Low-likelihood storylines for climate extremes

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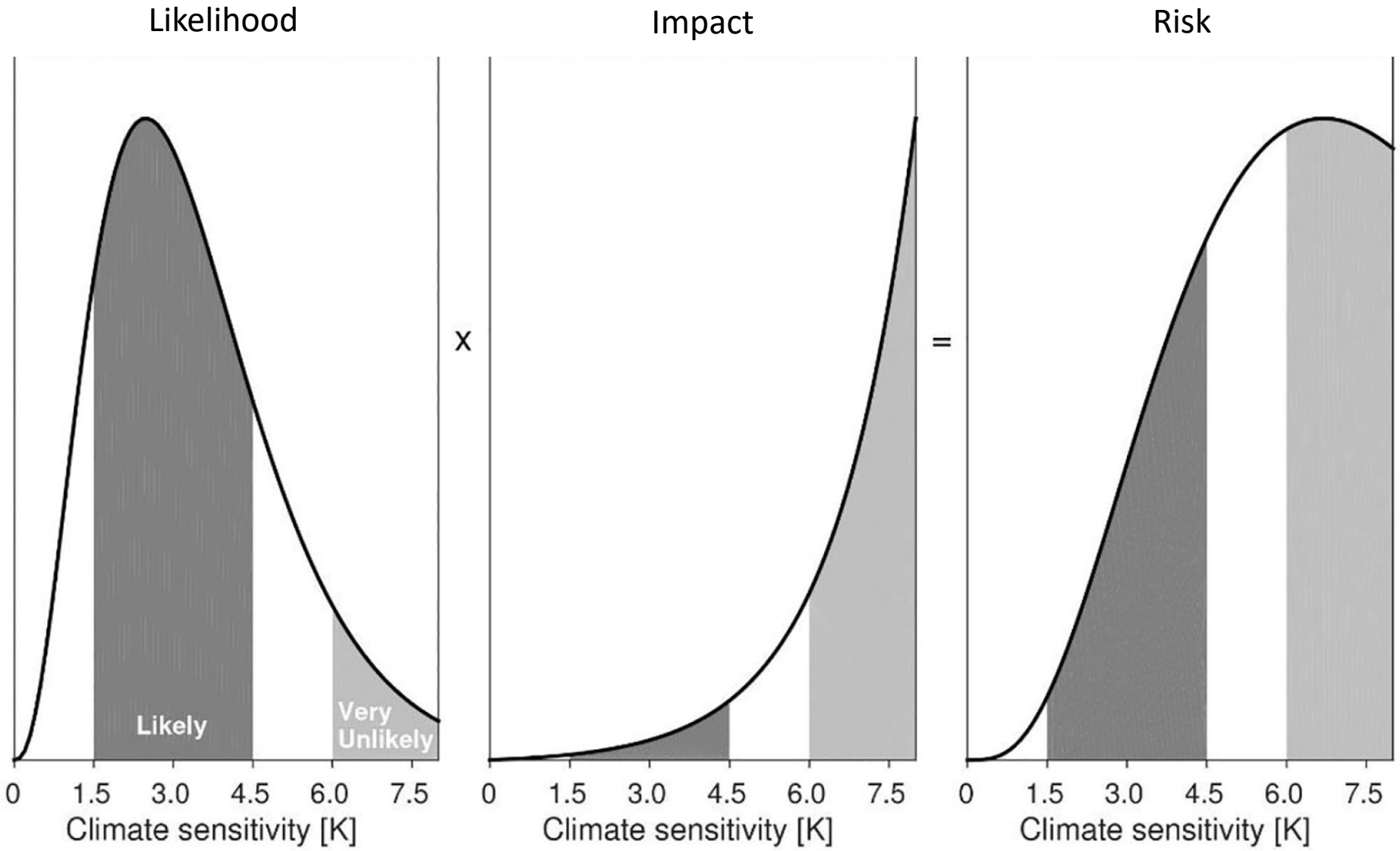
Highest risk at *unlikely* very high levels of warming

How would multiple hazards change at a very high level of global warming?



