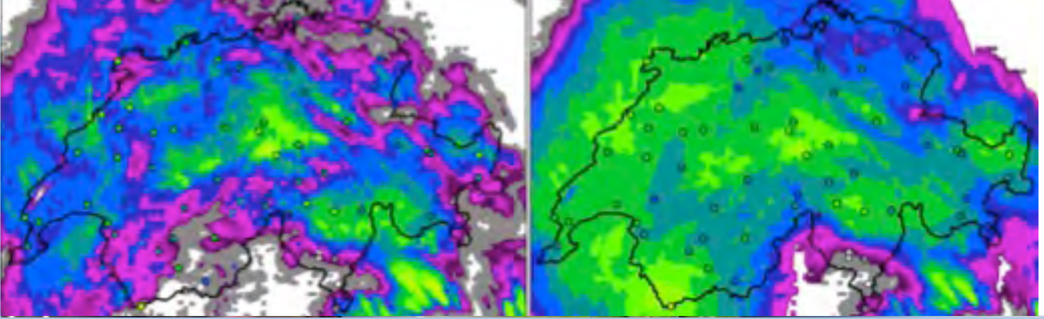


UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH

Climatology and extreme value analysis of a high-resolution blended radar and rain-gauge sub-daily precipitation dataset for Switzerland

Olivia Martius[1] Yannick Barton[1] Luca Panziera[2,1]

[1] Oeschger Centre for Climate Change Research, Institute of Geography, Mobilar Lab for Natural Risks, University of Bern

[2] Federal Office of Meteorology, MeteoSwiss

High impact events related to sub-daily precipitation extremes

Sub-daily extreme precipitation is relevant for

- surface water floods
- flash floods
- urban flooding

Often high intensity, very localized convective events

→ need for high-resolution (space / time) data

UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Data set

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

1. **CPC**

   Combination of radar and rain gauges
   (Co-kriging with external drift)
   real-time operational product
   5 minutes temporal resolution
   1 km^2 spatial resolution

   Sideris et al. 2014

   12 years: 2005 to 2017 (no 2011)

2. **68 rain gauges**

Figures MeteoSwiss

Storyline

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

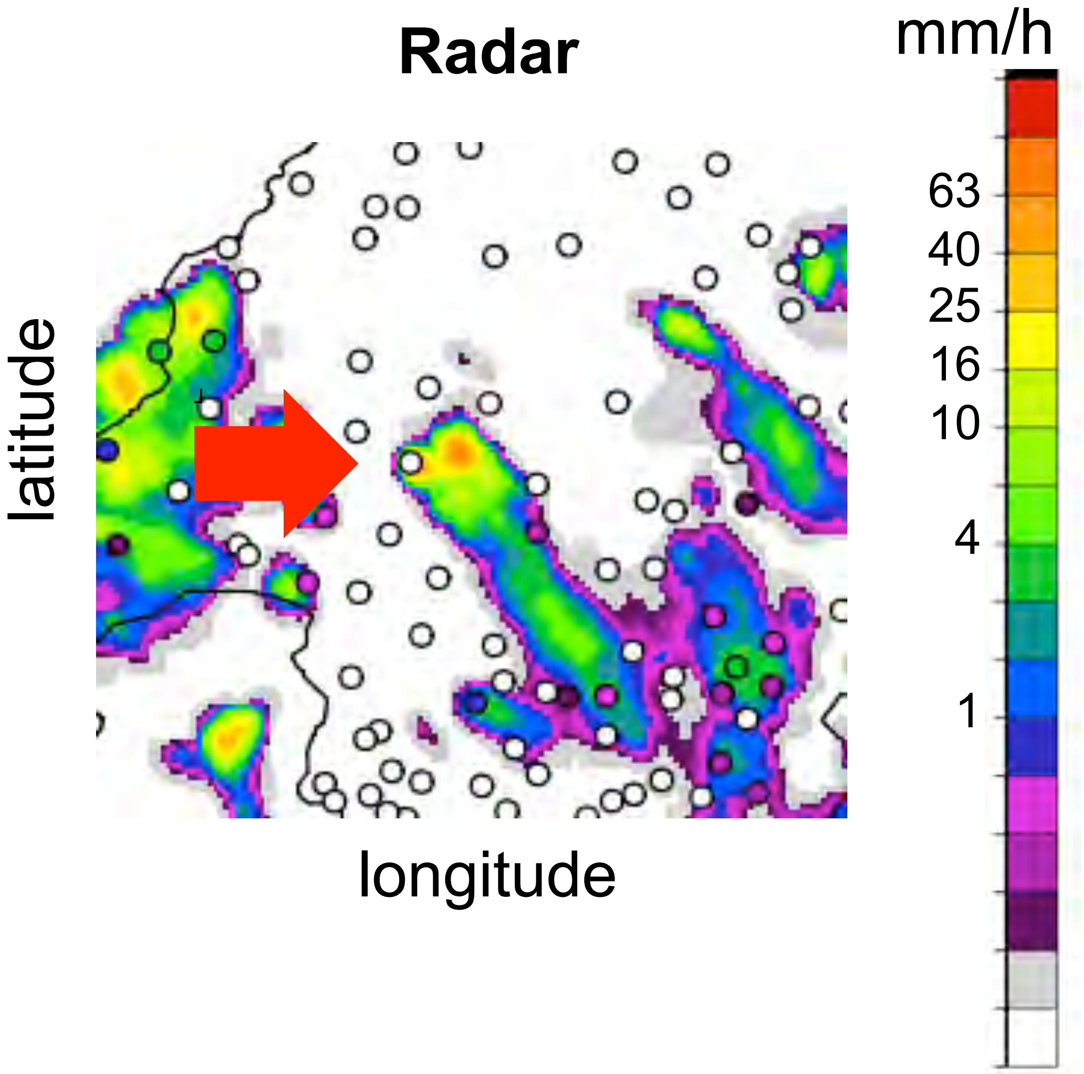
> A data set that captures convective precipitation extremes?

> Some ideas for simple indices for convection-permitting model validation

> Compare rain gauge and CPC extreme precipitation – point scale vs. volume integral scale

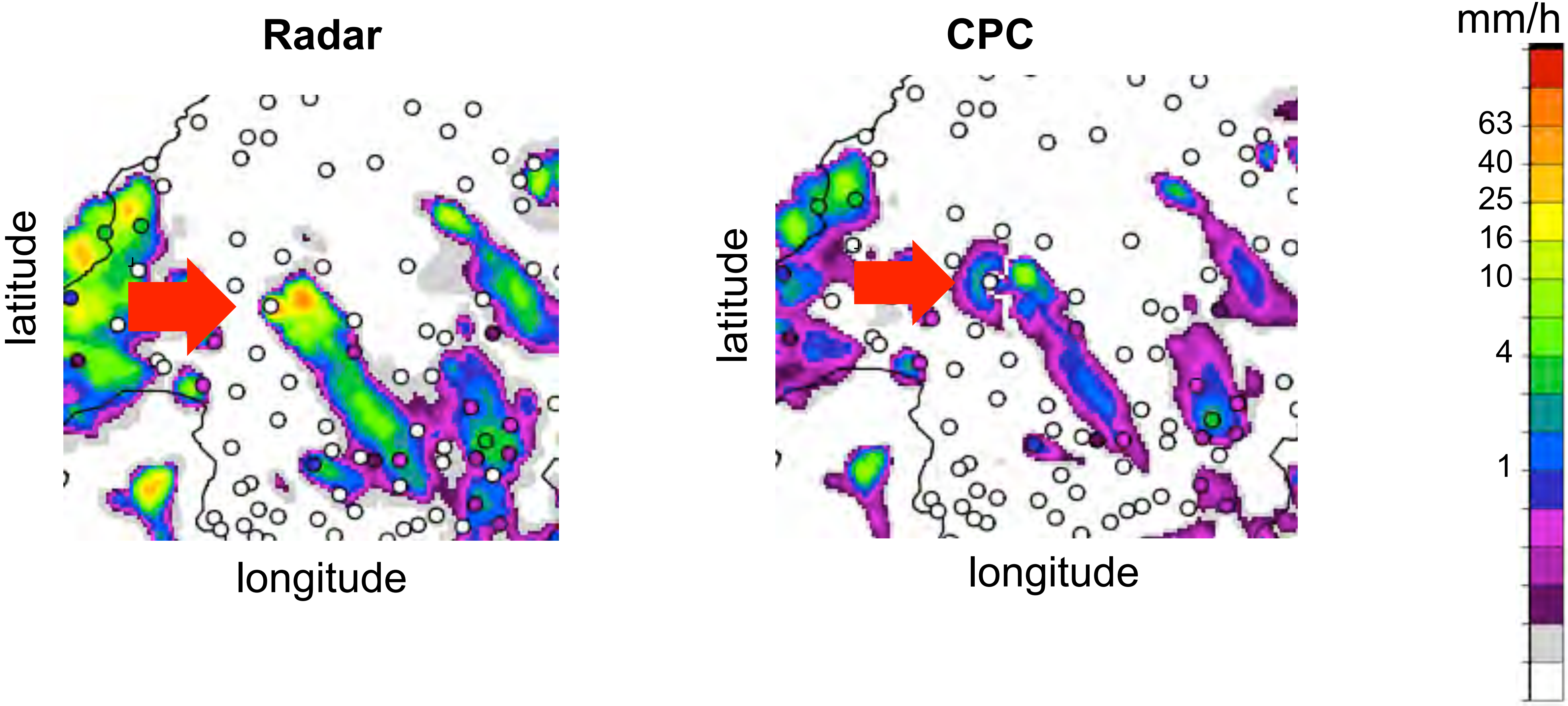
> Can we provide return levels of rainfall for automatic alert systems?

