



OPUS & Geometric Datum updates

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National Geodetic Survey

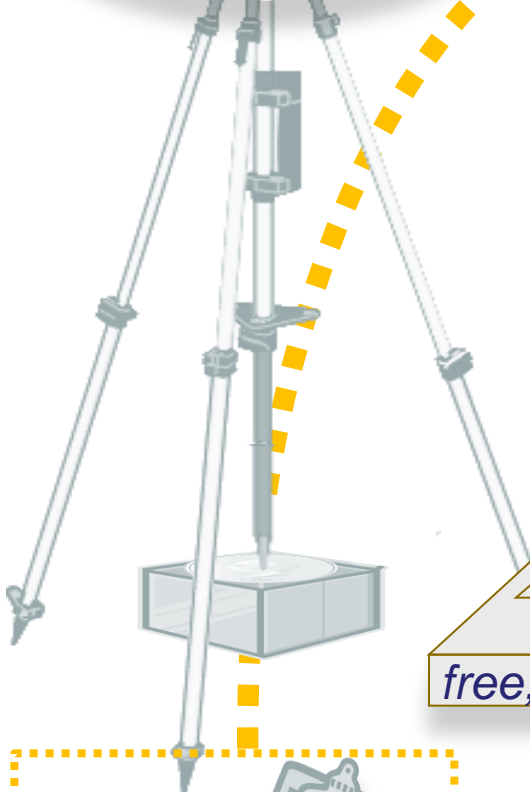
54th Meeting of the Civil GPS Service Interface Committee

at the Institute of Navigation GNSS+ 2014 Conference

Tampa Convention Center

08 September 2014

**your
GPS data**



**standard
geodetic data**

- IGS & NGS base stations & site information files
- IGS antenna calibrations & satellite orbits & reference frames
- UNAVCO teqc converter
- PAGES baseline processor
- var. geophysical models
- NGS geodetic toolkit

geodesy.noaa.gov/OPUS

OPUS

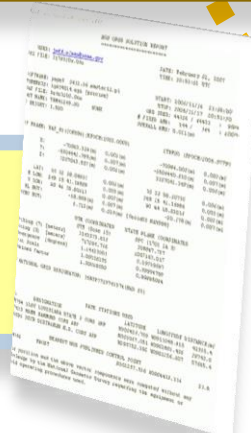
Online Positioning User Service

free, fast, easy, consistent coordinates JGE 2013 v2

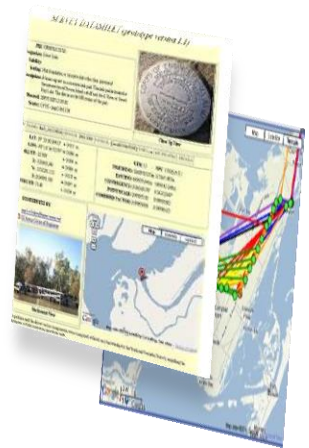


mark description

**your
solution**

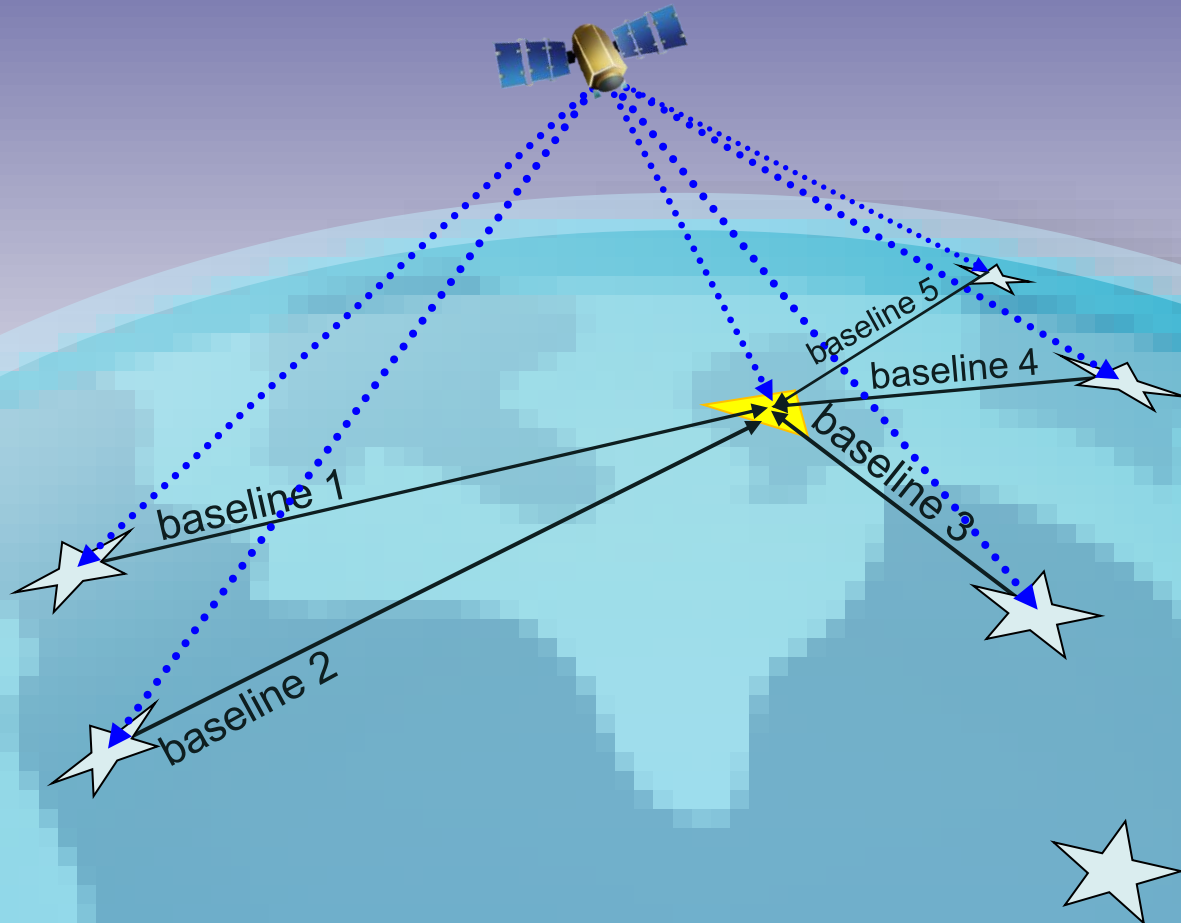


**sharing
& project
options**



OPUS Static: your position is determined with a differential GPS static solution, using hours of data.

This process is repeated 4x from other CORS.





OPUS: Online Positioning User Service

NGS Home About NGS Data

Options to customize your solution.



OPUS Menu

- Upload about OPUS
- projects shared solutions
- contact OPUS

formats

base stations

Use:

Exclude:



format details

type in 4-char site IDs, or select from map, any CORS you wish to explicitly include or exclude from your solution

sample

NOTE: the automated selection of base stations has recently improved; this option should now be used only sparingly

state plane

override your native **SPCS zone**

project identifier

enter the id provided by your project manager

my profile

customize OPUS defaults for future solutions

share my solution

why share?

for data 15 min. - 2 hrs.

for data 2 hrs. - 48 hrs.

recent OPUS improvements



www.ngs.noaa.gov/OPUS/

National Geodetic Survey

- OPUS-projects released
- OPUS-S now computes 5 baselines, uses the best 3
- reference frames: NAD_83(2011)(EPOCH:2010.0), IGS08
- GEOID12A orthometric heights, HTDP 3.2.3 velocities
- Almost 8,000 OPUS solutions shared by users



BETA

This is a BETA Release Site

beta.ngs.noaa.gov/OPUS/

National Geodetic Survey



DEV

Internal Development Area

[no public access](#)

National Geodetic Survey

- OPUS-NET
- composite published solutions
- defaults from RINEX

OPUS Output - Standard

OPUS Output - XML

FILE: corv0590.05o 000416827

1008 NOTE: Antenna offsets supplied by the user were zero. Coordinates
1008 returned will be for the antenna reference point (ARP).
1008

