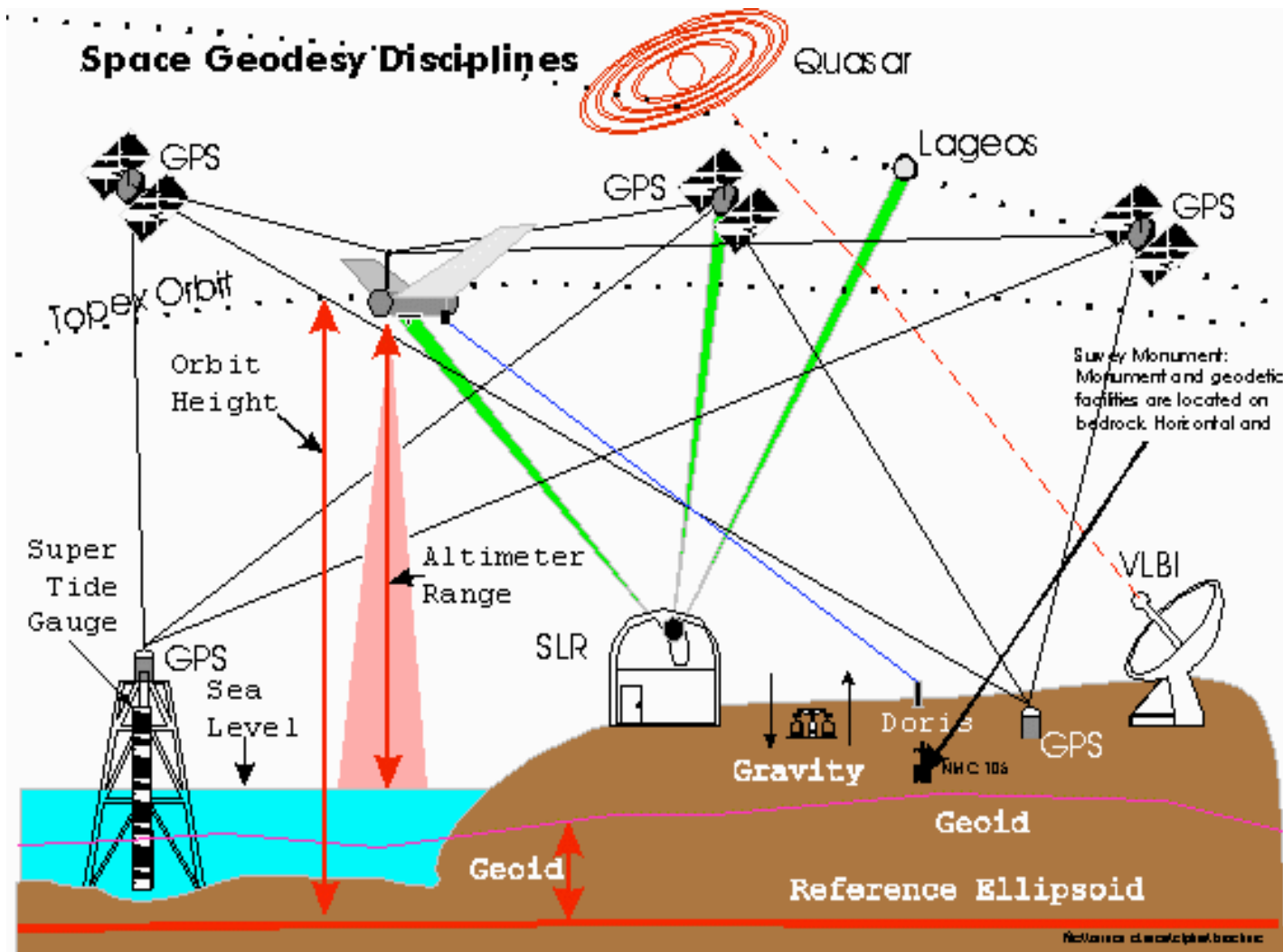


Lecture 15 – Geodetic Datums



23 February 2010
GISC3325

Significant dates

- 15-19 March 2010 is Spring Break
- 4 March 2010 is Exam Two
 - Emphasizing chapters 5, 6 and 8 of text as well as all lectures and labs.
- Remember to start on the Article Review Assignment!
- Web reference for today's lecture:
 - http://www.ngs.noaa.gov/PUBS_LIBTRNOS88NGS19.pdf

Assigned outside reading

- Articles covering the two tools listed below. Material shall appear on the next exam.
- NADCON - North American Datum Conversion
- VERTCON - Vertical Datum Conversion
 - http://www.ngs.noaa.gov/TOOLS/Professional_Surveyor_Articles/

Geodetic Datums

- A set of constants specifying the coordinate system used for geodetic control, i.e., for calculating the coordinates of points on the Earth.
- The datum, as defined in (1), together with the coordinate system and the set of all points and lines whose coordinates, lengths, and directions have been determined by measurement or calculation.
 - From NGS Geodetic Glossary (a link to this document is on the class web page).

Horizontal, Vertical and 3-D Datums

- Before GPS work horizontal and vertical datums were accomplished and maintained separately.
- Horizontal surveys provided a framework of latitudes and longitudes attached to a reference ellipsoid.
- Vertical surveys provided a framework of heights with respect to a height reference.
- GPS changed the way geodesy works.

Horizontal networks

- North American Datum of 1927 (NAD 27)
 - Official datum until 1986
 - Based on the Clarke Spheroid of 1866 ellipsoid.
- North American Datum of 1983 (NAD 83)
 - Modified a number of times.
 - First version NAD 83 (1986) did NOT include GPS
 - Uses Geodetic Reference System of 1980 (GRS 80) reference ellipsoid.

Horizontal Datums Used in the United States

BESSEL 1841 -----

LOCAL ASTRO DATUMS (1816-1879)

NEW ENGLAND DATUM (1879-1901)
U.S. STANDARD DATUM (1901-1913)
NORTH AMERICAN DATUM (1913-1927)
NORTH AMERICAN DATUM OF 1927
OLD HAWAIIAN DATUM

CLARKE 1866

PUERTO RICO DATUM

ST. GEORGE ISLAND - ALASKA
ST. LAWRENCE ISLAND - ALASKA
ST. PAUL ISLAND - ALASKA
AMERICAN SAMOA 1962
GUAM 1963

GRS80 -----

NORTH AMERICAN DATUM OF 1983
(As of June 14, 1989)

NAD 27 Characteristics

- Consisted of about 25,000 horizontal control stations.
- It is an adjustment of a network, US Standard Datum, that had been expanded in piecemeal fashion from a much smaller network.
- Triangulation station MEADES RANCH was chosen as initial point with azimuth to station WALDO .
 - Its position was fixed to its astronomic latitude and longitude. Therefore the geoid was coincident with the point.

COMPARISON OF DATUM ELEMENTS

NAD 27

NAD 83

ELLIPSOID

CLARKE 1866

$a = 6,378,206.4 \text{ m}$

$1/f = 294.9786982$

GRS80

$a = 6,378,137. \text{ M}$

$1/f = 298.257222101$

DATUM POINT

Triangulation Station
MEADES RANCH, KANSAS

NONE
EARTH MASS CENTER

ADJUSTMENT

25k STATIONS
Several Hundred Base Lines
Several Hundred Astro Azimuths

250k STATIONS
Approx. 30k EDM Base Lines
5k Astro Azimuths
Doppler Point Positions
VLBI Vectors

BEST FITTING

North America

World-Wide

NAD 27

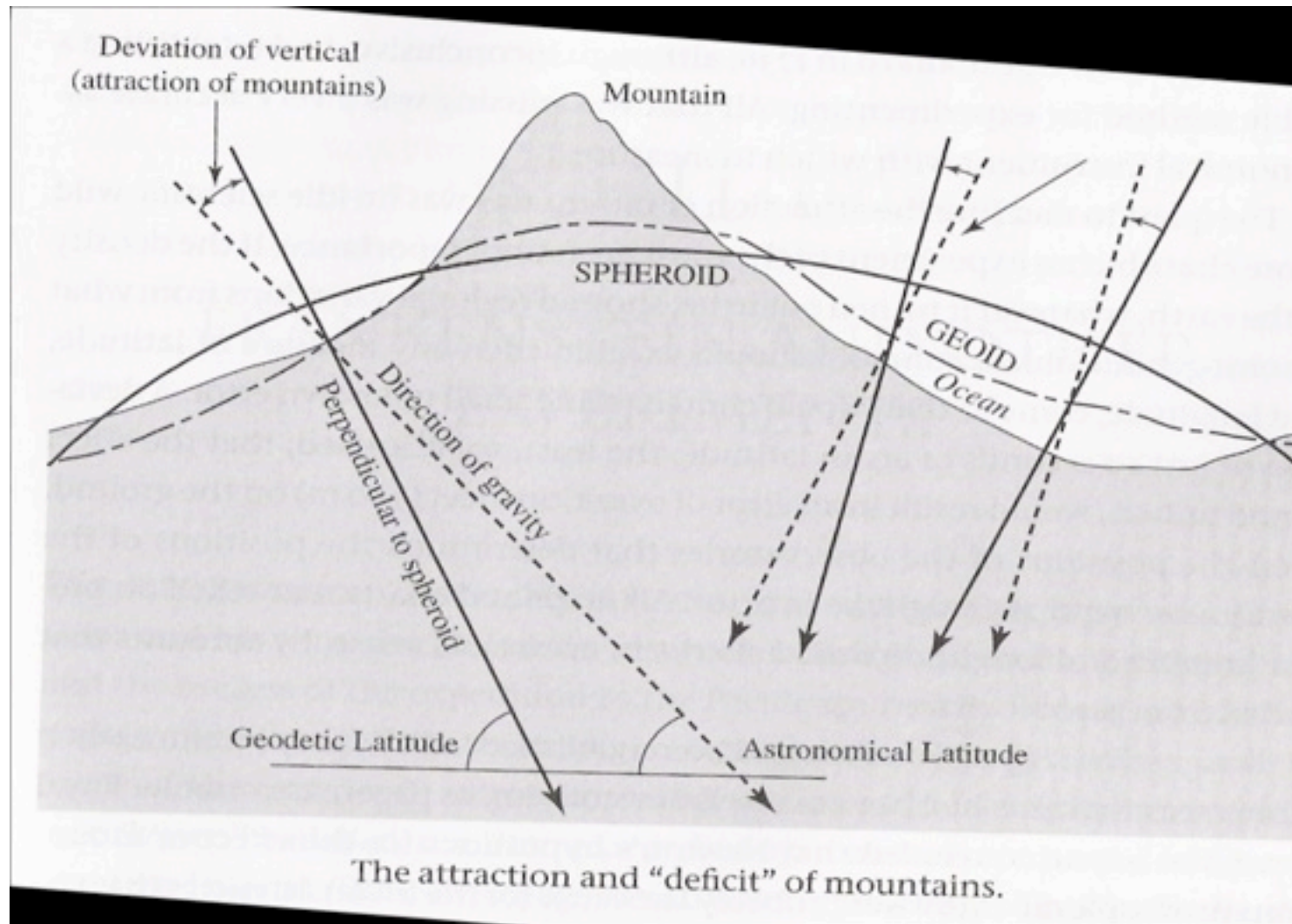




NAD 27 a regional datum

- Regional datum must include these elements:
 - Semi-major axis
 - Semi-minor axis
 - Deflection of vertical in meridian and in the vertical at the initial point
 - Geodetic azimuth from initial point
 - The ellipsoid minor axis and earth's rotation axis must be parallel.

Deflection of the vertical





<http://www.swisstek.com>

Output from DEFLEC99

	latitude	longitude	Xi	Eta	Hor Lap
Station Name	ddd mm ss.sssss	ddd mm ss.sssss	arc-sec	arc-sec	arc-sec
USER LOCATION	27 42 52.08911	97 19 44.31383	4.61	-1.63	0.86

Output from DEFLEC09

	latitude	longitude	Xi	Eta	Hor Lap
Station Name	ddd mm ss.sssss	ddd mm ss.sssss	arc-sec	arc-sec	arc-sec
USER LOCATION	27 42 52.08911	97 19 44.31383	4.09	-1.25	0.66

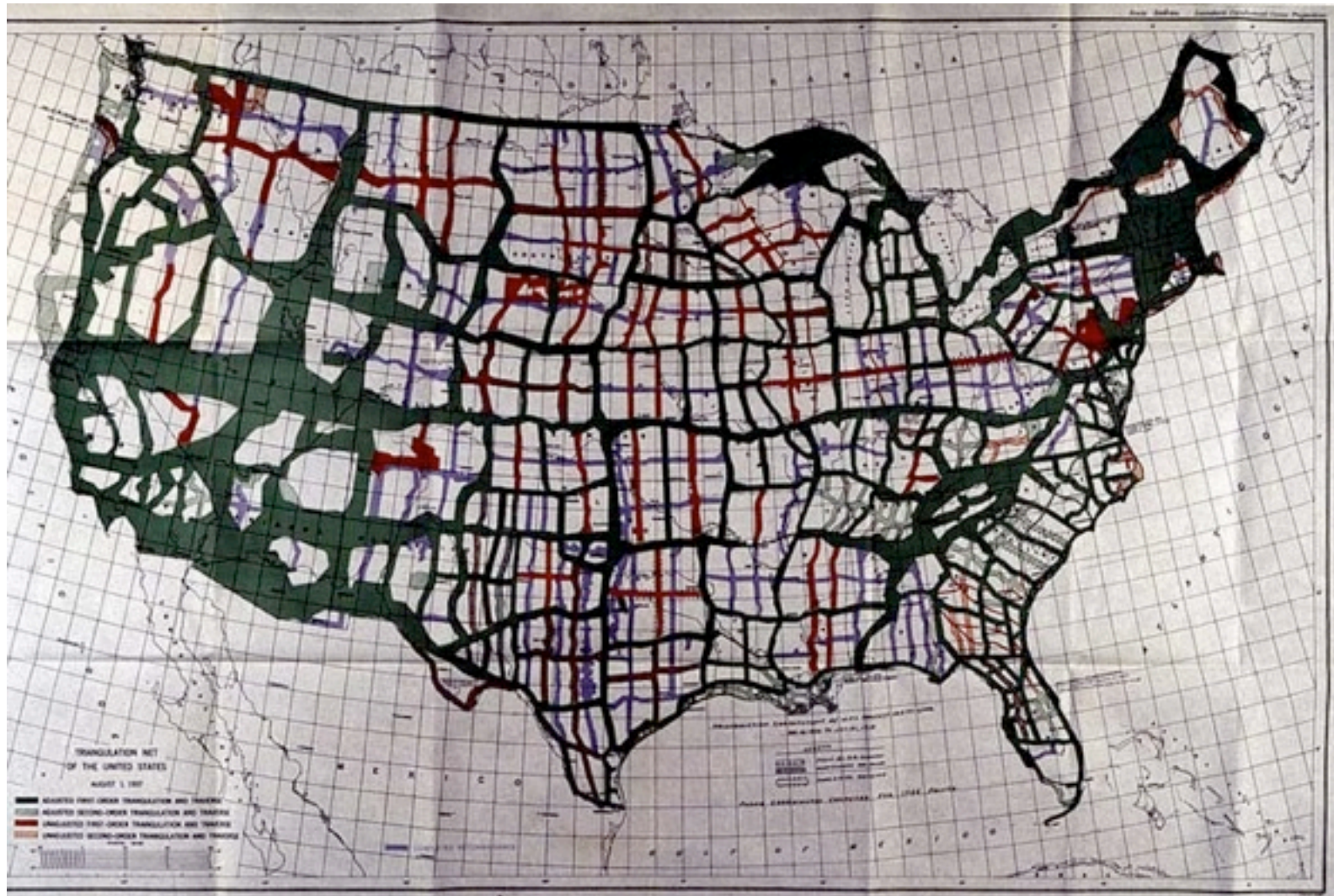
Additional details

- Choice of MEADES RANCH based on an analysis of the minimization of sum of squares of differences between astronomic and geodetic azimuths.
- Clarke 1966 reference ellipsoid was oriented through use of Laplace stations.
 - They are points where astronomic latitude, longitude and azimuth are known.
 - Deflections and geoid height at initial point were intended to be zero.

