NAVD 88 No More: A Modernized Vertical Datum for the Future

2018 ASFPM Conference
June 20, 2018

Christine Gallagher
Communications Branch Chief, NGS

Poll

How aware are you that NGS is replacing NAD 83 and NAVD 88?

A. Very

B. Somewhat

C. Not at all

D. Unsure

Outline

1. **Getting started…**

   Who is NGS and what is NAVD 88?

2. **What is replacing NAVD 88?**

   NAPGD 2022, part of larger NSRS Modernization

3. **What do I use today?**

   Data, tools and metadata

4. **What's next?**

   Coordination, education and preparation!

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6.1 Vertical and Horizontal Control

All FIS Reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS Reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS Reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations shown in this FIS Report and on the FIRMs are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between NGVD29 and NAVD88 or other datum conversion, visit the National Geodetic Survey website at www.ngs.noaa.gov.

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the archived project documentation associated with the FIS Report and the FIRMs for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks in the area, please visit the NGS website at www.ngs.noaa.gov.

The datum conversion locations and values that were calculated for Flood County are provided in Table 20.

Table 20: Countywide Vertical Datum Conversion

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
Flood Forest	SE	44.500	-83.625	-0.620
Flood Lake	SE	44.500	-83.500	-0.665
Flood Point	SE	44.500	-83.875	-0.658
Flood Pond	SE	44.500	-83.750	-0.594
Flood SE	SE	44.250	-83.750	-0.647
Flood SW	SW	44.250	-83.625	-0.682
Floodland	SE	44.250	-83.500	-0.705
Metropolis SE	SE	44.375	-83.875	-0.554
Metropolis SW	SW	44.500	-83.375	-0.722

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
Average Conversion from NGVD29 to NAVD88 = -0.650 feet				

A countywide conversion factor could not be generated for Flood County because the maximum variance from average exceeds 0.25 feet. Calculations for the vertical offsets on a stream by stream basis are depicted in Table 21.

Table 21: Stream-Based Vertical Datum Conversion

Flooding Source	Average Vertical Datum Conversion Factor (feet)
Flower Creek	-0.604
Inundation River	-0.681
Little Creek	-0.545
North Fork Inundation River	-0.627
Petal Creek	-0.513

geodesy.noaa.gov

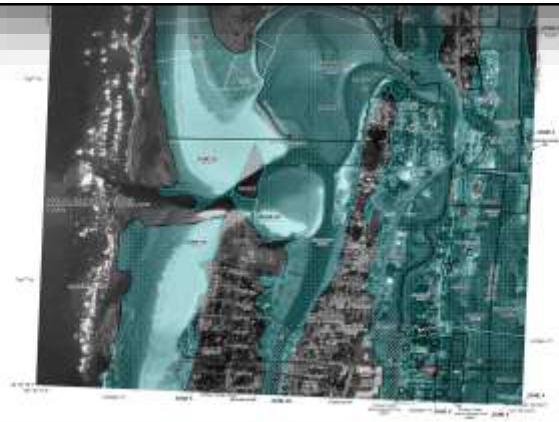
National Geodetic Survey

The **projection** used in the preparation of this map is State Plane Zone (FIPS Zone 3601). The **horizontal datum** was NAD 83, GRS 80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

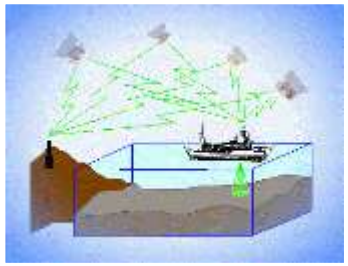
NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301)713-3242**, or visit its website at http://www.ngs.noaa.gov/.



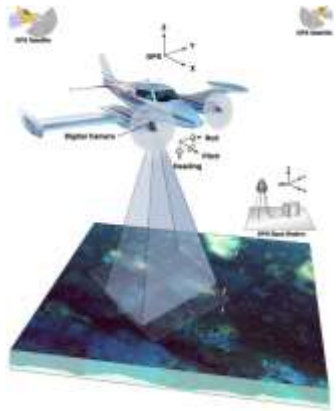
3 Categories of Vertical Datums

Ellipsoidal



Raw Hydrographic Surveys vertically referenced with RTK-GPS

Native GPS measurements

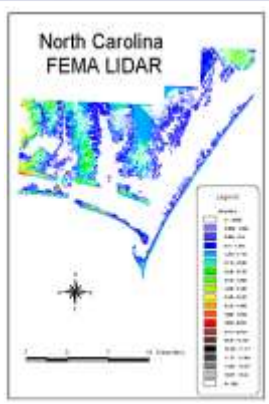


Raw Lidar

Orthometric

USGS Topography

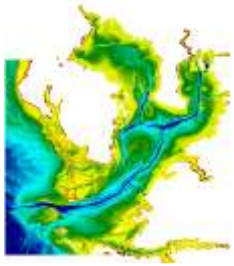
Engineering and Development Site Surveys



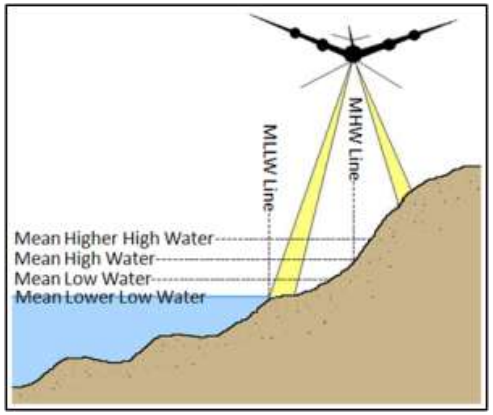
FEMA Flood Insurance Rate Maps

Tidal

Daily and Extreme Water Levels



NOAA Bathymetry (MLLW)



Shoreline Mapping (MHW) and Regulatory Boundaries at the Coast

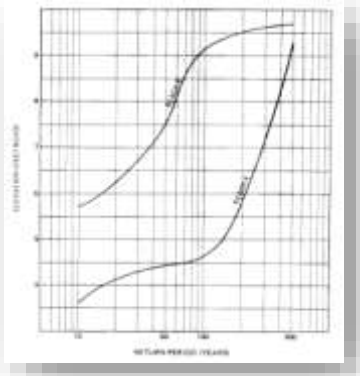
The National Spatial Reference System (NSRS)

A **common** and **consistent** geospatial framework to meet the economic, social, and environmental positioning needs of our Nation.

