Climate change and droughts in Europe

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Droughts in the Past

Elbe river: the Děčín Hunger Stone, August 2022

Loire river, July 2003

en.wikipedia.org phys.org

Droughts in the Past

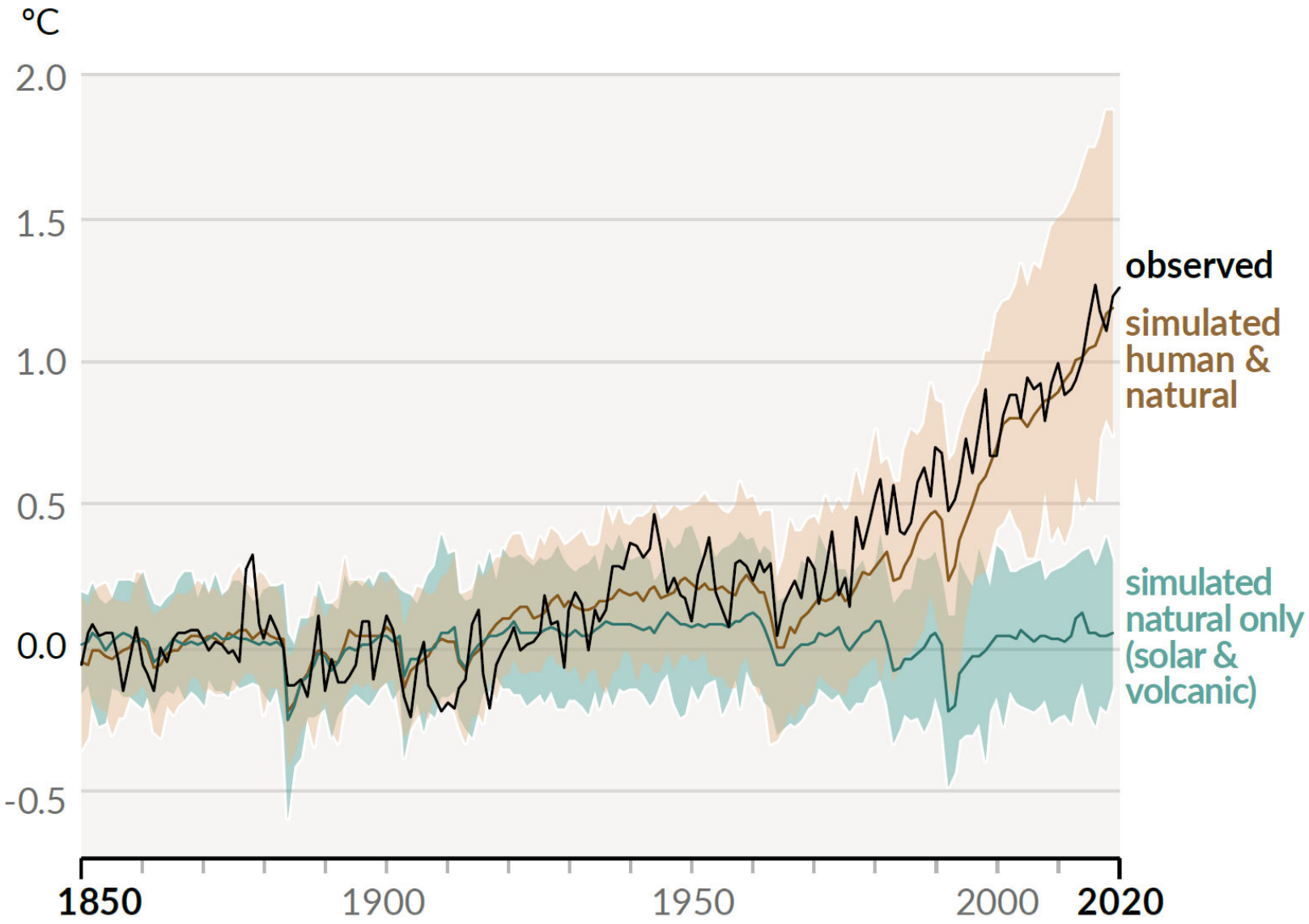
August 2015
Lower Austria

August 2015
Upper Austria

kurier.at www.nachrichten.at

1. Climate change and precipitation

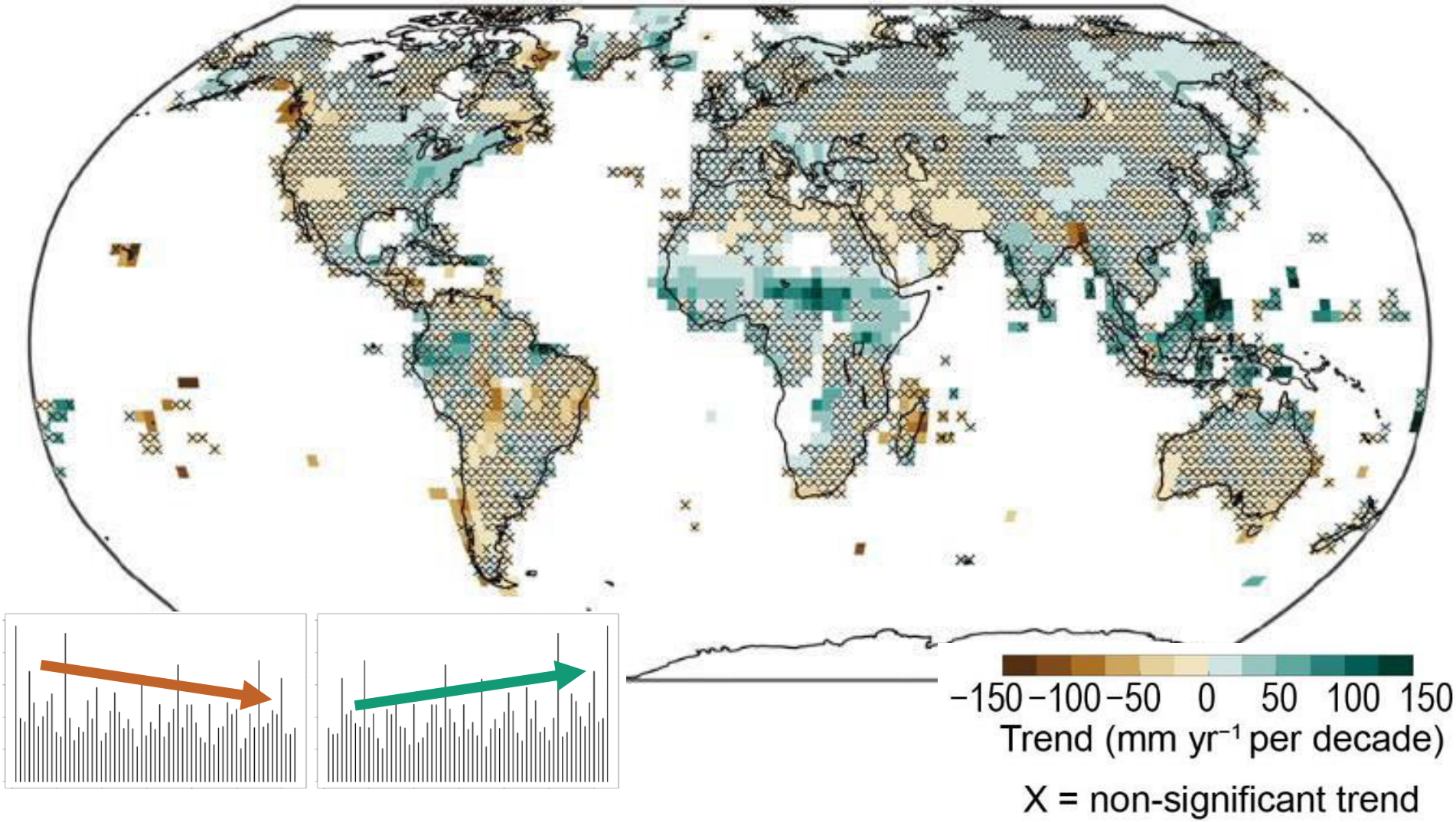
Global air temperatures



IPCC AR6 (2021)

