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Introduction to GPS/GIS

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Course Overview

I. Introduction to GPS
- Principles of GPS
- Mapping Theory
- GPS Hardware

II. Introduction to Solo Forest
- Collecting Field Data
- Office Procedures

III. Advanced GPS Concepts

IV. fGIS

V. ArcGIS

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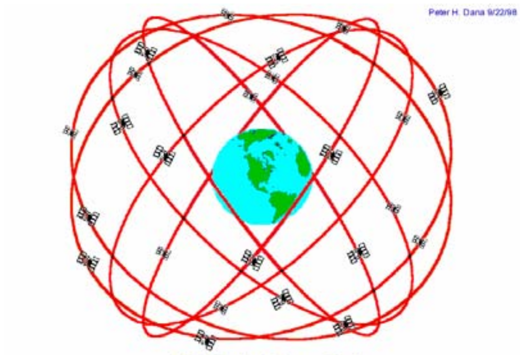
I. Introduction to GPS

GPS Satellite Constellation



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Overview of GPS

- Funded and controlled by U.S. DOD
- Provides specially coded radio signals that can be processed in a GPS receiver.
  - position
  - velocity
  - time
- All depends on highly accurate timing

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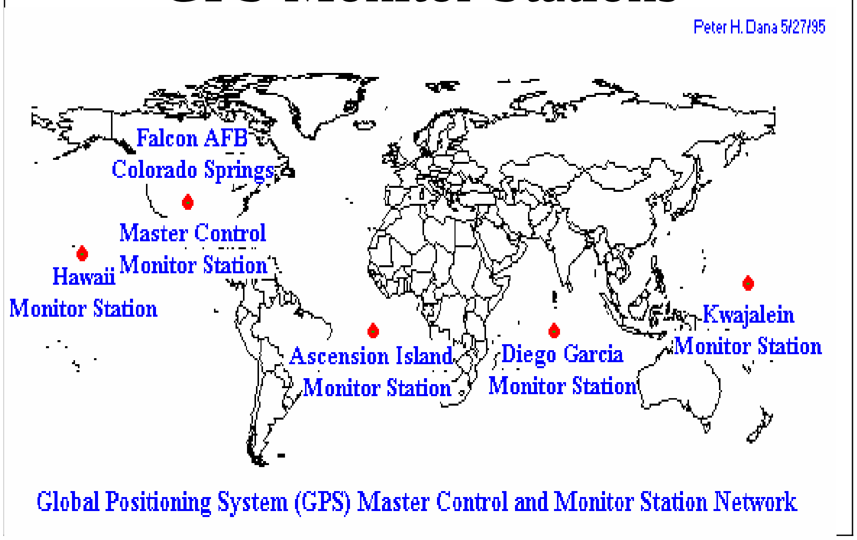
GPS Monitor Stations



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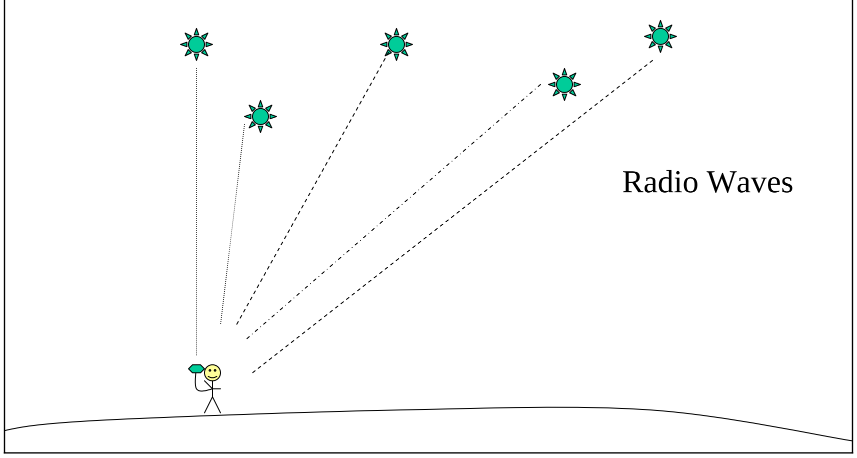
How Signals are Sent/Received



