

# OPUS solution : 018697\_14\_217\_A0.14O OP1407514247549

opus <opus@ngs.noaa.gov>

Fri 8/8/2014 10:13 AM

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

FILE: 018697\_14\_217\_A0.14O OP1407514247549

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: 0186217s.14o                      TIME: 16:12:38 UTC

SOFTWARE: page5 1209.04 master90.pl 022814    START: 2014/08/05 18:46:00  
 EPHEMERIS: igr18042.eph [rapid]              STOP: 2014/08/05 22:50:00  
 NAV FILE: brdc2170.14n                      OBS USED: 9259 / 10375 : 89%  
 ANT NAME: CHCX90D-OPUS    NONE              # FIXED AMB: 76 / 81 : 94%  
 ARP HEIGHT: 2.1000                      OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.5942)

X: -1368973.325(m) 0.004(m)              -1368974.199(m) 0.004(m)  
 Y: -4053781.992(m) 0.009(m)              -4053780.766(m) 0.009(m)  
 Z: 4715719.103(m) 0.004(m)              4715719.092(m) 0.004(m)

LAT: 47 58 23.29735    0.006(m)              47 58 23.31832    0.006(m)  
 E LON: 251 20 24.11914    0.006(m)              251 20 24.06031    0.006(m)  
 W LON: 108 39 35.88086    0.006(m)              108 39 35.93969    0.006(m)  
 EL HGT: 1133.276(m) 0.008(m)              1132.678(m) 0.008(m)  
 ORTHO HGT: 1148.541(m) 0.016(m) [NAVD88 (Computed using GEOID12A)]

UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 12)              SPC (2500 MT )

Northing (Y) [meters]    5315964.504              414046.693  
 Easting (X) [meters]    674641.566              662689.841  
 Convergence [degrees]    1.73868637              0.61448774  
 Point Scale              0.99997478              0.99953350  
 Combined Factor              0.99979720              0.99935599

US NATIONAL GRID DESIGNATOR: 12TXU7464115964(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI3425	P052 LRRNCHJRDNMT2006	CORS ARP	N472229.026 W1070107.185	140079.0
DL7731	P053 WHITEWATERMT2007	CORS ARP	N484333.865 W1074331.456	108678.7
DG9749	MTMS MONTANA STATE UNI	CORS ARP	N483227.426 W1094111.858	98997.6

NEAREST NGS PUBLISHED CONTROL POINT

SR0247	P 135	N475837.	W1084023.	1063.5
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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 9.5933 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 @ 2014.5941
XYZ	-0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1266648.3540	-4138194.6249	4670709.5636	NEW L1 PHS CEN @ 2014.5941
XYZ	-1266648.3379	-4138194.5698	4670709.4996	NEW ARP @ 2014.5941
XYZ	-1266648.3363	-4138194.5645	4670709.4935	NEW MON @ 2014.5941
LLH	47 22 29.04864	252 58 52.75789	858.7208	NEW L1 PHS CEN @ 2014.5941
LLH	47 22 29.04860	252 58 52.75785	858.6348	NEW ARP @ 2014.5941
LLH	47 22 29.04860	252 58 52.75785	858.6265	NEW MON @ 2014.5941

STATION NAME: p053 a 1 (WhitewaterMT2007; Whitewater, Montana USA)

MONUMENT: NO DOMES NUMBER

XYZ	-1283559.0999	-4015770.3187	4771131.6503	MON @ 2005.0000 (M)
XYZ	-0.0164	-0.0004	-0.0047	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	-0.1575	-0.0037	-0.0452	VEL TIMES 9.5933 YRS
XYZ	-0.0017	-0.0052	0.0062	MON TO ARP
XYZ	-0.0163	-0.0534	0.0654	ARP TO L1 PHASE CENTER
XYZ	-1283559.2753	-4015770.3811	4771131.6767	L1 PHS CEN @ 2014.5942
XYZ	0.0001	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1283559.2753	-4015770.3811	4771131.6767	NEW L1 PHS CEN @ 2014.5942
XYZ	-1283559.2590	-4015770.3277	4771131.6114	NEW ARP @ 2014.5942
XYZ	-1283559.2573	-4015770.3225	4771131.6051	NEW MON @ 2014.5942
LLH	48 43 33.88709	252 16 28.48430	815.0921	NEW L1 PHS CEN @ 2014.5942

