

A systematic evaluation of return period estimates from short observational records

Joel Zeder, Sebastian Sippel, Erich Fischer
Climate Physics Group, ETH Zurich

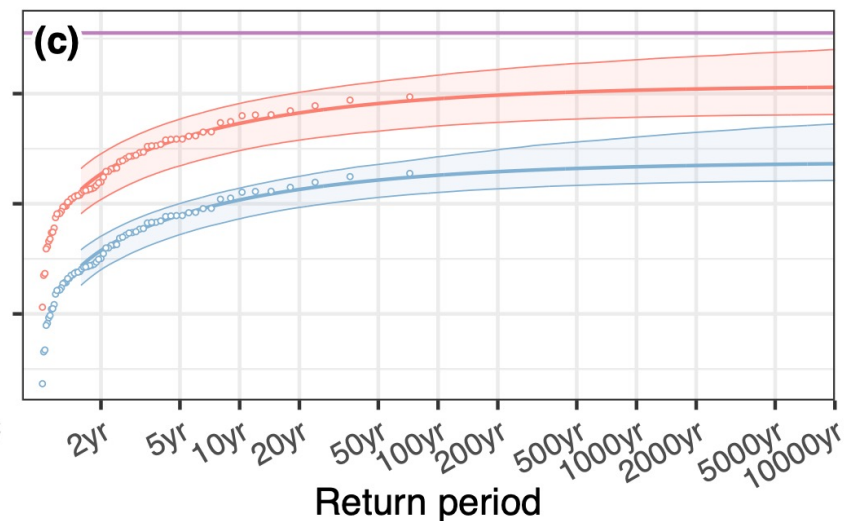
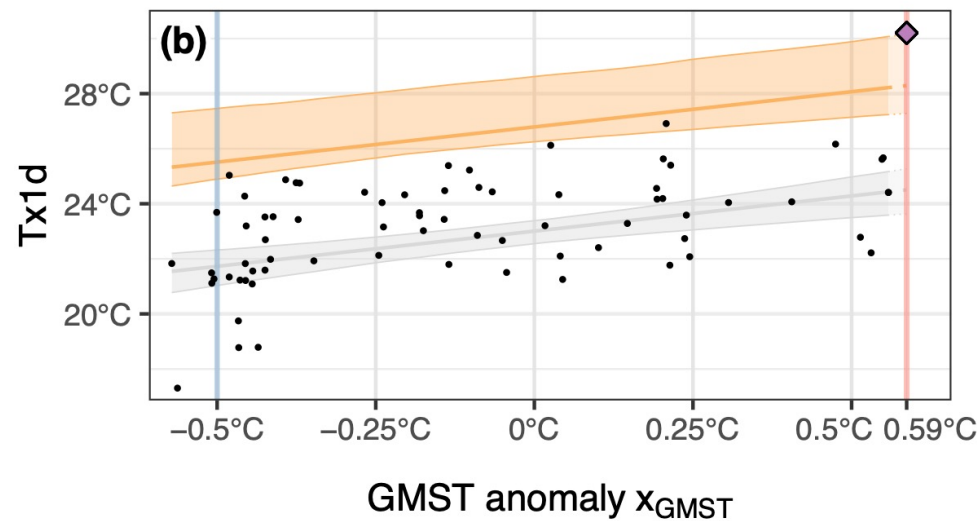
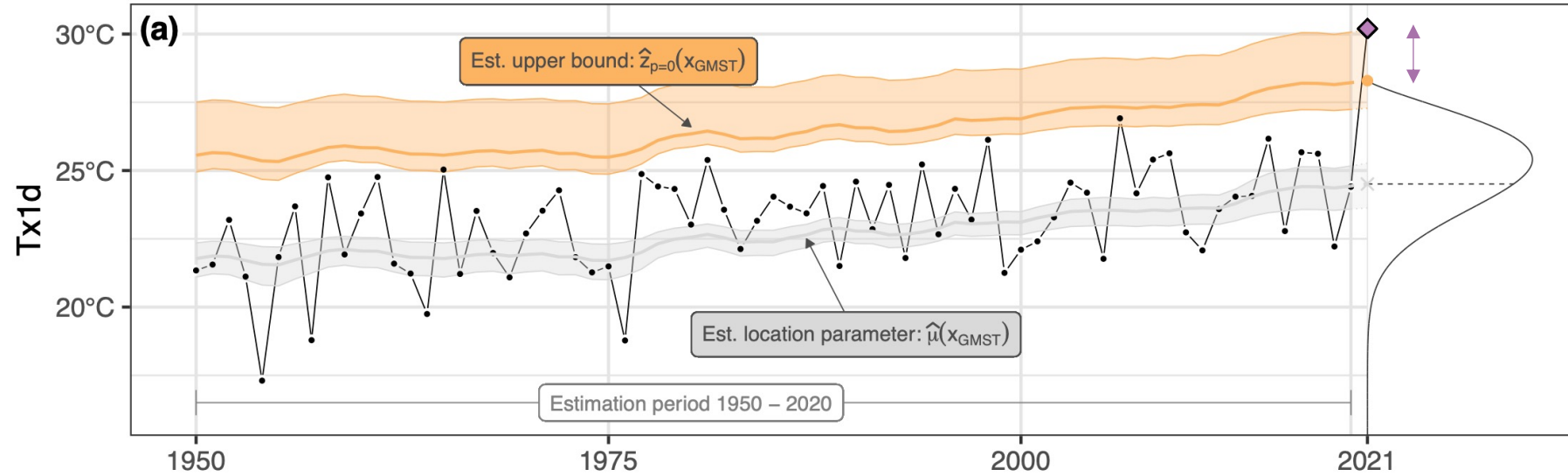
EGU General Assembly, Session CL3.1.2
25.04.2023

