How does the assessment of extreme precipitation profit from convection permitting climate ensembles?

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RegIKlim – Regionale Informationen zum Klimahandeln

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1. Motivation

- Conventional rainfall risk products fail to represent extremes in changing climate [e.g. 1]
- Added value of convection permitting (CP) scale for extreme precipitation [2]

Research questions posed to novel CP Ensemble:
⟶ How is extreme precipitation of different scales represented?
⟶ Which changes are projected?
⟶ What are the errors?

2. The Ensemble

The convection permitting **KIT-KLIWA ensemble** [3]:

- four CMIP5 GCMs coupled to regional climate model COSMO-CLM.
- Three nesting steps: 50km, 7km, 2.8km (Analysis of German part of the domain)
- Historical: 1971-2005
  Projection: 2006 to 2100
- Emission scenario RCP8.5

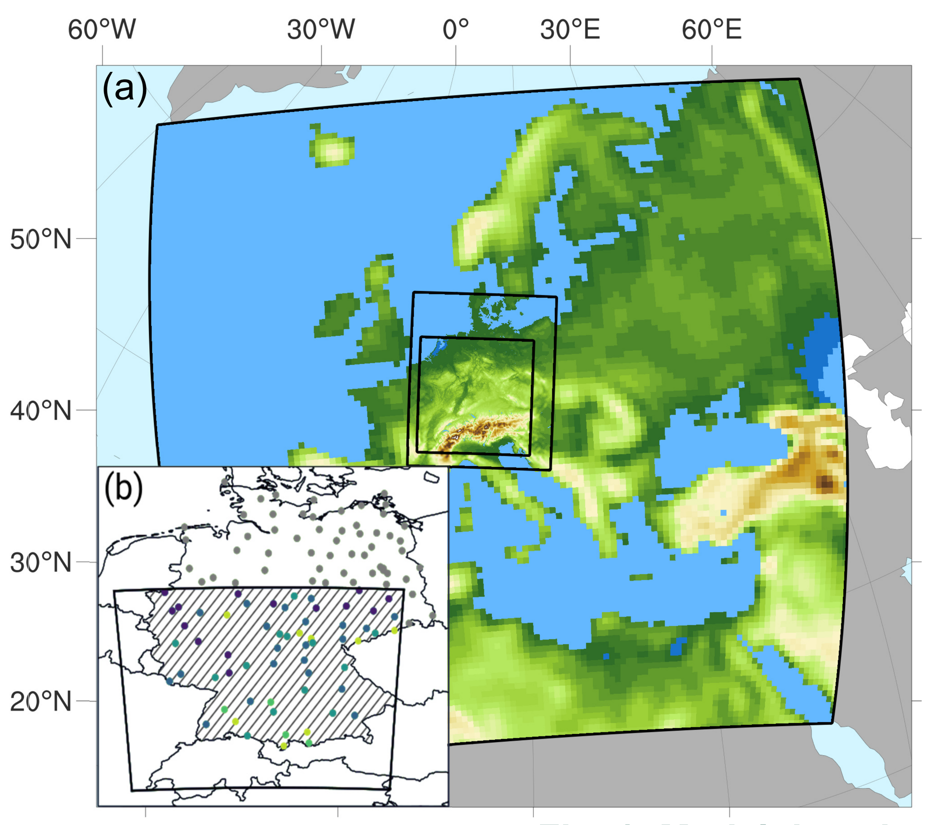


Fig. 1: Model domain

Method & Evaluation

Return level (RL) from 30a time slices [4]:

1) Selection of 2.7 × # years strongest individual events
2) Fit of exponential function

