

MosaicHydro SBET Inspector

User Guide

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Contents

1. Introduction **3**
1.1 Typical tasks 3
2. Installation and first start **3**
2.1 What you receive 3
2.2 Windows security prompts 4
3. The main window **4**
3.1 Tabs 4
3.2 Plot toolbar 4
3.3 Time axis and GPS week 4
4. Quick start **5**
5. Files the program reads **5**
5.1 SBET files 5
5.2 SMRMSG files 5
5.3 How the companion SMRMSG is found 5
6. SBET tab **6**
6.1 The summary 6
6.2 Plots 7
6.3 Export KML 8
6.4 Export CSV 8
7. Accuracy (SMRMSG) tab **9**
7.1 Choosing what to plot 9
7.2 Display options and statistics 9
8. Compare SBETs tab **10**
8.1 Loading solutions A, B and C 10
8.2 Choosing what to plot 11
8.3 How the comparison works 11
8.4 Display modes 11
8.5 Zooming: statistics for the visible window 12
8.6 Statistics table 13
8.7 Export 14
9. About tab **14**
10. Example workflows **14**
10.1 Quality check of a new SBET 14
10.2 Comparing PPP and RTX solutions 14
10.3 Three processing runs 15
10.4 Track for a client report 15
11. Troubleshooting **15**
12. Reference **16**
12.1 SBET record layout 16
12.2 SMRMSG record layout 16
12.3 Glossary 17
13. Disclaimer and credits **17**

> **Tip:** The contents list has clickable links. Page numbers are correct for this edition; if you edit the guide, check them again.

1. Introduction

MosaicHydro SBET Inspector opens the trajectory files produced by inertial post-processing software, such as Applanix POSPac and SBG Systems Qinertia, and shows what is inside them. It reads two kinds of file:

- **SBET** (Smoothed Best Estimate of Trajectory): position, velocity, attitude and body dynamics, typically at 200 Hz.
- **SMRMSG**: the matching accuracy file, with the estimated RMS error of position, velocity and attitude over time.

With it you can check a trajectory before it is used for processing, export it to Google Earth (KML) or a spreadsheet (CSV), plot its accuracy, and compare up to three solutions of the same survey, in reported accuracy and in altitude, for example base-station PPK against PPP.

1.1 Typical tasks

You want to…	Use	See
Check an SBET for gaps, time problems or odd values	SBET tab, summary	Section 6.1
Show the track to a client or check coverage	SBET tab, Export KML	Section 6.3
Get the trajectory into Excel or another program	SBET tab, Export CSV	Section 6.4
See when accuracy degraded during a survey	Accuracy (SMRMSG) tab	Section 7
Decide which of two or three solutions is better	Compare SBETs tab	Section 8
Check the vertical agreement of solutions	Compare SBETs tab, Altitude	Section 8

2. Installation and first start

2.1 What you receive

The program is a single file. Nothing needs to be installed: everything the program needs is built in. Copy it to any folder, for example `C:\Tools\SBET Inspector`, and double-click it.

File	What it is
MosaicHydro SBET Inspector.exe	The program. Double-click it to start.
MosaicHydro SBET Inspector 1.2.0 User Guide.pdf	This document.

2.2 Windows security prompts

The program is code-signed by Mosaic Hydrographic Services (Canada) Ltd, so Windows can confirm who published it and that it has not been changed. For a new release, Windows SmartScreen may still show **Windows protected your PC** the first time. Check that the publisher shown is Mosaic Hydrographic Services (Canada) Ltd, then click **More info**, then **Run anyway**. The program does not use the network.

Each .exe unpacks itself to a temporary folder when it starts, so the window can take 5–10 seconds to appear, longer on the first run or while antivirus software scans it.

3. The main window

The window has four tabs, a status bar along the bottom that reports what was loaded or written, and a plot area on each data tab.

3.1 Tabs

Tab	Purpose
SBET	Summary of one SBET file, seven plot types, and KML / CSV / summary export.
Accuracy (SMRMSG)	RMS accuracy against time for one SMRMSG file, with statistics.
Compare SBETs	Accuracy and altitude of two or three solutions (A, B and optional C) over their common time span; statistics follow the zoomed window.
About	Version, contact, disclaimer and credits.

3.2 Plot toolbar

Every plot has the standard toolbar underneath it:

- **Home** returns to the full view; **Back / Forward** step through earlier views.
- **Pan** (cross arrows) drags the plot; **Zoom** (magnifier) zooms to a rectangle you draw. Plots stacked on one tab share the time axis, so zooming one zooms them all.
- **Save** (disk) writes the plot as PNG, PDF or SVG for a report.

Long files are thinned for display (about 20 000 points per line) so plots stay responsive. Statistics and exports always use every record. Lines break at data gaps rather than joining across them.

3.3 Time axis and GPS week

SBET and SMRMSG times are **GPS seconds of the week**. Each data tab has a **Time axis** choice of GPS seconds of week or elapsed minutes from the start.

