Digging for Datums and Aligning Aerial Imagery

Association of State Floodplain Managers Conference - 2019

Christine Gallagher - Communication & Outreach Branch Chief

Outline

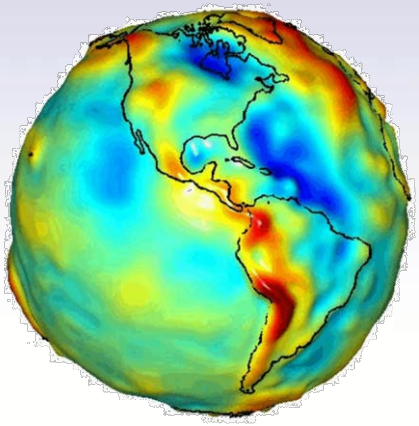
1. **Introducing** NOAA's National Geodetic Survey (NGS)
2. **Remote Sensing** at NGS
3. **Aligning** Data
   - ***Terminology** Review*

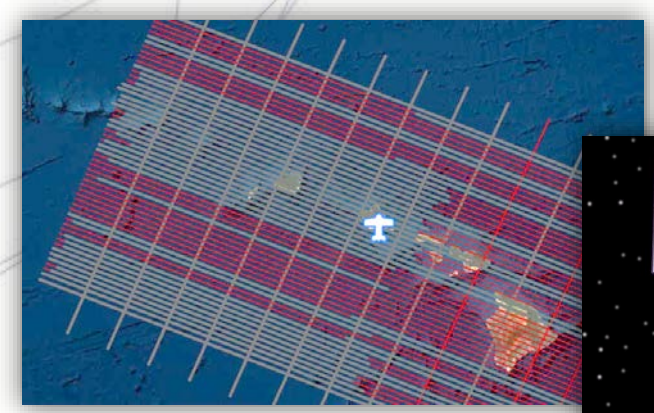
Technical "datums deeper dive"

4. **Improving** Height and Elevation Information
5. **Case Studies** NEW!!!
6. **Get Engaged and Learn More!**

What does NGS do?

Geodesy: measuring and monitoring the size and shape of the Earth…





from the Sky

from Space, and

from the Ground.

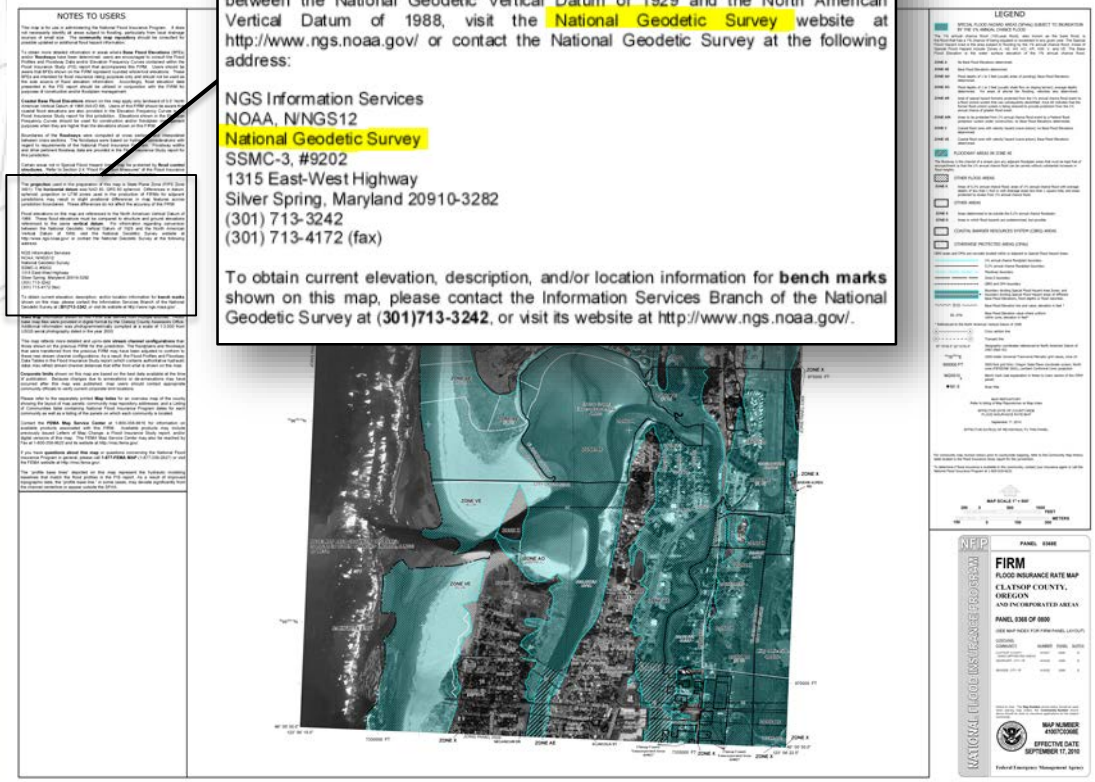
NGS and Floodplain Mapping

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/.



SECTION 6.0 – MAPPING METHODS

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

NGS in the News

Hurricane Michael October 2018

Images can be viewed at:
https://storms.ngs.noaa.gov

NGS' Emergency Response

Mission: Meet NOAA requirements and Pre-Scripted Mission Assignments with FEMA

Data: Typically nadir or oblique imagery in GIS-ready formats

NADIR

Oblique

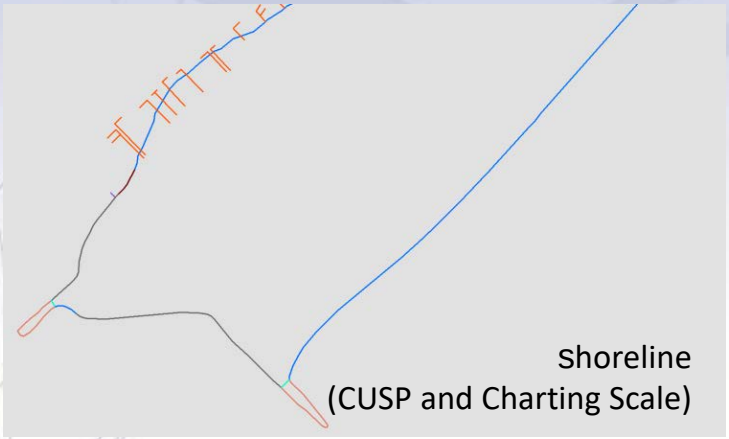
Oblique

Coastal Mapping Program

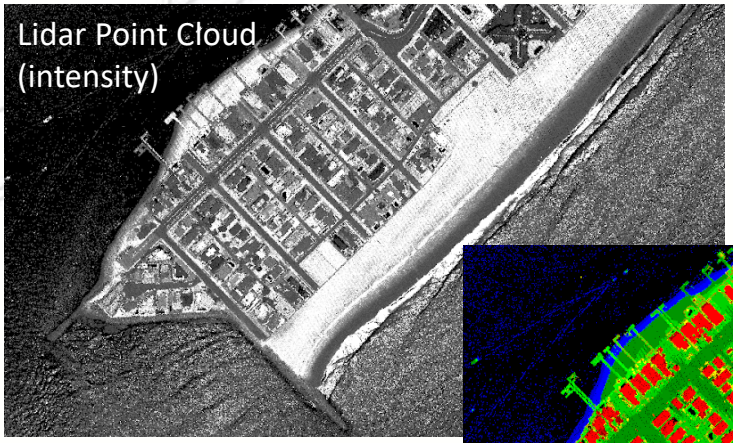
National Shoreline defines territorial limits, used in NOAA Nautical Charts, and supports many other coastal applications

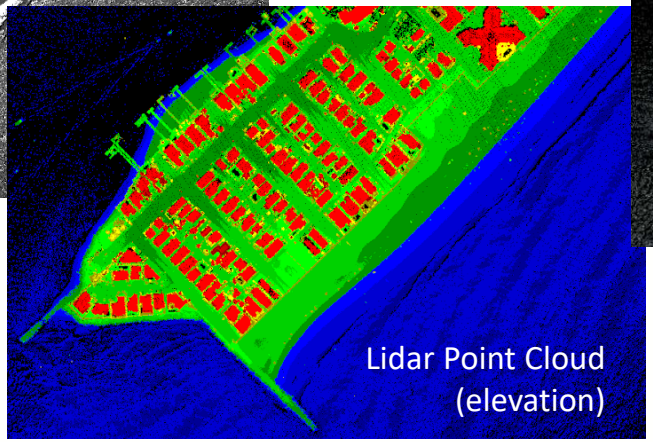
Remote sensing technologies include imagery, lidar, radar, etc. from various sources, like aircraft and satellites.

