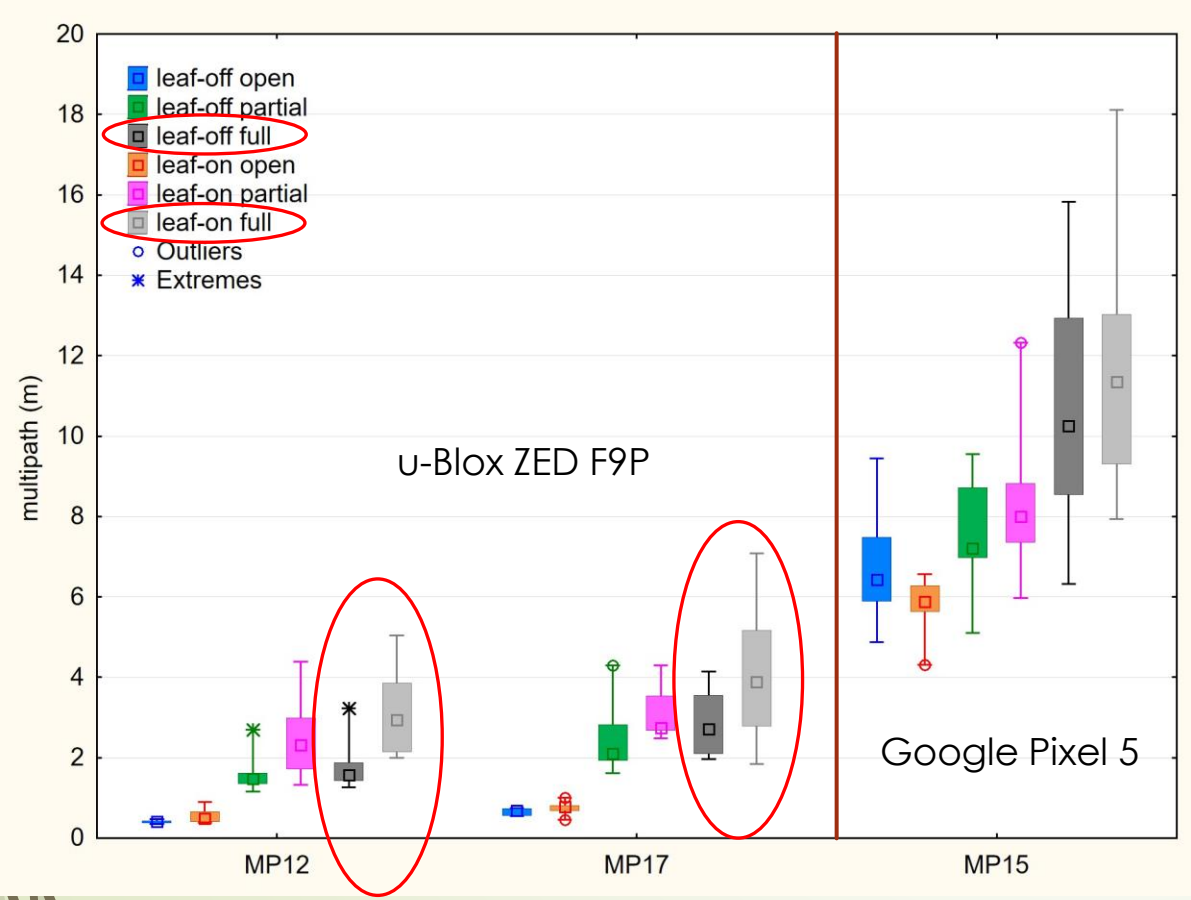
Posúdenie možností sledovania fenologického stavu vegetácie na základe kvalitatívnych charakteristík GNSS signálov

ASSESSMENT OF THE POSSIBILITIES OF MONITORING THE PHENOLOGICAL STATE OF VEGETATION BASED ON THE QUALITATIVE CHARACTERISTICS OF GNSS SIGNALS