The SBET tab has a **GPS week** box. It is optional; when filled in, the summary also shows UTC times and the KML attribute points get time stamps, which turns on the time slider in Google Earth. GPS weeks can be looked up in any GPS calendar; for example, the week starting Sunday 10 March 2024 is week 2305.

4. Quick start

1. Start **MosaicHydro SBET Inspector.exe**.
2. On the **SBET** tab, click **Open SBET...** and choose the trajectory file. The summary appears on the left and the track on the right.
3. Read the **CHECKS** section at the end of the summary. **No problems detected** means the file structure and time stamps look sound.
4. If the matching SMRMSG file is in the same folder, it is loaded automatically into the **Accuracy (SMRMSG)** tab. Open that tab and tick the parameters you want to see.
5. To share the track, set the export options and click **Export KML...**.
6. To compare solutions, open the **Compare SBETs** tab and load the reference as **A** and the others as **B** (and **C**), choosing the SBET or SMRMSG of each.

5. Files the program reads

5.1 SBET files

An SBET is a plain binary file with no header: a sequence of records of 17 numbers each (136 bytes). File names often end in `.out`, for example `sbet_Mission1.out`. The full layout is in Section 12.1.

5.2 SMRMSG files

An SMRMSG has the same structure with 10 numbers per record (80 bytes): time, then the estimated RMS error of north, east and down position (m), of north, east and down velocity (m/s), and of roll, pitch and heading (arc-minutes). POSPac usually writes it at 1 Hz; Qinertia can write it at the full SBET rate.

5.3 How the companion SMRMSG is found

When you open an SBET, the program looks in the same folder for its SMRMSG by name:

Software	SBET name	SMRMSG name looked for
POSPac	`sbet_Mission1.out`	`smrmsg_Mission1.out`
Qinertia	`Job-PPP.out`	`Job-PPP-smrmsg.out` (also `_smrmsg` or `smrmsg`)

Upper and lower case do not matter. If no matching name is found, nothing is loaded; the program never guesses, because pairing an SBET with another solution's accuracy file would be misleading. You can always open an SMRMSG yourself on the Accuracy tab.

6. SBET tab

Click **Open SBET...** to load a file. **Loading…** appears in the plot area and summary at once, so you can see the click was received; large files take a few seconds (a 2.6-hour, 200 Hz file of 1.9 million records takes about four).

If no solution has been loaded as **A** on the **Compare SBETs** tab yet, the SBET (with its SMRMSG) is also used as solution A there, ready to compare against B and C.

6.1 The summary

The text panel on the left lists everything the program found in the file:

Section	What it shows
Header lines	File name, size and number of records.
TIME	Start and end (GPS seconds of week, and UTC if the GPS week is set), duration, median time step and data rate, and every gap where the step is more than twice the median.
POSITION	Minimum, mean and maximum of latitude, longitude and ellipsoidal height, and the 2D path length.
VELOCITY	Horizontal speed (m/s and km/h) and vertical velocity.
ATTITUDE	Roll, pitch, true heading and wander angle, in degrees.
BODY DYNAMICS	Largest acceleration (m/s²) and angular rate (deg/s) on each axis: a quick check for spikes.
CHECKS	Problems found in the file (see the next table), or **No problems detected**.

The checks look for:

Message	Meaning
File size is not a multiple of 136 bytes	The file is truncated (copy interrupted, disk full) or is not an SBET. The partial record at the end is ignored.
Non-finite (NaN/Inf) values	Some numbers are invalid; the processing software may have written placeholders.
Latitude/longitude exceed radian limits	The file is not an SBET, uses a different byte order, or stores degrees.
Time values are outside 0–604800 s	Time is not GPS seconds of week (for example adjusted standard GPS time).
Epochs where time goes backwards / duplicate time stamps	Records out of order, often from merged files.
GPS week rollover detected	The survey crossed Saturday/Sunday midnight GPS time. Times after the rollover are shifted by +604 800 s so plots and statistics run on.

Save summary... writes the summary text to a .txt file for your records.

6.2 Plots

Choose a plot from the **Plot** list:

Plot	Shows
Track (lat/lon)	The trajectory in plan, with the start (green) and end (red) marked. The axes are scaled so distances look true.
Height	Ellipsoidal height against time.
Attitude	Roll, pitch and true heading against time. Heading jumps between 0° and 360° are normal.
Speed & Z velocity	Horizontal speed and vertical velocity.
Body accelerations	X, Y and Z accelerations in the body frame.
Angular rates	X, Y and Z rotation rates (deg/s).
Time step	The interval between records. Gaps show as points far above the median line; the scale turns logarithmic when gaps are large.

