Space-time variability of random cascade model parameters for rainfall disaggregation

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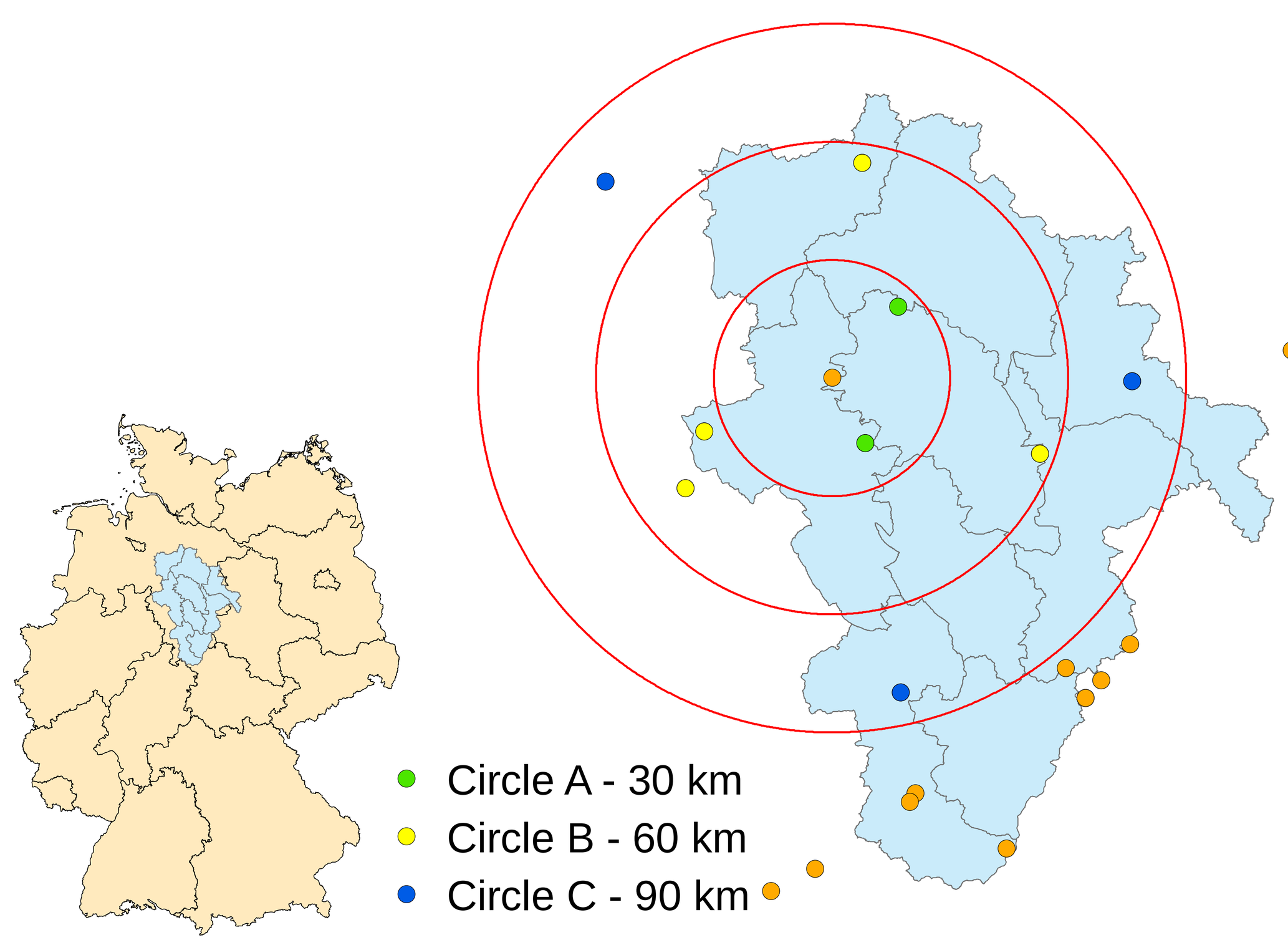
1. Motivation and Aims

- Poor density of recording stations network
- Cascade model (Olsson, 1998) well-known for temporal rainfall disaggregation
- Which time series length and what minimum station distance is sufficient for parameter estimation?

