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Explanation of GPS/GNSS Drift

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Introduction

Often times, long-term GPS/GNSS guidance system accuracy (commonly referred to as GPS drift) is not clearly understood, nor its potential impact on field operations and ultimately one's bottom-line. The Alabama Precision Agriculture Team discovered that some users of GPS/GNSS-based technologies were not optimizing the GPS/GNSS correction services for their particular field operations (e.g. using the WAAS correction service for planting). It is imperative to understand the different accuracies associated with GPS/GNSS correction services so one can maximize benefits of their precision ag technologies.

GPS/GNSS Drift

Upon returning to the field, a producer may notice discrepancy between what he/she knows to be the crop row where an AB line was previously established, and where the guidance device is suggesting the AB line is located. WAAS and sub-meter correction services may seem accurate during one field operation but be off-track when the operator returns to the field. This result is because there is typically large ambiguity between pass-to-pass accuracy and year-to-year accuracy or GPS drift.

- **GPS/GNSS Drift / Year-To-Year Accuracy (Y2Y) / Long-term Accuracy**: Drift can be defined as GPS/GNSS receiver (guidance system) accuracy over time. Causes of drift are changes in satellite configuration, operating near trees or other obstacles, and satellite data errors.
- **Pass-to-Pass Accuracy (P2P)**: Represents the short-term (<15 min.) relative accuracy of a GPS/GNSS receiver but does not necessarily reflect long-term accuracy (which includes drift). One can think of this as the accuracy between adjacent, parallel passes made within 15 minutes of one another.

Since manufacturers typically report pass-to-pass accuracy, it is generally used for equipment purchasing decisions. However, this accuracy may not reveal how the guidance or GPS/GNSS-based system will perform relative to the last operation or over the course of time if previously established AB lines are re-used. This result is especially true when AB lines are established for planting and re-used for harvesting.

As mentioned above, GPS/GNSS drift is largely due to the changing GPS/GNSS satellite constellation patterns used by the guidance device to derive positional information. GPS/GNSS satellites are in continuous motion orbiting the earth twice per day in a repeated pattern. It is assumed that the GPS/GNSS satellite constellation and environmental conditions will not drastically change within a given 15 minute time span, thus derived positions using the same satellite constellation and environmental conditions will be closely correlated relative to each other. However, the GPS/GNSS satellite constellation and atmospheric conditions change over just short time periods resulting in different satellites in varying geometric configurations. *Therefore, the* *magnitude of drift expressed by your device is dependent on the correction service used*. Table 1 illustrates typical pass-to-pass accuracies versus GPS/GNSS drift that can be experienced.

Table 1. Pass-to-Pass and GPS/GNSS drift accuracies of correction services in Alabama.

Correction Service	Pass-to-Pass Accuracy*	Potential Range of Drift†
WAAS	± 6 to 13 inches	± 4.7 ft
Sub-meter	± 6 to 13 inches	± 2.3 ft
Decimeter	± 2 to 4 inches	± 1.7 ft
RTK	± 1 inch	± 1 inch

* Based on manufacturer literature.
† Based on research conducted at Auburn University.

Solutions to GPS/GNSS Drift

There are two common methods used to overcome GPS/GNSS drift: 1) **Shift Track/Nudge feature** or 2) **GPS/GNSS correction service upgrade.** The Shift Track or Nudge feature allows a user to manually compensate for drift by nudging the AB line to correspond to its known location. The downfall to this method is that a visual absolute reference (e.g. crop row, fence post) is required to accurately re-align the AB line to the crop row. *It may even have to be performed each time you go to the field or multiple times within a specific operation*. Alternatively, a farmer can upgrade their GPS/GNSS correction service from WAAS to sub-meter or decimeter services such as SF2 or OmniSTAR® to minimize GPS/GNSS drift or ultimately to sub-inch repeatable accuracy provided by RTK (Real-Time Kinematic) correction.

Importance

Matching the type of correction service to a specific application is important as illustrated in Figure 1**.** GPS/GNSS drift is a function of time. Therefore, field operations conducted at higher ground speeds or shorter times between adjacent passes (i.e. spraying) can utilize higher drift services (e.g. WAAS) without apparent errors. This result occurs because drift accumulation over a short period is small. Other operations, such as planting, take place over longer periods or at slower speeds potentially leading to unacceptable drift buildup or performance. Therefore, RTK correction is recommended for many field operations to improve spatial accuracy over time thereby minimizing drift. Technically, RTK correction does experience drift over time. However, considering the stated accuracy (± 1 inch), inherent drift will be negligible or not observable in agricultural operations.

Figure 1. GPS/GNSS drift display carpet illustrates potential drift of correction services within a field. Cotton is planted on 40 inch centers and the color corresponds to correction service labels in Table 1.

Disclaimer

The mention of trade names and commercial products is for informational purposes and does not necessarily imply endorsement by the Alabama Cooperative Extension System.

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