Foundational elements include:

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

+



+

=

Reliable FIRMs require data from disparate sources and dates be consistently aligned

The NSRS of Today *(simplified)*

Primary elements:

- Horizontal North American Datum of 1983 - **NAD 83(2011)** coordinates
- Vertical North American Vertical Datum of 1988 - **NAVD88** orthometric heights

These elements are **geodetic datums** that define the shape and size of the earth to enable precise positioning

System based on connections to published passive control

NGS Supports Access to NAVD88 Heights

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New Reference Frames

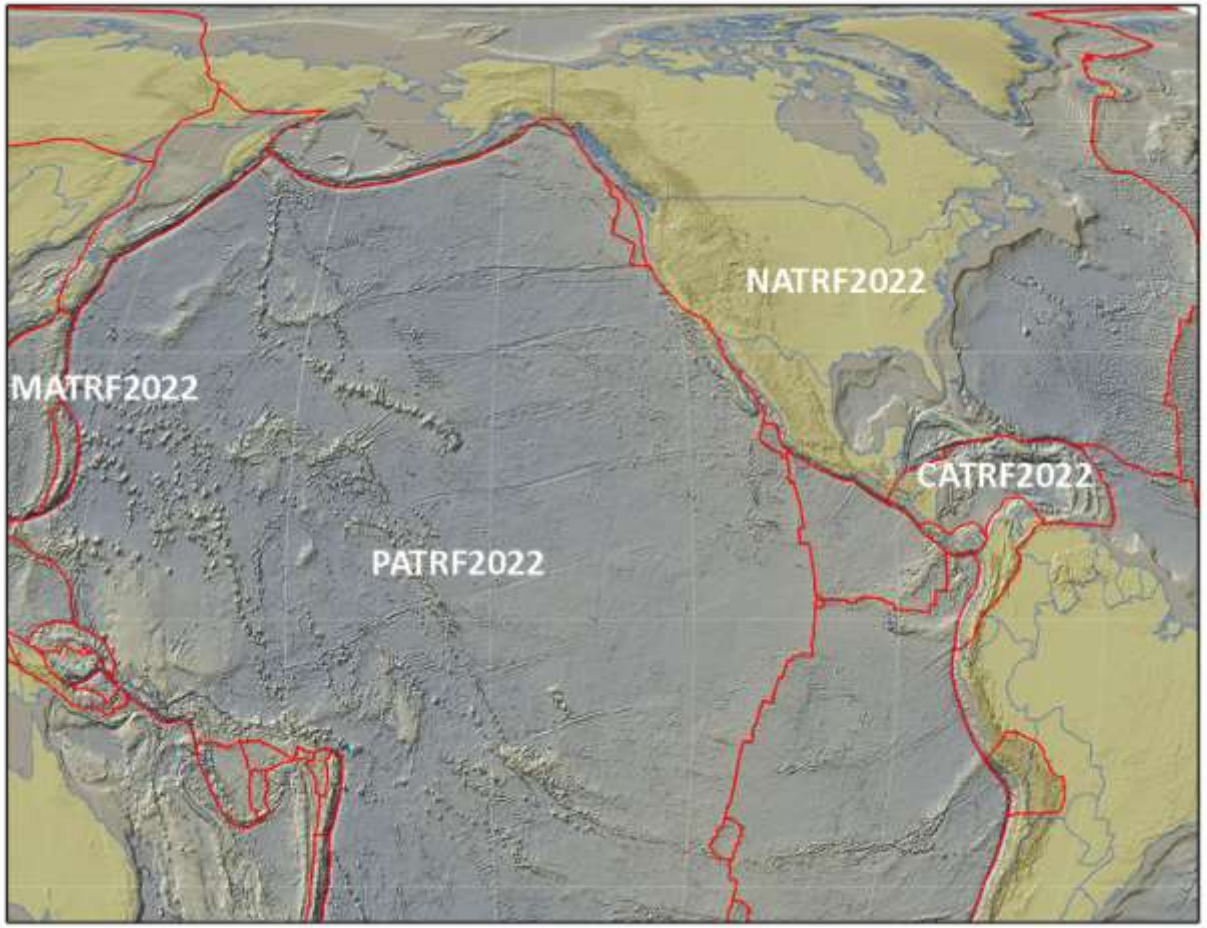
Blueprint for 2022, Part 1: Geometric Coordinates

The **North American Terrestrial Reference Frame of 2022 (NATRF2022)** to replace ***NAD 83 (2011)***

The **Caribbean Terrestrial Reference Frame of 2022 (CATRF2022)** to replace ***NAD 83 (2011)***

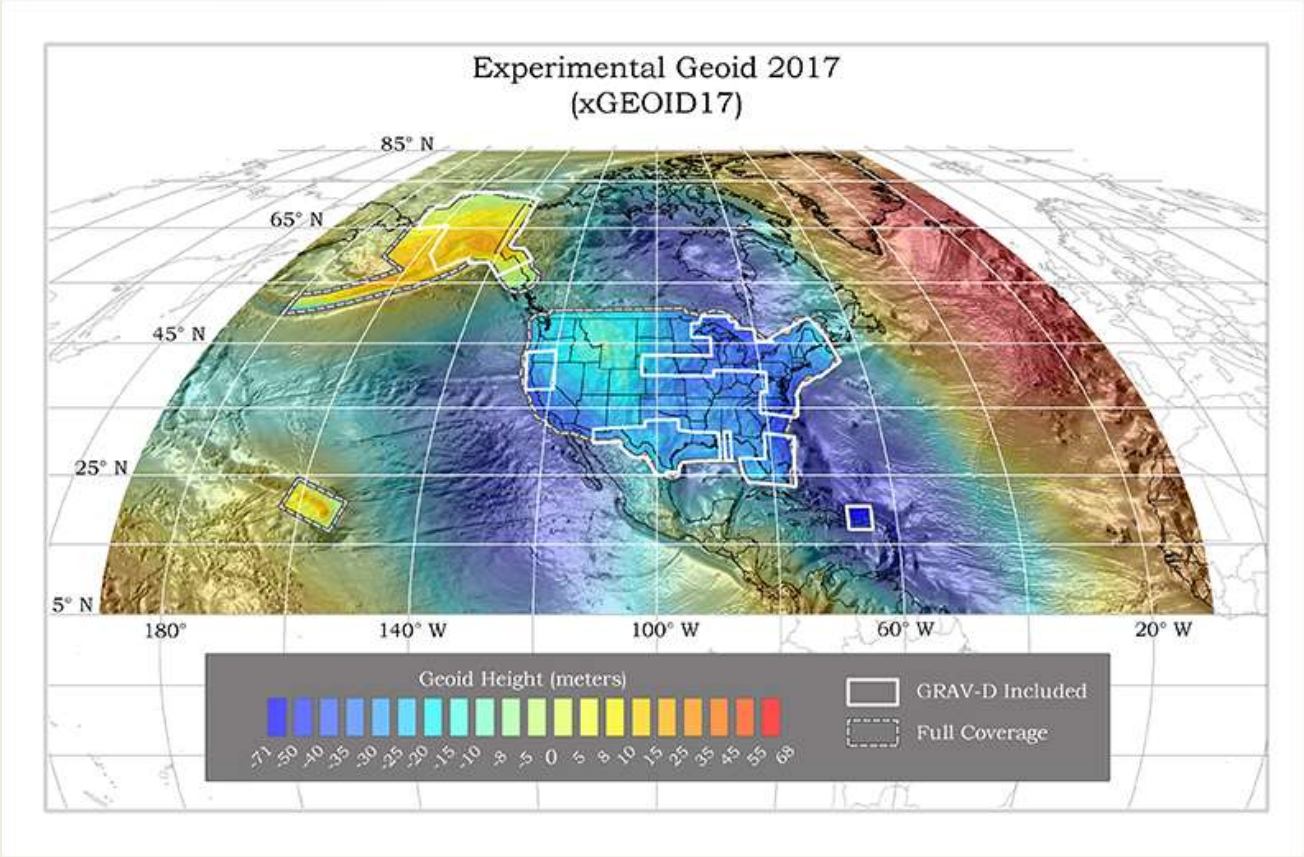
The **Pacific Terrestrial Reference Frame of 2022 (PATRF2022)** to replace ***NAD 83 (PA11)***