2. Data & Model



- Aller-Leine-catchment (15.744 km²) with 20 recording rain gauges (with time length > 8 years (see Fig. 1))

Fig. 1: Aller-Leine-catchment with recording stations

- Cascade model (Olsson, 1998) (Fig. 2):
  - Multiplicative weights $W_1, W_2 = \{1,0; x,1-x; 0,1\}$ and distribution function F(x) are estimated from aggregating time series of nearby recording stations
  - Separate parameter sets for each combination of position (starting, enclosed, ending, isolated) and volume class (upper and lower, divided by mean)

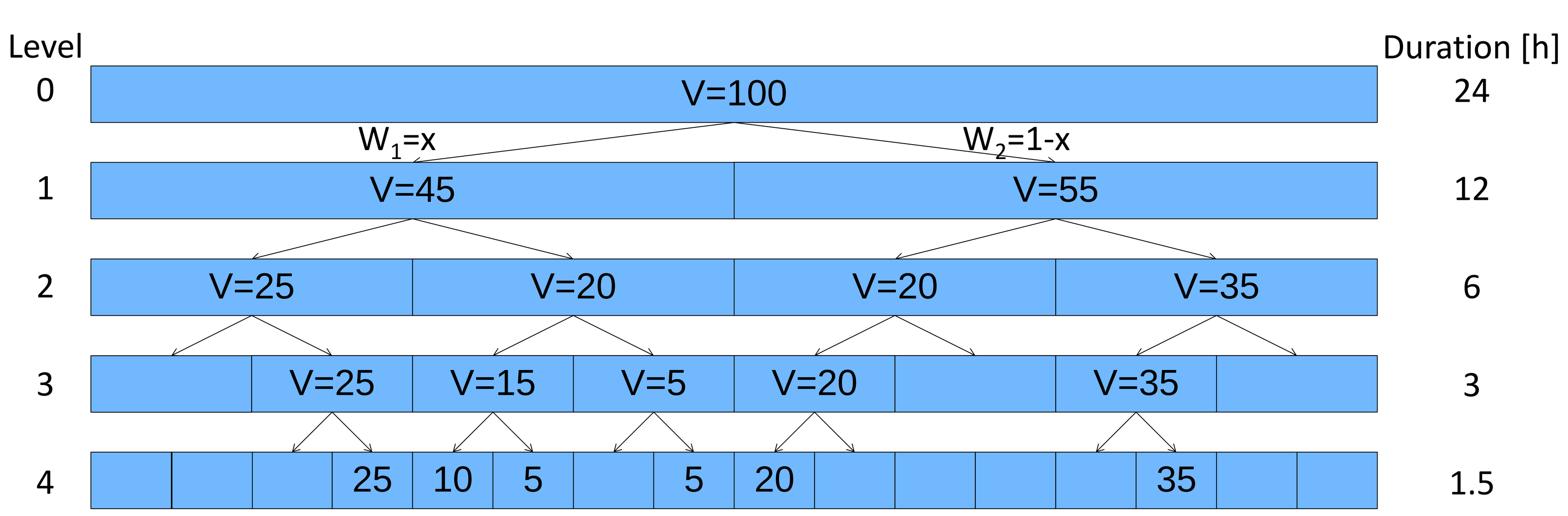


Fig. 2: Cascade schema after Olsson (1998), altered (V is rainfall volume; W_1, W_2 are multiplicative weights)

3. Validation of the model

- Comparing rainfall characteristics on 1 h-level (see Tab. 1)
  - Overestimation of wet spell duration: 1 h (~ 30 %)
  - Overestimation of dry spell duration: 1 h (~ 8 %)
- Deviation is most likely caused by last step of disaggregation, the "diversion" (see Fig. 3)

Tab. 1: Rainfall characteristics of observed and disaggregated (10x) time series

	Time series length [yr]	Fraction of wet hours [%]		Average wsd [h]		Average wsa [mm]		Average dsd [h]	
		Original	Disagg.	Original	Disagg.	Original	Disagg.	Original	Disagg.
3984	17.8	17.8	19.3	3.7	4.6	3.3	3.6	16.3	17.2
3400	17.7	11.6	12.7	2.7	3.6	2	2.2	19.7	21.8
3189	17.7	15.3	18.0	3.3	4.4	3.1	3.5	18.3	19.8

