

**MGA Webinar 1<sup>st</sup> June**

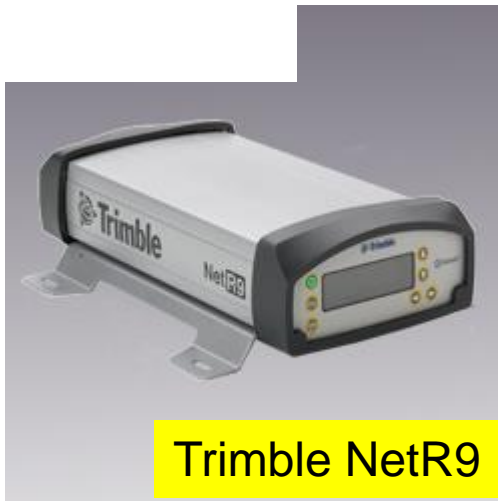
# How to use free RTK Software?

Tokyo Univ. of Marine Science and Technology : Nobuaki Kubo

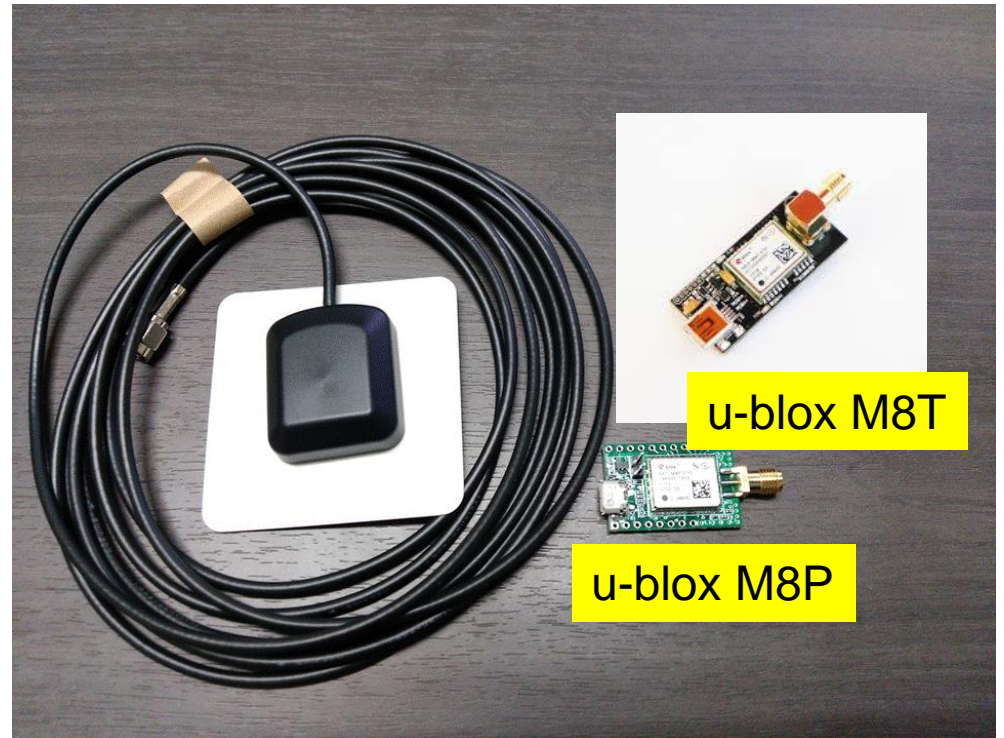
# Receiver used in this training

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1. u-blox GNSS receiver (M8P or M8T)
2. Trimble NetR9



Trimble NetR9




u-blox M8T

u-blox M8P

# You can purchase M8T

- [http://www.csgshop.com/product.php?id\\_product=205](http://www.csgshop.com/product.php?id_product=205)

**UBLOX NEO-M8T TIME & RAW RECEIVER BOARD WITH SMA (RTK READY)**



UBLOX NEO-M8T GPS, GLONASS, Galileo, BeiDou, QZSS and SBAS RAW and timing receiver EVAL module USB, I2C, UART with SMA antenna connectors. RTK ready.

[More details](#)

Quantity:  **\$74.99**

167 items in stock

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# Some Data used in Practice

---

## Static raw data set (24h)

- u-blox M8T (ref/rover) + Trimble/NovAtel ant.
- Trimble NetR9 (ref) Trimble ant.

## Static raw data set (1h)

- u-blox M8P (ref/rover) + Trimble/NovAtel ant.
- Trimble NetR9 (ref/rover) + Trimble/NovAtel ant.

## Kinematic raw data set (0.5h)

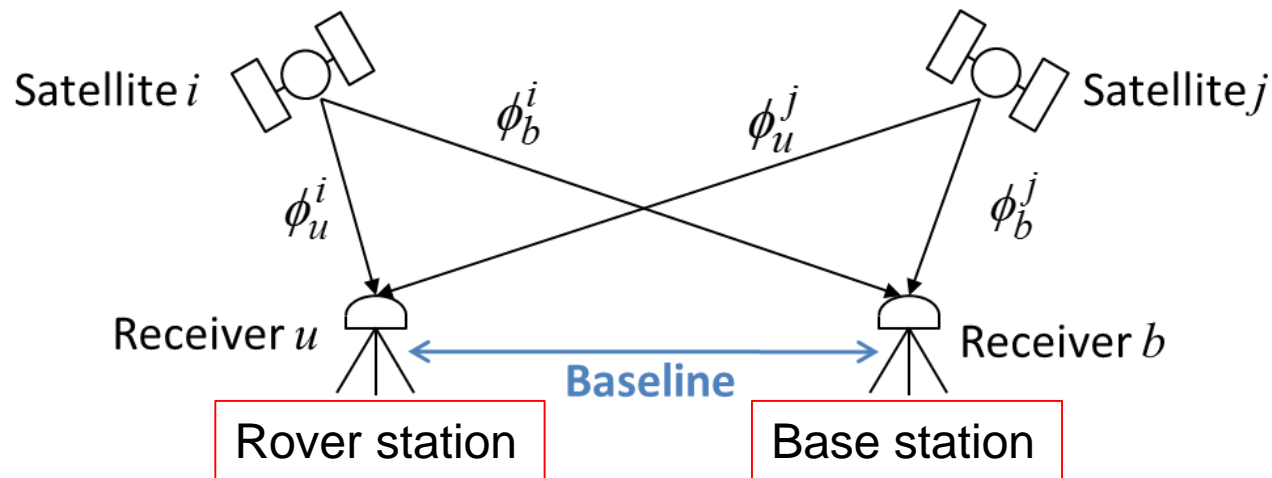
- u-blox M8T (ref/rover) + Trimble/NovAtel ant.
- Trimble NetR9 (ref/rover) + Trimble/NovAtel ant.

# You will learn...

---

- Using the “RTKLIB” and “internet(smart-phone)” + Ntrip server, you can check RTK.
- Through this webinar, you will learn how to process RTKLIB in the post-processing or real-time processing.
- You need to decide which is more important for your purpose.
- Please keep in mind that there are specific terms in GNSS.

# RTK tells you not absolute position but vector from base station

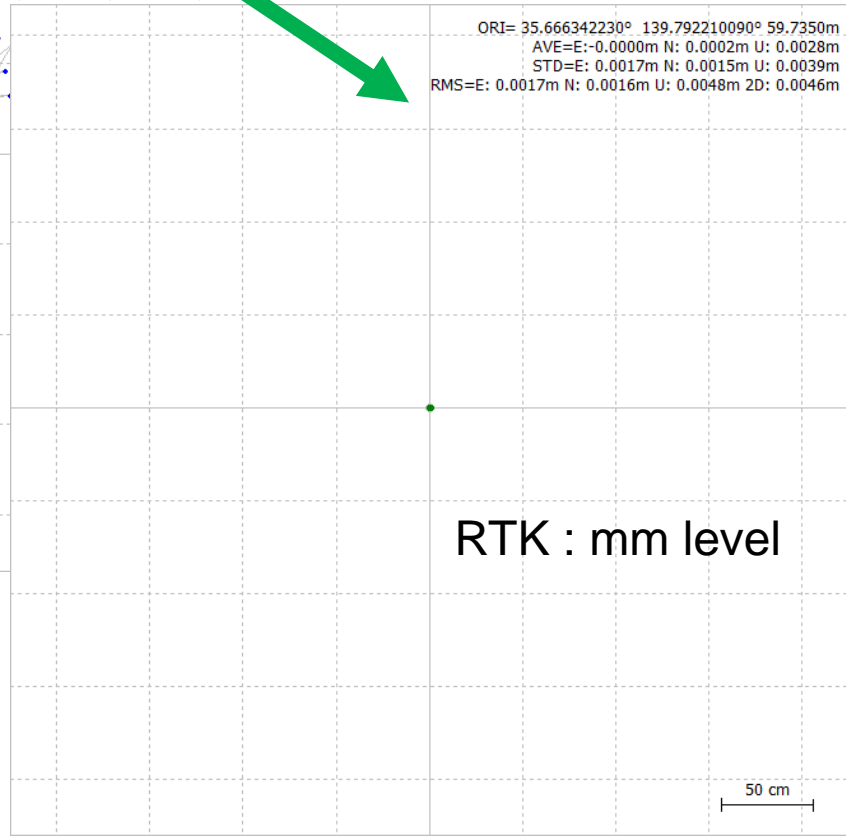
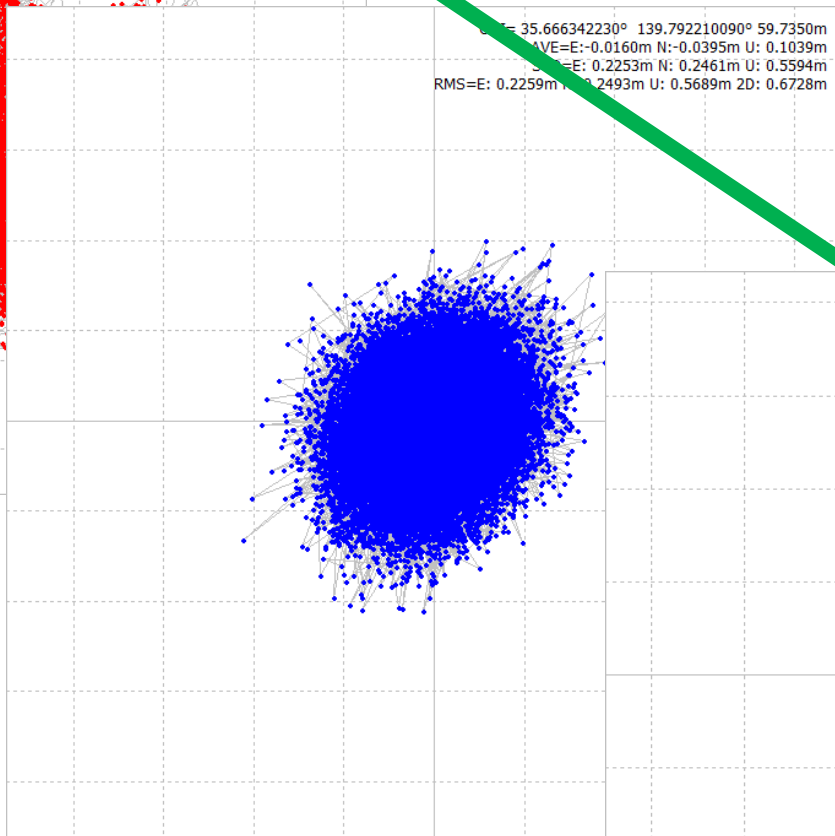
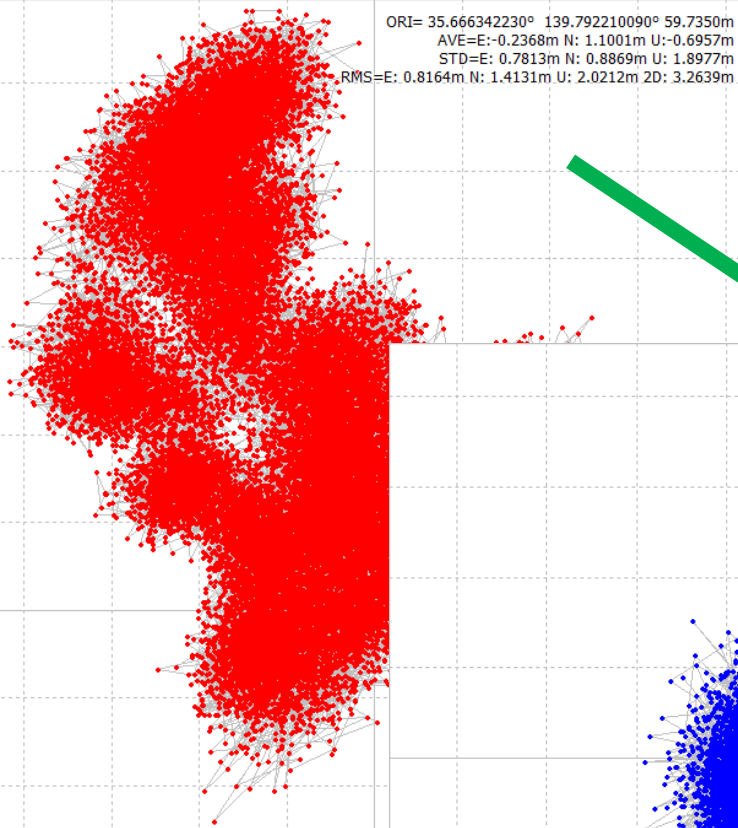


Once you determine the precise position at base station, you will know the precise vector from base antenna to rover antenna.

