



NGS is Scheduled to Replace NAVD 88 and NAD 83 In 2022

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New **GEOPOTENTIAL** (vertical) datum to
replace **NAVD 88**

Which precipitated a change to.....

New **GEOMETRIC** (horizontal/3-D) datum to
replace **NAD 83**

Let's start with the
GEOPOTENTIAL (vertical) datum.....

Why isn't NAVD 88 good enough anymore? (1 of 3)

NAVD 88 suffers from bench marks that:

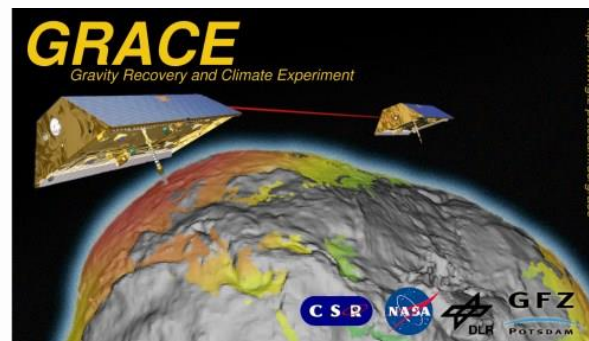
- Are often 80+ years old
- Are almost never re-checked for movement
- Disappear by the thousands every year
- Are seldom being replaced
- May not exist near locations where they are needed
- Were all determined by leveling from a single point, allowing unwanted cross-country error build up



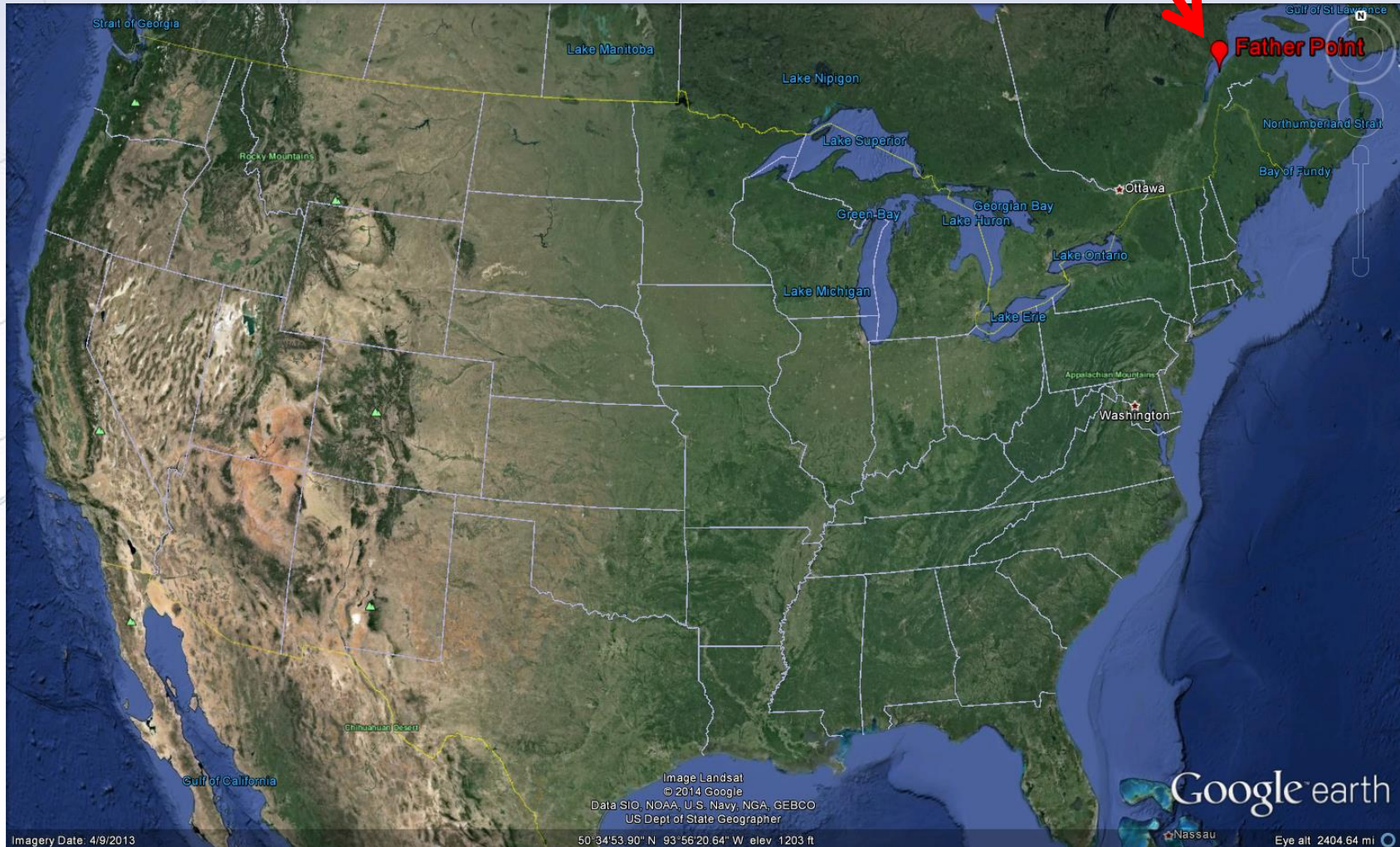
Why isn't NAVD 88 good enough anymore? (2 of 3)

NAVD 88 suffers from a zero height surface that:

- Has been proven to be ~50 cm biased from the latest, best geoid models (“GRACE” satellite program)**
- Has been proven to be ~ 1 meter tilted across CONUS (again, based on the independently computed geoid from the GRACE satellite)**

