NSRS Modernization

New Datums are Coming in 2022

What's Being Replaced?

Horizontal

- NAD 83(2011)
- NAD 83(PA11)
- NAD 83(MA11)

Latitude
Longitude
Ellipsoid Height
State Plane Coordinates

Vertical

- NAVD 88
- PRVD 02
- VIVD09
- ASVD02
- NMVD03
- GUVD04
- IGLD 85

Heights

New Reference Frame Names

NAD 83 becomes:

- North American Terrestrial Reference Frame (NATR2022)
- Caribbean Terrestrial Reference Frame (CTRF2022)
- Mariana Terrestrial Reference Frame (MTRF2022)
- Pacific Terrestrial Reference Frame (PTRF2022)

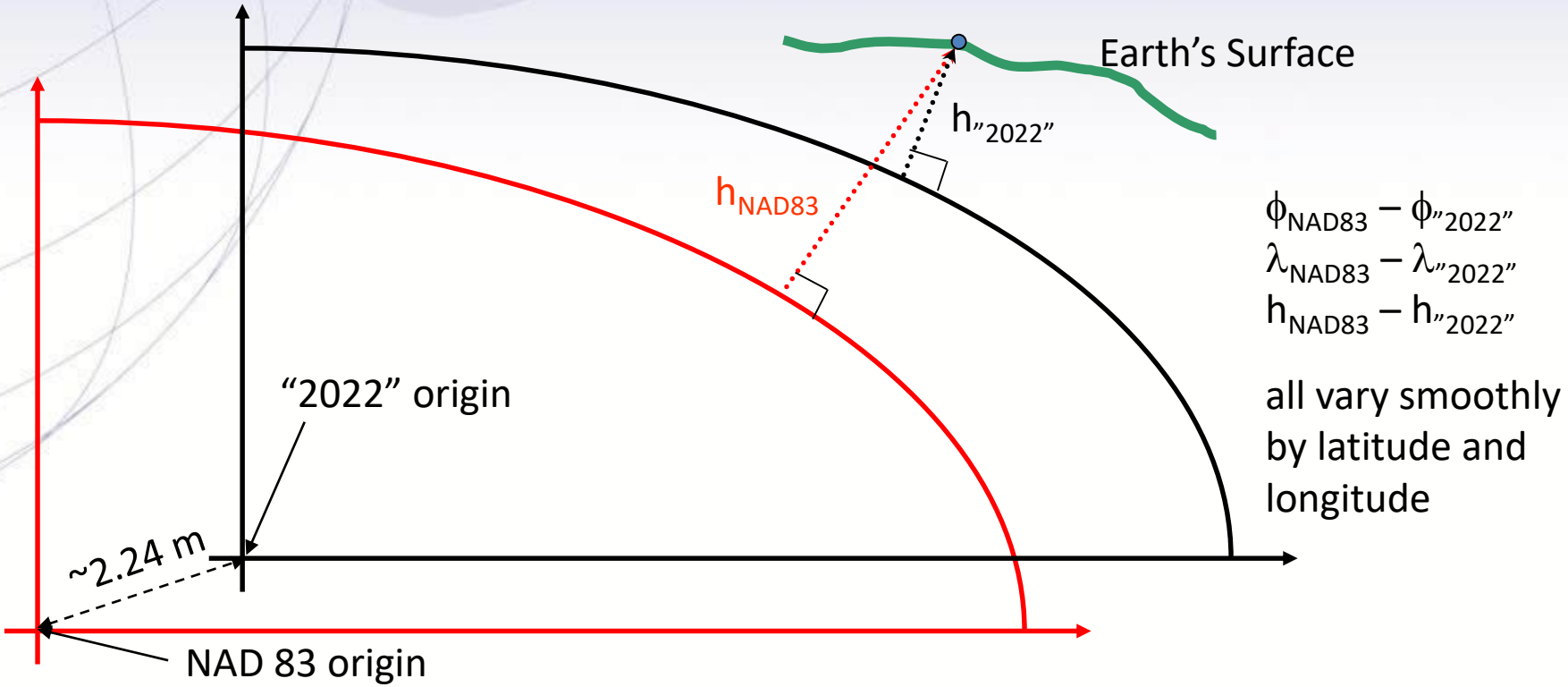
NAVD88 becomes:

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

(Realized by GEOID2022)

Replace NAD 83

Simplified concept of NAD 83 vs. "2022"

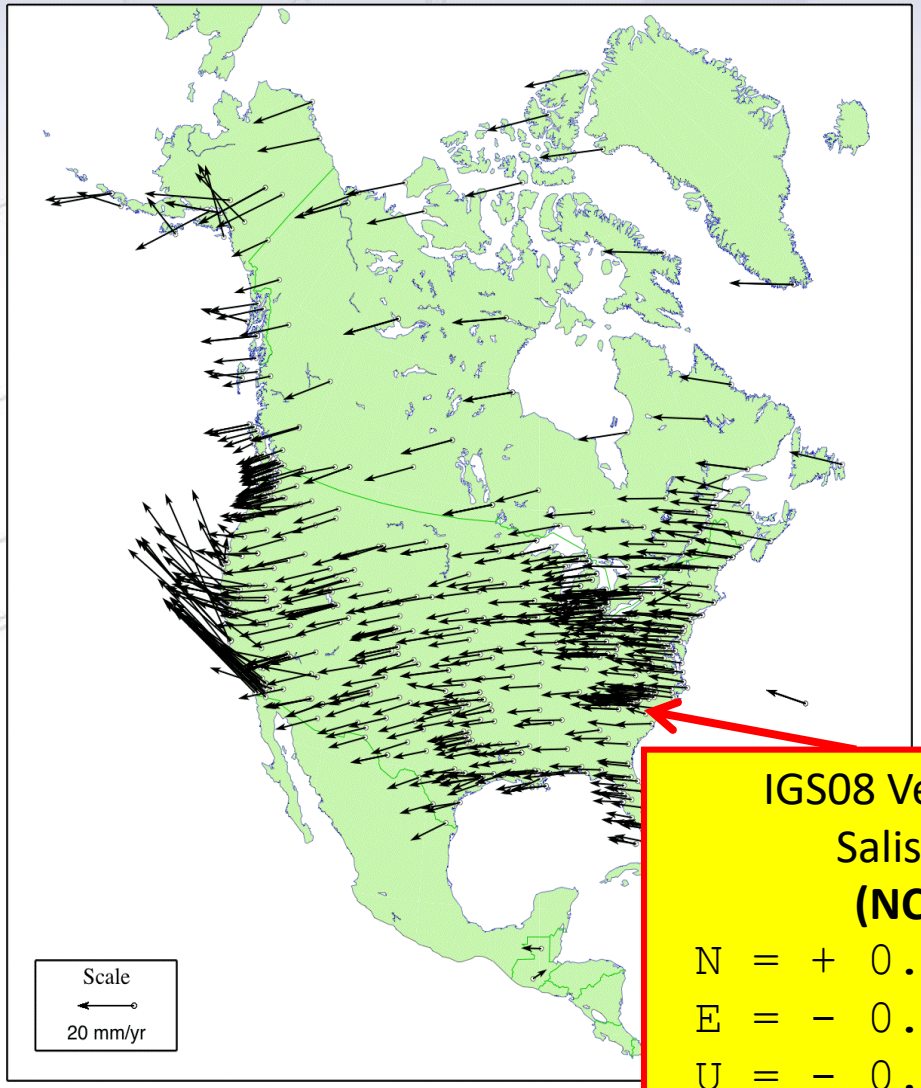


$\phi_{NAD83} - \phi_{"2022"}$
$\lambda_{NAD83} - \lambda_{"2022"}$
$h_{NAD83} - h_{"2022"}$

