The Modernized National Spatial Reference System (NSRS)

A 2019 update to the NGAC

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NOAA's National Geodetic Survey

Outline

- Refresher
- Summary of big changes
- Shift and Drift
- Alpha Products

Refresher

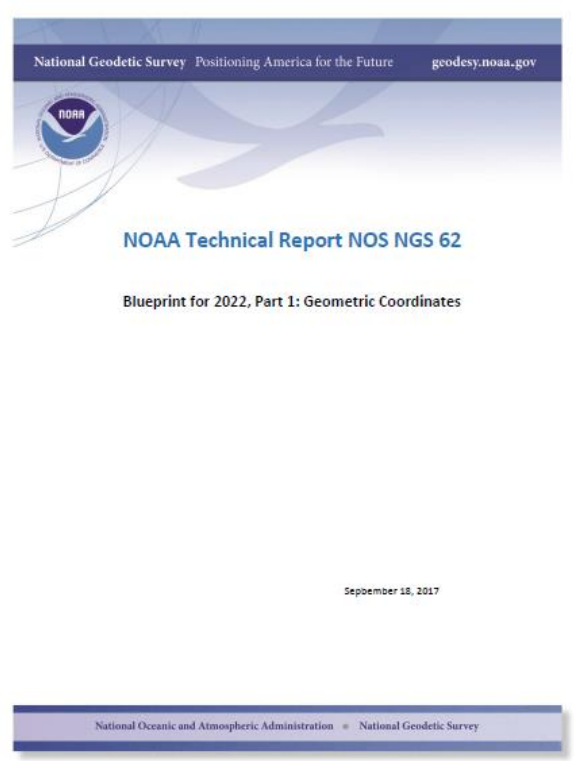
"Modernizing the NSRS" means…

- Replacing NAD 83 — Blueprint for 2022, Part 1
- Replacing NAVD 88 — Blueprint for 2022, Part 2
- Re-inventing Bluebooking
- Improving the Geodetic Toolkit
- Better Surveying Methodologies

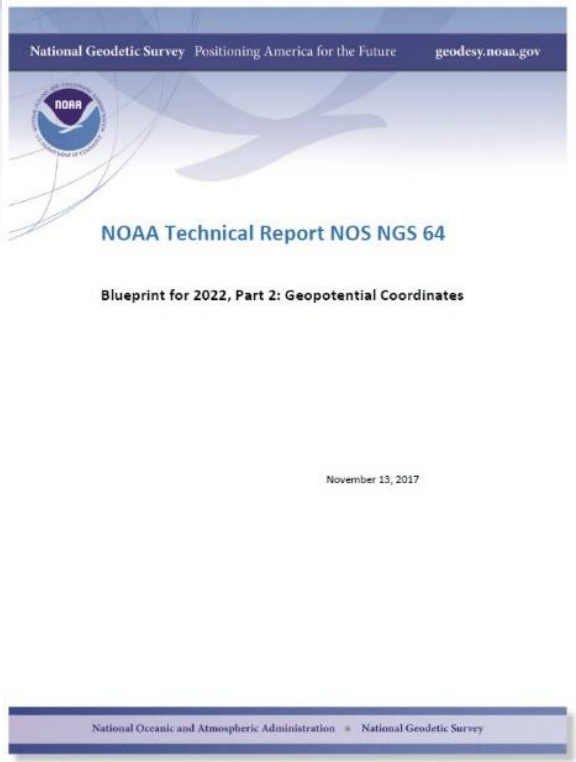
Blueprint for 2022, Part 3

Modernizing the NSRS

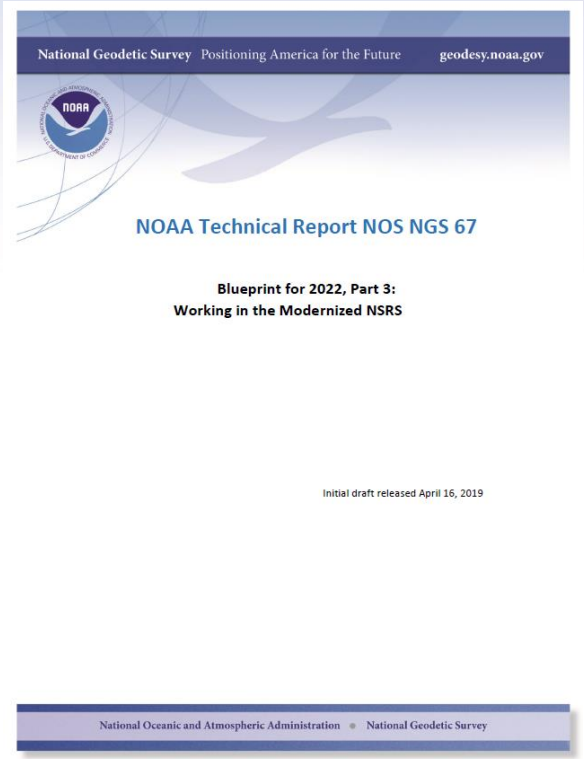
The "blueprint" documents: Your best source for information