Pre-GPS Surveying



NAD 27 network



NAD 27 deficiencies

- Despite intent, the components of the deflection of the vertical at MEADES RANCH were not zero.
 - Initial assumptions about initial point map to network.
 - As network attached to initial point deflections are relative (NOT GLOBAL).
- Adjustment was NOT simultaneous least squares.
- No geoid model.

More problems ...

- NAD 27 designed to provide relative precision of 1:25,000.
 - Insufficient number of baselines
- Work after 1927 was attached to the existing network.
- New work was better than the network could support.

Degradation of results when constraining to NAD 27 control points.

- Deflections are used to relate the orientation of a locally-leveled instrument to a spatial reference system.
 - Used to correct zenith distance (vertical angle) measurements, and to convert between astronomic and ellipsoidal azimuths (the Laplace correction).
- Both N-S (Meridian component), " ξ " and E-W components (Prime Vertical component, " η ")
- ξ and η are the differences between astronomic and geodetic latitude/longitude respectively.

BC-4 Camera Program

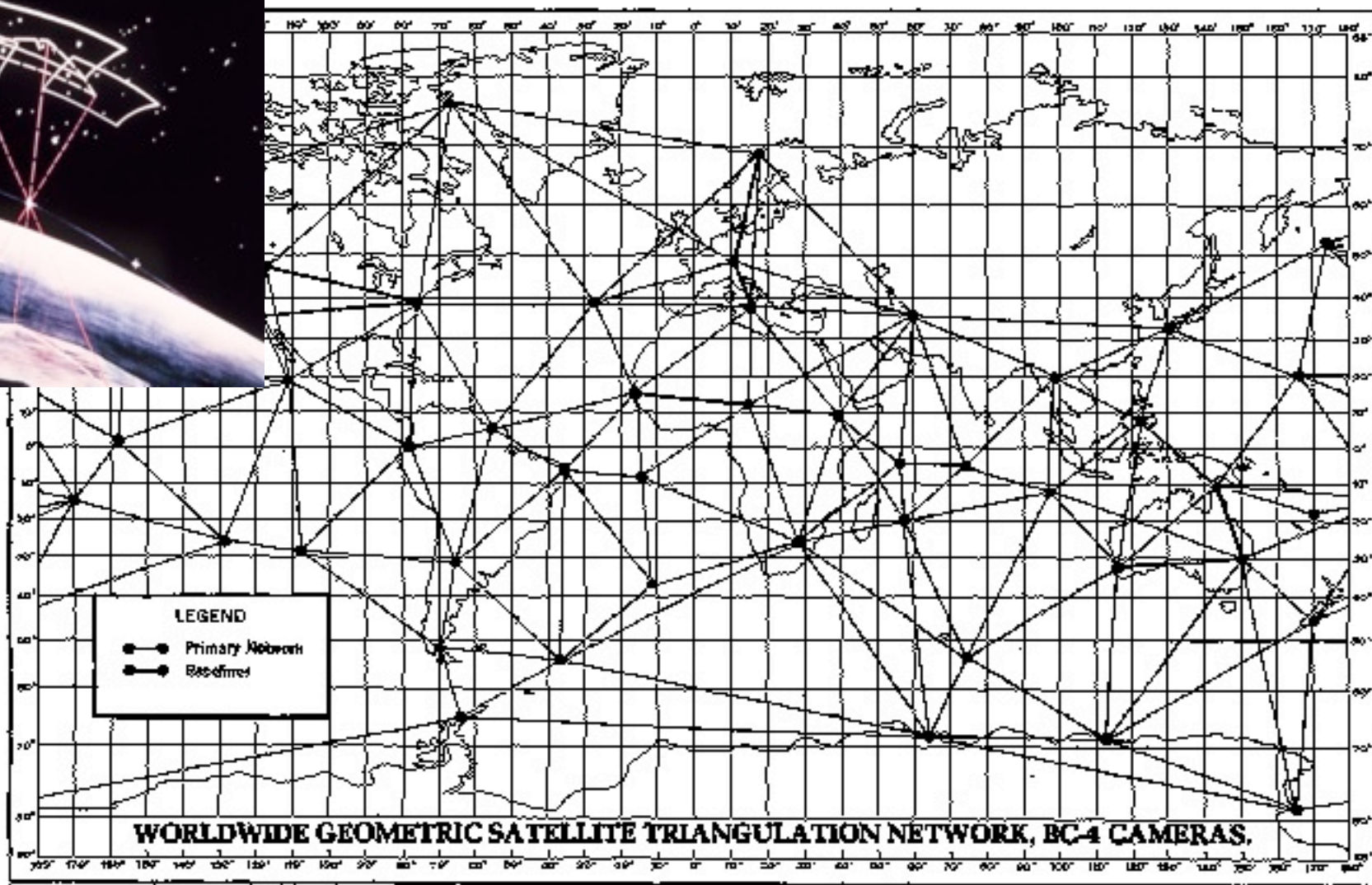
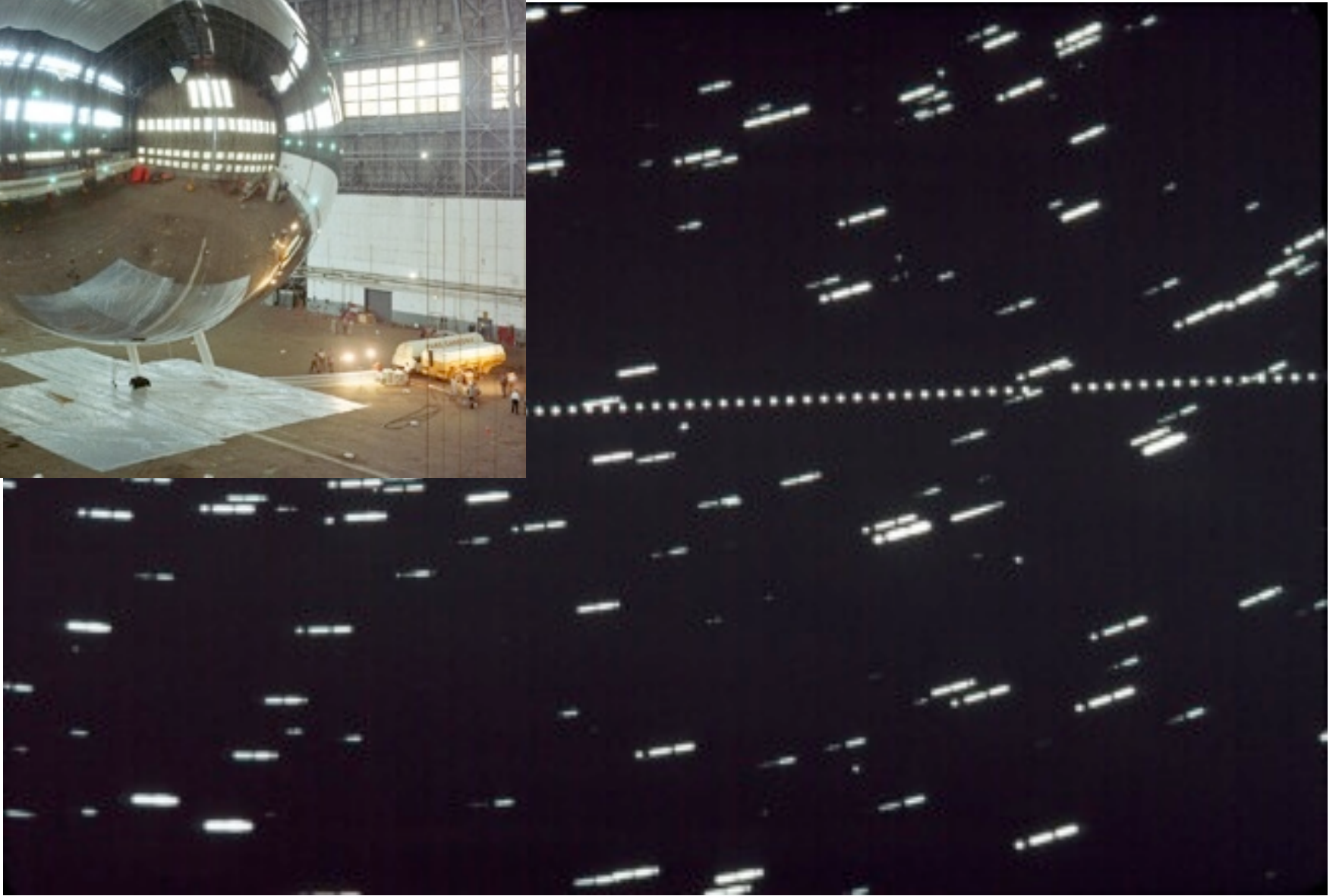
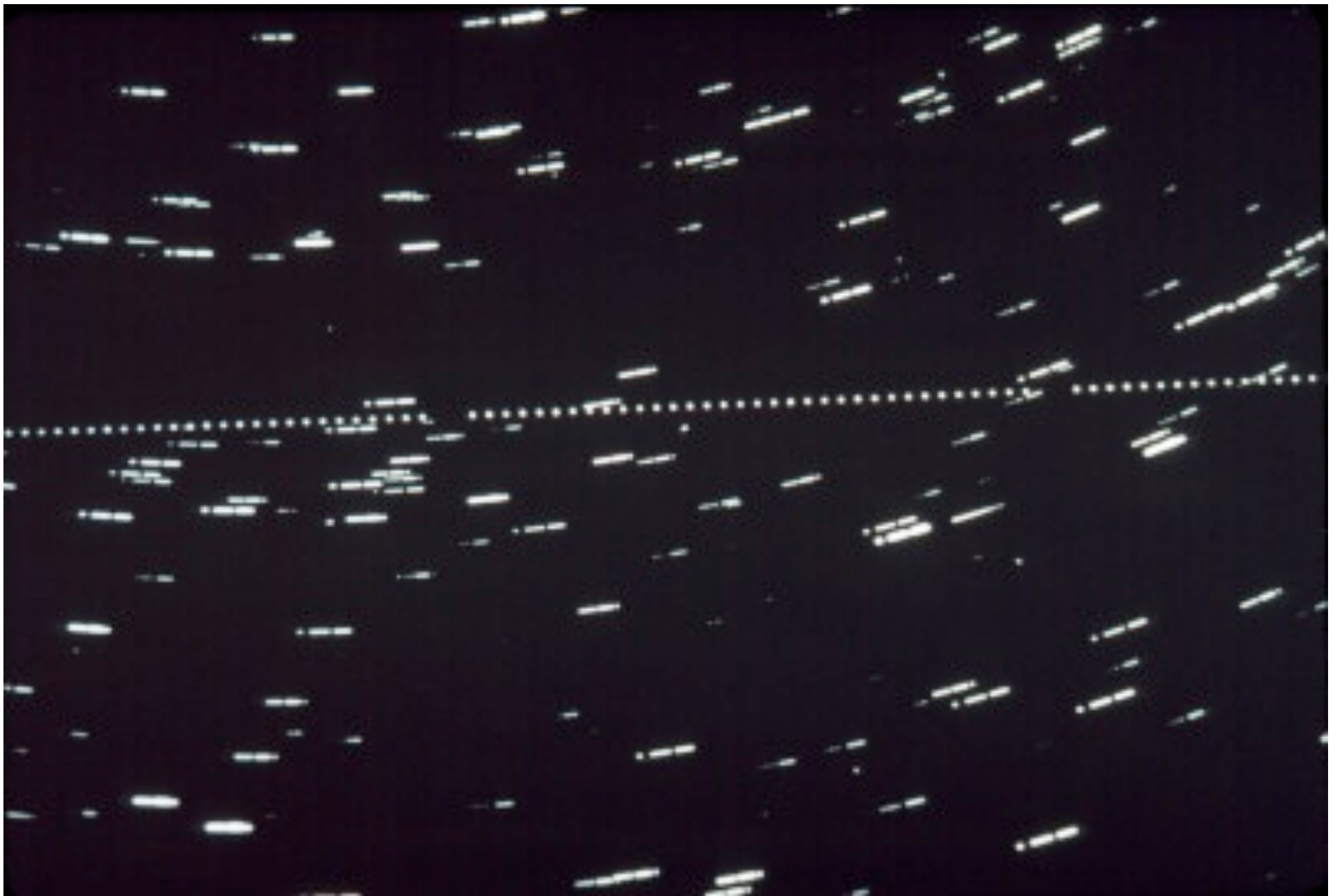


Figure 39



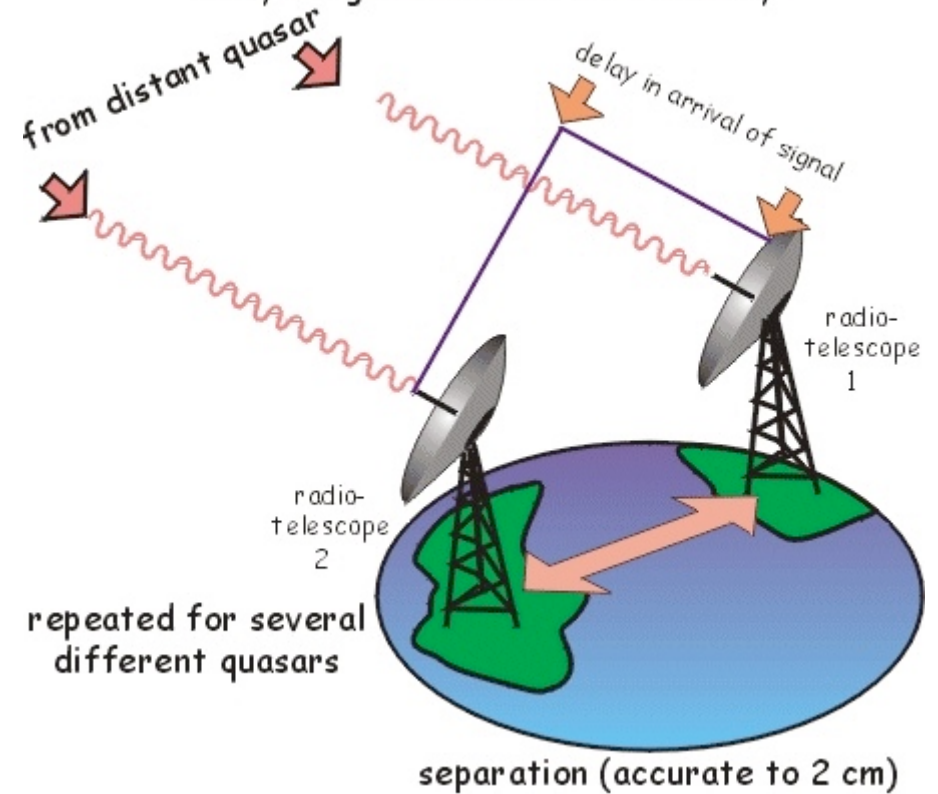
**BC-4 camera photograph
stars in circular pattern
satellite is a series of dots in straight line.**



