

John Freetly

From: opus <opus@ngs.noaa.gov>
Sent: Wednesday, September 10, 2014 1:42 PM
To: John Freetly
Subject: OPUS solution : 018506_14_251_A1.14O OP1410377926595

FILE: 018506_14_251_A1.14O OP1410377926595

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: john.freetly@neciusa.com DATE: September 10, 2014
RINEX FILE: 0185251v.14o TIME: 19:41:25 UTC

SOFTWARE: page5 1209.04 master51.pl 022814 START: 2014/09/08 21:42:00
EPHEMERIS: igr18091.eph [rapid] STOP: 2014/09/09 00:02:00
NAV FILE: brdc2510.14n OBS USED: 4594 / 5211 : 88%
ANT NAME: CHCX90D-OPUS NONE # FIXED AMB: 37 / 40 : 93%
ARP HEIGHT: 2.0000 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2014.6875)

X:	-1410040.530(m)	0.003(m)	-1410041.391(m)	0.003(m)
Y:	-4259466.695(m)	0.012(m)	-4259465.446(m)	0.012(m)
Z:	4519798.696(m)	0.012(m)	4519798.657(m)	0.012(m)

LAT:	45 24 8.52594	0.013(m)	45 24 8.54616	0.013(m)
E LON:	251 41 0.78882	0.002(m)	251 41 0.73320	0.002(m)
W LON:	108 18 59.21118	0.002(m)	108 18 59.26680	0.002(m)
EL HGT:	1322.281(m)	0.010(m)	1321.611(m)	0.010(m)
ORTHO HGT:	1334.699(m)	0.020(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 12) SPC (2500 MT)

Northing (Y) [meters]	5031153.380	128776.762
Easting (X) [meters]	710018.427	692640.207
Convergence [degrees]	1.91153297	0.86577359
Point Scale	1.00014234	0.99978231
Combined Factor	0.99993505	0.99957509

US NATIONAL GRID DESIGNATOR: 12TYR1001831153(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI3064	BIL6 BILLINGS 6 CORS ARP	N455816.251	W1075948.499	67960.3
DG9745	MTEI ENGINC CORS ARP	N454447.035	W1083600.736	44197.4
DL7728	P051 BILLINGSAPMT2005 CORS ARP	N454823.741	W1083246.070	48378.1

NEAREST NGS PUBLISHED CONTROL POINT
 QW0678 22 DHW N452420. W1081934. 834.5

BASE STATION INFORMATION

STATION NAME: bil6 a 2 (Billings 6; Billings, Montana USA)
 MONUMENT: NO DOMES NUMBER
 XYZ -1372181.4039 -4223938.0322 4563651.1242 MON @ 2005.0000 (M)
 XYZ -0.0157 0.0001 -0.0063 VEL (M/YR)
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)
 NEU -0.0028 -0.0023 0.0631 ARP TO L1 PHASE CENTER (M)
 NEU -0.0038 -0.0021 0.0612 ARP TO L2 PHASE CENTER (M)
 XYZ -0.1521 0.0012 -0.0612 VEL TIMES 9.6866 YRS
 XYZ 0.0000 0.0000 0.0000 MON TO ARP
 XYZ -0.0163 -0.0430 0.0434 ARP TO L1 PHASE CENTER
 XYZ -1372181.5723 -4223938.0740 4563651.1065 L1 PHS CEN @ 2014.6875
 XYZ -0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS
 XYZ -1372181.5723 -4223938.0740 4563651.1065 NEW L1 PHS CEN @ 2014.6875
 XYZ -1372181.5560 -4223938.0310 4563651.0630 NEW ARP @ 2014.6875
 XYZ -1372181.5560 -4223938.0310 4563651.0630 NEW MON @ 2014.6875
 LLH 45 58 16.27151 252 0 11.44462 874.6856 NEW L1 PHS CEN @ 2014.6875
 LLH 45 58 16.27160 252 0 11.44473 874.6224 NEW ARP @ 2014.6875
 LLH 45 58 16.27160 252 0 11.44473 874.6224 NEW MON @ 2014.6875