Geometric:
Sep 2017
NOAA TR NOS NGS 62
32 pages



Geopotential:
Nov 2017
NOAA TR NOS NGS 64
41 pages



Working in the modernized NSRS:
April 2019
NOAA TR NOS NGS 67
77 pages

Summary list of "big changes"

(warning…lots of words on the next four slides)

Some of the biggest changes (1)

The old	The new
Existing meters-level systematic errors in geocenter and geoid	Alignment to ITRF and IHRF ensures reduction of systematic errors to cm level, globally
Different datums for every physical quantity (dynamic heights, orthometric heights, gravity, DoVs, etc)	The North American-Pacific Geopotential Datum of 2022
The only GNSS supported is GPS	New PAGES software will support all constellations
Lat/Lon/Ellipsoid Height are dominant coordinates	ECEF ITRF XYZ are dominant coordinates
H=h-N does not close	H=h-N closes by definition
Presuming the Caribbean plate is locked in movement with the North American Plate	The two plates will be treated as moving independently
Hybrid geoids ≠ Gravimetric geoids	No more hybrid geoids

Some of the biggest changes (2)

The old	The new
Adjusting data in an NGS defined frame	Adjusting data in the ITRF, and then rotating into four NGS defined frames
Assigning a coordinate to a point based upon decades of measurements, without accounting for vertical movements or considering that leveling and GNSS both inform the heights of points	Assigning coordinates to points at every epoch it has ever been surveyed by any kind of instrument, then using those time-dependent coordinates to estimate snapshots of the entire NSRS every 5 years, starting in 2020.00
Adjusting measurements to passive control	OPUS will allow users to perform adjustments any way they wish, but that adjustment won't go into the database. Rather, NGS will ingest their raw measurements in house, combine it with other surveys performed at the same time, and will adjust all that data solely to active control to become part of the NSRS

Some of the biggest changes (3)

The old	The new
NGS Bluebooking and Adjustment software is done offline, using command line executables, FORTRAN code, and different approaches for GPS, leveling, gravity (and no support for DoVs or classical surveys)	"OPUS" being expanded to support the processing of all possible data types within a single project, online, with a simple "submit to NGS" button replacing "bluebooking"
Orthometric heights from leveling and/or Height Mod depending upon passive control network that is old, out of date (often by decades) and rapidly disappearing.	Users can adjust a leveling network within OPUS, but will only get *differential* heights. If they want *absolute* heights, they will be required to add GNSS to their leveling project according to new NGS specifications.

Some of the biggest changes (4)

The old	The new
Mark Discovery means searching the NGS database, printing out datasheets, and hunting physically in the world	New smartphone-enabled, browser-independent mark discover/recovery tool with "find marks near me" functionality.
Mark Recovery done either through a poorly designed web page or WinDESC (which requires download, install, and only works on a PC). Both treat the users as highly trained expert surveyors.	New smartphone-enabled, browser-independent mark discover/recovery tool will allow for both expert users and amateur users. Descriptions can be long and tedious as before, or as simple as a photograph and lat/lon. Submission through a single button to NGS in general, and/or to existing user-specified projects.
A toolbox full of unintegrated FORTRAN-based executables which either don't run online or run in a clunky Pearl-wrapper around said executable.	A fully integrated toolkit (NCAT) with expanded wet datum capabilities (VDatum) run online (interactively or file upload/download), or downloadable to a users computer. Written in JAVA, so platform independent.

