

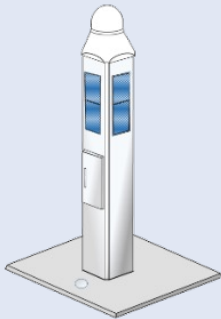


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Geospatial Information
Authority of Japan (GSI)

Modernizing Multi-GNSS data pre-processing tools: RINGO and RNXCMP Updates with RINEX 4.02 format compatibility



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ORGANIZING INSTITUTIONS



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www.igs-workshop-2026.com

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RINEX 4.02 update

RINGO

RNXCMP (Compact RINEX)

Summary

Recent updates in RINEX 4.02 (Oct. 2024)

IGS News

RINEX version 4.02 has been officially released on the IGS webpage: https://files.igs.org/pub/data/format/rinex_4.02.pdf, and also available here:

- <https://igs.org/wg/rinex/#documents-formats>
- <https://igs.org/formats-and-standards/>

RINEX 4.02 highlights

The main changes with respect to the previous version are:

- RINEX observations-related updates:
 - Update of the Epoch time tagging in Observation files to allow for extra second digits to reach pico-sec resolution
- RINEX navigation messages-related updates:
 - Addition of NavIC L1 **L1NV** Navigation message
 - Addition of GLONASS **L10C**, and **L30C** CDMA Navigation message
 - Addition of navigation message subtypes for all navigation record message, and definition of subtypes for the QZSS **ION** and NavIC **ION** messages

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Includes support for new obs codes **and major changes to the data structure**

- Addition of an extra five digits (picoseconds) in the time tag
- Addition of “navigation message subtype” in navigation files

The latest RINEX 4.02 update (2024.10)

Observation RINEX

```
> 2025 01 06 00 00 0.00000000 0 1 0.0000000000000 12345
J02 37190312.039 195436358.647 7
> 2025 01 06 00 00 30.00000000 0 1 0.0000000000000 67890
J02 37191023.758 195440099.882 7
> 2025 01 06 00 01 0.00000000 0 1 0.0000000000000 12345
J02 37191749.016 195443911.191 7
> 2025 01 06 00 01 30.00000000 0 1 0.0000000000000 23456
J02 37192487.484 195447791.423 7
> 2025 01 06 00 02 0.00000000 0 1 0.0000000000000 34567
J02 37193238.820 195451740.408 7
> 2025 01 06 00 02 30.00000000 0 1 0.0000000000000 45678
J02 37194003.438 195455758.537 7
> 2025 01 06 00 03 0.00000000 0 1 0.0000000000000 56789
```

Navigation RINEX

```
> ION J03 LNAV WIDE
2024 11 01 00 01 54 1.583248376846e-08-7.450580596924e-09 0.000000000000e+00
2.980232238770e-07 1.372160000000e+05-3.932160000000e+05 3.932160000000e+05
3.211264000000e+06
> ION J02 LNAV WIDE
2024 11 01 01 01 54 1.583248376846e-08-7.450580596924e-09 0.000000000000e+00
2.384185791016e-07 1.392640000000e+05-3.932160000000e+05 3.932160000000e+05
3.538944000000e+06
> ION J02 LNAV WIDE
2024 11 01 02 01 54 1.583248376846e-08-7.450580596924e-09 5.960464477539e-08
2.980232238770e-07 1.392640000000e+05-4.096000000000e+05 3.276800000000e+05
3.735552000000e+06
```

Addition of navigation message subtype

Addition of optional pico-second timetag record (extra 5 digits)

- RINEX 4.02 is not a major release; however, it includes relatively substantial changes, including modifications to the data structure
- Especially, optional picosecond timetag may affect existing software

Details of the timetag extension in RINEX 4.02

- Five additional digits (picoseconds) are appended beyond the seventh digit of the seconds field in the time tag.
- The optional picosecond record **must be “text”, not as a “numeric value”**

```
> 2025 01 06 00 00 0.00000000 0 1      0.000000000000000 12345
```



```
2025-01-06 00:00:00.0000000012345
```

