Assessment of Premature Heat-Related Mortality in Cyprus

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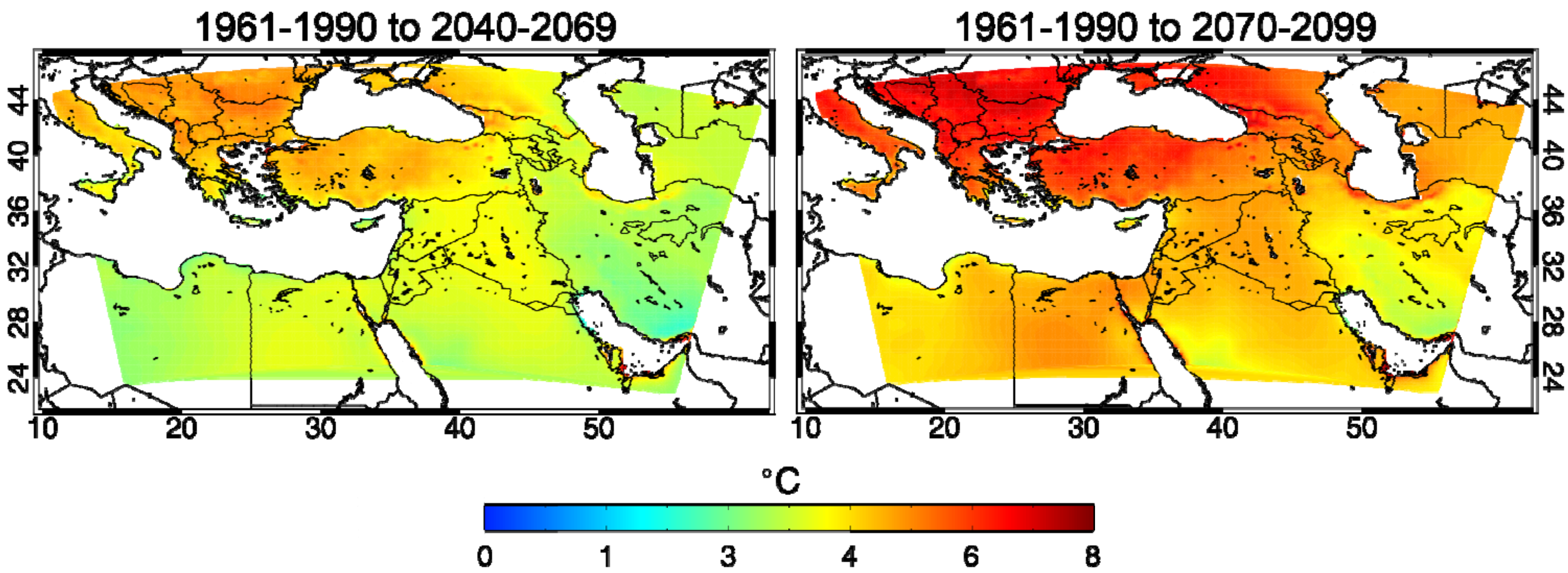
Outline

- Background and context
- Goal of this study
- Methodology
- Data
- Results
- Conclusions

