Topic 2: Factors Affecting GPS Reception and Accuracy.

Now we're going be talking about some of the sources of error that can affect the information or the coordinates that you receive from your GPS receiver. Some of these errors can be corrected for and some of them can't or are just kind of inherent in the data that you're retrieving from your GPS receiver.

The first thing we're gonna be talking about are the errors that can be corrected. The first one is satellite clock errors which are caused by slight discrepancies in each satellite's atomic clock. These errors are monitored for and, and usually corrected by the master station but they can influence, the information that's sent down from these satellites to your GPS receiver. The next one is orbital errors, which pertain to the altitude, position, trajectory, and velocity of these satellites. Orbits can fluctuate due to orbital decay, gravitational attraction, and solar pressure. These orbital errors are also monitored for. Another thing that can affect, your GPS accuracy are ionospheric interference, which occurs when the GPS signals slow down and scatter as they pass through levels of our atmosphere. The GPS signals themselves contain information to help correction this portion of the interference.

Yeah, Aaron that's right, and that's why it's real important that GPS practitioners remember to turn on that WAAS component in their GPS receiver that will

eliminate up to, you know, 1 or 2 meters of, of error in the signals that they receive.

WAAS is really a beneficial thing for sure. It corrects all of those type of errors automatically. There are some errors that you can't correct for though, Carl. Some of those errors include receiver noise. Any electromagnetic field generated by the GPS unit's own internal electronics or that Bendix King radio that you have in a chest harness, or a vehicle or power lines can greatly affect the accuracy of your position. Another thing that can affect the accuracy of your position are multi-path interferences and this is basically where the GPS signal is actually bouncing off some reflective object like a building or a car or a lake before it actually enters into your GPS and that extra little delay allows, an error to go into that trilateration that Carl talked about in the first segment.

One, one of the other things that I've noticed that really causes, uh multi-path error is chain link fences. You can, there's a lot of multifaceted surface there and walking along a chain link fence will do bad things for you.

That's good to know. Another thing that can really affect, your GPS error is sky obstructions and the most common one of these are, are heavy canopy cover, heavy trees, terrain, buildings, and even your body if it gets in the way of the receiver's view of the sky or that particular satellite can, can cause a delay in that signal being received by your unit and will affect the math that goes into that

calculation. One last error that, that we really need to talk about, Carl is the user mistakes. These include incorrect datum settings, incorrect transcription errors due to not understanding coordinate systems, and relying on 2-dimensional positions instead of 3-dimensional positions and even holding the GPS receiver too close to your body.

One great way to avoid that situation of having to actually hold that GPS receiver for the entire time that you're working is to get an external antenna then you can start your GPS receiver up, clip it to your pack or put it inside your pack or in your pocket, and as long as that external antenna has a good clear view of the sky, for instance you can stick it on top of your hard hat, you've got a great view of the sky with your antenna and you don't have to hand hold that gadget while you're working.

I tend to put mine on my backpack instead of my head but I think anything would work, for sure.

The next thing we're gonna be talking about is satellite arrangement and kind of understanding what the satellites are doing will help you know how accurate your GPS reception is. On the very first page that we're gonna be talking about in a later lesson you're gonna see where you can see the satellite arrangement on your GPS receiver. The arrangement of these GPS satellites affects the receiver's ability to resolve or do the math for the positions it gets from the

satellites. There's something called dilution of precision or DOP, which is basically a unit-less index of a satellite's constellation arrangements in the visible sky and that kind of affects how the, the GPS is able to do the math involved with figuring out where it is. The satellite constellation geometry and your DOP or dilution of precision fluctuate constantly as the satellites proceed along their orbits and as the GPS receiver's view of the sky changes due to vegetation, terrain, or other obstacles or even the GPS user moving around. In the diagram above on the slide it kind of shows where each ring represents a GPS receiver's different view of the sky or horizon. The center cross-hairs represent the sky directly overhead and the yellow circles represent the satellites' positions. The 6 examples illustrated show the effect of a satellite arrangement on several different types of dilution of precision. The example in the upper left is considered optimal for providing the best accurate information to your GPS receiver, but you don't always get that type of reception.

