Comparative evaluation of H SAF, ERA5-Land, and IMERG precipitation products for dry-spell climatology in Poland

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Introduction

Reliable detection of low-precipitation spells is essential for drought monitoring, agricultural risk assessment, and water management. However, satellite and reanalysis precipitation products are still most commonly evaluated against rainfall totals, biases, correlations, or wet-day occurrence, while their ability to reproduce consecutive periods with little or no effective precipitation remains less frequently assessed. A product may reproduce monthly or seasonal precipitation totals reasonably well, but still misrepresent the number, duration, or timing of low-precipitation spells. Such discrepancies may limit the usefulness of precipitation products in drought-related applications, especially where the persistence of dry conditions is more important than total rainfall alone. This is evident in the context of soil moisture dynamics, plant water stress and agricultural applications, among others.

Here, we assess four precipitation products: H SAF H61, H SAF H64, ERA5-Land, and IMERG Late Run against daily IMGW-PIB meteorological station observations across Poland. Low-precipitation spells are evaluated using four metrics: spell count, maximum length, mean length, and median length. In addition, ROC/AUC analysis is applied to assess the ability of each product to discriminate observed low-precipitation days.

Methods

Daily precipitation totals from H SAF H61 and H64, ERA5-Land, and IMERG Late Run were evaluated against IMGW-PIB meteorological station observations across the territory of Poland. Gridded products were matched to station locations using the nearest grid cell. Low-precipitation days were defined as days with precipitation below 5 mm/day. Consecutive low-precipitation days were grouped into spells, and four metrics were calculated: spell count, maximum length, mean length, and median length. Metrics were derived for the full year and for meteorological seasons: spring, summer, autumn, and winter. To capture spatial differences in product performance, stations were assigned to major physiographic regions according to Kondracki's regionalisation: Coastal, Lakelands, Lowlands, Uplands, Subcarpathia, Sudetes, and Carpathians. The performance of the product was evaluated at the national, seasonal, and regional levels. Distribution-based comparisons of spell metrics were combined with Receiver Operating Characteristic (ROC) analysis. In the ROC analysis, observed low-precipitation days from station data were used as the reference class, while continuous product precipitation values were used as predictors. The Area Under the Curve (AUC) was used as a threshold-independent measure of each product's ability to discriminate low-precipitation days.