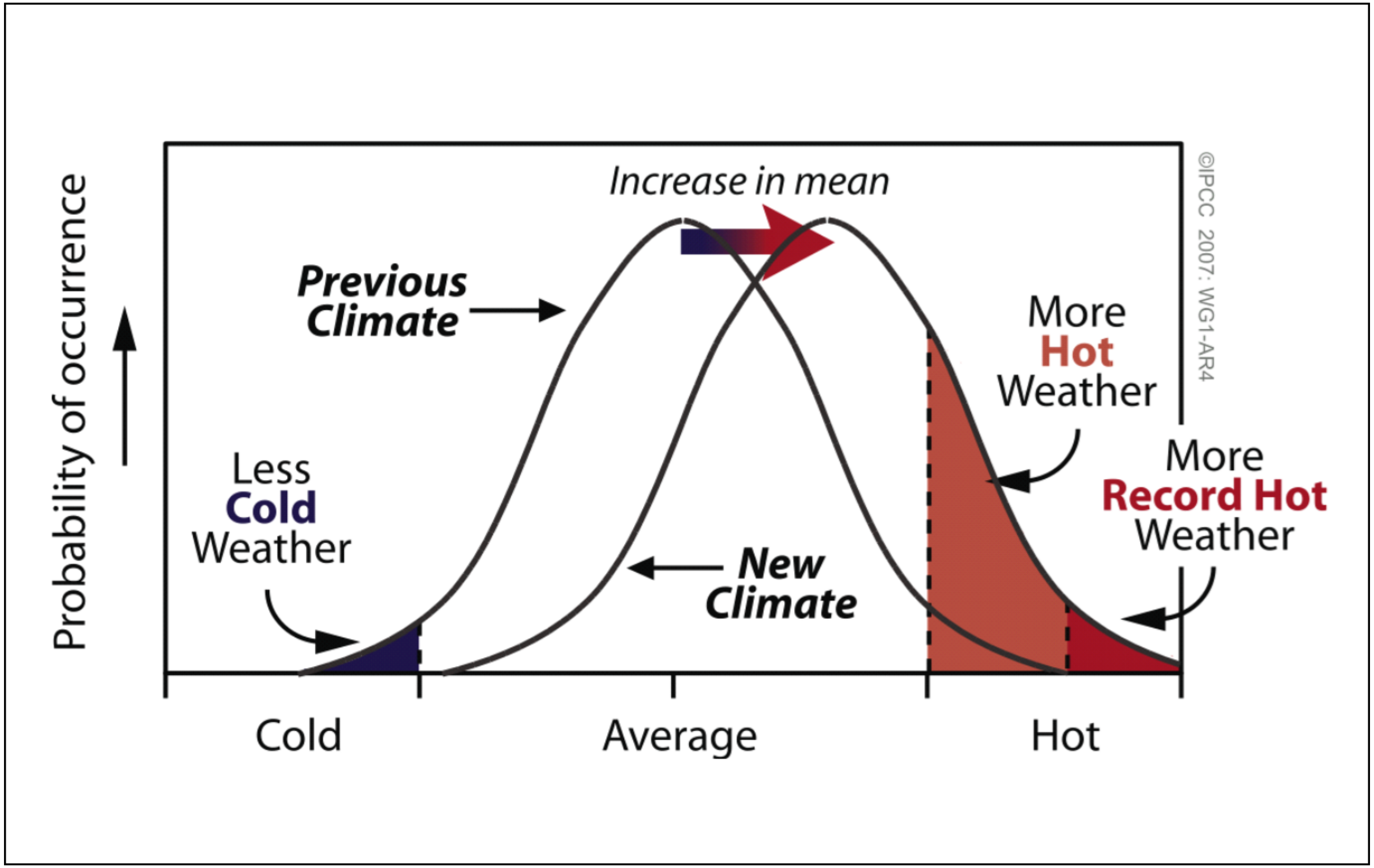
Background and context

Change in daytime maximum temperature in summer months (JJA) from baseline period to mid-century (left panel) and end-century (right panel) periods for the East Mediterranean and Middle East (EMME) region



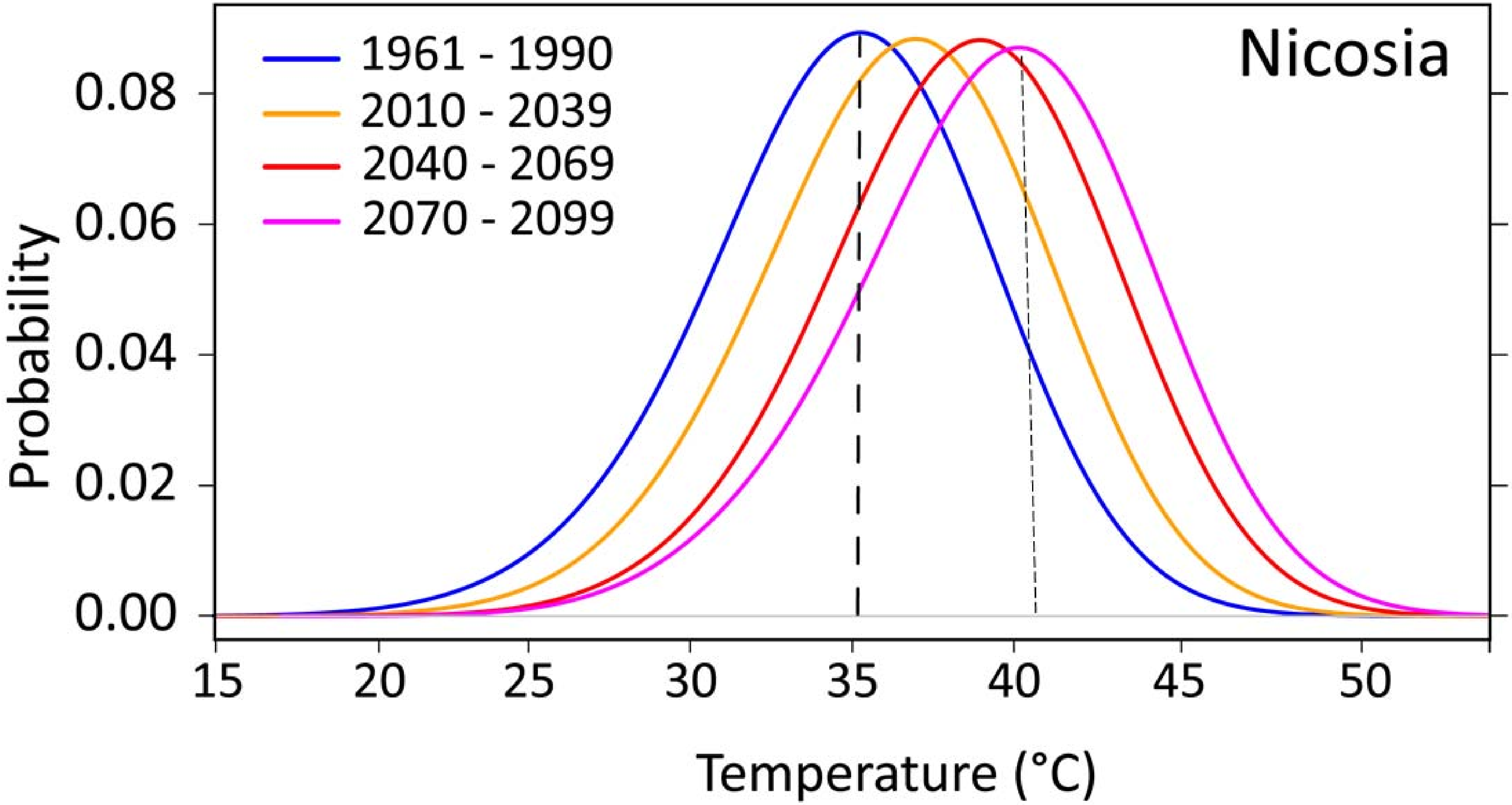
Background and context

Schematic showing the effect on extreme temperatures when the mean temperature increases, for a normal temperature distribution



