



Supplement of

A Bayesian statistical method to estimate the climatology of extreme temperature under multiple scenarios: the ANKIALE package

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S.1 More details about the inference of θ

S.1.1 Smoothing of external forcings

S.1.1.1 Definition

In this section, we will explain how, starting from the mean regional and global temperatures $\tilde{X}_{t,m}^{R,SSP}$ and $\tilde{X}_{t,m}^{G,SSP}$ of a climate model m for the SSP scenario ($SSP \in \{SSP_1, \dots, SSP_{N_{SSP}}\}$), we construct $X_{t,m}^{R,SSP}$ and $X_{t,m}^{G,SSP}$. The goal is to construct the following decomposition:

$$\left\{ \begin{array}{l} \tilde{X}_{t,m}^{R,SSP_1} = X_m^{R,0} + X_m^{R,N} \times X_t^{\mathcal{N}} + X_{t,m}^{R,A,SSP_1} + \varepsilon^{R,SSP_1}, \\ \vdots = \vdots \\ \tilde{X}_{t,m}^{R,SSP_{N_{SSP}}} = X_m^{R,0} + X_m^{R,N} \times X_t^{\mathcal{N}} + X_{t,m}^{R,A,SSP_{N_{SSP}}} + \varepsilon^{R,SSP_{N_{SSP}}}, \\ \tilde{X}_{t,m}^{G,SSP_1} = X_m^{G,0} + X_m^{G,N} \times X_t^{\mathcal{N}} + X_{t,m}^{G,A,SSP_1} + \varepsilon^{G,SSP_1}, \\ \vdots = \vdots \\ \tilde{X}_{t,m}^{G,SSP_{N_{SSP}}} = X_m^{G,0} + X_m^{G,N} \times X_t^{\mathcal{N}} + X_{t,m}^{G,A,SSP_{N_{SSP}}} + \varepsilon^{G,SSP_{N_{SSP}}}. \end{array} \right. \quad (S.1)$$

With the following terms:

- $X_m^{R,0}$ and $X_m^{G,0}$ are constants;
- $X_t^{\mathcal{N}}$ is the temperature response to natural forcings (see Fig. S2), and $X_m^{R,N}$ and $X_m^{G,N}$ are therefore constants to be inferred. With a slight abuse of notation in the main text, we will instead write $X_{t,m}^{R,N} = X_m^{R,N} \times X_t^{\mathcal{N}}$ and $X_{t,m}^{G,N} = X_m^{G,N} \times X_t^{\mathcal{N}}$. The response $X_t^{\mathcal{N}}$ is inferred from an EBM model for CMIP5 defined by Held et al. (2010) and studied by Geoffroy et al. (2013). For CMIP6, we use the values given by Smith (2020);
- $X_{t,m}^{R,A,SSP}$ and $X_{t,m}^{G,A,SSP}$ are the smoothing of anthropogenic forcings with splines, we will return to this in more detail later;
- $\varepsilon^{R,SSP}$ and $\varepsilon^{G,SSP}$ are Gaussian error terms, representing natural variability.

This decomposition allows us to define for each $SSP \in \{SSP_1, \dots, SSP_{N_{SSP}}\}$:

$$\left\{ \begin{array}{l} X_{t,m}^{R,SSP} := X_m^{R,0} + X_{t,m}^{R,N} + X_{t,m}^{R,A,SSP}, \\ X_{t,m}^{G,SSP} := X_m^{G,0} + X_{t,m}^{G,N} + X_{t,m}^{G,A,SSP}. \end{array} \right.$$

Before tackling the general case of Eq. (S.1), we will consider the specific case where we only have the regional temperature and a single SSP scenario.

S.1.1.2 Special case: regional temperature for a single scenario

In this case, simplifying the notation, our problem boils down to constructing the following decomposition:

$$\tilde{X}_t = X^0 + X_t^N + X_t^A + \varepsilon \quad (S.2)$$

To construct X_t^A , let \mathbf{B} be the basis matrix of the B -splines (see, e.g. Hastie et al., 2001; James et al., 2021; James et al., 2023). This is a matrix with N_T rows (number of time steps) and the size of the basis for columns. We then have:

$$\begin{aligned}
\tilde{X}_t &= X^0 + X_t^N + X_t^A + \varepsilon \\
&= (1, X_t^N, \mathbf{B}) \cdot \begin{pmatrix} X^0 \\ X^N \\ X^A \end{pmatrix} + \varepsilon \\
&= (1, X_t^N, \mathbf{B}) \cdot \theta + \varepsilon
\end{aligned}$$

The vector $\theta = (X^0, X^N, X^A)$ can be inferred using the least squares method, which amounts to minimizing the following functional:

$$\theta \mapsto \left\| \tilde{X}_t - (1, X_t^N, \mathbf{B}) \cdot \theta \right\|^2.$$

To smooth the anthropic term X_t^A , noting Ω as the matrix of second derivatives of splines, we can introduce a regularization term controlled by a parameter λ that controls the number of residual degrees of freedom. This minimization problem can be written as:

$$\theta \mapsto \left\| \tilde{X}_t - (1, X_t^N, \mathbf{B}) \cdot \theta \right\|^2 + \lambda \|\Omega \cdot \theta\|^2.$$

Noting $\mathcal{B} := (1, X_t^N, \mathbf{B})$, the solution to this problem is given by:

$$\hat{\theta} = (\mathcal{B}^T \cdot \mathcal{B} + \lambda \Omega^T \cdot \Omega)^{-1} \mathcal{B}^T \tilde{X}_t$$

The projection matrix $\hat{\mathbf{P}}$ is given by:

$$\hat{\mathbf{P}} = \mathcal{B}(\mathcal{B}^T \cdot \mathcal{B} + \lambda \Omega^T \cdot \Omega)^{-1} \mathcal{B}^T$$

This allows us to calculate the number of degrees of freedom, given by $\text{Tr}(\hat{\mathbf{P}})$. We also have an estimator of the covariance matrix of $\hat{\theta}$, given by:

$$\begin{aligned}
\text{Cov}(\hat{\theta}) &= (\mathcal{B}^T \cdot \mathcal{B} + \lambda \Omega^T \cdot \Omega)^{-1} \sigma^2 \\
\sigma^2 &= \frac{1}{N_T - \text{Tr}(\hat{\mathbf{P}})} \|\tilde{X}_t - \mathcal{B} \hat{\theta}\|^2
\end{aligned}$$

In the end, we do have the solution $\hat{\theta}$ to the problem in Eq. (S.2), as well as an estimate of the error with $\text{Cov}(\hat{\theta})$.

S.1.1.3 General case

The general idea is to rewrite Eq. (S.1) in the same form as Eq. (S.2), which will allow us to use the same estimators to calculate the solution. One way to do this is to concatenate the entire left-hand side of Eq. (S.1), which leads to:

$$X_t := \begin{pmatrix} \tilde{X}_{t,m}^{R,SSP_1} \\ \vdots \\ \tilde{X}_{t,m}^{R,SSP_{N_{SSP}}} \\ \tilde{X}_{t,m}^{G,SSP_1} \\ \vdots \\ \tilde{X}_{t,m}^{G,SSP_{N_{SSP}}} \end{pmatrix}$$

And the equivalent matrix B is then given by:

$$B = \begin{pmatrix} 1 & X_t^{\mathcal{N}} & \mathbf{B} & 0 & \dots & 0 & 0 & 0 & 0 & 0 & \dots & 0 \\ \vdots & \vdots & 0 & \mathbf{B} & \ddots & \vdots & \vdots & \ddots & \ddots & \ddots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \ddots & 0 & \vdots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 1 & X_t^{\mathcal{N}} & 0 & 0 & 0 & \mathbf{B} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 1 & X_t^{\mathcal{N}} & \mathbf{B} & 0 & \dots & 0 \\ \vdots & \ddots & \ddots & \ddots & \ddots & \vdots & \vdots & \vdots & 0 & \mathbf{B} & \ddots & \vdots \\ \vdots & \ddots & \ddots & \ddots & \ddots & \vdots & \vdots & \vdots & \vdots & \ddots & \ddots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & X_t^{\mathcal{N}} & 0 & 0 & 0 & \mathbf{B} \end{pmatrix}$$

Smoothing is performed by no longer taking a single λ , but by considering a vector λ , each term of which applies to each of the spline components. This allows us to control the desired number of degrees of freedom for each scenario. With these elements, we find ourselves in the case of Eq. (S.2), which solves the general case of Eq. (S.1).

S.1.1.4 Parameters used

For our inference, we chose a constant spline basis for each scenario, with 10 knots distributed uniformly between 1850 and 2100. For the number of degrees of freedom, we chose the value of 8, which is slightly higher than the value of 6 used by Robin and Ribes (2020) and Ribes et al. (2020) in order to better represent a scenario such as SSP1-2.6, which increases and then decreases. Choosing the number of degrees of freedom is always tricky, as it determines what will be signal and what will be noise. The historical value of 6 was chosen by cross-validation, and we have retained this methodology.

S.1.2 Prior: the multi-model synthesis

The prior is constructed as a synthesis of different climate models, using the following hypothesis: “*the models are statistically indistinguishable from truth*”, developed by Ribes et al. (2017). Let:

- $\theta_* \sim \mathcal{N}(\hat{\theta}_*, \Sigma_{\hat{\theta}_*})$ be the desired multi-model synthesis
- $\theta_{\mathcal{M}}$ the mean response of an infinite set of models, and $\Sigma_{\mathcal{M}}$ the climate modelling uncertainty (assumed to be equal for each model);
- $\bar{\theta}$ the multi-model mean;
- $\check{\theta}$ the “truth” (not assumed to be equal to the multi-model mean).

The indistinguishability hypothesis is equivalent to saying that θ_m , θ_* and $\check{\theta}$ all come from the same distribution, i.e. $\theta_m, \theta_*, \check{\theta} \sim \mathcal{N}(\theta_{\mathcal{M}}, \Sigma_{\mathcal{M}})$. Note the difference with the “truth plus error” hypothesis, where the θ_m are centred on reality, i.e. $\theta_m \sim \mathcal{N}(\check{\theta}, \Sigma_{\mathcal{M}})$.

Let us continue by decomposing the $\hat{\theta}_m$ of each model as follows:

$$\begin{aligned} \hat{\theta}_m &= \theta_{\mathcal{M}} + \tilde{\theta}_m + \varepsilon_m \\ \tilde{\theta}_m &\sim \mathcal{N}(0, \Sigma_{\mathcal{M}}) \\ \varepsilon_m &\sim \mathcal{N}(0, \Sigma_m), \end{aligned}$$

Here, Σ_m is the internal variability of the model θ_m . Assuming that the two error terms are independent, we therefore have:

$$\theta_m \sim \mathcal{N}(\theta_{\mathcal{M}}, \Sigma_{\mathcal{M}} + \Sigma_m)$$

The multi-model mean is written as:

$$\bar{\theta} \sim \mathcal{N}\left(\theta_{\mathcal{M}}, \frac{1}{N_M} \Sigma_{\mathcal{M}} + \frac{1}{N_M^2} \sum_m \Sigma_m\right)$$

With our paradigm, $\theta_* - \theta_{\mathcal{M}}, \bar{\theta} - \theta_{\mathcal{M}} \sim \mathcal{N}(0, \Sigma_{\mathcal{M}})$, so $\bar{\theta} - \theta_* \sim \mathcal{N}(0, \Sigma_{\mathcal{M}})$. Consequently $\text{Cov}(\bar{\theta}) + \text{Cov}(\theta_*) = \Sigma_{\mathcal{M}}$. We found:

$$\text{Cov}(\theta_*) = \left(1 + \frac{1}{N_M}\right) \Sigma_{\mathcal{M}} + \frac{1}{N_M^2} \sum_{m=1}^{N_M} \Sigma_m \quad (\text{S.3})$$

We therefore need to find an estimator for $\Sigma_{\mathcal{M}}$. Let us take the difference between a model and the multi-model mean:

$$\begin{aligned} \text{Cov}(\theta_m - \bar{\theta}) &= \left(1 - \frac{1}{N_M}\right)^2 \text{Cov}(\theta_m) + \frac{1}{N_M^2} \sum_{k \neq m} \text{Cov}(\theta_k) \\ &= \left(1 - \frac{1}{N_M}\right)^2 (\Sigma_{\mathcal{M}} + \Sigma_m) + \frac{1}{N_M^2} \sum_{k \neq m} (\Sigma_{\mathcal{M}} + \Sigma_k) \\ &= \left(1 - \frac{1}{N_M}\right) \Sigma_{\mathcal{M}} + \left(1 - \frac{1}{N_M}\right)^2 \Sigma_m + \frac{1}{N_M^2} \sum_{k \neq m} \Sigma_k \end{aligned}$$

Consequently:

$$\begin{aligned} \mathbb{E}\left(\sum_m \text{Cov}(\theta_m - \bar{\theta})\right) &= \sum_m \left[\left(1 - \frac{1}{N_M}\right) \Sigma_{\mathcal{M}} + \left(1 - \frac{1}{N_M}\right)^2 \Sigma_m + \frac{1}{N_M^2} \sum_{k \neq m} \Sigma_k \right] \\ &= (N_M - 1) \Sigma_{\mathcal{M}} + \left(1 - \frac{1}{N_M}\right) \sum_m \Sigma_m \\ &=: \Sigma_e \end{aligned}$$

An estimator of Σ_e is given by the method of moments, taking the empirical covariance matrix of all realizations of all models. Finally, denoting “+” as the operator “positive part of a matrix”, we find:

$$\begin{cases} \hat{\Sigma}_m = \Sigma_{\hat{\theta}_m} \\ \hat{\Sigma}_{\mathcal{M}} = \frac{1}{N_M - 1} \left[\hat{\Sigma}_e - \left(1 - \frac{1}{N_M}\right) \sum_m \hat{\Sigma}_m \right]_+ \end{cases}$$

By substituting this term into Eq. (S.3), we find that the multi-model synthesis θ_* follows a normal distribution with parameters:

$$\begin{cases} \hat{\theta}_* = \frac{1}{N_M} \sum_m \hat{\theta}_m \\ \Sigma_{\hat{\theta}_*} = \left(1 + \frac{1}{N_M}\right) \hat{\Sigma}_{\mathcal{M}} + \frac{1}{N_M^2} \sum_m \Sigma_{\hat{\theta}_m} \end{cases}$$

S.1.3 Posterior of covariates

Recall that at this step we have a prior $\theta_* \sim \mathcal{N}(\hat{\theta}_*, \Sigma_{\hat{\theta}_*})$ as well as observations of regional mean temperatures $X_t^{o,R}$ and global mean temperatures $X_t^{o,G}$. The goal is to find the distribution of θ_* constrained by the observations, i.e. $(\theta_* | (X_t^{o,R}, X_t^{o,G}))$.

