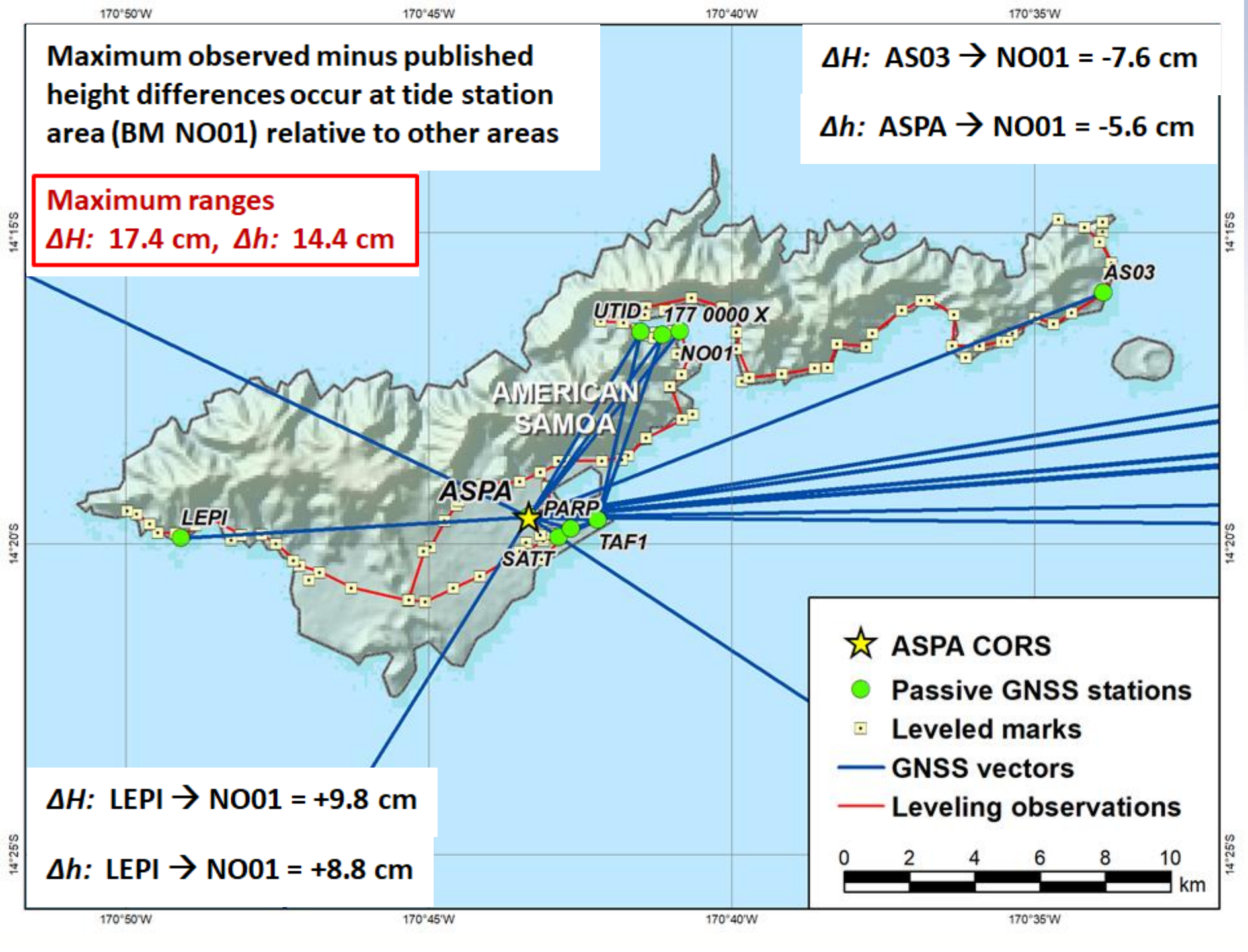
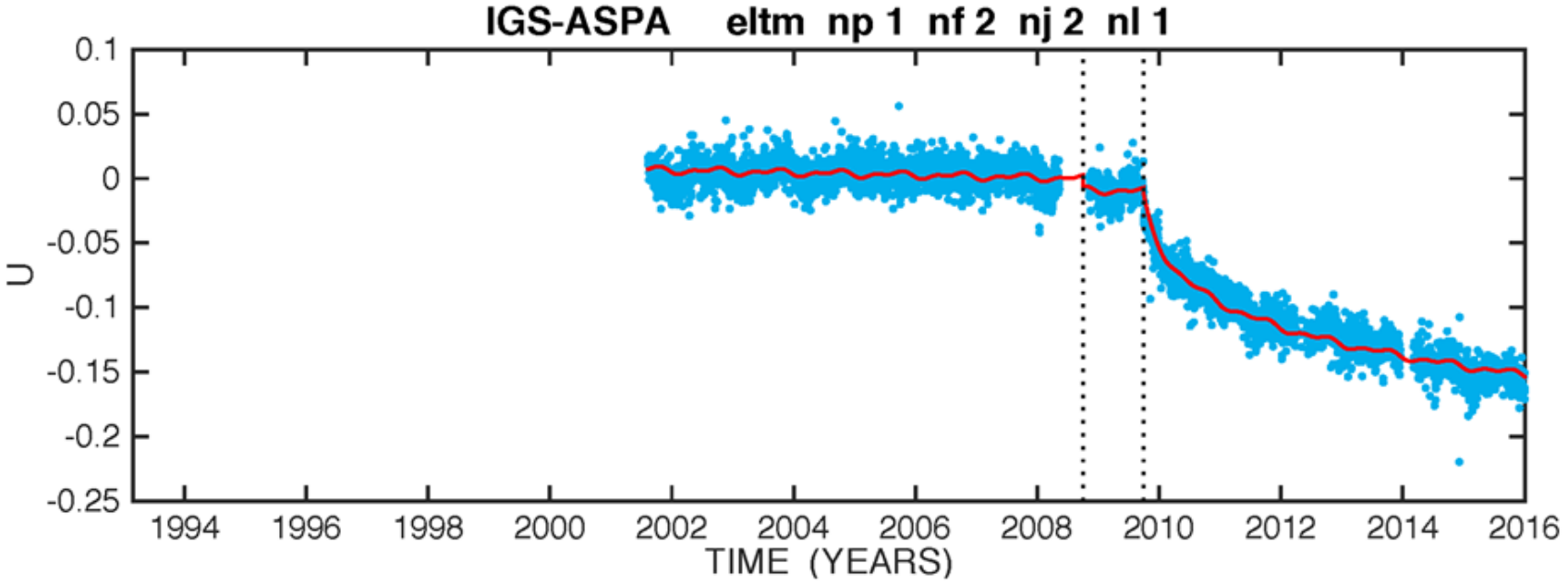
Deprecation of the American Samoa Vertical Datum of 2002 (ASVD02)

- ASVD02
  - Official vertical datum of American Samoa
  - Based in first order, class II leveling in 2002
- Large earthquake Sep 2009 and subsequent motion
  - Absolute decrease in heights 15-20 cm
  - Relative height change up to ~17 cm
- FAA surveys performed in 2017
  - Waiting on NGS guidance for vertical reference
  - Deprecate ASVD02 => allow use of local tidal datum


Maximum observed minus published height differences occur at tide station area (BM NO01) relative to other areas
ΔH: AS03 → NO01 = -7.6 cm
Δh: ASPA → NO01 = -5.6 cm
Maximum ranges
ΔH: 17.4 cm, Δh: 14.4 cm
170°50'W
170°45'W
170°40'W
170°35'W
14°15'S
14°20'S
14°25'S
AMERICAN SAMOA
AS03
UTID
177 0000 X
NO01
ASPA
PARP
TAF1
SATT
LEPI
ΔH: LEPI → NO01 = +9.8 cm
Δh: LEPI → NO01 = +8.8 cm
ASPA CORS
Passive GNSS stations
Leveled marks
GNSS vectors
Leveling observations
0 2 4 6 8 10
km

Change in height of ASPA

- Preliminary results from Dana Caccamise
  - More than 15 cm decrease in height since 2009
  - Appears height is still decreasing



Key Discussion Points

1. Seismic activity changed heights on American Samoa
2. ASVD02 no longer recoverable or accessible
3. FAA survey waiting on NGS guidance
4. Results indicate relative height change not uniform
5. Relative change > leveling accuracy by order magnitude
6. ASPA CORS decreased in height by ~15-20 cm
7. Decrease in tidal BM by ~20 cm w.r.t. local sea level

For FGCS Consideration:

- Deprecate ASVD02
- Initiate accompanying Federal Register Notice

NGS will continue to examine the issue

Alternatives

1. Ignore problem and keep ASVD02
   a. Would have 15-20 cm bias
   b. Would not meet relative accuracies between BMs
2. Shift heights to match current local tidal datum
   a. Would not resolve relative height change between BMs
   b. GNSS survey to provide new leveling constraints
   c. Likely insufficient accuracy and spatial resolution
   d. Costly and would result in new vertical datum
3. Re-level ASVD02 network
   a. Costly and also would result in new vertical datum
   b. If done, should be consistent with NAPGD2022

Federal Geodetic Control Subcommittee Meeting

October 25, 2018

Time	Topic	Presenter
1:00 – 1:10	Welcome, introductions and updates	Juliana Blackwell
1:10 – 1:30	NSRS Modernization Efforts	Dru Smith
1:30 – 1:40	Deprecation of the American Samoa Vertical Datum of 2002 (ASVD02)	Dan Roman
1:40 – 2:00	GEOID18 Update/GPS on Benchmarks	Galen Scott
2:00 – 2:20	Status of SPCS2022	Galen Scott
2:20 – 2:40	ISO standards for Geodetic References (19161) and Referencing by Coordinates (19111)	Larry Hothem
2:40 – 3:00	Work Group Updates, Open Discussion, Closing Remarks	Work Group Chairs Everyone

FGCS Member Roll Call

This subcommittee coordinates geodetic data-related activities among 24 Federal and non-Federal agencies and will report its activities to FGDC.

http://www.fgdc.gov/participation/working-groups-subcommittees/fgcs/directory

Geospatial Data Act

"Geospatial Data Act" language included in FAA Reauthorization Act of 2018, under Subtitle F.
https://www.fgdc.gov/gda/geospatial-data-act-of-2018.pdf

Highlights:

- Codifies the existing executive orders and other guidance documents that direct work by the Federal Geographic Data Committee (FGDC)
- Keeps FGDC in the Department of Interior (DOI)
- Keeps Secretary of DOI as Chair of the FGDC and adds OMB as Vice Chair
- Provides the following requirement on use of federal funds:

  5 years after the FGDC establishes a "data theme," and the associated standards, no covered agency can use federal funds "for the collection, production, acquisition, maintenance, or dissemination of geospatial data that does not comply with the applicable standards." This limitation does not apply to data collected prior to the establishment of the "data theme."
- Does not contain language requiring modification of Part 36 of Federal Acquisition Regulation Section (which would have required "architectural and engineering services" be covered by the act's definition of geospatial data and services)
- Provides Congressional oversight of geospatial activities of FGDC members and other agencies. Covered agencies will be audited every two years by their Inspector General/ethics office to ensure compliance (section 759c).
- Requires reporting that will allow Congress to track progress on the national spatial data infrastructure and ensure funding is spent wisely
- Provides more clout to input developed by the multi-sector membership of the National Geospatial Advisory Committee (NGAC) and requires the FGDC to address NGAC's concerns
- Requires federal agencies to coordinate and work in partnership with other federal agencies, agencies of state, tribal and local governments, institutions of higher education, and the private sector to efficiently and cost-effectively collect, integrate, maintain, disseminate and preserve geospatial data

Visit the **FGDC Geospatial Data Act of 2018** webpage at https://www.fgdc.gov/gda for additional information and updates.

GPS on Bench Marks & GEOID18 Update for FGCS

FGCS Quarterly meeting

October 25th, 2018

Galen Scott – GEOID18 Project Lead

Kevin Ahlgren – GEOID18 Technical Lead

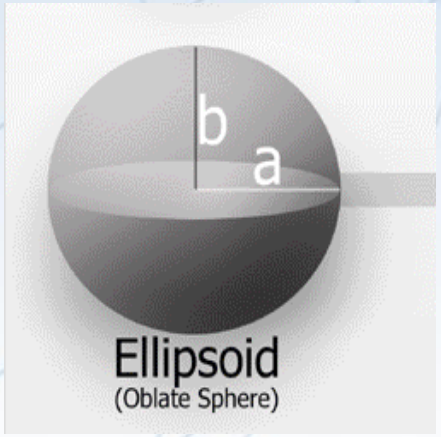
GPS Data on NAVD 88 leveled marks will support development of GEOID18 and the transformation tools to NAPGD2022

Geoid Modeling Improvements

Prototype used GPS on Bench Marks data and the results of the residual analysis.
Prototype model differs in several significant ways from GEOID 12B:

1. New satellite and airborne gravity data has been included, and improved gravity processing and geoid modeling methods have been used.
2. New topography data and interpolation mechanisms have been employed which has improved the accuracy and spatial resolution of required elevation models
3. New GPS and leveling observations submitted to NGS since 2012 have been incorporated into the model,
4. Some marks that were used in GEOID 12b have been removed for a variety of reasons.

Residual = h - H - N



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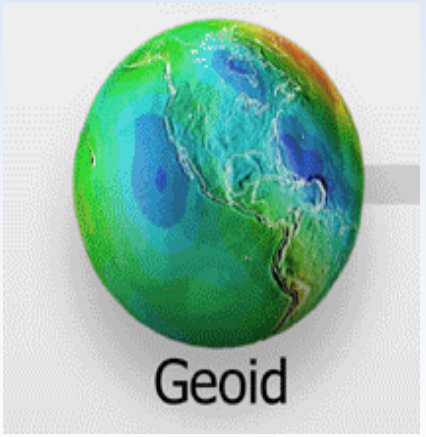


h is ellipsoid height measured using GPS

H is an NAVD 88 Orthometric Height from Leveling

N is from a geoid model
(xGeoid18 & Prototype hybrid)

Theoretically, the difference between these three values should be zero. In practice, using actual observations gives a residual, or measure of the misfit between the three. We use the residual to evaluate the observations.

National Geodetic Survey

Positioning America for the Future

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

GPS on BM Links
- Home
- Recover
- Observe
- Report
- 2018 Web Map
- Prioritized Marks
- Training Resources
- GPS on BM FAQ
- GPS on BM One Pager

Related Links
- GEOID18
- NGS Data Explorer
- DSWorld
- OPUS Upload
- Mark Recovery Form
- Photo Submission

For geocachers:
- Hunt for marks!
- Bench Mark Hunting

Prioritized Marks

Currently there are over 400,000 bench marks across the Conterminous United States (CONUS), Alaska, Hawaii and U.S. territories. Tidal marks and bench marks are used for determining heights and when possible providing GPS on these marks can help to relate the GPS derived ellipsoid height with the leveling derived orthometric height associated with these marks.

NGS will create models and tools that cover the nation using the data we have. The information provided on this page will enable local users to collect and submit data that will improve the accuracy of those products in their local regions.

Over the past year NGS has analyzed the leveling and GPS data we have on bench marks to determine where additional data would be most helpful in creating the next hybrid geoid model, GEOID18 and the transformation tools that will be produced with NAPGD2022. This rigorous analysis examined the ellipsoid-orthometric-geoid relationship at over 30,000 individual bench mark as well as the patterns in that relationship over broad regions. A prioritized list of bench marks where additional GPS data would be most helpful has been generated from that analysis and is available to download below.

Download Prioritized Marks

A listing of prioritized marks has been generated and is downloadable in various formats (.xls; .kmz; and .shp). There are approximately 6100 benchmarks in this listing. Click the icons to the right to download the files.

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

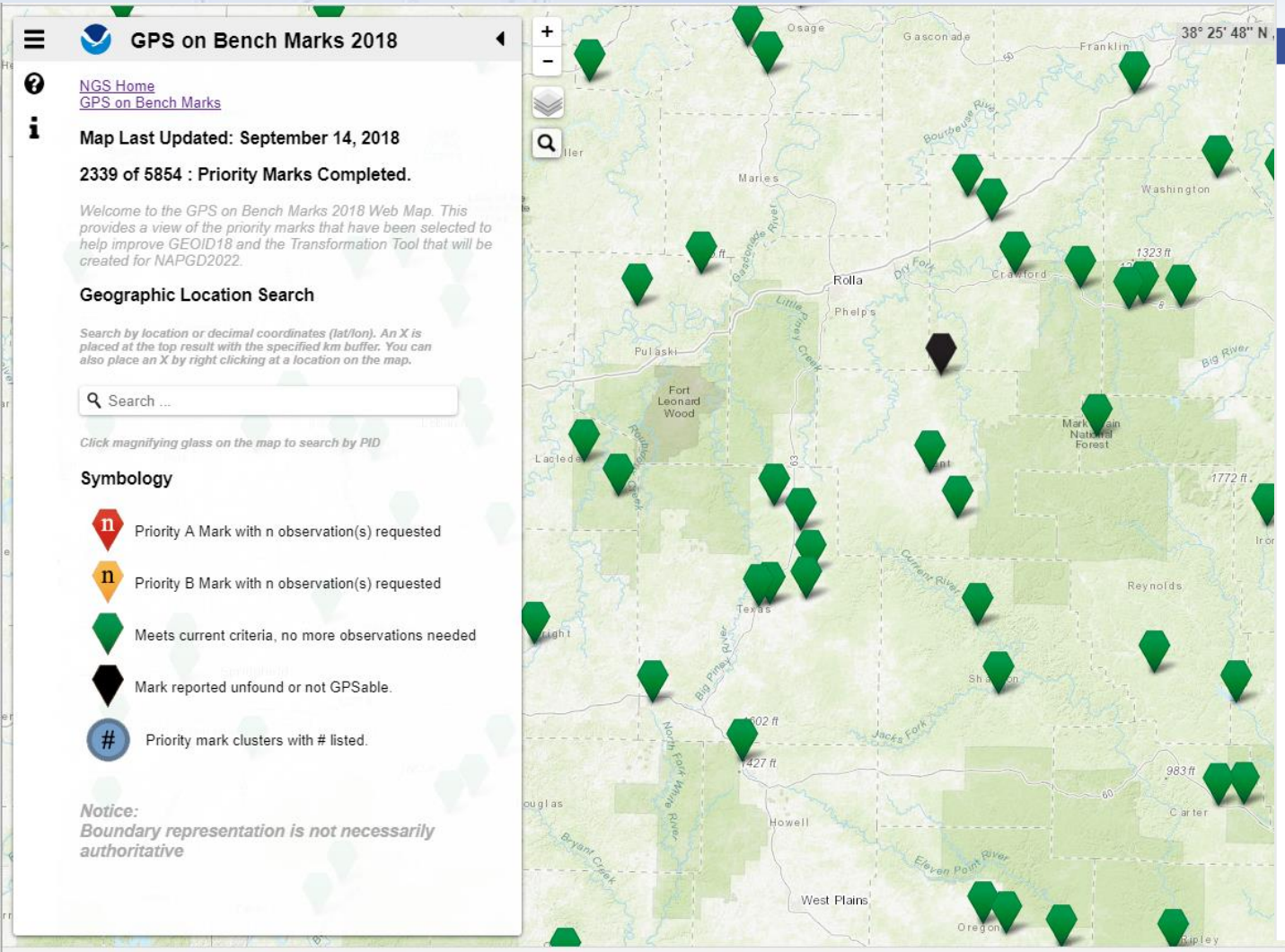
Prioritized List is available as excel file, ESRI shapefile, and Google Earth kmz file.

