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A Recipe for Processing Positions of a GPS Network Using GAMIT/GLOBK

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Objective: calculate coordinates of permanent stations in post-processing using GAMIT/GLOBK

This recipe will describe the step for process GPS data using GAMIT/GLOBK in batch processing.

Version of software: Gamit/Globk version 10.40 – 2011.

Commands in italics are from GAMIT, and thus they require that GAMIT is correctly compiled and installed on your server/workstation. You can ask for a free GAMIT license from Robert King at MIT. This information is at the GAMIT/GLOBK homepage:

<http://www-gpsg.mit.edu/~simon/gtgk/>

After which You received the license from Dr. Bob King, is possible to download the source files from terminal in binary typing:

- ftp chandler.mit.edu [18.83.0.146]
- login *****
- password *****
- *cd /path of source file/*

Within the README is described each step of install process.

All files must be stored at top directory (e.g. “gg”) and is possible to download all necessary files described within README with the command “get” directly by terminal (e.g. *get gamit*).

To install the software, the file "install_software" need to be marked executable. This is possible using the command by terminal:

- `chmod 777 "install_software"`
(readable,writable,executable)

After these commands is possible to run "install_software" typing "install_software" by terminal at the same level of that file (within "gg" directory).

When the process is completed, for work whit the gamit/globk is necessary to set the path within the shell's file system (e.g. ".bashrc" (debian)) located within system directory.

An example of this pat is:

- `PATH=/home/labtopo/Scrivania/gg/gamit/bin:/home/labtopo/Scrivania/gg/kf/bin:$PATH`
`export PATH`
`HELP_DIR=/home/labtopo/Scrivania/gg/help/`
`export HELP_DIR`
`INSTITUTE=where_i_work`
`export INSTITUTE`

When the source of gamit/globk it is installed, is necessary to install also the "incremental updates".

Note that "installing" incremental_updates just involves copying the incremental_updates tar-file (from *ftp* chandler.mit.edu) to the gg level, untarring it (which will cause the new source files to replace the old ones within each source directory), and then executing the command "install_updates" it will be installed.

To connect on a pc where is installed gamit/globk (e.g. labtopo pc of surveying and mapping laboratory of Perugia University) via ssh it is necessary to install the "ssh" :

- `apt-get install ssh`

To login it is necessary to type from terminal:

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- `username@ip` (e.g. `labtopo@IPaddress`)
- password: *****(password imposed on "labtopo" pc)

- CREATE A PROJECT DIRECTORY

You can create manually or by terminal typing (on the path where you will work on GAMIT e.g. your ftp address or local disk etc):

`mkdir <name of your project directory>`

e.g. - `mkdir EXPT`

(be careful because your project directory must be named with 4 digit)

- CREATE A FOLDER FOR YOUR GPS DATA AND OTHER FILES (within project directory):

For work in batch processing within the project directory you must create this folder (must be respected the name otherwise the software can't find the files for processing):

```
-rinex
-gfiles
-brdc
-igs
-tables
```

- STORE YOUR DATA IN YOUR FOLDER

Rinex data:

For obtain the rinex you can download manually and copy it within "rinex directory", but usually you have some IGS stations between your selected station and GAMIT allow to download them automatically by SOPAC archive in this way:

- a) Go to "rinex" directory by terminal typing: `cd <path of your rinex directory>` (if you don't know in which folder you are you can type `pwd` on terminal for check it out)
- b) When you are in your rinex directory type:

```
sh_get_rinex <list of stations which need to be downloaded with 4 character code>
    (if you type only sh_get_rinex is possible to visualize the help with all
    possible uses of this command)
```

Be careful: is really important to include an adequate number of IGS station on our network to align our solution to ITRF datum (10 stations should be ok).