Motivation

What was the likelihood of the PNW heatwave?

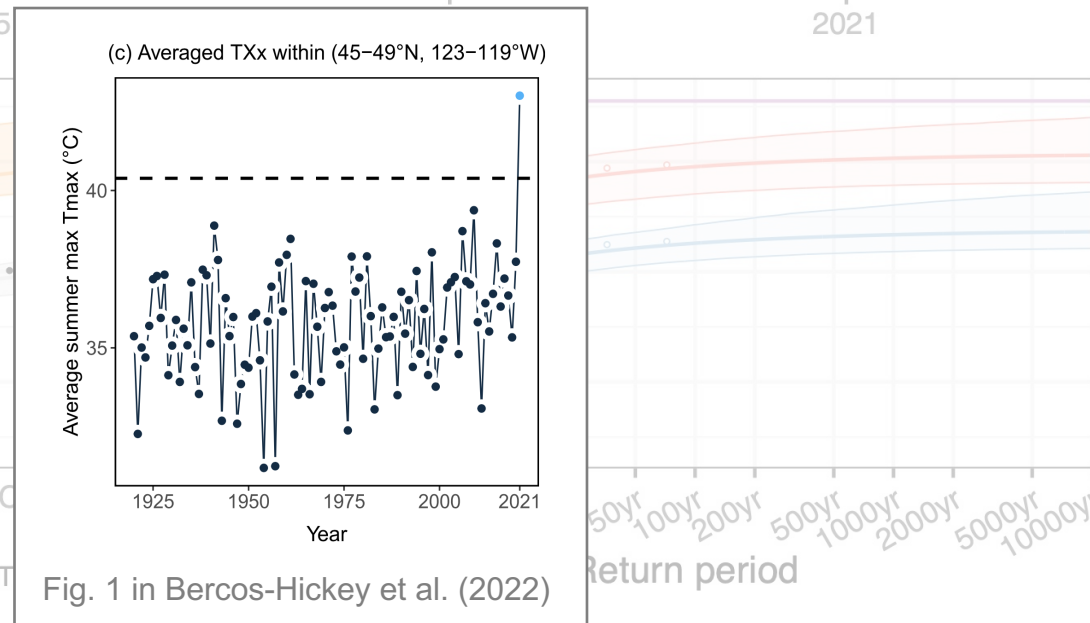