0.75 h	0	0	0	0	0	6	0	6	0	0	0	0

0.25 h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0

1 h	0	0	0	2	4	6	0	0	0

Fig. 3: Diversion as a cause for deviations in wsd and number of wet hours

4. Variability and sensitivity in space and time

Temporal variability

- Parameters are estimated for different 2-, 5-, 8- and 18-year periods of the same time series (see Fig. 4)
  - Parameter vary in time
  - Depend strongly on estimation period

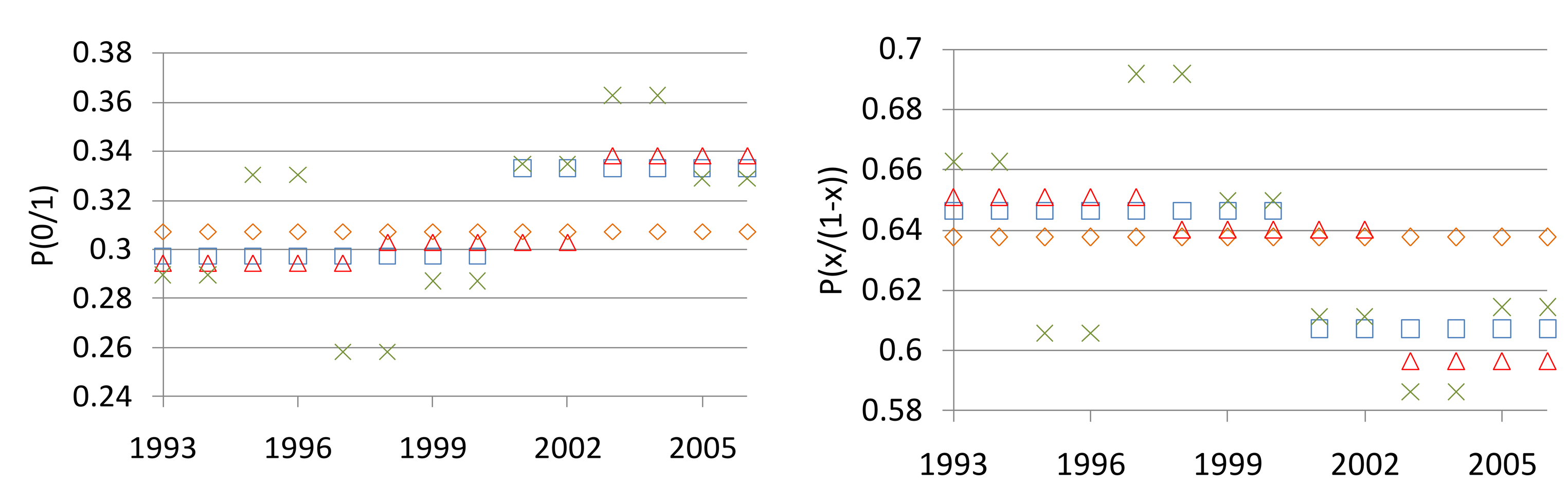


Fig. 4: Probabilities for station 3400 of a starting box-upper volume class (◇ - 18 years (complete time series), □ - 8 years, Δ - 5 years, x – 2 years)

- Influence on rainfall characteristics
  - Decreasing time series length causes increasing of uncertainty (see Fig. 5)

