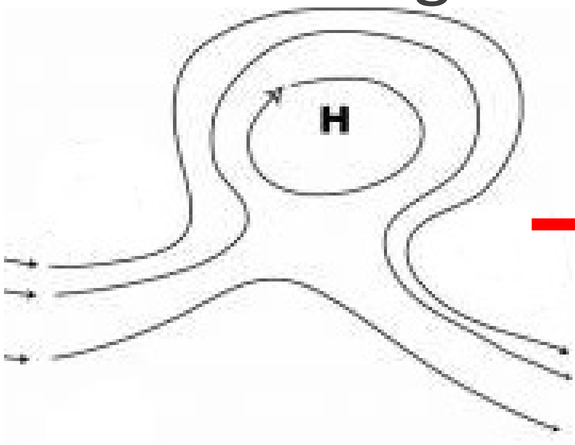
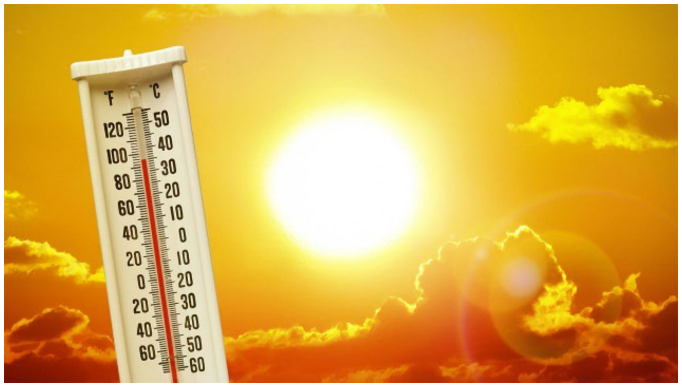
复旦大学大气与海洋科学系
DEPARTMENT OF ATMOSPHERIC AND OCEANIC SCIENCES
FUDAN UNIVERSITY

Blocking



Heatwaves

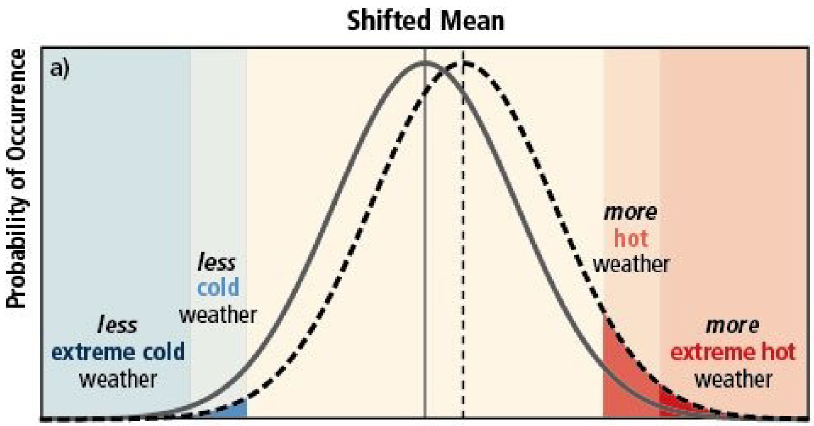


Significant slope change but insignificant correlation change between heatwaves and blocking under future global warming

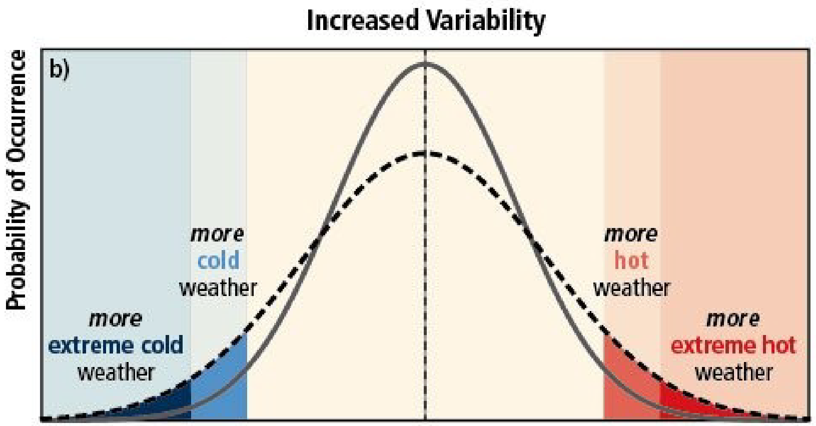
Pak Wah CHAN

Collaborators: Jilin Zhang, Jennifer Catto, Matthew Collins

Factors in heatwave frequency



Mean: Easy to adapt

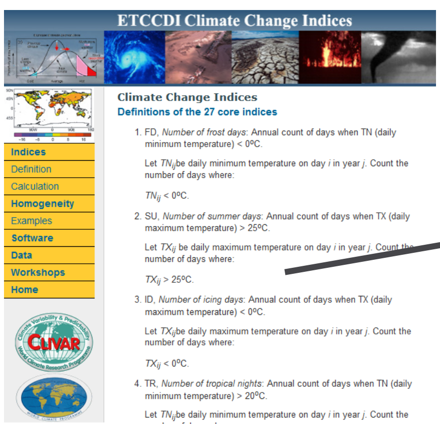


IPCC 2012

Variability: Hard to adapt

Heatwave definition

- **CMIP6** daily: $T_{2m,max}$
- Seasonal cycle and **long-term trend removed**
- Land only, summer (Jun 20 – Aug 18)
- **Heatwaves:** $T_{2m,max}$ exceed 90^{th} percentile for 6+ days
- **Historical** percentile



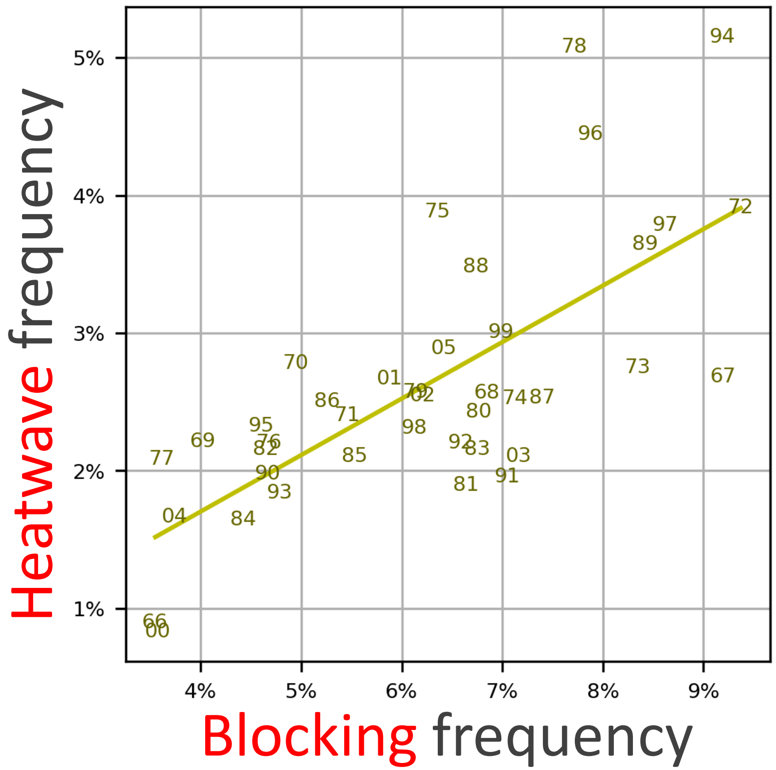
14. WSDI, *Warm speel duration index*: Annual count of days with at least 6 consecutive days when TX > 90^{th} percentile

Let TX_{ij} be the daily maximum temperature on day *i* in period *j* and let $TX_{in}90$ be the calendar day 90^{th} percentile centred on a 5-day window for the base period 1961-1990. Then the number of days per period is summed where, in intervals of at least 6 consecutive days:

