GEOL4733

Applications of GPS Geodesy in Geosciences

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Laboratory Exercise 5 – GIPSY-OASISII Processing

In this laboratory, you will learn how to process data using **GIPSY-OASISII** (GIPSY: **G**PS **I**nferred **P**ositioning **SY**stem-OASIS: **O**rbit **A**nalysis and **SI**mulation **S**oftware). This software is very complex and requires significant use over a long time to master. Our goal is only to gain some basic level of familiarity with the GOA environment, the required input files, and its output. The software was developed by engineers at NASA's Jet Propulsion Laboratory with some additional contributions academic scientists. Nearly all the individual software modules within GOA are documented online. The software is composed of binary executable code (both ANSI C and Fortran 77/90), c-shell, and bourne-shell scripts. The latter may be modified by the end-user, if necessary, but the former cannot.

GOA currently runs only under UNIX (HP or Solaris) or LINUX (i86) operating systems. Currently, the UARK Geodesy Lab is running GOA release 2.6, update 1 under Solaris 8 (patch level 10/02) on Sun Microsystems UltraSPARC10 and UltraSPARC60.

There are numerous papers and references available outlining the theory, use, and application of GOA. Two major sources are by far the most important, however, and copies of both are available in the Geodesy Laboratory (Ozark Hall 27A/B).

Webb, F.H., Zumberge, J.F., 1995, An Introduction to GIPSY-OASIS II, Jet Propulsion Laboratory User Manual, JPL Technical Document D-11088, California Institute of Technology.

Gregorius, T., 1996, GIPSY-OASISII: How it works, Dept. of Geomatics, Univ. of Newcastle upon Tyne, U.K. (self-published).

These resources are not to be removed from the lab under any circumstances.

Class Notes from the JPL GIPSY-OASISII class attended by Dr. Mattioli in 1997 are also available and were the basis for the presentation in class, with contributions from various authors including: Y. Bar-Sever, M. Heflin, K. Hurst, and F. Webb. Copies of these were provided to you during our previous lectures on GOA. You should refer to the document called "xt-gipsy: A Graphical User and Command Line Interface for Processing GPS data with GIPSY-OASISII" by Ken Hurst, which was given to you in class. Please read this carefully prior to starting this lab.

Task 1 – Connecting to the UARK GOA server using SSH

In order to use GOA, you must have either network or direct access to the server on which the software resides. This requires a userid and password. All communication with the server, if you are not directly logged onto to the console, must be through a secure communications channel using SSH-2 (secure shell – protocol version 2) in which all network packets are encrypted during transport.

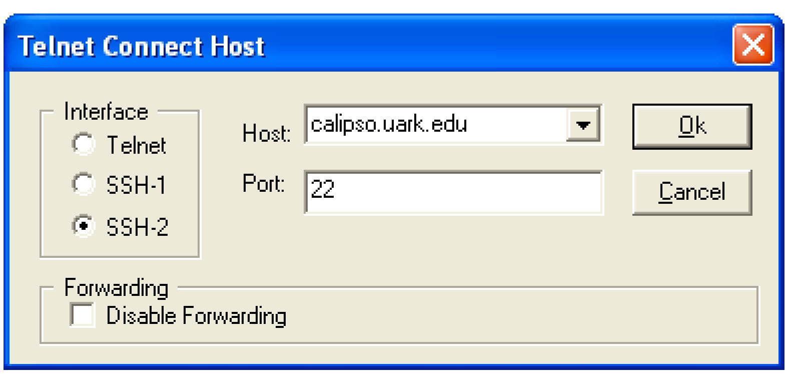
Server: calipso.uark.edu
Userid: geodesy
Password: !foobar

GOA may be used either through a command line interface where one simply types individual commands at the prompt or by using a graphical user interface developed by Ken Hurst at JPL called xt-gipsy, which is based on the X-windows system protocols. As this will be our first use of GOA we will use xt-gipsy.

