Preparing for National Spatial Reference System Modernization

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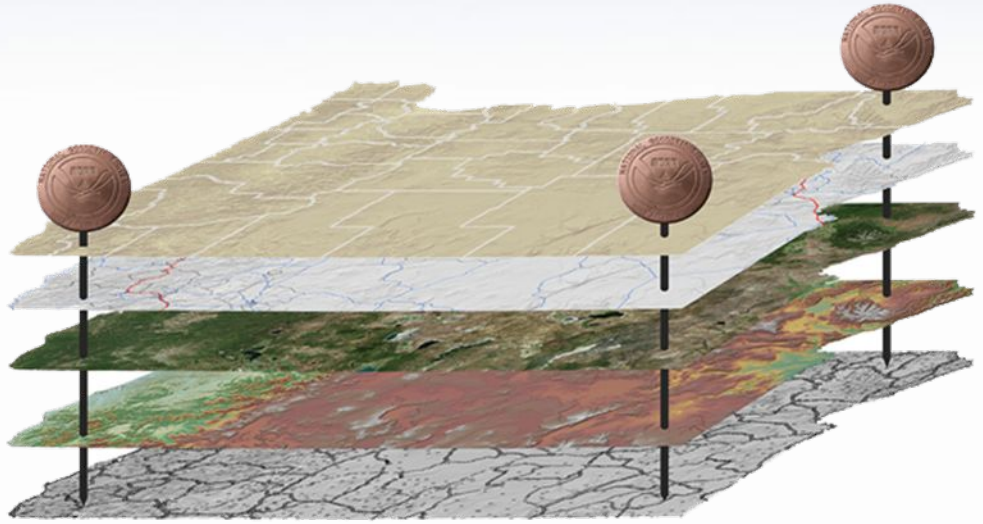
The National Spatial Reference System (NSRS)

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)**



Today's NSRS

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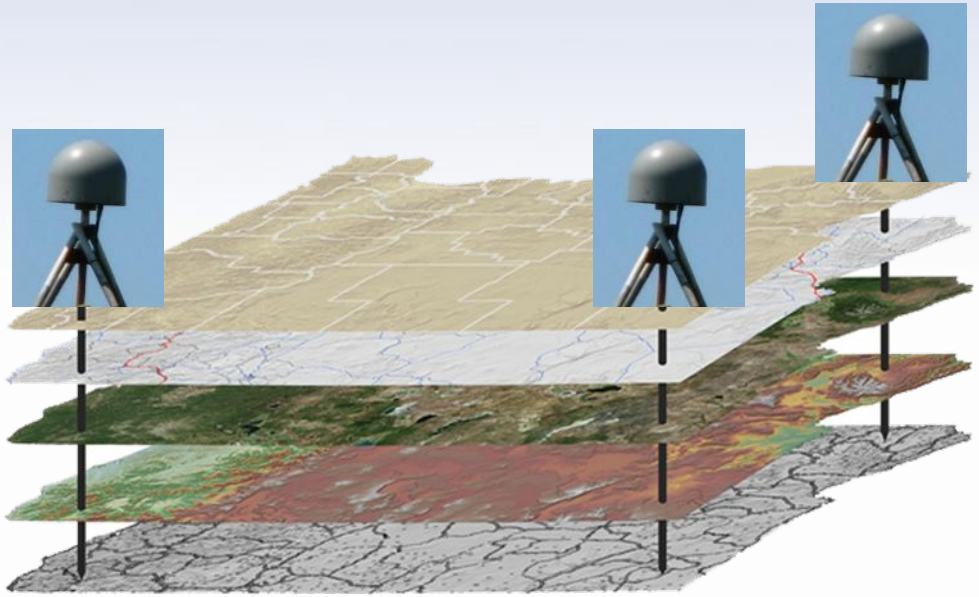
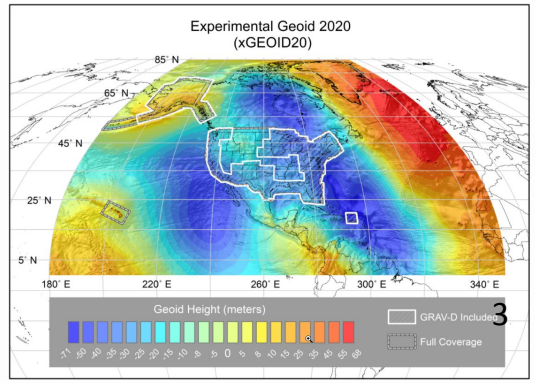


Tomorrow's NSRS

North American Terrestrial Reference Frame (NATREF 2022)
Caribbean Terrestrial Reference Frame (CATREF 2022)
Pacific Terrestrial Reference Frame (PATREF 2022)
Marianas Terrestrial Reference Frame (MATREF 2022)
North America and Pacific Geopotential Datum (NAPGD 2022)



What life will be like in the future

Fast, Accurate, Consistent Elevations Everywhere

Revolutionize professional surveying

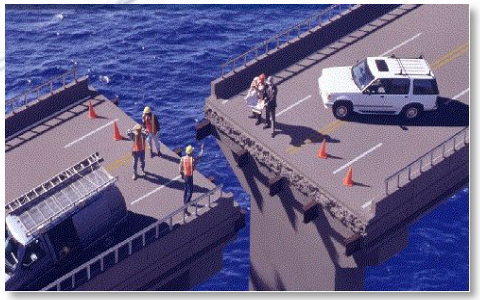
No more need for installing and locating bench marks

Absolute, consistent positioning autonomously, anywhere

Vastly improved flood plain mapping

Water flows due to differences in gravity

Critically important in low-lying, flat communities



Impacts on infrastructure

Any application requiring precise positioning -- bridges, tunnels, railways, agriculture, navigation -- will be easier and more accurate

