12 Health (Temperature-related mortality)

12.1 11.1 Scenarios

The following protocol has been designed for contributions on temperature-related mortality (TRM). There are no restrictions regarding the type of empirical models (GAMs, DLNMs, log-linear, simple exponential etc.) to be used as long as the methodology has been documented in previous peer-reviewed publications. It also does not matter at which spatial scale the model operates (city-scale, regional, national, global), with the possible restrictions stemming from the input data provided.

Group 3 runs (experiments IV to VII, blue cells in Table 23) only refer to models that are able to represent future changes in societal conditions (demographic changes, shifts in mortality baselines, adaptation/acclimatization).

Climate	
picontrol	Pre-industrial climate (year specific for the entire period 1661-2299)
historical	Historical climate
rcp26	Future climate from RCP2.6
rcp60	Future climate from RCP6.0
Human influence	
2005soc	Representation of fixed year 2005 society: • Present-day exposure-response functions • Present-day mortality baselines (average from observational records, or from grid based 2005 mortality data (SSP2) • 2005 population data from your observational records, or from ISIMIP grid based population data (SSP2)
ssp2soc	Varying society according to SSP2 – no adaptation • Present-day exposure-response functions • Mortality baselines according to SSP2[a] • Population data according to SSP2[b]
2100ssp2soc	Society in 2100 according to SSP2 – no adaptation • As ssp2soc but mortality and population data fixed at 2100 levels
ssp2soc-adapt	Varying society according to SSP2 – with adaptation • changing exposure-response relationships according to default adaptation assumptions[c] • mortality baselines and population according to SSP2

[a] It is also possible to neglect shifts in mortality baselines and only consider population shifts in this experiment; if changes in mortality baselines are accounted for, scaling from SSP2 national projections to city-scale/regional scale should be done as for population data (see [b])

[b] Use grid-based or national population data for 2005-2100 in 5-year intervals for 5-year age groups (0-4,5-9,…,100+), split between urban and rural population from SSP database. For mortality models working on city scale, projected national urban population growth rates should be applied to 2005 city populations (assuming that city-scale projections scale directly to nation-scale projections)

[c] Uncertainty on acclimatization/adaptation is large. Based on your available data choose the most plausible approach to incorporate acclimatization into your exposure-response functions (e.g., shift MMT, shift slope); this approach will have to be documented in detail

Additional Notes:

Definition of attributable mortality: Where applicable attributable mortality should be defined as e.g., in Gasparrini & Leone (2014); Here attributable refers to mortality attributable to excursion of ambient temperature from MMT.

Definition of climate change impacts: Additional deaths due to climate change will be derived as the difference between attributable mortality estimates based on the pre-industrial control (picontrol) and climate change scenario runs (rcp26, rcp60) or as difference between present-day reference (2010-2019) and future decades.

Local bias-correction of climate time-series: For TRM models working on a point scale (e.g., city scale) or small regional scale, a downscaling and bias correction to the local observational climate time-series will be undertaken (using ISIMIP2b bias-correction method). Other support regarding preparation of climate input data (aggregation to specific regions, conversion from netcdf to txt etc.) might be provided on demand.

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Table 29 ISIMIP2b scenarios for temperature-related mortality simulations. Option 2* only if option 1 not possible.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2099	Extended future 2100-2299
I	no climate change	Climate	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying society up to 2005, then fixed at 2005 levels thereafter, no adaptation	Human	Option 1: **1860soc**	Option 1: **histsoc**	**2005soc**	**2005soc**
	society fixed at 2005 levels, no adaptation		Option 2*: **2005soc**	Option 2*: **2005soc**		
II	RCP2.6 climate	Climate	Experiment I	**historical**	**rcp26**	**rcp26**
	varying society up to 2005, then fixed at 2005 levels thereafter, no adaptation	Human		Option 1*: **histsoc**	**2005soc**	**2005soc**
	society fixed at 2005 levels, no adaptation			Option 2*: **2005soc**		
III	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	society fixed at 2005 levels, no adaptation	Human			**2005soc**	
IV	no climate change	Climate	Experiment I	Experiment II	**picontrol**	**picontrol**
	varying society (SSP2) up to 2100, then fixed at 2100 levels thereafter, no adaptation	Human			**ssp2soc**	**2100ssp2soc**
V	Not simulated					
VI	RCP2.6 climate	Climate	Experiment I	Experiment II	**rcp26**	**rcp26**
	varying society (SSP2) up to 2100, then fixed at 2100 levels thereafter, no adaptation	Human			**ssp2soc**	**2100ssp2soc**

VIa	RCP2.6 climate	Climate	Experiment I	Experiment II	**rcp26**	not simulated
	varying society (SSP2) with adaptation	Human			**ssp2soc-adapt**	
VII	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	varying society (SSP2), no adaptation	Human			**ssp2soc**	
VIIa	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	varying society (SSP2), with adaptation	Human			**ssp2soc-adapt**	

12.2 Output data

Table 30 *Variables to be reported by TRM models*

Note: The variable name should specify the age group x for which mortality estimates are supplied:

x = -all, -65minus, -65plus, etc.

Long name	Units	Variable name	Spatial resolution	Temporal resolution	Comments
Number of deaths attributable to cold in age group x	Total number of deaths	**an-tot-cold-x**	Per city/region /grid cell	daily	Temperature below minimum mortality temperature (MMT)
Number of deaths attributable to heat in age group x	Total number of deaths	**an-tot-heat-x**	Per city/region /grid cell	daily	Temperature above MMT
Death rate attributable to cold in age group x	Deaths per 100 000 population	**an-rate-cold-x**	Per city/region /grid cell	daily	Temperature below MMT
Death rate attributable to heat in age group x	Deaths per 100 000 population	**an-rate-heat-x**	Per city/region /grid cell	daily	Temperature above MMT
Attributable fraction (cold) in age group x	%	**af-cold-x**	Per city/region /grid cell	daily	Temperature below MMT
Attributable fraction (heat) in age group x	%	**af-heat-x**	Per city/region /grid cell	daily	Temperature above MMT