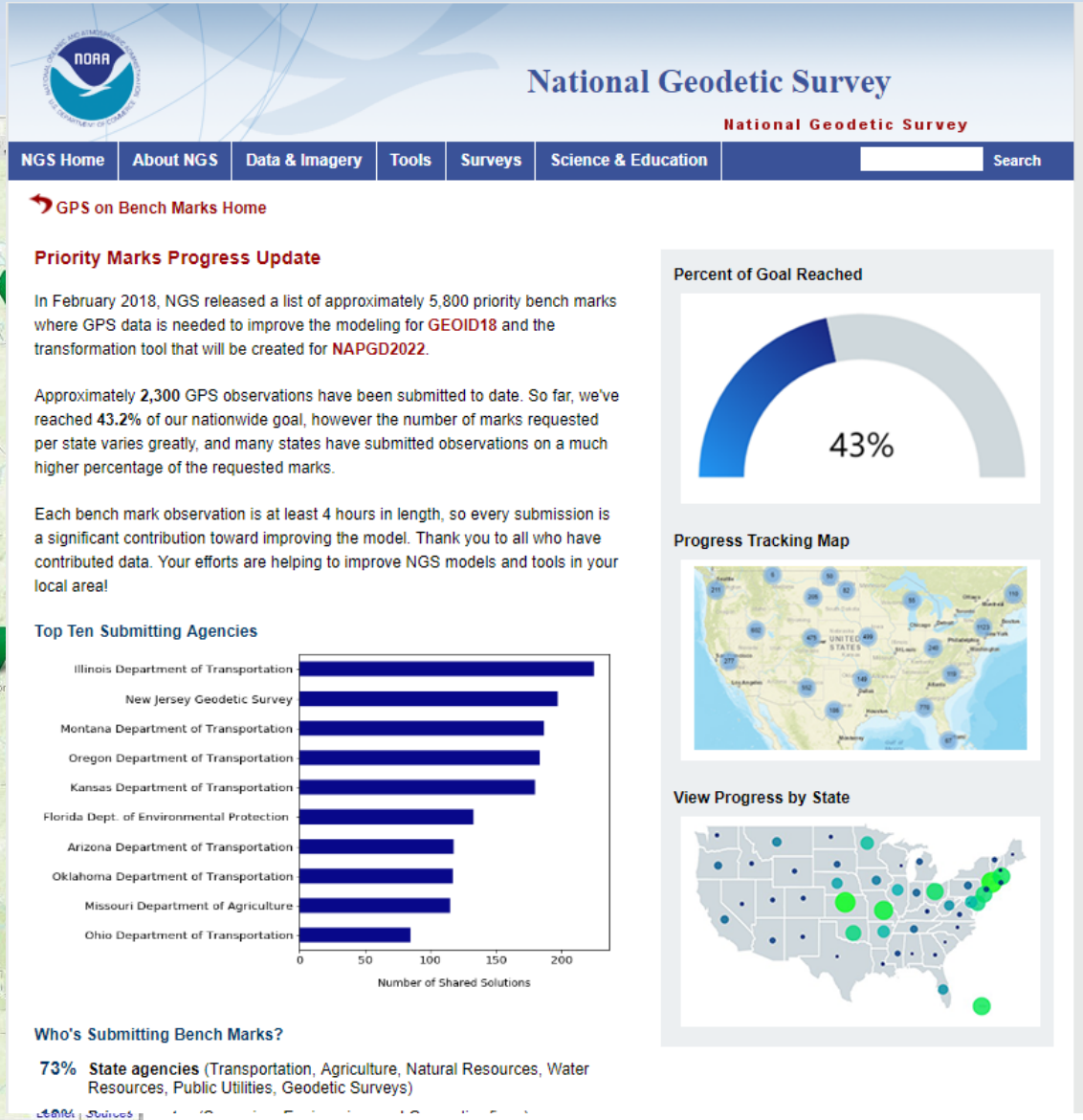
Definition of Columns of GPS on BMs Data Files

pid	Unique Identifier
lat	NAD 83 (2011) Latitude
lon	NAD 83 (2011) Longitude
eht	NAD 83 (2011) Ellipsoid Height (blank if the station doesn't have a published ellipsoid height)
state	State Code
county	County Name
priority	Priority for Observing
obs_cnt	Number of Times the Station's Ellipsoid Height Has Been Estimated
near_pid	PID of "Near By" Station
datasheet	Link to NGS Data Sheet for the Station

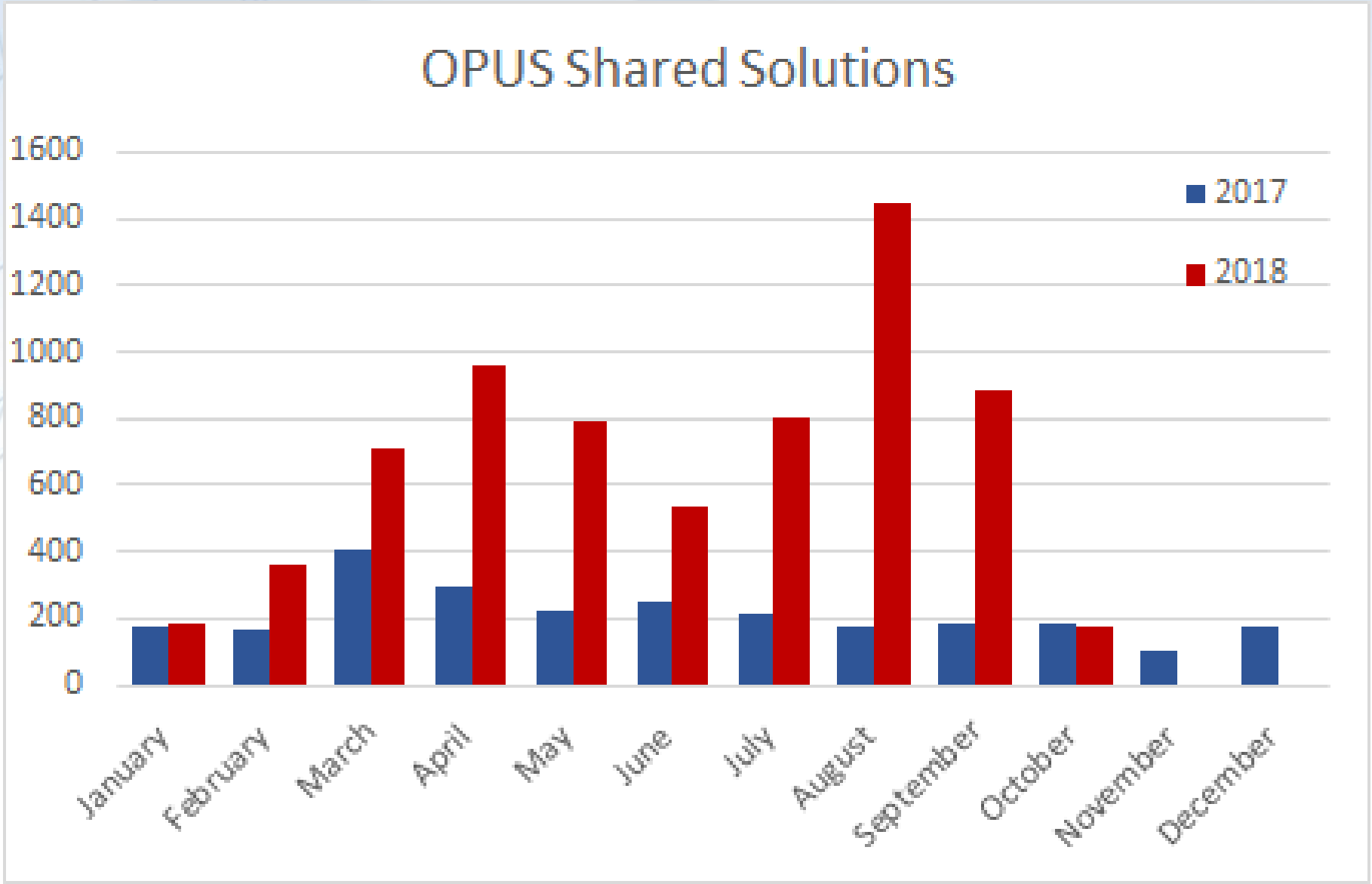
From Zilkoski GPS World 2/7/2018

Tracking Map & Progress Dashboard





OPUS Share has broken records every month this year



Submitting Mark Recoveries through DSWorld

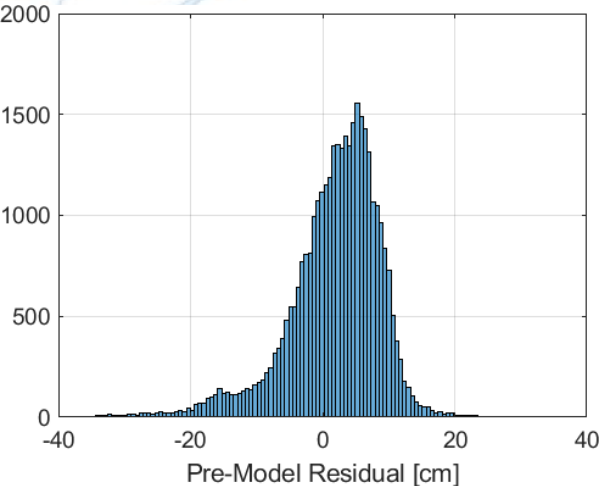
DSWorld is a multifunction application that enables you to plot bench marks in Google Earth and submit bench mark recoveries to NGS.

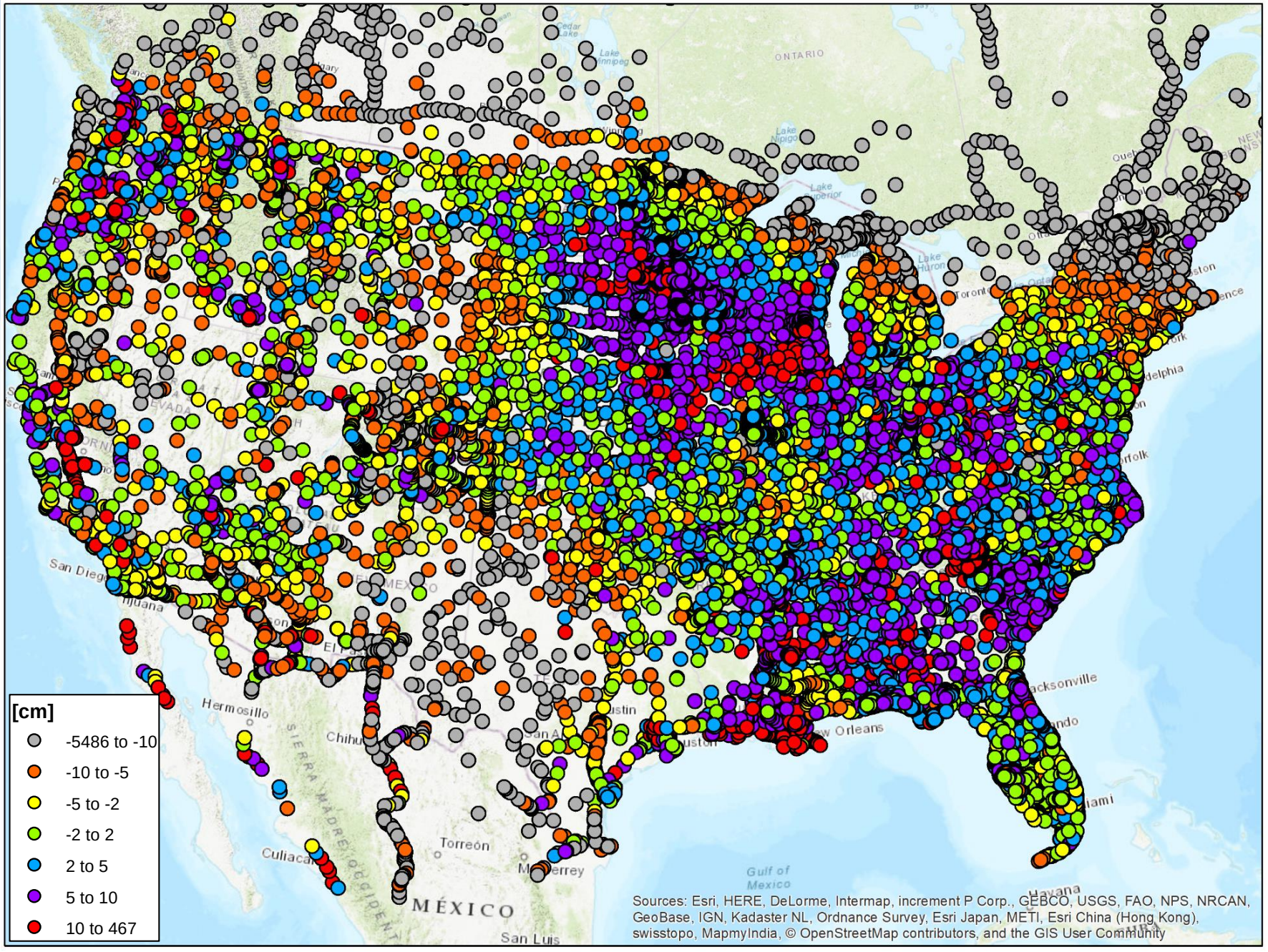
Recovery information will let NGS and others know if the mark is still usable and pictures will make it easier to find.

https://geodesy.noaa.gov/PC_PROD/PARTNERS/

Pre-Model Residual

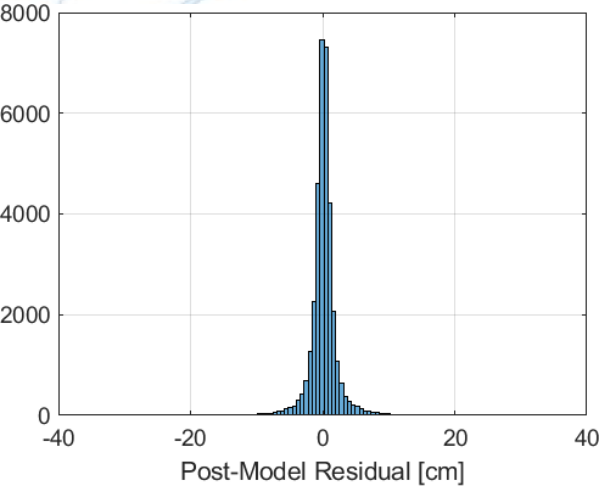
- N is from xGEOID18 (gravimetric geoid model)

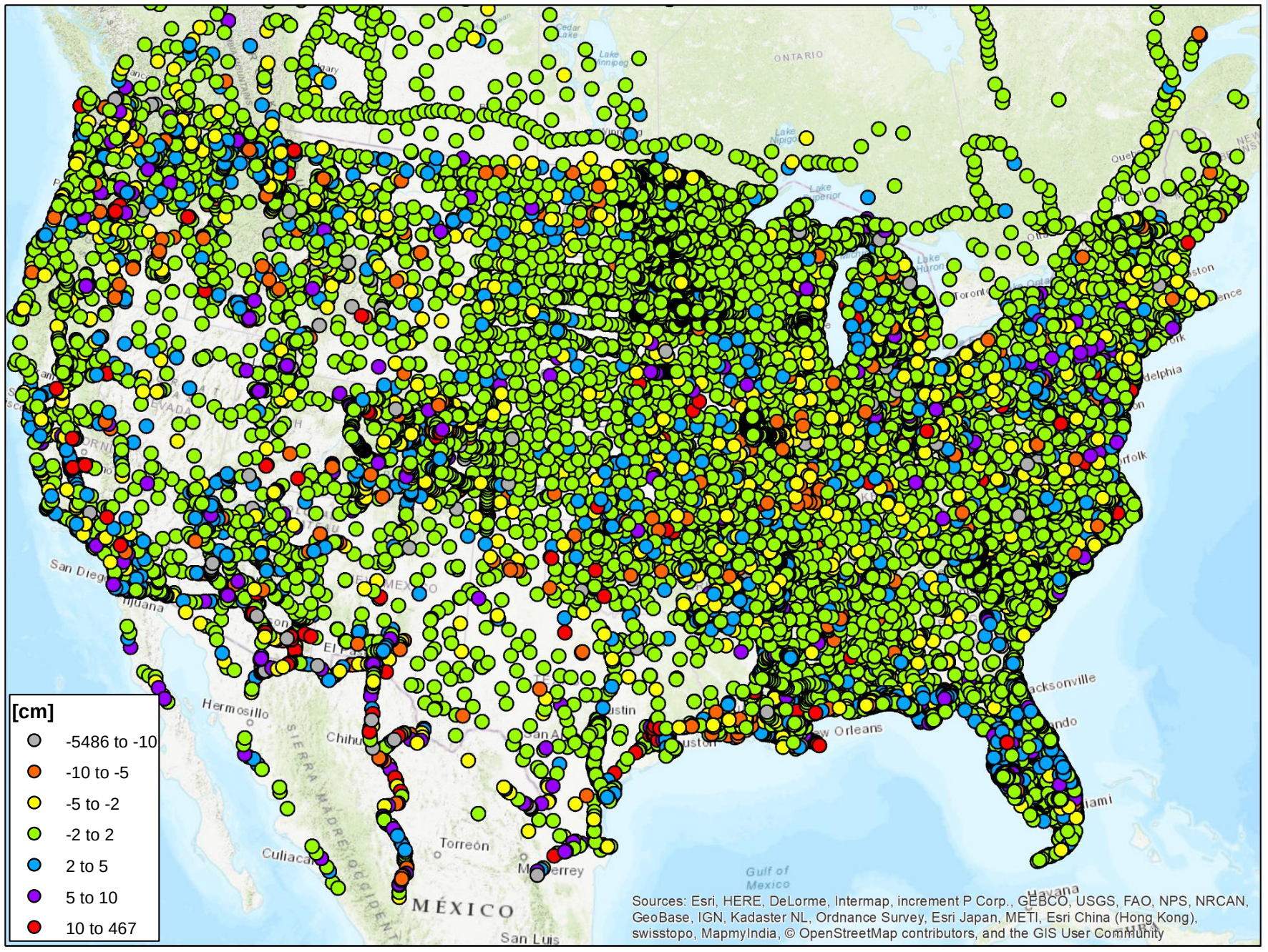




Post-Model Residual

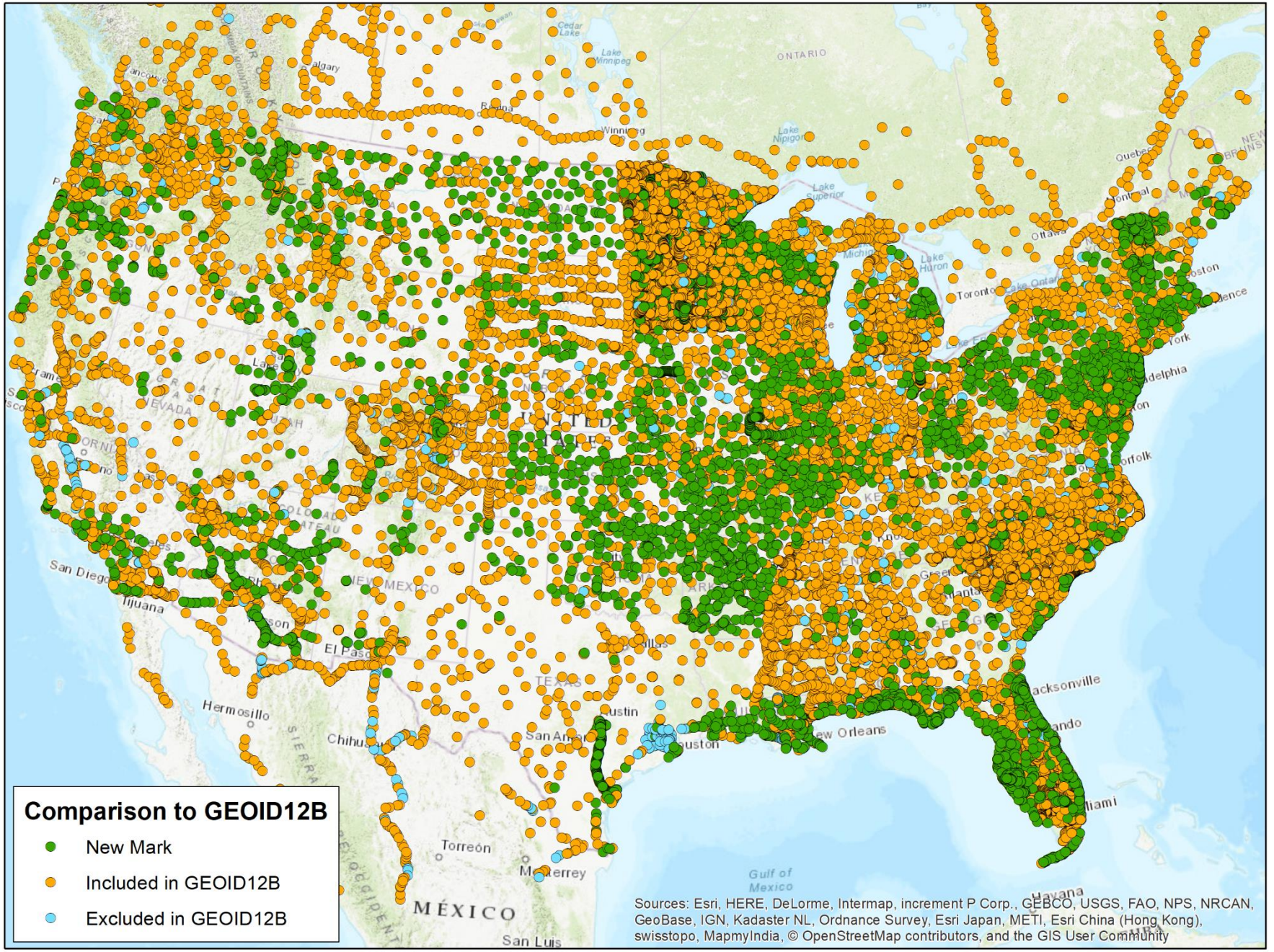
- N is from prototype hybrid geoid model





