

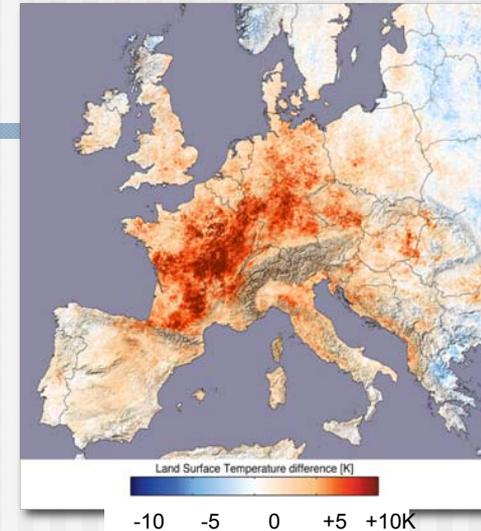
# Land surface predictability in Europe: Extremes & trends

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Eric B. Jaeger and S. I. Seneviratne  
*ECMWF workshop, 9-12 November 2009*

# Motivation

Several major **extreme events** over Europe in recent years (e.g. 2003 heat wave: Schär et al. 2004, *Nature*; Ciais et al. 2005, *Nature*)

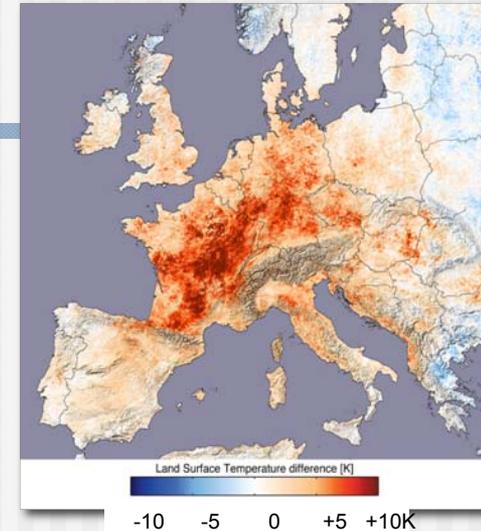


R. Stöckli

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**Land-atmosphere interactions** are a substantial contributor to European heat waves in present and future climate (Seneviratne et al. 2006, *Nature*)



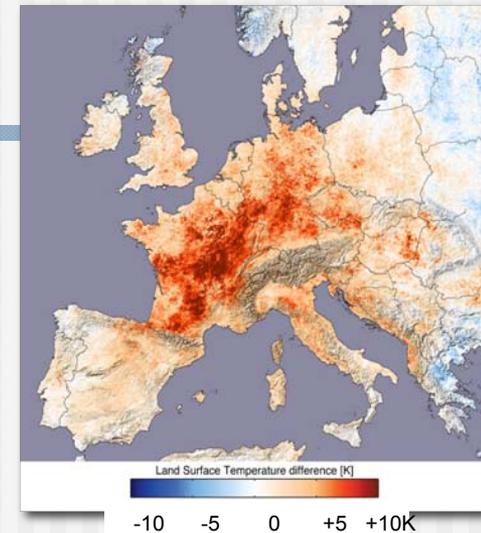
R. Stöckli

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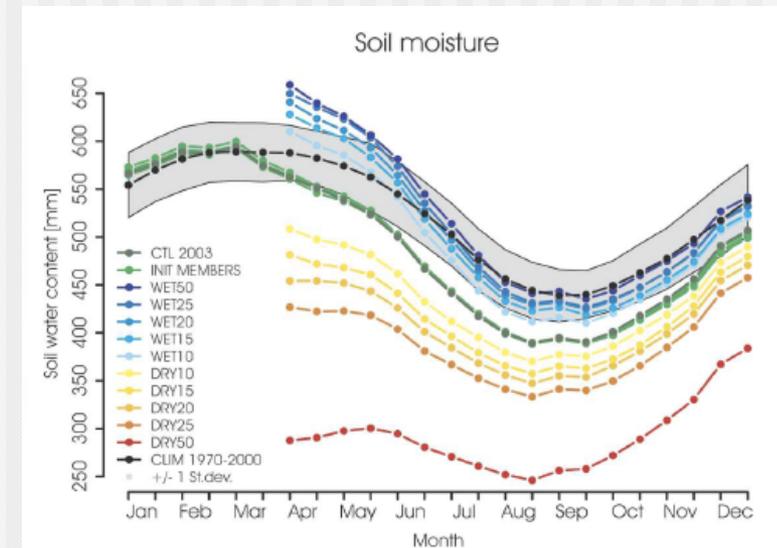
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Land surface and its memory cause some **predictability** (Fischer et al. 2007, *J. Climate*)



R. Stöckli



# Outline

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1.part: land-atmosphere interactions  
and impact on European summer climate

*Impact on: ...the mean climate*

*...temperature extremes*

*...precipitation extremes*

*...trends*

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*Impact on: ...the mean climate*

*...temperature extremes*

*...precipitation extremes*

*...trends*

2.part: Implications for predictability &  
ongoing projects at ETH

# Model experiments

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Regional climate model **CLM**, 50km, driven by ECMWF re-analysis and operational analysis (1958-2006)

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## *Interactive SM:*

- CTL: control simulation

## *Prescribed SM:*

- SSV: lowpass filtered SM from CTL (cutoff ~10d)
- ISV: lowpass filtered SM from CTL (cutoff ~100d)
- IAV: SM climatology from CTL
- PWP: SM const. at plant wilting point
- FCAP: SM const. at field capacity

# Model experiments

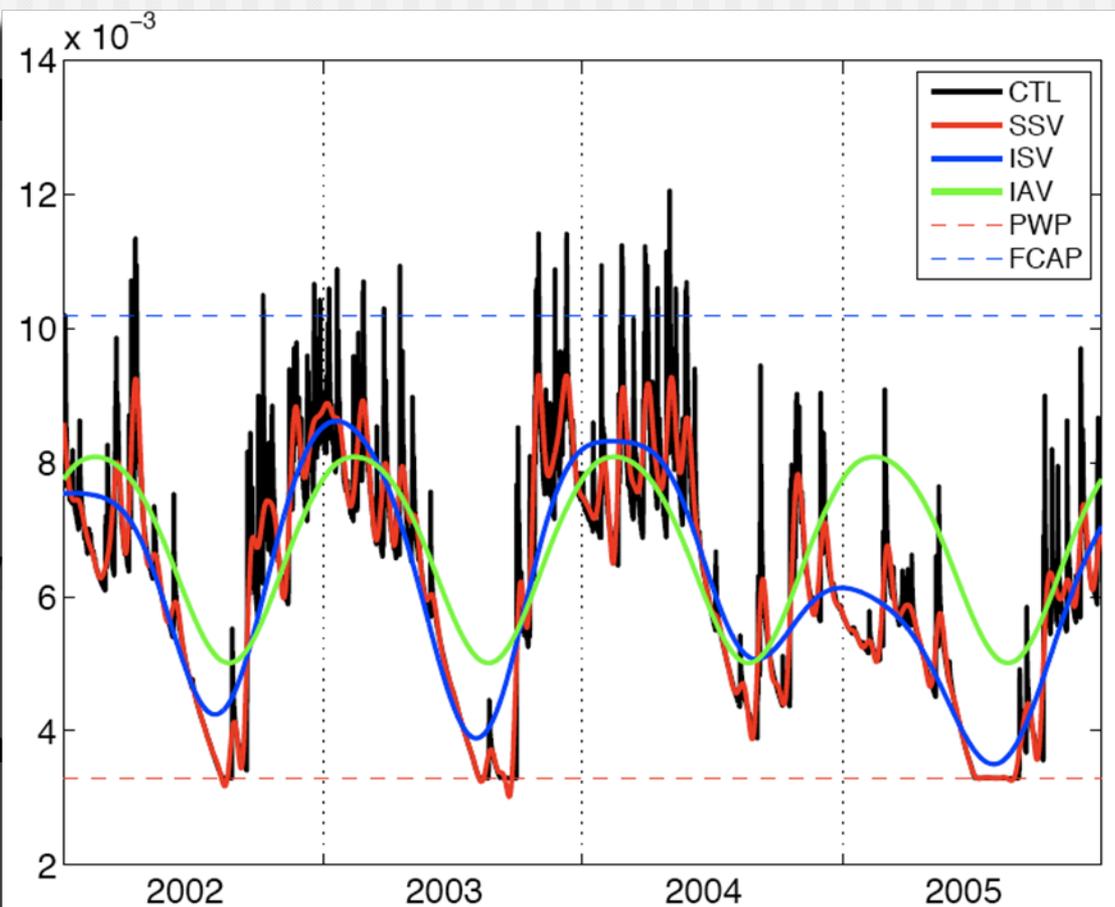
Regional climate model  
analysis and operation

*Interactive SM:*

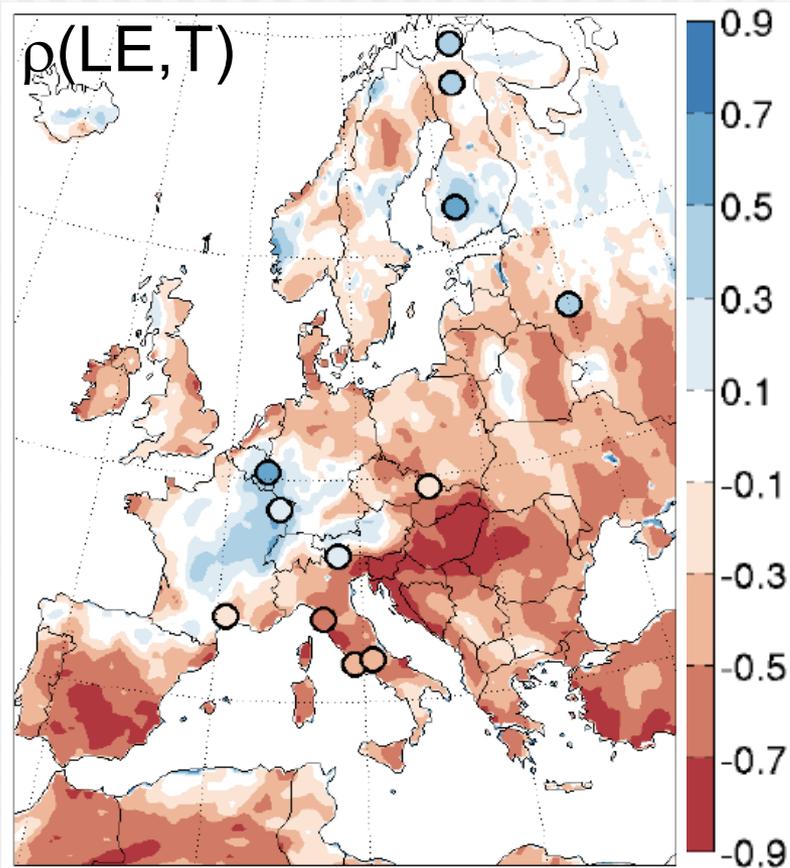
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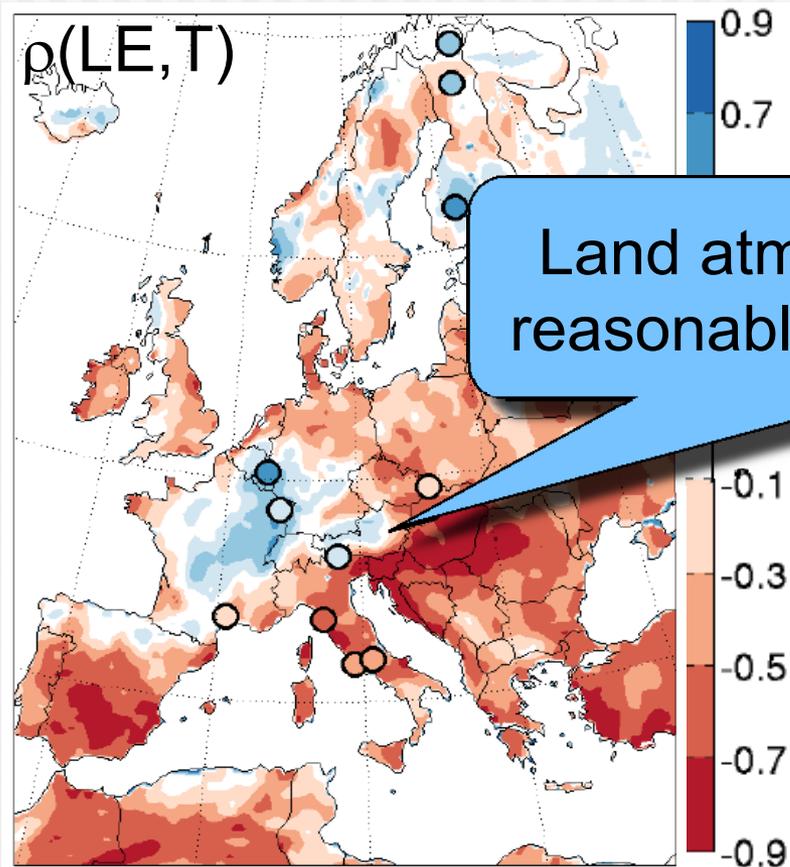