Then you can know your precise position :  $(X, Y, Z) = (X_{ref}, Y_{ref}, Z_{ref}) + (dX, dY, dZ)$   
If the position at base station deviates 1m, your RTK position will be deviates 1m

# RTK performance

## 12h, rooftop, our building

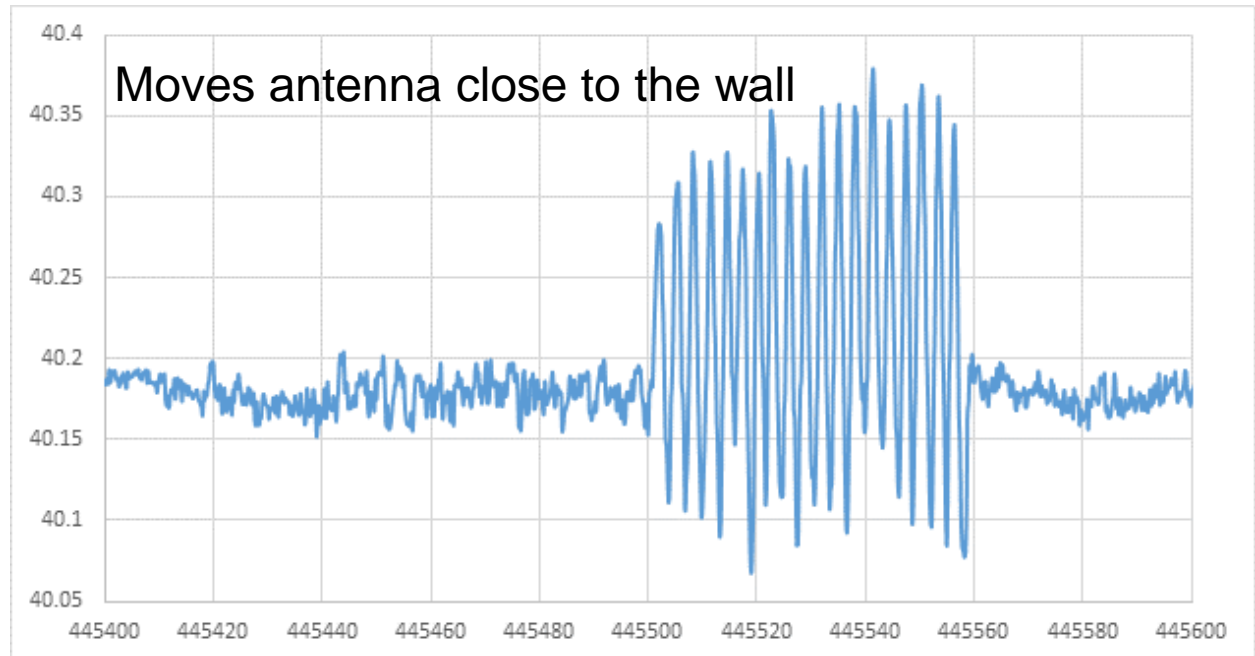
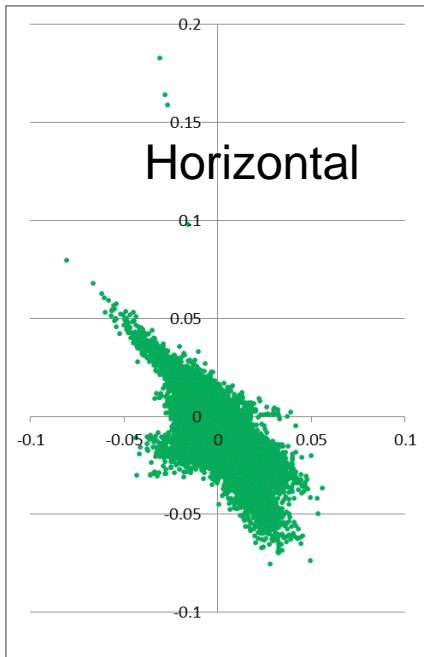
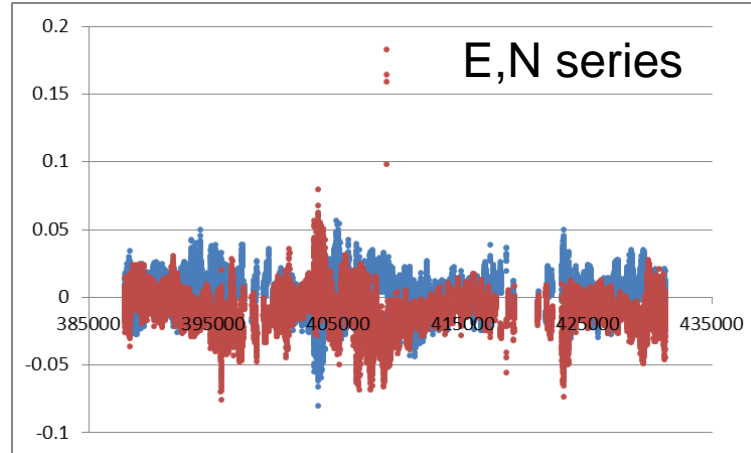


Same scale

# Recent Test : RTK on the wall



Monitoring for structure deformations



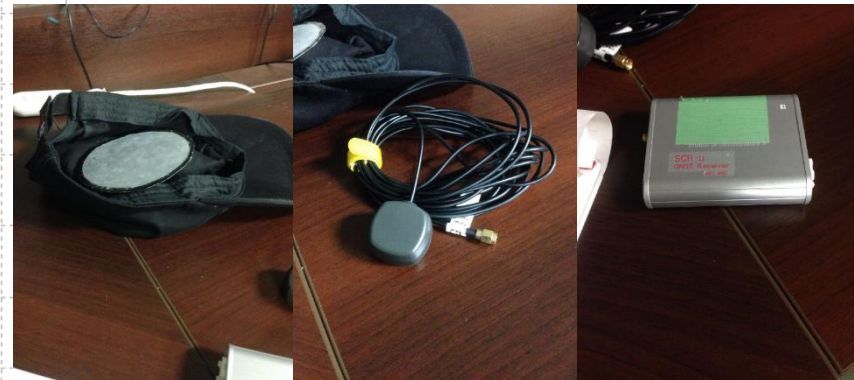


# Recent Test : Running



Horizontal

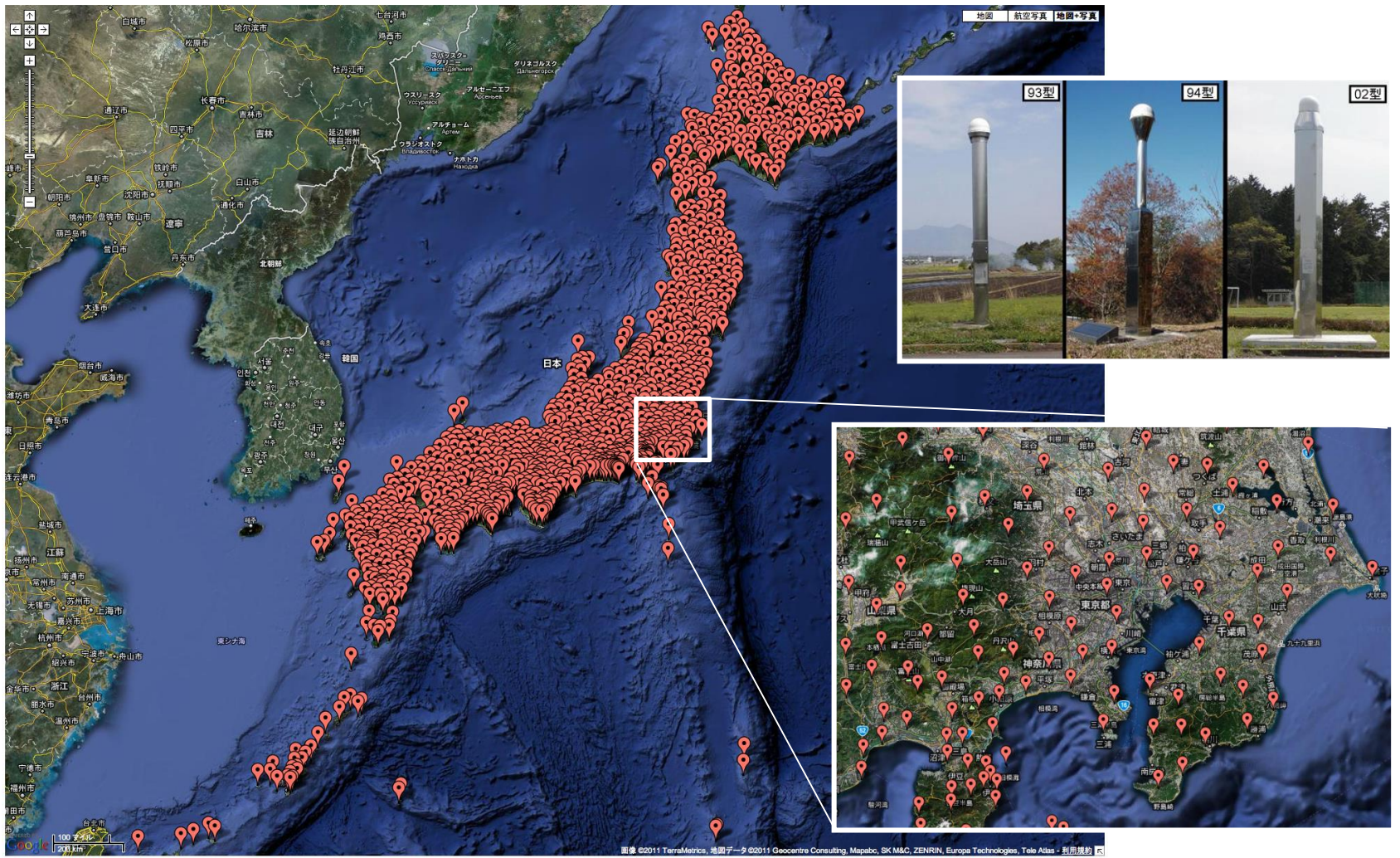
5 m



# Japanese GEONET

GEONET STATIONS MAP by Google Map : [GEONET Stations](#)

[IGS Map](#) | [Home](#)



The station coordinates are based on the 2011 positions on 2007/1/1 provided by GSI. Height: ellipsoidal height (WGS84)

(<http://terras.gsi.go.jp/ja/index.htm>)

# Difference between expensive and low-cost receiver

---

	<b>Survey-grade receiver</b>	<b>Low-cost receiver</b>
Cost	\$ 100,00~	\$100~
Multiple GNSS	Perfect	BeiDou or Glonass Other are OK
Multiple Frequency	Perfect	L1/B1/E1/G1 only
Number of channel	400-500-	-100
RTK (short baseline) + open sky	<b>Perfect</b>	<b>Almost perfect</b>
RTK (over 20 km baseline) + open sky	<b>Almost perfect up to 100 km or more</b>	<b>Impossible</b>
RTK under mid obstructed area (short)	<b>Almost perfect</b>	<b>May be difficult</b>
RTK under dense obstructed area (short)	<b>Sometimes not good</b>	<b>Difficult</b>
Accuracy of fixed position + open	mm	→
Accuracy of code position + open	Deci-meter	1-2 meter

# Error source mitigation (Typical)

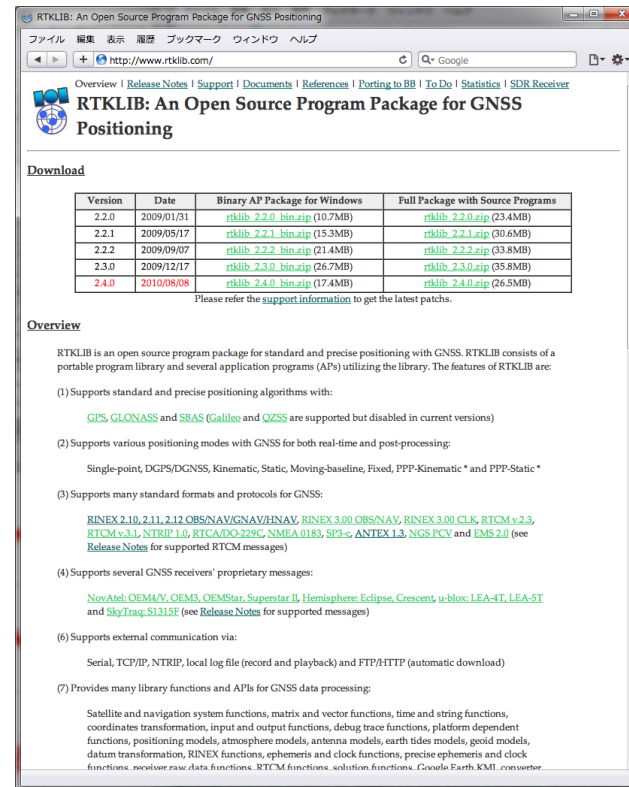
Source/Error	SPP	DGNSS	RTK	PPP
Satellite clock model 1 m (rms)	→	0.0 m	0.0 m	0.01 – 0.1 m
Satellite ephemeris 1 m (rms)	→	0.0 m	0.0 m	0.01 - 0.1 m
Ionospheric delay 2-10 m (zenith) × 3 at 5°	1 - 2 m (zenith)	0.1 - 0.2 m	0.01 m	0.01 m
Tropospheric delay 2.3-2.5m (zenith) × 10 at 5°	0.1 - 0.5 m (zenith)	0.1 - 0.2 m	0.01 m	0.01 m
Multipath (open sky) Code : 0.5-1 m Carrier : -1 cm	→ Code	→ Code	→ Carrier	→ Carrier
Receiver Noise Code : 0.1-0.5 m Carrier : 1-2 mm	→ Code	→ Code	→ Carrier	→ Carrier
Finally...	2-3 m	- 1 m	- 1 cm	- 10 cm

---

# RTKLIB Practice (1)



- **An Open Source Software Package for GNSS Positioning**
  - Has been developed since 2006
  - The latest version 2.4.2 p12 distributed under BSD license
- **Portable APIs and Useful APs**
  - "All-in-one" package for Windows
  - CLI APs for any environments



RTKLIB: An Open Source Program Package for GNSS Positioning

Overview | Release Notes | Support | Documents | References | Porting to BB | To Do | Statistics | SDR Receiver

## RTKLIB: An Open Source Program Package for GNSS Positioning

**Download**

Version	Date	Binary AP Package for Windows	Full Package with Source Programs
2.2.0	2009/01/31	<a href="#">rtklib_2.2.0_bin.zip</a> (10.7MB)	<a href="#">rtklib_2.2.0.zip</a> (23.4MB)
2.2.1	2009/05/17	<a href="#">rtklib_2.2.1_bin.zip</a> (15.3MB)	<a href="#">rtklib_2.2.1.zip</a> (30.6MB)
2.2.2	2009/09/07	<a href="#">rtklib_2.2.2_bin.zip</a> (21.4MB)	<a href="#">rtklib_2.2.2.zip</a> (33.8MB)
2.3.0	2009/12/17	<a href="#">rtklib_2.3.0_bin.zip</a> (26.7MB)	<a href="#">rtklib_2.3.0.zip</a> (35.8MB)
2.4.0	2010/08/08	<a href="#">rtklib_2.4.0_bin.zip</a> (17.4MB)	<a href="#">rtklib_2.4.0.zip</a> (26.5MB)

Please refer the [support information](#) to get the latest patches.

