Web Appendix

Changes in susceptibility to heat within the summer: a multi-country analysis

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Web Appendix 1

Australia

We collected data from Melbourne, Sydney and Brisbane between 1st of January 1988 and 31st 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. These data were used and described in previous publications (1-4).

Canada

We collected data from 20 census metropolitan areas (CMA) (see full list in Table S1 and in Figure S2 below) and 6 cities (Hamilton, Niagara, Oakville, Oshawa, Sarnia, Sault-Ste Marie) between 1st of January 1986 and 31st of December 2011. 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. These data (or a subset of them) were used and described in previous publications (3-6).

China

We collected data from the city of Anshan (1st of January 2004 to 31st of December 2006), Beijing (1st of January 2007 to 30th of September 2008), Fuzhou (1st of January 2004 to 31st of December 2006), Guangzhou (1st of January 2007 to 31st of December 2008), Hong Kong (1st of January 1996 to 31st of December 2002), Hangzhou (1st of January 2002 to 29th of December 2004), Lanzhou (1st of January 2004 to 31st of December 2008), Nanjing (1st of January 2007 to 31st of December 2010), Shanghai (1st of January 2001 to 31st of December 2004), Shenyang (1st of January 2005 to 31st of December 2008), Suzhu (1st of January 2005 to 31st of December 2008), Taiyuan (1st of January 2004 to 31st of December 2008), Tianjin(1st of January 2005 to 31st of December 2008), Wuhan (1st of January 2003 to 31st of December 2005), Wulumqi (1st of January 2006 to 31st of December 2007), and Xian (1st of January 2004 to 31st 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_2, in μg/m^3), particles (PM10, in in μg/m^3) and sulphur dioxide (SO2, in in μg/m^3) 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. These data were used and described in previous publications (3).

Italy

We collected data from the city of Bari (1st of January 1996 to 31st of December 2007), Bologna (1st of January 1996 to 31st of December 2010), Brescia (1st of January 1993 to 31st of December 2003), Civitavecchia (1st of January 1996 to 31st of December 2006), Frosinone (1st of January 1995 to 31st of December 2006), Genova (1st of January 1999 to 31st of December 2007), Latina (1st of January 1995 to 31st of December 2006), Palermo (1st of January 1997 to 31st of December 2001), Roma (1st of January 1987 to 31st of December 2010), Torino (1st of January 1991 an to 1st of December 1999), and Viterbo (1st of January 1995 to 1st 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 (3, 7, 8).

Japan

We collected data from 47 prefectures (see full list in Table S1 and in Figure S2 below) between 1st of January 1985 and 31st 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. These data were used and described in previous publications (3, 4).

South Korea

We collected data from 7 cities (see full list in Table S1 and in Figure S2 below) between 1st of January 1992 and 31st 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. Daily level of pollutants were computed as the 24-hour mean based on hourly measurements. These data were used and described in previous publications (3, 4).

Spain

We collected data from the 51 capital cities (see full list in Table S1 and in Figure S2 below) between 1st of January 1990 and 31st 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. These data (or a subset of them) were used and described in previous publications (3, 4, 9).

UK

We collected data in 9 regions of England and in Wales (see full list in Table S1 and in Figure S2 below) between 1^{st} of January 1990 and 30^{st} of August 2012. 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, 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. Missing values were imputed through interpolation between stations within the same region. A subset of these data were used and described in previous publications (3, 4, 10, 11).

USA

We collected data from 135 cities (see full list in Table S1 and in Figure S2 below) between 1^{st} of January 1985 and 31^{st} 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. These data were used and described in previous publications (3, 4, 12, 13).

Web Table 1. List of the 305 locations in 9 countries with study periods, total number of deaths and summer temperature (mean and range).

Location	*Country*	*Period*	*Total deaths*	*Summer temperature (°C)*
BRISBANE	Australia	1988-2009	58836	24.2 (17.4 to 31.4)
MELBOURNE	Australia	1988-2009	140400	20.0 (10.6 to 35.0)
SYDNEY	Australia	1988-2009	161899	22.2 (14.0 to 31.8)
ABBOTSFORD	Canada	1986-2011	8572	17.0 (8.9 to 29.0)
CALGARY	Canada	1986-2011	42293	14.3 (-2.5 to 24.3)
EDMONTON	Canada	1986-2011	49262	15.3 (0.4 to 29.4)
HALIFAX	Canada	1986-2011	22407	16.9 (5.2 to 26.6)
HAMILTON	Canada	1986-2011	35884	18.9 (4.2 to 29.6)
KINGSTON	Canada	1986-2011	12362	18.8 (4.5 to 29.5)
KITCHENER-WATERLOO	Canada	1986-2011	22176	17.9 (3.6 to 29.8)
LONDON ONTARIO	Canada	1986-2011	30429	18.9 (4.3 to 30.7)
MONTREAL	Canada	1986-2009	79813	18.9 (3.3 to 29.3)
NIAGARA	Canada	1986-2011	30931	19.9 (6.2 to 30.5)
OAKVILLE	Canada	1986-2011	18543	19.4 (5.7 to 31.1)
OSHAWA	Canada	1986-2011	22707	18.3 (4.4 to 30.2)
OTTAWA	Canada	1986-2011	43017	18.7 (2.9 to 29.7)
REGINA	Canada	1986-2011	15797	16.3 (0.0 to 31.4)
SARNIA	Canada	1986-2011	8874	19.5 (6.0 to 30.7)
SUDBURY	Canada	1986-2011	13079	16.8 (1.2 to 28.8)
SAINT JOHN NB	Canada	1986-2011	13676	15.3 (4.0 to 25.7)
ST. JOHN'S NFL	Canada	1986-2011	17001	14.0 (1.2 to 24.3)
SAULT STE. MARIE	Canada	1986-2011	9327	16.4 (3.4 to 27.7)
SASKATOON	Canada	1986-2011	18102	15.8 (-1.4 to 32.1)
THUNDER BAY	Canada	1986-2011	11437	15.3 (0.9 to 27.3)
TORONTO	Canada	1986-2011	215163	19.6 (5.3 to 31.5)
VICTORIA	Canada	1986-2011	26457	15.7 (6.7 to 26.7)
VANCOUVER	Canada	1986-2011	103396	16.7 (9.2 to 28.4)
WINDSOR	Canada	1986-2011	20264	21.0 (6.0 to 31.5)
WINNIPEG	Canada	1986-2011	53136	17.2 (1.1 to 30.9)
ANSHAN	China	2004-2006	9404	24.2 (10.1 to 36.4)
BEIJING	China	2007-2008	24718	25.0 (12.5 to 30.7)
FUZHOU	China	2004-2006	5422	28.0 (20.3 to 32.2)
GUANGZHOU	China	2007-2008	17633	28.8 (23.7 to 33.5)
HONG KONG	China	1996-2002	67289	28.4 (21.1 to 33.8)
HANGZHOU	China	2002-2004	6370	26.9 (17.7 to 36.4)
LANZHOU	China	2004-2008	10552	17.6 (7.0 to 33.0)
SHANGHAI	China	2001-2004	51408	27.1 (19.4 to 34.0)
SHENYANG	China	2005-2008	30197	21.6 (10.0 to 28.0)
SUZHU	China	2005-2008	14563	27.0 (17.5 to 33.8)
TAIYUAN	China	2004-2008	13454	22.0 (9.9 to 30.5)
TIANJIN	China	2005-2008	4814	25.1 (12.2 to 31.3)
WUHAN	China	2003-2005	17896	27.6 (18.1 to 35.8)

WULUMQI	China	2006-2007	4048	22.1 (7.3 to 32.6)
XIAN	China	2004-2008	13807	23.4 (10.0 to 32.0)
BARI	Italy	1996-2007	9487	23.4 (11.9 to 35.2)
BOLOGNA	Italy	1996-2010	17787	23.8 (9.6 to 32.3)
BRESCIA	Italy	1993-2003	6664	22.2 (10.9 to 31.9)
CIVITAVECCHIA	Italy	1996-2006	1169	23.9 (16.1 to 30.3)
FROSINONE	Italy	1995-2006	996	23.3 (12.6 to 31.6)
GENOA	Italy	1999-2007	21779	23.2 (11.6 to 32.5)
LATINA	Italy	1995-2006	2532	23.6 (13.2 to 31.7)
PALERMO	Italy	1997-2001	8009	24.9 (15.2 to 37.8)
ROME	Italy	1987-2010	159066	23.2 (12.4 to 31.1)
TURIN	Italy	1991-1999	20441	20.6 (9.3 to 27.9)
VITERBO	Italy	1995-2006	1898	22.3 (10.6 to 32.7)
AICHI	Japan	1985-2012	383746	25.5 (15.5 to 32.7)
AKITA	Japan	1985-2012	101267	22.0 (12.1 to 31.6)
AOMORI	Japan	1985-2012	113976	20.4 (10.6 to 30.1)
CHIBA	Japan	1985-2012	313873	24.4 (13.1 to 32.2)
EHIME	Japan	1985-2012	116503	25.6 (16.6 to 31.9)
FUKUSHIMA	Japan	1985-2012	154544	22.8 (11.3 to 31.4)
FUKUI	Japan	1985-2012	58665	24.5 (14.6 to 32.1)
FUKUOKA	Japan	1985-2012	324858	25.8 (17.5 to 32.4)
GIFU	Japan	1985-2012	136903	25.5 (15.6 to 32.9)
GUNMA	Japan	1985-2012	135317	24.1 (12.6 to 32.6)
HOKKAIDO	Japan	1985-2012	389479	19.6 (9.8 to 30.1)
HIROSHIMA	Japan	1985-2012	194391	25.7 (15.6 to 32.7)
HYOGO	Japan	1985-2012	354299	25.7 (16.2 to 32.0)
IBARAKI	Japan	1985-2012	189316	22.8 (11.6 to 31.3)
ISHIKAWA	Japan	1985-2012	80735	24.3 (15.0 to 32.3)
IWATE	Japan	1985-2012	107927	20.8 (10.4 to 29.3)
KAGAWA	Japan	1985-2012	76721	25.8 (16.9 to 32.3)
KANAGAWA	Japan	1985-2012	430516	24.3 (13.1 to 30.9)
KAGOSHIMA	Japan	1985-2012	146568	26.7 (18.5 to 31.1)
KOCHI	Japan	1985-2012	70061	25.6 (15.8 to 32.1)
KUMAMOTO	Japan	1985-2012	134895	26.1 (16.2 to 31.5)
KYOTO	Japan	1985-2012	170793	25.7 (15.1 to 32.8)
MIE	Japan	1985-2012	127223	25.3 (15.9 to 33.5)
MIYAGI	Japan	1985-2012	142635	21.6 (10.8 to 31.2)
MIYAZAKI	Japan	1985-2012	84538	25.8 (16.7 to 32.0)
NAGANO	Japan	1985-2012	159353	22.6 (11.9 to 30.7)
NAGASAKI	Japan	1985-2012	115970	25.7 (17.4 to 32.2)
NARA	Japan	1985-2012	87912	24.5 (14.6 to 31.7)
NIIGATA	Japan	1985-2012	184269	23.7 (14.4 to 32.6)
OITA	Japan	1985-2012	94400	25.2 (16.2 to 31.6)
OKAYAMA	Japan	1985-2012	140908	25.9 (15.9 to 32.3)
OKINAWA	Japan	1985-2012	68982	28.1 (21.1 to 31.1)
OSAKA	Japan	1985-2012	526314	26.3 (15.5 to 32.9)

SAGA	Japan	1985-2012	65842	25.8 (16.0 to 32.2)
SAITAMA	Japan	1985-2012	343311	24.4 (12.9 to 33.7)
SHIGA	Japan	1985-2012	77718	24.6 (15.1 to 31.4)
SHIMANE	Japan	1985-2012	65113	24.2 (15.0 to 32.2)
SHIZUOKA	Japan	1985-2012	234281	24.9 (14.6 to 31.9)
TOKUSHIMA	Japan	1985-2012	66168	25.6 (16.9 to 32.3)
TOCHIGI	Japan	1985-2012	130789	23.3 (12.0 to 31.4)
TOKYO	Japan	1985-2012	710556	25.0 (13.2 to 33.1)
TOTTORI	Japan	1985-2012	48663	24.5 (14.5 to 32.3)
TOYAMA	Japan	1985-2012	84518	23.9 (15.1 to 33.8)
WAKAYAMA	Japan	1985-2012	85859	25.8 (16.9 to 31.9)
YAMAGATA	Japan	1985-2012	99932	22.3 (12.0 to 31.1)
YAMAGUCHI	Japan	1985-2012	124916	25.0 (13.9 to 31.2)
YAMANASHI	Japan	1985-2012	61561	24.4 (14.7 to 31.8)
BUSAN	South Korea	1992-2010	107590	23.3 (16.1 to 30.2)
DAEGU	South Korea	1992-2010	65670	24.4 (15.5 to 32.9)
DAEJEON	South Korea	1992-2010	32897	23.6 (13.0 to 31.8)
GWANGJU	South Korea	1992-2010	34231	24.2 (15.7 to 31.3)
INCHEON	South Korea	1992-2010	62066	23.0 (13.5 to 31.4)
SEOUL	South Korea	1992-2010	228164	23.7 (13.0 to 33.0)
ULSAN	South Korea	1992-2010	17677	23.6 (15.1 to 30.8)
A CORUNA	Spain	1990-2010	23135	18.9 (13.0 to 29.0)
ALBACETE	Spain	1990-2010	10495	23.0 (10.7 to 31.6)
ALICANTE	Spain	1990-2010	15634	24.7 (17.3 to 32.2)
ALMERIA	Spain	1990-2010	12709	25.2 (17.2 to 36.2)
AVILA	Spain	1990-2010	6736	19.0 (6.4 to 28.6)
BADAJOZ	Spain	1990-2010	11335	24.7 (15.1 to 33.9)
BARCELONA	Spain	1990-2010	110440	23.0 (14.2 to 30.9)
BILBAO	Spain	1990-2010	24210	19.7 (11.9 to 32.2)
BURGOS	Spain	1990-2010	13026	18.1 (6.6 to 29.8)
CACERES	Spain	1990-2010	6682	24.5 (13.6 to 34.1)
CADIZ	Spain	1990-2010	12588	23.8 (16.8 to 32.9)
CASTELLON	Spain	1990-2010	12557	24.4 (14.8 to 32.0)
CEUTA	Spain	1990-2010	3069	23.7 (14.9 to 32.8)
CORDOBA	Spain	1990-2010	21505	26.3 (15.7 to 36.3)
CIUDAD REAL	Spain	1990-2010	6933	24.7 (11.9 to 33.7)
CUENCA	Spain	1990-2010	5159	21.6 (9.2 to 29.8)
GIRONA	Spain	1990-2010	9619	22.0 (12.3 to 30.4)
GRANADA	Spain	1990-2010	23194	24.0 (12.8 to 32.7)
GUADALAJARA	Spain	1990-2010	6275	21.5 (10.0 to 29.0)
HUELVA	Spain	1990-2010	13142	24.5 (15.8 to 36.2)
HUESCA	Spain	1990-2010	4824	22.2 (11.3 to 32.0)
JAEN	Spain	1990-2010	11011	25.2 (13.1 to 35.3)
LEON	Spain	1990-2010	13663	18.2 (7.4 to 27.9)
LLEIDA	Spain	1990-2010	11309	23.4 (12.4 to 30.6)
LOGRONO	Spain	1990-2010	10081	21.4 (9.5 to 31.5)

