Supplemental Material for

Long-term Variances of Heavy Precipitation across Central Europe using a Large Ensemble of Regional Climate Model Simulations

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1.   Data sets

This section contains supplemental figures to the used RCM ensemble, which is discussed in Section 2 of the main paper.
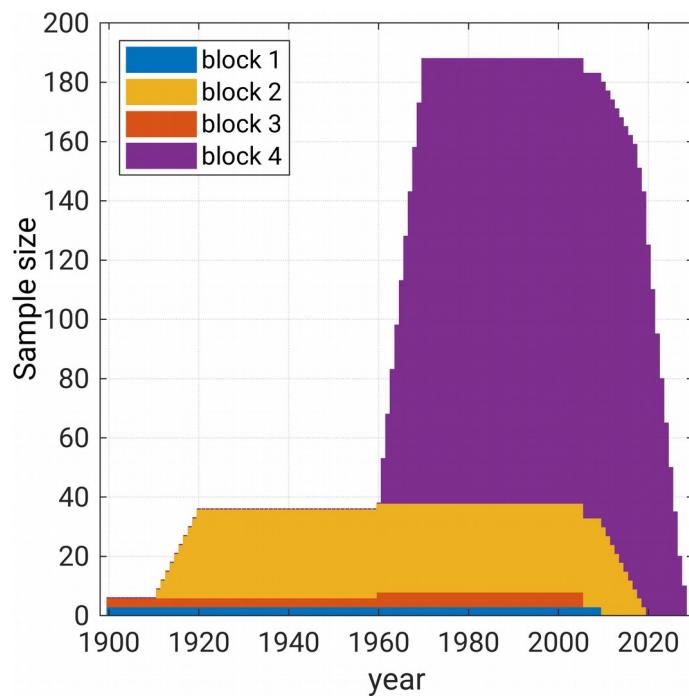
Figure S1: Temporal evolution of the number of members of the RCM ensemble. The colors correspond to the different data blocks, in which the RCM ensemble is divided to (cf. Table 1 in the main paper).

2.   Validation of the RCM ensemble

This section contains supplemental figures for the validation of the RCM ensemble, which is discussed in Section 4 of the main paper.
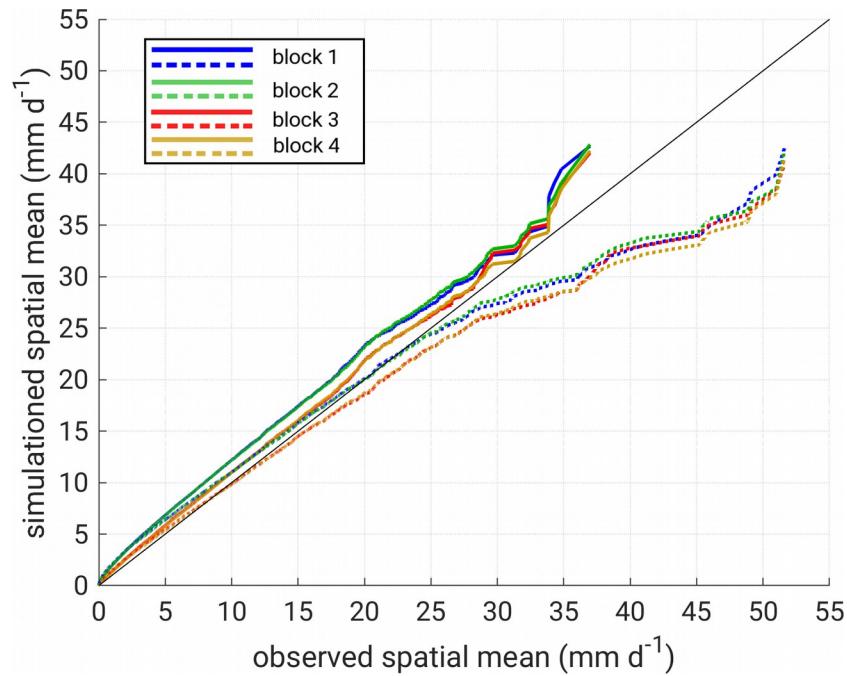
Figure S2: Quantile-quantile plot of spatial mean daily precipitation for investigation period TP1b comparing the RCM simulations (block 1-4) with E-OBS (solid lines) and HYRAS (dashed lines) for the Alps (AL).
