

GPS Data Not Lining Up With GIS Data

October 26, 2007

Problem: The GPS data collected in the field does not line up properly with known features in a GIS.

This issue can be a result of several issues. Due to the accuracy expectations, it is most noticeable with sub-foot devices (GeoXH, ProXH). Some reasons for such a shift are:

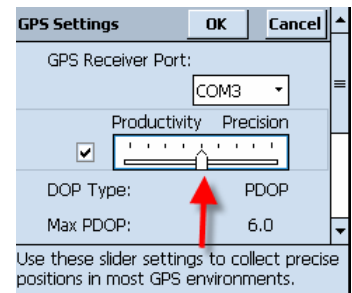
1. Improper field data collection, settings or methodology.
2. Improper settings in differential correction and export of data.
3. Comparing to GIS data with its own relative accuracy.
4. Improper settings when comparing to existing data (datum, coordinate units, ect.)

Maintain Proper Field Data Collection, Settings and Methodology

Especially with the subfoot devices, improper field data collection is the number one cause of GPS data not appearing in the right location. Please be sure to apply the following techniques when in the field:

Set your GPS “Productivity/Precision” slider bar to the middle.

This is the factory default. Setting it closer to Productivity will increase the amount of data you can collect, but it can also introduce error to your GPS. *We will not address accuracy issues unless this slider bar is set to the middle or toward “Precision”.* In TerraSync or GPSCorrect, the slider bar can be seen by going to Setup/GPS Settings.



Make sure that the antenna is over the point you are mapping. Note where your antenna is, and make sure that it is directly over or next to the item you are mapping.

Make sure you log enough data when creating point features. With H-Star collection, carrier lock must be maintained for at least 2 minutes. Although you can move around during this time, some prefer to remain stationary for the entire 2 minutes to ensure H-Star accuracy. Generally, sub-meter collection does not require the averaging of many positions, although collection in tree canopy may require averaging more positions than normal.

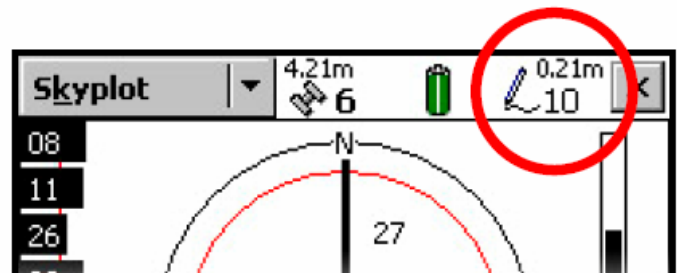
If you are having trouble keeping a lock on the satellites, consider an external antenna on a pole. Otherwise, your body becomes a large obstacle to GPS. *Be aware that for sub-foot devices, only the Zephyr antenna is recommended. Hurricane antennas and other external antennas may provide better satellite reception, but are not guaranteed to get the sub-foot accuracy provided by H-star data collection.*

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For sub-foot devices (GeoXH, ProXH), pay attention to your accuracy indicator. Sub-foot devices have a PPA (Post-Processing Accuracy) indicator in the upper right of TerraSync or GPSCorrect. That number needs to fall below the accuracy you seek.



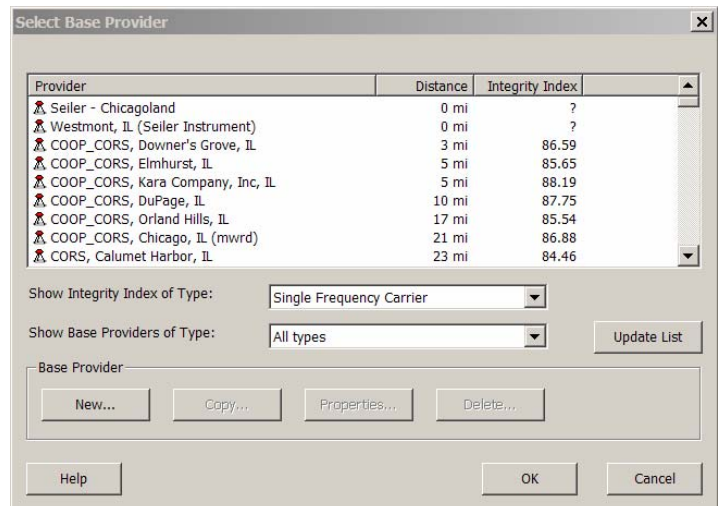
For ArcPad users, make sure you are collecting data in the correct projection and with the correct datum transformation. You can see the projection you are working in by tapping the dropdown arrow to the right of the Open Map button on the Main toolbar. Tap Map Properties, and then scroll through the different tabs until you find the Projection tab. Tap the Projection tab to see the projection you are working in, and change it by loading a file with the correct projection if necessary.