Fundamental support for new technologies

Smart Highways for autonomous vehicles in Smart Cities

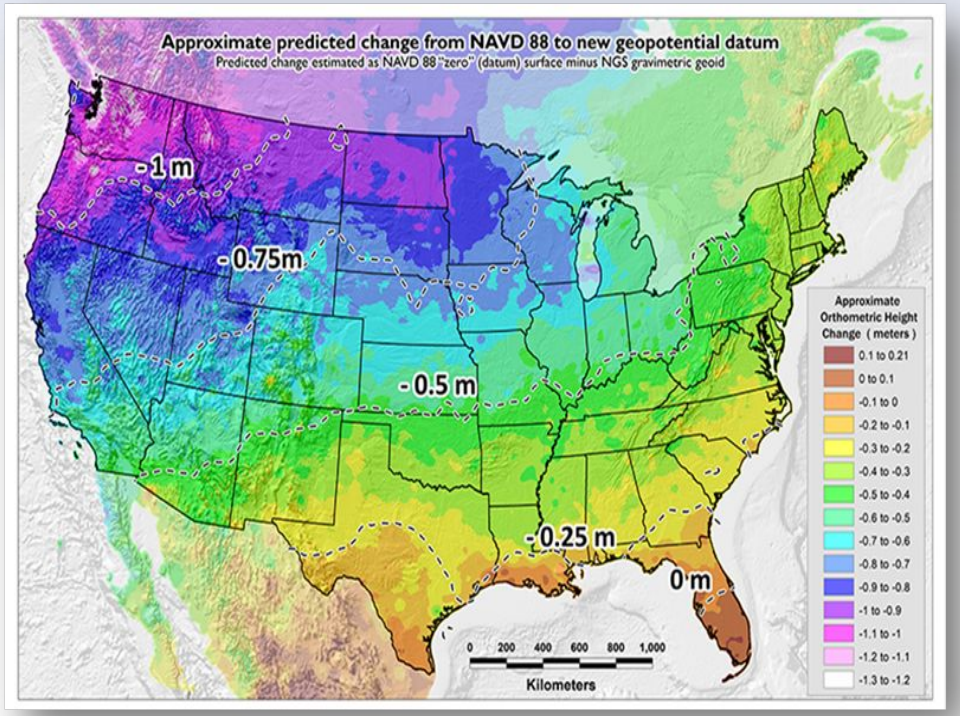
Practical Impacts

- Every **latitude, longitude and ellipsoid height** will change from its NAD 83 values in the +/- 2 meter range
- Every **orthometric height** will change from its NAVD 88 (et al.) values in the +/-2 meters *median* range, with an unknown limit on change due to (as yet) unquantified subsidence impacts
- Published coordinate functions at active control stations will be the primary geodetic control of the NSRS
- Greater integration of NGS tools will improve consistency and reduce confusion

Benefits of Modernizing the NSRS

Why Modernize?

- Current Datums were defined *before* GPS technology, so not geo-centric (~2.2m)
- They rely on old tech & physical survey marks in the ground
- Today's technology requires better accuracy



Modernization will:

- Improve **accuracy, access, and alignment** of our positioning systems
- Provide ~$8.7 B in benefits to the nation over 10 years, more for early adopters
- Enable better alignment of NOAA and other data to support emerging needs to address sea level rise, floodplain mapping, and geohazards

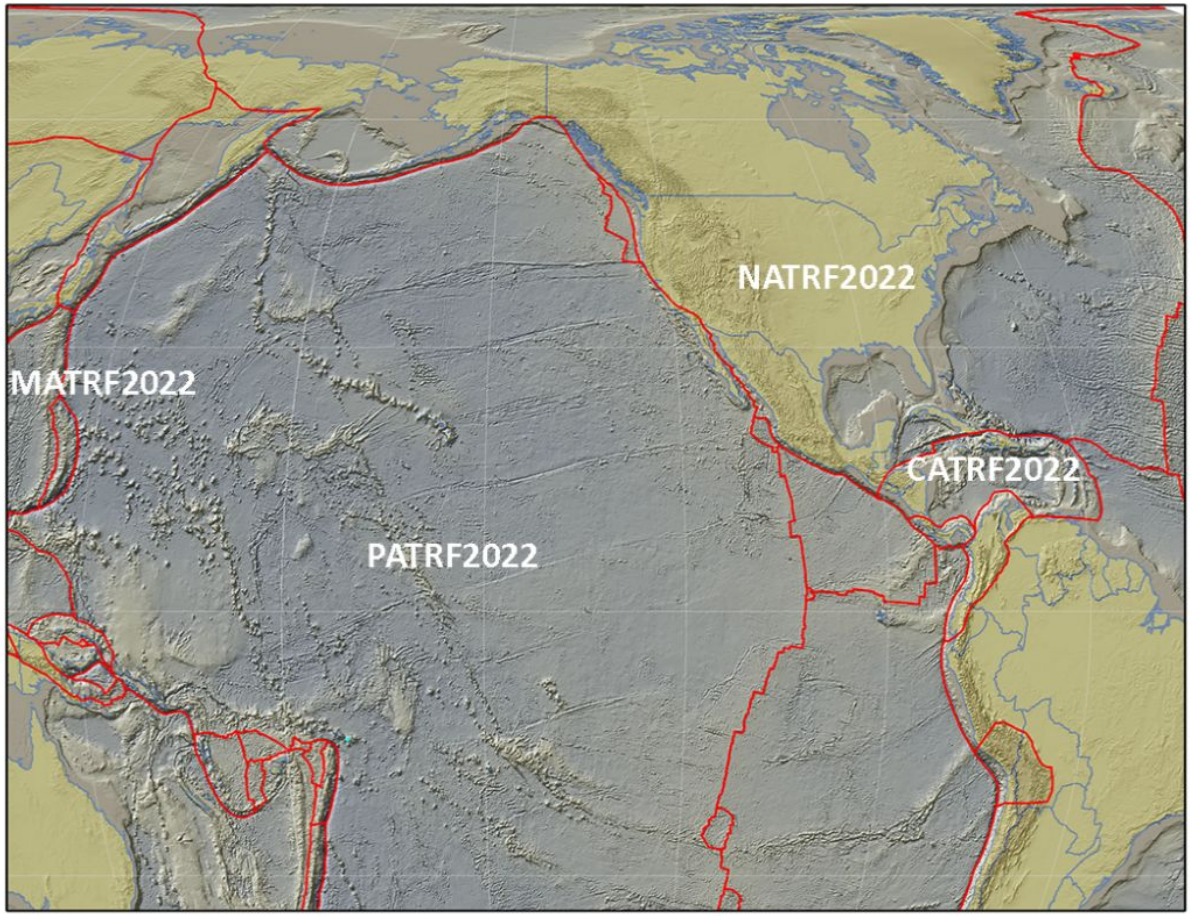
The Future Reference Frames

Will be based on a densified ITRF model (e.g. SIRGAS)

