

)Title:	GNSS Solutions 3.80.8; Reference Frame and GEOID Notes
Date:	Revised 1 January 2013
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Thesis:	Step-by-Step Instructions: GNSS Solutions with NAD83_2011, Geoid2012A

This document describes, step-by-step, how to use GNSS to derive accurate NAD83-2011 framed solutions with the latest Geoid 2012A.

While there is currently no direct GNSS Solutions support for NAD83-2010, GEOID 2012A; this document describes how to 'hotwire' GNSS Solutions to support these new frames and GEOID 12A.

I have also appended my list of common GNSS Solutions screw-ups at the end of this document. Chances are you have already made some of these mistakes.

One note before we start: I (Mark Silver) am not an employee of Trimble/SP- Ashtech and these notes are my personal suggestions. While I have verified them on a few projects in my neighborhood, you should check your results carefully. I look forward to any suggestions that you might have.

## 1. Download and Install GNSS Solutions 3.80.8 from the Ashtech FTP Site

Download and install the latest GNSS Solutions from the Ashtech FTP site.

You will need a good FTP program as there are 286 files occupying 331 Megabytes of space. FileZilla is a great no-cost FTP client if you don't already have one.

Do NOT use 'Internet Explorer', 'Windows Explorer', Firefox or other web tools. You will probably end up downloading incomplete/truncated files.

The correct web folder (as of January 1, 2013) is:

ftp://ftp.ashtech.com/Land%20Survey/GNSS%20Solutions/software/3.80.8/

download the entire folder "GNSS Solutions 3.80 CD PN 501421-V" to your local drive.

If GNSS Solutions is already installed on your machine the existing version will be uninstalled and you will need to run the installation program again (twice.)

While you are in the setup menu screen also install the latest RINEX tool (from the GNSS Setup menu,) you may need it.

## 2. Download and Install GEOID12A from My Website

Download and install GEOID12. I have provided a signed, self installing tool for this purpose:

http://www.ashgps.com/ms/G2012A/Install\_GEOID12A\_RevC.exe

Close GNSS Solutions, run the program. When the installer completes, you can restart GNSS Solutions and GEOID12A will be available for your projects.

# 3. Insure that GNSS Solutions has Latest Absolute Antenna Definitions

Download the latest absolute antenna definition file from the NGS website (or use my direct link below):

http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ngs08.003

the link will display a page, you then must right-click on the page, choose 'Save As...' and select a path and filename. Make sure the file extension is .003 by enclosing the entire filename in quotes:





alternatively you can just download a copy of the file from my website: <a href="http://www.ashgps.com/ms/GNSS\_Solutions\_FAQ/ngs08\_abs.003">http://www.ashgps.com/ms/GNSS\_Solutions\_FAQ/ngs08\_abs.003</a>

Start GNSS Solutions, then from the main menu select: "Tools: GNSS Antenna...", from the "GNSS Antenna" dialog box, click the import-from-file button:

GNSS Antenna		
		-
		1 🛛 🖓 🔁
		T AERATIC?
	☆ ACCG5ANT_123CAN	AERAT277
	← ACCG5ANT 2AT1	

Browse for the file you downloaded in step-1:

😻 Open	100			×
Look in: 🚺	antcal	•	← 🗈 🖻	* ⊞-
Name	^	Date modified	Туре	Siz
🔳 ngs08_a	bs.003	12/30/2012 4:02 PM	003 File	
•		III		•
File <u>n</u> ame:	ngs08_abs.003	3		<u>O</u> pen
Files of type:	NGS Antenna	Calibration Files (.003)	-	Cancel
	Open as rea	ad-only		/

and click 'Open'

When prompted to overwrite, choose "Yes to All", the entire "GNSS Antenna" list will be updated.



Check and make sure that you have loaded the new absolute antenna calibrations: scroll through the list of antennas and double-click on the ASH111661 entry. It should look like this:



If C1 is 0.0573 then you have successfully loaded absolute calibration values. If C1 is 0.0754 then you screwed up and still have relative antenna values.

## 4. Install the Latest NGS CORS Coordinates

The NGS maintains an FTP folder with current coordinates for every CORS station in IGS08/NAD83\_2011 based frame:

ftp://www.ngs.noaa.gov/cors/coord/coord\_08/

All of the stations in US are summarized in two files: <u>ftp://www.ngs.noaa.gov/cors/coord\_08/nad83\_2011\_xyz.comp.txt</u> <u>ftp://www.ngs.noaa.gov/cors/coord/coord\_08/nad83\_2011\_xyz.htdp.txt</u>

The '.comp.txt' file contains stations that are modeled with computed velocities. The '.htdp.txt' file contains stations that are modeled with HDTP velocities.

2011-> North America Plate Fixed MAII -> Marianas plate fixed PAII -> Pacific Plate Fixed

These additional files contain the NAD83 epoch 2010.0 coordinates for MA11 and PA11:

ftp://www.ngs.noaa.gov/cors/coord\_08/nad83\_ma11\_xyz.comp.txt ftp://www.ngs.noaa.gov/cors/coord\_08/nad83\_ma11\_xyz.htdp.txt ftp://www.ngs.noaa.gov/cors/coord\_coord\_08/nad83\_pa11\_xyz.comp.txt ftp://www.ngs.noaa.gov/cors/coord/coord\_08/nad83\_pa11\_xyz.htdp.txt

If you download and combine the two matching files (comp and htdp,) I believe you will end up with an exhaustive list of all NGS CORS stations, in the latest NAD83-2011 reference frame. All six of these files appear to be updated automatically every single day.

