



# Geodesy and GIS

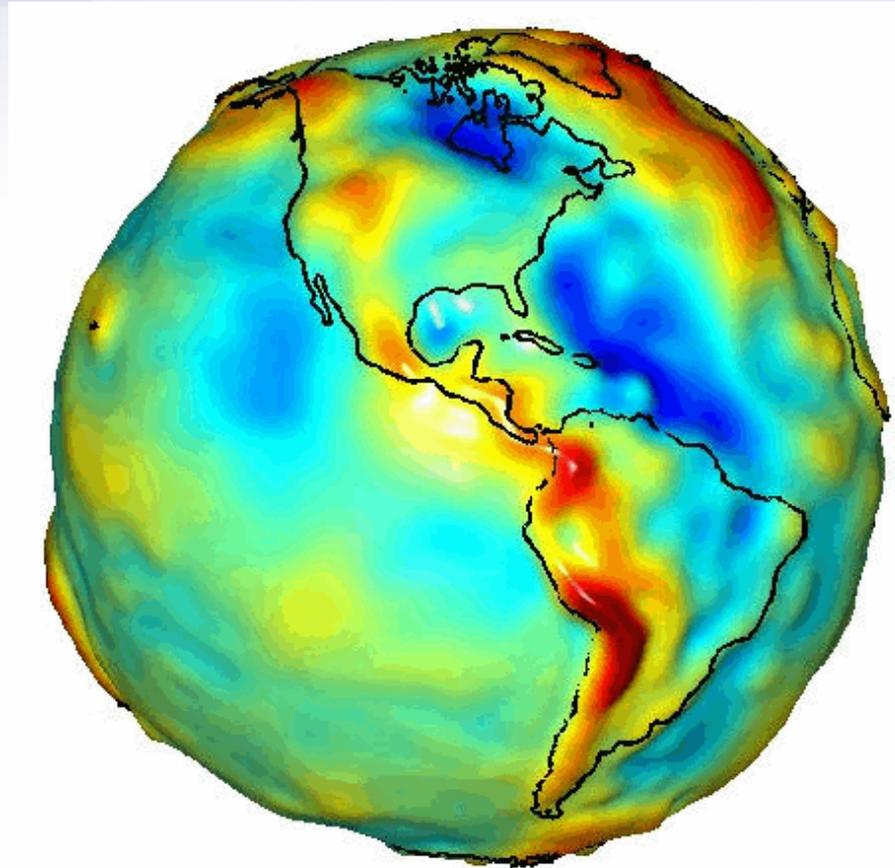
Pamela Fromhertz

Colorado State Geodetic Advisor

National Geodetic Survey

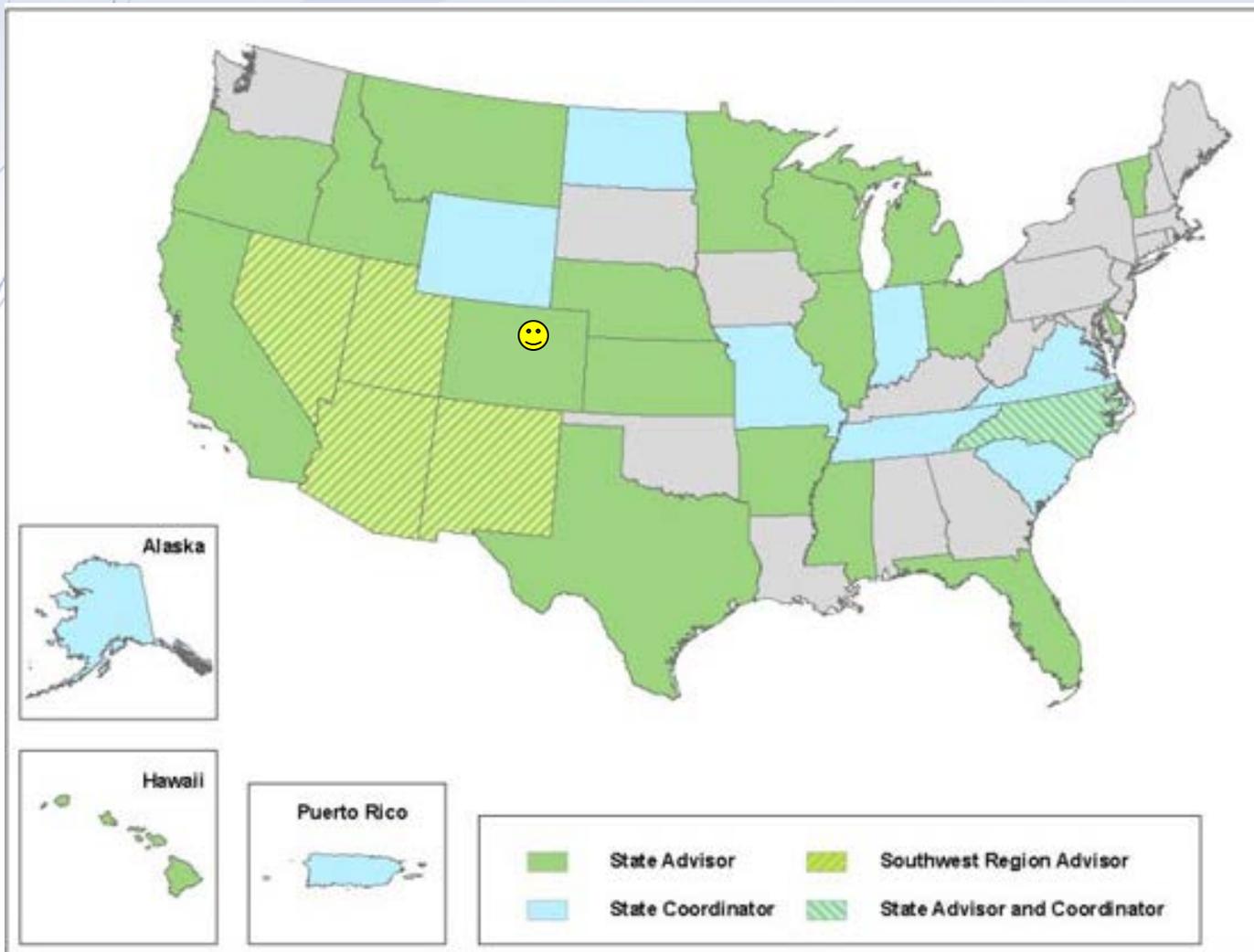
National Oceanic and Atmospheric  
Administration

# Exaggerated view of the Earth's Gravity Measure.

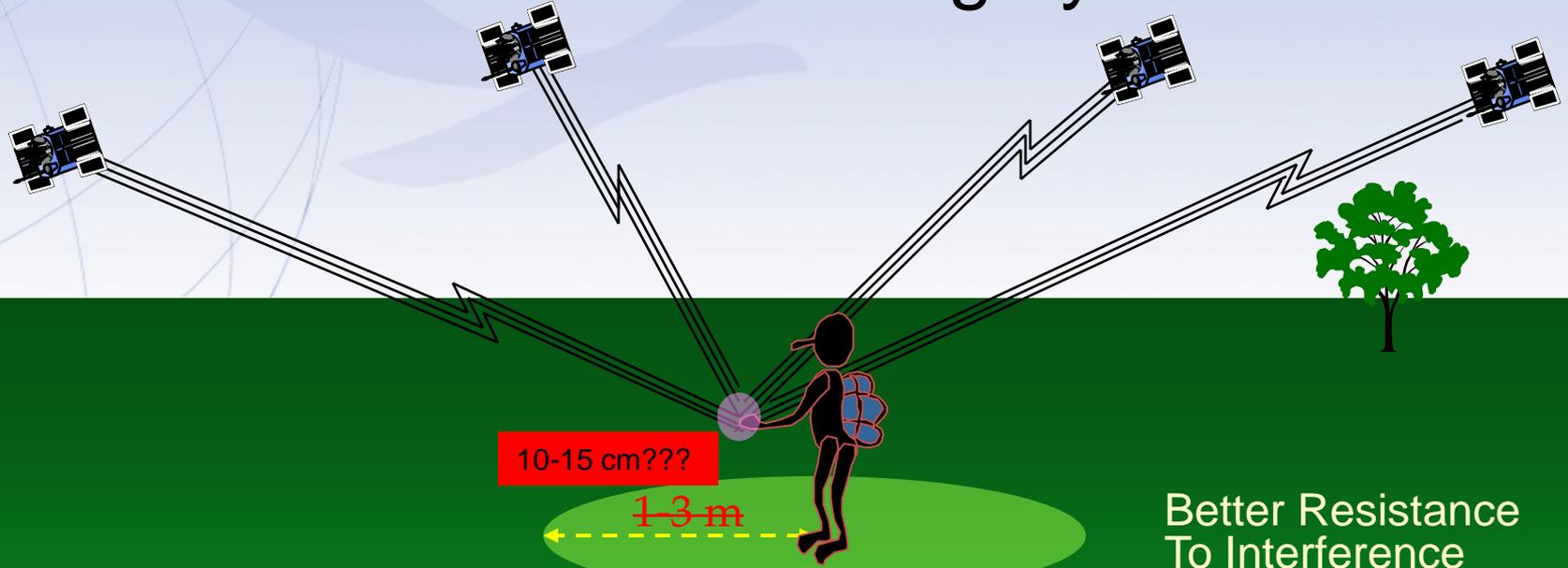




# Advisor Status In Your State



# Standalone Positioning by 2017?



10-15 cm???

1-3 m

Better Resistance  
To Interference

Faster Ambiguity  
Resolution

- C/A Code on L1
- C/A Code on L2
- New Code on L5

## GPS Modernization

# Global Navigation Satellite System

GPS

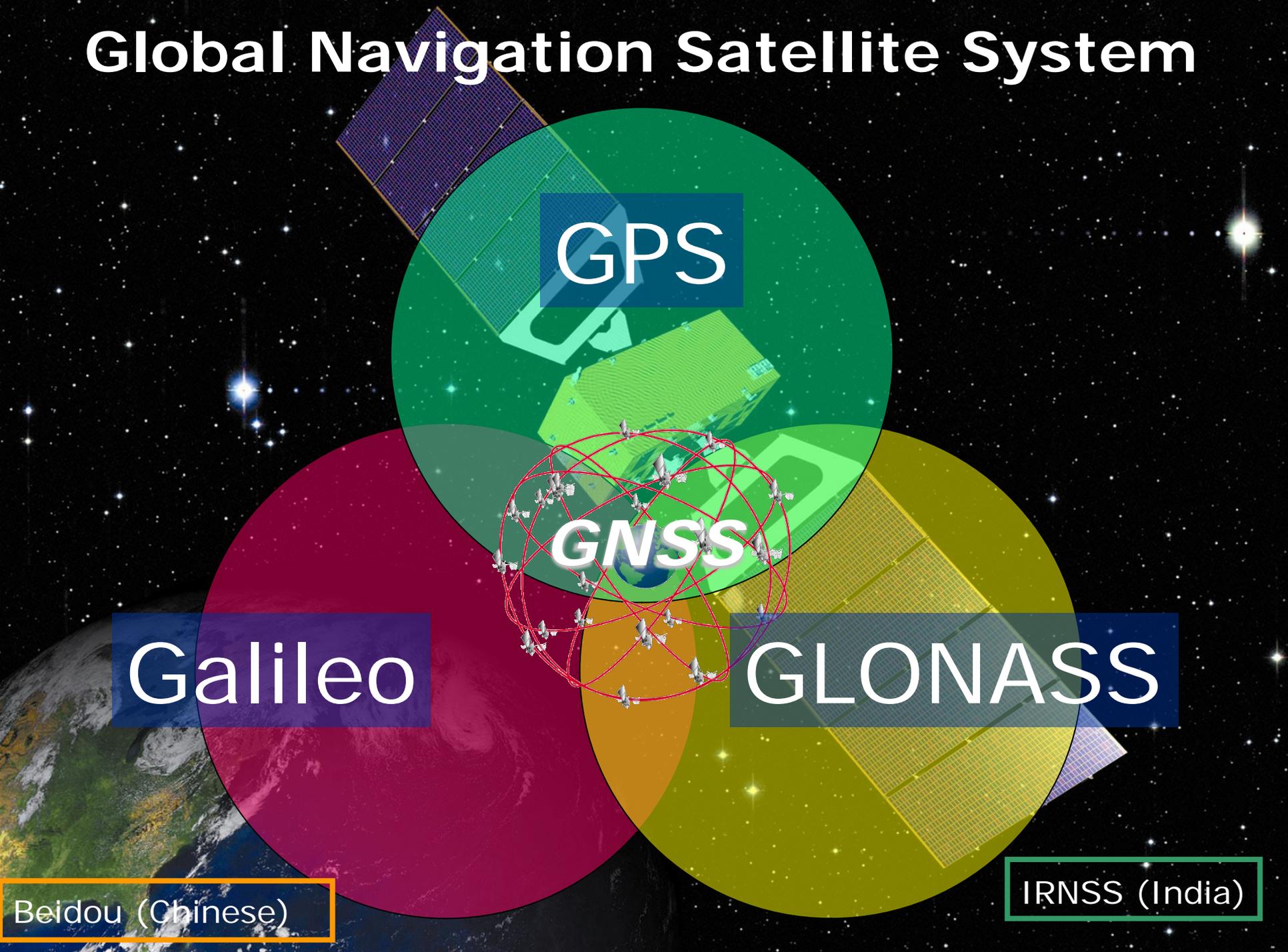
GNSS

Galileo

GLONASS

Beidou (Chinese)

IRNSS (India)



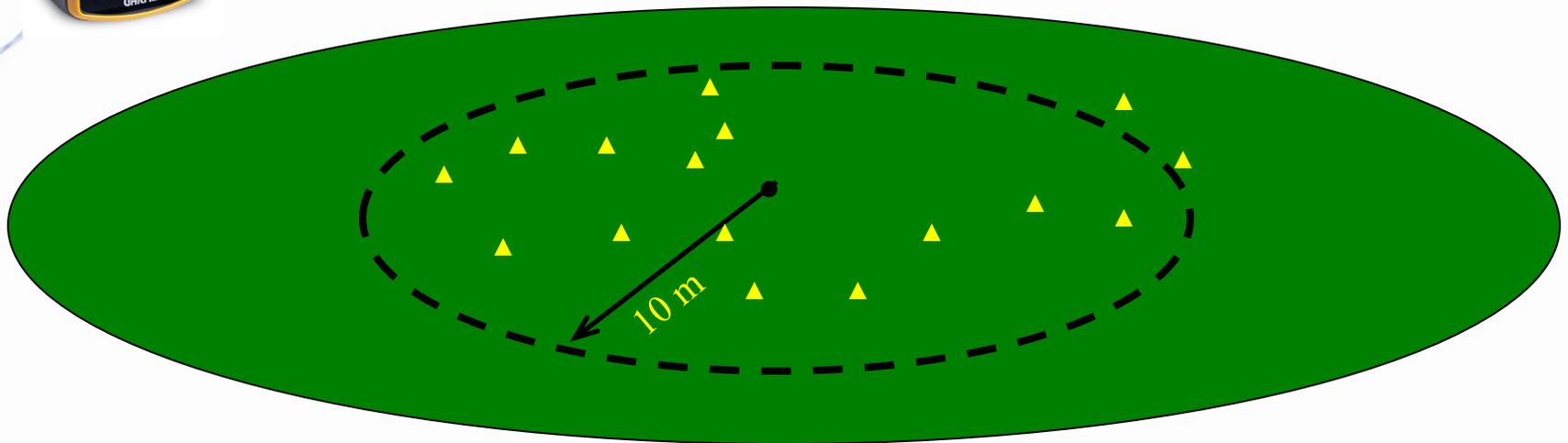
# Recreational Grade Accuracy

## \$100-\$1000



### Autonomous Position

- +/- 10 m (33 ft) error (horizontal)
- +/- 15 m (52 ft) error (vertical)
- +/- 1 m (horizontal) within 10 years