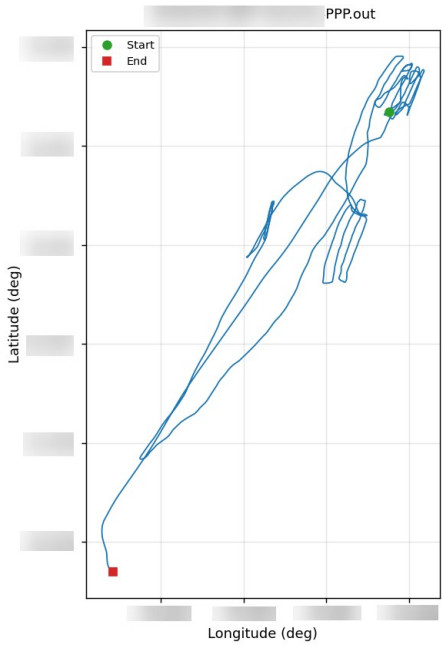


Figure 1 – Track plot of the Qinertia PPP sample SBET (2 h 38 min, 15.6 km).

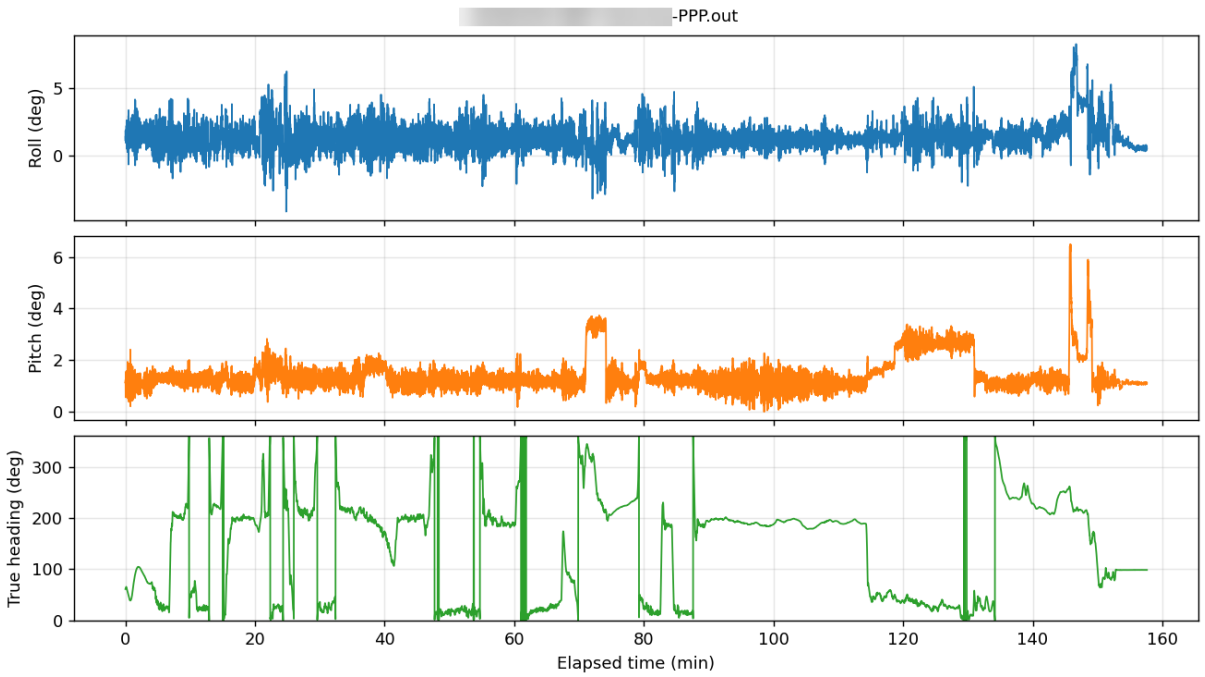


Figure 2 – Attitude plot of the same file, elapsed-minutes time axis.

6.3 Export KML

Export KML... writes the trajectory for Google Earth or any GIS that reads KML. It contains the track line, start and end markers, and optional attribute points. Set the options first:

Option	Effect
KML vertex spacing (s)	One line vertex per this many seconds. 1 s is a good default; 0 writes every record, which makes very large files.
Line colour	Colour of the track line.
Altitude mode	**clampToGround** drapes the line on the terrain (recommended). **absolute** uses the heights from the file; **relativeToGround** treats them as heights above the terrain.
Height offset (m)	Added to every height. SBET heights are ellipsoidal, but Google Earth expects heights above sea level: with **absolute**, enter minus the local geoid separation (−N). Example: where N = −33 m, enter 33.
Attribute points every (s)	When ticked, adds a clickable point at this interval showing time, position, height, roll, pitch, true heading and speed. With the GPS week set, the points also get time stamps.

Tip: For a long survey, use a 1 s vertex spacing and attribute points every 60 s. The file stays small and Google Earth stays responsive.