Prototype Hybrid Geoid (v5.1)

- Similar construction as GEOID12B
- Gravimetric Geoid Model: xGEOID17B (**Interpolate**)
- GPS on Bench Marks (**Constrain**)



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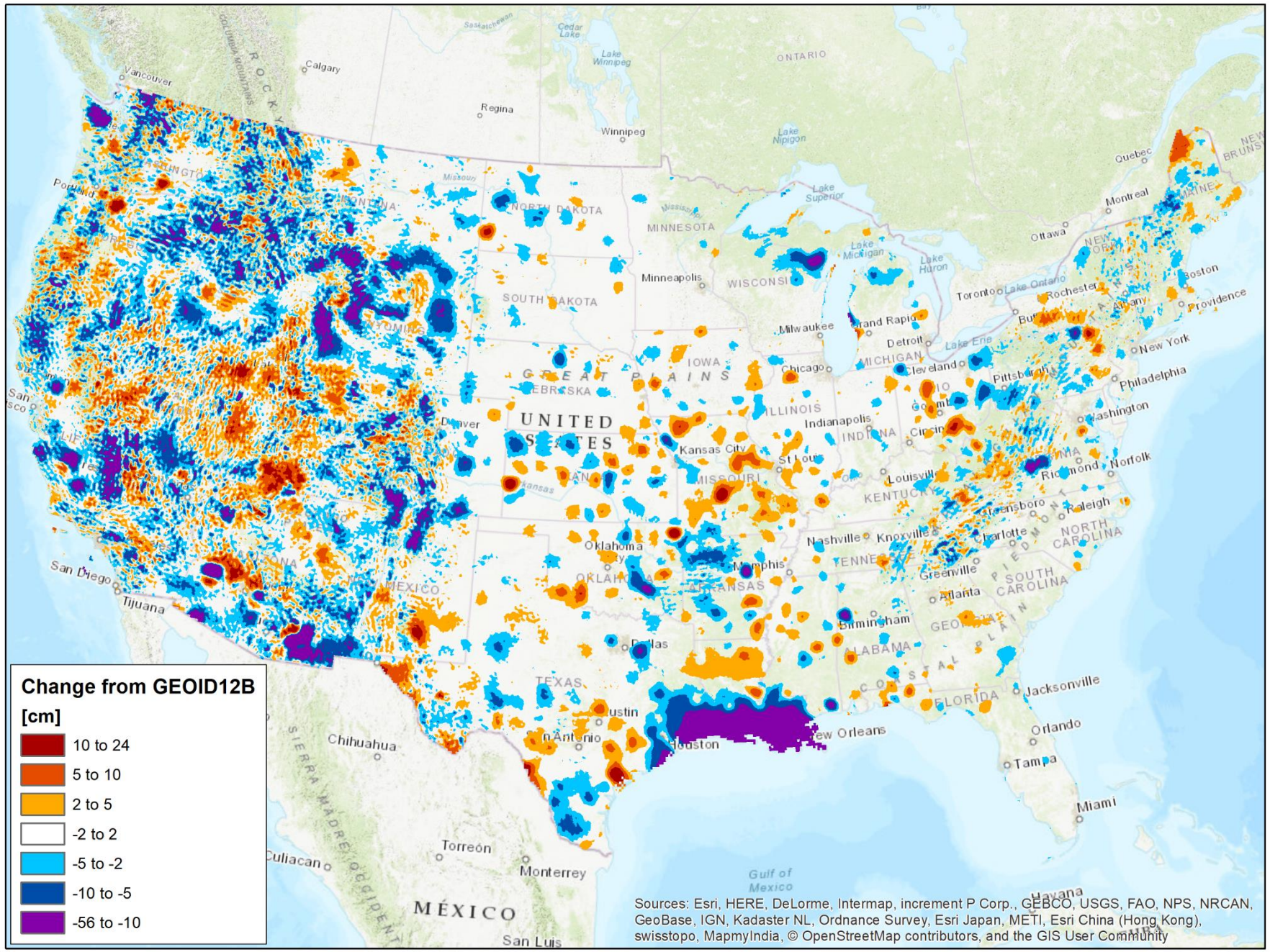
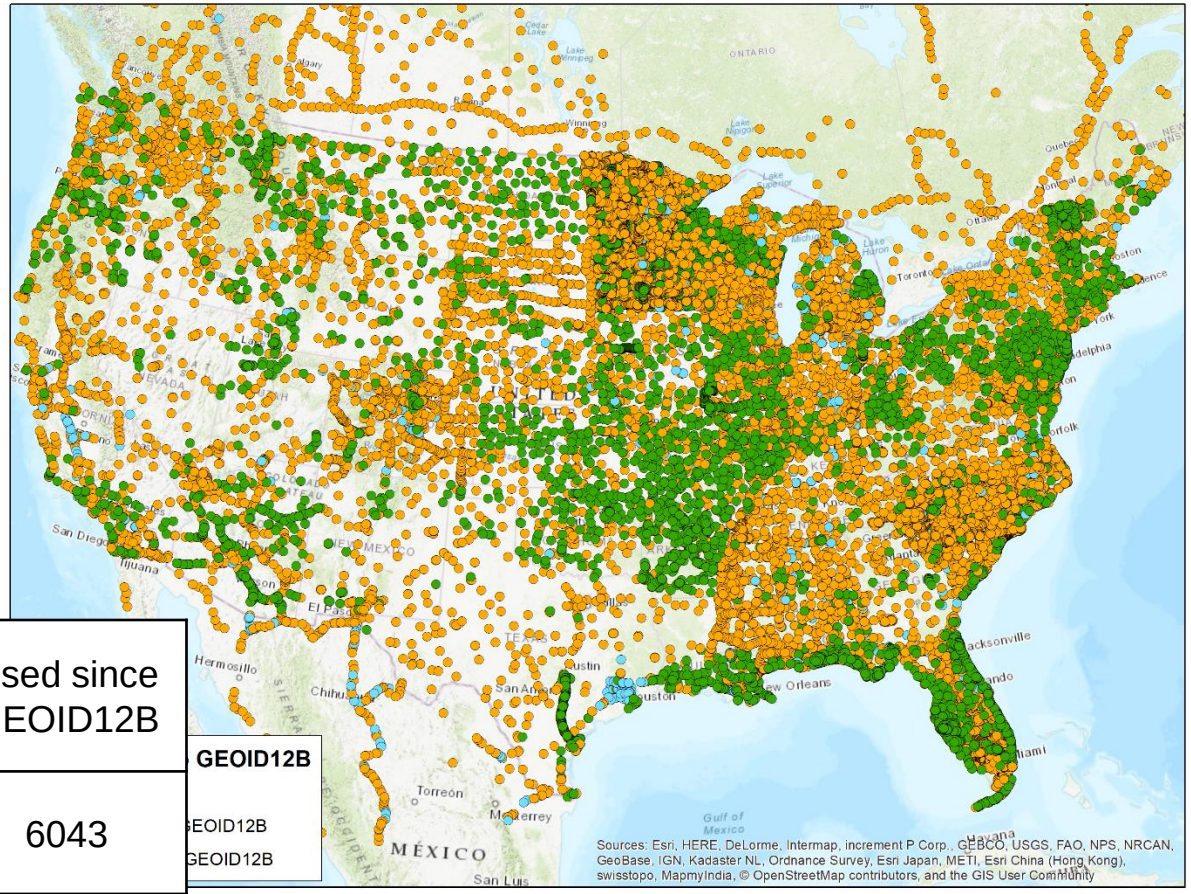


Prototype Hybrid Geoid (v8.2) Statistics

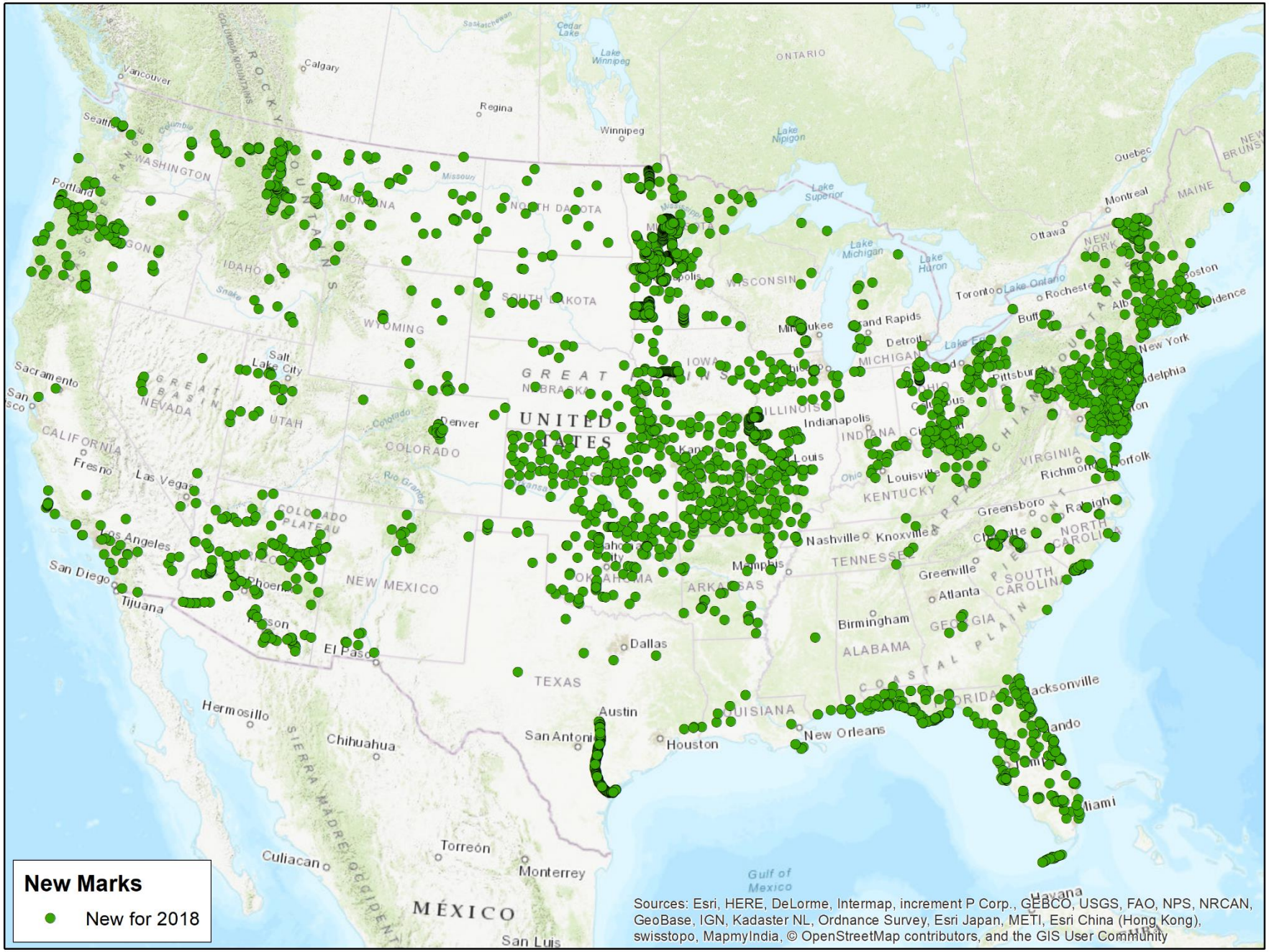
Data through 11 Oct 2018



GPS on BM	Available	Flagged as bad fit	Used in Model	Number since GEOID12B	Used since GEOID12B
NGS IDB:	30,585	1,397(4.6%)	29,188	6311	6043
OPUS Share: 2+ Obs.	3,212	215(6.7%)	2,997	2942	2754
OPUS Share: 1 Obs.	2,245	-	0	2,050	2039
Total:	**36,042**		**32,185**	**11,303**	**10,836**

Prototype Hybrid Geoid (v5.1)

- New marks since GPS on Bench marks Priority List (n = 3430)
- NGS Integrated Database – GPS Projects or Leveling Projects
- OPUS Share



Outreach Progress

- In Jan 2018, held region by region meetings with Advisors, Coordinators, and some DOT's to develop priority lists
- Released Priority Marks list with 5,800 marks, updated 2X per week to reduce duplication of effort (see tracking map)
- Held 2 GPSonBM webinars: 500 people in Feb. + 250 in Aug.
- Set up JIRA workflow for GPSonBM email Q&A's with public
  - 112 emails
- Set up Granicus email list & sent 2 updates so far
- Held three training sessions on AGOL for Advisors

April 4, 2018 Leave a comment Share

GEOID18: Make Your Mark and Improve Your Heights

This entry is part 2 of 5 in the series April 2018

As a community, we have the unique opportunity to contribute to the densification and improvement of our national geoid model and vertical transformation tools in support of the ongoing modernization of the National Spatial Reference System (NSRS). While the geoid model is a national level product, the impacts of this work are

NGS 2018 GPS on BMs program in support of NAPGD2022 — Part 8

August 1, 2018 - By David B. Zilkoski

Est. reading time: 9:30

Facebook Twitter Google LinkedIn 0 Comments

My last two columns (NGS 2018 GPS on BMs program in support of NAPGD2022 — Part 6 and NGS 2018 GPS on BMs program in support of NAPGD2022 — Part 7)
letic Survey's (NGS) GPS on BMs 2018 interactive web

NSPS NEWS & VIEWS
National Society of Professional Surveyors

NOAA's National Geodetic Survey (NGS) to replace GEOID12B with GEOID18

Galen Scott, NOAA/National Geodetic Survey, Geosciences Research Division

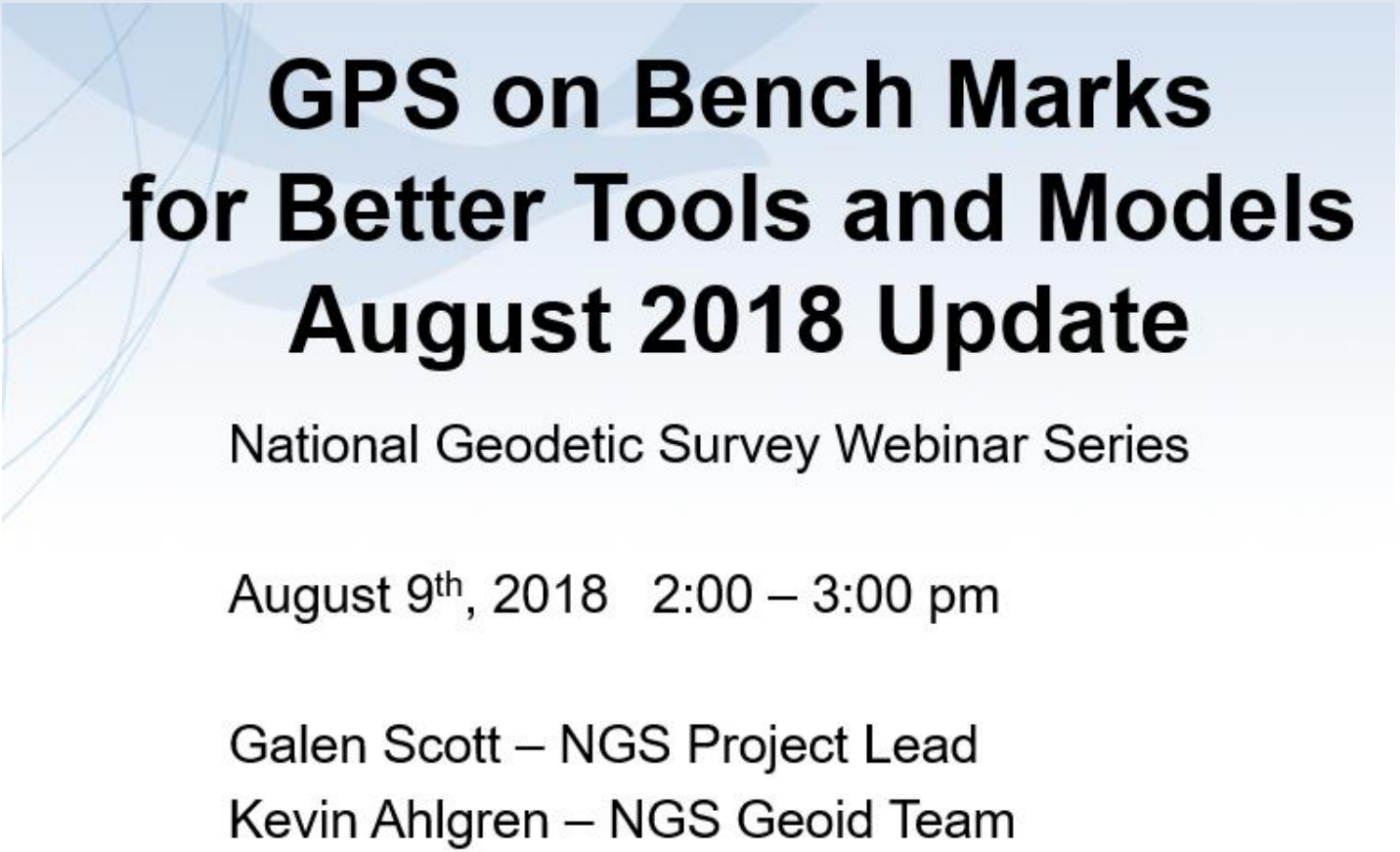
In early 2019, NOAA's National Geodetic Survey (NGS) will replace GEOID12B with GEOID18, a new hybrid geoid model to deliver improved GPS-derived NAVD 88-equivalent orthometric heights. This new model will serve as the official means for obtaining NAVD 88-equivalent heights via GPS. It will be the last hybrid geoid model that NGS will create before NAVD 88 is replaced by NAPGD2022.

NGS will use available GPS on bench mark data to create the new model. Recent analysis of existing GPS on bench mark data and a prototype of the new hybrid geoid model created using

2 Webinars - 750 People

February - 500

August - 250



External Testing Plan

External Testing

Between December 2018 and April 2019, the beta product will be made available to external stakeholders and outreach efforts will focus on promoting the model and asking people to test it in their areas and provide feedback. Presentations at surveying conferences and professional society meetings and discussions lead by the regional advisors will be used to elicit feedback.

