



Datums and Tools to Connect Geospatial Data Accurately

Pamela Fromhertz

Colorado State Geodetic Advisor

National Geodetic Survey

National Oceanic and Atmospheric Administration

Back up POC for NOAA to NORTHCOM

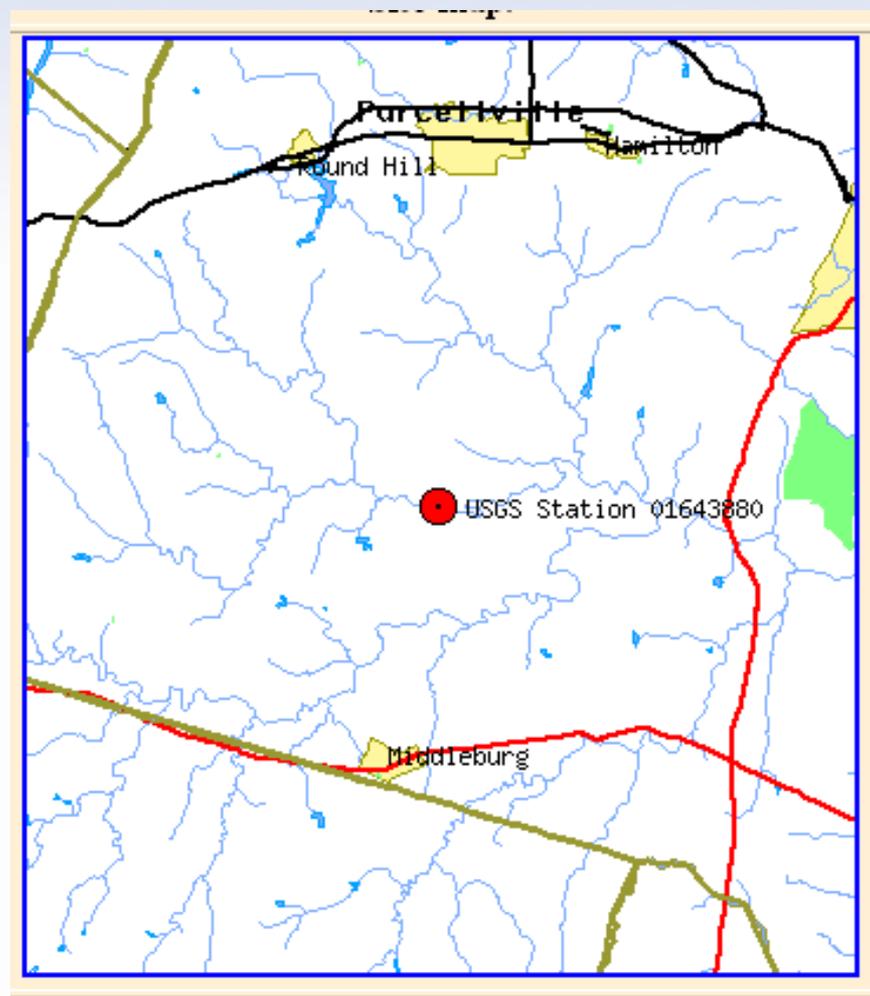
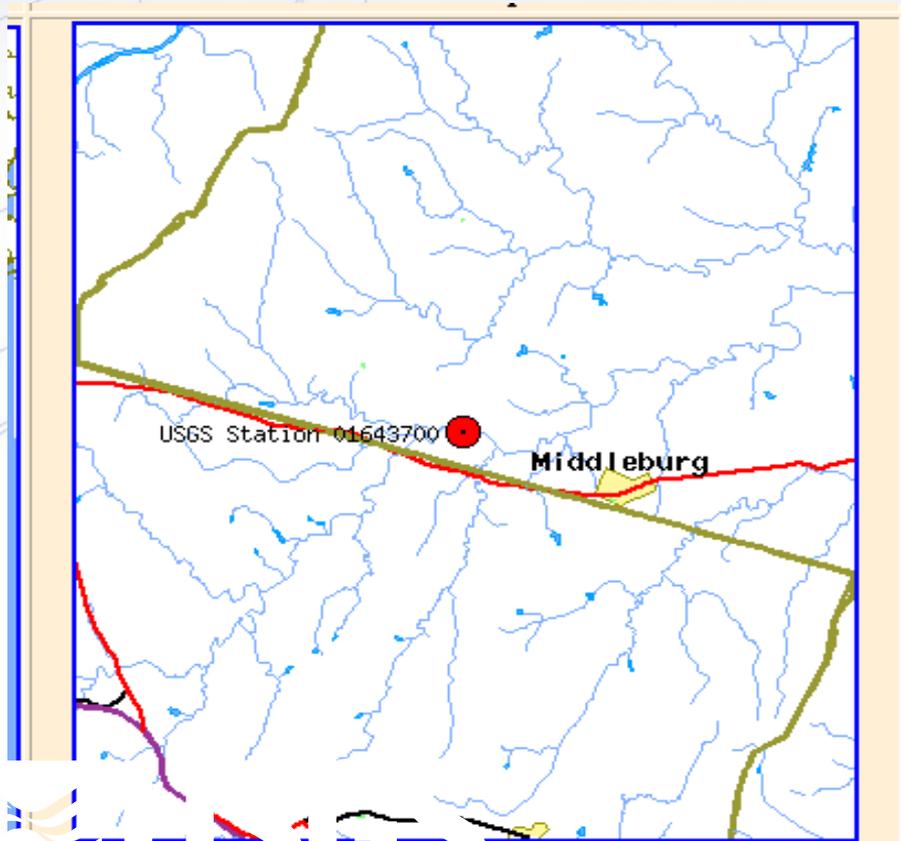
Acting Regional Coordinator for NOAA's Central Region Team

Agenda

- What is a Datum
- GPS - Accuracy
- NGS - National Spatial Reference System
- **MetaData**
- Tools
 - DS-World
 - CORS
 - OPUS

CHANGE
IMPROVEMENTS

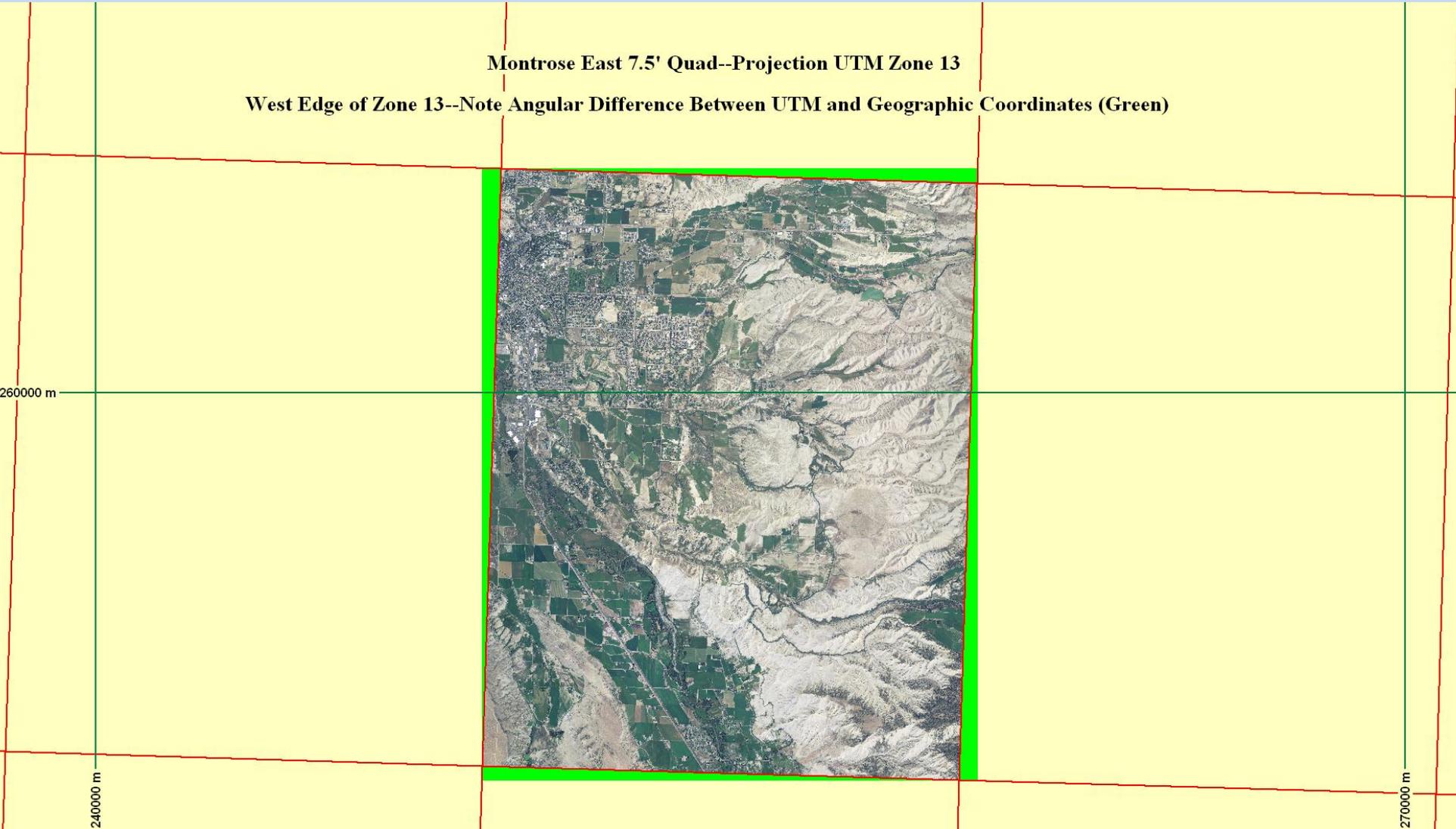
Problem



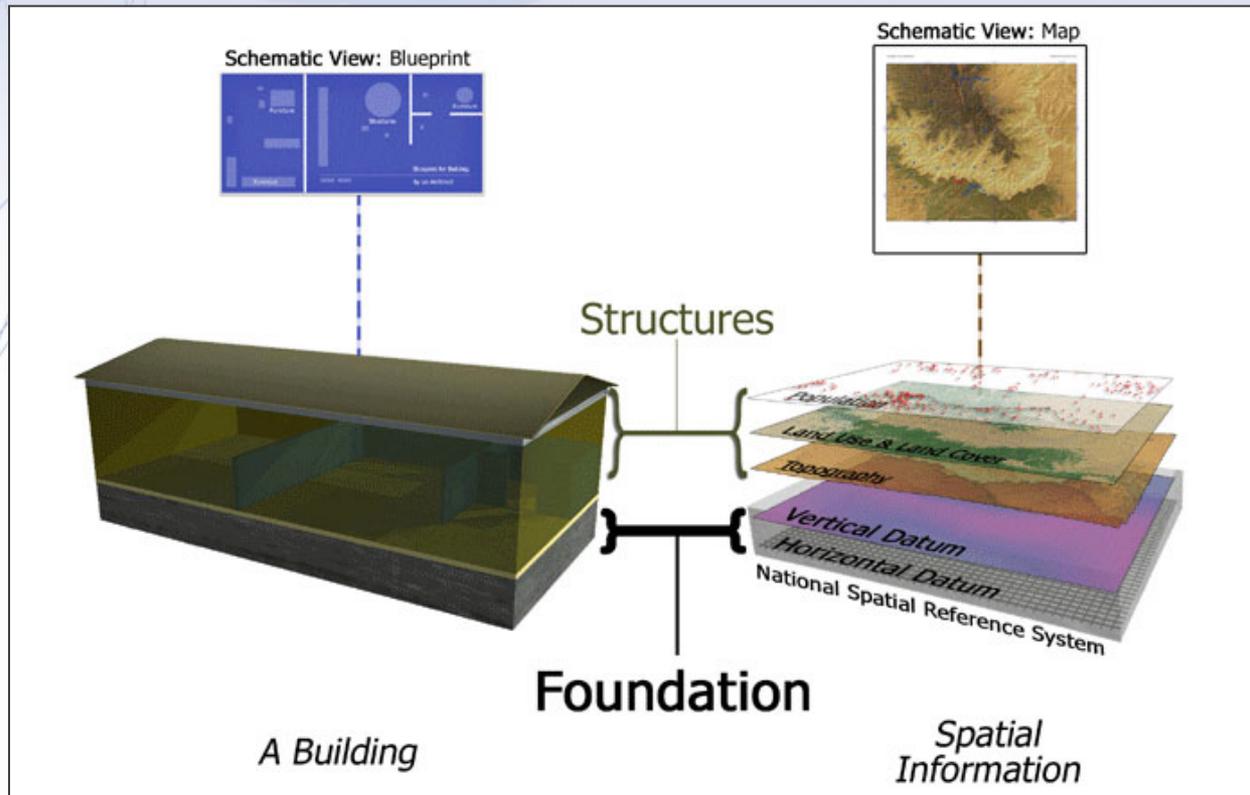
UTM Grid to Ground Differences

Montrose East 7.5' Quad--Projection UTM Zone 13

West Edge of Zone 13--Note Angular Difference Between UTM and Geographic Coordinates (Green)

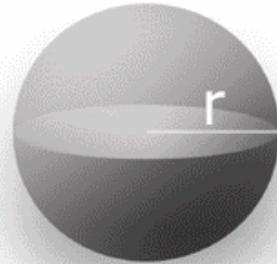


Datums



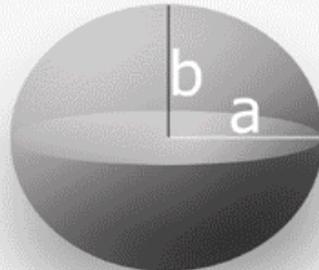
A mathematical and geometric concept that serves as a foundation or starting point for mapping, surveying, engineering based on realization of actual geospatial data points.