Observed trends of annual precipitation

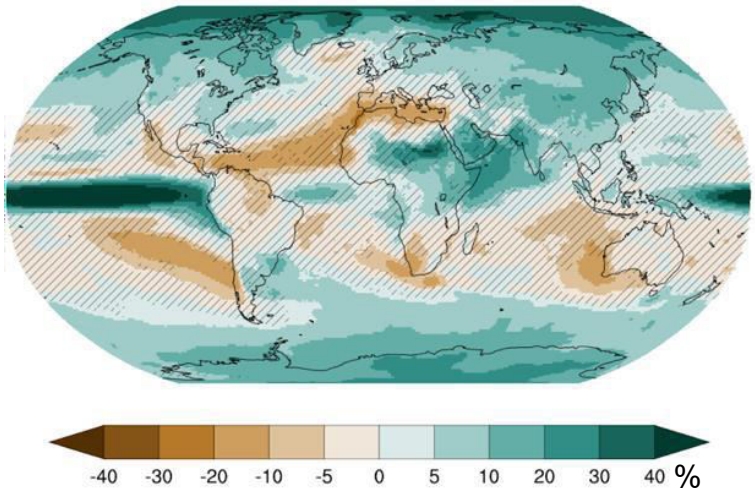
1980-2019



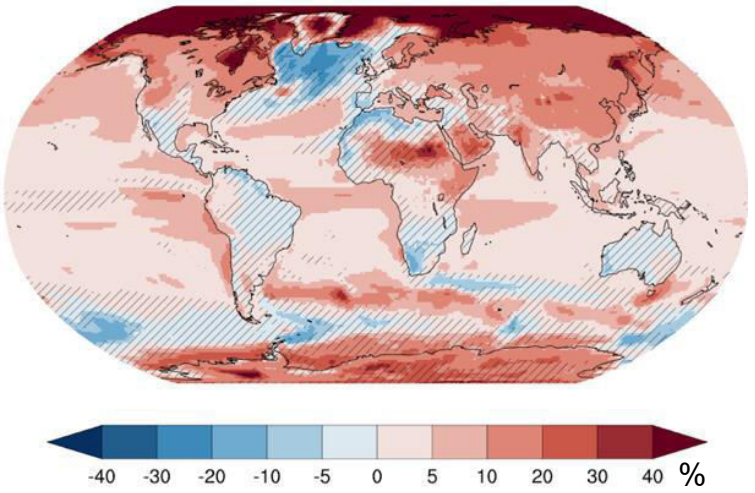
Projections of annual precipitation

SSP2-4.5 (2081-2100 vs 1995-2014)

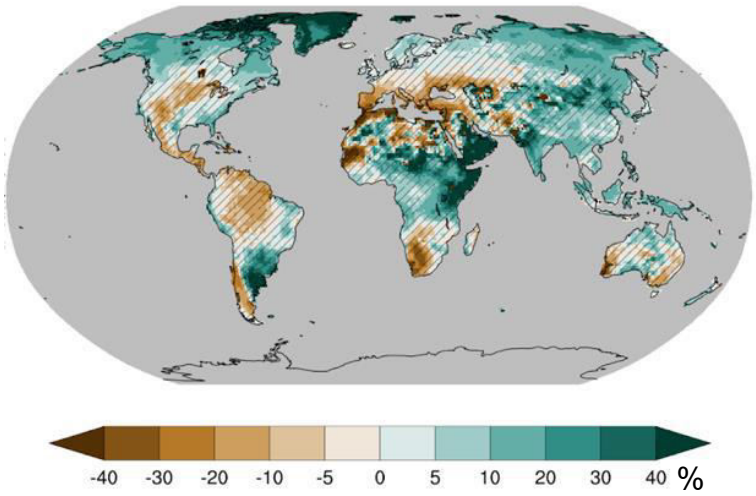
Precipitation



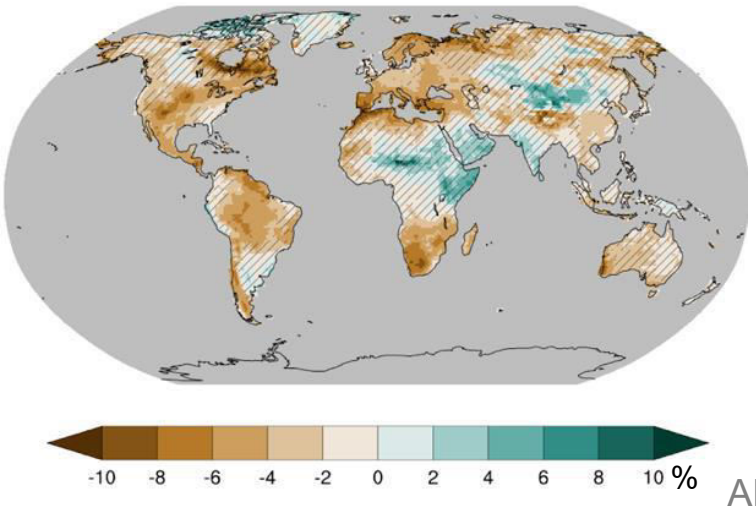
Evapotranspiration



Runoff

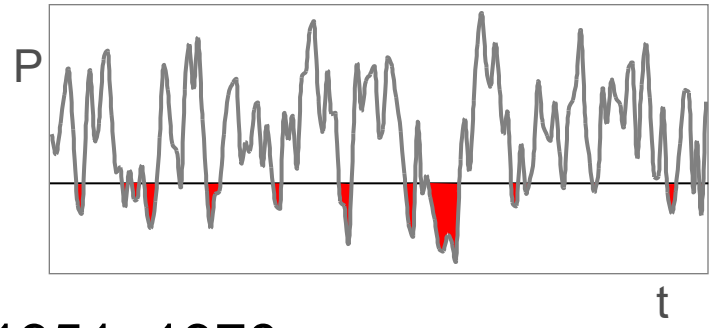


Surface soil moisture



AR6 (2021)

Observed precipitation deficit (drought severity)



