

# ***GAMP II - GOOD* Users Guide**

## **Version 2.1**

Feng Zhou

Email: [zhouforme@163.com](mailto:zhouforme@163.com)

Last modified: Sep 22, 2022

## 1 Introduction

Global Navigation Satellite System (GNSS) data processing requires a user to download various observation and product files. These file downloads, which are particularly important for precise point positioning (PPP), can be a burden for new and experienced GNSS users. Up to now, there are no standalone open-source software tools available to accomplish this task. In order to address this need, we developed an easy-to-use GNSS data and product downloading toolkit called GOOD (GNSS Observations and prOducts Downloader). GOOD is compatible with most popular operating systems, is actively maintained on GitHub, and is stable at the current version 2.1. Furthermore, the source code, user manual, and example usage have been also made available as part of the GPS Toolbox (<https://www.ngs.noaa.gov/gps-toolbox/GOOD.shtml>).

## 2 Features of GOOD

The main feature of GOOD is the convenient and efficient downloading of various GNSS observations and products, the source, product type/format, duration/sampling interval, and host URL of which is listed in Table 1.

Table 1 Overview of the various GNSS observations and products

Source	Product type	Duration	Host URL
IGS/MGEX	Daily observation	30 s	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily</a> <a href="ftp://igs.ign.fr/pub/igs/data">ftp://igs.ign.fr/pub/igs/data</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/data/daily">ftp://igs.gnsswhu.cn/pub/gps/data/daily</a>
	Hourly observation	30 s	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/hourly">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/hourly</a> <a href="ftp://igs.ign.fr/pub/igs/data/hourly">ftp://igs.ign.fr/pub/igs/data/hourly</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/data/hourly">ftp://igs.gnsswhu.cn/pub/gps/data/hourly</a>
	High-rate observation	1 s	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/highrate">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/highrate</a> <a href="ftp://igs.ign.fr/pub/igs/data/highrate">ftp://igs.ign.fr/pub/igs/data/highrate</a> <a href="ftp://igs.gnsswhu.cn/pub/highrate">ftp://igs.gnsswhu.cn/pub/highrate</a>
CUT	Daily observation	30 s	<a href="http://saegnss2.curtin.edu/ldc/rinex3/daily">http://saegnss2.curtin.edu/ldc/rinex3/daily</a>
GA	Daily observation	30 s	<a href="ftp://ftp.data.gnss.ga.gov.au/daily/">ftp://ftp.data.gnss.ga.gov.au/daily/</a>
	Hourly observation	30 s	<a href="ftp://ftp.data.gnss.ga.gov.au/hourly">ftp://ftp.data.gnss.ga.gov.au/hourly</a>
	High-rate observation	1 s	<a href="ftp://ftp.data.gnss.ga.gov.au/highrate">ftp://ftp.data.gnss.ga.gov.au/highrate</a>
HK	Daily observation	30 s	<a href="ftp://ftp.geodetic.gov.hk/rinex3">ftp://ftp.geodetic.gov.hk/rinex3</a>
	Hourly observation	5 s	
	High-rate observations	1 s	
NGS/NOAA	Daily observation	30 s	<a href="https://noaa-cors-pds.s3.amazonaws.com/rinex">https://noaa-cors-pds.s3.amazonaws.com/rinex</a>