I have prepared a combined file for North America Plate stations and placed it here: http://www.ashgps.com/ms/GNSS\_Solutions\_FAQ/nad83\_2011\_all\_xyz\_20121230.txt

You can either create an appropriate file or download my compilation to a folder on your local drive.

Next, from the main GNSS Solutions menu select "Tools: Reference Station Networks..." double-click on "NGS", then choose the 'Stations' tab. Finally click on the "Import Stations from Files" button:





and then click on 'OK'. Browse for the file containing both computed and HTDP stations, make sure the "Terrestrial Reference" is set to "WGS84" (yes I know this is wrong—it is part of the hotwiring, just go with it for now) and don't worry about the default epoch as it is set on each entry in the station list:

S Browse		x
Look in: 🔒 cors 💌	← 🗈 💣 📰 -	
Name	Date modified	
nad83_2011_all_xyz_20121230.txt	12/30/2012 9:34 PM	
nad83_2011_xyz.comp.txt	12/30/2012 9:00 PM	=
nad83_2011_xyz.htdp.txt	12/30/2012 9:00 PM	
nad83_ma11_xyz.comp.txt	12/30/2012 9:03 PM	
nad83_ma11_xyz.htdp.txt	12/30/2012 9:04 PM	-
•	÷.	
File name: nad83_2011_all_xyz_20121230.bt	<u>O</u> pen	
Files of type: NGS format (*.bd)	▼ Cancel	
Provider: NGS (National Geodetic Survey)	<b>•</b>	]
Terrestrial Reference: WGS84		
Default Epoch: 2000		

Press "Open" and GNSS Solutions will update the coordinates for every single station.

If you choose to check the coordinates by opening one of the CORS stations, be wary of directly comparing coordinates with different Epoch dates.

Consider SGU1 in Southwestern Utah: you can open the parameters by sliding over and doubleclicking SGU1.

Here is the reference station listing for SGU1 from GNSS Solutions:



Reference Station	×
Station	Antenna
Name: sgul	Antenna Model: 📃 💌
Comment:	Height To ARP: 0.000
Provider: NGS	
Reference Coordinates	Local Coordinates (in Project System)
Reference Frame: WGS84	System Name: LG NAD83_2011
Epoch: 2010	Epoch: 2012.9
Coordinates Velocity × -2036611.900 Vx 0.6	Coordinates Long 113° 34' 13.02335' W ± 0
Y -4668218.429 Vy 1.6	.at 37° 06' 47.48162''N ± 0
Z 3827958.246 Vz 0.3	Ellips height 895.630 ± 0
🚯 Download Data	ОК

And here is a portion of the SGU1 position data sheet, notice that the coordinates don't match well:



GNSS Solutions displays the coordinates transformed to the current Epoch (31 Dec 2012); while the data sheet is epoch 1 Jan 2010.

Most stations do have appreciable velocity, even in the NAD83 frame. To compare coordinates you need use a suitable tool (like HDTP) to normalize the Epoch dates. Transforming from 2010.0 to 2013.1 we get:



Once transformed, the epoch normalized coordinates are identical.



Hint: From the main menu, choose "Tools: Preferences." Set your GNSS Solutions Preferences to include 'Advanced Coordinate System settings':	;
to include Advanced Coordinate System settings :          Preferences         General Report         Image: Guide user on startup         Image: Data Management         Image: Advanced Coordinate System settings         Image: Show CAD functions         Image: Show RTK functions	
So that your configuration screeps will match those shown in the examples below.	

It would be nice to have both a projected (state plane) coordinate system and a geographic (lat/lon) system to match NAD83\_2011 directly.

Because we are 'hotwiring' the WGS84 coordinate system and using it to hold NAD83\_2011 framed coordinates in GNSS Solutions, this is not-quite-trivial.

## Add a State Plane Projected Coordinate System

First let's add a new projected reference frame; I am going to use an example in Southern Utah so I would like to have Utah South NAD83\_2011 available. From the main GNSS Solutions menu select "Tools: Coordinate Systems...":



Click the 'Add/New' button (circled in red below):

Coordinate Systems	
I⊈ <locab LaWGS 84</locab 	



Choose 'SELECT a PRE-DEFINED system' and press Next:

Coordinate S	iystem Wizard - Welcome	×
Welcom	ne to Coordinate System Wizard	
This wiz	ard will help you :	
ß	SELECT a PRE-DEFINED system	
N <sup>™</sup> , ■	C Define a NEW PROJECTED system (EASTING, NORTHING, HEIGHT)	
L× ↓ □	C Define a NEW GEOGRAPHIC system (LATITUDE, LONGITUDE, HEIGHT)	
<u>ب</u> بر	C Define a NEW GEOCENTRIC system (X ECEF, Y ECEF, Z ECEF)	
		_
	< Back Next > Cancel	

Choose USA, NAD83-CORS96 in the left panel and the appropriate state plane zone on the right-hand panel, then press 'Finish':

	Name Lance State	Datum NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N NAD83-CORS96=N
--	---	---

Double-click on the new state plane system (USA/NAD83-CORS96/Utah (South) in this case) to edit the configuration:





Projected System [USA/NAD83_2011/Utah (South) Ortho G2	012A *]
Datum Projection System	
System Name : USA/NAD83_2011/Utah (South) Ortho G2	012A
East -	
North 🕇 💌	
Ortho height 💿 💌	☐ With vertical correction H => H local
Unit Name : Meters	
Meters per unit : 1	
Vertical Datum : S GEOID12A	
Vertical Unit Name : Meters	
Meters per unit : 1	
✓ Set Vertical Unit = Horizontal Unit	
	OK Cancel Apply

Choose 'GEOID12A' for the 'Vertical Datum', change the 'System Name' to something appropriate; I used "USA/NAD83\_2011/Utah (South) Ortho G2012A" for Utah South.