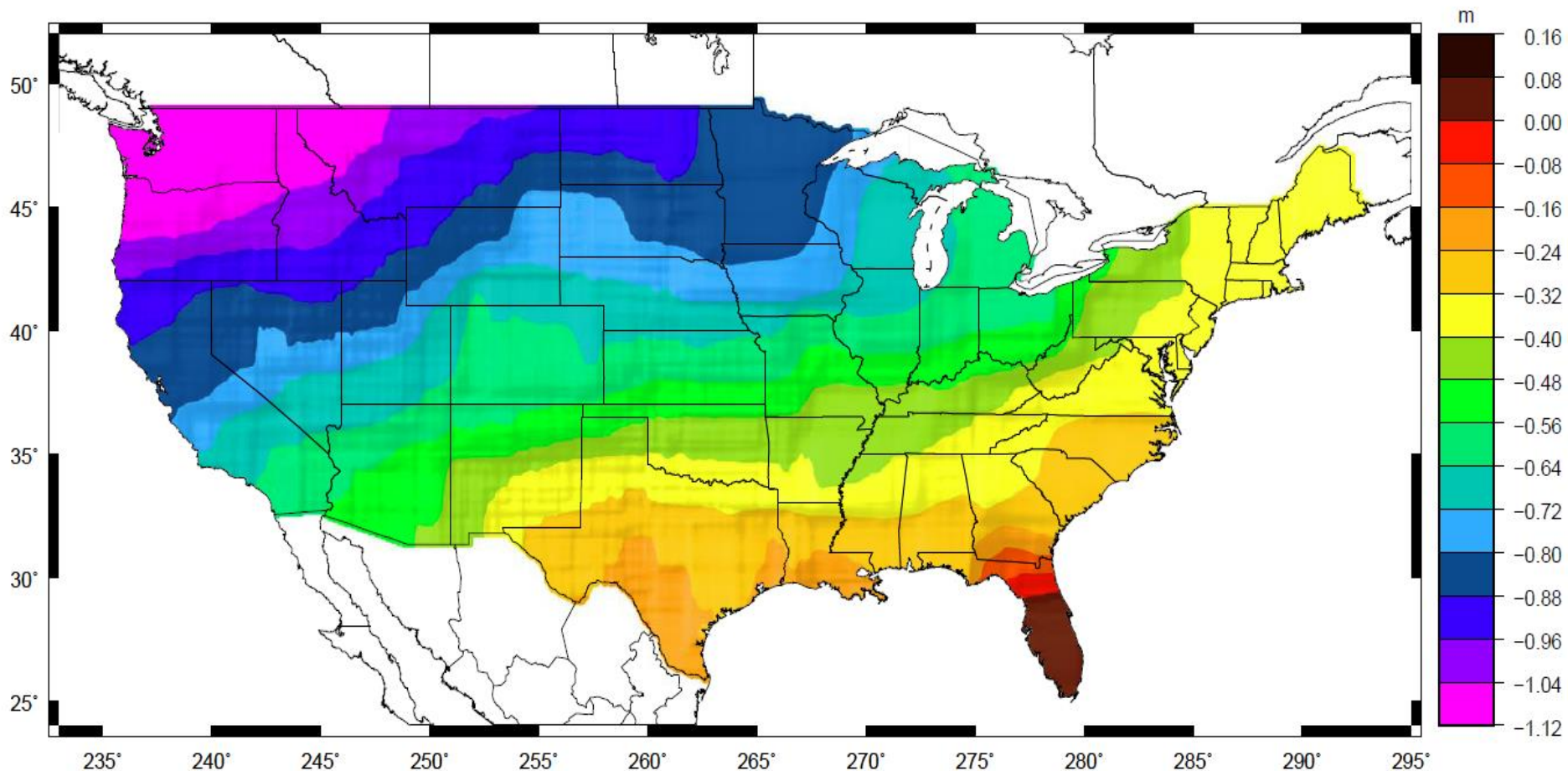


Initial point of NAVD 88 "FATHER POINT"



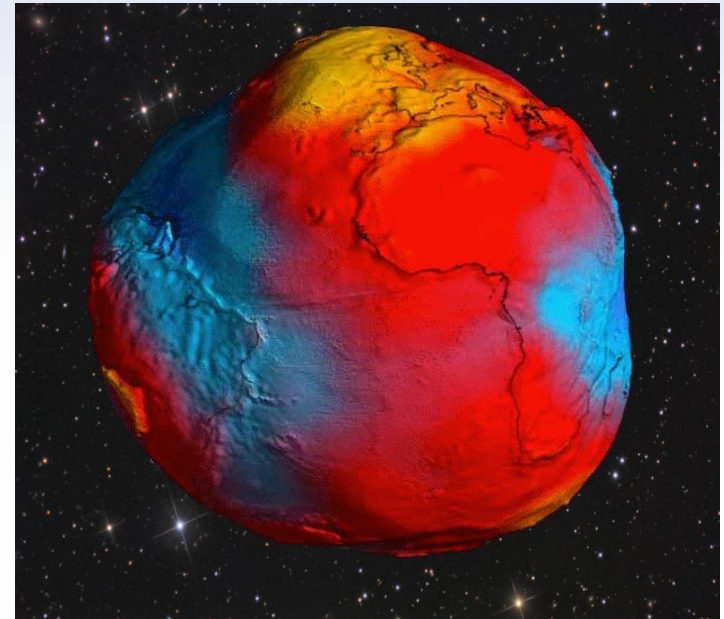
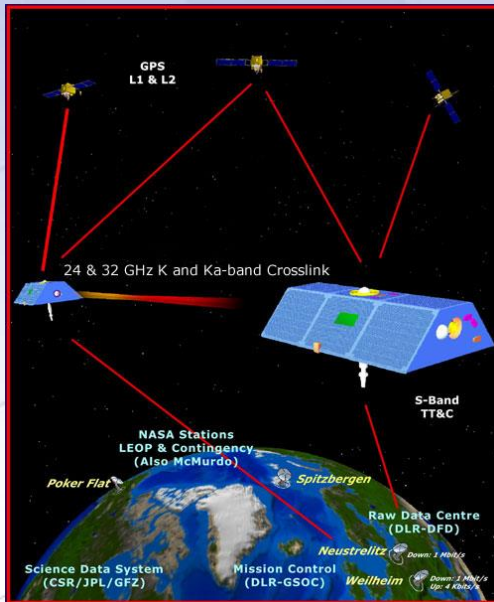
Why replace NAVD 88?

- **BIAS of Approximately 1/2 meter**
- **KNOWN TILT ..(about a meter) from SE to NW**



GRACE – (NASA and Germany)

“Gravity Recovery and Climate Experiment”
(launched 2002, expected out-of-service in 2016 – still going)



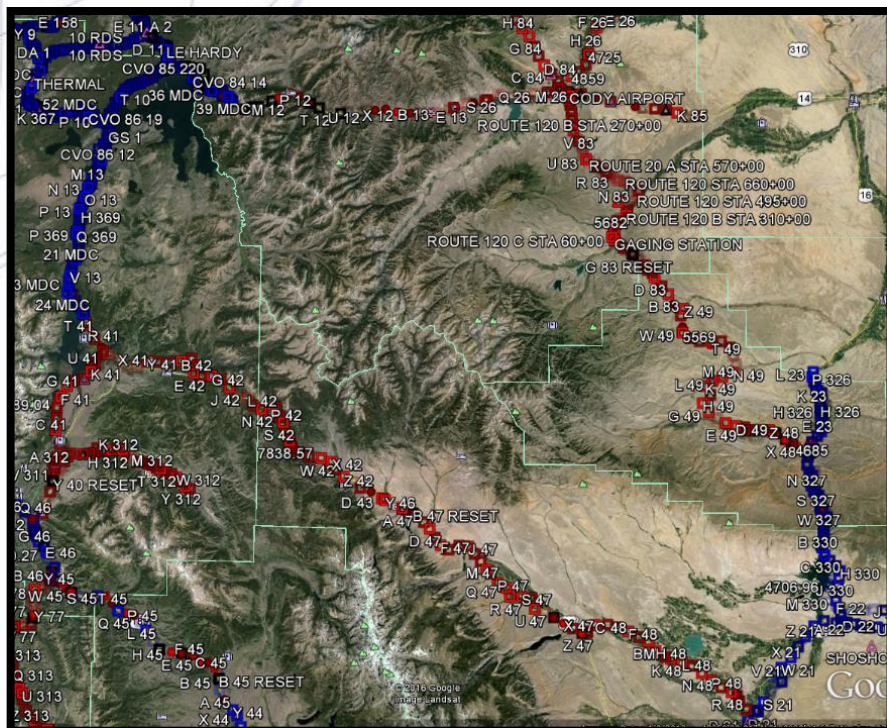
GOCE – (European Space Agency)

