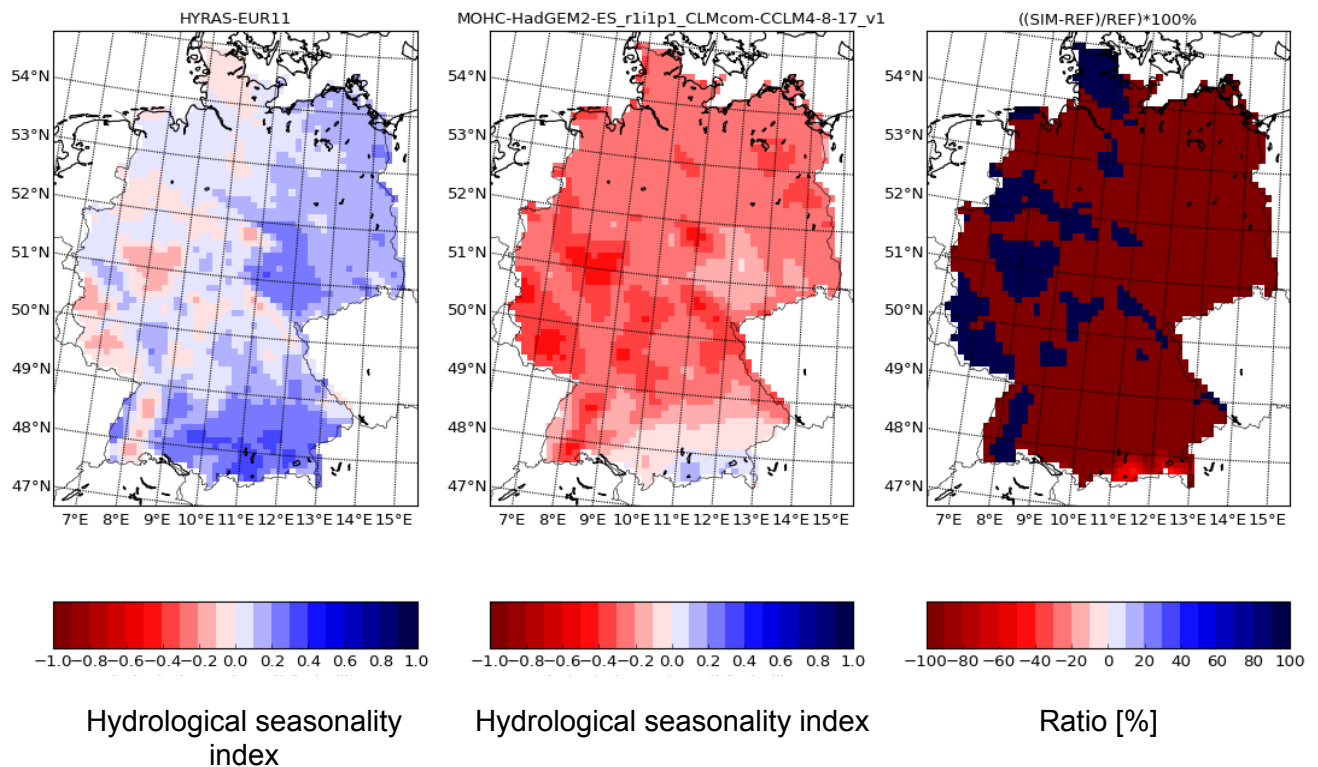


Supplementary information to the manuscript Tradowsky et al. (2023): Attribution of heavy rainfall events leading to the severe flooding in Western Europe during July 2021

This supplement includes several additional figures motivating the choice to exclude some of the available climate model simulations based on either the underlying global climate model or the regional climate model. These evaluations are based on the reference ensemble of Deutscher Wetterdienst in version v2018, see www.dwd.de/ref-ensemble. The simulations are examined in their original resolution (0.11°) for the region of Germany. HYRAS-PRE v3.0 (Rauthe et al., 2013; <https://www.dwd.de/DE/leistungen/hyras/hyras.html>) was used as an observational dataset for the evaluation. The evaluation period is 1971 to 2000.

