Supplement

Comparison of Respiratory and Ischemic Heart Mortality and its Relationship to Thermal Environment

A. Trend of IHD mortality in the years 2001 - 2015

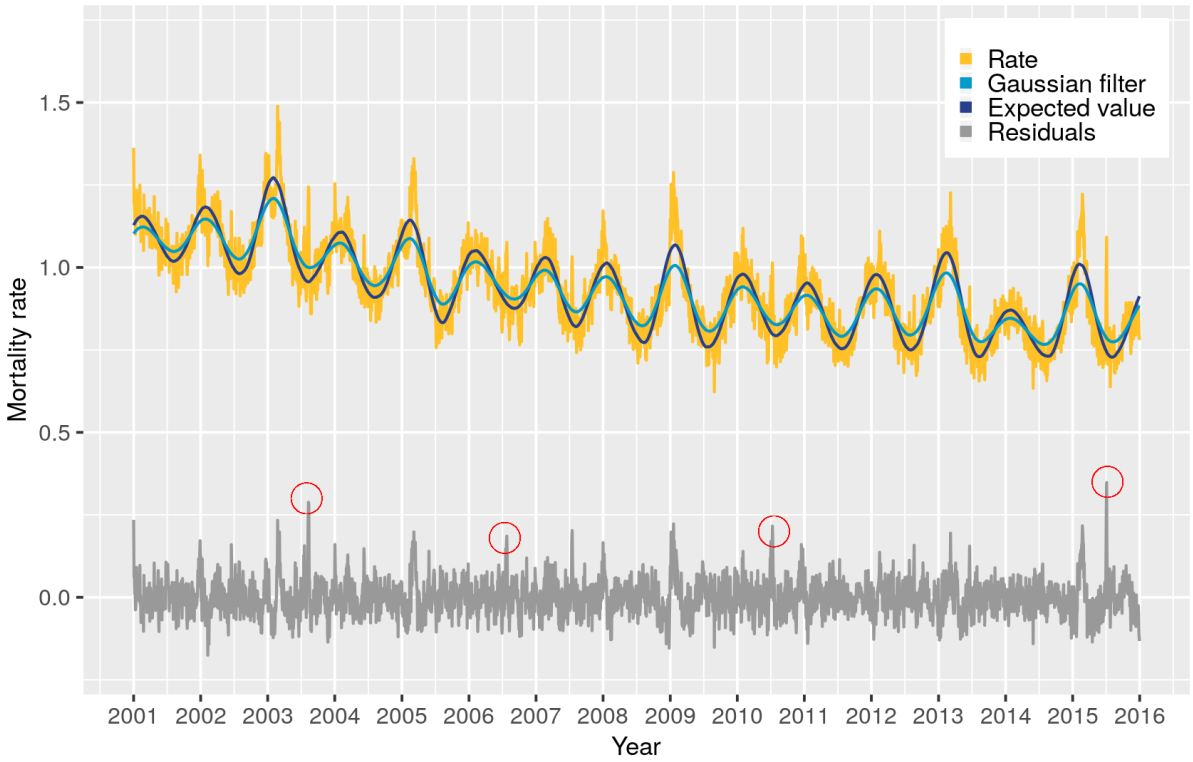

Figure S1. Expected value of IHD mortality with population-based two-day rate (yellow), result of the Gaussian low-pass filter (light blue), the corrected filter function of expected value (dark blue) and the residuals (grey). Marked in red are the deviations of mortality during the summers 2003, 2006, 2010 and 2015.

B. Relationship between mortality and PT

The human biometeorological Index (PT) uses the meteorological parameters T_a, vapour pressure, wind speed in approximately 1 meter height and mean radiant temperature (T_{mrt}) in hourly resolution as input. For the calculation of T_{mrt}, the approach of the RayMan model is used [1]. These input parameters were not consistently available at two of the 20 meteorological stations, therefore, PT is only available for 18 stations. Despite this, compiling PT data for the seven regions is still possible, however, PT in region North bases only on one station (station "Schleswig", on top of region North), PT in region Centre bases on two instead of three stations (station "Frizlar" in the upper-right corner is missing).