**BC-4 camera photograph
stars in circular pattern
satellite is a series of dots in straight line.**



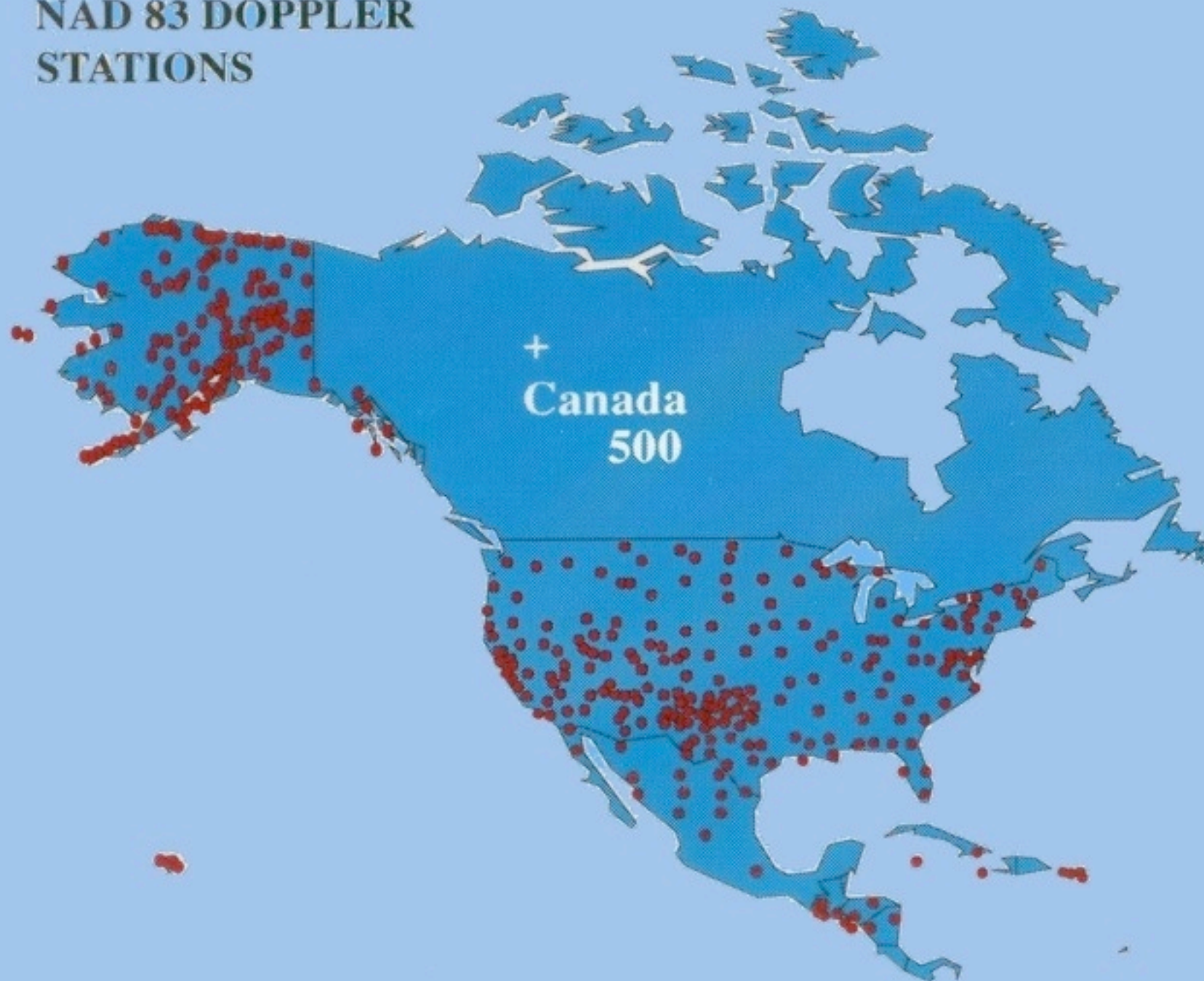
Very Long Baseline Interferometry



NAD 83 VLBI STATIONS



NAD 83 DOPPLER STATIONS



What is to be done?

NOAA
Professional Paper NOS 2



NORTH AMERICAN DATUM OF 1983

Charles R. Schwarz
Editor

National Geodetic Survey
Rockville, MD 20852
December 1989



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

NGS NAD83 Adjustment Team



Versions of NAD 83

- First implementation labeled NAD 83 (1986).
- Deficiencies in this version were discovered resulting in a state-by-state campaign to provide more accurate networks.
 - High Accuracy Reference Network (HARN)
 - NAD 83 (####) tag given to HARN project adjustment (NOT a new datum)
- Subsequent campaign to re-observe networks to generate good ellipsoid heights.

```

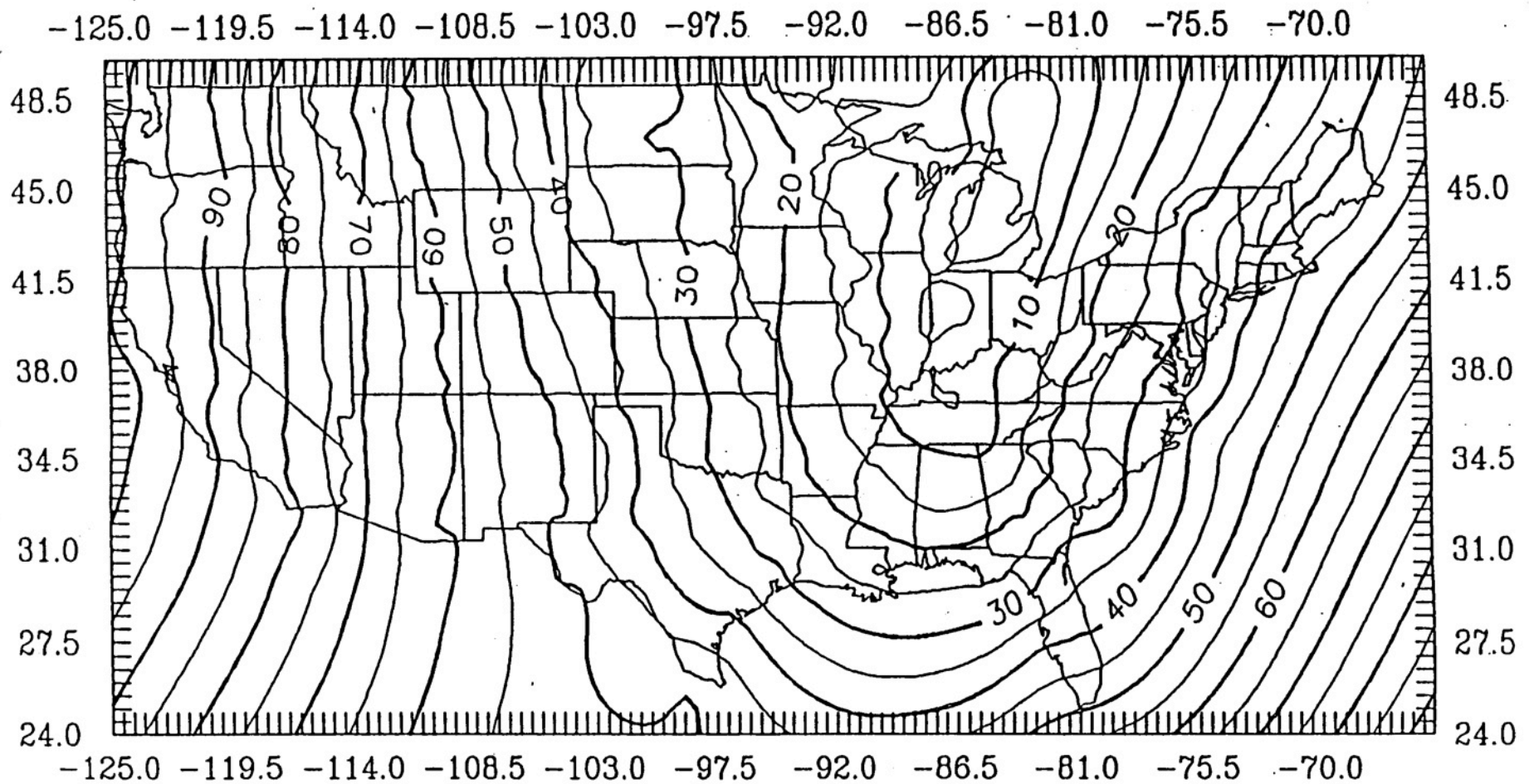
1      National Geodetic Survey,   Retrieval Date = MARCH  4, 2009
AH1671 *****
AH1671 DESIGNATION -   BLUCHER
AH1671 PID          -   AH1671
AH1671 STATE/COUNTY- TX/NUECES
AH1671 USGS QUAD    -   OSO CREEK NE (1975)
AH1671
AH1671                      *CURRENT SURVEY CONTROL
AH1671
AH1671* NAD 83(2007)- 27 42 52.08911(N)    097 19 44.31383(W)    ADJUSTED
AH1671* NAVD 88      -           5.0      (meters)          16.      (feet)    VERTCON
AH1671
AH1671 EPOCH DATE   -           2002.00
AH1671 X            -    -720,811.168 (meters)                COMP
AH1671 Y            -    -5,604,322.019 (meters)                COMP
AH1671 Z            -     2,948,520.461 (meters)                COMP
AH1671 LAPLACE CORR-           0.86 (seconds)                DEFLEC99
AH1671 ELLIP HEIGHT-          -21.385 (meters)                (02/10/07) ADJUSTED
AH1671 GEOID HEIGHT-          -26.21 (meters)                GEOID03
AH1671
AH1671 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AH1671 Type      PID      Designation                      North   East   Ellip
AH1671 -----
AH1671 NETWORK AH1671 BLUCHER                                1.12   0.88   3.29
AH1671 -----

AH1671
AH1671                      SUPERSEDED SURVEY CONTROL
AH1671
AH1671 ELLIP H (06/17/02) -21.359 (m)                        GP(      ) 5 1
AH1671 NAD 83(1993)- 27 42 52.08857(N)    097 19 44.31265(W) AD(      ) 1
AH1671 ELLIP H (02/16/96) -21.228 (m)                        GP(      ) 5 1
AH1671 NAD 83(1986)- 27 42 52.09526(N)    097 19 44.29162(W) AD(      ) 1
AH1671 NGVD 29 (04/09/92)  5.2 (m)                17.      (f) GPS OBS 3

```


NAD 27 and NAD 83

MAGNITUDE OF DATUM SHIFT (METERS)



Results of NAD83(86)

- **Network Accuracy - 1 Meter**
- **Local Accuracy – First-Order
(1 part in 100,000)**



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NAD 83(86) NETWORK PROBLEMS

Not “GPSABLE”

POOR STATION ACCESSIBILITY

IRREGULARLY SPACED

POSITIONAL ACCURACY



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NATIONAL GEODETIC SURVEY



National Oceanic and Atmospheric Administration

HIGH PRECISION GPS NETWORKS

“GPSABLE”

Clear Horizons for Satellite Signal Acquisition

EASY ACCESSIBILITY

Few Special Vehicle or Property Entrance Requirements

REGULARLY SPACED

Always within 20-100 Km

HIGH HORIZONTAL ACCURACY

A-Order (5 mm + 1:10,000,000)

B-Order (8mm + 1:1,000,000)



National Oceanic and Atmospheric Administration

HARN/HPGN ADJUSTMENT

A-Order Adjusted to VLBI-Existing FBN-CORS

B-Order Adjusted to A-Order

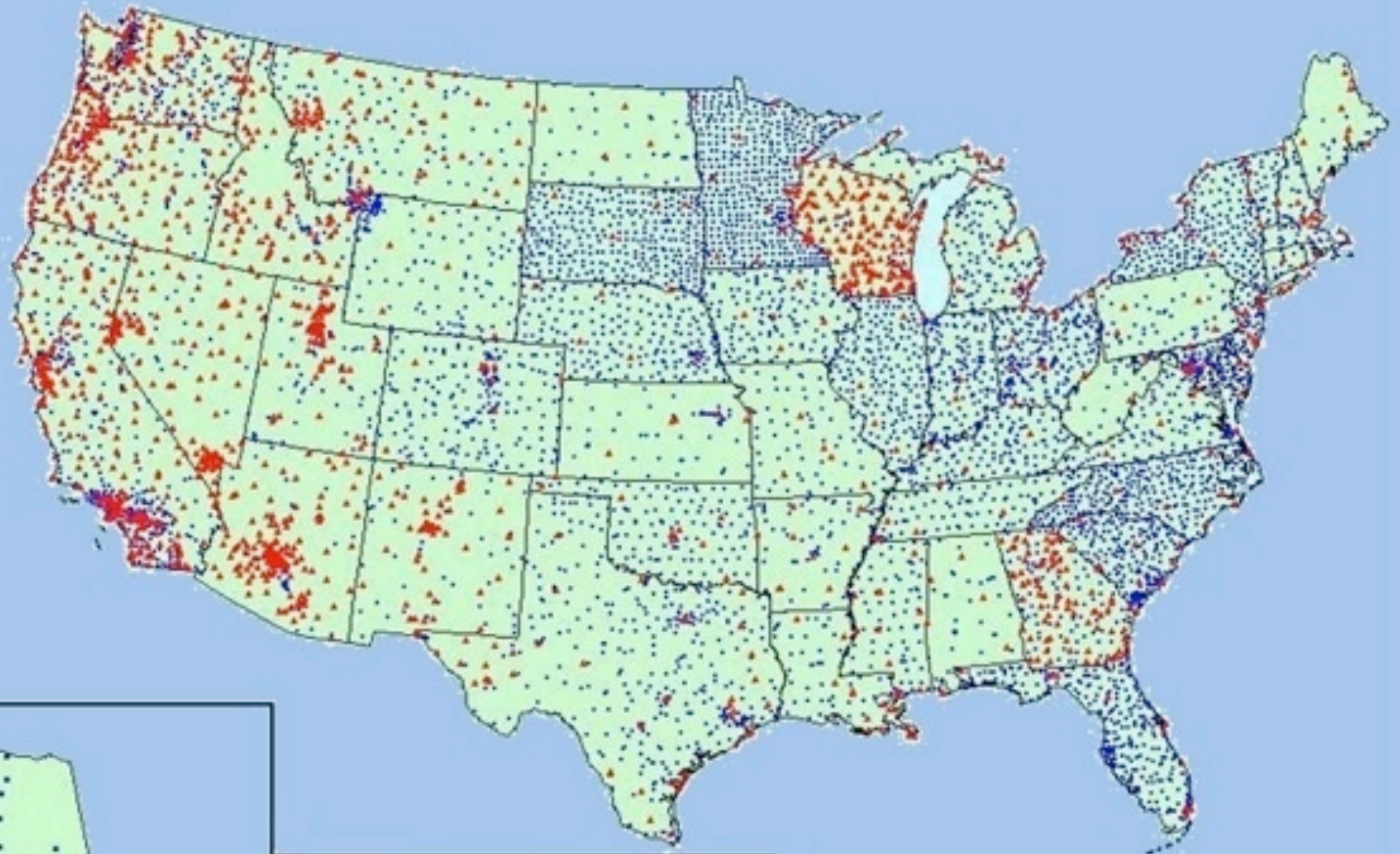
**Existing Horizontal (Conventional & GPS)
Readjusted to A/B-Order**

