

# THE LANCET

## **Supplementary appendix**

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

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## **Online appendix of the article:**

### **Mortality risk attributable to high and low ambient temperature: a multi-country study**

#### **Additional information on data collection**

##### **Australia**

We collected data from Melbourne, Sydney and Brisbane between 1<sup>st</sup> of January 1988 and 31<sup>st</sup> of May 2009. Daily mortality, obtained from the Australian Bureau of Statistics, is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed as the 24-hour average based on hourly measurements, were obtained from the Australian Bureau of Meteorology. We selected all available meteorological stations located within ≤30 km of each city's Central Business District (CBD) (7 stations in Brisbane, 7 stations in Melbourne and 11 stations in Sydney). We calculated the daily averages of climatic variables using all records from meteorological stations in each city. When there was a missing value (≤1.3%) for a particular meteorological station, observations recorded from the remaining weather stations were used to compute the daily average values. In total, missing data amount for 0.16% and 0.00% of the mortality and temperature series, respectively. These data were used and described in previous publications <sup>1,2</sup>

##### **Brazil**

We collected data from 18 cities (see full list in Table S1 below) between 1<sup>st</sup> of January 1997 and 31<sup>st</sup> of December 2011. Daily mortality, obtained from the Ministry of Health, Brazil, is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed from the 24-h average of hourly measurements) were obtained from the National Institute of Meteorology of Brazil. A single weather station located within the urban area was selected for each city. In total, missing data amount for 1.85% and 3.36% of the mortality and temperature series, respectively.

##### **Canada**

We collected data from 20 census metropolitan areas (CMA) and the city of Hamilton (see full list in Table S2 below) between 1<sup>st</sup> of January 1986 and 31<sup>st</sup> of December 2009. Daily mortality, obtained from Statistics Canada through access to the Canadian Mortality Database, is represented by counts of deaths for all causes. Mean daily temperature (in °C) and relative humidity (in %), computed as the 24-hour average based on hourly measurements, were obtained from Environment Canada. A single weather station was selected for each city using the airport monitoring station located closest to the CMA centre. Measures of ozone (O<sub>3</sub>, in ppb), nitrogen dioxide (NO<sub>2</sub>, in ppb) and particles (PM<sub>2.5</sub>, in ppb) were available in the same period from the National Air Pollution Surveillance (NAPS) network of Environment Canada. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements in different stations, and then averaged across stations with no missing data, with an average of 4 stations per city. In total, missing data amount for 1.98% and 0.91% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>3,4</sup>

##### **China**

We collected data from the city of Anshan (1<sup>st</sup> of January 2004 to 31<sup>st</sup> of December 2006), Beijing (1<sup>st</sup> of January 2007 to 30<sup>th</sup> of September 2008), Fuzhou (1<sup>st</sup> of January 2004 to 31<sup>st</sup> of December 2006), Guangzhou (1<sup>st</sup> of January 2007 to 31<sup>st</sup> of December 2008), Hong Kong (1<sup>st</sup> of January 1996 to 31<sup>st</sup> of December 2002), Hangzhou (1<sup>st</sup> of January 2002 to 29<sup>th</sup> of December 2004), Lanzhou (1<sup>st</sup> of January 2004 to 31<sup>st</sup> of December 2008), Nanjing (1<sup>st</sup> of January 2007 to 31<sup>st</sup> of December 2010), Shanghai (1<sup>st</sup> of January 2001 to 31<sup>st</sup> of December 2004), Shenyang (1<sup>st</sup> of January 2005 to 31<sup>st</sup> of December 2008), Suzhu (1<sup>st</sup> of January 2005 to 31<sup>st</sup> of December 2008), Taiyuan (1<sup>st</sup> of January 2004 to 31<sup>st</sup> of December 2008), Tianjin (1<sup>st</sup> of January 2005 to 31<sup>st</sup> of December 2008), Wuhan (1<sup>st</sup> of January 2003 to 31<sup>st</sup> of December 2005), Wulumqi (1<sup>st</sup> of January 2006 to 31<sup>st</sup> of December 2007), and Xian (1<sup>st</sup> of January 2004 to 31<sup>st</sup> of December 2008). Daily mortality is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %) were computed as the 24-hour average based on hourly measurements.

Measures of nitrogen dioxide (NO<sub>2</sub>, in µg/m<sup>3</sup>), particles (PM<sub>10</sub>, in µg/m<sup>3</sup>) and sulphur dioxide (SO<sub>2</sub>, in µg/m<sup>3</sup>) were available in the same period. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements. In total, missing data amount for 0.54% and 0.33% of the mortality and temperature series, respectively.

### **Italy**

We collected data from the city of Bari (1<sup>st</sup> of January 1996 to 31<sup>st</sup> of December 2007), Bologna (1<sup>st</sup> of January 1996 to 31<sup>st</sup> of December 2010), Brescia (1<sup>st</sup> of January 1993 to 31<sup>st</sup> of December 2003), Civitavecchia (1<sup>st</sup> of January 1996 to 31<sup>st</sup> of December 2006), Frosinone (1<sup>st</sup> of January 1995 to 31<sup>st</sup> of December 2006), Genova (1<sup>st</sup> of January 1999 to 31<sup>st</sup> of December 2007), Latina (1<sup>st</sup> of January 1995 to 31<sup>st</sup> of December 2006), Palermo (1<sup>st</sup> of January 1997 to 31<sup>st</sup> of December 2001), Roma (1<sup>st</sup> of January 1987 to 31<sup>st</sup> of December 2010), Torino (1<sup>st</sup> of January 1991 to 31<sup>st</sup> of December 1999), and Viterbo (1<sup>st</sup> of January 1995 to 31<sup>st</sup> of December 2006). Daily mortality, obtained from local mortality registries and from the rapid mortality surveillance system operational since 2004, is represented by counts of deaths for all causes. Mean daily temperature (in °C) and relative humidity (in %), computed as the 24-h average based on 6-h measurements, were obtained from the Meteorological Service of the Italian Air Force. A single weather station was selected for each city, using the airport monitoring station located closest to the city centre. In total, missing data amount for 1.95% and 3.30% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>5,6</sup>

### **Japan**

We collected data from 47 prefectures (see full list in Table S2 below) between 1<sup>st</sup> of January 1985 and 31<sup>st</sup> of December 2012. Daily mortality, obtained from computerized death certificate data from the Ministry of Health, Labour and Welfare, Japan, is represented by counts of deaths for all causes and for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed as the 24-hour average based on hourly measurements, were obtained from the Japan Meteorology Agency. A single weather station located within the urban area of the capital city was selected for each prefecture. In total, missing data amount for 0.00% and 0.04% of the mortality and temperature series, respectively.

### **South Korea**

We collected data from 7 cities (see full list in Table S2 below) between 1<sup>st</sup> of January 1992 and 31<sup>st</sup> of December 2010. Daily mortality is represented by counts of deaths for all causes and for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %) were computed as the 24-hour average based on hourly measurements. Measures of carbon monoxide (CO, in ppb), ozone (O<sub>3</sub>, in ppb), nitrogen dioxide (NO<sub>2</sub>, in ppb), particles (PM<sub>10</sub>, in ppb) and sulphur dioxide (SO<sub>2</sub>, in ppb) were available in the period 1999-2010. Fine particles measures (PM<sub>2.5</sub>, in ppb) were available only for Seoul in 2005-2009. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements. In total, missing data amount for 3.77% and 3.77% of the mortality and temperature series, respectively.

### **Spain**

We collected data from the 51 capital cities (see full list in Table S2 below) between 1<sup>st</sup> of January 1990 and 31<sup>st</sup> of December 2010. Daily mortality, obtained from Spain National Institute of Statistics, is represented by counts of deaths for all causes. Mean daily temperature (in °C), computed as the 24-hour average based on hourly measurements, was obtained from Spain National Meteorology Agency. A single weather station, located within the urban area or at the near airport, was selected for each city. Single-day missing values were imputed as the average of the days before and after. For periods longer than two days no imputation was done. In total, missing data amount for 0.00% and 2.00% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>7</sup>

### **Sweden**

We collected data from the county of Stockholm between 1<sup>st</sup> of January 1990 and 31<sup>st</sup> of December 2002. Daily mortality, obtained from the Swedish Cause of Death Register at the Swedish National Board of Health and

Welfare, is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed as the 24-hour average based on hourly measurements, were obtained from the Environment and Health Administration. A single weather station, located at Torkel Knutssongatan in Central Stockholm, was selected. Measures ozone (O<sub>3</sub>, in ppb) and nitrogen oxides (NO<sub>x</sub>, in ppb) were available in the same period. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements. In total, missing data amount for 0.00% and 6.59% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>8,9</sup>

### **Taiwan**

We collected data in Kaohsiung, Taipei and Taichung between 1<sup>st</sup> of January 1994 and 31<sup>st</sup> of December 2007. Daily mortality is represented by counts of deaths for all causes and for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %) were computed as the 24-hour average based on hourly measurements. Measures of carbon monoxide (CO, in ppb), ozone (O<sub>3</sub>, in ppb), nitrogen dioxide (NO<sub>2</sub>, in ppb), particles (PM10, in ppb) and sulphur dioxide (SO<sub>2</sub>, in ppb) were available for the same period. Fine particles measures (PM2.5, in ppb) were available only in 2005-2007. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements. Data were pooled from 1 meteorological station and 11 air quality monitoring stations in Kaohsiung, 2 meteorological station and 5 air quality monitoring stations in Taichung, and 3 meteorological station and 15 air quality monitoring stations in Taipei, respectively. In total, missing data amount for 0.03% and 0.00% of the mortality and temperature series, respectively.

### **Thailand**

We collected data from 62 provinces (see full list in Table S2 below) between 1<sup>st</sup> of January 1999 and 31<sup>st</sup> of December 2008. Daily mortality, obtained from the Ministry of Public Health, Thailand, is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed as the average between daily minimum and maximum, were obtained from the Meteorological Department, Ministry of Information and Communication Technology, Thailand. A total of 117 weather stations in 62 provinces, with at least one weather monitoring station in each province. In total, missing data amount for 0.00% and 6.10% of the mortality and temperature series, respectively. Humidity measurements were missing in at least 10% of days in 12 provinces.

### **UK**

We collected data in 9 regions of England and in Wales (see full list in Table S2 below) between 1<sup>st</sup> of January 1993 and 31<sup>st</sup> of December 2006. Daily mortality, obtained from the Office of National Statistics, is represented by counts of deaths for all causes and for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C) and relative humidity (in %), computed from the 24-h average of hourly measurements) were obtained from the British Atmospheric Data Centre. An average of 29 stations contributed data to each regional series, from a minimum of 7 in London to a maximum of 44 in Wales. In total, missing data amount for 0.00% and 0.00% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>10,11</sup>

### **USA**

We collected data from 135 cities (see full list in Table S2 below) between 1<sup>st</sup> of January 1985 and 31<sup>st</sup> of December 2006. Daily mortality, obtained from the National Center for Health Statistics (NCHS), is represented by counts of deaths for non-external causes only (ICD-9: 0-799; ICD-10: A00-R99). Mean daily temperature (in °C, computed as the 24-hour average based on hourly measurements) and relative humidity (in %, computed from the 24-h average of hourly measurements of dew point temperature) were obtained from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). A single weather station was selected for each city in the land-based station data or NCDC, based on the proximity to the city's population centre. In 6 cities where multiple observations were missing from all the nearby monitors, hourly data from the Integrated Surface Database Lite of NCDC were converted in daily values. For 25 stations missing dew point data, dew point data were obtained from the nearest station with dew point data. In total, missing data amount for 0.32% and 1.89% of the mortality and temperature series, respectively. These data were used and described in previous publications.<sup>12,13</sup>

## Additional information on the statistical methods

### Details on the computation of the attributable risk

The mortality risk attributable to a temperature  $x_t$  for a given day  $t$  in the series is defined as the number  $AN_{x,t}$  and fraction  $AF_{x,t}$  of deaths experienced in the next  $L$  days, with  $L$  as the maximum lag period, defined by:

$$AF_{x,t} = 1 - \exp\left(-\sum_{l=0}^L \beta_{x_t,l}\right)$$

and

$$AN_{x,t} = AF_{x,t} \cdot \sum_{l=0}^L \frac{n_{t+l}}{L+1}$$

with  $\sum \beta_{x_t,l}$  as the overall cumulative log-relative risk for temperature  $x_t$  in day  $t$ , and  $n_t$  as the number of deaths in day  $t$ . To be noted how the number of attributable deaths  $AN_{x,t}$  is computed as the fraction of the average mortality in the future  $L$  days. The risk estimate  $\sum \beta_{x_t,l}$  is obtained by the BLUP of the overall cumulative exposure-response association, re-centered on the temperature of minimum mortality (MMT). The MMT is therefore the counterfactual condition for the definition of the attributable risk. Therefore, the attributable risk can be interpreted as the excess deaths due to non-optimal temperature, if compared to a hypothetical situation in which temperature is constantly equal to the MMT.

The total attributable number of deaths  $AN_{tot}$  due to temperature is given by the sum of  $AN_{x,t}$  for all the days  $t$  of the series, and its ratio with the total number of deaths provides the total attributable fraction  $AF_{tot}$ . The components attributable to cold and heat are computed by summing the subsets of  $AN_{x,t}$  lower or higher than the temperature corresponding to the location-specific MMT. These components are further separated in moderate and extreme contributions by selecting low and high temperature cut-offs. Here extreme cold and heat are defined as the temperatures lower than the 2.5<sup>th</sup> and higher than the 97.5<sup>th</sup> city-specific percentiles, respectively. Moderate temperatures are instead defined as the ranges between the MMT and these cut-offs. Other cut-offs are used for a further stratification for different temperature ranges in Table S3.

