# National Spatial Reference System "Positioning Changes for 2022"

## Civil GPS Service Interface Committee Meeting

## Miami, Florida

### September 24, 2018

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

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

## National Spatial Reference System

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

***& their variations in time***

# U. S. Geometric Datums in 2022

# National Spatial Reference System (NSRS) Improvements in the Horizontal Datums

| NETWORK | TIME SPAN | NETWORK ACCURACY | METHOD OF REFERENCE |
|---|---|---|---|
| NAD 27 | 1927-1986 | 10 meter | TRAVERSE & TRIANGULATION - GROUND MARKS USED FOR REFERENCING THE NSRS. |
| NAD83(86) | 1986-1990 | 1 meter | |
| NAD83(199x)* HARN | 1990-2007 | 0.1 meter | GPS BECOMES THE MEANS OF POSITIONING – STILL GRND MARKS. |
| NAD83(2007) (CORS) | 2007 - 2011 | 0.01 meter | GPS – CORS STATIONS ARE MEANS OF REFERENCE FOR THE NSRS. |
| NAD83(2011) (CORS) | 2011 - 2022 | 0.01 meter | |

# NSRS Reference Basis

**Old Method - Ground Marks (Terrestrial)**

**Current Method - GNSS Stations (CORS)**

# Why Replace NAD83?

- **Datum based on best known information about the earth's size and shape from the early 1980's (45 years old), and the terrestrial survey data of the time.**

- **NAD83 is NON-geocentric & hence inconsistent w/GNSS .**

- **Necessary for agreement with future ubiquitous positioning of GNSS capability.**

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

# NOAA Technical Report NOS NGS 62

## Blueprint for 2022, Part 1: Geometric Coordinates

**Dru Smith**
**Dan Roman**
**Steve Hilla**

April 21, 2017

National Oceanic and Atmospheric Administration • National Geodetic Survey

# Future Geometric (3-D) Reference Frame

## Blueprint for 2022: Part 1 – Geometric Datum

- **Replace NAD83 with new geometric reference frame – by 2022.**
- **CORS-based, accessed via GNSS observations.**
- **Coordinates & velocities in ITRF (IGS) & new US reference frame.**
- **Passive control tied to new reference frame (not a component).**
- **Transformation tools will relate NAD83 to new US reference frame (NCAT with 2022 transformation).**

# Datum Names

The Old:

NAD 83(2011)

NAD 83(PA11)

NAD 83(MA11)

The New:

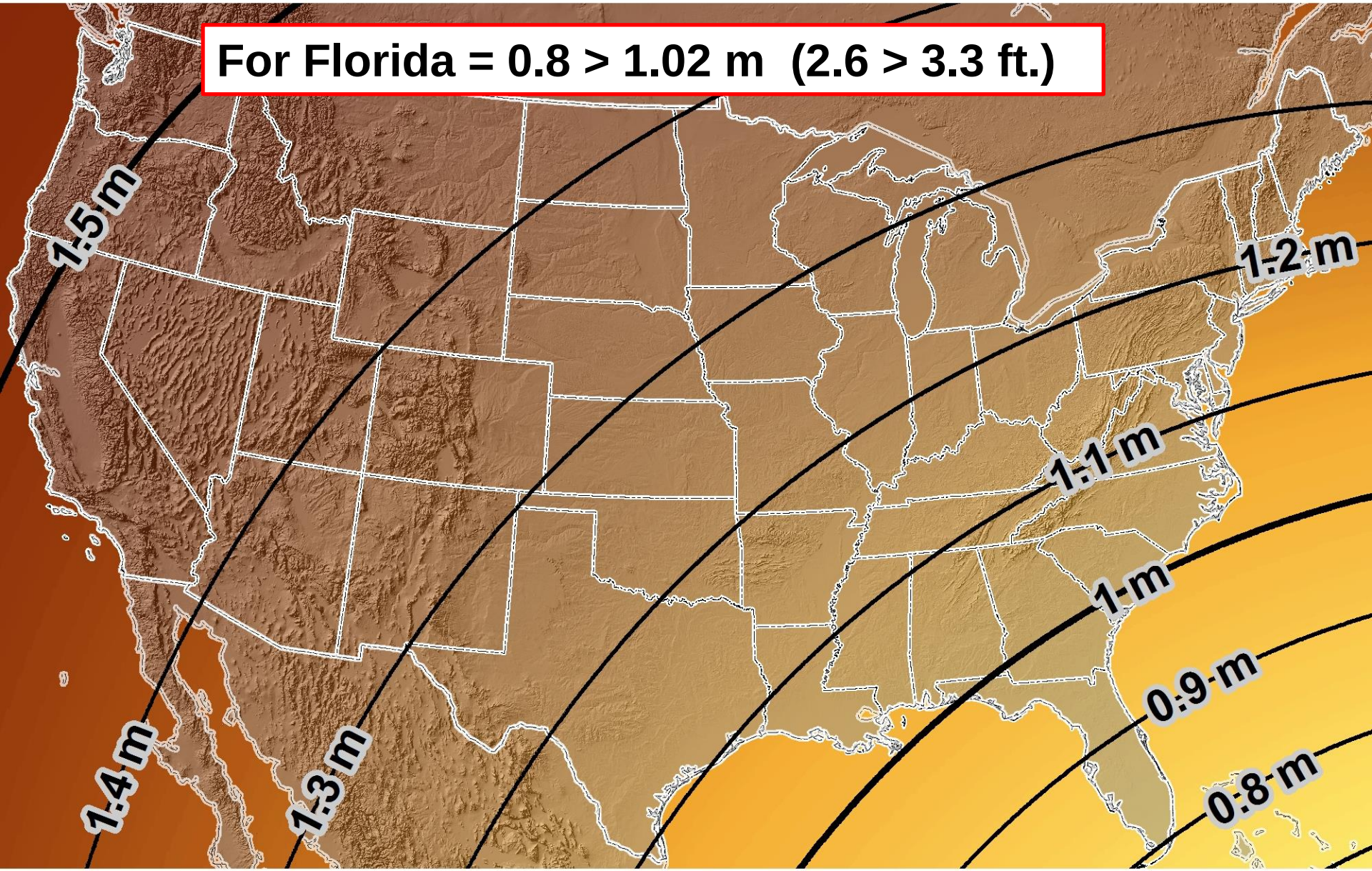
The North American Terrestrial Reference Frame of 2022 (NATRF2022)

The Caribbean Terrestrial Reference Frame of 2022 (CATRF2022)

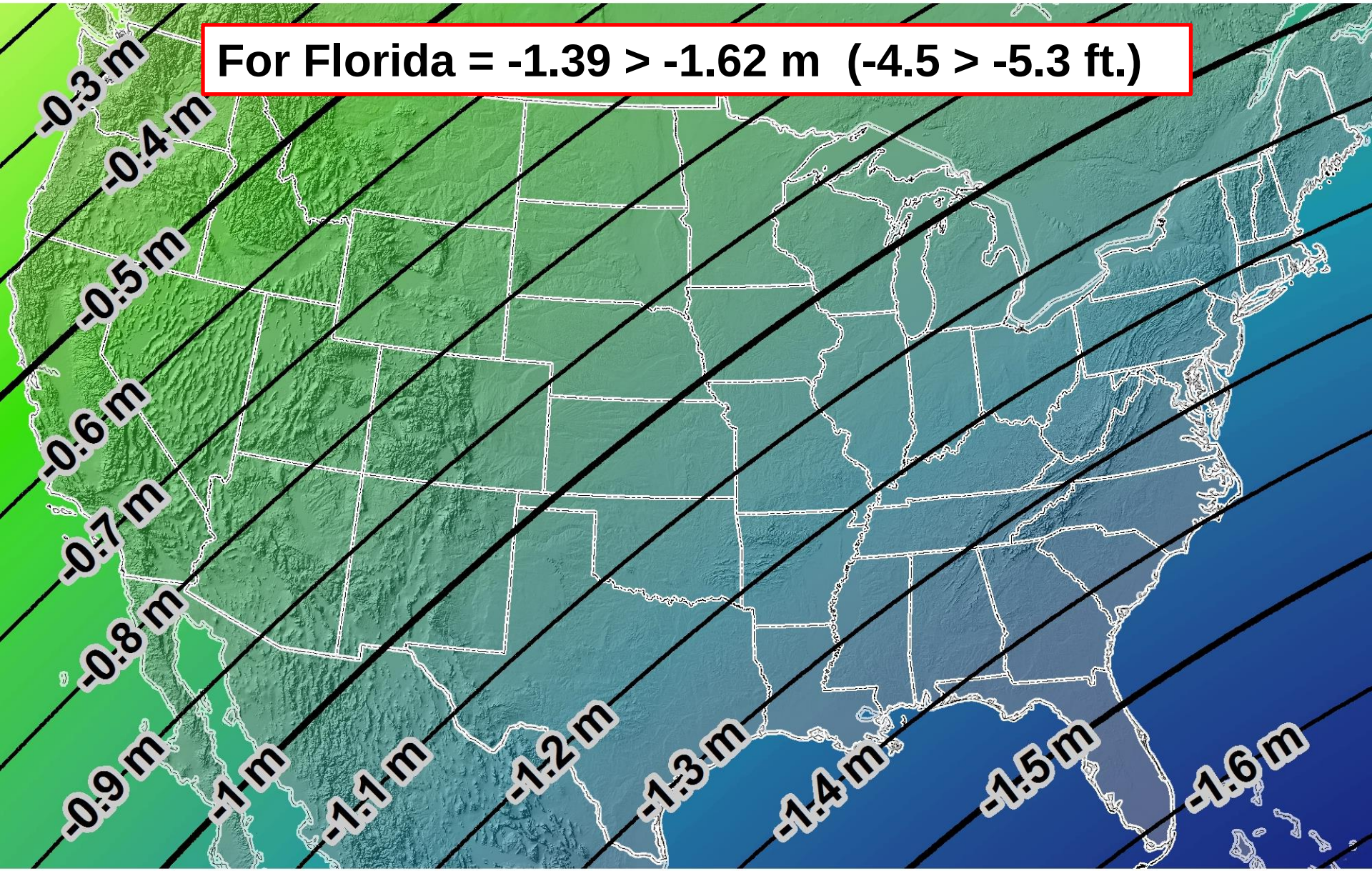
The Pacific Terrestrial Reference Frame of 2022 (PATRF2022)

