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Expected annual minima from an idealized moving-average drought index

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S1. Additional Figures

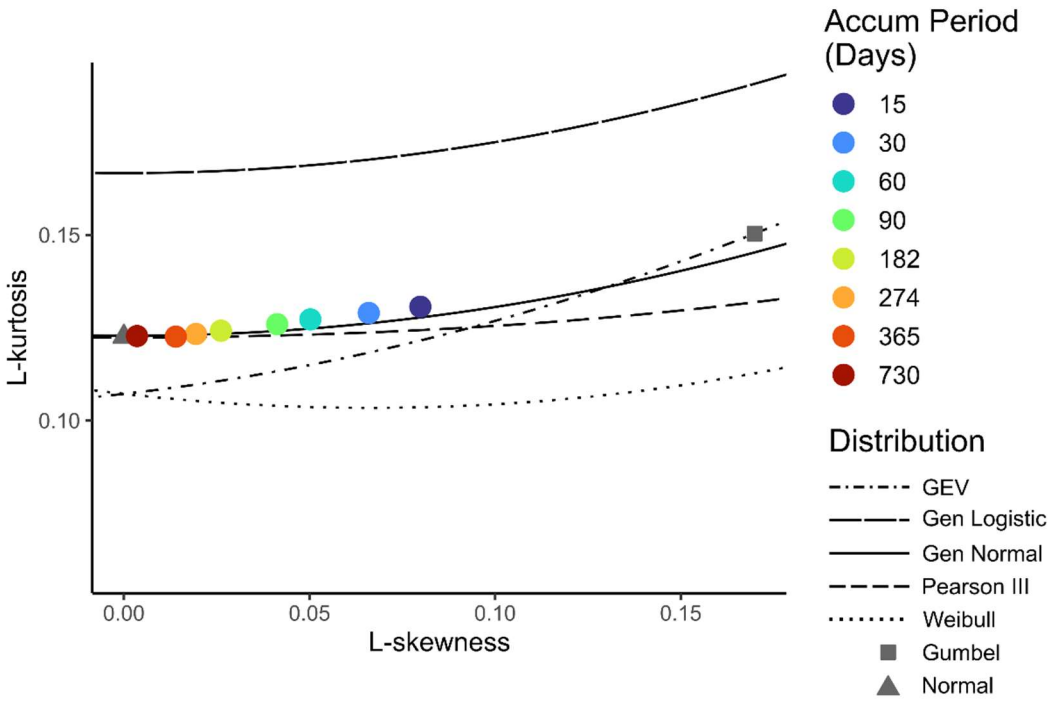

Figure S1: L-moment ratios for annual extremes from daily simulated series. Coloured points refer to fitted moments across varying accumulation periods, while lines correspond to theoretical distributions. Note, this figure shows distributions with a flipped sign. True skewness for annual minima is negative.

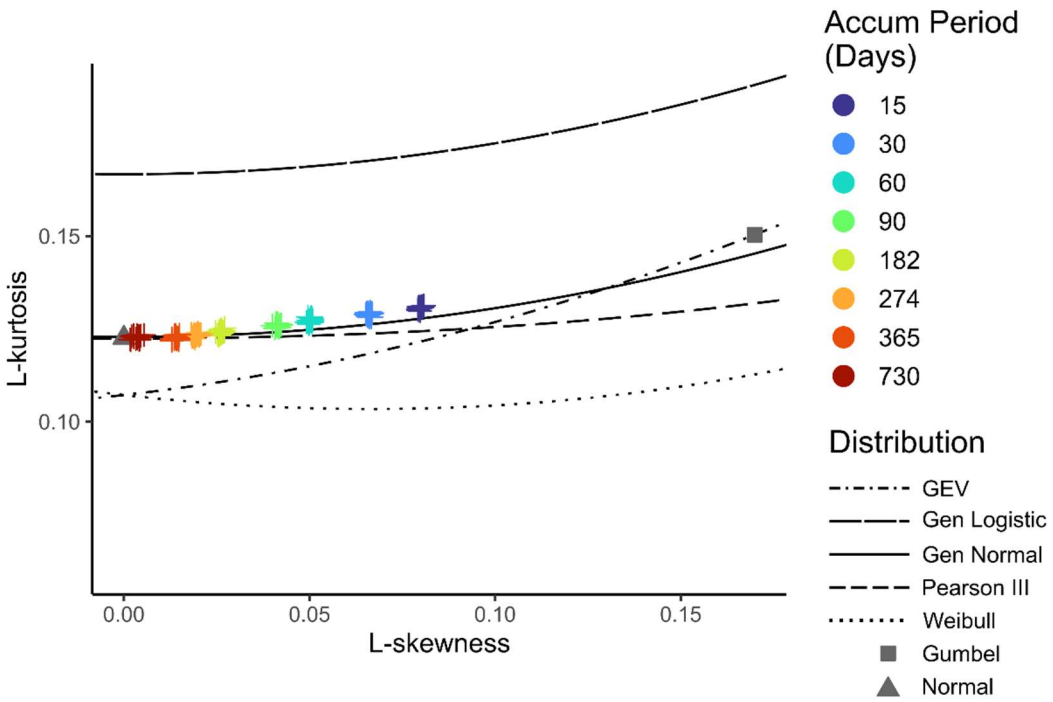

Figure S2: L-moment ratios for annual extremes from daily simulated series. Each of the 20 replicates are shown as unique crosses (+). Colours refer to accumulation periods, while lines correspond to theoretical distributions. Note, this figure shows distributions with a flipped sign. True skewness for annual minima is negative.

