Risk Analytics - Practical 2

Winter semester 2024-2025, HEC, UNIL

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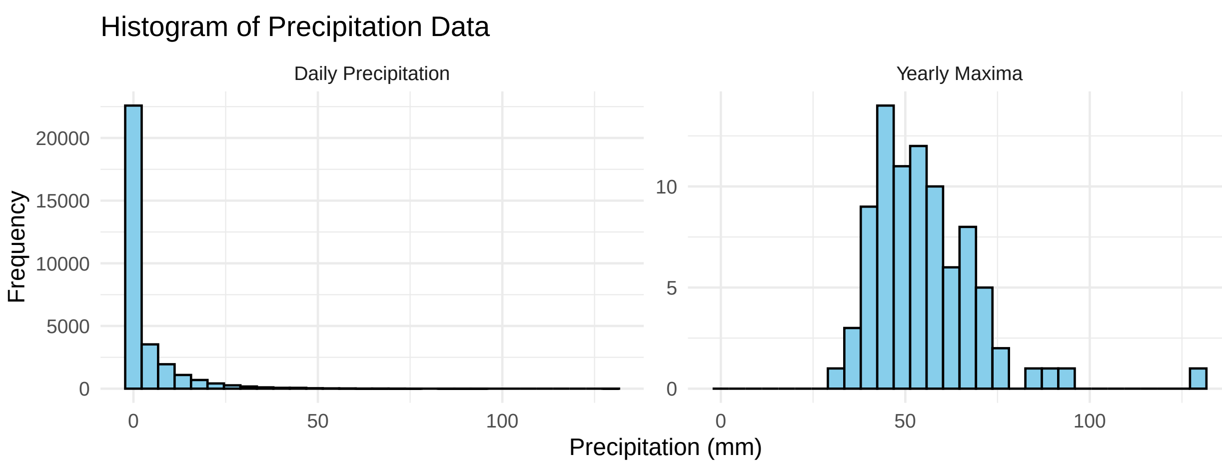
2024-11-25

Part 1: Block maxima approach

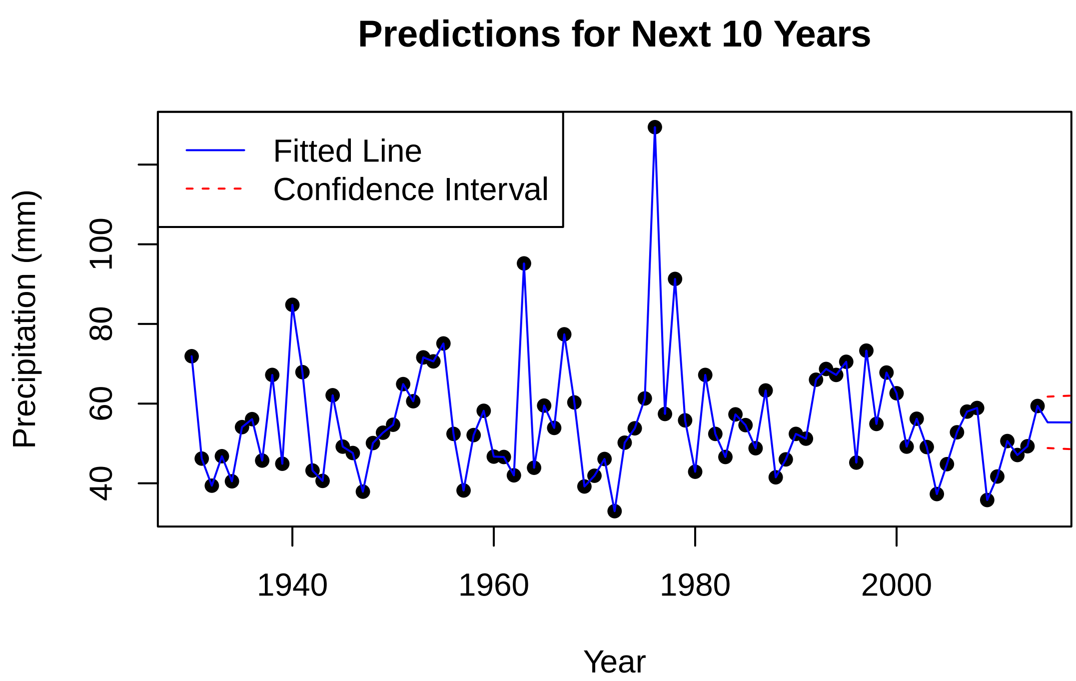
a) Read in the data and plot daily precipitation historgram & b) Extract yearly maxima and plot histogram



The majority of daily precipitation values are below 10 mm. Extreme precipitation values above 40 mm are rare but present. A Generalized Extreme Value (GEV) distribution may be suitable for the extremes, while a Gamma distribution better fits overall data.