The method is described in details in a previous publication.<sup>14</sup>

## Additional tables

**Table S1: Sensitivity analysis**

Computed on the fraction (%) attributable to temperature (total, heat, and cold components), by varying modelling choices, fitting the models to all-cause vs non-external mortality, and controlling for PM<sub>10</sub>, ozone and humidity.

	Total (%)	Cold (%)	Heat (%)
<b>Modelling choices (384 locations)</b>			
Main model	7.71	7.29	0.42
Knots for exposure-response: 10 <sup>th</sup> , 50 <sup>th</sup> , and 90 <sup>th</sup>	7.04	6.7	0.34
Knots for exposure-response: 10 <sup>th</sup> , 25 <sup>th</sup> , 75 <sup>th</sup> and 90 <sup>th</sup>	7.68	7.22	0.46
Cubic B-spline for exposure-response	7.51	7.08	0.43
Df for lag-response: 6	7.65	7.23	0.42
Lag period: 14 days	6.94	6.46	0.48
Lag period: 28 days	7.96	7.60	0.36
Df/year for seasonal control: 6	7.08	6.76	0.32
Df/year for seasonal control: 10	6.25	5.85	0.40
<b>Outcome: all-cause or non-external mortality (67 locations)</b>			
All-cause	9.58	9.25	0.33
Non-external	9.64	9.33	0.30
<b>Control for PM<sub>10</sub> (25 locations)</b>			
Without PM <sub>10</sub>	7.94	7.27	0.67
With PM <sub>10</sub>	8.43	7.64	0.80
<b>Control for ozone (24 locations)</b>			
Without ozone	6.10	5.59	0.51
With ozone	6.34	5.86	0.49
<b>Control for relative humidity (320 locations)</b>			
Without relative humidity	7.82	7.43	0.39
With relative humidity	7.77	7.36	0.41

**Table S2: Second-stage random-effects meta-regression models**

Significance test for predictors (p-value), multivariate Cochran Q test for heterogeneity (p-value), and  $I^2$  statistic (%) in different multivariate random-effects meta-regression models.

Model	Predictor	Test for predictor	Q test	$I^2$
<b>Intercept-only</b>	-	-	<0.001	57.50%
	Average temperature	<0.001	<0.001	54.10%
<b>Single predictor</b>	Temperature range	<0.001	<0.001	53.60%
	Country	<0.001	<0.001	41.80%
<b>Full model</b>	Average temperature	<0.001		
	Temperature range	<0.001	<0.001	36.30%
	Country	<0.001		

**Table S3: Attributable mortality fraction by country computed as separated components for heat and cold at different temperature percentiles ranges**

Country-specific fraction (%) of all-cause mortality attributable to temperature in each country, reported as separated components due to different temperature ranges, with 95% empirical confidence intervals.

		Min ≤ t ≤ 2.5 <sup>th</sup>	2.5 <sup>th</sup> < t ≤ 10 <sup>th</sup>	10 <sup>th</sup> < t ≤ 25 <sup>th</sup>	25 <sup>th</sup> < t < 50 <sup>th</sup>	50 <sup>th</sup> ≤ t < 75 <sup>th</sup>	75 <sup>th</sup> ≤ t < 90 <sup>th</sup>	90 <sup>th</sup> ≤ t < 97.5 <sup>th</sup>	97.5 <sup>th</sup> ≤ t ≤ Max
<b>Australia</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (-0.01 – 0.01)	0.01 (-0.04 – 0.06)	0.13 (-0.03 – 0.30)	0.32 (0.19 – 0.42)
	Cold (%)	0.67 (0.49 – 0.83)	1.43 (0.99 – 1.82)	2.04 (1.27 – 2.73)	1.75 (0.85 – 2.65)	0.56 (0.05 – 1.07)	0.04 (-0.10 – 0.17)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Brazil</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.01)	0.09 (0.02 – 0.16)	0.21 (0.09 – 0.32)	0.18 (0.10 – 0.26)	0.22 (0.17 – 0.27)
	Cold (%)	0.49 (0.44 – 0.54)	0.89 (0.76 – 1.00)	0.90 (0.73 – 1.05)	0.47 (0.30 – 0.64)	0.08 (0.02 – 0.14)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Canada</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.04 (0.01 – 0.07)	0.23 (0.15 – 0.32)	0.26 (0.21 – 0.31)
	Cold (%)	0.25 (0.17 – 0.32)	0.76 (0.58 – 0.92)	1.30 (1.00 – 1.58)	1.53 (1.12 – 1.91)	0.61 (0.41 – 0.78)	0.01 (0.00 – 0.02)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>China</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.01 (-0.02 – 0.04)	0.23 (0.12 – 0.32)	0.40 (0.32 – 0.47)
	Cold (%)	1.06 (0.96 – 1.15)	1.98 (1.73 – 2.19)	2.97 (2.54 – 3.35)	3.26 (2.67 – 3.81)	1.04 (0.71 – 1.34)	0.06 (-0.05 – 0.16)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Italy</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.19 (0.09 – 0.30)	0.75 (0.52 – 0.97)	0.67 (0.56 – 0.77)
	Cold (%)	0.85 (0.69 – 0.98)	1.86 (1.43 – 2.23)	2.79 (2.03 – 3.44)	2.93 (1.82 – 3.86)	0.93 (0.36 – 1.43)	0.00 (0.00 – 0.01)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Japan</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.01 (0.00 – 0.02)	0.12 (0.10 – 0.15)	0.18 (0.16 – 0.20)
	Cold (%)	0.77 (0.74 – 0.79)	1.79 (1.71 – 1.86)	2.88 (2.74 – 3.01)	3.09 (2.92 – 3.24)	1.18 (1.08 – 1.27)	0.10 (0.06 – 0.12)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>South Korea</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (-0.01 – 0.01)	0.10 (0.01 – 0.19)	0.21 (0.13 – 0.27)
	Cold (%)	0.35 (0.22 – 0.46)	0.96 (0.60 – 1.28)	1.83 (1.17 – 2.38)	2.48 (1.54 – 3.27)	1.16 (0.57 – 1.73)	0.13 (-0.19 – 0.42)	0.02 (-0.13 – 0.15)	0.00 (-0.01 – 0.01)
<b>Spain</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.10 (0.07 – 0.13)	0.44 (0.38 – 0.50)	0.52 (0.49 – 0.55)
	Cold (%)	0.71 (0.67 – 0.75)	1.20 (1.08 – 1.30)	1.61 (1.43 – 1.78)	1.50 (1.24 – 1.74)	0.44 (0.31 – 0.56)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Sweden</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.03 (-0.09 – 0.14)	0.15 (-0.39 – 0.53)
	Cold (%)	0.27 (-0.32 – 0.75)	0.70 (-0.73 – 1.85)	0.99 (-1.50 – 3.07)	0.99 (-2.53 – 4.03)	0.50 (-2.11 – 2.91)	0.25 (-1.20 – 1.47)	0.01 (-0.06 – 0.06)	0.00 (0.00 – 0.00)
<b>Taiwan</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (-0.01 – 0.01)	0.08 (-0.14 – 0.29)	0.23 (-0.05 – 0.50)	0.29 (0.04 – 0.52)	0.25 (0.11 – 0.37)
	Cold (%)	0.71 (0.55 – 0.83)	1.30 (0.93 – 1.66)	1.31 (0.79 – 1.81)	0.56 (0.06 – 1.08)	0.02 (-0.07 – 0.11)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>Thailand</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.01 (0.00 – 0.03)	0.14 (0.10 – 0.19)	0.32 (0.27 – 0.37)	0.28 (0.24 – 0.31)
	Cold (%)	0.44 (0.41 – 0.47)	0.99 (0.93 – 1.04)	0.86 (0.76 – 0.96)	0.30 (0.19 – 0.40)	0.02 (-0.01 – 0.05)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>UK</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.07 (0.04 – 0.11)	0.22 (0.19 – 0.26)
	Cold (%)	0.86 (0.82 – 0.90)	1.27 (1.14 – 1.37)	2.04 (1.84 – 2.24)	2.73 (2.45 – 3.02)	1.42 (1.25 – 1.59)	0.16 (0.10 – 0.23)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)
<b>USA</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.01 (0.00 – 0.01)	0.02 (0.01 – 0.03)	0.11 (0.09 – 0.13)	0.21 (0.19 – 0.23)
	Cold (%)	0.45 (0.43 – 0.47)	1.06 (1.01 – 1.11)	1.57 (1.48 – 1.65)	1.61 (1.49 – 1.71)	0.71 (0.64 – 0.78)	0.10 (0.07 – 0.13)	0.01 (0.00 – 0.01)	0.00 (0.00 – 0.00)
<b>TOT</b>	Heat (%)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.00 (0.00 – 0.00)	0.01 (0.00 – 0.01)	0.03 (0.03 – 0.04)	0.15 (0.13 – 0.16)	0.23 (0.22 – 0.24)
	Cold (%)	0.63 (0.61 – 0.64)	1.36 (1.32 – 1.39)	2.08 (2.01 – 2.14)	2.22 (2.13 – 2.30)	0.90 (0.85 – 0.95)	0.09 (0.07 – 0.11)	0.00 (0.00 – 0.01)	0.00 (0.00 – 0.00)

**Table S4: Attributable mortality fraction by location computed as total and as separated components for cold and heat**

Number of deaths, location-specific minimum mortality temperature (MMT) and percentile (MMP), and fraction (%) of all-cause mortality attributable to temperature in each location. The latter is reported as total and as separated components due to cold and heat, with 95% empirical confidence intervals.

Country	Location	Deaths	MMP	MMT	Overall (%)	Cold (%)	Heat (%)
Australia	Brisbane	191996	68	22.8	5.06	4.65	0.42
Australia	Melbourne	449092	90	22.4	6.48	5.99	0.49
Australia	Sydney	536862	83	22.6	8.04	7.6	0.44
Brazil	Belem	132910	41	26.7	2.13	1.06	1.07
Brazil	Belo Horizonte	464778	60	22.8	2.04	1.58	0.47
Brazil	Brasilia	114801	81	22.9	3.04	2.73	0.31
Brazil	Cuiaba	51336	75	28.1	2.45	2	0.45
Brazil	Curitiba	155276	80	21.3	4.99	4.68	0.31
Brazil	Fortaleza	202340	42	26.9	3.21	1.68	1.52
Brazil	Goiania	134263	46	24.2	2.26	1.12	1.14
Brazil	Joao Pessoa	53970	47	27.1	2.83	2.08	0.75
Brazil	Maceio	92525	60	25.6	2.74	2.27	0.47
Brazil	Manaus	98204	56	27.4	2.58	1.7	0.88
Brazil	Natal	80753	83	24.5	4.18	3.88	0.3
Brazil	Porto Alegre	215734	81	24.2	7.08	6.58	0.5
Brazil	Recife	263492	39	25.7	2.1	0.89	1.2
Brazil	Salvador	223545	78	27	3.19	2.96	0.23
Brazil	Sao Luis	81852	46	26.9	2.08	1.28	0.8
Brazil	Sao Paulo	916233	60	21.5	4.62	3.93	0.69
Brazil	Teresina	67174	67	28	3.48	2.85	0.62
Brazil	Vitoria	51950	75	26.8	3.17	2.79	0.38
Canada	Abbotsford	24745	79	16.4	2.19	1.98	0.21
Canada	Calgary	121137	82	14.7	3.72	3.51	0.21
Canada	Edmonton	141883	81	15.6	5.89	5.43	0.46
Canada	Halifax	65807	80	16.4	4.83	4.41	0.43
Canada	Hamilton	105812	79	18.2	3.88	3.36	0.52
Canada	Kingston	36322	79	18	5.23	4.67	0.56
Canada	Kitchener-Waterloo	65205	82	18.1	5.59	5.01	0.57
Canada	London Ontario	89695	80	18.5	4.76	4.16	0.6
Canada	Montreal	255487	81	18.9	3.22	2.54	0.68
Canada	Ottawa	126248	80	18.3	5.81	5.19	0.62
Canada	Regina	45728	82	16.6	5.95	5.46	0.49
Canada	Sudbury	37715	81	16.7	5.96	5.38	0.59
Canada	Saint John NB	41001	83	15.6	4.38	4.1	0.28
Canada	St. John's NFL	50285	90	16.5	4.76	4.28	0.48
Canada	Saskatoon	52741	82	16.1	5.66	5.13	0.53
Canada	Thunder Bay	32761	82	15.4	5.84	5.27	0.57
Canada	Toronto	632509	80	18.9	6.04	5.32	0.72
Canada	Victoria	78187	82	15.7	2.59	2.41	0.18