New Adjustment Date Tag e.g. NAD83(1991.35)



National Oceanic and Atmospheric Administration

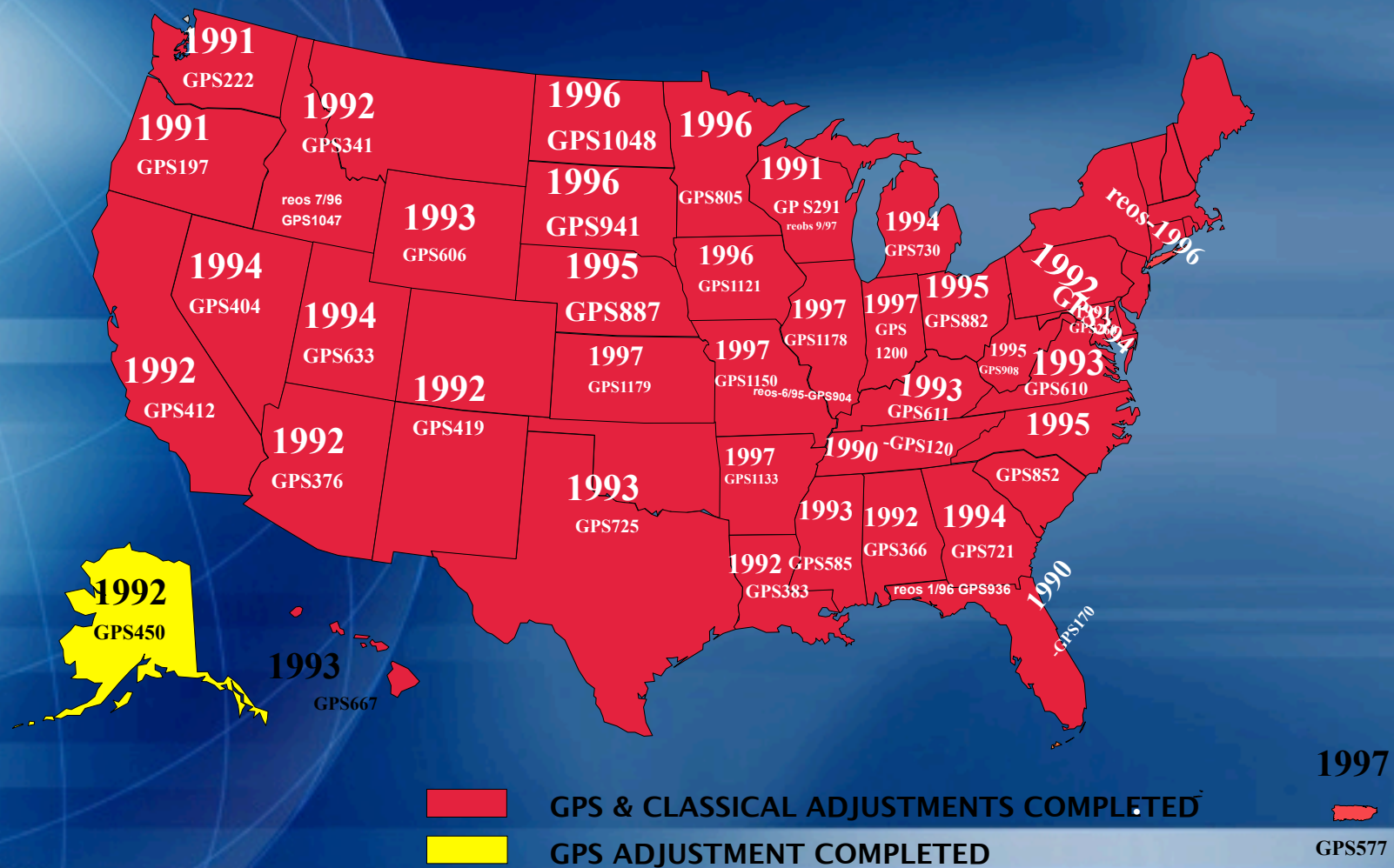
U.S. HARN



- ▲ A-Order Control
- B-Order Control

HPGN/HARN & STATEWIDE NETWORK STATUS

NATIONAL GEODETIC SURVEY



National Oceanic and Atmospheric Administration

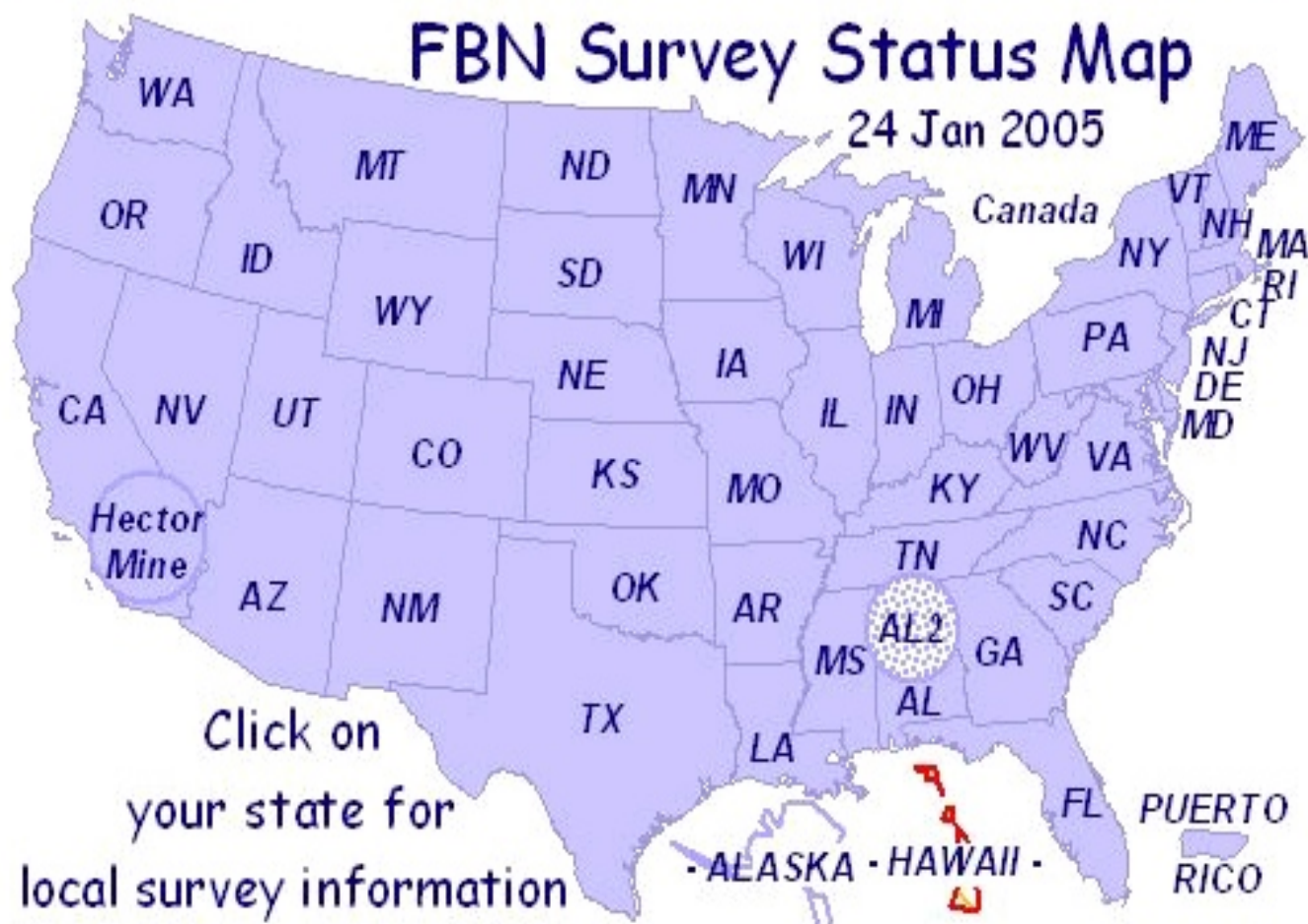
Federal Base Network Surveys



For Project Maps, Schedules,

— Select your state here or click map below —

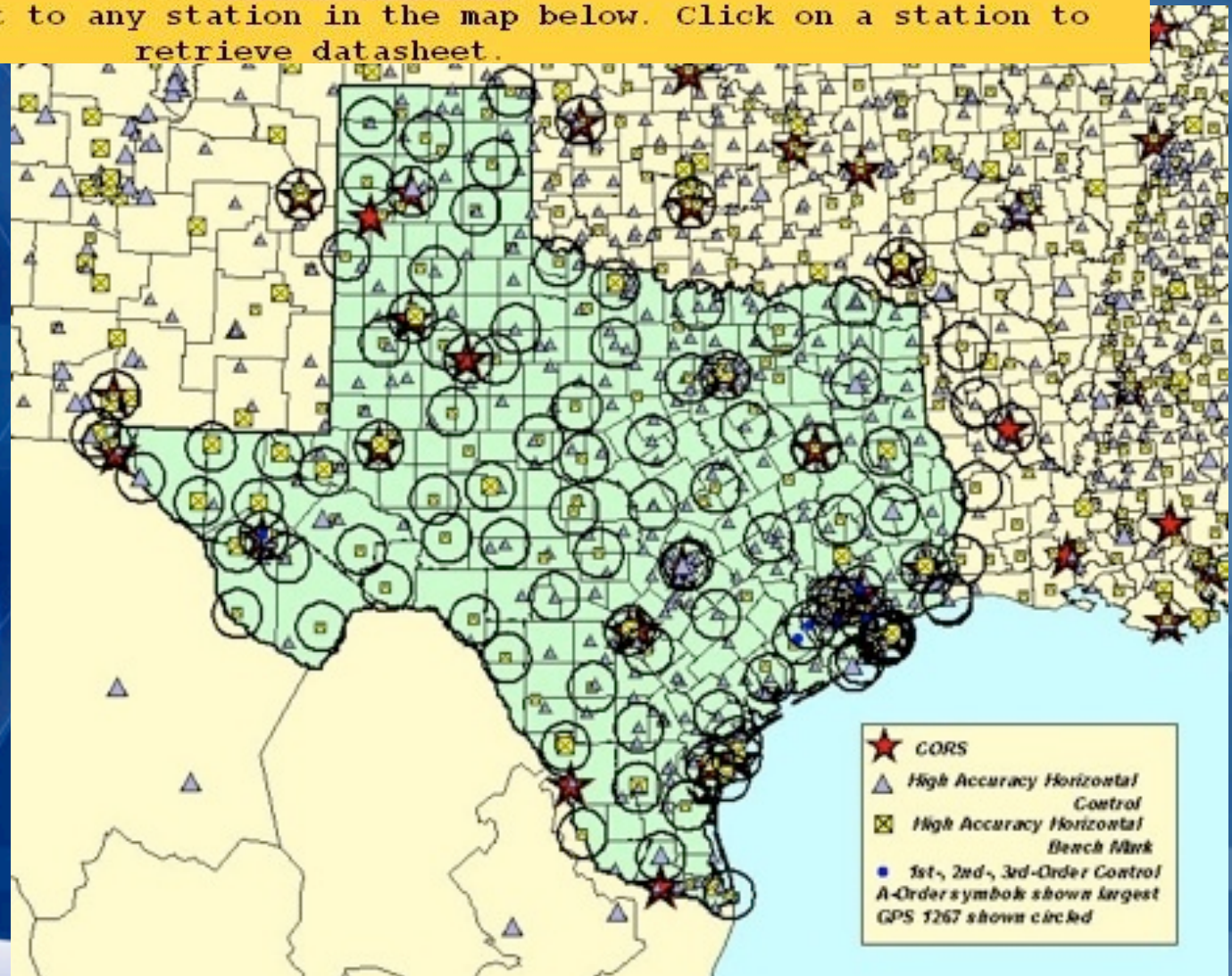
Station Lists, Instructions, etc.



NATIONAL GEODETIC SURVEY

Retrieved from the NGS data base on March 15, 2002, subject to changes. See also [interactive map](#).

Using your mouse, point to any station in the map below. Click on a station to retrieve datasheet.



National Oceanic and Atmospheric Administration

Old Datasheet format

NATIONAL GEODETIC SURVEY

```

DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.49
1      National Geodetic Survey,  Retrieval Date = AUGUST 14, 2007
CS2429 *****
CS2429 FBN          -   This is a Federal Base Network Control Station.
CS2429 DESIGNATION -   ALEDO 3
CS2429 PID          -   CS2429
CS2429 STATE/COUNTY-   TX/PARKER
CS2429 USGS QUAD    -   ALEDO (1981)
CS2429
CS2429                                     *CURRENT SURVEY CONTROL
CS2429
CS2429* NAD 83 (1993)- 32 43 49.16436(N)    097 36 00.31546(W)    ADJUSTED
CS2429* NAVD 88      -          318.869  (meters)    1046.16    (feet)    ADJUSTED
CS2429
CS2429 X              -          -710,350.482  (meters)    COMP
CS2429 Y              -          -5,323,767.124 (meters)    COMP
CS2429 Z              -          3,428,994.855 (meters)    COMP
CS2429 LAPLACE CORR-          3.17  (seconds)    DEFLEC99
CS2429 ELLIP HEIGHT-          290.653 (meters)    (05/01/00) GPS OBS
CS2429 GEOID HEIGHT-          -28.21 (meters)    GEOID03
CS2429 DYNAMIC HT   -          318.483 (meters)    1044.89  (feet)    COMP
CS2429 MODELED GRAV-          979,420.2  (mgal)    NAVD 88
CS2429
CS2429 HORZ ORDER   -   B
CS2429 VERT ORDER   -   FIRST    CLASS II
CS2429 ELLP ORDER   -   THIRD    CLASS I
CS2429
CS2429.The horizontal coordinates were established by GPS observations
CS2429.and adjusted by the National Geodetic Survey in May 1994.
  