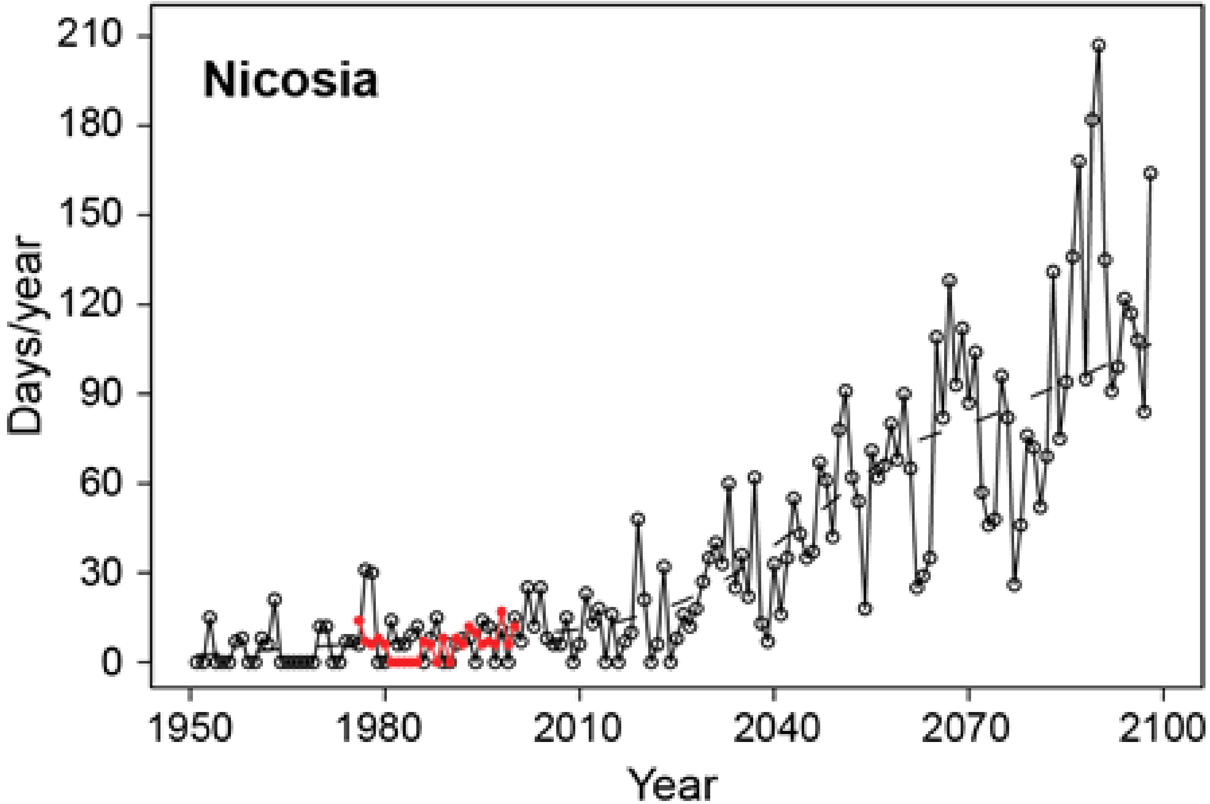
Background and context

Probability distribution of daytime maximum temperatures in the summer months (JJA) in Nicosia



Background and context

The frequency and intensity of heat waves is projected to increase due to climate change:



Heat wave definition used here:

six or more consecutive days with maximum temperatures exceeding the local 90th percentile of the reference period 1961-1990

Changing number of heat wave days per year: observations (red) and model calculations (black)

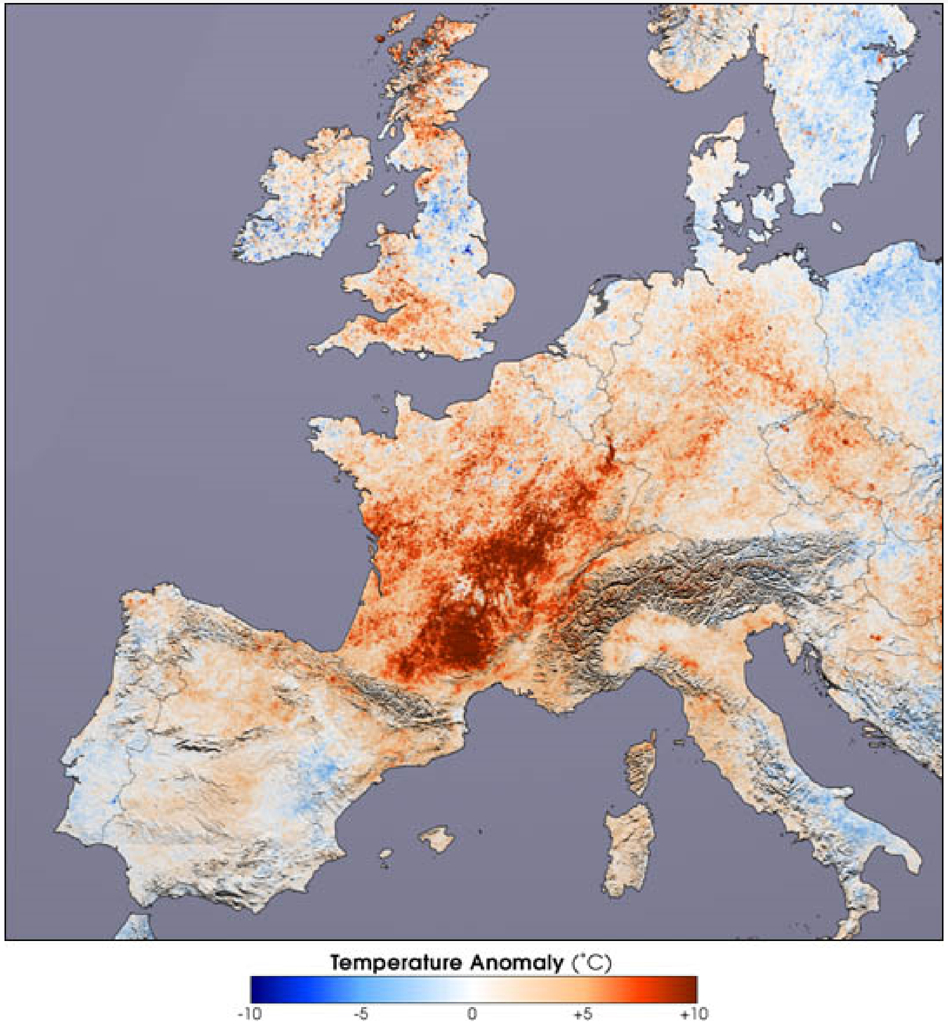
Background and context

Hot effects are an increasing public health threat, especially in the light of climate change.