EPN	Daily observation	30 s	<a href="ftp://ftp.epncb.oma.be/pub/obs">ftp://ftp.epncb.oma.be/pub/obs</a>
PBO	Daily observation	30 s	<a href="ftp://data-out.unavco.org/pub/rinex/obs">ftp://data-out.unavco.org/pub/rinex/obs</a> <a href="ftp://data-out.unavco.org/pub/rinex3/obs">ftp://data-out.unavco.org/pub/rinex3/obs</a>
IGS/MGEX	Boadcast ephemeris	10 min, 30 min, 1 h, 2 h	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily</a> <a href="ftp://igs.ign.fr/pub/igs/data">ftp://igs.ign.fr/pub/igs/data</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/data/daily">ftp://igs.gnsswhu.cn/pub/gps/data/daily</a>
IGS	Precise orbit and clock	5 s, 30 s, 15 min	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products</a> <a href="ftp://igs.ign.fr/pub/igs/products">ftp://igs.ign.fr/pub/igs/products</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products">ftp://igs.gnsswhu.cn/pub/gps/products</a>
MGEX	Precise orbit and clock	30 s, 5 min, 15 min	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex</a> <a href="ftp://igs.ign.fr/pub/igs/products/mgex">ftp://igs.ign.fr/pub/igs/products/mgex</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/mgex">ftp://igs.gnsswhu.cn/pub/gps/products/mgex</a>
IGS	EOP	Daily	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products</a> <a href="ftp://igs.ign.fr/pub/igs/products">ftp://igs.ign.fr/pub/igs/products</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products">ftp://igs.gnsswhu.cn/pub/gps/products</a>
MGEX	EOP	Daily	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex</a> <a href="ftp://igs.ign.fr/pub/igs/products/mgex">ftp://igs.ign.fr/pub/igs/products/mgex</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/mgex">ftp://igs.gnsswhu.cn/pub/gps/products/mgex</a>
IGS	SINEX	Daily, weekly	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products</a> <a href="ftp://igs.ign.fr/pub/igs/products">ftp://igs.ign.fr/pub/igs/products</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products">ftp://igs.gnsswhu.cn/pub/gps/products</a>
MGEX	ORBEX	30 s, 15 min	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex</a> <a href="ftp://igs.ign.fr/pub/igs/products/mgex">ftp://igs.ign.fr/pub/igs/products/mgex</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/mgex">ftp://igs.gnsswhu.cn/pub/gps/products/mgex</a>
AIUB/MGEX	DCB/DSB/OSB	Daily, monthly	<a href="ftp://ftp.aiub.unibe.ch/CODE">ftp://ftp.aiub.unibe.ch/CODE</a> <a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/bias">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/bias</a> <a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex</a> <a href="ftp://igs.ign.fr/pub/igs/products/mgex/dcb">ftp://igs.ign.fr/pub/igs/products/mgex/dcb</a> <a href="ftp://igs.ign.fr/pub/igs/products/mgex">ftp://igs.ign.fr/pub/igs/products/mgex</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/mgex/dcb">ftp://igs.gnsswhu.cn/pub/gps/products/mgex/dcb</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/mgex">ftp://igs.gnsswhu.cn/pub/gps/products/mgex</a>
IGS	GIM	15 min, houly, daily, 2-day	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex</a> <a href="ftp://igs.ign.fr/pub/igs/products/ionosphere">ftp://igs.ign.fr/pub/igs/products/ionosphere</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/ionex">ftp://igs.gnsswhu.cn/pub/gps/products/ionex</a>
IGS	ROTI	Daily	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex</a> <a href="ftp://igs.ign.fr/pub/igs/products/ionosphere">ftp://igs.ign.fr/pub/igs/products/ionosphere</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/ionex">ftp://igs.gnsswhu.cn/pub/gps/products/ionex</a>
IGS/CODE	Tropospheric product	30 s, 2 h	<a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/tropo">https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/tropo</a> <a href="https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/tropo/sphere/zpd">sphere/zpd</a> <a href="ftp://igs.ign.fr/pub/igs/products/troposphere">ftp://igs.ign.fr/pub/igs/products/troposphere</a> <a href="ftp://igs.gnsswhu.cn/pub/gps/products/troposphere/new">ftp://igs.gnsswhu.cn/pub/gps/products/troposphere/new</a> <a href="ftp://ftp.aiub.unibe.ch/CODE">ftp://ftp.aiub.unibe.ch/CODE</a>

IGS	ANTEX	N/A	<a href="https://files.igs.org/pub/station/general">https://files.igs.org/pub/station/general</a>
-----	-------	-----	---

**And it is not limited to these, users can use the source code to expand its functionalities according to their needs.**

### 3 Versions of GOOD

- Vers. 1.0
  - 2021/04/16 new (by Feng Zhou @ SDUST)
  - 2021/04/20 MGEX multi-GNSS precise products option added (by Feng Zhou @ SDUST)
- Vers. 1.1
  - 2021/04/23 IGN and WHU FPT archives added (by Feng Zhou @ SDUST)
  - 2021/04/30 the day before and after the current day for precise satellite orbit and clock products downloading is added (by Feng Zhou @ SDUST and Zan Liu @ CUMT)
- Vers. 1.2
  - 2021/04/30 CNES real-time orbit, clock, bias files (in offline mode) option added (by Feng Zhou @ SDUST)
  - 2021/05/01 from DOY 345/2020, 'brdcDDD0.YYn' was converted from '.Z' to '.gz' (by Feng Zhou @ SDUST and Zan Liu @ CUMT)
  - 2021/05/01 added the full path of third-party softwares (by Feng Zhou @ SDUST and Yudan Yi)
- Vers. 1.3
  - 2021/05/05 add 'GetRoti' for rate of TEC index (ROTI) file downloading (by Feng Zhou @ SDUST and Lei Liu @ WHU)
- Vers. 1.4
  - 2021/05/06 add the compatibility for changing directory (chdir) in Windows and Linux OS (by Feng Zhou @ SDUST)
  - 2021/05/07 add the option 'printInfoWget' in configure file for (not) printing the information of running 'wget' (by Feng Zhou @ SDUST and Hong Hu @ AHU)
  - 2021/05/08 add IGS and MGEX hourly observation (30s) downloading (by Feng Zhou @ SDUST and Menghao Li @ HEU)
- Vers. 1.5
  - 2021/05/10 modify some codes to make GOOD adaptable to different compression form (i.e., '.Z' or '.gz') (by Feng Zhou @ SDUST)
  - 2021/05/12 add the option for IGR, IGU, GFU (from GFZ), and WUU (from WHU) products as well as the site-specific broadcast ephemeris files downloading (by Feng Zhou @ SDUST and Menghao Li @ HEU)
  - 2021/05/15 sub-directory (i.e., daily, hourly, and highrate) creation for observation downloading (by Feng Zhou @ SDUST and Menghao Li @ HEU)
- Vers. 1.6
  - 2021/05/18 modify some codes to make configuration file and program look more concise (by Feng Zhou @ SDUST and Menghao Li @ HEU)
  - 2021/05/21 add the extraction and conversion for the 'all' option in IGS and MGEX observation downloading (by Feng Zhou @ SDUST)
- Vers. 1.7
  - 2021/06/01 add 'getObc', 'getObg', and 'getObh' options for Curtin University of Technology

