[UC]² | ProPolis

[UC]² Urban Climate Under Change
Stadtklima im Wandel

GEFÖRDERT VOM
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Case study simulation of the green infrastructure influence on heat stress with urban climate model PALM-4U

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GERICS Climate Service Center Germany
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1 Urban climate model PALM-4U and the ProPolis project

PALM: Core model (Maronga et al. 2020)

- PALM + additional model components = **PALM-4U:** "**Pa**rallelized **L**arge Eddy Simulation **M**odel **for** **u**rban application"
- Microscale model: spatial scale from whole cities (ca 15 m grid resolution) to **quarters** (ca **4 m**) to single buildings (ca 1-2 m)

Maronga, B et al.: Overview of the PALM model system 6.0, Geosci. Model Dev., 13, 1335–1372, 2020.
https://palm.muk.uni-hannover.de/trac

MODEL APPLICATION CASE

Together with a municipal partner, identify an urban climate question from real planning practice that PALM-4U can simulate. Collect input data with partner. Create a setup, run the simulation and analyse the output. Check usability of results with partner.

Application fields covered by practical cases in ProPolis:

- **Thermal comfort (heat stress)** and cold air analysis
- Dispersion of pollutants (including traffic)
- Wind comfort

Planners' question: What effect do **climate adaption measures** in the urban development area have on **thermal comfort**?

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2 The municipal model application case

Scenario with fewer adaption measures

Surroundings of the area identical, changes only to the development area

<u>Differences of green and blue infrastructure between scenarios:</u>

1. Higher fraction of green ground surfaces (e.g. inner patios)
2. Green façades on all new buildings
3. Intensive roof greening on all new buildings
4. 2.5 times more trees
5. Addition of ponds

<u>Common setup:</u> **autochthonous conditions** with

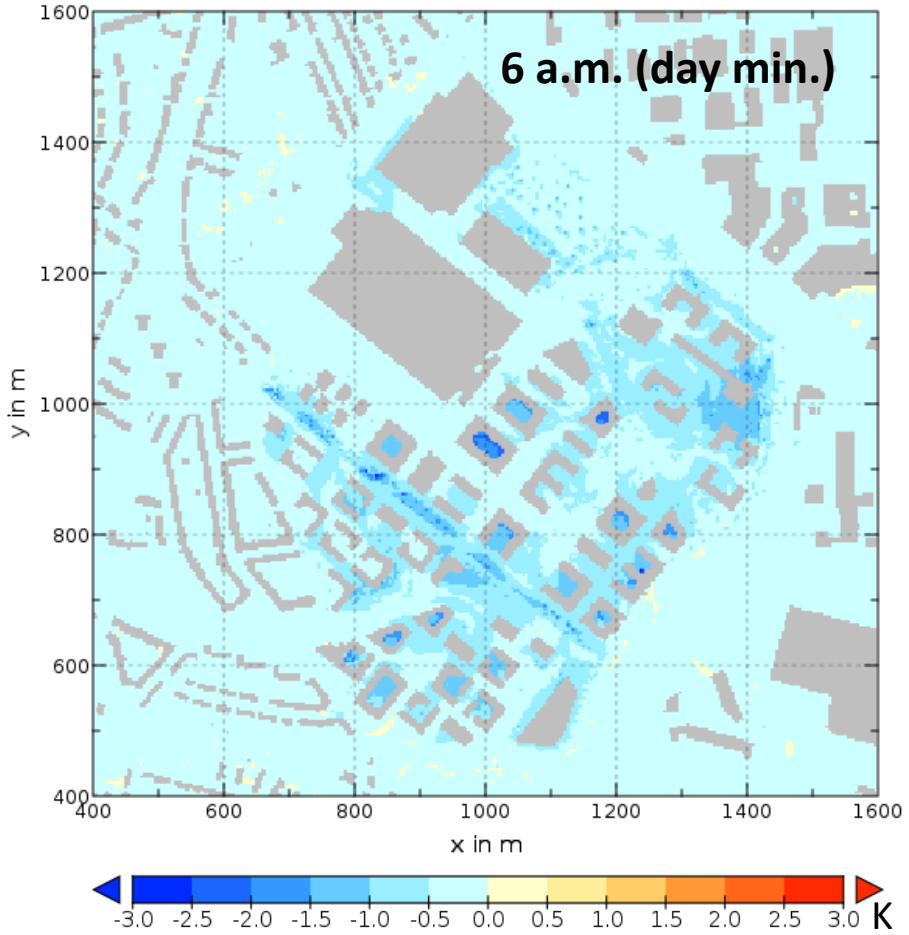
- solar input: summer solstice
- „Hot Day“ and „Tropical Night“
- 1 m/s wind from E