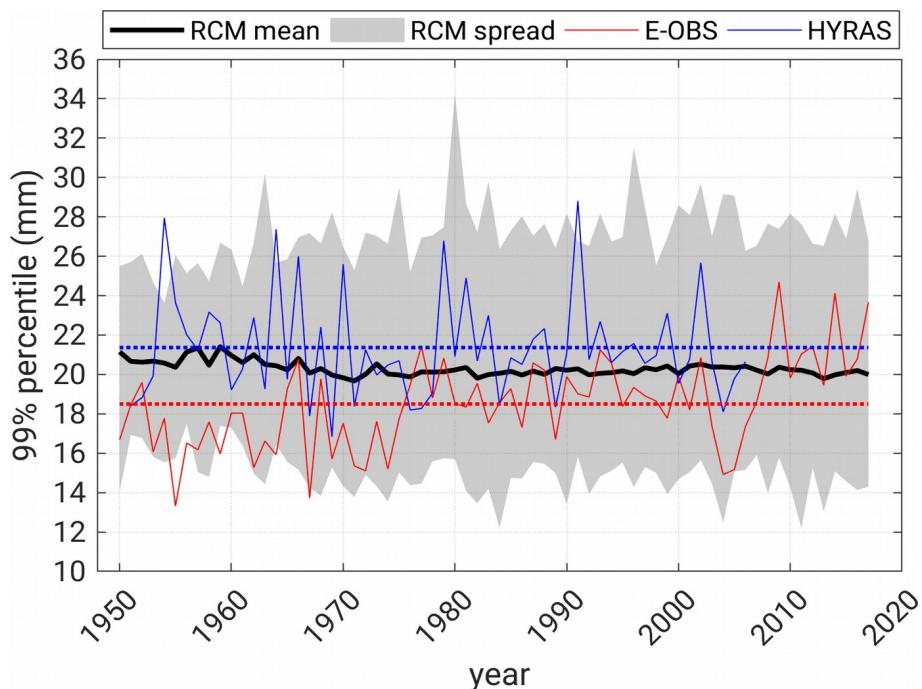
Figure S3: Time series of the yearly 99 % of spatial mean precipitation for the Alps (AL) during TP1b of the RCM ensemble mean (black), the ensemble spread (minimum to maximum; gray), E-OBS (red), and HYRAS (blue). The dotted lines symbolize the mean values of the observations throughout TP1b.
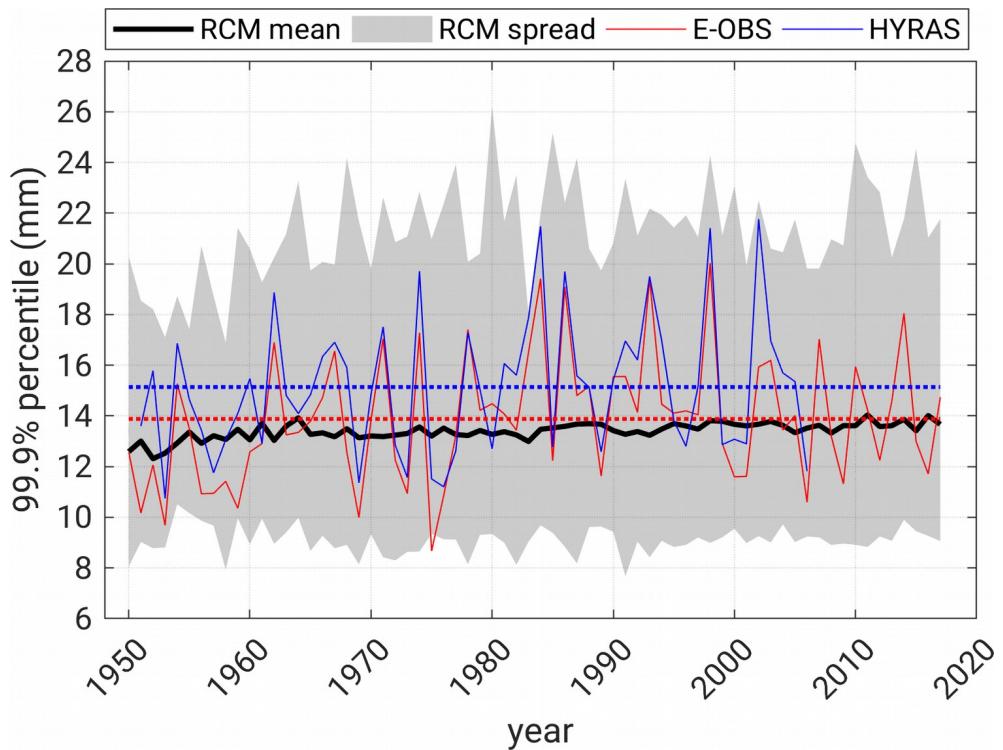
Figure S4: Same as Fig. S3, but for Mid-Europe (ME) and the 99.9 % percentile.
