



# GAMIT/GLOBK In A Day

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*Massachusetts Institute of Technology*

GAGE/SAGE 2023 Community Science Workshop  
Pre-Workshop Short Course  
26 March 2023

[http://geoweb.mit.edu/gg/courses/202303\\_GAGE-SAGE/](http://geoweb.mit.edu/gg/courses/202303_GAGE-SAGE/)

Material from R. W. King, T. A. Herring, M. A. Floyd (MIT) and S. C. McClusky (now at ANU)

# Installation

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## MIT/GLOBK

Welcome to the GAMIT and GLOBK home page at the Department of Earth, Atmospheric and Planetary Sciences, MIT.

**The current release is 10.71 (9 March 2020).**

GAMIT, GLOBK and TRACK form a comprehensive suite of programs for analyzing GNSS measurements primarily to study crustal deformation. The software has been developed by MIT, Scripps Institution of Oceanography and Harvard University with support from the National Science Foundation.

The software may be obtained without written agreement or royalty fee by universities and government agencies for any non-commercial purposes. To obtain the download password and be added to the mailing list for future updates, please send an e-mail to Dr. [Robert W. King](mailto:king@mit.edu). You must include in the e-mail the full name, address, and telephone and fax numbers of your institution. If you are a student, you must also include the name and email of your advisor or other permanent staff member who will receive the announcements and be responsible for the terms of the license.

**GAMIT** ("GNSS at MIT") is collection of programs to process phase data to estimate three-dimensional relative positions of ground stations and satellite orbits, atmospheric zenith delays, and Earth orientation parameters. The software is designed to run under any UNIX operating system.

**GLOBK** ("Global Kalman filter") is a Kalman filter whose primary purpose is to combine various geodetic solutions such as GPS, VLBI, and SLR experiments. It accepts as data, or "quasi-observations", the estimates and covariance matrices for station coordinates, Earth orientation parameters, orbital parameters, and source positions generated from the analysis of the primary observations. The input solutions are generally performed with loose a priori uncertainties assigned to all global parameters, so that constraints can be uniformly applied in the combined solution.

The most recent full workshops, for which the presentations are available under [Documentation](#), were at UNAVCO in Boulder, Colorado, in June 2017.

Last modified: 2020-03-10, M. Floyd (MIT)

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## GAMIT/GLOBK License Request

**You need a valid user ID and password to download GAMIT and/or GLOBK.**

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# License form

## Required Information

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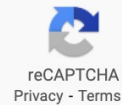
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# Understand and install the prerequisites

<http://geoweb.mit.edu/gg/pre.php>



## GAMIT/GLOBK Prerequisites

*A PDF version (68 kB) of this web page is available in [A4](#) or [letter](#) paper format and in the documentation directory of the GAMIT/GLOBK FTP server.*

This information is compiled through experience with first-time users of GAMIT/GLOBK from workshops and elsewhere. Details are provided for installing GAMIT/GLOBK on [Linux](#), [Mac](#) and [Windows](#). Additional information is provided on optional programs such as [GMT](#) (required for any GAMIT/GLOBK scripts that produce plots), Tom Herring's [tview and velview tools](#) and [CATS](#) (see [here](#) also).

*All GAMIT/GLOBK workshop participants must arrive having read through and completed the steps shown on this web page before the start of the workshop.*

This is particularly important given the time and resource constraints when downloading very large package files such as Xcode for Mac users, which will produce unnecessary and unwanted delays.

### GAMIT/GLOBK

#### Introductory and reference manuals

We provide an [Introduction to GAMIT/GLOBK](#) as well as more detailed reference manuals for [GAMIT](#) and [GLOBK](#). We recommend that all users using the software at least read the former document before starting with the software and refer to the latter documents for more advanced information as you gain experience.

In addition to a basic UNIX- or Linux-based operating system, there are four fundamental requirements for installing GAMIT/GLOBK on any system:

- a Fortran compiler;
- a C compiler;
- X11 libraries and headers, specifically:
  - an X11 library (libX11.a, libX11.so, libX11.dylib, libX11.la or libX11.dll.a); and
  - an X11 header file (Xlib.h).

Many systems will have some or all of these installed by default but others may not. Below are some details about what to expect from various systems that I have experience with.

