

GNSS Online Lecture # 1

Lecture ID: WT-103-401

Lecture Topic: GNSS Data Processing in RTKLIB

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11th May 2018

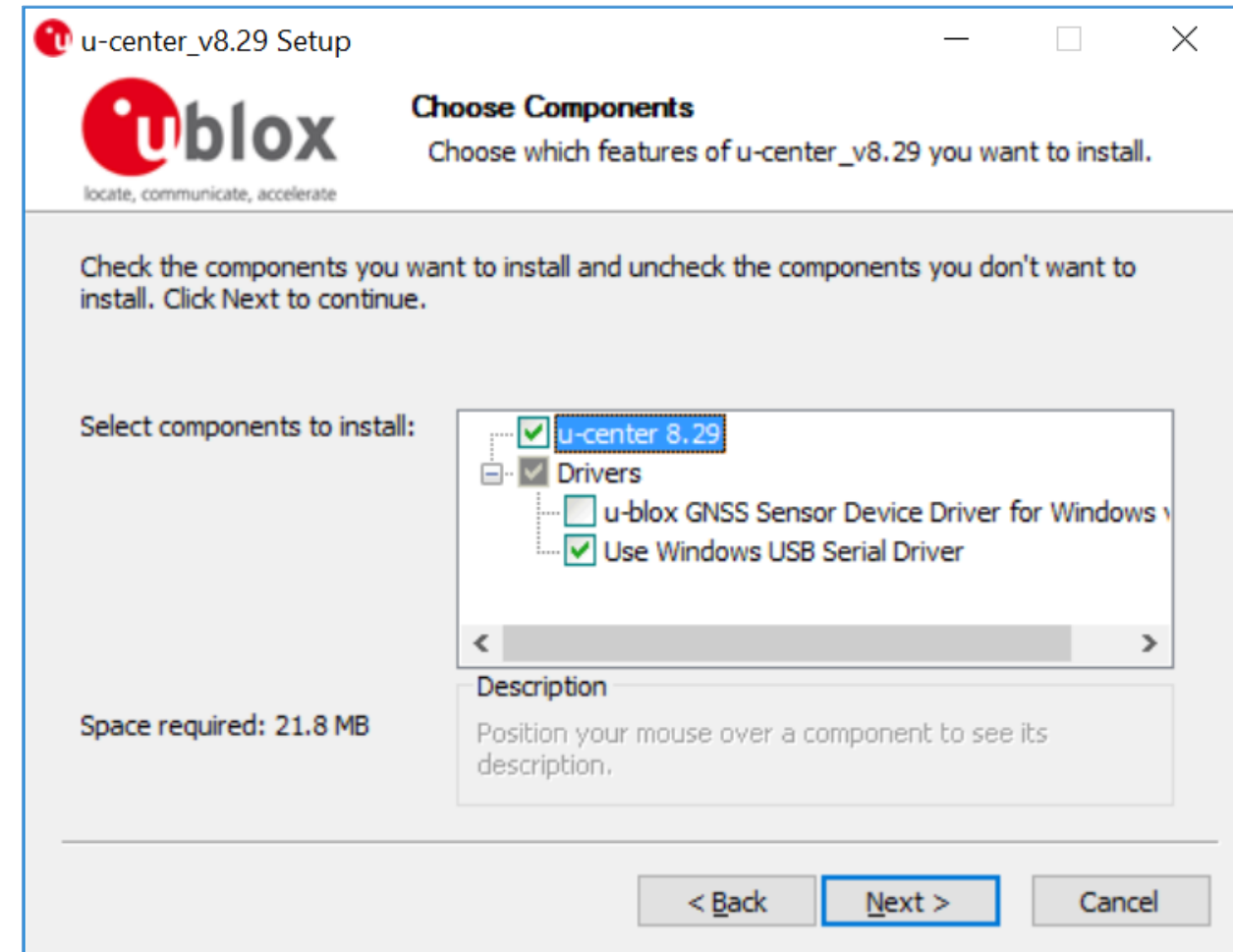
Webinar Information

- Lecture Type : Webinar
- Webinar ID : WT-103-401
- Webinar Topic : GNSS Data Processing in RTKLIB
- Technical Level : Intermediate
- Pre-Requisite (Recommended):
 - Webinar ID : WT-101-101: Introduction to GNSS
 - Webinar ID : WT-102-302: GNSS Field Survey
 - Or general knowledge about GNSS, field survey and data collection.
- Date : 11th MAY 2018 Friday, Time : 18:00 (JST) 09:00 (UTC)
- Duration : 75 minutes
- Resource Person : Dinesh Manandhar, Associate Professor, The University of Tokyo
- This Webinar is Technical. We discuss the followings:
 - (1) How to setup u-blox receiver to collect raw data for RTK
 - (2) How to convert u-blox data into RINEX format
 - (3) How to download base-station data from our ABN stations (NetR9)
 - (4) How to process raw data for RTK using RTKLIB
- Registration : <https://gnss.peatix.com> or <https://s-gnss.peatix.com>

u-center Software Installation

Install u-center Software

- u-center is a software for u-blox receivers
 - Available for Windows and Android Device
 - It can also be used with other receivers that output NMEA data
- Download the software from
 - <https://www.u-blox.com/en/evaluation-software-and-tools>
- Install the software with driver
 - Select “Use Windows USB Serial Driver”
 - Follow the instructions
- Connect u-blox receiver to one of the USB ports. The device is now ready for use.



Select COM Port to Connect the Receiver

Click here

This will show the COM port on which u-blox receiver is connected

Select the port which is connected to u-blox

Hint:

If you don't know which COM port is used for u-blox:

- * disconnect the receiver
- * check COM ports now
- Re-connect the receiver
- check the COM ports

You will see one new COM port now.

Select this COM port to connect the receiver

COM20 - u-center 8.29 - [Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)]

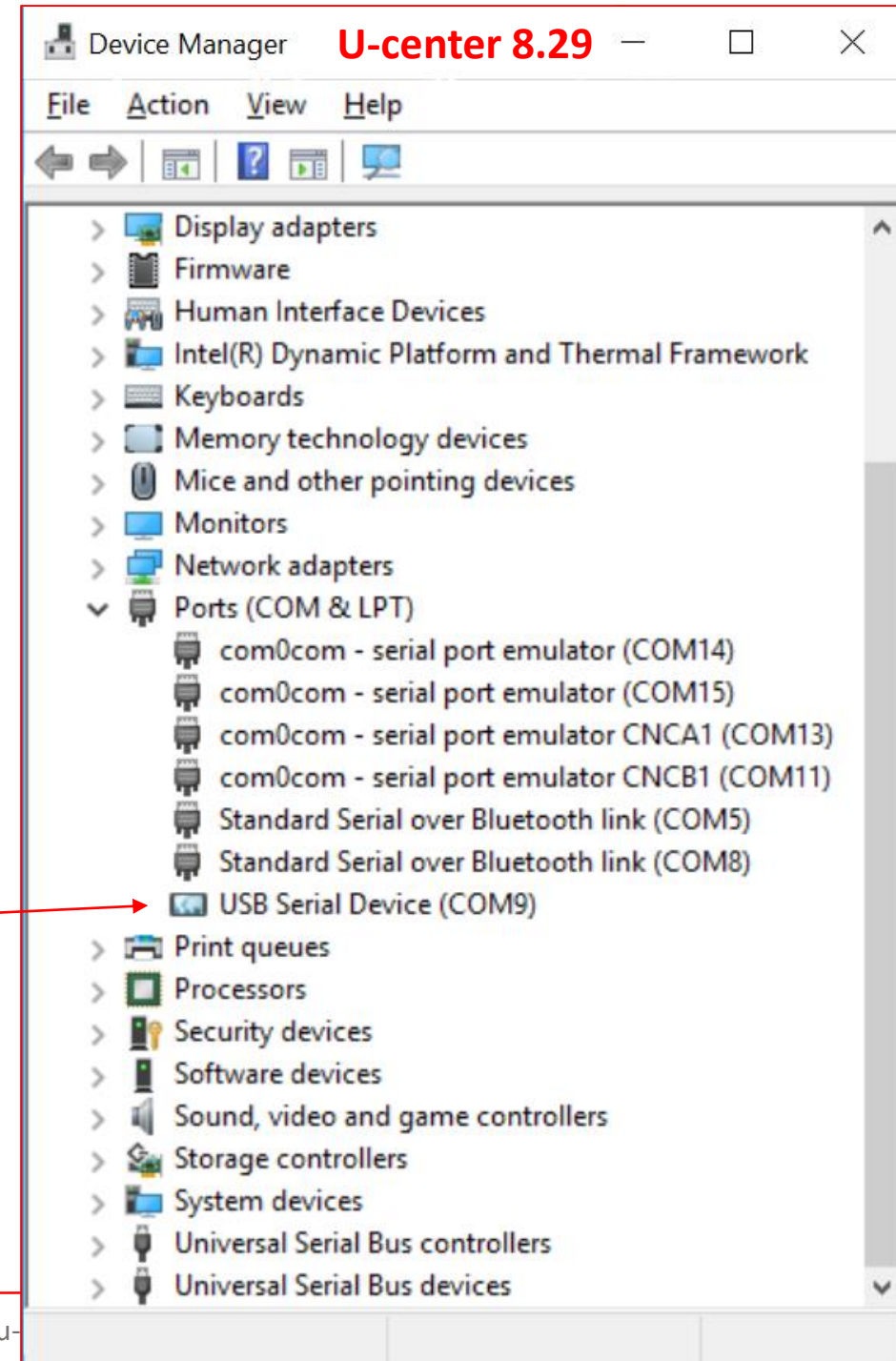
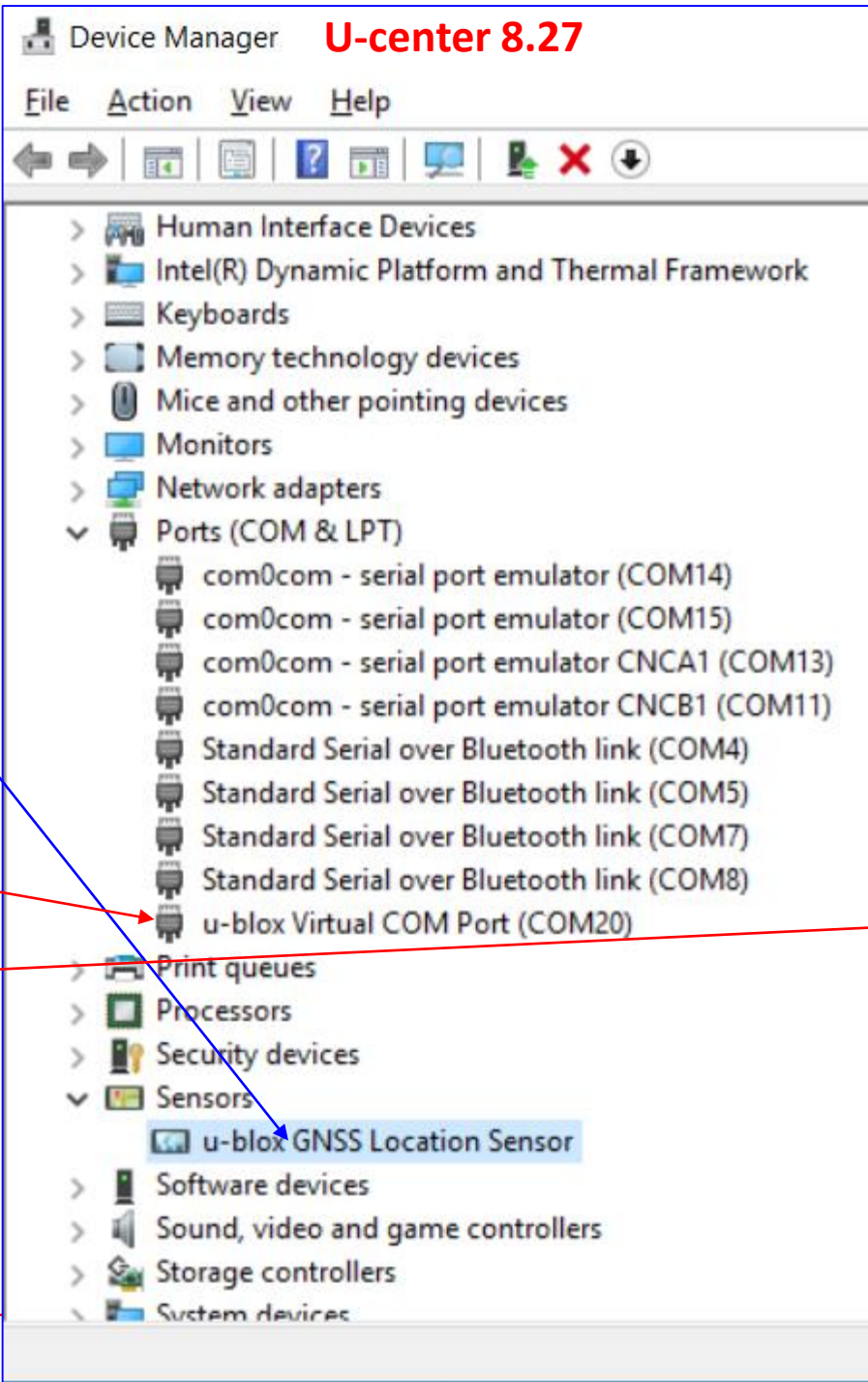
File Edit View Player Receiver Tools Window Help

Disconnect Ctrl-0
COM5 Ctrl-5
COM11 Ctrl-11
COM13 Ctrl-13
COM14 Ctrl-14
COM15 Ctrl-15
• COM20 Ctrl-20
Network connection >

	MSG	DATA (* denotes invalid w
DS 7 B1D1 0	1	389012E4 2F900060 050
DS 10 B1D1 0	1	389012E4 2F900060 050
DS 16 B1D1 0	1	389512E4 2F92006D 050
DS 29 B1D1 0	1	389012E4 2F929F64 050
PS 7 L1C/A 0	3	22C3D032 8F952B58 00C
PS 8 L1C/A 0	3	22C3D032 8F952B58 00C
GPS 9 L1C/A 0	3	22C3D032 8F92AB7C 3FF
GPS 18 L1C/A 0	3	22C3D032 8F952B58 00C
GPS 21 L1C/A 0	5/3/1	22C3D032 8F924DD4 10
GPS 26 L1C/A 0	1	22C3D032 8F8FE970 3D
GPS 27 L1C/A 0	3	22C3D032 8F952B58 00C