Remote Sensing Products


Shoreline
(CUSP and Charting Scale)


Ortho Mosaic Imagery


Lidar Point Cloud
(intensity)

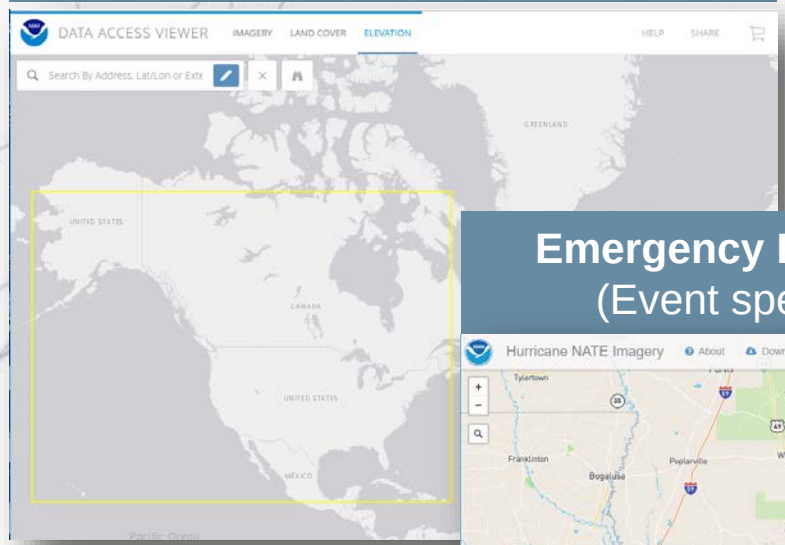

Lidar Point Cloud
(elevation)


RGB Colorized Lidar
Point Cloud

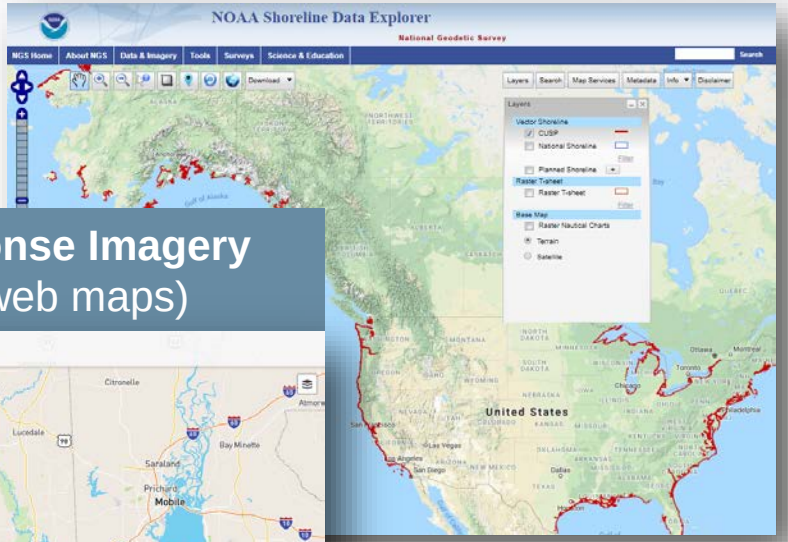
View Related Video:
The Importance of Accurate Coastal Elevation and Shoreline Data

Accessing Remotely Sensed Data

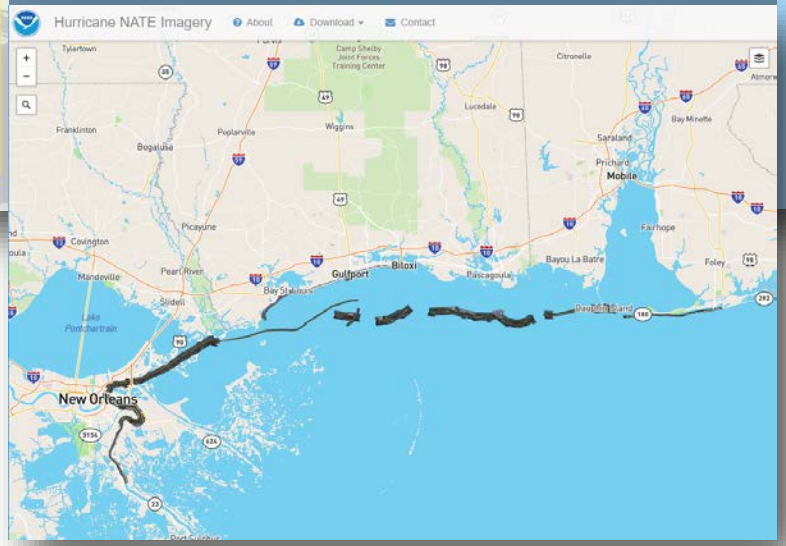
Imagery and Lidar
(NOAA Data Access Viewer)



Shoreline Vector Data
(Shoreline Data Explorer)



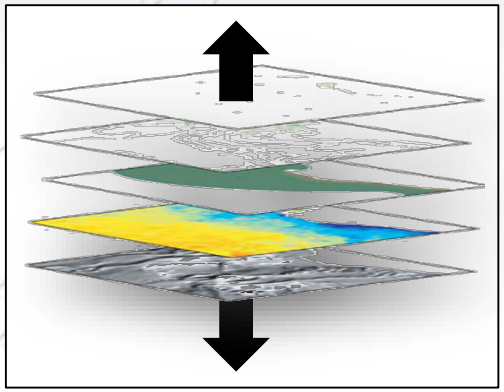
Emergency Response Imagery
(Event specific web maps)