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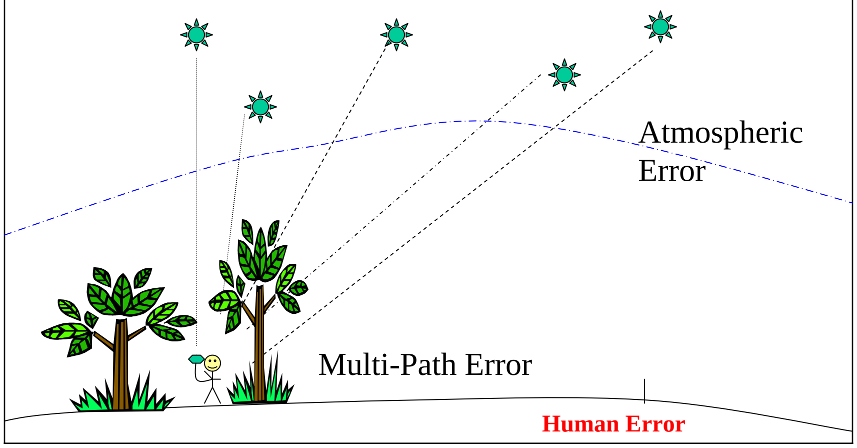
What Affects a GPS Signal



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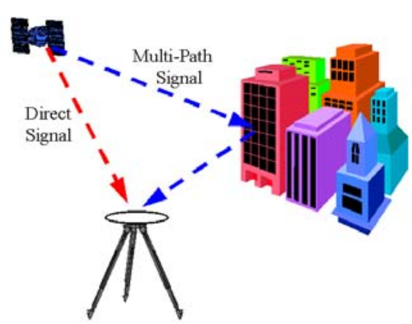
What is multi-path?

Multi-path occurs when signals are reflected off of objects such as trees or buildings. These reflections delay the signal before it reaches the antenna and throw off the range calculations. Since accurate timing is necessary for accurate positioning, this can cause significant error. Multi-path is the greatest source of error in forestry settings and the most difficult to combat.



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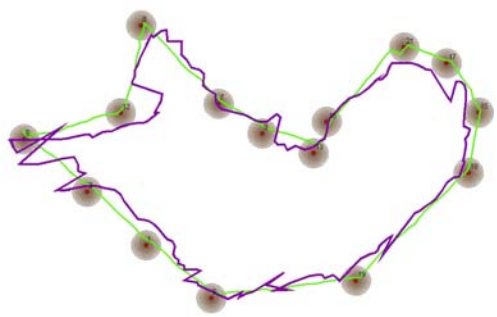
Dynamic Multi-path Errors



Note the jagged data created caused by Multi-path errors.

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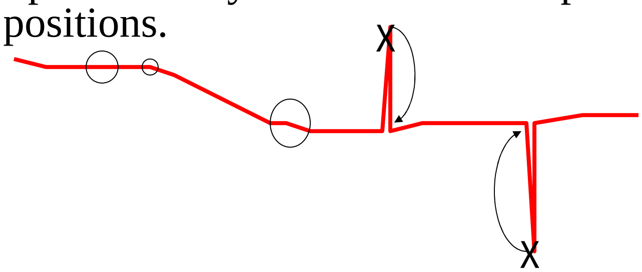
Multi-path Filtering for Dynamic Lines

The Kalman Filter (Velocity Filter) is an inertial filter that monitors direction and speed and detects and corrects erroneous data due to multi-path error by a continuous comparison to past positions.



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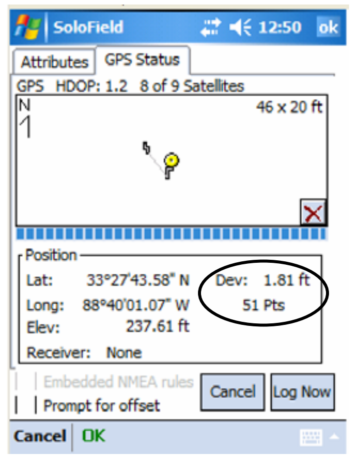
Static Point Multipath Errors

Multipath errors can affect static point data as well as dynamic data. When collecting static point data in SoloFieldCE, you will see a screen like this one that actually shows a visualization of the GPS points in relation to the antenna. Solo will constantly average the static points together and supply an estimated deviation of the current point location compared to the previous total average at 1 standard deviation. **Most of the time we recommend collection at least 30 points with a Deviation of less that 5 feet.**



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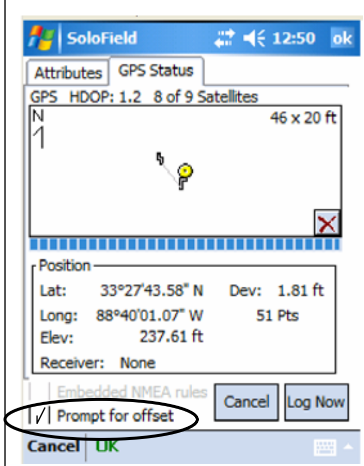
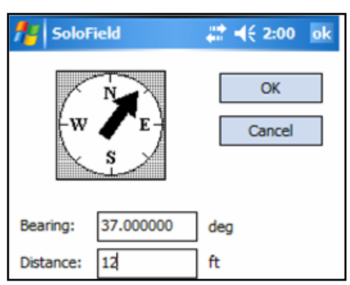
Static Point Multipath Errors



If multipath conditions are precluding you from collecting an acceptable static point, you can use the **Prompt for offset** tool to actually collect the static point in a location that is not being adversely affected by multipath.