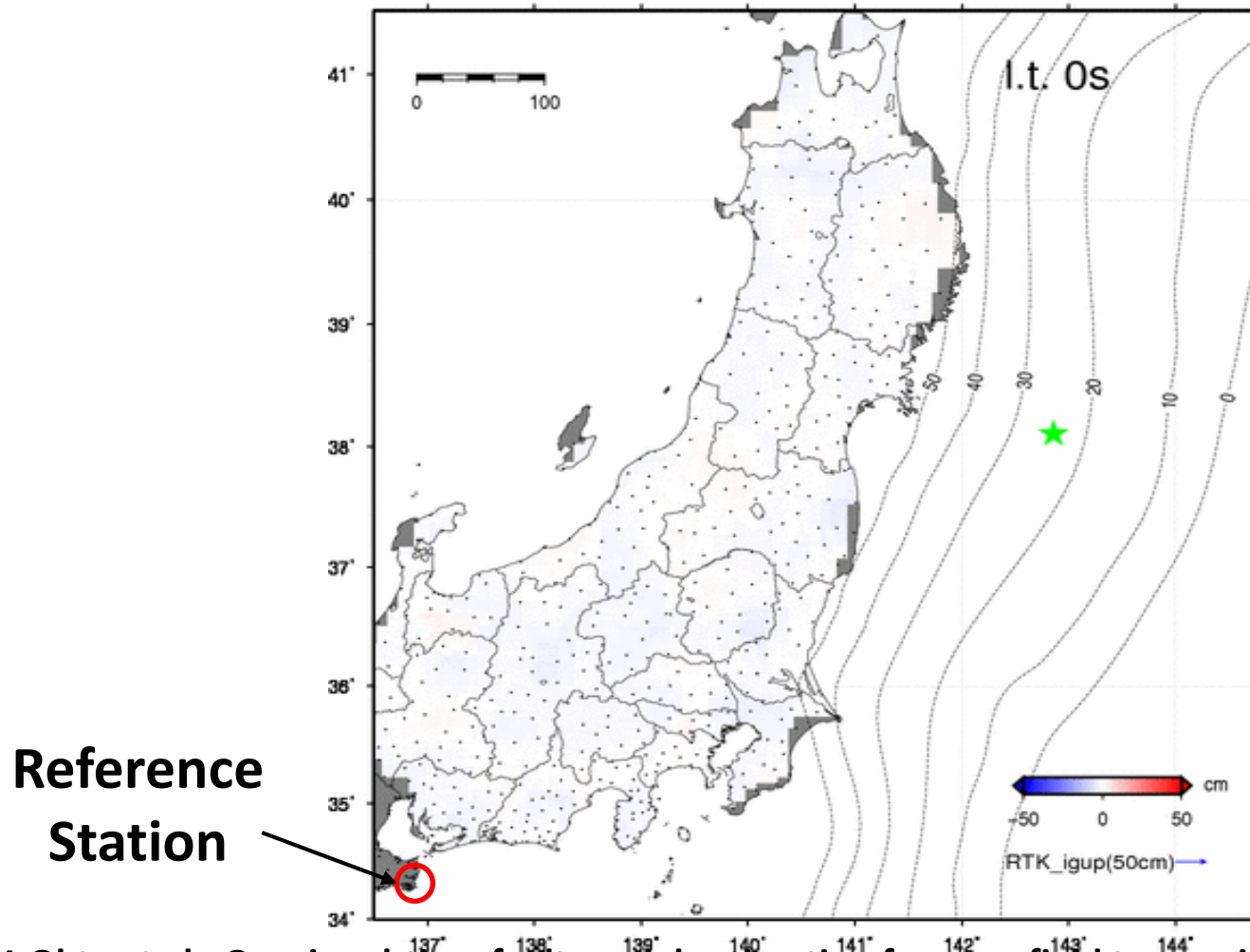
**Overview**

RTKLIB is an open source program package for standard and precise positioning with GNSS. RTKLIB consists of a portable program library and several application programs (APs) utilizing the library. The features of RTKLIB are:

- (1) Supports standard and precise positioning algorithms with:
  - GPS, GLONASS and SBAS (Galileo) and QZSS are supported but disabled in current versions
- (2) Supports various positioning modes with GNSS for both real-time and post-processing:
  - Single-point, DGPS/DGNSS, Kinematic, Static, Moving-baseline, Fixed, PPP-Kinematic \* and PPP-Static \*
- (3) Supports many standard formats and protocols for GNSS:
  - RINEX 2.10, 2.11, 2.12 OBSNAV/IGNAV/HNAV, RINEX 3.00 OBSNAV, RINEX 3.00 CLK, RTCM v.2.3, RTCM v.3.1, NTRIP 1.0, RTCADDO-222C, NMEA 0183, SP3-C, ANTEX 1.3, NGS PCV and EMS 2.0 (see [Release Notes](#) for supported RTCM messages)
- (4) Supports several GNSS receivers' proprietary messages:
  - NovAtel: OEM4V, OEM3, OEMStar, Superstar II, Hemisphere Eclipse, Crescent u-blox: LEA-4T, LEA-5T and SkyTraq: S1313F (see [Release Notes](#) for supported messages)
- (6) Supports external communication via:
  - Serial, TCP/IP, NTRIP, local log file (record and playback) and FTP/HTTP (automatic download)
- (7) Provides many library functions and APIs for GNSS data processing:
  - Satellites and navigation system functions, matrix and vector functions, time and string functions, coordinates transformation, input and output functions, debug trace functions, platform dependent functions, positioning models, atmosphere models, antenna models, earth tides models, geoid models, datum transformation, RINEX functions, ephemeris and clock functions, precise ephemeris and clock functions, receiver raw data functions, RTCM functions, solution functions, Coe/le Earth KML converter

**<http://www.rtklib.com> or  
<https://github.com/tomojitakasu/RTKLIB>**

# RTKLIB: Application



Y. Ohta et al., Quasi real-time fault model estimation for near-field tsunami forecasting base on RTK-GPS analysis: Application to the 2011 Tohoku-Oki earthquake (Mw 9.0), JGR-solid earth, 2012

# RTKLIB: History

---

- 2006/4 v.0.0.0 First version for RTK+C program lecture
- 2007/1 v.1.0.0 Simple post processing AP
- 2008/7 v.2.1.0 Add APs, support medium-range
- 2009/1 v.2.2.0 Add real-time AP, support NTRIP, start to distribute as **Open Source S/W**
- 2009/5 v.2.2.1 Support RTCM, NRTK, many receivers
- 2009/12 v.2.3.0 Support GLONASS, several receivers
- 2010/8 v.2.4.0 Support PPP Real-time/Post-processing PPP and Long-baseline RTK (<1000 km)
- 2011/6 v.2.4.1 Support QZSS, JAVAD receiver, ...
- 2013/4 v.2.4.2 Support Galileo, Enable BeiDou, ...
- 2016/12 v.2.4.3 TBD



# RTKLIB: Features

---

- **Standard and precise positioning algorithms with:**
  - GPS, GLONASS, QZSS, Galileo, BeiDou and SBAS
- **Real-time and post-processing by various modes:**
  - Single, SBAS, DGPS, RTK, Static, Moving-base and PPP
- **Supports many formats/protocols and receivers:**
  - RINEX 2/3, RTCM 2/3, BINEX, NTRIP 1.0, NMEA0183, SP3, RINEX CLK, ANTEX, NGS PCV, IONEX, RTCA-DO-229, EMS,
  - NovAtel, JAVAD, Hemisphere, u-blox, SkyTraq, NVS, ...
- **Supports real-time communication via:**
  - Serial, TCP/IP, NTRIP and file streams

# RTKLIB: GUI APs

The image displays a collection of screenshots for various GUI applications associated with RTKLIB. The applications shown are:

- RTKPlot**: A network graph showing station connections and signal quality.
- RTKNAVI**: A navigation solution window showing coordinates (N: 35° 43' 08.2300", E: 138° 27' 02.1531", H: 367.442 m) and a bar chart of rover SNR.
- RTKGET**: A window for configuring data retrieval from a server, showing fields for Time Span, Stations, and various protocol options.
- STRSVR**: A stream server interface showing connection details and data flow statistics.
- RTKPOST**: A window for configuring data post-processing, including time spans and output file names.
- RTKCONV**: A window for converting data between different formats, showing input/output file paths and format options.
- Ntrip Browser**: A window for managing Ntrip network connections, listing various stations and their coordinates.

Each application window includes standard GUI elements like menus, toolbars, and status bars. The screenshots are arranged in a grid-like fashion, with some overlapping.

# RTKLIB: CLI APs

- **RNX2RTKP (rnx2rtkp)**  
Post-processing Positioning
- **RTKRCV (rtkrcv)**  
Real-time Positioning
- **CONVBIN (convbin)**  
RINEX Translator
- **STR2STR (str2str)**  
Stream Server
- **POS2KML (pos2kml)**  
Google Earth Converter

RTKLIB ver. 2.4.1 Manual

## A.2 RNX2RTKP

### SYNOPSIS

```
rnx2rtkp [option ...] file file [...]
```

### DESCRIPTION

Read RINEX OBS/NAV/GNAV/HNAV/CLK, SP3, SBAS message log files and compute receiver (rover) positions and output position solutions. The first RINEX OBS file shall contain receiver (rover) observations. For the relative mode, the second RINEX OBS file shall contain reference (base station) receiver observations. At least one RINEX NAV/GNAV/HNAV file shall be included in input files. To use SP3 precise ephemeris, specify the path in the files. The extension of the SP3 file shall be .sp3 or .eph. All of the input file paths can include wild-cards (\*). To avoid command", line deployment of wild-cards, use "...". Command line options are as follows ([ ]:default). With -k option, the processing options are input from the configuration file. In this case, command line options precede options in the configuration file. For configuration file, refer B.4.

### OPTIONS

```
-?          print help
-k file     input options from configuration file [off]
-o output   output file [stdout]
-ts ds ts   start day/time (d=yr/m/d ts=hm:s) [obs start time]
-te de te   end day/time (d=yr/m/d te=hm:s) [obs end time]
-ti tint    time interval (sec) [all]
-p mode     mode (0:single,1:dgps,2:kinematic,3:static,4:moving-base
           5:fixed,6:ppp-kinematic,7:ppp-static) [2]
-m mask     elevation mask angle (deg) [15]
-f freq     number of frequencies for relative mode (1:L1,2:L1+L2,3:L1+L2+L5) [2]
-v thres    validation threshold for integer ambiguity (0.0:no AR) [3.0]
-b          backward solutions [off]
-c          forward/backward combined solutions [off]
-i          instantaneous integer ambiguity resolution [off]
-h          fix and hold for integer ambiguity resolution [off]
-e          output x/y/z-ecef position [latitude/longitude/height]
```

59

## CLI Command Reference

# RTKLIB: Package Structure

---

## rtklib\_2.4.2.zip

```
/src          : Source programs of RTKLIB libraries
  /rcv        : Source programs depending on GPS/GNSS receiv.
/bin         : Executable binary APs and DLLs for Windows
/data       : Sample data for APs
/app        : Build environment for APs
  /rtknavi    : RTKNAVI (GUI)
  /strsvr     : STRSVR (GUI)
  /rtkpost    : RTKPOST (GUI)
  /rtkpost_mkl : RTKPOST_MKL (GUI)
  /rtkplot    : RTKPLOT (GUI)
  /rtkconv    : RTKCONV (GUI)
  /srctblbrows : NTRIP source table browser (GUI)
  /rtkrcv     : RTKRCV (console)
  /rnx2rtkp   : RNX2RTKP (console)
  /pos2kml    : POS2KML (console)
  /convbin    : CONVBIN (console)
  /str2str    : STR2STR (console)
  /appcmn     : Common routines for GUI APs
  /icon       : Icon data for GUI APs
/mkl         : Intel MKL libraries for Borland environment
/test       : Test program and data
/util       : Utilities
/doc        : Document files
```

