Changes in Maximum Precipitation and Vb-Cyclones over Europe

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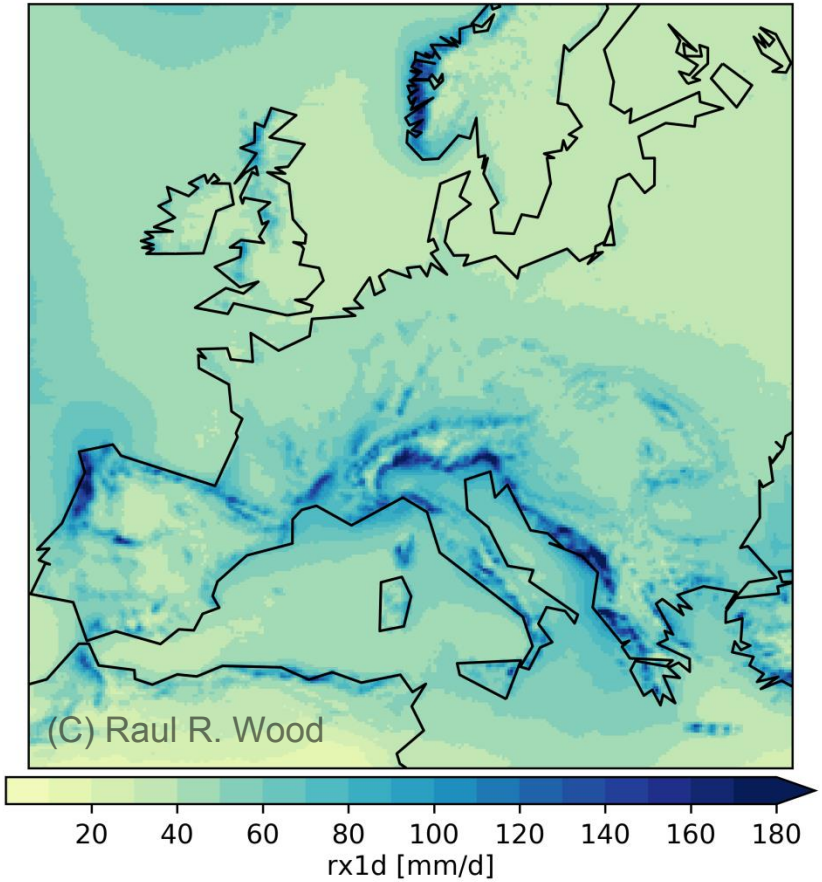
Maximum Annual Precipitation

Maximum Precipitation in the CRCM5-LE

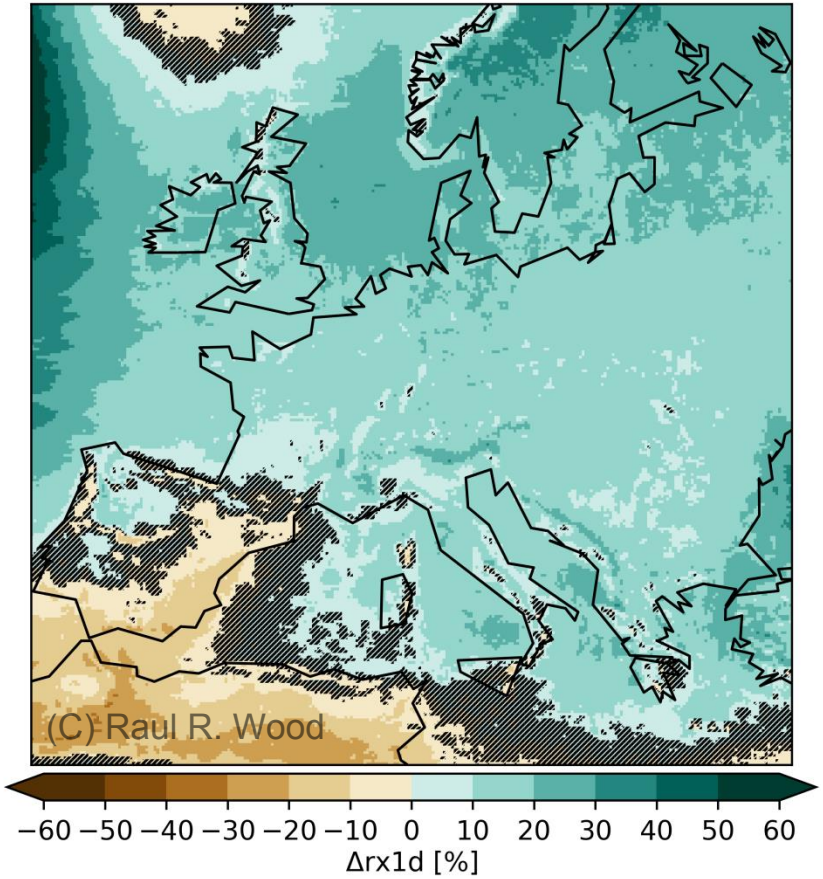
How is the daily annual maximum precipitation changing?

