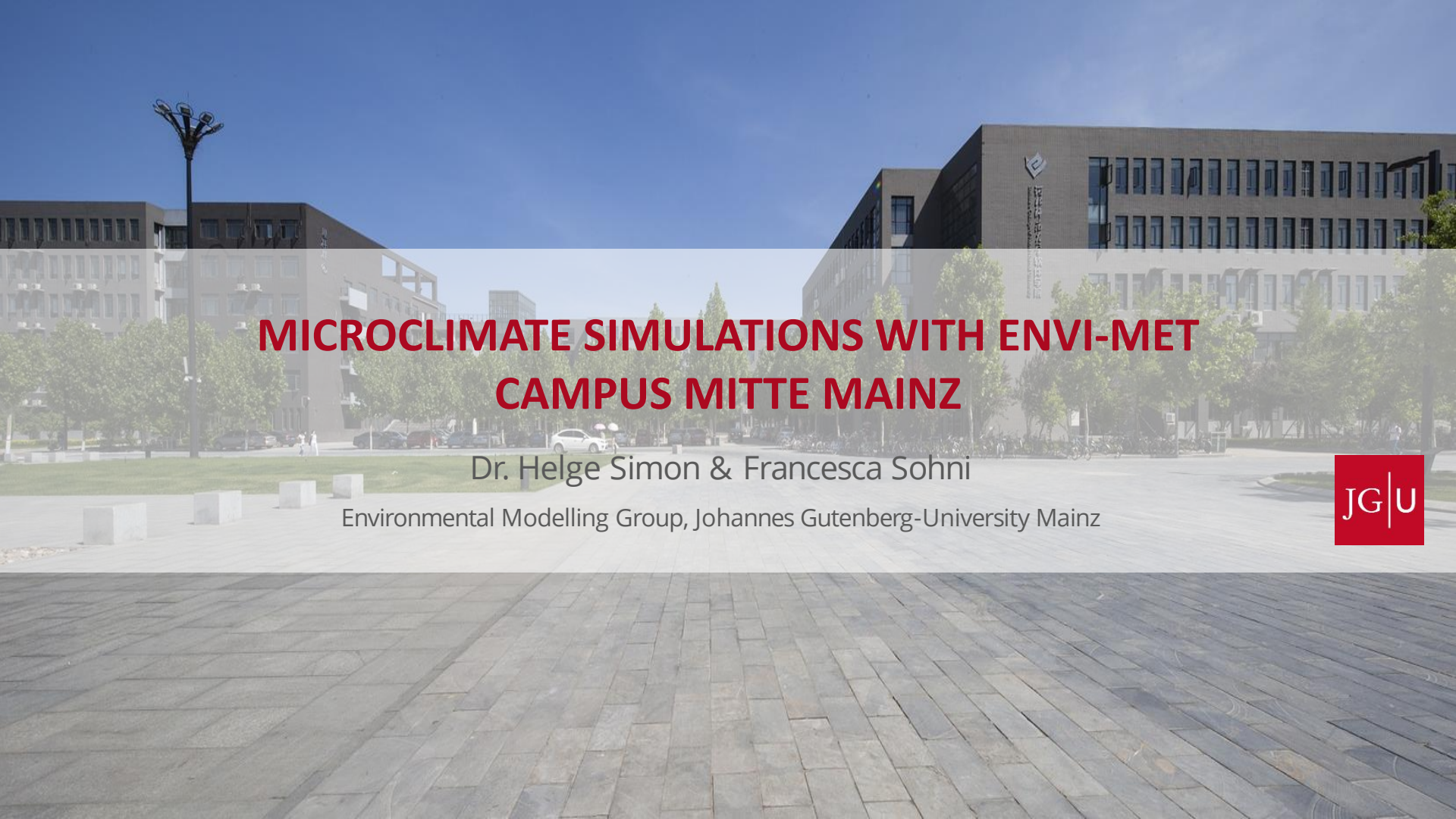


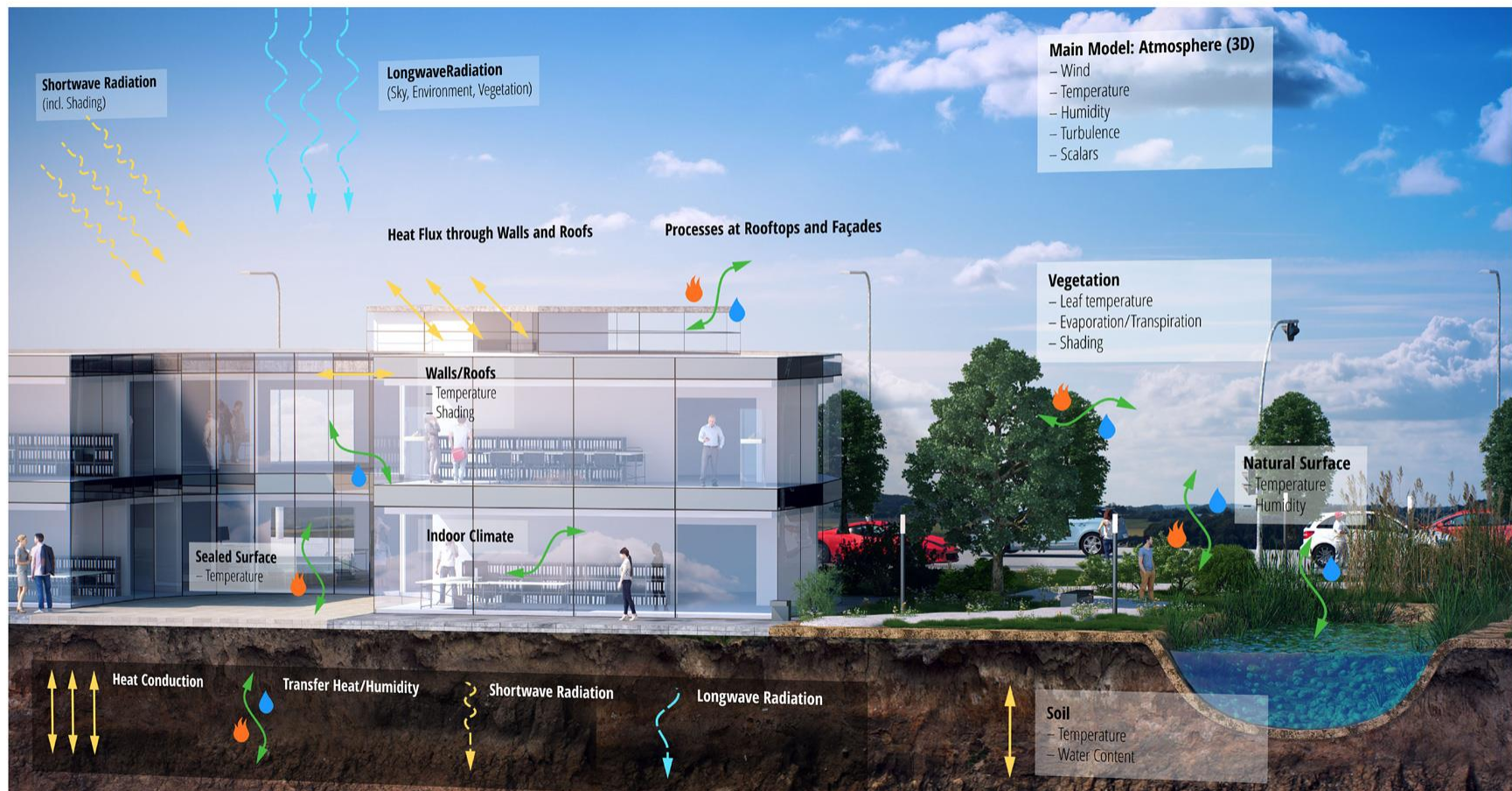


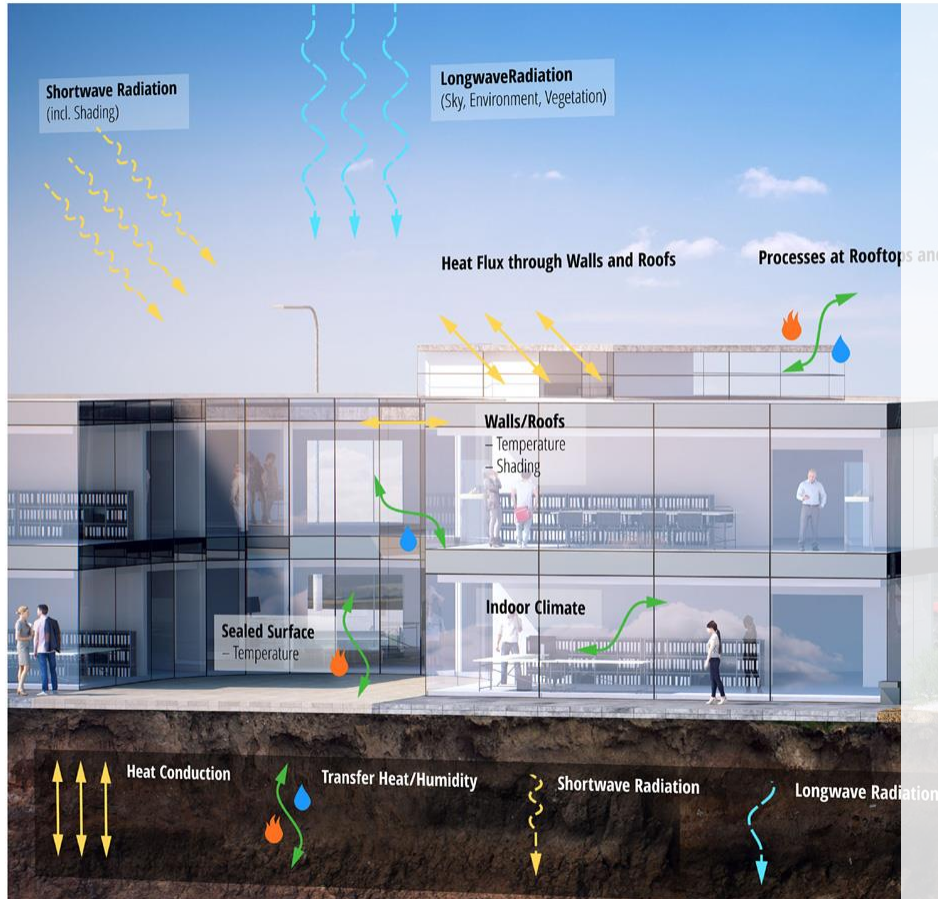
MICROCLIMATE SIMULATIONS WITH ENVI-MET CAMPUS MITTE MAINZ

Dr. Helge Simon & Francesca Sohni

Environmental Modelling Group, Johannes Gutenberg-University Mainz







SIMULATION MODEL

- Initial versions were designed in 1994
- Leading simulation system worldwide when addressing the impact of architecture and urban planning on the microclimate system
- Integration of all interacting elements in outdoor environments
- Proving & evaluating the beneficial effects of sustainable architecture, urban designs, Green & Blue technologies and thermal benefits of landscape visions
- Results: scientific experience building residential cities

