News from Lohmeyer

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Dear Readers

I am delighted to present the 50th issue of our company magazine. This issue focuses on two topics from the fields of air quality and urban climate. When modeling the dispersion of air pollutants, the correct choice of meteorological input data is of great importance, as these impact the results significantly. For suitably researched meteorological time series, the question arises, besides orographically structured environments especially study areas characterised by buildings, for which location in the model area the meteorological time series is representative. The first article presents how measured or synthetic wind speed and direction data can be best placed in windfields calculated with MISKAM. The second article explains the work of evaluating the PALM4U model results using Bochum as an example. PALM4U is increasingly being used in expert reports to assess the effect of construction measures on the urban climate or to analyze entire urban districts. The application of PALM4U requires a high degree of experience, which is amongst other thing, drawn from the comparison with measurement data. In a master's thesis co-supervised by our Bochum branch, PALM4U model results were evaluated using meteorological crowdsourcing measurement data. The insights gained from the master's thesis are used to build our expertise in the application of PALM4U.

In addition to our daily efforts to improve the environment, we are part of a charity organization. Lohmeyer GmbH supports the project "Help for the Meno Highlands in Ethiopia". The aim of the project is to support Ethiopian farmers in initiating sustainable developments that unite ecological, economic and social aspects. More information on the project can be found here: www.meno-hochland.de.

I wish you a peaceful and blessed Christmas season and a Happy New Year 2024.

Yours sincerely

BRIEF SUMMARY OF CURRENT NEWS

- A voluntary group of international experts from 17 countries published the "International Handbook on the Assessment of Odor Exposure using Dispersion Modelling" on 12/02/2023. The handbook presents the current state of odor dispersion modelling in an international context and includes chapters on meteorological data, the models and dispersion algorithms used, emission determination and assessment. It is available free of charge at https://zenodo.org/doi/10.5281/zenodo.8367723.
- According to an evaluation of the measurement data from the federal states and the Federal Environment Agency for 2022, no exceedances of the particulate matter limit values in Germany were made for the fifth year in a row. The annual average limit value for nitrogen dioxide (NO_2) of 40 µg/m³ air was only exceeded at two measuring stations, both located near traffic in Munich and Essen. It must be taken into account that the current limit values for particulate matter and nitrogen dioxide were set more than 20 years ago and do not correspond to current scientific knowledge regarding the health effects of air pollution on the human health. You can find out more at: https://www.lohmeyer.de/aktuelles/messdaten-2022-das-funfte-jahr-in-folge-keine-uberschreitungen-der-feinstaubgrenzwerte-in-deutschland/.

CONTENT

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DETERMINATION OF THE SUBSTITUTE ANEMOMETER POSITION FOR AUSTAL WHEN USING WIND AND TURBULENCE FIELDS FROM MISKAM

For dispersion calculations in accordance with the Technical Instructions on Air Quality Control (TA Luft), meteorological data is generally used that is either measured at the site or, if no on-site measurements are available, transferred there (QPR) or based on model calculations. Meteorological data has to be transferred in accordance with guideline VDI 3783 Part 20 (2017). Since meteorological data is not always available in the desired quality and may not be representative for the location, especially in complex terrain, modeled data based on (usually prognostic) model calculations has been used more and more frequently. Requirements for procedures for generating modeled data sets and for their quality assurance are to be described in guideline VDI 3783 Part 22. For dispersion simulations with AUSTAL, a suitable substitute anemometer position SAP (xa, ya, ha) must still be found in the area under investigation, even though the transfered or modeled meteorological data are available for the facility site. This results from the fact that the transmitted or modeled meteorological data are representative of the location, but generally do not take into account the local influence on the wind caused by buildings in the study area. Thus, the coordinates given for transfered or modeled meteorological data do not usually reflect the appropriate SAP in the investigation area and should be checked before use for the dispersion calculation. When choosing the SAP, it must be ensured that, on the one hand, the average wind speed at the SAP corresponds to the transmitted or modeled meteorological data and, on the other hand, that the deviation of the wind direction and wind speed at the SAP is minimal compared to the transmitted or modeled wind direction. In accordance with the first requirement, for dispersion calculations with AUSTAL for which wind and turbulence fields are provided by the prognostic microscale model MISKAM, first all locations in the investigation area are investigated for which the mean speed corresponds to the measured mean wind speed. As a rule, this is an area h(x,y)