Mean maximum daily precipitation rx1d in the reference (left) and changes (right)

REF: 1980-2009



FUT: 2070-2099

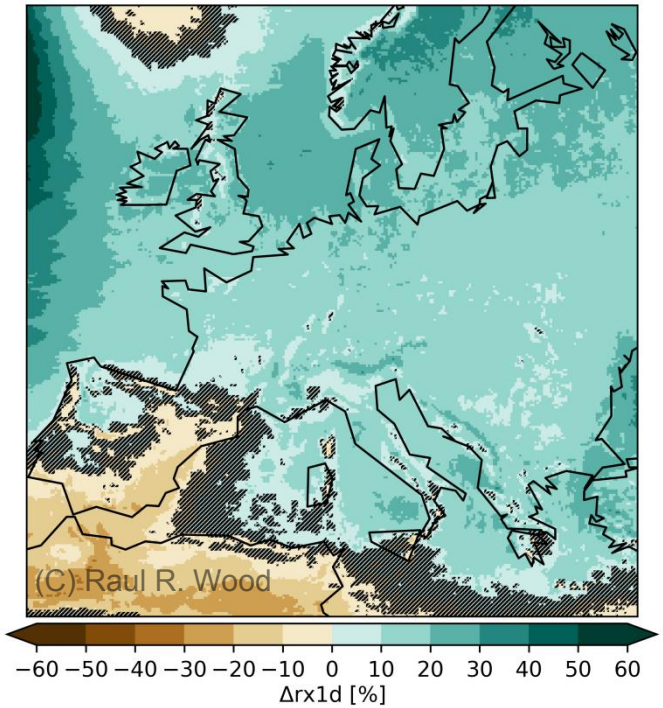


Signals at short timescales

Is hourly precipitation changing at the same rate?

Annual maximum **daily** precipitation (left) and maximum **hourly** precipitation (right)

