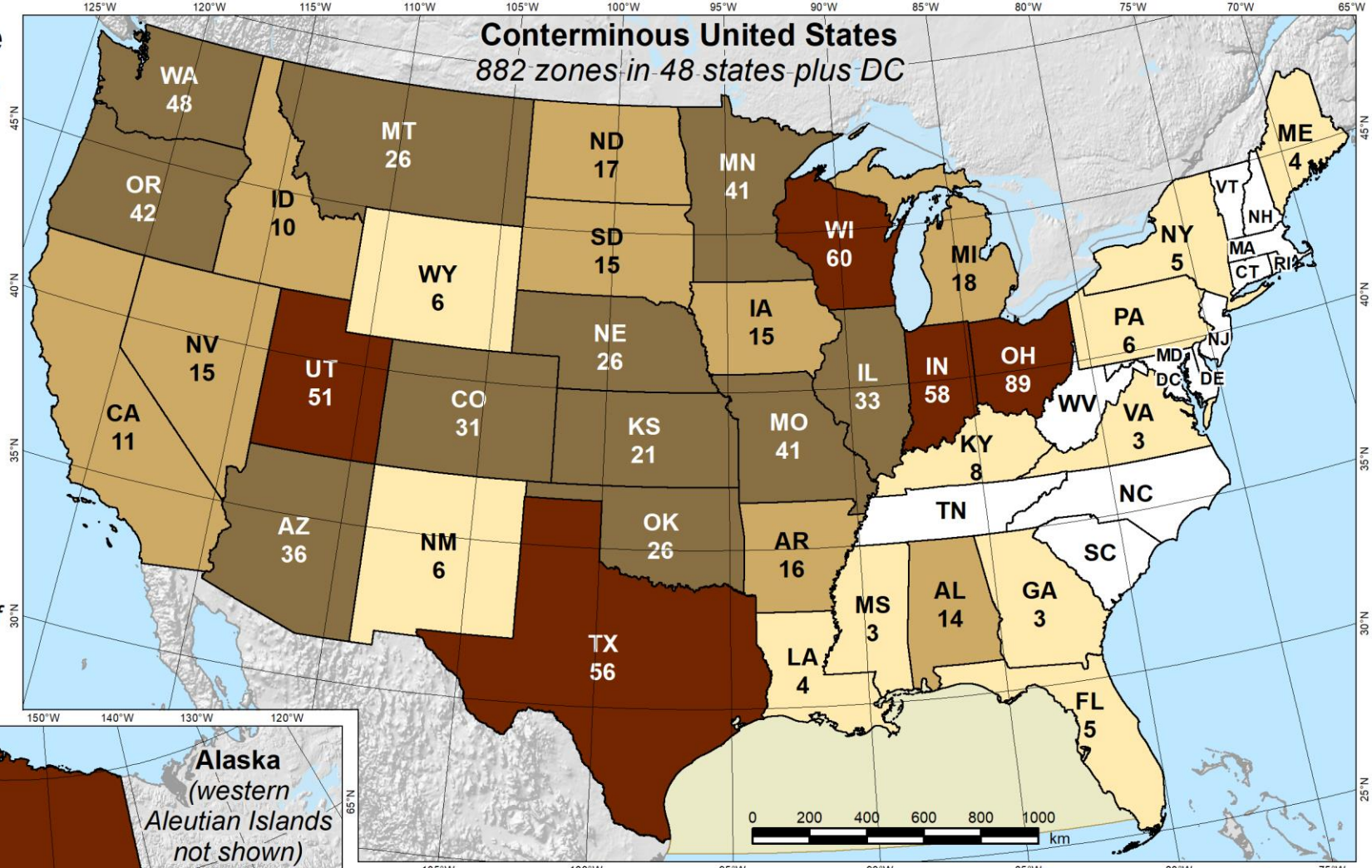
State Plane Coordinate System of 2022 (CONUS, Alaska, and Hawaii)

Three island zones not shown:
Puerto Rico and U.S. Virgin Islands

American Samoa

Guam and Commonwealth of the Northern Mariana Islands

Conterminous United States 882 zones in 48 states plus DC



Number of zones per state
Total = 955 (as of 6/11/2020)

- 1 zone (16 states)
- 3 - 8 zones (11 states)
- 10 - 18 zones (9 states)
- 20 - 48 zones (12 states)
- 50 - 89 zones (6 states)



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Coming in 2022:
New Datums!
Learn more...



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- Maps of SPCS 83 and 27
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Have State Plane Questions?
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State Plane Coordinate System (SPCS)

SPCS is a system of large-scale conformal map projections originally created in the 1930s to support surveying, engineering, and mapping activities throughout the U.S. and its territories. As a reminder, a map projection is a systematic transformation of the latitudes and longitudes of locations on the surface of a sphere or ellipsoid representing the Earth to grid coordinates (x, y or easting, northing values) on a plane.