Replacing NAD 83

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)

Replacing NAVD 88

	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

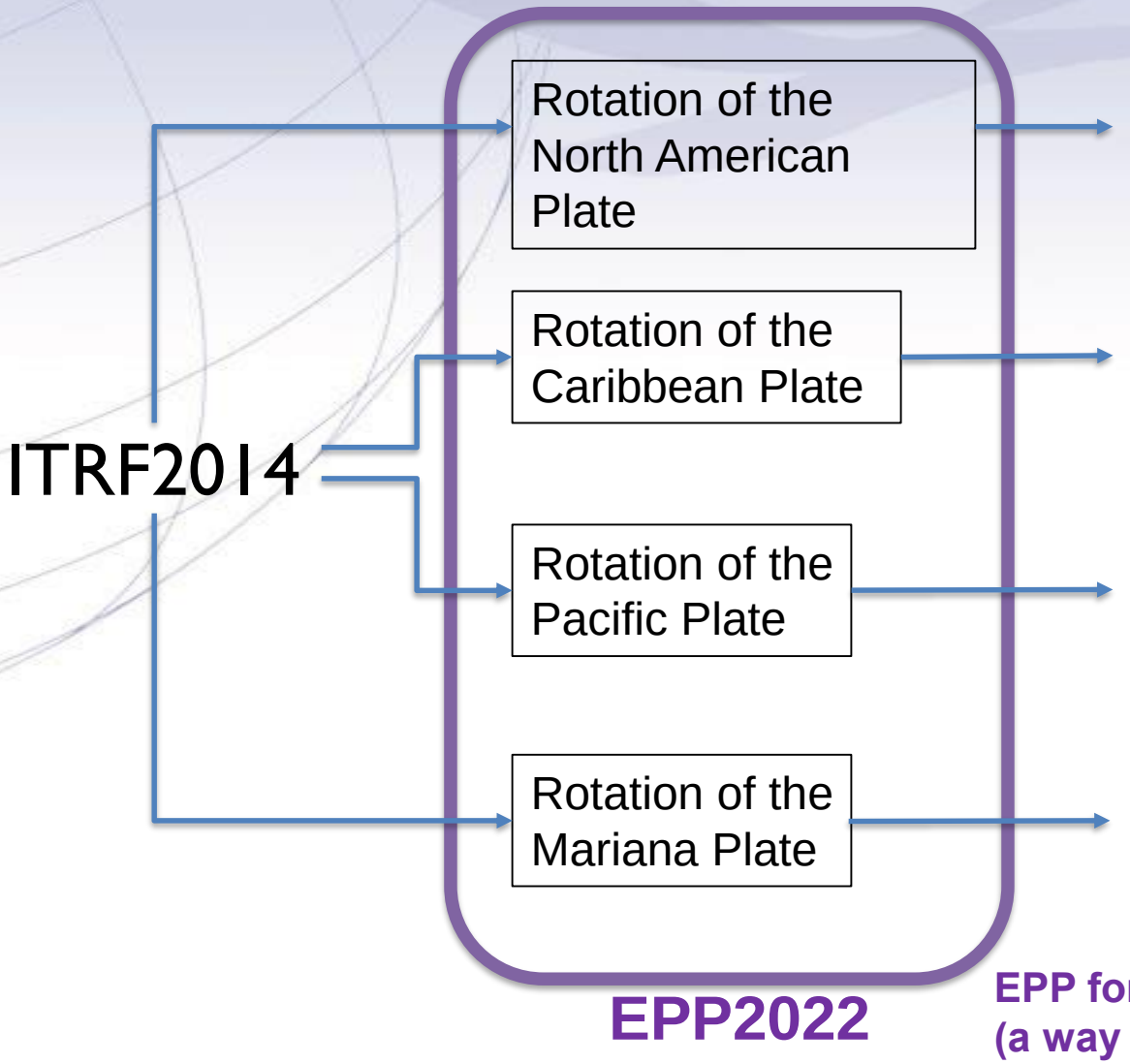
The New:

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

Will include:

- GEOID2022
- DEFLEC2022
- GRAV2022
- DEM2022
- More

The preeminence of ITRF



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)