The **Mariana Terrestrial Reference Frame of 2022 (MATRF2022)** to replace ***NAD 83 (MA11)***



New Geopotential Datum

Blueprint for 2022, Part 2: Geopotential Coordinates



The North American-Pacific Geopotential Datum of 2022 (NAPGD2022) will include GEOID2022

The NSRS of Tomorrow (2022)

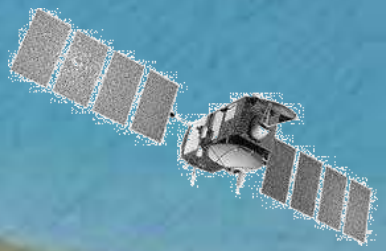
Primary elements:

- The geometric North American Terrestrial Reference Frame of 2022 (**NATRF2022**)
  plus the Caribbean, Pacific, and Mariana plates
- The North American-Pacific Geopotential Datum of 2022 (**NAPGD2022**)

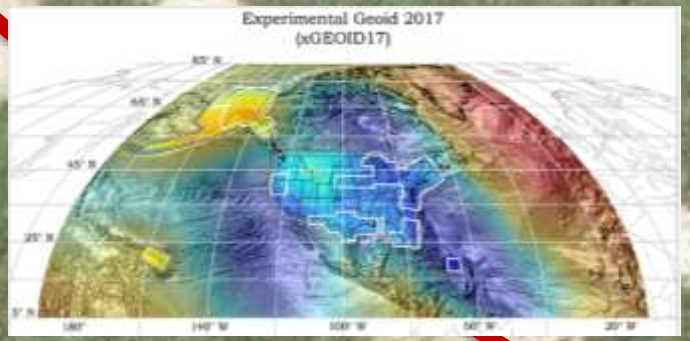
New reference system is:

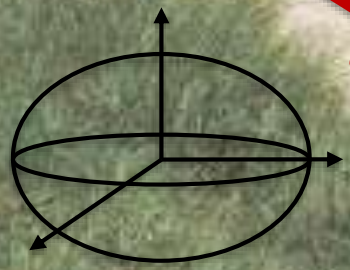
- Geocentric and defined by relationships to a global/international ideal frame;
- Time-dependent; and
- Primarily accessed via GPS technology and a newly refined semi-dynamic geoid model

NGS Will Support Access to NAPGD 2022 Heights



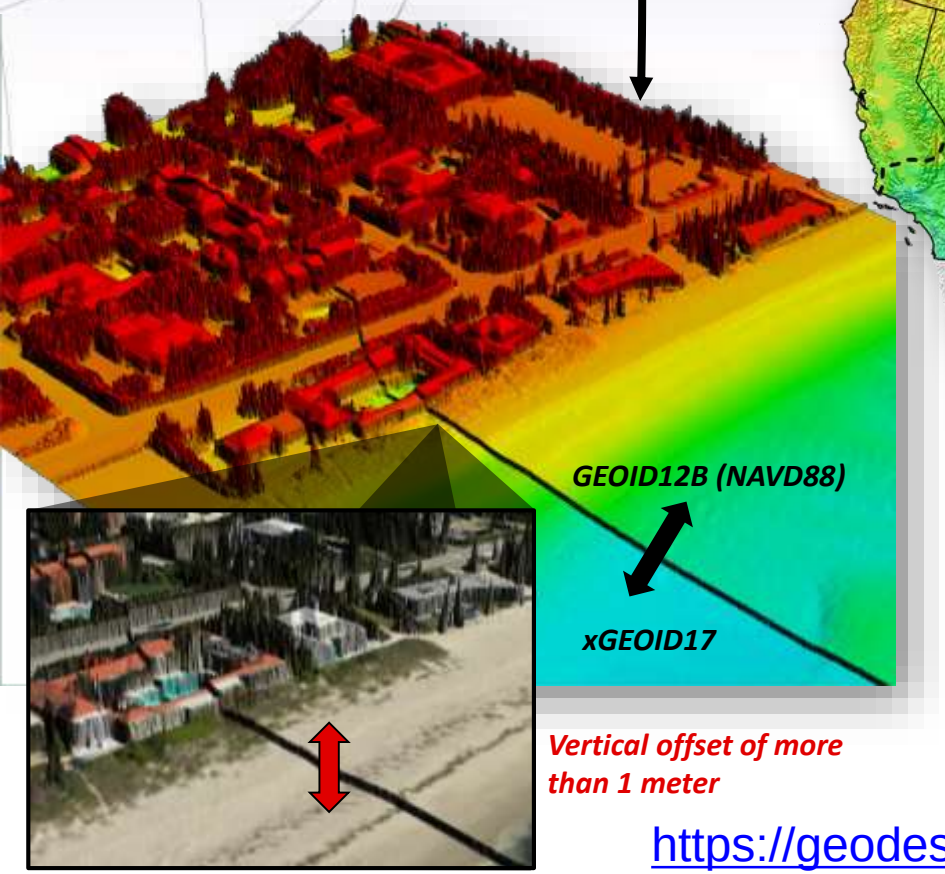
GEOID 2022



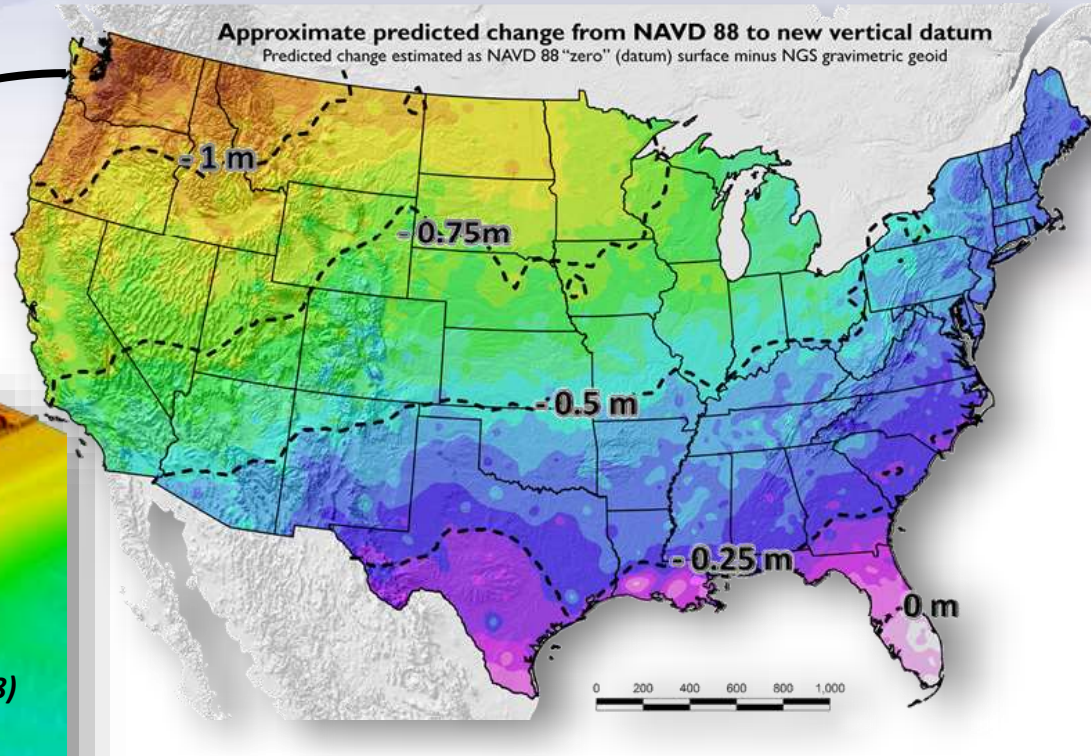


official path

Vertical Change (Offset)