Next, click on the 'Datum' tab:

Projected System [USA/NAD83_2011/Utah (South) Ortho	G2012A *]
Datum Projection System	
Datum Name : WGS 84	•
Ellipsoid Name : WGS 84	•
Semi-major Axis : 6378137.000 m	
Inverse Flattening : 298.257222101	
DX to WGS84 : 0.0000 m	
DY to WGS84 : 0.0000 m	
DZ to WGS84 : 0.0000 m	$\Box$ \ $\parallel$
RX to WGS84 : -0.000000 "	
RY to WGS84 : -0.000000 "	
RZ to WGS84 : -0.000000 "	
ppm to WGS84 : 0.00000000000	

This is **IMPORTANT**: Change the 'Datum Name' to 'WGS84'; make sure the 'Ellipsoid Name' is 'WGS84' and most importantly make sure the "Inverse Flattening Raio" is **298.257222101** as shown above. (More hotwiring here, just go with it for now.)

Leave all the values on the 'Projection' tab alone.

Finally click on OK to save changes.

#### Add a Geographic (Lat/Lon) Coordinate System

We need to add a new projected reference frame. From the main GNSS Solutions menu choose "Tools: Coordinate Systems...":





Click the 'Add/New' button:

Coordinate Systems	
t⊈ <local> La<mark>V/GS 84</mark></local>	×  <u>'</u>

Double-click on WGS84, the configuration dialog will be shown, change the system name to "NAD83\_2011 Geographic Ellipsoid":

Geographic System [NAD83_3	2011 Geographic Ellipsoid *]	-	×
Datum System			
System Name : NAD83	2011 Geographic Ellipsoid		
Long	→ <b>▼</b>		
Lat	<b>↑ ▼</b>		
Ellips height	•	With vertical correction	H => H local
Unit Name :	Radians 🗨		
Radians p	per unit : 1		
Vertical Datum :	C Ellipsoid		
Vertical Unit Name :	Meters 💌		
Meters p	per unit : 1		
		ОК	Cancel Apply

Click on OK, and you are ready to go.

## **Create a New Project and Import Data**

For the purpose of this demo, I am going to use a 2 hour file from the UNAVCO PBO station P009 as my observation file. When our processing is complete, we will benefit from published NGS coordinates to check our results against. (You can use this same recipe to configure and check for the specific State Plane zones that your local area.)

If you would like to follow me along with the same data, download and extract this ZIP file: <u>http://www.ashgps.com/ms/GNSS\_Solutions\_FAQ/p009336.zip</u>



1. Start GNSS Solutions and choose "Create a New Project":

come	
What	would you like to do?
*	Create a n project
5	Open an existing project
<b>1</b>	Open the last project you worked on
×	Run without a project
🗆 Don	't show this dialog again

2. Let's modify the default coordinate style so we can display NAD83\_2011 geographic coordinates directly. From the 'New' dialog, click on 'Modify Default Settings...':

New	×
Projects	
Land Survey Project	Project name: Project4
	Modify Default Settings
ОК	Cancel Apply

3. Choose 'NAD83-Geographic Ellipsoid' as the 'Spatial Reference System' and choose 'Meters' as the 'Linear unit':



Default Project Settings	×
Region   Precise Ephemeris   Miscellaneous   Feature Code List	1
Spatial Reference System	
Time zone (UTC-07:00) Mountain Time (US & Canada)	T
Linear unit All distances in Meters	
ОК	Cancel Apply

Next select the "Miscellaneous" tab and uncheck "Use Adaptive static detection"

Default Project Settings	<b>X</b>
Region       Precise Ephemeris       Miscellaneous       Feature Comparison         Blunder Detection       Minimum observation time span :       1       min         Valid antenna height range :       From       0.000       To       3.000       m         Network Adjustment       Confidence scaling factor :       1       1       1	Ode List       Quality Control       Desired project accuracy :       Horizontal : [0.020] m + 1       ppm       Vertical : [0.040] m + 2       Maximum acceptable control error :       Total : [0.100] m
Satellites       Image: GPS     Image: GLONASS     Image: SBAS       Image: GPS     Image: GLONASS     Image: SBAS	Half-cycle ambiguity for GLONASS L2 Use adaptive static detection Use VRS Max. Range: 200 km
	OK Cancel Apply

This won't affect the processing of this sample static job, but if you ever process a dynamic (Stop-and-Go) file, it may save you from observation mayhem.

Click on 'OK', then click on 'OK' from the 'New' dialog to create a new job.

4. The "Import" dialog is shown:





Next, click on "Import Raw Data from Files or ProMark/ProFlex devices."

#### Import Observation File

5. Browse for the P009 static file we downloaded (our test observation data):

🔮 Browse		×
Look in: 🚺	gnsssol 💌	⇐ 🗈 💣 📰▼
Name	*	Date modified Ty
🔳 p009336	0.12o	12/31/2012 4:45 PM 12
•		4
File name:	p0093360.12o	Open 👩
Files of type:	Raw Data Files (g*.*,q*.*,b*.*,**o;*.*d,*.bi	n;*.
	Copy file(s) into the project folder before	re import

then click Open.

6. On the 'Importing GPS Data' dialog, you can check the antenna height and type. These values are automatically extracted from the RINEX file that we imported.