# Mapping Accuracy \$2,000-\$6,000



Submeter to 3 meter

L1 CA Code

Data is being corrected from base station

Post-Processed or RTK





# Survey Accuracy \$10,000 Or More

L1 C/A and L2 - Dual Frequency

5 mm - 2 cm

Must have open view of the sky

Second receiver needed on site

or transmitting from

pre-established base

Post-Processed or RTK



# Autonomous GPS Accuracy

GPS Receiver Datum  
NAD83

HDOP <= 1.0  
HDOP <= 2.0  
HDOP > 2.0  
Display@15sec

Reference Latitude-Longitude  
1,844m 35:08:04.59 N 106:29:30.92

25 hrs @ 1 fix/15 sec = 6,000 fixes

Weighted Mean Latitude-Longitude  
1,844m 35:08:04.56 N 106:29:30.93

Mean Fix: 0.8m @ 212 deg

Mouse Pointer Latitude-Longitude  
35:08:04.92 N 106:29:31.23 W

50% of fixes w/in 1.8m

68% of fixes w/in 2.4m

95% of fixes w/in 4.2m

99% of fixes w/in 5.7m

Reference to: Pointer Now Mean  
13m@323° 3.4m@207° 0.8m@212°

Now: SVs AURA HDOP EPE UTC  
GPS port closed

MA: Count AURA HDOP EPE Drift  
31 5m 1.3 4.9m 4m/min

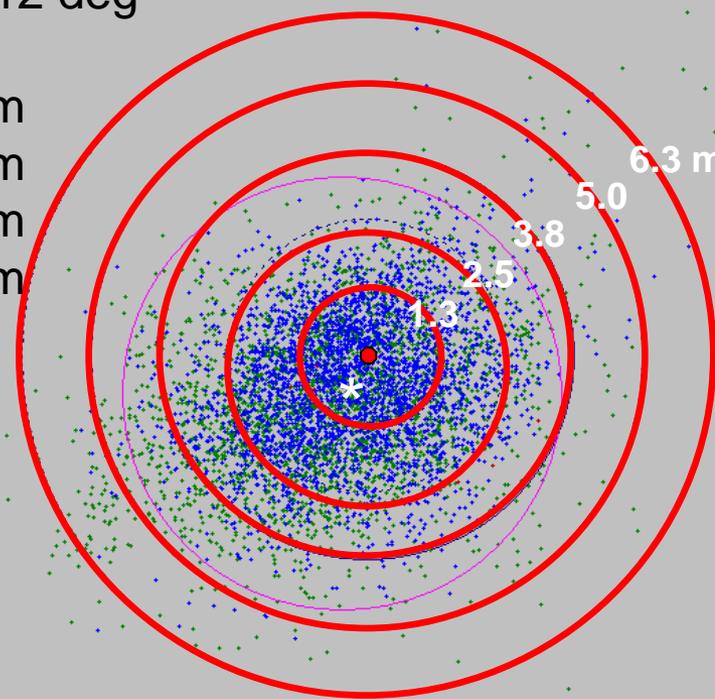
MA: Time 97% 94% 68% 48%  
01:00 3.2m 3.2m 2.9m 2.7m

All: Count AURA HDOP EPE Drift  
6,000 6m 1.1 4.7m 5m/min

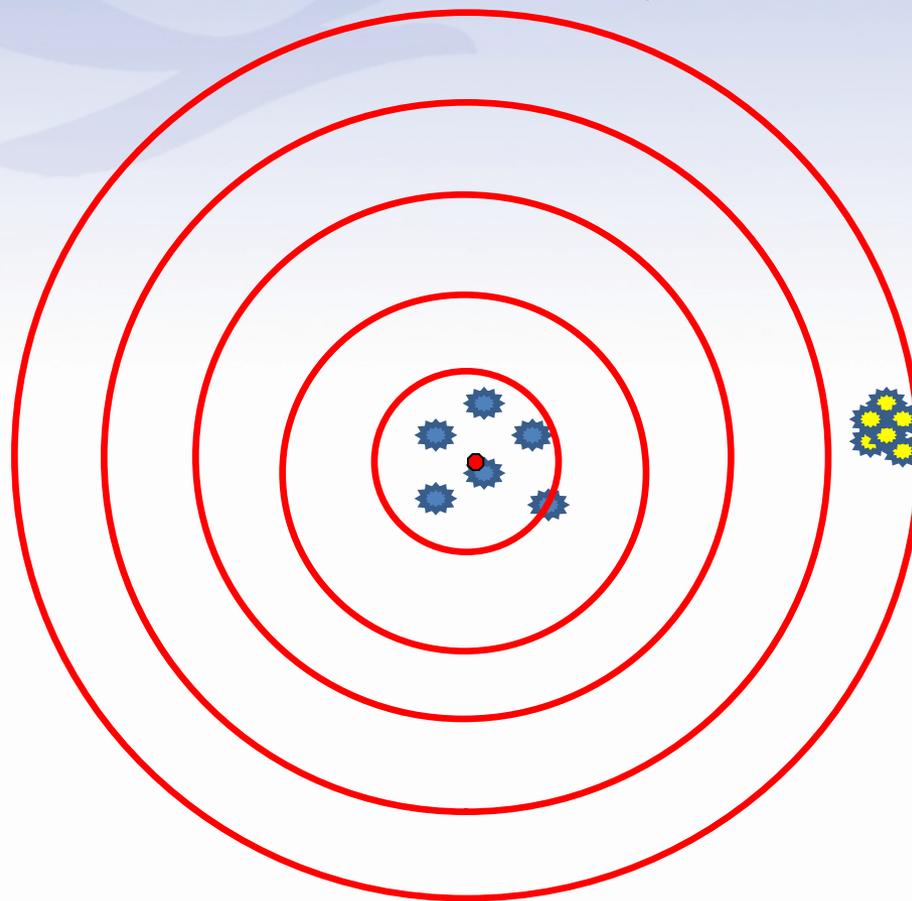
All: Time 99% 95% 68% 50%  
1:00:59:54 5.7m 4.2m 2.4m 1.8m

UTC Date Distribution by HDOP  
4/13/2006 54% 46% 0%

SVs/Position Error (Scale Max: 10m)

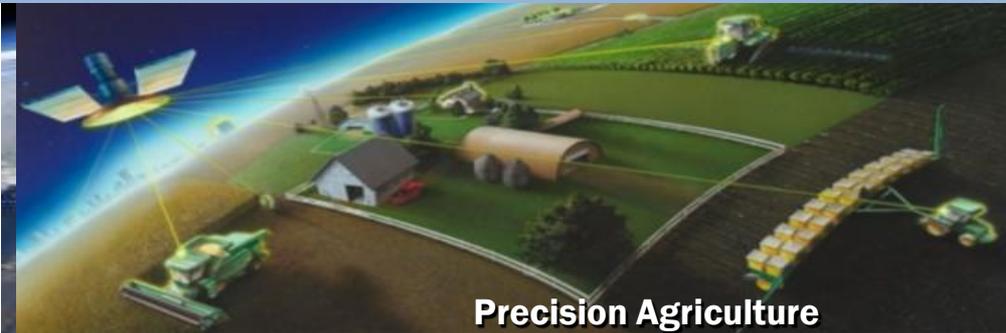


# Accuracy



Precision

# NGS' NSRS provides the Geospatial Infrastructure Critical to Our Economy



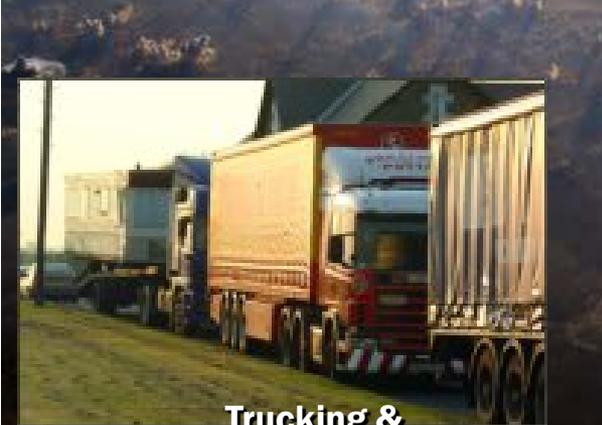
Precision Agriculture



Aviation



Satellite Operations



Trucking & Shipping



Surveying & Mapping



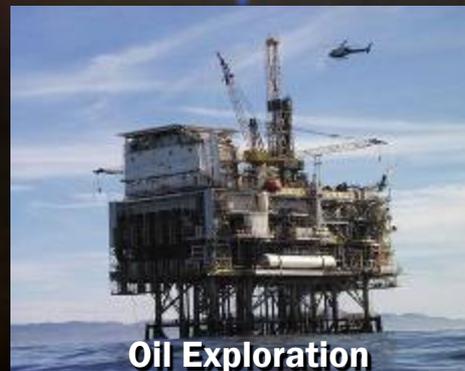
Power Grids



TeleComm



Oil Exploration



Fishing & Boating



Personal Navigation



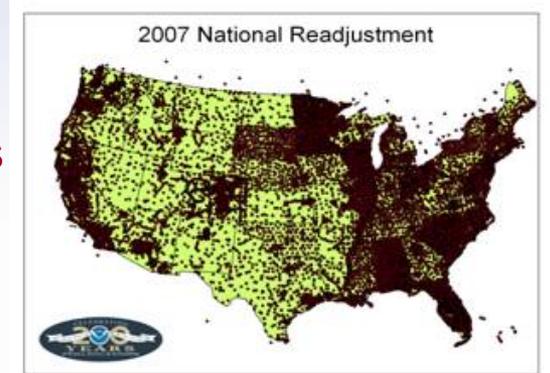
# The NSRS has evolved

**Evolving from passive to active to real-time augmentations**



1 Million →  
Monuments  
(Separate  
Horizontal and  
Vertical Systems)

70,000  
Passive Marks  
(3-Dimensional)



Passive  
Marks  
(Limited  
Knowledge of  
Stability)



1,320 CORS  
(Time Dependent  
System Possible;  
4-Dimensional)



GPS CORS → GNSS CORS



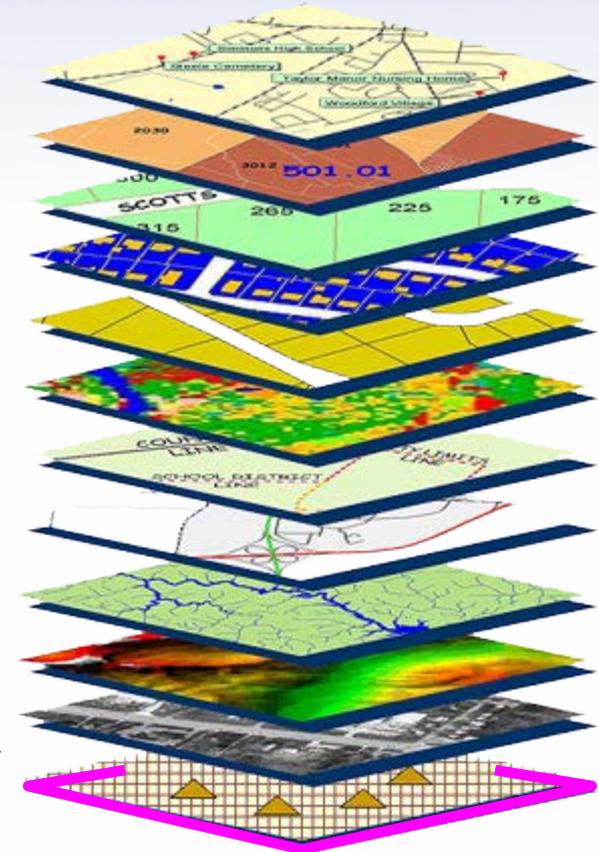
# Accurate positioning begins with *accurate* coordinates

Geodetic control 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



# Geodetic Datums

## Horizontal

2-D (Latitude and Longitude) (e.g. NAD 27, NAD 83 (1986))

## Vertical/Geopotential

1-D (Orthometric Height) (e.g. NGVD 29, NAVD 88, Local Tidal)

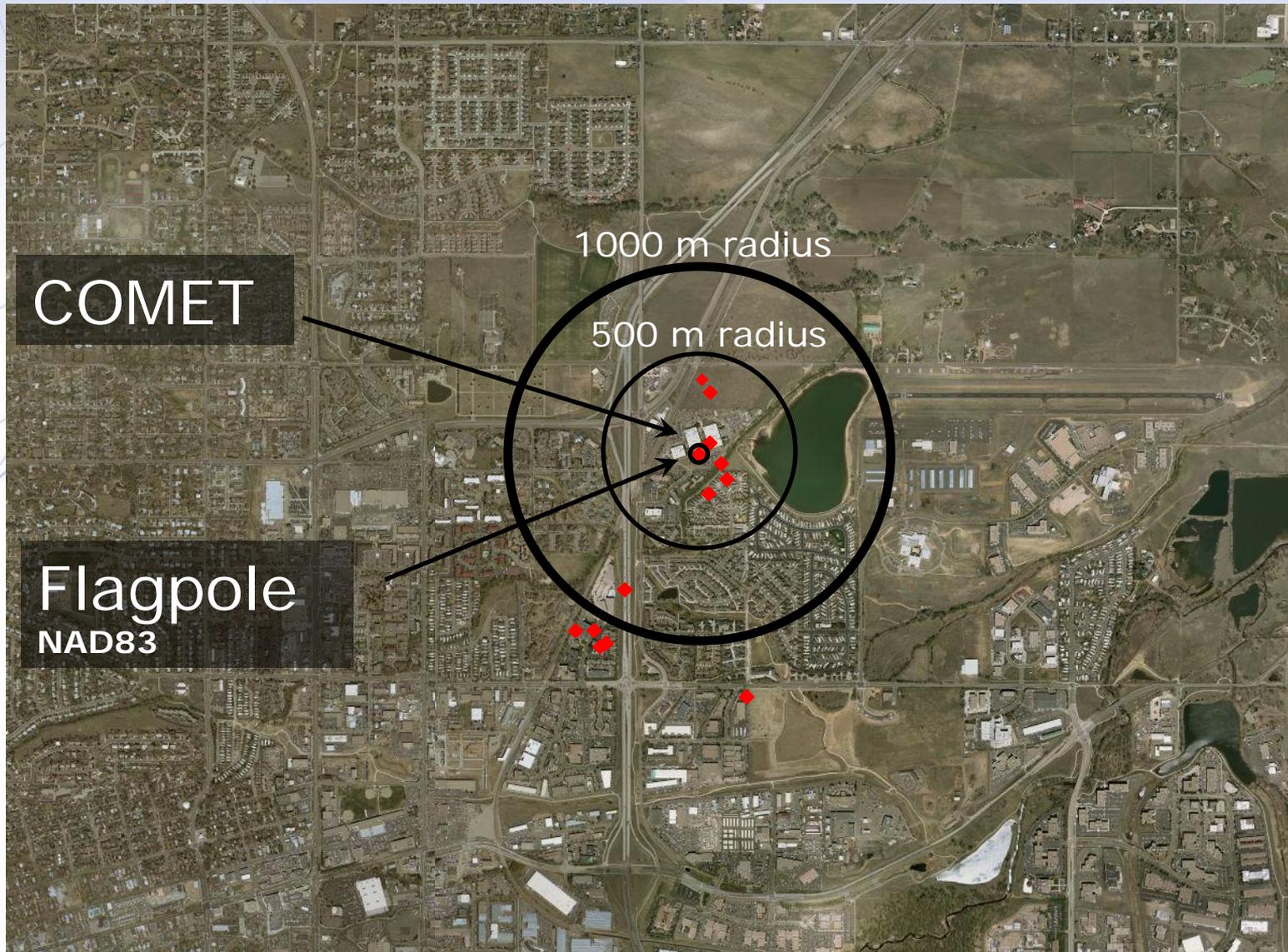
## Geometric

3-D (Latitude, Longitude and Ellipsoid Height)  
Fixed and Stable(?) - Coordinates seldom change  
(e.g. NAD 83 (1993), NAD 83 (2007))

also

4-D (Latitude, Longitude, Ellipsoid Height, Velocities)  
Coordinates change with time  
(e.g. NAD 83, ITRF00, ITRF05)

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



# Improving Positional Accuracy Horizontal

<u>NETWORK</u>	<u>TIME SPAN</u>	<u>NETWORK ACCURACY</u>	<u>LOCAL ACCURACY</u>
NAD 27	1927-1986	10 METERS	(1 part in 100,000)
NAD83(86)	1986-1990	1 METER	(1 part in 100,000)
NAD83(199x) HARN	1990-1997	0.1 METER	B-order (1 part in 1 million) A-order (1 part in 10 million)
NAD83(NSRS2007) (CORS)	1996 - 2011	0.01 meter	0.01 meter
NAD83 (? 2011)	2012-		