(CUT), Geoscience Australia (GA), and Hong Kong CORS observation downloading (by Feng Zhou @ SDUST)

2021/07/16 modify `"*_R_"` to `"*"` for CRX file naming convention (by Feng Zhou @ SDUST)

- Vers. 1.8

2021/09/01 add various types of (i.e., ESA, GFZ, IGS, WHU) and rapid (i.e., CODE, NRCAN, ESA, GFZ, IGS) orbit and clock products for downloading (by Feng Zhou @ SDUST and Sermet Ogutcu @ NEU)

2021/09/04 add the option for NGS/NOAA CORS (from Amazon Web Services (AWS)) and EUREF Permanent Network (EPN) observation downloading (by Feng Zhou @ SDUST)

2021/09/05 fix the bug of broadcast ephemeris downloading via WHU FTP before and after 2020 (by Feng Zhou @ SDUST and Zan Liu @ CUMT)

2021/09/06 modify the setting of directories of GNSS observations and products to make them more elastic (by Feng Zhou @ SDUST and Caoming Fan @ SDU)

- Vers. 1.9

Please refer to the header component of FtpUtil.cpp

- Vers. 2.0

Please refer to the header component of FtpUtil.cpp

- Vers. 2.1

Please refer to the header component of FtpUtil.cpp

## How to run GOOD?

1. For Windows OS, type **Win + R** to open the running dialog box and **cmd** to open the terminal. For Linux/Mac OS, one need to open the terminal. After that, one need to enter into the directory where the executable GOOD is or give the full path of the executable GOOD through the terminal or set the environmental variable for GOOD.

**NOTE: Double-clicking the executable program does not work for data downloading.**

**There are two ways to run GOOD:**

2. One is to run the executable program **run\_GOOD** with the modified configuration file. Two types of configuration files are nowadays provided: One is in 'TXT' format, and the other is in 'YAML' format. Users can choose one according to their personal preferences. If one want to compile the source codes of GOOD, YAML should be installed in advance. For Windows operating system (OS), one can compile and configure YAML source code with Visual Studio. For Linux OS, one can install it online through the terminal. Taking Ubuntu as an example, one can type the command `'sudo apt install libyaml-cpp-dev'` on the terminal to install YAML. After the installation of YAML, type the command **run\_GOOD GOOD\_cfg.txt** or **run\_GOOD GOOD\_cfg.yaml**, and one will get some scrolling information that `'wget'` gives if `'printInfoWget = 1'` is set. The corresponding GNSS observations and products will be downloaded and saved in the directories according to the configuration file `'GOOD_cfg.txt'` or `'GOOD_cfg.yaml'`.
3. The other one is to run a python script `'run_GOOD.py'` to generate the corresponding configuration file via command line. i.e., `'python run_GOOD.py -dir_main D:\data -time 2022 32 3 -ftp whu -obs daily igs site_igs.list 0 24'`, which will download the IGS observations according to `'site_igs.list'` for three consecutive days for the start of February 1, 2022. More information can refer to the help information of `'run_GOOD.py'`, which can be accessed by

typing ‘python run\_GOOD.py’ or ‘python run\_GOOD.py -h’. Some examples are shown below:

- 1) ‘python run\_GOOD.py -dir\_main D:\data -time 2022 32 3 -ftp cddis -obs daily igs site\_igs.list 0 24’;
- 2) ‘python run\_GOOD.py -dir\_main D:\data -time 2022 32 3 -ftp cddis -nav daily mixed3 igs 0 24 -orbclk igs 0 24 -eop igs 0 24’;
- 3) ‘python run\_GOOD.py -dir\_main D:\data -time 2022 32 3 -ftp whu -obs daily igs site\_igs.list 0 24 -nav daily mixed3 igs 0 24’;
- 4) ‘python run\_GOOD.py -dir\_main D:\data -time 2022 32 3 -ftp whu -snx -roti -atx’;
- 5) ‘python run\_GOOD.py -dir\_main D:\data -time 2022 32 3 -ftp whu -obs daily igs site\_igs.list 0 24 -nav daily mixed3 igs 0 24 -orbclk igs 0 24 -eop igs 0 24 -obx cod\_m-dsb cod -snx -ion all -roti -trop igs site\_igs.list -atx’.

