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

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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

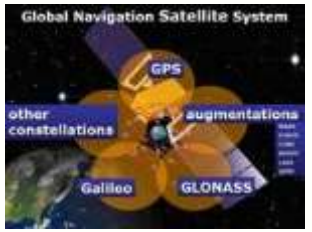
1970
NOAA is established

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!

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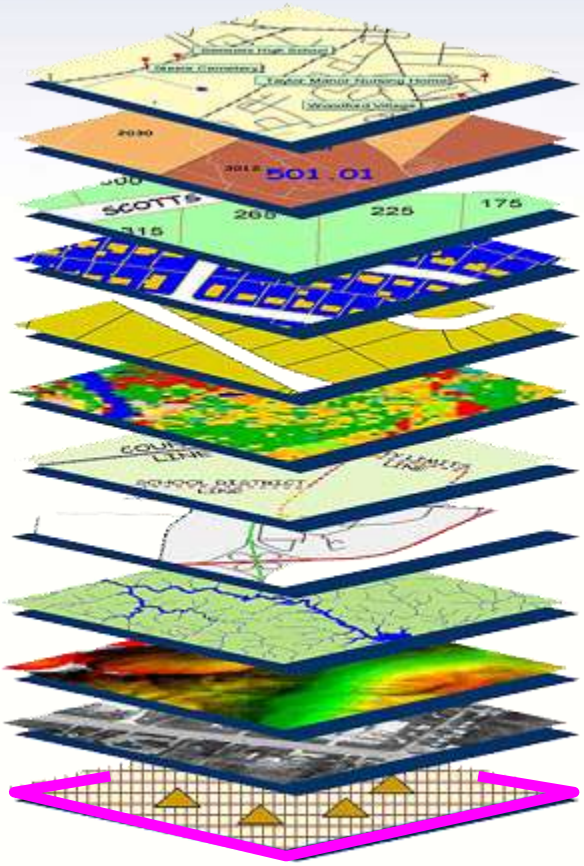
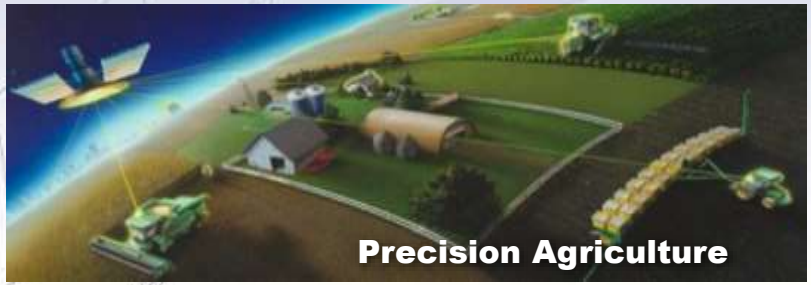
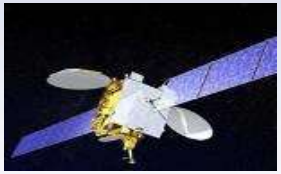


NGS Provides the Geospatial Infrastructure Critical to Our Economy through the NSRS





Satellite Operations

Personal Navigation

Survey Marks

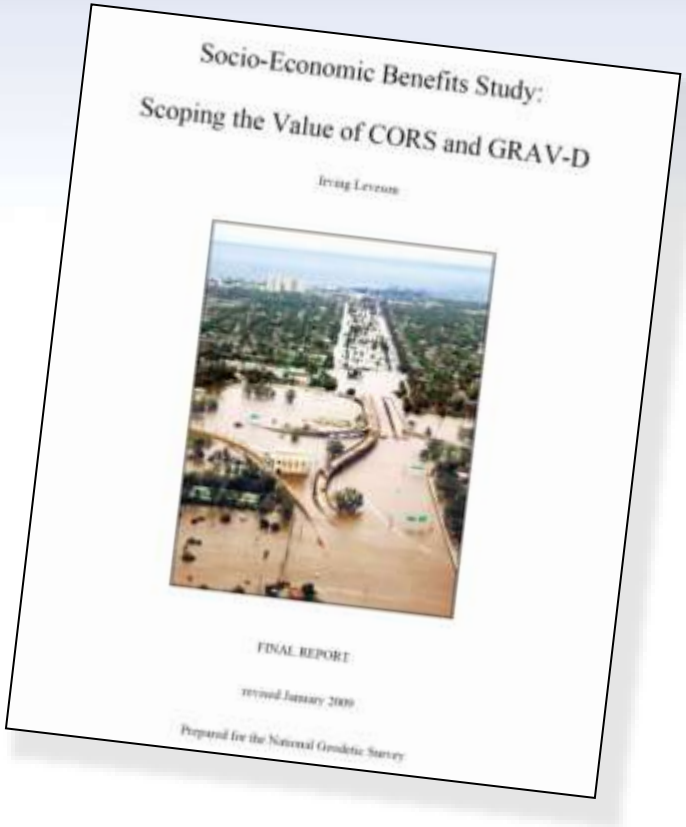
Location, Location, and Elevation!
NGS Positioning Products Worth Billions!

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.


Socio-Economic Benefits Study:

Scoping the Value of CORS and GRAV-D

Irving Leveson

FINAL REPORT

Revised January 2009

Prepared for the National Geodetic Survey

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

NGS Programs

Modernizing the NSRS

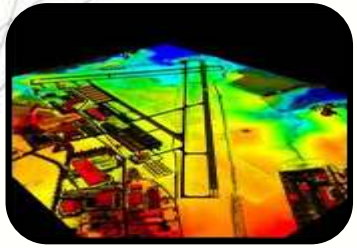
CORS

Height Modernization

GRAV-D

ECO

NGS Products and Services

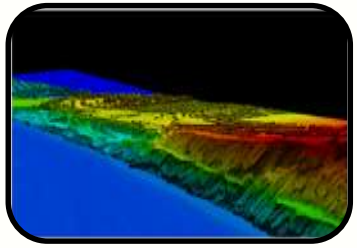


Airport Surveys

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.

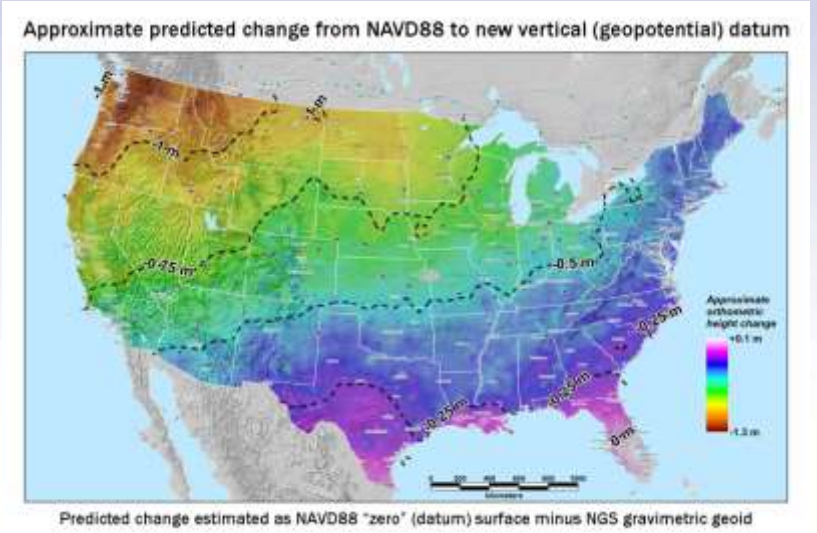
Improve organizational and administrative functionality.