The estimate of $(\theta_* | (X_t^{o,R}, X_t^{o,G}))$ is in fact analytical, and the Gaussian conditioning theorem (Eaton, 2007) applies. Let X^o be a global vector of observations that concatenates $X_t^{o,R}$ and $X_t^{o,G}$ over time, and $\varepsilon^o \sim \mathcal{N}(0, \Sigma^o)$ be white noise of the same dimension as X^o . If we find a matrix A such that

$$X^o = A \cdot \theta_* + \varepsilon^o. \quad (\text{S.4})$$

And since θ_* follows a normal distribution, then $(\theta_* | X^o) = (\theta_* | (X_t^{o,R}, X_t^{o,G}))$ also follows a normal distribution, i.e. $(\theta_* | X^o) \sim \mathcal{N}(\mu_{(\theta_* | X^o)}, \Sigma_{(\theta_* | X^o)})$, with value:

$$\begin{cases} \mu_{(\theta_* | X^o)} = \theta_* + (\Sigma_{\theta_*} A^T) \cdot (A \Sigma_{\theta_*} A^T + \Sigma^o)^{-1} \cdot (X^o - A \theta_*), \\ \Sigma_{(\theta_* | X^o)} = \Sigma_{\theta_*} - (\Sigma_{\theta_*} A^T) \cdot (A \Sigma_{\theta_*} A^T + \Sigma^o)^{-1} \cdot (A \Sigma_{\theta_*}). \end{cases}$$

Our goal here is to develop the construction of the matrix A (Sect. S.1.3.1) as well as the error term Σ^o (Sect. S.1.3.2).

S.1.3.1 Projection matrix

To create matrix A , we will first consider the case where the observations are assimilated into a particular scenario: in other words, the constraint applies to only one of the scenarios (and an external expert must choose one). Recall that θ_* can be broken down into its regional, global, and GEV components (the operator \oplus indicating concatenation):

$$\theta_* = \theta_*^R \oplus \theta_*^G \oplus \theta_*^{\text{GEV}}.$$

If we looking for to constrain the regional part of θ_* by the scenario SSP_r , and the global part by the scenario SSP_g , then the matrix sought is of the following form:

$$A^o := \begin{pmatrix} 1 & X_t^{\mathcal{N}} & 0 & \dots & 0 & \mathbf{B}_r & 0 & \dots & 0 \\ 0 & \dots & \dots & \dots & \dots & \dots & \dots & 0 & 1 & X_t^{\mathcal{N}} & 0 & \dots & 0 & \mathbf{B}_g & 0 & \dots & 0 & \dots & 0 \end{pmatrix}$$

In this matrix, \mathbf{B}_r and \mathbf{B}_g are the spline basis at the positions of scenarios SSP_r and SSP_g . We then have:

$$A^o \cdot \theta_* = \begin{pmatrix} X_*^{R,0} + X_{t,*}^{R,N} + X_{t,*}^{R,A,\text{SSP}_r} \\ X_*^{G,0} + X_{t,*}^{G,N} + X_{t,*}^{G,A,\text{SSP}_g} \end{pmatrix} = \begin{pmatrix} X_{t,*}^{R,\text{SSP}_r} \\ X_{t,*}^{G,\text{SSP}_g} \end{pmatrix}.$$

We are almost in the case of Eq. (S.4). The difference is an error term ε^o (see Sect. S.1.3.2), as well as the time axes, which are not necessarily the same. For example, $X_{t,*}^{G,\text{SSP}_g}$ is defined

over the period 1850–2100, while the corresponding observation is only known for 1880–2024. The time axis can be restricted with a matrix R with $2100 - 1850 + 1 = 251$ columns and $2024 - 1880 + 1 = 145$ rows, which only has 1s on the diagonal 1880 / 2024. We then obtain the following matrix A :

$$A := R \cdot A^o.$$

A second possible case is if we want to constrain *all scenarios simultaneously*. In this case, the following matrix allows us to place ourselves in the case of Eq. (S.4):

$$A^o := \frac{1}{N_{\text{SSP}}} \begin{pmatrix} N_{\text{SSP}} & X_t^{\mathcal{N}} \times N_{\text{SSP}} & \mathbf{B} & \cdots & \mathbf{B} & 0 & \cdots & 0 & \cdots & 0 \\ 0 & \cdots & \cdots & \cdots & \cdots & N_{\text{SSP}} & X_t^{\mathcal{N}} \times N_{\text{SSP}} & \mathbf{B} & \cdots & \mathbf{B} \end{pmatrix}$$

Let us assume that the scenarios are indistinguishable over the observed period, we then obtain:

$$\begin{aligned} R \cdot A^o \cdot \theta_* &= \frac{1}{N_{\text{SSP}}} \begin{pmatrix} N_{\text{SSP}} X_*^{R,0} + N_{\text{SSP}} X_{t,*}^{R,N} + \sum_{\text{SSP}} X_{t,*}^{R,A,\text{SSP}} \\ N_{\text{SSP}} X_*^{G,0} + N_{\text{SSP}} X_{t,*}^{G,N} + \sum_{\text{SSP}} X_{t,*}^{G,A,\text{SSP}} \end{pmatrix} \\ &= \begin{pmatrix} X_*^{R,0} + X_{t,*}^{R,N} + \frac{1}{N_{\text{SSP}}} \sum_{\text{SSP}} X_{t,*}^{R,A,\text{SSP}} \\ X_*^{G,0} + X_{t,*}^{G,N} + \frac{1}{N_{\text{SSP}}} \sum_{\text{SSP}} X_{t,*}^{G,A,\text{SSP}} \end{pmatrix} \\ &\simeq \begin{pmatrix} X_*^{R,0} + X_{t,*}^{R,N} + X_{t,*}^{R,A,\text{SSP}_1} \\ X_*^{G,0} + X_{t,*}^{G,N} + X_{t,*}^{G,A,\text{SSP}_1} \end{pmatrix} = \begin{pmatrix} X_{t,*}^{R,\text{SSP}_1} \\ X_{t,*}^{G,\text{SSP}_1} \end{pmatrix} \\ &\simeq \begin{pmatrix} X_*^{R,0} + X_{t,*}^{R,N} + X_{t,*}^{R,A,\text{SSP}_{N_{\text{SSP}}}} \\ X_*^{G,0} + X_{t,*}^{G,N} + X_{t,*}^{G,A,\text{SSP}_{N_{\text{SSP}}}} \end{pmatrix} = \begin{pmatrix} X_{t,*}^{R,\text{SSP}_{N_{\text{SSP}}}} \\ X_{t,*}^{G,\text{SSP}_{N_{\text{SSP}}}} \end{pmatrix} \end{aligned}$$

These two approaches allow θ_* to be constrained by the observations. It should be noted that in both cases, we assume that the SSP scenarios, like the historical scenario, are constrained by observations over the observed period that do not belong to the historical scenario (2014/2024 in our case for CMIP6). We believe that this is not a problem for the current period, as the four scenarios used are indistinguishable over this period, particularly when their uncertainties are taken into account, which is the case here. A longer period would require greater precautions, such as choosing the scenario closest to the observations.

S.1.3.2 Internal variability of observations

For the covariance matrix Σ^o , two approaches are also proposed. The first is simply to consider it as white noise, estimates of observations from which a trend has been removed. The difficulty is that the observed trend is very difficult to estimate (otherwise this approach would not be necessary). The idea is therefore to calculate the matrix Σ^o on the residuals $X^o - A\hat{\theta}_*$, the trend being given by the prior. The problem that arises is that the residuals $X^o - A\mu_{(\theta_*|X^o)}$ must have the same covariance matrix Σ^o . To ensure this assumption, we construct the sequence of matrices Σ_i^o such that:

- $\Sigma_0^o := \text{Cov}(X^o - A\hat{\theta}_*)$
- $\Sigma_{i+1}^o := \text{Cov}(X^o - A\mu_{(\theta_*|X^o)}), (\theta_*|X^o)$ being constructed from Σ_i^o

This sequence Σ_i^o is calculated until stabilization, with the latter matrix being used for the final constraint $(\theta_*|X^o)$ produced.

The second approach was developed by Ribes et al. (2021) and Qasmi and Ribes (2022), and assumes that ε^o takes the form of a sum of two first-order autoregressive processes. One is *fast*

to model inter-annual variability, while the second is *slow* to model decadal variability. The same iterative method can be applied, with the empirical covariance simply being replaced by the inference of the mixture of the AR processes.

S.2 Others statisticals models

S.2.1 Normal distribution

The original model proposed by Ribes et al. (2020) used a normal distribution and was written as follows:

$$\begin{cases} T_t \sim \mathcal{N}(\mu_t, \sigma_t), \\ \mu_t = \mu_0 + \mu_1 X_t \\ \log \sigma_t = \sigma_0 + \sigma_1 X_t \end{cases} \quad (\text{S.5})$$

S.2.2 GEV distribution for precipitations

The following model is used for precipitation P_t in attribution studies (see the work of, e.g., van der Wiel et al., 2017; van Oldenborgh et al., 2017; Uhe et al., 2018; Tradowsky et al., 2023):

$$\begin{cases} P_t \sim \text{GEV}(\mu_t, \sigma_t, \xi_t), \\ \mu_t = \mu_0 \exp(\alpha/\mu_0 X_t), \\ \sigma_t = \sigma_0 \exp(\alpha/\mu_0 X_t), \\ \xi_t \equiv \xi_0. \end{cases} \quad (\text{S.6})$$