Examples of format violation:

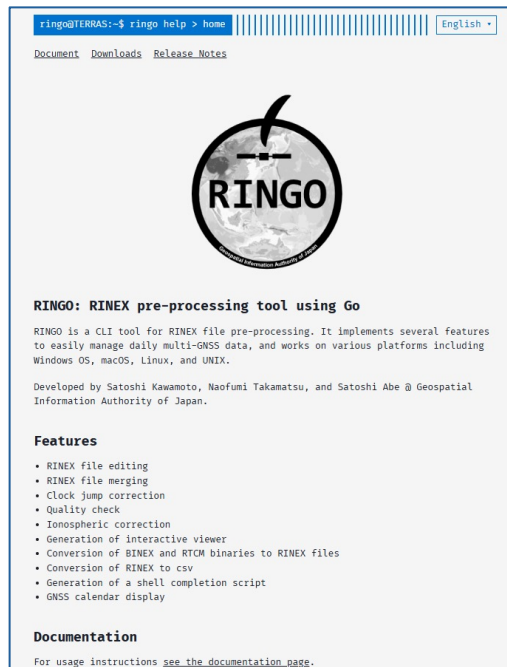
```
> 2025 01 06 00 00 0.00000000 0 1      0.000000000000000 -2345
> 2025 01 06 00 00 0.00000000 0 1      0.000000000000000 123
> 2025 01 06 00 00 0.00000000 0 1      0.000000000000000 345
```

Update of RINEX pre-processing software packages to support the latest RINEX 4.02

GSI has released updates to the RINEX pre-processing software packages, “RINGO” and “RNXCMP”, to support RINEX 4.02.

RINGO

Editing, merging, and QC, etc.



<https://terras.gsi.go.jp/software/ringo/en/>

RNXCMP

Compact RINEX compression/decompression

Download page for the RNXCMP software

RNXCMP is the software for compression/restoration of RINEX observation files developed by Y. Hatanaka of GSI. It converts the format of GNSS observation files from the RINEX format (version 2.xx, 3.xx or 4.xx) to a compressed format (the CompactRINEX format, or often called the Hatanaka-compressed format) and vice versa. This format is frequently used to exchange GNSS observation data through internet. See the following paper for more detail of the compression format and the tools:

Hatanaka, Y. (2008): A Compression Format and Tools for GNSS Observation Data, Bulletin of the Geographical Survey Institute, 55, 21-30, available at <https://www.gsi.go.jp/ENGLISH/Bulletin55.html>

The source codes, binaries compiled for several OS types, and some texts can be downloaded by clicking the following items. Use of this service is subject to read and follow the README.txt

[README.txt](#)

[CHANGES.txt](#)

[LICENSE.txt](#)

[RNXCMP_4.1.0_Linux_x86_32bit.tar.gz](#)

[RNXCMP_4.1.0_Linux_x86_64bit.tar.gz](#)

[RNXCMP_4.1.0_MacOSX10.14_gcc.tar.gz](#)

[RNXCMP_4.1.0_SunOS5.9_32bit.tar.gz](#)

[RNXCMP_4.1.0_Windows_mingw_32bit.tar](#)

[RNXCMP_4.1.0_Windows_mingw_32bit.zip](#)

[RNXCMP_4.1.0_Windows_mingw_64bit.tar](#)

[RNXCMP_4.1.0_Windows_mingw_64bit.zip](#)

[RNXCMP_4.1.0_src.tar.gz](#)