Tectonic Plate based

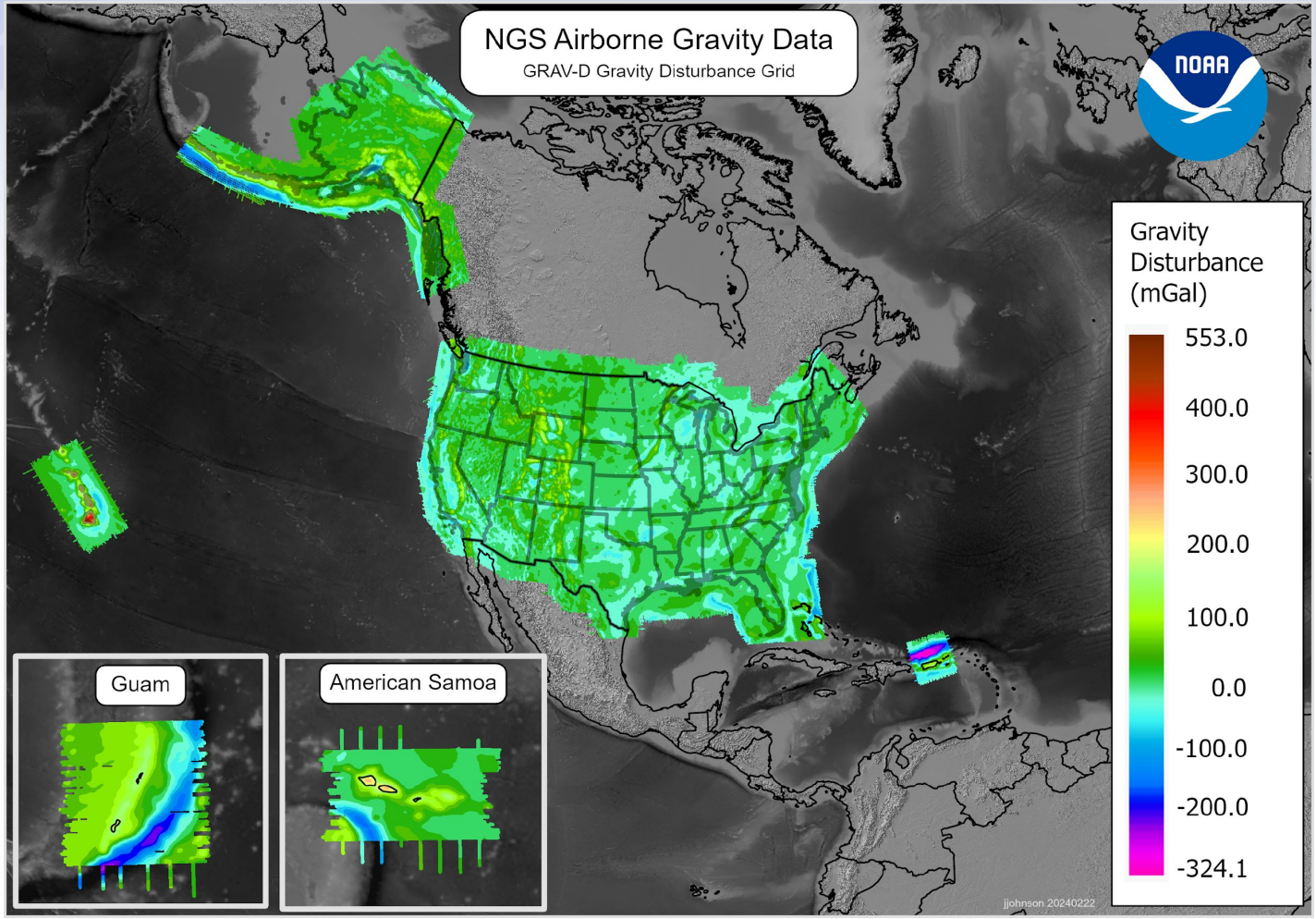
Each Plate is based on the same densified ITRF model

North America	NATRF
Caribbean	CATRF
Pacific	PATRF
Mariana	MATRF



GRAV-D is 100% complete!

- **Our longest project – started in 2007!**
- 15.7 million sq km
- 4,759 flight lines
- 2.3 million linear km flown
  - Nearly 3 times to the moon and back!!
- Final data set was sent to the geoid team in February

