TROPOSPHERE MONITORING AT HIGH SPATIO-TEMPORAL RESOLUTION USING LOW-COST GNSS RECEIVERS

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MOTIVATION

- The growing popularity of low-cost sensor applications.
- Cost-effective construction of a dense network of GNSS receivers based on low-cost solutions.
- Monitoring the results obtained from low-cost dual-frequency GNSS receivers.
- Assessing the feasibility of utilizing low-cost receivers in programs such as E-GVAP.
- Advancement of a university-developed low-cost GNSS receiver.

Experimental equipment

1. Raspberry Pi 3B+

2. U-blox C099-F9P

3. Power supply

4. Ethernet socket

5. Power socket

6. GNSS antenna socket

7. u-blox patch antenna

8. ArduSimple survey antenna
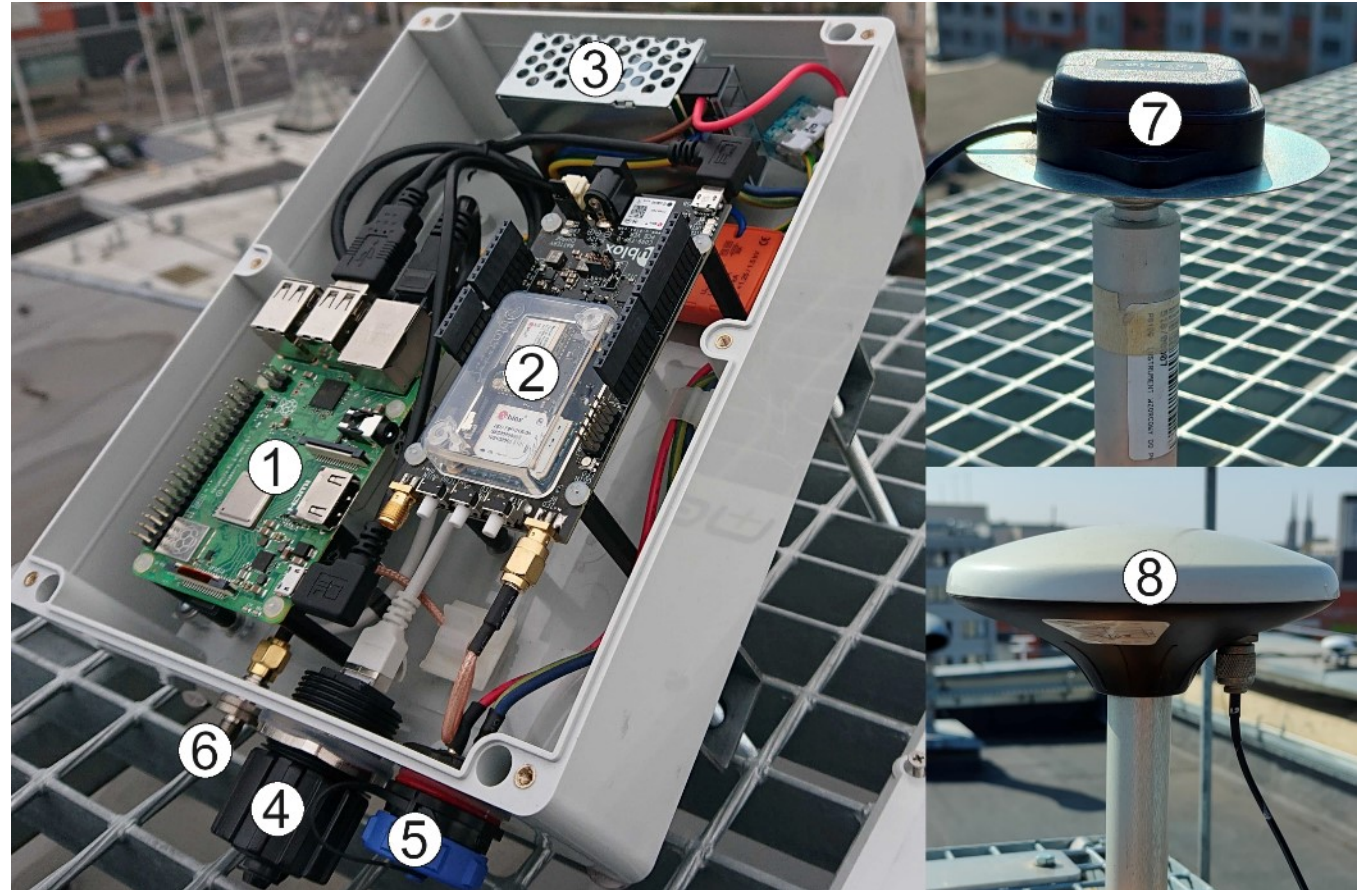
STUDY AREA

Validation:

- Place: Roof of Institute of Geodesy and Geoinformatics

- Period: 09.12.2020 – 27.12.2020

- Stations: WROC and BX02

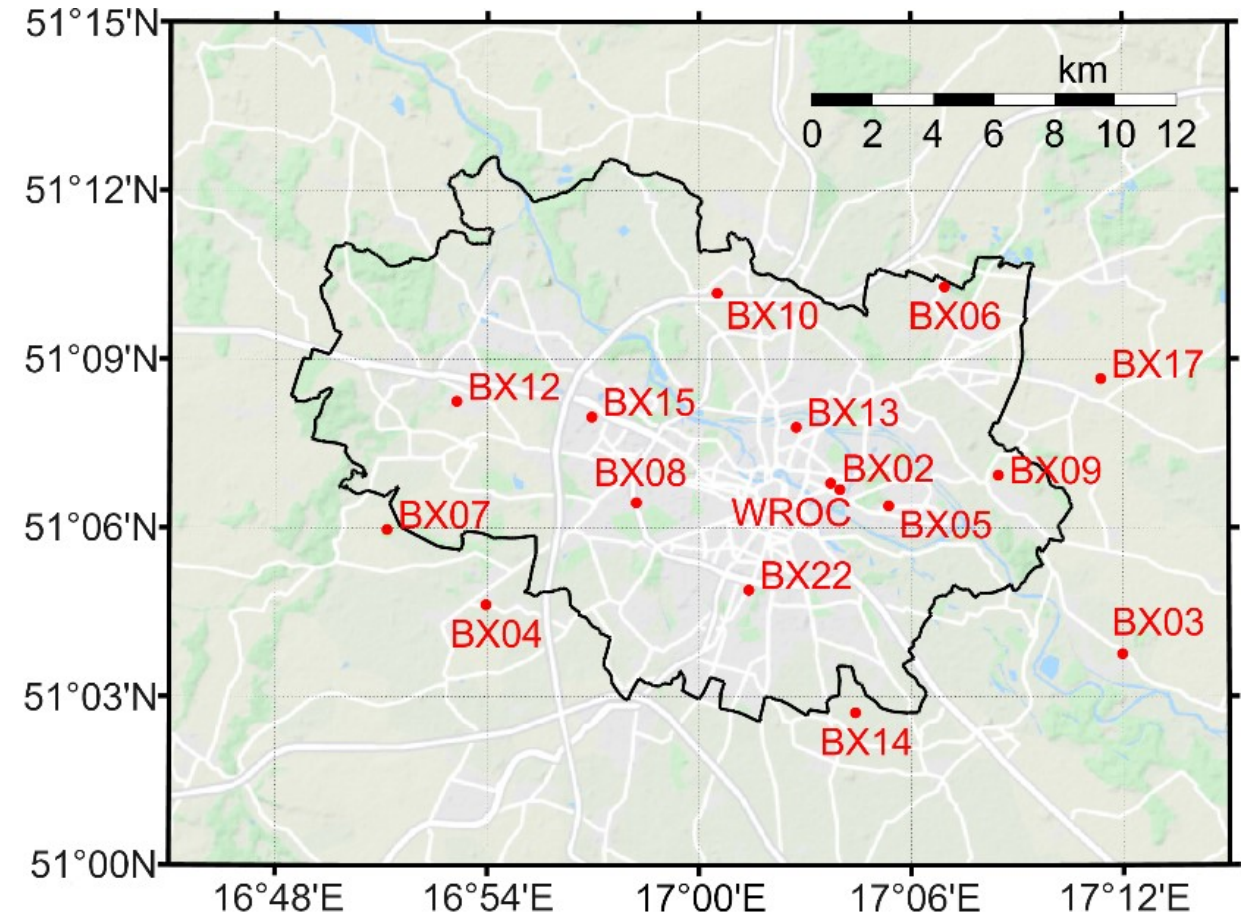- Reference: ZTD from EPN, IWV from collocated water vapour radiometer