1951–1970 1971–1990 1991–2010

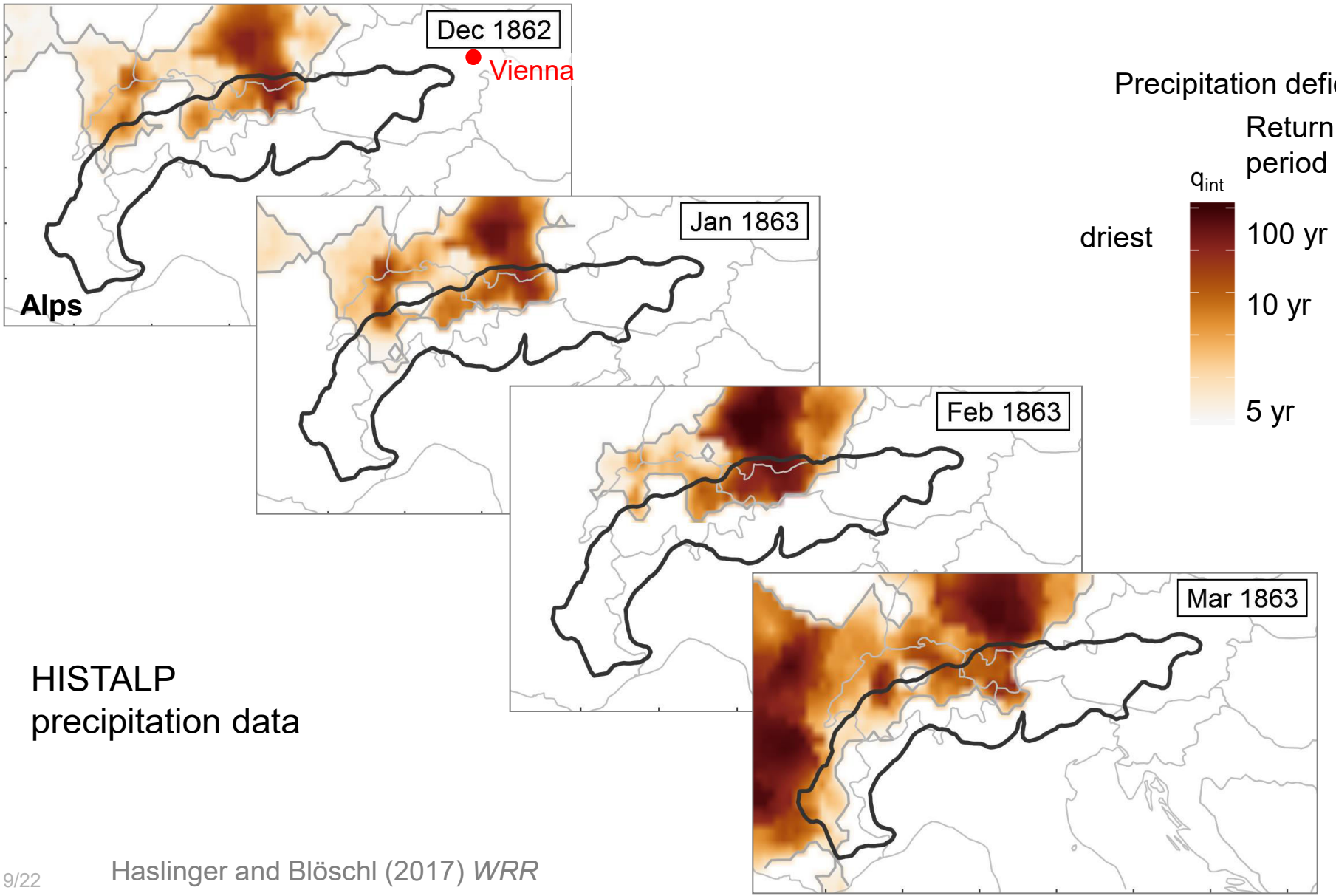
Severe droughts

Few droughts

Spinoni et al. (2015)

Example of meteorological drought event

Dec 1862 - April 1863. Dark colours: least precipitation

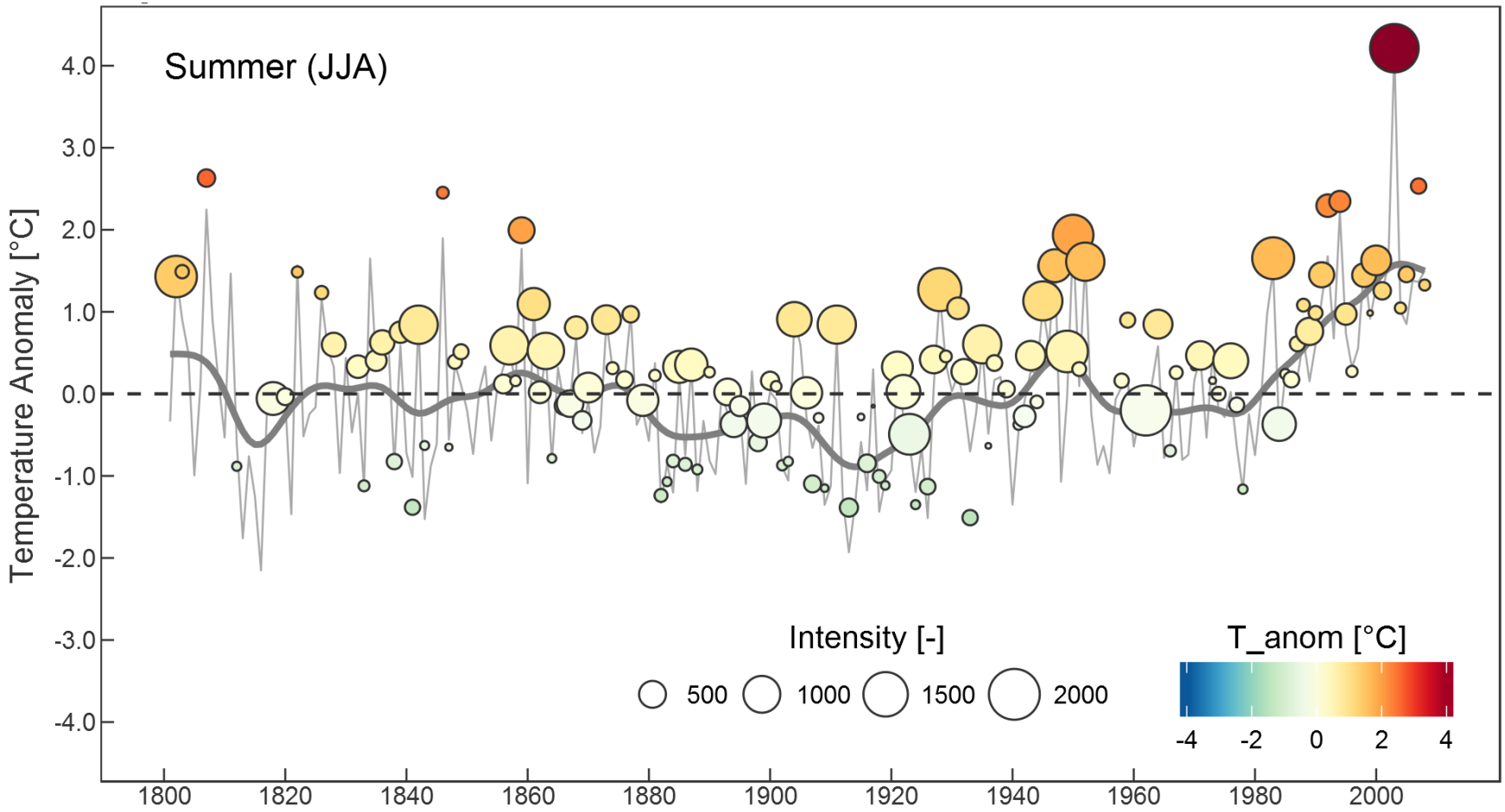


HISTALP
precipitation data

Haslinger and Blöschl (2017) *WRR*

Drought intensities and air temperatures Summer

Size of circles: drought intensity (lack of precipitation)
Colour: air temperature anomaly during drought