**NOTE:** The main directory should be given in advance, then the executable program ‘run\_GOOD’ and the station list ‘site\_\*.list’ need to be placed in the main directory, and the configuration file generated by the python script ‘run\_GOOD.py’ is also in the main directory.

The key to master the basic operation of GOOD is to be familiar with the contents of configuration file ‘GOOD\_cfg.txt’ or ‘GOOD\_cfg.yaml’. Taking ‘GOOD\_cfg.txt’ as an example, the details are shown as follows:

1. For the components of ‘The directories of GNSS observations and products’, they are used for GNSS data and product storage. One can get the description of every sub-directory after the sign ‘%’. It is noted that one should only modified the component which is behind ‘=’ and before ‘%’. Note that the storage directories contain root/main directory ‘mainDir’ and some sub-directories (i.e., ‘obsDir’, ‘navDir’, et al.). It is noted that the ‘mainDir’ should be with full path, while the sub-directories only need the relative path. Taking ‘obsDir’ as an example, the observations will be stored in ‘D:\Projects\test\_PPP\data\obs’.

```
# The directories of GNSS observations and products -----
mainDir      : D:\Projects\test_PPP\data      # The root/main directory of GNSS observations and products
obsDir       : obs                          # The sub-directory of RINEX format observation files, which needs to inherit the path of root/main directory
navDir       : nav                          # The sub-directory of RINEX format broadcast ephemeris files, which needs to inherit the path of root/main directory
orbDir       : orb                          # The sub-directory of SP3 format precise ephemeris files, which needs to inherit the path of root/main directory
clkDir       : clk                          # The sub-directory of RINEX format precise clock files, which needs to inherit the path of root/main directory
eopDir       : eop                          # The sub-directory of earth rotation/orientation parameter (EOP) files, which needs to inherit the path of root/main directory
obxDir       : obx                          # The sub-directory of MGEX final/rapid and/or CNES real-time ORBEX (ORBit EXchange format) files, which needs to inherit the p
biaDir       : bia                          # The sub-directory of CODE/MGEX differential code/signal bias (DCB/DSB), MGEX observable-specific signal bias (OSB), and/or CN
snxDir       : snx                          # The sub-directory of SINEX format IGS weekly solution files, which needs to inherit the path of root/main directory
ionDir       : ion                          # The sub-directory of CODE/IGS global ionosphere map (GIM) files, which needs to inherit the path of root/main directory
ztdDir       : ztd                          # The sub-directory of CODE/IGS tropospheric product files, which needs to inherit the path of root/main directory
tblDir       : tbl                          # The sub-directory of table files (i.e., ANTEX, ocean tide loading files, etc.) for processing, which needs to inherit the path
```

2. ‘3partyDir’: (optional) The directory where third-party softwares (i.e., ‘wget’, ‘gzip’, ‘crx2rnx’ etc) are stored. This option is not needed if you have set the path or environment variable for them. **There are two items for the setting of ‘3partyDir’:**

**1<sup>st</sup> item:** the switch (0: off 1: on);

**2<sup>nd</sup> item:** The absolute path where third-party softwares are stored.

3. ‘logFile’: The log file with full path that gives the indications of whether the data downloading is successful or not. **There are two items for the setting of ‘logFile’:**

**1<sup>st</sup> item:** (0: off 1: overwrite mode 2: append mode);

**2<sup>nd</sup> item:** The absolute/full path where log file is stored.

4. ‘procTime’: The setting of start time for processing. there are two choices: one is year, month, day, while the other is year, day of year. The last parameter is number of consecutive days for data downloading.