Campaign:

Place: Wrocław city and its suburbs

Period: 27.02.2021 – 28.03.2021

Stations: WROC and 15 x low-costs

Reference: IWV from WRF

PROCESSING STRATEGY

|	RT	FIN
Processing engine	GNSS-WARP	CSRS-PPP
GNSS selection	GPS + Galileo	GPS + GLONASS
Technique	static PPP	
Functional model	undifferenced and uncombined observations (Schönemann, 2013)	
Elevation mask	3°	7.5°
Estimation interval	60 s	30 s
Satellite PCO/PCV	igsR3_2077.atx	igs14.atx
Receiver PCO	Kretowicz (2021) for u-blox antennas; none for ArduSimple antenna	none for all antennas
Satellite orbits and clocks	real-time CNES	IGS Final/NRCan
A priori hydrostatic delays	VMF-1	
Troposphere mapping function	VMF-1	

VALIDATION - ZTD

• ZTD consistent with the reference for WROC and BX02 in both solutions

• ~2.5% of results rejected as outliers for RT WROC and RT BX02

• σRT BX02 is 2.5x larger than WROC (σRT BX02 < 9 mm).

• σFIN BX02 is 4x larger than WROC (σFIN BX02 < 7 mm).
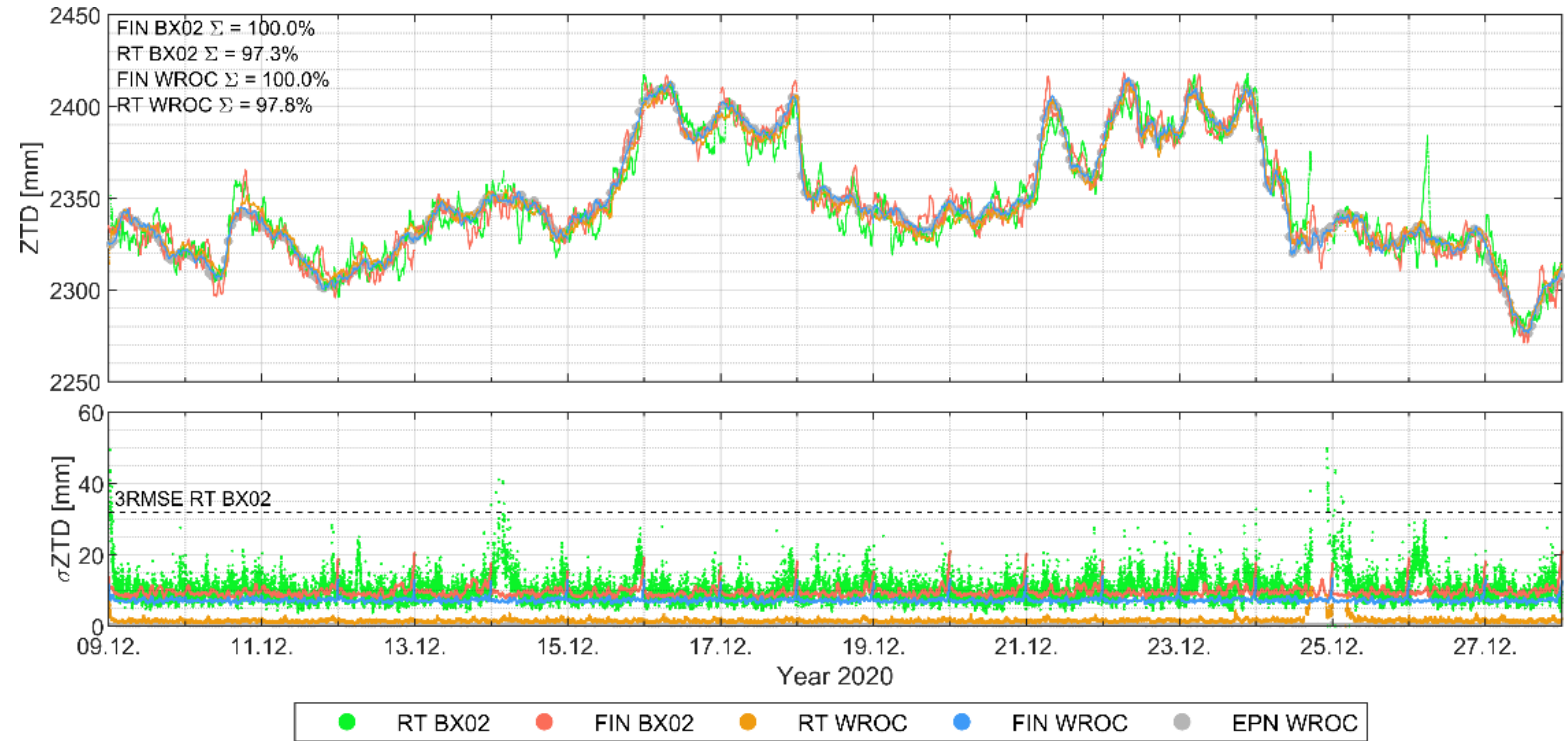
VALIDATION - IWV

