

# OPUS solution : 018697\_14\_218\_A0.14O OP1407514278236

opus <opus@ngs.noaa.gov>

Fri 8/8/2014 10:13 AM

To:Chad Mozol <Chad.Mozol@neciusa.com>;

FILE: 018697\_14\_218\_A0.14O OP1407514278236

NGS OPUS SOLUTION REPORT  
 =====

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

USER: cmozol@neciusa.com                      DATE: August 08, 2014  
 RINEX FILE: 0186218r.14o                      TIME: 16:13:06 UTC

SOFTWARE: page5 1209.04 master93.pl 022814    START: 2014/08/06 17:20:00  
 EPHEMERIS: igr18043.eph [rapid]              STOP: 2014/08/06 19:28:00  
 NAV FILE: brdc2180.14n                      OBS USED: 5781 / 6104 : 95%  
 ANT NAME: CHCX90D-OPUS    NONE              # FIXED AMB: 41 / 41 : 100%  
 ARP HEIGHT: 2.1000                      OVERALL RMS: 0.017(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.5966)

X:	-1369729.100(m)	0.004(m)	-1369729.974(m)	0.004(m)
Y:	-4050986.140(m)	0.016(m)	-4050984.915(m)	0.016(m)
Z:	4717849.369(m)	0.015(m)	4717849.359(m)	0.015(m)

LAT:	48 0 7.33871	0.004(m)	48 0 7.35967	0.004(m)
E LON:	251 19 6.43342	0.008(m)	251 19 6.37456	0.008(m)
W LON:	108 40 53.56658	0.008(m)	108 40 53.62544	0.008(m)
EL HGT:	1105.232(m)	0.021(m)	1104.635(m)	0.021(m)
ORTHO HGT:	1120.585(m)	0.036(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 12)              SPC (2500 MT )

Northing (Y) [meters]	5319127.723	417241.417
Easting (X) [meters]	672934.525	661045.918
Convergence [degrees]	1.72342697	0.59870234
Point Scale	0.99996749	0.99954214
Combined Factor	0.99979430	0.99936902

US NATIONAL GRID DESIGNATOR: 12UXU7293419127(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI3425	P052 LRRNCHJRDNMT2006	CORS ARP	N472229.026 W1070107.185	143015.8
DM7133	MTLW LEWISTOWN	CORS ARP	N470314.929 W1092633.764	119985.3
DI2257	P049 ARMINGTON_MT2006	CORS ARP	N472059.850 W1105422.382	182125.4

NEAREST NGS PUBLISHED CONTROL POINT

SR1020	Q 135	N475921.	W1084135.	1669.8
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BASE STATION INFORMATION

STATION NAME: p052 a 2 (LRRnchJrdnMT2006; Jordan, MT United States)

MONUMENT: NO DOMES NUMBER

XYZ	-1266648.1846	-4138194.5676	4670709.5484	MON @ 2005.0000 (M)
XYZ	-0.0158	0.0003	-0.0057	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	0.1183	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1517	0.0031	-0.0550	VEL TIMES 9.5957 YRS
XYZ	-0.0016	-0.0054	0.0061	MON TO ARP
XYZ	-0.0161	-0.0551	0.0641	ARP TO L1 PHASE CENTER
XYZ	-1266648.3540	-4138194.6249	4670709.5636	L1 PHS CEN @ 2014.5966
XYZ	0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	-1266648.3540	-4138194.6249	4670709.5636	NEW L1 PHS CEN @ 2014.5966
XYZ	-1266648.3380	-4138194.5698	4670709.4996	NEW ARP @ 2014.5966
XYZ	-1266648.3363	-4138194.5645	4670709.4935	NEW MON @ 2014.5966
LLH	47 22 29.04864	252 58 52.75789	858.7208	NEW L1 PHS CEN @ 2014.5966
LLH	47 22 29.04860	252 58 52.75785	858.6348	NEW ARP @ 2014.5966
LLH	47 22 29.04860	252 58 52.75785	858.6265	NEW MON @ 2014.5966

STATION NAME: mtlw a 1 (Lewistown; Lewistown, Montana USA)

MONUMENT: NO DOMES NUMBER

XYZ	-1449333.3267	-4105829.8275	4646773.5579	MON @ 2005.0000 (M)
XYZ	-0.0160	-0.0003	-0.0053	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	-0.1540	-0.0033	-0.0506	VEL TIMES 9.5957 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	-0.0152	-0.0420	0.0496	ARP TO L1 PHASE CENTER
XYZ	-1449333.4959	-4105829.8728	4646773.5570	L1 PHS CEN @ 2014.5966
XYZ	0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1449333.4959	-4105829.8728	4646773.5570	NEW L1 PHS CEN @ 2014.5966
XYZ	-1449333.4807	-4105829.8307	4646773.5074	NEW ARP @ 2014.5966
XYZ	-1449333.4807	-4105829.8307	4646773.5074	NEW MON @ 2014.5966
LLH	47 3 14.94992	250 33 26.17775	1236.4224	NEW L1 PHS CEN @ 2014.5966

