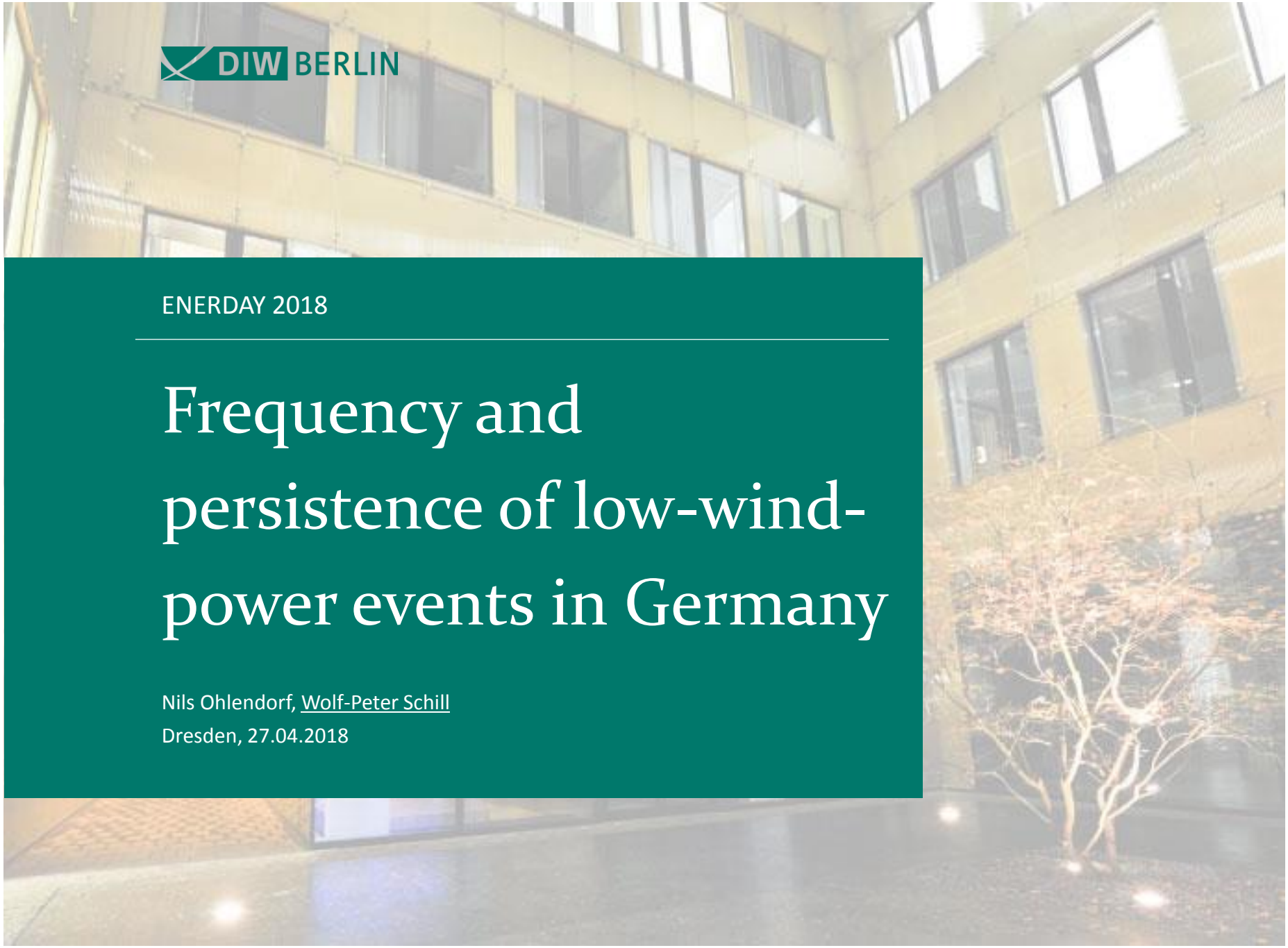

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ENERDAY 2018

Frequency and persistence of low-wind-power events in Germany

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1 Motivation

- German power system increasingly relies on variable renewable energy sources
  - Solar PV: diurnal and seasonal patterns
  - Wind power: more irregular fluctuations
    → security of supply concerns (*Dunkelflaute*)
- Most power system analyses do not cover low-wind-power (LWP) events
- We examine LWP events in Germany
  - Frequency
  - Persistence
  - Magnitude
  - Geographical distribution