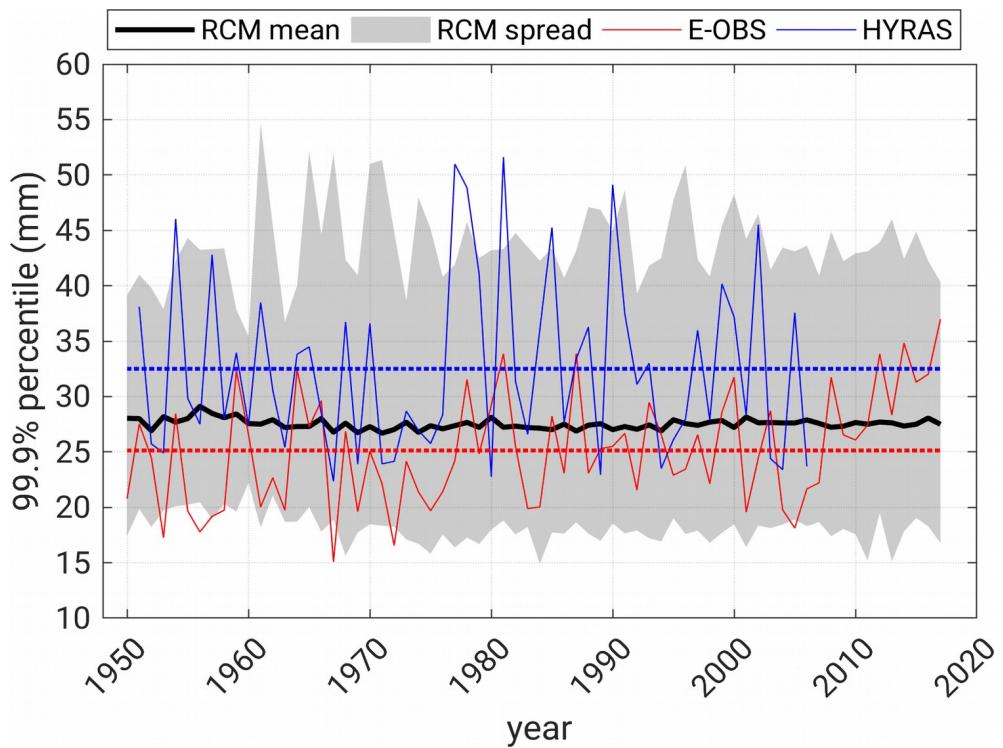
Figure S5: Same as Fig. S4, but for the Alps (AL).

3.   Long-term variances and trend

This section contains supplemental figures and tables for the analysis, which is discussed in Section 5 of the main paper.
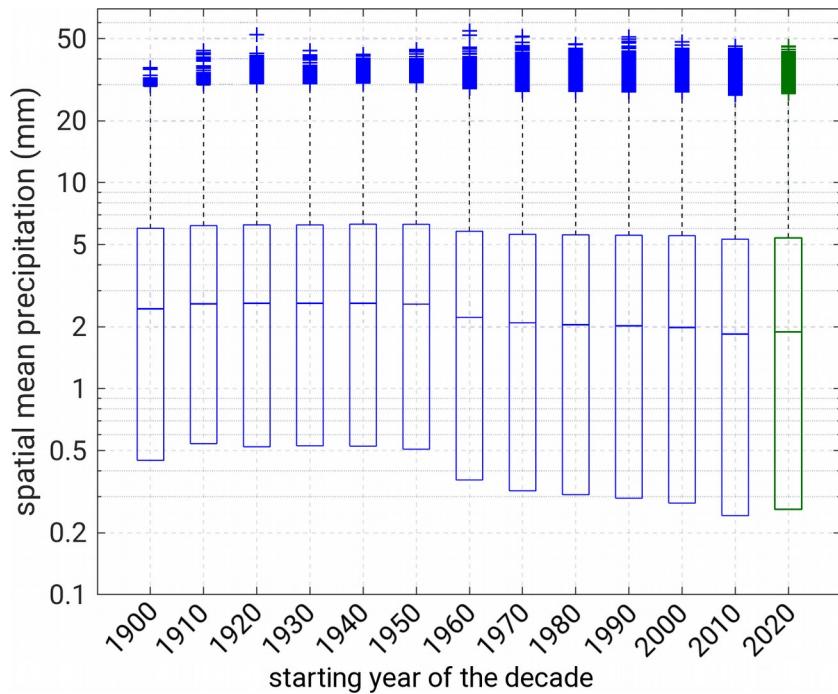
Figure S6: Boxplot of the distribution of daily spatial mean precipitation values for AL. Each decade during TP1 (blue) was considered separately. The centerline of a box marks the median; the lower and upper end of the box mark the 25th and 75th percentile (interquartile range); the whiskers represent approximately the 99.9 % percentile; TP2 is marked in green.
