



NGS and the Modernization of the National Spatial Reference System (NSRS)

Dr. Dana Caccamise

Pacific Southwest Region (CA,NV) Geodetic Advisor
dana.caccamise@noaa.gov
NOAA's National Geodetic Survey
geodesy.noaa.gov



Simposio SIRGAS 2016

Quito, Ecuador

Noviembre 16 - 18, 2016

NGS and the NSRS continue to evolve!

The National Geodetic Survey (NGS) has been around a long time!

Our Nation's first science agency (209 years).



1807

Thomas Jefferson
Survey of the Coast



Ferdinand Hassler
First Director



1878

U.S. Coast and
Geodetic Survey



1970

NOAA is
established

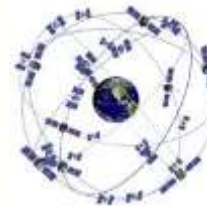
**The National Spatial
Reference System continues
to evolve with us.**



Passive
Control
(Monuments)



Active
Control
(CORS)



GPS



GNSS

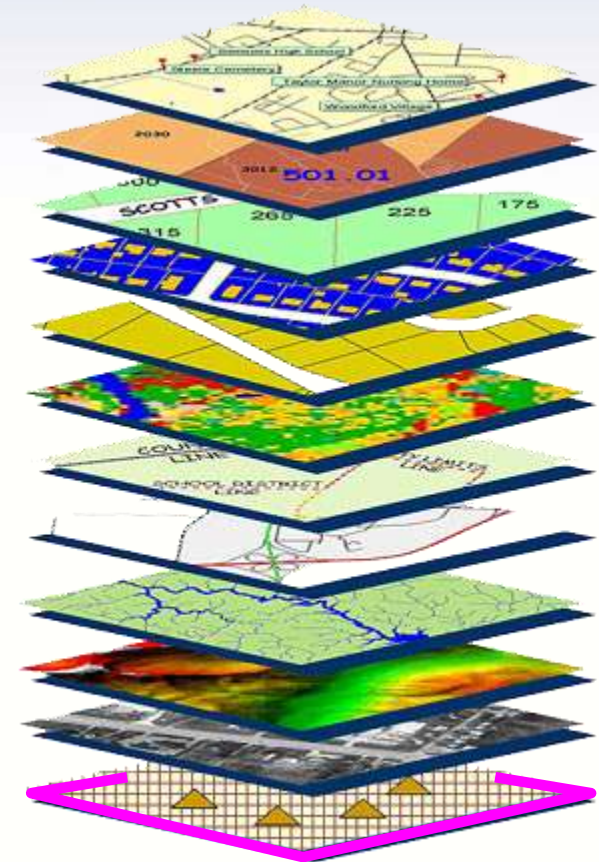
Accurate positions begin with accurate coordinates!

Geodetic control (NSRS) is the foundation for all geospatial products.

Without a geodetic control “base map” layer, GIS applications will not work properly!



Image Source: Unknown



NGS Provides the Geospatial Infrastructure Critical to Our Economy through the NSRS



Precision Agriculture



Aviation



Satellite Operations



Trucking and Shipping



Surveying and Mapping



Disaster Response



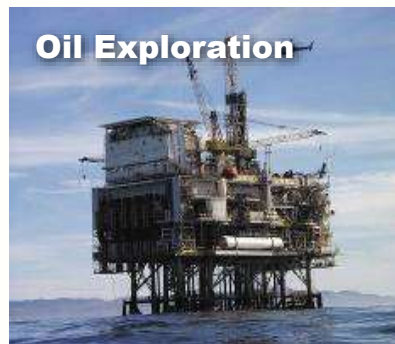
Personal Navigation



CORS



Navigation



Oil Exploration



Fishing and Boating



Survey Marks

Location, Location, and Elevation!

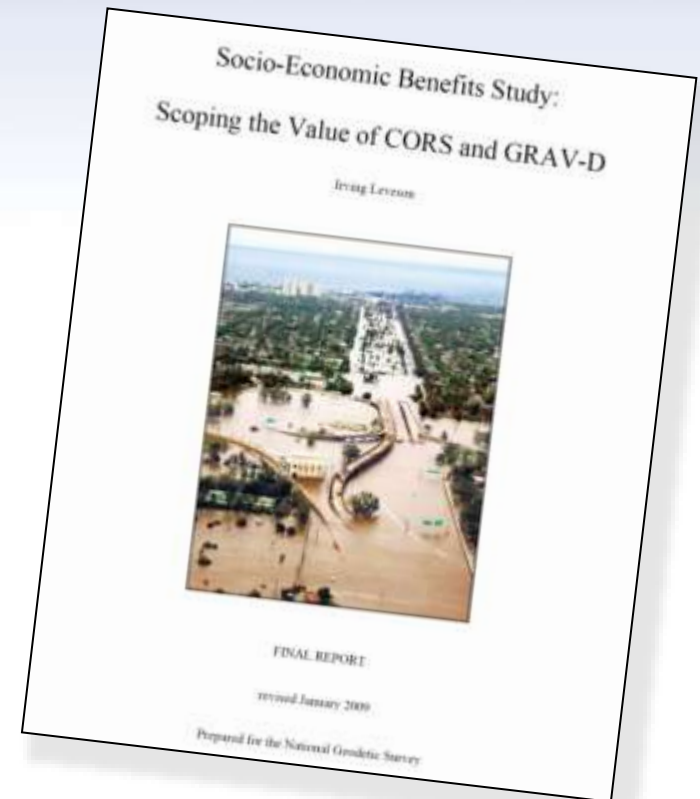
NGS Positioning Products Worth Billions!

http://www.ngs.noaa.gov/PUBS_LIB/Socio-EconomicBenefitsofCORSandGRAV-D.pdf

NSRS worth \$2.4 billion per year,
\$22 billion over 15 years at a discounted rate.

CORS worth \$758 million per year;
\$6.9 billion over 15 years at a discounted rate.

GRAV-D worth \$522 million per year
through implementation of a new national vertical datum; \$4.8 billion over 15 years at a discounted rate, including \$2.2 billion for improved floodplain management alone.



One-page handout available at: http://www.ngs.noaa.gov/INFO/OnePagers/socio_eco_handout.pdf