Geodetic Reference Surfaces



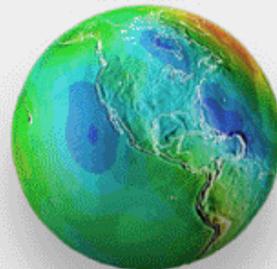
Sphere

A beachball globe



Ellipsoid
(Oblate Sphere)

Mathematical best fit to Earth's surface...
used for defining Latitude and Longitude



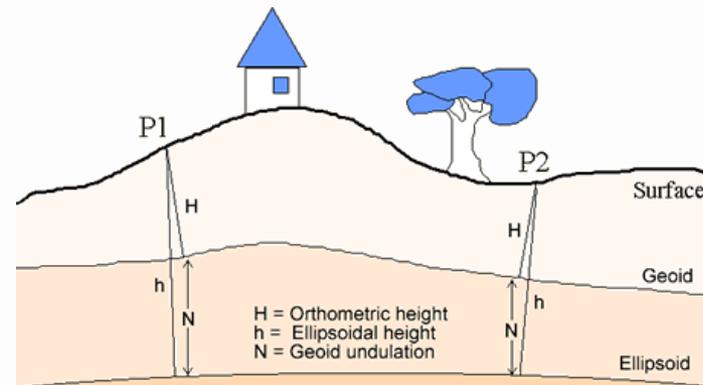
Geoid

Modeled best fit to "sea surface"
equipotential gravity field
used for defining Elevation

National Geodetic Survey Mission

To define, maintain and provide access to the National Spatial Reference System (NSRS) to meet our Nation's economic, social and environmental needs.

- Latitude
- Longitude
- Height
- Scale
- Gravity
- Orientation
- Time Variations





The NSRS Supports



Nautical charts, among many other geospatial applications
National Oceanic and Atmospheric Administration



Flood zones for the National Flood Insurance Program
Emergency Response Imagery
Federal Emergency Management Agency



Levee Safety Program to determine levee heights and positions
United States Army Corps of Engineers



Topographic Maps and interior water data for the nation
United States Geological Survey



NSRS gravity data for the **geospatial mission of NGA**
National Geospatial-Intelligence Agency



Aeronautical Data Quality Assurance
Federal Aviation Administration

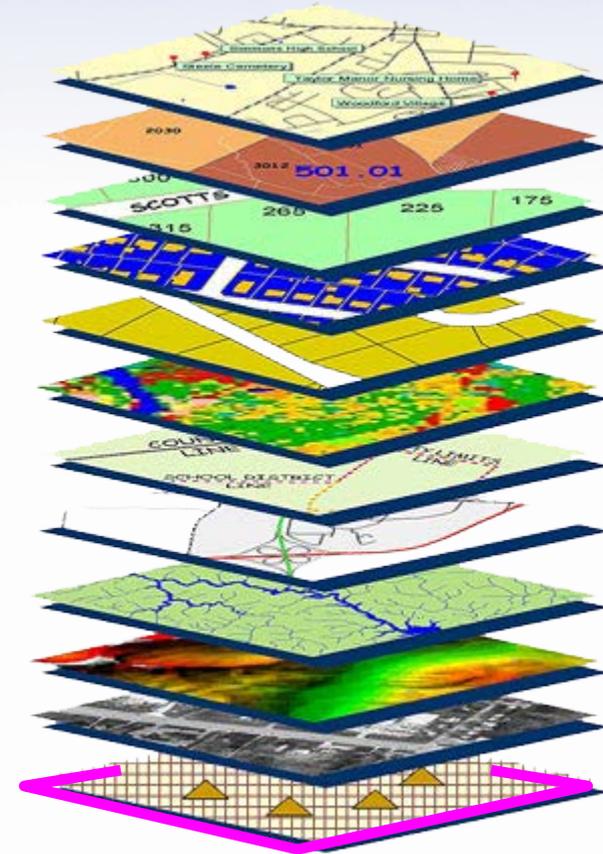
Accurate positioning begins with *accurate* coordinates

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

Without Geodetic Control as a "base map" layer, GIS applications will not work properly



Source: Zurich-American Insurance Group



Datum Differences On Average in COLORADO

DRAFT

	Meters	Feet
Horizontal		
NAD 27 - NAD 83 (1986)	40-57	131-187
NAD 83 (1986) - NAD 83 (199x) HARN	0.2-0.6	0.66-1.97
NAD 83 (199x) HARN - NAD 83 (2007)	0.02	0.06
NAD 83 (2007) - NAD 83 (2011)	0.02-0.04	0.06-0.13
NAD 83 (2011) - New Datum (2022)	1.3 - 1.4	4.3 - 4.6

DRAFT

Vertical		
Orthometric Heights		
NGVD 29 - NAVD 88	0.46 - 1.5	1.5 - 5.0
NAVD 88 - New Datum (2022)	0.5 - 0.75	1.6 - 2.5

DRAFT

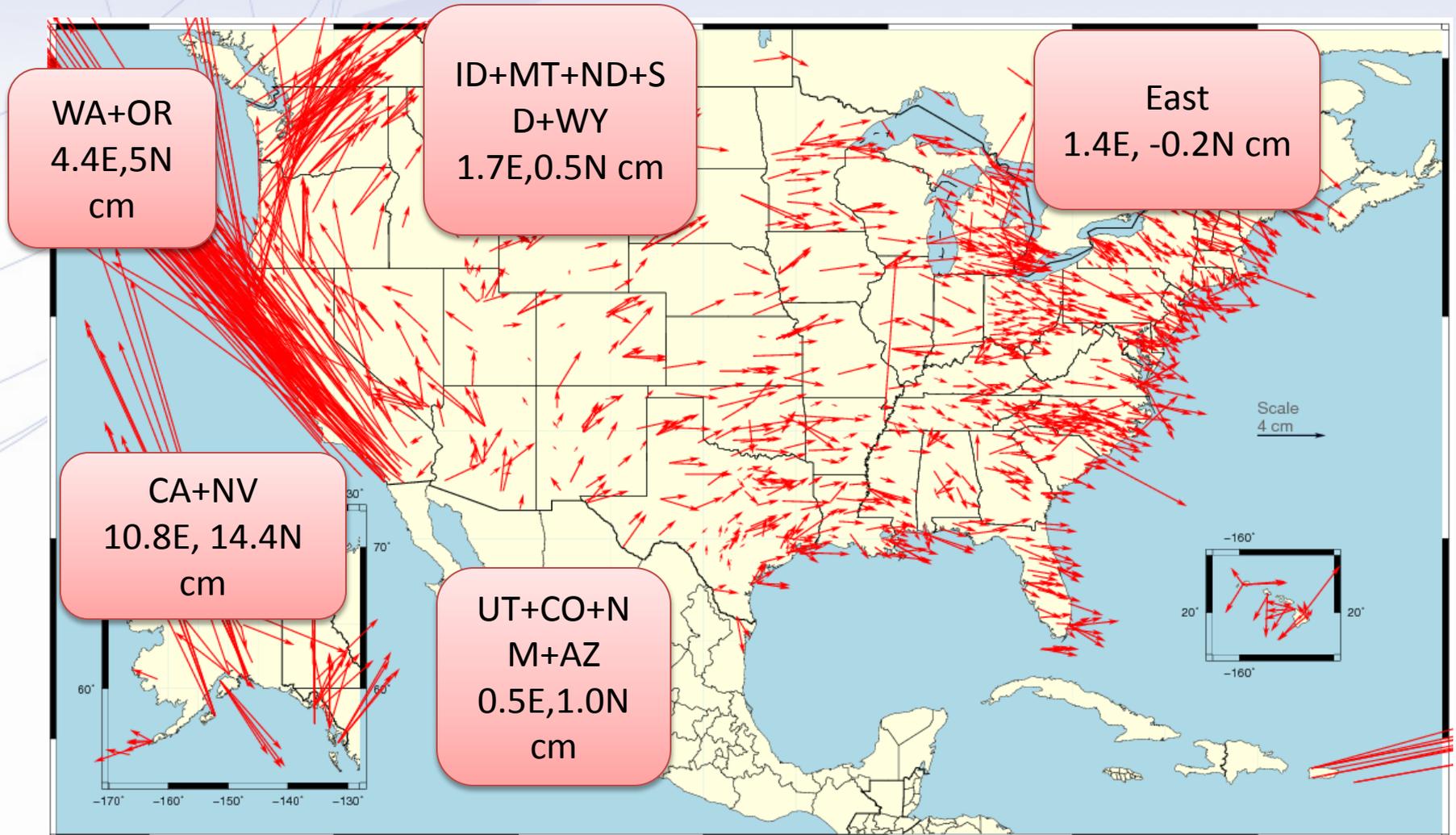
NAVD 88- NAD 83 ellipsoidal height	18	60
------------------------------------	----	----

DRAFT

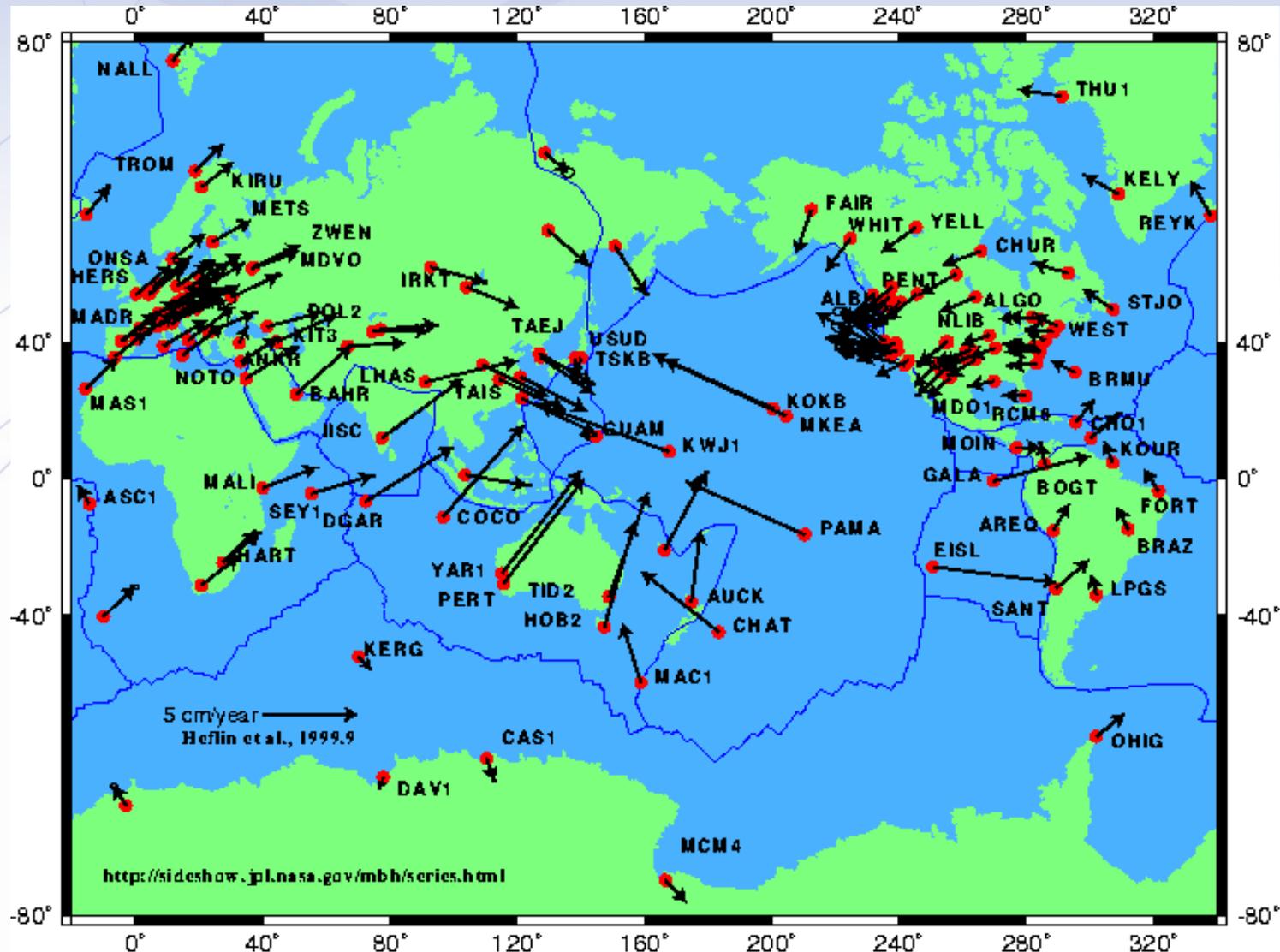
Geoid Models		
Geoid 96 - Geoid 99		
Geoid 99 - Geoid 03	0.02-1.3	0.06-4.3
Geoid 03 - Geoid 09	-0.05-(+)0.05	-0.16-(+) 0.16
Geoid 09- Geoid 12		