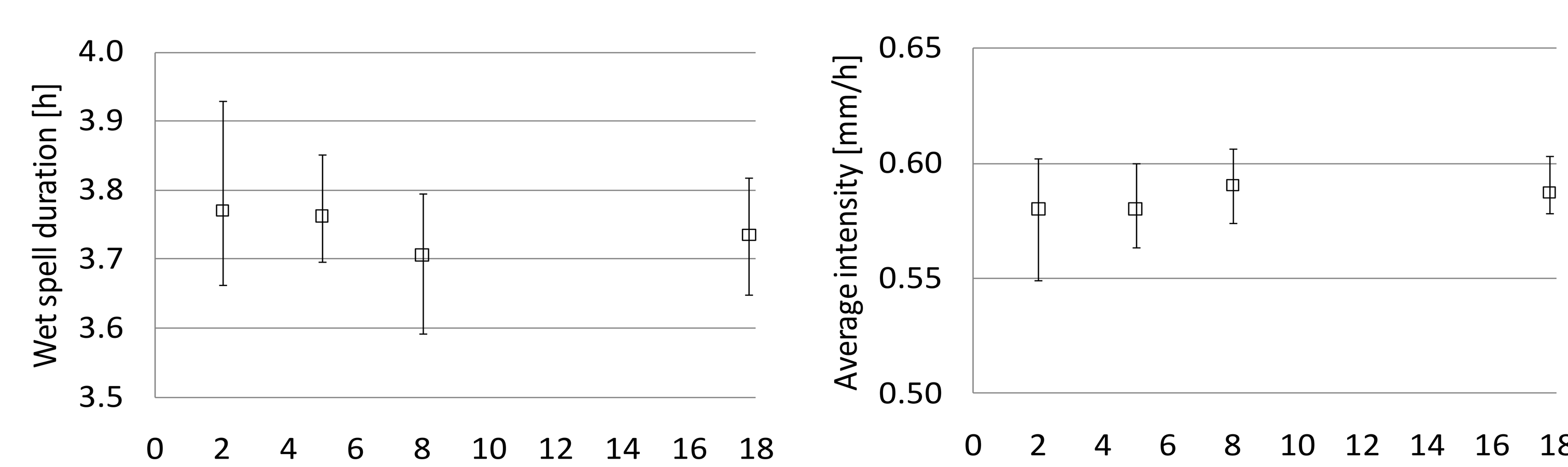


Fig. 5: Rainfall statistics of disaggregated time series (70 disaggregations) depending on time series length for parameter estimation

Spatial variability

- Analyzing the influence using "distance classes"
  - Increasing distance of 30 km to centre-station 54939 (Fig. 1)
  - Increasing distance causes spreading of rainfall characteristics range (see Fig. 6)

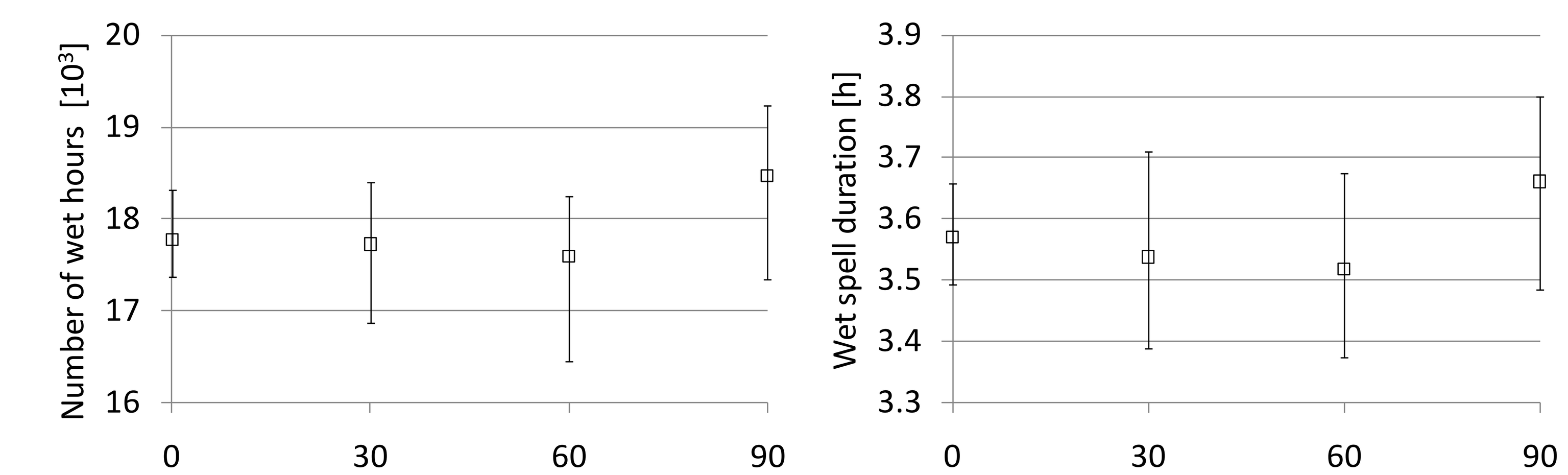


Fig. 6: Rainfall statistics depending on distance class (100 disaggregations)

5. Conclusions

- Parameter vary in time, so time series with a time length > 8 years should be used
- Parameters can be estimated using time series of nearby recording stations (< 30 km)
- Diversion is a bigger problem than parameter consistency

References:

Olsson, J. (1998): Evaluation of a scaling cascade model for temporal rainfall disaggregation, Hydrology & Earth System Sciences 2 (1), 1998

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