Aligning Geospatial Products

Requirements

CONSISTENCY



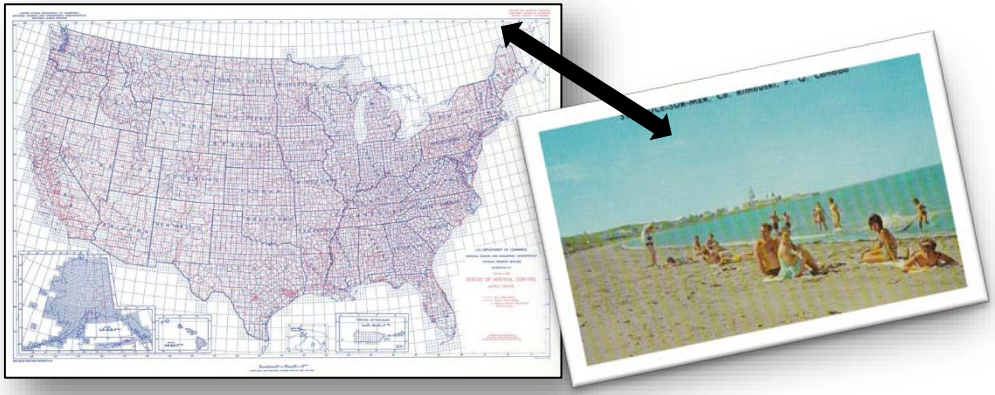
CONVENIENCE

Expectations

Semi-CONSTANT Coordinates

stamped with position and elevation information

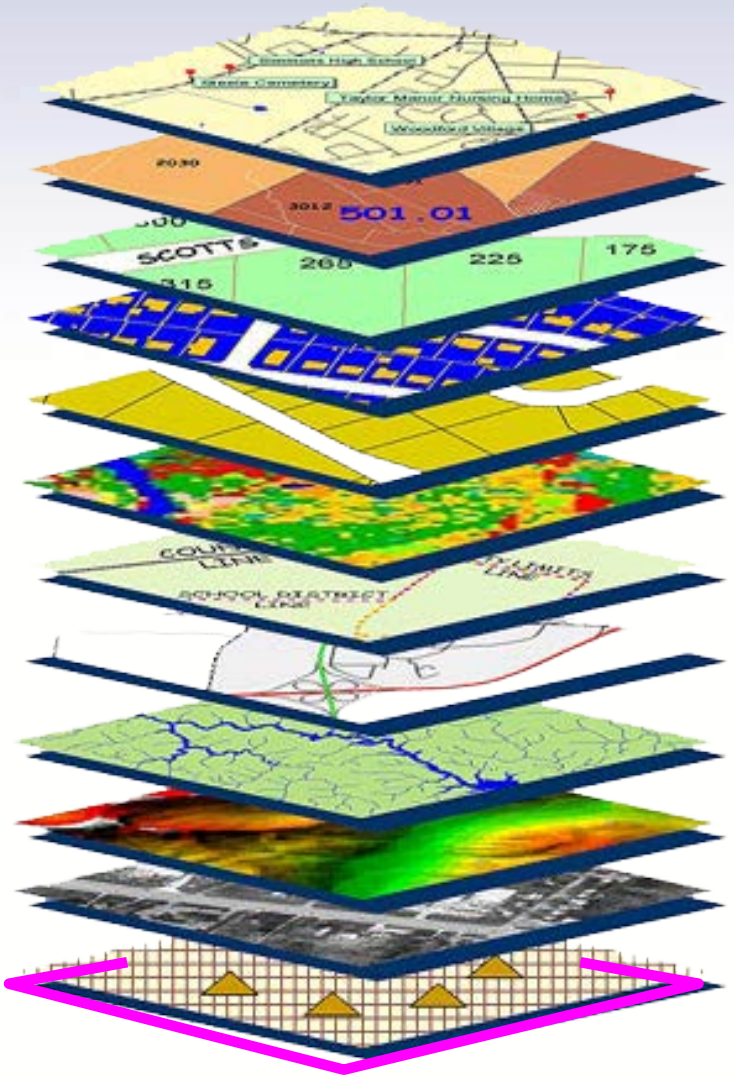
COHERENCE with Sea Level



The National Spatial Reference System (NSRS)

NGS defines, maintains and provides access to the NSRS

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



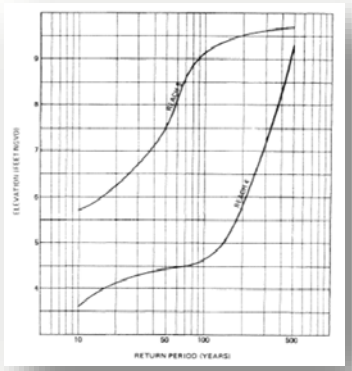
- North American Datum of 1983 **(NAD 83)**
- North American Vertical Datum of 1988 **(NAVD 88)**

Aligning Floodplain Mapping Data

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

Airborne or mobile lidar data.

+



Stream hydrograph

+

Elevation certificate

=

Flood Insurance Rate Map

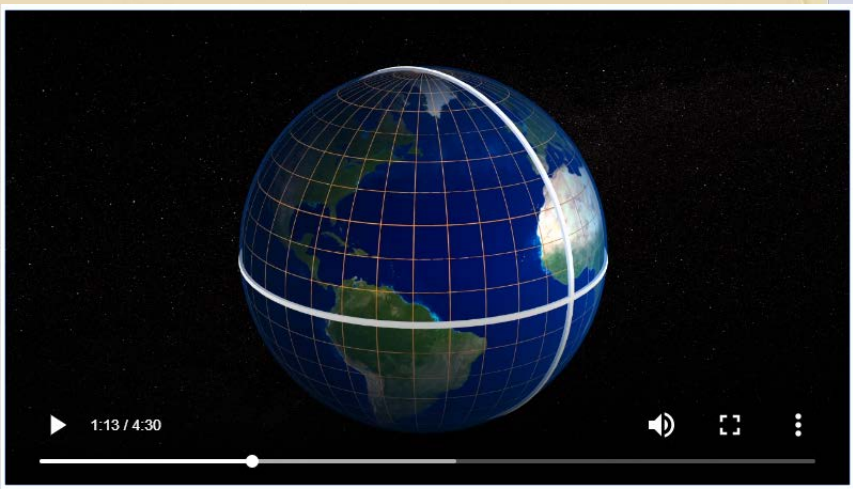
Recap

1. **NGS measures the Earth** from the sky, space and ground
2. **NGS collects imagery** for Emergency Response and Coastal Mapping NGS
3. **NGS defines the NSRS,** helping align geospatial data
   - ***Terminology*** *Review*

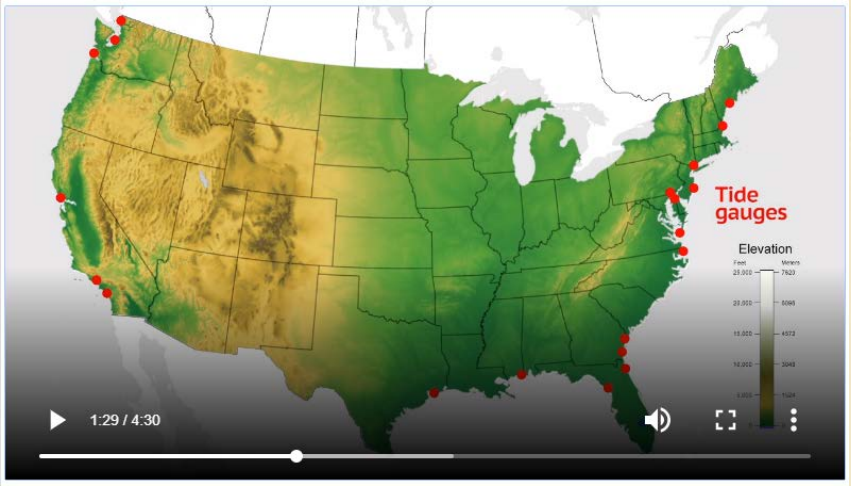
4. **Improving** Height and Elevation Information
5. **Practical advice:** Case Studies and Learning More!

What is a Datum?

Datums are a starting point for surveys



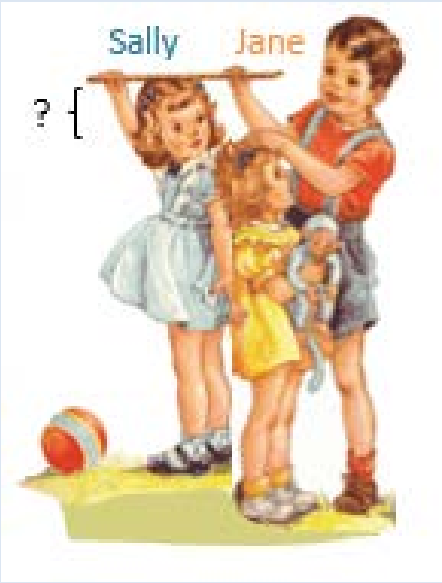
Horizontal datums let us measure distances



Vertical datums let us measure heights

An example…

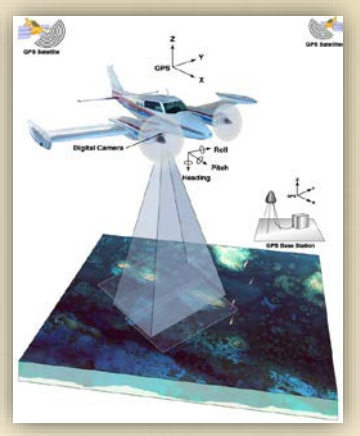
Mixing datums can give you the wrong answer.