Ready u-blox M8/8 COM20 9600 No file open NMEA 00:20:07 05:11:08

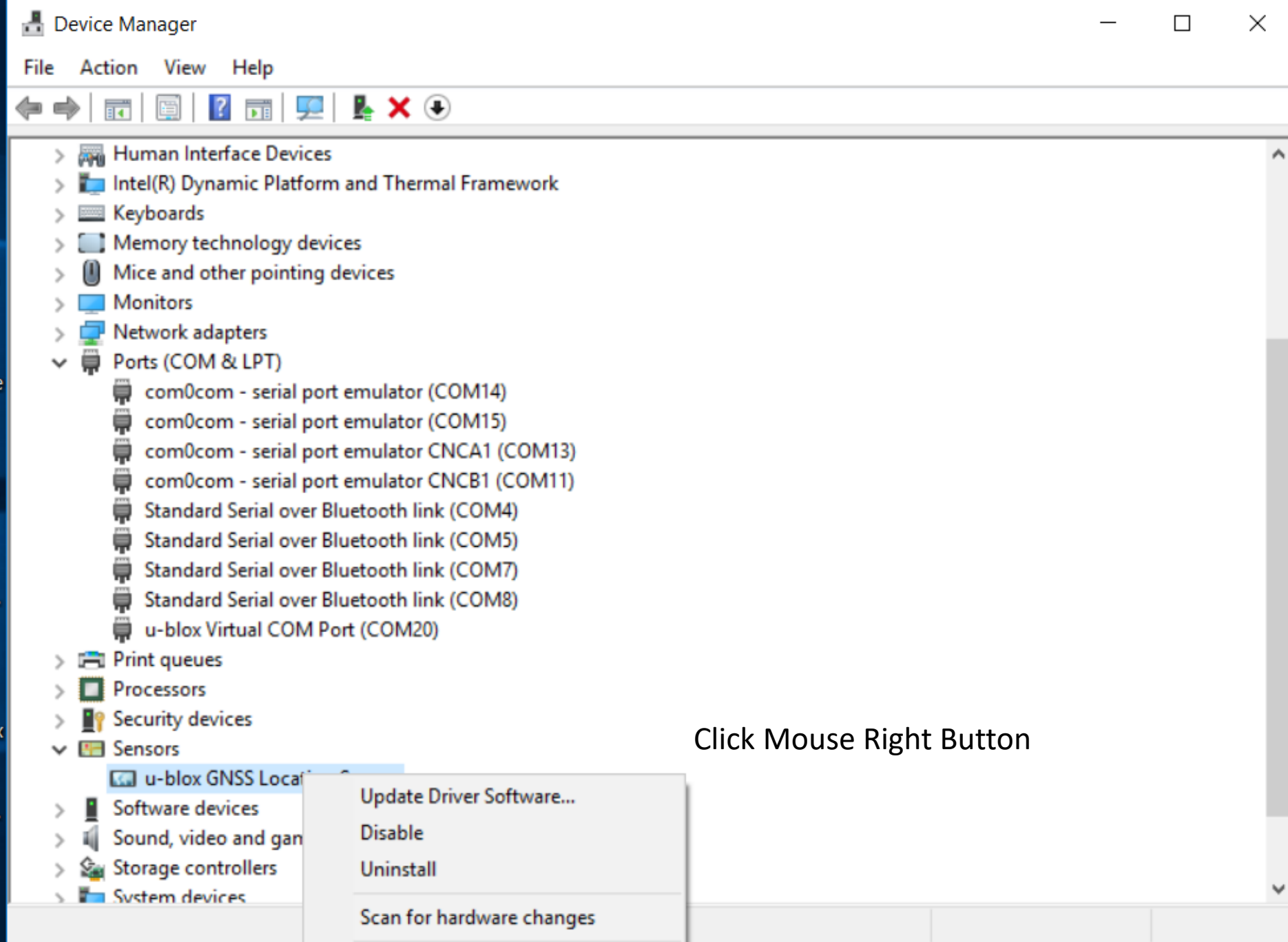
Troubleshooting COM Port Setting



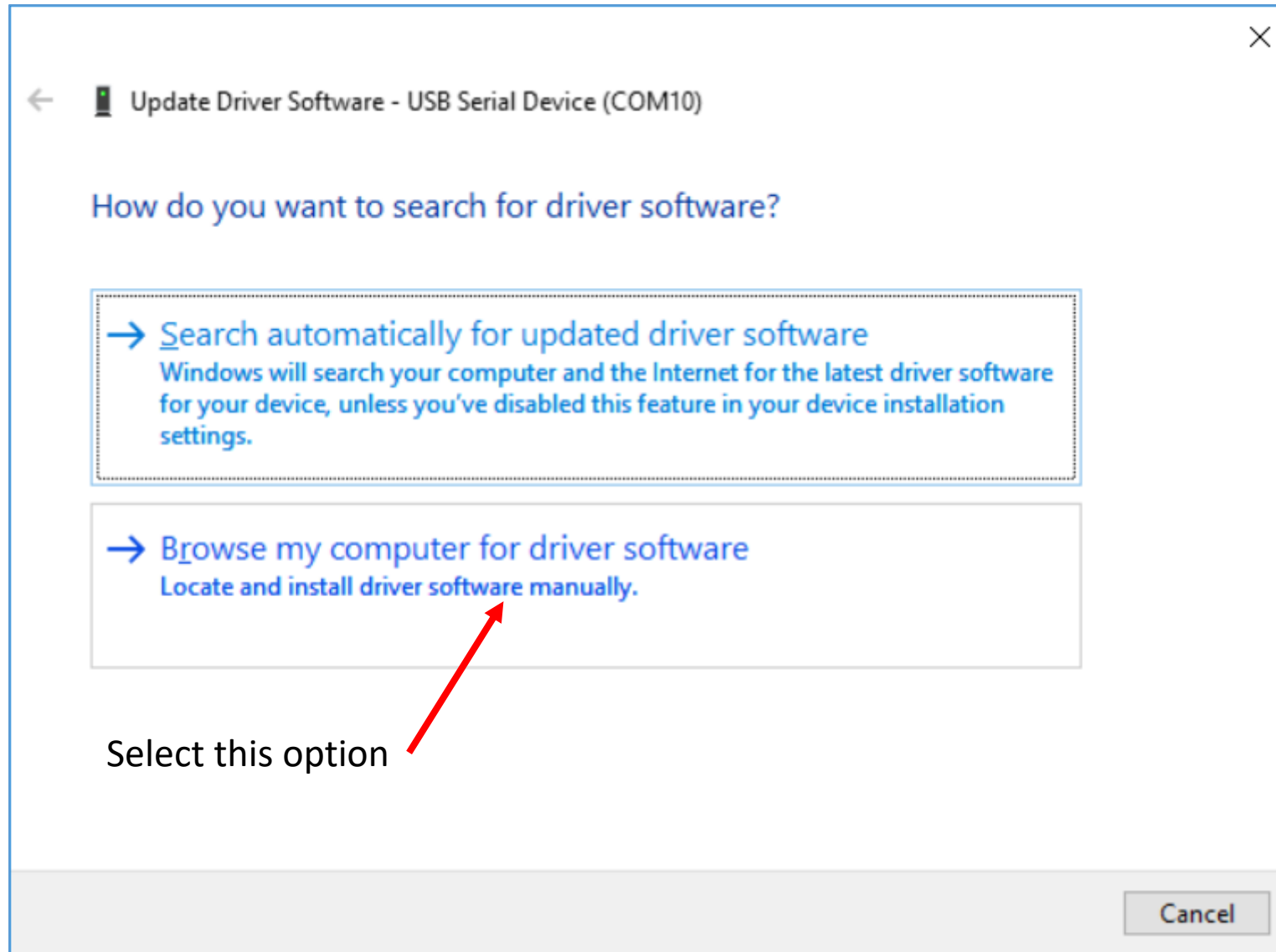
Run Device Manager
You will see SENSORS
– u-blox GNSS Location Sensor
If your receiver doesn't work
with this setting, update this
driver

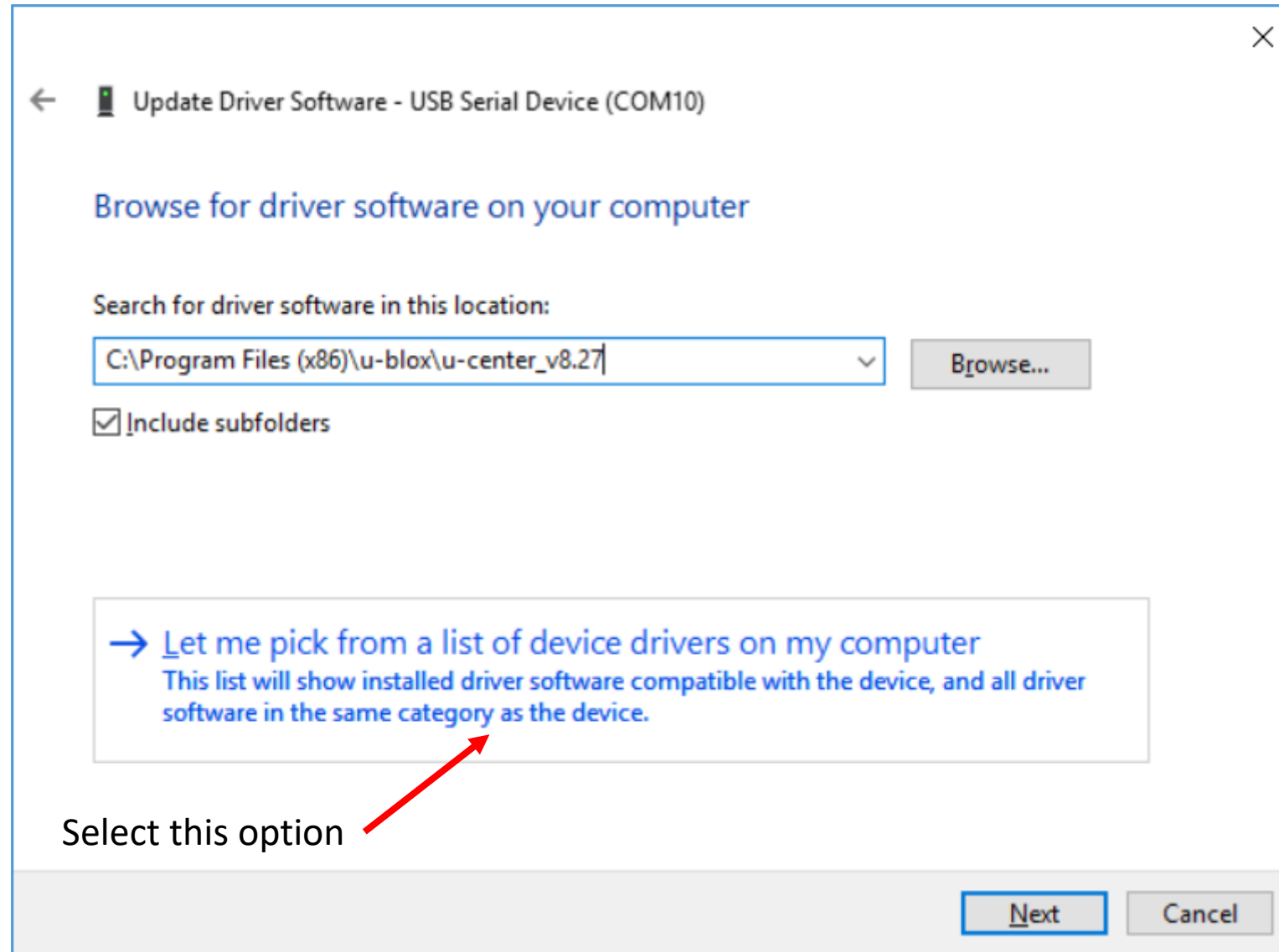
Instructions for update are given
in the next few slides

- After update you will see
- (1) U-blox Virtual COM Port (COM ID) OR
 - (2) USB Serial Device (COM ID)
 - (3) Repeat update process for all USB ports that you want to connect the u-blox receiver
 - (4) Otherwise it will use Virtual COM port



Click Mouse Right Button





← Update Driver Software - USB Serial Device (COM10)

Select the device driver you want to install for this hardware.

Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.

Show compatible hardware

Model

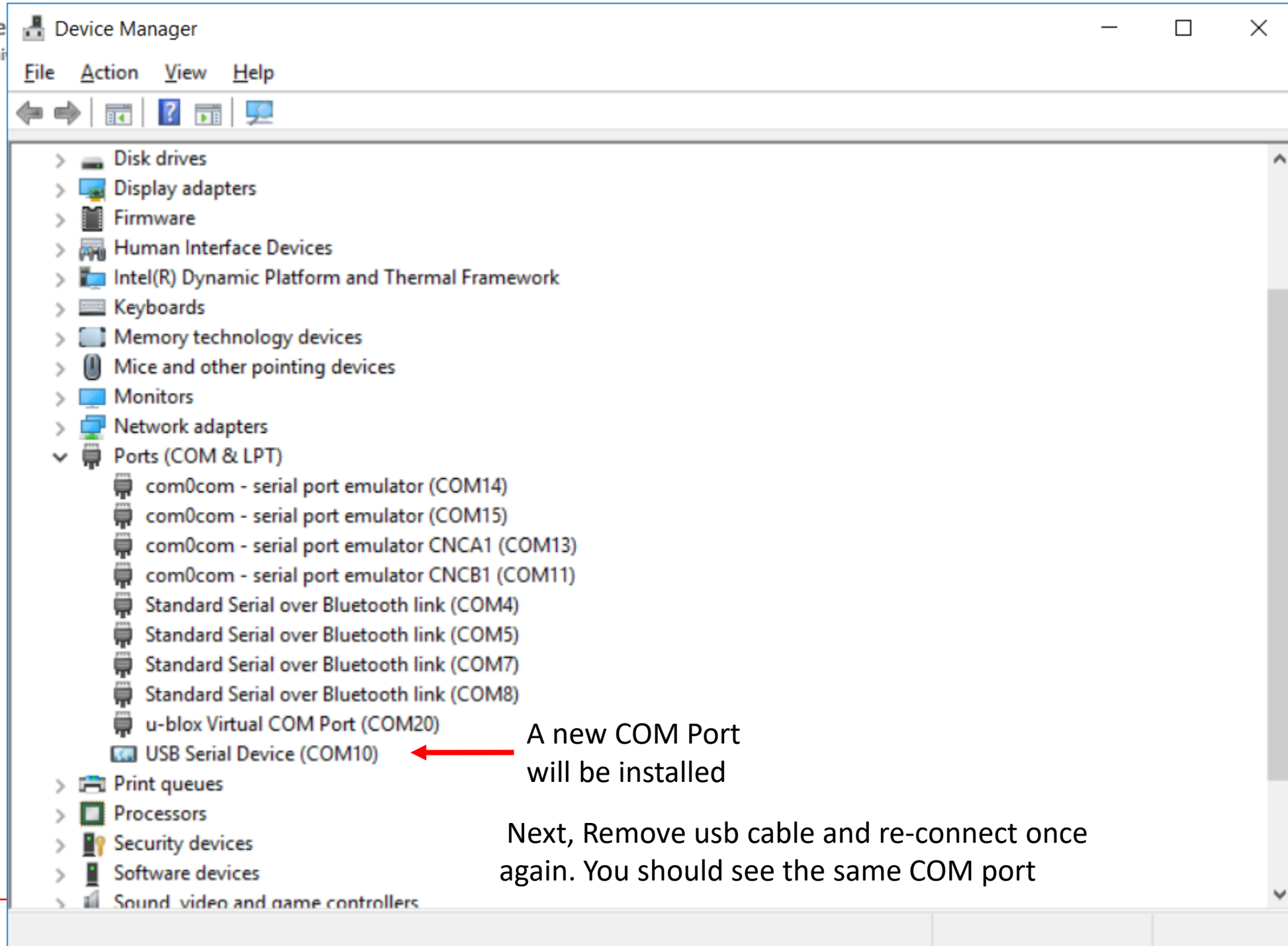
- u-blox GNSS Location Sensor Version: 2.32.0.0 [12/12/2016]
- u-blox GNSS Location Sensor Version: 2.33.0.0 [4/12/2017]
- USB Serial Device
- USB Serial Device

This driver is digitally signed. [Tell me why driver signing is important](#)

Have Disk...

Select this option

Next Cancel



COM10 - u-center 8.26 - [Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data ...

File Edit View Player Receiver Tools Window Help

Disconnect Ctrl-0
COM5 Ctrl-5
COM7 Ctrl-7
• COM10 Ctrl-10
COM11 Ctrl-11
COM13 Ctrl-13
COM14 Ctrl-14
COM15 Ctrl-15
Network connection >

MSG	DATA (* denotes inv
0	5/74 389055C3 3D0D28C;
0	5/74 389055C3 3D0D28C;
0	5/74 389055C3 3D0D28C;
0	5/74 389055C3 3D0D28C;
0	E3 031E7FF4 D487F24C
0	A 0 4/55/1 22C3C527 1EFC6C11
0	A 0 4/55/1 22C3C527 1EFC6C11
GPS 8 L1C/A 0	4/55/1 22C3C527 1EFC2A21
GPS 9 L1C/A 0	2 22C3C527 1EFC6C11
GPS 11 L1C/A 0	4/55/1 22C3C527 1EFC6C11
GPS 21 L1C/A 0	4/55/1 22C3C527 1EFC6C11
GPS 23 L1C/A 0	4/55/1 22C3C527 1EFC6C11
GPS 26 L1C/A 0	4/55/1 22C3C527 1EFC6C11
GPS 31 L1C/A 0	4/55/1 22C3C527 1EFC6C11
QZSS 2 L1C/A 0	4/56/3 22C0AA81 9EFC6421
QZSS 2 L1SAIF 0	50 9AC90C3D FC00056
SBAS 128 L1C/A 0	28 9A720CE5 AD0FE08
SBAS 129 L1C/A 0	4 9A118031 FFDFFDF
SBAS 137 L1C/A 0	4 9A118031 FFDFFDF

MEASX (Measure
PMREQ (Power M
RAW (Raw Meas
RAWX (Multi-GN
RLM (Return Link
RTCM (RTCM inp
SFRB (Subframe
+ SFRBX (Subframe
SVSI (SV Status In
SEC (Security)
TIM (Timing)
UPD (Firmware Upd
??-?? (Unknown)
??-?? (Custom)

53.400 m x100

51 43 33 42 42 41 37 39 45 41 45 39 37 30 40 31 31 17
53G 42B1G 85 29 26 25 25 10 28 4E 14 38 2G 9197 251B 1610 8B

09:45:39 UTC
Thursday 02/22/2018

Ready u-blox M8/ COM10 9600 No file open NMEA 00:08:0 09:45:5

Run u-center and select COM Port. You will see the New COM port here. Select it.

It should work now See the COM Port and green light blinking here

u-Blox Receiver Setup to Log Raw Data for RTK

Output Data Types from a GPS Receiver

- PVT Data
 - Position, Velocity and Time
 - All receivers output these data
 - Data format is NMEA
- Raw Data
 - Pseudorange, Carrier-phase and Doppler
 - Required for RTK
 - Some receivers output these data
 - File format may be proprietary or RINEX Observation File
- Navigation Message Data
 - Satellite Ephemeris, Almanac and Clock Data, Satellite Health Status etc.
 - Required for RTK
 - File format may be proprietary or RINEX Navigation File
- Satellite Related Data
 - Number and Type of Satellites, Azimuth, Elevation, Satellite Types and Signals
 - Many Receivers output these data
 - Data Format is NMEA
- Signal Quality Data
 - C/No or SNR
- Other Data
 - Noise related data
 - Receiver specific proprietary information

Connect receiver by selecting COM port

Select COM Port

Select Speed 115200

The screenshot shows the 'COM17 - u-center 8.26 - [Messages - UBX - CFG (Config) - GNSS (GNSS Config)]' window. The 'COM' dropdown menu is open, showing options from COM5 to COM17, with COM17 selected. The 'Channels' table is visible, listing various GNSS systems and their configurations.

ID	GNSS	Configure	Enable	min	max	Signals
0	GPS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	8	16	<input checked="" type="checkbox"/> L1C/A
1	SBAS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	3	<input checked="" type="checkbox"/> L1C/A
2	Galileo	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	4	8	<input checked="" type="checkbox"/> E1
3	BeiDou	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	8	16	<input checked="" type="checkbox"/> B1
4	IMES	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0	8	<input checked="" type="checkbox"/> L1C/A
5	QZSS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2	3	<input checked="" type="checkbox"/> L1C/A
6	GLONASS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	8	14	<input checked="" type="checkbox"/> L1OF
7	IRNSS	<input type="checkbox"/>	<input type="checkbox"/>			

Number of channels available: 32
Number of channels to use: 32 Auto set

For specific SBAS configuration use

Monitoring windows include a compass, a signal strength bar chart, and a clock.

At the bottom, the status bar shows 'u-blox M COM17 96 No file open NME/00:05 02:01'.