LUGO	Spain	1990-2010	10413	17.4 (7.9 to 29.1)
MADRID	Spain	1990-2010	171802	23.6 (10.8 to 32.4)
MALAGA	Spain	1990-2010	35549	24.8 (16.4 to 34.2)
MELILLA	Spain	1990-2010	2699	24.5 (17.5 to 36.1)
MURCIA	Spain	1990-2010	23245	24.5 (17.5 to 36.1)
OURENSE	Spain	1990-2010	11763	21.5 (10.4 to 31.5)
OVIEDO	Spain	1990-2010	21508	18.1 (10.0 to 28.4)
PAMPLONA	Spain	1990-2010	17661	20.0 (9.1 to 31.6)
PALMAS G. CANARIA	Spain	1990-2010	26984	23.8 (19.0 to 33.4)
PALMA MALLORCA	Spain	1990-2010	25347	23.6 (15.3 to 32.1)
PONTEVEDRA	Spain	1990-2010	9707	19.6 (11.6 to 30.4)
SALAMANCA	Spain	1990-2010	13985	19.8 (9.6 to 29.1)
SANTANDER	Spain	1990-2010	17796	19.3 (12.5 to 27.8)
TENERIFE	Spain	1990-2010	16084	24.7 (20.0 to 34.3)
SEGOVIA	Spain	1990-2010	5424	20.3 (7.5 to 31.4)
SEVILLA	Spain	1990-2010	52635	26.9 (17.0 to 36.8)
SORIA	Spain	1990-2010	4055	18.7 (7.0 to 28.1)
SAN SEBASTIAN	Spain	1990-2010	20326	18.4 (10.9 to 30.3)
TARRAGONA	Spain	1990-2010	8439	25.0 (14.2 to 32.4)
TERUEL	Spain	1990-2010	3844	20.2 (8.8 to 27.8)
TOLEDO	Spain	1990-2010	9639	24.7 (11.3 to 34.0)
VALENCIA	Spain	1990-2010	63401	24.8 (14.3 to 33.8)
VITORIA	Spain	1990-2010	11721	18.0 (7.8 to 30.6)
VALLADOLID	Spain	1990-2010	20582	20.7 (9.6 to 30.9)
ZAMORA	Spain	1990-2010	6435	21.1 (10.4 to 30.8)
ZARAGOZA	Spain	1990-2010	43127	23.7 (13.3 to 32.9)
EAST	UK	1990-2012	362868	16.1 (7.5 to 25.2)
EAST MIDLANDS	UK	1990-2012	293288	15.5 (6.2 to 25.3)
LONDON	UK	1990-2012	401709	17.2 (9.2 to 29.1)
NORTH EAST	UK	1990-2012	197506	14.5 (6.0 to 25.0)
NORTH WEST	UK	1990-2012	515728	14.9 (7.5 to 23.7)
SOUTH EAST	UK	1990-2012	546649	16.2 (8.3 to 25.3)
SOUTH WEST	UK	1990-2012	374222	15.6 (8.5 to 24.8)
WALES	UK	1990-2012	228091	15.1 (8.1 to 24.0)
WEST MIDLANDS	UK	1990-2012	372152	15.4 (6.8 to 25.0)
YORKSHIRE & HUMBER	UK	1990-2012	362345	15.2 (7.0 to 26.1)
AKRON, OH	USA	1985-2006	33295	20.3 (6.4 to 30.8)
ALBUQUERQUE, NM	USA	1985-2006	22151	23.8 (9.7 to 32.2)
ALLENTOWN-BETHLEHEM, PA	USA	1985-2006	18616	21.2 (6.9 to 31.4)
ATLANTA, GA	USA	1985-2006	96303	25.4 (11.7 to 32.5)
ATLANTIC CITY, NJ	USA	1985-2006	15199	22.1 (8.1 to 32.2)
AUSTIN, TX	USA	1985-2006	21831	28.4 (14.2 to 35.0)
BAKERSFIELD, CA	USA	1985-2006	27716	26.5 (14.2 to 36.7)
BALTIMORE, MD	USA	1985-2006	99401	23.2 (9.7 to 32.5)
BARNSTABLE-	USA	1985-2006	16153	19.5 (7.8 to 30.6)

YARMOUTH, MA				
BERGEN-PASSAIC, NJ	USA	1985-2006	73212	23.4 (10.6 to 34.7)
BIRMINGHAM, AL	USA	1985-2006	53165	25.6 (13.1 to 32.2)
BOSTON, MA	USA	1985-2006	145615	20.9 (7.5 to 32.2)
BATON ROUGE, LA	USA	1985-2006	19473	27.2 (14.4 to 32.8)
BROWNSVILLE, TX	USA	1985-2006	10965	28.9 (17.5 to 33.1)
BUFFALO, NY	USA	1985-2006	65843	19.8 (5.8 to 30.3)
CANTON-MASSILLON, OH	USA	1985-2006	23766	20.3 (6.4 to 30.8)
CHARLESTON, WV	USA	1985-2006	15363	22.3 (8.1 to 31.7)
CHARLOTTE, NC	USA	1985-2006	25311	24.8 (11.7 to 32.5)
CHATTANOOGA, TN	USA	1985-2006	18913	25.0 (12.8 to 32.8)
CHICAGO, IL	USA	1985-2006	349050	21.1 (5.6 to 33.6)
CINCINNATI, OH	USA	1985-2006	53094	22.7 (9.2 to 33.1)
CLEVELAND, OH	USA	1985-2006	125455	20.7 (7.5 to 30.8)
COLUMBIA, SC	USA	1985-2006	23635	26.2 (13.3 to 32.8)
COLUMBUS, OH	USA	1985-2006	49586	22.0 (8.3 to 31.7)
DALLAS, TX	USA	1985-2006	81635	28.1 (12.2 to 35.8)
DAYTONA BEACH, FL	USA	1985-2006	33248	27.1 (21.1 to 31.7)
DAYTON, OH	USA	1985-2006	33728	21.7 (7.2 to 32.2)
DENVER, CO	USA	1985-2006	56583	20.7 (-5.0 to 30.3)
DES MOINES, IA	USA	1985-2006	16899	22.0 (4.7 to 32.8)
DETROIT, MI	USA	1985-2006	229193	21.0 (6.4 to 31.4)
DUTCHESS COUNTY, NY	USA	1985-2006	13143	20.2 (6.4 to 31.7)
EL PASO, TX	USA	1985-2006	22366	26.8 (11.4 to 36.7)
ERIE, PA	USA	1985-2006	16916	20.3 (7.5 to 30.0)
FLINT, MI	USA	1985-2006	23674	19.6 (4.7 to 30.8)
FRESNO, CA	USA	1985-2006	31852	26.3 (13.6 to 38.6)
FT. LAUDERDALE, FL	USA	1985-2006	97450	27.4 (23.1 to 30.8)
FORT MYERS-CAPE CORAL, FL	USA	1985-2006	27339	28.2 (22.8 to 31.4)
FORT PIERCE-PORT ST. LUCIE, FL	USA	1985-2006	20681	27.3 (22.8 to 30.8)
FORT WORTH-ARLINGTON, TX	USA	1985-2006	53579	28.0 (13.1 to 35.6)
GALVESTON, TX	USA	1985-2006	12921	27.1 (16.7 to 32.8)
GARY, IN	USA	1985-2006	28345	20.9 (5.3 to 31.7)
GRAND RAPIDS, MI	USA	1985-2006	24572	19.9 (4.4 to 31.7)
GREENSBORO, NC	USA	1985-2006	20318	23.7 (11.1 to 30.6)
GREENVILLE, SC	USA	1985-2006	17982	24.5 (11.7 to 32.8)
HAMILTON, OH	USA	1985-2006	15447	22.7 (9.2 to 33.1)
HARRISBURG-CARLISLE, PA	USA	1985-2006	15600	22.6 (8.1 to 32.5)
HARTFORD, CT	USA	1985-2006	48290	20.8 (5.8 to 31.1)
HONOLULU, HI	USA	1985-2006	24364	27.5 (24.2 to 30.3)
HOUSTON, TX	USA	1985-2006	115796	28.0 (15.3 to 33.3)
INDIANAPOLIS, IN	USA	1985-2006	46853	22.3 (7.8 to 32.2)
JACKSONVILLE, FL	USA	1985-2006	38724	27.0 (17.8 to 32.5)

JERSEY CITY, NJ	USA	1985-2006	31701	23.4 (10.6 to 34.7)
KANSAS CITY, MO-KS	USA	1985-2006	67807	23.5 (6.1 to 33.9)
KNOXVILLE, TN	USA	1985-2006	24834	24.1 (10.8 to 30.3)
LAKELAND-WINTER HAVEN, FL	USA	1985-2006	29250	27.9 (21.4 to 32.2)
LANCASTER, PA	USA	1985-2006	24548	21.7 (8.9 to 31.1)
LANSING, MI	USA	1985-2006	11583	19.4 (5.3 to 30.8)
LAS VEGAS, NV-AZ	USA	1985-2006	56467	30.7 (14.7 to 41.1)
LOS ANGELES, CA	USA	1985-2006	382554	20.4 (13.6 to 31.1)
LOUISVILLE, KY	USA	1985-2006	42618	24.2 (10.0 to 34.2)
LITTLE ROCK, AR	USA	1985-2006	19999	26.4 (13.3 to 35.3)
LUBBOCK, TX	USA	1985-2006	10691	25.2 (6.4 to 35.6)
MADISON, WI	USA	1985-2006	15106	19.7 (5.0 to 32.8)
MCALLEN-EDINBURG-MISSION, TX	USA	1985-2006	15090	29.9 (16.7 to 36.7)
MELBOURNE-TITUSVILLE-PALM BAY, FL	USA	1985-2006	27810	27.2 (21.9 to 31.9)
MEMPHIS, TN	USA	1985-2006	47476	26.5 (13.6 to 33.9)
MIAMI, FL	USA	1985-2006	119487	28.5 (23.3 to 31.4)
MIDDLESEX, NJ	USA	1985-2006	33829	21.8 (8.6 to 32.5)
MILWAUKEE, WI	USA	1985-2006	71799	20.3 (6.1 to 33.9)
MINNEAPOLIS-ST. PAUL, MN	USA	1985-2006	74244	20.4 (4.7 to 32.5)
MOBILE, AL	USA	1985-2006	22679	26.8 (15.0 to 32.8)
MONMOUTH-OCEAN, NJ	USA	1985-2006	73356	21.8 (8.1 to 31.9)
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OCALA, FL	USA	1985-2006	17933	27.2 (19.4 to 32.2)
OKLAHOMA CITY, OK	USA	1985-2006	36601	25.7 (7.5 to 34.7)
OMAHA, NE	USA	1985-2006	22024	22.3 (2.2 to 33.3)
ORANGE COUNTY, CA	USA	1985-2006	98795	22.4 (14.4 to 32.8)
ORLANDO, FL	USA	1985-2006	49272	27.8 (21.9 to 32.2)
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WASHINGTON, DC-MD-VA	USA	1985-2006	44237	24.4 (10.6 to 33.9)
WICHITA, KS	USA	1985-2006	21215	24.9 (5.0 to 33.9)

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YORK, PA	USA	1985-2006	19280	22.0 (8.3 to 31.1)
YOUNGSTOWN-WARREN, OH	USA	1985-2006	26632	19.6 (6.4 to 30.6)

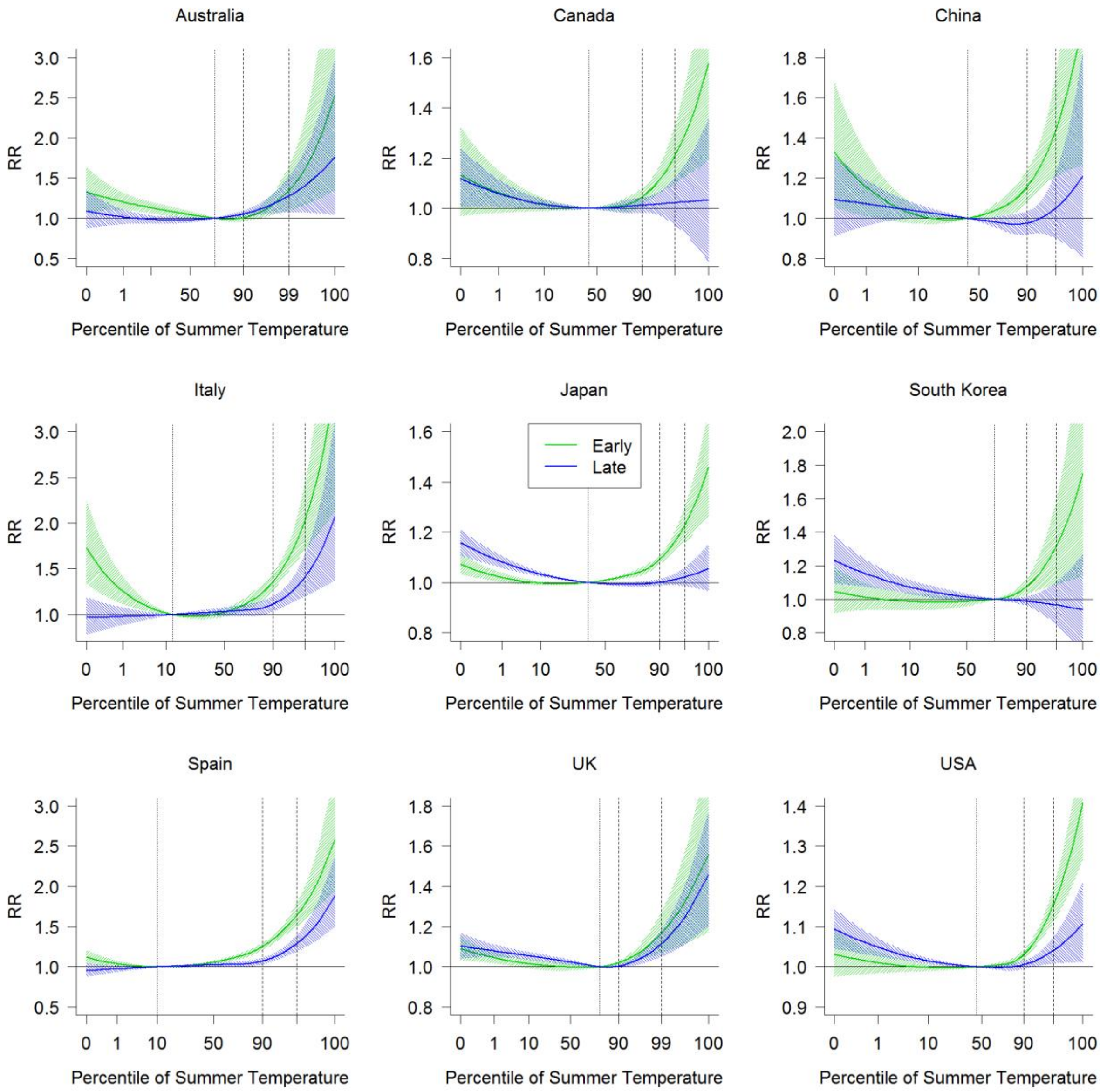
Web Appendix 2

The analysis of the multi-country data set was performed in R, version 3.2.1.(14) The first and second-stage models were performed using the two packages `dlnm` (version 2.1.4) and `mvmeta` (version 0.4.7), respectively (15, 16).