More About Vertical Datums

Ellipsoidal

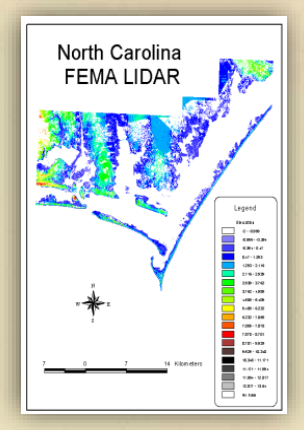
Native GPS measurements



Raw Lidar

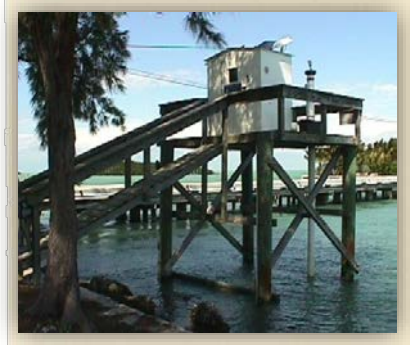
Orthometric

USGS Topography

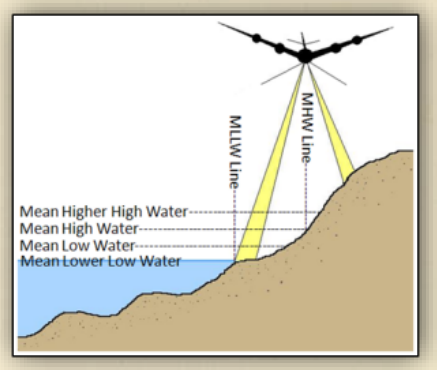


FEMA Flood Insurance Rate Maps

Tidal



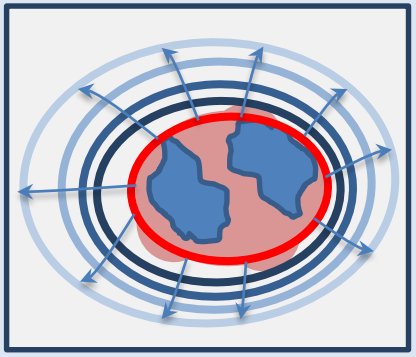
Daily and Extreme Water Levels



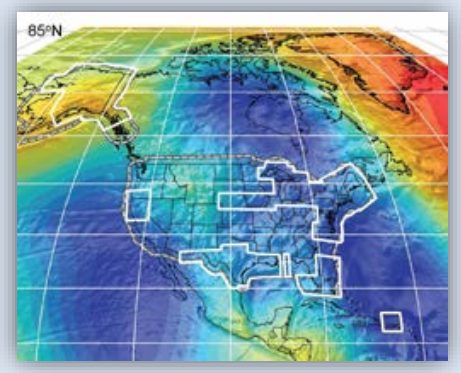
Shoreline Mapping (MHW) and Boundaries

Geoid

NOT A DATUM, but useful surface…



Earth's gravity field and the geoid



Experimental Geoid 2018 (XGEOID18)

Do you know your datum?

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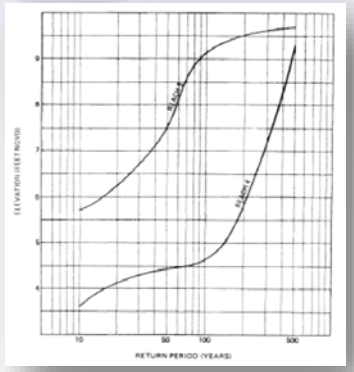

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NAD83(2011) epoch 2010.00

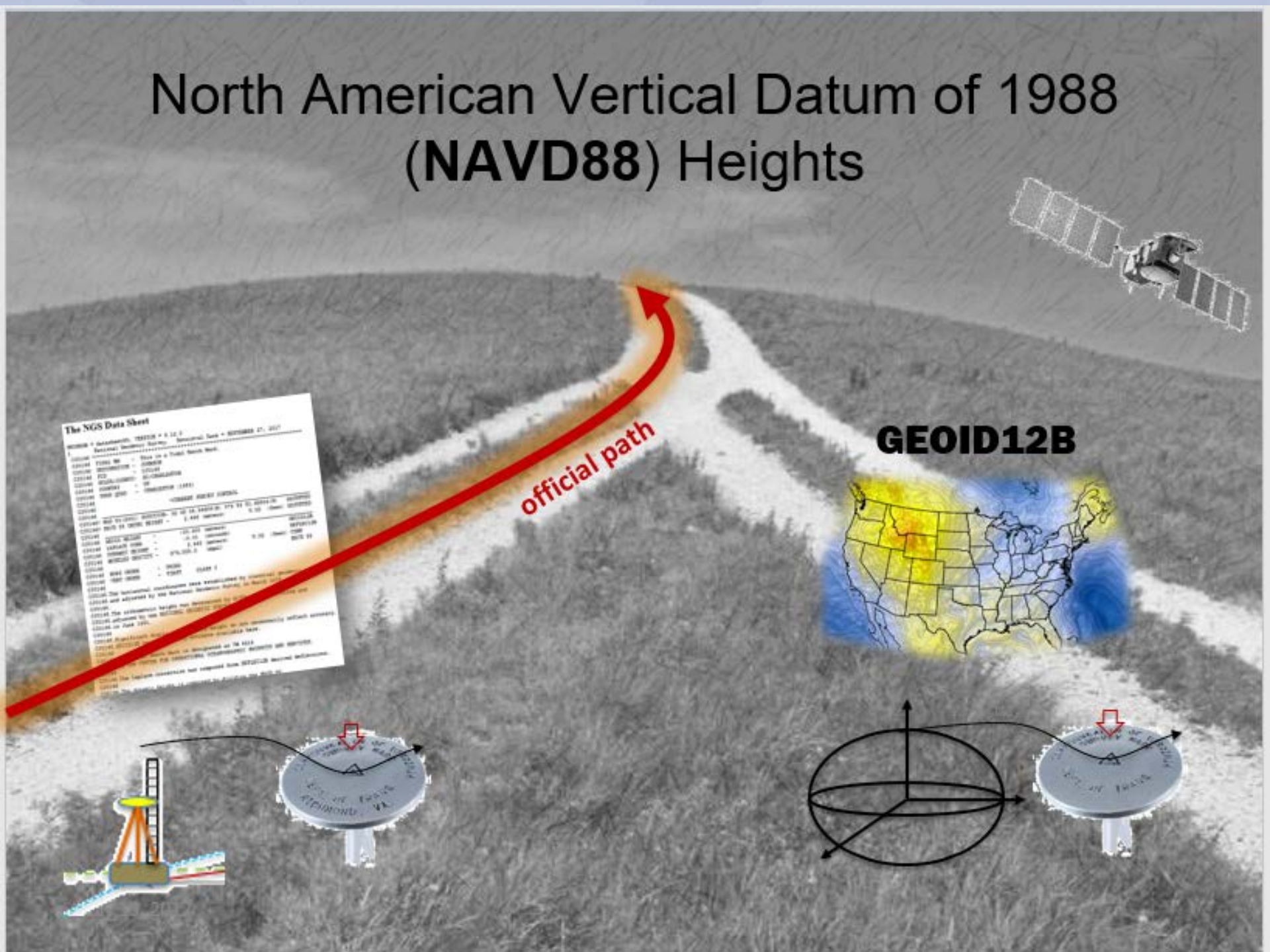
H. Datum — Realization/Adjustment — Reference Epoch