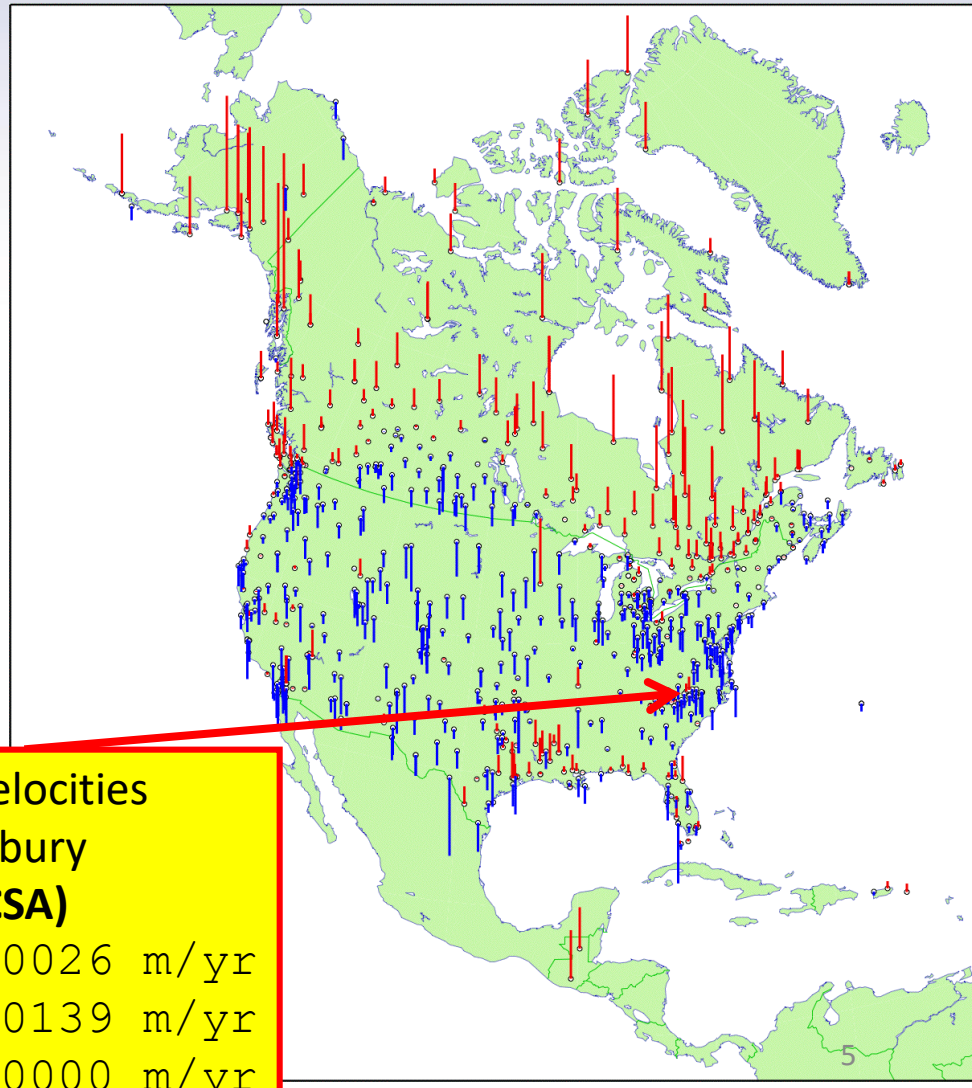
all vary smoothly by latitude and longitude