NGS Programs

Modernizing the NSRS



CORS



Height Modernization

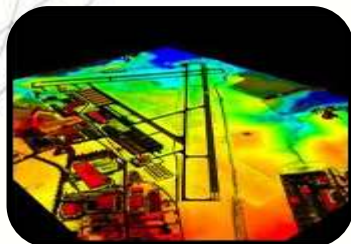


GRAV-D



ECO

NGS Products and Services



Airport Surveys



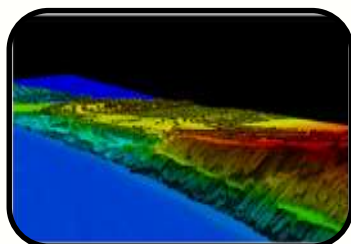
OPUS



VDatum



GPS Satellite Orbits



Coastal Mapping



Geodetic Advisor Program



Emergency Response Imagery



The National Geodetic Survey Ten-Year Plan

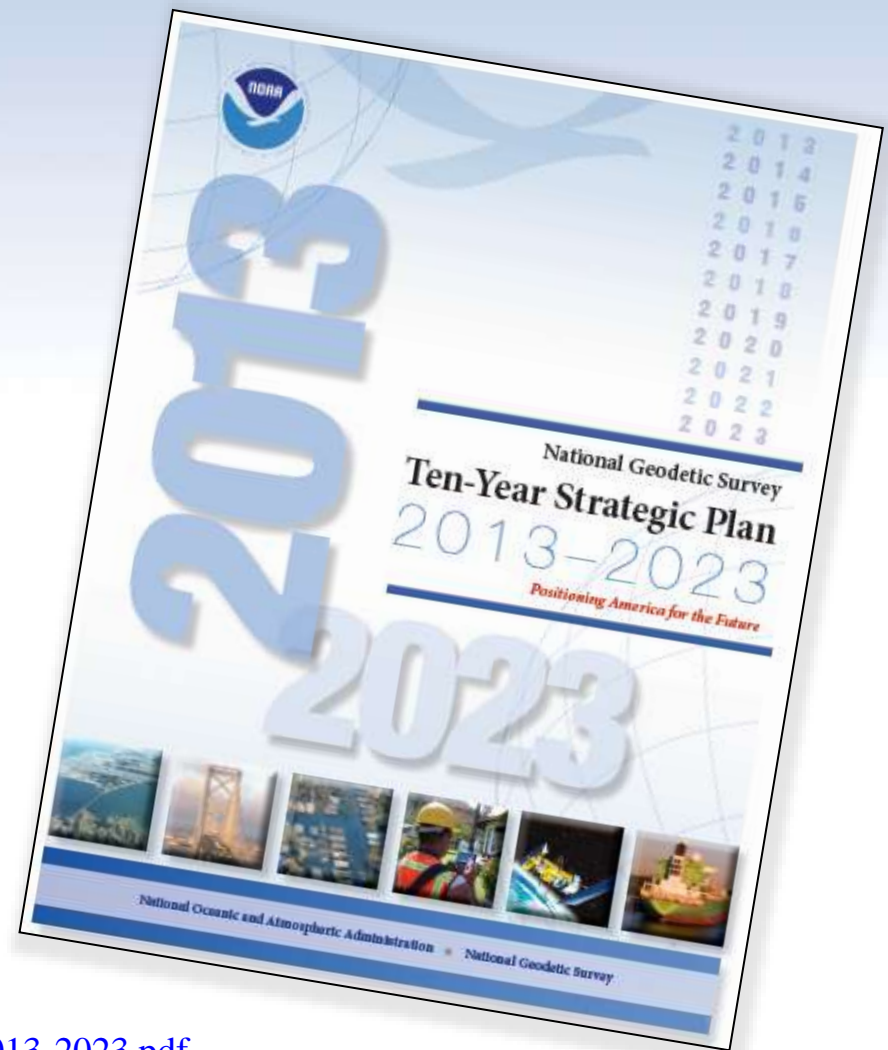
Support the users of the National Spatial Reference System.

Modernize and improve the National Spatial Reference System.

Expand the National Spatial Reference System stakeholder base through partnerships, education, and outreach.

Develop and enable a workforce with a supportive environment.

Improve organizational and administrative functionality.



http://www.ngs.noaa.gov/web/news/Ten_Year_Plan_2013-2023.pdf

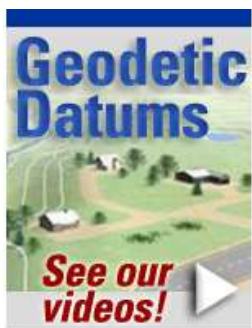
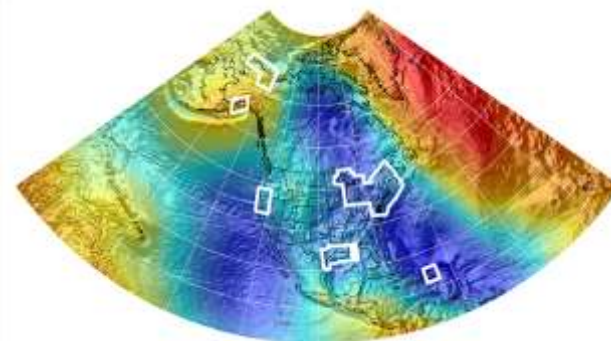
New Datums Are Coming in 2022!

- NOAA's National Geodetic Survey will release new **geometric** (horizontal) and **geopotential** (vertical) datums in **2022**
- The realization of the new datums will be through **GPS/GNSS receivers** and will replace the **current datums**:
NAD 83(geometric) and NAVD 88 (geopotential)
- Target:** 2-centimeter accuracy relative to sea level (orthometric heights) using GPS/GNSS and a geoid (gravity) model from NGS' GRAV-D project.
- NGS will provide the tools** to easily transform between the new and old datums.

Approximate predicted change from NAVD88 to new vertical (geopotential) datum



Predicted change estimated as NAVD88 "zero" (datum) surface minus NGS gravimetric geoid



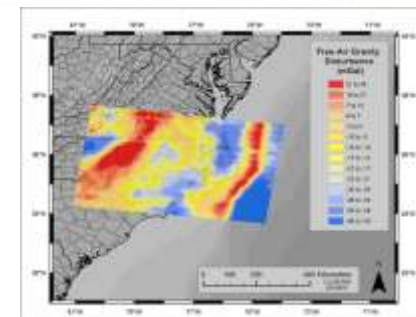
MORE INFO:

April 24-26, 2017 NGS Geospatial Summit:

<http://www.geodesy.noaa.gov/2015GeospatialSummit/>

New Datums Webpage and Videos:

<http://www.geodesy.noaa.gov/datums/newdatums/NewDatums.shtml>



What's Being Replaced

- What's being replaced:

Horizontal

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

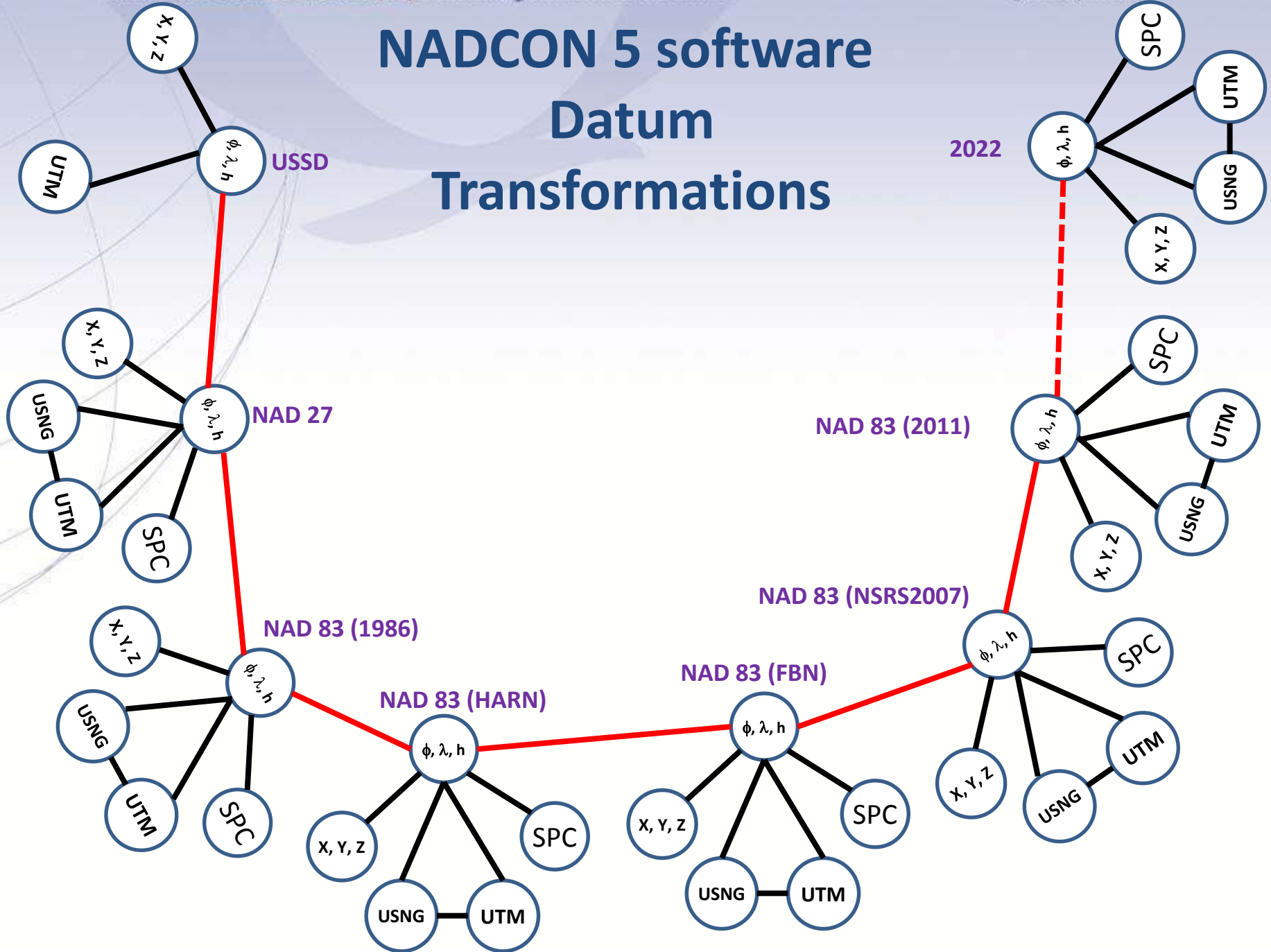
Vertical

- NAVD 88
- PRVD 02
- VIVD09
- ASVD02
- NMVD03
- GUVVD04
- IGLD 85

Heights

Latitude
Longitude
Ellipsoid Height
State Plane Coordinates

NADCON 5 software Datum Transformations



The current naming proposal

- Geometric Reference Frames (XYZ, $\phi\lambda h$):

Plate	Name	Acronym
North American	North American Terrestrial Reference Frame of 2022	NATRF2022
Pacific	Pacific Terrestrial Reference Frame of 2022	PTRF2022
Caribbean	Caribbean Terrestrial Reference Frame of 2022	CTRF2022
Marianas	Marianas Terrestrial Reference Frame of 2022	MTRF2022

- Geoid Models (N):

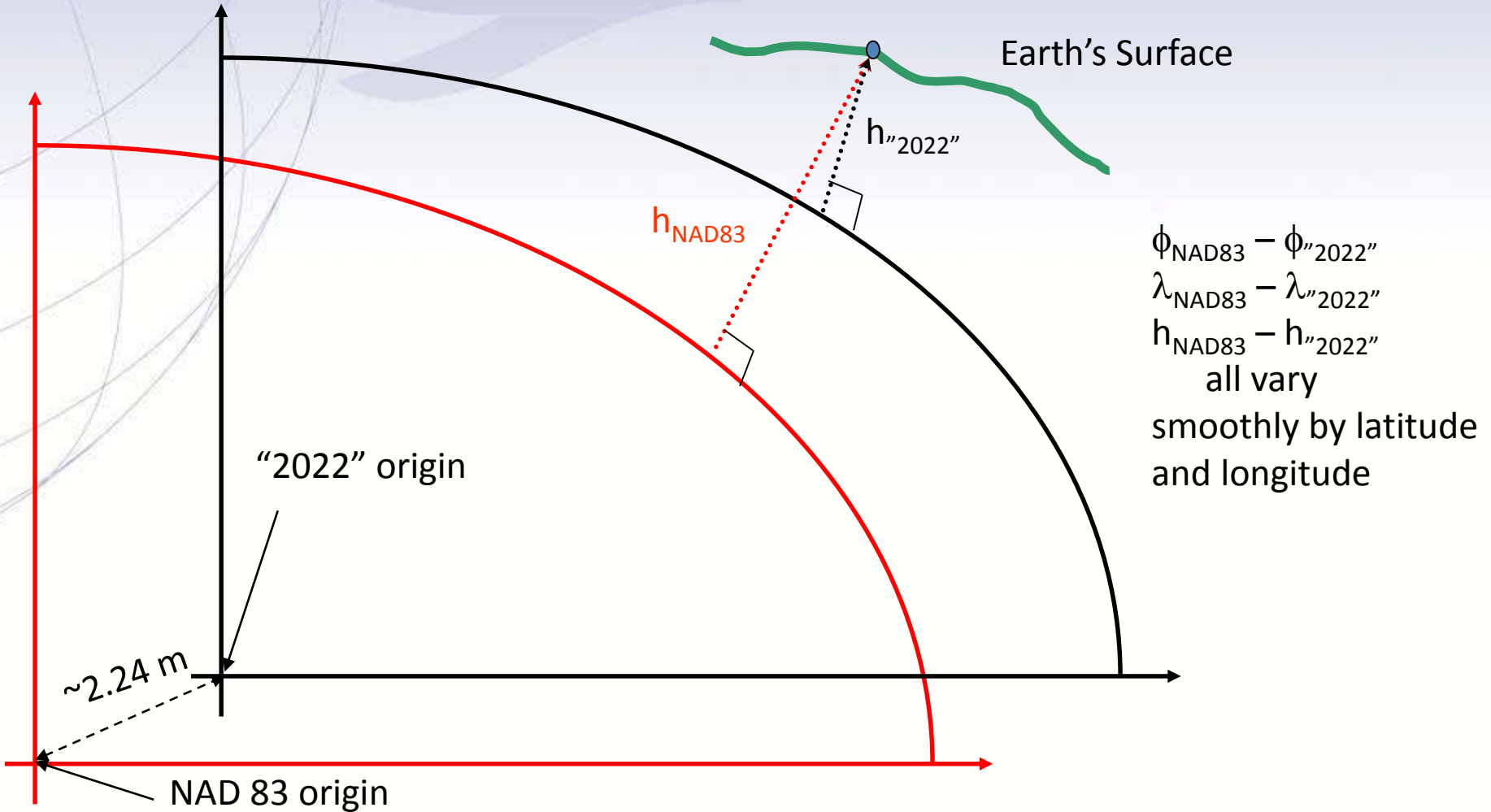
Grid Area	Name
North America (pole to equator; Aleutians to Greenland)	GEOID2022-NA
American Samoa	GEOID2022-AS
Guam and CNMI	GEOID2022-GC

- Geopotential Datum (H , H_{dyn} , g , Δg , ξ , η , etc)