Figures

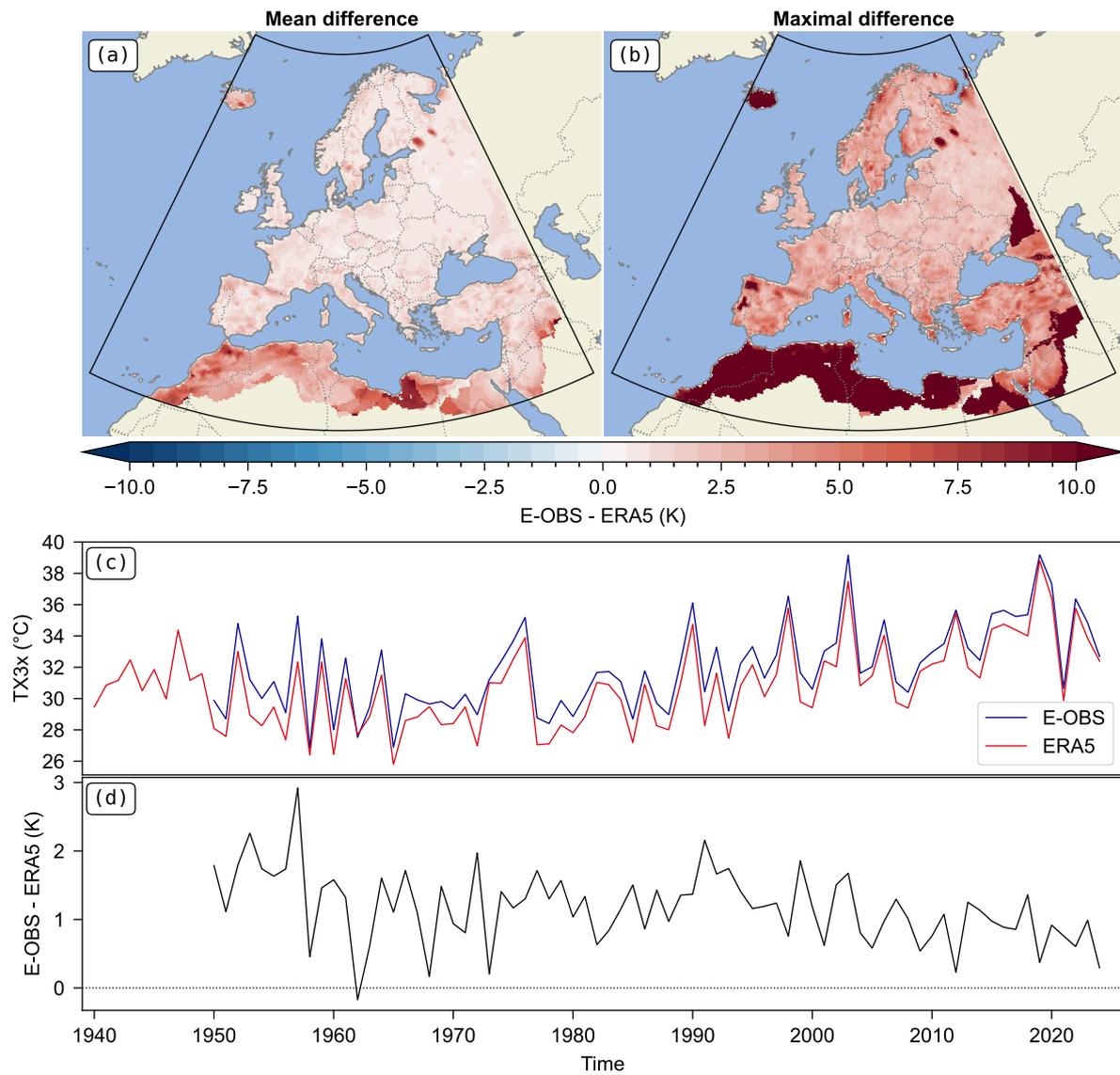


Figure S1: Difference between E-OBS and ERA5 for the TX3x variable over Europe. **a.** Average difference over the period 1940–2024. **b.** Maximum difference over the period 1940–2024. **c.** TX3x series from E-OBS (blue) and ERA5 (red) in Paris. **d.** Difference between E-OBS and ERA5 in Paris between 1950 and 2024.

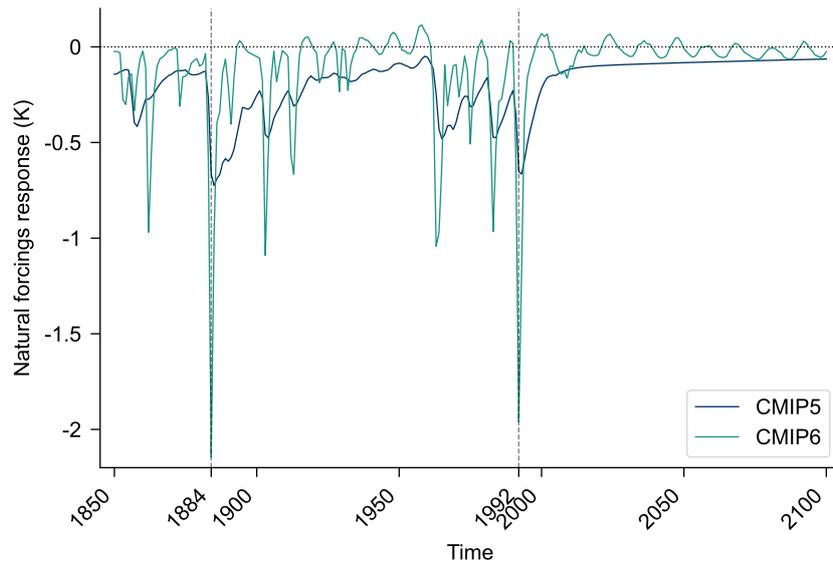


Figure S2: Response to natural forcings between 1850 and 2100 used for the CMIP5 and CMIP6 models. The years 1884 and 1992 are highlighted as local minima.

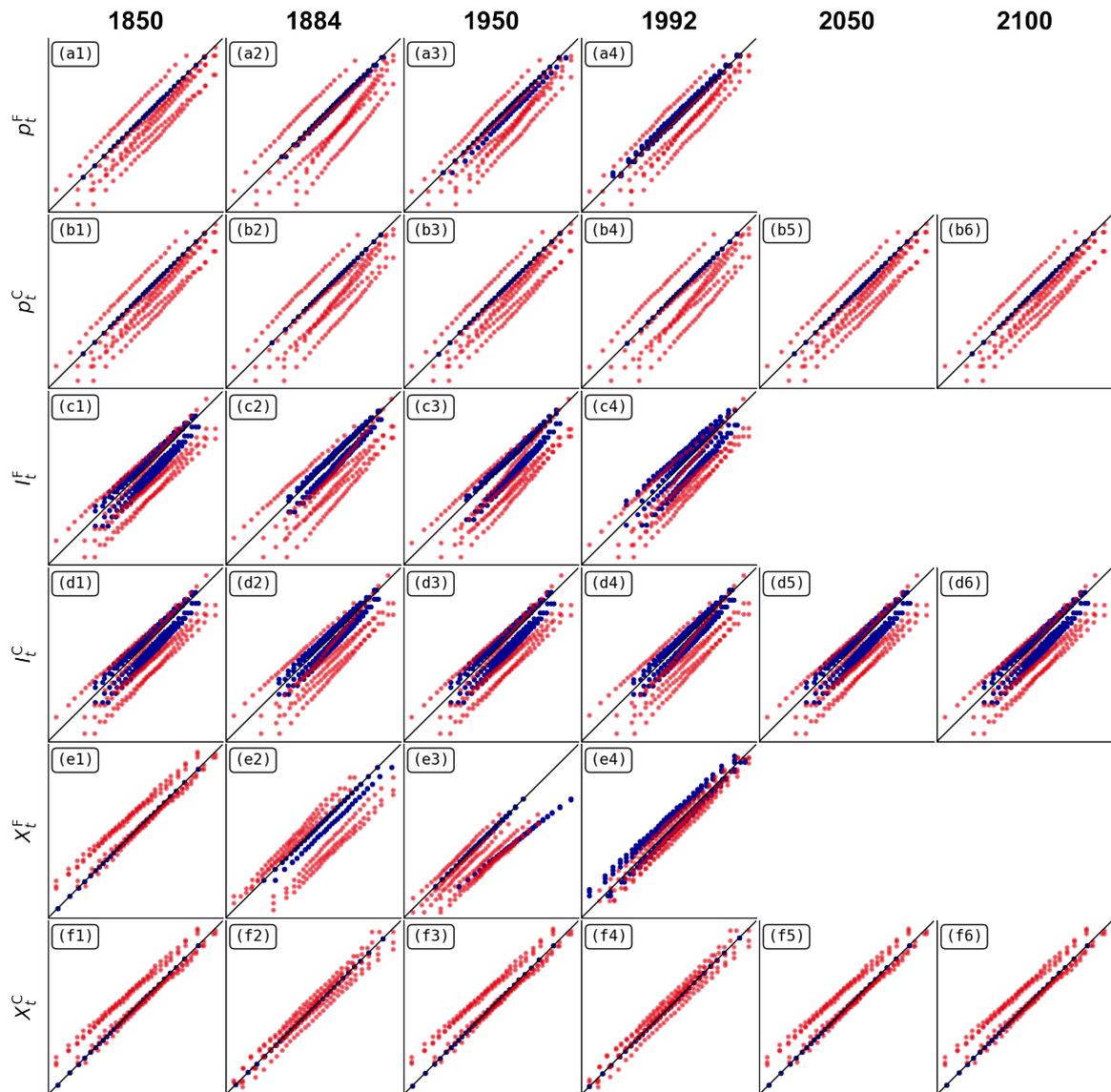


Figure S3: Same as Fig. 4 but for the median value of the GEV distribution for the year 2019 for the variable TX3x.

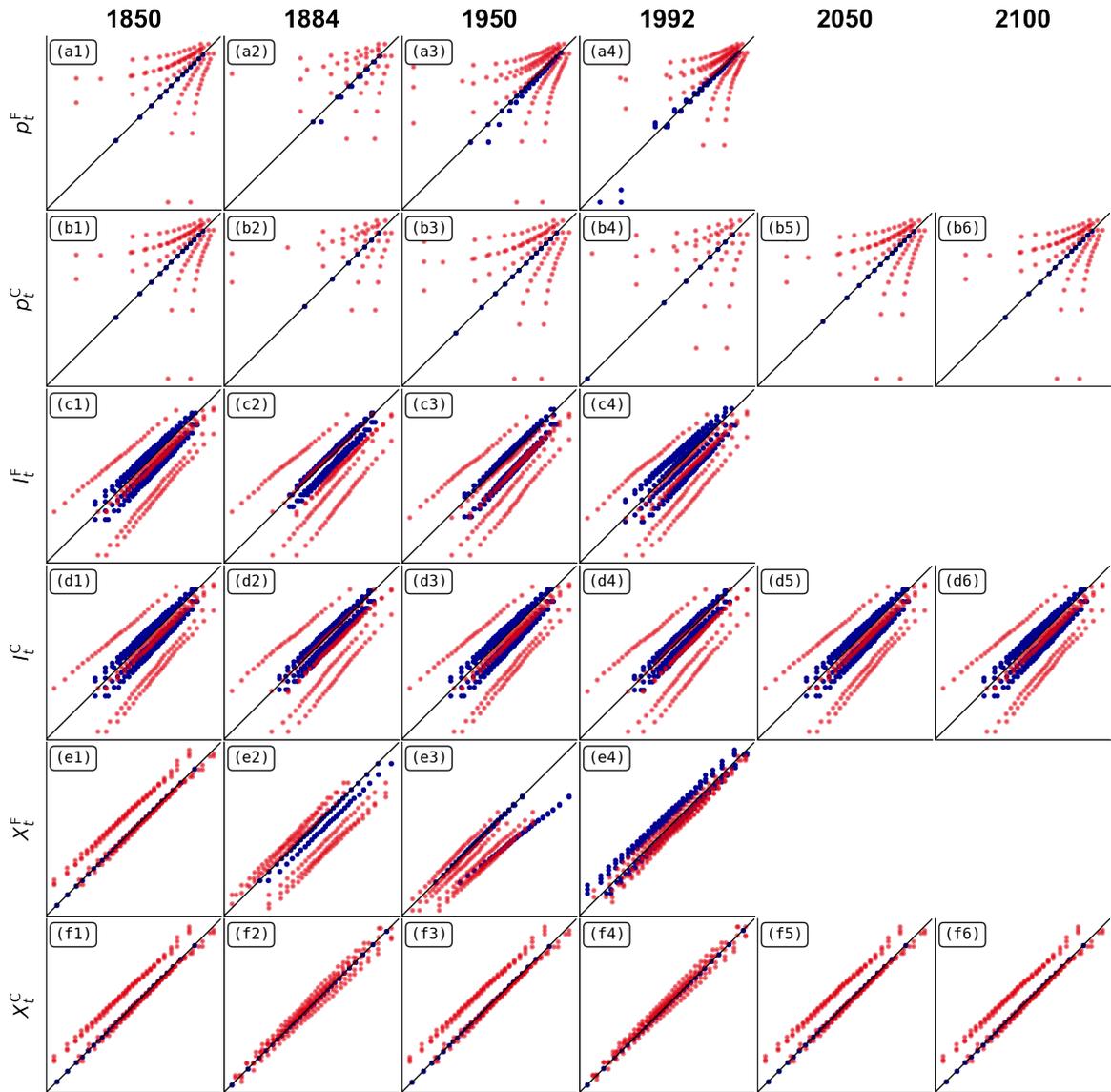


Figure S4: Same as Fig. 4 but for the 99.9% value of the GEV distribution for the year 2019 for the variable TX3x.