“Gravity Field and Steady-State Ocean Circulation Explorer”
(launched 2009, ended November 2013)

Why isn't NAVD 88 good enough anymore? (3 of 3)

Newer methods to determine/establish heights are available (GNSS), but in many places NAVD 88 doesn't support them very well

There are areas where NAVD 88 marks are scarce....or do not exist



Geoid

Geopotential surfaces

Ellipsoid surface

Gravity vector
(aka "plumbline"),
pointing "up"

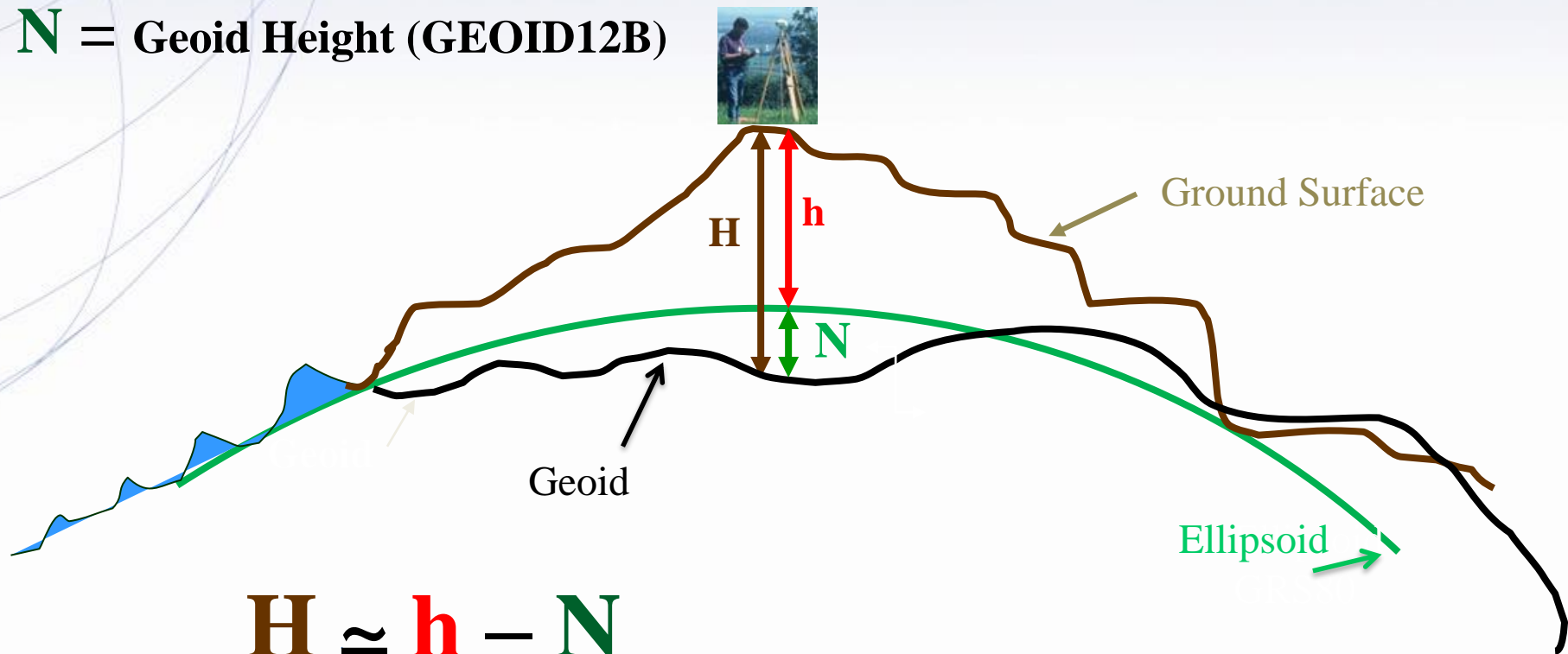
The relationships between the ellipsoid surface (solid red), various geopotential surfaces (dashed blue), and the geoid (solid blue). The geoid exists approximately at mean sea level (MSL). Not shown is the actual surface of the earth, which coincides with MSL but is generally above the geoid.

ELLIPSOID - GEOID RELATIONSHIP

H = Orthometric Height (NAVD 88)

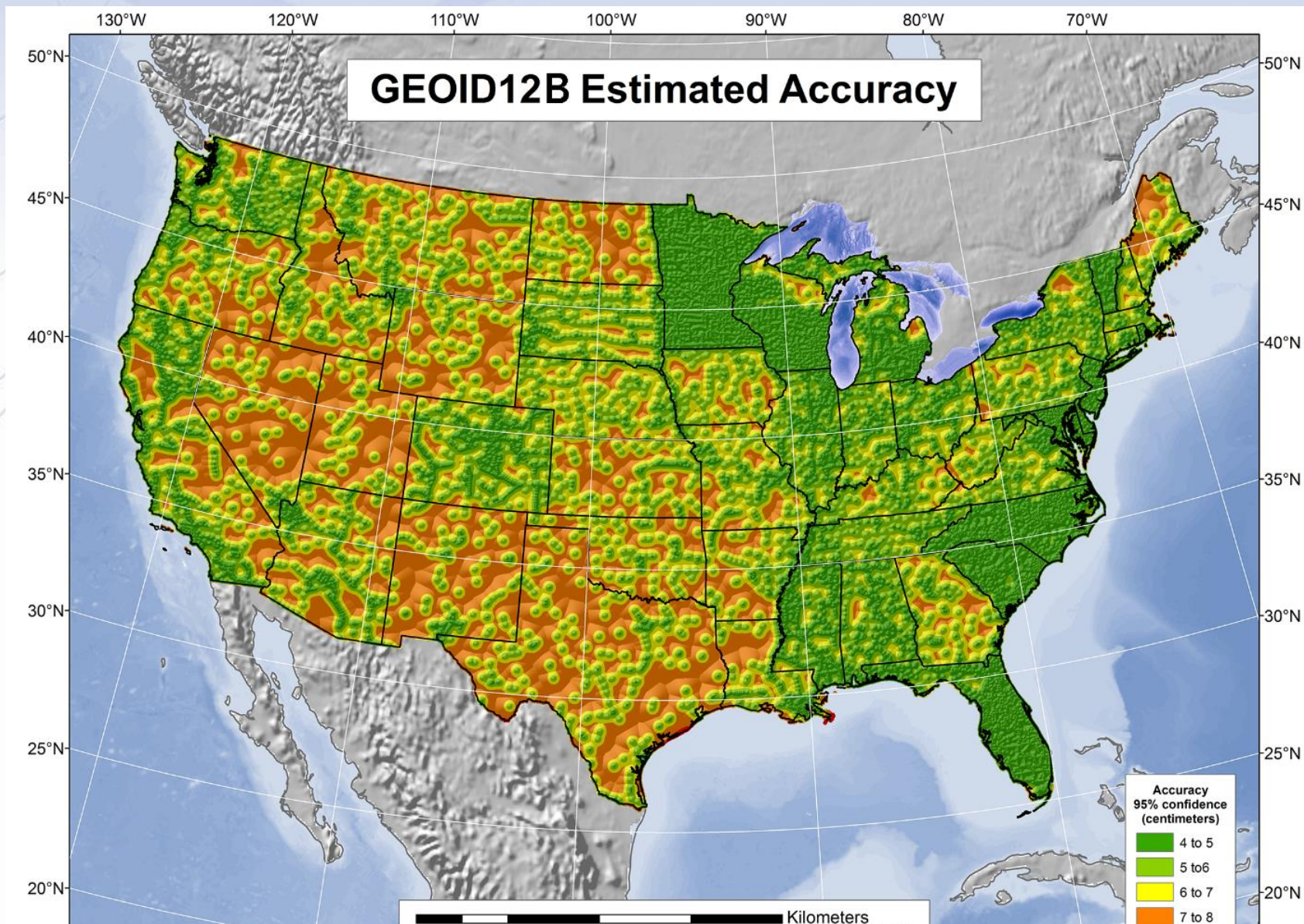
h = Ellipsoidal Height (NAD 83 (2011))

