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Title:	GNSS Solutions 2.5 Reference Frame Adjustments
Date:	June 13, 2007, revised Jan 15, 2008
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Thesis:	GNSS Solutions has been enhanced to support reference frame
adjustments. It	is now possible to enter control coordinates in ITRFxx reference frame and
get NAD83-C	ORSxx adjusted outputs. However, existing users will need to make a few
coordinate sys	tem changes to get expected results and to match previous GNSS Solutions

Assumption: You want NAD83 adjusted results (not ITRF). If you want ITRF adjusted results you will need to change this procedure slightly.

Short Answer:

results.

- 1. Use the predefined WGS-84 system for entering control points in geographic coordinates.
- 2. Override the default 'Predefined State Plane' Coordinate System to prevent GNSS Solutions from performing a reference frame adjustment.

For example: To create a new "Utah Central NAD88" system follow these instructions:

Create A New Coordinate System

First select "Tools: Coordinate Systems..." from the main menu:



Click the 'Add' button:

Coordinate Systems	
	<u>r</u> r
t⊈ <locab ⊈GWGS 84</locab 	Add

Choose 'Select a Predefined System':

Coordinate System Wizard - Welcome	
Welcome to Coordinate System Wizard	
This wizard will help you :	
SELECT a PRE-DEFINED system	
C Define a NEW PROJECTED system (EASTING, NORTHING, HEIGHT)	
C Define a NEW GEOGRAPHIC system (LATITUDE, LONGITUDE, HEIGHT)	
Define a NEW GEOCENTRIC system (X ECEF, Y ECEF, Z ECEF)	
< <u>B</u> ack <u>N</u> ext > Ca	ncel

Press Next, then browse to the 'USA' selection on the left list, click on the '+' to display the USA selections, choose "NAD83" (don't choose NAD83-HARN!):

Coordinate System Wizard - Sel	ect		×
Image: Second system Image: Second system Image: Second	Name ^M -c USA/NAD83/Alabama (East) ^M -c USA/NAD83/Alabama (West) ^M -c USA/NAD83/Alaska (Zone 1) ^M -c USA/NAD83/Alaska (Zone 2) ^M -c USA/NAD83/Alaska (Zone 2) ^M -c USA/NAD83/Alaska (Zone 3) ^M -c USA/NAD83/Alaska (Zone 3) ^M -c USA/NAD83/Alaska (Zone 6) ^M -c USA/NAD83/Alaska (Zone 6) ^M -c USA/NAD83/Alaska (Zone 7) ^M -c USA/NAD83/Alaska (Zone 8) ^M -c USA/NAD83/Alaska (Zone 9) ^M -c USA/NAD83/Alaska (Zone 1) ^M -c USA/NAD83/Alaska (Zone 2) ^M -c USA/NAD83/Alaska (Zone	Datum NAD83-Alabama NAD83-Alabama NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83 NAD83-Arizona NAD83-Arizona NAD83-Arizona NAD83-Arizona	
		< <u>B</u> ack Finish	Cancel

Choose the State Plane Zone on the right hand list and press 'Finish':



Now edit the new Coordinate System that we just created. Highlight the system and press the 'Edit' button:

Coordinate Systems	
	<u>Ö</u> r <u>×</u> B
t⊈ <local> ≮GWcs 94</local>	Edit
Lis wus o4 Lis USA/NAD83/Utah (Central)	

Select the 'Datum' tab:

Projected System [USA/N	IAD83/Utah (Central)]			X
Datum Projection System				
System Name : USA/NA	AD83/Utah (Central)			
East	→			
North	†			
Elips height	0	With vertical correction H =	> H local	
Vertical Datum :	🕒 Elipsoid 👱			
			-	
		ОК	Cancel	Apply

Change the Datum Name to "WGS-84"

Projected System [USA/N Datum Projection System	IAD83/Utah (Central)]		×
Datum Name : NAD83 Ellipsoid NAD83- N	Utah CORS94 CORS96 HARN Utah		
Mean DX to WGS84 :	0.0000 m		
Mean DY to WGS84 :	0.0000 m	Overwritten by NGS NADCON transformation	
Mean DZ to WGS84 :	0.0000 m	NAD83 (HARN/HPGN) <=> NAD83 (86)	
Mean RX to WGS84 :	0.000000 "		
Mean RY to WGS84 :	0.000000 "		
Mean RZ to WGS84 :	0.000000 "		
Mean ppm to WGS84 :	0.0000000000		
		OK Cancel Apply	