(a)



(b)

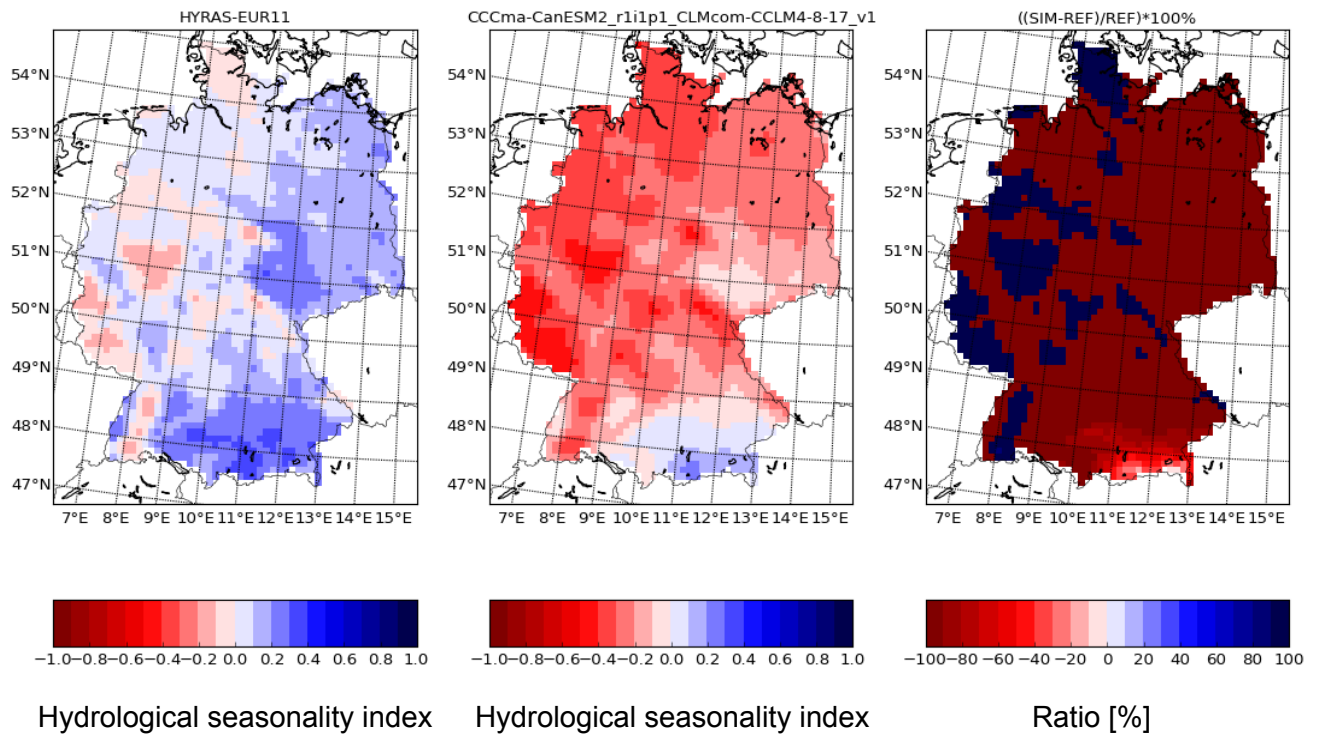


Fig. S1 Shown is the seasonality index for the period 1971 to 2000 for the gridded observational dataset HYRAS (left) and the respective model chains (middle) HADGEM plus CCLM4 in (a) and CanESM2 plus CCLM4 in (b). The ratio $[(\text{Simulation} - \text{HYRAS})/\text{HYRAS}] \times 100$ is shown on the right. The seasonality index is calculated from the normalized difference of the precipitation totals in summer months (May, June, July, August; MJJA) vs. winter months (November, December, January, February; NDJF), i.e. $(P_{\text{MJJA}} - P_{\text{NDJF}})/(P_{\text{MJJA}} + P_{\text{NDJF}})$. The values of the seasonality index range from -1 (winter dominated) to +1 (summer dominated). The two examples shown here present simulations for which the hydrological seasonality index presents an opposite sign compared to the seasonality index calculated based on the observational HYRAS dataset. Analysed are observations and simulations for the period 1971 to 2000, however note that data for the winter 1970/1971 are included and the winter of 2000/2021 has not been excluded to cover 30 winters.