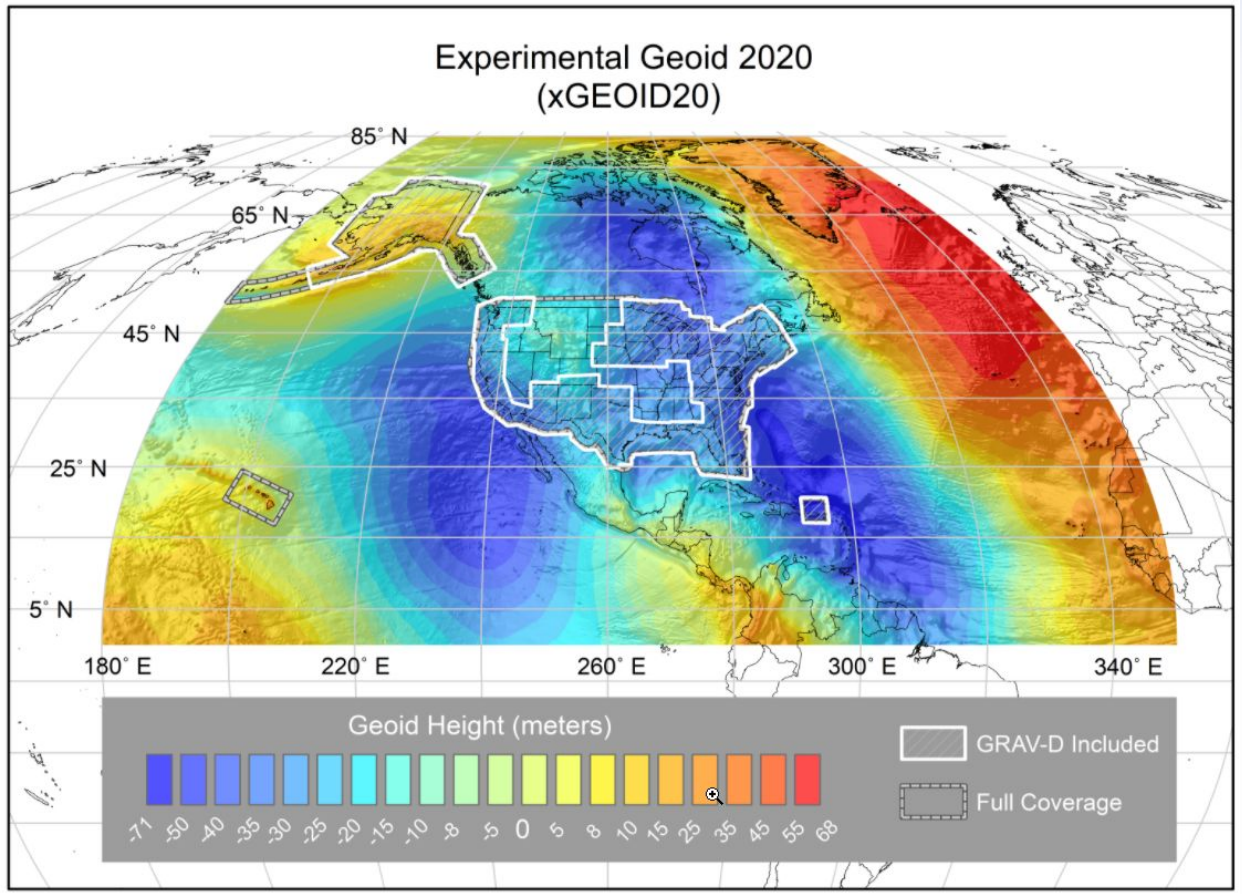


Gravity for the **R**edifinition of the **A**merican **V**ertical **D**atum

NAPGD2022 Geopotential Datum

North American-Pacific Geopotential Datum of 2022

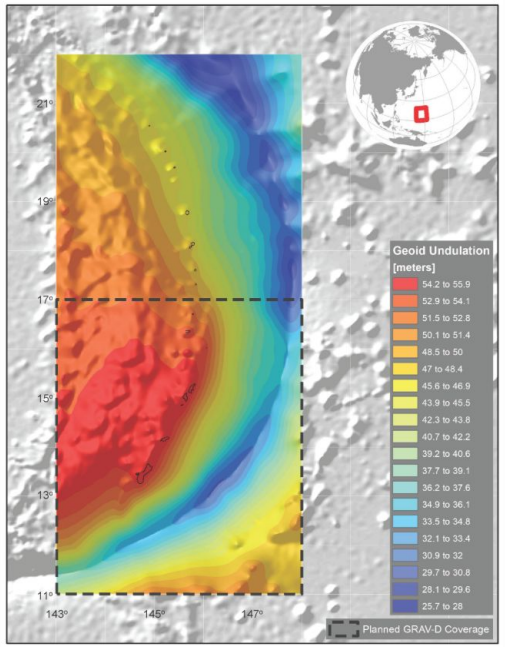
Not a vertical datum, it is more than just heights.



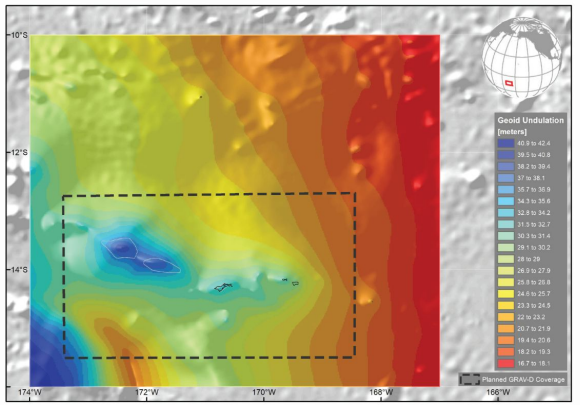
¼ Earth's Surface

Models include:

- Geopotential
- Deflection
- Gravity
- Geoid



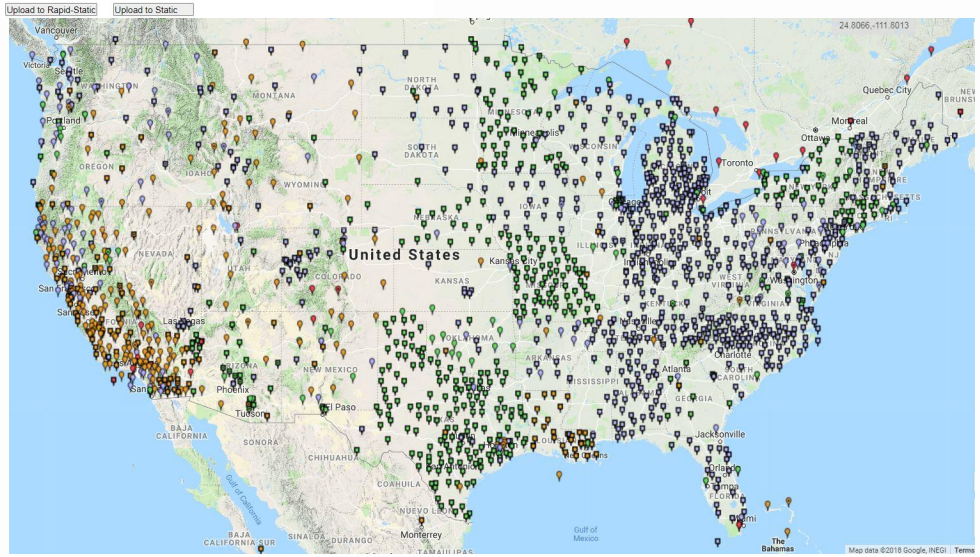
Guam/CNMI



American Samoa

Modernized Access: Through the CORS and OPUS

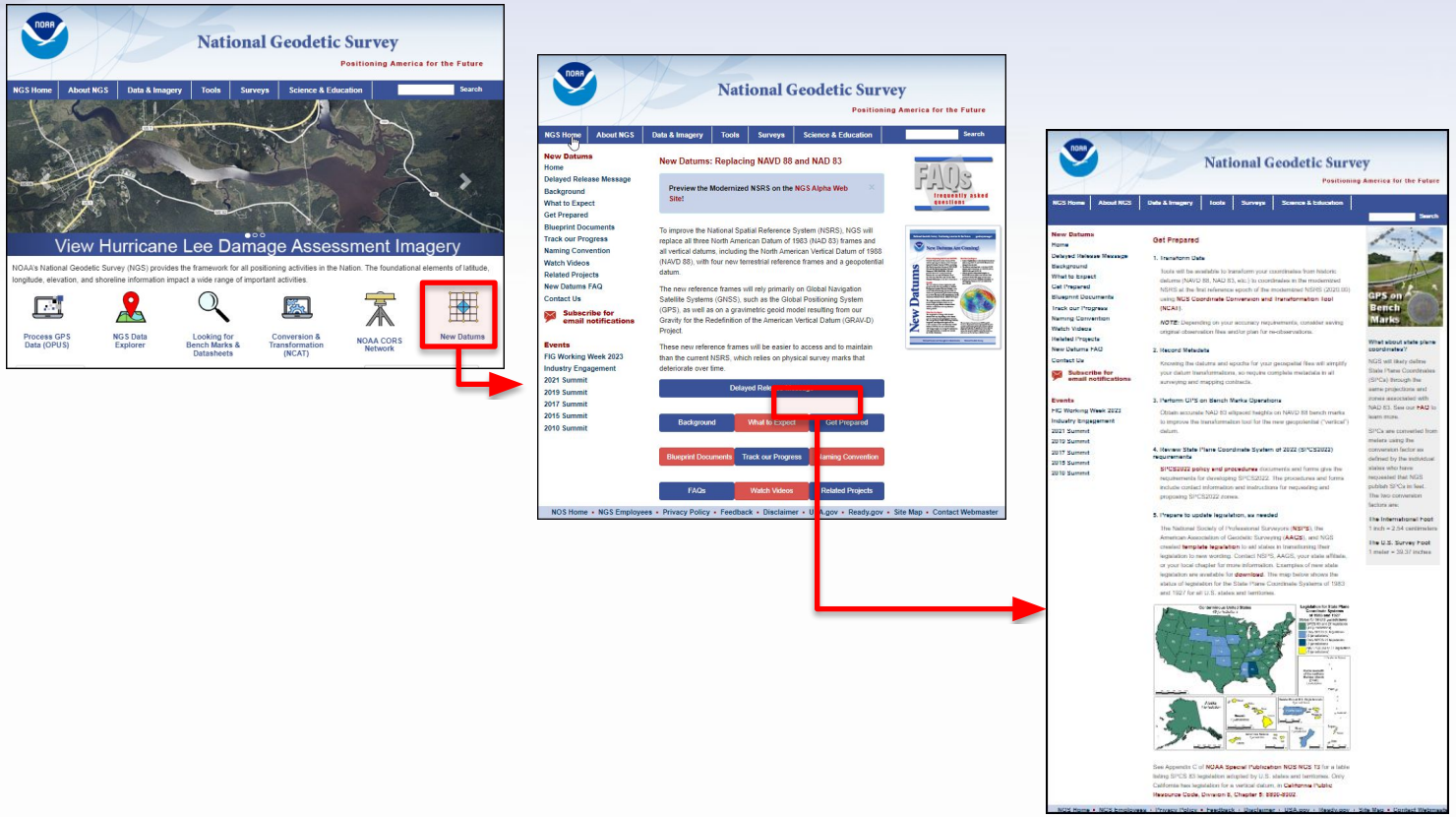
NGS provides data and one definitive coordinate functions for each station in the NOAA CORS Network (NCN)



NGS provides software (M-PAGES / OPUS / OPUS Projects) to differentially position your GPS receiver to each station

Preparation Steps You Can Take

- Everyone's situation is different, so no set of steps is universal.
- NGS has listed 5 such steps on its New Datums page.



Preparation Steps You Can Take

Metadata is essential for efficient file management and transformational certainty.

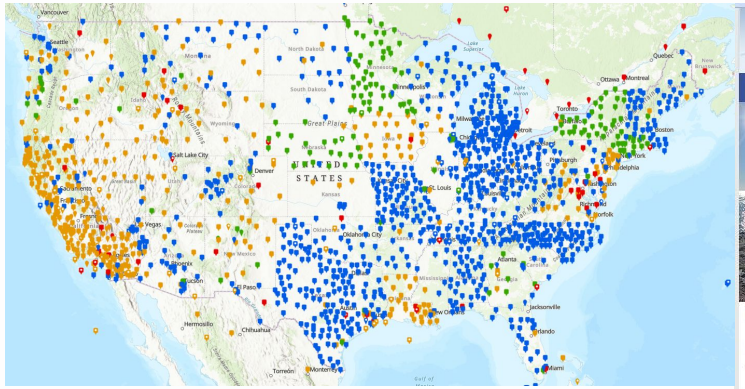
- Metadata - **Require complete metadata** in all surveying and mapping field activities and contracts.
  - **Preserve all original observations**. For GNSS, save your data in ellipsoid heights
  - **Inventory your existing geospatial data and metadata** to enable prioritizing their transformations based on their accuracy requirements
    - Knowing the datums and epochs for your geospatial files will simplify their datum transformations – What version of NAD83?
    - How was data collected and processed? What method used for deriving orthometric heights (NAVD88)? What geoid model was used?
    - Method for deriving water levels and computed tidal datums

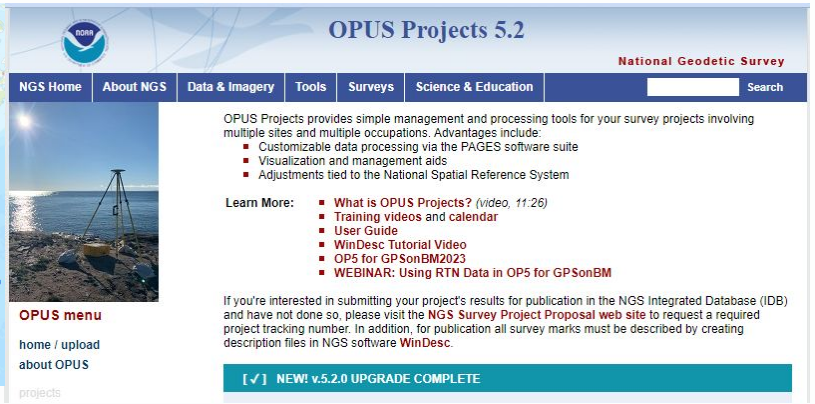
3 Ways to Get into the Modernized NSRS

- **Re-survey**
  - Return to the field, and survey points of interest, relying on the modernized NSRS control
    - Definitely can yield new "geodetic control" (for a while) for you to use
- **Re-adjust**
  - Using pre-existing observations, load them up to OPUS, and re-adjust them to modernized NSRS control
    - Probably yields new "geodetic control" (for a while) for you to use
- **Transform**
  - Using tools like NCAT and VDatum (NGS models) estimate mass-changes to your datasets.
    - Does not yield new "geodetic control"