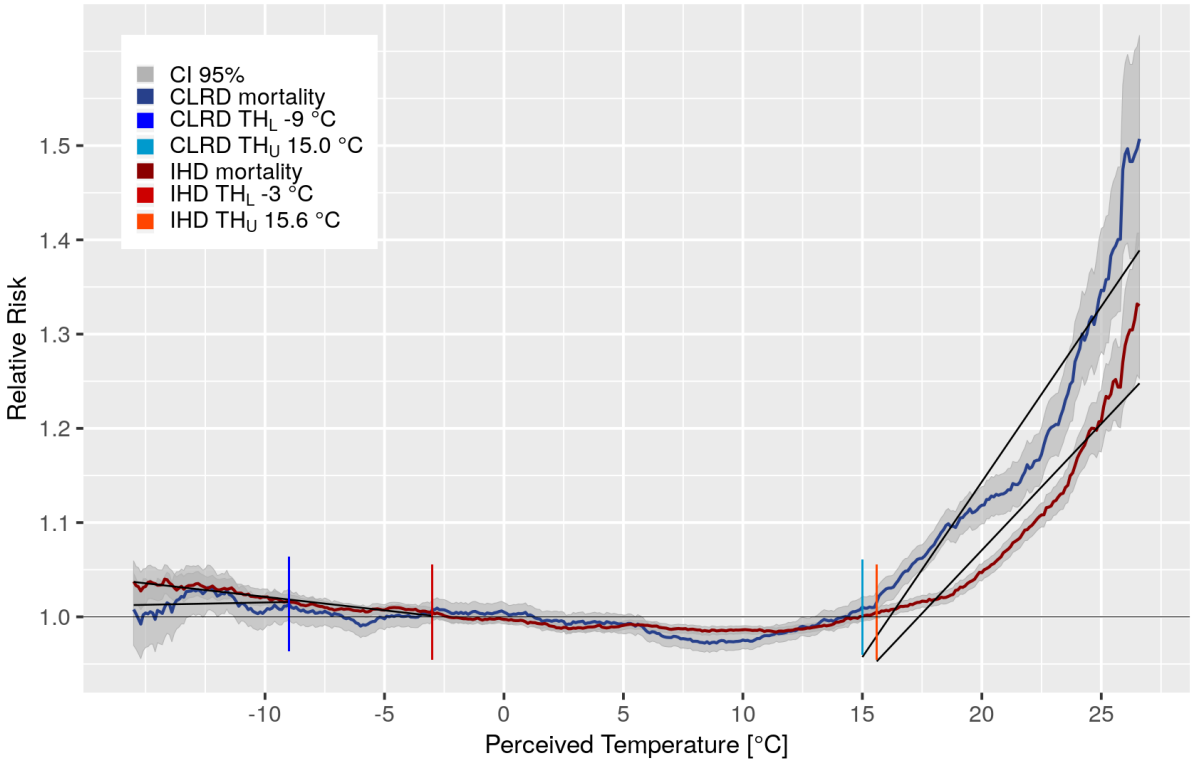

Figure S2. Relationship between PT and RR of CLRD and IHD mortality in the years 2001 – 2015 in Germany.

Table S1. Lower (TH_L) and upper (TH_U) threshold values of PT of CLRD mortality (blue) and IHD mortality (red) as well as the gradients of RR below resp. above these TH for Germany and its seven regions. Significant gradients on 95 % level ($\alpha = 0.05$) are marked in bold.