```



National Oceanic and Atmospheric Administration

NATIONAL GEODETIC SURVEY

```

DF8986 *****
DF8986  CORS          -   This is a GPS Continuously Operating Reference Station.
DF8986  DESIGNATION -   DENTON CORS ARP
DF8986  CORS_ID      -   TXDE
DF8986  PID           -   DF8986
DF8986  STATE/COUNTY-   TX/DENTON
DF8986  USGS QUAD     -   DENTON WEST (1960)
DF8986
DF8986                                     *CURRENT SURVEY CONTROL
DF8986
DF8986* NAD 83 (CORS) -   33 12 37.61290 (N)      097 09 45.97082 (W)      ADJUSTED
DF8986* NAVD 88        -
DF8986
DF8986  EPOCH DATE    -           2002.00
DF8986  X              -           -666,070.910 (meters)      COMP
DF8986  Y              -           -5,300,189.189 (meters)      COMP
DF8986  Z              -           3,473,608.415 (meters)      COMP
DF8986  ELLIP HEIGHT-           179.979 (meters)      (11/??/03) GPS OBS
DF8986  GEOID HEIGHT-           -26.69 (meters)      GEOID03
DF8986
DF8986  HORZ ORDER    -   SPECIAL (CORS)
DF8986  ELLP ORDER    -   SPECIAL (CORS)
DF8986
DF8986. ITRF positions are available for this station.
DF8986. The coordinates were established by GPS observations
DF8986. and adjusted by the National Geodetic Survey in November 2003.
DF8986. The coordinates are valid at the epoch date displayed above.
DF8986. The epoch date for horizontal control is a decimal equivalence
DF8986. of Year/Month/Day.

```



National Oceanic and Atmospheric Administration

NATIONAL GEODETIC SURVEY

Antenna Reference Point(ARP): DENTON CORS ARP

PID = DF8986

ITRFOO POSITION (EPOCH 1997.0)

Computed in November, 2003 using 19 days of data.

X =	-666071.448 m	latitude	=	33 12 37.63379 N
Y =	-5300187.759 m	longitude	=	097 09 45.99833 W
Z =	3473608.299 m	ellipsoid height	=	178.784 m

ITRFOO VELOCITY

Predicted with HTDP_2.7 November 2003.

VX =	-0.0149 m/yr	northward	=	-0.0050 m/yr
VY =	-0.0012 m/yr	eastward	=	-0.0146 m/yr
VZ =	-0.0040 m/yr	upward	=	0.0004 m/yr

NAD_83 POSITION (EPOCH 2002.0)

Transformed from ITRFOO (epoch 1997.0) position in Nov. 2003.

X =	-666070.910 m	latitude	=	33 12 37.61290 N
Y =	-5300189.189 m	longitude	=	097 09 45.97082 W
Z =	3473608.415 m	ellipsoid height	=	179.979 m

NAD_83 VELOCITY

Transformed from ITRFOO velocity in Nov. 2003.

VX =	-0.0000 m/yr	northward	=	0.0000 m/yr
VY =	0.0000 m/yr	eastward	=	0.0000 m/yr
VZ =	-0.0000 m/yr	upward	=	0.0000 m/yr

Difference is:

DN = -0.644 (m)

DE = +0.712 (m)

DU = 1.195 (m)



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IMPROVING POSITIONAL ACCURACY

<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)
HARN	1990-1997	0.1 METER	B-order (1.0 ppm) A-order (0.1 ppm)
CORS	1996 -	0.01 meter	0.01 meter



National Oceanic and Atmospheric Administration

Reasons for Readjustment of NAD 83(HARN)

- Multiple epoch dates
- Inconsistencies between states
- Need to be Consistent with CORS
- Compute Network and Local accuracies

September 24, 2003 NGS Executive Steering Committee approved a plan for the readjustment of the horizontal positions and ellipsoid heights for GPS stations in the contiguous United States.



National Oceanic and Atmospheric Administration

NGS Adjustment Team (1986)



Thursday, February 25, 2010

NGS Adjustment Team (2005)



Thursday, February 25, 2010

NGS Adjustment Team (2005)



Thursday, February 25, 2010

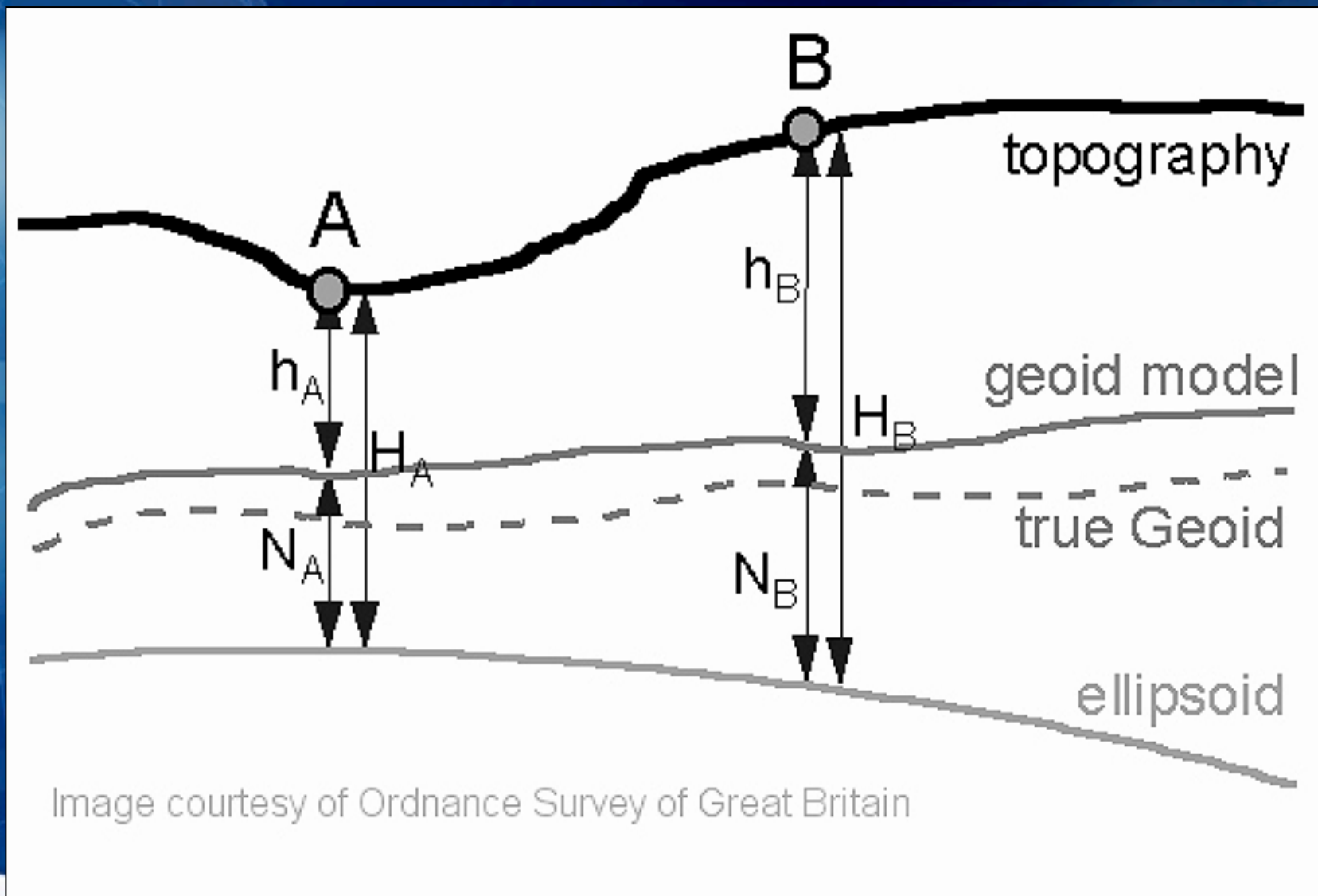
What about Orthometric Heights?

- **Decision was made not to perform a National Readjustment of orthometric heights at this time**
 - **Control = NAVD 88 not the CORS**
 - **Since no change in control most orthometric elevations would not change significantly**
 - **Network & Local Accuracy numbers for the orthometric heights would be the primary reason for readjustment**
 - **Would require relevant network accuracies for the NAVD 88 network-This would require a complete analysis of the NAVD 88 network**



Heights

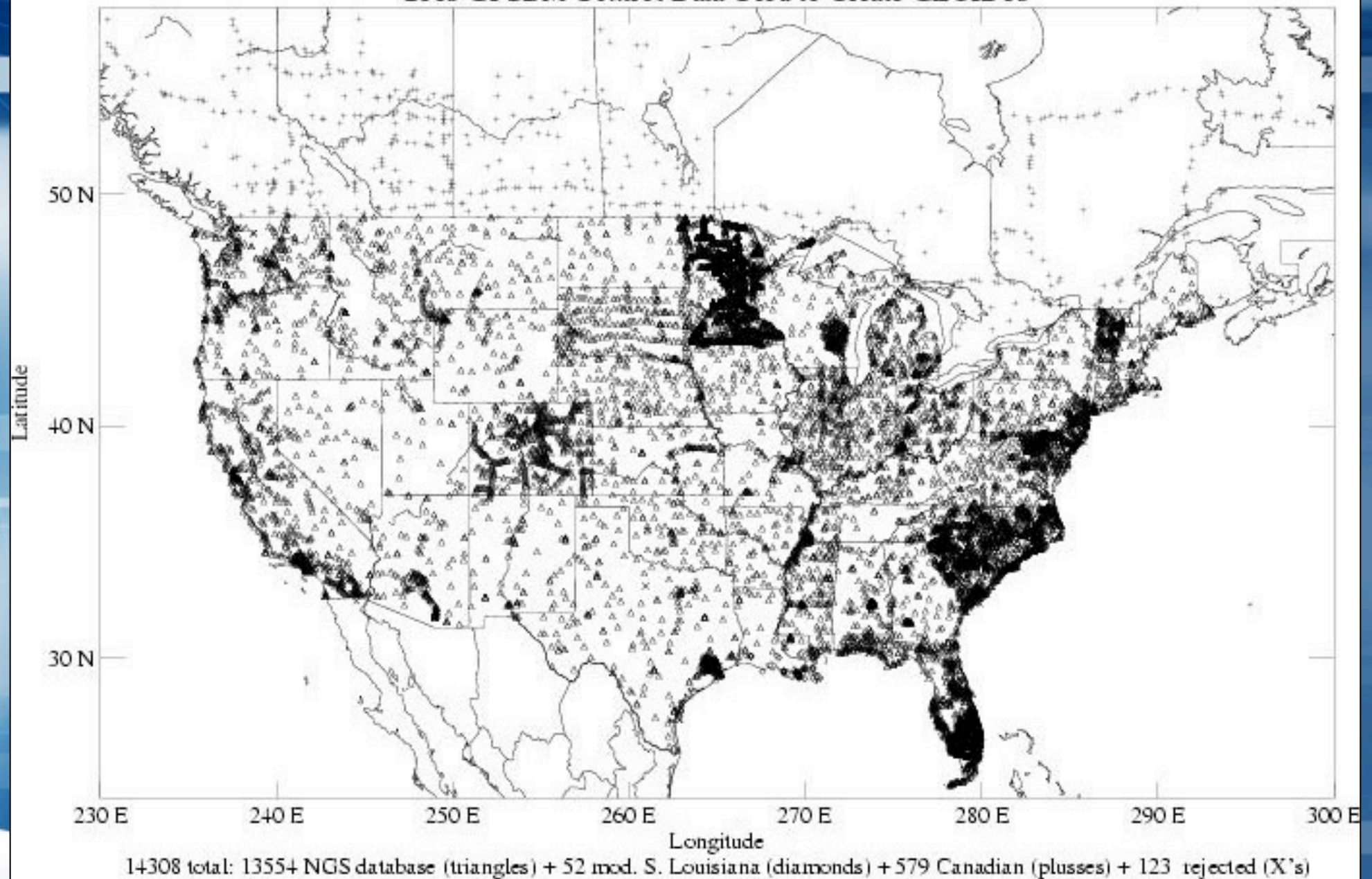
NATIONAL GEODETIC SURVEY



National Oceanic and Atmospheric Administration

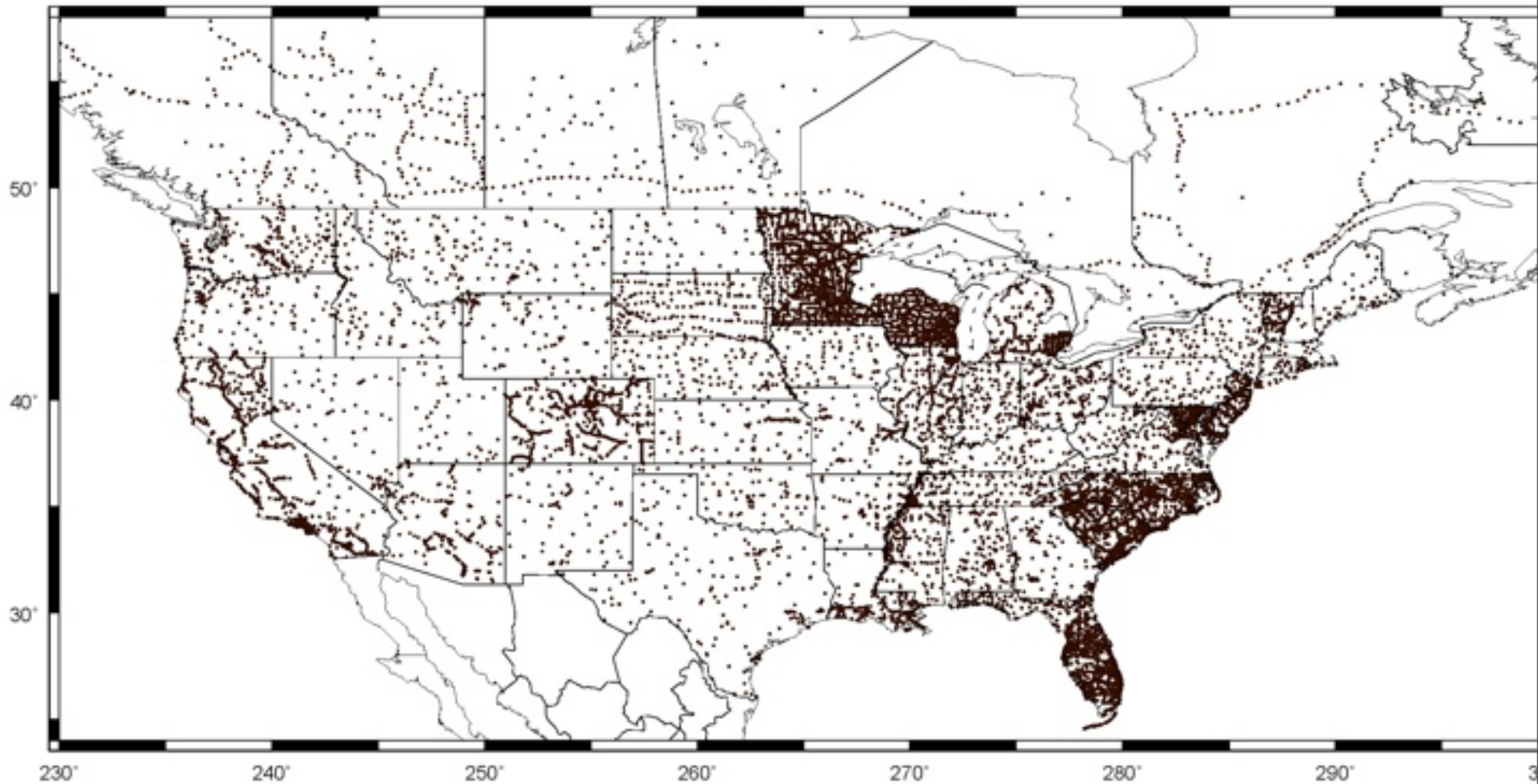
$$h - H - N = 0 + \text{errors in components}$$