Sutton (2018) *Earth Syst. Dynam.*

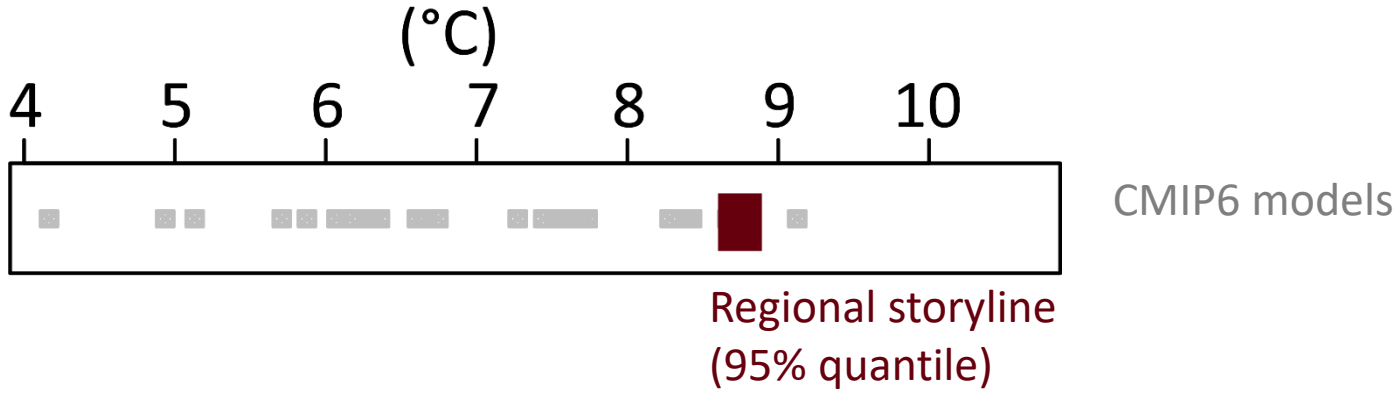
Physical climate storyline

A self-consistent and **plausible** unfolding of a physical trajectory of the climate system

Definition adapted from Shepherd (2019) *Proc. R. Soc. A.*

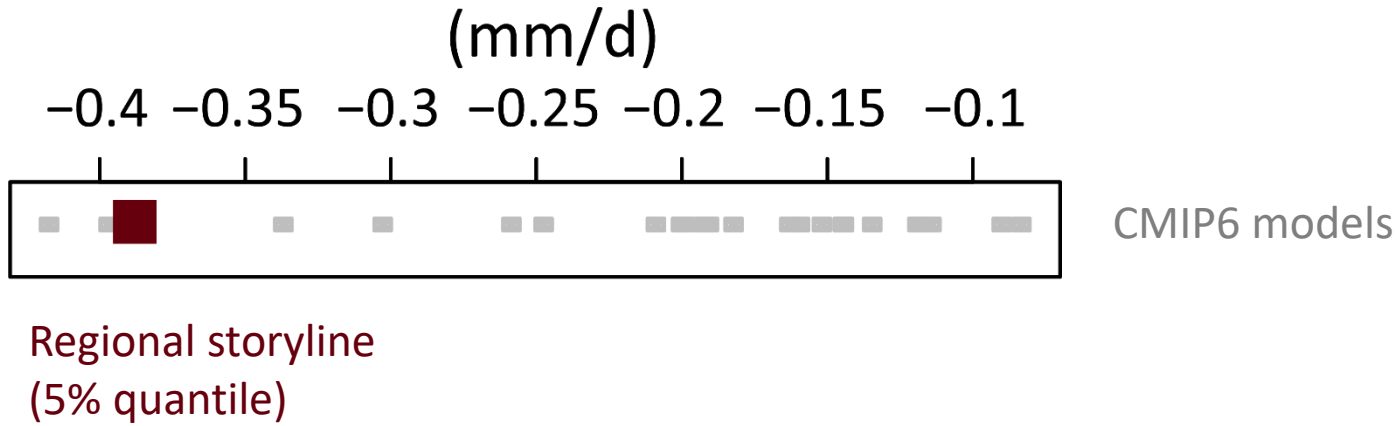
Challenge 1: Consistency across multiple hazards

Heatwave intensity (Tx7day) in 2081-2100 relative to 1995-2014 over Mediterranean (SSP5-8.5)



Are the storylines for the two hazards consistent?

Annual dryness (P-E) in 2081-2100 relative to 1995-2014 over Mediterranean (SSP5-8.5)