Challenging small-scale thunderstorms



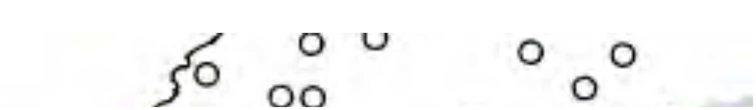
rain gauges

Challenging small-scale thunderstorms



Challenging small-scale thunderstorms

Radar **CPC**

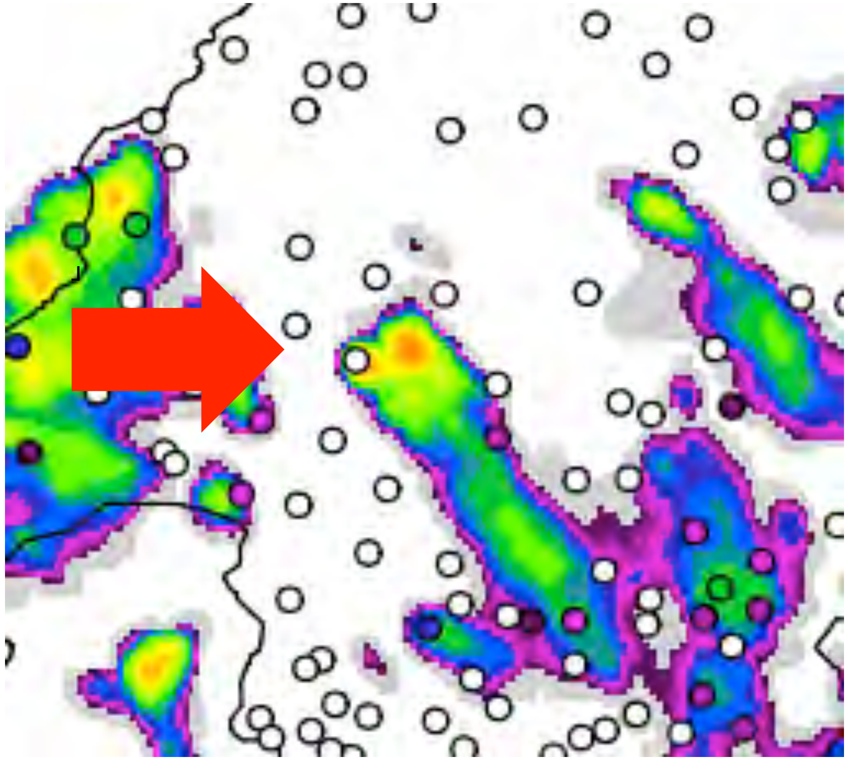


→ Coefficient of variation (STD/mean) in a 5 by 5 km box

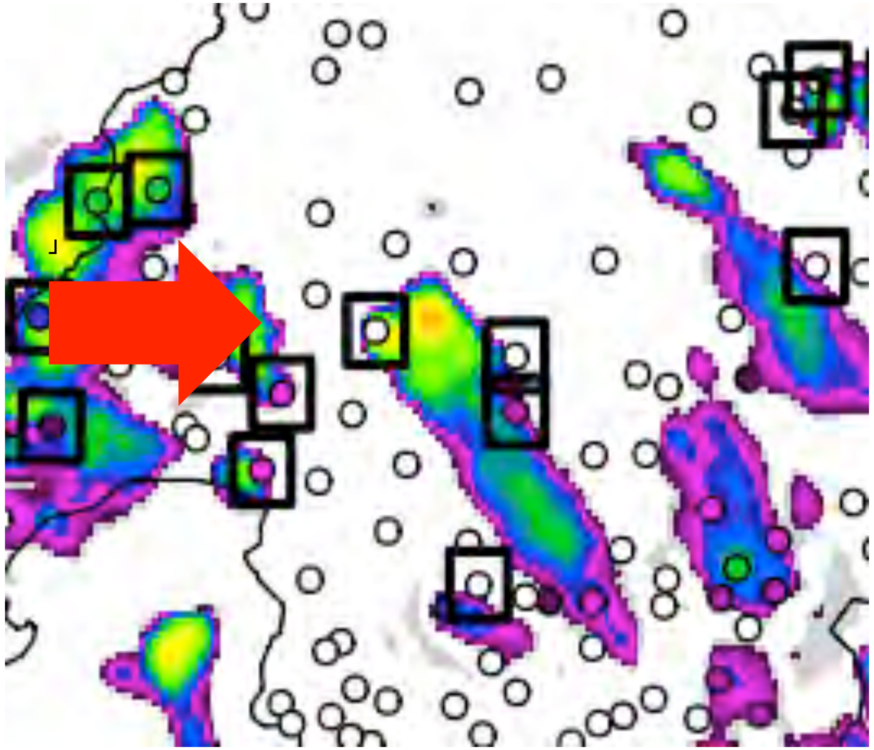
→ Solution replace radar pixel above the rain gauge with a nearby pixel that best matches the rain gauge value