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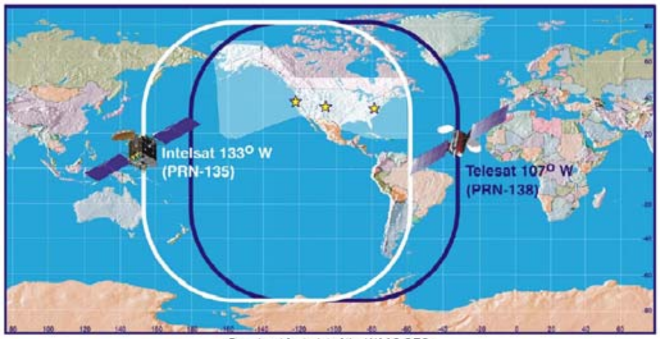
WAAS Differential

Correction for Atmospheric Errors



New WAAS coverage as of Summer 2007.

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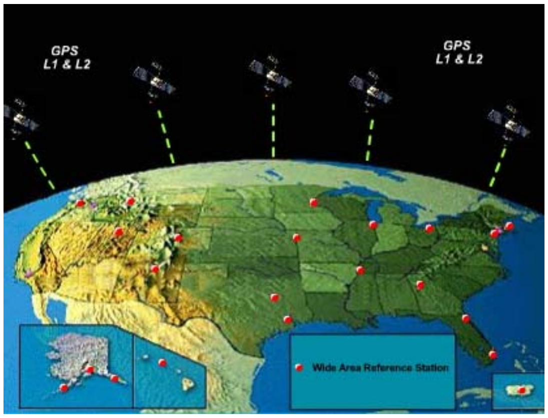
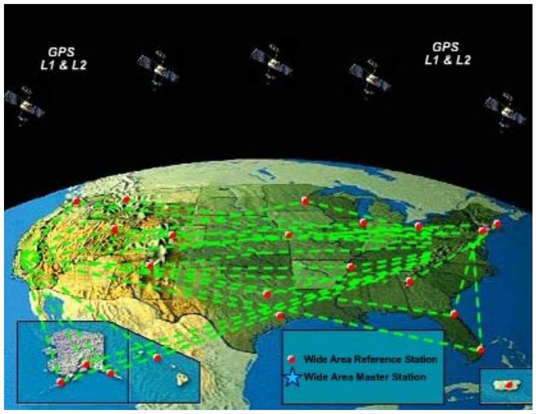
WAAS Differential

Step #1 – Reference stations receive GPS signals and calculate error



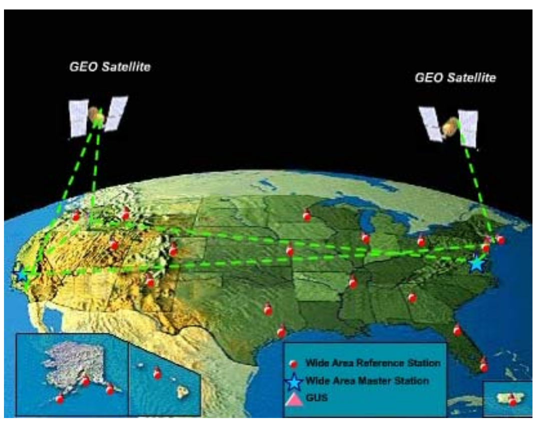
WAAS Differential

Step #2 – Reference stations create interpolated error map



WAAS Differential

Step #3 – Master stations upload error map to WAAS satellites



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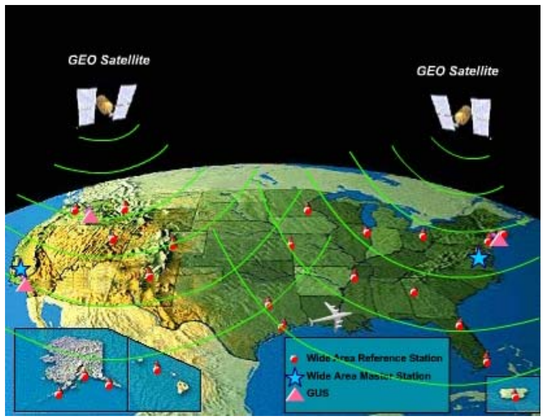
WAAS Differential