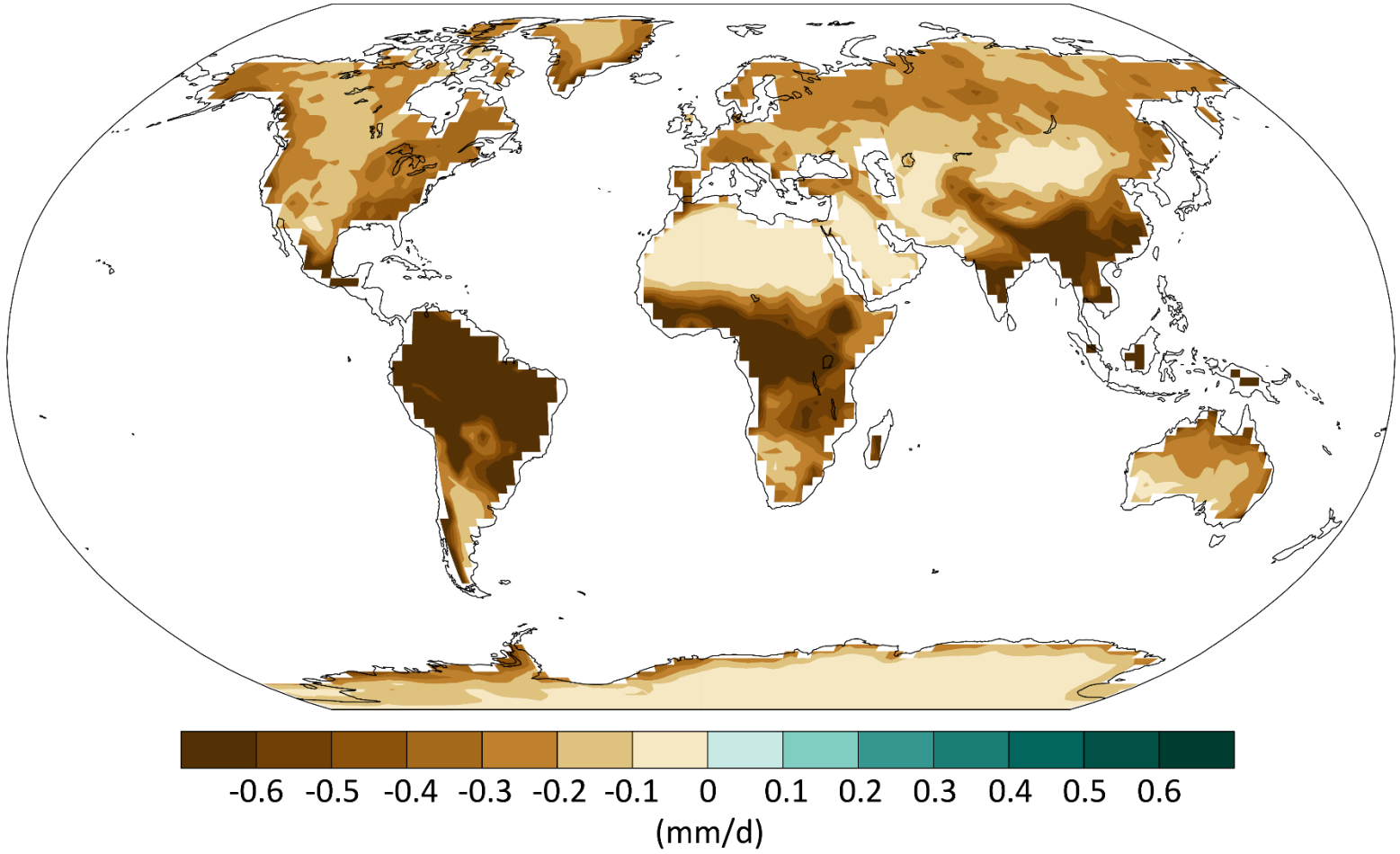


Fischer, Schwingshackl and Sillmann (2021) *in prep.*.

Challenge 2: Physical consistency across the global pattern

A global map of the highest local changes everywhere is physically implausible

Dryness storylines (P-E) calculated at each gridpoint



5% quantile of local changes in 2081-2100 relative to 1995-2014 (SSP5-8.5)

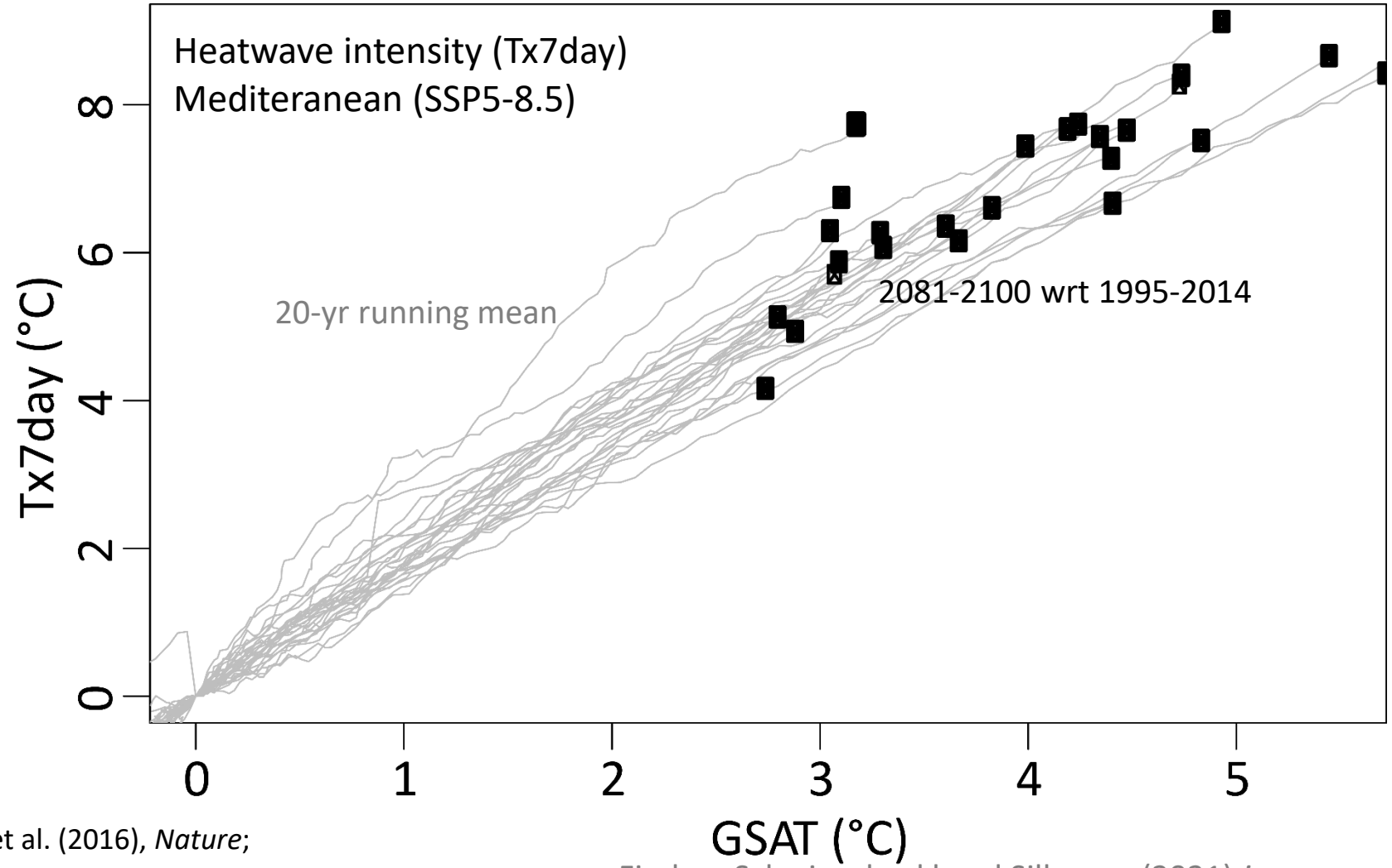
Fischer, Schwingshackl and Sillmann (2021) *in prep.*.