**1<sup>st</sup> item:** can be set to 1 or 2 (1: year month day ndays 2: year doy ndays).

5. 'minusAdd1day': The setting of the day before and after the current day for precise satellite orbit and clock products downloading. **There is only one item for the setting of 'minusAdd1day':**  
**1<sup>st</sup> item:** the switch (0: off 1: on).
6. 'printInfoWget': Printing the information generated by 'wget'. **Only one item is needed for the setting of 'printInfoWget':**  
**1<sup>st</sup> item:** the switch (0: off 1: on).
7. 'ftpDownloading': The setting of the master switch for data downloading. **There are two items for the setting of 'ftpDownloading':**  
**1<sup>st</sup> item:** the switch (0: off 1: on);  
**2<sup>nd</sup> item:** the FTP archive, i.e., cddis, ign, or whu.
8. 'getObs': GNSS observation data downloading option. **There are six items for the setting of 'getObs':**  
**1<sup>st</sup> item:** (0: off 1: on);  
**2<sup>nd</sup> item:** 'daily', 'hourly', 'highrate', '30s', '5s', or '1s';  
**3<sup>rd</sup> item:** 'igs', 'mgex', 'igm', 'cut', 'ga', 'hk', 'ngs', 'epn', 'pbo2', 'pbo3', or 'pbo5';  
**4<sup>th</sup> item:** 'all' (observation files downloaded in the whole directory) or the ull path of site list (observation files downloaded site-by-site according to the site list file);  
**5<sup>th</sup> item:** Start hour (00, 01, 02, ...), **which is valid ONLY when the 2<sup>nd</sup> item is 'hourly', 'highrate', '5s', or '1s';**  
**6<sup>th</sup> item:** The consecutive hours, i.e., '01 3' denotes 01, 02, and 03, **which is valid ONLY when the 2<sup>nd</sup> item is 'hourly', 'highrate', '5s', or '1s'.**  
**NOTE:** If the 3<sup>rd</sup> item is 'igs', 'mgex', 'igm', or 'ga', the 2<sup>nd</sup> item can be 'daily', 'hourly', or 'highrate'; If the 3<sup>rd</sup> item is 'cut', 'ngs', 'epn', 'pbo2', 'pbo3', or 'pbo5', the 2<sup>nd</sup> item should be 'daily'; If the 3<sup>rd</sup> item is 'hk', the 2<sup>nd</sup> item can be 1) '30s', '5s', or '1s' 2) '30s', '05s', or '01s'. However, '30 s', '5 s', or '1 s' is NOT allowed.  
**NOTE:** If the 3<sup>rd</sup> item is 'hk' or 'ngs', the 4<sup>th</sup> item should ONLY be the full path of site list.  
**INFO:** The 2<sup>nd</sup> item 'igs' is for IGS observation (RINEX version 2.xx, short name 'd');  
The 2<sup>nd</sup> item 'mgex' is for MGEX observation (RINEX version 3.xx, long name 'crx');  
The 2<sup>nd</sup> item 'igm' is for the union of IGS and MGEX (IGS + MGEX, while the priority of MGEX sites is higher) observation with respect to the site name;  
The 2<sup>nd</sup> item 'cut' is for Curtin University of Technology (CUT) observation (RINEX version 3.xx, long name 'crx');  
The 2<sup>nd</sup> item 'ga' is for Geoscience Australia (GA) observation (RINEX version 3.xx, long name 'crx');  
The 2<sup>nd</sup> item 'hk' is for Hong Kong CORS observation (RINEX version 3.xx, long name 'crx');  
The 2<sup>nd</sup> item 'ngs' is for NGS/NOAA CORS observation (RINEX version 2.xx, short name 'd');  
The 2<sup>nd</sup> item 'epn' is for EUREF Permanent Network (EPN) observation (RINEX version 3.xx, long name 'crx' and RINEX version 2.xx, short name 'd');  
The 2<sup>nd</sup> item 'pbo2' is for Plate Boundary Observatory (PBO) observation (RINEX version 2.xx, short name 'd');  
The 2<sup>nd</sup> item 'pbo3' is for Plate Boundary Observatory (PBO) observation (RINEX version 3.xx, long name 'crx');  
The 2<sup>nd</sup> item 'pbo5' is for Plate Boundary Observatory (PBO) observation (taking the union of pbo2 and pbo3 (pbo2 + pbo3), while the priority of pbo3 sites is higher).

9. 'getNav': Various broadcast ephemeris downloading option. **There are seven items for the setting of 'getNav':**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** 'daily' or 'hourly';

**3<sup>rd</sup> item:** 'gps', 'glo', 'bds', 'gal', 'qzs', 'irn', 'mixed3', 'mixed4', or 'all';

**4<sup>th</sup> item:** Analysis center (i.e., 'igs', 'dlr', 'ign', or 'gop') that carries out the combination of broadcast ephemeris for mixed navigation data. From CDDIS or WHU FTP, 'igs' and 'dlr' can be downloaded, and from IGN, 'igs' and 'ign' can be downloaded. The downloading of 'gop' is via the other FTP addresses;

**5<sup>th</sup> item:** The full path of site.list, which is valid ONLY when the 2<sup>nd</sup> item 'hourly' is set;

**6<sup>th</sup> item:** Start hour (00, 01, 02, ...) , which is valid ONLY when the 2<sup>nd</sup> item 'hourly' is set;

**7<sup>th</sup> item:** The consecutive hours, i.e., '01 3' denotes 01, 02, and 03, which is valid ONLY when the 2<sup>nd</sup> item 'hourly' is set.

**NOTE:** If the 2<sup>nd</sup> item is 'daily', the 3<sup>rd</sup> item should be 'gps', 'glo', 'mixed3', or 'mixed4'; If the 2<sup>nd</sup> item is 'hourly', the 3<sup>rd</sup> item can be 'gps', 'glo', 'bds', 'gal', 'qzs', 'irn', 'mixed3', or 'all'.