The yearly maxima are right-skewed, with extreme values reaching above 120 mm. This suggests GEV modeling is appropriate for analyzing these extremes.

c) Fit a linear model to yearly maxima and predict next 10 years



The linear model suggests a steady increase in yearly maximum precipitation. This method sees oversimplify the complexities of extreme precipitation patterns.

d) Fit GEV models and compare AIC/BIC

```
## AIC (Constant Parameters): 672.9433
```

```
## AIC (Time-Varying Location): 674.8906
```

```
## BIC (Constant Parameters): 680.2712
```

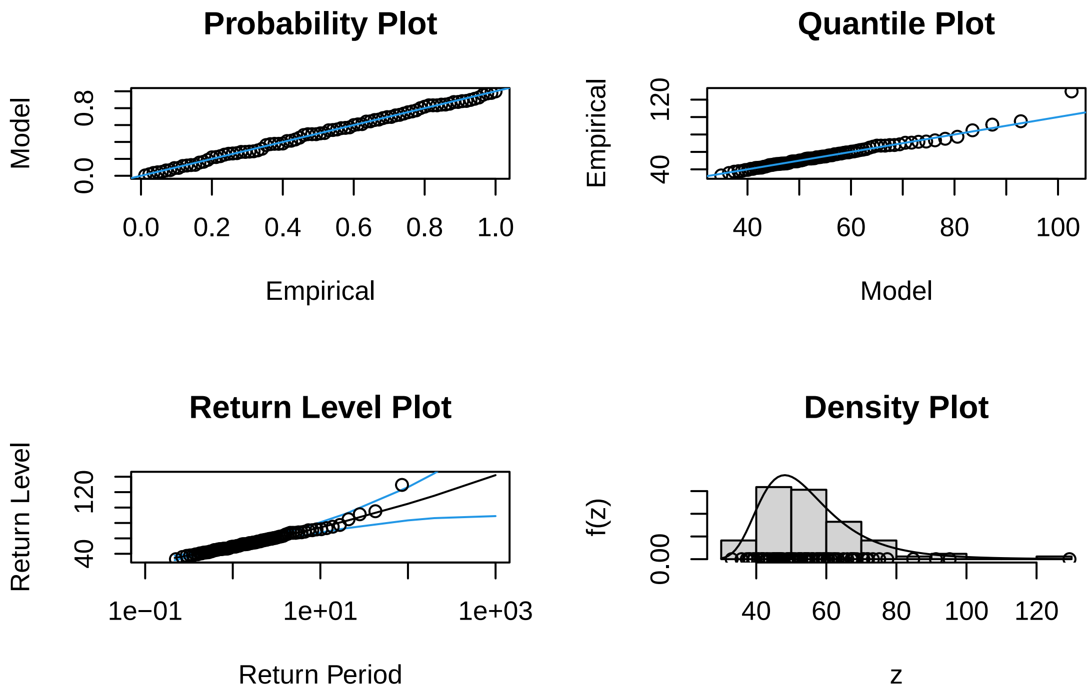
```
## BIC (Time-Varying Location): 684.6612
```

The constant GEV model has slightly lower AIC and BIC values, indicating better fit compared to the time-varying model. Therefore, the constant model is recommended.