If COM port is open properly,
You will see Green color flashing

COM3 - u-center 8.18 - [Messages - UBX - CFG (Config) - GNSS (GNSS Config)]

File Edit View Player Receiver Tools Window Help

NMEA
UBX
ACK (Acknowledge)
AID (GPS Aiding)
CFG (Config)
ANT (Antenna Settings)
CFG (Configuration)
DAT (Datum)
DOSC (Disciplined Oscillator)
EKF (EKF Settings)
ESFGWT (Gyro+Wheeltick)
ESRC (External Source Config)
FXN (Fix Now Mode)
GNSS (GNSS Config)
INF (Inf Messages)
ITFM (Jamming/Interference Monitor)
LOGFILTER (Log Settings)
MSG (Messages)
NAV5 (Navigation 5)
NAVX5 (Navigation Expert 5)
NMEA (NMEA Protocol)
ODO (Odometer/Low-Speed COG filter)
PM (Power Management)
PM2 (Extended Power Management)
PRT (Ports)
PWR (Power)
RATE (Rates)
RINV (Remote Inventory)
RST (Reset)
RXM (Receiver Manager)
SBAS (SBAS Settings)
SMGR (Sync Manager Config)
TMODE (Time Mode)
TMODE2 (Time Mode 2)

UBX - CFG (Config) - GNSS (GNSS Config)

GNSS ID	configure	GNSS name	enable	min	max	Signals
0	<input checked="" type="checkbox"/>	GPS	<input checked="" type="checkbox"/>	8	16	
1	<input checked="" type="checkbox"/>	SBAS	<input checked="" type="checkbox"/>	1	3	
2	<input type="checkbox"/>	Galileo	<input type="checkbox"/>	0	0	
3	<input checked="" type="checkbox"/>	BeiDou	<input checked="" type="checkbox"/>	8	16	
4	<input checked="" type="checkbox"/>	IMES	<input type="checkbox"/>	0	8	
5	<input checked="" type="checkbox"/>	QZSS	<input checked="" type="checkbox"/>	1	3	
6	<input checked="" type="checkbox"/>	GLONASS	<input type="checkbox"/>	8	14	
7		IRNSS				

Number of channels available: 32
Number of channels to use: 32 Auto set

For specific SBAS configuration use CFG-SBAS

For specific GLONASS configuration use CFG-GLONASS

Enable QZSS & L1SAIF

Enable either Beidou or Glonass. Both systems can't be enabled at the same time.

Ready

COM3-u-blox M8 No file open UBX 00:10:24 04:54:55

Search the web and Windows

ENG 1:54 PM
INTL 1/10/2016

COM3 - u-center 8.18 - [Messages - UBX - RXM (Receiver Manager) - RAWX (Multi-GNSS Raw Measurement Data)]

File Edit View Player Receiver Tools Window Help

EKFSTATUS (Status)
ODO (Odometer)
ORB (Orbit Info)
POSECEF (Position ECEF)
POSLLH (Geodetic Position)
PVT (Navigation PVT Solution)
RESETODO (Reset Odometer)
SAT (Satellite Information)
SBAS (SBAS Status)
SOL (Navigation Solution)
STATUS (Navigation Status)
SVINFO (SV Information)
TIMEBDS (BDS Time)
TIMEGLO (GLO Time)
TIMEGPS (GPS Time)
TIMEUTC (UTC Time)
VELECEF (Velocity ECEF)
VELNED (Velocity WGS84)

RXM (Receiver Manager)
ALM (Almanac)
EPH (Ephemeris)
PMREQ (Power Mode Request)
RAW (Raw Measurement Data)
RAWX (Multi-GNSS Raw Measurement Data)
SFRB (Subframe Data)
SFRBX (Subframe Data NG)
SVSI (SV Status Info)
TIM (Timing)
UPD (Firmware Update Messages)
??-?? (Unknown)
??-?? (Custom)
UNKNOWN
CUSTOM

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

Local Time 1879:18340.000000000 [s]
Leap seconds 17 (VALID) [s] Clock reset

SV	Sig...	G	Pseudo R...	Carrier Pha...	Dop...	Loc...	S.	PR...	CP...	DO...	P.	C...	H...
G13	L1CA	-	21866446.00	114908958.34	-1537.2	64500	45	0.32	0.004	0.128	Y	Y	Y
G20	L1CA	-	20164563.29	105965503.74	-267.5	64500	43	0.32	0.004	0.128	Y	Y	Y
G24	L1CA	-	20895121.89	109804604.66	2311.9	64500	46	0.32	0.004	0.128	Y	Y	Y
G18	L1CA	-	23028434.54	121015223.10	3227.6	4320	24	2.56	0.023	0.512	Y	Y	N
Q01	L1CA	-	37643705.39	197819000.49	947.4	64500	45	0.32	0.004	0.128	Y	Y	Y
G28	L1CA	-	24393452.53	128188487.02	-452.8	64500	39	0.32	0.004	0.128	Y	Y	Y
B07	B1D1	-	38361221.03	199756941.67	1611.4	64500	41	0.32	0.004	0.128	Y	Y	Y
B10	B1D1	-	40729445.15	212088958.42	1651.1	64500	44	0.32	0.004	0.128	Y	Y	Y
G15	L1CA	-	20651887.71	108526371.00	287.1	64500	42	0.32	0.004	0.128	Y	Y	Y
B01	B1D2	-	37463069.21	195080048.66	393.2	64500	39	0.32	0.004	0.128	Y	Y	Y
B03	B1D2	-	38220823.14	199025854.22	369.6	64500	36	0.64	0.004	0.256	Y	Y	Y
B06	B1D1	-	36268397.28	188859098.43	811.4	41100	27	1.28	0.012	0.256	Y	Y	Y
G21	L1CA	-	22859001.39	120124862.31	823.0	0	21	20.48	-	8.192	Y	N	N
S137	L1CA	-	37278429.74	195899467.17	367.0	64500	42	0.32	0.004	0.128	Y	Y	Y
S128	L1CA	-	39826787.70	209291176.84	373.3	64500	40	0.32	0.004	0.128	Y	Y	Y
G12	L1CA	-	25108078.56	131943748.92	3843.8	11800	28	0.64	0.012	0.256	Y	Y	Y
S129	L1CA	-	37378427.10	195899444.81	366.8	64500	41	0.32	0.004	0.128	Y	Y	Y
G05	L1CA	-	23150253.89	121655418.08	-2569.8	22040	30	2.56	0.012	1.024	Y	Y	Y
B02	B1D2	-	40125144.86	208942158.58	353.1	0	28	5.12	-	4.096	Y	N	N
B08	B1D1	-	41634571.87	216802025.14	-1340.4	64500	41	0.32	0.004	0.128	Y	Y	Y
G10	L1CA	-	25818085.89	135674805.26	3792.2	56180	28	1.28	0.012	0.256	Y	Y	Y

Select RAWX

This logs raw data for each visible satellite like:
Pseudorange
CarrierPhase
Doppler
SNR (C/No) etc

COM3u-blox M8 No file open UBX 00:20:53 05:05:24

Ready

Search the web and Windows

ENG 2:05 PM
INTL 1/10/2016

COM17 - u-center 8.26 - [Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)]

File Edit View Player Receiver Tools Window Help

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

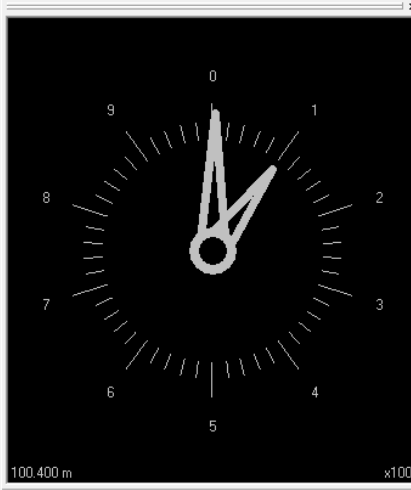
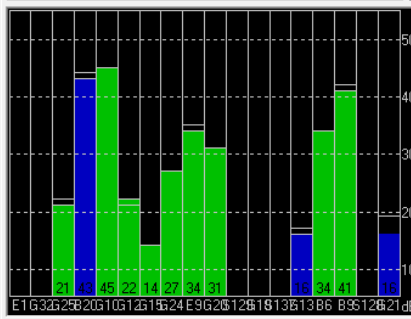
denotes data received on subChn

SV	MSG	DATA (* denotes invalid words)
BDS 6 B1D1 0 1		389012C2 06D00010 04F257A6 3904EF1
BDS 9 B1D1 0 1		389012C2 06D00010 04F257A6 3903F01
BDS 20 B1D1... 1		389012C2 06D2FF19 04F246A0 140912C
GAL 9 E1B 0 E0		00955555 55555555 55555555 4F14800C
GPS 10 L1C/A... 3		22C3C527 0EB42B7F 00148057 36836D:
GPS 12 L1C/A... 3		22C3C527 0EB2EB6B 3FFFA12A 9EFE1
GPS 15 L1C/A... 3		22C3C527 0EB2EB6B 0000CA4D 95FFA
GPS 20 L1C/A... 3		22C3C527 0EB42B7F 000C3F66 AAA5D:
GPS 24 L1C/A... 2		22C3C527 0EB2CAE3 10013F93 0EA591
GPS 25 L1C/A... 3		22C3C527 0EB42B7F 0009E09D 865FAE

Enable Message
Disable Message

Select SFRBX
Select Enable

This logs Navigation Data bits for each visible satellite

100.400 m x100

02:11:35 UTC

Tuesday 02/20/2018

Ready

u-blox M COM17 9€ No file open UBX 00:15:02:11

COM3 - u-center 8.18 - [Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)]

File Edit View Player Receiver Tools Window Help

Port Baudrate Network connection Autobauding Debug Messages Generation Protocol Filter Action

Hotstart Warmstart Coldstart Save Config Load Config Revert Config

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

denotes data received on subChn Strip Parity Bits

C.	SV	MSG	DATA (* denotes invalid words)
0	SBAS 129 L1CA	0 63	53FC0000 00000000 00000000 00000000 00000000 00000000 01803
1	SBAS 137 L1CA	0 25	53665A07 ABFE0234 000403FD 00126080 00000000 00000000 1E2A8
2	SBAS 128 L1CA	0 63	53FC0000 00000000 00000000 00000000 00000000 00000000 01803
3	GPS 13 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 89043476 BF598036 A84347FF 2271E2C5 A4B77
4	GPS 20 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 8E44331D BF57C00C 28434678 22702317 24B79
5	GPS 24 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 89043476 BF598036 A84347FF 2271E2C5 A4B77
6	GPS 5 L1CA	0 2	22C3571C 018AAA44 11C0E290 0E609FF1 AFE20BE3 00C2008F 15F84787 02D67
7	QZSS 1 L1CA	0 5/2/0	22C00012 818B05B4 009F3FF9 890007B1 BF5403F5 A843500A 81D4ECE6 A9B60
8	GPS 28 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 89043476 BF598036 A84347FF 2271E2C5 A4B77
9	BDS 7 B1D1	0 2	38902041 27E01D81 3F460331 3633167D 2370085B 0C01671B 09E5CE7E 28AC4
10	BDS 10 B1D1	0 2	38902041 27E02486 1146FBCC 25369E7E 080007F9 1CD44248 0BC69ECE 09864
11	GPS 18 L1CA	0 4/27/1	22C3571C 01890C44 16C626FF 090477BA BF4C8013 28432873 377EDA2B 023A7
12	GPS 15 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 8E44331D BF57C00C 28434678 22702317 24B79
13	BDS 1 B1D2	0 3	3890304E 2805E065 003C0099 0777772A 1DDDDDE 3777776A 1DDE00D4 03C00
14	BDS 3 B1D2	0 3	3890304E 2805E065 003C0099 0777772A 1DDDDDE 3777776A 1DDE00D4 03C00
15	GPS 5 L1CA	0 2	22C3571C 016F2AE8 11C0E290 0E609FF1 AFE20BE3 00C2008F 15F84787 02D67
16			
17	GPS 21 L1CA	0 3	22C3571C 01884BE0 003741EC 396332BC 0042C996 88320474 03C76D22 B53AF
18	GPS 21 L1CA	0 4/25/1	22C3571C 01688CD0 164A2554 0E45DD4D BF53C034 28430ECA ACDDC754 0711B
19			
20	GPS 12 L1CA	0 5/7/1	22C3571C 018B0D84 11D27772 89043476 BF598036 A84347FF 2271E2C5 A4B77
21	BDS 6 B1D1	0 3	3890304E 2708469D 144D13B6 1A5CFFBD 3F3FFF1F 0BC1FFCB 15E07CBF 27FA2
22	BDS 9 B1D1	0 2	38902041 22405D56 2300CD4D 3AC59522 2EC00719 0010E56C 00085032 3B230
23	GPS 18 L1CA	0 5/16/1	22C3571C 01810D88 14112D88 0907D776 BF53803A A84349DC 2D911AF6 83364
24	BDS 14 B1D1	0 2	38902041 2768BEE0 3301DC94 0AF2A3CC 0E2403AC 19DAA730 02599197 039F0
25	GPS 10 L1CA	0 3	22C3571C 01898B9C 3FF74CE4 15F2E744 3FFF09FC 04D4805C 083D21F3 0DA11
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			

After setting all the parameters, save it to EPROM by selecting RECEIVER-> ACTION -> SAVE CONFIG

Save current receiver configuration

COM3u-blox M8 No file open UBX 00:31:13 05:15:44

Search the web and Windows

ENG 2:15 PM
INTL 1/10/2016

COM3 - u-center 8.18 - [Messages - UBX - RXM (Receiver Manager) - SFRBX (Subframe Data NG)]

File Edit View Player Receiver Tools Window Help

NAV5 (Navigation 5)
NAVX5 (Navigation Expert 5)
NMEA (NMEA Protocol)
ODO (Odometer/Low Speed COG filter)
PM (Power Management)
PM2 (Extended Power Management)
PRT (Ports)
PWR (Power)
RATE (Rates)
RINV (Remote Inventory)
RST (Reset)
RXM (Receiver Manager)
SBAS (SBAS Settings)
SMGR (Sync Manager Config)
TMODE (Time Mode)
TMODE2 (Time Mode 2)
TP (Timepulse)
TP5 (Timepulse 5)
TXSLOT (Tx Time Slots)
USB (Universal Serial Bus)

ESF (External Sensor Fusion)
INF (Information)
LOG (Data Logger)
MGA (Multiple GNSS Assistance)
MON (Monitor)
NAV (Navigation)
AOPSTATUS (AssistNow Autonomous S
CLOCK (Clock Status)
DGPS (DGPS Data)
DOP (Dilution of Precision)
EKFSTATUS (Status)
ODO (Odometer)
ORB (Orbit Info)

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

denotes data received on subChn Strip Parity Bits

C.	SV	MSG	DATA (* denotes invalid words)
0	SBAS 129 L1CA	0 2	9A091FFD FFDFFC00 DFFDFDFD FDFFC0B9 FFFFF800 9FFFBBDB BBBAFAS
1	SBAS 137 L1CA	0 2	9A091FFD FFDFFC00 DFFDFDFD FDFFC0B9 FFFFF800 9FFFBBDB BBBAFAS
2	SBAS 128 L1CA	0 2	9A089FFD FFDFFC00 DFFDFDFD FFFA5FFF FF5FFDFD DFFFBBBF BBBB97E
3	GPS 13 L1CA	0 5/16/1	22C3571C 0190ADAC 14112D88 0907D776 BF53803A A84349DC 2D911AF
4	GPS 20 L1CA	0 5/16/1	22C3571C 0190ADAC 141130D7 0E47D804 3F55C018 28434B46 AD8F4F8
5	GPS 24 L1CA	0 5/16/1	22C3571C 0190ADAC 14112D88 0907D776 BF53803A A84349DC 2D911AF
6	GPS 5 L1CA	0 5/16/1	22C3571C 0190ADAC 14112D88 0907D776 BF53803A A84349DC 2D911AF
7	QZSS 1 L1CA	0 4/1/3	22C00012 81908414 305E06C8 08339658 3FC20058 32BA8259 8A5024E
8	GPS 28 L1CA	0 5/16/1	22C3571C 0190ADAC 14112D88 0907D776 BF53803A A84349DC 2D911AF
9	BDS 7 B1D1	0 2	38902041 2C181DD1 3F460331 3633167D 2370085B 0C01671B 09E5CE7
10	BDS 10 B1D1	0 2	38902041 2C1824D6 1146FBCC 25369E7E 080007F9 1CD44248 0BC69EC
11	GPS 18 L1CA	0 4/27/1	22C3571C 01890C44 16C626FF 090477BA BF4C8013 28432873 377EDA2
12	GPS 15 L1CA	0 5/16/1	22C3571C 0190ADAC 141130D7 0E47D804 3F55C018 28434B46 AD8F4F8
13	BDS 1 B1D2	0 1	38901043 2C3DB518 1D8BB205 2EA53862 3C00555D 1555554B 1555554
14	BDS 3 B1D2	0 1	38901043 2C3DBA1A 22247227 2EC96121 040155E2 1555554B 1555554
15	GPS 5 L1CA	0 2	22C3571C 016F2AE8 11C0E290 0E609FF1 AFE20BE3 00C2008F 15F8478
16			
17	GPS 21 L1CA	0 5/16/1	22C3571C 0190ADAC 141130D7 0E47D804 3F55C018 28434B46 AD8F4F8
18	GPS 21 L1CA	0 4/25/1	22C3571C 01688CD0 164A2554 0E45DD4D BF53C034 28430ECA ACDDC75
19			
20	GPS 12 L1CA	0 5/16/1	22C3571C 0190ADAC 14112D88 0907D776 BF53803A A84349DC 2D911AF
21	BDS 6 B1D1	0 4/16	38904045 2BD04037 00000000 00000000 00000000 00000000 0000000
22	BDS 9 B1D1	0 3	3890304E 296046BD 144D84B4 142FFFCF 3787FF2F 0CCDFFC2 3C4064E
23	GPS 18 L1CA	0 5/16/1	22C3571C 01810D88 14112D88 0907D776 BF53803A A84349DC 2D911AF
24	BDS 14 B1D1	0 4/16	38904045 2BD04037 00000000 00000000 00000000 00000000 0000000
25	GPS 10 L1CA	0 1	22C3571C 018EE93C 35740024 1DA386E9 9CB3B2BF 1335FD90 3B8381E
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			

After setting all the parameters, save the output by selecting FILE-> SAVE or by clicking RED Record circle.