Step #4 – WAAS satellites broadcast corrections



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WAAS Differential

Long-term WAAS

If you have been tracking the WAAS differential correction signal and then you lose that signal, our GPS units will continue to differentially correct your GPS data with a long-term estimated WAAS correction. The length of time that various GPS units will utilize long-term WAAS corrections depends upon the Age of Data setting that is built into the antenna. Here are the Age of Data settings our GPS units:

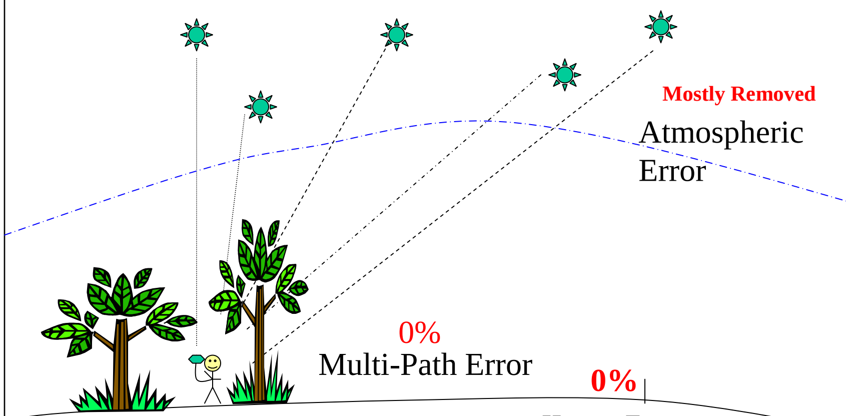
Garmin – up to 20 minutes

Hemisphere – up to 40 minutes

Trimble – up to 4 minutes

With the Garmin and Hemisphere systems that we sell, normally you will regain the WAAS correction signal within 1-2 minutes of losing it.

Which Error can Be Removed and How Much



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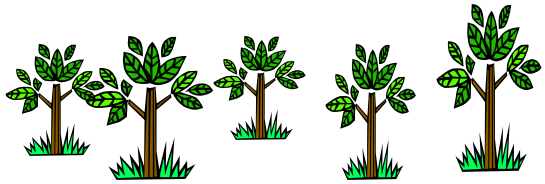
With all of this error, what can we expect?

In an open field (no multi-path), stated accuracies



Under canopy, **double** the stated accuracies

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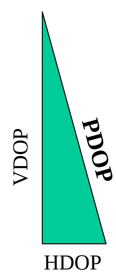
How Error is Measured: DOP (Dilution of Precision)



•The geometry of the satellite constellation can affect the accuracy of the GPS positions.

•DOP is an indicator of quality of the constellation at any given time.

•Lower the DOP, the better the geometry of the constellation and the more accurate the GPS positions.

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Mapping Theory

- Static Data vs. Dynamic Data
- Different Feature Types
- Definition of Feature File
- Planning the Mapping Project
- Working with Map Projections

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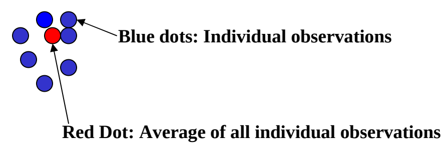
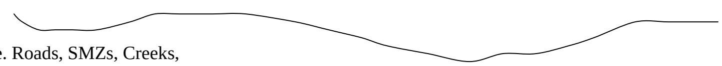
Static Data vs. Dynamic Data

Static Features: the process of averaging GPS positions taken successively over a period of time with a stationary antenna to increase accuracy.

i.e. Property Corners, Stand Points, Log Decks, Gates, etc.



Dynamic Features: the process of collecting GPS data while the GPS antenna is in motion. Often associated with Line or Area Features.



i.e. Roads, SMZs, Creeks, Meandering Property Lines, etc.

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The 3 Different Feature Types

Point: Always a Static feature

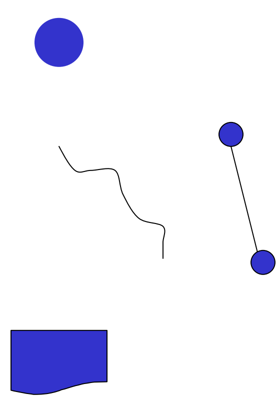
i.e. Property Corners, Stand Points, Log Decks, Gates, etc.