NGS OPUS SOLUTION REPORT

<http://teqc.silkwerks.com/>

```
<?xml version="1.0" encoding="UTF-8"?>
<OPUS_SOLUTION>
  <USER_INFORMATION>
    <USER_EMAIL> joe.evjen@gmail.com </USER_EMAIL>
    <SOLUTION_DATE> February 19, 2008 </SOLUTION_DATE>
    <SOLUTION_TIME> 01:16:22 UTC </SOLUTION_TIME>
    <RINEX_FILE_NAME> zzyy1500.07o </RINEX_FILE_NAME>
  </USER_INFORMATION>
  <DATA_INFORMATION>
    <SOFTWARE>
      <PAGES_VERSION> page5 0612.06 </PAGES_VERSION>
      <OPUS_VERSION> master3.pl </OPUS_VERSION>
    </SOFTWARE>
    <EMPHEMERIS> igs14293.eph [precise] </EMPHEMERIS>
    <NAV_FILE> brdc1500.07n </NAV_FILE>
    <ANTENNA_NAME> TRM41249.00 </ANTENNA_NAME>
    <ARP_HEIGHT> 0.0 </ARP_HEIGHT>
    <START_TIME> 2007/05/30 00:00:00 </START_TIME>
    <END_TIME> 2007/05/30 23:59:00 </END_TIME>
    <OBS_USED>
      <NUMBER_USED> 52955 </NUMBER_USED>
      <TOTAL_OBS> 55069 </TOTAL_OBS>
      <PERCENTAGE> 96 </PERCENTAGE>
    </OBS_USED>
    <FIXED_AMP>
      <NUMBER_FIXED> 218 </NUMBER_FIXED>
      <NUMBER_AMP> 242 </NUMBER_AMP>
      <PERCENTAGE> 90 </PERCENTAGE>
    </FIXED_AMP>
    <OVERALL_RMS UNIT="m"> 0.021 </OVERALL_RMS>
  </DATA_INFORMATION>
  <POSITION>
    <REF_FRAME> NAD_83 (CORS96) </REF_FRAME>
    <EPOCH> 2002.0000 </EPOCH>
    <COORD_SET>
      <RECT_COORD>
        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.003"> -496255.901 </COORDINATE>
        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.022"> -5510741.49 </COORDINATE>
        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.017"> 3162058.243 </COORDINATE>
      </RECT_COORD>
      <ELLIP_COORD>
        <LAT>
          <DEGREES> 29 </DEGREES>
          <MINUTES> 54 </MINUTES>
          <SECONDS> 48.44070 </SECONDS>
        </LAT>
        <UNCERTAINTY> 0.003 </UNCERTAINTY>

```

USERS: SOLUTION@NOAA.GOV
RINEX FILE: RINEX_FILE_NAME

```
SOFTWARE: page5 0612.06 mast
EPHEMERIS: igs14293.eph [precise]
NAV FILE: brdc1500.07n
ANT NAME: TRM41249.00 NONE
ARP HEIGHT: 0.0
BRDC1500.07N
NONE FRAM<ANTENNA_NAME> (EPOCH
0.0
2007/05/30 00:00:00
2007/05/30 23:59:00
Z: 4454737.695 (m)
```

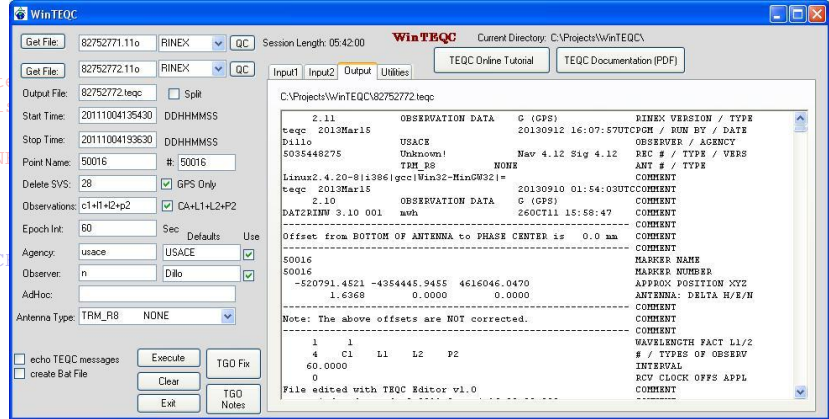
```
LAT: 29 54 48.44070
E LONG: -122 54 55.107419
W LONG: -122 54 55.107419
EL HGT: 107.485 (m)
ORTHO HGT: 130.010 (m)
Northing (Y) [meters] 493699
Easting (X) [meters] 47583
Convergence [degrees] -0.21
Point Scale 0.99
Combined Factor 0.99
```

US NATIONAL CENTER FOR GEODETIC SURVEILLANCE DESIGNATOR: 107

AJ6959 CHZZ CAPE MEARS CORS ARP
DH4503 P376 EOLARESVR_OR2004 CO

NEAREST NGS PUBLISHED CONTROL POINT

AH2486 CORVALLIS CORS ARP N443507.910 W1231816.519 0.0



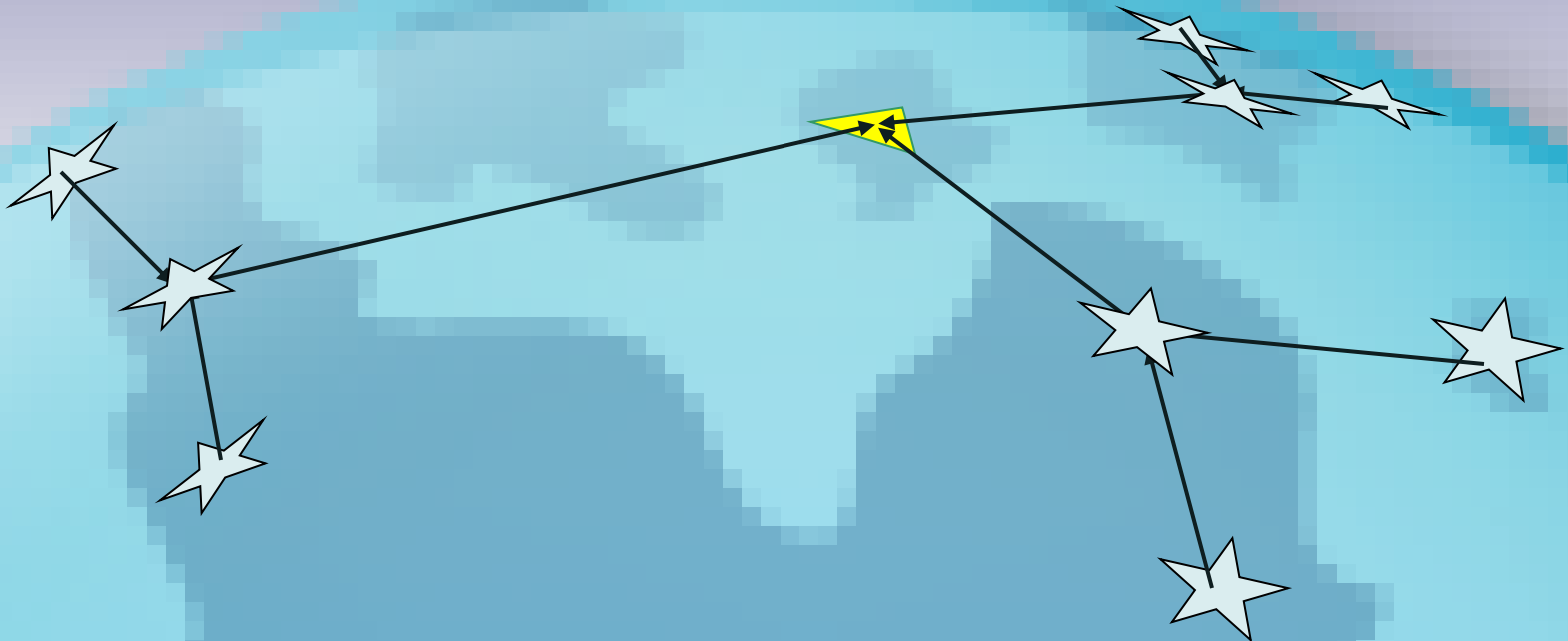
<http://x90gps.com/Tools.htm>



OPUS-NET:

first, run OPUS to solve for CORS from IGS CORS

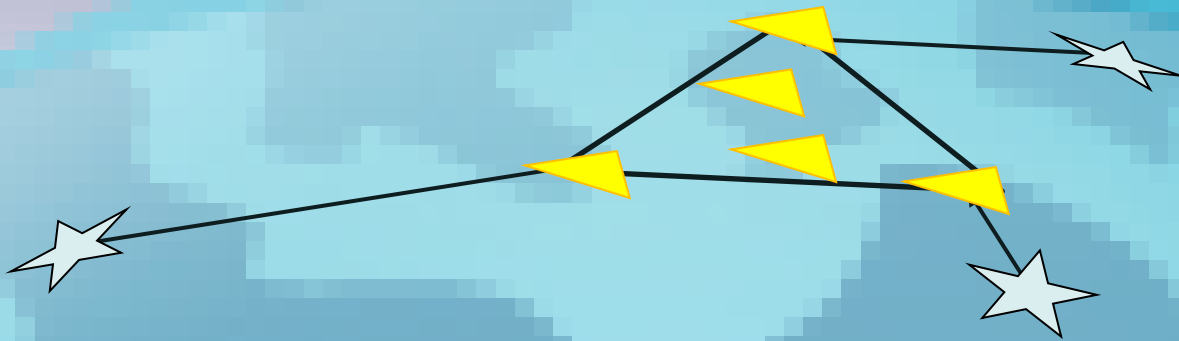
then run OPUS-Static using improved CORS positions and tropospheric corrections, along with ocean-tide loading & absolute antenna calibration models



OPUS projects:

first, run OPUS to harvest all project data

OPUS automatically forms sessions from simultaneously observed marks, enabling multi-baseline processing and adjustment of redundant observations.