$TX_{ij} > TX_{in}90$

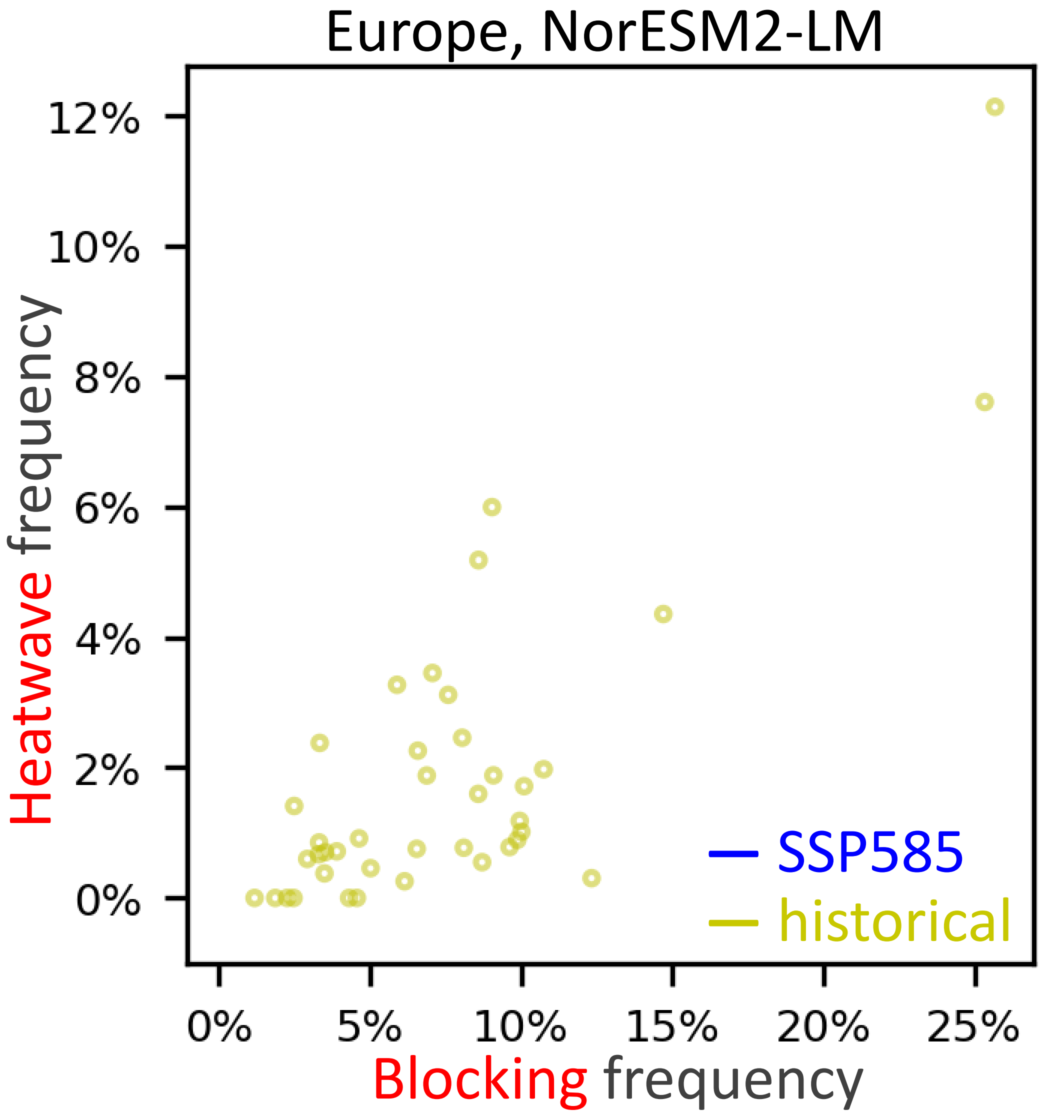
Optimized blocking index

- Maximizes corr (heatwave, blocking) [framework from Chan et al. 2019 GRL]
- Optimized blocking index
  := Dole & Gordon 1983 (anomaly-based) with *A*=1 stdev, *D*=5 days