<https://terras.gsi.go.jp/ja/crx2rnx.html>

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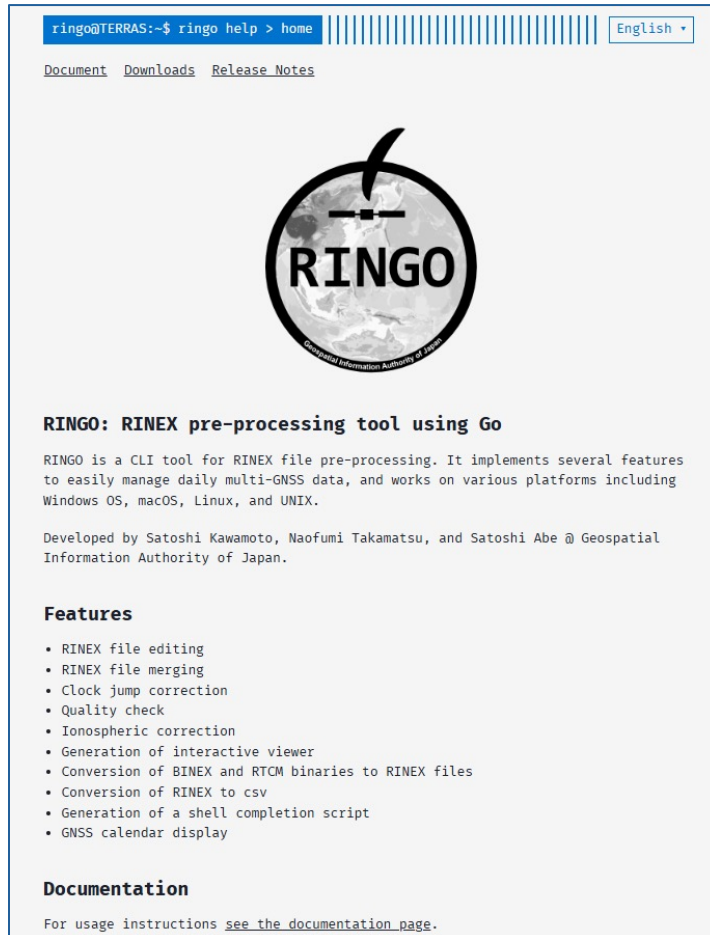
RINEX 4.02 update

RINGO

RNXCMP (Compact RINEX)

Summary

RINGO software



RINGO: RINEX preprocessing tool using GO

Command example:

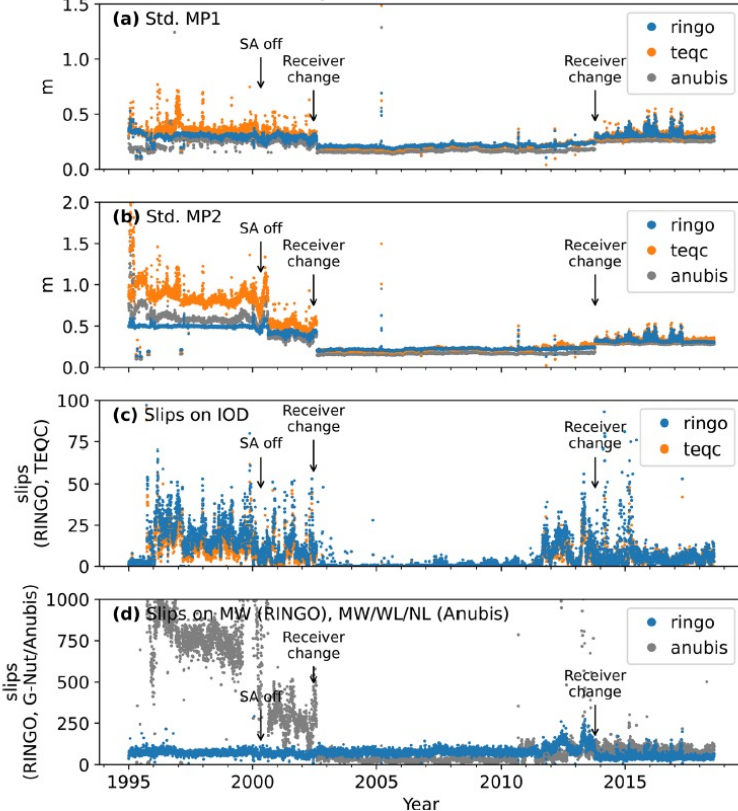
```
> ringo merge 0255001?.24o.gz > 02550010.24o
> ringo qc 02550010.24o 02550010.24N.tar.gz > qc.log
> ringo viewer 02550010.24o > viewer.html
```