Main Model: Atmosphere (3D)

– Wind
– Temperature
– Humidity
– Turbulence
– Scalars

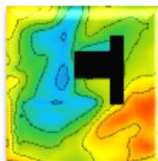
Natural Surface

Soil
– Temperature
– Water Content



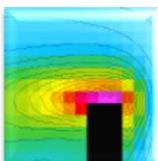
Wind field

- 3D Computational Fluid Dynamics
- Effects of vegetation included as drag forces



Air temperature and humidity

- determined by sources and sinks of sensible heat and water vapor
- advection and diffusion based on the calculated 3d wind field



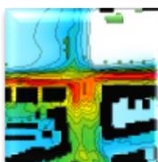
Turbulence

- E-epsilon 1.5-order closure model
- prognostic equations for turbulent energy production and dissipation



Radiative fluxes

- analysis modules to model the fluxes of shortwave and longwave radiation inside of complex environments
- shading by complex geometries, reflections by different surface and building materials effects of vegetation



Pollutant dispersion

- synchronous release, dispersion and deposition of up to 6 different pollutants
- Sedimentation and deposition at surfaces and vegetation



CAMPUS MAINZ MITTE

Analysis of microclimate conditions
Evaluation of mitigations strategies

Meteorological scenario

- hot summer day 2018

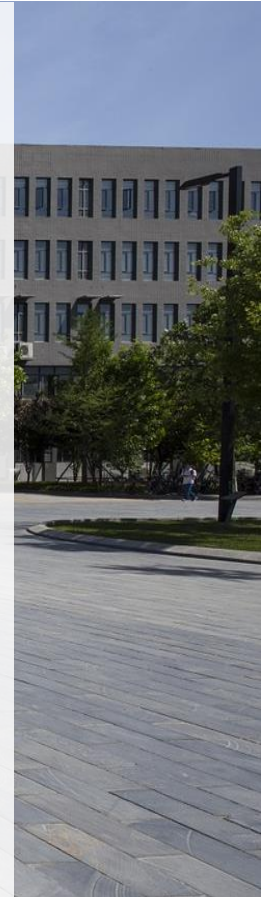
Model domain

- Plan 01 - Master
- Plan 02 - Raster
- Plan 03 - Forest

Voxel-based model environment

model size: 900 m × 510 m × 150 m

resolution: 3 m × 3 m × 2.5 m

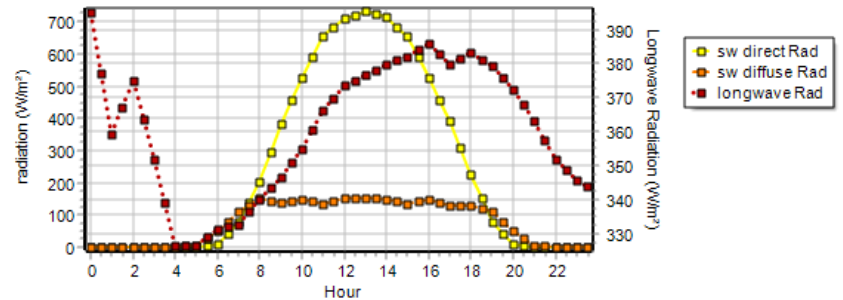
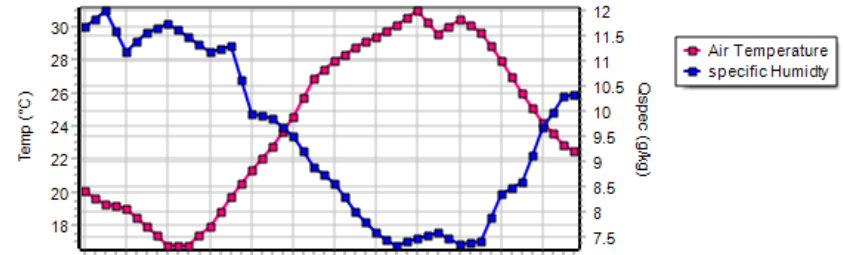


CAMPUS MITTE

Microclimate Simulations

METEOROLOGICAL FRAMEWORK

- Date 6th July
- Wind 2.2 m/s 10m height coming from SSW
- Cloud Cover No clouds
- Simulation Time 24 hours
- Hot summer day



A wide-angle photograph of a modern university campus under a clear blue sky. In the foreground, a large, paved plaza with rectangular stone tiles leads towards a green lawn. To the left, a tall, black, multi-lamp street light stands. In the background, several multi-story university buildings with grey facades and many windows are visible, interspersed with green trees. A semi-transparent white horizontal band is overlaid across the middle of the image, containing the text.