2 Methods

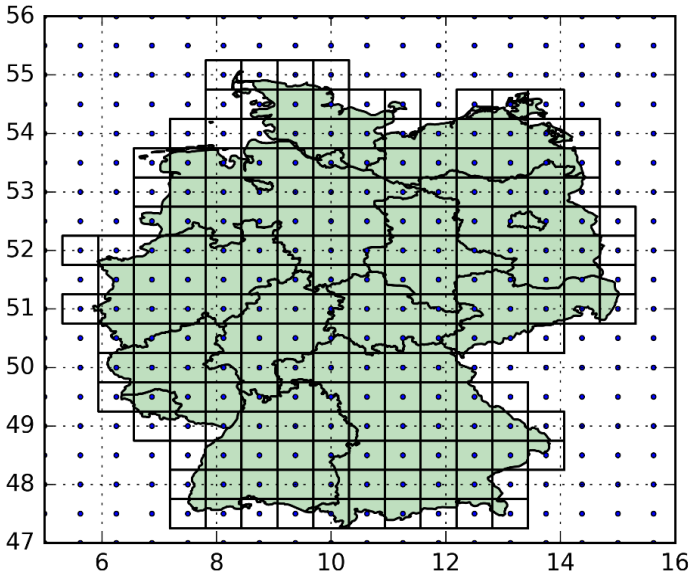
General approach

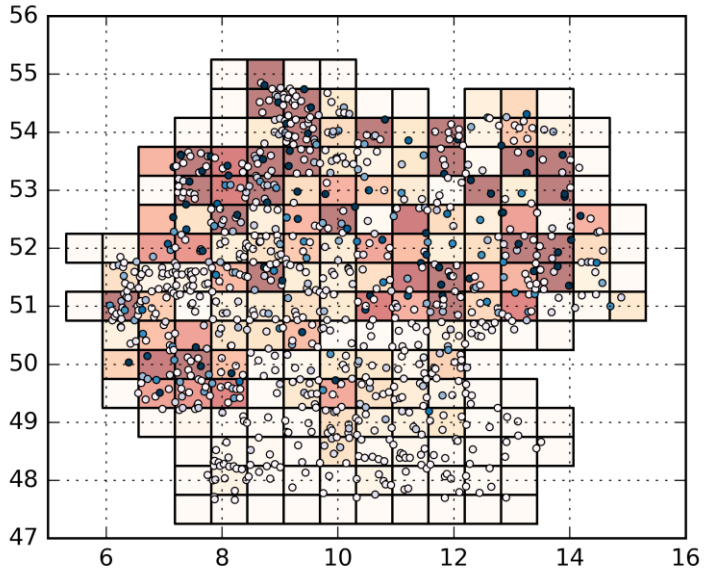
- Simulation of hourly wind power generation based on reanalysis data and power curves
- Four main steps:
  - 1) Regional wind speeds from reanalysis data set, covering 36 years from 1981 to 2016
  - 2) Regional capacity factors based on power curves
  - 3) Spatial aggregation to a single time series
  - 4) Definition and investigation of LWP events
- We provide the model and all data open source

2 Methods

Data

- MERRA-2: 1981-2016, hourly resolution, 0.5° x 0.625°, wind speeds 50m above surface
- OPSD: Currently installed onshore wind capacity



