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

Research questions

Projection period 2012-2100 – Change of Regional Climate

- What are the spatial and temporal changes of the statistical mean (characterizing intensity) and the margin of deviation (characterizing variability) of relevant meteorological variables?

- What will be the frequency distribution of extreme events in the future?

- What is the uncertainty of the climate predictions?

Projection period 2041-2050 – Interactions of Climate Change and Urban Climate

- What are combined effects of potential future climate change and urban development on future climate in mid-latitude cities such as Berlin?

- What is, the relationship between extreme heat events, heat hazard and vulnerability for particular urban development scenarios for the city of Berlin?

Research approach

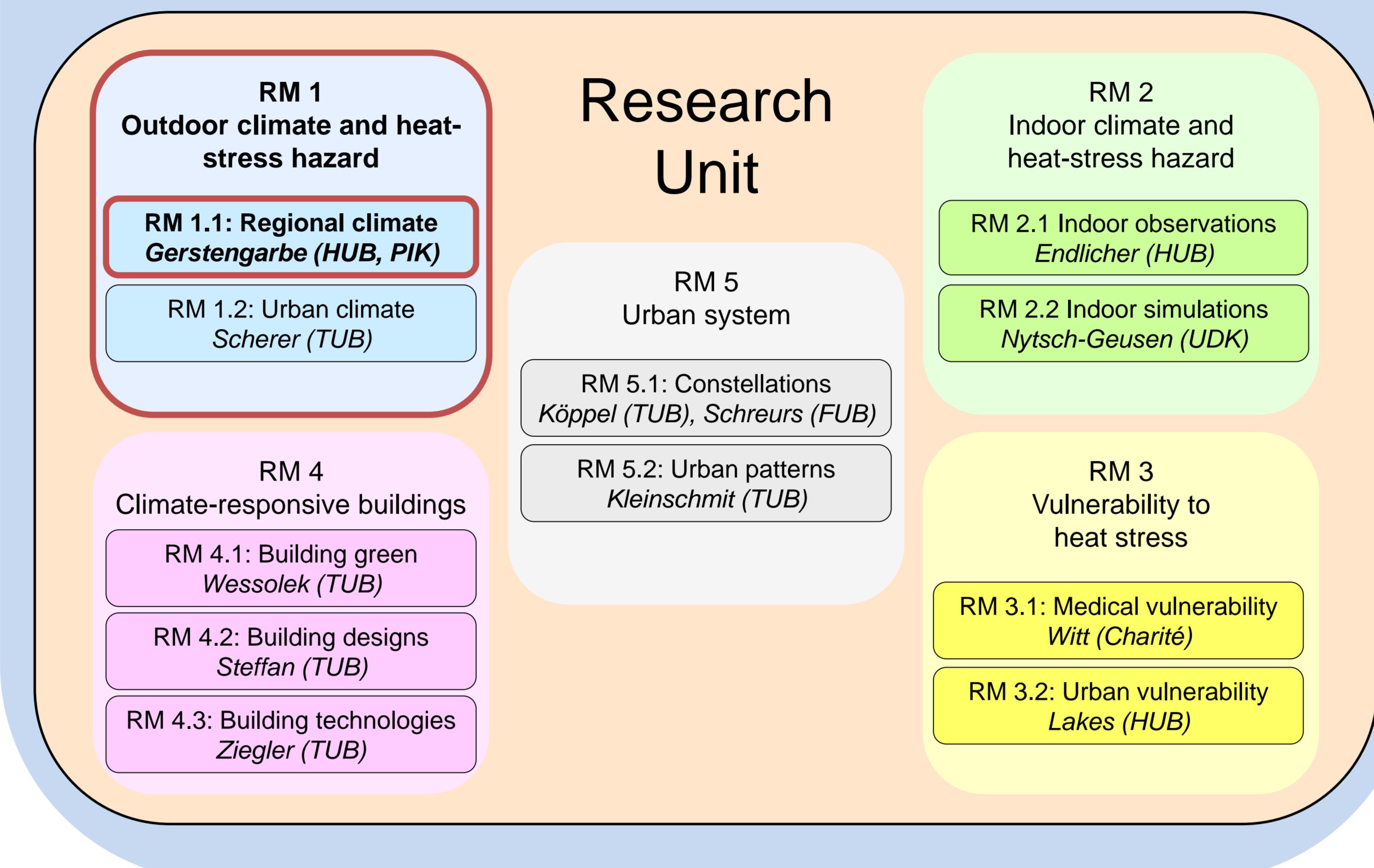**Downscaling of global climate projections to regional and urban scales**

