Climate change effects on hydrometeorological compound events over southern Norway

EGU 2020 – B. POSCHLOD, J. ZSCHEISCHLER, J. SILLMANN, R. R. WOOD, R. LUDWIG

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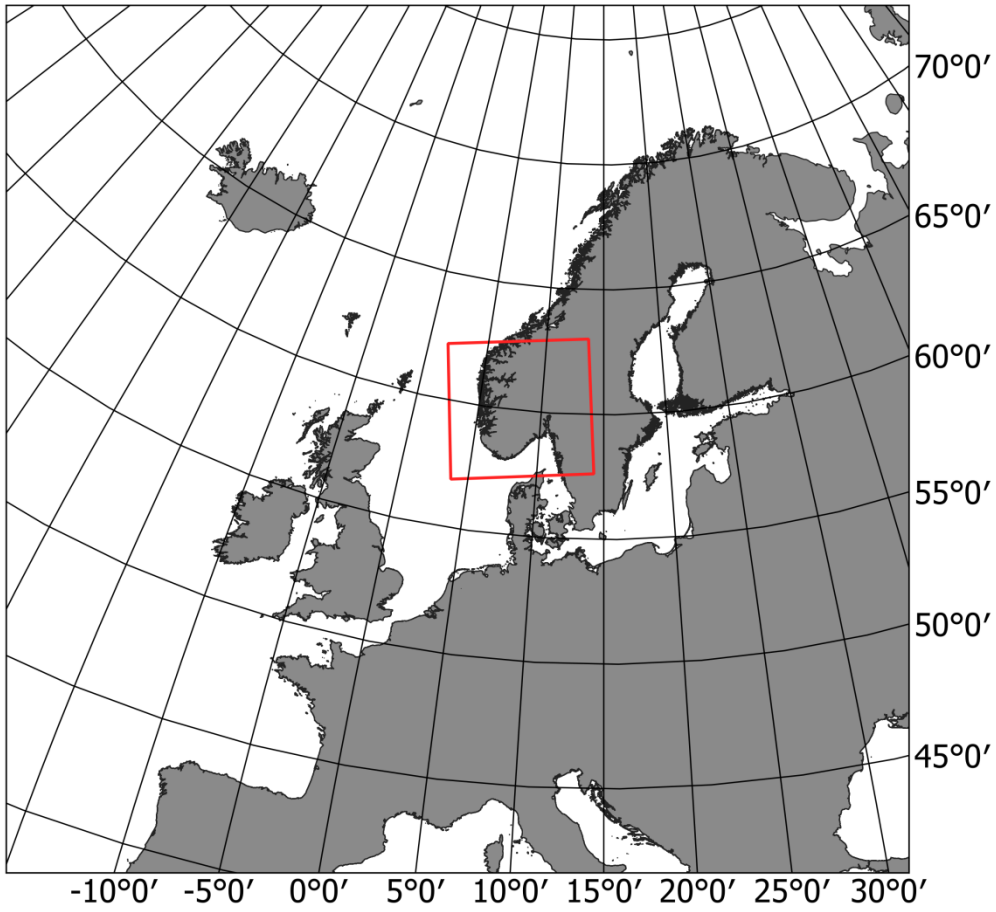
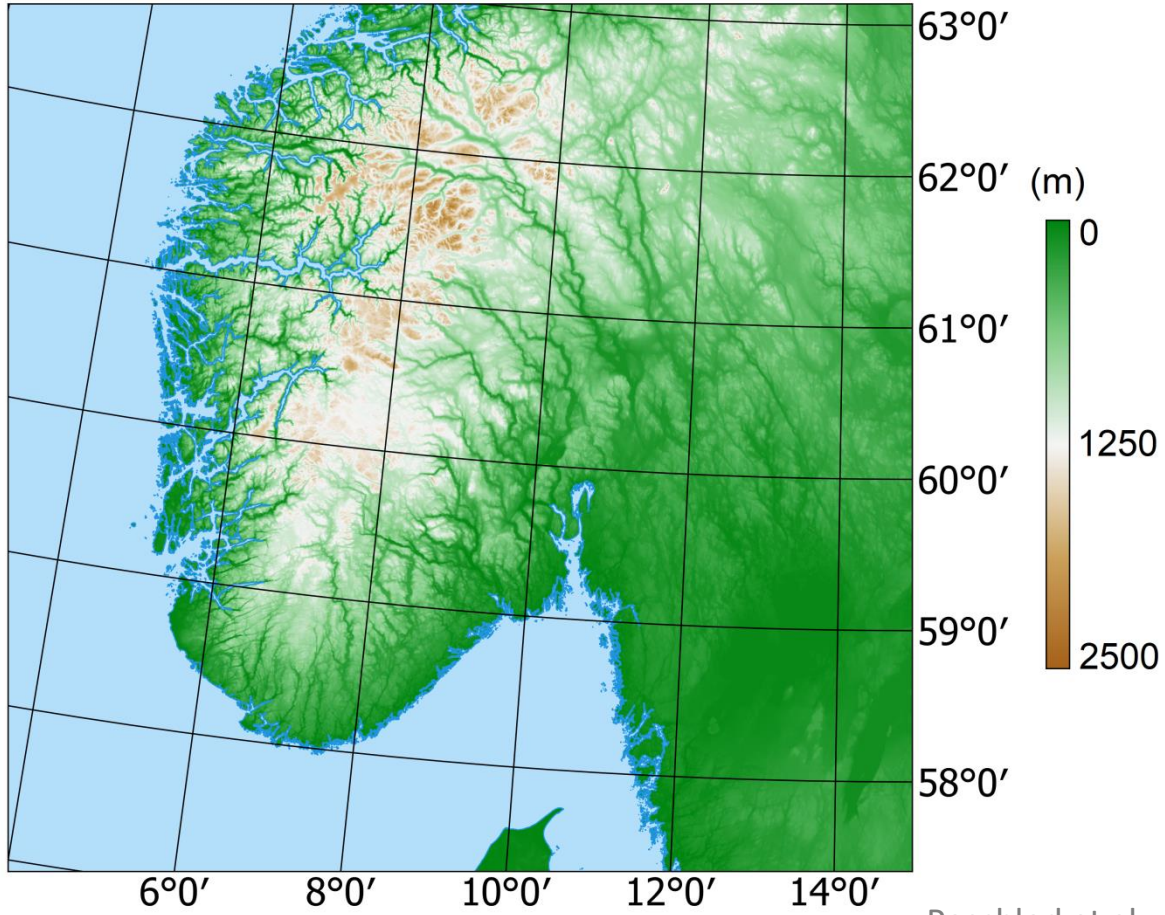
(hydrometeorological) Compound Events