MODEL AREAS

CAMPUS MITTE MAINZ

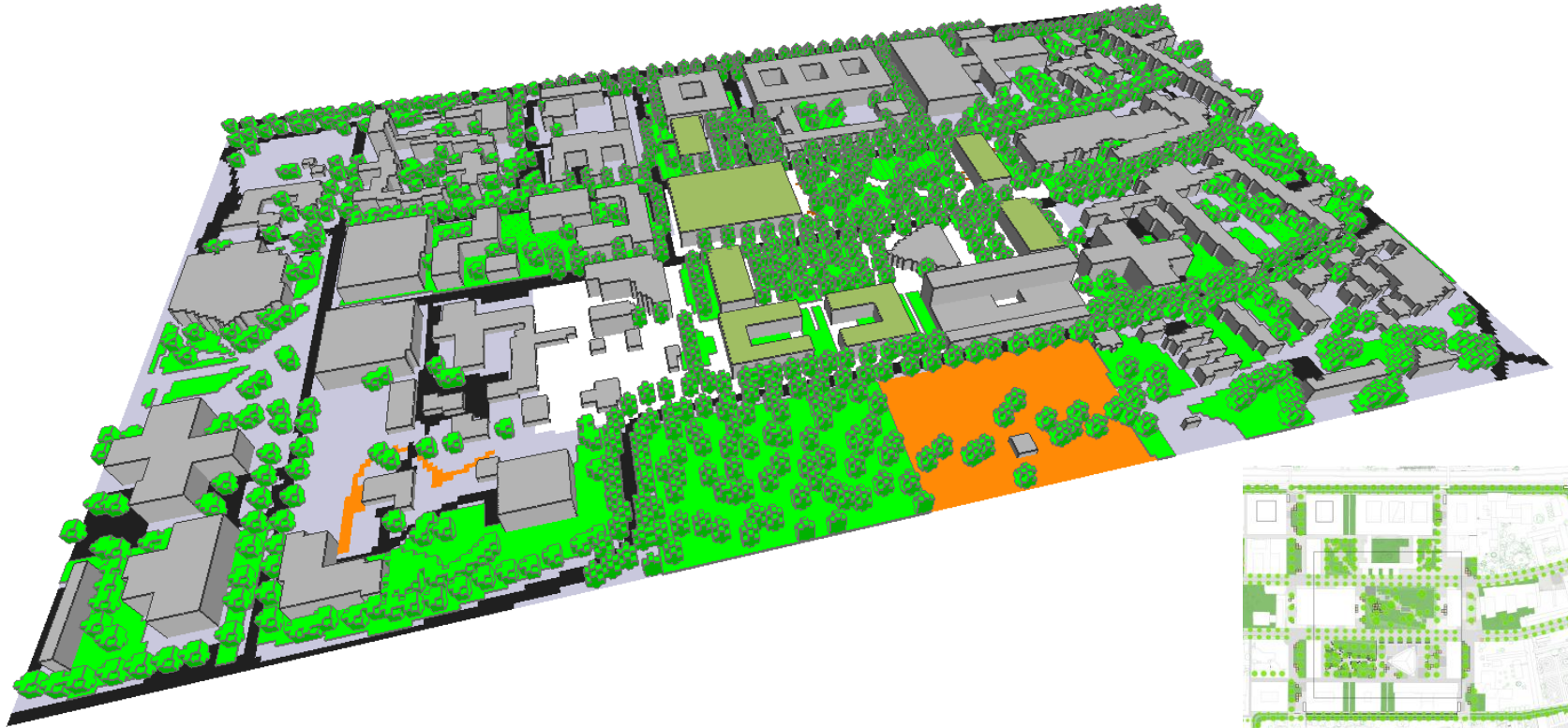
MODEL AREAS

DESIGN 01 - MASTERPLAN LBB



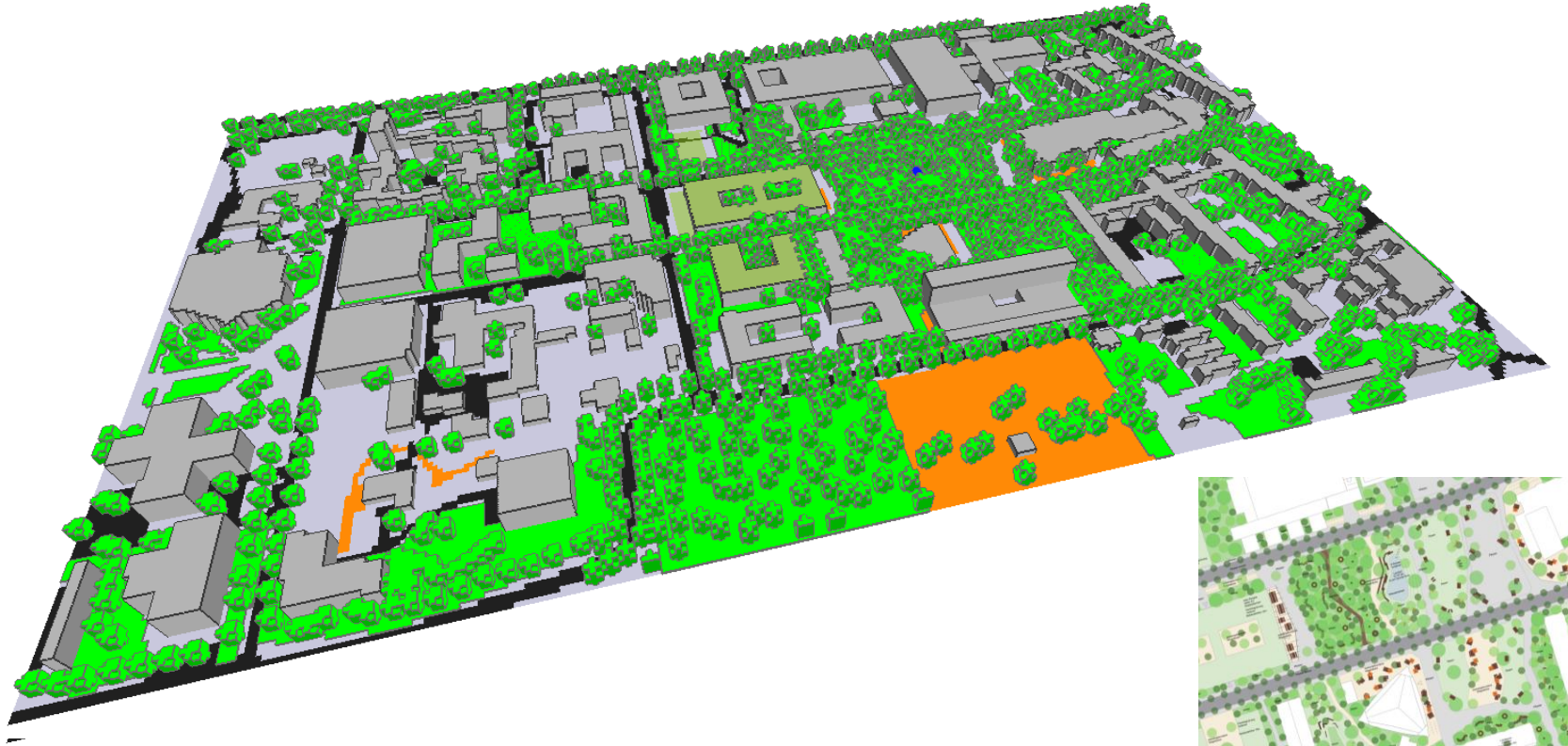
MODEL AREAS

DESIGN 02 – GEMAINZAM LEBEN



MODEL AREAS

DESIGN 03 – FOREST FOR FUTURE



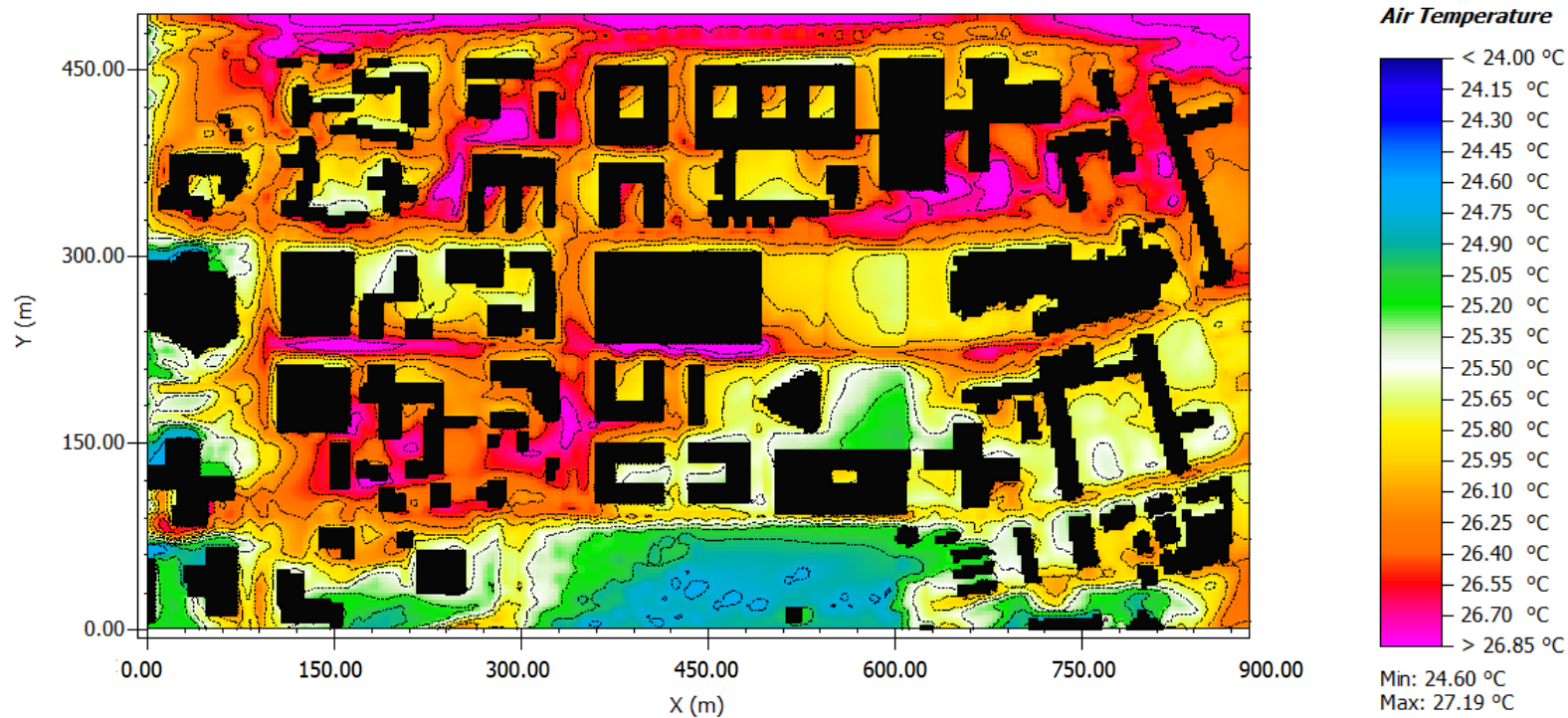
An architectural rendering of a modern university campus. The foreground is a wide, paved plaza with a pattern of light and dark grey rectangular stones. In the middle ground, there is a green lawn with several young trees and a few people walking. The background features several multi-story buildings with a mix of dark and light grey facades and large windows. A tall, black, modern lamppost stands on the left. The sky is a clear, bright blue.