- Simple command-line interface
- Multi-purpose RINEX pre-processing tool
- Supports RINEX 2.1x, 3.0x, 4.0x
- Fully supports Multi-GNSS data
- Available free of charge with no subscription required

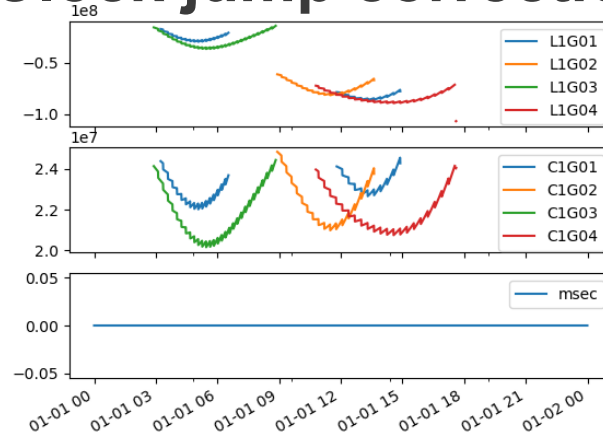
RINGO Features

Quality check

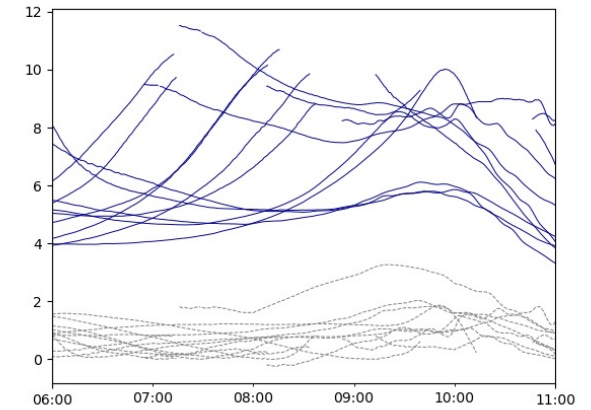
Quality Check Results for 'TSKB'



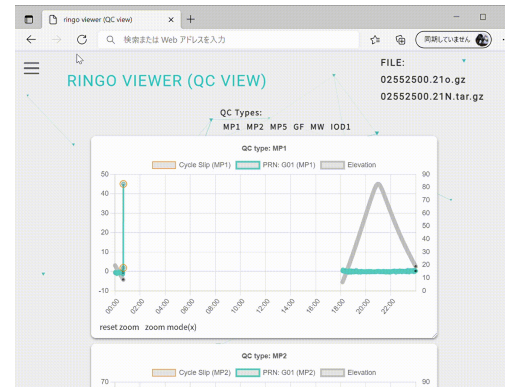
Clock jump correction



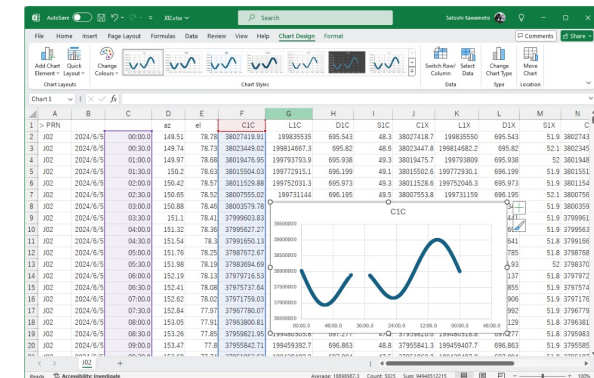
Ionospheric correction



Viewer



Conversion to csv



RINGO updates and new features (v0.9.4 & v0.9.6)