Canada	Vancouver	302493	82	16.7	4.42	4.11	0.31
Canada	Windsor	60532	78	20.2	4.61	4.06	0.55
Canada	Winnipeg	155293	81	17.2	6.07	5.53	0.54
China	Anshan	30076	82	24.2	12.31	11.62	0.69
China	Beijing	74786	80	25.5	12.07	11.32	0.75
China	Fuzhou	17142	80	27.6	9.95	9.19	0.76
China	Guangzhou	57721	82	28.7	10.2	9.53	0.68
China	Hong Kong	213860	82	28.6	7.74	7.53	0.22
China	Hangzhou	21743	84	27	11.29	10.58	0.71
China	Lanzhou	33877	90	20	12.11	11.88	0.22
China	Shanghai	172940	90	29.2	11.82	11.14	0.68
China	Shenyang	96588	80	22	12.17	11.39	0.78
China	Suzhu	49633	82	26.9	12.18	11.43	0.75
China	Taiyuan	43771	86	23.3	12.74	11.85	0.89
China	Tianjin	15857	83	25.6	11.91	10.87	1.03
China	Wuhan	62440	90	29.9	12.94	11.75	1.2
China	Wulumqi	12281	85	23.3	12.19	11.46	0.74
China	Xian	47415	83	24	12.3	11.47	0.83
Italy	Bari	30526	78	22.6	10.35	8.93	1.42
Italy	Bologna	58033	78	22.9	10.69	8.28	2.41
Italy	Brescia	20318	79	22	10.73	8.69	2.04
Italy	Civitavecchia	3912	78	23.1	9.96	8.19	1.77
Italy	Frosinone	3537	78	22.1	10.73	8.96	1.77
Italy	Genoa	71214	79	22.4	10.46	9.21	1.24
Italy	Latina	7976	78	22.6	9.55	7.56	1.99
Italy	Palermo	26865	79	24.5	9.55	8.31	1.23
Italy	Rome	522179	78	22.1	11.53	9.96	1.57
Italy	Turin	69544	79	19.8	8.62	6.85	1.77
Italy	Viterbo	6286	79	21.5	10.69	8.87	1.82
Japan	Aichi	1275798	83	25.6	11.11	10.62	0.49
Japan	Akita	331451	91	24.1	11.96	11.52	0.44
Japan	Aomori	367639	89	22	10.13	9.53	0.6
Japan	Chiba	1043841	91	27	9.39	9.23	0.16
Japan	Ehime	389884	86	26.6	8.49	8.3	0.19
Japan	Fukushima	520578	92	25.8	12.09	11.67	0.42
Japan	Fukui	196861	84	24.7	10.23	9.98	0.24
Japan	Fukuoka	1079937	81	25.3	9.54	9.12	0.41
Japan	Gifu	461978	89	27.3	10.01	9.66	0.35
Japan	Gunma	452208	86	25.2	10.65	10.36	0.29
Japan	Hokkaido	1225695	93	22.4	8.67	8.47	0.19
Japan	Hiroshima	650143	83	25.8	10.46	10.08	0.38
Japan	Hyogo	1179655	86	26.8	8.85	8.78	0.07
Japan	Ibaraki	636919	91	25.3	10.1	9.88	0.22
Japan	Ishikawa	266873	86	25.2	10.62	10.18	0.44
Japan	Iwate	359039	91	23.2	12.82	12.38	0.44
Japan	Kagawa	259957	81	25.4	11.36	10.87	0.49

Japan	Kanagawa	1410360	88	26.1	9.82	9.56	0.26
Japan	Kagoshima	488815	80	26.6	9.16	8.93	0.23
Japan	Kochi	233994	93	27.9	8.4	8.37	0.03
Japan	Kumamoto	455294	82	26.2	9.65	9.51	0.14
Japan	Kyoto	566646	82	25.6	10.55	10.13	0.42
Japan	Mie	429830	91	27.5	10.5	10.29	0.21
Japan	Miyagi	478243	92	24.4	12.3	12	0.3
Japan	Miyazaki	283834	87	27.1	9.99	9.72	0.27
Japan	Nagano	539233	90	24.8	11.69	11.36	0.33
Japan	Nagasaki	384449	81	25.5	9.24	9	0.24
Japan	Nara	292894	85	25.3	9.93	9.69	0.24
Japan	Niigata	614347	83	23.6	11.96	11.37	0.59
Japan	Oita	314390	91	27.4	9.92	9.67	0.25
Japan	Okayama	474479	90	28.1	10.97	10.85	0.12
Japan	Okinawa	218136	91	29.1	6.48	6.37	0.11
Japan	Osaka	1718353	82	26.2	9.2	8.85	0.35
Japan	Saga	221728	81	25.4	11.22	10.82	0.4
Japan	Saitama	1132794	84	24.8	12	11.51	0.49
Japan	Shiga	260846	88	26.1	10.16	10.04	0.11
Japan	Shimane	219027	85	24.6	10.04	9.86	0.18
Japan	Shizuoka	789815	91	27	10.83	10.61	0.22
Japan	Tokushima	221039	90	27.5	8.14	8.05	0.09
Japan	Tochigi	441327	90	25.6	10.79	10.4	0.39
Japan	Tokyo	2318083	87	26.5	9.06	8.7	0.36
Japan	Tottori	163483	85	25	10.67	10.3	0.37
Japan	Toyama	277171	83	23.8	10.74	10.36	0.39
Japan	Wakayama	287978	80	25.4	10.96	10.6	0.36
Japan	Yamagata	332903	90	24.4	11.97	11.61	0.36
Japan	Yamaguchi	416241	81	24.5	9.38	8.89	0.49
Japan	Yamanashi	209009	85	25.2	10.42	10.11	0.3
South Korea	Busan	340551	99	28.7	6.97	6.98	0
South Korea	Daegu	207086	90	26.4	5.4	5.12	0.29
South Korea	Daejeon	105049	85	24.1	8.27	7.71	0.56
South Korea	Gwangju	108222	90	25.9	7.37	6.89	0.48
South Korea	Incheon	193478	88	24.1	6.49	6.32	0.17
South Korea	Seoul	716638	86	24.5	8.03	7.59	0.44
South Korea	Ulsan	55914	91	25.9	5.92	5.68	0.25
Spain	A Coruna	75572	80	18.7	5.71	5.15	0.56
Spain	Albacete	34158	78	22	7.65	6.25	1.39
Spain	Alicante	51253	76	23.6	6.88	6	0.89
Spain	Almeria	41618	77	24.1	6.59	5.65	0.94
Spain	Avila	21147	80	18.5	7.67	6.34	1.33
Spain	Badajoz	37608	78	23.7	7.48	6.16	1.31
Spain	Barcelona	365724	73	21	6.78	6.11	0.67
Spain	Bilbao	82030	80	19.6	4.74	4.07	0.68
Spain	Burgos	41193	81	17.8	7.22	6.14	1.08

Spain	Caceres	22017	78	23.2	8.06	6.63	1.43
Spain	Cadiz	40682	78	22.8	6.42	5.27	1.15
Spain	Castellon	41632	76	23.3	6.69	5.82	0.88
Spain	Ceuta	9793	76	22.8	5.7	4.85	0.85
Spain	Cordoba	71562	77	25	8.4	7.07	1.33
Spain	Ciudad Real	22650	78	23.6	8.74	7.16	1.59
Spain	Cuenca	16498	78	20.6	7.63	6.02	1.61
Spain	Girona	30810	78	21	6.75	5.6	1.15
Spain	Granada	77716	78	23	7.56	6.19	1.37
Spain	Guadalajara	20115	78	20.4	7.71	6.12	1.59
Spain	Huelva	43169	78	23.6	6.72	5.74	0.98
Spain	Huesca	15670	79	21.2	6.84	5.53	1.31
Spain	Jaen	36427	78	24	7.22	5.82	1.4
Spain	Leon	44880	80	17.7	8.07	6.91	1.16
Spain	Lleida	37200	78	22.4	6.67	5.1	1.56
Spain	Logrono	33058	80	20.7	6.28	5.15	1.13
Spain	Lugo	35048	81	17.2	7.16	6.38	0.77
Spain	Madrid	576566	76	21.9	5.4	4	1.4
Spain	Malaga	116461	74	23.1	6.54	5.47	1.07
Spain	Melilla	8727	78	23.7	5.53	4.82	0.71
Spain	Murcia	77678	76	23.3	4.93	4.32	0.61
Spain	Ourense	38757	78	20.5	6.45	5.53	0.92
Spain	Oviedo	71913	80	18	6.65	6.05	0.6
Spain	Pamplona	56897	81	19.7	5.12	4.16	0.96
Spain	Palmas G. Canaria	85973	64	22.6	4.24	3.6	0.64
Spain	Palma Mallorca	83128	77	22.6	7.19	6.23	0.96
Spain	Pontevedra	31206	79	19	7.48	6.62	0.87
Spain	Salamanca	45440	79	19.2	6.56	5.48	1.08
Spain	Santander	58362	78	18.8	5.01	4.35	0.66
Spain	Tenerife	52474	71	23.7	4.4	3.67	0.73
Spain	Segovia	17095	80	19.8	7.48	6.14	1.34
Spain	Sevilla	177514	77	25.7	8.89	7.43	1.46
Spain	Soria	12594	80	18.3	7.23	5.95	1.28
Spain	San Sebastian	66047	81	18.5	4.02	3.26	0.75
Spain	Tarragona	26417	77	23.8	6.37	5.13	1.24
Spain	Teruel	11995	78	19.3	7.31	5.6	1.71
Spain	Toledo	31042	77	23.4	7.1	5.67	1.43
Spain	Valencia	214073	78	24	7.81	7.03	0.78
Spain	Vitoria	38581	81	17.8	6.18	5.33	0.85
Spain	Valladolid	67795	79	20	7.98	6.75	1.23
Spain	Zamora	20858	79	20.3	7.44	6.16	1.28
Spain	Zaragoza	143087	78	22.6	6.14	4.81	1.33
Sweden	Stockholm	190092	93	18.9	3.87	3.69	0.18
Taiwan	Kaohsiung	212330	43	25.4	4.1	2.74	1.36
Taiwan	Taipei	390749	63	26	5.24	4.53	0.71
Taiwan	Taichung	162814	62	26.3	4.43	3.9	0.54

Thailand	Amnat Charoen	10191	56	27.8	3.15	2.4	0.75
Thailand	Ayutthaya	24630	56	28.9	3.3	2.38	0.92
Thailand	Bangkok	242841	64	29.9	2.87	2.1	0.77
Thailand	Buri Ram	31550	63	28.2	3.28	2.64	0.64
Thailand	Chachoengsao	19972	74	28.2	3.97	3.31	0.66
Thailand	Chumphon	11974	65	29.4	2.93	2.24	0.69
Thailand	Chon Buri	46481	65	29	2.69	1.98	0.72
Thailand	Chiang Mai	76294	69	27.9	3.58	2.95	0.63
Thailand	Chiang Rai	52925	74	27.4	3.87	3.25	0.61
Thailand	Chanthaburi	21381	60	27.9	3.3	2.69	0.61
Thailand	Chaiyaphum	28116	59	28.6	3.1	2.39	0.71
Thailand	Kalasin	30249	70	29.3	3.15	2.55	0.6
Thailand	Khon Kaen	59977	55	27.9	3.62	2.53	1.09
Thailand	Kamphaeng Phet	13792	65	27.9	3.51	2.81	0.7
Thailand	Kanchanaburi	21633	70	29.6	3.69	2.84	0.85
Thailand	Krabi	7368	61	28.1	4.11	3.31	0.81
Thailand	Lamphun	16192	76	28	4.27	3.47	0.8
Thailand	Lampang	37781	51	28.4	3.21	2.16	1.06
Thailand	Lop Buri	29371	59	27.7	3.58	2.93	0.65
Thailand	Maha Sarakham	25121	58	29.4	2.89	2.11	0.78
Thailand	Mukdahan	7688	58	28.1	3.63	2.85	0.78
Thailand	Nan	19042	61	27.9	3.79	3.08	0.71
Thailand	Nakhon Phanom	15974	51	28	3.45	2.57	0.88
Thailand	Nakhon Pathom	25135	61	28.8	3.65	2.78	0.87
Thailand	Nakhon Ratchasima	73701	76	28.8	3.88	3.25	0.63
Thailand	Nakhon Sawan	37873	62	29.2	3.38	2.37	1.01
Thailand	Nakhon Si Thammarat	38612	60	27.8	3.81	3.08	0.73
Thailand	Nong Bua Lam Phu	12259	57	28.9	3.3	2.57	0.72
Thailand	Nong Khai	20118	59	28.8	2.88	2.18	0.7
Thailand	Nonthaburi	30838	64	28.8	3.14	2.26	0.87
Thailand	Narathiwat	15506	52	28.1	2.5	1.81	0.69
Thailand	Pattani	12344	57	28.1	3.49	2.72	0.77
Thailand	Phayao	23941	60	28.3	3.4	2.71	0.69
Thailand	Phichit	15039	54	28.1	2.85	1.78	1.07
Thailand	Phrae	22432	53	28.7	2.82	2.04	0.78
Thailand	Phetchabun	26200	57	27.4	3.3	2.38	0.92
Thailand	Phetchaburi	14351	57	28.2	3.15	2.43	0.72
Thailand	Phitsanulok	31576	54	28.8	3.11	2.16	0.96
Thailand	Prachin Buri	14841	64	28.8	4.1	3.34	0.76
Thailand	Prachuap Khiri Khan	13912	60	28.4	3.7	3.09	0.61
Thailand	Pathum Thani	22274	61	28.2	3.34	2.66	0.68
Thailand	Rayong	18185	65	26.8	3.32	2.56	0.76
Thailand	Roi Et	39160	73	28.9	3.63	3.02	0.61
Thailand	Ratchaburi	29860	74	28.5	4.21	3.46	0.75
Thailand	Sa Kaeo	13335	55	28.1	2.88	2.11	0.77
Thailand	Saraburi	22361	53	28.5	3.16	2.3	0.86

