

Project: **1365**

Project title: **CoKLIMAx: Simulation, Analyse, Auswertung des städtischen Mikroklimas für die klimaresiliente Stadtplanung**

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Report period: **2023-05-01 to 2024-04-30**

The initial phase of the project revolved around data collection and preparing them into suitable formats for PALM simulation. The data collection focuses on acquiring both geographical and meteorological data across different reliable sources that are relevant to Konstanz. The geospatial data such as buildings, trees, ALKIS for land use, water, and elevation models were used for creating static driver for the simulation in PALM. The data preparation all the available geodata were collected and prepared that fit the PALM input standards the data preparation is done in locally in an in-house cluster (Figure 1). Then the files are transferred to the DKRZ cluster where the actual simulations were carried out.

Before conducting the simulations, however, rigorous testing of simulation parameters and conditions within the cluster established for the project were carried out. The preliminary results which were carried with very small test domain allowed further discussion with stakeholders; suitable simulation scenarios were determined. As the major interest of the project was to understand the microclimate dynamics of urban heat island prone areas in Konstanz, 3 areas of interest for UHI study were determined as Augustinerplatz, Marktstätte and Sank-Stephans-Platz. (Figure 1).

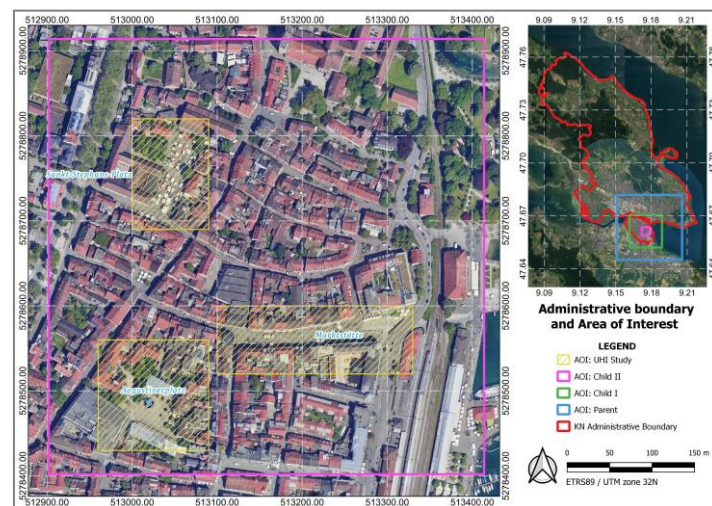


Figure 1: Overview of Project domain and simulation domain

The initial simulation, established as the Baseline Condition, serves as a foundational reference against which variations and interventions can be compared. In this baseline scenario, the simulation was conducted using real-time physical and meteorological data from the selected day of 16 June 2023, without any alterations. This baseline condition acts as a benchmark against which subsequent simulations are compared, enabling the identification and quantification of the impacts resulting from changes made to the physical urban infrastructure.

As for the test scenario, Augustinerplatz which is currently covered almost entirely with concrete tiles, is replaced with short grass. Likewise, in the Marktstätte area, trees were added to either side of the street stretching west to east direction for an additional study of dominant wind direction within the Marktstätte area. All of the trees used in the test scenario are identical tree species (Celtis), tree height (10m), crown diameter (8m), and trunk diameter (17cm) with leaf area index (LAI) of 6. In this simulation scenario, however, no change is made in Sankt-Stephans-Platz.

With the differences in two distinct places in Altstadt, Konstanz simulations were carried out in the DKRZ cluster. The simulation outputs contain multiple variables including air temperature, surface temperature, wind, and radiation. The variables are visualized and analysed using tools like QGIS (Figure 2), python and streamlit (<https://palm-web.streamlit.app/>), as well as a combination of both (Figure 3). Considering all the parameters, a sensitivity analysis was performed on how the change in urban characteristics influences the simulation results.

