

***GOOD* Users Guide**

Version 3.1

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Last modified: Feb 20, 2024



泛在导航与融合定位

Ubiquitous Navigation & Integrated positioning lab in Quest

GOOD (Gnss Observations and prOducts Downloader) is a powerful and easy-to-use lightweight GNSS observations and product downloading toolkit, which is developed by the **UNI**Q group (**U**biquitous **N**avigation & **I**ntegrated positioning lab in **Q**uest) at Shandong University of Science and Technology (SDUST). Since April 16, 2021, GOOD has been continuously updated and improved with fourteen versions from 1.0 to 3.1, and it has received unanimous praise from many universities and scientific research institutions throughout China. Inspired by this, we decided to make the recent version available to GNSS users around the world with the hope to help more people. The source codes, user manual, and some examples are now available at GPS Toolbox (<https://www.ngs.noaa.gov/gps-toolbox/GOOD.shtml>) and also GitHub (<https://github.com/zhouforme0318/GAMPII-GOOD>).

Features

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 observations	30 s	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily ftp://igs.ign.fr/pub/igs/data ftp://igs.gnsswhu.cn/pub/gps/data/daily
	Hourly observations	30 s	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/hourly ftp://igs.ign.fr/pub/igs/data/hourly ftp://igs.gnsswhu.cn/pub/gps/data/hourly
	High-rate observations	1 s	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/highrate ftp://igs.ign.fr/pub/igs/data/highrate ftp://igs.gnsswhu.cn/pub/highrate
	Precise satellite orbits	5 min, 15 min	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products ftp://igs.ign.fr/pub/igs/products ftp://igs.gnsswhu.cn/pub/gps/products
	Precise satellite clocks	5 s, 30 s, 5 min	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex ftp://igs.ign.fr/pub/igs/products/mgex ftp://igs.gnsswhu.cn/pub/gps/products/mgex
	EOP	Daily	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products ftp://igs.ign.fr/pub/igs/products ftp://igs.gnsswhu.cn/pub/gps/products https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex

			ftp://igs.ign.fr/pub/igs/products/mgex ftp://igs.gnsswhu.cn/pub/gps/products/mgex
	SINEX	Daily, weekly	ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products ftp://igs.ign.fr/pub/igs/products ftp://igs.gnsswhu.cn/pub/gps/products
	ORBEX	30 s, 15 min	ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products ftp://igs.ign.fr/pub/igs/products ftp://igs.gnsswhu.cn/pub/gps/products ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex ftp://igs.ign.fr/pub/igs/products/mgex ftp://igs.gnsswhu.cn/pub/gps/products/mgex
IGS/DLR/IGN /GOP/WRD	Broadcast ephemeris	10 min, 30 min, 1 h, 2 h	ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/data/daily ftp://igs.ign.fr/pub/igs/data ftp://igs.gnsswhu.cn/pub/gps/data/daily ftp://ftp.pecny.cz/LDC/orbits_brd/gop3 https://igs.bkg.bund.de/root_ftp/IGS/BRDC
CUT	Daily observations	30 s	http://saegnss2.curtin.edu/lcd/rinex3/daily
HK	Daily observations	30 s	https://rinex.geodetic.gov.hk
	Hourly observations	5 s	
	High-rate observations	1 s	
NGS/NOAA	Daily observations	30 s	https://noaa-cors-pds.s3.amazonaws.com/rinex
EPN	Daily observations	30 s	ftp://ftp.epncb.oma.be/pub/obs
PBO	Daily observations	30 s	https://data.unavco.org/archive/gnss/rinex3
	Hourly observations	15 s	https://data.unavco.org/archive/gnss/hourly/rinex
	High-rate observations	1 s, 0.5 s, 0.2 s, 0.1 s, 0.05 s	https://data.unavco.org/archive/gnss/highrate
AIUB/MGEX/ CAS	DCB/DSB/OSB	Daily, monthly	ftp://ftp.aiub.unibe.ch/CODE ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/bias ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/mgex ftp://igs.ign.fr/pub/igs/products/mgex/dcb ftp://igs.ign.fr/pub/igs/products ftp://igs.ign.fr/pub/igs/products/mgex ftp://igs.gnsswhu.cn/pub/gps/products/mgex/dcb ftp://igs.gnsswhu.cn/pub/gps/products ftp://igs.gnsswhu.cn/pub/gps/products/mgex
IGS	Ionospheric products	15 min, hourly, daily, 2-day	ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex ftp://igs.ign.fr/pub/igs/products/ionosphere ftp://igs.gnsswhu.cn/pub/gps/products/ionex
	ROTI	Daily	ftp://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/ionex ftp://igs.ign.fr/pub/igs/products/ionosphere ftp://igs.gnsswhu.cn/pub/gps/products/ionex

	ANTEX	N/A	https://files.igs.org/pub/station/general
IGS/CODE	Tropospheric products	30 s, 2 h	https://gdc.cddis.eosdis.nasa.gov/pub/gnss/products/troposphere/zpd ftp://igs.ign.fr/pub/igs/products/troposphere ftp://igs.gnsswhu.cn/pub/gps/products/troposphere/new ftp://ftp.aiub.unibe.ch/CODE

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

How to run GOOD?