SIMULATION RESULTS

CAMPUS MITTE MAINZ

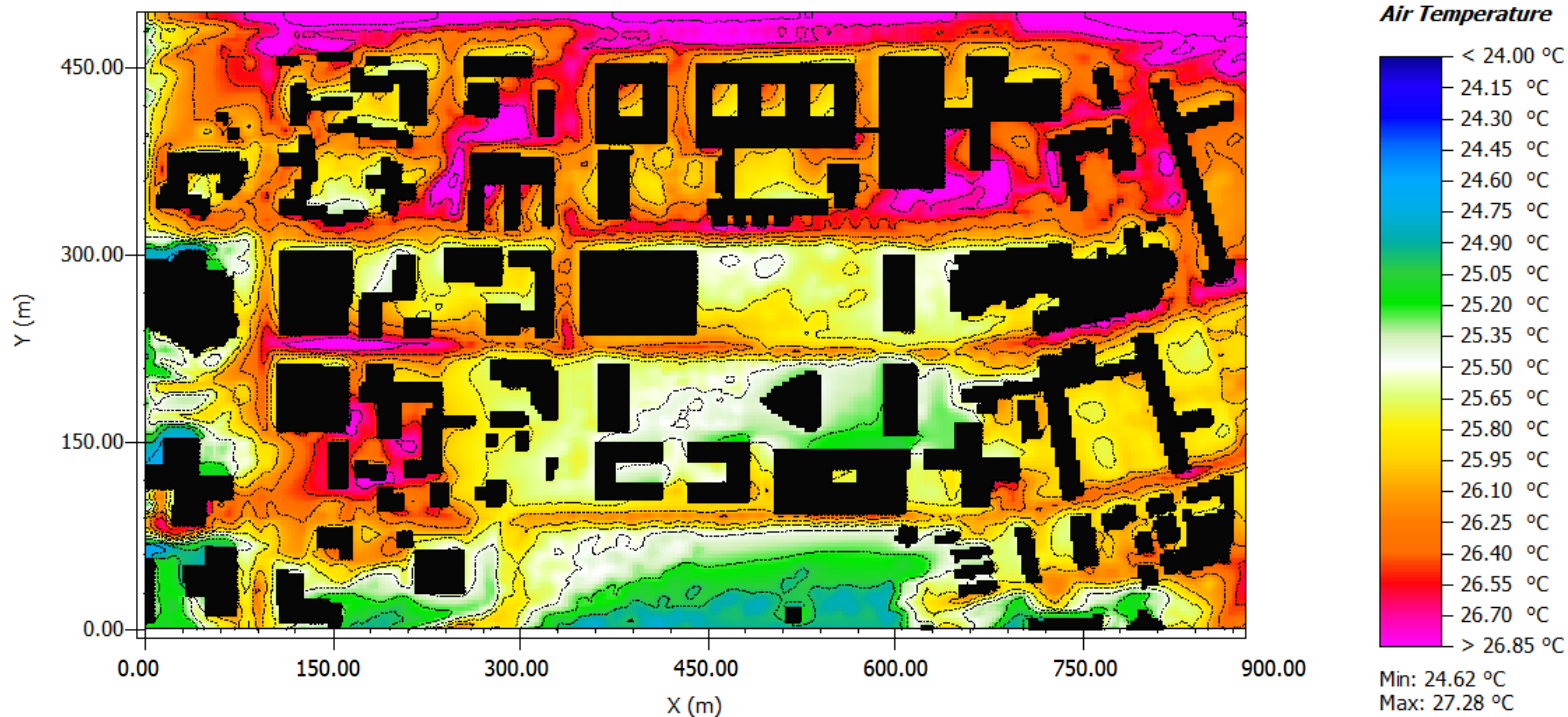
SIMULATION RESULTS

DESIGN 01 – MASTERPLAN LBB, AIR TEMPERATURE, 10.00 H, Z=1.25 M



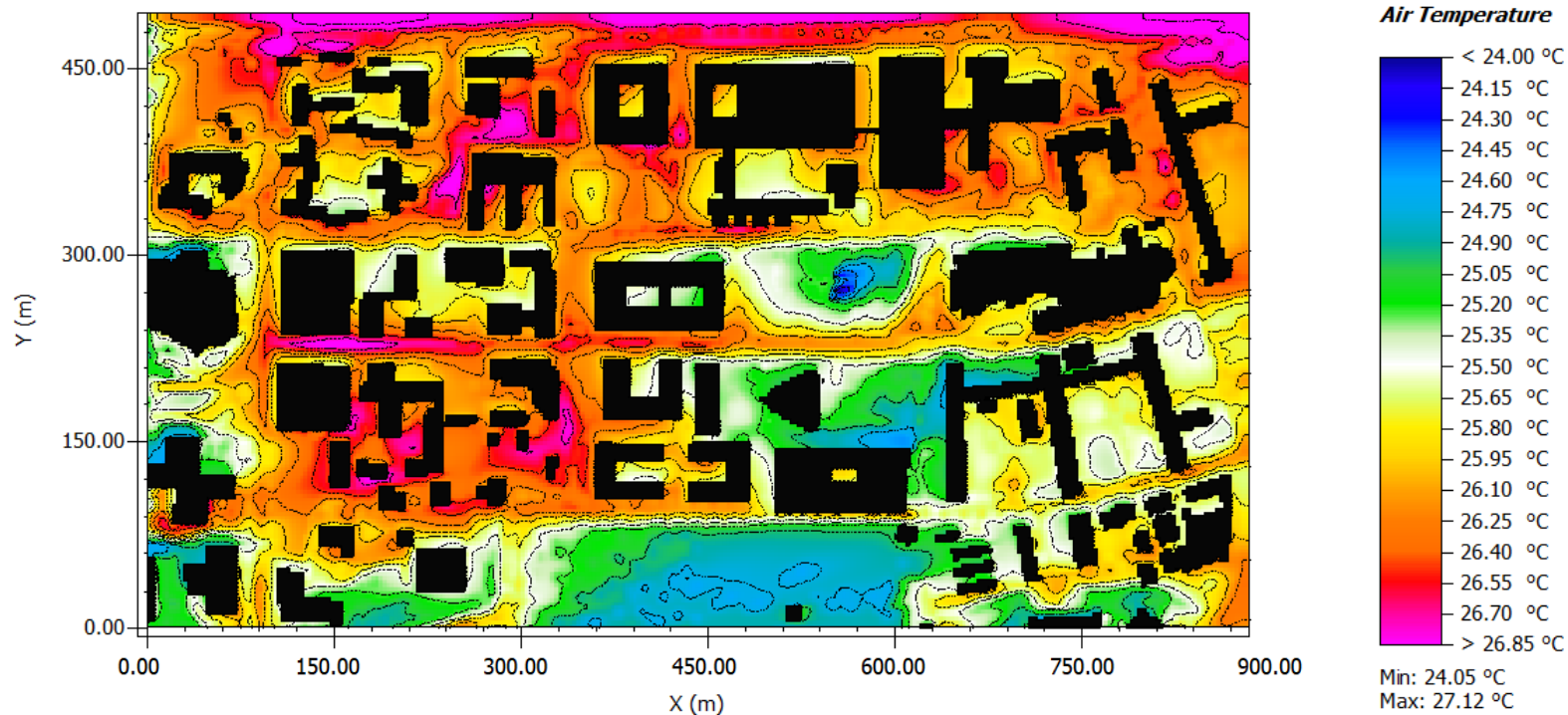
SIMULATION RESULTS

DESIGN 02 – GEMAINZAM LEBEN, AIR TEMPERATURE, 10.00 H, Z=1.25 M



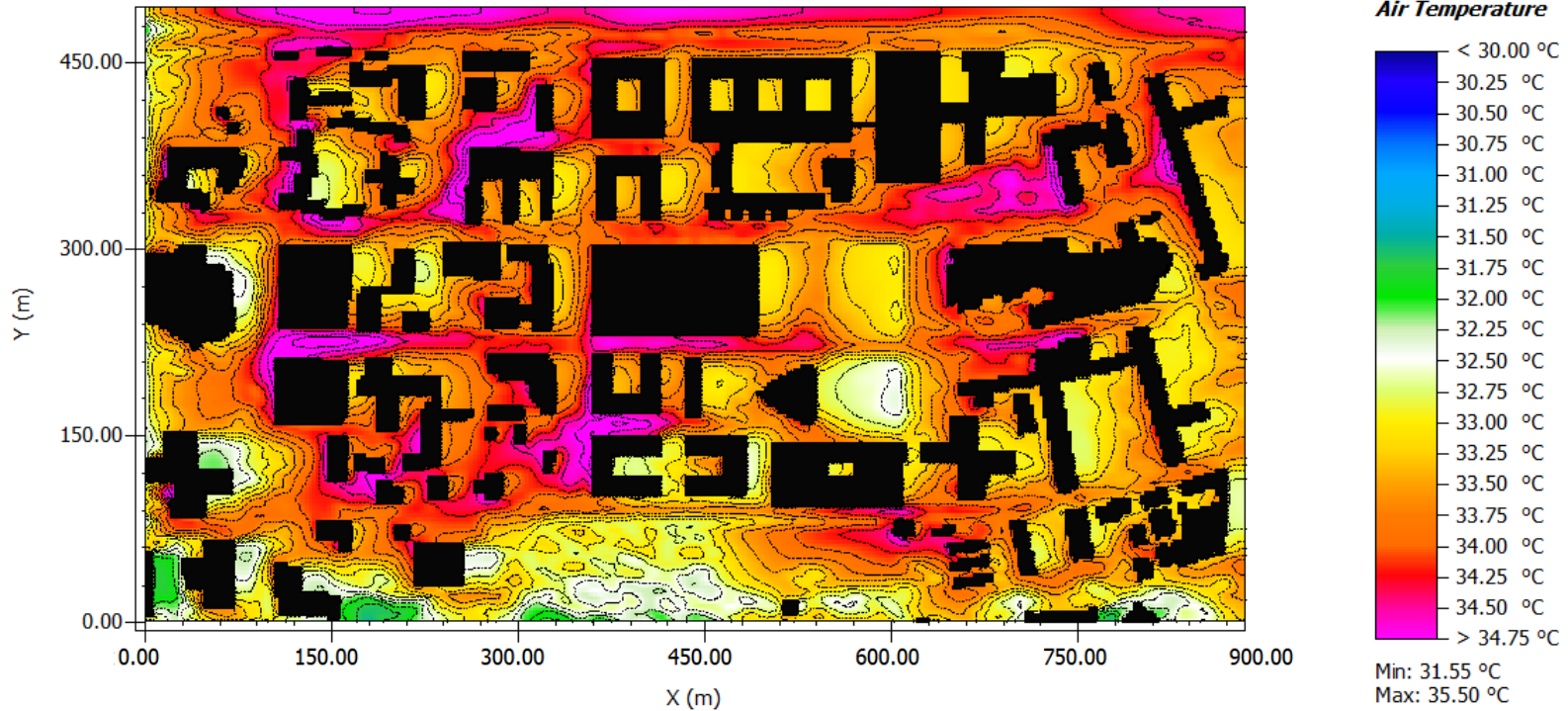
SIMULATION RESULTS

DESIGN 03 – FOREST FOR FUTURE, AIR TEMPERATURE, 10.00 H, Z=1.25 M



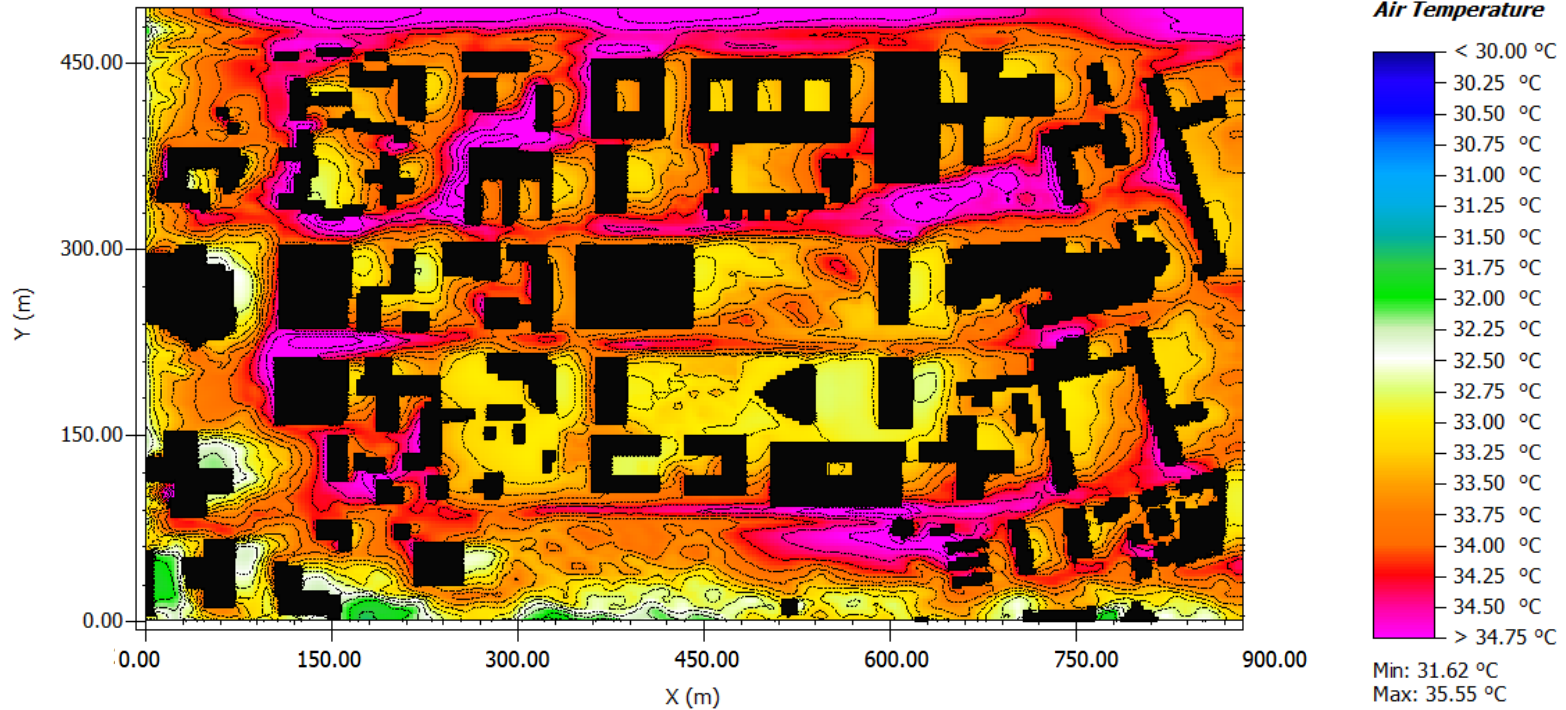
SIMULATION RESULTS