Maintain Proper Settings During Differential Correction and Export

Differential Correction: Without differential correction, all Trimble GPS units can be expected to get 10-15 meter accuracy (horizontal). To get to the various levels of mapping-grade accuracy (2-5 meters, 1-3 meters, sub-meter, sub-foot), it is necessary to post-process your GPS data.

In Pathfinder Office or GPS Analyst, go to the Differential Correction Wizard. Make sure you have a connection to the Internet, and click the “Update List” button.

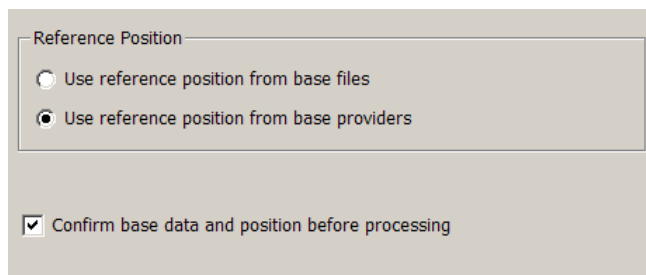
Select a base provider that is close to the location of your data collection and has a relatively high Integrity Index. You should be within 300 miles of the base station for regular code correction. If you are running H-Star differential correction, you need to select one base station within 50 miles or three stations within 120 miles.



When you correct your GPS data, you are doing it against a certain “datum”. Datums are used as a basis for all coordinate systems. When you correct against a datum that is different than the datum of your GIS data, a “shift” can occur. This shift can be small (a few centimeters) or large (a few meters). *If you have been comparing your GPS data to your GIS, and everything is shifted by a constant amount to the same direction, this is very likely a datum shift, not a faulty GPS unit.*

There are two setting choices for 'Reference Position' when correcting.

- 'Use reference position from base providers' (Default) - uses reference position from Trimble's base station list, all of which are ITRF00 positions. By selecting this option, you ensure that your .cor file remains in Lat/Long WGS84.
- 'Use reference position from base files' - uses reference position from base station files. In the case of CORS and COOP_CORS stations, these positions are NAD83 (CORS96) positions. *By selecting this option, your .cor file will have a datum shift applied and will be Lat/Long NAD83 (CORS96).*



When the differential correction is complete, it will show the estimated accuracies of the corrected positions in your file. These estimates are based on the receiver used to collect, satellite conditions, base station used, base station proximity, and other factors.

Please be aware that these are conservative estimates. Do not base your accuracy tests on these numbers.

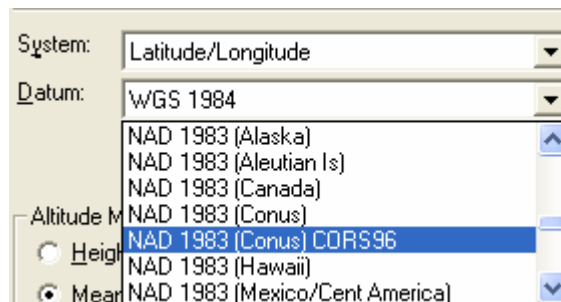
Note: Another thing to keep in mind here is that these estimates look at the PDOP levels in your data. If you are using an HDOP in the field, your data may contain higher PDOP levels, resulting in higher accuracy estimates, even though the horizontal accuracy of your data may still be sub-meter.

Estimated accuracies for 122 corrected positions are as follows:

Range	Percentage
0-15cm	-
15-30cm	50.0%
30-50cm	50.0%
0.5-1m	-
1-2m	-
2-5m	-
>5m	-

Differential correction complete.

Export: Another common source of error in GPS data occurs during the export of the corrected data in Pathfinder Office. Keeping in mind the datum of your GPS data (as described above), be certain you are exporting to the correct coordinate system and especially *selecting the appropriate datum* in the Export Settings. For example, selecting the NAD 1983 (Conus) datum will apply a 'zero' datum shift between WGS 1984 and NAD 1983, whereas the NAD 1983 (Conus) CORS96 datum choice will apply an ITRF00 to NAD 1983 (CORS96) datum shift.



Note: If you are exporting to a State Plane coordinate system, you must also set the coordinate units in the Export Settings correctly. Most State Plane systems use US Survey Feet, although some use International Feet. Carefully check which units your State Plane coordinate system uses. Leaving the coordinate units at the default of meters can cause shifts of 100 feet or more in your data.

GPS Analyst: In GPS Analyst, when a geodatabase is GPS-enabled, you are prompted to specify a datum transformation if your geodatabase is referenced to something other than WGS 84. For WGS 84 to NAD 83 transformation, the choices are:

NAD_1983_To_WGS_1984_1	NAD 83 (1996) - "zero" datum shift
NAD_1983_To_WGS_1984_2	Alaska Aleutians
NAD_1983_To_WGS_1984_3	Hawaii
NAD_1983_To_WGS_1984_4	United States - ITRF94
NAD_1983_To_WGS_1984_5	United States - ITRF96

Specify the _5 transformation for NAD83 (CORS96).