# Validation of CTL



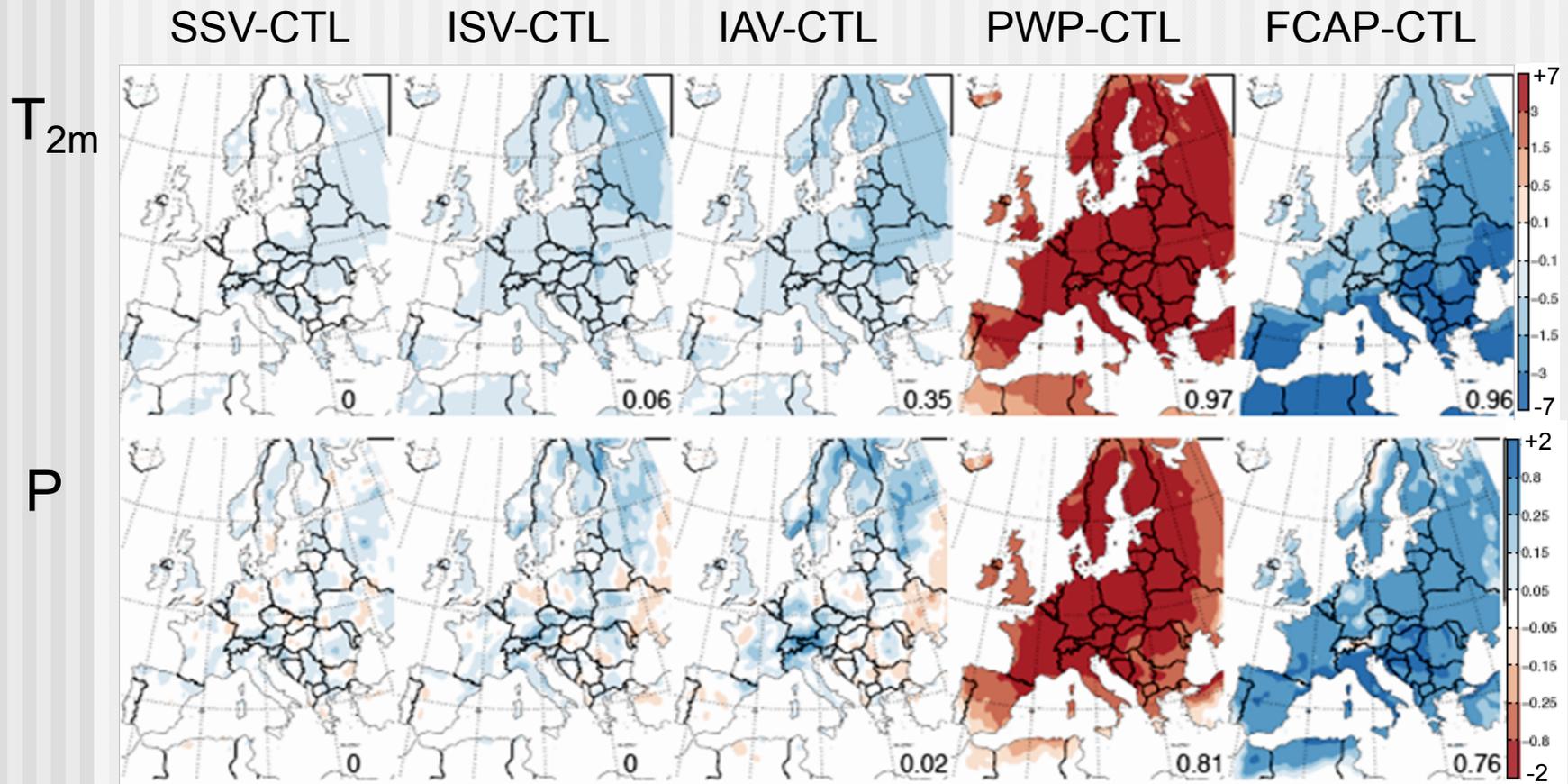
Jaeger et al., *JGR* (2009)

