



PRIORITY SUPPORT

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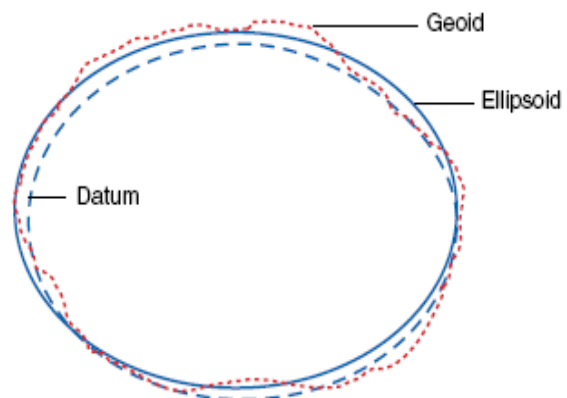
GPS and Mean Sea Level in ESRI® ArcPad®

June 9, 2015

Summary

In order to record elevation values as accurately as possible with ArcPad®, it is necessary to understand how ArcPad records elevation. Rather than storing elevation values relative to Mean Sea Level (MSL), ArcPad records z values as Height Above Ellipsoid (HAE) meters. HAE values can differ by up to hundreds of feet from MSL, and in coastal areas, HAE values can even be negative.

GPS satellites use an ellipsoid as the basis for their height measurement. An ellipsoid is a three-dimensional mathematical model of the earth's shape. GPS uses the WGS 1984 ellipsoid, which has as its origin the center of the earth's mass. Since GPS satellite orbits also originate with the center of the earth's mass, it is easy for GPS to calculate a height relative to this surface.



Note: Trimble® GPS Analyst™ Extension for ArcGIS® always rebuild the z values from the underlying GPS data, which is always stored as Height Above Ellipsoid in meters. Therefore, neither of the workarounds suggested in this Support Bulletin will have any effect for GPS Analyst users, who must wait until ArcGIS support vertical datum transformations. Geoid calculations can be done after the data is processed in ArcGIS Desktop.

Since sea level is a function of gravity, and is therefore an irregular shape, HAE values must be converted to MSL values using a geoid model. A geoid is defined as the surface of gravitational equipotential - basically what sea level would be if projected through land masses.

A geoid model applies geoid separation values for a particular location. Geoid separation values are not constant, but vary with location. Many GPS receivers store a lookup table of geoid separation values, but due to storage constraints on the GPS receiver, these values may not be very accurate. For example, many GPS receivers use a DMA10x10 geoid model, which stores geoid separation values for a 10° x 10° area. In such a large area, geoid separation values would actually vary a great deal, meaning that MSL values calculated with such a 'rough' geoid model could tend to be very inaccurate. Accurate geoid separation values are available from national geodetic agencies. The following will show 2 ways to change the height reference with ArcPad to MSL without sacrificing accuracy.



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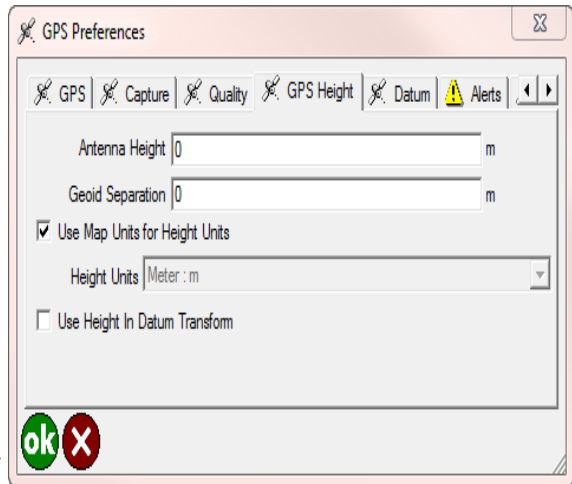
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Setting Geoid Separation in ArcPad GPS Preferences

To obtain accurate MSL values in the field with ArcPad, it is necessary to enter both the antenna height and a geoid separation on the GPS Height tab in GPS Preferences.

Make sure to enter the geoid separation in the specified height units. Geoid separation values for the US can be obtained from the [National Geodetic Survey](#). These values are supplied in meters. ArcPad subtracts the geoid separation from the ellipsoidal height (HAE) to determine the height for the z-value. The resultant height is MSL.

Be aware that geoid separation values can vary with location. Therefore this method may be best when working in a relatively small geographic area, or if you have determined that the geoid separation is the same wherever you work. If an incorrect geoid separation is entered in ArcPad, resulting z-values will be incorrect.