For both internal and external testing processes, the feedback will be considered by the technical oversight committee and the model will be run iteratively with and without the specific data points in question to determine which data provides the best overall fit for the model. The Technical Oversight Committee will vote to approve the final list of GPSonBM that are used in the Prototype, beta, and Final models.

ArcGIS Online Tools for Analysis

Home ▾ Map for Advisors - v6.1.1

Details | Add ▾ | Edit | Basemap | Analysis | Save ▾ | Share | Print ▾ | Directions | Measure | Bookmarks

About | Content | Legend

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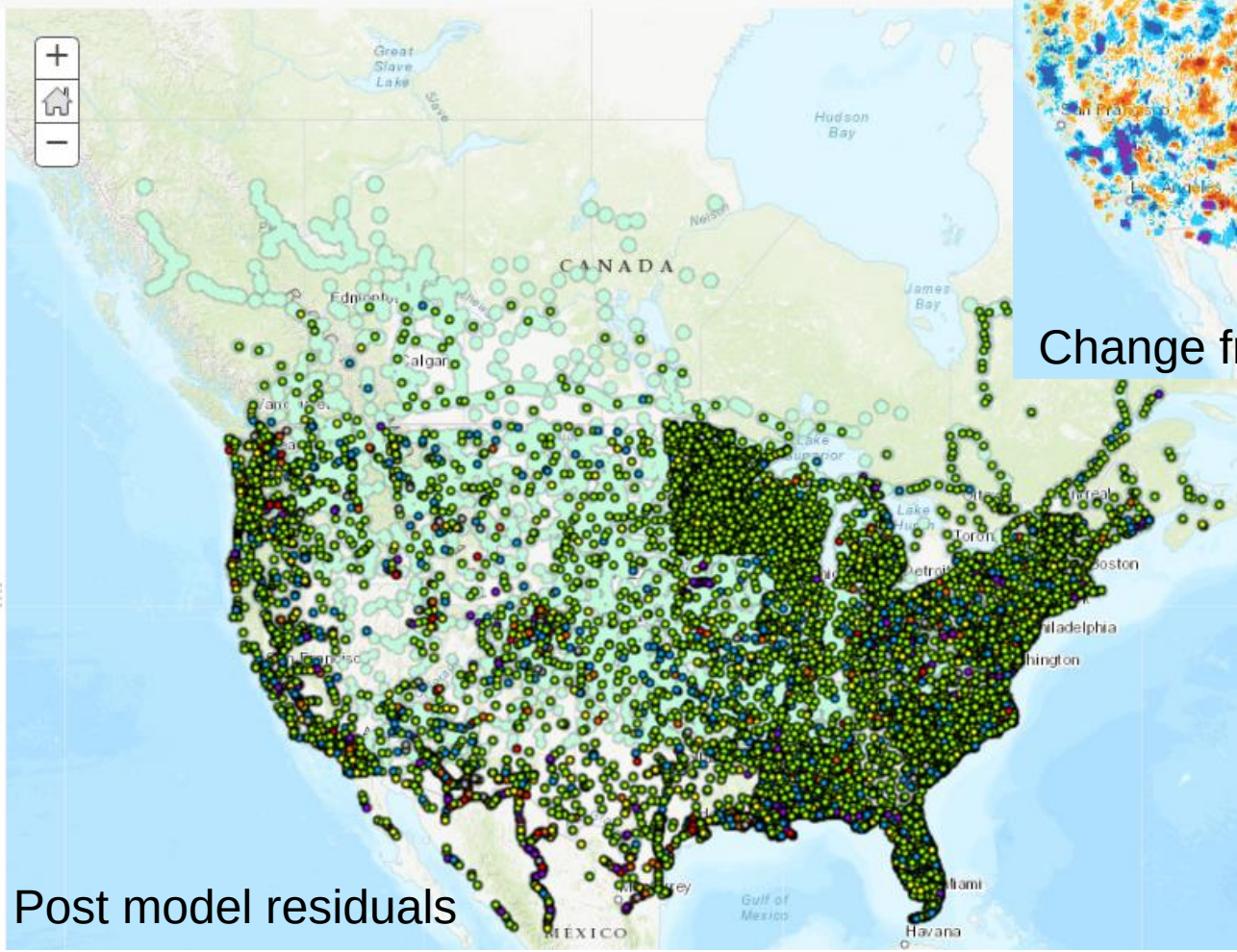
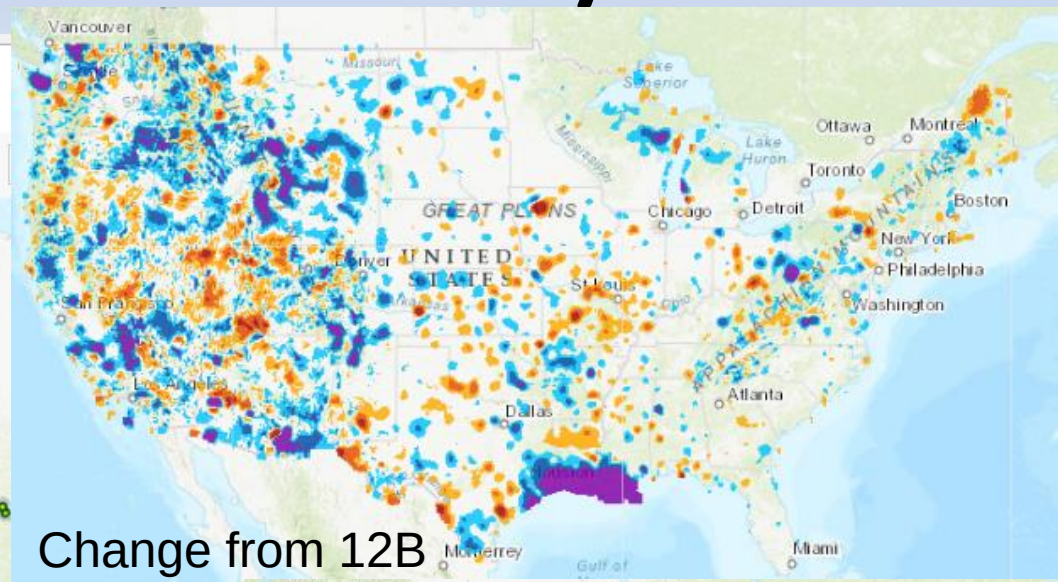
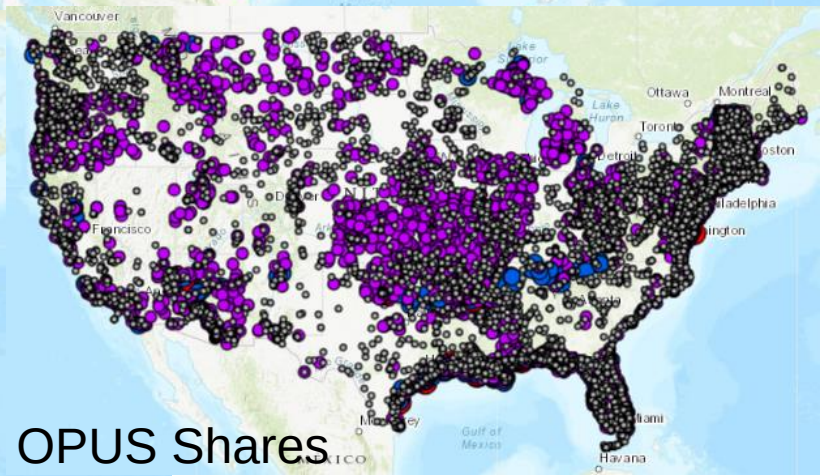
- GPSonBM v6 1 1 - preModel Residual
- ☑ GPSonBM v6 1 1 - postModel Residual
- GPSonBM v6 1 1 - inModel
- GPSonBM v6 1 1 - gps on bms priority list 081518
- GPSonBM v6 1 1 - opus share full 081518
- ☑ GPSonBM v6 1 1 - inModel 30km buffer
- change from geoid12b
- Topographic



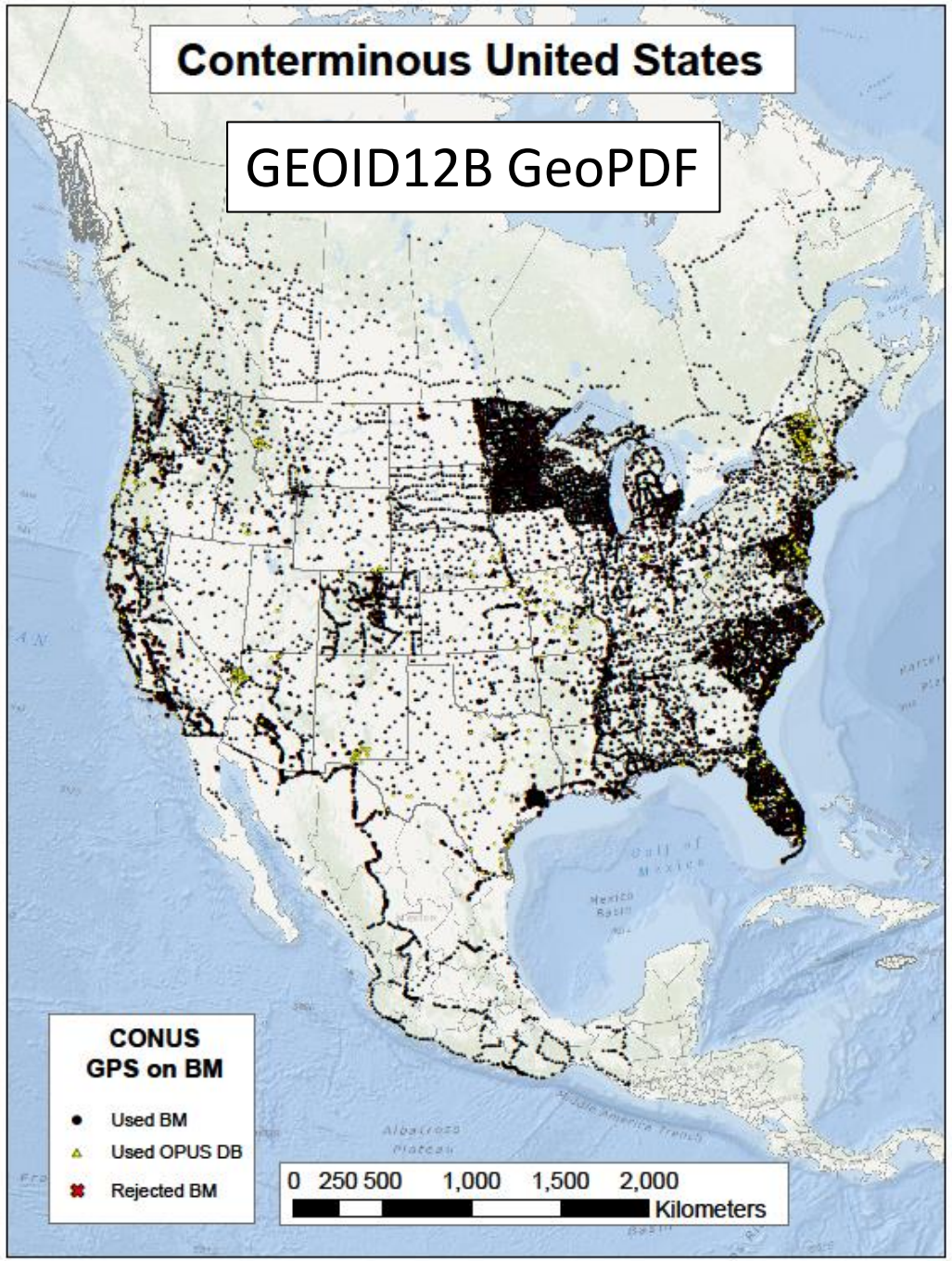
Post model residuals



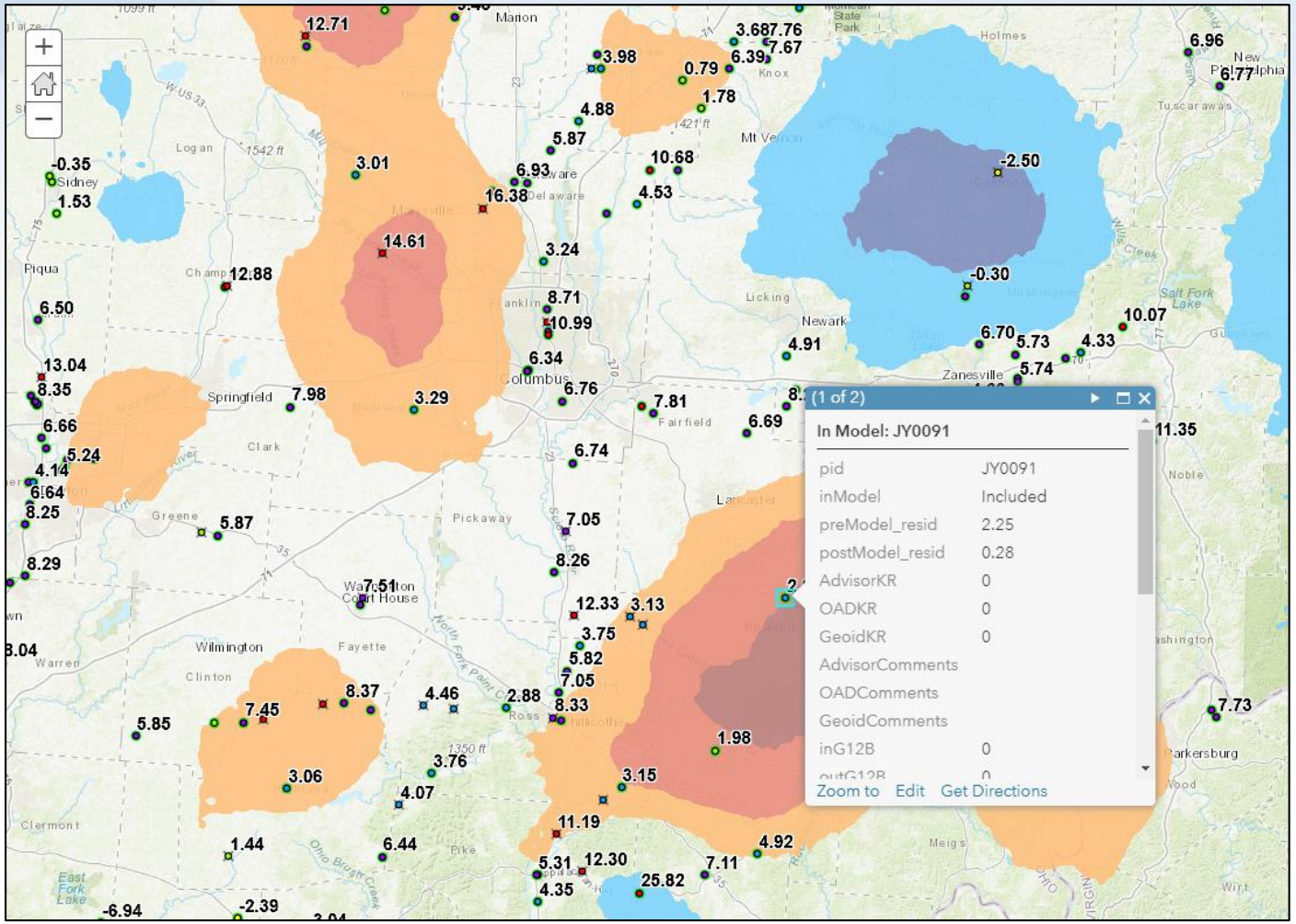
Change from 12B



OPUS Shares



How we share the GPSonBM data that goes into hybrid geoid models



GEOID18: Proposed ArcGIS Online Webmap

GEOID 18 Project Time Line

Cut Off for Data Submission	**9/21/2018**
Prioritize project loading into NGS IDB based on where we need data	**10/1/2018**
Reprocess all OPUS data with IGS14 updated CORS	**9/14/2018**
Final Data Pull	11/16/2018
Final Data Review (tech team and advisors)	12/7/2018
Create new geoid webpages in Dev	12/1/2018
Beta Product and webpage Release	1/15/2019
Outreach at Surveying Conferences	2018-2019
Incorporate feedback & make necessary fixes	3/15/2019
Integrate new geoid into other NGS products (OPUS, datasheets)	3/29/2019
Final Product Release	4/15/2019

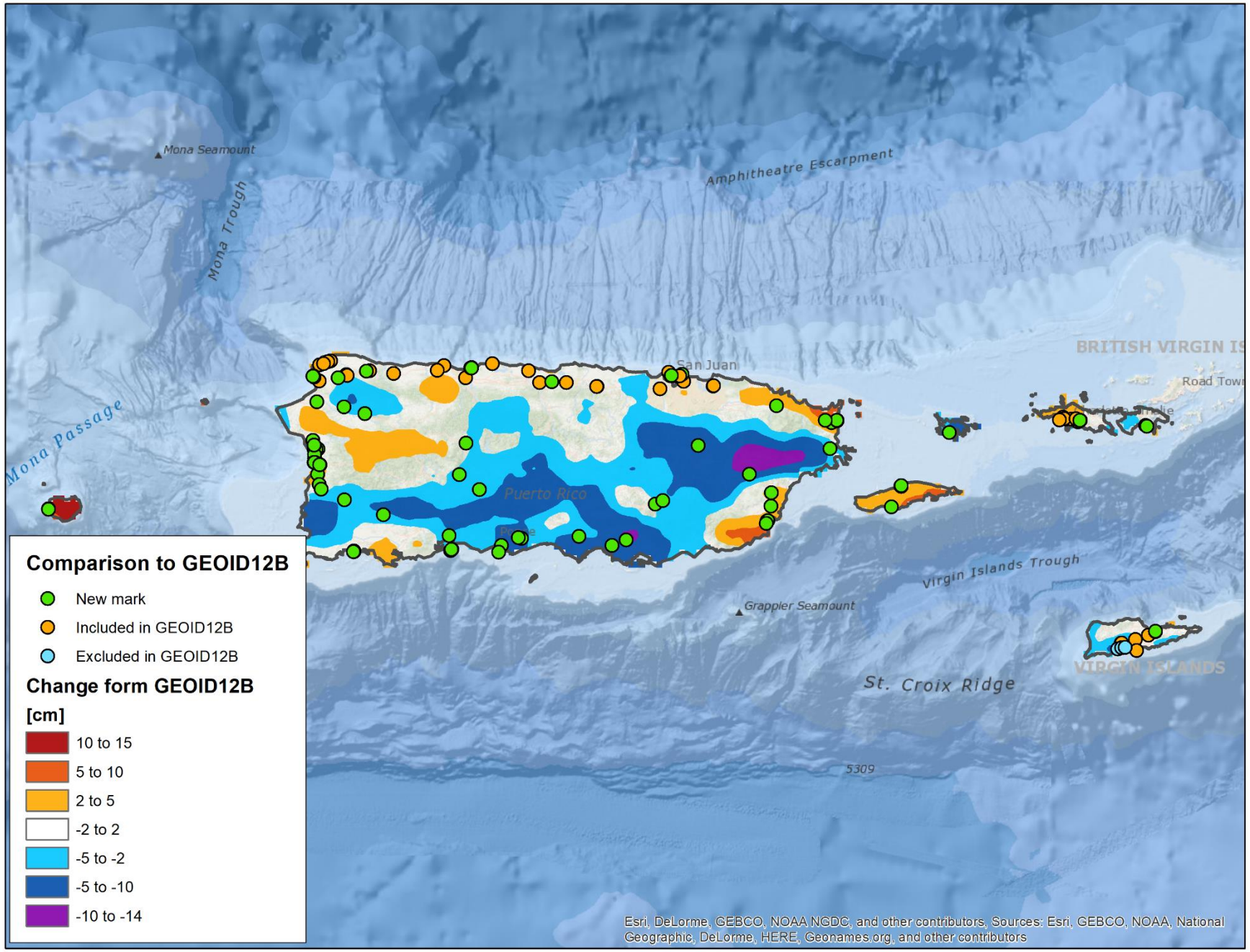
Questions?