- ΔIWV BX02 = +/- 4 kg/m^2

- σIWV BX02 <= 1.5 kg/m^2

- σBX02 is 2x larger than WROC for both solutions

- Both solutions meet the minimum requirements of the E-GVAP program.
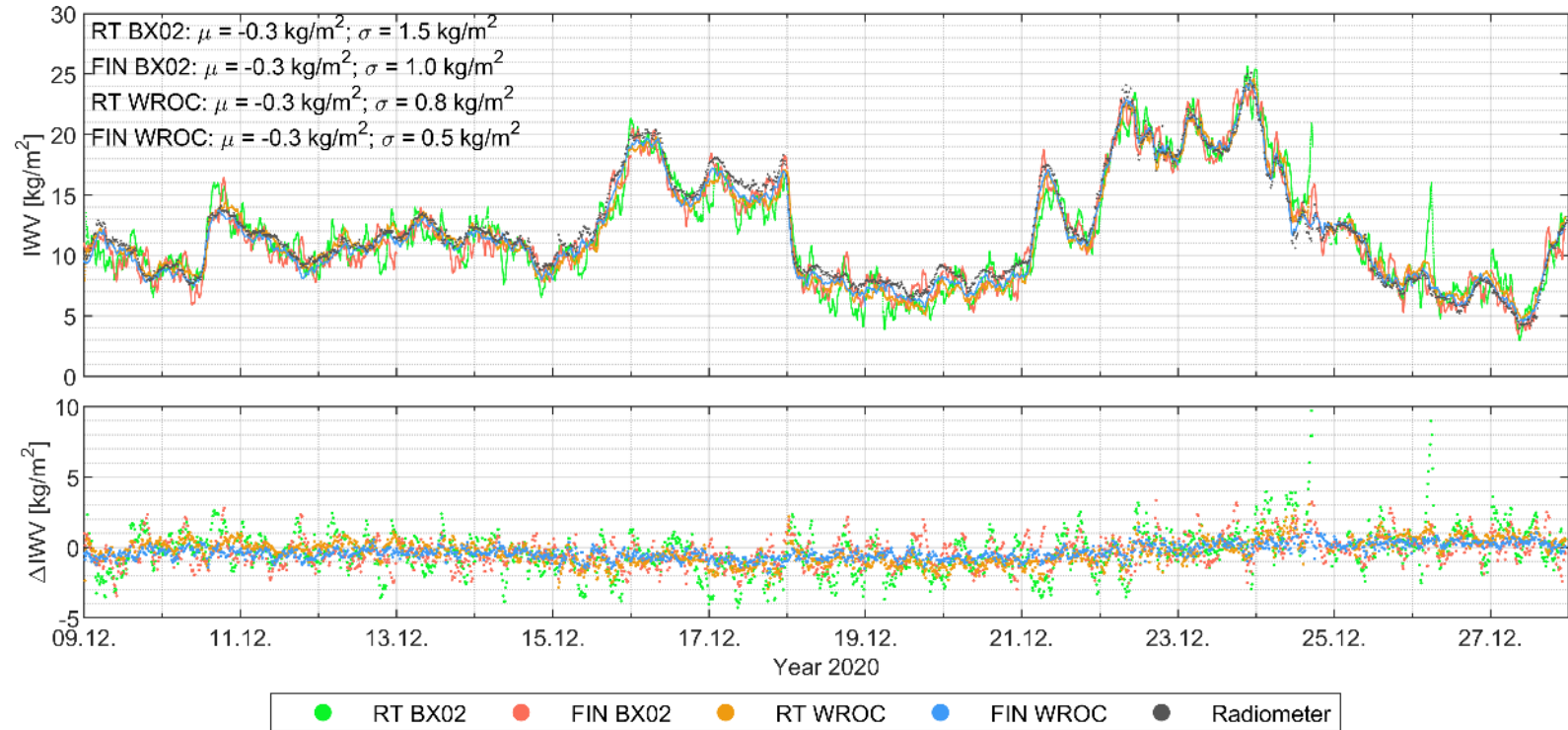
CAMPAIGN – CORELATION

