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1. Programme

Thursday, 22.10.2026

Welcome

12:00	Welcome Reception
13:00	Opening Remarks, Britta Jänicke

Session 1: Urban Climate Observations and Processes

Chair: Sascha Henninger

13:15	Vanessa Reinhart; Van de vrecken, Ella; Fedele, Giusy; Kittner, Jonas; Bechtel, Benjamin	Assessing the added value of Netatmo Data for Urban Climate Monitoring across European Cities
13:45	Celine Zangerl; Paeth, Heiko; Cantat, Olivier	Influence of Local Breezes on Urban Heat Island in Caen, France
14:15	Robin Borger; Leuchner, Michael	Assessing small-scale cooling effects of urban vegetation: Evaluating thermal inertia of mobile microclimate sensors
14:45	Coffee Break	

Session 2: Urban Climate Modelling

Chair: Shakir Ahmed

15:15	Niklas Stuhmann; Sülzer, Yannik; Marschner, Bernd; Stumpe, Britta	Tageszeitliche Dynamik der Kühlwirkung urbaner Grünflächen: Eine PALM-4U-Stadtklimasimulation des Berliner Tiergartens
15:45	Friederike Schäfer Roy, Etienne; Paeth, Heiko	SMART-TWIN: Modelling different spatial planning and climate scenarios of Würzburg using the urban climate model PALM-4U
16:15	Nisha Patel; Mackey, Lester; Zhong, Jian; Lu, Yanzhi; Jänicke, Britta et al.	Towards Fast Urban Climate Assessment using Data-Efficient Machine Learning Frameworks: A case study using ADMS-Urban at Birmingham, UK
16:45	Marius Sorgenfrei; Mölg, Thomas; Appelhans, Tim	Assessment of Urban Heat Stress on the TechFak Campus in Erlangen Using Field Measurements and Microclimate Modeling

Postersession

17:15	Postersession 1
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Evening Programme

18:45	Hotel Check-In (the rooms are available from 15:00)
19:00	Dinner
20:30	Meet & Mingle -Bingo

Friday, 23.10.2026

Session 3: Cloud Dynamics

Chair: Marco Otto

09:00	Olimpia Bruno; Dupuis, Sonia; Andersen, Hendrik; Cermak, Jan	The relationship between land surface temperature and ice fog and low clouds in the Arctic
09:30	Bhawuk Verma; Wallentin, Gabriella; Barthlott, Christian; Hoose, Corinna	Does secondary ice production modulate Mediterranean deep convective clouds across different aerosol regimes and terrain forcing?
10:00	Eva Pauli; Andersen, Hendrik; Nowack, Peer; Cermak, Jan	How does the land surface shape cloud occurrence? A neural network approach
10:30	Sheetabh Gaurav; Thies, Boris, Egli, Sebastian, Bendix, Jörg	A 30-year fog climatology across Europe based on harmonized data records from two Meteosat generations

Postersession (with Coffee)

11:00	Postersession 2
12:00	Lunch

Session 4: Climate Change Impacts

Chair: Ben Marzeion

13:00	Somayeh Ahmadpour; Trachte, Katja	Evapotranspiration-Driven Water Stress and Compound Drought-Heatwave Risks under Climate Warming in the Temperate Eastern German Lowlands
13:30	Napoleon Kabama; Tshimanga, Raphael M; Knight, Jasper, Bangelesa, Freddy; Rai, Praveen et al.	Integrated Assessment of Climate and Land-Use Change Impacts on Hydropower Generation in the Congo Basin under Future Scenarios.
14:00	Mostafa Sayeed; Trachte, Katja	Projected changes in energy, water and carbon dioxide dynamics under future climate change in an agroecosystem in eastern Germany
14:30	Coffee Break	

Coordination Meeting

15:00	Information on the Evening Programme
15:15	Coordination Meeting

Conference Diner

17:15	Evening at the UNESCO World Heritage Site Bergpark Wilhelmshöhe
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Saturday, 24.10.2026

Session 5: Climate and Health

Chair: Vanessa Reinhart

09:00	Clarissa Likidis Gäbel, Paul; Kaspar-Ott, Irena; Hertig, Elke	TOUCH – Temperatur, Ozon und urbane Einflussfaktoren auf die Gesundheit
09:30	Irena Kaspar-Ott; Sasse, Katharina; Álvarez, Fabio; Gäbel, Paul; Herrmann, Alina et al.	Atmosphärische Expositionsmuster und klimasensitive Gesundheitsversorgung im urbanen und ländlichen Bayern
10:00	Susanne A. Benz; Chawla, Jayati, Keller, Philipp	Comparing land surface temperature and air temperature for assessing socio-demographic inequalities in urban heat exposure: evidence from Germany
10:30	Coffee Break	

Session 6: Climate and Vegetation

Chair: Eva Pauli

11:00	Armin Hofmann Keupp, Luzia; Paeth, Heiko	Evaluation of past and future simulated Mildew in Bavarian vineyards using agricultural weather stations and regional climate models
11:30	Jeremias Gebhardt; Buermann, Wolfgang	How Data and Methodological Choices Affect Satellite-Based Estimates of Boreal Vegetation Resilience
12:00	Christopher Jung; Stahl, Kerstin; Schindler, Dirk	Raumzeitlich hochaufgelöste meteorologische Daten für Umweltfragen

Updates and Ending

12:30	Closing & Farewell	
13:00	Excursions (by prior registration)	
–	A: Wanderung durch den Bergpark	
15:00	B: Spaziergang durch Kassel – Auf den Spuren der Documenta	

Posters

Authors, Presenter	Title
Ahmed, Shakir; Gaußmann, Max-Jannick; Jänicke, Britta	A Comparative Analysis of Air Temperature and Mean Radiant Temperature Variability between Kassel and Trier based on observations from multiple weather stations
Alferink, Alice; Ganz, Henri; Vahdatinia, Farshad; Foken, Thomas; Niklas, Daniela; Ackermann, Leonie	Climate Walking: An App-Supported Citizen Science Approach
Auer, Isabel; Beck, Christoph; Traidl-Hoffmann, Claudia; Plaza, Maria P.	Identifizierung mikroskaliger Umweltrisikogebiete: Analyse multipler Umweltstressoren zur Verbesserung der städtischen Gesundheit
Bart, Frederik; Otto, Marco	Climatology of Urban Precipitation Effects in Berlin-Brandenburg
Beier, Christian; Trachte, Katja	Assessment of future changes to the Universal Thermal Climate Index (UTCI) under +2 and +3K global warming levels using ICON-CLM
Cheng, Ge; Nickel-Kuhn, Julia; Rutz, Andreas; Katzschner, Lutz; Schlünzen, K. Heinke	An Introduction to the VDI Standards on Urban Climate
Delgado-Maldonado, Byron; Schmidt, Benjamin; Scherer, Dieter; Bendix, Jörg; Turini, Nazli	Spatial Correlations between SST Patterns and Rainfall in the Galápagos Archipelago
Fenner, Daniel; Meier, Fred; Holtmann, Achim; Otto, Marco; Scherer, Dieter	Unprecedented warming over the past 30 years in Berlin, Germany, unaffected by urban effects
Gaurav, Sheetaab; Grigusova, Paulina; Schütz, Michaela; Bendix, Jörg	Integrating downscaled weather and air quality forecasts for predicting environmental related hospitalization risks
Gaußmann, Max-Jannick; Hilden, Frederik; Kulhavy, Jonas; Schmidt, Luigina; Francke, Angela; Jänicke, Britta	Physiologische Reaktion auf thermischen Diskomfort im urbanen Rad- und Fußverkehr
Gentsch, Thomas; Otto, Marco; Fenner, Daniel	A low-cost automated chamber for distributed soil CO ₂ efflux monitoring in heterogeneous urban landscapes
Grau, Leonie; Leitl, Bernd; Teichmann, Claas	Transport of heat at the neighbourhood scale: preliminary insights from PALM simulations in an urban environment
Grigusova, Paulina; Windhorst, David; Trachte, Katja; Bendix, Jörg	Ecuadorian Latent Heat Flux Projections through 2100
Haupt, Moritz; Poschlod, Benjamin; Huang-Lachmann, Jo-Ting; Linha, Amelie; Teichmann, Claas; Sillmann, Jana	A climate-model-informed framework for stress-testing urban critical infrastructure under extreme heat scenarios
Hertig, Elke; Anthonj, Carmen; Fahlbusch, Fabian; Hasan, Alkomiet; Keck, Markus; Kunz, Miriam; Lamy, Evelyn	GROW – Stärkung der Gesundheits-Resilienz junger Menschen in Städten in Zeiten von Klima- und Umweltveränderungen