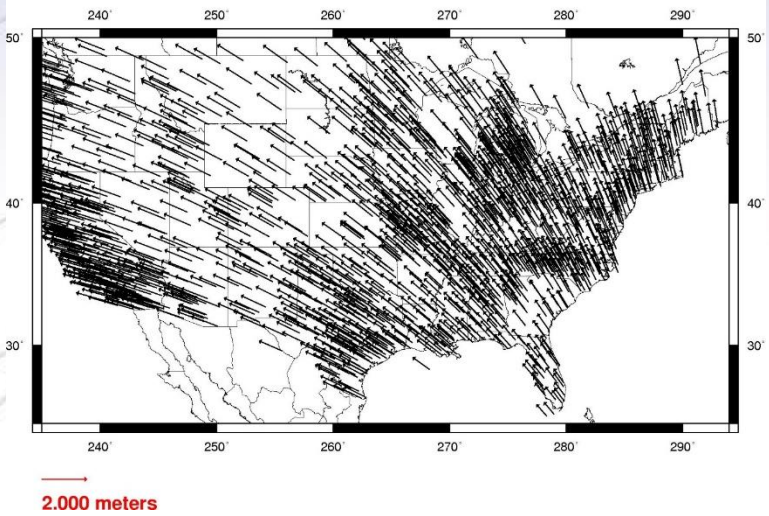
EPP for "Euler Pole Parameters"
(a way of describing a plate's rotation)

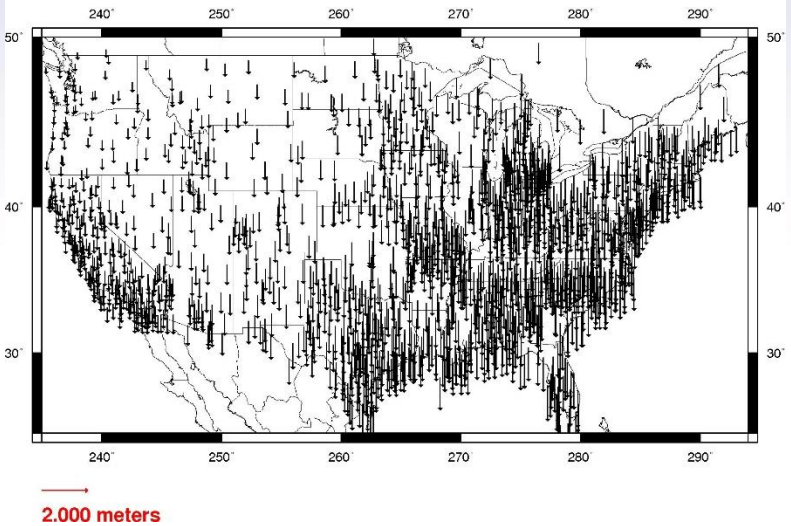
Shift and Drift

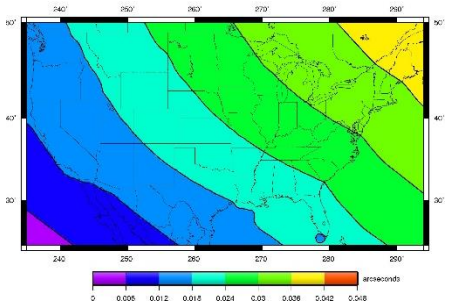
Shift

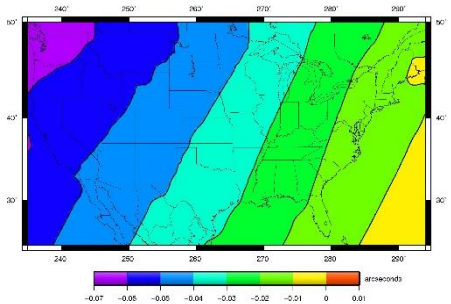
- One of the two major changes you'll see in 2022 is a ***shift*** in coordinates
  - Latitude, Longitude, Ellipsoid Height: -2 to +4 meters
    - Non-geocentricity of NAD 83
  - Orthometric Height: -0.5 to +2.0 meters
    - Bias and tilt in NAVD 88
  - Other shifts will occur in non-CONUS, non-Alaska regions of the USA
  - There will be outliers!
    - "Old" unsurveyed points might be off by meters if they've moved!

