Precision Agriculture: Commonly Used Terms & Applications

AgGIS – a geographic information system suited for agricultural applications. Farmers are able to use an AgGIS to produce detailed harvest reports, determine trends from harvest to harvest, and compare production capabilities of different varieties and crop inputs. An AgGIS is also used for precision ag data and maps for management decisions such as management zone creation, variable-rate application, prescription maps, planting decisions, and targeted soil sampling. Agriculture GIS software can also serve as valuable accounting, record keeping, and decision support tools for farmers. See also Geographic Information Systems.

Automatic Section Control – turns application equipment OFF in areas that have been previously covered, or ON and OFF at headland turns, point rows, terraces, and/or no-spray zones such as grass waterways. Sections of a boom or planter or individual nozzles/rows may be controlled.

Auto-guidance – See Guidance

Base Station – a stationary GPS/GNSS receiver, setup over a geo-referenced point that provides correction data to a GPS/GNSS rover unit. Correction data can be broadcast via radio frequency or the internet. The premise behind the service is simple: a base station receiver is placed on a stable, immobile mount at a known point; the base station continually collects static position information under local or wide-area field conditions and the positioning errors computed at the base station (the differences between “observed” values and “truth”) are assumed to be the same errors occurring at the mobile receiver (rover). The base-station errors are transmitted to the mobile receiver on the tractor, allowing the rover unit to use this information to calculate corrected positions. A personal or local base station is often used in precision agriculture applications for RTK guidance to calculate highly accurate corrected positions. A wide-area base station may be used for differential correction signals such as WAAS, John Deere’s SF 1 or SF 2, OmniSTAR or US Coast Guard Beacon. See also Guidance.

CF card (Compact Flash card) – a small, portable card used for storing data in electronic devices. In precision ag equipment it is used in monitors and/or controllers to store and transfer data.

Coordinate System – coordinate systems are used in GPS/GNSS navigational systems to reference locations on Earth. There are many coordinate systems but frequently used ones include: latitude and longitude, Universal Transverse Mercator (UTM), and State Plane coordinate systems.

CORS (Continuously Operating Reference Stations) – a survey-grade GPS receiver positioned on a known, fixed location which provides continuous RTK-level GPS/GNSS correction information. Coordinated by the National Geodetic Survey (NGS) of the National Oceanic and Atmospheric Administration (NOAA), CORS data can be used for Real-Time Kinematic...
(RTK) applications, meaning that the station provides continuous correction data to roving GPS/GNSS receivers with internet accessible capabilities. CORS has traditionally been used for surveying, construction, and transportation industries but is now available for agriculture applications (consult your GPS/GNSS manufacturer or dealer to determine if your equipment is CORS compatible). An internet-capable cellular phone or cellular modem must be used to transmit correction signals from a server to the tractor (cellular coverage and a data plan are required). The Alabama Department of Transportation (ALDOT) has established many CORS stations throughout Alabama which are available to farmers in Alabama for real-time RTK correction. CORS eliminates the need for producers to purchase a personal base station, thereby lowering investment costs for RTK applications, and initial research has indicated that CORS can provide RTK-level correction within a 20 mile radius of the station’s location. Because CORS data is transmitted over the internet there are no line of sight requirements as with radio transmitted signals.

Datum – a geodetic datum defines the reference systems that describe the size and shape of the earth. Datum have evolved from those describing a spherical earth to ellipsoidal models derived from years of satellite measurements. Frequently used datum include: World Geodetic System 1984 (WGS 84), North American Datum of 1983 (NAD 83), and North American Datum of 1927 (NAD 27). Referencing geodetic coordinates to the wrong datum can result in large position errors.

DEM (Digital Elevation Model) – A digital representation of a surface, usually for topography calculations. Also, *.dem is a file format defined by the US Geological Survey (USGS) for digital elevation data. DEMs are often utilized in geographic information system (GIS) analyses.

DGPS (Differential GPS) – differential GPS is a correction service that increases the accuracy of the position provided by GPS satellites. This service is used to derive “corrected” GPS positions as opposed to “non-corrected,” or autonomous, positions. Some correction services available in Alabama include: WAAS, Coast Guard Beacon, John Deere StarFire™ System, OmniSTAR®, and Real-Time Kinematic (RTK) including CORS and network solutions.

Directed Soil Sampling – Traditionally fields have been sampled on a whole-field basis, i.e. one sample from an entire field. With directed soil sampling, a field is divided into grids (typically 2.5 acres each) or zones (typically 10-20 acres each) and a soil sample is collected from each grid or zone. Directed soil sampling allows targeted application of specific nutrients within a field.

