Global Positioning Systems (GPS)

- The term Global Positioning System is used generically to refer to any satellite system that determines the geographic position of objects on the earth.
- GPS is one of the two main “global positioning systems.”
  - GPS:
    - U.S. Department of Defense NAVSTAR (NAVigation Satellite Timing And Ranging) satellite system.
  - GLONASS is the Russian counterpart of GPS.
Space Segment
- First GPS satellites launched in 1978
- 24 satellites in 6 orbital planes; 20,200 km altitude
- Satellites orbit the earth every 12 hours
- Satellite constellation and orbits allow a GPS receiver to obtain signals from between 5 and 8 satellites from any point on the earth.

Control Segment
- Master Control Station at Falcon Air Force Base
- 5 Monitor Stations
- 3 ground antennas

User Segment
Consists of GPS receivers on or near the surface of the earth that convert the signals from GPS satellites into geographic position (X, Y, and Z) and time.
How GPS Works..

- GPS satellites emit high-frequency radio waves with a coded signal that travel at the speed of light (186,000 miles/second).
- GPS satellites also have superaccurate atomic clocks (accurate to within 0.000000003 seconds) that transmit the time the signal was sent (TS).
- GPS receivers contain quartz clocks that record the time the signal was received (TR).
- Distance of the GPS receiver from the GPS satellite is calculated as:
  \[ \text{Distance to the satellite} = (\text{TS} - \text{TR}) \times \text{speed of light} \]
- The signal from at least 3 satellites must reach the receiver to determine 2-dimensional position. This is done using a process known as triangulation (or trilateration).

Sources of GPS Errors

- Initialization: GPS receiver does not get enough time to warm up before the signal is recorded.
- Energy Waves from microwave and high power lines.
- Time of Day & Time Zone: Because a GPS receiver uses time to establish its position, the time of day and time zone are important.
- Type of Clock: GPS satellites use atomic clocks; GPS receivers use inexpensive and less accurate quartz clocks.
- Atmospheric Condition: GPS can operate under different types of weather conditions, but some loss in accuracy occurs under severe weather conditions.

Differential GPS
Map Projection

- A mathematical system of projecting the spheroid-shaped Earth onto a flat plane such as a paper map or computer screen.
- Allows the representation of the 3-D Earth on a 2-D (flat) surface.
- There are hundreds of map projections, each with their own unique properties.

Map Coordinate Systems

- An X,Y system used to reference the location of any point on the earth’s surface.
  1. Geographic (Spherical) Coordinate System (e.g., Latitude and Longitude with units in degrees).
  2. Planar Coordinate Systems (e.g., Universal Transverse Mercator (UTM) with units in meters).

Universal Transverse Mercator (UTM) Zones

http://mac.usgs.gov/mac/aboutpubs/factsheets/fs07701.html
http://www.maptools.com/UsingUTM/