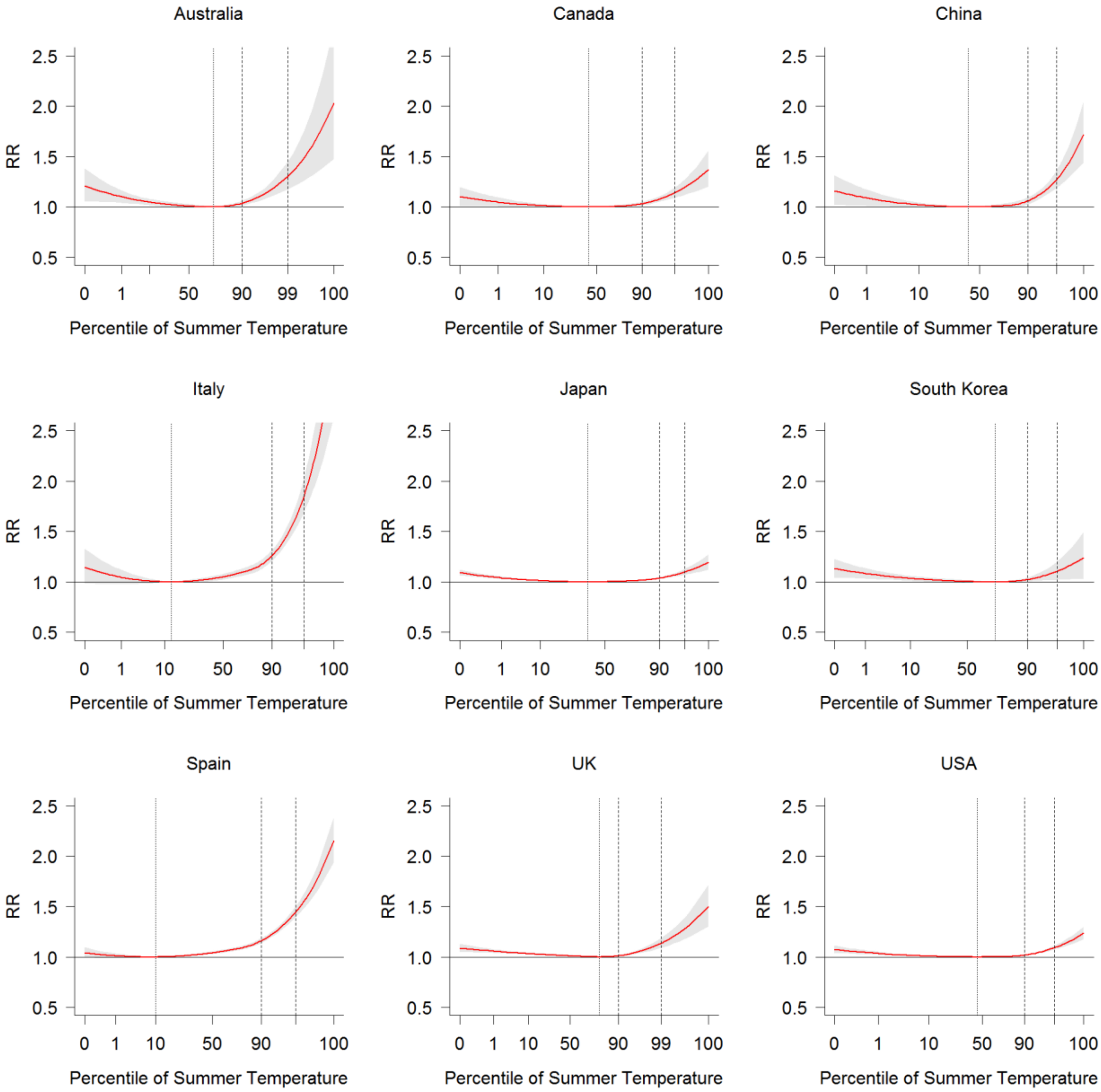
The R code and data reproducing all the steps of the analysis are provided in a single zipped file as Supplemental Material on the Journal's website. An update version is also available at the personal web page of the first author (http://www.ag-myresearch.com/), and at the time of writing can be accessed via the sections 'Publications' (through the link to this article) or 'R code'. The code will be updated consistently with the development of the two R packages.

The code consists of a series of scripts to be run consecutively. Although the full results cannot be reproduced as most of the data are not publicly available, we provide a subset of the dataset for the 10 regions of the UK used in the analysis. We anticipate that the results are similar yet not identical to those reported in the article, as the latter are based on the full data and a different dataset for the UK.

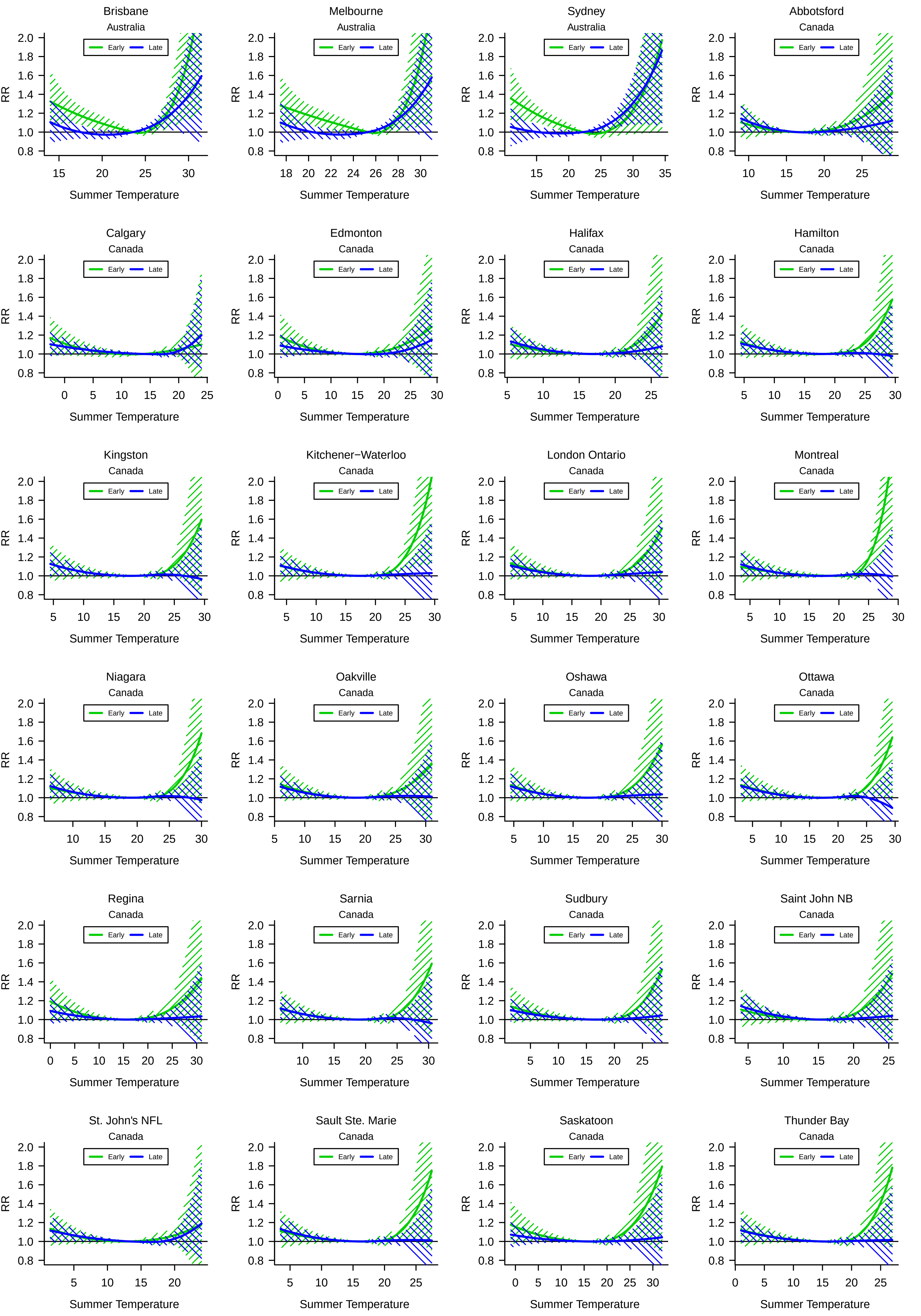
Web Figure 1. Replication of Figure 2 in the manuscript, including colours and confidence intervals as shaded areas.



Web Figure 2. Replication of Figure 2 in the manuscript for the average across the summer, with confidence intervals as grey areas.



Web Figure 3. Overall cumulative exposure-response relationships[a] between heat and mortality predicted for early (corresponding to the mid-point of the first summer month) and late summer (corresponding to the mid-point of the last summer month) in 305 locations, with 95% confidence intervals. The curves are represented on a relative scale of summer temperature percentiles, using country-specific distributions. Different study periods in 1985-2012.



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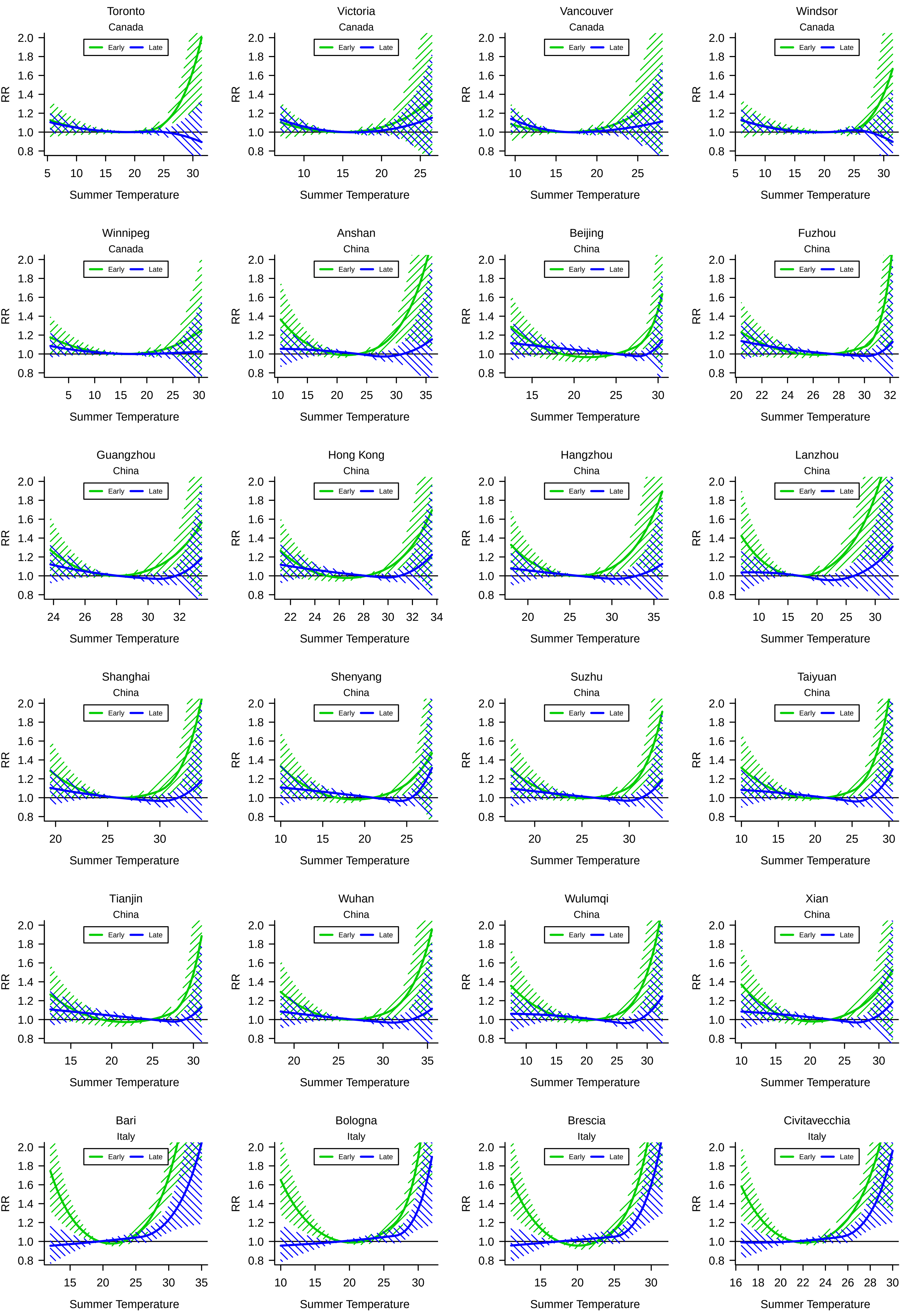
Summer Temperature