In order for use to proceed, we need to first initiate an X-windows session on our PC. Mac, or UNIX/LINUX workstation. Simply logging on to the LINUX workstation or the Sun UltraSPARC10 will initiate the X-windows server, but if you are attempting to connect to "calipso" from a PC or Mac or need to run additional software, as follows:

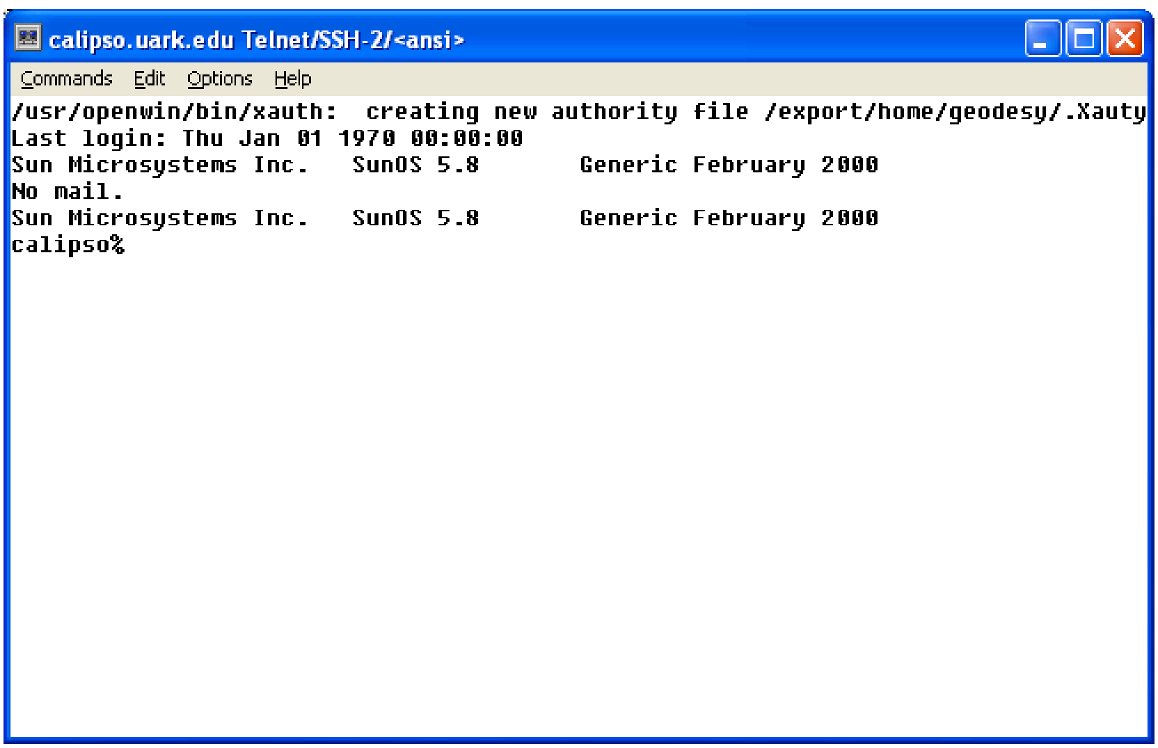
On a Windows XP machine, start Xsession from main windows "start" menu.

The Xsession program, once started, will automatically minimize itself. You must right click on the X-Session program and select "Run -> Telnet." This will bring up the window below:



Select "SSH-2" and enter the server name, as shown above and then click "OK." This will cause the following screen to be presented. Make sure you do not select "Disable Forwarding," otherwise the graphical commands from the server will not be displayed locally. Enter the USERID and PASSWD information from above and again click "OK."

Now you are logged onto "calipso" through a secure network tunnel that will allow the x-windows packets to be forwarded automatically to your local PC. You see something like this when you log in:

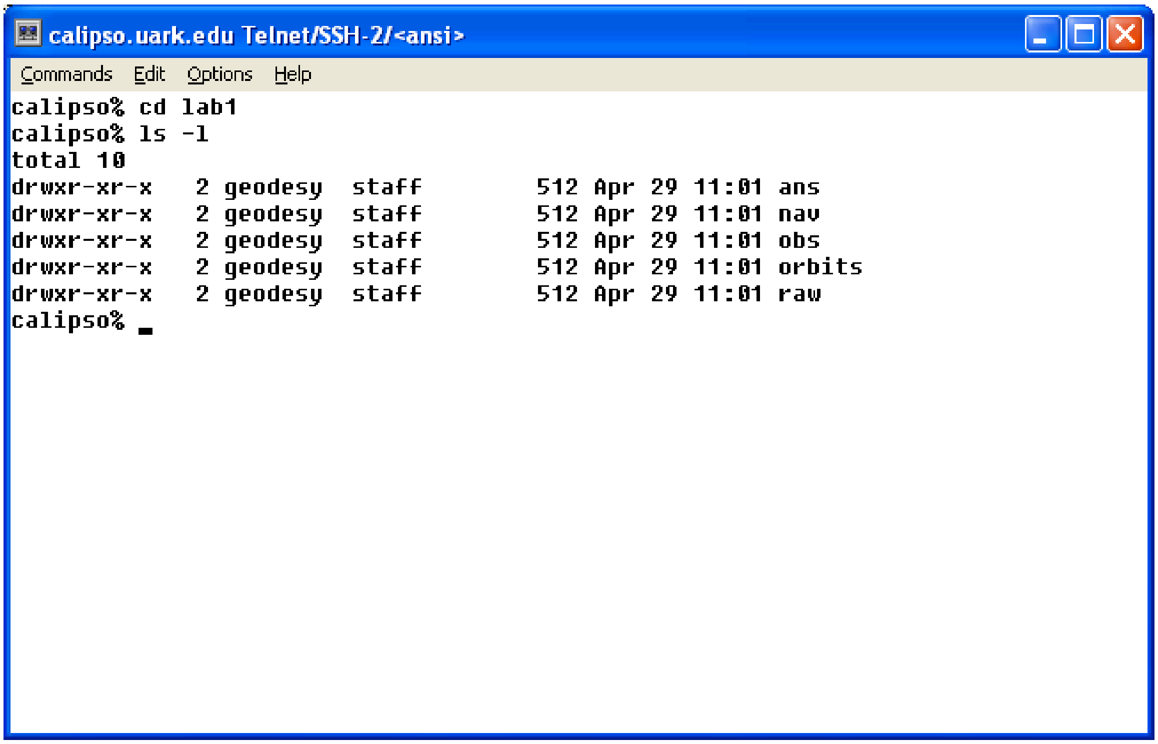


In order for the local "Backspace" key to map correctly to delete on the server, type the following command at the "**calipso%**" prompt:

calipso% stty erase ^H

Task 2 – Preparing to Estimate a Network Solution using GOA

Now that you have successfully connected to the server on which GOA resides, you can start the lab exercise. First you should change directory into “lab1” do a directory list on your home directory, the commands and output are shown below:



You should see five sub-directories listed in alphabetical order: **1) ans; 2) nav; 3) obs; 4) orbits; and 5) raw**. Each of these contains the following: **1) ans:** these are the results that I obtained when I processed the example; you should use these to compare with your results later in the lab exercise. **2) nav:** this directory contains the RINEX navigation files from five of the six CGPS sites that your will process in this exercise; **3) obs:** this directory contains the RINEX observation (data) files for all six sites. NB that this example has several different receiver types and file name formats. **4) orbits:** this directory has the orbit, clock, and earth orientation data necessary to process the GPS data; and **5) raw:** this directory should be empty initially, but the RINEX files must be copied there in order for xt-gipsy to execute properly.

As many of you may not be facile with basic UNIX commands, here is a very brief primer:

Command	**Name**	**Form**	**Purpose**
cd	change directory	cd *dir_name*	To move to another directory.
compress; uncompress	compress; uncompress	compress *file1;* uncompress *file1*	Compress or uncompress file using standard UNIX compress algorithm.
cp	copy	cp *file1 file2*	Copy file1 to file2: NB that you can use relative or full path names.
grep	grep	grep *"pattern" files*	Look for specific text patterns in a single or multiple files.
lp	line printer	lp *files*	Print the files to the device named "lp," which in this case is the geod_lab_4500.
ls	list	ls	Get a directory listing. NB that it doesn't require an argument.
man	manual page	man *unix_command*	Get online info on a UNIX command or program.
more	more	more *files*	Display the contents of a text file(s) page by page. Use spacebar to advance.
rm	remove	rm *file1 file2…*	Remove files. Be careful, there is not recovery once the files have been deleted.