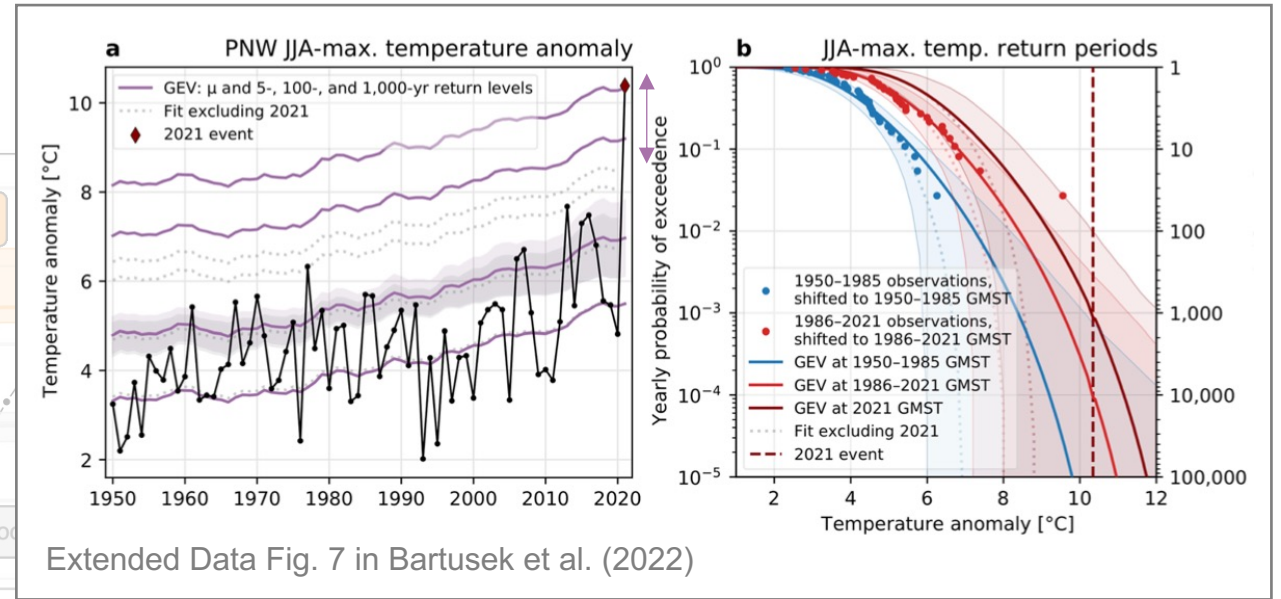
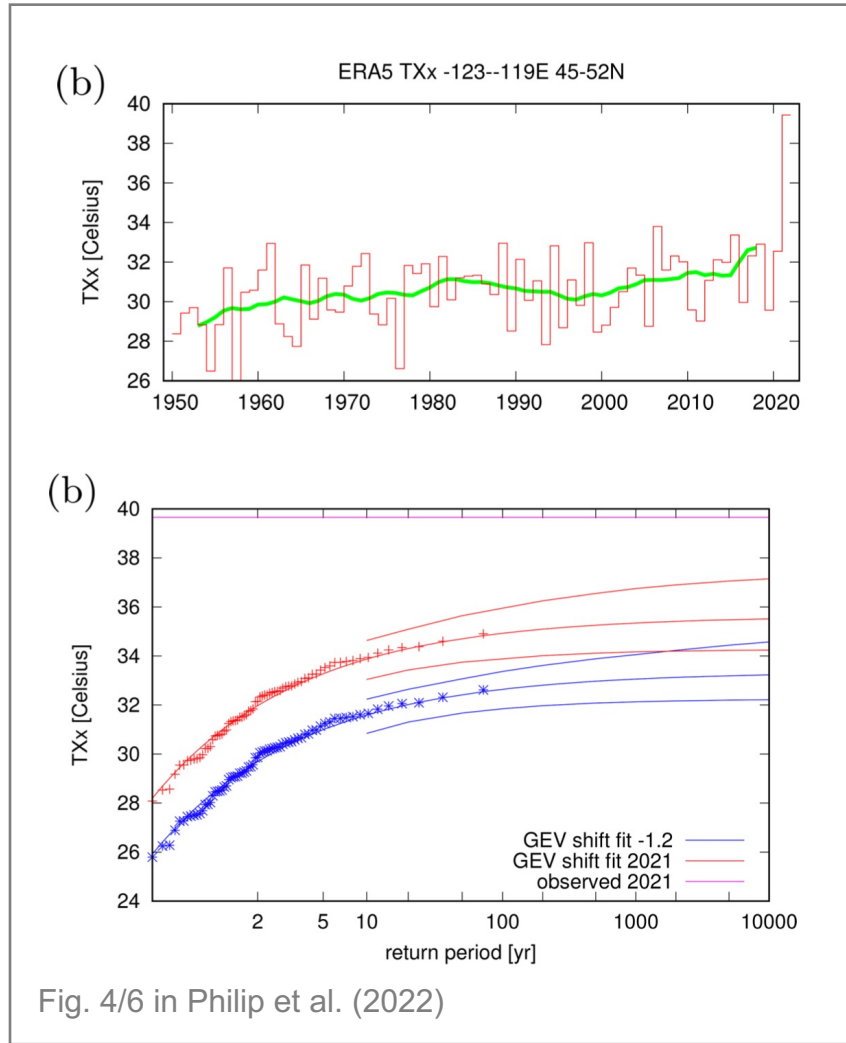
$$P(Z \leq z) = G_Z(z; \mu, \sigma, \xi)$$