# Are NAD 83 & WGS 84 The Same?

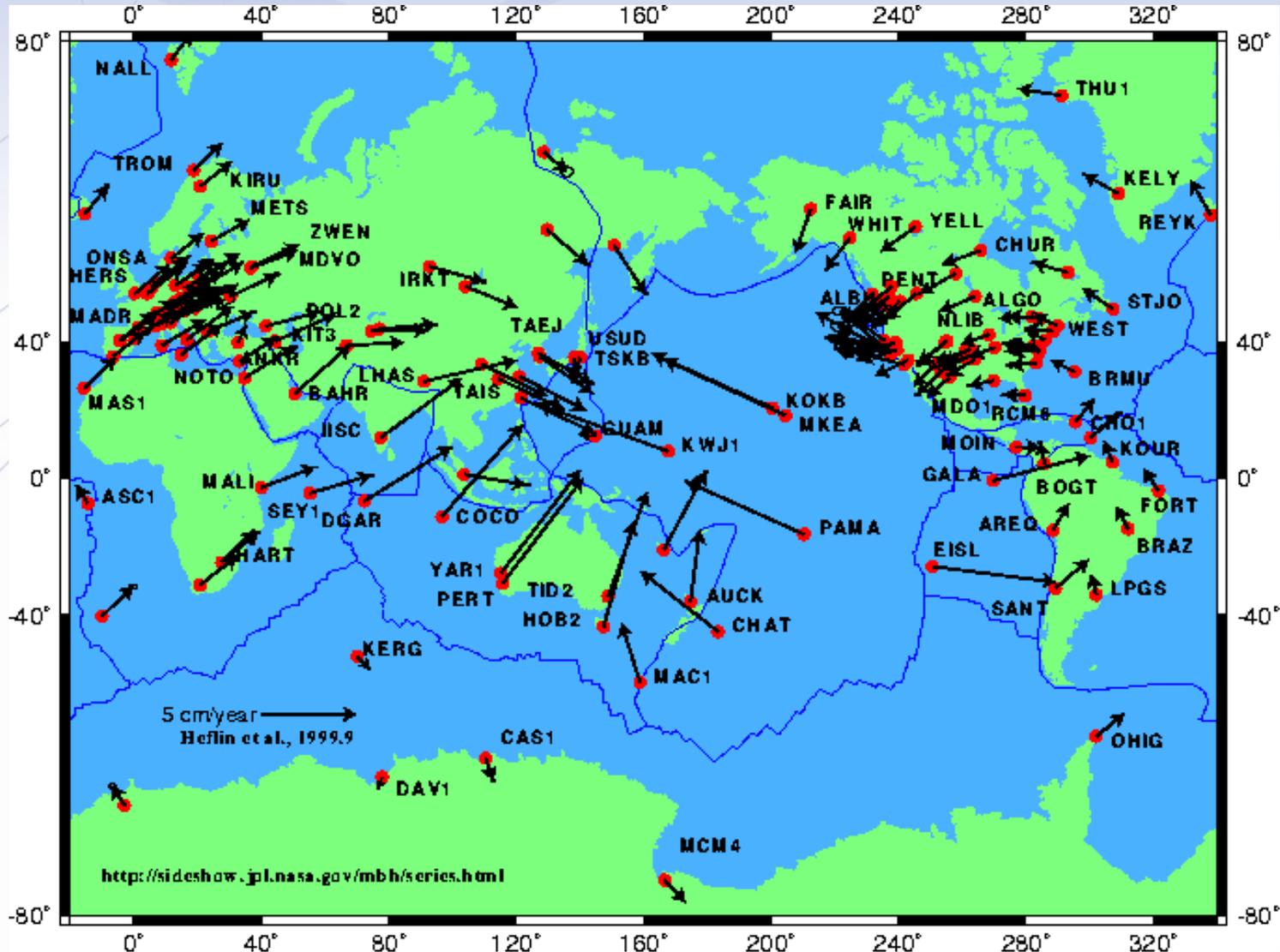
**NO,  
but for your application is it  
significant?**

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"

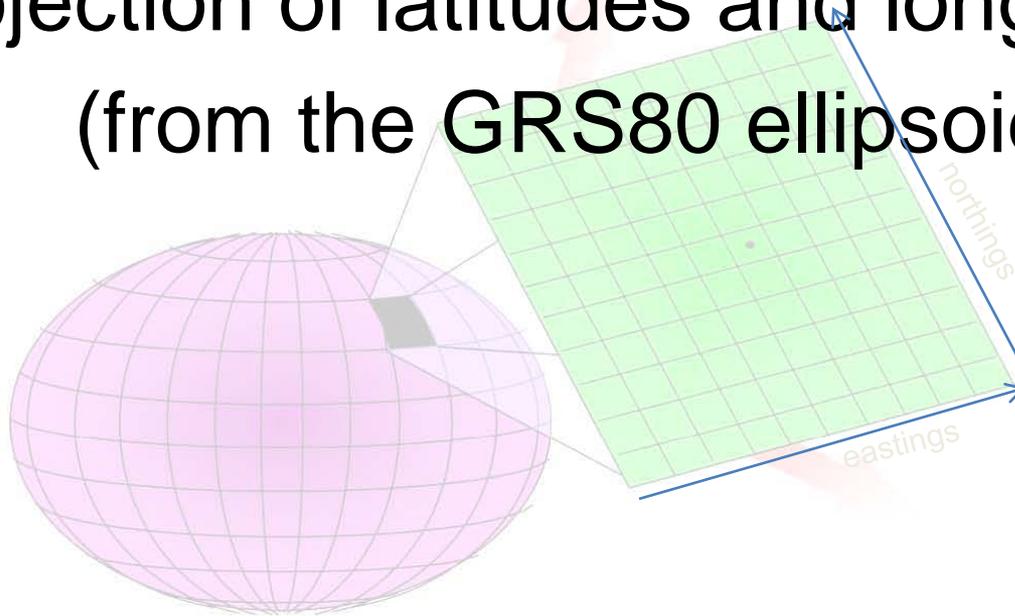
# Tectonic Motions



<http://sideshow.jpl.nasa.gov/mbh/series.html>

# 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

# 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](http://www.ngs.noaa.gov)

[www.geodesy.noaa.gov](http://www.geodesy.noaa.gov)



# National Geodetic Survey

Positioning America for the Future

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



November 8, 2011

## Announcements

### National Geodetic Survey Announces National Adjustment of 2011 Project

As part of the National Geodetic Survey's (NGS) continuing efforts to improve the National Spatial Reference System (NSRS), on May 27, NGS was pleased to announce the National Adjustment of 2011 (NA2011) project...[more](#)

### Notice: Planned Updates to NGS Datasheet Format

In response to stakeholder and NGS staff concerns, NGS has developed several modifications to the format of the **NGS datasheet**—the primary method for accessing the passive control network of the National Spatial Reference System (NSRS)...[more](#)

### Trial Version of the New NOAA Shoreline Data Explorer Available:

[http://beta.ngs.noaa.gov/shoreline\\_raster](http://beta.ngs.noaa.gov/shoreline_raster)

### 2010 Federal Geospatial Summit Proceedings on Improvements to the National Spatial Reference System available:

<http://www.ngs.noaa.gov/2010Summit/proceedings.shtml>

### A 2009 independent study shows the benefits to the U.S. economy from NOAA's positioning products and services are in the billions of dollars.

Click [here](#) for a one page overview of the study

Click [here](#) for a copy of the full report

## In The News

### 11/03/2011 - Hydrographic Services Review Panel Sets Path Forward

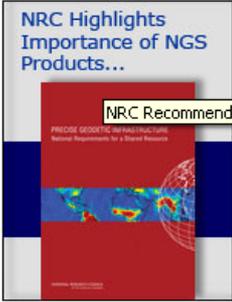
NOAA's Hydrographic Services Review Panel (HSRP) met last week in Norfolk, Virginia, and set their sights on a path forward for the coming years...[more](#)

### 10/27/2011 - NOAA Assists NIST with Net-zero Energy Home

The National Institute of Standards and Technology (NIST) recently requested assistance from the National Geodetic Survey (NGS) in their construction of a full-scale net-zero energy home...[more](#)

### 10/20/2011 - NGS Educates Partners at Great Lakes Height Modernization Consortium

National Geodetic Survey's (NGS) Height Modernization Program educated partners at this fall's Great Lakes Region Height Modernization Consortium meeting. Participants included representatives from the U.S. Army Corps of Engineers, U.S. Coast Guard, and U.S. Environmental Protection Agency.



[NRC Recommendation Link](#)



[Click here to subscribe or unsubscribe.](#)

www.ngs.noaa.gov

www.geodesy.noaa.gov

# Height Modernization



Height Modernization

- faster
- cheaper

Differential  
Leveling  
(Orthometric HT)

GNSS  
(Ellipsoid Ht)

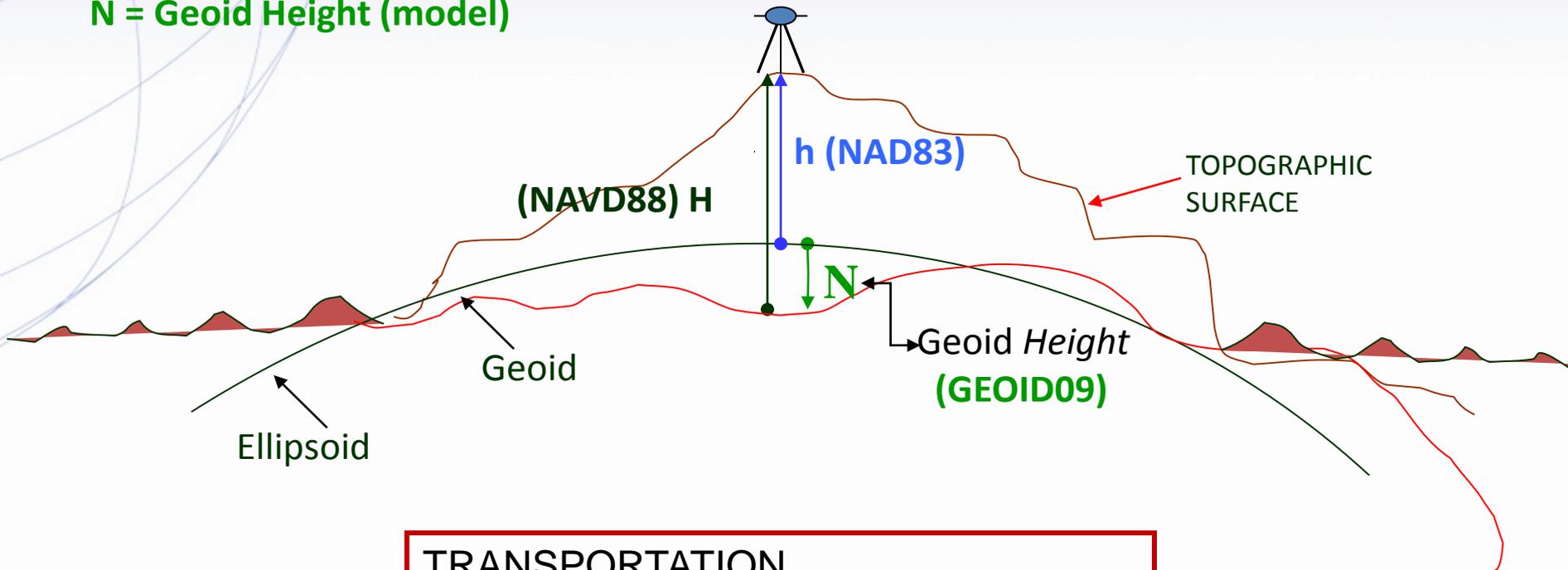
# Ellipsoid, Geoid, and Orthometric Heights

**H = Orthometric Height (leveling)**

**h = Ellipsoidal Height (GPS)**

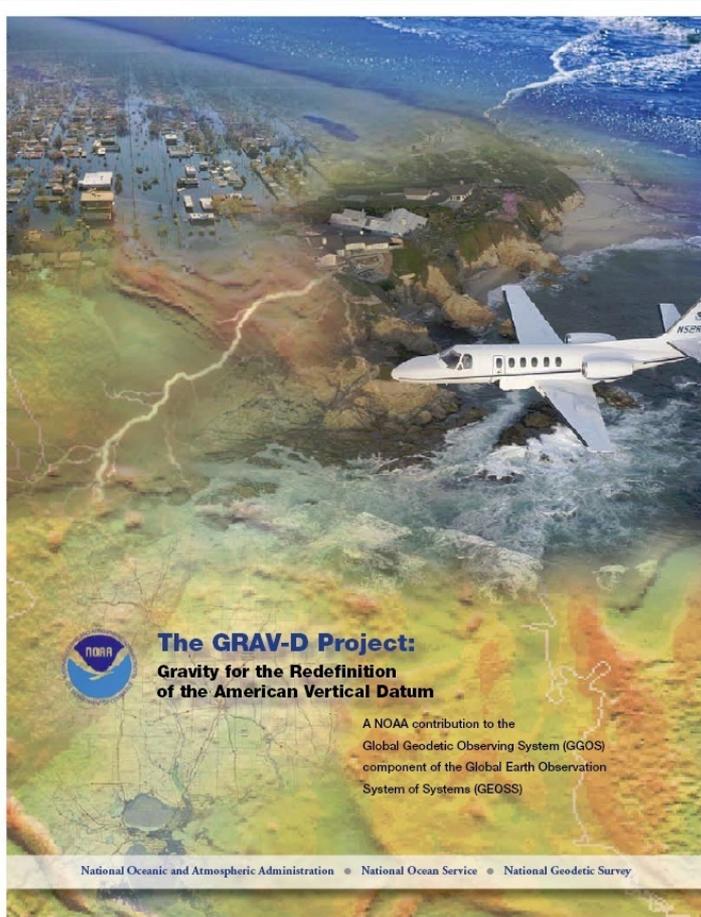
**N = Geoid Height (model)**

$$H = h - N$$



**TRANSPORTATION**  
 $1660.6 = 1643.354 - (-17.23) \text{ METERS}$   
 $1660.6 = 1643.4 + 17.2$

# GRAV-D



- GRAV-D means **fast, accurate, consistent orthometric heights** everywhere in the USA
- GPS already gives fast accurate *ellipsoid* heights
- If the geoid were **modeled** (and **monitored**) to highest accuracy...
- Voila... Fast, accurate orthometric heights, anywhere, anytime
- No need to use leveling to “bring in the datum”

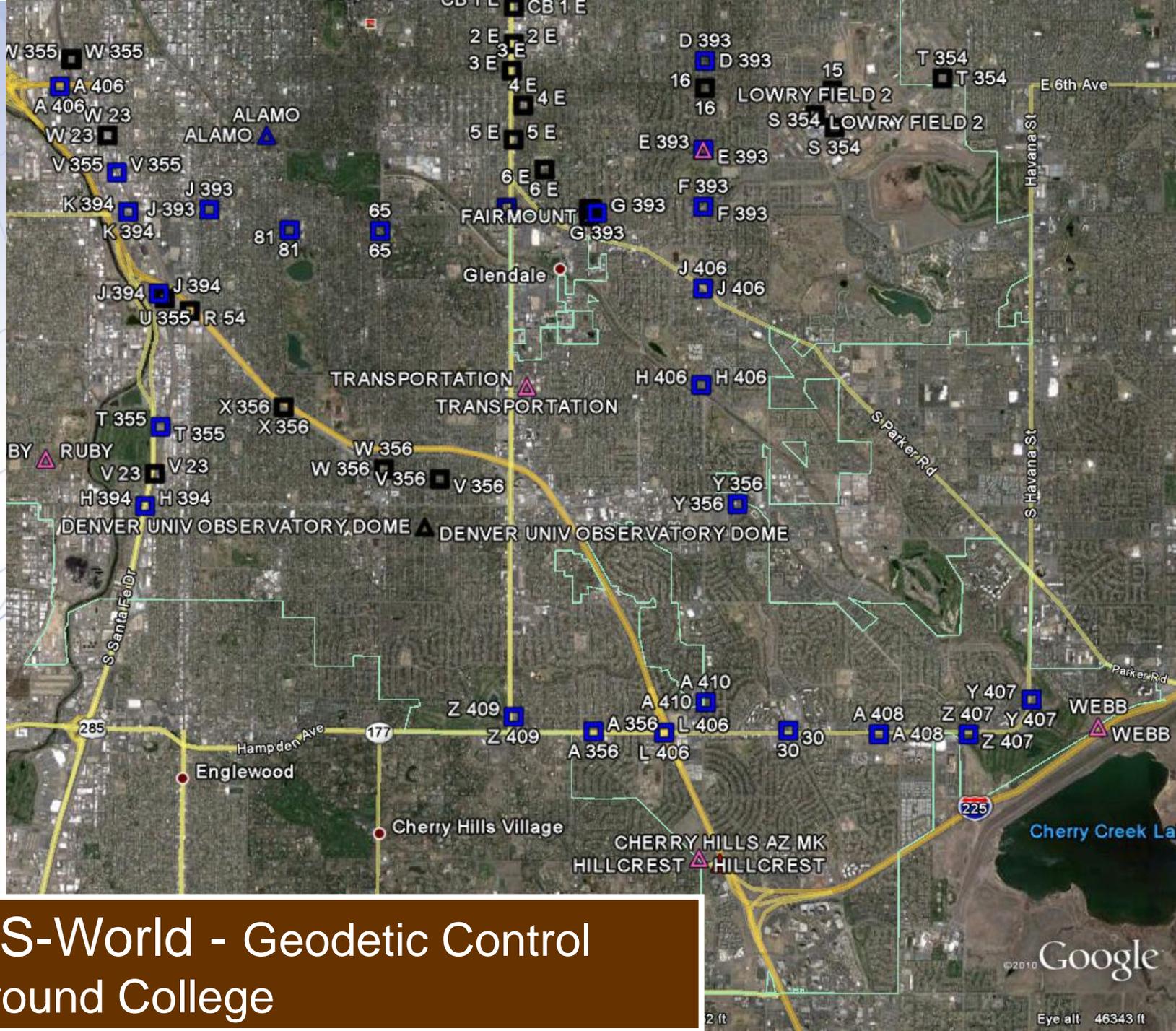
# Metadata

The RT Practitioner must record items not recorded in the Field. For instance:

- ✓ What is the Source of the Data?
- ✓ What is the Datum/Adjustment Epoch?
- ✓ What are the Field Conditions?
- ✓ What Equipment was used, especially what Antenna?
- ✓ What firmware was in the receiver and collector?
- ✓ What redundancy, if any, was used?