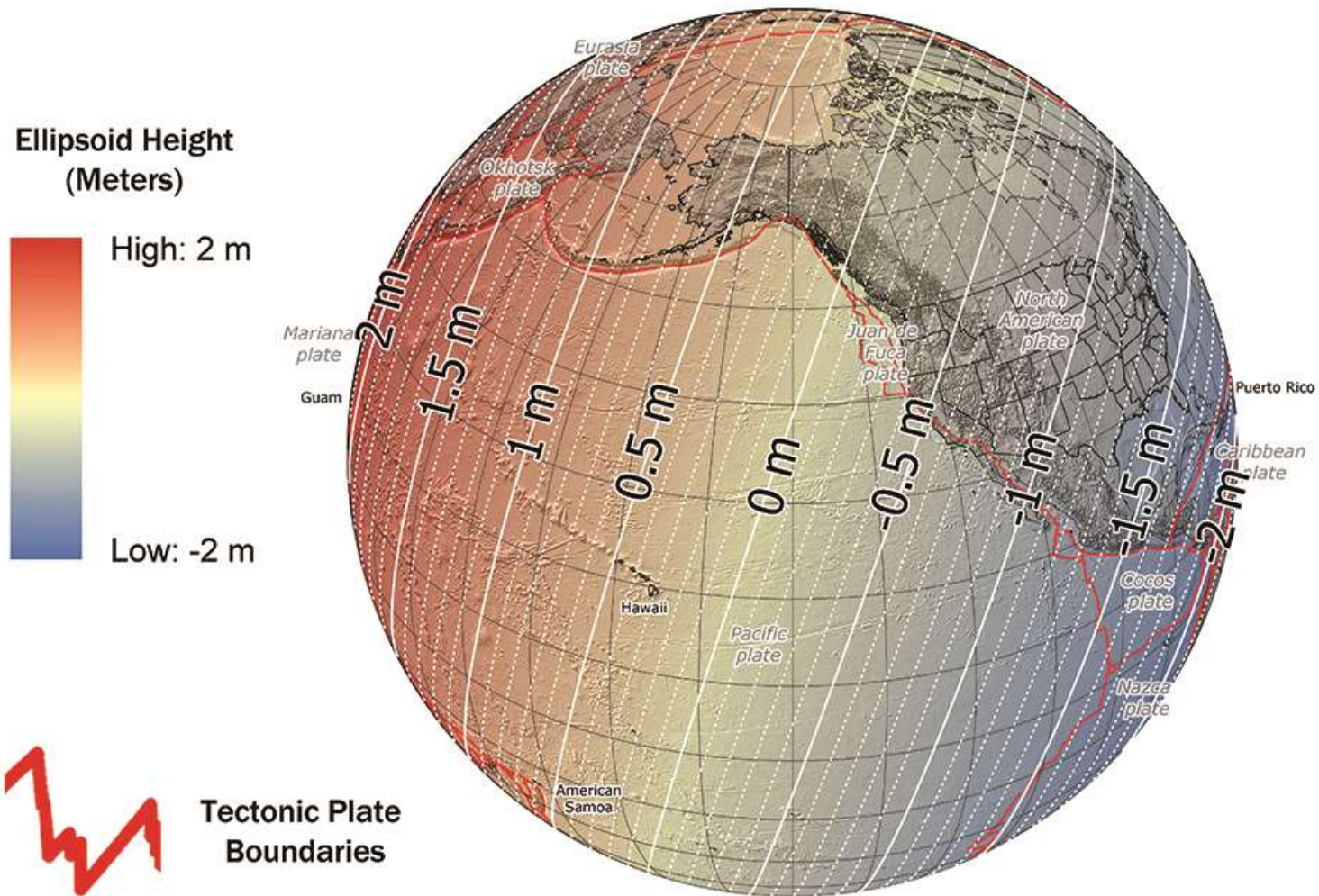
Area	Name	Acronym
All	North American-Pacific Geopotential Datum of 2022	NAPGD2022

Replace NAD 83

Simplified Concept of NAD 83 vs. "2022"

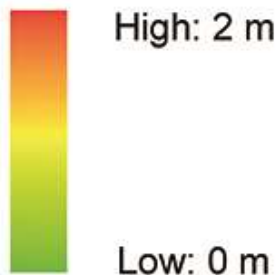


Approximate Ellipsoid Height Change

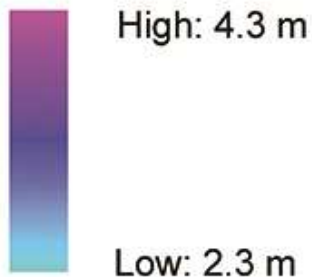


Approximate Horizontal Change North American Plate

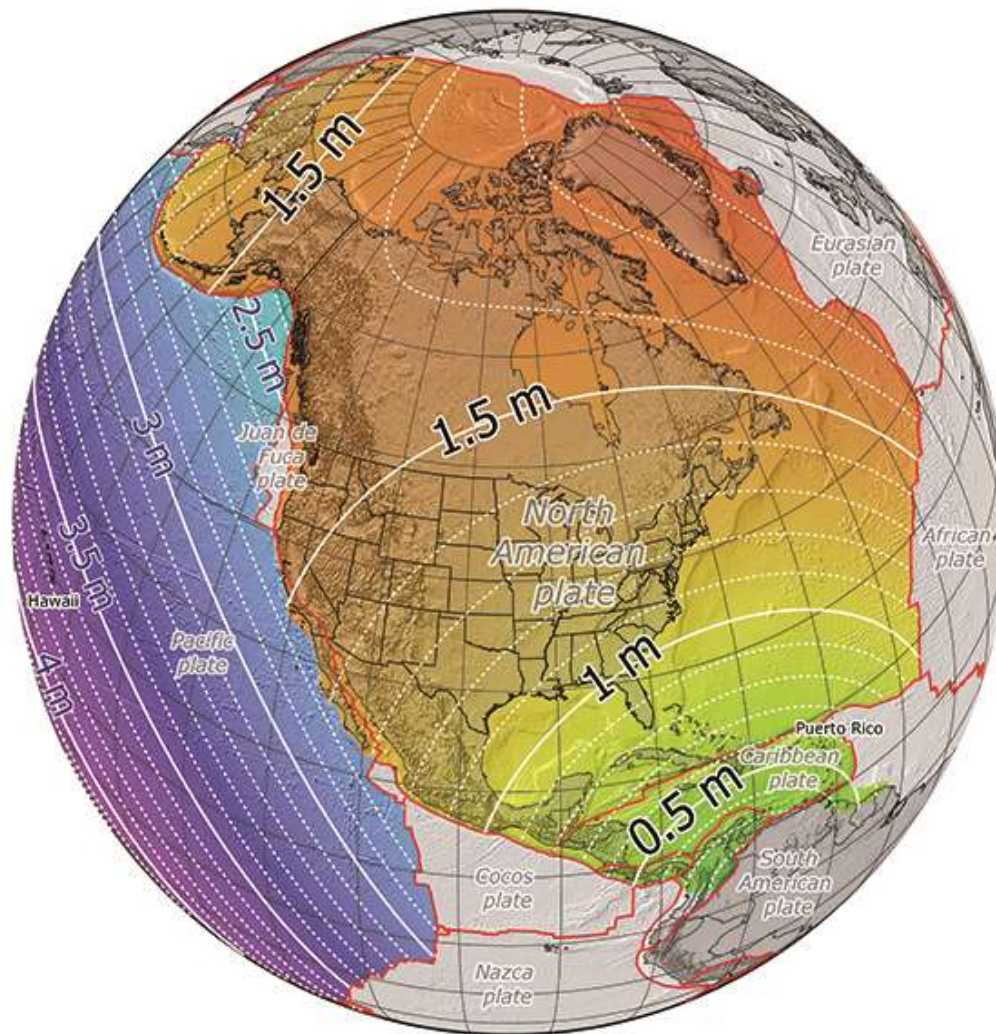
North American Plate
(Meters)



Pacific Plate
(Meters)



 Tectonic Plate Boundaries



Replace NAD 83

ACCESS AND DEFINITION

- **Primary: CORS**

- Continuous monitoring
- OPUS
- IGS coordinates
 - Transformable to any national reference frame chosen for 2022
- Static Surveys
- RTK/RTN
 - Validation service