$$\mu = \mu_0 + \mu_{\text{GMST}} x_{\text{GMST}}$$



Motivation

Was this heatwave impossible?



Research Goals

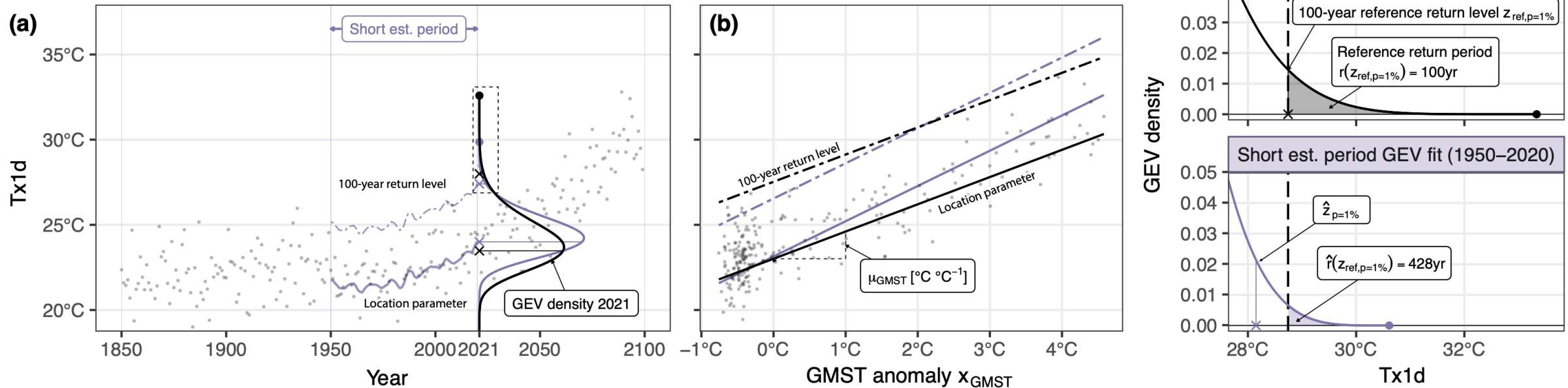
A systematic evaluation of return level and return period estimates

- How well are return levels and return periods estimated based on a limited amount of data?
 - Does climate change play a role?
 - Should the event be included in the fit?