Electrical Conductivity (EC) – EC is the ability of a soil to carry an electrical current. EC readings can be used to differentiate soil textures and as a tool for developing management zones.

DOP (Dilution Of Precision) – One of many GPS quality measurements used to evaluate solutions derived by a positioning receiver. This is a numeric value that refers to the geometries among positioning satellites as well as the geometries between the satellites and the receiver. A lower value increases the probability of acceptable accuracy with desired values typically less than 4. DOP can be further classified into other variables: GDOP (three-dimensional position plus clock offset), HDOP (horizontal position), PDOP (three-dimensional position), TDOP (clock offset) and VDOP (vertical position).

Firmware – refers to the program that internally controls an electronic device. Precision ag systems and GPS receivers contain firmware and manufacturers often offer updates to the firmware when new features and system advancements are available.

Geo-referenced – data that has position information such as latitude and longitude associated with it.

Geographic Information System (GIS) – a GIS is a computer program that displays, stores and allows for analysis of geo-referenced data. See also AgGIS.
GLONASS – (ГЛОbal'наyа НAвиgatsионная Sпутниковая СиSTEMа) – the satellite-navigation network maintained by the Russian government. The English translation of this name is “ГЛОbal NAвиgation Satellite System,” or more commonly named “GLONASS.” Utilizing GLONASS enabled receivers for precision ag applications provides additional satellite coverage and often improved performance of guidance systems. See also GNSS.

GNSS (Global Navigation Satellite System) – refers to using multiple satellite navigation systems concurrently by a GPS receiver to compute its position. What makes a GNSS receiver superior to a GPS receiver is its capabilities of receiving signals from navigational satellites other than, and in addition to, those that are of the GPS network. There are two operational satellite navigation systems at this time: The United States of America’s GPS and Russia’s GLONASS. In addition, the governments of the European Union, China, Japan and India are developing satellite-navigation networks of their own—Galileo, COMPASS, QZSS, and IRNSS, respectively. As a result, GNSS users will be able to utilize more satellites to compute a position with increased position accuracy and reliability.

GPS (Global Positioning System) – the satellite-navigation network maintained by the United States Department of Defense (USDOD). The Global Positioning System consists of a minimum of 24 operational satellites that orbit the earth and provide positional information to GPS receivers. Using the geometric principle of triangulation, a position on earth can be determined when a GPS receiver obtains data from a minimum of three satellites. Receiving data from additional satellites further increases the positional accuracy.

Grid Soil Sampling – dividing of a field into grids (typically 2.5 acres each) for soil sampling. Grids are established using the field boundary and an AgGIS software program. Once established a handheld device equipped with GPS and GIS software is used to navigate to the grid and a soil sample is collected from each grid. Soil sample results are then linked to the appropriate grid in an AgGIS for variable rate fertilizer and lime applications. See also Directed Soil Sampling.

Guidance – There are two basic categories of guidance products: lightbar/visual guidance and auto-guidance. For lightbar/visual guidance, the operator responds to visual cues to steer the equipment based on positional information provided by a GPS. For auto-guidance, the driver makes the initial steering decisions and turns the equipment toward the following pass prior to engaging the auto-guidance mechanism. Auto-guidance can use differential correction such as WAAS, subscription services, and RTK. RTK is the most accurate level of auto-guidance available, typically +/- 1 inch. Benefits include improved field efficiency, reduced overlap of pesticide applications, time management and reduced driver fatigue. See also WAAS, Subscription Correction Signal and RTK.

Management Zones – Management zones are created by subdividing a field into 10-20 acre areas with similar characteristics. Yield maps, soil texture maps, elevation data, EC data, sensor data and farmer knowledge can be used to create management zones in GIS software. There are several methods available for creating management zones.

Modem (modulator-demodulator) – A modem is a device that enables computers to access the internet to exchange data over telephone lines, cable lines or wirelessly. Cellular modems are typically used to access Real-time RTK Network or CORS data via the internet. When using a cellular modem, a data plan is required for internet access.

NAD83 (North American Datum 1983) – one of many different mathematical projection models used for precision agriculture data and mapping. NAD83 is a best-fit model for North America, Canada, Mexico, and Central America, while the previous model (NAD27) was designed for a central portion of North America only. Neither datum is wrong; however, errors may be introduced into positioning if one operates outside of the datum’s range or if coordinates from one datum are compared to coordinates from another datum.
OmniSTAR HP/XP – DPGS correction services provided by OmniSTAR which provides reported pass-to-pass accuracy of +/- 4 inches (HP) or +/- 6 inches (XP).