Towards a global low-likelihood high-warming (LLHW) storyline

Goal: globally coherent pattern and physically consistent storyline across multiple hazards

Anchoring the storyline on global temperature

Extremes tend to intensify with GSAT warming

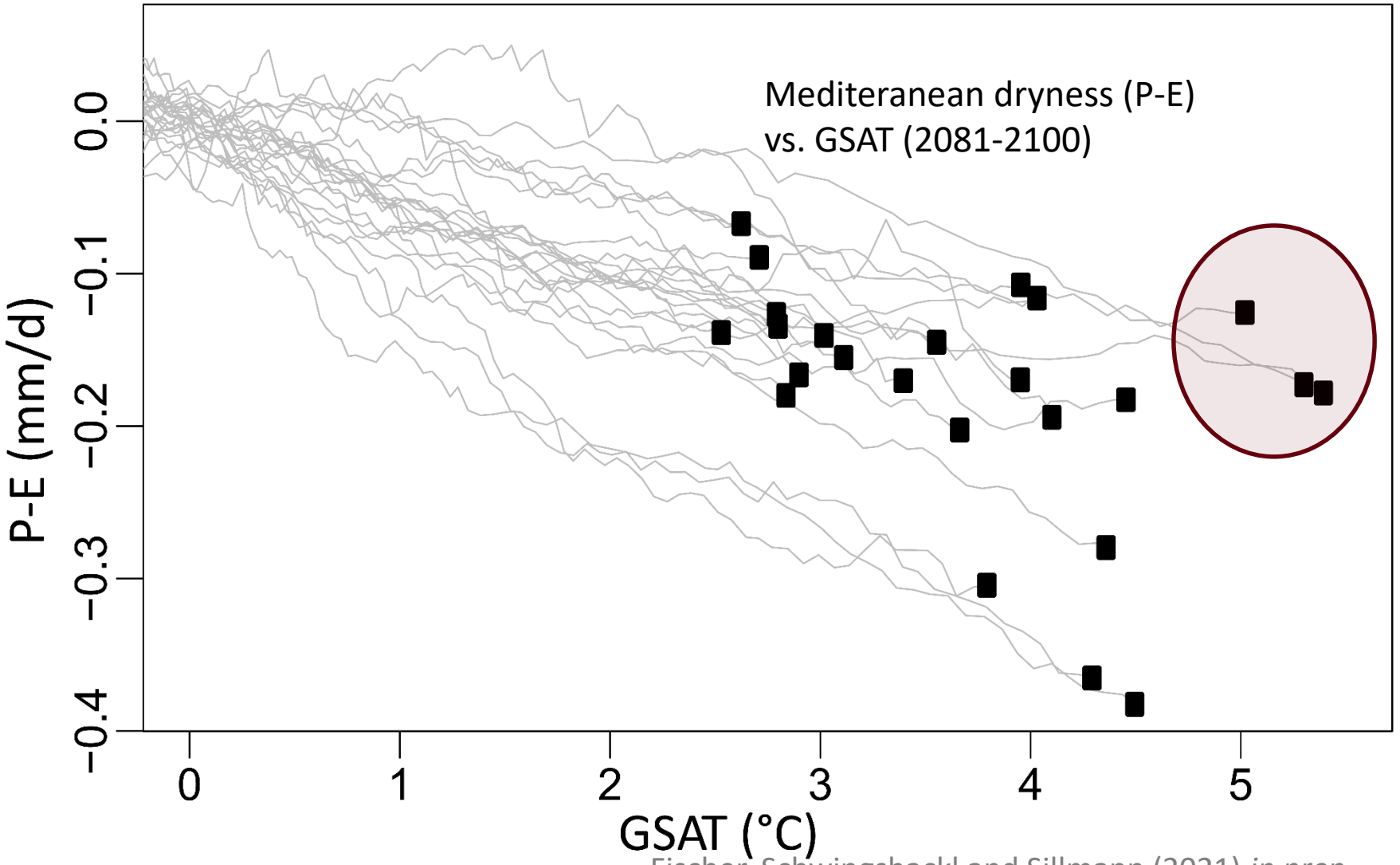


See also Fischer et al. (2014), *GRL*; Seneviratne et al. (2016), *Nature*; Seneviratne and Hauser (2020) *Earth's Future*

Fischer, Schwingshackl and Sillmann (2021) *in prep.*.