Usually these GPS data are in "hatanaka format" and you must uncompress and convert to rinex format directly within rinex folder using these commands:

```
uncompress <name of rinex file>
```

(Usually You need to uncompress all files and the shortest way to do it is to use "*uncompress *.Z*").

```
crx2rnx <name of rinex file> (e.g. -crx2rnx mate001.12d)
(this one need to be repeated for all rinex files)
```

brdc (Broadcast message: ephemeris transmitted by satellites):

Is possible to download the navigation data from cddis archive and store it directly within “brdc” directory typing:

```
sh_get_nav -archive <name of archive for download data> (e.g cddis) -yr < year>
(e.g. 2012) -doy < starting doy> (e.g 001) -ndays <number of considered julian
doy> (e.g. 365)
```

igs (Precise ephemerides)

Is also possible to download precise ephemerides automatically typing within “igs” folder:

```
sh_get_orbits -yr <year> -doy <starting doy> -ndays <number of julian doy> --
makeg <no>
```

gfiles

Is possible to download manually all necessary gfiles directly from fpt of SOPAC archive:

<http://sopac.ucsd.edu/cgi-bin/dbDataByDate.cgi>

The data must be stored into gfiles folder renaming them in the follow format:

“gigsfy.ddd”

(e.g. gigsf2.001 □ it means the gfiles for 1 genuary (ddd=001) of 2012 (y=2))

tables

All folder can be copied from gamit directory and the path is ...gg/tables.

If some files are old, the latest version of it usually can be downloaded from SOPAC archive (e.g file “otl_FES2004.grid” and renamed into “otl.grid” according with GAMIT/GLOBK code)

- FILE EDITING

To edit the files, KATE editor can be more efficient respect to “gedit” and is possible to install it from terminal with the following command:

```
apt-get install kate
```

All files which need to be edited are within “tables” folder. GAMIT/GLOBK works whit the follow 6 command files:

- autcln.cmd
- sestbl.
- sittbl.

-sites.defaults
-process.defaults
-station.info
-autcln.cmd:

represent a command file for AUTCLN (*Gamit manual for detail*) and usually no need of any edits.

sestbl. :

list and setting of parameters used on GAMIT computation

sittbl. :

are listed IGS stations used by GAMIT to compute loose constrained solution (will be tightly constrained when it will be used GLOBK for frame the network applying general constrain on our network through the appropriate IGS stations listed within `stab_site.global` located within “tables” directory).

sites.defaults :

file to control the use of stations in the processing.
This file needs to contain the list of stations which compose our network and the structure is explained clearly within that file:

first row:

`all_sites` <name of experiment (4 character)> (e.g. `all_sites 2008`)

other rows:

-each site need to be listed with the name of station (4 character) followed with “_gps” and followed with the “name of experiment” and “ftprnx” if you have already all rinex files on rinex folder.
(e.g. `mate_gps 2008 ftprnx`)

The last rows:

```
all_sites `expt` xstinfo
# templates for removing sites
ttht_gps `expt` xsite:1999_256-1999_278 glreps xsite:1999_300-
1999_365
thht_gps `expt` xsite glreps
```

need to be modified only on ‘expt’ name replacing it with your experiment name.

process.defaults:

file which contain the default process setting. Usually don’t need to be modified.

station.info:

file with all information about the station (antennas and receivers type, horizontal and vertical offset, etc).

These information should be kept directly from rinex and saved replacing the station.info located within "tables" directory and edited with the following commands written on that directory.

To create "station.info.new":

```
sh_upd_stnfo -l sd
```

To replace the old file (station.info) with the new ones (station.info.new):

```
mv station.info.new station.info
```

To compile the file station.info from each rinex header (antenna type, receiver type etc):

```
sh_upd_stnfo -files /rinexpathdirectory/*.yyo
```

After this operation check the created file (station.info) and in case of some bad interpretation of antenna type you can correct manually.

- GAMIT RUN

Now which the editing is completed, within project directory it is possible to run GAMIT computation.

Is typing from terminal only. You "sh_gamit" will see all possible use of these commands.