Since its inception, SPCS has served as a practical means for NGS customers to access to the National

Spatial
policies
SPCS v
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Preliminary SPCS2022 Design Maps

NGS is currently in the process of creating preliminary designs for State Plane Coordinate System of 2022 (SPCS2022) zones. These preliminary designs will likely be very close to those eventually adopted by NGS, except in cases where U.S. state and territory stakeholders adopt approved alternative designs.

Download SPCS2022 Design Maps

Continuously updated **SPCS2022 design map** images and associated **map data** are available for download.

The maps show linear distortion at the topographic surface for SPCS2022, along with existing State Plane and Universal Transverse Mercator (UTM) for comparison.

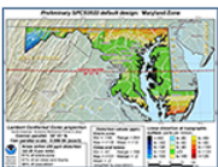
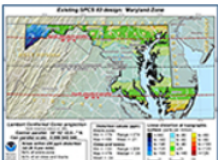
Map data consists of linear distortion rasters and other GIS feature datasets used to create the map.

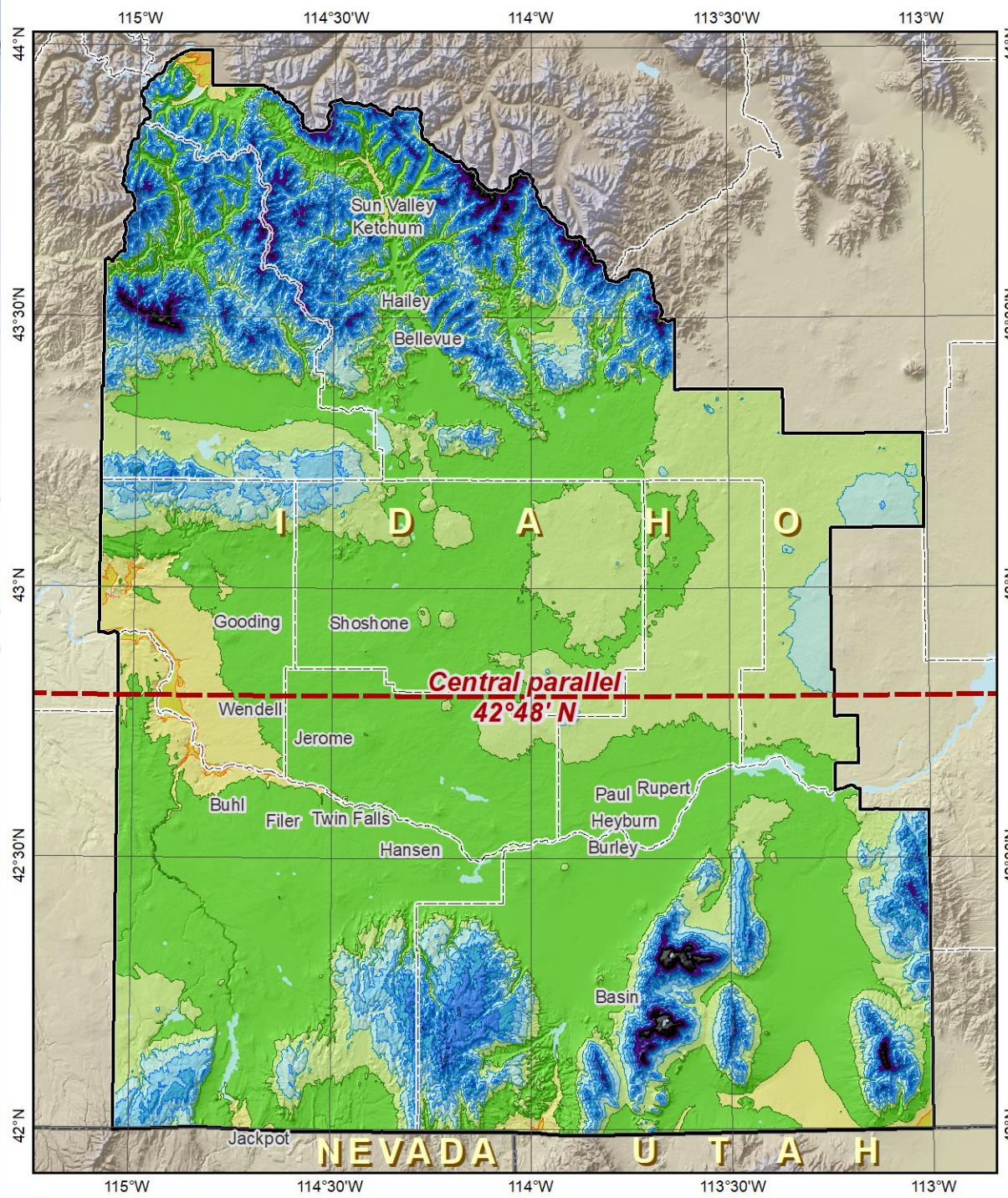
Download
SPCS2022 Design Maps

Download
SPCS2022 Map Data

If zones for your state or territory are not available, please contact the **SPCS Team**.