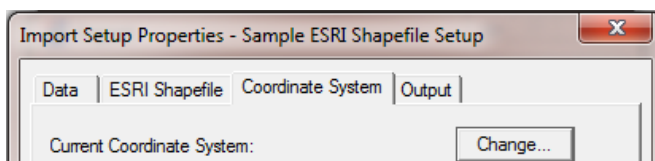
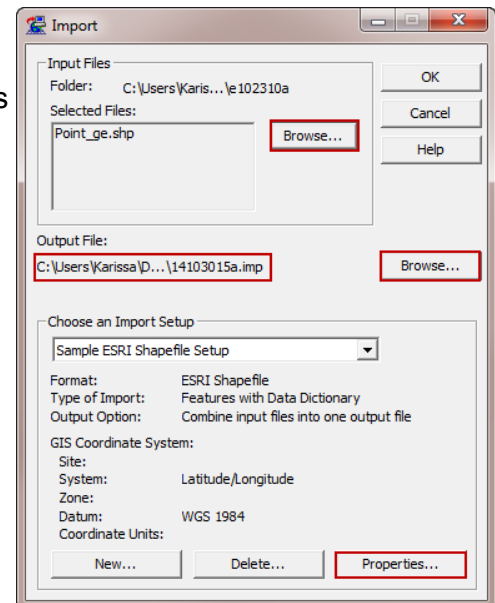
Using Trimble GPS Pathfinder® Office to Change Height Reference

An alternative to entering a geoid separation in ArcPad involves using Pathfinder Office to convert HAE to MSL. An accurate and up-to-date geoid model is available in this software. If employing this method, leave the geoid separation set to 0 in ArcPad, so that HAE values are recorded in the field.

To perform the conversion, do the following:

1. Use the Import utility in Pathfinder Office to transform shapefiles that are HAE meters into Trimble IMP files.

- Press the top Browse button to select shapefiles to convert.
- Press the Browse button next to 'Output File' to change the name of the Trimble IMP file.
- Beneath 'Choose an Import Setup,' select the Sample ESRI Shapefile Setup from the drop-down list.
- Press the Properties... button in the lower right.
- Click on the Coordinate System tab, then press the Change... button.



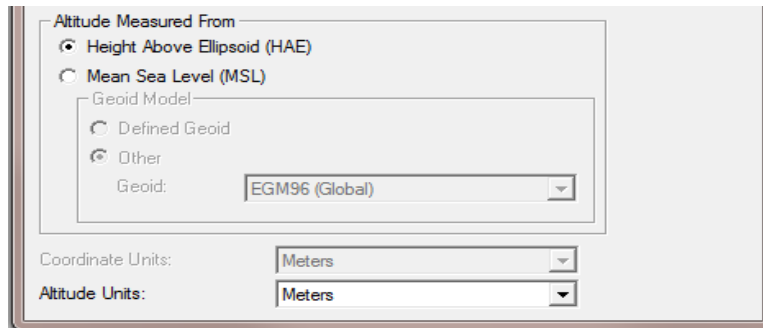
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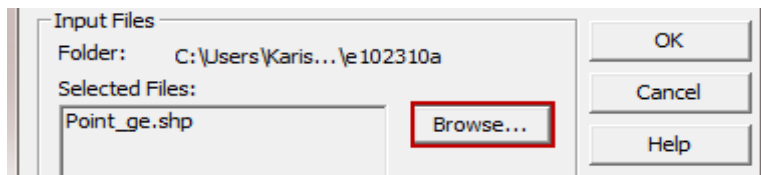
- Specify the coordinate system, zone, datum, and coordinate units that the shapefiles are currently in.



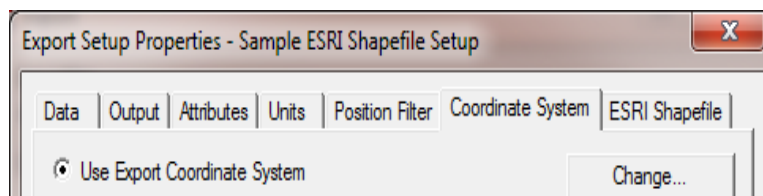
- Most importantly, specify HAE meters for the current height reference.
- Press OK to save settings changes until you are at the main Import screen. Press OK to run Import.

2. Use the Export utility to transform Trimble IMP files into shapefiles that are referenced to MSL.

- If not already listed, press the top Browse button to choose the IMP file created in the last step.



- Press the center Browse button to set the output folder to the original ArcPad shapefile location.
- Beneath 'Choose an Export Setup,' select 'Sample ESRI Shapefile Setup' and press the Properties... button.
- Click on the Coordinate System tab, choose 'Use Export Coordinate System' and click the Change... button



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- Set the output coordinate system, zone, datum, and coordinate units to match the original shapefiles.
- Most importantly, change the 'Altitude Measured From' to MSL and specify the GEOID12A (Conus) geoid model. This is the most up-to-date geoid model available in Pathfinder Office.

Altitude Measured From

Height Above Ellipsoid (HAE)

Mean Sea Level (MSL)

Geoid Model

Defined Geoid

Other

Geoid:

Coordinate Units:

Altitude Units:

- Tap OK.
- At the bottom of the dialog, select the 'Export Coordinates as XYZ' to ensure a 3D shapefile is created by the Export utility.

Export Coordinates As

XY

XYZ

- Click on the Position Filter tab.