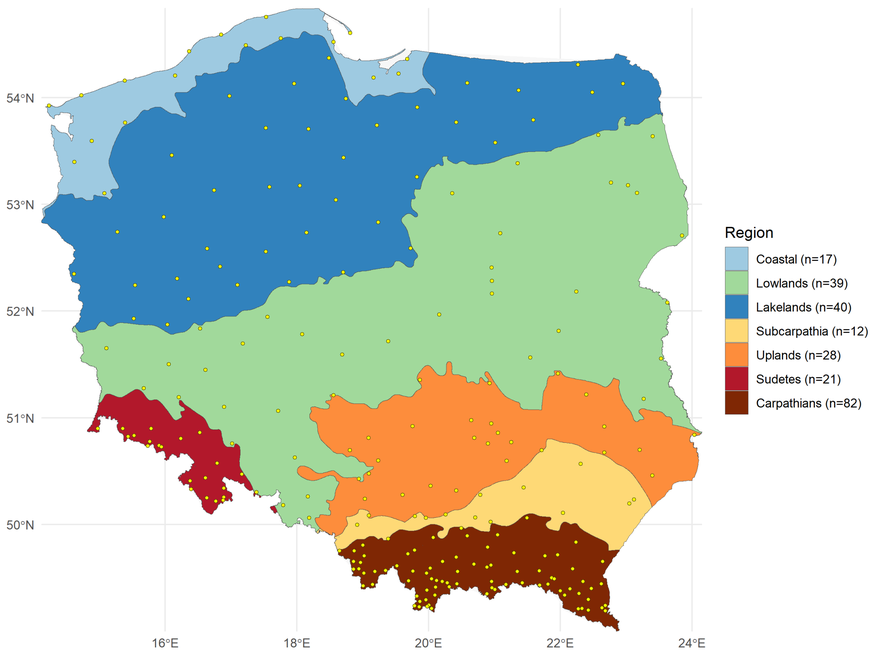

Fig. 1. Meteorological stations across Kondracki regions

Results

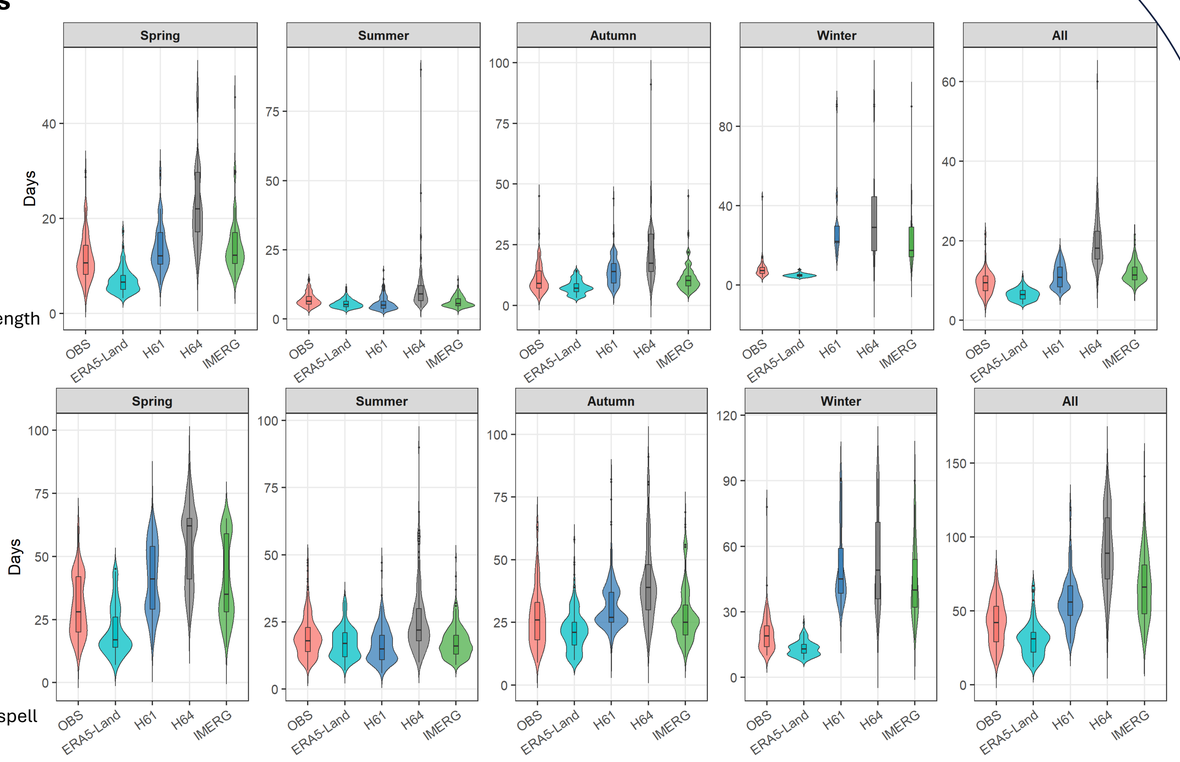

Fig. 2. Dry-spell mean length

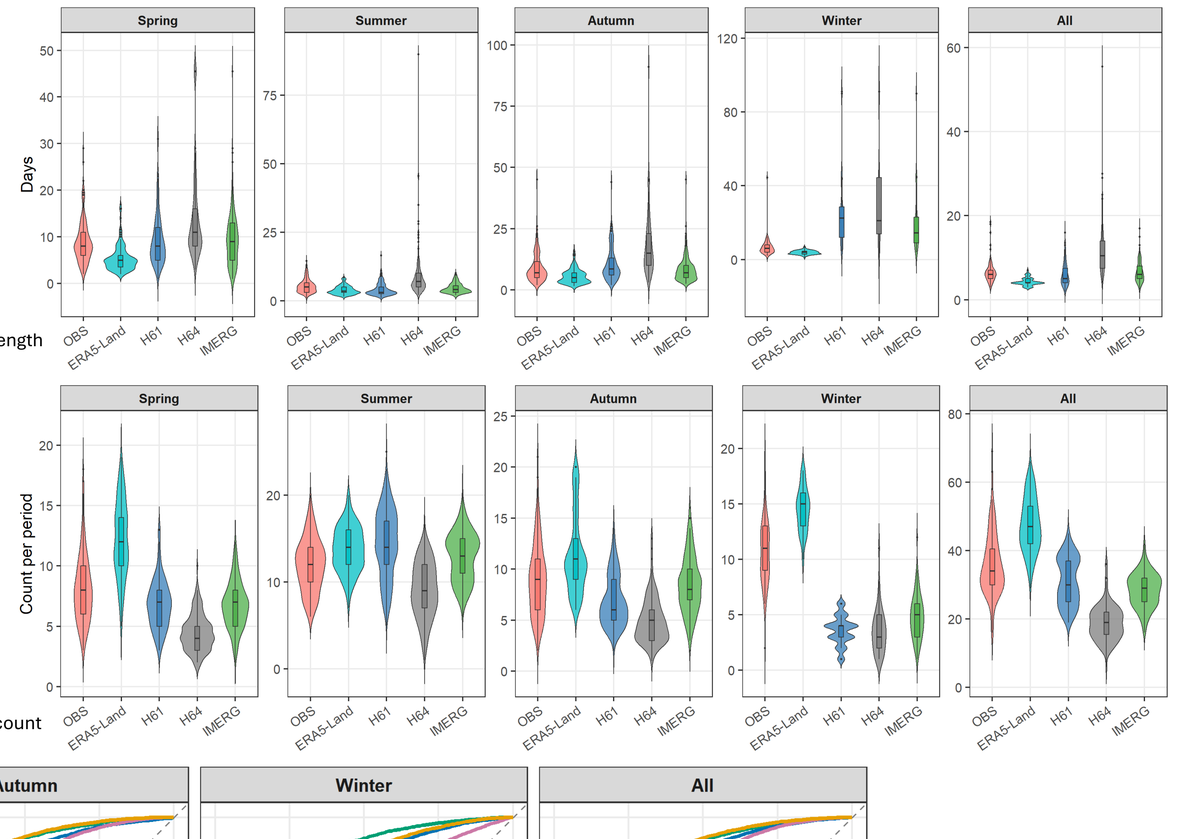

Fig. 3. Maximum length of dry-spell

Fig. 4.Dry-spell median length

Fig. 5. Dry-spell count

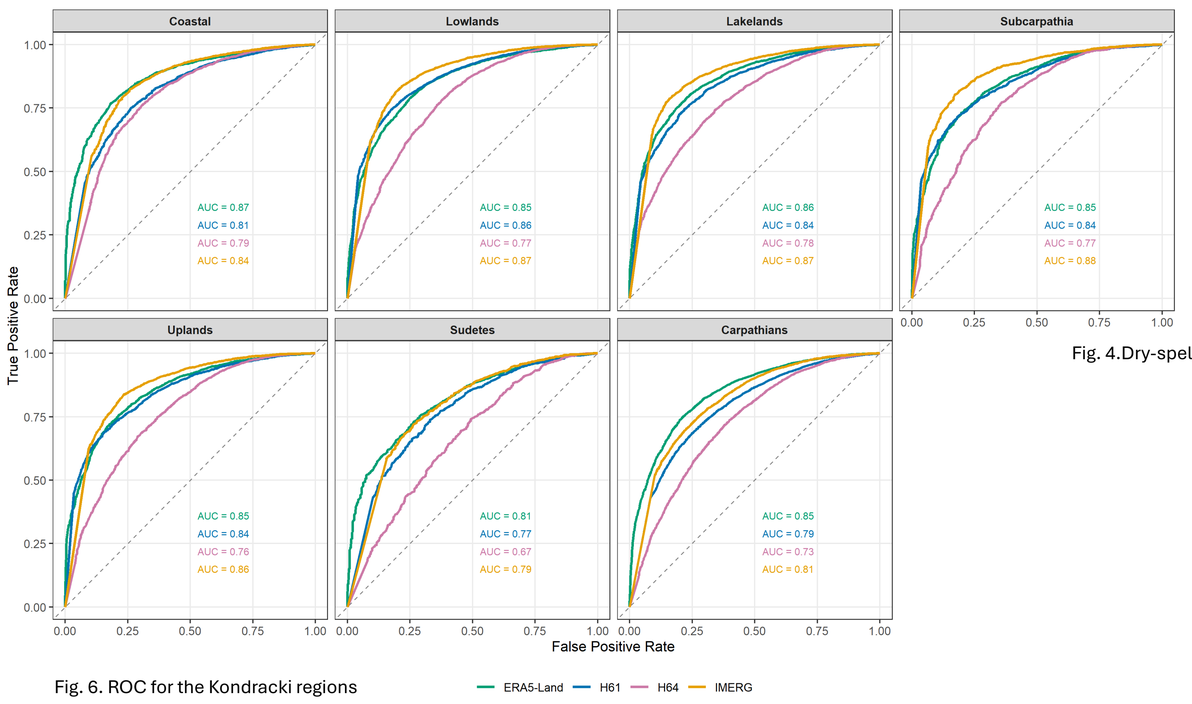

Fig. 6. ROC for the Kondracki regions

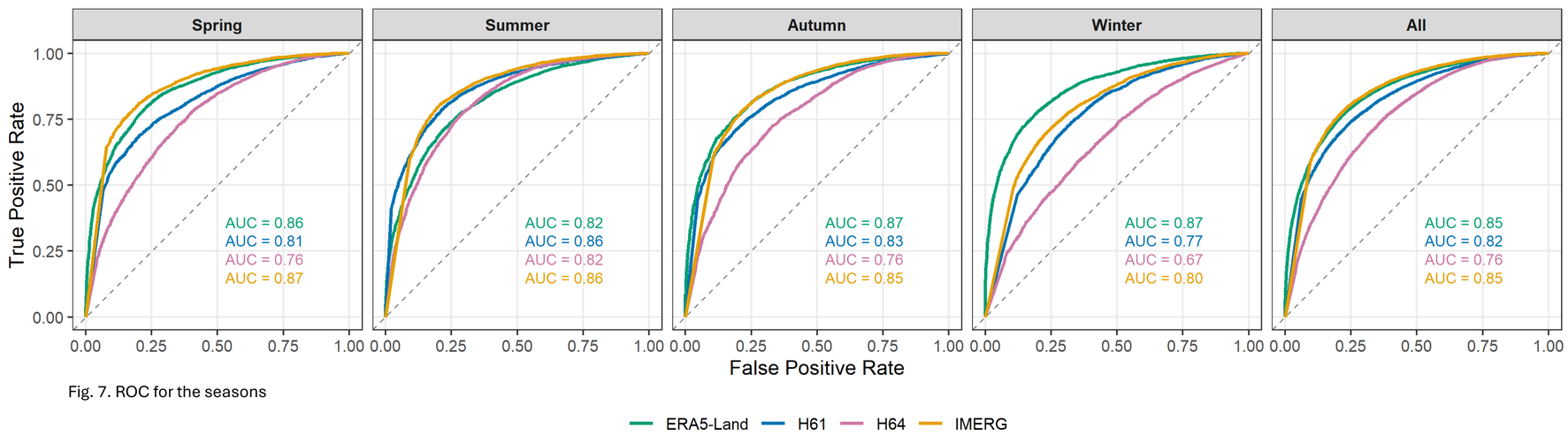

Fig. 7. ROC for the seasons

Conclusions

- The evaluated precipitation products differed substantially in their ability to reproduce low-precipitation spell characteristics in Poland.
- ERA5-Land and IMERG Late Run demonstrated the highest overall skill in discriminating low-precipitation days, with country-level AUC values of approximately 0.85.
- The lowest AUC values were observed for H64, especially in winter and in mountain regions, indicating reduced reliability under more complex seasonal and topographic conditions.
- High AUC values did not always translate into accurate reproduction of spell duration, frequency, or persistence.
- ERA5-Land tended to produce more frequent but shorter low-precipitation spells, suggesting possible fragmentation of observed low-precipitation periods.
- H64 often overestimated spell duration and underestimated spell count, indicating a tendency to produce overly persistent low-precipitation sequences.
- H61 and IMERG generally showed more balanced spell-length characteristics, although their performance varied across seasons and regions.
- Regional analysis based on Kondracki physiographic regions revealed spatially variable product performance, with lower and more variable skill in mountainous regions.
- For dry-spell climatology, product-specific biases in spell count and duration should be considered before applying gridded precipitation products in drought monitoring, agriculture, or water management applications.