Kittner, Jonas; Holtmann, Achim; Looschelders, Dana; Fenner, Daniel; Bechtel, Benjamin	The <i>ceilometer-toolbox</i> : streamlining state-of-the-art tools for seamless end-to-end processing and data management of LiDAR-ceilometer data
Lehmann, Angela; Sismanidis, Panagiotis; Bechtel, Benjamin	Elevation-dependent changes in the annual land surface temperature cycle across Arctic mountain ranges (2000–2020)
Mähner, Selina; Wolf, Luise; Bechtel, Benjamin; Rowell Hagemann	Nighttime cooling conditions in Dortmund: Development of an empirical potential model based on local site factors and comparison with KLAM_21
Mähner, Selina; Wawrzyniak, Nicolas; Grimm, Nils; Maurer, Swantje; Kittner, Jonas; Wolf, et al.	Spatiotemporal characteristics of the June 2026 heat wave in Dortmund and Bochum in a long-term context
Meier, Fred, Fenner, Daniel; Holtmann, Achim; Otto, Marco; Scherer, Dieter	The Urban Climate Observatory (UCO) Berlin for integrative research on atmospheric processes in cities
Müller, Pierre; Henninger, Sascha; Stopp, Benjamin	Using digital and AI-based tools to assess risks and potentials in urban climate-related issues
Otto, Marco; Trachte, Katja; Müller, Carsten; Farfan Flores, Dina; Baiker, Jan R.	CarBotAs – Understanding the Carbon-Water-Energy Nexus of High-Andean Wetlands
Philipps, Johanna; Schröer, Katharina	Compound risk from extreme convective events and drought
Rai, Praveen, Maharana, Pyarimohan; Pietikäinen, Joni- Pekka; Paeth, Heiko	Performance of a modernized RCM in capturing heatwaves and their impact on human discomfort over India
Remetter, Pascal; Leist, Leander; Hemp, Andreas; Bendix, Jörg	Thermal Patterns and Their Interactions with Land Use and Land Cover across Mt. Kilimanjaro's Altitudinal Gradient: Insights from a High-Resolution Multimodal Airborne Campaign
Richter, Erik	Reconstructing Urban Surface Temperatures: A Deep Learning Approach to Bridging Temporal Gaps in High-Resolution LST Data
Roy, Etienne; Schäfer, Friederike; Paeth, Heiko	SMART-TWIN: Integrating PALM-4U into a geospatial digital twin for urban climate planning
Rupp, Saskia; Leichtle, Tobias; Hiete, Michael; Beck, Christoph	Decoding Urban Heat Risk – Towards Multi-Scale Urban Heat Risk Typologies for Climate Adaptation
Sander, Leon; Matzarakis, Andreas; Christen, Andreas	Weltweite Globalstrahlung: Harmonisierte Kennzahlen aus qualitätskontrollierten Messzeitreihen
Schmidt, Benjamin; Scherer, Dieter; Trachte, Katja	GArua – From synoptic forcing to boundary layer response: cross-scale mechanisms of cloud and precipitation in a changing climate
Simon, Jonathan; Stocker, Max; Mahesh, Bhargavi; Brandl Samuel; Falkenrodt, et al.	Mobile microclimate and human physiological responses across urban forest structures
Wagner, Oakley; Bouwer, Laurens; Rechid, Diana; Conrad, Olaf; Böhner, Jürgen	Bridging the resolution gap: From convection-permitting climate models to high-resolution hydrological models using Random Forest
Wolf, Luise; Sismanidis, Panagiotis; Bechtel, Benjamin; Middel, Ariane	Evaluating Dortmund's SOLWEIG-based thermal comfort now-casting service

2. Abstracts

Session 1

Urban Climate Observations and Processes

Chair: Sascha Henninger

Presentation

Assessing the added value of Netatmo Data for Urban Climate Monitoring across European Cities

Reinhart, Vanessa¹, Van de vrecken, Ella², Fedele, Giusy³, Kittner, Jonas¹, Bechtel, Benjamin¹

1: Ruhr-Universität Bochum, Fakultät für Geographie und Geowissenschaften, Geographisches Institut, Bochum Urban Climate Lab, Bochum, Germany

2: B-Kode VOF, Belgium

3: CMCC Foundation – Euro-Mediterranean Center on Climate Change, via Marco Biagi, Italy

Citizen weather stations (CWS) have become an increasingly valuable complement to official meteorological observations by providing dense spatial coverage of urban environments. Their high spatial density offers considerable potential for monitoring urban climate variability and phenomena such as the urban heat island at resolutions that are difficult to achieve with conventional monitoring networks. However, the scientific value of these observations depends not only on the quality of individual measurements, but also on whether the resulting network remains representative of the diversity of urban environments after quality assurance and data filtering.

Within the Horizon Europe project CARMINE, we investigate the suitability of Netatmo citizen weather stations for characterising intra- and inter-urban climate variability across 8 European Case Study Areas (CSAs), selected for their diversity in climate risks, urban morphology, and socio-economic context. Using observations from dense CWS networks, we evaluate their agreement with nearby professional meteorological stations while simultaneously assessing how successive quality-control procedures and Local Climate Zone (LCZ)-based representativeness criteria influence network composition, spatial coverage, and the representation of different urban environments. The multi-city perspective enables the assessment of these aspects across different climates, urban morphologies, and network configurations, providing insight into the transferability of methodological approaches.

This study contributes to a comprehensive evaluation of dense CWS networks as a complementary source of urban climate observations. By combining comparisons between Netatmo and professional weather stations with assessments of spatial and environmental representativeness, we aim to identify both the opportunities and the limitations of crowdsourced observations for urban climate research, climate model evaluation, and operational climate services.

Presentation

Influence of Local Breezes on Urban Heat Island in Caen, France

Zangerl, Celine¹, Paeth, Heiko², Cantat, Olivier¹

1: University of Caen Normandie, Laboratoire IDEES, Caen, France,

2: Julius-Maximilians-Universität, Institute of Geography and Geology, Würzburg, Germany

The recent heatwaves have highlighted the challenges faced by populations exposed to the urban heat island (UHI). Local breezes can shape the spatial and temporal variability of the UHI, depending on the geographical context and the urban characteristics (*Oke et al., 2017*). This study investigates the role of these breezes in Caen, France, a medium-sized city located approximately 15 km from the English Channel.