Improved solutions for simultaneous or repeated observations

harvest data from multiple observers

share upload & processing tasks

customize your processing using PAGES

simple data quality analysis

improve survey accuracy

constrain to local networks

publishing support (limited)

OPUS sharing: add a description and photos, archive your work for others to use



mark description

SURVEY DATASHEET (prototype version 1.1)

ID: OPUS1234

Designator: Great Lake

Utility:

Setting: The location of survey data for the project

Description: A survey of an ancient lake port. The lake port is located in the suburbs of Ames, Iowa, and is a 1/2 mile from the lake. The data is available from the port.

Observed: 2015-10-10 10:00:00

Source: OPUS-1234-5678



View by:

Lat: 41° 52' 30.0000" N **4099 m**

Long: -87° 14' 30.0000" W **4099 m**

ELEV: 2100 **4099 m**

N: -2280.240 **4099 m**

N: 552296.100 **4099 m**

E: 25091.700 **4099 m**

OSTROID: 114 **4099 m**

UTM ID: **SPC (PROJ. ID)**

PROJID: 32QURDQW **32QURDQW**

EXTENT: 4000000.000 **4000000.000**

COORDINATE: 2000000.000 **4000000.000**

COORDINATE FACTOR: 0.000000 **0.000000**

CONTRIBUTED BY:

[User 1](#)

[User 2](#)



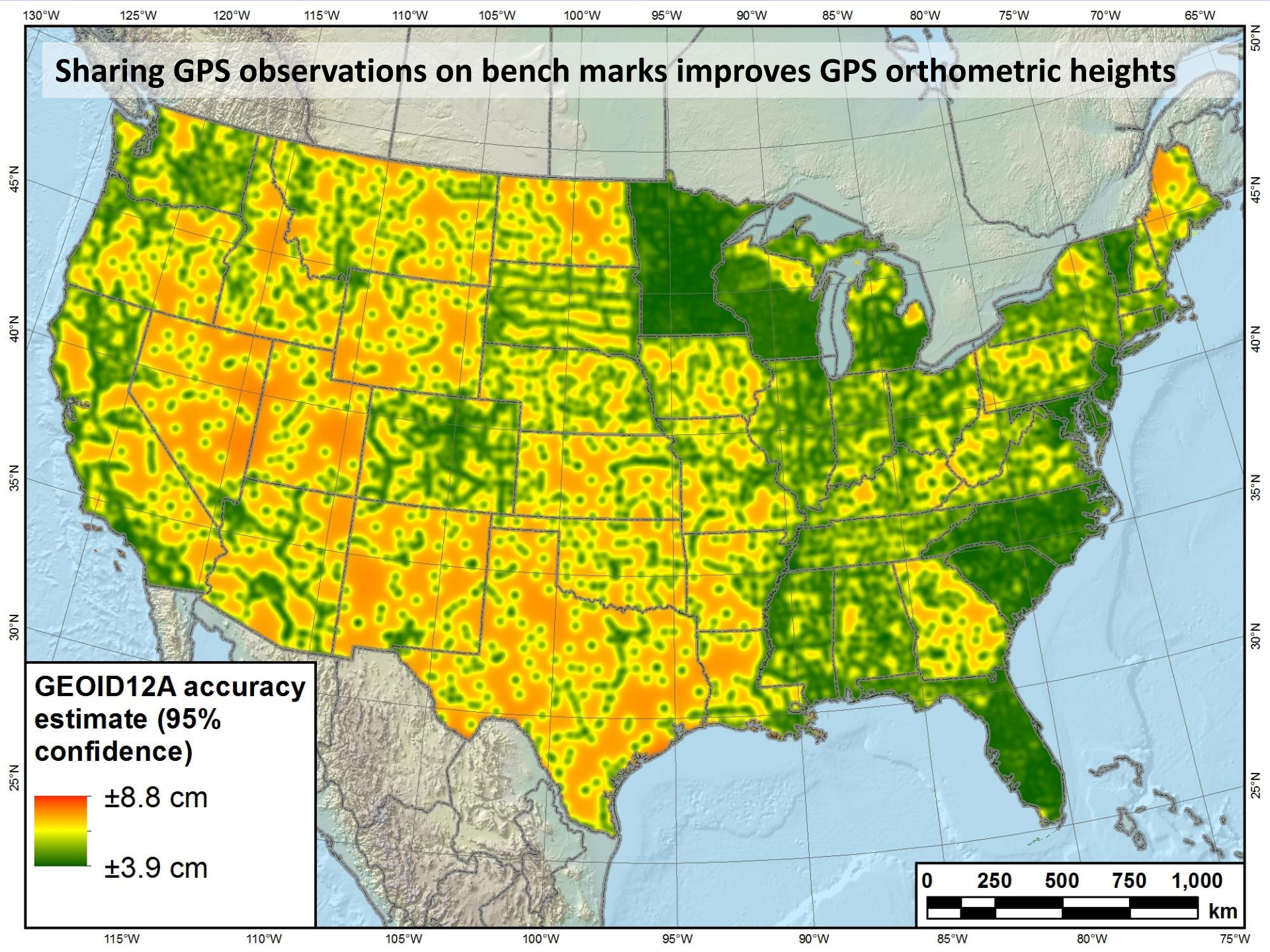
Observed View



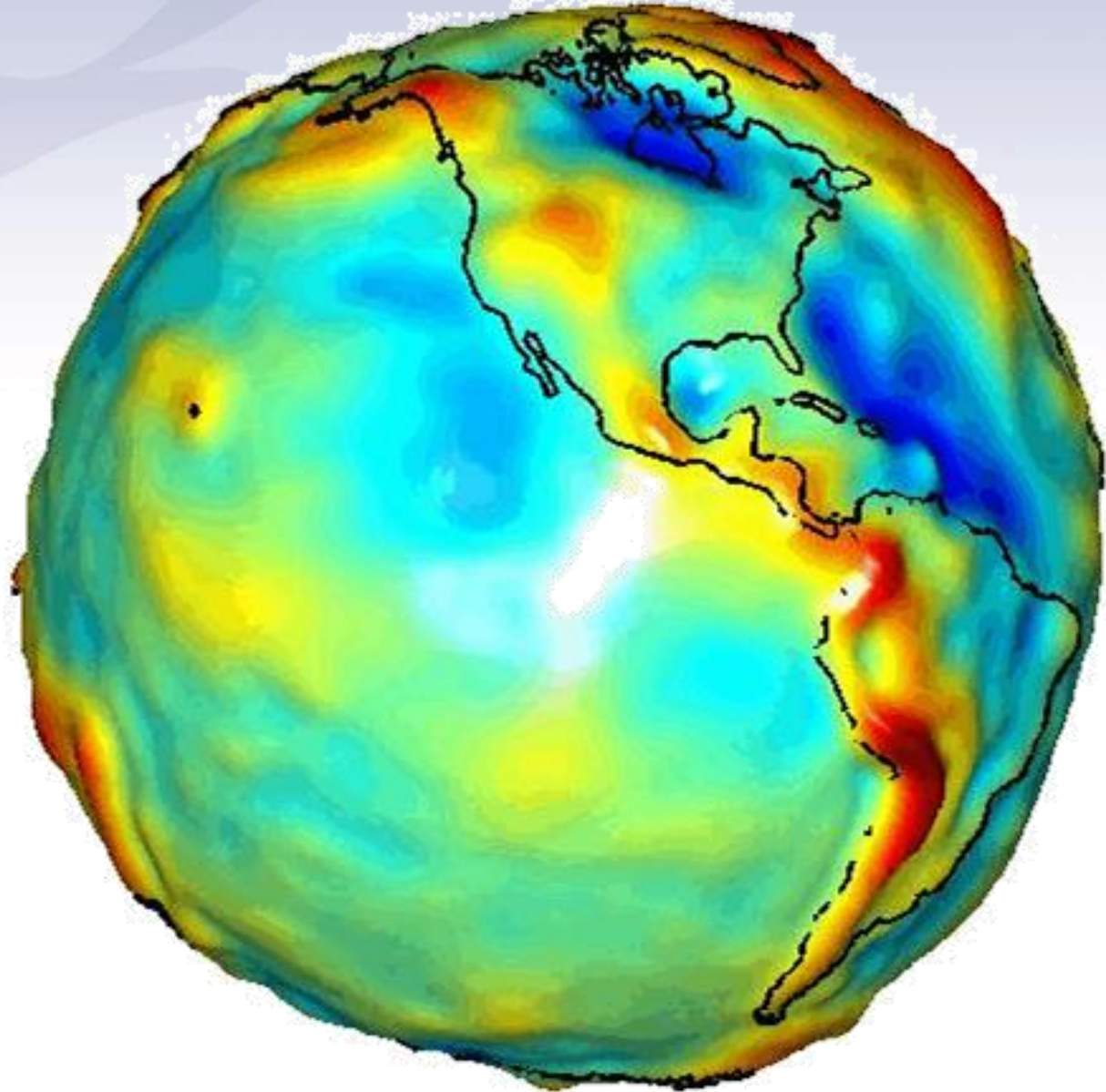
Map **Layers** **Layers**

This project and the data within it are licensed under the Creative Commons Attribution-NonCommercial-ShareAlike license.