• High correlation (>= 0.85) observed for the majority of stations regardless of distance.

• Correlation between receivers depends on their location, not the distance between them.

• Higher correlation of results observed for the FIN solution compared to the RT solution.

• Receivers BX05 and BX17 positioned in less favorable locations.
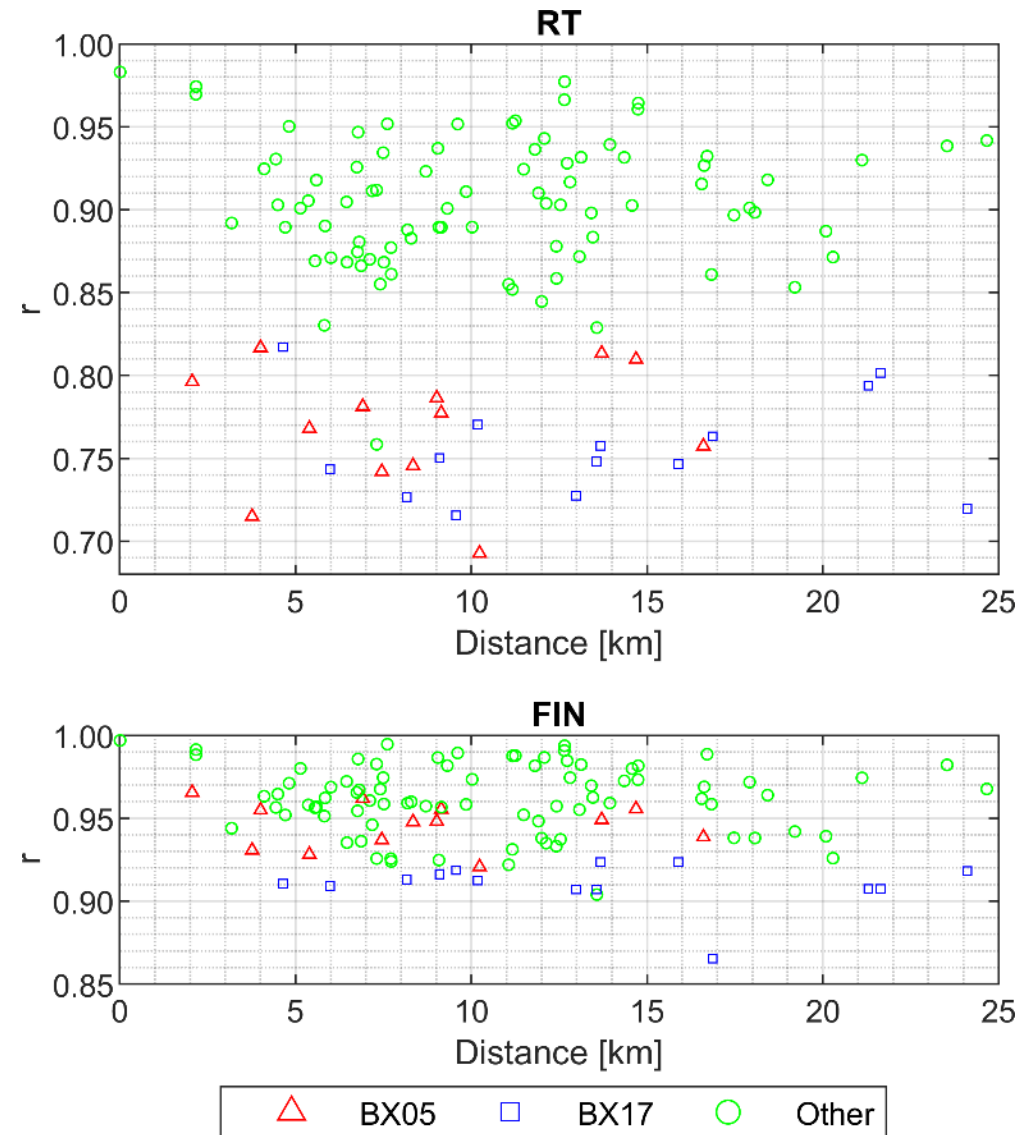
Campaign – GNSS vs. WRF

- IWV is consistent between GNSS and WRF for most of the period.

- Significant detectable differences are present in both solutions.

- Consistent differences are observed for receivers located nearness.