Data and Methods

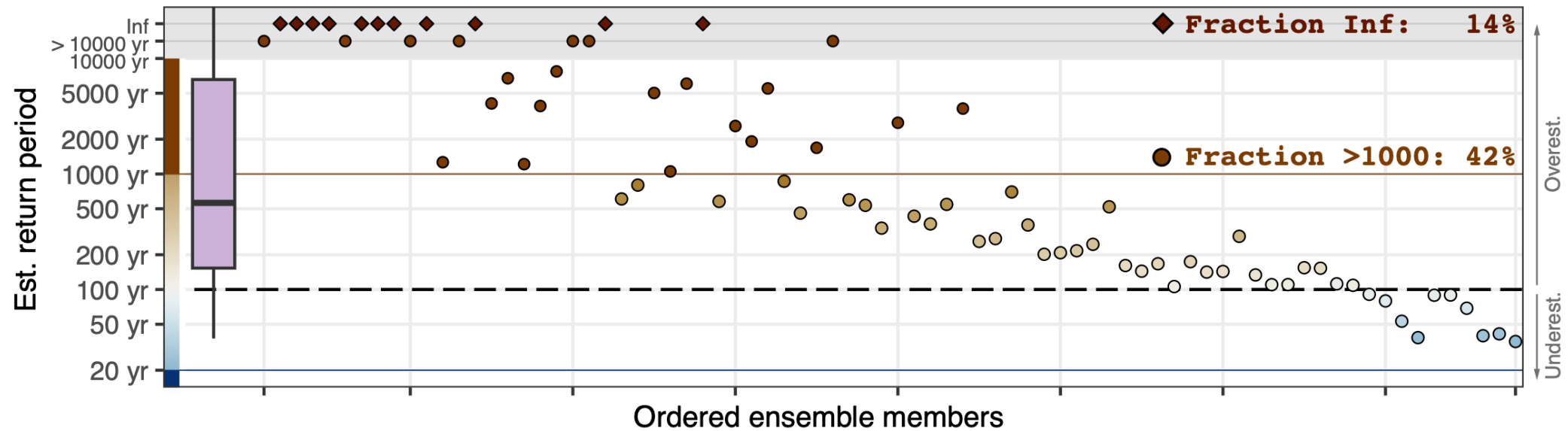
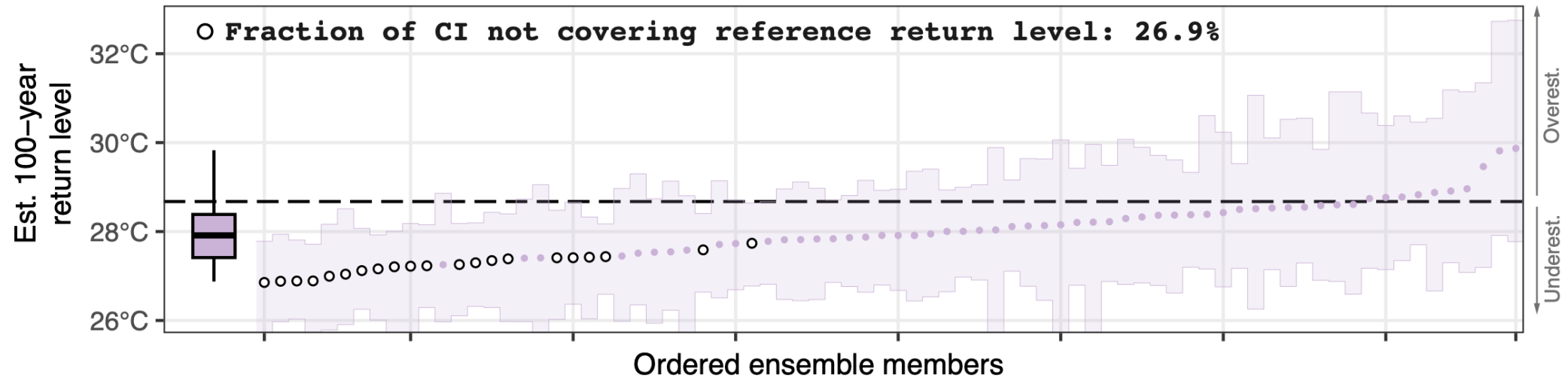
Making use of large ensemble climate model data