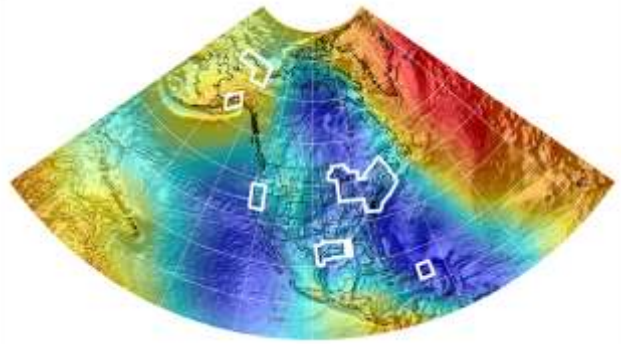
http://www.ngs.noaa.gov/web/news/Ten_Year_Plan_2013-2023.pdf

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.





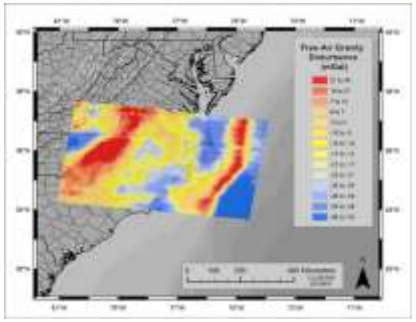
MORE INFO:

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

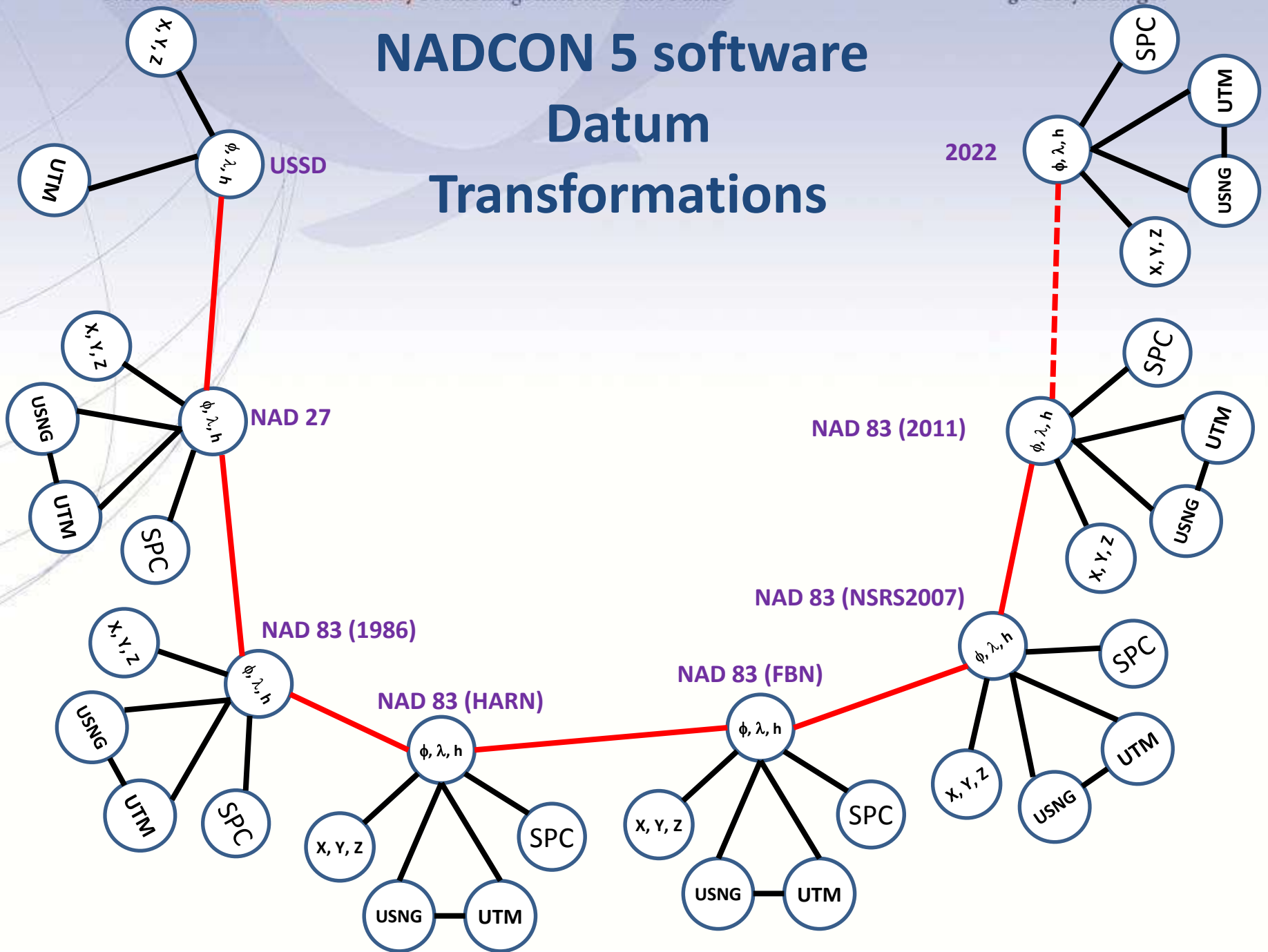
- What's being replaced:

Horizontal	Vertical
~~NAD 83(2011)~~	NAVD 88
NAD 83(PA11)	PRVD 02
NAD 83(MA11)	VIVD09
	ASVD02
	NMVD03
	GUVD04
	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):

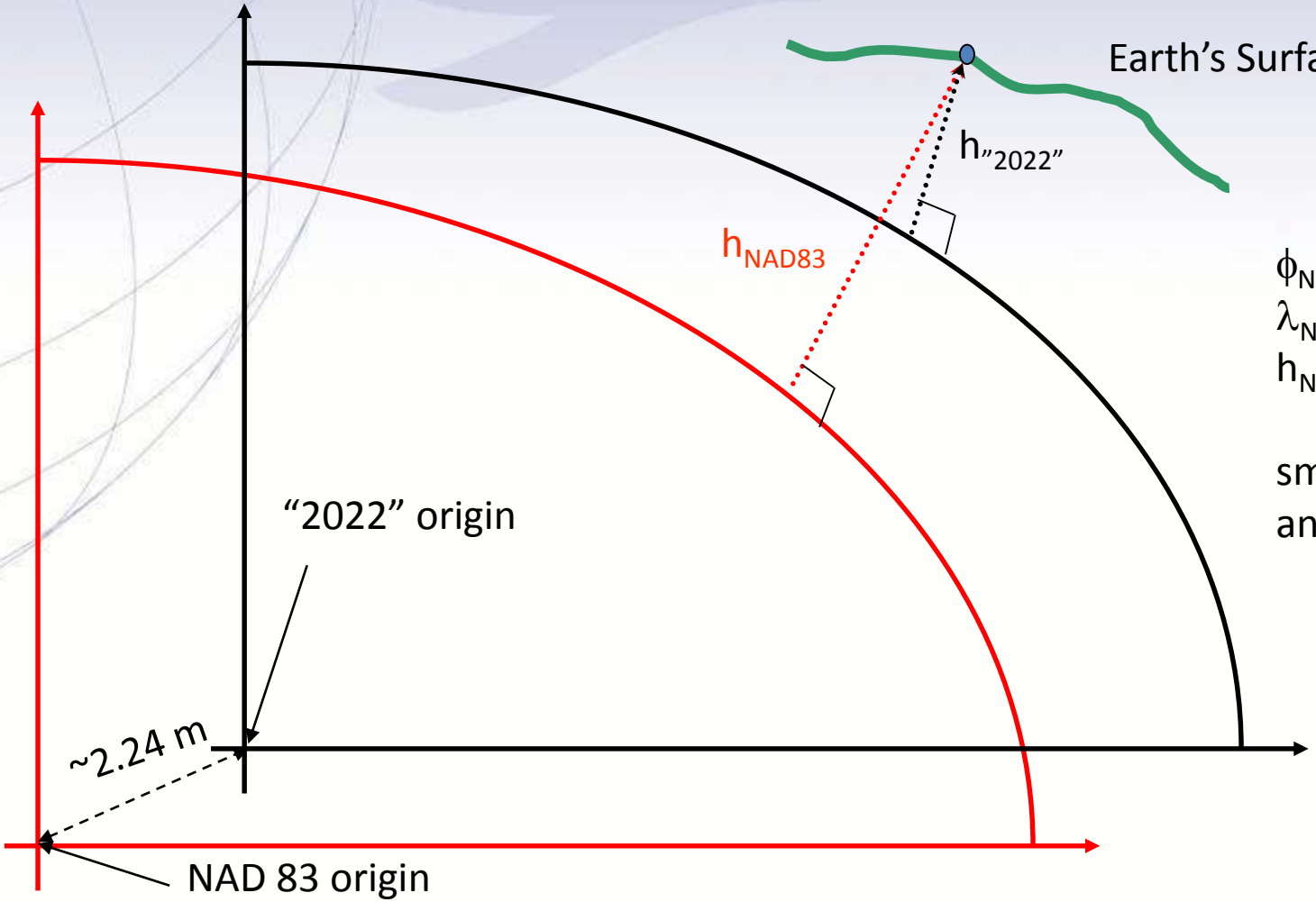
Grid Area	Name
North America (pole to equator; Aleutians to Greenland)	GEOID2022-NA
American Samoa	GEOID2022-AS
Guam and CNMI	GEOID2022-GC

