# Why we should measure net precipitation in grassland at multiple locations?

## Do grasslands canopies create less spatial heterogeneity in net precipitation than a forest?

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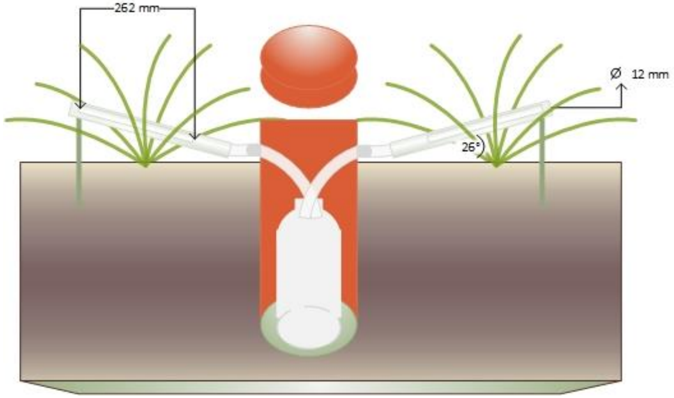


- Vegetation characteristics strongly influence the interception as well as the redistribution of precipitation.
- Net precipitation patterns are important to understand hydrologic fluxes, and more commonly studied in forests.
- Grasslands are generally assumed to evapotranspire less than forests because of their shallower root structure and smaller leaf area, although some studies also indicate the opposite.
- A small canopy structure complicates net precipitation measurement in grassland, and it generally assumed that grassland is not a source of heterogeneity in precipitation patterns. Yet, there is a lack of experimental studies.
- Here we proposed a new way to measure throughfall in grassland.