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 (i.e., ‘run_GOOD’) is or give the full path of the executable GOOD through the terminal or set the environmental variable for GOOD. Type ‘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.yaml’.

NOTE: Double-clicking the executable program will NOT work for data downloading.

The key to master the basic operation of GOOD is to be familiar with the contents of configuration file ‘GOOD_cfg.yaml’, which is expressed in YAML format. The detailed description of YAML can be accessed at ‘<https://github.com/jbeder/yaml-cpp>’.

If one uses Visual Studio, we also provide the document named ‘Configure and build YAML lib for Visual Studio under Windows_xx’ in English (xx=en) and Chinese (xx=cn) version for reference. In fact, we have added the source codes of YAML as a third-party library, which will be compiled with the source codes of GOOD. The details of ‘GOOD_cfg.yaml’ are shown as follows:

1. For the components of ‘The root/main/sub 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 sub-directories need to inherit the path of ‘mainDir’. For example, if

the setting of ‘**mainDir**’ is ‘C:\data’ and ‘**obsDir**’ is ‘obs’, the observations will be downloaded in the directory of ‘C:\data\obs’. For Windows OS, some third-party softwares (i.e., ‘wget’, ‘gzip’, ‘crx2rnx’ etc) should be stored in the directory of ‘**3partyDir**’. This option is not needed for Linux/Mac if you have set the path or environment variable for them.

NOTE: It is recommended that one can modify the setting of ‘mainDir’, while one don’t need to modify the setting of sub-directory. Keeping the default setting for each sub-directory is OK.

2. ‘**procTime**’: The setting of start time for processing. there are three choices: the first one is year, month, day, the second one is year, day of year, and the third one is GPS week, day within week. The last parameter is number of consecutive days for data downloading.

1st item: can be set to 1, 2 or 3 (1: the format of year month day 2: the format of year doy 3: the format of GPS week, day within week).

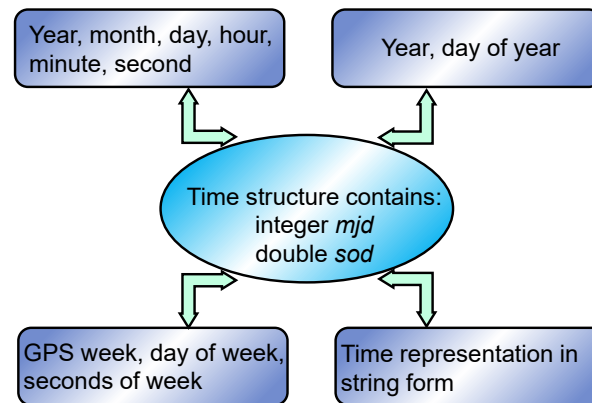


Fig. 1 The structure of time conversion module

3. ‘**minusAdd1day**’: The setting (0: off 1: on) of day before and after the current day for precise satellite orbit and clock products downloading.
4. ‘**merge_sp3files**’: The setting (0: off 1: on) of merging three consecutive SP3 files into one file.
5. ‘**printInfoWget**’: The setting (0: off 1: on) of printing the information generated by ‘wget’.
6. ‘**ftpDownloading**’: The first-level setting of master switch for data downloading. There are two second-level settings as follows:
‘**opt4ftp**’: the switch (0: off 1: on).

‘ftpArch’: the FTP archive, i.e., cddis, ign, or whu.

7. ‘getObs’: The first-level setting of GNSS observation data downloading option.

There are seven second-level settings as follows:

‘opt4obs’: the switch (0: off 1: on).

‘obsType’: ‘daily’, ‘hourly’, ‘highrate’, ‘30s’, ‘5s’, or ‘1s’.

‘obsFrom’: ‘igs’, ‘mgex’, ‘igm’, ‘cut’, ‘hk’, ‘ngs’, ‘epn’, ‘pbo’, or ‘chi’.

‘obsList’: ‘all’ (observation files downloaded in the whole directory) or the file name of site list (observation files downloaded site-by-site according to the site list file).

‘sHH4obs’: Start hour (00, 01, 02, ...).

‘nHH4obs’: The consecutive hours.

‘l2s4obs’: Valid only for the observation files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.

NOTE: The items of ‘sHH4obs’ and ‘nHH4obs’ are valid ONLY when the item of ‘obsType’ is ‘hourly’, ‘highrate’, ‘5s’, or ‘1s’.