Contact the team:
ngs.gpsonbm@noaa.gov

Puerto Rico / U.S Virgin Islands

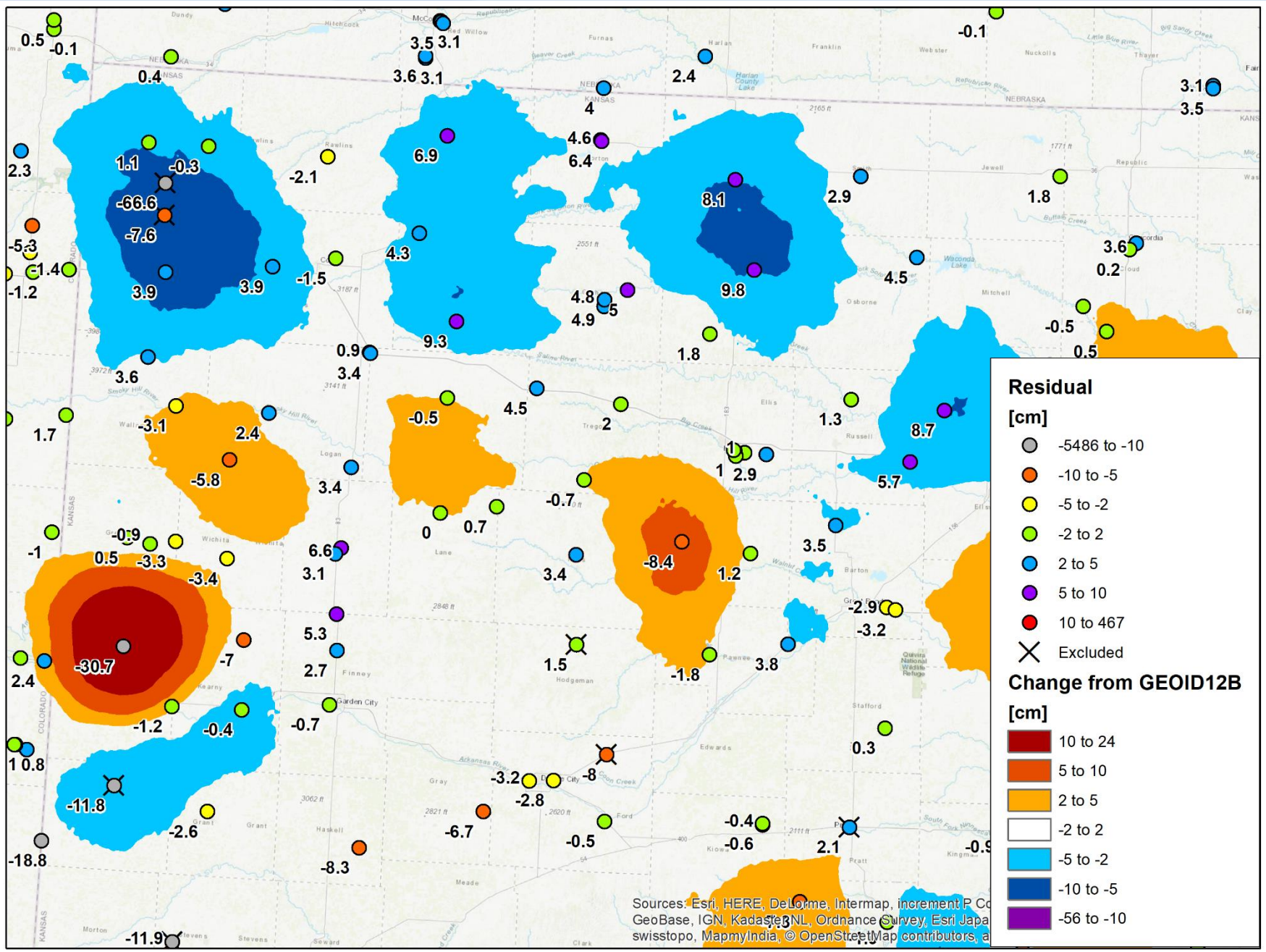
What's new?

- 141 GPS on Bench Marks (**Constrain**)
- 91 New Marks:
  - IDB: 14
  - OPUS Share: 77
- Gravimetric Geoid Model: xGEOID17B (**Interpolate**)



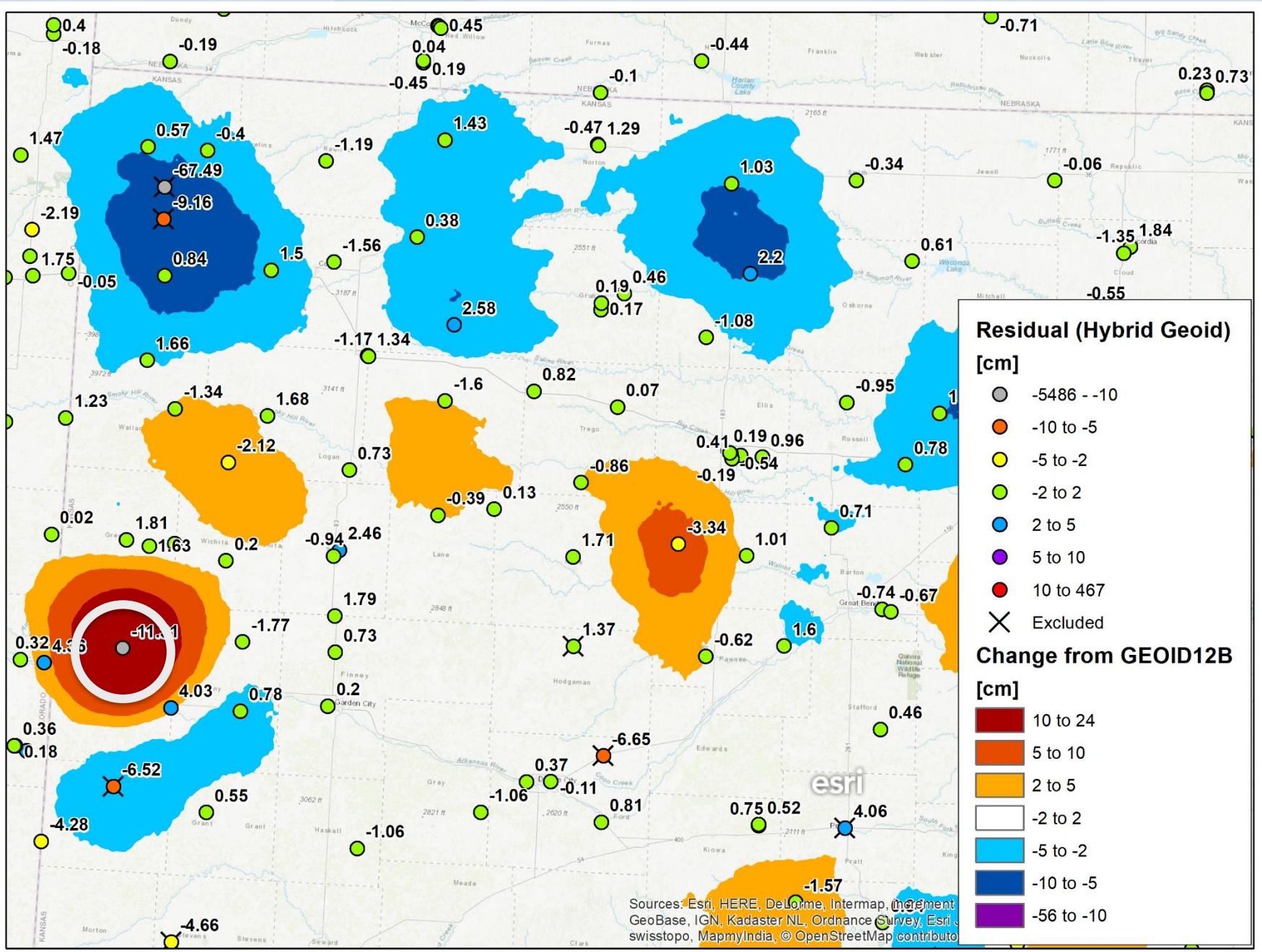
Western Kansas
Before Modeling

- Labels = Residuals in cm (r = H - h - N)
- Gravimetric Geoid Model: xGEOID17B (**Interpolate**)
- GPS on Bench Marks (**Constrain**)



After Modeling:

- Residuals to current prototype hybrid geoid model
- Discrepancy that one would feel if you observed the bench mark
- Labels = (postfit) Residuals in cm
- (r = H - h - N)



Y 18 RESET - JH0282

```
JH0282 ************************************************************************
JH0282  DESIGNATION -  Y 18 RESET
JH0282  PID         -  JH0282
JH0282  STATE/COUNTY-  KS/HAMILTON
JH0282  COUNTRY     -  US
```

Shared Solution

PID: JH0282
Designation: Y 18 RESET
Stamping: Y 18 1934 RESET 1964
Stability: May hold commonly subject to gr
Setting: Set in top of concrete monument
Mark Condition: G
Description: Found monument in good conditi
sheet.
Observed: 2018-04-10T13:42:00Z
Source: OPUS - page5 1603.24

REF_FRAME:	EPOCH:	S
NAD_83(2011)	2010.0000	(

LAT:	38° 7' 1.36618"	± 0.023	m
LON:	-101° 45' 40.21747"	± 0.009	m
ELL HT:	1045.605	± 0.025	m
X:	-1024308.539	± 0.013	m
Y:	-4919741.708	± 0.033	m
Z:	3916318.922	± 0.005	m
ORTHO HT:	1069.928	± 0.029	m

	UTM 14	**SPC** 1502(KS S)
NORTHING:	4222403.542m	565971.753m
EASTING:	257939.818m	114094.043m
CONVERGENCE:	-1.70521556°	-2.00408160°
POINT SCALE:	1.00032169	0.99994195
COMBINED FACTOR:	1.00015760	0.99977792

Shared Solution

PID: JH0282
Designation: Y 18 RESET
Stamping: Y 18 1934 RESET 1964
Stability: May hold commonly subject to ground movement
Setting: Set in top of concrete monument
Mark Condition: G
Description: Found monument in good condition as described on NGS data sheet.
Observed: 2018-04-11T16:58:00Z See Also 2018-04-16
Source: OPUS - page5 1603.24

Close-up View

REF_FRAME:	EPOCH:	SOURCE:	UNITS:	SET PROFILE	DETAILS
NAD_83(2011)	2010.0000	NAVD88 (Computed using GEOID12B)	m		

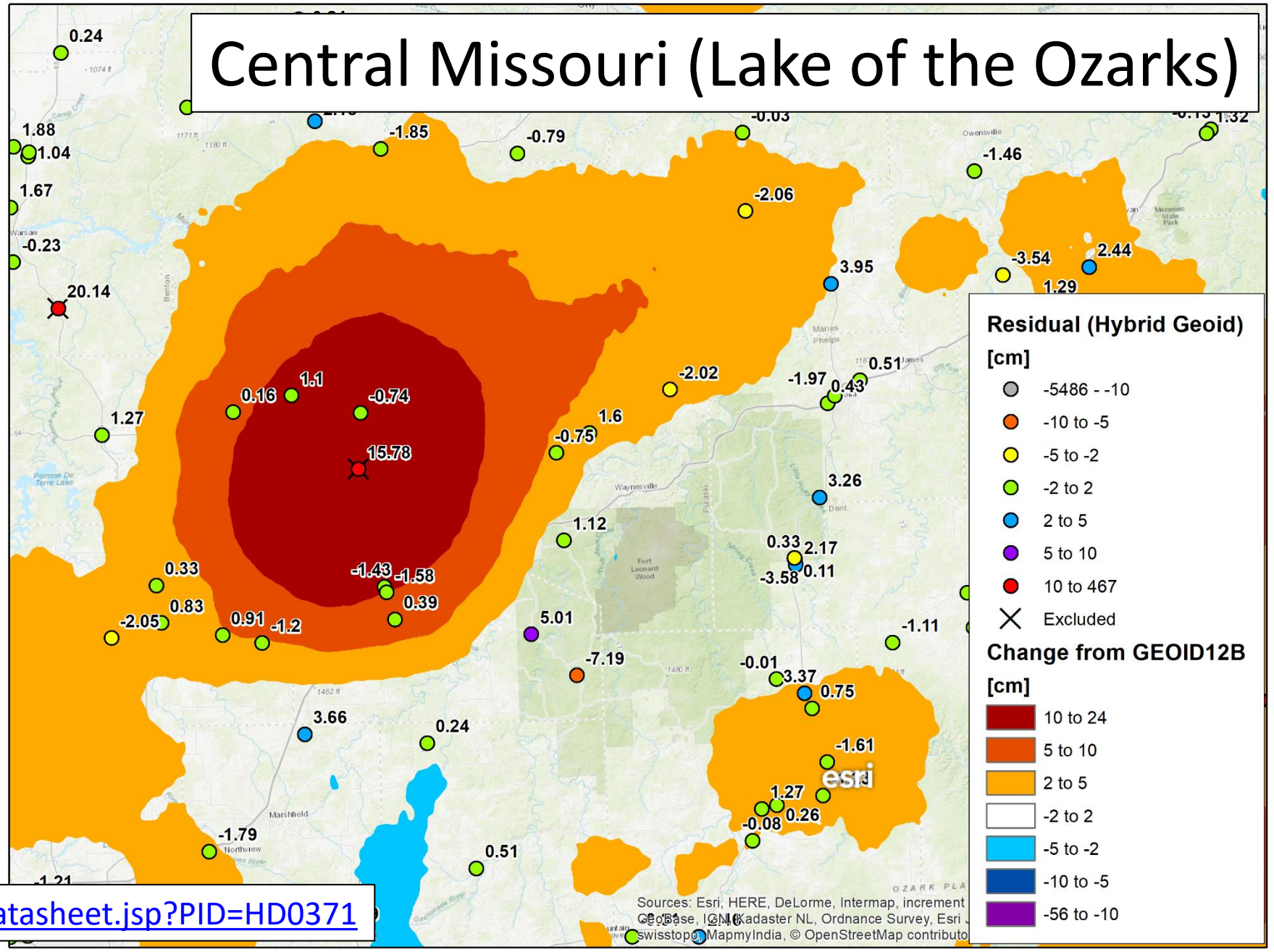
LAT:	38° 7' 1.36618"	± 0.011	m
LON:	-101° 45' 40.21758"	± 0.007	m
ELL HT:	1045.573	± 0.019	m
X:	-1024308.536	± 0.005	m
Y:	-4919741.683	± 0.010	m
Z:	3916318.903	± 0.020	m
ORTHO HT:	1069.896	± 0.025	m

	UTM 14	**SPC** 1502(KS S)
NORTHING:	4222403.542m	565971.753m
EASTING:	257939.818m	114094.043m
CONVERGENCE:	-1.70521556°	-2.00408160°
POINT SCALE:	1.00032169	0.99994195
COMBINED FACTOR:	1.00015760	0.99977792

```
                                                    40.22    (W)    HD_HELD1
                                                    09.2     (feet) RESET

                                                                    GEOID12B

                                                    ferentially corrected
                                                    sitioning techniques

                                                    ed reset data.
```

G 30 – HD0371

- OPUS Solution from 2011 with ellip. ht = **262.737** m
- OPUS Solution from 2016 with ellip. ht = **262.909** m
- Requested another observation…
- NEW OPUS Solution from 8/1/2018 confirming ellip. ht = **262.915** m



https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=HD0371

ISO Standards
Geodetic References (19161), Referencing by Coordinates (19111) and the Geodetic Registry

Larry Hothem
USGS Member, ANSI INCITS-L1 Committee-Technical Advisory Group to ISO/TC 211

FGCS Meeting, Silver Spring, MD
October 25, 2018

Outline

- ISO Technical Committee (TC) 211 – Geographic Information and Geomatics
- TC 211 Geodetic standards
  - 19111, 19127 and 19161
- ISO Geodetic registry
- Other TC 211 geodetic related or support standards: 6709, 19116 and 19162

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Overview

- ISO Technical Committee (TC) 211, Geographic information/Geomatics, is one among over 200 ISO technical committees working on development and maintenance of a variety standards.
- TC 211 is developing a suite of standards for geographic and geospatial information that forms a basis upon which geomatics – the modeling of the Earth – can be performed.
- The ISO process for standardizing is an open, consensus based public method for establishing standards.

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ISO/TC 211 Geodetic standards

- **19111** – Referencing by coordinates
- **19127** – Geodetic register
- **19161** – Geodetic references – Part 1: The International Terrestrial Reference System (ITRS)

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19111 (2018) – Referencing by coordinates

- Data model of how coordinates, dynamic and static reference frames, geoid-based vertical datums, and transformations are represented
  - represent modern dynamic 3D reference frames
  - represent modern geoid-based vertical datums
  - represent reference frames defined as transformations from other reference frames (e.g., from ITRF)
  - uses modern terminology (e.g., such as used in the IERS Conventions)
- Since initial standard published in the 1990s, adopted by many countries and organizations –
  - Used by GIS/geomatics industry and academic institutions
- **ISO Geodetic Registry** must conform to this standard
- **Project team lead**: Roger Lott, UK

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19127 (2018) – Geodetic Register

- **Defines** the management and operation of the ISO Geodetic Registry and identifies the required data elements that conforms with 19111.

- **Publication** is pending

- **Project team lead:** Patrick Vorster, South Africa and member Control Body, ISO Geodetic Registry

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19161-1 – Geodetic references – Part 1: The International Terrestrial Reference System (ITRS)

Standard provides basic information and requirements related to the:

- ITRS, specifically its definition, realizations and access.