# Validation of CTL

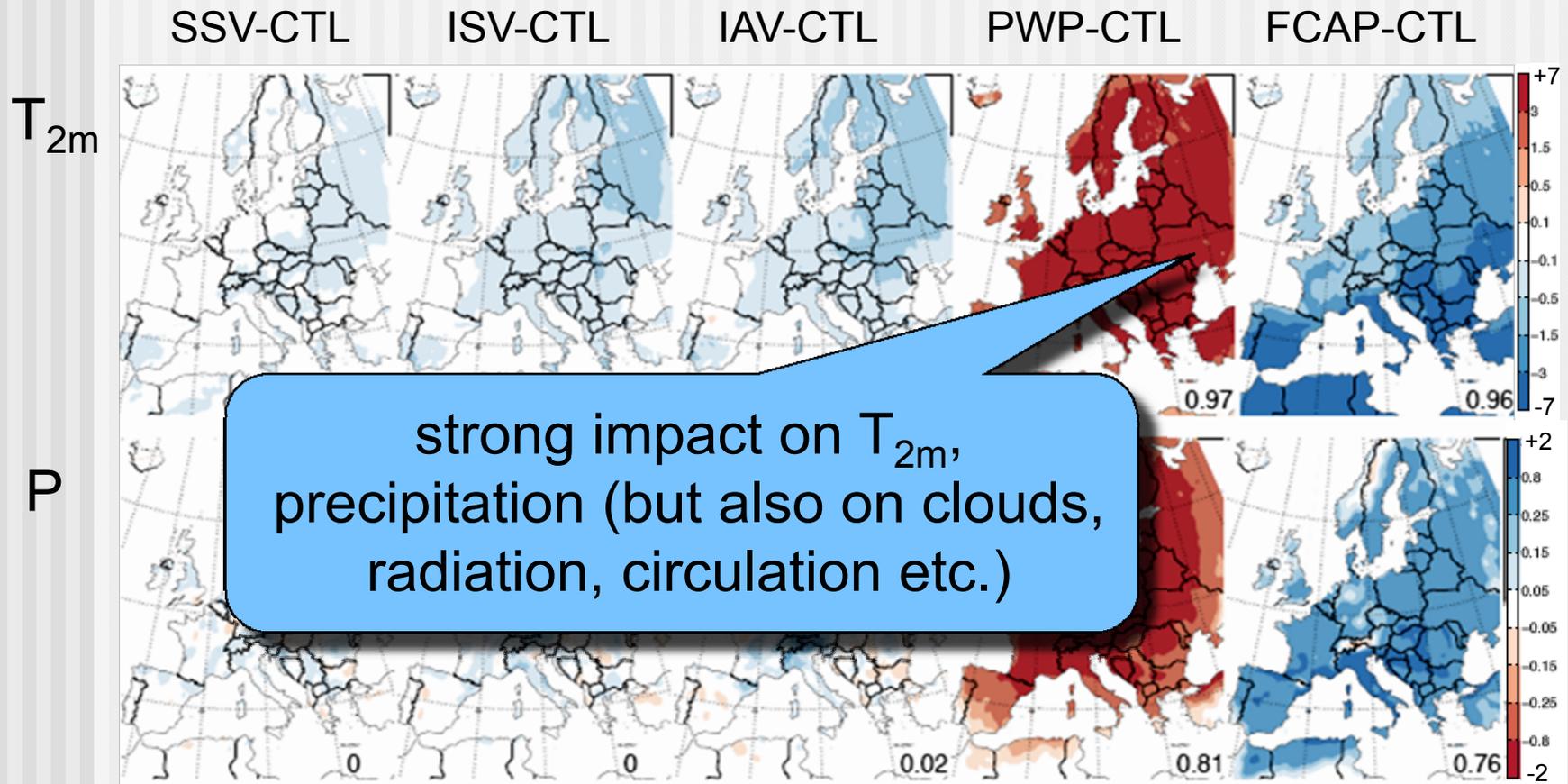


Land atmosphere coupling is reasonably represented in CLM

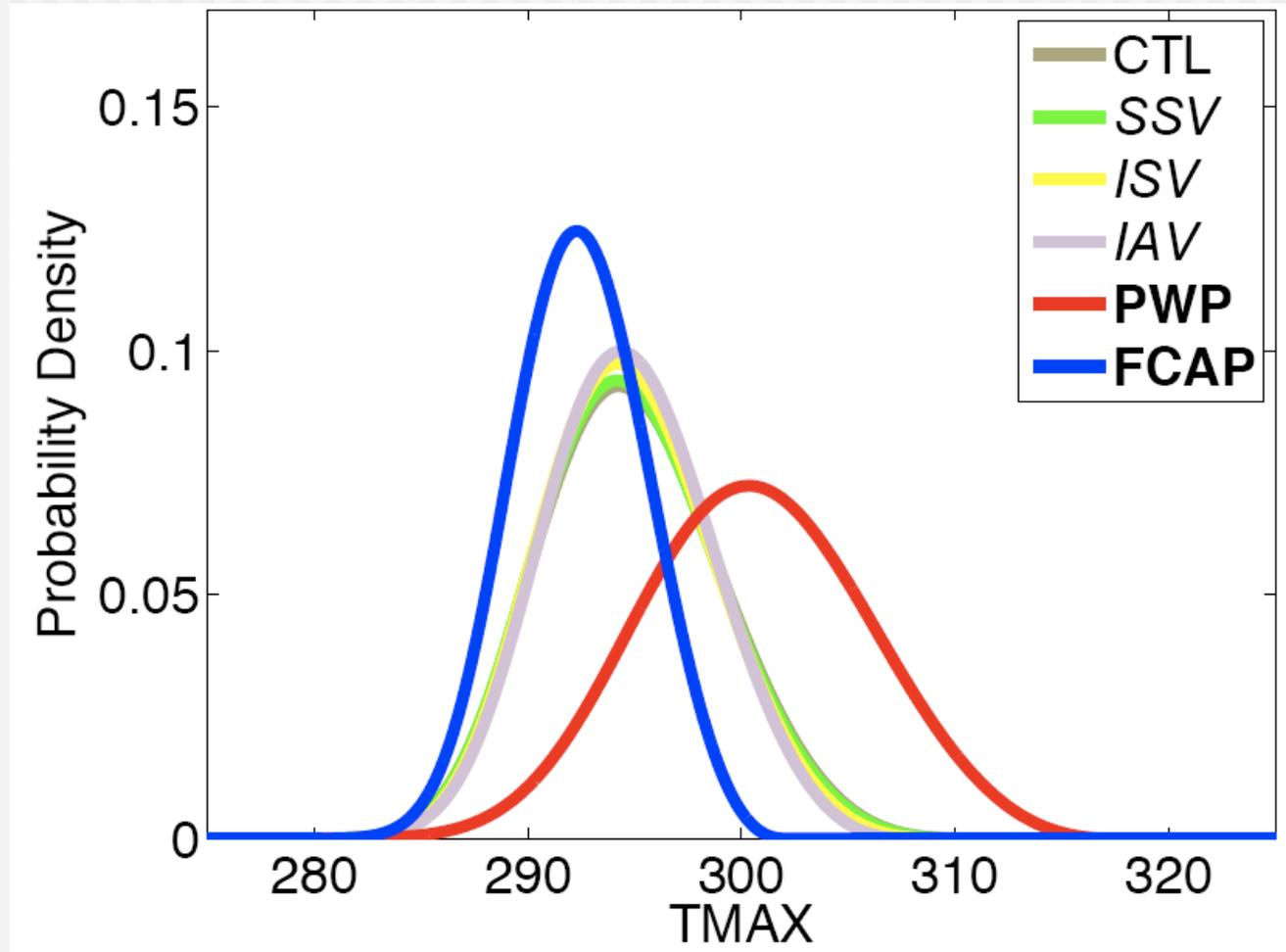
# Mean climate: JJA



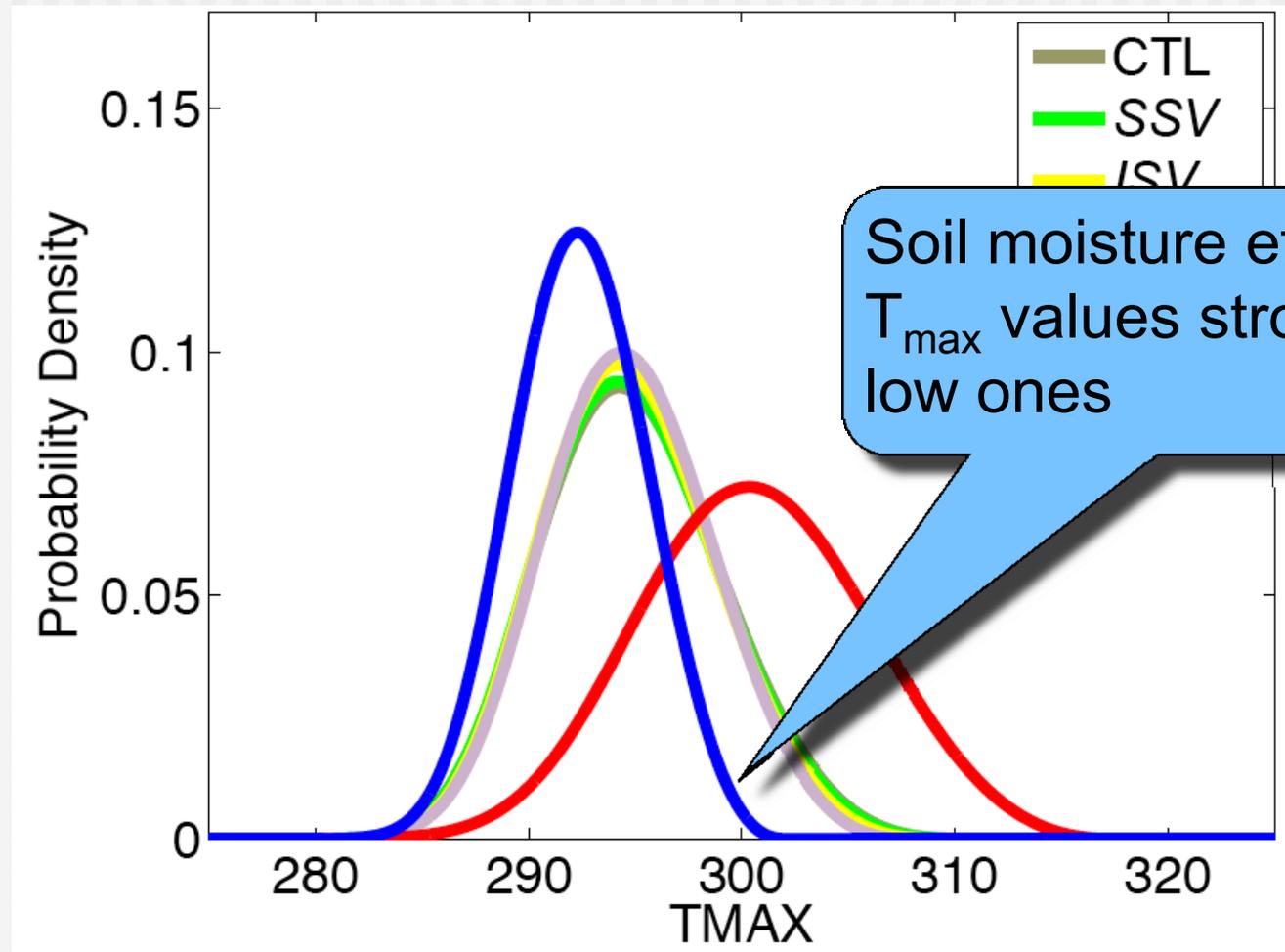
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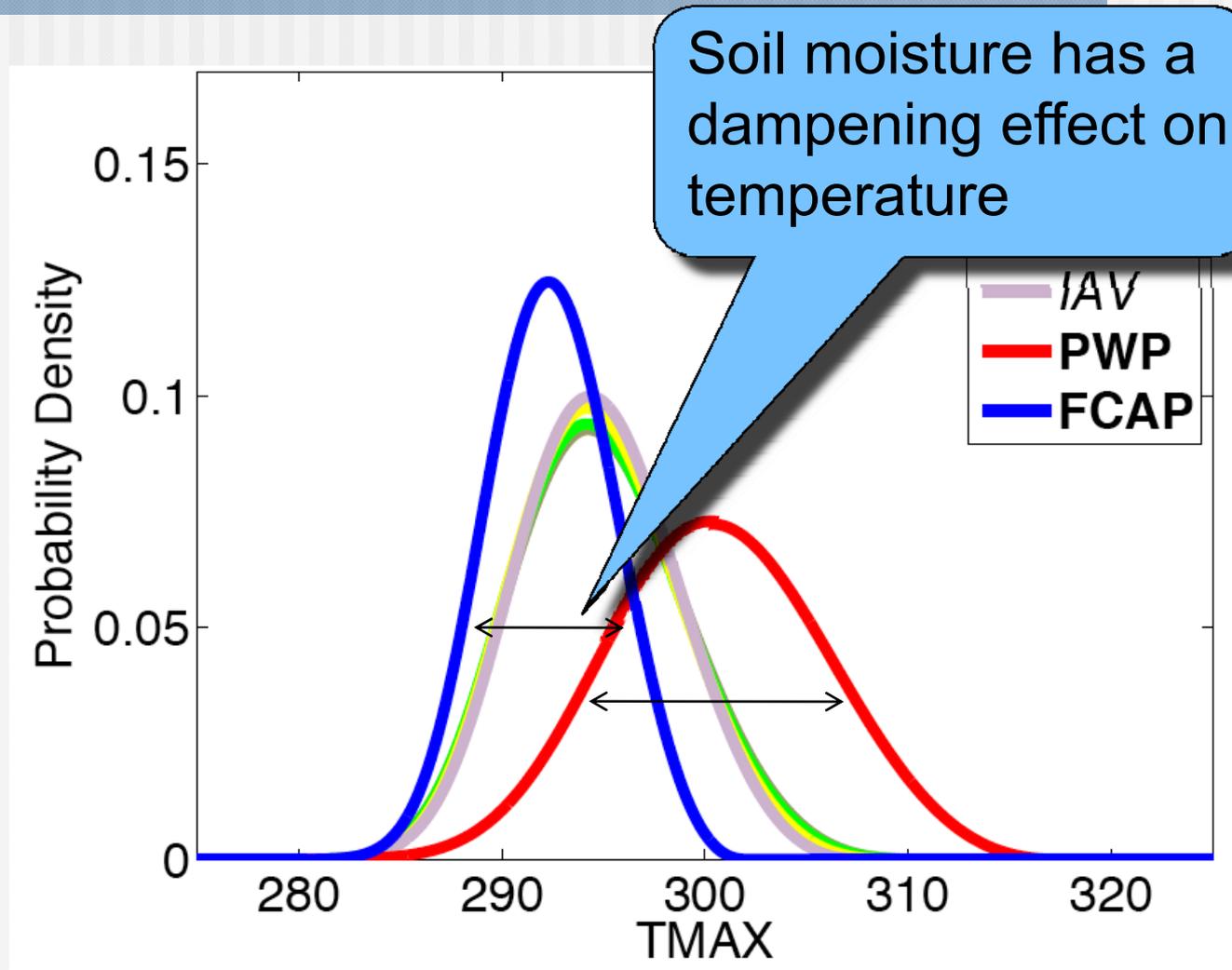
# PDFs of $T_{\max}$



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# Extremes: HWDI

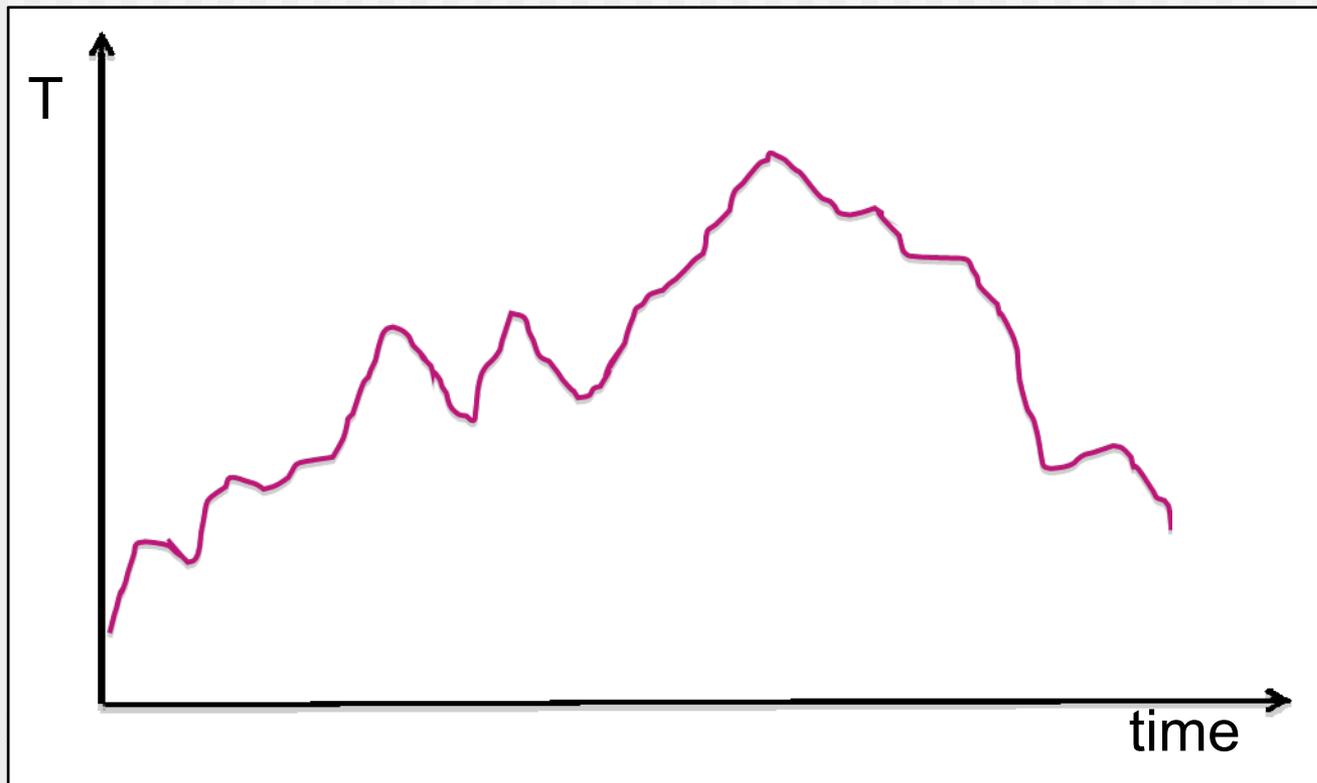
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HWDI = heat wave duration index:

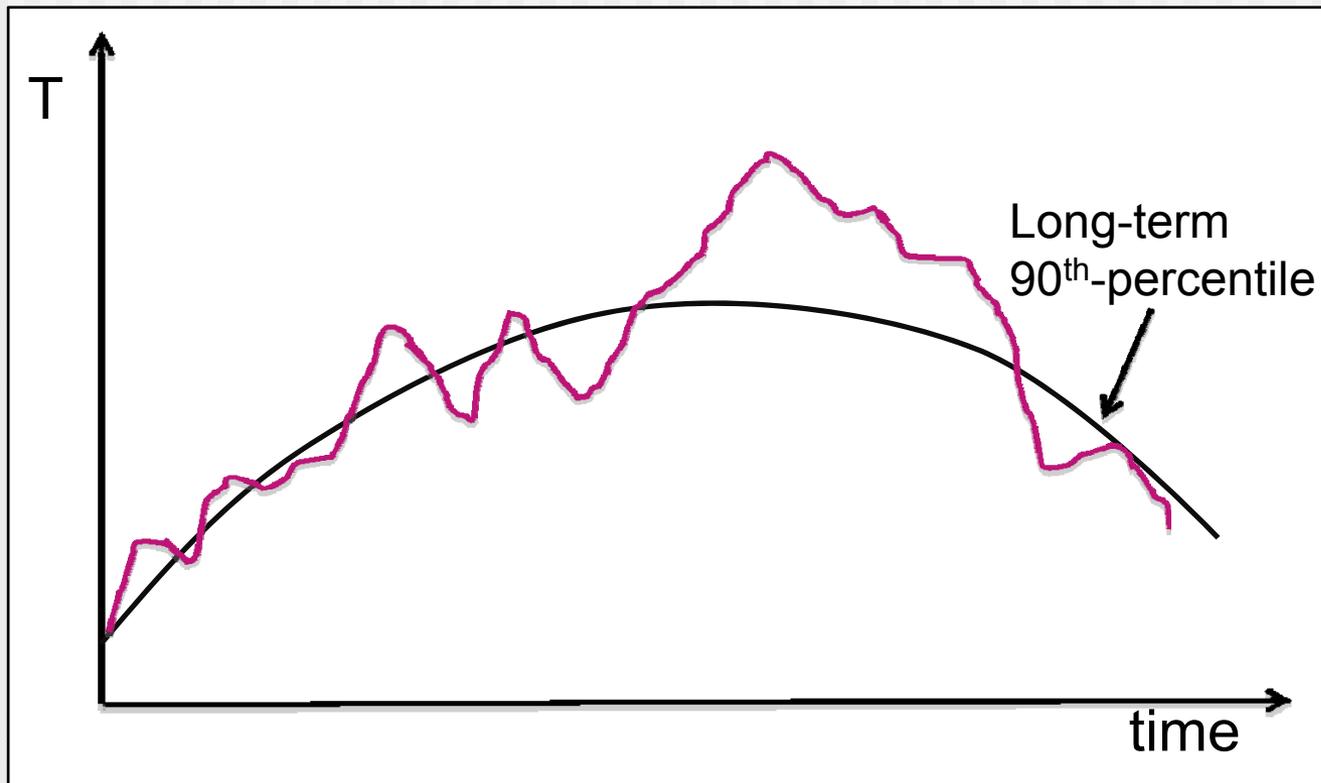
*'(max, mean) number of consecutive days (at least two) with values above the long-term 90<sup>th</sup>-percentile'*