# “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



DS-World - Geodetic Control  
around College

Search

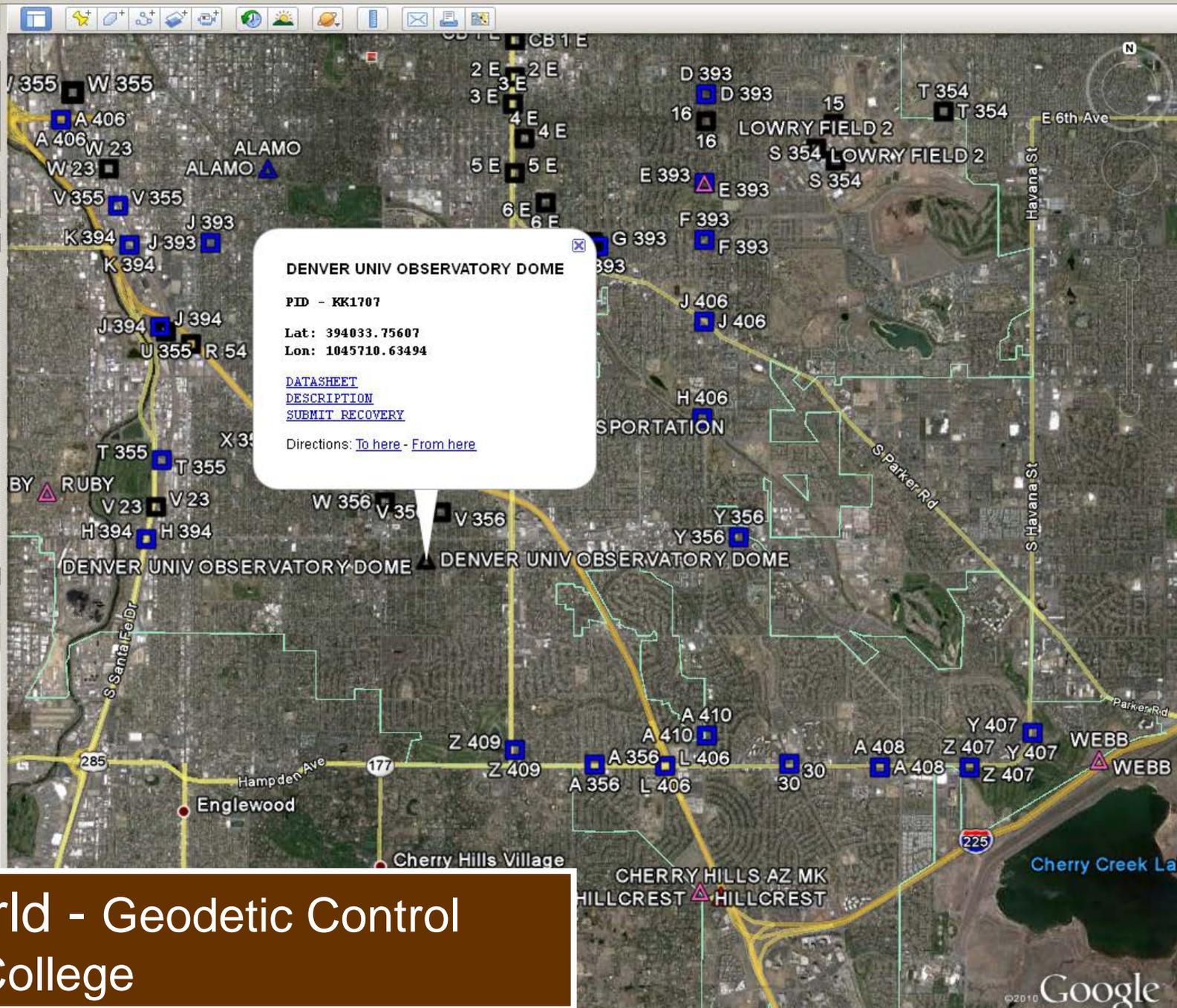
Fly To Find Businesses Directions  
Fly to e.g., Reservoir Rd, Clayville, NY

Places

- Horizontal
- Vertical
- 1A  
PID - KK0664
- 1DHW  
PID - KK1545
- 1SIA  
PID - KK1538
- 15  
PID - KK0445
- 16  
PID - KK0440
- 166A  
PID - DJ8149
- 2A  
PID - KK0665

Layers Earth Gallery >>

- Primary Database
- Earth Pro (US)
- Borders and Labels
- Places
- Photos
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness



**DENVER UNIV OBSERVATORY DOME**  
 PID - KK1707  
 Lat: 394033.75607  
 Lon: 1045710.63494  
[DATASHEET](#)  
[DESCRIPTION](#)  
[SUBMIT RECOVERY](#)  
 Directions: [To here](#) - [From here](#)

# DS-World - Geodetic Control around College

Fly To Find Businesses Directions

Fly to e.g., Reservoir Rd. Clayville, NY

Places

- Horizontal
  - Vertical
    - 1A PID - KK0664
    - 1DHW PID - KK1545
    - 1SIA PID - KK1538
    - 15 PID - KK0445
    - 16 PID - KK0440
    - 166A PID - DJ8149
    - 2A PID - KK0665

Layers Earth Gallery

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- Earth Pro (US)
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- Ocean
- Weather
- Gallery
- Global Awareness
- More
- Terrain

# The NGS Data Sheet

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

```

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1      National Geodetic Survey,  Retrieval Date = NOVEMBER  8, 2011
KK1707 *****
KK1707 DESIGNATION -  DENVER UNIV OBSERVATORY DOME
KK1707 PID          -  KK1707
KK1707 STATE/COUNTY-  CO/DENVER
KK1707 USGS QUAD    -  ENGLEWOOD (1997)
KK1707
KK1707                *CURRENT SURVEY CONTROL
KK1707
KK1707* NAD 83 (1992)-  39 40 33.75607(N)   104 57 10.63494(W)   ADJUSTED
KK1707* NAVD 88      -                    ** (meters)           ** (feet)
KK1707
KK1707 LAPLACE CORR-   -6.42 (seconds)           DEFLECO9
KK1707 GEOID HEIGHT-  -17.16 (meters)           GEOID09
KK1707 HORZ ORDER   -  THIRD
KK1707
KK1707.The horizontal coordinates were established by classical geodetic methods
KK1707.and adjusted by the National Geodetic Survey in January 1993.
KK1707
KK1707.Photos are available for this station.
KK1707
KK1707.The Laplace correction was computed from DEFLECO9 derived deflections.
KK1707
KK1707.The geoid height was determined by GEOID09.
KK1707
KK1707:
KK1707:          North      East      Units Scale Factor Converg.
KK1707:SPC CO C   -  509,502.023   961,335.259   MT  0.99998621  +0 20 42.1
KK1707:SPC CO C   -  1,671,591.22   3,153,980.76   sFT 0.99998621  +0 20 42.1
KK1707:SPC CO N   -  342,996.421   961,336.211   MT  1.00000681  +0 21 12.5
KK1707:SPC CO N   -  1,125,314.09   3,153,983.89   sFT 1.00000681  +0 21 12.5
KK1707:UTM 13    -  4,391,803.264   504,034.733   MT  0.99960020  +0 01 48.1
KK1707
KK1707                SUPERSEDED SURVEY CONTROL
KK1707
KK1707 USSD          -  39 40 34.18500(N)   104 57 08.71000(W) AD( ) 3
KK1707 NAD 83 (1986)-  39 40 33.75346(N)   104 57 10.61905(W) AD( ) 3
KK1707 NAD 27        -  39 40 33.80000(N)   104 57 08.70900(W) AD( ) 3
KK1707
KK1707.Superseded values are not recommended for survey control.
KK1707.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KK1707. See file dsdata.txt to determine how the superseded data were derived.
KK1707
KK1707 U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEDO403491803 (NAD 83)
KK1707_MARKER: 55 = TOWER
KK1707 SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

```

**Search**

Fly To Find Businesses Directions

Fly to e.g., Reservoir Rd. Clayville, NY

**Places**

- Horizontal
- Vertical
- [1A](#)  
PID - KK0664
- [1DHW](#)  
PID - KK1545
- [15IA](#)  
PID - KK1538
- [15](#)  
PID - KK0445
- [16](#)  
PID - KK0440
- [166A](#)  
PID - DJ8149
- [2A](#)  
PID - KK0665

**Layers** Earth Gallery >>

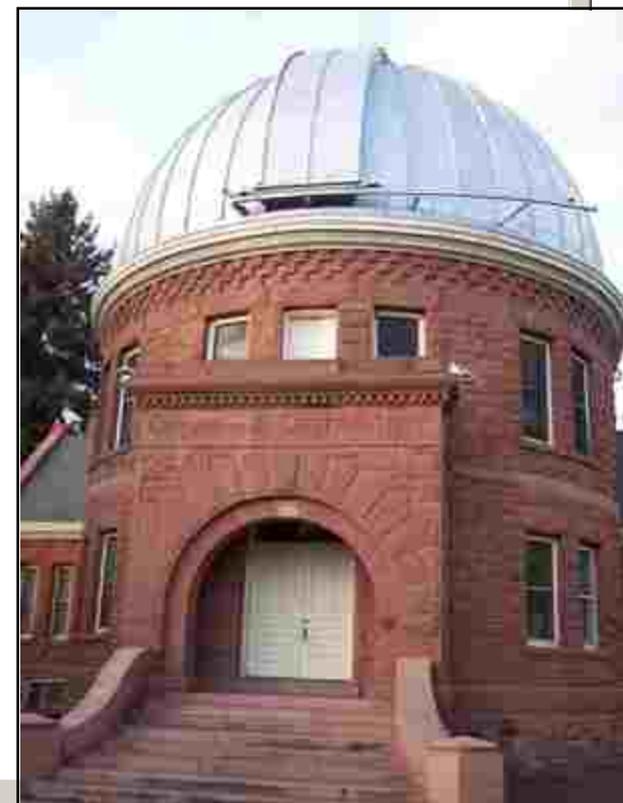
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<< Back to Google Earth

```

KK1707* NAVD 88      -          ** (meters)          ** (feet)
KK1707
KK1707 LAPLACE CORR-      -6.42 (seconds)          DEFLECO9
KK1707 GEOID HEIGHT-    -17.16 (meters)          GEOID09
KK1707 HORZ ORDER  -   THIRD
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KK1707
KK1707;
          North      East      Units Scale Factor Converg.
KK1707;SPC CO C      - 509,502.023  961,335.259  MT  0.99998621  +0 20 42.1
KK1707;SPC CO C      - 1,671,591.22  3,153,980.76  sFT 0.99998621  +0 20 42.1
KK1707;SPC CO N      - 342,996.421  961,336.211  MT  1.00000681  +0 21 12.5
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KK1707
KK1707_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SED0403491803 (NAD 83)
KK1707_MARKER: 55 = TOWER
KK1707_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KK1707+SATELLITE: SATELLITE OBSERVATIONS - June 27, 2009
KK1707
KK1707 HISTORY      - Date      Condition      Report By
KK1707 HISTORY      - 1895      FIRST OBSERVED CGS
KK1707 HISTORY      - 1934      GOOD           COGS
KK1707 HISTORY      - 20090627  GOOD           GEOCAC
KK1707
KK1707              STATION DESCRIPTION
KK1707
KK1707'DESCRIBED BY COLORADO GEODETIC SURVEY 1934 (FHP)
KK1707' IN DENVER, IN DENVER UNIVERSITY OBSERVATION TOWER. NO FURTHER
KK1707' INFORMATION AVAILABLE.
KK1707
KK1707              STATION RECOVERY (2009)
KK1707
KK1707'RECOVERY NOTE BY GEOCACHING 2009 (LPC)
KK1707'RECOVERED IN GOOD CONDITION.
    
```

