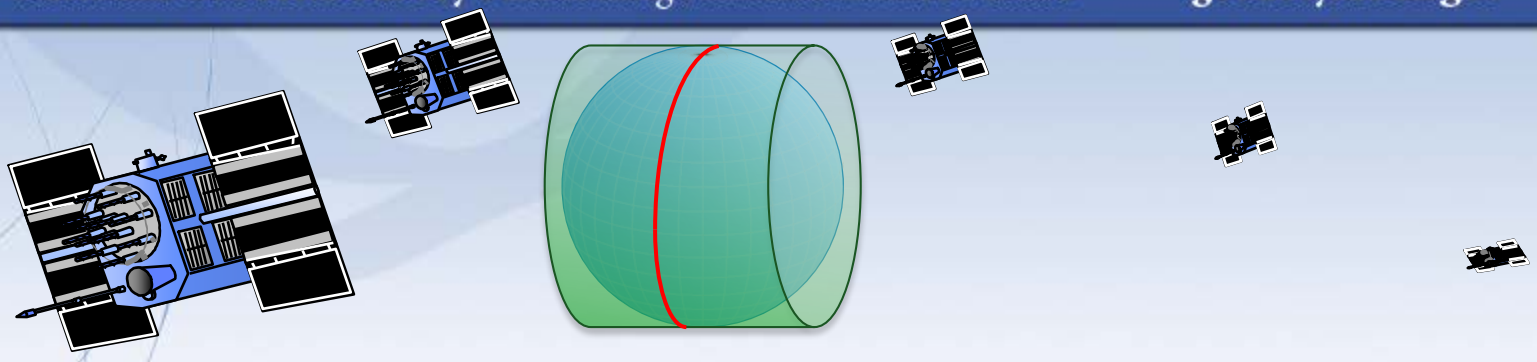


Shifting Ground: An Update on the *State Plane Coordinate System of 2022*

(one part of Replacing NAD83 & NAVD88)

William (Bill) Stone
Southwest Region (AZ, NM, UT) Geodetic Advisor

william.stone@noaa.gov

NOAA's National Geodetic Surve
geodesy.noaa.gov

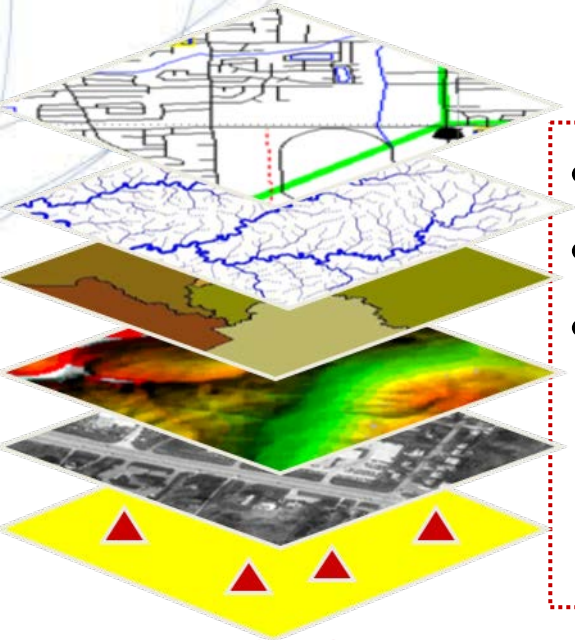
April 26, 2019
Albuquerque

NMGIC
New Mexico Geographic Information Council, Inc.
P.O. Box 92712, Albuquerque, NM 87199


FOSSILS!!
NAD83
NAVD88
BUGS
DINOSAUR BONES
SHARK TOOTH
DINOSAUR TOOTH
WE ACCEPT CREDIT CARDS

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

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



NSRS

NSRS

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

& their time variations

(& National Shoreline, etc.)

- **North American Datum 1983 (NAD83)**
- **North American Vertical Datum 1988 (NAVD88)**

LOS ANGELES AIR FORCE BASE

First GPS III satellite successfully launched

SMC Public Affairs / Published December 23, 2018

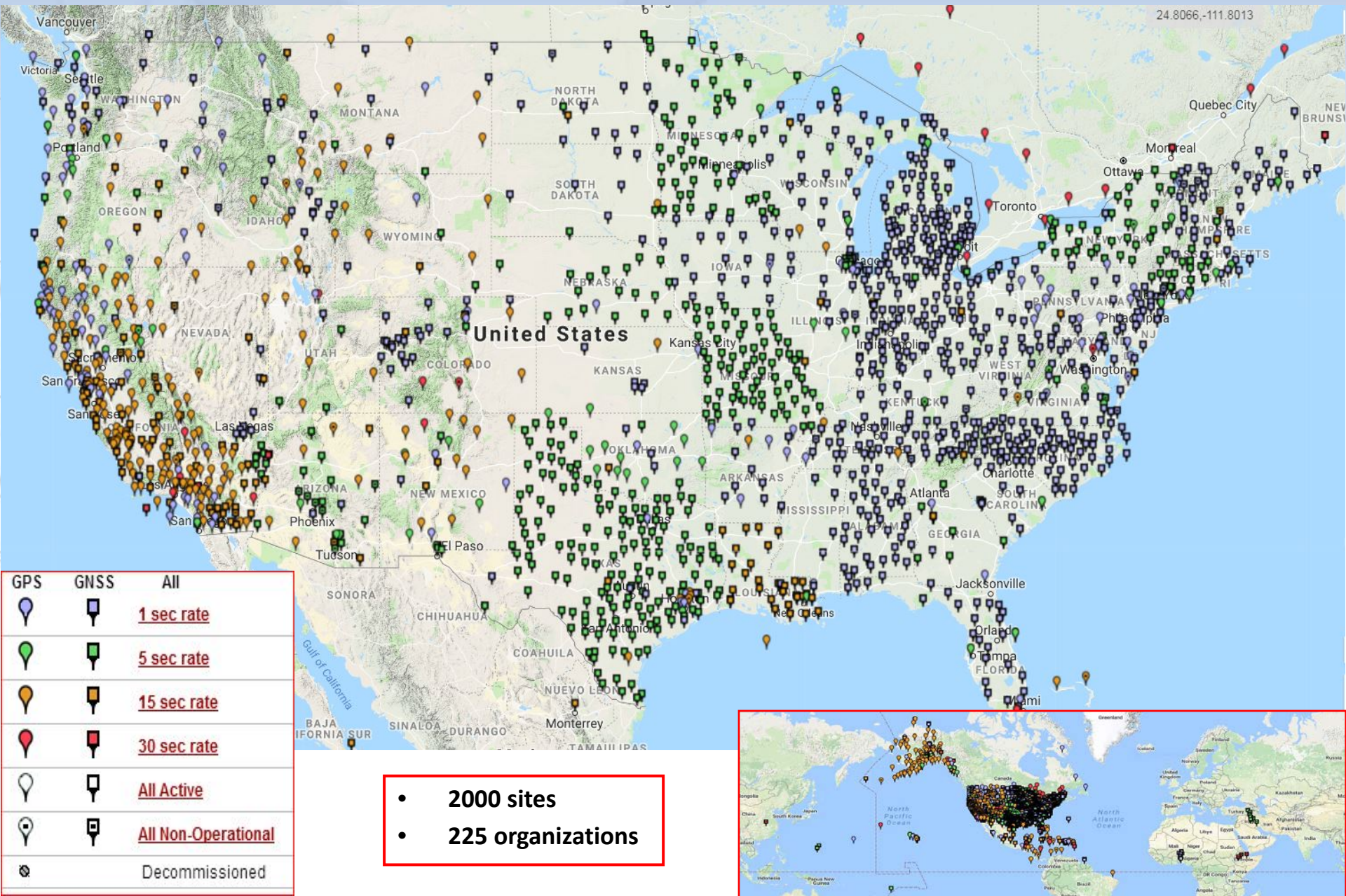
GPS III

GPS III will meet users' emerging needs and respond to tomorrow's threats with improved safety, signal integrity and unbelievable accuracy.

- On contract for 10 GPS III satellites
- Doubled design life of 15 years
- 3 times more accurate
- 8 times improved anti-jam capability
- L1C Global Navigation Satellite Systems (GNSS) compatibility
- Search and Rescue, Laser Reflector Array and Digital Payload at SV 11+
- Proven compatible with the current GPS constellation and the OCX ground control segment
- Designed to evolve to incorporate new technology and changing mission needs

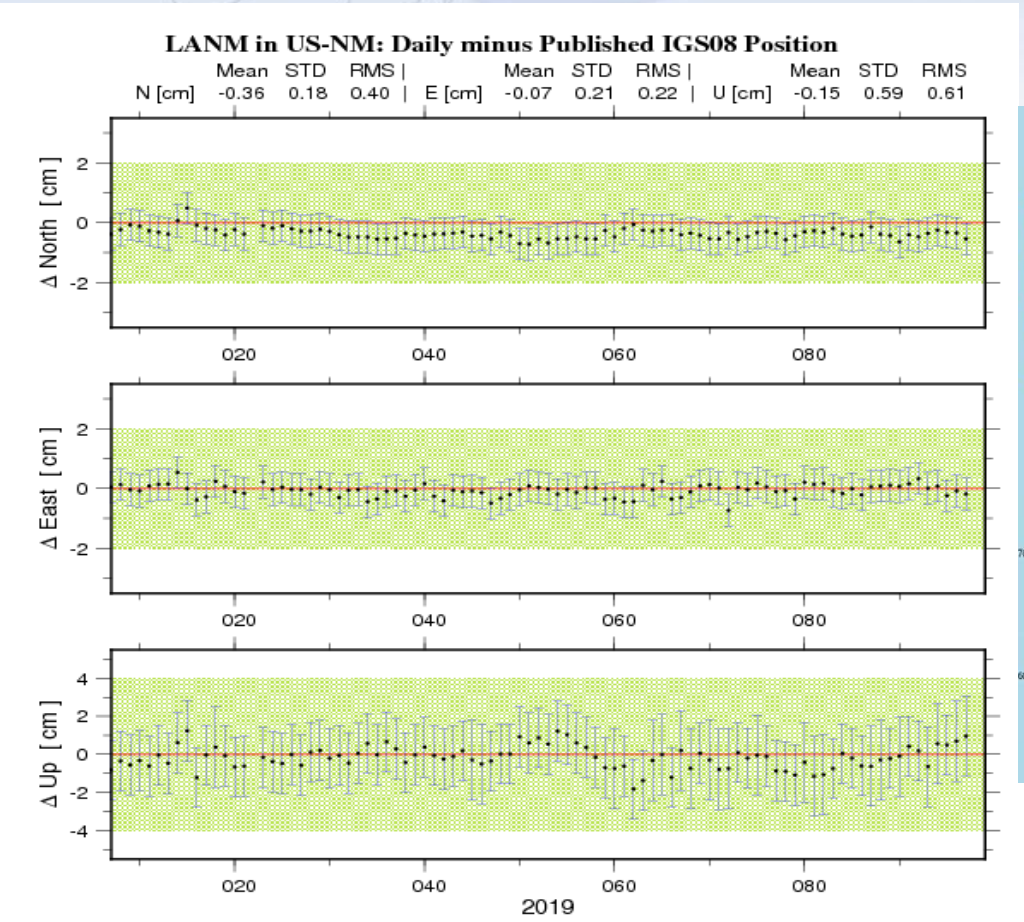
Continuously Operating Reference Station (CORS)

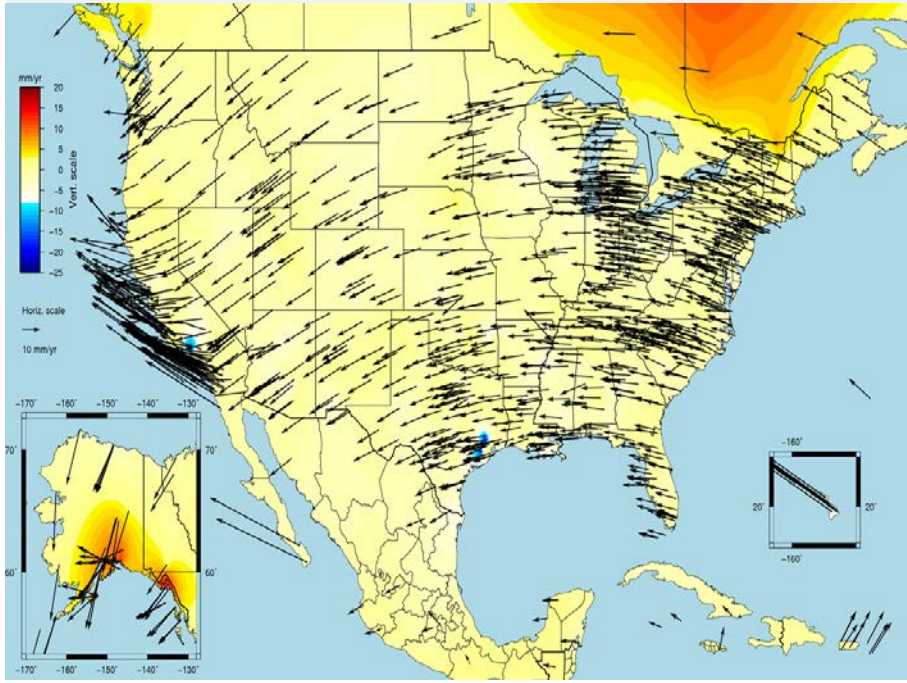
NOAA Continuously Operating Reference Station (CORS) Network



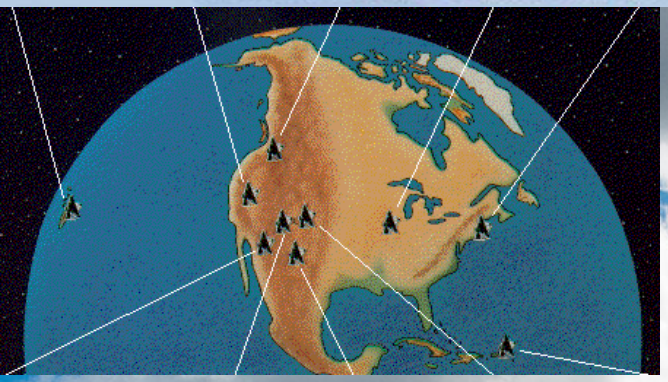
- **2000 sites**
- **225 organizations**

Tracking CORS Movement – Short & Long Term





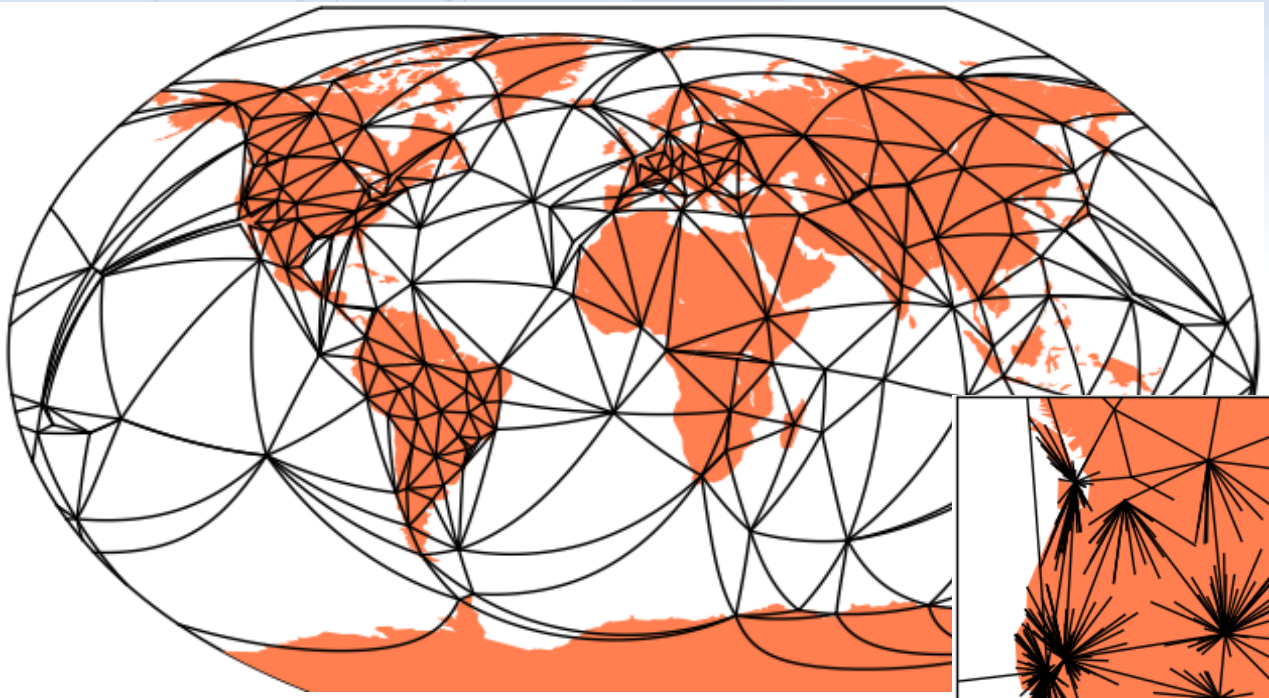
NOAA's National Geodetic Survey Positioning America for the Future