# Extremes: HWDI

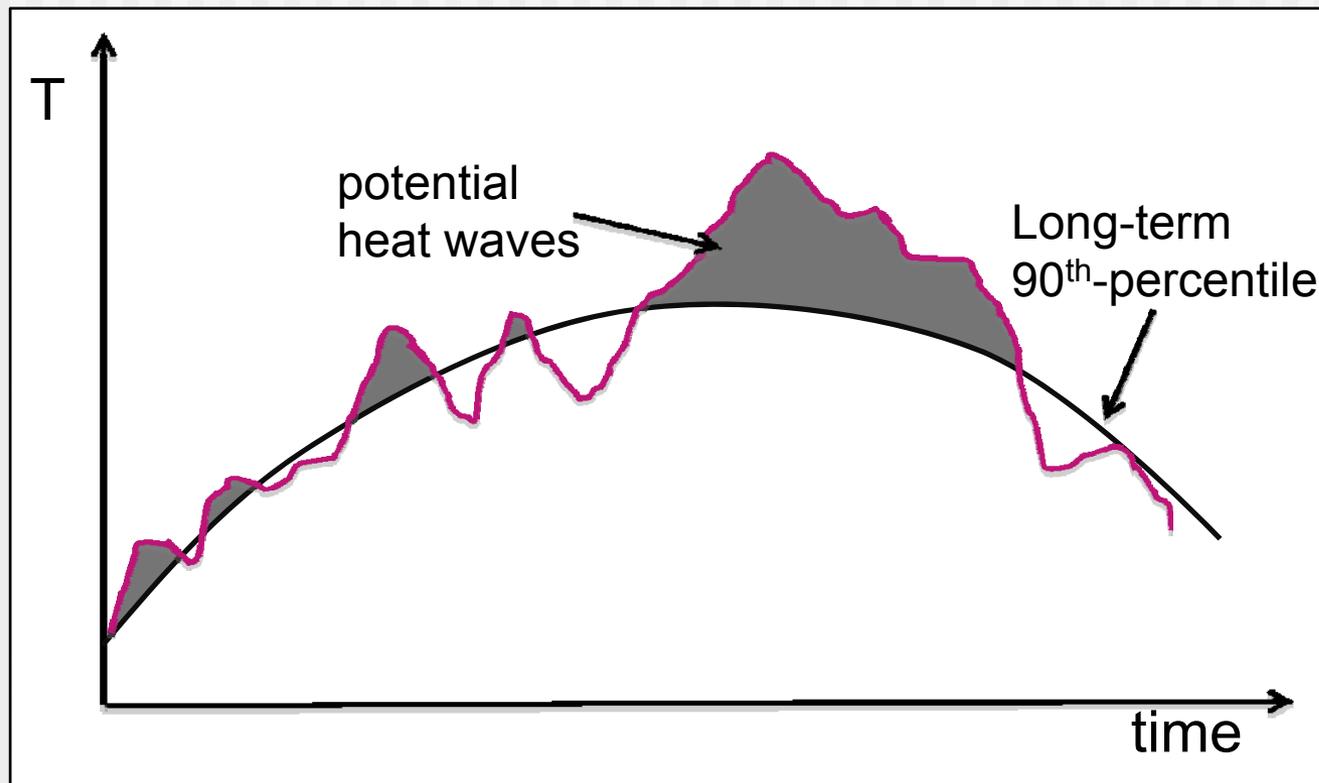
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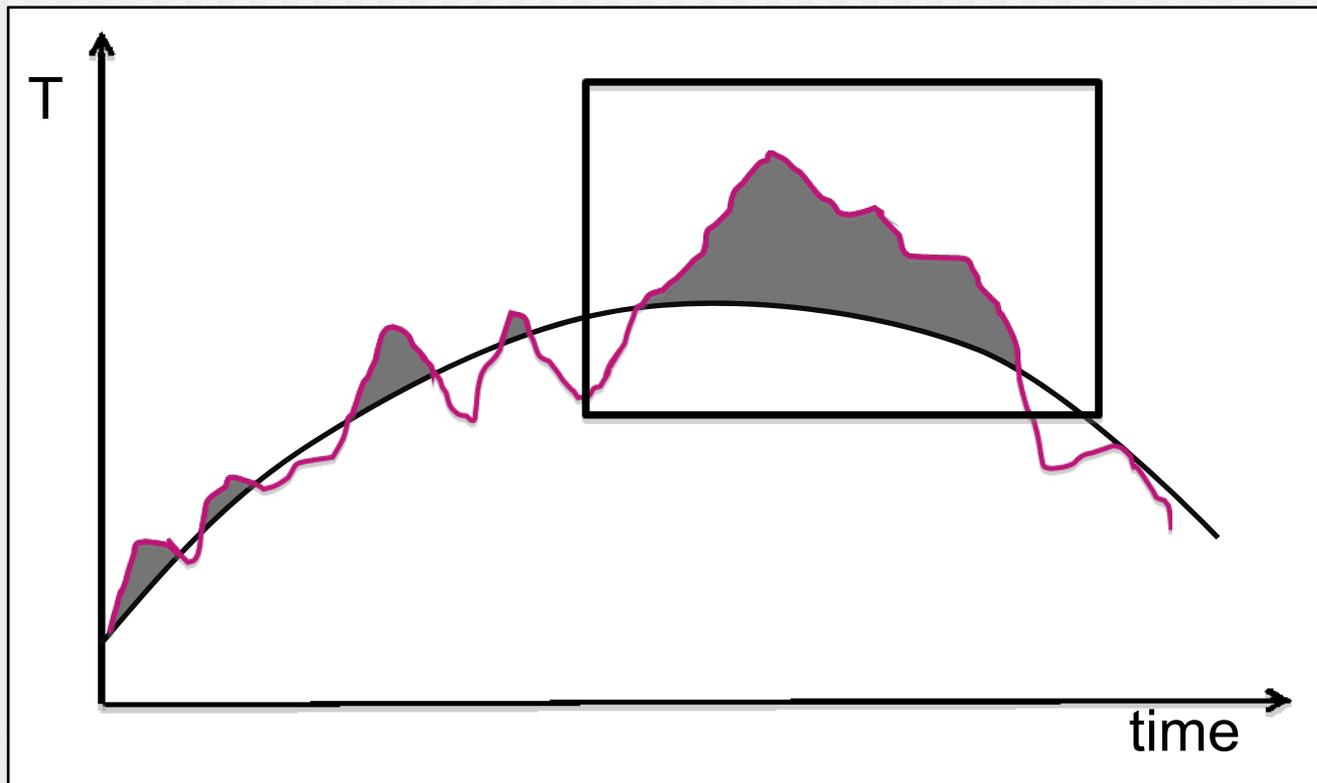
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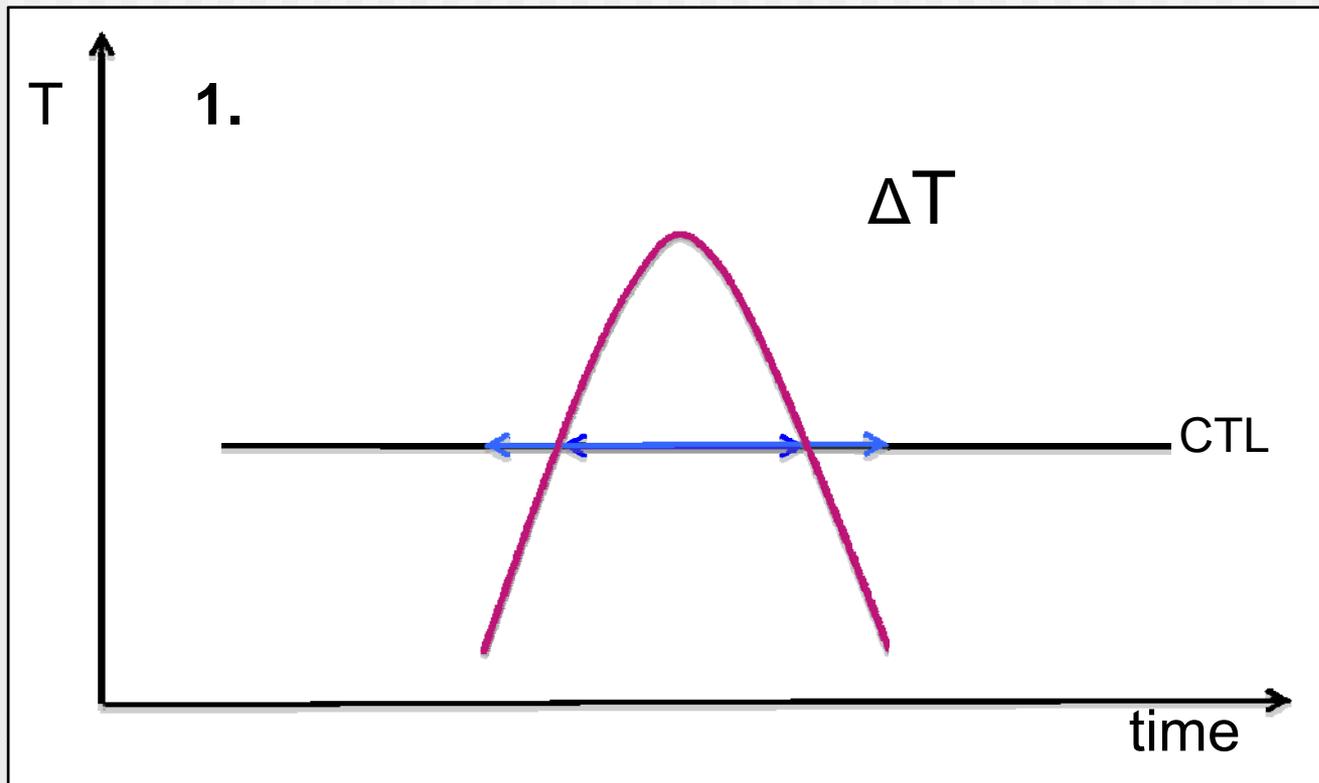
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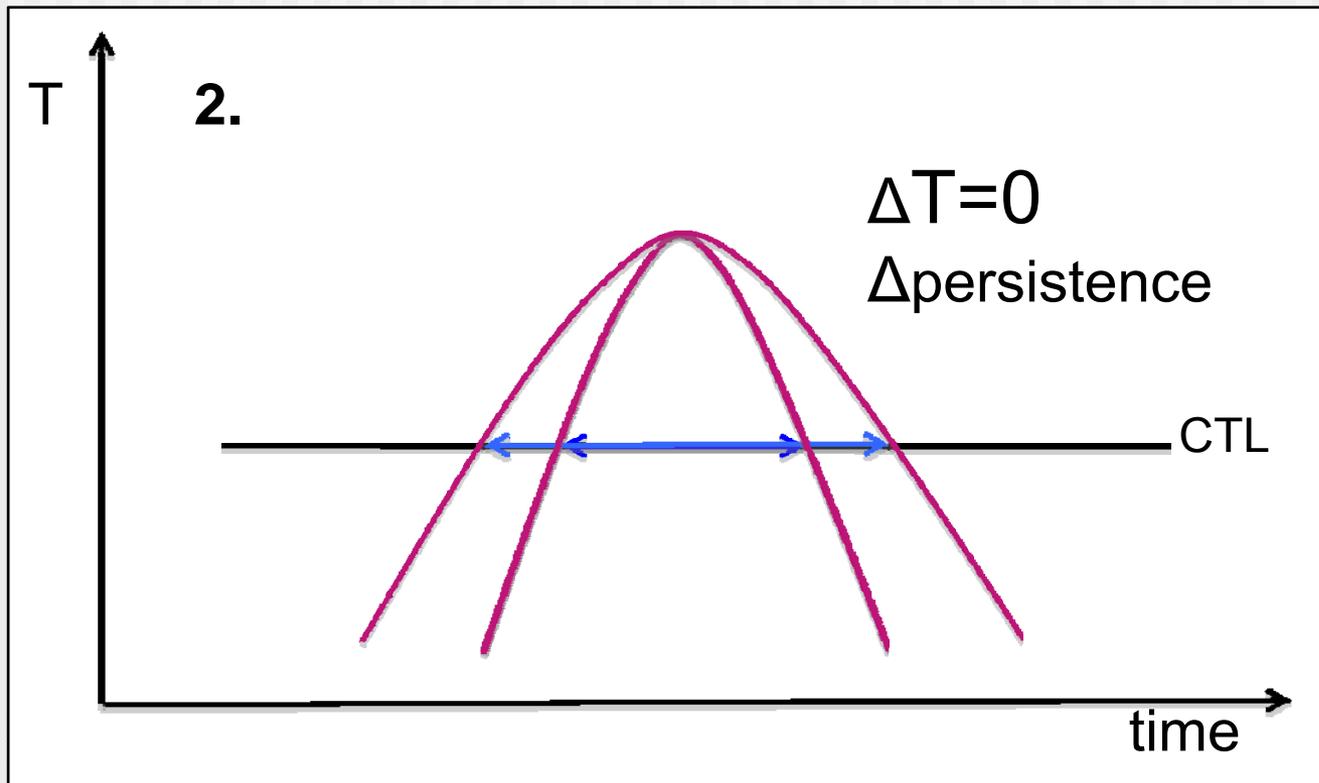
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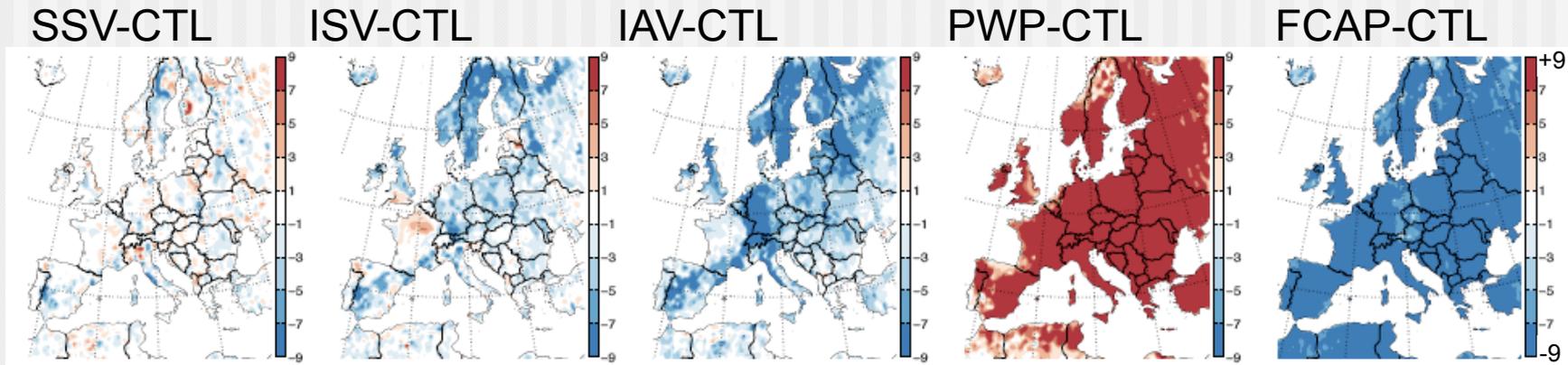