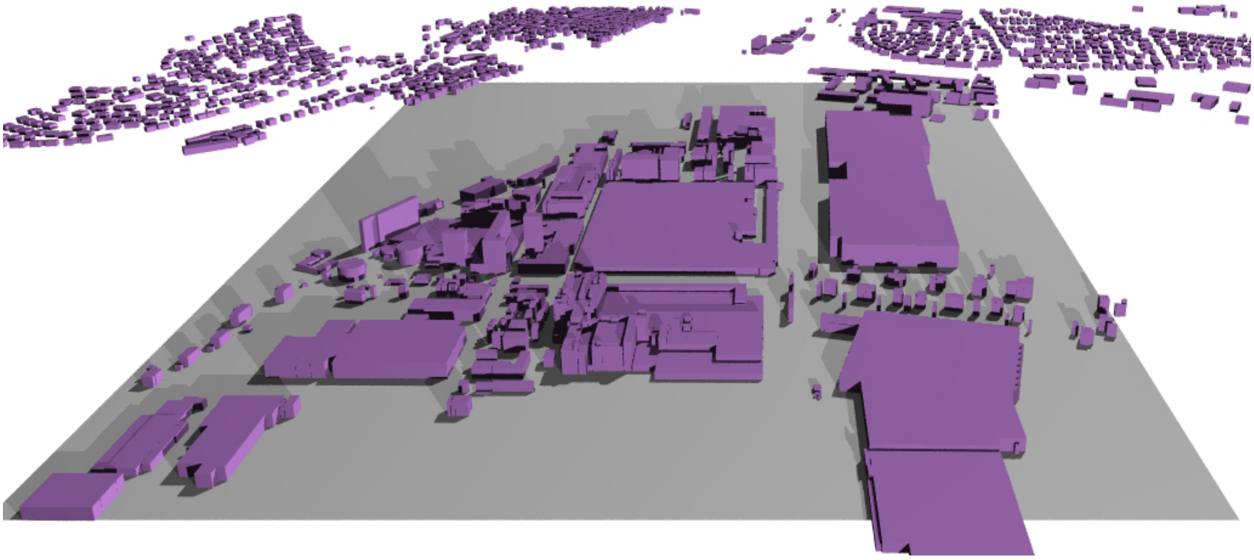

Fig. 1: Buildings in the MISKAM area. Gray area: Area with horizontally constant grid width = AUSTAL investigation area