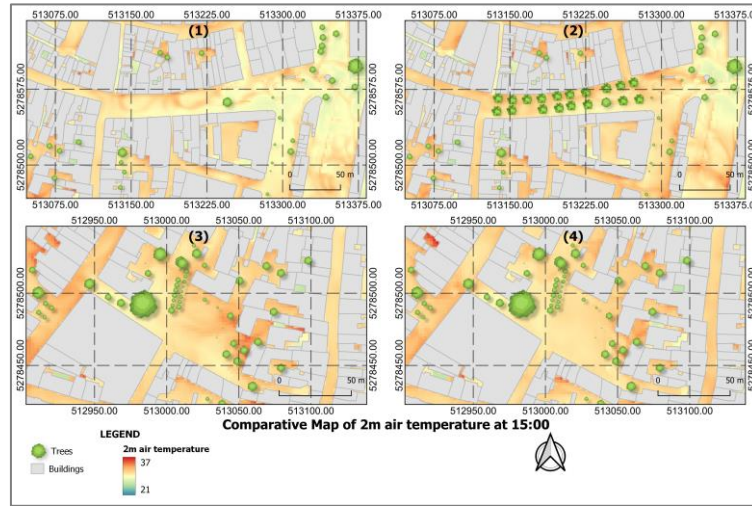


Figure 2: Comparative map of 2m air temperature; (1) and (3) Baseline simulation of Marktstätte and Augustinerplatz, (2) and (4) Test Simulation of Marktstätte and Augustinerplatz respectively

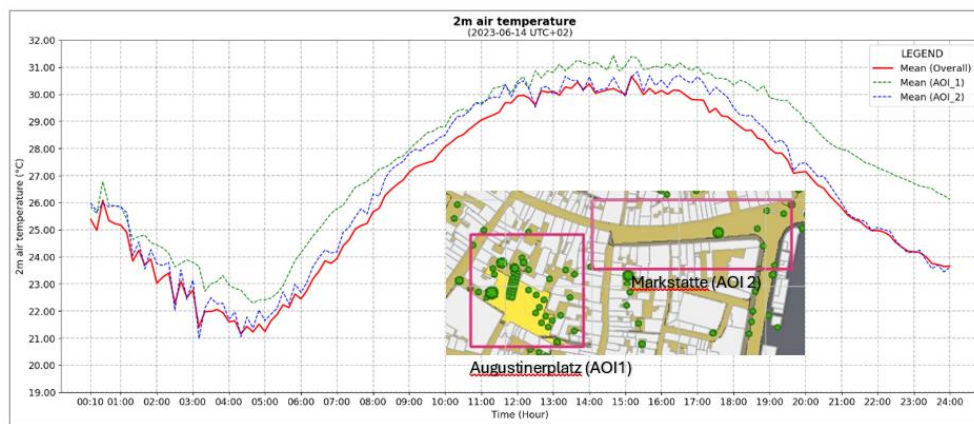


Figure 3: Trend of 2m air temperature over the AOI over the simulation duration

The current simulation results provide insights into some aspects of the microclimate of Konstanz. We aim to incorporate the “Redesign of Sankt-Stephans Plans” (Source) into our planning scenario for the city of Konstanz. The aim of this planning prepared by the city of Konstanz is to create added value for the neighboring residents and the general public. Additionally, two alternative simulation scenarios also need to be tested in order to verify all the results from the previous runs and the planned runs. The microclimate of urban areas, especially dense areas depends upon multiple factors including the proximity of the geographical and physical parameters. Therefore, by analyzing the effects of different initial simulation conditions or a combination of varying simulation conditions can give a deeper insight into the dynamics of urban microclimate. In consultation with the Constance city administration we further need to include the effects on human thermal comfort (indices UTCI/PET), an aspect that we did not include in the test runs.

	Time step	Time (hr)	Mean (v1)	Std (v1)	Mean (v2)	Std (v2)	alpha	p-value	t-test
0	0	10	-0.01	0.04	-0.01	0.043	0.05	1.42E-01	Fail to reject null
1	5	100	0.03	0.046	0.03	0.059	0.05	4.21E-03	Reject null
2	11	200	-0.01	0.047	-0.01	0.051	0.05	2.24E-02	Reject null
3	17	300	0.01	0.061	0	0.06	0.05	4.23E-11	Reject null
13	77	1300	-2.37	1.922	-2.04	1.838	0.05	7.53E-09	Reject null
14	83	1400	-2.51	2.179	-1.87	1.587	0.05	2.68E-28	Reject null
15	89	1500	-1.9	1.403	-1.79	1.663	0.05	1.23E-02	Reject null
16	95	1600	-1.65	1.389	-1.56	1.568	0.05	5.79E-02	Fail to reject null
17	101	1700	-1.31	1.089	-1.19	1.24	0.05	5.44E-04	Reject null
22	131	2200	-0.06	0.108	-0.04	0.11	0.05	6.21E-08	Reject null
23	137	2300	-0.05	0.094	-0.03	0.091	0.05	5.21E-08	Reject null
24	143	2400	-0.04	0.088	-0.03	0.084	0.05	7.68E-10	Reject null

Figure 4: T-test result of hourly data of the two simulation conditions where the t-test failed to reject the null hypothesis at 6 instances