*Most annual maximum floods in Europe are not caused by the highest annual rainfall peaks, but by the **co-occurrence** of rainfall and snowmelt or rainfall on saturated soil* (see Berghuijs et al., 2019).

*In south-eastern Norway, the **combination** of rainfall and snowmelt has resulted in the largest floods, for instance in 1995 and 2013* (Krøgli et al., 2018).

Study area: Southern Norway



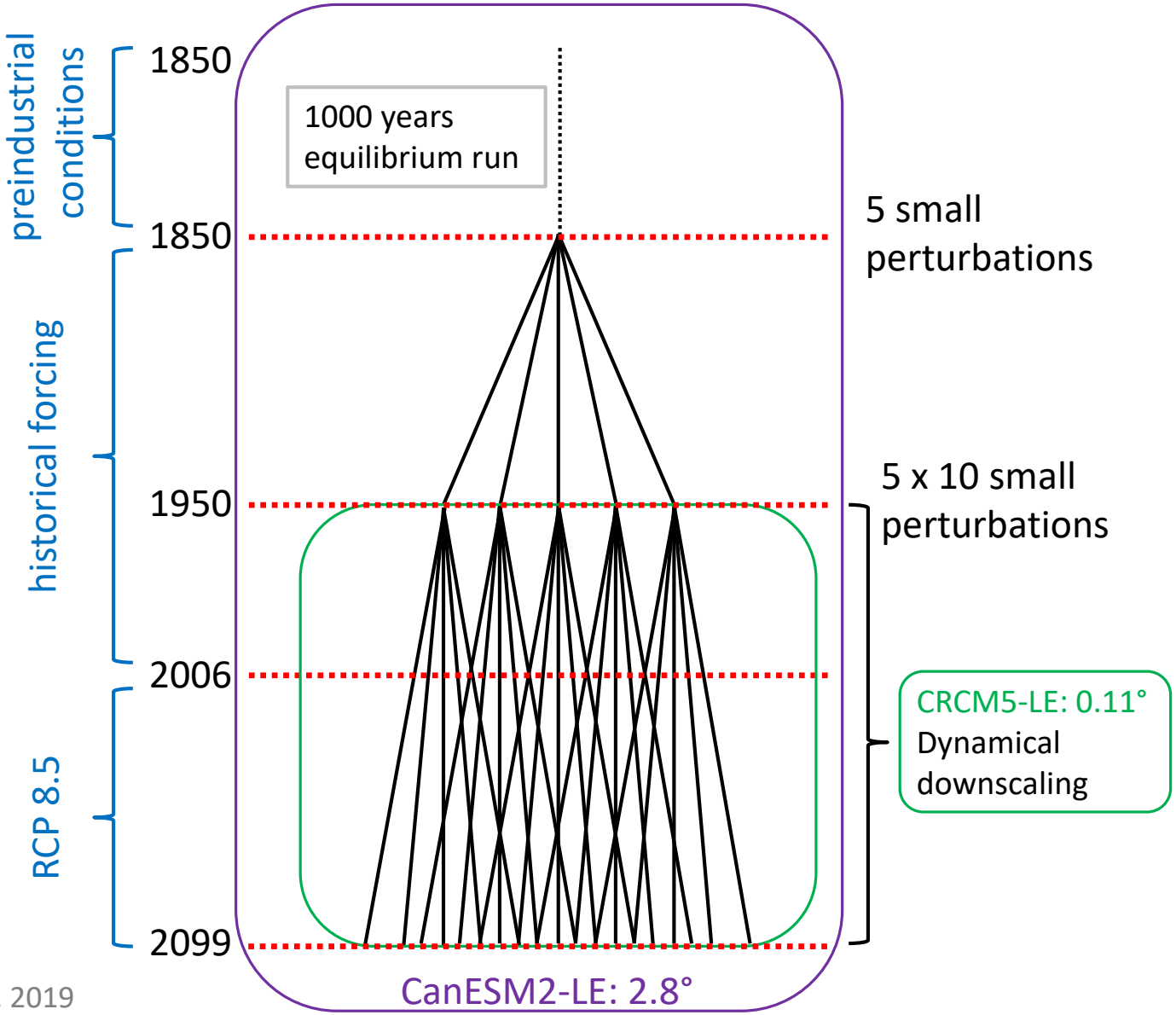


Poschlod et al., 2020

Data: CRCM5-LE