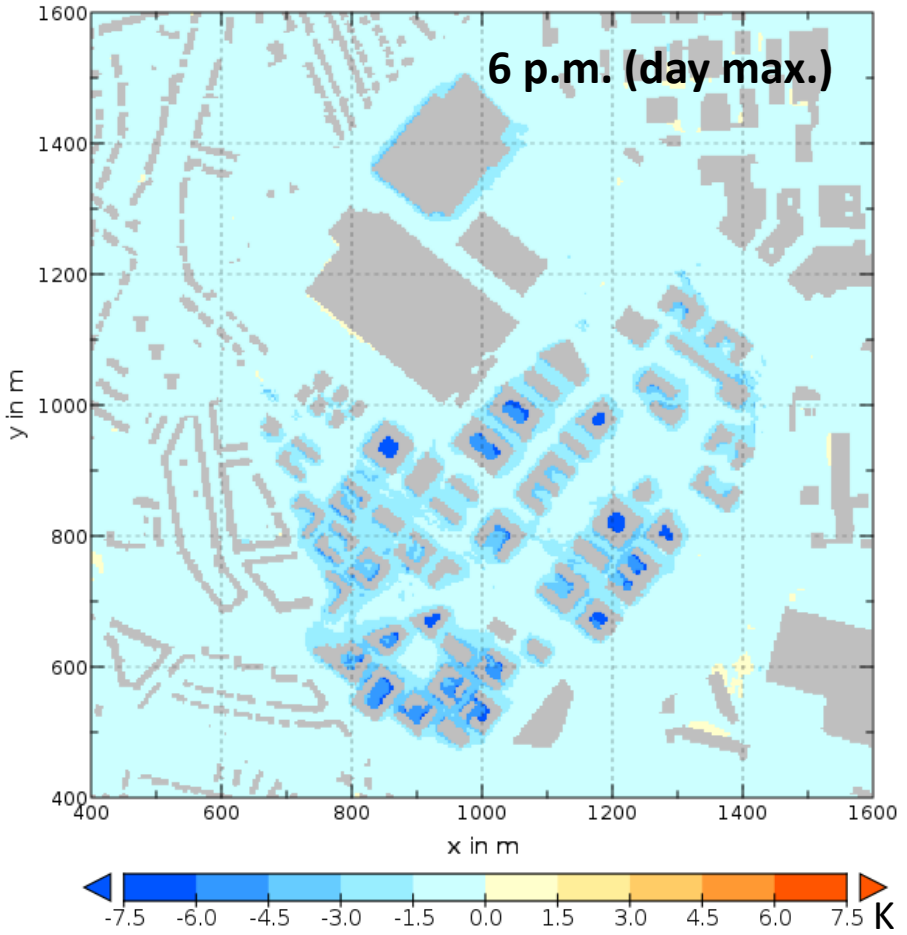
Cyclic boundary conditions

Scenario with more adaption measures

3 Case study simulation results

Difference in 2m air temperature: *more* minus *fewer* adaption measures

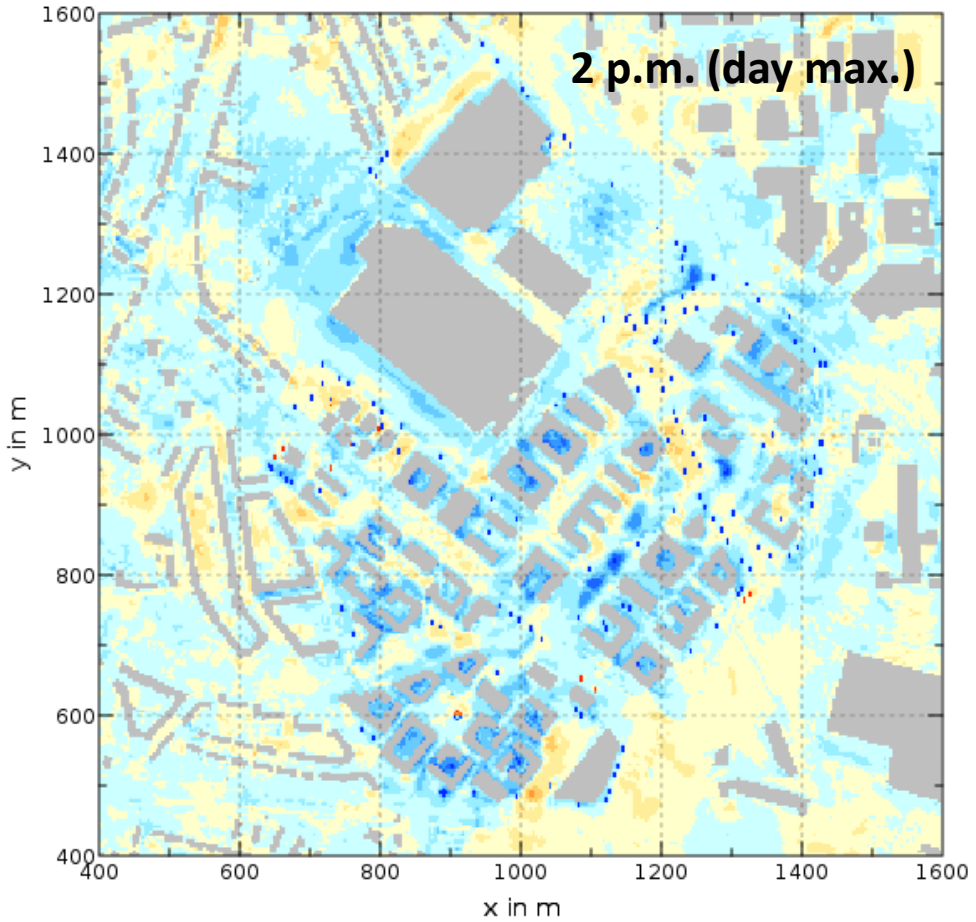




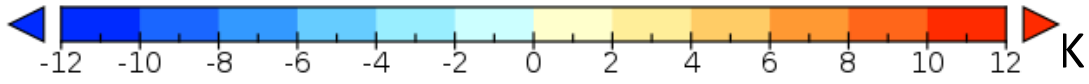
- **Replacing pavement surfaces with grass** lowers temperatures by 0.5-1.5K at 6 a.m. and by up to 3K at 6 p.m..
- The addition of **green façades** and small **trees** has only a local effect of ~1K (6 a.m. and 6 p.m.).
- Up to 3K lower temperatures in **patios with green walls and floors** at 6 a.m. and even more than 7.5K at 6 p.m.

3 Case study simulation results

Difference in Physiologically Equivalent Temperature (PET): *more* minus *fewer* adaption measures