It:

- endorses definitions & terminology adopted by International Union of Geodesy and Geophysics (IUGG), the International association of Geodesy (IAG) and the International Astronomical Union (IAU)
- describes various realizations (such as ITRF, WGS-84, NAD, etc.)
- provides the required methods of realizing the ITRS.
- describes various ways of getting positions expressed in a realization of the ITRS
- **Project team:** Claude Boucher, Leader; Thierry Gattacceca, Technical editor & member Control Body, Geodetic registry

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The ISO Geodetic Registry

- **A database (register)**
  - Defining global and regional geodetic reference frames
  - Transformations between geodetic reference frames
  - Must conform to ISO standards
- **Control Body (CB)**
  - Chair, Mike Craymer, Canada; Larry Hothem, Vice-Chair
    - Appointed by the IAG
  - CB members – geodetic experts from various countries and regions
    - US members: Dan Roman, NGS and Michael Nolte, NGA
  - CB approves the content of the register
  - Validates information using authoritative sources
- **Public release by end of 2018**

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ISO/TC 211

Other TC 211 geodetic related or support standards

- **6709:2008 - -** Standard representation of geographic point locations by coordinates
- **19116:2004 - -** Positioning services (revision underway)

  - **Other:**

- **19130 - -** Imagery sensor models for geopositioning – optical, SAR, InSAR, LiDAR and SONAR
- **19135-2 - -** Procedures for item registration
- **19159 - -** Calibration and validation of remote sensing imagery sensors – optical, LiDAR, SAR/InSAR and SONAR
- **19162 - -** Well-known text representation of coordinate reference systems

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Thank You

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FGCS Update

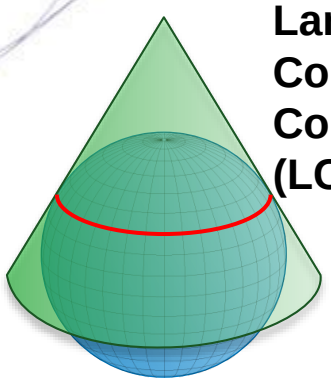
State Plane Coordinate System of 2022 Project

Federal Geodetic Control Subcommittee Meeting
Silver Spring, Maryland
October 25, 2018

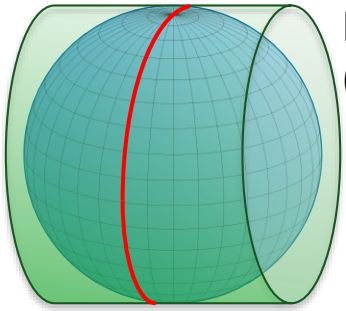
Galen Scott
***for* Michael Dennis**
michael.dennis@noaa.gov

A New State Plane Coordinate System

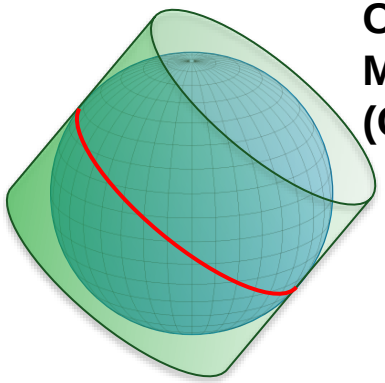
- **State Plane Coordinate System of 2022 (SPCS2022)**
  - Referenced to 2022 Terrestrial Reference Frames (TRFs)
  - Based on same reference ellipsoid as SPCS 83 (GRS 80)
  - Same 3 ***conformal*** projection types as SPCS 83 and 27:



Lambert Conformal Conic (LCC)



Transverse Mercator (TM)



Oblique Mercator (OM)

Since last we met in Feb 2018…

- Publish State Plane history report: **March 6**
- Webinars (available for viewing and download)
  - State Plane history and future directions: **March 8**
  - Building State Plane for the future: **April 12**
- Launch new SPCS web pages: **March 19**
- Publish Federal Register Notice (FRN) and draft SPCS2022 Policy & Procedures: **April 18**
- FRN response deadline: **August 31**
- Provide preliminary design maps: **October 11**
- Finalizing policy & procedures: ***Right now!***
  - Goal is completion in **January 2019**

Who attended the SPCS2022 webinars?

Location	Mar 8	Apr 12	Location	Mar 8	Apr 12	Location	Mar 8	Apr 12
Alabama	7	8	Maryland	25	20	Rhode Island	0	1
Alaska	26	20	Massachusetts	1	1	South Carolina	7	6
Arizona	48	42	Michigan	34	57	South Dakota	7	4
Arkansas	1	1	Minnesota	124	34	Tennessee	1	1
California	35	30	Mississippi	8	6	Texas	20	16
Colorado	17	25	Missouri	7	11	Utah	2	9
Connecticut	4	11	Montana	16	13	Vermont	0	3
Delaware	1	2	Nebraska	16	11	Virginia	8	5
Florida	52	44	Nevada	5	1	Washington	12	16
Georgia	8	3	New Hampshire	1	1	West Virginia	1	0
Hawaii	5	6	New Jersey	4	1	Wisconsin	9	27
Idaho	12	11	New Mexico	12	7	Wyoming	3	2
Illinois	15	12	New York	4	5	American Samoa	0	0
Indiana	4	7	North Carolina	10	8	District of Columbia	2	1
Iowa	6	7	North Dakota	33	13	Guam and CNMI	0	0
Kansas	5	3	Ohio	31	24	Puerto Rico	2	3
Kentucky	5	5	Oklahoma	3	1	U.S. Virgin Islands	0	1
Louisiana	13	10	Oregon	53	23	International	8	13
Maine	1	1	Pennsylvania	23	18	Unknown location	45	26

geodesy.noaa.gov/SPCS/

National Geodetic Survey

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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.

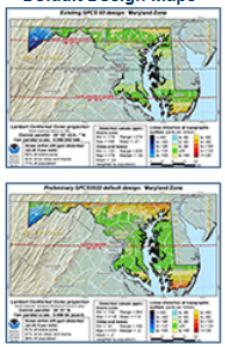
Download SPCS2022 Design Maps

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

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Federal Register Notice

https://www.federalregister.gov/

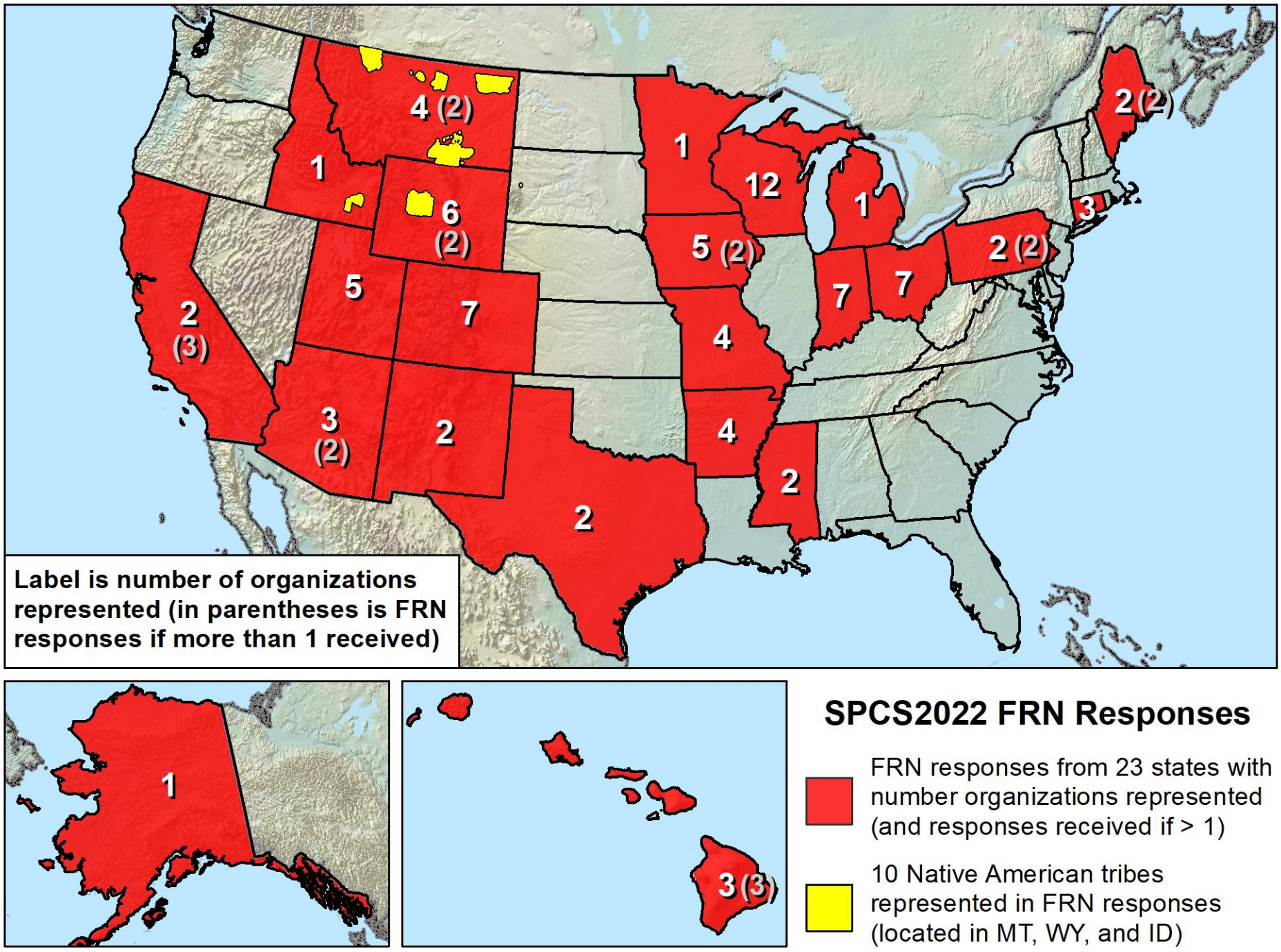
- Announced ***draft*** **SPCS2022 Policy and Procedures**
- Also asked for input on **"special purpose"** zones
- Public comment period ended **Aug 31, 2018**

Overview of FRN feedback

- FRN public comment period April 18-Aug 31
  - For ***draft*** SPCS2022 policy & procedures
  - Wide variety of formats and content
  - Individuals, organizations, and groups of organizations
- Received 41 unique responses:
  - 4 national in scope (3 from USGS)
  - 3 for Native American tribes
  - 1 regional (3 states)
  - 33 from states
- 105 people represented by name
- 97 organizations represented

Organizations represented

- 1 federal agency (USGS)
- 10 Native American tribes
- 23 states (includes state and private organizations)
  - 17 state DOTs
  - 12 state GIS/GIO/cartographer offices
  - 21 state professional societies (surveying and GIS)
  - 12 universities and colleges
  - 6 city and county groups
  - 7 private companies
  - 10 other state organizations


4 (2)
1
6 (2)
5
7
2 (3)
3 (2)
2
2
1
12
1
5 (2)
7
7
4
4
2
2 (2)
3
2 (2)
Label is number of organizations represented (in parentheses is FRN responses if more than 1 received)
1
3 (3)
SPCS2022 FRN Responses
FRN responses from 23 states with number organizations represented (and responses received if > 1)
10 Native American tribes represented in FRN responses (located in MT, WY, and ID)

The 5 FRN questions

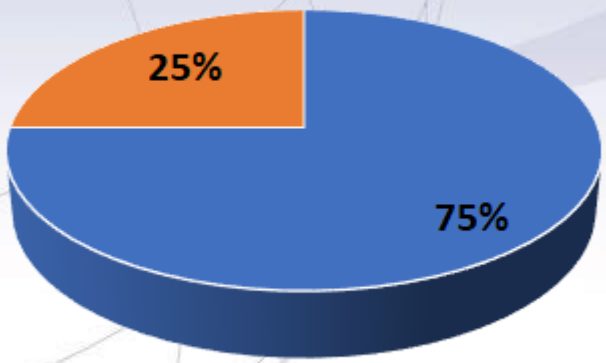
1. **Usage of current SPCS** in your organization.
2. Whether **default SPCS2022 definitions** impose hardship or be beneficial.
3. Whether there is sufficient **flexibility** in SPCS2022 characteristics.
4. Whether the SPCS2022 **deadlines** are acceptable.
5. Whether **"special purpose" zones** in SPCS2022 would be beneficial, problematic, or irrelevant.

Reminders about SPCS2022 stuff

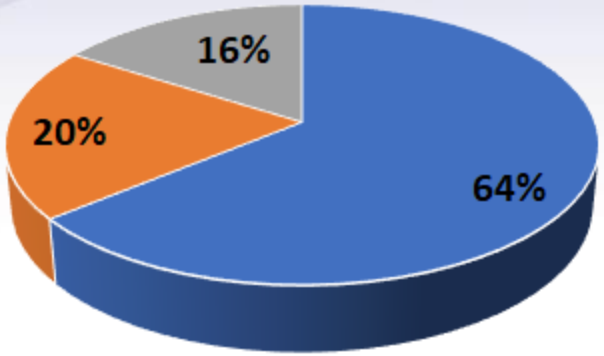
- **Default zone designs**
  - Created by NGS if get no input; similar to SPCS 83
- **Special purpose zones**
  - For regions that span multiple states/zones
  - e.g., Navajo Nation (3 states, 5 SPCS 83 zones)
- **Layered zones:** Max 2 layers (e.g., Kentucky)
  - A statewide zone plus 1 layer of multiple zones
- **Low distortion projections (LDPs)**
  - Can be part of SPCS2022, but with min size limits
  - Must be designed by others (not by NGS)

Responses to the 5 FRN questions

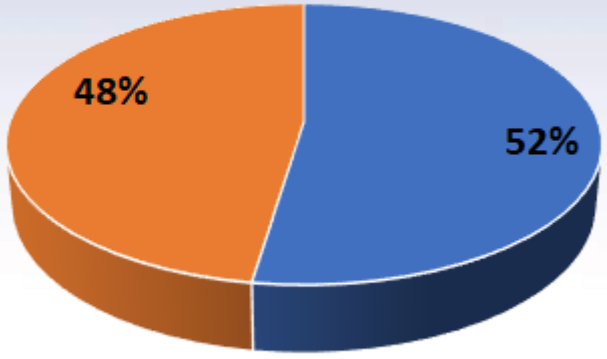
1. Currently use SPCS?
(24 responses)



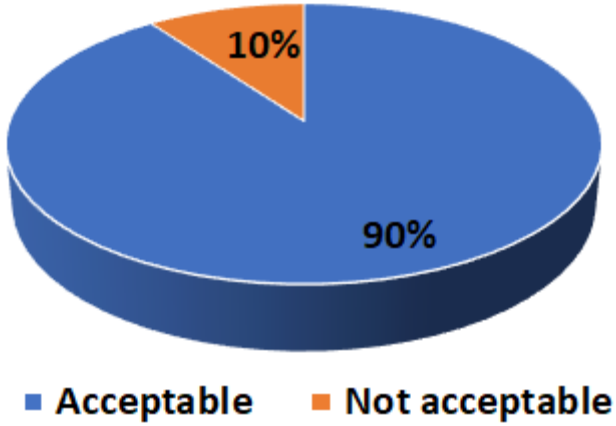
2. Default SPCS2022 zones
(25 responses)



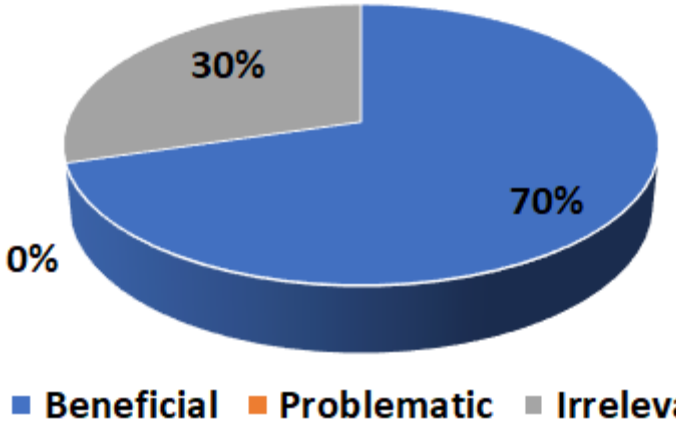
3. Flexibility of policy
(21 responses)



4. Deadlines
(20 responses)

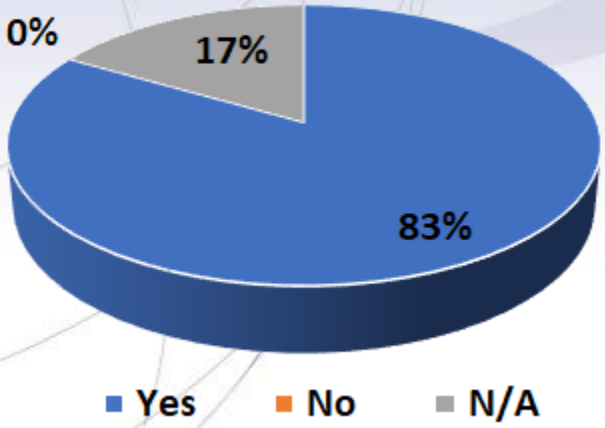


5. Special purpose zones
(27 responses)

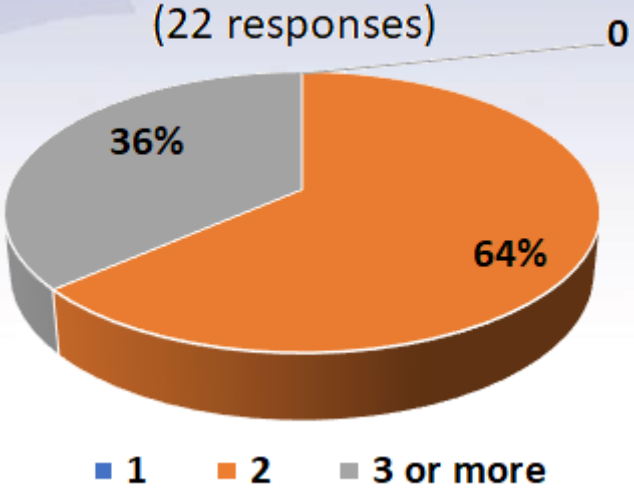


Summary of other FRN input

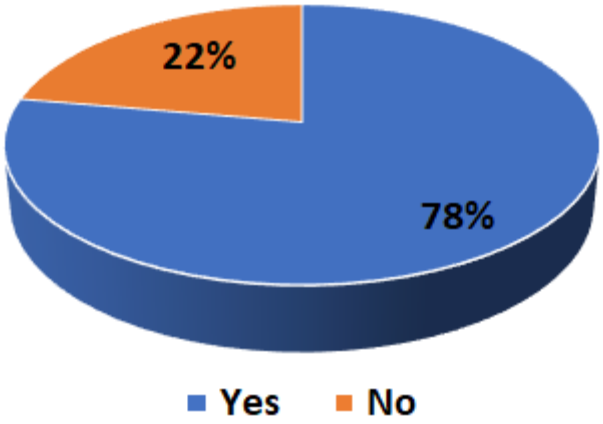
Want a statewide zone
(18 responses)



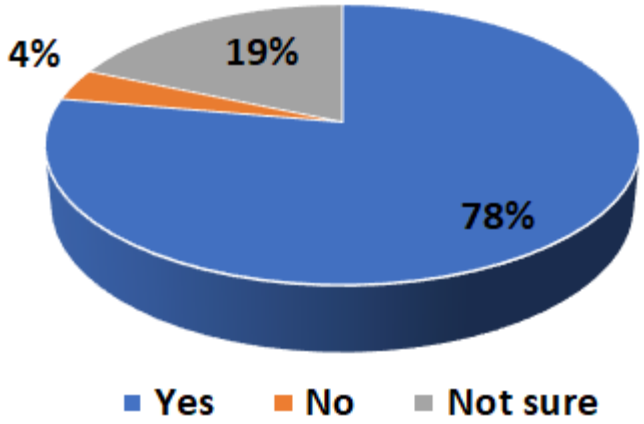
Number of layers
(22 responses)



Currently use LDPs?
(18 responses)



Want SPCS2022 LDP layer
(27 responses)



FRN feedback from federal partners

- Only from USGS
  - 3 responses
  - All wanted special purpose zones
  - 2 specifically wanted zone for Grand Canyon
    - Grand Canyon Monitoring & Research Center (GCMRC)
- Grand Canyon Colorado River Ecosystem (CRE)
  - Currently in 2 SPCS 83 zones
  - Intensive mapping and surveying along CRE
  - Want one LDP for entire length of CRE (470 km)
    - This is likely technically feasible

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

NGS.SPCS@noaa.gov
by **December 31, 2019** for ***requests*** and ***proposals***
by **December 31, 2020** for ***submittal*** of ***approved*** designs

Summary

- **Federal Register Notice** (FRN) input received
  - On *draft* SPCS2022 policy & procedures
  - On "special purpose" zones
- **SPCS2022 Policy & Procedures**
  - Only one federal agency gave FRN feedback (USGS)
  - If there are concerns should let NGS know ***ASAP***
  - Will be finalized soon (**January 2019**)
- ***Consensus*** state stakeholder input ***required*** for SPCS2022 zone requests, proposals, and designs