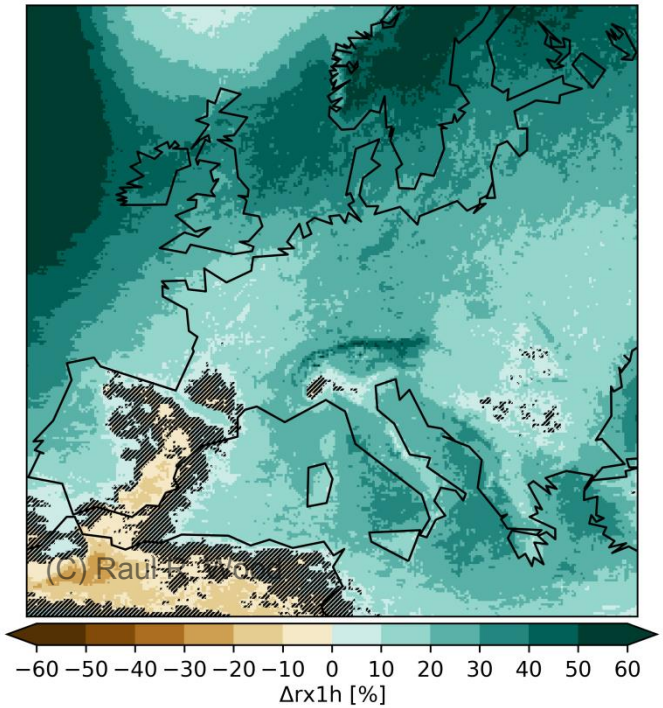
Daily



Higher

Increase

Hourly

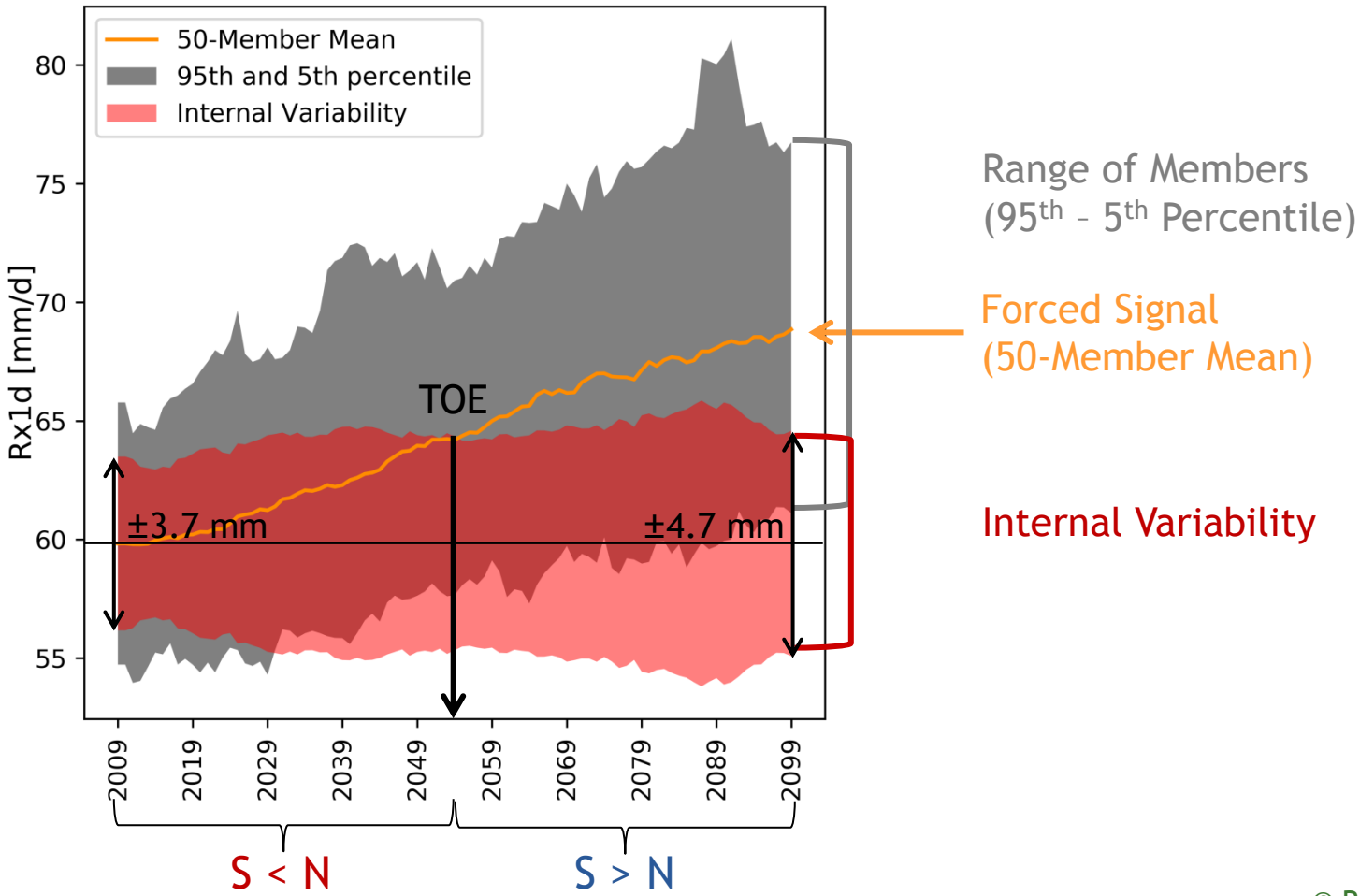


- Sub-daily maximum precipitation is increasing at a higher rate than the daily maximum
- Hourly maximum precipitation shows very strong increases just north of the Alps

Emerging Signals for Munich

When can we expect a robust climate change signal?