Thailand	Sukhothai	17727	54	28.7	3.13	2.09	1.04
Thailand	Sakon Nakhon	31563	74	28.5	3.81	3.17	0.64
Thailand	Samutprakan	29796	65	29.1	2.89	2.3	0.59
Thailand	Samut Sakhon	15214	55	28.7	3	2.34	0.67
Thailand	Songkhla	33372	58	28.2	3.15	2.4	0.75
Thailand	Suphanburi	24506	67	29.1	3.29	2.5	0.79
Thailand	Surat Thani	21994	79	29.4	4.32	3.7	0.62
Thailand	Si Sa Ket	35365	59	28.3	3.2	2.52	0.68
Thailand	Surin	30862	57	28.4	3.22	2.3	0.93
Thailand	Tak	11373	60	28.4	3.54	2.72	0.82
Thailand	Trang	13314	63	29.2	3.37	2.55	0.82
Thailand	Ubon Ratchathani	48333	74	29.1	3.84	3.21	0.62
Thailand	Udon Thani	44428	75	29.2	3.9	3.18	0.71
Thailand	Uttaradit	19590	56	28.2	3.61	2.71	0.9
Thailand	Yala	10887	58	27.9	3.78	2.99	0.79
Thailand	Yasothon	15133	68	27.7	3.97	3.27	0.69
UK	East	749380	92	18.3	8.84	8.54	0.31
UK	East Midlands	606487	91	17.3	8.59	8.32	0.27
UK	London	845215	92	19.5	9.92	9.47	0.45
UK	North East	407862	90	15.9	7.6	7.27	0.33
UK	North West	1069737	88	16.2	8.52	8.23	0.29
UK	South East	1132649	91	17.9	8.9	8.59	0.31
UK	South West	771244	86	16.3	9.48	9.19	0.29
UK	Wales	472014	89	16.5	9.31	9.08	0.23
UK	West Midlands	771704	92	17.4	8.06	7.85	0.21
UK	Yorkshire & Humber	747424	88	16.2	8.06	7.8	0.26
USA	Akron, OH	107392	87	21.9	7.15	6.76	0.38
USA	Albuquerque, NM	73279	83	24.2	5.99	5.7	0.28
USA	Allentown-Bethlehem, PA	61366	88	23.1	6.86	6.48	0.38
USA	Atlanta, GA	310249	81	25.6	4.9	4.75	0.15
USA	Atlantic City, NJ	49410	85	23.1	7.26	6.79	0.47
USA	Austin, TX	69427	79	28.3	4.06	3.82	0.24
USA	Bakersfield, CA	88852	92	29.2	4.82	4.6	0.22
USA	Baltimore, MD	319591	83	23.9	7.23	6.76	0.47
USA	Barnstable-Yarmouth, MA	51337	92	22.2	6.75	6.58	0.17
USA	Bergen-Passaic, NJ	239023	83	23.9	7.77	7.34	0.43
USA	Birmingham, AL	171109	79	25.6	5.86	5.56	0.31
USA	Boston, MA	475683	86	21.9	8.72	8.32	0.4
USA	Baton Rouge, LA	62561	77	26.9	4.84	4.57	0.27
USA	Brownsville, TX	36059	61	26.9	2.93	2.71	0.22
USA	Buffalo, NY	212201	86	21.1	8.95	8.51	0.44
USA	Canton-Massillon, OH	77288	90	22.8	6.06	5.74	0.31
USA	Charleston, WV	49105	82	22.8	6.48	6.11	0.36
USA	Charlotte, NC	82255	87	26.1	4.85	4.81	0.04
USA	Chattanooga, TN	60219	81	25.3	4.46	4.25	0.22
USA	Chicago, IL	1115158	93	24.7	8.37	8.01	0.37

USA	Cincinnati, OH	171958	83	23.3	6.72	6.3	0.41
USA	Cleveland, OH	404057	86	21.9	7.99	7.56	0.43
USA	Columbia, SC	75994	81	26.4	5.63	5.3	0.33
USA	Columbus, OH	159353	87	23.6	6.05	5.71	0.34
USA	Dallas, TX	260718	79	27.8	4.73	4.34	0.39
USA	Daytona Beach, FL	107272	78	26.9	2.76	2.62	0.14
USA	Dayton, OH	108776	83	22.5	6.8	6.46	0.34
USA	Denver, CO	182600	82	21.1	5.75	5.32	0.43
USA	Des Moines, IA	54488	82	22.5	8.06	7.63	0.43
USA	Detroit, MI	729077	91	23.9	7.26	6.87	0.39
USA	Dutchess County, NY	43055	88	21.9	7.12	6.83	0.29
USA	El Paso, TX	73269	85	27.5	5.09	4.9	0.19
USA	Erie, PA	54723	91	23.1	7.49	7.11	0.37
USA	Flint, MI	75484	91	22.5	7.34	6.89	0.45
USA	Fresno, CA	104033	84	26.9	5.04	4.88	0.16
USA	Ft. Lauderdale, FL	308032	64	26.1	2.17	1.99	0.18
USA	Fort Myers-Cape Coral, FL	88850	44	24.2	2.11	1.62	0.49
USA	Fort Pierce-Port St. Lucie, FL	67004	48	23.9	1.71	1.49	0.22
USA	Fort Worth-Arlington, TX	172892	80	27.8	3.81	3.59	0.21
USA	Galveston, TX	40680	91	28.3	3.7	3.62	0.08
USA	Gary, IN	90669	91	23.9	7.14	6.8	0.34
USA	Grand Rapids, MI	78804	90	22.5	7.76	7.55	0.22
USA	Greensboro, NC	65906	91	26.1	6.3	6.06	0.24
USA	Greenville, SC	58344	81	24.7	5.94	5.69	0.24
USA	Hamilton, OH	49618	84	23.6	6.65	6.35	0.29
USA	Harrisburg-Carlisle, PA	49992	86	23.9	6.59	6.35	0.24
USA	Hartford, CT	159050	84	21.4	7.65	7.03	0.61
USA	Honolulu, HI	75775	99	29.2	2.87	2.87	0
USA	Houston, TX	366340	63	25.3	3.38	3.23	0.15
USA	Indianapolis, IN	149459	86	23.6	6.01	5.75	0.27
USA	Jacksonville, FL	124017	77	26.7	4.54	4.28	0.26
USA	Jersey City, NJ	103084	84	24.2	7.31	6.93	0.39
USA	Kansas City, MO-KS	218933	82	23.9	6.86	6.43	0.43
USA	Knoxville, TN	80418	81	24.4	5.42	5.05	0.36
USA	Lakeland-Winter Haven, FL	95395	61	26.1	2.99	2.74	0.25
USA	Lancaster, PA	80724	91	24.4	6.3	6.09	0.21
USA	Lansing, MI	37393	90	22.2	8.06	7.64	0.42
USA	Las Vegas, NV-AZ	182220	78	30	4.63	4.24	0.39
USA	Los Angeles, CA	1239036	95	22.8	2.48	2.34	0.14
USA	Louisville, KY	139347	80	24.2	6.54	6.07	0.47
USA	Little Rock, AR	63901	79	26.1	5.15	4.8	0.36
USA	Lubbock, TX	35407	83	26.1	5.69	5.51	0.18
USA	Madison, WI	48763	90	22.5	7.24	6.96	0.28
USA	McAllen-Edinburg-Mission, TX	49998	71	29.2	3.19	2.98	0.21
USA	Melbourne-Titusville-Palm Bay, FL	88449	73	26.7	3.44	3.28	0.16
USA	Memphis, TN	152003	79	26.4	6.54	6.28	0.26

USA	Miami, FL	372130	39	24.7	1.9	1.07	0.83
USA	Middlesex, NJ	110324	90	24.2	8.01	7.57	0.44
USA	Milwaukee, WI	232056	83	20.8	9.7	9.14	0.56
USA	Minneapolis-St. Paul, MN	241475	87	22.2	8.21	7.83	0.37
USA	Mobile, AL	72746	78	26.7	3.34	3.24	0.11
USA	Monmouth-Ocean, NJ	235036	90	24.2	6.94	6.69	0.25
USA	Myrtle Beach, SC	30268	82	25.8	4.9	4.73	0.17
USA	Naples, FL	36951	49	24.7	2.28	1.91	0.37
USA	Nashua, NH	51115	91	22.2	8.37	7.97	0.41
USA	Nashville, TN	97358	80	25	6.81	6.36	0.45
USA	Nassau-Suffolk, NY	460192	85	22.2	8.89	8.57	0.33
USA	Newark, NJ	220980	83	23.9	6.76	6.22	0.54
USA	Newburgh, NY	49890	91	23.3	7.59	7.32	0.27
USA	New Haven-Meriden, CT	157415	85	21.7	8.57	7.98	0.59
USA	New London, CT	40419	91	23.3	7.2	6.84	0.36
USA	New York, NY	1367085	80	23.1	7.71	6.9	0.82
USA	Oakland, CA	325028	95	20.8	4.09	3.95	0.14
USA	Ocala, FL	58345	73	26.7	3.49	3.36	0.13
USA	Oklahoma City, OK	118753	90	28.1	5.36	5.2	0.16
USA	Omaha, NE	71558	84	23.3	7.6	7.02	0.58
USA	Orange County, CA	320343	96	25.6	2.04	1.99	0.05
USA	Orlando, FL	157019	73	27.2	2.6	2.41	0.19
USA	Pensacola, FL	50546	77	26.9	4.84	4.53	0.31
USA	Philadelphia, PA-NJ	911888	80	23.3	8.17	7.71	0.47
USA	Phoenix, AZ	386802	65	29.2	2.92	2.74	0.18
USA	Pittsburgh, PA	317935	90	23.3	6.68	6.31	0.37
USA	Portland, ME	46217	90	20.6	8.08	7.67	0.42
USA	Portland, OR	210301	91	21.4	6.86	6.49	0.37
USA	Providence-Fall River, RI-MA	36108	91	23.3	7.23	7	0.22
USA	Punta Gorda, FL	37773	59	25.8	2.62	2.46	0.16
USA	Raleigh, NC	58561	84	25.3	5.41	5.14	0.27
USA	Reading, PA	72337	80	24.4	5.37	4.94	0.43
USA	Riverside-San Bernardino, CA	433285	95	28.3	2.78	2.74	0.04
USA	Rochester, NY	127040	89	21.7	7.71	7.28	0.43
USA	Rockford, IL	46380	85	21.9	8.02	7.65	0.38
USA	Sacramento, CA	172136	92	25.3	4.23	4.07	0.16
USA	Saginaw, MI	39515	87	21.4	8.05	7.61	0.43
USA	Salinas, CA	45929	97	20.6	3.95	3.87	0.08
USA	Salt Lake City, UT	89770	86	24.7	6.32	6.03	0.29
USA	San Antonio, TX	186461	89	30	3.01	2.9	0.11
USA	Sarasota-Bradenton, FL	151551	47	23.9	1.85	1.51	0.34
USA	Scranton--Wilkes-Barre-- Hazleton, PA	150119	84	20.8	7.71	7.39	0.32
USA	San Diego, CA	369956	96	23.3	3.45	3.39	0.06
USA	Seattle, WA	225451	92	19.4	6.67	6.39	0.28
USA	San Francisco, CA	248607	97	20.8	3.33	3.27	0.06
USA	Shreveport, LA	51716	78	26.9	5.33	4.97	0.36

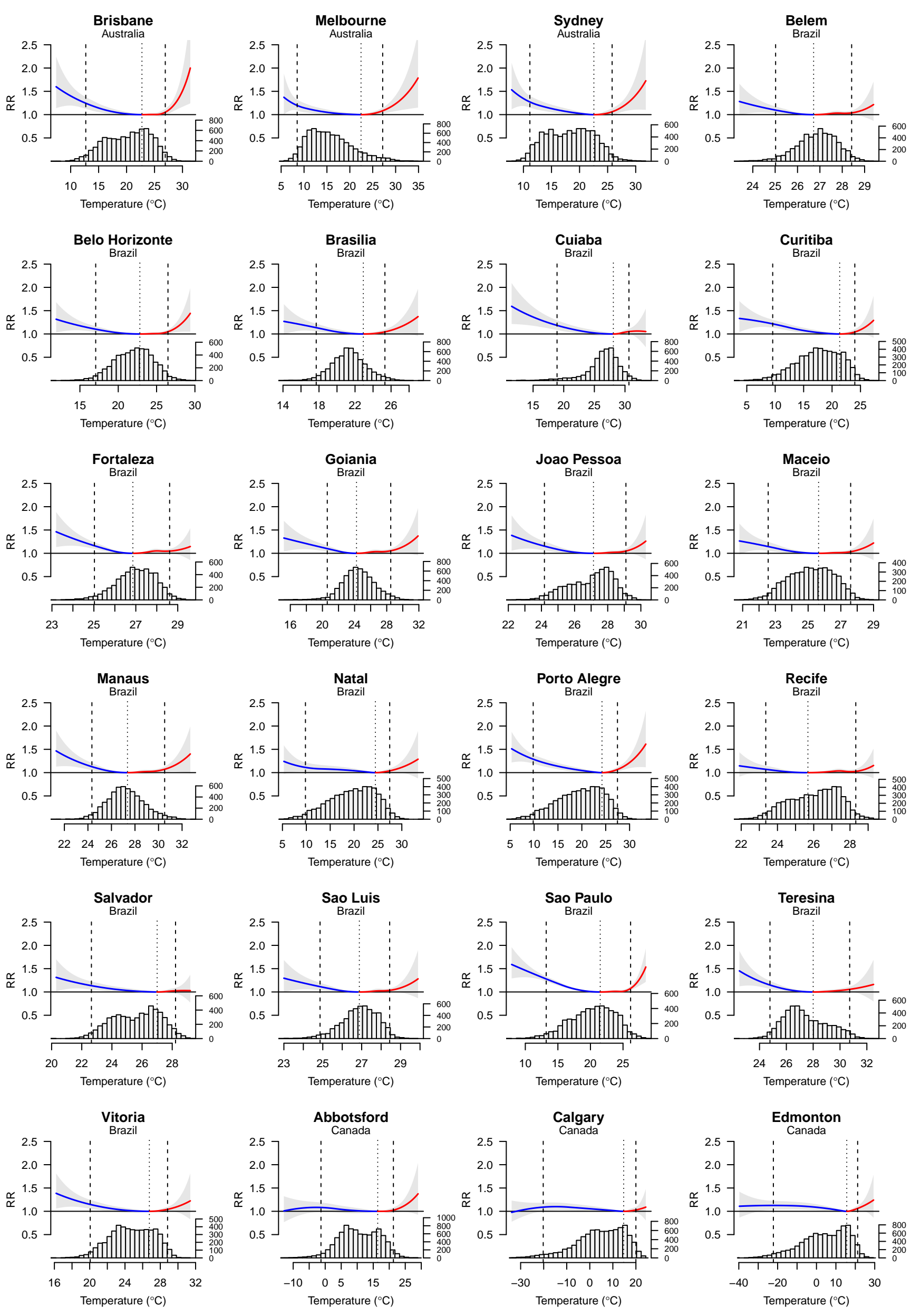
USA	San Jose, CA	176066	94	23.3	3.14	2.97	0.17
USA	Spokane, WA	68681	89	20.8	7.33	6.92	0.41
USA	Springfield, MA	94971	84	21.4	8.65	8.08	0.58
USA	Stamford-Norwalk, CT	142216	86	22.5	7.56	7.2	0.36
USA	St. Louis, MO-IL	312923	91	27.2	5.87	5.62	0.25
USA	Stockton-Lodi, CA	82225	90	25.6	6.02	5.86	0.16
USA	Syracuse, NY	84451	86	21.1	7.36	6.87	0.49
USA	Tacoma, WA	96086	93	20	6.26	6.17	0.1
USA	Tampa-St. Petersburg-Clearwater, FL	158555	54	25	2.69	2.44	0.25
USA	Toledo, OH	92004	84	21.7	7.91	7.42	0.5
USA	Trenton, NJ	58430	90	24.2	6.9	6.63	0.27
USA	Tucson, AZ	131053	78	28.9	4.27	4.04	0.24
USA	Tulsa, OK	95475	84	26.9	5.74	5.63	0.11
USA	Utica-Rome, NY	53724	90	21.7	7.59	7.26	0.33
USA	Ventura County, CA	87603	96	21.7	2.77	2.69	0.08
USA	Virginia Beach, VA	187233	83	25.3	5.26	4.94	0.32
USA	Washington, DC-MD-VA	141028	87	25.8	6.44	6.07	0.37
USA	Wichita, KS	68542	81	25	6	5.55	0.45
USA	Wilmington, DE	76254	84	23.6	7.11	6.63	0.48
USA	Worcester, MA	135785	85	20	8.23	7.68	0.55
USA	West Palm Beach-Boca Raton, FL	233887	40	24.2	1.99	1.28	0.71
USA	York, PA	62767	82	22.5	6.92	6.54	0.38
USA	Youngstown-Warren, OH	86656	85	20.8	6.69	6.36	0.33