Changes in *Horizontal* NAD 83 Positions Different Epochs

NAD 83(2011) epoch 2010.0 – NAD 83(2007) epoch 2002.0



Tectonic Motions



GPS Receiver Grades

- Recreational Grade

 - \$100-\$1000

 - 1-10 meters



- Mapping

 - \$2,000-\$6,000

 - submeter - 3 meter



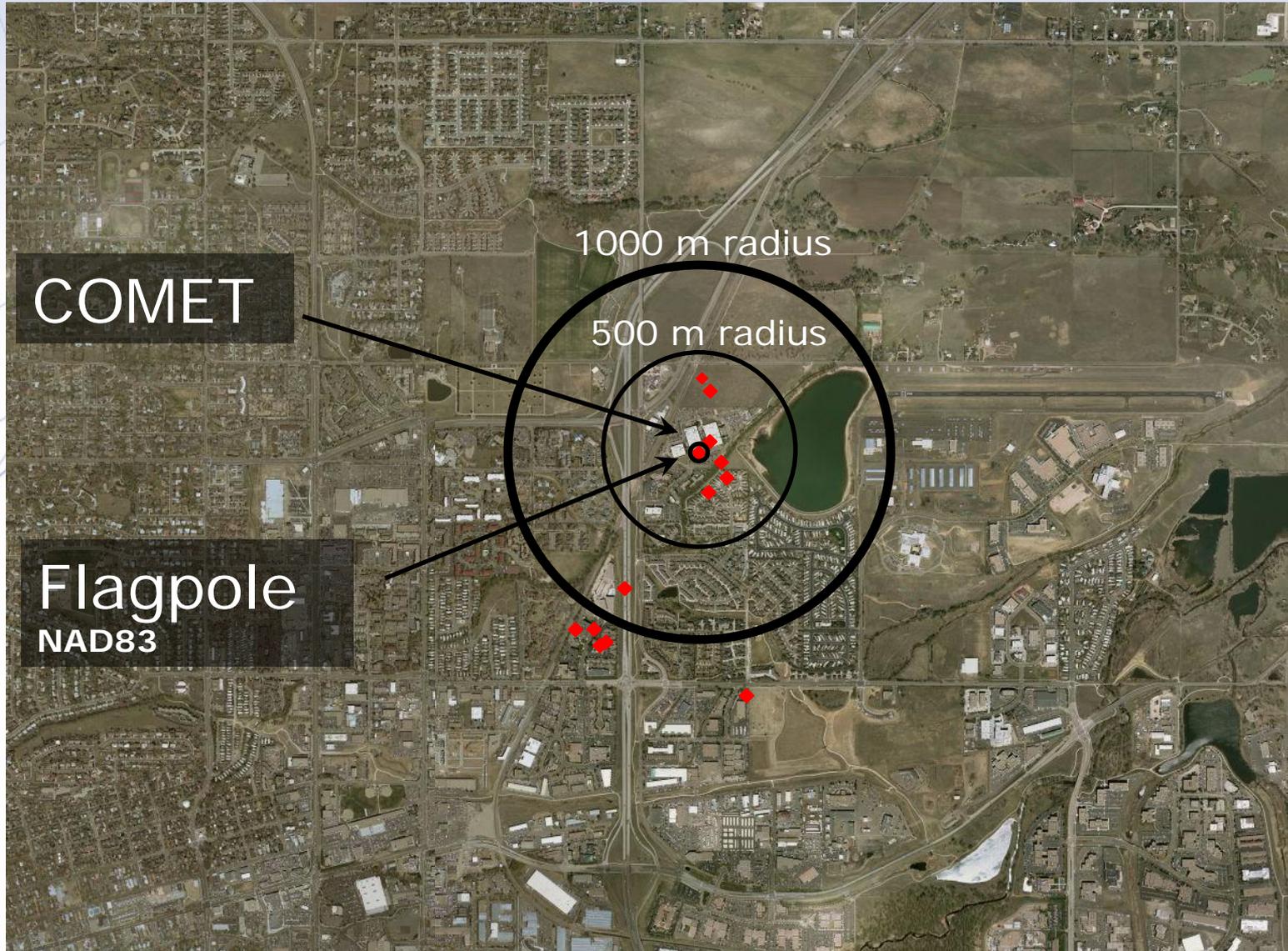
- Survey Grade

 - \$10,000 +

 - 5mm – 2 cm



Same point different datum's = different lat/long's



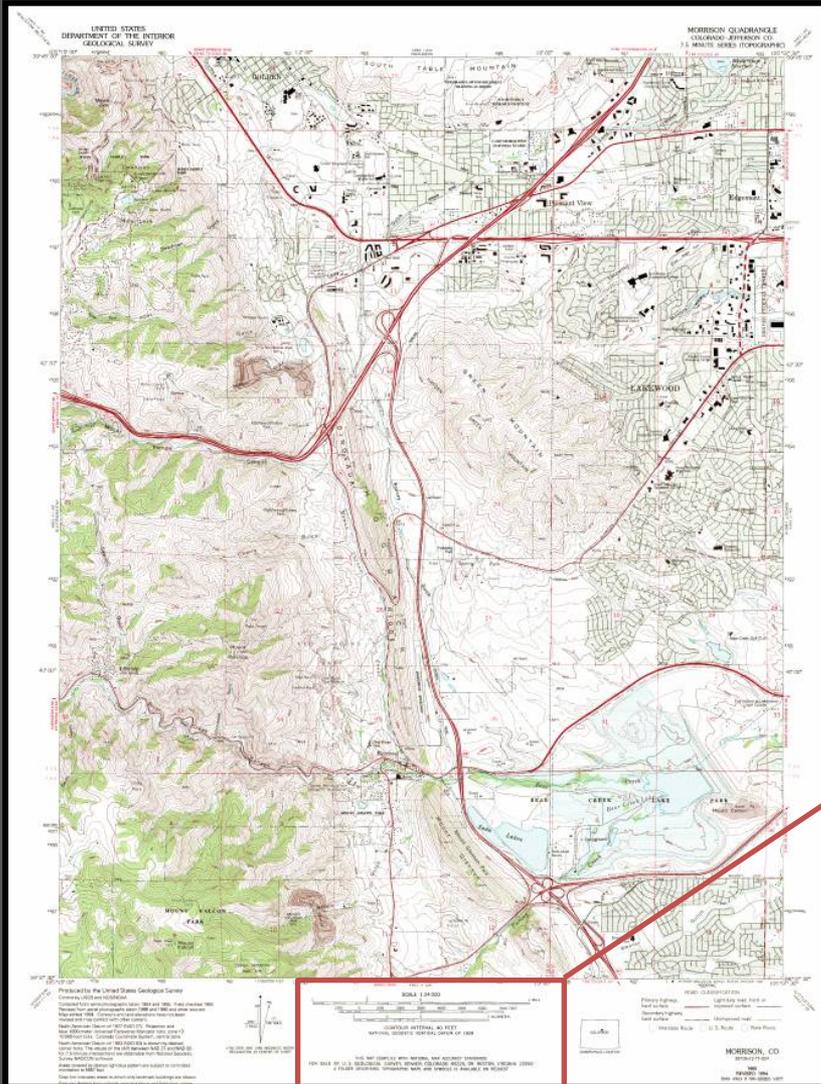
Morrison, CO Quad

1994 7.5-minute Topographic Map

Horizontal datum = NAD27

Projection = UTM Zone 13

Contours = 1955 vintage



30" 105° 15' 00" 479 480

Produced by the United States Geological Survey
Control by USGS and NOS/NOAA

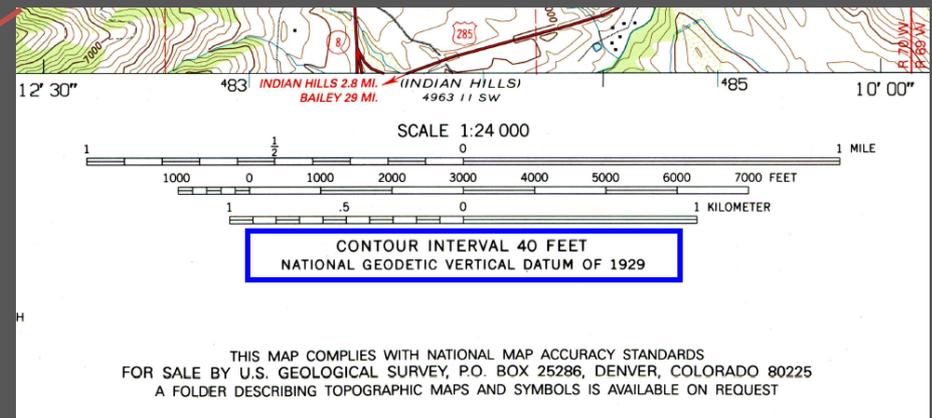
Compiled from aerial photographs taken 1954 and 1955. Field checked 1965
Revised from aerial photographs taken 1988 and 1990 and other sources
Map edited 1994. Contours and land elevations have not been revised and may conflict with other content

North American Datum of 1927 (NAD 27). Projection and blue 1000-meter Universal Transverse Mercator ticks, zone 13
10000-foot ticks: Colorado Coordinate System, central zone
North American Datum of 1983 (NAD 83) is shown by dashed corner ticks. The values of the shift between NAD 27 and NAD 83 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

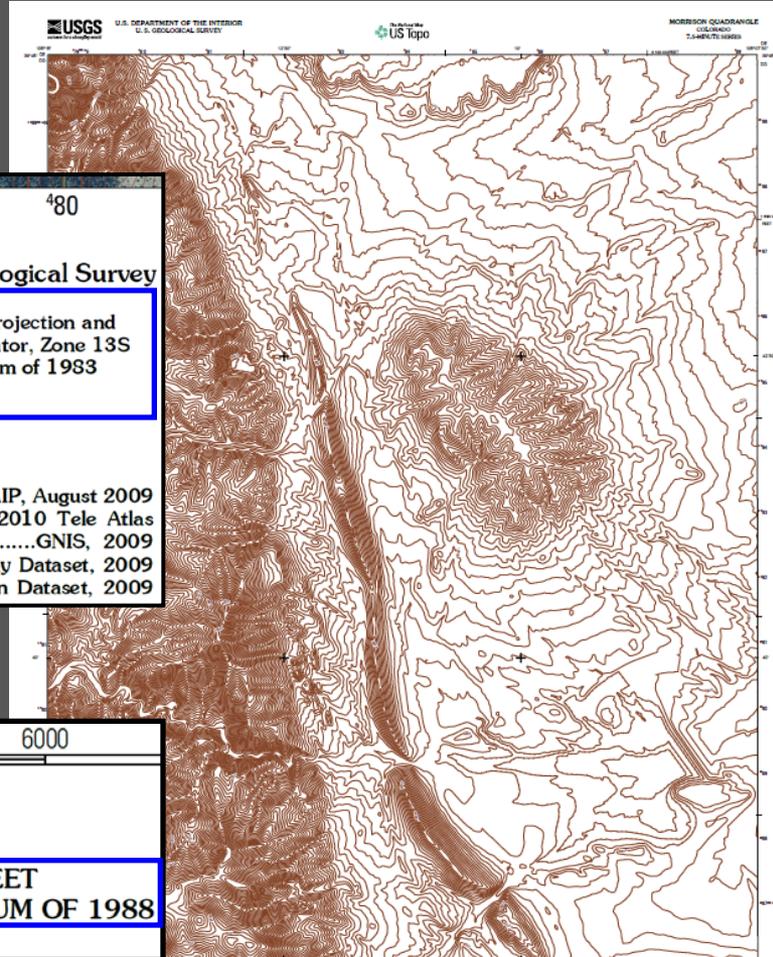
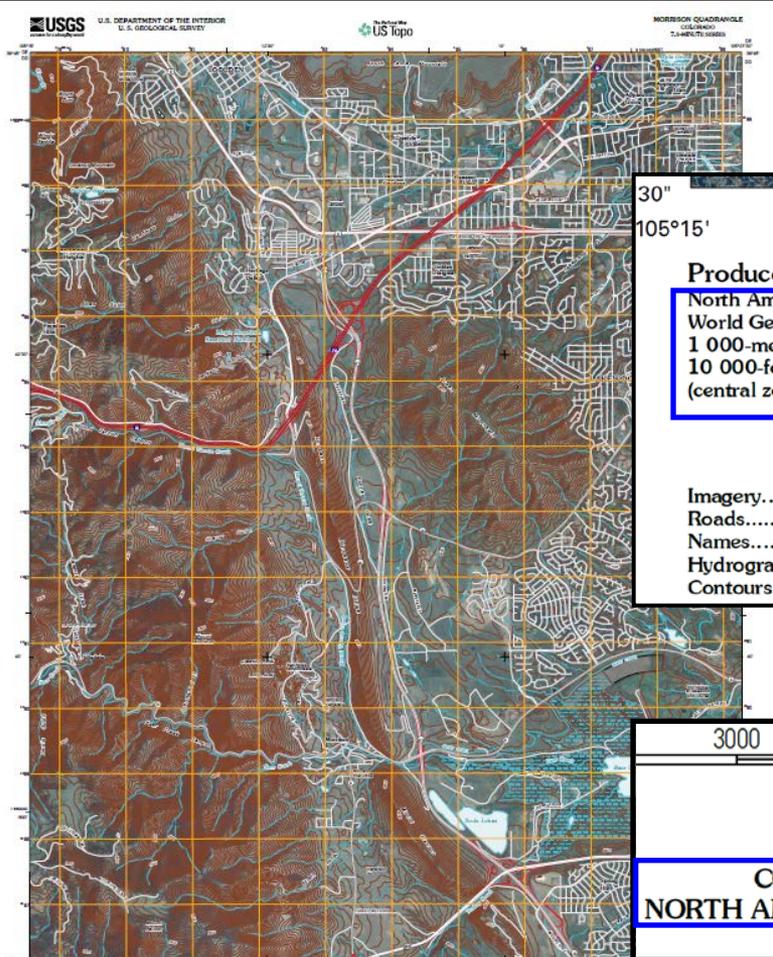
Areas covered by dashed light-blue pattern are subject to controlled inundation to 5667 feet