Model with highest warming does not show greatest drying

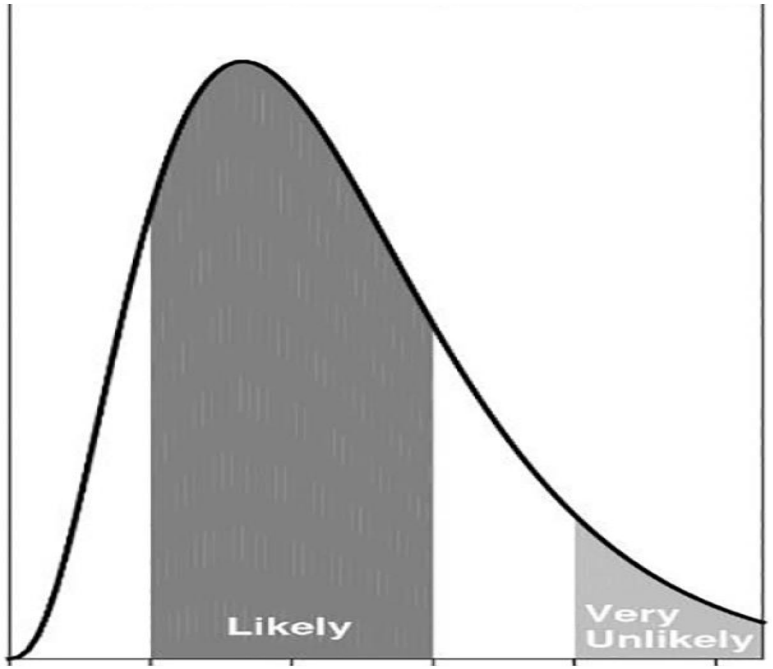
Scaling with GSAT *within* models does not imply that response can be scaled *across* models