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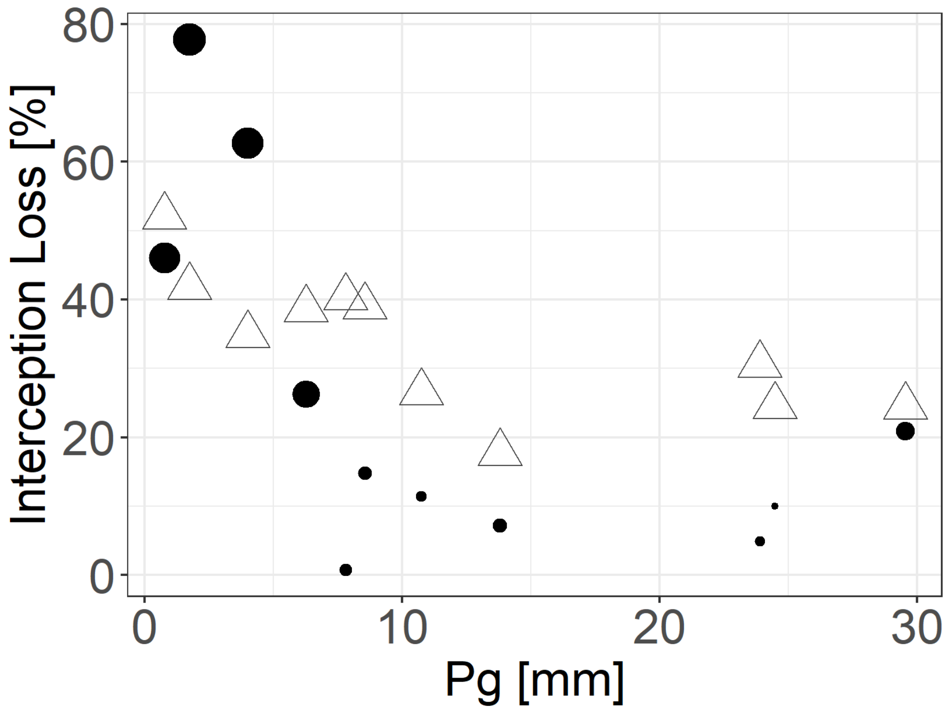
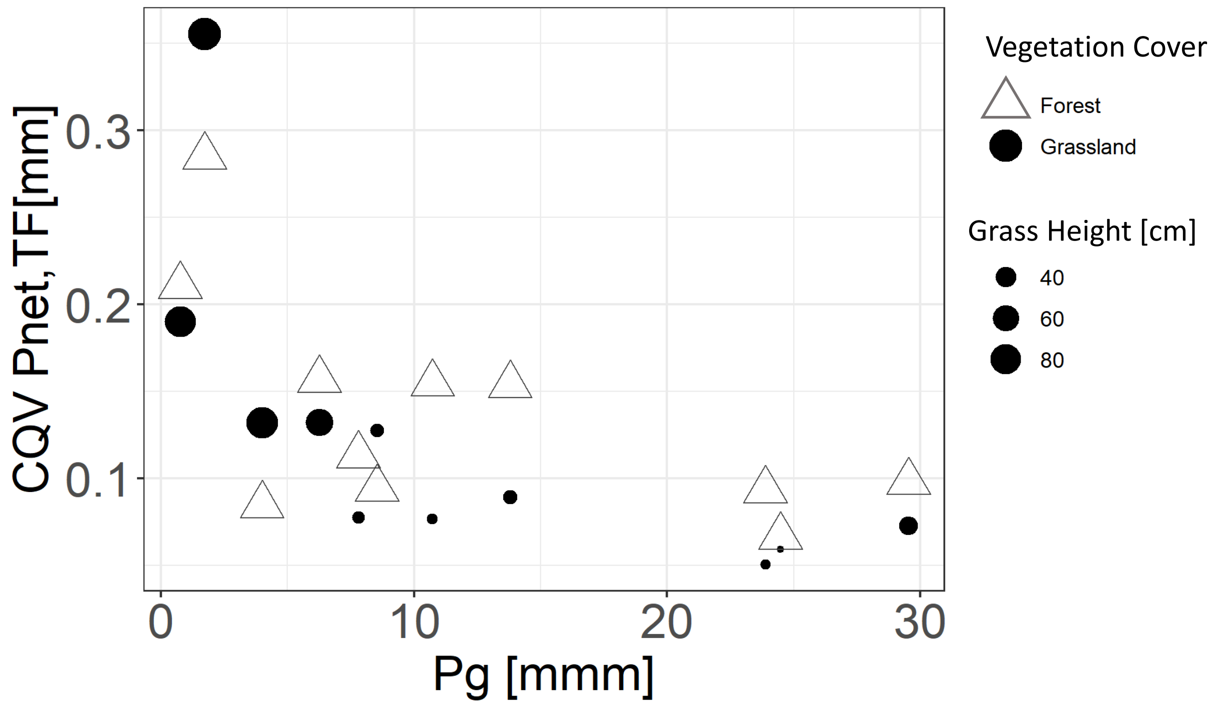
We conducted throughfall (TF) measurements in adjacent forest and grassland in 2019 for 22 weeks. Preliminary data shows that the grassland exhibited a similar level of interception loss [%] in the forest. Surprisingly, for weeks with gross precipitation (Pg) higher than 5 mm, the spatial variation of the throughfall in both vegetation cover was similar in magnitude. The coefficient of variation (CQV) of throughfall in the forest varied between 0.06 and 0.16, and in grassland between 0.05 and 0.14. Both interception and spatial variation in throughfall decreased, with increasing gross precipitation in both vegetations. An overall taller grass cover (later in the growing season) increased interception and enhanced its spatial variation in the grassland.




Here we ask: **Is the strong spatial variation in grassland real or is it related to measurement errors, specifically splash loss from the interception grid?**

**The research site** is located in Hainich CZE (central Germany ), which consists of an adjacent forest (1 ha) and grassland (0.047 ha).