Example: European heat wave of 2003

- Temperature anomalies up to 10°C
- 70 thousand fatalities

Main causes of death during a prolonged period of extreme temperatures are of respiratory and/or cardiovascular origin and the most vulnerable people to heat-related mortality are the elderly and people with pre-existing diseases.



Source: NASA

Background and context

Period	Event	Affected Area	Fatalities
12 January 2010	earthquake	Haiti	222,570
26 December 2004	earthquake/tsunami	South East Asia	220,000
02-05 May 2008	cyclone	Myanmar	140,000
29-30 April 1981	cyclone	Bangladesh	139,000
08 October 2005	earthquake	South West Asia	88,000
12 May 2008	earthquake	China	84,000
July - August 2003	**heat wave**	**Europe**	**70,000**
July - September 2010	**heat wave**	**Russian Federation**	**56,000**
20 June 1990	earthquake	Iran	40,000
26 December 2003	earthquake	Iran	26,200

10 deadliest worldwide natural events 1980 – 2012

Source: NatCatSERVICE

Due to climate change, EMME region is projected to experience a rapid rise of extremely high summer temperatures.

However, little research on the heat-mortality relationship has been done so far in this region.

Goal of this study

Assessment of the impacts of climate change on heat-related cardiovascular mortality risk in Cyprus

The temperature-response relationship is not universal. Differences in sensitivity, coping capacity and adaptation measures of different populations as well as climatic differences across the globe, all play a role.

The bigger picture:

In order to assess the heat-related premature mortality for the entire EMME region, the relative risk derived for Cyprus will be used in the health impact function assuming that due to its central position, Cyprus is climatically as well as socio-economically representative for the region.

So how do we estimate the relative risk?

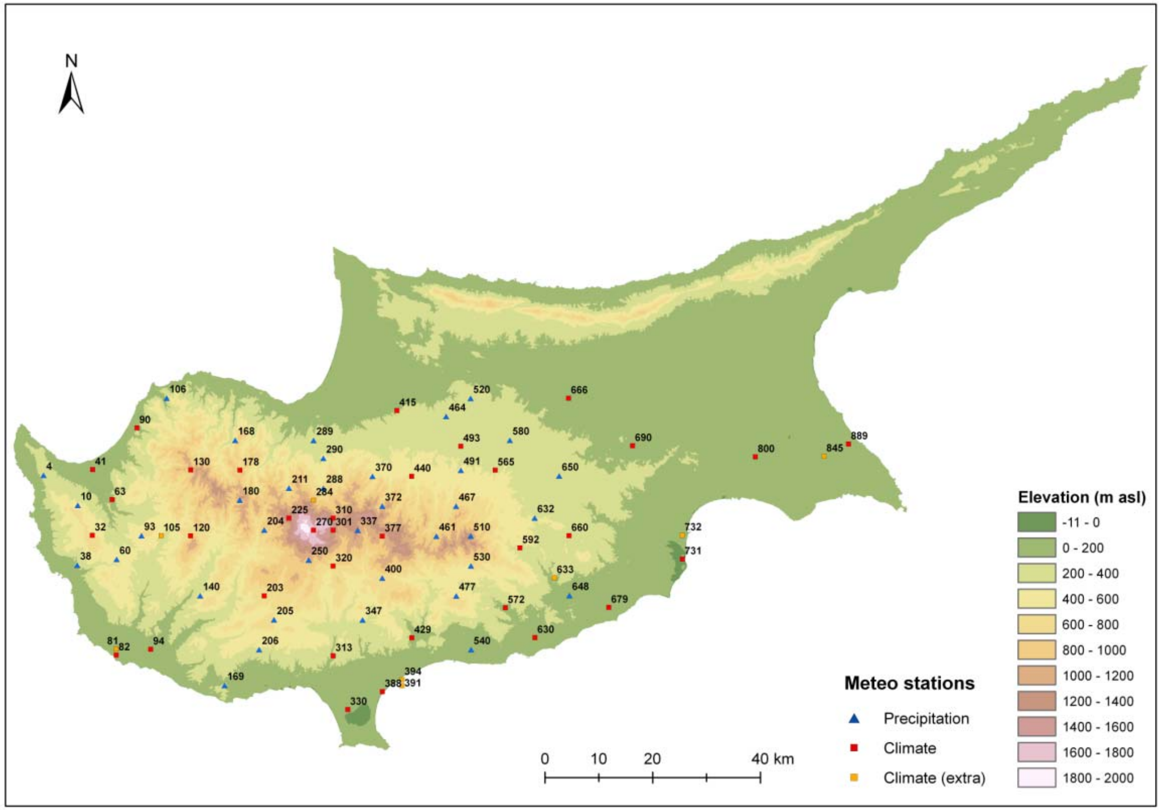
Methodology

The analysis of the relationship between temperature and mortality is carried out using a case-crossover design that captures the non-linear and distributed lag effects of temperature on mortality using a distributed lag non-linear model (DLNM)