NAVD88 *(GRS80, Geoid12B)*

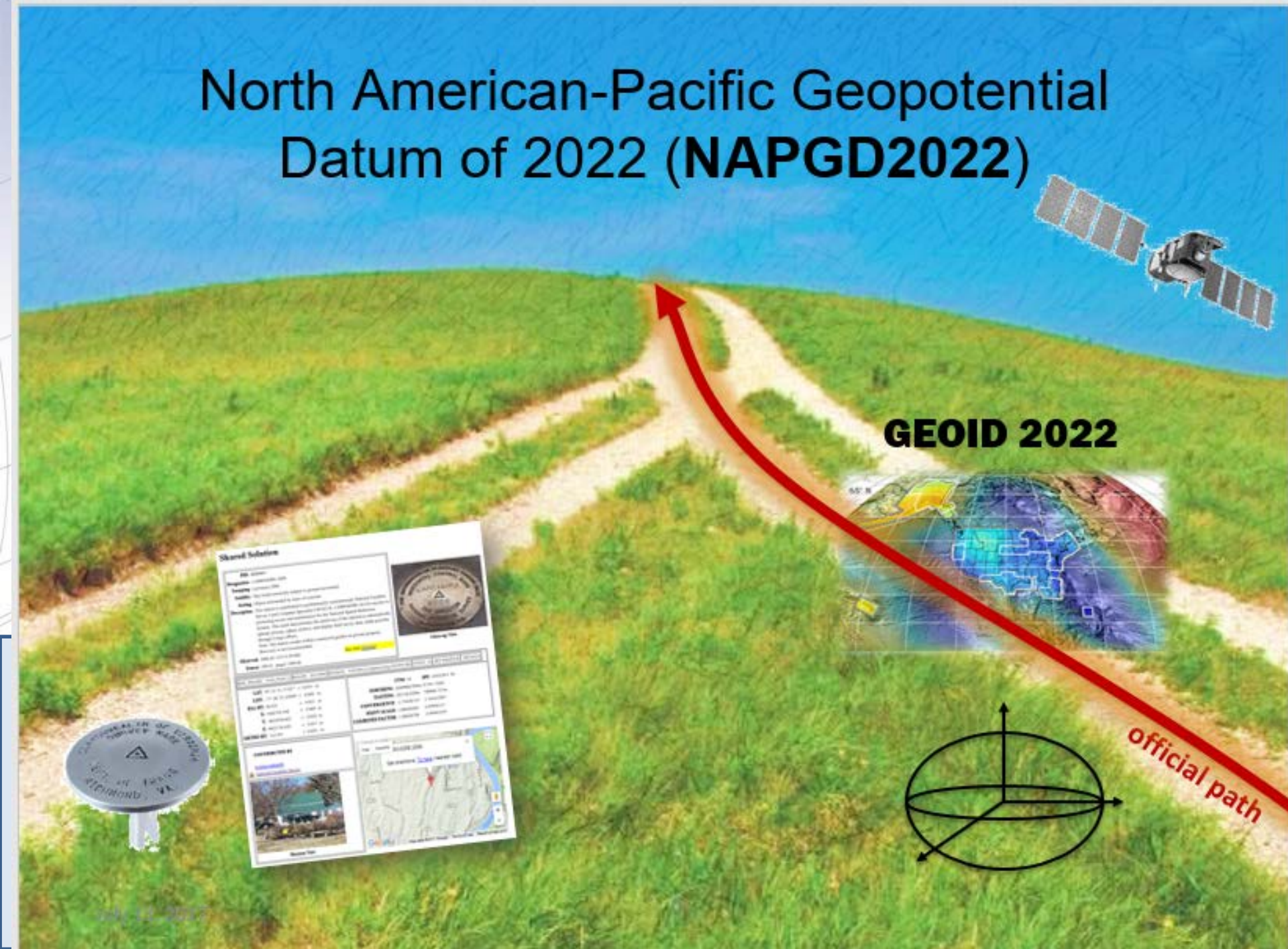
V. Datum — Reference Ellipsoid — Geoid Model

Coming Soon: HYBRID GEOID18

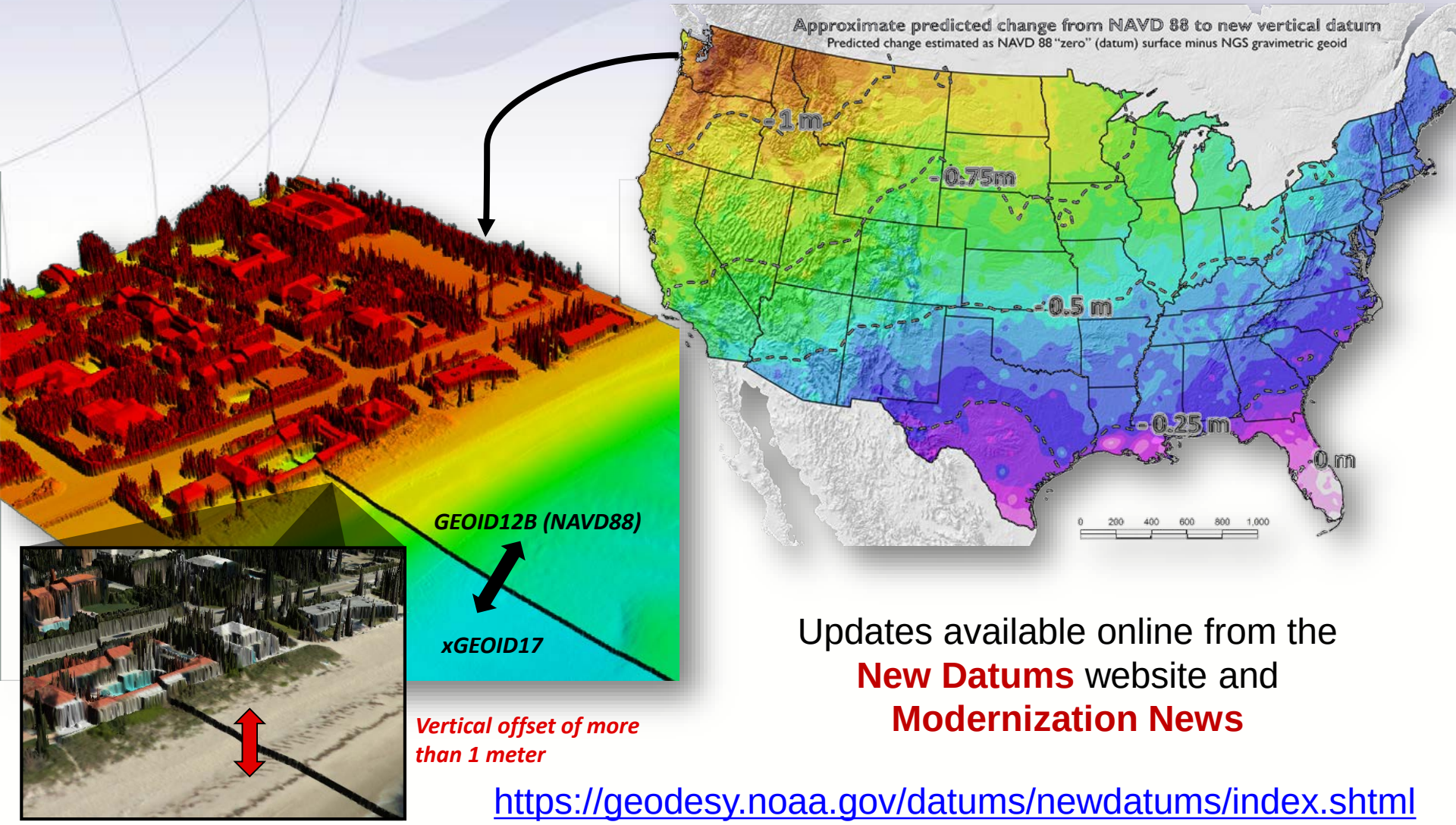
North American Vertical Datum of 1988 (**NAVD88**) Heights