Press the OK button:

Projected System [USA/N	IAD83/Utah	(Central) *]					Đ
Datum Projection System							
Datum Name : WGS 84	1		•				
Ellipsoid Name :	WGS 84		•				
Semi-ma	jor Axis : 6378	137.000 m					
Inverse Fla	ttening : 298.	257223563					
DX to WGS84 :	0.0000 m						
DY to WGS84 :	0.0000 m						
DZ to WGS84 :	0.0000 m						
RX to WGS84 :	0.000000 "						
RY to WGS84 :	0.000000 "						
RZ to WGS84 :	0.000000 "						
ppm to WGS84 :	0.000000000	00					
				ОК	- Ş	Cancel	Apply

Close the 'Coordinate Systems' box:

Coordinate Systems	
Coordinate Systems	

Orthometric Elevations

The coordinate system that we just created will have ellipsoid elevations. Lets take a moment and build another coordinate system with orthometric elevations. From the main menu select "Project: Edit Settings...":

GNSS Solutions - [Su	irvey View.map - GTest001 - WGS 84 - Met	ers]
🛄 File Edit View Map	Project Tools Window Help	
10 🗟 🖬 🕼 🐰	Bdit Settings	
	Download Raw Data from Receiver or Card	F3
النہ	Import Raw Data from Files	F4
	🚯 Download Raw Data from Internet	
Project	Pownload Positions from External Device	
Process	Import Geo Data from Files	
	Change Into	
Define Control Points	Merge Points	
Adjustme	🛧 Define Control Points	
Export	Plunder Detection	
Мар	Rebuild Process Scenario	
Utilities	Process All Baselines	F5
	Process Unprocessed Baselines	F6
	Process Options	
workbook.tur=Grestool	X Clear Process Results	
V	Adjust Network	F7
1 IG01	Check Loop Closure	
2 SLCU	🗙 Clear Adjustment Results	
	Group Points	
	II Upload Positions to External Device	<u>هم</u>
× Updating post-proc	Export Geo Data to File	F8
Computing site "I	Land Survey Report	F9
Computing site it	Compute Datum Shifts	0
	Coordinate Calibration	
ા હ હ હ હ 🥑 🖉	Compute Ground System	
Edit project settings	VZ Import Vactor Man	

Choose the State Plane projected selection:

"GTest001" Project Settings	X
Region Miscellaneous Feature Code List	
Spatial Reference System	
I ^M , € USA/NAD83/Utah (Central)	
1 C <local></local>	
(Cantral)	
Linear unit	
All distances in Meters	
Save As Defaults OK Cancel	ly 🔤

Now, press the dot-dot-dot button to the right of the 'Spatial Reference System':

"GTest001" Project Settings
Region Miscellaneous Feature Code List
Spatial Reference System Image: USA/NAD83/Utah (Central) Time zone (GMT-07:00) Mountain Time (US & Canada)
All distances in Meters
Save As Defaults OK Cancel Apply

Give the system a new name. I suggest adding "Ortho G03" to the current 'System Name':

Projected System [USA/N	IAD83/Utah (Central) Orthe	o G03 *] 🛛 🔀
Datum Projection System		
System Name : USA/NA	AD83/Utah (Central) Ortho G03	
East		
Noth	↑ •]
Ellips height	•	With vertical correction H => H local
Vertical Datum :	Ellipsoid]
		OK Cancel Apply

Choose 'Geoid03' for the Vertical Datum

Projected System [USA/N	AD83/Utah (Central) O	rtho C	:03 *]	
Datum Projection System				
System Name : USA/NA	D83/Utah (Central) Ortho G0	3		
East	→	•		
North	†	•		
Ellips height	0	•	□ With vertical correction H => H local	
Vertical Datum :	Ellipsoid	•		
		1		
	VGS_84			
	SOSJULY			
	Alaska99			
	G EGM96			
	Geoid03			
	Geoid95			
	GGF97		OK Cancel Apply	

Finally, press the OK button:

Projected System [USA/N	AD83/Utah (Central) Ortho	G03] 🛛 🔀
Datum Projection System		
System Name : USA/NA	D83/Utah (Central) Ortho G03	
East	→ •	
North	↑	
Ortho height	•	☐ With vertical correction H => H local
Vertical Datum :	🕟 Geoid03 🔄	
		OK Cancel Apply

Using the New Coordinate System

When you enter control positions you are going to be reading geographic coordinates from NGS datasheets. Use the NAD83 adjusted coordinates from the data sheet. Choose WGS84 as the Coordinate System when entering.