e) Diagnostic plots of GEV fit

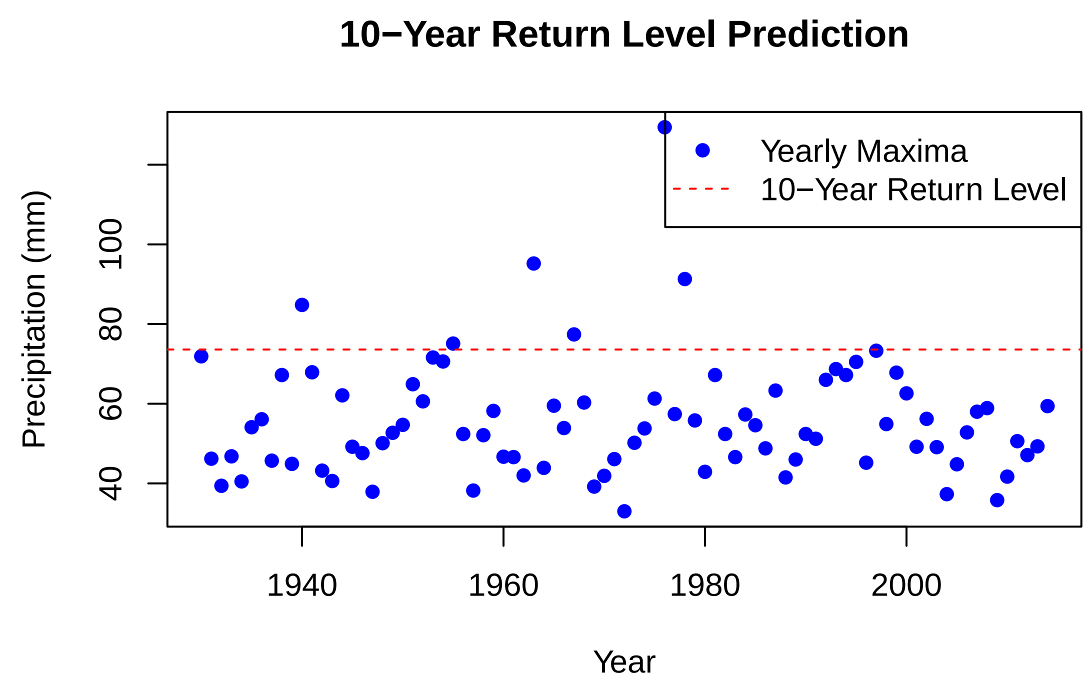
```
## $conv
## [1] 0
##
## $nllh
## [1] 333.4716
##
```

```
## $mle
## [1] 48.92521354  9.97227559  0.08329645
##
## $se
## [1] 1.21298615 0.90492022 0.07773763
```



Diagnostic plots suggest the model fits the data well, as evidenced by the quantile and return-level plots. Slight deviations at extremes should be noted, as they may affect predictions.

f) Predict the 10-year return level and plot



The 10-year return level is approximately 73.61 mm. Few historical events exceed this level.

g) Count exceedances for return levels

```
##         10         20         50         85
##   73.60759   82.53069   94.90440  102.45270
```

```
## 10 20 50 85
##  6  4  2  1
```

The historical counts above the 10-, 20-, 50-, and 85-year return levels are 6, 4, 2, and 1 respectively.

h) Return period for 100 mm of precipitation

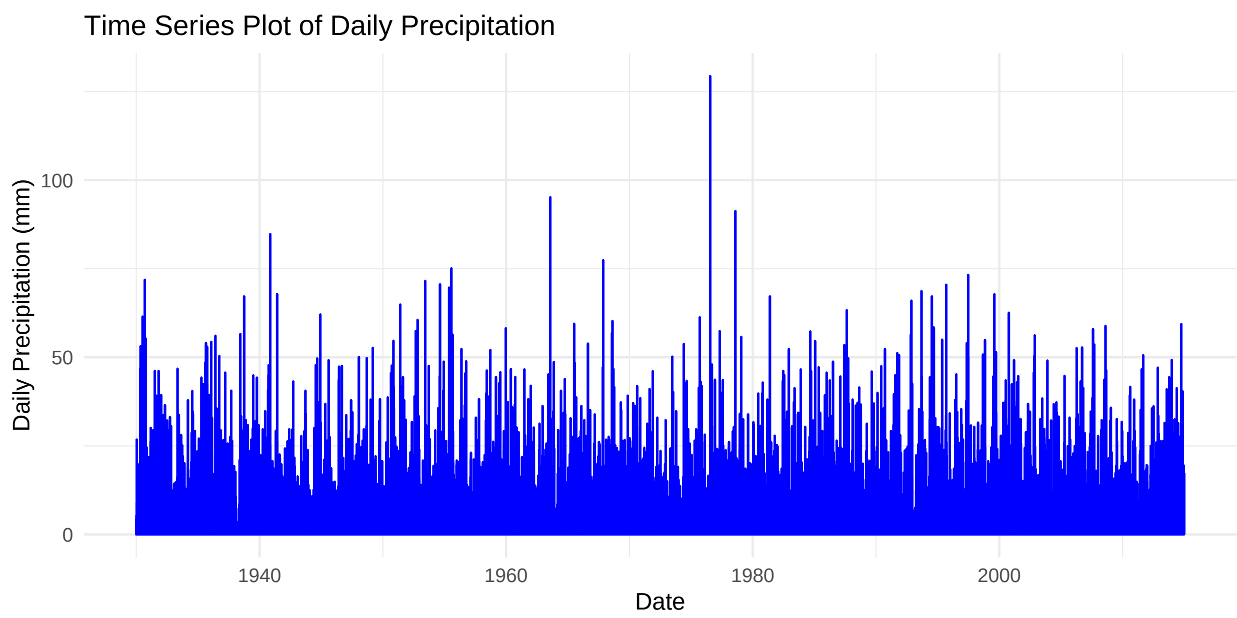
```
## Return period for 100 mm precipitation: 71.70624 years
```