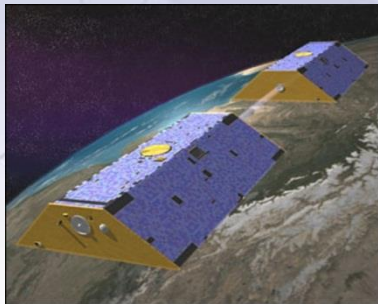
Sharing GPS observations on bench marks improves GPS orthometric heights



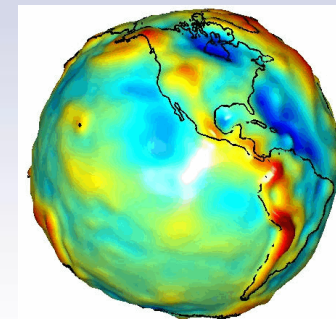
geoid
“flat”
≠
ellipsoid
“flat”



Building a Gravity Field



Long Wavelengths
(≥ 250 km)

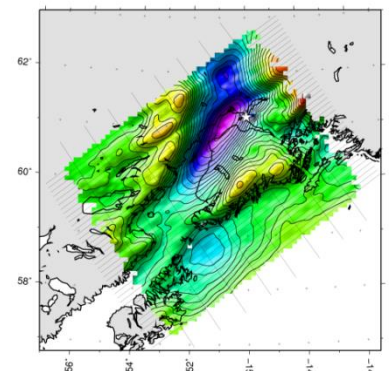


GRACE/GOCE/Satellite Altimetry +



Intermediate Wavelengths
(500 km to 20 km)

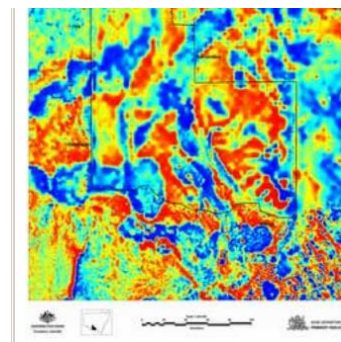
Airborne Measurement



+

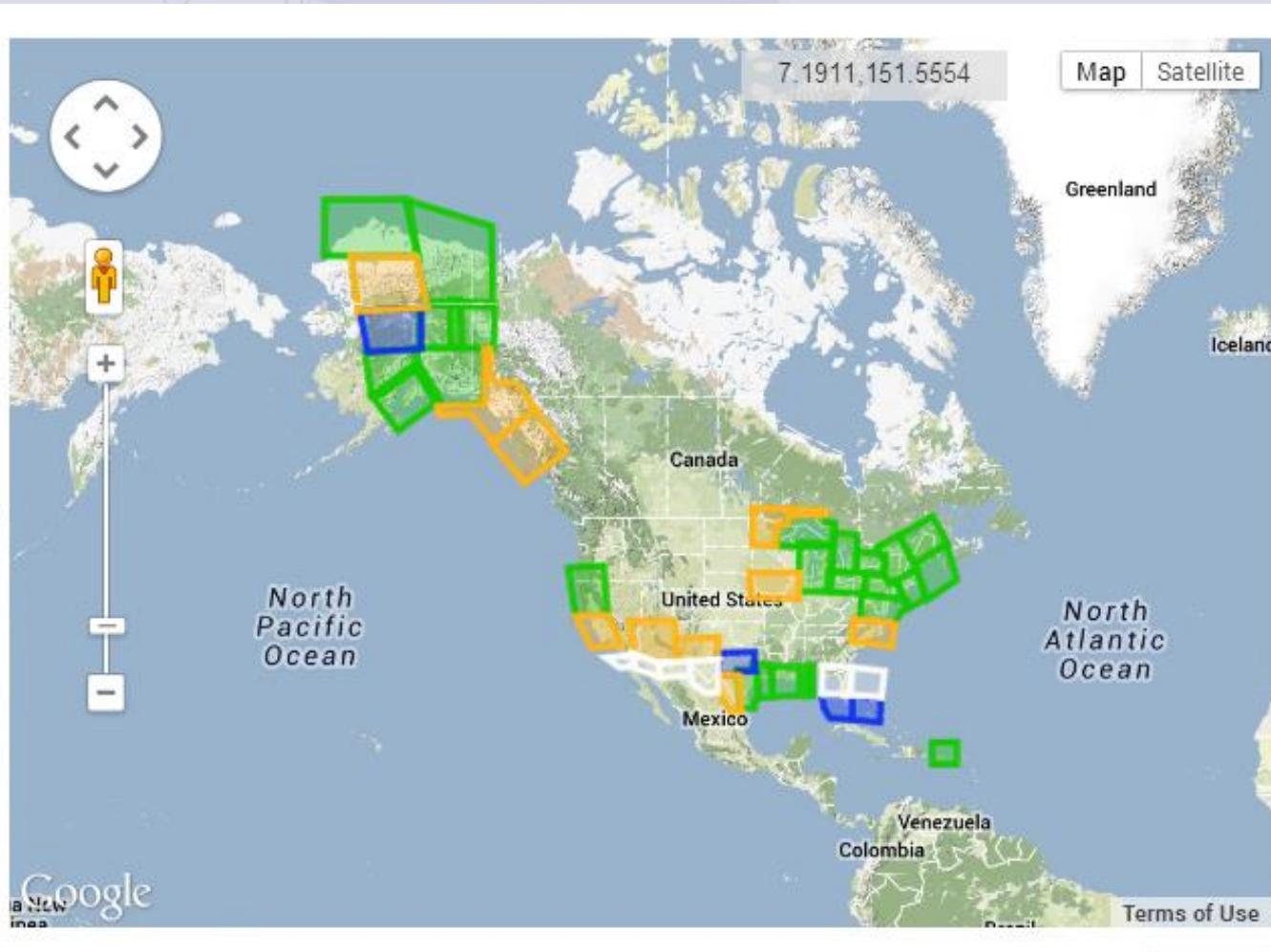


Short Wavelengths
(< 100 km)