This work is based on empirical data collected since April 2022. A network of 40 urban weather stations records air temperature, relative humidity, atmospheric pressure, and solar irradiance (MeteoHelix), as well as wind speed and direction (MeteoWind), at 10-minute intervals. The analysis focuses on periods with clear skies and low wind speed, favourable to the development of UHI and local breezes.

In general, daytime UHI remains limited (1.5–2°C), while nighttime UHI intensity can exceed 6°C between the city centre and surrounding rural areas, with a maximum intensity occurring between 23:00 and 00:00 UTC (*Cantat et al., 2024*). Compared to the city centre, urban weather stations located around the Hippodrome, a large open green space connecting the countryside to the city centre, experience a stronger nocturnal cooling. The onset of this cooling is progressively delayed with increasing distance from the Hippodrome. Wind observations at the Hippodrome and Louvigny (rural reference) stations indicate the advection of a cooler air mass from the southwest through this open corridor. This airflow may result from thermally driven circulations, such as coastal breezes, urban–rural breezes, and local topographic effects.

These findings highlight the importance of considering local thermally driven circulations and urban ventilation corridors when assessing urban climate and heat exposure. Future work combining these observations with PALM-4U simulations will further investigate these airflow patterns and their interactions with the urban morphology at finer spatial and temporal scales.

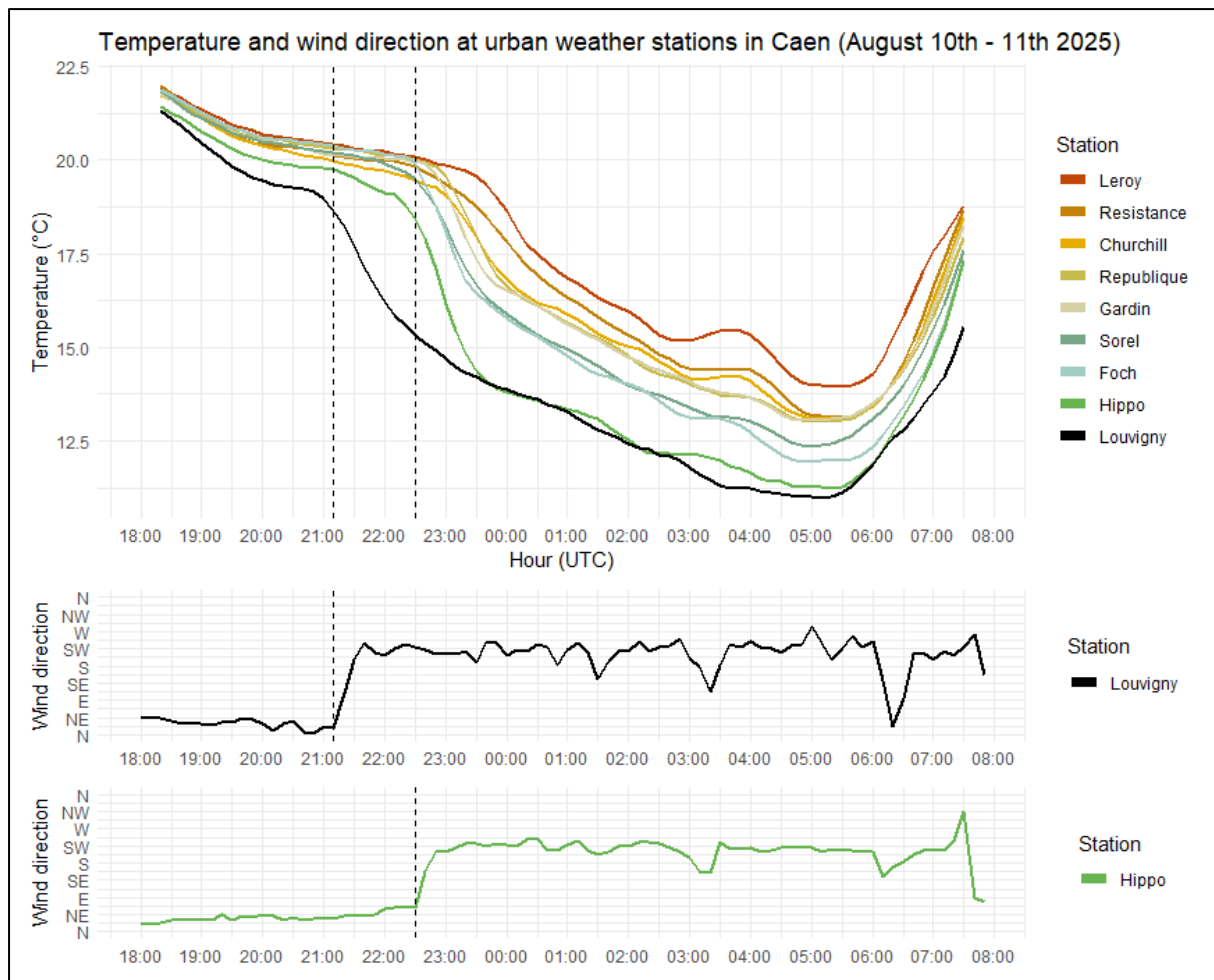


Figure 1 : Evolution of temperature and wind direction at urban weather stations in Caen during the night of 10–11 August 2025. Urban stations are ordered from the farthest (Leroy) to the closest (Foch) to the Hippodrome. Louvigny station, located outside the city in the southwestern direction, serves as the rural reference.

Reference :

Oke, T. R., Mills, G., Christen, A., Voogt, J. A., 2017 : Urban Climates. Cambridge University Press.

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Presentation

Assessing small-scale cooling effects of urban vegetation: Evaluating thermal inertia of mobile microclimate sensors

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Urban vegetation and blue-green infrastructure play a critical role in mitigating urban heat by providing localized microclimatic cooling, yet their efficacy is modulated by thermal inertia effects of mobile sensors during high-resolution measurements. High-resolution mobile transects are increasingly utilized to capture these fine-scale temperature patterns across heterogeneous urban landscapes. However, sensor thermal inertia presents a significant methodological challenge during mobile measurements across steep thermal gradients, often introducing spatial displacement and signal smoothing. This study presents a high-resolution, bicycle-based sensing methodology designed to quantify microclimatic cooling and empirically evaluate sensor response dynamics under dynamic real-world conditions. Mobile transects were conducted using a bicycle equipped with a Kestrel 5400 weather tracker recording meteorological parameters at 2-second intervals, combined with a high-frequency GNSS smartwatch logging 1-second positioning data. Spatial and meteorological datasets were aligned using a custom Python timestamp-matching pipeline. Initial lab experiments indicated a sensor response time of approximately 10 seconds. To rigorously validate this lag under real-world conditions, field calibration experiments were designed in the suburban stream valleys of Aachen, Germany. These topographically distinct channels exhibit sharp microclimatic transitions, featuring air temperature drops of up to 5 K relative to the surrounding built environment. Transects crossing the valley profiles were coupled with an array of stationary reference sensors deployed across the microclimatic gradient. By comparing mobile sensor trajectories with stationary reference measurements, sensor response dynamics were precisely quantified under realistic conditions. This integrated validation framework provides empirical grounds for sensor lag correction, ensuring high spatial data fidelity necessary for microclimate modeling, urban planning, and assessing human thermal exposure during physical activities.

