



How To
Measurements on floating objects
Version 4.5



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1. Introduction

This document describes how measurement taken on floating objects can be adjusted. The last paragraph explains how to deal with object that are on stable ground, but have their own local coordinate frame, with a height direction that is not parallel to the direction of the gravity.

For measurements on floating object the compensator should be disabled since the total station should not compensate for the movements of the object.

When using multiple setups a sufficient number of overlapping points is required to solve for the additional unknown deflection of the vertical.

The TPS measurements taken on floating objects can be imported from Leica GSI/DBX (Leica 1200), Topcon, Sokkia SDR33 and Trimble DC/JobXML format.

Please note that this is a sample. The actual settings may differ depending on your local requirements.

2. New MOVE3 Project

Create a new MOVE3 project by specifying the project name. A template project (option file) can be selected to use previously defined project settings.

3. Options

Starting a new project without using a template will set all options to the MOVE3 defaults. In this case you must set at least some of the options to meet the adjustment requirements. Set the *Project* options to terrestrial only and set the Geoid model to Automatic. In this case the Geoid model will not be used to correct orthometric heights to ellipsoidal heights, but to introduce additional deflection of the vertical unknowns to the adjustment.

General options

Project Geometry Adjustment MOVE3 output selection Units Datasnooping

Network name : FloatingObjects

Terrestrial :
 Observations
 Coordinates

Feature code
None

GNSS/GPS :
 Observations
 Coordinates

Project type
Default

Project Height 0 m

Geoid model :
Automatic

Geoid precision 0.0000 m 0.0000 ppm

Terr -> Local (stereographic)

OK Cancel Help

Project tab sheet.

In the *Geometry* tab the Dimension must be set to 3D. In most cases these specific measurements will be attached to a local defined coordinate system, so the Local (Stereographic) projection can be used. Use a proper setting for False Easting and False Northing to make sure that the scale distortion is minimal. Typically the False Easting and False Northing could be set to the coordinates of the centre of the network. Due to the limited extends of this type of network the setting of the (shape of the) ellipsoid is not important, nor is the exact location of the network (Latitude of origin and Longitude of origin).

Parameter	Value	Unit
Dimension	3D	
Projection	Local (stereographic)	
Projection name	Local (stereographic)	
Longitude of origin/CM	0 00 00.00000	
Latitude of origin	0 00 00.00000	
Standard parallel 1		
Standard parallel 2		
Scalefactor	1.000000000	
False Easting	0.0000	m
False Northing	0.0000	m
Ellipsoid	Bessel 1841	
Semi major axis	6377397.1550	m
Inverse flattening	299.152812800	
Transformation	None	
GPS coordinate type	ELL	

Geometry tab sheet.

4. Default standard deviations

Before importing the data it is important to properly set the defaults for the standard deviations of the TPS observations direction, distance and zenith angle. The standard deviations have an absolute part and a relative. The default values are added to each imported observation.

Standard Deviations

Standard deviations for observations | Standard deviations for stations

Terrestrial Observations:

Direction	<input type="text" value="0.00000"/> gon	<input type="text" value="0.00100"/> gon.km
Distance	<input type="text" value="0.0100"/> m	<input type="text" value="0.0"/> ppm
Zenith Angle	<input type="text" value="0.00000"/> gon	<input type="text" value="0.00100"/> gon.km
Azimuth	<input type="text" value="0.00000"/> gon	<input type="text" value="0.00000"/> gon.km
Height Difference	<input type="text" value="0.00"/> mm	<input type="text" value="1.00"/> mm/sqrt(km)
		<input type="text" value="0.00"/> mm/km
Shift Vector EN	<input type="text" value="0.0100"/> m	H <input type="text" value="0.0100"/> m
Local Coordinate EN	<input type="text" value="0.0100"/> m	H <input type="text" value="0.0100"/> m

GNSS/GPS Observations:

GNSS/GPS Baseline	<input type="text" value="0.0100"/> m	<input type="text" value="1.0"/> ppm
GNSS/GPS Coordinate	<input type="text" value="0.0100"/> m	

Geometrical Relations:

Angle	<input type="text" value="0.10000"/> gon	Update Observations <input type="radio"/> All <input type="radio"/> All types with changed defaults <input type="radio"/> All with old defaults <input checked="" type="radio"/> None
Distance / collinearity	<input type="text" value="0.0150"/> m	