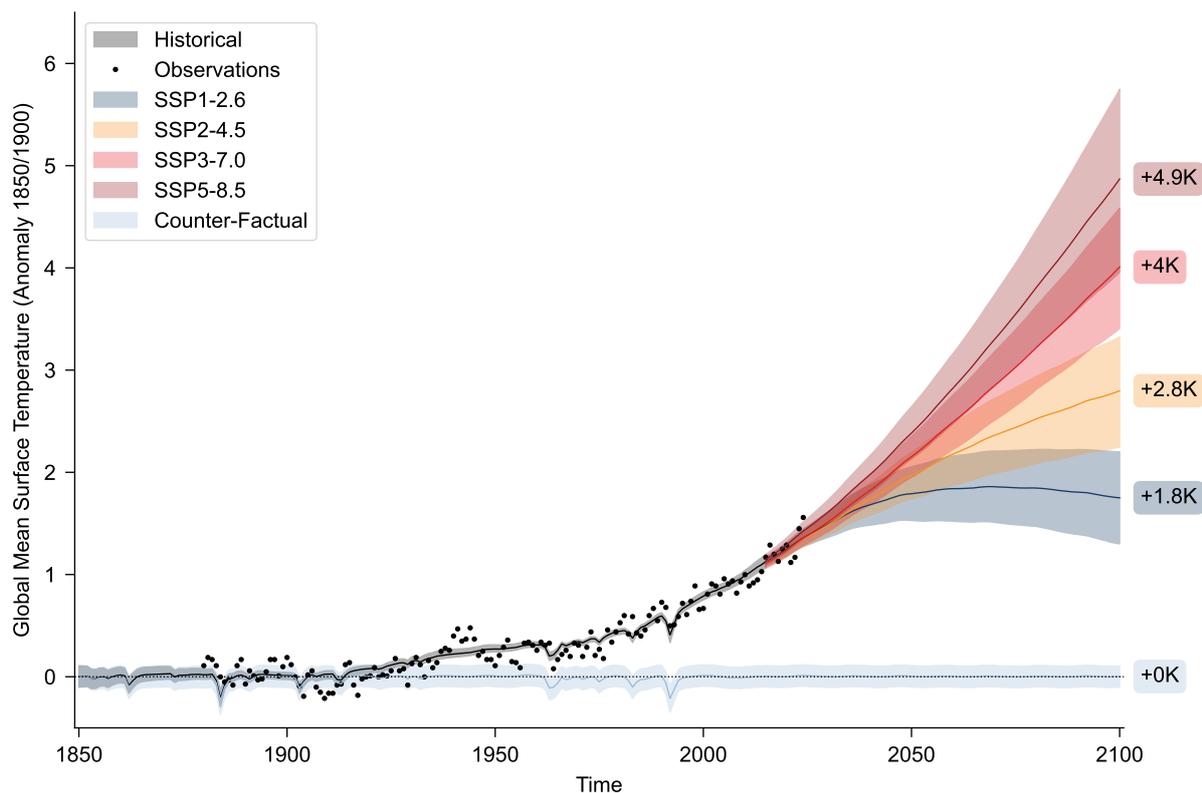


Figure S5: Global mean surface temperature estimated using a multi-model synthesis constrained by GIS-TEMP observations (the black points), with the 95% confidence interval (the filled areas). The area in black corresponds to the historical period, followed by the four scenarios: SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5. The counterfactual where external forcings due to human influence have been removed has been represented in light blue.

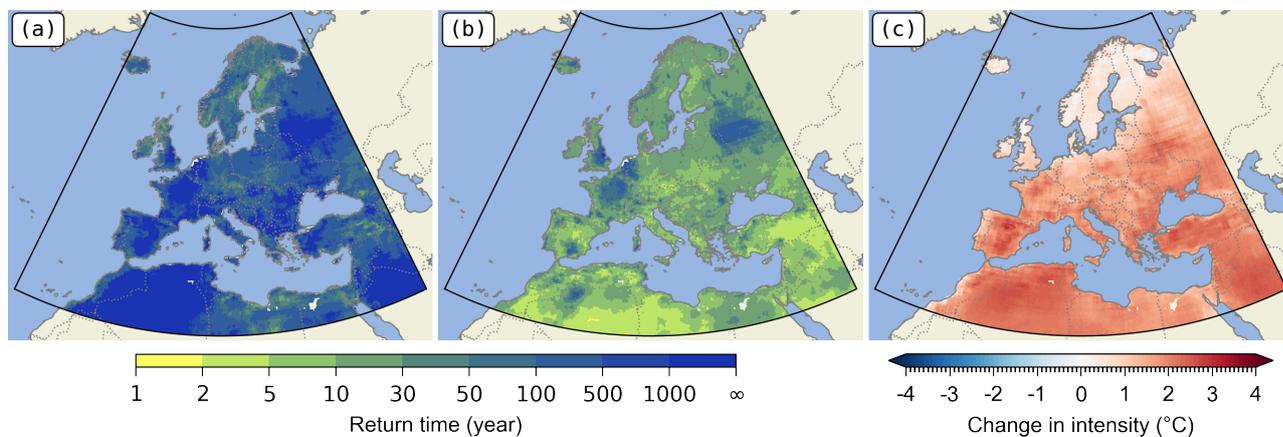


Figure S6: Lower confidence interval (quantile 2.5%) of **a.** Return time of the maximum observed between 1940 and 2024 in TX_{3x} over Europe, in 2024, without human influence. **b.** Same as **a.**, but for the factual world. **c.** Change in intensity in 2024.

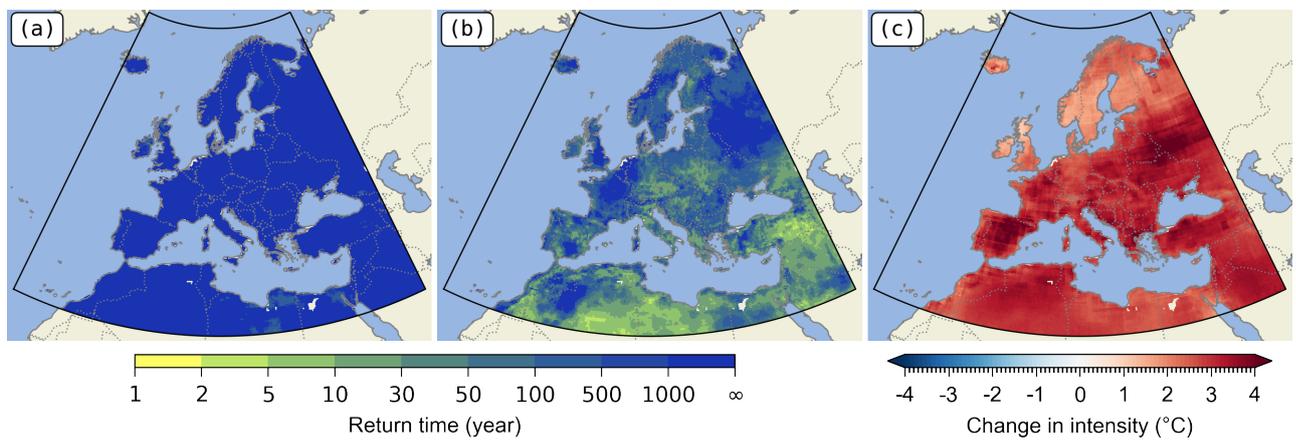


Figure S7: Upper confidence interval (quantile 97.5%) of **a.** Return time of the maximum observed between 1940 and 2024 in TX3x over Europe, in 2024, without human influence. **b.** Same as a., but for the factual world. **c.** Change in intensity in 2024.

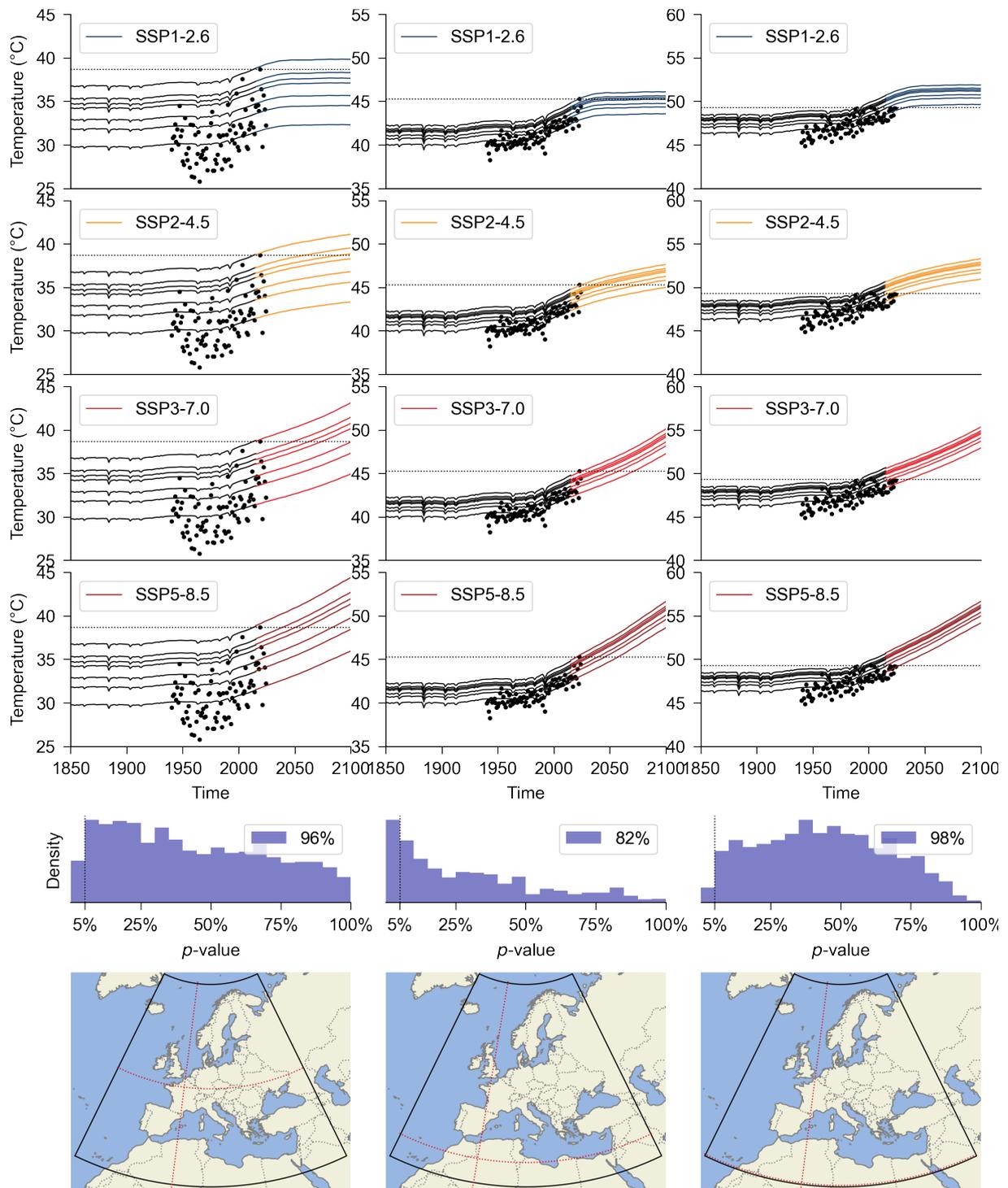


Figure S8: Comparison between observations and the inferred GEV distribution for three grid points (one per column). The position of the grid point is shown on the map (last row). The grid points are chosen, in order, in Paris, at a point where the maximum has a return period > 1000 years in 2024, at a point where the maximum has a return period < 10 years in 2024. The first 4 lines (representing, in order, the 4 scenarios SSP1-2.6 to SSP5-8.5) show ERA5 (black dots), the maximum value of ERA5 (black dotted line), as well as the following return levels: 2, 5, 10, 30, 50, 100, and 1000 years. Note that the scale is chosen to be comparable between the three columns (spread of 20°C). The fifth line shows the histogram of the p -values of the KS-test of 1000 samples compared to ERA5. The probability indicates the number of tests where the p -value is greater than 5% (threshold where we do not reject that the observations follow the inferred GEV law).