Once you have completed the steps described for your system, below, you may download and install GAMIT/GLOBK from the source code provided on the FTP server. Further information is available on the main [GAMIT/GLOBK web page](#).

- A Fortran compiler (e.g. gfortran)
- A C compiler (e.g. gcc or clang)
- X11 libraries and header files
- Generic Mapping Tools (GMT)
- Linux:
- Mac:
  - Xcode or Command Line Tools for Xcode from the Apple Developer (for C compiler and command line programs in general for Terminal)
    - From Terminal: `xcode-select --install`
  - gfortran (e.g. <https://gcc.gnu.org/wiki/GFortranBinaries#MacOS>)
  - XQuartz (<https://www.xquartz.org/>)
- Windows:
  - Use Windows Subsystem for Linux (WSL) for Windows 10 and follow instructions for Linux
    - Ubuntu 16.04, Ubuntu 18.04, Debian 9, openSUSE 15.1 and openSUSE 43.1 Linux shells available for free
  - Use a virtual machine (e.g. <https://www.vmware.com/> or <https://www.virtualbox.org/>), or Cygwin (<https://www.cygwin.com/>) for other versions of Windows

# Read the notes

[http://geoweb.mit.edu/gg/docs/GG\\_Quick\\_Start\\_Guide.pdf](http://geoweb.mit.edu/gg/docs/GG_Quick_Start_Guide.pdf)

- A brief guide to installation steps and prerequisites described here

[https://chandler.mit.edu/gps/...:](https://chandler.mit.edu/gps/...)

- README
  - General overview of the GAMIT/GLOBK software, including details of prerequisites and installation
- `source/relnote.<NN.nn>`
  - Specific details of the latest release (<NN.nn> is currently 10.71)

# Preparation

- We recommend you separate tasks into three separate directories:
  - Source code directory (to keep a local copy of the source code files; optional)
  - Installation directory (to compile and install the source code)
  - Processing directory (to process without overwriting files in the installation directory)
- Make a main installation directory of your choice on the command line
  - We *highly recommend* using a separate directory for each release of GAMIT; do *not* mix source code from different versions, e.g. (“maf” is the username)
    - On Mac, /Users/maf/Applications/gg/10.71/
    - On Linux, /home/maf/Programs/gg/10.71/

# Source code directory

- Users may wish to keep a local copy of source code
  - As backup in case of problems during installation
  - If unable to reconnect to the source code repository (<https://chandler.mit.edu/gps/>)
- If you wish to do this, keep it separate from where you intend to install GAMIT/GLOBK, e.g.
  - `~/src/gg/10.71`
  - `~/Applications/src/gg/10.71`



# Download source code

- Log in to <https://chandler.mit.edu/gps/> using the username and password provided with the license
- Download *at least* these required files
  - `libraries.10.71.tar.gz` (common subroutines)
  - `gamit.10.71.tar.gz` (GAMIT source code)
  - `kf.10.71.tar.gz` (GLOBK source code)
  - `com.10.71.tar.gz` (scripts to run the software from the command line)
  - `tables.10.71.tar.gz` (metadata and other definitions and information)
  - `help.10.71.tar.gz` (program help pages)
  - `incremental_updates.*.tar.gz` (all updates to date for the current release version)
- Additional files (optional)
  - `com_preGMT5.10.71.tar.gz` (scripts using syntax prior to GMT 5; no longer supported)
  - `maps.10.71.tar.gz` (used with `sh_plotvel` and `velview`; not necessary for most users)
  - `test_install.10.71.tar.gz` (instructions and output files for comparison to test installation)
  - `relnote.10.71` (release notes for version 10.71)
- Copy these files into your main installation directory if downloaded to a source code directory

# Compilation

- From the main installation directory
  - *Either* extract `install_software` from `com.10.71.tar.gz` and run it:

```
tar xfvz com.10.71.tar.gz com/install_software
com/install_software
```
  - *Or* download `install_software` from <https://chandler.mit.edu/gps/>, make it executable and run it:

```
chmod +x install_software
./install_software
```