									ND83-G
Importing GPS Data	-								
Raw Data								TH REX	
Import	Site		Date 1	Time Dynar	mic Antenna Heigl	ht Height Type	Antenna Type	Receiver Type	
▶ p0093360.12o	P009	Decer	nber 1 2012 08	3:00:00.0	0.0	08 Vertical	TRM29659.00	TRIMBLE	
Control Points	Long	95% Frr						×	
	LOUIG		Lat	1 95% Err. 1	Ellips height	95% Err. Cont	rol Fixed		00.00000
*	Long	00.0 2111	Lat	95% Err.	Ellips height	95% Err. Cont	rol Fixed		00.00000"E
*	Long		Lat	95% Err.	Ellips height	95% Err. Cont	rol Fixed		00.00000"E
* Add Raw Data V	Long		Lat	95% Err.	Ellips height	95% Err. Cont	rol Fixed	Cancel	00.00000"E
Add Raw Data	Long	) Danacity		95% Err.	Ellips height	95% Err. Cont	rol Fixed	Cancel	00.00000"E
Add Raw Data	itions / Vectors /	λ Repeat v	Lat	95% Err.	Ellips height	95% Err. Cont	Fixed DK b	Cancel Dimport Dimport  Dimport and Process S	00.00000"E
Add Raw Data	itions \ Vectors ,	λ Repeat v	rectors À Loop	95% Err.	Ellips height	95% Err. Cont	5 / Tc	Cancel Cancel Import Import and Process S Import and Process B	00.00000"E

#### Click on "OK, To Import"

7. Right-click over the map, and choose the Zoom + magnifying glass. Zoom in so we can see our data file in the center of the map and the first tier of surrounding CORS sites:

3	GNSS	Solutions	- [Su	rvey View.ma	ap - Pro	oject4	- ND83 2	2011 Ge	ographic Ellip:	soid - Mete	rs]					X
	<u>F</u> ile	<u>E</u> dit <u>V</u> ie	ew	<u>Map</u> roje	ct <u>T</u> o	ols	Window	Help							0	_ 8 ×
1	5   6		8		<u>_</u> + 9	2.										
ĴΓ					3 Z	U,	<u>A</u>   ==									
ž	Dow Prof	P In miload Raw I Mark 3 (F3) oft Raw Data	<b>roje</b> mpo Data	rt from Z-Max or Files or			30	00.000	000"Nin nvsv		¢	P009 p0093360.3	<u>ND8</u>	3_2011 Geo msee mc04	acos	ec01
	Prof	Mark/ProFlex Pr Adju	cdevi roce ustn CAD	ices (F4) ss nent			38° 00'	00.000	nveri	10	p	009	р	▲ mc09 012	mc10	-
	!	E Ut	×po Map tiliti	es			37° 00'	00.000 1116° View.t	000" N 00' 00.00000 00 Design Vie	<mark>کی</mark> sgul <u>sgul v</u> <u>sgul</u> surv	<u>frec</u> 00.0000	<u>ک</u> 00" <u>7112° 00' 00.</u>	00000"%110°	00' 00.00000	▲ ▲ <sup>ti4</sup> ±	50000 n 00.000
Wo	rkboo	ok.tbl - Proj	ect4	- ND83_2011	Geogra	aphic	Ellipsoid	- Meters	;							0 🛙
		Name		Site		S	tart_Time		Time_Span	Sampling	Dynamic	Receiver_Type	Antenna_Type	e Antenna_H	eight Heigh	it_Type
1		p0093360.1	120	P009	Decem	nber 1	2012 08:0	0:00.00	02:00:00.00	15.00	Г	TRIMBLE	TRM29659.00		0.008 Vertic	al
X	Copy Impo	File File File	es A "p0 le "	Occupatio	ons入F o" in 120"	Poin 100	ts) Cont al folde	trol Po	sitions). Ve Ok	ctors <b>)</b> R	epeat ve	ctors) Loop C	losure), Cor	itrol Tie)∖A	dju	•
	upda	ting post	c-pr	cocess scer	nario.	(	JK				(					*
	3 O	୍ର୍ଷ୍	> 🖱	1/556170	5		• ×	< • •	Project4:\Point:	s 💌						
Rea	dy														NUM	

right-click again and select the arrow cursor.

8. Now let's download some CORS data from a couple of nearby sites. On the map, find P105 to the north and double-click on the site. The 'Reference Station' dialog will be shown:



Reference Station	
Station	Antenna
Name: p105	Antenna Model: 📃 👻
Comment:	Height To ARP: 0.000
Provider: NGS	
Reference Coordinates	Local Coordinates (in Project System)
Reference Frame: WGS84	System Name: ⊈G WGS 84
Epoch: 2010	Epoch: 2012.9
Coordinates Velocity	Coordinates
× -1889726.387 Vx 1.0	Long 112° 30' 14.66916''W ± 0
Y -4561285.538 Vy 4.4	Lat 39° 23' 15.14017''N ± 0
Z 4026570.151 ∀z −2.4	Ellip: height 1432.198 ± 0
Download Data	ОК

This dialog is worth a few comments be ore we proceed. The coordinates downloaded from the NGS ftp site listing are in the left hand column. The frame, Epoch, XYZ coordinates and velocities exactly match those from the CORS station list that we imported earlier:



On the right side, GNSS Solutions has computed the Lat/Lon/Height coordinates for the P009 station on the Epoch of our observation data.

In other words GNSS Solutions has applied the velocities to the Epoch 2010.0 coordinates and computed the NAD83\_2011 framed coordinates for the day (December 1, 2012) of our observation data.

If you compare the displayed coordinates on the right-hand side to the position data sheet they won't match because the data sheet is epoch dated 2010.0 <u>not 2012.9</u>:



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#### Portion of the position data sheet for P105

If you want to compare the coordinates that GNSS Solutions computed, you need to transform the epoch from 1-1-2010 to 12-1-2012. Here is the output from HTDP:

HTDP (version 3.2.3) OUTPUT



These transformed coordinates match exactly.