N = Geoid Height (GEOID12B)

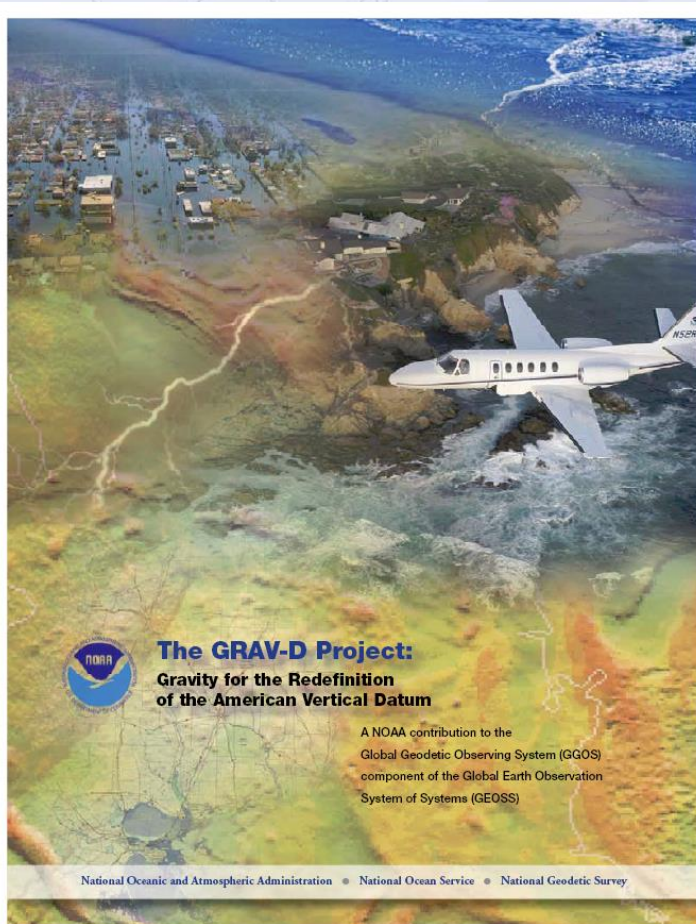


$$H \approx h - N$$

“N” is negative in conterminous US



Gravity for the Redefinition of the American Vertical Datum



- **Overall Target:** 2 cm accuracy orthometric heights from GNSS and a geoid model
- **GRAV-D Goal:** Create gravimetric geoid accurate to 1 cm where possible using airborne gravity data
- **GRAV-D:** Two thrusts of the project
 - Airborne gravity survey of entire country and its holdings
 - Long-term monitoring of geoid change
- Leveraging partnerships to improve and validate gravity data

GRAV-D Website

<http://www.ngs.noaa.gov/GRAV-D>

National Geodetic Survey

www.ngs.noaa.gov/GRAV-D/data_products.shtml

GRAV-D Google Map

National Geodetic Survey

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

GRAV-D Data Products

Products will be posted as they are completed.
Available data may include airborne and terrestrial survey information, gravity data, and gravity-based geoids or datums. Click the block of interest to view general information and a link will appear if data are available.

General Airborne Gravity User Manual

The General User Manual, which describes data distribution, field operation details, post-processing, and how to calculate commonly used gravity values, is available below. User Manuals for each block, which describes specific collection and error details for those data, are included in the zip file when the data is downloaded. Each User Manual specifies which version of the General Manual applies to that data set.

Version 2.0: Released on March 28, 2013, this version includes significant updates to field procedures and post-processing and applies to data releases starting in February 2013.

Version 1.1: Released on December 5, 2012, this version supersedes v 1.0 of the manual and fixes minor errors in the previous version. Most important is a corrected typo for the GRS-80 first eccentricity squared value reported on page 20 of the document.

Airborne Gravity Data - Map Key

Green: Available data and metadata
Blue: Data being processed
Orange: Data collection underway
White: Planned for data collection

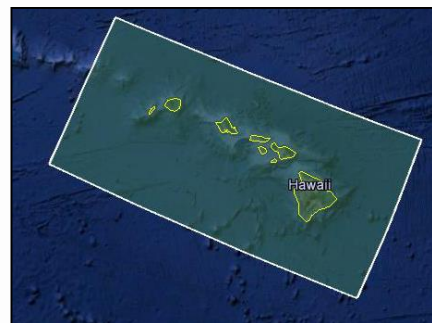
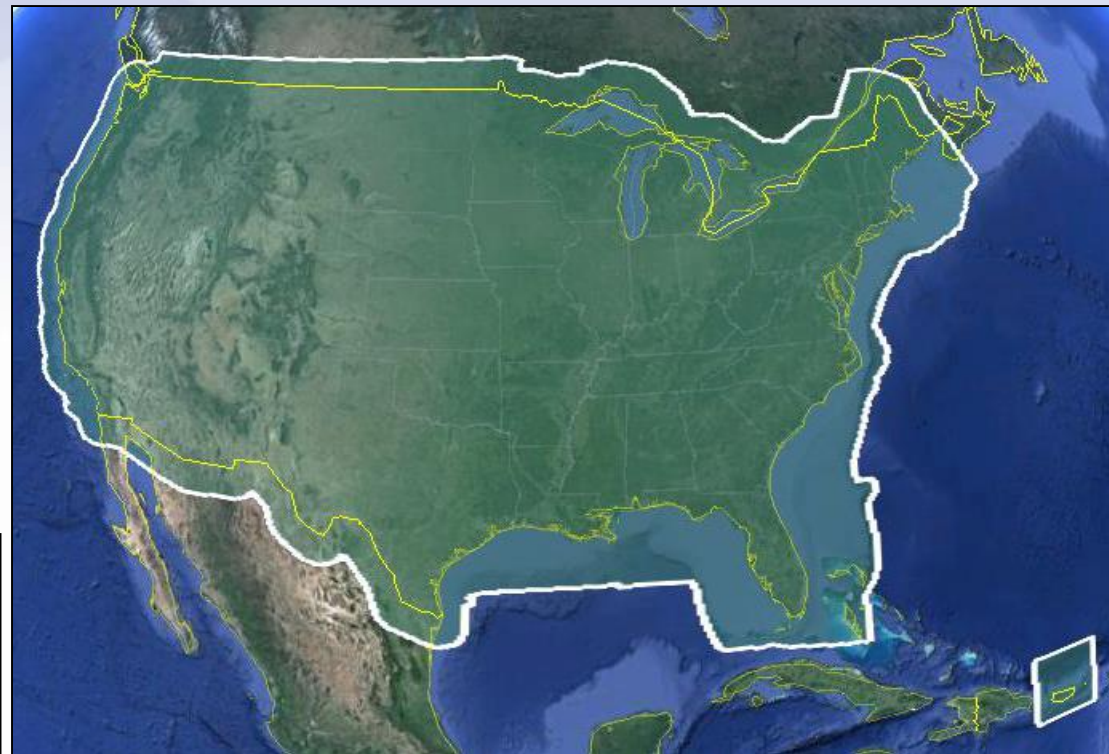
GRAV-D Quick Links

