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GPS Correction Services for Alabama

Introduction

Today's standalone GPS receivers are capable of determining their position to within 30 - 60 ft. However, improvement in calculated GPS position accuracy along with reliability and repeatability can be obtained using a correction process referred to as ***Differential Global Positioning System (DGPS)***. Several types of DGPS correction services are available to civilian users in Alabama. Simply, these correction services minimize and in some cases eliminate the potential errors (multi-path, atmospheric interference, orbital errors, clock errors, etc.) which can be introduced when a GPS computes its position. Costs for these correction services can range from free to around a $1,500 per year subscription fee. *The cost is largely dependent on the desired level of positional accuracy.* GPS correction services available in Alabama include:

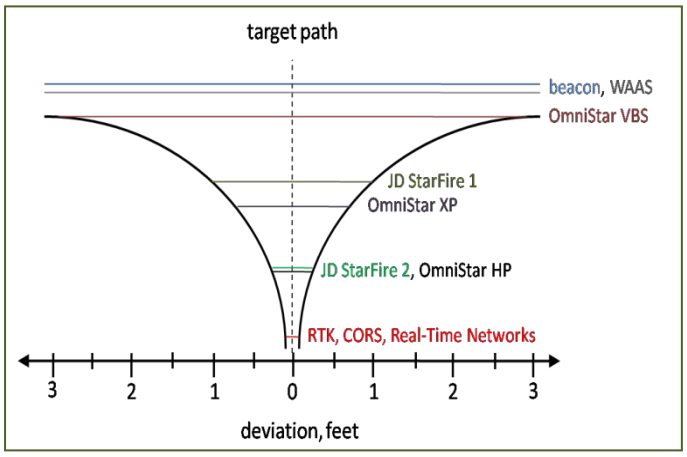

Figure 1. Approximate positioning accuracies between various GPS correction services.

- WAAS
- Coast Guard Beacon
- John Deere Starfire System
- OmniSTAR®
- Real-Time Kinematic (RTK) including CORS and network solutions

Figure 1 provides a graphical illustration of advertised accuracies of these different correction services. The remainder of this publication provides an overview of each of these correction services.

WAAS

The *Wide Area Augmentation System* (WAAS) is a free service that provides coverage throughout the US along with part of Canada and Mexico. WAAS is managed by the Federal Aviation Administration (FAA). Many GPS receivers (especially mapping and navigational units) manufactured today in the US utilize WAAS. Through a network of ground-based reference stations and two geostationary satellites, WAAS correction signals can be received by L1-capable, DGPS-enabled receivers. Since WAAS signals are broadcasted over such a large area, WAAS is termed a "wide area" correction service.

Coast Guard Beacon

The *Coast Guard beacon* is a free, land-based radio signal offered managed by the U.S. Coast Guard's Navigation Center (NAVCEN). Anyone operating a DGPS-capable unit can utilize the USCG's broadcast signal, if they are located in established coverage areas (Figure 2). Accuracy is comparable to WAAS but is reduced as one travels farther from a Beacon broadcast tower. This correction service consists of two control centers and over 85 remote broadcast sites, three of which are in Alabama. The service broadcasts correction signals on marine radio-beacon frequencies. This service is currently undergoing a multi-phase modernization project that is expected to increase accuracies in the future.

Figure 2. Coast Guard Beacon coverage in Alabama.

OmniSTAR®

OmniSTAR® is a wide-area correction service, much like WAAS; however, several error sources are filtered and modeled in ways that are proprietary. OmniSTAR® is a global service, with geostationary satellites encompassing most of Earth. Currently, three services are offered with differing levels of positional accuracy: VBS, XP, and HP (Table 1). All three services require subscription fees. Similar to WAAS, OmniSTAR's VBS is a single frequency correction signal while "XP" and "HP" are dual frequency based correction services. Several GPS receiver manufacturers offer receivers capable of utilizing OmniSTAR's correction signals.

John Deere® StarFire™

John Deere *StarFire* DGPS receivers (Figure 3) can utilize three types of correction: SF1, SF2, and RTK. Each correction type provides a different level of position accuracy (Table 1). SF1 and SF2 are wide-area correction services broadcasted using geostationary satellites and are only available for John Deere receivers. These services cover the entire US along with several other countries around the globe. The main difference between SF1 and SF2 is that SF2 is a dual-frequency based correction providing a higher level of accuracy over SF1. It is important to note that a StarFire receiver can be upgraded to a higher accuracy correction if one starts with the free, SF1. John Deere can also provide RTK level correction through networks (see below).

Figure 3. Example RTK base station using a StarFire GPS receiver.

