UCaHS - Urban Climate and Heat Stress in mid-latitude cities in view of climate change

Research questions

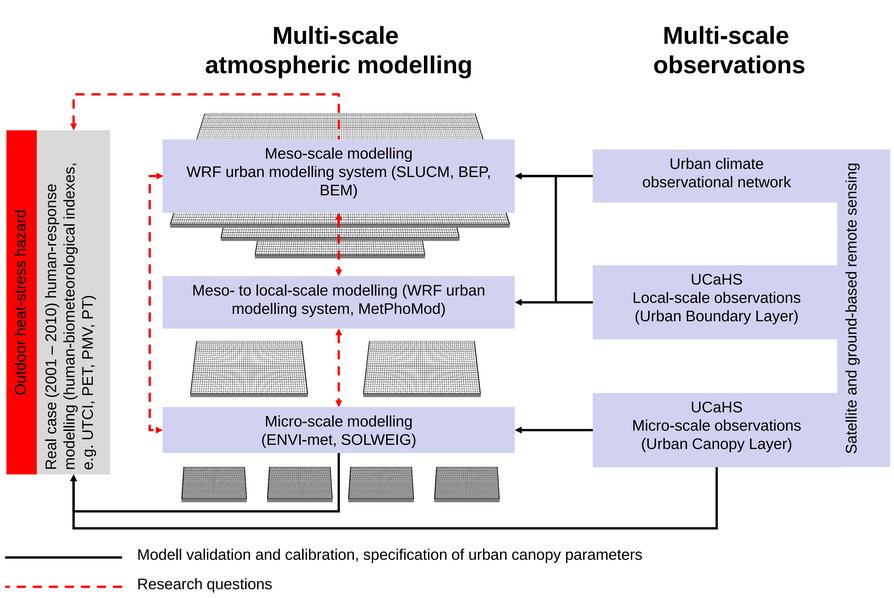
Analysis period 2001 to 2010

- How many heat-stress events were observed in Berlin between 2001 to 2010?
- How large are the heat-stress risks, in particular excess mortality and morbidity, as well as prolongation of medical care in hospitals?
- Which approach to quantifying heat-stress hazards is most appropriate for explaining a statistically significant part of the variances in the time series of the observed effects that define the respective risks?
- How do outdoor urban-weather conditions force indoor climates and heat-stress hazards, depending on a broad variety of controlling factors?
- How accurately can time series of heat-stress hazards be derived from validated atmospheric model simulations? What level of detail is required for the model simulations? How do errors/uncertainties in the forcing data propagate to the resulting hazard time series?
- Which kind of statistical weather-data aggregation is most appropriate to characterise the urban climate with respect to heat-stress hazards and energy demands by buildings for heating and cooling?

Projection period 2041-2050

- Which change in heat-stress hazards would result from different building designs and technologies, as well as from different forms of urban green and open spaces?
- What methods are suitable for down-scaling global climate projections to urban scales, and how large are the errors/uncertainties in the urban-climate projections?
- How strongly will heat-stress hazards and risks change in the future, applying three by three combinations of different projected urban climates and different projections of urban development?

Research approach



Sub-project 1.2
Urban climate

RM 1
Outdoor climate and heat-stress hazard

- RM 1.1: Regional climate *Gerstengarbe (HUB, PIK)*
- **RM 1.2: Urban climate *Scherer (TUB)***

RM 4
Climate-responsive buildings

- RM 4.1: Building green *Wessolek (TUB)*
- RM 4.2: Building designs *Steffan (TUB)*
- RM 4.3: Building technologies *Ziegler (TUB)*

Research Unit

RM 5
Urban system

- RM 5.1: Constellations *Köppel (TUB), Schreurs (FUB)*
- RM 5.2: Urban patterns *Kleinschmit (TUB)*

RM 2
Indoor climate and heat-stress hazard

- RM 2.1 Indoor observations *Endlicher (HUB)*
- RM 2.2 Indoor simulations *Nytsch-Geusen (UDK)*

RM 3
Vulnerability to heat stress

- RM 3.1: Medical vulnerability *Witt (Charité)*
- RM 3.2: Urban vulnerability *Lakes (HUB)*

