Optimizing accuracy with MobileMapper CE

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General Guidelines

There are five basic guidelines for recording MobileMapper CE rover data so as to optimize accuracy:

1. Make sure you are using the latest firmware (both the Operating System firmware and GPS firmware) for the MobileMapper CE receiver and the latest version of MobileMapper Office).

2. Allow the receiver to have full "view" of the sky *the entire time a job is open, not just when logging data to a feature.* There are three things you can do to improve signal reception:
    a. While you do <u>not</u> need a survey-grade external antenna for sub-meter accuracy, using one will yield better accuracy in all environments, but especially under tree canopy.
    b. If you are not using an external antenna, keep the MobileMapper CE receiver *at a 45-degree angle* the entire time a job is open (or as long as possible).
    c. If you are not using an external antenna, keep the MobileMapper CE receiver *as high as possible* the entire time a job is open (or as long as possible).

3. You should average all point features for at least 30 seconds. However, you do <u>not</u> need to average vertices of line and area features.

4. Use SNR, PDOP and Elevation masks on the receiver appropriate to the environment.

5. If you are using SBAS corrections allow the MobileMapper CE receiver to track at least one SBAS satellite for four minutes before logging data.

Explanations

1. *Use the latest receiver OS and GPS Firmware and the latest version of MobileMapper Office (when post-processing data)*
    Magellan is constantly improving the firmware and software of its products. You may download the latest versions of MobileMapper CE's firmware at no charge from ftp.magellangps.com in the /Mobile Mapping/MM CE/Firmware/ folder. Tap Start > Settings > Control Panel > Thales System Info to determine which version of firmware is currently installed in your receiver. If you purchased GPSDifferential for ArcPad, you can find the latest version of MobileMapper Office in the /Mobile Mapping/MM CE/Software/MM Office/ folder. The latest version of GPSDifferential for ArcPad is located in the /Mobile Mapping/MM CE/Software/GPSDifferential for ArcPad/ folder.

2. *Allow the receiver to have full "view" of the sky the entire time a job is open, not just when logging data to a feature. There are three ways to achieve this:*
   a. While you do <u>not</u> need a survey-grade external antenna for sub-meter accuracy, using one will yield better accuracy. All of Magellan's published MobileMapper CE accuracy specifications were derived from tests using the receiver's internal antenna. However, survey-grade antennas such as the one used by the Magellan ProMark3 are built to higher specifications enabling them to pick up GPS signals more reliably and with less distortion. Some tests have shown that when using a ProMark3 external antenna (P/N 110454-01), the MobileMapper CE yielded accuracy better than 50 cm as opposed to better than 100 cm with the receiver's internal antenna. Note: the magnetically mounted external antenna sold as an option for MobileMapper CE is for real-time use only in vehicles when the MobileMapper CE receiver cannot be placed in such a way that the internal antenna can see the sky. However, accuracy with the internal antenna - *when it can see the sky* - is better than with the magnetically mounted external antenna.
   b. If you are not using an external antenna, hold the MobileMapper CE receiver *at a 45-degree angle* the entire time a job is open, not just when a feature is open. The internal antenna works best when it is horizontal, but it is built into the receiver housing at a 45-degree angle inside the receiver housing so you can hold the MobileMapper CE comfortably and keep the antenna horizontal.
   c. If you are not using an external antenna, keep the MobileMapper CE receiver *as high as possible* the entire time a job is open, not just when a feature is open. If you hold the receiver at eye level, for example, your head and body will not block the internal antenna's view of the sky. It still works when at chest level, but accuracy can be degraded.

3. *Average all point features for at least 30 seconds.*
   The accuracy of point positions increases as the square root of the number of positions averaged. The longer you average positions recorded for point features, the greater the accuracy. While MobileMapper CE's GPS utilities do not include a means to set a 30-second timer, data collection applications typically do. In open areas, 30 seconds of averaging is a good mix of accuracy vs. time spent in one location. Accuracy continues to improve with time spent averaging on a point, but after 2-3 minutes, you get little additional improvement. An exception to this rule is when you must record data under dense tree canopy. Quantifying the extra amount of averaging time required under tree canopy is as hard as quantifying tree canopy.