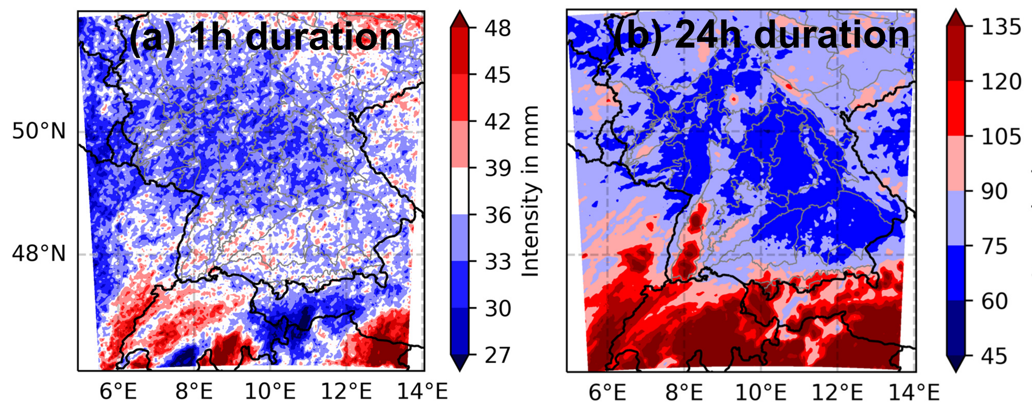


Fig. 2: Ensemble median of 10-year return level for 1971-2005

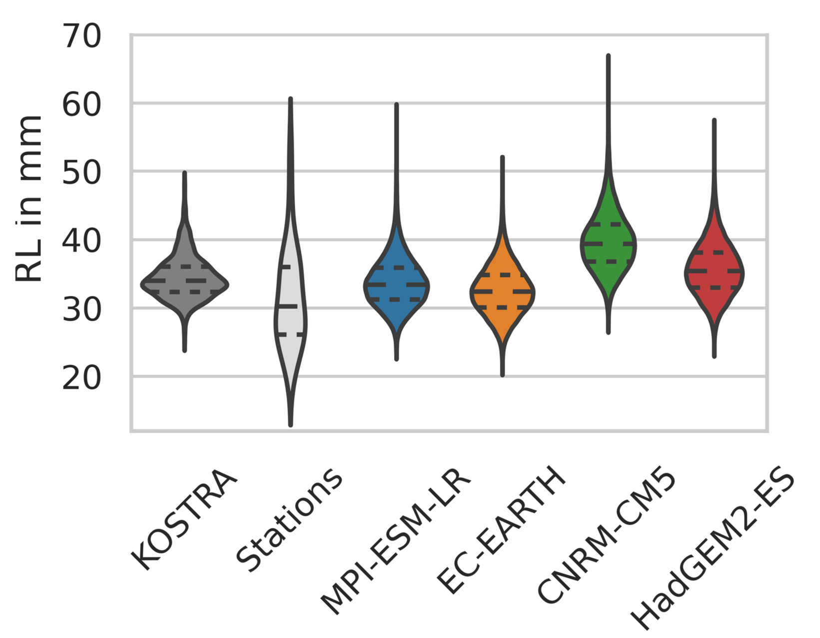


Fig. 3: Grid point distribution of hourly 10-year return level (RL) for historical period 1971-2005

Evaluation:

- No resolution of spatial patterns for extremes with short duration (Fig. 2)
  ⟶Evaluation of grid point distribution (Fig.3)
- Better agreement for short duration (±10% excluding CNRM-CM5)
- General overestimation of RL with duration >1h (not shown)

3. Climate Change Signal

Definition:
Slope of a linear regression to the normalized intensity trajectory over global warming (Fig. 4).

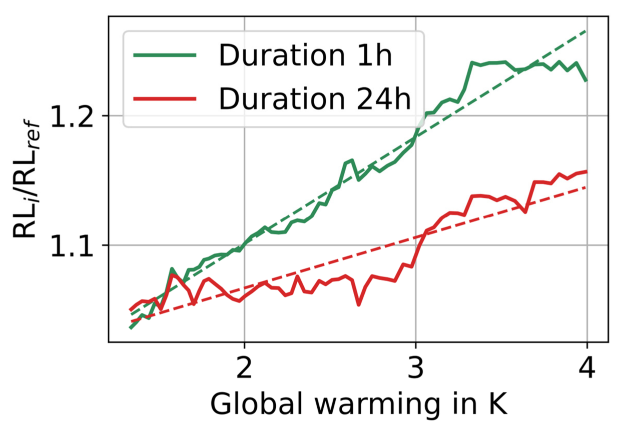


Fig. 4: Example calculation of change signal for EC-EARTH

The climate change signal depends on (Fig. 5):