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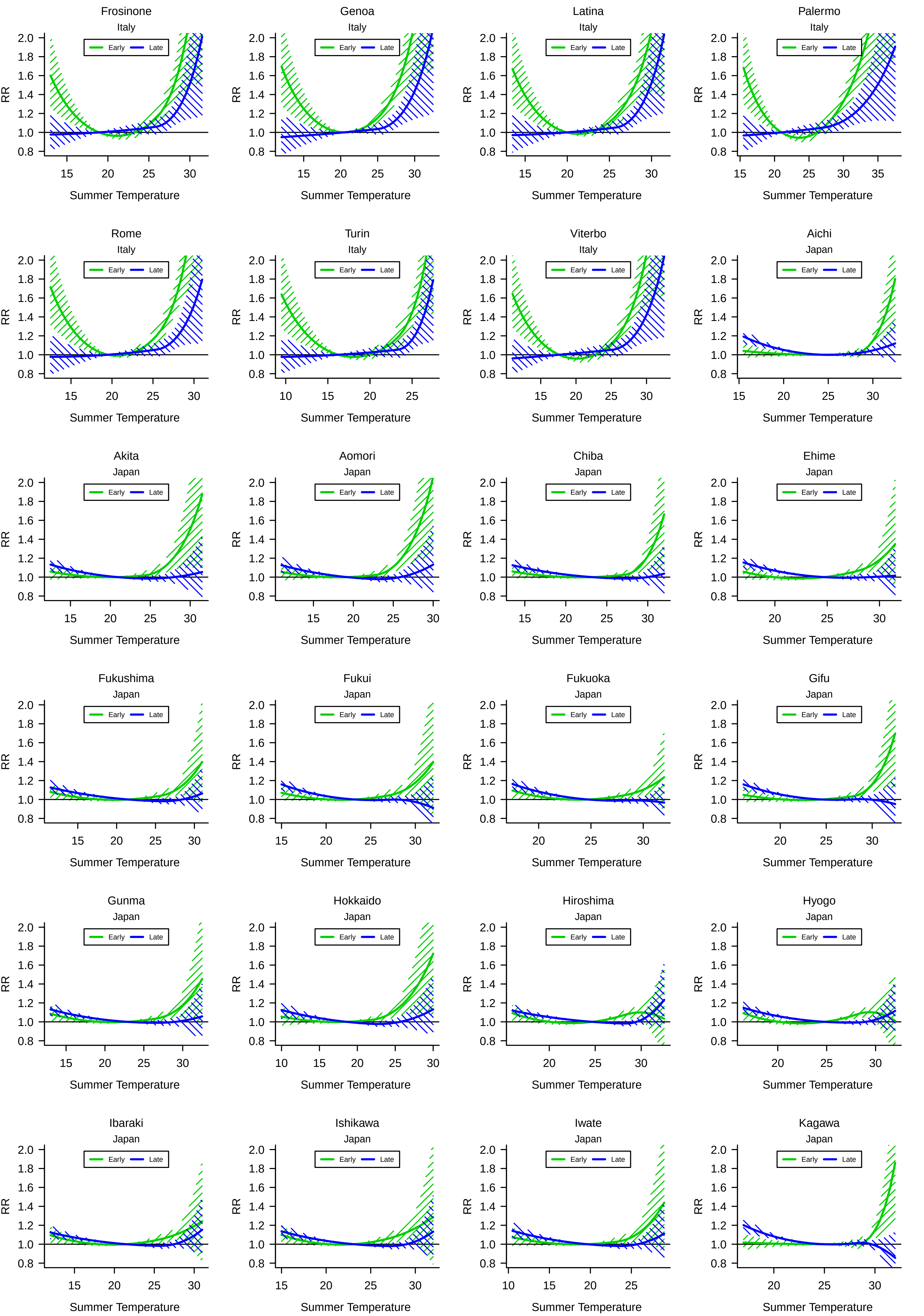
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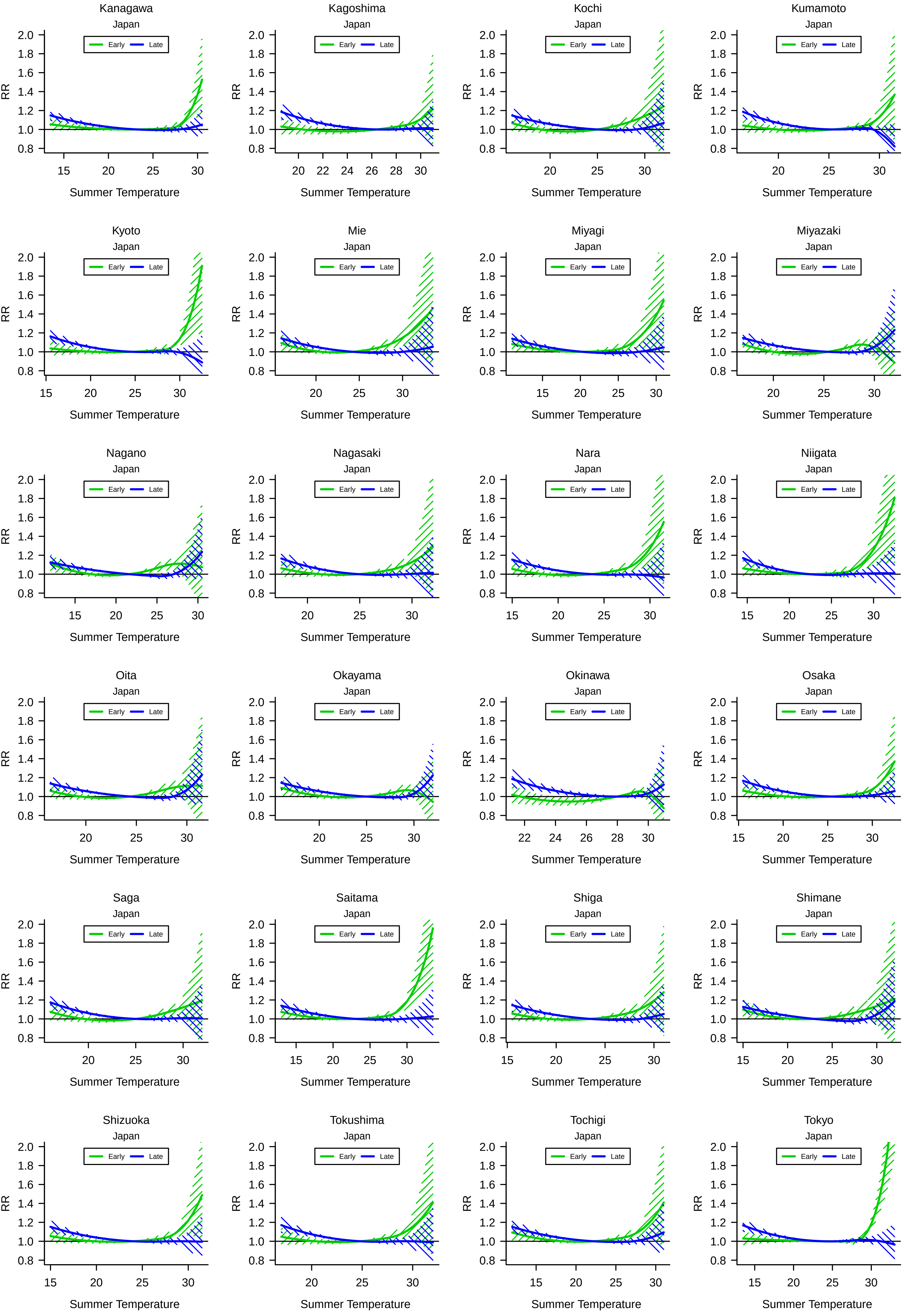