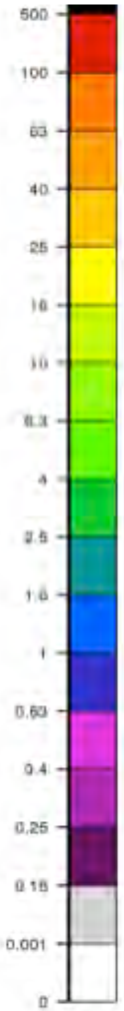
Challenging small-scale thunderstorms

Radar



CPC

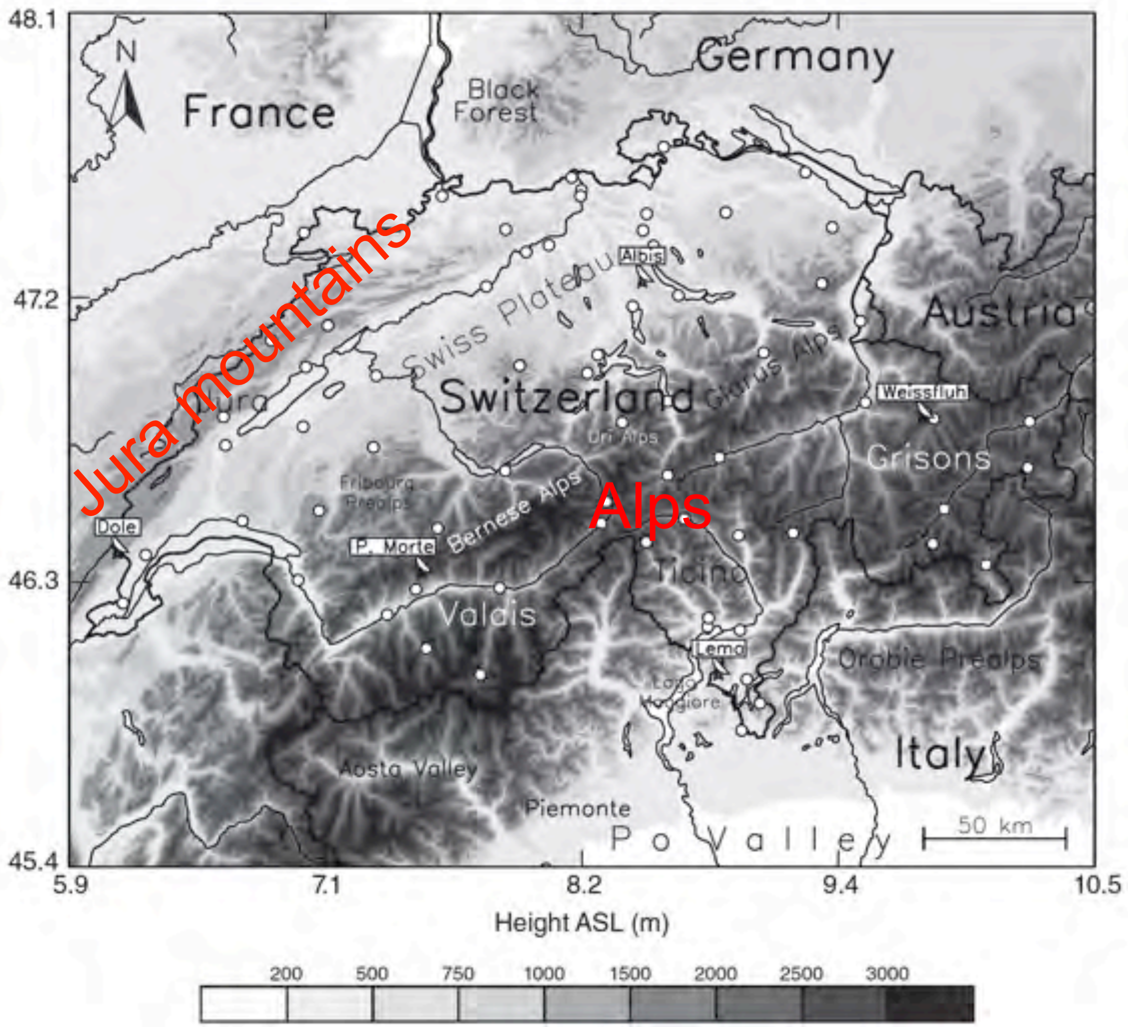




mm/h

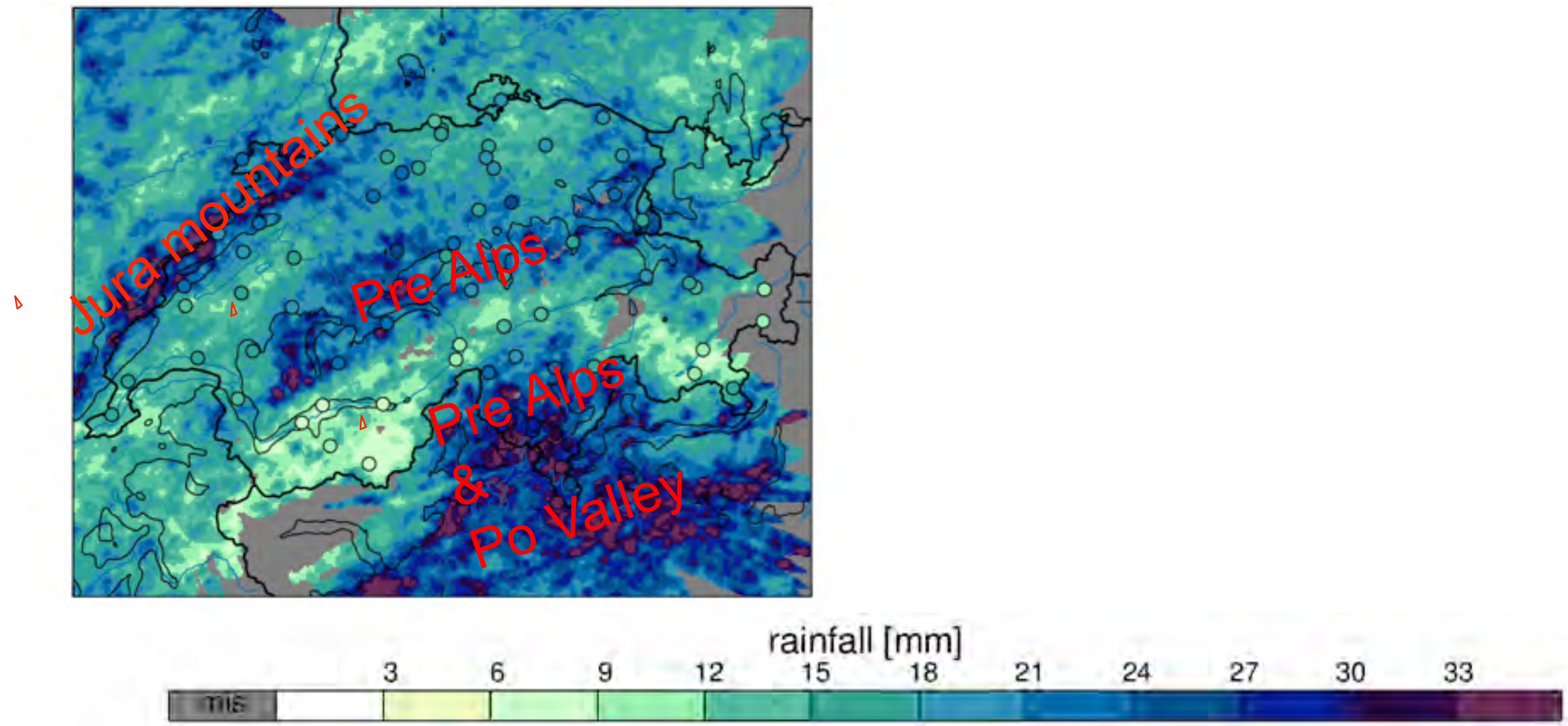
Geographical setting

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH



12-year average seasonal maximum 1 hour rainfall

Summer JJA



rain gauges

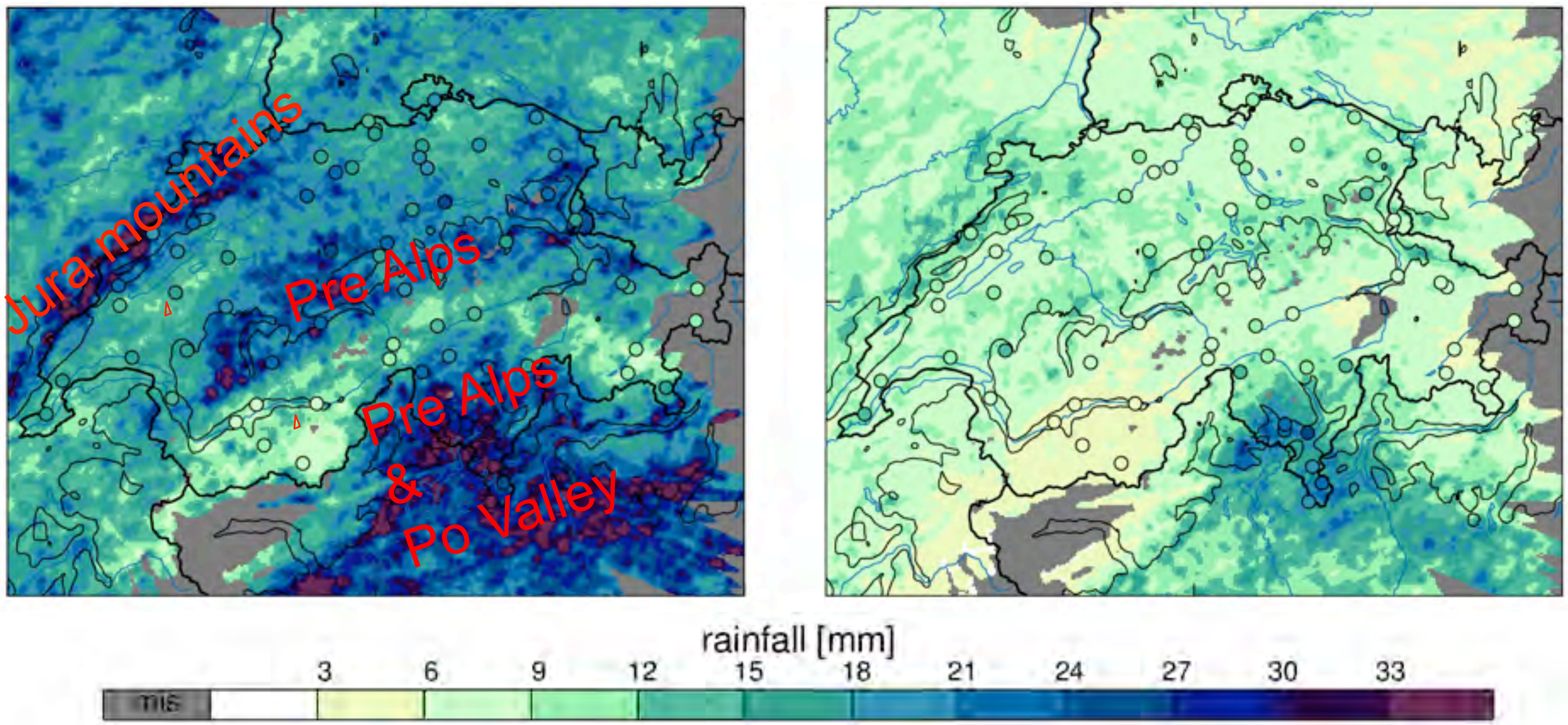
radar data not reliable

Panziera et al. 2018

12-year average seasonal maximum 1 hour rainfall

Summer JJA

Autumn SON



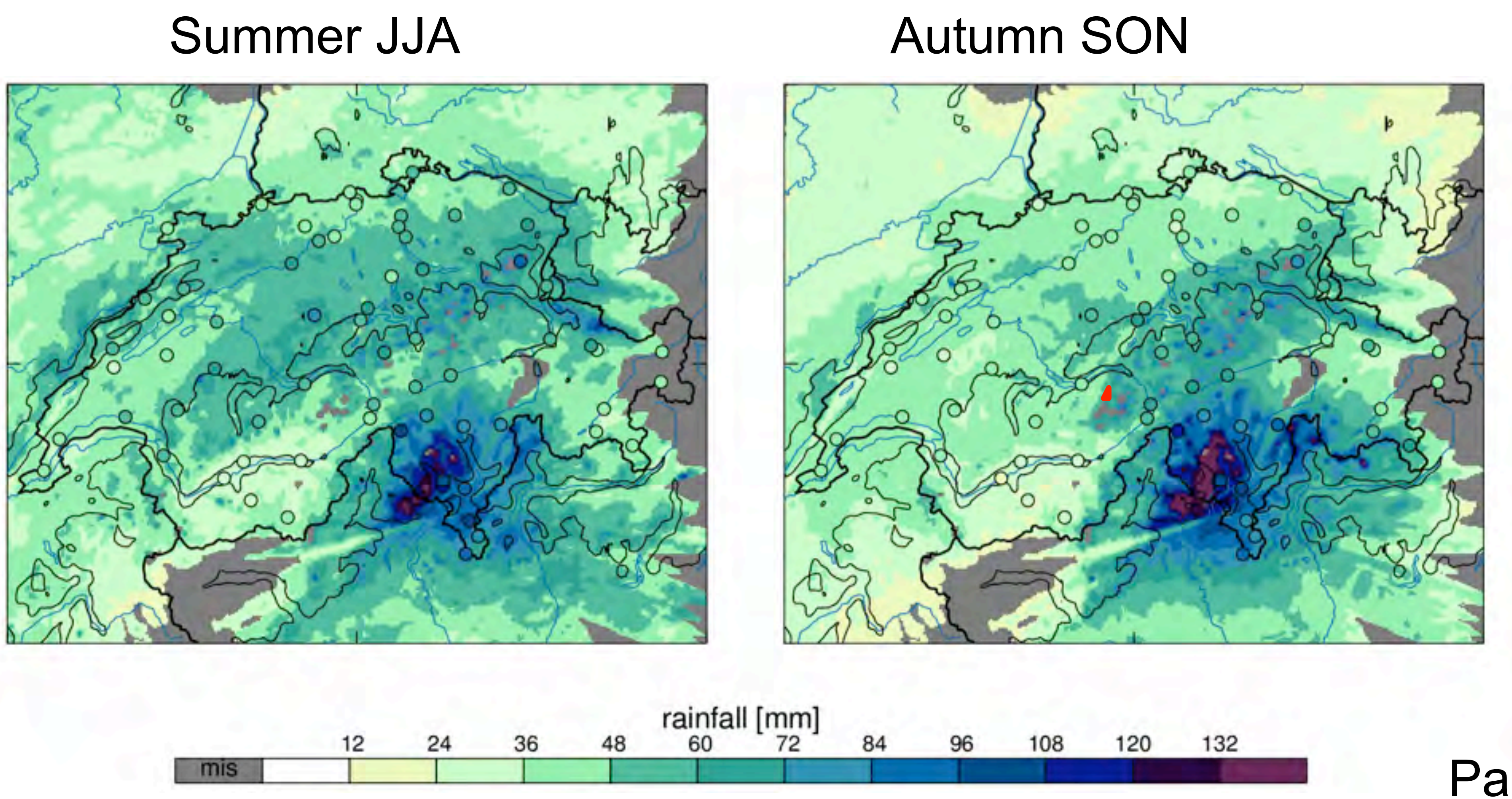
rain gauges

radar data not reliable

Panziera et al. 2018

12-year average seasonal maximum daily rainfall

UNIVERSITÄT
BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH



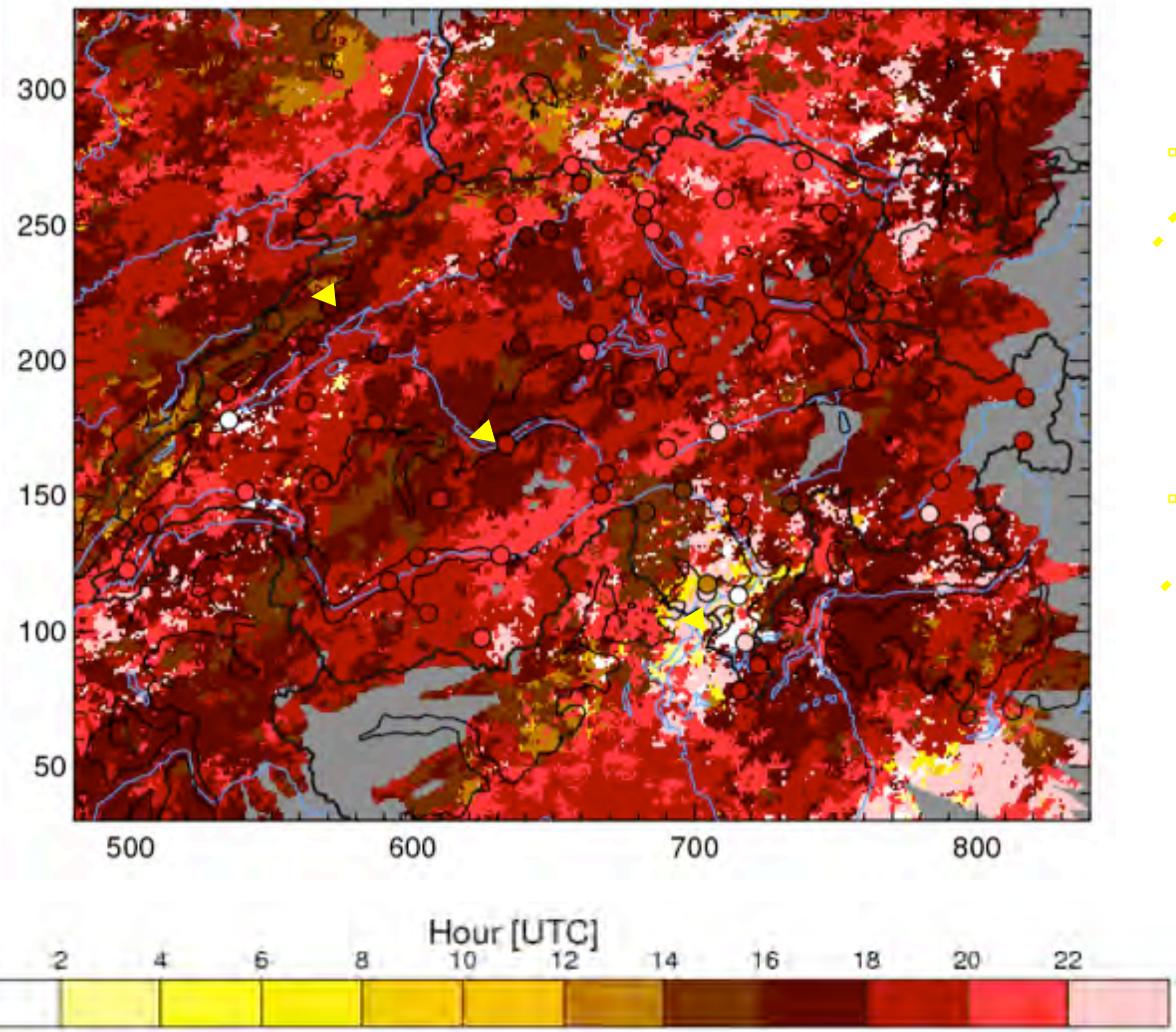
rain gauges

Panziera et al. 2018

Diurnal cycle of extremes in summer (JJA)

Panziera et al. 2018

hour of the day with the most frequent occurrence of extremes



- Alpine pumping
  valley → mountain winds
- drainage flow
  mountain → foreland winds

\+ 2 hours for local time

Verification CPC Cross Val. vs. rain gauges

50% - 65% of the rain gauge extremes are also extremes in CPC (POD)

40% - 50% of the CPC extremes are not extremes for the rain gauges (FAR)