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

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

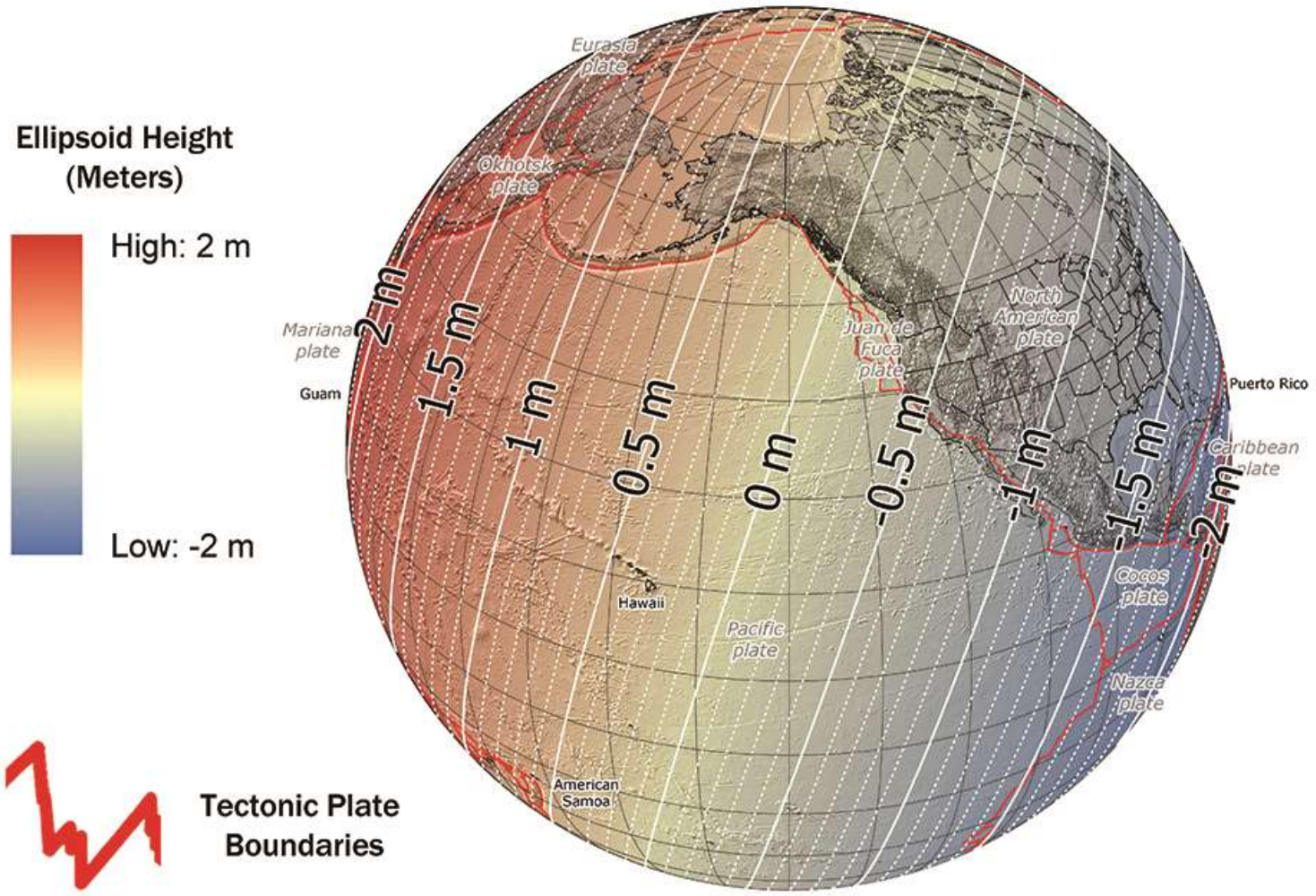
Replace NAD 83

Simplified Concept of NAD 83 vs. "2022"



$\phi_{NAD83} - \phi_{"2022"}$
$\lambda_{NAD83} - \lambda_{"2022"}$
$h_{NAD83} - h_{"2022"}$
all vary smoothly by latitude and longitude

Approximate Ellipsoid Height Change



Approximate Horizontal Change North American Plate

North American Plate (Meters)