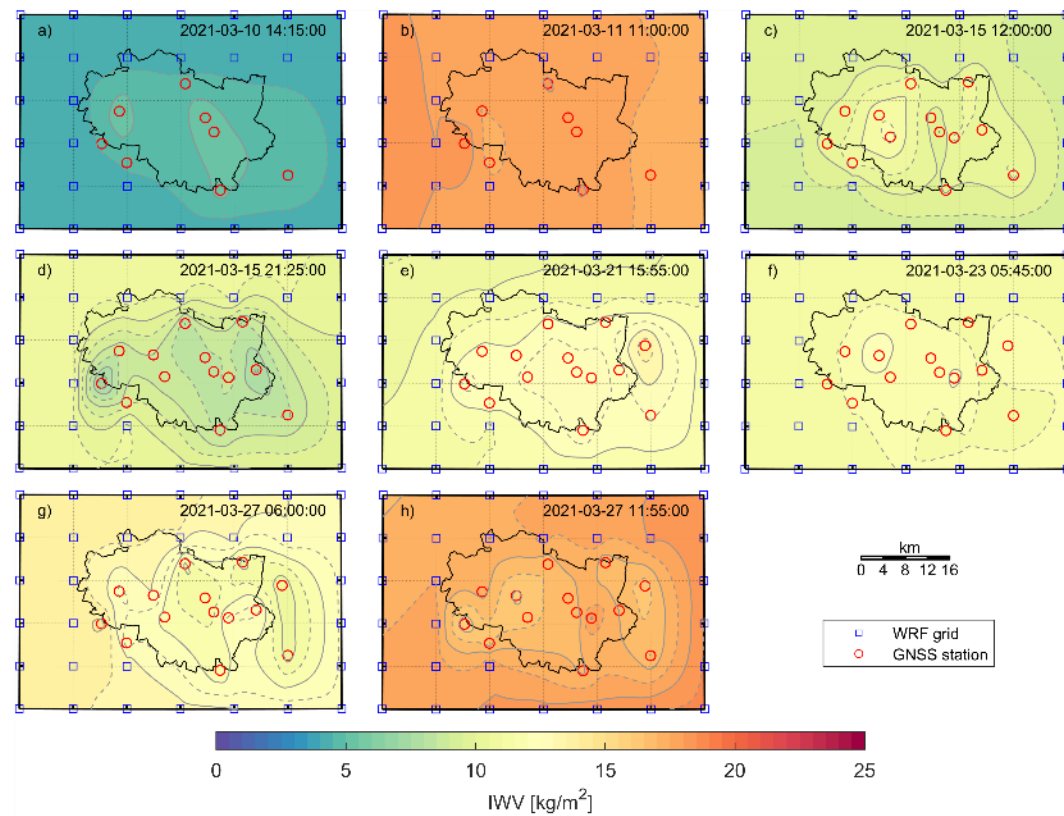- The RT solution exhibits larger detected differences