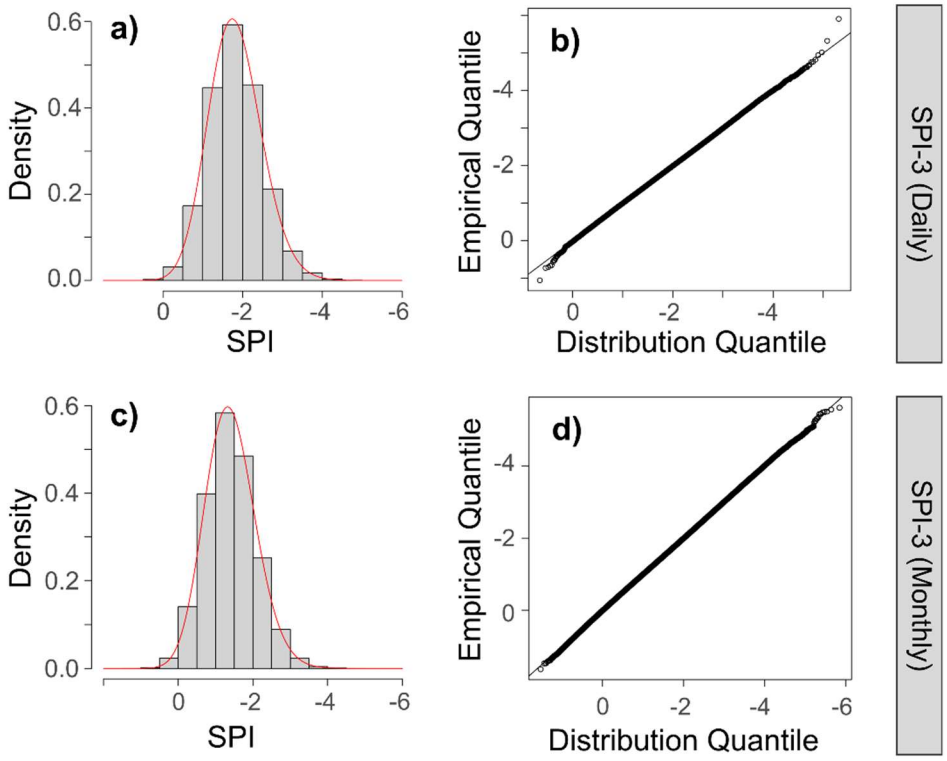

Figure S3: Example distribution fit for the SPI-3 using (a-b) daily and (c-d) monthly data. On the left (subfigures a and c), empirical density is shown as a grey histogram, while the fitted Generalized Normal distribution is shown in red. The right (subfigures b and d) shows a quantile-quantile plot comparing empirical to fitted quantiles.

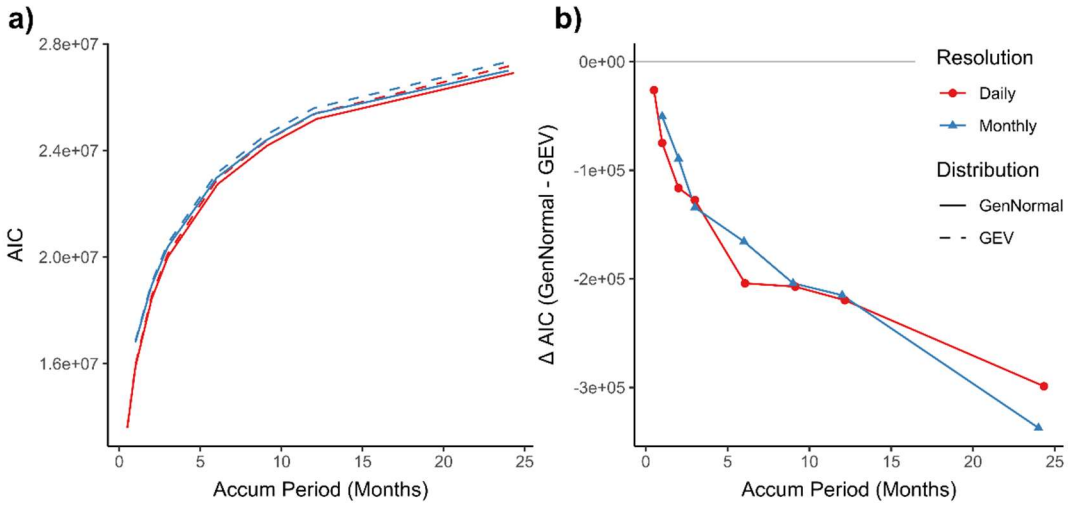

Figure S4: Comparison of Akaike information criterion (AIC) between the Generalized Normal and GEV distributions. This is shown as (a) raw AIC values, where lower values represent better fits, and (b) the difference between AIC for the Generalized Normal and GEV distributions, where negative values suggest the Generalized Normal distribution fits better. Colours refer to the distribution in both figures, while the line style (solid vs dashed) refers to the distribution.