Region	PT thresholds [°C]				Gradients of RR below/above TH [% / °C] (CI)			
	CLRD		IHD		CLRD		IHD	
	TH_L	TH_U	TH_L	TH_U	< TH_L	> TH_U	< TH_L	> TH_U
Germany	-9.0	15.0	-3.0	15.6	0.1 (±0.1)	**3.7** (±0.2)	**-0.3** (±0.0)	**2.7** (±0.2)
North	-	12.9	-5.2	16.7	-	**3.3** (±0.3)	**-0.2** (±0.0)	**1.0** (±0.2)
North-West	-2.9	14.5	-3.3	15.4	**-0.2** (0.1)	**2.8** (±0.1)	**-0.5** (±0.1)	**1.9** (±0.1)
East	-11.6	15.8	-4.4	16.5	**-1.8** (±0.9)	**1.0** (±0.1)	**-0.1** (±0.0)	**2.2** (±0.2)
West	-	15.6	-1.7	16.8	-	**3.1** (±0.2)	**-0.1** (±0.0)	**2.6** (±0.2)
Centre	-	15.7	-10.3	18.3	-	**3.0** (±0.3)	**-0.2** (±0.2)	**2.5** (±0.1)
South-West	-11.8	17.1	-6.3	18.9	**-1.8** (±1.0)	**2.5** (±0.1)	**-0.3** (±0.1)	**2.3** (±0.2)
South-East	-1.4	17.0	-7.9	15.6	**-0.1** (±0.1)	**2.6** (±0.2)	**-0.3** (±0.1)	**1.4** (±0.1)

C. Heat waves

Comparing the days identified as heat waves based on T_a or PT, approximately 93 % of days are compliant, meaning, that 93 % of dates identified as associated to heat waves by T_a are identified by PT as well (Table S2). In most regions, slightly more days are identified as heat waves with PT than T_a. The average duration of heat waves is 3.3 twin-days occurring in one or several regions in Germany. On average, three events per year occurred in Germany, within the regions, two to three events per year occurred.

Table S2. Difference between heat waves based on T_a and based on PT for the years 2001 – 2015 for seven regions in Germany. Consensus between both methods is depicted as percentage of dates identified as heat wave by T_a, which are identified by PT as well.

Region	Sum of HW days 2001 - 2015 [based on T_a]	Sum of HW days averaged per year [based on T_a]	Sum of HW days 2001 - 2015 [based on PT]	Sum of HW day averaged per year [based on PT]	Consensus of HW-T_a days [%]
North	105	7.0	110	6.5	90
North-West	95	5.0	99	6	95
East	98	6	99	7	93
West	103	7.5	104	8	90
Centre	96	4	100	5	96
South-West	110	6.5	116	7	94
South-East	108	6.5	105	5	86