CRCM5-LE: RCM single model initial-condition large ensemble (**SMILE**)

- CRCM5-LE with 50 members
- Reference period (1980-2009) and far future (2070-2099)
- 0.11° resolution (~ 12 km)
- RCP 8.5



Further details of the CRCM5-LE setup in Martynov et al. 2013, Leduc et al. 2019

Definition of two compound events in the CRCM5-LE

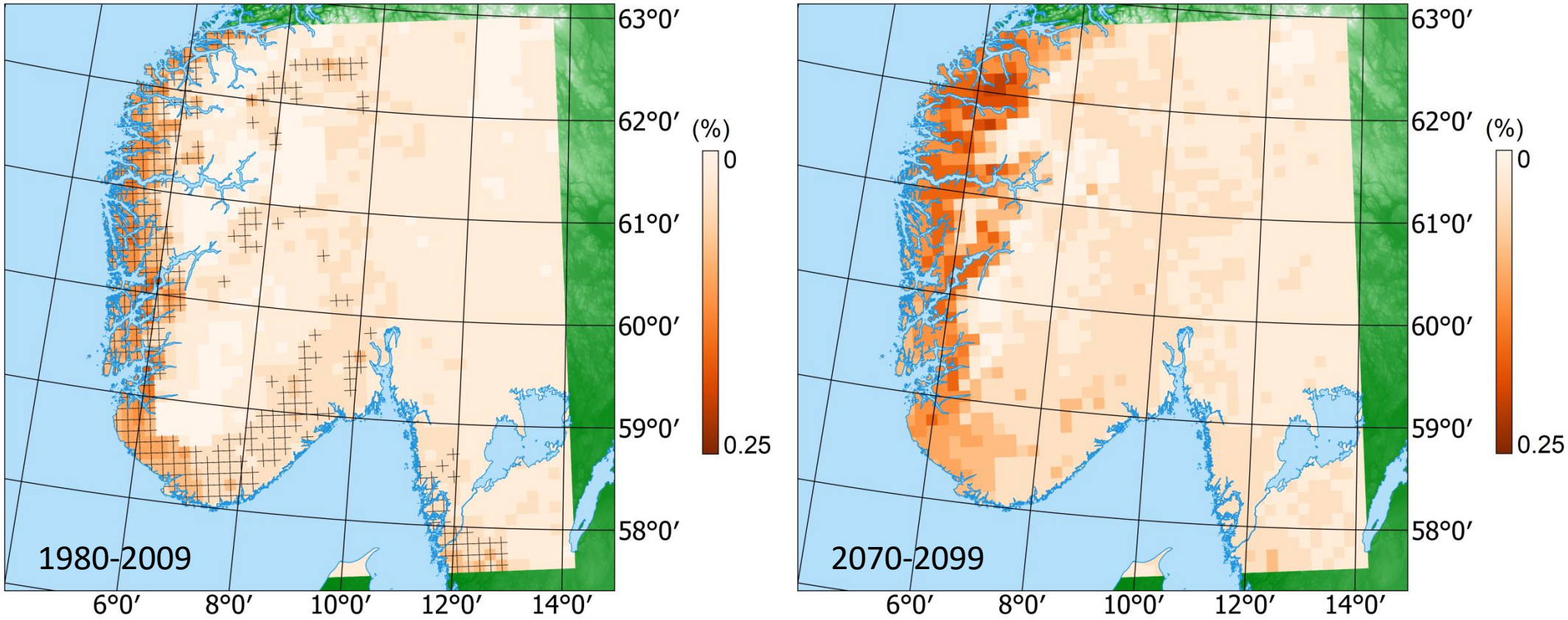
Concurrent heavy rainfall and snowmelt (rain-on-snow: **ROS**)
Heavy rainfall on saturated soil during June to September (**SES**)