Tectonic Plate Velocities

Horizontal



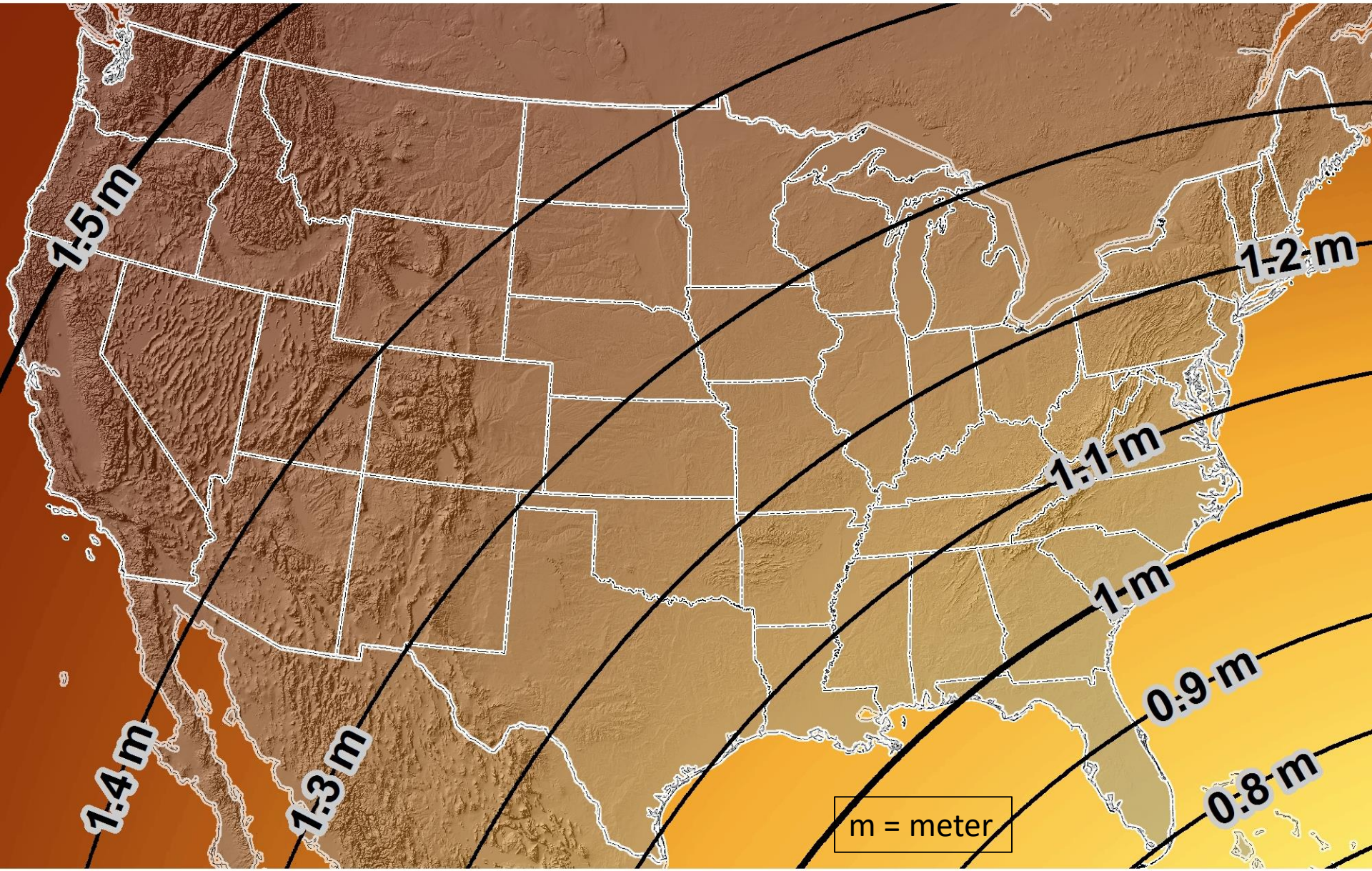
Vertical



IGS08 Velocities
Salisbury
(NCSA)