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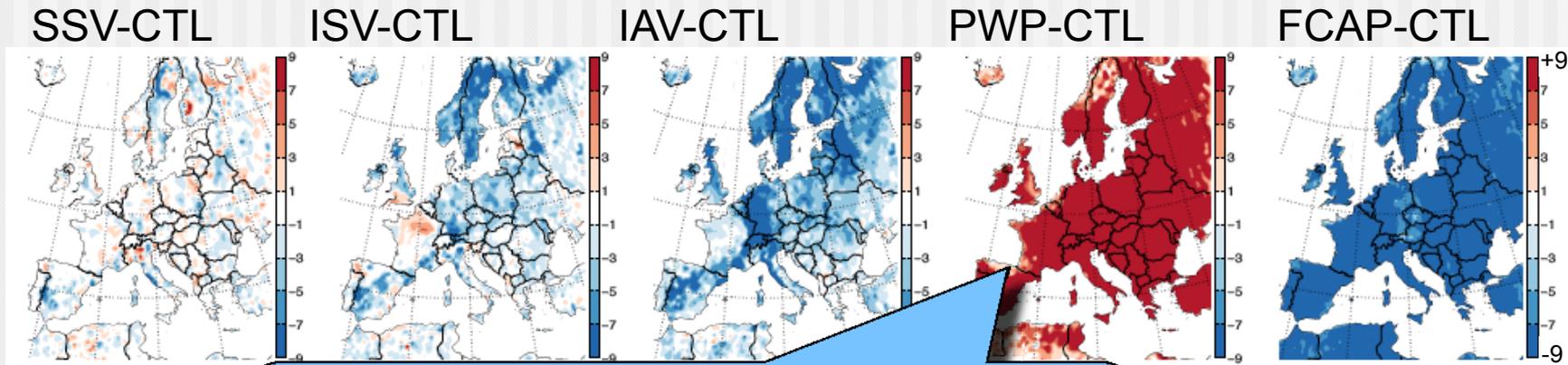
# Extremes: HWDI

hwdi



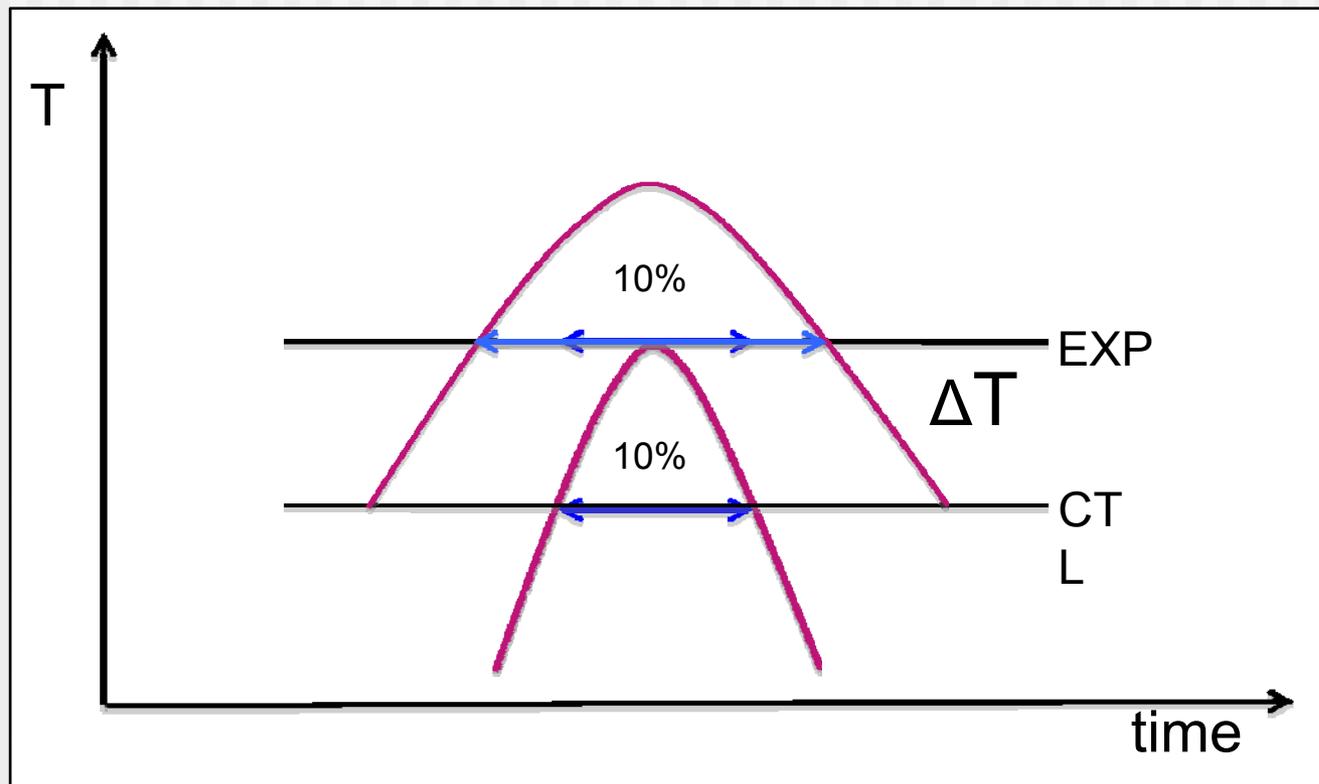
# Extremes: HWDI

hwdi



Due to changes in the PDF of  $T_{\max}$   
or due to changes in persistence?

# Extremes: HWDI



# Extremes: HWDI

hwdi

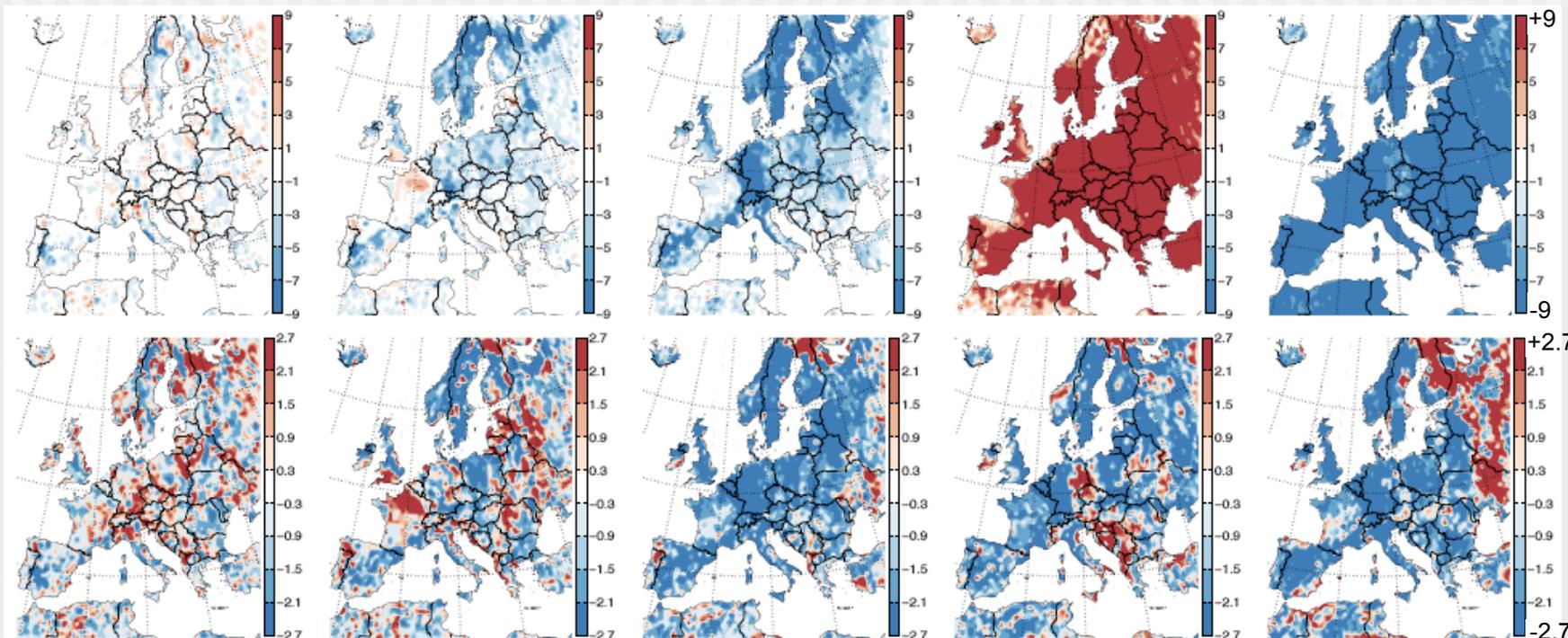
SSV-CTL

ISV-CTL

IAV-CTL

PWP-CTL

FCAP-CTL

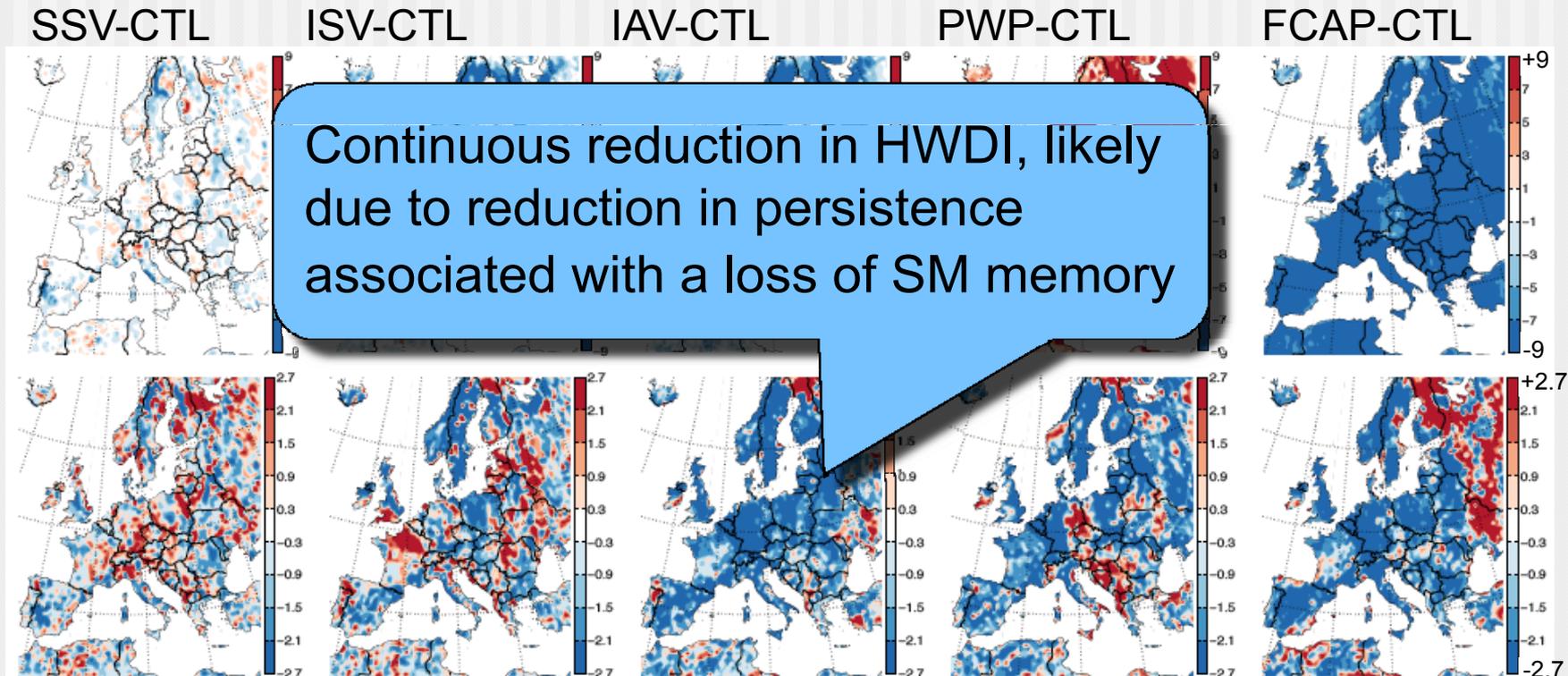


hwdi\*

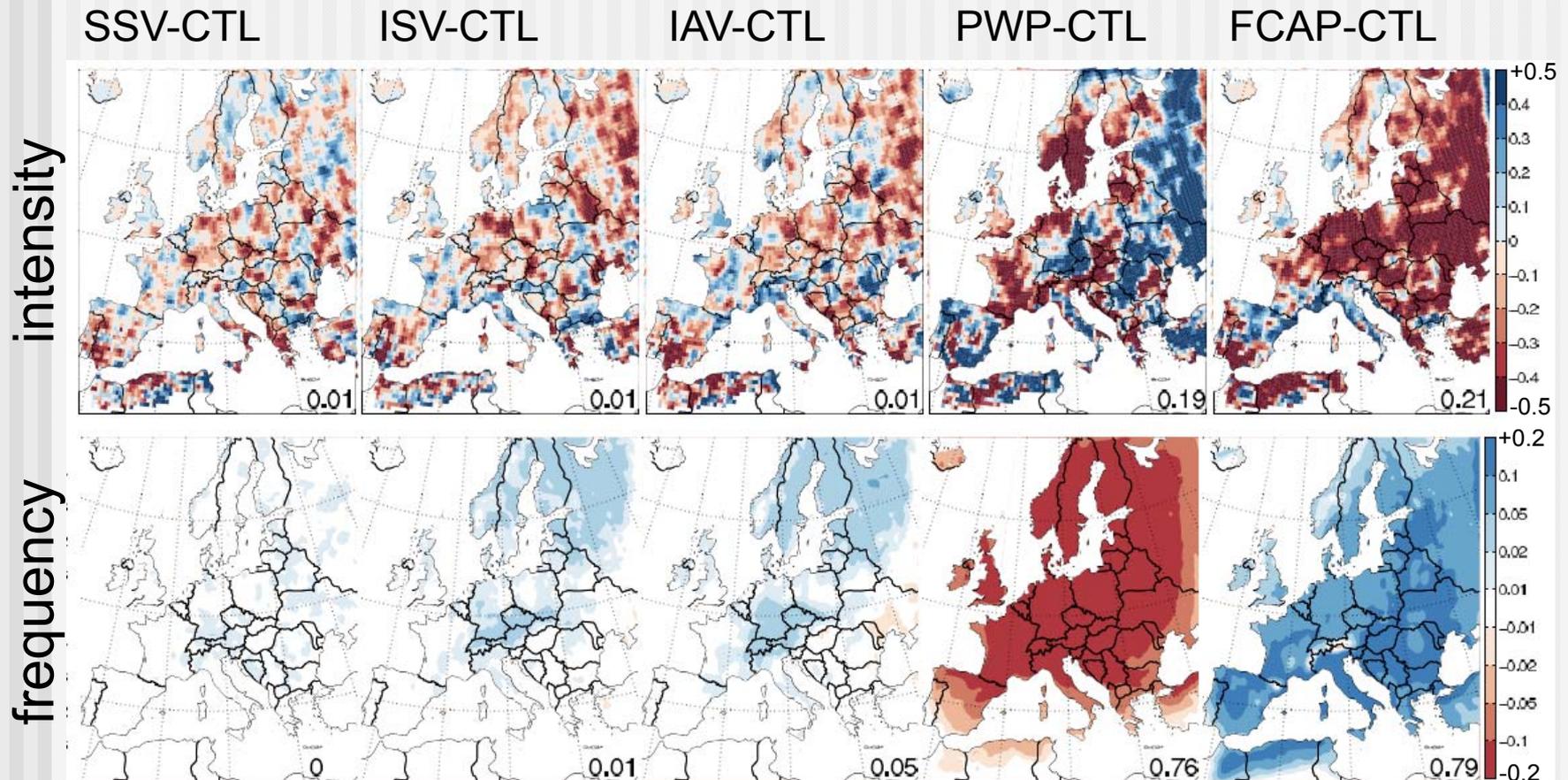
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hwdi