STATION NAME: mtei a 1 (ENGINC; Billings, Montana, U.S.A.)
 MONUMENT: NO DOMES NUMBER
 XYZ -1422328.9082 -4226311.5606 4546317.4839 MON @ 2005.0000 (M)
 XYZ -0.0155 0.0003 -0.0078 VEL (M/YR)
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)
 NEU 0.0011 -0.0003 0.0668 ARP TO L1 PHASE CENTER (M)
 NEU 0.0001 0.0007 0.0578 ARP TO L2 PHASE CENTER (M)
 XYZ -0.1497 0.0025 -0.0753 VEL TIMES 9.6866 YRS
 XYZ 0.0000 0.0000 0.0000 MON TO ARP
 XYZ -0.0149 -0.0433 0.0486 ARP TO L1 PHASE CENTER
 XYZ -1422329.0727 -4226311.6014 4546317.4571 L1 PHS CEN @ 2014.6875
 XYZ -0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS
 XYZ -1422329.0727 -4226311.6014 4546317.4571 NEW L1 PHS CEN @ 2014.6875
 XYZ -1422329.0578 -4226311.5581 4546317.4085 NEW ARP @ 2014.6875
 XYZ -1422329.0578 -4226311.5581 4546317.4085 NEW MON @ 2014.6875
 LLH 45 44 47.05574 251 23 59.20743 970.2673 NEW L1 PHS CEN @ 2014.6875
 LLH 45 44 47.05570 251 23 59.20745 970.2005 NEW ARP @ 2014.6875
 LLH 45 44 47.05570 251 23 59.20745 970.2005 NEW MON @ 2014.6875

STATION NAME: p051 a 1 (BillingsAPMT2005; Billings, MT United States)

MONUMENT: NO DOMES NUMBER

XYZ -1416838.9478 -4223178.9397 4551064.1207 MON @ 2005.0000 (M)
XYZ -0.0158 -0.0003 -0.0052 VEL (M/YR)
NEU -0.0000 0.0000 0.0083 MON TO ARP (M)
NEU 0.0012 0.0008 0.0860 ARP TO L1 PHASE CENTER (M)
NEU 0.0006 -0.0006 0.1184 ARP TO L2 PHASE CENTER (M)
XYZ -0.1530 -0.0029 -0.0504 VEL TIMES 9.6866 YRS
XYZ -0.0018 -0.0055 0.0060 MON TO ARP
XYZ -0.0181 -0.0563 0.0625 ARP TO L1 PHASE CENTER
XYZ -1416839.1208 -4223179.0044 4551064.1387 L1 PHS CEN @ 2014.6875
XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
XYZ -1416839.1208 -4223179.0044 4551064.1387 NEW L1 PHS CEN @ 2014.6875
XYZ -1416839.1027 -4223178.9481 4551064.0763 NEW ARP @ 2014.6875
XYZ -1416839.1008 -4223178.9426 4551064.0703 NEW MON @ 2014.6875
LLH 45 48 23.76229 251 27 13.87304 1081.1886 NEW L1 PHS CEN @ 2014.6875
LLH 45 48 23.76225 251 27 13.87301 1081.1026 NEW ARP @ 2014.6875
LLH 45 48 23.76225 251 27 13.87301 1081.0943 NEW MON @ 2014.6875

REMOTE STATION INFORMATION

STATION NAME: 0185 1

MONUMENT: NO DOMES NUMBER

XYZ -1410041.3703 -4259465.4746 4519798.3220 MON @ 2014.6874 (M)
NEU -0.0011 0.0007 1.9999 MON TO ARP (M)
NEU 0.0011 -0.0007 0.0893 ARP TO L1 PHASE CENTER (M)
NEU 0.0007 -0.0031 0.1017 ARP TO L2 PHASE CENTER (M)
XYZ -0.4409 -1.3340 1.4233 MON TO ARP
XYZ -0.0201 -0.0585 0.0643 ARP TO L1 PHASE CENTER
XYZ -1410041.8313 -4259466.8672 4519799.8096 L1 PHS CEN @ 2014.6875