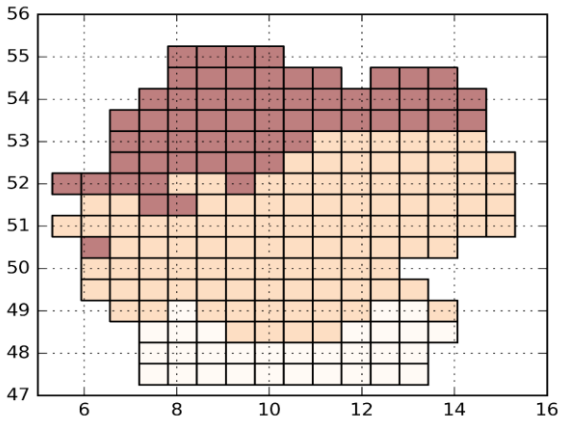


➢Geographical weighting with installed capacity

2 Methods

Capacity factor calculation

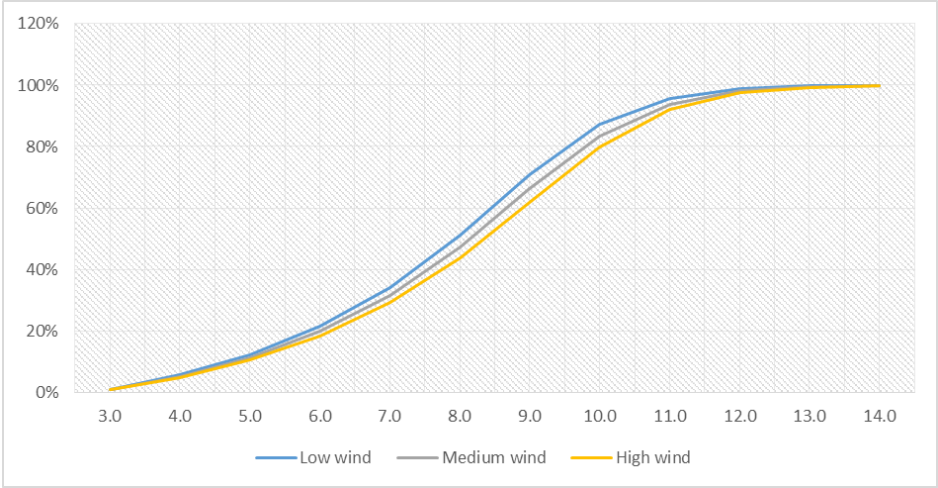
Three wind zones



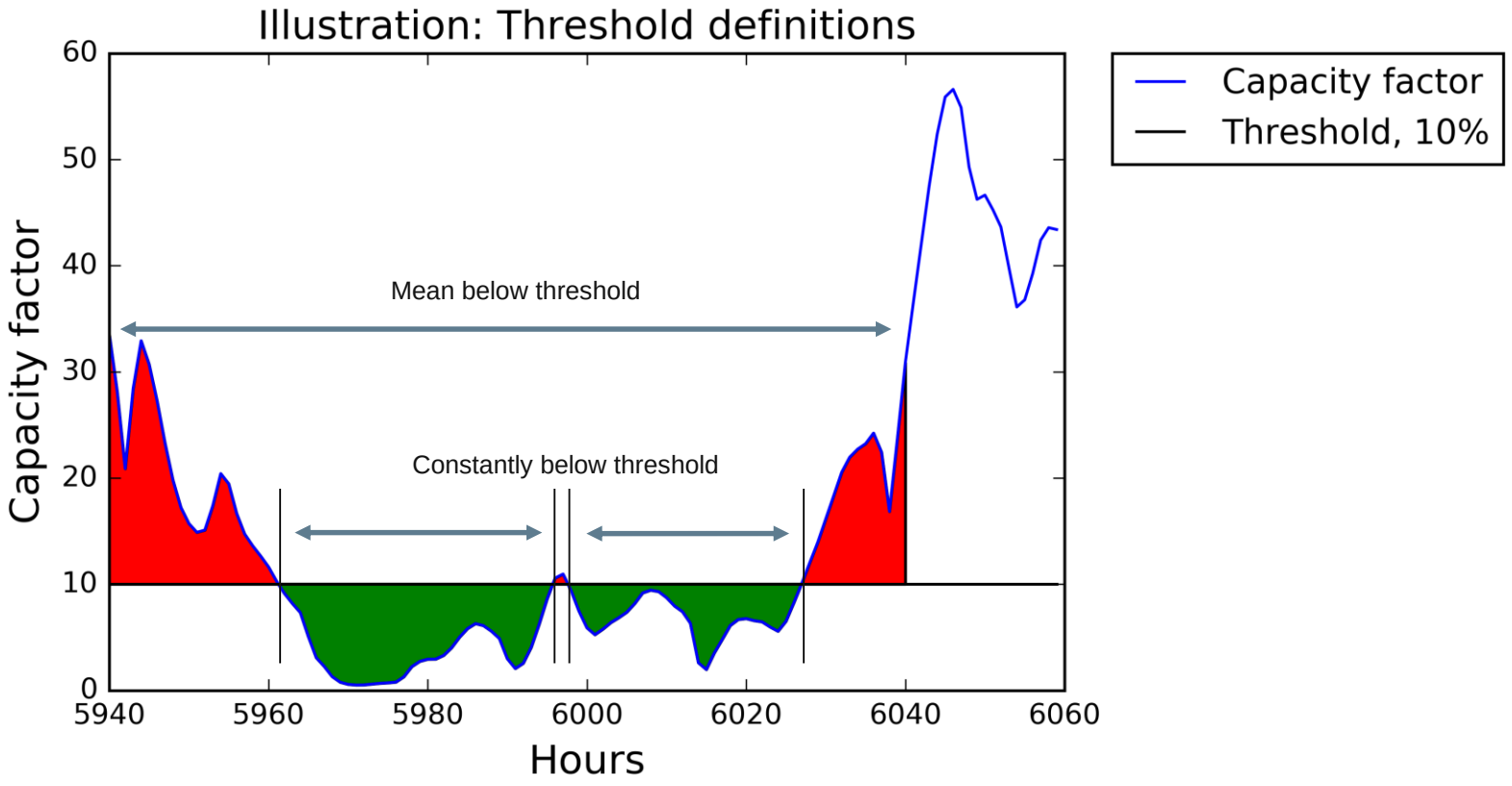