Evolution of daily annual maximum precipitation in Munich

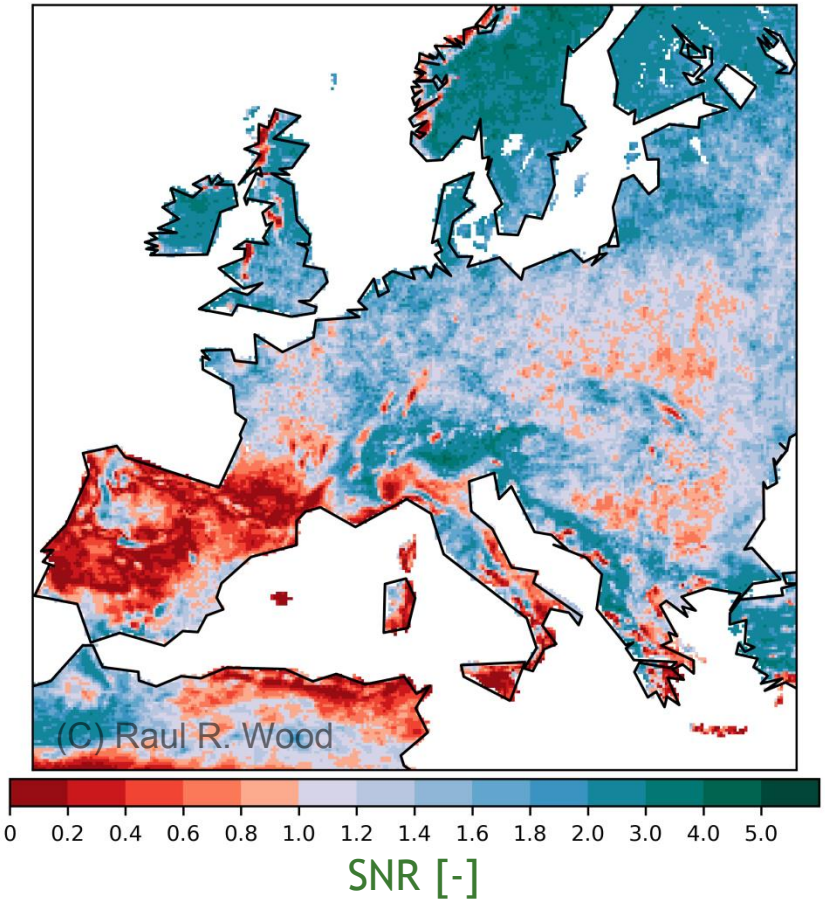


Emerging Signals over Europe

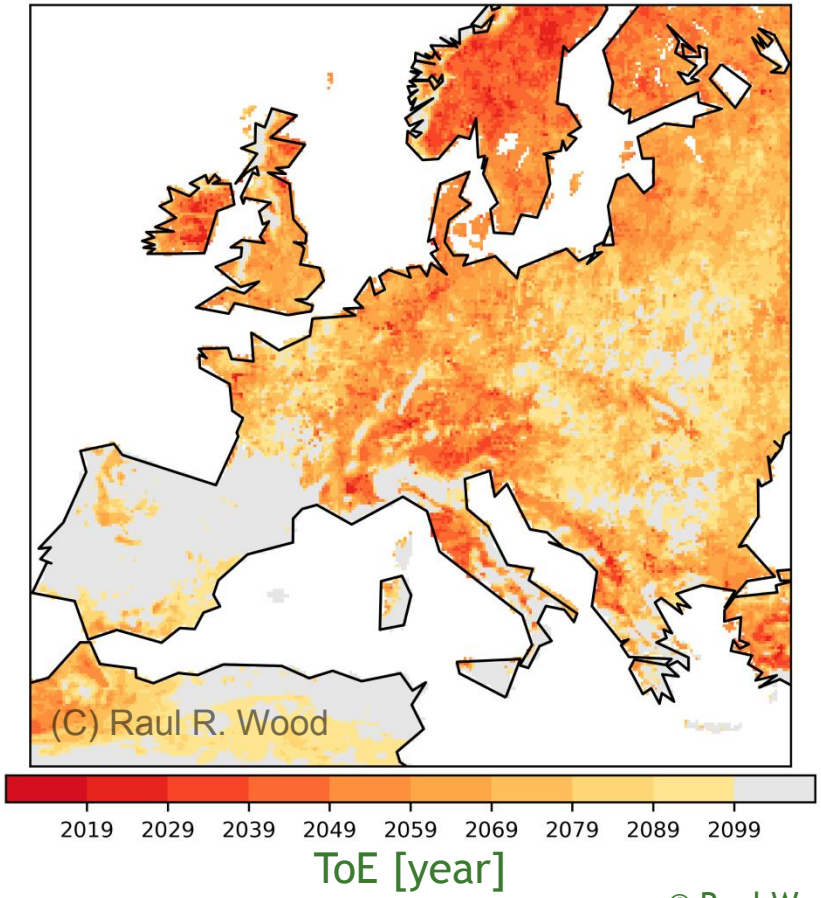
When can we expect a robust climate change signal?