- Home
- Science Fundamentals
- Data Products
- Publications
- Meetings/Workshops/Schools
- Informational Materials
- Research Projects
- Contact Us

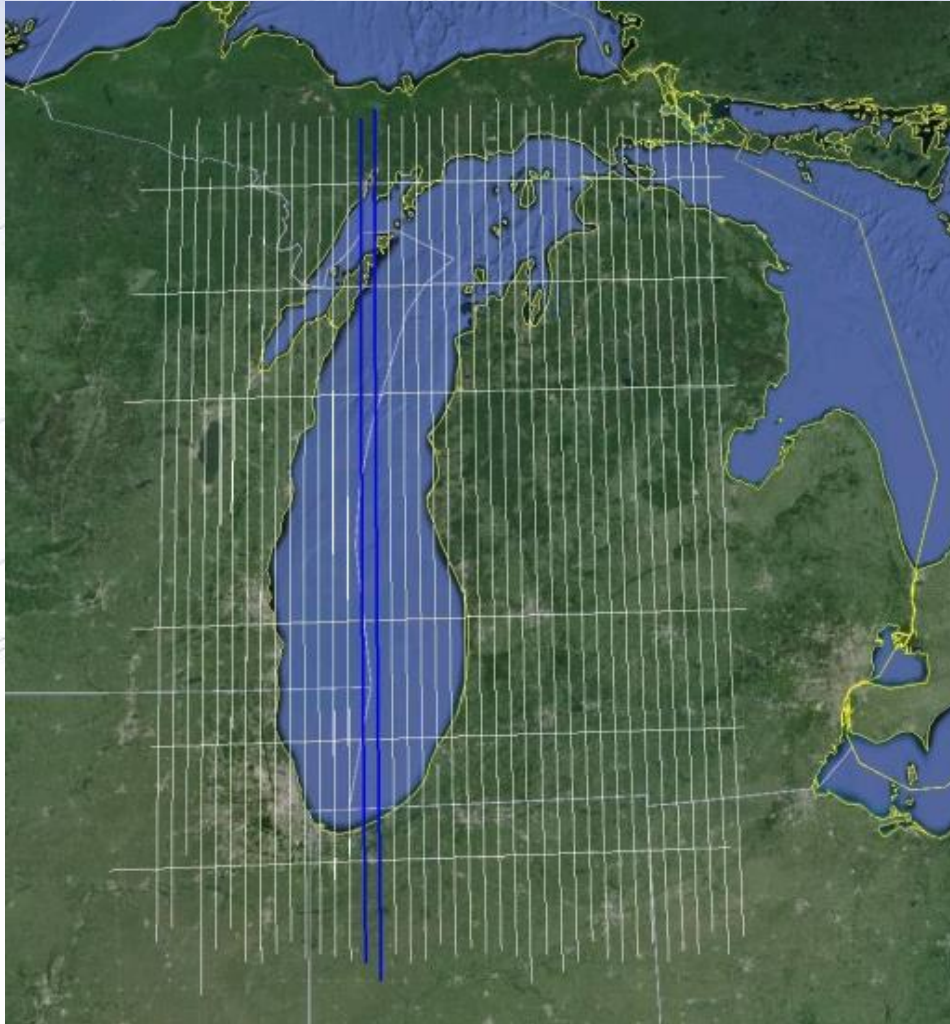
Download the GRAV-D Project Plan (.PDF):

Data Collection Scope

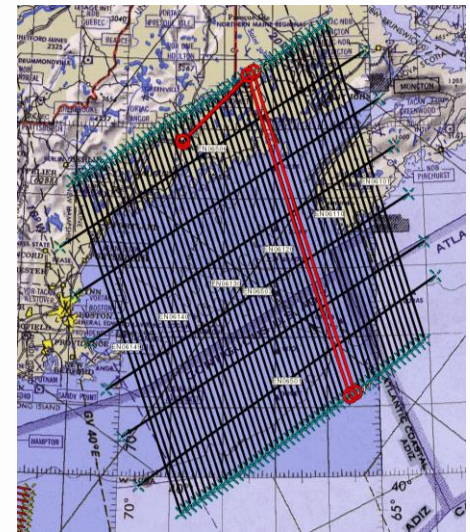
- Entire U.S. and territories
 - Total Square Kilometers: 15.6 million (~6 million Sections)
 - ~200 km buffer around territory or shelf break if possible
 - Initial target area for 2022 deadline