Gray tint indicates areas in which only landmark buildings are shown
Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

Vertical datum = NGVD29



2011 US Topo Map



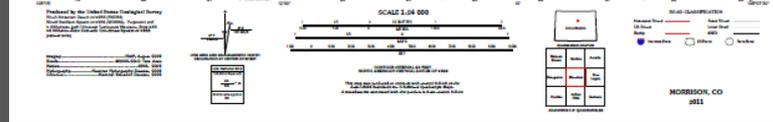
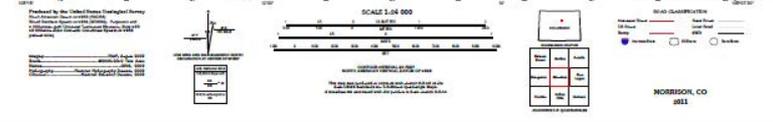
30" 49 80
105°15'

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGSS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 13S
10 000-foot ticks: Colorado Coordinate System of 1983
(central zone)

Imagery.....NAIP, August 2009
Roads.....©2006-2010 Tele Atlas
Names.....GNIS, 2009
Hydrography.....National Hydrography Dataset, 2009
Contours.....National Elevation Dataset, 2009



CONTOUR INTERVAL 40 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988



Are NAD 83 & WGS 84 The Same?

NO

but for your application is it significant?

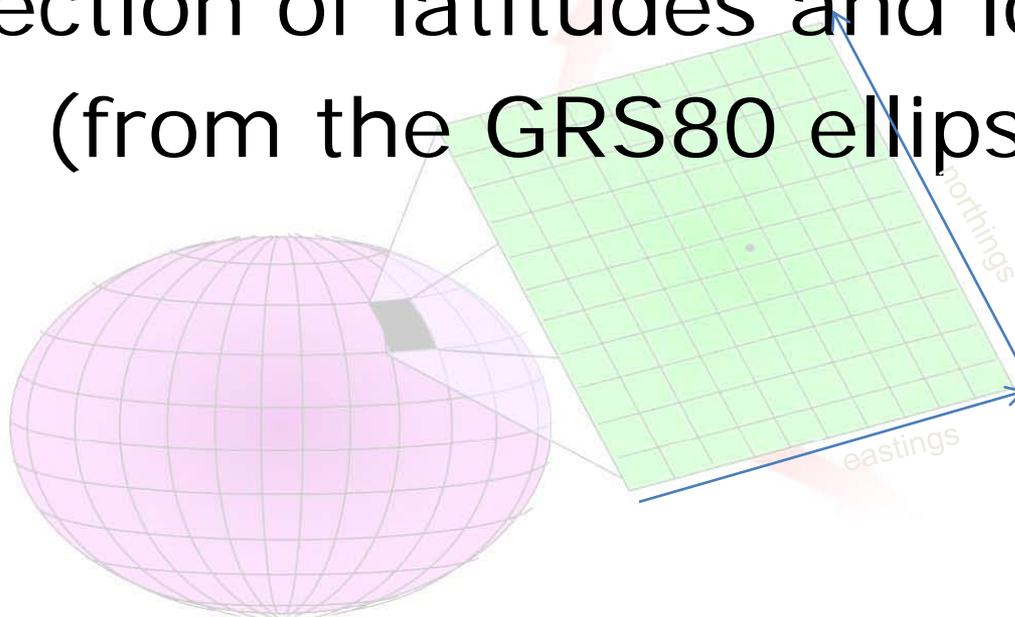
If requirements are *greater* than 3m
then *Yes*

If requirements are *less* than 3m then
No

Federal Register Notice: Vol. 60, No. 157, August 15, 1995, pg. 42146
"Use of NAD 83/WGS 84 Datum Tag on Mapping Products"

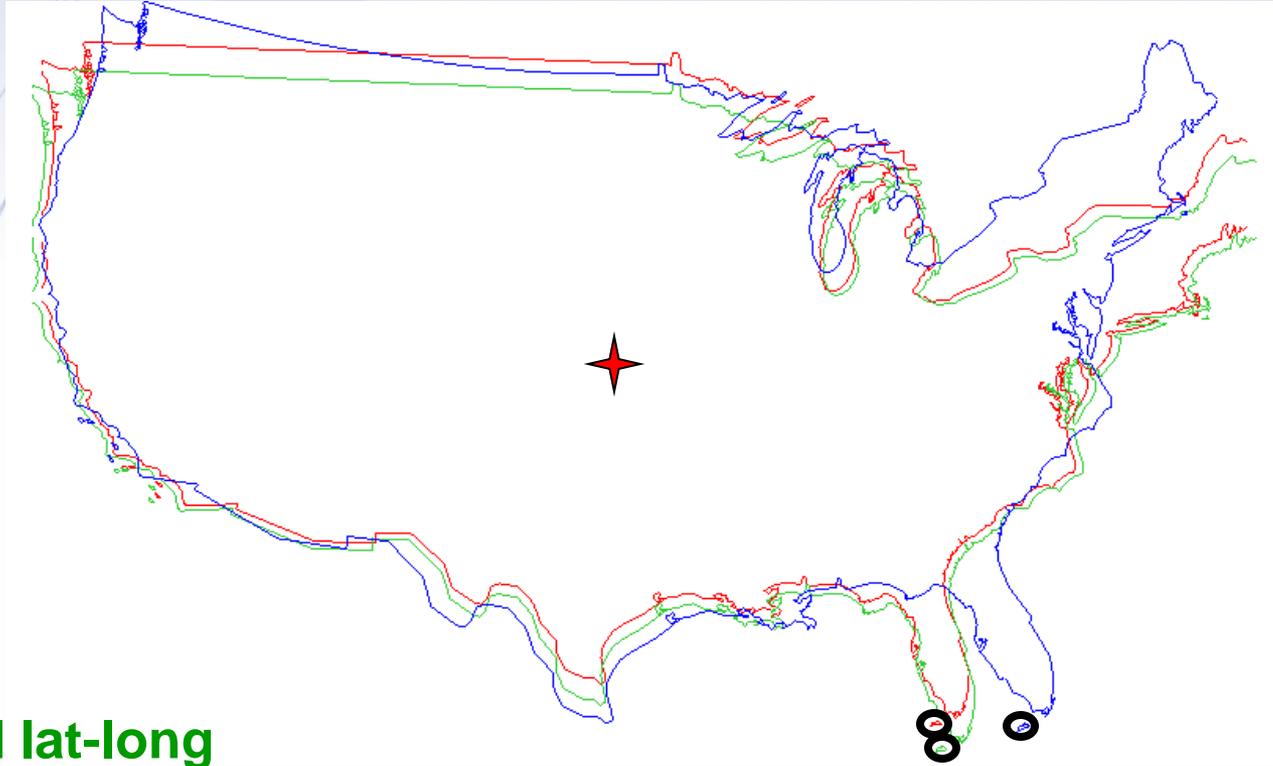
State Plane Coordinates

State plane coordinates are the projection of latitudes and longitudes (from the GRS80 ellipsoid)



To a flat mapping surface that is usually defined by state law

Three projections centered at 39° N, 96 ° W



Unprojected lat-long

Lambert Conformal Conic

Mercator

**What is the
x,y of Key
West, FL?**

Plane Coordinate Conversion Tools

State Plane Coordinates

GPPCGP (NAD 27 only)

SPCS83 (NAD 83 only)

<http://www.ngs.noaa.gov/TOOLS/spc.shtml>

UTM

UTMS (Both NAD 27 & NAD 83)

<http://www.ngs.noaa.gov/TOOLS/utm.shtml>

Both

CORPSCON (Both NAD 27 & NAD 83)

<http://crunch.tec.army.mil/software/corpscon/corpscon.html>

www.ngs.noaa.gov

www.geodesy.noaa.gov



National Geodetic Survey

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November 11, 2012

Announcements

NOTICE: November 2, 2012

NGS Responds to Hurricane Sandy

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NOTICE: October 19, 2012

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NOTICE: NGS Update, September 11, 2012

GEOID12A Model Released

The National Geodetic Survey has released the **GEOID12A model**

NRC Highlights Importance of NGS Products...



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Upcoming Events



Metadata

Metadata

Metadata

Height Modernization



Differential Leveling (Orthometric HT)

GNSS (Ellipsoid Ht)

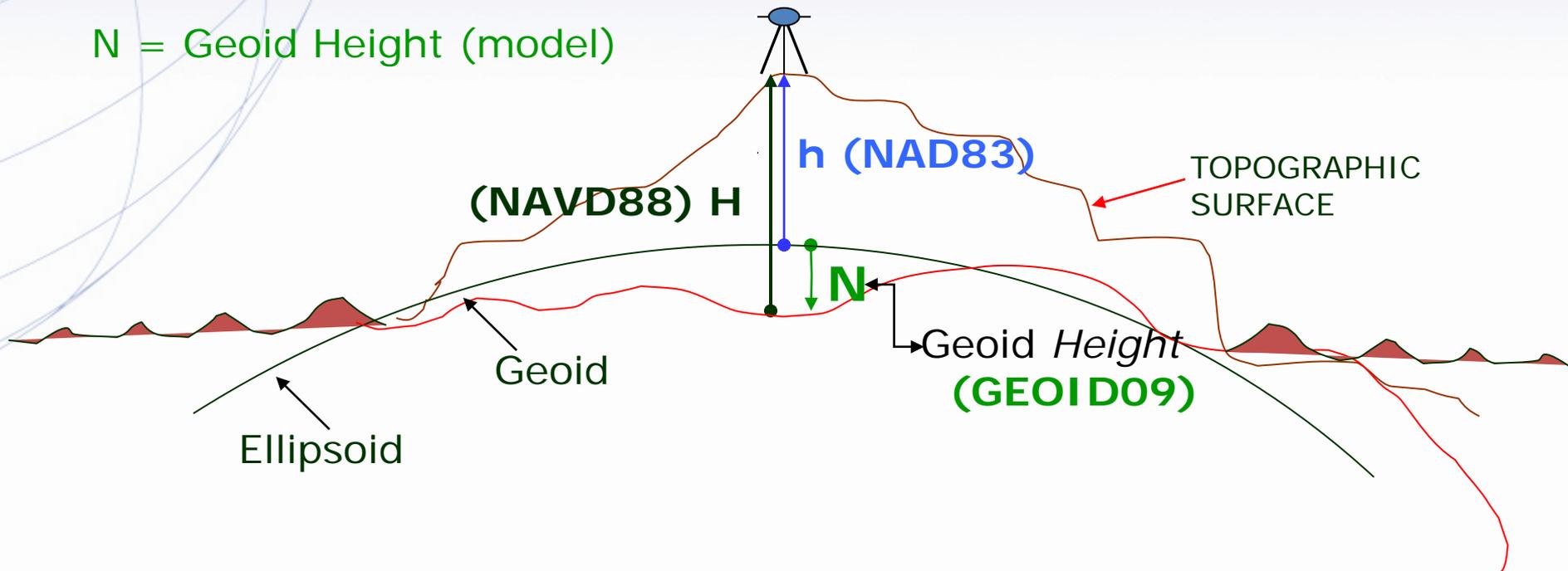
Ellipsoid, Geoid, and Orthometric Heights