Surface Measurement and
Predicted Gravity from Topography

Airborne Gravity Current Coverage



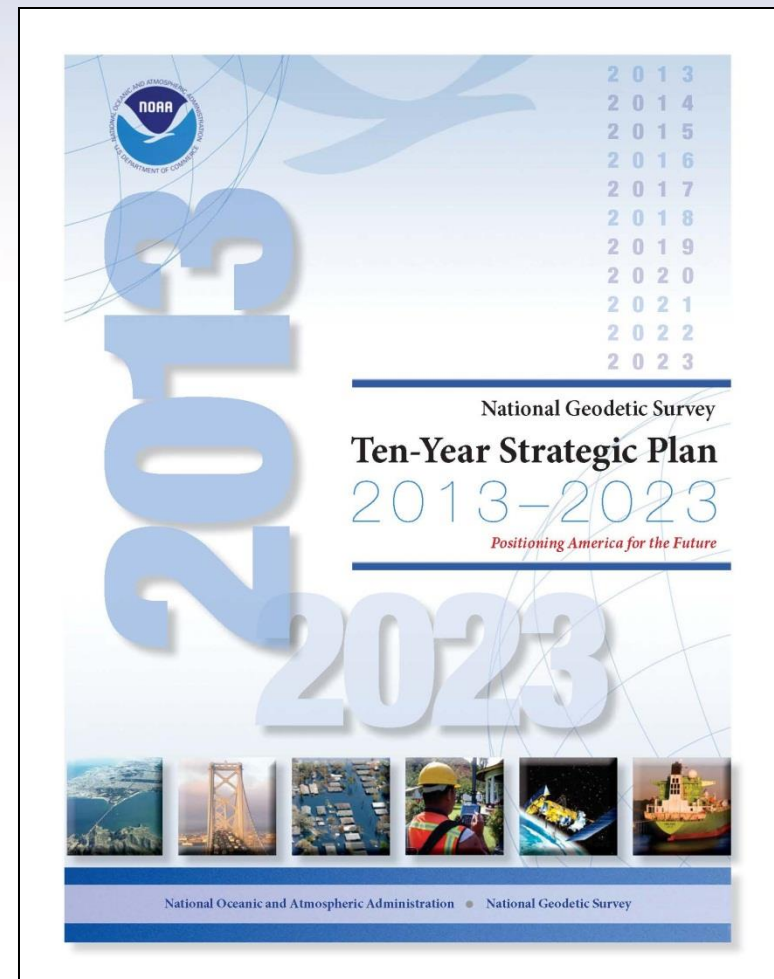
Data Block Status

- Complete
- Processing
- Collecting
- Planned

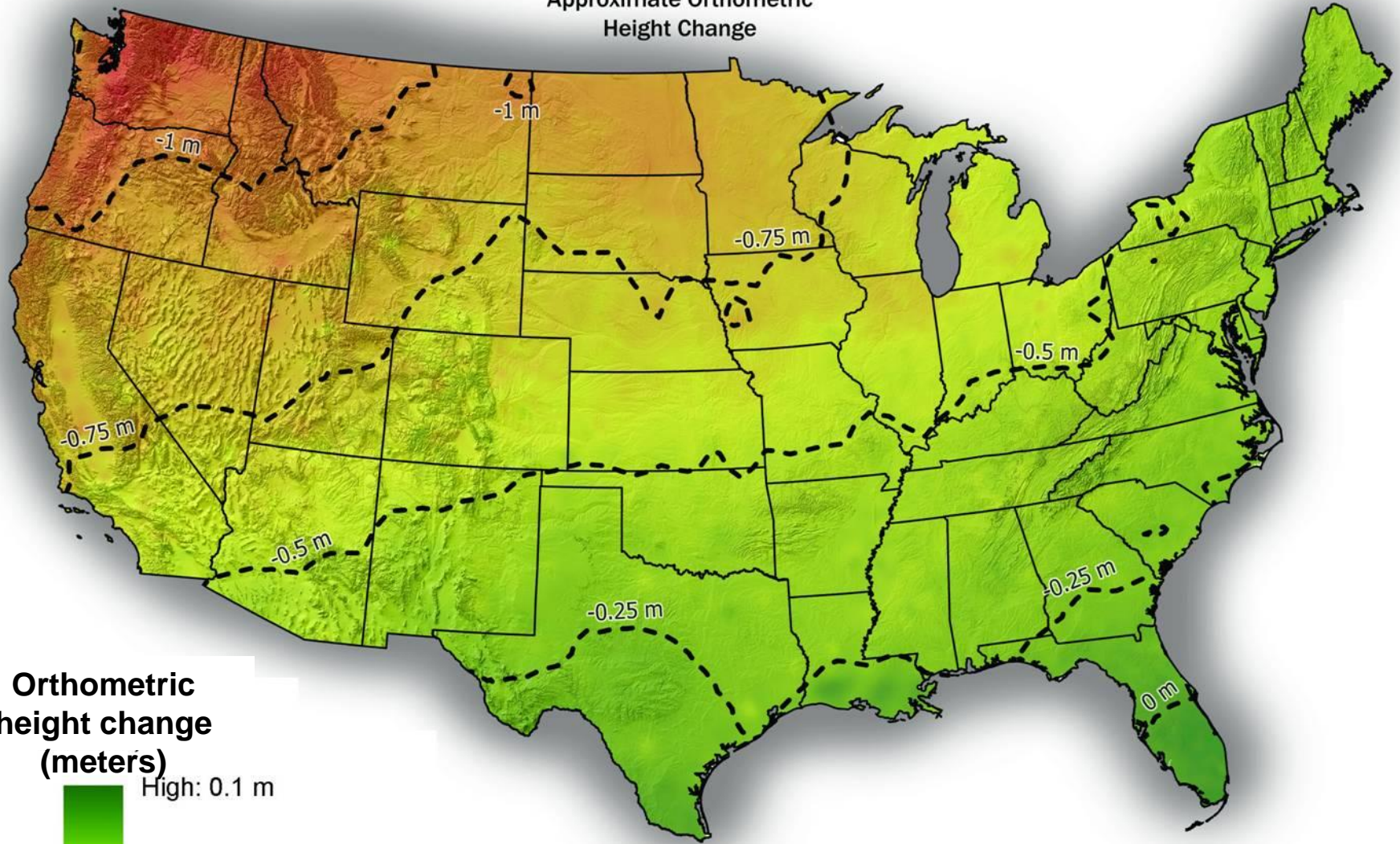
34.0% complete
as of Jan. 2014

NGS Ten Year Plan

- Updated Plan
 - Four main goals
 - One enterprise goal
- Replace NAVD 88 with a GPS/geoid datum
- Replace NAD 83 with a geocentric GPS based datum
- Implement new datums in 2022



Approximate Orthometric
Height Change



Orthometric
height change
(meters)

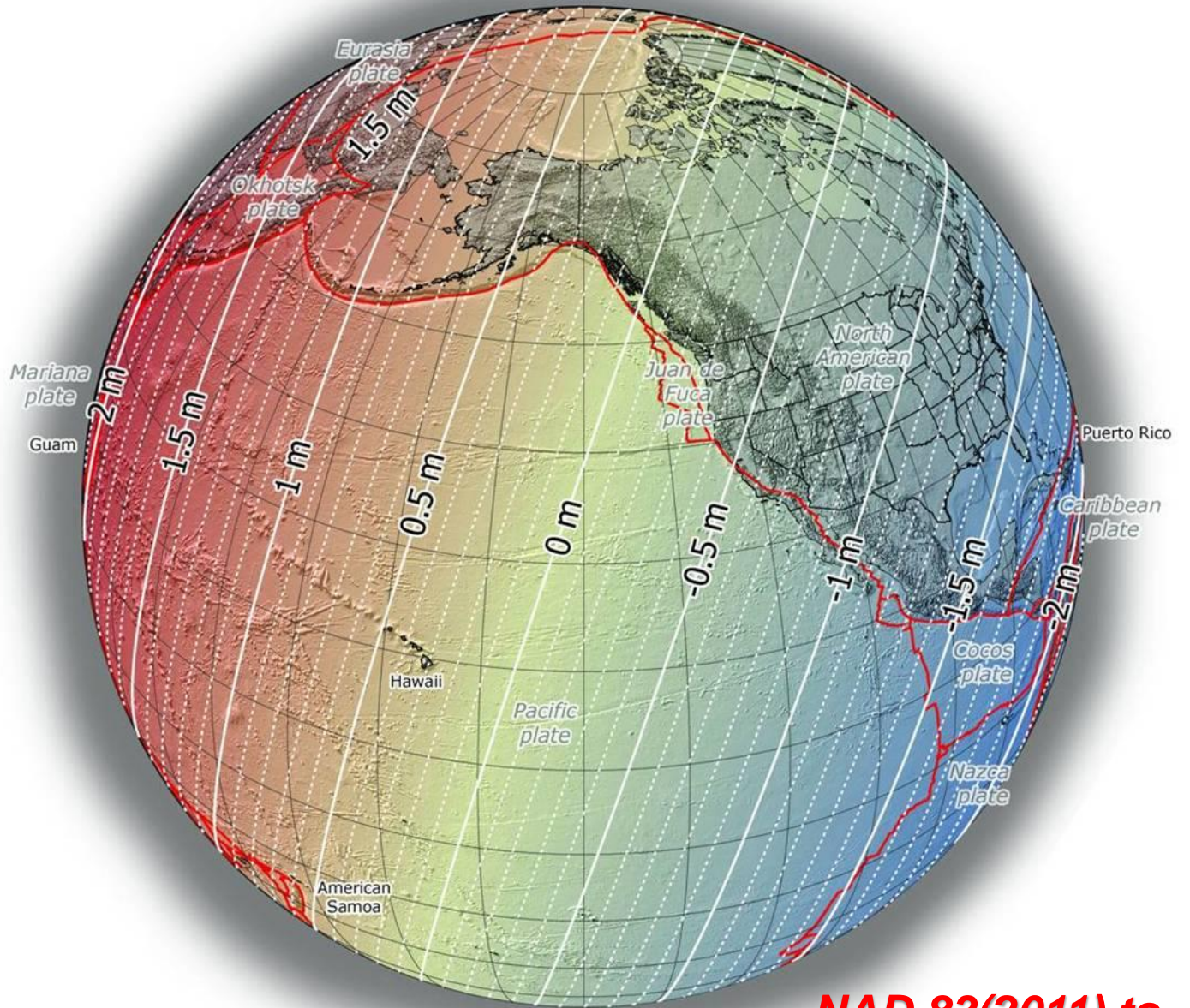


High: 0.1 m

Low: -1.3 m

***NAVD 88 to new vertical datum
Estimated as NAVD 88 "zero" (datum)
surface minus NGS gravimetric geoid***

Approximate Ellipsoid Height Change



Ellipsoid Height
(Meters)