1. Determine reference 100-year return level by fitting a non-stationary GEV to the pooled large-ensemble data (84 members CESM1.2 / 90 members CESM2)
2. Fit GEV on 71-year subperiod in individual ensemble member
3. Evaluate estimates of
 - 100-year return levels &
 - return periods of the 100-year reference return level



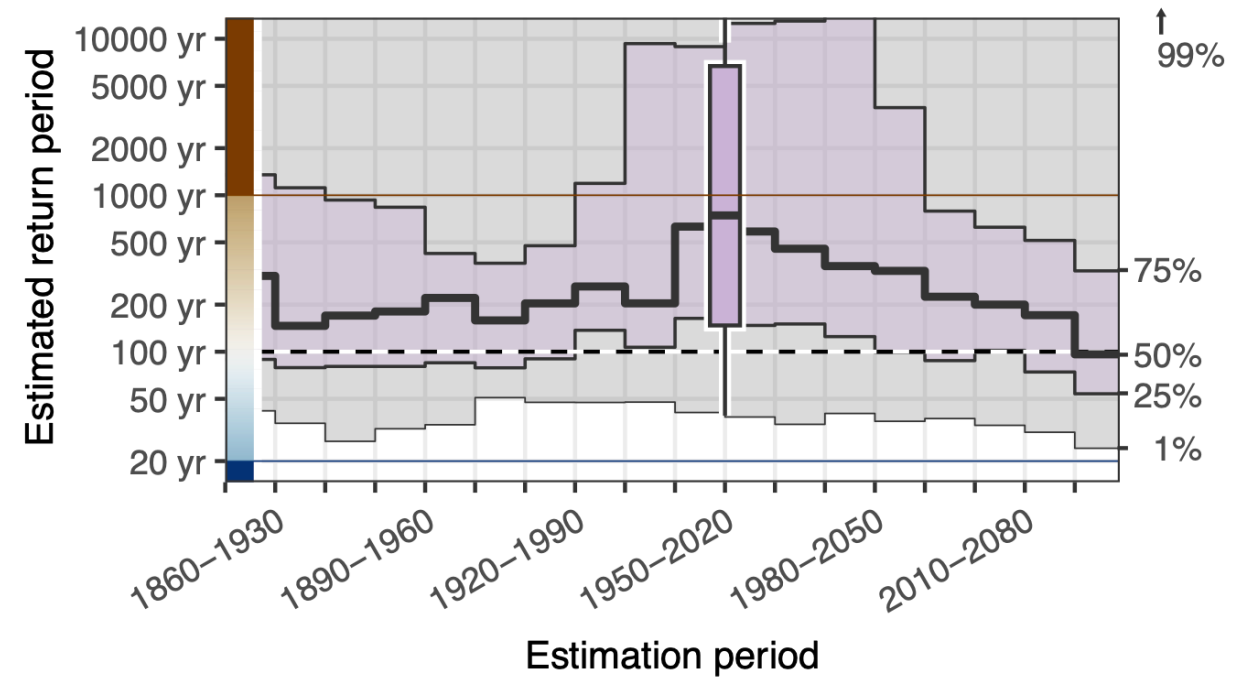
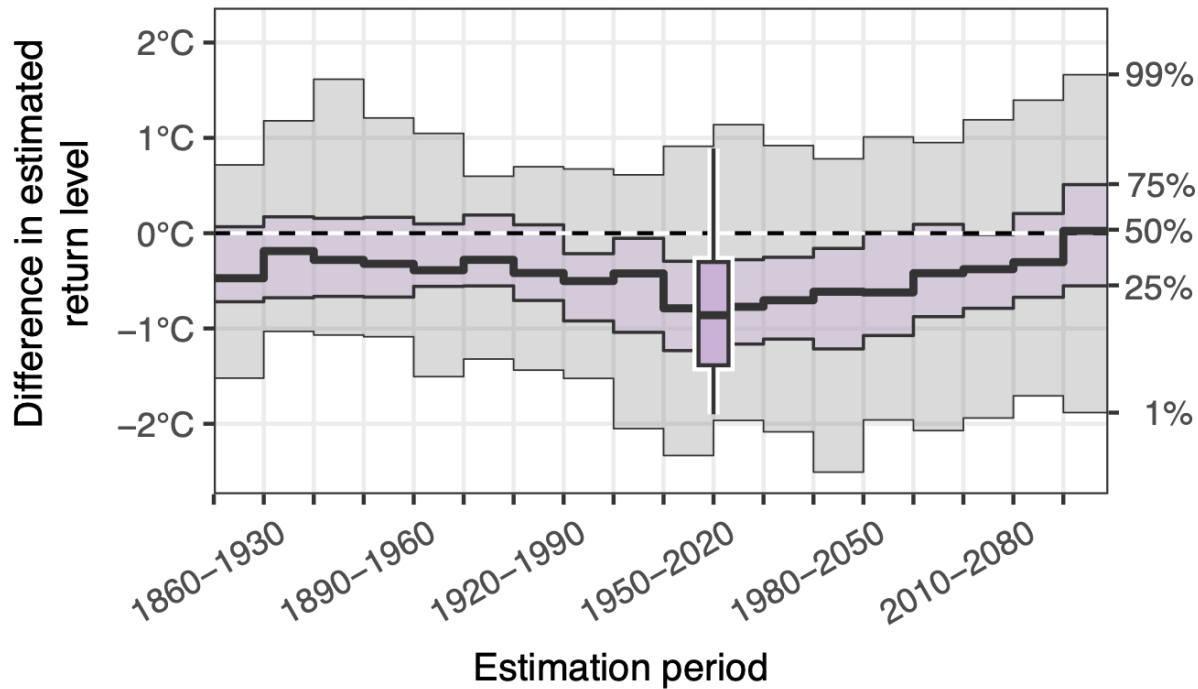
Evaluation Results 1