i) Probability of exceeding 150 mm in a given year

```
## Probability of exceeding 150 mm in a day at least once in a year: 0.2094091
```

Part 2: Peaks-Over-Threshold Approach

a) Time series plot of daily precipitation



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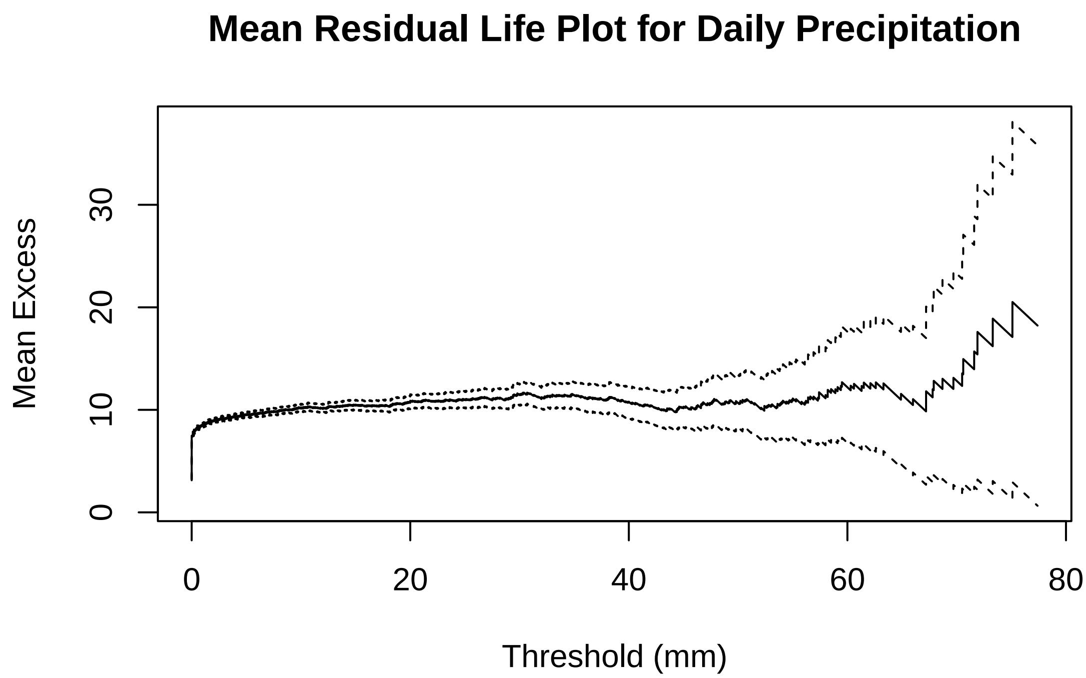
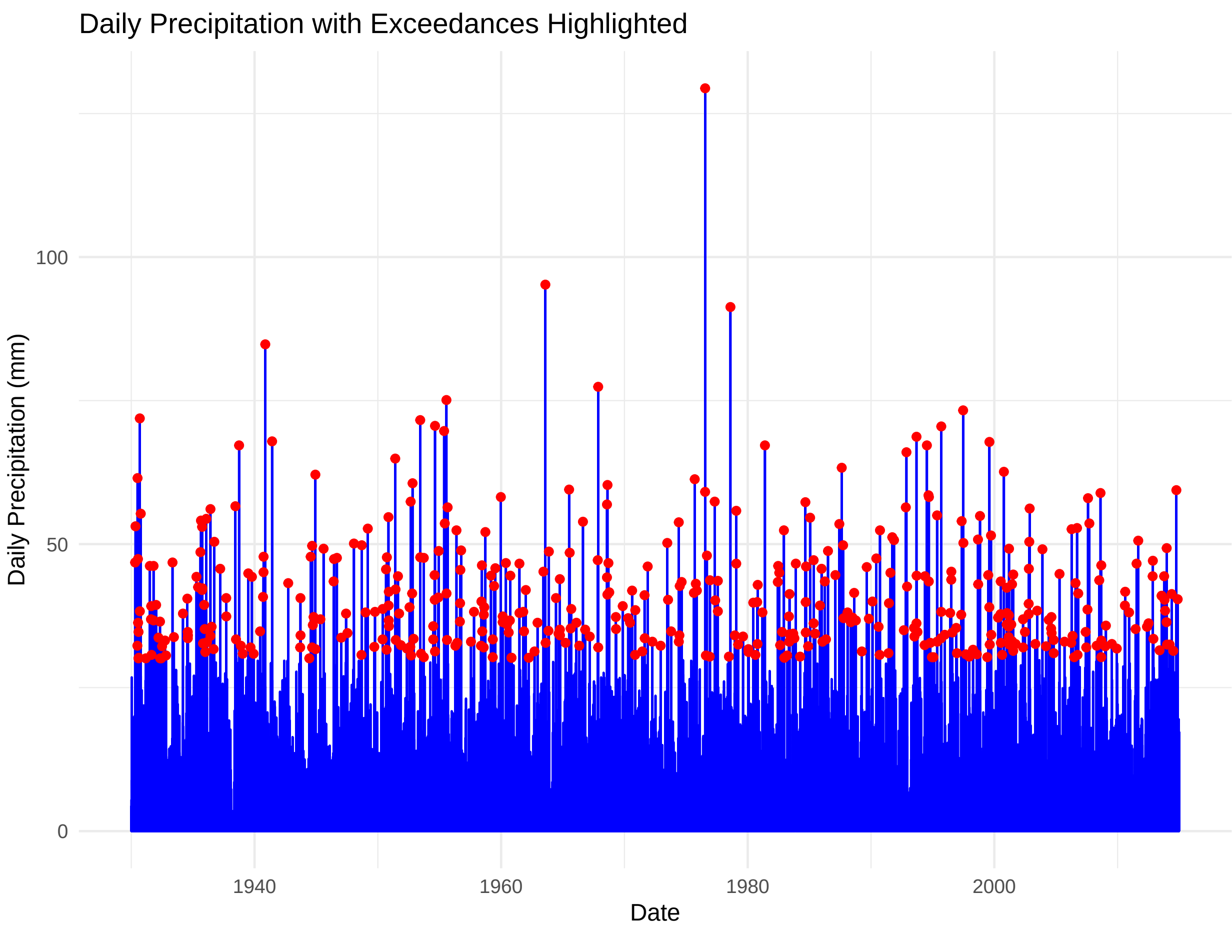
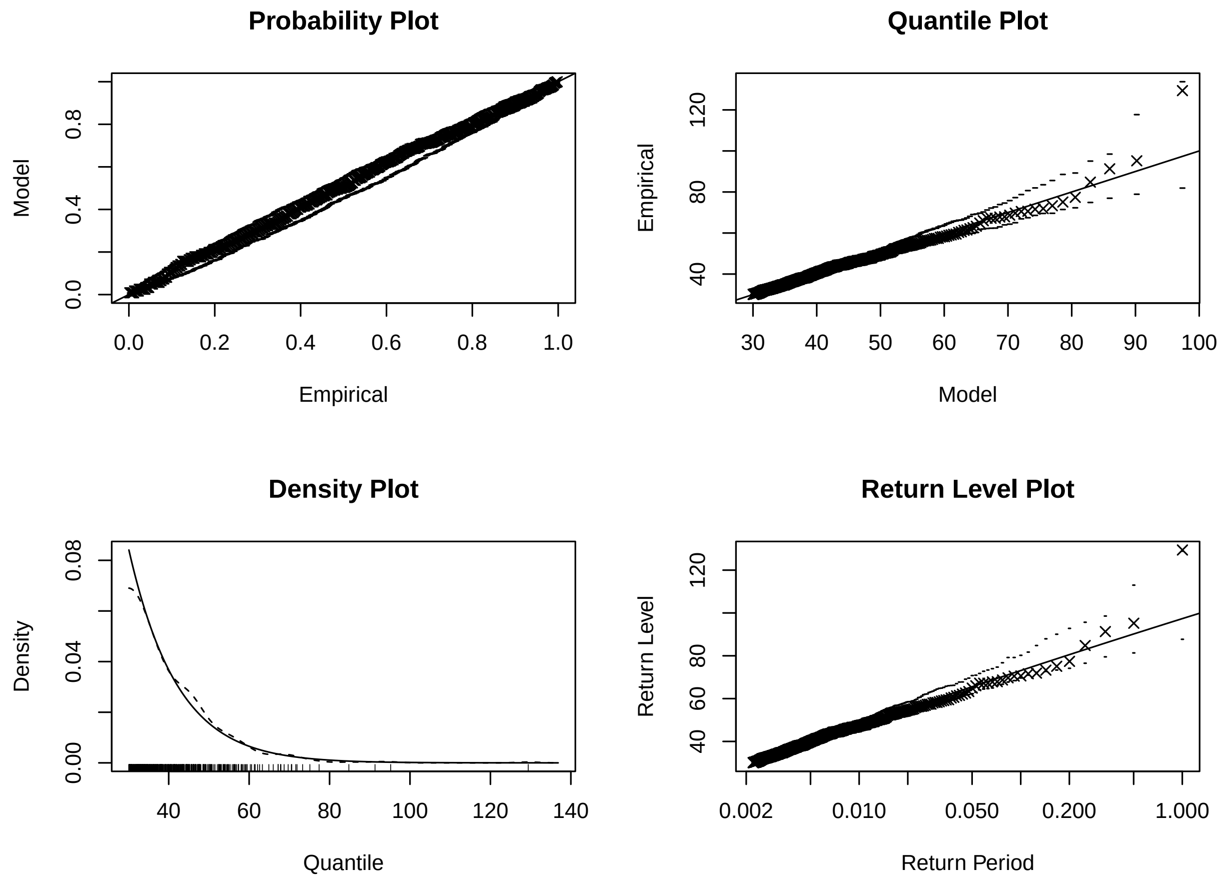
b) Mean Residual Life Plot and Threshold Selection