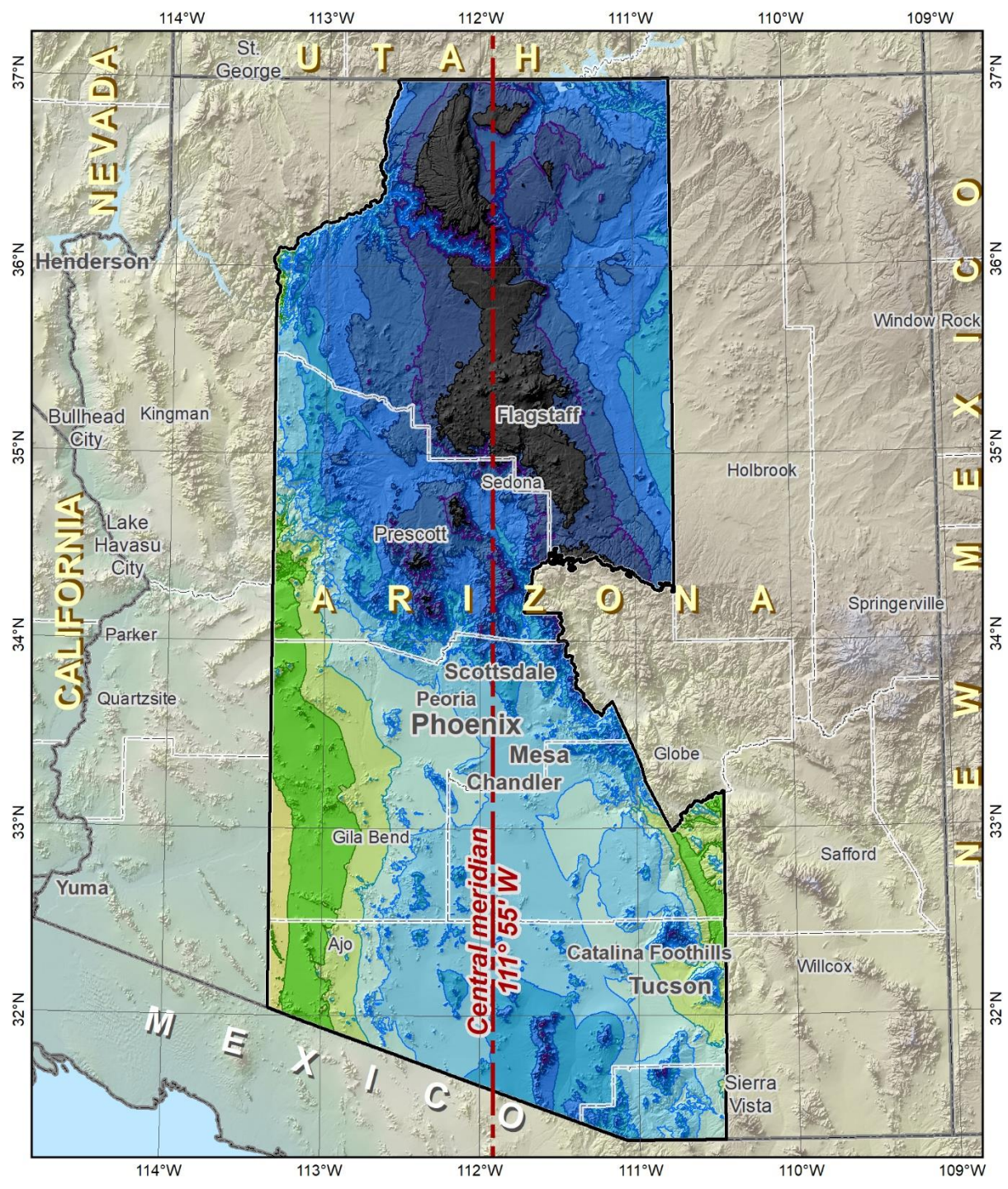
P.S. Default and statewide zones design maps available for download at **ftp://www.ngs.noaa.gov/pub/SPCS/DistortionMaps/**

General SPCS2022 characteristics

- Technical requirements
  - ***Linear distortion*** design criterion at topographic surface (*not* at ellipsoid surface)
    - Difference in distance between "ground" and "grid"
  - Use 1-parallel definition for LCC projections
- Other characteristics
  - Default designs (if no consensus stakeholder input)
  - "Special purpose" zones
  - "Layered" zones
  - Low-distortion projections (LDPs)

Default SPCS2022 designs

- For complete system even with no stakeholder input
  - To ensure coverage of ***all*** states and U.S. territories
- Nearly same as SPCS 83 but with some modifications
  - Almost all zone projection types and extents the same
  - Modified to align with SPCS2022 policy and procedures
  - Small number of zones may change projection type, extents
- Modifications to align with SPCS2022 policy:
  - Scale redefined with respect to **topographic surface**
  - One-parallel Lambert and local Oblique Mercator



Existing SPCS 83 design: Arizona Central Zone

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Datum of 1983

Central meridian: 111° 55' W
Cen merid scale: 0.999 9 (exact)

Areas within ±100 ppm distortion (±0.53 ft per mile):
14% of entire zone
10% of all cities and towns
2% of population

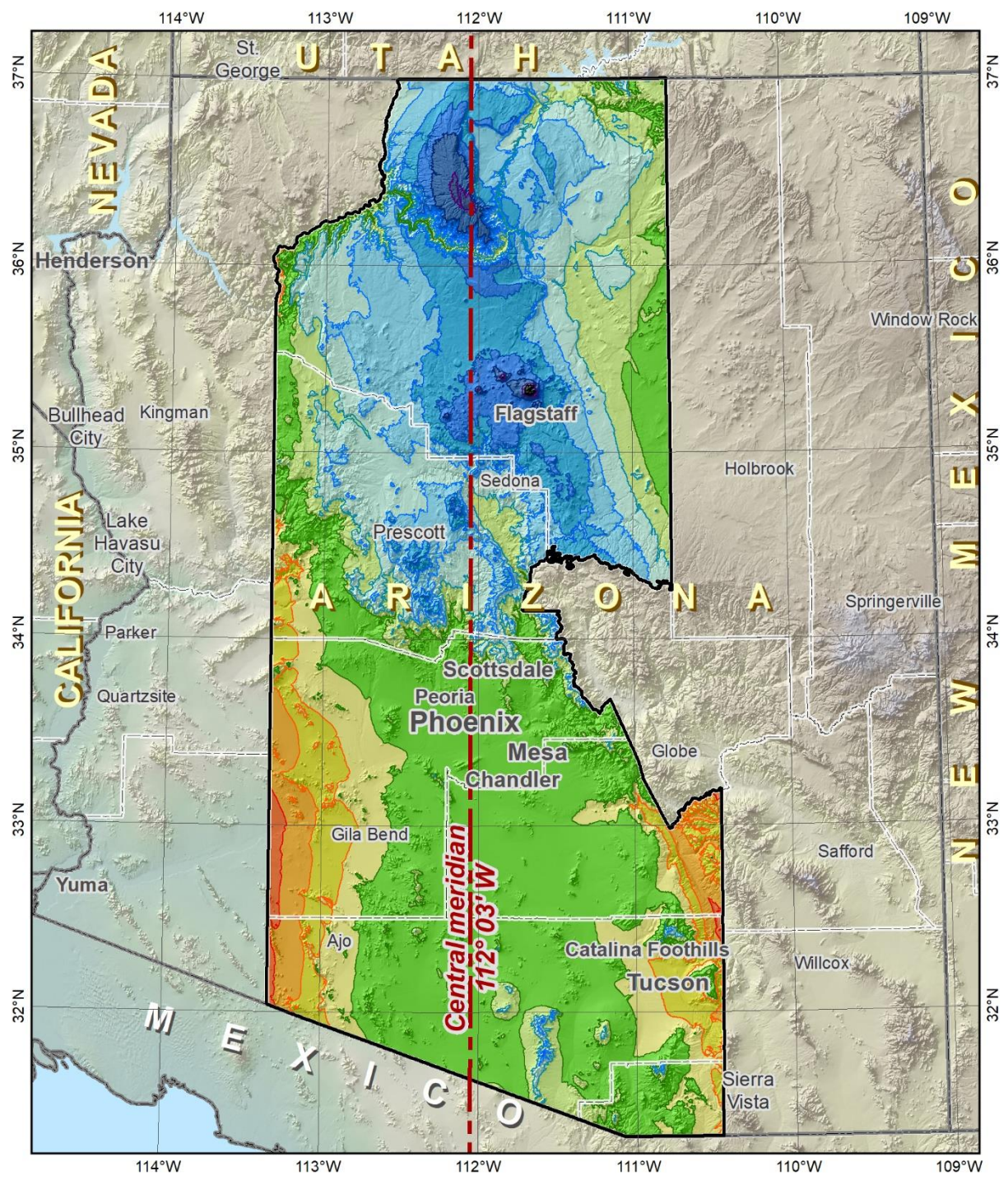
Distortion values (ppm)

Entire zone:	*Cities and towns:*
Min = -684	Min, Max = -491, +53
Max = +100	Range = 544
Range = 784	Median = -164
Mean = -224	Mean = -151 (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: Arizona Central Zone

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Terrestrial Reference Frame of 2022

Central meridian: 112° 03' W
Cen merid scale: 1.000 07 (exact)

Areas within ±100 ppm distortion (±0.53 ft per mile):
55% of entire zone
76% of all cities and towns
95% of population

Distortion values (ppm)

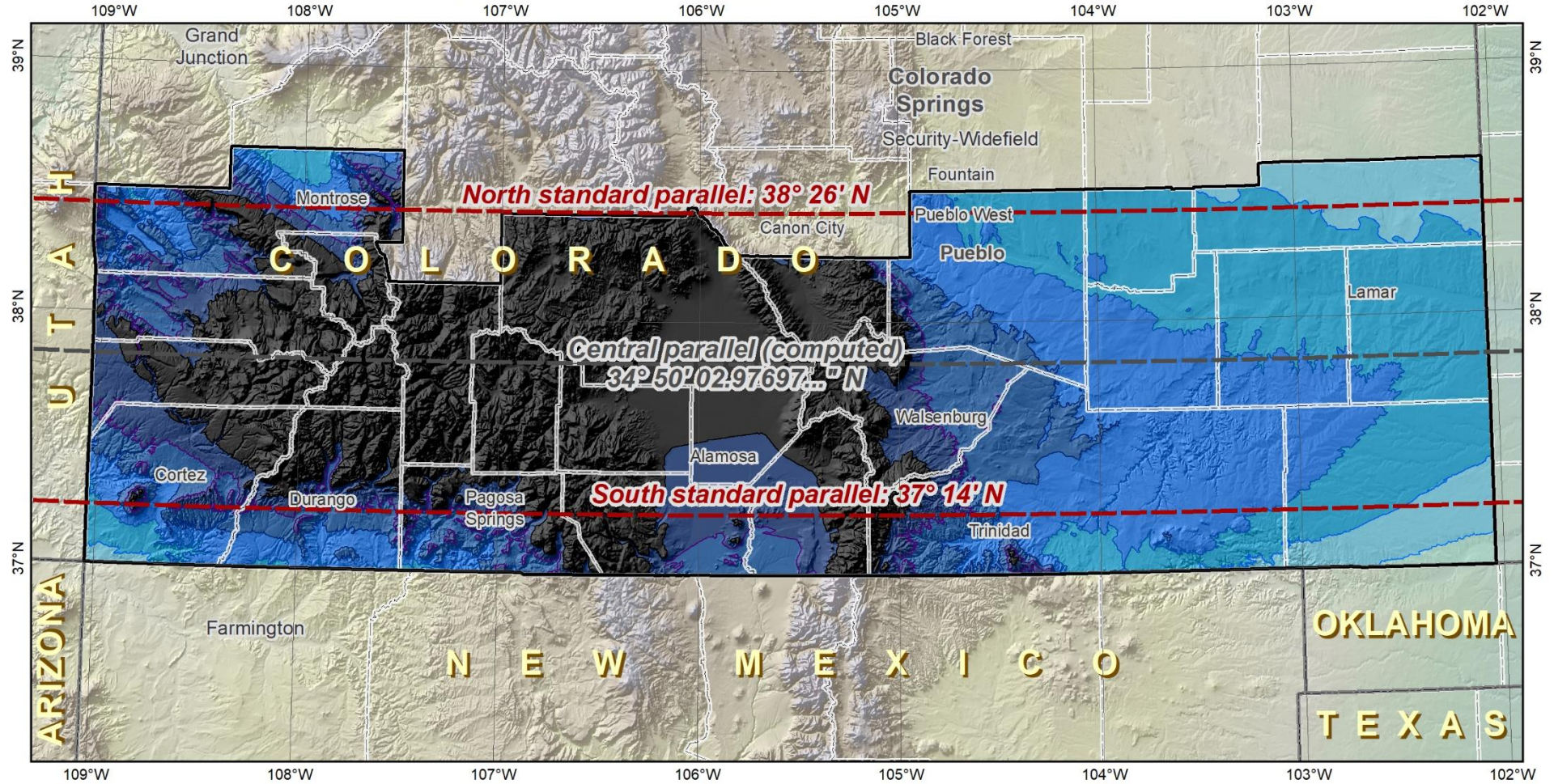
Entire zone:	*Cities and towns:*
Min = -506	Min, Max = -323, +188
Max = +232	Range = 511
Range = 738	Median = +13
Mean = -54	Mean = +24 (weighted by population)

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 SPCS 83 design: Colorado South Zone



Lambert Conformal Conic projection

North American Datum of 1983

Central parallel: 37° 50' 03.0…" N

Cen parallel scale: 0.999 945 398...

Areas within ±100 ppm distortion (±0.53 ft per mile):

0% of entire zone

0% of all cities and towns

0% of population

NOAA's National Geodetic Survey

Distortion values (ppm)

For entire zone:

Min = -715 Range = 598

Max = -117 Mean = -352

Cities and towns:

Min = -515 Range = 338

Max = -177 Median = -317

Mean = -280

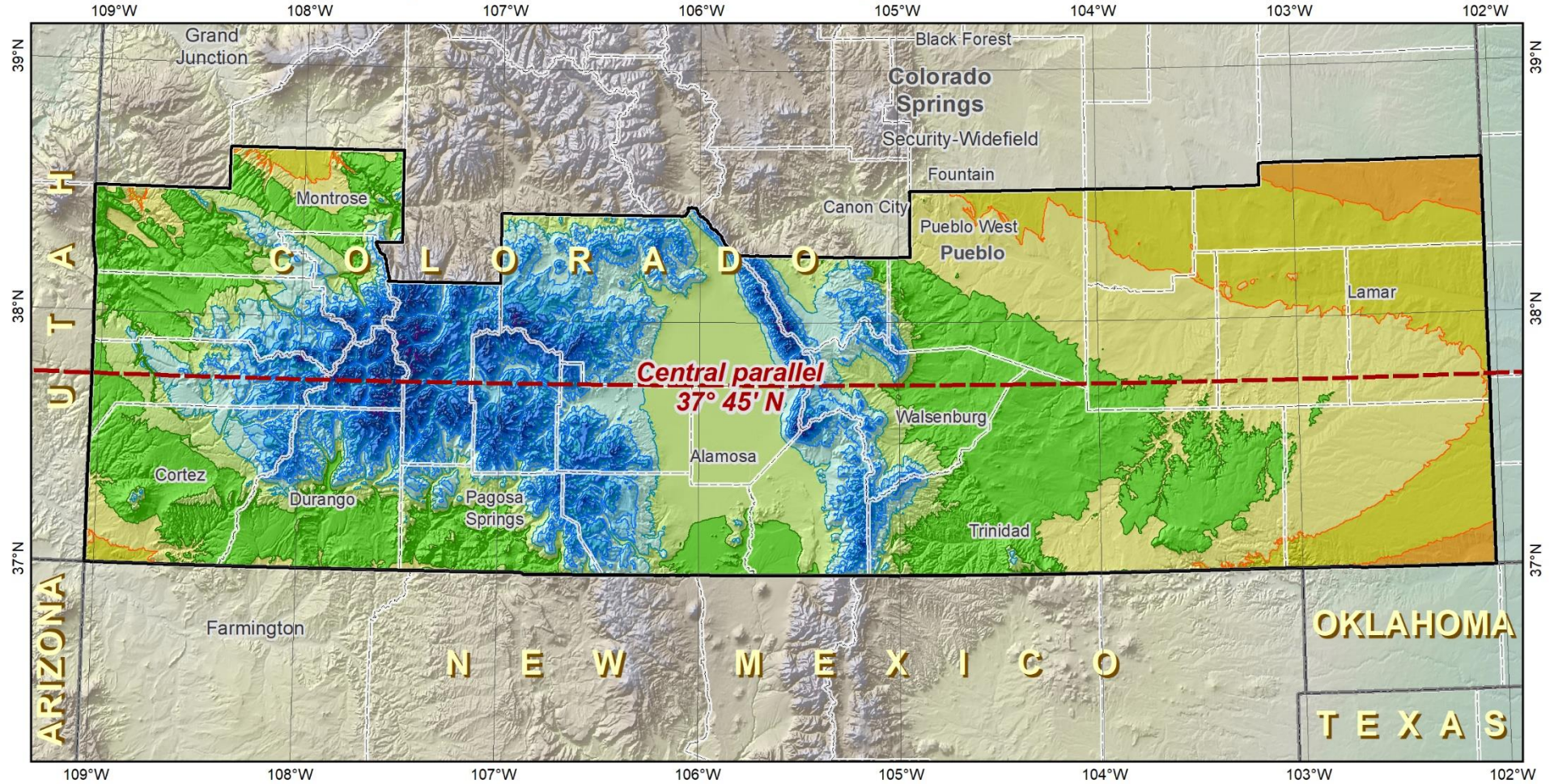
(weighted by population)

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 km

Preliminary SPCS2022 default design: Colorado South Zone



Lambert Conformal Conic projection

North American Terrestrial Reference Frame of 2022

Central parallel: 37° 45' N

Cen parallel scale: 1.000 27 (exact)

NOAA's National Geodetic Survey

Areas within ±100 ppm distortion (±0.53 ft per mile):

59% of entire zone

76% of all cities and towns

91% of population

Distortion values (ppm)

For entire zone:

Min = -389 Range = 589

Max = +200 Mean = -28

Cities and towns:

Min = -189 Range = 354

Max = +165 Median = -0.1

Mean = +50

(weighted by population)

Linear distortion at topographic surface (parts per million)

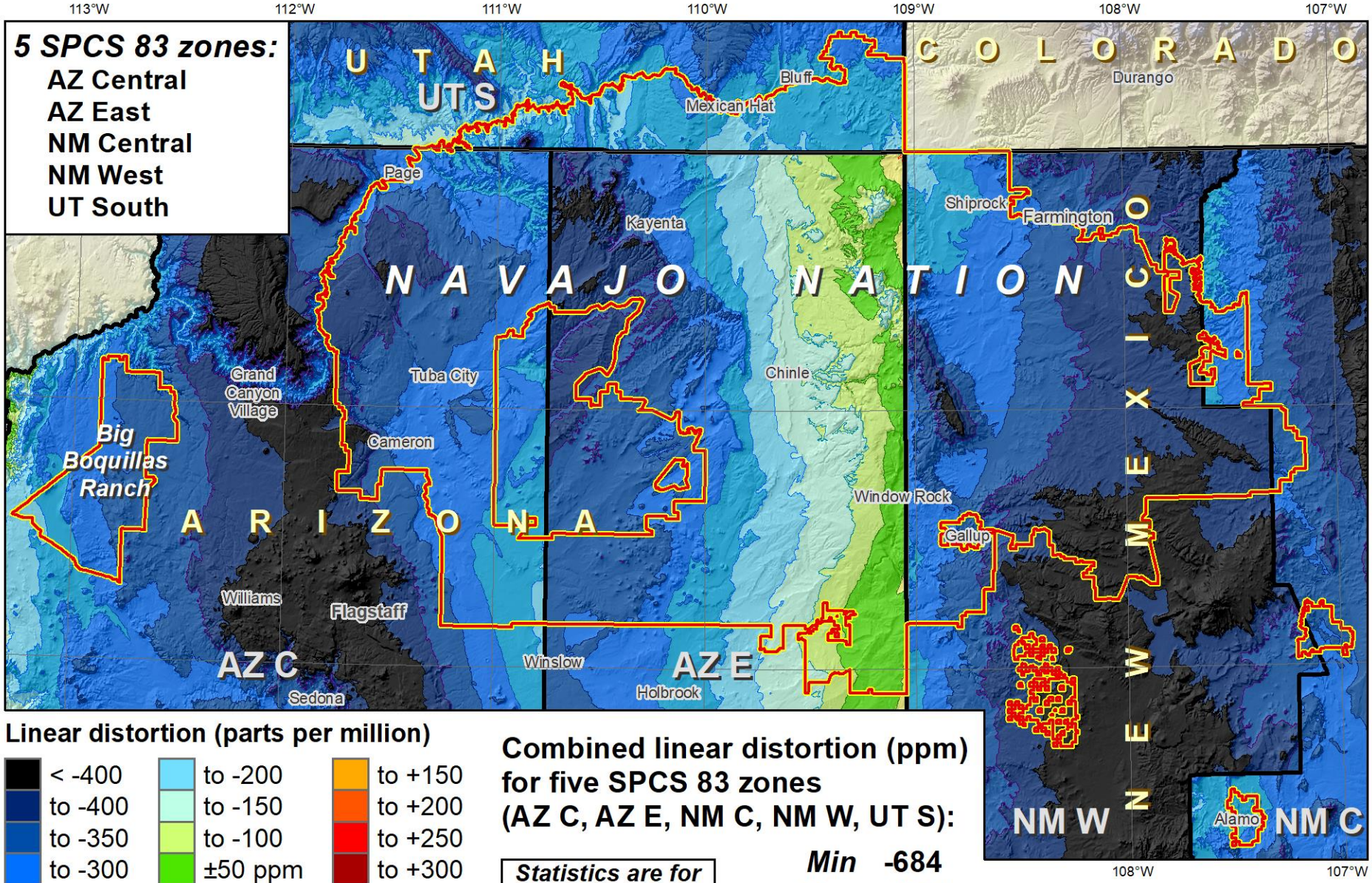
< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 km