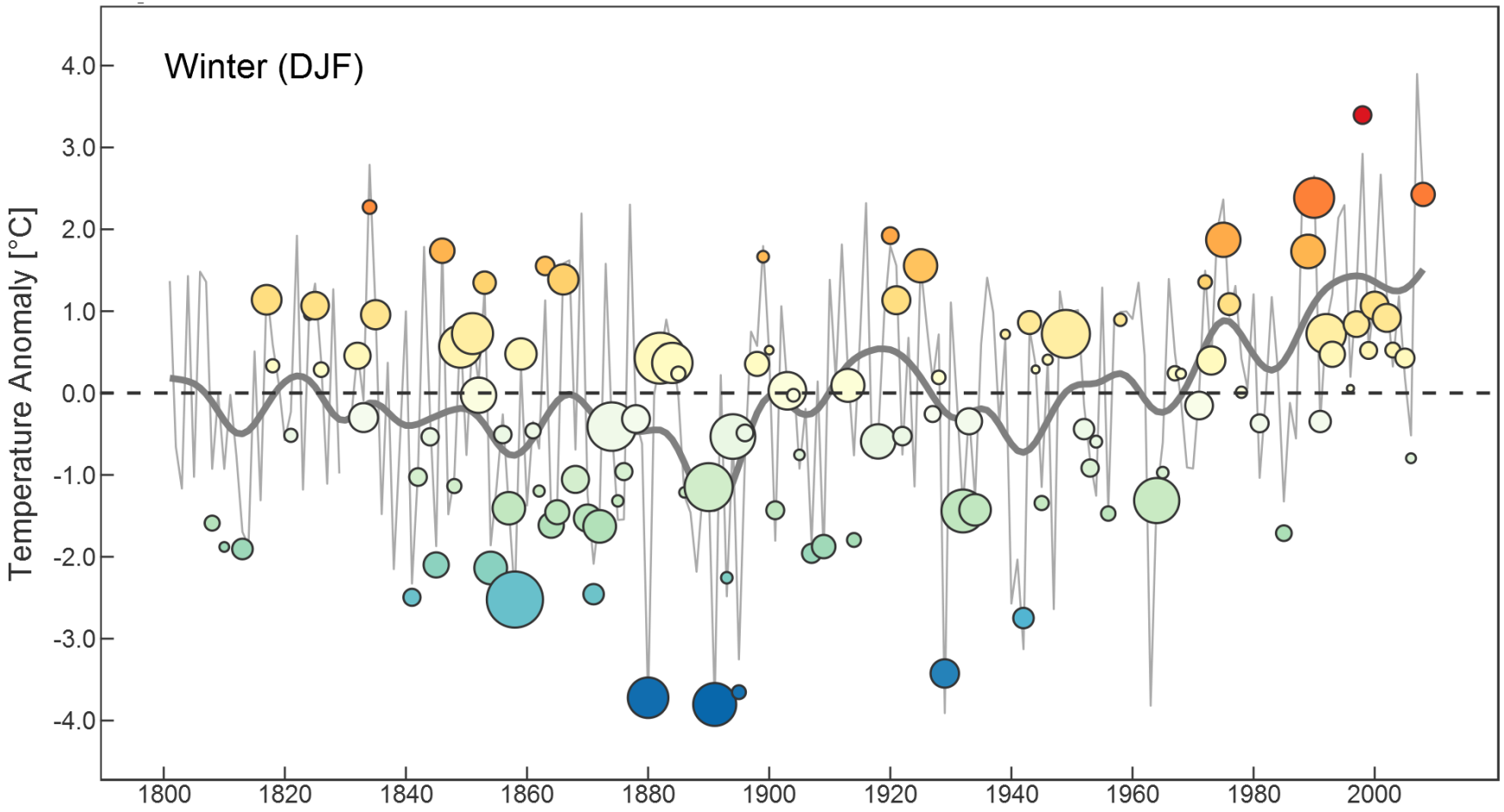


HISTALP data

Haslinger and Blöschl (2017) *WRR*

Drought intensities and air temperatures Winter

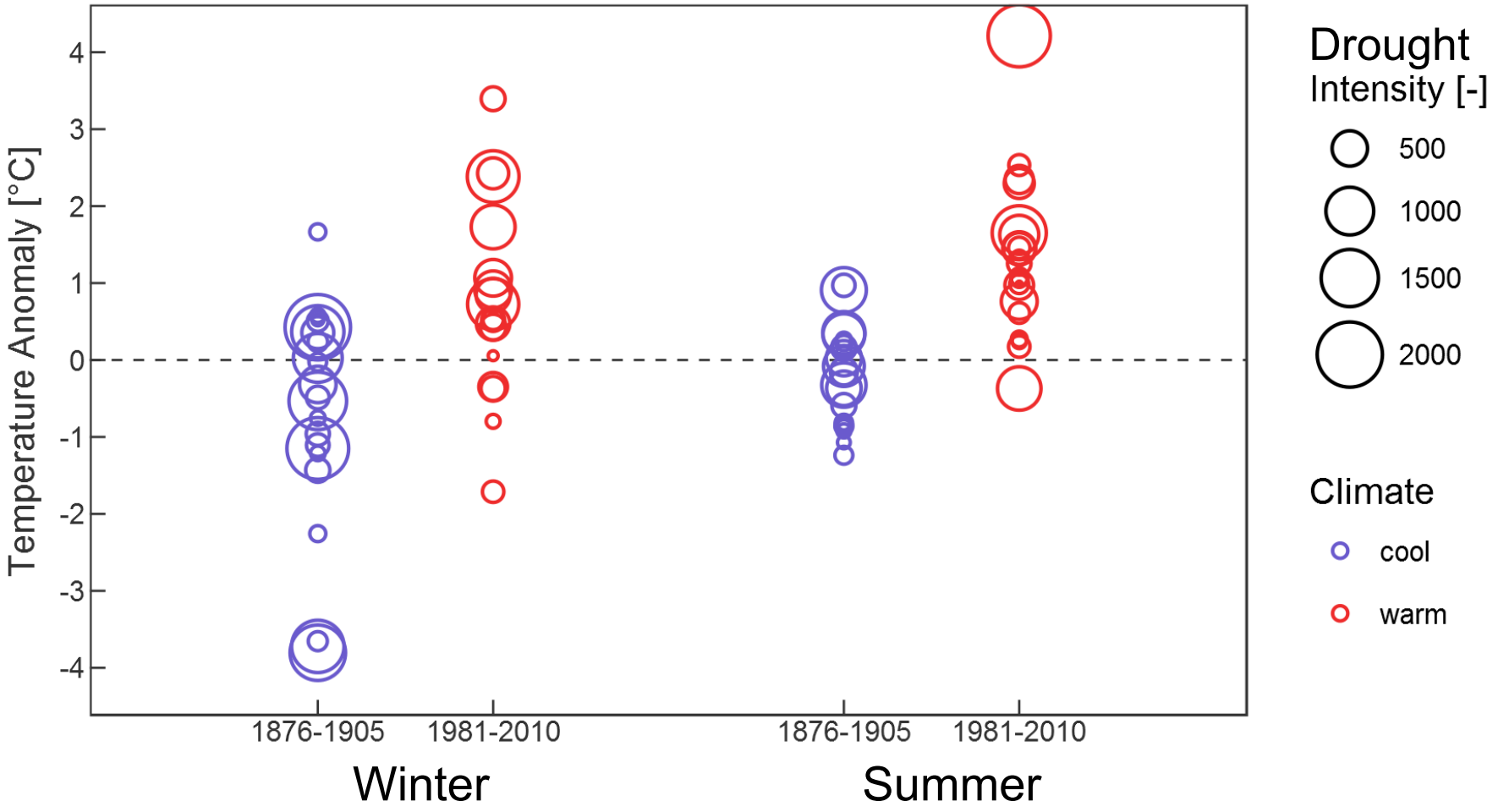
Size of circles: drought intensity (lack of precipitation)
Colour: air temperature anomaly during drought



