Don't let your GPS mislead you, by Jim Murrant

GPS is not infallible and the voyager should take seriously the possibility of danger from an incorrect position. Some people will find some of what follows elementary, but if they don't know what WAAS stands for they should read on.

I'll give you a simple example. The signal from the GPS satellite to your receiver can be bent if you are near high hills or tall buildings. Not much of a problem, you say, out at sea. True, but think about this. If you are entering port, at night or in bad conditions and you are relying on the GPS for safety, that can be compromised if you are coming into a big city. Even if you are coming into a smaller port, in a remote area, your signal can be scrambled and your position compromised.

Imagine you are entering a port between two very high, almost conical peaks and the harbour inside is very shallow in parts.

At night there are excellent lead lights that shine miles out to sea. There are lights in warning colours before you come on to the lead light proper, which is white. In the right (bad) conditions there can be severe overfalls – which can easily displace a boat – starting some way from the entrance. On the northern approach there is a dangerous rock only a slight distance from the edge of the light's safe zone. If an approaching vessel were to rely on GPS to enter, rather than the lead light, she could be at risk if the signal was degraded by the two peaks. Even a few feet off course would put the yacht on the rock.

Some hydrographers believe there is a dangerous and growing assumption that GPS devices are infallible. One area of worry is the fact that a GPS position is often more accurate than the chart being used by the sailor. In other words the position given may be accurate to within 10 metres in terms of the Earth's surface, but the chart is not that accurate, so you could be much closer to a potential danger than indicated.

The older the chart the more likely this is to happen. If the chart is corrected to WGS84, which means to a standard adopted world-wide in 1984, and the GPS has been initialised to that standard or a later one there should be no problem. But any earlier charts are likely to suffer from inaccuracies.

Another contributing factor in countries such as Australia, with its enormously long coastline and thousands of offshore islands, is that they have not been thoroughly charted until recently.

To back my claim that navigators are still needed, and GPS has to be combined with some other elements of navigational procedure, here is a simplified list of the factors that can degrade the GPS signal:

The atmosphere can be responsible for almost half the total error of a signal. There are charged particles in the atmosphere which can bend the signal. Because it has to travel further it takes more time. Also the bending is not constant.

Linked to the previous error is multipath error, which occurs when the signal arrives at the receiver from more than one direction. This is where local conditions such as tall buildings, peaks or mountain ranges can bend the signal.

Another significant cause of error is that the receiver does not get a good view of the sky, in other words it is not positioned carefully. If any part of the aerial is blocked from the sky, for instance if the GPS receiver is handheld awkwardly, or is lying down, it can't read all the available satellites and will not get a good signal. Therefore it should be placed so that it has an unblocked view of the sky.

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Satellite clocks, although remarkably accurate, can lose their rate, like any other timepiece. It is as bad for the time to be inaccurate as for the distance, since time and distance are so closely related in navigation.

Another source of degradation is ephemeris, which is basically variation of the height of the orbit of the satellite. If the satellite slows or speeds up it can lose or gain height, giving the wrong data about its orbit to the receiver. When this happens the scientists have to reposition the satellite, then recalculate the future position and update the satellite.

The way to get a more accurate position is well-known to most navigators – DGPS or differential GPS. In this case a land-based GPS station in a precisely known location sends another signal to the vessel with corrections to the errors listed above. The position improves out of sight. But there is a catch. The vessel has to have extra equipment, including DGPS aerial, aerial adapter and receiver. So there is the cost of purchase plus installation. The reward is a position accurate to the order of 3-5 metres (9-16 feet).

Now. What is WAAS? It stands for Wide Area Augmentation System and it provides the same sorts of correction to satellite data that DGPS does. But you don't have to have extra equipment. WAAS collects its information in the same way as DGPS does, from a network of fixed stations. The difference is that these stations are linked and give their information to a master station which sends the corrected information to a geostationary satellite, one which is orbiting at the precise height that cancels out the rotation of the Earth and therefore seems to be stationary in the sky. GPS receivers now exist which can receive the WAAS signal, which is more accurate than DGPS.

The bad news is that only the US has such a network of stations, although Europe is working on a similar project.

The above article is an extract from *The Boating Bible Manual of Seamanship - Navigation and Passage Planning*.

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