Vertical offset of more than 1 meter



Updates available online from the **New Datums** website and **Modernization News**

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

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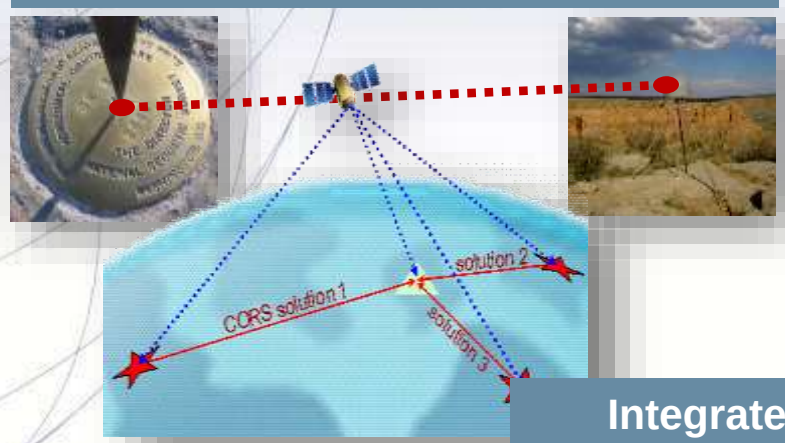
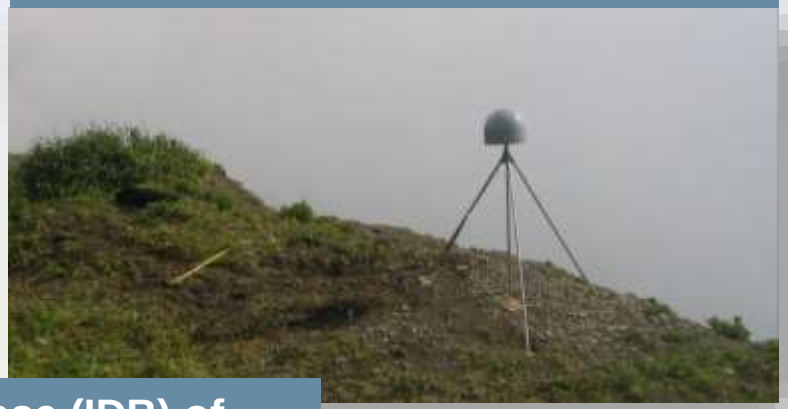
Tools to Access the NSRS

Online Positioning User Service (OPUS) Tool Suite



Continuously Operating Reference Stations (CORS)



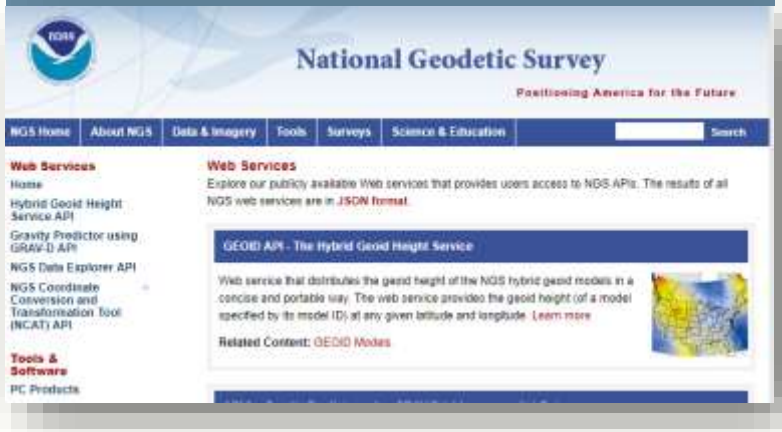
Integrated Database (IDB) of Published & OPUS Shared Control (NGS Data Explorer)

Transformation Tools

NGS Coordinate Conversion and Transformation Tool (NCAT)*

Vertical Datum Transformation (VDatum)*

Web Services*



Transformation Tool Notes

- *NCAT and VDatum will draw from same source code for identical transformations.*
- *VDatum includes tidal datums and HTDP.*
- *NCAT has a web service; VDatum will have one soon.*
- *Make sure to note version numbers when using tools.*

Document Datums (Metadata)