Variables used:
- Liquid precipitation on day *d*
- Soil moisture on day *d-1*
- Snowmelt: snow height on day *d-1* - snow height on day *d+1*

Occurrence of compound event:
Both process variables exceed its 98th percentile on the same day

If both processes were uncorrelated, the probability of simultaneous occurrence would be $0.02 \cdot 0.02 = 0.0004 = 0.04\%$

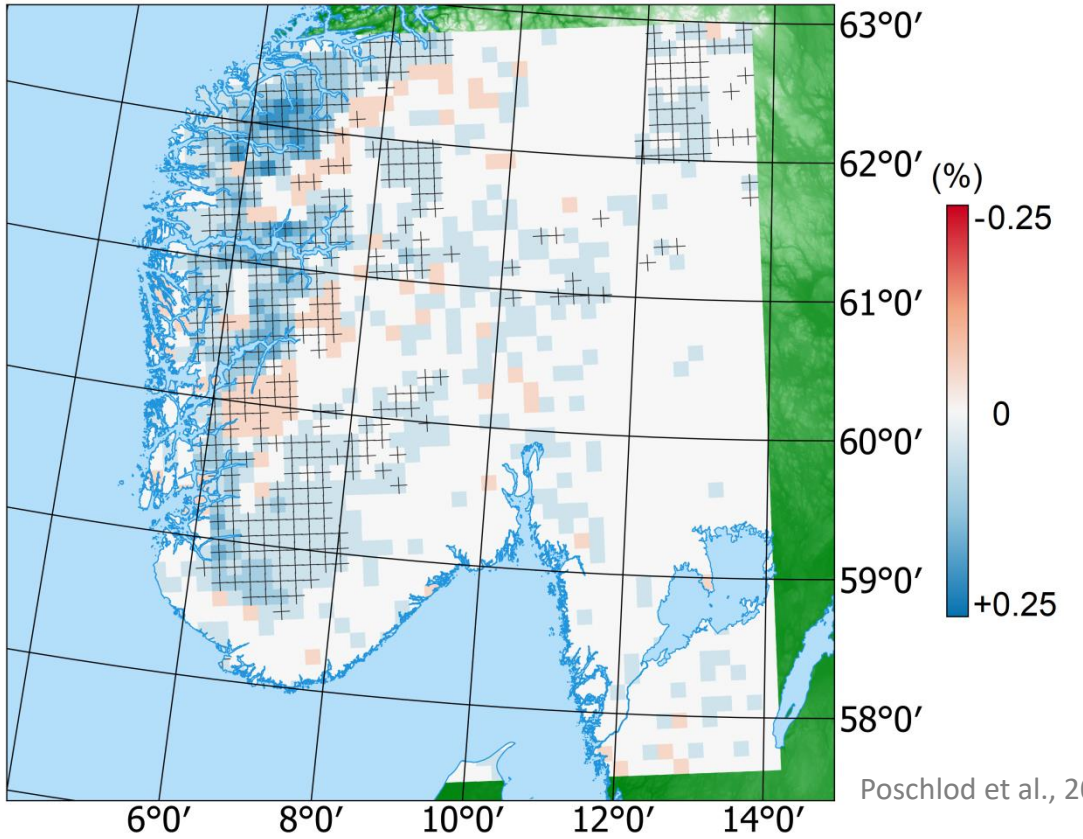