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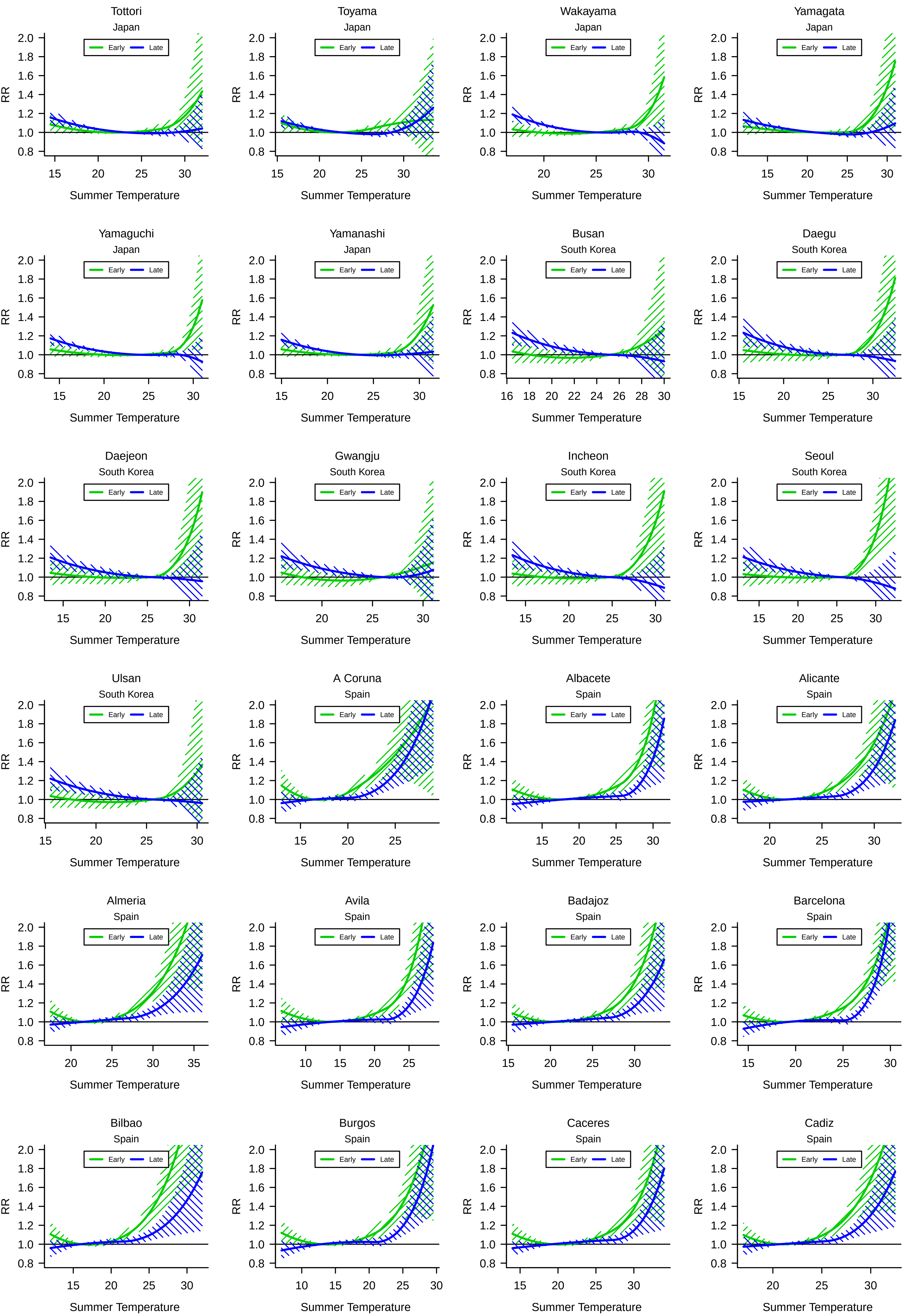
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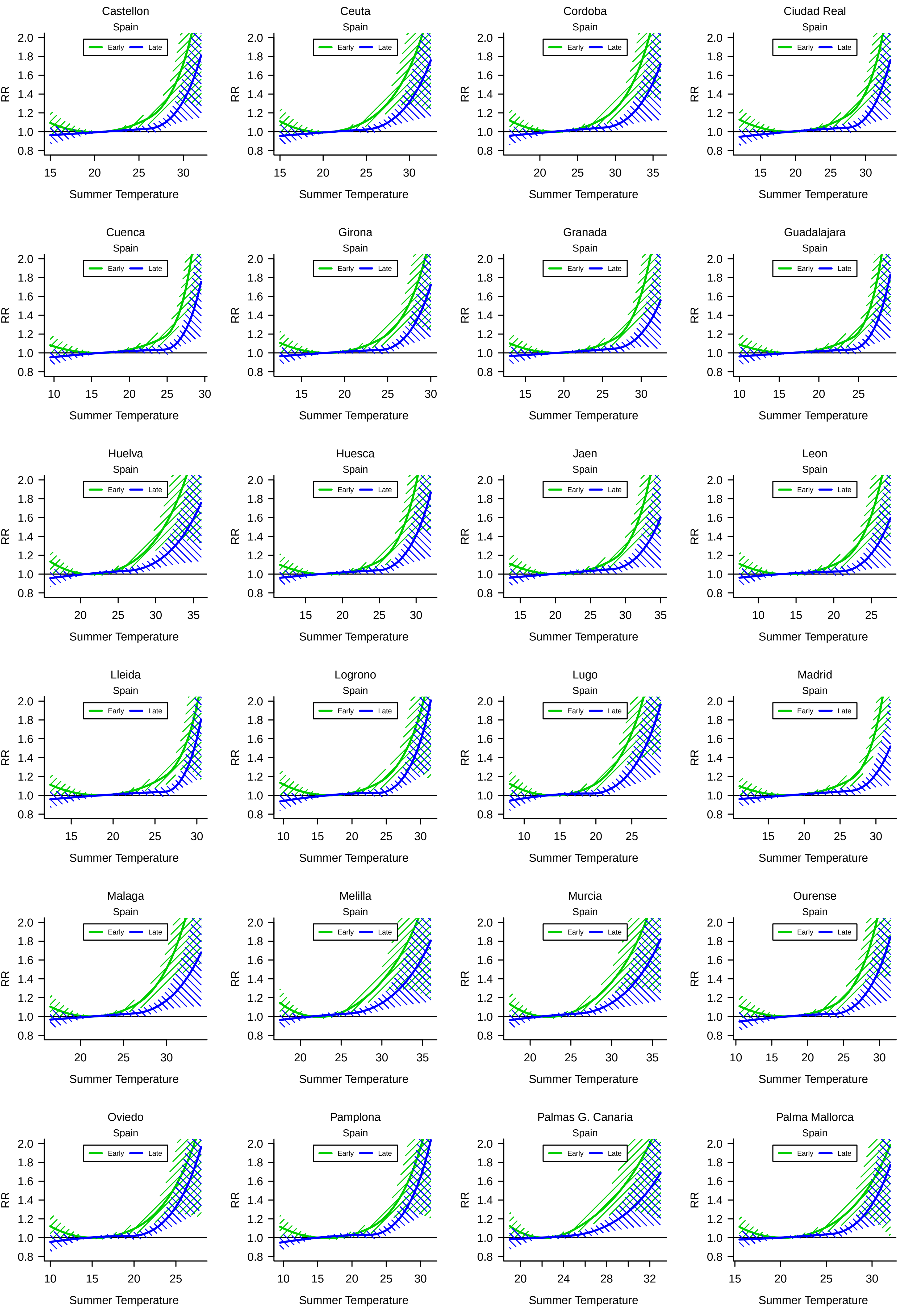
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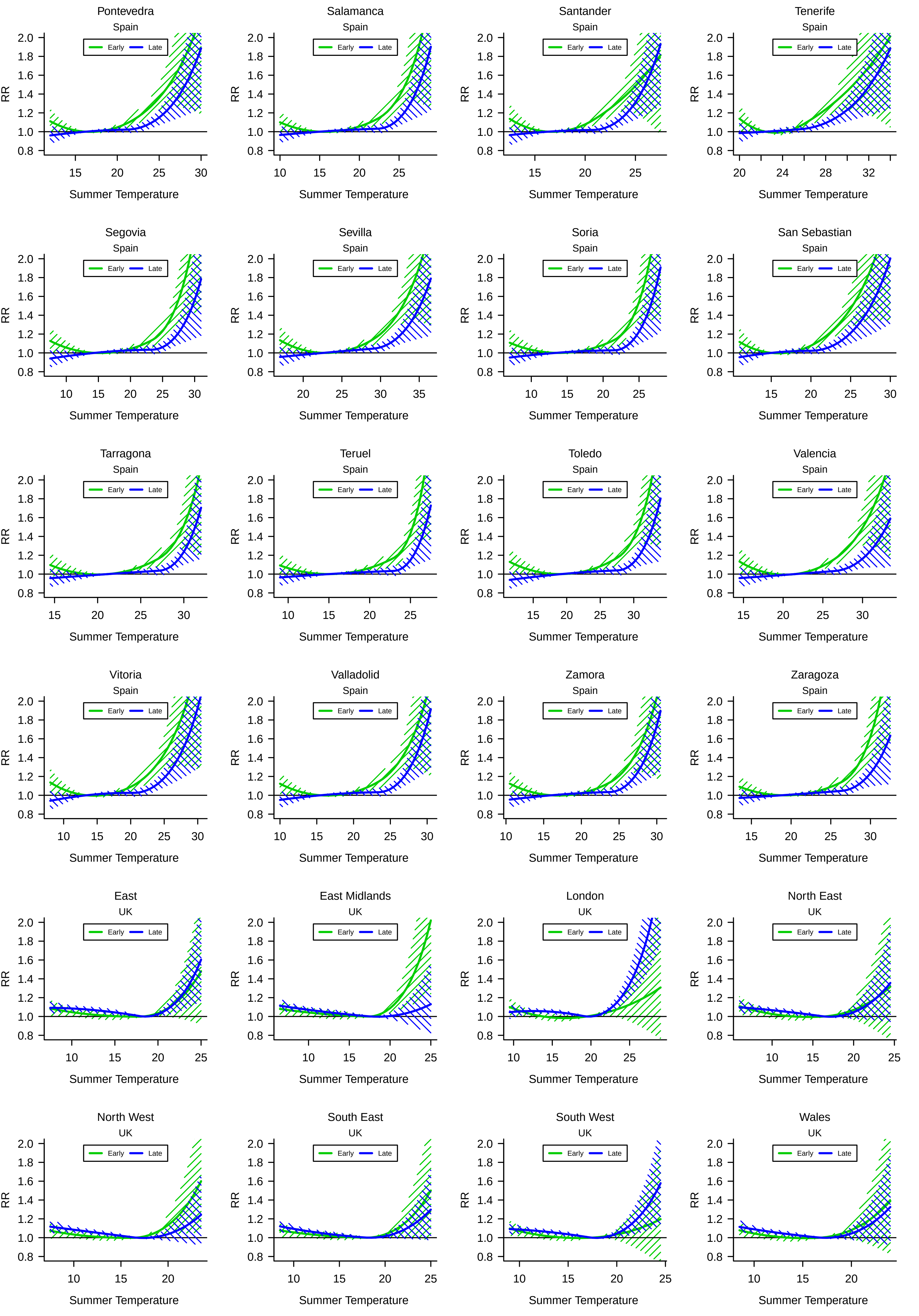
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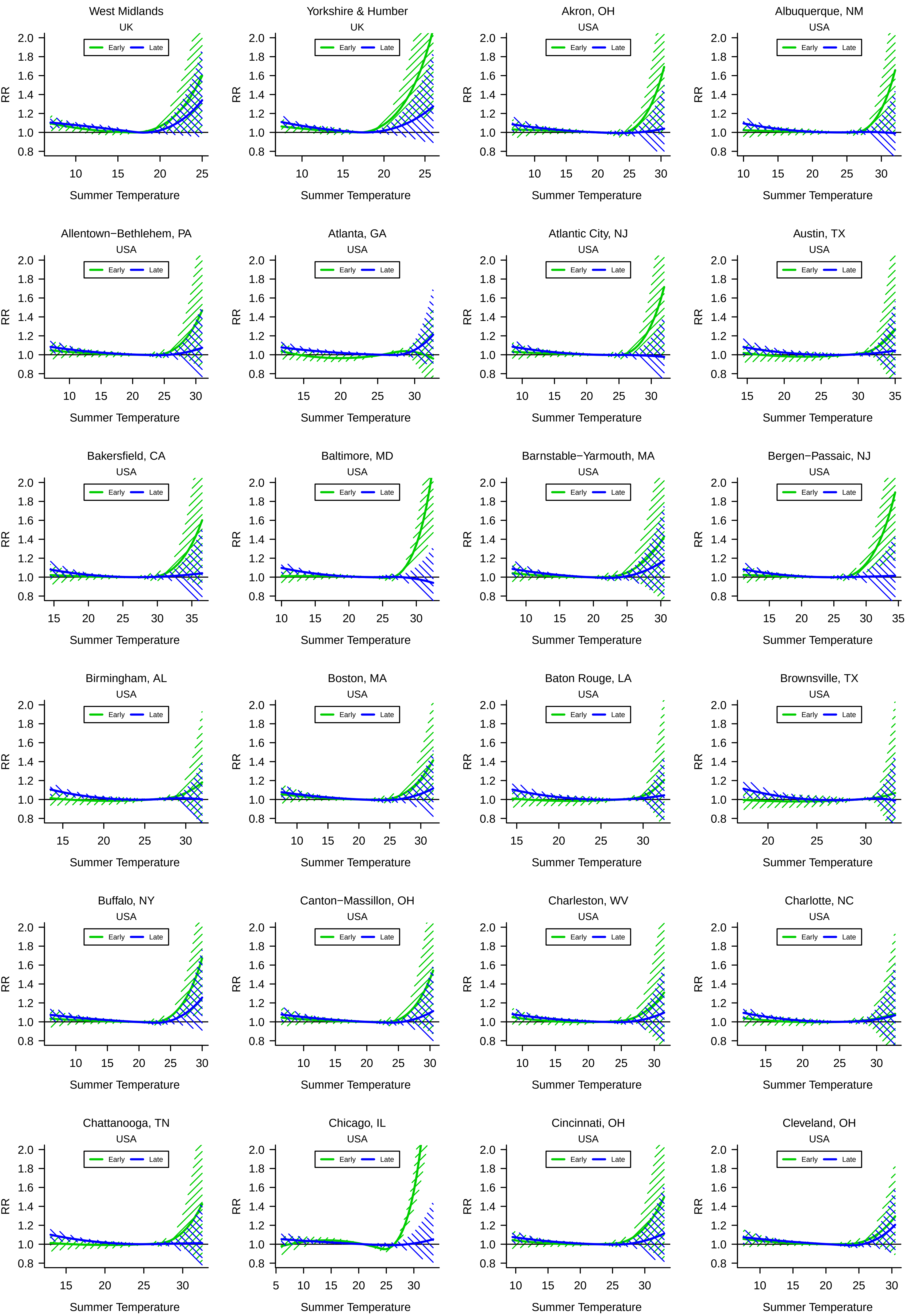
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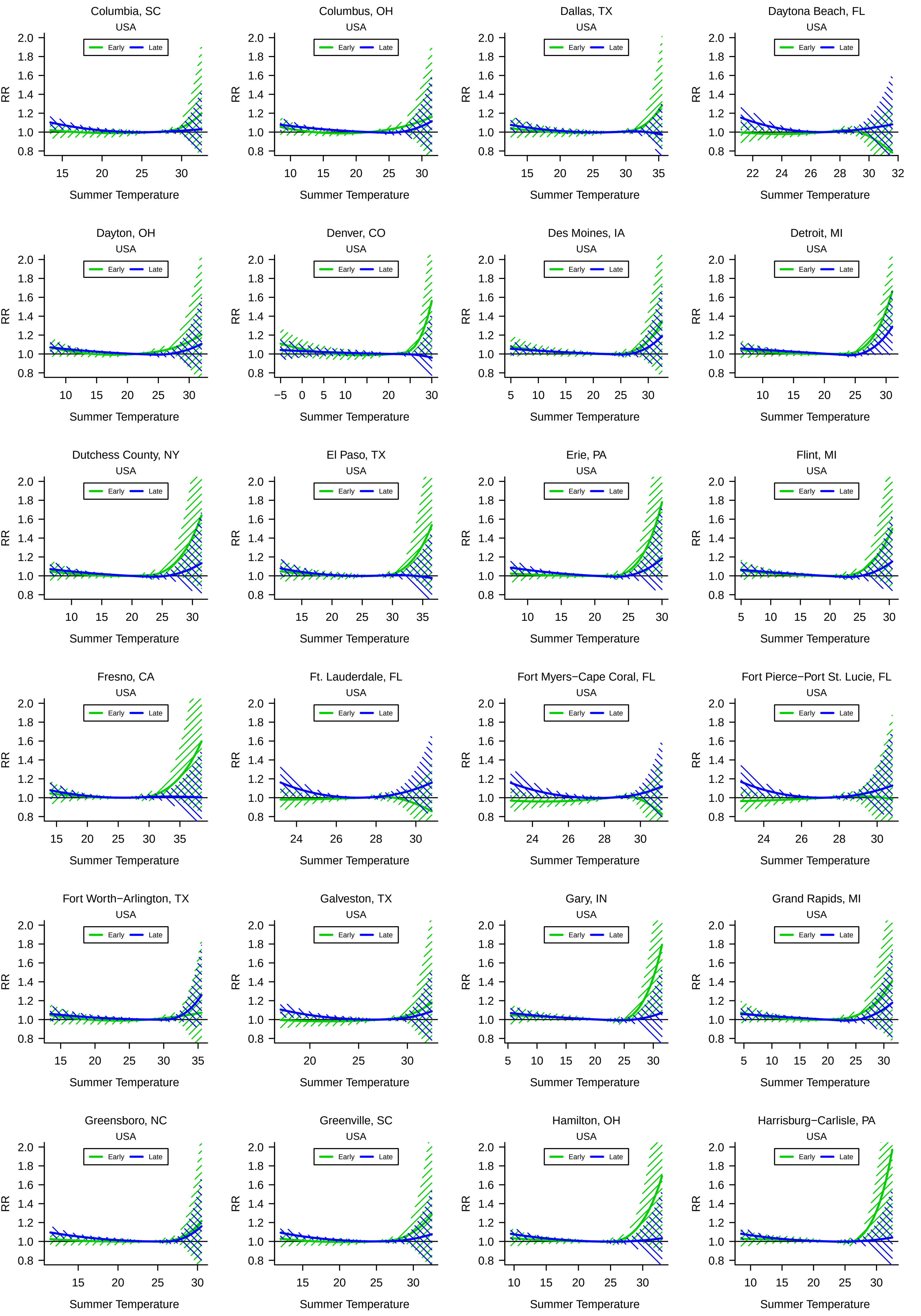
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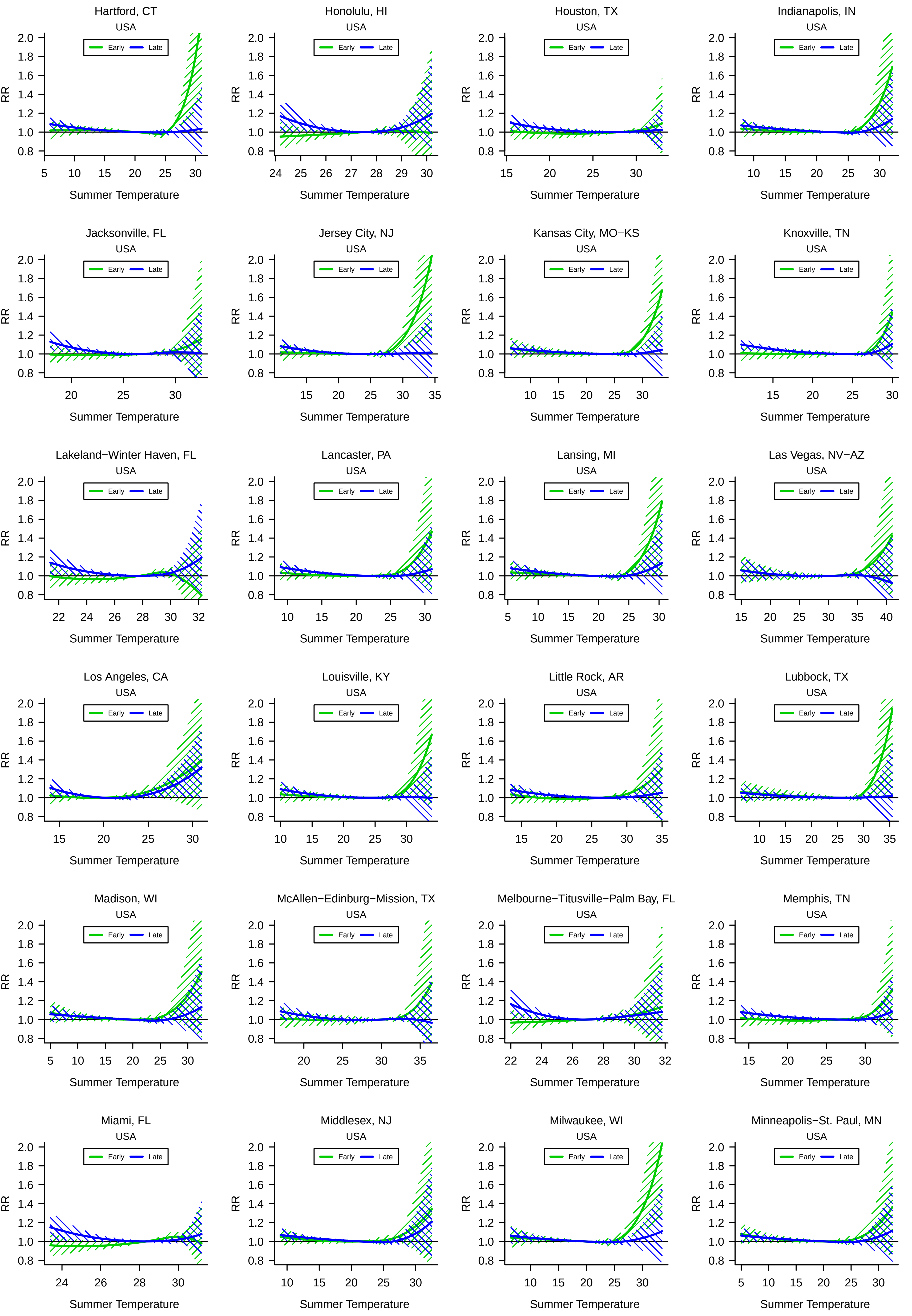
Summer Temperature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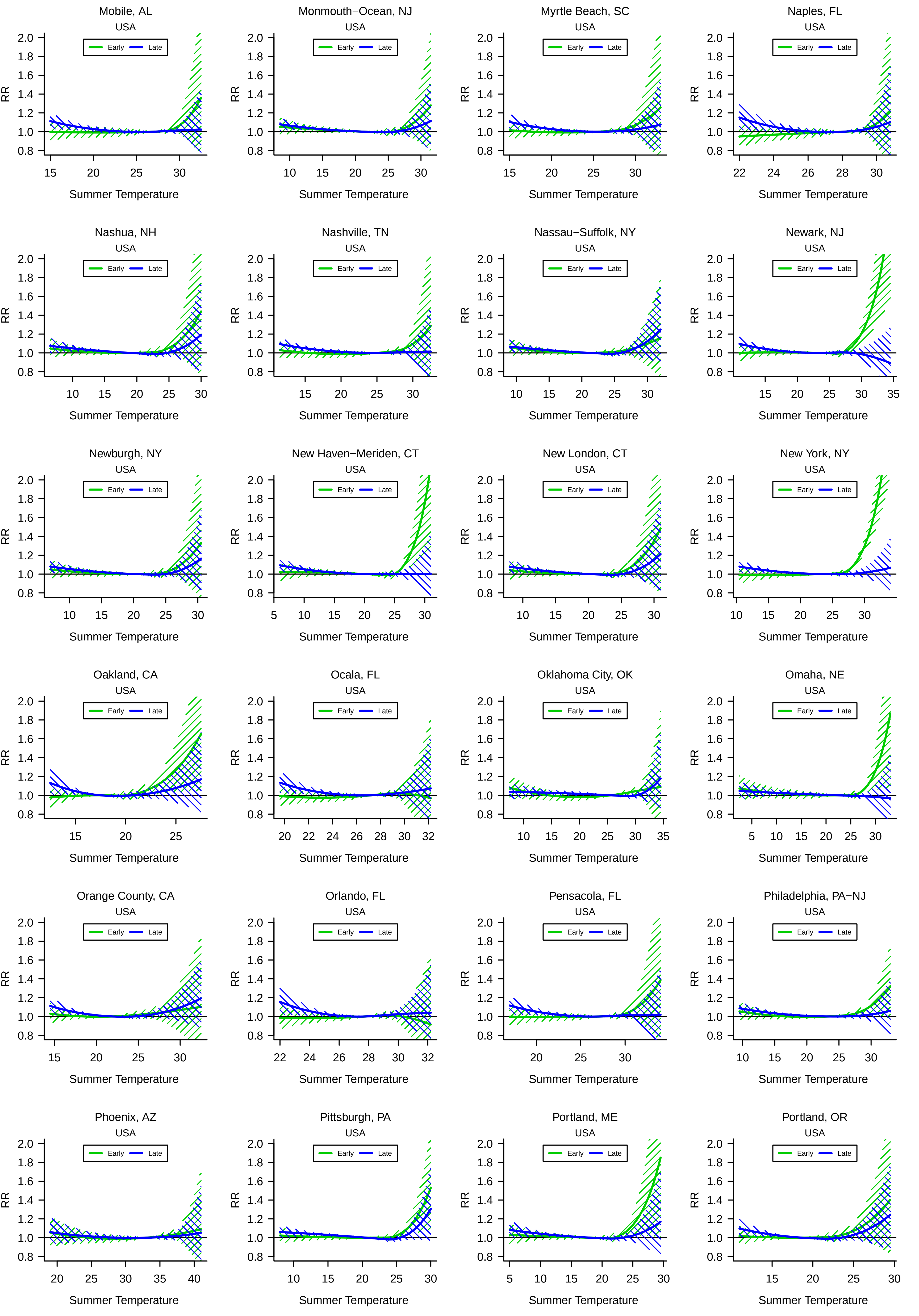
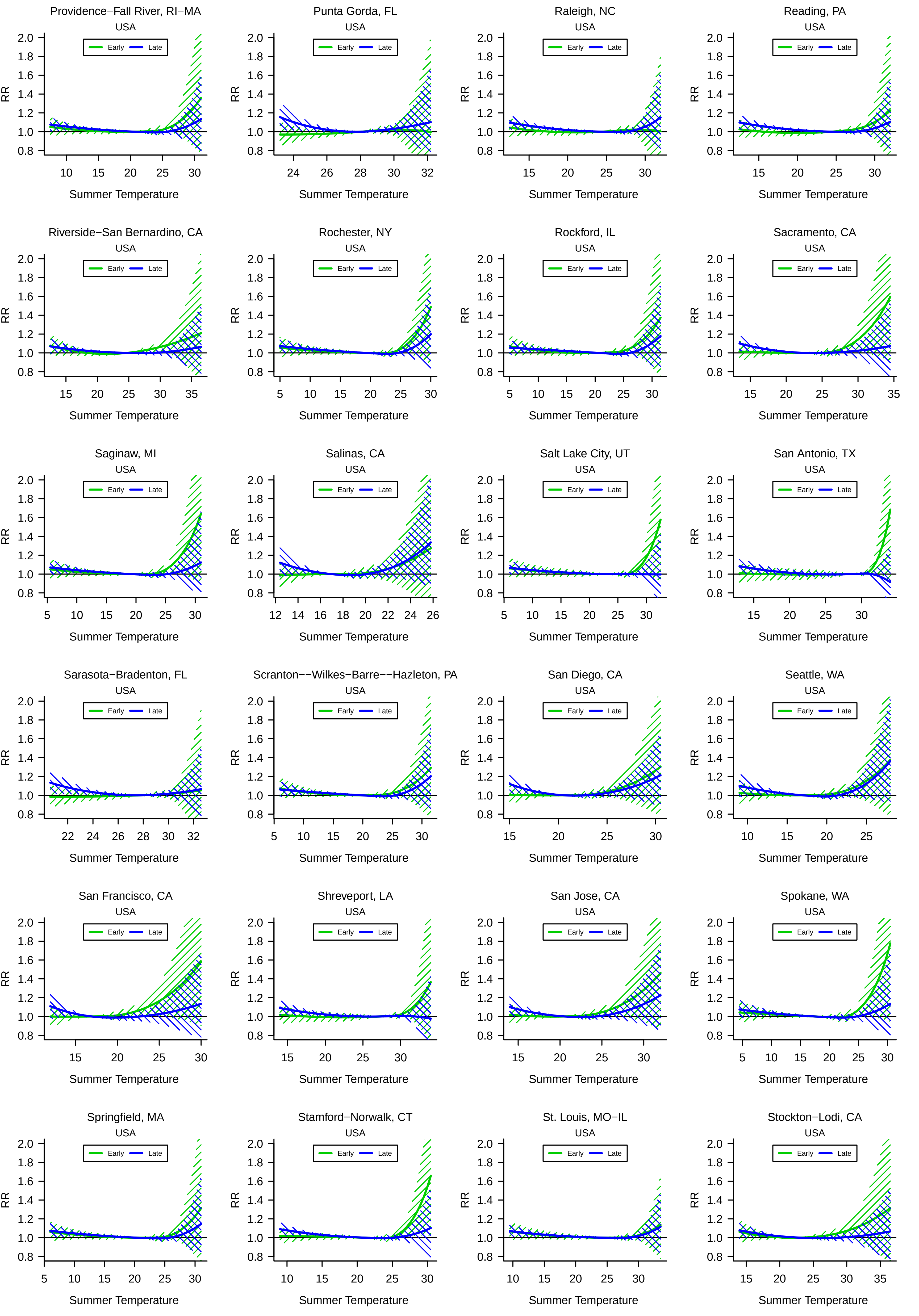
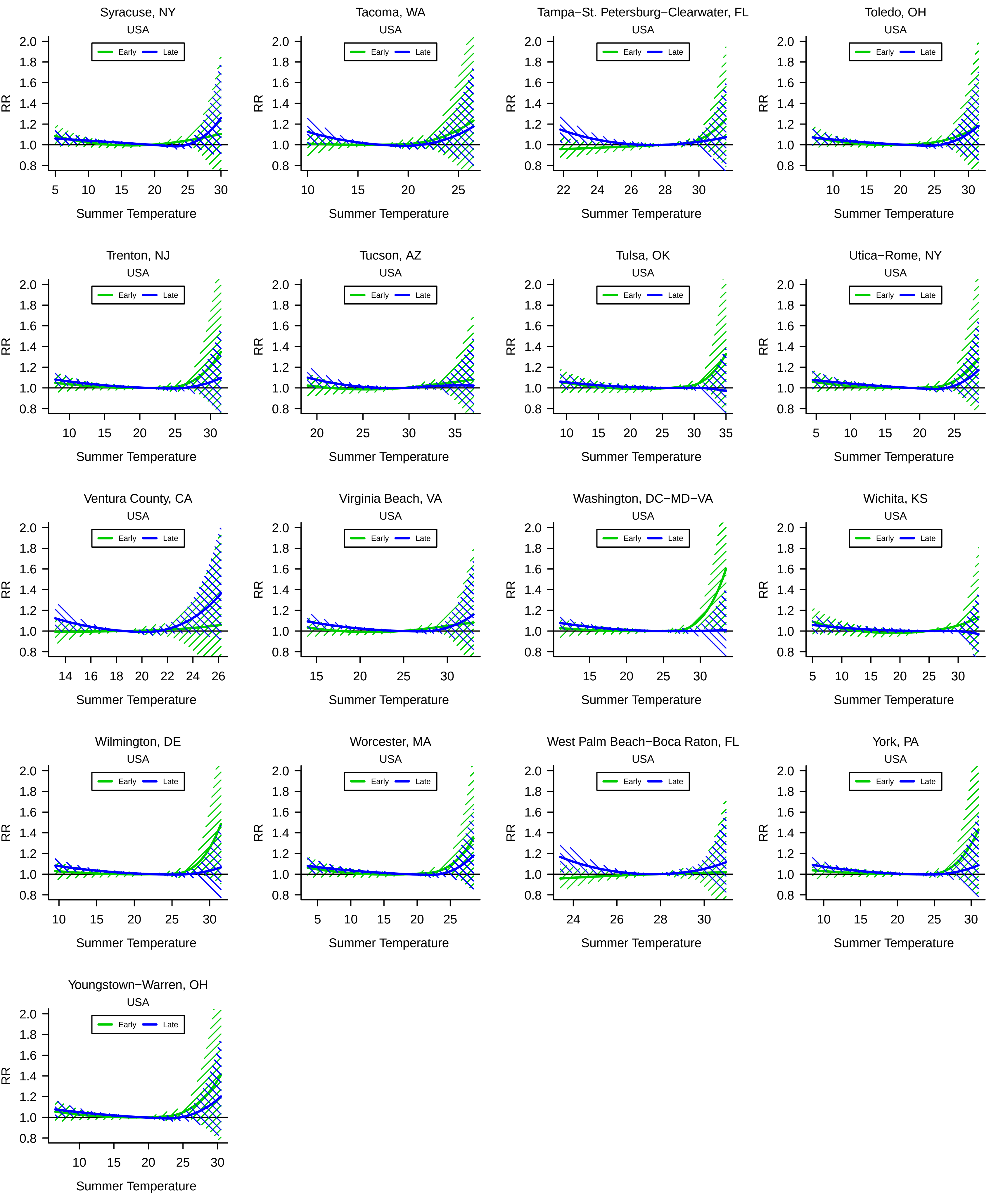
USA
Middlesex, NJ
USA
Milwaukee, WI
USA
Minneapolis−St. Paul, MN
USA
Early
Late
RR
Summer Temperature