Power curves + hub heights

(100, 125, 139 meters)

Hourly weighted aggregated time series of capacity factors



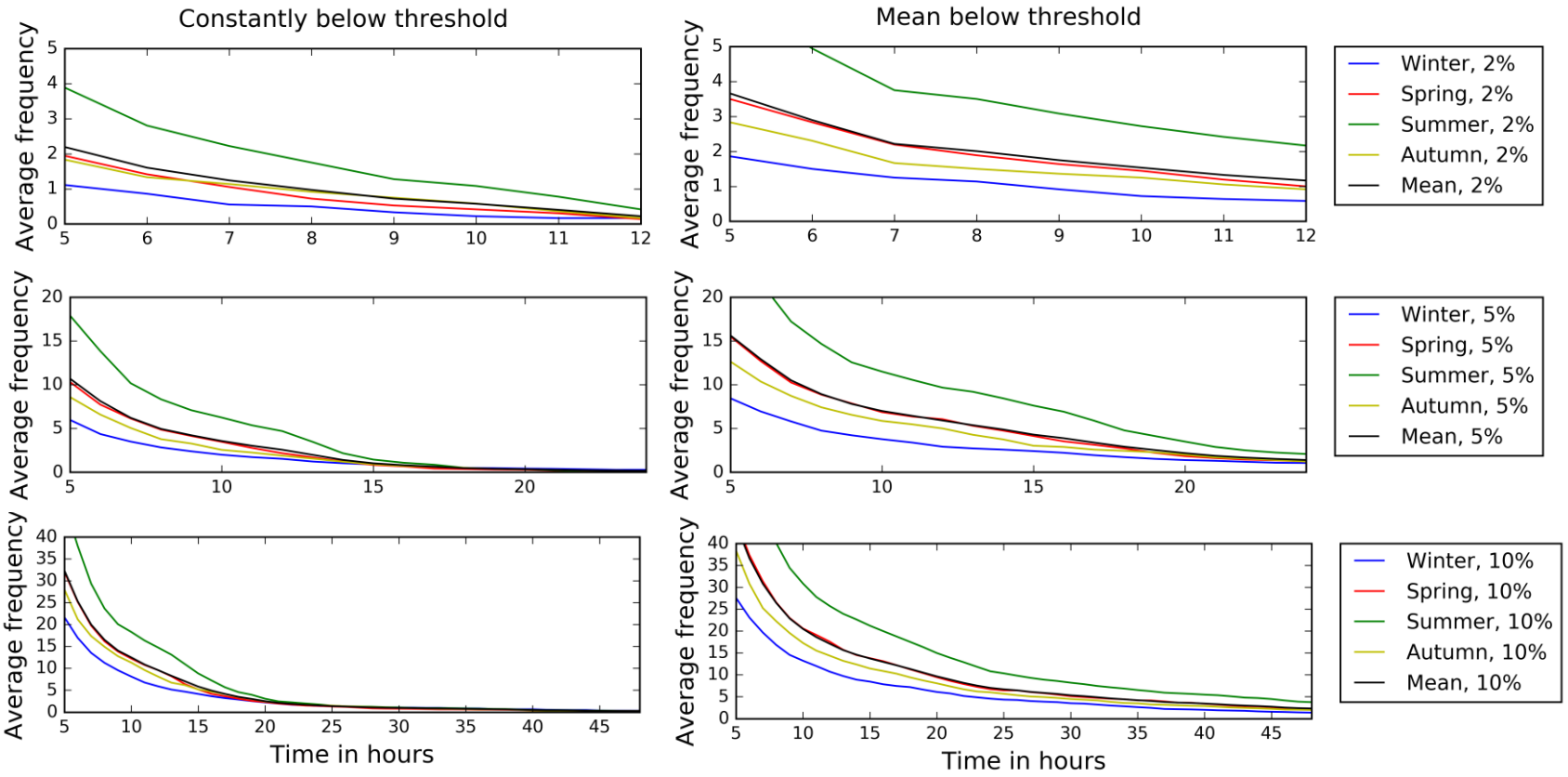
Two definitions of low-wind power events