**Measurement Design**

- Gross precipitation measurements were conducted above the canopy (ca. 1.5 meters) in the grassland

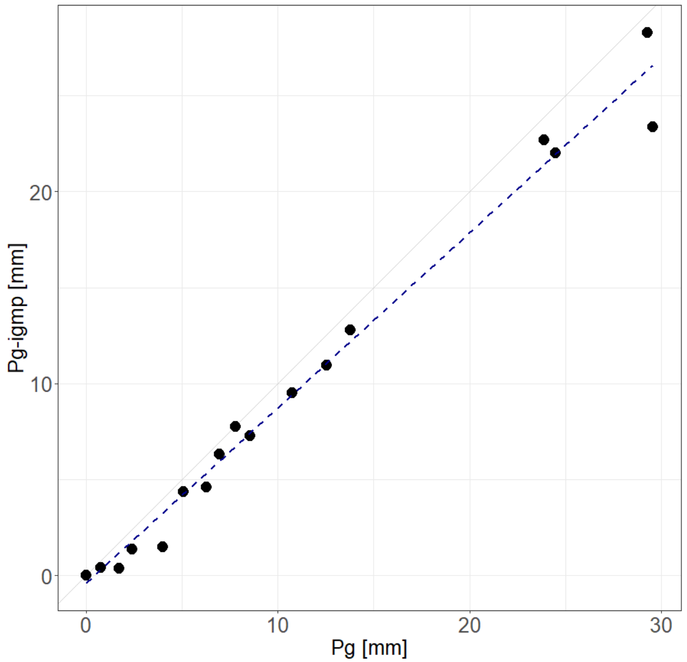
- Throughfall measurements in the grassland were done at 25 locations with interception grids based on a nested triangular random design in 2019 (March- August) and in 2020 (January- February). The spatial extent of each grid is around 1 m.

- Throughfall samplers were located in the forest at 25 locations (kernel points ) as a part of a stratified randomly distributed design in 2019 (March- August). These samplers are additionally equipped with transect points (0.1, 0.5, 1 m distance).

- The Time interval of the sampling was one week and, measurements were collected on dry days.

We used meteorological station (in Hainich CZE) data to understand event properties such as rain intensity, wind speed and event duration. We assumed that splash loss was related to the total kinetic energy. We therefore, the cumulative weekly rainfall events is calculated by using its functional relationship between rain intensity (Salles et al., 2002).

**In order to investigate potential sources of measurement errors for the interception grids, we focusses the analysis on periods without vegetation cover (late fall to spring and after mowing).**




For 2019, 9 of the total 22 measurement weeks, the grass was short and left the grids uncovered. This data suggests that the grids captured well up to 30 mm precipitation per week.

However, stronger precipitation was underestimated. To tackle this problem we continued to measurements in early 2020. With the increased data set for the uncovered period, we used the linear mixed effect model to understand possible reasons behind the underestimation.

## Statistical Analysis: Linear Mixed Effect Model for Uncovered Period

We used two random effects to count the nature of the repeated measurement in this particular design. The random effects played a great role in the model, in the final model suggests that the influence of the mean wind speed varies among measurement locations.

**Final Model:** Pg_igmp ~ Pg_mean +KE +ED + MaxW + ED:KE + (1+MeanWD | igmp_ID)+(1 | Record_Date)

| | | p- value |
|---|---|---|
| **Fixed effects** | Gross precipitation ($P_{g-mean}$) | < 0.001 |
| | Kinetic energy (KE) | <0.001 |
| | Event duration (ED) | <0.01 |
| | Maximum wind speed (MaxW) | 0.16 |
| | Mean wind speed (MeanW) | |
| | | |
| **Random effects** | Interception grid Id (igmp_ID) | <0.001 |
| | Measurement date (Record_Date) | <0.001 |

**$R^2$ = 0.92 for the full model**

# Results & Outlook

- As expected weekly cumulative precipitation ($P_g$ ) and kinetic energy of the rainfall (KE) are the most significant predictors. However, the difference between gross precipitation measurements ($Pg_{mean}$- $Pg_{-igmp-mean}$) showed better correlation with the mean wind speed (R = 0.71) than kinetic energy ($R_{KE}$ = 0.49).

- The kinetic energy (KE) is likely related to splash, which will be investigated next in the laboratory conditions.

- The wind speed effect might be related to the difference in susceptibility to undercatch between the two collector types in windy conditions. We expect this effect to be less important when grass cover is present.

- In the long term, by these measurements, we aim to understand the influence of vegetation-induced water input on percolation at the plot scale with the help of intensive field observations. Observing the variation in net precipitation patterns in the grassland can improve our understanding of sub-surface hydrological fluxes.

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