

How To Measurements on floating objects Version 4.6



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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 Terrestrial Positioning System (= 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 for each setup point.

General options		×
Project Geometry Adjustment MOVE3 output selection	Units	Datasnooping
Network name :       FloatingObjects         Terrestrial :       Feature code         Ø Observations       None         Observations       Project type         Observations       Default         Observations       Default	-	
Geoid model :	0 m	
Automatic	-	
Geoid precision 0.0000 m 0.0000 pp	) m	
Terr -> Local (stereographic)		
OK <u>C</u> ancel		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).

General options		<b>X</b>
Project Geometry Adjus	tment MOVE3 output selection	n Units Datasnooping
Dimension	3D 🔻	
Projection	Local (stereographic) 🔹	More
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	1.00000000	
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	
	DK <u>C</u> ancel	Help

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. These values are added as defaults to each imported observation.



Standard Deviations						×
Standard deviations for station	ns Standard dev	iations for	obse	rvations		
Terrestrial Observations:						
Direction	0.00100	gon			0.00000	gon.km
Distance	0.0100	m			0.0	ppm
Zenith Angle	0.00200	gon			0.00000	gon.km
Azimuth	0.00100	gon			0.00000	gon.km
Height Difference	0.10	mm			1.00	mm/sqrt(km)
					0.00	mm/km
Shift Vector EN	0.0100	m	н		0.0100	m
Local Coordinate EN	0.0100	m	н		0.0100	m
GNSS/GPS Observations:						
GNSS/GPS Baseline	0.0100	m			1.0	ppm
GNSS/GPS Coordinate	0.0100	m				
Geometrical Relations:			_ 11	pdate Obs		
Angle	0.10000	gon			servations	
Distance / collinearity	0.0150	m	0	All types defaults	with chan	ged
Offsets:			0	All with ol	ld defaults	3
Steel Tape measurement	0.0100	m	0	None		
Auxiliary point	0.0100	m				
	OK	<u>C</u> an	cel			Help

Standard deviations for observations tab sheet.

# 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.

lose <u>E</u> dit	<u>T</u> ools										H
No.	F. T	o Instr Hgt	Target	Re	ading[gon/m]	Read	ling[gon/m]	Rea	ding[gon/m]		
] 1	ຣ1 2	0.0000	1.1300	RO	394.94200	SO	33.6620	ZO	118.62900	3D	
2	s1 13	0.0000	0.2500	RO	197.40500	SO	62.6290	ZO	108.21700	ЗD	
3	s1 3	0.0000	0.1250	RO	0.00000	SO	36.0410	ZO	114.76300	ЗD	
4	s1 4	0.0000	2.3200	RO	10.03700	SO	34.1170	Z0	115.03600	3D	
5	s1 6	0.0000	1.5300	RO	13.48200	SO	29.1620	ZO	115.25100	ЗD	
6	s1 7	0.0000	0.0850	RO	386.12700	SO	21.2340	ZO	122.25100	ЗD	
7	s1 8	0.0000	0.2500	RO	119.86400	SO	10.8880	Z0	106.54600	3D	
8	s1 9	0.0000	0.2500	RO	237.94800	SO	5.5430	Z0	111.54300	3D	
9	s1 10		0.0850	RO	163.98500	SO	7.0580	ZO	110.75300	3D	
10	s1 12	0.0000	0.2500	RO	184.77200	SO	63.3090	ZO	108.26500	ЗD	
11	s1 14	0.0000	0.2500	RO	189.71000	SO	73.5850	Z0	105.34500	ЗD	
12	s1 15	0.0000	0.2500	RO	193.39900	SO	73.3000	Z0	105.32200	ЗD	
13	s1 16	0.0000	1.8800	RO	192.78200	SO	36.6470	ZO	108.22700	ЗD	
14	s1 17	0.0000	1.8800	RO	184.84100	SO	36.9590	Z0	108.20300	3D	
15	s1 20	0.0000	2.1400	RO	197.08300	SO	32.9520	Z0	109.43100	ЗD	
16	s1 21	0.0000	2.1400	RO	179.26700	SO	33.5400	ZO	109.37000	ЗD	
17	s2 2	0.0000	1.5300	RO	378.08100	SO	10.9590	ZO	113.02800	ЗD	
18	s2 8	0.0000	1.5300	RO	220.34300	SO	29.6070	Z0	84.22400	ЗD	
19	s2 9	0.0000	1.5300	RO	249.10200	SO	31.5500	Z0	85.01400	ЗD	
20	s2 6	0.0000	1.5300	RO	43.70400	SO	2.8090	ZO	95.75100	ЗD	
21	s2 7	0.0000	0.0850		298.51800	SO	11.1700	ZO	101.04000	3D	
22	s2 1	0.0000	1.5300	RO	11.80800	SO	8.3910	Z0	117.58400	3D	
23	s2 3	0.0000	0.1250	RO	0.00000	SO	11.5400	Z0	106.57800	ЗD	
24	s2 4	0.0000	1.5300		29.69300	SO	8.0090	ZO	113.36000	ЗD	
25	s2 5	0.0000	1.5300		369.92900	SO	12.4090	ZO	107.99800	ЗD	
26	s2 22		-0.0850		227.25850	SO	32.3650	Z0	57.29000	ЗD	
27	s2 22		-0.1720	RO	227.25850	SO	32.3650	ZO	57.29000	3D	
28	s3 10		1.3300	RO	394.90600	SO	45.8840	ZO	91.68700	3D	
29	s3 14	0.0000	0.0850	RO	196.22600	SO	21.4950	Z0	101.73000	ЗD	
30	s3 15	0.0000	0.0850	RO	208.72500	SO	21.7570	Z0	101.61700	ЗD	
31	s3 12	0.0000	1.8300	RO	171.64400	SO	11.3620	ZO	104.61900	3D	
32	s3 13	0.0000	1.8300	RO	238.82800	SO	13.0850	Z0	103.61100	ЗD	