- Two definitions: Constantly or mean below threshold (CBT, MBT)
- Three thresholds: 10%, 5%, 2%

3.1 Results

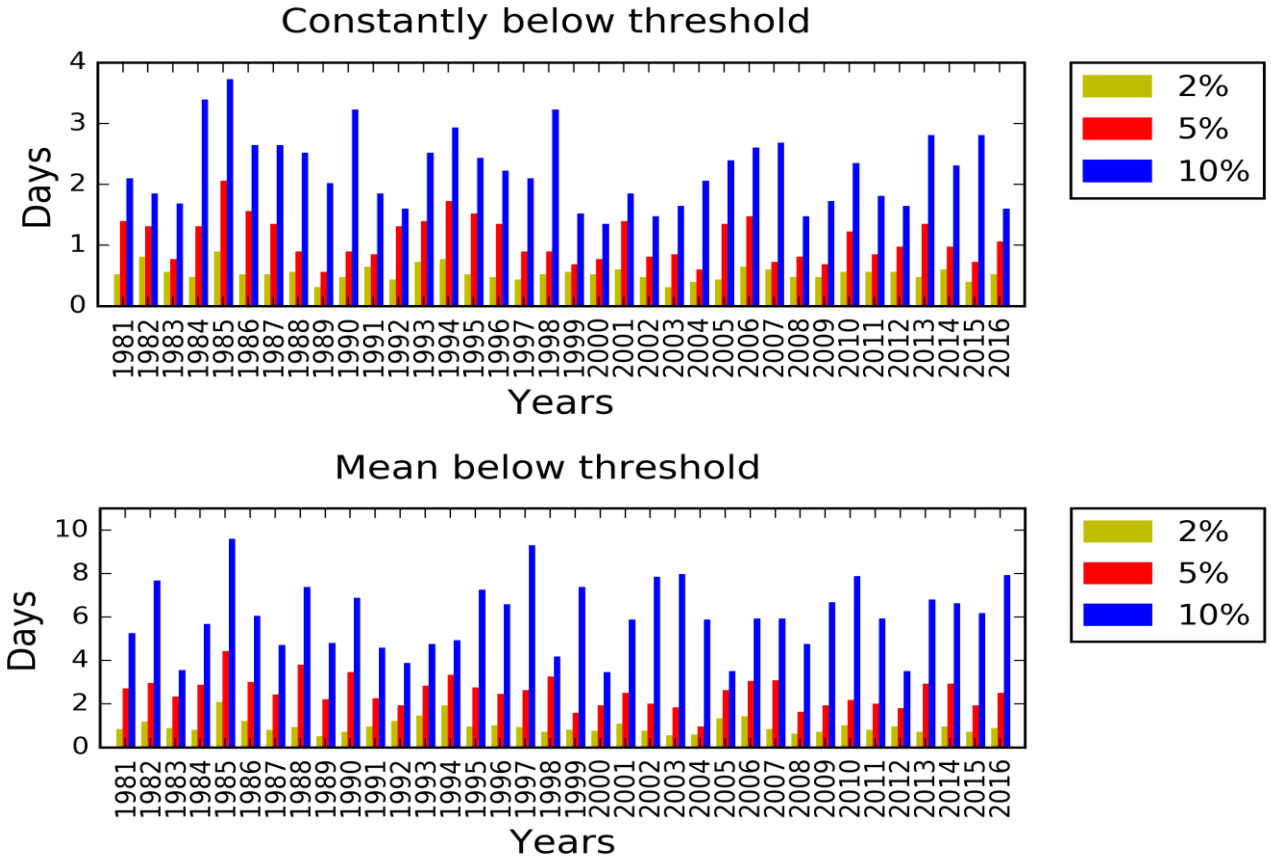
Frequency and seasonal distribution



- LWP events least frequent in winter
- For MBT definition, frequency 1.5-3 times higher than CBT
- Larger thresholds strongly increase frequency