HISTALP data

Haslinger and Blöschl (2017) *WRR*

Summer droughts have become more frequent, winter droughts less frequent



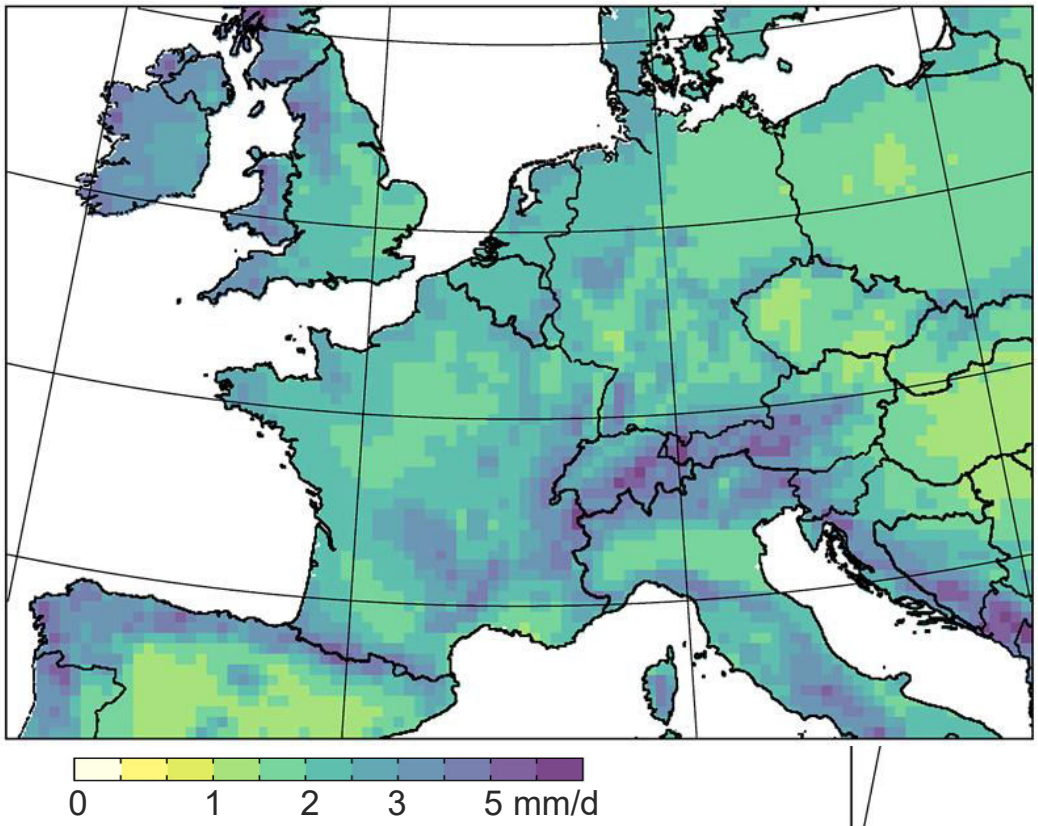
HISTALP data

Haslinger and Blöschl (2017) *WRR*

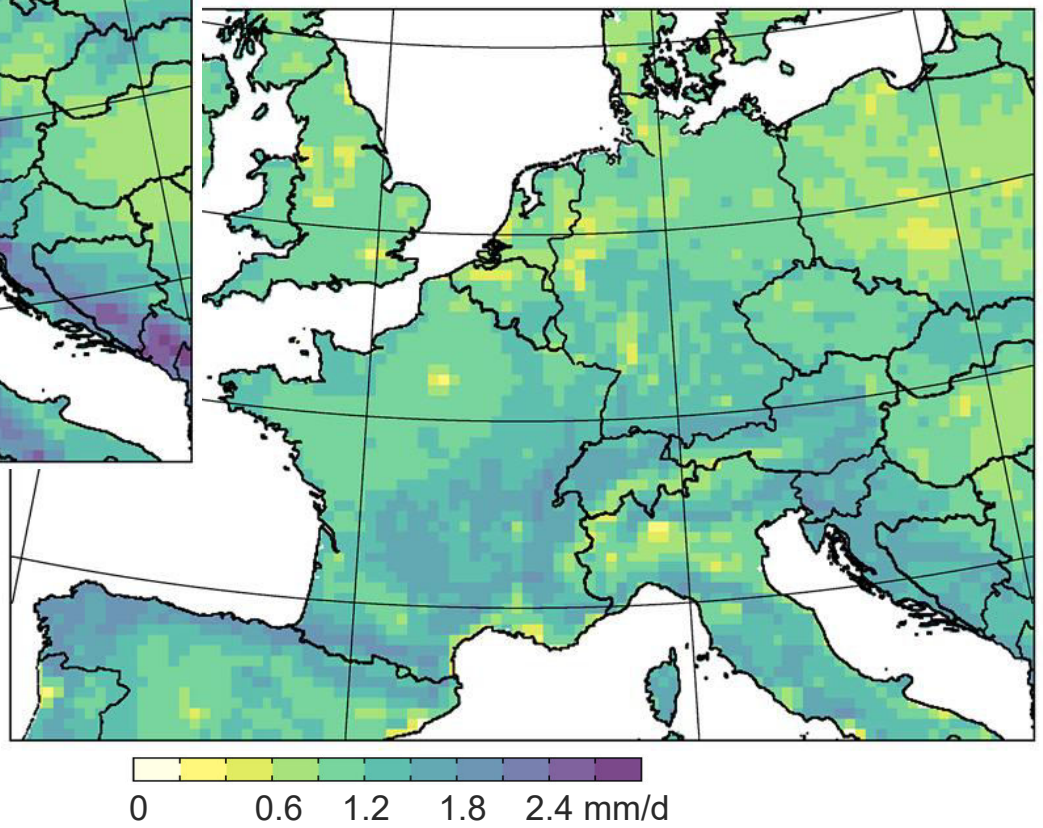
2. Climate change and low flows

Long term water balance

Mean precipitation



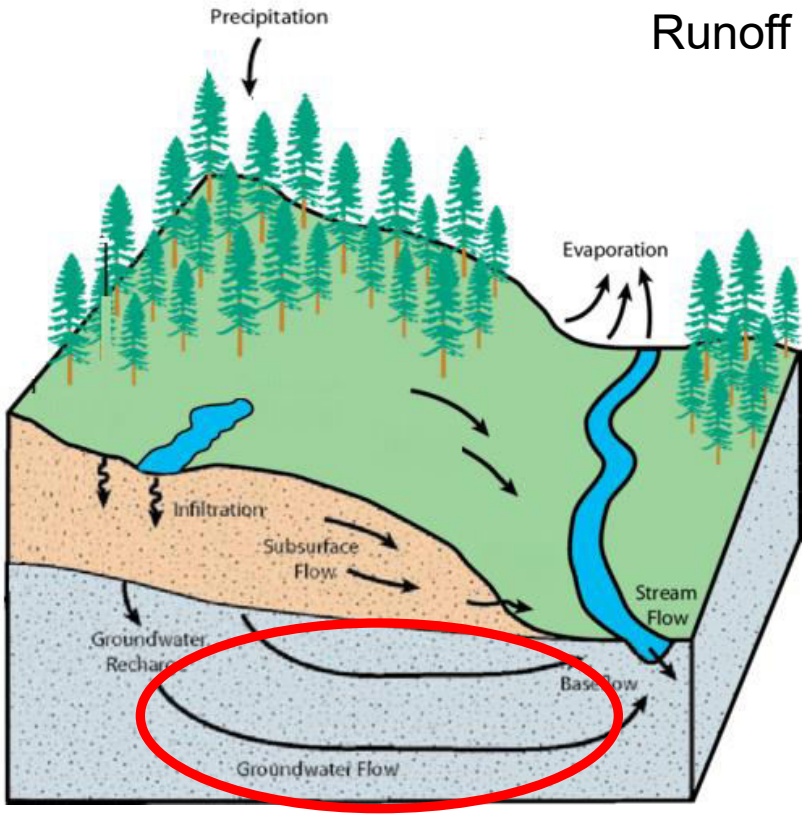
Mean evaporation



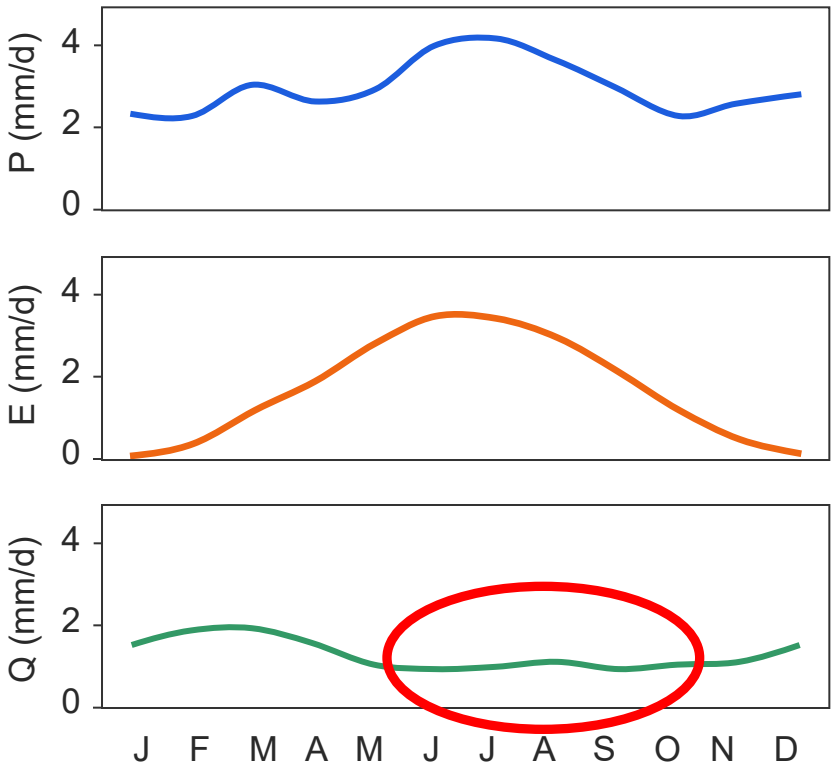
Arnault et al. (2021)