High: 2 m

Low: -2 m

**NAD 83(2011) to
IGS08 at epoch 2022.0**

Approximate Horizontal Change

Approximate Horizontal Change North American Plate

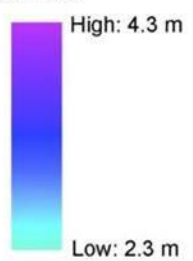
Mariana Plate (Meters)



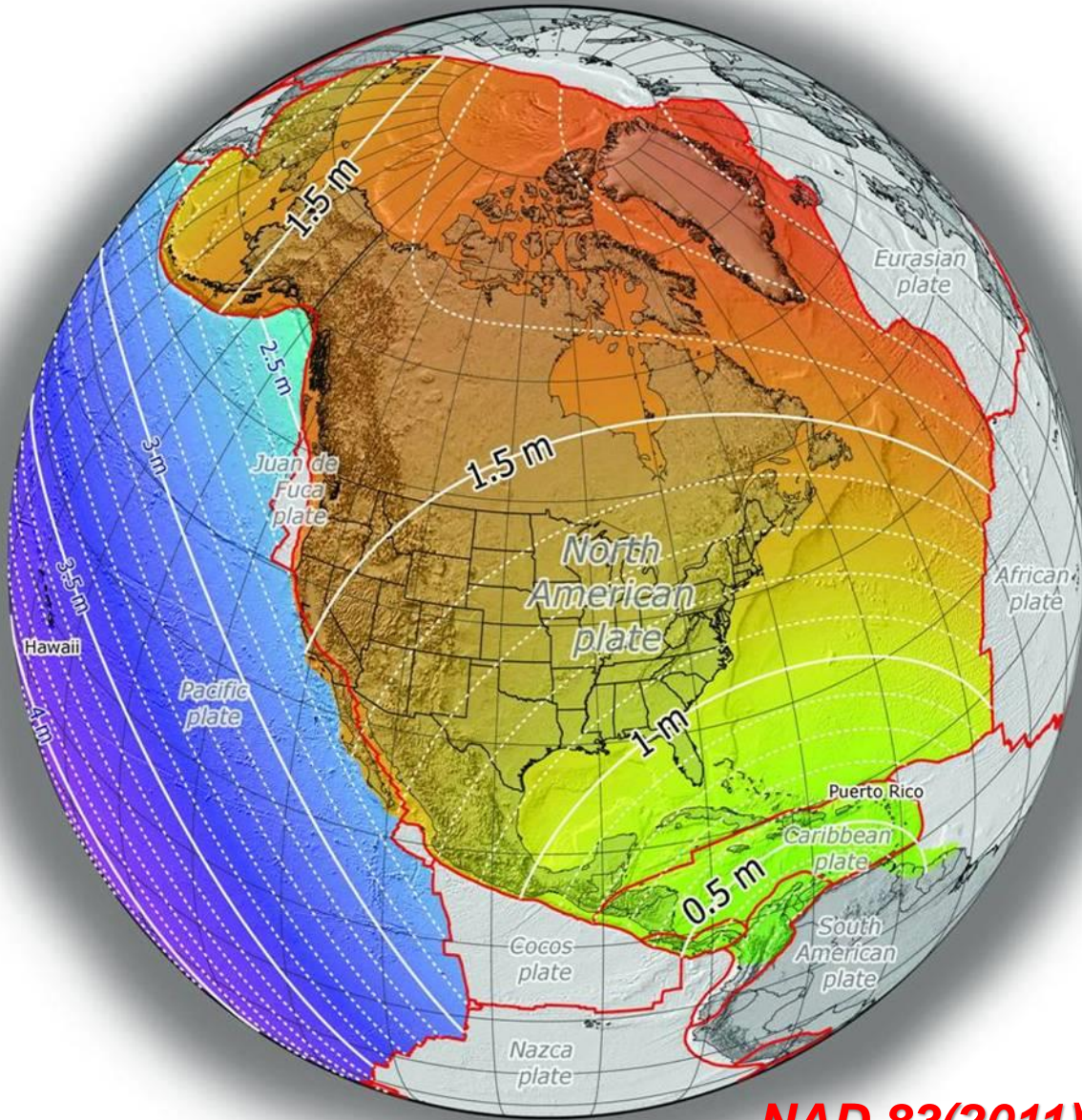
North American Plate (Meters)



Pacific Plate (Meters)