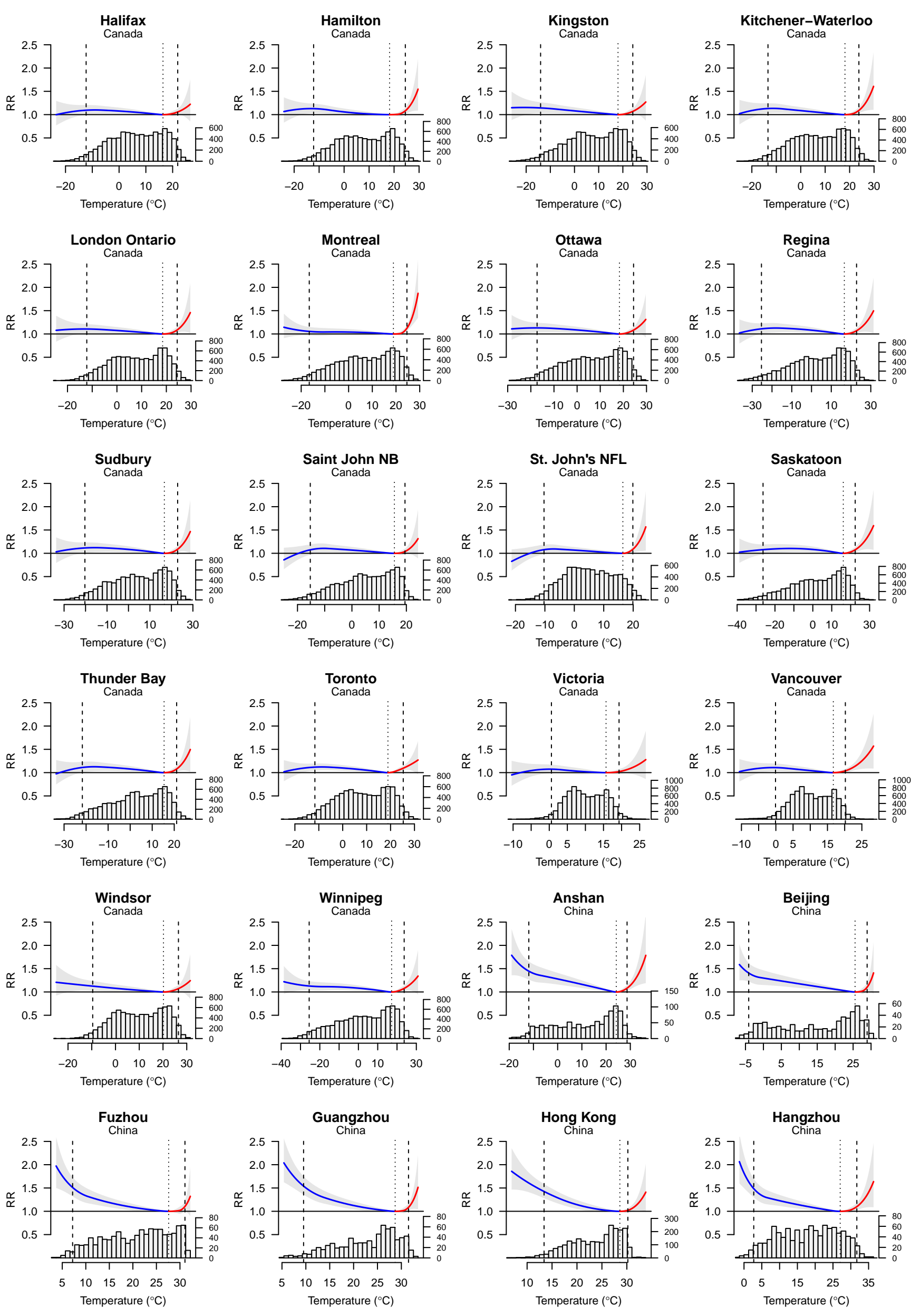


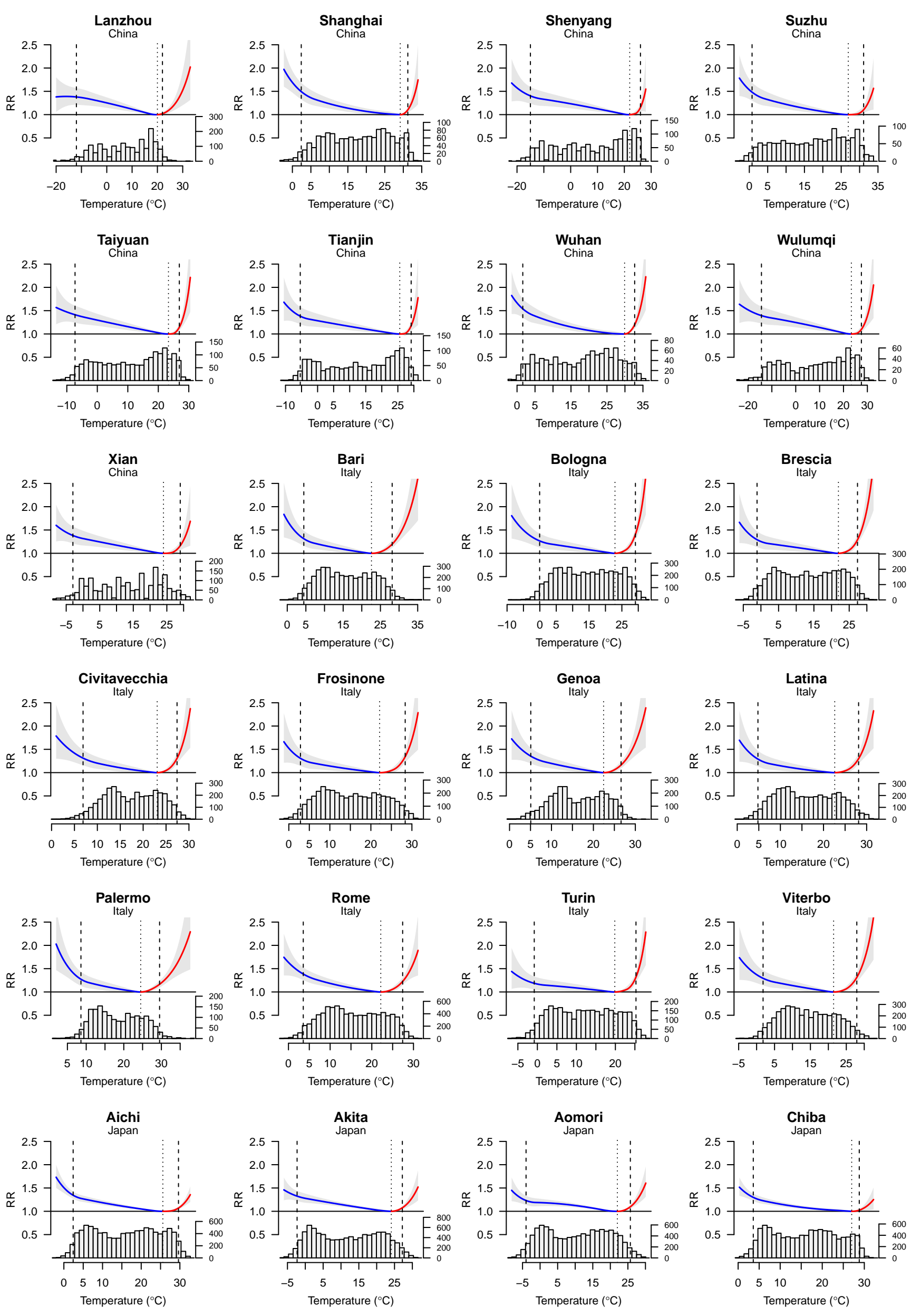
## **Additional figures**

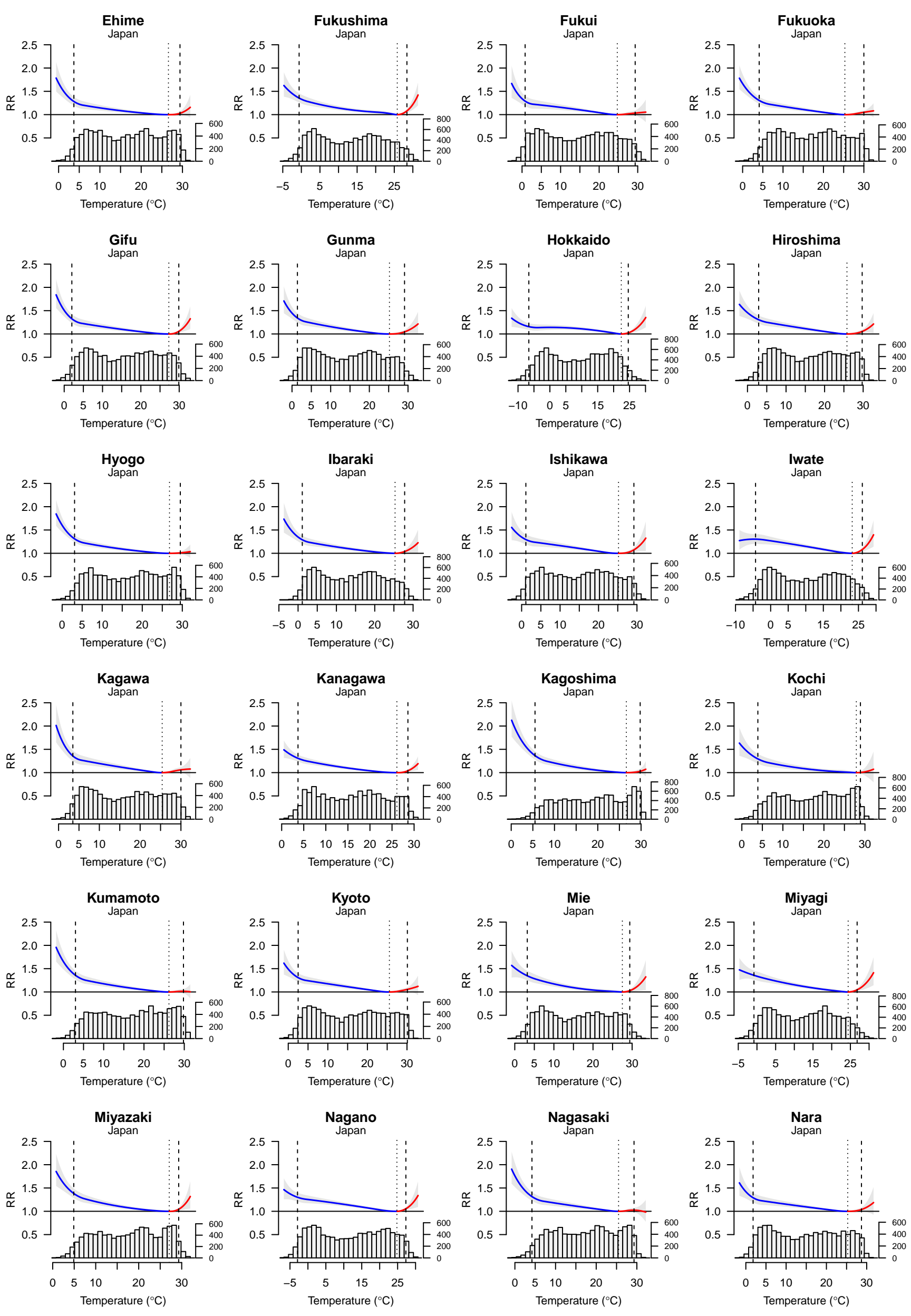
### ***Figure S1: Overall cumulative exposure-response relationships in 384 locations***