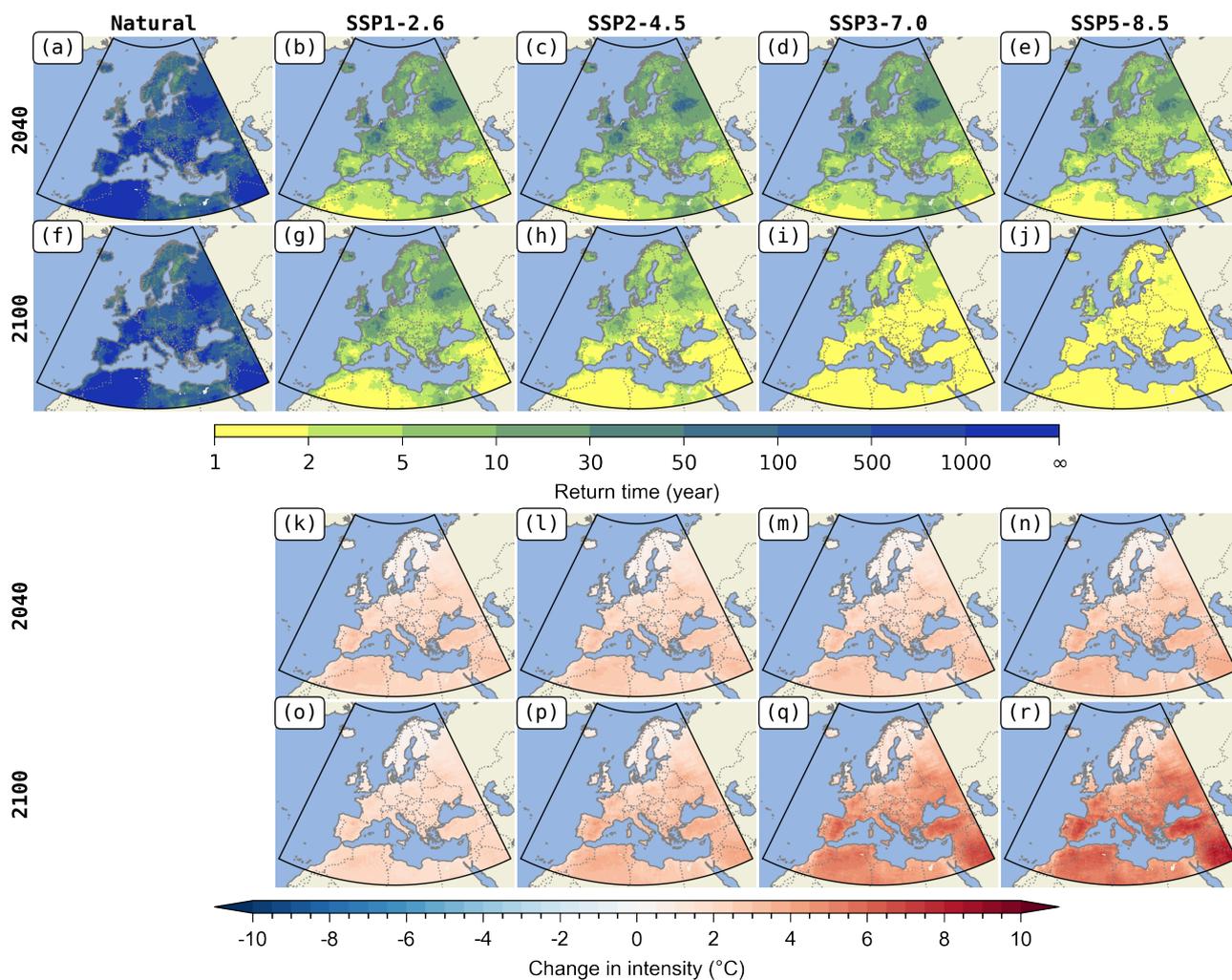


Figure S9: Lower confidence interval (quantile 2.5%) of projection of return time (1st and 2nd row) and change in intensity (3rd and 4th row) in 2040 (1st and 3rd row) and 2100 (2nd and 4th row) of the attribution of the maximum event observed in TX3x between 1940 and 2024. In columns: in the counter-factual world and for the four scenarios SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5.

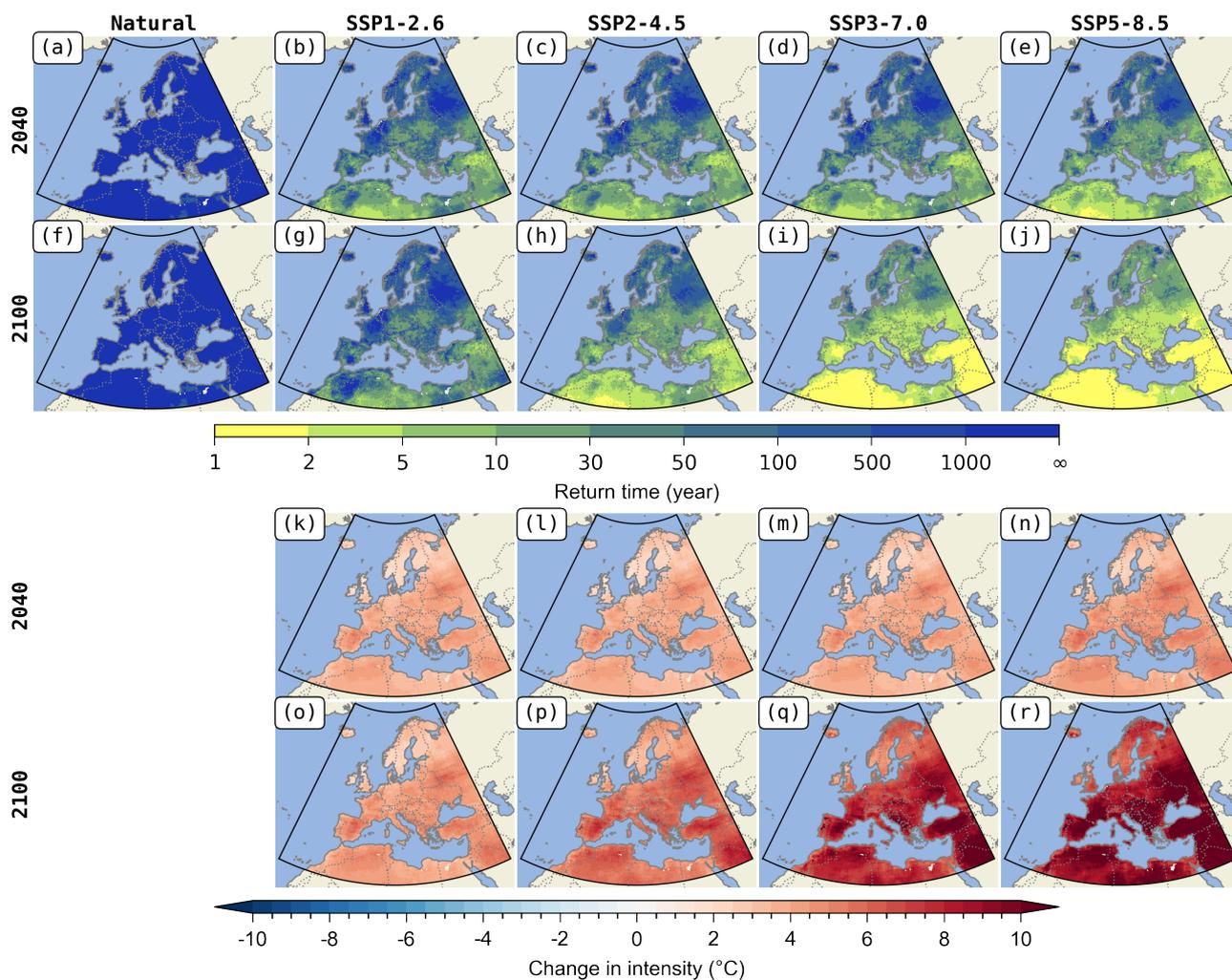


Figure S10: Upper confidence interval (quantile 97.5%) of projection of return time (1st and 2nd row) and change in intensity (3rd and 4th row) in 2040 (1st and 3rd row) and 2100 (2nd and 4th row) of the attribution of the maximum event observed in TX3x between 1940 and 2024. In columns: in the counter-factual world and for the four scenarios SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5.

Tables

Area	Country	ISO	Percent Area	Area	Country	ISO	Percent Area	
AFR-N	Algeria	DZA	64.2%	EU-N	Finland	FIN	100%	
	Egypt	EGY	50.8%		Iceland	ISL	89.3%	
	Libya	LBY	57.4%		Ireland	IRL	100%	
	Morocco	MAR	100%		Latvia	LVA	100%	
	Tunisia	TUN	100%		Lithuania	LTU	100%	
ASI-S	Iran	IRN	2.1%		Norway	NOR	100%	
ASI-W	Armenia	ARM	76.9%		Sweden	SWE	100%	
	Cyprus	CYP	100%		United Kingdom	GBR	100%	
	Georgia	GEO	88.5%		EU-S	Albania	ALB	100%
	Iraq	IRQ	79.5%			Bosnia and Herzegovina	BIH	100%
	Israel	ISR	100%			Croatia	HRV	100%
	Jordan	JOR	100%	Greece		GRC	100%	
	Lebanon	LBN	100%	Italy		ITA	100%	
	Saudi Arabia	SAU	25.8%	Kosovo		XKO	100%	
	Syria	SYR	100%	Macedonia		MKD	100%	
	Türkiye	TUR	100%	Montenegro		MNE	100%	
	EU-E	Belarus	BLR	100%		Portugal	PRT	97.6%
		Bulgaria	BGR	100%		Serbia	SRB	100%
		Czechia	CZE	100%		Slovenia	SVN	100%
Hungary		HUN	100%	Spain		ESP	100%	
Moldova		MDA	100%	EU-W		Austria	AUT	100%
Poland		POL	100%		Belgium	BEL	100%	
Romania		ROU	100%		France	FRA	100%	
Russian Federation		RUS	9.2%		Germany	DEU	100%	
Slovakia		SVK	100%		Luxembourg	LUX	100%	
Ukraine		UKR	100%		Netherlands	NLD	100%	
EU-N	Denmark	DNK	100%		Switzerland	CHE	100%	
	Estonia	EST	100%					

Table S1: List of countries in the Europe area, including the Mediterranean basin. The area column follows the UNSD M49 standard, and the ISO column follows the ISO-3166-1 standard.

Area	Country	Code	Observed	Natural Only	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
AFR-N	Algeria	DZA	30 +2.7	> 1000 0	5 +3.2	5 +3.2	5 +3.3	2 +3.8
	Egypt	EGY	30 +2.1	> 1000 0	10 +2.5	10 +2.5	10 +2.5	10 +2.9
	Libya	LYB	10 +2.3	> 1000 0	10 +2.7	10 +2.7	5 +2.8	5 +3.2
	Morocco	MAR	30 +2.4	> 1000 0	10 +2.8	10 +2.8	10 +2.9	5 +3.4
	Tunisia	TUN	30 +2.6	> 1000 0	10 +3.1	10 +3.1	10 +3.2	10 +3.6
ASI-S	Iran	IRN	5 +2.3	> 1000 0	5 +2.9	5 +2.9	5 +2.9	2 +3.5
ASI-W	Armenia	ARM	10 +2.1	> 1000 0	5 +2.6	5 +2.6	5 +2.7	5 +3.2
	Cyprus	CYP	30 +1.9	> 1000 0	10 +2.3	10 +2.3	10 +2.4	10 +2.7
	Georgia	GEO	30 +2.1	> 1000 0	10 +2.5	10 +2.6	10 +2.6	10 +3.1
	Iraq	IRQ	10 +2.6	> 1000 0	5 +3.2	5 +3.2	5 +3.3	2 +3.9
	Israel	ISR	10 +2.4	> 1000 0	10 +2.8	10 +2.9	10 +2.9	5 +3.3
	Jordan	JOR	10 +2.7	> 1000 0	10 +3.2	10 +3.2	10 +3.3	5 +3.8
	Lebanon	LBN	10 +2.3	1000 0	10 +2.7	10 +2.8	10 +2.8	5 +3.3
	Saudi Arabia	SAU	10 +2.8	> 1000 0	5 +3.4	5 +3.5	5 +3.5	2 +4.2
	Syria	SYR	10 +2.6	> 1000 0	5 +3.1	5 +3.2	5 +3.2	2 +3.8
	Türkiye	TUR	30 +2.6	> 1000 0	10 +3.2	10 +3.2	10 +3.3	5 +3.8
EU-E	Belarus	BLR	100 +2.7	> 1000 0	50 +3.2	50 +3.3	50 +3.3	30 +3.8
	Bulgaria	BGR	50 +2.7	> 1000 0	30 +3.2	30 +3.2	30 +3.3	10 +3.8
	Czechia	CZE	10 +2.3	> 1000 0	10 +2.7	10 +2.7	10 +2.8	5 +3.2
	Hungary	HUN	30 +2.3	> 1000 0	10 +2.8	10 +2.8	10 +2.9	10 +3.4
	Moldova	MDA	50 +2.6	> 1000 0	30 +3.1	30 +3.2	30 +3.2	10 +3.7
	Poland	POL	30 +2.3	> 1000 0	30 +2.7	30 +2.7	10 +2.8	10 +3.2
	Romania	ROU	50 +2.5	> 1000 0	30 +2.9	30 +3	30 +3	10 +3.5
	Russian Federation	RUS	100 +2.1	> 1000 0	50 +2.5	50 +2.5	50 +2.6	30 +3
	Slovakia	SVK	30 +2.5	> 1000 0	10 +3	10 +3	10 +3	10 +3.5
	Ukraine	UKR	30 +2.6	> 1000 0	10 +3.1	10 +3.2	10 +3.2	10 +3.7
EU-N	Denmark	DNK	50 +1.4	> 1000 0	50 +1.6	50 +1.7	50 +1.7	30 +2
	Estonia	EST	30 +1.7	> 1000 0	30 +2	30 +2.1	30 +2.1	10 +2.4
	Finland	FIN	30 +1.3	> 1000 0	30 +1.6	30 +1.6	30 +1.6	10 +1.9
	Iceland	ISL	100 +1.3	> 1000 0	100 +1.5	100 +1.5	100 +1.6	50 +1.9
	Ireland	IRL	50 +1.2	> 1000 0	30 +1.5	30 +1.5	30 +1.6	30 +1.8
	Latvia	LVA	30 +2	> 1000 0	30 +2.3	30 +2.4	30 +2.4	10 +2.8
	Lithuania	LTU	30 +2	> 1000 0	30 +2.4	30 +2.4	30 +2.5	10 +2.8
	Norway	NOR	50 +1.3	> 1000 0	50 +1.5	50 +1.6	50 +1.6	30 +1.9
	Sweden	SWE	50 +1.3	> 1000 0	30 +1.5	30 +1.5	30 +1.6	30 +1.8
	United Kingdom	GBR	500 +1.3	> 1000 0	500 +1.5	100 +1.6	100 +1.6	100 +1.8
EU-S	Albania	ALB	10 +2.4	> 1000 0	10 +2.8	10 +2.9	10 +2.9	5 +3.4
	Bosnia and Herzegovina	BIH	30 +2.6	> 1000 0	10 +3.2	10 +3.2	10 +3.2	5 +3.8
	Croatia	HRV	30 +2.5	> 1000 0	10 +3	10 +3	10 +3.1	10 +3.6
	Greece	GRC	30 +2.6	> 1000 0	10 +3.1	10 +3.1	10 +3.2	10 +3.7
	Italy	ITA	50 +2.4	> 1000 0	30 +2.9	30 +2.9	30 +3	10 +3.4
	Kosovo	XKO	100 +2.5	> 1000 0	30 +3	30 +3.1	30 +3.1	10 +3.7
	Macedonia	MKD	30 +2.7	> 1000 0	10 +3.2	10 +3.3	10 +3.3	10 +3.9
	Montenegro	MNE	50 +2.6	> 1000 0	10 +3.2	10 +3.2	10 +3.3	10 +3.9
	Portugal	PRT	50 +2.1	> 1000 0	30 +2.5	30 +2.5	30 +2.6	30 +3
	Serbia	SRB	30 +2.4	> 1000 0	10 +2.9	10 +2.9	10 +3	10 +3.5
	Slovenia	SVN	30 +2.6	> 1000 0	30 +3.1	30 +3.1	10 +3.2	10 +3.7
	Spain	ESP	50 +2.7	> 1000 0	30 +3.3	10 +3.3	10 +3.3	10 +3.9
EU-W	Austria	AUT	30 +2.4	> 1000 0	10 +2.9	10 +2.9	10 +2.9	10 +3.4
	Belgium	BEL	100 +2.3	> 1000 0	100 +2.7	100 +2.7	100 +2.8	50 +3.2
	France	FRA	100 +2.4	> 1000 0	50 +2.9	50 +2.9	50 +3	30 +3.4
	Germany	DEU	100 +2	> 1000 0	50 +2.3	50 +2.4	50 +2.4	30 +2.8
	Luxembourg	LUX	100 +2.3	> 1000 0	50 +2.7	50 +2.7	50 +2.8	30 +3.2
	Netherlands	NLD	1000 +2.1	> 1000 0	500 +2.5	500 +2.5	100 +2.5	100 +2.9
	Switzerland	CHE	100 +2.1	> 1000 0	50 +2.5	50 +2.5	50 +2.6	30 +2.9