The agreement between radar-derived and rain gauge rainfall:

- is lower in winter → snowfall
- increases with reducing the threshold used to define extremes
- increases with increasing length of the accumulation period

Modeling of precipitation extremes for short time series

UNIVERSITÄT
BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Automated Peaks over threshold:
Generalized Pareto distribution (Fukutome et al. 2015)

Extended Generalized Pareto Distribution
(Naveau et al. 2016)

Modeling of precipitation extremes for short time series

Automated Peaks over threshold: Generalized Pareto distribution (Fukutome et al. 2015)

Need to choose threshold and run parameter in an automatic way

Extended Generalized Pareto Distribution (Naveau et al. 2016)

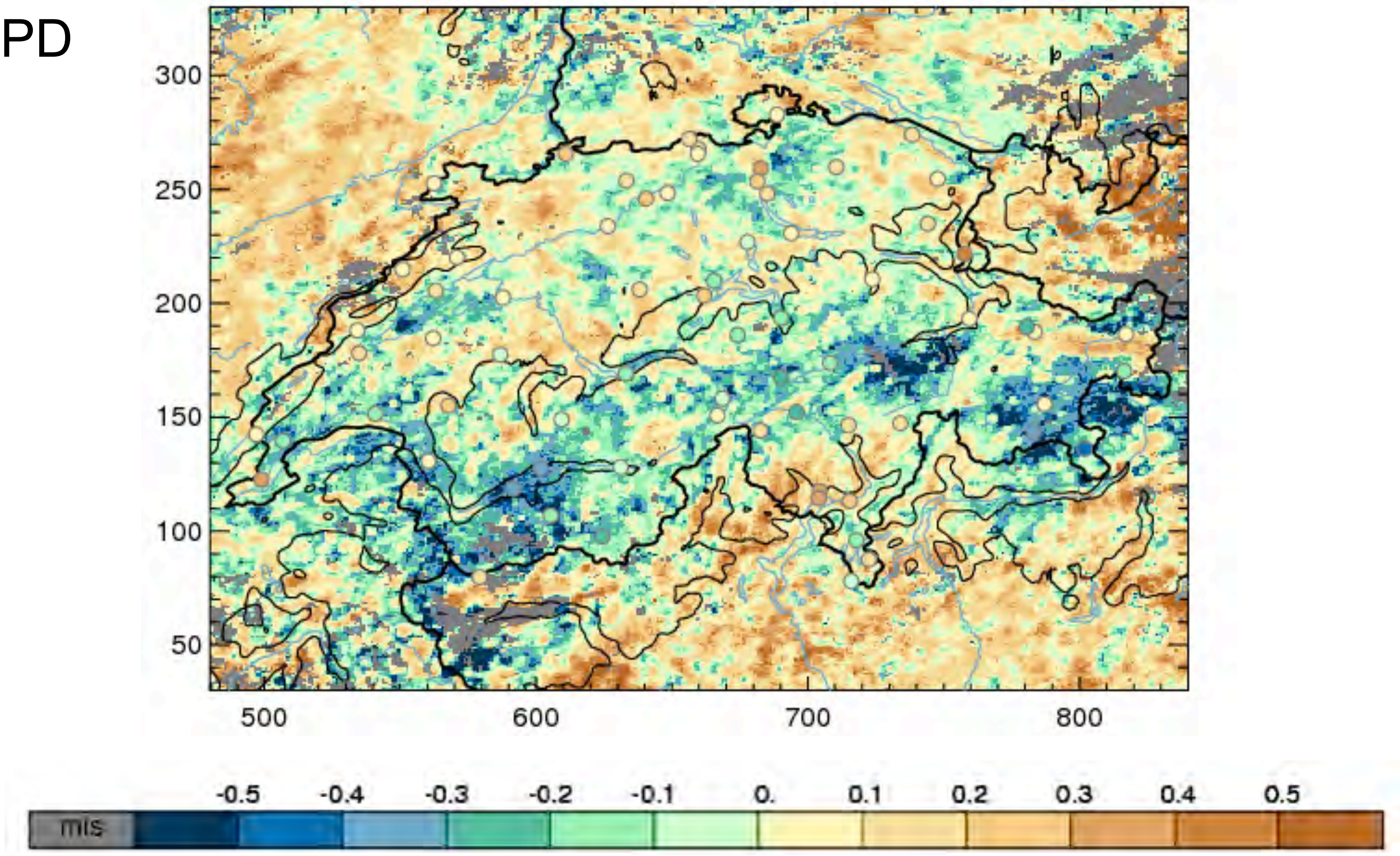
Model the entire distribution

Temporal dependence not easy to remove

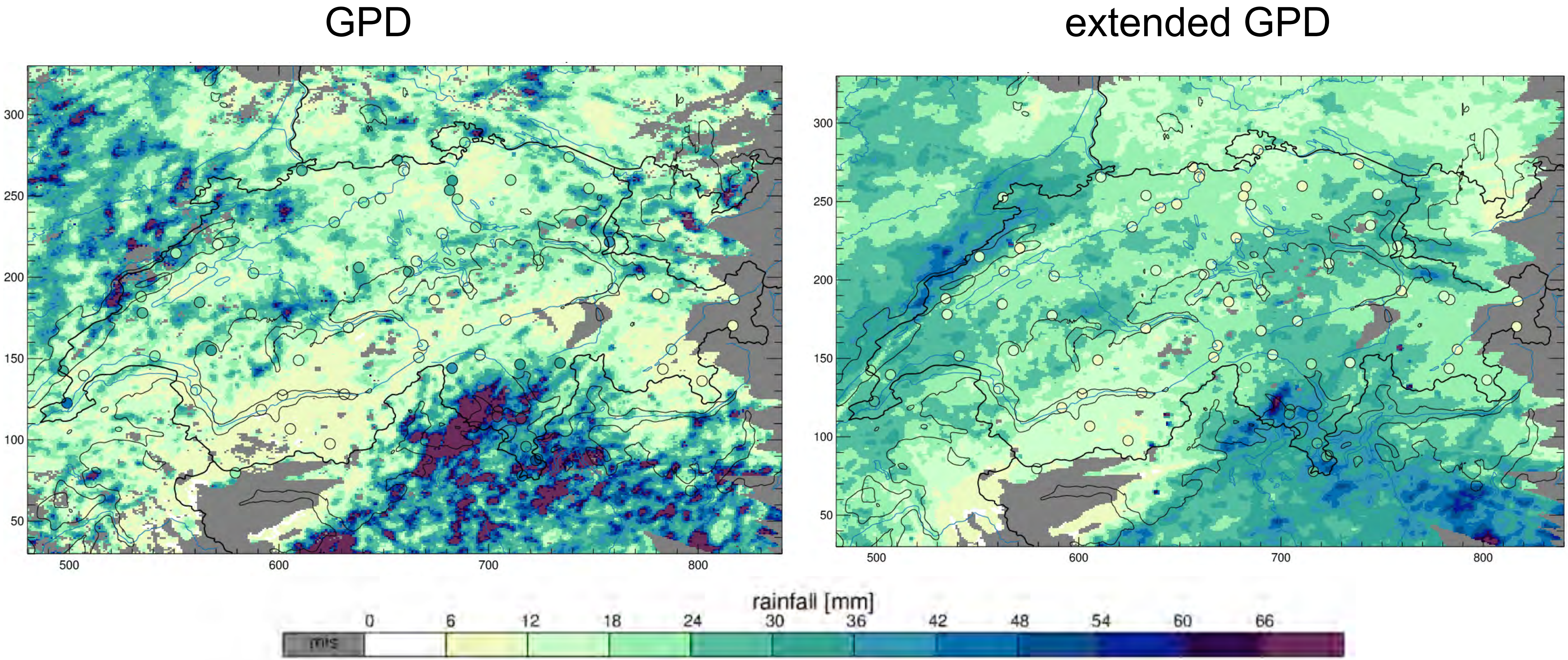
Assumes a positive shape parameter

Autumn 1-hour rainfall → shape parameter

GPD

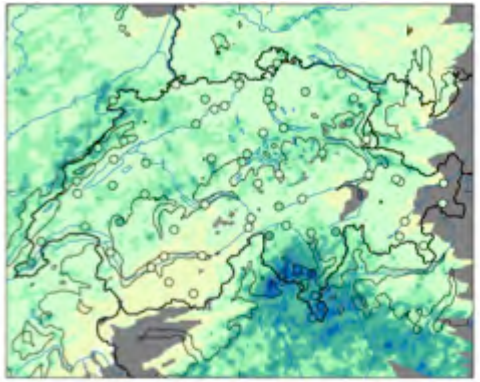


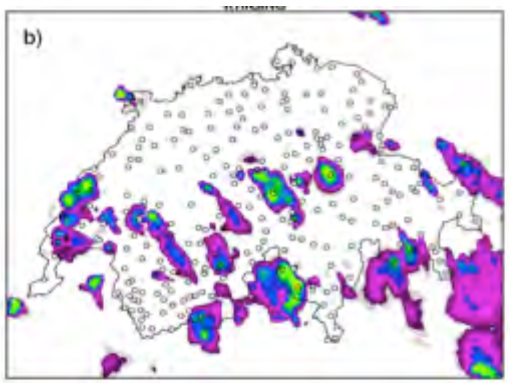
2-seasons return-level for 1-hour rainfall in autumn