DESIGN 01 – MASTERPLAN LBB, AIR TEMPERATURE, 16.00 H, Z=1.25 M



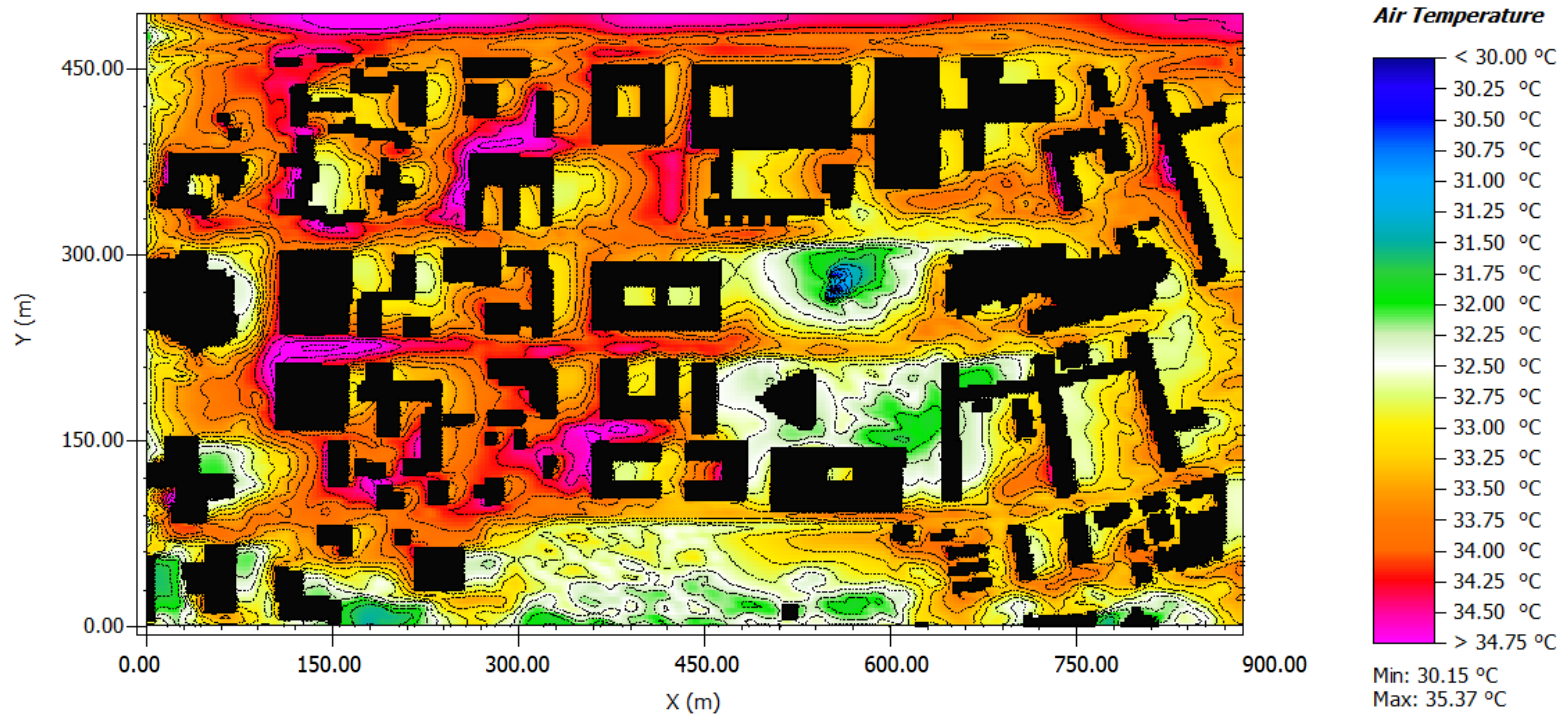
SIMULATION RESULTS

DESIGN 02 – GEMAINZAM LEBEN, AIR TEMPERATURE, 16.00 H, Z=1.25 M



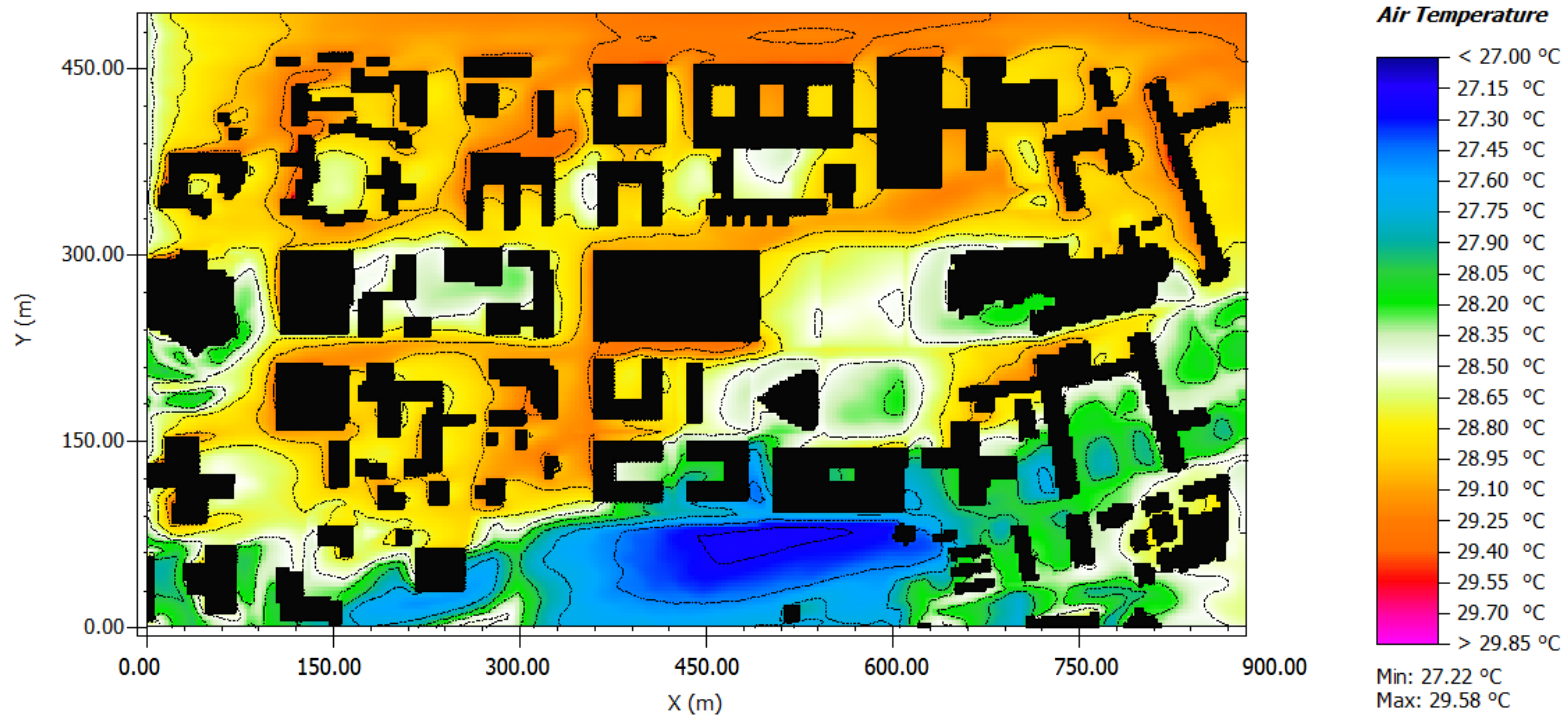
SIMULATION RESULTS

DESIGN 03 – FOREST FOR FUTURE, AIR TEMPERATURE, 16.00 H, Z=1.25 M



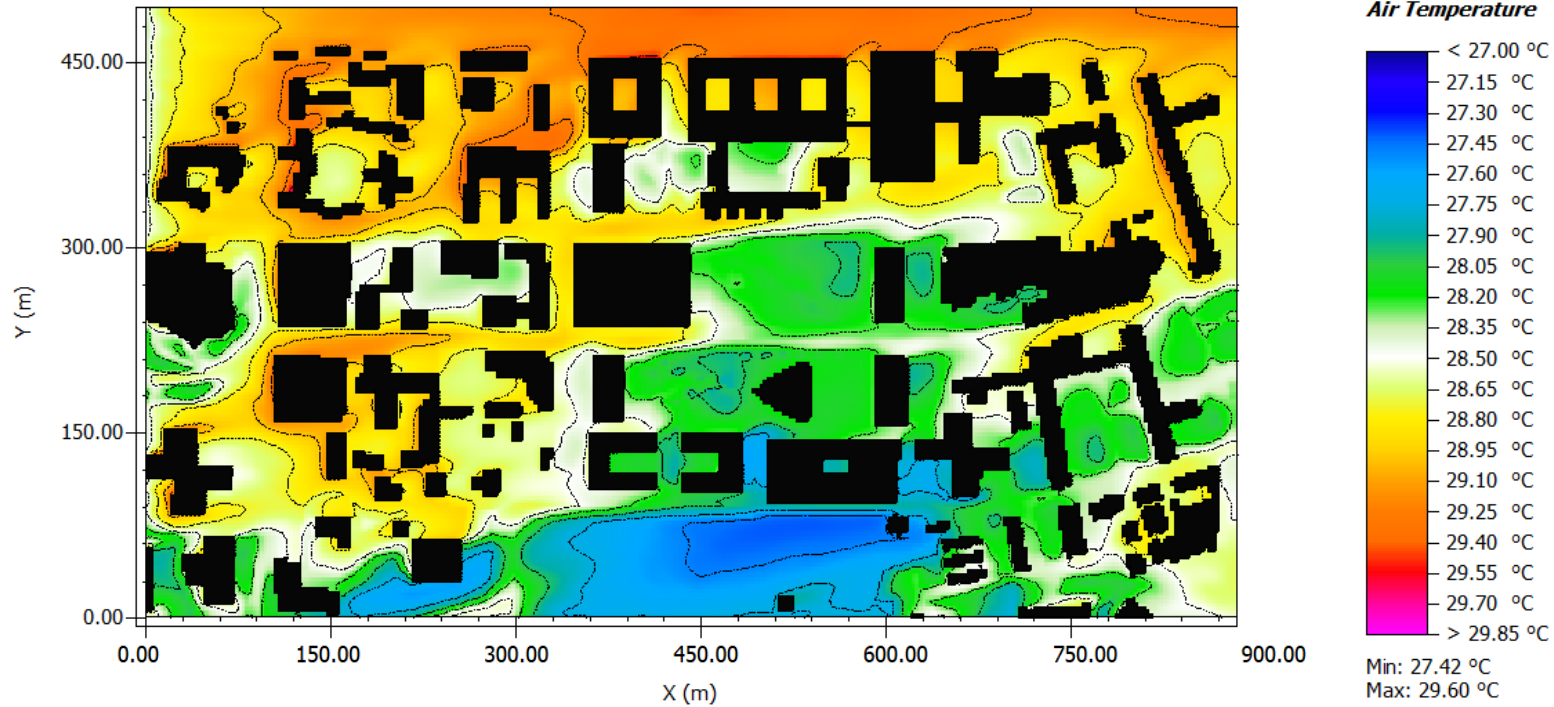
SIMULATION RESULTS

DESIGN 01 – MASTERPLAN LBB, AIR TEMPERATURE, 20.00 H, Z=1.25 M



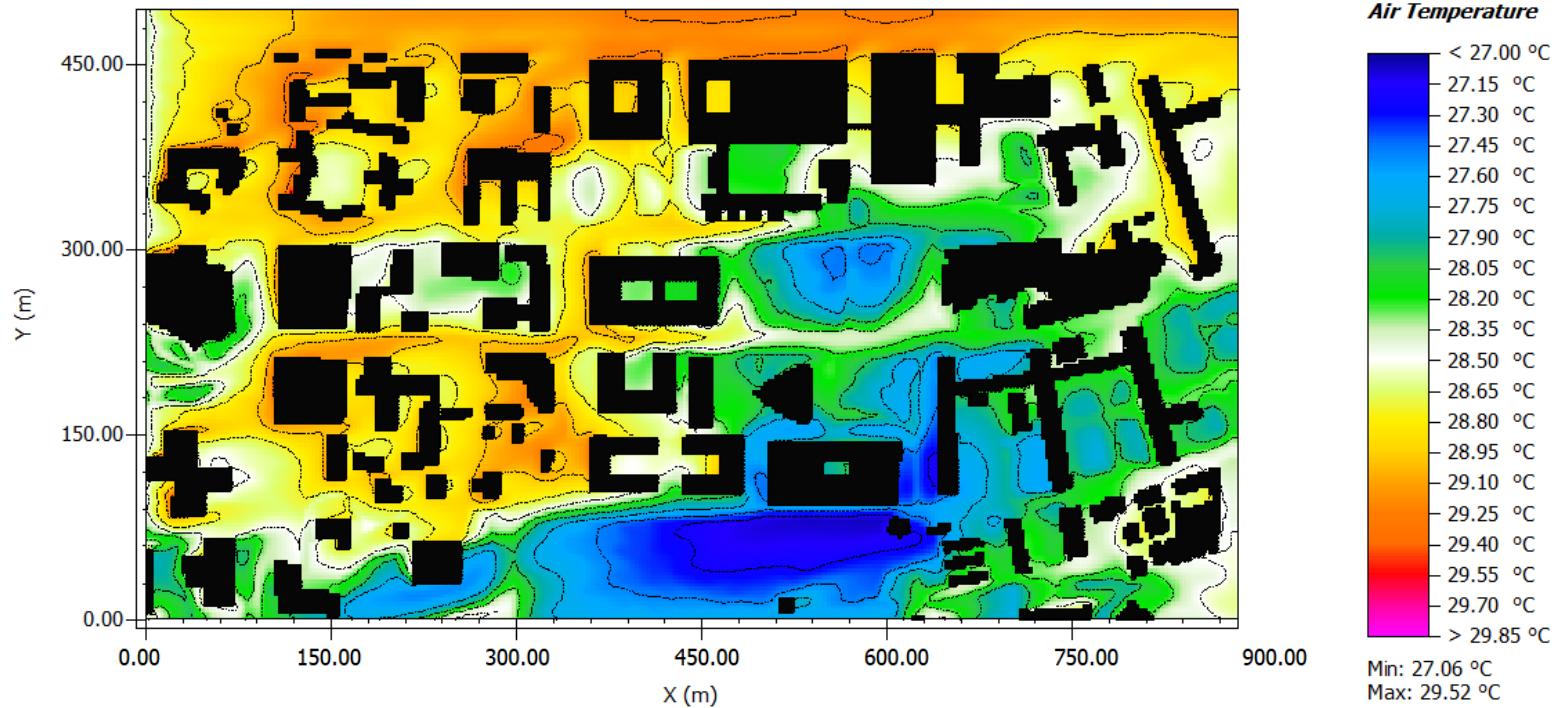
SIMULATION RESULTS

DESIGN 02 – GEMAINZAM LEBEN, AIR TEMPERATURE, 20.00 H, Z=1.25 M



SIMULATION RESULTS

DESIGN 03 – FOREST FOR FUTURE, AIR TEMPERATURE, 20.00 H, Z=1.25 M



LOCAL MICROCLIMATE = THERMAL COMFORT ?

- Not as simple as that...
- Complex interaction of different physical parameter onto human strengthening & weakening each other
- Humans are not static objects
 - warm-blooded thermoregulation as reaction to environment (we are no alligators)

Increase, decrease blood flow, sweating, shivering

BIOMETEOROLOGICAL MODELS...