NOTE: If the item of ‘obsFrom’ is ‘igs’, ‘mgex’, or ‘igm’, the item of ‘obsType’ can be ‘daily’, ‘hourly’, or ‘highrate’; If the item of ‘obsFrom’ is ‘cut’, ‘ngs’, ‘epn’, or ‘pbo’, the item of ‘obsType’ should be ‘daily’; If the item of ‘obsFrom’ is ‘hk’, the item of ‘obsType’ can be ‘30s’, ‘5s’, or ‘1s’.

INFO: The item of ‘obsFrom’ is ‘igs’, denoting IGS observation (RINEX version 2.xx, short name ‘d’).

The item of ‘obsFrom’ is ‘mgex’, denoting MGEX observation (RINEX version 3.xx, long name ‘crx’).

The item of ‘obsFrom’ is ‘igm’, denoting the union of IGS and MGEX (IGS + MGEX, while the priority of MGEX sites is higher) observation with respect to the site name.

The item of ‘obsFrom’ is ‘cut’, denoting Curtin University of Technology (CUT) observation (RINEX version 3.xx, long name ‘crx’).

The item of ‘obsFrom’ is ‘hk’, denoting Hong Kong CORS observation (RINEX version 3.xx, long name ‘crx’).

The item of ‘obsFrom’ is ‘ngs’, denoting NGS/NOAA CORS observation (RINEX

version 2.xx, short name 'd').

The item of 'obsFrom' is 'epn', denoting EUREF Permanent Network (EPN) observation (RINEX version 3.xx, long name 'crx' and RINEX version 2.xx, short name 'd').

The item of 'obsFrom' is 'pbo3', denoting Plate Boundary Observatory (PBO) observation (RINEX version 3.xx, long name 'crx').

8. 'getNav': The first-level setting of various broadcast ephemeris downloading option.

There are eight second-level settings as follows:

'opt4nav': the switch (0: off 1: on).

'navType': 'daily' or 'hourly'.

'navSys': 'gps', 'glo', 'bds', 'gal', 'qzs', 'irn', 'mixed3', 'mixed4', or 'all'.

'navFrom': Analysis center (i.e., 'igs', 'dlr', 'ign', 'gop', or 'wrđ') 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' and/or 'wrđ' is via the other FTP addresses.

'navList': The file name of site.list is ONLY valid if the item of 'navType' is 'hourly'.

'sHH4nav': Start hour (00, 01, 02, ...).

'nHH4nav': The consecutive hours.

'ls4nav': Valid only for the broadcast ephemeris files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.

NOTE: The items of 'navList', 'sHH4nav', and 'nHH4nav' are valid ONLY when the item of 'navType' is set to be 'hourly'.

NOTE: If the item of 'navType' is 'daily', the item of 'navSys' should be 'gps', 'glo', 'mixed3', or 'mixed4'; If the item of 'navType' is 'hourly', the item of 'navSys' can be 'gps', 'glo', 'bds', 'gal', 'qzs', 'irn', 'mixed', or 'all'.

NOTE: The item of 'navFrom' is ONLY valid when the item of 'navSys' is 'mixed3'.

NOTE: The item of 'navSys' is 'mixed3' denoting RINEX 3.xx format broadcast ephemeris, while 'mixed4' denotes RINEX 4.xx format broadcast ephemeris.

9. 'getOrbClk': The first-level setting of satellite final/rapid/ultra-rapid precise orbit

and clock downloading option. There are five second-level settings as follows:

'opt4oc': the switch (0: off 1: on).

'ocFrom': Analysis center (i.e., IGS final: 'cod', 'emr', 'esa', 'gfz', 'grg', 'igs', 'jgx', 'jpl', 'mit', 'all', 'cod+igs', 'cod+gfz+igs', ...; MGEX final: 'cod_m', 'gfz_m', 'grg_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').

'sHH4oc': 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).

'nHH4oc': The consecutive sessions.

'l2s4oc': Valid only for the precise orbit and clock files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.

NOTE: The items of **'sHH4oc'** and **'nHH4oc'** are ONLY valid when the item of **'ocFrom'** is set to be 'esa_u', 'gfz_u', 'igs_u', or 'whu_u' is set.

10. **'getEop'**: The first-level setting of earth rotation/orientation parameter (ERP/EOP) downloading option. There are five second-level settings as follows:

'opt4eop': the switch (0: off 1: on).

'eopFrom': Analysis center (i.e., final: 'cod', 'emr', 'esa', 'gfz', 'grg', 'igs', 'jpl', 'mit'; ultra-rapid: 'esa_u', 'gfz_u', 'igs_u').

'sHH4eop': Valid ONLY when the item of **'eopFrom'** is set to be 'esa_u', 'gfz_u', or 'igs_u'.