H = Orthometric Height (leveling)

h = Ellipsoidal Height (GPS)

N = Geoid Height (model)

$$H = h - N$$



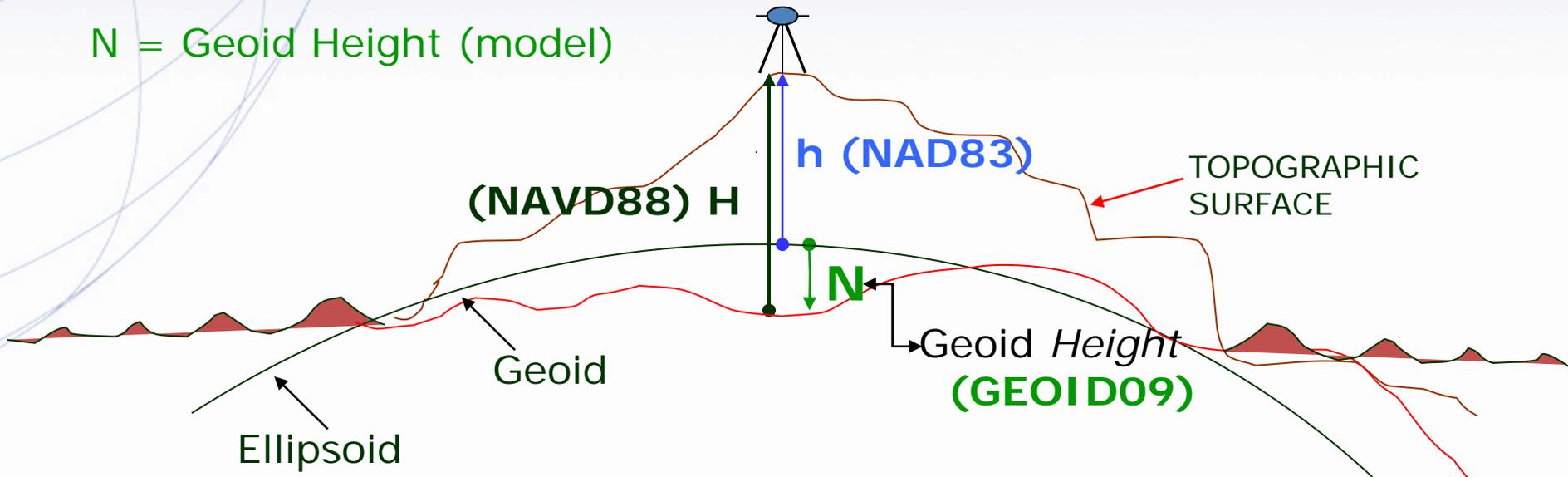
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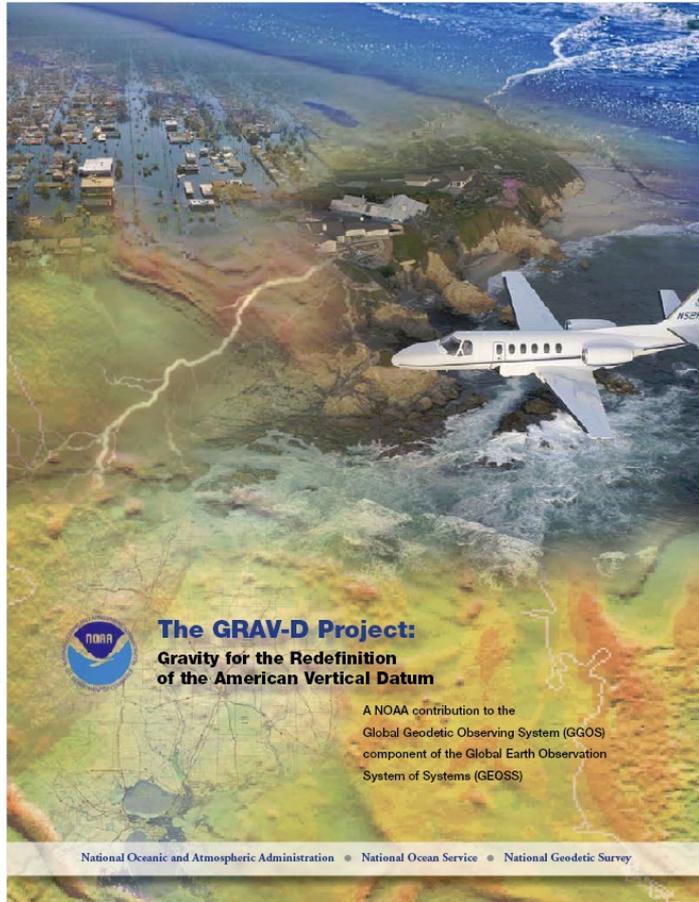
TRANSPORTATION

$$1660.6 = 1643.354 - (-17.23^*) \text{ METERS}$$

$$1660.6 = 1643.4 + 17.2$$

*56.53 feet

Gravity for the Redefinition of the American Vertical Datum (GRAV-D)



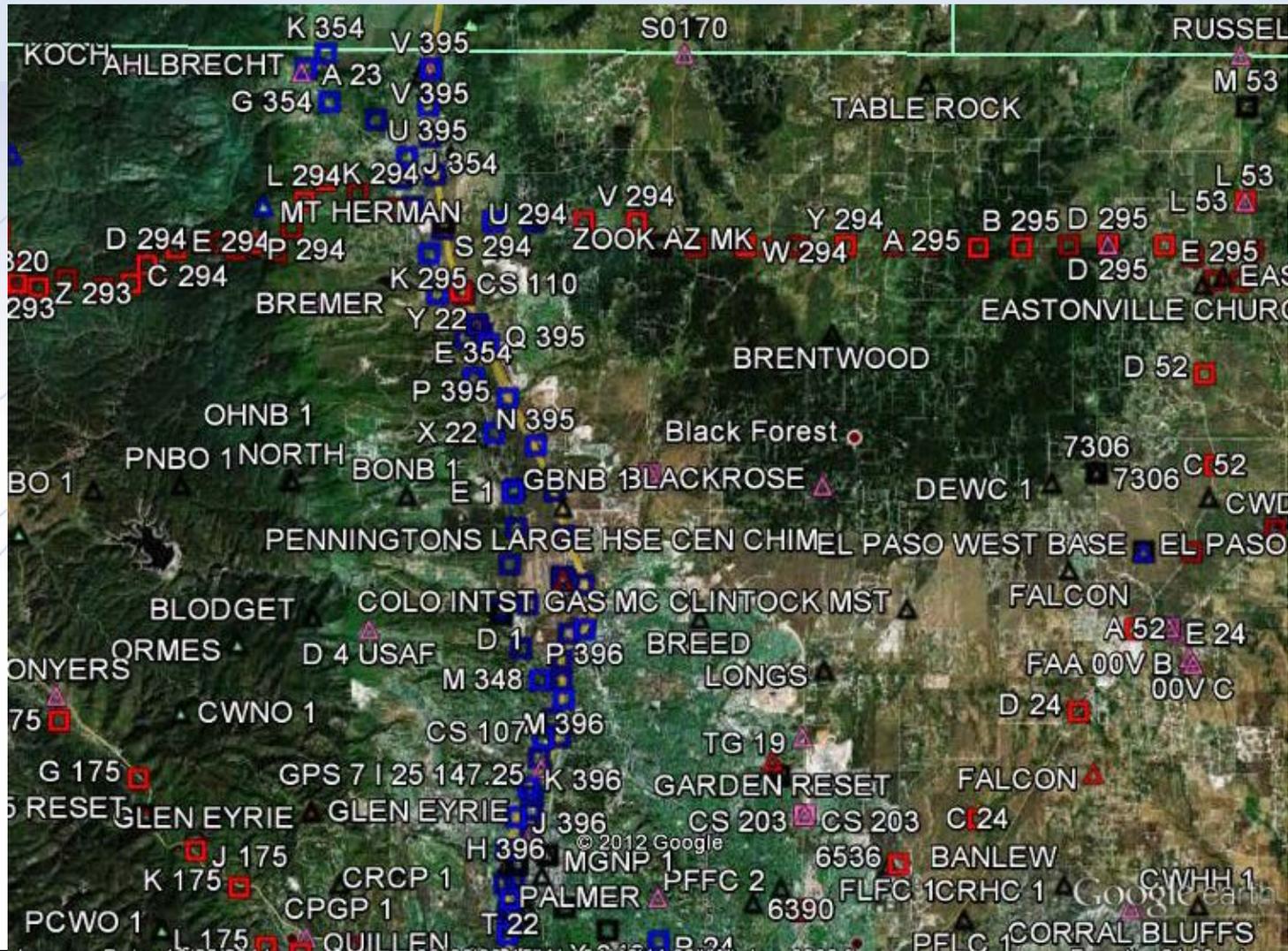
- Replace the Vertical Datum of the USA by 2022 (at today's funding) with a **gravimetric geoid accurate to 1 cm**
- Orthometric heights accessed via GNSS accurate to 2 cm
- Three components of project:
 - Airborne gravity survey of entire country and its holdings
 - Long-term monitoring of geoid change
 - Partnership surveys

Gravity and Heights are inseparably connected

"DSWorld" Software Program

- Highly rated new NGS software tool
- Developed to search the NGS database
- Easy to learn/use
- Multiple search options available
- Displays search results using Google Earth