Export Setup Properties - Sample ESRI Shapefile Setup

Data | Output | Attributes | Units | Position Filter | Coordinate System | ESRI Shapefile

- Check the box to 'Include Positions That Are Uncorrected.'
- Click OK to return to the main Export dialog.
- Click OK to complete Export. When warned that files will be overwritten, click Yes.

Include Positions That Are

Uncorrected

Setting Geoid Separation in Positions™ ArcPad Extension

In Positions ArcPad Extension version 10.2.1.1 or higher, there is the functionality to send a geoid file (GGF) to handheld to calculate MSL levels in the field. There is no interface in the extension itself to specify the GGF to use. This must be done in the office as the registry entry will have to be changed.

- To do this, you will need to download the [Geoid Model Configuration Utility](#) and the [GGF](#) that you will be using.
- Once these files are downloaded, you will copy them over to the handheld using Windows® Mobile Device Center or ActiveSync®.
- You will navigate to the file explorer on the handheld and run the Geoid Model Configuration Utility .exe file.
- In the utility, you will need to check the box next to Use geoid file for MSL. Click the Browse button to select the GGF file that you would like to use.

Select a geoid file

Use geoid file for MSL

File name:

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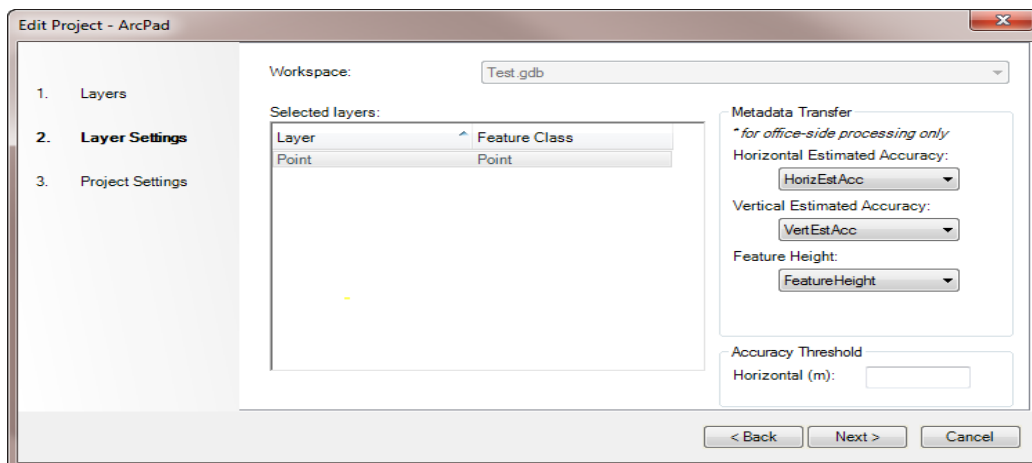
When you have a geoid file specified, ArcPad will receive only the MSL elevations from the extension. If you want to confirm the difference between HAE and MSL, you can navigate to the Skyplot screen in the Positions extension and note the HAE value and compare this with what you see on the GNSS overlay in ArcPad.

Setting Geoid Separation in Positions Desktop Add-in

In Positions Desktop Add-in version 10.3.0.1 or higher, a geoid can be selected to view MSL after processing in the data.

Note: *The MSL values won't be populated in the attribute table till after the features have been updated.*

- You will need to download the [GGF](#) that you will be using to your computer. You will need to save the files in an unzipped format to C:\ProgramData\Trimble\Positions\10.1\GeoidFiles.
- In the Trimble Positions Desktop Administration, go to Projects and Create a new project.
- When you get to the Layer Settings, you will need to select the feature class and choose the field to populate with the Feature Height. If you don't have a field setup ahead of time, you can select New: FeatureHeight and it will create a new field for you.





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- On the Project Settings, you will need to change the Feature Height down to Calculate geoid separation from file. Select the geoid you would like to use in the dropdown box.

1. Layers

2. Layer Settings

3. **Project Settings**

Project name: Test

Map document: Test.mxd

Accuracy reporting: ** for office-side processing only*
68% Circular Error Probable (DEFAULT)

Feature heights:

Use height above ellipsoid (HAE)

Apply fixed geoid separation (m)

Calculate geoid separation from file: G12AUS.ggf

< Back Finish Cancel

Conclusion

Using a geoid separation value in ArcPad GPS Preferences results in MSL values being stored while data is collected in the field. However, care must be taken that the geoid separation value entered is correct as location varies.

Using Pathfinder Office to convert from HAE to MSL allows the use of the most up-to-date geoid model from the NGS but involves several extra steps. In addition, it only works with shapefiles, not with ArcPad AXF data.

Using a GGF file in Positions software suite will allow the software to calculate the geoid model for MSL values in the field and in the office. This must be setup ahead of data collection.

Either method will result in the most accurate MSL value possible. Absolute accuracy will vary, as vertical accuracy (HAE) is 1-3 times worse than horizontal to begin with, and conversion from HAE to MSL also introduces some error.