N = + 0.0026 m/yr
E = - 0.0139 m/yr
U = - 0.0000 m/yr

Estimated horizontal change from NAD 83 to new geometric datum



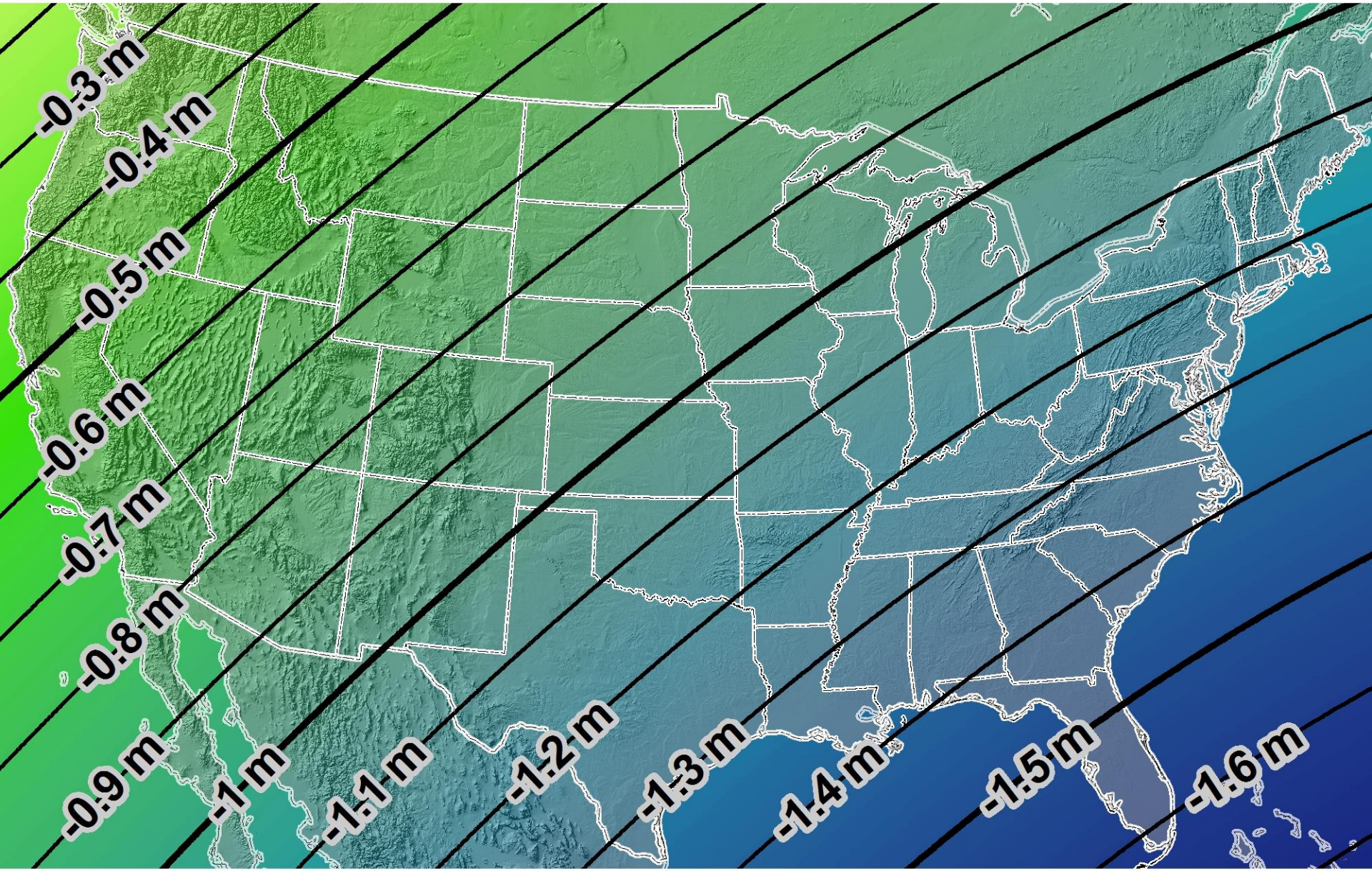
0 500 1000 km

April 5, 2017

Northern Chester PLSC

Delta Horizontal = (ITRF 05) minus (NAD 83) at 2020.0

Estimated ellipsoid height change from NAD 83 to new geometric datum

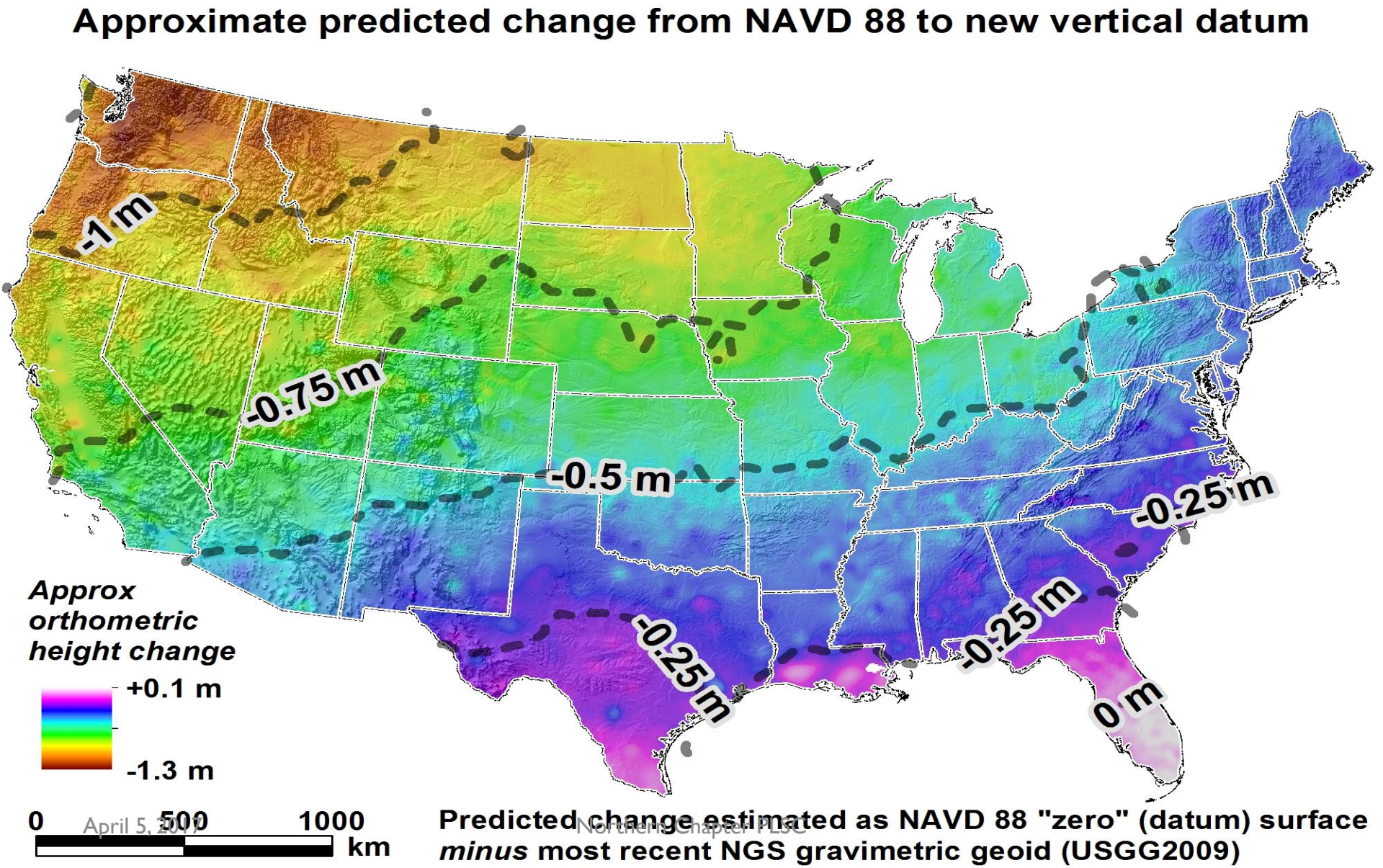


April 5, 2017

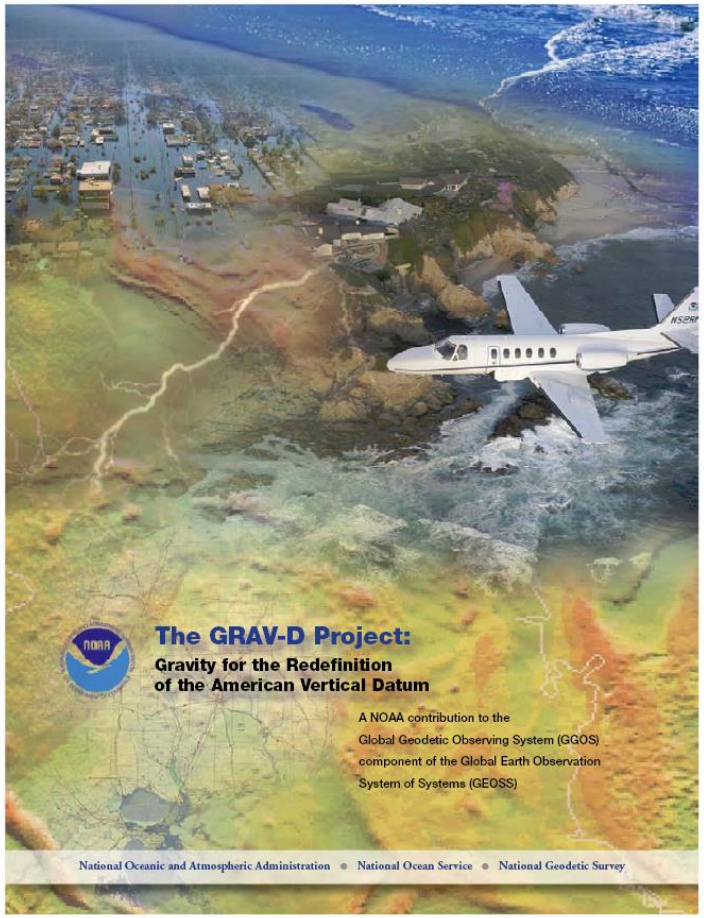
Northern Chapter PLSC

Delta h = h(ITRF 05) minus h(NAD 83) at 2020.0

New Vertical Datum



GRAV-D Project Overview



- **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

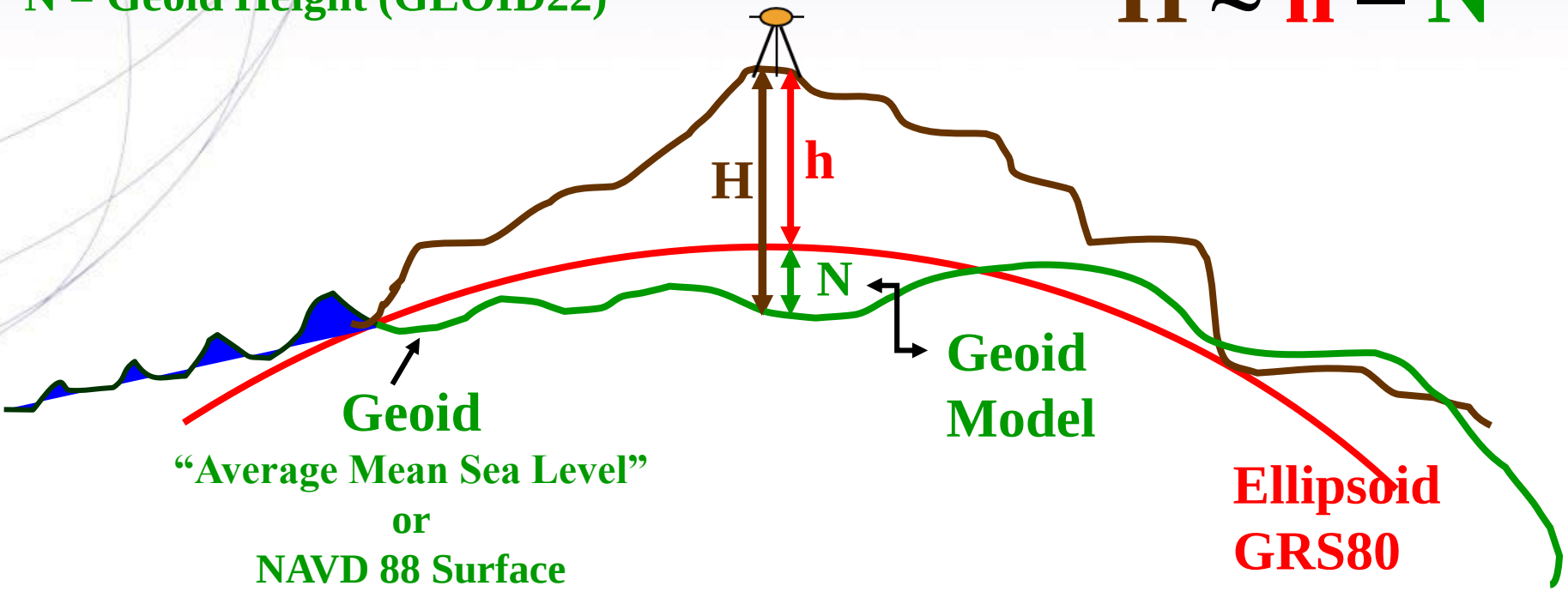
ELLIPSOID – GEOID RELATIONSHIP

H = Geopotential Height (NAPGD2022)

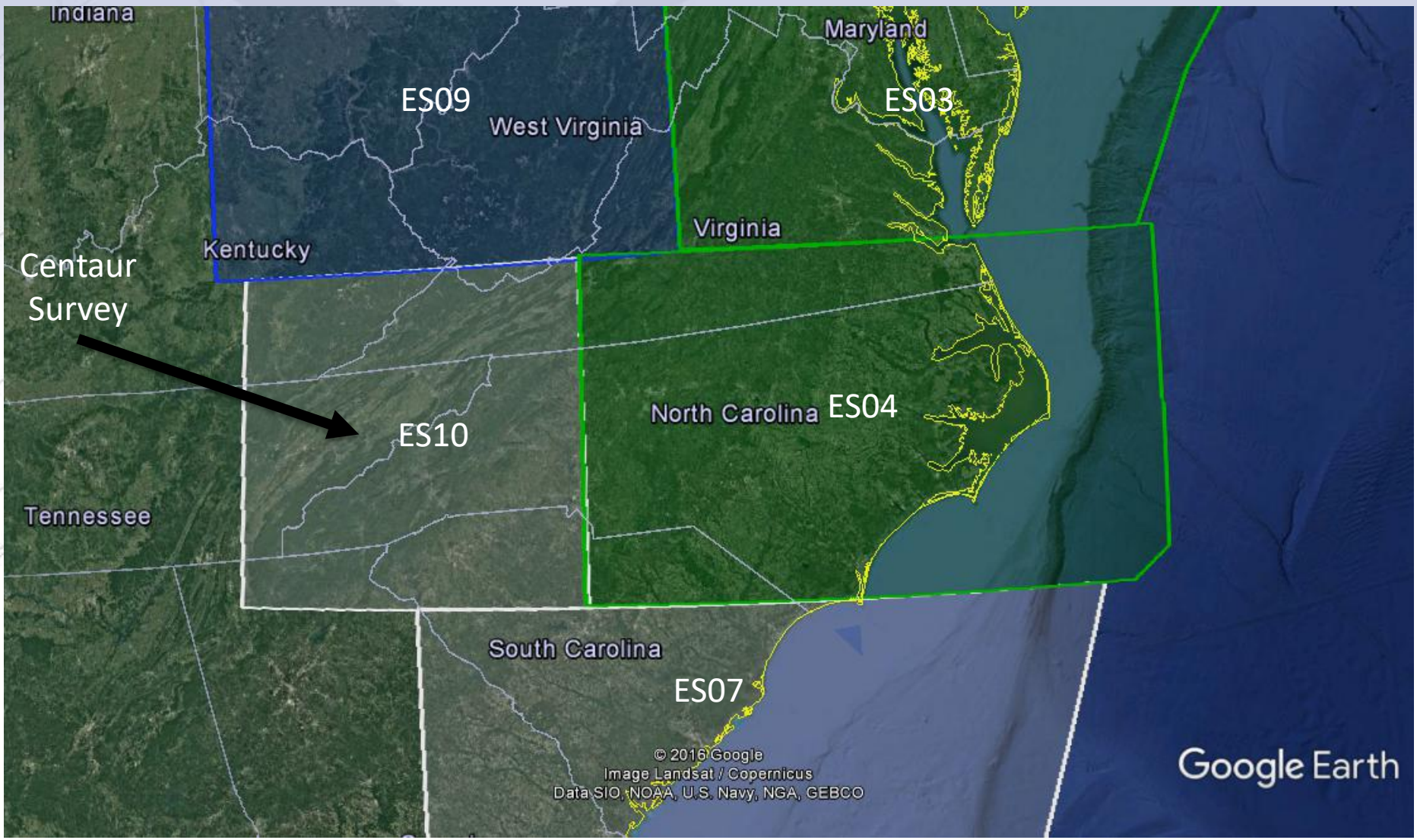
h = Ellipsoid Height (NATR2022)

N = Geoid Height (GEOID22)

$$H = h - N$$
$$H \approx h - N$$



Current North Carolina GRAV-D Survey


Indiana
ES09
West Virginia
Maryland
ES03
Virginia
Kentucky
Centaur
Survey
ES10
North Carolina
ES04
Tennessee
South Carolina
ES07
© 2016 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

Centaur OPA

- Optionally piloted aircraft system based on Diamond DA42MNG
- Aurora Flight Sciences Modified for Multi-role
  - Manned (certified)
  - Unmanned
  - Hybrid
- Unmanned Aircraft Vehicle (UAV) performance with ability to operate in unrestricted airspace
- Key attributes:
  - One system, multi-roles
  - Safety & reliability
  - Heavy fuel, low burn diesel engines
  - Multi-Payload Ready
  - Low acquisition & life cycle costs

Modes of Operation - Hybrid

Hybrid Mode: Fly like a UAV, but a "hands-off" safety pilot is on-board the aircraft – control of the vehicle is from the ground station

Operational Benefits:

- Allows use of the aircraft in restricted airspace with UAV control
  - Realistic unmanned testing can be performed almost anywhere (Ex: Testing Sense-n-Avoid technologies and airspace integration capabilities)
  - Realistic UAV training can be performed almost anywhere
  - Eliminates need for a Certificate of Authorization (COA) or the expense of a controlled range location to operate
  - Robot can fly aircraft during dull missions to take stress off pilot (Ex: Large area geo mapping in a "lawn mowing" pattern is extremely dull.)

