OPUS-Database: Supplemental Data for Better Datum Conversion Models

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F.I.G. Working Week
Session TS04A: National Geodesy I
Marrakech, Morocco 18-22 May 2011

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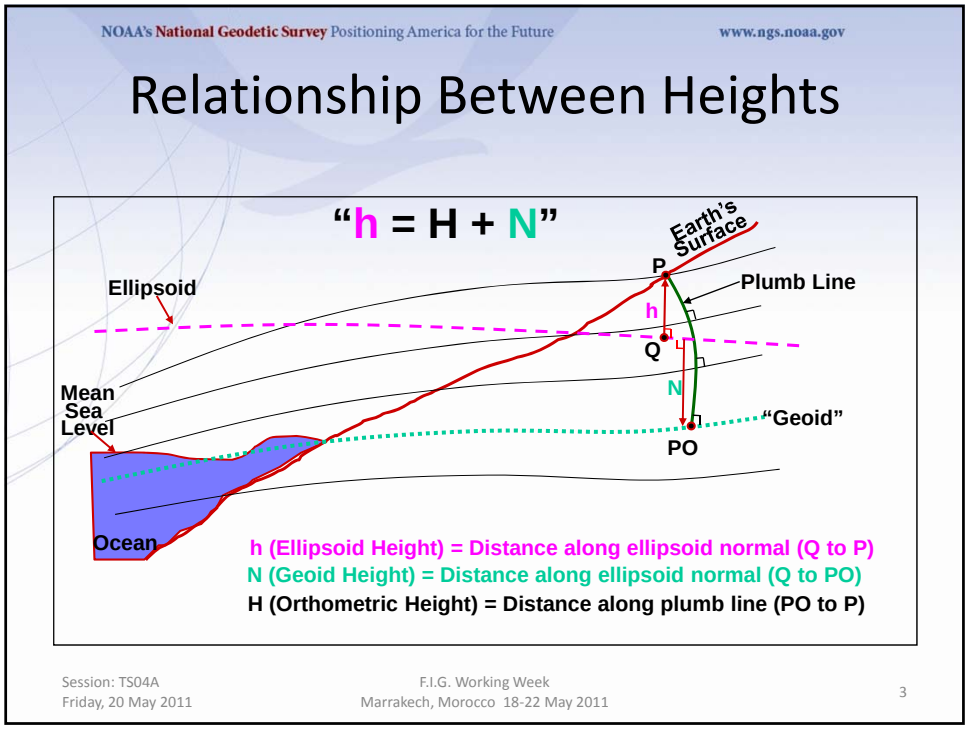
OUTLINE