Geodetic Control

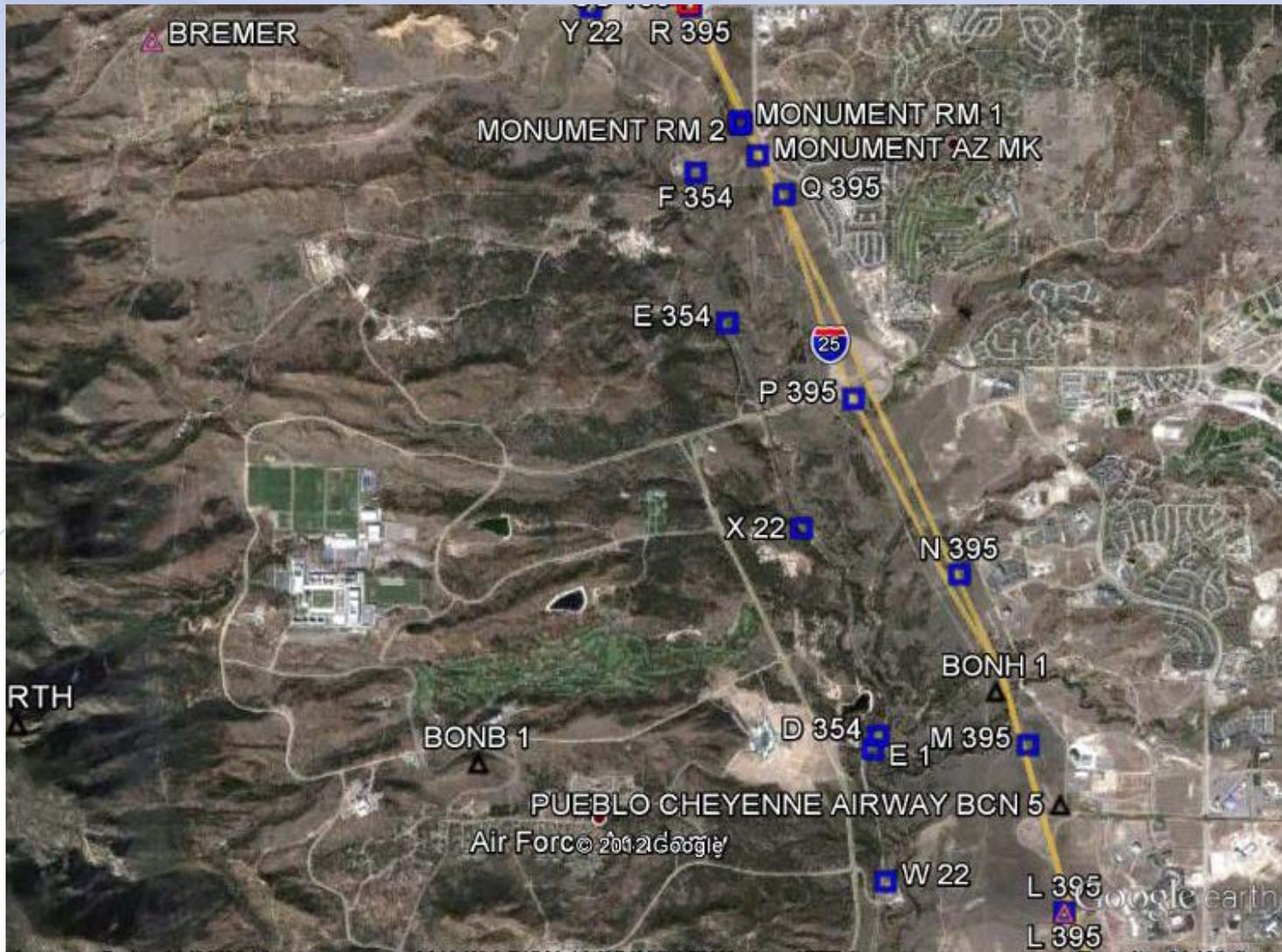


Triangles – Horizontal Control

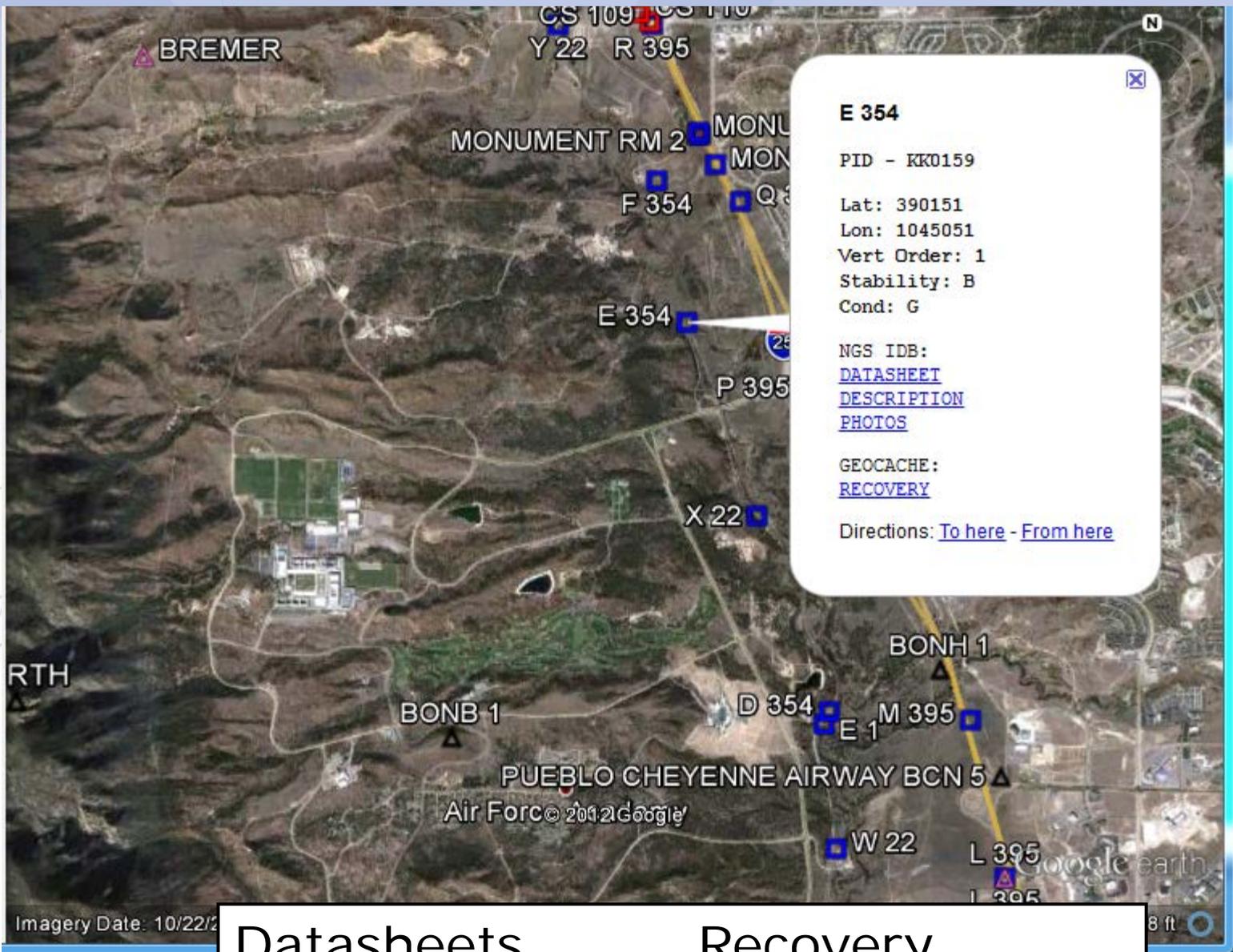
Squares – Vertical Control

Blue – First Order

Red – Second Order



Squares – Vertical Control
Blue - First Order



Datasheets

Recovery

Photos

Directions

Descriptions

The NGS Data Sheet

See file [dsdata.txt](#) for more information about the datasheet.

```

PROGRAM = datasheet95, VERSION = 7.89.6
1      National Geodetic Survey,  Retrieval Date = NOVEMBER  7, 2012
JK0858 *****
JK0858 DESIGNATION - L 395
JK0858 PID - JK0858
JK0858 STATE/COUNTY- CO/EL PASO
JK0858 COUNTRY - US
JK0858 USGS QUAD - PIKEVIEW (1994)
JK0858
JK0858                +CURRENT SURVEY CONTROL
JK0858
JK0858+ NAD 83(2011) POSITION- 38 58 58.53372(N) 104 48 44.63304(W) ADJUSTED
JK0858+ NAD 83(2011) ELLIP HT- 1994.303 (meters) (06/27/12) ADJUSTED
JK0858+ NAD 83(2011) EPOCH - 2010.00
JK0858+ NAVD 88 ORTHO HEIGHT - 2011.084 (meters) 6598.03 (feet) ADJUSTED
JK0858
JK0858 NAD 83(2011) X - -1,269,600.483 (meters) COMP
JK0858 NAD 83(2011) Y - -4,801,038.222 (meters) COMP
JK0858 NAD 83(2011) Z - 3,992,098.380 (meters) COMP
JK0858 LAPLACE CORR - -11.35 (seconds) DEFLEC12A
JK0858 GEOID HEIGHT - -16.77 (meters) GEOID12A
JK0858 DYNAMIC HEIGHT - 2008.863 (meters) 6590.74 (feet) COMP
JK0858 MODELED GRAVITY - 979,451.5 (mgal) NAVD 88
JK0858
JK0858 VERT ORDER - FIRST CLASS II
JK0858
JK0858 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
JK0858 Type Horiz Ellip Dist(km)
JK0858 -----
JK0858 NETWORK 0.51 0.98
JK0858 -----
JK0858 MEDIAN LOCAL ACCURACY AND DIST (007 points) 0.49 0.90 8.79
JK0858 -----
JK0858 NOTE: Click here for information on individual local accuracy
JK0858 values and other accuracy information.
JK0858
JK0858
JK0858 The horizontal coordinates were established by GPS observations

```

Sampling Rate (clickable legend icons)



Non-Operational



250 km radius



1 sec



5 sec



10 sec



15 sec



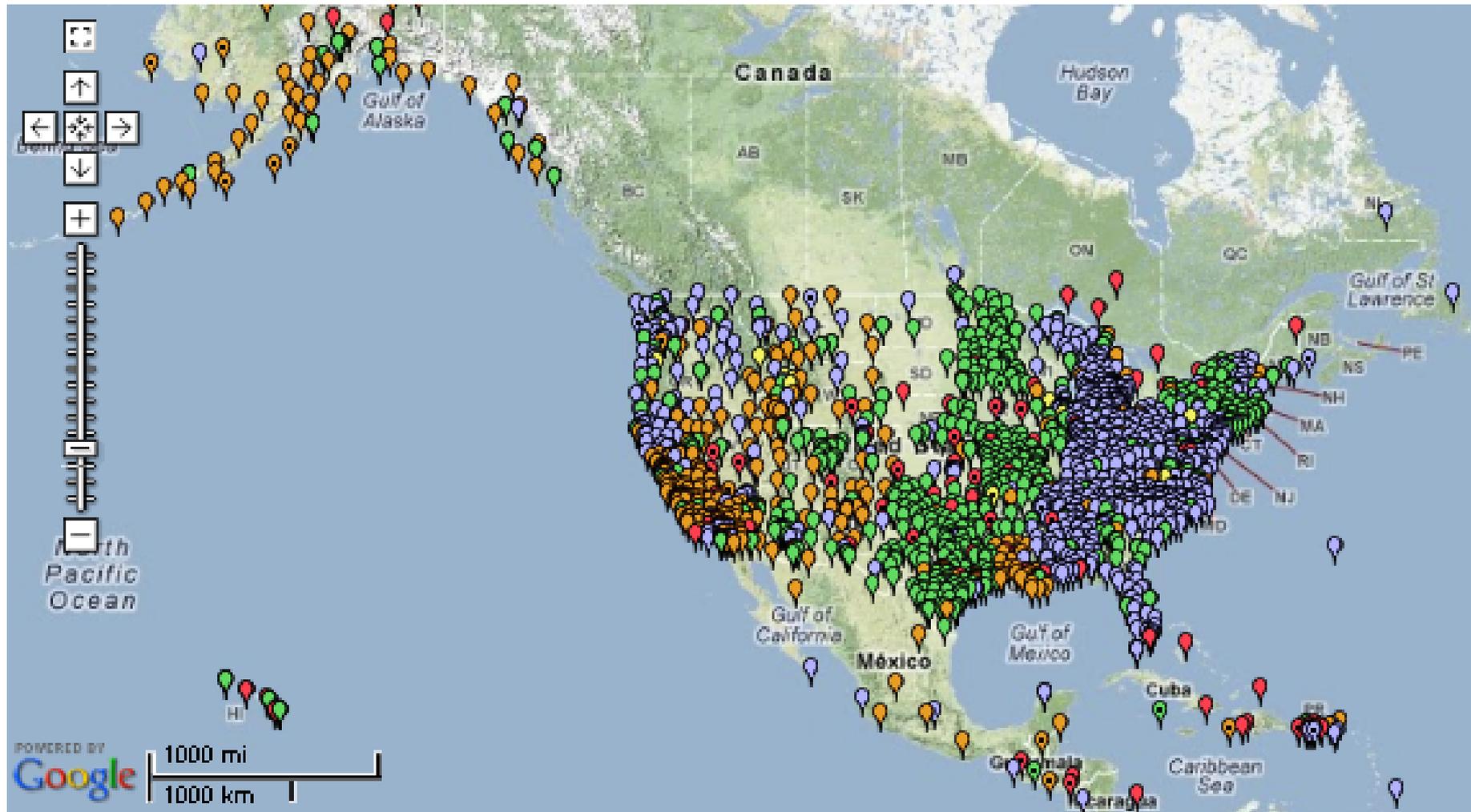
30 sec



All Active



Decom



OPUS

Online Positioning User Service

- OPUS – S (2 hrs)
- OPUS – RS (15 minutes)
- OPUS – DB (Publish)
- OPUS – Projects (Network)

OPUS Submission Webpage

OPUS: the Online Positioning User Service, process your GNSS data in the National Spatial Refer - Windows Internet Explorer

http://www.ngs.noaa.gov/OPUS/

File Edit View Favorites Tools Help

OPUS: the Online Positioning User Service, process yo...

OPUS: Online Positioning User Service
National Geodetic Survey

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Upload your data file.

Tie your GPS observation to the National Spatial Reference System.
What is OPUS? FAQs

* Email address - your solution will be sent here.

* Data file of dual-frequency GPS observations. [sample](#)

no antenna selected

Antenna type - choosing wrong may degrade your accuracy.

meters above your mark.

Antenna height of your antenna's reference point.

to customize your solution.

for data > 15 min. < 2 hrs. for data > 2 hrs. < 48 hrs.