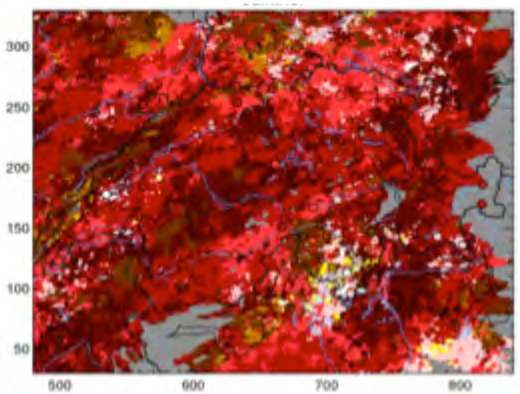


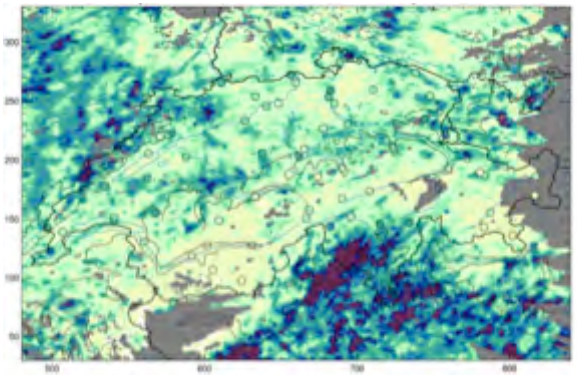
Summary

UNIVERSITÄT
BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH









Blended precipitation maps can be used to investigate (subdaily) extremes

Careful treatment of convective situations is required

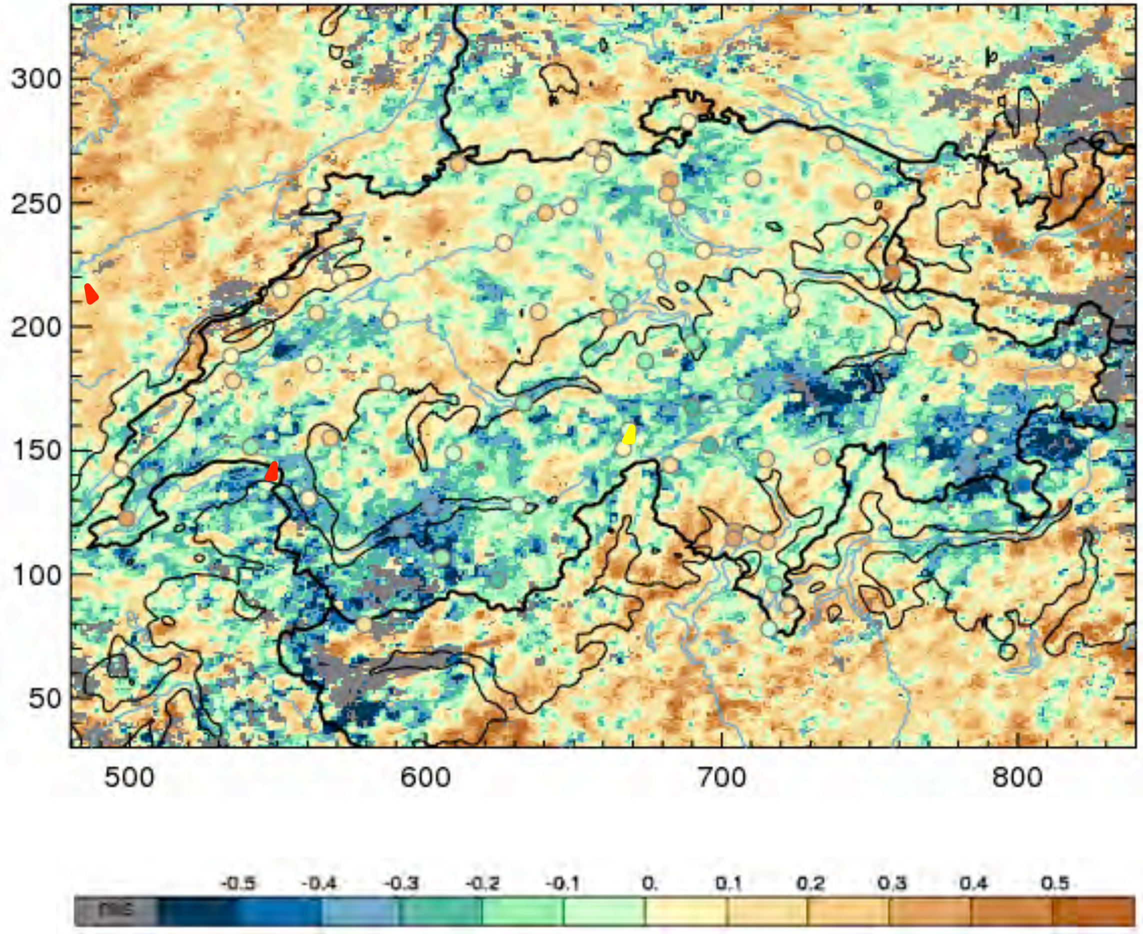
Climatologies of sub-daily extremes are valuable for convection-permitting model validation and process studies

Unexplored potential for extreme value analysis

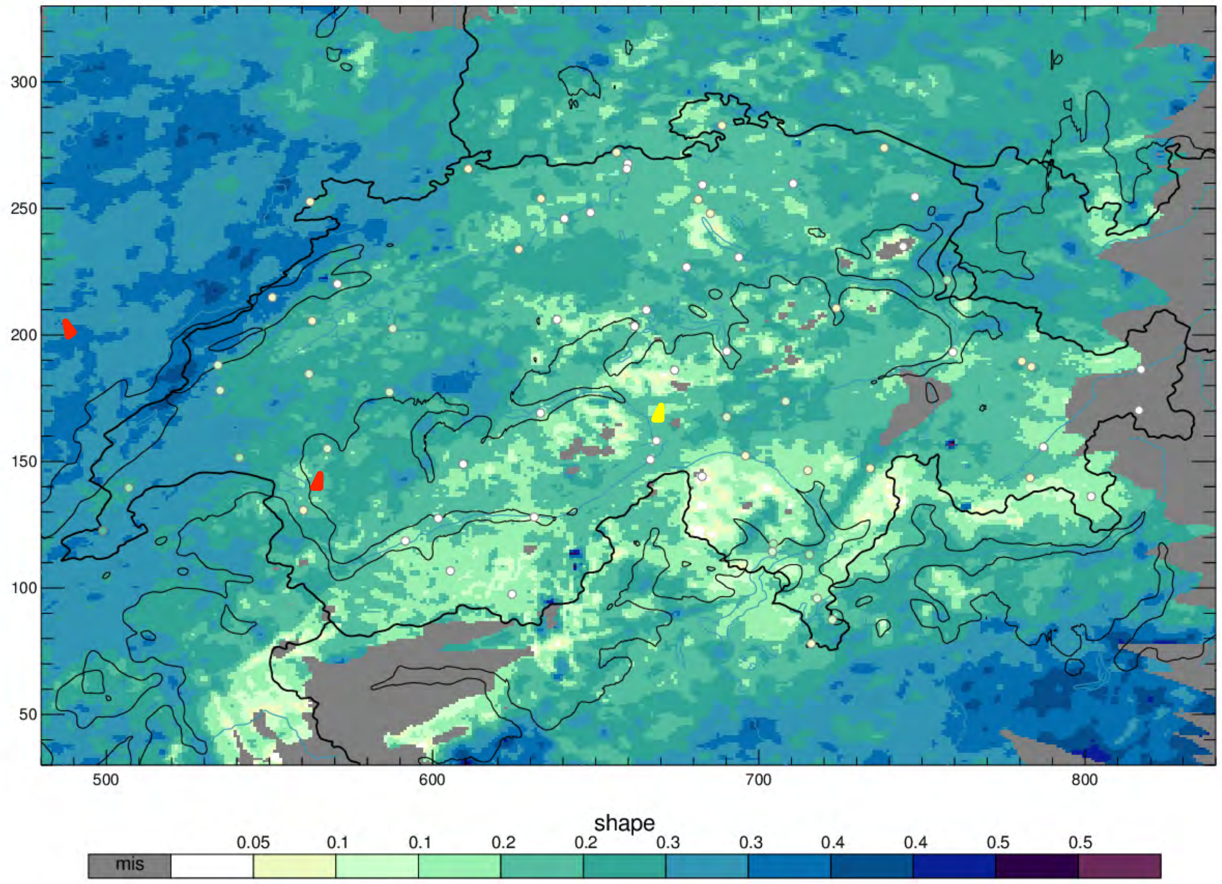
Panziera et al, 2018, Int. J. Climatology