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



NSRS Modernization: Vertical Change



Vertical offset of more than 1 meter

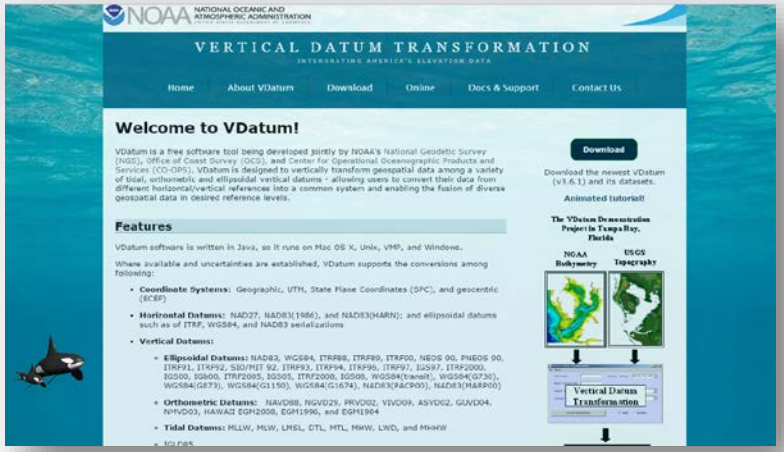
Updates available online from the **New Datums** website and **Modernization News**

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

Transformation Tools

NGS Coordinate Conversion and Transformation Tool (NCAT)*

Vertical Datum Transformation (VDatum)*



***Notes**

- *Identical Transformations*
- *Web Services*
- *Be aware of versioning*

VDatum includes

- *tidal datums*
- *Horizontal time dependent positioning (HTDP)*
- *Geoids: BOTH NSRS (hybrid) and experimental models*

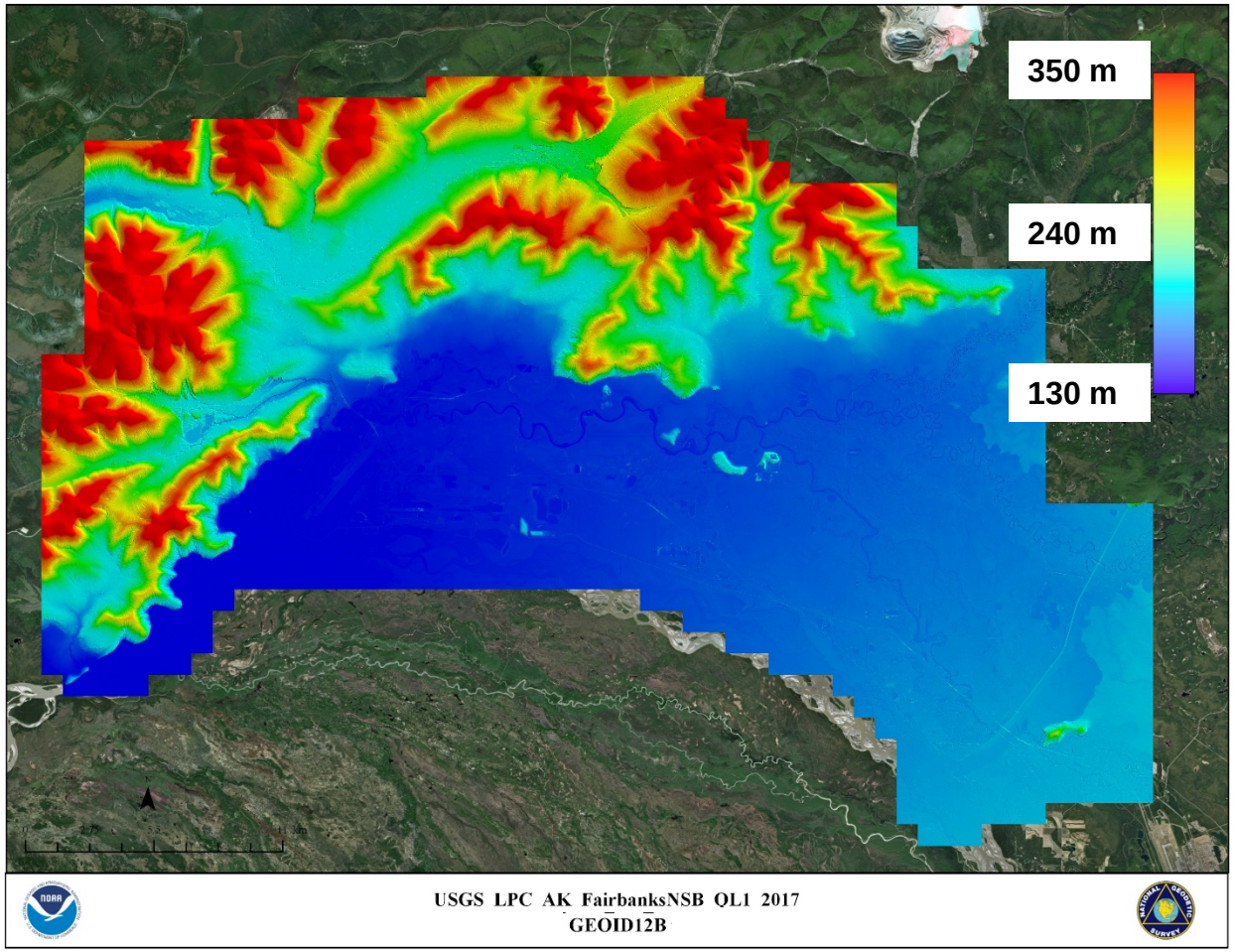
Recap

1. **NGS measures the Earth** from the sky, space and ground
2. **NGS collects imagery** for Emergency Response and Coastal Mapping NGS
3. **NGS defines the NSRS,** helping align geospatial data
4. NGS will **modernize the NSRS in 2022**, replacing *NAVD 88* with *NAPGD2022* and a *new geoid model*
5. **Practical advice:** Case Studies and Learning More!

Lidar Case Study

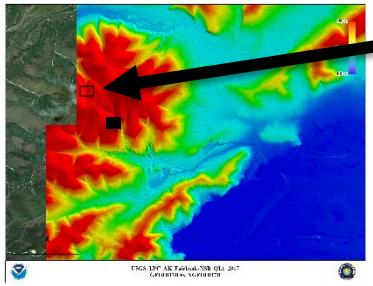
Fairbanks 2017 Lidar

- 2017 3DEP Project
- USGS/Borough/GVEA Partnership
- QL1 and QL2 lidar
- Acquired to support range of applications

