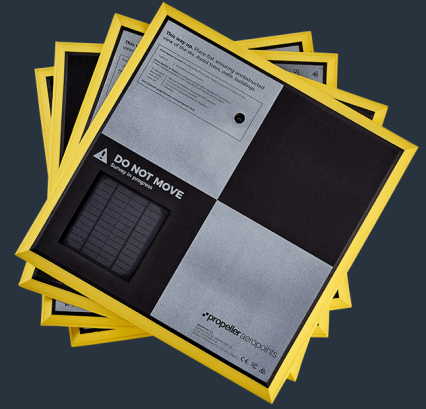


ACCURACY, RELIABILITY, AND SIMPLICITY

Using AeroPoints for Aerial Surveying



Introduction

For those who are considering using AeroPoints, or using them for the first time, this guide is designed to help you understand how to get optimum results for your specific region and requirements.

This guide explains how Propeller's AeroPoints and processing platform work to deliver the most accurate ground control point results for your drone surveys. It's of interest to technical users who want to understand the behind-the-scenes workings of the system.

If you want to learn about how to operate AeroPoints in the field, and access the resulting ground control points data, refer to the AeroPoints Manual and Propeller's Help Center.

AeroPoints use the combination of a detectable visual pattern and highly accurate positioning data (traditionally used by photogrammetry software) to 'pin' a photogrammetry reconstruction to its correct real-world location.

Below, we'll explain how this positioning data is recorded, corrected and validated.

[AEROPOINTS MANUAL](#)

[HELP CENTER](#)

How AeroPoints work

Upon activation, each AeroPoint unit begins to independently record raw satellite observations via an inbuilt GPS. These recordings occur at 10 second intervals, resulting in a set of point readings that will later be processed into accurate coordinates.

Due to signal errors caused by constantly changing atmospheric and ionospheric conditions, each 10-second individual satellite observation will vary slightly. For this reason, each AeroPoint must be receiving a satellite signal for at least 45 minutes in order to accurately compute its distance from the satellite.

This period provides an adequately varied set of point readings from a wide range of atmospheric conditions. This variance is important for the most accurate calculation of average coordinates, as it allows for the filtering out any individual observation that is outside the normal range.

Once deactivated, each AeroPoint will independently search for a pre-configured wifi hotspot. When this hotspot is detected, the AeroPoint will automatically upload its recorded positioning data to the Propeller platform.

The raw satellite observables are then post-processed against a correction source to correct for the changing atmospheric conditions that introduce most of the error in GPS measurements. Applying corrections results in a set of highly accurate positions for the AeroPoints relative to each other (internal accuracy). The global and local site-calibrated accuracy of the results will be determined by the source of the corrections and the corrections method used.

Correction Methods

The Propeller platform can use a number of correction methods to process and correct AeroPoints data. The best correction source is determined by the region where AeroPoints have been deployed, and the purpose for which the data will be used.

Multiple correction options make AeroPoints an extremely flexible product, able to be used in any above-ground location on Earth.

If you need results that will align with third party data sources (eg. prior surveys or site design linework), you should find out what kind of control has been used to create that data. Worksites often use their own local calibrations. In this case, the best choice is the Known Point method detailed below.

CORS NETWORK

In some countries (like Australia, Japan and New Zealand), a government-operated CORS (Continuously Operating Reference Station) network is a well established and trusted reference point for surveying work in many situations. If available, it's often the best choice for environmental or general mapping applications.

You can see the available CORS networks Propeller has already integrated for automated AeroPoint processing on our coverage map.

COVERAGE MAP

If AeroPoints are within range of a CORS base station, the Propeller platform can correct point readings according to the following processing sequence:

- 1** Locate the nearest CORS base station to each AeroPoint and process point data from that AeroPoint using correction data from that base station.
- 2** Identify the CORS-corrected AeroPoint with the lowest expected error rate (lowest variation in point readings) and use the position of that AeroPoint as the correction source to reprocess the point data from all other AeroPoints. (In many cases, this increases accuracy, as the AeroPoints are closer to each other than they are to the base station).
- 3** Compare the results of the initial correction process (CORS network) with the second correction process (CORS-corrected AeroPoint) and, for each individual AeroPoint unit, identify (and retain) the result with the best point quality (ie. the lowest variation in point readings).