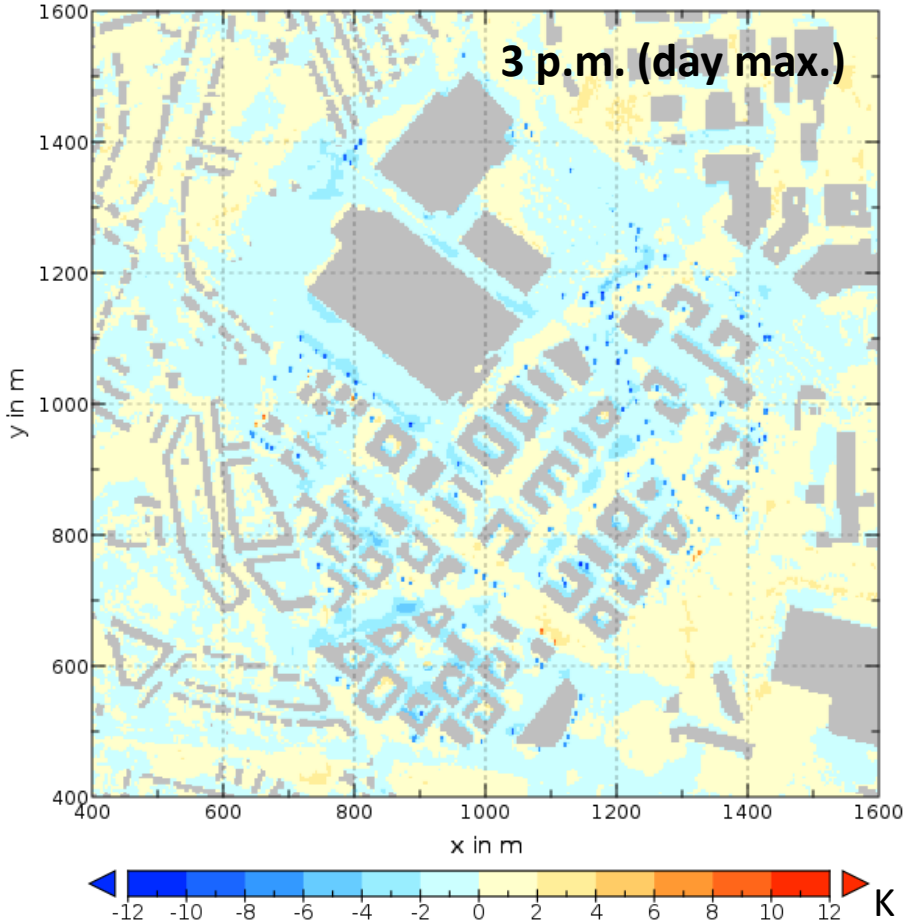


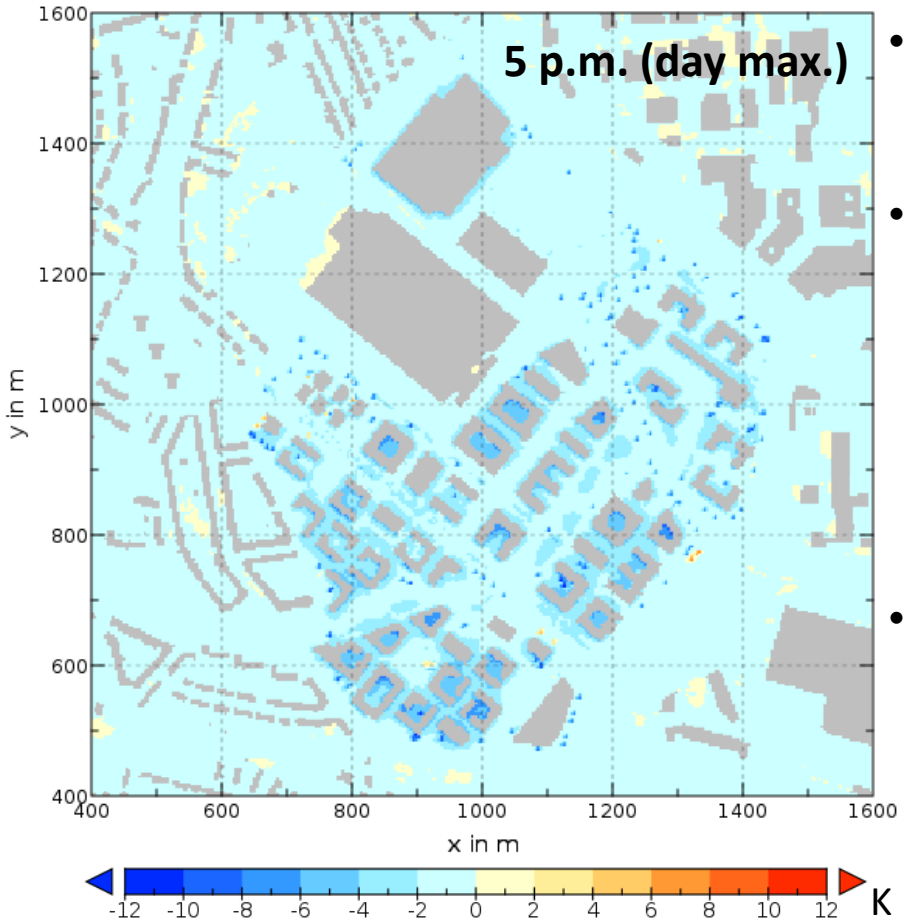
- PET changes at 2 p.m. dominated by turbulence pattern variations (slight **wind**).
  - Where **green surfaces** replace pavement surfaces, PET changes -6K to +4K.
  - Local but great PET reductions from cold water bodies and in **patios with shadow and green floor and walls**.
  - **Shadowing measures** like densely planted **trees** help most to lower heat stress, best in combination with a green floor.



3 Case study simulation results

Difference in Perceived Temperature (PT, left) and UTCI (right): *more* minus *fewer* adaption measures





- Smoother patterns than PET (same colour scale): less influence of **wind**
- PT: heat stress differences are small
  - In **tree shadows** up to 10K cooling, other **shadows** up to 4K
  - **floor greening** effects small/inconsistent
- UTCI: less heat stress almost everywhere
  - **Shadows** and **grass replacing pavement** bring cooling of 2-6K.