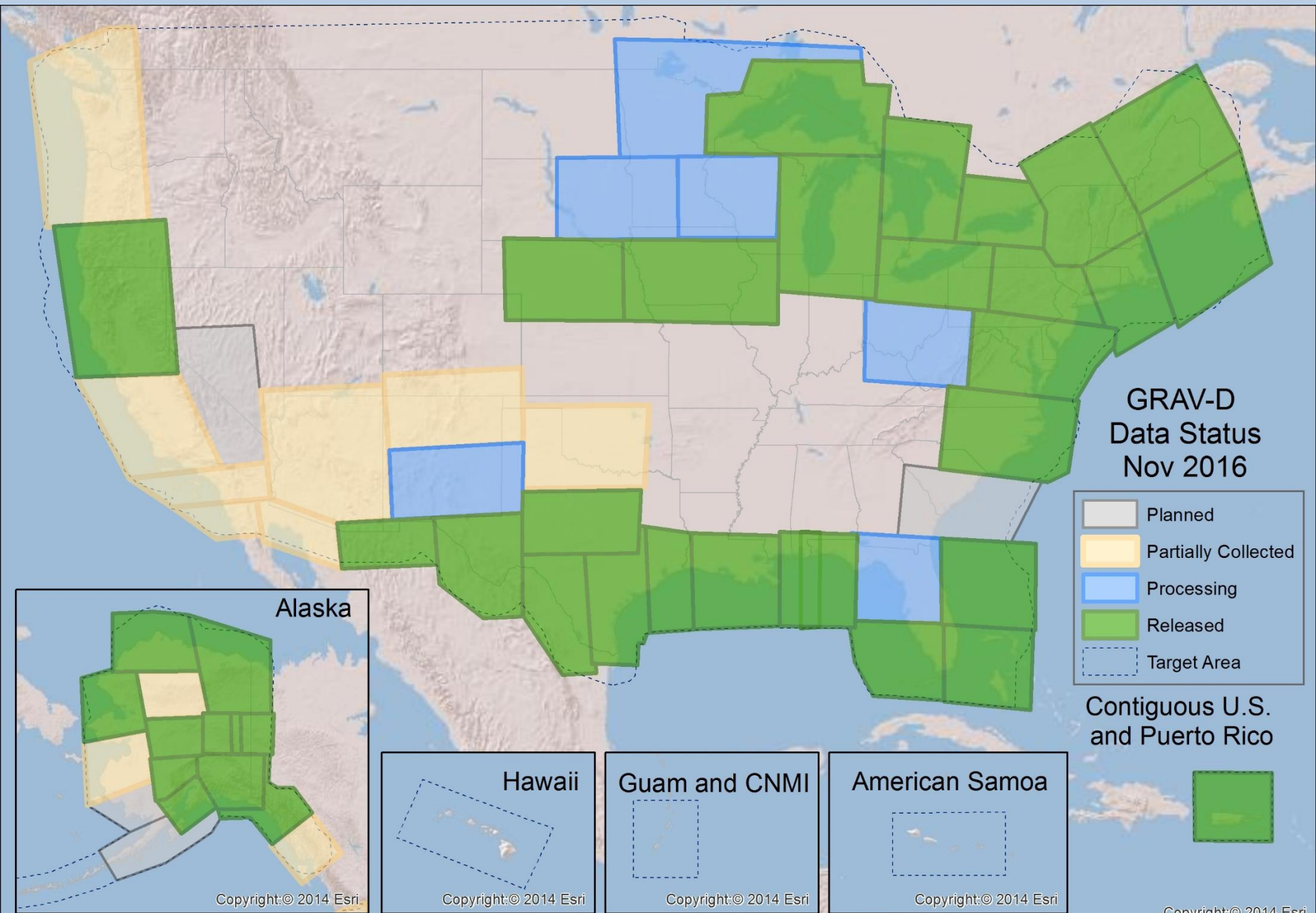
Survey and Block Plans



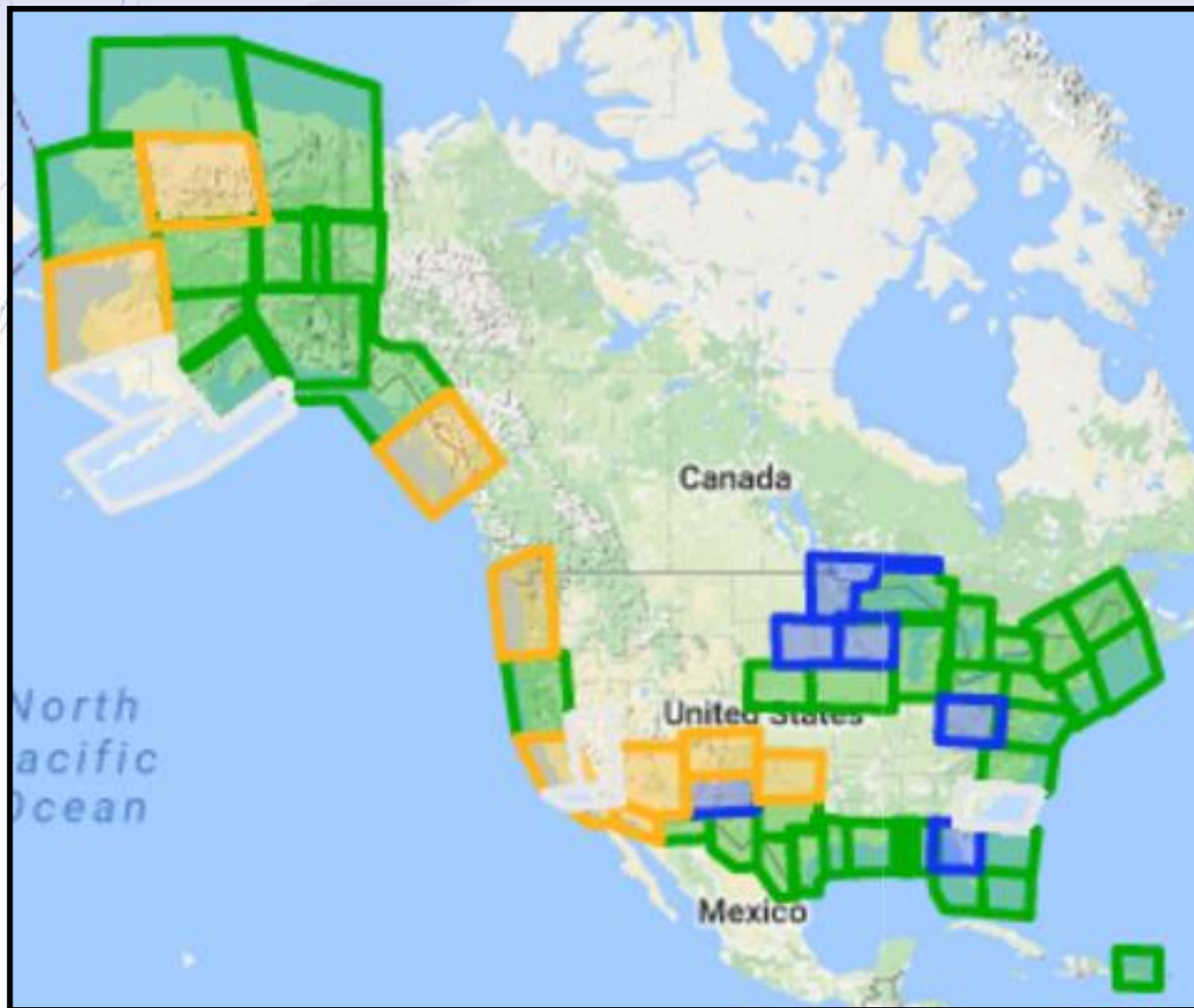
- Data lines spaced 10 km apart
- Cross lines spaced 60-80 km apart
- Flight altitude 20,000 ft.
- Nominal speed 220-250 knots



GRAV-D Status 11-30-16: 58%



Properly Scaled Coverage Map



NGS produces:

- **GRAVIMETRIC GEOID:**

Converts heights from ITRFxx to the NGS geoid surface (is not NAVD 88 or other Vertical datums). **Used by scientists.**

USGG**** (Last one was completed in 2012)

- **HYBRID GEOID:**

Converts heights from NAD 83 to regional Vertical datums (e.g., NAVD 88). **Used by surveyors - engineers - others.**

GEOID12B (same model values as GEOID12A in this region)

GEOID12A

GEOID09

GEOID03

GEOID99

GEOID96

- **xGEOID16:**

Experimental models related to the upcoming 2022 datum changes. NOT for current NAVD 88 values. **Primarily used by scientists.**

The new GEOPOTENTIAL datum should produce accuracies within 1 to 2 centimeters.