Here is a portion of the datasheet for the SLCU CORS station. Note the highlighted values:

Retrieved from NGS DataBase on 08/27/07 at 17:45:27. Antenna Reference Point(ARP): SALT LAKE CITY CORS ARP PID = AJ6822 ITRF00 POSITION (EPOCH 1997.0) Computed in Aug. 2007 using 1232 days of data. X = -1808865.436 m latitude = 40 46 19.82371 N Y = -4487249.263 m longitude = 111 57 17.89411 W Z = 4144130.262 m ellipsoid height = 1277.965 m ITRF00 VELOCITY Estimated in Aug. 2007 using 1232 days of data. VX = -0.0139 m/yr northward = -0.0096 m/yr VY = 0.0091 m/yr eastward = -0.0163 m/yr VZ = -0.0155 m/yr upward = -0.0126 m/yr NAD_83 (CORS96) POSITION (EPOCH 2002.0) Transformed from ITRF00 (epoch 1997.0) position in Aug. 2007.

SALT LAKE CITY (SLCU), UTAH

L	X = -1808864.866 m	latitude = <mark>40 46 19.80218 N</mark>
	Y = -4487250.495 m	longitude = <mark>111 57 17.85195 W</mark>
	Z = 4144130.186 m	ellipsoid height = <mark>1278.618 m</mark>
	NAD_83 (CORS96) VELOCITY	
	Transformed from ITRF00 ve	elocity in Aug. 2007.
	VX = 0.0035 m/yr	northward = 0.0011 m/yr
	VY = 0.0101 m/yr	eastward = -0.0005 m/yr
	VZ = -0.0077 m/yr	upward = -0.0131 m/yr
1		

Select 'WGS 84' for the coordinate system when entering these coordinates. From the main menu, choose 'Project, Edit Settings...':

"GTest001" Project Settings	×
Region Miscellaneous Feature Code List	
Spatial Reference System	
Linear unit All distances in Meters	
Save As Defaults OK Cancel	ylqq

Now you can verify the coordinates for the control point:

Points [[SLCU]			000000000000000000000000000000000000000	X
Point					
₹.	Control Point				
Name	s: SLCU				
Desc	ription :				
			†		
Cor	nment				
	Control		Survey	Em	sic
	1 🖁 WGS 84 🛛 👻		L @ WGS 84		Total Error :
1	Long	₿	Long [Fixed] :		0.000 m
•	111° 57' 17.85195"W ± 0.000		111° 57° 17.85195"W ± 0.000		0.000
	Lat		Lat [Fixed] :		0.000
	Ellips height	1	Ellips height [Fixed] :	1	0.000
•	1278.618 ± 0.000	•	1278.618 ± 0.000		0.000
			ОК	Cancel	Apply

Once you verify that all control positions exactly match the published coordinate you can choose the coordinate system you want to display. For this example we have

Geographic Coordinates Meters:

			Ellips
Description	Long	Lat	height
	111° 51' 33.62782"W	40° 44' 09.87023"N	1308.391
	111° 57' 17.85195"W	40° 46' 19.80218"N	1278.618
	Description	Description Long 111° 51' 33.62782"W 111° 57' 17.85195"W	Description Long Lat 111° 51' 33.62782"W 40° 44' 09.87023"N 111° 57' 17.85195"W 40° 46' 19.80218"N

Utah Central State Plane NAD83 Ellipsoid Meters:

Name	Description	East	No	rth	Ellips height
IG01			469645.895	2266823.182	1308.391
SLCU			461589.357	2270868.017	1278.618

Utah Central State Plane NAD83 Ortho Meters:

					Ortho
Name	Description	East	Nort	h	height
IG01			469645.895	2266823.182	1325.038
SLCU			461589.357	2270868.017	1295.607

For reference, here is the Geoid03 results for SLCU:

Output from GEOID03

	1.	ati	tude]	long	gitude	N
Station Name	ddd i	mm	SS.SSSSS	ddd	mm	SS.SSSSS	meters
USER LOCATION	40	46	19.82371	111	57	17.89411	-16.988