compared to the FIN solution.
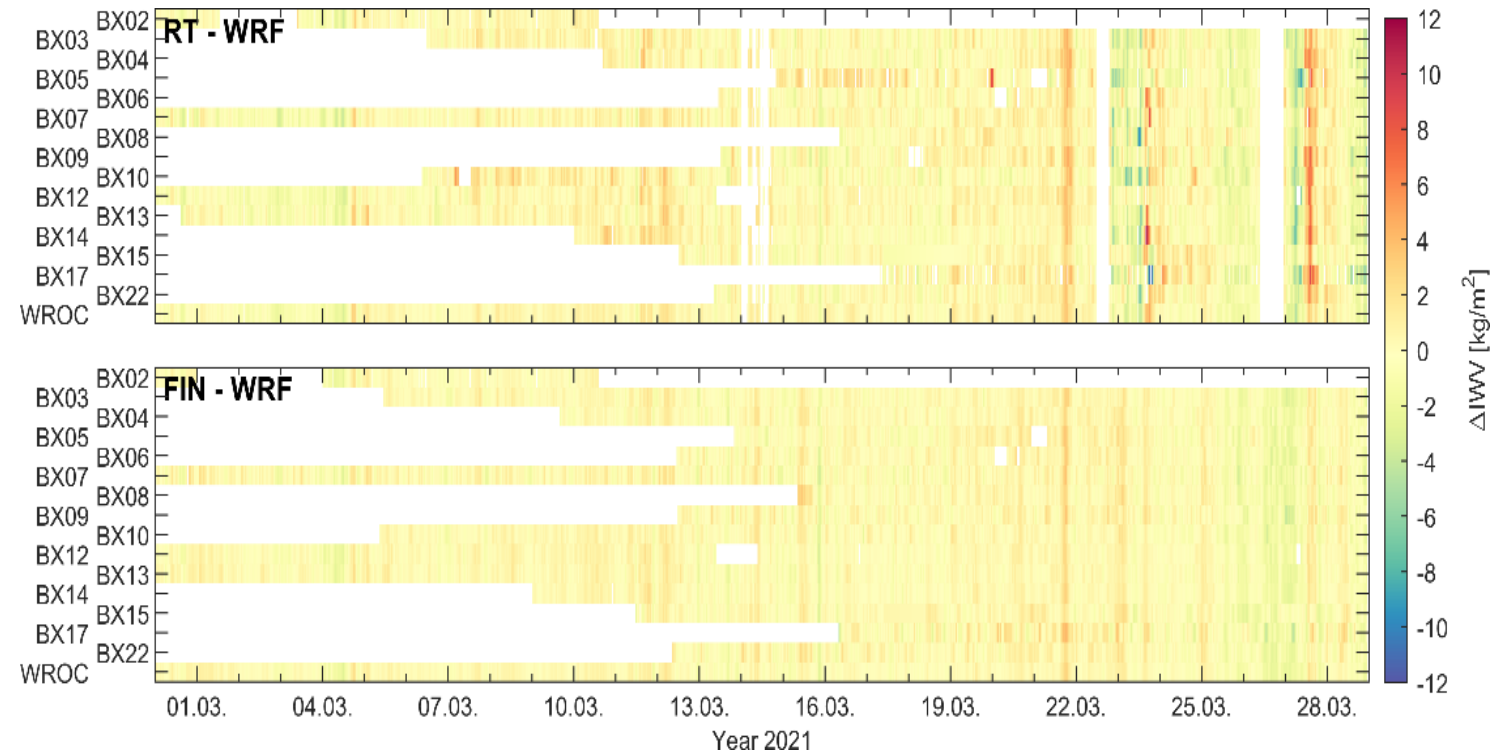
CAMPAIGN – IWV