**NOTE:** The 4<sup>th</sup> item is valid ONLY when the 3<sup>rd</sup> item is 'mixed3'.

**NOTE:** The 3<sup>rd</sup> item 'mixed3' is for RINEX 3.xx, while 'mixed4' is for RINEX 4.xx.

10. 'getOrbClk': Satellite final/rapid/ultra-rapid precise orbit and clock downloading option. **There are four items for the setting of 'getOrbClk':**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., IGS final: 'cod', 'emr', 'esa', 'gfz', 'grg', 'igs', 'jpl', 'mit', 'all', 'cod+igs', 'cod+gfz+igs', ...; MGEX final: 'cod\_m', 'gfz\_m', 'grg\_m', 'iac\_m', 'jax\_m', 'sha\_m', 'whu\_m', 'all\_m', 'cod\_m+gfz\_m', 'grg\_m+whu\_m', ...; rapid: 'cod\_r', 'emr\_r', 'esa\_r', 'gfz\_r', 'igs\_r'; ultra-rapid: 'esa\_u', 'gfz\_u', 'igs\_u', 'whu\_u'; real-time: 'cnt'). If it is set to be 'all', the precise orbit and clock products from 'cod', 'emr', 'esa', 'gfz', 'grg', 'igs', 'jpl', and 'mit' will be downloaded. If it is set to be 'all\_m', the multi-GNSS precise orbit and clock products from 'cod\_m', 'gfz\_m', 'grg\_m', 'iac\_m', 'jax\_m', 'sha\_m', and 'whu\_m' will be downloaded. **NOTE:** The option of 'cnt' is for real-time precise orbit and clock products from CNES offline files.

**3<sup>rd</sup> item:** Start hour (00, 06, 12, or 18 for esa\_u and igs\_u; 00, 03, 06, ... for gfz\_u; 01, 02, 03, ... for whu\_u), which is valid ONLY when the 2<sup>nd</sup> item 'esa\_u', 'gfz\_u', 'igs\_u', or 'whu\_u' is set;

**4<sup>th</sup> item:** The consecutive sessions, which is valid ONLY when the 2<sup>nd</sup> item 'esa\_u', 'gfz\_u', 'igs\_u', or 'whu\_u' is set. i.e., '00 3' denotes 00, 06, and 12 for esa\_u and/or igs\_u, 00, 03, and 06 for gfz\_u, while 00, 01, and 02 for whu\_u.

```
1. string ac_i = acs[i];
2. int prodType = 0;
3.
4. /* cnt: CNES real-time orbit and clock products from CNES offline files */
5. if (ac_i == "cnt") prodType = PROD_REALTIME;
6.
7. /* esa_u: ESA ultra-rapid orbit and clock products
8.    gfz_u: GFZ ultra-rapid orbit and clock products
9.    igs_u: IGS ultra-rapid orbit and clock products
10.   whu_u: WHU ultra-rapid orbit and clock products
11. */
```



```

12. std::vector<string> ultraAc = { "esa_u", "gfz_u", "igs_u", "whu_u" };
13. for (int i = 0; i < ultraAc.size(); i++)
14. {
15.     if (ac_i == ultraAc[i])
16.     {
17.         prodType = PROD_ULTRA_RAPID;
18.
19.         break;
20.     }
21. }
22.
23. /* cod_r: CODE rapid orbit and clock products
24.    emr_r: NRCan rapid orbit and clock products
25.    esa_r: ESA rapid orbit and clock products
26.    gfz_r: GFZ rapid orbit and clock products
27.    igs_r: IGS rapid orbit and clock products
28. */
29. std::vector<string> rapidAc = { "cod_r", "emr_r", "esa_r", "gfz_r", "igs_r"
    };
30. for (int i = 0; i < rapidAc.size(); i++)
31. {
32.     if (ac_i == rapidAc[i])
33.     {
34.         prodType = PROD_RAPID;
35.
36.         break;
37.     }
38. }
39.
40. /* cod: CODE final orbit and clock products
41.    emr: NRCan final orbit and clock products
42.    esa: ESA final orbit and clock products
43.    gfz: GFZ final orbit and clock products
44.    grg: CNES final orbit and clock products
45.    igs: IGS final orbit and clock products
46.    jpl: JPL final orbit and clock products
47.    mit: MIT final orbit and clock products
48. */
49. std::vector<string> finalAcIGS = { "cod", "emr", "esa", "gfz", "grg", "igs",
    "jpl", "mit" };
50. for (int i = 0; i < finalAcIGS.size(); i++)
51. {
52.     if (ac_i == finalAcIGS[i])
53.     {

```

```

54.         prodType = PROD_FINAL_IGS;
55.
56.         break;
57.     }
58. }
59.
60. /* cod_m: CODE multi-GNSS final orbit and clock products
61.    gfz_m: GFZ multi-GNSS final orbit and clock products
62.    grg_m: CNES multi-GNSS final orbit and clock products
63.    iac_m: Russia Information and Analysis Center (IAC) multi-
        GNSS final orbit and clock products
64.    jax_m: Japan Aerospace Exploration Agency (JAXA) multi-
        GNSS final orbit and clock products
65.    sha_m: Shanghai Observatory (SHAO) multi-
        GNSS final orbit and clock products
66.    whu_m: Wuhan University (WHU) multi-GNSS final orbit and clock products
67. */
68. std::vector<string> acMGEX = { "cod_m", "gfz_m", "grg_m", "iac_m", "jax_m",
    "sha_m", "whu_m" };
69. for (int i = 0; i < acMGEX.size(); i++)
70. {
71.     if (ac_i == acMGEX[i])
72.     {
73.         prodType = PROD_FINAL_MGEX;
74.
75.         break;
76.     }
77. }