Runoff generation and water balance

Runoff = precipitation – evaporation ± storage change



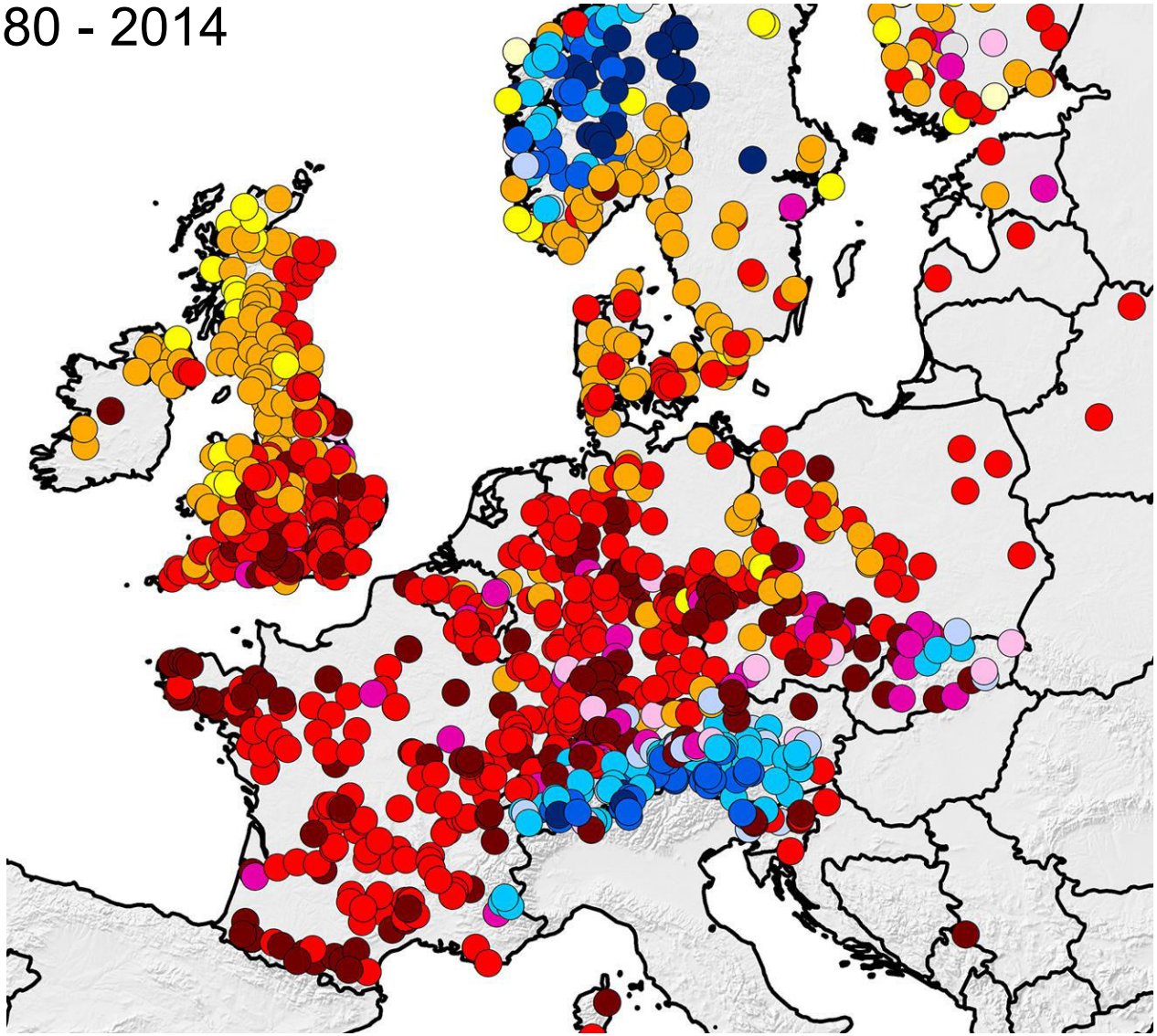
Runoff generation during droughts



Potential for low flows

Mean date of occurrence of annual low flows

1980 - 2014

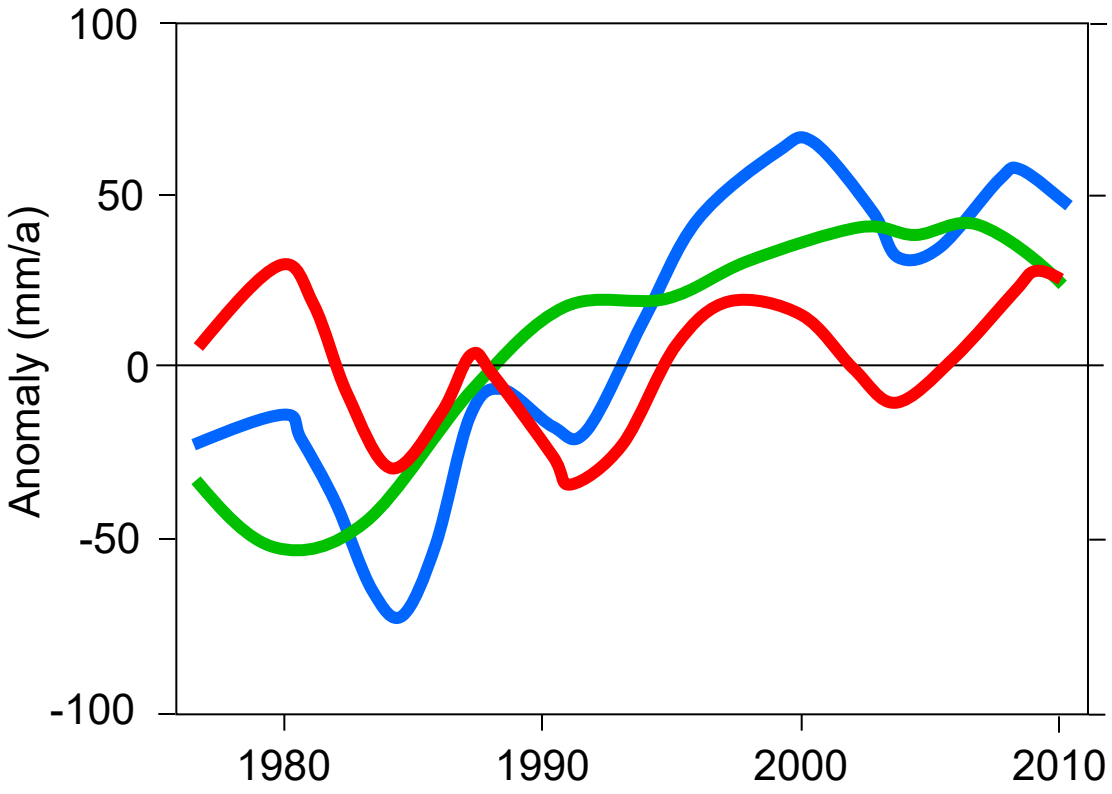


Floriancic et al. (2021)

Water balance of Austria

Based on streamflow measurements

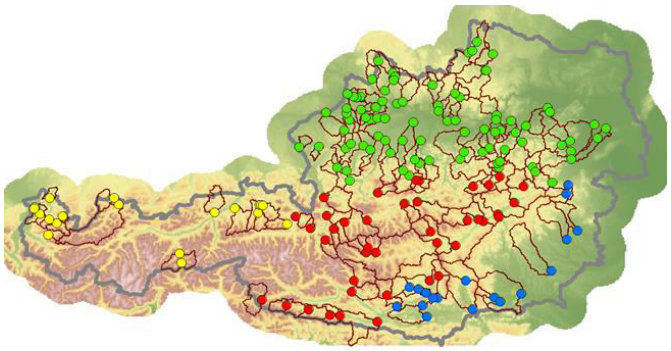
Evaporation has increased by 80 mm/a (i.e. by 17%)