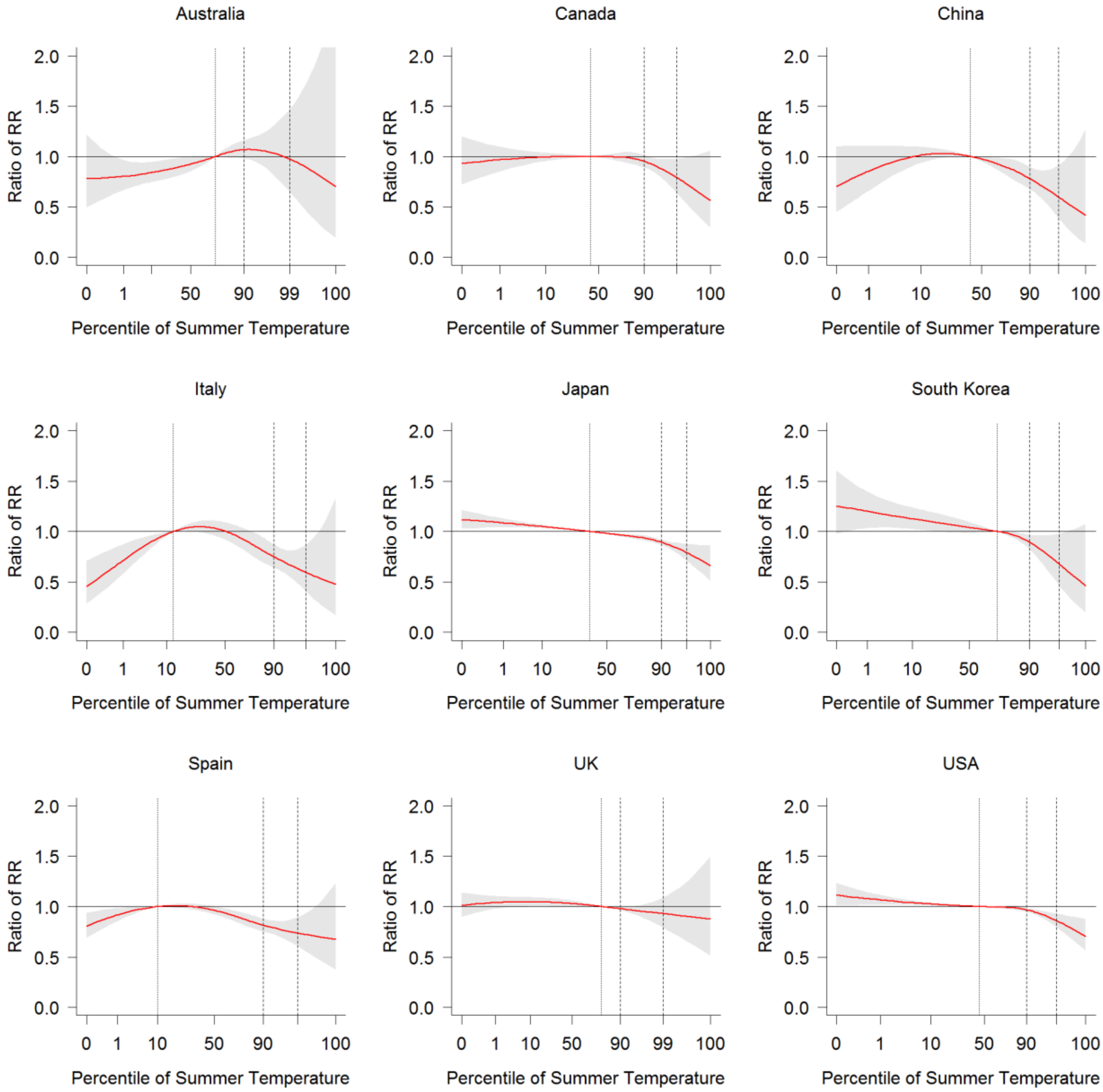

Mobile, AL
USA
Monmouth−Ocean, NJ
USA
Myrtle Beach, SC
USA
Naples, FL
USA
Nashua, NH
USA
Nashville, TN
USA
Nassau−Suffolk, NY
USA
Newark, NJ
USA
Newburgh, NY
USA
New Haven−Meriden, CT
USA
New London, CT
USA
New York, NY
USA
Oakland, CA
USA
Ocala, FL
USA
Oklahoma City, OK
USA
Omaha, NE
USA
Orange County, CA
USA
Orlando, FL
USA
Pensacola, FL
USA
Philadelphia, PA−NJ
USA
Phoenix, AZ
USA
Pittsburgh, PA
USA
Portland, ME
USA
Portland, OR
USA
Early
Late
RR
Summer Temperature