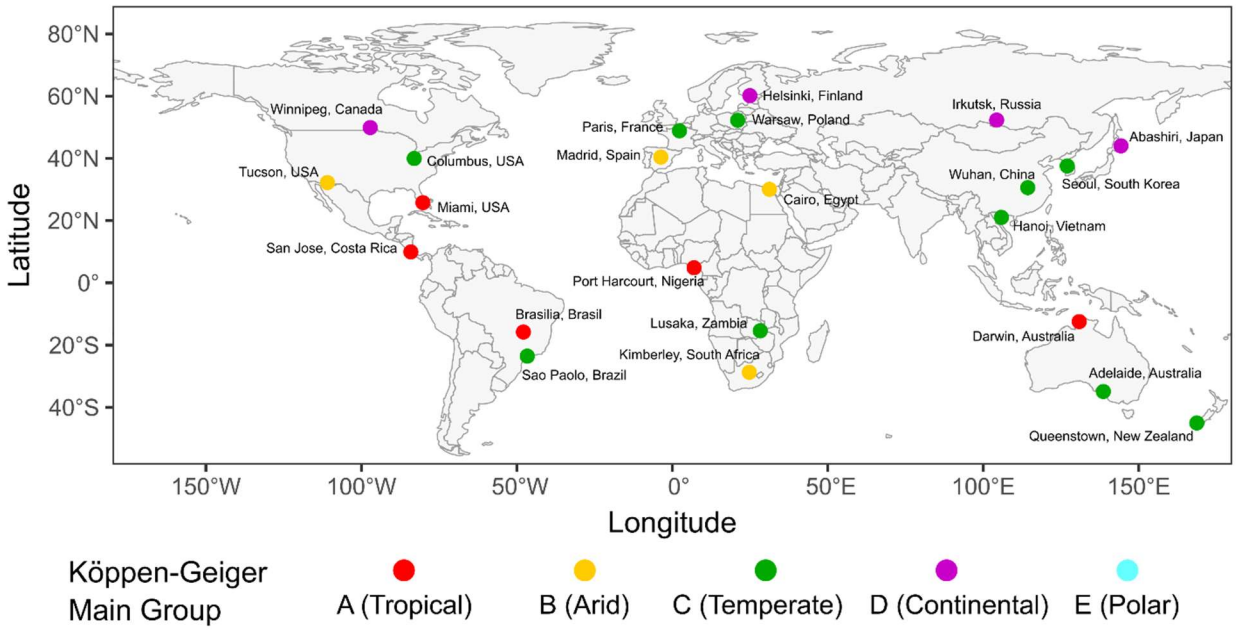

Figure S5: Location of case study grid cells used to compare observed SPI temporal autocorrelation with theoretical autocorrelation.

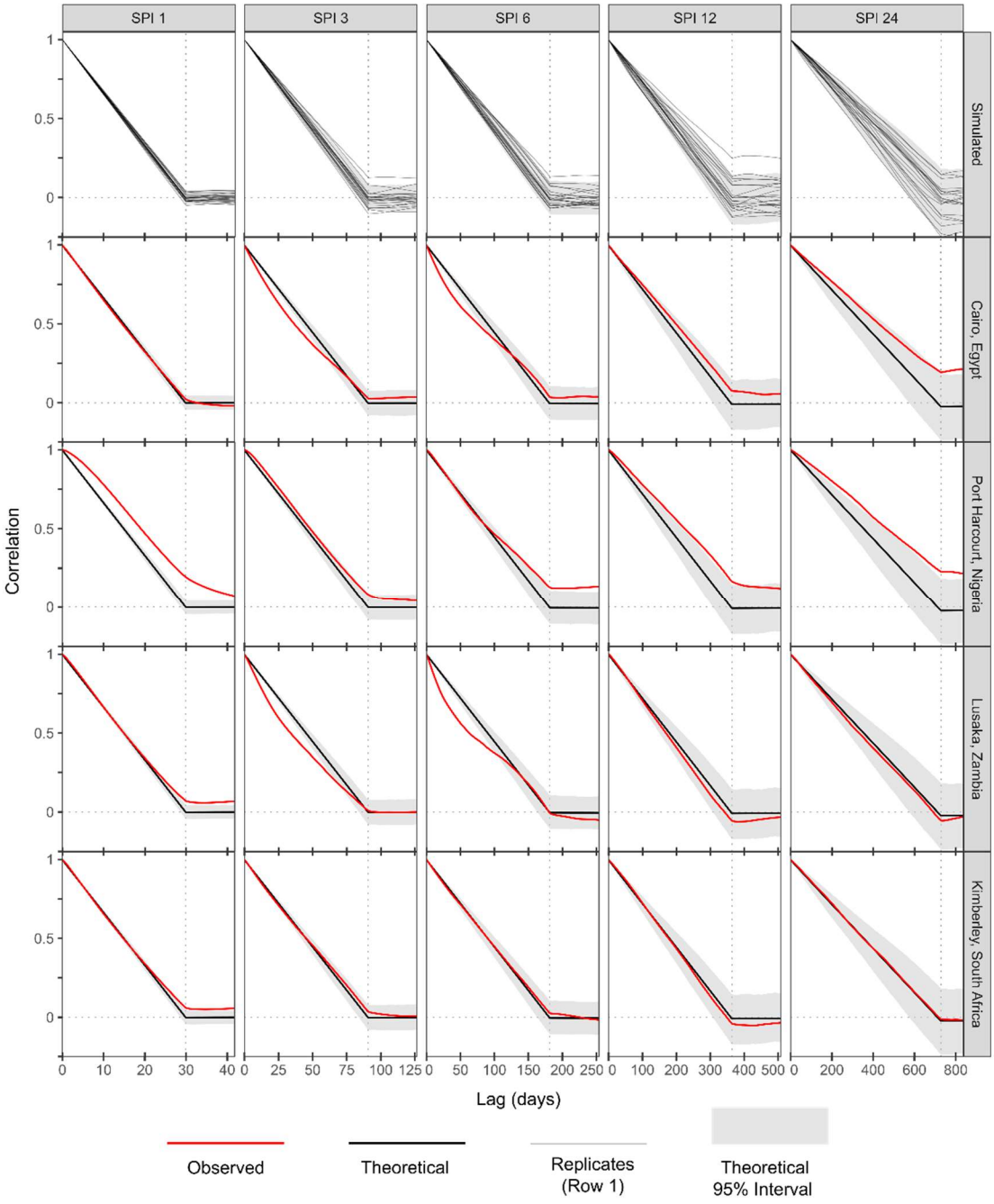

Figure S6: Identical format to Fig 3 for representative grid cells in Africa. Lagged correlation for the SPI-1, 3, 6, 12, and 24 moving windows. The first row shows 20 replicates from random simulation in light grey, while subsequent rows contrast observed autocorrelation (red) with theoretical (grey interval with black line).