NAD83(2011) epoch 2010.00

H. Datum | Realization/Adjustment | Reference Epoch

NAVD88 *(GRS80, Geoid12B)*

V. Datum | Reference Ellipsoid | Geoid Model

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NOAA/Federal Coordination

2017 Geospatial Summit

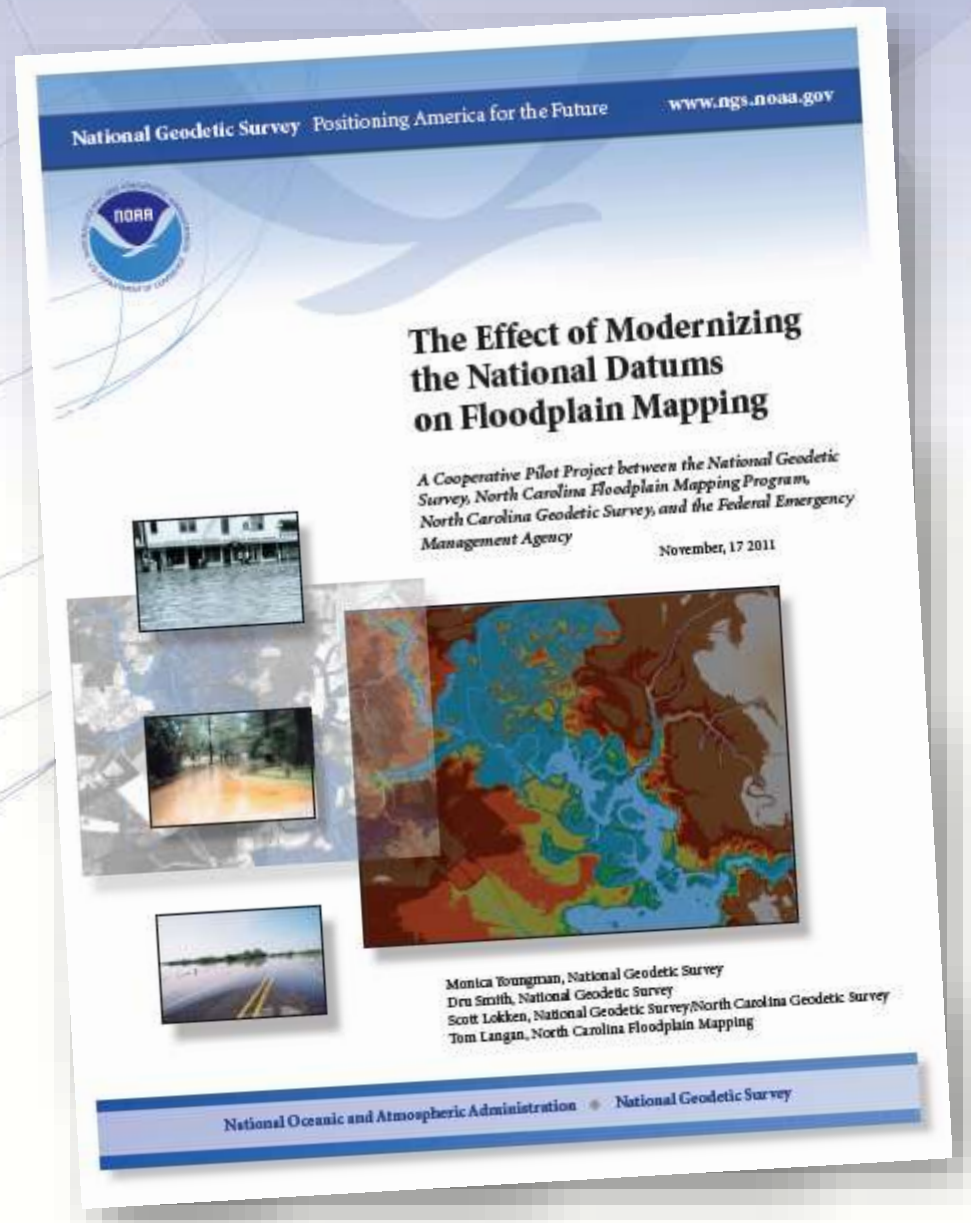
Feedback on the New Datums

- Preparations to-date
- Advantages and challenges
- Necessary transition tools, products, and services

FEMA Feedback

- Kimberly Pettit, FEMA GIS Coordinator
- Prepared with Paul Rooney

watch online


National Geodetic Survey Positioning America for the Future www.ngs.noaa.gov

The Effect of Modernizing the National Datums on Floodplain Mapping

A Cooperative Pilot Project between the National Geodetic Survey, North Carolina Floodplain Mapping Program, North Carolina Geodetic Survey, and the Federal Emergency Management Agency

November, 17 2011

Monica Youngman, National Geodetic Survey
Dru Smith, National Geodetic Survey
Scott Lokken, National Geodetic Survey/North Carolina Geodetic Survey
Tom Langan, North Carolina Floodplain Mapping

National Oceanic and Atmospheric Administration • National Geodetic Survey

NOAA/FEMA Coordination

Cooperative Pilot Study (2011):

- NGS and FEMA;
- North Carolina Floodplain Mapping Program, and
- North Carolina Geodetic Survey.

Key Outcomes:

- Recommendation of FEMA **implementation plan** to account for coordinate and height shifts.
- Improved relative positional accuracies and greater understanding of height uncertainties **will enhance quality of flood mapping**.

NOAA/Industry Coordination

- **Vendor software** and tools let users access NSRS.
- **Workshop** held to discuss industry requirements and concerns.
- **Software developers** (surveying and GIS) met with NGS subject matter experts.
- **Outcomes** include anticipated alpha/beta products and more standardized formats / documentation.

2018 NSRS Modernization Industry Workshop Attendees (Silver Spring, MD).

Resources from geodesy.noaa.gov

National Geodetic Survey

Positioning America for the Future

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

New Datums
- Home
- What to expect
- Get prepared
- Track our progress
- Naming Convention
- Watch videos
- Related projects
- Learn more
- New Datums FAQ
- Contact Us

Subscribe for email notifications

Events
- Industry Engagement
- 2017 Summit
- 2015 Summit
- 2010 Summit

New Datums: Replacing NAVD 88 and NAD 83

NAD 83 and NAVD 88 will be replaced in 2022, and there are many related projects to make sure the transition goes smoothly. Read the NGS Ten-Year Plan to learn more and continue to visit this web-page for more information.

What to Expect | Get Prepared | Track our Progress | Naming Convention | Watch Videos | Related Projects

Why is NGS replacing NAD 83 and NAVD 88?
NAD 83 and NAVD 88, although still the official horizontal and vertical datums of the National Spatial Reference System (NSRS), have been identified as having shortcomings that are best addressed through defini new horizontal and vertical datums.

Specifically, NAD 83 is non-geocentric by about 2.2 meters. Secondly, NAVD

Click icon on home-page

Email Subscriptions

Stay informed!