P = 1247 mm/a

Q = 732 mm/a

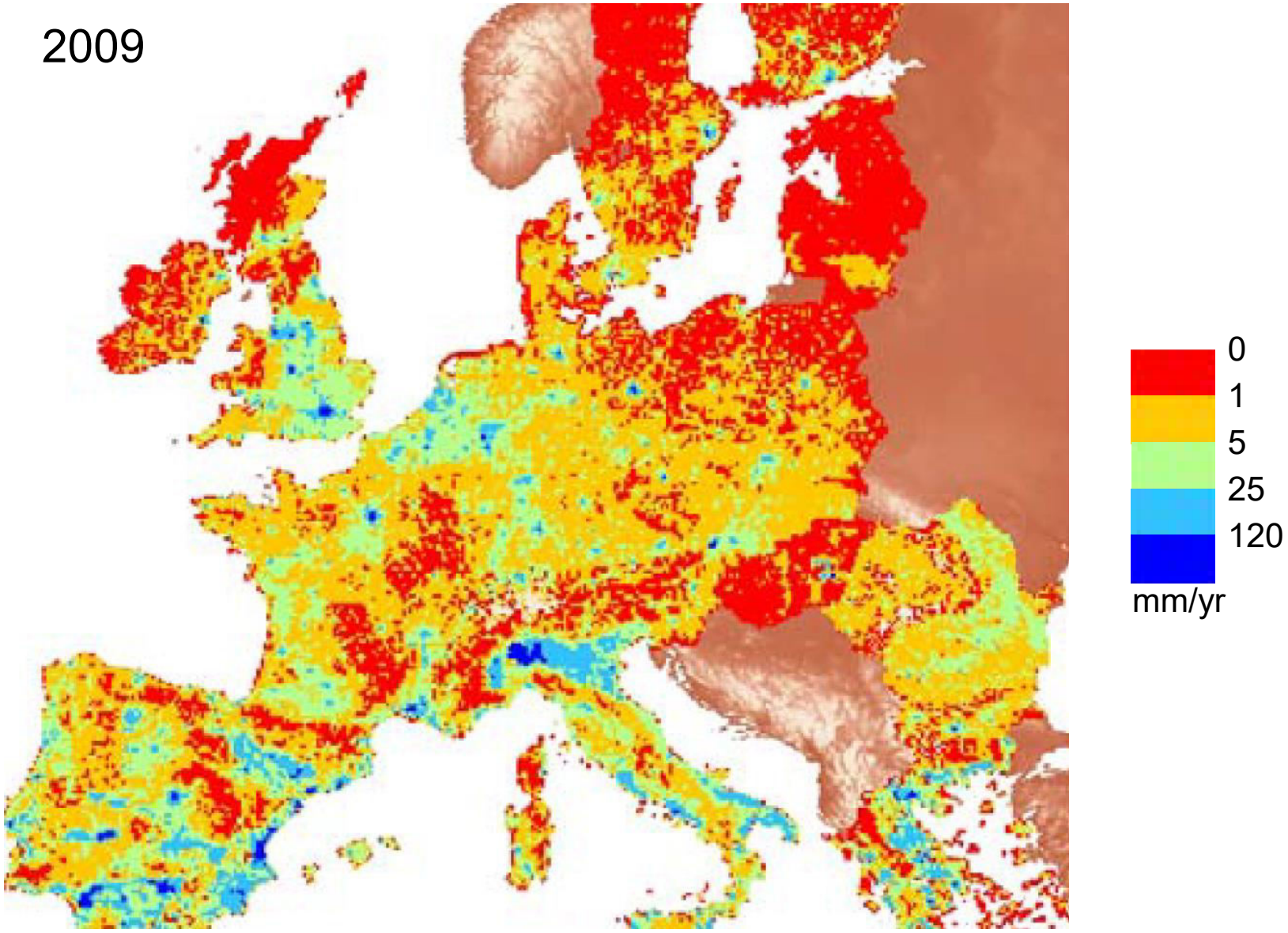
E = 514 mm/a



Average of 166 catchments, running mean

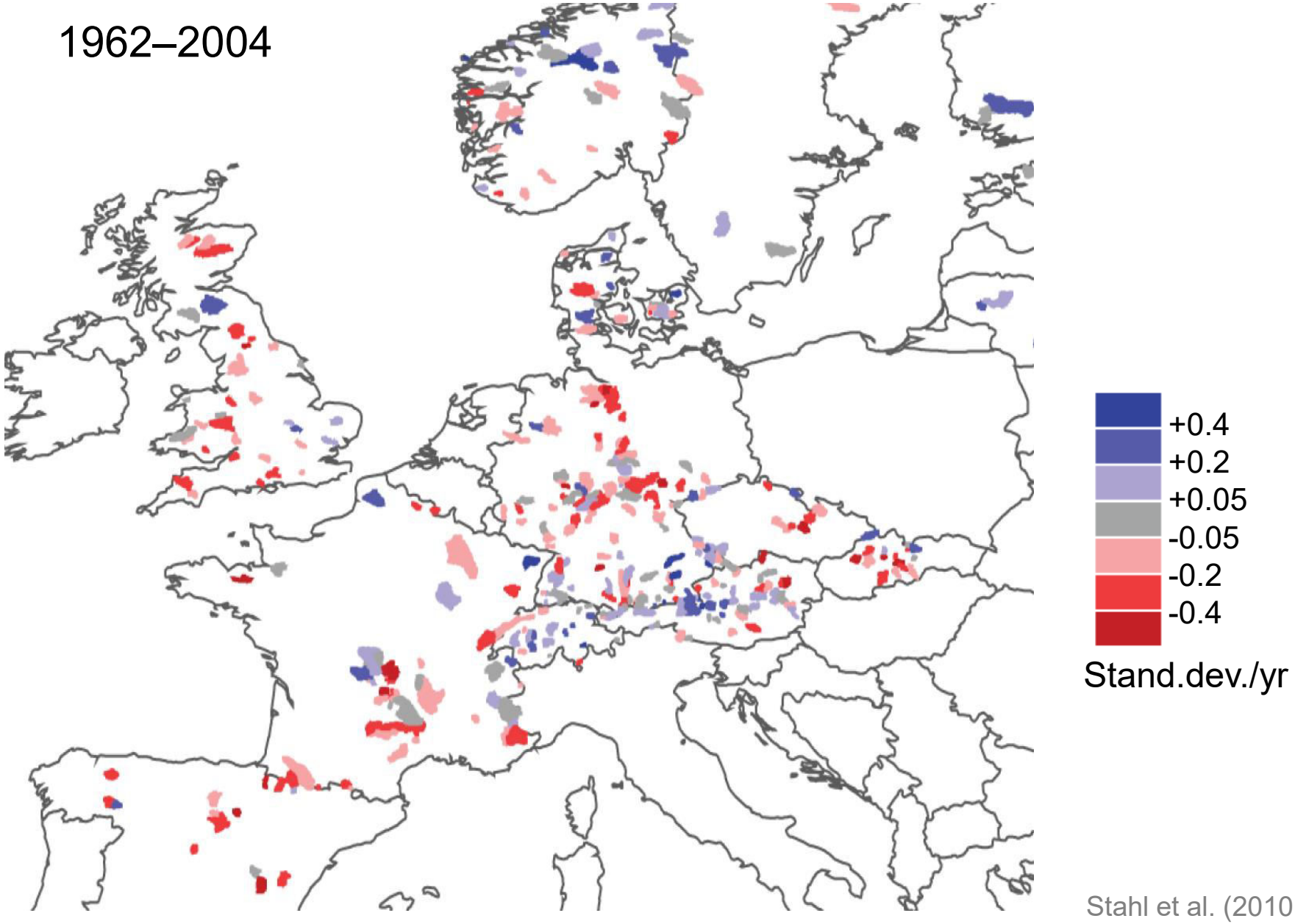
Duethmann and Blöschl (2018)