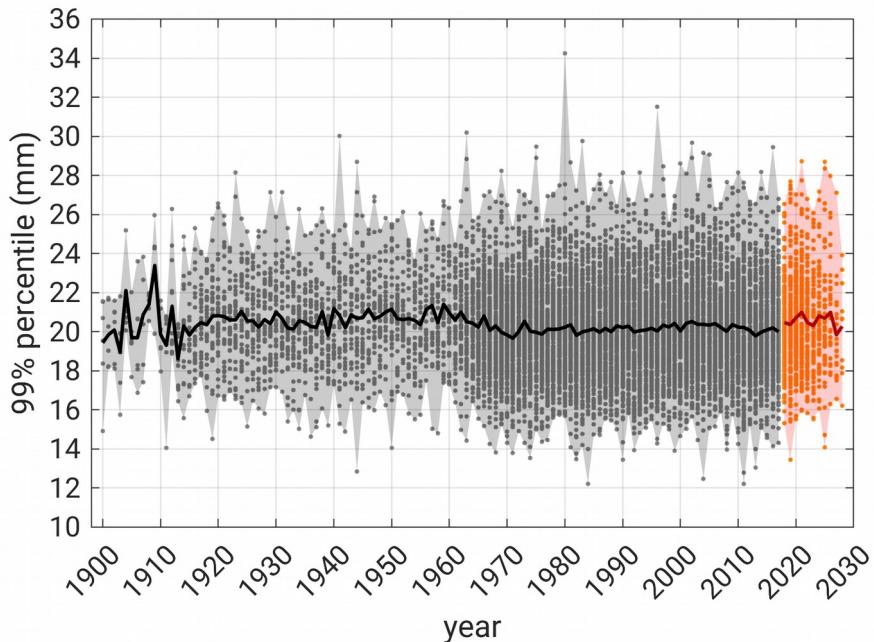
Figure S7 Time series of the yearly 99 % percentile of spatial mean precipitation for the Alps (AL) of the RCM ensemble mean (solid line), and the ensemble spread (dots and shaded area) during TP1 (black/gray) and TP2 (reddish).
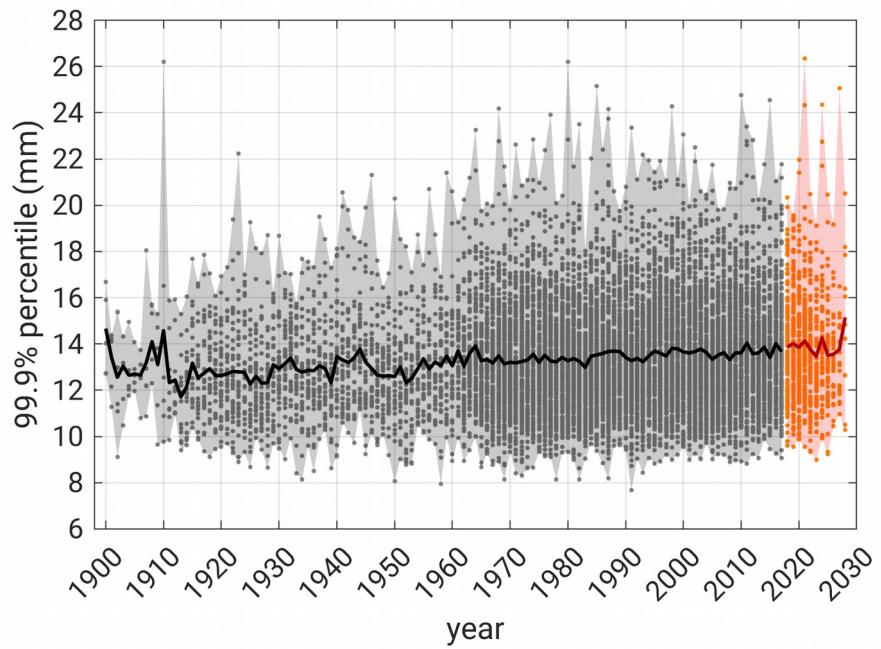
Figure S8: Same as Fig. S7 but for the 99.9 % percentile for ME.
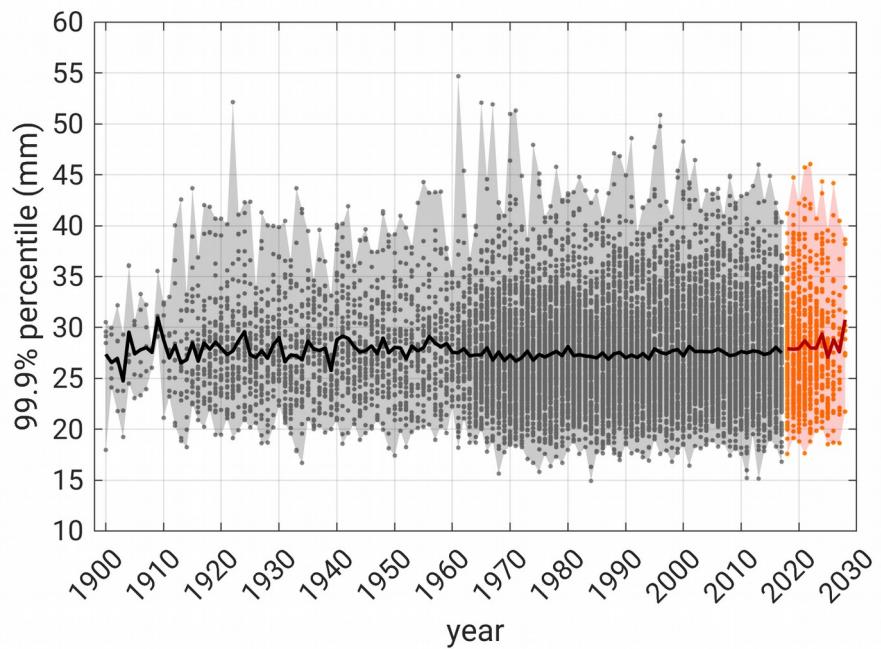
Figure S9: Same as Fig. S7, but for the Alps (AL).