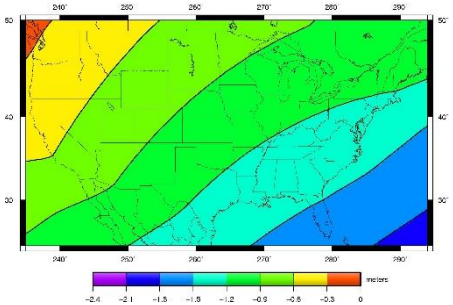
NAD 83(2011) epoch 2010.0 to NATRF2022 epoch 2020.00 (estimate)



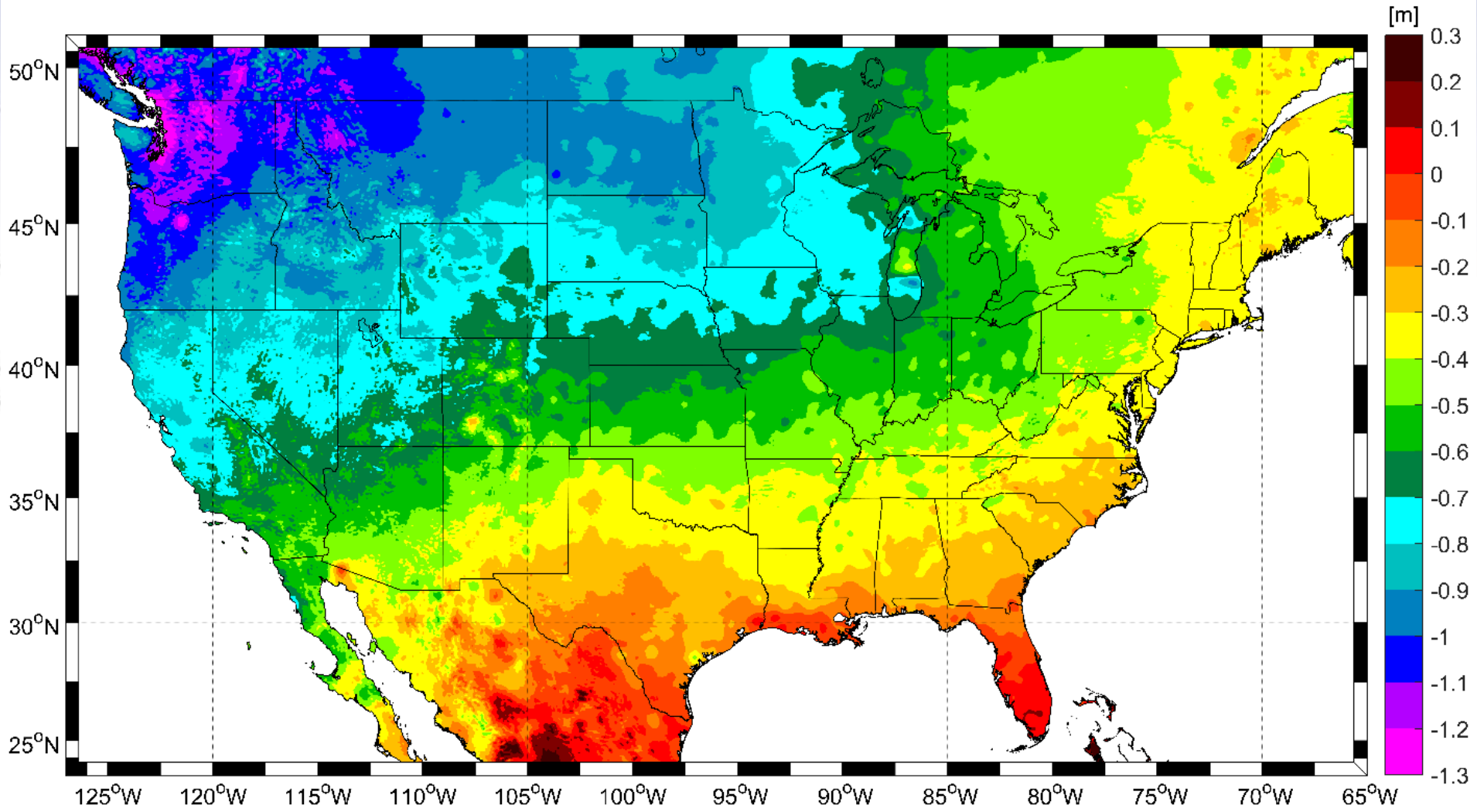








NAVD 88 to NAPGD2022 epoch 2020.00 (estimate)



Drift

- The second major change you'll see in 2022 is a ***drift*** in coordinates
  - Everything in the world moves
  - Coordinates will be associated with the actual date when the data was taken!

The wrong question, circa 2022:

"What is the latitude of that point?"