Autumn 1-hour rainfall → shape parameter

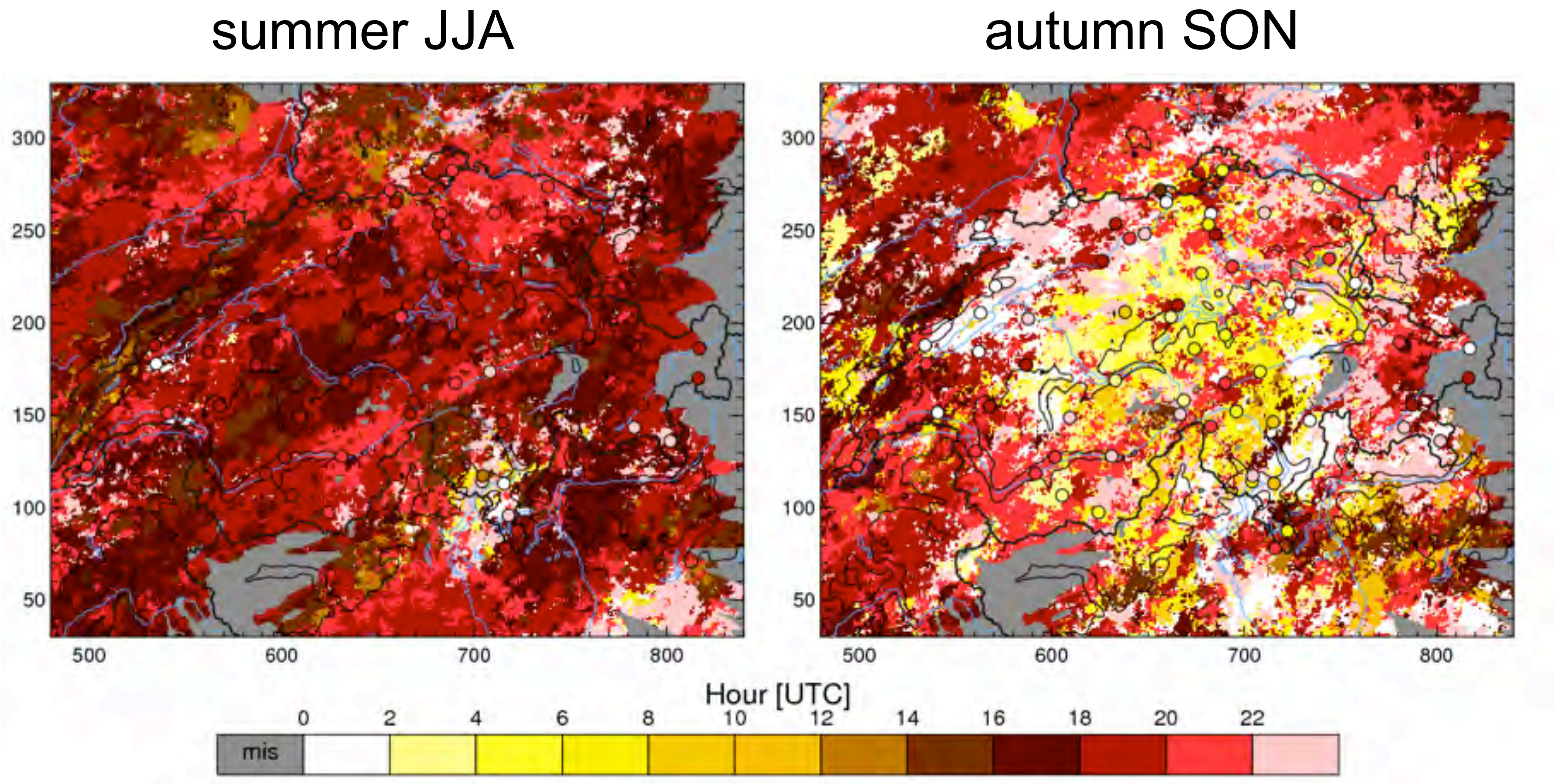
GPD



extended GPD



Diurnal cycle of extremes

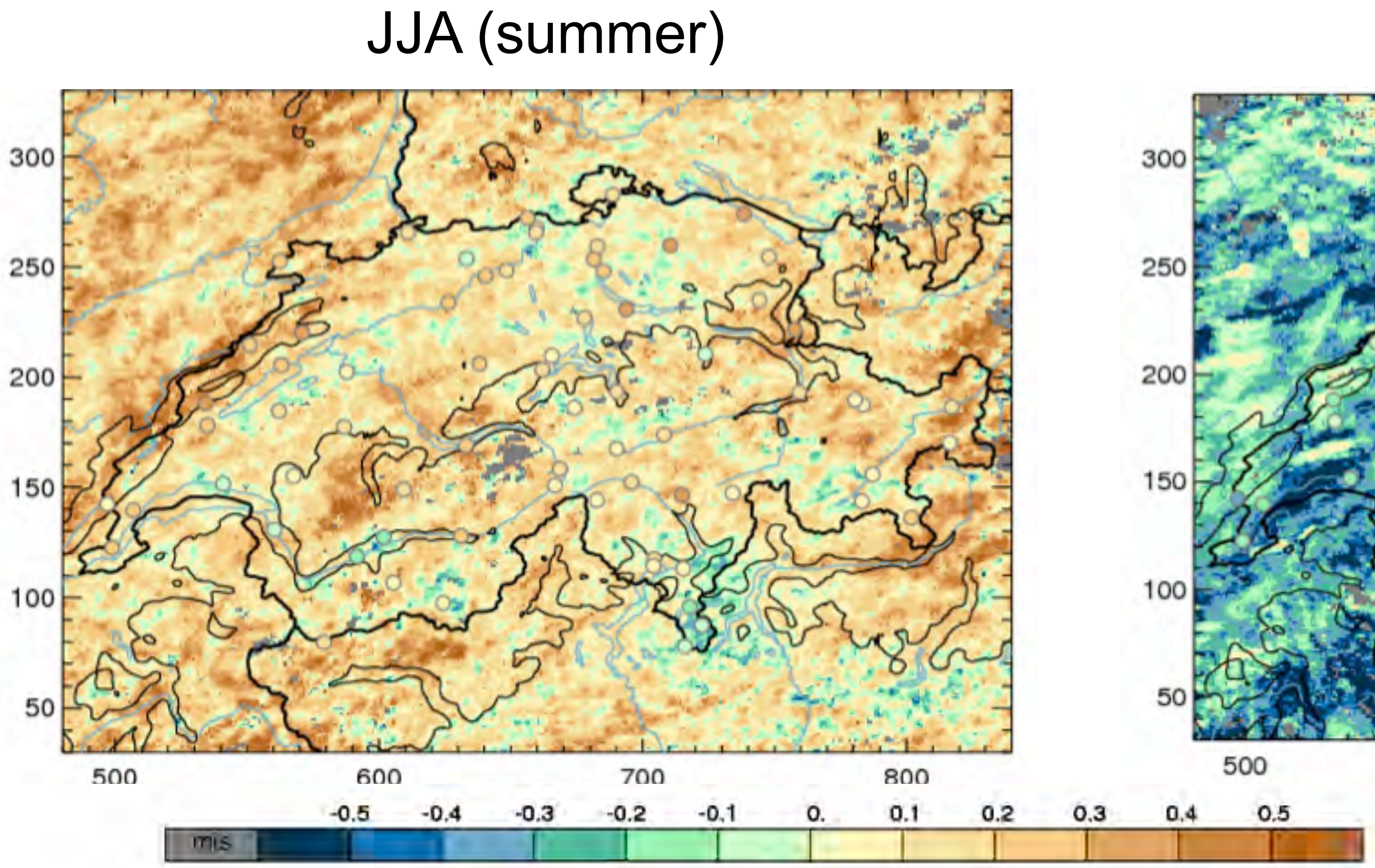


hour of the day with the most frequent occurrence of extremes

Panziera et al. 2018

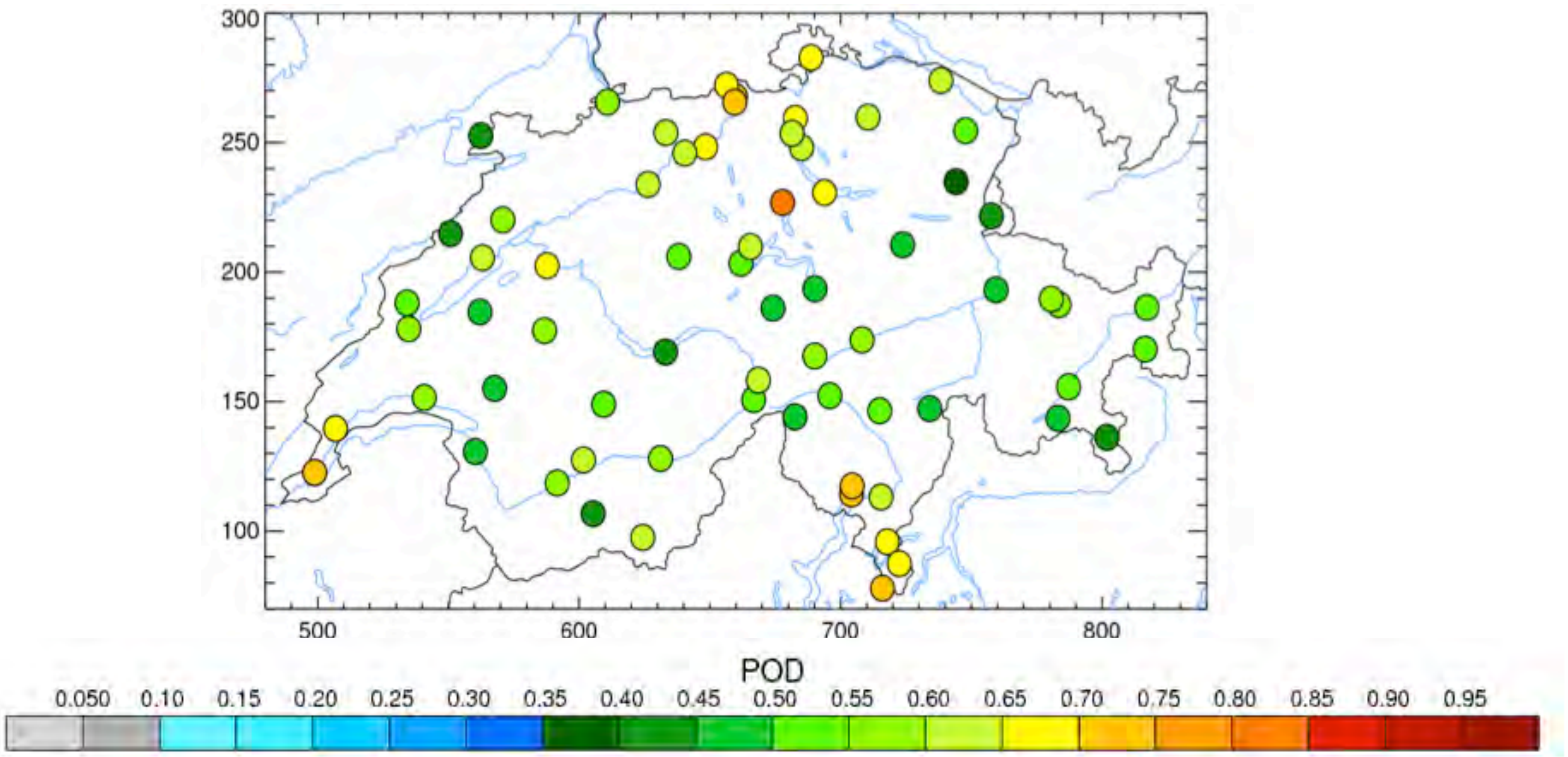
UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

1-hour rainfall GPD shape parameter

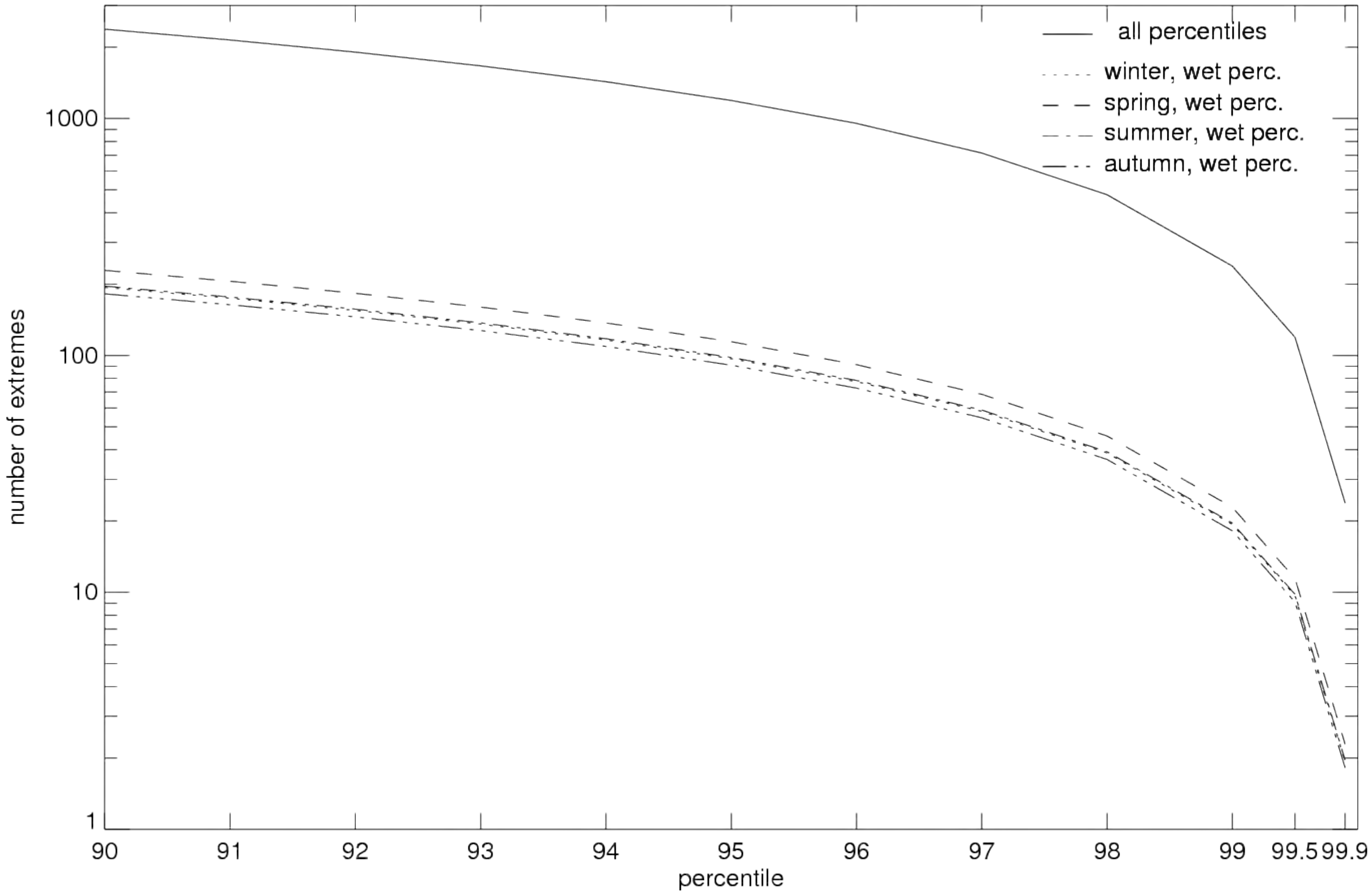


Verification CombiPrecip Cross Val. vs. rain gauges – Probability of Detection (POD) in summer

UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH



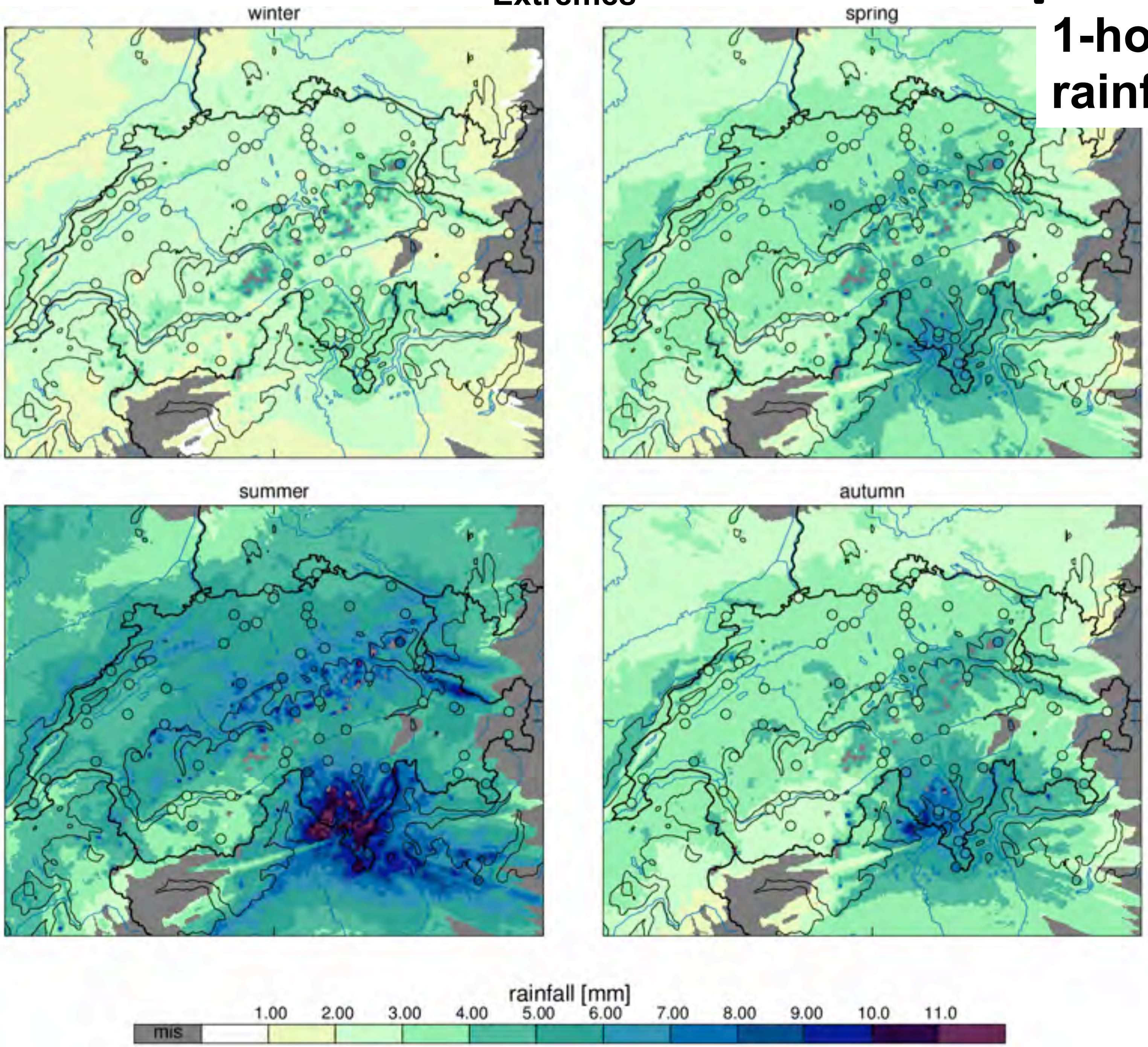
50% - 65% of the rain gauges extremes are extremes also in CPC


all percentiles
winter, wet perc.
spring, wet perc.
summer, wet perc.
autumn, wet perc.
number of extremes
1000
100
10
1
90
91
92
93
94
95
96
97
98
99
99.5
99.9
percentile

Extremes

- 1-hour rainfall

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

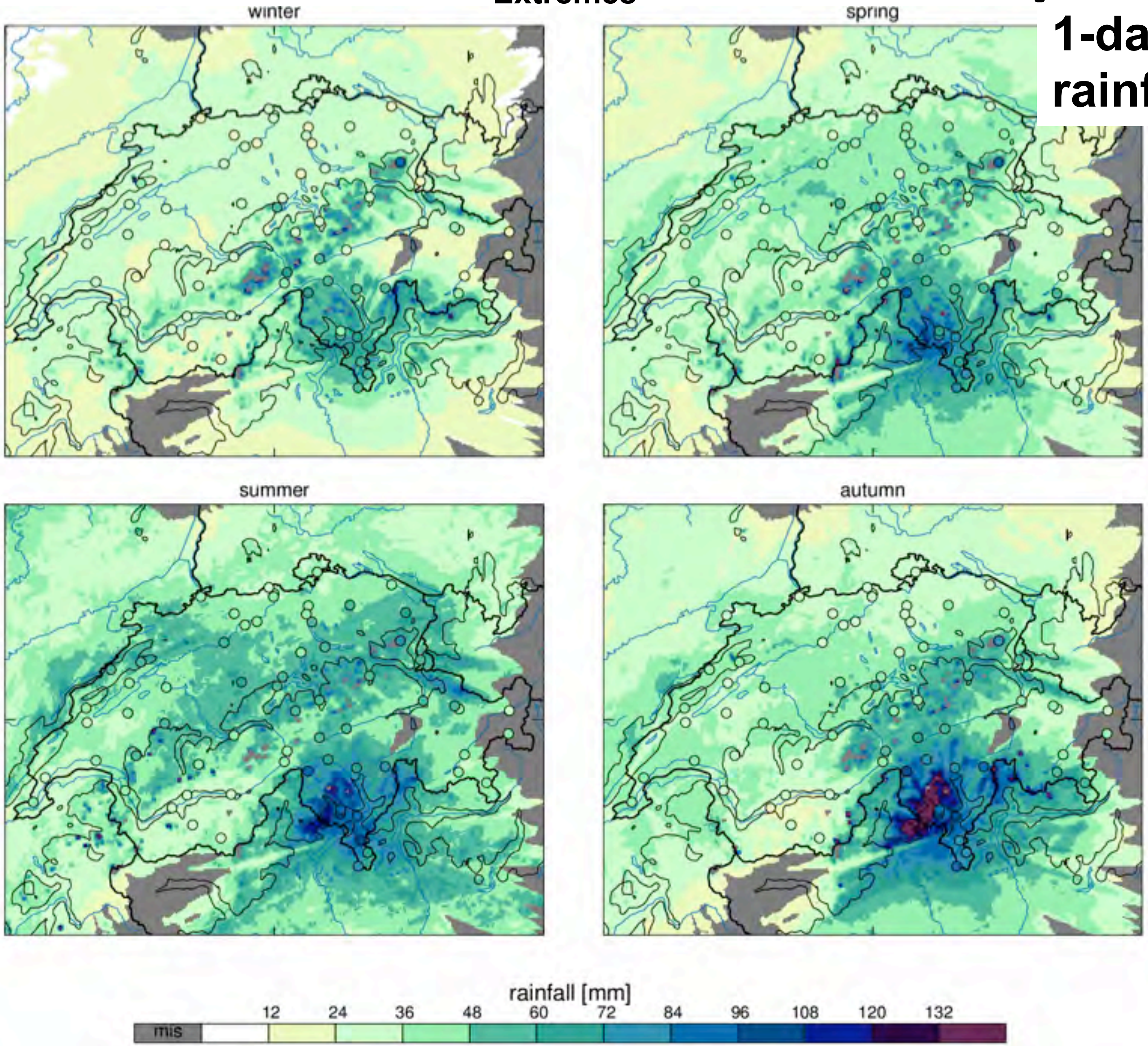


Extremes

- **1-day rainfall**

UNIVERSITÄT BERN

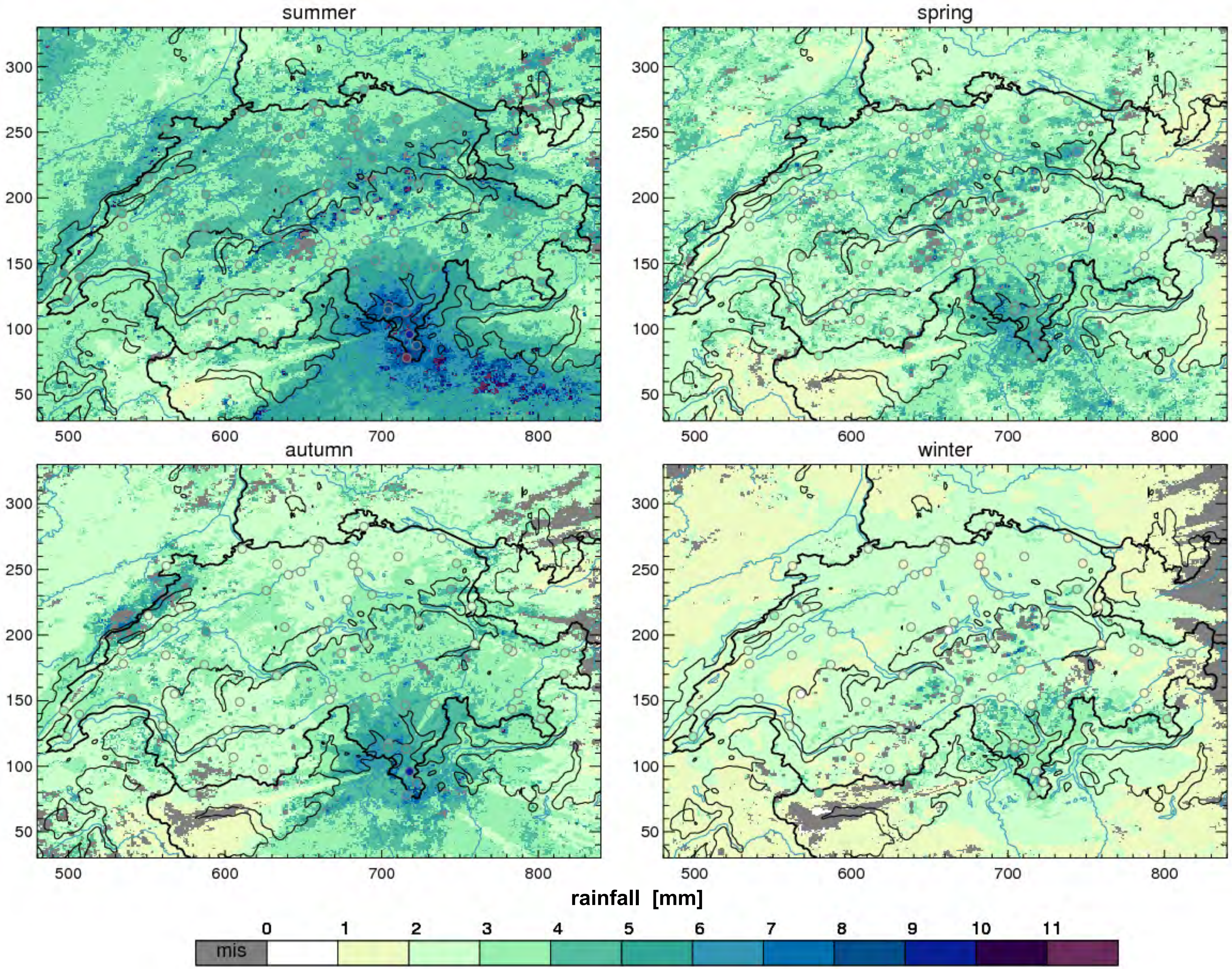
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