# Compilation

- Read the output and answer the questions appropriately
- `install_software` will first extract the source code from all the tar-files
- You are then quite likely to need to stop the installation process to edit `libraries/Makefile.config` according to your operating system, e.g.
  - `X11LIBPATH` (path to `libX11`)
  - `X11INCPATH` (path to `Xlib.h`)
  - `MAXSIT` (maximum number of sites to process simultaneously; must be  $< 100$ )
  - `MAXSAT` (do not change)
  - `MAXATM` (maximum atmospheric estimates per session)
  - `MAXEPC` (maximum epochs per session, e.g. 24 hours at 30 s interval = 2880 measurement epochs)
  - OS block (usually no need to change but see next slide)

# Compilation: version of gfortran

- Run `gfortran --version`
- If your gfortran version is greater than or equal to 10, then you will need to include the `--follow-argument-mismatch` option with `FFLAGS` in `libraries/Makefile.config` and `gamit/solve/Makefile.generic`
- Unfortunately this option is not even recognized by gfortran version 9 and below, which causes an error if you try to include it, so you must *not* include this option with `FFLAGS` in `libraries/Makefile.config` and `gamit/solve/Makefile.generic`

# Compilation: version of gfortran

## GAMIT/GLOBK Known Issues

Here we present a list of known issues with GAMIT/GLOBK, in [general](#) and due to problems on [Ubuntu](#), [Debian](#), [openSUSE](#) and [Fedora](#) Linux operating systems and [macOS](#).

### General

- Recent versions of curl, using OpenSSL version 3, will not connect to the CDDIS server to download data and products, resulting in failed processing runs due to missing files. This appears to be a server-side (CDDIS) issue.

*Solution:* The ultimate solution appears to be for CDDIS to upgrade their server's security protocols, over which we have no control. In the meantime, a change of the client-side (local) OpenSSL (version 3) settings described [here](#) circumvents the recent security updates. CDDIS's own recommendation of adding a `--ciphers DEFAULT@SECLEVEL=1` option (e.g. Question 17 at their [Archive Download FAQ web page](#)) does not appear to work for this issue.

- Recent versions of gfortran (10 and greater) require the addition of a compiler option which is not valid in prior versions. If using gfortran 10 and greater without this addition, one may see a compilation error such as:

```
gfortran -c -O3 -Wuninitialized -fno-f2c -ffast-math -fno-automatic -fno-  
backslash -m64 -mcmmodel=large lread.f  
lread.f:616:53:  
  
616 | call read_line( line,indx,'I4',ioerr,irate(i),string )  
|  
.....  
718 | call read_line( line,indx,'CH',ioerr,rvalue,string )  
| 2  
Error: Type mismatch between actual argument at (1) and actual argument at (2)  
(INTEGER(4)/REAL(8)).  
lread.f:634:53:
```

# Setting the environment

At the end of the installation you will see instructions such as:

```
Don't forget to set your : PATH to include /Users/maf/Applications/gg/10.71/com,  
                                         /Users/maf/Applications/gg/10.71/gamit/bin and  
                                         /Users/maf/Applications/gg/10.71/kf/bin;  
: HELP_DIR environment variable in your shell profile; and  
: INSTTUTE evnironment variable in your shell profile
```

For example, if using sh or bash ("echo \$SHELL" = /bin/sh or /bin/bash),  
add the following lines to ~/.bashrc (or ~/.bash\_profile on Mac):

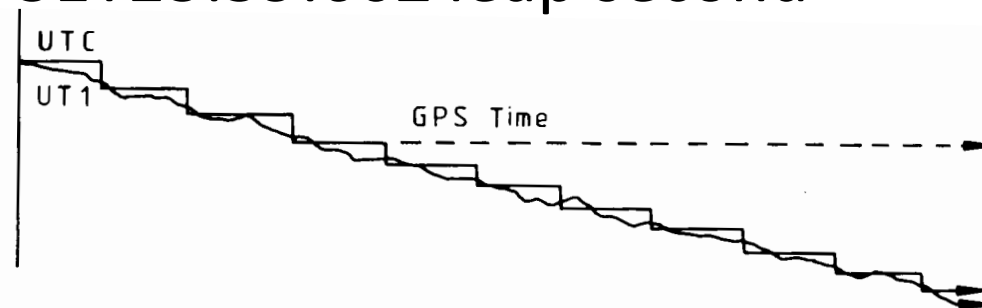
```
PATH="/Users/maf/Applications/gg/10.71/com:/Users/maf/Applications/gg/10.71/gamit/bin:/Use  
rs/maf/Applications/gg/10.71/kf/bin:$PATH"; export PATH  
HELP_DIR="/Users/maf/Applications/gg/10.71/help"; export HELP_DIR
```