Re-survey or Re-adjust via CORS & OPUS

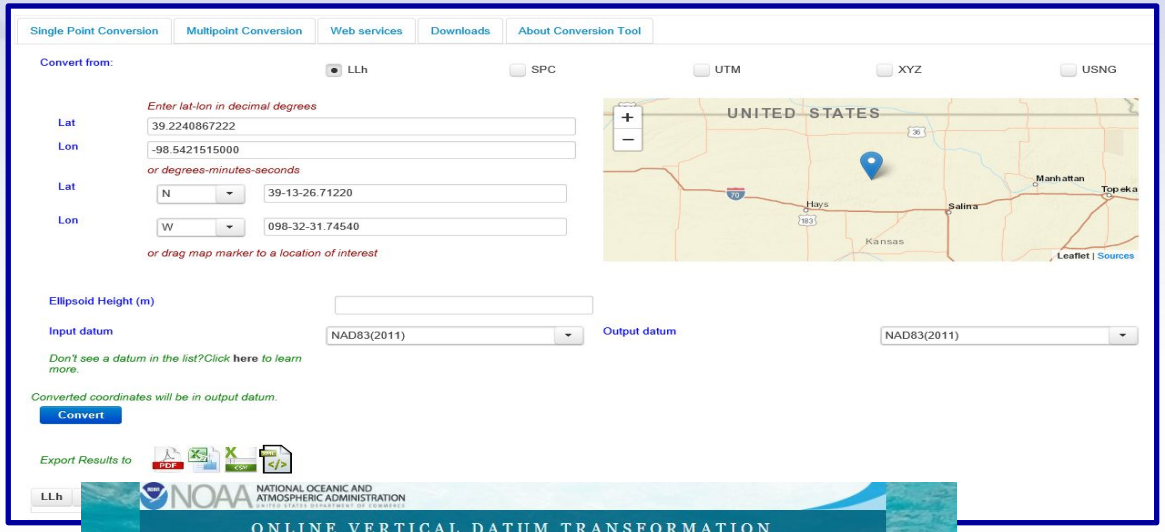
- The NOAA CORS Network will be improved
- OPUS-S and OPUS-Projects 5.x will be available for GNSS only
  - OPUS 6 (the do-it-all suite) will not be ready until after 2025
- Multiple constellations (M-PAGES)
- Coordinates in ITRF2020, N/M/P/CATRF2022, NAPGD2022, SPCS2022

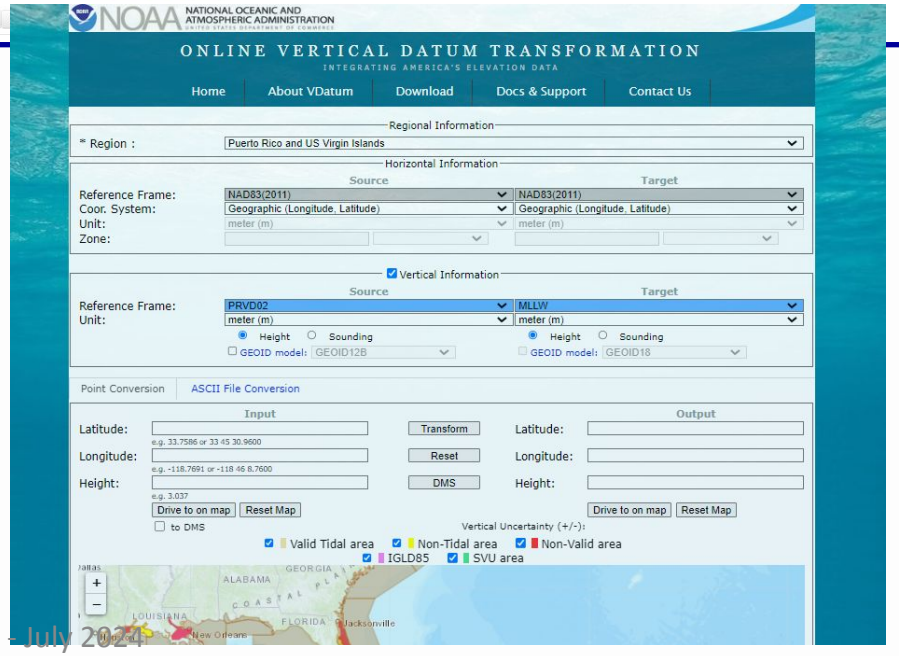




Transform via NCAT & VDatum

- Using all GNSS and leveling data ever provided to NGS, we will create updates to NADCON and VERTCON, the engines in OPUS and VDatum
- Will get your data to the 2020.00 epoch in the new frames / new geopotential datum
- GPSonBM door to improve transformations closes soon





NGS Monthly Webinar Series

Join us as we highlight geodesy and coastal mapping programs, products, and research.

Each webinar features an NGS employee delving into a topic of interest, and generally includes a moderated question and answer session. These webinars are geared toward geospatial professionals as well as educators/students of geodesy and remote sensing.

Registration is free, webinars are streamed via GoToWebinar, and video recordings are made available for later viewing.

https://geodesy.noaa.gov/web/science_edu/webinar_series/index.shtml

NGS Resources – Educational Videos

Video Library

NGS, in partnership with **The COMET Program**, has developed short videos about topics related to geodesy and mapping. View or download our featured video or previous videos. Please visit the **COMET YouTube Channel** to view the **entire playlist**.


What are Geodetic Datums?


How Were Geodetic Datums Established?

What Is the Status of Today's Geodetic Datums?


Geospatial Infrastructure for Coastal Communities: Informing Adaptation to Sea Level Rise


Best Practices for Minimizing Errors during GNSS Data Collection


The Importance of Accurate Coastal Elevation and Shoreline Data

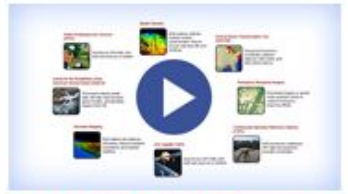

What's Next for Geodetic Datums?