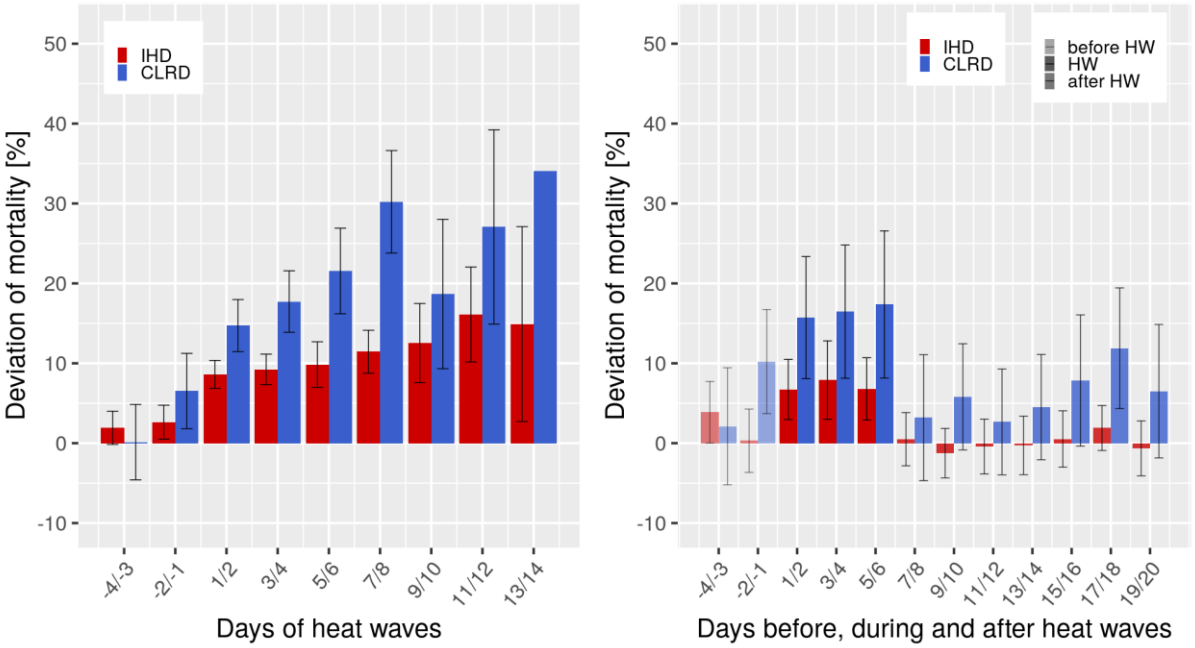

Figure S3. Deviation of CLRD and IHD mortality from the expected value due to heat waves based on PT. Left: Averaged over all heat waves between 2001 – 2015 in Germany. Right: Days before, during and after 6-day (3 twin days) heat waves in Germany averaged over the years 2001 - 2015.

Table S3. Deviation of CLRD (blue) and IHD (red) mortality during heat waves based on PT. Significant deviations on 95 % level ($\alpha = 0.05$) are marked in bold.

			CLRD	IHD
Region	95th Percentile of PT [°C]	Average PT [°C]	Deviation of mortality [%]	Deviation of mortality [%]
Germany	18.7	21.2	**19.5**	**9.9**
North	16.1	18.4	**20.8**	**5.8**
North-West	17.9	20.5	**18.2**	**8.7**
East	19.2	21.7	**15.3**	**11.5**
West	18.5	21.1	**22.7**	**12.3**
Centre	18.9	21.4	**22.3**	**9.9**
South-West	20.6	22.8	**22.3**	**10.5**
South-East	19.1	21.2	**12.7**	**7.0**

D. Cold waves

The difference between cold waves based on T_a and PT is slightly higher than by heat waves. The agreement is about 88 % (Table S4). In most regions, PT identifies a few days less as cold waves than T_a. The average duration of cold waves is 3.6 twin-days occurring in one or several regions in Germany. On average, four events per year occurred in Germany, within the regions, two events occurred.

Table S4. Difference between cold waves based on T_a and based on PT for the years 200 – 2015 for seven regions in Germany. Consensus between both methods is depicted as percentage of dates identified as cold wave by T_a, which are identified by PT as well.

Region	Sum of CW days 2001 - 2015 [based on T_a]	Sum of CW days averaged per year [based on T_a]	Sum of CW days 2001 - 2015 [based on PT]	Sum of CW days averaged per year [based on T_a]	Consensus of CW-T_a days [%]
North	105	7	107	7	81
North-West	112	6	110	6	92
East	117	8	112	7	86
West	122	7	118	6.5	89
Centre	116	8	115	9	91
South-West	117	8.5	113	9	88
South-East	112	6.5	115	7.5	88