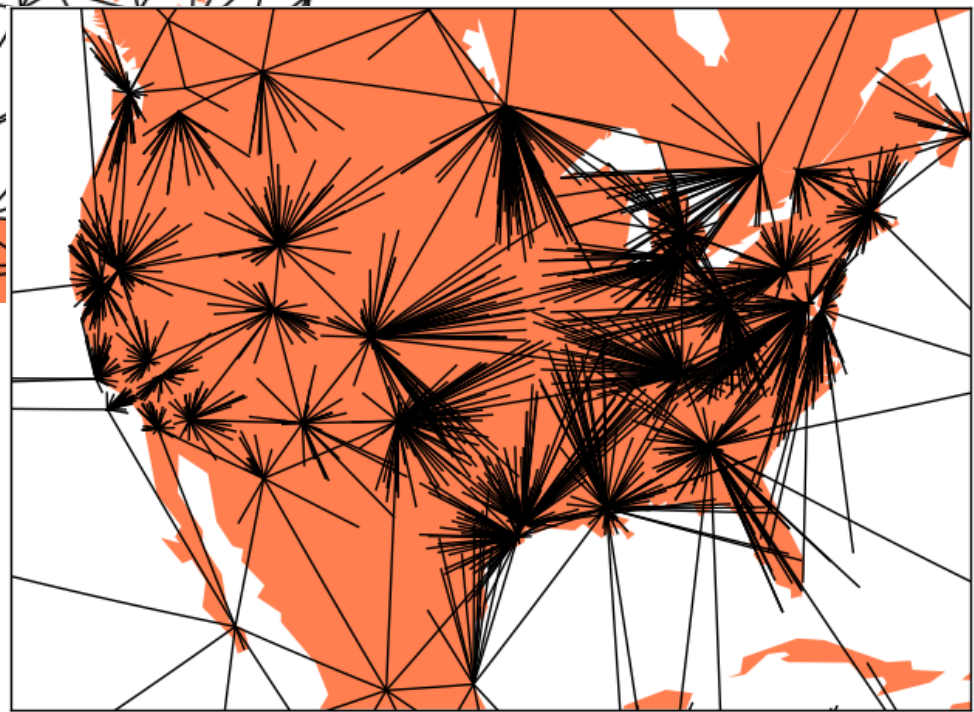


National Radio Astronomy Observatory
Enabling forefront research into the Universe at radio wavelengths

International Terrestrial Reference Frame
ITRF

NGS Multi-year CORS Solution: International Terrrestrial Reference Frame 2014





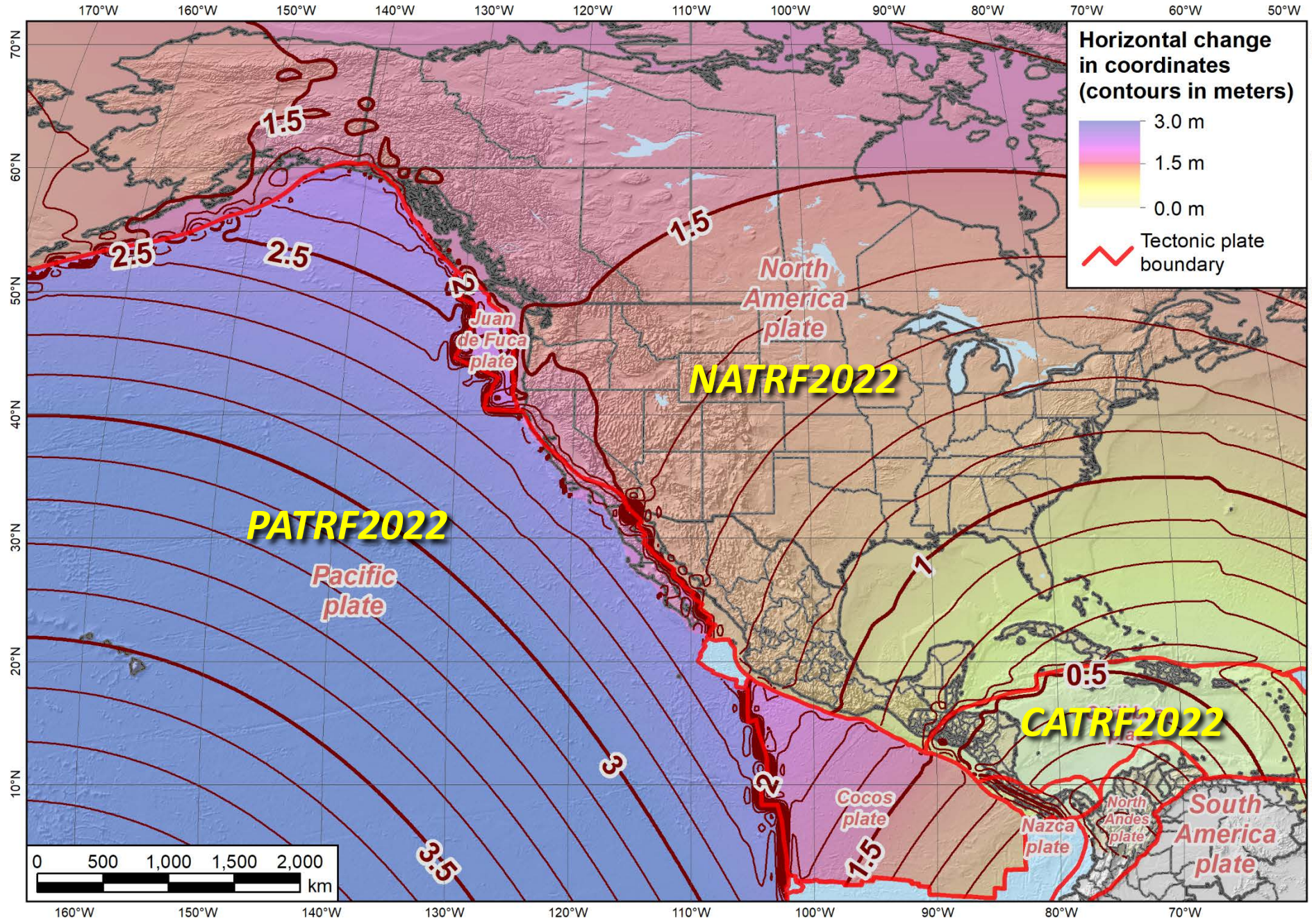
- 1996 -2016 data
- 3050 stations
- 25 TerraBytes of data

4 Reference Frames & Tectonic Plates

In 2022, the National Spatial Reference System will be modernized with
4 new geometric reference frames (REPLACING NAD83)**:**

- **North American Terrestrial Reference Frame of 2022 (NATRF2022)**
- Pacific Terrestrial Reference Frame of 2022 (PATRF2022)
- Caribbean Terrestrial Reference Frame of 2022 (CATRF2022)
- Mariana Terrestrial Reference Frame of 2022 (MATRF2022)

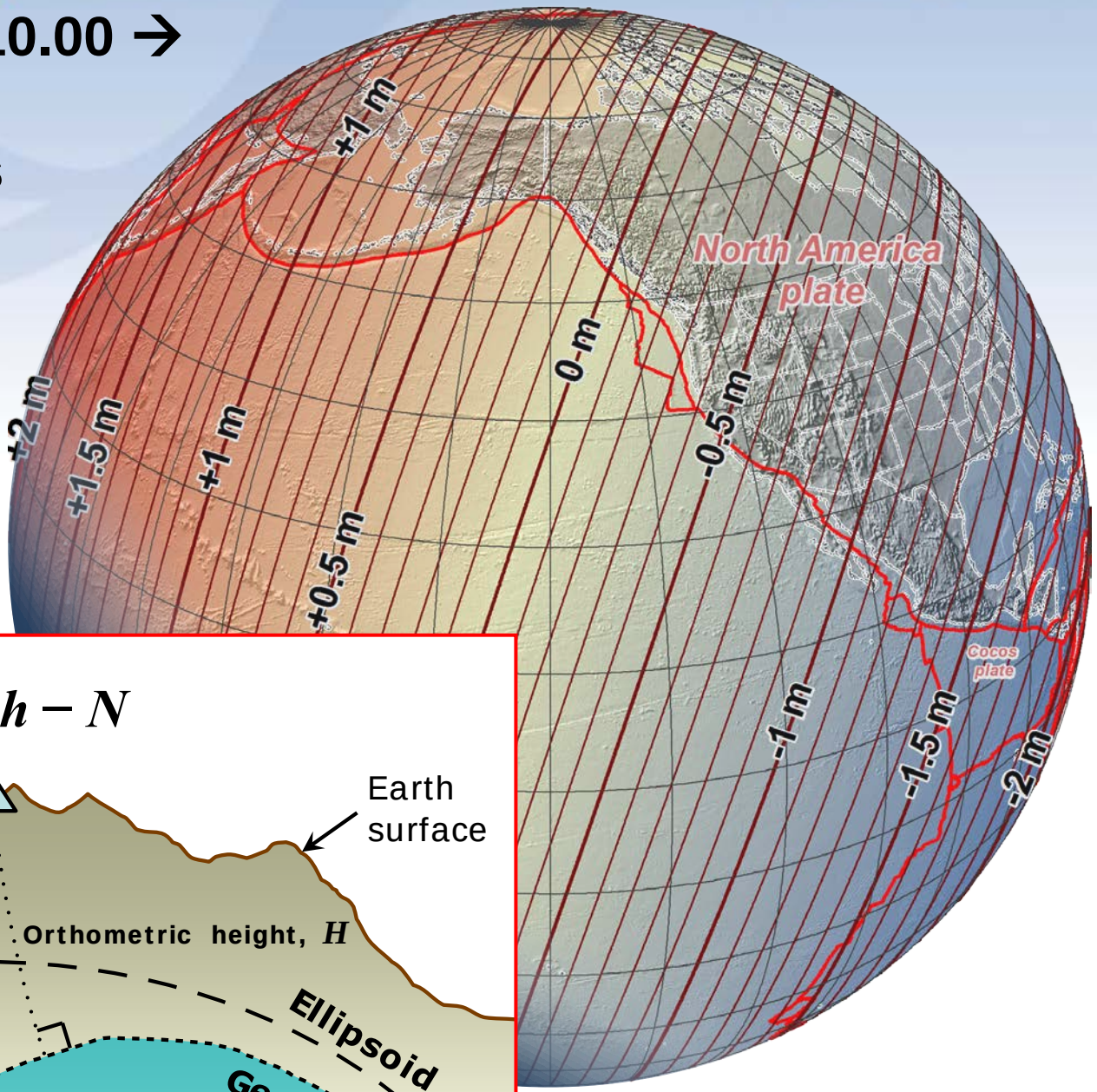
Horizontal change in coordinates: NAD 83 epoch 2010.0 → TRF2022 epoch 2020.0



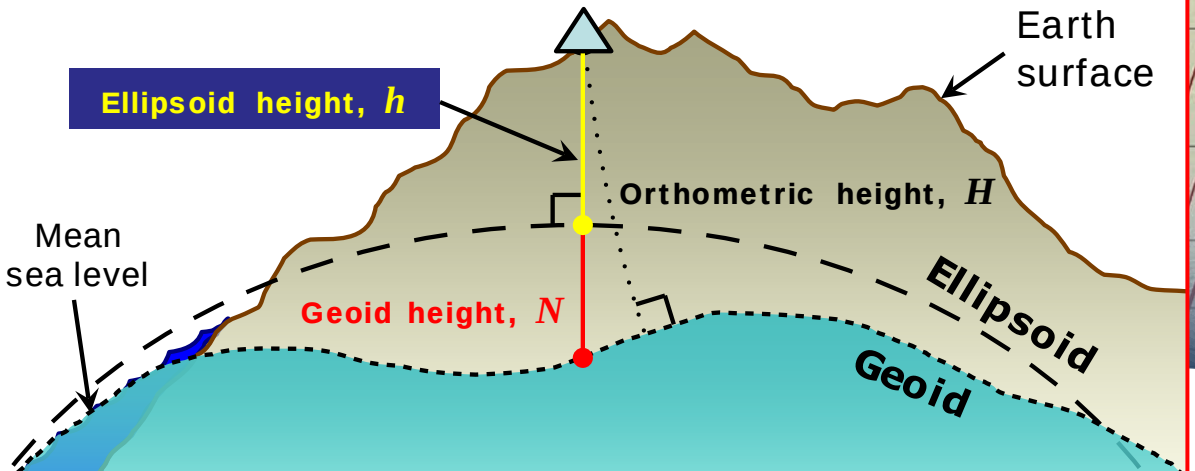
NAD 83 epoch 2010.00 → 2022 Terrestrial Reference Frames

Change in ellipsoid heights at epoch 2020.00

(contours in meters)



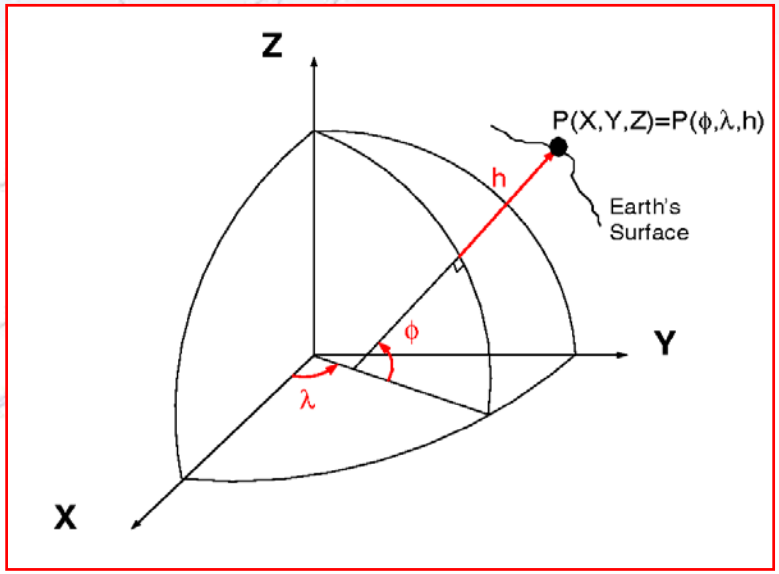
$$H \approx h - N$$

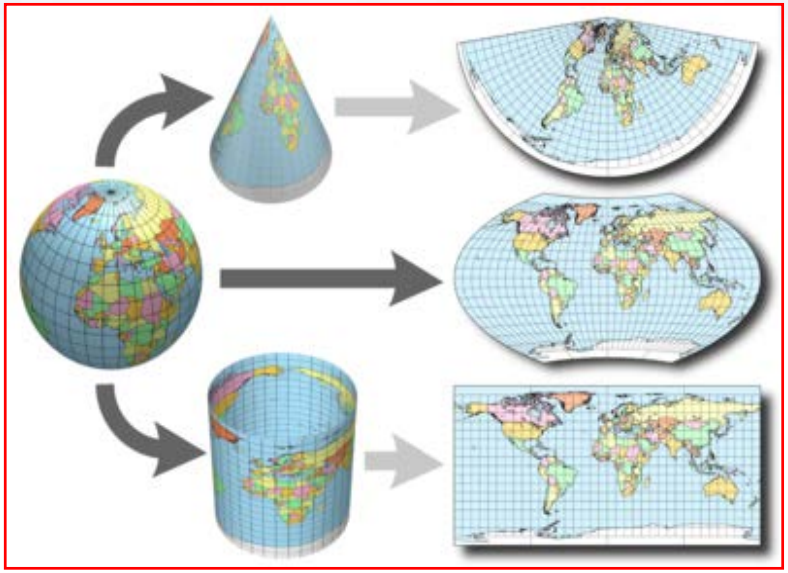


Geodetic < > Projected Coordinates

X: -1,497,036.137m
Y: -5,007,566.966m
Z: 3,646,527.290m

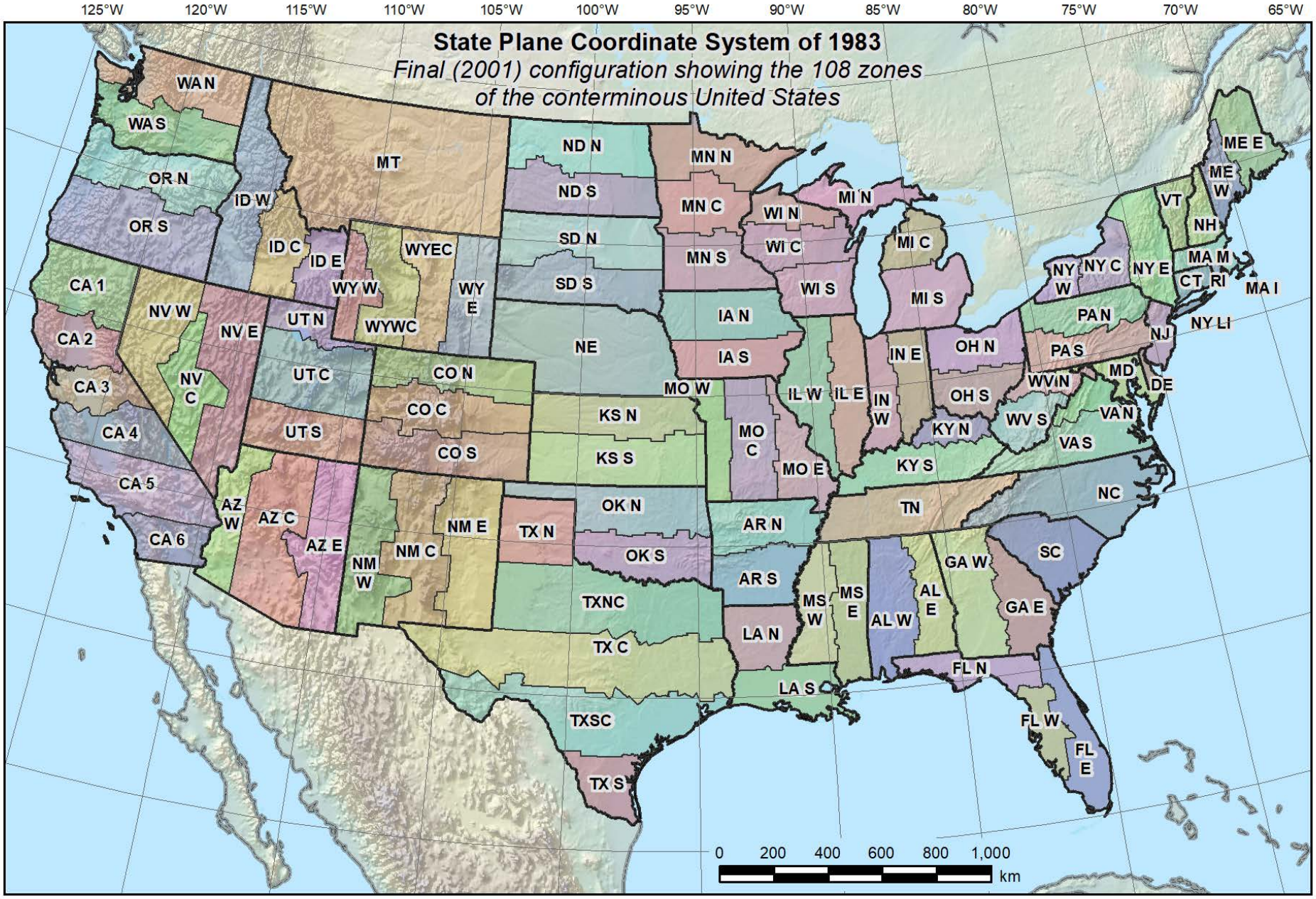
lat: N 35 05 02.24009dms
lon: W 106 38 39.43359dms
eHt: 1800.000m