* required fields

Your email address

Location of your data file

Your antenna type

Antenna height

Customize your solution - details on next slide

Sample Solutions

start

8 5 M... D... 2 G... D... T... P... Survey Software

Internet 100% 10:45 AM

NGS Data Sheets

Traditional
blue booking

New
OPUS-DB

```
SE = , PROGRAM = datasheet, VERSION = 7.86
National Geodetic Survey, Retrieval Date = APRIL 20, 2011
*****
4 DESIGNATION - C 281
4 PID - DO0454
4 STATE/COUNTY- TX/THROCKMORTON
4 USGS QUAD - THROCKMORTON NE (1965)
4
4 *CURRENT SURVEY CONTROL
4
4 NAD 83(2007)- 33 11 10.75472(N) 099 06 11.86433(W) NO CHECK
4* NAVD 88 - 383.465 (meters) 1258.08 (feet) ADJUSTED
4
4 EPOCH DATE - 2002.00
4 X - -845,419.278 (meters) COMP
4 Y - -5,276,185.563 (meters) COMP
4 Z - 3,471,464.429 (meters) COMP
4 LAPLACE CORR- 0.24 (seconds) DEFLECO9
4 ELLIP HEIGHT- 353.943 (meters) (02/10/07) NO CHECK
4 GEOID HEIGHT- -28.98 (meters) GEOID09
4 DYNAMIC HT - 383.004 (meters) 1256.57 (feet) COMP
4
4 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
4 Type PID Designation North East Ellip
4 -----
4 NETWORK DO0454 C 281 1.10 1.47 2.14
4 -----
4 MODELED GRAV- 979,426.2 (mgal) NAVD 88
4
4 VERT ORDER - SECOND CLASS 0
4
```

SURVEY DATASHEET (Version 1.0)

PID: DO0454
 Designation: C 281
 Stamping: C 281 1934
 Stability: Most reliable; expected to hold position well
 Setting: In rock outcrop or ledge
 Mark Condition: G
 Description: Recovered as described by "Alpha Land Surveying, Inc."
 Observed: 2006-09-28T22:19:00Z See Also [2006-09-28](#)
 Source: OPUS - page 5 0810.20



Close-up View

REF_FRAME: NAD_83(CORS96)	EPOCH: 2002.0000	SOURCE: NAVD88 (Computed using GEOID09)	UNIT S: m	SET PROFILE	DETAILS
LAT: 33° 11' 10.78167" ± 0.010 m		UTM 14 SPC 4202(TXNC)			
LON: -99° 6' 11.86387" ± 0.016 m		NORTHING: 3671943.370m 2168676.749m			
ELL HT: 354.428 ± 0.028 m		EASTING: 490370.894m 543746.220m			
X: -845419.259 ± 0.014 m		CONVERGENCE: -0.05654024° -0.32903401°			
Y: -5276185.517 ± 0.020 m		POINT SCALE: 0.99960114 0.99987537			
Z: 3471465.389 ± 0.023 m		COMBINED FACTOR: 0.99954552 0.99981974			
ORTHO HT: 383.464 ± 0.070 m					

CONTRIBUTED BY

[dbrouty](#)

Conrad Blucher Institute

Horizon View



The numerical values for this position solution have satisfied the quality control criteria of the National Geodetic Survey. The contributor has verified the information submitted is accurate and complete.

NGS Training Center



Webinars!

<http://www.ngs.noaa.gov/corbin/>

More information...

NGS Home Page: <http://www.geodesy.noaa.gov>
geodesy.noaa.gov

CORS Webpage: <http://www.ngs.noaa.gov/CORS/>
CORS newsletter

OPUS Webpage: <http://www.ngs.noaa.gov/OPUS/>

Find Your Advisor:

www.ngs.noaa.gov/ADVISORS/AdvisorsIndex.shtml

This presentation will be uploaded to:

http://www.ngs.noaa.gov/web/science_edu/presentations_archive/

FAQs on the various webpages



November 11, 2012

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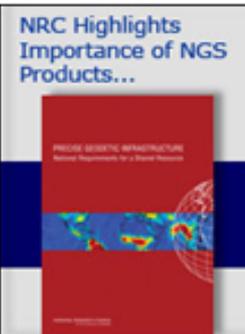
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The National Geodetic Survey has released the **GEOID12A model**. Analysis of the underlying control data has been completed and a number of corrections were made to the original data used in making GEOID12. Changes impacted regions in the states of Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Wisconsin. GEOID12A is now available for production and use.



Most Popular

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NAD 83(2011) epoch 2010.00

OPUS

LOCUS

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UFCORS

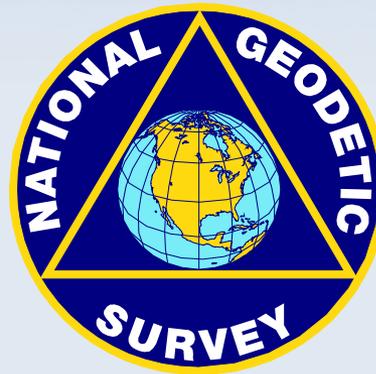
Upcoming Events

www.ngs.noaa.gov

www.geodesy.noaa.gov

Questions

GOOD COORDINATION BEGINS WITH
GOOD COORDINATES



GEOGRAPHY WITHOUT GEODESY IS A FELONY

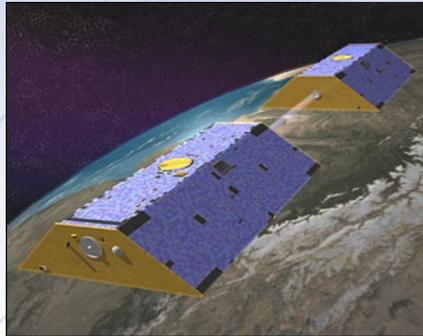
pamela.fromhertz@noaa.gov

303-202-4082

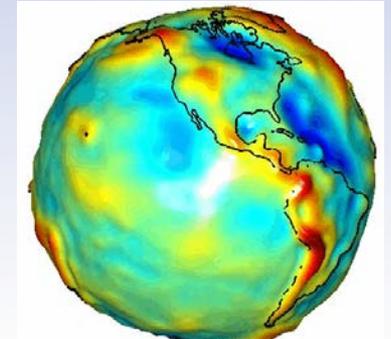
240-988-6363

Backup

Building a Gravity Field



Long Wavelengths:
(≥ 350 km)

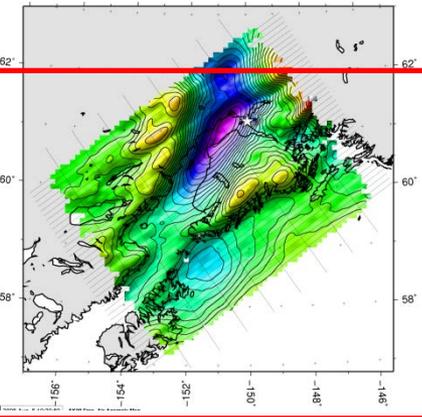


GRACE and GOCE (not shown)

+



Intermediate Wavelengths
(500 km to 20 km)

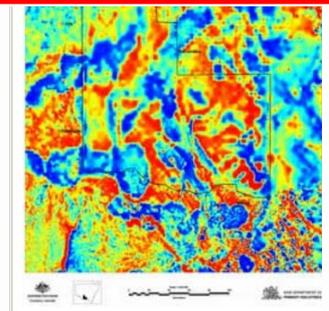


Airborne Measurement

+



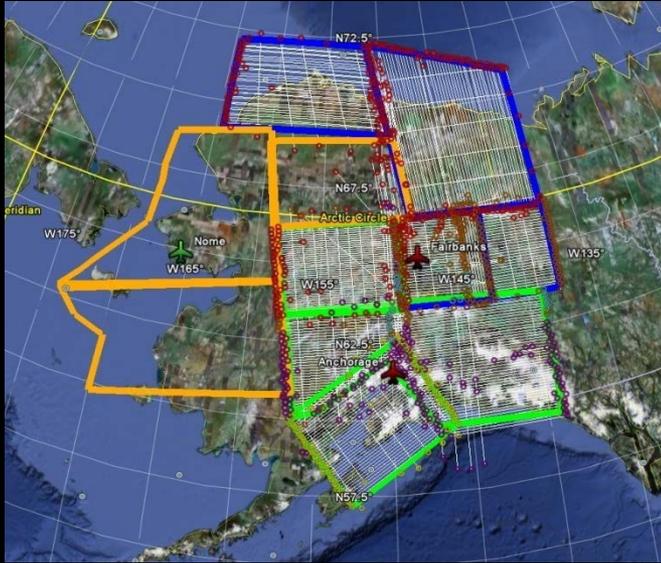
Short Wavelengths
(< 100 km)



Surface Measurement

GRAV-D Update

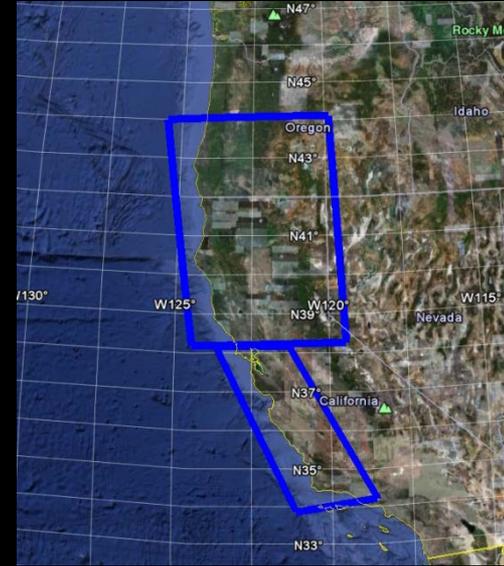
Alaska FY10-13



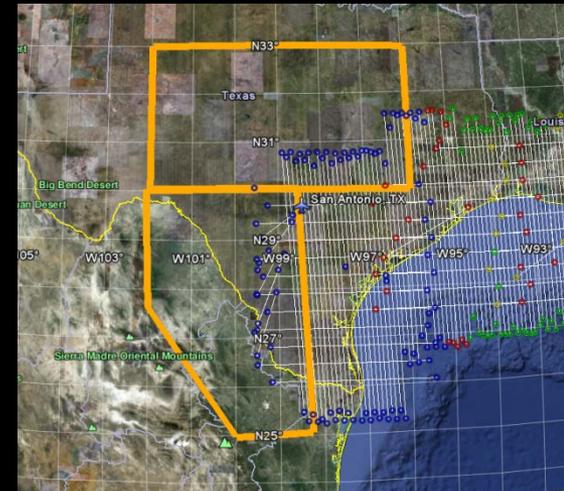
15.6% of total area is surveyed (as of 11-23-11)