Installation

Relative Gravity Meter Data Collection

- New gravity marks established
  - One hundred and twenty (120) in western North Carolina
  - Partnering with NGS to establish eleven (11) new absolute gravity stations in western North Carolina (NC)
    - Observations Spring 2019

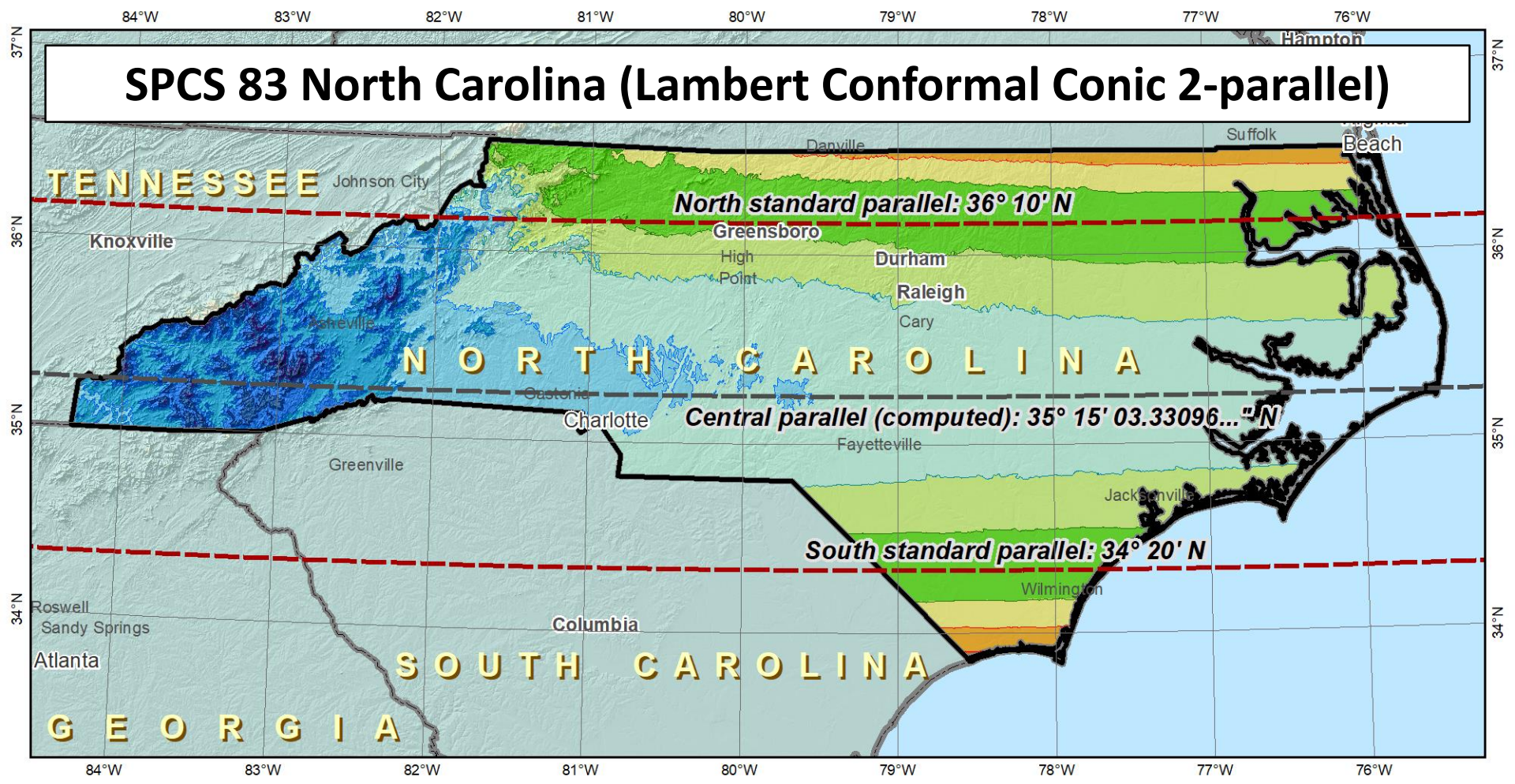
SPCS2022 in North Carolina

- New State Plane Coordinate System in 2022
  - Will replace SPCS 83
  - Referenced to new terrestrial reference frames
- Two conflicting desires for SPCS2022 coordinates:
  - Change coordinates as little as possible
    - Preserve systems based on SPCS 83 coordinates (sft)
    - E.g., parcel numbering system, FEMA flood mapping tiles
  - Change coordinates by large amount
    - Reduces confusion with SPCS 83 coordinates
    - Satisfies NGS policy on SPCS2022

SPCS2022 characteristics

- Characteristics pertinent to North Carolina:
  - Minimize distortion at **ground surface**
  - Lambert Conformal Conic: **1-parallel definition**
    - Central parallel defined to **nearest arc-minute**
    - Central parallel scale **≤ 6 decimal places**
  - Coordinates must change **≥ 10,000 m (~33,000 ft)**
  - Grid origins rounded to **nearest 1000 m**

SPCS 83 North Carolina (Lambert Conformal Conic 2-parallel)

