OPUS solution : 018697_14_218_A1.14O OP1407514344432

opus <opus@ngs.noaa.gov>

Fri 8/8/2014 10:14 AM

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

FILE: 018697_14_218_A1.14O OP1407514344432

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: cmozol@neciusa.com DATE: August 08, 2014
RINEX FILE: 0186218u.14o TIME: 16:14:17 UTC

SOFTWARE: page5 1209.04 master51.pl 022814 START: 2014/08/06 20:23:00
EPHEMERIS: igr18043.eph [rapid] STOP: 2014/08/06 23:13:30
NAV FILE: brdc2180.14n OBS USED: 6070 / 6872 : 88%
ANT NAME: CHCX90D-OPUS NONE # FIXED AMB: 55 / 59 : 93%
ARP HEIGHT: 2.1000 OVERALL RMS: 0.018(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2014.5970)

X:	-1370493.337(m)	0.004(m)	-1370494.211(m)	0.004(m)
Y:	-4053266.866(m)	0.009(m)	-4053265.640(m)	0.009(m)
Z:	4715717.115(m)	0.019(m)	4715717.104(m)	0.019(m)
LAT:	47 58 23.28835	0.006(m)	47 58 23.30931	0.006(m)
E LON:	251 19 6.74979	0.005(m)	251 19 6.69094	0.005(m)
W LON:	108 40 53.25021	0.005(m)	108 40 53.30906	0.005(m)
EL HGT:	1130.850(m)	0.020(m)	1130.252(m)	0.020(m)
ORTHO HGT:	1146.118(m)	0.035(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES (UTM (Zone 12))	STATE PLANE COORDINATES (SPC (2500 MT))
Northing (Y) [meters]	5315915.764	414029.434
Easting (X) [meters]	673037.710	661086.041
Convergence [degrees]	1.72270982	0.59876663
Point Scale	0.99996793	0.99953350
Combined Factor	0.99979073	0.99935637

US NATIONAL GRID DESIGNATOR: 12TXU7303715915(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM7133	MTLW LEWISTOWN CORS ARP	N470314.929	W1092633.764	117183.0
DG9749	MTMS MONTANA STATE UNI CORS ARP	N483227.426	W1094111.858	97774.0
DI3425	P052 LRRNCHJRDNMT2006 CORS ARP	N472229.026	W1070107.185	141501.1

NEAREST NGS PUBLISHED CONTROL POINT

SR0247	P 135	N475837.	W1084023.	756.2

BASE STATION INFORMATION

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 9.5961 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 @ 2014.5970
XYZ	-0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1449333.4959	-4105829.8728	4646773.5570	NEW L1 PHS CEN @ 2014.5970
XYZ	-1449333.4808	-4105829.8307	4646773.5074	NEW ARP @ 2014.5970
XYZ	-1449333.4808	-4105829.8307	4646773.5074	NEW MON @ 2014.5970
LLH	47 3 14.94991	250 33 26.17774	1236.4224	NEW L1 PHS CEN @ 2014.5970
LLH	47 3 14.94988	250 33 26.17776	1236.3556	NEW ARP @ 2014.5970
LLH	47 3 14.94988	250 33 26.17776	1236.3556	NEW MON @ 2014.5970

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 9.5961 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	4757493.9199	L1 PHS CEN @ 2014.5970
XYZ	0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	-1425435.5869	-3984013.2404	4757493.9199	NEW L1 PHS CEN @ 2014.5970
XYZ	-1425435.5750	-3984013.2055	4757493.8779	NEW ARP @ 2014.5970
XYZ	-1425435.5750	-3984013.2055	4757493.8779	NEW MON @ 2014.5970
LLH	48 32 27.44706	250 18 48.08175	773.4072	NEW L1 PHS CEN @ 2014.5970

LLH 48 32 27.44705 250 18 48.08172 773.3513 NEW ARP @ 2014.5970
LLH 48 32 27.44705 250 18 48.08172 773.3513 NEW MON @ 2014.5970