- ...first need to simulate the physical parameters in high resolution
Especially in urban areas due to huge heterogeneity
- ...then simulate the heat and energy budget of humans in that environment, but humans vary
 - in gender
 - in age
 - in body shapes
 - clothing
 - in activities
 - in climate perception

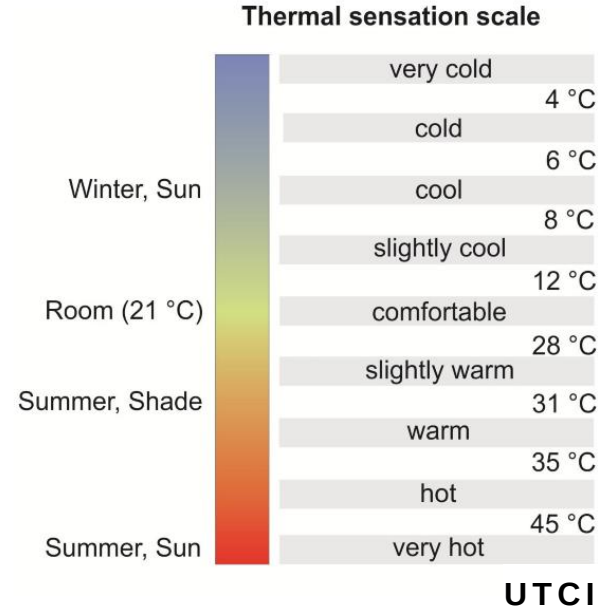
SIMULATION THERMAL COMFORT

UTCI

Universal Thermal Climate Index

Considers

- Wind
- Solar and Infrared Radiation
- Air temperature
- Air humidity



RELEVANT METEOROLOGICAL PARAMETERS



AIR HUMIDITY



MEAN RADIANT TEMPERATURE

WIND SPEED

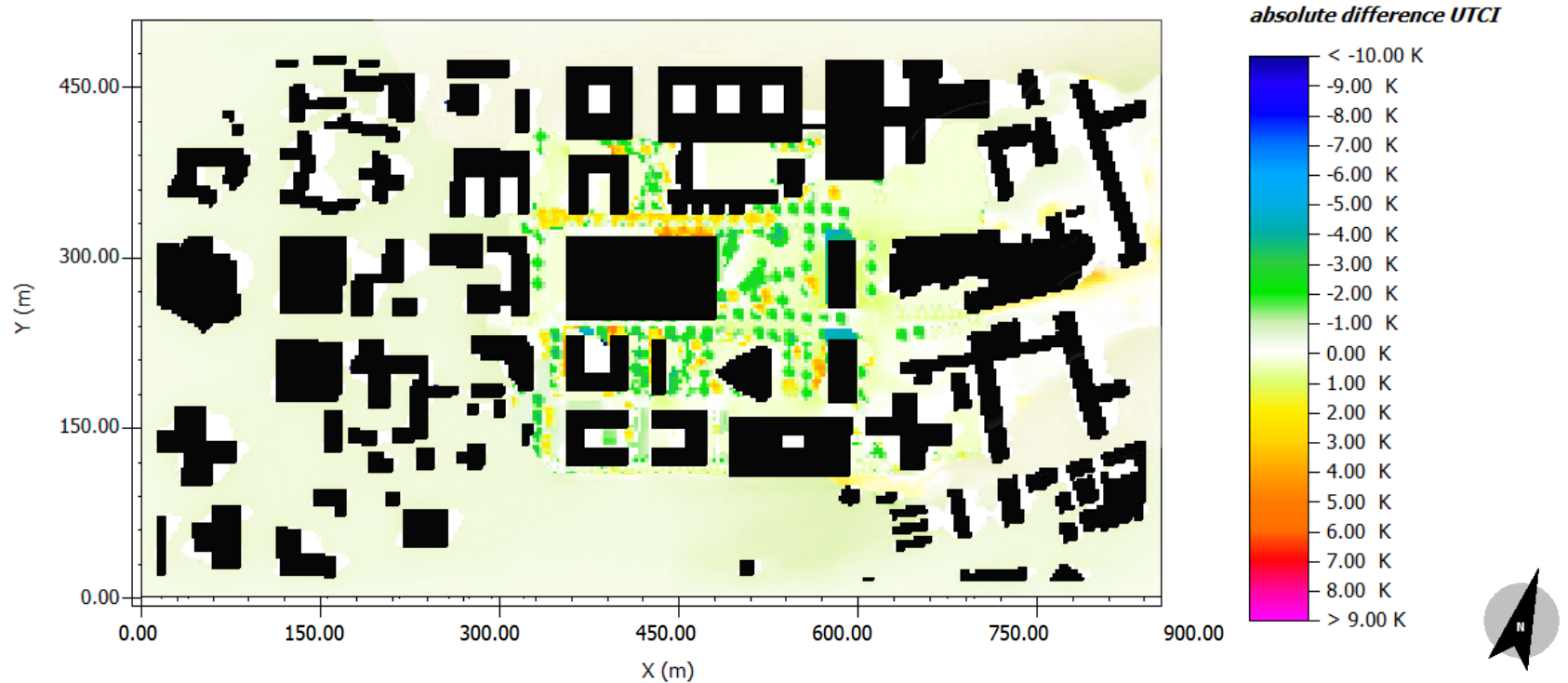


AIR TEMPERATURE



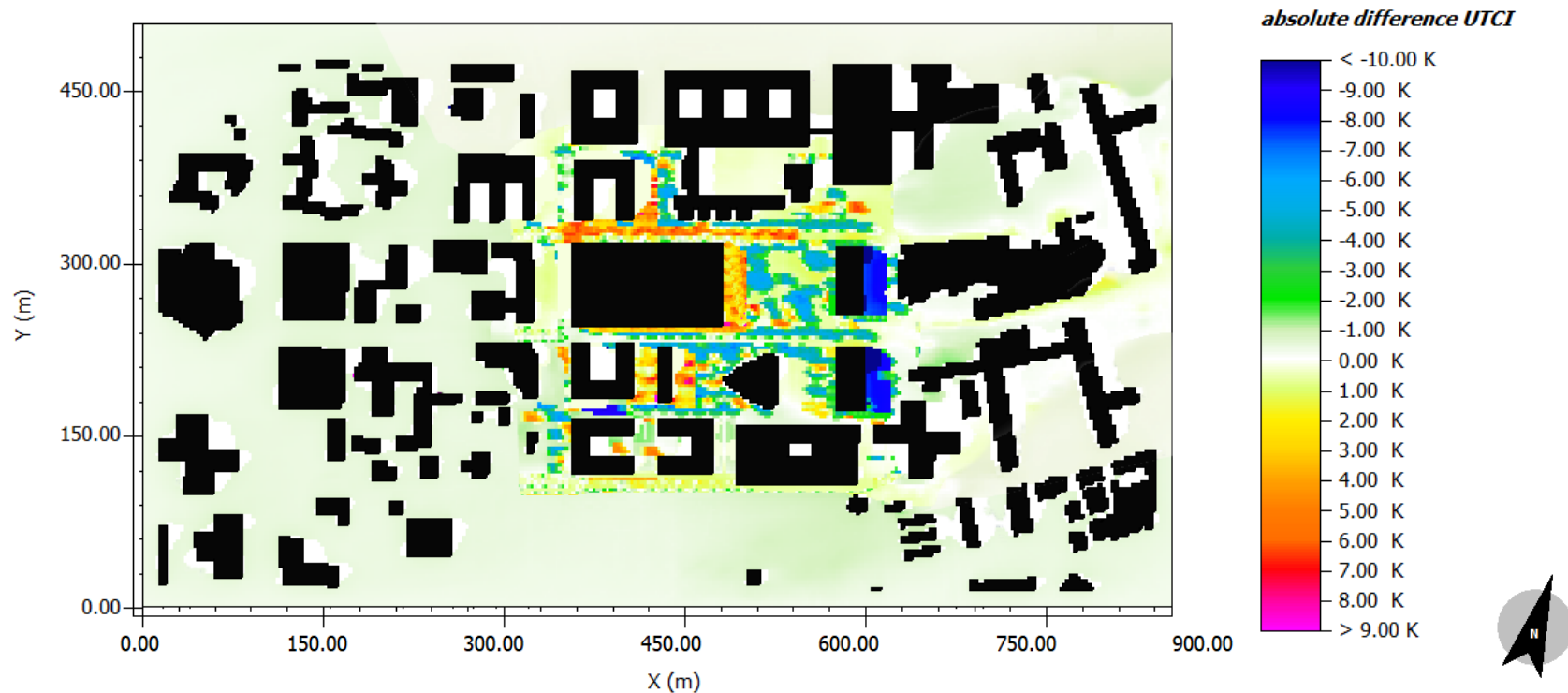