Session 2

Urban Climate Modelling *Chair: Shakir Ahmed*

Presentation

Tageszeitliche Dynamik der Kühlwirkung urbaner Grünflächen: Eine PALM-4U-Stadtklimasimulation des Berliner Tiergartens

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Der städtische Wärmeinseleffekt stellt vor dem Hintergrund des Klimawandels eine zunehmende Belastung für dicht bebaute Stadtquartiere dar. Steigende Lufttemperaturen und häufigere Hitzeereignisse beeinträchtigen den thermischen Komfort und erhöhen insbesondere für vulnerable Bevölkerungsgruppen gesundheitliche Risiken. Urbane Grünflächen können zur Minderung dieser Wärmebelastung beitragen, indem sie sowohl innerhalb der Grünfläche als auch in angrenzenden Stadträumen thermische Entlastung bewirken. Bisherige Untersuchungen zu Kühlreichweite (Park Cooling Distance, PCD) und Kühlintensität (Park Cooling Intensity, PCI) urbaner Grünflächen, basieren jedoch vielfach auf fernerkundungsbasierten Analysen der Landoberflächentemperatur. Diese Ansätze sind hinsichtlich zeitlicher und räumlicher Auflösung sowie ihrer Aussagekraft für die tatsächlich empfundene Wärmebelastung mit Unsicherheiten verbunden. Ziel dieses Beitrags ist es, die tageszeitliche Dynamik der Kühlwirkung urbaner Grünflächen sowie deren Einflussfaktoren mithilfe einer PALM-4U-Stadtklimasimulation zu analysieren. Die Untersuchung erfolgt exemplarisch am Berliner Tiergarten und fokussiert insbesondere dessen nach außen gerichtete Kühlwirkung in die angrenzende städtische Umgebung. Für einen heißen Sommertag werden Oberflächentemperatur, Lufttemperatur und thermischer Komfort räumlich und zeitlich differenziert simuliert. Darauf aufbauend werden Kühlreichweiten und Kühlintensitäten im Tagesverlauf abgeleitet und potenzielle Einflussfaktoren statistisch geprüft. Ein besonderer Schwerpunkt liegt auf der erwarteten Diskrepanz zwischen der aus Oberflächentemperaturen bestimmten PCD und den aus Lufttemperatur sowie thermischem Komfort abgeleiteten Kühlreichweiten. Da es sich um ein laufendes Projekt handelt, stehen finale Ergebnisse noch aus. Erwartet wird ein differenzierter Erkenntnisgewinn zur tageszeitlichen Variabilität grüner Kühlleistung und zu den Faktoren, die deren Wirksamkeit beeinflussen. Im Vergleich zu rein fernerkundungsbasierten Ansätzen ermöglicht die Modellierung eine höhere zeitliche und räumliche Auflösung sowie die Berücksichtigung mehrerer thermischer Indikatoren. Der Beitrag leistet damit einen methodischen und anwendungsbezogenen Beitrag zur Bewertung grüner Infrastruktur als Maßnahme zur Minderung des urbanen Wärmeinseleffekts.

Presentation

SMART-TWIN: Modelling different spatial planning and climate scenarios of Würzburg using the urban climate model PALM-4U

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This work presents part of the EU-project “SMART-TWIN – AI-supported planning tool for a climate-adapted green urban development in Bavaria”.

Climate resilience in urban planning is becoming increasingly important, especially regarding the adaption to extreme weather events and mitigating of associated risks.

For a more sustainable and efficient urban and land-use planning, the SMART-TWIN project develops an AI-supported digital planning tool for the city of Würzburg. Main objective of the project is the extension of the existing digital twin by integrating the urban climate model PALM-4U. This tool enables local authorities and planning offices to simulate different scenarios for real or potential construction projects as well as modifications to green and blue infrastructure, and to assess their impacts on the urban climate, under both current and prospective (extreme) weather conditions. This way, planning processes can be carried out with greater precision, speed, and cost-efficiency.

As a practical contribution to the planning tool, we provide predefined simulations for typical urban planning scenarios, including the unsealing of parking areas, tree planting on squares and along major roads, changes in surface albedo, and the conversion of sealed areas into inner-city parks. Also, each planning scenario can be evaluated under different characteristic (extreme) weather conditions, including a heat day, a tropic night, and a day with intense solar radiation. To define the boundary conditions of these characteristic days, we use regional climate data provided by the NUKLEUS project at a spatial resolution of 3. The urban climate model then performs simulations at resolutions of 100 m, 10 m and 1 m, enabling a detailed assessment of urban climate impacts. The preliminary PALM-4U configuration and domain setup promise comprehensive results for the early identification of urban hotspots and urban heat island patterns and features the positive effect of shading and urban vegetation. Würzburg offers particularly suitable conditions for this project: its warm and dry climate, dense building structures, and low proportion of green spaces make the city a climate change hotspot in Central Europe.

Presentation

Towards Fast Urban Climate Assessment using Data-Efficient Machine Learning Frameworks: A case study using ADMS-Urban at Birmingham, UK

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Physics-based, high-resolution urban climate models provide physically rigorous representations of micro- and neighbourhood-scale urban environments. However, their computational expense, data intensity, and limited scalability constrain their use in rapid scenario analysis and operational planning. To address this, the present study proposes and evaluates two Machine Learning Frameworks (MLFs) with contrasting spatial philosophies for emulating urban climate scenarios. The first, a fine-resolution pixel-based framework (MLF1), resolves intraurban thermal heterogeneity at the pixel scale, while the second, a coarse-resolution tile-based framework (MLF2), compresses spatial information into learned embeddings to prioritise computational efficiency. Both frameworks were trained on outputs from the Atmospheric Dispersion Modelling System for urban environments (ADMS Urban), applied to Birmingham, United Kingdom, using a representative snapshot at 11:00 on 26 August 2019. To generate near-surface air temperature, surface input variables (i) thermal admittance, (ii) surface resistance to evaporation, (iii) albedo, (iv) surface roughness length, (v) normalised building volume, and (vi) terrain elevation have been used. Both frameworks reconstructed urban thermal patterns with high fidelity, though each revealed complementary strengths. MLF1 achieved superior accuracy under well-distributed training data, capturing localised hotspots and cooling corridors, while MLF2 remained more robust under data-limited conditions, at the cost of sub-tile detail. Spatial cross-validation showed that north-south partitioning of training data caused the greatest performance decline ($R^2 = 0.87 - 0.89$), revealing directional thermal heterogeneity. Notably, a randomly sampled 10% training subset matched or outperformed ($R^2 = 0.91 - 0.93$) spatially concentrated configurations, indicating that geographic representativeness can offset reduced local density (clustered samples). Gap-filling experiments confirmed that interpolation outperformed extrapolation, while RMSE- R^2 divergence showed that low error does not guarantee accurate spatial reconstruction. These findings support hybrid frameworks combining computational efficiency with spatial precision for scalable urban heat adaptation planning.

Presentation

Assessment of Urban Heat Stress on the TechFak Campus in Erlangen Using Field Measurements and Microclimate Modeling

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Due to global warming and the health risks caused by extreme heat exposure during summer heat waves, climate adaptation is becoming an increasingly important aspect of urban planning. Identifying heat stress hotspots in a given area is essential for using the resources available for climate adaptation as efficiently as possible.

The aim of this ongoing master's thesis project is to analyze the microclimate on the Technische Fakultät campus of the Friedrich-Alexander-Universität Erlangen-Nürnberg in order to identify the locations experiencing the highest heat stress. The results are intended to serve as a guideline for future climate adaptation measures.