Julián Tomaštík

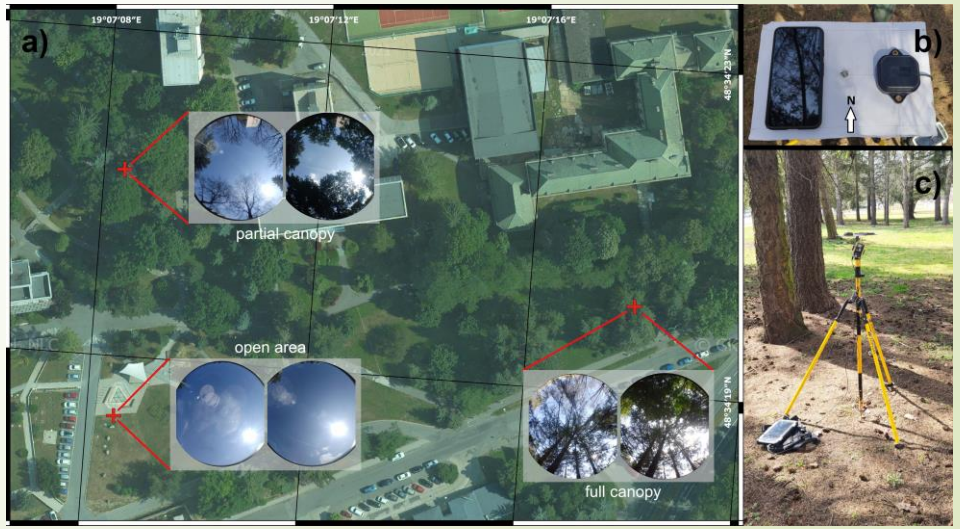
FACULTY OF FORESTRY
TECHNICAL UNIVERSITY IN ZVOLEN

Starting points



(e.g. Tomaštík, Everett 2023)

- Availability of low-cost GNSS sensors
- Previous research
- Demandingness of phenological observations



Monitoring station

Raspberrry Pi 4B + Witty Pi

powerbank

4G modem

GNSS receiver

Ardusimple RTK3B Pro receiver

mosaic-X5

FEATURES

GNSS technology

448 hardware channels for simultaneous tracking of all visible supported satellite signals[1]:

- GPS: L1C/A, L1PY, L2C, L2P, L5
- GLONASS: L1CA, L2CA, L2P, L3 CDMA
- Beidou: B1I, B1C, B2a, B2b, B2I, B3
- Galileo: E1, E5a, E5b, E5 AltBoc, E6
- QZSS: L1C/A, L1 C/B, L2C, L5
- Navic: L5
- SBAS: Egnos, WAAS, GAGAN, MSAS, SDCM (L1, L5)
- On module L-band