- **Case cross-over study design:**
  - Special case of time-series analysis
  - Each case serves as its own control and is used to investigate the transient effects of an intermittent exposure on the onset of acute outcomes
  - Benefits of self-matching:
    - *increased efficiency*
    - *elimination of the bias normally imposed by the selection of the control*
- **DLNM**
  - Nonlinear temperature effect and the lagged effect are both modeled using a natural cubic spline
  - R software package "dlnm" is used

Data

- **Climate Data – Cyprus Meteorological Service**
  - Period: 01/01/2003 – 31/12/2010
  - 34 weather stations

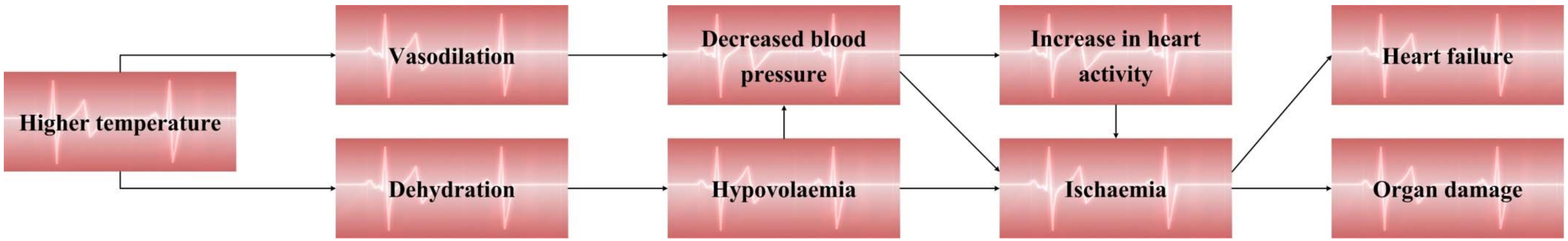


- Mean, maximum and minimum temperature records are analyzed
- The data is weighed in order to create one representative daily value for the entire area under study

Data

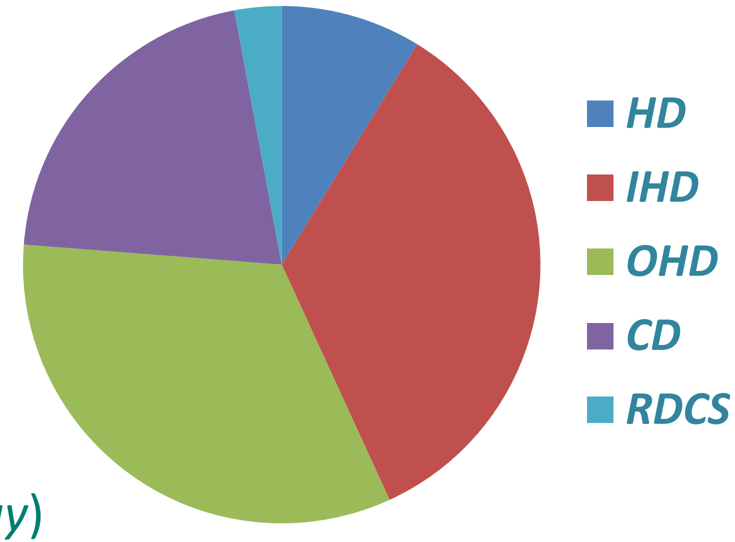
- **Daily Mortality Data – Ministry of Health**

  - Diseases taken into account – ICD10 (by WHO) classification:
    - *Hypertensive diseases (HD) - 1066*
    - *Ischaemic heart diseases (IHD) – 1067*
    - *Other heart diseases (OHD) - 1068*
    - *Cerebrovascular diseases (CD) - 1069*
    - *Remainder of diseases of circulatory system (RDCS) - 1071*
  - Period: 01/01/2004 – 31/12/2011
  - No spatial distribution