COM3u-blox M8 No file open UBX 00:35:42 05:20:13

Ready Search the web and Windows

ENG 2:20 PM
INTL 1/10/2016

Output rate can be changed from 1Hz to 5Hz or 10Hz

Change UBX-CFG-RATE parameter
Change Measurement Period to 200 [ms] for 5[Hz] output

UBX - CFG (Config) - RATE (Rates)

Time Source: 1 - GPS time

Measurement Period: 200 [ms]

Measurement Frequency: 5.00 [Hz]

Navigation Rate: 1 [cyc]

Navigation Frequency: 5.00 [Hz]

COM20 - u-center 8.29 - [Messages - UBX - CFG (Config) - RATE (Rates)]

File Edit View Player Receiver Tools Window Help

UBX - CFG (Config) - RATE (Rates)

Time Source: 1 - GPS time

Measurement Period: 1000 [ms]

Measurement Frequency: 1.00 [Hz]

Navigation Rate: 1 [cyc]

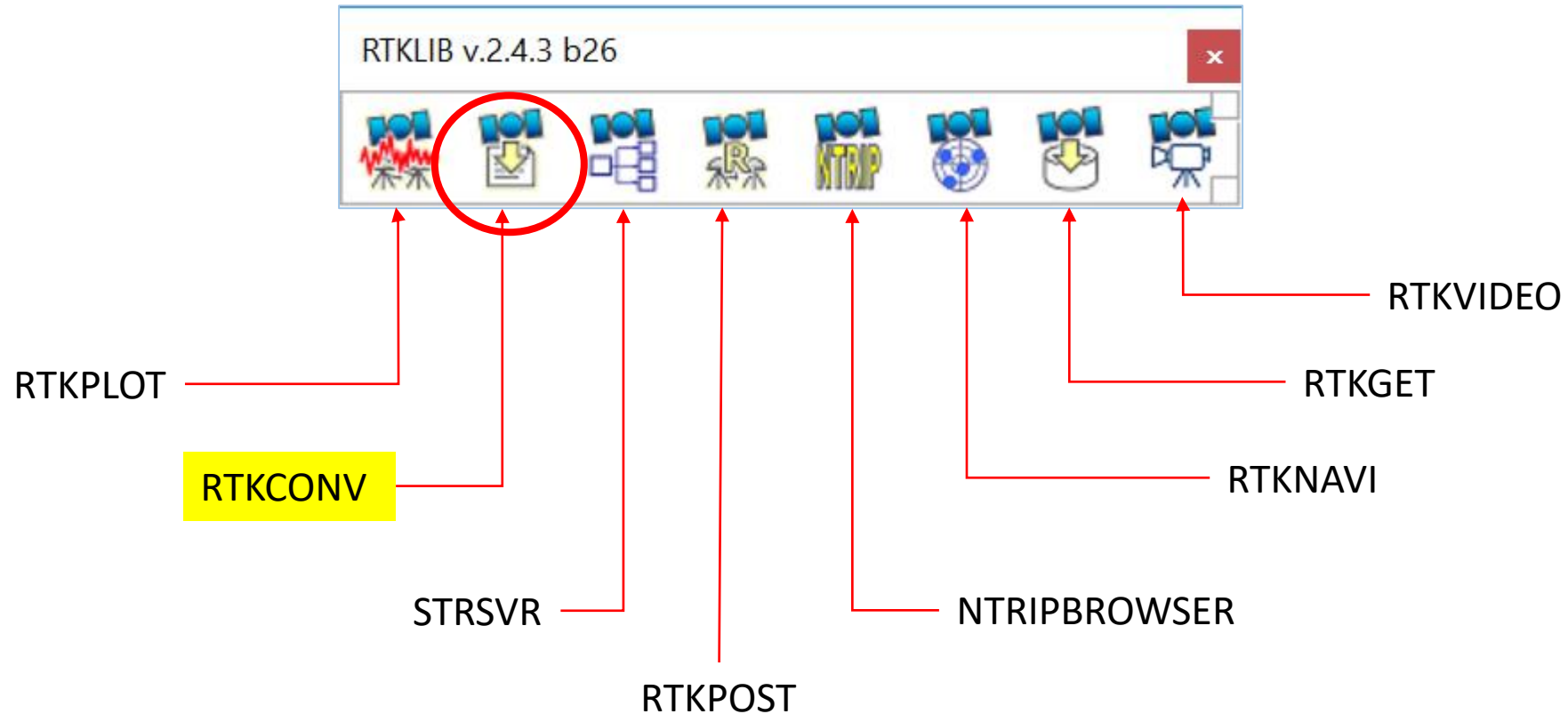
Navigation Frequency: 1.00 [Hz]

... DAT (Datum)
... DGNSS (Differential GNSS config)
... DOSC (Disciplined Oscillator)
... DYNSEED (Dynamic Seed)
... EKF (EKF Settings)
... ESFGWT (Gyro+Wheeltick)
... ESRC (External Source Config)
... FIXSEED (Fixed Seed)
... FXN (Fix Now Mode)
... GEOFENCE (Geofence Config)
... GNSS (GNSS Config)
... HNR (High Nav Rate)
... INF (Inf Messages)
... ITFM (Jamming/Interference Mo)
... LOGFILTER (Log Settings)
... MSG (Messages)
... NAV5 (Navigation 5)
... NAVX5 (Navigation Expert 5)
... NMEA (NMEA Protocol)
... ODO (Odometer/Low-Speed CO
... PM (Power Management)
... PM2 (Extended Power Managem
... PMS (Power Management Setup
... PRT (Ports)
... PWR (Power)
... RATE (Rates)
... RINX (Remote Inventory)

Ready u-blox M8/8 COM20 9600 No file open NMEA 00:53:31 05:44:32

Convert from UBX format to RINEX

RTKLIB Main Menu, Ver 2.4.3 b26



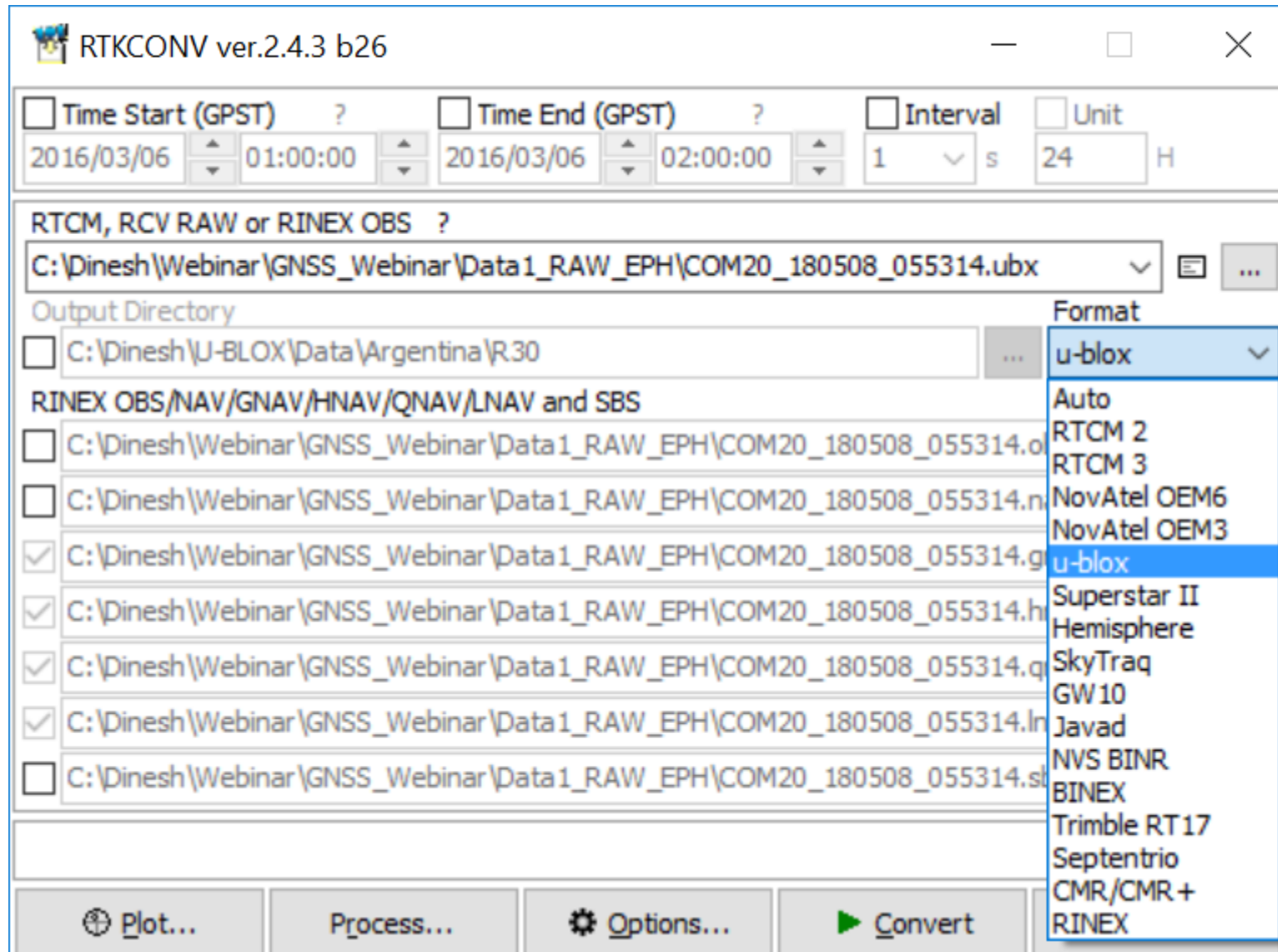
Convert from UBX to RINEX

The screenshot shows the RTKCONV v.2.4.3 b26 application window. The interface includes a toolbar with various icons, a main configuration area, and a bottom toolbar with buttons for Plot..., Process..., Options..., Convert, and Exit. Red circles and arrows highlight specific elements:

- 1**: Points to the RTKCONV icon in the taskbar.
- 2**: Points to the input file selection dropdown menu.
- 3**: Points to the 'Format' dropdown menu, which is currently set to 'u-blox'.
- 4**: Points to the '.gnav' checkbox in the RINEX output format list.
- 5**: Points to the '.hnav' checkbox in the RINEX output format list.
- 6**: Points to the 'Options...' button in the bottom toolbar.
- 7**: Points to the 'Convert' button in the bottom toolbar.

Text labels with arrows point to the annotated elements:

- Select RTKCONV (points to 1)
- Select UBX file (points to 2)
- Select Format (points to 3)



Select RINEX Version →

Select Satellite Types →

Select RAW Data Types
C: Codephase
L: Carrierphase
D: Doppler
S: SNR

Select Frequencies →

Options

RINEX Version 3.03 1 Station ID 0000 RINEX Name

RunBy/Obsv/Agency

Comment

Maker Name/#/Type

Rec #/Type/Vers

Ant #/Type

Approx Pos XYZ 0.0000 0.0000 0.0000

Ant Delta H/E/N 0.0000 0.0000 0.0000

Scan Obs Types Half Cyc Corr Iono Corr Time Corr Leap Sec

Satellite Systems Excluded Satellites

GPS GLO GAL QZS SBS BDS IRN

Observation Types Frequencies

C L D S L1 L2 L5/3 L6 L7 L8 L9 Mask...

Option Debug OFF OK Cancel

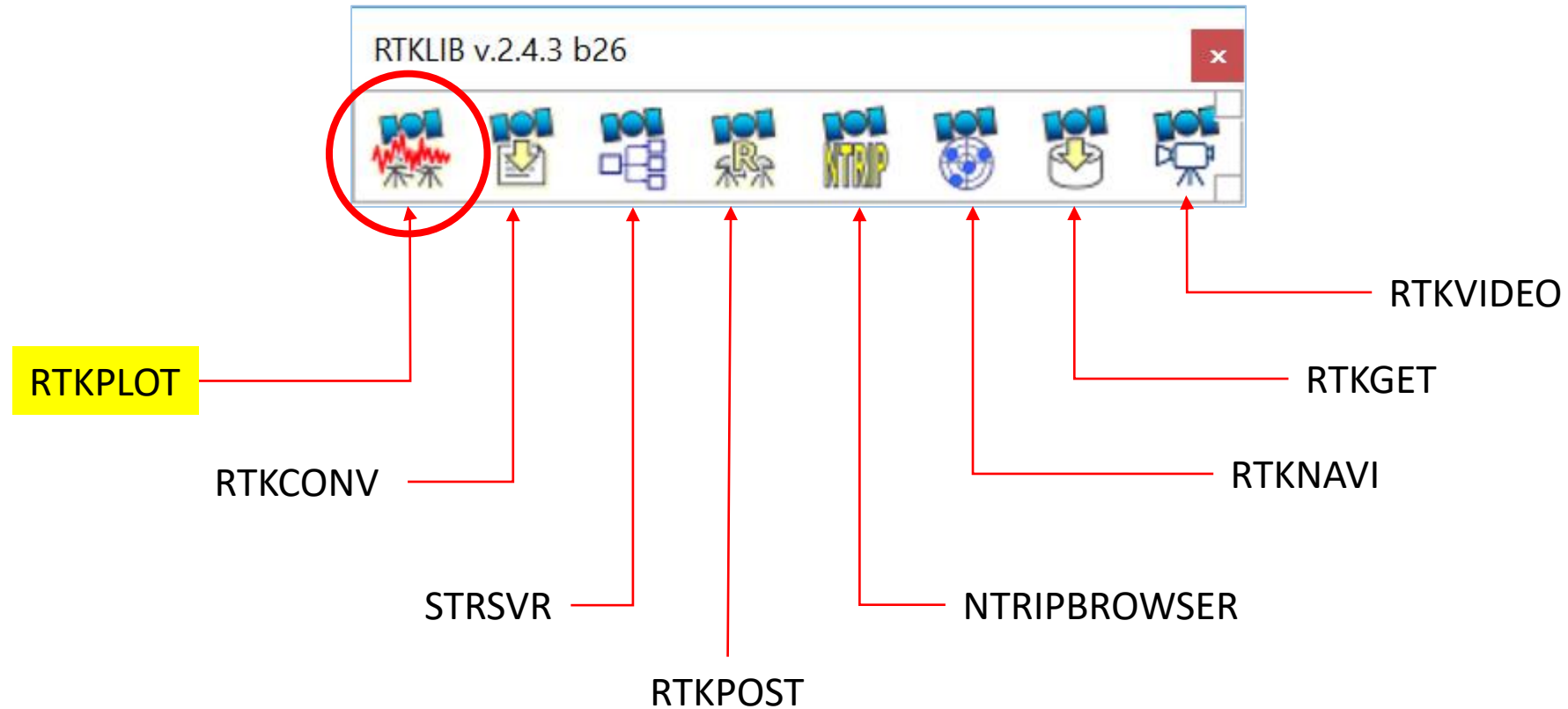
```

C:\Dinesh\Webinar\GNSS_Webinar\Data1_RAW_EPH\COM20_180508_055314....
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
WebRefInfo.bt new 1 Weblink.bt new 2 new 3 new 4 COM20_180508
1 3.03 OBSERVATION DATA M: Mixed RINEX VERSION / TYPE
2 RTKCONV 2.4.3 b26 20180508 063741 UTC PGM / RUN BY / DATE
3 log: C:\Dinesh\Webinar\GNSS_Webinar\Data1_RAW_EPH\COM20_18 COMMENT
4 format: u-blox COMMENT
5 MARKER NAME
6 MARKER NUMBER
7 MARKER TYPE
8 OBSERVER / AGENCY
9 REC # / TYPE / VERS
10 ANT # / TYPE
11 -3958743.6815 3329014.4044 3719521.8668 APPROX POSITION XYZ
12 0.0000 0.0000 0.0000 ANTENNA: DELTA H/E/N
13 G 4 C1C L1C D1C S1C SYS / # / OBS TYPES
14 E 4 C1C L1C D1C S1C SYS / # / OBS TYPES
15 J 4 C1C L1C D1C S1C SYS / # / OBS TYPES
16 S 4 C1C L1C D1C S1C SYS / # / OBS TYPES
17 C 4 C1I L1I D1I S1I SYS / # / OBS TYPES
18 2018 5 8 5 53 53.8020000 GPS TIME OF FIRST OBS
19 2018 5 8 5 58 39.8020000 GPS TIME OF LAST OBS
20 G SYS / PHASE SHIFT
21 E SYS / PHASE SHIFT
22 J SYS / PHASE SHIFT
23 S SYS / PHASE SHIFT
24 C SYS / PHASE SHIFT
25 0 GLONASS SLOT / FRQ #
26 C1C 0.000 C1P 0.000 C2C 0.000 C2P 0.000 GLONASS COD/PHS/BIS
27 END OF HEADER
28 > 2018 5 8 5 53 53.8020000 0 11
29 G 8 21422159.747 112574213.209 443.982 47.000
30 G 7 22980603.593 1962.350 25.000
31 J 3 39409862.656 207100226.953 -537.128 36.000
32 G18 22521155.170 118349454.925 3152.973 29.000
33 G27 21412034.625 -1696.892 23.000
34 G16 22340686.030 -2003.634 17.000
35 G10 24698675.041 1297.075 19.000
36 C 7 36340268.883 189233234.024 72.968 37.000
37 C10 37625862.965 195927711.819 474.266 42.000
38 G 1 24489851.016 128695035.3342 3704.419 28.000
39 C16 37772326.978 196690397.959 474.114 38.000
length: 1002222 lines: 1474 Ln: 1 Col: 1 Sel: 0 | 0 Dos\Windows UTF-8 INS
  