c) Fit a Generalized Pareto Distribution (GPD) and the data exceeding the threshold





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d) Return Levels for Different Periods

```
## Return levels for specified return periods (in mm):

##       10       20       50       85
## 101.5261 108.5137 117.5826 122.7484
```

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e) Return Period for 100 mm Precipitation

```
## Return period for 100 mm precipitation: 68.38326 years
```

---

f) Probability of Exceeding 150 mm in a Given Year

```
## Probability of exceeding 150 mm at least once in a year: 0.003411695
```

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g) Comparison of POT and Block Maxima Methods

Comparison of POT and Block Maxima Methods

Advantages of POT Approach

- More data points: Uses all exceedances over a threshold, providing more data for analysis and improving parameter estimation.
- Better tail modeling: Focuses on extreme data, making it more effective for modeling the tail of the distribution, which is critical for extreme event analysis.

Drawbacks of POT Approach

- Threshold selection: Requires careful selection of a threshold, which can be subjective and significantly impact model fit.
- Sensitivity: Results can be highly sensitive to the chosen threshold, potentially leading to biased estimates if the threshold is poorly chosen.

Advantages of Block Maxima Method

- Simplicity: Conceptually simple and widely understood, involving the selection of maximum values from defined blocks (e.g., annual maxima).
- Practical focus: Often focuses on annual maxima, which can be of direct practical interest for many risk assessment applications.

Drawbacks of Block Maxima Method

- Data inefficiency: Discards all but the maximum value from each block, leading to a loss of information, especially when more extreme values exist within the block.
- Higher variance: Due to fewer data points, the resulting estimates tend to have larger variance compared to the POT approach.

Preference

The POT method is generally preferred when the objective is to make full use of available extreme data and a good threshold can be selected. However, the Block Maxima method is simpler and often sufficient for practical purposes, especially when clear block segmentation exists (e.g., annual maxima).