BASELINE NAME: bil6 0185

XYZ -0.0215 0.0301 0.3422 + XYZ ADJUSTMENTS
XYZ -1410041.8528 -4259466.8370 4519800.1518 NEW L1 PHS CEN @ 2014.6875
XYZ -1410041.8327 -4259466.7785 4519800.0875 NEW ARP @ 2014.6875
XYZ -1410041.3918 -4259465.4445 4519798.6642 NEW MON @ 2014.6875
LLH 45 24 8.54635 251 41 0.73314 1323.7044 NEW L1 PHS CEN @ 2014.6875
LLH 45 24 8.54632 251 41 0.73317 1323.6151 NEW ARP @ 2014.6875
LLH 45 24 8.54635 251 41 0.73314 1321.6152 NEW MON @ 2014.6875

BASELINE NAME: mtei 0185

XYZ -0.0221 0.0228 0.3303 + XYZ ADJUSTMENTS
XYZ -1410041.8534 -4259466.8444 4519800.1399 NEW L1 PHS CEN @ 2014.6875
XYZ -1410041.8333 -4259466.7858 4519800.0756 NEW ARP @ 2014.6875
XYZ -1410041.3924 -4259465.4518 4519798.6523 NEW MON @ 2014.6875
LLH 45 24 8.54592 251 41 0.73322 1323.7009 NEW L1 PHS CEN @ 2014.6875
LLH 45 24 8.54588 251 41 0.73325 1323.6117 NEW ARP @ 2014.6875
LLH 45 24 8.54592 251 41 0.73322 1321.6117 NEW MON @ 2014.6875

BASELINE NAME: p051 0185

XYZ -0.0193 0.0344 0.3326 + XYZ ADJUSTMENTS
XYZ -1410041.8506 -4259466.8328 4519800.1422 NEW L1 PHS CEN @ 2014.6875
XYZ -1410041.8305 -4259466.7742 4519800.0779 NEW ARP @ 2014.6875

XYZ -1410041.3896 -4259465.4402 4519798.6546 NEW MON @ 2014.6875
 LLH 45 24 8.54624 251 41 0.73318 1323.6942 NEW L1 PHS CEN @ 2014.6875
 LLH 45 24 8.54621 251 41 0.73321 1323.6050 NEW ARP @ 2014.6875
 LLH 45 24 8.54624 251 41 0.73318 1321.6050 NEW MON @ 2014.6875

G-FILES

Axx2014 9 8 14 9 9
 B2014 9 82142 14 9 9 0 2 1 page5 v1209.04IGS 126 1 2 27NGS 2014 910IFDDPX
 IIGS08_1808 IGS 20140831
 C00090003 378598359 9 355274135 27 438523988 34 X2514A0185X2514ABIL6
 D 1 2 8011374 1 3 -4607159 2 3 -7776303

Axx2014 9 8 14 9 9
 B2014 9 82142 14 9 9 0 2 1 page5 v1209.04IGS 126 1 2 27NGS 2014 910IFDDPX
 IIGS08_1808 IGS 20140831
 C00090001 -122876654 10 331538937 24 265187562 29 X2514A0185X2514AMTEI
 D 1 2 7439707 1 3 -8776860 2 3 -7599626

Axx2014 9 8 14 9 9
 B2014 9 82142 14 9 9 0 2 1 page5 v1209.04IGS 126 1 2 27NGS 2014 910IFDDPX
 IIGS08_1808 IGS 20140831
 C00090002 -67977113 8 362864976 23 312654157 28 X2514A0185X2514AP051
 D 1 2 7640072 1 3 -8091478 2 3 -7026991

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 02 05 06 10 12 15 16 18
 bil6-0185| 0.014 0.017 0.009 ... 0.015 0.018 0.015 0.021 0.012
 21 25 26 29
 bil6-0185| 0.010 0.012 0.015 ...