The Mariana Terrestrial Reference Frame of 2022 (MATRF2022)

# Estimated horizontal change from NAD 83 to new geometric datum



# Estimated ellipsoid height change from NAD 83 to new geometric datum

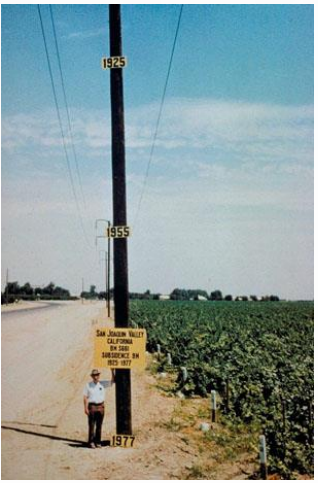


# U.S. Vertical Datum in 2022

# Why isn't NAVD 88 good enough anymore?

* **NAVD 88 is a terrestrial based vertical datum that changes as the land changes.**

- **NAVD 88 suffers from <u>use of bench marks</u> that:**
  - –Are almost never re-checked for movement
  - –Disappear by the thousands every year
  - –Are not funded for replacement
  - –Are not necessarily in convenient places
  - –Don't exist in most of Alaska
  - –Were determined by leveling from a single point, allowing cross-country error build up




# NEW VERTICAL DATUM (Rationale)

- A move away from differentially leveled passive control as the defining mechanism of the reference surface
- To be consistent with the shift in the geometric reference frame/ellipsoid (2022)
- Improvement in our technical abilities in reference surface realization (geopotential gravimetric reference surface - 1cm accuracy of the geoid *(GNSS/GRAV-D)*)
- Goal - ability to establish 2cm orthometric height anywhere in U.S. using a minimum of 15 min. of GNSS data.
- The new geopotential reference surface will be aligned with the geometric reference frame/ellipsoid (i.e., no hybrid geoid)

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# NOAA Technical Report NOS NGS 64

## Blueprint for 2022, Part 2: Geopotential Coordinates

November 13, 2017

National Oceanic and Atmospheric Administration • National Geodetic Survey

# Scientific Decisions

- Blueprint for 2022, Part 2: Geopotential
  - ✓Global 3-D Geopotential Model (GGM)
    - ✓Will contain all GRAV-D data
    - ✓Able to yield any physical value on/above surface
  - ✓Special high-resolution geoid, DoV and surface gravity products consistent with GGM
    - ✓Not global: NA/Pacific, American Samoa, Guam/CNMI
  - ✓Time-Dependencies
    - ✓Geoid monitoring service
      - ✓Impacts of deglaciation, sea level rise, earthquakes, etc