Estimated water abstractions



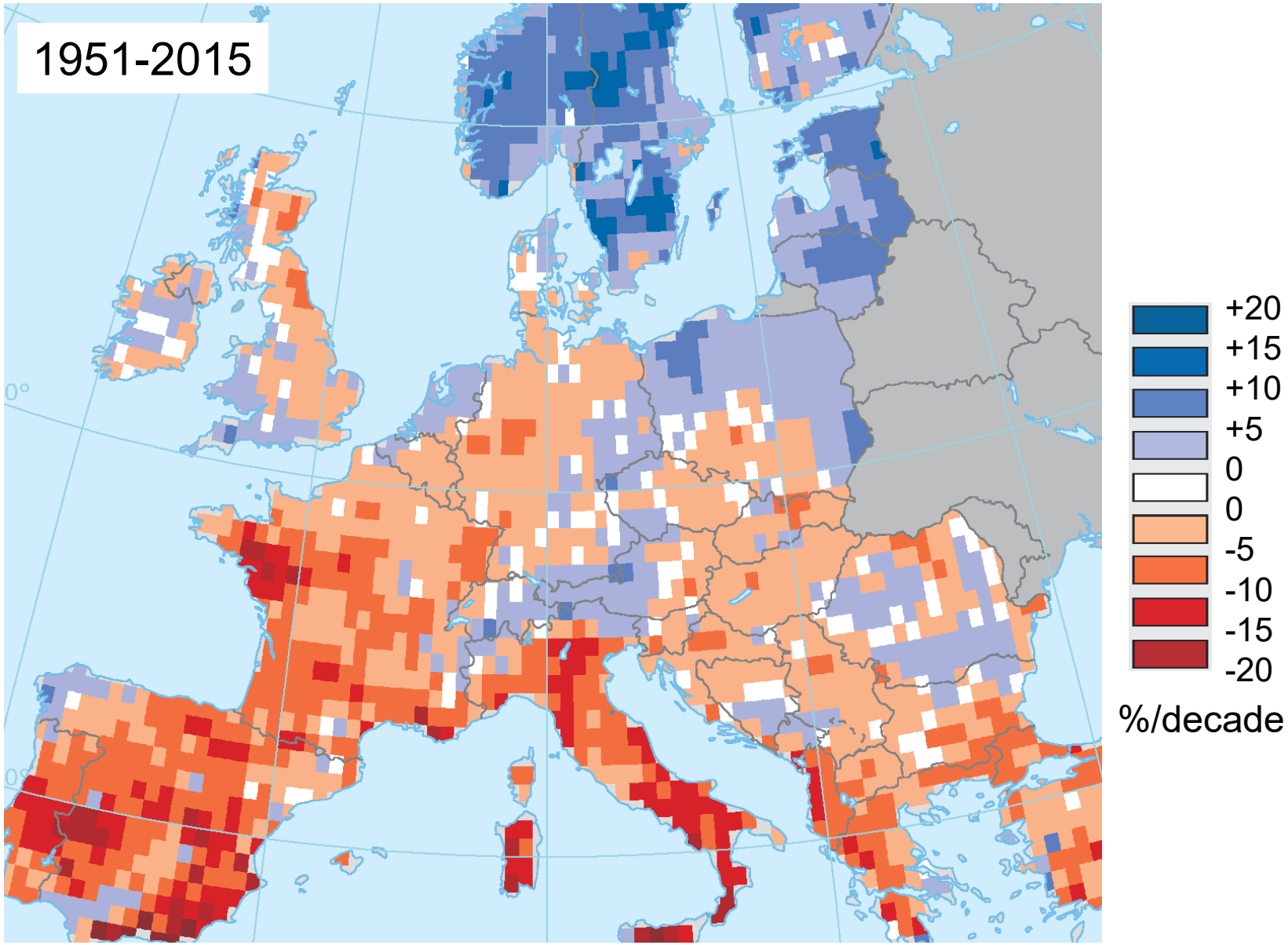
Vandecasteele et al. (2014), Wriedt and Bouraoui (2009)

Observed trends in low flow (AM7) May–Nov.



Stahl et al. (2010)

Gridded trend in runoff of driest months

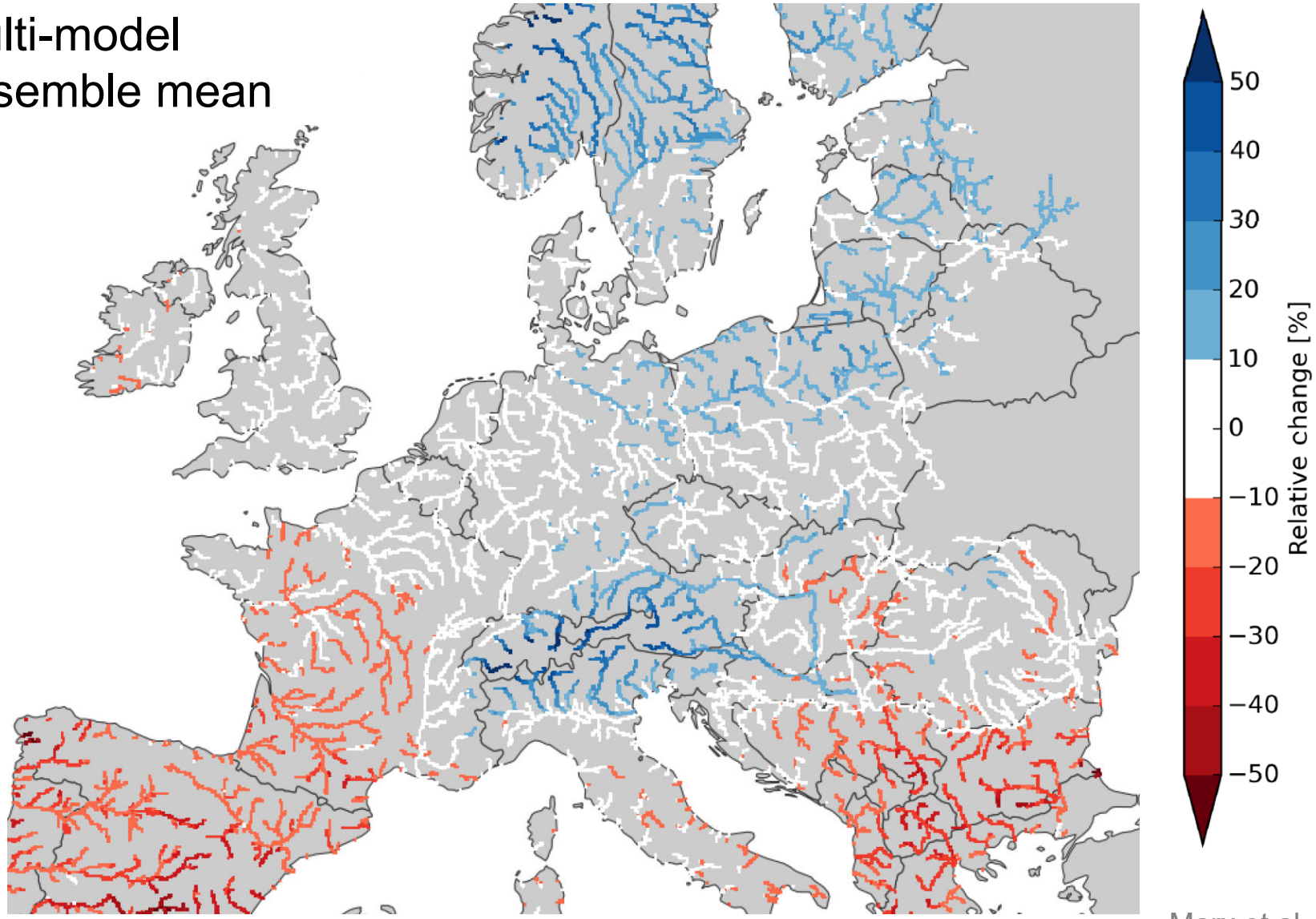


Gudmundsson (2016)

Projected change in low flow (Q90)

under 2K warming compared to 1971–2000

Multi-model ensemble mean



Marx et al. (2018)

Conclusions

- Global rainfall changes mainly due to changed atmospheric circulation patterns
- Central Europe: Summer droughts have become more frequent, winter droughts less frequent

- Mediterranean: Decreasing summer low flows
- Cold areas: Increasing winter low flows due to warmer climate
- Central Europe: Slightly decreasing summer low flows due to more frequent summer droughts and increasing evaporation

- Observed low flow trends likely to continue into the future