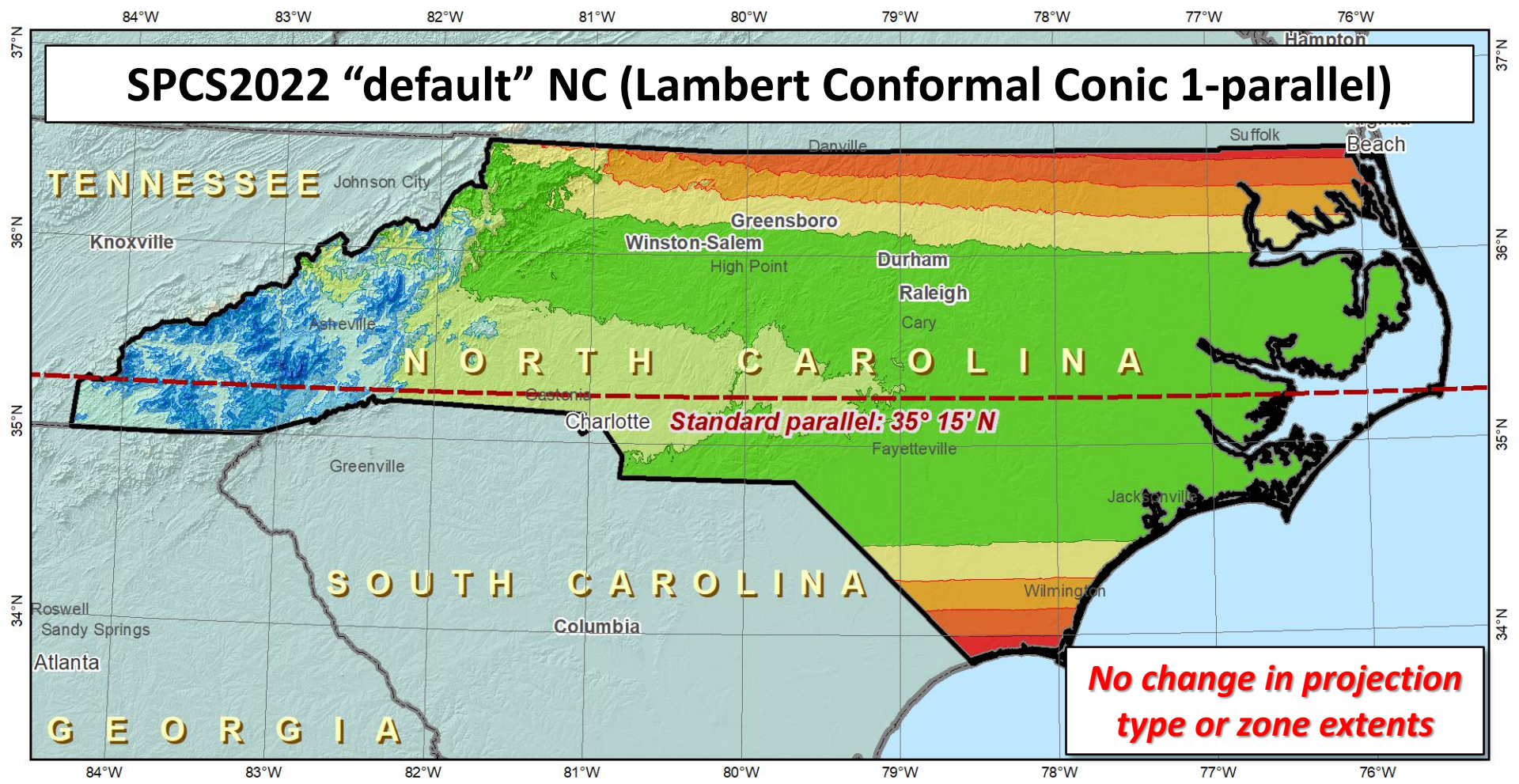


Linear distortion (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 km

	SPCS 83 NC	
Central parallel	35°15'06.33..."N	
Cen parallel scale	0.9998 7259...	
	Height (m)	Distortion (ppm)
Min	-41	-413
Max	1939	+176
Mean	197	-93



Linear distortion (parts per million)

< -400	to -200	to +150
to -400	to -150	to +200
to -350	to -100	to +250
to -300	±50	to +300
to -250	to +100	> +300

0 50 100 150 200 250 km

	SPCS 83 NC	SPCS2022
Central parallel	35°15’06.33…”N	35°15’N
Cen parallel scale	0.9998 7259…	0.99996
	Height (m)	Distortion (ppm)
Min	-41	-413	-325
Max	1939	+176	+263
Mean	197	-93	-5

New Datums are Coming in 2022

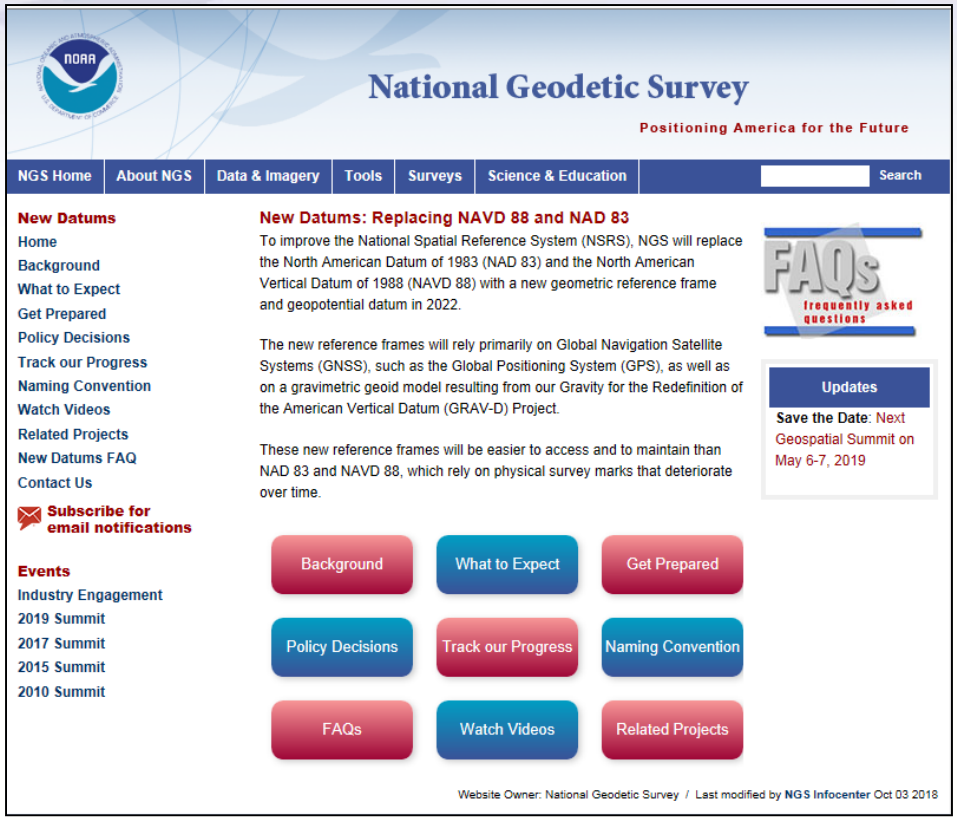
Our preparations to date include:

- Created a 2022 Datum Working Group to develop implementation recommendations ✓
- Working with SC Geodetic Survey, SC, NC, and VA Department's of Transportation to develop common implementation plans ✓
- Working with the National Geodetic Survey to complete GRAV-D in North Carolina
  - Collecting terrestrial gravity data ✓
  - Collection of airborne gravity data completed ✓
- Partnering with UNCC to purchase an absolute gravity meters ✓
- Obtaining ellipsoidal heights on NAVD88 bench marks ✓
- Collecting statewide LiDAR elevation data (USGS QL1 and QL2) ✓
- Created 2022 Datum web page ✓
- Education outreach ✓
- National Geodetic Survey GPS on Bench Marks project ✓
- Plan to meet with NGS in March in Silver Springs to discuss the NCSPCS 2022