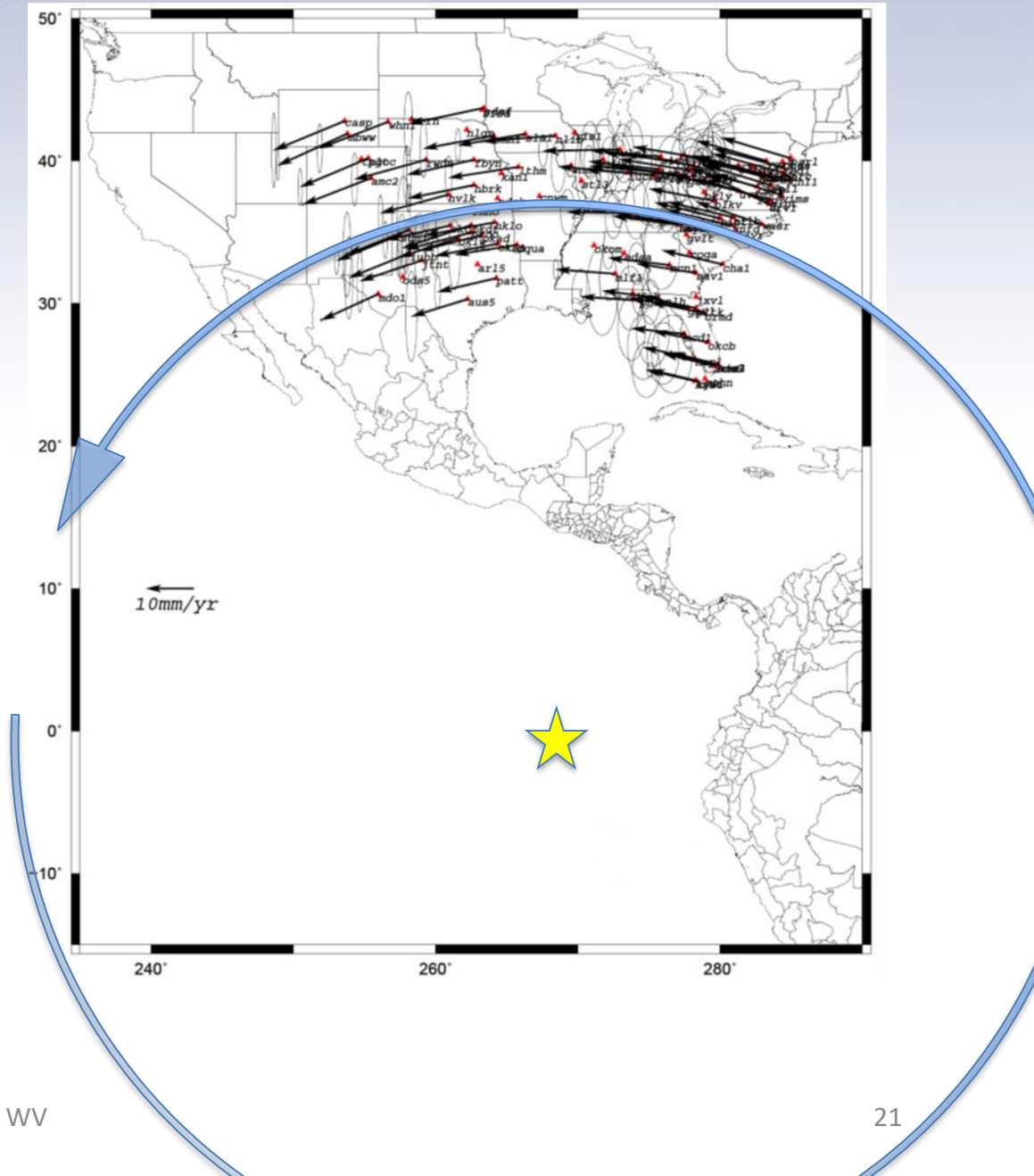
The right question, circa 2022:

"What is the latitude of that point, on some specific date?"