Providence−Fall River, RI−MA
USA
Early Late
RR
Summer Temperature
Punta Gorda, FL
USA
Early Late
RR
Summer Temperature
Raleigh, NC
USA
Early Late
RR
Summer Temperature
Reading, PA
USA
Early Late
RR
Summer Temperature
Riverside−San Bernardino, CA
USA
Early Late
RR
Summer Temperature
Rochester, NY
USA
Early Late
RR
Summer Temperature
Rockford, IL
USA
Early Late
RR
Summer Temperature
Sacramento, CA
USA
Early Late
RR
Summer Temperature
Saginaw, MI
USA
Early Late
RR
Summer Temperature
Salinas, CA
USA
Early Late
RR
Summer Temperature
Salt Lake City, UT
USA
Early Late
RR
Summer Temperature
San Antonio, TX
USA
Early Late
RR
Summer Temperature
Sarasota−Bradenton, FL
USA
Early Late
RR
Summer Temperature
Scranton−−Wilkes−Barre−−Hazleton, PA
USA
Early Late
RR
Summer Temperature
San Diego, CA
USA
Early Late
RR
Summer Temperature
Seattle, WA
USA
Early Late
RR
Summer Temperature
San Francisco, CA
USA
Early Late
RR
Summer Temperature
Shreveport, LA
USA
Early Late
RR
Summer Temperature
San Jose, CA
USA
Early Late
RR
Summer Temperature
Spokane, WA
USA
Early Late
RR
Summer Temperature
Springfield, MA
USA
Early Late
RR
Summer Temperature
Stamford−Norwalk, CT
USA
Early Late
RR
Summer Temperature
St. Louis, MO−IL
USA
Early Late
RR
Summer Temperature
Stockton−Lodi, CA
USA
Early Late
RR
Summer Temperature

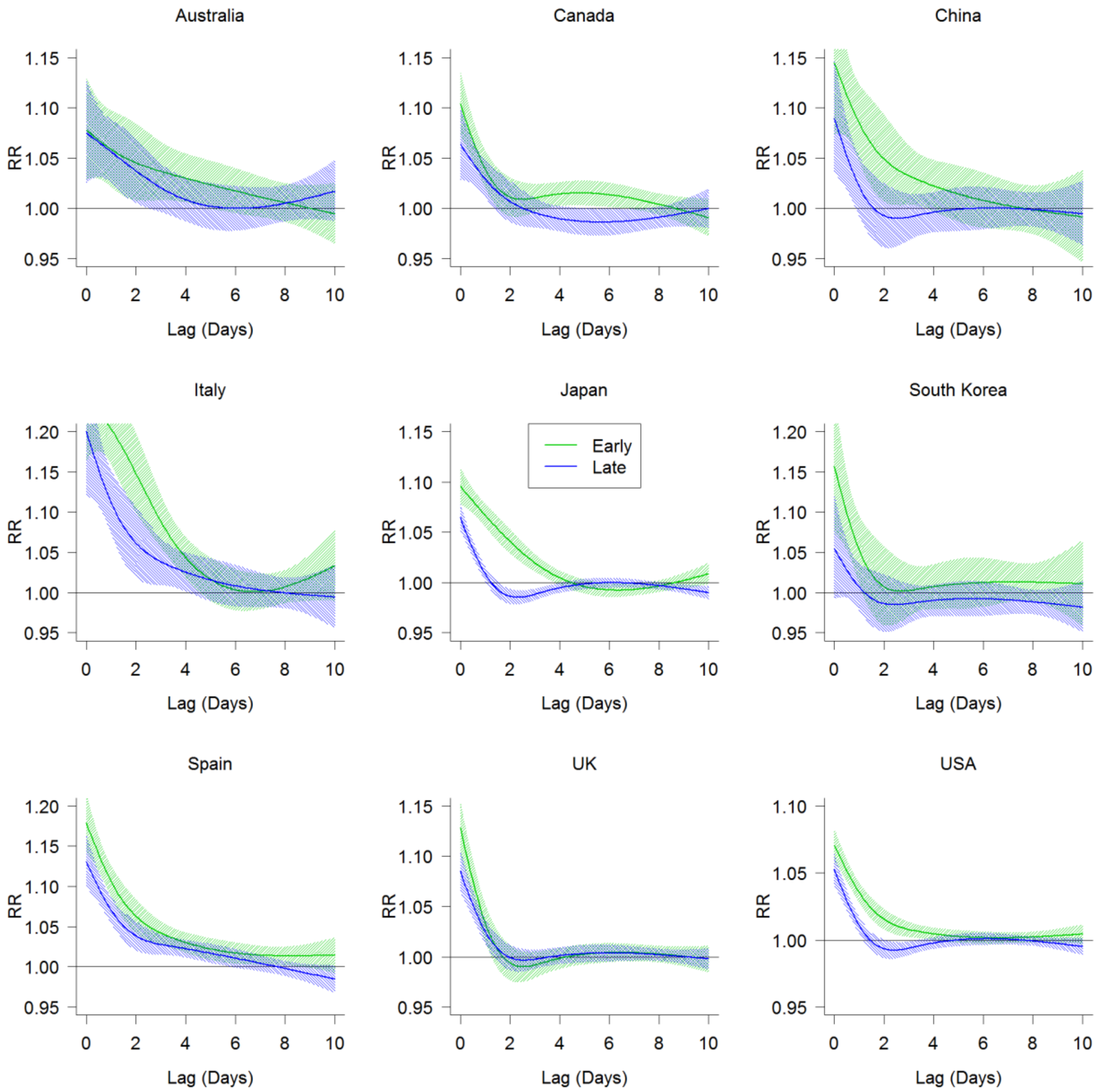


Syracuse, NY
USA
Early
Late
RR
2.0
1.8
1.6
1.4
1.2
1.0
0.8
5
10
15
20
25
30
Summer Temperature
Tacoma, WA
USA
Early
Late
RR
10
15
20
25
Summer Temperature
Tampa−St. Petersburg−Clearwater, FL
USA
Early
Late
RR
22
24
26
28
30
Summer Temperature
Toledo, OH
USA
Early
Late
RR
10
15
20
25
30
Summer Temperature
Trenton, NJ
USA
Early
Late
RR
10
15
20
25
30
Summer Temperature
Tucson, AZ
USA
Early
Late
RR
20
25
30
35
Summer Temperature
Tulsa, OK
USA
Early
Late
RR
10
15
20
25
30
35
Summer Temperature
Utica−Rome, NY
USA
Early
Late
RR
5
10
15
20
25
Summer Temperature
Ventura County, CA
USA
Early
Late
RR
14
16
18
20
22
24
26
Summer Temperature
Virginia Beach, VA
USA
Early
Late
RR
15
20
25
30
Summer Temperature
Washington, DC−MD−VA
USA
Early
Late
RR
15
20
25
30
Summer Temperature
Wichita, KS
USA
Early
Late
RR
5
10
15
20
25
30
Summer Temperature
Wilmington, DE
USA
Early
Late
RR
10
15
20
25
30
Summer Temperature
Worcester, MA
USA
Early
Late
RR
5
10
15
20
25
Summer Temperature
West Palm Beach−Boca Raton, FL
USA
Early
Late
RR
24
26
28
30
Summer Temperature
York, PA
USA
Early
Late
RR
10
15
20
25
30
Summer Temperature
Youngstown−Warren, OH
USA
Early
Late
RR
10
15
20
25
30
Summer Temperature

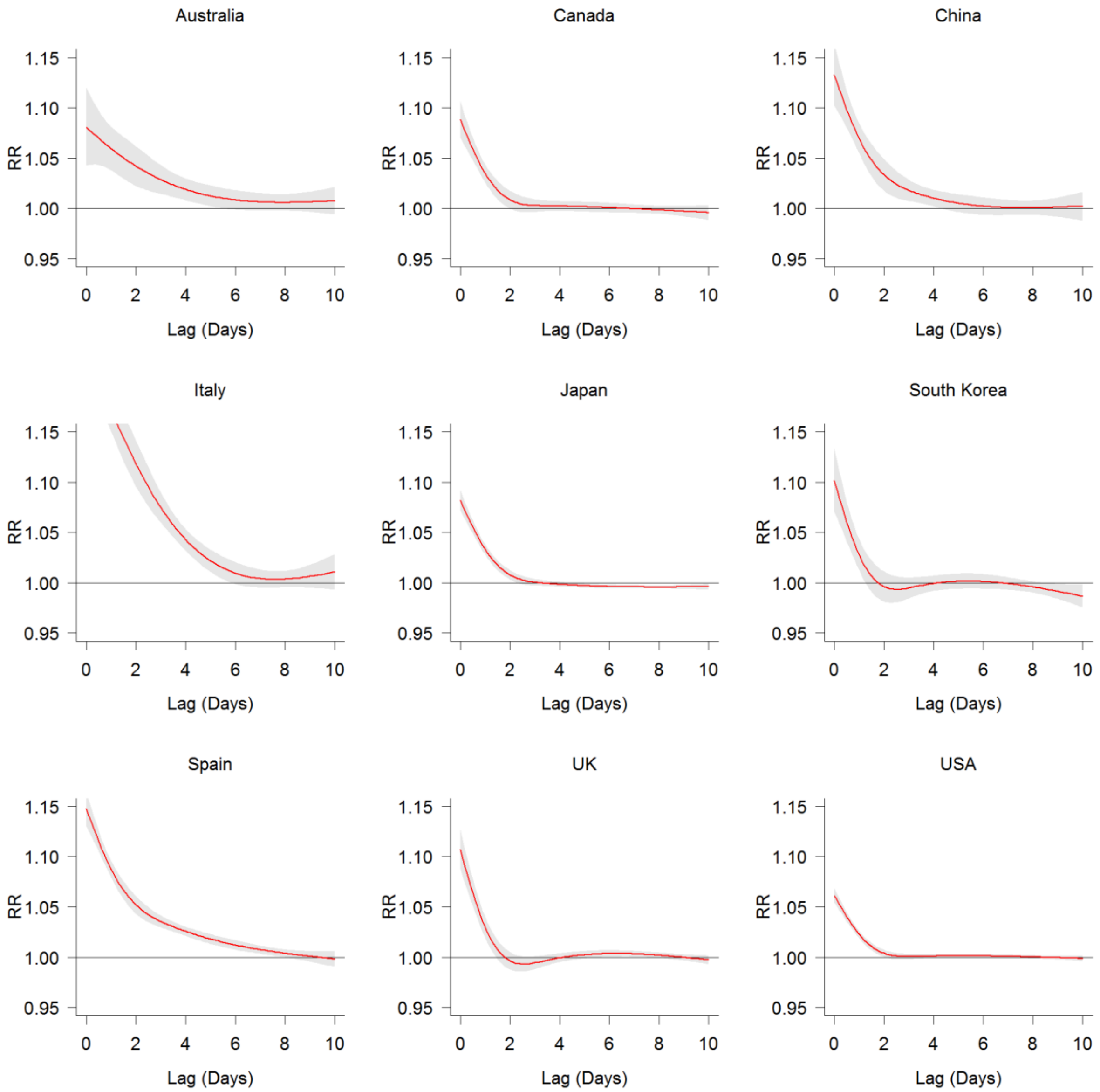
Web Figure 4. Effect modification of day of season on the overalll cumulative exposure-response relationships between heat and mortality in 9 countries, expressed as late/early ratio of RRs (corresponding to the mid-point of the last and first summer months, respectively), with 95% confidence intervals. The curves are represented on a relative scale of summer temperature percentiles, using country-specific distributions. The vertical lines represent the average minimum mortality percentile (dotted) and the 90th and 99th percentiles of the temperature distribution (dashed). Note that the *y*-axis is scaled to the country-specific range.