Offsets:

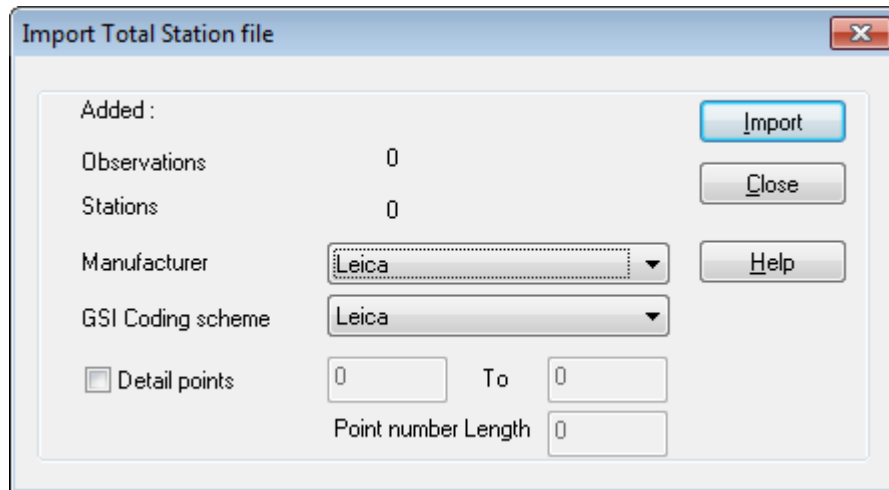
Steel Tape measurement	<input type="text" value="0.0100"/> m
Auxiliary point	<input type="text" value="0.0100"/> m

OK Cancel Help

Standard Deviations.

5. Import TPS measurements

Select the menu option Import/export | Total Station and specify the manufacturer. Then click Import and select the raw data file(s).



Import Total Station dialog.

The imported data will be shown in the observation list that can be opened under View | Observations.

No.	F. To	Instr Hgt	Target...	Reading[gon/m]	Reading[gon/m]	Reading[gon/m]
1	s1 2	0.0000	1.1300	R0	394.94200	S0 33.6620 Z0 118.62900 3D
2	s1 13	0.0000	0.2500	R0	197.40500	S0 62.6290 Z0 108.21700 3D
3	s1 3	0.0000	0.1250	R0	0.00000	S0 36.0410 Z0 114.76300 3D
4	s1 4	0.0000	2.3200	R0	10.03700	S0 34.1170 Z0 115.03600 3D
5	s1 6	0.0000	1.5300	R0	13.48200	S0 29.1620 Z0 115.25100 3D
6	s1 7	0.0000	0.0850	R0	386.12700	S0 21.2340 Z0 122.25100 3D
7	s1 8	0.0000	0.2500	R0	119.86400	S0 10.8880 Z0 106.54600 3D
8	s1 9	0.0000	0.2500	R0	237.94800	S0 5.5430 Z0 111.54300 3D
9	s1 10	0.0000	0.0850	R0	163.98500	S0 7.0580 Z0 110.75300 3D
10	s1 12	0.0000	0.2500	R0	184.77200	S0 63.3090 Z0 108.26500 3D
11	s1 14	0.0000	0.2500	R0	189.71000	S0 73.5850 Z0 105.34500 3D
12	s1 15	0.0000	0.2500	R0	193.39900	S0 73.3000 Z0 105.32200 3D
13	s1 16	0.0000	1.8800	R0	192.78200	S0 36.6470 Z0 108.22700 3D
14	s1 17	0.0000	1.8800	R0	184.84100	S0 36.9590 Z0 108.20300 3D
15	s1 20	0.0000	2.1400	R0	197.08300	S0 32.9520 Z0 109.43100 3D
16	s1 21	0.0000	2.1400	R0	179.26700	S0 33.5400 Z0 109.37000 3D
17	s2 2	0.0000	1.5300	R0	378.08100	S0 10.9590 Z0 113.02800 3D
18	s2 8	0.0000	1.5300	R0	220.34300	S0 29.6070 Z0 84.22400 3D
19	s2 9	0.0000	1.5300	R0	249.10200	S0 31.5500 Z0 85.01400 3D
20	s2 6	0.0000	1.5300	R0	43.70400	S0 2.8090 Z0 95.75100 3D
21	s2 7	0.0000	0.0850	R0	298.51800	S0 11.1700 Z0 101.04000 3D
22	s2 1	0.0000	1.5300	R0	11.80800	S0 8.3910 Z0 117.58400 3D
23	s2 3	0.0000	0.1250	R0	0.00000	S0 11.5400 Z0 106.57800 3D
24	s2 4	0.0000	1.5300	R0	29.69300	S0 8.0090 Z0 113.36000 3D
25	s2 5	0.0000	1.5300	R0	369.92900	S0 12.4090 Z0 107.99800 3D
26	s2 22	0.0000	-0.0850	R0	227.25850	S0 32.3650 Z0 57.29000 3D
27	s2 22a	0.0000	-0.1720	R0	227.25850	S0 32.3650 Z0 57.29000 3D
28	s3 10	0.0000	1.3300	R0	394.90600	S0 45.8840 Z0 91.68700 3D
29	s3 14	0.0000	0.0850	R0	196.22600	S0 21.4950 Z0 101.73000 3D
30	s3 15	0.0000	0.0850	R0	208.72500	S0 21.7570 Z0 101.61700 3D
31	s3 12	0.0000	1.8300	R0	171.64400	S0 11.3620 Z0 104.61900 3D
32	s3 13	0.0000	1.8300	R0	238.82800	S0 13.0850 Z0 103.61100 3D