1. **Statistical downscaling with STARS (Statistical Analog Resampling Scheme) for 2012-2100**

- Foundation is a description of the climate "current-state" that is based on weather data for the time period 1951-2011.

- Temperature trend of GCM model output scenarios is used in STARS to simulate future regional climate for urban regions.

- The uncertainty of the climate predictions will be quantified based on the ensemble of model simulations.

2. **Dynamical downscaling with CCLM (Climate Local Model) for 2041-2050**
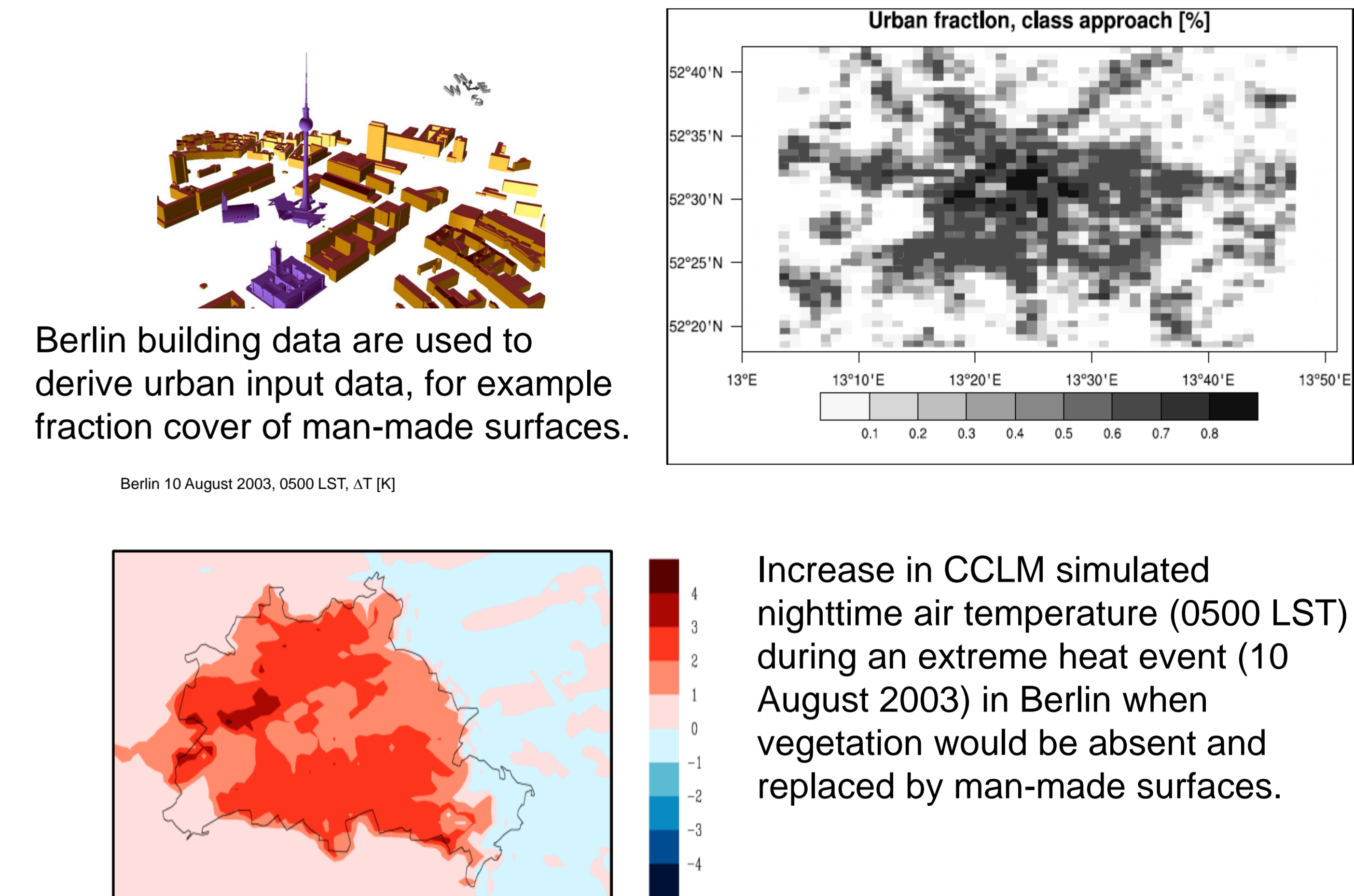
- Investigation of interactions of future global/regional climate change and urban development:

- CCLM with the urban canopy model BEP (Building Energy Parameterization) system will be tested for the Berlin region for the historic period of 2001-2010.

- Projections of urban climate change for the UCaHS projection period 2041-2050 with high-resolution (approximately 3 km) CCLM/BEP simulations.

- For selected future extreme events sensitivity studies will be carried out for Berlin (and other cities)

- Investigate air temperatures for urban development scenarios as characterized by land use patterns and building technologies such as cooling appliances or green roofs.

Sub-project 1.1
Regional climate

Research Unit

RM 1 Outdoor climate and heat-stress hazard
- RM 1.1: Regional climate *Gerstengarbe (HUB, PIK)*
- RM 1.2: Urban climate *Scherer (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 5 Urban system
- RM 5.1: Constellations *Köppel (TUB), Schreurs (FUB)*
- RM 5.2: Urban patterns *Kleinschmit (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)*

RM 3 Vulnerability to heat stress
- RM 3.1: Medical vulnerability *Witt (Charité)*
- RM 3.2: Urban vulnerability *Lakes (HUB)*

Methodology

STARS relies on observed time series of meteorological data and aims at generating simulated series for a period of interest for the locations of the meteorological stations. Statistical approach allows fast production of climate projections (hundreds of realizations). The results presented above show the median of scenarios obtained for a moderate future temperature trend, reaching 1.2 K in 2040.
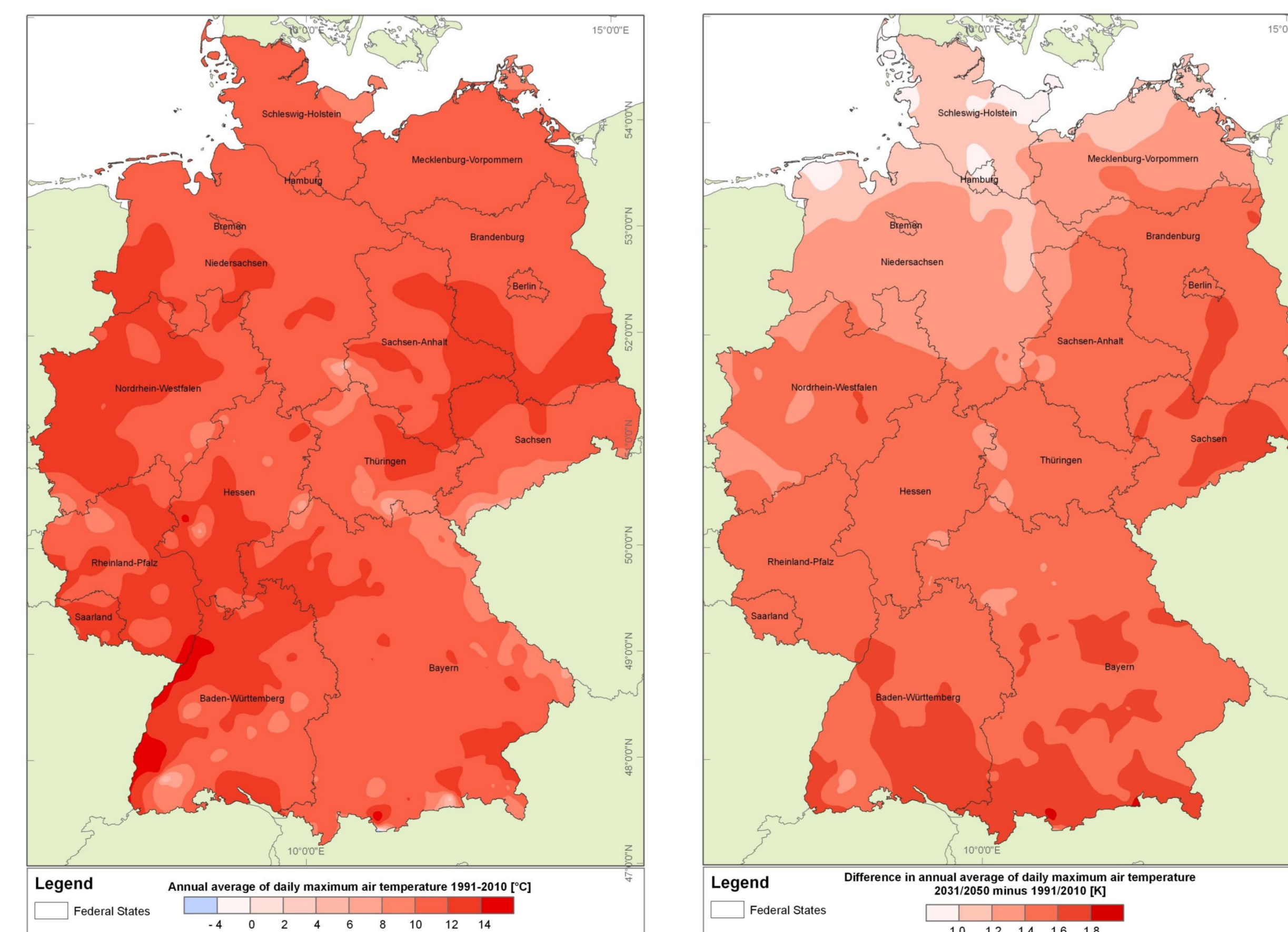