PDA (Personal Digital Assistant) – A portable computing device capable of receiving, storing and transmitting data. PDA’s are often used in precision ag with a GPS for the collection of field data and directed soil sampling applications.

Prescription – refers to the map created in an AgGIS which assigns product application rates for variable rate applications. Prescription information is exported to a precision ag controller for application. Prescription maps are commonly used for variable rate seeding, fertilizer, lime and irrigation.

Projection – refers to the map projection used for precision ag data and mapping. A map projection represents the surface of the earth (sphere) as a flat plane for GIS analysis. Different mathematical parameters are used in the calculation of each projection therefore it is important when working with GIS data that the projection of the data is taken into consideration. Using data layers with varying projections can result in erroneous analyses.

Receiver – refers to a GPS/GNSS receiver in which computations are performed internally to derive a positional solution. The GPS/GNSS receiver and antenna can be located within the same housing or may be separate.

Repeater – a device that receives a radio signal and amplifies or re-transmits it. It is used to extend the range of base station signals and to expand coverage.

Rover – refers to a mobile GPS/GNSS device

Remote Sensing – examples of remote sensing data include satellite imagery, aerial photography and thermal imagery. This data can be used to identify problem areas (such as plant stress and irrigation deficiencies), differentiate bare ground from vegetation and as a tool in the creation of management zones. See also Thermal Imagery.

RTK (Real Time Kinematic) – the most accurate form of GPS/GNSS correction and the only GPS/GNSS correction that provides +/-1 inch (centimeter-level) accuracy and year-to-year repeatability. RTK utilizes two dual-frequency receivers which are necessary for highly accurate operations, such as precision guidance for row crop production. RTK correction can be provided in two ways: personal base stations or Continuously Operating Reference Stations (CORS). Personal base stations utilize radios to communicate the correction signal from the base station to the rover radio on the tractor, and typically have a 6 mile line-of-sight radius. CORS utilizes an internet-capable device such as a cellular phone or cellular modem to transmit correction signals from a server to the tractor. Initial research has indicated that CORS can provide accurate correction signals up to a 20 mile radius. Cellular coverage and a cellular data plan are required to utilize CORS. See also Base station and/or CORS.

RTN / RTKN (Real-Time Network or Real-Time Kinematic Network) – a generic term for a correction service offering greater reliability than single-station RTK. This is accomplished by connecting RTK or CORS stations in a “mesh” fashion, so that correction data is utilized from multiple stations in an effort to increase accuracy and reliability over longer baseline distances. Current Real-Time Networks include cellular-based networks and radio-based RTK station networks. Cellular-based networks available for use in Alabama include Virtual Reference Stations™ (VRS) provided by Trimble™, iNET GPS Network provided by Earl Dudley, Inc. and individual Master Auxiliary Correction (iMAX) provided by Leica Geosystems™. A subscription fee is often associated with using real-time networks, due to infrastructure costs. Contact your local manufacturer to determine compatibility and availability of RTKN services.

SD card (secure digital card) – a small card used in mobile devices such as digital cameras, PDAs, and GPS receivers to store and transfer data.
**Serial port** – a serial communication interface which transfers information. In precision agriculture, serial ports are often used to transfer data between a personal computer and precision ag equipment such as a monitor, modem or receiver.

**Site-specific Management (SSM)** – also referred to as precision farming, SSM targets or varies inputs to meet crop needs. In SSM a field is divided into smaller management areas, rather than using the same management on the entire field. For example, fertilizer can be applied in a field only where it is needed instead of applying a broadcast application across the field. GPS/GNSS technology is often used to implement SSM.

**Smartphone** – refers to a cellular phone with advanced capabilities, often with PC-like functionality, internet capability, and a complete operating system.

**Sensor Technologies** – Sensor technology refers to on-the-go optical sensors used to measure crop status. These sensors utilize an active LED light source to measure NDVI (Normalized Difference Vegetative Index) to predict crop yield potential. NDVI values reflect the health or “greenness” of a crop and can also provide a relative biomass measurement. Data collected from these sensors are being used to direct variable rate nitrogen applications in grain crops and plant growth regulator and defoliants in cotton.