The analysis consists of two main components: field measurements conducted at five different points of interest and a model-based analysis using the SOLWEIG microclimate model. The selected field locations include a courtyard, three highly sealed and sun-exposed locations, and a densely vegetated reference location. So far, measurements have been conducted on three days during the heat wave in late June 2026, each day twice during the fore- and afternoon. The measurements were taken using a Kestrel 5400 Heat Stress Tracker, which was left stationary at each point of interest for at least 10 minutes, capturing in a 10 second interval.

A preliminary analysis of the measurements revealed that the courtyard and the reference location may experience the highest heat stress among the five locations, as they exhibited the highest wet-bulb temperatures and the lowest wind speeds. Additionally, wind speed and air temperature appear to be strongly correlated, with more wind-sheltered locations experiencing higher air temperatures. Temperatures fluctuated up to 3°C during the 10 minute measuring periods, parallel to wind speed fluctuations.

Further analysis will include the calculation of the Physiological Equivalent Temperature (PET) and the Universal Thermal Climate Index (UTCI). The SOLWEIG modeling will provide spatial heat stress estimates across the entire area of interest, revealing potential additional hotspots.

Session 3

Cloud Dynamics

Chair: Marco Otto

Presentation

The relationship between land surface temperature and ice fog and low clouds in the Arctic

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Satellite observations indicate that ice fog and low-level ice clouds (ice FLCs) occur predominantly at latitudes above 60°N. Understanding changes in their spatial and temporal distribution is particularly important in the Arctic, where surface temperatures are increasing nearly four times faster than the global average due to Arctic amplification. This study investigates the Pan-Arctic region using cloud observations from CALIOP and surface-temperature measurements from MetOp-A over the period 2008–2020.

Our results reveal a predominantly negative correlation between ice FLC occurrence and surface temperature. An exception is observed over the ocean during the second winter half, when the two variables are positively correlated. This contrasting behaviour highlights the complexity of Arctic cloud processes. Temperature variations may affect relative humidity and aerosol properties, thereby influencing the availability of cloud condensation nuclei and ice-nucleating particles and, ultimately, the ice fraction of low-level clouds.

The largest changes, namely an increase in surface temperature and a decrease in ice FLC, are observed in April and October, i.e., the main transition months between winter and summer conditions. This finding is consistent with a shortening of the Arctic winter season. Future work will quantify the impact of the observed changes in ice FLCs on the Earth's energy budget.

Presentation

Does secondary ice production modulate Mediterranean deep convective clouds across different aerosol regimes and terrain forcing?

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Secondary ice production (SIP) can substantially modify mixed-phase cloud microphysics, yet its role in aerosol–orography interactions within deep convection remains poorly constrained. We investigate this interplay using 48 convection-permitting ICON simulations at 1 km horizontal resolution for three real-case events over Corsica and Sardinia. The simulations combine reference and reduced 1 km orography, four cloud condensation nuclei (CCN) concentrations ranging from maritime to continental–polluted conditions, and configurations with SIP mechanisms switched on and off. The precipitation response to terrain height and aerosol loading is strongly non-linear and case dependent. Reduced orography generally produces warmer, moister, and more unstable pre-convective conditions, but does not consistently enhance precipitation. Collisional breakup is the dominant SIP mechanism, with maximum rates several orders of magnitude greater than rime splintering and droplet-shattering. Including SIP changes 24 h accumulated total precipitation by –38% to +144%, with the strongest enhancements under maritime and intermediate CCN conditions; under continental and continental–polluted conditions, the response weakens or reverses. SIP also modifies surface precipitation composition: at low CCN concentrations, the hail contribution decreases from 20–50% in SIP-Off simulations to 5–15% in SIP-On simulations, while the rain fraction increases. In two cases, enhanced riming and subsequent melting explain the increase in surface rain at low CCN concentrations, whereas in the remaining case reduced sub-cloud evaporation provides an alternative pathway. Overall, SIP modulates the orography–CCN interactions; however, the magnitude and direction depend strongly on CCN concentration and, to a lesser extent, on terrain height.

Presentation

How does the land surface shape cloud occurrence? A neural network approach

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The land surface impacts clouds through its influence on surface turbulent heat fluxes, local moisture availability and surface roughness. However, quantifying these effects from observations remains challenging: the temporal and spatial variability of cloud occurrence is large, land surface signals are often confounded by meteorological influences, and the relevant drivers interact nonlinearly. The aim of this study is to investigate the effect of land surface conditions on local cloud occurrence given the same large-scale meteorological conditions through a data-driven neural network approach.

To this end, we develop a process-oriented framework to quantify the contribution of land surface conditions to cloud occurrence over Europe (2004–2024) based on satellite observations. We employ a convolutional neural network (CNN) to predict daily satellite-observed cloud fraction at 12 UTC from the CM SAF CLOUD property dAtAset using SEVIRI (CLAAS) using predictors derived from the ERA5 reanalysis, including ERA5–Land variables and atmospheric fields on single and pressure levels.

To isolate the contribution of land surface conditions to cloud occurrence predictability, we develop two model configurations: one driven solely by large-scale meteorological conditions (CNN_{Atmo}), and a second one that additionally incorporates meteorological conditions in the boundary-layer and land surface variables such as near-surface temperature, humidity and wind conditions and surface turbulent heat fluxes ($\text{CNN}_{\text{Atmo+Land}}$).

Over the study period, the $\text{CNN}_{\text{Atmo+Land}}$ model achieves R^2 values up to 0.2–0.4 higher than the atmosphere-only model on individual days. Overall predictive skill ranges from 0.52 when evaluated over all pixels to 0.57 when evaluated over land-only pixels for $\text{CNN}_{\text{Atmo+Land}}$ compared to 0.48 and 0.52, respectively, for CNN_{Atmo} . The CNN exhibits greater skill in capturing spatial variability (mean daily R^2 of 0.49 for $\text{CNN}_{\text{Atmo+Land}}$) than temporal variability (mean pixel-wise R^2 of 0.41). However, the temporal variability is better captured by $\text{CNN}_{\text{Atmo+Land}}$ than by CNN_{Atmo} , particularly over the central part of the study domain encompassing Germany, Poland, and the Czech Republic. These results demonstrate a measurable contribution of land-surface information to cloud occurrence predictability, with the magnitude of this contribution likely varying with season and synoptic conditions.

This framework provides an observationally constrained approach to quantify the impact of land-atmosphere interactions on cloud occurrence. The model can be easily adjusted to predict clouds over the diurnal cycle and establishes a transferable methodology to assess how land cover change may modify cloud patterns.

Presentation

A 30-year fog climatology across Europe based on harmonized data records from two Meteosat generations

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Fog and low clouds act as a cooling engine for the warming Earth's atmosphere by regulating the incoming solar radiation and reflecting sunlight back to space, thereby influencing surface energy balance. Long-term analyses of fog occurrence based on ground station data suggest a decline in fog frequency over Europe since the 1960s. However, these findings are limited by sparse spatial coverage of ground-based observations, which are predominantly located in low-altitude regions. Hence, a satellite-based fog dataset providing spatially coherent fog distribution across Europe is essential. To have this kind of long-term satellite-based fog dataset, two Meteosat generation datasets, i.e. Meteosat First (MFG) and Second Generation (MSG) are harmonized using a machine learning based Random Forest model, to generate a synthetic one-generation homogeneous MFG dataset (1991–2020). The ground fog classification scheme employs the harmonized MFG thermal Infrared (IR, 10.5–12.5 μm) and Water Vapour (WV, 5.7–7.1 μm) channels with visibility data obtained from ground station observations (METAR and SYNOP records) using a machine learning based eXtreme Gradient Boosting (XGBoost) regression model. Cross-validation scores results demonstrate a good agreement with the observational data with R^2 score of 0.47. Here, we present a spatially continuous, satellite-based analysis of winter fog occurrence across Europe from 1991 to 2020.