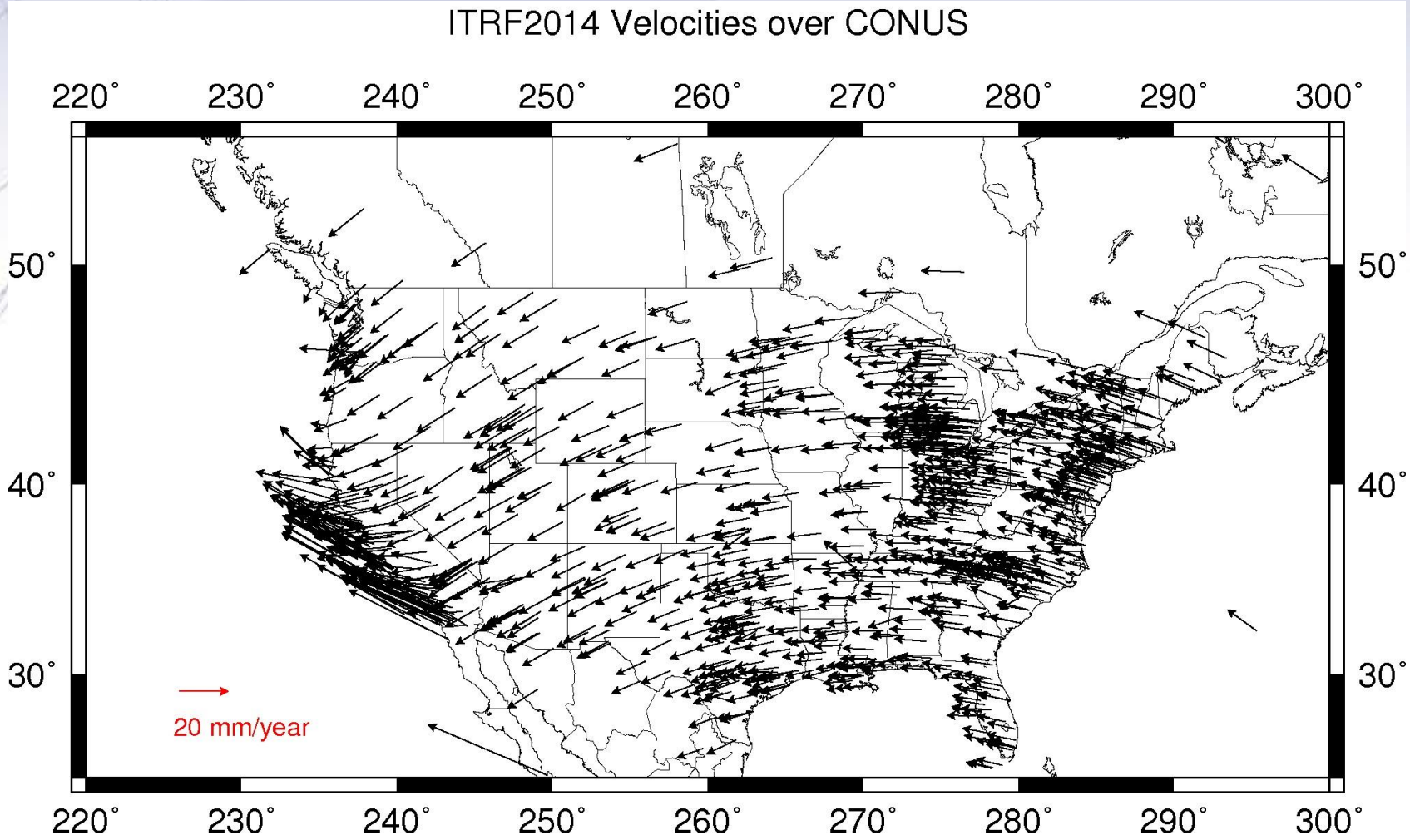
Drift

- The second major change you'll see in 2022 is a ***drift*** in coordinates
  - Everything in the world moves
  - Coordinates will be associated with the actual date when the data was taken!
  - Velocities at all marks can be estimated
    - Using a new tool, called the Intra-Frame Velocity Model (IFVM2022)
  - Two things will mitigate the pain of time-dependent coordinates:
    - "Plate Fixed" frames
    - "Reference Epoch" coordinates