First copy the entire contents of the lab1 directory to a directory with your name. This will allow you to have only one userid but process the data independently. This is done by executing the following command:

calipso% cp –R lab1 shane_lab1

Now change directory to your new directory and copy the RINEX observation files from the **obs** directory to the **raw** directory and do a directory listing. Shown below are the commands and the expected output:

```
calipso.uark.edu Telnet/SSH-2/<ansi>
Commands  Edit  Options  Help
calipso% ls -l
total 10
drwxr-xr-x   2 geodesy  staff        512 Apr 29 11:01 ans
drwxr-xr-x   2 geodesy  staff        512 Apr 29 11:01 nav
drwxr-xr-x   2 geodesy  staff        512 Apr 29 11:01 obs
drwxr-xr-x   2 geodesy  staff        512 Apr 29 11:01 orbits
drwxr-xr-x   2 geodesy  staff        512 Apr 29 11:04 raw
calipso% cp obs/* raw
calipso% ls -l raw
total 9024
-rw-r--r--   1 geodesy  staff     631263 Apr 29 11:26 00dec25cro1____r0.rnx.Z
-rw-r--r--   1 geodesy  staff     962993 Apr 29 11:26 bggy3600.00o.Z
-rw-r--r--   1 geodesy  staff     792116 Apr 29 11:26 geol3600.00o.Z
-rw-r--r--   1 geodesy  staff     532390 Apr 29 11:26 harr3600.00o.Z
-rw-r--r--   1 geodesy  staff     943578 Apr 29 11:26 mvo13600.00o.Z
-rw-r--r--   1 geodesy  staff     680732 Apr 29 11:26 souf3600.00o.Z
calipso% _
```

NB that I executed the copy command using a "*wildcard,*" which in this case was "*." This caused all the files in the **obs** sub-directory to be copied into the **raw** directory. You should see six files, each one corresponding a distinct CGPS site:

00dec25cro1____r0.rnx.Z	**CRO1**	IGS CGPS site on St. Croix, USVI
bggy3600.00o.Z	**BGGY**	CGPS site at Boggy Peak on Antigua
geol3600.00o.Z	**GEOL**	CGPS site at UPRM in Mayaguez, PR
harr3600.00o.Z	**HARR**	CGPS site at Harris Lookout in Montserrat
mvo13600.00o.Z	**MVO1**	CGPS site at the MVO north in Montserrat
souf3600.00o.Z	**SOUF**	CGPS site at S. Soufriere Hills in Montserrat

These sites are located on four different islands in the northeastern Caribbean. The approximate distance from GEOL to HARR is 550 km. Your RINEX data files use both the GOA naming convention (*e.g.* 00dec25cro1____r0.rnx.Z) and the standard IGS naming convention (*e.g.* bggy3600.00.o.Z). Both naming conventions contain the necessary information to determine when and where the observations were obtained. Also note that all the files are "compressed" and hence have a *.Z at the end of the name. This means that the files have been converted from their original ASCII text format to a binary, compressed UNIX format that is widely used throughout the world. Under normal GOA operations files would have to be renamed to the form used for the CRO1 site and uncompressed prior to processing. As we will see below xt-gipsy will do both the file name translation and uncompressing for us automatically.

In addition to putting the data files in the appropriate place, we also must make sure the "station information" database files, which are used by GOA contain the appropriate information for each site. The four files and their formats were discussed in class and you should have the documentation in your handouts. The files are 1) sta_id, the station identification file; 2) sta_pos, the station position file; 3) sta_svec, the station vector file, and 4) pcenter, the phase center offset file, which maps the antenna type listed in the sta_svec file to the its appropriate phase center offset. NB that GOA has specified physical offset datum for different types of antennae. Choke rings are referenced from the base of the pre-amp, thus the height entered into the sta_svec file must be true vertical at the base of the pre-amp.

All of these files may either reside in a location that may be accessed by all users or within a user-specified location. The default location is the /goa/sta_info directory. The files located in /goa/sta_info are only editable by the superuser, but may be read by anyone. I have already entered the appropriate information in the general database files. You should verify that this is correct and write all the information to a file and print.