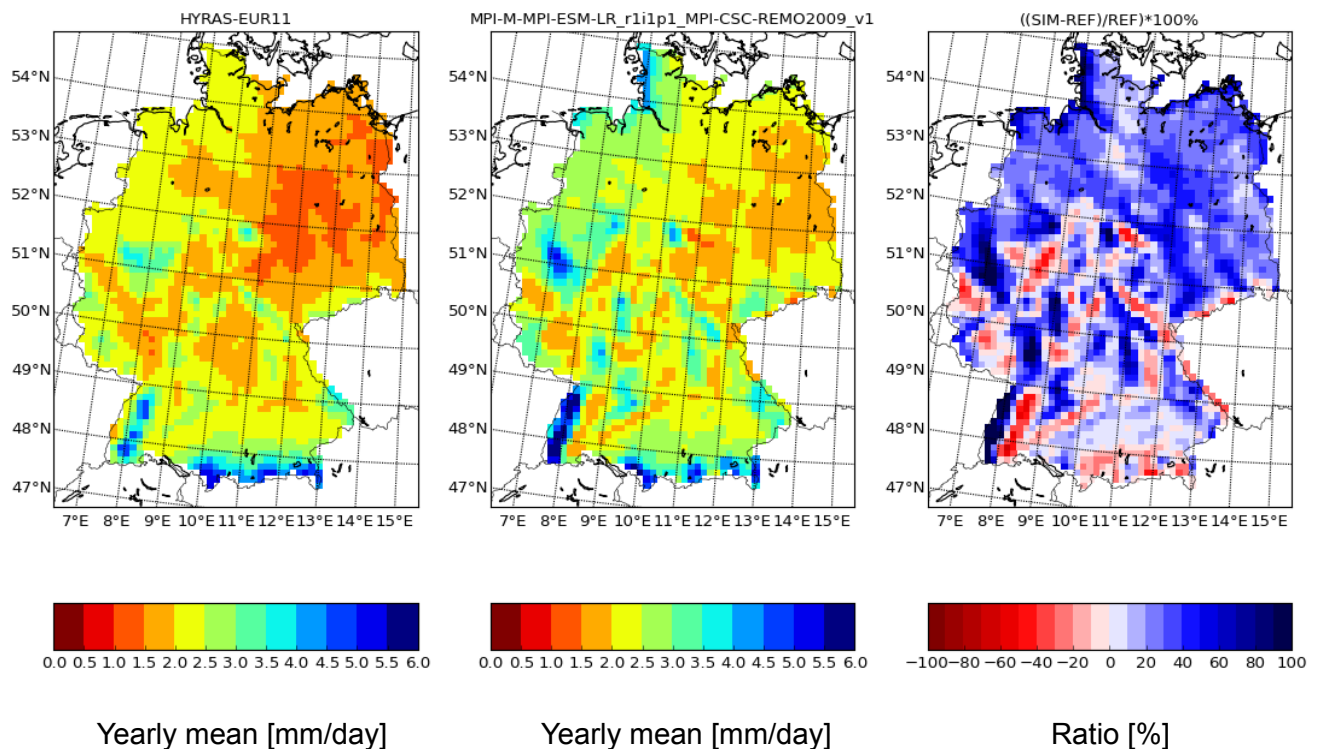


Fig. S2 Comparison of the mean precipitation amounts in mm/day of the gridded observation data set HYRAS (left) and the results of the model chain MPI-ESM plus REMO (historical run; middle). The ratio $(((\text{Simulation} - \text{HYRAS})/\text{HYRAS}) \cdot 100)$ is shown on the right. The rainfall pattern shows that precipitation within the REMO model falls with a spatial offset, when compared to the observations, on the windward side of the mountains. Analysed are observations and simulations for the period 1971 to 2000.

References:

Rauthe, M., H. Steiner, U. Riediger, A. Mazurkiewicz, and A. Gratzki. 2013. A Central European precipitation climatology – Part I: Generation and validation of a high-resolution gridded daily data set (HYRAS). *Meteorologische Zeitschrift* 22: 235–256. <https://doi.org/10.1127/0941-2948/2013/0436>