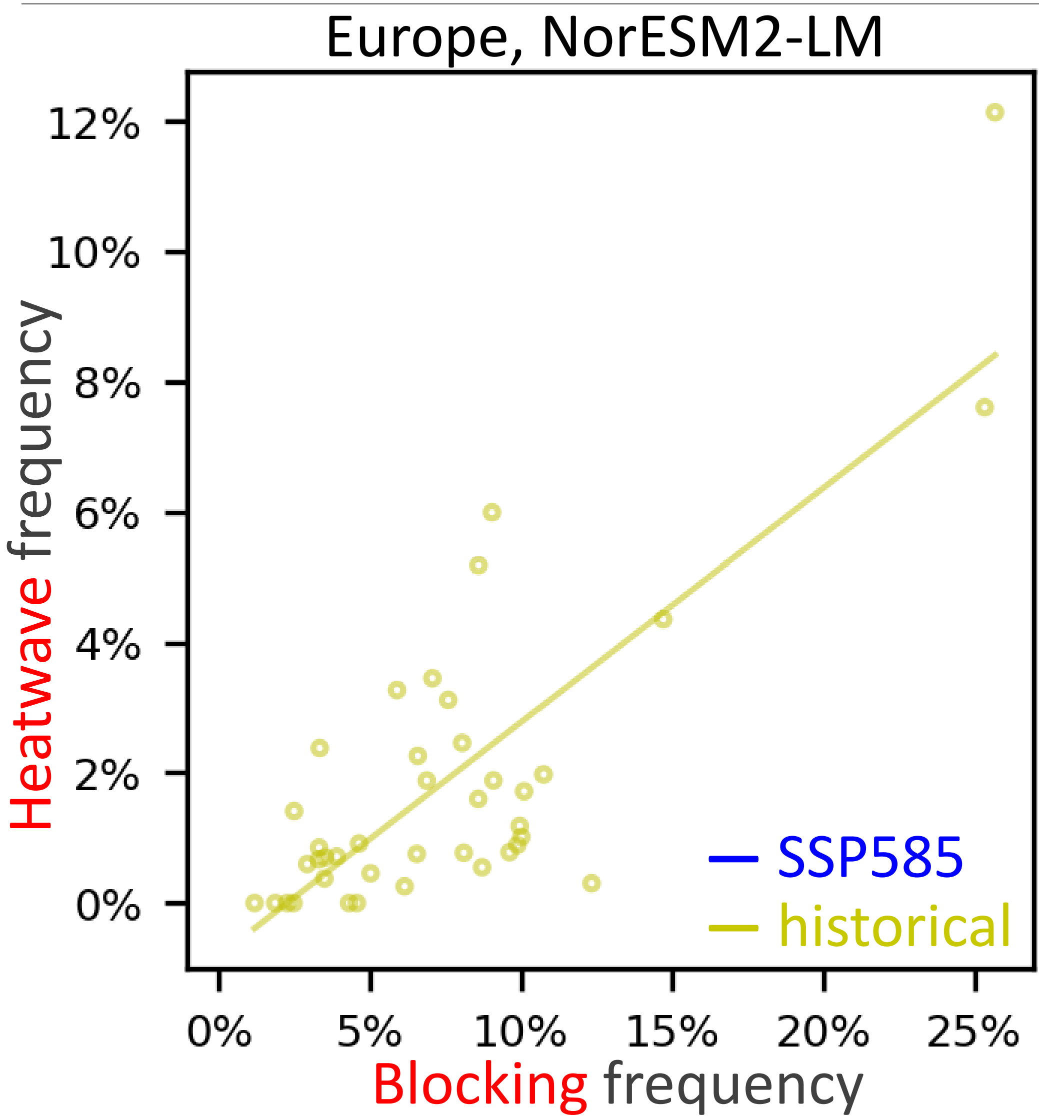


$r = 0.74$

Europe in one CMIP6 model

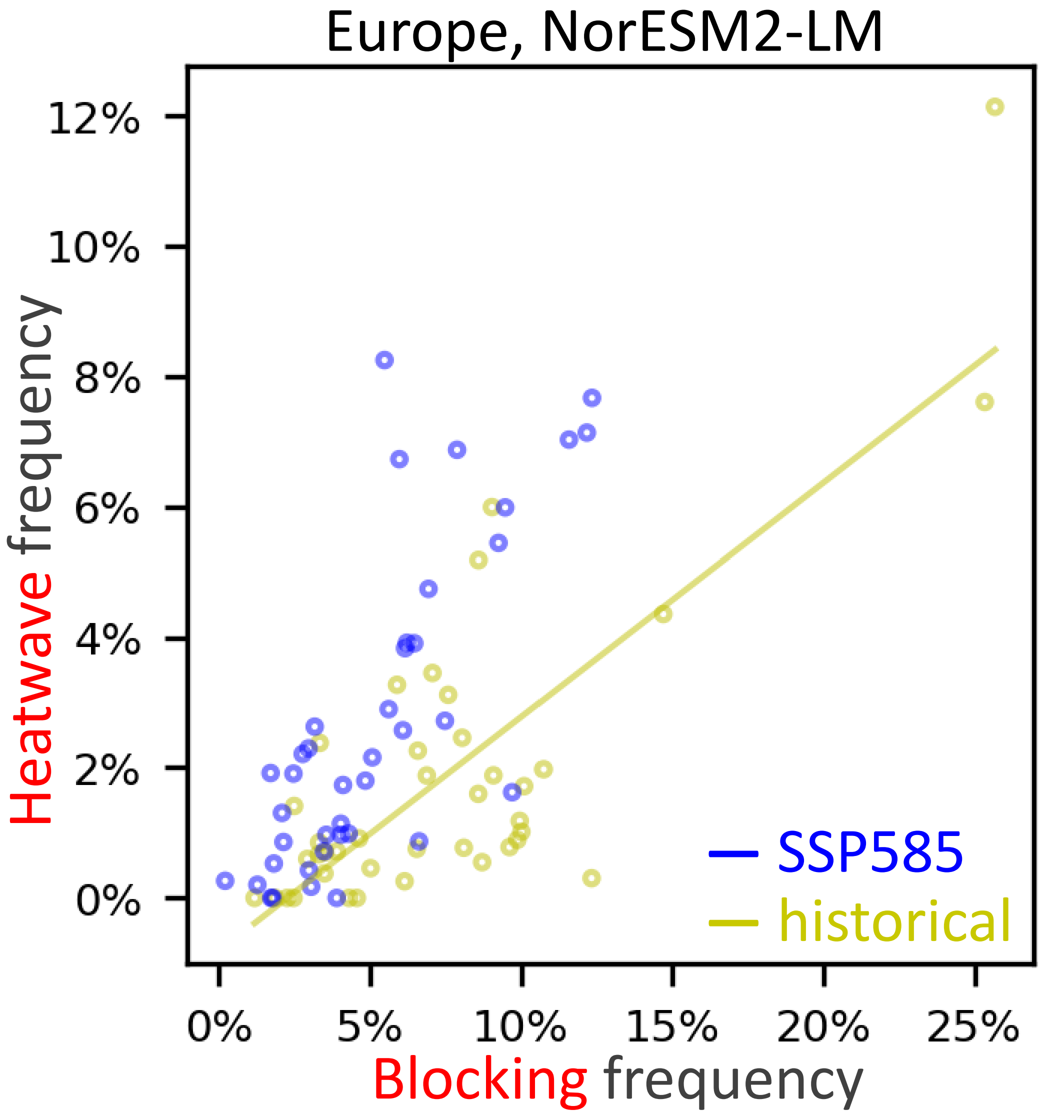


Europe in one CMIP6 model

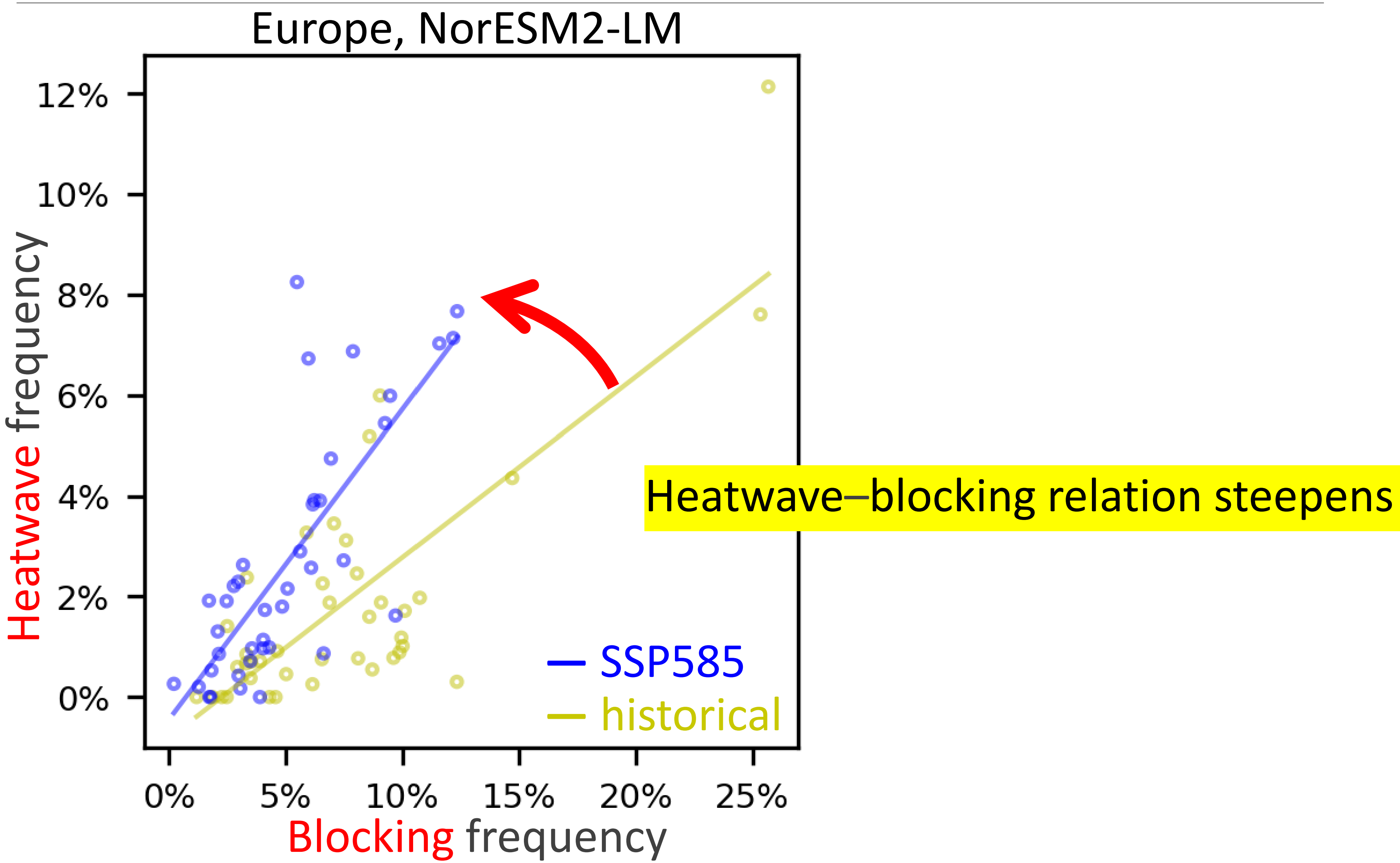


Linear regression

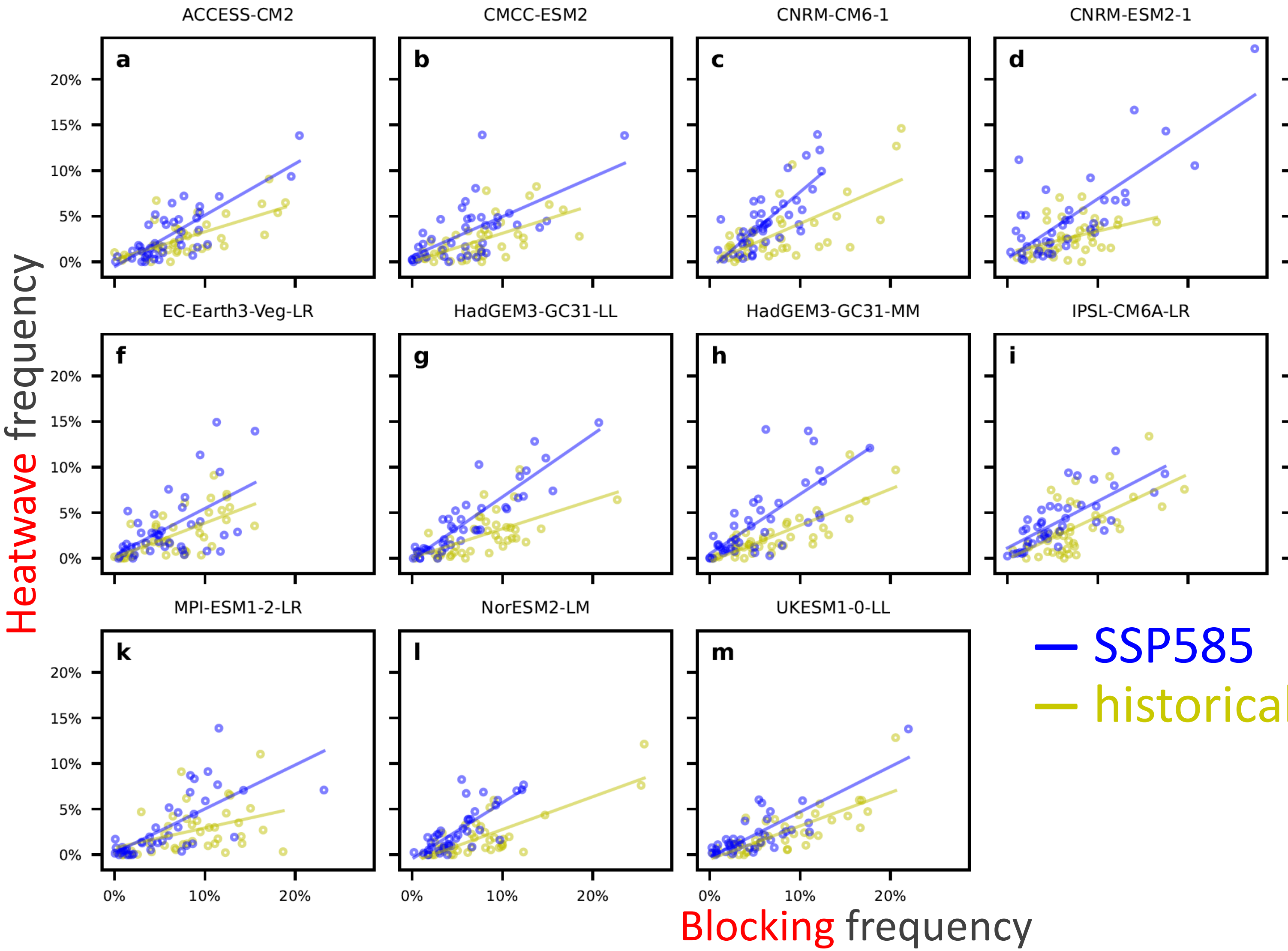