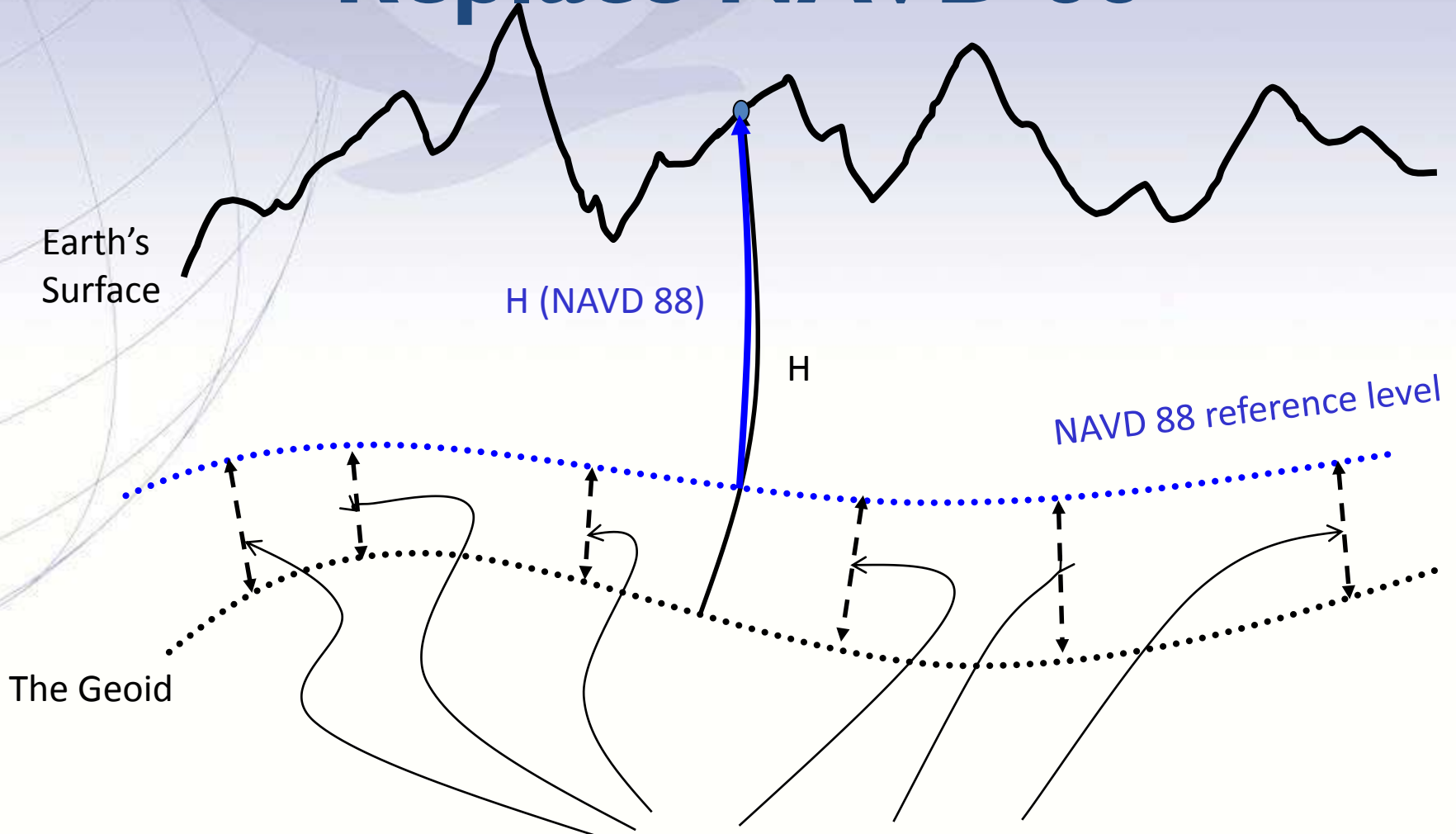


- **Secondary: Passive**

- Time-tagged coordinates
- Will reflect each occupation of the mark
- Will *generally* not be accepted as “fixed control” in surveys turned in to NGS



Replace NAVD 88



**Errors in NAVD 88 : ~50 cm average, 100 cm CONUS tilt,
1-2 meters average in Alaska, NO tracking**

Replace NAVD 88

- Changing from a leveling-based to a geoid/GNSS-based vertical datum
- Biggest requirement: An updated, accurate, nationwide gravity survey
 - Airborne
 - GRAV-D!
 - **G**ravity for the **R**edefinition of the **A**merican **V**ertical **D**atum