Table S1: Trend during TP1b (1950–2017) using a linear regression of the yearly series of the 99 % and 99.9 % percentile (pct) for ME and AL; Given are absolute values and the relative changes (RC) compared to the climatological mean (climTP) for the minimum values (min), the mean, and the maximum (max) and the related significance (p-value).

area	pct	variable	trend (mm)	RC (%)	climTP (mm)	p_α
ME	99	min	-0.2	-3.0	7.5	0.7865
		mean	0.6	5.7	10.0	1.0
		max	1.5	10.7	13.7	1.0
ME	99.9	min	0.0	0.0	9.0	0.3164
		mean	0.7	5.5	13.4	1.0
		max	2.7	12.3	21.7	1.0
AL	99	min	-1.5	-10.1	14.6	0.9929
		mean	-0.6	-3.0	20.2	0.9982
		max	2.2	8.1	27.7	1.0
AL	99.9	min	-1.8	-10.4	17.8	0.9940
		mean	-0.2	-0.8	27.3	0.2612
		max	1.1	2.4	44.0	0.6290
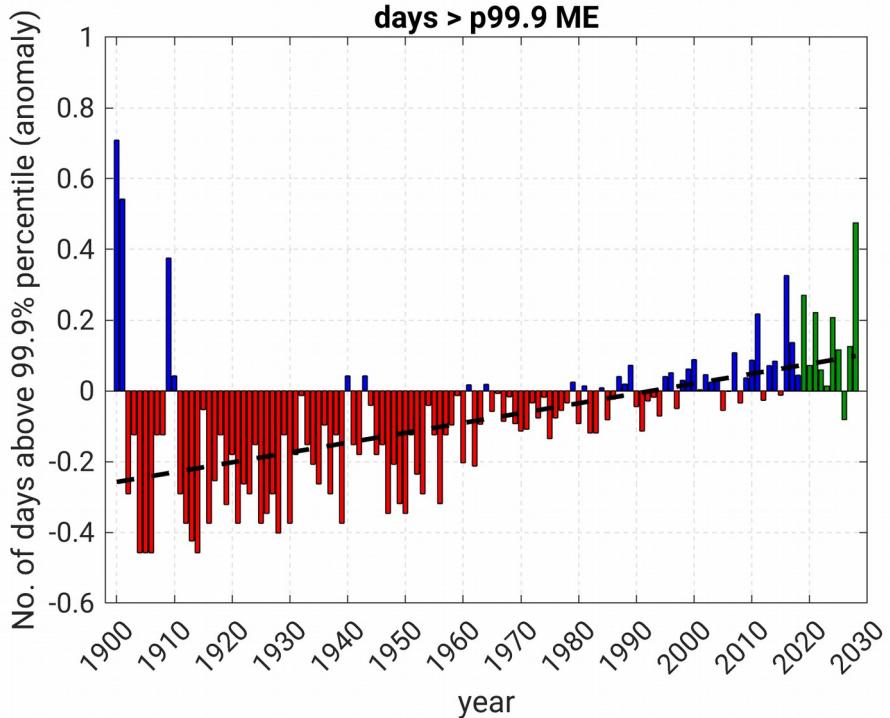
Figure S10: Deviation of the mean yearly number of days above the 99.9 % percentile compared to the climatology (1961–1990; climTP) for ME. Red bars indicate negative anomalies (less days), blue bars positive anomalies (more days). The predictions (TP2) are given in green; the black line indicates a linear regression.