6.4 Export CSV

Export CSV... writes a comma-separated file with a header row, ready for Excel. **CSV record spacing (s)** thins the output the same way as the KML spacing; 0 writes every record. Columns:

Column	Unit
time_sow	GPS seconds of week
lat_deg, lon_deg	degrees
ell_height_m	metres (ellipsoidal)
roll_deg, pitch_deg, true_heading_deg, platform_heading_deg, wander_deg	degrees
vx_mps, vy_mps, vz_mps, speed_h_mps	m/s (wander frame; speed_h is horizontal speed)
ax_mps2, ay_mps2, az_mps2	m/s² (body frame)
wx_degps, wy_degps, wz_degps	deg/s (body frame)

Important: A 200 Hz SBET produces 720 000 rows per hour. Excel stops at 1 048 576 rows, so use a spacing of 0.1 s or more for files longer than about 1.4 hours.

7. Accuracy (SMRMSG) tab

Click **Open SMRMSG...**, or let the SBET tab load the companion file for you.

7.1 Choosing what to plot

The parameters are grouped by unit, and each group gets its own plot panel so values with different units are never mixed on one axis:

Group	Parameters	Unit
Position RMS	North, East, Down	m
Velocity RMS	North, East, Down	m/s
Attitude RMS	Roll, Pitch, Heading	arc-minutes

Tick one or several parameters in any group; the plot updates immediately. **All** and **None** set a whole group at once. Groups with nothing ticked are not drawn.

7.2 Display options and statistics

- **Time axis**: GPS seconds of week or elapsed minutes.
- **Log y-axis**: useful when short periods of poor accuracy (for example GNSS outages) would otherwise flatten the rest of the plot.

The panel below the tick boxes lists, for each ticked parameter, the mean, the 95th percentile and the maximum. The 95th percentile is often the most useful single figure: 95% of the survey was at least this good.

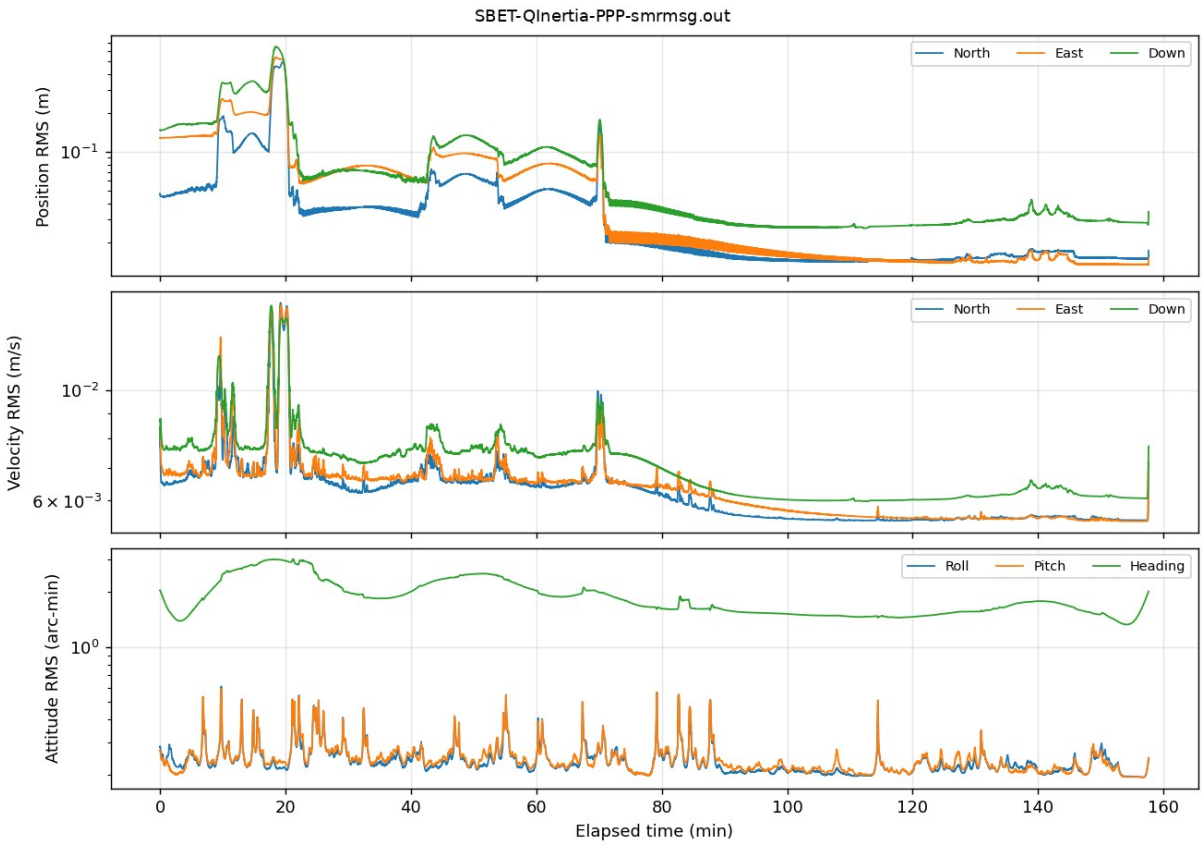


Figure 3 – All nine accuracy parameters of the Qinertia PPP sample, log scale. Accuracy improves markedly after about 70 minutes as the PPP solution converges.

