Community-based lightning detection in Europe: studying the detection efficiency of the BlitzOrtung network – a case study concerning lightning climatology over Hungary

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(1) Introduction

- **Lightning** is not only a **natural hazard**, but it has been declared as an **essential climate variable** which provides important information about Earth's changing climate.
- There are more and more **lightning detection networks** around the globe both **on the surface** (e.g., WWLLN, LINET, EUCLID, Earth Networks) and **in the space** (GLM, LIS, OTD).
- **BlitzOrtung (BO)** is a dynamically developing, community-based, low-cost lightning detection network based on the principle of the time of arrival (TOA). BO has more than 3000 stations in the world [1].

(2) Data

- **BO** data were compared to lightning strokes data from **LINET** [2] and the **WWLLN** [3] from **30 July 2022** in the **case study**.
- The lightning strokes from the BO **were paired** with those detected by the reference networks (LINET and WWLLN): the **maximum allowed time difference and spatial distance** between the lightning strokes detected by the BO and the reference networks were **200 µs and 100 km**, respectively.
- An area, **focused on Hungary** (45.5°–49° N, 16°–23° E), was selected for the analyses and it was divided into **392 cells with a 0.25°x0.25° spatial extent**.
- **Four classes** were defined to describe the main geographical characteristics of the cells: water (w), plane (p), hill (h), and mountain (m) (Fig. 1).