\*\*\* retrieval complete.  
Elapsed Time = 00:00:01



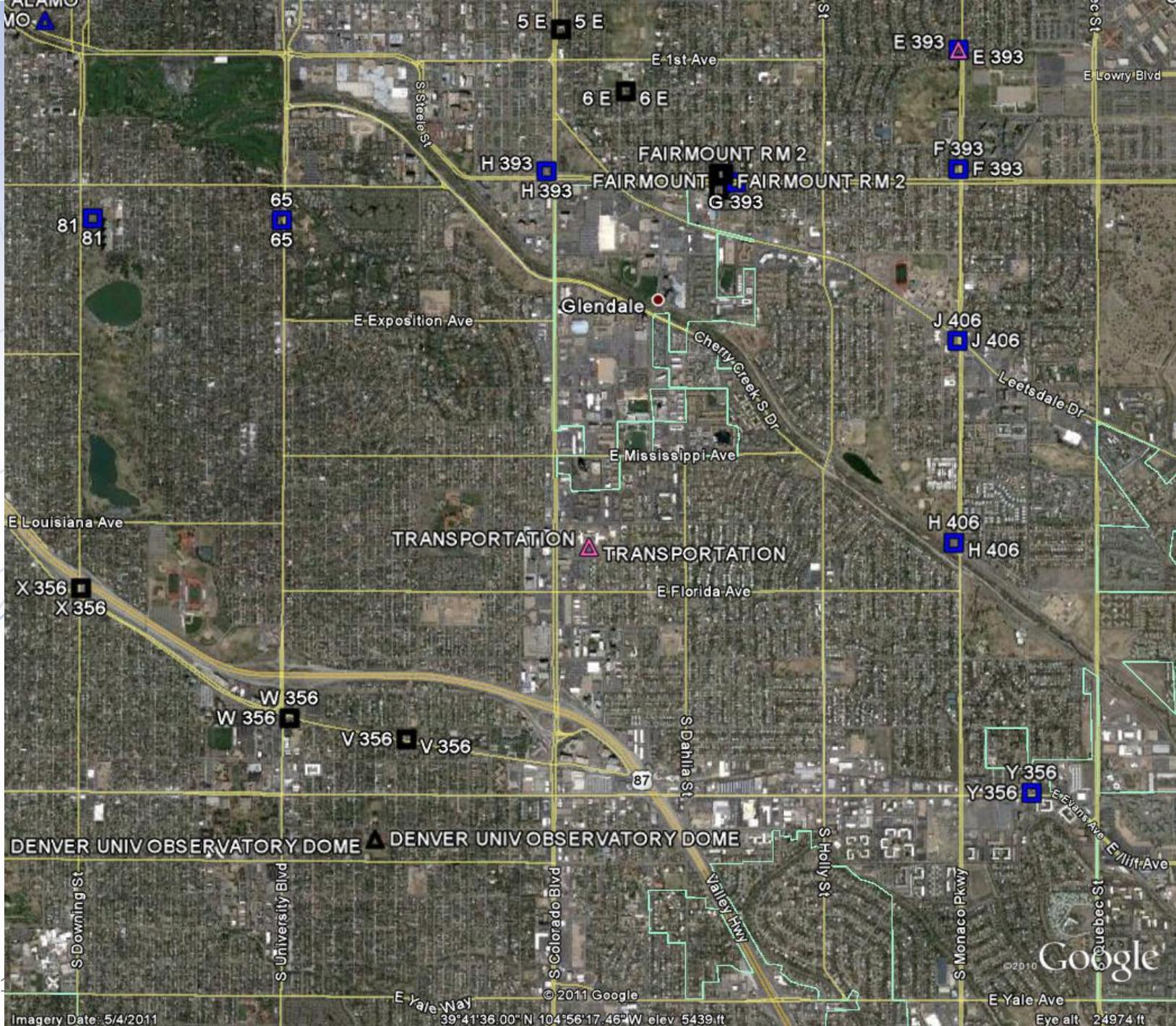
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KK1707 PID - KK1707
KK1707 STATE/COUNTY- CO/DENVER
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KK1707 USSD - 39 40 34.18500(N) 104 57 08.71000(W) AD( ) 3
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KK1707 NAD 27 - 39 40 33.80000(N) 104 57 08.70900(W) AD( ) 3
KK1707
KK1707.Superseded values are not recommended for survey control.
KK1707.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KK1707. See file dsdata.txt to determine how the superseded data were derived.
KK1707
KK1707_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SED0403491803(NAD 83)
KK1707 MARKER: 55 = TOWER
KK1707_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KK1707+SATELLITE: SATELLITE OBSERVATIONS - June 27, 2009
KK1707
KK1707 HISTORY - Date Condition Report By
KK1707 HISTORY - 1895 FIRST OBSERVED CGS
KK1707 HISTORY - 1934 GOOD COGS
```

KK1707 HISTORY - 20090627 GOOD GEOCAC  
KK1707  
KK1707 STATION DESCRIPTION  
KK1707  
KK1707'DESCRIBED BY COLORADO GEODETIC SURVEY 1934 (FHP)  
KK1707'IN DENVER, IN DENVER UNIVERSITY OBSERVATION TOWER. NO FURTHER  
KK1707'INFORMATION AVAILABLE.  
KK1707  
KK1707 STATION RECOVERY (2009)  
KK1707  
KK1707'RECOVERY NOTE BY GEOCACHING 2009 (LPC)  
KK1707'RECOVERED IN GOOD CONDITION.

\*\*\* retrieval complete.  
Elapsed Time = 00:00:01



**Search**

Fly To Find Businesses Directions

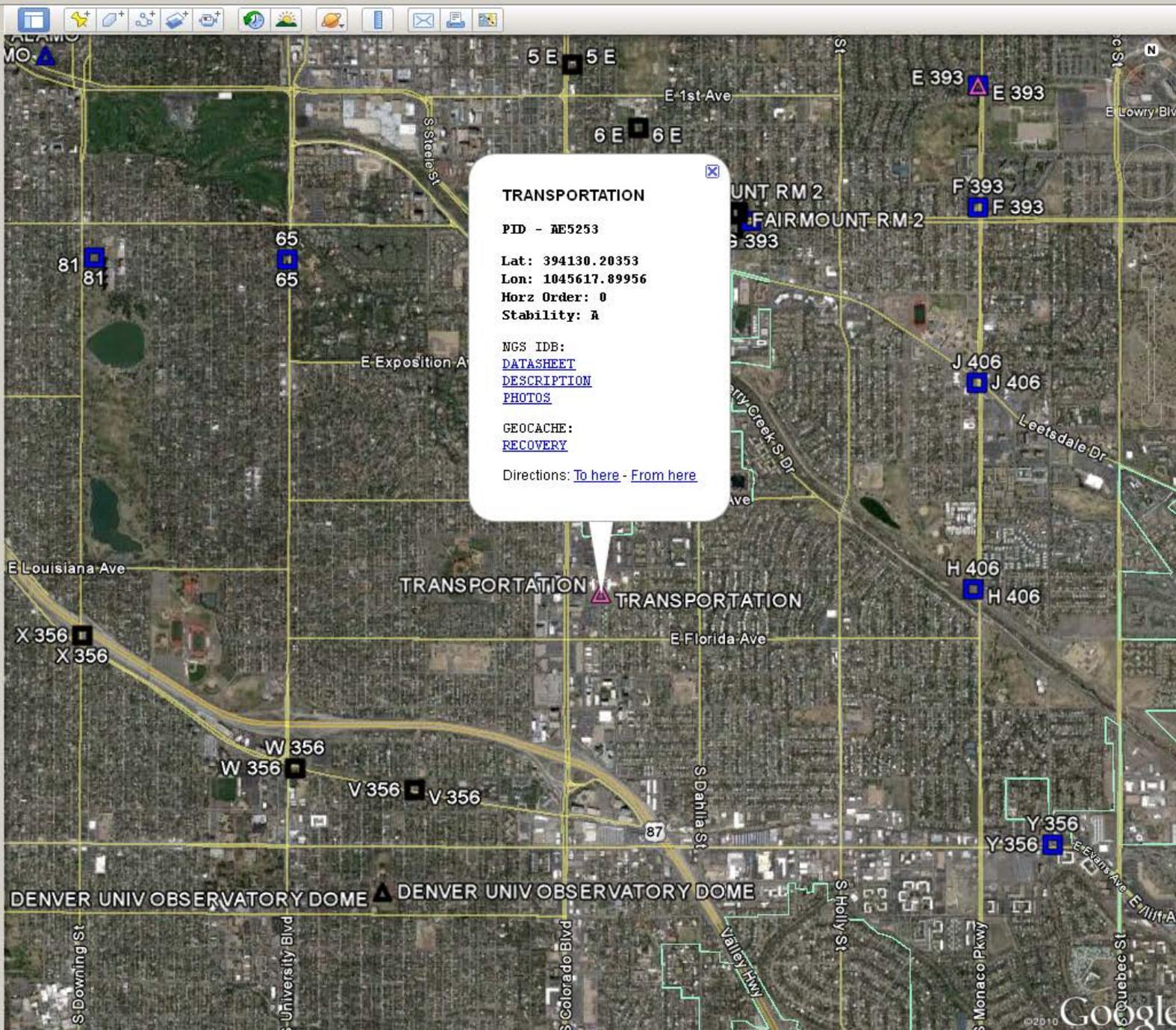
Fly to e.g., Reservoir Rd. Clayville, NY

**Places**

- NEW POINT 2**  
PID -
- CO\_GUNNISON\_X-0-0.kml
  - Horizontal
  - Vertical
- TX\_HARRIS\_X-0-0.kml
  - Horizontal
  - Vertical
- CO\_DENVER\_X-0-0.kml
  - Horizontal
  - Vertical
- CO\_ARAPAHOE\_X-0-0.kml
- CO\_BOULDER\_X-0-0.kml
- CO\_C 411.kml
- CO\_NOAA.kml
- CO\_BOULDER\_X-0-0.kml
- CO\_GEOMAG.kml
- Temporary Places
- CO\_DENVER\_X-0-0.kml

**Layers** Earth Gallery >>

- Primary Database
- Earth Pro (US)
- Borders and Labels
- Places
- Photos
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness
- More
- Terrain



**TRANSPORTATION**

PID - AE5253

Lat: 394130.20353  
Lon: 1045617.89956  
Horz Order: 0  
Stability: A

NGS IDB:  
[DATASHEET](#)  
[DESCRIPTION](#)  
[PHOTOS](#)

GEOCACHE:  
[RECOVERY](#)

Directions: [To here](#) - [From here](#)

DENVER UNIV OBSERVATORY DOME

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2  
 1 National Geodetic Survey, Retrieval Date = NOVEMBER 8, 2011

AE5253 \*\*\*\*\*  
 AE5253 DESIGNATION - TRANSPORTATION  
 AE5253 PID - AE5253  
 AE5253 STATE/COUNTY- CO/DENVER  
 AE5253 USGS QUAD - ENGLEWOOD (1997)  
 AE5253  
 AE5253 \*CURRENT SURVEY CONTROL  
 AE5253

AE5253*	NAD 83 (2007)-	39 41 30.20353 (N)	104 56 17.89956 (W)	ADJUSTED
AE5253*	NAVD 88	- 1660.6 (meters)	5448. (feet)	GPS OBS

AE5253  
 AE5253 EPOCH DATE - 2002.00  
 AE5253 X - -1,267,215.675 (meters) COMP  
 AE5253 Y - -4,749,765.071 (meters) COMP  
 AE5253 Z - 4,052,755.506 (meters) COMP  
 AE5253 LAPLACE CORR- -6.36 (seconds) DEFLEC09  
 AE5253 ELLIP HEIGHT- 1643.354 (meters) (02/10/07) ADJUSTED  
 AE5253 GEOID HEIGHT- -17.23 (meters) GEOID09  
 AE5253

AE5253 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----  
 AE5253 Type PID Designation North East Ellip  
 AE5253  
 AE5253 NETWORK AE5253 TRANSPORTATION 0.73 0.55 2.14  
 AE5253 -----  
 AE5253

AE5253. The horizontal coordinates were established by GPS observations  
 AE5253. and adjusted by the National Geodetic Survey in February 2007.  
 AE5253  
 AE5253. The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).  
 AE5253. See [National Readjustment](#) for more information.  
 AE5253. The horizontal coordinates are valid at the epoch date displayed above.  
 AE5253. The epoch date for horizontal control is a decimal equivalence  
 AE5253. of Year/Month/Day.  
 AE5253  
 AE5253. The orthometric height was determined by GPS observations and a  
 AE5253. high-resolution geoid model.  
 AE5253  
 AE5253. The X, Y, and Z were computed from the position and the ellipsoidal ht.  
 AE5253  
 AE5253. The Laplace correction was computed from DEFLEC09 derived deflections.  
 AE5253  
 AE5253. The ellipsoidal height was determined by GPS observations  
 AE5253. and is referenced to NAD 83.  
 AE5253  
 AE5253. The geoid height was determined by GEOID09.  
 AE5253

AE5253;		North	East	Units	Scale	Factor	Converg.
AE5253; SPC CO C	-	511,250.548	962,581.256	MT	0.99998899	+0 21	15.3
AE5253; SPC CO C	-	1,677,327.84	3,158,068.67	sFT	0.99998899	+0 21	15.3
AE5253; UTM 13	-	4,393,544.241	505,289.835	MT	0.99960034	+0 02	21.8

AE5253  
 AE5253! - Elev Factor x Scale Factor = Combined Factor  
 AE5253!SPC CO C - 0.99974225 x 0.99998899 = 0.99973124  
 AE5253!UTM 13 - 0.99974225 x 0.99960034 = 0.99934269

AE5253

SUPERSEDED SURVEY CONTROL

AE5253

AE5253 ELLIP H (12/03/02) 1643.393 (m) GP( ) 4 2

AE5253 NAD 83(1992)- 39 41 30.20295(N) 104 56 17.89912(W) AD( ) 1

AE5253 ELLIP H (01/12/98) 1643.401 (m) GP( ) 4 1

AE5253

AE5253.Superseded values are not recommended for survey control.

AE5253.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

AE5253.[See file dsdata.txt](#) to determine how the superseded data were derived.

AE5253

AE5253 U.S. NATIONAL GRID SPATIAL ADDRESS: 13SED0528993544(NAD 83)

AE5253\_MARKER: I = METAL ROD

AE5253\_SETTING: 59 = STAINLESS STEEL ROD IN SLEEVE (10 FT.+)

AE5253\_STAMPING: TRANSPORTATION 1995

AE5253\_MARK LOGO: CODH

AE5253\_PROJECTION: FLUSH

AE5253\_MAGNETIC: I = MARKER IS A STEEL ROD

AE5253\_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD

AE5253+STABILITY: POSITION/ELEVATION WELL

AE5253\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

AE5253+SATELLITE: SATELLITE OBSERVATIONS - February 17, 2005

AE5253\_ROD/PIPE-DEPTH: 4.0 meters

AE5253\_SLEEVE-DEPTH : 0.9 meters

AE5253

AE5253 HISTORY	- Date	Condition	Report By
AE5253 HISTORY	- 1995	MONUMENTED	CODOT
AE5253 HISTORY	- 20050217	GOOD	CO0600

AE5253

STATION DESCRIPTION

AE5253

AE5253'DESCRIBED BY COLORADO DEPARTMENT OF TRANSPORTATION 1995 (RSC)

AE5253'THE STATION IS LOCATED IN THE CITY OF DENVER, IN THE NORTHWEST 1/4 OF

AE5253'SECTION 19, T 4 S, R 67 W. OWNERSHIP--COLORADO DEPT. OF

AE5253'TRANSPORTATION HEADQUARTERS BUILDING TO REACH THE STATION FROM THE

AE5253'MAIN ENTRANCE TO THE HEADQUARTERS BUILDING AT 4201 EAST ARKANSAS

AE5253'AVENUE, GO NORTH TOWARD THE CENTRAL DOORS FOR 0.05 MI (0.08 KM) TO THE

AE5253'STATION IN THE GRASS AREA OF A PARKING CIRCLE THE STATION IS A PUNCH

AE5253'MARK TOP CENTER OF A STAINLESS STEEL ROD DRIVEN TO REFUSAL IN A

AE5253'GREASED SLEEVE, ENCASED IN A 5-INCH PVC PIPE WITH A LOGO CAP SET IN A

AE5253'0.9 M (3.0 FT) DIAMETER CONCRETE COLLAR, FLUSH WITH THE GROUND. IT IS

AE5253'65.3 M (214.2 FT) NORTH OF THE CENTER LINE OF ARKANSAS AVENUE, 60.7 M

AE5253'(199.1 FT) SOUTH OF THE CENTER OF THE MAIN DOORS TO 4201 ARKANSAS

AE5253'AVENUE, 13.2 M (43.3 FT) NORTHWEST OF THE EASTERN FLAGPOLE, 13.1 M

AE5253'(43.0 FT) NORTHEAST OF THE WESTERN FLAGPOLE AND 1.05 M (3.44 FT) NORTH

AE5253'OF THE NORTH EDGE OF AN EAST-WEST SIDEWALK.

AE5253

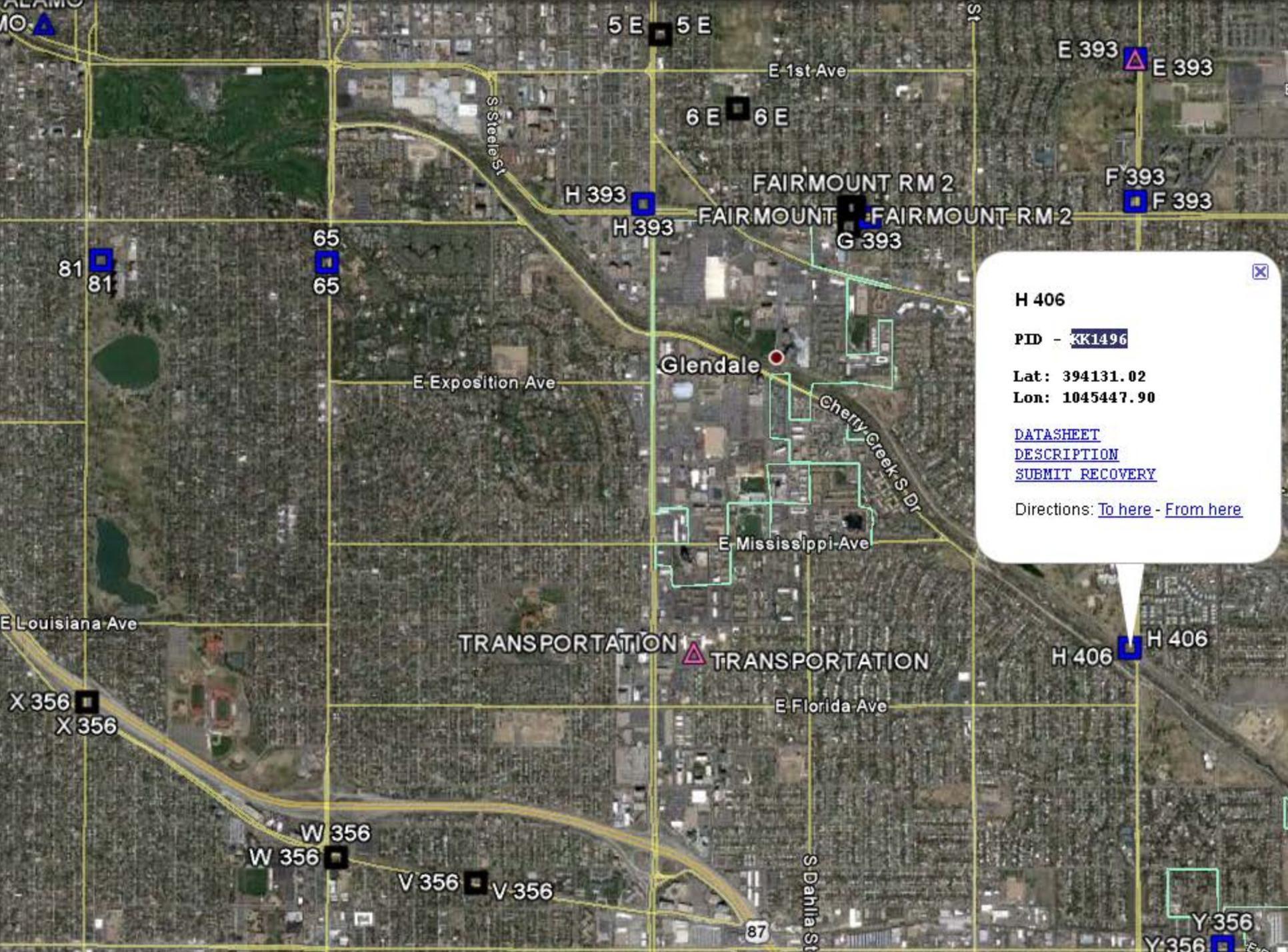
STATION RECOVERY (2005)

AE5253

AE5253'RECOVERY NOTE BY CITY AND COUNTY OF DENVER COLORADO 2005 (RTE)

AE5253'RECOVERED IN GOOD CONDITION.

\*\*\* retrieval complete.



H 406

PID - KK1496

Lat: 394131.02

Lon: 1045447.90

[DATASHEET](#)

[DESCRIPTION](#)

[SUBMIT RECOVERY](#)

Directions: [To here](#) - [From here](#)

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