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 9.5961 YRS
XYZ -0.0016 -0.0054 0.0061 MON TO ARP
XYZ -0.0161 -0.0551 0.0641 ARP TO L1 PHASE CENTER
XYZ -1266648.3541 -4138194.6249 4670709.5636 L1 PHS CEN @ 2014.5970
XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
XYZ -1266648.3541 -4138194.6249 4670709.5636 NEW L1 PHS CEN @ 2014.5970
XYZ -1266648.3380 -4138194.5698 4670709.4996 NEW ARP @ 2014.5970
XYZ -1266648.3363 -4138194.5645 4670709.4935 NEW MON @ 2014.5970
LLH 47 22 29.04864 252 58 52.75789 858.7208 NEW L1 PHS CEN @ 2014.5970
LLH 47 22 29.04860 252 58 52.75785 858.6348 NEW ARP @ 2014.5970
LLH 47 22 29.04860 252 58 52.75785 858.6265 NEW MON @ 2014.5970

REMOTE STATION INFORMATION

STATION NAME: 0186 1
MONUMENT: NO DOMES NUMBER
XYZ -1370494.1472 -4053265.5362 4715716.6344 MON @ 2014.5968 (M)
NEU -0.0011 0.0007 2.1000 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 -0.4499 -1.3328 1.5592 MON TO ARP
XYZ -0.0195 -0.0556 0.0670 ARP TO L1 PHASE CENTER
XYZ -1370494.6166 -4053266.9246 4715718.2606 L1 PHS CEN @ 2014.5970

BASELINE NAME: mtlw 0186
XYZ -0.0614 -0.1034 0.4704 + XYZ ADJUSTMENTS
XYZ -1370494.6780 -4053267.0280 4715718.7310 NEW L1 PHS CEN @ 2014.5970
XYZ -1370494.6585 -4053266.9723 4715718.6640 NEW ARP @ 2014.5970
XYZ -1370494.2086 -4053265.6396 4715717.1048 NEW MON @ 2014.5970
LLH 47 58 23.30936 251 19 6.69104 1132.4412 NEW L1 PHS CEN @ 2014.5970
LLH 47 58 23.30932 251 19 6.69108 1132.3519 NEW ARP @ 2014.5970
LLH 47 58 23.30936 251 19 6.69104 1130.2520 NEW MON @ 2014.5970