Calibrated antenna

Timelapse camera

Reference station

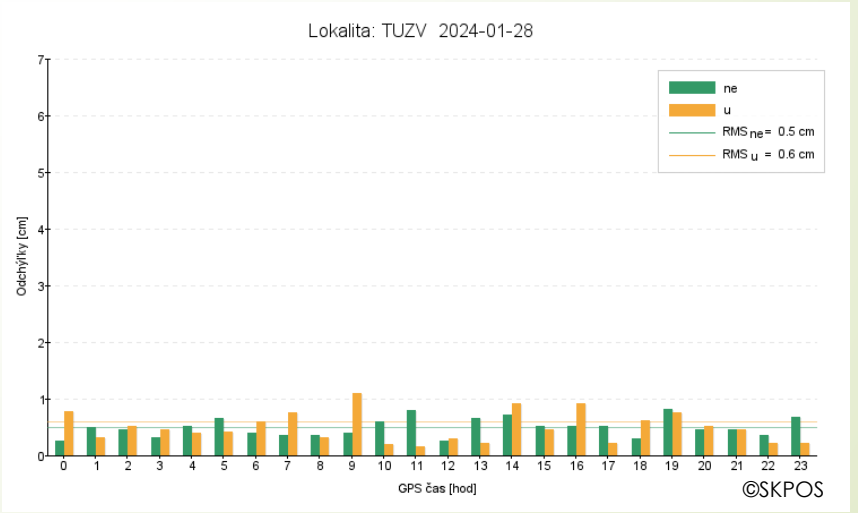
Calibrated antenna

GNSS receiver

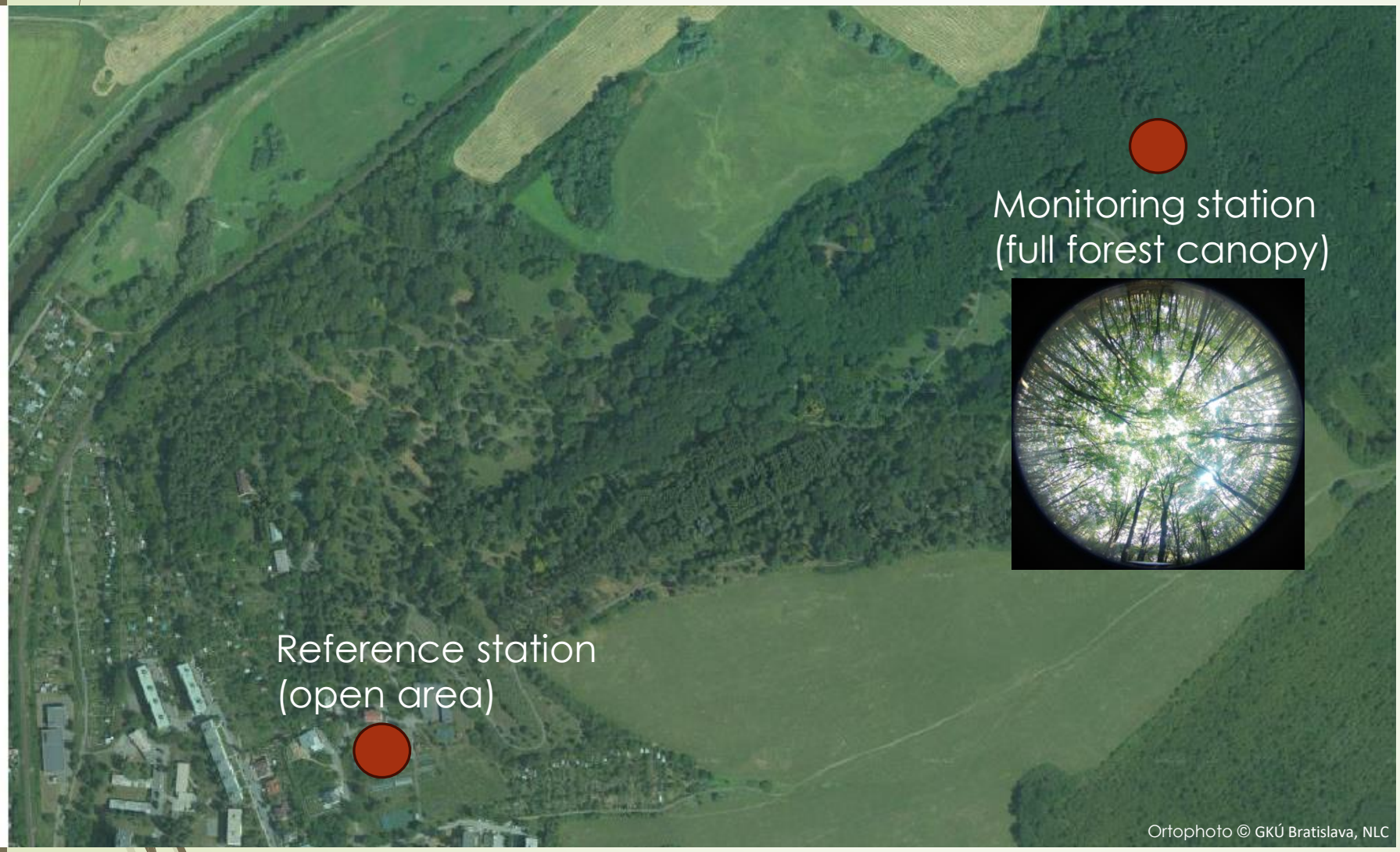
Raspberry Pi

Intended use:
- checking local extremes in data
- optional: base for positioning solutions

Free NTRIP caster via rtk2go.com service
Included in SKPOS monitoring network



Test area, data and evaluated characteristics



First (autumn) data collection campaign (15.9.-15.12.2023)

Daily (60s) RINEXes

↓

Carrier-to-noise density
Multipath
Cycle slips

Imagery from timelapse camera (or spherical photography)