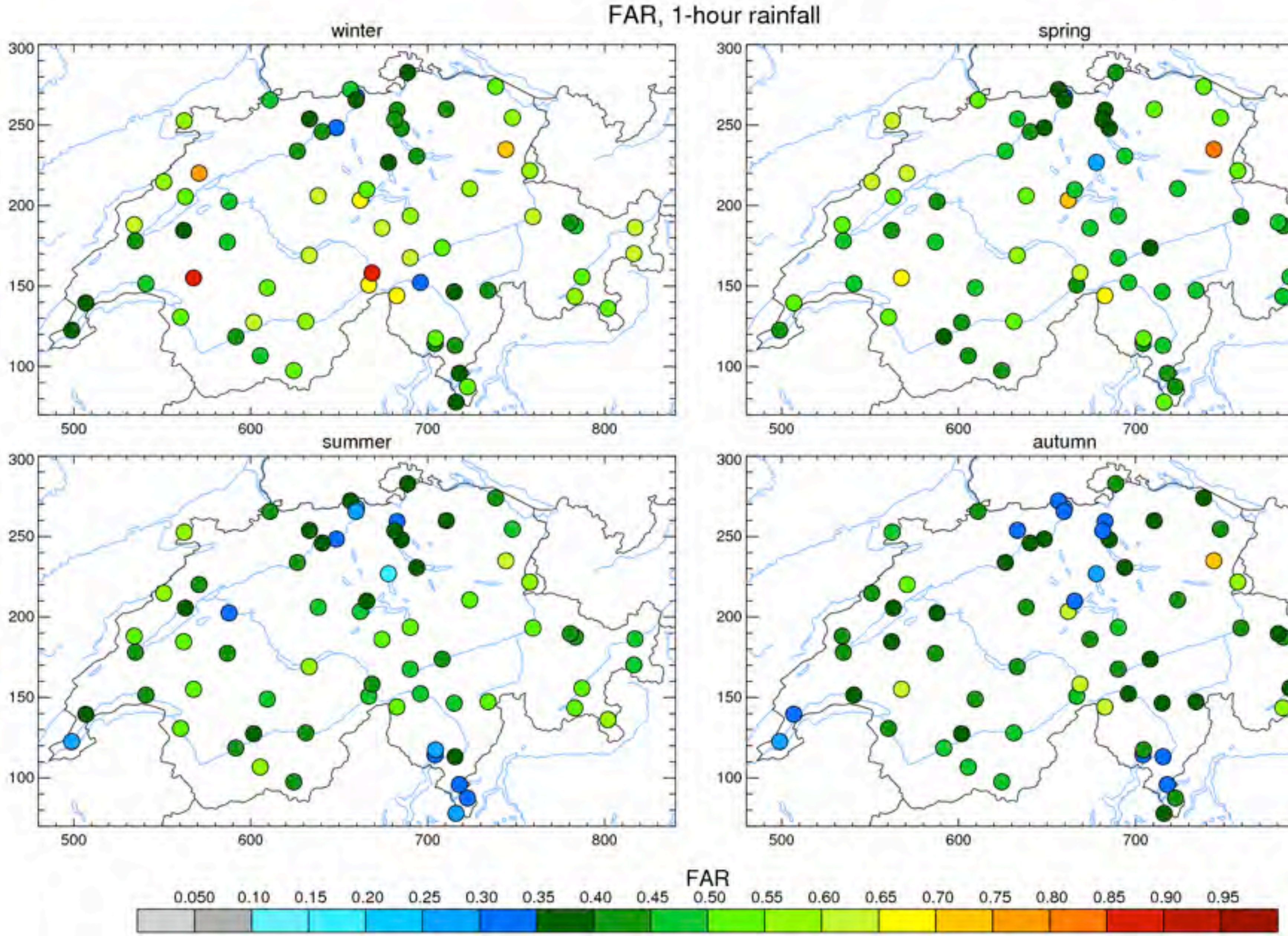


1-hour rainfall, GP

UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH




FAR, 1-hour rainfall
winter
spring
summer
autumn
300
250
200
150
100
500
600
700
800
FAR
0.050 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95

Verification skill scores
CPC Cross Val. vs. rain gauges

0.5 dB = 12 %
1 dB= 26%
2 dB = 59 %

UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

Contingency table

	G > th.	G < th.
CPC > th.	a	b
CPC < th.	c	d

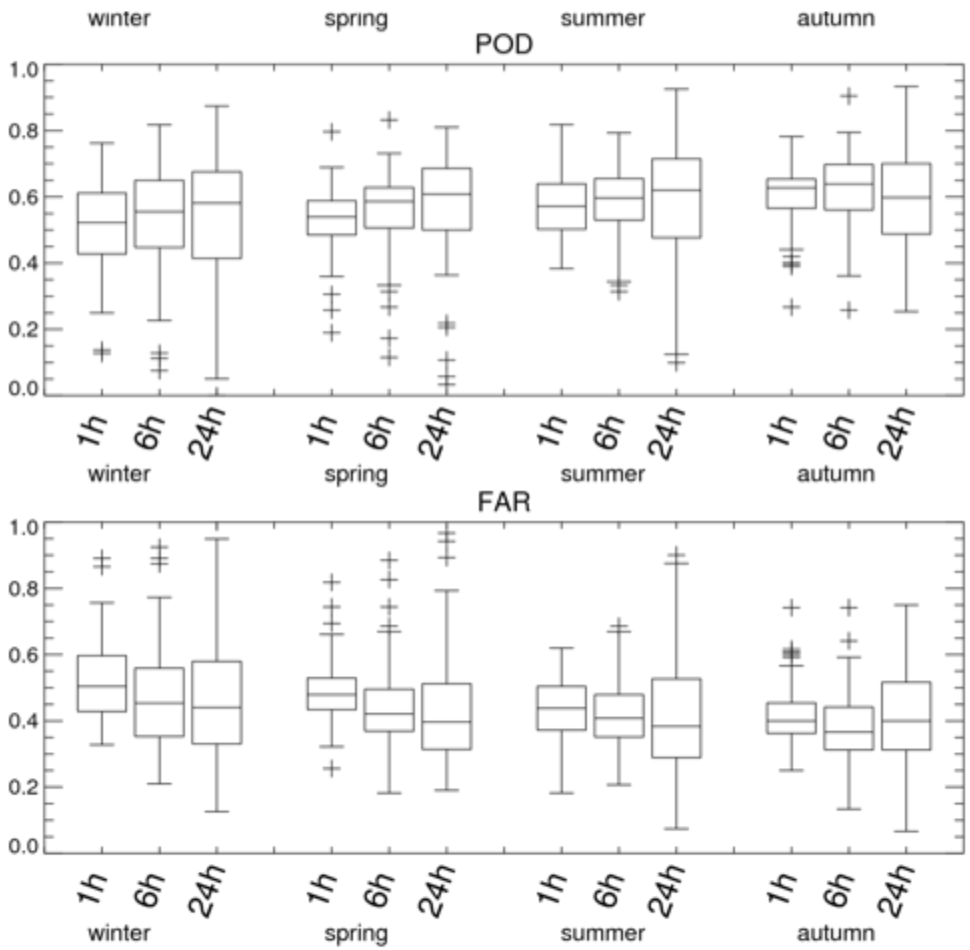
th = 99.5th percentile

Probability of detection

$$POD = a/(a+c)$$

False alarm ratio

$$FAR = b/a+b$$



Verification skill scores
CPC Cross Val. Vs. rain gauges

Contingency table

	G > th.	G < th.
CPC > th.	a	b
CPC < th.	c	d

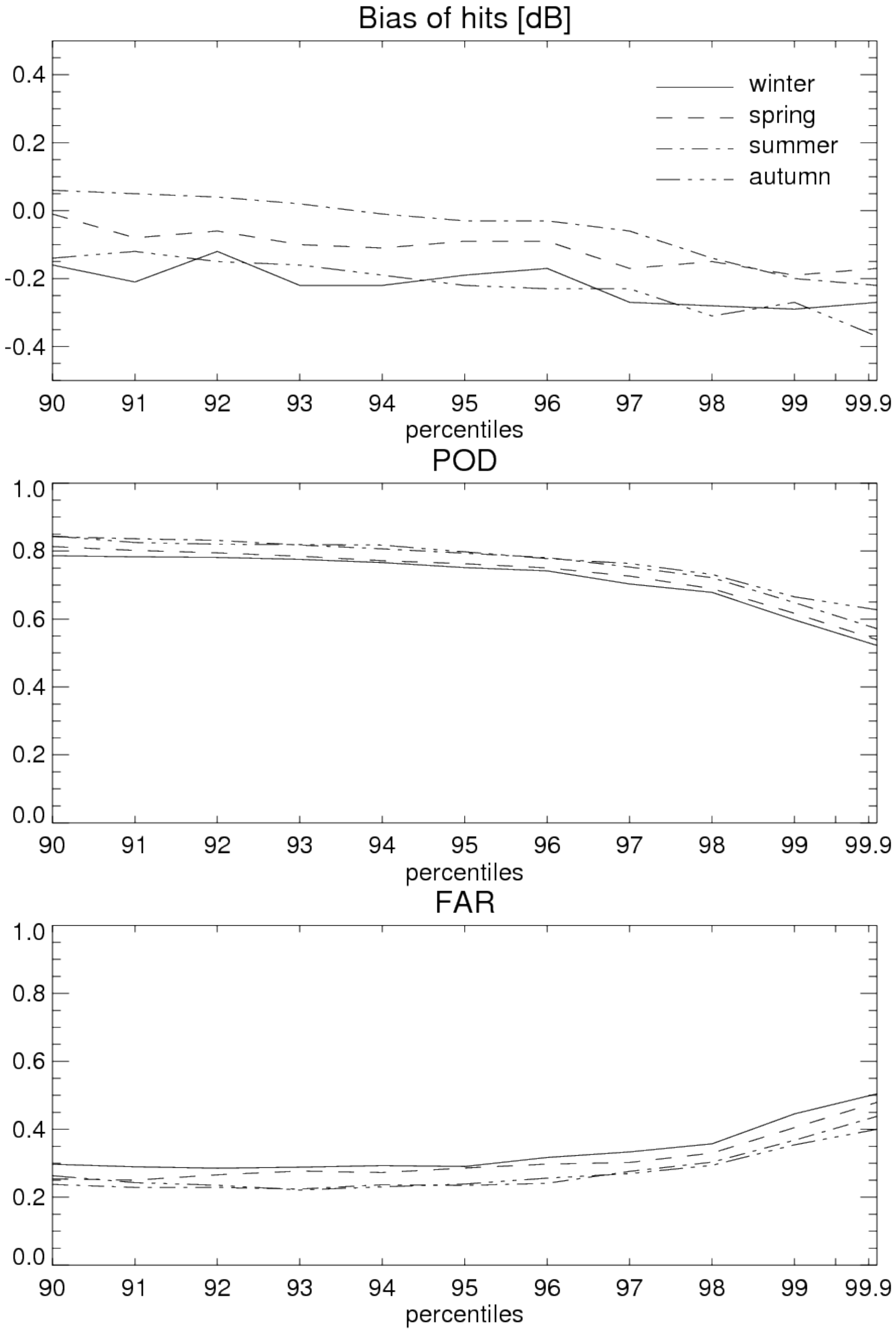
th = 99.5th percentile

Bias of hits
$$bias\ [dB]=10\ log10(tot(CPC_a)/tot(G_a))$$

Probability of detection
$$POD=a/(a+c)$$

False alarm ratio
$$FAR=b/a+b$$

0.5 dB = 12 %
1 dB= 26%
2 dB = 59 %



UNIVERSITÄT BERN
OESCHGER CENTRE CLIMATE CHANGE RESEARCH

High impact events related to sub-daily precipitation extremes

Sub-daily precipitation is relevant for

surface water floods

flash floods

urban flooding

Often high intensity, very localized convective events → need for high-resolution (space / time) data