Table S2: Average values for return periods and change in intensity in 2040 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century). The 95% confidence interval is given in tables S3 and S4.

Area	Country	Code	Observed	Natural Only	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
AFR-N	Algeria	DZA	10 +2.3	> 1000 0	2 +2.6	2 +2.7	2 +2.7	1 +2.3
	Egypt	EGY	10 +1.6	100 0	10 +1.9	10 +1.9	10 +1.9	5 +2.3
	Libya	LYB	5 +1.9	100 0	5 +2.1	5 +2.2	5 +2.3	2 +2.7
	Morocco	MAR	10 +1.9	> 1000 0	5 +2.2	5 +2.2	5 +2.3	2 +2.7
	Tunisia	TUN	10 +2.1	> 1000 0	10 +2.5	10 +2.5	10 +2.6	5 +3
ASI-S	Iran	IRN	5 +1.9	500 0	2 +2.2	2 +2.3	2 +2.3	1 +2.8
ASI-W	Armenia	ARM	5 +1.6	100 0	5 +1.9	5 +2	5 +2	2 +2.4
	Cyprus	CYP	10 +1.5	500 0	5 +1.8	5 +1.8	5 +1.9	5 +2.2
	Georgia	GEO	10 +1.5	100 0	5 +1.8	10 +1.8	5 +1.9	5 +2.3
	Iraq	IRQ	5 +2.1	> 1000 0	2 +2.5	2 +2.6	2 +2.6	1 +3.2
	Israel	ISR	10 +1.8	500 0	5 +2.1	5 +2.2	5 +2.2	2 +2.6
	Jordan	JOR	10 +2.2	> 1000 0	5 +2.5	5 +2.6	5 +2.6	2 +3.1
	Lebanon	LBN	5 +1.8	100 0	5 +2.1	5 +2.2	5 +2.2	2 +2.6
	Saudi Arabia	SAU	10 +2.3	> 1000 0	2 +2.7	2 +2.8	2 +2.9	1 +3.5
	Syria	SYR	5 +2.1	500 0	2 +2.5	2 +2.5	2 +2.6	2 +3.1
	Türkiye	TUR	10 +2.1	> 1000 0	5 +2.4	5 +2.5	5 +2.6	2 +3.1
EU-E	Belarus	BLR	30 +1.9	> 1000 0	10 +2.2	10 +2.2	10 +2.3	10 +2.6
	Bulgaria	BGR	10 +2	> 1000 0	10 +2.4	10 +2.4	10 +2.5	5 +2.9
	Czechia	CZE	10 +1.5	100 0	5 +1.8	5 +1.8	5 +1.8	2 +2.1
	Hungary	HUN	10 +1.6	500 0	5 +1.9	5 +2	5 +2	5 +2.4
	Moldova	MDA	30 +2	> 1000 0	10 +2.3	10 +2.4	10 +2.4	5 +2.8
	Poland	POL	10 +1.5	100 0	10 +1.7	10 +1.8	10 +1.8	5 +2.1
	Romania	ROU	30 +1.8	> 1000 0	10 +2.1	10 +2.1	10 +2.2	5 +2.6
	Russian Federation	RUS	30 +1.3	> 1000 0	30 +1.5	30 +1.5	10 +1.6	10 +1.8
	Slovakia	SVK	10 +1.7	500 0	5 +2	5 +2.1	5 +2.1	2 +2.5
	Ukraine	UKR	10 +1.9	500 0	10 +2.2	10 +2.3	10 +2.3	5 +2.7
EU-N	Denmark	DNK	30 +0.7	100 0	10 +0.8	10 +0.8	10 +0.8	10 +1
	Estonia	EST	10 +0.9	100 0	10 +1.1	10 +1.1	10 +1.1	5 +1.3
	Finland	FIN	10 +0.5	50 0	10 +0.6	10 +0.6	10 +0.6	5 +0.7
	Iceland	ISL	30 +0.5	100 0	30 +0.6	30 +0.6	30 +0.6	10 +0.7
	Ireland	IRL	10 +0.8	100 0	10 +0.9	10 +1	10 +1	10 +1.2
	Latvia	LVA	10 +1.1	500 0	10 +1.4	10 +1.4	10 +1.4	5 +1.6
	Lithuania	LTU	10 +1.1	500 0	10 +1.3	10 +1.3	10 +1.4	5 +1.6
	Norway	NOR	30 +0.6	100 0	10 +0.7	10 +0.7	10 +0.7	10 +0.9
	Sweden	SWE	10 +0.5	100 0	10 +0.6	10 +0.6	10 +0.7	10 +0.8
	United Kingdom	GBR	100 +0.7	> 1000 0	50 +0.9	50 +0.9	50 +0.9	30 +1
	EU-S	Albania	ALB	10 +1.6	500 0	5 +1.9	5 +1.9	5 +2
Bosnia and Herzegovina		BIH	10 +1.8	> 1000 0	5 +2.2	5 +2.2	5 +2.3	2 +2.7
Croatia		HRV	10 +1.9	> 1000 0	5 +2.2	5 +2.2	5 +2.3	5 +2.7
Greece		GRC	10 +2	> 1000 0	10 +2.3	10 +2.4	10 +2.4	5 +2.8
Italy		ITA	30 +1.9	> 1000 0	10 +2.2	10 +2.2	10 +2.3	5 +2.6
Kosovo		XKO	30 +1.6	> 1000 0	10 +2	10 +2	10 +2.1	5 +2.5
Macedonia		MKD	10 +1.9	> 1000 0	5 +2.3	5 +2.4	5 +2.4	5 +2.9
Montenegro		MNE	10 +1.8	> 1000 0	5 +2.1	5 +2.1	5 +2.2	2 +2.6
Portugal		PRT	30 +1.4	> 1000 0	10 +1.6	10 +1.7	10 +1.7	10 +2
Serbia		SRB	10 +1.7	> 1000 0	10 +2	10 +2	10 +2.1	5 +2.5
Slovenia		SVN	10 +1.9	> 1000 0	10 +2.3	10 +2.3	10 +2.4	5 +2.7
Spain		ESP	10 +2	> 1000 0	10 +2.4	10 +2.5	10 +2.5	5 +2.9
EU-W		Austria	AUT	10 +1.7	1000 0	5 +2	5 +2	5 +2.1
	Belgium	BEL	50 +1.5	> 1000 0	30 +1.7	30 +1.8	30 +1.8	30 +2.1
	France	FRA	50 +1.7	> 1000 0	30 +2.1	30 +2.1	30 +2.2	10 +2.5
	Germany	DEU	30 +1.2	> 1000 0	10 +1.5	10 +1.5	10 +1.5	10 +1.8
	Luxembourg	LUX	30 +1.5	500 0	30 +1.7	30 +1.7	30 +1.8	10 +2.1
	Netherlands	NLD	100 +1.3	> 1000 0	100 +1.5	100 +1.5	50 +1.6	50 +1.8
	Switzerland	CHE	30 +1.5	> 1000 0	10 +1.7	10 +1.7	10 +1.8	10 +2.1

Table S3: Lower bound of the 95% confidence interval (quantile 2.5%) for return periods and change in intensity in 2040 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century).