BASELINE NAME: mtms 0186
XYZ -0.0655 -0.1079 0.4780 + XYZ ADJUSTMENTS
XYZ -1370494.6822 -4053267.0325 4715718.7386 NEW L1 PHS CEN @ 2014.5970
XYZ -1370494.6626 -4053266.9768 4715718.6716 NEW ARP @ 2014.5970
XYZ -1370494.2127 -4053265.6441 4715717.1124 NEW MON @ 2014.5970
LLH 47 58 23.30939 251 19 6.69093 1132.4506 NEW L1 PHS CEN @ 2014.5970
LLH 47 58 23.30935 251 19 6.69096 1132.3613 NEW ARP @ 2014.5970
LLH 47 58 23.30939 251 19 6.69093 1130.2614 NEW MON @ 2014.5970

```
 BASELINE NAME:   p052  0186
 XYZ       -0.0655       -0.0988        0.4590  + XYZ ADJUSTMENTS
 XYZ  -1370494.6822  -4053267.0234   4715718.7196  NEW L1 PHS CEN @ 2014.5970
 XYZ  -1370494.6626  -4053266.9678   4715718.6526  NEW ARP @ 2014.5970
 XYZ  -1370494.2127  -4053265.6350   4715717.0934  NEW MON @ 2014.5970
 LLH  47 58 23.30918  251 19  6.69079   1132.4307  NEW L1 PHS CEN @ 2014.5970
 LLH  47 58 23.30915  251 19  6.69082   1132.3414  NEW ARP @ 2014.5970
 LLH  47 58 23.30918  251 19  6.69079   1130.2415  NEW MON @ 2014.5970

                          G-FILES

Axx2014 8 6  14 8 6
B2014 8 62022  14 8 62313 1 page5 v1209.04IGS     126 1 2 27NGS   2014 8 8IFDDPX
IIGS08_1804          IGS   20140803
C00090003 -788392722   10 -525641912   23 -689435974   31 X2184A0186X2184AMTLW
D  1  2  6739834  1  3 -4235071  2  3 -8794886

Axx2014 8 6  14 8 6
B2014 8 62022  14 8 62313 1 page5 v1209.04IGS     126 1 2 27NGS   2014 8 8IFDDPX
IIGS08_1804          IGS   20140803
C00090002 -549413623   15  692524385   35  417767654   40 X2184A0186X2184AMTMS
D  1  2  6484342  1  3 -7605164  2  3 -8987080

Axx2014 8 6  14 8 6
B2014 8 62022  14 8 62313 1 page5 v1209.04IGS     126 1 2 27NGS   2014 8 8IFDDPX
IIGS08_1804          IGS   20140803
C00090005 1038458764   12 -849289295   27 -450075999   30 X2184A0186X2184AP052
D  1  2  6467702  1  3 -7300830  2  3 -9139113

              POST-FIT RMS BY SATELLITE VS. BASELINE

         OVERALL     02     04     05     06     10     12     17     20
 mtlw-0186|  0.016    ...  0.017  0.017  0.013  0.016  0.012  0.016  0.027
            24     25     28     29     31
 mtlw-0186|  0.021  0.017  0.023  0.026  0.037

         OVERALL     02     04     05     06     10     12     17     20
 mtms-0186|  0.020    ...  0.022  0.021  0.013  0.020  0.014  0.022  0.028
            24     25     28     29     31
 mtms-0186|  0.024  0.019    ...  0.042  0.039

         OVERALL     02     04     05     06     10     12     17     20
 p052-0186|  0.017    ...  0.018  0.019  0.011  0.014  0.012  0.014  0.027
            24     25     28     29     31
 p052-0186|  0.022  0.019    ...  0.030  0.033

                  OBS BY SATELLITE VS. BASELINE

         OVERALL     02     04     05     06     10     12     17     20
 mtlw-0186|   2068    ...    168    125    332    263    332    218     54
```

```
            24     25     28     29     31
mtlw-0186|    201    253     22     73     27
         OVERALL     02     04     05     06     10     12     17     20
mtms-0186|   1900    ...    159     93    331    210    321    169     40
            24     25     28     29     31
mtms-0186|    201    249    ...     72     55
         OVERALL     02     04     05     06     10     12     17     20
p052-0186|   2102    ...    184    103    331    260    331    221    100
            24     25     28     29     31
p052-0186|    201    258    ...     73     40
```

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

```
 0.0000009911     0.0000001401    -0.0000001609
 0.0000001401     0.0000048778    -0.0000005278
-0.0000001609    -0.0000005278     0.0000070800
```

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

```
 0.0000013049    -0.0000007797     0.0000007300
-0.0000007797     0.0000051511     0.0000011986
 0.0000007300     0.0000011986     0.0000064929
```

Horizontal network accuracy = 0.00466 meters.
Vertical network accuracy = 0.00500 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)	
MTLW	-1449332.61170	-4105831.06162	4646773.52520	2010.00
MTMS	-1425434.69795	-3984014.42122	4757493.88638	2010.00
P052	-1266647.47169	-4138195.81057	4670709.52375	2010.00

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

	Xr(m)	Yr(m)	Zr(m)	
MTLW	-1449332.61170	-4105831.06162	4646773.52520	2010.00
MTMS	-1425434.69795	-3984014.42122	4757493.88638	2010.00
P052	-1266647.47009	-4138195.80517	4670709.51765	2010.00

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
MTLW	-0.01600	-0.00030	-0.00530
MTMS	-0.01650	-0.00090	-0.00660
P052	-0.01580	0.00030	-0.00570

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)	
MTLW	-78839.27470	-52564.19562	-68943.58980	2010.00

MTMS -54941.36095 69252.44478 41776.77138 2010.00
P052 103845.86691 -84928.93917 -45007.59735 2010.00

STATE PLANE COORDINATES - International Foot
SPC (2500 MT)
Northing (Y) [feet] 1358364.285
Easting (X) [feet] 2168917.457
Convergence [degrees] 0.59876663
Point Scale 0.99953350
Combined Factor 0.99935637

** 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: 1145.116 (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.