Line: Can be Static, Dynamic, or Both

i.e. Roads, SMZs, Creeks, etc.

Area: Can Be Static, Dynamic, or Both

i.e. Stands, Tracts, Fields, etc.



Definition of Feature Files

Feature: the object which is being mapped with a GPS system. Features may be points, lines or areas. In this example the feature will be a line that we will name **Road.**

Attribute: a characteristic which describes a Feature. Attributes can be thought of as questions which are asked about the Feature, i.e. **Type, Number, Condition, Name.**

Value: descriptive information about a Feature. Values can be thought of as the answers to the questions posed by Attributes, i.e. **Dirt, Rd. # 322, Fair, Johnson Rd.,** respectively.

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Importance of Feature Files

Why Describe the Features Being Collected?

- Feature Files are the Beginning of a GIS Database
- Allows the Forester to Make Better Decisions
- Easily Produce Professional Maps Very Quickly
- Easier to Manage Large Amounts of Data

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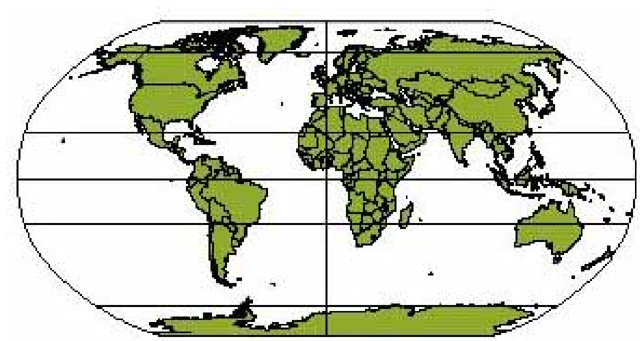
Working with Map Projections



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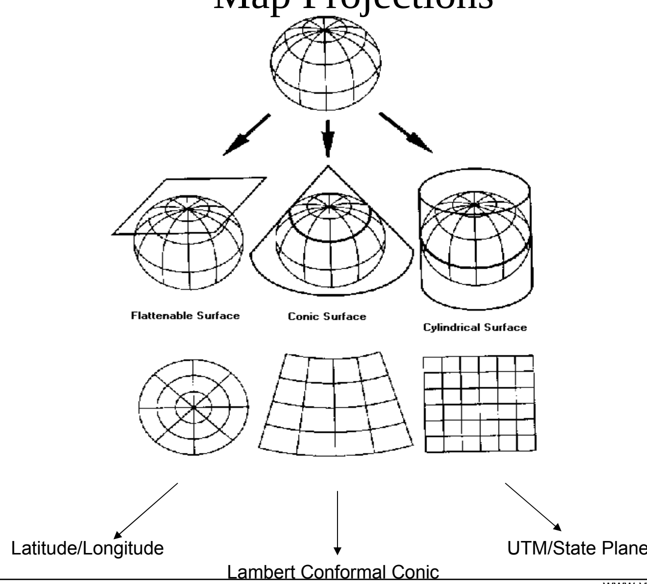
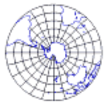
Map Projections



www.vterrain.org/projections/

What are Map Projections?

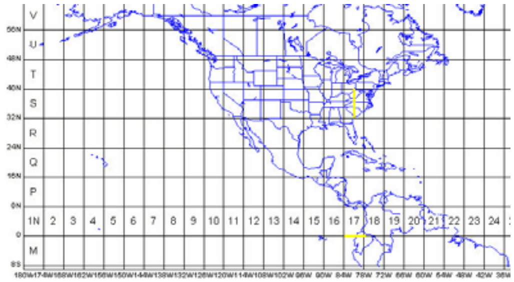


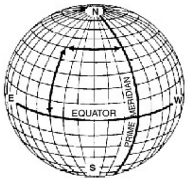
A map projection is simply a way of representing the 3D surface of the Earth onto a 2D map. Often the Earth's surface, which is an ellipsoid, is reprojected onto another surface such as a plane so that distance and azimuth computations are much simpler. As a result, all map projections have some distortion that has to be corrected. SoloField requires the user to choose between a U.S.-based National Geodetic System (NGS) or an International System.

What are Coordinate Systems?

A coordinate system is simply a means for identifying a point on the earth on a 2 dimensional map. The coordinate system is typically defined using an x- and y-ordinate or northing and easting.

The most commonly used are UTM and State Plane Coordinates. Latitude and longitude are actually a special kind of coordinate system, using spherical coordinates.