RTK (Real-Time Kinematic)

With RTK, a base station is placed over a known geographical point allowing multiple roving GPS receivers to utilize this type of correction within a limited range of the base station. The premise behind the service is simple: as the base station continually collects static position information under local environmental conditions, the positioning errors are computed at the base station, which are assumed to be the same being experienced at the rover receiver. Those errors are transmitted to the rover receiver, usually via a short-range radio or other communication device allowing the rover unit to use this information to calculate a highly accurate position. Radios operate best within line of sight or a repeater may be used to extend the operational range. RTK can be used for highly accurate operations, such as precision guidance for row crop production or collecting GPS elevation data for topography mapping.

John Deere offers an RTK correction option for their StarFire receiver. To upgrade to RTK, one must either purchase a base station (Figure 3) from John Deere or operate within range of a John Deere-supported RTK network. Without a repeater, John Deere advertises an approximate radio range of 2 to 6 miles from the RTK base station. There are also other manufacturers of RTK systems available for Alabama farming operations having similar setups and operational ranges. These include Trimble®, TOPCON®, AutoFarm, and Leica®.

CORS

For sub-inch accuracy without the need of a base station, utilization of a Continuously Operating Reference Station (CORS) is an option being used in agriculture, construction, and surveying. Many of these stations are operated and monitored by the National Geodetic Survey (NGS). They are immobile base stations (Figure 4) that continuously collect positional data and, through the "law of averages," generate an accurate geographic position for the GPS rover unit. CORS station data are routinely checked for integrity and made available for public use. Some CORS stations are configured to stream error correction data to an internet server allowing users to access the data with a cellular modem or a radio. The phone or radio relays the correction signal to the roving GPS receiver. This system's functionality and reliability are dependent upon adequate cellular phone or radio coverage. Computed GPS position errors increase the farther the rover GPS is from the CORS station. Currently, 15 to 20 miles is the maximum to maintain the RTK stated sub-inch accuracy under dynamic operating conditions.

Figure 4. Example CORS station (courtesy of NGS).

Real-Time Networks

Real-Time Networks (Fig. 5B) are being developed in Alabama. Such a service will replace single-station CORS correction solutions due to their capability of providing a high order of accuracy (sub-inch) over an increased distance versus that from an individual base station. This will be accomplished by providing a new variable to the accuracy equation: real-time accuracy of each station related to one another. Such a service will link all CORS stations together in a "mesh" fashion. If a receiver is operating "under the mesh," the position calculation accuracy will be increased along with the receiver's ability to operate farther from the base stations while maintaining the sub-inch accuracy. A subscription fee will most likely be associated with using RTK networks to help support infrastructure and maintenance costs. Two examples include Virtual Reference Stations (VRS) and eGPS®, currently used in Florida and Georgia, respectively.

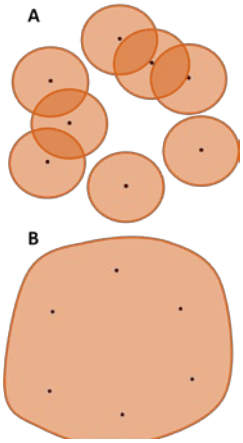

Figure 5. Individual CORS station coverage (A) versus a Real-Time network (B).

Additional Comments

Along with the correction services outlined, current modernization of the GPS system will increase a receiver's accuracy. This improved accuracy will come in the form of new signals (L2C and L5) available to compatible civilian GPS receivers. These signals will be stronger and more reliable under tree cover or near obstructions. Also, new receivers may be GNSS equipped, meaning they can use data from other navigational satellite systems beyond GPS.

For additional information see ACES Timely Information Sheets:

- Update on GPS: New Civilian Accessible Signals – L1C, L2C, and L5
- Update on GPS: Explanation of GNSS
- Application of CORS in Agriculture.

Table 1. Differential correction services available in Alabama for agricultural production.

Correction Service	Provider	Operating Fee[†]	Pass-to-Pass Accuracy *[+]	Static Accuracy*
WAAS	Federal Aviation Administration (FAA)	No	8-12 in	>2 ft
Beacon	US Coast Guard	No	3 – 6 ft	3 – 6 ft
VBS	OmniSTAR®	$800/year	< 40 in	<40 in
XP		$800/year	+/- 6 in	+/- 8 in
HP		$1500/year	< 4 in	+/- 4 in
StarFire 1	John Deere®	No	+/- 12 in	+/- 30 in
StarFire 2		$800/year	+/- 4 in	+/- 10 in
RTK	*Multiple providers*	No	< 1 in	+/- 1 in
CORS	National Geodetic Survey (NGS)	No	< 1 in	+/- 1 in
Real-Time Networks	*Multiple providers*	*To be determined*	< 1 in	+/- 1 in

[†] All yearly subscriptions fees are only estimates and could vary depending upon provider.

* Reported accuracies are only estimates and can vary by receiver and operating environment.

[+] Pass-to-pass accuracy is the position accuracy over a 15-minute period.

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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