USING THE TRIMBLE GEOEXPLORERS FOR SUB-METER ACCURACY

To acquire and process data for sub-meter accuracy, you need to go through the following steps.

- Configure Amelia and/or Sir John to acquire high-accuracy, carrier phase data.

- Record your data, at positions of interest, in GeoExplorer files.

- Download your data from the GPS unit. This has to be done on a computer sporting Trimble's annoying security dongle and Trimble's **PathFinder Office** software.

  LAB RULE: Once equipment is back in the lab, anybody can delete your files - **Download when you return.**

- Download high accuracy data from the Missoula County GPS Base Station The Missoula data are posted the day after they are acquired, you cannot immediately process your GPS data. The US Forest Service posts their base station data on the web but as of 12/97 their elevation was different than the county's and the county's provided differentially corrected positions closer to benchmark values.

- Use Trimble's software to combine multiple base-station files. Usually you will have several such files after a day in the field because the data are posted in two hour blocks.

- Use Trimble's **Phase Processor** software to make differential corrections to your high-accuracy, carrier-phase data. This software also calculates and saves statistics from your differentially corrected points. After you select your combined base station file you must correct the base station location, an older location is recorded in the file headers. The true location of the county base station, in NAD83, coordinates is:

  Latitude: 46^{o} 52' 32.12519" N Longitude: -113^{o} 59' 43.99883"
  Orthometric Height: 989.05292 Ellipsoidal Height: 974.1878.

The following pages describe each of these steps.

CONFIGURING A GEOEXPLORER FOR SUB-METER ACCURACY

Turn on Amelia or Sir John, scroll in the **Main Menu** and select:

Configuration, then **Rover Options** and set these (others are sub-critical and/or obvious):

Pos Mode = 3D **Elev Mask** = 15° **SNR Mask** = 6 **Velocity** = OFF
PDOP Mask = 6 **Log DOPs** = off **Dynamics** = land **Not in Feature, Rate** = 15s
Antenna Ht = height of receiver above station (add 0.1 m for holder)
Set **High Accuracy Recording =** on; in that sub-menu set:
Min Time = 10m **Log Rate** = 15s **Pt Feats** = off

ESC to return to **Base Options** and then set **Coordinates**, **Datum** and **Units** as desired and hit **ESC** again to return to the **Main Menu** and select:

Data Capture

Get a clear view of the sky. Buildings, heavy tree cover, people and cliffs block satellite signals and, along with water, reflect satellite signals. For high-accuracy data you must be particularly careful to get good observations and minimal multipath reflections.

To begin recording data, select **Open Rover File**. The GeoExplorer now asks if you want to proceed, respond appropriately. Now the GeoExplorer records satellite data until you select **Close File**. Open a new file for the next position. Note that Amelia or Sir John will automatically and logically name files for you; I set them so that rover files will start with "R". Under the **Main Menu**, **GPS Status** has several options that provide information about the satellites and positions you are collecting. Each file will eventually be collapsed into one differentially corrected point by **Phase Processor**. If you want multiple observations at a point, collect multiple files.

Back in the lab, use **PathFinder Office** and Data Transfer, as described below, to download your data for post processing and differential corrections.

DOWNLOADING DATA FROM THE GEOEXPLORER

PathFinder Office is the software that handles data transfer, plotting, and some manipulations. You'll need the computer in my lab that has Trimble's annoying dongle security device attached to the parallel port and Trimble's serial cable that attaches to a GeoExplorer.

< Before you start the computer, carefully plug the GeoExplorer serial cable into the GeoExplorer; the cable should already be attached to the computer. Start the computer and the GeoExplorer.

< Select **Data Transfer** from the GeoExplorer's **Main Menu**.

< Start **PathFinder Office,** the "Select Project" window should popup; if it doesn't you access it under the File Menu. Hit "NEW" to make a project directory that includes your name or initials; it must be under the DATA Directory (e.g. *C:\PFINDER\DATA\SDS_MSO*).

< In **PathFinder Office**, under the **Utilities Menu**, work through these steps:
Data Transfer/Connect
Select the desired files by clicking on the filename, then click **ADD**
Click the **Transfer** button; all goes smoothly and easily if everything is hooked up correctly.
Click **Disconnect** & **Close**; you'll need base-station data and Phase Processor for sub-meter results.

DOWNLOADING MISSOULA COUNTY'S COMMUNITY BASE STATION GPS DATA

The county surveyor maintains a 12-channel Trimble Community Base Station. Each day they post the previous day's data, recorded at five second intervals, in two hour blocks. The files are labeled with the month, day and Greenwich Mean Time. You need an MS/DOS-Windows computer with a modem and communication software to access the County BBS. The County system is platform (MS/DOS) dependent because the files are compressed using an MS/DOS program. The BBS has a 28k baud modem which will sync with anything slower as well. Steve Niday, Missoula County GPS Surveyor, reports the true location of the county base station (which is different than in the files headers) in NAD83 coordinates as:

Latitude: 46° 52' 32.12519" N	Longitude: -113° 59' 43.99883"
Orthometric Height: 989.05292	Ellipsoidal Height: 974.1878.