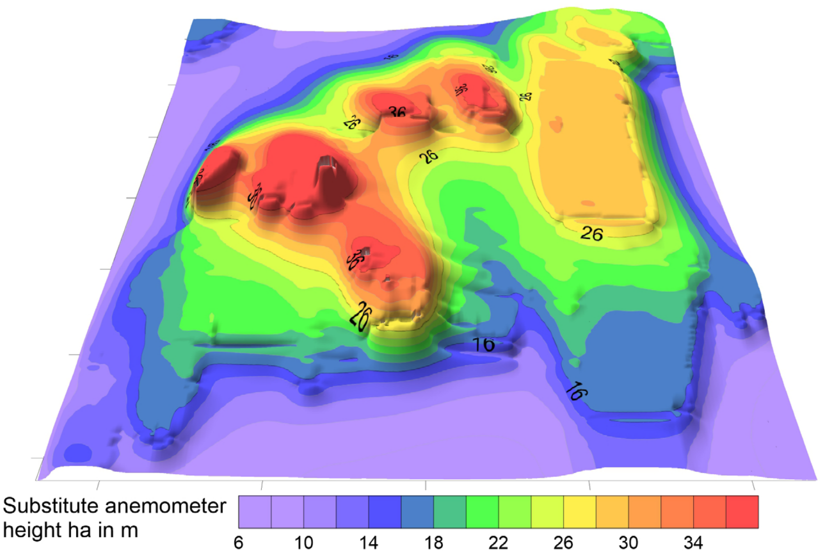

Fig. 2: Possible substitute anemometer heights h (x, y) at which the mean wind speed at the SAP corresponds to the transfered or modeled meteorological data.

which is dependent on the horizontal coordinates x and y. As an example, the possible substitute anemometer heights h(x,y) at which the mean wind speed corresponds to the transfered or modeled meteorological data are shown in **Fig. 2** for an area shown in **Fig. 1**. Points at which the height h(x,y) is calculated directly in the vertical layer above a building are discarded ("holes" in **Fig. 2**) In a second step, the local wind direction and wind speed influenced by buildings is compared with the transferred or modeled wind direction and wind speed on the area h for 36 wind directions. From this the error sum for the 36 wind directions is calculated and normalized (smallest or largest value is set to 1 or 0). These two normalized error square sums represent the quality measures gd and gf for wind direction deviation and wind speed deviation. The quality measure g, from which the optimal SAP is derived, is the product of gd and gf (see **Fig. 3**). The optimum SAP in the investigation area is the position on the surface h(x,y) at which the quality measure g has its maximum (white triangle in **Fig. 3**). As an undesirable side effect, different heights on the surface h (x,y) also result in different turbulence fields for the dispersion calculation. As a result, the relevant parameters can be specified separately in the WinMISKAM interface for generating the turbulence fields. Since this isolation is not provided for the dispersion calculation with AUSTAL when using the diagnostic flow model TALdia integrated in AUSTAL, the method presented can hereupon only be applied to a limited extent.

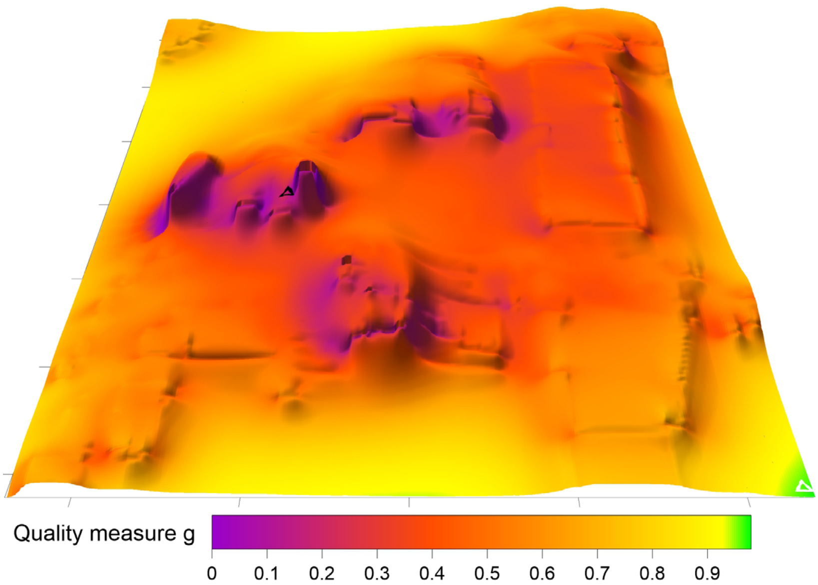

Fig. 3: Quality factor g on the surface of the possible replacement anemometer heights. White or black triangle: EAP with highest (= recommended SAP) or lowest quality measure.

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EVALUATION OF THE PALM4U MODEL WITH CROWD-SOURCED AIR TEMPERATURE DATA.

