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GPS Changes: How to be Prepared

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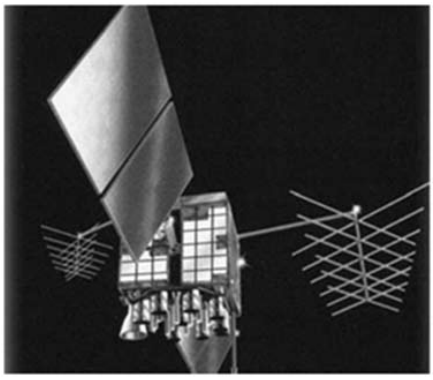


GPS technology is an integral part of modern agricultural production systems. There are several major upcoming changes in the GPS world that will impact users of GPS technologies in agriculture. Some of these changes will improve receiver performance and some will actually degrade performance even to the point of rendering some receivers completely obsolete.

The purpose of this publication is to point out some of the major GPS changes that will be taking place over the next several years and to explain in layman's terms how they will affect GPS accuracy and purchasing decisions, particularly for those people already familiar with and using GPS in agriculture. The discussions below will all point toward the following conclusions.

Take-home Lessons

- Expect the accuracy of current GPS technology to degrade over the next several years because of solar activity.
- When purchasing new equipment, ask about L2C and L5 compatibility.
- Be prepared to upgrade current RTK equipment before 2020.
- Keep receiver firmware up to date.

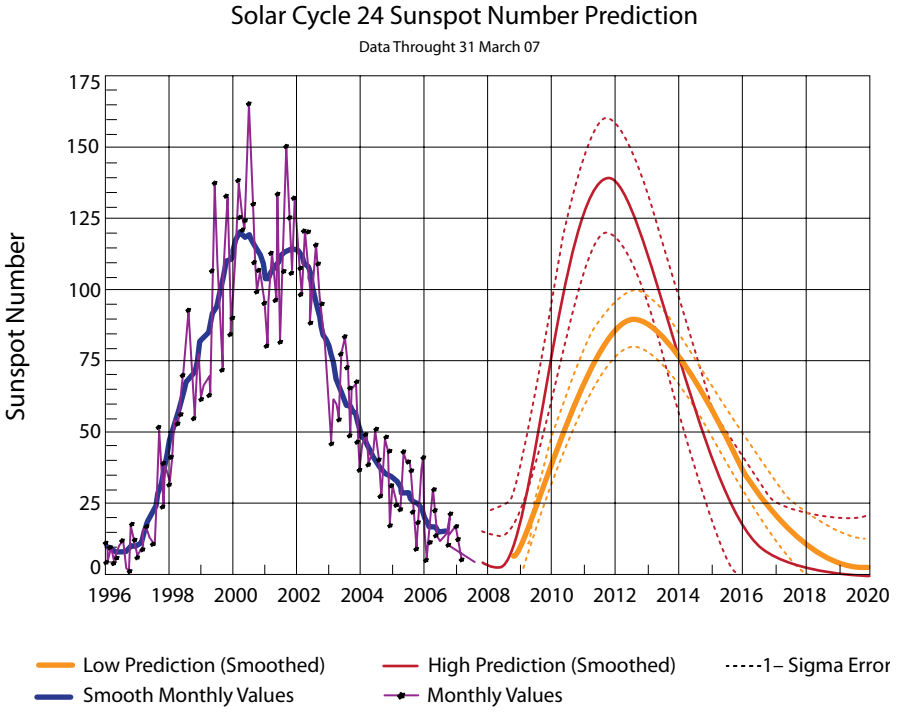
Solar Changes

Not all of the future GPS changes are man-induced. In fact, one of the biggest concerns is actually caused by the sun. Solar radiation activity, or sun spots, affects the quality of all radio transmissions, including GPS signals. The level of solar activity is cyclic and somewhat predictable. The graph below shows a record of the solar activity from 1996 to 2008 along with two scientific predictions of activity through 2020. At the time this document was published (2008), the solar activity was near a minimum, which means that the integrity of radio signals and correspondingly the accuracy of GPS receivers were at a high point. While scientists don't completely agree on exactly how much or how quickly the solar activity will increase, it is universally recognized that the situation will worsen over the next several years. This means that *with all other things equal,* a GPS receiver used in 2008 will not be as accurate when used in 2010 or 2011. Some experts have estimated that the accuracy of some lower end receivers may be cut in half. That said, it should be noted that *all other things* will probably not be equal in 2010 or 2011. The U.S. Department of Defense will be making changes to the GPS signals that should bring significant enhancements to the accuracy and reliably of properly equipped GPS receiver technology.