RT
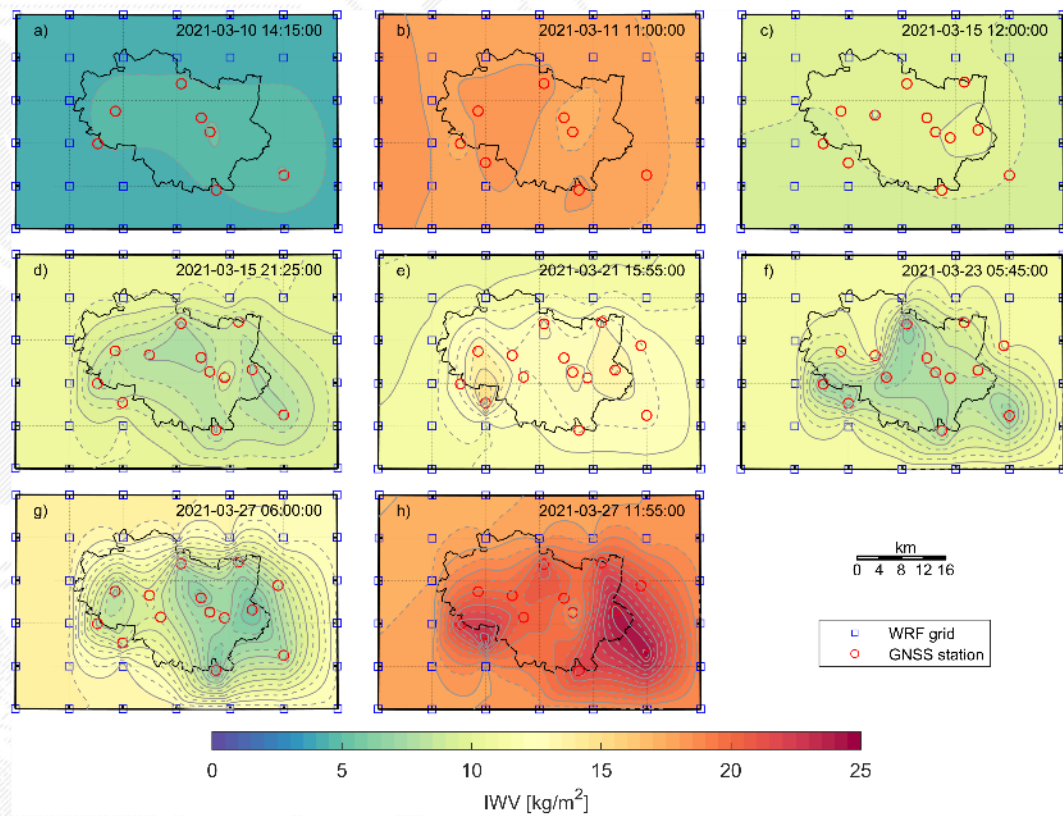
FIN

SUMMARY

- The low-cost GNSS receivers have great potential in future researches of local change of the troposphere.

- In future experiments, all u-blox patch antennas should be replaced with antennas although of measurement grade.

- The low-cost receivers meet E-GVAP programme requirements.

- The locations of the devices to be set up should be selected accordingly.

Thank you for your attention ☺

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