In summer and during heat events, the urban heat island can have a negative impact on human health, leading to adaptations measures for a changing climate being particularly necessary for cities in the context of climate change. Detailed information on the microclimate within cities is required for the planning of efficient adaptation measures. This information can be generated with micro-scale urban climate models. The PALM4U model has been extended in recent years specifically for urban applications as with PALM4U it is possible to model urban structures in a high level of detail while also taking mesoscale weather influences into account.

In this study, PALM4U is used to simulate a hot day in Bochum. For this purpose, a mesoscale domain with a horizontal resolution of 50 m is defined, which receives its boundary conditions from the analysis data of the former weather model COSMO-D2 of the German Weather Service (DWD). Two further domains are defined within this mesoscale domain: A parent domain with 10 m resolution and a child domain with 2.5 m resolution. The parent domain is driven by the results of the mesoscale calculation while the child domain is calculated simultaneously with the parent domain using a nesting procedure. These two domains cover the city center of Bochum and the northern half of the city. The model results for the modeled day show a pronounced diurnal cycle with typical temperature differences

Child domain			Parent domain		
	PALM	Netatmo		PALM	Netatmo
Mean [°C]	27.6	27.0	**Mean [°C]**	27.1	27.1
SD [°C]	5.0	4.8	**SD [°C]**	5.3	5.4
Evaluation metrics					
R^2	0.86		**R^2**	0.88	
RMSE	1.98		**RMSE**	1.89	
MSE	3.92		**MSE**	3.57	
n stations	9		**n stations**	59	

Tab. 1: Statistical parameters of the model evaluation broken down by parent and child domain for the air temperature in °C

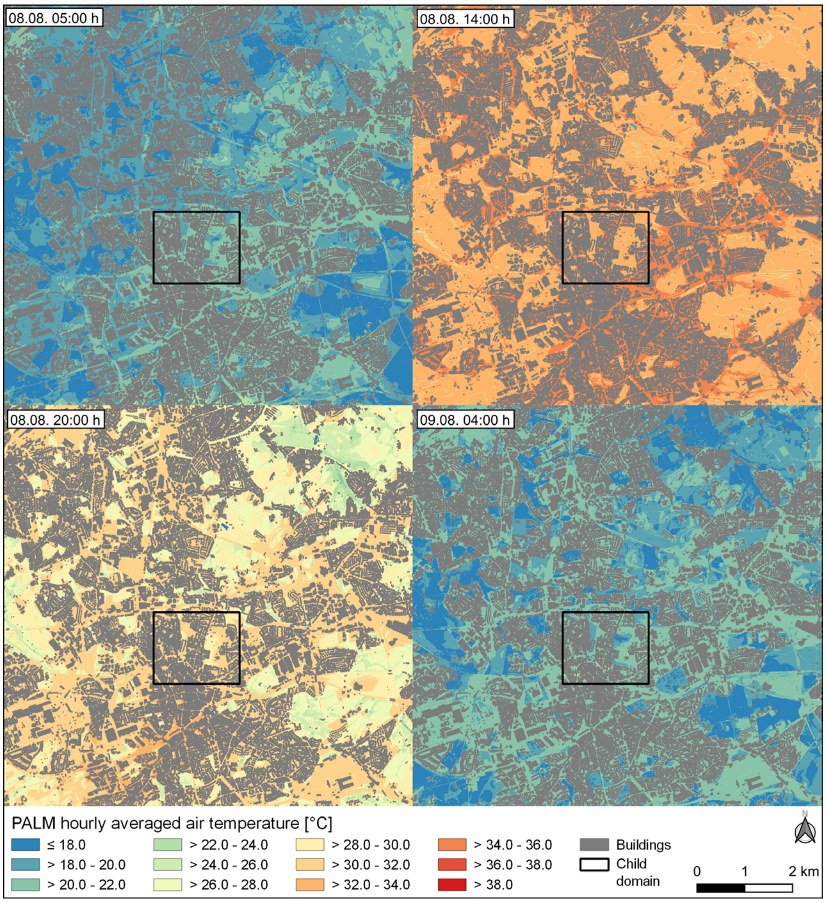

Fig. 1: Spatiotemporal pattern of the hourly air temperature in °C at a height of 2 m for four different time steps