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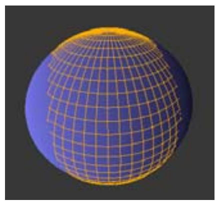
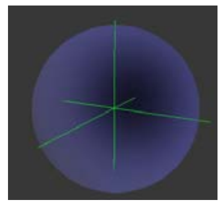
What are Datums?

A datum defines an ellipsoid (a three-dimensional ellipse), which is the currently accepted `best fit' for the overall shape of the Earth. When an ellipsoid is fixed at a particular orientation and position with respect to the Earth, it constitutes a so-called `Geodetic Datum'. In other words, a datum describes the model (including the size and shape of the earth as well as the origin and orientation of the coordinate system) that was used to match the location of features on the ground to coordinates and locations on the map.





WGS 84, NAD27, and NAD83 are examples of Horizontal Datum.
NAV88 is an example of Vertical Datum.

http://exchange.manifold.net/manifold/manuals/5_userman/mfd50The_Earth_as_an_Ellipsoid.htm

http://ludwig.missouri.edu/137/datum/datumppshow/index.htm

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What are Zones?

Because coordinate systems were designed for detailed calculations and positioning, they are usually divided into different zones to preserve accuracy. The boundaries of UTM zones follow lines of latitude and longitude while State Plane zones generally follow political boundaries.

www.vterrain.org/projections/

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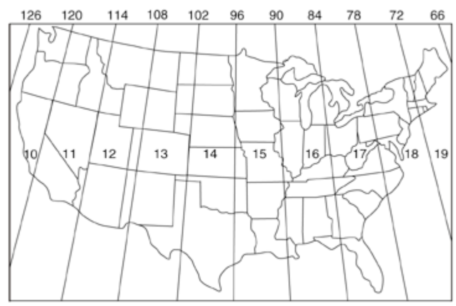
UTM Zones

The Earth is divided into 60 UTM Zones following lines of Longitude. The continental US is covered by Zones 10 – 19 with each zone representing 6 degrees of longitude.



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State Plane Zones

Generally, the boundaries between state plane zones follow county lines. Depending on its size each state is represented by anywhere from one to ten zones.

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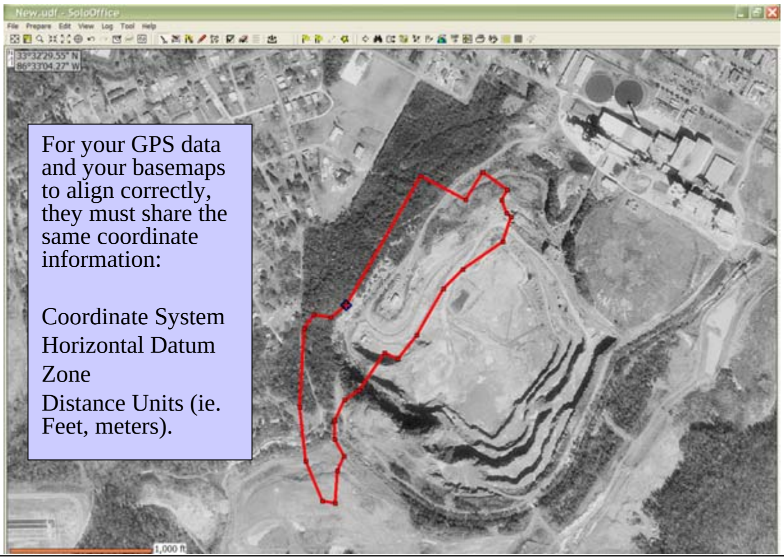
Why is All of This Stuff Important to Me?



For your GPS data and your basemaps to align correctly, they must share the same coordinate information:

Coordinate System
Horizontal Datum
Zone
Distance Units (ie. Feet, meters).