Note: This is a transformation between NAD 83 (CORS 96) and ITRF96, which is only a few centimeters different from ITRF00. ESRI ArcGIS does not yet provide a NAD 83 (CORS 96) to ITRF00 transformation.

Be aware of the accuracy of your GIS data when comparing to GPS data

If you are trying to line your GPS data up to existing GIS data, it is important to look at the "metadata" of your GIS. Are all layers the same, or are they mixed in with other reference frames? If they are all the same, what are the details?

- Coordinate System (UTM, US State Plane 1983, etc.)
- Datum (NAD83, WGS-84, etc.)
- Datum Version ("Epoch")? Choosing the wrong version can cause data to shift by as much as 3-4 feet! Common examples are NAD83 (86), NAD83 (91), NAD83 (CORS96).
- Units of measurement (Meters, US Survey Feet, etc)
- Estimated accuracy of GIS data
- Pixel size of aerial photo (this is usually buried in the metadata somewhere). For example, a 6" pixel –size aerial photo may have 3-10 feet of error.

Maintain proper settings when comparing to known NGS points

The only valid way to test the accuracy of your particular GPS receiver is to compare to a known survey point. If you have followed all the steps above and continue to produce what looks like inaccurate data, you will need to log your GPS (using the proper field techniques outlined at the beginning of this paper) over a known NGS benchmark. There should be one available near you.

You can then send the SSF file of that point and the NGS "PID" (Point ID) to your local support representative. This way we can determine if the problem is hardware, software, or source data .

The first step is locating a nearby benchmark. Go to this site: <http://www.ngs.noaa.gov/cgi-bin/datasheet.prl>. Click "Datasheets".

If you have an approximate coordinate of your location, the fastest way to narrow down your search is to enter those details in the webform (see right).

Set your radius to about 2 miles. You can always adjust this and re-submit for different results. Select "GPS Sites Only" and click "Submit".

You can choose to enter the coordinate in multiple formats (SPC is State Plane Coordinates):

Change Input Format: DEG MIN SEC | Explain Input Format: Explain DEG MIN SEC | Sample: Sample DEG MIN SEC | Clear: Clear

Center Latitude = N414924 | Example = N384417
 Center Longitude = W0875719 | Example = W0982215
 Radius = 2.0 | Max = 30.0 Miles

Data Type Desired:
 GPS Sites Only
 Any Horizontal Control
 Horizontal Order-A

Stability Desired:
 Any Stability
 Stability A only
 Stability B or better

Output in East Longitude.
 Include suspect heights in subsidence areas
 Browse Mode

Submit | Reset

Then click "Get Datasheets".

Help

Re-Sort-By: Dist Pid H V Vert_Source Lat_approx Lon_approx Stab Designation

Dist	PID...	H	V	Vert_Source	Approx.	Approx..	Stab	Designation
0.7	AJ2796	0	.	88/GPS OBS.	N415002	W0875724	B...	DUP83_2
1.4	AF9278	0	.	88/GPS OBS.	N415038	W0875729	B...	EWT IL 83A

Database retrieval time = 00:00:00

Select All

Get Datasheets (for the stations I've selected above)

Move (the above station list to a File->Print Window)

Reset

The NGS Data Sheet

See file [dsdata.txt](#) for more information about the datasheet.

DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.50

1 National Geodetic Survey, Retrieval Date = SEPTEMBER 17, 2007

```
AJ2796 *****  
AJ2796 DESIGNATION - DUP83 2  
AJ2796 PID - AJ2796  
AJ2796 STATE/COUNTY- IL/DU PAGE  
AJ2796 USGS QUAD - HINSDALE (1993)  
A.T2796
```

Check at the bottom of the datasheet to make sure that the benchmark has been found recently. If the location description is old or the monument has been declared “missing”, close that sheet and select another.

Note the PID (Point ID) so we can search for the datasheet’s coordinates for the test. Open a new SSF file and name it “GPS Test”. Go to the benchmark and collect GPS data using the tips outlined at the beginning of this paper. E-mail the SSF file of that data collection project and the PID of the monument to your tech support rep. They will test the data using various base stations and then call you to walk you through their process. If the GPS data has been found to line up with the benchmark, the issue is most likely a datum transformation or inaccurate GIS metadata.

References:

Resolving the NAD83 Datum Transformation Issue:

http://trl.trimble.com/docushare/dsweb/Get/Document-170369/SprtNote_PFO-GPSA_NAD83Datum.pdf