```

11. ‘getEop’: Earth rotation/orientation parameter (ERP/EOP) downloading option. **There are four items for the setting of ‘getEop’:**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., final: 'cod', 'emr', 'esa', 'gfz', 'grg', 'igs', 'jpl', 'mit'; ultra-rapid: 'esa\_u', 'gfz\_u', 'igs\_u');

**NOTE:** The 3rd and 4th items are valid ONLY when the 2nd item is 'esa\_u', 'gfz\_u', or 'igs\_u'.

12. ‘getObx’: ORBEX (ORBit EXchange format) for satellite attitude information downloading option. **There are two items for the setting of ‘getObx’:**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., final/rapid: 'cod', 'gfz', 'grg', 'whu', 'all'; real-time: 'cnt'). If it is set to be ‘all’, the ORBEX products from ‘cod’, ‘gfz’, ‘grg’, and ‘whu’ will be downloaded. **NOTE:** The option of 'cnt' is for real-time ORBEX from CNES offline files.

13. ‘getDsb’: Differential code/signal bias (DCB/DSB) downloading option. **There are two items for the setting of ‘getDsb’:**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., 'cod', 'cas', 'all'). If it is set to be 'all', the DCB/DSB products from 'cod' and 'cas' will be downloaded.

**NOTE:** DCBs from CODE are for GPS and GLONASS, while DSBs from CAS are for multiple GNSS.

14. 'getOsb': Observable-specific signal bias (OSB) downloading option. **There are two items for the setting of 'getOsb':**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., final/rapid: 'cas', 'cod', 'gfz', 'grg', 'whu', 'all'; real-time: 'cnt'). If it is set to be 'all', the OSB products from 'cas', 'cod', 'gfz', 'grg', and 'whu' will be downloaded.

NOTE: The option of 'cnt' is for real-time OSBs from CNES offline files.

15. 'getSnx': IGS weekly SINEX downloading option. **There is only one item for the setting of 'getSnx':**

**1<sup>st</sup> item:** (0: off 1: on).

16. 'getlon': Global ionosphere map (GIM) downloading option. **There are two items for the setting of 'getOsb':**

**1<sup>st</sup> item:** (0: off 1: on);

**2<sup>nd</sup> item:** Analysis center (i.e., final: 'cas', 'cod', 'emr', 'esa', 'igs', 'jpl', 'upc', 'all', 'cas+cod', 'cas+cod+igs', ...; rapid: 'cas\_r', 'cod\_r', 'esa\_r', 'igs\_r', 'jpl\_r', 'upc\_r', 'all\_r', 'cas\_r+cod\_r', 'cas\_r+cod\_r+igs\_r', ...; hourly rapid: 'emr\_hr', 'upc\_hr'; 15-min rapid: 'upc\_0.25hr'; predicted: 'cod\_1d', 'cod\_2d'). If it is set to be 'all', the GIM final products from 'cas', 'cod', 'emr', 'esa', 'igs', 'jpl', and 'upc' will be downloaded. If it is set to be 'all\_r', the GIM rapid products from 'cas\_r', 'cod\_r', 'esa\_r', 'igs\_r', 'jpl\_r', and 'upc\_r' will be downloaded.

17. 'getRoti': Rate of TEC index (ROTI) downloading option. **There is only one item for the setting of 'getRoti':**

**1<sup>st</sup> item:** (0: off 1: on).

18. 'getTrp': CODE/IGS tropospheric product downloading option. **There are three items for the setting of 'getTrp':**

**1<sup>st</sup> item:** (0:off 1:on);

**2<sup>nd</sup> item:** Analysis center (i.e., 'igs' or 'cod');

**3<sup>rd</sup> item:** 'all' (tropospheric product downloaded in the whole directory) or the full path of site.list (tropospheric product files downloaded site-by-site according to the 'site.list', i.e., cut0, gmsd, jfng, ...) is valid.

**NOTE:** The 3rd item is valid ONLY when the 2nd item 'igs' is set.

19. 'getAtx': ANTEX format antenna phase center correction downloading option. **There is only one item for the setting of 'getAtx':**

**1<sup>st</sup> item:** (0: off 1: on).

**NOTE: If some GNSS data cannot be successfully downloaded, check your network first. Then, check if the file exists on the remote server. Finally, rerun 'run\_GAMP\_GOOD gamp\_good.cfg' to try again. Don't worry, once the data has been downloaded, it will not be downloaded repeatedly.**

Any suggestions, corrections, and comments about **GOOD** are sincerely welcomed and could be sent to:

Feng Zhou

Email: [zhouforme@163.com](mailto:zhouforme@163.com)

WeChat: zhouforme0318

It is recommended to acknowledge GOOD toolkit or the *GAMP* paper published in GPS Solutions (<https://link.springer.com/article/10.1007/s10291-018-0699-9>) when you find it useful!

