Limitations and Accuracy with GPS

Objective:
Students will learn about the problems that can affect the accuracy of GPS receivers.

Background:

In the beginning of civilian GPS receivers, the accuracy level was very low, 100 meters or more. This was due to the fact that the government had intentionally degraded the satellite signal. This was called Selective Availability (SA) and the reasoning was to protect our military and country. However, President Bill Clinton decided to have this turned off on May 1, 2000. However, it can be turned back on at anytime deemed necessary.

There are many other factors that affect the accuracy of GPS receivers. The atmosphere is one. As the radio signal passes through the ionosphere and troposphere, the water vapor and particles can slow a signal down, therefore affecting the time. Another error called signal multi-path is caused by the satellite signal reflecting off of buildings, rocks, water, trees, etc. Accuracy tends to be better in open areas where the likelihood of reflection is decreased.

Receiver clock errors can also cause decreased accuracy. This is because the clocks within a receiver are not as accurate as an atomic clock. The cost of atomic clocks is expensive but satellites are equipped with these. The number of satellites visible can also cause problems. The more satellites available or visible, the more accuracy increases. At all times there should be at least 3 satellites visible. Another variable is whether the satellites are bunched up or spread out. This is called satellite geometry and shading. The ideal positioning is when the satellites are spread out evenly.

The FAA and Coast Guard have developed programs to help increase the accuracy of GPS. Both are free to the public, but may require special equipment such as an antenna. **W**ide **A**rea **A**ugmentation **S**ystem or WAAS, was developed by the FAA to increase the accuracy of GPS. It consists of approximately 25 ground reference stations, two master stations located on either coast, and 2 geostationary satellites, designed to increase GPS accuracy in real-time. The surveyed ground reference stations collect GPS data, compare the calculated position with their known position, remove the error then send the corrected information to the master control stations to be uploaded to the WAAS satellites. The satellites then broadcast the corrected GPS signal. WAAS reached Full Operational Capacity on July 10, 2003. This is currently only available in North America, but other governments are developing this technology. Garmin claims with WAAS its receiver's accuracy is three meters or less, 95% of the time. Newer GPS units have this capability which can be turned off.

The Coast Guard developed Differential GPS or DGPS which is another correctional differential signal. It uses two receivers, a precisely surveyed reference station and a moving receiver (you). The stationary receiver works in reverse by using its location to determine the timing errors from the satellites. It figures what the time travel should be and compares it to what the satellite sends. It then sends out correction signal to the moving receiver. There are two control centers and 60 plus remote broadcast sites. It allows for one to three meter error typically but ten meter accuracy in all established coverage areas. It reached Full Operational Capacity on March 15, 1999. If this signal is being received, it will show up as D's on the satellite page.

For More Information:

www.navcen.uscg.gov/dgps/default.htm
http://gpsinformation.net
www.trimble.com
www.garmin.com

Limitations and Accuracy with GPS
Activity

Using Pan Map, find what cities and/or countries across the world are located at these locations:

1. N 45° 31.558’
   W 073° 33.867’ ______________________

2. S 37° 47.825’
   E 144° 57.382’ ______________________

3. N 35° 40.521’
   E 139° 46.166’ ______________________

4. N 55° 45.007’
   E 037° 34.971’ ______________________

5. N 51° 30.729’
   W 000° 03.873 ______________________

6. S 33° 55.547’
   E 018° 27.422’ ______________________

7. S 12° 03.038’
   W 077° 2.992 ______________________

8. S 23° 33.446’
   W 046° 34.922’ ______________________

Writing with GPS

You will need a large flat area to do this activity, like a football field. Make sure the GPS units are tracking.

Tell the students to visualize their name on the athletic field. Then have them write their name by walking the letter on the field.

Questions:
How successful were they?
What are some of the problems they experienced?
Did they have more success moving slow or fast?
What would they change if they did it again?
What other activities can this apply to? (Laying out corn mazes)

Answers to Limitations and Accuracy with GPS Activity

1. Montreal, Canada, North America
2. Melbourne, Australia
3. Tokyo, Japan, Asia
4. Moscow, Russia, Asia
5. London, England, Europe
6. Cape Town, South Africa, Africa
7. Lima, Peru, South America
8. Sao Paulo, Brazil, South America

Students may need to use Zoom buttons to find locations.