# RTKLIB: APIs

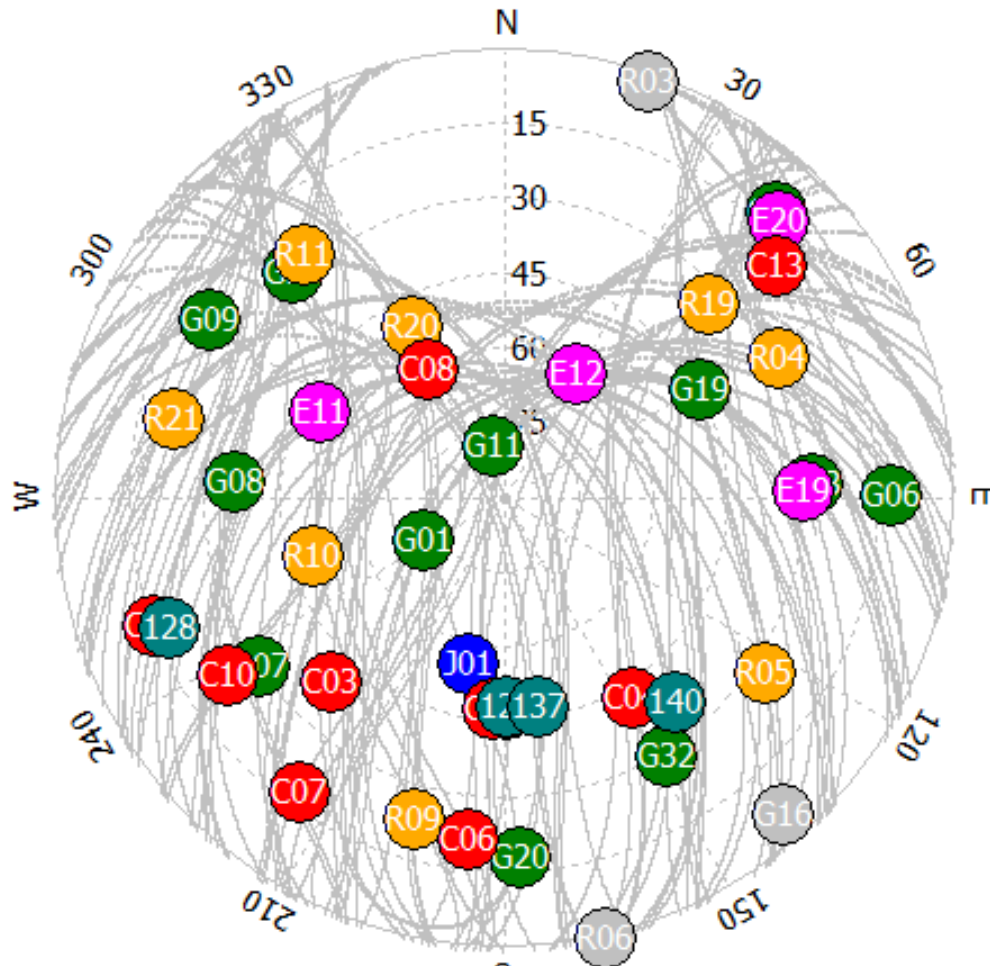
---

```
/* matrix and vector functions */
mat(),imat(),zeros(),eye(),dot(),norm(),matcpy(),matmul(),matinv(),solve(),lsq(),filter(),smoother(),matprint(),matfprint()
/* time and string functions */
str2num(),str2time(),time2str(),epoch2time(),time2epoch(),gpst2time(),time2gpst(),timeadd(),timediff(),gpst2utc(),utc2gpst(),
timeget(),time2doy(),adjgpsweek(),tickget(),sleepms()
/* coordinates functions */
ecef2pos(),pos2ecef(),ecef2enu(),enu2ecef(),covenu(),covecef(),xyz2enu(),geoidh(),loaddatump(),tokyo2jgd(),jgd2tokyo()
/* input/output functions */
readpcv(),readpos(),sortobs(),uniqeph(),screent()
/* positioning models */
eph2pos(),geph2pos(),satpos(),satposv(),satposiode(),satazel(),geodist(),dops(),ionmodel(),ionmapf(),tropmodel(),tropmapf(),
antmodel(),csmooth()
/* single-point positioning */
pntpos(),pntvel()
/* rinex functions */
readrnx(),readrnxt(),outrnxobsh(),outrnxnavh(),outrnxnavb(),uncompress(),convrnx()
/* precise ephemeris functions */
readsp3(),readsap(),eph2posp(),satposp()
/* receiver raw data functions */
getbitu(),getbits(),crc32(),crc24q(),decode_word(),decode_frame(),init_raw(),free_raw(),input_raw(),input_rawf(),input_oem4(),
input_oem3(),input_ubx(),input_ss2(),input_cres(),input_oem4f(),input_oem3f(),input_ubxf(),input_ss2f(),input_cresf()
/* rtcm functions */
init_rtcm(),free_rtcm(),input_rtcm2(),input_rtcm3(),input_rtcm2f(),input_rtcm3f()
/* solution functions */
readsol(),readsolt(),outsolheads(),outsols(),outsolsexs(),outsolhead(),outsol(),outsolsex(),setsolopt(),setsolformat(),
outnmea_rmc(),outnmea_gga(),outnmea_gsa(),outnmea_gsv(),
/* SBAS functions */
sbsreadmsg(),sbsreadmsgt(),sbsoutmsg(),sbsupdatestat(),sbsdecodemsg(),sbssatpos(),sbspntpos()
/* integer least-square estimation */
lambda()
/* realtime kinematic positioning */
rtkinit(),rtkfree(),rtkpos()
/* post-processing positioning */
postpos(),postposopt(),readopts(),writeopts()
/* stream data input/output */
strinitcom(),strinit(),strlock(),strunlock(),stropen(),strclose(),strread(),strwrite(),strsync(),strstat(),strsum(),strsetopt(),
strgettime()
/* stream server functions */
strsvrinit(),strsvrstart(),strsvrstop(),strsvrstat()
/* rtk server functions */
rtksvrinit(),rtksvrstart(),rtksvrstop(),rtksvrlock(),rtksvrunlock(),rtksvrstat(),rtksvrsstat() ...
```

# RTKLIB: Supported Receivers

Format	Data Message Types							
	GPS Raw Meas Data	GLONASS Raw Meas	GPS Ephemeris	GLONASS Ephemeris	ION/UTC Parameters	Antenna Info	SBAS Messages	Others
<b>RTCM v.2.3</b>	Type 18, 19	Type 18, 19	Type 17	-	-	Type 3, 22	-	Type 1, 9, 14, 16
<b>RTCM v.3.1</b>	Type 1002, 1004	Type 1010, 1012	Type 1019	Type 1020	-	Type 1005, 1006, 1007, 1008, 1033	-	SSR corrections
<b>NovAtel OEM4/V, OEMStar</b>	RANGEB, RANGECMPB	RANGEB, RANGECMPB	RAWEPHEMB	GLO-EPHEMERISB	IONUTCB	-	RAWWAAS-FRAMEB	-
<b>NovAtel OEM3</b>	RGEB, RGED	-	REPB	-	IONB, UTCB	-	FRMB	-
<b>NovAtel Superstar II</b>	ID#23	-	ID#22	-	-	-	ID#67	ID#20, #21
<b>u-blox LEA-4T, LEA-5T</b>	UBX RXM-RAW	-	UBX RXM-SFRB	-	UBX RXM-SFRB	-	UBX RXM-SFRB	-
<b>Hemisphere Crescent, Eclipse</b>	bin 96	-	bin 95	-	bin 94	-	bin 80	-
<b>SkyTraq S1315F</b>	msg 0xDD (221)	-	msg 0xE0 (224)	-	msg 0xE0 (224)	-	-	msg 0xDC (220)
<b>JAVAD (GRIL/GREIS)</b>	[R*],[r*],[*R], [*r],[P*],[p*], [*p],[D*],[*d], [E*],[*E],[F*]	[R*],[r*],[*R], [*r],[P*],[p*], [*p],[D*],[*d], [E*],[*E],[F*]	[GE],[GD], [gd]	[NE],[LD]	[IO],[UO], [GD]	-	[WD]	[~],[::],[RD], [SI],[NN],[TC], QZSS Data, Galileo Data
<b>Furuno GW10 II</b>	msg 0x08	-	msg 0x24	-	msg 0x26	-	msg 0x03	msg 0x20

# Multi-GNSS Support



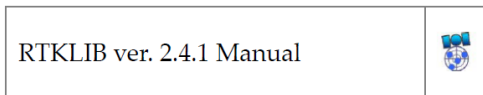
2013-06-12 10:20 GPST

Visibility at Tokyo by RTKPLOTT

- GPS (12)
- GLONASS (8)
- Galileo (4)
- QZSS (1)
- BeiDou (10)
- SBAS (4)

# Total (39)  
(El>10deg)

# RTKLIB: References



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**RTKLIB: Support Information** update 2011/03/05

**Inquiry**

Please send e-mail to the following address for inquiry. (replace (a) by @)

[rtklib\\_support@igspp.sakura.ne.jp](mailto:rtklib_support@igspp.sakura.ne.jp)

**Bug and Known Problem List**

**No.64 A half hour offset of time-tag in converted RINEX OBS files (CONVBIN ver.2.4.0)**

In some environment, the time-tags in RINEX OBS files have a half hour (30 minutes) offset to proper values.

Due to a problem on converting internal time struct to calendar date/time by using standard C-library localtime(). The localtime() returns daylight time flag as the member tm\_isdst in struct tm if the daylight saving time applied. The current version assumes the time-shif is just an hour. The half-hour shift did not be considered. It will be fixed in next release (v.2.4.1) (2011/03/05)

**No.63 POS2KML always returns read error (POS2KML ver. 2.4.0)**

POS2KML always returns "file read error". Any Google Earth KML file is not generated.

Due to the same bug as No.55. Apply the patch [rtklib\\_2.4.0\\_p3.zip](#). For NMEA, it still remains the problem same as No.59. It will be fixed in next release (v.2.4.1). (2011/02/24)

**No.62 Sol1-Sol2 difference mode plot does not indicate proper values (RTKPLOT ver.2.4.0)**

After reading solution 1 and solution 2 with RTKPLOT and pushing [1-2] button to show the difference between the solutions, the plots indicate improper values in "Gnd Trk" display mode.

Due to a bug in app/rtkplot/plotmain.cpp. It will be fixed in the next release (v.2.4.1). (2011/02/04)

**No.61 AP running as a TCP server stops if a TCP client stops (RTKNAVI, STRSVR, RTKRCV, STR2STR ver.2.4.0)**

In case that an output or log stream type of AP is set as "TCP server" and TCP clients connect to the AP, the AP stops if one of the TCP clients stops caused by some errors.

In current version, a writing socket is implemented as blocking-mode. If the socket buffer is full, "write" or "send" API blocks the TCP server. If the TCP client stops reading the socket without closing the socket, the TCP server thread stops due to the blocking socket. It will be improved in the next release (v.2.4.1) by using non-blocking mode socket. Until the next release, restart the AP in such situation. (2011/01/23)

**No.60 50 Hz or higher rate observation data are not properly analyzed (RTKPOST, RTKPOST\_MKL, RNX2RTKP ver.2.4.0)**

With 50 Hz or higher rate observation data, the analysis sometimes failed caused by misinterpretation of time-tags in the observation data.

Current version (v.2.4.0) does not support the analysis of 50 Hz or higher rate observation data. Under consideration for the next version (v.2.4.1). (2011/01/23)

**No.59 NMEA solution data can not be read and displayed (RTKPLOT ver.2.4.0)**

In case of reading NMEA solution data by RTKPLOT, RTKPLOT always shows the error message "no solution data : ..." and never displays the solution data.

Due to a bug in src/solution.c. It will be fixed in the next version (v.2.4.1). Wait for a while. (2011/01/23)

**No.58 RTKNAVI crashes due to MKL library (RTKNAVI ver.2.4.0)**

In some environments, RTKNAVI crashes due to MKL library used for fast matrix computation.

Use non-MKL version RTKNAVI (rtknavi\_nomkl.exe) in the patch [rtklib\\_2.4.0\\_p9.zip](#) instead of original rtknavi.exe for the environment having the problem. (2010/11/27)

[rtklib\\_2.4.2/doc/manual\\_2.4.2.pdf](#)

<http://www.rtklib.com>



# RTKLIB Practice (1)

---

- **Install RTKLIB**
- **Setup Receivers and Antennas**
- **Use RTKLIB in Post Processing Mode**
- **RTKLIB in Real-Time Mode**

# RTK Practice

---



- **Post processing:** Observation and Navigation data are required (RINEX).
- **Real-Time:** Communication link and differential data reception are required (RTCM/NTRIP).

# What if you can't receive correction data for 1 minutes ?

---

- RTK requires the robust communication link. This is demerit of RTK because **continuous data link** is sometimes troublesome...
- **How long can RTK keep their fixed solutions without correction data ?** We can't answer. Some receivers give up 10 seconds or 30 seconds...
- It also depends on the environment.

# RTCM

---

- The standard for differential global navigation satellite system was defined in RTCM Special Committee 104 and its current version is Version 3. RTCM standard for differential global navigation satellite services are **communication protocols between reference stations and mobile receivers** which allow very high accurate positioning, when compared with positioning system without augmentation.

# NTRIP

---

- The NTRIP was also defined in the RTCM Special Committee 104. NTRIP stands for “**Networked Transport for RTCM via Internet Protocol**”. It is based on Hypertext transfer Protocol version 1.1 and the intention is to disseminate differential correction data through the internet.

# Download

---

- [http://www.denshi.e.kaiyodai.ac.jp/kubo/kubo\\_data.html](http://www.denshi.e.kaiyodai.ac.jp/kubo/kubo_data.html)
- rtklib.zip
- 1h.zip
- 24h.zip
- car.zip

If you need the raw-data used in this presentation, please download the following 4 files.