```
DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1      National Geodetic Survey,  Retrieval Date = NOVEMBER  8, 2011
KK1496 *****
KK1496 DESIGNATION -  H 406
KK1496 PID          -  KK1496
KK1496 STATE/COUNTY-  CO/DENVER
KK1496 USGS QUAD   -  ENGLEWOOD (1997)
KK1496
KK1496                                *CURRENT SURVEY CONTROL
KK1496
KK1496* NAD 83(1986)- 39 41 31.02 (N) 104 54 47.90 (W) HD_HELD1
KK1496* NAVD 88      -      1643.697 (meters) 5392.70 (feet) ADJUSTED
KK1496
KK1496 GEOID HEIGHT-          -17.30 (meters) GEOID09
KK1496 DYNAMIC HT  -          1642.103 (meters) 5387.47 (feet) COMP
KK1496 MODELED GRAV-          979,599.6 (mgal) NAVD 88
KK1496
KK1496 VERT ORDER -  FIRST CLASS II
KK1496
KK1496.The horizontal coordinates were established by differentially corrected
KK1496.hand held GPS obs and have an estimated accuracy of +/- 3 meters.
KK1496
KK1496.The orthometric height was determined by differential leveling and
KK1496.adjusted in June 1991.
KK1496
KK1496.Photographs are available for this station.
KK1496
KK1496.The geoid height was determined by GEOID09.
KK1496
KK1496.The dynamic height is computed by dividing the NAVD 88
KK1496.geopotential number by the normal gravity value computed on the
KK1496.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KK1496.degrees latitude (g = 980.6199 gals.).
KK1496
KK1496.The modeled gravity was interpolated from observed gravity values.
KK1496
KK1496;
KK1496;          North          East      Units  Estimated Accuracy
KK1496;SPC CO C  -  511,289.3    964,725.4    MT  (+/- 3 meters HH1 GPS)
KK1496
KK1496                                SUPERSEDED SURVEY CONTROL
KK1496
KK1496 NGVD 29 (??/??/??) 1642.779 (m)          5389.68 (f) ADJUSTED 1 2
KK1496
KK1496.Superseded values are not recommended for survey control.
KK1496.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KK1496.See file dsdata.txt to determine how the superseded data were derived.
KK1496
KK1496 U.S. NATIONAL GRID SPATIAL ADDRESS: 13SED0743393571(NAD 83)
KK1496 MARKER: DB = BENCH MARK DISK
KK1496 SETTING: 41 = SET IN A LARGE STRUCTURE WITH FOUNDATIONS ON BEDROCK
KK1496 SP_SET: TOWER FOUNDATION
KK1496 STAMPING: H 406 1984
```

KK1496 MARK LOGO: NGS

KK1496\_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD

KK1496+STABILITY: POSITION/ELEVATION WELL

KK1496\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

KK1496+SATELLITE: SATELLITE OBSERVATIONS - February 16, 2007

KK1496

KK1496	HISTORY	- Date	Condition	Report By
KK1496	HISTORY	- 1984	MONUMENTED	NGS
KK1496	HISTORY	- 20070216	GOOD	METRSC

KK1496

KK1496 STATION DESCRIPTION

KK1496

KK1496'DESCRIBED BY NATIONAL GEODETIC SURVEY 1984

KK1496'IN DENVER.

KK1496'IN DENVER, AT THE JUNCTION OF SOUTH MONACO STREET PARKWAY AND CHERRY

KK1496'CREEK NORTH DRIVE, IN TOP OF THE SOUTHEAST EDGE OF THE CONCRETE

KK1496'FOUNDATION OF THE SOUTHEAST LEG OF A STEEL HIGHLINE TOWER, 30.6 METERS

KK1496'(100.4 FT) NORTHEAST OF THE CENTER OF THE DRIVE, 29.4 METERS (96.5 FT)

KK1496'WEST OF THE CENTERLINE OF THE SOUTH BOUND LANES OF THE PARKWAY,

KK1496'0.2 METER (0.7 FT) SOUTHEAST OF THE SOUTHEAST LEG OF THE TOWER,

KK1496'0.2 METER (0.7 FT) NORTHWEST OF THE SOUTHEAST EDGE OF THE FOUNDATION.

KK1496'NOTE=THIS FOUNDATION IS TO A DEPTH OF 56.0 FEET AND IS SETTING ON

KK1496'BEDROCK.

KK1496'THE MARK IS ABOVE LEVEL WITH THE GROUND.

KK1496

KK1496

STATION RECOVERY (2007)

KK1496

KK1496'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE OF DENVER 2007 (CR)

KK1496'RECOVERED IN GOOD CONDITION.





# *Announcing...*

## A New NGS Datasheet Format

- **Update to new Datasheet version (8.00)**
  - Changed location, length, and text for many fields
  - Added new fields, deleted fields, augmented existing fields
  - Implemented by end of calendar year 2011
  - Will add announcement and prototype to NGS web site soon
- **Summary of content changes**
  - Added country (e.g., USA) where control station located
  - Hyperlinked vertical datum designation to datum web page
  - Ortho height epoch date, if applicable (e.g., subsidence areas)
  - Note for geoid model used on Ht Mod stations if not current geoid
  - Network and (median) local accuracies
    - Horizontal and ellipsoid height accuracy at 95% confidence (per FGDC)
    - Includes link to detailed accuracy info, list of all local accuracies
  - Superseded Ht Mod ortho heights indicate geoid model used

## National Geodetic Survey

Surveys Science & Education

Clickable legend icons)

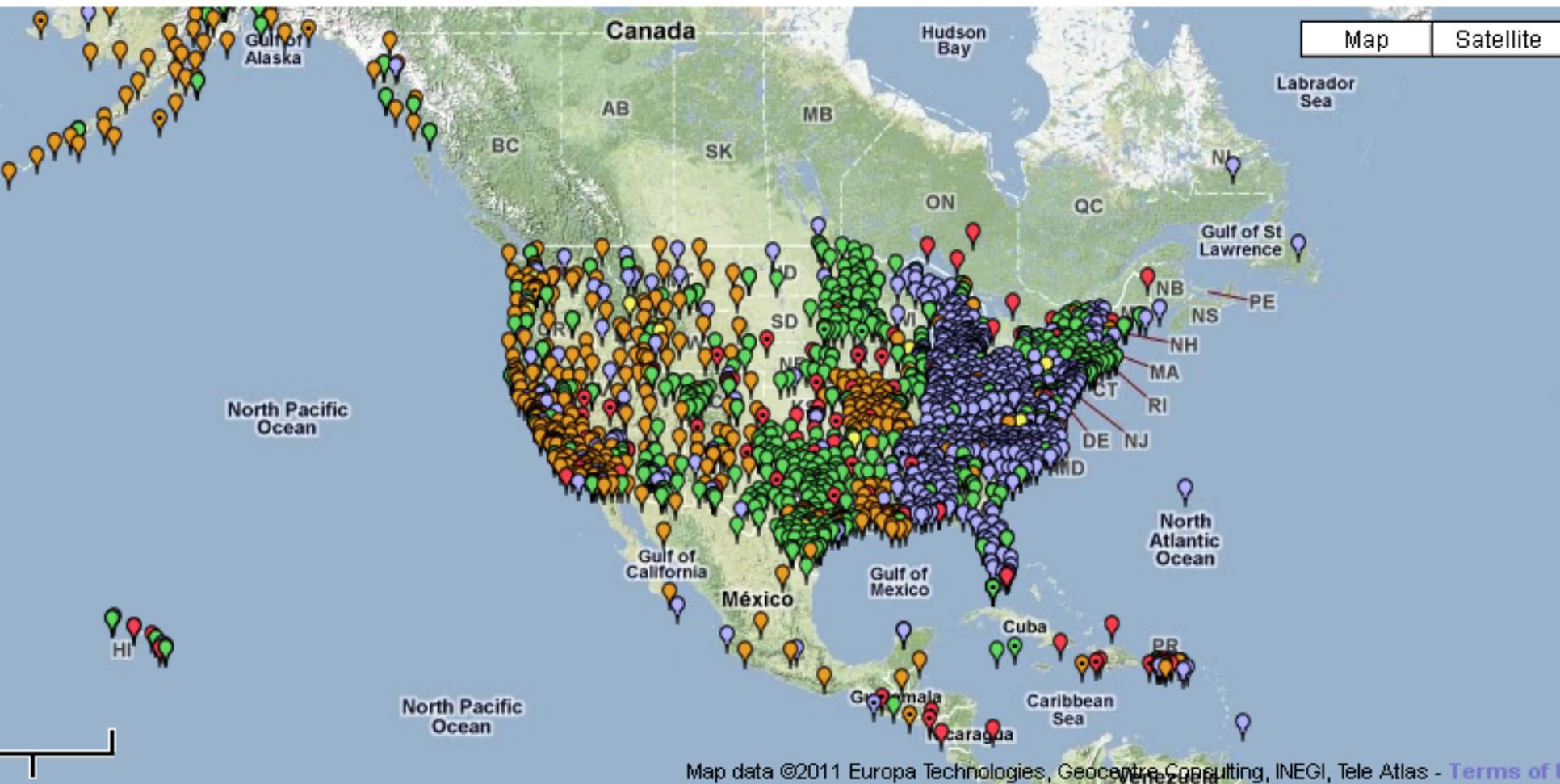
10 sec 15 sec 30 sec All Active Decom



Non-Operational



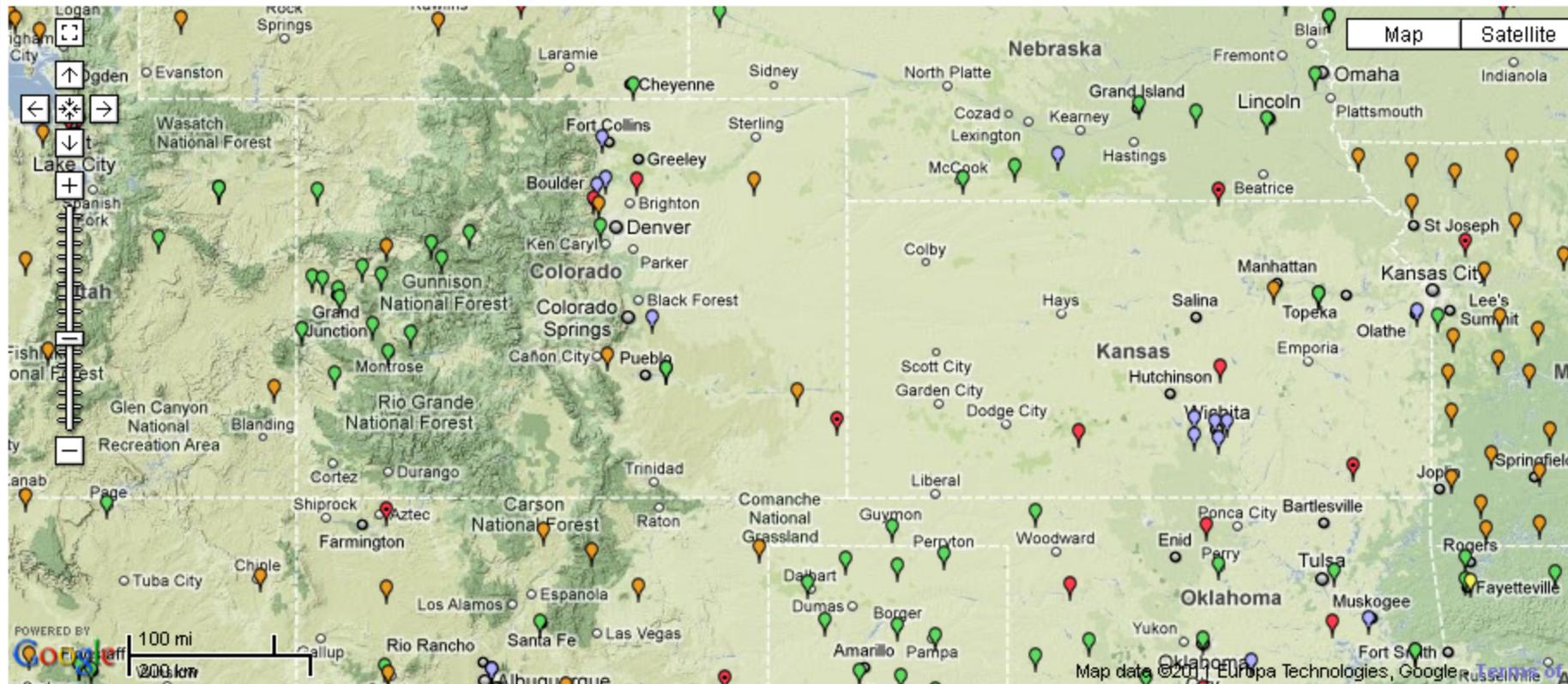
250 km radius



### Sampling Rate (clickable legend icons)

 Non-Operational  250 km radius

 1 sec  5 sec  10 sec  15 sec  30 sec  All Active  Decom



Map data ©2011 Europa Technologies, Google, Russia, etc. Website Owner: National Geodetic Survey / Last modified by

# “OPUS”

## Online Positioning User Service

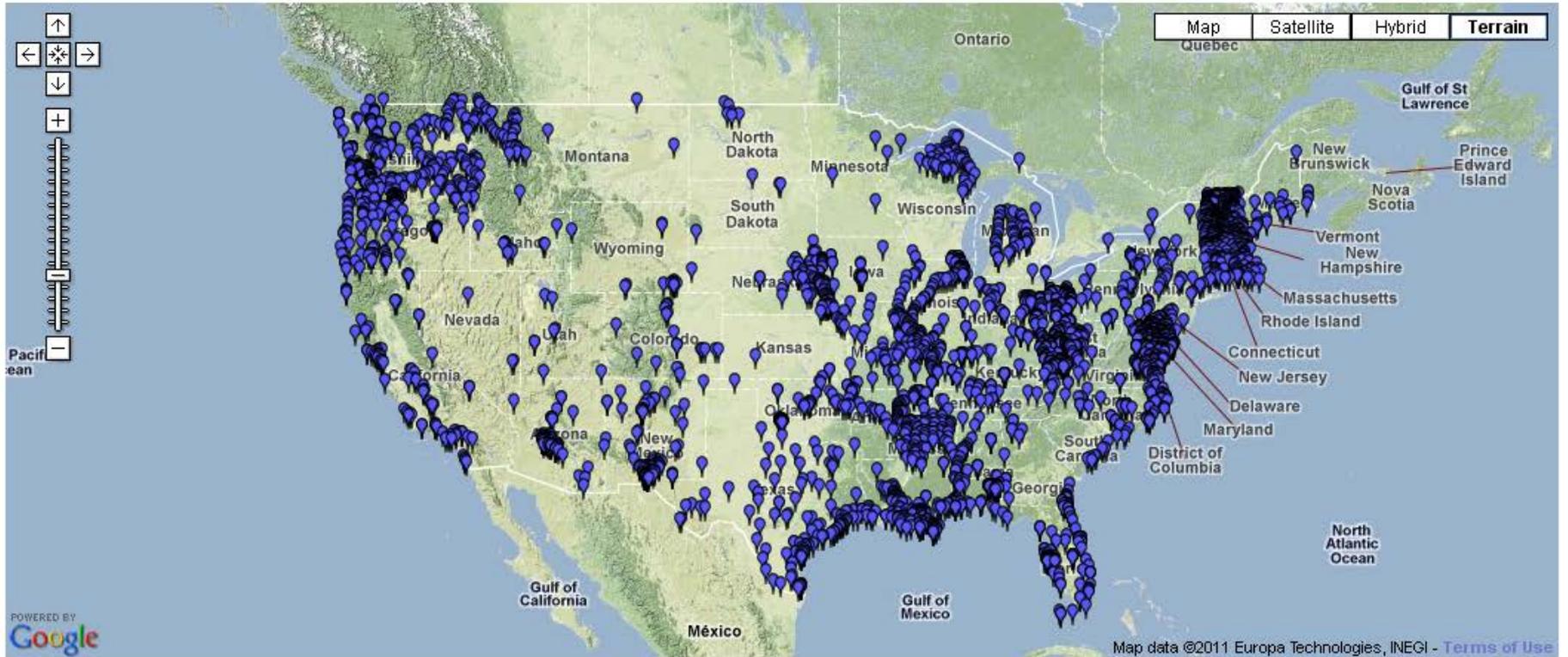
- OPUS – Rapid-Static (15 min to 2 hrs of obs.)
- OPUS – Static (2 hrs to 48 hrs of obs.)
- OPUS – DataBase (>4 hrs of obs.)  
publish your info
  
- OPUS – Projects (beta)

# OPUS: Online Positioning User Service

National Geodetic Survey

Home & Imagery | Tools | Surveys | Science & Education |  Search

Browse map to locate and access datasheets.



Map data ©2011 Europa Technologies, INEGI - [Terms of Use](#)

Website Owner: National Geodetic Survey / Last modified by NGS.OPUS Monday, 19-Sep-2011 14:45:34 EDT

# NGSIDB Versus OPUS-DB

## NGSIDB

- Passive control
- Episodically refined (NRA2011)
- Traditional surveying
- A lot of (important!) numbers and text

### The NGS Data Sheet

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