	SPC (NM-C)	UTM (13 N)
Easting:	464,046.553m	350,102.456m
Northing:	452,958.535m	3,883,589.968m

State Plane Coordinate System 1983 Zones



SPCS 83 Zone Parameters

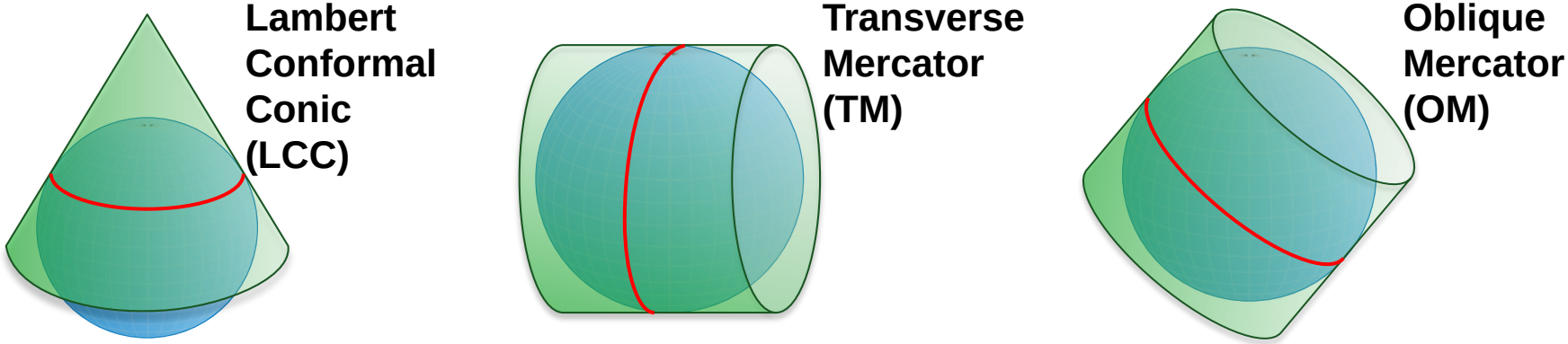
Zone abrev	Zone code	Zone designation	Type	Projection axis scale (ratio)	Projection axis scale (decimal)	Origin longitude	Origin latitude	S std parallel	N std parallel	Grid origin (U.S. survey ft) x	Grid origin (U.S. survey ft) y
Nebraska (NE): SPCS 27											
NE N	2601	North	LCC	1:28,210	0.999 964 551...	100°00'W	41°20'N	41°51'N	42°49'N	2,000,000	0
NE S	2602	South	LCC	1:12,833	0.999 922 075...	99°30'W	39°40'N	40°17'N	41°43'N	2,000,000	0
Nevada (NV): SPCS 27											
NV E	2701	East	TM	1:10,000	0.999 9	115°35'W	34°45'N	—	—	500,000	0
NV C	2702	Central	TM	1:10,000	0.999 9	116°40'W	34°45'N	—	—	500,000	0
NV W	2703	West	TM	1:10,000	0.999 9	118°35'W	34°45'N	—	—	500,000	0
New Hampshire (NH): SPCS 27											
NH	2800		TM	1:30,000	0.999 966 667...	71°40'W	42°30'N	—	—	500,000	0
New Jersey (NJ): SPCS 27											
NJ	2900		TM	1:40,000	0.999 975	74°40'W	38°50'N	—	—	2,000,000	0
New Mexico (NM): SPCS 27											
NM E	3001	East	TM	1:11,000	0.999 909 091...	104°20'W	31°00'N	—	—	500,000	0
NM C	3002	Central	TM	1:10,000	0.999 9	106°15'W	31°00'N	—	—	500,000	0
NM W	3003	West	TM	1:12,000	0.999 916 667...	107°50'W	31°00'N	—	—	500,000	0
New York (NY): SPCS 27											
NY E	3101	East	TM	1:30,000	0.999 966 667...	74°20'W	40°00'N	—	—	500,000	0
NY C	3102	Central	TM	1:16,000	0.999 937 5	76°35'W	40°00'N	—	—	500,000	0
NY W	3103	West	TM	1:16,000	0.999 937 5	78°35'W	40°00'N	—	—	500,000	0
NY L	3104	Long Island	LCC	1:196,102	0.999 994 901...	74°00'W	40°30'N	40°40'N	41°02'N	2,000,000	100,000
North Carolina (NC): SPCS 27											
NC	3200		LCC	1:7,849	0.999 872 598...	79°00'W	33°45'N	34°20'N	36°10'N	2,000,000	0

A New State Plane Coordinate System

- **State Plane Coordinate System of 2022 (SPCS2022)**
  - Referenced to 2022 Terrestrial Reference Frames (TRFs)

  (North American Terrestrial Reference Frame of 2022 [NATRF2022] &…)
  - Same ellipsoid as SPCS 83 (Geodetic Reference System of 1980)
  - Same 3 ***conformal*** projection types as SPCS 83 and 27

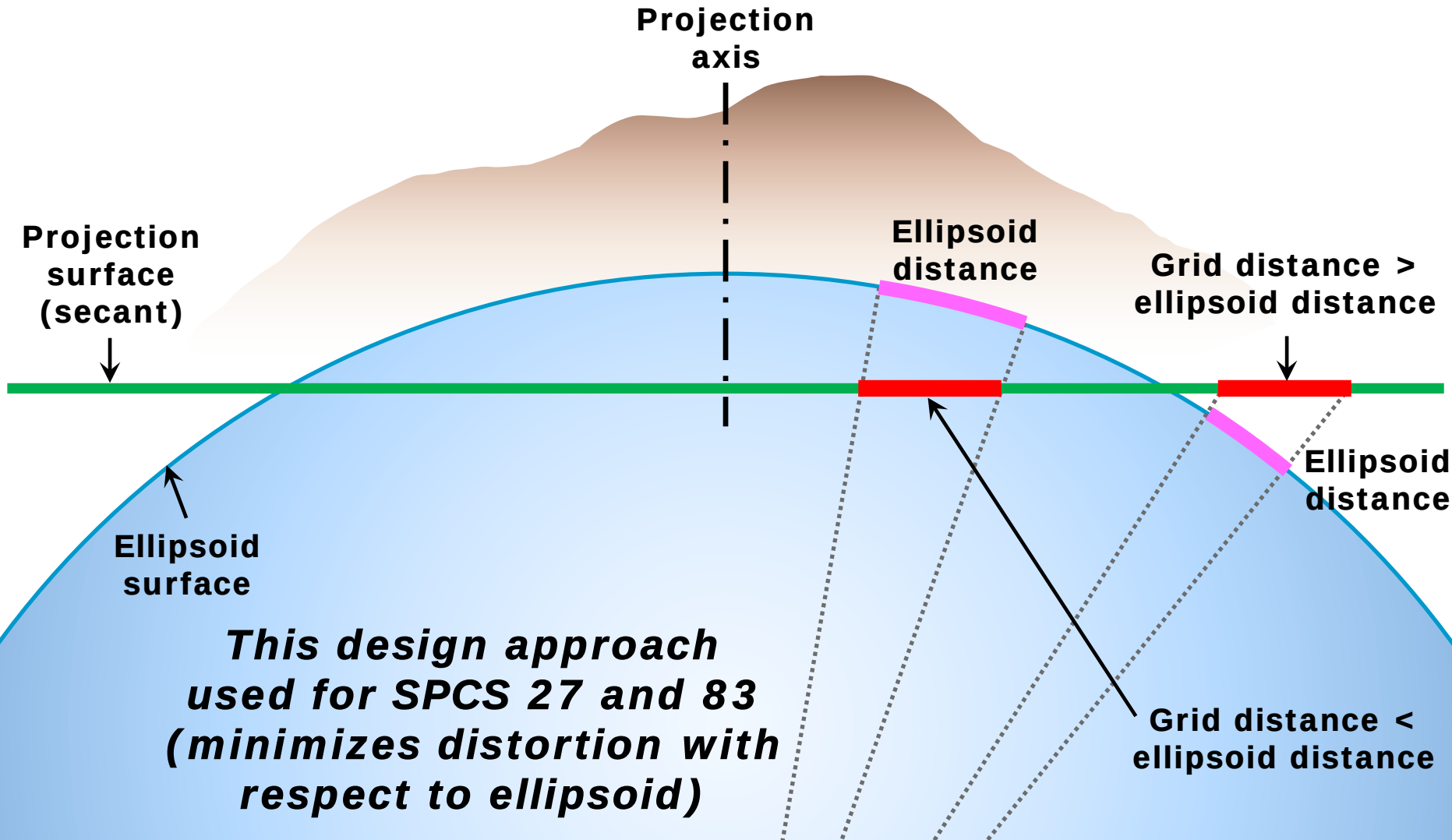
  (preserves "local" shape; scale is unique / independent of direction):



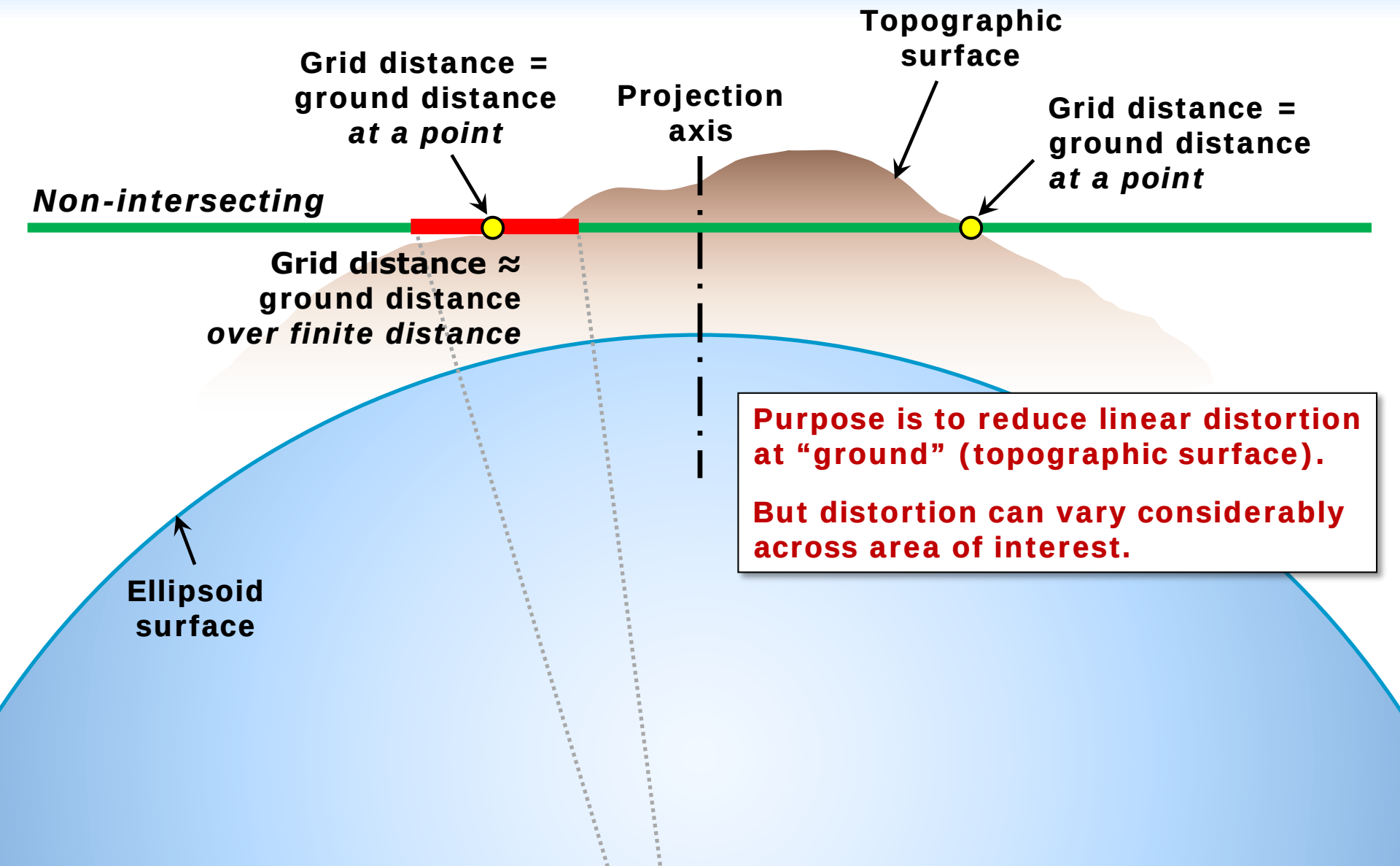
Past Year's SPCS2022 Activity

- Publish State Plane history report: **March 2018**
- Webinars on **March, April 2018; March 2019**
- Launch new SPCS web pages: **March 2018**
- Publish Federal Register Notice (FRN) and draft SPCS2022 Policy & Procedures: **April 2018**
- FRN response deadline: **August 2018**
- First preliminary design maps: **October 2018**
- Finalizing policy & procedures: ***Right now … any day!***

Linear distortion *with respect to ellipsoid*



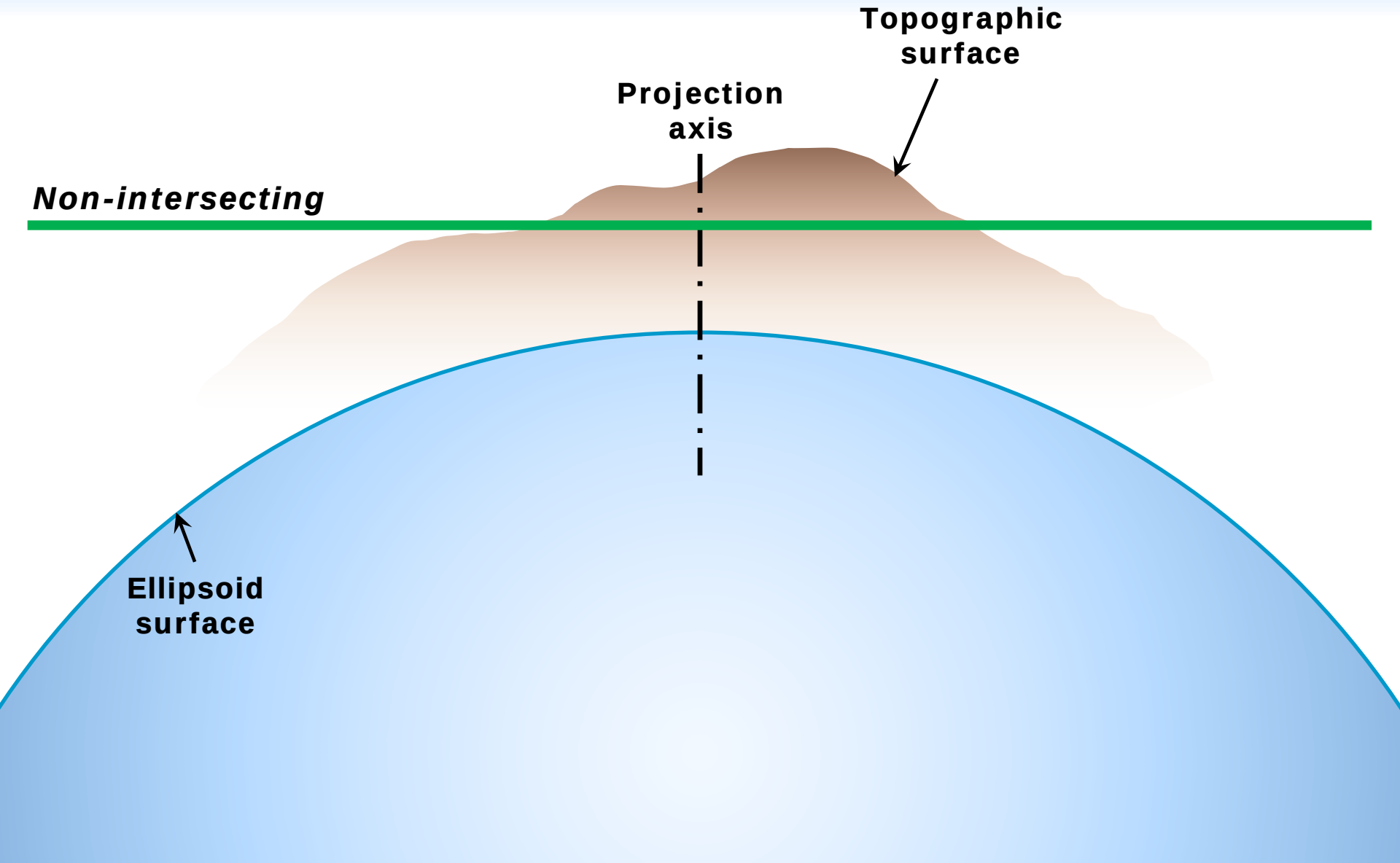
“Non-intersecting” conformal map projection