Quantification of heat-stress hazards and risks

Human bio-meteorological indexes e.g. UTCI PET PT

Mean radiant temperature T_{mrt}

Air temperature

Clothing Metabolic rate

Wind speed

Humidity

$$intensity_{hs,hour} = \begin{cases} (index_{hs,hour} - index_{hs,threshold}) \cdot \text{hour} : index_{hs,hour} > index_{hs,threshold} \\ 0 : index_{hs,hour} \le index_{hs,threshold} \end{cases}$$

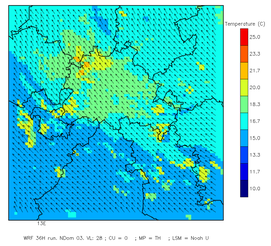
$$hazard_{hs} \cdot vulnerability_{hs,effect} = risk_{hs,effect}$$

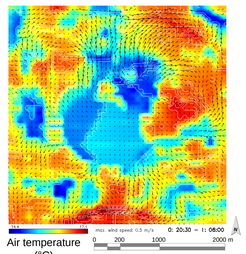
Projections

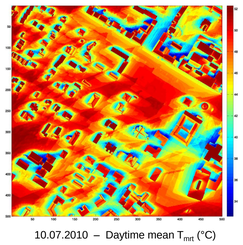
Change of heat-stress (HS) hazard and risks as assessed from nine different projections of urban climate (UC) and urban development (UD)

	UD 1	UD 2	UD 3
UC 1	HS 1.1	HS 1.2	HS 1.3
UC 2	HS 2.1	HS 2.2	HS 2.3
UC 3	HS 3.1	HS 3.2	HS 3.3

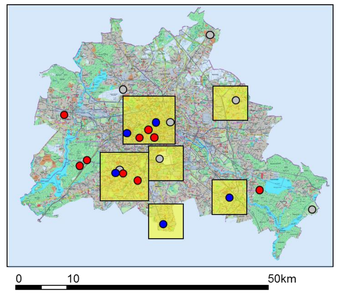
Methodology

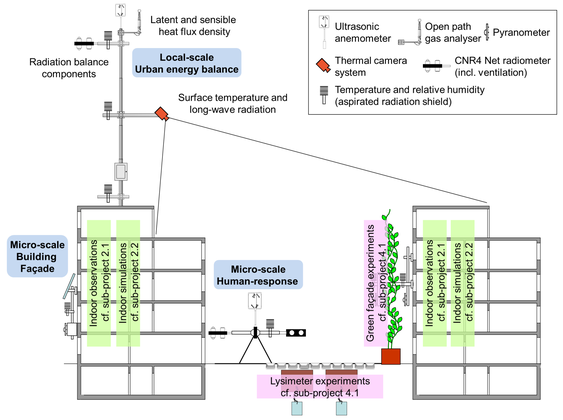






10.07.2010 – Daytime mean T_{mrt} (°C)





Work schedule

Table 1: Work packages (WP) and associated work schedule (in half-yearly intervals)

WP	Description	Work schedule
100	**Project management**	
110	Reporting	
120	Logistics and organisation	
200	**Individual research**	
210	Meso- to local-scale simulations of atmospheric processes	
220	Local- to micro-scale simulations of atmospheric processes	
230	Multi-scale observations of atmospheric processes	
240	Human response modelling for outdoor weather conditions	
300	**Collaboration within the Research Module (RM)**	
310	Urban canopy parameters for multi-scale atmospheric modelling	
320	Model inter-comparison for error/uncertainty assessment	
330	From regional weather and climate to outdoor climates	
400	**Collaboration within Research Links (RL)**	
410	Atmospheric processes, urban/building green and pavements	
420	Urban climate and building energy demands	
490	Urban climate projections	
500	**Collaboration within Research Clusters (RC)**	
510	From regional weather and climate to indoor climates	
520	Present-day heat-stress hazards, vulnerabilities and risks	
530	Effectiveness of actions for reducing heat-stress risks	
540	Efficiency of actions for reducing heat-stress risks	
600	**Collaboration within the Research Unit (RU)**	
610	Projected heat-stress hazards, vulnerabilities and risks	
620	Transferability of the methodology to other mid-latitude cities	
630	Identification of future research and development activities	
640	Preparation of the follow-up proposal	

Prof. Dr. Dieter Scherer, Chair of Climatology, Department of Ecology, School VI Planning – Building – Environment, Technische Universität Berlin (dieter.scherer@tu-berlin.de)
Dr. Fred Meier, Chair of Climatology, Department of Ecology, School VI Planning – Building – Environment, Technische Universität Berlin (fred.meier@tu-berlin.de)