4. *Use SNR, PDOP and Elevation masks appropriate to the environment*
   Low SNR (Signal-to-Noise Ratio) and high PDOP can degrade accuracy. Signals from satellites that are at low elevations travel through more of the earth's atmosphere and can take indirect paths to the receiver. MobileMapper CE firmware allows you to mask signals from satellites that have less than a specified SNR or are too low in elevation. You can also prevent the receiver from calculating a position when the PDOP is too high. The default values for these masks should be sufficient to achieve sub-meter accuracy, but in open environments you can raise the SNR and

elevation masks and lower the PDOP mask to optimize accuracy. However, there is a risk that you will prevent the receiver from tracking the satellites it needs to calculate a position. Also, in difficult environments such as under tree canopy, you may not be able to calculate a position at all unless you drop the SNR and Elevation masks and raise the PDOP mask. To change the values for these masks, tap **Start > Programs > GPS Utilities > GPS Settings > Tree Canopy**. The default settings for the Tree Canopy mode are: Maximum PDOP = 20; Minimum SNR = 28; Elevation Mask = 10. However, some people have found that when they use these generic settings in difficult GPS environments such as in forests, they exclude data from some satellites that, if used, might improve accuracy. Although it is generally not recommended, you can sometimes improve accuracy by setting the Maximum PDOP to 8, Minimum SNR to 20 and Elevation Mask to 8. This will allow more noise to come in, which can theoretically *degrade* accuracy, but it may also allow you to track more satellites and so *improve* accuracy. If you are unsure what to do, and do not have time to experiment, please use the default values for Open Sky, Tree Canopy or Urban Canyon.

5. *If you are using SBAS corrections, allow the MobileMapper CE receiver to track at least one SBAS satellite for four minutes before logging data*
   Most SBAS systems (e.g., WAAS, EGNOS and MSAS) transmit a complete correction message once every four minutes. If you begin logging data before the receiver has a complete message, accuracy may not be optimal yet. Because you only have to track one SBAS satellite to get a complete message and do not have to be tracking any GPS satellites, you might consider turning the receiver on four minutes before arriving at the first location at which you will collect data.

A Special Requirement for Recording Data for Post-Processing

Three different programs are used to post-process MMCE data:
1. Various data logging applications for the MMCE, such as GPSDifferential for ArcPad, record GPS measurements used by PC programs for post-processed differential correction.
2. Programs like GPSDifferential log GPS measurements in the background while GIS data logging applications like ArcPad log real-time GPS positions from the MMCE's GPS receiver as attributes of GIS features.
3. Magellan's MobileMapper Office includes a module that post-processes the GPS measurements logged by GPSDifferential, for example, to calculate sub-meter positions. MobileMapper Office then associates these positions with the GIS features recorded while the GPS measurements were recorded.

The post-processing software in MobileMapper Office requires roughly 20 minutes of uninterrupted lock on the signals from five or more GPS satellites, with a PDOP less than 4, to deliver sub-meter accuracy for any *line* or *area* features recorded within that time period. Any *point* feature recorded during that time and averaged for at least 30 seconds will be post-processed to sub-meter accuracy.

The post-processing software in MobileMapper Office calculates a differentially corrected position for each "epoch" of GPS data recorded – regardless of whether an epoch was recorded as part of a GIS feature or not. (GPS satellites broadcast one "epoch" of GPS data every second.) MobileMapper Office post-processes all of a job's epochs together, not just those epochs making up individual GIS features. This is similar in concept to recording and post-processing a GPS track log that would appear on a map like a string of bread crumbs – except that with Mobile Mapper Office only those bread crumbs associated together as a point, line or area feature will be displayed. Although any bread crumb not recorded as a GIS feature will not be displayed, a continuous stream of them is required for providing sub-meter accuracy to those bread crumbs comprising the GIS features.

The way MobileMapper Office works, a continuous stream of bread crumbs will be post-processed to sub-meter accuracy only if it is at least 20 minutes long. If the 20-minute stream of bread crumbs comprises 40, 30-second point features, all of the point features will be sub-meter. If 20.5 minutes of bread crumbs comprise 10-minutes of bread crumbs followed by one point feature lasting 30 seconds and 10 more minutes of bread crumbs, that one point feature will be sub-meter. If the 20 minutes of bread crumbs were recorded as a single sidewalk, all of the points making up the sidewalk will be sub-meter.

Lastly, logging a series of GPS raw measurement files instead of just one can degrade accuracy because it reduces the duration of continuously logged raw measurements. Unless there is some special need to open and close multiple raw measurement files, you should start logging GPS raw measurements before you log data for the first feature and stop logging raw measurements after you close the last feature.