Signal-To-Noise (2070-99, left) and Time of Emergence (right) for daily max. precipitation

Signal-to-Noise



Time of Emergence



Key messages: Maximum Precipitation

Take-Home Messages

- Maximum precipitation is increasing over large parts of Europe
- Sub-daily maximum precipitation is increasing at a higher rate than daily maximum
- Central Europe shows emerging signals by mid-century
- Northern side of the Alps shows pronounced positive signals for hourly precipitation

Implications

- Increased soil erosion
- Urban inundation (gully, underpass, subway station, …)
- Intermittence of public transport (airports, buses, trains, …)
- Flash Floods

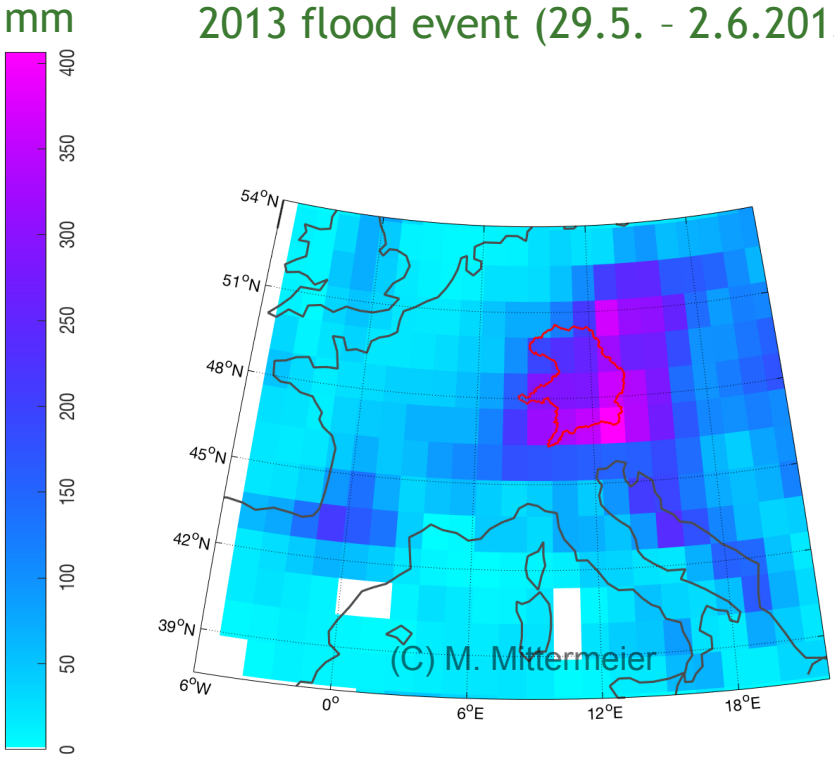
Vb-cyclones and extreme precipitation

Vb-cyclones

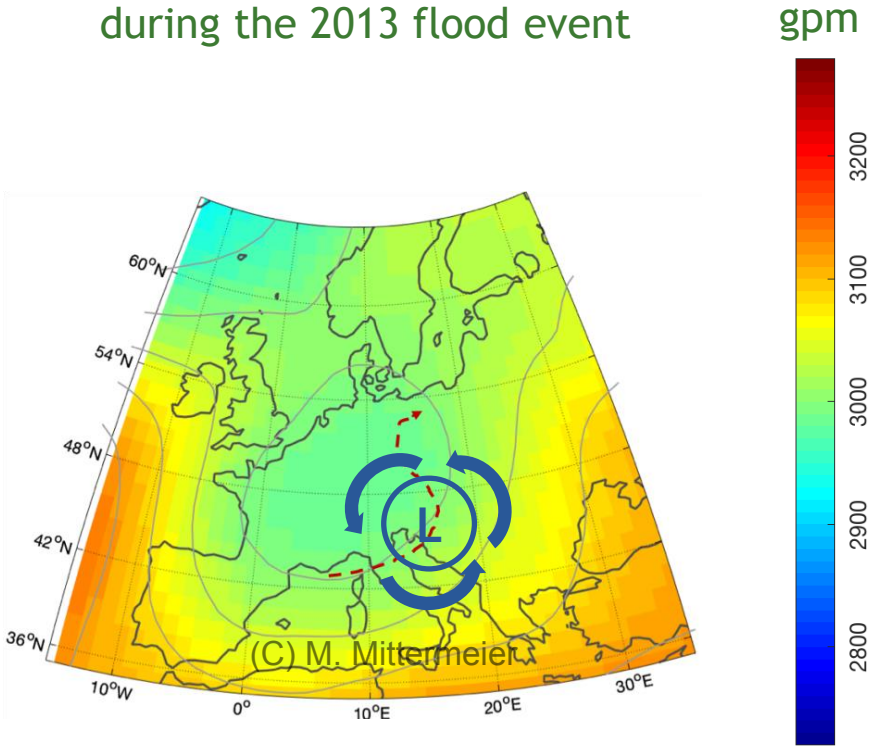
How does climate change affect Vb-cyclones?