Methodology (continued)

CCLM simulations with BEP allow simulation of physical interactions of city and atmosphere. Building and vegetation distribution are model input data.

Berlin building data are used to derive urban input data, for example fraction cover of man-made surfaces.

Increase in CCLM simulated nighttime air temperature (0500 LST) during an extreme heat event (10 August 2003) in Berlin when vegetation would be absent and replaced by man-made surfaces.

Work schedule

WP	Description	Work schedule
100	**Project management**	
110	Reporting	
120	Logistics and organization	
200	**Individual research**	
210	Provide description of climate "current state" 1951-2011	
220	Regional-scale simulations with STAR for 2012-2070	
230	Enhancements of urban parameterization BEP	
240	Regional-scale simulations with CCLM for 2001-2010	
250	Regional-scale simulations with CCLM for 2041-2050	
300	**Collaboration within the Research Module (RM)**	
310	Urban canopy parameters for multi-scale atmospheric simulations	
320	Model inter-comparison for error/uncertainty assessment	
330	From regional weather and climate to outdoor weather and climate	
340	Urban climate projections	
400	**Collaboration within Research Links (RL)**	
410	Atmospheric processes, urban/building green and pavements	
490	Urban climate projections	
500	**Collaboration within Research Clusters (RC)**	
510	From regional weather and climate to indoor climates	
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**	

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