GPS System Changes

GPS Legacy

Understanding "GPS modernization," or upgrades, requires a basic understanding of the current GPS satellite transmissions. The GPS industry often refers to these un-modernized signals as *legacy* signals, and the receivers that are bound to these signals are called *legacy* receivers. Currently the 24+ GPS satellites in



orbit broadcast signals on two different frequencies: L1 at 1575.42 MHz and L2 at 1227.60 MHz. There are different digital "codes" that are sent across each of these frequencies. The C/A code is broadcast on L1 and is often denoted L1C. This is the code that all lower-end non-military receivers utilize to calculate position. There is also a P code that is broadcast on both L1 and L2. This code is scrambled and is used only by military and authorized personnel. Having the same code available on two different frequencies enhances accuracy by providing a means for correcting errors caused when the GPS signals travel through the earth's ionosphere.

Although the P code information is not fully available to them, some civilian receivers are designed to utilize part of the information provided on the L2 signal to augment the L1 information. These dual frequency receivers have implemented advanced "semicodeless" algorithms to achieve decimeter and centimeter position accuracy. This technology includes the RTK receivers that are commonly used in surveying and precise agricultural operations.

GPS Modernization

The new satellites that are launched to replace older satellites in the GPS constellation will implement several signal changes. One important change is the addition of a second civil code on the L2 frequency (L2C). As of publication, there were six satellites broadcasting this signal. When it becomes fully functional, L2C should allow significant accuracy increases. Some experts feel that some receivers may be able to achieve near meter-level accuracy without differential correction, and that receivers with WAAS or other basic differential correction signals may operate in the decimeter accuracy range.

Another change that will happen in the next generation of GPS satellites is the addition of a third frequency, L5, at 1176.45 MHz. This signal will be broadcast at a higher power than current L1 and L2 signals and the codes will be available to civil users. Though intended to enhance performance of GPS indoors, it should increase performance along tree lines and in forests where current agricultural users often experience great frustration. This third frequency should also bring better performance to higher-end GPS receivers.

There is one other major signal change planned that may have a profound negative impact on current RTK users. The P code that is currently broadcast on L1 and L2 will become obsolete after implementation of L2C, L5, and other changes; therefore, it may be completely eliminated. This change could come as early as December 31, 2020, but will more likely be pushed back a bit depending on the speed of implementation of other modernization changes. Many legacy RTK receivers will become completely inoperable when the P code transmissions are turned off.

Other Satellite Systems

GPS is not the only game in town. In fact, it is one of several other Global Navigation Satellite Systems (GNSS). There are some newer GPS receivers that have cross compatibility with other GNSS satellites, in particular the GLONASS system, which is maintained by Russia. In general, multiple system augmentation will not give better accuracy, but the additional satellites available can greatly increase the reliability of the signal, particularly when using high precision GPS equipment along tree lines and in other places where it can be difficult to acquire and hold satellite signals. Multiple system compatibility is a good idea for high precision systems.

Will current receivers become obsolete?

Obsolescence can mean different things. If obsolescence is defined as not having the latest and greatest bells and whistles or the smallest form factor, then many of the current receivers used in agriculture could already be considered obsolete, but they are certainly more than sufficient for their tasks. If obsolescence means that the device will be useless, then most non-RTK agricultural receivers will *not* become obsolete with GPS modernization.

Most of the GPS modernization changes, including the L2C, L5, and even some changes in the L1C signal, are backward compatible, which means that the old legacy signals are still there, and currently functional receivers will continue to be functional at their current performance level. However, current receiver technology may or may not be able to fully utilize the advantages of the new signals. The discussion becomes a software vs. hardware issue. If the hardware has the capability to receive the new signals, receivers may be upgradeable simply by updating their firmware, which is the internal software algorithm that performs the computations.

The L5 signal is the least likely enhancement to be utilized by a simple firmware upgrade to legacy receivers. Because it is a different frequency, the antenna technology in the receiver will have to be tuned to that frequency, and the hardware will need the capability to process an extra parallel data stream. These may require changes to the physical hardware. On the other hand, if a receiver is already a dual frequency receiver capable of utilizing the L1C and L2P signals, then a firmware upgrade may be all that is needed to allow it to utilize the L2C code.

The elimination of the P code is a more serious issue for legacy RTK receivers. Much of this equipment will become inoperable when this change is implemented because the signals it relies on will be gone. Many of these devices will not be upgradeable either.

The only way to know for sure about the compatibility or upgradeability of current technology is to contact the GPS supplier or manufacturer. Be aware that some manufacturers may simply choose not to develop upgrades for legacy equipment. When purchasing new equipment, make sure to ask about L2C and L5 compatibility so that there is some assurance of the longevity of the equipment.

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