### **Processing of raw GNSS data**

Automated Survey Systems

Bence Takács



**BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS** Faculty of Civil Engineering - Since 1782

Department of Geodesy and Surveying

## CONTENT

- Get raw data of permanent GNSS stations
- Post-process with different scenarios
- Open-source software RTKLIB (demo5 fork): <u>https://rtklibexplorer.wordpress.com/</u>
- Used last week
- Use GUI
- Use CLI



### **RAW DATA OF PERMANENT STATIONS**

- Free data for scientific and educational purposes
- IGS: <u>https://igs.org/</u>
- EUREF: <u>https://epncb.oma.be/</u>

 Task to do: find and download raw data of BUTE, BME1 or other stations in your country

# **BUTE PERMANENT STATION**

- Download from web
  - <u>http://www.epncb.oma.be/ networkdata/siteinfo4onestatio</u> <u>n.php?station=BUTE00HUN</u>
  - One-day session, in RINEX 3 format
- Download directly from command prompt
  - Copy the link
  - Open a command prompt and use wget. Install if it is needed
  - wget

http://www.epncb.oma.be/pub/RINEX/2025/085/BUTE 00HUN R 20250850000 01D 30S MO.crx.gz

# **NAVIGATION DATA**

 Download directly from the command prompt, use wget <u>http://www.epncb.oma.be/pub/RINEX/BRDC/2025/BRDC00G</u> OP R 20250850000 01D MN.rnx.gz

# UNCOMPRESSING

- Work in the command prompt
- Gzip (install if it is needed): c:\gzip\bin\gzip.exe
  BUTE00HUN\_R\_20250850000\_01D\_30S\_MO.crx.gz -d
- Hatanaka decompression (e.g. in c:\rtklib\crx2rnx): c:\rtklib\_demo5\_b34k\crx2rnx.exe BUTE00HUN\_R\_20250850000\_01D\_30S\_MO.crx
- Check out the compact RINEX and RINEX files

### **POST-PROCESS - SPP**

- Launch RTKPOST
- BME1 as rover

C RTKPOST demo5 b34k	_		×
Time Start (GPST)      Time End (GPST)      ?        2024/12/15      06:20:00      2025/01/04      00:00:00	□ Interval 0 ∨ s	Unit 24	Н
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		~	
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Solution Dir D:\kutat\Paripa\HC\data\Y2024\D342\PildoBox20	5\sol_BUTE2	\kinemati	
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# **SPP - SETTINGS**

- Single
- GPS+GLO+GAL+BDS

Options								×
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Rec D	ynamics / E	Earth Tide	s Correction	n	OFF		OFF	$\sim$
Iono/T	ropo Corre	ection			Broadcast	$\sim$	Saastamoir	$\sim$
Satelli	te Epheme	ris/Clock			Broadcast			$\sim$
Sa	t PCV 🗌 F	Rec PCV	PhWU	Rej Ed	RAIM FDI	E	DBCorr	
Exclud	led Satellit	es (+PRN	· Included)					
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Load		Save	·		<u>0</u> K		<u>C</u> ancel	

### **TRUE POSITIONS**

- <u>http://www.epncb.oma.be/\_productsservices/coordinates/cr</u> <u>d4station.php?station=BME100HUN</u>
- Use ETRF2000
- Convert cartesian to geodetic
  - Online: <u>https://www.apsalin.com/cartesian-to-geodetic-on-ellipsoid/</u>
  - With proj: cs2cs -f "%.8f" +proj=cart +to +proj=latlong
- BUTE: 4082001.374 1410144.840 4678052.896
- 47.4790182480 19.0576908520 178.357

# **PLOT THE RESULTS**

#### Set coordinate origin to the true position





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# **POST-PROCESS** - DGPS

• Base: BUTE, rover: BME1

C RTKPOST demo5 b34k -		×
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D:\oktatas\geodeziai_automatizalas\2025\8ora\BRDC00GOP_R_20250850	000_01D	_ ~ [
		~
		×
		~
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D:\oktatas\geodeziai_automatizalas\2025\8ora\BME100HUN_R_202508500	000_01D	_ ~
🗉 🗆 done		?
⊕ Plot  E View  KML/GPX  ¢ Options  ► Execut	e	E <u>x</u> it



### **POST-PROCESS - DGPS**

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Base Station	~		
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Antenna Type	(*: Auto)	Delta E/N/U (	(m)
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Options								>
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Rec D	ynamics / E	arth Tide	s Correction	ı	OFF		OFF	`
Iono/	Tropo Corre	ection			Broadcast	$\sim$	Saastamoir	`
Satelli	te Epheme	ris/Clock			Broadcast			1
Sa	t PCV 🗌 R	lec PCV	PhWU	Rej Ed	RAIM FE	DE	DBCorr	
Exclud	ded Satellit	es (+PRN	: Included)					
🗹 GP	′s √GLO	🗹 Galil	eo 🗌 QZS	IS 🗌 SB	BAS 🗹 Be	iDou	IRNSS	

### **PLOT THE RESULTS**



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### **POST-PROCESS – KINEMATIC**

#### Turn off Rec Dynamics



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# **POST-PROCESS IN CLI**

In GUI save the settings into a config file (e.g. spp.conf)

Options		×
Setting <u>1</u> Setting <u>2</u> O <u>u</u> tput S <u>t</u> atistics <u>P</u> ositions	Files <u>M</u> isc	
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Frequencies	1+L2/E50	~
Filter Type	Forward	~
Elevation Mask (°) / SNR Mask (dBHz)	15 ~	]
Rec Dynamics / Earth Tides Correction	OFF ~	OFF ~
Iono/Tropo Correction	Broadcast ~	Saastamoir 🗸
Satellite Ephemeris/Clock	Broadcast	```
🗌 Sat PCV 🗌 Rec PCV 🗌 PhWU 🗌 Rej Ed	RAIM FDE	DBCorr
Excluded Satellites (+PRN: Included)		
☑ GPS ☑ GLO ☑ Gailieo   QZSS   SI	BAS 🔽 BeiDo	u 🗌 IRNSS
Load	ОК	<u>C</u> ancel

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# **POST-PROCESS IN CLI - SPP**

- Open a command prompt
- Type: c:\rtklib\_demo5\_b34k\rnx2rtkp.exe -k spp.conf BME100HUN\_R\_20250850000\_01D\_30S\_MO.rnx BRDC00GOP\_R\_20250850000\_01D\_MN.rnx -o BME100HUN\_R\_20250850000\_01D\_30S\_MO.pos
- All the settings are in the conf file, all you need to give are the output file name, RINEX observation and navigation file names
- You can give the full path if the files are in different directories which is highly recommended
- Some parameters can be given in the command prompt, see the help

# **POSS-PROCESS IN CLI - DGPS**

- c:\rtklib\_demo5\_b34k\rnx2rtkp.exe -k dgps.conf BME100HUN\_R\_20250850000\_01D\_30S\_MO.rnx BRDC00GOP\_R\_20250850000\_01D\_MN.rnx BUTE00HUN\_R\_20250850000\_01D\_30S\_MO.rnx -o BME100HUN\_R\_20250850000\_01D\_30S\_MO.pos
- Give the rover observation file at first



- run rnx2rtkp in kinematic mode
- plot the results (pos files) using rtkplot
- develop your own script to make the plots in Python
- develop Python scripts to run rnx2rtkp (see the handout in the moodle)