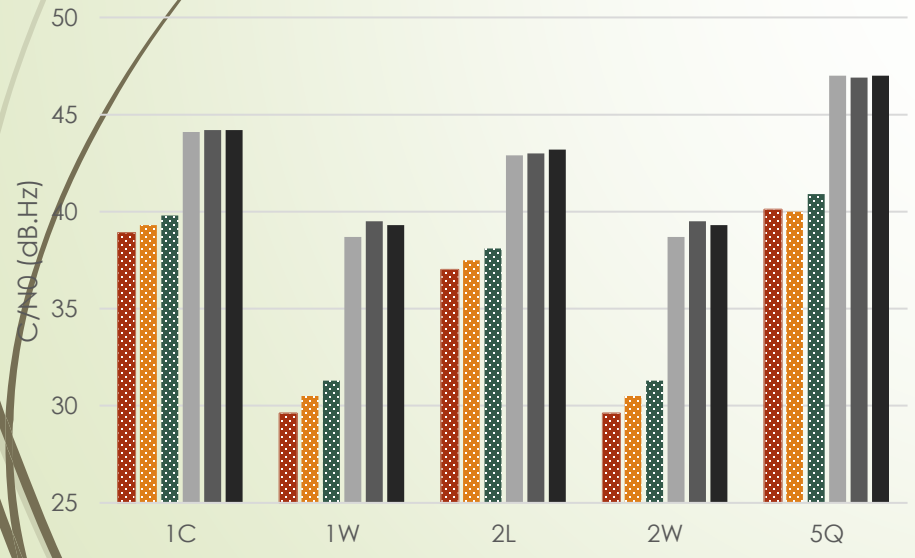
Optional:
- positioning performance
- meteorological data