In Bavaria 30% of summer floods are triggered by Vb-cyclones

Precipitation sum during the 2013 flood event (29.5. – 2.6.2013)



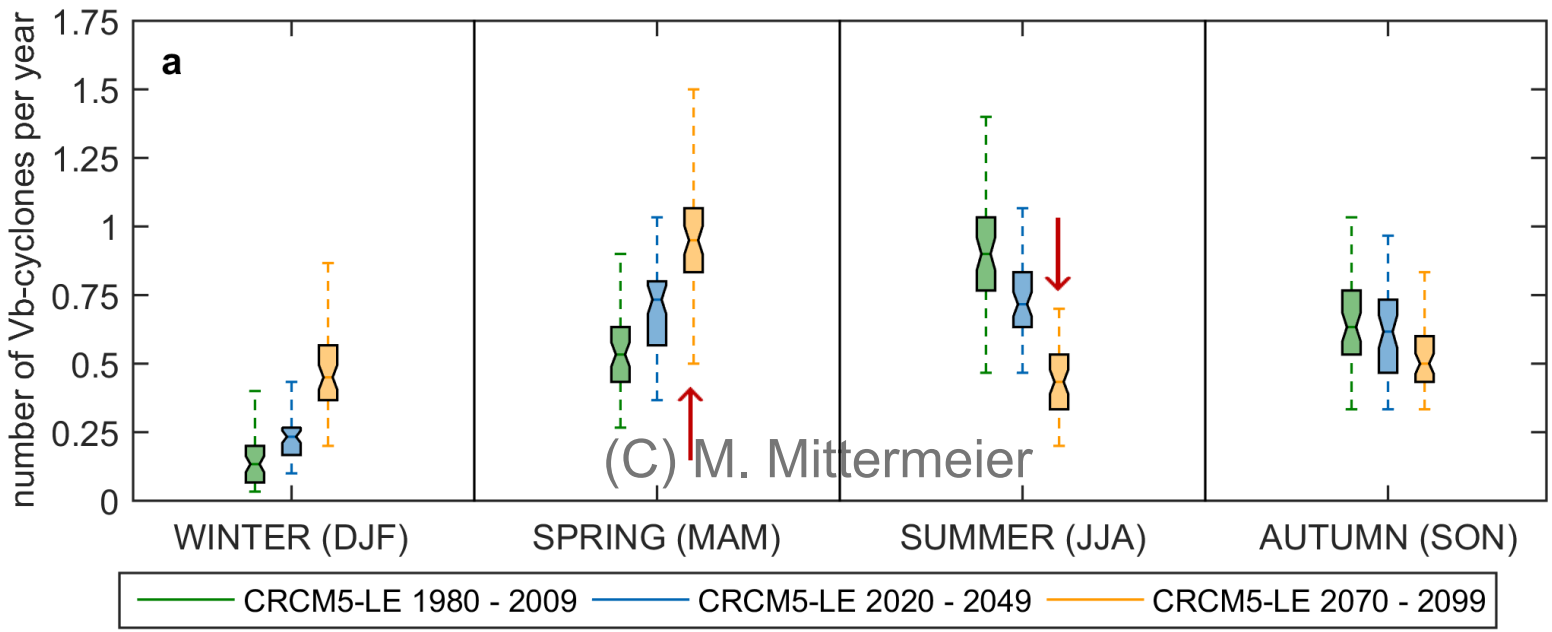
Mean synoptic pattern at 700 hPa during the 2013 flood event



Frequency of Vb-cyclones

How does climate change alter the frequency of Vb-cyclones?