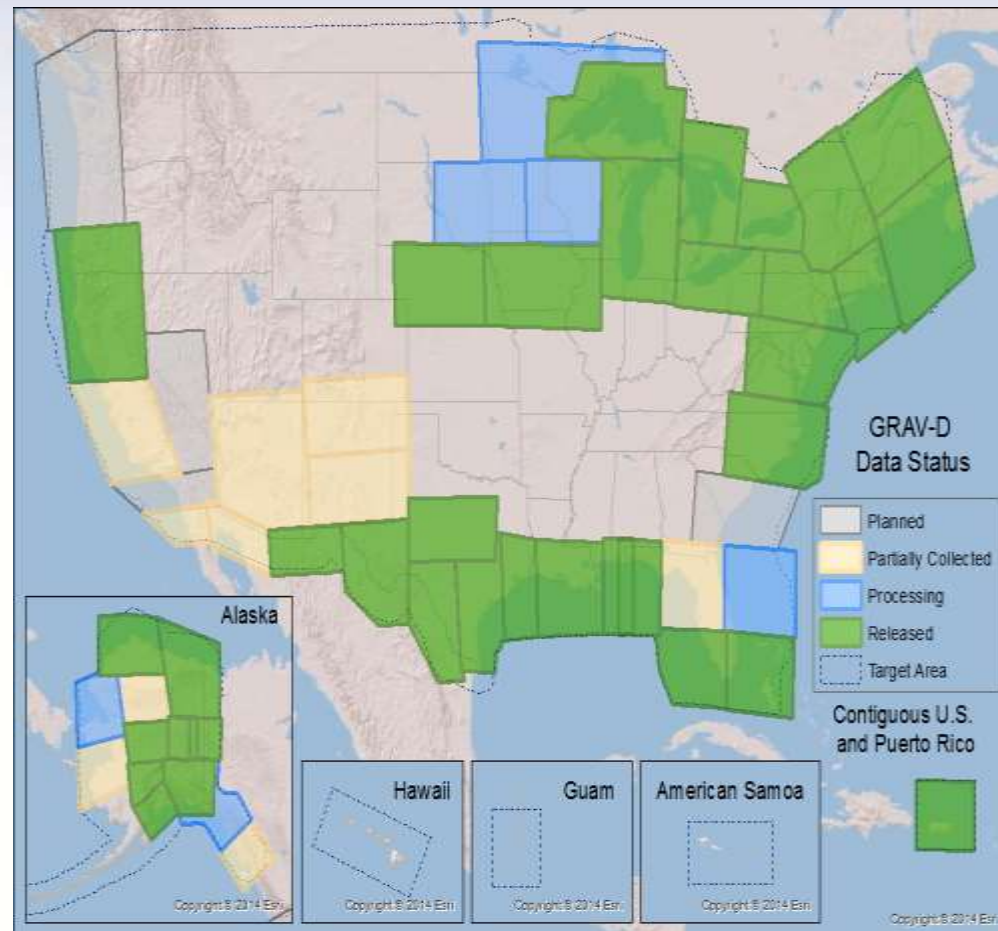
GRAV-D Coverage



GRAV-D Status

100% BY 2022

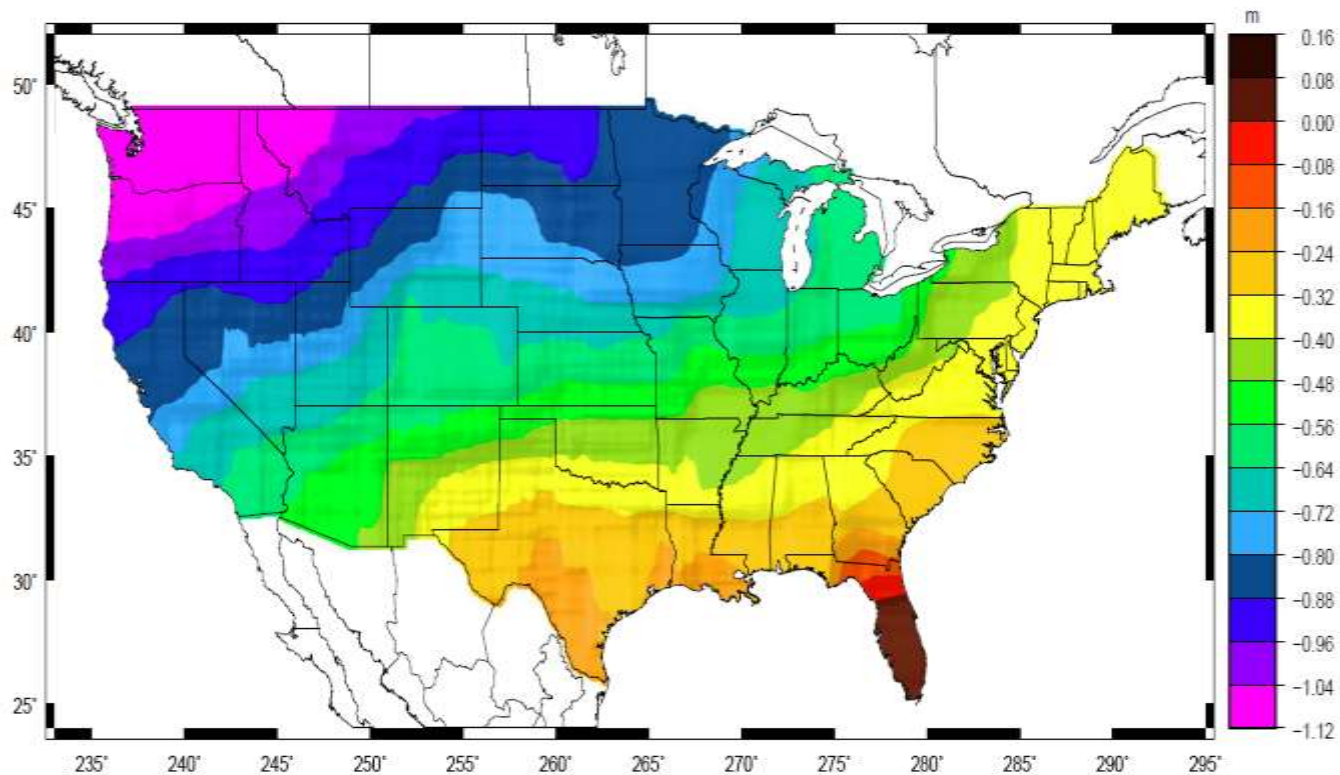
- 50% mark hit in FY2016
 - FY2017 target: 62%
- Two aircrafts at a time
 - Occasionally three
- Mix of Government and Private Industry Flights
- Experiments with G4
 - If successful, begin using G4 to collect Pacific states and territories as early as next year



Orthometric Heights

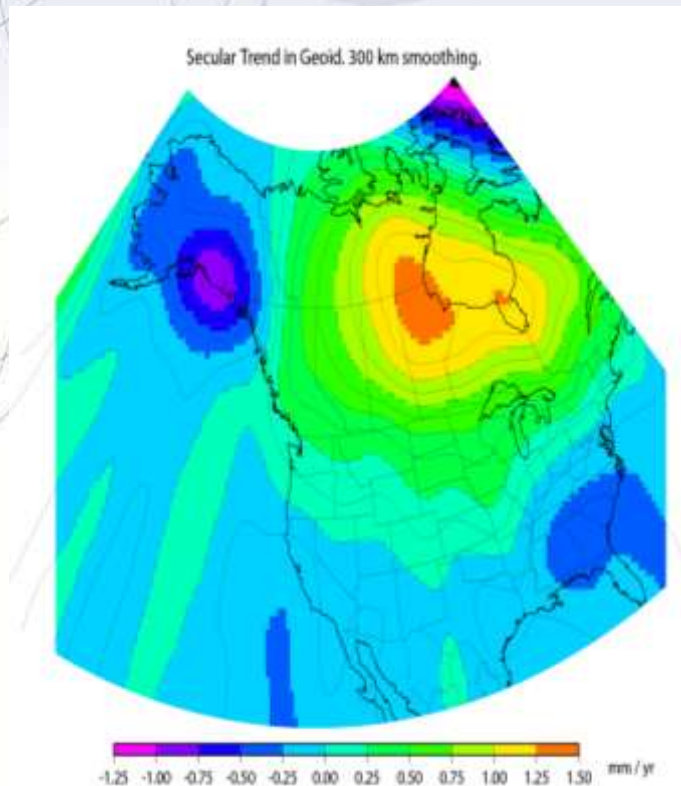
APPROXIMATE EXPECTED SHIFTS

- **Approximate level of geoid mismatch known to exist in the NAVD 88 zero surface:**
 - **Does not include local subsidence issues**



Time Dependencies

GEOID CHANGES CAUSE HEIGHT CHANGES



- The zero elevation surface will change with time
- Heights will be time tagged to respect:
 - Geoid change
 - Subsidence
- Possibly start a Geoid monitoring service?



National Geodetic Survey

Positioning America for the Future

geodesy.noaa.gov

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



February 17, 2015

Notices

NGS Announces 2015 Geospatial Summit on Improvements to the National Spatial Reference System, April 13-14, 2015 [01.08.2015](#)

NGS Announces Joint Release of GEOCON v1.0 and GEOCON11 v1.0 [08.12.2014](#)

June 30, 2014: The National Geodetic Survey (NGS) Releases new Beta experimental geoid height model "xGEOID14B," spanning one-quarter of Earth's surface [06.27.2014](#)

Popular GPS Positioning Service Is Enhanced: OPUS Projects [01.28.2014](#)

In The News

02/13/2015 - NGS Collects Damage Assessment Images in Aftermath of Storm

The National Geodetic Survey (NGS) collected **damage assessment imagery** in the aftermath of the January 2015 Nor'easter that blanketed the region in snow and caused significant storm surge along the New England coast. NGS imagery covered coastal portions of...[more](#)

02/05/2015 - World-Renowned Visiting Scientist from Denmark Collaborates with Researchers

Rene Forsberg, professor and head of the Geodynamics Department at Denmark Technical University (DTU) Space, recently visited NGS. Forsberg is arguably the world's leading researcher in airborne gravity for geodesy...[more](#)

01/29/2015 - Federal Government Agencies Participate in FGCS Semiannual Meeting

From Jan. 26-27, National Geodetic Survey (NGS) Director Juliana Blackwell chaired the semi-annual meeting of the Federal Geodetic Control Subcommittee (FGCS) at the NOAA complex in Silver Spring. Representatives from across the Federal government participated...[more](#)

01/15/2015 - NOAA Heritage Asset on Loan to City of Ukiah, California

The National Geodetic Survey (NGS) recently loaned the City of Ukiah, California, a Wanschaff zenith telescope for display in the original observatory building where it was used for nearly a century. This zenith telescope was one of six used to observe the wobble of the Earth on its axis...[more](#)

[Previous NGS News Stories](#)

Looking for Bench Marks?