RINEX DATA

Many sites where survey accuracy is critical (eg mine sites) have a permanent local base station that continuously records RINEX data.

You may also be able to download RINEX data from a local CORS network that is not yet available on Propeller's coverage map.

If an alternative RINEX corrections source is available, the Propeller platform can correct point readings according to the following processing sequence:

- 1** Take the provided RINEX data (uploaded by the user prior to processing) and use it as the initial corrections source when processing the point data from each AeroPoint.
- 2** Identify the RINEX-corrected AeroPoint with the lowest expected error rate (lowest variation in point readings) and use the position of that AeroPoint as the correction source to reprocess the point data from all other AeroPoints. (In many cases, this increases accuracy, as the AeroPoints are closer to each other than they are to the local base station).
- 3** Compare the results of the initial correction process (CORS network) with the second correction process (RINEX-corrected AeroPoint) and, for each individual AeroPoint unit, identify (and retain) the result with the best point quality (ie. the lowest variation in point readings).

KNOWN MARK

You may have a known point (eg. State Mark or Local Grid Mark) that can be used as a reference base point. You may also be able to create your own known mark on a site with a GPS rover. By placing an AeroPoint over this known mark, you can use the AeroPoint to create a new base station with a known location to provide corrections to the other AeroPoints.

If AeroPoints are being processed against a known mark , the Propeller platform corrects point readings according to the following processing sequence:

- 1** Use the ID of the AeroPoint that was placed on top of the known mark (as communicated by the user prior to processing).
- 2** Use the known mark location of that AeroPoint to process and correct the data from every other AeroPoint.

Types of Accuracy

Accuracy can mean different things to different people, depending on the job at hand.

INTERNAL ACCURACY

Internal accuracy describes the accuracy of position relative to any other point within the same dataset, and is important for measurements and calculations within that singular dataset (eg. stockpile volumes, road grades, blast and extraction estimations).

The internal accuracy of AeroPoints is extremely good (down to 1mm) due to the short baseline distance between each AeroPoint in a set.

No special action is required to ensure internal accuracy when using AeroPoints. Simply place the units according to standard instruction and activate within range of a GPS signal. Slight improvements in internal accuracy may be achieved when AeroPoints are left in place longer (recording more positioning data), and/or when AeroPoints are able to connect to more GPS satellites.

LOCAL ACCURACY

Local accuracy describes the accuracy of a position relative to the coordinate reference system (CRS) in use at that particular location (eg. State or Local Grid) and is important for comparison and analysis against other types of spatial data (eg. design files) that use the same CRS.

AeroPoints can achieve good local accuracy when all units are calibrated against an individual unit that has been placed on a known mark according to Local or State data.

To ensure local accuracy, a single AeroPoint should be directly centred on top of a known mark that has its position recorded in both the local and a global CRS. This mark can be up to 20 kilometres (12.5 miles) from the other AeroPoints in the set.

Note: The altitude of an AeroPoint is measured from the top of its GPS antenna (where the crosshairs meet on the top face of the unit) so will be 32mm higher than the known mark position.

GLOBAL ACCURACY

Global accuracy describes the accuracy of a position in relation to the rest of the world, using a global CRS and datum like WGS84, and is important for jobs where datasets need to integrate with maps and other globally aligned spatial data.

AeroPoints can achieve high global accuracy when data is corrected against both the CORS network, and then the most accurate CORS-corrected AeroPoint (using the method described in the previous section).