That's right Aaron. For instance if, if you take a look at that illustration in, in the lower left-hand corner where all the satellites are just lined up in a row that's a, that's a great example of the, the sort of satellite reception you might get if you were down in the bottom of a canyon with steeply rising terrain on both sides and all you could see was just a slice of sky over head. Those kinds of things will really reduce the accuracy of your GPS position but sometimes that's what you've got. That's what you've gotta live with, but as long as you kinda have that, that sense of what the satellite arrangement does to your GPS positions –

I think the important thing to remember here is that the GPS positions that you get from your GPS receiver are not absolute. The Garmin receivers will always try and provide you a position even if it's a poor one.

The next thing we're gonna be talking about is signal strength and signal strength is, is a really important thing to, to be monitoring while you're out in the field collecting data. The signal strength bar seen here in this slide is a screen capture of your particular GPS unit. The height of those bars in that bottom graph tell you how good of reception you're receiving from the satellites that it's using to do the math to figure out where you are. A good satellite arrangement cannot compensate for low signal strength.

Yeah, Aaron that, uh that whole concept with the signal strength is a lot like your cellphone. You know if you take your cellphone out and you've got 1 bar of coverage and that bar is really short and tiny that means you're probably gonna be hearing every 3rd or 4th word of that conversation and the message is not really getting' across. Well the GPS is the same way. If the signal strength that it is receiving is very small it's not really gonna be receiving that full complement of information that it needs to resolve those positions. So the taller the bar, the more bars, the better off you're gonna be.

The better off you are for sure. And I think the things that affect that signal strength the most are vegetation, terrain, buildings, and electrical power lines, all affect that signal strength. It's important to remember that these Garmin receivers, these recreational grade Garmin receivers that we're using in the field will always try and give you a position even if it's not a good one. So understanding how accurate your position is important.

The next slide gives a good demonstration of that. In the figure above the illustration has 5 different GPSs that were stationary. They were fixed in one spot and they weren't moving around. They recorded points, or wave points, for roughly a 3-hour period. The receivers themselves never moved but you can see by the spread of points on that graph that the location it was reporting varied widely. The 1st ring is a 10 m ring and the 2nd meter is a 20 m ring. All of the points were within that 20 m ring but you can see that the GPS position it was giving you, uh fluctuated over the course of a 3-hour period.

That's right Aaron. And the main reason for that fluctuation really has to do #1 with the sophistication of the GPS receiver's antenna. For instance I took apart the antenna of a Garmin GPS receiver and it's a foil tube with 4 spiralling elements that go up it. It's just a foil tube whereas if you buy a more expensive GPS receiver there are very highly engineered, very sophisticated antenna and it, in that illustration there, that little blob of red points right in the middle was with a very sophisticated GPS antenna, whereas the ones that have the bigger

spread are less sophisticated antennas. The antenna is really the thing that, that will, that will save you on really accurate positions.

And I know a lot of times I'll use that external antenna that you mentioned previously to get a better reception than the antenna that's built into my receiver. Since these GPS positions are not absolute a receiver may have difficulty navigating to an exact point. You're gonna get within 20 m of what you're looking for, and sometimes within 10 m and sometimes within even 1 m, but you may not get exactly where you're looking for so it might make finding a piece of rebar that's a plot center, or an archeological site or some other exact small thing out in the forest or in the woods difficult to find.

It's a lot like "hide and seek" sometimes.

It is. The thing to remember is that you should not use these recreational grade GPS receivers for legal boundaries or contracts but they are the perfect tool for keeping you safe and keeping you from getting lost and for collecting data on fire assignments. Now that we've covered GPS accuracy we're gonna look at the wide area augmentation system.