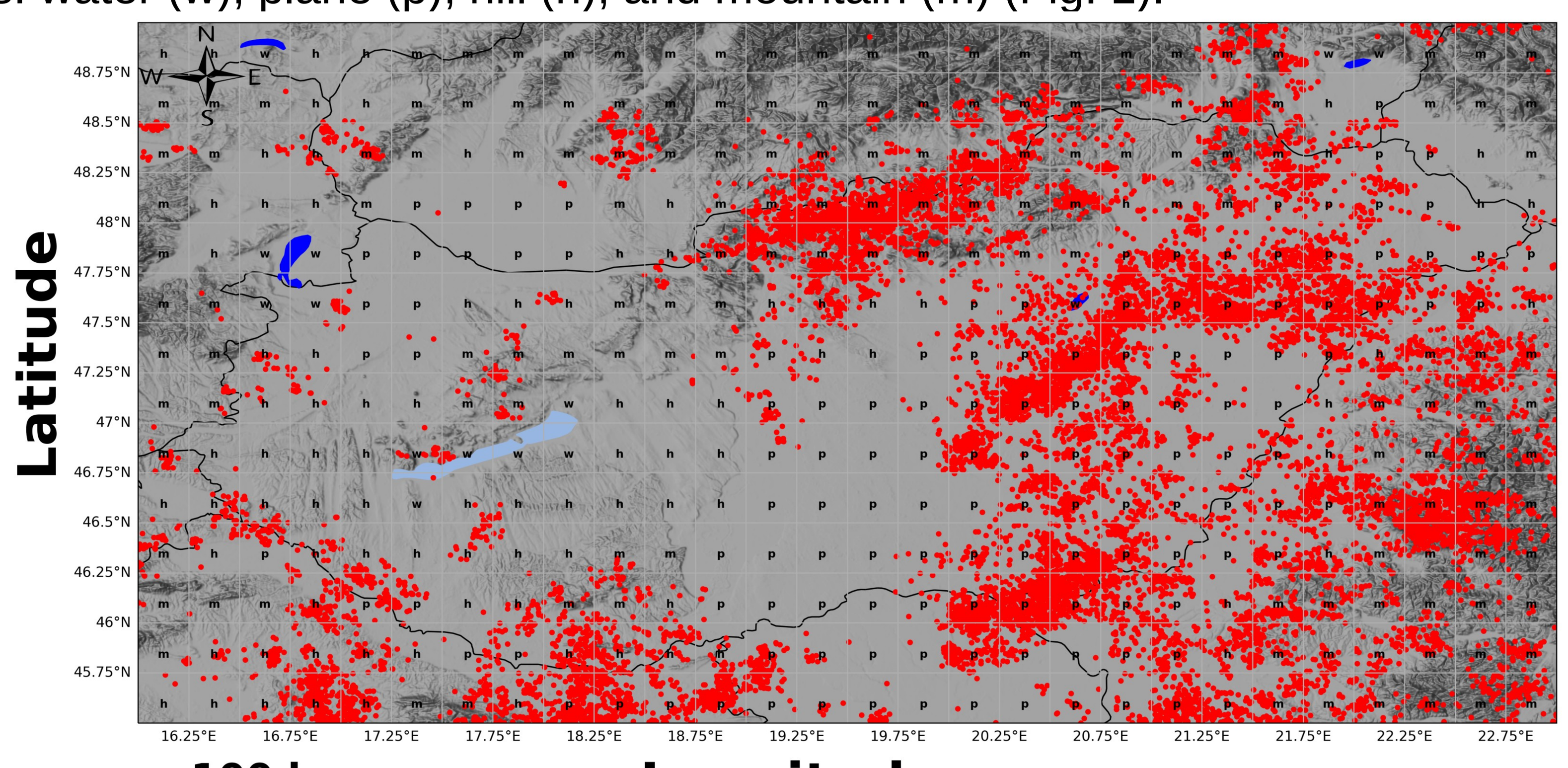

Fig. 1. Map of the investigated area with the BO lightning strokes from 30 July 2022 as red dots.

- The **lightning climatology** was computed from the BO data (on a 0.25˚x0.25˚ grid) measured in the years of 2015, 2016, 2017, 2018, and 2022, and using the High Resolution Monthly Climatology (HRMC) product of NASA's spaceborne instrument, the **OTD** (Optical Transient Detector), on a 0.5˚x0.5˚ grid, from data recorded between 1995 and 2000 [4].

(3) Results

Tab. 1. Results of the pairing of the lightning strokes.

BO-LINET					
BO#	16662	**BO# paired**	5361	**% paired**	32.18%
LN#	196362	**LN# paired**	5361	**% paired**	2.73%
4295 CG strokes were detected by BO	1066 IC strokes were detected by BO	2.83% of LINET CGs was detected by BO	2.39% of LINET ICs was detected by BO	CG/IC ratio in LINET: 3.41	CG/IC ratio in paired BO: 4.03
BO-WWLLN					
BO#	16662	**BO# paired**	561	**% paired**	3.4%
WL#	8368	**WL# paired**	561	**% paired**	6.7%