A widespread declining winter fog trend is observed across much of Europe, particularly in western and central Europe, with declines more pronounced over the British Isles, north-western to central European lowlands and the Po Valley region in Italy. In contrast, localized increasing trends in winter fog occurrences are observed in south-western Europe, mainly across the Iberian Peninsula in Spain and Portugal, as well as parts of southwest France. The observed fog trends are linked to variations in near-surface atmospheric conditions, with a negative association (Pearson correlation coefficient $r = -0.51$, $p = 0.004$) between fog occurrence and saturation deficit indicating near-surface drying plays an important role in shaping European fog trends.

Session 4

Climate Change Impacts

Chair: Ben Marzeion

Presentation

Evapotranspiration–Driven Water Stress and Compound Drought–Heatwave Risks under Climate Warming in the Temperate Eastern German Lowlands

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Evapotranspiration (ET) is process through which water moves from the Earth's surface into the atmosphere. It plays a key role in the climate system as it regulates the exchange of energy between the land and the atmosphere. Because ET depends on both water availability and atmospheric conditions, the most accurate measurement is essential for assessing and understanding ecosystem responses to climate change, and maintaining the balance of global water and energy. Brandenburg is one of the driest regions in Germany, with a negative, declining water balance, indicated by a potential ET (PET) exceeding precipitation levels. Recently, the region has experienced severe summer droughts and water shortages between 2018 and 2022 associated with an increased variability in both precipitation and evaporation that further affects drought conditions. Therefore, information on present–day and future ET variability is crucial for estimating potential drought conditions and the development of effective water management in this region.

This study aims to assess future changes in ET and water availability across Brandenburg, Germany, under +2K and +3K global warming levels (GWL). A multi–model ensemble of regional climate projections, combining the GCMs EC–Earth, MIROC, and MPI with the RCM ICON–CLM, is used to understand how warming–driven shifts in the water balance lead to greater agricultural drought stress and compound climate extremes. Specifically, we aim to (i) characterize projected changes in actual and ET and growing–season water deficit relative to the historical baseline across different warming levels, (ii) assess how ET–driven changes in soil moisture (SM) and water balance conditions change the frequency, intensity, and spatial extent of meteorological and hydrological drought across the region, and (iii) examine the co–occurrence of drought conditions with heatwave events as compound extremes, and evaluate how the interplay between increased evaporative demand and moisture deficits increases agricultural water stress under global warming.

The results show a robust and statistically significant increase in CDHW frequency, severity, and spatial extent across both warming scenarios, with significantly greater changes under +3K warming. Precipitation–driven (CMDH) and SM–driven (CSDH) compound events become increasingly frequent throughout the 21st century, with trends accelerating during the second half of the century (2050–2099). Meteorological droughts result in SM deficits after a lag of 1 to 3 months, with warming amplifying this relationship and increasing drought stress during the growing season. Gaussian copula analysis shows that compound drought–heatwave risks rise faster than individual extremes, with historically rare events becoming common under +3K warming.

Presentation

Integrated Assessment of Climate and Land-Use Change Impacts on Hydropower Generation in the Congo Basin under Future Scenarios.

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The Congo Basin represents one of the world's largest freshwater systems and holds exceptional hydropower potential, positioning it as a strategic pillar of Africa's renewable energy future. However, hydropower generation is highly dependent on the availability and variability of water resources, which are shaped by both climate change and land-use dynamics. Changes in precipitation patterns, temperature, evapotranspiration, and land surface characteristics may substantially alter the basin's hydrological regime, with direct consequences for the reliability of hydropower production.

This study assesses the combined impacts of climate change and land-use change on hydropower generation in the Congo Basin under the climate scenario, over the 2050 and 2100 horizons. An integrated modelling framework is developed, combining high-resolution climate projections for the Congo Basin, based on CORDEX-CORE simulations and an updated REMO2020-iMOVE model runs with land-use change scenarios and the SWAT-WEAP hydrological modelling approach. Variations in key hydro-climatic variables, including precipitation, temperature, evapotranspiration, runoff, and river discharge, are evaluated across the major sub-basins of the Congo River for both projection horizons. The resulting hydrological projections are then translated into hydropower generation indicators to assess potential changes in energy production, seasonal variability, and the vulnerability of hydropower resources under the projected 2050 and 2100 conditions.

Attention is given to how the interplay between climate-driven changes and land-use transformations may affect the water availability underpinning major hydropower developments, including the Inga hydropower complex. By integrating climate, land surface, hydrological, and energy perspectives, this research offers a comprehensive assessment of the challenges and opportunities for hydropower development in Central Africa by mid and end century.

As the research is ongoing, this presentation will focus on the integrated SWAT-WEAP based methodological framework, modelling strategy, and expected contributions to a deeper understanding of future climate and land-use change impacts on the Congo Basin's hydro-energy system. The findings are expected to support climate-informed energy planning and the design of resilient hydropower strategies in one of the world's most significant river basins.

Presentation

Projected changes in energy, water and carbon dioxide dynamics under future climate change in an agroecosystem in eastern Germany

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Climate change is one of the most serious problems affecting the world, driven primarily by increasing anthropogenic greenhouse gas (GHG) emissions. Among these GHGs, atmospheric CO₂ has strong influence on global energy and carbon balance and is the main driver of global warming. Agricultural ecosystems are particularly important in this context because of their role in capturing carbon from atmosphere and food production. Gross primary production (GPP) represents the total amount of atmospheric CO₂ absorbed by vegetation through photosynthesis. It reflects the ecosystem's capacity to offset anthropogenic CO₂ emissions and serves as a key indicator of ecosystem responses to climate change. Understanding GPP dynamics in agroecosystems, particularly in climatological-sensitive regions such as Brandenburg in eastern Germany, is therefore essential for elucidating carbon dynamics and ecosystem responses to climate change. However, GPP dynamics in this region are highly sensitive to ongoing climate change and to associated extreme events such as flash droughts. Yet how future climate will influence the GPP dynamics in this region remains unclear.

This study examines projected changes in GPP, sensible heat (H), latent heat (LE), and evapotranspiration (ET) during the growing season in an irrigated agroecosystem under four CMIP6 Shared Socioeconomic Pathway (SSP) scenarios to the end of the 21st century, using the Community Land Model version 5.0 (CLM5). The simulated fluxes were compared with eddy covariance (EC) data to evaluate the performance of the model. A Random Forest (RF) model was subsequently applied to identify the dominant environmental controls on GPP. Model evaluation showed that CLM5 reproduced the seasonal dynamics of ecosystem fluxes reasonably well, although simulated peaks of GPP, LE, and ET occurred earlier than observed, indicating structural limitations in representing crop phenology. Future projections showed consistent reductions in H, LE, and ET across scenarios, mainly associated with reduced net radiation (R_n). Growing-season GPP decreased under SSP1–2.6 but increased under SSP2–4.5, SSP3–7.0, and SSP5–8.5, with the strongest increase under SSP3–7.0. GPP increased in spring and summer but declined in autumn, while summer GPP remaining nearly unchanged under SSP5–8.5. RF analysis identified water (LE, ET) and energy (R_n) availability as the dominant controls of GPP in spring and summer, whereas R_n and vapor pressure deficit (VPD) became more important in autumn. These findings underscore the pivotal role of seasonal climate variability in regulating future agricultural carbon uptake in this region.