```

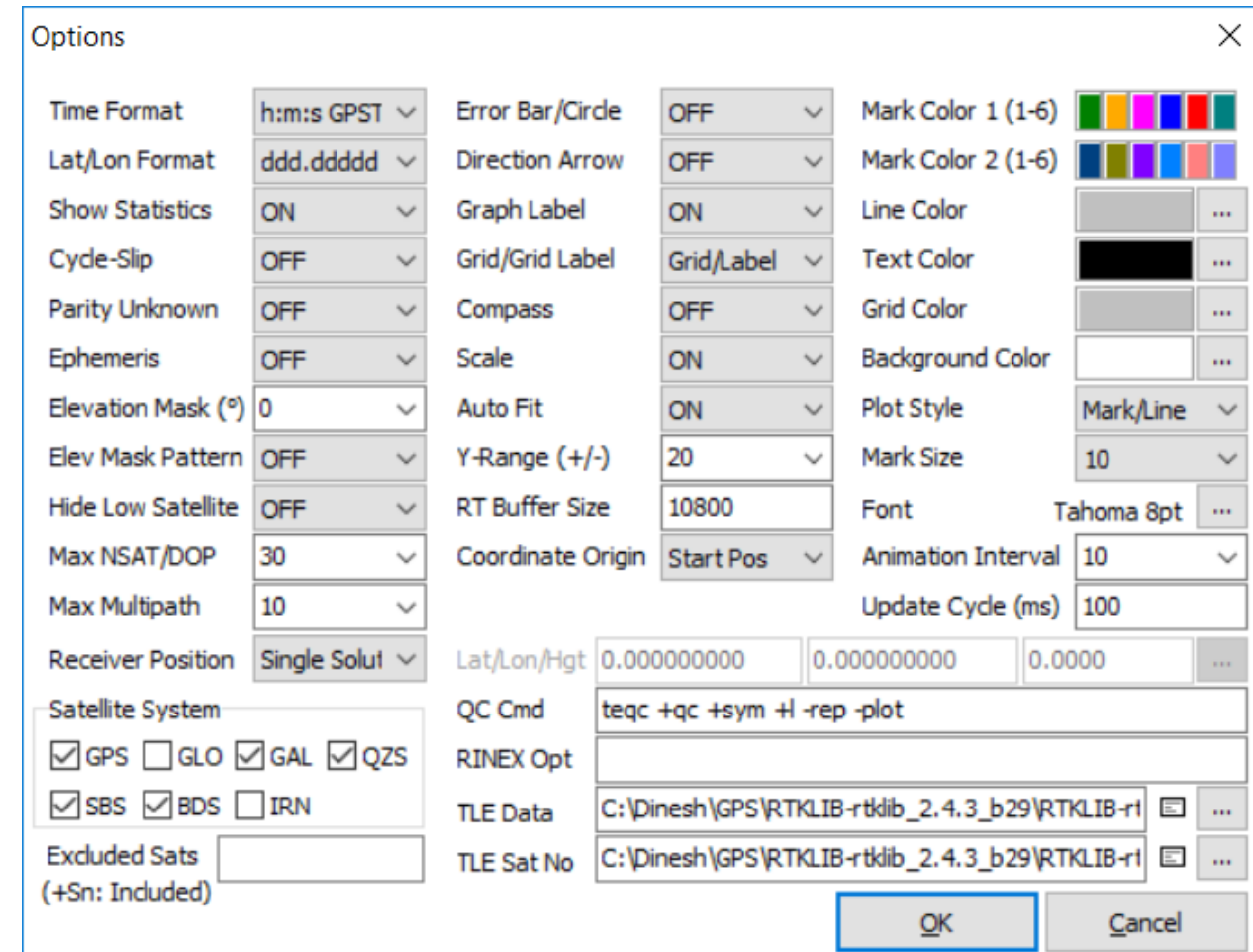
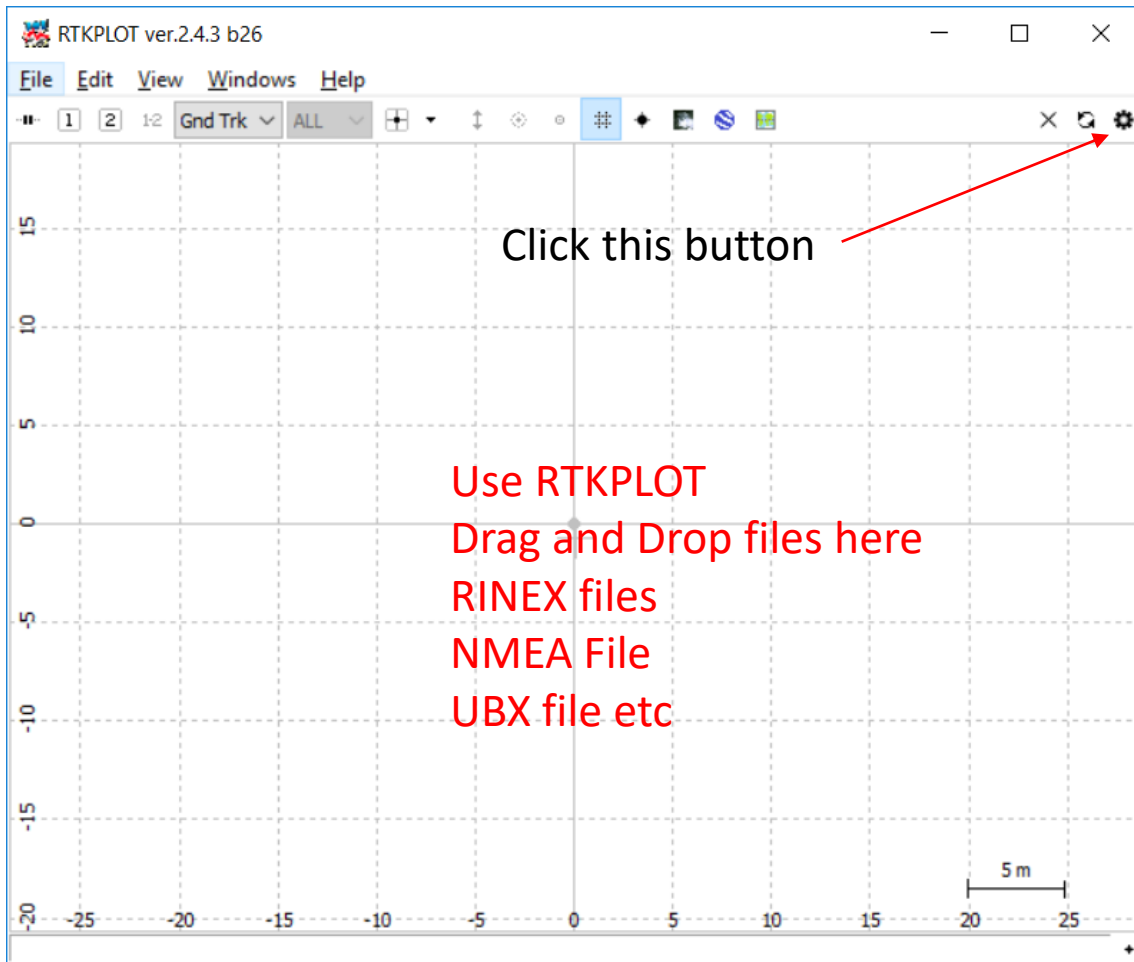
```

C:\Dinesh\Webinar\GNSS_Webinar\Data1_RAW_EPH\COM20_180508_055314....
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
new 2 new 3 new 4 COM20_180508_055314.obs COM20_180508_055314.nav
1 3.03 N: GNSS NAV DATA M: Mixed RINEX VERSION / TYPE
2 RTKCONV 2.4.3 b26 20180508 063741 UTC PGM / RUN BY / DATE
3 log: C:\Dinesh\Webinar\GNSS_Webinar\Data1_RAW_EPH\COM20_18 COMMENT
4 format: u-blox COMMENT
5 END OF HEADER
6 G 8 2018 5 8 6 0 0 -.100512988865E-03 -.136424205266E-11 .000000000000E+00
7 .900000000000E+01 .160000000000E+02 .428910722996E-08 .147692161388E+01
8 .864267349243E-06 .348555727396E-02 .481680035591E-05 .515356233788E+04
9 .194400000000E+06 .726431608200E-07 .284651424308E+01 .782310962677E-07
10 .969367427919E+00 .290312500000E+03 -.449887798558E+00 -.806676458455E-08
11 .191079387795E-09 .100000000000E+01 .200000000000E+04 .000000000000E+00
12 .200000000000E+01 .000000000000E+00 .512227416039E-08 .900000000000E+01
13 .194046000000E+06 .400000000000E+01
14 G18 2018 5 8 6 0 0 .637071207166E-05 .466116034659E-11 .000000000000E+00
15 .600000000000E+02 -.556562500000E+02 .501270879944E-08 -.127096391090E+01
16 -.254623591900E-05 .144587917021E-01 .578723847866E-05 .515365813255E+04
17 .194400000000E+06 .409781932831E-07 -.241907867044E+01 .346451997757E-06
18 .949411554665E+00 .261937500000E+03 .130286780183E+01 -.837677749783E-08
19 .610739725475E-10 .100000000000E+01 .200000000000E+04 .000000000000E+00
20 .200000000000E+01 .000000000000E+00 -.698491930962E-08 .600000000000E+02
21 .194046000000E+06 .400000000000E+01
22 G 1 2018 5 8 6 0 0 -.462024472654E-04 -.284217094304E-11 .000000000000E+00
23 .490000000000E+02 -.598437500000E+02 .449125850752E-08 -.989631350758E+00
24 -.302866101265E-05 .770077644847E-02 .601634383202E-05 .515366776085E+04
25 .194400000000E+06 .139698386192E-06 -.237237279590E+01 .465661287308E-07
26 .971024933120E+00 .266250000000E+03 .621077511057E+00 -.808712257540E-08
27 .678599694973E-10 .100000000000E+01 .200000000000E+04 .000000000000E+00
28 .200000000000E+01 .000000000000E+00 .558793544769E-08 .490000000000E+02
29 .194046000000E+06 .400000000000E+01
30 J 3 2018 5 8 6 0 0 -.154855661094E-04 .454747350886E-12 .000000000000E+00
31 .213000000000E+03 .192625000000E+03 .189507893764E-08 .284036630351E+01
32 .578351318836E-05 .744588590460E-01 -.409223139286E-05 .649349954605E+04
33 .194400000000E+06 -.288709998131E-06 .276081194061E+01 -.815838575363E-06
34 .708645506593E+00 .282750000000E+03 -.156176460704E+01 -.222580699951E-08
35 -.173221501085E-09 .200000000000E+01 .200000000000E+04 .100000000000E+01
36 .280000000000E+01 .000000000000E+00 .000000000000E+00 .981000000000E+03
37 .194046000000E+06 .100000000000E+01
38 C 7 2018 5 8 5 0 0 .158527866006E-03 -.152864387815E-10 .000000000000E+00
39 .100000000000E+01 .204875000000E+03 .114361906490E-08 -.152242445482E+01
length: 5354 lines: 70 Ln: 1 Col: 1 Sel: 0 | 0 Dos\Windows UTF-8 INS
  
```

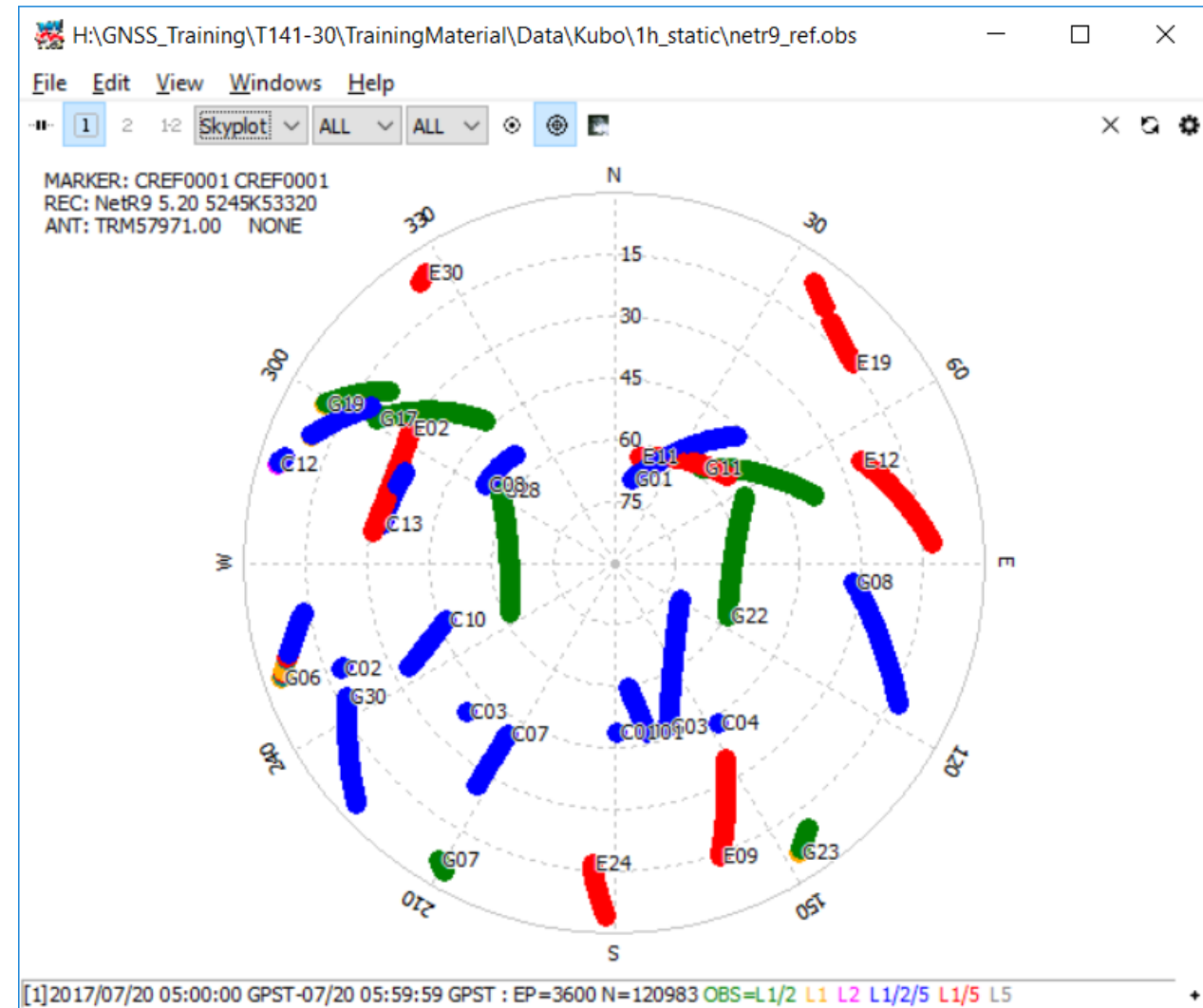
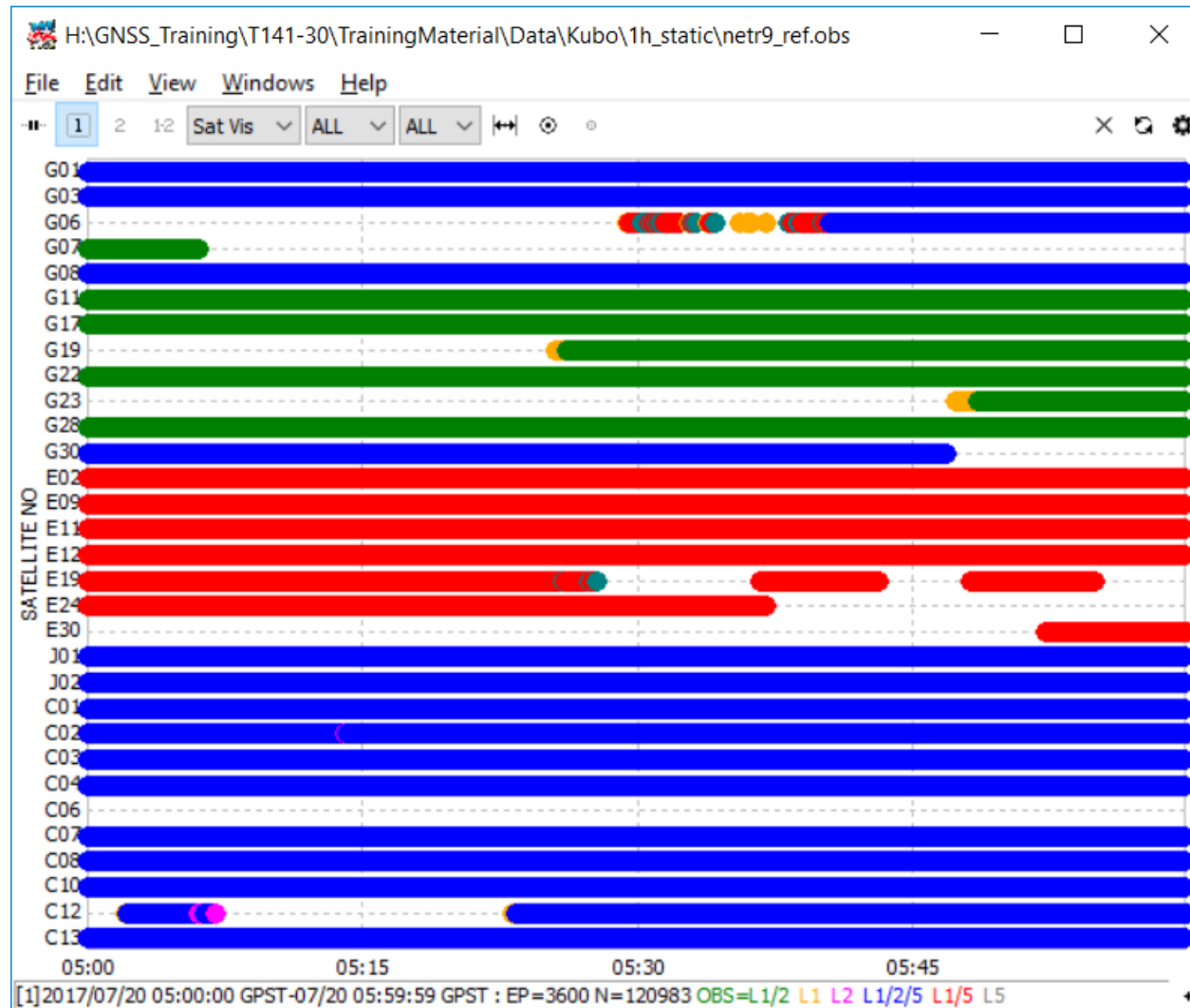
Check RINEX Data