High: 2 m

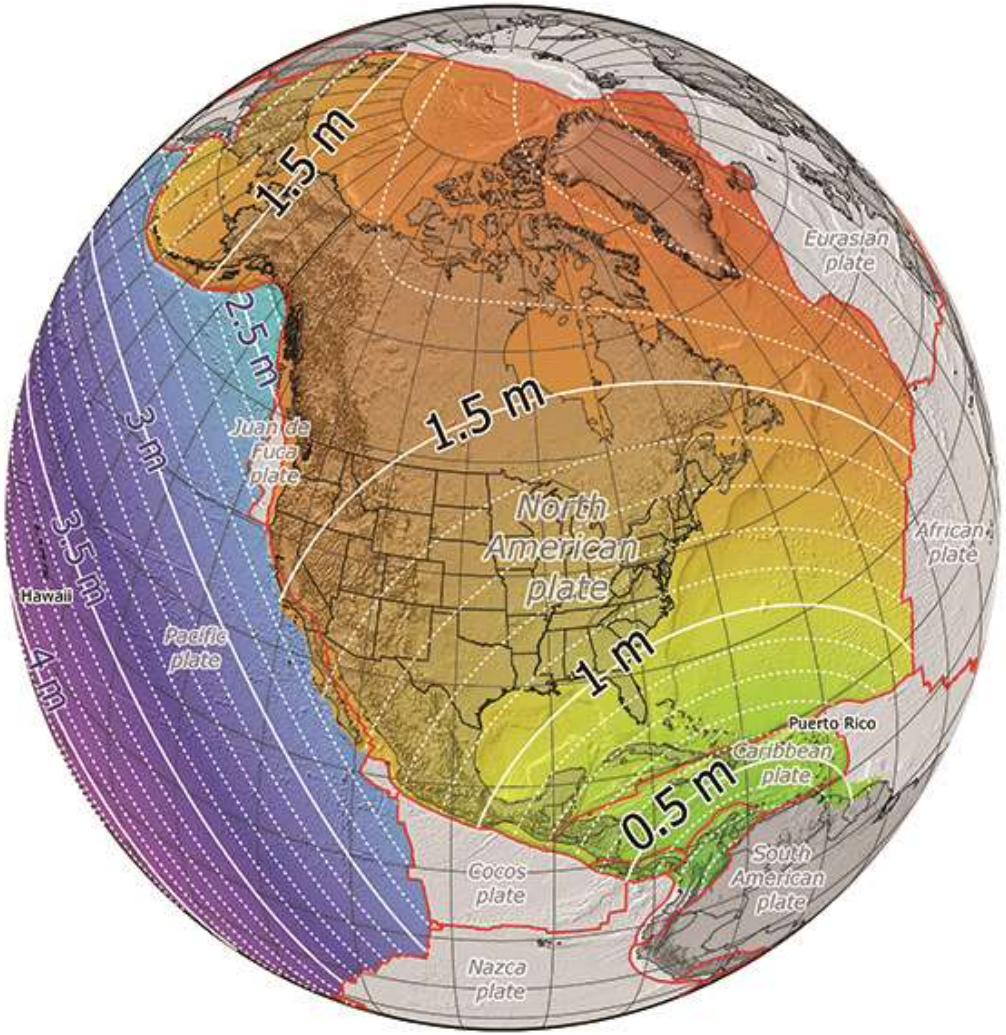
Low: 0 m

Pacific Plate (Meters)

High: 4.3 m

Low: 2.3 m

Tectonic Plate Boundaries



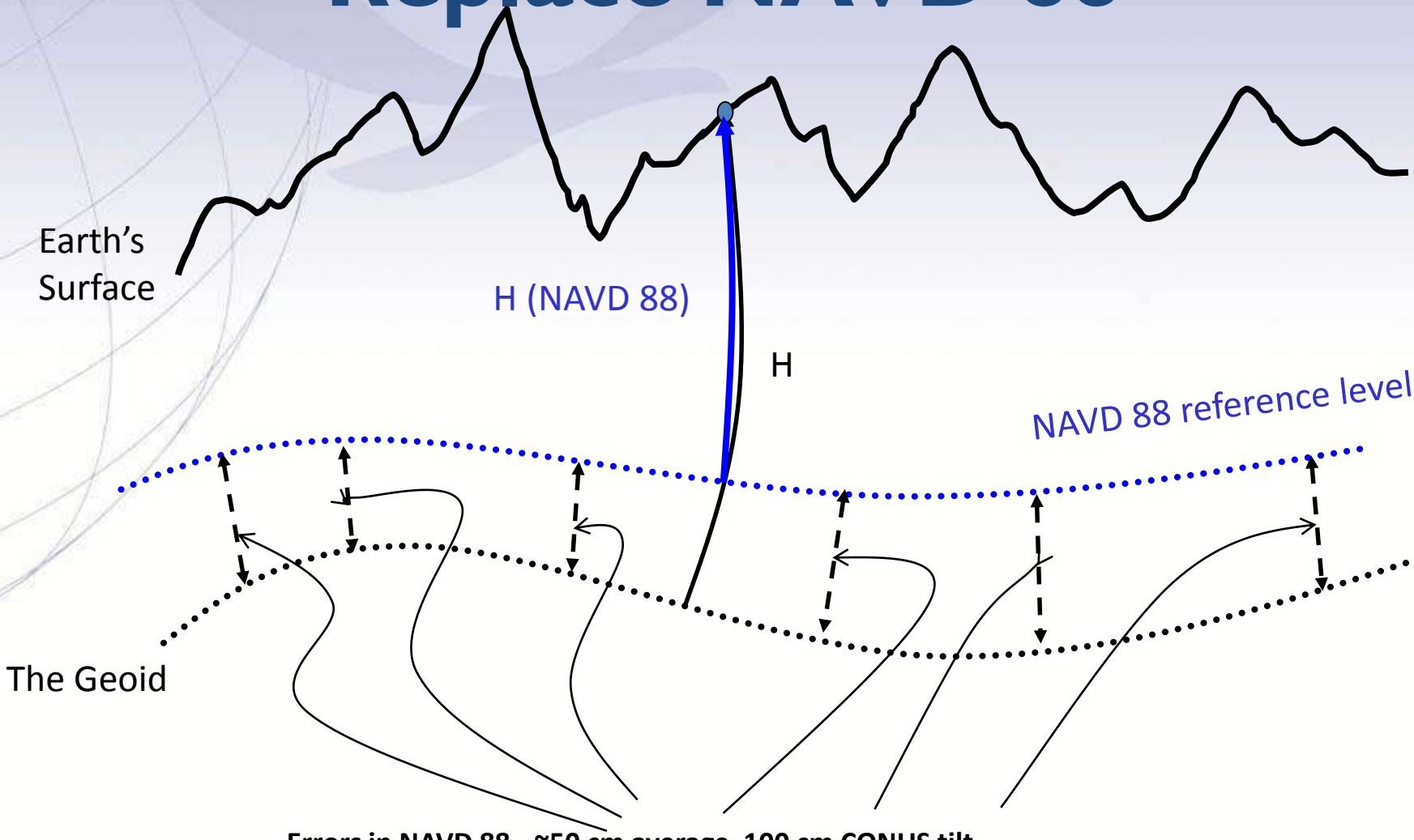
Replace NAD 83

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

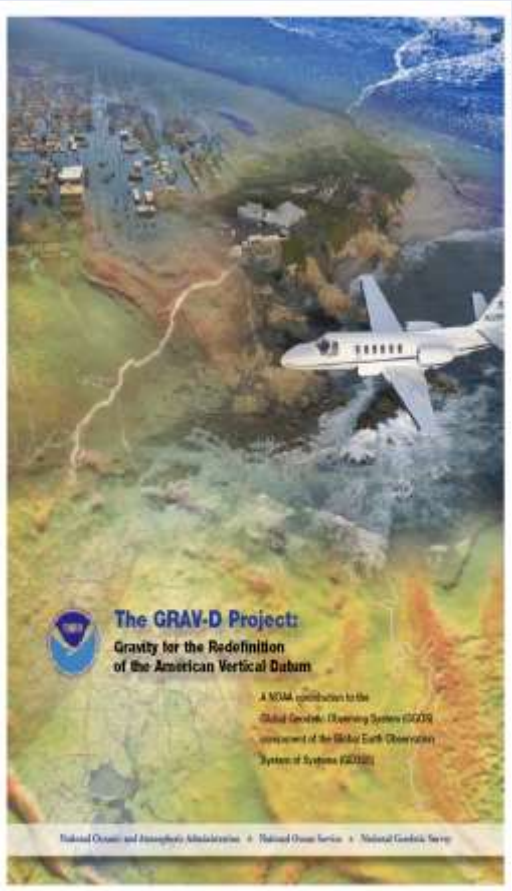


Errors in NAVD 88 : ~50 cm average, 100 cm CONUS tilt,
1-2 meters average in Alaska, NO tracking