DIFFERENCE MAP

MASTERPLAN LBB VS. GEMAINZAM LEBEN, AIR TEMPERATURE, 10.00 H, Z=1.25 M



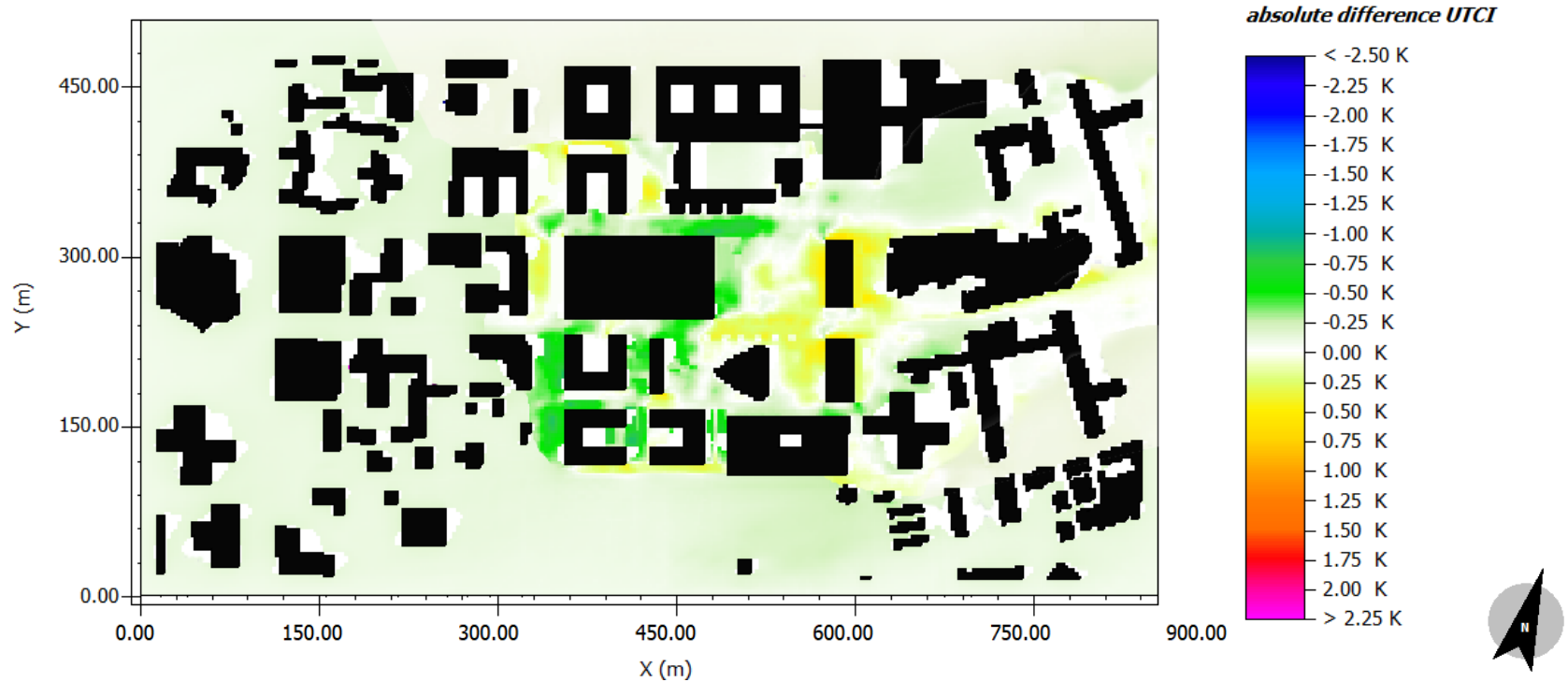
DIFFERENCE MAP

MASTERPLAN LBB VS. GEMAINZAM LEBEN, AIR TEMPERATURE, 16.00 H, Z=1.25 M



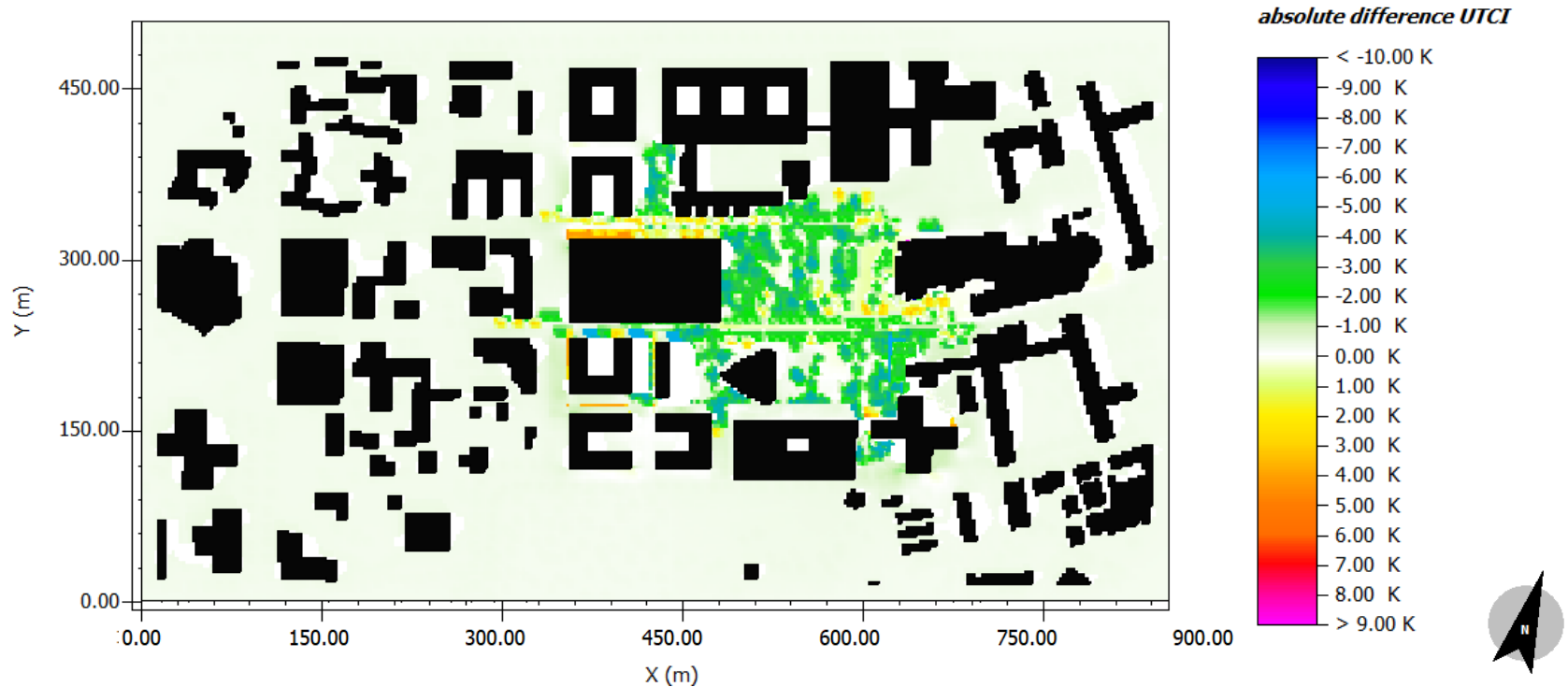
DIFFERENCE MAP

MASTERPLAN LBB VS. GEMAINZAM LEBEN, AIR TEMPERATURE, 20.00 H, Z=1.25 M



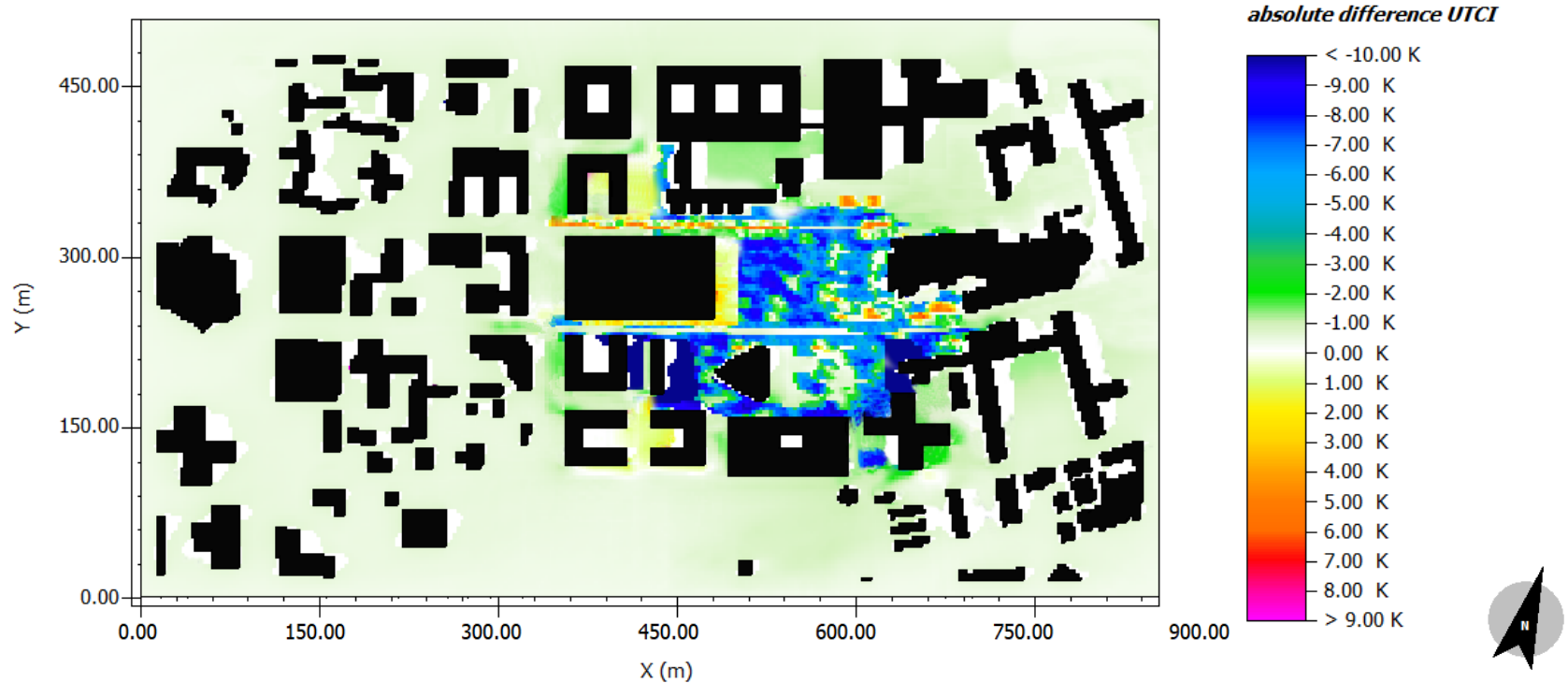
DIFFERENCE MAP

MASTERPLAN LBB VS. FOREST FOR FUTURE, AIR TEMPERATURE, 10.00 H, Z=1.25 M



DIFFERENCE MAP

MASTERPLAN LBB VS. FOREST FOR FUTURE, AIR TEMPERATURE, 16.00 H, Z=1.25 M



DIFFERENCE MAP

MASTERPLAN LBB VS. FOREST FOR FUTURE, AIR TEMPERATURE, 20.00 H, Z=1.25 M