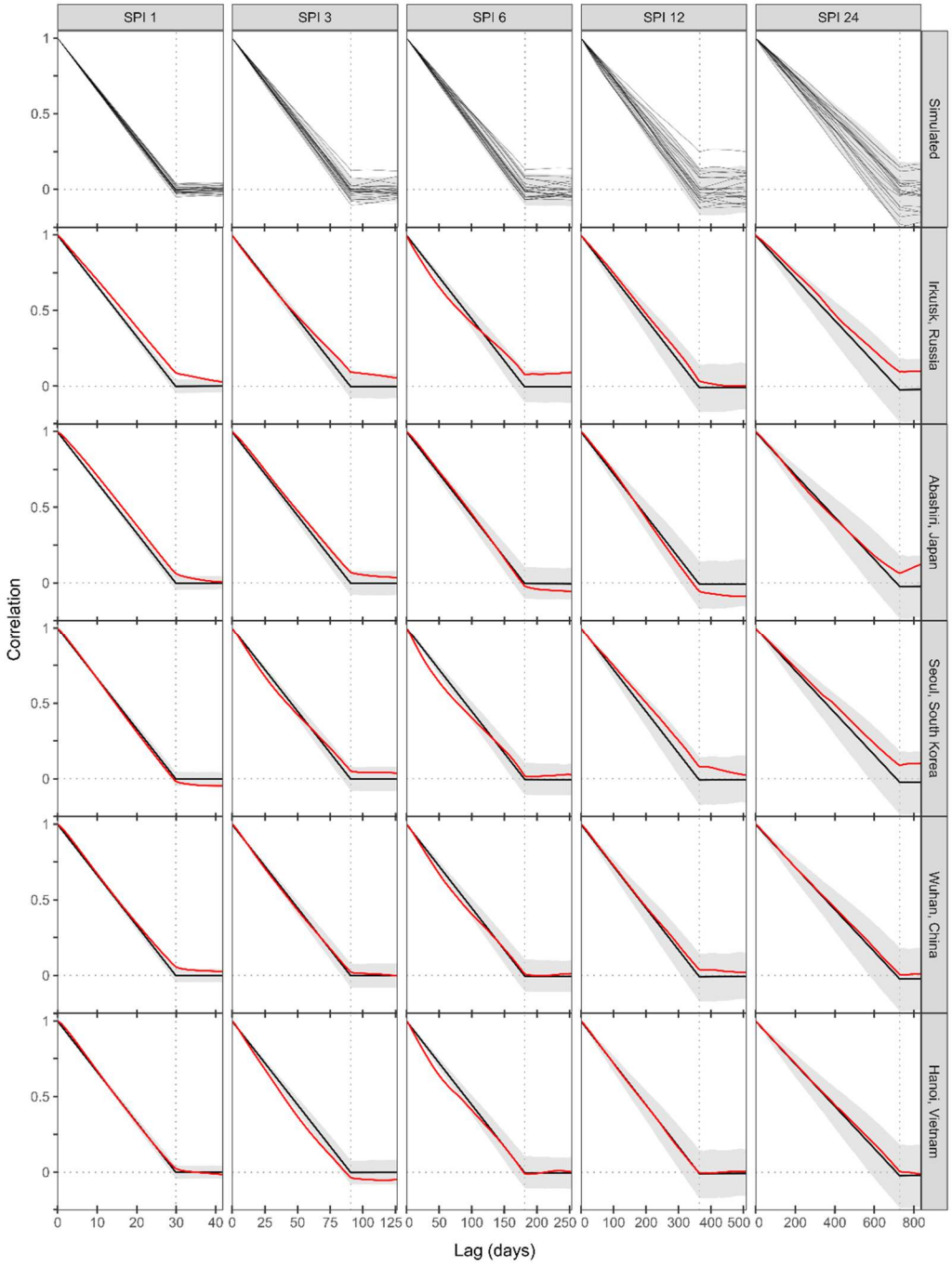

Figure S7: Identical format to Fig 3 for representative grid cells in Africa. Lagged correlation for the SPI-1, 3, 6, 12, and 24 moving windows. The first row shows 20 replicates from random simulation in light grey, while subsequent rows contrast observed autocorrelation (red) with theoretical (grey interval with black line).