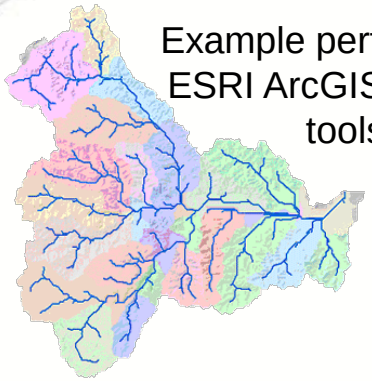


Improvements to Hydrologic Flow Models

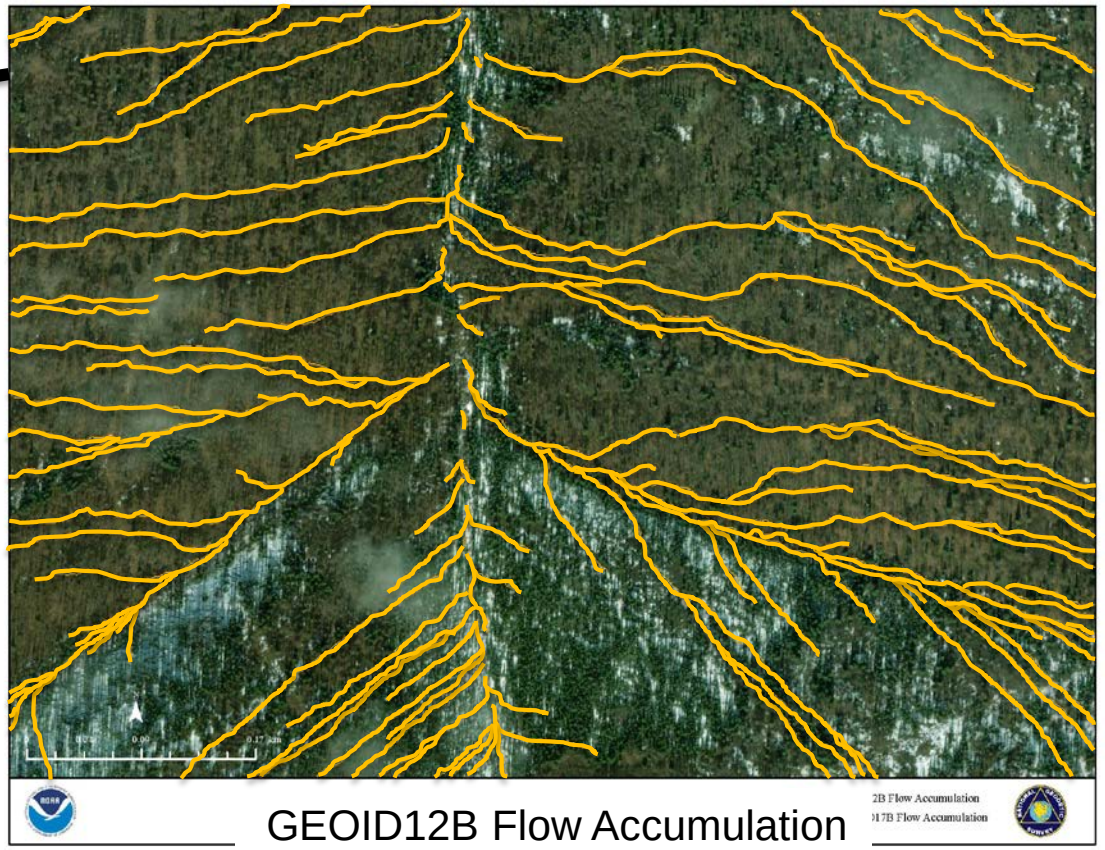
Location Map



GIS Flow Accumulation Analysis



Example performed with ESRI ArcGIS hydrology toolset

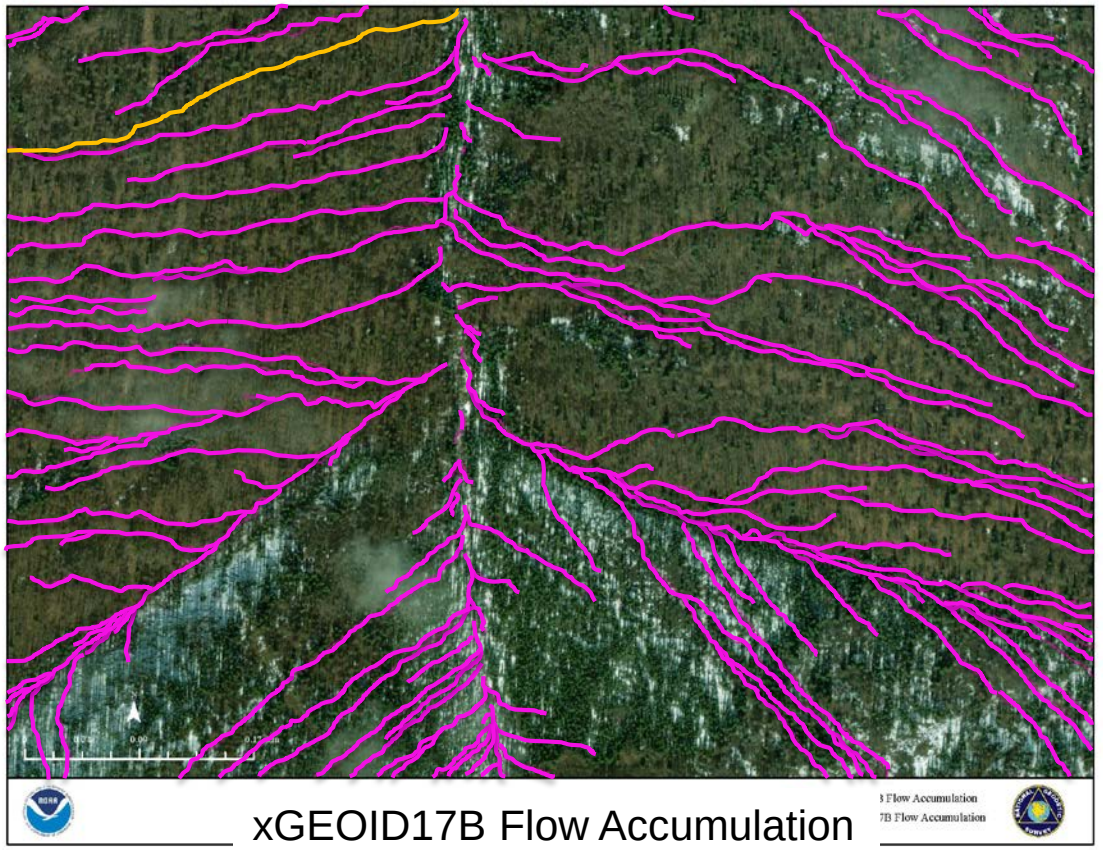


GEOID12B Flow Accumulation

Improvements to Hydrologic Flow Models

Notes
- Same lidar data
- Fully gravimetric geoid model

Impacted products/activities
- DEM blunder control
- Automated stream mapping
- Watershed determination
- Contaminant flow models
- Runoff management plans
- Floodplain mapping



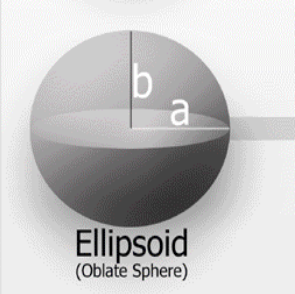
xGEOID17B Flow Accumulation

Remember Your Vertical Datums

Ellipsoidal

Today
NAD 83 (2011)

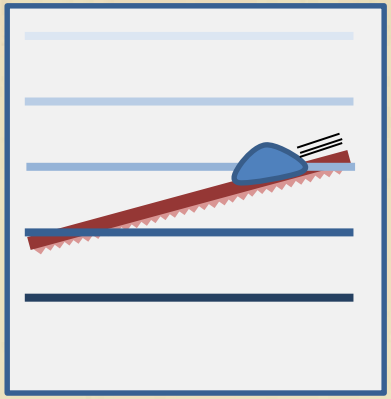
Future
NATRF 2022



Orthometric

Today
NAVD 88

Future
NAPGD 2022

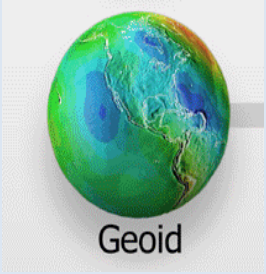


Geoid

NOT A DATUM, but useful surface…

HYBRID
GEOID 12B
Soon geoid18

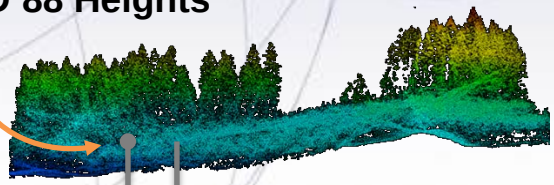
GRAVIMETRIC
GEOID 2022
Test with xGEOID18
etc