Dynami	c Coordinates – The Plate is Moving	
If you are not yet comfortable with read up. Perhaps you should attend	the reality of dynamic coordinates, 2013 would be a great time to some NGS online seminars!	)
Different CORS sites around the lo frame. These velocities range from	wer-48 have varying velocities, even in the NAD83 local reference a minimum:	2
P057 0.3 mm / year	(in Utah)	
to a maximum:		
AB42 50.3 mm / year	(in Alaska)	
With the average X, Y, Z motion c	of CORS sites in the PA11 group being 6.5 mm per year!	
Modern GPS receivers and process times. The solution is to document, and geoid-stamp your results. Thus	ing tools can easily resolve these differences with short occupation document, document and at a minimum epoch-stamp, frame-stam a traditional XYZ measurement:	۱p
X= 112° 13' 21.72563"W	Y= 38° 28' 47.73271"N Z= 1782.199	
becomes:		
112° 13' 21.72563"W 38°	<sup>°</sup> 28' 47.73271"N NAD83_2011 Epoch 2010.0	

Ortho Height 1782.199 M transformed with GEOID 12A from Ellipsoid 1762.304 M

9. Click on the 'Download' button, the 'Internet Download' dialog will be shown:



Internet Download 3.	12		×
	Provider:	NGS	
	Service:	NGS CORS Raw Data	•
	Station:	p105	
<b>~</b>	Time Zone:	(UTC-07:00) Mountain Time (US & Canada)	•
	Start Date:	12/ 1/2012  Start Time: 8:00:00 AM	•
I SR	Duration:	02:00	
	End Date:	12/ 1/2012 Tend Time: 10:00:00 AM	
	Target Path:	C:\My Projects\Project4	
Provider Infos : <u>http://w</u>	ww.ngs.noaa.g	Download Help	Close

Click on the 'Download' button and wait for GNSS Solutions to automatically download the O and N files:

	Provider: NGS	-			
61% Receiving /	cors/rinex/2012/336/p105/p10	053360.12d.Z	× –		-
	~				
💔 💆					
p1053360.12d.	Z (240 of 384 KBvtes transferred)		1		Ŧ
to : C:\Users\M	ark\AppData\Local\Temp\IDLoa	d\p1053360.12d.Z			
		Can	cel .	0.00.00 AM	-
	End Date: 12/ 1/2012	~	End Time:	10:00:00 AM	
				1	
	Target Path: C:\My Project	ts\Project4			
D 14 4 6 1 1		Davi	uteral 1		
Provider Intos : <u>http:</u>	//www.ngs.noaa.gov/COR5/		moau		Close
Connecting to Host "w	www.ngs.noaa.gov" OK	0 10 I 7			
Searching for file "/co	rs/rinex/2012/336/p105/p10533t rs/rinex/2012/336/brdc3360.12n.	gz" OK			
Downloading File '/co	prs/rinex/2012/336/p105/p10533	60.12d.Z''			

When the download is complete, press the 'Close' button and "Importing GPS Data" dialog is shown:



In	por	ting GPS Data	7 hours													
	Ra	w Data													[	
		Import	Site		Date	Time	Dynan	nic	Antenna Hei	ght	Heig	ht Type	Ant	enna Type	Receiv	er Type
	▶	p1053361.12o	P105	<ul> <li>Dece</li> </ul>	mber 1 2012	07:55:00.0			C	.008	Vertic	al	TRM2	29659.00	TRIMBLE	
	Co	ntrol Points														×
		Name	Long	95% Err.	Lat	95	% Err.	EI	llips height	95%	Err.	Contro	ol	Fixed		
		P105	112° 30' 14.66907"	0.000	39° 23' 15.1	4008"N	0.000		1432.213	C	.000	Hor.&Ver	: I	lor.&Ver.		
	Ac	d Raw Data ▼												OK	•	Cancel

Take a moment do to a reality check on the antenna height, the height type and antenna type. Sometimes GNSS Solutions will not be able to match the antenna type / dome information from the RINEX file and the internal antenna database. When this happens, the 'Antenna Type' value will be bold highlighted and you will need to manually match up the correct antenna.

When you are satisfied that the information is correct, click on "OK – To Import" and GNSS Solutions will display a map showing our observation and the single CORS site:

🧶 GNS	Solutions - [Su	irvey View.ma	ap - Projec	t4 - WGS 84 - Meter	5]							×
📕 <u>F</u> ile	<u>E</u> dit <u>V</u> iew	<u>M</u> ap <u>P</u> roje	ct <u>T</u> ools	<u>W</u> indow <u>H</u> elp							<u></u>	- 8 ×
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	Name	Site		Start_Time	Time_Span	Sampling	Dynamic	Receiver_Type	Antenna_Type	Antenna_He	eight Height	_Туре
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Keady											NUM	1.1.