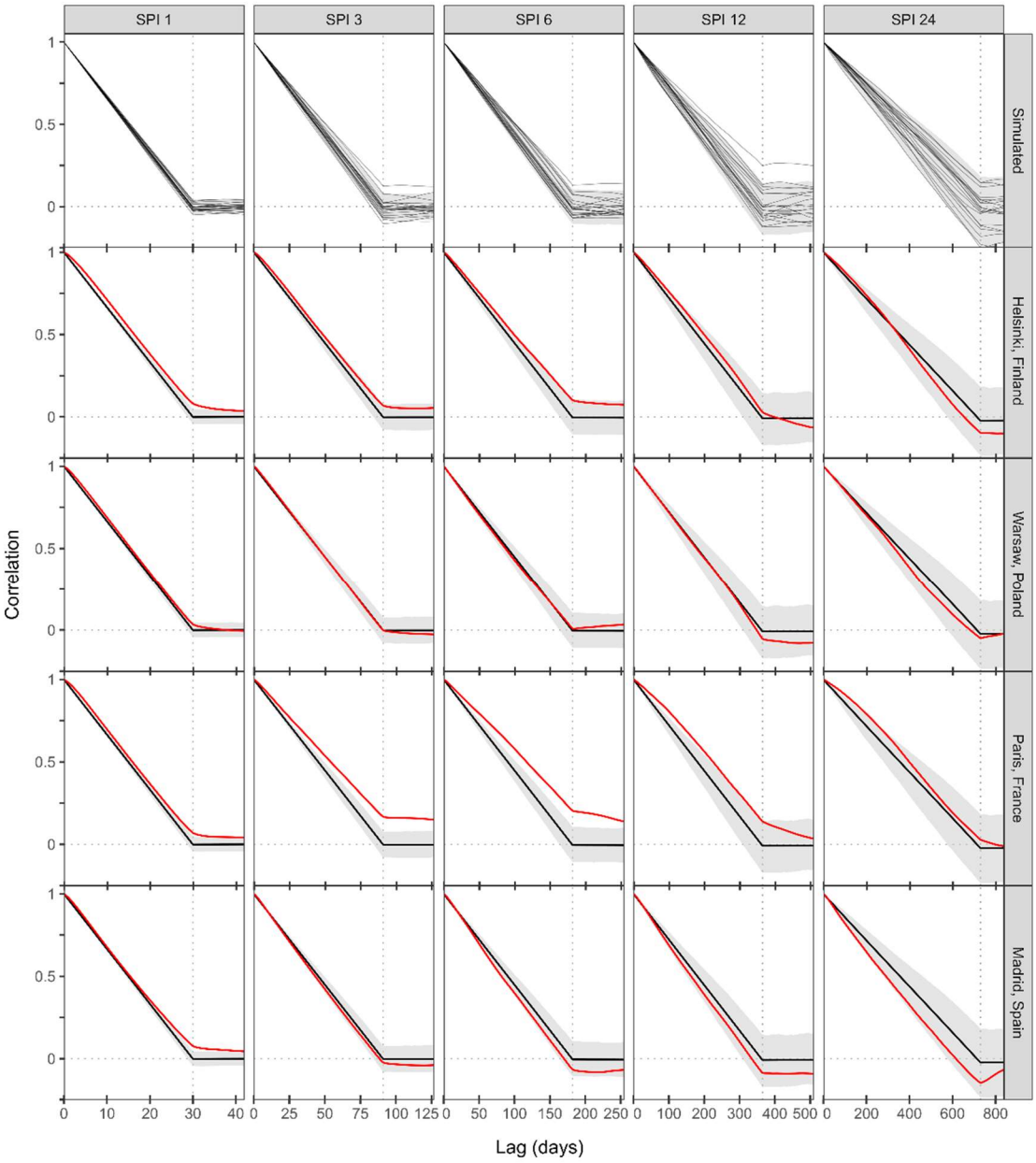

Figure S8: Identical format to Fig 3 for representative grid cells in Europe. Lagged correlation for the SPI-1, 3, 6, 12, and 24 moving windows. The first row shows 20 replicates from random simulation in light grey, while subsequent rows contrast observed autocorrelation (red) with theoretical (grey interval with black line).