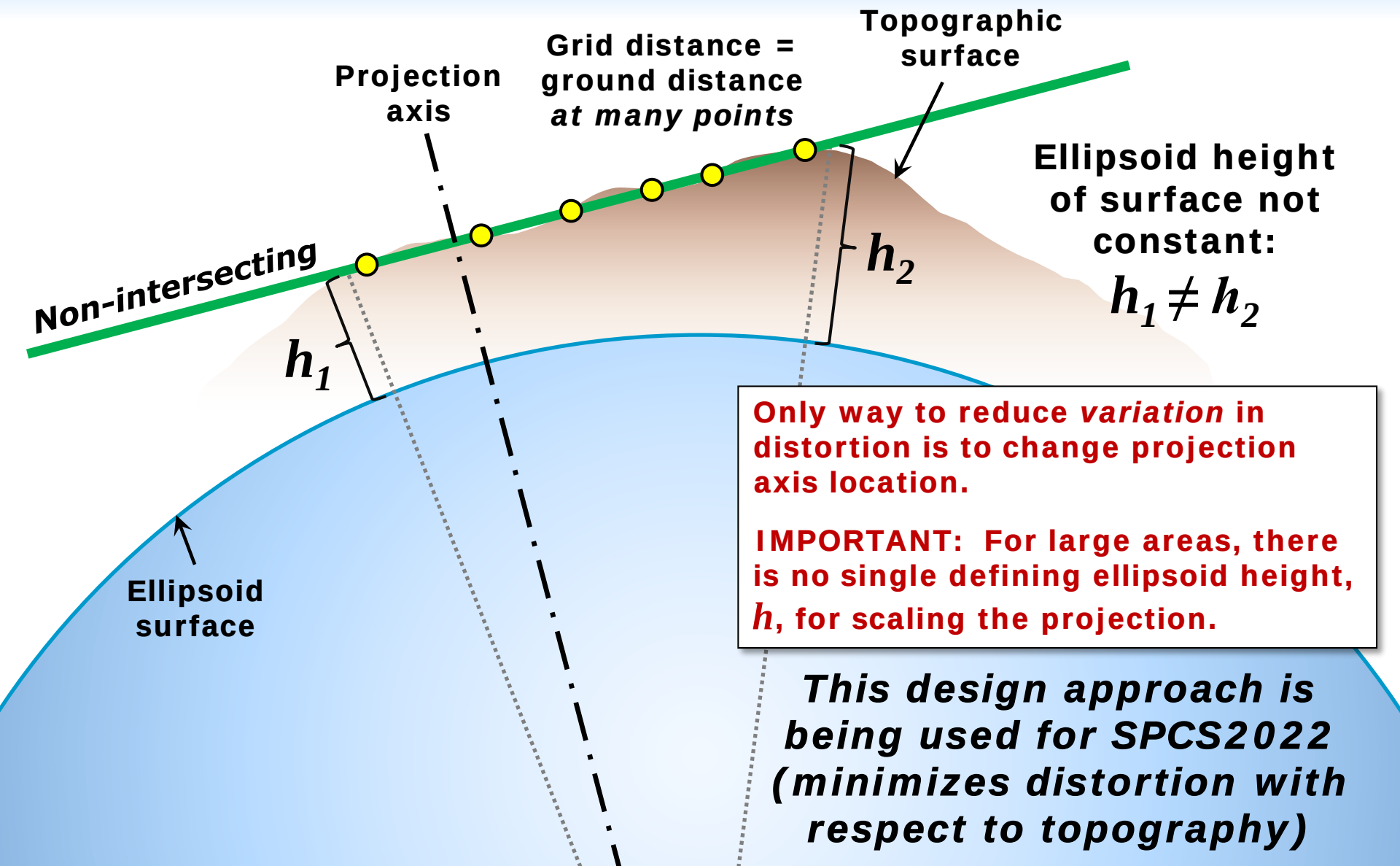
Purpose is to reduce linear distortion at “ground” (topographic surface).

But distortion can vary considerably across area of interest.

“Non-intersecting” conformal map projection



Changing projection axis to reduce distortion variation



Only way to reduce *variation* in distortion is to change projection axis location.

IMPORTANT: For large areas, there is no single defining ellipsoid height, h, for scaling the projection.

This design approach is being used for SPCS2022 (minimizes distortion with respect to topography)

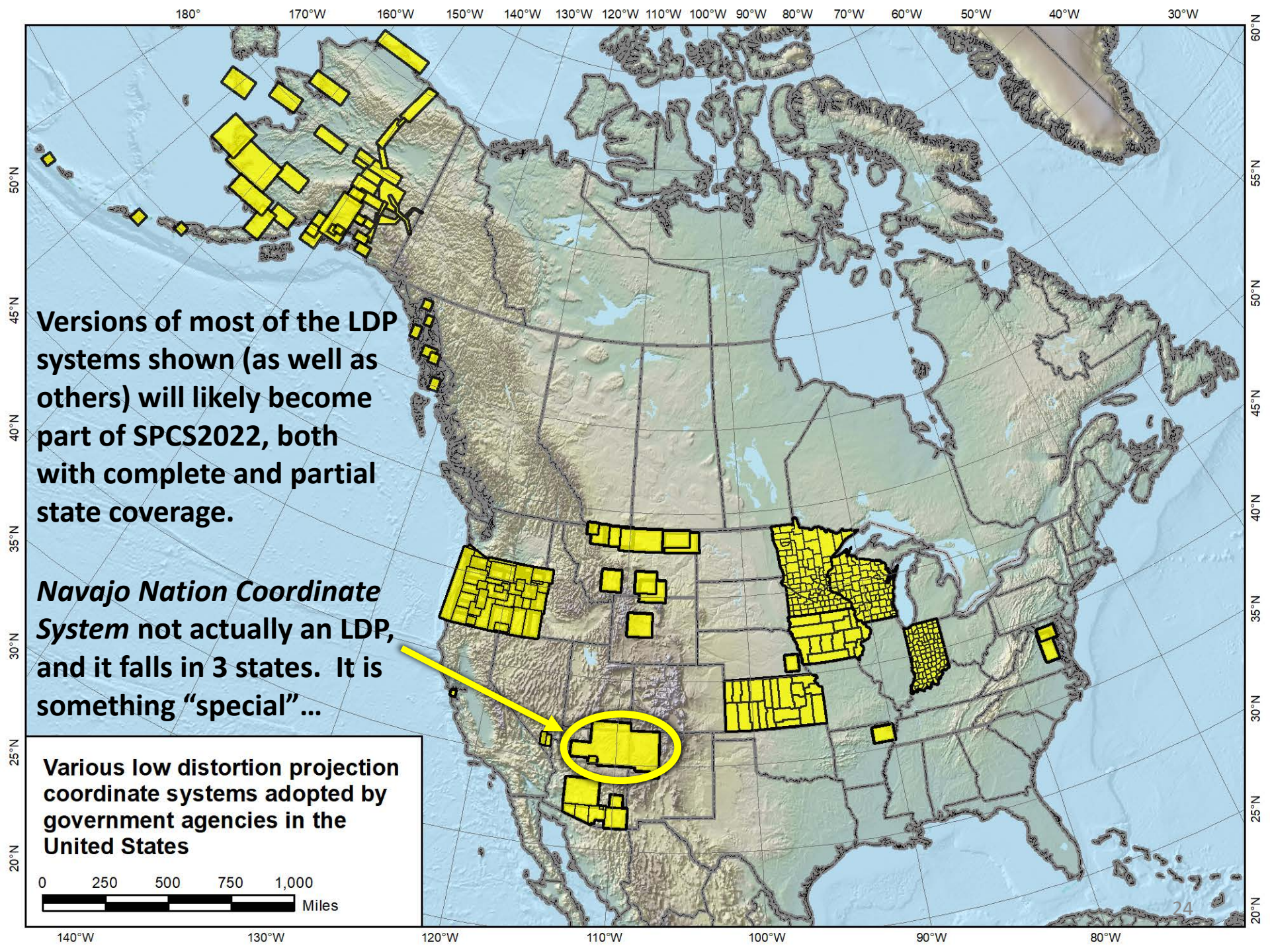
Default SPCS2022 zones

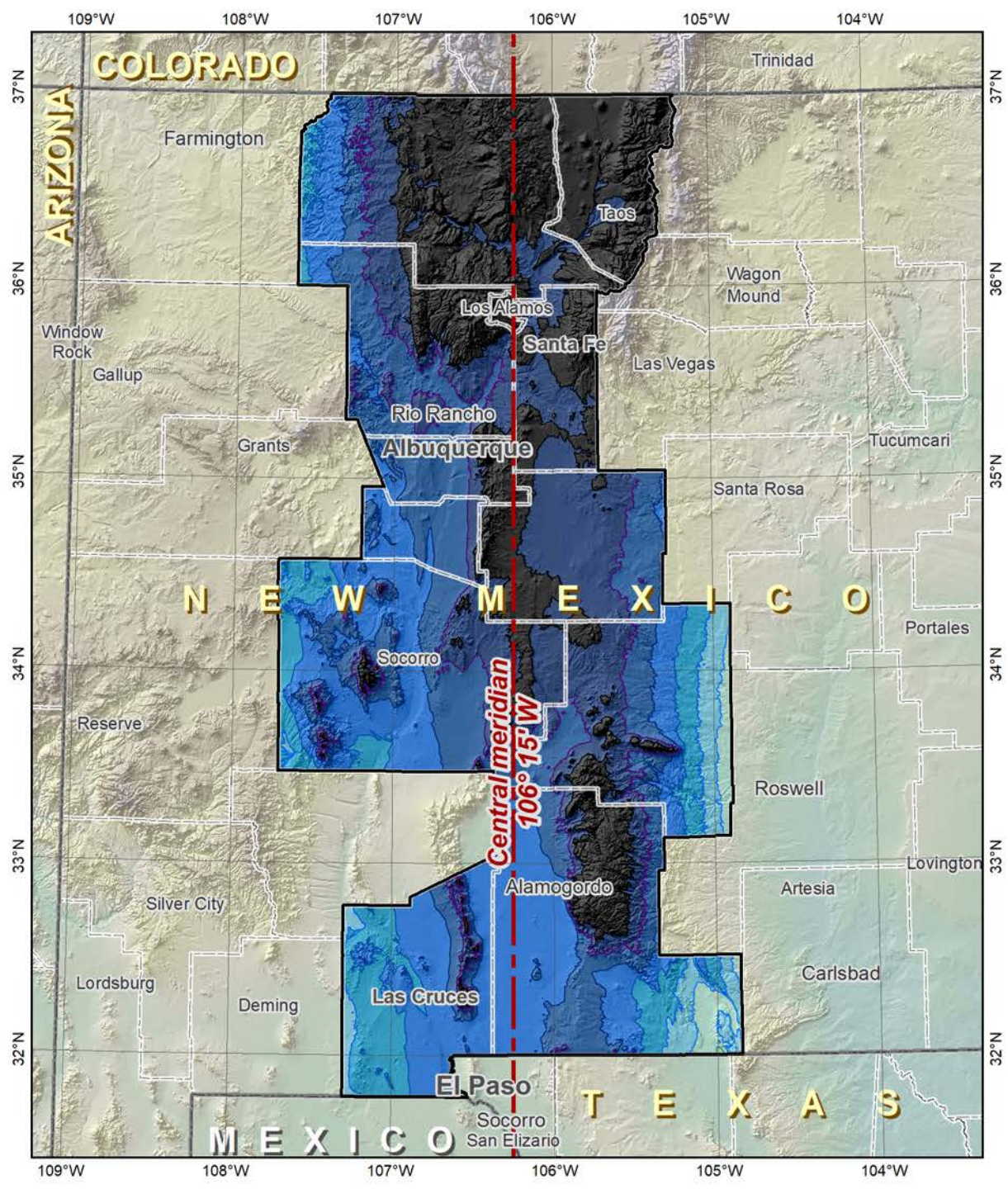
- To ensure ***all*** states and U.S. territories covered
  - For complete system if no consensus stakeholder input
  - Nearly same as SPCS 83 but with some changes
  - Almost all zone projection types and extents the same
- Modify existing zones to meet SPCS2022 policy
  - Scale redefined with respect to **topographic surface**
  - Use 1-parallel Lambert and local Oblique Mercator
- Will also create a statewide zone for ***all*** states

Zone "layers" and LDPs

- Each state may have max of ***THREE*** zone "layers"
  - One layer *must* be statewide zone (designed by NGS)
  - Other layers have two or more zones ("multi-zone")
  - Only one layer can have discontinuous coverage

- Multi-zone layer can consist of LDPs
  - Designed by stakeholder "contributing partners"
  - Minimum zone width 50 km (if height range < 250 m)
    OR 10 km (if height range > 250 m)
  - LDP coverage can be discontinuous


Versions of most of the LDP systems shown (as well as others) will likely become part of SPCS2022, both with complete and partial state coverage.
Navajo Nation Coordinate System not actually an LDP, and it falls in 3 states. It is something "special"…
Various low distortion projection coordinate systems adopted by government agencies in the United States
0 250 500 750 1,000
Miles
180° 170°W 160°W 150°W 140°W 130°W 120°W 110°W 100°W 90°W 80°W 70°W 60°W 50°W 40°W 30°W
60°N 55°N 50°N 45°N 40°N 35°N 30°N 25°N 20°N
140°W 130°W 120°W 110°W 100°W 90°W 80°W
24



Existing SPCS 83 design: New Mexico Central Zone

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Datum of 1983

Central meridian: 106° 15' W
Cen merid scale: 0.999 9 (exact)

Areas within ±100 ppm distortion (±0.53 ft per mile):
0% of entire zone
0% of all cities and towns
0% of population