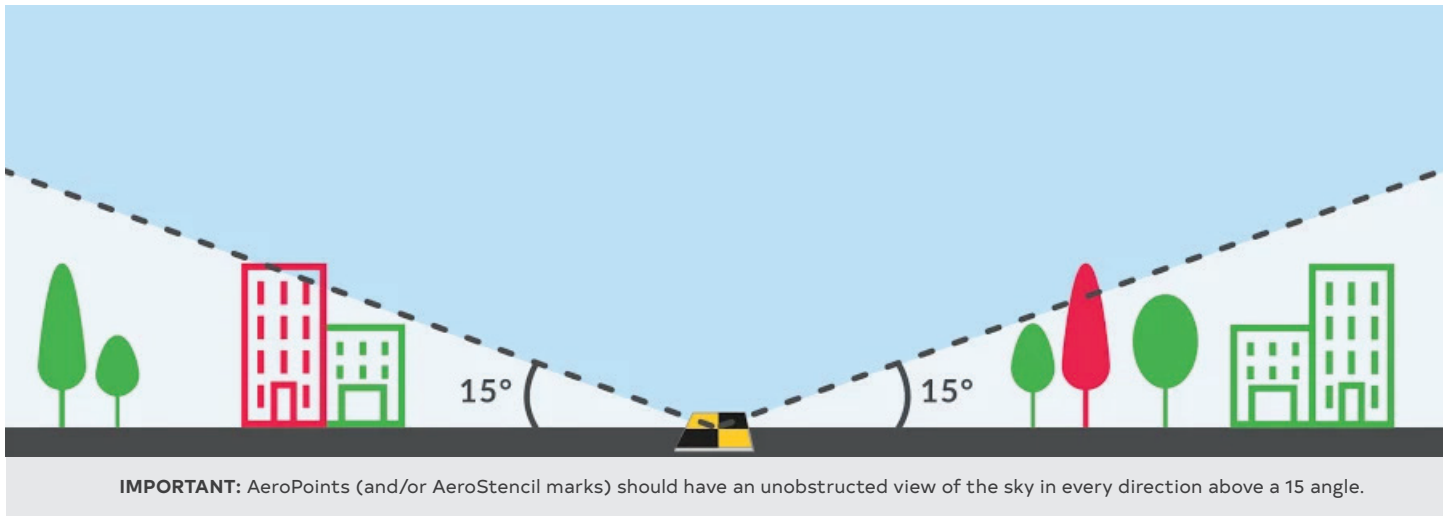
To ensure global accuracy, AeroPoints should be deployed either within 40kms (25 miles) of either a CORS network base station (see coverage map) or a local base station (such as a Trimble R9s).

If you're using a CORS or private base station not available on Propeller's coverage map, you can upload a RINEX file for global accuracy in that CORS network.

You can also place a GPS rover directly on top of a single AeroPoint and take a GPS shot, and then use the Known Point method to achieve global accuracy.

Best practices for optimizing AeroPoints accuracy

Operators should always take care to place each AeroPoint where it can receive the best possible GPS signal. This means avoiding objects such as trees, hills or buildings that block visibility of the sky above 15 degrees from ground level in any direction.

