Applicability Analysis of Automatic Precipitation Gauge Network Using GPM IMERG

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Introduction

eDWIN is an **extensive network** of automatic weather stations developed as part of a project led by **Agricultural Advisory Centers** across **Poland**. This large network of rain gauges and other sensors offers the potential for more precise analysis of weather phenomena, particularly **precipitation**. The more extensive the network, the better it can capture the localized nature of precipitation events, making it easier to accurately study their characteristics.

This poster is based on a thesis written under the supervision and with resources provided by ICM UW [3]. The thesis includes an analysis conducted not only on GPM IMERG data but also on **POLRAD radar** network **precipitation data**, offering a more comprehensive examination of precipitation patterns. The full thesis is available via the QR code in the bottom right corner.

Aim

Evaluating the quality of data from a eDWIN network to check in what extent it can be used beyond agricultural applications.

Conclusion

The primary finding of the study is that **using eDWIN stations in colder months is not advisable**. Numerous statistics indicate inferior performance, especially in December and to a lesser extent in April. Additionally, the research highlights **regional variations** in performance, pointing to characteristic biases in local subnetworks of the eDWIN network.

Method

The study investigates the performance of the eDWIN agricultural weather station network by **comparing it** to the **well-established synoptic station network** of the Polish Institute of Meteorology and Water Management (**IMGW**-PIB). The analysis evaluates the accuracy of each station's measurements against **GPM IMERG** satellite precipitation product, focusing on both **daily and monthly** precipitation **accumulations**. The comparison focuses on statistical metrics—correlation, POD (Probability of Detection), NME (Normalized Mean Error), and NMAE (Normalized Mean Absolute Error)—to evaluate the reliability of each network. The metrics were **normalized by** the **average monthly precipitation** in Poland. The analysis covers December 2021, April 2022, and July 2022, with December 2021 data limited to the second and third weeks due to poor GPM IMERG quality.

eDWIN Network

- Nearly **500 stations** during the study period.
- **Non-uniform** network **characteristics.**
- Includes **solar-powered** stations, which increases the likelihood of **malfunction**.
- **Rare inspections** and **calibrations** of stations.

IMGW Network

- **63** synoptic **stations**.
- Long history of using **standardized** observational **methods**.
- **Potential errors correction** by trained meteorologist
- The locations of each station are carefully selected.
- The measuring instruments are kept in secure, fenced **meteorological enclosures**.

Results

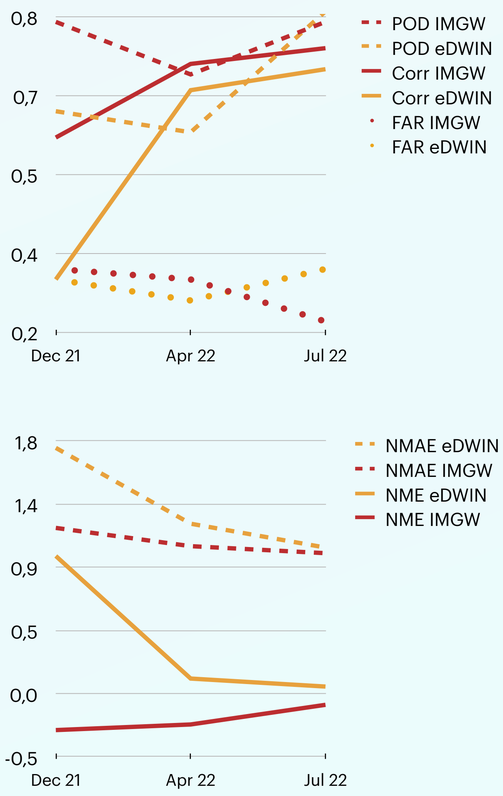

Fig. 1: Comparison of correlation POD, FAR, NME and NMAE between eDWIN and IMGW in each month.

eDWIN's **performance** against IMGW **varies by month**. This can be easily seen in Figure 1. In **December**, eDWIN performs worse than IMGW. The similar FAR but lower POD suggests **detection issues**. By **April**, eDWIN's **performance improves**, with closer correlation and NMAE to IMGW, but still shows differences. In **July**, eDWIN's **performance** nearly **matches** IMGW, with similar correlation, POD, and FAR, and a smaller NME gap, indicating better accuracy but **slightly higher** estimates on average. Overall, these findings suggest a need for targeted **bias** correction and further investigation into station characteristics affecting eDWIN's performance, particularly in colder months. Research comparing GPM IMERG with an extensive gauge network over **China** found **similar correlation** values, slightly better than eDWIN but worse than IMGW for the corresponding month [1]. This reflects the known **limitations of GPM IMERG in mountainous areas** [2].

The ratios of the numbers of stations in **correlation range groups**, presented in Figure 2, exhibit **similar trends** to IMGW synoptic stations in the analogous analysis, yet they differ in some aspects. In **July**, IMGW synoptic stations continue to slightly outperform eDWIN, with a larger proportion of stations falling within the top-performing correlation range. In **December**, eDWIN stations have a share twice as large in the lowest correlation range compared to IMGW, indicating that eDWIN stations face **challenges during** the **winter** months.