Precision and Accuracy in Geodetic Surveying


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


NOAA's VDatum Tool: Transforming Heights Between Vertical Datums


Geodetic Control in Land Surveying: Active vs. Passive


Location Science Improves Everyday Life

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

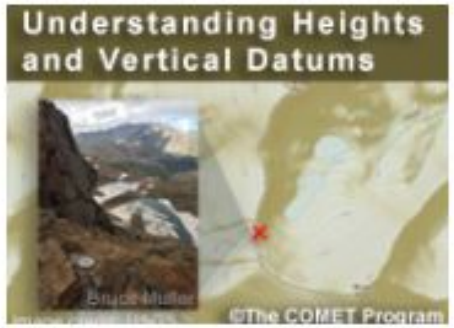
NGS Resources – Online Lessons

Online Lessons

NGS, in partnership with **The COMET Program**, has developed a series of self-paced lessons on geodetic and remote sensing topics. **Create a free user account** to gain access to the courses below and **many others that may be of interest**. You will have the option of printing out a certificate upon successful completion of the quiz at the end of each lesson.

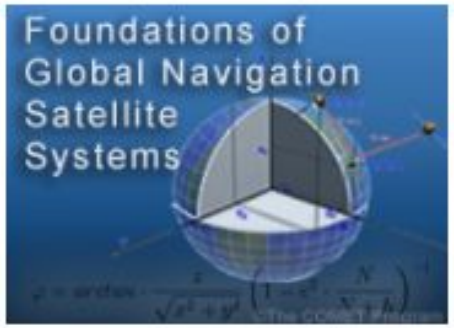
These lessons are rated by skill level:

- **0** = Suitable for non-scientists
- **1** = Requires basic scientific literacy
- **2** = Requires some prior knowledge of the topic