8. Compare SBETs tab

This tab compares two or three solutions of the same survey: for example a base-station PPK against PPP, a loose against a tightly-coupled solution, or the same data processed with different settings. It compares the **accuracy** each solution reports (from its SMRMSG file) and the **altitude** of the trajectories themselves (from the SBET files).

8.1 Loading solutions A, B and C

- **Open A...** loads the **reference**. Differences are always reported against A.
- **Open B...** and **Open C...** load the solutions to compare. C is optional.
- For each solution select its **SBET**, its **SMRMSG**, or **both** (Ctrl-click in the file dialog). When you select one, the program finds its partner file in the same folder by name (Section 5.3), in either direction.
- **Make A** (next to B and C) swaps that solution with A, making it the reference. **Clear** removes a solution.
- If slot A is empty when you open an SBET on the **SBET** tab, that SBET becomes solution A automatically. A solution already in slot A is never replaced.

Each solution's line shows which SBET and SMRMSG were loaded (or “not found”), its time span and rate. The bold lines below show the overlap of each comparison:

Comparison	Uses	Needs
Accuracy (SMRMSG)	Position, velocity and attitude RMS	The SMRMSG of A and of at least one other solution
Altitude (SBET)	Ellipsoidal height (the Z component)	The SBET of A and of at least one other solution

The two are independent: each uses the time common to its own files, so a solution with only an SMRMSG still takes part in the accuracy comparison.

8.2 Choosing what to plot

Tick parameters in the four groups on the left. Each group gets its own plot panel, so values with different units are never mixed:

Group	Parameters	From
Position RMS (m)	North, East, Down	SMRMSG
Velocity RMS (m/s)	North, East, Down	SMRMSG
Attitude RMS (arc-min)	Roll, Pitch, Heading	SMRMSG
Altitude (m)	Height (Z, ellipsoidal)	SBET

8.3 How the comparison works

1. Only the time span common to **all** files of that comparison is used.
2. Inside it, the values are compared at the epochs of the **sparsest** file. The other files are interpolated onto those times, so a 1 Hz file is never stretched to match a 200 Hz one. Files with identical time stamps are used directly.
3. Epochs that fall inside a data gap in any file are skipped and counted on the overlap line.

The accuracy comparison tells you which solution **reports** better accuracy and when; it does not measure the true error. The altitude comparison measures how far the trajectories themselves differ vertically.

> **Important:** The Altitude group compares **ellipsoidal** heights. Solutions processed in different reference frames or epochs (for example ITRF and NAD83) differ by a nearly constant offset that shows up in **Mean − A**. Check the processing datum before reading it as an error.

8.4 Display modes

Mode	Shows
Overlay files	The ticked parameters for every file on the same axes. **Colour identifies the file**: A blue, B orange, C green. **Line style identifies the component**: North and Roll solid, East and Pitch dashed, Down and Heading dotted. A is drawn on top so the reference is never hidden.
Difference from A	B − A (orange) and C − A (green), with the same line styles. For accuracy, below zero means that file reports better (smaller) RMS than A; for altitude, below zero means that trajectory is lower than A.
Overlay + difference	Both, one above the other for each group.

Log y-axis applies to the accuracy overlays. **Fit y-axis to visible window** (on by default) rescales every panel to the data in view as you zoom or pan.