# Names

## The Old:

Orthometric Heights
- NAVD 88

Normal Orthometric Heights
- PRVD 02
- VIVD09
- ASVD02
- NMVD03
- GUVD04

Dynamic Heights
- IGLD 85

Gravity
- IGSN71

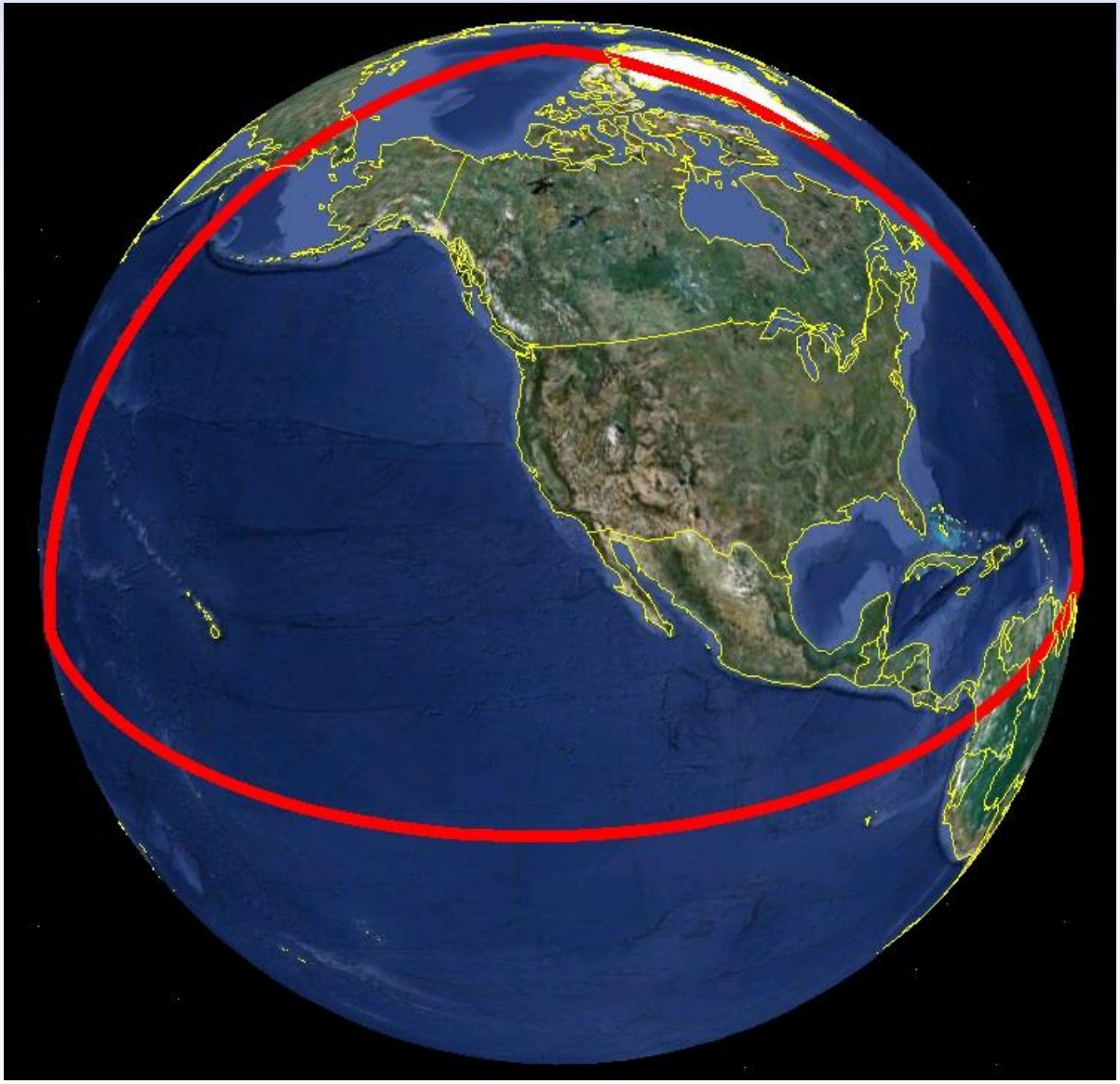
Geoid Undulations
- GEOID12B

Deflections of the Vertical
- DEFLEC12B