Zoom back out and choose another nearby CORS site 'ECHO' to the west. Double-click on ECHO, then click on 'Download':



Reference Station	1		×
Station		Antenna	
Name: echo		Antenna Model:	Ţ
Comment:		Height To ARP: 0.000	ī
Provider: NGS Info: <u>http://www.ngs.nc</u>	Naa.gov/CORS/		
Reference Coordinates		Local Coordinates (in Project Sy	stem)
Reference Frame: WGS84	<b>v</b>	System Name: 🔀 WGS 84	<b>v</b>
Epoch: 2010		Epoch: 2012.9	
Coord	nates Velocity	Coordinates	
×   -2070	969.605 Vx 0.0	Long   114" 15' 51.24340	
Z 3899	086.808 Vz 0.7	Lat   37° 54° 55,90491 Ellips height   1684.9	"N ± 0
Download Data			ОК

and click on 'Download' to retrieve data from the ECHO site;

🚷 Internet Download	3.12					2
	Provider:	NGS	Ψ.			
	Service:	NGS CORS Raw	Data			
	Station:	echo	~			
	Time Zone:	(UTC-07:00) Mou	ntain Time (US	6 & Canada)		
	Start Date:	12/ 1/2012	-	Start Time:	7:55:00 AM	1
	Duration:	02:10	•			
	End Date:	12/ 1/2012	Ţ	End Time:	10:05:00 AM	
,	Target Path:	C:\My Projecte\P	roject4			
Provider Infos : http://	www.ngs.noaa.go	w/CORS/	Do	wnload	Help	Close
						~
				$\sim$		
		/				

wait for download, then click 'Close' and the 'Importing GPS Data' screen will be shown:

	echo3361.120		Date Tir	ne Dynar	nic Antenna Hei	iaht Heia	ht Type	Antenna Type	Receiver Type	
		ECHO	Dece	mber 1 2012 07:5	0:00.0	0	0.129 Vertic	al 1	RM29659.00	TRIMBLE
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	Name	Long	95% Err.	Lat	95% Err.	Ellips height	95% Err.	Control	Fixed	
	Name ECHO	Long 114° 15' 51.24326"	95% Err. 0.000	Lat 37° 54' 55.90481"N	95% Err. 0.000	Ellips height 1684.957	95% Err. 0.000	Control Hor.&Ver.	Fixed Hor.&Ver.	
	Name ECHO P105	Long 114° 15' 51.24326" 112° 30' 14.66907"	95% Err. 0.000 0.000	Lat 37° 54' 55.90481"N 39° 23' 15.14008"N	95% Err. 0.000 0.000	Ellips height 1684.957 1432.213	95% Err. 0.000 0.000	Control Hor.&Ver. Hor.&Ver.	Fixed Hor.&Ver. Hor.&Ver.	-

click on 'OK – To Import':



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Eile	<u>E</u> dit <u>V</u> iew	<u>M</u> ap <u>P</u> roje	ct <u>T</u> ools	<u>W</u> indow <u>H</u> elp							◇ -	. 8 ×
	<b>9 9 9</b>	% <b>№ №</b>   		<ul> <li>□□□□</li> <li>▲   == = =  </li> </ul>								
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Workbo	ok.tbl - Project4	- WGS 84 - N	1eters									0 🛙
	Name	Site	:	Start_Time	Time_Span	Sampling	Dynamic	Receiver_Type	Antenna_Type	Antenna_Height	Height_	Туре
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	) Q Q	1/7066212	2	•   × > • F	roject4:\Points	•						
Ready							109°	36' 58.63304"W	37° 36' 00.35	440"N	NUM	

repeat the process again for a third CORS site P012. The Survey View map should now look like this:



Press F5 to process all baselines, and then press F7 to adjust the network:



🧶 GN	GNSS Solutions - [Survey View.map - Project4 - WGS 84 - Meters]												
📕 Eil	le <u>E</u> dit <u>V</u> ie	w T <u>a</u> ble <u>P</u> roject	<u>T</u> ools <u>W</u> indow	<u>H</u> elp				<u> </u>	Ξ×				
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		B Z	UA ==										
	Pr	oject		1		P105	Δ	WGS	5 84				
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Pr													
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	E E S	rnort											
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	Uti	dap ilities	<u></u>		00.00000"W	,112° 00' 00	.00000"W ,110	5000 5000 00:000000	0 m V				
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. Workbe	Name	Map ilities ct4 - WGS 84 - Meters		,114° 00'	00.00000"W	,112° 00' 00		p01201 5000					
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Workby	Name	Aap Aap Ilities ct4 - WGS 84 - Meters Description P009		114° 00' ,114° 00' wt Design Vie Lat	00.00000" W I Survey V Ellips height 1762.304	,112° 00' 00 fie Status Adjusted	Constraints	5000 00' 00.00000"V Surv_Horz_Conf 0.003	0 m V				
Workbe	Name P009 P105 ECHO	Ap ilities Description P009 P105 EFCHO		Lat	00.00000"W Ellips height 1762.304 1432.213 1684.957	,112° 00' 00 ie Status Adjusted Adjusted	Constraints No constraints Horizontal & Vertical Fixed Horizontal & Vertical Fixed	5000 500 5000 5	00 m V Surv_				
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Vorkbu Vorkbu 1 2 3 4 4 1 4 4 1 4 4 1 2 3 4 4 1 2 3 4 4 1 2 3 4 4 1 2 5 6 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8	Name     Proje     Proje     Proje     Pros     ECHO     Pro     Pros     ECHO     Pros     ECHO     Pol     Pol	Aap ilities cct4 - WGS 84 - Meters Description Pi05 ECHO P012 Points ∕ Control F 2012 Points ∕ Control F	Long 112' 13' 21'7263' 112' 30' 14.6690' 114' 15' 51 24326' 109' 20' 01.7630'' ositions / Vector	Lat 39'28'47'327'11' 39'28'47'327'11' 39'28'47'327'11' 39'28'47'327'11' 39'28'55'048'N' 38'05'50'74025'N 15'40'85'048'N' 38'05'50'74025'N 15'40'85'048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'8048'N' 18'50'85'804'N' 18'50'804'N' 18'50'804'N' 18'50'804'N' 18'50'804'N' 18'50'80'80'80'80'80'80'80'80'80'80'80'80'80	00.0000°*W Ellips height 1762:304 1432:213 1684:95° 1789:330 tors \ Loop C "	Adjusted Adjusted Adjusted Adjusted Adjusted Adjusted Adjusted	Constraints Constraints No constraints No constraints Horizontal & Vertical Fixed Horizontal & Vertical Fixed Horizontal & Vertical Fixed Constraints	surv_Horz_Conf 0000 0000 0000 0000 0000 0000 0000 0					