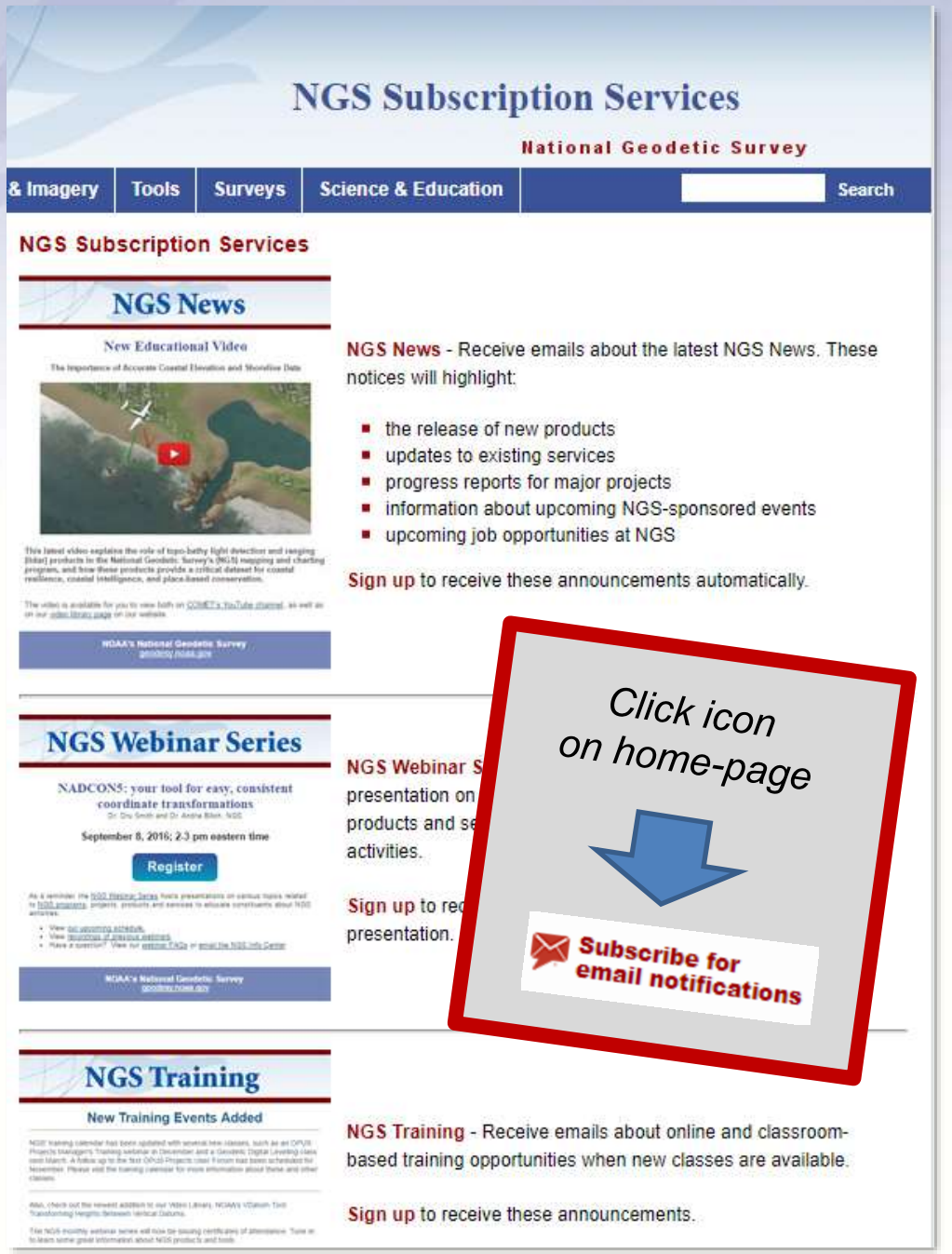
- **NGS News**

  Includes quarterly NSRS Modernization newsletter

- **NGS Webinar**

- **NGS Training**

Only 1-2 messages / month



NGS Monthly Webinar Series

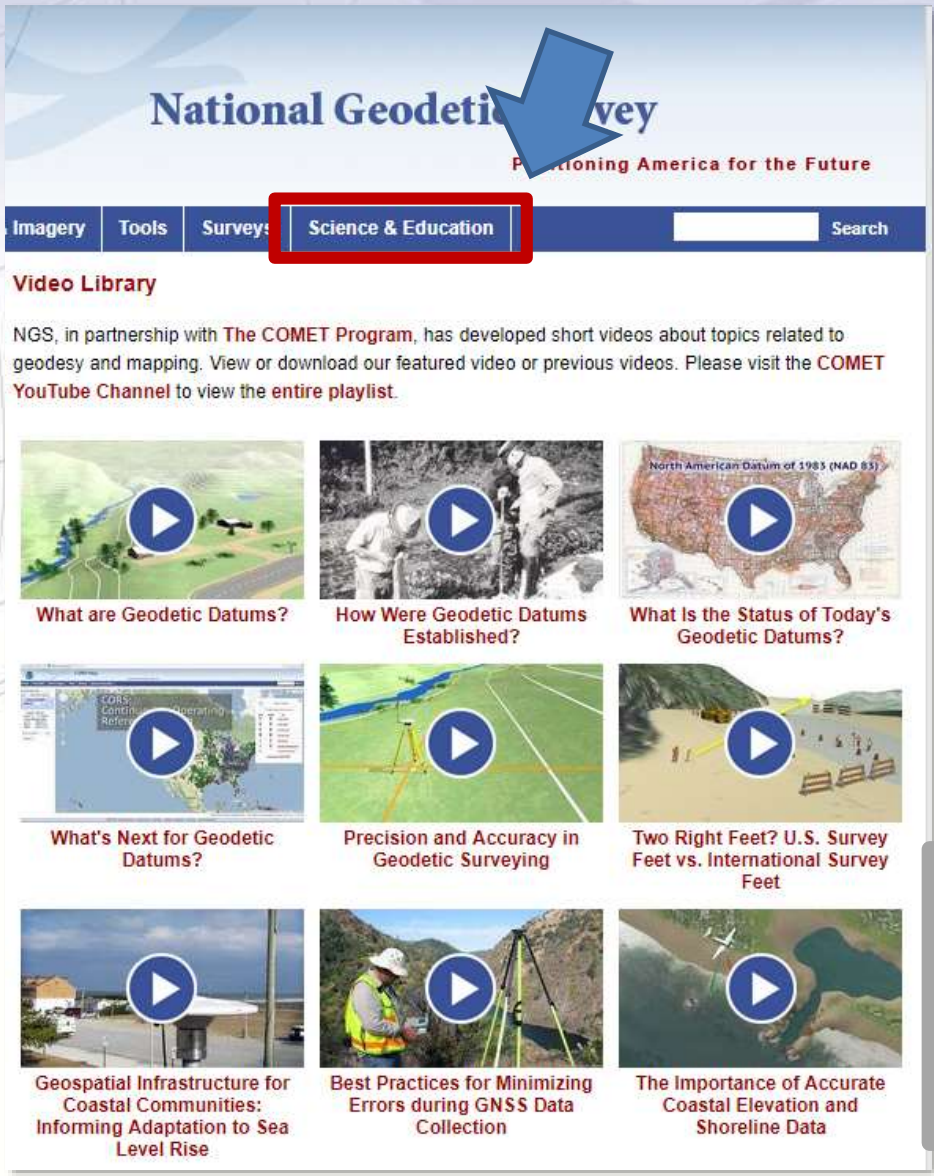
- **Learn** about NGS products and services
- Technical rating published in advance
- Live questions / answers
- All webinars are recorded / posted online
- **Join us**: second Thursday of each month / 2 pm eastern