Return level and return period estimates in 2021



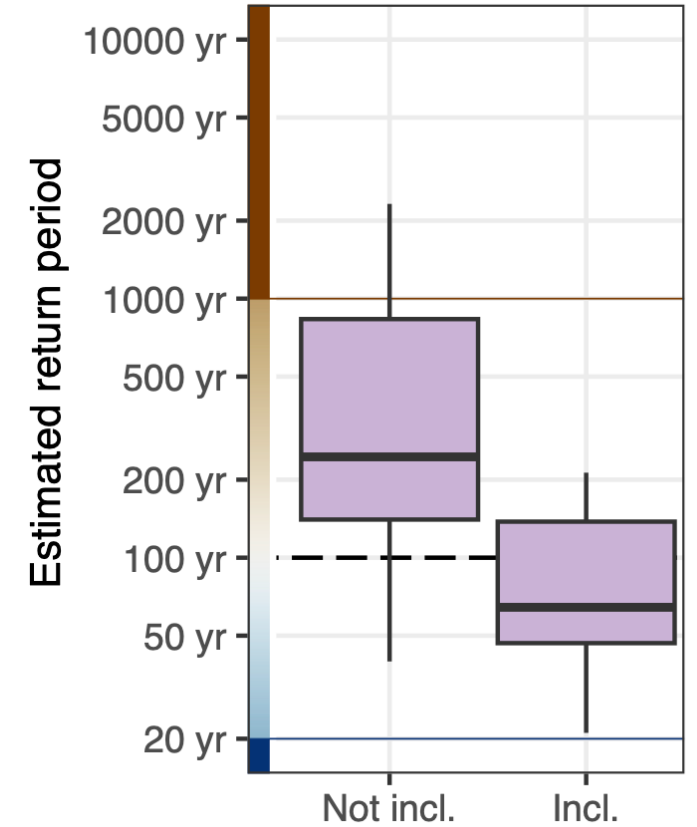
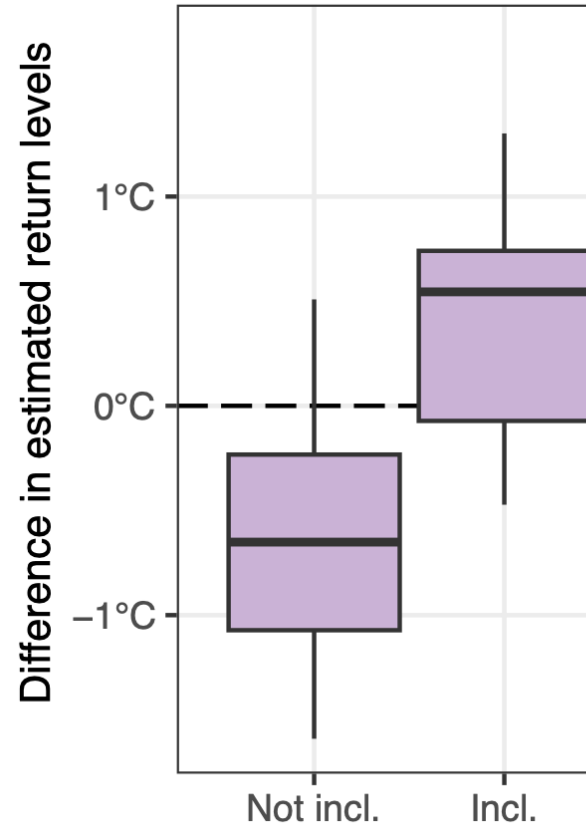
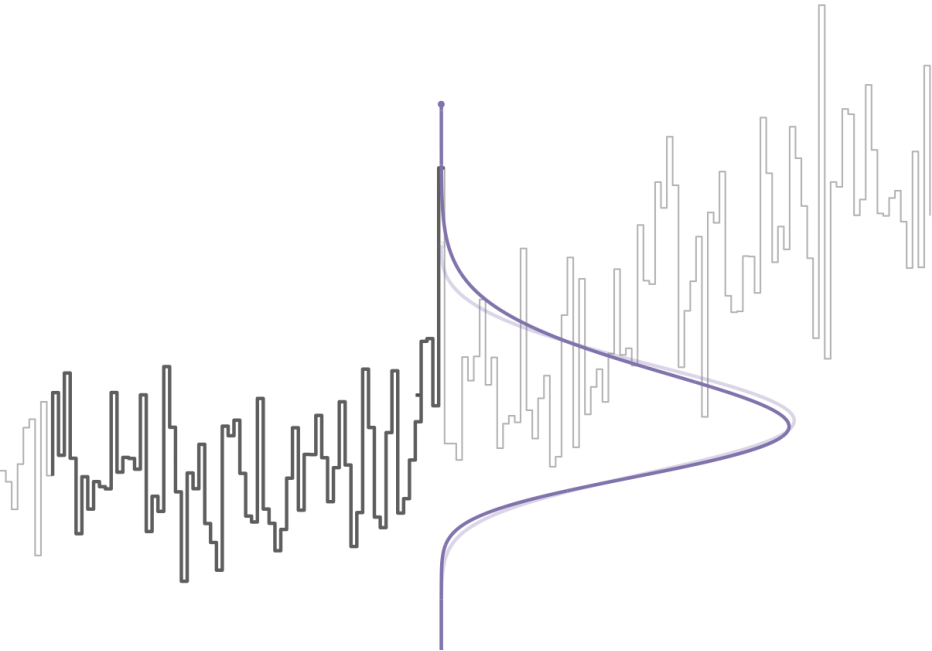
Evaluation Results 2

Return level and return period estimates over time



Evaluation Results 3

Change of estimates if the extreme event is included



Take Away Messages

A systematic evaluation of return level and return period estimates

- How well are return periods estimated based on a limited amount of data?
 - Systematic asymptotic bias (vanishes for larger samples)

- Does climate change play a role?
 - Aggravates bias in the transition period

- Should the event be included in the fit?
 - Estimates are also biased when including the event