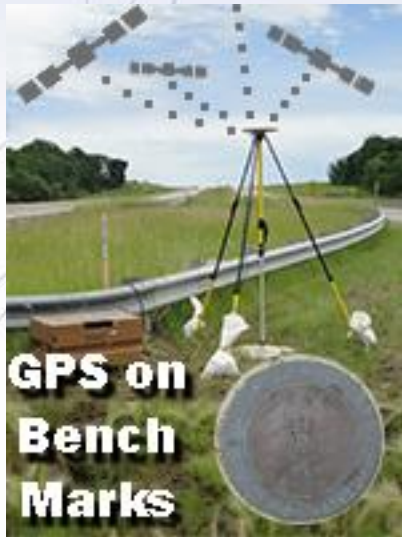


Photo courtesy of RW Engineering & Surveying

Projects that were formerly leveled will most often obtain vertical control based on GNSS.



**Let's move on to the
GEOMETRIC (3D)
datum...**

Why replace NAD 83?

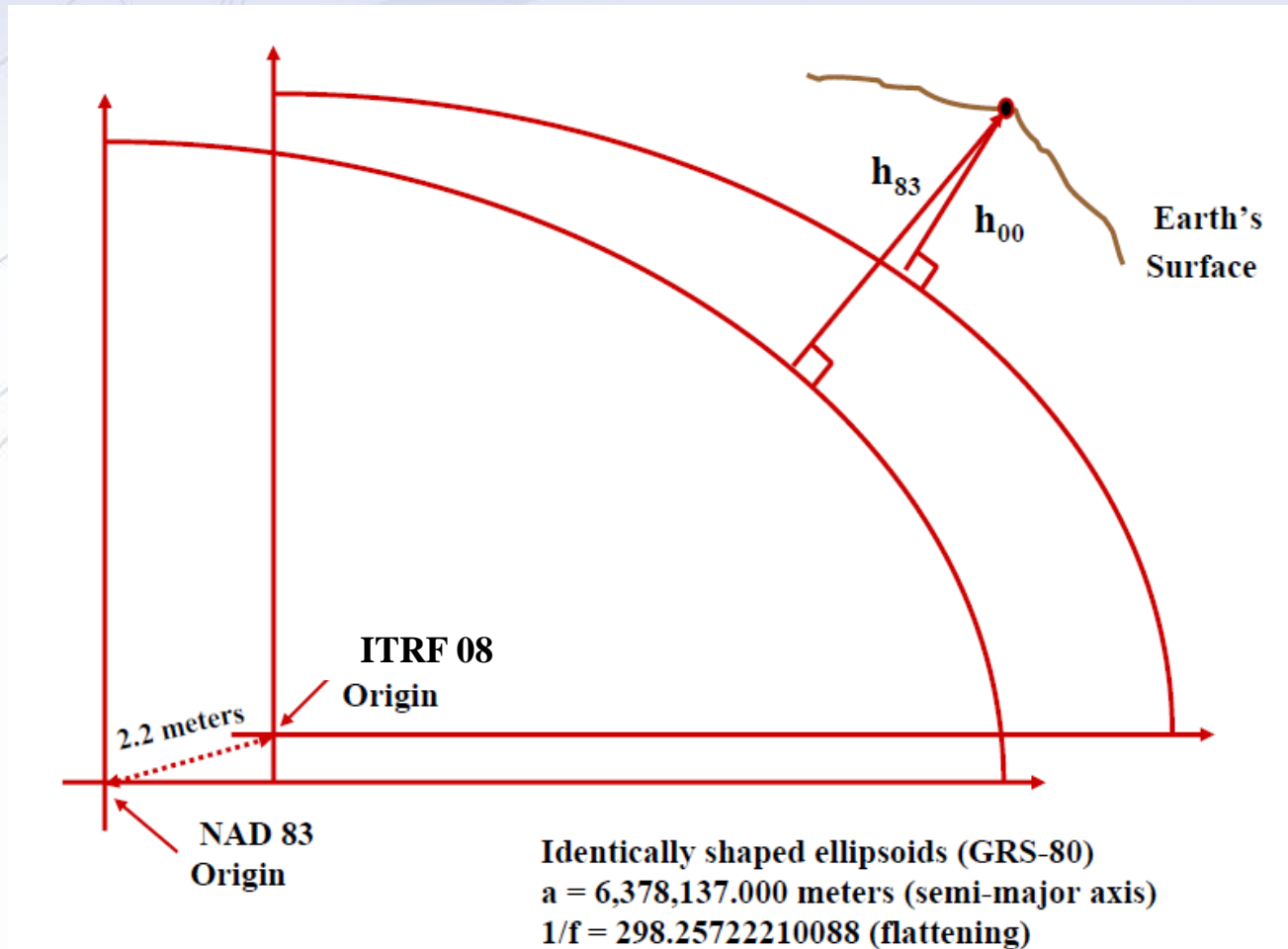
NAD 83 was aligned to “Geodetic Reference System 1980” (GRS80), and so was the original “World Geodetic System 1984 (WGS84) meaning.....

NAD 83 **IS** equivalent to the original WGS 84but **NOT** to the newer versions.

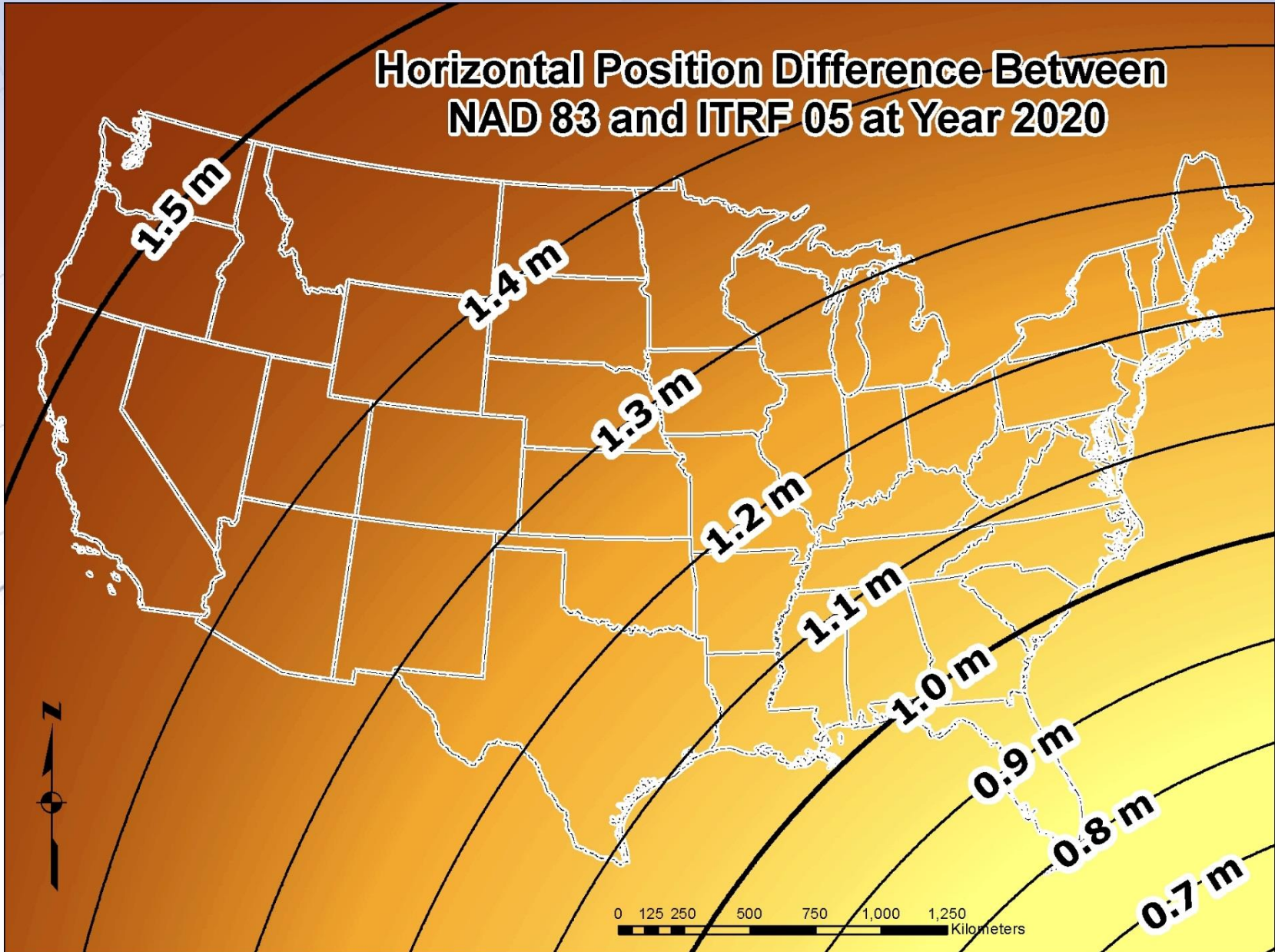
Newer versions of WGS 84 have been developed to be consistent with updated International Terrestrial Reference Frames (ITRFXX)