Europe in one CMIP6 model



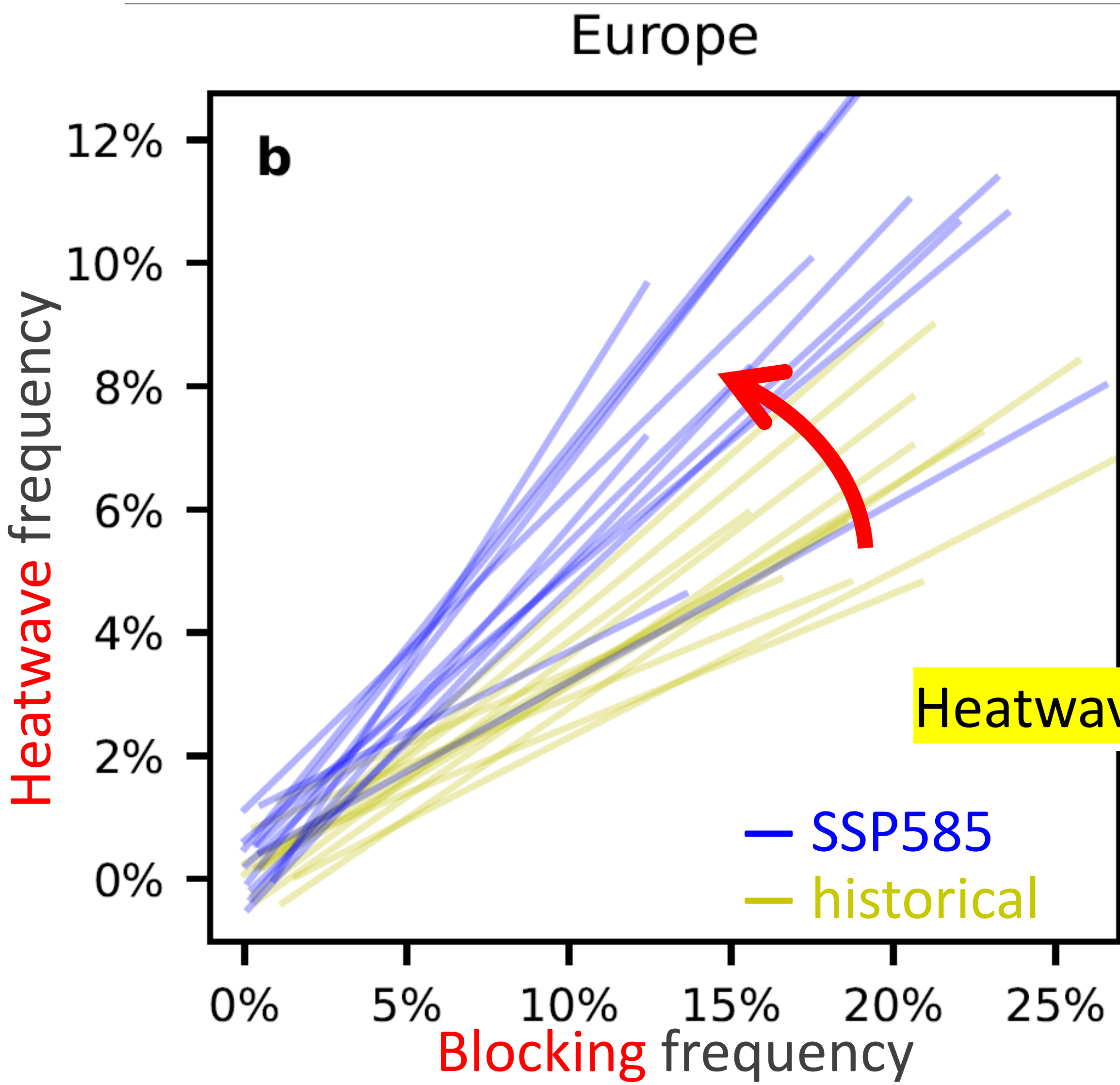
Europe in one CMIP6 model



Europe in 13 CMIP6 models



Europe in 13 CMIP6 models



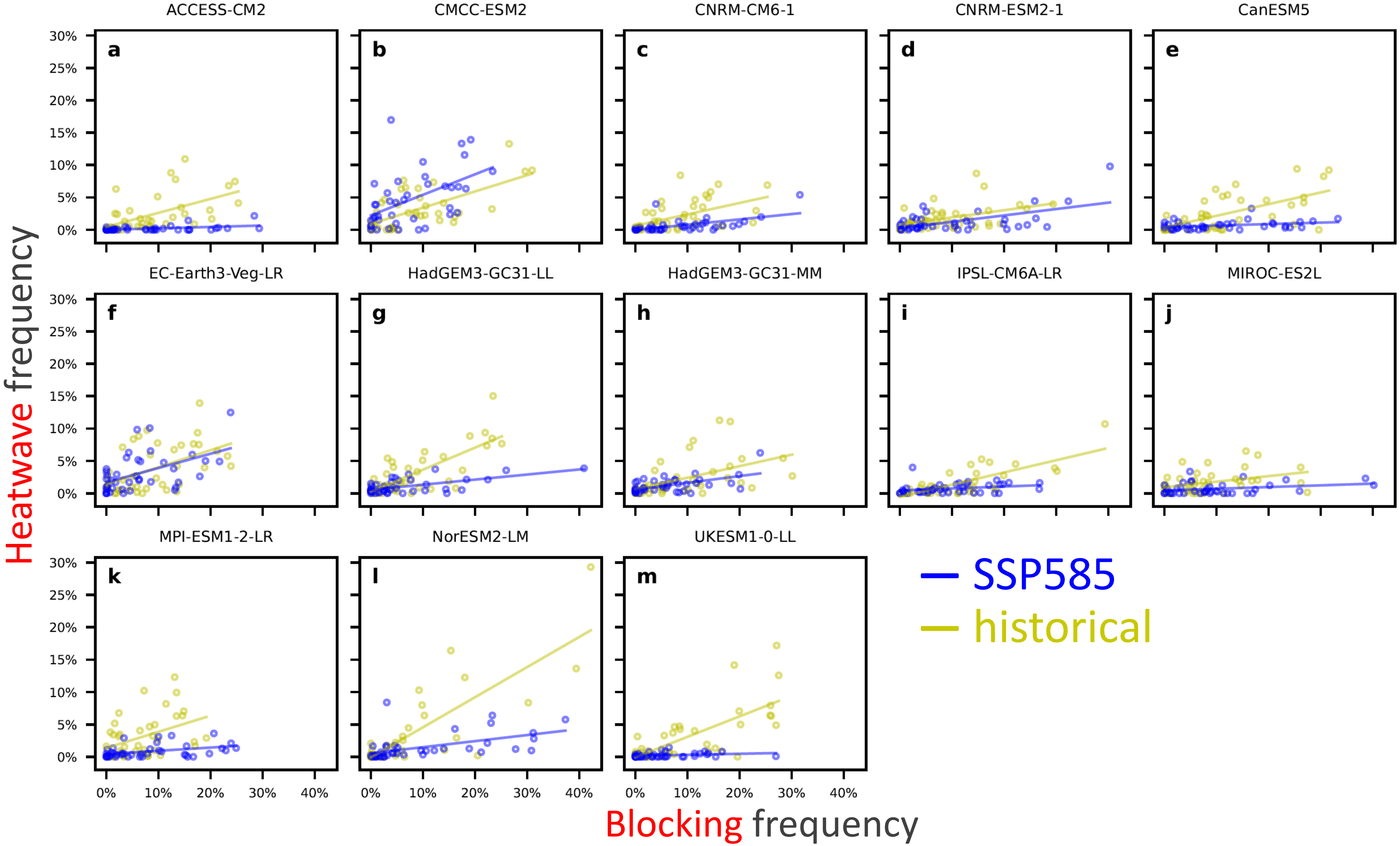
Heatwave–blocking relation steepens

Heatwave–blocking relation steepens