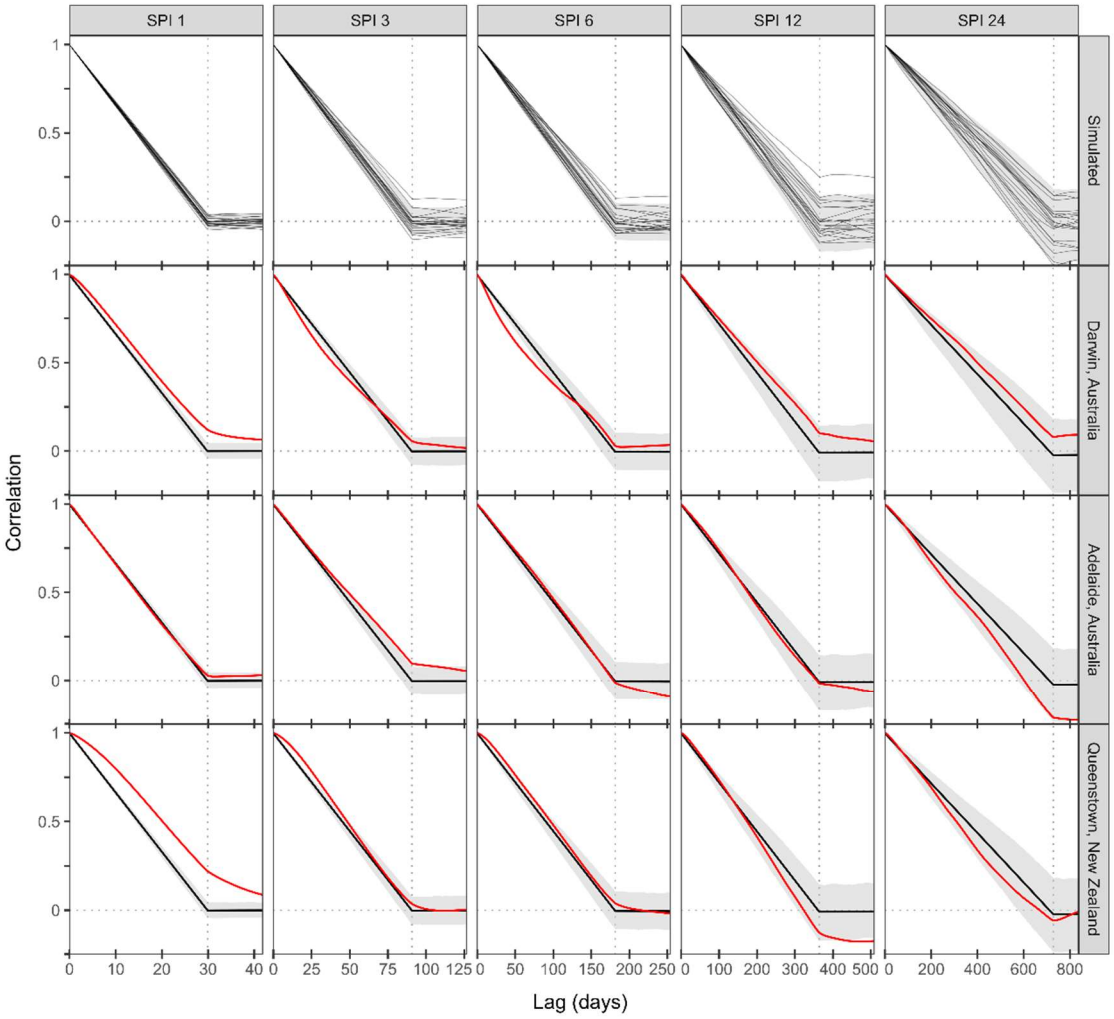

Figure S9: Identical format to Fig 3 for representative grid cells in Oceania. Lagged correlation for the SPI-1, 3, 6, 12, and 24 moving windows. The first row shows 20 replicates from random simulation in light grey, while subsequent rows contrast observed autocorrelation (red) with theoretical (grey interval with black line).

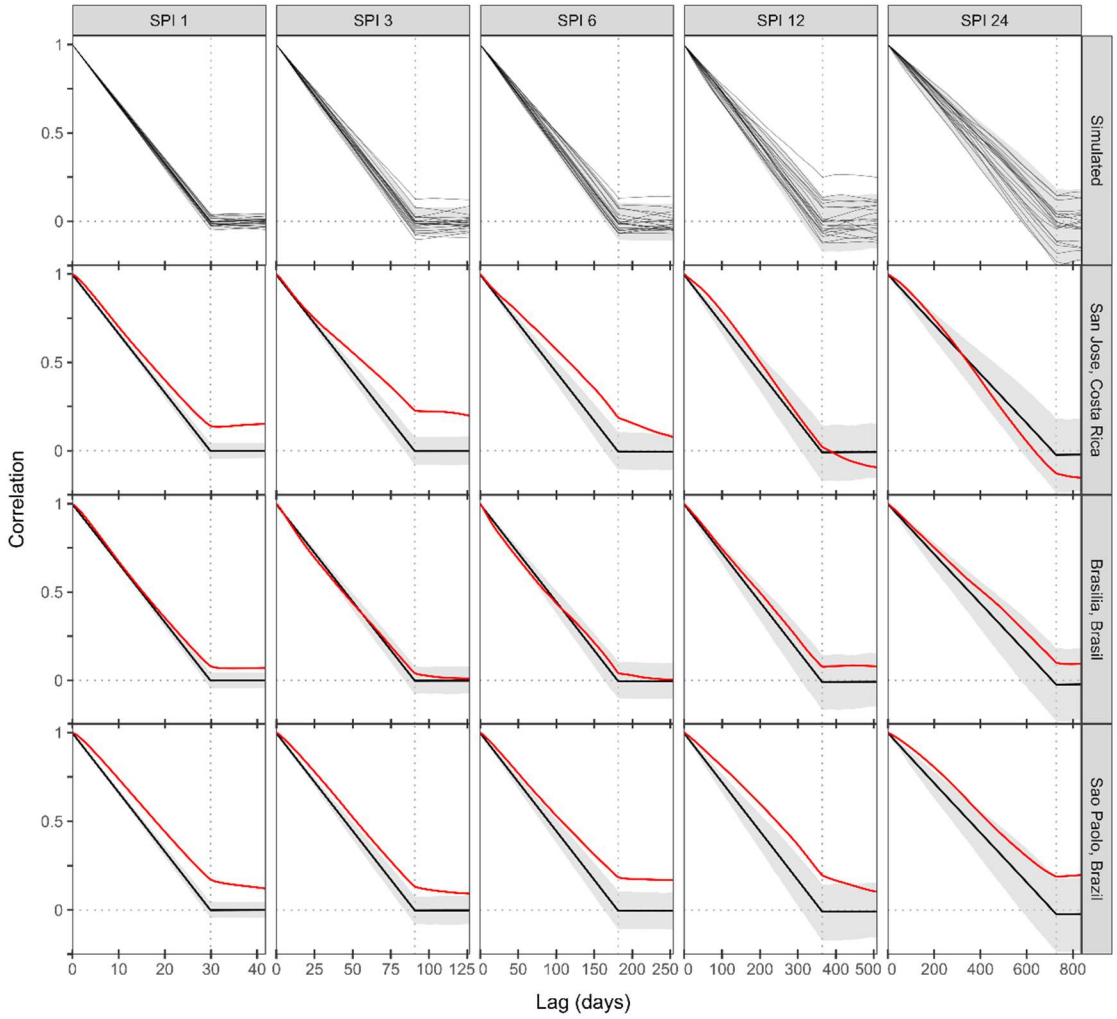

Figure S10: Identical format to Fig 3 for representative grid cells in South America. Lagged correlation for the SPI-1, 3, 6, 12, and 24 moving windows. The first row shows 20 replicates from random simulation in light grey, while subsequent rows contrast observed autocorrelation (red) with theoretical (grey interval with black line).