Observation dialog

6. Adding known points

A proper adjustment requires that all control points are added as known stations. Go to the View | Station and edit the control stations. Enter the proper station coordinates and check the Known check boxes.

TER GEO

1

Station name 1

X East -2.7810 m

Y North -0.0034 m

Height -2.9182 m

Known

		Standard Deviations	
X East	<input checked="" type="checkbox"/>	0.0000	m
Y North	<input checked="" type="checkbox"/>	0.0000	m
Height	<input checked="" type="checkbox"/>	0.0000	m

Precision of idealisation XY 0.0000 m

Precision of idealisation height 0.0000 m

Deselection

Add GPS Apply Apply all

OK Cancel Help

Adding Known Points

Alternatively known points can also be added via the Import/export menu option Coordinate file.

Import Coordinate file ✕

Added :

Observations 0

Stations 0

Add as:

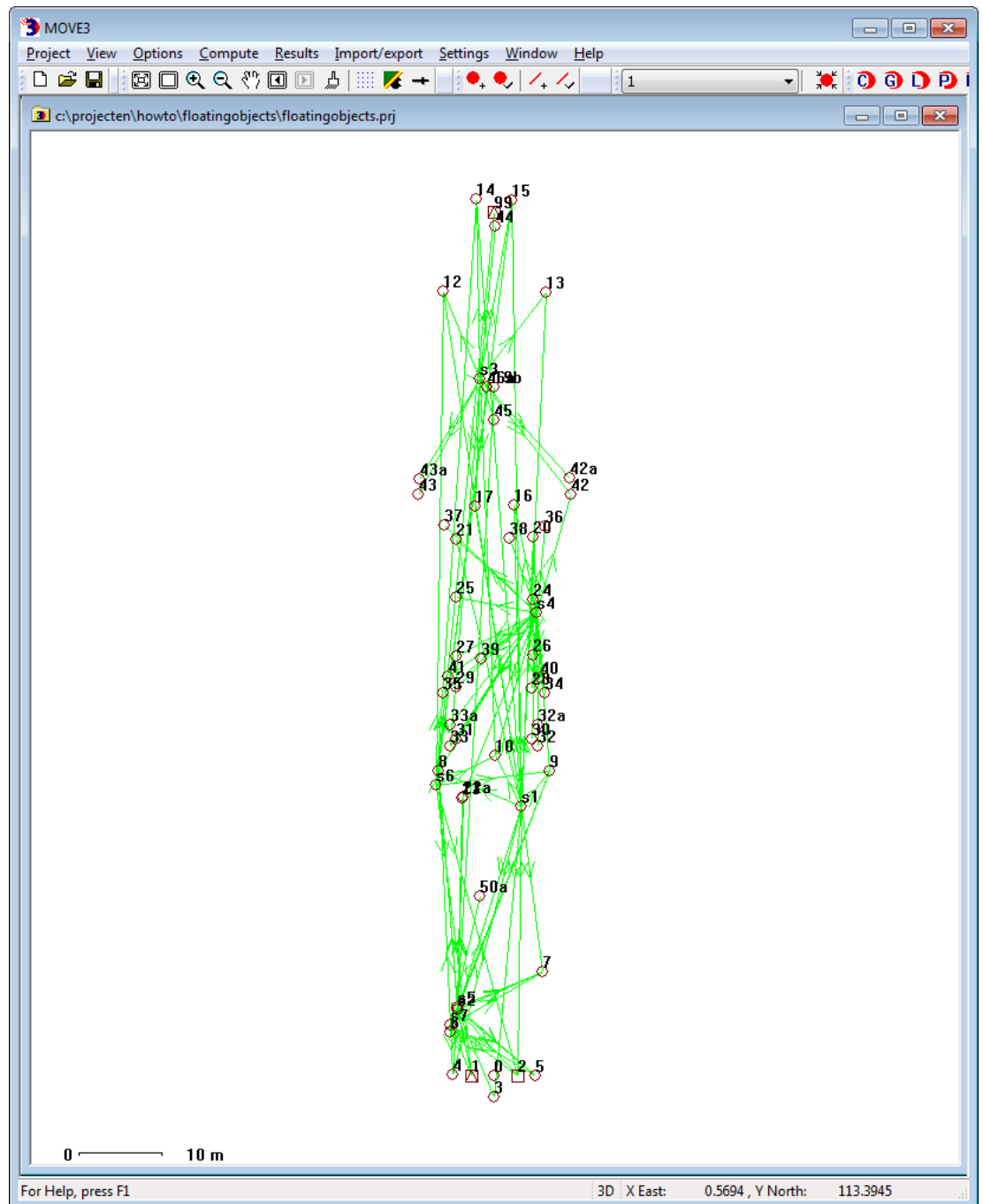
Update existing only

Format:

	Begin	Length	Field
Station name	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="1"/>
X East	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="2"/>
Y North	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="3"/>
Height	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="4"/>
St dev X East	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
St dev Y North	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
St dev Height	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

Import Known Points

Once the known points have been added the approximate coordinates can be computed using the COGO3 option from the compute menu. The graphics view now shows the layout of the network.



7. Deflections of the vertical for Total Station setups

Open the Edit station dialog, for the points with a total station setup and go to the GEO tab. Un-check the deflection of the vertical fixed check box. Now 2 additional unknown deflections of the vertical will be added to the adjustment thus solving for the tilt of the total station with respect to the object.

The screenshot shows the 'Edit station' dialog box with the 'GEO' tab selected. At the top, there are two tabs: 'TER' and 'GEO'. Below the tabs is a dropdown menu showing 's4'. Underneath, there are two main sections. The first is 'Geoid Height', which contains a text box with the value '0.0000'. The second is 'Deflections of the vertical', which contains two text boxes: 'East' with '0.000'' and 'North' with '0.000''. Below these is a checkbox labeled 'Fixed' which is currently unchecked. At the bottom of the dialog, there are six buttons: 'Add GPS', 'Apply', 'Apply all', 'OK', 'Cancel', and 'Help'.