- Intro to hybrid geoid modeling
- NGSIDB versus OPUS-DB
- Comparison to Common Points
- Implications of New Control Points
- Examining Some of the Suspect data
- Conclusions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Relationship Between Heights
"h = H + N"
Earth's Surface
P
Plumb Line
Ellipsoid
h
Q
N
Mean Sea Level
"Geoid"
PO
Ocean
h (Ellipsoid Height) = Distance along ellipsoid normal (Q to P)
N (Geoid Height) = Distance along ellipsoid normal (Q to PO)
H (Orthometric Height) = Distance along plumb line (PO to P)
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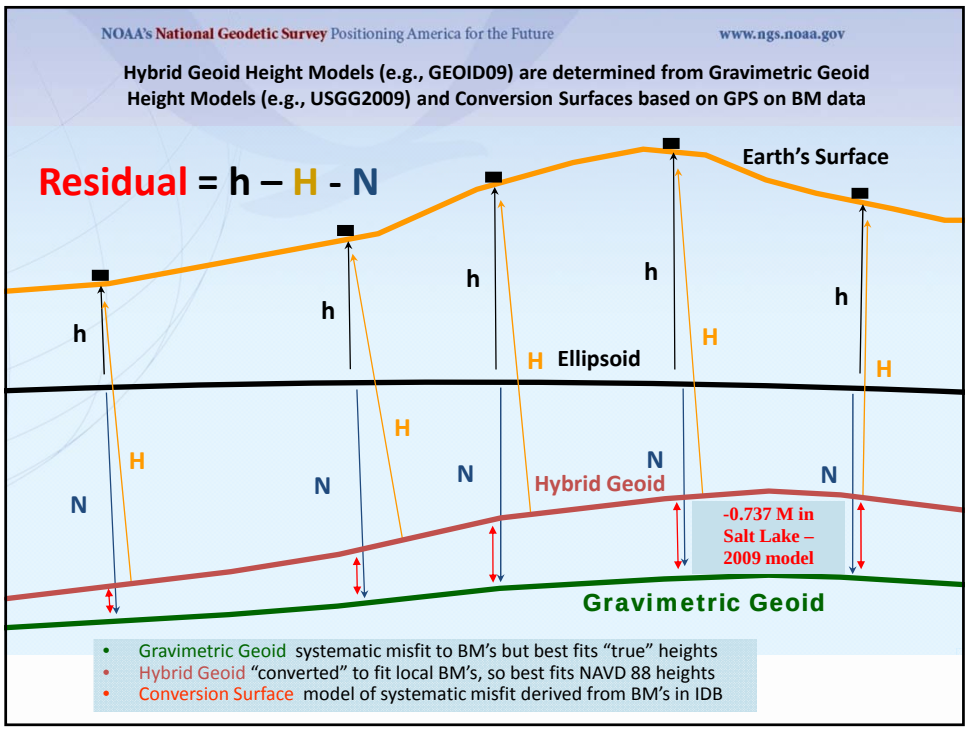
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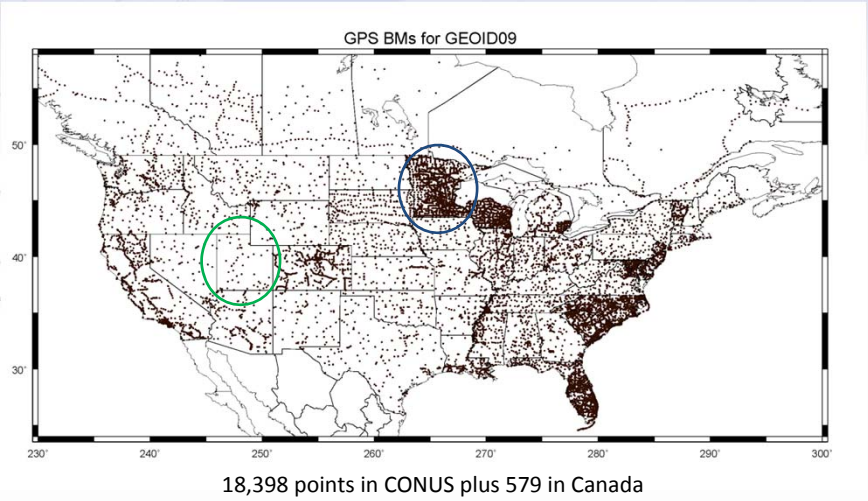
Hybrid Geoid Height Models (e.g., GEOID09) are determined from Gravimetric Geoid Height Models (e.g., USGG2009) and Conversion Surfaces based on GPS on BM data
Residual = h – H - N
Earth's Surface
h
H
Ellipsoid
N
Hybrid Geoid
-0.737 M in Salt Lake – 2009 model
Gravimetric Geoid
Gravimetric Geoid systematic misfit to BM's but best fits "true" heights
Hybrid Geoid "converted" to fit local BM's, so best fits NAVD 88 heights
Conversion Surface model of systematic misfit derived from BM's in IDB

Distribution of GPSBM2009



18,398 points in CONUS plus 579 in Canada

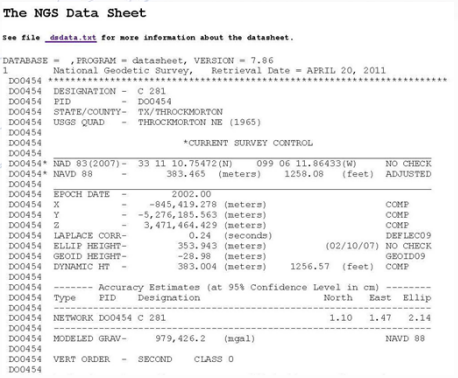
NGSIDB Versus OPUS-DB

NGSIDB

- Passive control adjustment of stored data
- Episodically refined (NA2011 starting very soon)
- Traditional surveying
- A lot of (important!) numbers and text

OPUS-DB

- Actively determined from CORS
- Constantly refined using current CORS
- Dynamic Surveying
- A lot of numbers/text as well as some useful images



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The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