- RINGO update released (v0.9.6, May 2026)
- **Support for RINEX 4.02 (including preservation of picosecond record)**
- The geomagnetic model used for the higher-order ionospheric correction in “ioncorr” command has been updated to the latest IGRF14 model
- New option “--sortorder-sys” to change sorting order of satellite systems
- Support for highrate (>1Hz) BINEX and RTCM data conversion
- Support for system time (previous versions assumed GPST for obs RINEX)
- Several bug fixes and stability improvements



RINGO software website:
<https://terras.gsi.go.jp/software/ringo/en/>

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Compact RINEX (Hatanaka RINEX)

GSI provides Compact RINEX compression/decompression tool RNXCMP

- RINEX compression format
- The data size is reduced to ~30% by storing time-differenced observation data

FILE		Size (KB)	Size (%)
02550010.25o	No compression	21,128	100.0 %
02550010.25o.gz	gzip	5,937	28.1 %
02550010.25d	Compact RINEX	6,284	29.7 %
02550010.25d.gz	Compact RINEX + gzip	2,423	11.5 %

New Compact RINEX 3.1

RINEX



Compact RINEX

```
> 2025 01 06 00 00 0.0000000 0 1 0.000000000000 12345
J02 37190312.039 195436358.647 7
> 2025 01 06 00 00 30.0000000 0 1 0.000000000000 67890
J02 37191023.758 195440099.882 7
> 2025 01 06 00 01 0.0000000 0 1 0.000000000000 12345
J02 37191749.016 195443911.191 7
> 2025 01 06 00 01 30.0000000 0 1 0.000000000000 23456
J02 37192487.484 195447791.423 7
> 2025 01 06 00 02 0.0000000 0 1 0.000000000000 34567
J02 37193238.820 195451740.408 7
> 2025 01 06 00 02 30.0000000 0 1 0.000000000000 45678
J02 37194003.438 195455758.537 7
> 2025 01 06 00 03 0.0000000 0 1 0.000000000000 56789
```

Extension in RINEX 4.02

```
> 2025 01 06 00 00 0.0000000 0 1 J02
3&0 12345
3&37190312039 3&195436358647 &&&7
3
0 67890
711719 3741235
1 &
0 12345
13539 70074
3
0 23456
-329 -1151
2 &
```

Extension of Compact RINEX format

- New Compact RINEX 3.1 introduces an additional field to preserve optional picosecond record (extra 5 digits)
- Raise “error” if it is not five digits or contains any non-numeric characters

RINEX-Compact RINEX version correspondence

- RNXCMP software uses different Compact RINEX formats depending on the RINEX versions
- For RINEX 4.02, a new compact RINEX version 3.1 has been defined

RINEX version 2.xx ↔ Compact RINEX version 1.0

RINEX version 3.00 – 4.01 ↔ Compact RINEX version 3.0

RINEX version 4.02 ↔ Compact RINEX version 3.1

New

Important Notes on RNXCMP

- Previous RNXCMP ($\leq$ v4.1.0) cannot handle optional picosecond records in RINEX 4.02
- If RINEX 4.02 with picosecond record is **processed by previous RNXCMP ($\leq$ 4.1.0)**, picosecond record will be removed

Updating RNXCMP is strongly recommended for users of RINEX 4.02 or later

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Summary



- GSI has updated the RINEX pre-processing software packages “RINGO” and “RNXCMP” capable of supporting RINEX 4.02, and promotes its broader use
- “RINGO” update includes RINEX 4.02 support and other improvements
- In particular, users of RINEX 4.02 are strongly recommended to update RNXCMP, as the newly introduced optional picosecond time tag cannot be handled by older versions

Feedback and comments are always welcome!