Join Us! NGS 2015 Geospatial Summit April 13-14

Geodetic Datums See our videos!

Federal Geodetic Control Subcommittee of the fgdc

NGS Public News Subscription Service Click here to subscribe or unsubscribe

NGS Homepage: geodesy.noaa.gov

NGS Public News Subscription Service

Click here to subscribe or unsubscribe.

NGS Training/Online Learning Email Notifications

If you would like to receive an email informing you of upcoming training/learning opportunities presented by NOAA's National Geodetic Survey, please fill in the information below.

* Required

Your email address *

Thank You !

QUESTIONS?

INSTITUTO GEOGRÁFICO MILITAR
SIRGAS 2016 ECUADOR
Simposio y Taller



Thank You !

QUESTIONS? 2nd

INSTITUTO GEOGRÁFICO MILITAR
SIRGAS 2016 ECUADOR
Simposio y Taller

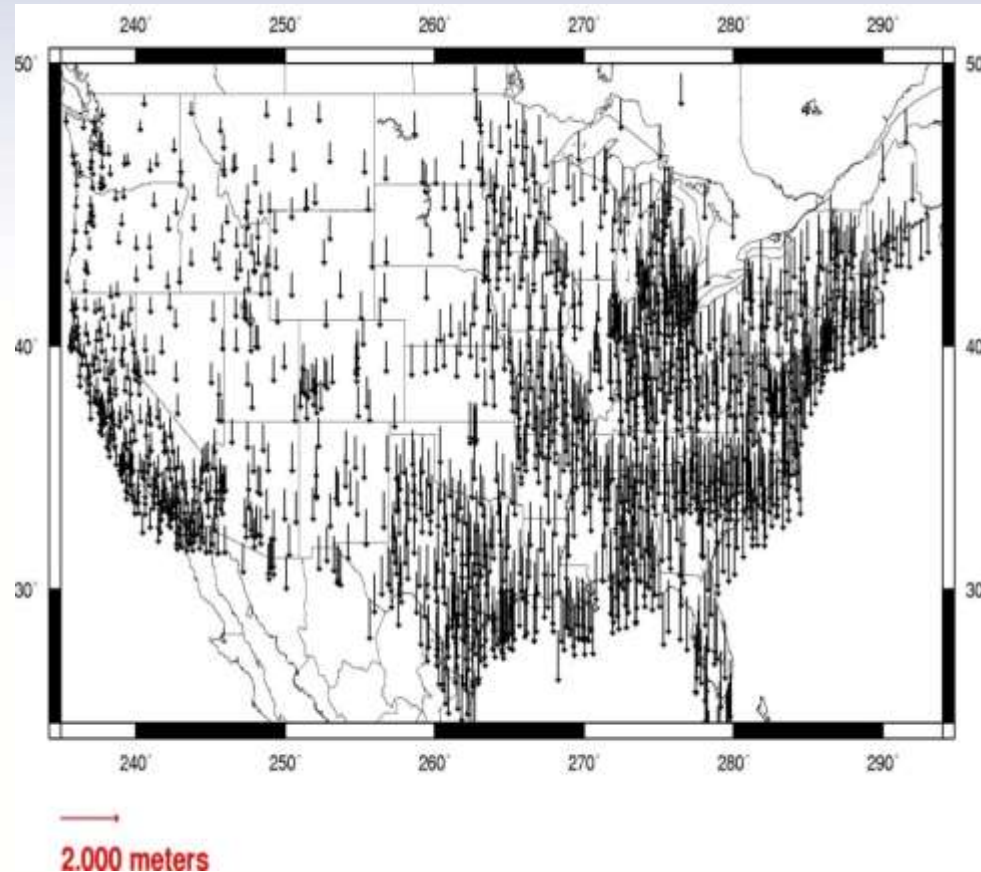
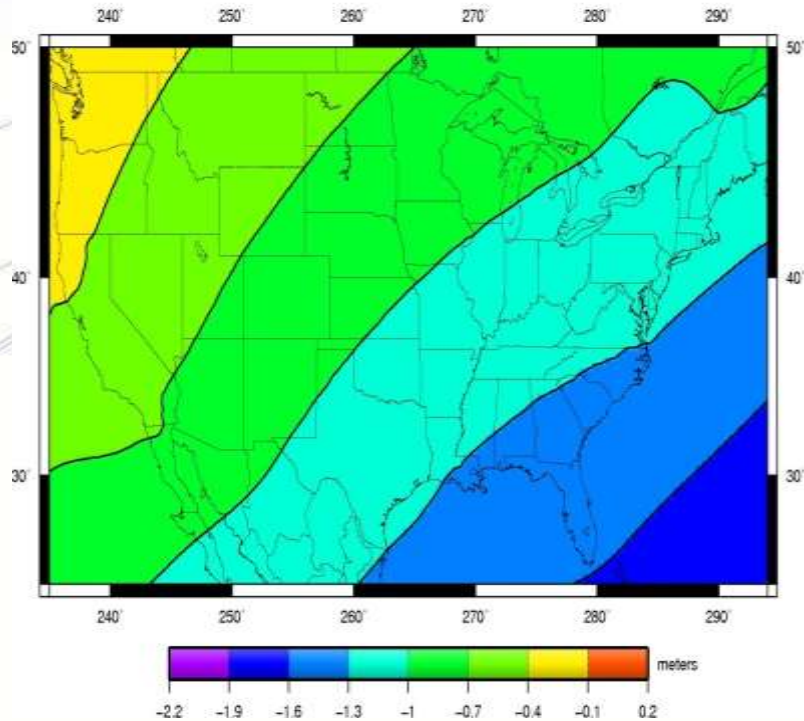


Nomenclature

- A chance to increase accuracy in *naming*!
 - “North American”?
 - Ignores Guam, Hawaii, American Samoa, Northern Mariana Islands
 - Datum vs Reference Frame?
 - Plate-specific?
 - Vertical vs Geopotential?
- 6/8/2016: NGS and the Canadian Geodetic Survey negotiated a naming proposal
 - Approved by NGS ESC
 - Approved by the CGS leadership (with minor reservations)
 - *Awaiting final word from INEGI as of 10/26/2016....*

Ellipsoid Height Shifts

- Approximate
 - IGS08(GRS-80) minus NAD 83(2011)