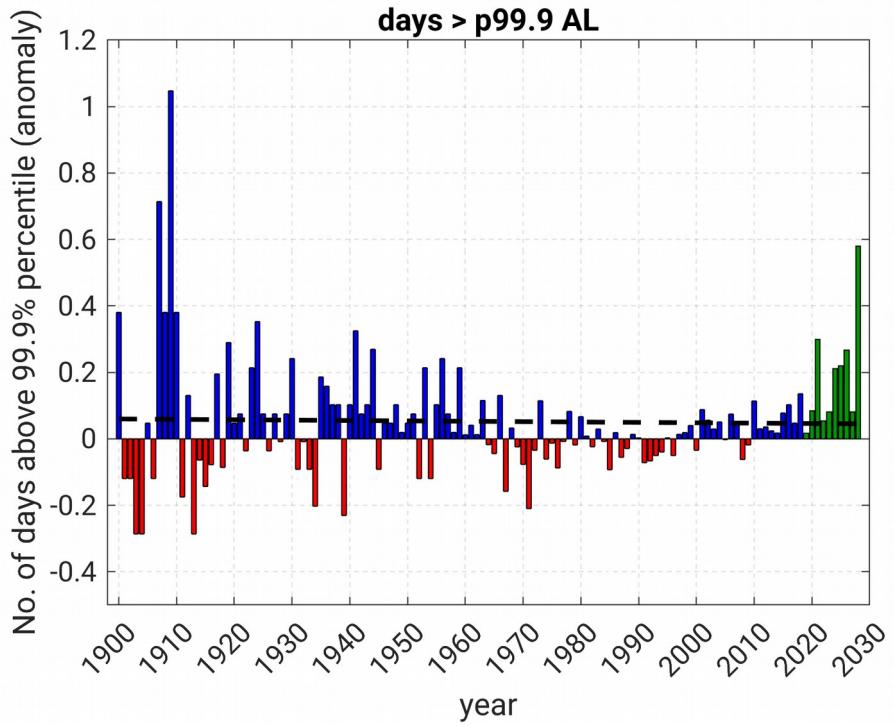
Figure S11: Same as Fig. S10, but for the Alps (AL).
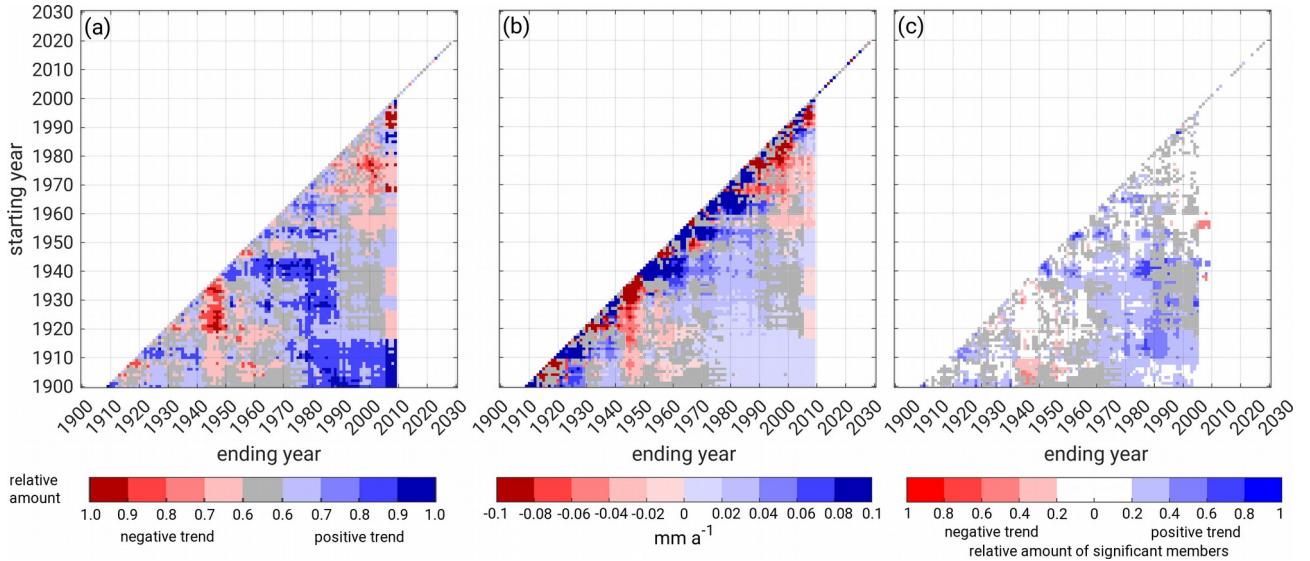
Figure S12: Trend analysis of the 99 % percentile for AL with (a) the relative amount of members of the total RCM ensemble size with a positive (blue) or negative (red) trend; (b) the trend in mm per year averaged over the members from (a), and (c) relative amount of members from (a) that have a significant trend; cases with no distinct number (less than 60 %) of members with same trend sign are marked in gray in (a)‒(c).