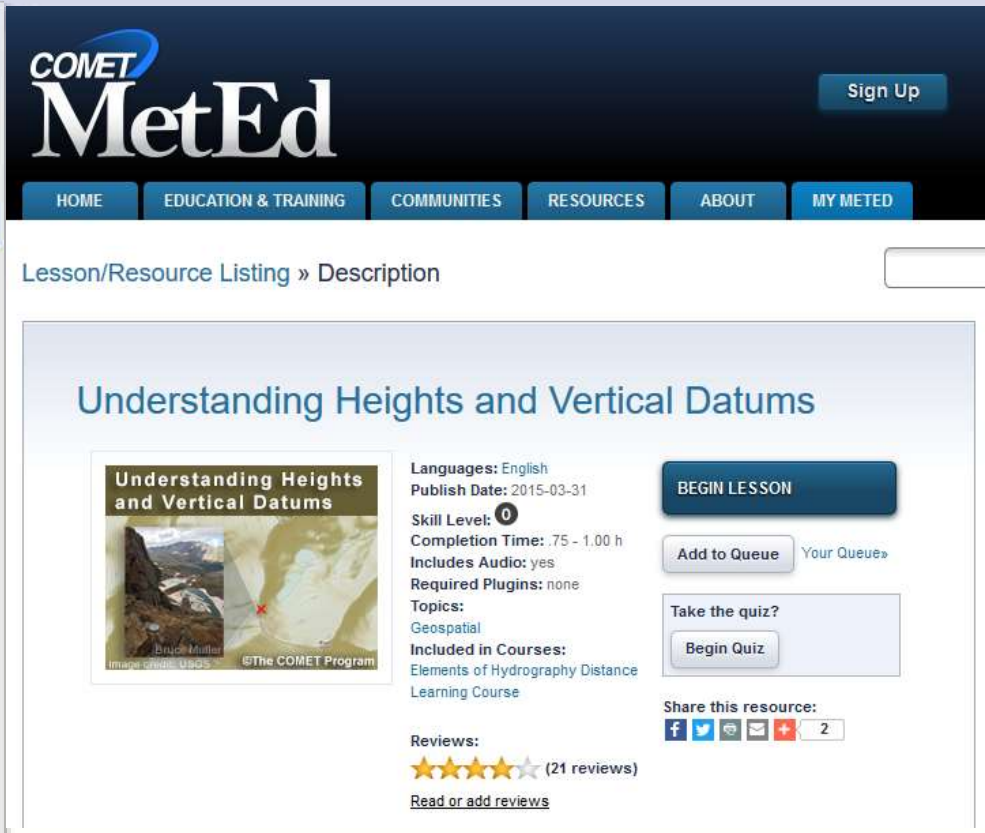
Save the Date & Spread the Word

Webinar on Oct. 11th at 2 pm eastern

Case Studies on Limitations of Static Vertical Datums

Educational Videos & Online Tutorials





Videos are ~3-5 minutes

Vertical Datums Tutorial is ~1 hour

NGS Regional Advisor Program

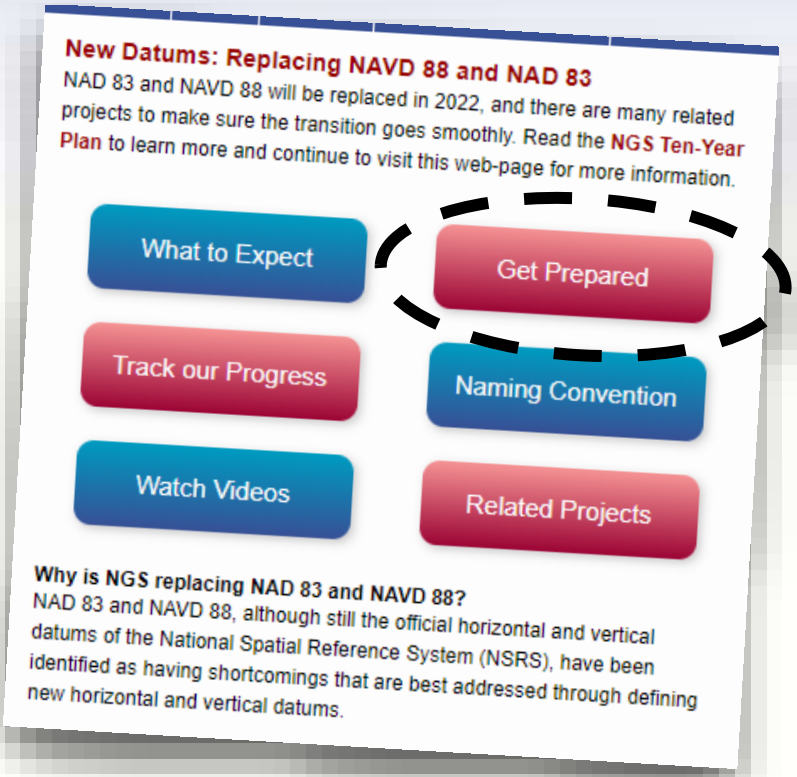
Get Prepared

EVERYONE

- Spread the word…

More active NSRS users

- Metadata, metadata, metadata..
- Use current datums / realizations
- Keep original ("raw") GNSS observation files



Poll

How do you feel about NSRS Modernization?

A. Excited

B. Neutral

C. Concerned

D. Excited and concerned

E. Unsure

Recap

1. **NGS and NAVD 88** are critical to floodplain mapping.

2. NAVD 88 is going to be **replaced in 2022.**

3. The tools to **access NSRS and transform/convert data** that you used today will be expanded for 2022.

4. **Spread the word** to help coordinate, educate and prepare!

THANK YOU!

Christine.Gallagher@noaa.gov

Special thanks to:

Nicole.Kinsman@noaa.gov

EXTRA SLIDES

Why replace NAD 83 and NAVD 88?

ACCESS!

- easier to find the sky than a 60-year-old bench mark
- GNSS equipment is cheap and fast

ACCURACY!

- easier to trust the sky than a 60-year old bench mark
- immune to passive mark instability

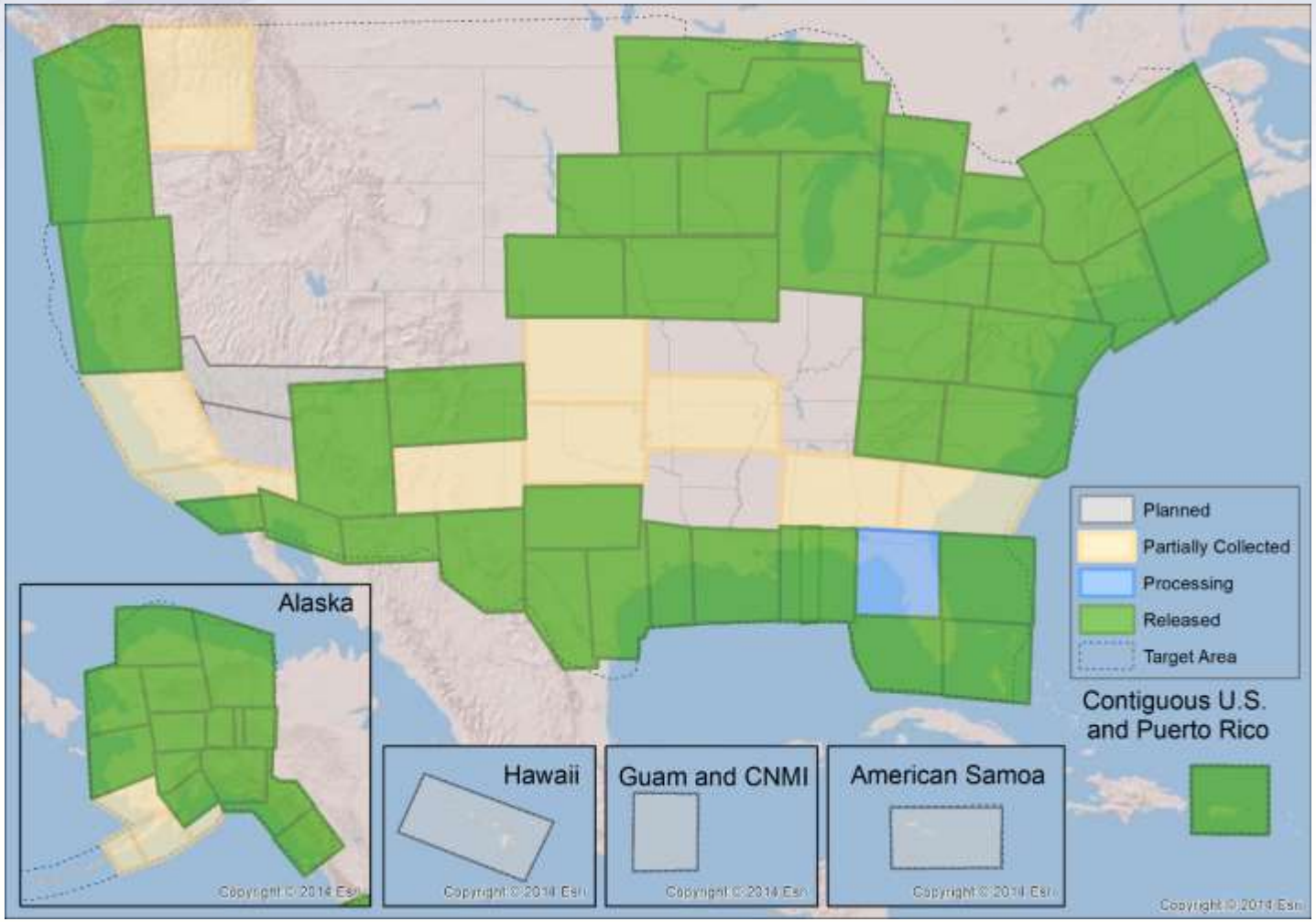
GLOBAL STANDARDS!