# Install RTKLIB



You can refer to the latest update : <https://github.com/tomojitakasu/RTKLIB>

# u-blox NEO-M8P



## NEO-M8P

u-blox M8 high precision GNSS modules



Standard
  Professional
  Automotive

### Highlights

- Centimeter-level GNSS positioning for the mass market
- Integrated Real Time Kinematics (RTK) for fast time-to-market
- Smallest, lightest, and energy-efficient RTK module
- Complete and versatile solution due to base and rover variants
- World-leading GNSS positioning technology



NEO-M8P  
12.2 x 16 x 2.4 mm

### Product variants

NEO-M8P-0	u-blox M8 high precision module with rover functionality
NEO-M8P-2	u-blox M8 high precision module with rover and base station functionality

[Order online](#)
[Evaluation Kit](#)

Model	Category	GNSS	Supply	Interfaces	Features	Grade
	Standard Precision GNSS High Precision GNSS Dead Reckoning Timing	GPS / QZSS GLONASS Galileo BeiDou Number of Concurrent GNSS	2.7 V – 3.6 V	UART USB SPI DDC (I <sup>2</sup> C compliant)	Programmable (Flash) Data logging Carrier phase output Additional SAW Additional LNA RTK rover Base station with survey-in Timepulse	Standard Professional Automotive
NEO-M8P-0	•	• • •	•	• • • •	• • • • • • • •	1
NEO-M8P-2	•	• • •	•	• • • •	• • • • • • • •	1

<https://www.u-blox.com/en/product/neo-m8p>

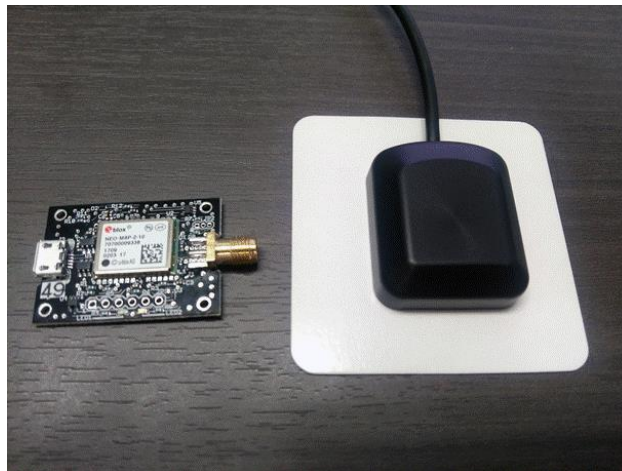


# Setup u-blox Receiver/u-center

---

- **Install Support S/W to your laptop PC**
  - **u-blox u-center**  
(u-centersetup\_v8.2\*.zip)

**u-blox NEO-M8P-2  
Mini-EVK Card + antenna**



**u-blox  
u-center v8.26**

micro  
USB



**your Laptop PC**

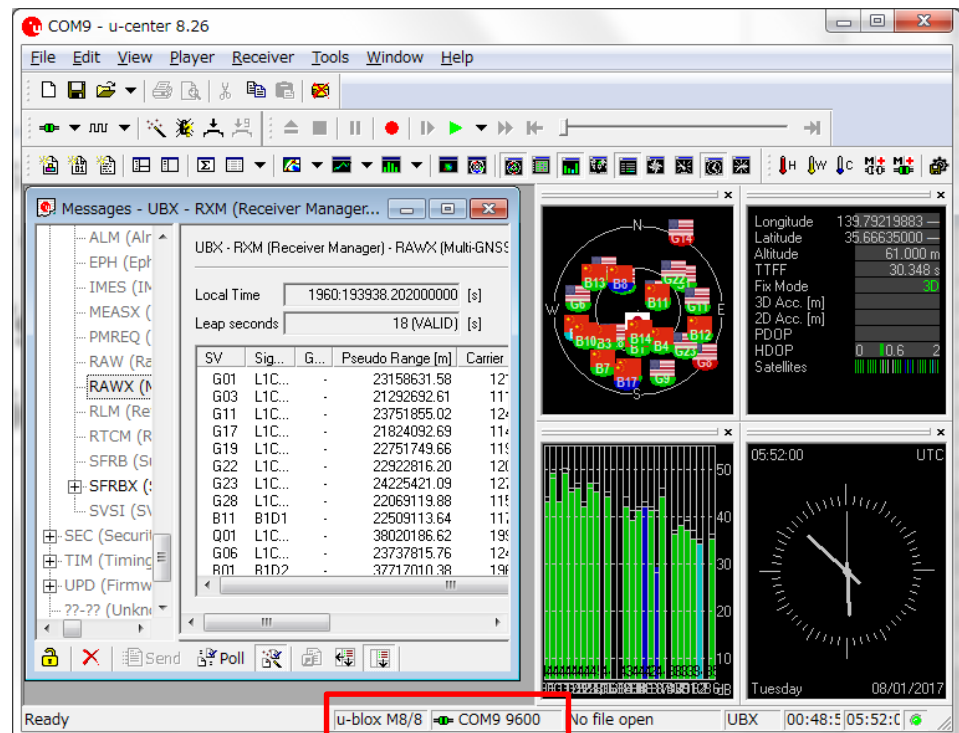
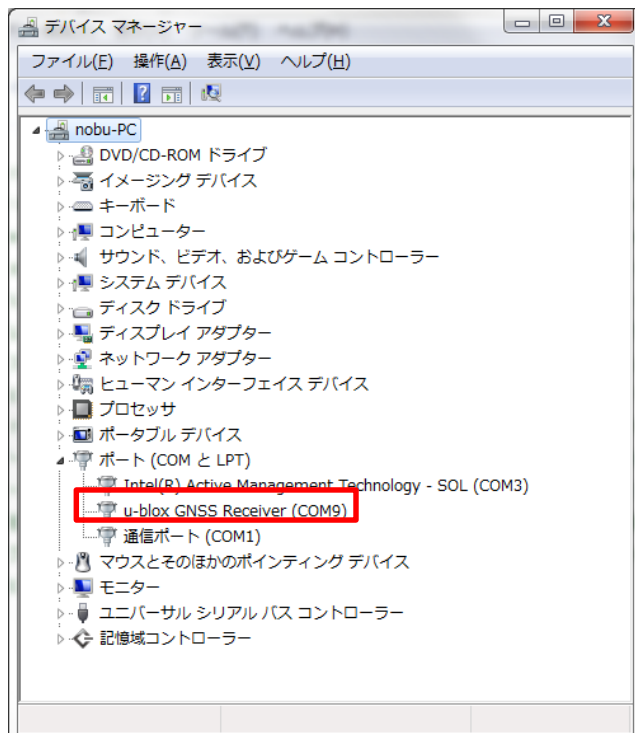
# Which is good ?

---



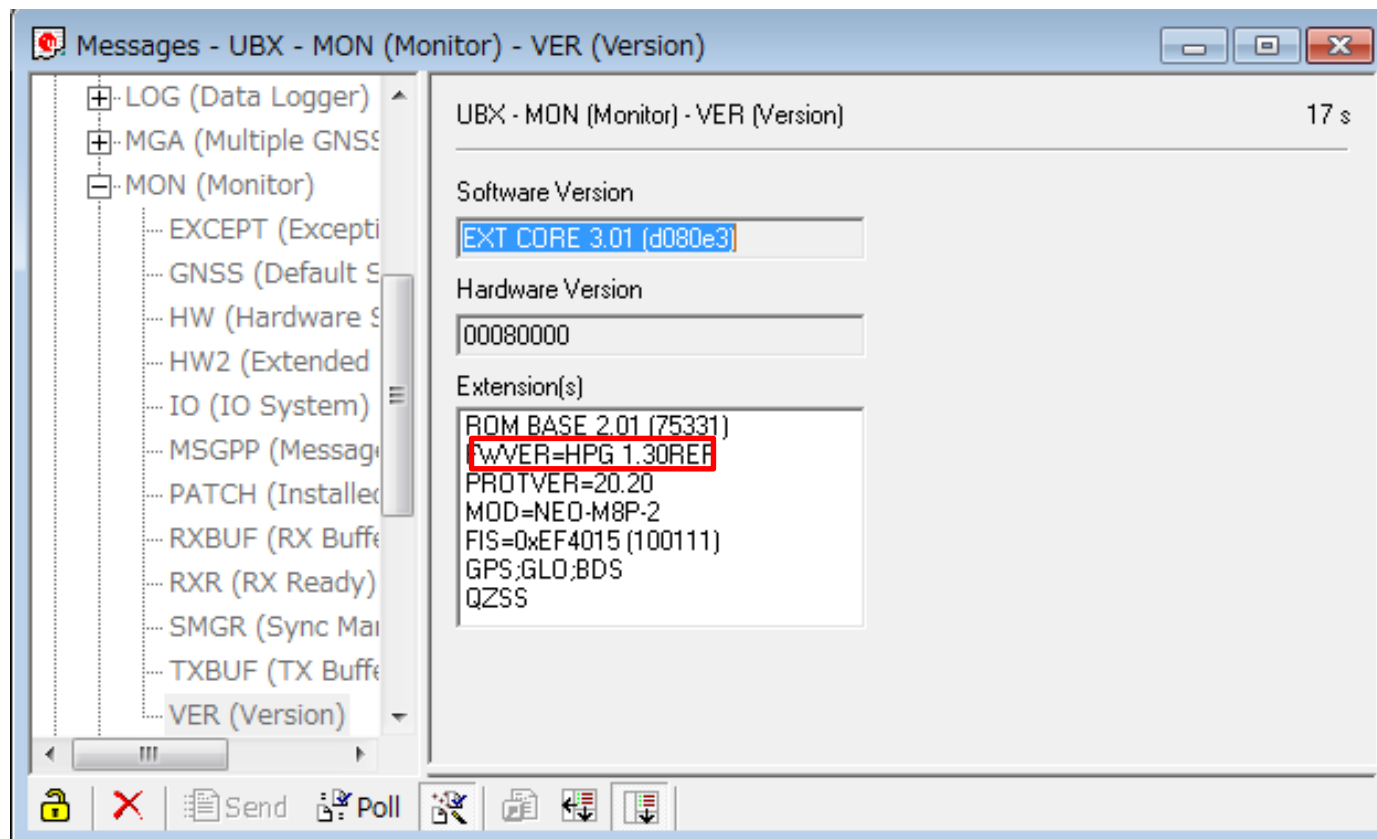
# Connection

- Start u-center and select Receiver->Port
- You will see COM\*. You can check your COM port in your laptop's device manager
- If you have any difficulties(win10), please catch us.