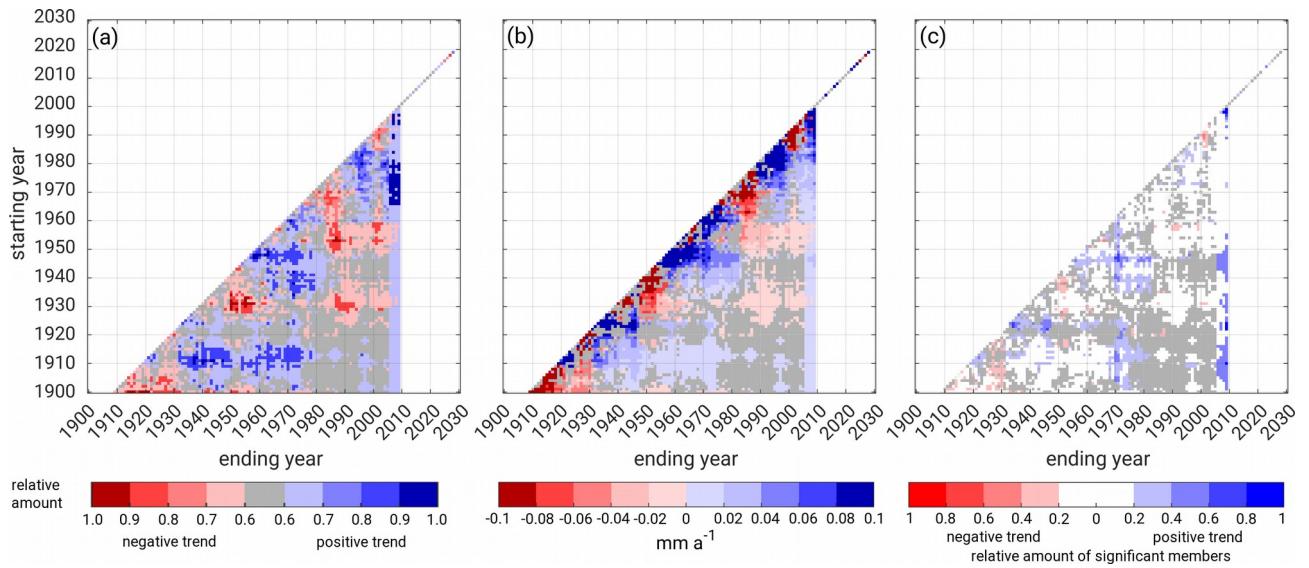
Figure S13: Same as Fig. S12, but for the 99.9 % percentile of ME.
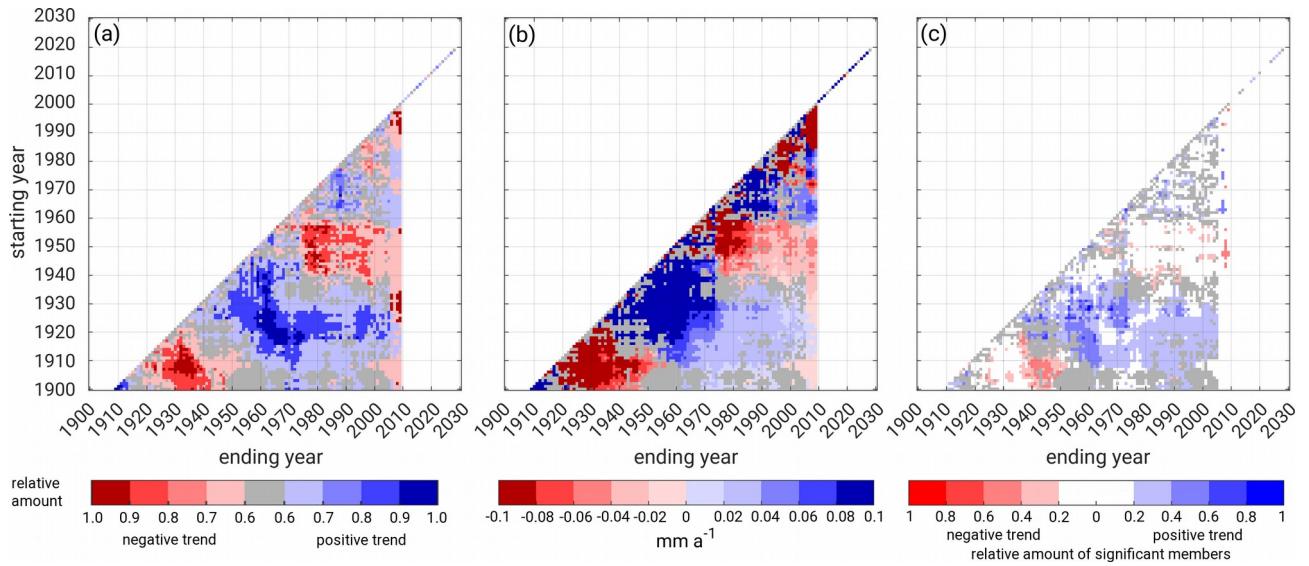
Figure S14: Same as Fig. S13, but for the Alps (AL).