'nHH4eop': Valid ONLY when the item of **'eopFrom'** is set to be 'esa_u', 'gfz_u', or 'igs_u'.

'l2s4eop': Valid only for EOP files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.

11. **'getObx'**: The first-level setting of ORBEX (ORBit EXchange format) for satellite attitude information downloading option. There are two second-level settings as follows:

'opt4obx': the switch (0: off 1: on).

- ‘obxFrom’**: Analysis center (i.e., final/rapid: ‘cod_m’, ‘gfz_m’, ‘grg_m’, ‘whu_m’, ‘all_m’; real-time: ‘cnt’).
12. **‘getDsb’**: The first-level setting of differential code/signal bias (DCB/DSB) downloading option. There are two second-level settings as follows:
- ‘opt4dsb’**: the switch (0: off 1: on).
- ‘dsbFrom’**: Analysis center (i.e., ‘cod’, ‘cas’, ‘all’);
- NOTE**: DCBs from CODE are for GPS and GLONASS, while DSBs from CAS are for multiple GNSS.
13. **‘getOsb’**: The first-level setting of observable-specific signal bias (OSB) downloading option. There are two second-level settings as follows:
- ‘opt4osb’**: the switch (0: off 1: on).
- ‘osbFrom’**: Analysis center (i.e., final/rapid: ‘cas_m’, ‘cod_m’, ‘gfz_m’, ‘grg_m’, ‘whu_m’, ‘all_m’; real-time: ‘cnt’).
14. **‘getSnx’**: The first-level setting of IGS weekly SINEX downloading option. There are two second-level settings as follows:
- ‘opt4snx’**: the switch (0: off 1: on).
- ‘l2s4snx’**: Valid only for SINEX files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.
15. **‘getIon’**: The first-level setting of global ionosphere map (GIM) downloading option. There are three second-level settings as follows:
- ‘opt4ion’**: the switch (0: off 1: on).
- ‘ionFrom’**: 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’).
- ‘l2s4ion’**: Valid only for GIM files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.
16. **‘getRoti’**: The first-level setting of rate of TEC index (ROTI) downloading option. There is one second-level settings as follows:

‘opt4rot’: the switch (0: off 1: on).

17. ‘getTrp’: The first-level setting of CODE/IGS tropospheric product downloading option. There are four second-level settings as follows:

‘opt4trp’: the switch (0: off 1: on).

‘trpFrom’: Analysis center (i.e., ‘igs’ or ‘cod’).

‘trpList’: ‘all’ (tropospheric product downloaded in the whole directory) or the file name of site.list (tropospheric product files downloaded site-by-site according to the ‘site.list’, i.e., cut0, gmsd, jfng, ...).

‘l2s4trp’: Valid only for troposphere product files with long name, 0: only long file names exist locally, 1: only short file names exist locally, 2: both long and short file names exist locally.

NOTE: The item is of ‘trpList’ is ONLY valid when the item of ‘trpFrom’ is set to be ‘igs’.

18. ‘getAtx’: The first-level setting of ANTEX format antenna phase center correction downloading option. There is one second-level settings as follows:

‘opt4atx’: the switch (0: off 1: on).

Moreover, **a Python script named ‘run_GOOD.py’ is provided for ease of use.**

For details, one can follow the help section of the script. For example, under Windows, for MGEX observations downloading, one can type the following command line: `python run_GOOD.py -exe D: GOOD\dataset_Win\run_GOOD.exe -datadir D: GOOD\dataset_Win -time 2024 1 1 -ftp cddis -obs daily mgex site_mgex.list`. for IGS precise satellite orbit and clock products downloading, one can type the following command line: `python run_GOOD.py -exe D: GOOD\dataset_Win\run_GOOD.exe -datadir D: GOOD\dataset_Win -time 2024 1 1 -ftp cddis -orbclk igs`.

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_GOOD GOOD_cfg.yaml’ to try it again. Don’t worry, once the data has been downloaded, it will not be downloaded repeatedly.

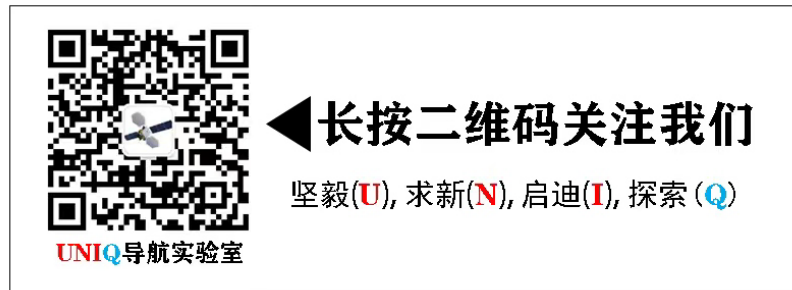
Any suggestions, corrections, and comments about **GOOD** are sincerely welcomed and

could be sent to:

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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!