```

DATABASE = , PROGRAM = datasheet, VERSION = 7.86
1 National Geodetic Survey, Retrieval Date = APRIL 20, 2011
DO0454 *****
DO0454 DESIGNATION - C 281
DO0454 PID - DO0454
DO0454 STATE/COUNTY- TX/THROCKMORTON
DO0454 USGS QUAD - THROCKMORTON NE (1965)
DO0454
DO0454 *CURRENT SURVEY CONTROL
DO0454
DO0454* NAD 83(2007)- 33 11 10.75472(N) 099 06 11.86433(W) NO CHECK
DO0454* NAVD 88 - 383.465 (meters) 1258.08 (feet) ADJUSTED
DO0454
DO0454 EPOCH DATE - 2002.00
DO0454 X - -845,419.278 (meters) COMP
DO0454 Y - -5,276,185.563 (meters) COMP
DO0454 Z - 3,471,464.429 (meters) COMP
DO0454 LAPLACE CORR- 0.24 (seconds) DEFLECO9
DO0454 ELLIP HEIGHT- 353.943 (meters) (02/10/07) NO CHECK
DO0454 GEOD HEIGHT- -28.98 (meters) GEOD09
DO0454 DYNAMIC HT - 383.004 (meters) 1256.57 (feet) COMP
DO0454
DO0454 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
DO0454 Type PID Designation North East Ellip
DO0454 -----
DO0454 NETWORK DO0454 C 281 1.10 1.47 2.14
DO0454 -----
DO0454 MODELED GRAV- 979,426.2 (mgal) NAVD 88
DO0454
DO0454 VERT ORDER - SECOND CLASS 0
DO0454
    