LLH 48 43 33.88705 252 16 28.48427 815.0061 NEW ARP @ 2014.5942  
 LLH 48 43 33.88705 252 16 28.48427 814.9978 NEW MON @ 2014.5942

STATION NAME: mtms a 1 (MONTANA STATE UNIVERSI; Havre, Montana, U.S.A.)  
 MONUMENT: NO DOMES NUMBER

XYZ -1425435.4171 -3984013.1973 4757493.9413 MON @ 2005.0000 (M)  
 XYZ -0.0165 -0.0009 -0.0066 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0003 0.0005 0.0559 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0001 0.0005 0.0580 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1579 -0.0082 -0.0635 VEL TIMES 9.5933 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ -0.0119 -0.0348 0.0421 ARP TO L1 PHASE CENTER  
 XYZ -1425435.5869 -3984013.2404 4757493.9200 L1 PHS CEN @ 2014.5942  
 XYZ 0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS  
 XYZ -1425435.5869 -3984013.2404 4757493.9200 NEW L1 PHS CEN @ 2014.5942  
 XYZ -1425435.5750 -3984013.2055 4757493.8779 NEW ARP @ 2014.5942  
 XYZ -1425435.5750 -3984013.2055 4757493.8779 NEW MON @ 2014.5942  
 LLH 48 32 27.44706 250 18 48.08175 773.4072 NEW L1 PHS CEN @ 2014.5942  
 LLH 48 32 27.44705 250 18 48.08172 773.3513 NEW ARP @ 2014.5942  
 LLH 48 32 27.44705 250 18 48.08172 773.3513 NEW MON @ 2014.5942

REMOTE STATION INFORMATION

STATION NAME: 0186 1  
 MONUMENT: NO DOMES NUMBER  
 XYZ -1368974.0996 -4053780.7479 4715718.6032 MON @ 2014.5939 (M)  
 NEU -0.0011 0.0007 2.1000 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 -0.4494 -1.3329 1.5592 MON TO ARP  
 XYZ -0.0195 -0.0556 0.0670 ARP TO L1 PHASE CENTER  
 XYZ -1368974.5685 -4053782.1365 4715720.2294 L1 PHS CEN @ 2014.5941

BASELINE NAME: p052 0186  
 XYZ -0.0985 -0.0149 0.4894 + XYZ ADJUSTMENTS  
 XYZ -1368974.6670 -4053782.1513 4715720.7189 NEW L1 PHS CEN @ 2014.5941  
 XYZ -1368974.6475 -4053782.0957 4715720.6518 NEW ARP @ 2014.5941  
 XYZ -1368974.1981 -4053780.7628 4715719.0926 NEW MON @ 2014.5941  
 LLH 47 58 23.31842 251 20 24.06030 1134.8650 NEW L1 PHS CEN @ 2014.5941  
 LLH 47 58 23.31838 251 20 24.06034 1134.7757 NEW ARP @ 2014.5941  
 LLH 47 58 23.31842 251 20 24.06030 1132.6758 NEW MON @ 2014.5941

BASELINE NAME: p053 0186  
 XYZ -0.1012 -0.0153 0.4858 + XYZ ADJUSTMENTS  
 XYZ -1368974.6697 -4053782.1518 4715720.7152 NEW L1 PHS CEN @ 2014.5942  
 XYZ -1368974.6502 -4053782.0962 4715720.6481 NEW ARP @ 2014.5942  
 XYZ -1368974.2008 -4053780.7632 4715719.0890 NEW MON @ 2014.5942  
 LLH 47 58 23.31830 251 20 24.06019 1134.8631 NEW L1 PHS CEN @ 2014.5942  
 LLH 47 58 23.31827 251 20 24.06022 1134.7739 NEW ARP @ 2014.5942  
 LLH 47 58 23.31830 251 20 24.06019 1132.6739 NEW MON @ 2014.5942

BASELINE NAME: mtms 0186

XYZ -0.0971 -0.0237 0.4902 + XYZ ADJUSTMENTS  
 XYZ -1368974.6657 -4053782.1602 4715720.7196 NEW L1 PHS CEN @ 2014.5942  
 XYZ -1368974.6462 -4053782.1046 4715720.6526 NEW ARP @ 2014.5942  
 XYZ -1368974.1967 -4053780.7716 4715719.0934 NEW MON @ 2014.5942  
 LLH 47 58 23.31824 251 20 24.06050 1134.8709 NEW L1 PHS CEN @ 2014.5942  
 LLH 47 58 23.31820 251 20 24.06053 1134.7817 NEW ARP @ 2014.5942  
 LLH 47 58 23.31824 251 20 24.06050 1132.6817 NEW MON @ 2014.5942