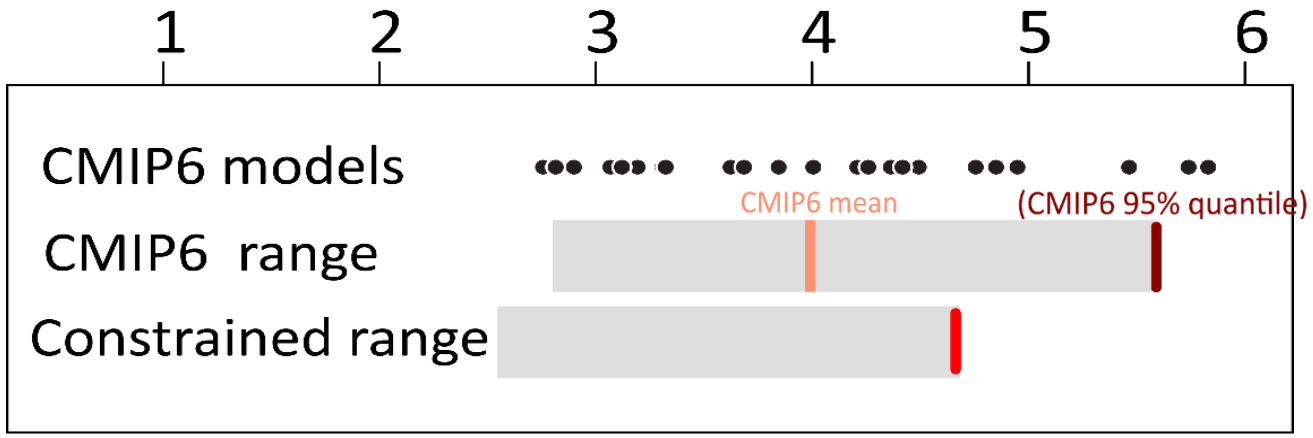


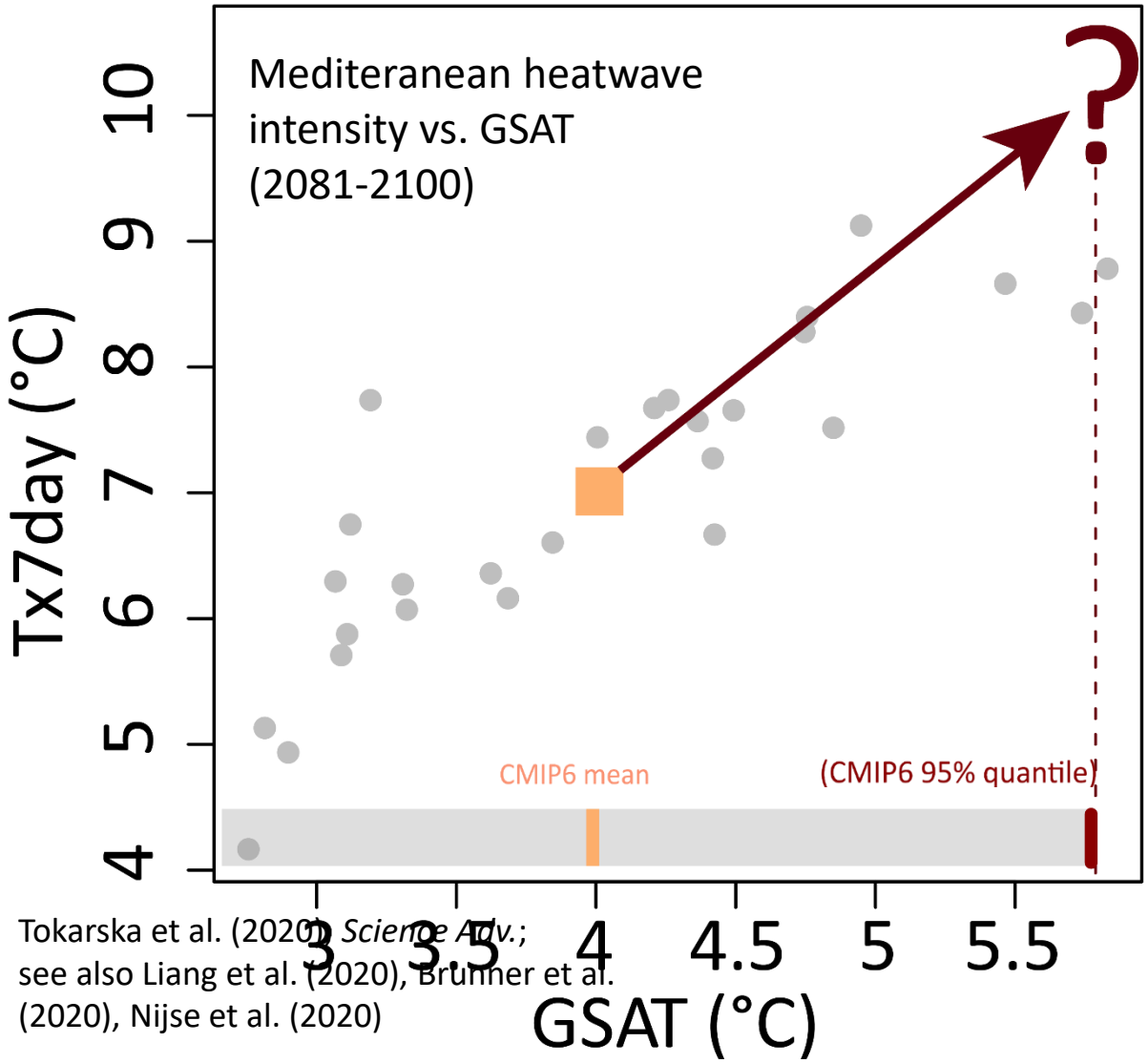
Fischer, Schwingshackl and Sillmann (2021) *in prep.*.

How would extremes change at a very high level of warming?