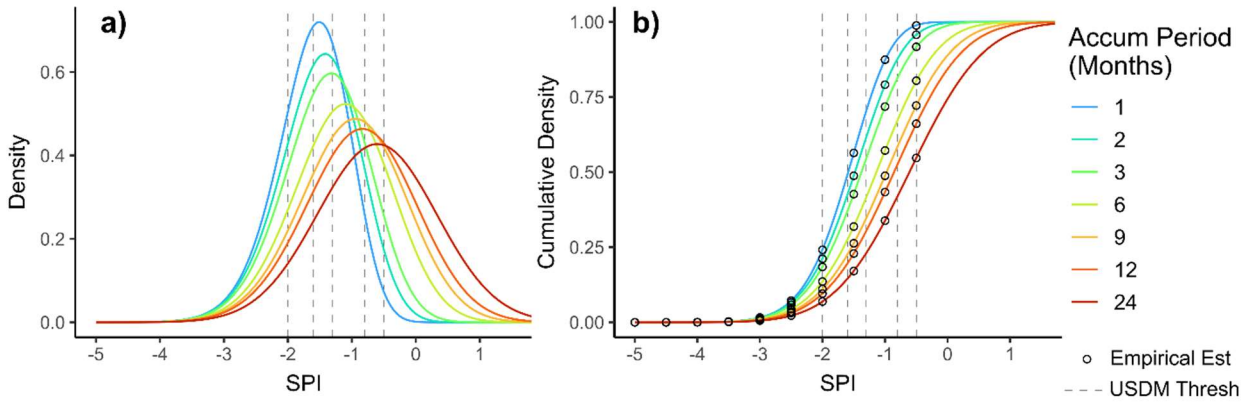

Figure S11: Equivalent to Fig. 3, but calculated for monthly sequences. Annual minima (a) distribution and (b) cumulative probability density for monthly sequences of varied accumulation periods, indicated by colour. Colours are identical to Fig. 2. Vertical grey lines correspond to US Drought Monitor thresholds for D0-D4 (-0.5, -0.8, -1.3, -1.6, and -2.0). Open points represent empirical estimates directly from simulation.

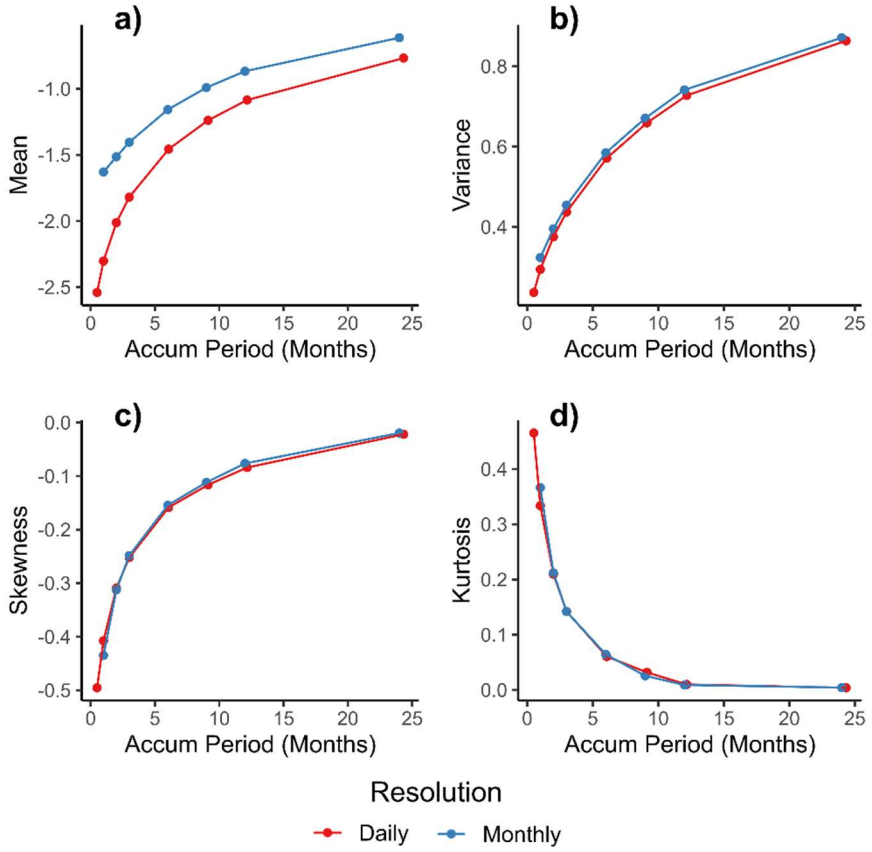

Figure S12: The first four distribution moments for the annual minima from daily and monthly simulations (shown as colours). Accumulation period plotted on the x-axis.

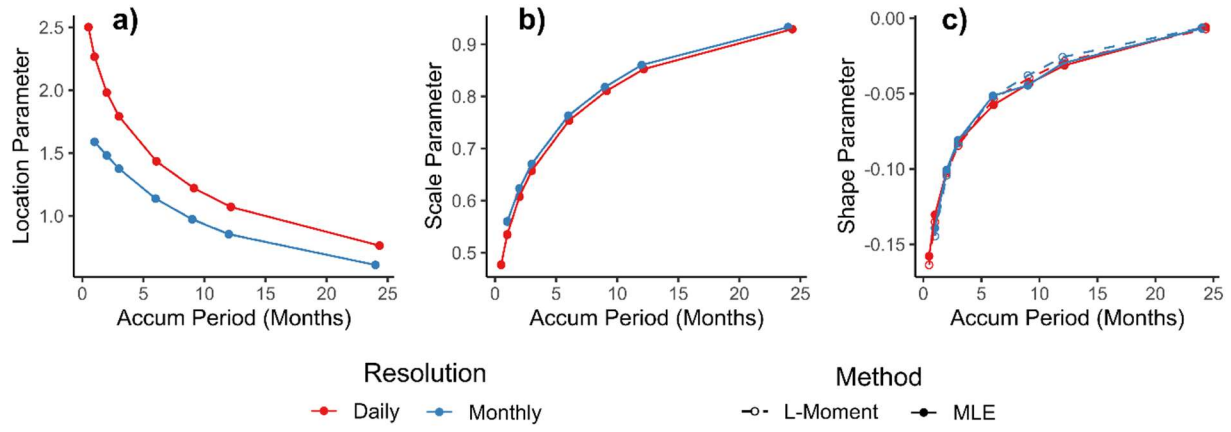

Figure S13: Fitted distribution parameters for the Generalized Normal distribution describing annual minima from daily and monthly simulations (shown as colours). Accumulation period plotted on the x-axis. Fitting method are shown as linetype, though these are largely indistinguishable.