GNSS Solutions has solved NAD83\_2011 Epoch 2010.0 coordinates for 'our' two-hour occupation of P009 with these results:

	Desc	Long		Lat	Ellips heigh	6 Horz t Conf	Height Conf
	P009	<mark>112° 13' 21.725</mark>	<mark>63"</mark> W <mark>38° 2</mark>	2 <mark>8' 47.73271"</mark>	N <mark>1762.30</mark>	0.003 0.003	0.002
Н	ere is portion o	of the data shee	t for P009 fro	om NGS:			
	NAD_83 (2011)	) POSITION (EP	OCH 2010.0)				1
	Transformed i	from IGS08 (ep	och 2005.0)	position in	n Aug 2011	•	
	X = -189	91354.110 m	latitude	= <mark>38 28</mark>	47.73269	N	1
	Y = -462	29377.720 m	longitude	= <mark>112 13</mark>	21.72562	W	1
1	Z = 394	48381.781 m	ellipsoid	height = 1	762.278	m	1

That is a 0.000,663 meter horizontal difference (~0.7 mm); and a 0.026 meter elevation difference. Not bad for a 2-hour occupation and like I like to say

"this doesn't happen by accident!"

#### Hey, wait a second! What epoch are these results in?

You might notice: "We have been screwing around with HTDP computing positions with velocities, but now it appears that our end results are epoch 2010, not 2012.91!"

Yes, we ended up with EPOCH 2010 coordinates. Check out the full listing including the reference CORS stations:

				Surv	Surv	
			Ellips	Horz	Height	
Description	Long	Lat	height	Conf	Conf	
P009	112° 13' 21.72563"W	38° 28' 47.73271"N	1762.304	0.003	0.002	
P105	<mark>112° 30' 14.66907"W</mark>	<mark>39° 23' 15.14008"N</mark>	<mark>1432.213</mark>	0.000	0.000	
ECHO	114° 15' 51.24326"W	37° 54' 55.90481"N	1684.957	0.000	0.000	
P012	109° 20' 01.76307"W	38° 05' 50.74025"N	1789.330	0.000	0.000	

The listed coordinates for each of the reference CORS stations (P105, ECHO, P012) all exactly match the NGS position sheets:



Think about it, do you really want your job coordinates to change month to month? I did not think so. The computed results are NAD83-2011EPOCH 2010 which is what you really want.

## **Display State Plane Coordinates with GEOID12A Ortho**

It would be great if we could convert our geographic results to state plane coordinates with orthometric heights.

This is easy, from the main menu select "Project: Edit Settings...":



The 'Project Settings' will be displayed:

Project4" Project Settings	
Region Precise Ephemeris Miscellaneous Feature Code List	
Spatial Reference System	
NAD83_2011 Geographic Ellipsoid	
All distances in Meters	
Save As Defaults OK Cancel Apply	

Drop down the 'Spatial Reference System' combo box and choose the state plane projection we setup earlier. Press OK.

GNSS Solutions will re-compute all of the displayed coordinates to Utah South Ortho Meters:



😻 GNSS Solutions - [Survey View.map - Proj	ject4 - USA/NAD8	3_2011/Utah (Sout	h) Ortho G2012	A - Meters]		_ 0	×				
<u>File Edit View Table Project To</u>	ools <u>W</u> indow <u>H</u>	<u>H</u> elp				⊘	. 8 ×				
	⊆ -   <b>⊡  &gt;</b>   u <u>A</u>   ≡ ≡	Image: A state of the state									
Project Project Project Project Project Process Adjustment CAD Export Map Utilities	2250000.0 3250000.0 3150000.0 20000 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 0 10 10 10 10 10 10 10 10 10	,44	P105 USA p1053361.120 p0053360.120 p005350 p0050 p005350 p0050 p0	NAD23 2011/Utah (Se	uth) Ortho 620	222A				
Workbook.tbl - Project4 - USA/NAD83_2011/	Utah (South) Orth	o G2012A - Meters									
Name Description	East	North	Ortho height	Status	Constraints	Surv_Horz_Conf	Surv_				
M         P009           2         P105         P105           3         ECH0         ECH0           4         P012         P012           Id         ▲ ▶ bins A Points A Control Points         Control Points	436938.303 413468.967 256978.872 689985.250 sitions & Vector	3201494.370 3302489.677 3142195.713 3160993.518 rs λ Repeat vec	1781.430 1451.390 1708.089 1808.216 tors λ Loop C	Adjusted Adjusted Adjusted Adjusted Iosure & Control T	No constraints Horizontal & Vertical Fixed Horizontal & Vertical Fixed Horizontal & Vertical Fixed Te A Adjustment Anal	0.003 0.000 0.000 0.000 vsis/  4	•				
Image: State											

Here are the results tabulated:

			Ortho		
Name	East	North	height	Surv_Horz_Conf	Surv_Height_Conf
P009	436938.303	3201494.370	1781.430	0.003	0.002

#### Verify GEOID Reduction

First, let's check GNSS Solution's GEOID computation:

Ellipsoid 1762.304 Ortho G12A 1781.430 Geoid -**19.126** 

We can use the NGS Online GEOID 12A Toolkit (<u>http://www.ngs.noaa.gov/cgi-bin/GEOID\_STUFF/geoid12A\_prompt1.prl</u>) to verify:

Output from GEOID12A			
	latitude	longitude	Ν
Station Name	ddd mm ss.sssss	ddd mm ss.sssss	meters
USER LOCATION	38 28 47.73271	112 13 21.72563	<mark>-19.128</mark>

A 0.002 meter difference...probably close enough.