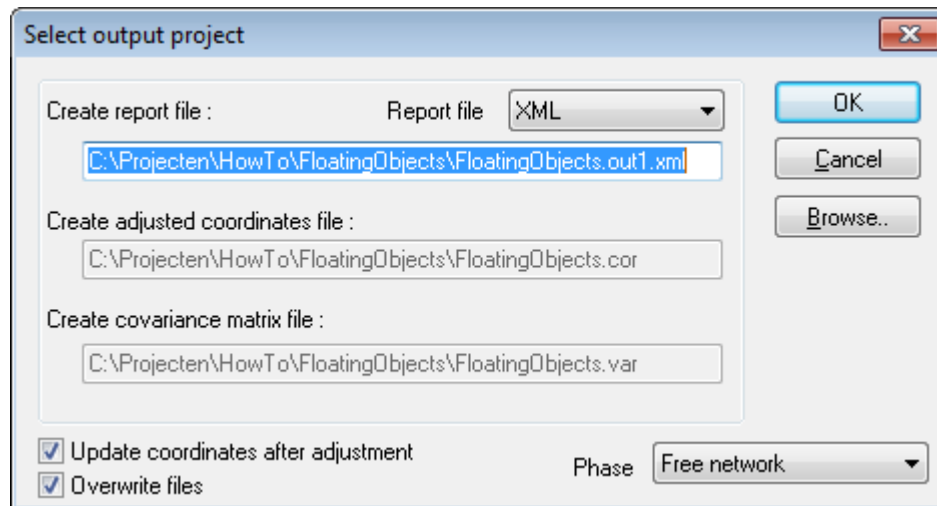
Edit station GEO tab

It does no harm when the deflections of the vertical are activated for a target only points, since the deflections of the vertical unknowns will only be added to observations that are measured from the setup point.

If the deflections of the vertical are kept fixed for a setup point numerous observations may be rejected. This is not caused by observation errors, but by ignoring the deflections of the vertical in the model.

8. Adjustment in Phases

You're now ready to adjust the network. It is best to do a free network first to test the observations for outliers. Go to Compute| MOVE3 and set the phase to Free network.

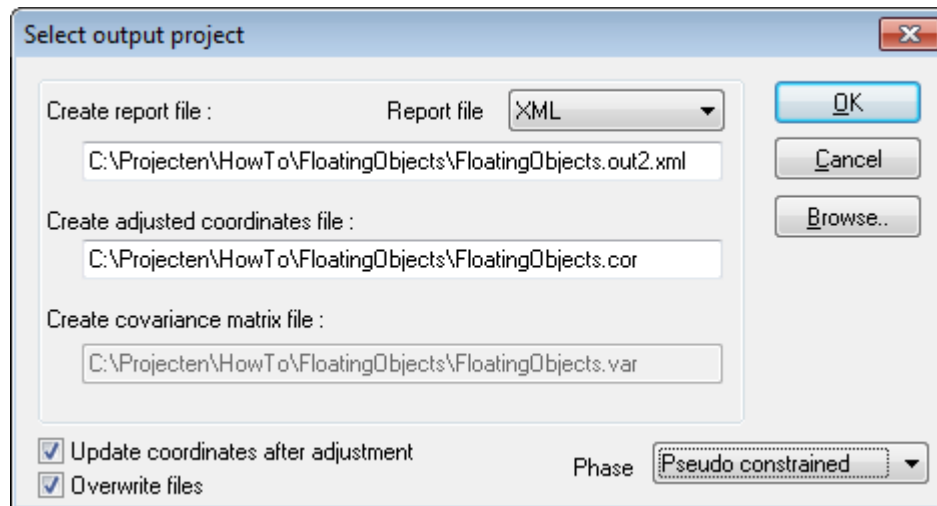


Compute Free network

The MOVE3 report will give the testing results of the adjustment, allowing to identify errors when sufficient redundancy is available.

In case one does not meet the predefined quality of the observations the global F-test will be rejected. This may be caused by either a too optimistic set of standard deviations of the observations or by observation errors. Usually a rejection is caused by errors in the observations. To identify the observation errors one can use the W-test. The observation with the largest W-test is the most suspect observation. One should try to solve the cause of the error, maybe there was a problem during import of the raw observations that can be corrected. The estimated error can be used for this purpose because it gives an estimate of the size of the observational error. If the error cannot be repaired, the observation can be deselected (not used in the adjustment). This will however affect the reliability of the network. In some cases rejected observations may have to be re-measured to maintain proper reliability.

After an acceptable Free network adjustment the combined network can be constrained to all available control points in the Absolute constrained adjustment. This phase will result in testing of the available control heights and the final adjusted coordinate computation.



Compute Absolute constrained network

The quality of the control points (the standard deviation of the known coordinates) is taken into account for testing. If the combined network does not fit to the control points there may be rejected points. If the F-test is rejected, the largest W-test value can be used to identify the errors. If a control point is rejected this may have been caused by a mistake in entering the known points coordinates or by entering a wrong control point. It is best to check this out first. There may be a deformation in the control points as well, causing the error. If the problem cannot be solved the control point can be removed as a control point for the adjustment. The point will then be re-adjusted, getting new adjusted coordinates.