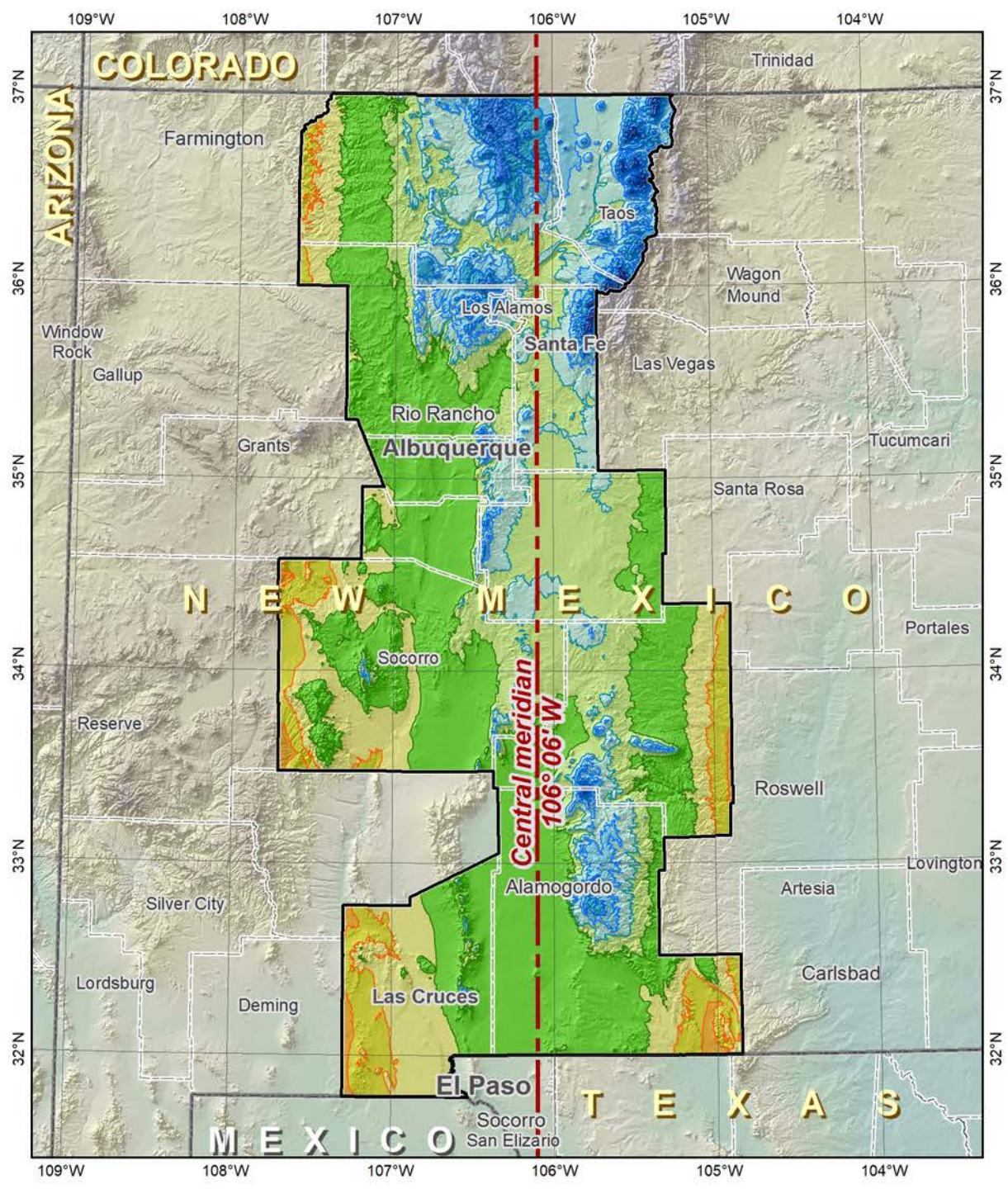
Distortion values (ppm)

Entire zone:	*Cities and towns:*
Min = -670	Min, Max = -484, -151
Max = -94	Range = 333
Range = 576	Median = -364
Mean = -346	Mean = -323 (weighted by population)

Linear distortion at topographic surface (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 km



Preliminary SPCS2022 default design: New Mexico Central Zone

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Terrestrial Reference Frame of 2022

Central meridian: 106° 06' W
Cen merid scale: 1.000 21 (exact)

Areas within ±100 ppm distortion (±0.53 ft per mile):
70% of entire zone
76% of all cities and towns
90% of population

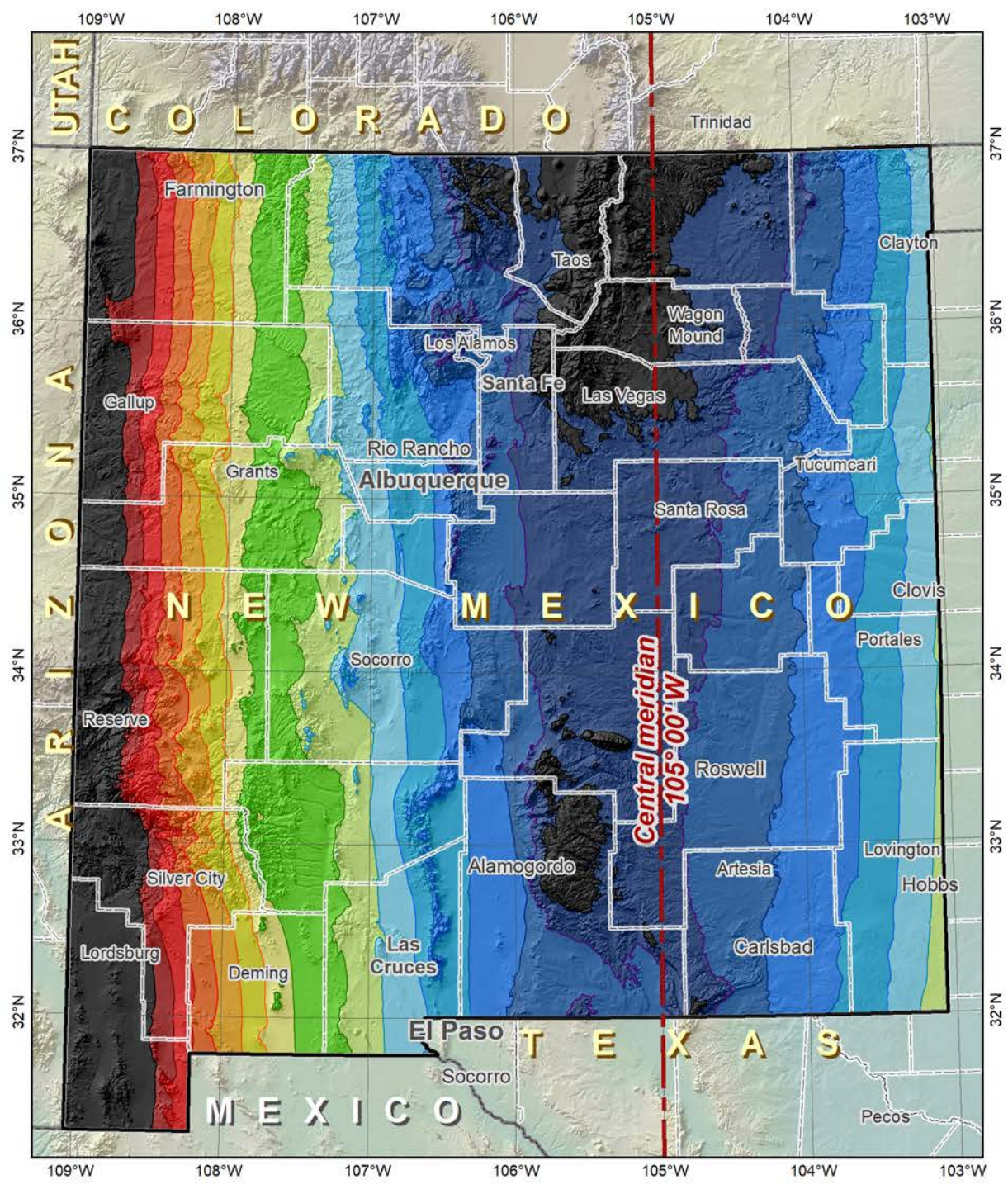
Distortion values (ppm)

Entire zone:	***Cities and towns:***
Min = -376	Min, Max = -188, +164
Max = +117	Range = 352
Range = 493	Median = -58
Mean = -32	Mean = -2 (weighted by population)

Linear distortion at topographic surface (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 km



Existing UTM Zone 13 North used as statewide zone: New Mexico

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Datum of 1983

Central meridian: 105° 00' W
Cen merid scale: 0.999 6 (exact)

Areas within ±400 ppm distortion (±2.11 ft per mile):
37% of entire zone
37% of all cities and towns
71% of population

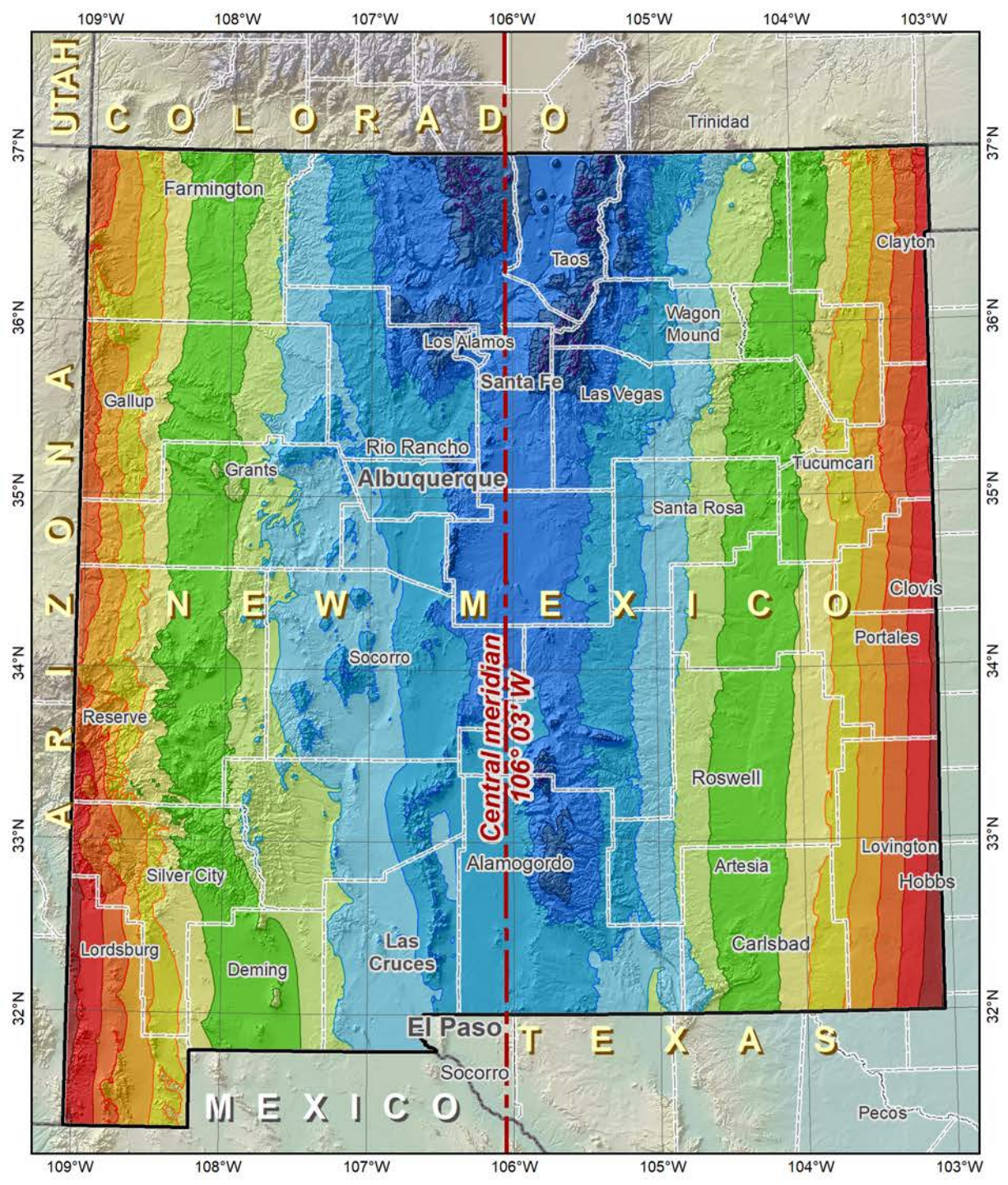
Distortion values (ppm)

Entire zone:	*Cities and towns:*
Min = -1000	Min, Max = -796, +1203
Max = +1223	Range = 1999
Range = 2223	Median = -426
Mean = -226	Mean = -294 (weighted by population)

Linear distortion at topographic surface (parts per million)

< -700	to -300	to +400
to -700	to -200	to +500
to -600	±100	to +600
to -500	to +200	to +700
to -400	to +300	> +700

0 50 100 150 200 250 km



Preliminary SPCS2022 statewide zone design: New Mexico

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Terrestrial Reference Frame of 2022

Central meridian: 106° 03' W
Cen merid scale: 0.999 87 (exact)

Areas within ±400 ppm distortion (±2.11 ft per mile):
75% of entire zone
66% of all cities and towns
82% of population

Distortion values (ppm)

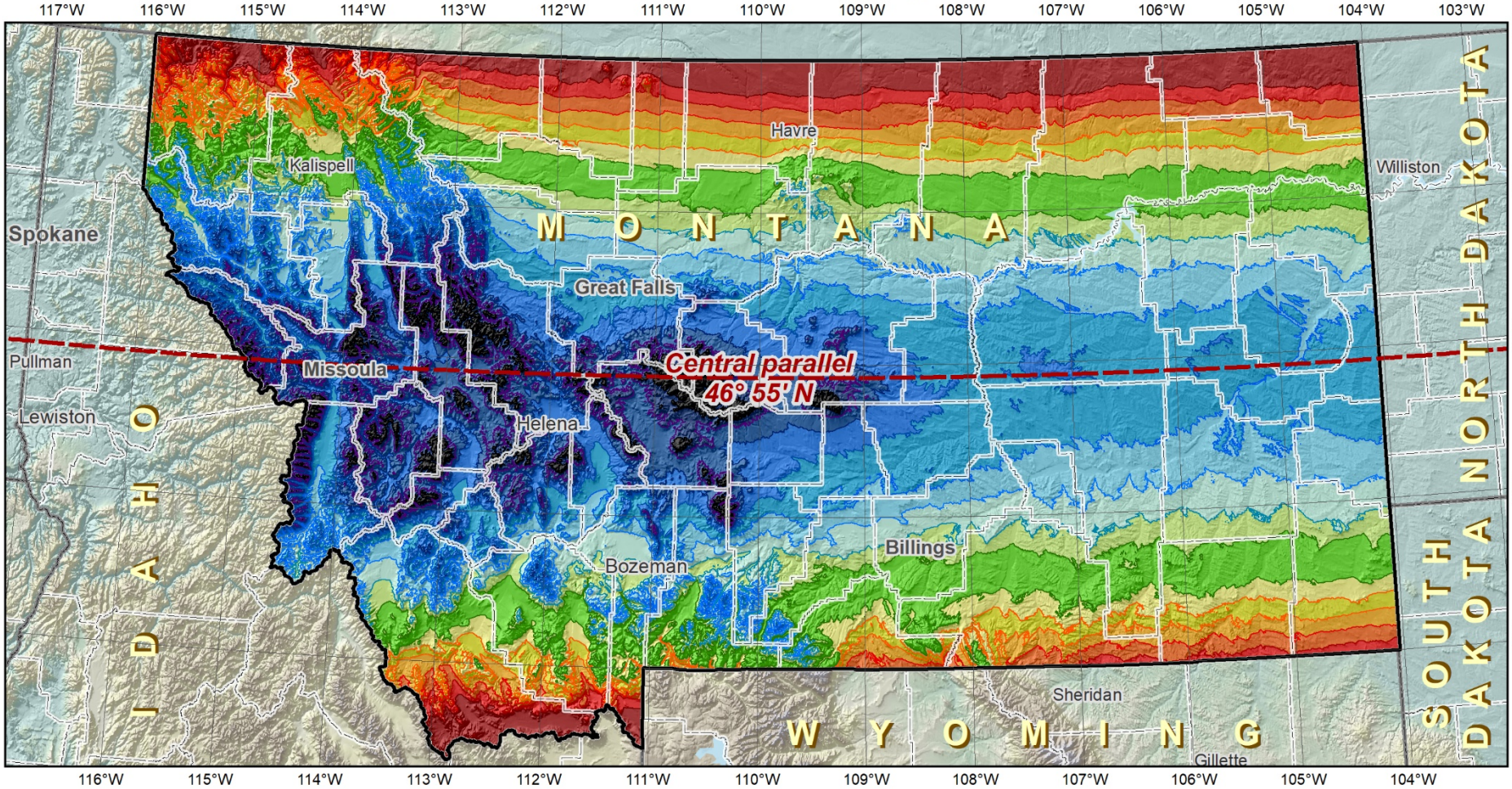
Entire zone:	*Cities and towns:*
Min = -724	Min, Max = -531, +659
Max = +713	Range = 1190
Range = 1437	Median = -271
Mean = -85	Mean = -199 (weighted by population)

Linear distortion at topographic surface (parts per million)

< -700	to -300	to +400
to -700	to -200	to +500
to -600	±100	to +600
to -500	to +200	to +700
to -400	to +300	> +700

0 50 100 150 200 250 km

Preliminary SPCS2022 default design: Montana Zone



Lambert Conformal Conic projection

North American Terrestrial Reference Frame of 2022

Central parallel: 46° 55' N

Cen parallel scale: 0.999 9 (exact)

NOAA's National Geodetic Survey

Areas within ±300 ppm distortion (±1.58 ft per mile):

98% of population

90% of all cities and towns

83% of entire zone area

Distortion values (ppm)

Entire zone:

Min = -534 Range = 1000

Max = +467 Mean = -79

Cities and towns:

Min = -380 Mean = -113

Max = +441 (weighted by

Range = 822 population)