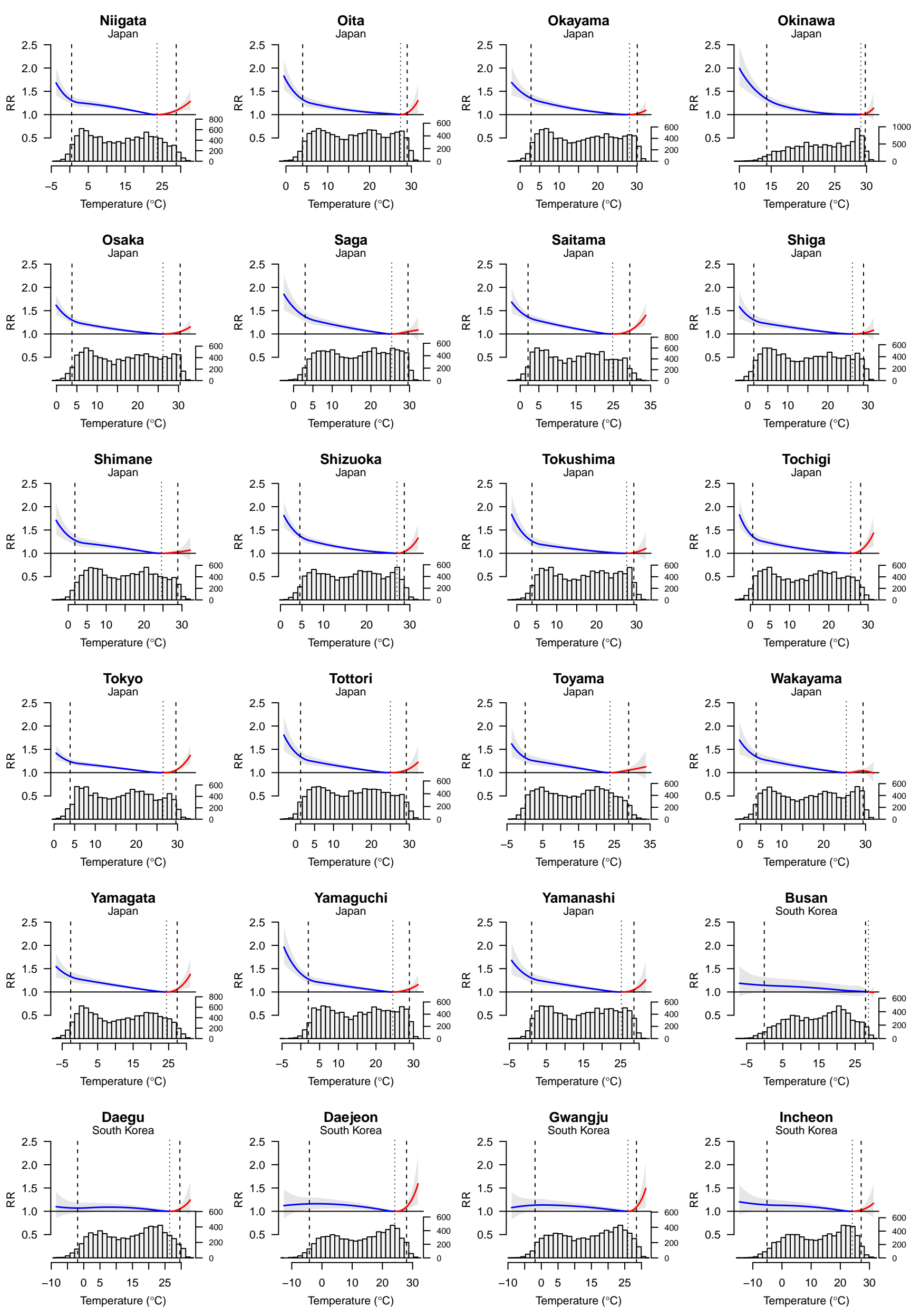
These exposure-response relationships are computed as BLUP (with 95%eCI) in the 384 locations of the 13 countries, with related temperature distributions. The minimum mortality temperature (MMT) and the 2.5<sup>th</sup> and 97.5<sup>th</sup> percentiles are added as dotted and dashed lines, respectively.