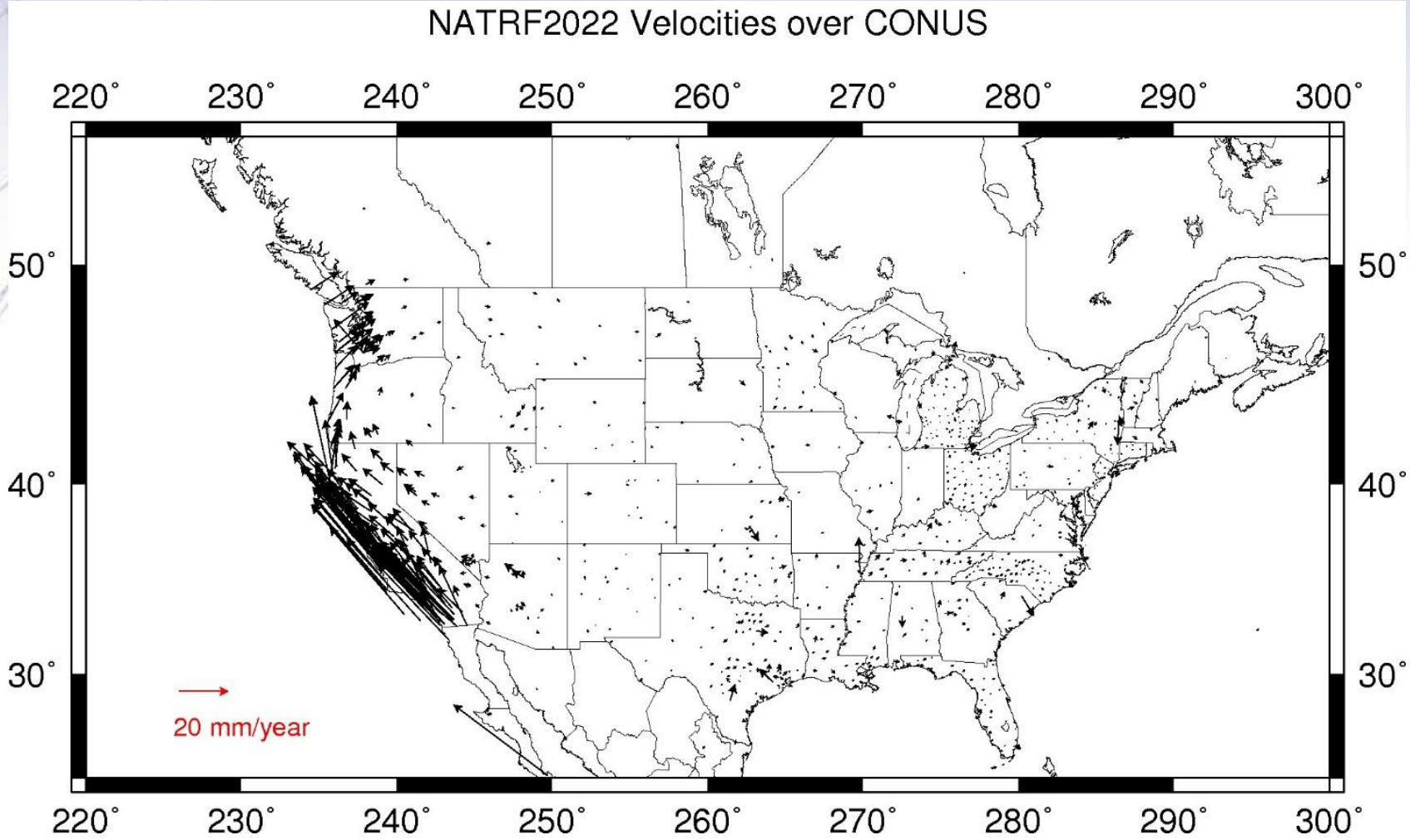
- Euler Poles and "Plate Fixed"
  - In the ITRF, many tectonic plates have one *dominant* motion: rotation
    - Plus plenty of other motions
  - The point about which a continent rotates is called its "Euler Pole"
  - In summary:
    - Under ITRF
      - Frame = constant
      - N.A. Plate = rotating
  - It is a fairly simple matter to reverse this and define a rotating frame in which the plate is not rotating.
    - Under NATRF2022:
      - Frame = rotating (relative to ITRF)
      - N.A. Plate = constant (relative to NATRF2022 frame)
  - We say "NATRF2022" is "fixed" to the N.A. Plate, making it a "plate fixed" frame



CORS Velocities – ITRF2014



CORS Velocities – NATRF2022



Alpha Products

Alpha Products

- NGS has set the goal of having an "alpha" version of every product/service of 2022 ready by the end of 2019.
  - Meaning bugs, limited availability in time/space, and generally not fully functional
    - But the intent is to show data formats, general direction and progress to the public
    - Information will be provided to industry partners so they can begin the process of ingesting the modernized NSRS into their software

Thank you!

Questions?