"Special purpose" zones

- For areas with inadequate SPCS zone coverage
  - Usually areas that are in more than one zone
- Categories:
  - Major urban areas (e.g., New York, Chicago, St. Louis, Denver)
  - Large Indian reservations (e.g., Navajo Nation)
  - Federal applications covering large areas (e.g., coastal mapping of Atlantic Coast; Grand Canyon National Park)
- Permitted for metro areas in 1977 policy (but never used)
- Only in FRN, ***not*** in draft policy & procedures

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

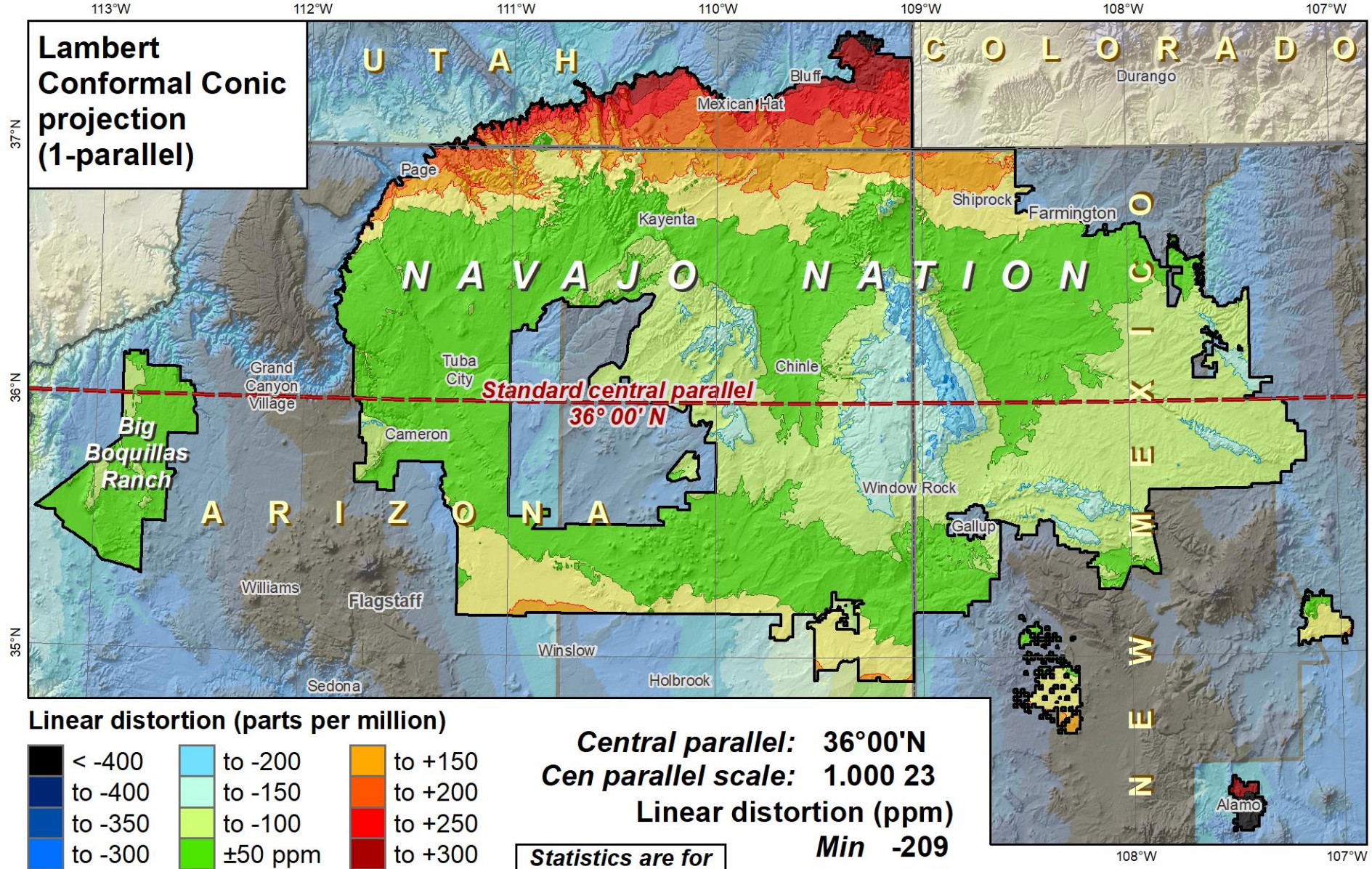
Combined linear distortion (ppm) for five SPCS 83 zones (AZ C, AZ E, NM C, NM W, UT S):

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)

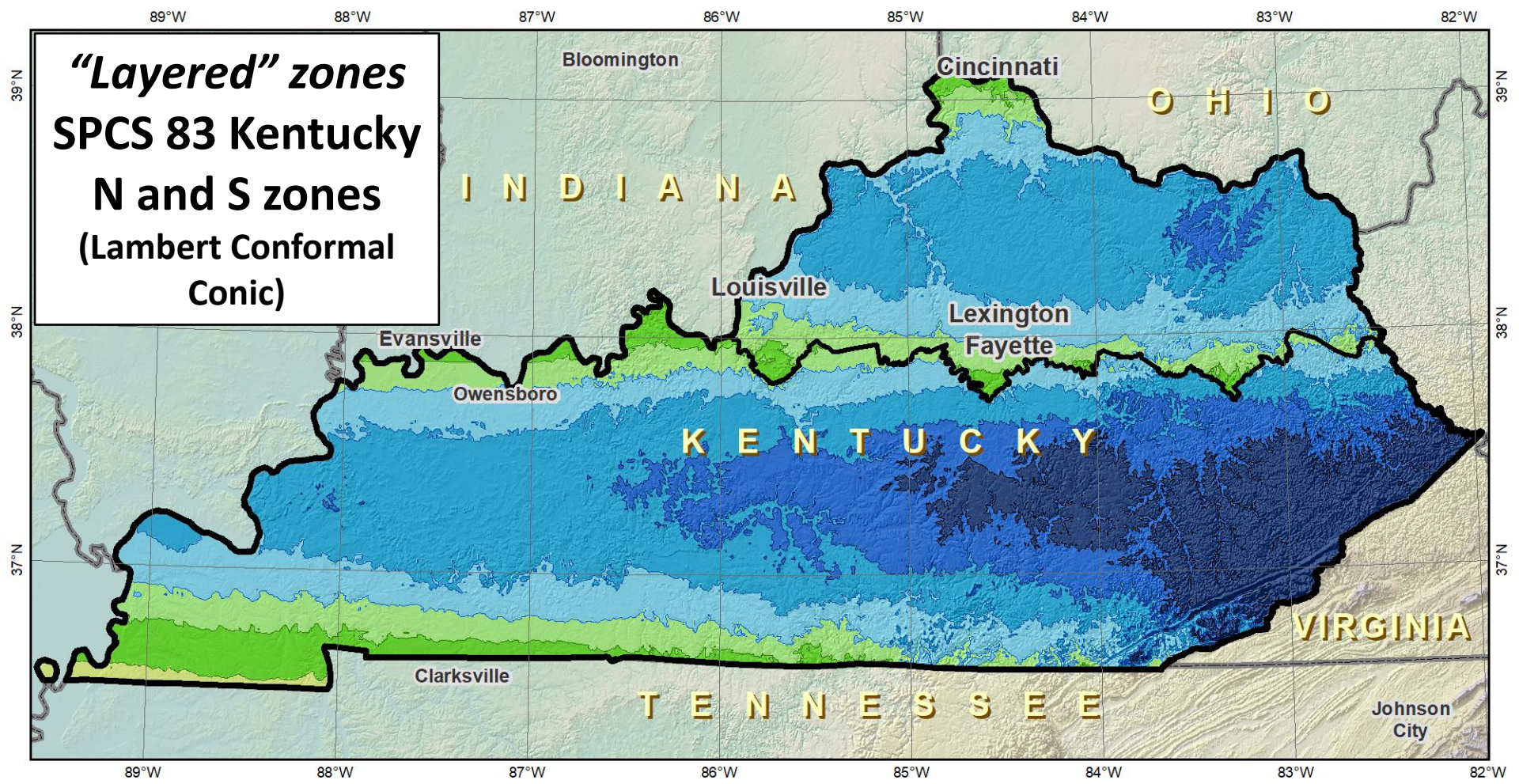
Min	**-209**
Max	**+348**
Range	**557**
Mean	**0**

Statistics are for area within entire Navajo Nation boundary

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

Statewide and "layered" zones

- Limitations
  - Max of ***TWO*** layers: Statewide and sub-zones
  - If two layers, one ***MUST*** be statewide
  - Minimum subzone dimension > 50 km
- States often want statewide ***and*** small zones
  - *Statewide:* Single geometry required for state GIS
  - *Sub-zones:* Lower distortion for surveying/engineering
- Accommodates state needs, but with restrictions
  - Prevent poor design choices for statewide zones
- One already exists in SPCS 83…

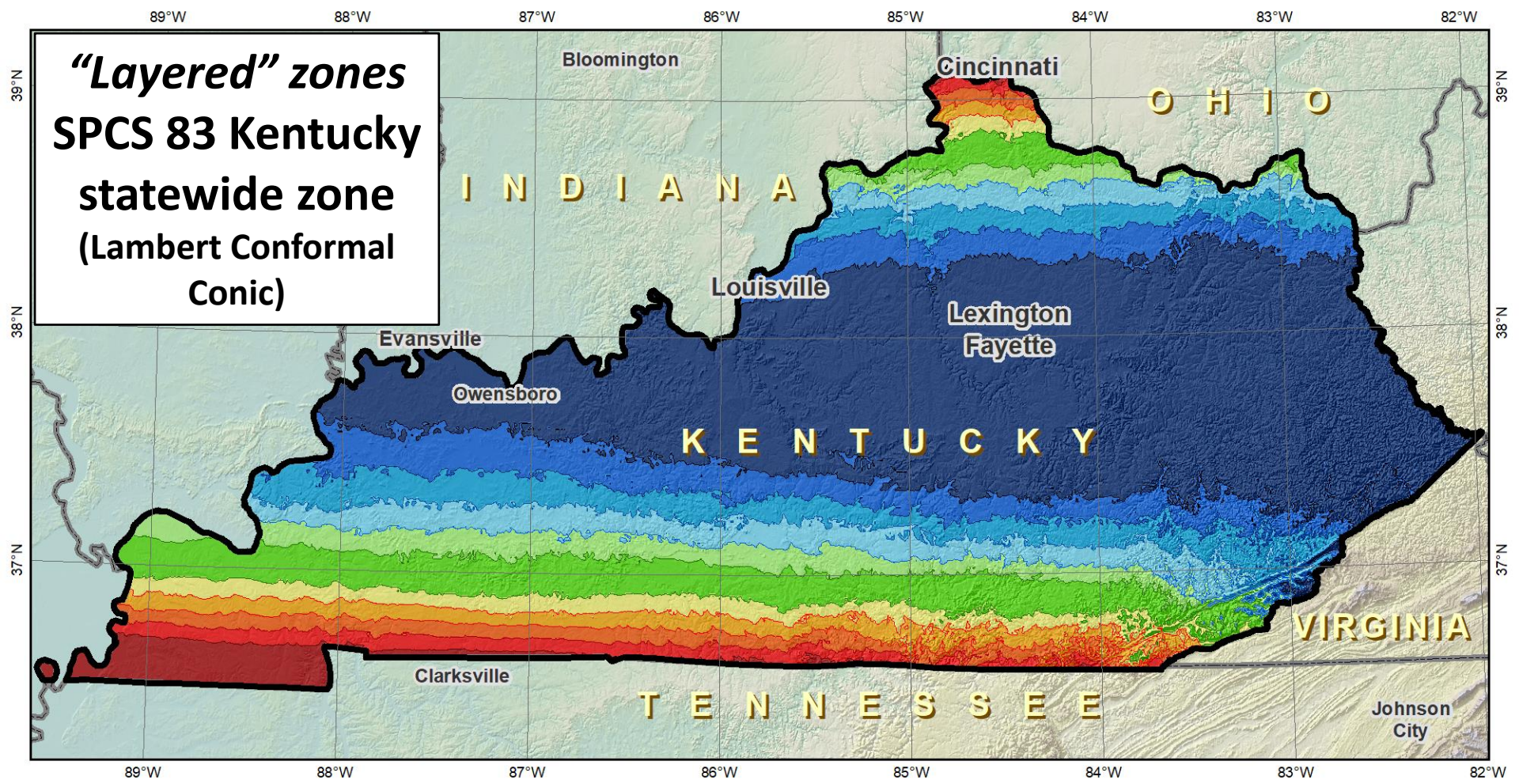


Linear distortion (parts per million)

<-100 ppm	+20 to +40
-80 to -100	+40 to +60
-60 to -80	+60 to +80
-40 to -60	+80 to +100
-20 to -40	>+100 ppm
±20 ppm	

0 50 100 150 200 km

	North	South
N parallel	38°58'N	37°56'N
S parallel	37°58'N	36°44'N
	Distortion (ppm)	
Min	-93	-211
Max	+17	+42
Mean	-56	-67



Linear distortion (parts per million)

<-100 ppm	+20 to +40
-80 to -100	+40 to +60
-60 to -80	+60 to +80
-40 to -60	+80 to +100
-20 to -40	>+100 ppm
±20 ppm	

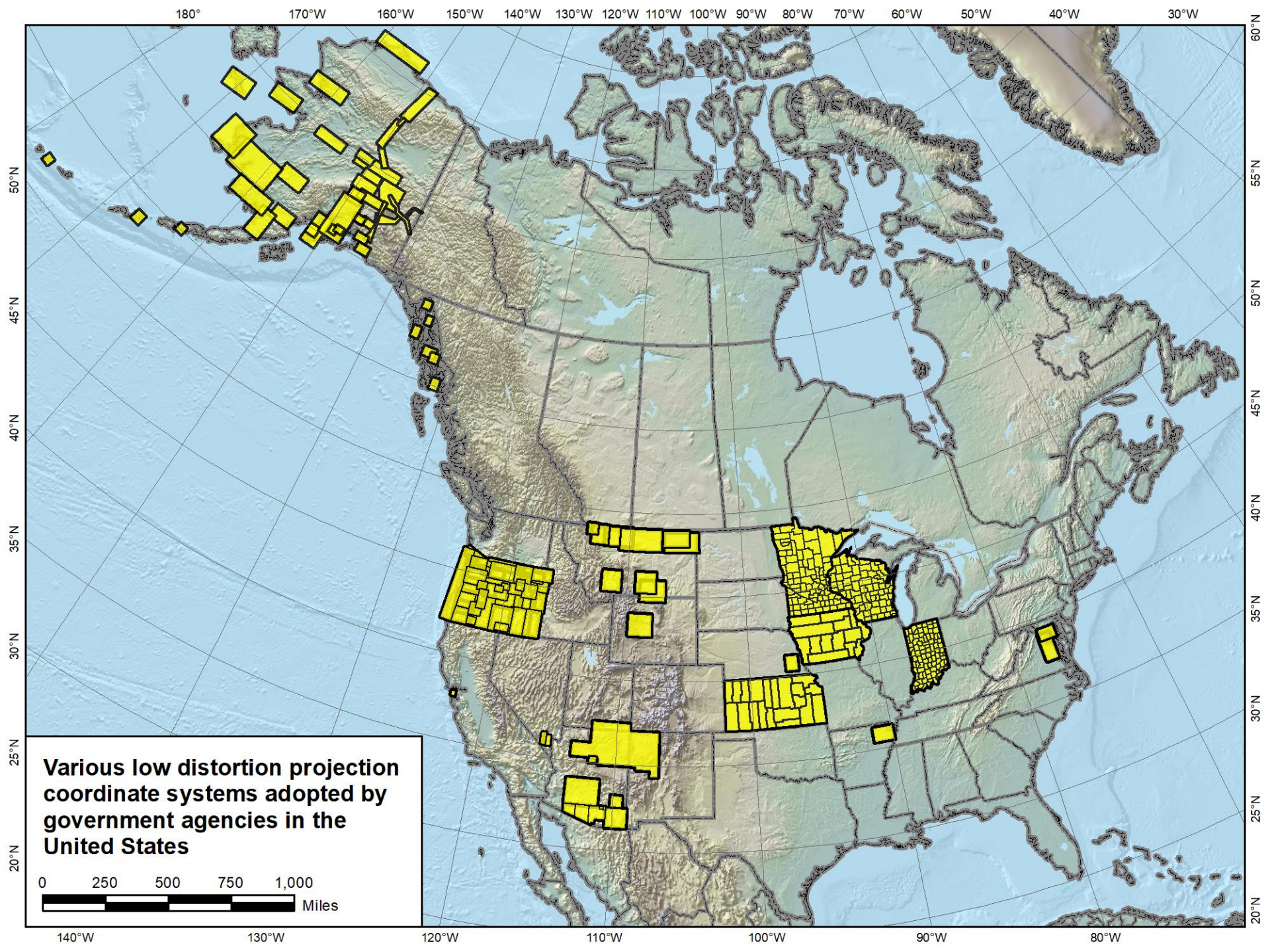
0 50 100 150 200 km

	North	South	Statewide
N parallel	38°58'N	37°56'N	38°40'N
S parallel	37°58'N	36°44'N	37°05'N
	Distortion (ppm)		
Min	-93	-211	-166
Max	+17	+42	+181
Mean	-56	-67	-58

Linear distortion design criteria

- NGS design of zones requested by stakeholders
  - Limited to zones with 50-400 ppm distortion criterion
    - **50 ppm** = 5 cm/km = 0.3 ft/mi = 1:20,000
    - **400 ppm** = 40 cm/km = 2.1 ft/mi = 1:2,500
- Design criterion < 50 ppm ("low distortion")
  - Min criterion **20 ppm** = 2 cm/km = 0.1 ft/mi = 1:50,000
  - Must be designed by others (not by NGS)
  - Proposed and final design reviewed by NGS

What is the current situation with "low distortion" projected coordinate systems?


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
Various low distortion projection coordinate systems adopted by government agencies in the United States
0
250
500
750
1,000
Miles