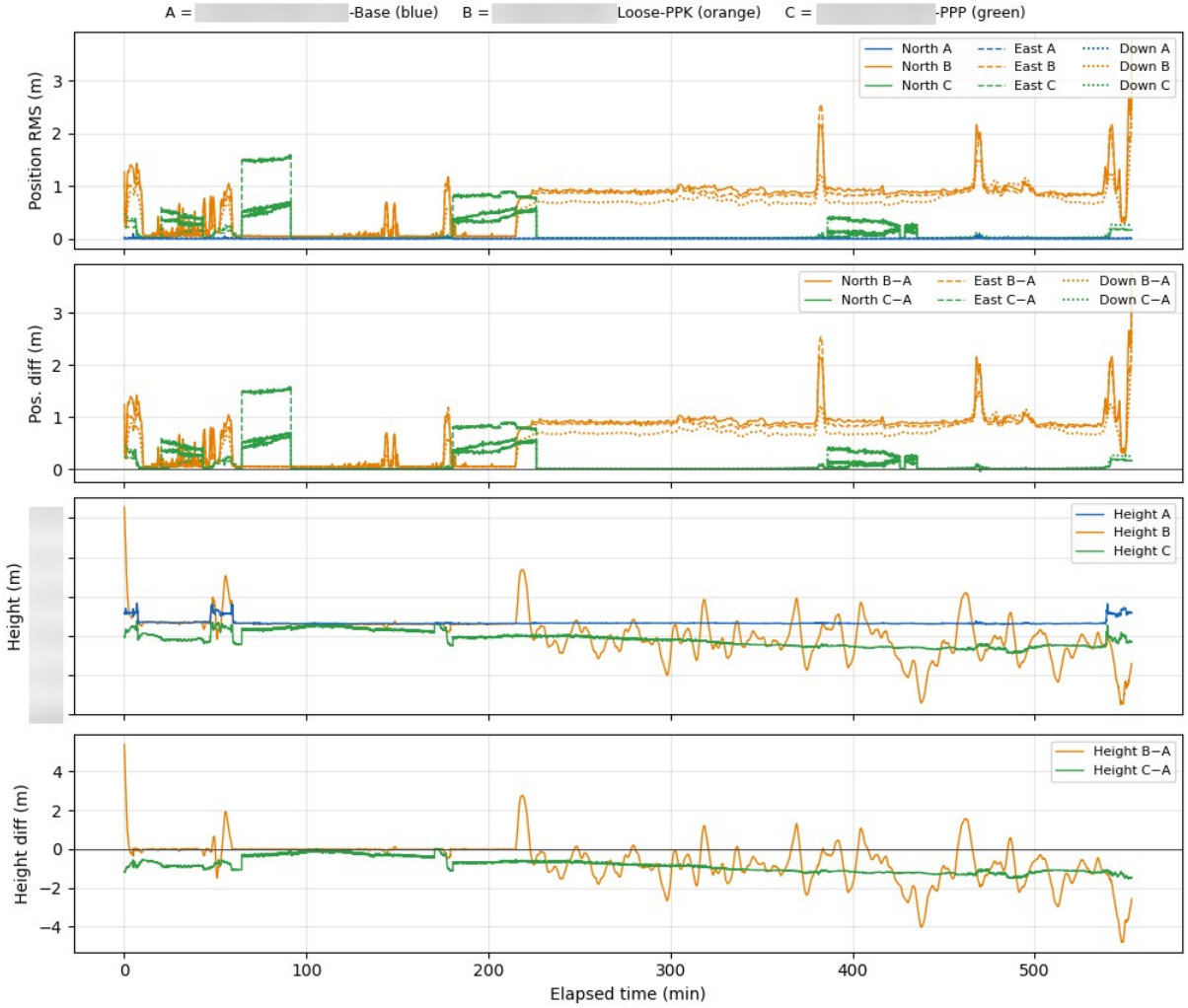


Figure 4 – Position accuracy and altitude for a sample survey: base-station PPK (A), loose PPK (B) and PPP (C), whole 9 h 13 min overlap.

8.5 Zooming: statistics for the visible window

The statistics table and the CSV export always describe **the time range visible in the plot**. Use the plot toolbar to zoom (magnifier) or pan (cross arrows): about a quarter of a second after you stop, the table is recalculated for the visible window only, and the lines are redrawn from the full-resolution data, so zooming into a few minutes of a 200 Hz file shows every detail.

The line above the table says which window the figures cover and how many epochs it contains. Click **Home** on the toolbar to return to the whole overlap. Windows you have already visited are remembered, so returning to them is instant.