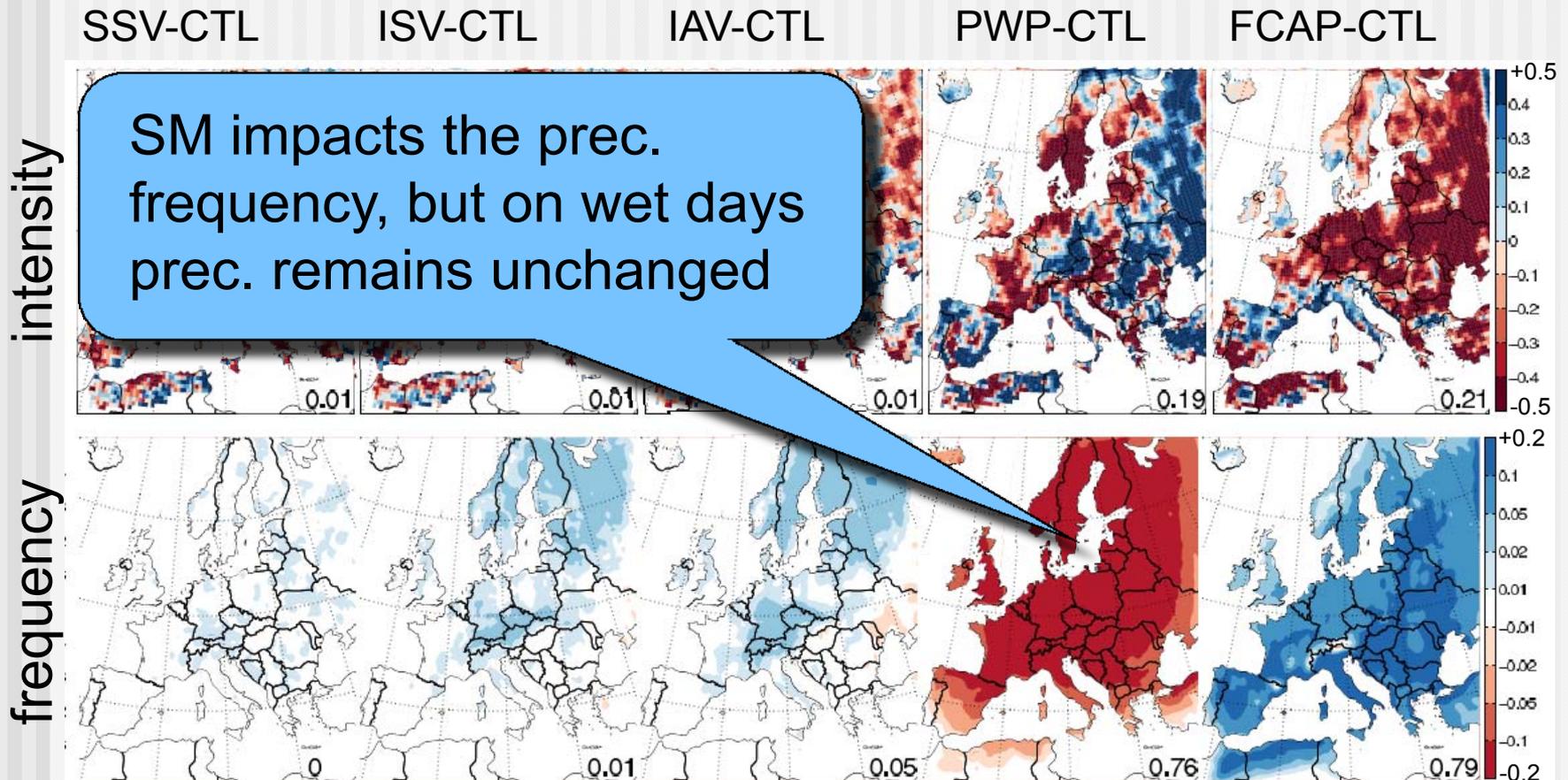
hwdi\*



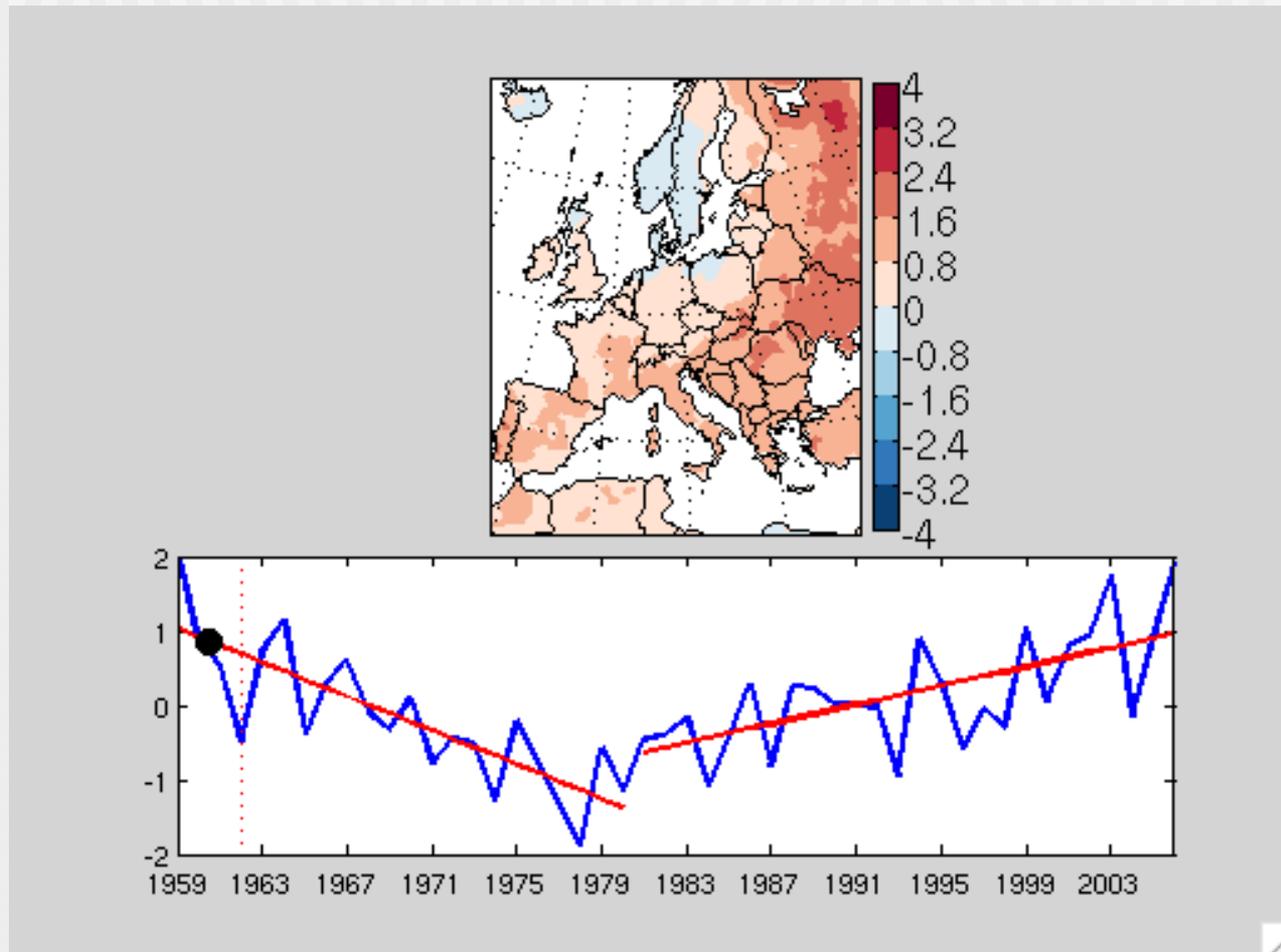
# Precipitation extremes



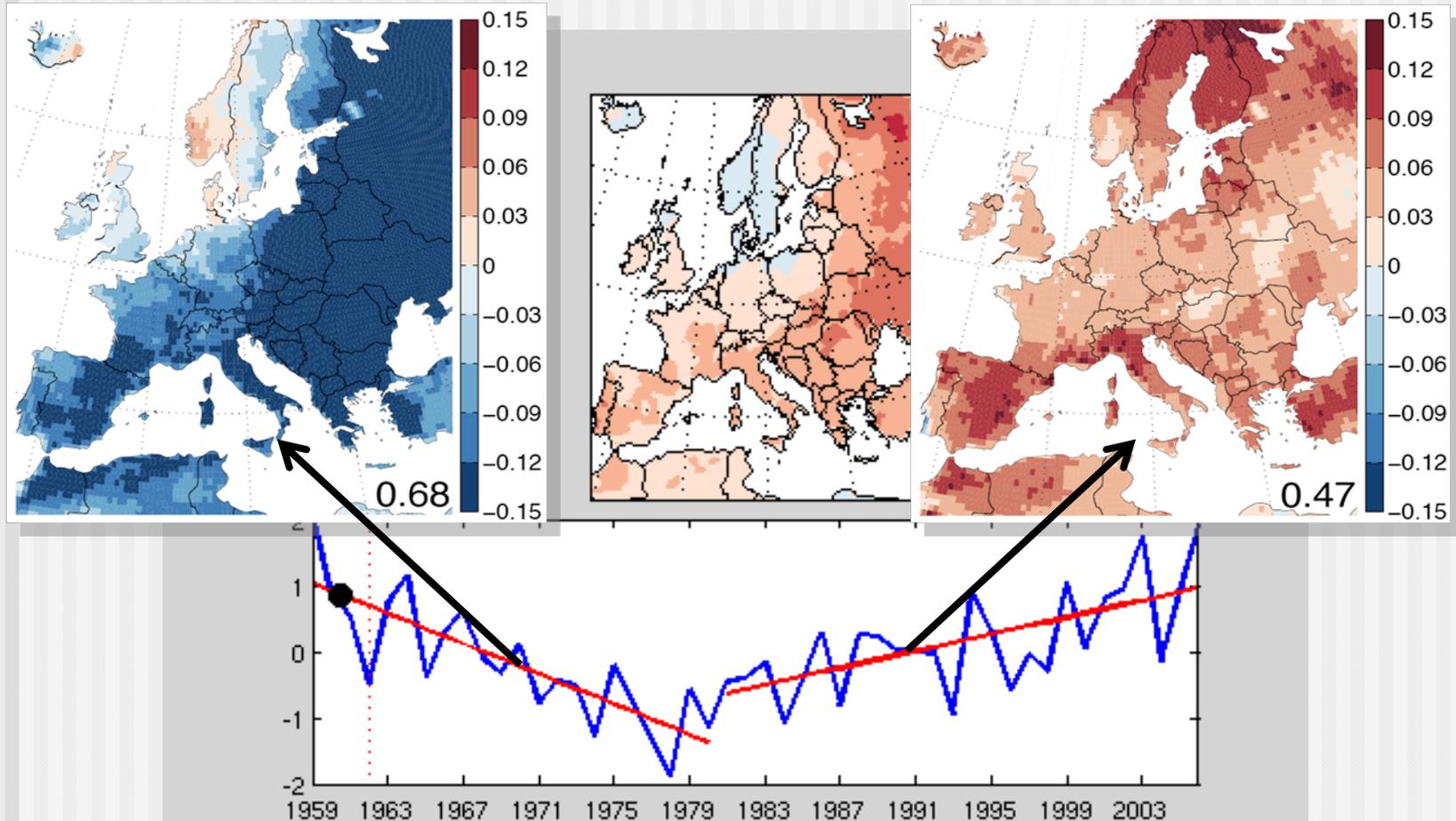
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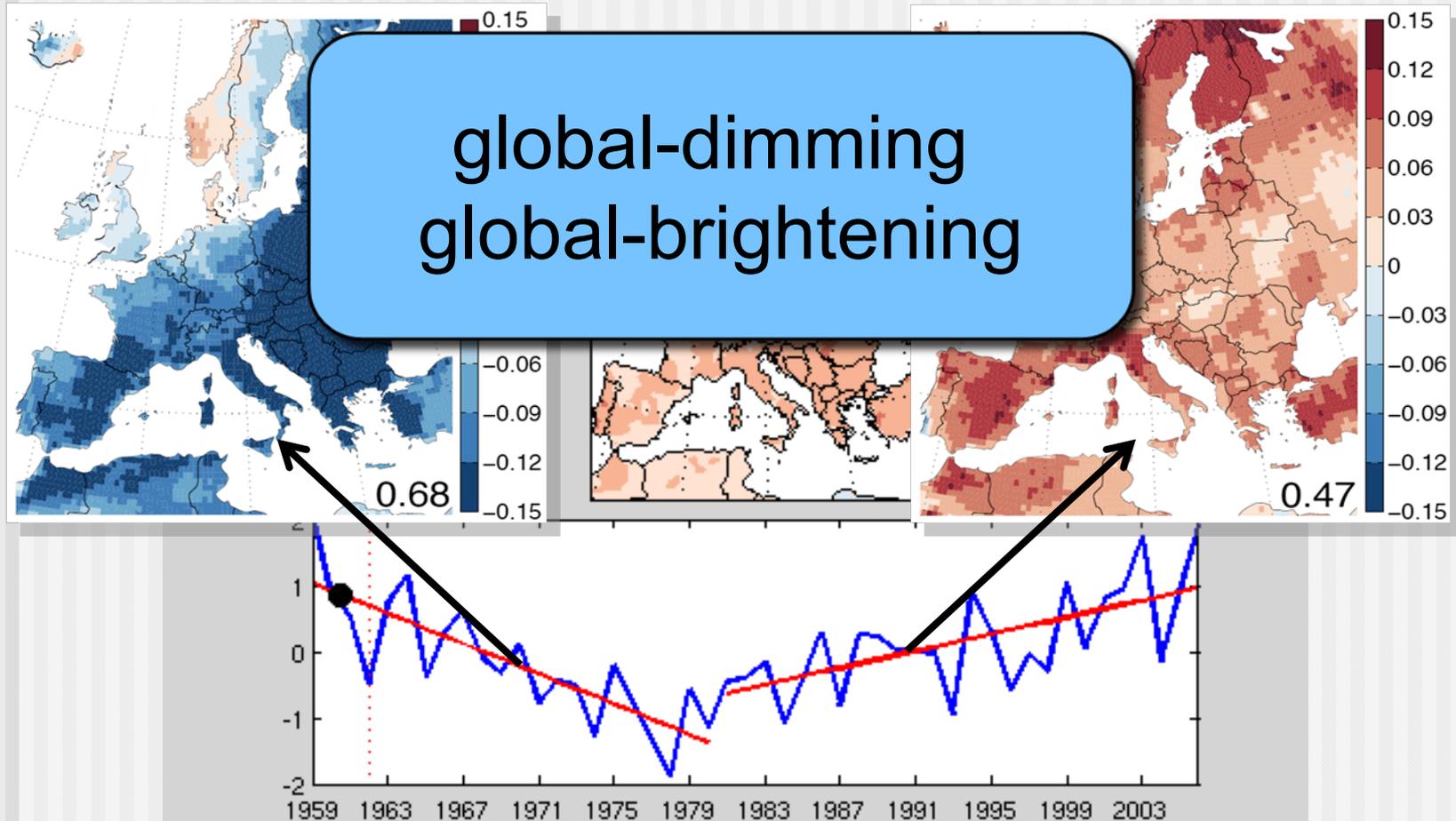
# Trends in $T_{\max}$ (mean)