#### Verify State Plane Coordinate Computation

GNSS Solutions coverts the geographic coordinate:

112° 13' 21.72563"W 38° 28' 47.73271"N

to Utah Central Meters:

436938.303 M East 3201494.370 M North

Let's compare this with the NGS online SPCS83 tool (<u>http://www.ngs.noaa.gov/cgi-bin/spc\_getpc.prl</u>):

	Latitude	Longitude	Datum	Zone
INPUT =	N382847.73271	W1121321.72563	NAD83	4303

Page 22 of 25



NORTH(Y) METERS	EAST(X) METERS	AREA	CONVERGENCE DD MM SS.ss	SCALE
3201494.370	<mark>436938.303</mark>	UT S	-0 26 34.04	1.00002498

\_\_\_\_\_

an exact match.

## **Conclusions**

GNSS Solutions can successfully be used to directly compute NAD82\_2011 framed results with GEOID 12A.

Remember to do a reality check with known coordinates when ever you create a new coordinate system in GNSS Solutions.



## **Common 'GNSS Solutions' Problems**

Over the years, I see the same mistakes over and over. Most are caused by a lose nut holding the instrument down or pushing on the keyboard. Here is my quick list:

1. Red vectors everywhere. Check the 'Repeat Vectors' tab. If there are any, and you don't have a darn good reason to have repeat vectors, then you have named two disparate points with the same name. In other words, you stored two points that are not at the same location, but assigned the same name to both of them. When you adjust, the adjustment engine has to make them line up. If they are 100 feet away from each other, this rarely works out well.

This is easy to fix on the Occupations tab. Just rename subsequent observations adding a 'A', 'B', 'C'... to the end of each same-named occupation. I get this problem/question three or four times each week. Please check it before you call me.

- 2. I have a thousand extra occupations! Check 'Tools: Project Settings: Miscellaneous (tab)'. If 'Use Adaptive static detection' is checked, uncheck it then delete process results, delete adjustment results, then press F5 and finally F7.
- 3. Bad HI. Really? You should know better. If the HI is 2 in meters and your job is in US Survey Feet, your HI is not 2 feet. If the HI is entered as zero, there is probably something wrong (I am in the habit of entering Zero HI's as 0.001 Meters.)
- 4. Wrong antenna model/name/offset. Here are some possibilities:
  - a. all of the values are 0 in the chosen model:

Antenna Parameters	
Antenna Model : ASH998998	
R (m): 0	
h (m) : 0	h
C1 (m): 0	42 4 1 1 1 1 1 1
C2 (m) : 0	Aer Aer
Description :	This is probably wrong
Advanced	OK Cancel

b. you have specified a slant measurement, but the R and H are "0.0":

	Antenna Parameters	<b>X</b>
	Antenna Model :	
1	ASH111661	
$\overline{\ }$	R (m): 0	
	h (m) : 0	h
	C1 (m): 0.0573	ANA
	C2 (m) : 0.0643	A
	Description :	GNSS Survey Antenna, base of RFC->N
	Advanced	OK Cancel

c. the RINEX file says "ASH700936E\_C NONE" but all GNSS Solutions knows about is "ASH700936E\_C". This is very common. If you just double-click past the warning message then GNSS solutions make a new entry with all zeros. Usually not good, but won't blow up if every antenna in your job is exactly the same.



d. Absolute vs. Relative: one or the other. All new jobs in the USA, should be done with absolute calibrations. I can't think of any exceptions.

- 5. Ellipsoid vs. Orthometric elevations. If your elevations are off about 20 meters, then check to make sure you have selected the vertical datum that you want. Consider watching this video: http://youtu.be/dX6a6kCk3Po
- 6. Survey Feet vs. International Feet: Really? If your state plane coordinates are off about 15 feet then watch this video: <u>http://www.youtube.com/watch?v=8pEdL9tgDZo</u> If your state plane coordinates are about 3 times too small, or 3 times too big, then I bet you have meters and want feet.
- 7. Distances are off a couple of feet per mile. Grid vs. Ground coordinates. GNSS Solutions has a great function "Compute Ground System." Watch this video: http://www.youtube.com/watch?v=iwCAAsRvNW4
- 8. Can't duplicate another surveyor's state plane coordinates on a large job; they match in the middle but diverge as I move away from the center. Answer: the other guy has created a ground system, based on the center of the job, applied a scale factor and not written anything down.

This is a pet peeve of mine. If you make a ground coordinate system and keep State Plane coordinates for the base point, you should loose your license. Drop the leading digits so everyone immediately knows that something is up:

436,938.303 M East 3,201,494.370 M North becomes

36.938.303 M East 01,494.370 M North and make a note of the base point location, the scale factor and make sure the word

'GROUND' appears someplace on your plat where the next guy can find it.

9. Confidence intervals just suck in 'Stop-and-Go' job. They are 10 times higher than I have ever seen before! A bunch of points that I am positive that I shot are missing when I post-process!

Answer: Your ROVER has the recording interval set to 15 seconds and you are recording 10second shots (or some derivation of this.)Always set the interval to 1 second on the rover. I don't care what the manual says!

10. My confidence intervals are 0.5 meters, even though I spent 30-seconds on each shot. Answer: Did you use a bi-pod? Probably not. Too bad 😊