Example of Downloaded Design Maps





**Preliminary SPCS2022
default design:
Idaho
Central South Zone**



Lambert Conformal Conic projection

North American Terrestrial Reference Frame of 2022

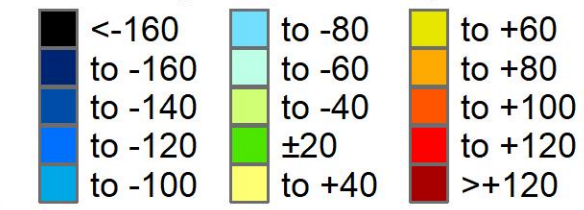
Central parallel: 42°48' N
Central parallel scale: 1.000 18 (exact)

**Areas within ±30 ppm distortion
(1:33,333 = ±0.16 ft per mile):**

- 97% of population
- 98% of all cities and towns
- 66% of entire zone area

Distortion values (ppm)	
Entire zone:	Cities and towns:
Min, Max = -250, +72	Min = -27
Range = 322	Max = +41
Mean = -26	Range = 69
Weighted mean = +5 (weighted by population)	Mean = +0.1

Linear distortion at topographic surface (parts per million)



SPCS2022 zone designs

- All designs so far are ***PRELIMINARY***
- Begin finalizing designs ***NOW***
 - Compile and compare all designs
 - Ensure consistent and correct
- Get stakeholder input before finalizing
 - Solicit input from stakeholders mid-2021
 - Finalize after stakeholder input
 - Provide preliminary complete parameters ***now***

About the timing of it all...

- Stakeholder designs due by **3/31/2021**
 - Finalize all designs by late 2021
- Official release with all of NSRS modernization
 - Cannot release prior to NSRS 2022 TRFs
 - But complete definitions available sooner
- Other things (by end of 2021...?)
 - Machine-readable definitions (e.g., WKT 2)
 - SPCS2022 report
 - Modify NGS algorithms (e.g., 1-parallel Lambert)
 - Check NGS algorithms (refine after 2021...?)

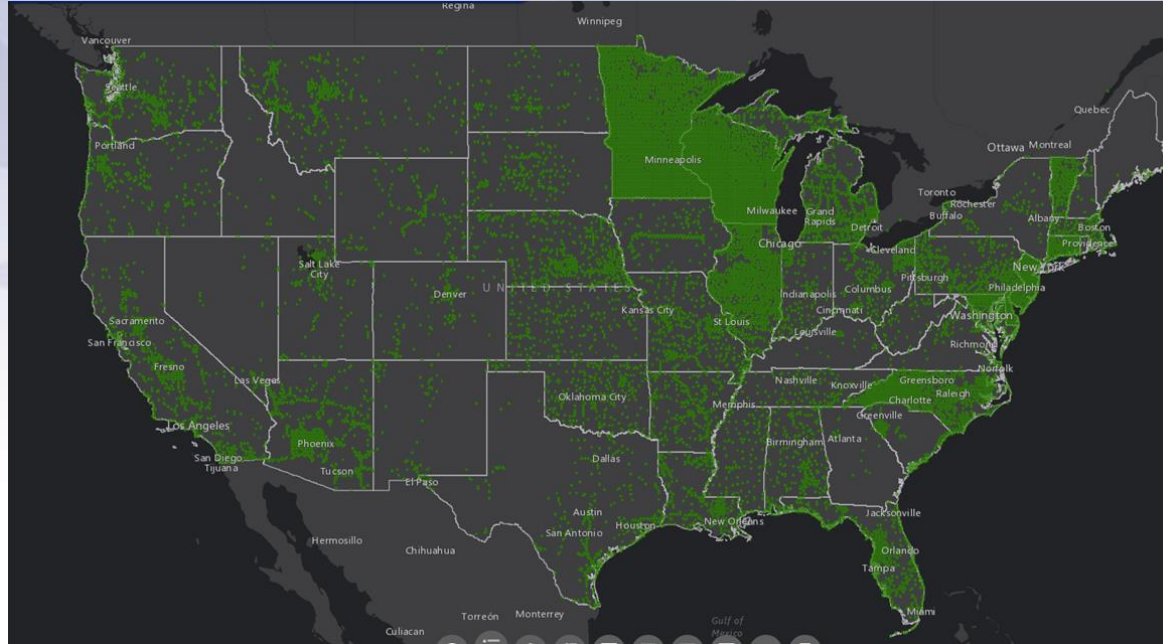
How can surveyors prepare?

- Research your published control
 - pre-1995 will **NOT** get new coordinates
- Use OPUS Projects to re-observe/process
- Set/occupy RTN Validation Stations (OPUS)
- Record ALL META DATA!
- Get familiar with terms, ask now, be ready

How can GIS experts prepare?

- Consider how you will store epoch dates
- Maps in ITRF2014 for LLh changes
- download xGEOID for elevation changes
 - could make difference maps
- Get familiar with terms, ask now, be ready
- Time dependency - some datasets will be good with transformations

***Think about how to document epochs/dates and ALL your meta data!!**



**The future is already here —
it's just not very evenly distributed.**

- William Gibson

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