3.2 Results

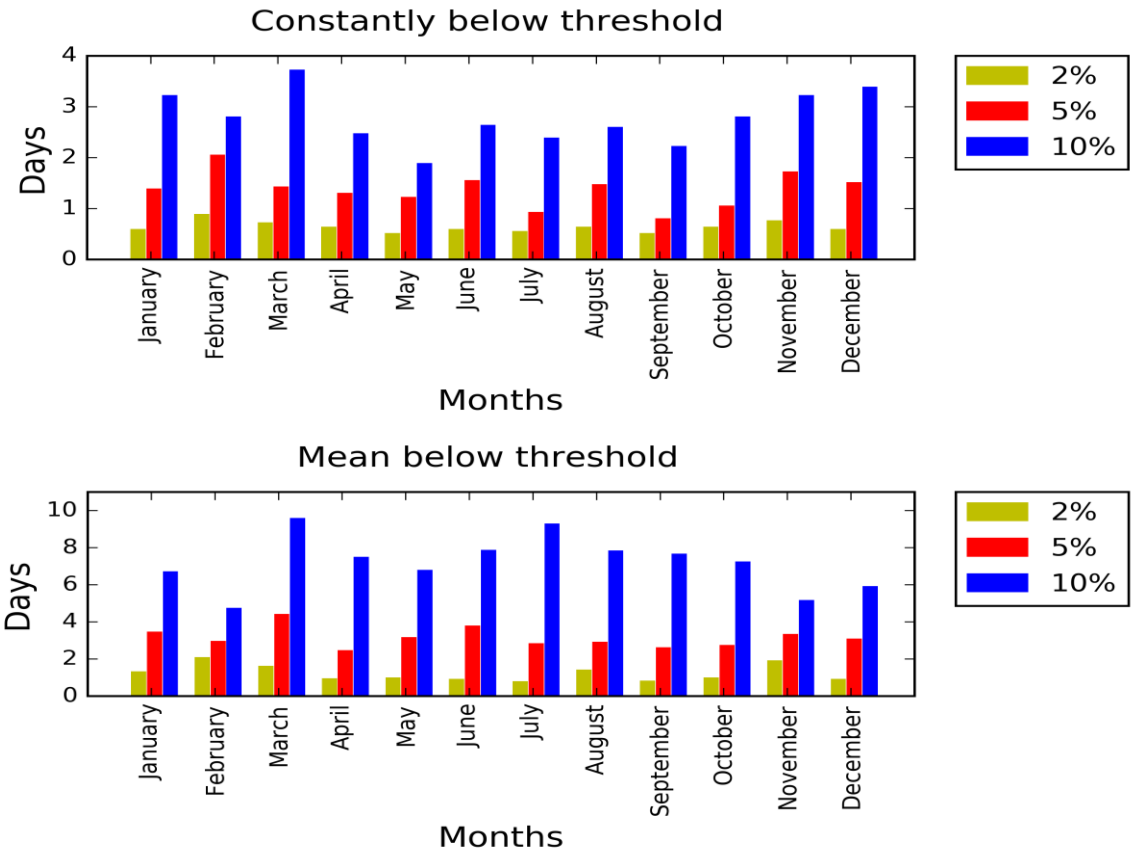
Most extreme LWP events: yearly perspective



- Longest event in 1985: ~10 days of less then 10% mean capacity
- Large inter-annual variation

3.3 Results

Most extreme LWP events: monthly perspective



- Winter and summer months rather similar
- Extreme LWP events also in winter – despite lower frequency