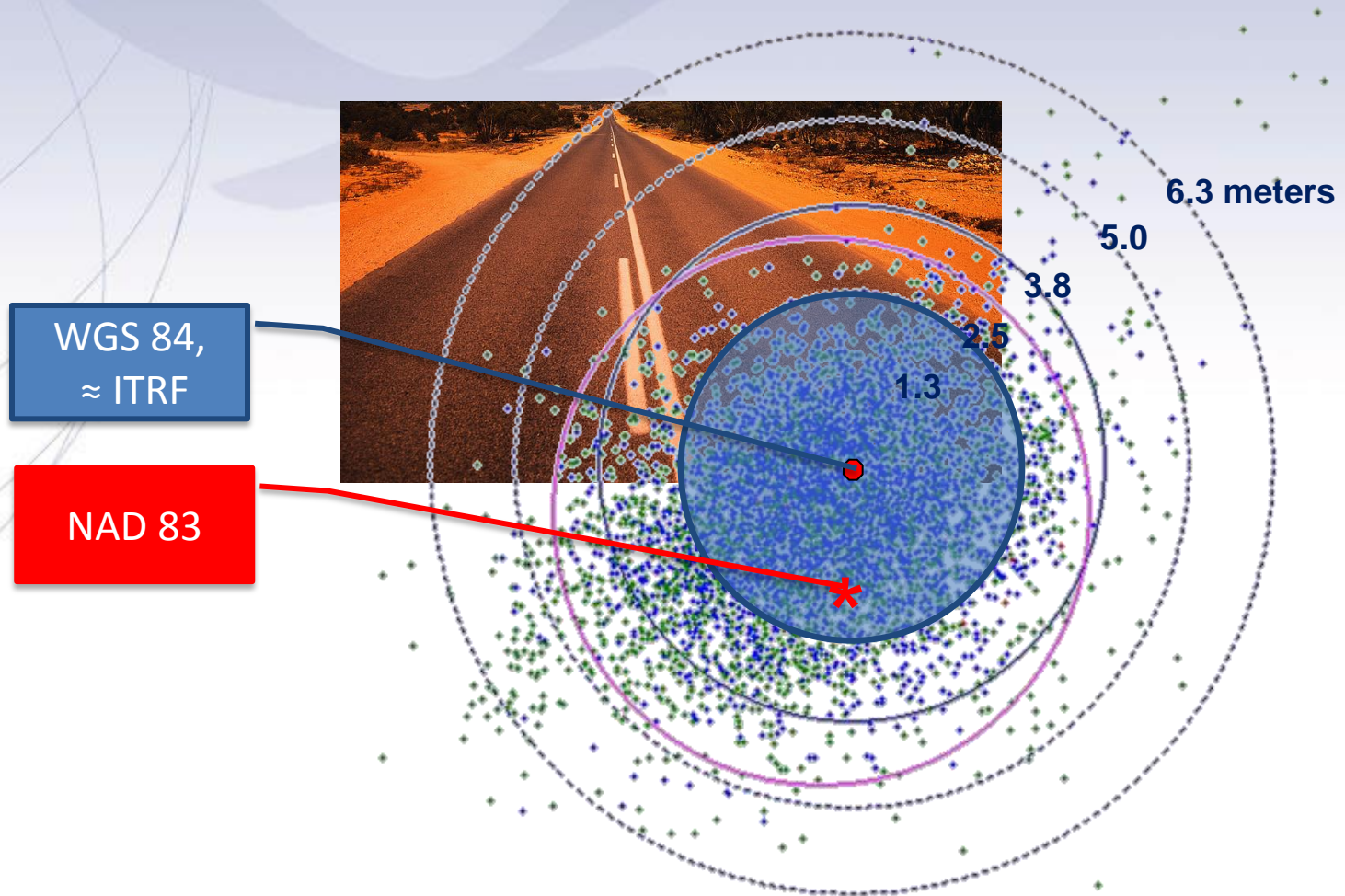


Tectonic Plate Boundaries



NAD 83(2011) to IGS08 at epoch 2022.0

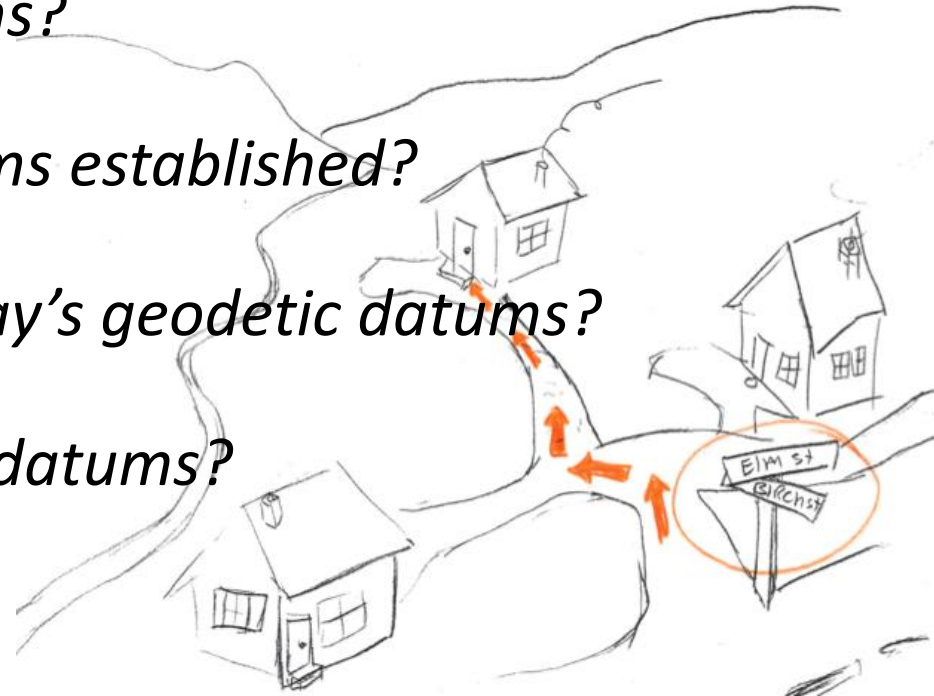
WGS84 and NAD 83 disagree



new datums: outreach

- new datums videos

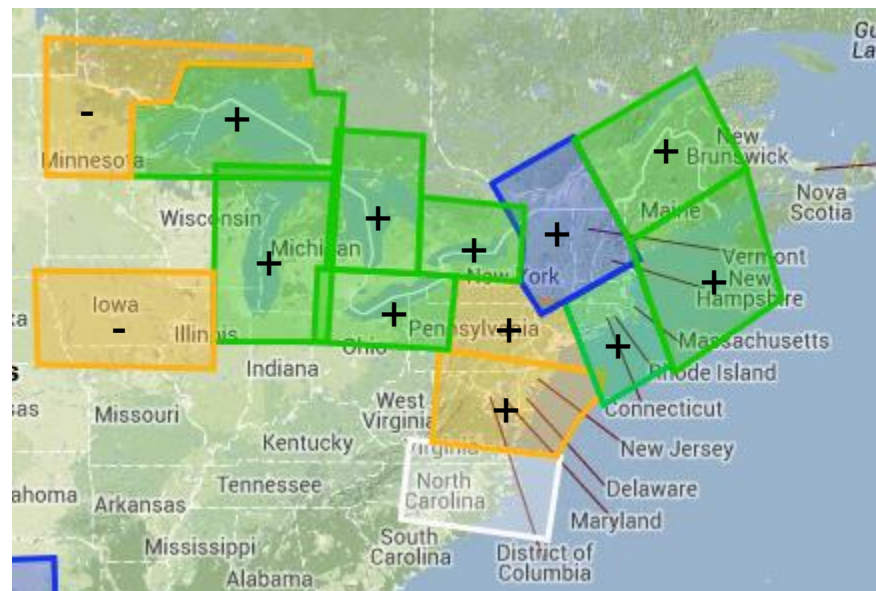
- *What are geodetic datums?*
- *How were geodetic datums established?*
- *What is the status of today's geodetic datums?*
- *What's next for geodetic datums?*



xGG2014

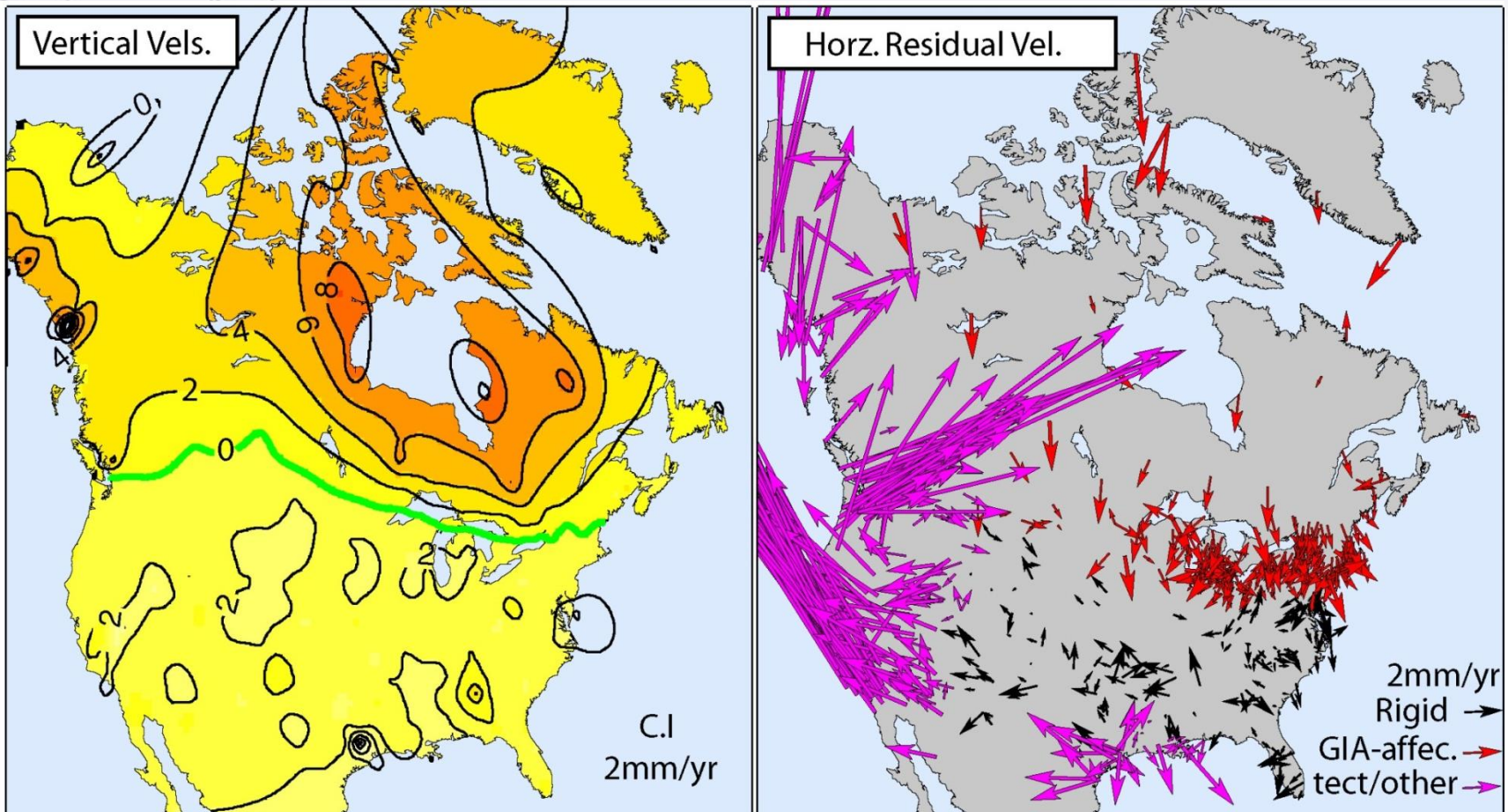
- First experimental geoid model available at <http://beta.ngs.noaa.gov/GEOID/xGEOID14/>
- Demonstrates contribution of GRAV-D data over the Great Lakes and Northeast, Gulf of Mexico, Puerto Rico, Alaska

- + included
- not included



The Dynamic Earth

Actual Motion as detected by the NGS CORS Network (Continuously Operating Reference Station)