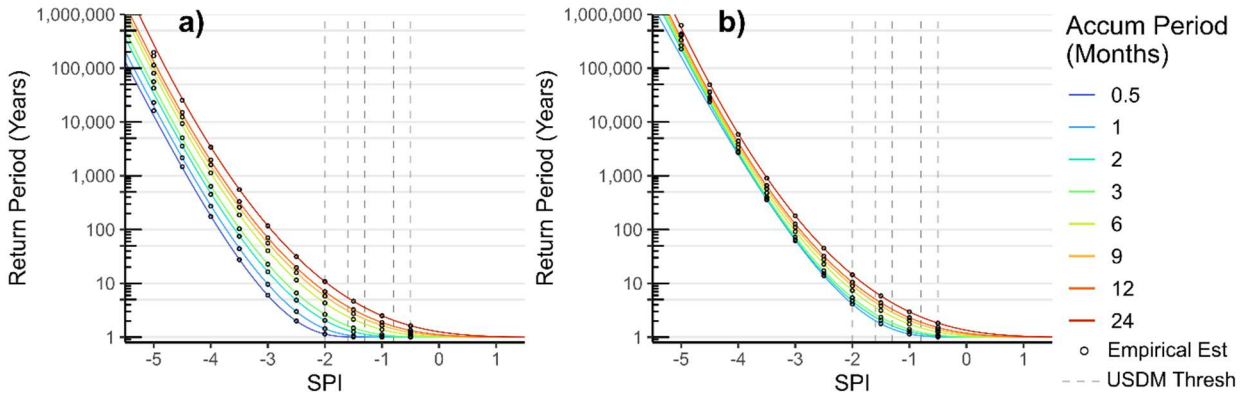

Figure S14: Equivalent to Fig. 4, but expanded to SPI < -5. Return periods for (a) daily and (b) monthly sequences with accumulation periods indicated by colour. Colours are identical to Figs. 2 and 3. Vertical grey lines correspond to US Drought Monitor thresholds. Open points represent empirical estimates directly from simulation.

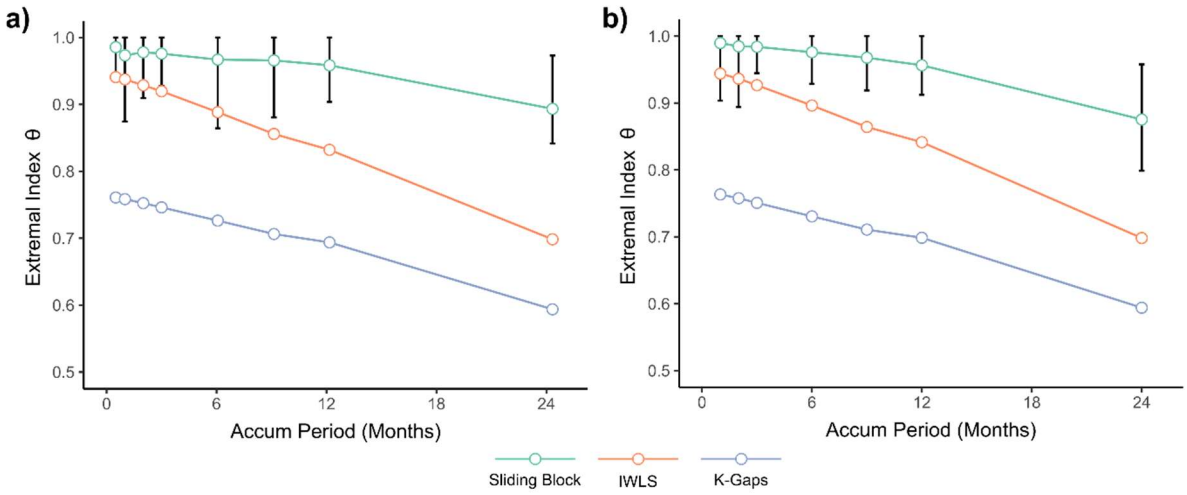

Figure S15: Extremal index, θ, calculated for (a) daily and (b) monthly records. Colours represent three approaches for calculating the extremal index: sliding block maxima (Berghaus and Bucher 2018), iterated weight least squares (Suveges 2007), and the K-gaps model (Suvege and Davison 2010). Empty circles represent the mean of the extremal index for the twenty subsets, while bars represent the min and max extremal index values. Extremal index is bounded between 0 and 1, with θ=1 representing completely independent extremes and values less than 1 suggesting increased extremal clustering.

Table S1: Distribution parameters for the generalized normal distribution.

	Daily			Monthly		
Accumulation (months)	**kappa**	**alpha**	**xi**	**kappa**	**alpha**	**xi**
0.5	-0.1578	0.4773	2.503			
1	-0.1303	0.5353	2.268	-0.1391	0.5605	1.590
2	-0.1015	0.6081	1.982	-0.1006	0.6239	1.483
3	-0.0820	0.6578	1.793	-0.0808	0.6706	1.377
6	-0.0574	0.7542	1.434	-0.0515	0.7634	1.138
9	-0.0432	0.8108	1.220	-0.0445	0.8181	0.973
12	-0.0313	0.8525	1.071	-0.0299	0.8604	0.854
24	-0.0059	0.9293	0.764	-0.0068	0.9332	0.610