2003 GPSBM Control Data Used to Create GEOID03

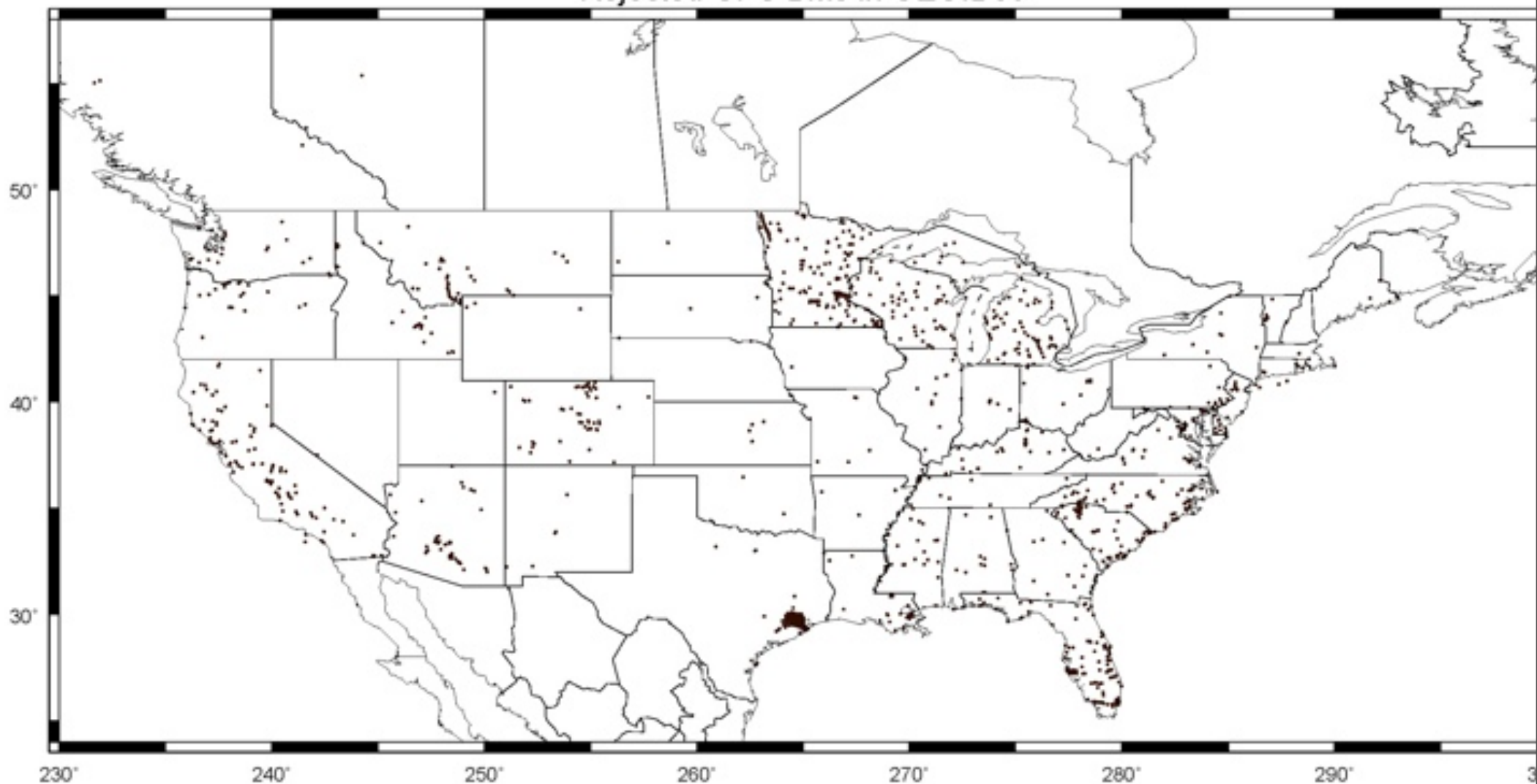


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GPS BMs for GEOID09



Rejected GPS BMs in GEOID09



Geoid Modeling Issues

- **The new ellipsoid heights will be used in the next hybrid geoid model.**
- **Future efforts will center on improvements to our gravity data.**
- **NGS has acquired an airborne gravity meter.**
- **We plan a comprehensive set of observations to capture gravity throughout the United States and our possessions.**
- **Airborne gravity data supplements terrestrial and satellite based gravity.**



National Oceanic and Atmospheric Administration

NAD 83 READJUSTMENT

NATIONAL GEODETIC SURVEY

ONLY GPS DATA WAS USED

**CONTINUOUSLY OPERATING REFERENCE
STATIONS (started in 1994)**

FEDERAL BASE NETWORK (A & B)

COOPERATIVE BASE NETWORK (B)

USER DENSIFICATION NETWORK (First)

AIRPORT SURVEYS (B & First)



National Oceanic and Atmospheric Administration

Project Adjustment Analysis

- **3375 Projects complete**
 - **Free Adjustment**
 - **Residual Plot**
 - **Outliers Rejected**
 - **Connectivity to A/B Order Network Verified**
 - **Summary sheet with Project Information Created**
 - **69117 stations**



National Oceanic and Atmospheric Administration

TRASH

Projects Not Recommended for Inclusion

- **Currently 149 Projects with 9903 stations**
 - **Many Third Order FAA Projects from 1980's**
 - **Some Projects that have no ties to the Network**
 - **Original TN HARN (Macrometer Data in 1990)**
 - **Original Eastern Strain Network Project**



National Oceanic and Atmospheric Administration

Macrometer GPS receiver and antenna



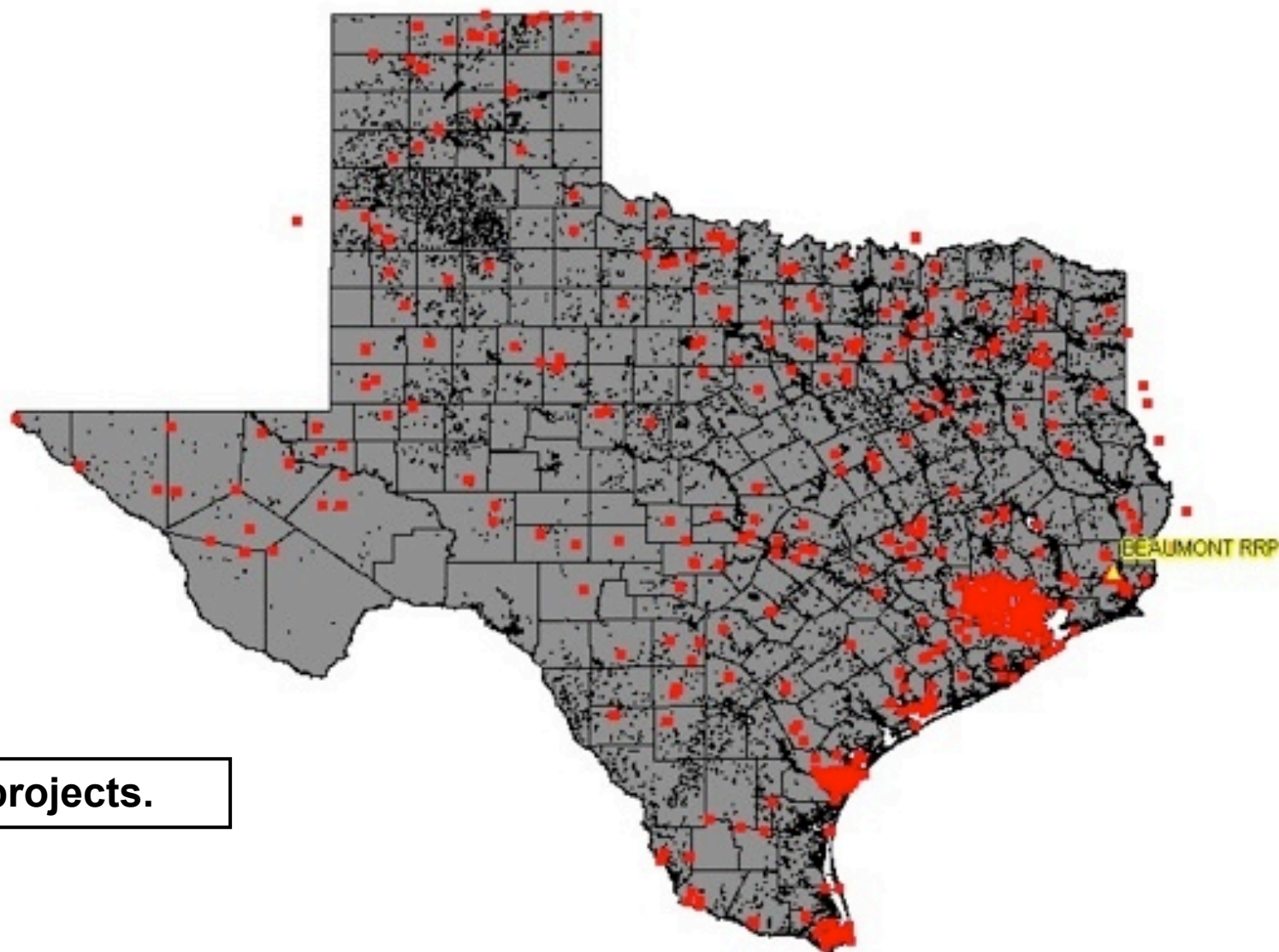
National Oceanic and Atmospheric Administration

<http://www.scg.ulaval.ca/gps-rs/images/GNSS/1982-Macrometer.jpg>

Texas Projects eliminated

- 17407
 - GPS078
 - GPS088
 - GPS1138
 - GPS1170/4
 - GPS146
 - GPS158
 - GPS288
 - GPS304
 - GPS407
- GPS482
 - GPS577
 - GPS577/D
 - GPS582
 - GPS584
 - GPS586
 - GPS849/193





Points in rejected projects.



National Oceanic and Atmospheric Administration

The National Readjustment General Comments

- **The CORS/CGPS sites were the control**
- **Only GPS projects participated**
- **The FBN/CBN Surveys are a key element since these are high accuracy (2 cm) surveys that tie the HARN to the CORS throughout the contiguous United States and provide more accurate values for the ellipsoid heights of most HPGN stations.**
- **The required free adjustment analysis of each GPS project that contributes to the National Spatial Reference System is complete.**



More Comments

- **Computation and database loading of scale factors for each project.**
- **Statewide GPS Readjustments provided extra information about the network on a state-by-state basis.**



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Concept of Operation

NATIONAL GEODETIC SURVEY

- **Helmert Blocking strategy used.**
- **NETSTAT- New Helmert Blocking software developed for the entire adjustment process incorporating more quality control and significant time saving features.**
- **Coordinates Produced and Published for both NAD83 (NSRS) and ITRF**
 - **Adjustment in NAD83-Transformed to ITRF**
- **Network and Local Accuracies Produced.**



National Oceanic and Atmospheric Administration

Network Accuracy

- **Network accuracy of a control point**
 - **A value that represents the uncertainty of its coordinates with respect to the geodetic datum at the 95-percent confidence level**
 - **Datum is considered to be best expressed by the Continuous Operating Reference Stations (CORS)**
- **Local and Network accuracy values at CORS sites are considered to be infinitesimal (approach zero)**
- **These accuracies were implemented with the National Readjustment**



Local Accuracy

- **Local Accuracy of a control point:**
 - **A value that represents the uncertainty of its coordinates relative to other directly connected, adjacent control points at the 95-percent confidence level**
 - **An approximate average of the individual local accuracy values between this control point and other observed control points used to establish its coordinates**



NEW STANDARDS FOR GEODETIC CONTROL

(<http://fgdc.er.usgs.gov/standards/status/swgstat.html>)

- local accuracy ----- adjacent points
- network accuracy ----- relative to CORS
- Numeric quantities, units in cm (or mm)
- Both are relative accuracy measures
- **Will not use distance dependent expression**
- Order/Class codes will no longer be used



National Oceanic and Atmospheric Administration

NATIONAL GEODETIC SURVEY

```

1      National Geodetic Survey,   Retrieval Date = OCTOBER  9, 2007
ABO199 *****
ABO199 CBN      -   This is a Cooperative Base Network Control Station.
ABO199 TIDAL BM  -   This is a Tidal Bench Mark.
ABO199 DESIGNATION -  LEGION 2
ABO199 PID      -   ABO199
ABO199 STATE/COUNTY-  TX/WILLACY
ABO199 USGS QUAD  -   PORT MANSFIELD (1975)
ABO199
ABO199                      *CURRENT SURVEY CONTROL
ABO199
ABO199* NAD 83 (2007)- 26 33 29.45610(N)    097 25 39.84853 (W)    ADJUSTED
ABO199* NAVD 88      -           3.4      (meters)      11.      (feet)  GPS OBS
ABO199
ABO199 X            -   -738,024.852 (meters)                      COMP
ABO199 Y            -   -5,661,019.549 (meters)                      COMP
ABO199 Z            -   2,834,503.771 (meters)                      COMP
ABO199 LAPLACE CORR-           2.09 (seconds)                      DEFLEC99
ABO199 ELLIP HEIGHT-          -19.511 (meters)                      (02/10/07) ADJUSTED
ABO199 GEOID HEIGHT-          -22.89 (meters)                      GEOID03
ABO199
ABO199 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
ABO199 Type      PID      Designation                      North      East      Ellip
ABO199 -----
ABO199 NETWORK ABO199 LEGION 2                      3.00      7.59      5.76
ABO199
ABO199
ABO199.The horizontal coordinates were established by GPS observations
ABO199.and adjusted by the National Geodetic Survey in February 2007.