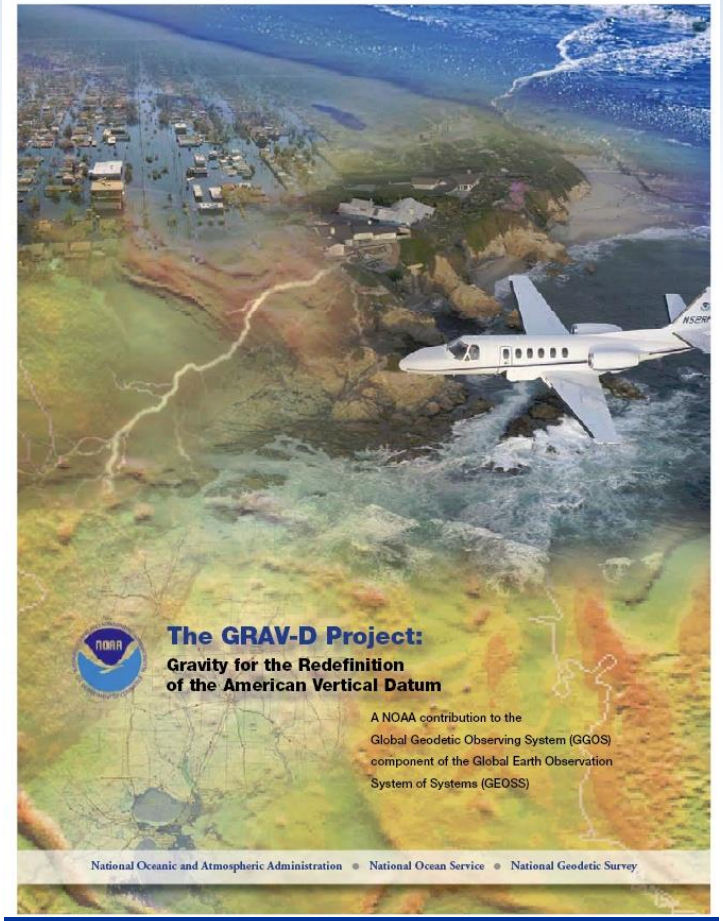
## The New:

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

# Extent of 2022 gravimetric geoid model used for new geopotential reference frame



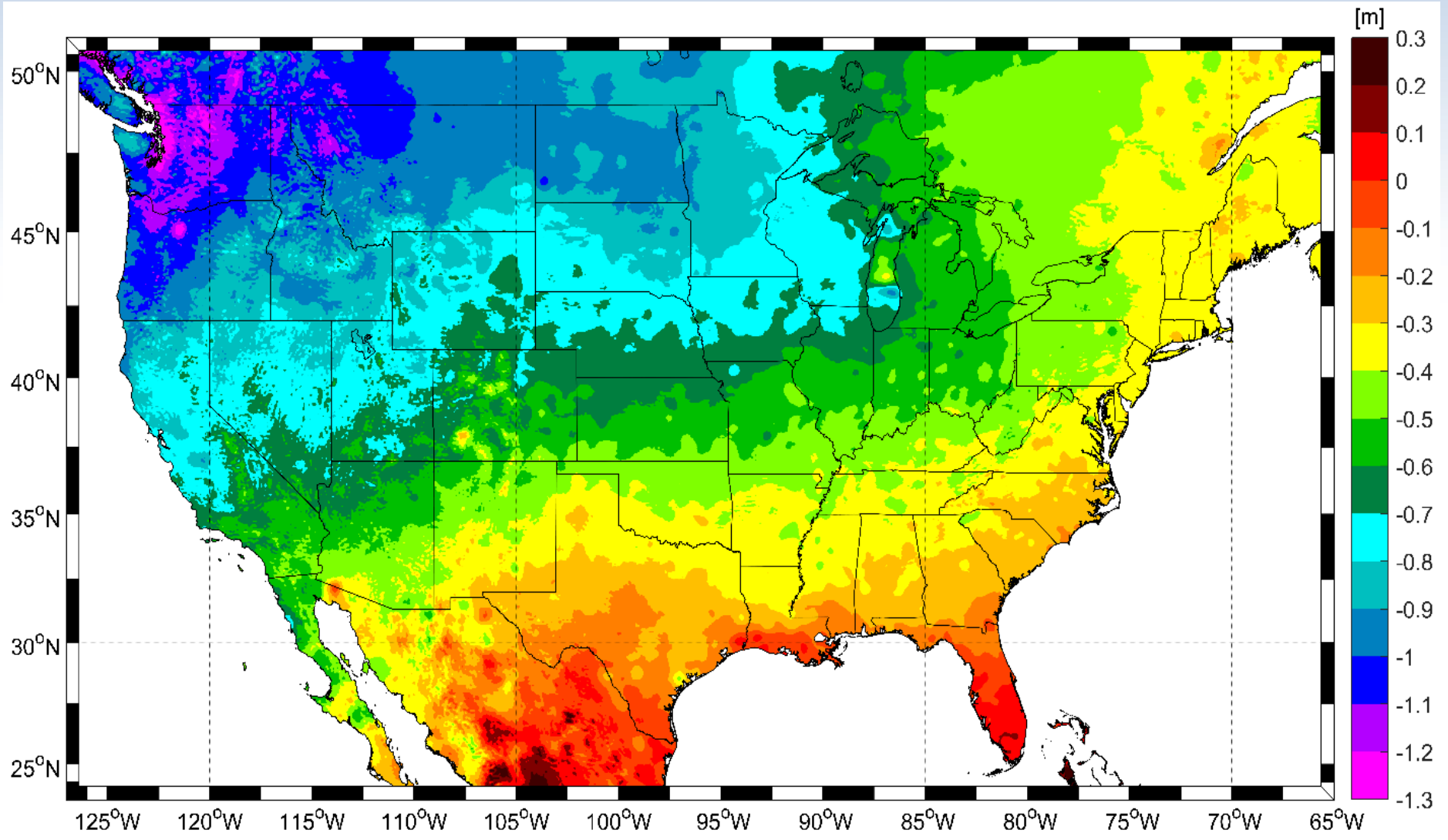
# Gravity for the Redefinition of the American Vertical Datum (GRAV-D)