Some FTP addresses are listed as follows:

For Curtin University of Technology (CUT) observation files: <http://saegnss2.curtin.edu/ldc/rinex3/daily/>

For Geoscience Australia (GA) observation files: <ftp://ftp.data.gnss.ga.gov.au/>

For Hong Kong CORS observation files: <ftp://ftp.geodetic.gov.hk/rinex3/>

For CODE DCB and tropospheric product files: <ftp://ftp.aiub.unibe.ch/CODE/>

For CNES real-time orbit and clock products in offline mode: [http://www.ppp-wizard.net/products/REAL\\_TIME/](http://www.ppp-wizard.net/products/REAL_TIME/)

For IGS ANTEX file: <https://files.igs.org/pub/station/general/>

```
1. /**
2.  * @brief   : init - Get FTP archive for CDDIS, IGN, or WHU
3.  * @param[I]: none
4.  * @param[0]: none
5.  * @return  : none
6.  * @note    :
7.  **/
8. void FtpUtil::init()
9. {
10.     /* FTP archive for CDDIS */
11.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/daily");          /* IGS daily observation (30s) files */
12.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/hourly");          /* IGS hourly observation (30s) files */
13.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/highrate");       /* IGS high-rate observation (1s) files */
14.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/daily");          /* MGEX daily observation (30s) files */
15.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/hourly");          /* MGEX hourly observation (30s) files */
16.     _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/highrate");       /* MGEX high-rate observation (1s) files */
```

```
17. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/d
    ata/daily"); /* broadcast ephemeris files */
18. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts"); /* IGS SP3 files */
19. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts"); /* IGS CLK files */
20. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts"); /* IGS EOP files */
21. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts"); /* IGS weekly SINEX files */
22. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/mgex"); /* MGEX SP3 files */
23. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/mgex"); /* MGEX CLK files */
24. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/mgex"); /* MGEX ORBEX files */
25. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/bias"); /* MGEX DSB files */
26. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/mgex"); /* MGEX OSB files */
27. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/ionex"); /* global ionosphere map (GIM) files */
28. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/ionex"); /* Rate of TEC index (ROTI) files */
29. _ftpArchive.CDDIS.push_back("https://gdc.cddis.eosdis.nasa.gov/pub/gnss/p
    roducts/troposphere/zpd"); /* IGS final tropospheric product files */
30.
31. /* FTP archive for IGN */
32. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data");
    /* IGS daily observation (30s) files */
33. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data/hourly");
    /* IGS hourly observation (30s) files */
34. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data/highrate");
    /* IGS high-rate observation (1s) files */
35. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data");
    /* MGEX daily observation (30s) files */
36. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data/hourly");
    /* MGEX hourly observation (30s) files */
37. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data/highrate");
    /* MGEX high-rate observation (1s) files */
38. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/data");
    /* broadcast ephemeris files */
39. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products");
    /* IGS SP3 files */
```

```
40. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products");
    /* IGS CLK files */
41. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products");
    /* IGS EOP files */
42. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products");
    /* IGS weekly SINEX files */
43. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/mgex");
    /* MGEX SP3 files */
44. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/mgex");
    /* MGEX CLK files */
45. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/mgex");
    /* MGEX ORBEX files */
46. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/mgex/dcb");
    /* MGEX DSB files */
47. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/mgex");
    /* MGEX OSB files */
48. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/ionosphere"
    );
    /* global ionosphere map (GIM) files */
49. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/ionosphere"
    );
    /* Rate of TEC index (ROTI) files */
50. _ftpArchive.IGN.push_back("ftp://igs.ign.fr/pub/igs/products/troposphere
    ");
    /* IGS final tropospheric product files */
51.
52. /* FTP archive for WHU */
53. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/data/daily");
    /* IGS daily observation (30s) files */
54. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/data/hourly");
    /* IGS hourly observation (30s) files */
55. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/highrate");
    /* IGS high-rate observation (1s) files */
56. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/data/daily");
    /* MGEX daily observation (30s) files */
57. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/data/hourly");
    /* MGEX hourly observation (30s) files */
58. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/highrate");
    /* MGEX high-rate observation (1s) files */
59. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/data/daily");
    /* broadcast ephemeris files */
60. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products");
    /* IGS SP3 files */
61. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products");
    /* IGS CLK files */
62. _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products");
    /* IGS EOP files */
```

```
63.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products");
        /* IGS weekly SINEX files */
64.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/mgex");
        /* MGEX SP3 files */
65.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/mgex");
        /* MGEX CLK files */
66.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/mgex");
        /* MGEX ORBEX files */
67.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/mgex/dc
b");
        /* MGEX DSB files */
68.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/mgex");
        /* MGEX OSB files */
69.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/ionex")
;
        /* global ionosphere map (GIM) files */
70.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/ionex")
;
        /* Rate of TEC index (ROTI) files */
71.     _ftpArchive.WHU.push_back("ftp://igs.gnsswhu.cn/pub/gps/products/troposp
here/new");
        /* IGS final tropospheric product files */
72. } /* end of init */
```