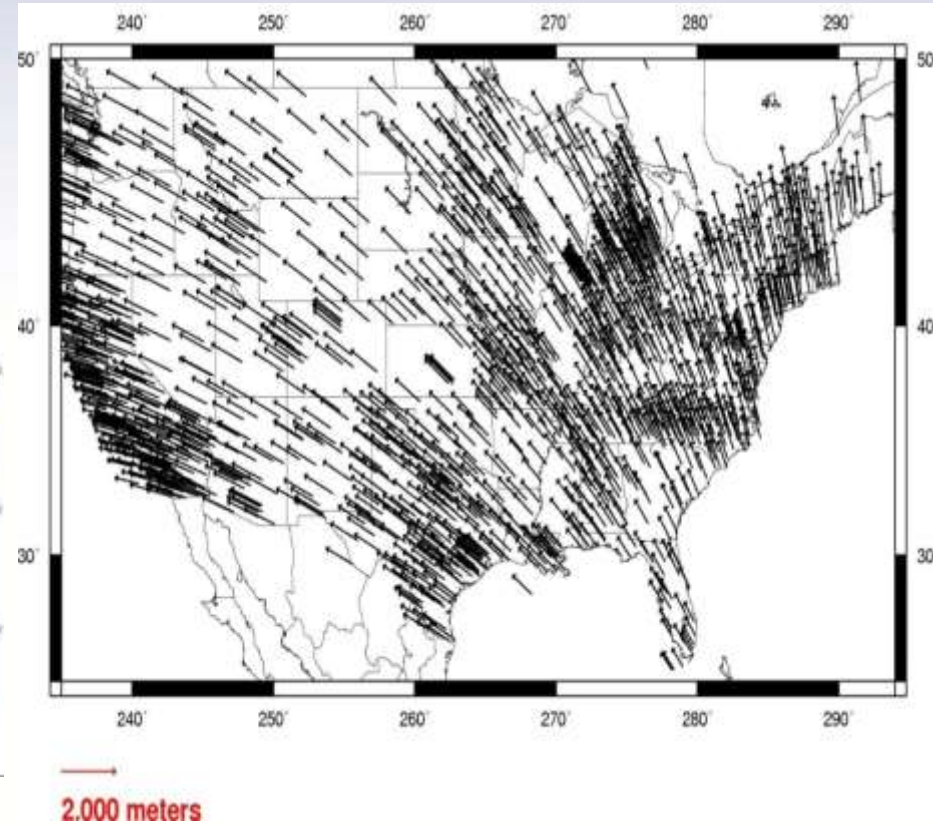
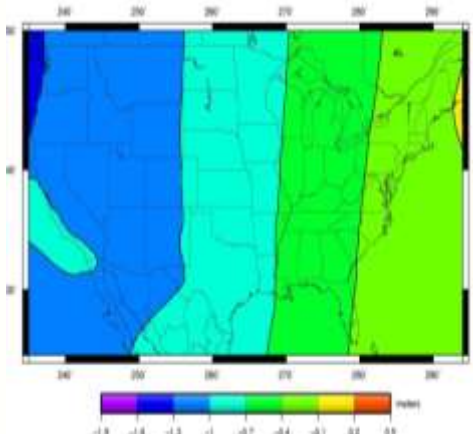
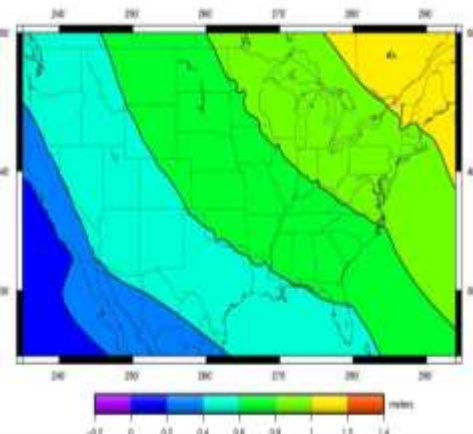


Horizontal Shifts

- Approximate
 - IGS08(GRS-80) minus NAD 83(2011)

Lat:

Lon:



Definition of new frames

“PLATE FIXED +” ... ANNOUNCEMENT COMING SOON

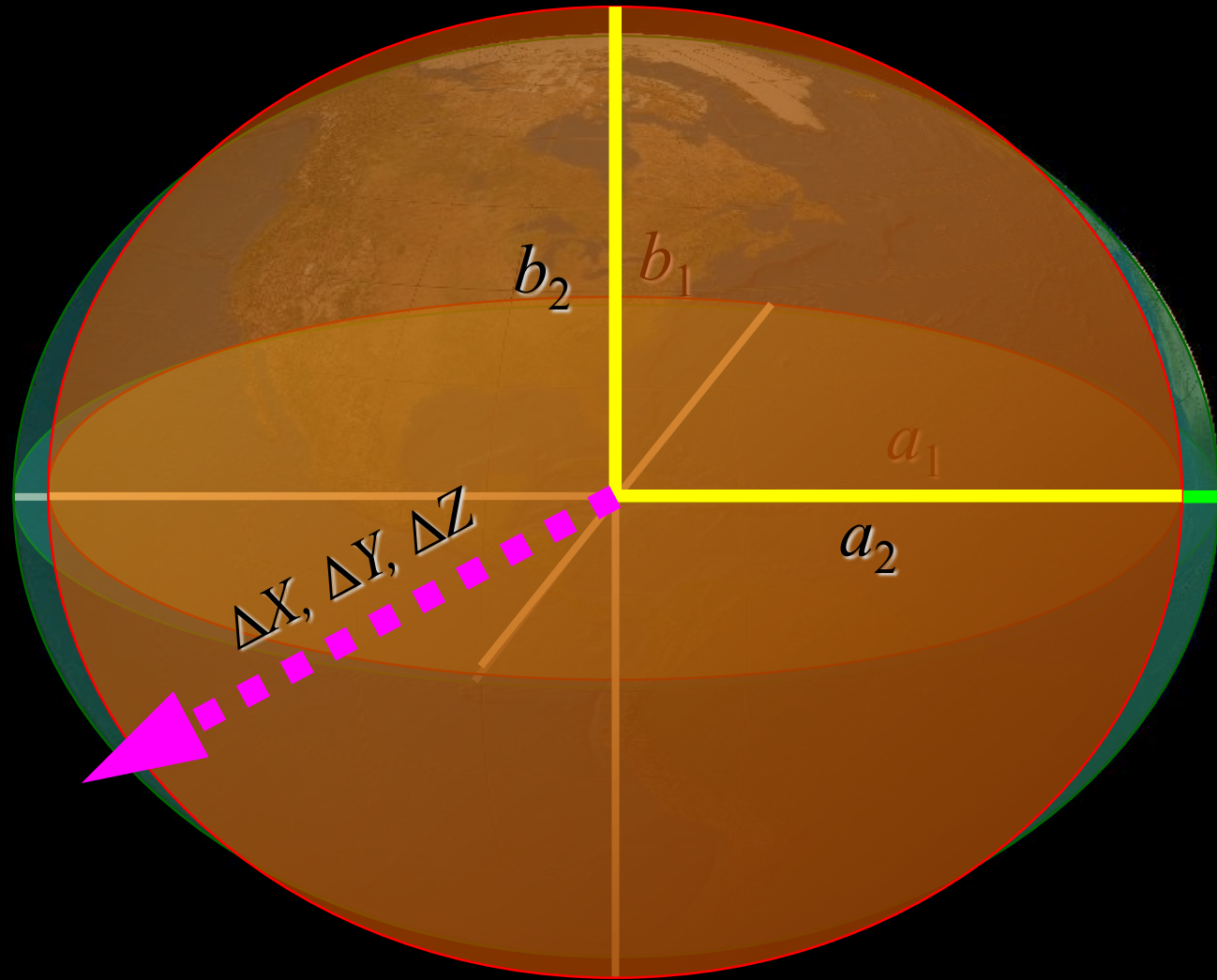
- Plate rotations will tie the new terrestrial reference frames of 2022 to the IGS frame
- Deformational velocities will be modeled separately

Time Dependencies

TRACK CORS AND ALWAYS KNOW WHERE YOU ARE

- Surveying to CORS positions at survey epoch
 - If we track CORS, we can do this easily
- Tectonic rotations
 - Easily removed for a “good east of the Rockies” solution
 - Lat/Lon only
- Residual deformations
 - Can be modeled many ways and provided for cross-epoch checking between surveys
 - 3-D

Geometric datum transformations



If datum changes with time, each component has a *velocity*...