Issue the following commands:

calipso% grep CRO1 /goa/sta_info/* > station_info
calipso% grep BGGY /goa/sta_info/* >> station_info

etc for all the stations

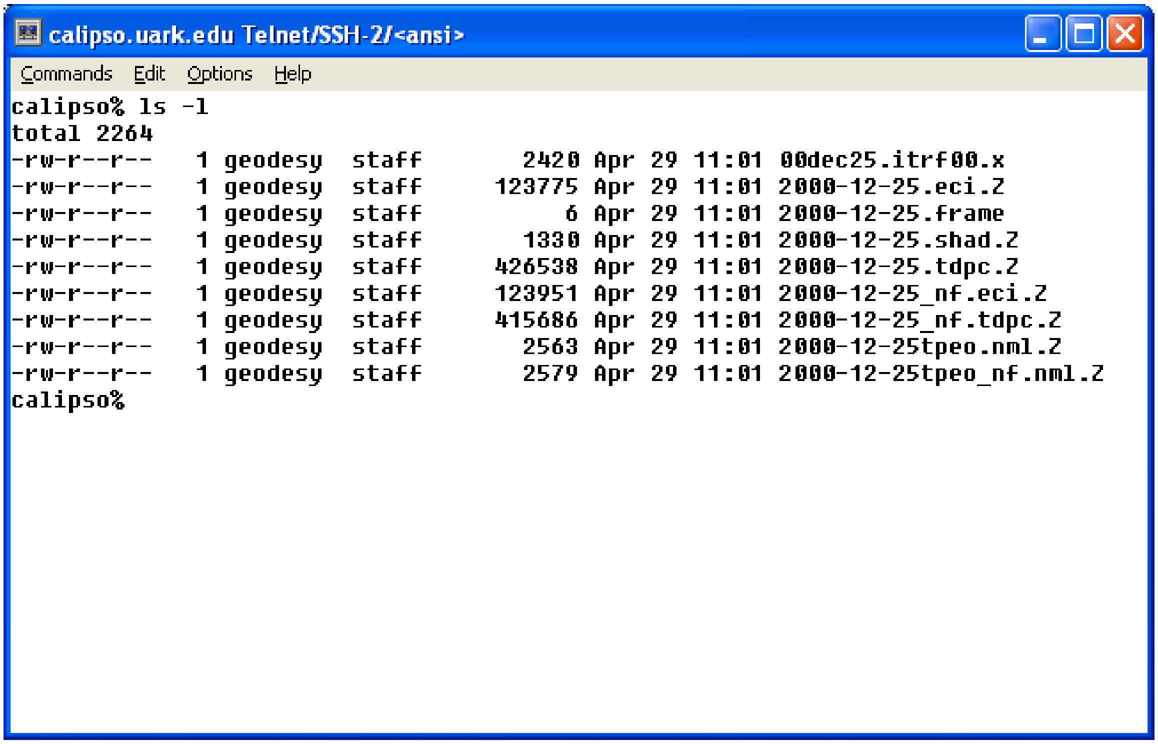
calipso% lp station_info

Note that the first command finds **all** the instances of CRO1 in **all** the files residing in the sub-directory /goa/sta_info and then writes that information into a new file called "station_info." The second command appends (using the >>) the information for BGGY to the same file and the third command prints the file to the Geodesy Lab Color LaserJet4500. If any station is not present in the station information database files (all three) GOA will either give an incorrect position estimate or crash, depending on what data are missing.

Examine the information for each site in the six station network. Describe below what each field is and its purpose in each of the three sta_info files:

Task 3 – Invoke xt-gipsy and Estimate a Network Solution using GOA

Under normal circumstances, prior to the execution of xt-gipsy, one would be required to obtain from JPL by anonymous ftp the required orbit, clock, and earth orientation parameters, lucky for you, however, I have already obtained the necessary data. Move to the orbits dir and do a directory listing. You should see the following:



Note that there are two sets of orbit, clock, and earth-orientation files: fiducial and non-fiducial and these are designated by “nf,” corresponding to the non-fiducial type. Also shown is an ASCII file, which allows one to convert your final solution to one mapped into the ITRF00: 00dec25.itrf00.x. This file corresponds to the “x-file,” and is only required if one uses the non-fiducial orbit, clock, and earth-orientation files. The fiducial versions of these files correspond to a specific reference frame in which the fiducial sites were processed by JPL. This “frame” is archived in the 2000-12-25.frame file.

Examine both these files either by printing them or by using “more” on the screen. Discuss the implications of using the non-fiducial versus fiducial approach below.

Prior to invoking xt-gipsy, we need to copy and rename the appropriate orbit, clock, and earth-orientation files from the orbit sub-directory to the main processing directory and name them appropriately. In our first example, we will process the data using the fiducial files.