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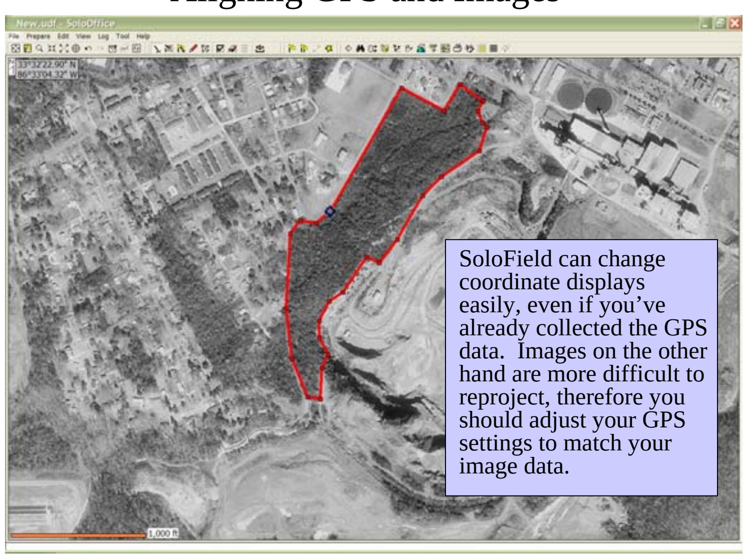
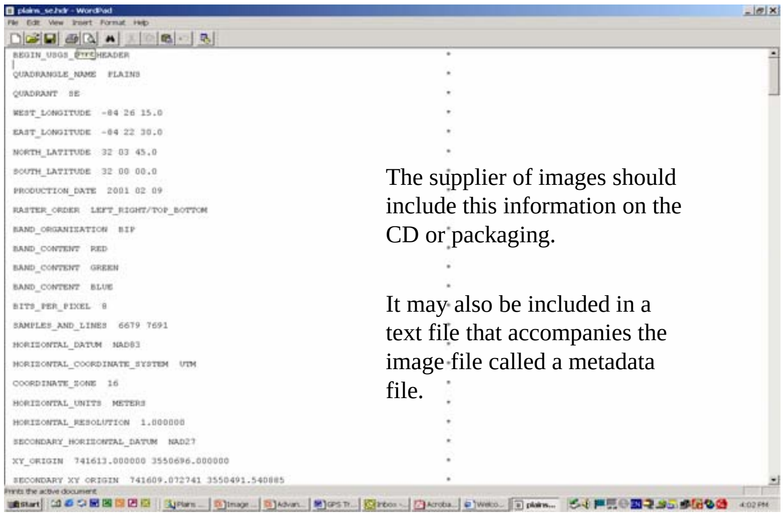
Aligning GPS and Images



SoloField can change coordinate displays easily, even if you've already collected the GPS data. Images on the other hand are more difficult to reproject, therefore you should adjust your GPS settings to match your image data.

Where Do I Find This Coordinate Information?


plains_se.hdr - WordPad

BEGIN_USGS_BYTEHEADER
QUADRANGLE_NAME PLAINS
QUADRANT SE
WEST_LONGITUDE -84 26 15.0
EAST_LONGITUDE -84 22 30.0
NORTH_LATITUDE 32 03 45.0
SOUTH_LATITUDE 32 00 00.0
PRODUCTION_DATE 2001 02 09
RASTER_ORDER LEFT_RIGHT/TOP_BOTTOM
BAND_ORGANIZATION BIP
BAND_CONTENT RED
BAND_CONTENT GREEN
BAND_CONTENT BLUE
BITS_PER_PIXEL 8
SAMPLES_AND_LINES 6679 7691
HORIZONTAL_DATUM NAD83
HORIZONTAL_COORDINATE_SYSTEM UTM
COORDINATE_ZONE 16
HORIZONTAL_UNITS METERS
HORIZONTAL_RESOLUTION 1.000000
SECONDARY_HORIZONTAL_DATUM NAD27
XY_ORIGIN 741613.000000 3550696.000000
SECONDARY XY ORIGIN 741609.072741 3550491.540885

The supplier of images should include this information on the CD or packaging.

It may also be included in a text file that accompanies the image file called a metadata file.

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GPS Hardware

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TDS Recon

- Windows Mobile 5.0 or 6.0 OS
- 400 MHz Processor
- 256 MB Non-volatile Flash Memory
- 64 MB High speed SDRAM
- 2 Slots for additional CF memory cards
- Color TFT Display
- Fully Rugged and Water Resistant
- 15 hour NiMH battery
- Optional Deluxe Carrying case
- Optional AA rechargeable battery pack
- Optional Built-in Bluetooth or WiFi

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TDS Nomad

- Windows Mobile 6.0 OS
- 800 MHz Processor
- 512 to 1 GB MB Non-volatile Flash Memory
- 128 MB DDR SDRAM
- 2 Slots for additional CF memory cards
- Full VGA Color Display
- Fully Rugged and Water Submersible
- 15 hour Li-ion battery
- Optional Deluxe Carrying case
- Optional AA rechargeable battery pack
- Built-in Bluetooth
- Numeric or PDA keypad
- USB host and client
- Optional WiFi, Laser Scanner, built-in GPS, 2 megapixel camera