SES: Daily occurrence probability



\+ significant positive correlation

Poschlod et al., 2020

SES: **Change** of daily occurence probability



Poschlod et al., 2020

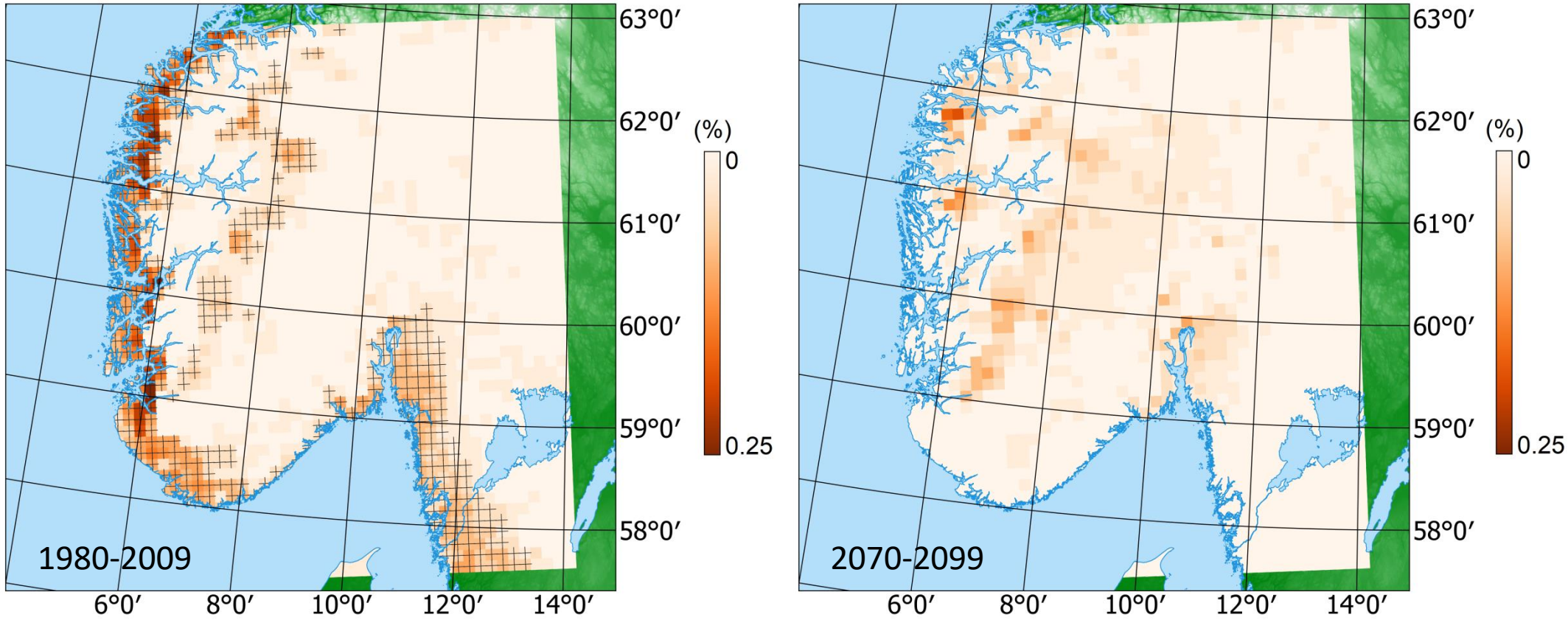
\+ significant change of the distribution

Underlying trends between 1980-2009 and 2070-2099 (JJAS):

- Total precipitation +4.2%
- Average soil moisture -4.0%
- Number of rainfall events exceeding P98: +45.2%

