# {06} The Global Positioning System

Map Interpretation & GPS
Spring 2010
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## What is it?

- G.P.S. = Global Positioning System
- Different from G.I.S. (Geographic Information Systems)

## History

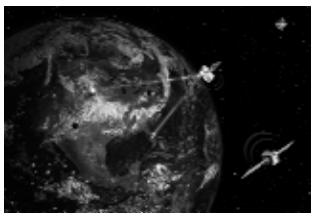
- Conceived by the Department of Defense in 1960 for missile targeting
  - Not fully operational until 1995
  - NAVSTAR
    - **Nav**igation **S**atellite **T**iming **a**nd **R**anging

## Other systems

- Non-US systems
  - EU, Russia, China

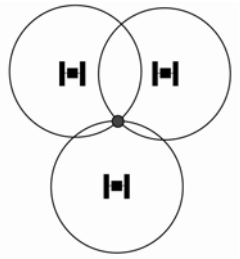
## How does it work?

- Constellation of 24 active satellites transmits radio signals
- The GPS receiver reads/interprets the signals



## Trilateration

- Uses trilateration to find position
- You need 3 satellites for horizontal location, 4 for vertical



## Satellite location

- Almanac data – contains approximate satellite locations
- Ephemeris data – table of corrected, exact, and predicted satellite locations
- Your GPS receives and uses this data to find satellites

## Distance & time

Distance = velocity of the radio wave • travel time of the wave

## Distance & time

- Coded signals are used for travel time
  - Satellites and GPS units generate the same code
  - GPS units adjust for the shift in the code (travel time)

## Finding your location

- Satellite's location & distance generates a sphere of potential location
- Multiple satellites generate multiple spheres
  - The intersection of the spheres gives your location

## Accuracy

- Many factors in accurately finding your position.
  - Not all GPS receivers are created equal!

## Access to the sky

- The most important factor – the sky
  - GPS only works if at least 3 satellites are 'visible'
  - Does not work inside, under dense tree canopies, in canyons, etc.
  - Difficult to use in dense urban areas

## Selective Availability

- SA introduced by DOD to make civilian receivers less accurate
  - Removed in May 2000
- ***Important to know that the government controls GPS.***
  - Other country's systems will effect this ability

## W.A.A.S.

- Wide Area Augmentation System
- Developed by FAA for airplanes
- Form of DGPS

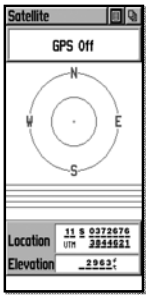
## D.O.P.

- Dilution of Precision (DOP)
  - Positional DOP (PDOP)
  - Horizontal DOP (HDOP)
  - Vertical DOP (VDOP)
  - Time DOP (TDOP)
- Measures quality of satellite geometry
- Higher number = less accurate

## Recreational units

- Garmin
- Magellan
- Brunton

## The constellation screen




## What they're good for

- Hiking, skiing, climbing, kayaking, etc.
- Anything where 15m (50ft) accuracy won't be a problem
  - Good to mark where you parked, get an idea of where you are on a trail, etc.

## What they're good for

- Can be used for fieldwork if you don't need survey-level accuracy
- Map vegetation, geology, wildlife, archaeological sites, fire
- Small-scale mapping

## What they can't do

- Can't get much better than 3m accuracy in the best of conditions
- Elevation data isn't reliable
  - Buy an altimeter if this is important

## Waypoints

- Marking a point in your GPS
- Make a waypoint at your car, at the summit, trailhead, etc.
- Pay attention to how many waypoints a receiver can hold
  - Do you plan on marking 1 or 2 or 10,000?

## Waypoints

- You can also enter coordinates from a map before you go out into the field
- Once in the field, you can see how close you are to a specific point (e.g. trailhead, summit, geocache, etc.)

## "GoTo"

- The "goto" function allows you to select a waypoint and the GPS will tell you how to get there.
  - Sends you in a straight line – Don't forget to look at where you're walking.

## Tracking

- The tracking function has your GPS record waypoints at a set interval to record where you've been (like breadcrumbs)

## What to buy

- Spend the extra money for WAAS
- Don't be fooled by color maps, walkie-talkie functions, etc.
- Buy a name brand
- Battery life is important
- Go to a store where you can try them out

## GPS maps

- Good for general navigation
- Might not be the best for your needs though
- Some receivers can now download National Geographic's TOPO! maps


## Older models

- Just because its last year's model doesn't mean it doesn't work
- Garmin 12 – brilliantly simple
- Always check reviews on these models though, and make sure they still work with newer computers…

## D.G.P.S.

- Differential GPS (DGPS)
- When accuracy is important
  - Of course it costs more…
- Corrects errors to achieve cm level accuracy

## How DGPS works

- 2 types of corrections
  - Real-time
  - Post-processing

## Real-time

- Uses a base station at a known point
  - Remember the benchmarks?
- Base station can be one you set up or a permanent station set up by the government
- Adjust for errors by comparing your location to that of known location

## Base station example


## Post-processing

- Back in the office
- Correction software analyzes each point taken by GPS, corrects according to known errors at that time
- Good for mapping, not navigation

## Remember

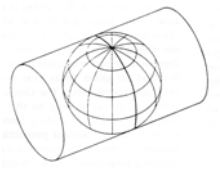
- You should never solely rely on GPS if heading out into the wilderness…
  - Always bring a map and compass too
  - Maps can be wrong, GPS batteries can die

## Universal Transverse Mercator

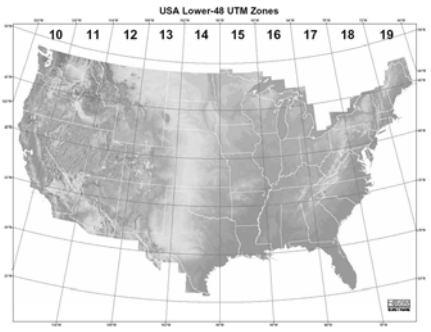
- UTM for short
- A projection and coordinate system
- Used along with Universal Polar Stereographic (UPS) system
- 60 zones that are 6° wide
- Civilian and military versions

## UTM - The projection

- The cylinder is moved so that the central parallel for each UTM zone coincides with the line of tangency

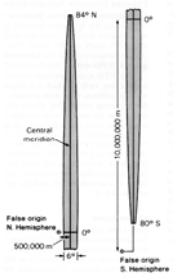


## UTM Zones



## How it works

- False origin established 500,000m meters west of zone's central meridian and at the Equator (for Northern Hemisphere)
- Coordinates presented in positive "Easting and Northing"




## More tools

## Military UTM

- For whatever reason, supposed to be better for military use
- UTM broken into smaller grids