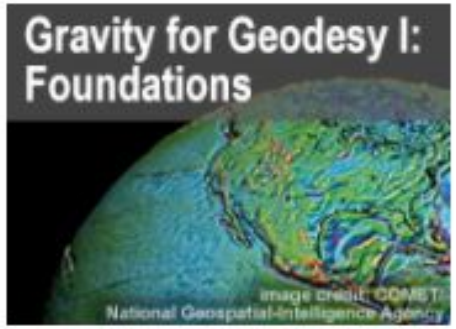


Understanding Heights and Vertical Datums
Skill Level: 0

GNSS Positioning: Survey Planning and Data Acquisition
Skill Level: 1



Foundations of Global Navigation Satellite Systems
Skill Level: 2

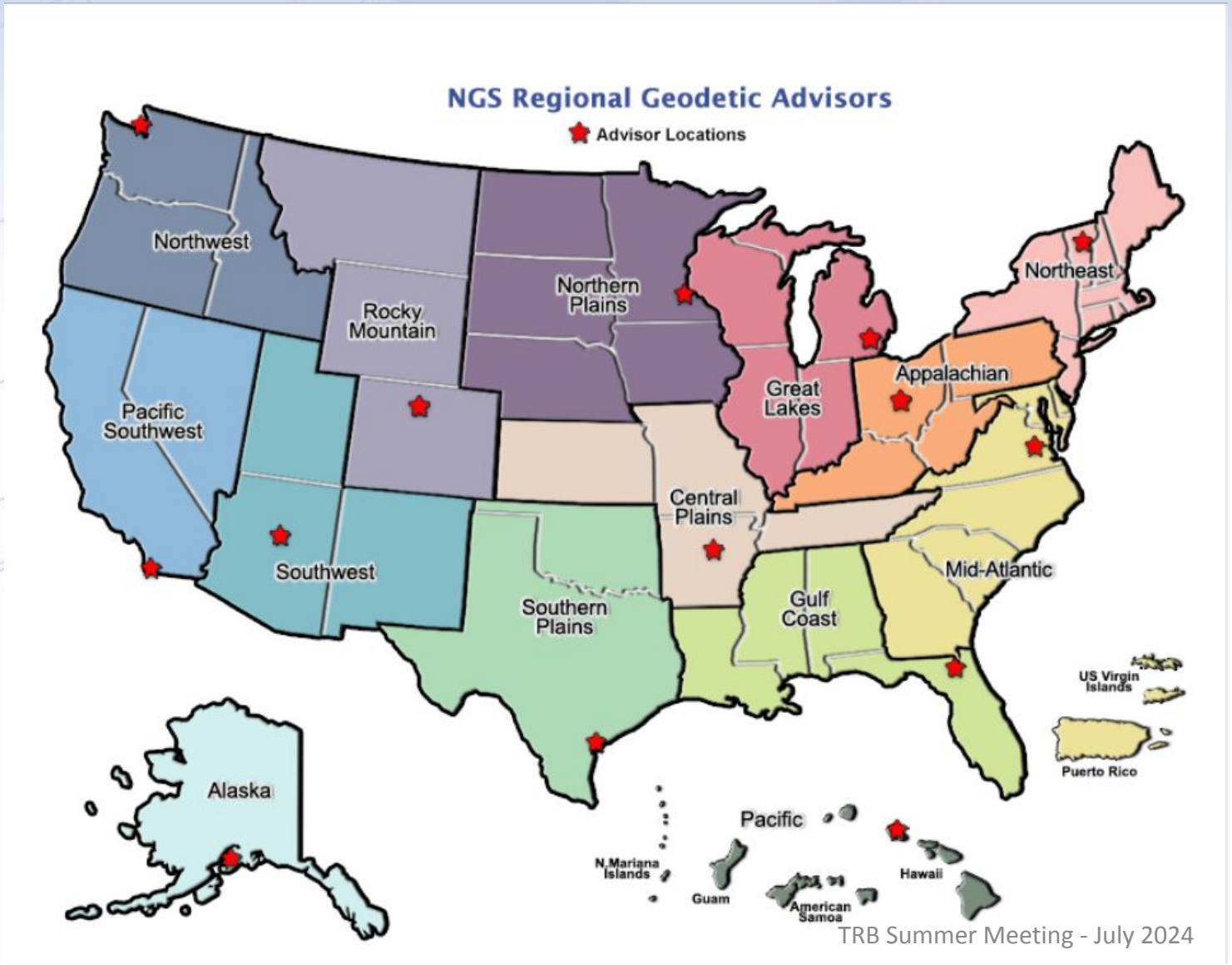


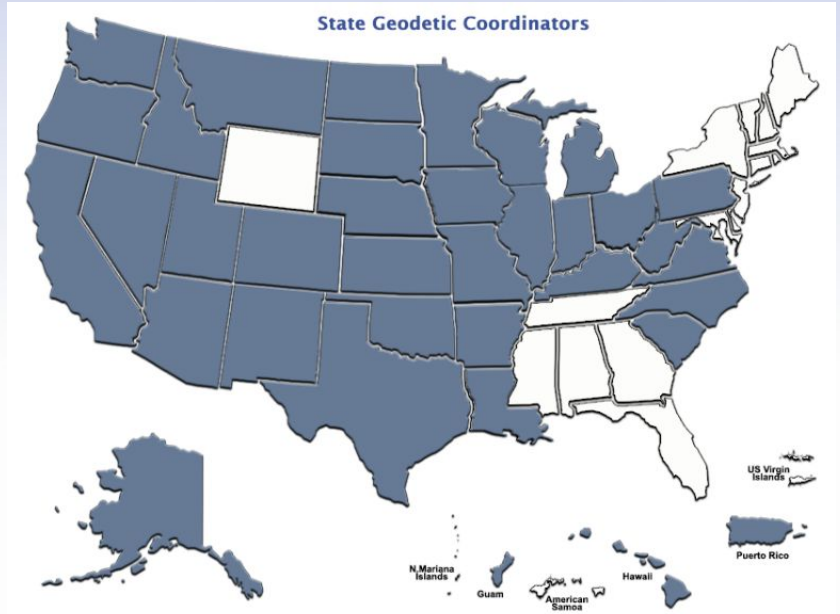
Gravity for Geodesy I: Foundations
Skill Level: 2

Gravity for Geodesy II: Applications
Skill Level: 2

https://geodesy.noaa.gov/web/science_edu/online_lessons/index.shtml

Regional Geodetic Advisors & State Coordinators



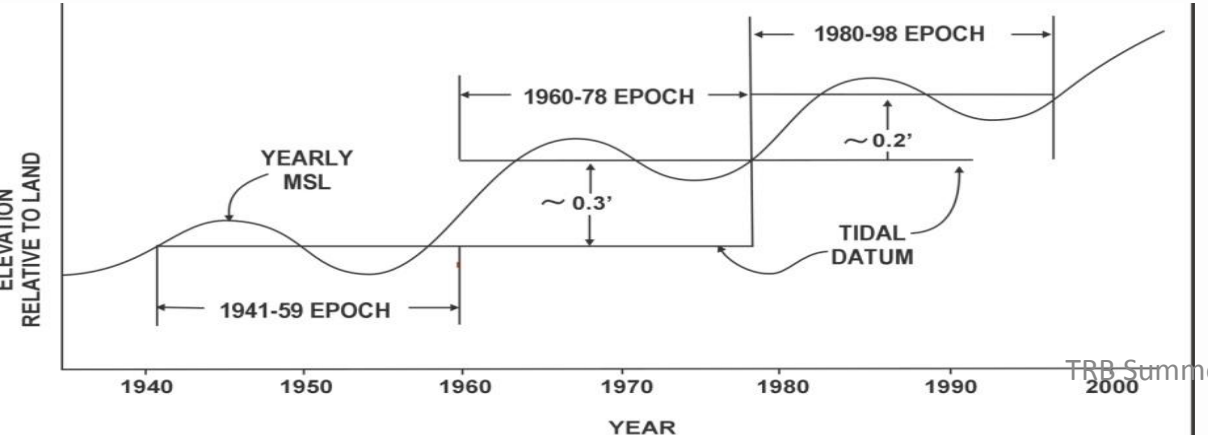


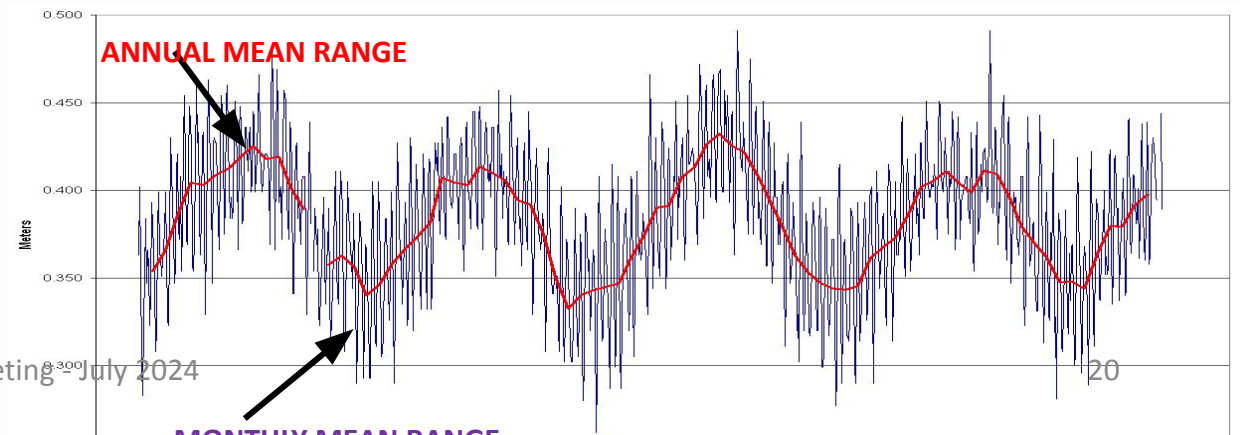
39 State Geodetic Coordinators

National Tidal Datum Epoch

Official time period of tidal observations that are used for primary datum calculations

- Time it takes the Earth, Moon, & Sun to complete an epoch tidal cycle
- 19 year time period (Present NTDE is 1983-2001)
- Considered for revision every ~20-25yrs
- Includes the longest period tidal variations *(18.6 year node cycle)*
- Averages out seasonal fluctuations
- Provides a nationally consistent tidal datum network by accounting for seasonal and apparent environmental trends in sea level that affect the accuracy of tidal datums





Looking Ahead

NGS is planning a workshop for the January 2025 TRB meeting.

How can we best use that time together?

- What format would be best?
- What topics should we cover?

Contact us: Galen.Scott@noaa.gov

Send us feedback: NGS.Feedback@noaa.gov