G-FILES

Axx2014 8 5 14 8 5

B2014 8 51845 14 8 52249 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090005 1023258618 6 -844138017 15 -450095992 17 X2174A0186X2174AP052  
 D 1 2 6599178 1 3 -7580476 2 3 -9116855

Axx2014 8 5 14 8 5

B2014 8 51845 14 8 52249 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090004 854149435 7 380104408 16 554125162 20 X2174A0186X2174AP053  
 D 1 2 7817410 1 3 -5928927 2 3 -9013510

Axx2014 8 5 14 8 5

B2014 8 51845 14 8 52249 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090002 -564613782 10 697675661 23 417747844 28 X2174A0186X2174AMTMS  
 D 1 2 6190488 1 3 -7800507 2 3 -8650447

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 01 02 04 05 06 08 10 11  
 p052-0186| 0.012 0.014 0.010 0.009 0.013 0.011 ... 0.013 0.024  
 12 15 17 20 24 25 26 28 29  
 p052-0186| 0.010 0.019 0.024 0.017 0.011 0.013 0.014 0.012 0.017  
 30 31  
 p052-0186| 0.012 ...

OVERALL 01 02 04 05 06 10 11 12  
 p053-0186| 0.013 0.014 0.011 0.010 0.018 0.011 0.014 0.029 0.012  
 15 17 20 24 25 26 28 29 30  
 p053-0186| 0.030 0.020 0.016 0.011 0.012 0.023 0.012 0.015 0.016  
 31  
 p053-0186| ...

OVERALL 01 02 04 05 06 10 11 12  
 mtms-0186| 0.018 0.020 0.016 0.014 0.023 0.020 0.019 ... 0.016  
 15 17 20 24 25 26 28 29 30  
 mtms-0186| 0.020 0.030 0.024 0.017 0.017 0.018 0.016 0.023 0.052  
 31

mtms-0186| ...

OBS BY SATELLITE VS. BASELINE

```

OVERALL 01 02 04 05 06 08 10 11
p052-0186| 3284 148 358 398 68 347 ... 209 41
          12 15 17 20 24 25 26 28 29
p052-0186| 355 77 61 218 456 180 48 252 26
          30 31
p052-0186| 42 ...
OVERALL 01 02 04 05 06 10 11 12
p053-0186| 3183 132 364 412 79 347 187 4 370
          15 17 20 24 25 26 28 29 30
p053-0186| 76 62 193 437 161 30 252 47 30
          31
p053-0186| ...
OVERALL 01 02 04 05 06 10 11 12
mtms-0186| 2792 99 345 320 60 288 125 ... 349
          15 17 20 24 25 26 28 29 30
mtms-0186| 73 50 169 435 188 51 195 43 2
          31
mtms-0186| ...
    
```

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

```

0.0000005111  0.0000000795  -0.0000000971
0.0000000795  0.0000025378  -0.0000002776
-0.0000000971 -0.0000002776  0.0000037978
    
```

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

```

0.0000006704  -0.0000004103  0.0000003680
-0.0000004103  0.0000027267  0.0000006778
0.0000003680  0.0000006778  0.0000034496
    
```

Horizontal network accuracy = 0.00339 meters.

Vertical network accuracy = 0.00364 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
P053 -1283558.38336 -4015771.55123 4771131.61488 2010.00
MTMS -1425434.69795 -3984014.42122 4757493.88638 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
P053 -1283558.38166 -4015771.54603 4771131.60868 2010.00
    
```

MTMS -1425434.69795 -3984014.42122 4757493.88638 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
P053	-0.01640	-0.00040	-0.00470
MTMS	-0.01650	-0.00090	-0.00660

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	102325.85491	-84413.81317	-45009.58535	2010.00
P053	85414.94334	38010.44597	55412.50568	2010.00
MTMS	-56461.37295	69767.57078	41774.78338	2010.00

STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet]	1358420.909
Easting (X) [feet]	2174179.268
Convergence [degrees]	0.61448774
Point Scale	0.99953350
Combined Factor	0.99935599

\*\* 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: 1147.539 (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.