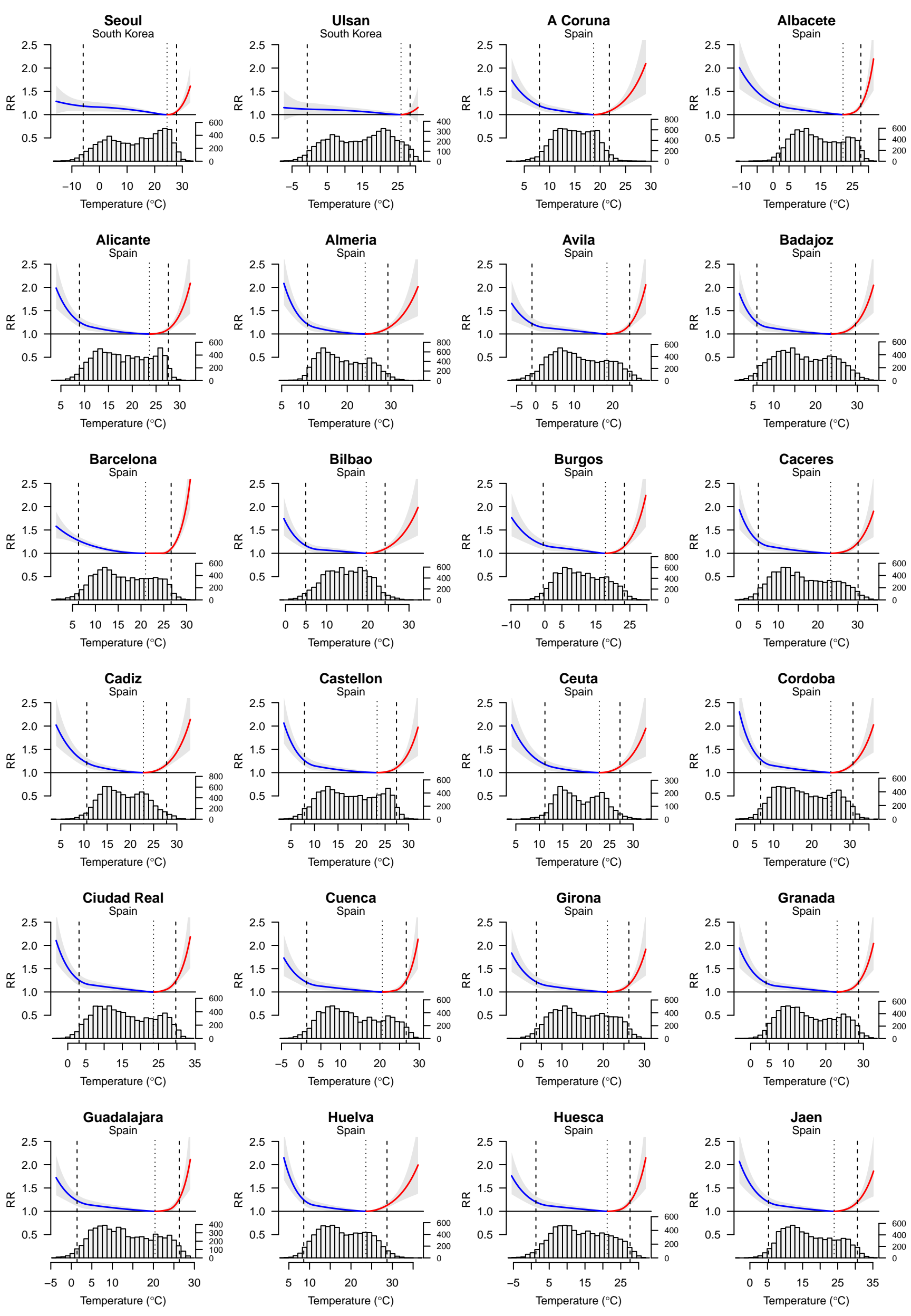


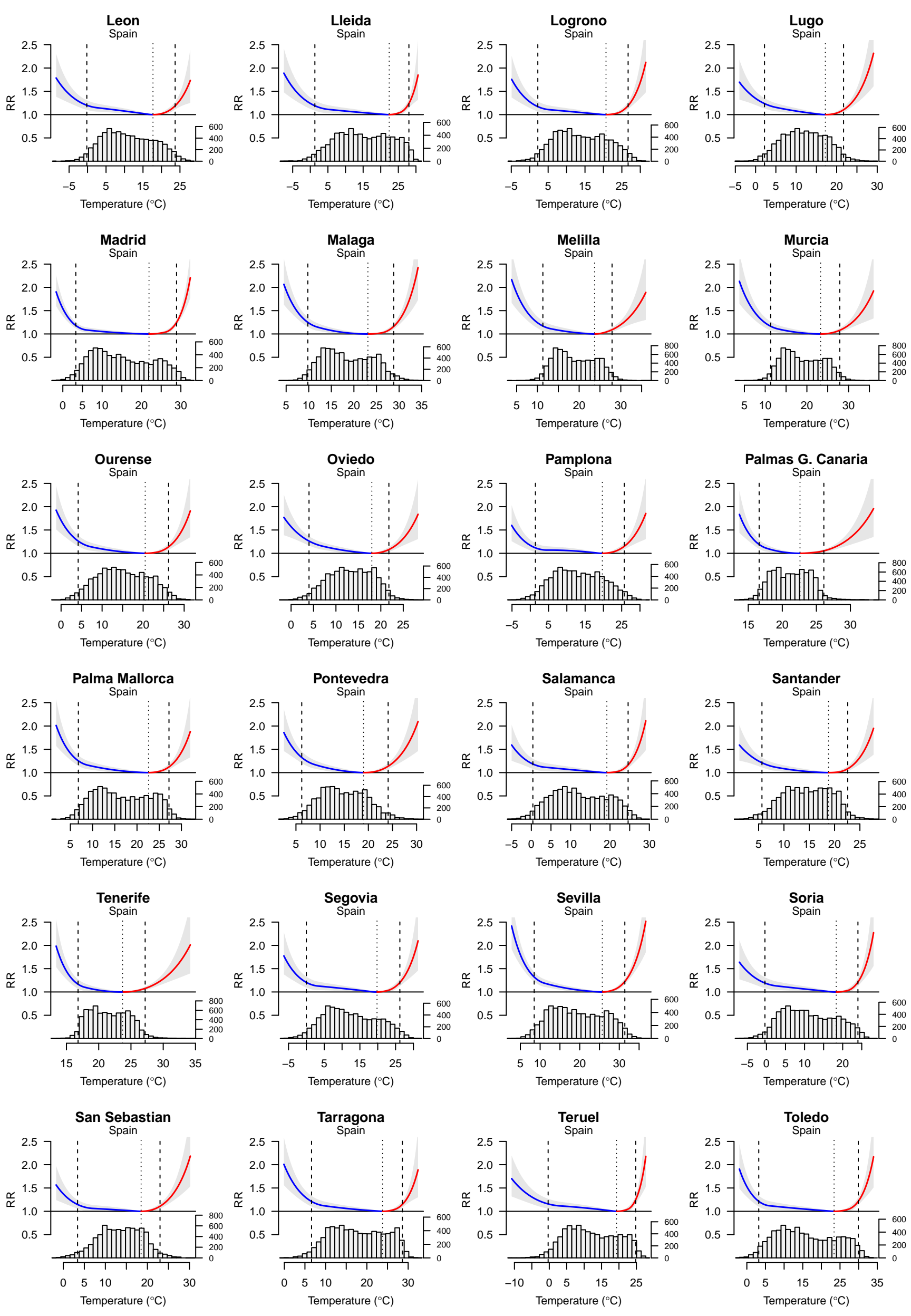




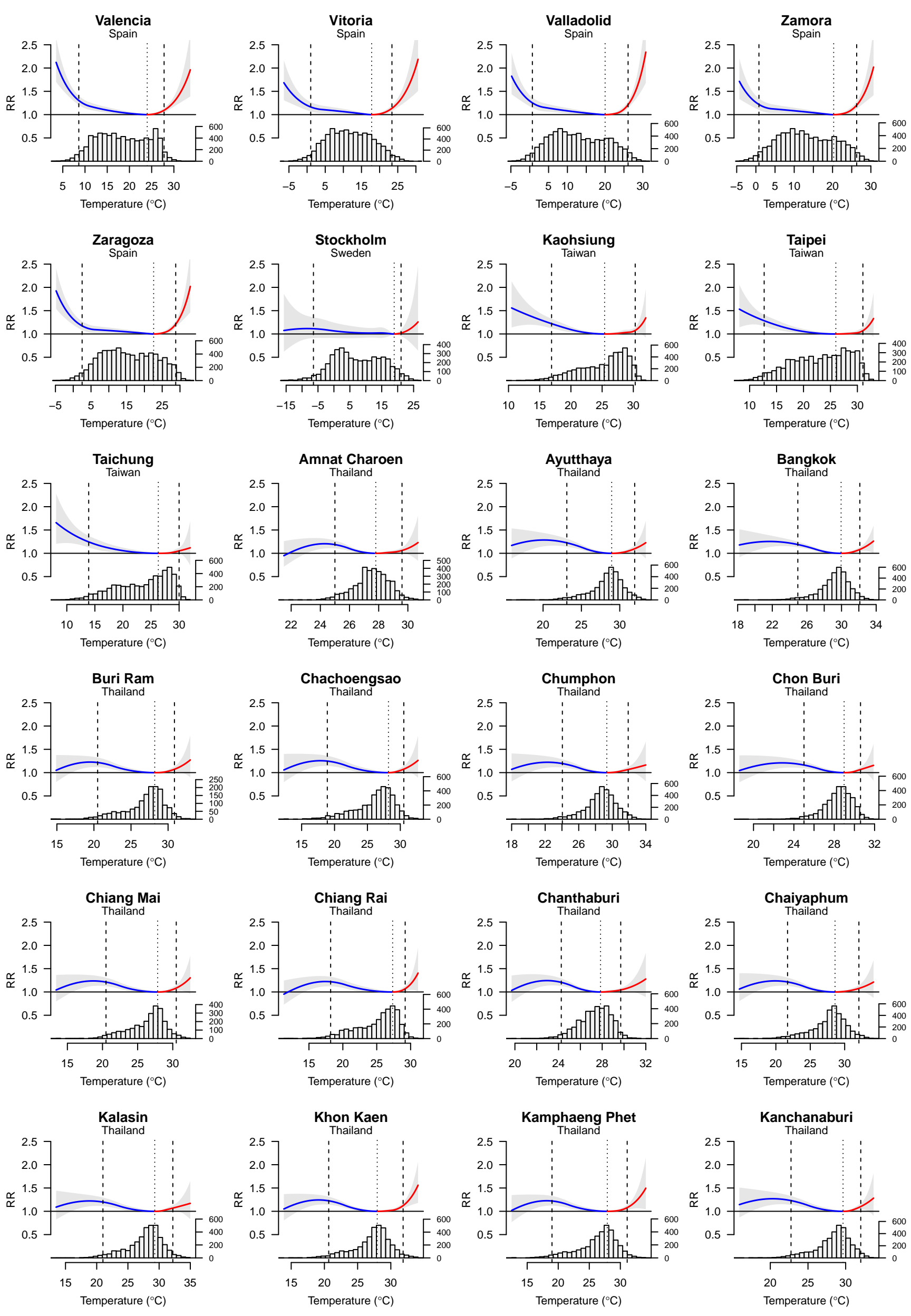


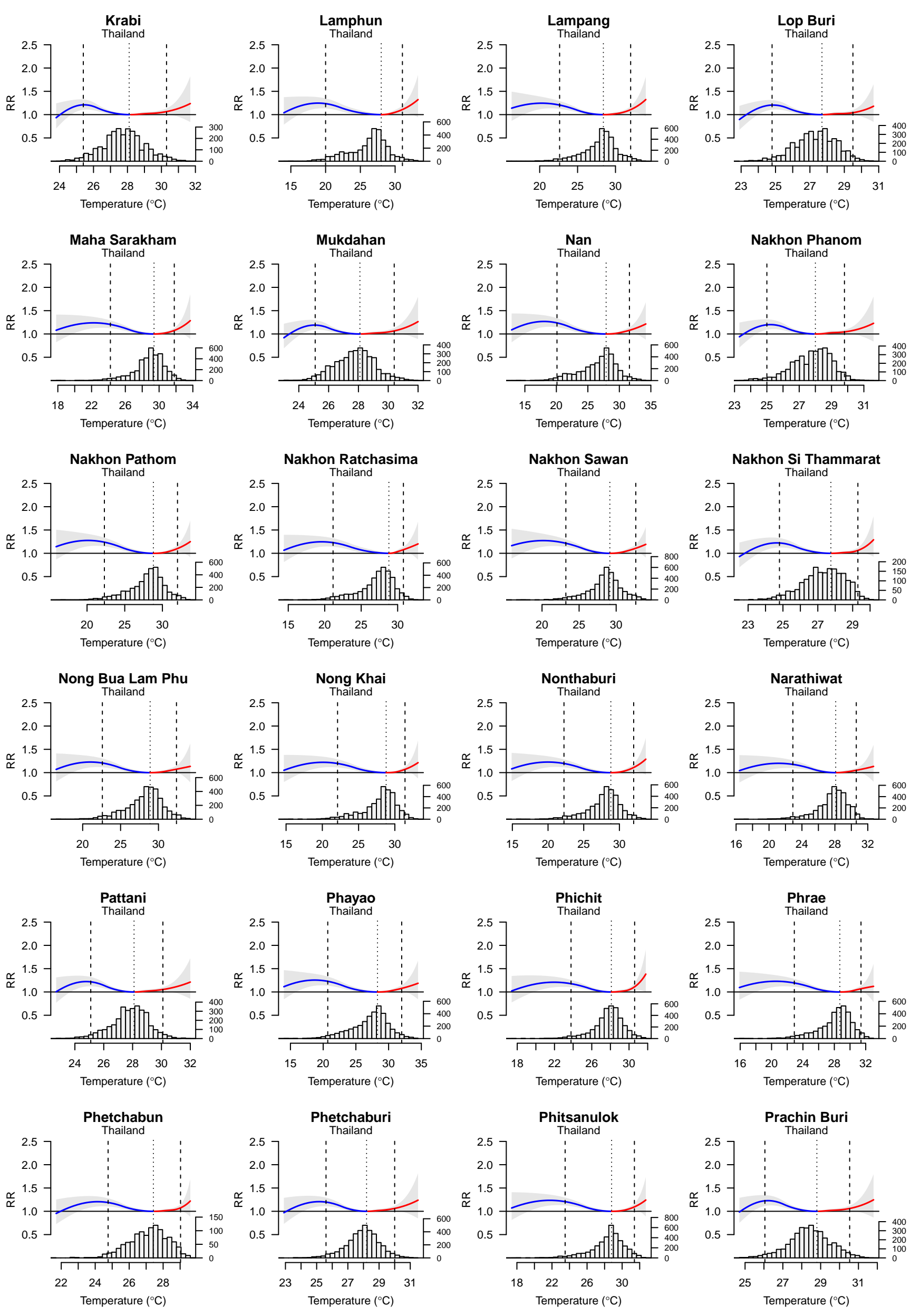






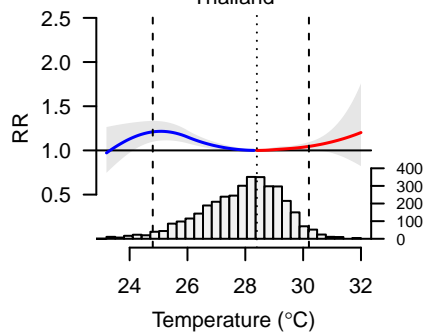




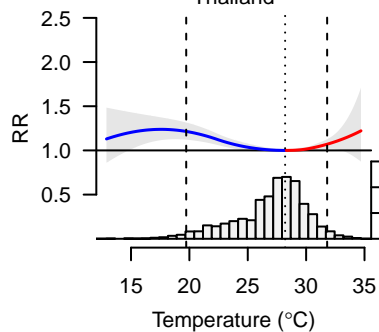


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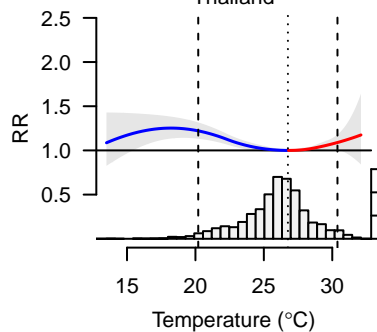
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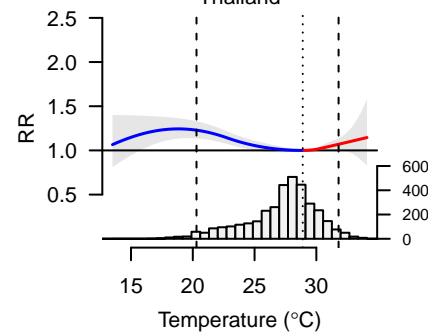
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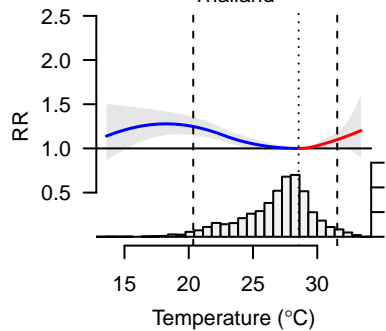
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**Roi Et**

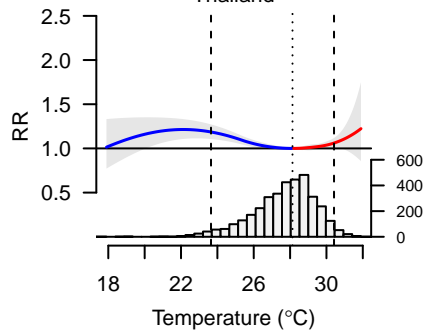
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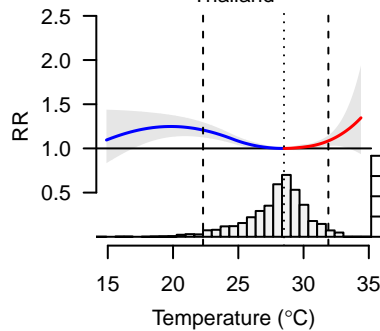
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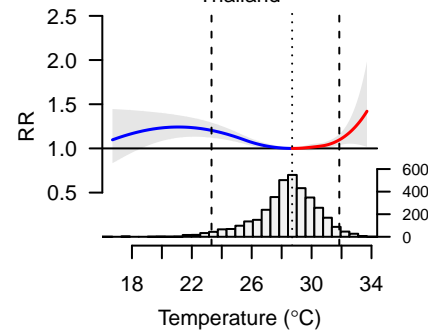
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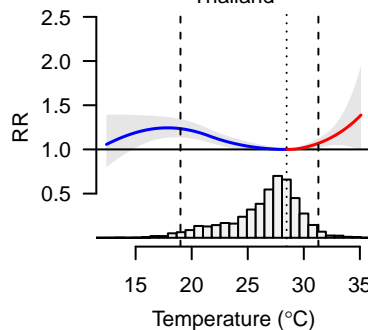
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**Sukhothai**

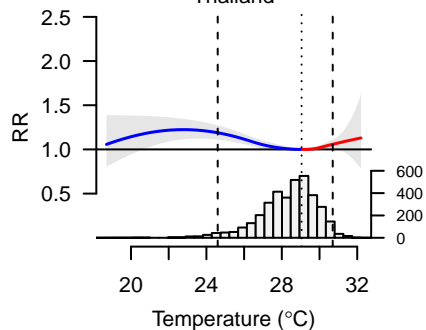
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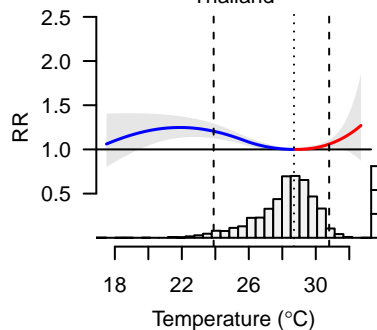
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**Samutprakan**

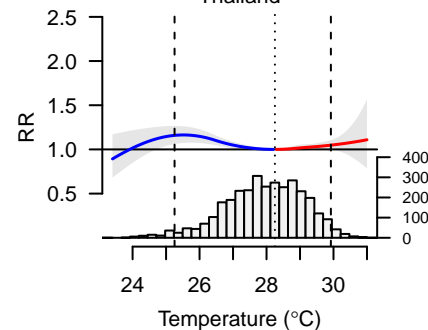
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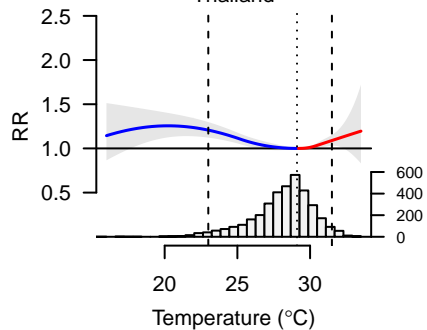
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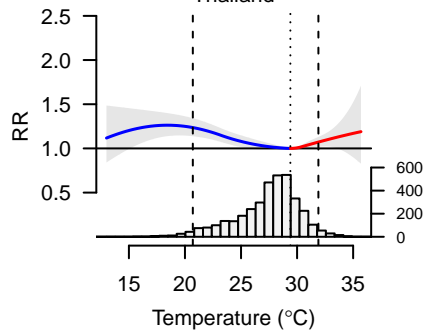
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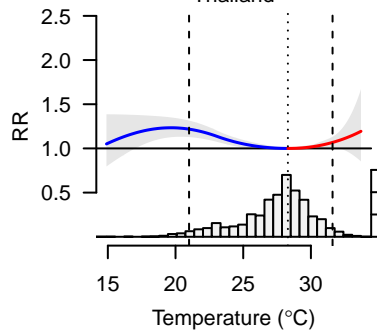
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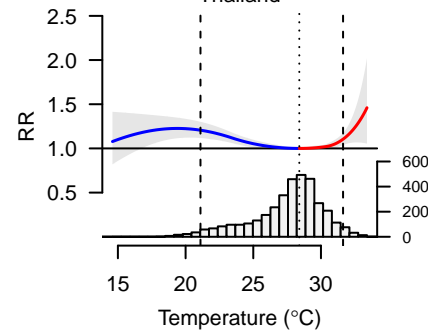
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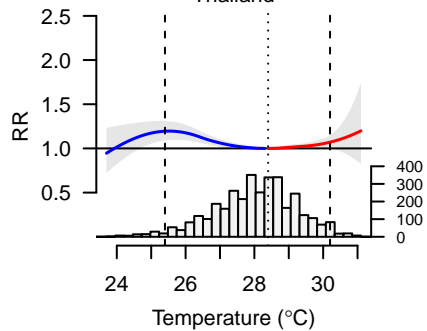
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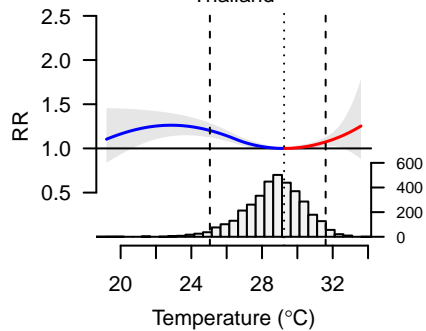
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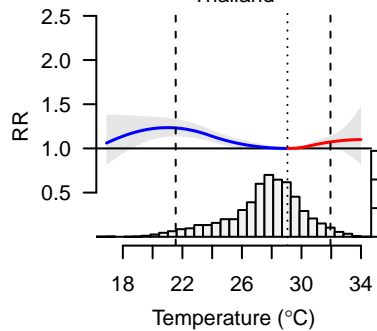
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**Trang**