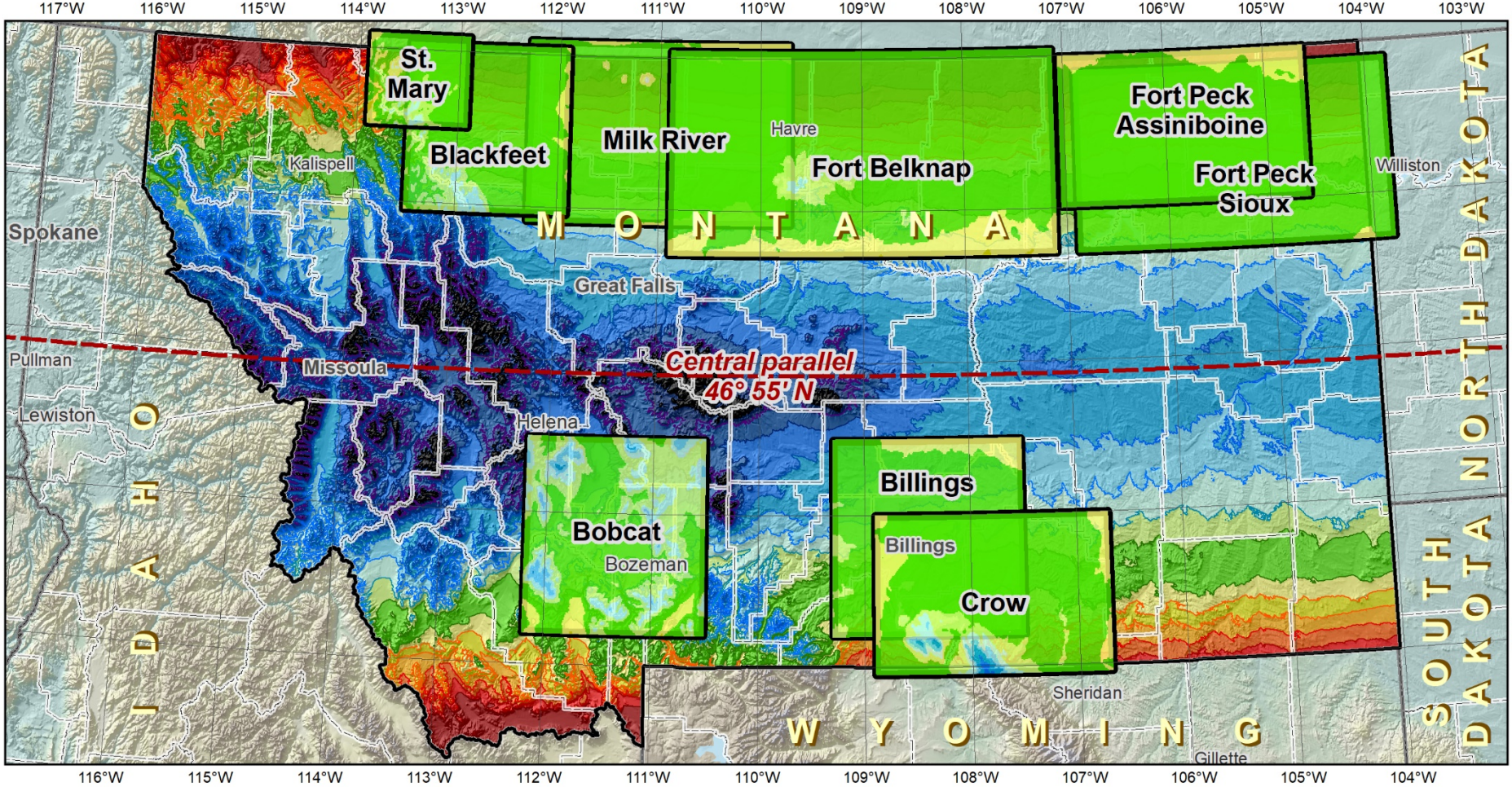
Created 01/13/2019

Linear distortion at topographic surface (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 300 km

SPCS2022 zone layers: Montana statewide zone and *discontinuous* LDP zones



Lambert Conformal Conic projection

North American Terrestrial Reference Frame of 2022

Central parallel: 46° 55' N

Cen parallel scale: 0.999 9 (exact)

NOAA's National Geodetic Survey

Areas within ±300 ppm distortion (±1.58 ft per mile):

98% of population

90% of all cities and towns

83% of entire zone area

Distortion values (ppm)

Entire zone:

Min = -534 Range = 1000

Max = +467 Mean = -79

Cities and towns:

Min = -380 Mean = -113

Max = +441 (weighted by

Range = 822 population)

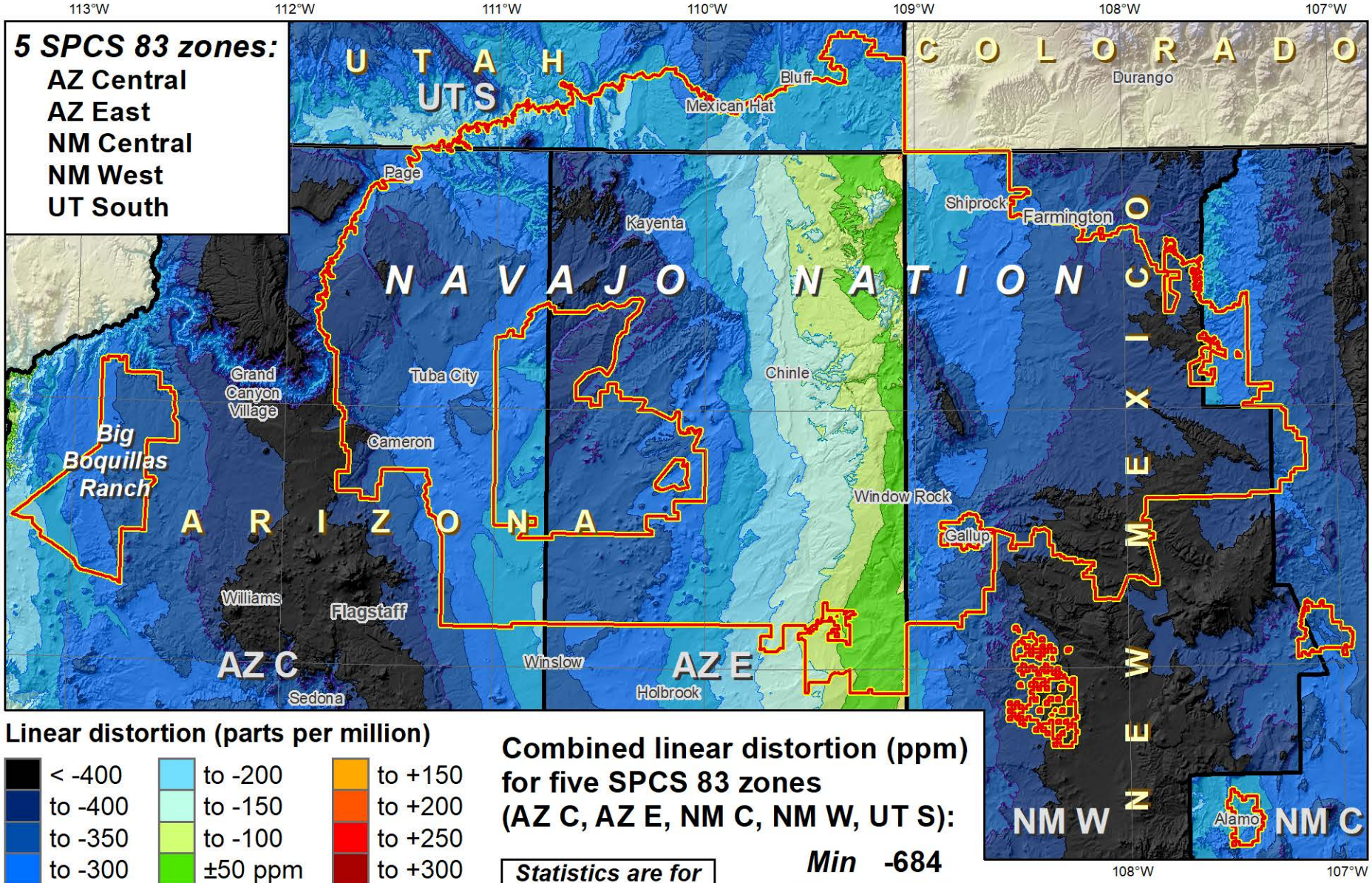
Created 01/13/2019

Linear distortion at topographic surface (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 300 km

Existing State Plane coverage for Navajo Nation



Linear distortion (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50 ppm	to +300
to -250	to +100	> +300

0 50 100 150 km

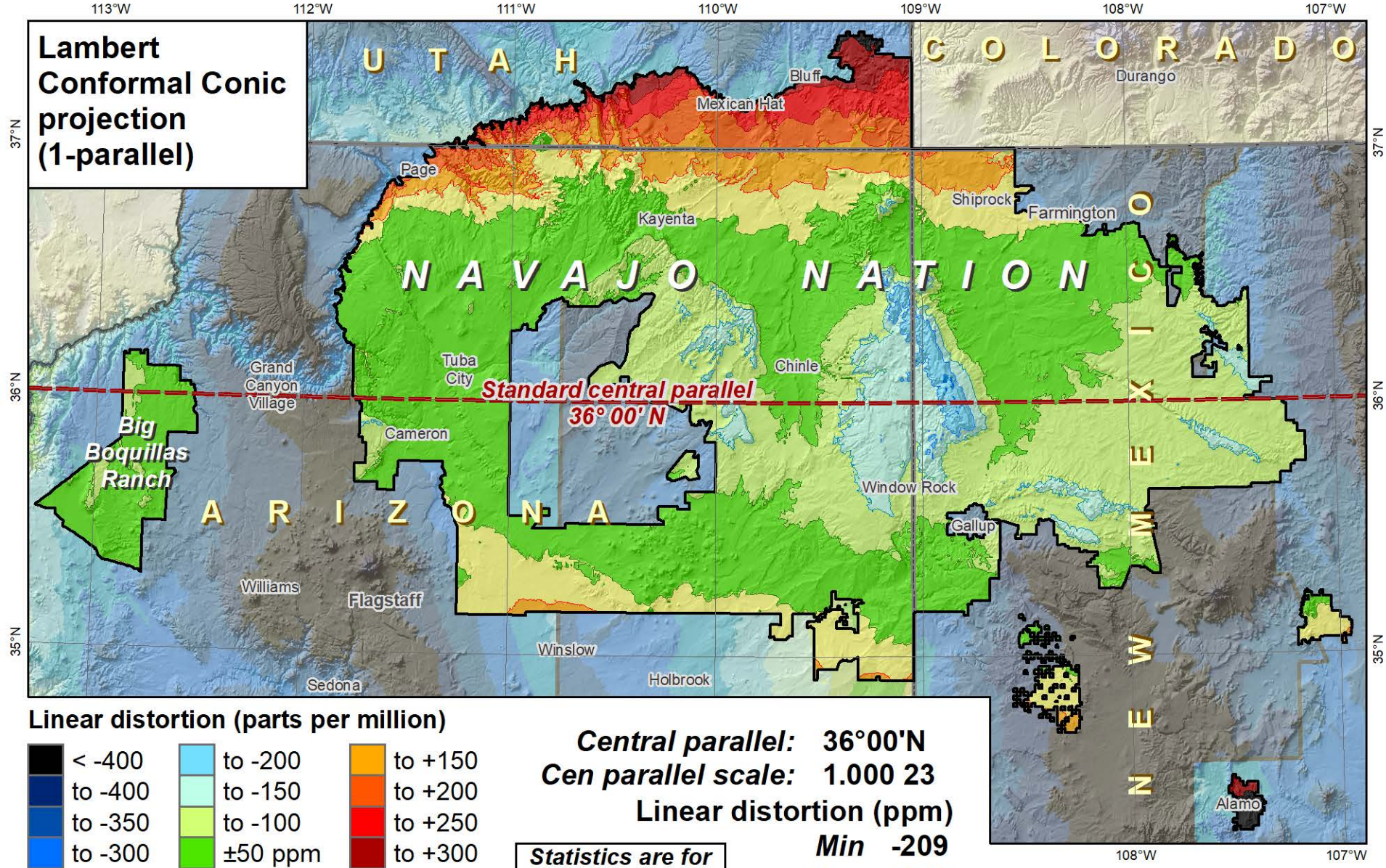
Combined linear distortion (ppm) for five SPCS 83 zones (AZ C, AZ E, NM C, NM W, UT S):

Statistics are for area within entire Navajo Nation boundary

Min	-684
Max	+214
Range	898
Mean	-272

Topographic ellipsoid height	*Min*	-882 m
	Max	3096 m
	Mean	1814 m

"Special purpose" zone: Navajo Nation Coordinate System



Linear distortion (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50 ppm	to +300
to -250	to +100	> +300

0 50 100 150 km

Central parallel: **36°00'N**
Cen parallel scale: **1.000 23**

Linear distortion (ppm)

Min	**-209**
Max	**+348**
Range	**557**
Mean	**0**

Statistics are for area within entire Navajo Nation boundary

Topographic ellipsoid height	***Min***	**-882 m**
	Max	**3096 m**
	Mean	**1814 m**

SPCS2022 deadlines

- **Consensus** input per SPCS2022 procedures
  - ***Requests*** for designs done by NGS
  - ***Proposals*** for designs by contributing partners
- Submittal of **approved** designs
  - Proposal must first be approved by NGS
  - Designs must be complete for NGS to review
- Later requests will be for ***changes*** *to* SPCS2022

by **March 31, 2020** for ***requests*** and ***proposals***
by **March 31, 2021** for ***submittal*** of ***approved*** designs

SPCS2022 stakeholders

- **State *groups*** that formally interface with NGS
  - Departments of transportation
  - Cartographer/GIS office
  - Professional surveying, engineering, GIS societies
  - Colleges/universities with geospatial curriculum
- Can submit ***requests*** and ***proposals*** for designs
  - ***Requests*** are for designs by NGS
  - ***Proposals*** are designs by contributing partners
- Stakeholder input must be ***unanimous***

NMGIC - *JOIN THE CONVERSATION!! …*

geodesy.noaa.gov/SPCS/

geodesy.noaa.gov

National Geodetic Survey

Positioning America for the Future

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

State Plane Coordinate System
- Home
- Maps
- Download Design Maps
- Convert Coordinates
- Current Policy
- 2022 Policy Changes
- Learn More

Have State Plane Questions?
- Contact Us

Preliminary Default SPCS2022 Design Maps

NGS is currently in the process of creating "default" 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.

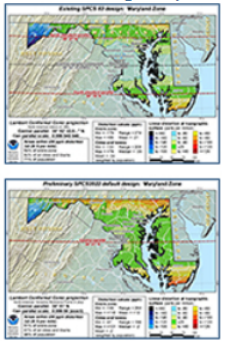
Download SPCS2022 Design Maps

A continuously updated set of **default SPCS2022 design maps** are available for download as .png image files.

The maps show linear distortion at the topographic surface for SPCS2022, along with existing State Plane and Universal Transverse Mercator (UTM) for comparison. Only projection parameters that affect linear distortion are given in the maps. Other parameters, such as false northing and easting, will be defined for the final SPCS2022 designs. Linear distortion rasters and other GIS feature datasets used to create the maps are **available for download**. If the state, territory, or subzone you require is not yet listed, please contact the **SPCS Team**.

Download SPCS2022 Design Maps

Example of Downloaded Default Design Maps



Learn More

Documents

Related documents are listed below.

- **Policy on Changes to State Plane Coordinates** (PDF, 141 KB)
- **Policy of the National Geodetic Survey Concerning Units of Measure for the State Plane Coordinate System of 1983** (PDF, 136 KB)
- **NOAA Manual NOS NGS 5** (PDF, 2 MB)
- **NOAA Special Publication NOS NGS 13** (PDF, 7 MB)

Webinars

NGS has and will host various webinars about State Plane. These will be added to the following list as they are developed.