Metadata is Critical

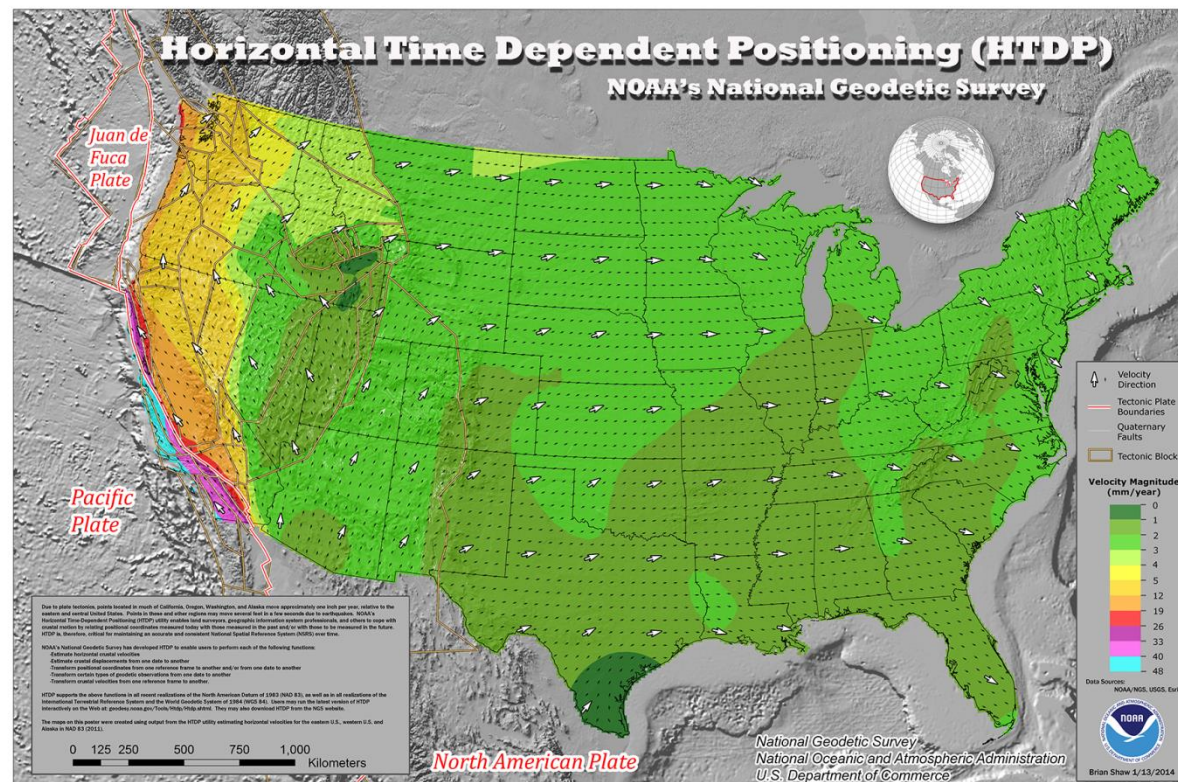
- Your positional metadata should include:
 - datum
 - epoch
 - source
- These will facilitate transforming from current to new datum
- Maintaining your original survey data will provide more accurate results

How to Plan for the Future

- Move to newest realizations
 - NAD 83(2011) epoch 2010.00
 - USGG12 (gravimetric geoid) / GEOID12A (hybrid geoid)
- Obtain precise ellipsoid heights on NAVD 88 bench marks (OPUS-DB, contact NGS Geodetic Advisor)
 - Improves hybrid geoid models and provides “hard points” in new vertical datum
 - Follow new NGS Guidelines when released
- Move off of NGVD 29 to NAVD 88
 - Understand the accuracy of VERTCON in your area
- Move away from passive marks to GNSS
 - Especially move off of classical passive control
- Require/provide complete metadata for all mapping contracts
 - How did they get the positions/heights? Document it!!

Horizontal Time-Dependent Positioning (HTDP) Tool

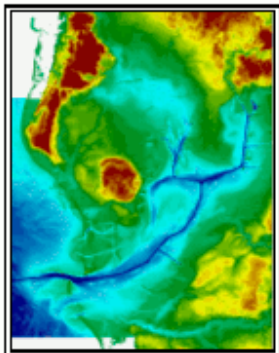
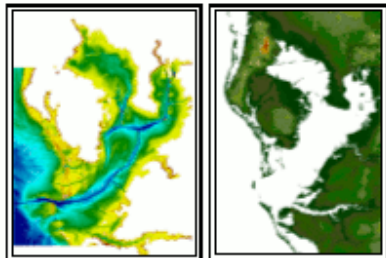
- Estimate horizontal crustal velocities / displacements
- Transform coords between reference frames and/or dates
- Models steady state & episodic crustal motions
- Transforms between NAD83 <> ITRF(IGS) <> WGS84
- Available @ NGS Geodetic Toolkit / software download



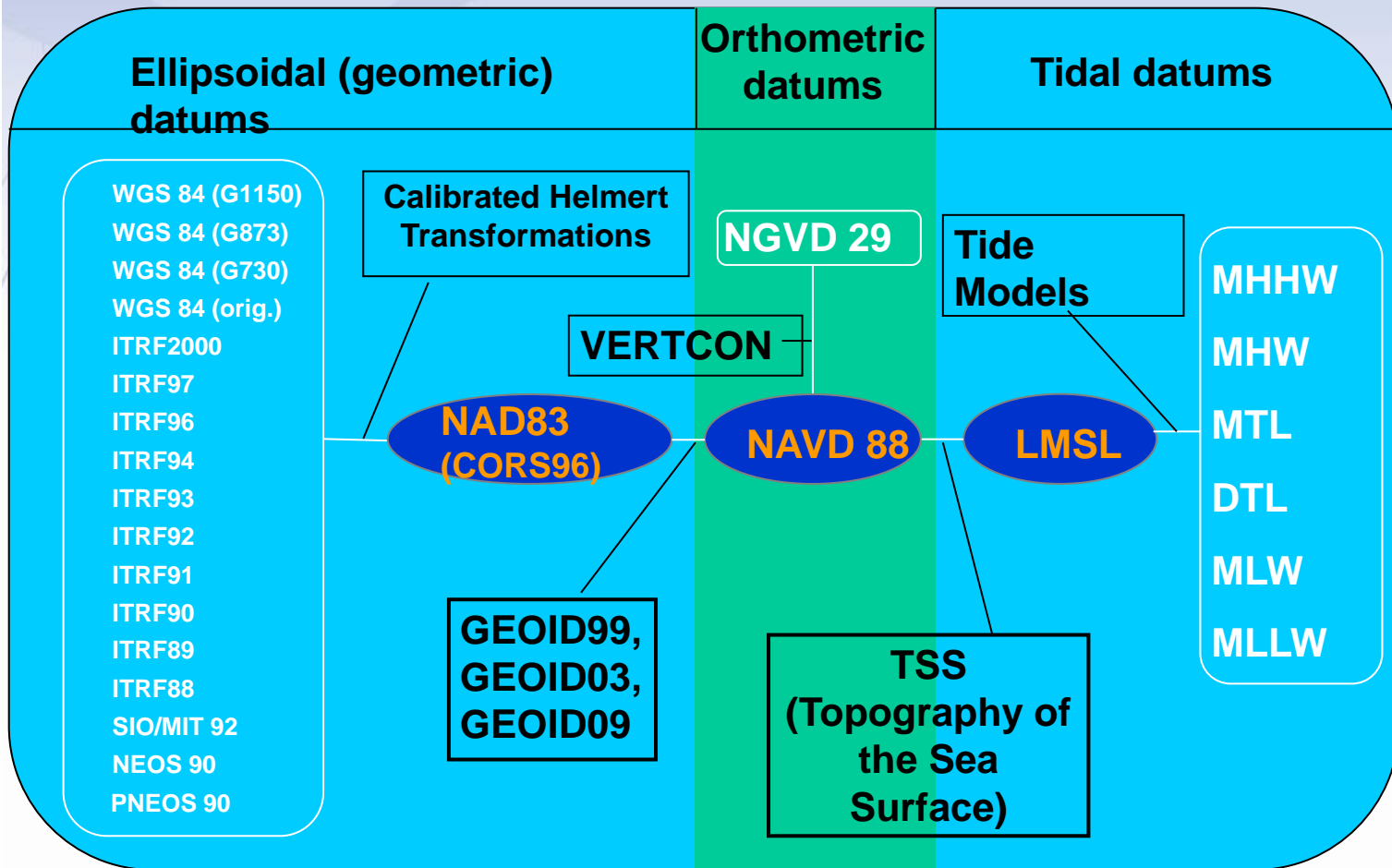
VDatum: Vertical Datum Transformation Tool

The VDatum Demonstration Project in Tampa Bay, Florida

NOAA Bathymetry USGS Topography



Integrated Bathy/Topo DEM



VDatum is a software tool capable of transforming coastal bathymetry and land topographic elevations between 36 different vertical datums.

<http://vdatum.noaa.gov/>



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