Innovative urban climate model PALM-4U as a support tool for municipal climate adaptation strategies

Antonina Kriuger, Alexander Reinbold, Jörg Cortekar, Martina Schubert-Frisius
Climate Service Center Germany (GERICS), Helmholtz-Zentrum hereon GmbH

Display materials for the virtual EGU General Assembly 2021, 19. – 30. April 2021
Content

- Project ProPolis - [UC]$^2$ (Module C)
- Microscale urban climate model PALM-4U and its application
- Application case of PALM-4U in a major German city

The workflow for the application case will be presented on **Tuesday, 27 April 2021, at 13:44 CEST** within CL2.2 Session – 'Urban climate, urban biometeorology, and science tools for cities'

The corresponding breakout text chat will run from **Tuesday, 27 April 2021, at 14:08-15:00 CEST**.
Funding measure Urban Climate Under Change, phase 2: Vision und Mission

“*We’re seeing an incredible momentum for action in cities.*”

*Statement by Patricia Espinosa, Executive Secretary UNFCCC, 2018*

**VISION**

Successful **market launch** of PALM-4U at the end of the project. The model will – in three years – be **freely available** to users and addresses both **experts and non-experts**.

**MISSION**

Further development of the innovative urban climate model PALM-4U to a **practicable and user-friendly tool** that supports the **urban planning processes** in consideration of **climate change adaptation** aspects.
Funding measure Urban Climate Under Change, phase 2: project structure

1st Phase (2016-2019)

**MODULE A**
development of a high-performance urban climate model

**MOSAIK**
application tests

**MODULE B**
observational data and evaluation of the urban climate model

3DO

**MODULE C**
review of the model’s suitability for practical application and user-friendliness to foster climate proof cities

KliMoPrax & UseUClim

2nd Phase (2019-2022)

**MODULE A**
model development

**MODULE B**
model evaluation

**MODULE C**
continuation strategy

© Kriuger 2020, based on Steuri, 2019
1. **Project ProPolis**
2. Microscale urban climate model PALM-4U
3. Municipal application case

---

**ProPolis - strategic goals**

### Basics for the Operationalization of PALM-4U – Practicability and Continuation Strategy

1. Developing a **continuation strategy** including governance structure, IT infrastructure planning and implementation, and operating models for a variety of possible application scenarios.

2. Ensuring **model practicability** through a strictly transdisciplinary approach applying Living Labs (Exlabs).
   - a. Application fields and model runs
   - b. Graphical User Interface - GUI

3. **Capacity building** and internationalization to increase impact and foster long-term uptake of PALM-4U.
   - a. (Advanced) trainings, services and support features, and academic offers
   - b. Community Building (Community of Practice)
   - c. Internationalization (e.g. applying PALM-4U in an international setting)
Transdisciplinary process – Living Lab approach

Our understanding of innovation is based on a comprehensive innovation concept that takes equal account of technological and social innovations and includes society as a central actor.


---

**Living Lab stages – iterative process in the experimental rooms (ExLabs) with practice partners**

**EXPLORATION:** What requirements do the potential PALM-4U users have & how can they be translated into the GUI? Which application settings do the users have?

**EXPERIMENTATION:** After trainings, the practice partners will apply the model by themselves for their specific application case; further support services will be tested. Training concepts and GUI will be further developed.

**EVALUATION:** What is required for the successful operationalization and continuation of PALM-4U to make it practical and user-friendly for the wider user circle?
Microscale urban climate model PALM-4U

**PALM**: Core model (Maronga et al. 2020)

- Parallelized Large Eddy Simulation Model (LES-Model)
- HPC: highly optimized for parallel calculation and scalable with CPU numbers
- Cartesian Grid
- Lateral boundary conditions by higher-scale models (COSMO-DE, more to follow)

**PALM-4U (PALM for urban application)**: PALM + additional model components

Based on Maronga et al. (Dachtagung, 2019)
PALM-4U application fields in the planning practice

Application fields covered by practical cases in ProPolis:
- Cold air balance and thermal well-being
- Dispersion of pollutants (including traffic)
- Wind comfort

Detailed application catalogue:
- Defining relevant application questions for an urban climate model in close exchange with our practice partners
- Compiling the detailed catalog: designing the associated model setups (GUI), instructions, recommendations, examples