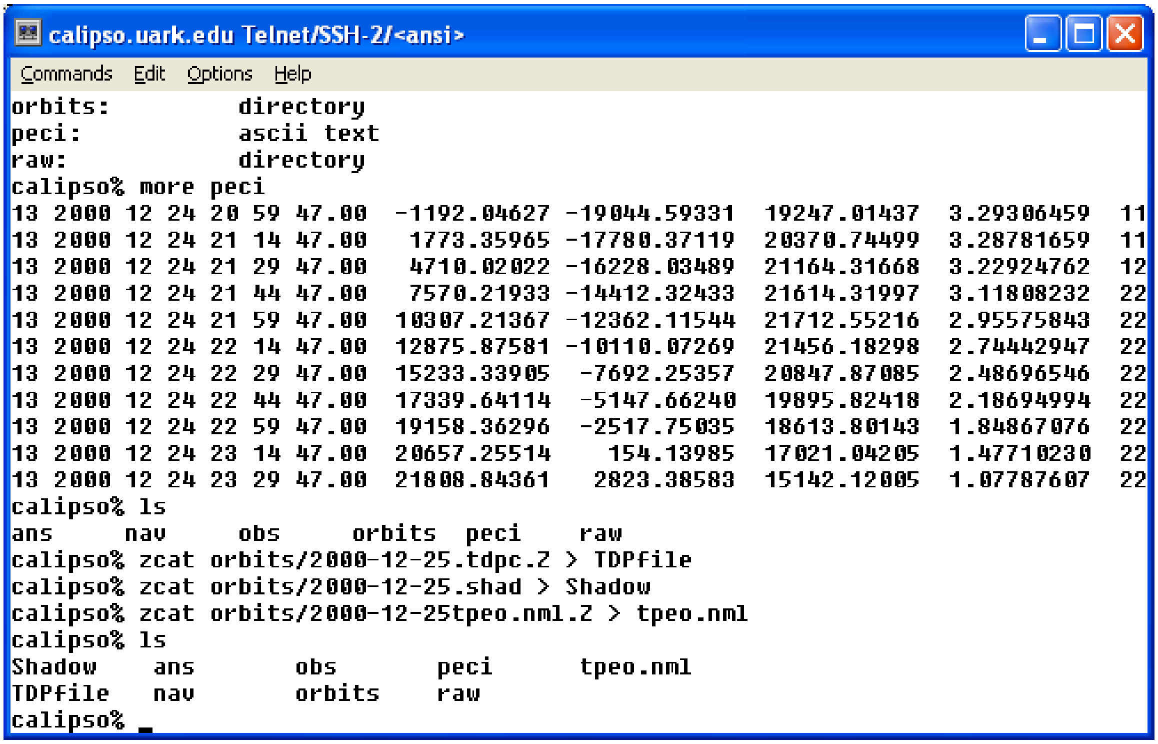
The original and xt-gipsy file names are shown below. Execute the required UNIX commands (NB that the files must be uncompressed. Describe briefly what it file is and its function in GOA GPS processing.

2000-12-25.eci -> peci
2000-12-25.tdpc -> TDPfile
2000-12-25.shad -> Shadow
2000-12-25tpeo.nml -> tpeo.nml

Try the following command and then examine the contents of your directory:

calipso% zcat orbits/2000-12-25.eci.Z > peci

Your output should look like this:



Now you are ready to start xt-gipsy. Issue the following command, making sure that you run the program in the background:

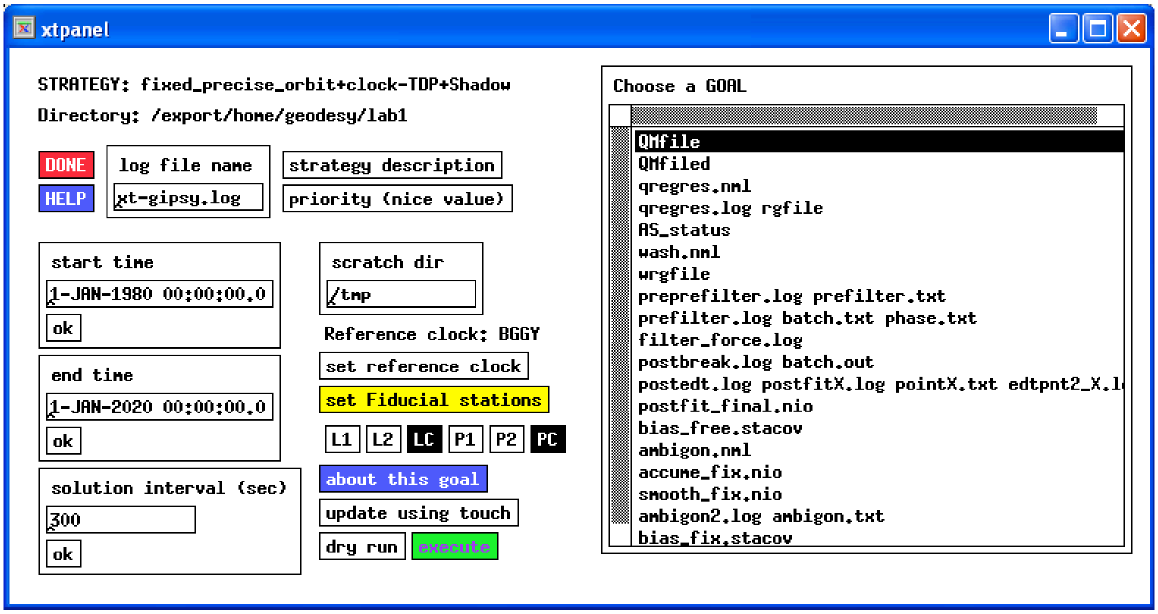
calipso% xt-gipsy &

You should see the following while xt-gipsy is starting up and translating the filenames in the **raw** sub-directory:

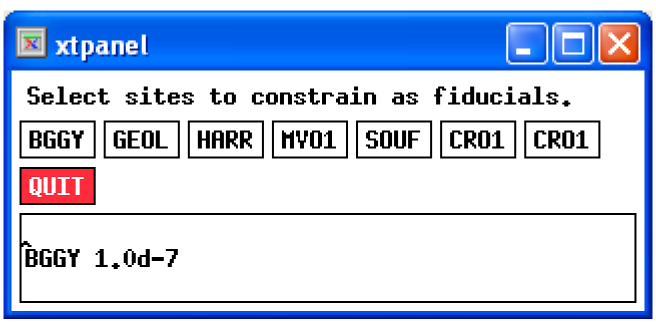
Once completed the following screen will be presented to you:

Now you are ready to choose a processing strategy from the "Choose a STRATEGY" menu.

Select "fixed_precise_orbit+clock-TDP+Shadow" and the following screen will be presented:



Now, let us select "set Fiducial stations" to pick BGGY as the fiducial site. This effectively puts our solution in the BGGY-fixed frame.



Click on "QUIT" once you have fixed the a priori sigma for the BGGY position at 1.0d-7 km, which is 0.1 mm.

On the right hand side of the main xt-gipsy window, there is a dialog box that lets you select a "goal." Each of these entries represents a specific step in the overall GOA processing. Select "wash.nml" for example and then click on "about this goal" to get information on that goal.

Your final goal should be “bias_fix.stacov.” This will produce a final solution that will have the phase ambiguities estimated and fixed between all the stations in our six station network. Select this goal and click on “execute.” This will initiate the GOA processing. The processing of this network will take some time, so you can relax and take a break will the CPU crunches the numbers. If all goes well, you will get a message indicating the final solution has been obtained.

Questions:

Examine the following log files: qregres.log, smapper.log, postfit_final.log, and xt-gipsy.log. What type of information is contained in each of these files and how is it useful to the GPS analyst?

Print the “bias_free.stacov” and the “bias_fix.stacov” files and label appropriately. Describe the contents of each file and discuss why they are different.

Compare the "bias_free.stacov" and the "bias_fix.stacov" using the GOA utility station_diff and write the output to a file. Print this file and include with you completed lab. Now compare your results with those found in the ans sub-directory. Again write the results to a file and print to include with your lab. Explain why the "free" and "fix" solution are different?

Task 4 – Rerun xt-gipsy using non-fiducial orbits

Complete all the same tasks that were done in Task 3 using fiducial orbits this time using the non-fiducial files also found in the orbits sub-directory. Compare the solutions for both the "free" and "fix" solutions. Make sure you create a new directory in which to do the new processing. Include the output with your lab. Are the solutions the same or different? Explain. Once you have completed you lab, please quit xt-gipsy, logout of calipso, and quit the local X-session program on the PC.