Number of Vb-cyclones per season for the reference and future

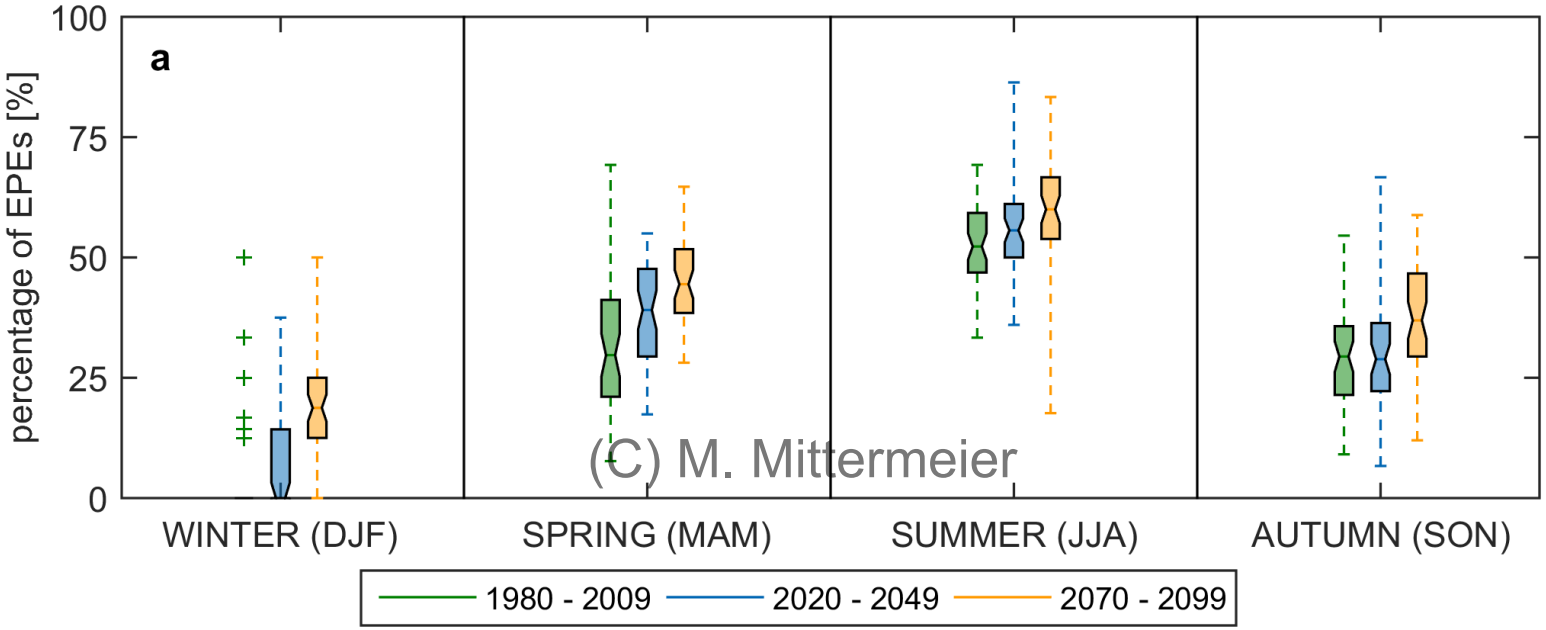


- Increasing frequency in spring
- Decreasing frequency in summer
- Increasing frequency in winter

Intensity of Vb-cyclones

Are Vb-cyclones becoming more intense in the future?

Percentage of Vb-cyclones triggering extreme precipitation in the reference and future



- In spring more frequent and more intense Vb-events
- In summer reduced frequency but increased intensity
- In winter increasing number of Vb-events with higher probability of extreme precipitation

Definition of extreme precipitation: >95th percentile of daily precipitation on Vb-days

Key messages: Vb-cyclones

Take-Home Messages

- In spring more frequent and more intense Vb-events
- In summer reduced frequency but increased intensity
- In winter increasing number of Vb-events with higher probability of extreme precipitation

Implications

- Increased potential for severe flood events
  - Vb-cyclones in spring might be superposed by snow-melt
  - Vb-cyclones in winter might lead to a rapid build-up of snow cover
  - Vb-cyclones in winter increase the risk of rain on snow events
- Changed seasonality requires new management strategies