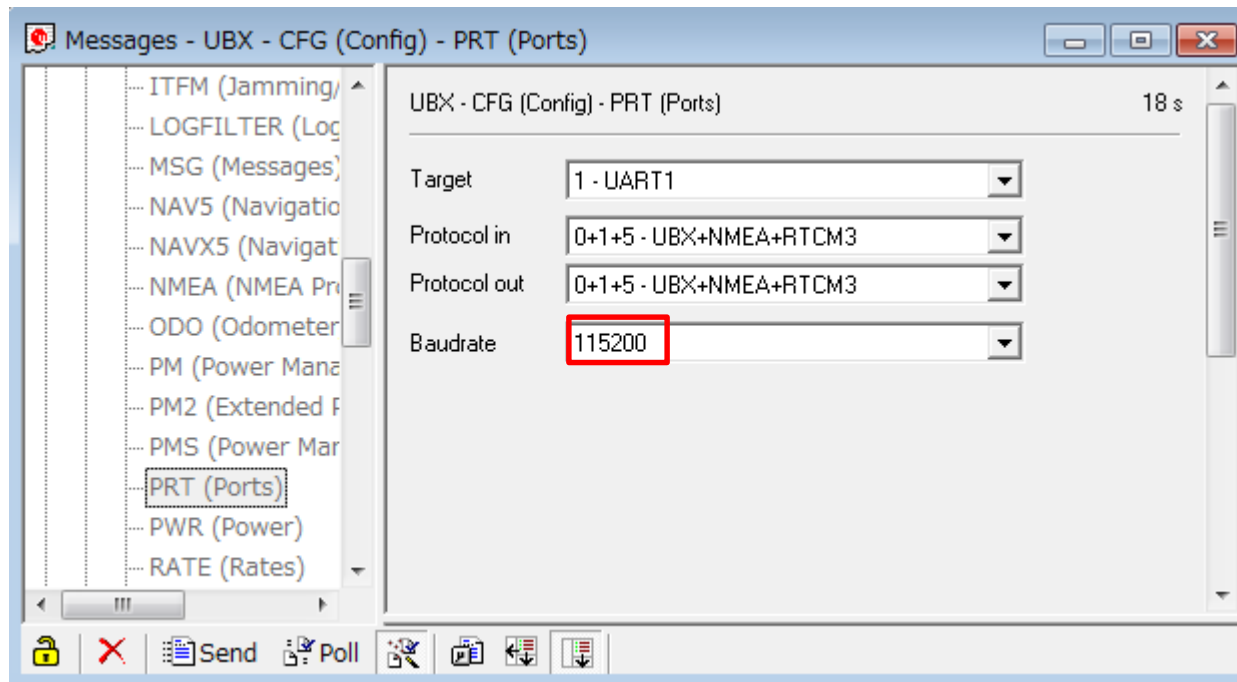
# Firmware Check

- View->Message View->UBX->MON->VER



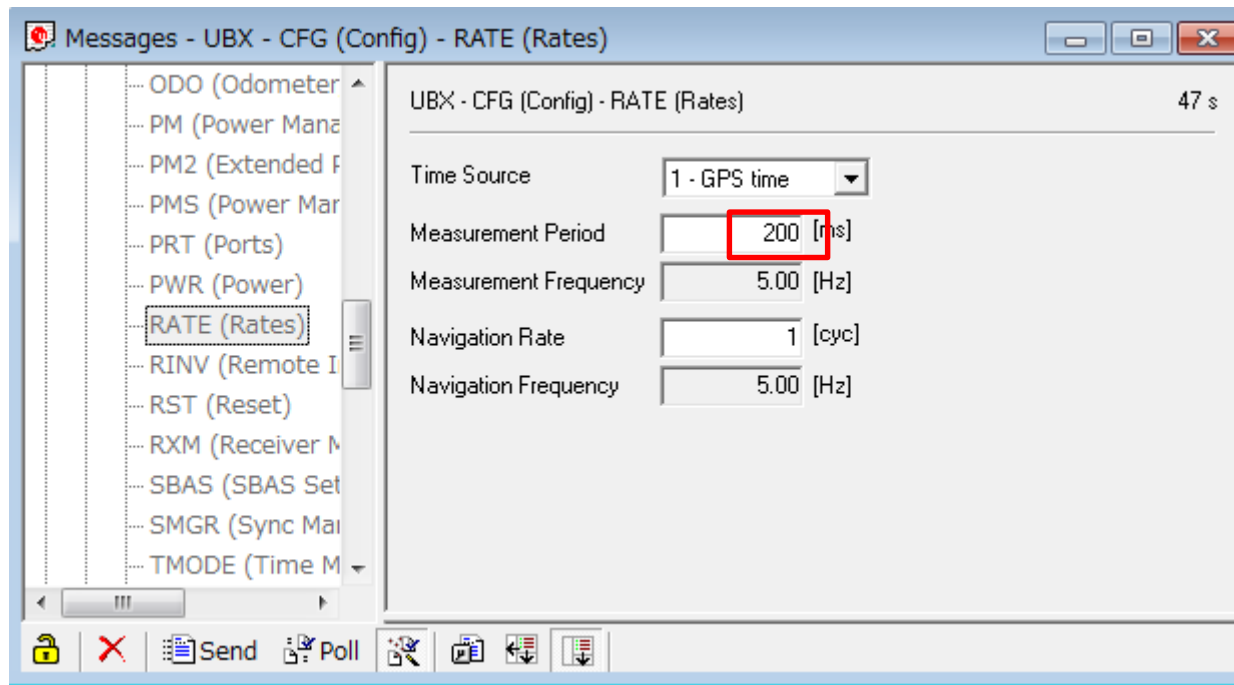
# Baud rate Check

- View->Message View->UBX->CFG->PRT
- Please change from 9600 to 115200



# If you want to change the rate...

- View->Message View->UBX->CFG->RATE
- Please change the measurement period



# If you want to save the raw-data...

- View->Message View->UBX->RXM->“RAWX” and “SFRBX”
- Right click->Enable Message

Messages - UBX - RXM (Receiver Manager) - RAWX (Multi-GNSS Raw Measurement ...)

UBX - RXM (Receiver Manager) - RAWX (Multi-GNSS Raw Measurement Data)

Local Time: 1959:453852.002000000 [s]  
Leap seconds: 18 [VALID] [s] Clock reset

SV	Sig...	G...	Pseudo Range [m]	Carrier Phase [c...	Dopple...	Lock T...
G03	L1C...	-	21063176.78	110687754.15	-1396.1	64500
G28	L1C...	-	21800206.76	114560847.77	-2131.3	64500
G22	L1C...	-	22633126.66	118937886.44	-2787.9	64500
G01	L1C...	-	22867045.86	120167128.60	-2664.8	64500
G11	L1C...	-	23446424.56	123211770.76	-3036.9	64500
G17	L1C...	-	21742316.71	114256647.42	1495.2	64500
B17	B1D1	-	38899893.60	202561921.98	-548.2	0
G19	L1C...	-	22711456.03	119349517.97	2321.2	64500
Q01	L1C...	-	37824318.07	198768143.16	-915.7	64500
G06	L1C...	-	23668967.14	124381256.77	1865.1	64500
B01	B1D2	-	37544536.20	195504220.60	-413.5	64500
B04	B1D2	-	38069193.90	198236251.81	-389.1	64500
B10	B1D1	-	39323374.77	204767090.44	-2195.2	64500
B03	B1D2	-	38324416.15	199565257.77	-393.1	64500
B13	B1D1	-	38408528.06	200003258.77	61.8	64500
B07	B1D1	-	39875539.72	207642347.99	-2255.9	64500
G23	L1C...	-	24172016.22	127024865.87	2064.4	64500
G09	L1C...	-	25040080.03	131586489.49	2795.7	64500
B08	B1D1	-	37512189.88	195335790.21	-27.1	64500
B02	B1D2	-	40032797.16	208461249.03	-330.9	64500
B06	B1D1	-	40303883.97	209872891.22	1194.5	64500

Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)

UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)

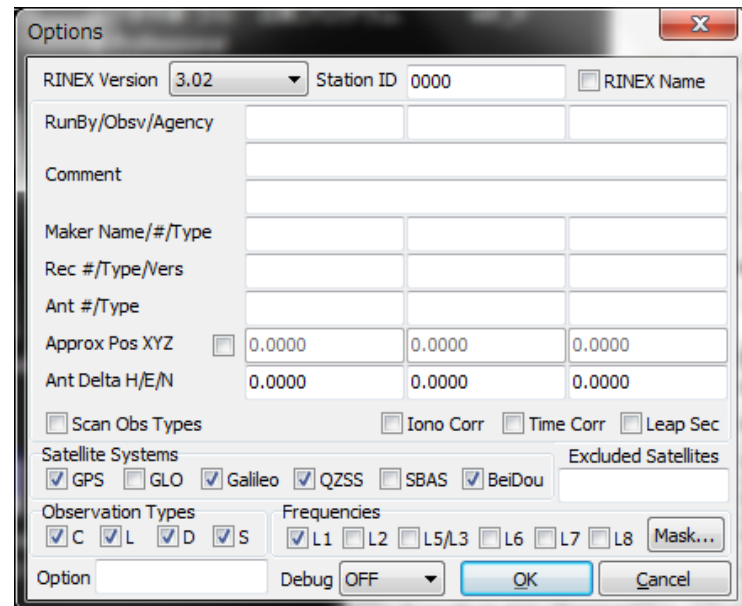
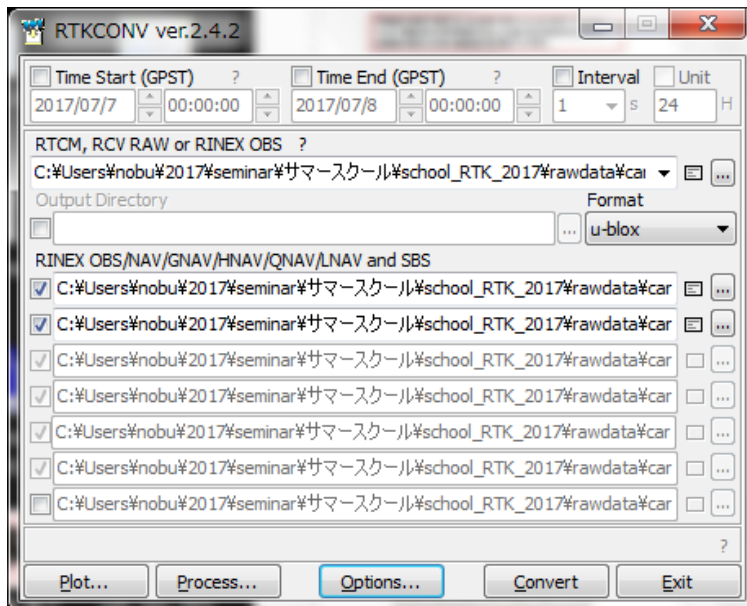
## denotes data received on subChn  Strip Parity Bits

SV	MSG	DATA [* denotes invalid words]
BDS 1 B1D2 0	4	389046E5 33B9105A 0C0F742F 023E38E0
BDS 2 B1D2 0	4	389046E5 33B81055 0FDFD47B 030209DE
BDS 3 B1D2 0	4	389046E5 33B9D053 0C089427 020C3D42
BDS 4 B1D2 0	4	389046E5 33B9105A 0C0F742F 023E38E0
BDS 6 B1D1 0	5/9	389056EA 33A02406 00000000 00000000
BDS 7 B1D1 0	5/9	389056EA 33A02406 00000000 00000000
BDS 8 B1D1 0	5/9	389056EA 33A02406 00000000 00000000
BDS 10 B1D1 0	5/9	389056EA 33A02406 00000000 00000000
BDS 13 B1D1 0	5/9	389056EA 33A02406 00000000 00000000
GPS 1 L1C/A 0	2	22C3A719 A4EFEACB 083E96CA 8C359941
GPS 3 L1C/A 0	2	22C3A719 A4EFEACB 0E3EA743 0BF7D1A
GPS 6 L1C/A 0	2	22C3A719 A4EFEACB 123ED23E 8C411A0
GPS 9 L1C/A 0	2	22C3A719 A4EFEACB 1581D0BD 8D5B705
GPS 11 L1C/A 0	2	22C3A719 A4EFEACB 0A400C89 9034137E
GPS 17 L1C/A 0	2	22C3A719 A4EFEACB 15C1A104 0B292F81
GPS 19 L1C/A 0	2	22C3A719 A4EFEACB 0C8164F1 8B5FCE41
GPS 22 L1C/A 0	2	22C3A719 A4EFEACB 19BEA345 8E22A96
GPS 23 L1C/A 0	2	22C3A719 A4EFEACB 1141EF8A 8DA2E18
GPS 28 L1C/A 0	2	22C3A719 A4EFEACB 060016CD 8AB8F88
QZSS 1 L1C/A 0	2	22C0AA24 24EFE2A8 0E6641F4 032B9527



# RTKCONV

- When you post-process of GNSS raw data, RINEX format is quite popular.
- You can convert other receiver's raw data to RINEX format using rtkconv.exe.
- In the case of Trimble T02 file, you can use “Convert To RINEX” which is available in the Trimble website.



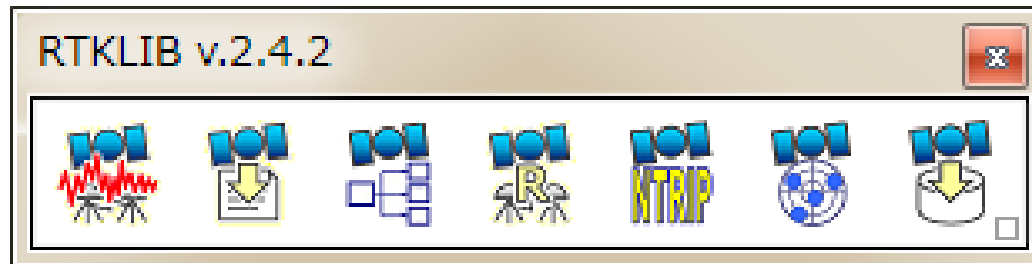


# Use RTKLIB (1)

---

- **Execute RTKLAUNCH.**

RTKLIB\_bin-master¥bin¥rtklaunch.exe

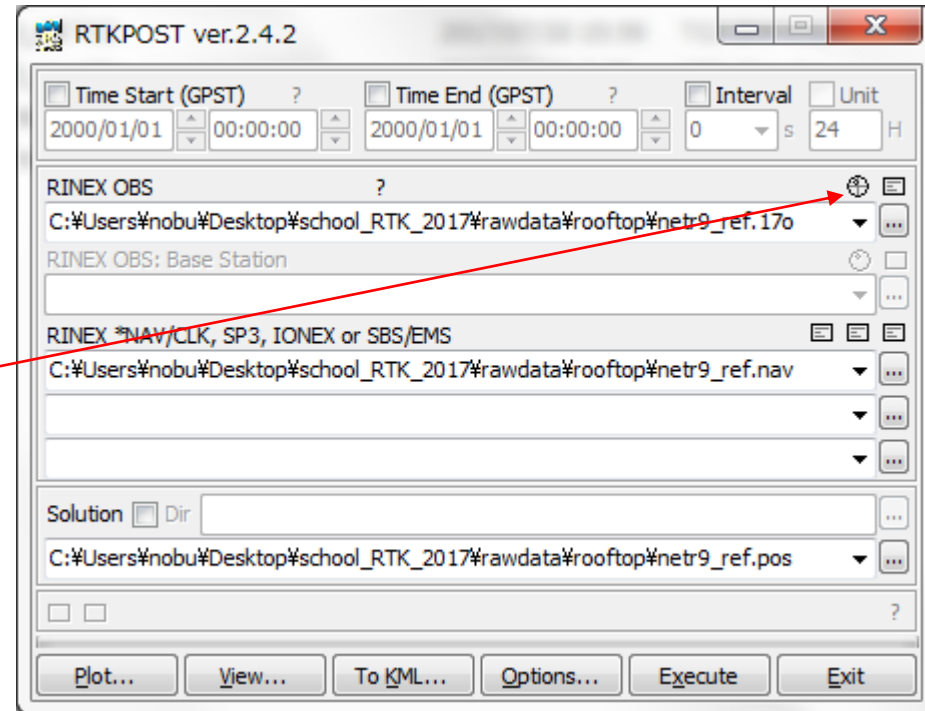


**RTKPLLOT   STRSVR   NTRIPBRS   RTEGET**

**RTKCONV   RTKPOST   RTKNAVI**

# Use RTKLIB (2)

- Execute RTKPOST by RTKLAUNCH
- Execute Menu of RTKPLOTT: rawdata¥rooftop¥ netr9\_ref.17o and netr9\_ref.nav
- Click here