LLH 47 3 14.94988 250 33 26.17776 1236.3556 NEW ARP @ 2014.5966  
 LLH 47 3 14.94988 250 33 26.17776 1236.3556 NEW MON @ 2014.5966

STATION NAME: p049 a 1 (Armington\_MT2006; Belt, MT United States)  
 MONUMENT: NO DOMES NUMBER

XYZ -1545099.6822 -4044895.8653 4669084.6330 MON @ 2005.0000 (M)  
 XYZ -0.0157 -0.0002 -0.0067 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 0.1183 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1511 -0.0017 -0.0645 VEL TIMES 9.5957 YRS  
 XYZ -0.0020 -0.0053 0.0061 MON TO ARP  
 XYZ -0.0198 -0.0539 0.0640 ARP TO L1 PHASE CENTER  
 XYZ -1545099.8551 -4044895.9261 4669084.6386 L1 PHS CEN @ 2014.5966  
 XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ -1545099.8551 -4044895.9261 4669084.6386 NEW L1 PHS CEN @ 2014.5966  
 XYZ -1545099.8353 -4044895.8722 4669084.5745 NEW ARP @ 2014.5966  
 XYZ -1545099.8333 -4044895.8669 4669084.5684 NEW MON @ 2014.5966  
 LLH 47 20 59.87006 249 5 37.55750 1186.1535 NEW L1 PHS CEN @ 2014.5966  
 LLH 47 20 59.87003 249 5 37.55747 1186.0675 NEW ARP @ 2014.5966  
 LLH 47 20 59.87003 249 5 37.55747 1186.0592 NEW MON @ 2014.5966

#### REMOTE STATION INFORMATION

STATION NAME: 0186 1

MONUMENT: NO DOMES NUMBER

XYZ -1369729.6950 -4050984.8376 4717848.7935 MON @ 2014.5965 (M)  
 NEU -0.0011 0.0007 2.0999 MON TO ARP (M)  
 NEU 0.0011 -0.0007 0.0892 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0007 -0.0031 0.1017 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.4497 -1.3320 1.5599 MON TO ARP  
 XYZ -0.0195 -0.0556 0.0671 ARP TO L1 PHASE CENTER  
 XYZ -1369730.1642 -4050986.2252 4717850.4204 L1 PHS CEN @ 2014.5966

BASELINE NAME: p052 0186

XYZ -0.2784 -0.0860 0.5722 + XYZ ADJUSTMENTS  
 XYZ -1369730.4426 -4050986.3112 4717850.9926 NEW L1 PHS CEN @ 2014.5966  
 XYZ -1369730.4231 -4050986.2556 4717850.9256 NEW ARP @ 2014.5966  
 XYZ -1369729.9734 -4050984.9236 4717849.3657 NEW MON @ 2014.5966  
 LLH 48 0 7.35963 251 19 6.37472 1106.8348 NEW L1 PHS CEN @ 2014.5966  
 LLH 48 0 7.35959 251 19 6.37475 1106.7455 NEW ARP @ 2014.5966  
 LLH 48 0 7.35963 251 19 6.37472 1104.6456 NEW MON @ 2014.5966

BASELINE NAME: mtlw 0186

XYZ -0.2778 -0.0755 0.5673 + XYZ ADJUSTMENTS  
 XYZ -1369730.4420 -4050986.3008 4717850.9878 NEW L1 PHS CEN @ 2014.5966  
 XYZ -1369730.4225 -4050986.2452 4717850.9207 NEW ARP @ 2014.5966  
 XYZ -1369729.9728 -4050984.9131 4717849.3608 NEW MON @ 2014.5966  
 LLH 48 0 7.35976 251 19 6.37459 1106.8244 NEW L1 PHS CEN @ 2014.5966  
 LLH 48 0 7.35973 251 19 6.37462 1106.7351 NEW ARP @ 2014.5966  
 LLH 48 0 7.35976 251 19 6.37459 1104.6352 NEW MON @ 2014.5966