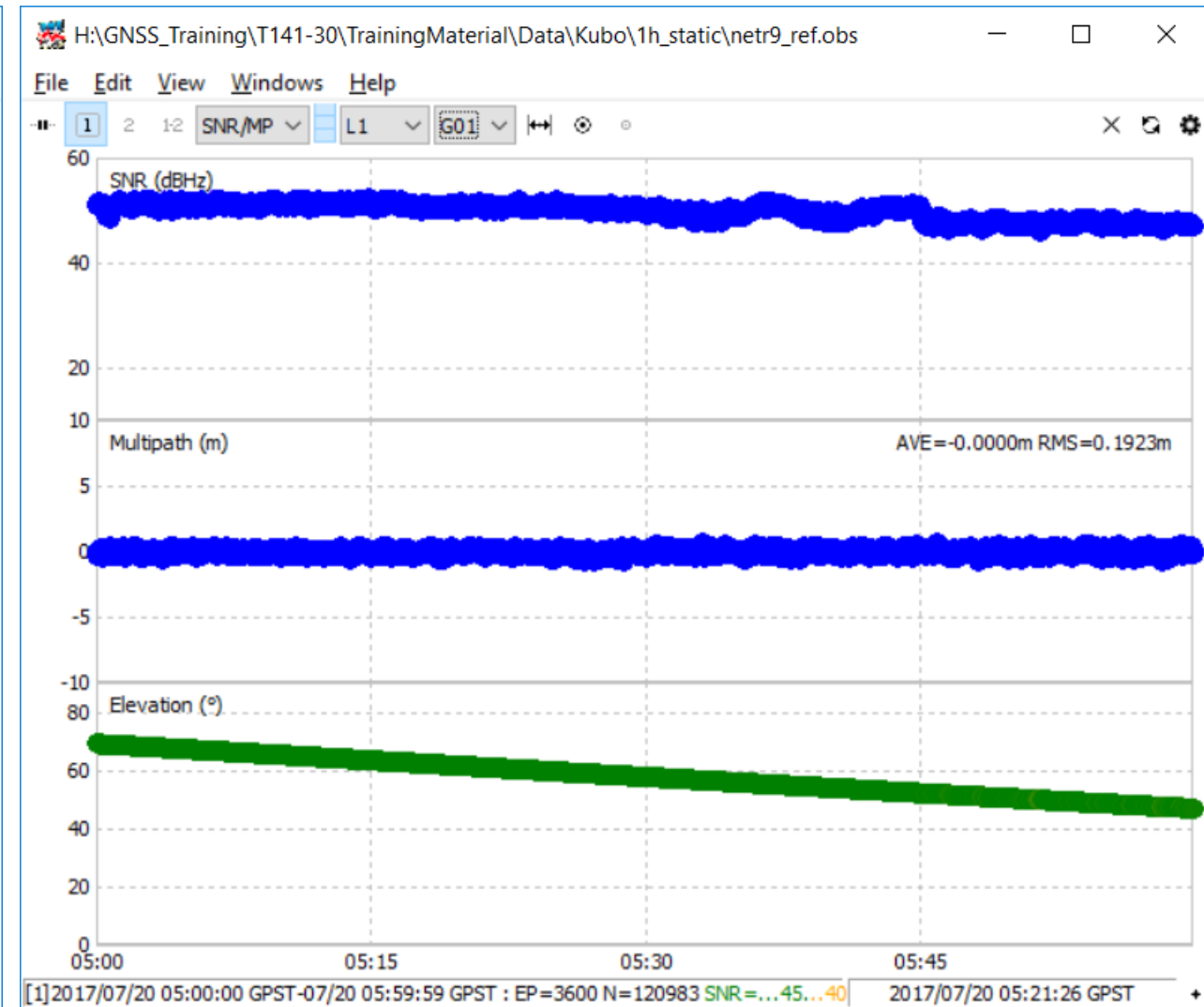
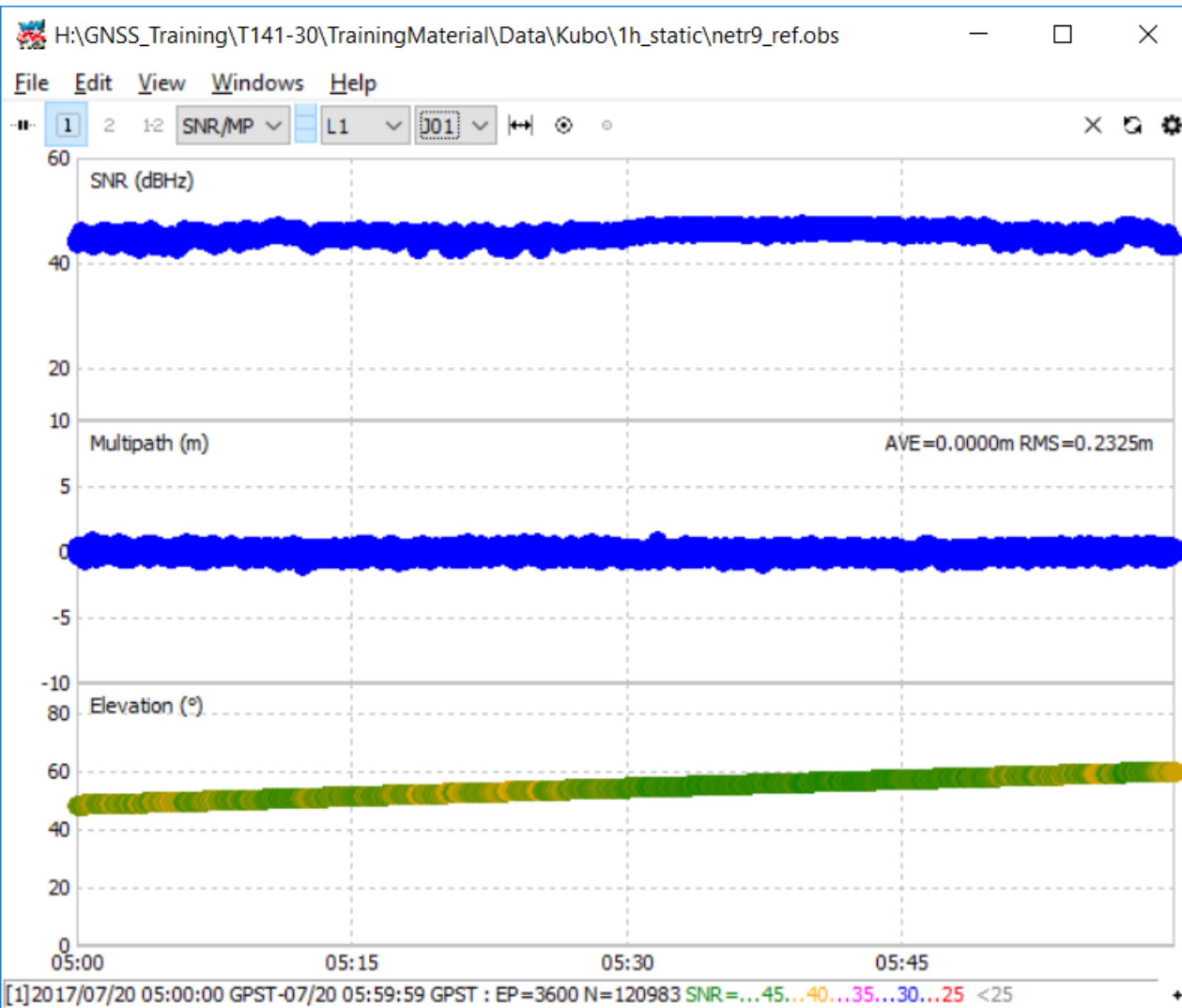
RTKPLOT to Check Data



Visible Satellites and Skyplot



SNR, Multipath and Elevation for J03 and G01 Satellites



How to Get Base-Station Data

Accessing Base-Station Data

- For Real-Time RTK
 - Get NTRIP Address
 - IP Address
 - Port ID
 - Mount Point
 - Login ID
 - Password
- For Post-Processing RTK
 - IP Address
 - Login ID
 - Password
 - Select the files
 - Select the data format
 - Download the files

Always request Base-station data in RINEX format if possible.
This will save your time in pre-processing of proprietary data formats

Sample of Data Files in NetR9

The screenshot shows the NetR9 web interface for a Trimble receiver. The browser address bar shows the IP address 192.244.150.156. The page title is "Data Files". A sidebar on the left contains navigation options: Receiver Status, Satellites, Data Logging (with sub-options: Summary, Data Files, Power Saving, File Protection, RINEX Metadata, FTP Push, FTP Push Log), Receiver Configuration, I/O Configuration, Bluetooth, MSS Corrections, Network Configuration, Security, Firmware, Programmatic Interface, and Help. The main content area displays a directory listing for "/Internal/1h_1hz/2018/05/08". The listing includes a table of files with columns for Filename, Created, and Size. Each file entry has a "Convert" button and a grid icon.

Directory: /Internal/1h_1hz/2018/05/08					
Top Level Directory					
Parent Directory					
	Filename		Created		Size
	5245K53320201805080300C.T02	Convert	2018-05-08T03:00:00 GPS		1.035 MB
	5245K53320201805080200C.T02	Convert	2018-05-08T02:00:00 GPS		1.894 MB
	5245K53320201805080100C.T02	Convert	2018-05-08T01:00:00 GPS		2.016 MB
	5245K53320201805080000C.T02	Convert	2018-05-08T00:00:01 GPS		1.939 MB

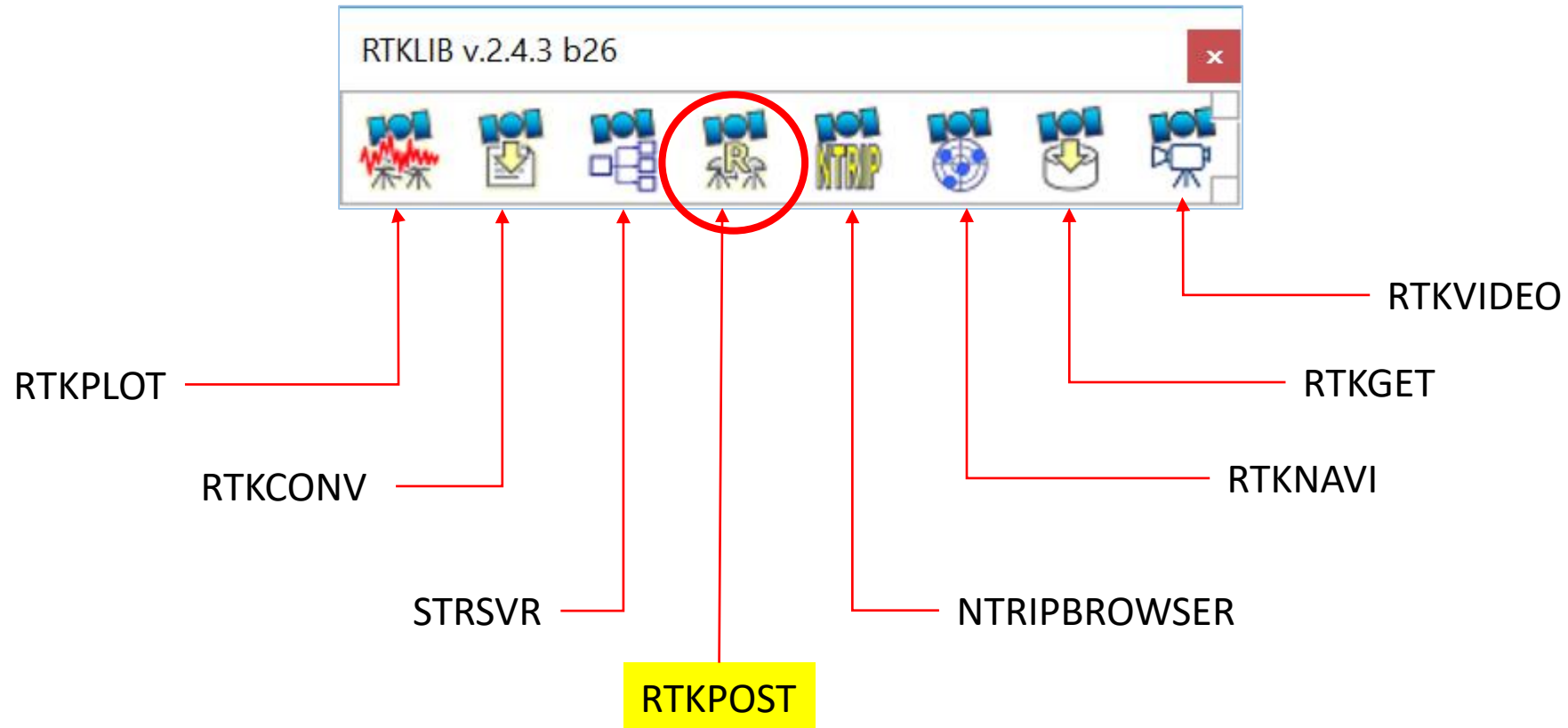
Select Required Data Type and Data

The image displays two side-by-side screenshots of the Trimble NetR9 web interface, showing the 'Data Files' section. Both screenshots show a directory listing for files in the path /Internal/1h_1hz/2018/05/08. The files listed are:

Filename	Created	Size
5245K53320201805080300C.T02		
5245K53320201805080200C.T02		
5245K53320201805080100C.T02	15-08T01:00:00 GPS	2.016 MB
5245K53320201805080000C.T02	15-08T00:00:01 GPS	1.939 MB

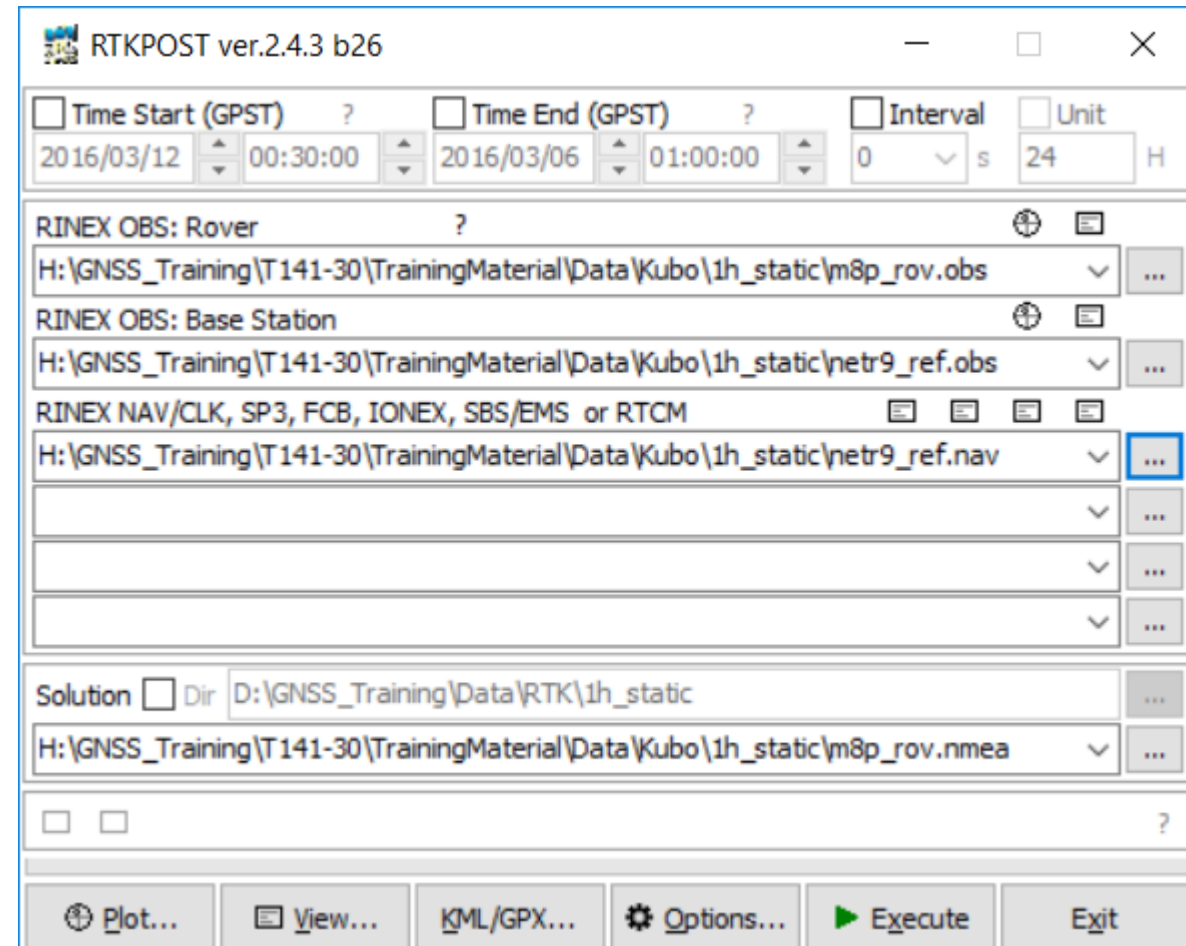
In the left screenshot, a context menu is open over the first file, showing options: RINEX 2.11, RINEX 2.12 w/QZSS (selected), RINEX 3.00, RINEX 3.02, RINEX 3.03, BINEX, and Google Earth. The right screenshot shows a similar context menu with options: Convert and Download, RINEX 2.12 w/QZSS (selected), Observables & Ephemeris, Hatanaka Observables & Ephemeris, Observables, Hatanaka Observables, GPS Ephemeris, GLONASS Ephemeris, Galileo Ephemeris, and QZSS Ephemeris.

RTK Post-Processing



RTK Post-Processing

- Prepare Data
 - Base Station Data
 - RINEX OBS File
 - RINEX NAV File
 - Rover (User) Data
 - RINEX OBS File
- Select Rover Observation Data
- Select Base Observation Data
- Select Navigation Data



Options

Setting1 Setting2 Output Statistics Positions Files Misc

Positioning Mode Static

Frequencies / Filter Type Single

Elevation Mask (°) / SNR Mask (dBHz) DGPS/DGNSS

Rec Dynamics / Earth Tides Correction Kinematic

Ionosphere Correction Static

Troposphere Correction Moving-Base

Satellite Ephemeris/Clock Fixed

PPP Kinematic

PPP Static

PPP Fixed

Broadcast

Sat PCV Rec PCV PhWU Rej Ed RAIM FDE DBCorr

Excluded Satellites (+PRN: Included) C02

GPS GLO Galileo QZSS SBAS BeiDou IRNSS

Load... Save... OK Cancel

Options

Setting1 Setting2 Output Statistics Positions Files Misc

Integer Ambiguity Res (GPS/GLO/BDS) Instant

Min Ratio to Fix Ambiguity OFF OFF ON

Min Confidence / Max FCB to Fix Amb Continuous

Min Lock / Elevation (°) to Fix Amb Instantaneous 0.25

Min Fix / Elevation (°) to Hold Amb Fix and Hold 0

Outage to Reset Amb/Slip Thres (m) PPP-AR 10 0

Max Age of Diff (s) / Sync Solution 5 0.050

Reject Threshold of GDOP/Innov (m) 30.0 ON

Max # of AR Iter/# of Filter Iter 30.0 30.0

Baseline Length Constraint (m) 1 1

0.000 0.000

Load... Save... OK Cancel

Options

Setting1 Setting2 **Output** Statistics Positions Files Misc

Solution Format NMEA0183

Output Header / Output Processing Options OFF OFF

Time Format / # of Decimals hh:mm:ss GPST 3

Latitude Longitude Format / Field Separator ddd.dddddd

Output Single if Sol Outage / Max Sol Std (m) OFF 0

Datum / Height WGS84 Ellipsoidal

Geoid Model Internal

Solution for Static Mode All

NMEA Interval (s) RMC/GGA, GSA/GSV 0 0

Output Solution Status / Output Debug Trace OFF OFF

Load... Save... OK Cancel

Options

Setting1 Setting2 Output Statistics **Positions** Files Misc

Rover

RINEX Header Position ...