→ **SES occurrcence probability increase by 38%**

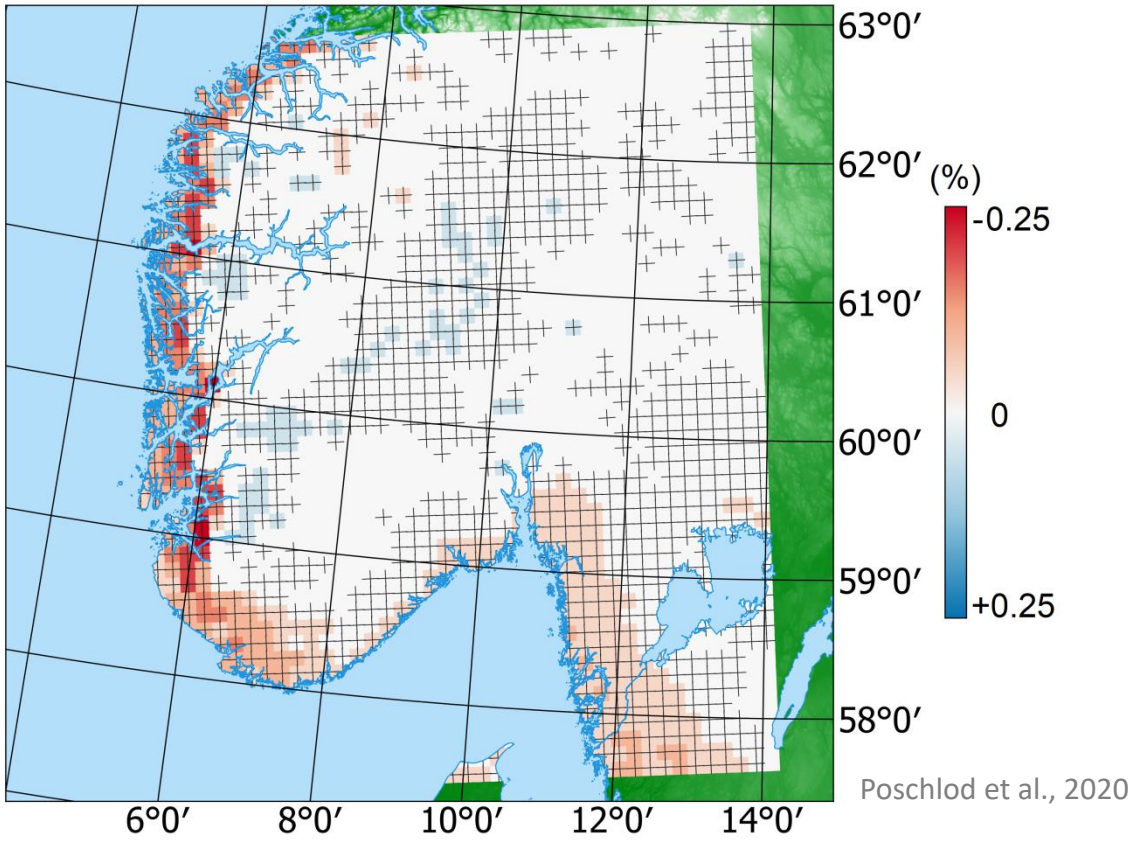
ROS: Daily occurrence probability



\+ significant positive correlation

Poschlod et al., 2020

ROS: **Change** of daily occurrence probability



Poschlod et al., 2020

\+ significant change of the distribution

Underlying trends between 1980-2009 and 2070-2099:

- Total liquid precipitation +38.0%
- Mean surface snow amount -59.2%
- Number of rainfall events exceeding *P98*: +78.3%

→ **ROS occurrcence probability decrease by 48%**

→ **Slight increases in mountainous areas, where ROS impact is higher**

Conclusion

- A single model large ensemble (SMILE) provides a broad database for the robust analysis of rare events.
- In southern Norway, the importance of the drivers of compound floods will shift towards a **flood regime less governed by snowmelt, but increasingly triggered by heavy rainfall and saturation excess**.

→ Publication for further details:

Poschlod, B., Zscheischler, J., Sillmann, J., Wood, R.R., Ludwig, R. (2020): Climate change effects on hydrometeorological compound events over southern Norway. Weather and Climate Extremes, 28, 100253, doi:10.1016/j.wace.2020.100253.

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Leduc, M., Mailhot, A., Frigon, A., Martel, J.L., Ludwig, R., Brietzke, G.B., GiguÃ¨re, M., Brissette, F., Turcotte, R., Braun, M., Scinocca, J., 2019. The climex project: A 50-member ensemble of climate change projections at 12-km resolution over europe and northeastern north america with the canadian regional climate model (crcm5). Journal of Applied Meteorology and Climatology, 58, 663-693. doi:10.1175/JAMC-D-18-0021.1.

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