**StarFire 1 (SF1)** – A free DGPS correction service provided by John Deere which provides reported pass-to-pass accuracy of +/- 10 inches. A tractor must be equipped with John Deere’s guidance system in order to be compatible.

**StarFire 2 (SF2)** – A subscription based DPGS correction service provided by John Deere which provides reported pass-to-pass accuracy of +/- 4 inches. A tractor must be equipped with John Deere’s guidance system in order to be compatible.

**Subscription Correction Signal** – a fee-based GPS/GNSS correction option available through a subscription service from the providing company. For those precision ag applications that need increased accuracy above WAAS or SF1, a subscription correction service can be purchased. OmniStar® (VBS/HP/XP) and John Deere (SF2) both offer subscription correction services that provide a +/- 6, +/- 4, +/- 6, or +/- 4 inch pass-to-pass accuracy, respectively, for agricultural equipment depending on the level purchased. See also HP/XP and SF2.

**Terrain compensation** – an add-on feature for auto-guidance systems which correct position error that may occur when equipment travels over rolling terrain. Roll, pitch and yaw are commonly referred to when discussing terrain compensation. Roll refers to the change in elevation between the left and right sides of the vehicle; pitch refers to the change in elevation between the front and rear of the vehicle; and yaw refers to any sliding or turning motion of the vehicle to the left of right.

**Thermal Imagery** – A type of remote sensing that depicts the heat emitted or reflected by an object, such as plants growing in the field. It can be used to detect plant stress and determine irrigation needs. See also *Remote Sensing*.

**Tilt compensation** – See *Terrain compensation*.

**USB (Universal Serial Bus) Mass Storage Device** – a memory device used to transfer and store data which uses the standard USB interface connection. In is also commonly referred to as a jump drive, flash drive or thumb drive.

**UTM (Universal Transverse Mercator)** – This is one of many different mathematical models upon which satellite-derived positions can be translated into a coordinate system that corresponds to positions derived through standard maps. For the sake of simplicity, each datum has mathematical parameters that define it, including the predicted center of the Earth and the mathematical shape of the Earth. Because the Earth is not perfectly spherical, the mathematical parameters may provide a model that is accurate on one portion of the planet, while being horribly inaccurate on
another. UTM, however, is a global model that has been divided into numerous parts that represent certain sections of the globe. UTM coordinates are conventionally presented in meters, unlike NAD-83 coordinates (conventionally presented in survey feet).

**WGS-84 (World Geodetic System 1984)** – one of many different mathematical datum models used for precision agriculture data and mapping. WGS-84 is a commonly used datum and is comprised of a standard coordinate frame, spheroidal reference surface, and nominal sea level, for Earth used by GPS since January 1987.

**Variable Rate Technology (VRT)** – virtually any agricultural input has the ability to be applied at a variable-rate. VRT allows varying rates to be applied within a field resulting in more efficient applications. Variable-rate applications typically use a prescription map to apply pre-determined rates at specific locations within a field. Required components for VRT are: DGPS (provides position information), metering device (changes the rate of input applied), computer (receives position information from DGPS, reads prescription files and logs as-applied data) and rate controller (communicates rate information to the metering device). The computer and controller may be integrated.

**WAAS (Wide Area Augmentation System)** – a free GPS differential correction service available in the United States through the Federal Aviation Administration (FAA). WAAS corrections are provided through a network of ground-based reference stations and two geostationary satellites. Most, if not all, current GPS equipment is WAAS compatible. WAAS can provide point accuracy between 9 – 15 feet and pass-to-pass accuracy of 6 – 12 inches.

**Yield Monitoring** – Yield monitoring allows growers to determine higher and lower yielding areas of the field. When coupled with a GPS, yield monitors can be used to produce yield maps. Yield monitor components include sensors (used to measure yield), DGPS (provides position information) and a display (processes information from sensors, displays information in the cab and writes yield data to a data card). Yield monitors are readily available for combines and cotton pickers. Equipment manufacturers offer the option to order yield monitors as a factory add-on and third-party products are also available.

For additional information, visit www.AlabamaPrecisionAgOnline.com.

**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.

**Prepared by**


ALABAMA A&M AND AUBURN UNIVERSITIES, AND TUSKEGEE UNIVERSITY, COUNTY GOVERNING BODIES AND USDA COOPERATING

The Alabama Cooperative Extension System offers educational programs, materials, and equal opportunity employment to all people without regard to race, color, national origin, religion, sex, age, veteran status, or disability.

www.alabamaprecisionagonline.com