FY10 = Green
FY11 = Blue
FY12 = Orange
FY13 = White

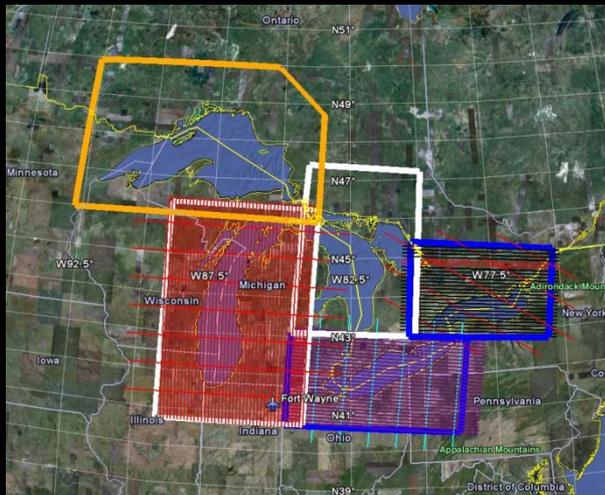
West Coast FY11



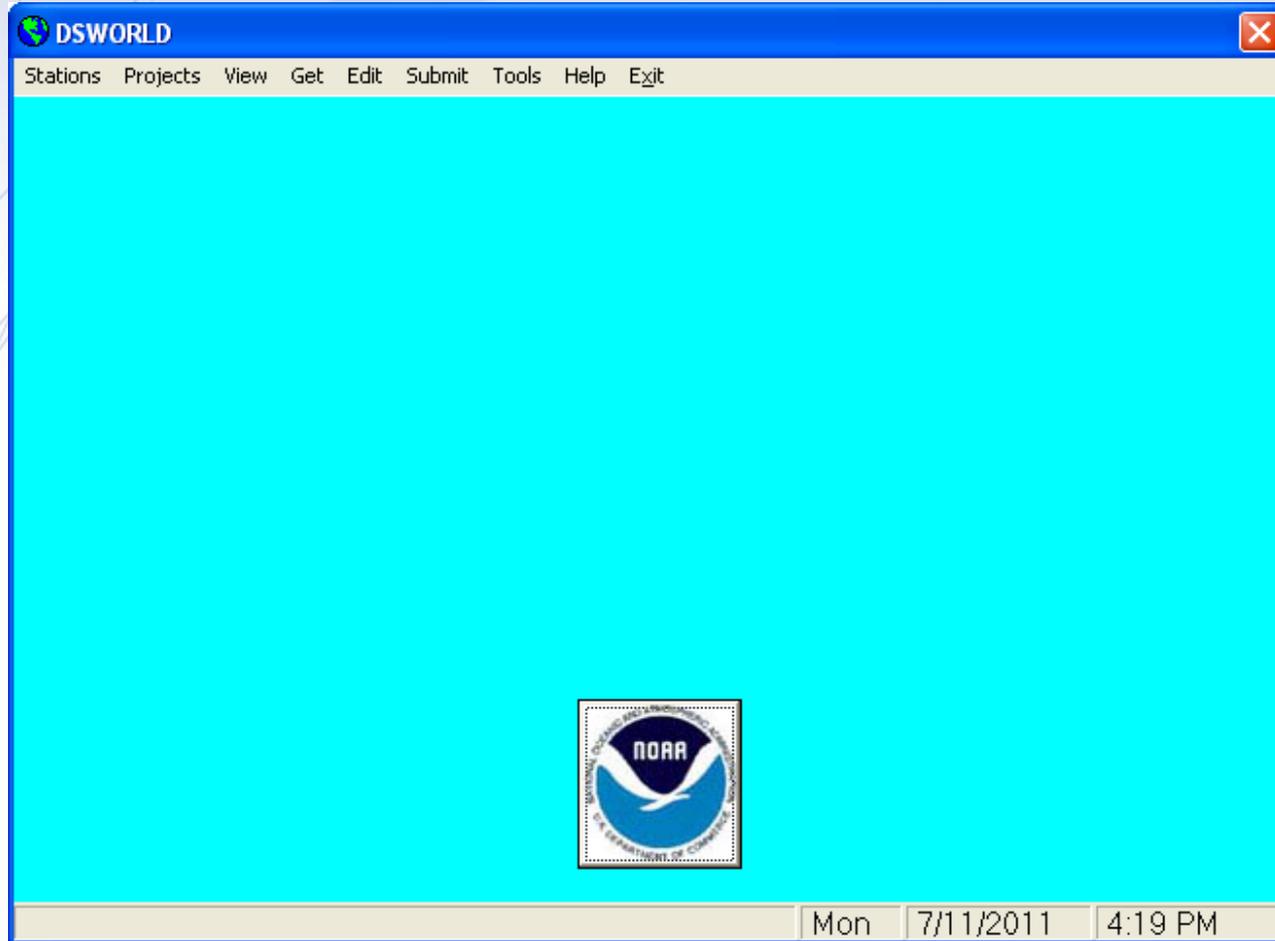
FY12 Texas



Great Lakes FY11-13



DSWorld opening screen



Introducing...

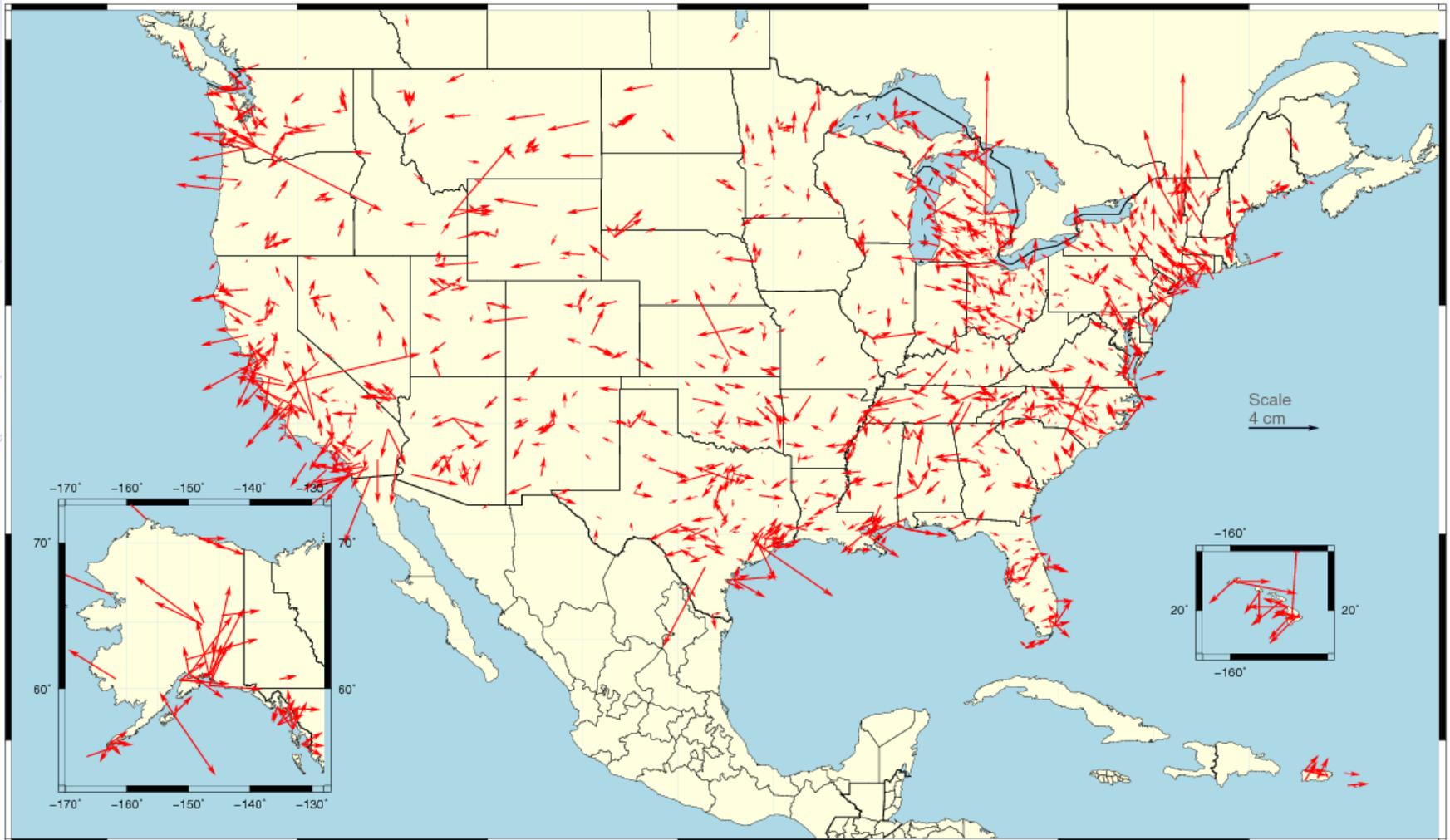
NAD 83(2011) epoch 2010.00

- **Multi-Year CORS Solution (MYCS)**
 - Reprocessed all CORS GPS data Jan 1994-Apr 2011
 - 2264 CORS & global stations
 - NAD 83 computed by *transformation* from IGS08
- **National Adjustment of 2011 (NA2011)**
 - New adjustment of GNSS passive control
 - GNSS vectors tied (and constrained) to CORS NAD 83(2011) epoch 2010.00
 - Approximately 80,000 stations and more than 400,000 GNSS vectors



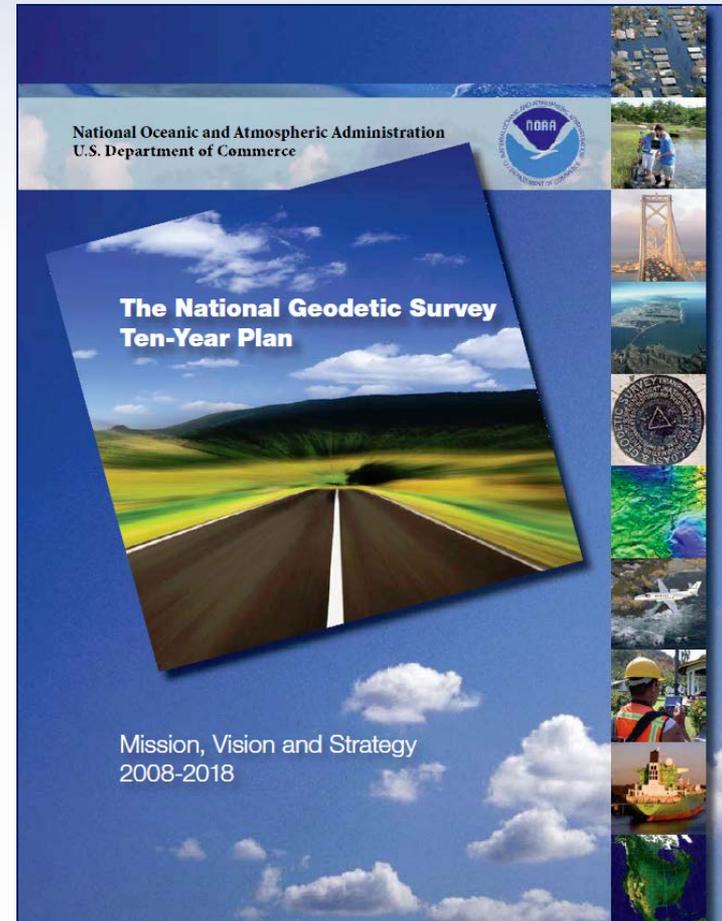
Changes in *Horizontal* NAD 83 Positions Same Epoch

NAD 83(2011) epoch 2002.00 – NAD 83(CORS96) epoch 2002.00

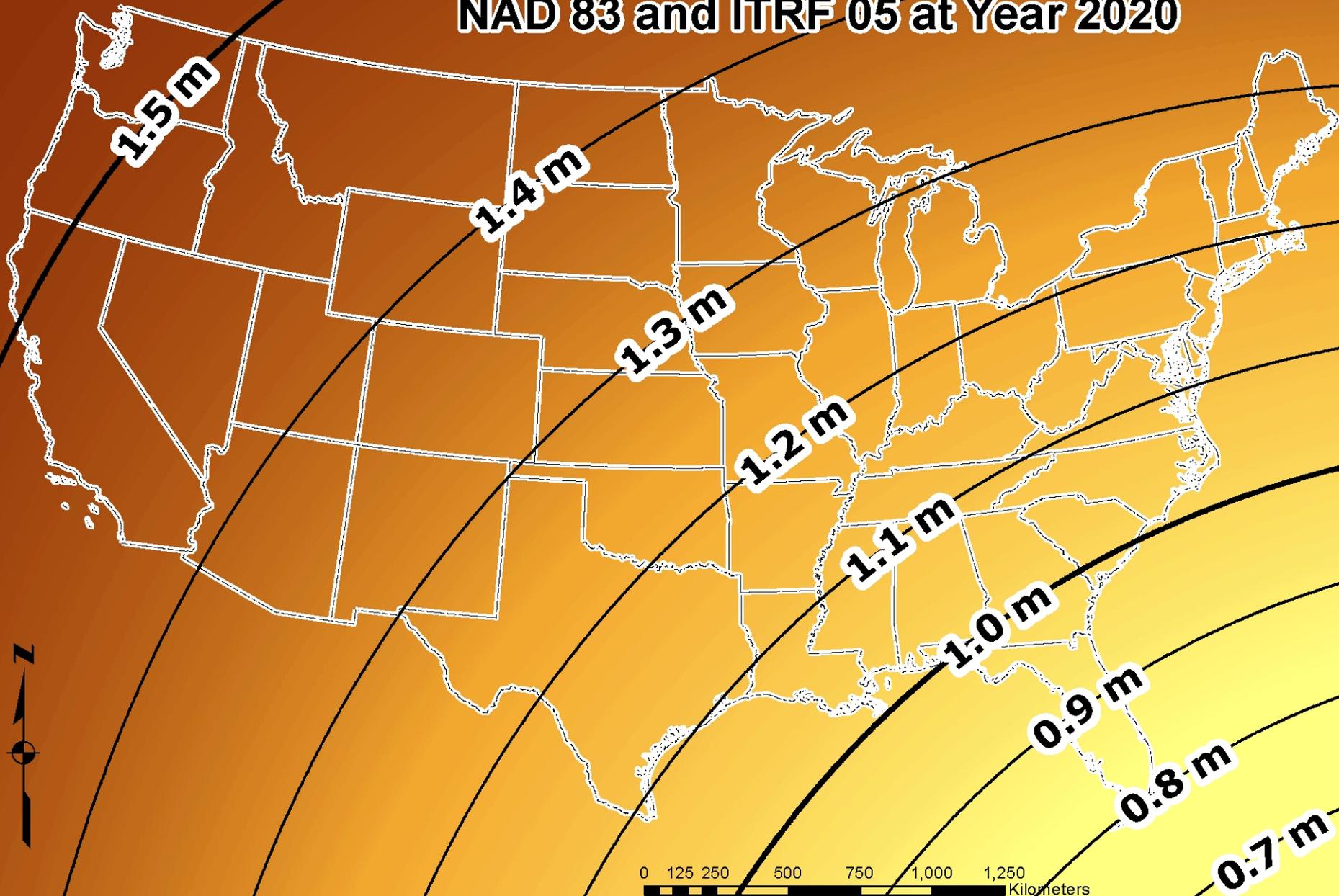


National Geodetic Survey Ten-Year Plan

- Official NGS policy as of January 2008
- Replace NAVD 88 with a GPS/geoid datum
- Replace NAD 83 with a geocentric GPS based datum



Horizontal Position Difference Between NAD 83 and ITRF 05 at Year 2020



New Vertical Datum

Approximate predicted change from NAVD 88 to new vertical datum