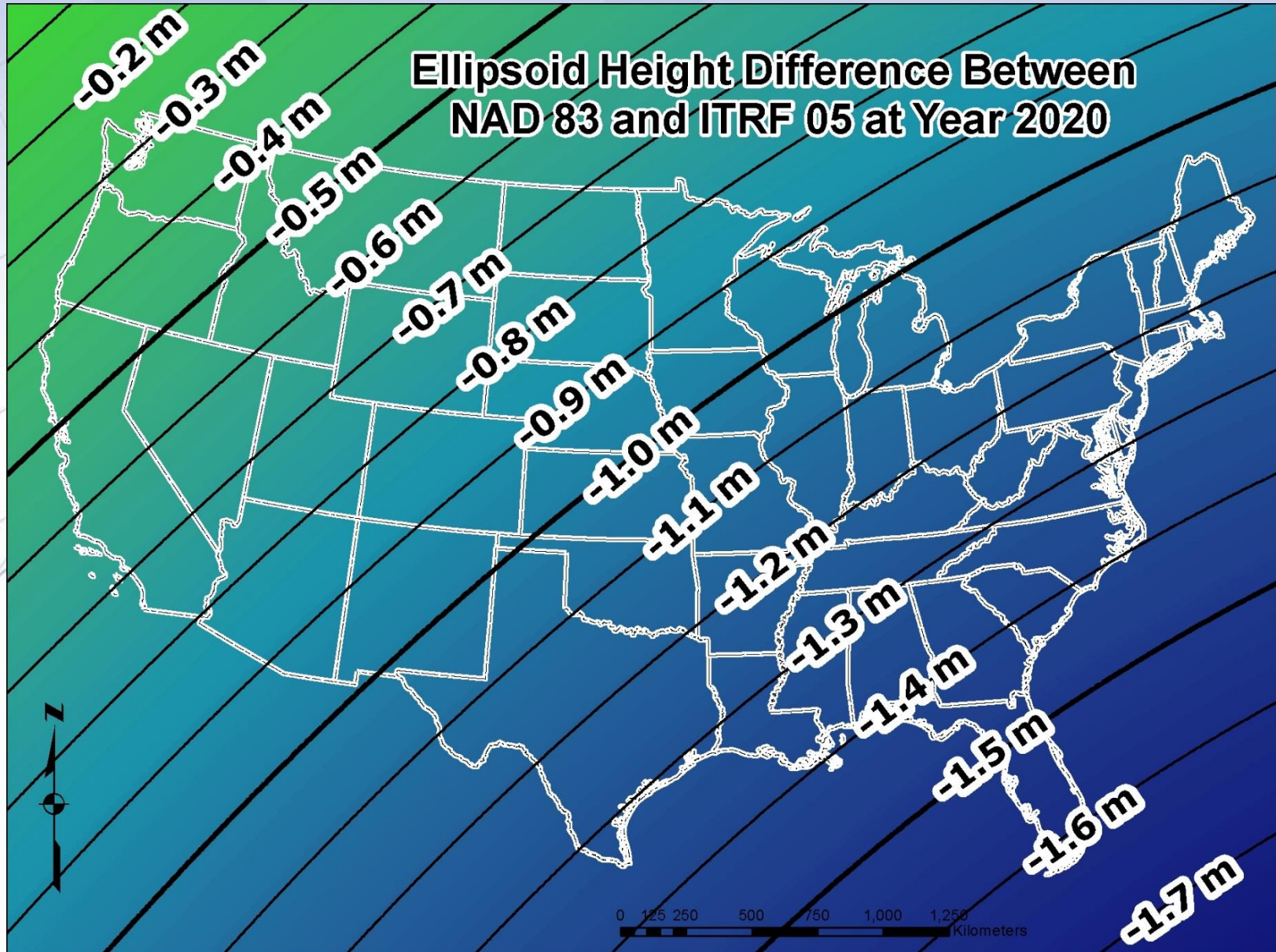
- **G730 (June 1994)** 0.7 m
- **G873 (January 1997)** 0.2 m
- **G1150 (January 2002)** 0.06 m
- **G1674 (February 2012)** 0.01 m

Sketch showing the difference between ITRF 2008 and NAD 83



Horizontal Position Difference Between NAD 83 and ITRF 05 at Year 2020





How will these new datums impact my work?

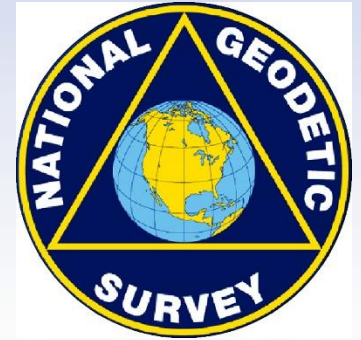
- Users in this region will see a **GEOMETRIC (3-D)** shift of about **2 meters**
- Users in this region will see a **GEOPOTENTIAL (Vert.)** shift of about **0.8 m.**
- * Some users will delay in switching to the new datums...

The NGS 10 year plan states that a transformation tool will be provided at the release of the new datums that will enable users to transform values between the older datums (NAD 83 and NAVD 88) and the new GEOMETRIC and GEOPOTENTIAL datums.

Summary and Questions

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<http://www.ngs.noaa.gov/datums/newdatums/FAQNewDatums.shtml>

<http://www.ngs.noaa.gov/GRAV-D/>

http://www.ngs.noaa.gov/corbin/class_description/NGS_Video_Library.shtml