Area	Country	Code	Observed		Natural Only		SSP1-2.6		SSP2-4.5		SSP3-7.0		SSP5-8.5	
AFR-N	Algeria	DZA	> 1000	+3.1	> 1000	0	30	+3.9	30	+3.8	10	+3.9	5	+4.4
	Egypt	EGY	50	+2.6	> 1000	0	50	+3.1	30	+3.1	30	+3.2	30	+3.6
	Libya	LYB	30	+2.7	> 1000	0	10	+3.3	10	+3.3	10	+3.4	10	+3.9
	Morocco	MAR	> 1000	+2.9	> 1000	0	50	+3.5	50	+3.5	50	+3.5	30	+4.1
	Tunisia	TUN	100	+3.1	> 1000	0	100	+3.8	100	+3.8	50	+3.8	30	+4.4
ASI-S	Iran	IRN	10	+2.8	> 1000	0	10	+3.6	10	+3.6	10	+3.6	5	+4.3
ASI-W	Armenia	ARM	30	+2.7	> 1000	0	10	+3.4	10	+3.4	10	+3.4	10	+4
	Cyprus	CYP	100	+2.4	> 1000	0	50	+2.9	50	+2.9	50	+2.9	30	+3.3
	Georgia	GEO	100	+2.7	> 1000	0	50	+3.3	50	+3.3	50	+3.4	30	+3.9
	Iraq	IRQ	30	+3.1	> 1000	0	10	+4	10	+3.9	10	+4	5	+4.7
	Israel	ISR	50	+3	> 1000	0	30	+3.6	30	+3.6	30	+3.6	10	+4.2
	Jordan	JOR	50	+3.2	> 1000	0	30	+4	30	+4	30	+4	10	+4.7
	Lebanon	LBN	30	+2.8	> 1000	0	30	+3.5	30	+3.5	10	+3.5	10	+4.1
	Saudi Arabia	SAU	100	+3.3	> 1000	0	10	+4.2	10	+4.2	10	+4.3	5	+5
	Syria	SYR	30	+3.1	> 1000	0	10	+3.9	10	+3.9	10	+3.9	5	+4.6
	Türkiye	TUR	100	+3.2	> 1000	0	50	+4	30	+4	30	+4	10	+4.7
EU-E	Belarus	BLR	> 1000	+3.6	> 1000	0	500	+4.3	500	+4.4	500	+4.4	100	+5
	Bulgaria	BGR	100	+3.3	> 1000	0	100	+4	100	+4	50	+4.1	30	+4.6
	Czechia	CZE	50	+3	> 1000	0	30	+3.7	30	+3.7	30	+3.7	10	+4.3
	Hungary	HUN	100	+3.1	> 1000	0	50	+3.8	50	+3.8	50	+3.8	30	+4.4
	Moldova	MDA	100	+3.3	> 1000	0	100	+4	100	+4	100	+4.1	50	+4.7
	Poland	POL	100	+3.1	> 1000	0	100	+3.8	100	+3.8	100	+3.8	50	+4.3
	Romania	ROU	500	+3.2	> 1000	0	100	+3.9	100	+3.9	100	+3.9	50	+4.5
	Russian Federation	RUS	> 1000	+2.9	> 1000	0	1000	+3.5	500	+3.5	500	+3.6	500	+4.1
	Slovakia	SVK	500	+3.3	> 1000	0	50	+4	50	+4	50	+4.1	30	+4.7
	Ukraine	UKR	100	+3.4	> 1000	0	100	+4.1	100	+4.1	100	+4.2	30	+4.8
EU-N	Denmark	DNK	500	+2.1	> 1000	0	500	+2.5	100	+2.5	100	+2.6	100	+3
	Estonia	EST	100	+2.5	> 1000	0	100	+3.1	100	+3.1	100	+3.1	50	+3.5
	Finland	FIN	500	+2.1	> 1000	0	100	+2.6	100	+2.6	100	+2.6	100	+3.1
	Iceland	ISL	> 1000	+2	> 1000	0	> 1000	+2.4	> 1000	+2.4	> 1000	+2.5	1000	+2.9
	Ireland	IRL	100	+1.7	> 1000	0	100	+2.1	100	+2.1	100	+2.1	100	+2.4
	Latvia	LVA	100	+2.8	> 1000	0	100	+3.4	100	+3.4	100	+3.4	50	+3.9
	Lithuania	LTU	100	+3	> 1000	0	100	+3.5	100	+3.6	100	+3.6	50	+4.1
	Norway	NOR	> 1000	+2	> 1000	0	500	+2.4	500	+2.4	500	+2.5	100	+2.9
	Sweden	SWE	> 1000	+2	> 1000	0	500	+2.4	500	+2.4	500	+2.5	100	+2.9
	United Kingdom	GBR	> 1000	+1.8	> 1000	0	> 1000	+2.3	> 1000	+2.3	> 1000	+2.3	> 1000	+2.6
	EU-S	Albania	ALB	100	+3.2	> 1000	0	30	+3.8	30	+3.9	30	+3.9	10
Bosnia and Herzegovina		BIH	100	+3.4	> 1000	0	50	+4.2	30	+4.2	30	+4.3	10	+4.9
Croatia		HRV	100	+3.2	> 1000	0	50	+3.9	50	+3.9	30	+4	10	+4.5
Greece		GRC	100	+3.3	> 1000	0	50	+3.9	50	+3.9	50	+4	30	+4.5
Italy		ITA	> 1000	+3	> 1000	0	100	+3.7	100	+3.7	100	+3.7	50	+4.2
Kosovo		XKO	500	+3.3	> 1000	0	100	+4.2	100	+4.1	100	+4.2	50	+4.9
Macedonia		MKD	100	+3.5	> 1000	0	50	+4.3	50	+4.3	50	+4.3	30	+5
Montenegro		MNE	> 1000	+3.5	> 1000	0	100	+4.4	50	+4.3	50	+4.4	30	+5.2
Portugal		PRT	500	+2.8	> 1000	0	100	+3.4	100	+3.4	100	+3.5	100	+4
Serbia		SRB	> 1000	+3.1	> 1000	0	100	+3.9	50	+3.9	50	+3.9	30	+4.6
Slovenia		SVN	100	+3.3	> 1000	0	100	+4	50	+4	50	+4.1	30	+4.6
Spain		ESP	> 1000	+3.4	> 1000	0	100	+4.2	100	+4.1	100	+4.2	30	+4.8
EU-W		Austria	AUT	100	+3.1	> 1000	0	50	+3.8	50	+3.8	50	+3.9	30
	Belgium	BEL	> 1000	+3.1	> 1000	0	> 1000	+3.7	> 1000	+3.7	> 1000	+3.7	500	+4.3
	France	FRA	> 1000	+3.1	> 1000	0	500	+3.8	500	+3.8	500	+3.8	100	+4.4
	Germany	DEU	> 1000	+2.7	> 1000	0	1000	+3.3	500	+3.3	500	+3.3	100	+3.8
	Luxembourg	LUX	> 1000	+3.1	> 1000	0	500	+3.7	500	+3.7	500	+3.8	100	+4.2
	Netherlands	NLD	> 1000	+2.9	> 1000	0	> 1000	+3.5	> 1000	+3.5	> 1000	+3.5	> 1000	+4.1
	Switzerland	CHE	> 1000	+2.7	> 1000	0	500	+3.3	500	+3.3	500	+3.4	100	+3.8

Table S4: Upper bound of the 95% confidence interval (quantile 97.5%) for return periods and change in intensity in 2040 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century).

Area	Country	Code	Observed		Natural Only		SSP1-2.6		SSP2-4.5		SSP3-7.0		SSP5-8.5	
AFR-N	Algeria	DZA	30	+2.7	> 1000	0	5	+3.4	1	+4.5	1	+6.3	1	+7.3
	Egypt	EGY	30	+2.1	> 1000	0	10	+2.6	5	+3.5	2	+4.9	1	+5.8
	Libya	LYB	10	+2.3	> 1000	0	5	+2.8	2	+3.9	1	+5.7	1	+6.7
	Morocco	MAR	30	+2.4	> 1000	0	10	+2.9	5	+4	2	+5.7	1	+6.7
	Tunisia	TUN	30	+2.6	> 1000	0	10	+3.2	5	+4.3	2	+6	1	+6.9
ASI-S	Iran	IRN	5	+2.3	> 1000	0	2	+3	1	+4.4	1	+6.7	1	+8.3
ASI-W	Armenia	ARM	10	+2.1	> 1000	0	5	+2.7	2	+3.9	1	+5.9	1	+7.1
	Cyprus	CYP	30	+1.9	> 1000	0	10	+2.3	5	+3.2	1	+4.4	1	+5.1
	Georgia	GEO	30	+2.1	> 1000	0	10	+2.6	5	+3.7	1	+5.6	1	+6.9
	Iraq	IRQ	10	+2.6	> 1000	0	5	+3.3	1	+4.9	1	+7.7	1	+9.7
	Israel	ISR	10	+2.4	> 1000	0	10	+2.9	5	+3.9	1	+5.3	1	+6.1
	Jordan	JOR	10	+2.7	> 1000	0	10	+3.3	2	+4.7	1	+6.8	1	+8.2
	Lebanon	LBN	10	+2.3	1000	0	10	+2.8	2	+3.9	1	+5.5	1	+6.4
	Saudi Arabia	SAU	10	+2.8	> 1000	0	5	+3.6	1	+5.3	1	+8.4	1	+10.2
	Syria	SYR	10	+2.6	> 1000	0	5	+3.3	2	+4.6	1	+6.9	1	+8.3
	Türkiye	TUR	30	+2.6	> 1000	0	10	+3.3	2	+4.7	1	+7	1	+8.4
EU-E	Belarus	BLR	100	+2.7	> 1000	0	50	+3.4	10	+4.5	2	+6.1	2	+6.9
	Bulgaria	BGR	50	+2.7	> 1000	0	30	+3.3	5	+4.5	2	+6.2	1	+7.1
	Czechia	CZE	10	+2.3	> 1000	0	10	+2.8	5	+3.8	2	+5.3	1	+6.1
	Hungary	HUN	30	+2.3	> 1000	0	10	+2.9	5	+4.1	1	+5.9	1	+7
	Moldova	MDA	50	+2.6	> 1000	0	30	+3.3	5	+4.5	2	+6.3	1	+7.4
	Poland	POL	30	+2.3	> 1000	0	10	+2.8	10	+3.8	2	+5.1	2	+5.9
	Romania	ROU	50	+2.5	> 1000	0	30	+3.1	5	+4.3	2	+6.1	1	+7.1
	Russian Federation	RUS	100	+2.1	> 1000	0	50	+2.6	10	+3.6	5	+5.1	2	+6.1
	Slovakia	SVK	30	+2.5	> 1000	0	10	+3.1	5	+4.3	1	+6.1	1	+7.2
	Ukraine	UKR	30	+2.6	> 1000	0	10	+3.3	5	+4.5	2	+6.4	1	+7.5
EU-N	Denmark	DNK	50	+1.4	> 1000	0	30	+1.7	10	+2.4	5	+3.5	5	+4.2
	Estonia	EST	30	+1.7	> 1000	0	30	+2.1	10	+2.9	5	+4.1	2	+4.7
	Finland	FIN	30	+1.3	> 1000	0	30	+1.6	10	+2.3	5	+3.5	2	+4.3
	Iceland	ISL	100	+1.3	> 1000	0	100	+1.6	30	+2.3	10	+3.5	10	+4.2
	Ireland	IRL	50	+1.2	> 1000	0	30	+1.6	10	+2.2	5	+3.2	5	+3.8
	Latvia	LVA	30	+2	> 1000	0	10	+2.5	10	+3.3	2	+4.6	2	+5.3
	Lithuania	LTU	30	+2	> 1000	0	30	+2.5	10	+3.4	2	+4.6	2	+5.3
	Norway	NOR	50	+1.3	> 1000	0	50	+1.6	30	+2.3	10	+3.4	5	+4.2
	Sweden	SWE	50	+1.3	> 1000	0	30	+1.6	10	+2.2	5	+3.3	5	+4
	United Kingdom	GBR	500	+1.3	> 1000	0	100	+1.6	50	+2.3	10	+3.3	10	+3.9
EU-S	Albania	ALB	10	+2.4	> 1000	0	10	+3	2	+4.2	1	+6.1	1	+7.3
	Bosnia and Herzegovina	BIH	30	+2.6	> 1000	0	10	+3.3	5	+4.7	1	+6.8	1	+8.2
	Croatia	HRV	30	+2.5	> 1000	0	10	+3.2	5	+4.4	1	+6.2	1	+7.3
	Greece	GRC	30	+2.6	> 1000	0	10	+3.2	5	+4.3	2	+5.9	1	+6.8
	Italy	ITA	50	+2.4	> 1000	0	30	+3	5	+4.1	2	+5.6	1	+6.5
	Kosovo	XKO	100	+2.5	> 1000	0	30	+3.2	5	+4.6	2	+7	1	+8.7
	Macedonia	MKD	30	+2.7	> 1000	0	10	+3.4	5	+4.8	1	+7	1	+8.4
	Montenegro	MNE	50	+2.6	> 1000	0	10	+3.3	5	+4.8	1	+7.3	1	+9.1
	Portugal	PRT	50	+2.1	> 1000	0	30	+2.6	10	+3.6	5	+5.3	2	+6.4
	Serbia	SRB	30	+2.4	> 1000	0	10	+3.1	5	+4.3	1	+6.3	1	+7.7
	Slovenia	SVN	30	+2.6	> 1000	0	10	+3.3	5	+4.4	2	+6	1	+6.9
	Spain	ESP	50	+2.7	> 1000	0	10	+3.4	5	+4.6	1	+6.4	1	+7.5
	EU-W	Austria	AUT	30	+2.4	> 1000	0	10	+3	5	+4.1	1	+5.7	1
Belgium		BEL	100	+2.3	> 1000	0	100	+2.8	30	+3.8	10	+5.4	5	+6.3
France		FRA	100	+2.4	> 1000	0	50	+3	10	+4.2	5	+5.9	2	+7
Germany		DEU	100	+2	> 1000	0	30	+2.5	10	+3.4	5	+4.8	2	+5.6
Luxembourg		LUX	100	+2.3	> 1000	0	50	+2.8	10	+3.8	5	+5.3	2	+6.1
Netherlands		NLD	1000	+2.1	> 1000	0	100	+2.6	50	+3.6	10	+5.1	5	+6
Switzerland		CHE	100	+2.1	> 1000	0	50	+2.6	10	+3.5	2	+4.9	2	+5.7

Table S5: Average values for return periods and change in intensity in 2100 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century). The 95% confidence interval is given in tables S6 and S7.