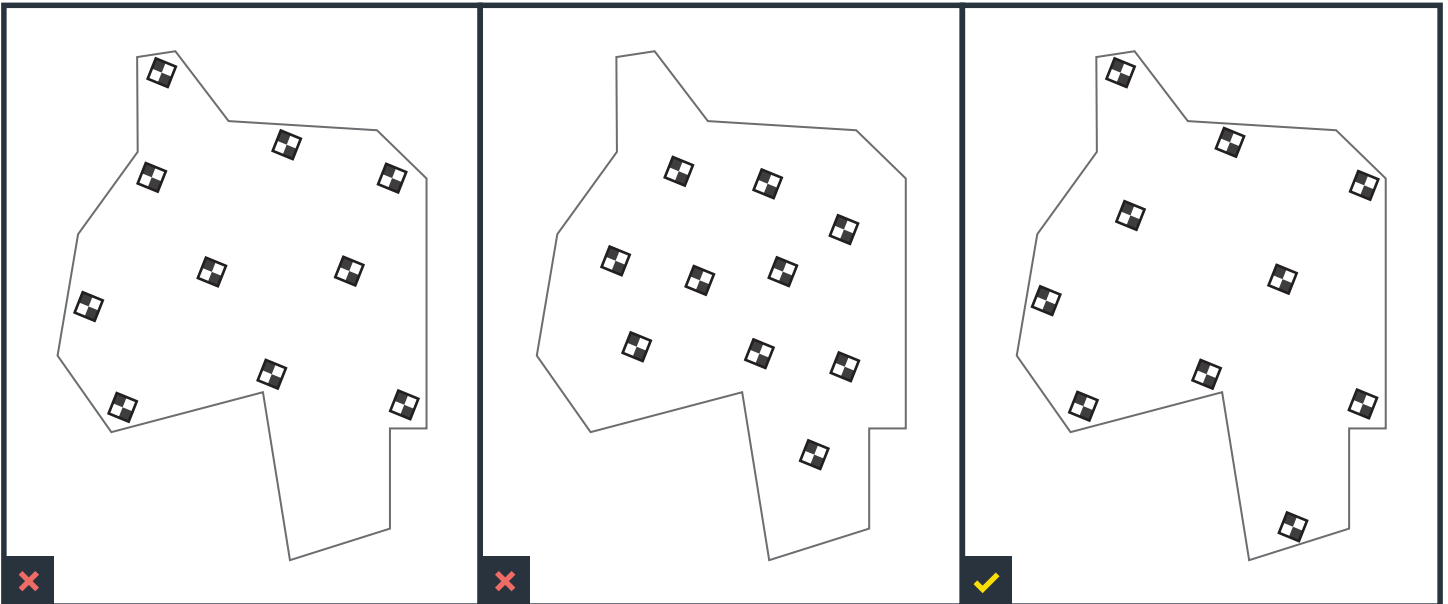


Operators should also avoid placing AeroPoints near buildings or rock faces to minimise the effect of the AeroPoint receiving multiple reflected signals from the same satellite (an effect known as 'multi-pathing').

AeroPoints should be placed as close as possible to the boundaries of a survey area, with remainder units evenly distributed through the centre.

Where a site varies greatly in terms of elevation, it's best to ensure that AeroPoints are placed at both the highest and lowest points of the survey area.

Correcting a set of AeroPoints against the individual AeroPoint with the lowest expected error rate is an important step in ensuring accurate results. Because of this, operators should make sure they use every AeroPoint in their set, for every flight, in order to increase the number of low error rate candidates.



FAIL: AeroPoints are missing from one part of the site (protruding area at bottom).

FAIL: AeroPoints are too far away from the site perimeter.

SUCCESS: AeroPoints are distributed evenly around the site perimeter, with remainder near the center.

Estimating the accuracy of your survey

You can calculate the minimum Global Accuracy of your AeroPoints corrected data using the equation below. (This equation assumes the base station provides the global reference frame and thus has 'perfect' global accuracy.)

$$\text{Global Accuracy} = \text{Internal Accuracy in mm} + (\text{distance from base station in km} * 2)$$

- AeroPoints internal horizontal accuracy is generally 10mm or better, and internal vertical accuracy is 20mm or better.
- Distance from base station is available via the AeroPoints report. Identify the AeroPoint with the longest Baseline Distance and use that figure.

Total Data Points	253
Fixes	224
Fixes Used	83
Baseline Distance	4.12 km
Point Variance (X / Y / Z)	0.4 mm / 0.7 mm / 2.9 mm

EXAMPLE: Using an example of an AeroPoint with a baseline distance of 4.12KM

$$\begin{aligned} \text{Horizontal (X/Y) Accuracy} &= 10 + (4.12 * 2) \\ &= 10 + 8.24 \\ &= \mathbf{18.24mm} \end{aligned}$$

$$\begin{aligned} \text{Vertical (Z) Accuracy} &= 20 + (4.12 * 2) \\ &= 20 + 8.24 \\ &= \mathbf{28.24mm} \end{aligned}$$

Note: Survey accuracy (X / Y / Z) = 18.24mm / 18.24mm / 28.24mm



DON'T HAVE AEROPOINTS YET?

Get your set now to ensure your drone data is survey-grade!

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Propeller turns your drone-captured images into accurate 3D site models. Powerful point-and-click tools let you take measurements, track progress, and share sites with others, right from your browser.

For accurate drone data, use Propeller alongside AeroPoints—the world's first smart Ground Control Points, purpose-built for drone surveying.