DATABASE =  ,PROGRAM = datasheet, VERSION = 7.06
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)                     DEFLEC09
 DO0454  ELLIP HEIGHT-         353.943 (meters)          (02/10/07) NO CHECK
 DO0454  GEOID HEIGHT-         -28.98  (meters)                     GEOID09
 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
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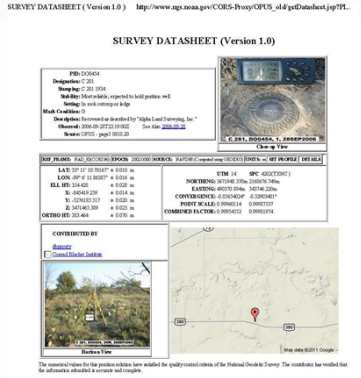
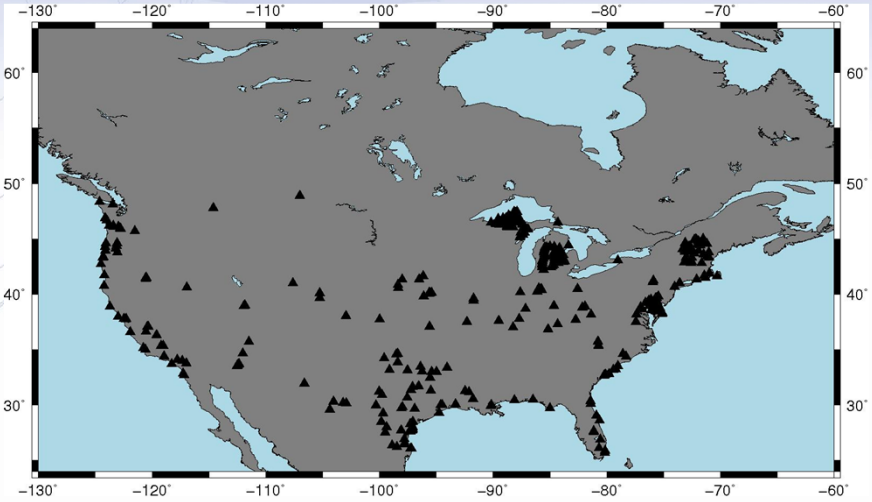


Developing a Better Distribution

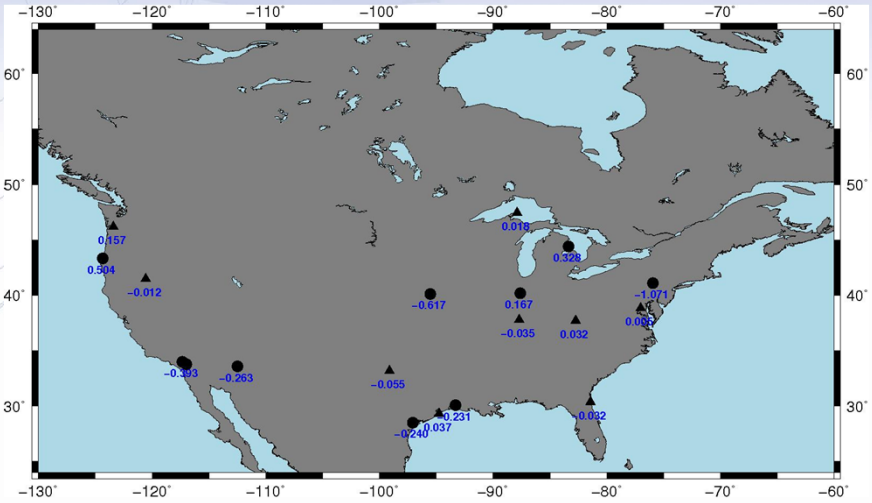
- Selectively occupy bench marks with no previous GPS
- Targeted campaign in coordination with states
- Fill voids to reduce the interpolated signal
- Modeling for hybrid geoid using multi-matrix least squares collocation
- Spacing of the control data directly impacts the interpolated signal

Leveled Bench Marks Occupied by GPS and stored in OPUS-DB



Groups of the 422 points pulled from OPUS-DB	No. Pts	A NGSIDB Res.		B OPUS-DB Res.		C OPUS-DB–NGSIDB	
		Ave	SD	Ave.	SD	Ave	SD
(1.a) All Common Points that were used in GEOID09	80	-0.009	0.065	0.004	0.036	0.013	0.060
(1.b) Common Points less the 9 rejects	71	-0.004	0.015	0.003	0.031	0.006	0.028
(2) Common Points but *not* used to make GEOID09	57	0.001	0.043	0.007	0.037	0.006	0.044
(3.a) Points Not Previously Observed with GPS	285	n/a	n/a	-0.011	0.112	n/a	n/a
(3.b) Points Not Previously Observed less the 11 rejects	274	n/a	n/a	-0.008	0.047	n/a	n/a

Rejected Points



Rejected Points Common to NGSIDB

PID	Reject Code	NAVD88 ortho. ht.	GEOID09 height	NGSIDB ellips. ht.	NGSIDB Residual	OPUSDB Ellips. ht.	OPUSDB Residual
AW5707	S	0.709	-26.638	-25.916	0.013	-25.892	0.037
HA0997	h	118.247	-30.526	87.726	0.005	87.686	-0.035
DO0454	H	383.465	-28.982	353.943	-0.540	354.428	-0.055
GY1636	h	218.677	-32.382	186.330	0.035	186.327	0.032
HV9071	h	3.505	-32.143	-28.656	-0.018	-28.633	0.005
MW0121	h	1337.183	-22.185	1314.984	-0.014	1314.986	-0.012
SC0330	H	17.233	-21.296	-3.923	0.140	-3.906	0.157
SG0004	h	189.404	-35.290	154.085	-0.029	154.132	0.018
BC2486	H	1.247	-28.527	-27.343	-0.063	-27.312	-0.032