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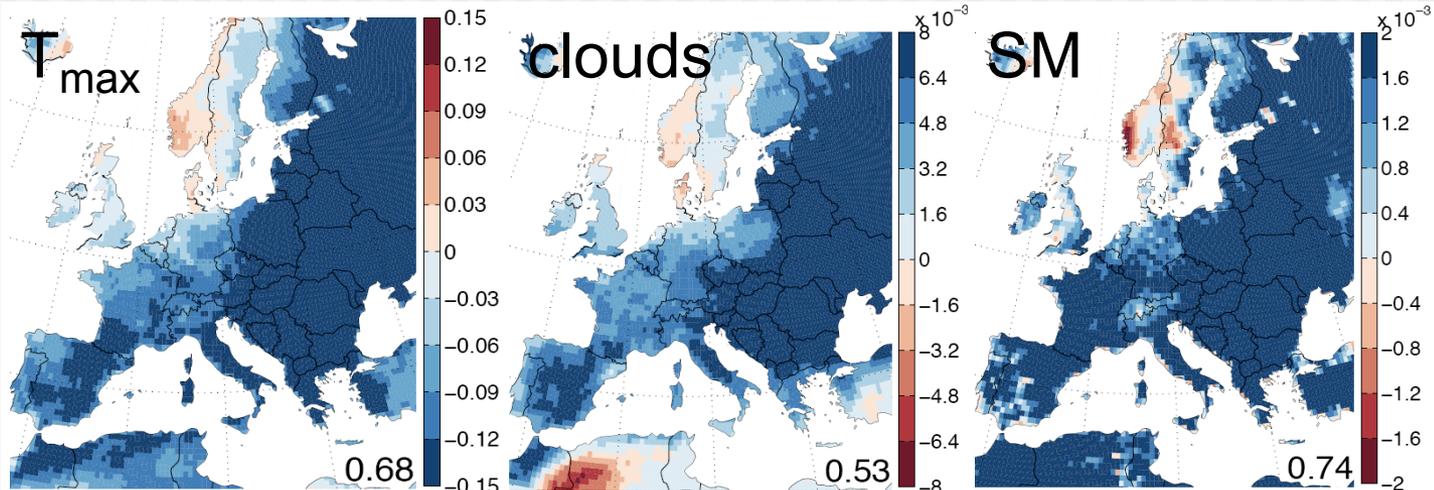


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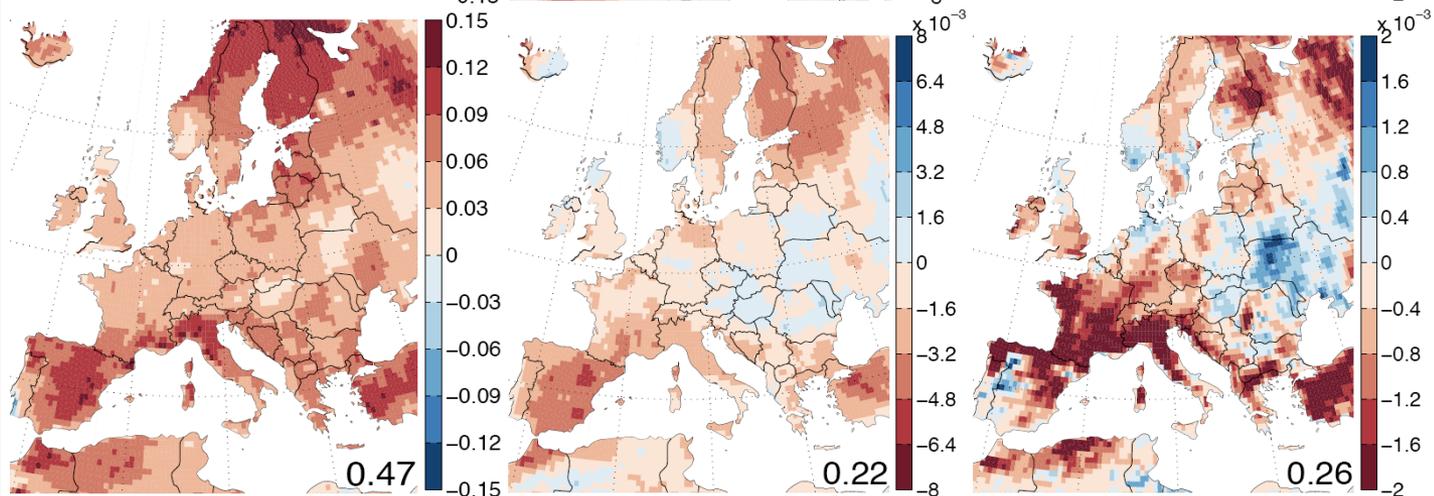


# Trends in $T_{\max}$ : mechanisms?

1959-1980

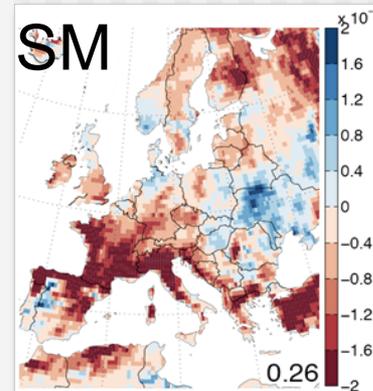
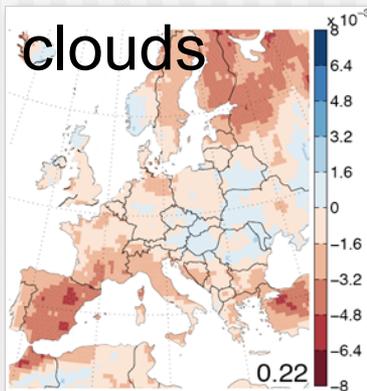
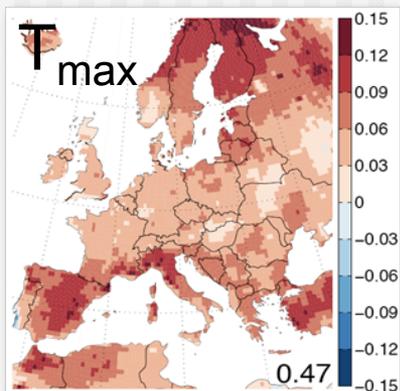


1981-2006

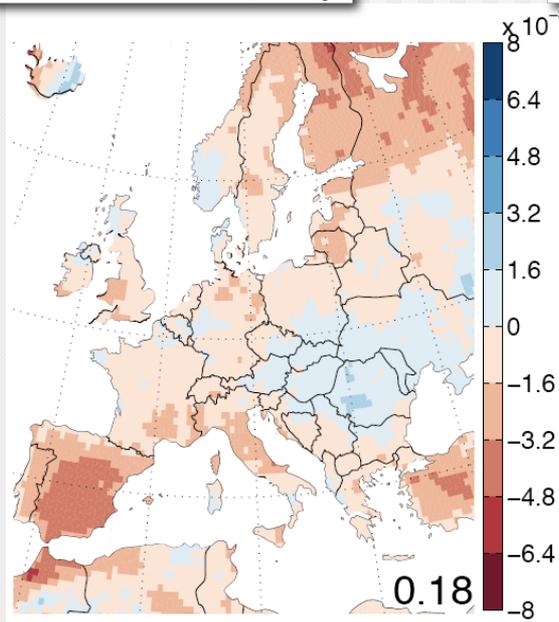
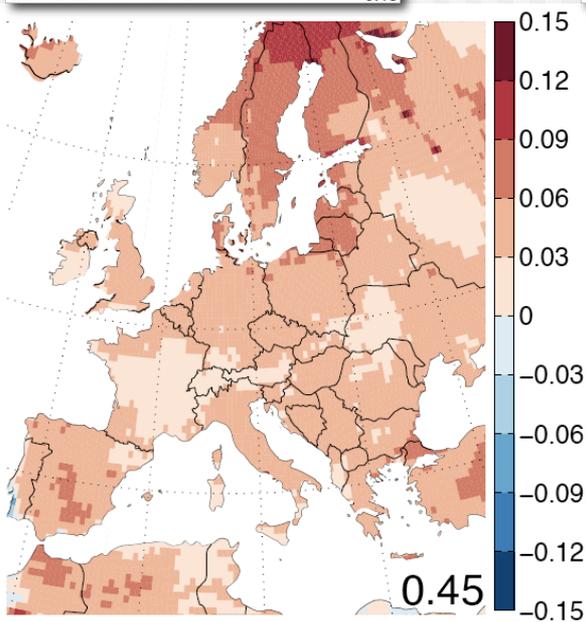