3.4 Results

Return times

Definition:	Constantly below threshold						Mean below threshold					
Time:	Winter			Year			Winter			Year		
Threshold:	2%	5%	10%	2%	5%	10%	2%	5%	10%	2%	5%	10%
1 year	5	14	31	11	21	46	8	24	64	18	52	123
2 years	7	17	42	13	29	57	12	39	92	21	67	152
3 years	9	22	48	14	32	62	15	52	102	23	69	163
4 years	9	28	49	14	33	64	21	59	112	27	72	176
5 years	10	30	57	15	33	65	22	61	113	28	73	176
6 years	12	32	60	15	34	67	27	67	114	31	75	187
7 years	12	32	60	15	34	67	27	67	114	31	75	187
8 years	14	32	63	17	35	70	28	68	114	33	77	188
9 years	14	33	64	17	36	77	28	69	117	34	79	189
10 years	14	33	64	17	36	77	28	69	117	34	79	189
15 years	17	33	67	18	37	77	31	70	127	38	82	190
20 years	19	36	77	19	41	81	34	73	131	45	90	222
25 years	19	36	77	19	41	81	34	73	131	45	90	222
30 years	19	36	77	19	41	81	34	73	131	45	90	222

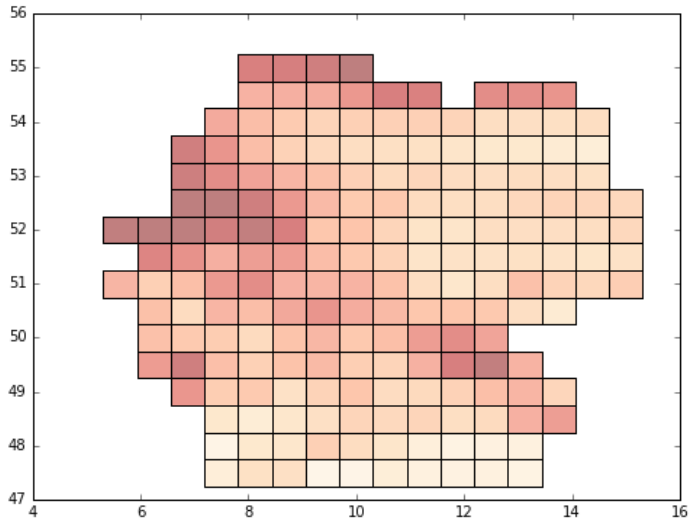
- Every 10 winters, one 64(117)-hour event below 10% under CBT (MBT)
- Every 30 winters, the length increases to 77(131) hours

3.5 Results

Longest winter extreme events, 10% threshold

Mean below threshold

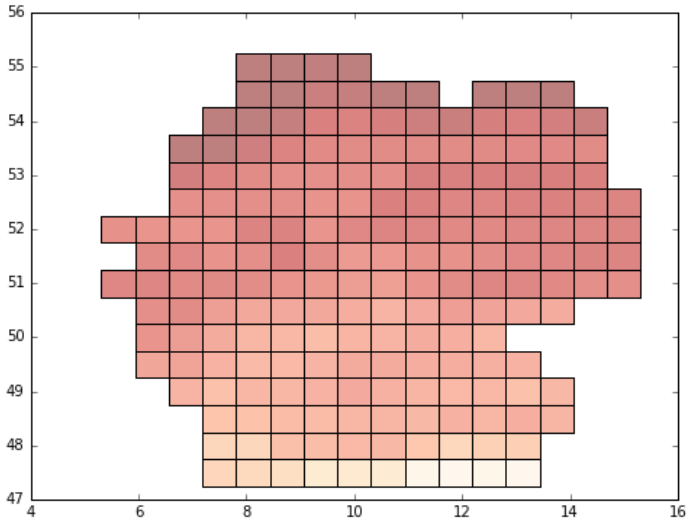
160 hours, 05.01.1997 – 11.01.1997



Scale: 0 – 20%

Annual mean capacity factors

in 1997



Scale: 5 – 50%

- Decentral solutions potentially more affected by low-wind power events

4 Conclusion

- Low wind power events in summer more frequent and more persistent than in winter
- But magnitude of most extreme LWP events almost similar in winter and summer months

  → „Dark-winter-low-wind“ important for system planning
- Most extreme LWP events differ strongly between years

  → Power system analyses only considering one / a few years are likely to underestimate LWP events

- Further research:
  - Inclusion of offshore wind, PV and European perspective

Vielen Dank für Ihre Aufmerksamkeit.

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