90.00000000 0.00000000 -6335367.6285

Antenna Type (*: Auto) Delta-E/N/U (m)

0.0000 0.0000 0.0000

Base Station

RINEX Header Position ...

Lat/Lon/Height (deg/m) 0000000000 -6335367.6285

Lat/Lon/Height (dms/m)

X/Y/Z-ECEF (m) Delta-E/N/U (m)

Average of Single Position 0.0000 0.0000 0.0000

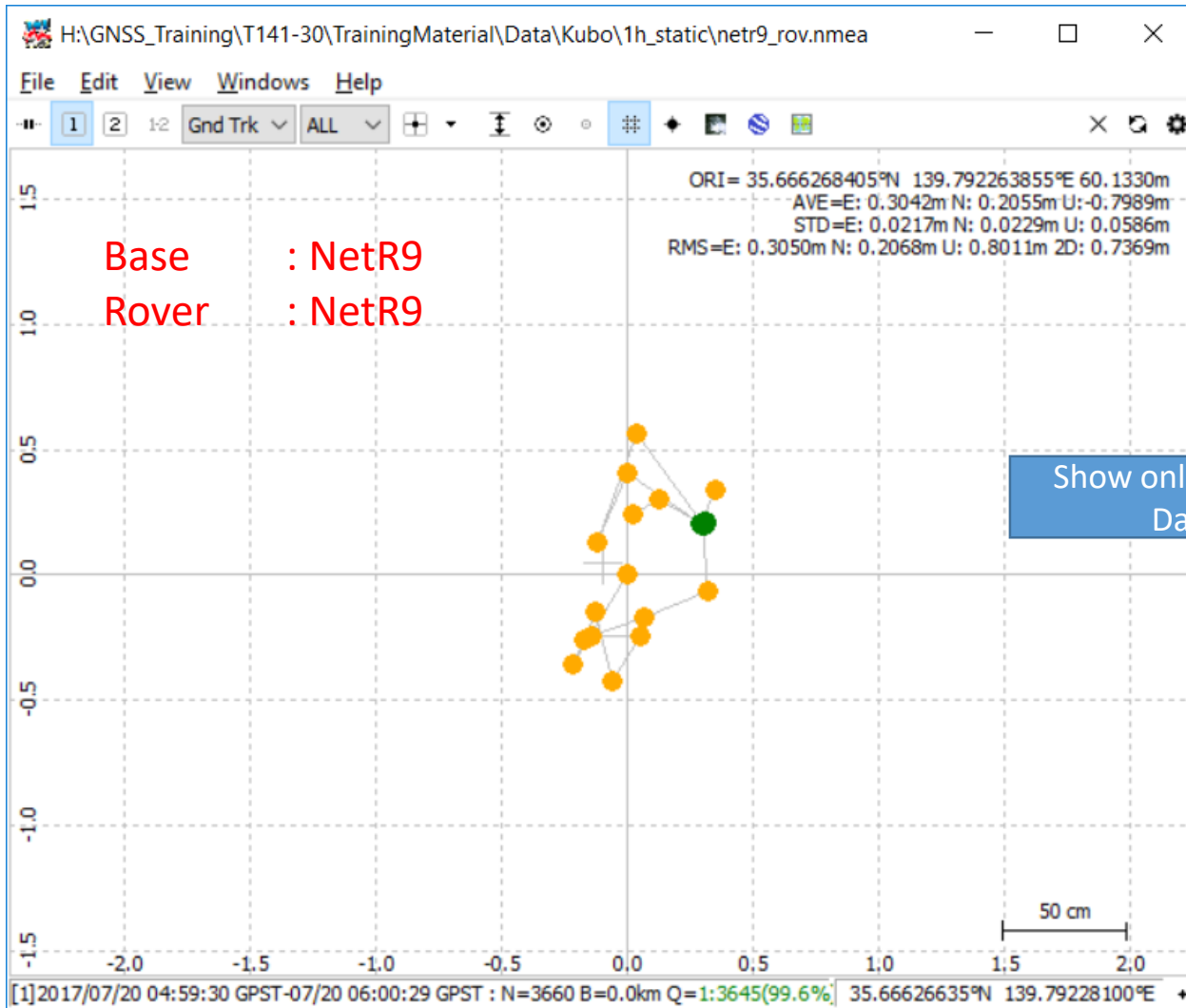
Get from Position File

RINEX Header Position

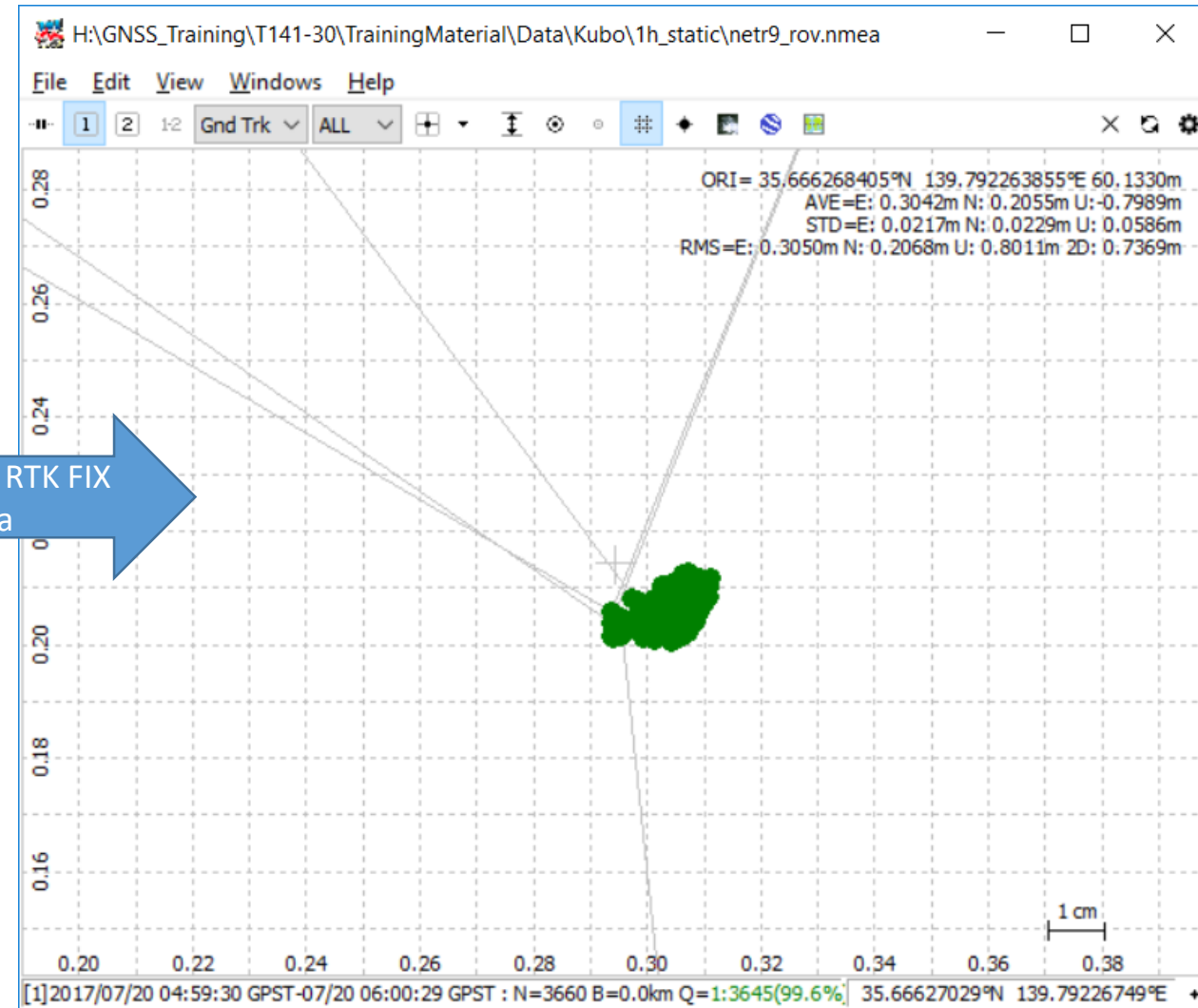
Load... Save... OK Cancel

35.66633461 139.7922008 59.741

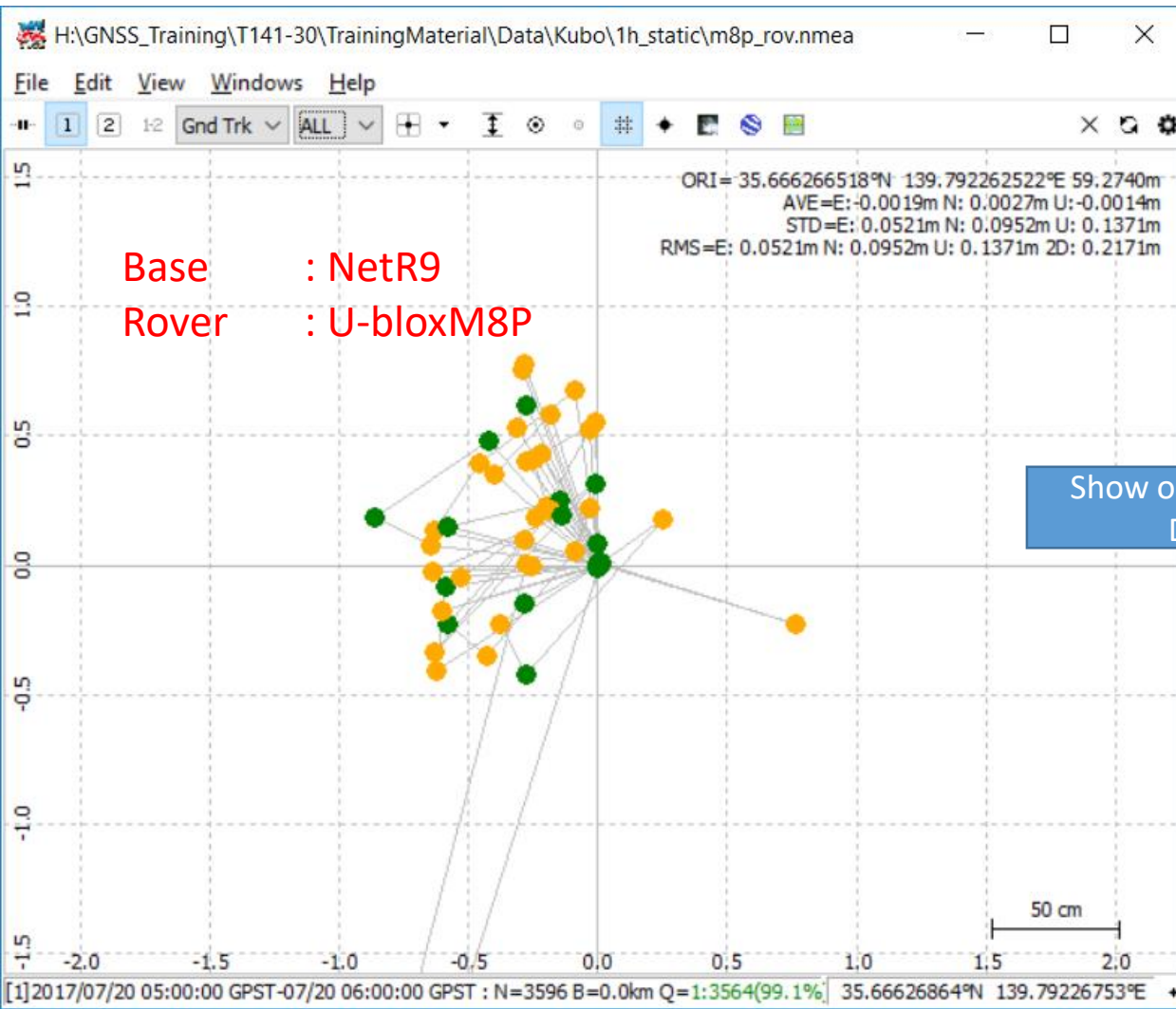
One Hour RTK Post-processing output



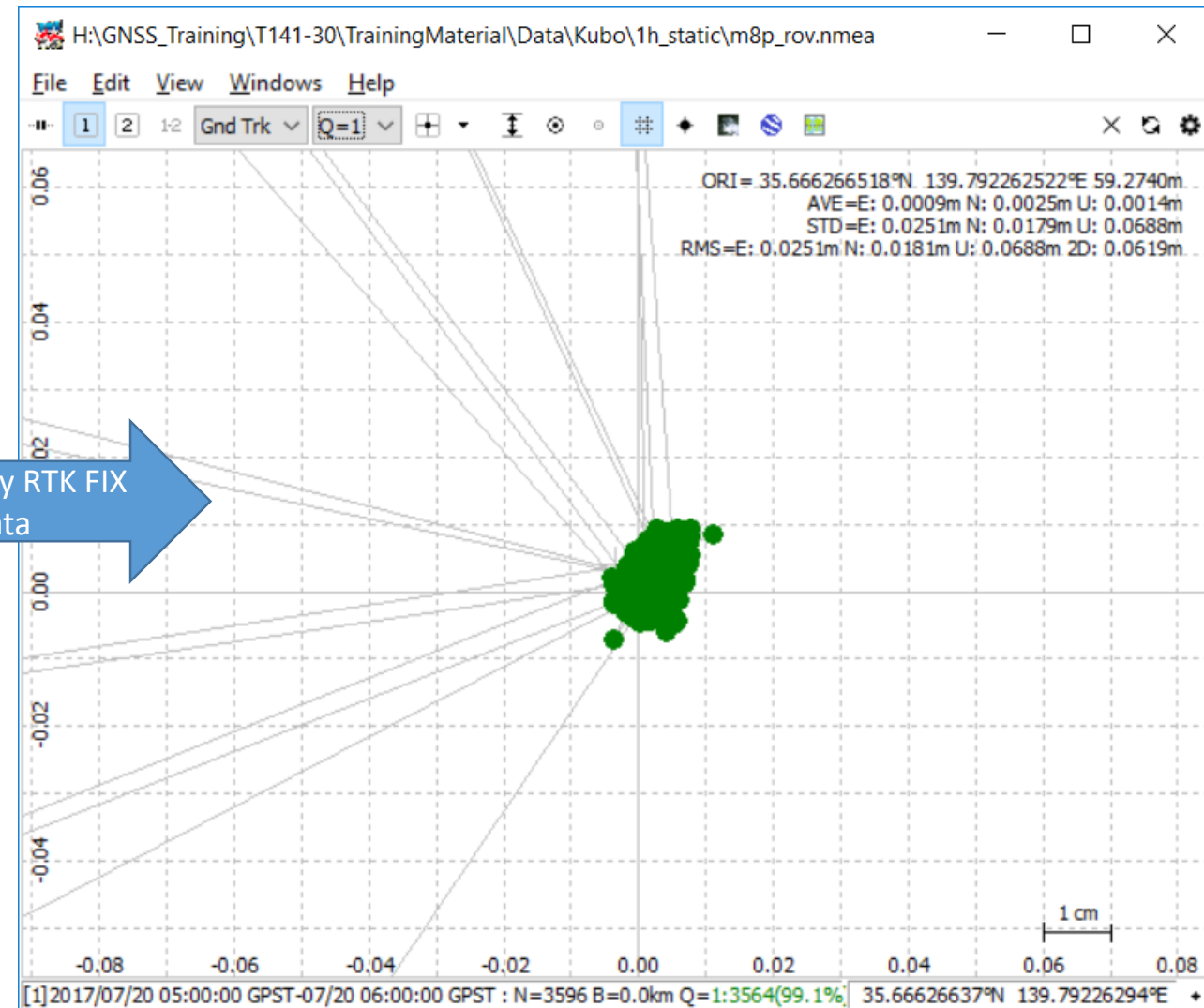
Show only RTK FIX Data

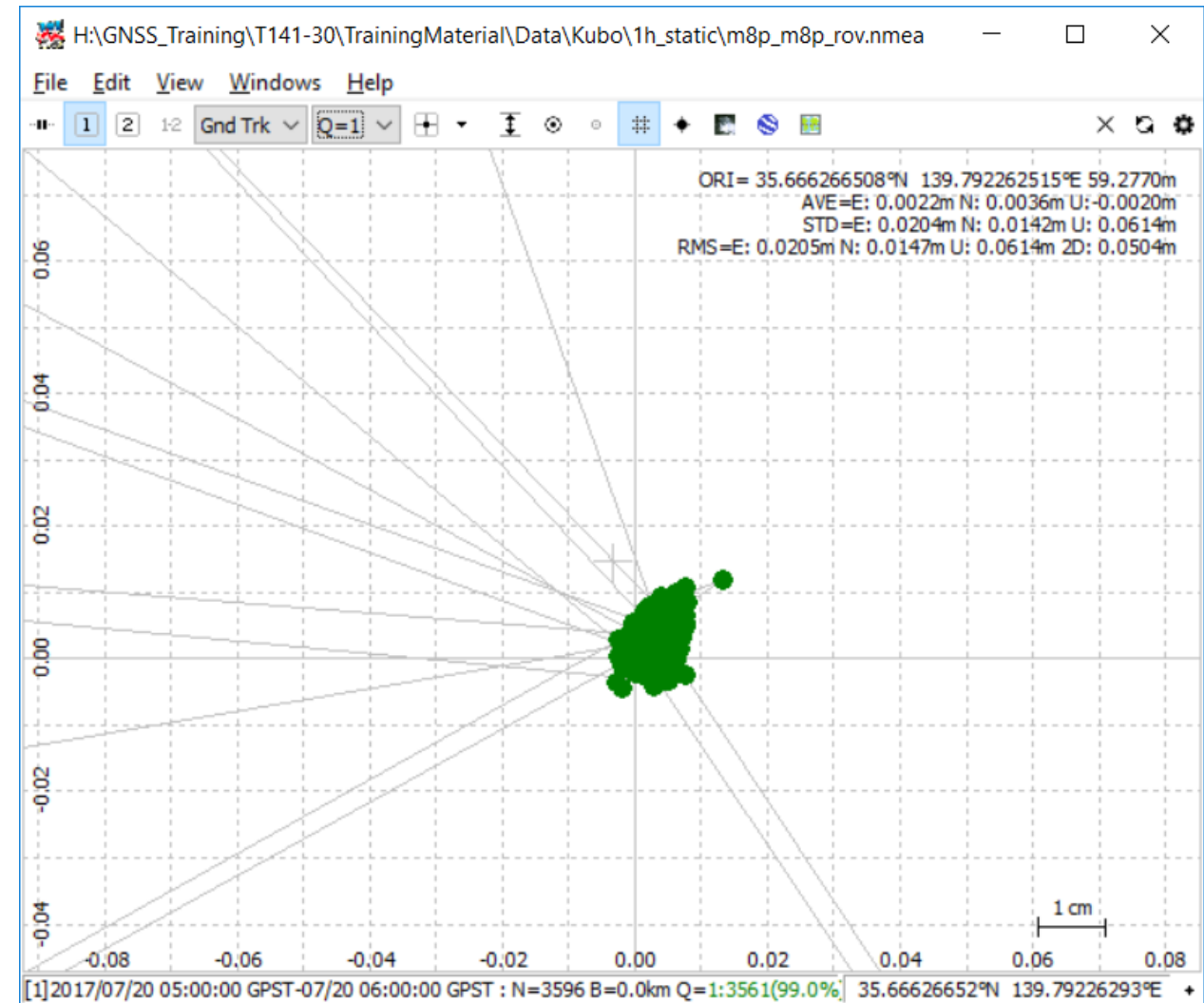
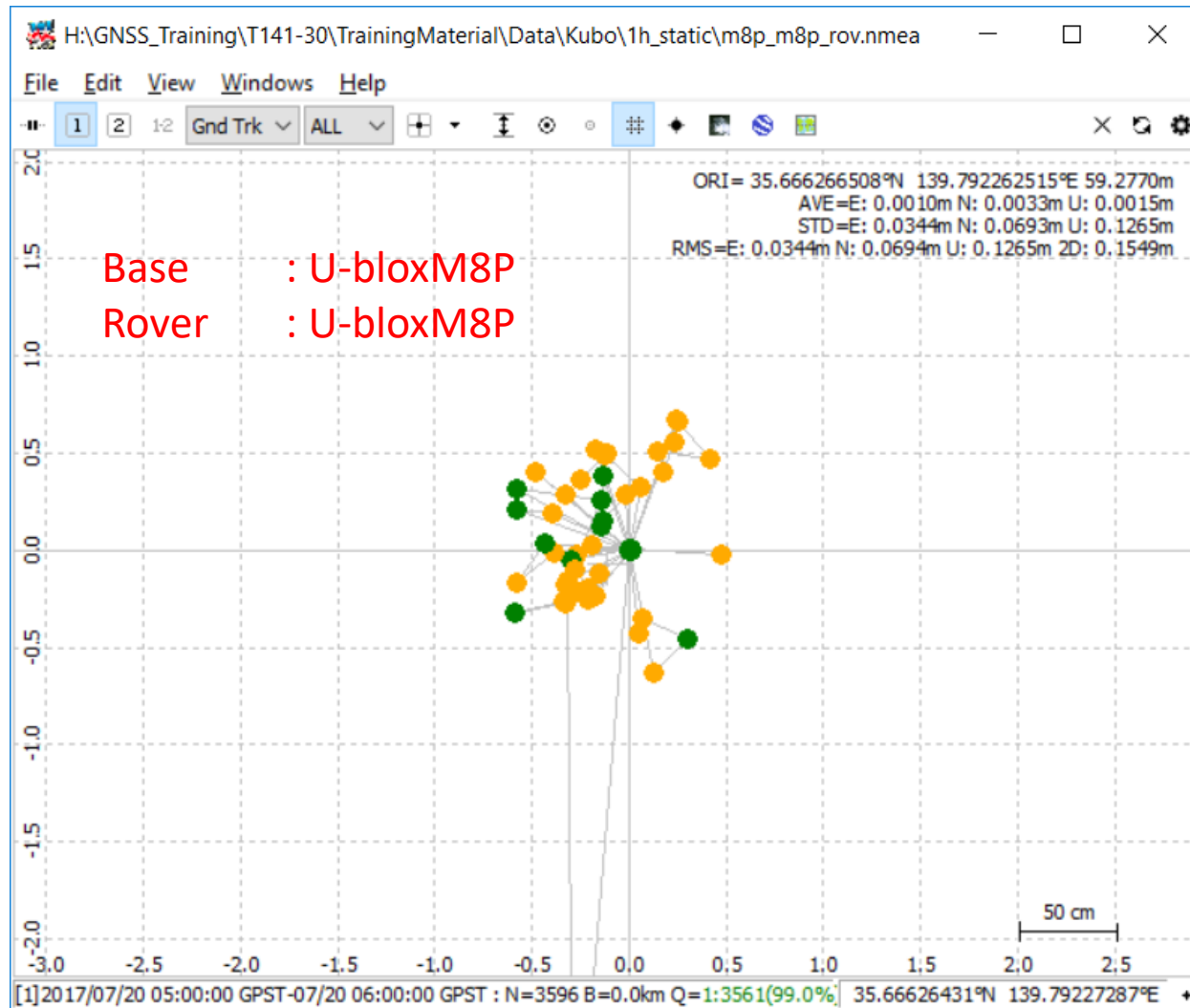


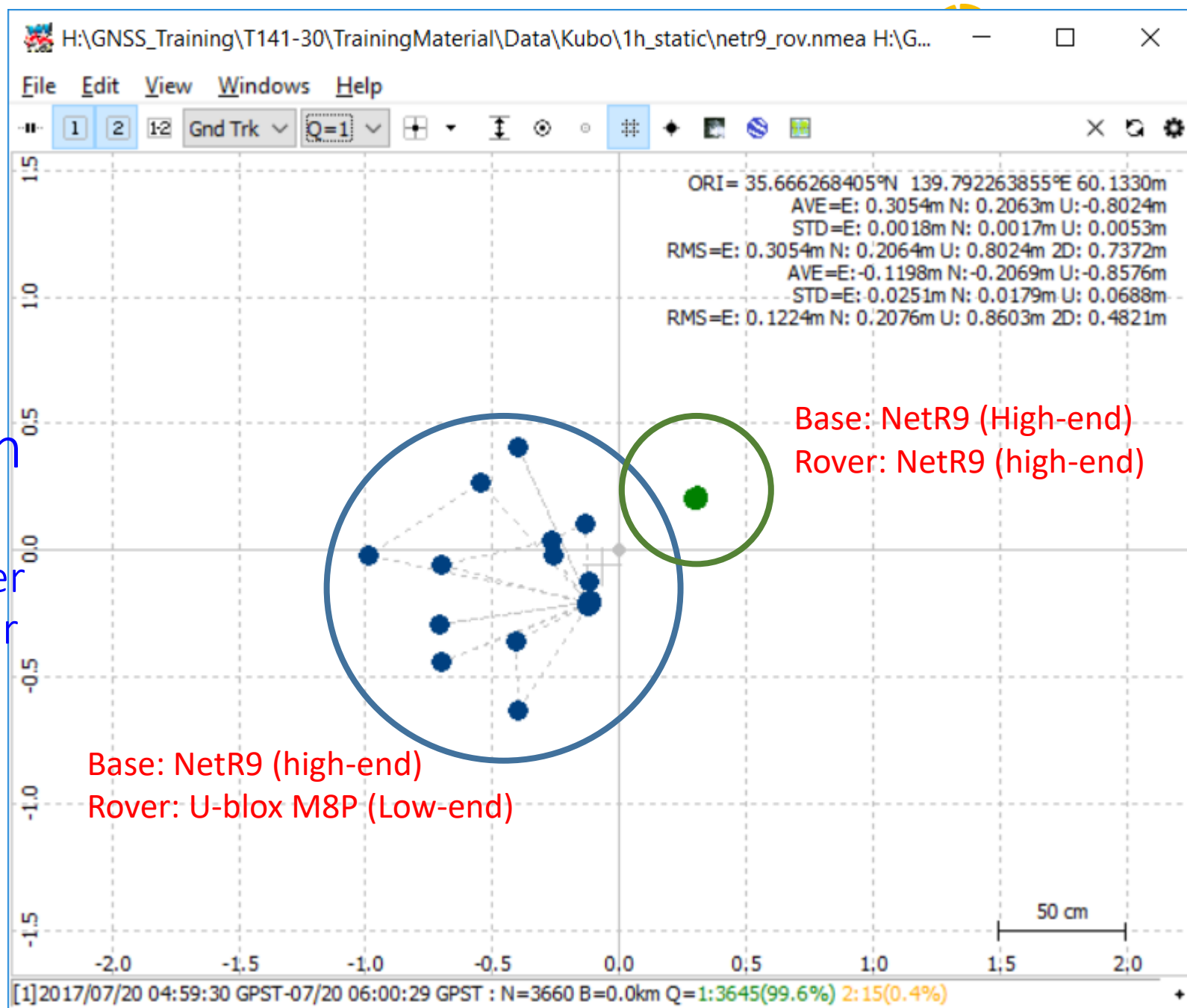
One Hour RTK Post-processing output



Show only RTK FIX Data







Position Output Comparison
between
 (a) High-end Base and High-end Rover
 (b) High-end Base and Low-end Rover

Reference Slides

Data Formats: NMEA, RINEX

References: <https://www.nmea.org/>
<http://freenmea.net/docs>

National Marine Electronics Association (NMEA) Format

- NMEA is format to output measurement data from a sensor in a pre-defined format in ASCII
- In the case of GPS, It output GPS position, velocity, time and satellite related data
- NMEA sentences (output) begins with a “Talker ID” and “Message Description”
 - Example: \$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
 - “\$GP” is Talker ID
 - “GGA” is Message Description to indicate for Position Data

NMEA Data Format

GGA - Fix data which provide 3D location and accuracy data.

\$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47

Where: GGA Global Positioning System Fix Data

123519 Fix taken at 12:35:19 UTC

4807.038, N Latitude 48 deg 07.038' N

01131.000, E Longitude 11 deg 31.000' E

1 Fix quality:

0 = invalid ,

1 = GPS fix (SPS),

2 = DGPS fix,

3 = PPS fix,

4 = Real Time Kinematic

5 = Float RTK

6 = estimated (dead reckoning) (2.3 feature)

7 = Manual input mode

8 = Simulation mode

08 Number of satellites being tracked

0.9 Horizontal dilution of position

545.4,M Altitude, Meters, above mean sea level

46.9,M Height of geoid (mean sea level) above WGS84 ellipsoid

(empty field) time in seconds since last DGPS update (empty field) DGPS station ID number

*47 the checksum data, always begins with *

RINEX Data Format

- Receiver Independent Exchange Format (RINEX) is a data exchange format for raw satellite data among different types of receivers.
 - Different types of receivers may output position and raw data in proprietary formats
 - For post-processing of data using DGPS or RTK it is necessary to use data from different types of receivers. A common data format is necessary for this purpose.
 - Example: How to post process data from Trimble, Novatel and Septentrio receivers to compute a position?
- RINEX only provides Raw Data. It does not provide position output.
 - User has to post-process RINEX data to compute position
 - Raw data consists of Pseudorange, Carrierphase, Doppler, SNR
- RINEX basically consists of two data types
 - “*.N” file for Satellite and Ephemeris Related data.
 - Also called Navigation Data
 - “*.O” file for Signal Observation Data like Pseudorange, Carrier Phase, Doppler, SNR
 - Also called Observation Data

RINEX "N" File for GPS

```

2.11 NAVIGATION DATA GPS (GPS) RINEX VERSION / TYPE
cnvtToRINEX 2.90.0 convertToRINEX OPR 05-Jul-17 03:38 UTC PGM / RUN BY / DATE
----- COMMENT
0.8382D-08 0.2235D-07 -0.5960D-07 -0.1192D-06 ION ALPHA
0.8602D+05 0.6554D+05 -0.1311D+06 -0.4588D+06 ION BETA
-0.931322574615D-09-0.355271367880D-14 405504 1947 DELTA-UTC: A0,A1,T,W
18 LEAP SECONDS
END OF HEADER
32 17 05 01 00 00 0.0-0.400723423809D-03-0.110276232590D-10 0.000000000000D+00
0.370000000000D+02-0.806250000000D+01 0.455840416154D-08-0.192420920137D+01