OVERALL 02 05 06 10 12 15 16 18
 mtei-0185| 0.013 0.015 0.008 ... 0.018 0.015 0.014 0.016 0.015
 21 25 26 29 31
 mtei-0185| 0.011 0.011 0.013

OVERALL 02 05 06 10 12 15 16 18
 p051-0185| 0.014 0.015 0.007 ... 0.017 0.015 0.013 0.013 0.017
 21 25 26 29 31
 p051-0185| 0.014 0.011 0.015

OBS BY SATELLITE VS. BASELINE

OVERALL 02 05 06 10 12 15 16 18
 bil6-0185| 1446 175 280 ... 112 110 100 47 89
 21 25 26 29
 bil6-0185| 190 193 150 ...

OVERALL 02 05 06 10 12 15 16 18
 mtei-0185| 1543 191 280 ... 101 102 100 79 113
 21 25 26 29 31
 mtei-0185| 218 209 150

```

OVERALL 02 05 06 10 12 15 16 18
p051-0185| 1605 179 280 ... 119 110 109 79 119
      21 25 26 29 31
p051-0185| 240 220 150 ... ..

```

Covariance Matrix for the xyz OPUS Position (meters^2).

```

0.0000005444  0.0000001142  -0.0000001282
0.0000001142  0.0000040756  -0.0000003767
-0.0000001282 -0.0000003767  0.0000061800

```

Covariance Matrix for the enu OPUS Position (meters^2).

```

0.0000008251 -0.0000006849  0.0000006753
-0.0000006849  0.0000045808  0.0000011896
0.0000006753  0.0000011896  0.0000053941

```

Horizontal network accuracy = 0.00434 meters.

Vertical network accuracy = 0.00455 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(2011)(EPOCH:2010.0000).

```

      Xa(m)   Ya(m)   Za(m)
BIL6 -1372180.69385 -4223939.27923 4563651.10165 2010.00
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00
P051 -1416838.24007 -4223180.19340 4551064.10960 2010.00

```

Position of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

```

      Xr(m)   Yr(m)   Zr(m)
BIL6 -1372180.69385 -4223939.27923 4563651.10165 2010.00
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00
P051 -1416838.23827 -4223180.18790 4551064.10360 2010.00

```

Velocity of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

```

      Vx (m/yr)  Vy (m/yr)  Vz (m/yr)
BIL6  -0.01570   0.00010  -0.00630
MTEI  -0.01550   0.00030  -0.00780
P051  -0.01580  -0.00030  -0.00520

```

Vectors from unknown station monument to reference station monument in NAD_83(2011)(EPOCH:2010.0000).

```

      Xr-X= DX(m)  Yr-Y= DY(m)  Zr-Z= DZ(m)
BIL6  37859.83615  35527.41577  43852.40565 2010.00
MTEI -12287.66717  33153.88885  26518.75838 2010.00
P051  -6797.70827  36286.50710  31265.40760 2010.00

```

STATE PLANE COORDINATES - International Foot

SPC (2500 MT)

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Northing (Y) [feet]  422495.938
Easting (X) [feet]  2272441.624

```

Convergence [degrees] 0.86577359
Point Scale 0.99978231
Combined Factor 0.99957509

** Orthometric Heights Above Future Geopotential Datum.

Prototype orthometric heights are now being made available as a precursor to the completion of GRAV-D and the replacement of NAVD 88 with a new geopotential reference system. The following height reflects the current best estimate of the true orthometric height, based on the existing gravimetric geoid model. This height is subject to change as data and modeling for the gravimetric geoid change throughout the lifetime of the GRAV-D project, or as new realizations of the ITRF are adopted. However, at the completion of GRAV-D, these heights will supersede the NAVD 88 heights

APPROX ORTHO HGT: 1333.798 (m) [PROTOTYPE (Computed using USGG2012,GRS80,IGS08)]

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.