# Trends in $T_{\max}$ : link to SM

1981-2006: CTL



1981-2006: IAV

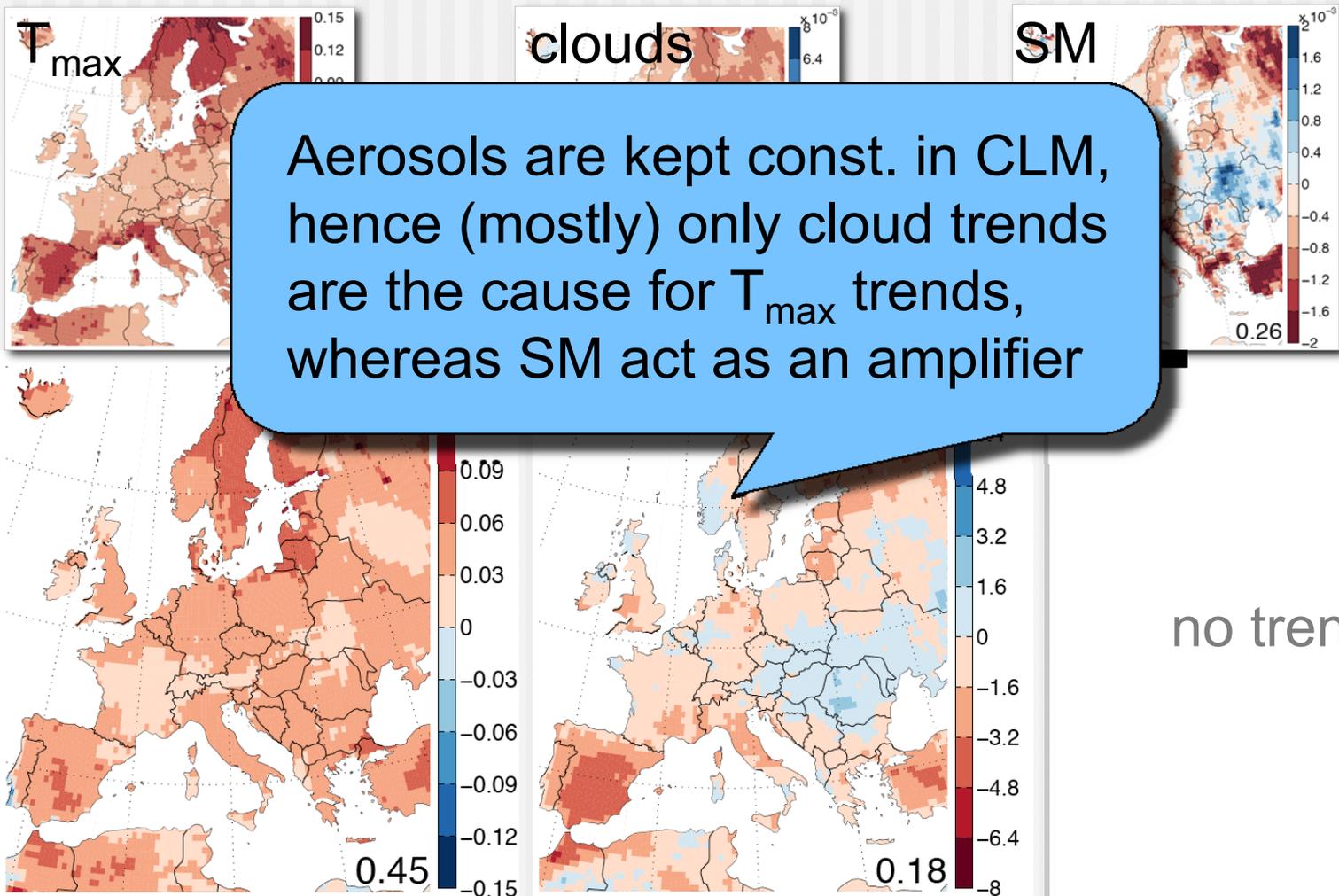


no trend

# Trends in $T_{\max}$ : link to SM

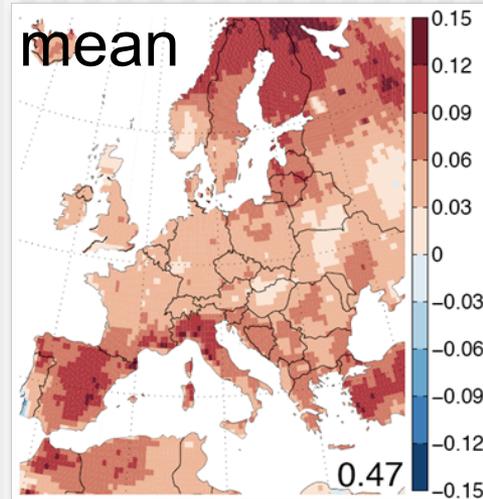
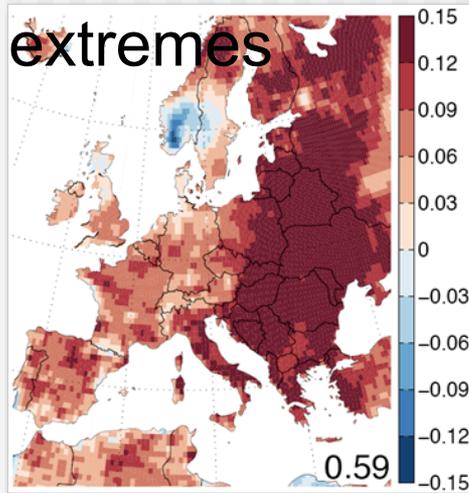
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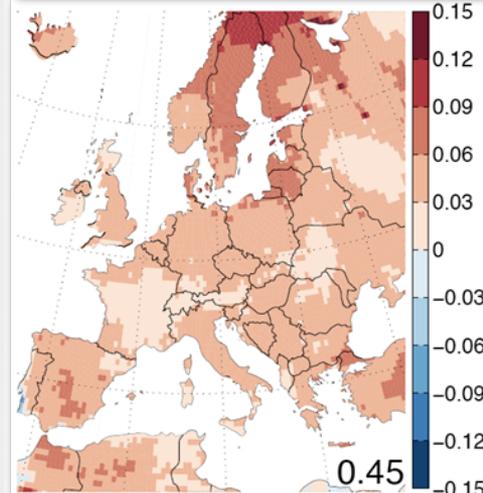
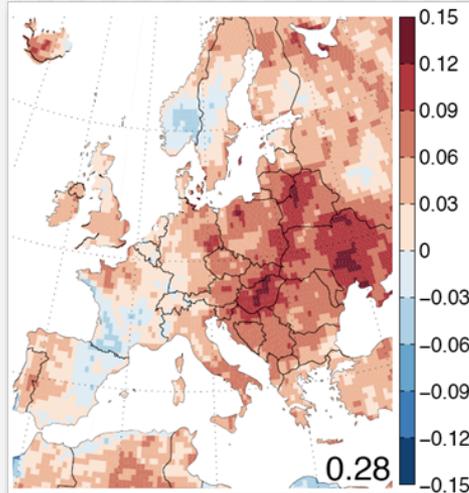


# Trends in $T_{\max}$ (extremes)

1981-2006: CTL

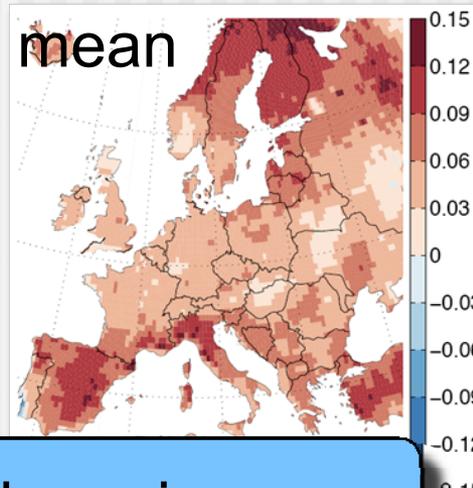
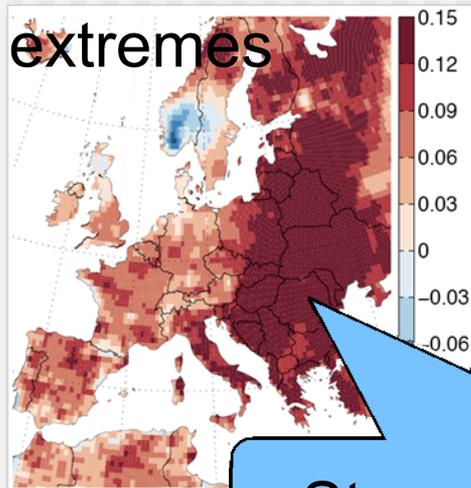


1981-2006: IAV



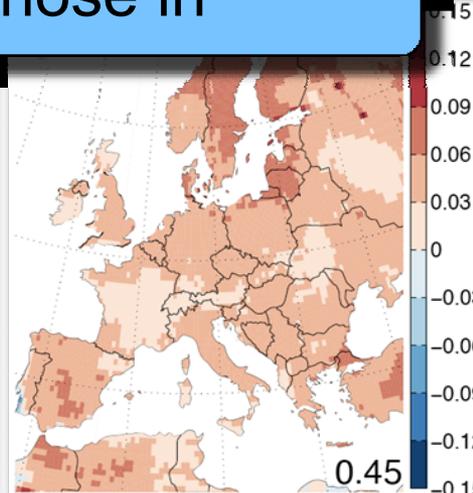
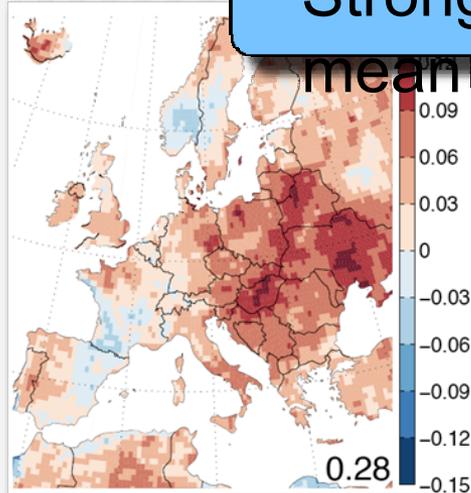
# Trends in $T_{max}$ (extremes)

1981-2006: CTL



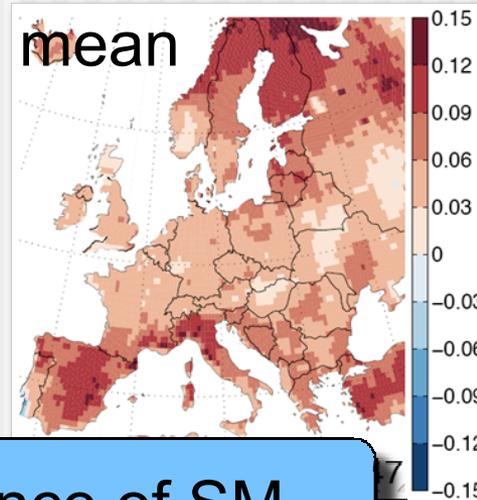
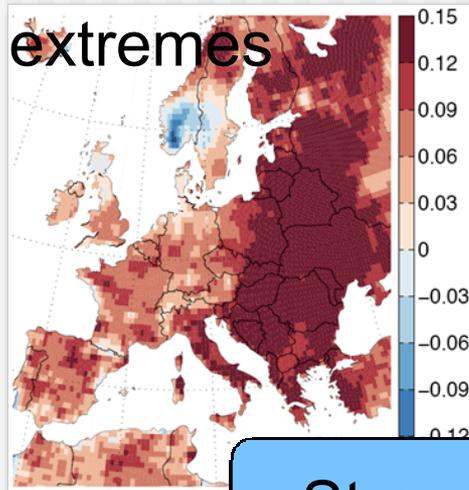
Stronger than those in

1981-2006: IAV



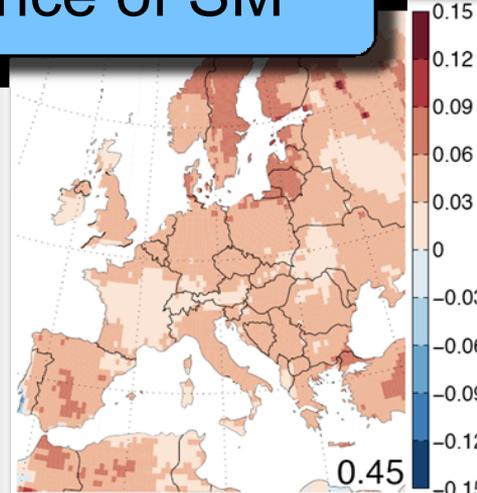
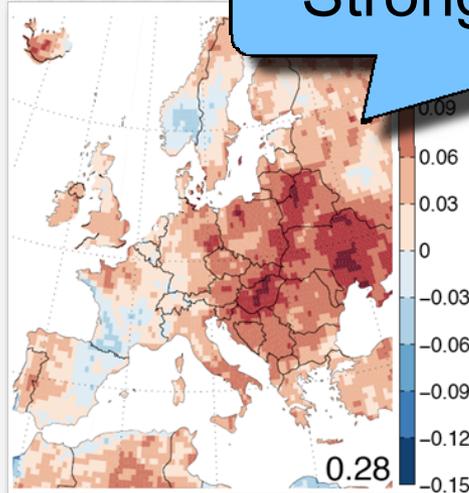
# Trends in $T_{\max}$ (extremes)

1981-2006: CTL



Stronger influence of SM

1981-2006: IAV



# Implications for predictability

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Soil moisture is found to play a major role for heat waves in Europe: asymmetric effect affecting mostly “hot” extremes; also effect on persistence

Identified effects on precipitation occurrence

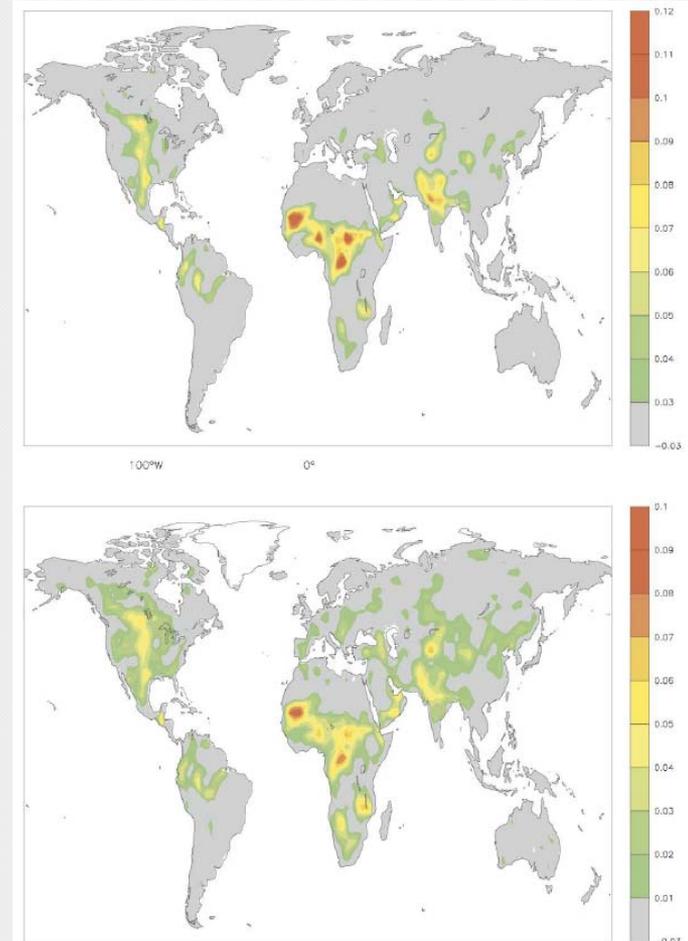
→ Major implications for:

- short-term predictability
- seasonal forecasting
- decadal forecasting
- climate-change projections

# Implications for predictability

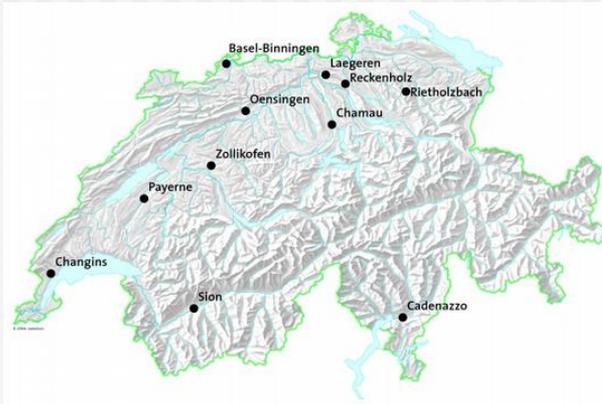
Despite low land-atmosphere coupling, diagnostic estimate of soil moisture predictability ( $\rho_{SM} * \Omega$ ) based on GLACE-1 data suggests significant potential in Europe (Seneviratne et al. 2006, *JHM*)

*(near-monthly) soil moisture autocorrelation*



# On-going projects at ETH

- SwissSMEX (Swiss Soil Moisture Experiment), 2008-2011



- NRP 61 project DROUGHT-CH: Drought early warning and forecasting in Switzerland and Central Europe (2010-2012)
- EU-FP7 Carbo-EXTREME: Impacts of extreme events on land carbon balance (modeling studies using CLM from NCAR)

# Conclusions

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- Soil moisture significantly impacts:
  - Extreme (hot) temperatures
  - Heat wave persistence
  - Precipitation frequency
  - Decadal trends in cloud cover and mean/extreme climate
  
- Important implications for predictability: Need also to be combined with analysis of soil moisture persistence!
  
- Potential of soil moisture initialization for weather, seasonal, and decadal forecasting needs to be better investigated! However, lack of observations remains an issue