Data

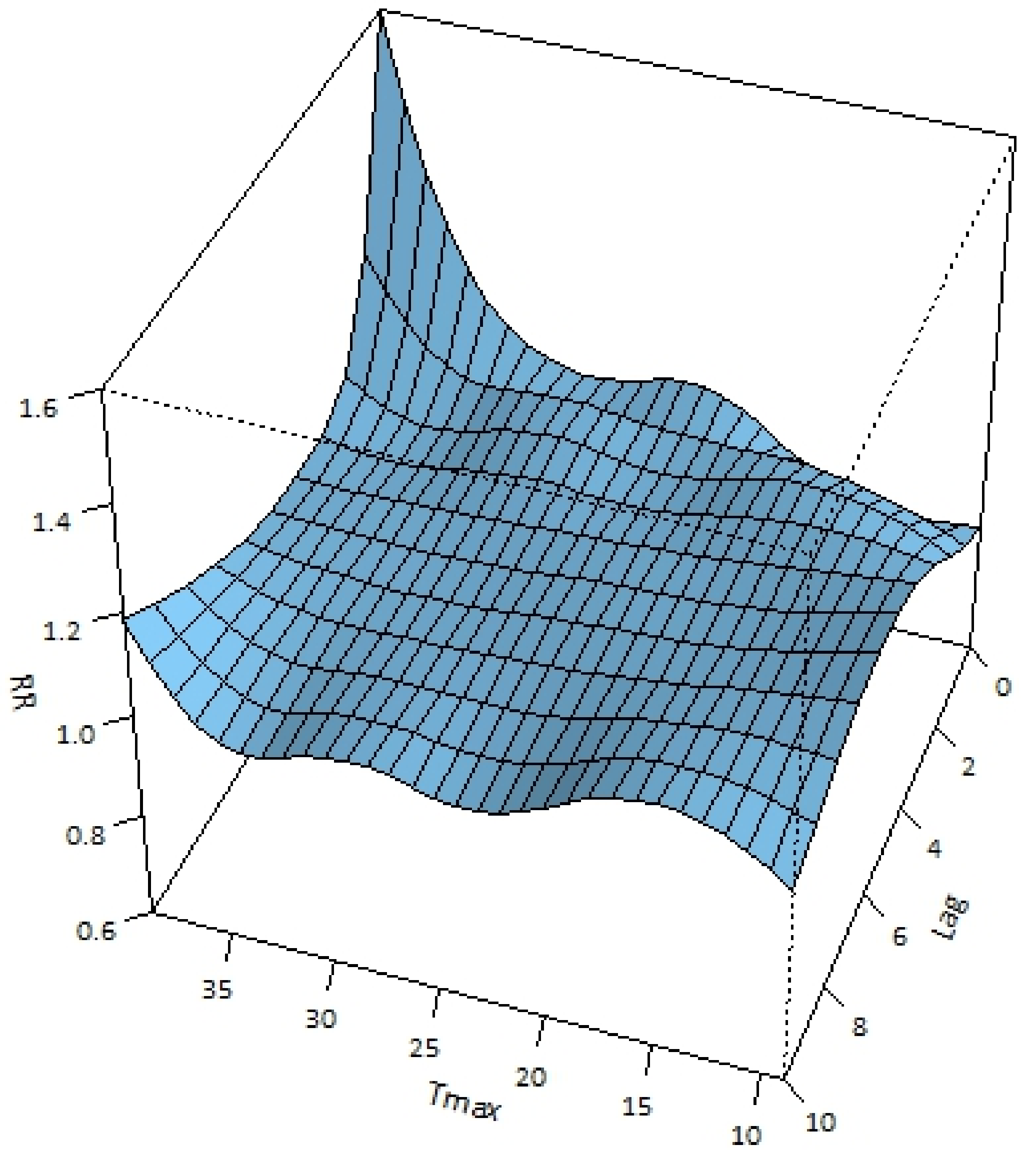
Mortality data at first glance



- Total 2004-2010: **13889** (*5.43 deaths per day*)
- Total 2004-2010 mortality per disease:
  - Hypertensive diseases – **1220** (*8.78% of the total*)
  - Ischaemic heart diseases – **4773** (*34.37% of the total*)
  - Other heart diseases – **4595** (*33.08% of the total*)
  - Cerebrovascular diseases – **2893** (*20.83% of the total*)
  - Remainder of diseases of circulatory system - **408** (*2.94% of the total*)

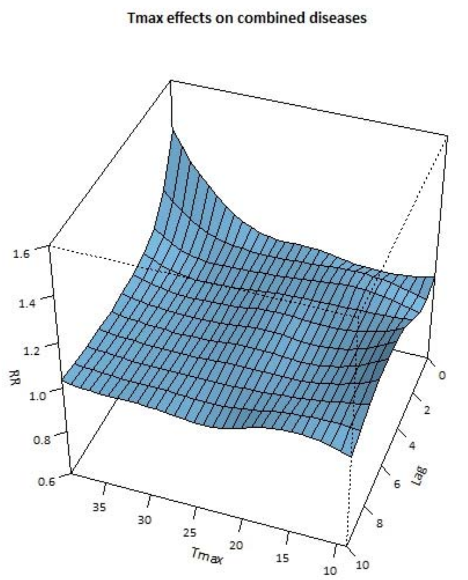
Results

How to read a 3D graph

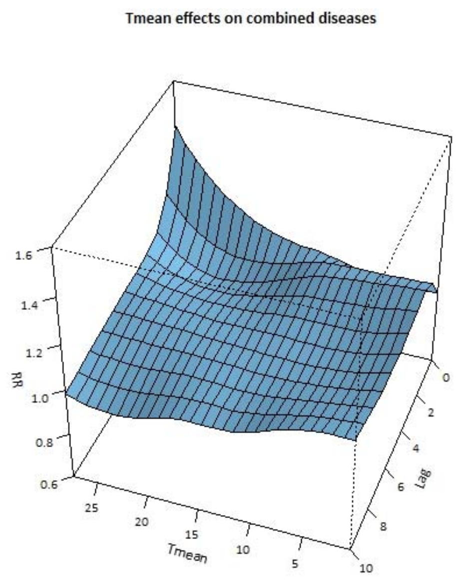


Results

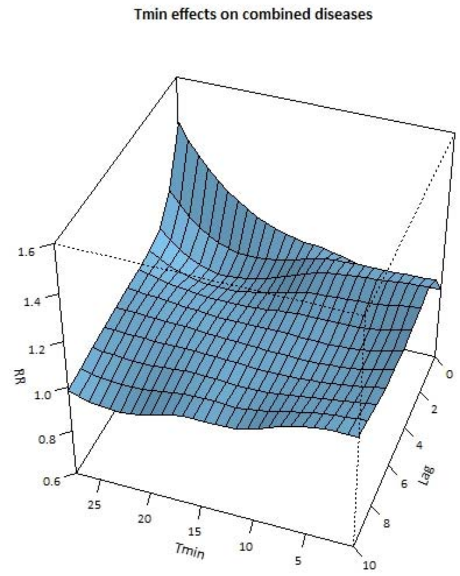
Temperature and lag effects on combined mortality