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.

Edit station			×
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 🔍	0.	0000 m	
Y North	0.	0000 m	
Height 🔽	0.	0000 m	
Precision of idealisation XY	0.	0000 m	
Precision of idealisation heigh	t 0.	0000 m	
Deselection			
Add GPS	Apply	Apply all	
ОК	<u>C</u> ancel	<u>H</u> elp	

Adding Known Points

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

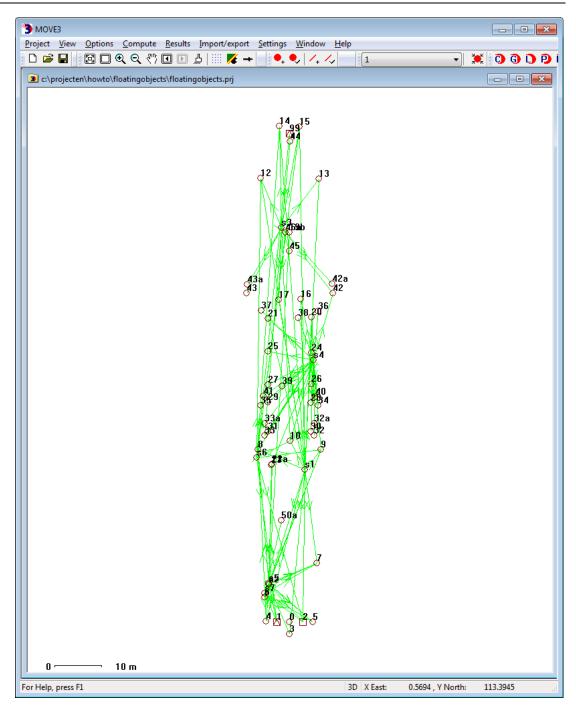


Added :				Import
Observations		0		
Stations		0		<u>C</u> lose
Add as:	Known statio	n	•	
	🔲 Update exi	sting only		
Format:	Separator	•	Space 👻	
	Begin	Length	Field	
Station name	0	0	1	
×East	0	0	2	
Y North	0	0	3	
Height	0	0	4	
St dev×East	0	0	0	
St dev Y North	0	0	0	
St dev Height	0	0	0	<u>H</u> elp

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. Note that this tab is only visible to the user in case the geoid model has been configured different than none, which is our case here.

Un-check the deflection of the vertical checkbox named "Fixed" for all setup points. 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. Any possible movement introduced during TPS measurements on the floating object is being adjusted. Corrections are being distributed in a least-squares manner over all observations.



Edit station	<b>—</b> ×-
TER GEO	
84	•
Geoid Height	
Geoid Height	0.0000
Deflections of the vertical	
East	0.000 "
North	0.000 "
Fixed	
Add GPS	Apply Apply all
<u>O</u> K	<u>C</u> ancel <u>H</u> elp

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.



Select output project				×
Create report file :	Report file	XML	-	ОК
C:\Projecten\HowTo\F	s file :		.xm	<u>C</u> ancel <u>B</u> rowse
C:\Projecten\HowTo\F		tingObjects.cor		
C:\Projecten\HowTo\F	FloatingObjects\Floa	tingObjects.var		
✓ Update coordinates after ✓ Overwrite files	adjustment	Phase	Free netv	vork 💌

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 Ftest 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 Wtest. 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.

Se	lect output project				<b>X</b>
	Create report file :	Report file	XML	•	<u>0</u> K
	C:\Projecten\HowTo	\FloatingObjects\Floa	tingObjects.out2	2. xml	<u>C</u> ancel
	Create adjusted coordinat	es file :			Browse
	C:\Projecten\HowTo	\FloatingObjects\Floa	tingObjects.cor		
	Create covariance matrix	file :			
	C:\Projecten\HowTo	\FloatingObjects\Floa	tingObjects.var		
	Update coordinates aft Overwrite files	er adjustment	Phase	Pseudo	constrained 🔹 🔻

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	- 0	Comma 👻	<u>E</u> xport
	Begin	Length	Field	<u>C</u> lose
Station name	1	10	1	
×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	<u>H</u> elp

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		×
Scale factor GNSS/GPS transfo	Vert refractioncoeff	Azimuth offset Other Parameters
CLocal Transformation	Parameters	•
Additional Transformation Parameters Rotations Always add		
	OK <u>Cancel</u>	Help

Additional parameters Other tab sheet