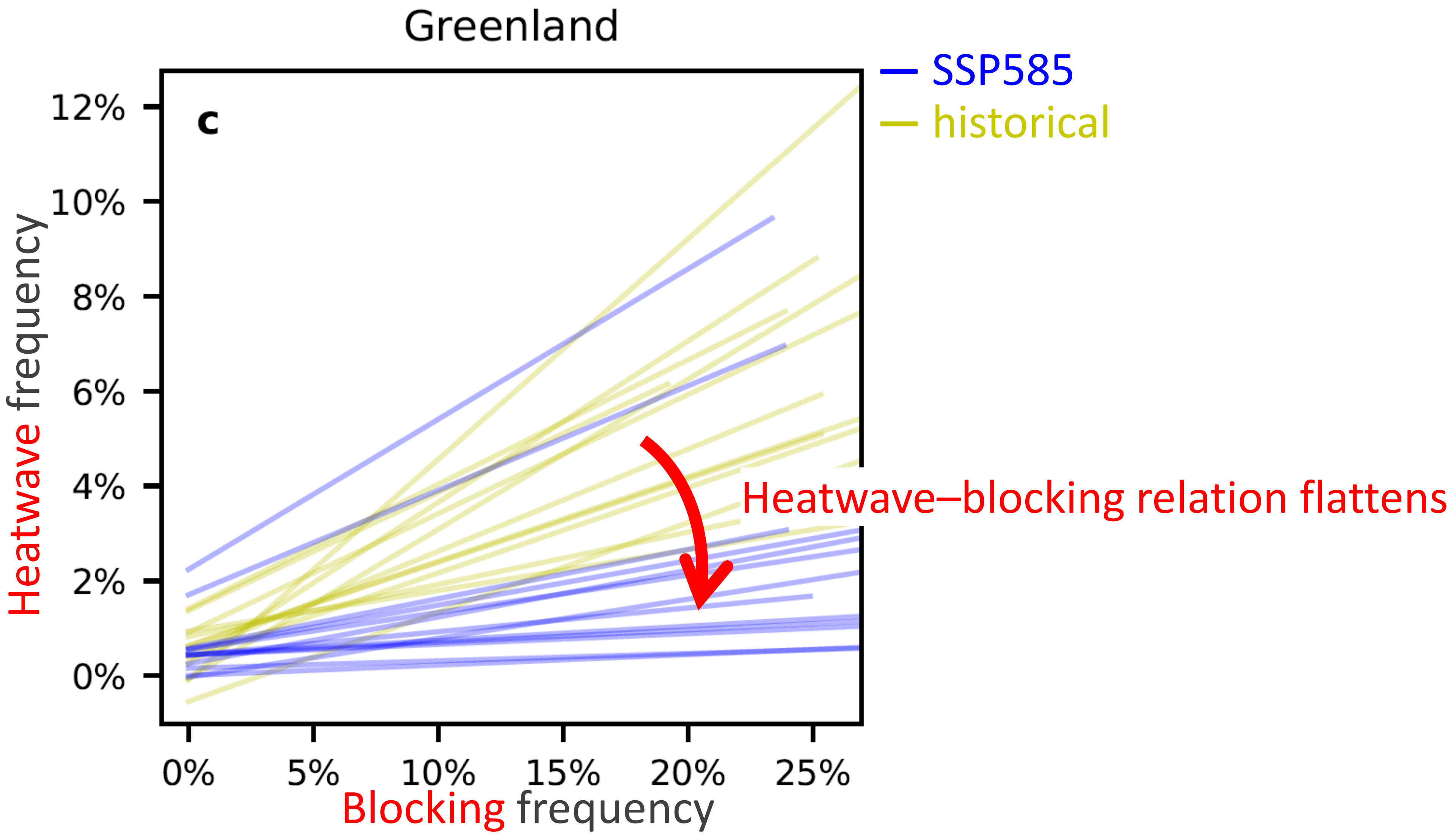
(Conventional wisdom)

historical	SSP585
Larger portion as latent heat flux	Smaller portion as latent heat flux
Temperature less sensitive to solar forcing	Temperature more sensitive to solar forcing