Session 5

Climate and Health
Chair: Vanessa Reinhart

Presentation

TOUCH – Temperatur, Ozon und urbane Einflussfaktoren auf die Gesundheit

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Städtische Hitze und Luftverschmutzung durch Ozon stellen gemeinsam zunehmende Risiken für die menschliche Gesundheit dar, insbesondere vor dem Hintergrund des fortschreitenden Klimawandels. Bodennahe Ozonkonzentrationen werden maßgeblich durch die Verfügbarkeit von Vorläufersubstanzen, meteorologische Bedingungen, städtische Strukturen und atmosphärenchemische Prozesse beeinflusst. Trotz seiner hohen Relevanz ist die kleinräumige räumliche Variabilität der Ozonkonzentrationen innerhalb von Städten bislang nur unzureichend untersucht.

Ziel dieser Studie ist es, die räumliche und zeitliche Variabilität der Ozonbelastung im Stadtgebiet Augsburg hochauflösend zu erfassen und flächendeckend abzubilden. Zudem soll untersucht werden, ob sich Hotspots der gemeinsamen lufthygienischen und thermischen Belastung identifizieren lassen. Hierzu wird ein urbanes Messnetzwerk aus elf Low-Cost-Sensor-Messboxen und drei stationären Referenzmessstationen verwendet. Die Messstandorte wurden gezielt so ausgewählt, dass unterschiedliche städtische Strukturen und Local Climate Zones (LCZs) repräsentiert werden und damit die innerstädtische Variabilität der Ozonkonzentrationen und der Temperaturen erfasst werden kann.

Auf Grundlage der kontinuierlichen Messungen wird der maximale tägliche 8-Stunden-Mittelwert der Ozonkonzentration (MDA8) als Zielvariable abgeleitet. Für die flächendeckende Modellierung werden ein Random-Forest-Ansatz sowie Generalized Additive Mixed Models entwickelt, in dem räumliche und zeitliche Einflussgrößen differenziert berücksichtigt werden. Dadurch sollen sowohl kleinräumige räumliche Unterschiede innerhalb des Stadtgebiets als auch zeitliche Schwankungen der Ozonbelastung abgebildet werden. Die räumliche Übertragbarkeit des Modells wird mittels Leave-one-station-out Cross-Validation evaluiert. Das validierte Modell wird anschließend auf flächendeckend verfügbare Prädiktorenraaster übertragen, um hochaufgelöste räumlich-zeitliche Ozonkonzentrationen für das gesamte Stadtgebiet Augsburg abzuschätzen.

Ergänzend werden die räumlich-zeitliche Temperaturverteilung in Augsburg sowie der Einfluss meteorologischer Bedingungen mittels Mixed-Effects-Modellen unter Berücksichtigung von Unterschieden zwischen den Local Climate Zones (LCZs) untersucht.

Die resultierenden Expositionskarten bilden die Grundlage für weiterführende Analysen urbaner Belastungsmuster sowie für die Abschätzung der individuellen Temperatur- und Ozonexpositionen im Rahmen gesundheitsbezogener Untersuchungen.

Presentation

Atmosphärische Expositionsmuster und klimasensitive Gesundheitsversorgung im urbanen und ländlichen Bayern

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Der Klimawandel wirkt sich nicht nur über Hitze auf die menschliche Gesundheit aus, sondern auch über Veränderungen der Luftqualität, der Temperaturvariabilität und hydrometeorologischer Bedingungen. Im AdaptNet-Projekt untersuchten wir, wie sich gesundheitsrelevante atmosphärische Einflussfaktoren zwischen zwei kontrastierenden Regionen in Bayern unterscheiden: der urban geprägten Region Nürnberg und dem ländlichen Landkreis Ansbach. Ziel war es, regionale Expositionsmuster, ihre zeitliche Dynamik und besonders vulnerable Bevölkerungsgruppen zu identifizieren.

Wir verwendeten Daten der gesetzlichen Krankenversicherung AOK Bayern für den Zeitraum 2016–2022, darunter stationäre Krankenhausaufnahmen und ambulante Versorgungsdaten zu kardiovaskulären, respiratorischen, metabolischen, renalen und psychischen Erkrankungen. Diese Daten wurden mit meteorologischen und luftqualitätsbezogenen Beobachtungen aus regionalen Messnetzen verknüpft. Drei komplementäre analytische Ansätze wurden angewendet: nichtparametrische Mann-Whitney-U-Tests zur Erkennung atmosphärischer Anomalien vor oder während Tagen mit hohen stationären Aufnahmezahlen, generalisierte additive Modelle zur Untersuchung linearer und nichtlinearer täglicher Expositionen–Wirkungs–Beziehungen sowie von Lag-Strukturen, und standardisierte relative Risiken auf Basis quartalsweiser ambulanter Daten zur Bewertung saisonaler Morbiditätsmuster.

Über die verschiedenen Methoden hinweg zeigten sich konsistente Zusammenhänge, insbesondere für kardiovaskuläre und respiratorische Erkrankungen. Ein zentrales Ergebnis war der deutliche Stadt–Land–Kontrast hinsichtlich der dominierenden atmosphärischen Einflussfaktoren. In Nürnberg war Luftverschmutzung über alle analytischen Ansätze hinweg der prominenteste Prädiktortyp, was auf eine starke Rolle urbaner, schadstoffbezogener Expositionen hinweist. Auch temperaturbezogene Effekte wurden konsistent beobachtet, was darauf hindeutet, dass thermischer Stress als zusätzlicher, übergreifender urbaner Einflussfaktor wirkt. Im Gegensatz dazu zeigte der Landkreis Ansbach ein anderes Muster: Hydrometeorologische und thermische Variablen, darunter Niederschlag, Luftfeuchtigkeit, Temperaturvariabilität und Kälteexposition, traten insbesondere in den Analysen der stationären Behandlungen stärker hervor. Diese regionalen Unterschiede waren über die Methoden hinweg stabil, was darauf hindeutet, dass sie tatsächliche Unterschiede in den atmosphärischen Expositionsregimen widerspiegeln und nicht auf methodische Artefakte zurückzuführen sind.

Die zeitliche Struktur der Effekte unterschied sich je nach Prädiktortyp. Luftverschmutzung wirkte vor allem als akuter Auslöser, mit Effekten, die sich auf Lags von 0–2 Tagen konzentrierten,

während temperaturbezogene Prädiktoren breitere Lag-Strukturen über mehrere Tage hinweg aufwiesen. Hydrometeorologische Variablen waren häufiger mit verzögerten Effekten verbunden, wobei die Zusammenhänge um Lags von 5-7 Tagen ihren Höhepunkt erreichten. Darüber hinaus zeigten sich deutliche altersspezifische Unterschiede: Signifikante Zusammenhänge traten vor allem bei Personen ab 65 Jahren auf, während sich bei Kindern und Jugendlichen weniger konsistente Signale zeigten.

Die Ergebnisse unterstreichen, dass klimawandel-sensitive Inanspruchnahme von Gesundheitsversorgung durch regionale Expositionsregime und zeitliche Lag-Strukturen geprägt wird. Eine geographisch differenzierte Perspektive ist daher wesentlich, um zu verstehen, wie sich atmosphärische Prozesse in gesundheitliche Auswirkungen übersetzen.