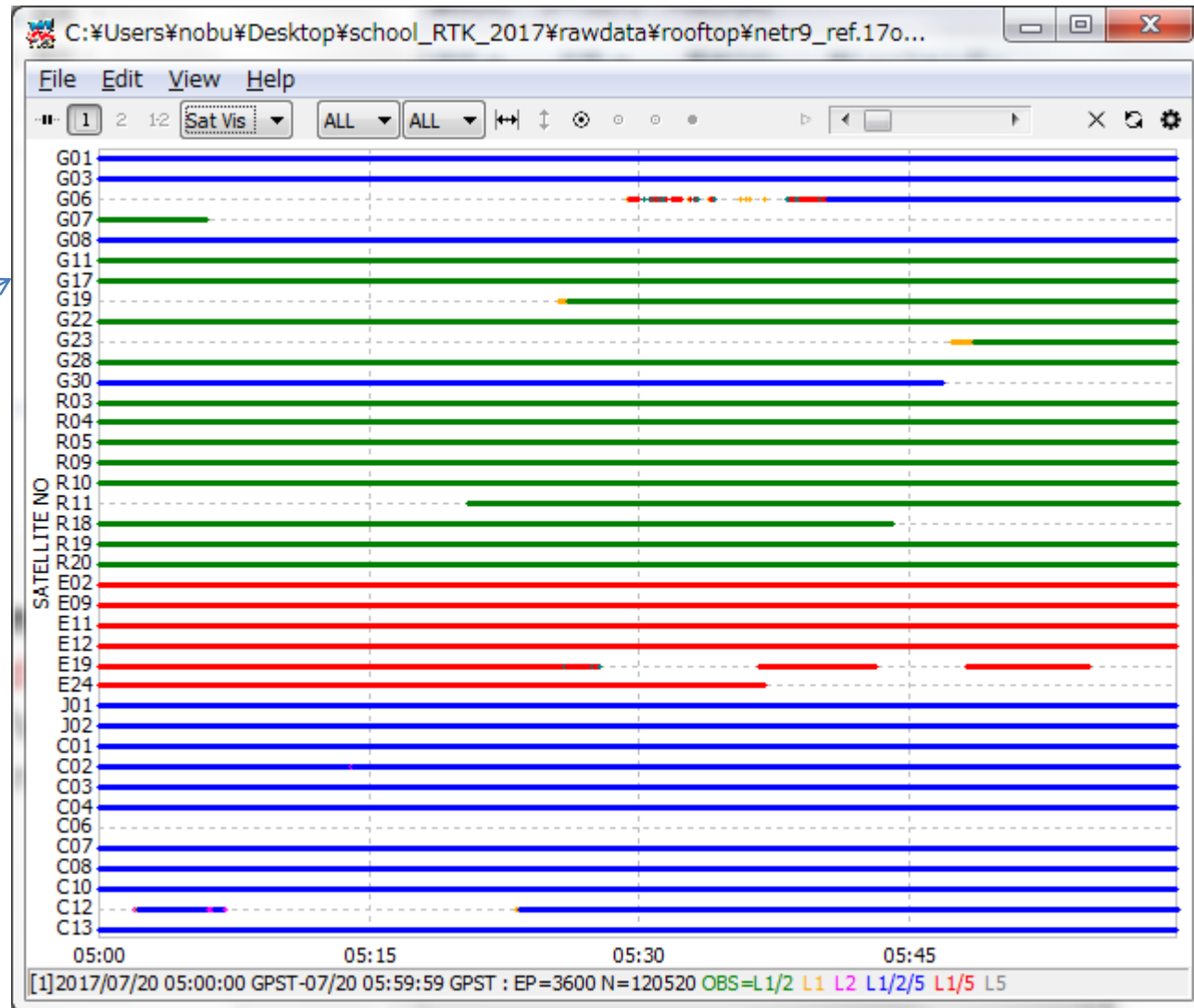


1h data was obtained on 20<sup>th</sup> July 2017 using NetR9 on the rooftop.  
2017/7/20 5:00:00-5:59:59 (GPST)

# Use RTKLIB (3)

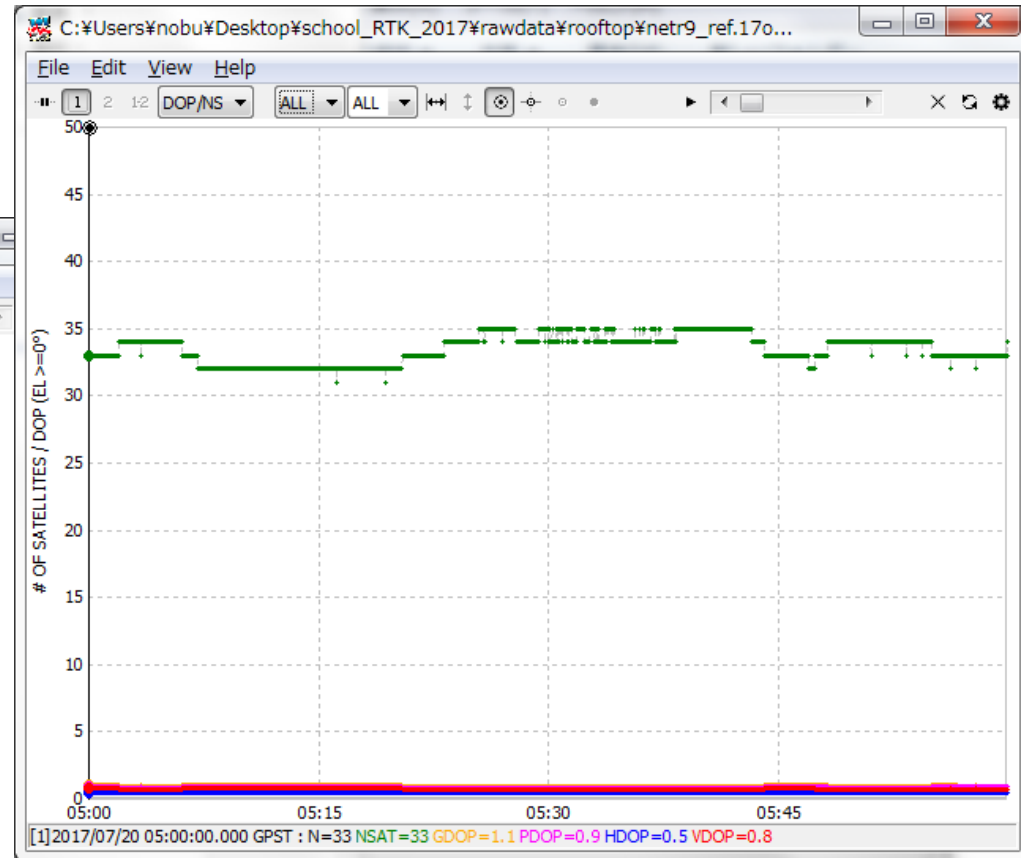
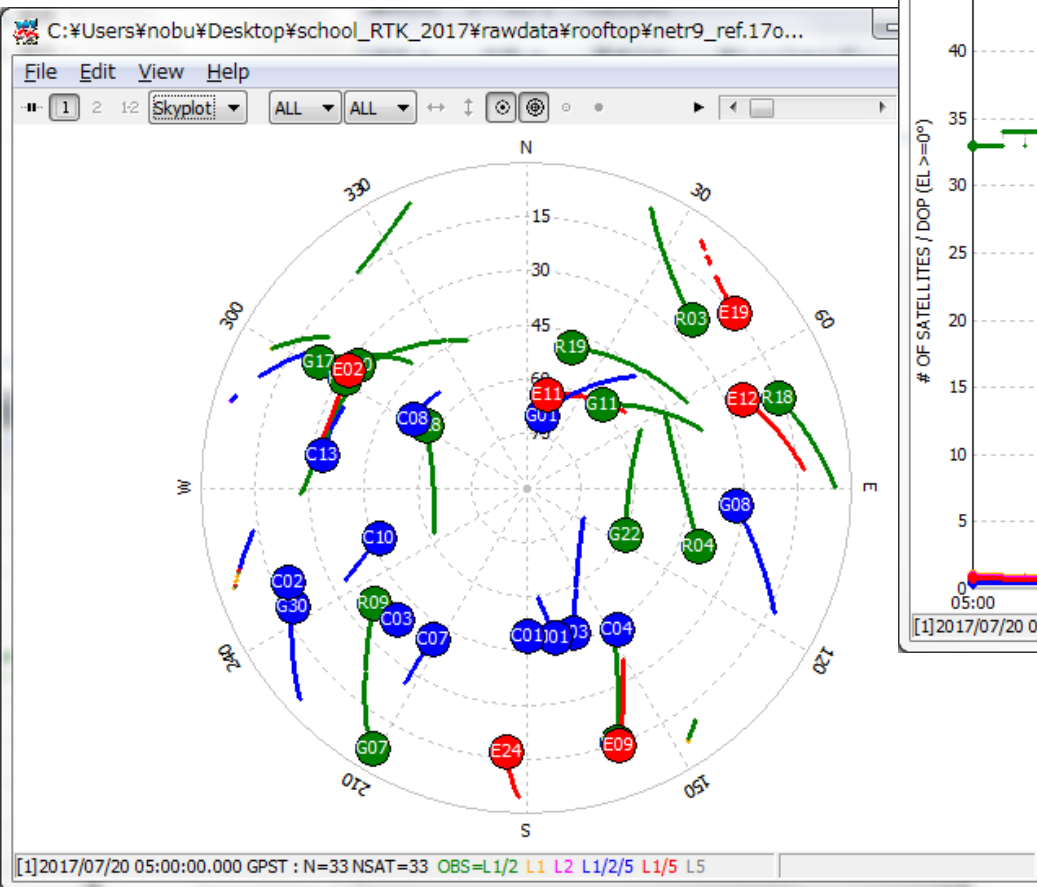
Satellite ID

- G: GPS
- R: GLO
- E: GAL
- J: QZS
- C: BEI



# Use RTKLIB (4)

## Skyplot



# of Visible Satellites and DOP

# Use RTKLIB (5)

## RTKPLOT - Options

The screenshot shows the RTKPLOT Options dialog box with three blue arrows pointing to specific sections:

- OBS Data Options:** This section includes settings for Time Format (h:m:s GPST), Lat/Lon Format (ddd.ddddd), Show Statistics (OFF), Cycle-Slip (OFF), Parity Unknown (OFF), Ephemeris (OFF), Elevation Mask (0), Elev Mask Pattern (OFF), Hide Low Satellite (OFF), Max NSAT/DOP (50), Max Multipath (10), Receiver Position (Single Solut), and Satellite System (GPS, GLO, Galileo, QZSS, SBAS, BeiDou).
- Solution Data Options:** This section includes settings for Error Bar/Circle (OFF), Direction Arrow (OFF), Graph Label (ON), Grid/Grid Label (Grid), Compass (OFF), Scale (ON), Auto Fit (ON), Y-Range (+/-) (5), RT Buffer Size (10800), and Coordinate Origin (Average Pc).
- Common Options:** This section includes settings for Mark Color 1 (1-6), Mark Color 2 (1-6), Line Color, Text Color, Grid Color, Background Color, Plot Style (Mark/Line), Mark Size (2), Font (Tahoma 8pt), Animation Interval (10), and Update Cycle (ms) (100).

OBS Data Options

Solution Data Options

Common Options

# Use RTKLIB (6)

## RTKPOST - Options

### Setting1

The screenshot shows the 'Setting1' tab of the RTKPOST Options dialog. The 'Ionosphere Correction' dropdown is highlighted with a blue box and set to 'Broadcast'. Other settings include Positioning Mode: Single; Frequencies / Filter Type: L1+2, Forward; Elevation Mask: 15; Rec Dynamics / Earth Tides Correction: OFF, OFF; Troposphere Correction: Saastamoinen; Satellite Ephemeris/Clock: Broadcast. Checkboxes for Sat PCV, Rec PCV, PhWindup, Reject Ed, and RAIM FDE are unchecked. Excluded Satellites (+PRN: Included) is empty. Checkboxes for GPS, GLO, Galileo, QZSS, SBAS, and BeiDou are checked.

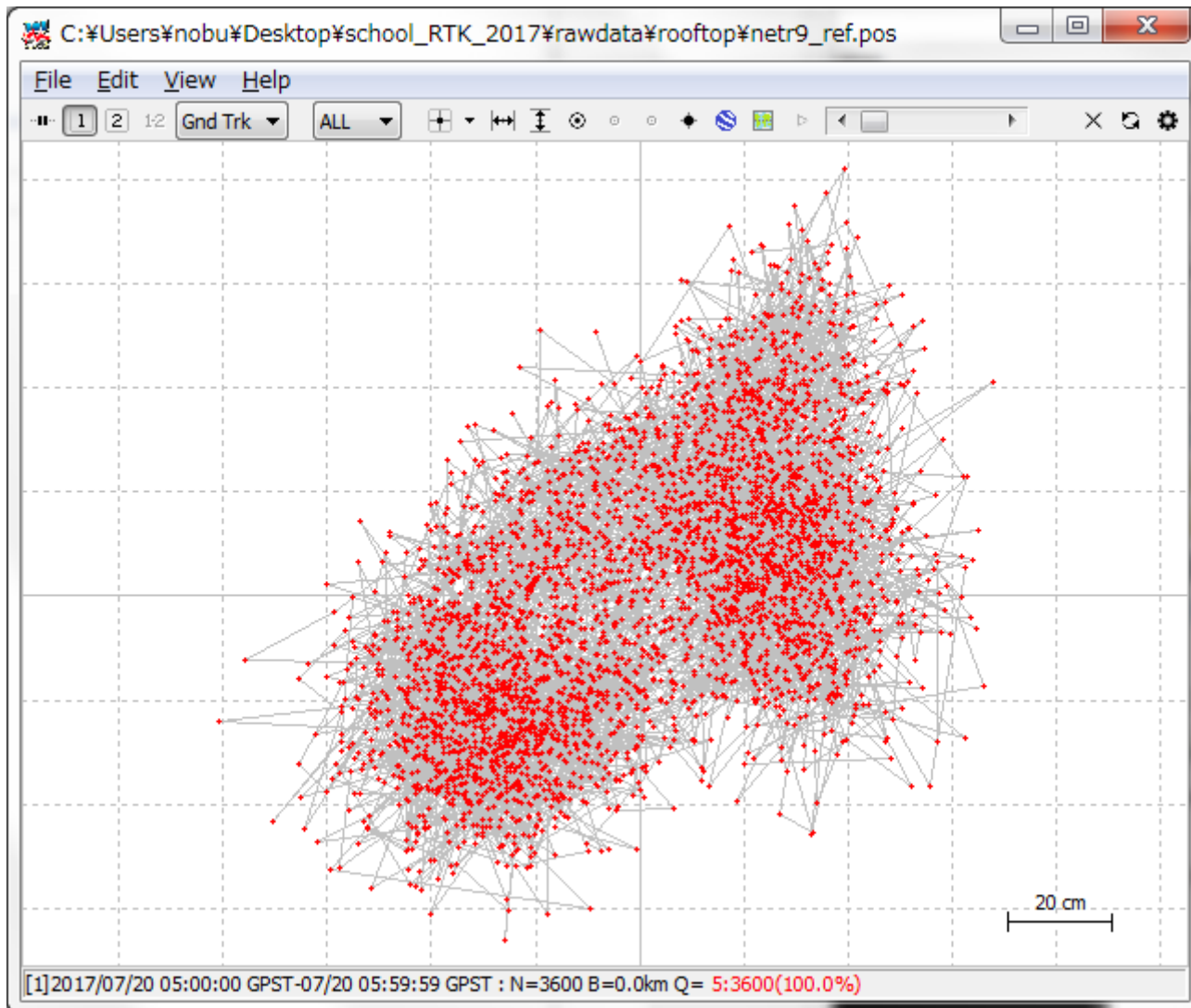
Positioning Mode	Single
Frequencies / Filter Type	L1+2 Forward
Elevation Mask (°) / SNR Mask (dBHz)	15 ...
Rec Dynamics / Earth Tides Correction	OFF OFF
Ionosphere Correction	Broadcast
Troposphere Correction	Saastamoinen
Satellite Ephemeris/Clock	Broadcast
Sat PCV	<input type="checkbox"/>
Rec PCV	<input type="checkbox"/>
PhWindup	<input type="checkbox"/>
Reject Ed	<input type="checkbox"/>
RAIM FDE	<input type="checkbox"/>
Excluded Satellites (+PRN: Included)	
GPS	<input checked="" type="checkbox"/>
GLO	<input checked="" type="checkbox"/>
Galileo	<input checked="" type="checkbox"/>
QZSS	<input checked="" type="checkbox"/>
SBAS	<input type="checkbox"/>
BeiDou	<input checked="" type="checkbox"/>