Tmax - total



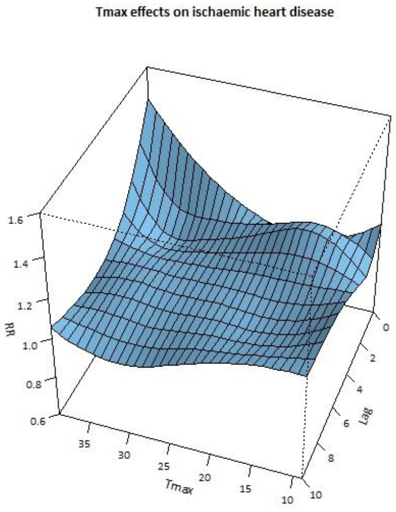
Tmean - total

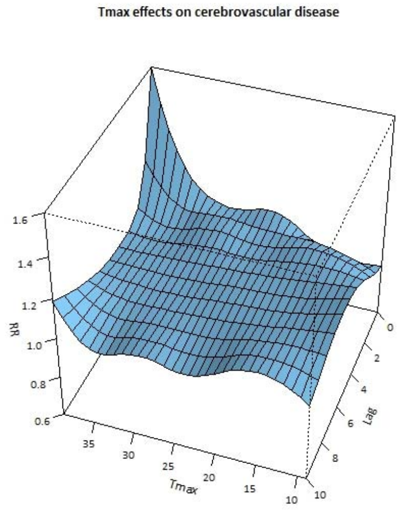


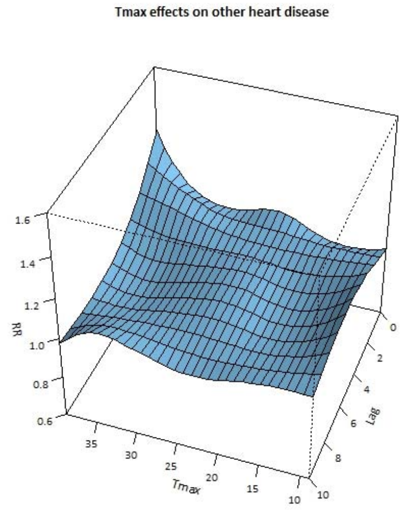
Tmin - total

- Lags up to 10 days were use
- The temperature that corresponds to minimum mortality was used as baseline temperature for calculating the relative risks
- 5 degrees of freedom for temperature and 4 degrees of freedom for lag

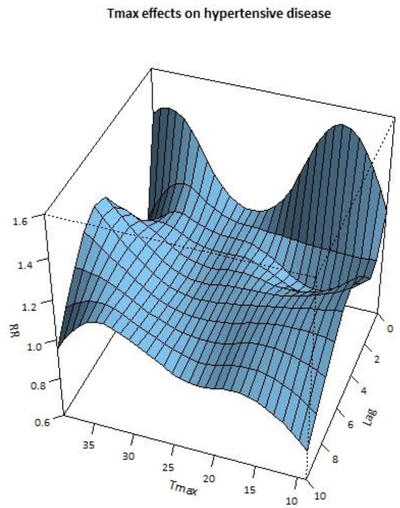
Maximum temperature and lag effects per disease

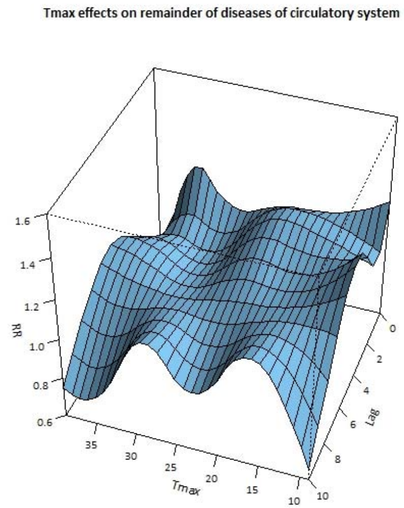




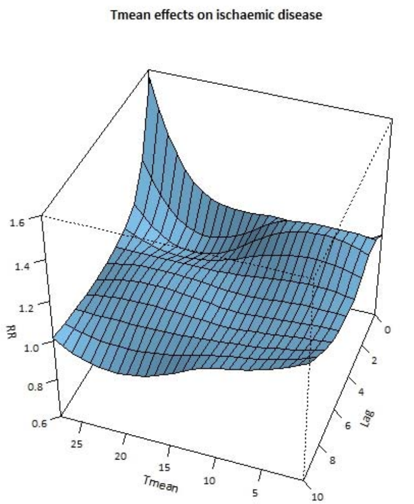


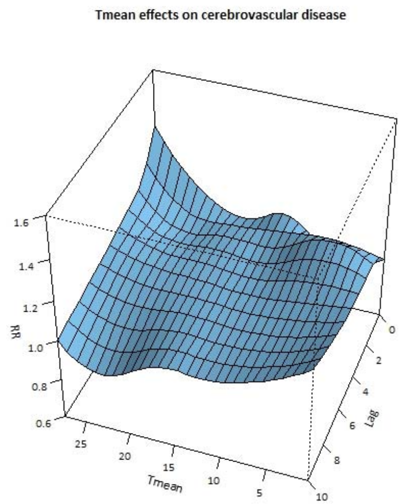
1. **Tmax – IHD**
2. **Tmax – CD**
3. **Tmax – OHD**
4. **Tmax – HD**
5. **Tmax - RDCS**

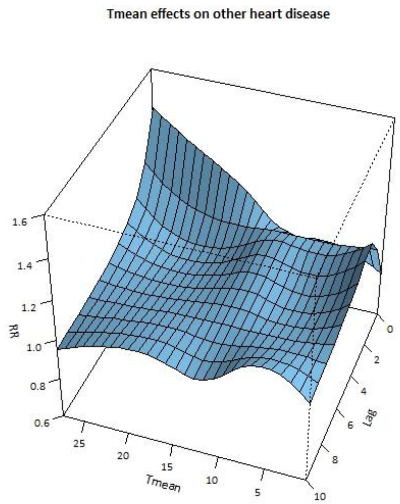




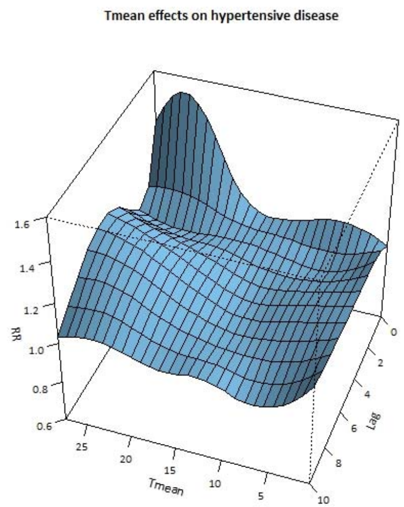
Mean temperature and lag effects per disease