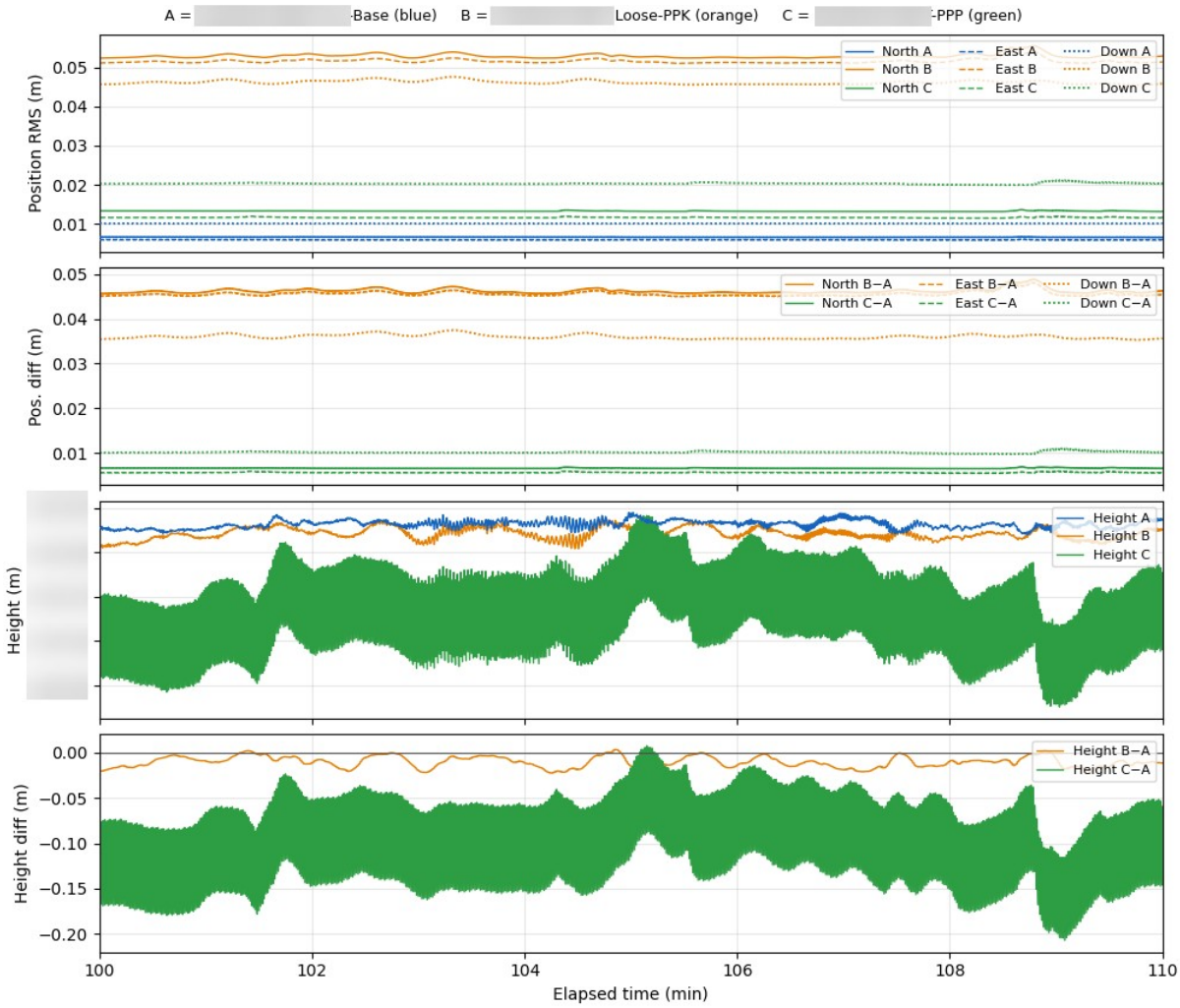


Figure 5 – The same comparison zoomed to minutes 100–110. The statistics now describe these ten minutes only, and the full-resolution redraw reveals a 1 Hz oscillation of about 3 cm in the PPP height (green) that the overview cannot show.

8.6 Statistics table

Below the plot, the table has one row per file for each ticked parameter:

Column	Meaning
Mean, Std, 95%, Max	Statistics of that file's values over the compared epochs in the visible window.
Mean − A, RMS − A, Max |− A|	Mean, RMS and largest absolute difference from A (blank on A's own row). For altitude, Mean − A is the vertical offset between the trajectories.
Better than A %	Accuracy only: share of epochs where that file's RMS is lower than A's.

Example from the sample survey (A = base-station PPK, B = loose PPK, C = PPP), for the whole overlap and for the ten minutes of Figure 5:

Parameter	File	Whole overlap: Mean − A	RMS − A	Minutes 100–110: Mean − A	RMS − A
North position RMS (m)	B	+0.645	0.791	+0.046	0.046
	C	+0.094	0.187	+0.007	0.007
Ellipsoidal height (m)	B	−0.587	1.156	−0.011	0.012
	C	−0.840	0.917	−0.101	0.107

Over the whole survey both alternatives look poor, because their worst periods dominate the averages. In a quiet ten-minute window the loose PPK height agrees with the base-station solution to about a centimetre, while PPP sits 10 cm lower. Zooming like this separates short bad periods from systematic differences.

8.7 Export

- **Export comparison CSV...** writes the compared epochs **in the visible window**: time, each file's value and each difference from A, for the ticked parameters. If both accuracy and altitude parameters are ticked, two files are written, ending in `_accuracy` and `_altitude`, because their epochs can differ.
- **Save stats...** writes the statistics for the visible window as text.

> **Tip:** Zoom to the period you need before exporting. A whole 9-hour 200 Hz survey is 6.6 million rows, which takes minutes to write and is too large for Excel.

9. About tab

Shows the program name and version, the contact address, the disclaimer (Section 13) and the versions of Python, Tk, numpy and matplotlib the program was built with. Quote the version when reporting a problem.

10. Example workflows

10.1 Quality check of a new SBET

Open the SBET. Check **CHECKS** says **No problems detected** and **Gaps** is 0. Look at the **Time step** plot for gaps and the **Track** plot for jumps. On the Accuracy tab, tick all three position parameters with **Log y-axis** on, and note the 95% values and any periods of poor accuracy.

10.2 Comparing PPP and RTX solutions

Load the RTX solution as **A** and the PPP solution as **B** (the SBET or SMRMSG of each). Use **Overlay + difference** with the position parameters ticked to see the convergence period, then read **Better than A %** in the table. Zoom past the convergence period to get statistics for the converged part only. Repeat with the attitude parameters and with **Altitude**.

10.3 Three processing runs

Load the run you trust most as **A** and the other two as **B** and **C**. Use **Difference from A** with **Altitude** and the position parameters ticked to see when each run is better or worse, and zoom into suspicious periods: the table then describes that period only. If a different run turns out to be the best, click its **Make A** to use it as the reference instead.