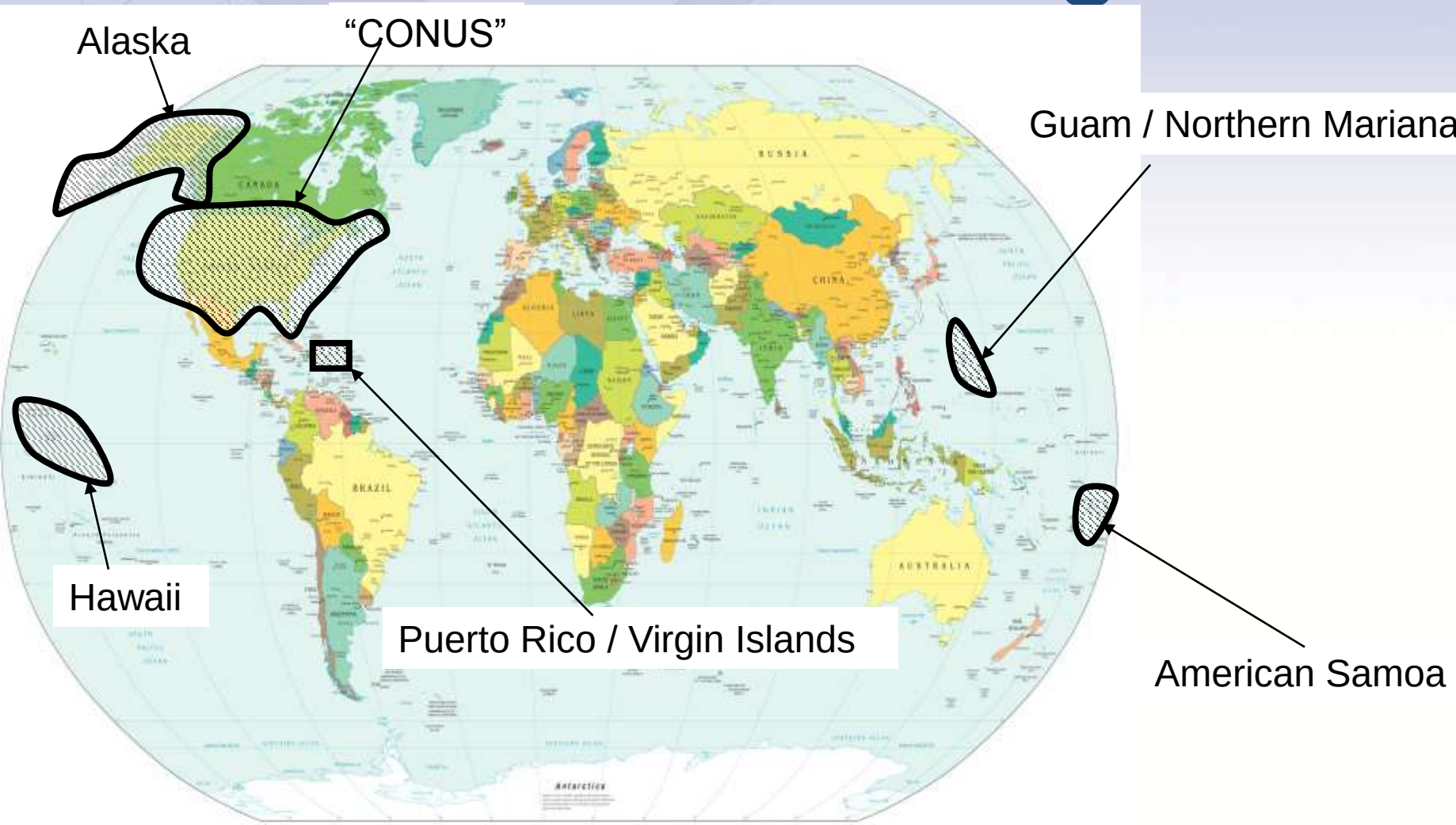
Replace NAVD 88

- 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



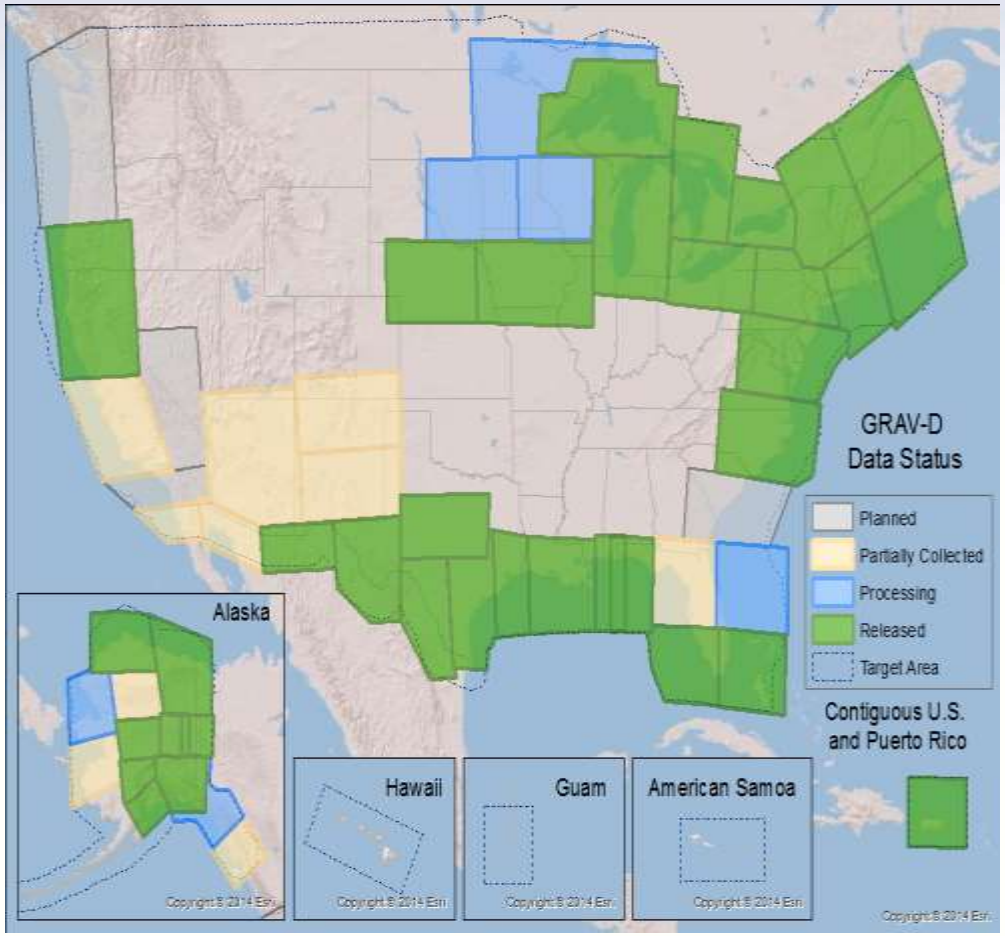
GRAV-D Coverage



GRAV-D Status

100% BY 2022

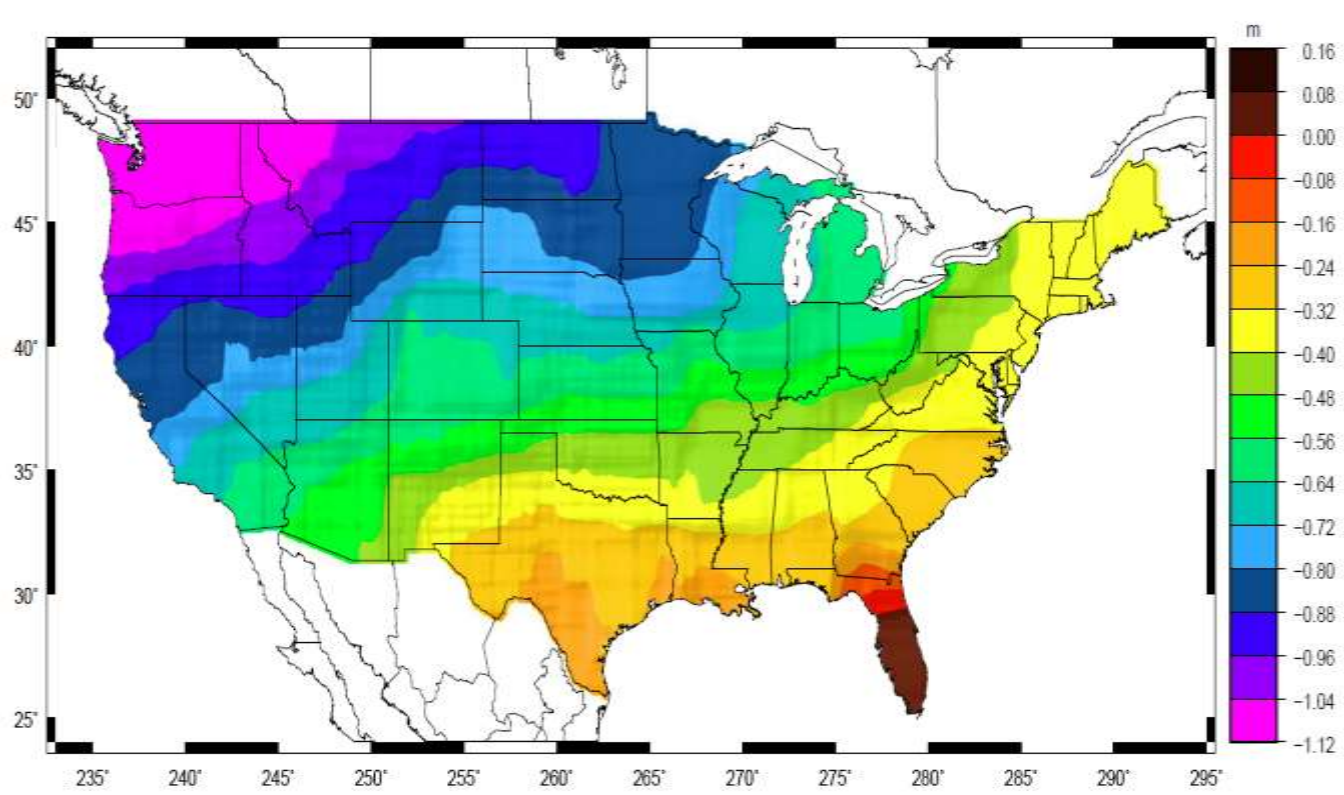
- 50% mark hit in FY2016
  - FY2017 target: 62%
- Two aircrafts at a time
  - Occasionally three
- Mix of Government and Private Industry Flights
- Experiments with G4