- **The State Plane Coordinate System: History, Policy, Future Directions (March 8, 2018)**
- **Building a State Plane Coordinate System for the Future (April 12, 2018)**

Website Owner: National Geodetic Survey / Last modified by **NGS Infocenter** Mar 08 2018

NOS Home ▪ NGS Employees ▪ Privacy Policy ▪ Disclaimer ▪ USA.gov ▪ Ready.gov ▪ Site Map ▪ Contact Webmaster

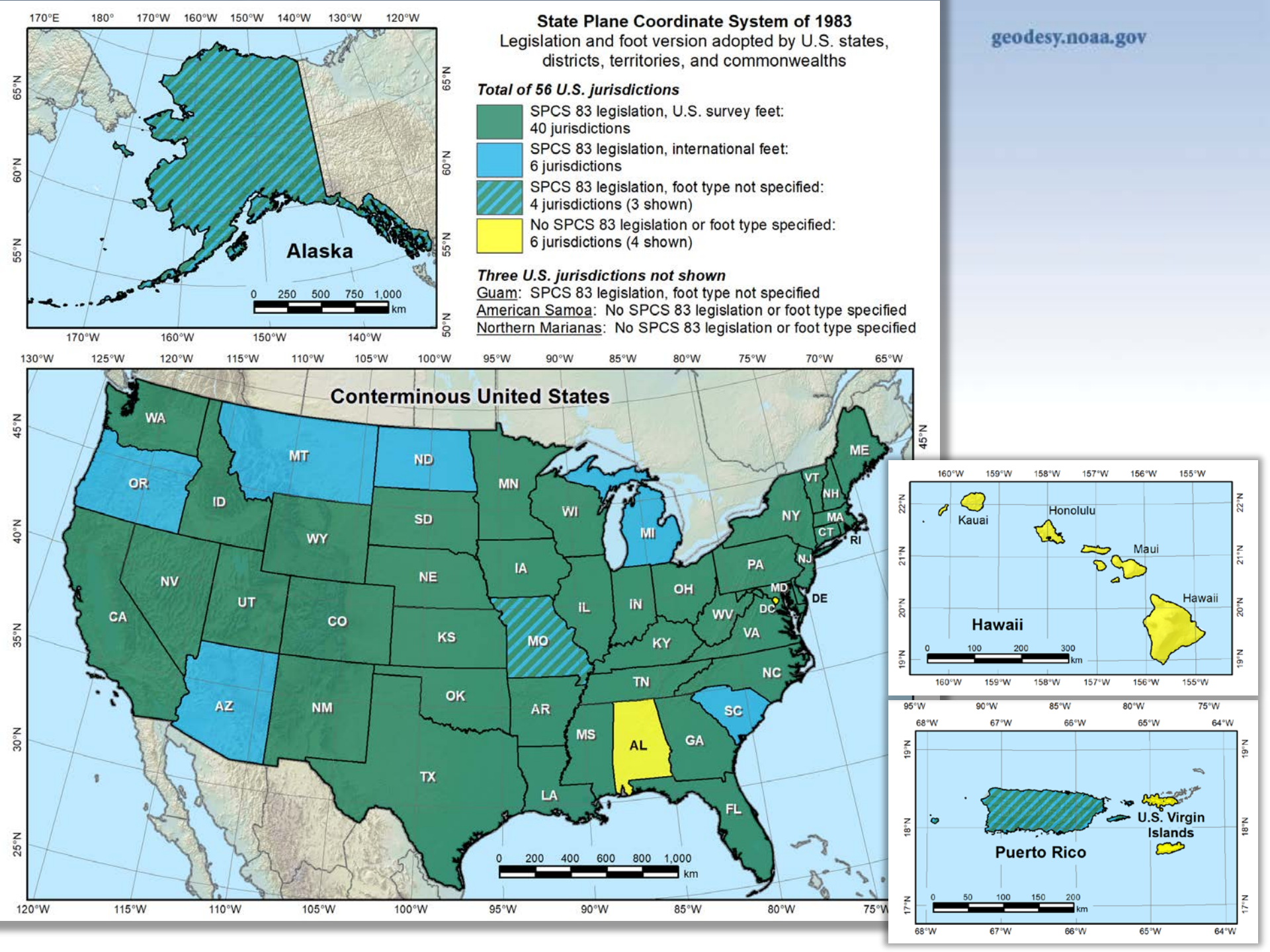
Different Feet: U.S. Survey vs. International

U.S. Survey Foot = 1200/3937 meter

International Foot = 0.3048 meter

Difference = 2 parts per million
(e.g. approx. 0.01 feet per mile OR
2 millimeters per kilometer)

[International Foot is slightly shorter]


State Plane Coordinate System of 1983
Legislation and foot version adopted by U.S. states, districts, territories, and commonwealths
geodesy.noaa.gov
Total of 56 U.S. jurisdictions
SPCS 83 legislation, U.S. survey feet: 40 jurisdictions
SPCS 83 legislation, international feet: 6 jurisdictions
SPCS 83 legislation, foot type not specified: 4 jurisdictions (3 shown)
No SPCS 83 legislation or foot type specified: 6 jurisdictions (4 shown)
Three U.S. jurisdictions not shown
Guam: SPCS 83 legislation, foot type not specified
American Samoa: No SPCS 83 legislation or foot type specified
Northern Marianas: No SPCS 83 legislation or foot type specified
Alaska
Conterminous United States
Hawaii
Kauai
Honolulu
Maui
Hawaii
Puerto Rico
U.S. Virgin Islands

NGS Webinar – Fate of the U.S. Survey Foot After 2022

APRIL
25
2019

2 pm eastern time

Fate of the U.S. Survey Foot after 2022: A Conversation with NGS

Dr. Michael Dennis, National Geodetic Survey

Since 1959, the U.S. has used two types of feet, the "international foot" and the "U.S. survey foot." They differ by only 0.01 foot per mile, but having both in use creates problems with real costs.This webinar discusses the history of the foot, the importance of standards, and shows how NGS can help move the U.S. to a single foot definition in 2022.

Beginner Technical Content Rating: No prior knowledge is necessary.

REGISTER

… recording available in a few days

NGS Educational Videos


What are Geodetic Datums?


How Were Geodetic Datums Established?

What Is the Status of Today's Geodetic Datums?


What's Next for Geodetic Datums?

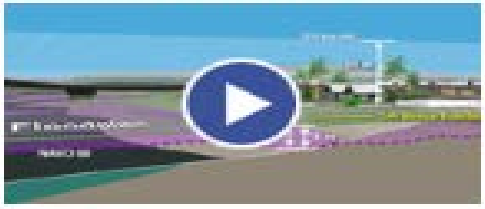

Precision and Accuracy in Geodetic Surveying


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


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


NOAA's VDatum Tool: Transforming Heights Between Vertical Datums


Geodetic Control in Land Surveying: Active vs. Passive


Location Science Improves Everyday Life

Your NAD 83-Based State Plane-Legislated Coordinates *Will Not* Be Maintained after 2022!

What will you and your fellow professionals do?
Panic? Ignore the Issue? *or Act?*
Please let us know!

What is changing?

The North American Datum of 1983 (NAD 83) will be replaced in 2022.
The new datum will have a different name.

The North American Vertical Datum of 1988 (NAVD 88) will also be replaced in 2022.
Its replacement will also have a new name.

Expected horizontal shifts from NAD 83 to the new datum are in the 1-2 meter range.
The National Geodetic Survey will provide a coarse, map-grade transformation tool (such as NADCON and GEOCON) to connect NAD 83 with the new datum.

Who will be affected?

All states and territories will be transitioned to the new datums.
Forty-eight states have a state-specific coordinate system law tied to NAD 83.
Your state law will not reflect the National Spatial Reference System after 2022.

Who can help?

The National Geodetic Survey (NGS), the National Society of Professional Surveyors (NSPS) and the American Association for Geodetic Surveying (AAGS) are here to help your state make these changes in legislation!

You can help by understanding your own state's laws and how these changes will impact you.

Should you change or modify your state law?

NGS, NSPS and AAGS believe it would benefit state surveyors and mapping professionals for laws or regulations to reflect the latest federal geodetic infrastructure, namely **the National Spatial Reference System.**

Why should you change or modify your state law?

1. Federal agencies will adopt the new datum, so national products like **Federal Emergency Management Agency (FEMA) flood insurance rate maps** will no longer reference NAD 83, nor NAVD 88. Using the current (most updated) datum will avoid confusion and increase consistency with federal engineering or constructions projects.

3. More geospatial data is being collected and shared every day. A consistent and regularly updated NSRS will provide greater efficiency across surveying and mapping sectors.

What do you think?

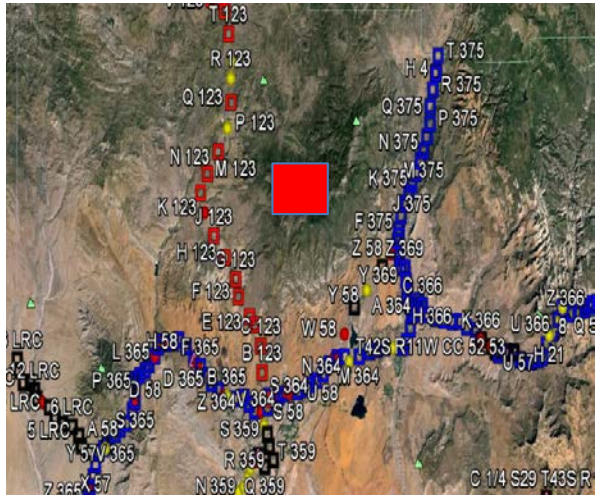
We welcome your feedback! Please provide any feedback you like to one of our committee members, below.

NSPS/AAGS/NGS Advisory Committee on National Spatial Reference System Legislation

J.B. Byrd	NSPS	jbyrd@jmpa.us
Dave Doyle	NSPS	base9geodesy@gmail.com

North American-Pacific Geopotential Datum of 2022 (**NAPGD2022**)

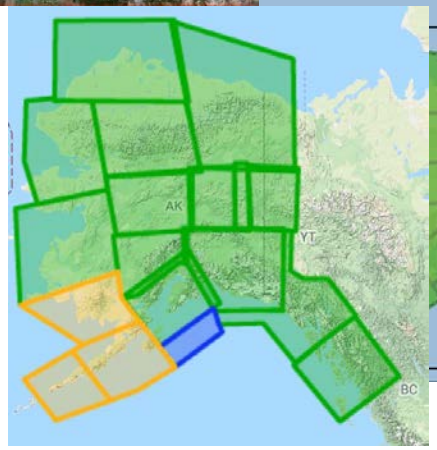
- replace NAVD88, etc. in 2022
- access via GNSS & **gravimetric geoid** (+ leveling, per needs)
- aligned: 2022 Terrestrial Reference Frames (eg **NATRF2022**)
- most accurate continental gravimetric geoid (1-2 cm goal)
- referenced to global mean sea level
- geoid coordinated w/Canada & Mexico
- monitor time-varying nature of gravity

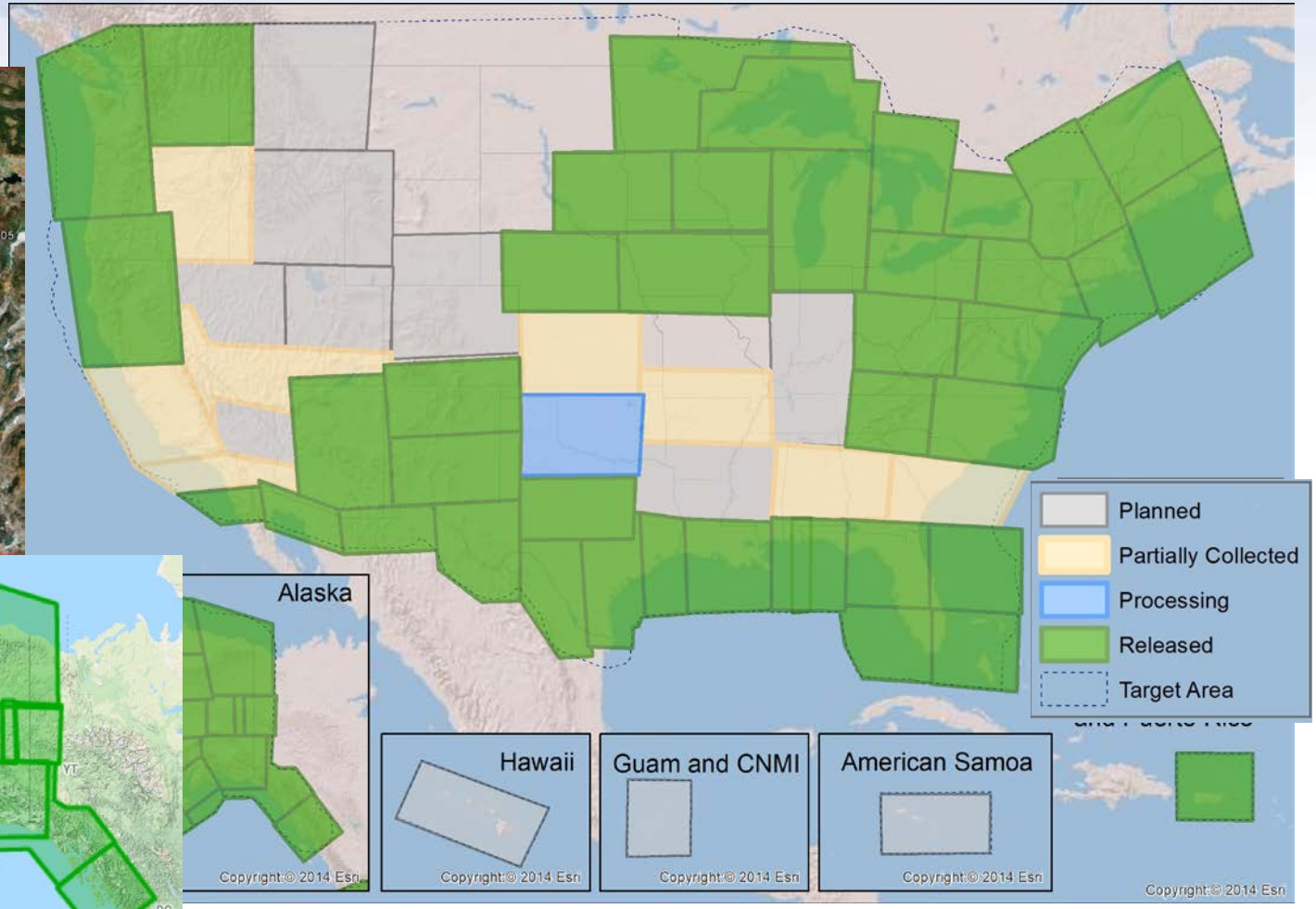


Gravity for the Redefinition of the American Vertical Datum (GRAV-D)

2019-Q1:
73% complete

- 10 km data lines
- 70 km cross lines
- 20,000 ft altitude
- 230 kt flight speed

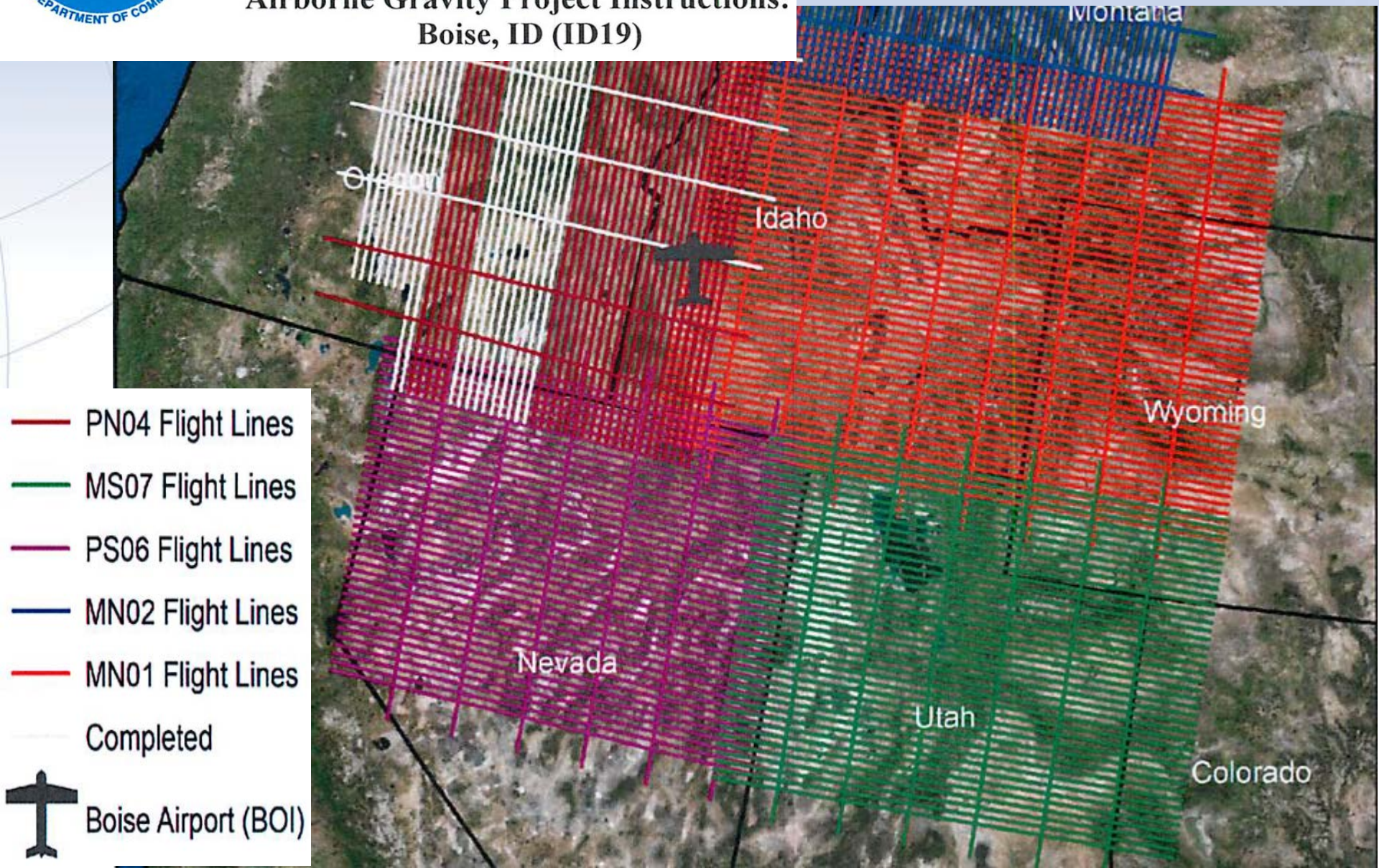




Gravity for the Redefinition of the American Vertical Datum (GRAV-D)

Airborne Gravity Project Instructions: Boise, ID (ID19)

geodesy.noaa.gov



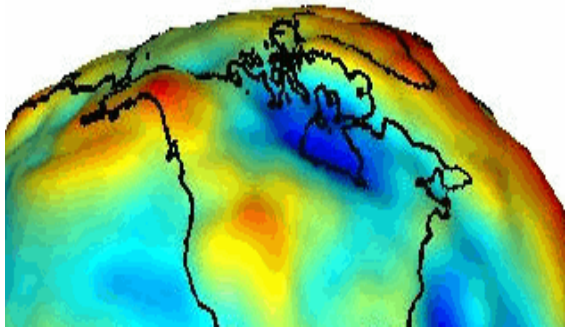
North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