10.4 Track for a client report

Set the KML spacing to 1 s, **clampToGround**, a line colour that shows on imagery (orange or yellow), and attribute points every 60 s. Enter the GPS week so the points carry times. Export, then open the KML in Google Earth.

11. Troubleshooting

Symptom	Likely cause	What to do
“Could not read SBET … too small”	The file is empty or is not an SBET.	Check that you chose the trajectory (SBET) file, not a log or project file.
CHECKS reports radian limits exceeded	Not an SBET, or a different format with the same extension.	Export the trajectory again as SBET from the processing software.
Companion SMRMSG not loaded	The names don't follow the POSPac or Qinertia pattern (Section 5.3).	Open the SMRMSG yourself on the Accuracy tab, or rename it to match.
UTC times are about 18 s (or 36 s) off	The software exported UTC seconds of week rather than GPS time. The program assumes GPS time (GPS − UTC = 18 s).	Check the time setting of the SBET export, or ignore the UTC display.
Track in Google Earth floats above or below the ground	**absolute** altitude mode with ellipsoidal heights.	Use **clampToGround**, or set **Height offset** to −N (Section 6.3).
“no time overlap” on an overlap line	The files are from different surveys or days.	Check the time ranges shown next to each solution.
“needs the SBET (or SMRMSG) file for A…”	The partner file was not found for that solution.	Select both files of the solution together (Ctrl-click), or rename them to match (Section 5.3).
Altitude differs by a constant 0.5–2 m	Solutions processed in different reference frames or epochs.	Process in the same datum, or treat the offset as a datum difference (Section 8.3).
Comparison shows many skipped epochs	One file has gaps.	Look at that file on the Accuracy tab; the skipped epochs are inside its gaps.
Excel shows only part of a CSV	More than 1 048 576 rows.	Export again with a larger CSV record spacing.
The program is slow to start	The .exe unpacks itself on start; antivirus scans it.	Wait 5–10 s; later starts are faster.

Symptom	Likely cause	What to do
Windows protected your PC	SmartScreen does not yet recognise a newly released version.	Check the publisher is Mosaic Hydrographic Services (Canada) Ltd, then click **More info**, then **Run anyway**.

For support, send the summary (**Save summary...**), the program version from the About tab and a description of the problem to **tools@mosaichydro.com**.

12. Reference

12.1 SBET record layout

17 little-endian 8-byte floating-point numbers per record (136 bytes), no header:

#	Field	Unit
1	Time	GPS seconds of week
2–3	Latitude, longitude	radians
4	Height	metres, ellipsoidal
5–7	X, Y, Z velocity (wander-angle frame)	m/s
8–9	Roll, pitch	radians
10	Platform heading	radians
11	Wander angle	radians
12–14	X, Y, Z body acceleration	m/s²
15–17	X, Y, Z body angular rate	rad/s

True heading = platform heading − wander angle. The datum is whatever the trajectory was processed in, usually WGS 84 or an ITRF realisation.

12.2 SMRMSG record layout

10 little-endian 8-byte floating-point numbers per record (80 bytes), no header:

#	Field	Unit
1	Time	GPS seconds of week
2–4	North, east, down position RMS	m
5–7	North, east, down velocity RMS	m/s
8–10	Roll, pitch, heading RMS	arc-minutes

12.3 Glossary

Term	Meaning
SBET	Smoothed Best Estimate of Trajectory: the post-processed position and attitude of a GNSS/inertial system.
SMRMSG	The accuracy file that accompanies an SBET: estimated RMS errors over time.
RMS	Root mean square: here, the processing software's estimate of the 1-sigma error.
GPS seconds of week	Seconds since the start of the GPS week (Sunday 00:00 GPS time), 0 to 604 800.
GPS week	Weeks since 6 January 1980.
Wander angle	Angle between the navigation frame's x-axis and north, used by some inertial systems near the poles.
Ellipsoidal height	Height above the reference ellipsoid. Height above sea level ≈ ellipsoidal height − geoid separation (N).
PPP / RTX	Precise Point Positioning, and Trimble's correction service: GNSS methods that need no local base station.
95th percentile	The value that 95% of the epochs are at or below.

13. Disclaimer and credits

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Trajectory, accuracy and comparison results are computed from the files as read and depend on the input data and on the format assumptions described in Section 12 (record layout, units, wander-angle and time conventions). The user is responsible for verifying all results before using them in survey deliverables, and must not rely on this tool for safety-critical navigation or positioning.

SBET and SMRMSG are trajectory and accuracy file formats produced by Applanix POSPac and by other post-processing software such as SBG Systems Qinertia. Applanix, POSPac, SBG Systems and Qinertia are trademarks of their respective owners; MosaicHydro is not affiliated with or endorsed by them. Built with Python, numpy and matplotlib.

Contact: **tools@mosaichydro.com**

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