for different areas of the city (see **Fig. 1**). Open spaces have higher air temperatures during the day due to the lack of shade with urban areas heating up during the day and storing the heat. After sunset, the stored heat is released resulting in higher air temperatures within the city compared to open spaces. All areas continue to cool down until the morning, with urban areas continuing to have higher air temperatures. However, as models are always a simplification of reality, it is important to evaluate the model results. So far, model evaluation is mostly limited to short-term field campaigns or a small number of existing climate measurement stations. Especially in urban areas, a small number of measuring points cannot represent the heterogeneous meteorological conditions in detail. Measurement campaigns are costly and often cannot be carried out as part of planning processes. Another option for obtaining climate data is crowdsourcing. In this case, data from private weather stations is freely available. In this study, measurement data from private weather stations operated by *Netatmo* is used to evaluate the model results. Before evaluation, the measurement data undergoes a quality control procedure to reduce measurement errors and increase the validity of the data. After quality control, a total of 59 stations are available for the parent domain and 9 stations for the child domain. The comparison between the model results and the measurement data reveals a good model performance (see **Fig. 2** and **Tab. 1**). The mean temperature and the standard deviations are close to each other for both domains. The coefficient of determination R^2 shows a high level of agreement and the root mean square error (RMSE) is less than 2 K. The diurnal cycle is well represented by the model. There are slight deviations in the evening hours with an underestimation of night-time air temperatures. One reason for this may be the existing cloud cover, which was not represented by the model. The crowdsourced air temperature data proved valuable for model evaluation due to the high number of stations within urban areas. Nevertheless, weaknesses related to data quality such as radiation errors must be considered during model evaluation. Furthermore, it is difficult to differentiate between micro-scale and local-scale effects on the measurement. Therefore, only the information derived from several stations is suitable for model evaluation. The full study has been published in the journal PLOS Climate and can be found at the following link: https://doi.org/10.1371/journal.pclm.0000197

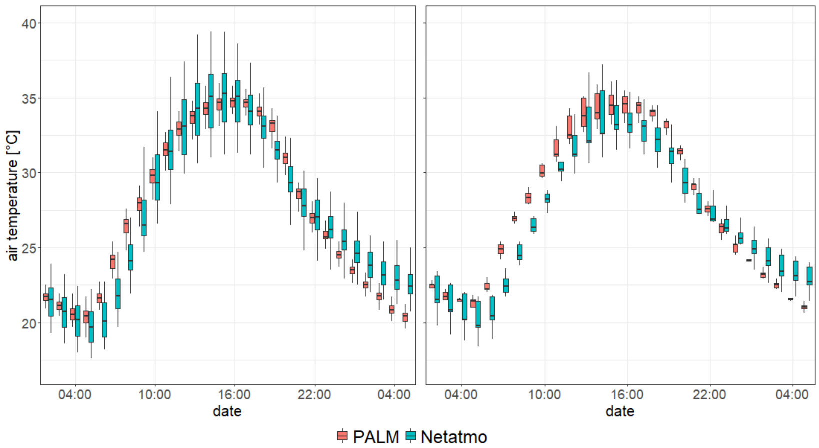

Fig. 2: Boxplot time series of the air temperature in °C at a height of 2 m from PALM4U and the measurement data from the private weather stations for the parent domain (left) and the child domain (right) for the investigation period from 08/08/2020 2:00 am to 08/09/2020 5:00 am

Literature

van der Linden, L.; Hogan, P.; Maronga, B.; Hagemann, R.; Bechtel, B. (2023): Crowdsourcing air temperature data for the evaluation of the urban microscale model PALM - A case study in central Europe. PLOS Clim 2 (8): e0000197

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