```



NATIONAL GEODETIC SURVEY

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AB0199
AB0199                                SUPERSEDED SURVEY CONTROL
AB0199
AB0199  ELLIP H (10/24/00)  -19.478  (m)                                GP (      ) 4 2
AB0199  NAD 83 (1993)-   26 33 29.45558 (N)    097 25 39.84827 (W) AD (      ) B
AB0199  ELLIP H (05/09/94)  -19.317  (m)                                GP (      ) 4 2
AB0199  NAD 83 (1986)-   26 33 29.46934 (N)    097 25 39.81286 (W) AD (      ) 1
AB0199  NAD 27          -   26 33 28.23453 (N)    097 25 38.88097 (W) AD (      ) 1
AB0199  NGVD 29 (06/28/90)   3.57   (m)                                11.7   (f) LEVELING 3
AB0199
AB0199.Superseded values are not recommended for survey control.
AB0199.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AB0199.See file dsdata.txt to determine how the superseded data were derived.
AB0199
AB0199_U.S. NATIONAL GRID SPATIAL ADDRESS: 14RPQ5660938462 (NAD 83)
AB0199_MARKER: DS = TRIANGULATION STATION DISK
AB0199_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
AB0199_SP_SET: SQUARE CONCRETE MONUMENT

```

Note that this position was formerly order “B” (1-ppm)



National Oceanic and Atmospheric Administration

SHIFTS (National results)

< 5 cm. in the horizontal component with an average shift of 2.2 cm.

< 10 cm. in the vertical component with an average shift of 4.6 cm.



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Transformation Parameters between ITRF2005 and ITRF2000

14 transformation parameters between ITRF2005 and ITRF2000 have been estimated and listed in Table 1, using 70 stations listed in Table 2 and located at sites shown on Figure 2.

	T1 mm	T2 mm	T3 mm	D 10-9	R1 mas	R2 mas	R3 mas
	0.1	-0.8	-5.8	0.40	0.000	0.000	0.000
+/-	0.3	0.3	0.3	0.05	0.012	0.012	0.012
Rates	-0.2	0.1	-1.8	0.08	0.000	0.000	0.000
+/-	0.3	0.3	0.3	0.05	0.012	0.012	0.012

Table 1: Transformation parameters at epoch 2000.0 and their rates from ITRF2005 to ITRF2000 (ITRF2000 *minus* ITRF2005)

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix}_S = \begin{pmatrix} \Delta x \\ \Delta y \\ \Delta z \end{pmatrix} + (1 + \Delta L) \begin{pmatrix} 1 & \omega_3 & -\omega_2 \\ -\omega_3 & 1 & \omega_1 \\ \omega_2 & -\omega_1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}_D$$



```

1      National Geodetic Survey,  Retrieval Date = OCTOBER 9, 2007
AB0199 *****
AB0199 CBN - This is a Cooperative Base Network Control Station.
AB0199 TIDAL BM - This is a Tidal Bench Mark.
AB0199 DESIGNATION - LEGION 2
AB0199 PID - AB0199
AB0199 STATE/COUNTY- TX/WILLACY
AB0199 USGS QUAD - PORT MANSFIELD (1975)
AB0199
AB0199 *CURRENT SURVEY CONTROL
AB0199
AB0199* NAD 83 (2007) - 26 33 29.45610(N) 097 25 39.84853(W) ADJUSTED
AB0199* NAVD 88 - 3.4 (meters) 11. (feet) GPS OBS
AB0199
AB0199 X -738,024.852 (meters) COMP
AB0199 Y -661,019.549 (meters) COMP
AB0199 Z -84,503.771 (meters) COMP
AB0199 LAPLACE CORR- 2.09 (seconds) DEFLEC99
AB0199 ELLIP HEIGHT- DF4377 *****
AB0199 GEOID HEIGHT- DF4377 HT_MOD - This is a Height Modernization Survey Station.
AB0199 DF4377 CORS - This is a GPS Continuously Operating Reference Station.
AB0199 ----- Accuracy Estimate DF4377 DESIGNATION - CORPUS CHRISTI R2 CORS ARP
AB0199 Type PID Designation DF4377 CORS_ID - TXCC
AB0199 ----- DF4377 PID - DF4377
AB0199 NETWORK AB0199 LEGION : DF4377 STATE/COUNTY- TX/NUECES
AB0199 ----- DF4377 QUAD - OSO CREEK NW (1975)
AB0199 DF4377
AB0199 The horizontal coordinates DF4377 *CURRENT SURVEY CONTROL
AB0199 and adjusted by the National Geodetic Survey DF4377
DF4377* NAD 83 (CORS) - 27 44 26.85486(N) 097 26 30.01102(W) ADJUSTED
DF4377* NAVD 88 - 17.33 (meters) 56.9 (feet) GPS OBS
DF4377
DF4377 EPOCH DATE - 2002.00
DF4377 X -731,658.400 (meters) COMP
DF4377 Y -5,601,558.467 (meters) COMP
DF4377 Z 2,951,108.298 (meters) COMP
DF4377 ELLIP HEIGHT- -9.054 (meters) (03/??/03) ADJUSTED
DF4377 GEOID HEIGHT- -26.36 (meters) GEOID03

```



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NATIONAL GEODETIC SURVEY

TRANSFORMATION PARAMETERS AND THEIR RATES FROM ITRF2000 TO PREVIOUS FRAMES
(See Note Below)

SOLUTION	T1	T2	T3	D	R1	R2	R3	EPOCH	Ref.
UNITS----->	cm	cm	cm	ppb	.001"	.001"	.001"		IERS Tech. Note #
RATES	T1	T2	T3	D	R1	R2	R3		
UNITS----->	cm/y	cm/y	cm/y	ppb/y	.001"/y	.001"/y	.001"/y		
ITRF97	0.67	0.61	-1.85	1.55	0.00	0.00	0.00	1997.0	27
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF96	0.67	0.61	-1.85	1.55	0.00	0.00	0.00	1997.0	24
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF94	0.67	0.61	-1.85	1.55	0.00	0.00	0.00	1997.0	20
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF93	1.27	0.65	-2.09	1.95	-0.39	0.80	-1.14	1988.0	18
rates	-0.29	-0.02	-0.06	0.01	-0.11	-0.19	0.07		
ITRF92	1.47	1.35	-1.39	0.75	0.00	0.00	-0.18	1988.0	15
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF91	2.67	2.75	-1.99	2.15	0.00	0.00	-0.18	1988.0	12
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF90	2.47	2.35	-3.59	2.45	0.00	0.00	-0.18	1988.0	9
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF89	2.97	4.75	-7.39	5.85	0.00	0.00	-0.18	1988.0	6
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		
ITRF88	2.47	1.15	-9.79	8.95	0.10	0.00	-0.18	1988.0	IERS An. Rep. for 1988
rates	0.00	-0.06	-0.14	0.01	0.00	0.00	0.02		



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ITRF and WGS 84

Parameters from ITRF90 to WGS84-Doppler realized system

	T1	T2	T3	D	R1	R2	R3
UNITS	(m)	(m)	(m)	(ppm)	(")	(")	(")
----->							
	0.060	-0.517	-0.223	-0.011	0.0183	-0.0003	0.0070

- New realizations of WGS84 based on GPS data, such as WGS84(G730 or G873). These new WGS84 realizations are coincident with ITRF at about 10-centimeter level. For these realizations there are no official transformation parameters. This means that one can consider that ITRF coordinates are also expressed in WGS84 at 10 cm level.



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ITRF to NAD 83 (????)

```
*** From ITRF94 to NAD 83
tx(1) = 0.9910d0
ty(1) = -1.9072d0
tz(1) = -.5129d0
dtx(1) = 0.d0
dty(1) = 0.d0
dtz(1) = 0.d0
rx(1) = 1.25033d-7
ry(1) = 0.46785d-7
rz(1) = 0.56529d-7
drx(1) = 0.00258d-7
dry(1) = -.03599d-7
drz(1) = -.00153d-7
scale(1) = 0.d0
dscale(1) = 0.0d0
refepc(1) = 1997.0d0
```