Global warming (SSP5-8.5)
2081-2100 wrt 1995-2014



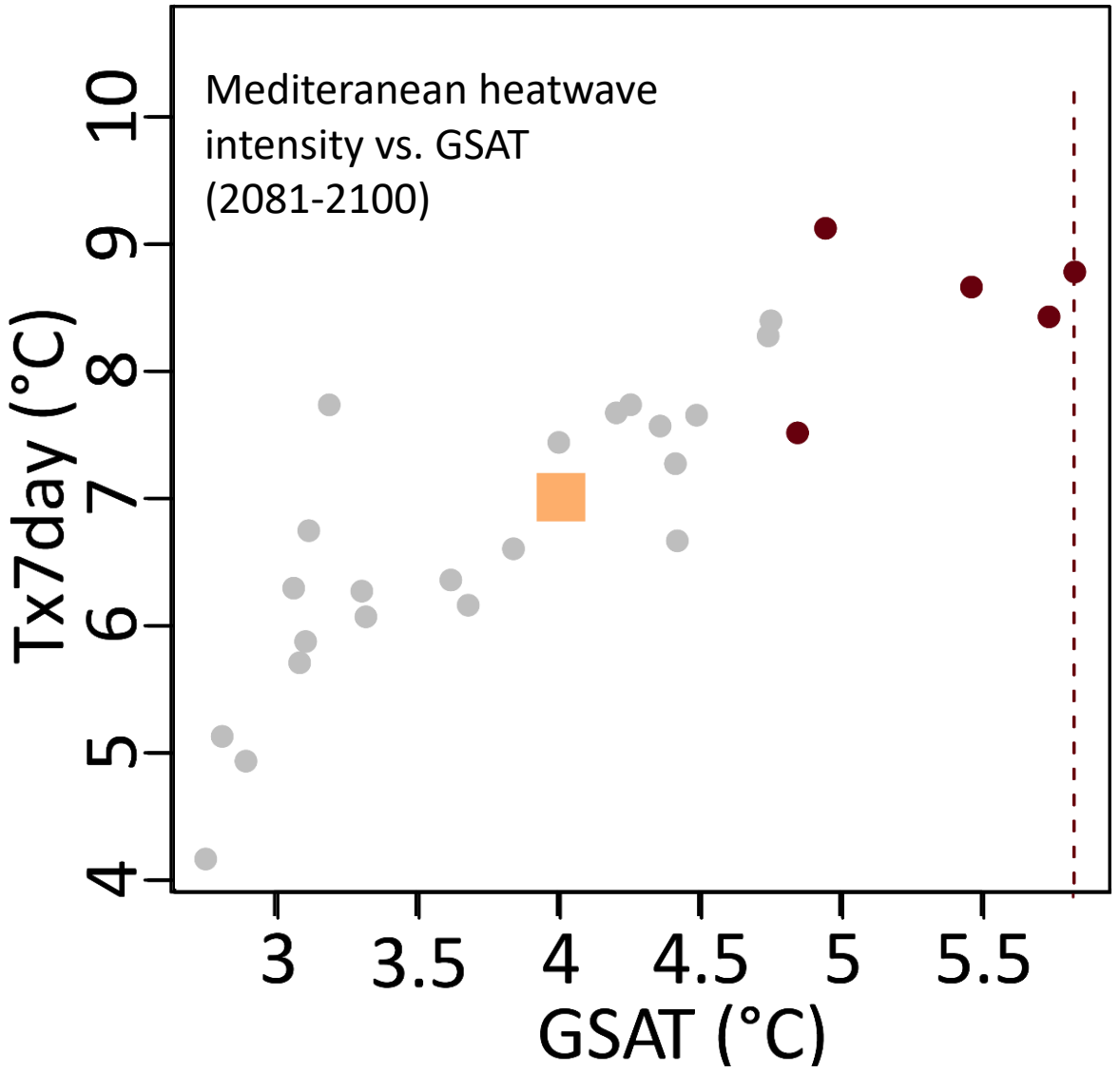




Tokarska et al. (2020) *Science Adv.*; see also Liang et al. (2020), Brunner et al. (2020), Nijse et al. (2020)

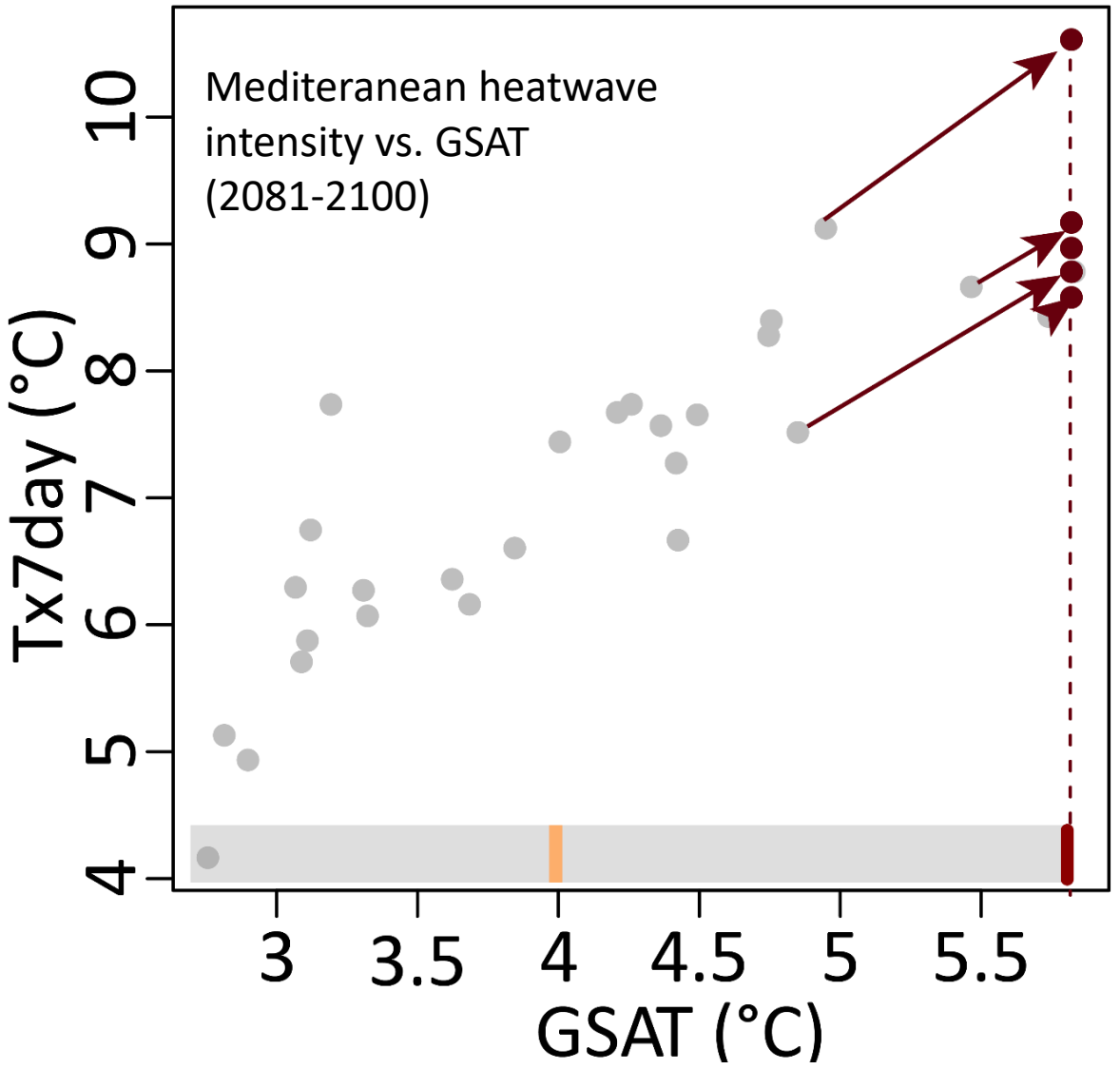
How would extremes change at a very high level of warming?