***Gravity*** *and* ***Heights*** *are inseparably connected*

- Replace the Vertical Datum of the USA by 2022 (at today's funding)
- GRAV-D is:
  - An airborne gravity survey of the entire country and its holdings
  - A 2022 gravimetric geoid accurate to 1 cm
  - Long-term monitoring of geoid change over time
  - Partnership surveys
- Working to launch a collaborative effort with the USGS for simultaneous magnetic measurement
- Acting Manager: Monica Youngman
  Monica.Youngman@noaa.gov

# Expected changes to orthometric heights

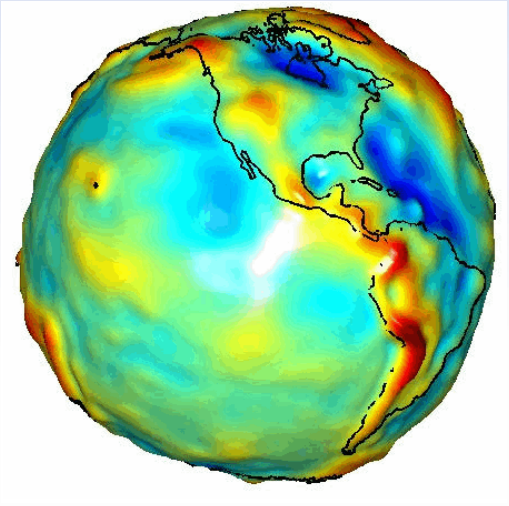


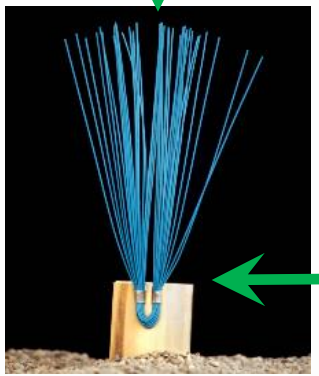

**For Florida = 0.1 > -0.3 m (4 > -11 in.)**

# Determining Orthometric Heights After 2022

Ellipsoid Height

Geoid Height





Orthometric Height

# Other Updated NGS Products

* **NCAT** - Updated Coordinate conversion program - NAD27 -> NAD83 (2011), also ready for 2022.

* **SPCS 2022** - Project to updated the State Plane Coordinate System of NAD83 in preparation for 2022. Current discussion between NGS and the stakeholders within each state (state specific).

* **OPUS PROJECT 4.0** - Updated OPUS Project program to modernize the NGS Bluebooking process and to allow for establishment of control networks (NGS published, FAA surveys, local control networks, etc.).

# ? ? QUESTIONS ? ?

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Views expressed are those of the author and not necessarily those of NGS.