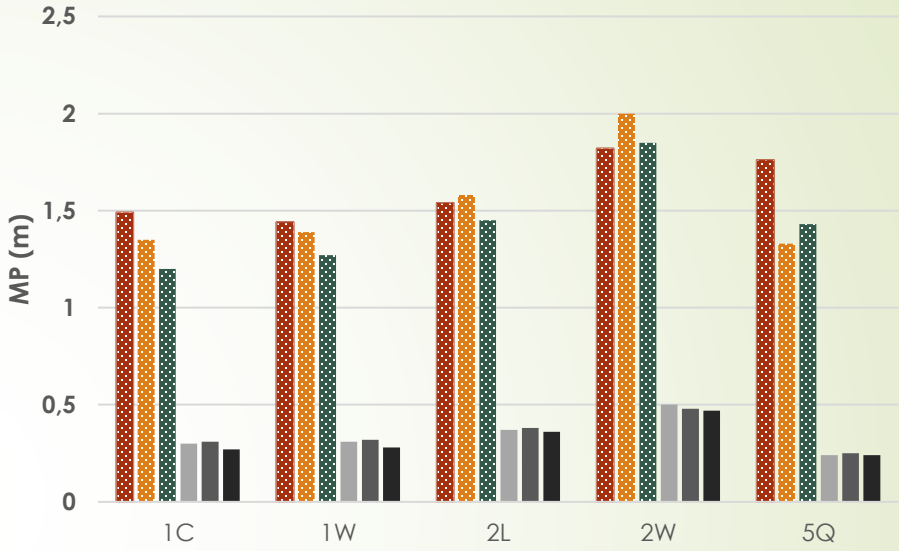
Preliminary results

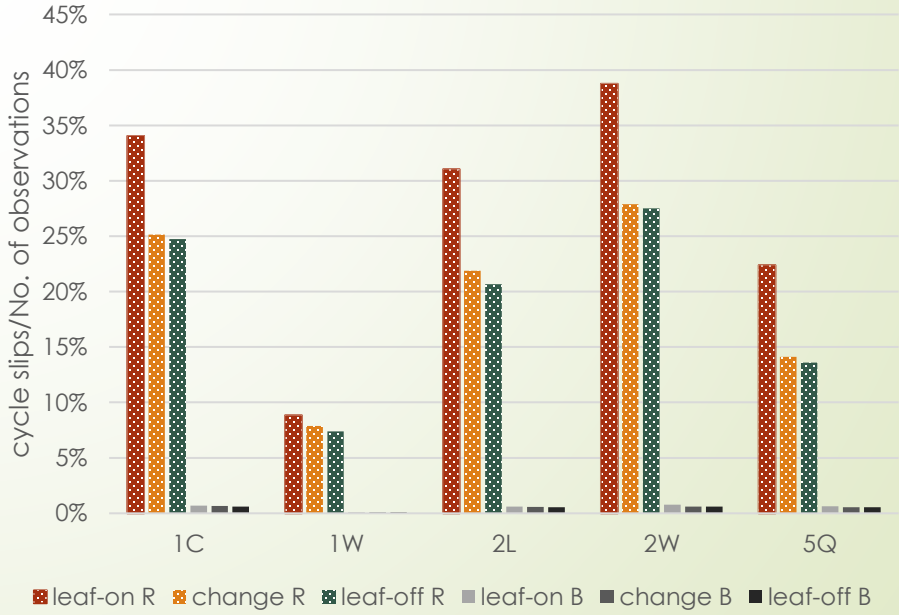
GPS only

Evaluated using BKG Ntrip Client

Monitoring st. (color) and reference st. (grey) during full foliage, 50% defoliation and full defoliation