```
*** From ITRF94 to ITRF00
*** assumes that ITRF94 = ITRF96 and
*** uses IGS values for ITRF96 -> ITRF97
*** and IERS values for ITRF97 -> ITRF00
tx(11) = -.00463d0
ty(11) = -.00589d0
tz(11) = +.00855d0
dtx(11) = -0.00069d0
dty(11) = 0.00070d0
dtz(11) = -0.00046d0
rx(11) = -.00012467d0 / rhosec
ry(11) = 0.00022355d0 / rhosec
rz(11) = 0.00006065d0 / rhosec
drx(11) = -0.00001347d0 / rhosec
dry(11) = 0.00001514d0 / rhosec
drz(11) = 0.00001973d0 / rhosec
scale(11) = -0.61504d-9
dscale(11) = 0.18201d-9
refepc(11) = 1997.0d0
```



NSRS 2007 adjustment

NATIONAL GEODETIC SURVEY

- **Four free iterations completed with decreasing numbers of residuals over 5 cm and with decreasing variances in each block and overall. Analysis of each block continues.**

No. of Observations = 851,073

No. of constrained parameters = 2055

No. of unknown parameters = 203,076

Degrees Of Freedom = 650,049

- **Constraints in adjustment: 471 National CORS, 3 Canadian CACS, 1 Mexican CORS and 213 California CGPS sites**



National Oceanic and Atmospheric Administration

TEXAS STATISTICS

- **Total # of Stations:** 2400
- **Max Horizontal Shift:** 0.208 (m)
- **Average Hz Shift:** 0.016 (m)
- **Max Vertical Shift:** 0.250 (m)
- **Average Vt. Shift:** 0.018 (m)



National Oceanic and Atmospheric Administration

Texas NAD 83(NSRS 2007) Adjustment Statistics

Free Statistics	FINAL FREE ADJUSTMENT						FINAL CONSTRAINED ADJUSTMENT			
	Constrained AF9522		Rejected Vectors	Station Summary	FINAL SHIFTS	Constrained 678 CORS /CGPS sites				
	Variance 2/6/2007	Horizontal Plot 2/6/07				Vertical Plot 2/6/07	Variance 2/6/2007	Horizontal Plot 2/6/07		Vertical Plot 2/6/07
TEXAS	0.70	yes	yes	813	2400	yes	TEXAS	1.38	yes	yes
UTAH	0.82	yes	yes	105	310	yes	UTAH	1.22	yes	yes

Texas Final Free Adjustment: Variance = 0.70

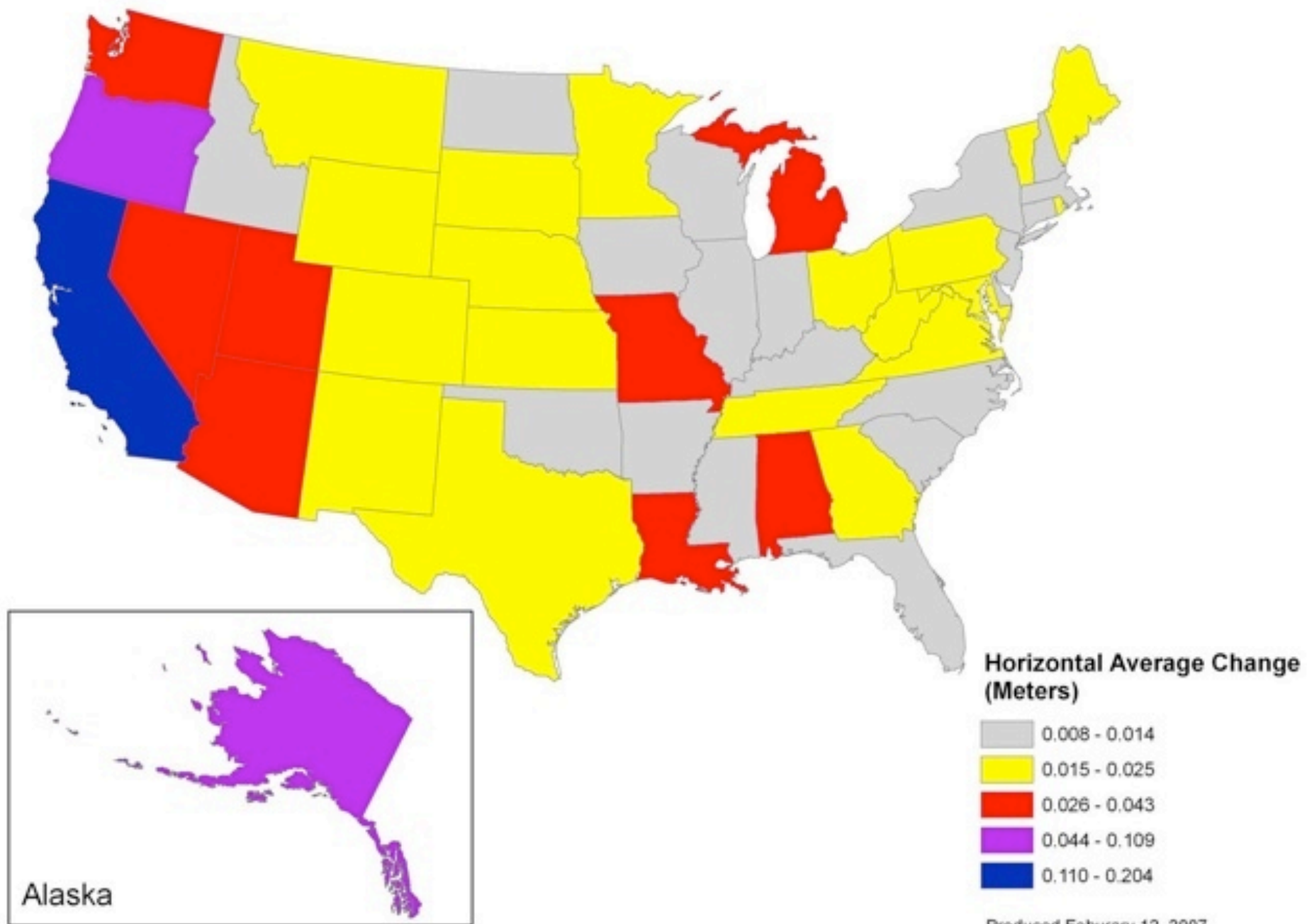
2400 stations and 813 rejected vectors

Texas Final Constrained Adjustment: Variance = 1.38

Note the sole constraint for the national free adjustment (CORS site GAIT) and the 678 CORS/CGPS sites for the constrained adjustment.

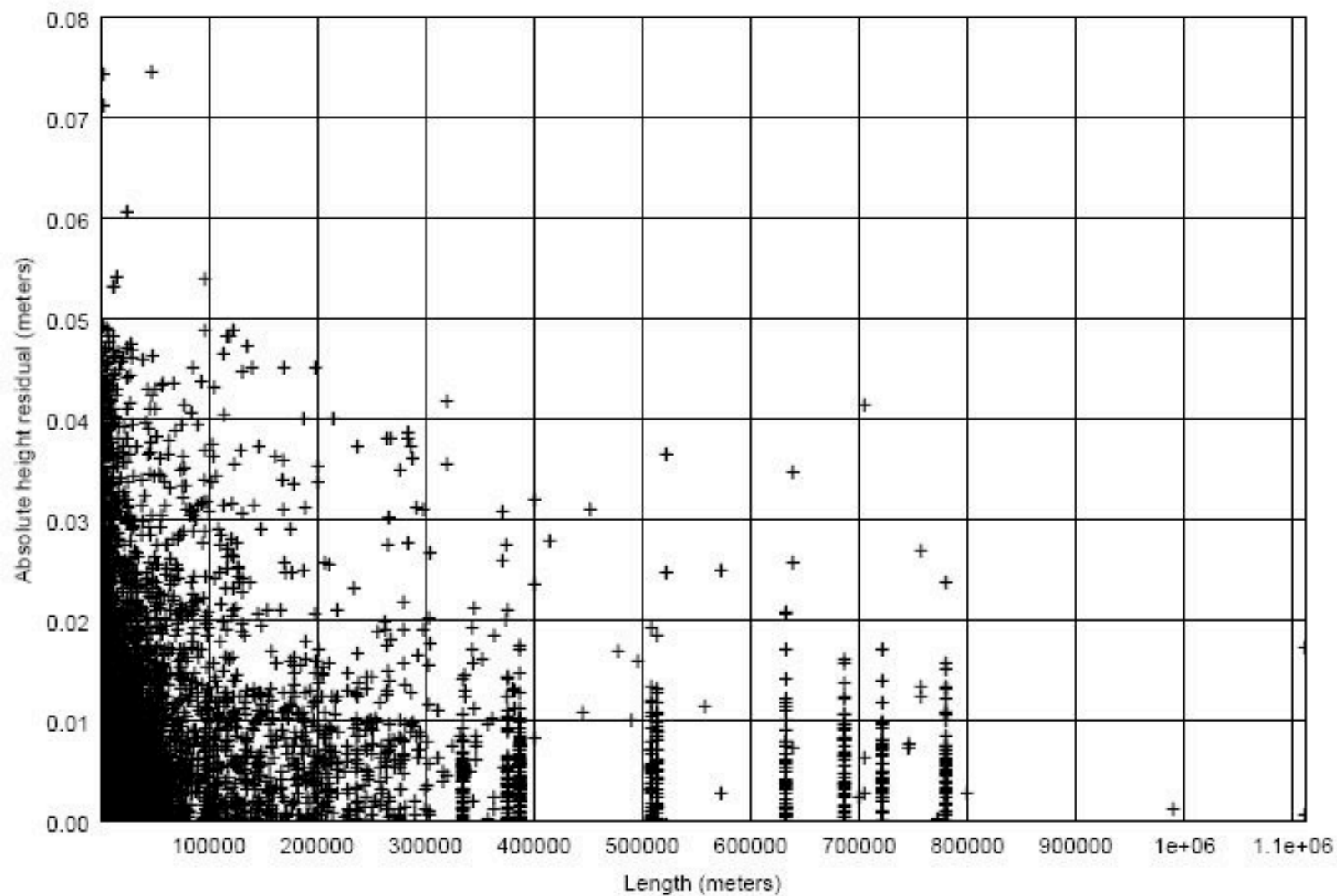


National Oceanic and Atmospheric Administration

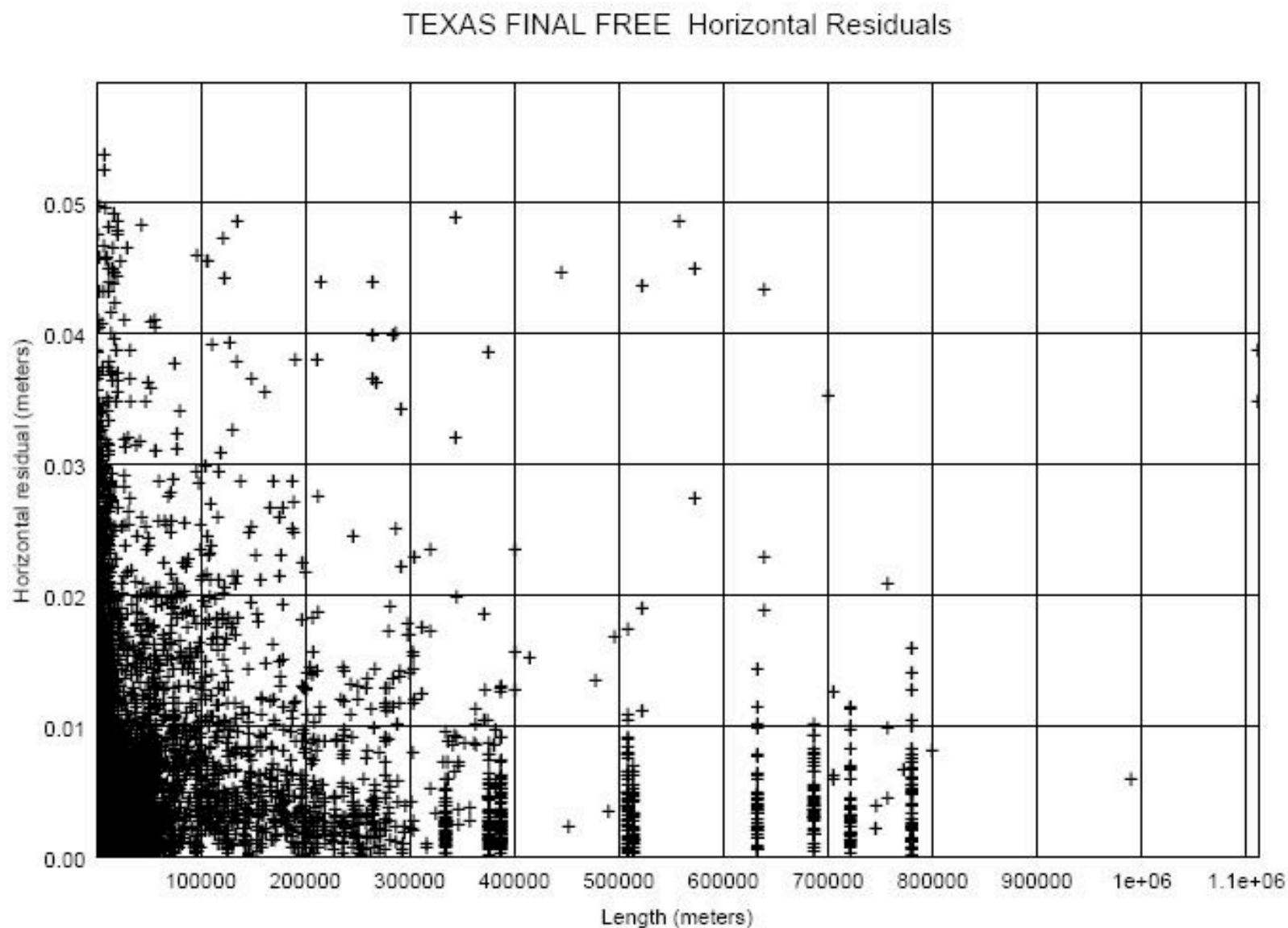


FREE ADJUSTMENT								CONSTRAINED ADJUSTMENT			
Free	Constrained AF9522			Rejected	Station	Preliminary		Constrained	Constrained 487 CORS and 198 CGPS sites		
Statistics	Variance	Horizontal	Vertical	Vectors	Summary	Shifts		Statistics	Variance	Horizontal	Vertical
	10/24/06	Plot 10/24	Plot 10/24						10/24/2006	Plot 10/24	Plot 10/24
ALASKA	1.30	yes	yes	805	792	yes		ALASKA	1.66	yes	yes
ALABAMA	1.87	yes	yes	3979	3668	yes		ALABAMA	1.87	yes	yes
ARKANSAS	1.76	yes	yes	88	396	yes		ARKANSAS	2.02	yes	yes
ARIZONA	1.53	yes	yes	333	1388	yes		ARIZONA	1.88	yes	yes
CALIFORNIA NORTH	1.18	yes	yes	1824	1688	yes		CALIFORNIA NORTH	1.41	yes	yes
CALIFORNIA SOUTH	0.94	yes	yes	5443	1950	yes		CALIFORNIA SOUTH	1.30	yes	yes
COLORADO	1.62	yes	yes	899	1737	yes		COLORADO	1.77	yes	yes
CONNECTICUT	1.25	yes	yes	82	103	yes		CONNECTICUT	1.24	yes	yes
DC	1.23	yes	yes	74	33	yes		DC	1.19	yes	yes
DELAWARE	1.74	yes	yes	86	91	yes		DELAWARE	2.90	yes	yes
FLORIDA NORTH	1.26	yes	yes	1427	3117	yes		FLORIDA NORTH	1.26	yes	yes
FLORIDA SOUTH	1.31	yes	yes	1683	3699	yes		FLORIDA SOUTH	1.35	yes	yes
GEORGIA	1.31	yes	yes	149	1529	yes		GEORGIA	1.82	yes	yes
IOWA	1.58	yes	yes	33	329	yes		IOWA	1.75	yes	yes
IDAHO	1.22	yes	yes	168	280	yes		IDAHO	1.60	yes	yes
ILLINOIS	1.36	yes	yes	452	2515	yes		ILLINOIS	1.42	yes	yes
INDIANA	1.68	yes	yes	33	270	yes		INDIANA	1.79	yes	yes
KANSAS	1.52	yes	yes	459	463	yes		KANSAS	1.79	yes	yes
KENTUCKY	1.49	yes	yes	201	1012	yes		KENTUCKY	1.58	yes	yes
LOUISIANA	1.16	yes	yes	555	1158	yes		LOUISIANA	2.19	yes	yes
MASSACHUSETTS	1.79	yes	yes	32	284	yes		MASSACHUSETTS	1.99	yes	yes
MARYLAND	1.57	yes	yes	1367	2097	yes		MARYLAND	1.65	yes	yes
MAINE	1.81	yes	yes	211	466	yes		MAINE	2.12	yes	yes
MICHIGAN	1.43	yes	yes	544	1090	yes		MICHIGAN	1.82	yes	yes
MINNESOTA NORTH	1.92	yes	yes	1038	3910	yes		MINNESOTA NORTH	1.93	yes	yes
MINNESOTA SOUTH	1.98	yes	yes	893	3184	yes		MINNESOTA SOUTH	2.00	yes	yes
MISSOURI	1.34	yes	yes	275	861	yes		MISSOURI	1.47	yes	yes
MISSISSIPPI	1.65	yes	yes	246	557	yes		MISSISSIPPI	1.91	yes	yes
MONTANA	1.53	yes	yes	256	383	yes		MONTANA	1.59	yes	yes

TEXAS FINAL FREE Height Residuals



National Oceanic and Atmospheric Administration



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For Stations not Included

NATIONAL GEODETIC SURVEY

- NGS recommends that NAD 83 data that is NOT part of the NSRS readjustment be readjusted by contractor/user with the original observations.
- A set of national transformation parameters for “classical” non-GPS stations and GPS stations that were excluded from the National Readjustment will be developed by NGS.
- Because of the relatively small shifts anticipated, a model such as NADCON **will not be developed** between previously determined GPS coordinates.



National Oceanic and Atmospheric Administration



NINTH CONGRESS OF THE UNITED STATES,

At the Second Session,

Begun and held at the city of Washington, in the territory of Columbia,
on Monday the first of December, one thousand eight
hundred and six.

AN ACT *to provide for surveying the coasts of the United States*

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, that the president of the United States shall be, and he is hereby authorized and requested, to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shore of the United States; and also the respective courses and distances between the principal capes, or head lands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid.

Sec: 2. And be it further enacted, that it shall be lawful for the president of the United States, to cause such examinations and observations to be made, with respect to St. George's bank, and any other bank or shoal, and the soundings and currents beyond the distance aforesaid, to the gulph stream, as in his opinion may be especially advantageous to the commercial interests of the United States.

Sec: 3. And be it further enacted, that the president of the United States shall be, and he is hereby authorized and requested, for any of the purposes aforesaid, to cause proper and intelligent persons to be employed, and also such of the public vessels in actual service, as he may judge expedient, and to give such instructions for regulating their conduct as to him may appear proper, according to the tenor of this act.

Sec: 4. And be it further enacted, that for carrying this act into effect there shall be, and hereby is appropriated, a sum not exceeding *by thousand dollars*, to be paid out of any moneys in the treasury, not otherwise appropriated.

Wm. M. McKim Speaker of the House of Representatives

John C. Calhoun Vice President of the United States, and President of the Senate.

May 10 1807

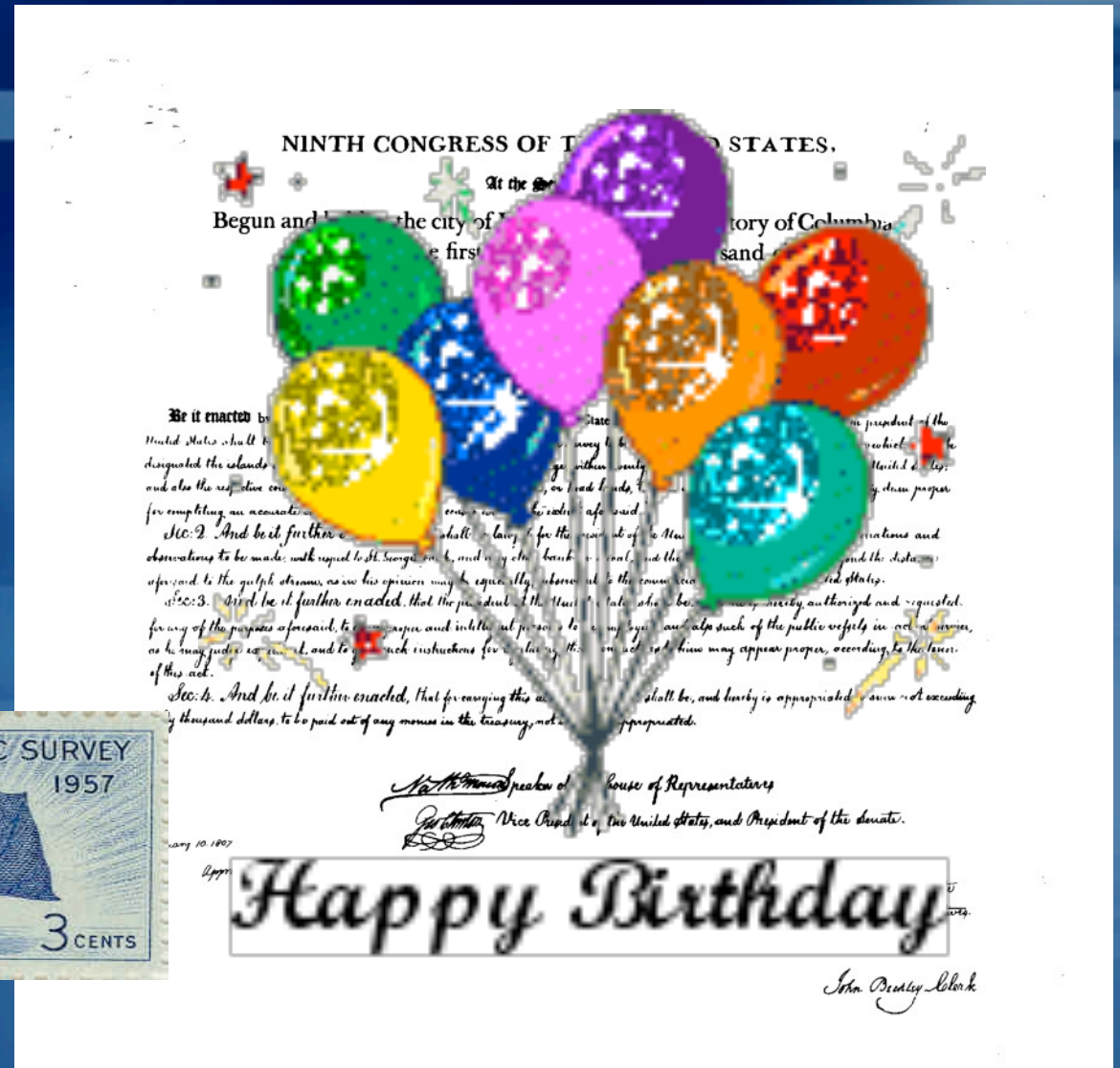
Approved

Jefferson

Testify that this act did originate
in the House of Representatives.

John Bradley Clark

We celebrated our 200th anniversary
on February 10, 2007!!



We celebrated our 200th anniversary
on February 10, 2007!!