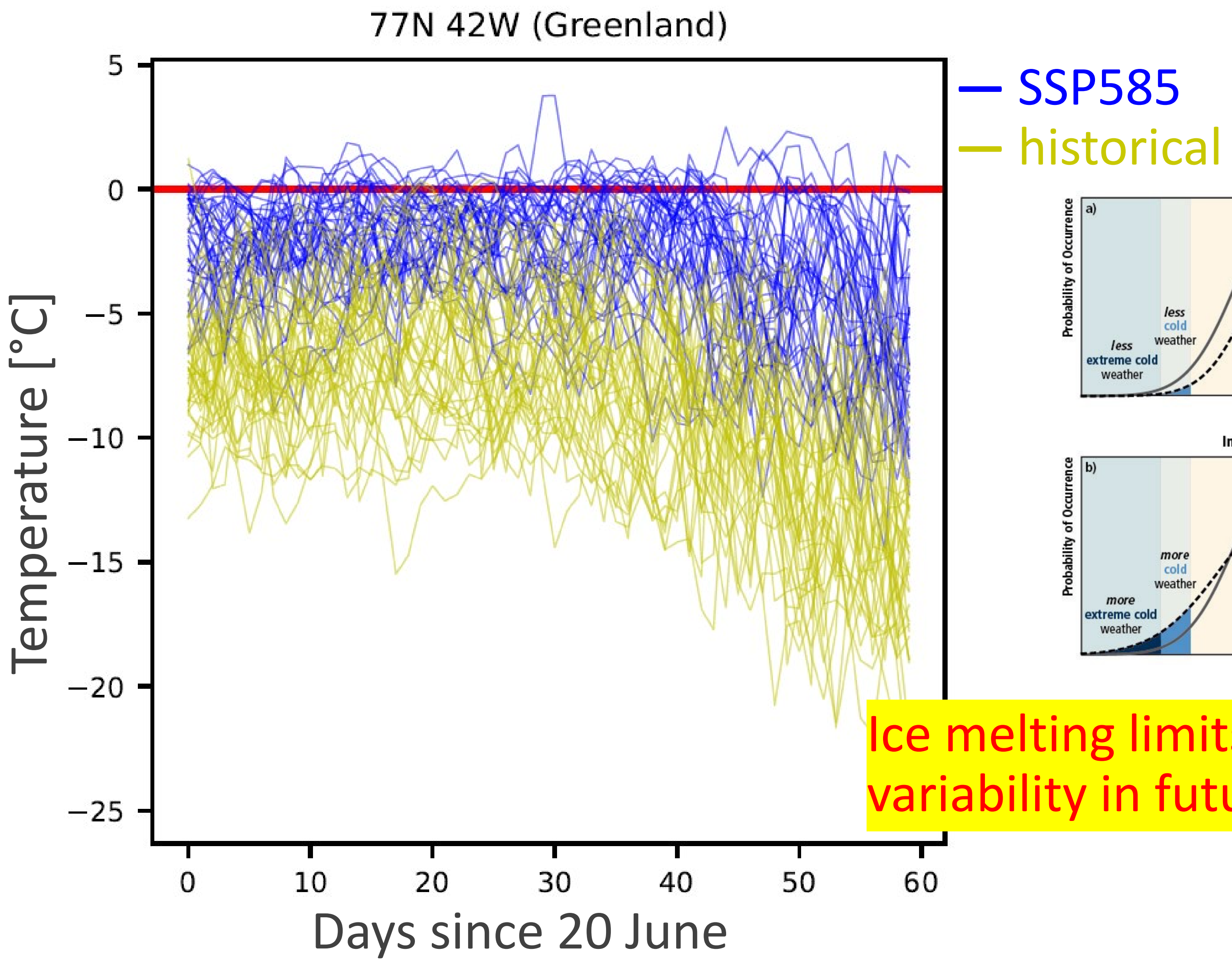
Greenland in 13 CMIP6 models

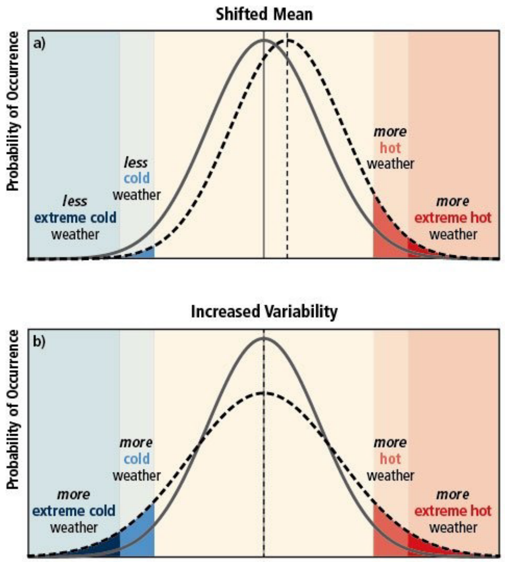


Greenland in 13 CMIP6 models



Greenland: Why relation flattens





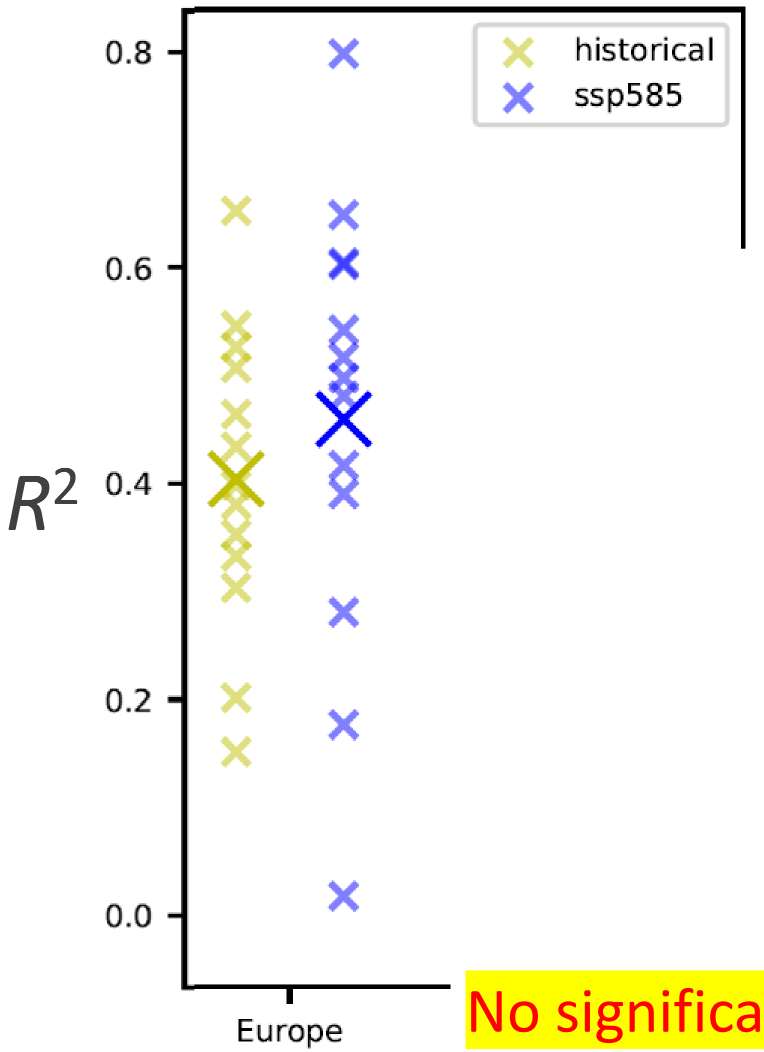
IPCC 2012

Ice melting limits temperature variability in future

R^2 (heatwave, blocking)

$$\text{Slope} = \frac{\overline{x'y'}}{\overline{x'^2}}$$

$$r = \frac{\overline{x'y'}}{\sqrt{\overline{x'^2} \cdot \overline{y'^2}}}$$

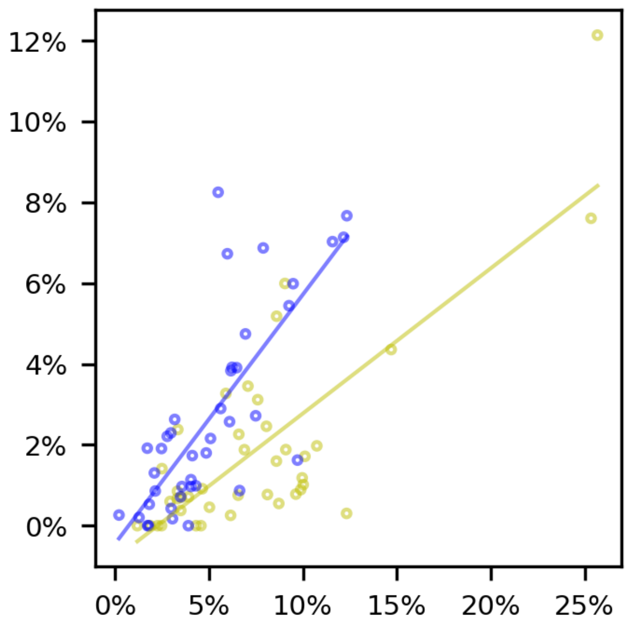


No significant change in R^2

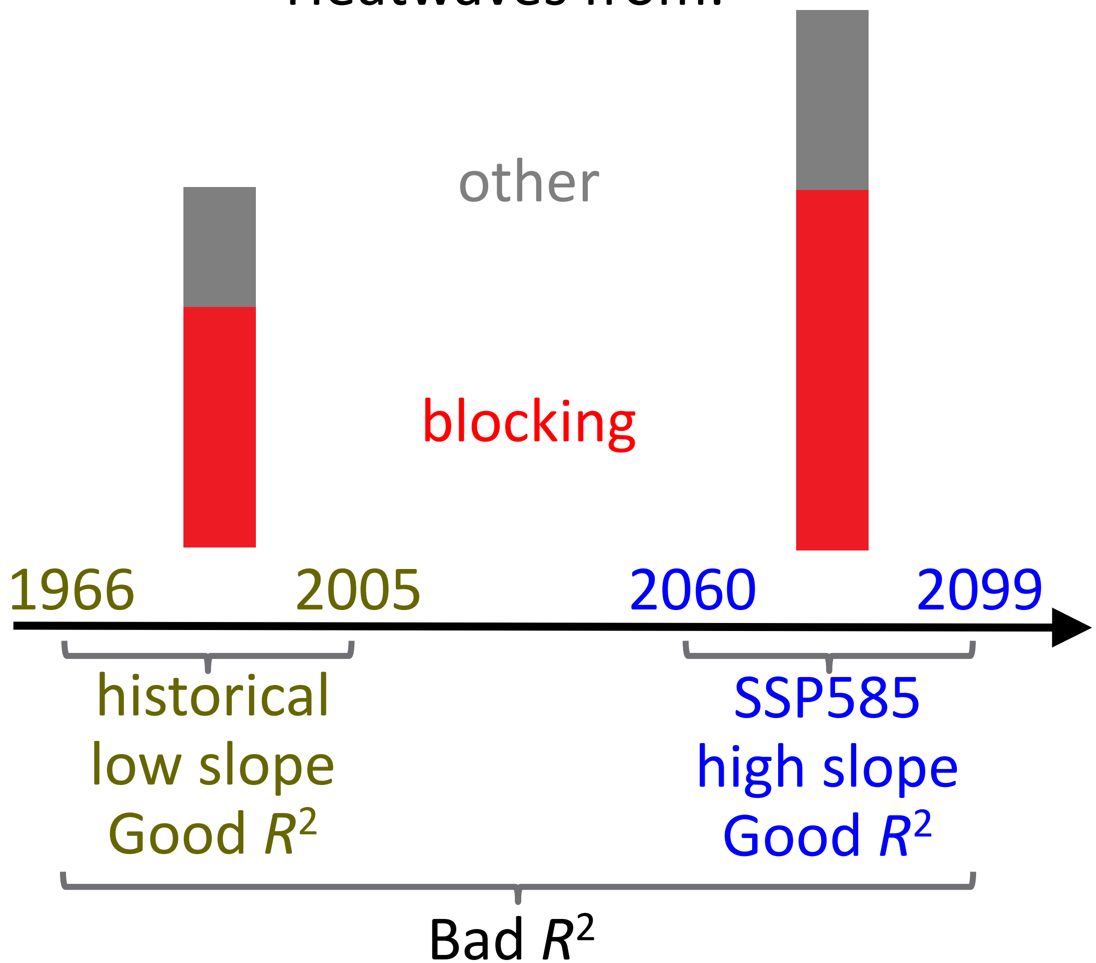
R^2 (heatwave, blocking)

$$\text{Slope} = \frac{\overline{x'y'}}{\overline{x'^2}}$$

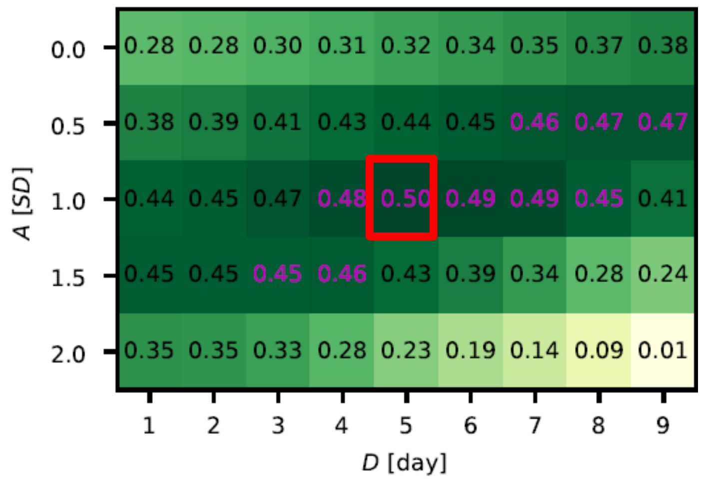
$$r = \frac{\overline{x'y'}}{\sqrt{\overline{x'^2} \cdot \overline{y'^2}}}$$