Rejected New Points

PID	Reject Code	NAVD88 ortho. ht.	GEOID09 height	NGSIDB ellips. ht.	NGSIDB Residual	OPUSDB Ellips. ht.	OPUSDB Residual
AN1829	not in IDB	21.222	-27.417	n/a	n/a	-6.438	-0.243
BK1521	not in IDB	1.319	-27.163	n/a	n/a	-26.075	-0.231
DV0102	not in IDB	404.859	-30.096	n/a	n/a	374.500	-0.263
DX5394	not in IDB	467.098	-32.369	n/a	n/a	434.548	-0.181
EV3460	not in IDB	284.083	-32.962	n/a	n/a	250.728	-0.393
OA0650	not in IDB	4.600	-26.362	n/a	n/a	-21.258	0.504
PK0048	not in IDB	184.093	-35.268	n/a	n/a	149.153	0.328
LB1860	not in IDB	201.307	-32.618	n/a	n/a	168.856	0.167
LF0630	not in IDB	336.765	-30.541	n/a	n/a	305.607	-0.617
LY1475*	not in IDB	372.450	-32.186	n/a	n/a	339.193	-1.071
TT0450	not in IDB	11.425	8.766	n/a	n/a	21.028	0.837

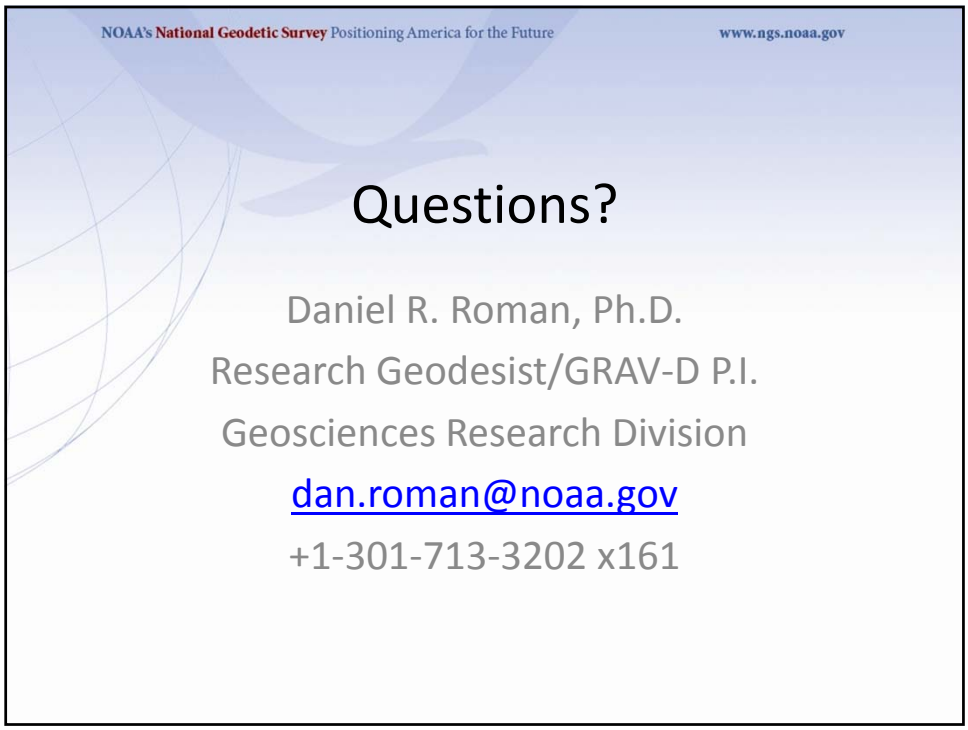
LY1475* has actually been pulled from OPUS-DB by the submitter

Possible Error Sources

- Human-Induced Subsidence
  - Groundwater Pumping
  - Oil Extraction
  - Mining Operations
- Earth Dynamics
  - Listric Faulting/Slumping
  - Coastal Erosion/Uplift

CONCLUSIONS

- Only a fraction of the leveling has been GPS'd
- Existing coverage in NGSIDB is very irregular
- OPUS-DB offers better results
- OPUS targeted to regions of poor coverage
- NGSIDB values to be integrated into OPUS-DB
- Problems remain in crustal movement regions
- Non-simultaneity of GPS & leveling
  - changes over time pass erroneously into geoid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Questions?
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