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TDS Ranger

- Pocket PC 2003 or Windows Mobile 5.0 OS
- 312 or 520 MHz Processor
- 64/128 MB Non-volatile Flash Memory
- 256/512 MB Flash Data Storage
- 2 Slots for additional CF memory cards
- 1 SD Card Slot
- Color TFT Display
- Fully Rugged and Water Resistant
- 30 hour Li-ion battery
- 4.5 Hrs to charge (2 hrs to 80%)
- Optional Built-in Bluetooth and WiFi

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Battery and Charging Info

- **Recon** and **Nomad** have 15 hour life
- **Ranger** has 30 hour life
- **Recon** requires 12 hours for Full Charge from Zero
- **Nomad** and **Ranger** require 4.5 hrs needed for full charge

- Batteries to not build up a “memory”.
- Do Not have to run battery completely dead before re-charging, but good to exercise battery.
- Power Status is displayed by tapping on-screen battery meter or by selecting Settings > System > Power

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Pocket PC 2003 Versus Windows Mobile

The biggest difference between Pocket PC 2003 and Windows Mobile has to do with persistent memory. Pocket PC 2003 has 2 separate data storage locations. One is where the operating system and default programs are installed and the second is a separate non-volatile persistent storage location called Built-in Storage. This location is not tied to power and so if your battery fails or you lock your handheld up, you do not lose anything on the Built-in Storage. That is why we install SoloField and TCruise and save all of the data in this location. Windows Mobile, however, combines the 2 separate locations into one persistent storage location. All of the programs and data can now be stored in the regular data storage location. Here is the how the file structure differs between the 2 operating systems.

Pocket PC 2003 – Built-in Storage\My Documents\Solo

Windows Mobile – My Documents\Solo

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Pocket PC/Windows Mobile Basics

- Start Menu, Programs list or Hot Buttons to access programs
- Input Panel using Stylus Pen
  - On-screen keyboard
  - Single tap = left mouse click
  - Tap & hold = right click
- Settings = Control Panel
- File Explorer – Pocket PC version of Windows Explorer
- Reset = Reboot
- Can run multiple programs at once.
- Embedded Windows Pocket Programs
  - Pocket Excel, Pocket Word, Pocket Internet Explorer
  - Many others available (www.handango.com is a great source of other 3rd party programs!!!!)
- Windows Task Manager = Start > Settings > System Tab > Memory > Running Programs Tab

Resets

When you turn the unit On/Off it suspends all running programs, it does not really shutdown and then reboot. The most common problem you will experience with any Windows device is a lockup or "screen freeze" when the screen stops responding. You should handle this with a reset. There are two types of resets; soft and hard.

Soft Reset - A soft reset (also called a "warm boot") is similar to restarting a desktop PC. It restarts the operating system and recovers system resources. Soft resets are the best method of dealing with lockups. To soft reset the Recon you should hold down the On/Off button for 5 seconds and the unit will restart automatically.

Hard Reset - A hard reset completely clears the contents of RAM (the flash disk storage is not affected), and resets the hardware interrupts for components such as the I/O ports, the keyboard and the touch screen. After a hard reset the touchscreen will need to be recalibrated. Hard resets should only be performed if a soft reset doesn't work. To hard reset hold the power button and application button 1 down for 8-10 seconds and release both buttons after a double beep.

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Resets & Backups

Q. How can I prevent lockups?

A. Avoid rapid-fire data entry, don't be impatient and continue to tap the screen or input data while the unit is processing (when you see the hourglass). Reset the unit often.

Q. How often should I reset my unit?

A. Reset every day before you collect data. You wouldn't go a month without restarting your PC, would you?

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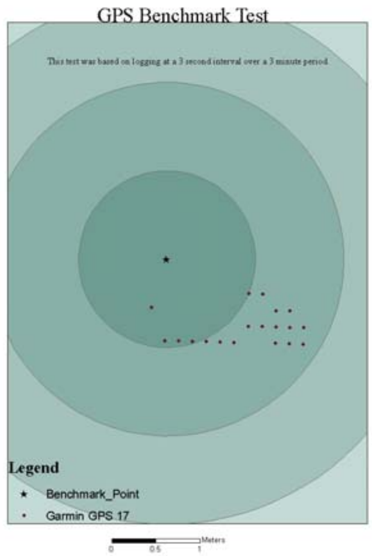

Garmin 17 HVS

Typical Results = 1-2 Meters with WAAS

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Li-Ion GPS Battery Configuration

The unit requires no pouch or external charger and powers the GPS 17 for over 24 hrs.

This unit will charge completely in 3 hrs. if completely dead. The battery level indicators are on top of the unit.

Optional items are the auto power adapter.