BASELINE NAME: p049 0186  
 XYZ -0.2815 -0.0695 0.5574 + XYZ ADJUSTMENTS  
 XYZ -1369730.4457 -4050986.2947 4717850.9778 NEW L1 PHS CEN @ 2014.5966  
 XYZ -1369730.4262 -4050986.2391 4717850.9108 NEW ARP @ 2014.5966  
 XYZ -1369729.9765 -4050984.9071 4717849.3509 NEW MON @ 2014.5966  
 LLH 48 0 7.35966 251 19 6.37432 1106.8140 NEW L1 PHS CEN @ 2014.5966  
 LLH 48 0 7.35962 251 19 6.37436 1106.7248 NEW ARP @ 2014.5966  
 LLH 48 0 7.35966 251 19 6.37432 1104.6248 NEW MON @ 2014.5966

G-FILES

Axx2014 8 6 14 8 6  
 B2014 8 61719 14 8 61928 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090005 1030816371 10 -872096409 28 -471398722 29 X2184A0186X2184AP052  
 D 1 2 4417261 1 3 -6558332 2 3 -8907731

Axx2014 8 6 14 8 6  
 B2014 8 61719 14 8 61928 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090003 -796035079 16 -548449176 31 -710758534 32 X2184A0186X2184AMTLW  
 D 1 2 8622238 1 3 -5243096 2 3 -8016110

Axx2014 8 6 14 8 6  
 B2014 8 61719 14 8 61928 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090001-1753698568 18 60890402 26 -487647825 32 X2184A0186X2184AP049  
 D 1 2 5945220 1 3 -4822025 2 3 -9327200

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 01 04 06 07 08 11 15 17  
 p052-0186| 0.016 0.015 0.013 0.023 0.019 0.015 0.014 0.029 ...  
 19 20 24 26 28 30  
 p052-0186| ... .. 0.018 0.016 0.010 0.013

OVERALL 01 04 06 07 08 11 15 17  
 mtlw-0186| 0.017 0.018 0.016 0.017 0.018 0.016 0.015 0.026 ...  
 19 20 24 26 28 30  
 mtlw-0186| ... .. 0.023 0.017 0.012 0.013

OVERALL 01 04 06 07 08 11 15 17  
 p049-0186| 0.017 0.017 0.014 0.017 0.016 0.022 0.015 0.031 ...  
 19 20 24 26 28 30  
 p049-0186| ... .. 0.020 0.016 0.010 0.016

OBS BY SATELLITE VS. BASELINE

OVERALL 01 04 06 07 08 11 15 17  
 p052-0186| 1937 255 241 94 66 152 181 158 ...

```

    19  20  24  26  28  30
p052-0186| ... .. 105 207 255 223
    OVERALL  01  04  06  07  08  11  15  17
mtlw-0186| 1900 255 229 76 59 152 180 151 ...
    19  20  24  26  28  30
mtlw-0186| ... .. 133 207 255 203
    OVERALL  01  04  06  07  08  11  15  17
p049-0186| 1944 255 239 94 59 152 181 158 ...
    19  20  24  26  28  30
p049-0186| ... .. 122 207 255 222

```

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

```

0.0000020911  0.0000002799  -0.0000003099
0.0000002799  0.0000081378  -0.0000007986
-0.0000003099 -0.0000007986  0.0000105600

```

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

```

0.0000025416  -0.0000012200  0.0000010548
-0.0000012200  0.0000081312  0.0000013456
0.0000010548  0.0000013456  0.0000101160

```

Horizontal network accuracy = 0.00593 meters.

Vertical network accuracy = 0.00624 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)
P052 -1266647.47169 -4138195.81057 4670709.52375 2010.00
MTLW  -1449332.61170 -4105831.06162 4646773.52520 2010.00
P049  -1545098.96458 -4044897.09606 4669084.59181 2010.00

```

Position of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

```

    Xr(m)    Yr(m)    Zr(m)
P052 -1266647.47009 -4138195.80517 4670709.51765 2010.00
MTLW  -1449332.61170 -4105831.06162 4646773.52520 2010.00
P049  -1545098.96258 -4044897.09076 4669084.58571 2010.00

```

Velocity of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

```

    Vx (m/yr)  Vy (m/yr)  Vz (m/yr)
P052  -0.01580   0.00030  -0.00570
MTLW   -0.01600  -0.00030  -0.00530
P049   -0.01570  -0.00020  -0.00670

```

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)
P052  103081.62991 -87209.66517 -47139.85135 2010.00

```

MTLW	-79603.51170	-54844.92162	-71075.84380	2010.00
P049	-175369.86258	6089.04924	-48764.78329	2010.00

## STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet]	1368902.287
Easting (X) [feet]	2168785.820
Convergence [degrees]	0.59870234
Point Scale	0.99954214
Combined Factor	0.99936902

\*\* 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: 1119.583 (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.