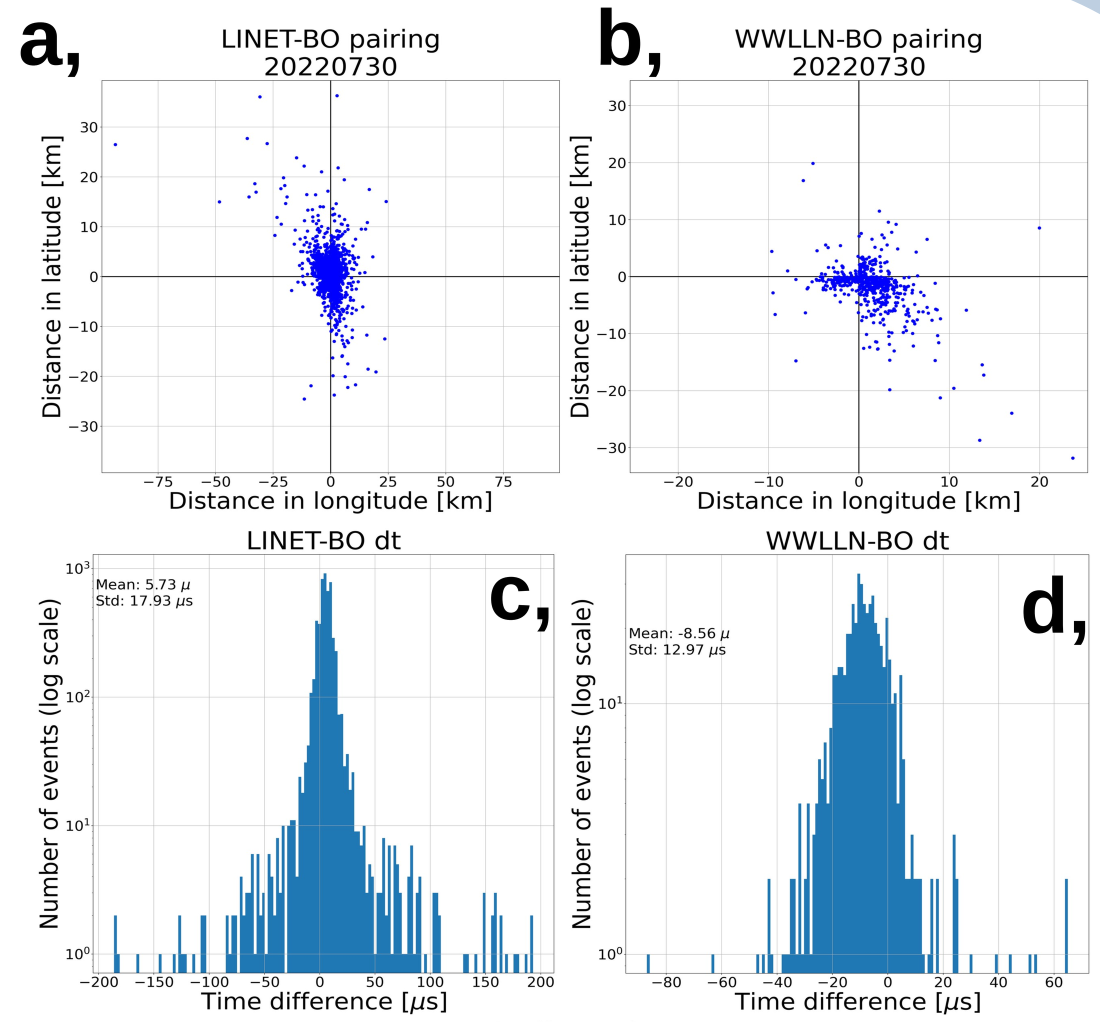

Fig. 2. Distribution of the spatial (**a-b**) and temporal (**c-d**) difference of the LINET-BO and WWLLN-BO paired lightning strokes.

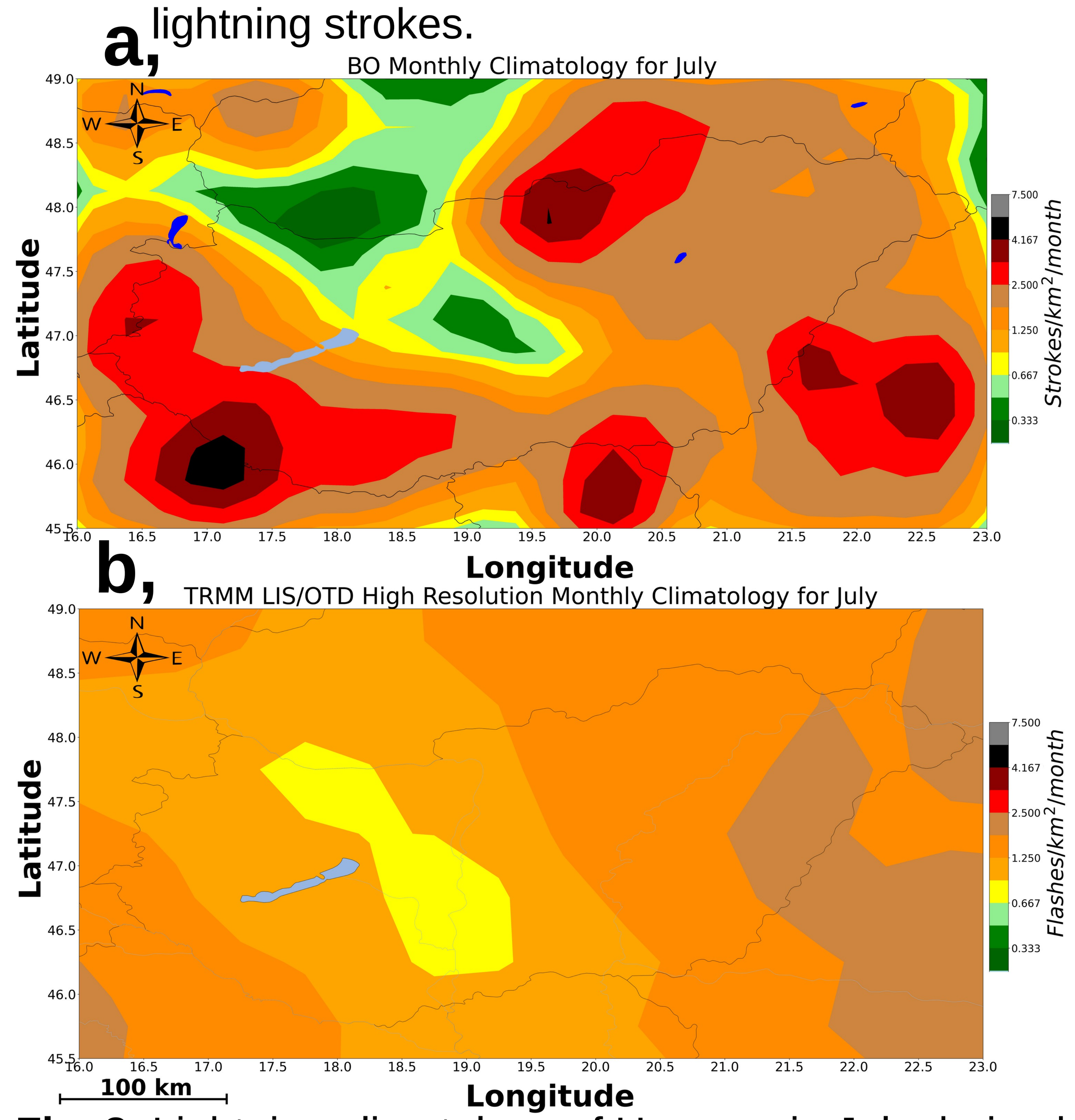

Fig. 3. Lightning climatology of Hungary in July derived from the BO (**a,**) and the OTD (**b,**) data. The BO data were smoothed with a Gaussian kernel. No smoothing was applied on the OTD data.