-0.353902578354D-06 0.111064908560D-02 0.826455652714D-05 0.515371503258D+04
0.864000000000D+05-0.782310962677D-07 0.675647076441D-01-0.838190317154D-07
0.958529124300D+00 0.221156250000D+03-0.265074890978D+01-0.796390315710D-08
-0.389659088008D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
0.240000000000D+01 0.000000000000D+00 0.465661287308D-09 0.370000000000D+02
0.795120000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00
24 17 05 01 00 00 0.0-0.341213308275D-04-0.454747350886D-12 0.000000000000D+00
0.100000000000D+02 0.787812500000D+02 0.459340561950D-08 0.167267059468D+01
0.404566526413D-05 0.564297637902D-02 0.102464109659D-04 0.515370226479D+04
0.864000000000D+05-0.782310962677D-07 0.108986675687D+01 0.484287738800D-07
0.945651423640D+00 0.170906250000D+03 0.490563049326D+00-0.815641117584D-08
-0.128933942045D-09 0.100000000000D+01 0.194700000000D+04 0.000000000000D+00
0.240000000000D+01 0.000000000000D+00 0.279396772385D-08 0.100000000000D+02
0.792180000000D+05 0.400000000000D+01 0.000000000000D+00 0.000000000000D+00

```

RINEX "O" File GPS, GLONASS, GALILEO, QZSS, SBAS

```

2.11 OBSERVATION DATA Mixed(MIXED) RINEX VERSION / TYPE
cnvtToRINEX 2.90.0 convertToRINEX OPR 05-Jul-17 03:38 UTC PGM / RUN BY / DATE
----- COMMENT
KMBA MARKER NAME
KMBA MARKER NUMBER
DM UT OBSERVER / AGENCY
5536R50102 TRIMBLE NETR9 5.20 REC # / TYPE / VERS
UNKNOWN EXT ANT # / TYPE
-3955510.8982 3357111.6791 3697796.5495 APPROX POSITION XYZ
0.0000 0.0000 0.0000 ANTENNA: DELTA H/E/N
1 1 0 WAVELENGTH FACT L1/2
8 C1 C2 C3 L1 L2 L3 P1 P2 # / TYPES OF OBSERV
1.000 INTERVAL
2017 5 1 0 0 0.0000000 GPS TIME OF FIRST OBS
2017 5 1 23 59 59.0000000 GPS TIME OF LAST OBS
0 RCV CLOCK OFFS APPL
18 LEAP SECONDS
59 # OF SATELLITES
G01 23351 23350 0 23350 46694 0 0 23344 PRN / # OF OBS
G02 22293 0 0 22293 22286 0 0 22286 PRN / # OF OBS
G03 19633 19632 0 19632 39259 0 0 19627 PRN / # OF OBS
G05 25303 25302 0 25299 50599 0 0 25297 PRN / # OF OBS
G06 24709 24708 0 24709 49411 0 0 24703 PRN / # OF OBS
G07 27766 27764 0 27764 55505 0 0 27741 PRN / # OF OBS

```

RINEX "O" File, Continued from previous slide

CARRIER PHASE MEASUREMENTS: PHASE SHIFTS REMOVED										PRN / # OF OBS							
										COMMENT							
										END OF HEADER							
S37	86400	0	0	86400	0	0	0	0	0	17	5	1	0	0	0.000000	0	19G10G12G14G15G18G24G25G31G32R01R02R03
S40	56700	0	0	56700	0	0	0	0	0	R11R12R13S28S29S37S40							
21375379.406	7	21375388.078	9					112328384.475	7	87528640.180	9						
							21375388.41448										
20991588.469	7	20991594.418	9					110311559.942	7	85957091.970	9						
							20991594.71548										
23097788.500	6							121379711.146	6	94581624.25147							
							23097793.85247										
24539464.648	6	24539473.480	8					128955722.954	6	100484989.893	8						
							24539473.66046										
21890081.000	6							115033147.870	6	89636240.02147							
							21890086.53547										
22760846.398	6	22760855.313	9					119609048.681	6	93201876.319	9						
							22760854.86347										
20303284.266	7	20303294.227	9					106694510.219	7	83138615.317	9						
							20303294.01248										
23440741.258	6	23440748.211	8					123181935.734	6	95985961.100	8						
							23440748.62147										
21395760.742	7	21395769.145	9					112435502.496	7	87612113.685	9						
							21395769.30548										

Additional Information

Please visit websites

For Webinar: <http://www.csis.u-tokyo.ac.jp/~dinesh/WEBINAR.htm>

<https://gnss.peatix.com>

Main Page : <http://www.csis.u-tokyo.ac.jp/~dinesh/>

Other: <https://www.youtube.com/watch?v=JaicV8egzFo>

Contact:

dinesh@iis.u-tokyo.ac.jp

Sample Raw Data can be downloaded to Check Accuracy of RTK Processing

1. High-End Base (NetR9) Data vs Low-End Rover (u-blox M8T) Data
2. Low-End Base (u-blox M8T) Data vs Low-End Rover (u-Blox M8T) Data