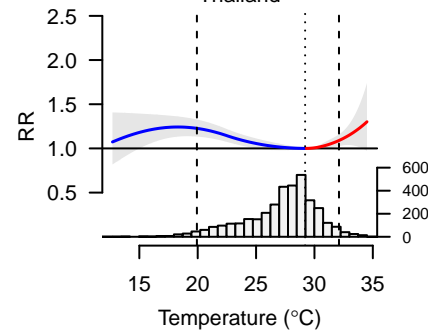
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**Ubon Ratchathani**

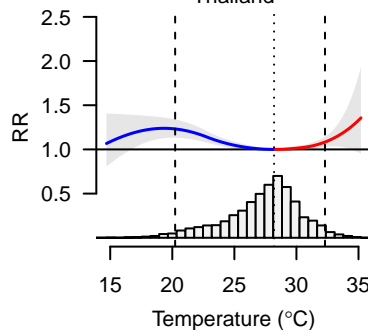
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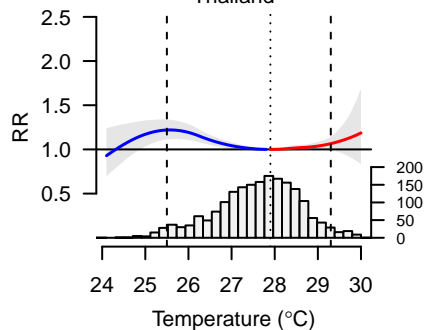
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**Uttaradit**

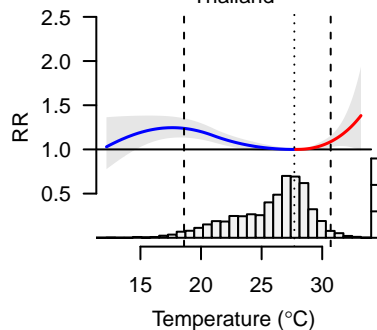
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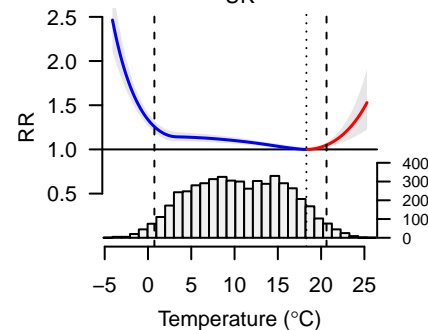
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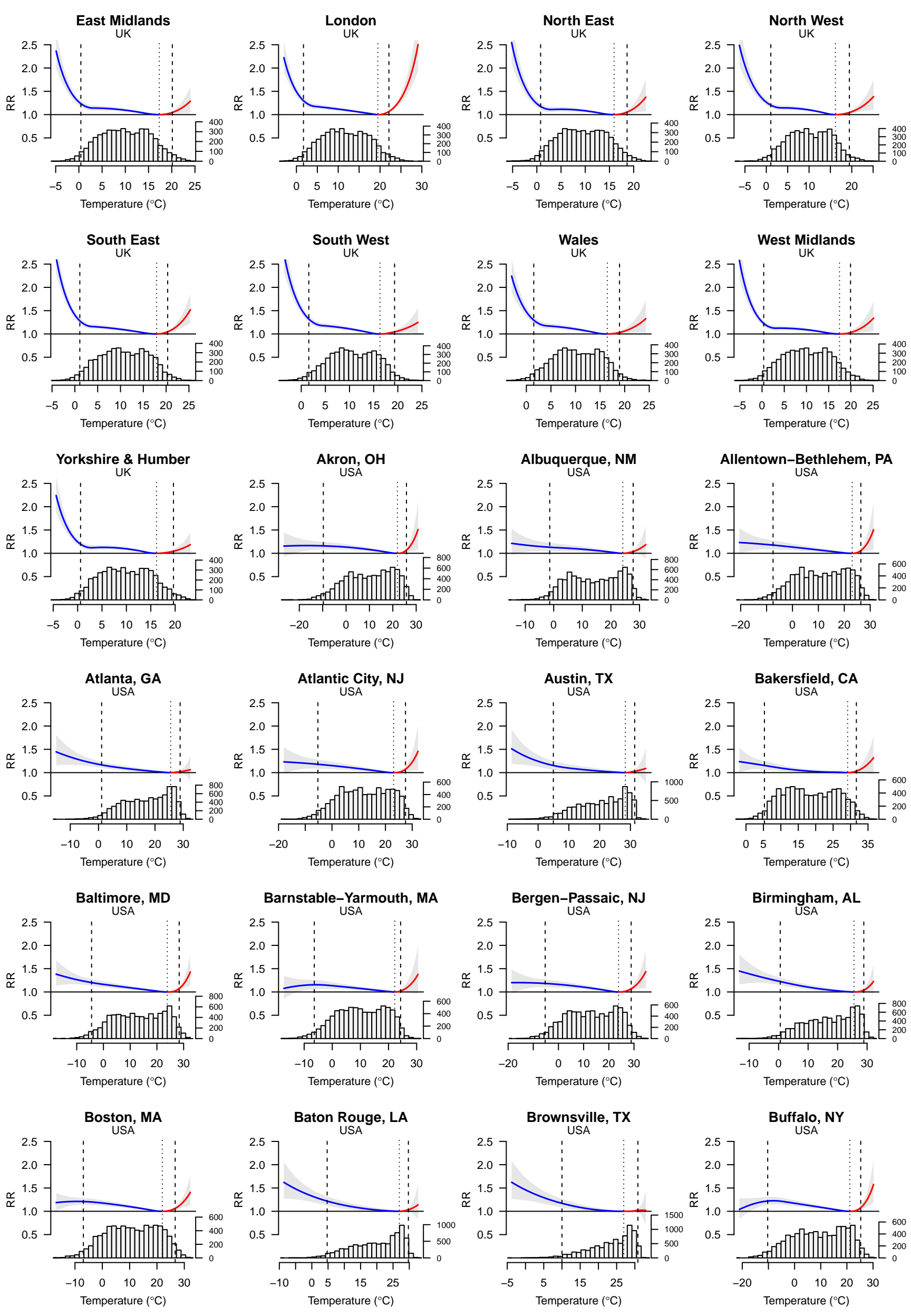
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Thailand

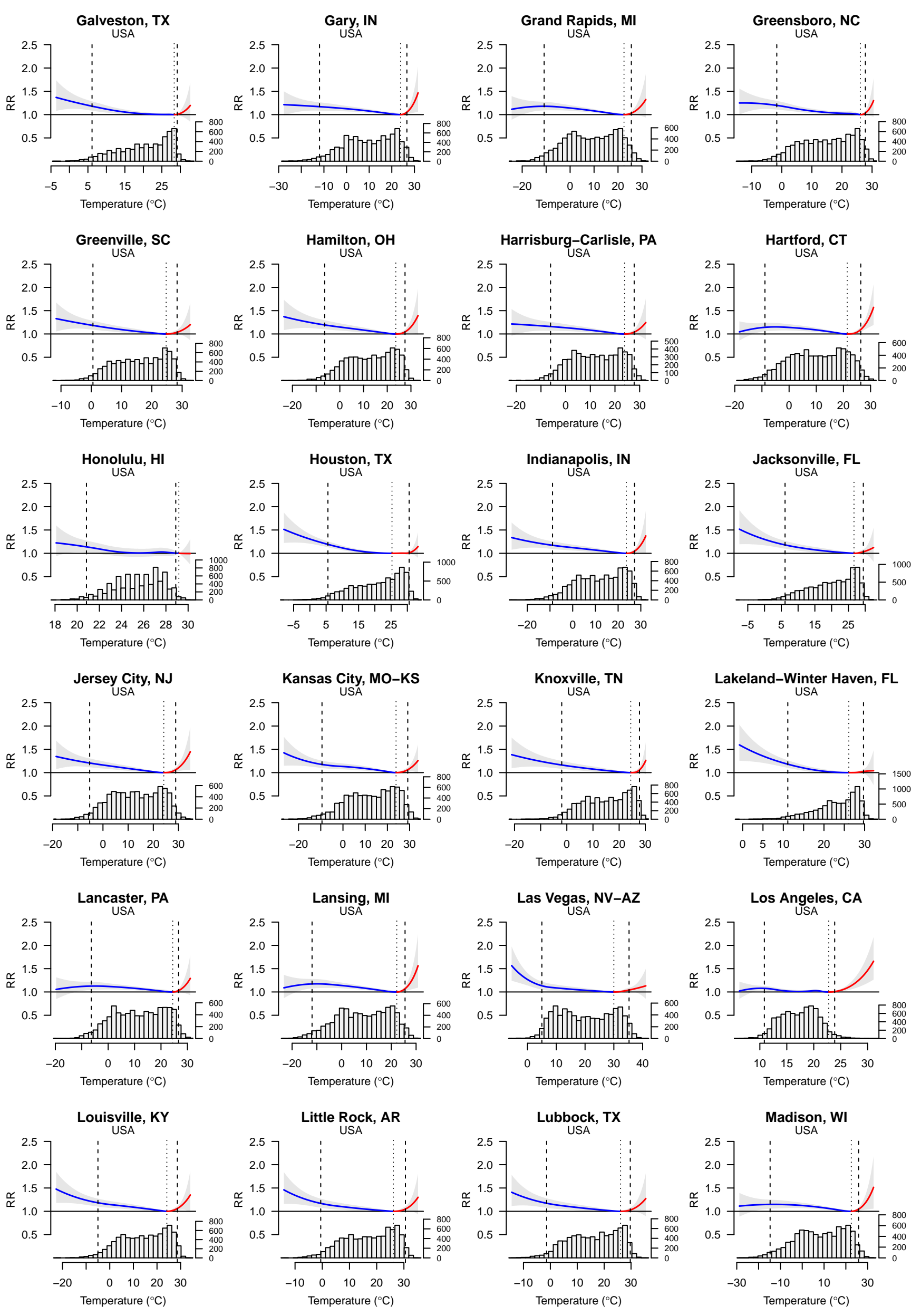
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UK

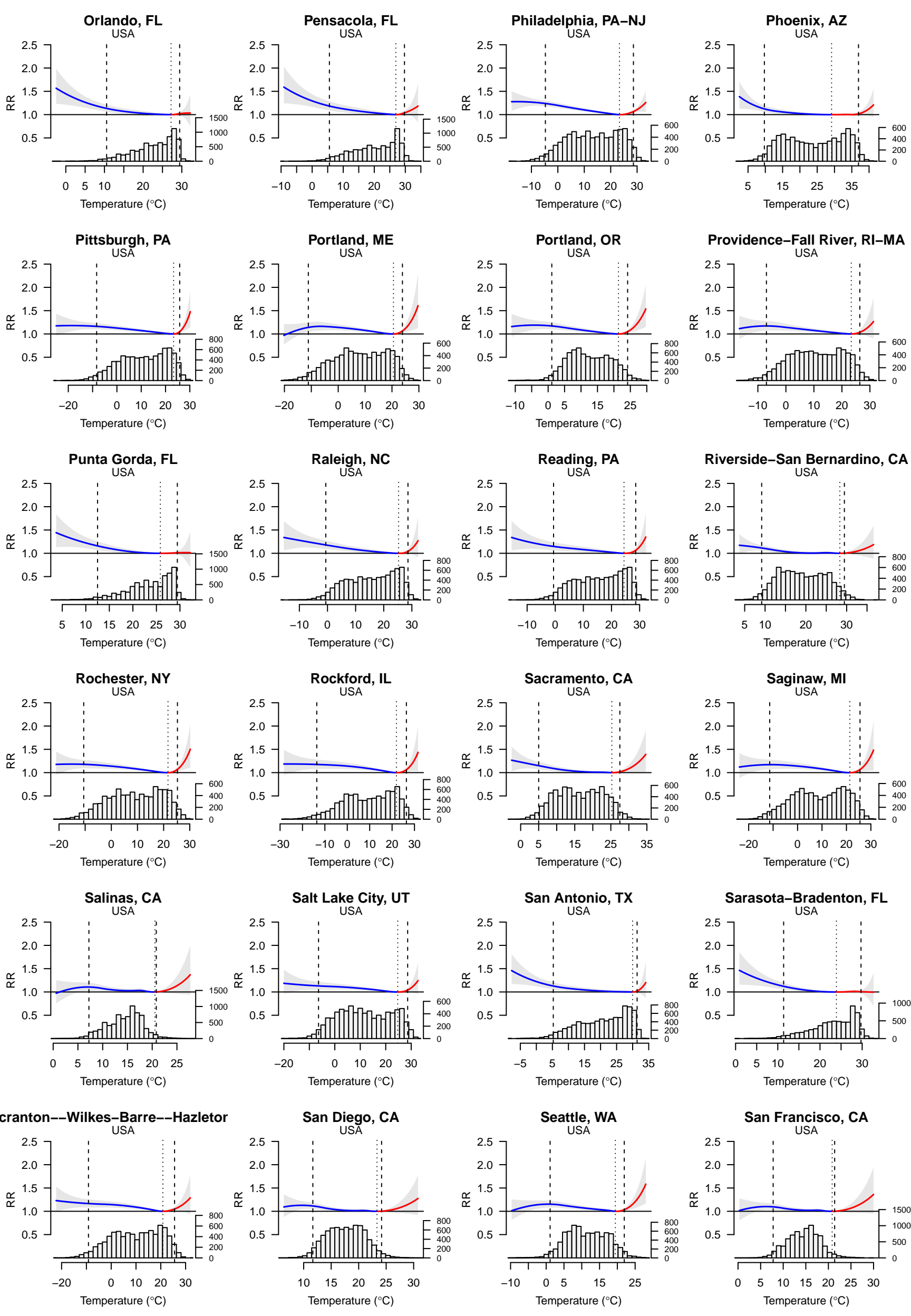
















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