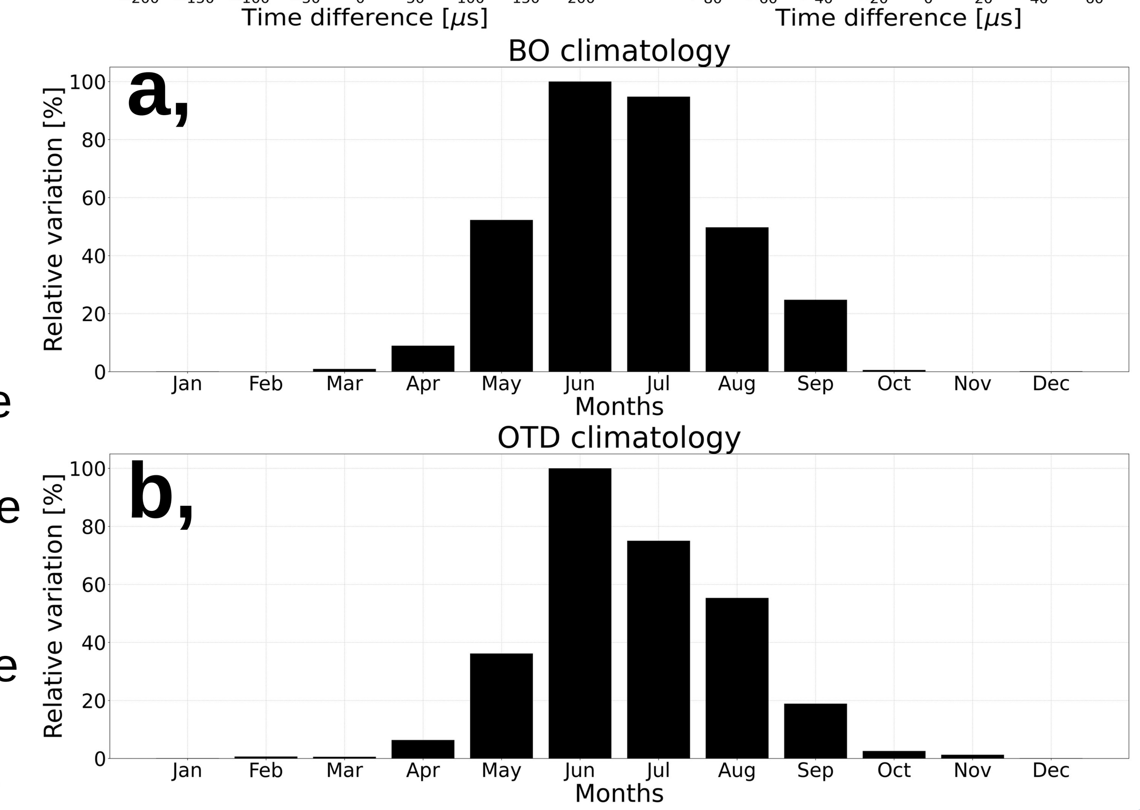

Fig. 4. Seasonal variation of the lightning activity over the investigated region as reflected by the BO **(a)** and OTD **(b)** data.

(4) Conclusions

- The **mean position and time accuracy** of BO was 5.73 km, 5.73 µs and 4.78 km, 8.56 µs as compared to LINET and WWLLN, respectively.
- LINET **detects** about an order of magnitude **more lightning strokes** than BO and BO detects about twice as many as WWLLN.
- The spatial pattern of the July **lightning climatology over Hungary** is similar in the case of the BO and OTD data, however, BO has higher temporal resolution.
- The average number and the standard deviation of the number of lightning strokes in a given cell were 24670±6476, 21292±6626, 21173±4848, and 23901±7415 over cells with class of **hill, mountain, plane, and water**, respectively, in the years of 2015, 2016, 2017, 2018, and 2022. No significant dependence on the terrain type but perhaps more lightning strokes were detected over hilly areas.
- The **seasonal variation** of the lightning activity has its **maximum in June** based on both the BO and the OTD datasets.

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