(e.g. If you want to process two months of data from 1 January of 2012 till 28 February (Julian Day 59) 2012 you can use:

```
sh_gamit -s 2012 1 59 -expt 2012 -noftp
```

The time of computation depends on how many stations and how many Julian days you need to process and usually it takes place also for many hours.

The GAMIT run creates one folder for each Julian day and within each file are contained the q-files (quasi observation file which represent the loose constrained solution of our network) and the h-files (file which contains the covariance matrix of our network) which represents the input for GLOBK which is used to constrain the GAMIT solution appropriately on datum ITRS (the default DATUM of GAMIT/GLOBK).

- GLOBK RUN

It reads the covariance matrix (within h-file), positions, and other information from the two files (q-file and h-file). In the step of GLOBK, the positions determined by GAMIT are combined and adjusted into a specified reference frame as ITRF. These reference frames are specified by groups of GPS sites designated to represent the reference frame (e.g. IGS sites contained within e.g. "stab.site.global" located within tables directory and which is necessary to edit appropriately with the "station name" (only 4character) considered stable for your network). The coordinates and rates of these sites are located within "itrffy.apr" and is really important to have in your network at least 8/9 stations contained within this file.

In case your station is not on that file is possible to edit appropriately the itrffy.apr file inserting the coordinates and rate and respectively uncertainties of reference site of your network on it.

Before to run GLOBK, is necessary to store the GLOBK command file (*globk_comb.cmd* and *glorg_comb.cmd*) within "gsoln" directory.

Editing the command file:

- *glorg_comb.cmd*

Opening this file, it is necessary to mention the appropriately file which contain the stable site

E.g. : source ../tables/stab.site.igs (default row)

can be replaced with

source ../tables/stab.site.global

Within "stab.site.igs" is necessary to comment all stations which are not used in our network and creates the strings with your IGS station considered stable.

- *globk_comb.cmd*

Is necessary to comment all string which is not important for your network and insert the right *itrffy.apr* file instead of default ones.

E.g. :

replacing the string ../tables/irtf00.apr

with

../tables/itrff08.apr

(that is because itrff08.apr is more recent then irtf00)

Now is possible to run the globk modules; with the following command is possible to obtain a time series of GPS network formed from daily solutions and to obtain the plots for the same period of GAMIT solution:

```
sh_glred -s 2012 1 2012 59 -expt 2012 -noftp -opt H G E
```

(Typing only *sh_glred* is possible to visualize the help, which contain the format for other kind of elaboration like combined solutions etc.)

The solutions are stored within “gsoln” directory.

N.B.

The easy way to visualize the graphs is to install the GMT:

```
apt-get install gmt
```

Like already mentioned, the GAMIT/GLOBK solutions are aligned with datum ITRS.

Usually, if you are working on European Plate, you are interested to align the solution on datum ETRF (European terrestrial reference frame). Is possible to obtain the solution directly with GAMIT editing appropriately the *itrffy.apr* file furnishing the a priori coordinated expressed in ETRF within “*stab_site.global*”.

Another option, is to use the EUREF online application (ITRS-ETRS89),

http://www.epncb.oma.be/_productsservices/coord_trans/

which allow to operate the datum transformation of ITRS into ETRS and reverse using the fourteen parameters transformation of Altamimi.

References

- Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign: <http://etrs89.ensg.ign.fr/memo-V8.pdf>
- Transformation parameters from ITRF web site: http://itrf.ign.fr/trans_para.php

Additional Resources

- <http://www-gpsg.mit.edu/~simon/gtgk/docs.htm>
 - Gamit-Globk homepage at MIT. The GAMIT and GLOBK manuals are found here.
- <http://sopac.ucsd.edu/processing/gamit/>
 - GAMIT setup files from SOPAC
- <ftp://garner.ucsd.edu/pub/gamit/>
 - Data for GAMIT/GLOBK processing like setup and tables file.

I hope which this short recipe could be useful for your work!

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