Gravity Potential Energy

$$V^{(1)}(r,\theta,\lambda) = \frac{(GM)_1}{r}\sum_{n=0}^{N}\left(\frac{a_1}{r}\right)^n \sum_{m=0}^{n}\left(\bar{C}_{n,m}cos(m\lambda) + \bar{S}_{n,m}sin(m\lambda)\right)\bar{P}_{n,m}(cos\theta)$$

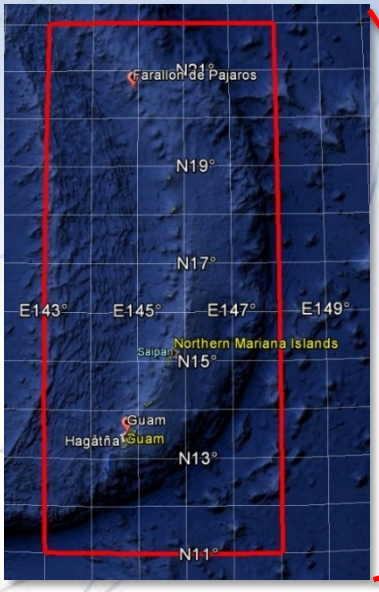
>>> <u>global</u> geopotential field model (GM2022)

- orthometric height (elevation; via GNSS)
- geoid undulation (GEOID2022; 0 elev.)
- deflection of the vertical (DEFLEC2022)
- gravity anomalies (GRAV2022)

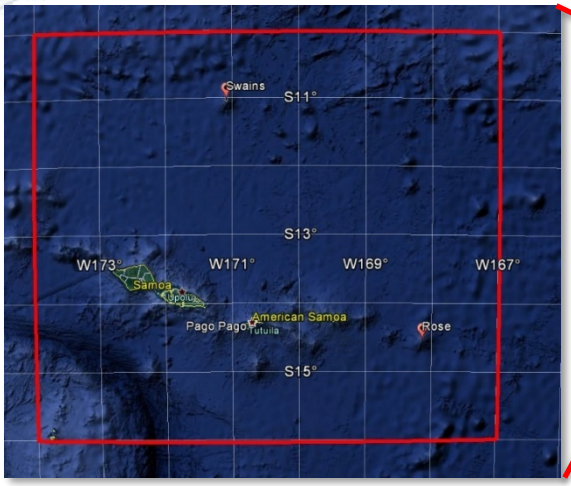


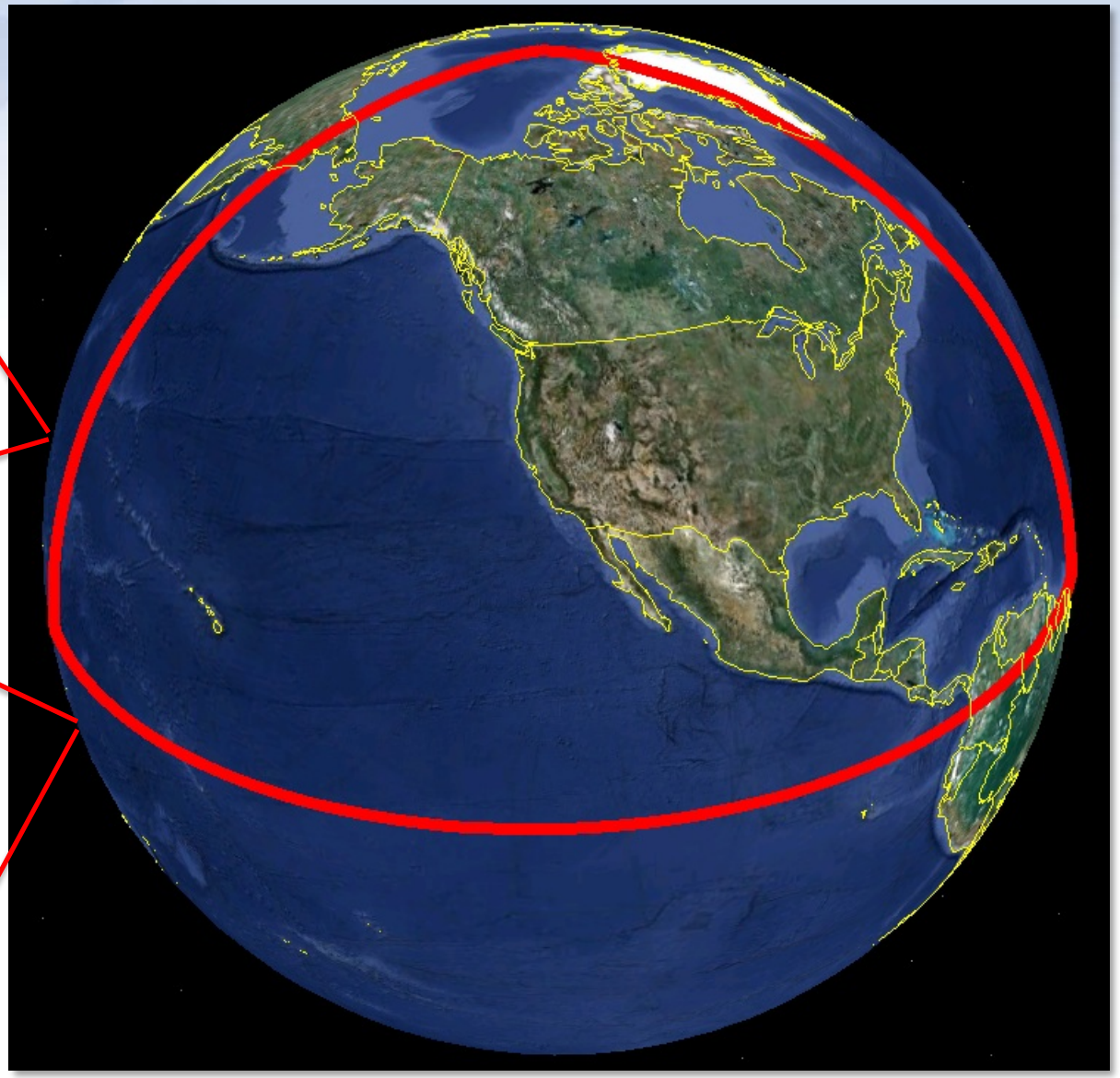
Extent of NAPGD2022 Gravimetric Geoid Model (GEOID2022)

Guam and Northern Marianas Islands

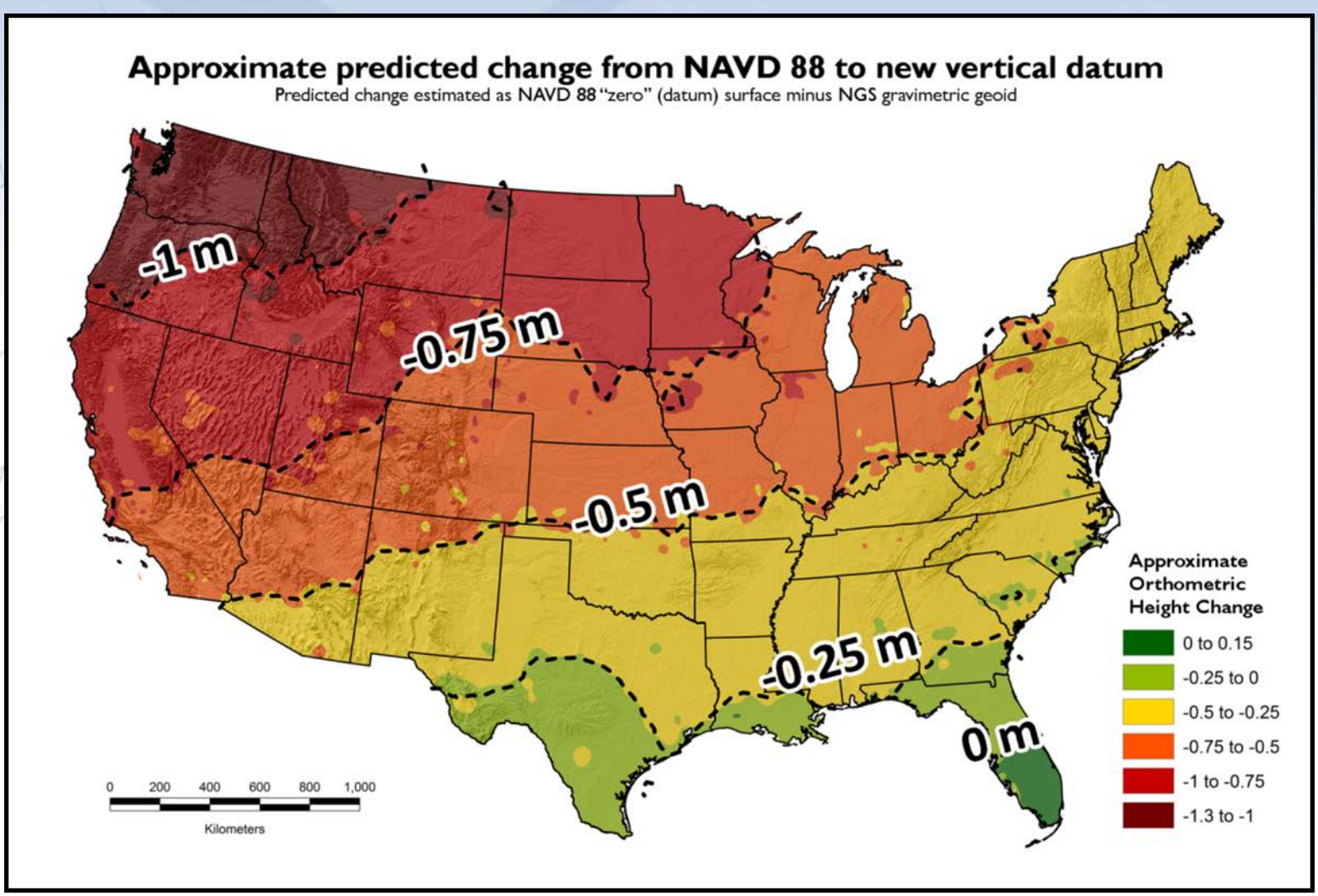


American Samoa





Predicted Change – NAVD88 to NAPGD2022



geodesy.noaa.gov

NOAA's National Geodetic Survey Positioning America for the Future

geodesy.noaa.gov

National Geodetic Survey

Positioning America for the Future

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

Quick Links

- OPUS
- CORS
- Survey Mark Datasheets
- NGS Data Explorer
- OPUS Projects
- Geodetic Tool Kit
- State Plane Coordinates
- Antenna Calibration
- UFCORS
- GEOID
- GPS on Bench Marks
- Geodetic Advisors
- Storm Imagery
- Publications
- 2019 Geospatial Summit
- FAQs
- Contact Us

Subscribe for email notifications

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

NOAA's National Geodetic Survey (NGS) provides the framework for all positioning activities in the Nation. The foundational elements of latitude, longitude, elevation, shoreline information impact a wide range of important activities.

Learn more about:

- Data and tools we provide
- Activities in your area
- Applications of geodesy

GNSS & GPS Data

Get coordinate information and the tools you need to work independently.

Learn More

Remote Sensing

Download data and critical information into nautical charts.

Learn More

Land Surveying

View guidelines and get tools to support land surveyors.

Learn More

Geodesy

NGS works closely with the global researchers advancing geodetic science.

Learn More

Training & Education

Datums & Transformations

Looking for Bench Marks?

Notices

Register: Geospatial Summit on May 6-7, 2019

BETA Releases: BETA GEOID18

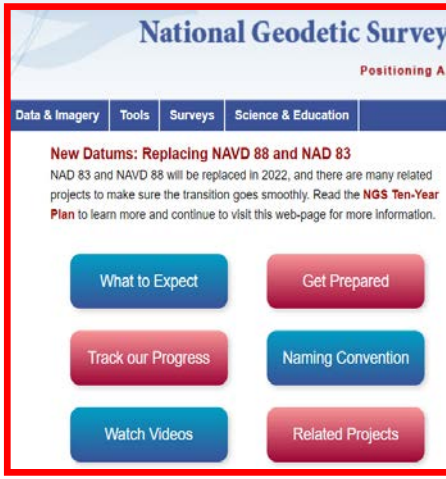
BETA CORS ITRF14 Coordinates

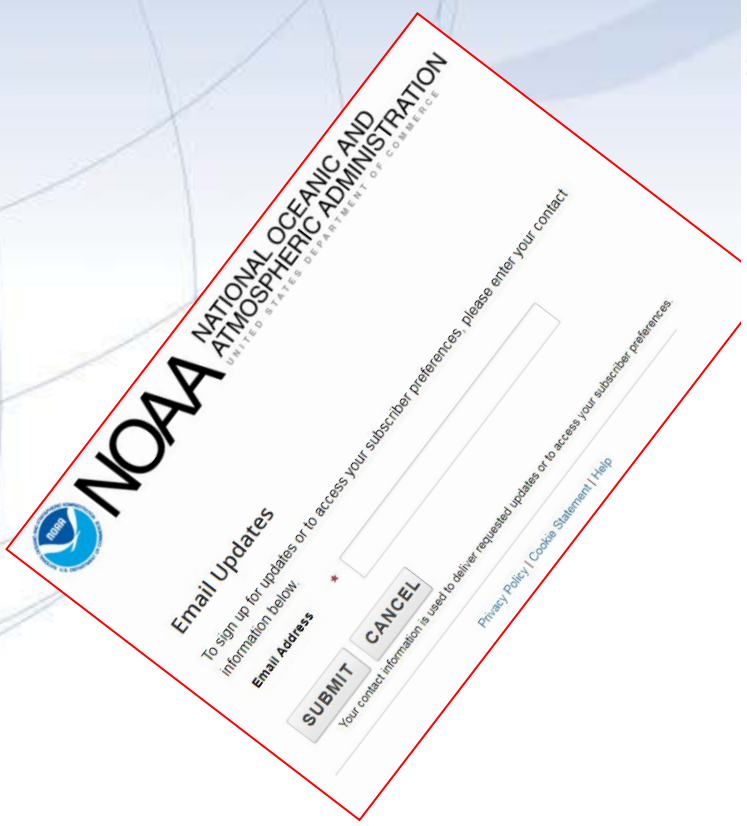
In the News

4/5/2019 - Participation in Monthly Geodesy Webinar Series Continues to Grow

03/29/2019 - Site Survey Contributes to Global Coordinate System

03/22/2019 - GPS on Bench Marks' Campaign Successes Presented at Conference





National Geodetic Survey *Positioning America for the Future* geodesy.noaa.gov

Issue 14, February 2019

NSRS Modernization News

For all issues of **NSRS Modernization News**, visit:
geodesy.noaa.gov/datums/newdatums/TrackOurProgress.shtml

Geospatial Summit 2019

The next Geospatial Summit about NSRS Modernization will take place May 6-7, 2019 in Silver Spring, MD. Mark your calendars and check the 2019 NGS Geospatial Summit page for more information when it becomes available.

Shutdown Impacts

The 35 day partial shutdown of the government included the Department of Commerce and subsequently the National Geodetic Survey. The potential damage caused to the already tight schedule of the NSRS Modernization effort is not yet fully known. However, some immediate impacts can be stated definitively:

1. The long-awaited GRAV-D airborne gravity survey of the Pacific Islands (Hawaii, Guam, CNMI and American Samoa) was scheduled to begin in early January, and run through March. Existing commitments of the aircraft mean that the entirety of that survey cannot be completed before March. The survey is now scheduled to begin in Hawaii in early February, then move to American Samoa, barring weather, maintenance or further shutdowns. The Guam and CNMI portions of the survey will be put off for a future date.
2. The significance of this delay should not be underestimated. The GRAV-D schedule is effectively the "long pole in the tent". Getting the modernized NSRS out, even in late 2022, depends upon mitigating any significant or unforeseen delays in GRAV-D. 2022 remains the official completion and rollout date, although the schedule is now questionable.
3. *The Blueprint for 2022, Part 3: Working in the modernized NSRS* document is now tentatively scheduled for release prior to the Geospatial Summit in May, despite the disruption to the writing and editing process. Still, the importance of this document to the NGS communications plan puts its release as a top priority under the modernization efforts.

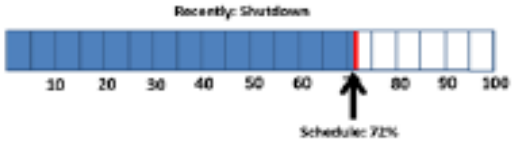
Progress in Ongoing Projects

There are currently 18 ongoing projects directly related to NSRS modernization around NGS. Here are highlights from a select few:

- **Comprehensive Toolkit Improvements**
  Project Manager: Dr. Dru Smith (*Acting*)

  It is NGS's intention that NCAT and VDatum eventually be able to perform all transformation and conversion functions that currently reside as separate tools in the NGS Toolkit. A complete diagram of that functionality has been completed and provided to both the NCAT and VDatum teams in order to assist in this effort. Look for updates to NGS Toolkit over the coming months.

GRAV-D progress last quarter: up 0.9% to 72.8%
Ahead of Schedule (despite the shutdown)!



NGS 2019 Geospatial Summit
May 6-7, 2019 --- Silver Spring, MD

National Geodetic Survey

Positioning America for the Future

2019 Geospatial Summit

2019 Summit Home
Register
Agenda

On May 6-7, 2019 NGS will host the 2019 Geospatial Summit at the Silver Spring Civic Building at 1 Veterans Pl, Silver Spring, MD 20910.