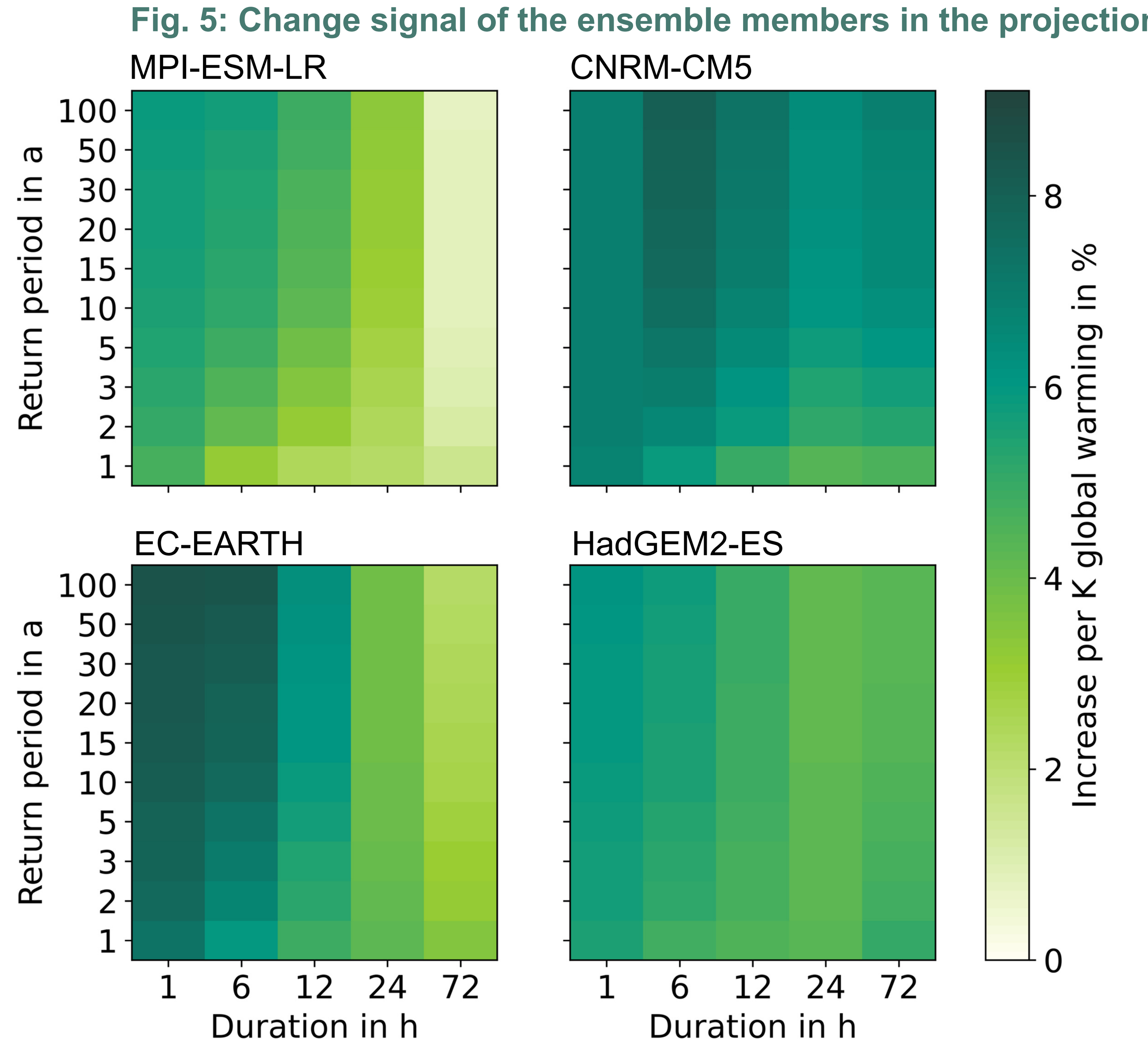
Return period (RP):

- Sub-daily: increasing change with RP
- Multi-day: similar/decreasing change with RP

Duration:

- Strongest change for short events

Fig. 5: Change signal of the ensemble members in the projection



Strongest changes of 6% to 8% per K global warming
⟶ close to Clausius-Clapeyron scaling