To get the Trimble base station files:

Dial into 523-4897 at 28k baud or slower.

Login with your name and password, if you haven't done so before you'll have to answer a few questions to get started. If your communication software support Z-modem for a transfer protocol, use it. The next step is to get to the **Files Menu**.

Use the ENTER key to get past the messages from the County's lawyer (read 'em carefully).
Use the ENTER key to skip past the **Bulletin Menu** and continue to:

Main Menu then select option **F** to go to:

Files Menu where you select each of the following:

- **N** to list **N**ew files
- **D** to choose how many days of old files you want to look through
- **81** because that's the file number of Community Base Station Files. The BBS will now scan all the files and list those new base station files within the days you chose.
- **M** asks for the files numbers that you want to download; **answer 1-3, or 4**, etc.
- **D** to advance to downloading the selected files after marking the ones you need.
- **G** begins the download and automatically logs you off the BBS when the files are all transferred. Note that since the files are in two hour blocks you will need to download several files for one days work in the field. Each two hour block of base station data is about 250 Kbytes compressed. Thus they take around 15 minutes each at 2400 baud or only a couple minutes at 14,400 baud.

Now you have multiple base station files that you can use with **Phase Processor**, the carrier-phase differential correction software for our Trimble GeoExplorers or with the **PathFinder Office** software. When you download the files into your project directory, they will have a *.EXE* file extension; they are self-expanding executable files. Double-click these *.EXE* files in Windows Explorer and they will uncompress into base station files with a *.SSF* file extension, the same as your rover files. PathFinder Office requires the *.SSF* extension.

Combine Multiple Base-Station Files: You must combine multiple base station files into a single file before you can proceed with differential corrections of any sort. **PathFinder Office**, under the **Utilities/Combine sub-Menu**, provides a point and click interface to combining your base station files; always use names that identify you and work in your own project directory.

Now proceed to using the **Phase Processor** for carrier-phase differential corrections.

POST-PROCESSING GPS DATA FOR SUB-METER ACCURACY
with PathFinder Office and Phase Processor

Assuming you have downloaded your high-accuracy rover files and downloaded/combined your community base-station files, you are ready to post-process your carrier phase data.

Select the Pfinder Group, start **Phase Processor,** click your way to the appropriate *project subdirectory.*

Select your base file (e.g. *combined.ssf*).

Fix the base station coordinates, for the Missoula County's Base Station in NAD83 coordinates:

Latitude: 46° 52' 32.12519" N	Longitude: -113° 59' 43.99883"
Orthometric Height: 989.05292	Ellipsoidal Height: 974.1878.

Select the rover files (*.SSF) that you want to correct

Phase Processor crunches away for a bit then shows you a "**Solution Summary**". In the Solution Summary you can double-click any line for additional details.

Click "Save As" to save the Solution Summary; make sure you click the "detailed summaries" box. Your solutions should be in the <50 cm range or better.

Phase Processor asks if you want to update the point feature in the file: you do, click "yes to all". The only time you might click "no" is if you had several points in a file and knocked over the tripod during one of them (see the manual).

Closing **Phase Processor** saves your differentially corrected, carrier-phase data, in a file named: *your_name*.**PHS**. *.**PHS** files are the same format as *.**SSF** files. Thus *.**PHS** files can be manipulated (averaged, graphed, saved to ASCII, have statistics calculated) just like *.**SSF** files by using **PathFinder Office**.

Results: Using this procedure, on February 8th, 1996, I collected about 2.5 hours of high accuracy data on the center (just south of the apex) of the western galvanized steel "pedestal" on the roof of the Science Complex. After **Phase Processor** finished, the result was:

Latitude = 46°,51',28.9066"N	Longitude = 113°,59',03.9368"W
Baseline = 2128.826 meters	HAE = 984.895 meters
Expected accuracy = <0.3 m	Altitude = 1002.301 meters

Multiple observations within a few kilometers of the base station indicate we can get spherical standard deviations, from a number of 10-minute observations, as good as 10 cm. Casey Evan's gravity/GPS work in the central Missoula Valley includes a large number of GPS observations that indicate we can regularly got 30 cm standard deviations.

Recommendations:

Plot your data: In PathFinder Office, select your project name (under *C:\PFINDER\DATA\yr_proj*), in the File Menu, highlight and OPEN your .SSF and .PHS files, and click OK. Next select VIEW/MAP, then VIEW/MAP/LAYERS-FEATURES and double-click on "point_generic" so that "SHOW" is available (not grayed out). Now you should have a map of your not-corrected (*.SSF) points and corrected (*.PHS) points.

Occupy benchmarks, re-occupy some base stations: It is up to you to determine the accuracy and precision of your GPS observations. Multiple observations will let you determine confidence parameters.