### Output

The screenshot shows the 'Output' tab of the RTKPOST Options dialog. The 'Datum/Height' dropdown is highlighted with a blue box and set to 'WGS84' and 'Ellipsoidal'. Other settings include Solution Format: Lat/Lon/Height; Output Header/Processing Options: ON, ON; Time Format / # of Decimals: hh:mm:ss GPST, 3; Latitude / Longitude Format: ddd.ddddddd; Field Separator: ; Datum/Height: WGS84, Ellipsoidal; Geoid Model: Internal; Solution for Static Mode: All; NMEA Interval (s) RMC/GGA, GSA/GSV: 0, 0; Output Solution Status / Debug Trace: OFF, OFF.

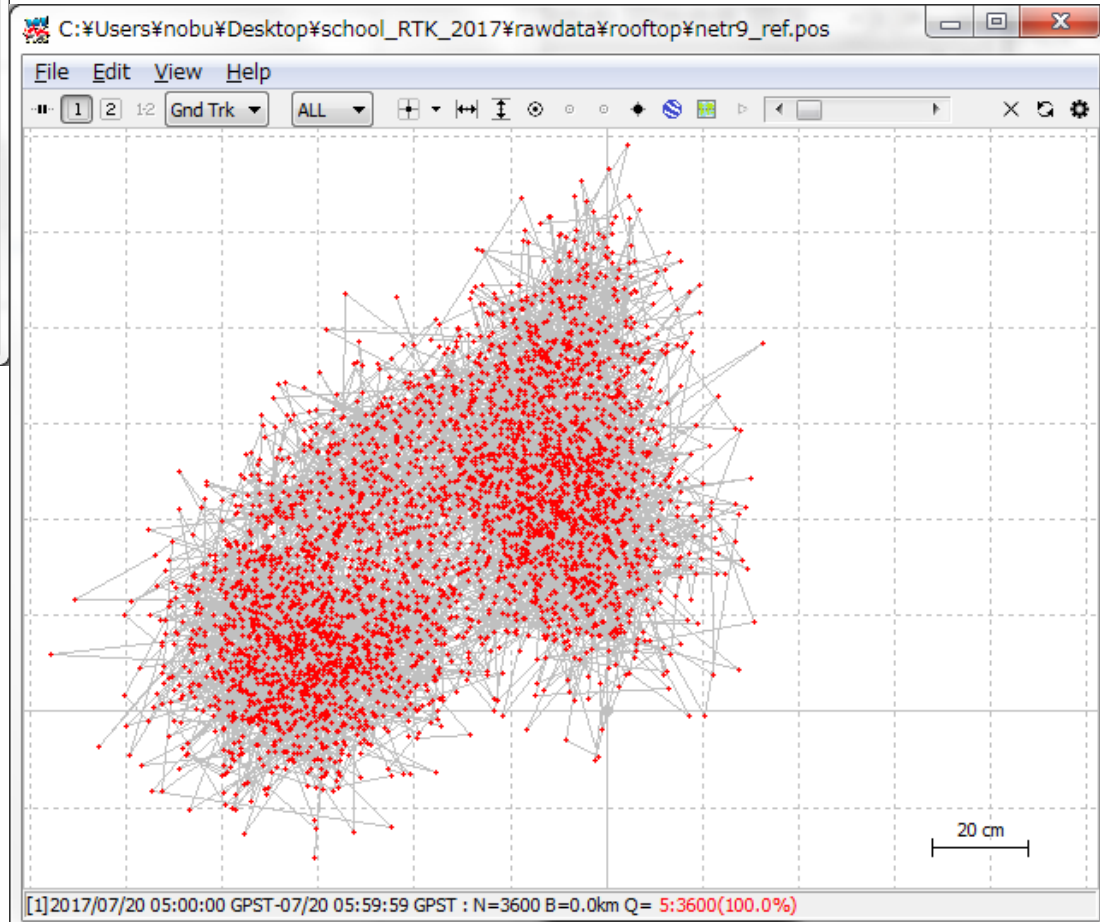
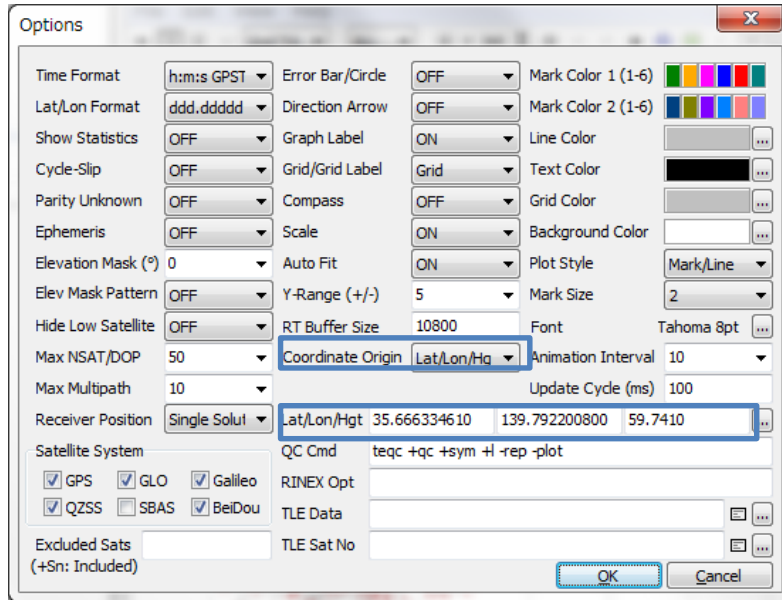
Solution Format	Lat/Lon/Height
Output Header/Processing Options	ON ON
Time Format / # of Decimals	hh:mm:ss GPST 3
Latitude / Longitude Format	ddd.ddddddd
Field Separator	
Datum/Height	WGS84 Ellipsoidal
Geoid Model	Internal
Solution for Static Mode	All
NMEA Interval (s) RMC/GGA, GSA/GSV	0 0
Output Solution Status / Debug Trace	OFF OFF

# Single Point Positioning



# Coordinate Origin

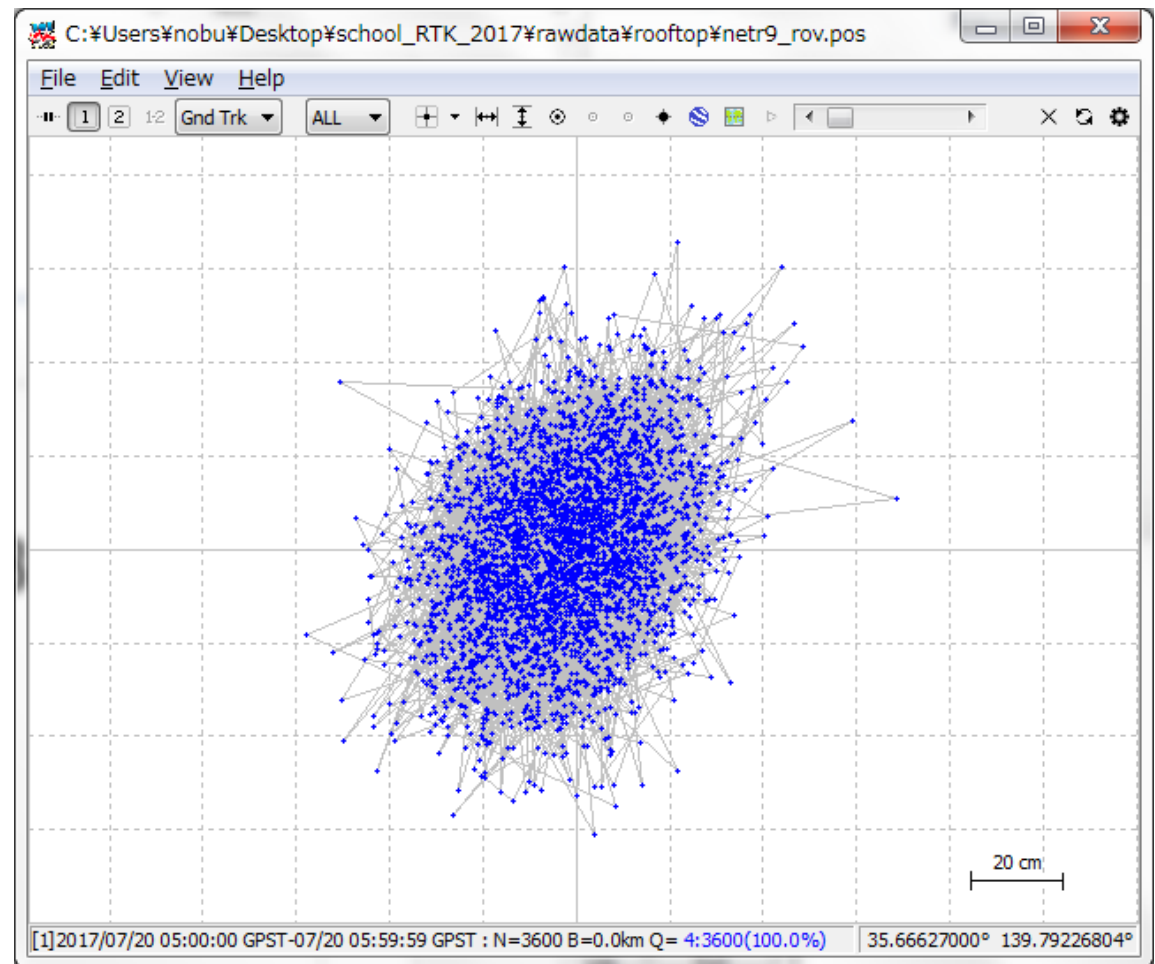
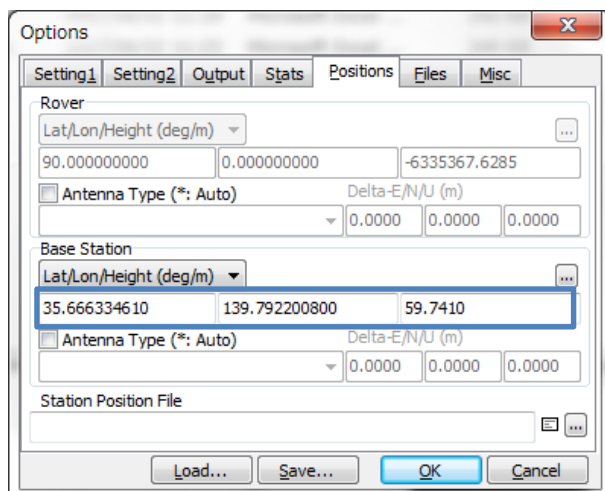
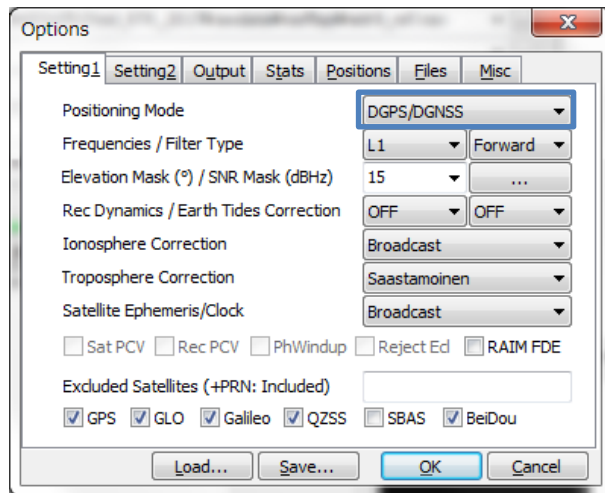
If you change the coordinate origin as a precise reference position, (35.66633461, 139.7922008, 59.741) you see bias like below.





# DGNSS

- Precise rover position(LAT/LON/HGT):  
35.66627025 139.79226723 59.33



# RTK-GNSS