Spatial scales:
- Whole city
- Quarter / building block
- Building

https://palm.muk.uni-hannover.de/trac/wiki/palm4u
Municipal application case – example on thermal well-being

- Application field: *Thermal comfort and cold air balance*
- Test case: Berlin-Friedrichshain
- Effects of green and blue infrastructure (green facades, intense green roofing, open green spaces, trees, water elements) on summer heat load of humans

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area: (x, y, z)</td>
<td>2.0 km x 2.0 km x 2.0 km</td>
</tr>
<tr>
<td>Grid spacing</td>
<td>10 m</td>
</tr>
<tr>
<td>Grid points</td>
<td>200 x 200 x 250</td>
</tr>
<tr>
<td>Initial conditions</td>
<td>T and q profiles of 20.06.2015, 09:00 pm</td>
</tr>
<tr>
<td>Synoptics</td>
<td>Autochthonous conditions</td>
</tr>
<tr>
<td>Lateral boundary conditions</td>
<td>cyclic</td>
</tr>
<tr>
<td>Simulation time (LES), Spinup</td>
<td>24 h, 24 h</td>
</tr>
</tbody>
</table>

Openstreetmap
Municipal application case – example on thermal well-being

Exemplary simulations of the current situation

Day: 20.06.2015, starting time: 09:00 pm CET

Surface temperature [°C], 09:00 pm

Surface temperature [°C], 03:00 am

Surface temperature [°C], 09:00 am

Surface temperature [°C], 03:00 pm

Colour scale: 10-minute mean of surface temperature
Municipal application case – example on thermal well-being

Universal thermal climate index (UTCI) [°C]

<table>
<thead>
<tr>
<th>UTCI</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 - 25</td>
<td>No thermal strain</td>
</tr>
<tr>
<td>26 - 31</td>
<td>Moderate heat stress</td>
</tr>
<tr>
<td>32 - 38</td>
<td>High heat stress</td>
</tr>
</tbody>
</table>

[1] based on ICEE, 2009
Outlook – what is happening next in ProPolis?

<table>
<thead>
<tr>
<th>Milestones</th>
<th>Use for practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation with a <strong>high degree of green infrastructure</strong> compared to current state</td>
<td>Knowledge about concrete effects of measures help to make and justify planning decisions</td>
</tr>
<tr>
<td>Development of a setup with <strong>RCP8.5 climate boundary conditions</strong> planned</td>
<td>Basis for climate change adaptation in urban planning processes</td>
</tr>
<tr>
<td><strong>Test simulations</strong> with municipal practice partners: Collection and processing of input data</td>
<td>Preparing the test simulations, gaining experience with setups and the model</td>
</tr>
<tr>
<td><strong>Assisted model usage by practice partners</strong> after the GUI trainings and ExLabs / workshops</td>
<td>Insides on practical simulation questions, gaining experience and building capacities</td>
</tr>
<tr>
<td>Developing the <strong>Catalogue for standard applications</strong> with specific setups for each field</td>
<td>Creating application possibilities of the model for practice users who are not experts in modelling</td>
</tr>
<tr>
<td>Evaluation of the <strong>model practicability</strong> and development of the <strong>continuation strategy</strong></td>
<td>Easy-to-use instrument which is fit for practice and for addressing planning questions related to urban climate</td>
</tr>
</tbody>
</table>
Further materials // publications

  https://www.researchgate.net/publication/345662243_Basics_for_the_operationalization_of_the_new_urban_climate_model_PALM-4U

- Steuri, B.; Bender, S; Cortekar, J. (2020) Successful user-science interaction to co-develop the new urban climate model PALM-4U In: Urban Climate 32, 100630.

ProPolis contact at GERICS

Jörg Cortekar  
Project coordinator Module C  
joerg.cortekar@hereon.de  
+49 (0)40-226 338-445

Antonina Kriuger  
Coordination office Module C  
antonina.kriuger@hereon.de  
+49 (0)40-226 338-480

Alexander Reinbold  
alexander.reinbold@hereon.de  
+49 (0)40 226 338 475

Martina Schubert-Frisius  
martina.schubert-frisius@hereon.de  
+49 (0)40-226 338-453