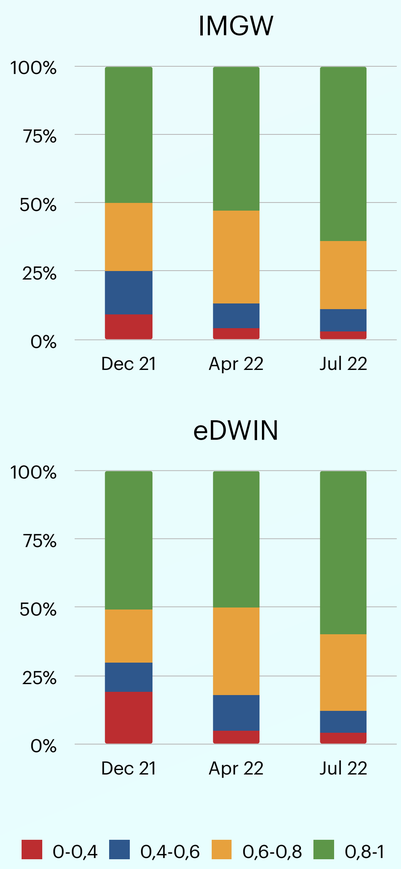

Fig. 2: Percentage of number of stations in each correlation range for eDWIN and IMGW in comparison with GPM IMERG.

Figure 3 illustrates how eDWIN's stations vary from the ideal line of perfect agreement, with color distinctions used to highlight subnetwork-related dependencies. The plot reveals distinct **groupings** of subnetworks. In **July and April**, a **linear relationship** is observed, whereas **December** shows a concentration of data points, with other **points more dispersed**, indicating a more varied relationship. This variability reflects the **different characteristics of measurements** depending on the eDWIN subnetwork, which may be influenced by factors such as **varying measurement tools**, **maintenance protocols**, or concentration in specific **locations**. Probably due to malfunctions some stations, particularly those within the IUNG subnetwork, show minimal measurements, despite what is indicated by GPM IMERG data.

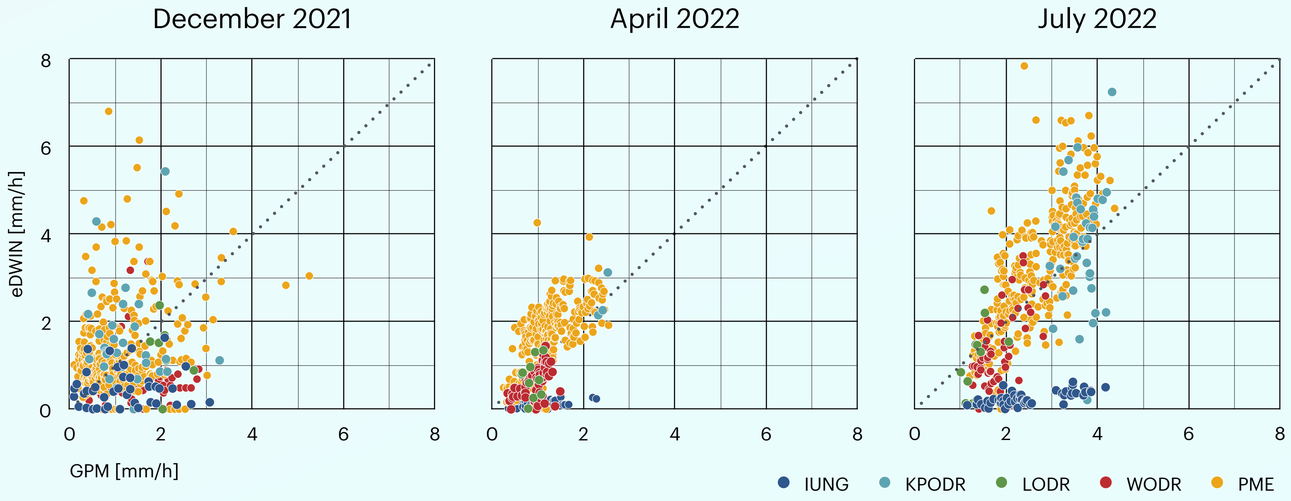

Fig. 3: Agreement plot for GPM IMERG, showing monthly accumulation with distinct colors for different local centers. The dotted line represents perfect agreement. The data is averaged by the number of days in each month.

Scan me!

References:

[1] Ning, Shaowei et al. (2016). "Assessment of the Latest GPM-Era High-Resolution Satellite Precipitation Products by Comparison with Observation Gauge Data over the Chinese Mainland". In: Water 8.11, p. 481. doi: 10.3390/w8110481.

[2]Pan, Xinshun et al. (2023). "Evaluation and Applicability Analysis of GPM Satellite Precipita- tion over Mainland China". In: Remote Sensing 15.11, p. 2866. doi: 10.3390/rs15112866.

[3] Zbytniewski, Antoni (2024). "Evaluation and Applicability Analysis of Automatic Precipitation Gauge Network Using GPM IMERG and Radar Data". Masters thesis. University of Warsaw