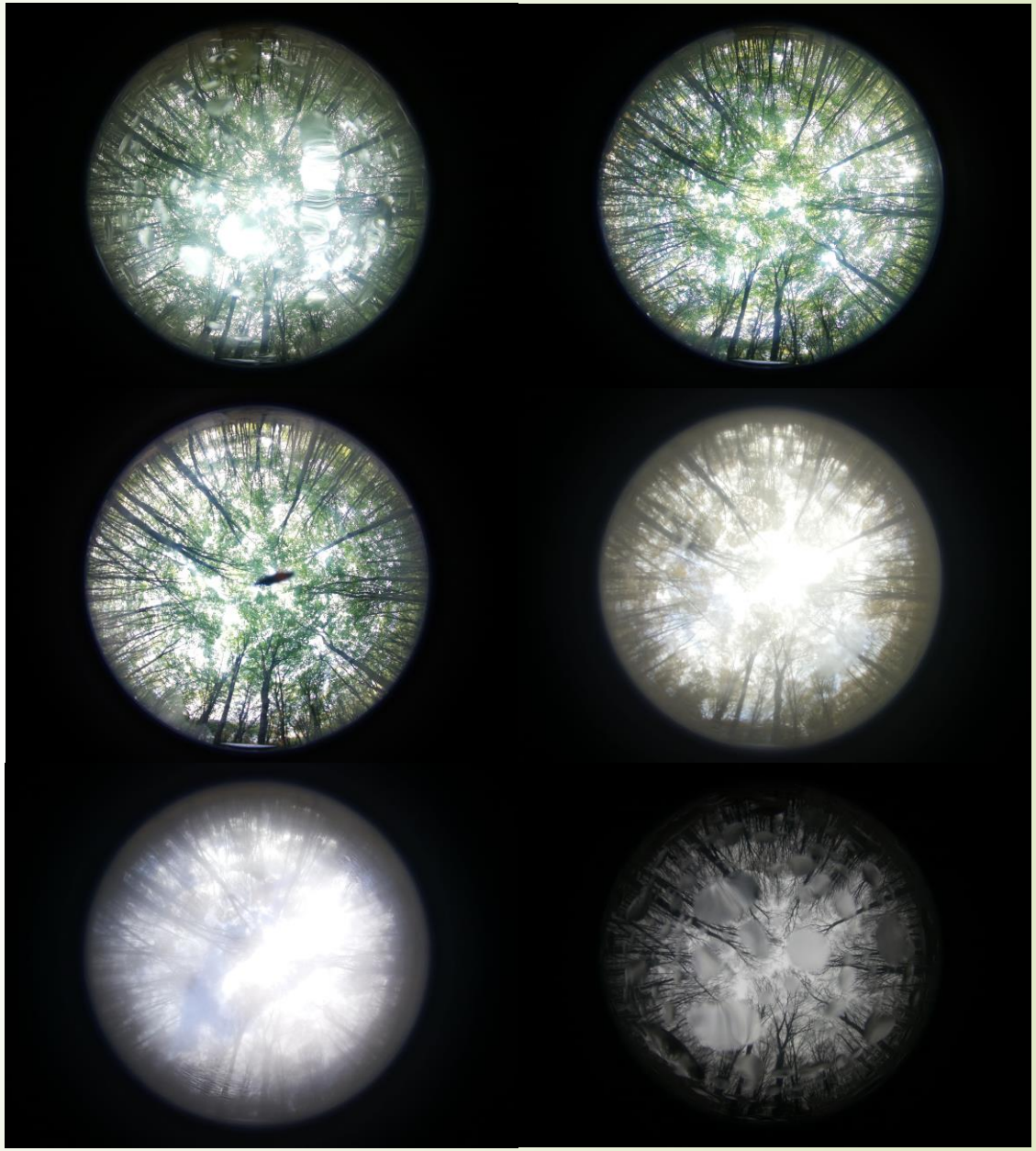




Experiences

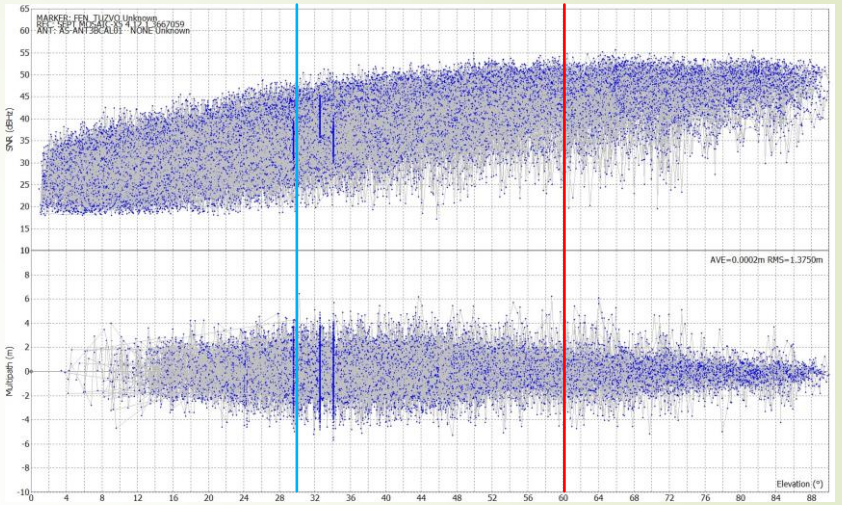
- Power consumption – the main constraint for practical applicability
- Cost efficiency – GNSS versus timelapse camera
- Timelapse camera problems – mostly due to climatic factors
- Weird (X1) observations in RINEX files – addressed in the RTKLIB: demo5 b34i

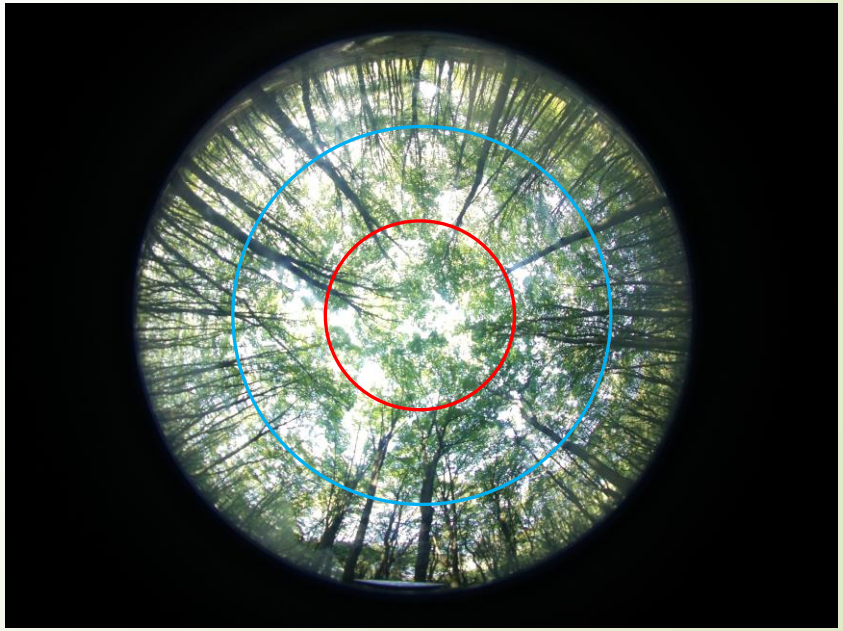
```
G   19 X1  C1C L1C D1C S1C C1W S1W C2W L2W D2W S2W C2L L2L  SYS / # / OBS TYPES
       D2L S2L C5Q L5Q D5Q S5Q                             SYS / # / OBS TYPES
E   17 X1  C1C L1C D1C S1C C5Q L5Q D5Q S5Q C7Q L7Q D7Q S7Q  SYS / # / OBS TYPES
       C8Q L8Q D8Q S8Q                                     SYS / # / OBS TYPES
S    9 X1  C1C L1C D1C S1C C5I L5I D5I S5I                  SYS / # / OBS TYPES
R   17 X1  C1C L1C D1C S1C C2P L2P D2P S2P C2C L2C D2C S2C  SYS / # / OBS TYPES
       C3Q L3Q D3Q S3Q                                     SYS / # / OBS TYPES
C   21 X1  C1P L1P D1P S1P C5P L5P D5P S5P C2I L2I D2I S2I  SYS / # / OBS TYPES
       C7I L7I D7I S7I C6I L6I D6I S6I                     SYS / # / OBS TYPES
J   13 X1  C1C L1C D1C S1C C2L L2L D2L S2L C5Q L5Q D5Q S5Q  SYS / # / OBS TYPES
I    5 X1  C5A L5A D5A S5A                                 SYS / # / OBS TYPES
```