- systematic errors of many meters across the US
- aligns with GPS (equipment), international efforts
- aligns with Canada, Mexico

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

Project to collect gravity data to redefine the U.S. vertical datum by 2022 (at current funding levels)

Target: 2-centimeter accuracy relative to sea level (orthometric heights) using GPS/GNSS and a geoid model.



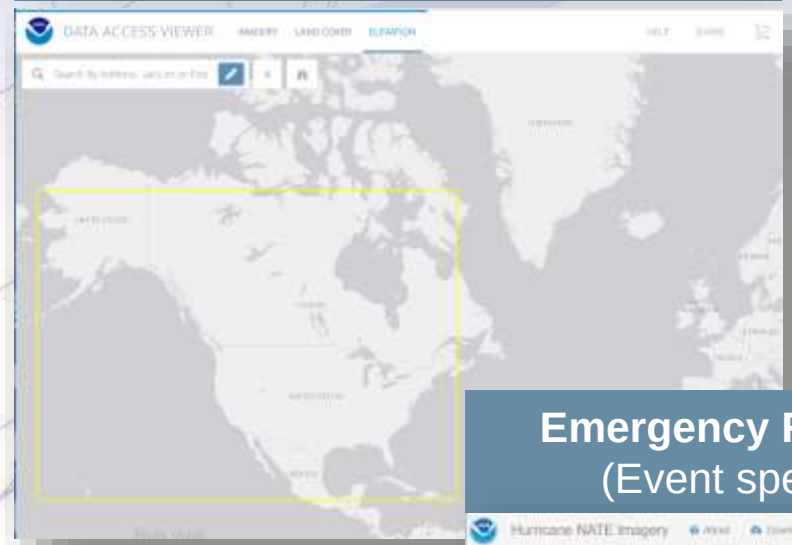
Map updated 04/2018.

Role of Passive Control

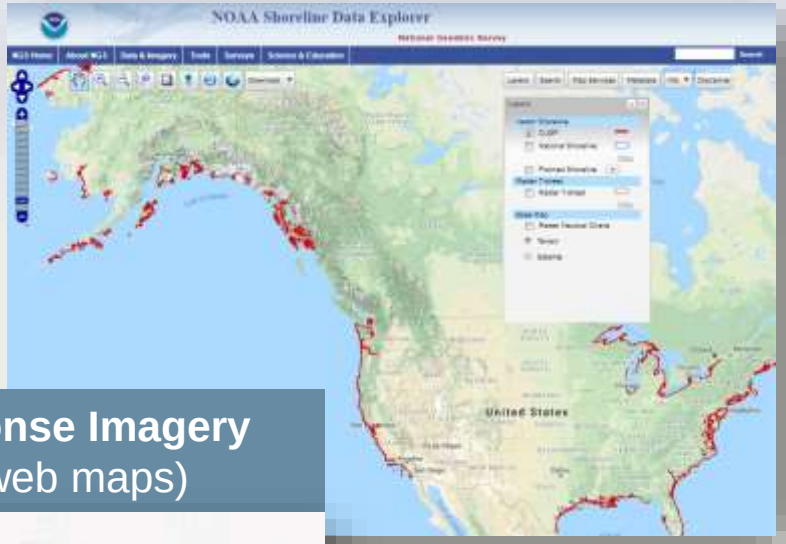
- **Calibration** sites for GNSS technology, Real Time Network validation, and verification of datum transformation tool results.
- Sites for **monitoring** motion to enhance velocity models (via repeat/campaign GNSS occupations)
- **Convenience** for local projects, in areas with limited GNSS coverage (e.g. cities, forests), or in the event of GNSS failure (e.g. geomagnetic storms)

Remotely Sensed Data

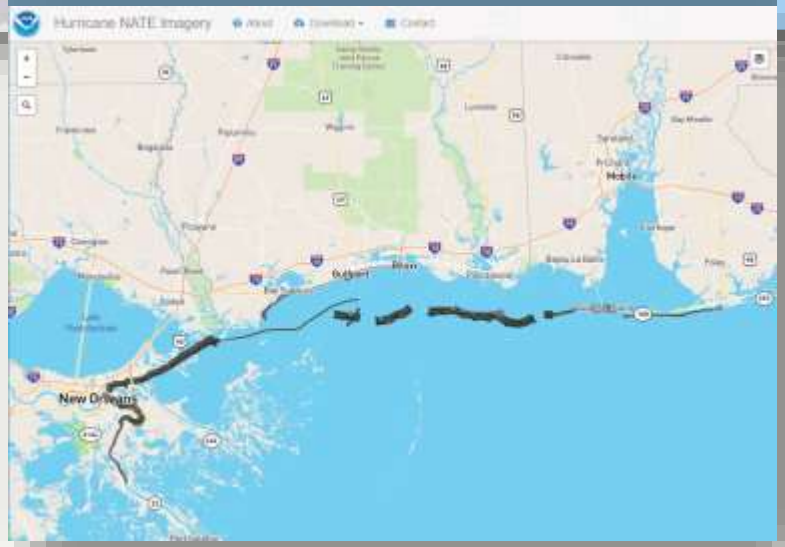
Imagery and Lidar
(NOAA Data Access Viewer)



Shoreline Vector Data
(Shoreline Data Explorer)



Emergency Response Imagery
(Event specific web maps)



Metadata "Deeper Dive"

Adjustments to the National Spatial Reference System (NSRS)

Birth: NAD83(1986)	Differential leveling only
1st adjustment NAD83(1997)	*GNSS/HARN and more leveling also: NAD83(HARN)*
NAD83(CORS96)	GNSS/CORS (2007.00 epoch in AK)
2nd adjustment NAD83(2007)	GNSS/CORS
3rd adjustment NAD83(2011)	CORS

All NGS hybrid geoid models are intended for use with NAD 83, but for the most consistent results, ensure that the geoid model used matches the correct 'flavor' of NAD 83

CONUS:	For NAD83(1986)	use	Geoid96, Geoid99, Geoid03
	For NAD83(2007), NAD83(CORS96)	use	Geoid09
	For NAD83(2011)	use	Geoid 12A/B
Alaska:	For NAD83(1986)	use	Geoid06
	For NAD83(2007), NAD83(CORS96)	use	Geoid09
	For NAD83(2011)	use	Geoid 12A/B

Note: for Alaska these are the only three hybrid geoid models that exist