Simplified Transformation of Elevation Models

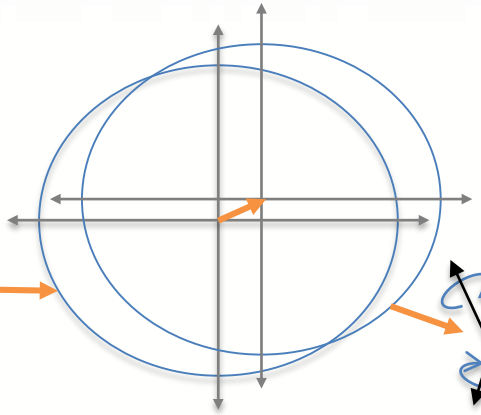
Input

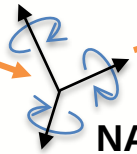
NAVD 88 Heights



GEOID12B

NAD 83 Ellipsoid





NATRF2022

Output

NAPGD2022 Heights

GEOID2022

NATRF2022 Ellipsoid

NCAT transformation grids are shared by VDatum

ONLINE VERTICAL DATUM TRANSFORMATION

INTEGRATING AMERICA'S ELEVATION DATA

Home | About VDatum | Download | Docs & Support | Contact Us

GPS on Bench Marks

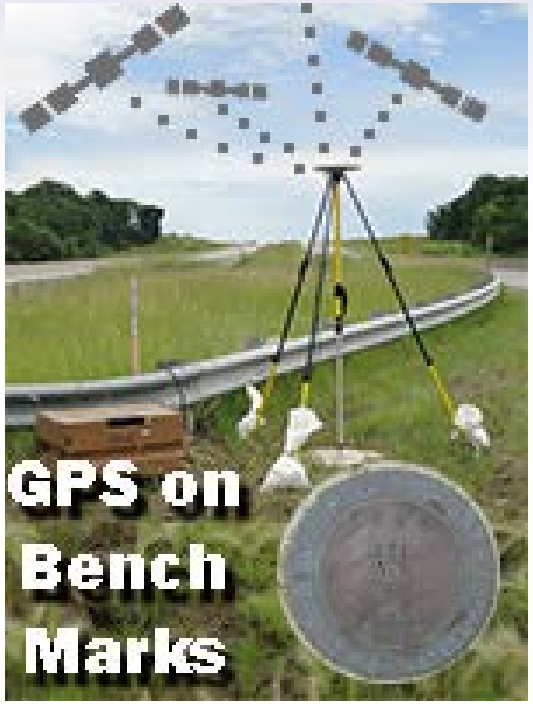
Objectives

- Improve the 2022 Transformation Tool
- Update Passive Control Status
- Automatic Reprocessing in 2022

How to participate?

- Recover
- Observe
- Report

Download Prioritized Marks

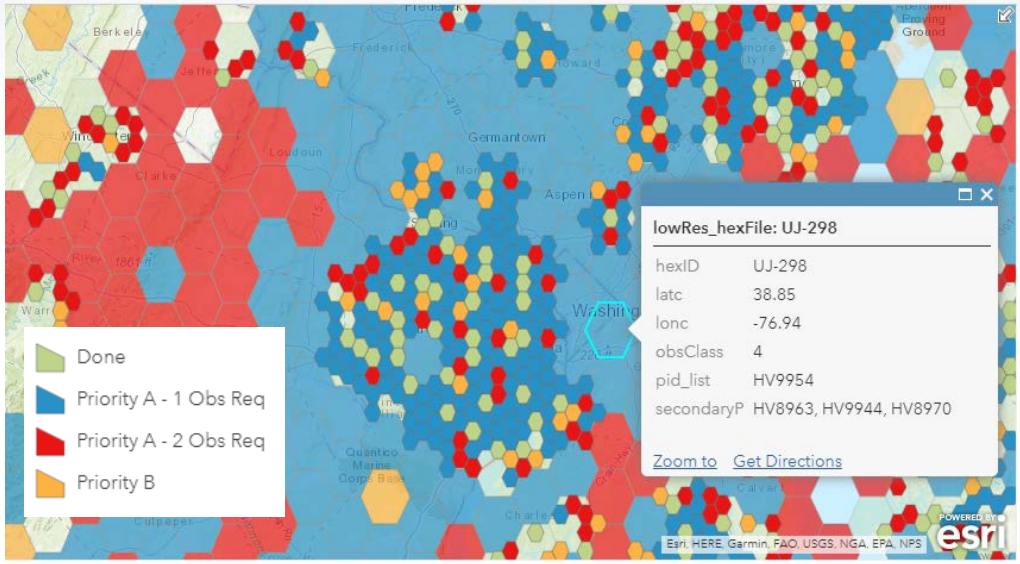


GPS on BM Priority List for Transformation Tools

Priority map shows where:

1) data is needed for minimum coverage

2) densification can take place to "buy up" the quality of the transformation.



Preparing Geospatial Data for NSRS Modernization

- Ensure **metadata** contain all information needed for best possible transformation:
  - reference frame and epoch (e.g. NAD 83 (2011) epoch 2010.0
  - geoid model (e.g. GEOID12B or GEOID18)
  - basis of project control (method and survey dates)

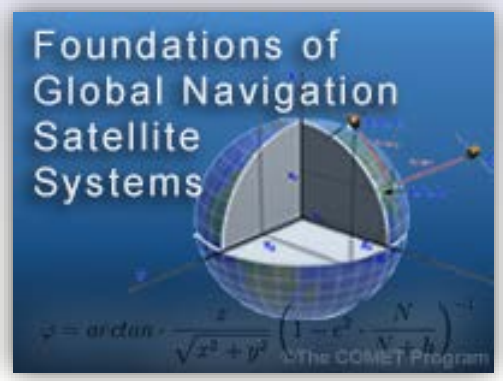
- **Retain original GPS data** whenever possible

- Keep apprised of, and help support, **NGS transformation tool development**
  - BETA testing and feature recommendation
  - GPS on Bench Marks

Thank You! Learn More:

Educational Videos (12)

Online Lessons (4)



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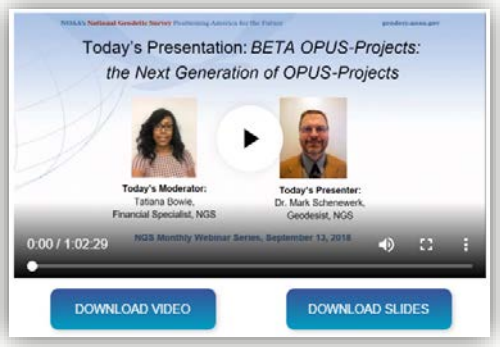

NGS Testing and Training Center

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Extra Slides

NSRS Modernization
Improving Height and Elevation Info.

	Primary Elements Today	2022 Replacements
Horizontal / Ellipsoid	North American Datum of 1983 **NAD 83 (2011)** coordinates	North American Terrestrial Reference Frame of 2022 **NATRF2022** plus the Caribbean, Pacific, and Mariana plates
Vertical	North American Vertical Datum of 1988 **NAVD88** orthometric heights	The North American-Pacific Geopotential Datum of 2022 **NAPGD2022**
Geoid	***HYBRID*** GEOID12B	***GRAVIMETRIC*** GEOID2022