Or, if using csh or tcsh ("echo \$SHELL" = /bin/csh or /bin/tcsh),  
add the following lines to ~/.cshrc:

```
setenv PATH  
"/Users/maf/Applications/gg/10.71/com:/Users/maf/Applications/gg/10.71/gamit/bin:/Users/ma  
f/Applications/gg/10.71/kf/bin:$PATH"  
setenv HELP_DIR "/Users/maf/Applications/gg/10.71/help"
```

# Updates!

- Incremental updates are made available on the first day of every month, so please check at least
  - Earth orientation parameters (pole.\* and ut1.\*; or sh\_update\_eop)
  - SVN-PRN translation tables (svnav.dat)
  - Differential code biases (dcb.dat)
  - Leap seconds (leap.sec)
  - Loading grids (<ftp://everest.mit.edu/pub/GRIDS/>)
- Example: 2016-12-31T23:59:60Z leap second



# Additional software

- Generic Mapping Tools (GMT)  
(<https://www.generic-mapping-tools.org/>)
  - Required for plotting scripts to work
  - Scripts in com/ use GMT 5+
  - Prepend com\_preGMT5/ to \$PATH if using GMT 4
    - These scripts are no longer updated, so switch to GMT 5 or GMT 6!
- Tom's GGMatlab tools  
(<http://geoweb.mit.edu/~tah/GGMatlab/>)
  - tsview
  - velview



# Useful commands

# Redirection

- The output from one command may be written to a file... (this is useful for us to review if you have a problem or bug to report)
  - “>” to overwrite an existing file
  - “>>” to append to an existing file
  - `sort [file] > [sorted file]`
- ...or “piped” to another command, effectively forming the second command’s input
  - “|”
  - `grep '^ .* P$' [file] | sort > [grep'd and sorted file]`

# Shorthands

- Top-level (“root”) directory = “/”, e.g.
  - `cd /`
- Your home directory = “~” or “\$HOME”, e.g.
  - `ls ~`
- “Links” or “shortcuts” may be created, e.g.
  - `ln -s /home/user/gg/10.71 ~/gg`
- This creates a link in the user’s home directory called “gg” that points to the directory `/home/user/gg/10.71`
  - Rather than “`cd /home/user/gg/10.71`”, one can get to the same place simply with “`cd ~/gg`”
  - (This is used in GAMIT/GLOBK scripts and must remain in place!)

# Checking processes and disk space

Processing sometimes fails, e.g. due to lack of available disk space, or stalls, e.g. due to a runaway process, which can be checked with the following:

- `du`
  - Disk usage: useful if you want to know how much space your (or others'!) directories are taking up
- `df`
  - Disk free space: useful if you want to know how much disk space is used and free
- `top`
  - Table Of Processes: useful if you want a real-time overview of processes that are running
- `ps`
  - List processes: useful if you want to see what processes are running and their process numbers, commands, etc.

# What is a script?

- Scripts contain a series of commands written in one file and prepended by a “hash-bang”
  - `#!/bin/sh` for original Bourne Shell (usually the same as `bash` on modern systems)
  - `#!/bin/bash` for Bourne Again Shell
  - `#!/bin/csh` for C Shell (usually the same as `tcsh` on modern systems)
  - `#!/bin/tcsh` for TENEX C Shell
- The script may then be executed to run all of the commands in sequence as written
- Most scripts in GAMIT/GLOBK are written in `csh` or `tcsh`; many newer scripts are written in `bash`
  - Must have both `csh` and `tcsh` installed to run GAMIT/GLOBK scripts
  - `bash` usually installed by default on current Linux distributions

# Script example

```
#!/bin/bash
printf `The ISO date is: `
date +%Y-%m-%dT%H:%M:%S%Z`
printf `The mean of all numbers between 1 and 10 is: `
printf `1 10\n` | awk `BEGIN {sum=0; n=0}; {for (i=$1; i<=$2; i++)
{sum=sum+i; n++}}; END {print sum/n}`
printf `Goodbye!\n`
```

(Some lines above are wrapped, and be careful with power point converting – to en-dash and ‘ to a fancy quote)