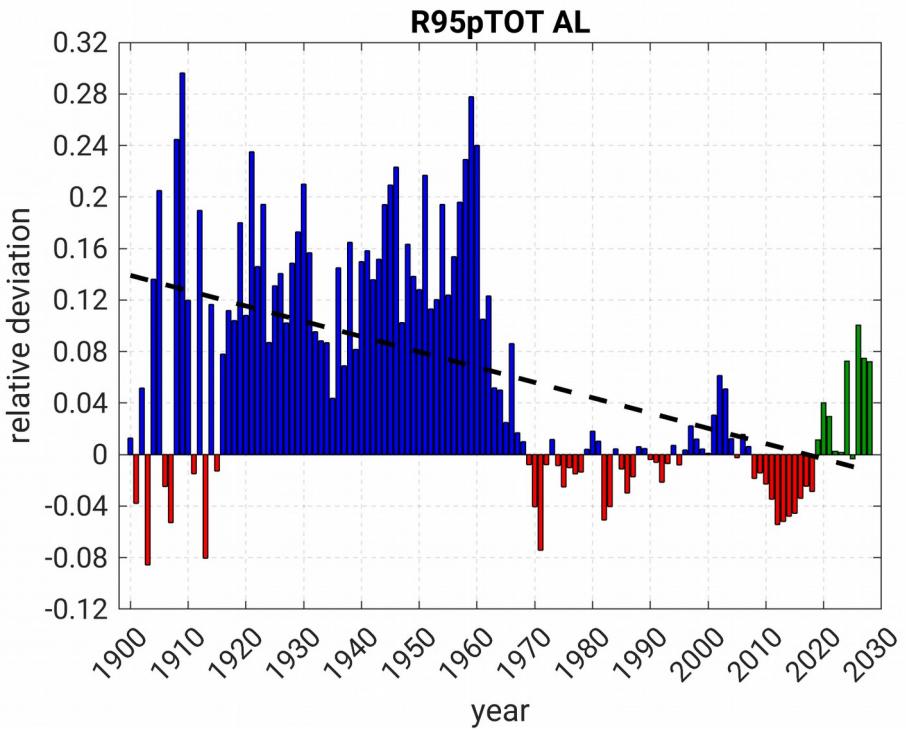
Figure S15: Relative deviation of the R95pTOT index of the RCM ensemble mean compared to the climatology (climTP) for AL. Red bars indicate negative (dry) anomalies, blue bars positive (wet) anomalies. The predictions (TP2) are given in green. The black line indicates a linear regression.
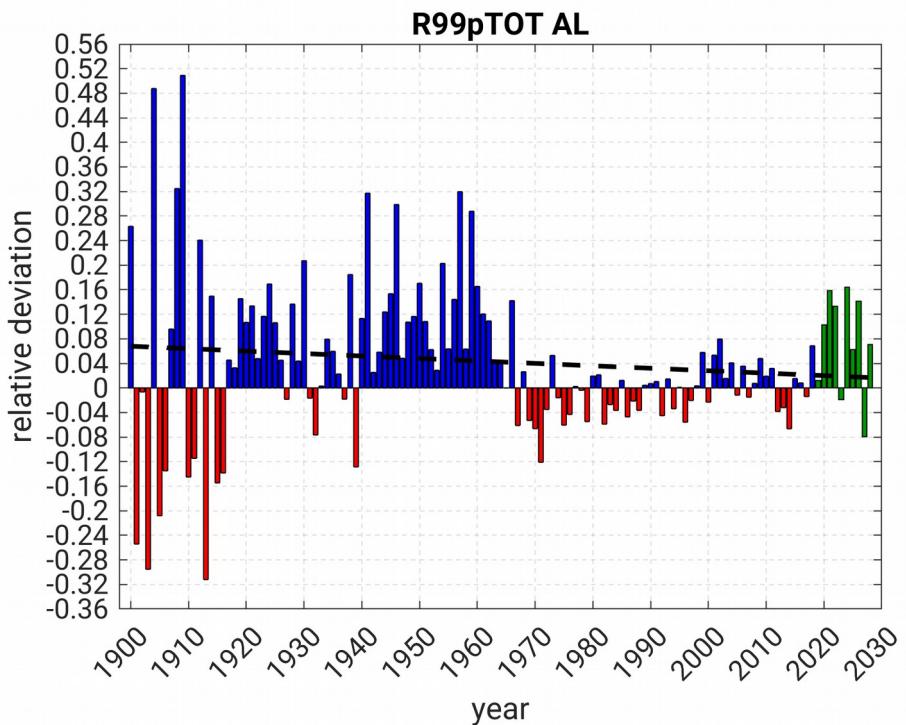
Figure S16: Same as Fig. S15, but for the R99pTOT index.