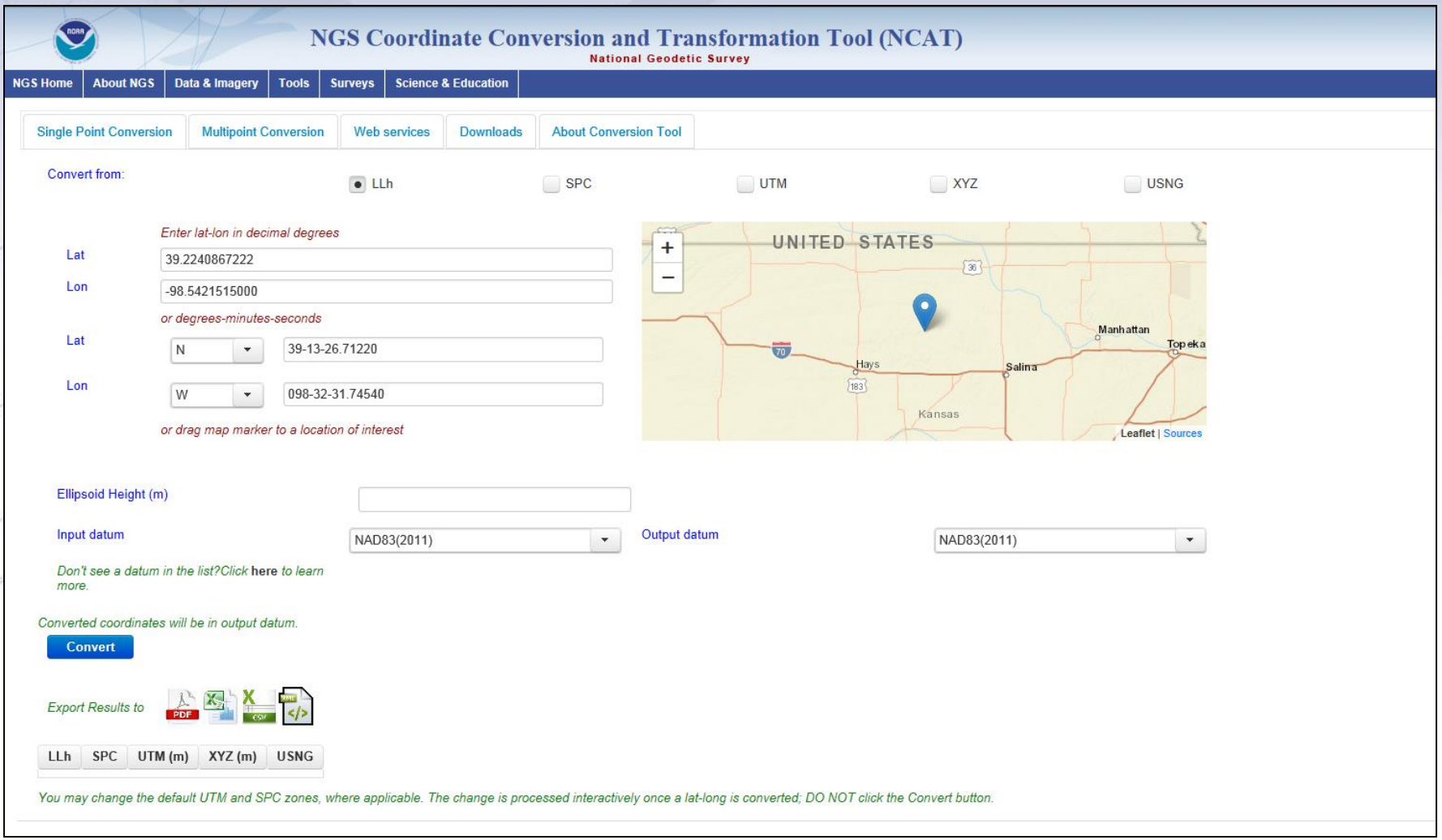
In progress = ✓
Completed = ✓

To Learn More

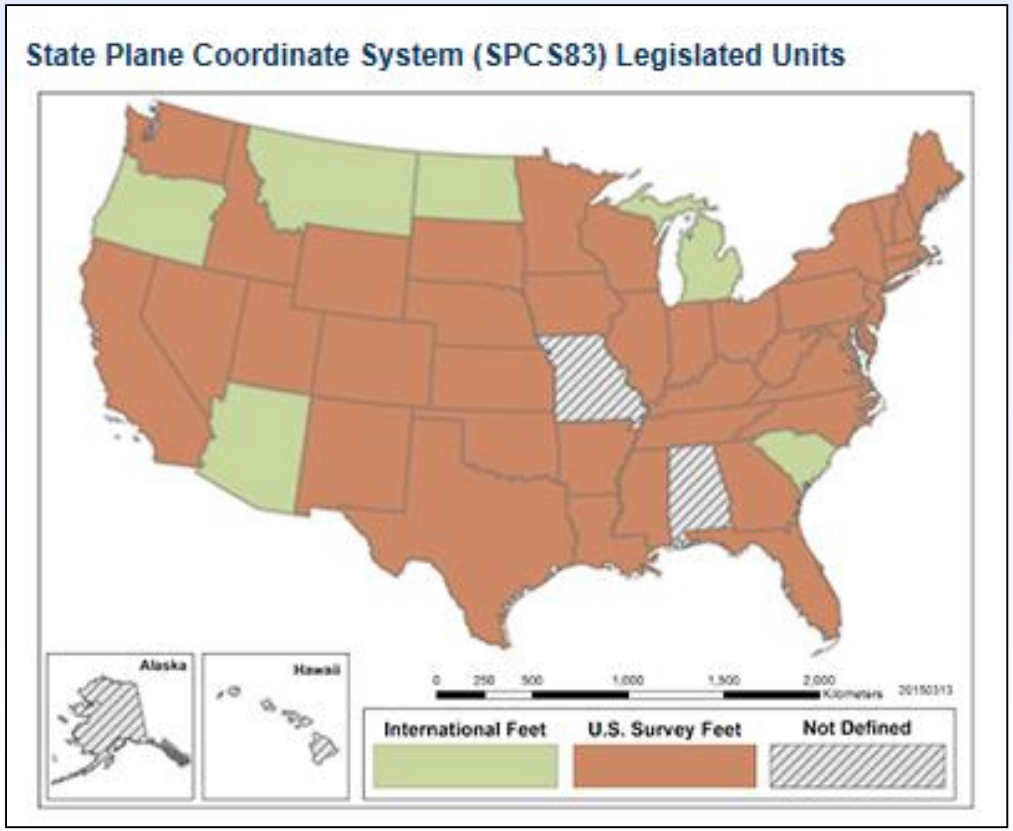
Visit the New Datums web page



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


NGS Coordinate Conversion and Transformation Tool (NCAT)
National Geodetic Survey
NGS Home
About NGS
Data & Imagery
Tools
Surveys
Science & Education
Single Point Conversion
Multipoint Conversion
Web services
Downloads
About Conversion Tool
Convert from:
LLh
SPC
UTM
XYZ
USNG
Enter lat-lon in decimal degrees
Lat
39.2240867222
Lon
-98.5421515000
or degrees-minutes-seconds
Lat
N
39-13-26.71220
Lon
W
098-32-31.74540
or drag map marker to a location of interest
UNITED STATES
Manhattan
Topeka
Hays
Salina
Kansas
Leaflet | Sources
Ellipsoid Height (m)
Input datum
NAD83(2011)
Output datum
NAD83(2011)
Don't see a datum in the list?Click here to learn more.
Converted coordinates will be in output datum.
Convert
Export Results to
LLh
SPC
UTM (m)
XYZ (m)
USNG
You may change the default UTM and SPC zones, where applicable. The change is processed interactively once a lat-long is converted; DO NOT click the Convert button.

Units


State Plane Coordinate System (SPCS83) Legislated Units
Alaska
Hawaii
0 250 500 1,000 1,500 2,000
Kilometers
20150313
International Feet
U.S. Survey Feet
Not Defined

Questions?

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