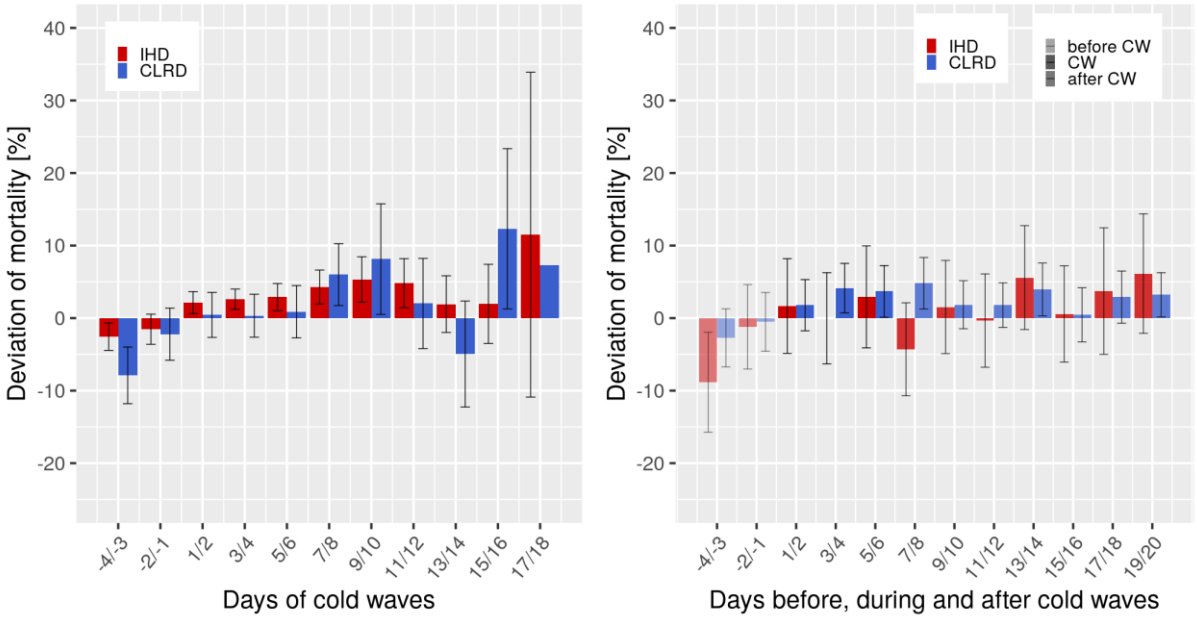

Figure S4. Deviation of CLRD and IHD mortality from the expected value due to cold waves based on PT. Left: Averaged over all cold waves between 2001 – 2015 in Germany. Right: Days before, during and afterwards of 6-day (3 twin-days) cold waves in Germany averaged over the years 2001 – 2015.

Table S5. Deviation of CLRD (blue) and IHD (red) mortality during cold waves based on PT. Significant deviations on 95 % level (a < 0.5) are marked in bold.

			CLRD	IHD
Region	5th Percentile of PT [°C]	Average PT [°C]	Deviation of mortality [%]	Deviation of mortality [%]
Germany	-8.8	-12.0	**1.8**	**3.0**
North	-9.3	-11.8	0.7	**2.5**
North-West	-8.1	-11.5	2.5	**4.3**
East	-9.8	-13.5	1.4	1.2
West	-7.6	-10.5	0.9	**2.8**
Centre	-10.0	-13.3	2.2	**3.4**
South-West	-7.6	-11.0	1.6	**4.0**
South-East	-10.5	-13.6	3.4	**2.8**

E. Comparing 2003 and 2015 heat waves

Table S6. Average two-daily PT [°C] as well as mean (max) of RR of CLRD (blue) and IHD (red) mortality during the heat waves of August 2003 and first part of July 2015 in seven regions in Germany.

	Heat wave August 2003			First heat wave July 2015		
Region	PT	RR CLRD	RR IHD	PT	RR CLRD	RR IHD
North	19.1	1.1 (1.2)	1.0 (1.1)	21.3	1.2 (1.4)	1.1 (1.2)
North-West	21.6	1.3 (1.7)	1.2 (1.2)	22.5	1.5 (1.6)	1.2 (1.3)
East	21.6	1.2 (1.6)	1.1 (1.2)	23.0	1.5 (1.9)	1.3 (1.4)
West	23.5	1.4 (1.9)	1.3 (1.6)	24.8	1.8 (2.0)	1.5 (1.7)
Centre	23.5	1.6 (2.1)	1.2 (1.6)	23.2	1.5 (1.7)	1.5 (1.9)
South-West	23.3	1.7 (2.4)	1.3 (1.7)	25.6	1.4 (1.7)	1.4 (2.0)
South-East	23.0	1.2 (1.4)	1.1 (1.3)	23.6	1.5 (1.8)	1.1 (1.2)