  - If successful, begin using G4 to collect Pacific states and territories as early as next year



Orthometric Heights

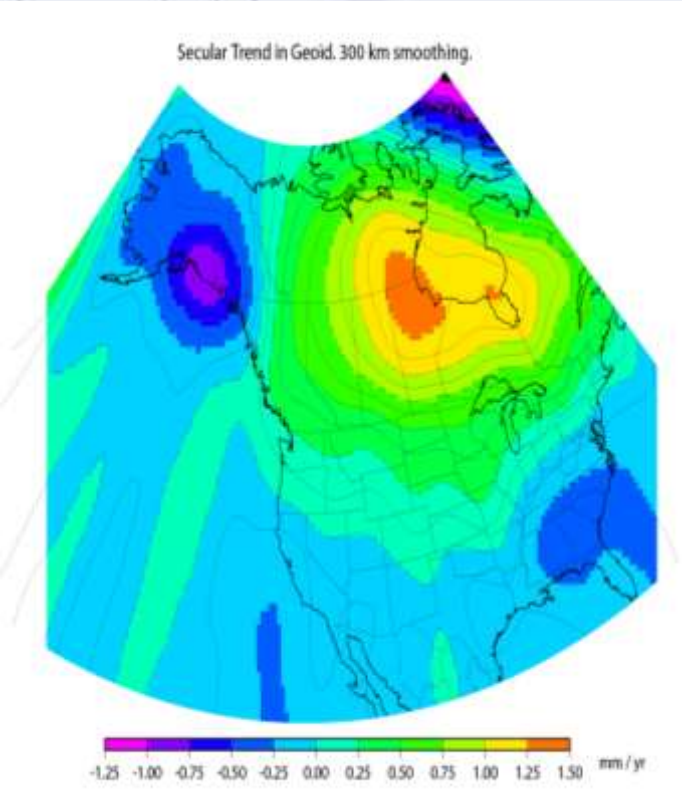
APPROXIMATE EXPECTED SHIFTS

- **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?

geodesy.noaa.gov

NGS Homepage:

geodesy.noaa.gov

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

SIRGAS

Thank You !

QUESTIONS? 2nd

INSTITUTO GEOGRÁFICO MILITAR
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Simposio y Taller