Heatwaves from:



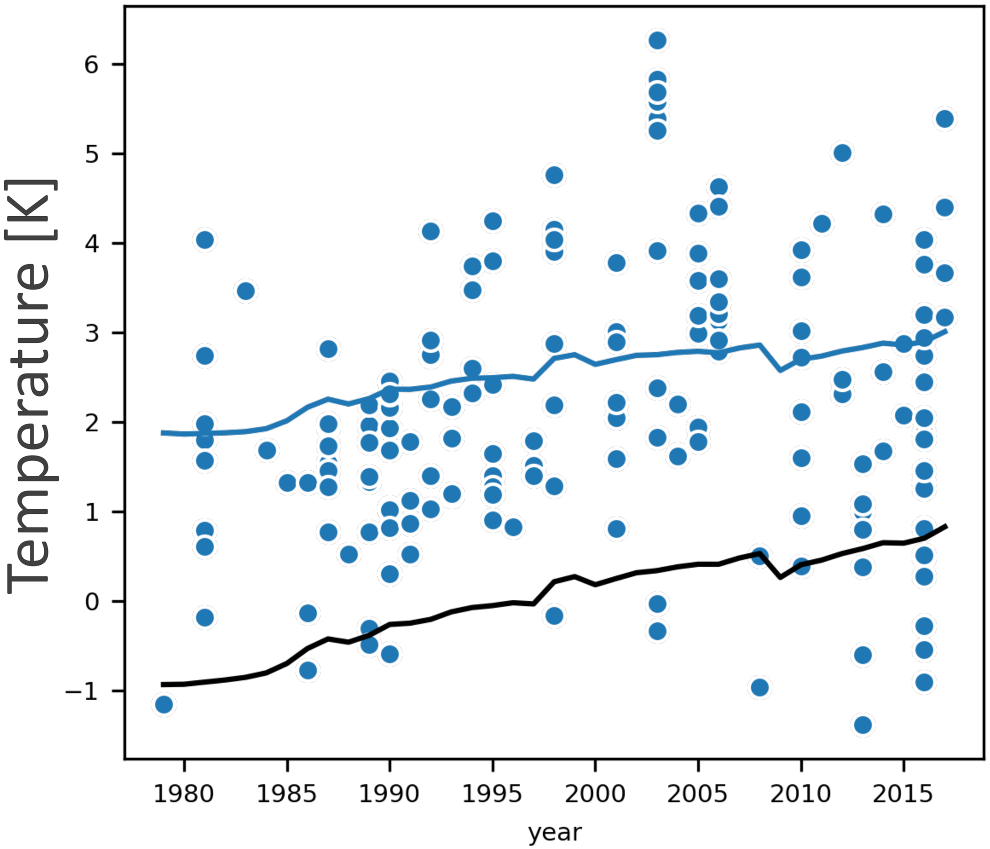
Heatwave-relevant circulation system



Still *A* = 1 *SD*, *D* = 5–6 days

Still same type of blocking most relevant to heatwaves

Contrasting claim

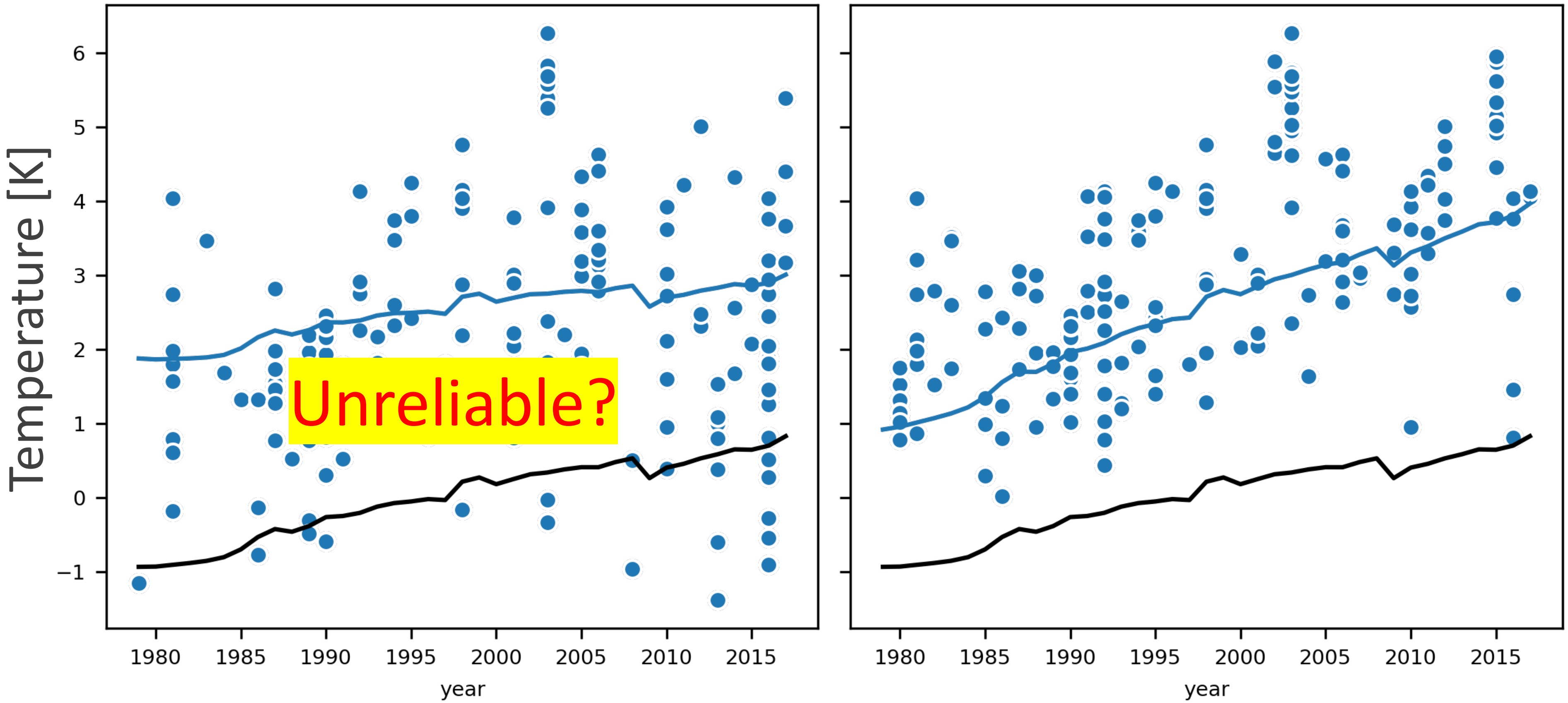


Jézéquel et al. 2020 ERL. Condition on circulation analog

∵ Conditional trend < unconditional trend

∴ Different circulation for future heatwaves?