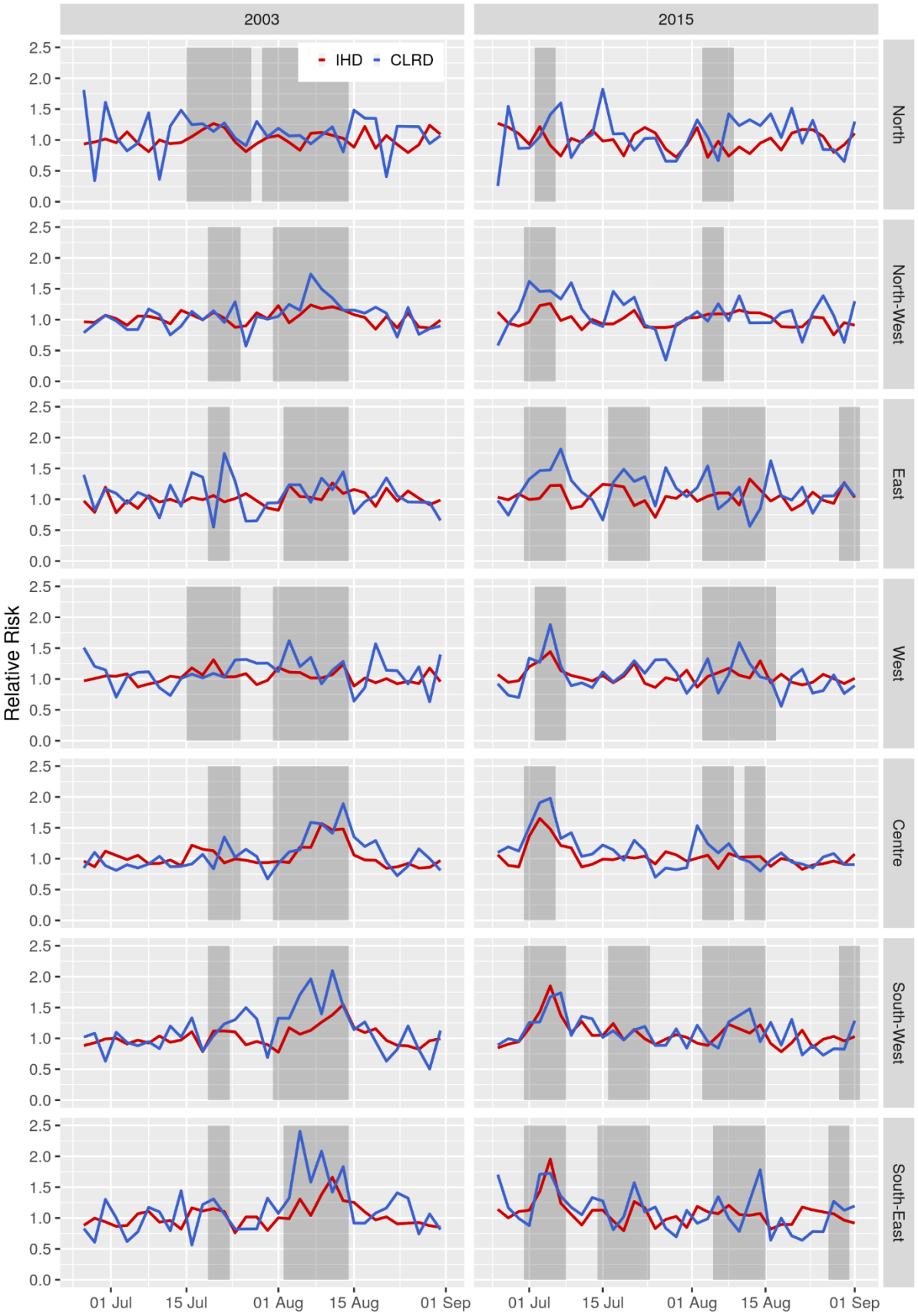

Figure S5. Relative Risk of CLRD and IHR mortality during heat waves based on PT (grey columns highlight the heat wave days) for summer 2003 (left) and summer 2015 (right) in seven regions in Germany.

1. Matzarakis, A.; Rutz, F.; Mayer, H. Modelling radiation fluxes in simple and complex environments: basics of the RayMan model. *Int J Biometeorol* **2010**, *54*, 131-139.