Area	Country	Code	Observed	Natural Only	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
AFR-N	Algeria	DZA	10 +2.3	> 1000 0	1 +2.3	1 +3.4	1 +4.9	1 +5.6
	Egypt	EGY	10 +1.6	100 0	5 +1.6	2 +2.4	1 +3.6	1 +4.1
	Libya	LYB	5 +1.9	100 0	2 +1.8	1 +2.8	1 +4.3	1 +4.9
	Morocco	MAR	10 +1.9	> 1000 0	2 +1.9	2 +2.8	1 +4.2	1 +4.8
	Tunisia	TUN	10 +2.1	> 1000 0	5 +2.1	2 +3.2	1 +4.6	1 +5.2
ASI-S	Iran	IRN	5 +1.9	500 0	1 +1.9	1 +3	1 +4.8	1 +5.6
ASI-W	Armenia	ARM	5 +1.6	100 0	2 +1.7	1 +2.6	1 +4.1	1 +4.8
	Cyprus	CYP	10 +1.5	500 0	5 +1.5	1 +2.2	1 +3.3	1 +3.7
	Georgia	GEO	10 +1.5	100 0	5 +1.6	2 +2.5	1 +4	1 +4.7
	Iraq	IRQ	5 +2.1	> 1000 0	1 +2.1	1 +3.3	1 +5.6	1 +6.6
	Israel	ISR	10 +1.8	500 0	2 +1.9	1 +2.8	1 +3.9	1 +4.4
	Jordan	JOR	10 +2.2	> 1000 0	2 +2.2	1 +3.3	1 +5.1	1 +5.8
	Lebanon	LBN	5 +1.8	100 0	2 +1.8	1 +2.7	1 +4	1 +4.6
	Saudi Arabia	SAU	10 +2.3	> 1000 0	1 +2.3	1 +3.6	1 +6.1	1 +7.2
	Syria	SYR	5 +2.1	500 0	2 +2.1	1 +3.3	1 +5.1	1 +5.9
	Türkiye	TUR	10 +2.1	> 1000 0	2 +2.1	1 +3.3	1 +5.2	1 +6
EU-E	Belarus	BLR	30 +1.9	> 1000 0	10 +2.1	5 +2.9	1 +4.2	1 +4.7
	Bulgaria	BGR	10 +2	> 1000 0	5 +2.2	2 +3.2	1 +4.7	1 +5.3
	Czechia	CZE	10 +1.5	100 0	5 +1.7	2 +2.4	1 +3.5	1 +4
	Hungary	HUN	10 +1.6	500 0	5 +1.8	2 +2.6	1 +4	1 +4.6
	Moldova	MDA	30 +2	> 1000 0	5 +2.1	2 +3.1	1 +4.6	1 +5.3
	Poland	POL	10 +1.5	100 0	5 +1.6	2 +2.3	1 +3.3	1 +3.8
	Romania	ROU	30 +1.8	> 1000 0	5 +1.9	2 +2.8	1 +4.3	1 +4.9
	Russian Federation	RUS	30 +1.3	> 1000 0	10 +1.4	5 +2.1	2 +3.1	1 +3.7
	Slovakia	SVK	10 +1.7	500 0	2 +1.9	1 +2.8	1 +4.1	1 +4.7
	Ukraine	UKR	10 +1.9	500 0	5 +2	2 +3	1 +4.5	1 +5.2
EU-N	Denmark	DNK	30 +0.7	100 0	10 +0.8	5 +1.2	2 +1.8	1 +2.2
	Estonia	EST	10 +0.9	100 0	5 +1	2 +1.5	1 +2.2	1 +2.6
	Finland	FIN	10 +0.5	50 0	5 +0.6	5 +0.9	1 +1.4	1 +1.8
	Iceland	ISL	30 +0.5	100 0	10 +0.5	10 +0.9	2 +1.6	2 +2
	Ireland	IRL	10 +0.8	100 0	10 +0.9	5 +1.3	2 +2	2 +2.4
	Latvia	LVA	10 +1.1	500 0	5 +1.3	2 +1.9	1 +2.7	1 +3.1
	Lithuania	LTU	10 +1.1	100 0	5 +1.3	2 +1.8	1 +2.6	1 +3
	Norway	NOR	30 +0.6	100 0	10 +0.7	5 +1	2 +1.6	1 +2
	Sweden	SWE	10 +0.5	100 0	10 +0.6	5 +0.9	2 +1.5	1 +1.8
	United Kingdom	GBR	100 +0.7	> 1000 0	50 +0.8	10 +1.2	5 +1.9	2 +2.2
EU-S	Albania	ALB	10 +1.6	500 0	2 +1.7	1 +2.6	1 +4.1	1 +4.8
	Bosnia and Herzegovina	BIH	10 +1.8	> 1000 0	2 +2	1 +3	1 +4.7	1 +5.5
	Croatia	HRV	10 +1.9	> 1000 0	5 +2	1 +3	1 +4.5	1 +5.1
	Greece	GRC	10 +2	> 1000 0	5 +2.1	2 +3.1	1 +4.5	1 +5.1
	Italy	ITA	30 +1.9	> 1000 0	5 +2	2 +2.9	1 +4.2	1 +4.8
	Kosovo	XKO	30 +1.6	> 1000 0	5 +1.9	2 +2.9	1 +4.6	1 +5.4
	Macedonia	MKD	10 +1.9	> 1000 0	5 +2.1	1 +3.2	1 +5	1 +5.8
	Montenegro	MNE	10 +1.8	> 1000 0	2 +1.9	1 +3	1 +4.8	1 +5.7
	Portugal	PRT	30 +1.4	> 1000 0	10 +1.5	5 +2.3	2 +3.6	1 +4.3
	Serbia	SRB	10 +1.7	> 1000 0	5 +1.8	2 +2.8	1 +4.3	1 +5
	Slovenia	SVN	10 +1.9	> 1000 0	5 +2.1	2 +3	1 +4.4	1 +5
	Spain	ESP	10 +2	> 1000 0	5 +2.1	2 +3.2	1 +4.8	1 +5.5
EU-W	Austria	AUT	10 +1.7	1000 0	5 +1.8	2 +2.7	1 +3.9	1 +4.5
	Belgium	BEL	50 +1.5	> 1000 0	30 +1.6	10 +2.4	2 +3.6	1 +4.2
	France	FRA	50 +1.7	> 1000 0	10 +1.9	5 +2.8	2 +4.3	1 +5
	Germany	DEU	30 +1.2	> 1000 0	10 +1.4	5 +2	1 +3.1	1 +3.6
	Luxembourg	LUX	30 +1.5	500 0	10 +1.6	5 +2.4	2 +3.5	1 +4.2
	Netherlands	NLD	100 +1.3	> 1000 0	50 +1.4	10 +2.1	5 +3.2	2 +3.8
	Switzerland	CHE	30 +1.5	> 1000 0	10 +1.6	5 +2.3	1 +3.4	1 +3.9

Table S6: Lower bound of the 95% confidence interval (quantile 2.5%) for return periods and change in intensity in 2100 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century).

Area	Country	Code	Observed		Natural Only		SSP1-2.6		SSP2-4.5		SSP3-7.0		SSP5-8.5		
AFR-N	Algeria	DZA	> 1000	+3.1	> 1000	0	> 1000	+4.5	5	+5.9	1	+8.1	1	+9.4	
	Egypt	EGY	50	+2.6	> 1000	0	50	+3.6	10	+4.8	5	+6.7	2	+8.3	
	Libya	LYB	30	+2.7	> 1000	0	30	+3.9	10	+5.3	2	+7.6	1	+9.5	
	Morocco	MAR	> 1000	+2.9	> 1000	0	> 1000	+4.1	10	+5.4	10	+7.7	5	+9	
	Tunisia	TUN	100	+3.1	> 1000	0	100	+4.3	30	+5.7	5	+7.8	2	+9.4	
ASI-S	Iran	IRN	10	+2.8	> 1000	0	10	+4.3	2	+6.2	1	+9.8	1	+13	
ASI-W	Armenia	ARM	30	+2.7	> 1000	0	30	+4	5	+5.5	2	+8.6	1	+11.6	
	Cyprus	CYP	100	+2.4	> 1000	0	100	+3.2	10	+4.3	2	+6.1	2	+7.5	
	Georgia	GEO	100	+2.7	> 1000	0	50	+3.9	10	+5.3	5	+7.8	2	+10.1	
	Iraq	IRQ	30	+3.1	> 1000	0	30	+4.8	5	+6.9	1	+10.7	1	+13.1	
	Israel	ISR	50	+3	> 1000	0	50	+4.1	10	+5.3	2	+7.1	2	+8.4	
	Jordan	JOR	50	+3.2	> 1000	0	50	+4.7	10	+6.4	2	+9.3	1	+11.7	
	Lebanon	LBN	30	+2.8	> 1000	0	30	+4	10	+5.3	2	+7.6	2	+9.3	
	Saudi Arabia	SAU	100	+3.3	> 1000	0	100	+5.2	5	+7.4	1	+11.4	1	+13.1	
	Syria	SYR	30	+3.1	> 1000	0	30	+4.6	5	+6.3	1	+9.4	1	+11.8	
	Türkiye	TUR	100	+3.2	> 1000	0	100	+4.7	10	+6.4	2	+9.6	1	+12.3	
EU-E	Belarus	BLR	> 1000	+3.6	> 1000	0	500	+4.9	100	+6.3	10	+8.3	10	+9.6	
	Bulgaria	BGR	100	+3.3	> 1000	0	100	+4.6	30	+5.9	5	+8	2	+9.6	
	Czechia	CZE	50	+3	> 1000	0	30	+4.2	10	+5.4	5	+7.4	2	+8.9	
	Hungary	HUN	100	+3.1	> 1000	0	50	+4.4	10	+5.9	5	+8.4	2	+10.4	
	Moldova	MDA	100	+3.3	> 1000	0	100	+4.7	30	+6.1	5	+8.5	5	+10.3	
	Poland	POL	100	+3.1	> 1000	0	100	+4.2	30	+5.4	10	+7.1	5	+8.3	
	Romania	ROU	500	+3.2	> 1000	0	100	+4.5	30	+5.9	5	+8.3	2	+10.2	
	Russian Federation	RUS	> 1000	+2.9	> 1000	0	1000	+4	100	+5.3	100	+7.3	100	+8.8	
	Slovakia	SVK	500	+3.3	> 1000	0	100	+4.6	10	+6.2	5	+8.7	2	+10.7	
	Ukraine	UKR	100	+3.4	> 1000	0	100	+4.8	30	+6.3	5	+8.7	2	+10.6	
EU-N	Denmark	DNK	500	+2.1	> 1000	0	500	+2.9	100	+3.8	50	+5.3	30	+6.4	
	Estonia	EST	100	+2.5	> 1000	0	100	+3.4	50	+4.4	10	+5.9	10	+6.9	
	Finland	FIN	500	+2.1	> 1000	0	100	+2.9	50	+3.9	30	+5.7	10	+7	
	Iceland	ISL	> 1000	+2	> 1000	0	> 1000	+2.8	1000	+3.7	500	+5.2	> 1000	+6.4	
	Ireland	IRL	1000	+1.7	> 1000	0	100	+2.4	50	+3.2	30	+4.4	10	+5.3	
	Latvia	LVA	100	+2.8	> 1000	0	100	+3.8	30	+5	10	+6.7	5	+7.9	
	Lithuania	LTU	100	+3	> 1000	0	100	+4	30	+5.1	10	+6.7	10	+7.7	
	Norway	NOR	> 1000	+2	> 1000	0	500	+2.7	100	+3.7	50	+5.3	50	+6.6	
	Sweden	SWE	> 1000	+2	> 1000	0	500	+2.7	100	+3.7	50	+5.3	30	+6.5	
	United Kingdom	GBR	> 1000	+1.8	> 1000	0	> 1000	+2.6	> 1000	+3.4	100	+4.7	100	+5.7	
	EU-S	Albania	ALB	100	+3.2	> 1000	0	50	+4.4	10	+6	2	+8.7	2	+11.1
		Bosnia and Herzegovina	BIH	100	+3.4	> 1000	0	50	+4.9	10	+6.7	2	+9.8	2	+12.6
		Croatia	HRV	100	+3.2	> 1000	0	50	+4.5	10	+6	2	+8.5	2	+10.6
Greece		GRC	100	+3.3	> 1000	0	100	+4.5	10	+5.7	5	+7.6	2	+9	
Italy		ITA	> 1000	+3	> 1000	0	500	+4.2	30	+5.5	5	+7.4	2	+8.9	
Kosovo		XKO	500	+3.3	> 1000	0	100	+4.9	30	+6.9	5	+10.5	2	+13.9	
Macedonia		MKD	100	+3.5	> 1000	0	100	+5	10	+6.7	2	+9.8	2	+12.6	
Montenegro		MNE	> 1000	+3.5	> 1000	0	100	+5.1	10	+7.2	2	+11.1	2	+14.8	
Portugal		PRT	500	+2.8	> 1000	0	100	+3.9	50	+5.1	10	+7.3	10	+9.1	
Serbia		SRB	> 1000	+3.1	> 1000	0	100	+4.6	30	+6.2	5	+9.2	2	+11.9	
Slovenia		SVN	100	+3.3	> 1000	0	100	+4.6	30	+6	5	+8	2	+9.5	
Spain		ESP	> 1000	+3.4	> 1000	0	500	+4.7	30	+6.1	5	+8.3	2	+10.1	
EU-W		Austria	AUT	100	+3.1	> 1000	0	100	+4.3	10	+5.7	5	+7.9	2	+9.6
	Belgium	BEL	> 1000	+3.1	> 1000	0	> 1000	+4.2	100	+5.4	30	+7.2	10	+8.5	
	France	FRA	> 1000	+3.1	> 1000	0	1000	+4.3	100	+5.7	10	+7.9	10	+9.6	
	Germany	DEU	> 1000	+2.7	> 1000	0	1000	+3.7	100	+4.9	10	+6.8	10	+8.2	
	Luxembourg	LUX	> 1000	+3.1	> 1000	0	500	+4.1	100	+5.4	30	+7	10	+8.1	
	Netherlands	NLD	> 1000	+2.9	> 1000	0	> 1000	+4	500	+5.2	100	+7.1	30	+8.4	
	Switzerland	CHE	> 1000	+2.7	> 1000	0	> 1000	+3.8	50	+4.9	10	+6.8	5	+8.2	

Table S7: Upper bound of the 95% confidence interval (quantile 97.5%) for return periods and change in intensity in 2100 in TX3x over the Europe. In columns: values are given for a world without human influence (Natural Only) and 4 CMIP6 scenarios. Observed values correspond to the year 2024. For each column, the first value is the return period, rounded to the nearest 1, 2, 5, 10, 30, 50, 100, 500 and 1000 years. The second is the difference with the world without human influence (i.e. this is an estimator of local climate change extremes at the end of the century).

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