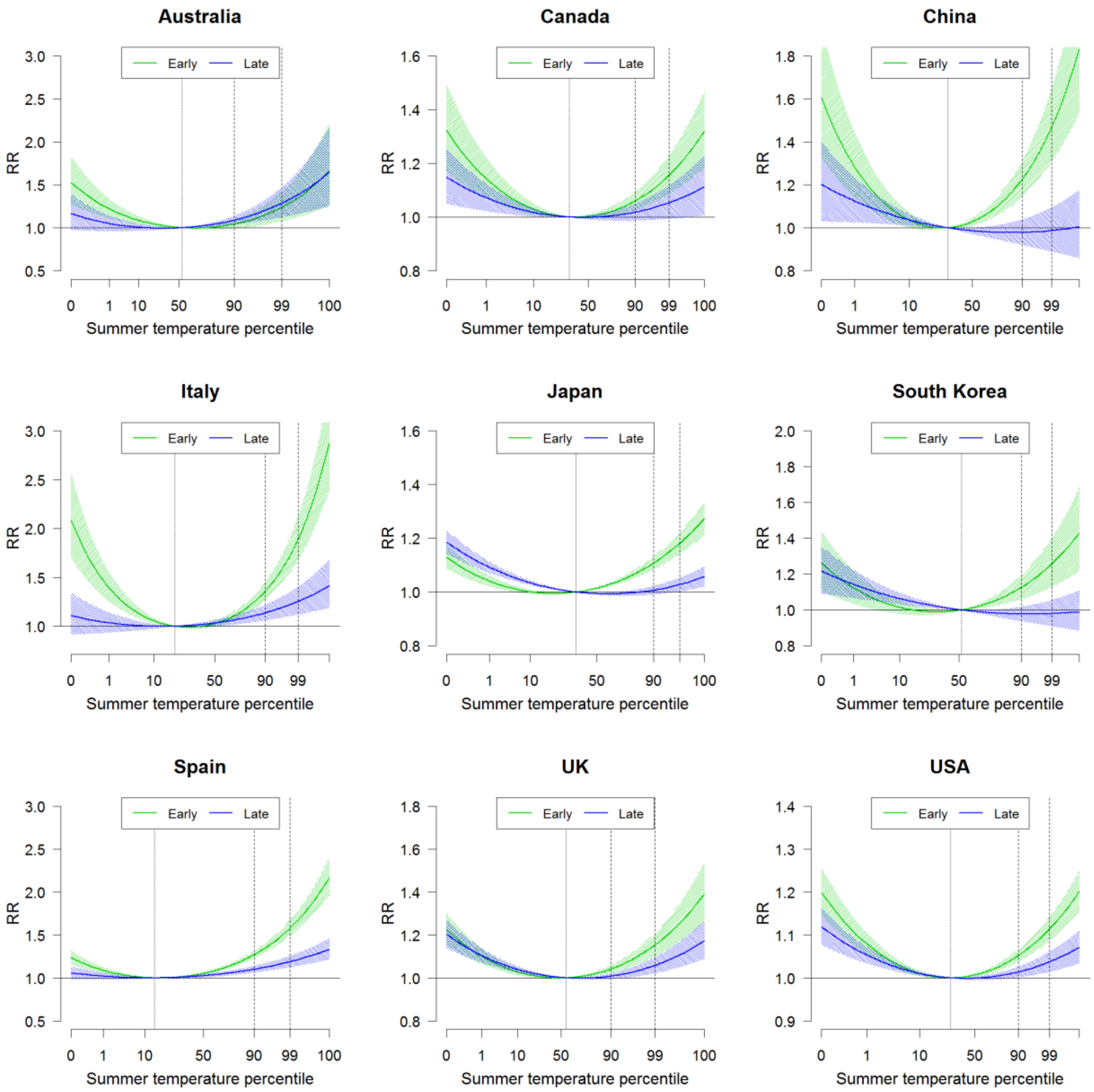
Web Figure 5. Replication of Figure 3 in the manuscript, including colours and confidence intervals as shaded areas.



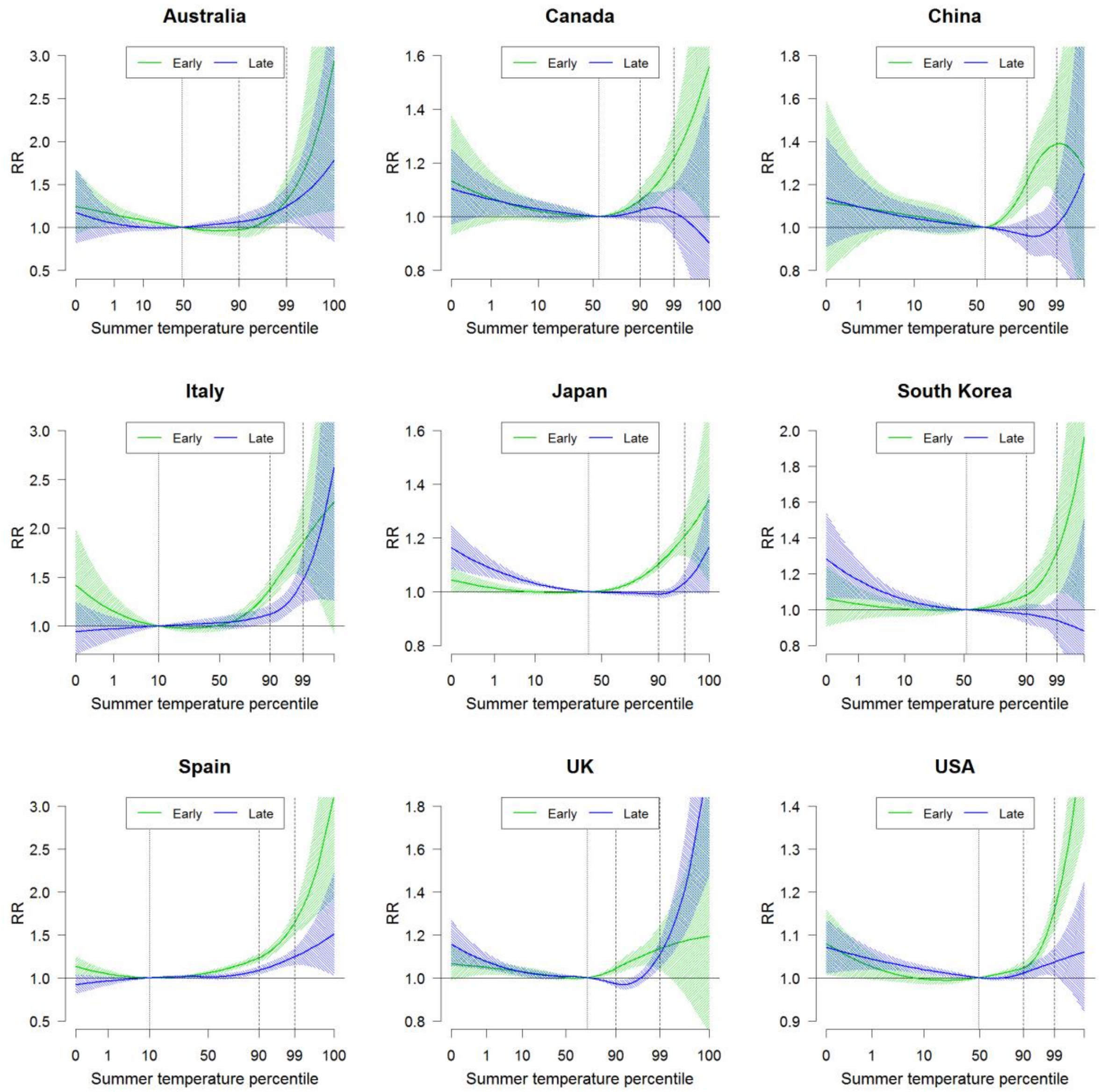
Web Figure 6. Replication of Figure 3 in the manuscript for the average across the summer, with confidence intervals as grey areas.



Web Figure 7. Replication of Figure 3 in the manuscript using a quadratic B-spline function with 2 df (no knots) as the exposure-response function.

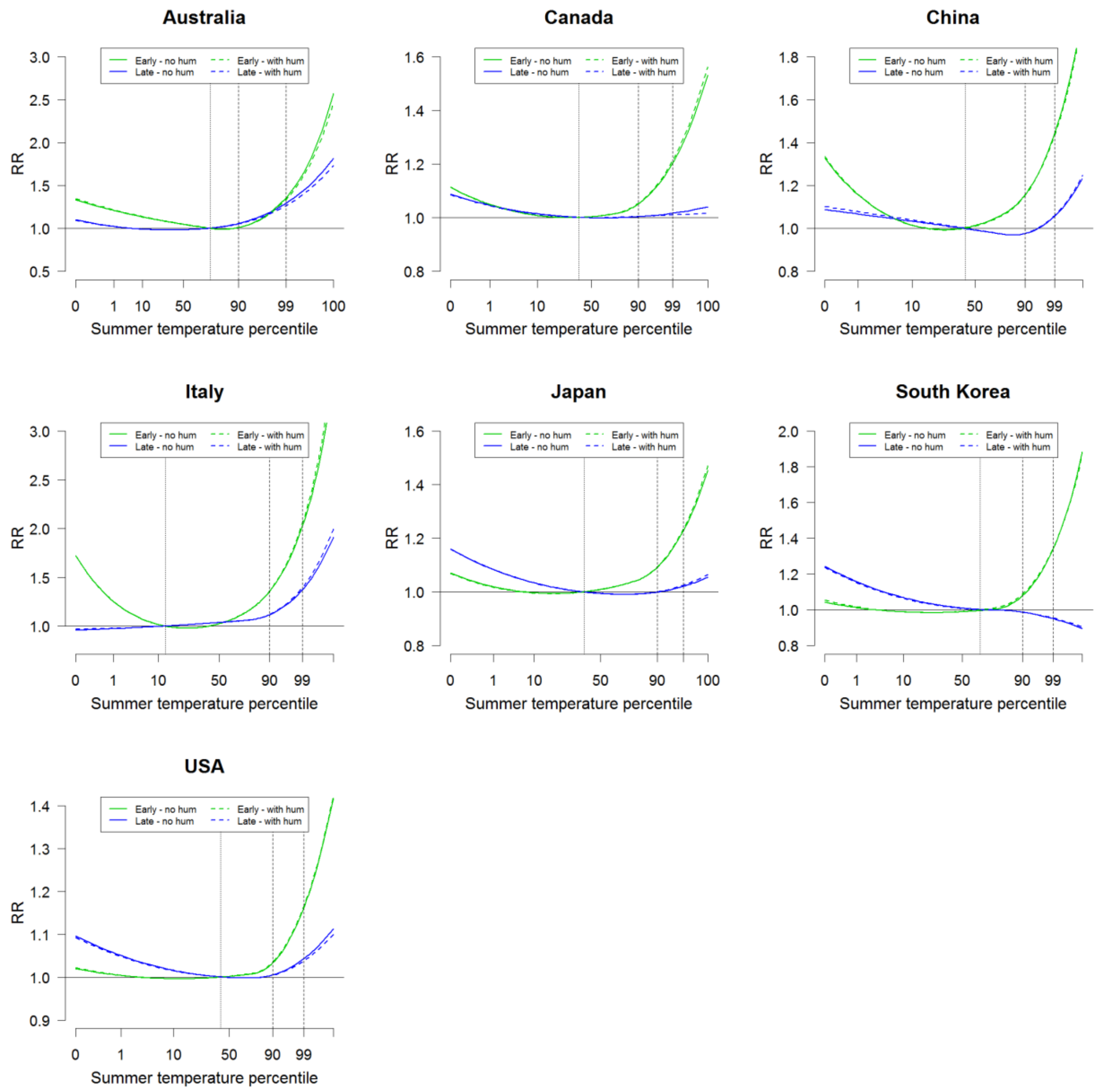


Web Figure 8. Replication of Figure 3 in the manuscript using a quadratic B-spline function with 4 df (knots at the 50th and 90th percentile of summer temperature distribution) as the exposure-response function.



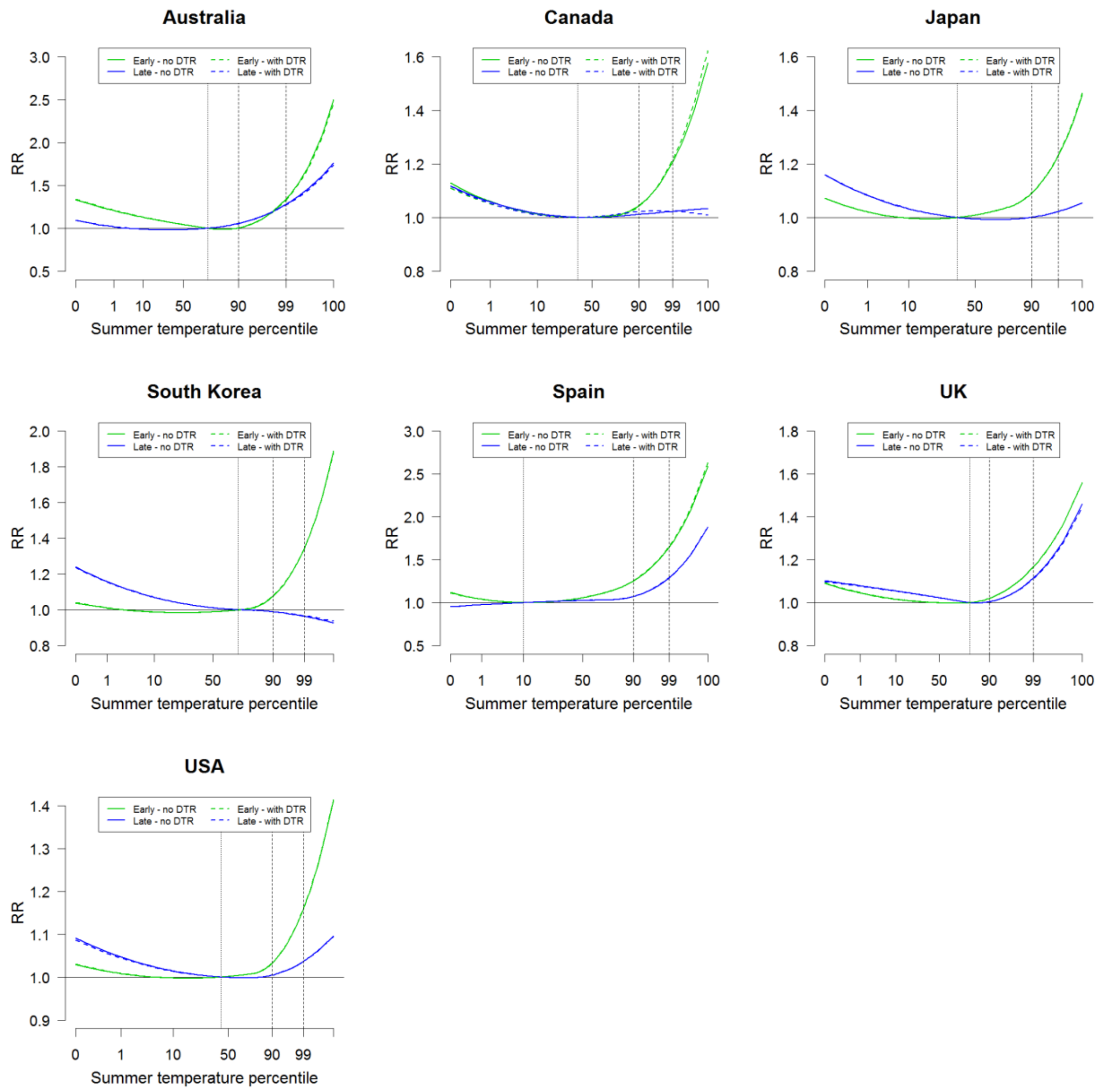
Web Figure 9. Replication of Figure 3 in the manuscript (excluding confidence intervals), with and without control for relative humidity, modelled using a natural cubic B-spline function with 3 df of the average over lag 0-1. The analysis is performed in the subset of 223 locations including at least 80% of daily measurement of relative humidity.

[a]The curves are represented on a relative scale of summer temperature percentiles, using country-specific distributions.



Web Figure 10. Replication of Figure 3 in the manuscript (excluding confidence intervals), with and without control for diurnal temperature range (DTR). The analysis is performed in the subset of 273 locations including at least 80% of daily measurement of maximum and minimum daily temperature.

[a]The curves are represented on a relative scale of summer temperature percentiles, using country-specific distributions.



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