4. Sensitivity Analysis

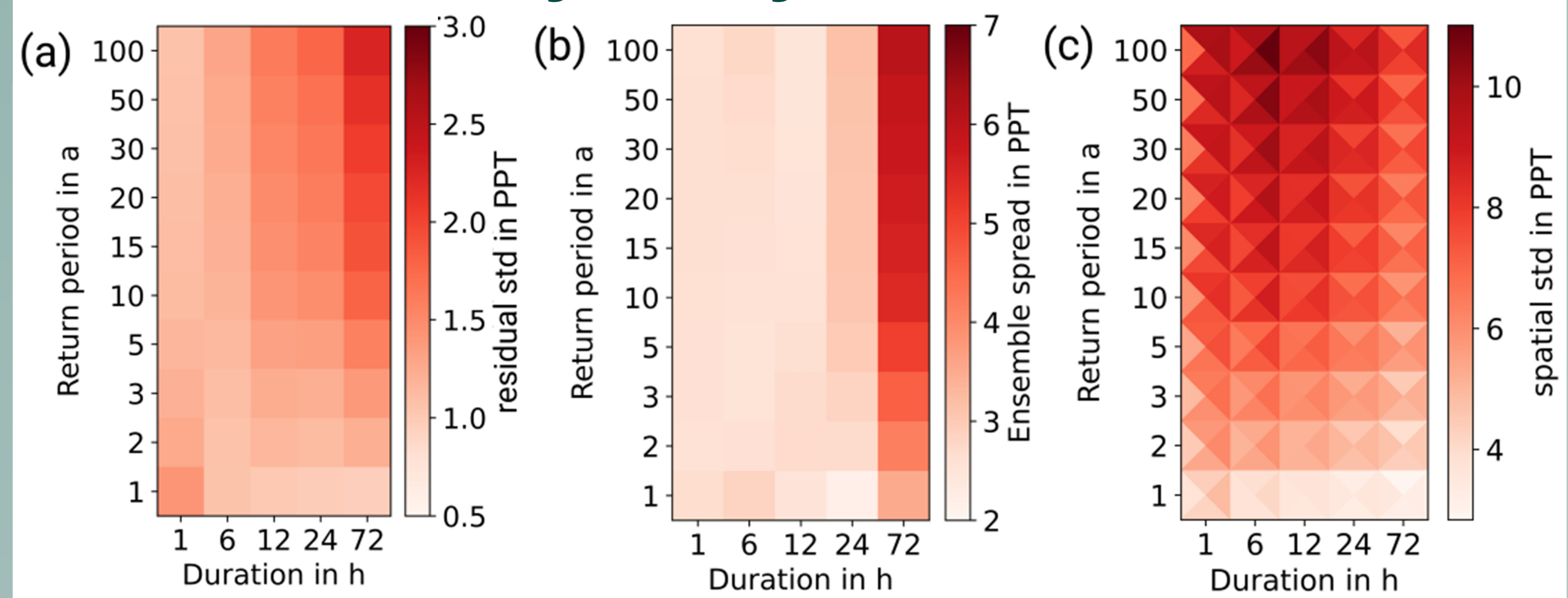


Fig. 6: Error analysis of the climate change signal

GCM
top: MPI-ESM-LR
right: EC-EARTH
bottom: CNRM-CM5
left: HadGEM2-ES

(a) Residual standard deviation (std) of fit

- 0.8 to 2 PPT (error in analysis of time slices)

⟶ Lin. regression better for short duration

(b) Ensemble spread

- 2 to 3 PPT for duration
- Higher for multi-day events

⟶ stronger dependence on large-scale circulation patterns (GCM?)

(c) Spatial std of the change signal

- Increase with RP

⟶ Pooling of information for large RP needed

5. Conclusion

1. The CP Ensemble represents short extreme events adequately, overestimation & large spread for longer events
2. Significant future increase over all scales and identification of scales that are expected to change most (short duration, long RP)
3. Transient data improves confidence in climate change signal

Outlook: CMIP6 downscaling and multi-RCM ensemble

Paper in preparation for submission in IJoC

References

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Abstract and suppl. information