```

## OPUS-DB

- Actively determined from CORS
- Constantly refined
- GPS Surveying
- A lot of numbers/text and some useful graphics/images

SURVEY DATASHEET (Version 1.0) [http://www.ngs.noaa.gov/CORS-Proxy/OPUS\\_old/getDatasheet.jsp?PL...](http://www.ngs.noaa.gov/CORS-Proxy/OPUS_old/getDatasheet.jsp?PL...)

### SURVEY DATASHEET (Version 1.0)

**PID:** DO0454  
**Designation:** C 281  
**Shipping:** C 281 1994  
**Stability:** Most visible; 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 [2006-02-22](#)  
**Source:** OPUS - page 5 0810.20



**C 281, DO0454, 1, 28SEP2006**  
Close-up View

<b>REF FRAME:</b> NAD 83(CORS96)	<b>EPOCH:</b> 2002.0000	<b>SOURCE:</b> NAVD88 (Computed using GEBCO)	<b>UNIT:</b> m	<b>SET PROFILE:</b>	<b>DETAILS:</b>
<b>LAT:</b> 33° 11' 10.75167" ± 0.010 m <b>LONG:</b> 99° 0' 11.86337" ± 0.016 m		<b>UTM 14 SPC 4202(TXGC)</b> <b>NORTHING:</b> 3671943.370m 2168676.749m <b>EASTING:</b> 400370.894m 543746.220m			
<b>ELL HT:</b> 354.428 ± 0.028 m <b>X:</b> -845419.259 ± 0.014 m <b>Y:</b> -5276185.517 ± 0.020 m <b>Z:</b> 3471465.389 ± 0.023 m <b>ORTHO HT:</b> 383.464 ± 0.070 m		<b>CONVERGENCE:</b> -0.05654024° -0.32603401" <b>POINT SCALE:</b> 0.999960114 0.99987537 <b>COMBINED FACTOR:</b> 0.99954332 0.99981974			

**CONTRIBUTED BY**

[dsurvey](#)  
 [Gerald Buecker, Inc./Texas](#)



**C 281, DO0454, 1, 28SEP2006**  
Horizon View



Map data ©2011 Google

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

# 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

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



**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

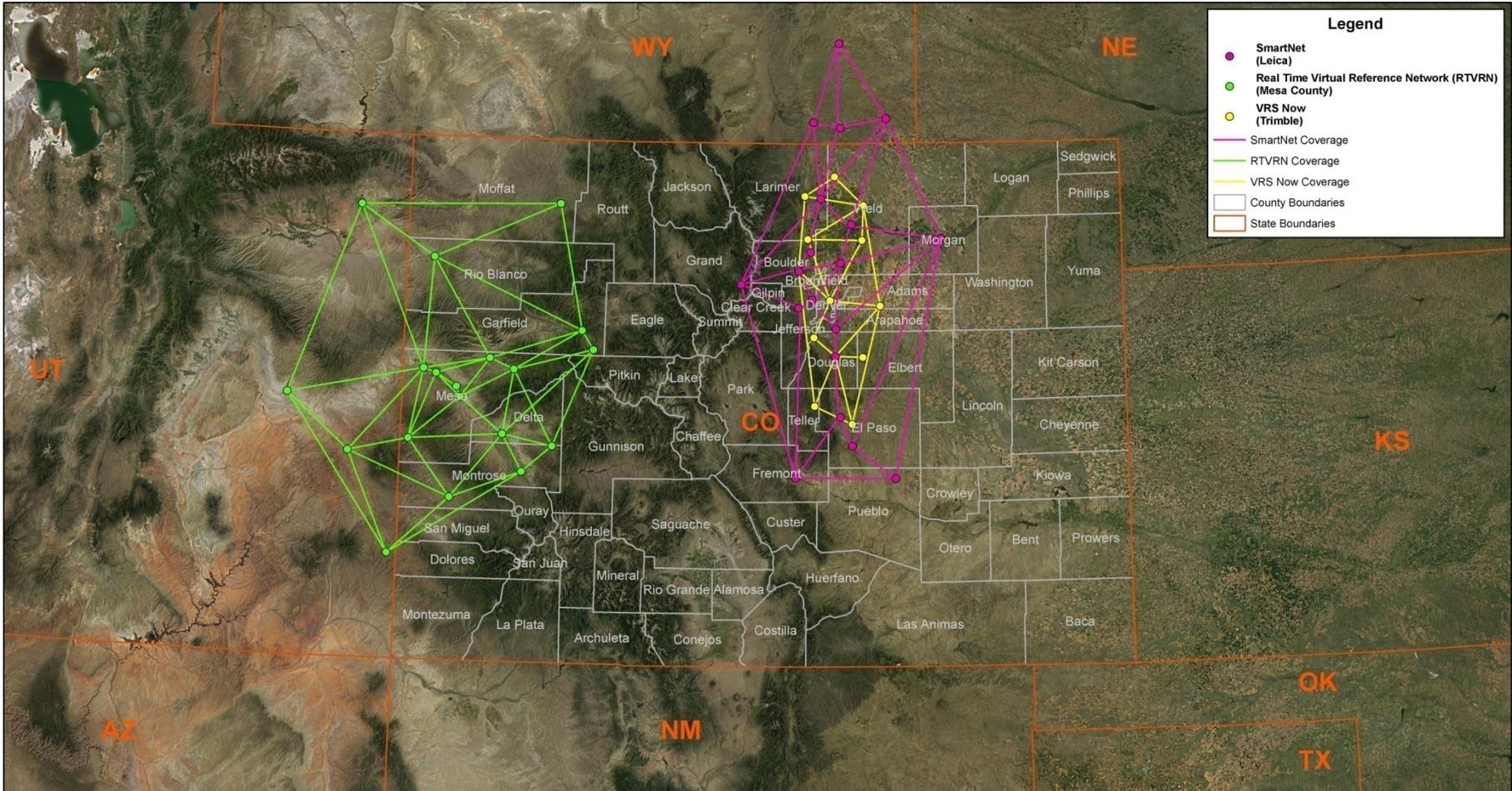
Internet 100% 10:45 AM



# Real Time Global Navigation Satellite System (GNSS) Reference Networks for the State of Colorado

Map Units: Meters  
Coordinate System: NAD 83, UTM Zone 13N

Kilometers



# NGS 10-Year Plan (excerpts)

## Vision 1# Summary:

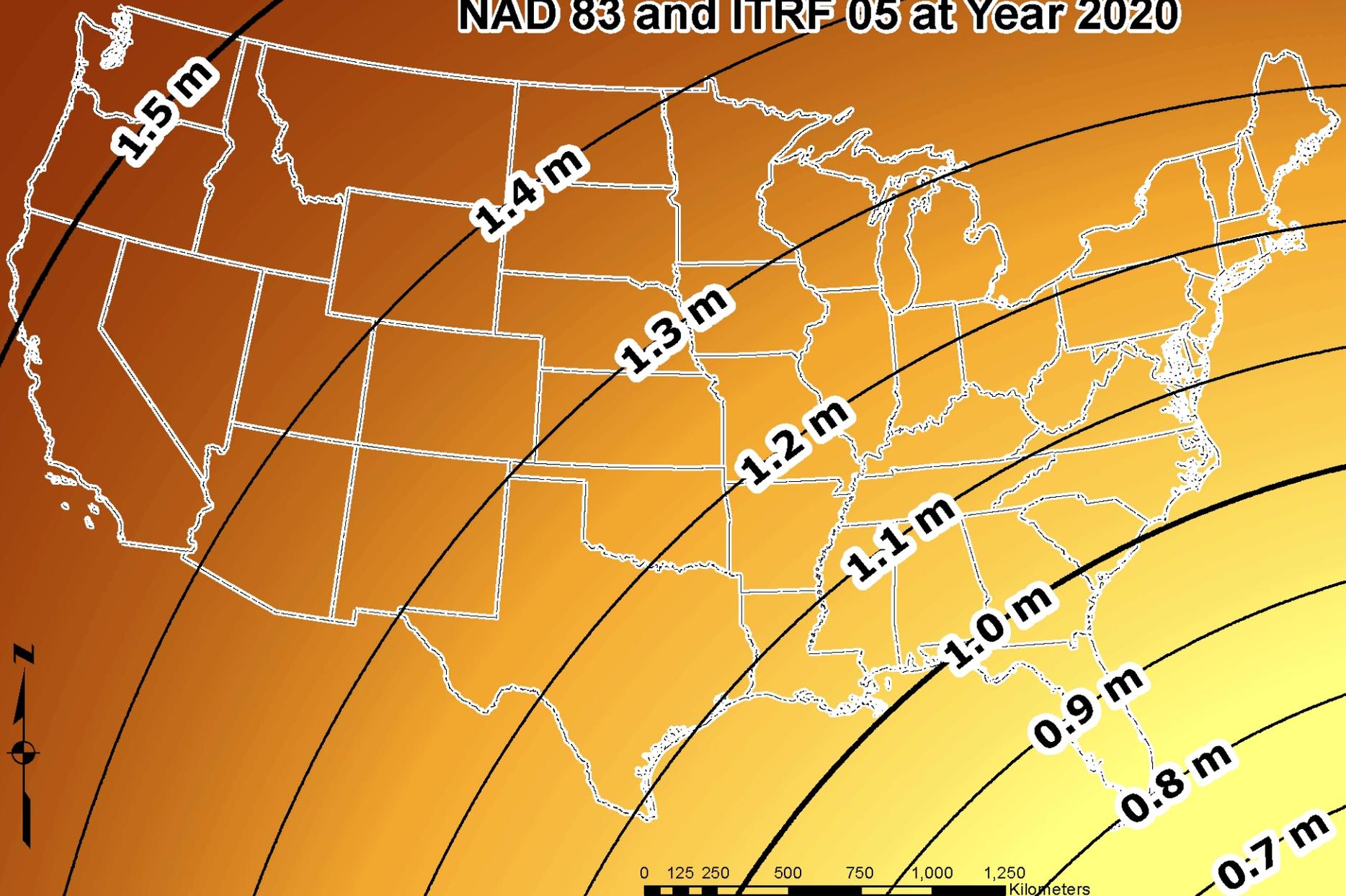
By 2020?, NGS has defined a **new geometric datum** (classically called “horizontal”) **to replace NAD 83** with its many systematic errors. The primary means of accessing this new datum is GNSS technology.

## Vision #2 Summary:

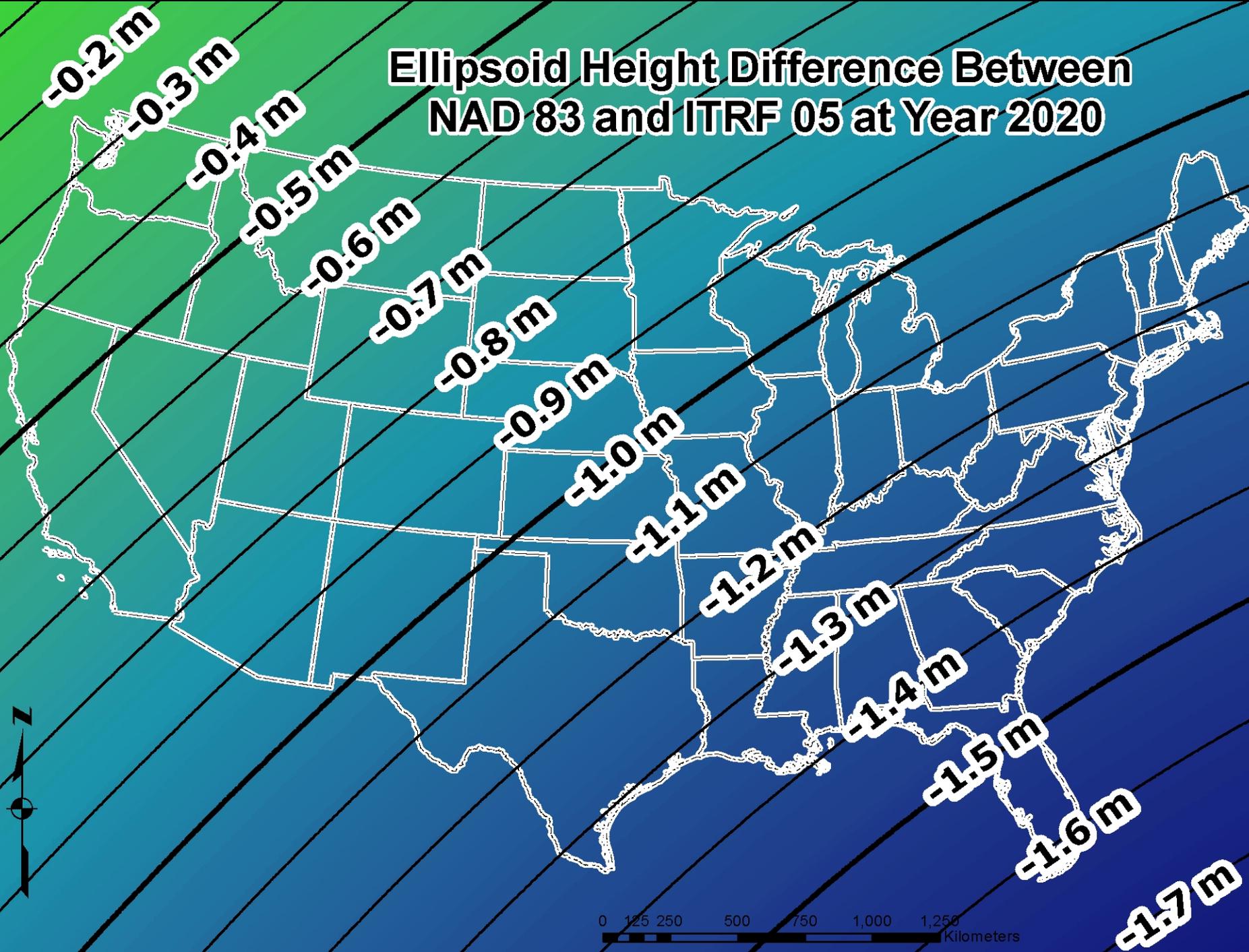
By 2020?, a new **geopotential datum** (for orthometric and dynamic heights) is defined and realized through the combination of **GNSS technology and gravity field modeling.**

Note: Vision #2 can not happen without Vision #1.

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



# Ellipsoid Height Difference Between NAD 83 and ITRF 05 at Year 2020



0 125 250 500 750 1,000 1,250 Kilometers

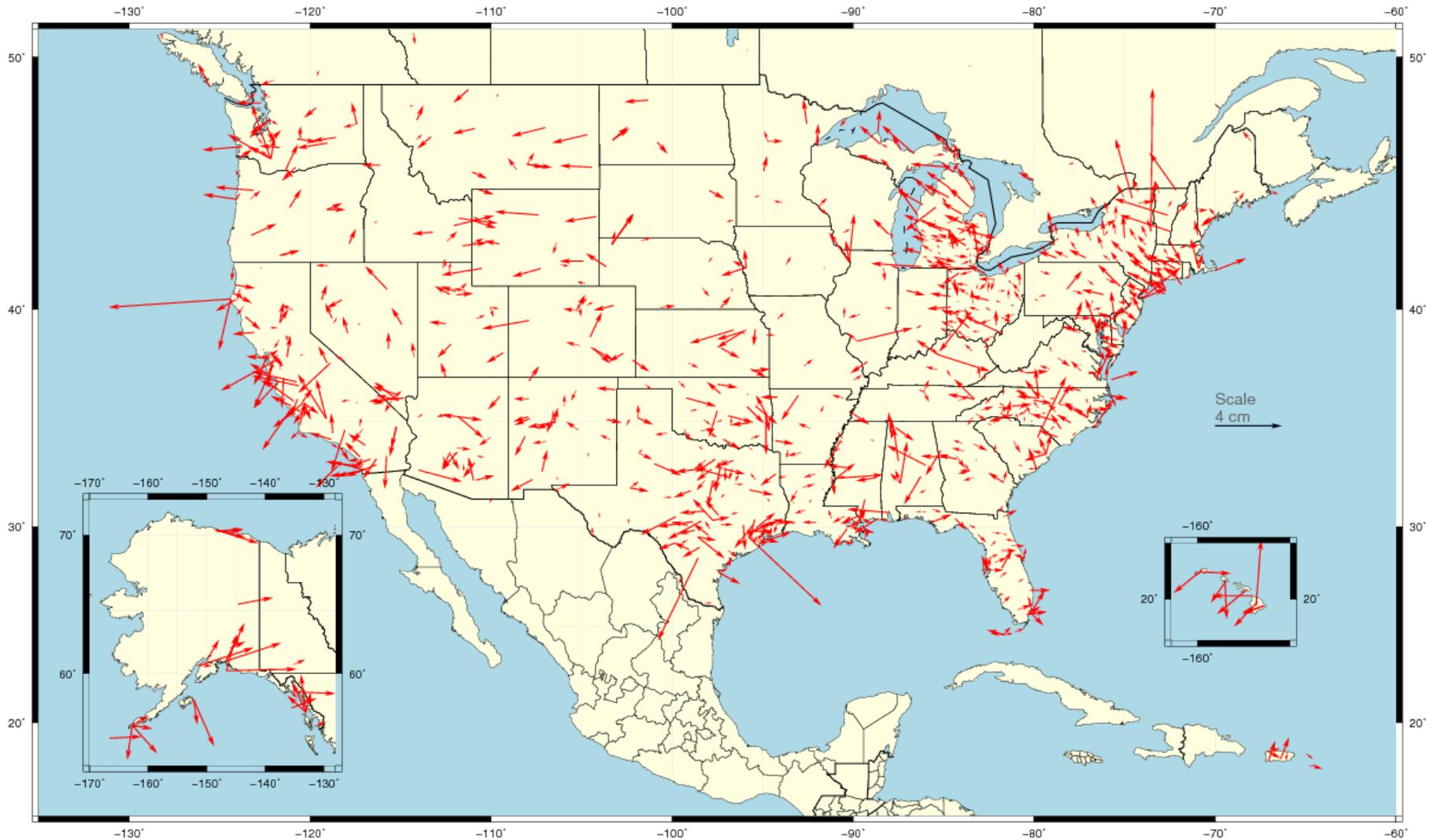
# Introducing...

## NAD 83(2011) epoch 2010.00

- **Multi-Year CORS Solution (MYCS)**
  - Reprocessed all CORS GPS data Jan 1994-Apr 2011
  - 2264 CORS & global stations
- **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
- **Realization SAME for CORS and passive marks**
- **This is *NOT* a new datum! (still NAD 83)**

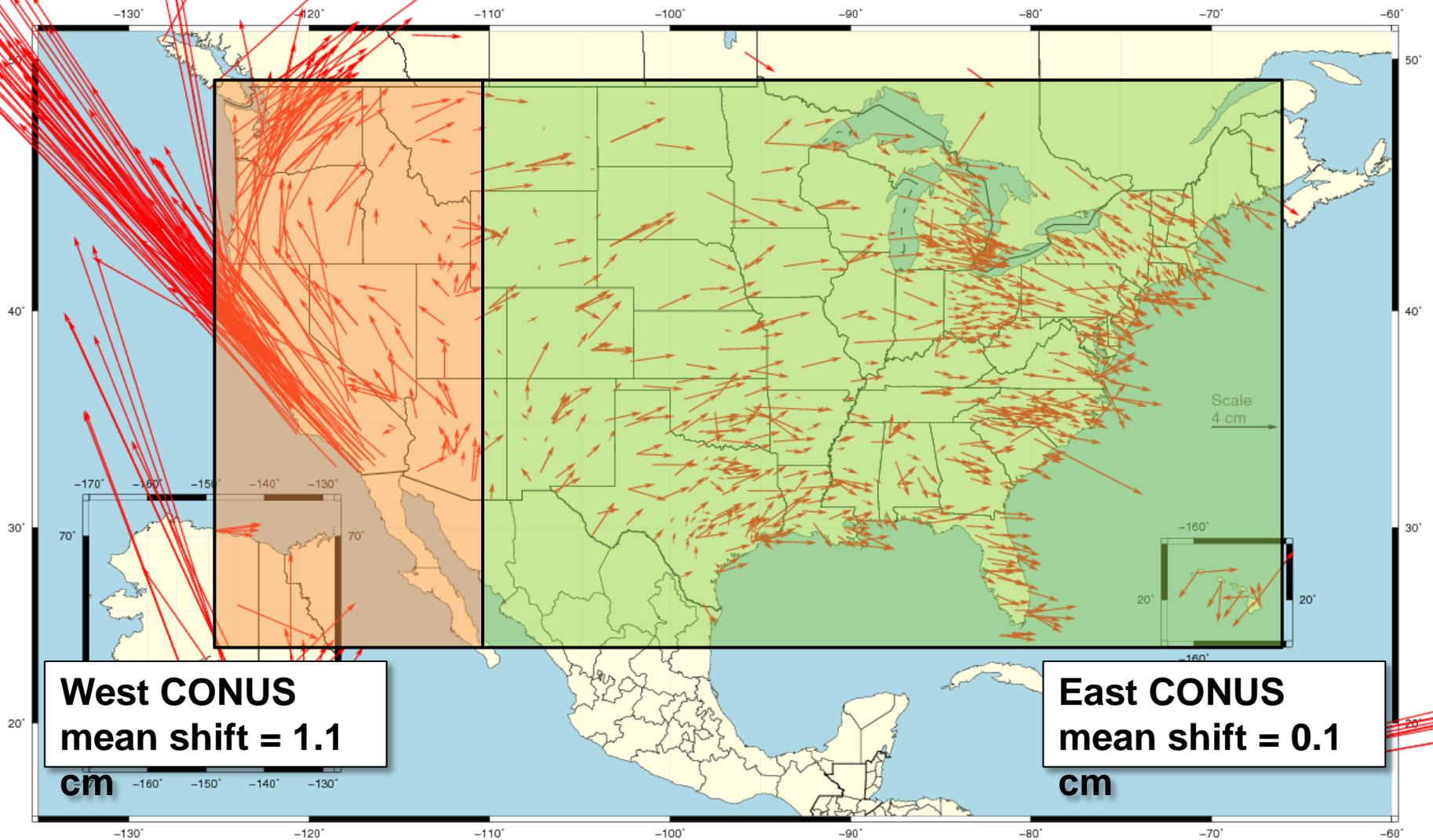


Horizontal Differences [ NAD 83(2011) epoch 2002.0 – NAD 83(CORS96) epoch 2002.0 ]



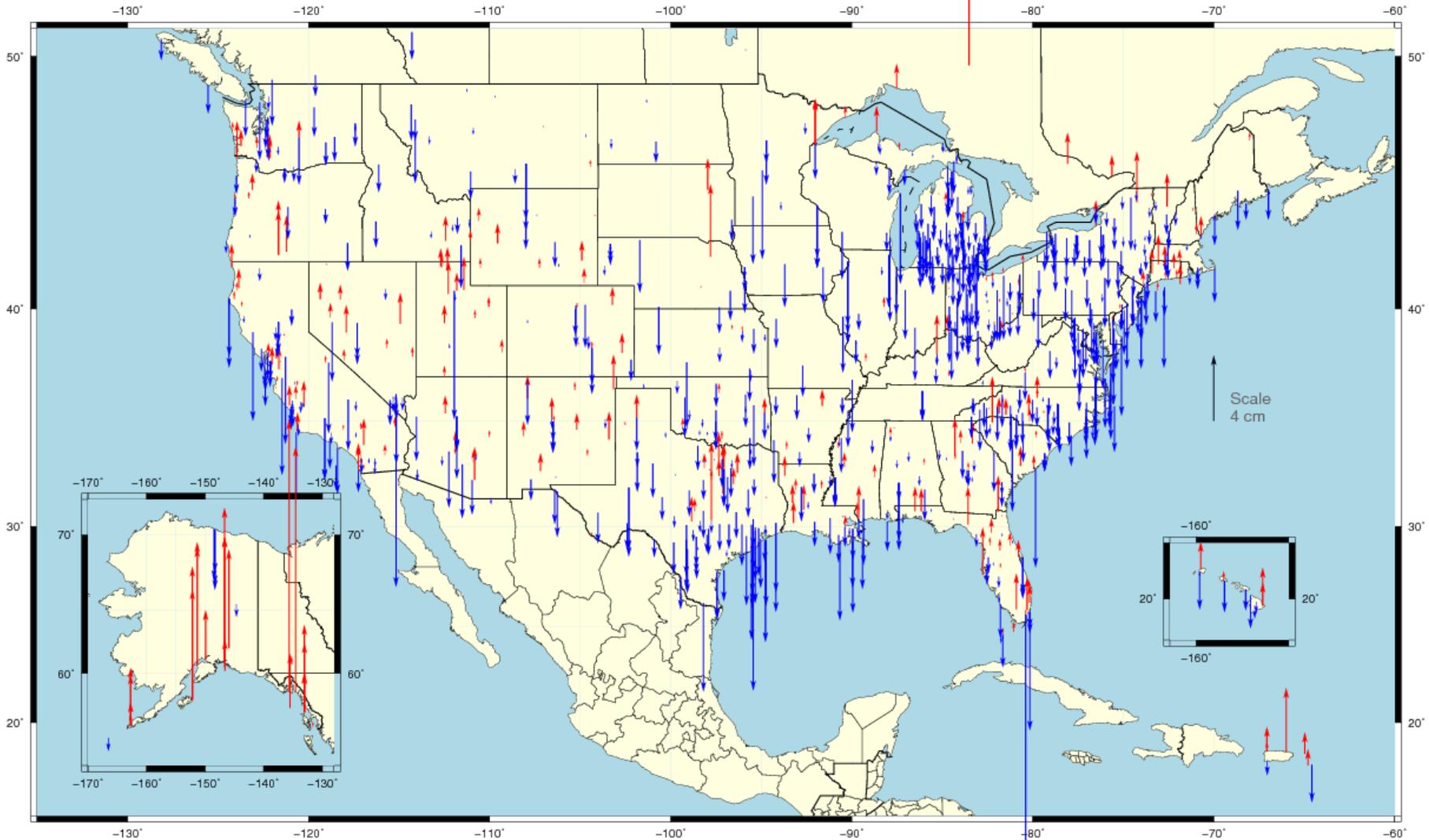
**Mean horizontal shift = 0.2 cm ( 2 cm ) at epoch 2002.0**

Horizontal Differences [ NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0 ]



Mean horizontal shift = 2.0 cm ( 8 cm) from 2002.0 → 2010.0

Vertical Differences [ NAD 83(2011) epoch 2010.0 – NAD 83(CORS96) epoch 2002.0 ]



**Mean vertical shift = -0.8 cm ( 2 cm) from 2002.0→2010.0**

**Mean vertical shift = +0.7 cm ( 2 cm) at epoch 2002.0**

# NGS Training Center



Webinars!

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

# *More information...*

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

**[geodesy.noaa.gov](http://www.geodesy.noaa.gov)**

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

CORS newsletter

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

Find Your Advisor:

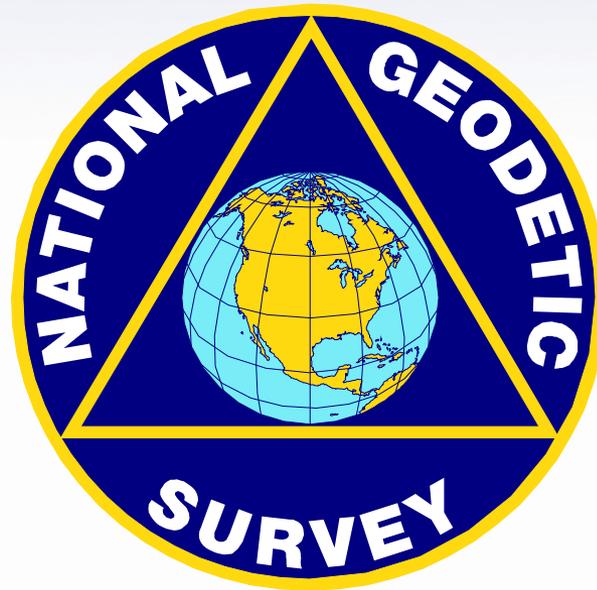
[www.ngs.noaa.gov/ADVISORS/AdvisorsIndex.shtml](http://www.ngs.noaa.gov/ADVISORS/AdvisorsIndex.shtml)

This presentation will be uploaded to:

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FAQs on the various webpages

# GOOD COORDINATION BEGINS WITH GOOD COORDINATES



**GEOGRAPHY WITHOUT GEODESY IS A FELONY**

# Questions



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