SIRGAS

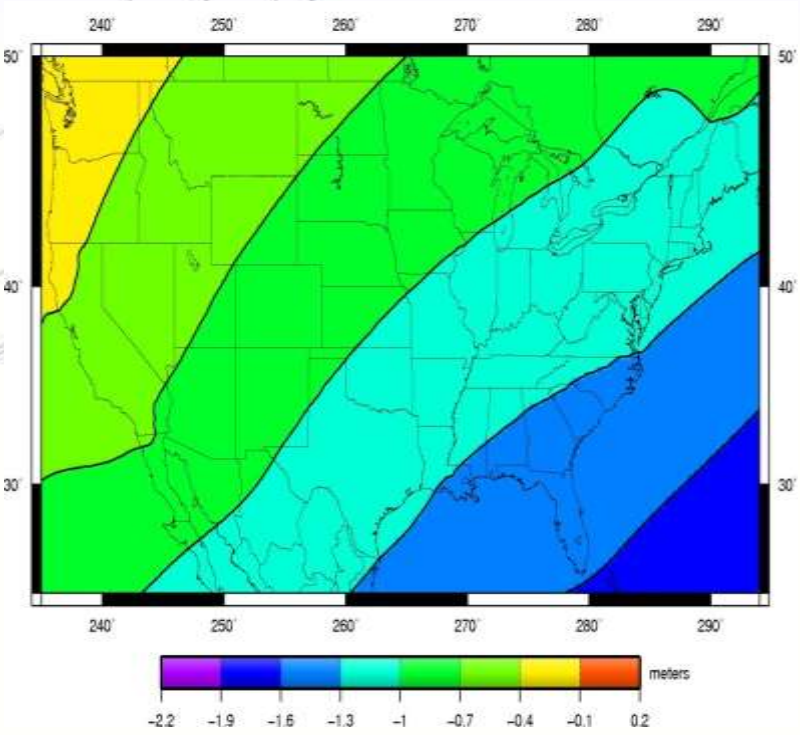
Nomenclature

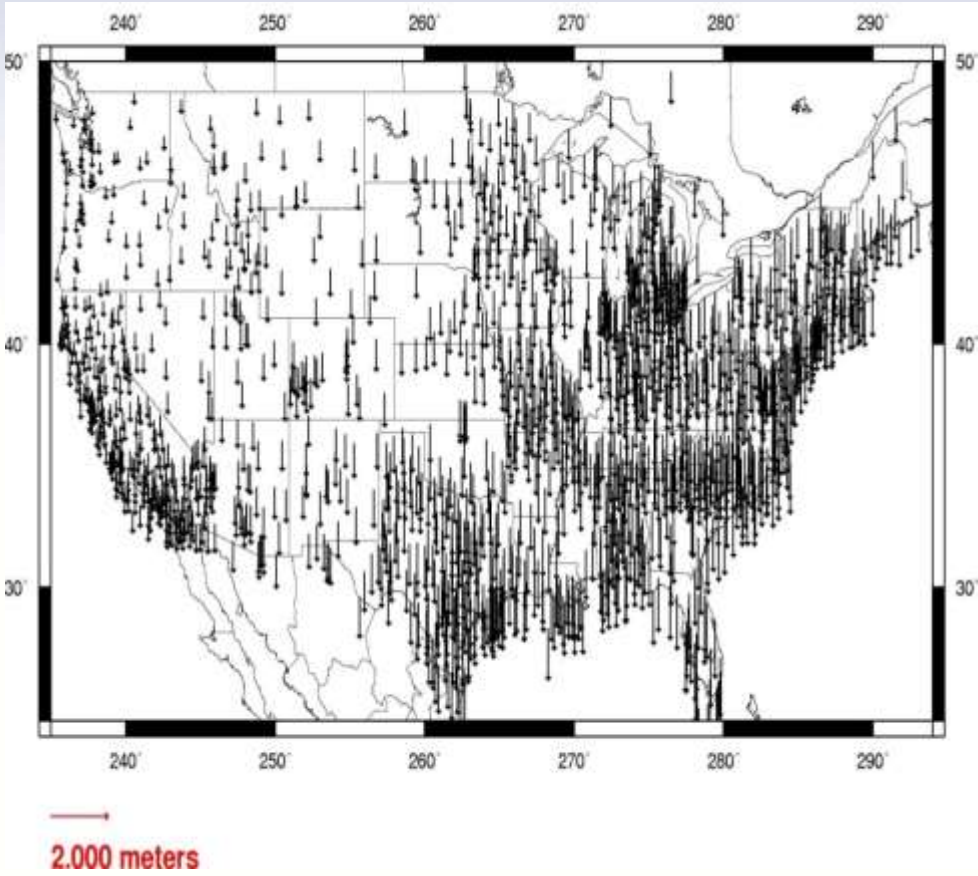
- A chance to increase accuracy in *naming*!
  - "North American"?
    - Ignores Guam, Hawaii, American Samoa, Northern Mariana Islands
  - Datum vs Reference Frame?
  - Plate-specific?
  - Vertical vs Geopotential?

- 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)

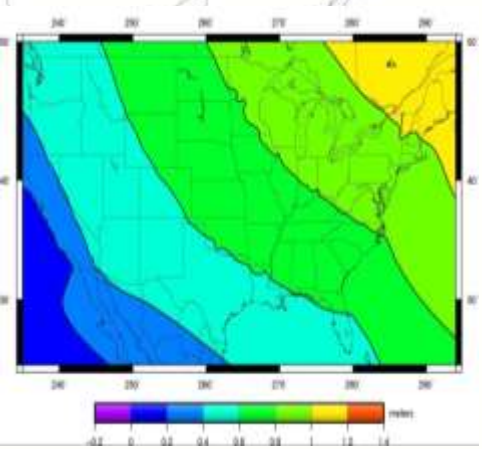




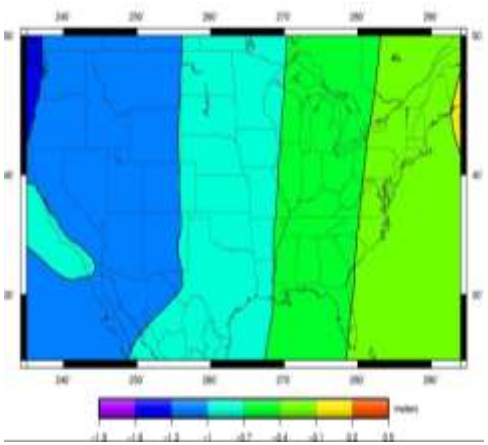
Horizontal Shifts

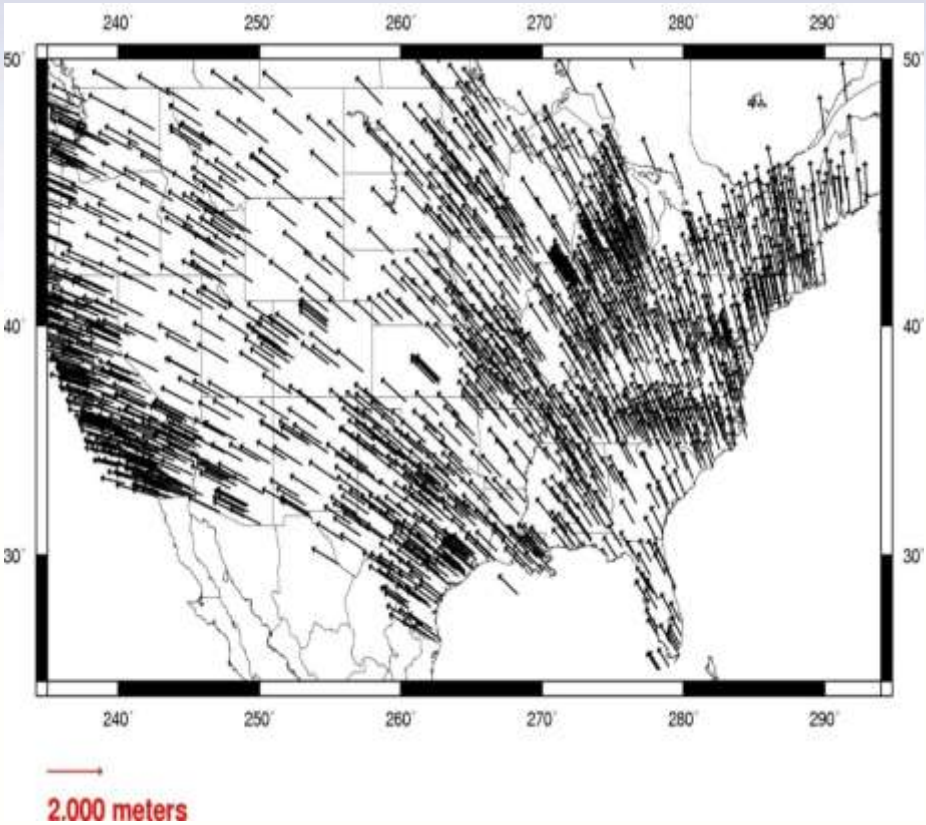
- Approximate
  - IGS08(GRS-80) minus NAD 83(2011)

Lat:



Lon:





Definition of new frames

"PLATE FIXED +" … ANNOUNCEMENT COMING SOON

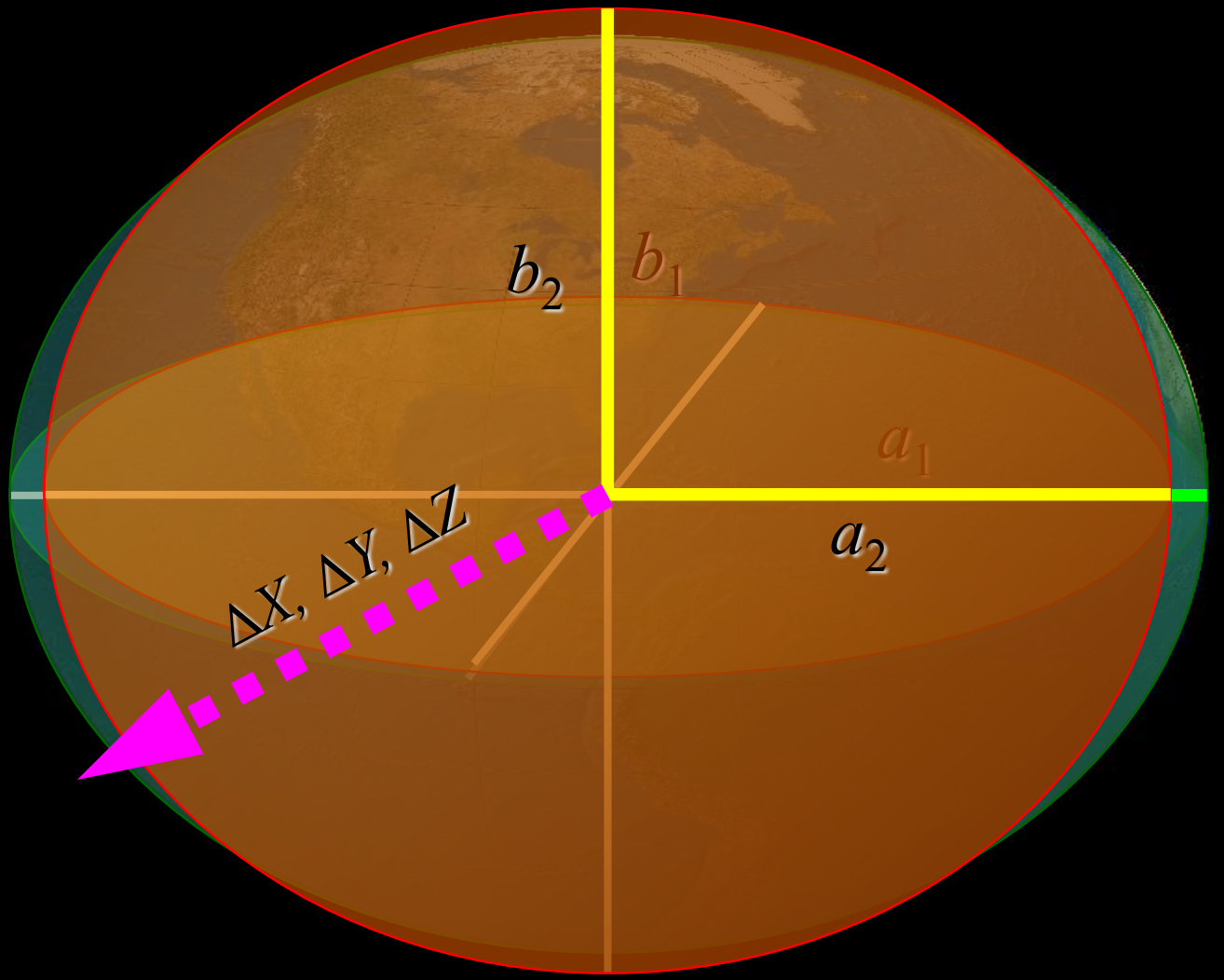
- Plate rotations will tie the new terrestrial reference frames of 2022 to the IGS frame
- Deformational velocities will be modeled separately

Time Dependencies

TRACK CORS AND ALWAYS KNOW WHERE YOU ARE

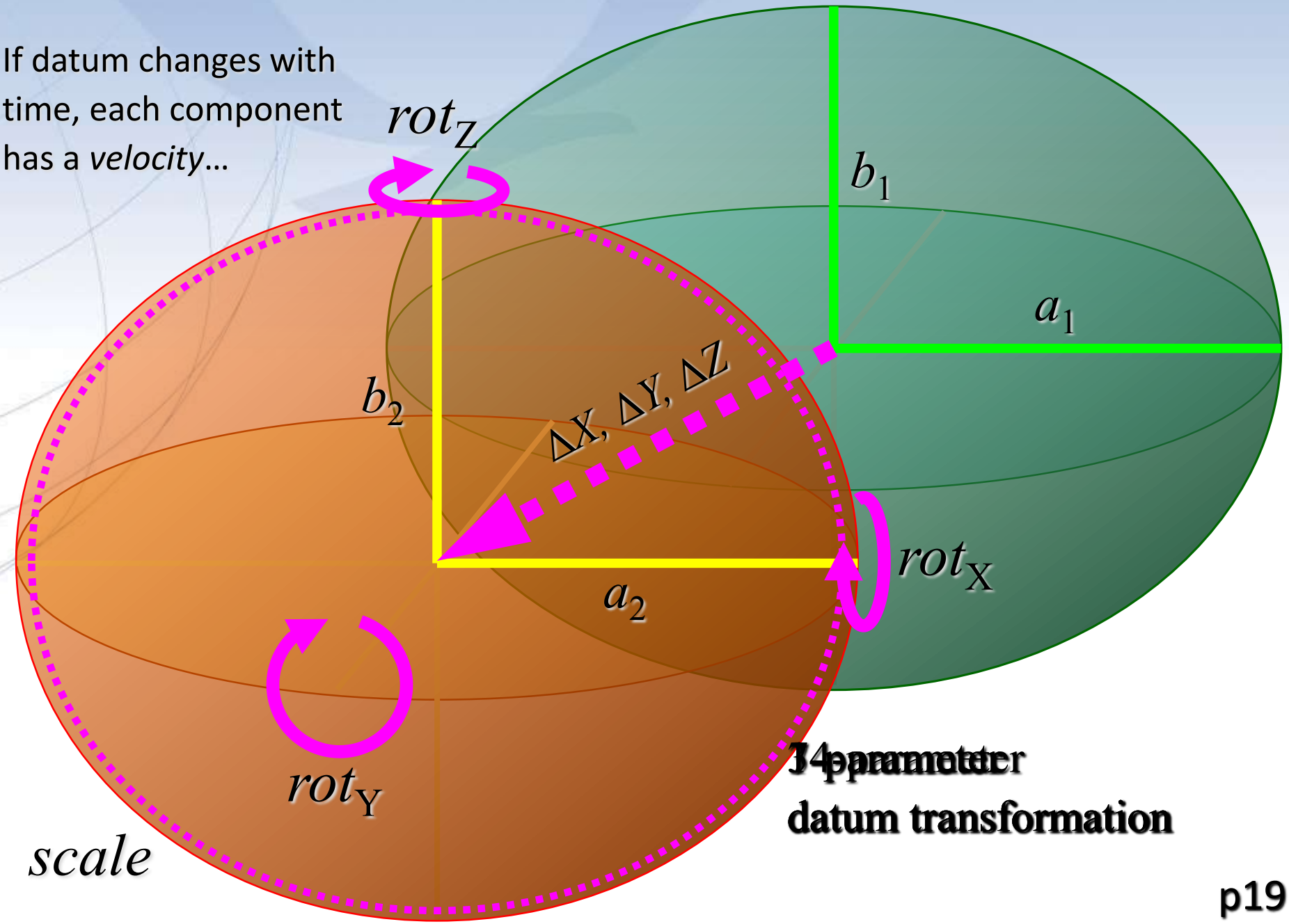
- Surveying to CORS positions at survey epoch
  - If we track CORS, we can do this easily
- Tectonic rotations
  - Easily removed for a "good east of the Rockies" solution
    - Lat/Lon only
- Residual deformations
  - Can be modeled many ways and provided for cross-epoch checking between surveys
  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

Geometric datum transformations



Geometric datum transformations

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



14 parameter datum transformation