The final results are stored in the MOVE3 report file, but they are also written to the MOVE3 COR file. The adjusted coordinates can also be exported using the Import/export menu option Adjusted Coordinates. Specify the format and the fields you want to export and write the data to an ASCII file.

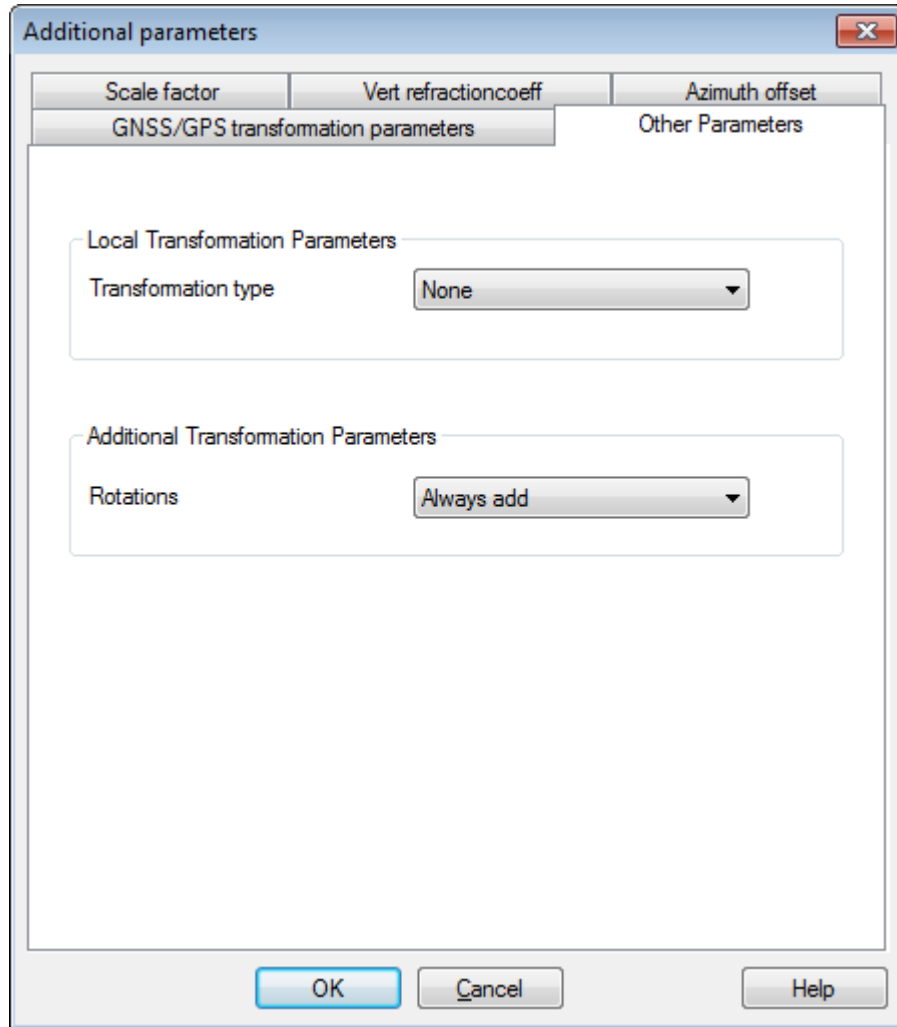
Format:	Separator	Comma	
	Begin	Length	Field
Station name	1	10	1
X East	0	0	2
Y North	0	0	3
Height	11	10	4
St dev X East	0	0	0
St dev Y North	0	0	0
St dev Height	0	0	0
Feature code	0	0	5
Ext Rel X East	0	0	0
Ext Rel Y North	0	0	0
Ext Rel Height	0	0	0
St Ellipse A	0	0	0
St Ellipse B	0	0	0
St Ellipse Phi	0	0	0

Export Adjusted Coordinates tab sheet

9. A different approach: Objects on land

If the object is located on land the total station setups may be properly levelled, but the objects height system may not be lined up with the direction of the gravity. For this case the Geoid model is set to None and the Additional Transformation Parameters setting is set to Always add.

Now one set of deflection of the vertical parameters is solved to cater for tilt between the total station setups and the height system of the object.



Additional parameters Other tab sheet