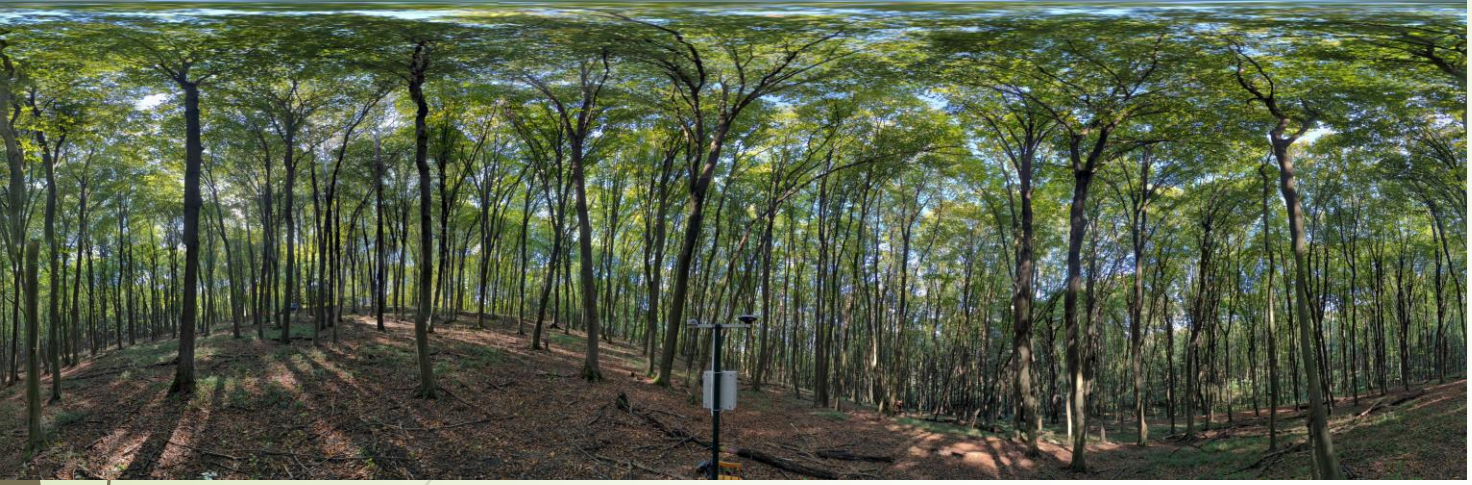


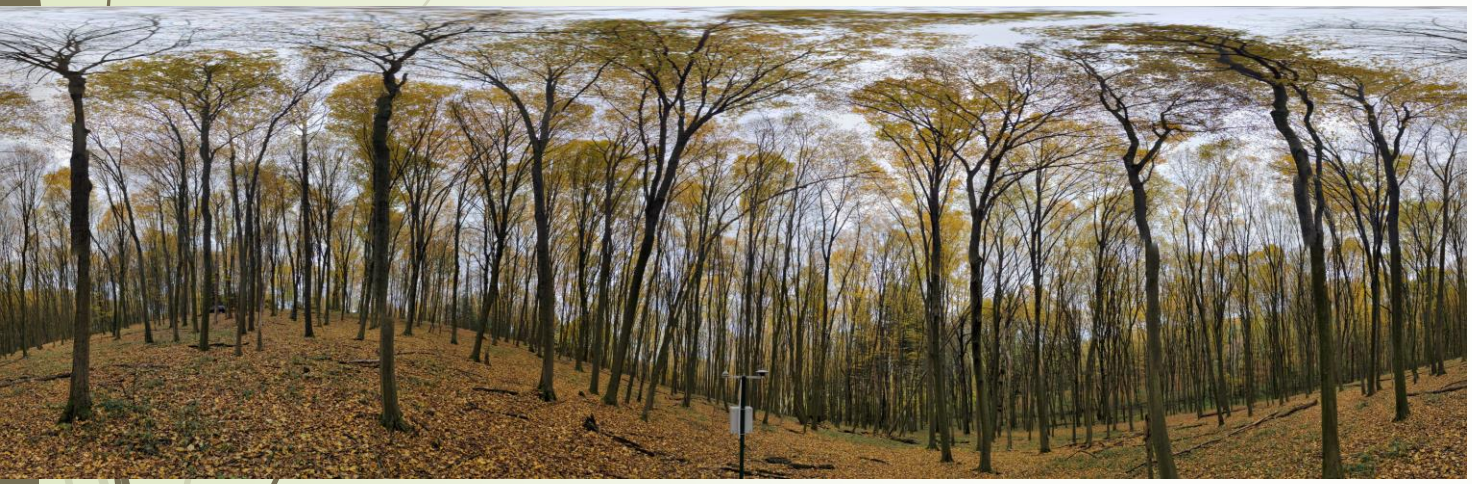
Future work

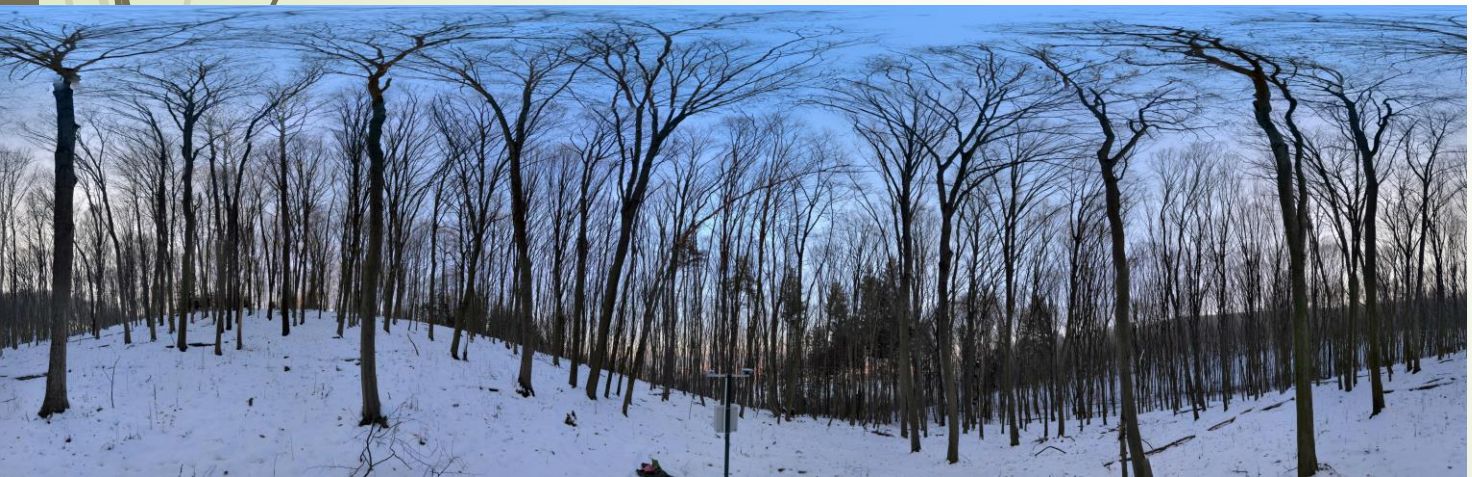
- Complex analysis using GNUT/Anubis software
- Identification of characteristics (or their combination) with the closest relation to the phenological changes
- Shift to some more cost- and power-efficient GNSS solution (e.g. u-Blox M10 platform)
- Spring campaign of data collection (starts in the first half of March 2024)
- Optional: elevation angle weighted evaluation











Thank you!

Author's RG profile

Supported by VEGA 1/0568/23 "The application of Global Navigation Satellite Systems (GNSS) signals for localization and monitoring of vegetation in the forest environment."