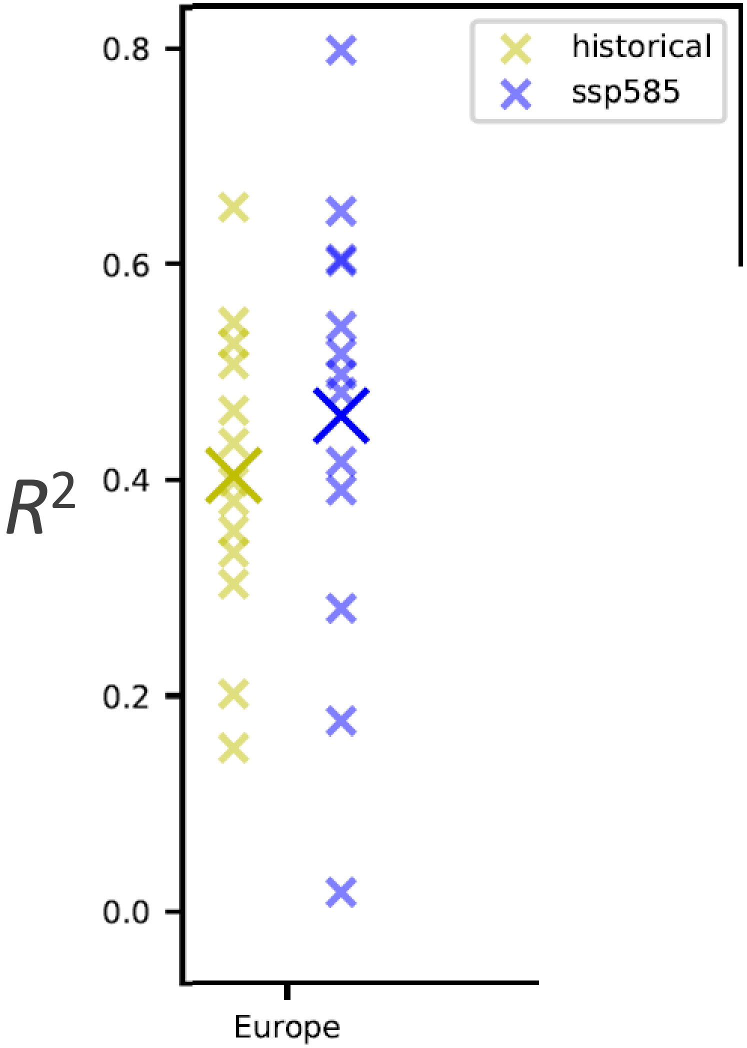
Contrasting claim - revisit

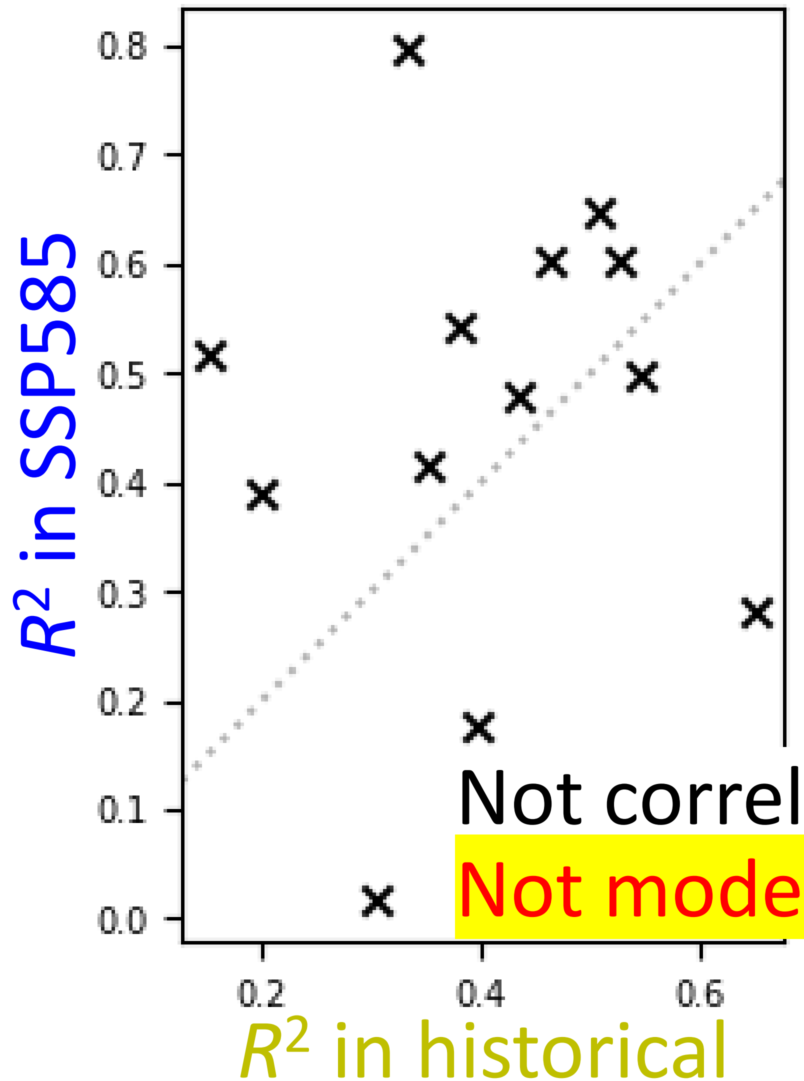


After some tweaks

Conditional trend > unconditional trend

Model bias?





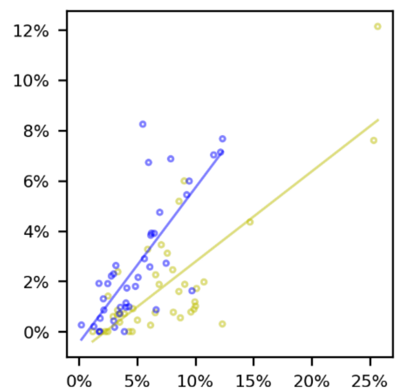
Not correlated

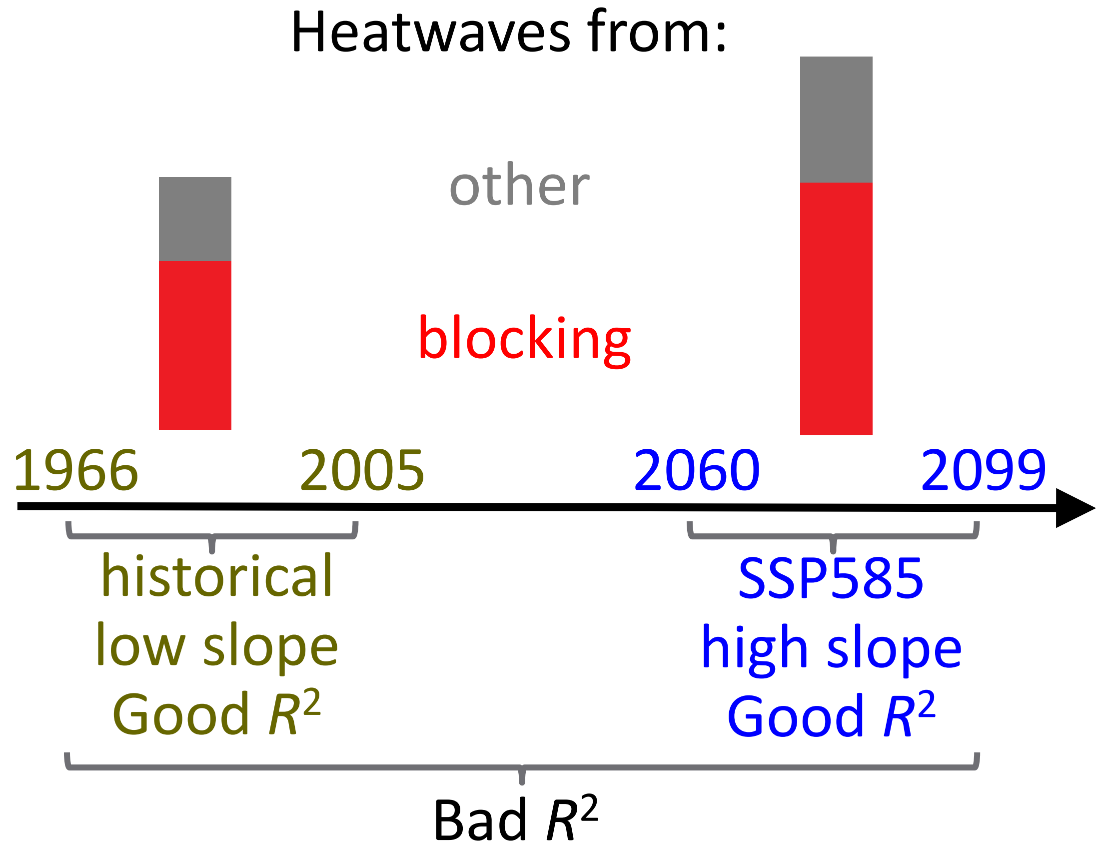
Not model biases

Conclusion

$$\text{Slope} = \frac{\overline{x'y'}}{\overline{x'^2}}$$

$$r = \frac{\overline{x'y'}}{\sqrt{\overline{x'^2} \cdot \overline{y'^2}}}$$





Chan, P. W., Catto, J. L., & Collins, M. (2022). *npj Climate and Atmospheric Science*, 5, 68.
Chan, P.-W., Hassanzadeh, P., & Kuang, Z. (2019). *Geophysical Research Letters*, 46(9), 4904.
More to come…