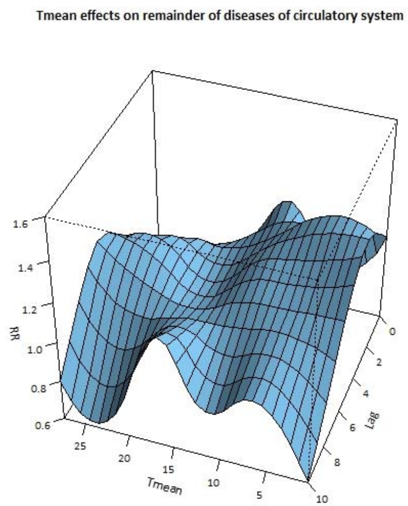






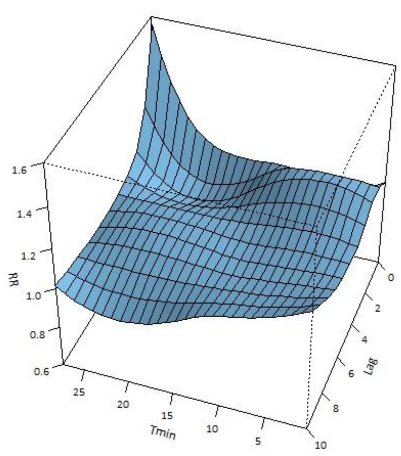
1. Tmean – IHD
2. Tmean – CD
3. Tmean – OHD
4. Tmean – HD
5. Tmean - RDCS



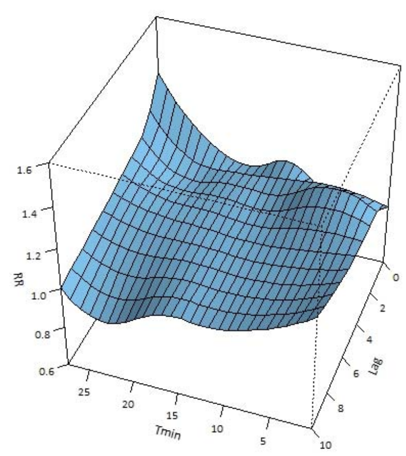


Minimum temperature and lag effects per disease

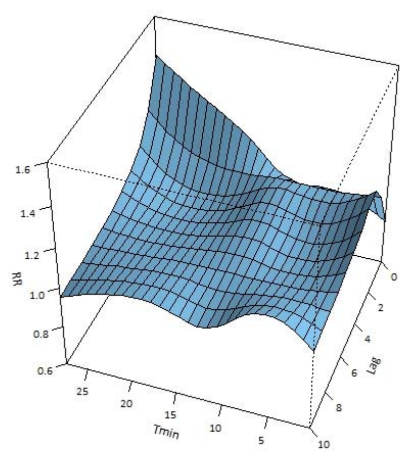
Tmin effects on ischaemic disease



Tmin effects on cerebrovascular disease

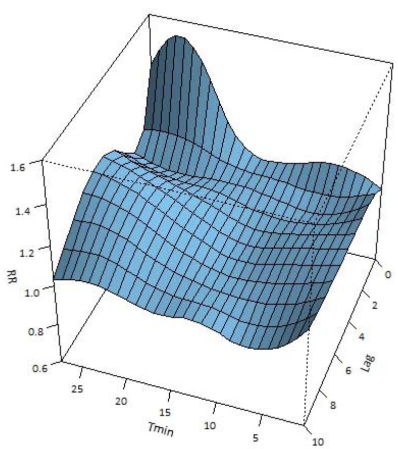


Tmin effects on other heart disease

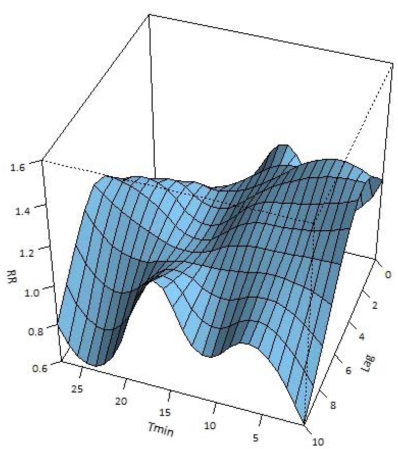


1. **Tmin – IHD**
2. **Tmin – CD**
3. **Tmin – OHD**
4. **Tmin – HD**
5. **Tmin - RDCS**

Tmin effects on hypertensive disease



Tmin effects on remainder of diseases of circulatory system



Conclusion

- *Ischaemic heart diseases*, *cerebrovascular diseases* and *other heart diseases* show a strong increase in relative mortality risk on days with maximum temperatures
- *Hypertensive diseases* and *remainder of diseases of circulatory system* show a random behaviour with respect to temperature:
  - Data scarcity?
  - Lack of interrelation with temperature?
- Short time lags (0-2 days) are of the highest importance in the occurrence of heat-related mortality. This is in accordance with previous studies
- No major differences between the effect of different temperature time-series (Tmax, Tmin, Tmean), however Tmean seems to have slightly higher peaks: highest relative risks are associated with consecutive high day and night-time temperatures.

Thank you for your attention!

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