Challenge: by constructions few models reach very high warming level



Nearest-neighbour warming level approach

Extrapolating response within model is different than multi-model mean pattern scaling

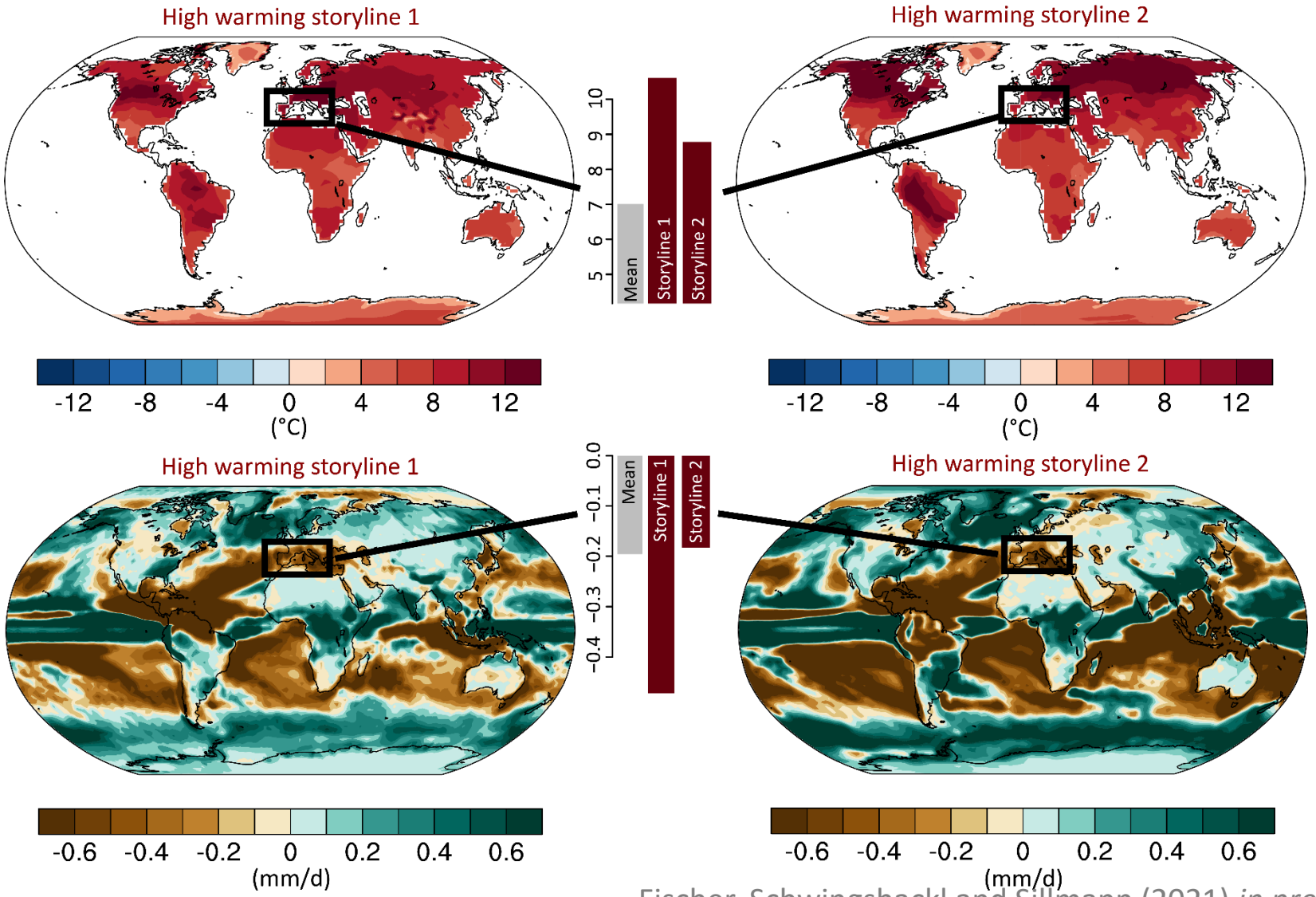


Two physically coherent global LLHW storylines

Heatwave intensity (Tx7day)

Dryness (P-E)

Advantage: Storylines are coherent across pattern and across multiple hazards



Fischer, Schwingshackl and Sillmann (2021) *in prep.*.

Preliminary conclusions

- Global LLHW storylines preserve physical consistency across pattern and multiple hazards
- LLHW storylines suggest that changes in different types of extremes may be substantially larger than in the multi-model mean
- Plausibility of LLHW storylines needs to be further tested