Presentation

Comparing land surface temperature and air temperature for assessing socio-demographic inequalities in urban heat exposure: evidence from Germany

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Urban heat exposure is an increasing challenge, intensified by climate change and urbanization with growing implications for social equity. Environmental justice research emphasizes that the impacts of environmental burdens are not distributed equally, yet evidence on the spatial distribution of heat exposure across different population groups remains fragmented specially for Global North. Most existing studies focus on individual cities or metropolitan regions, limiting the understanding of whether observed inequalities represent local phenomena or broader national patterns. Moreover, studies commonly rely on either land surface temperature (LST) or air temperature, despite these metrics capturing distinct dimensions of urban heat.

This study presents the first nationwide assessment of socio-demographic inequalities in urban heat exposure across Germany. We integrate satellite-derived LST and air temperature data with gridded census information to analyze patterns across urban, suburban, and rural contexts, as well as across daytime and nighttime periods; to assess whether specific population groups are disproportionately affected by higher temperatures.

Our results reveal persistent inequalities linked to nationality, with foreign populations more frequently residing in warmer areas. In over 84% of cities analyzed, districts with higher shares of foreign residents experience significantly elevated nighttime air temperatures. Furthermore, over half of the cities show significant disparities affecting foreign populations across both LST and air temperature measures. Variations between daytime and nighttime exposure, as well as between temperature metrics, underscore the importance of methodological choices in evaluating heat-related environmental justice.

By identifying spatial patterns of vulnerability, this study provides evidence to inform targeted mitigation strategies and supports more equitable climate adaptation and urban planning in Germany.

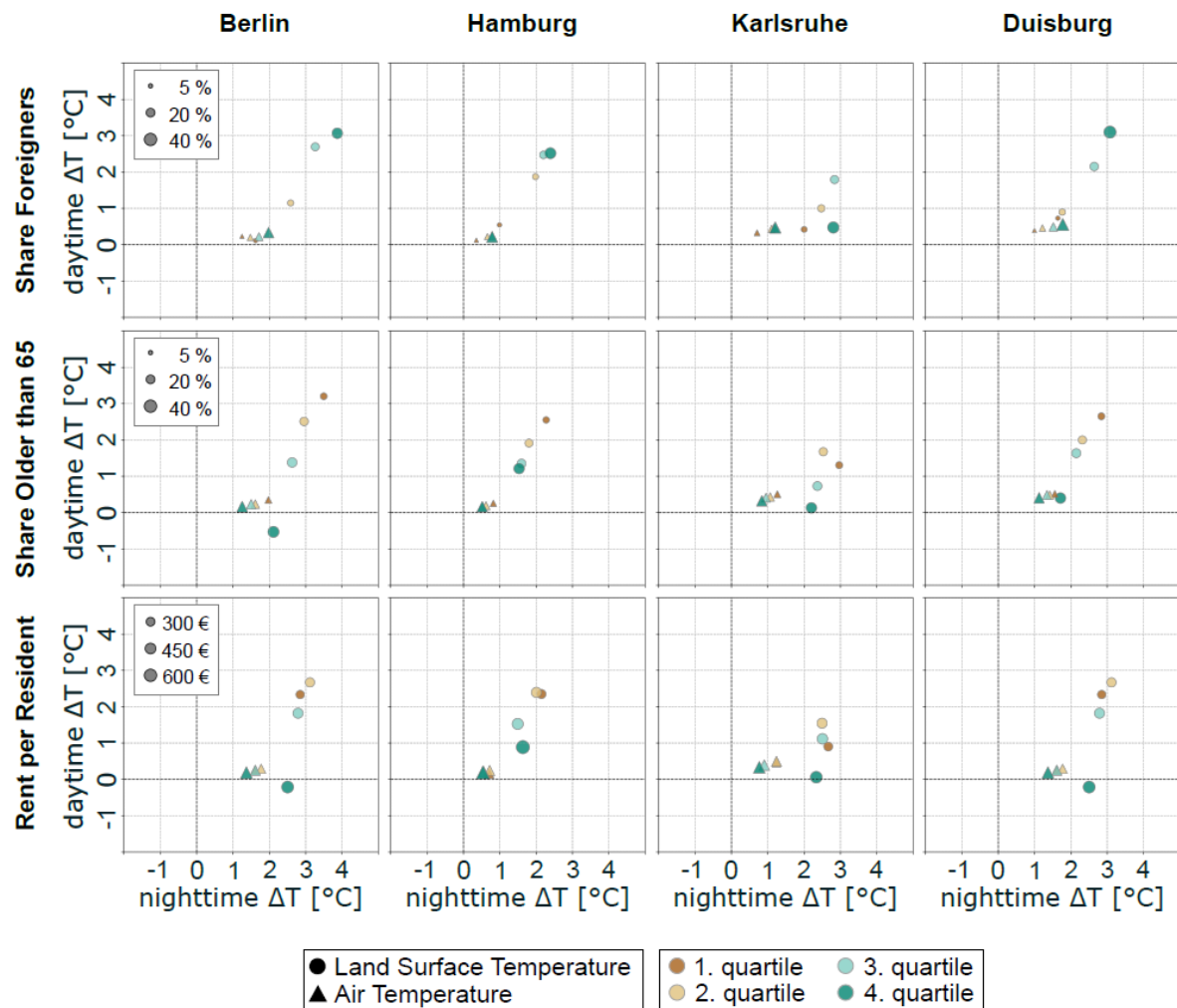


Figure: Temperature distribution across different socio-demographic variables. The distribution is shown for the four example districts for both LST and Air Temperature measurements. The ΔT [°C] for nighttime temperature is depicted by x-axis and daytime temperature is displayed across y-axis. Each dot represents one quartile. The quartiles are calculated separately for every variable and city. The dot size corresponds to the mean value of the displayed quartile. Source: Chawla et al. (2026), Environmental Research Letters. <https://doi.org/10.1088/1748-9326/ae929e>

Session 6

Climate and Vegetation

Chair: Eva Pauli

Presentation

Evaluation of past and future simulated Mildew in Bavarian vineyards using agricultural weather stations and regional climate models

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Climate crisis increases the accommodation pressure on the ecosystems and agriculture.

A simulation of the life cycle of *Plasmopara viticola* – the pathogen causing downy mildew on grapevine – based on regional climate model (RCM) output is conducted and evaluated to give an estimate on future pest pressure. The boundary condition is given by REMO2015 using an ensemble of two global drivers. The mechanistic model described in Rossi et al. (2008) is slightly modified and scaled to the spacial domain of Bavaria. Hourly data is evaluated for the simulation.

The model data, especially the drizzle effects that are inherent to all climate model's precipitation data, but rendering the *plasmopara viticola*'s cohort simulation unusable, are bias-corrected with the detrended quantile mapping method. For that, hourly data of Bavarian agricultural weather stations are used. Where applicable, 10 minute time steps are aggregated. Due to the former spatial sparseness and only recent deployment of parts of the station network, 83 viable sample locations are investigated. It is necessary for most locations to reduce the historical time frame to 20 years and extend it 5 years over the historical RCM time period into the scenario period until 2010. Current vineyard locations and wine regions are referenced to contextualise the sample locations. The simulation allows for trend calculation of the population in three different stages of the life cycle and a detailed analysis of the developmental conditions. It gives a detailed insight regarding risks and chances for future pest management. Validation with observed pest pressure can be only done indirectly since in Bavaria plant protection measures are strictly used before mildew epidemics start. Further comparisons between historical model data and station data are used to validate the transfer step between model and station data. An estimation about the transferability to other mildews and pests relies on expert knowledge.

Reference:

Rossi, V., Caffi, T., Giosuè, S., & Bugiani, R. (2008). A mechanistic model simulating primary infections of downy mildew in grapevine. *Ecological Modelling*, 212(3-4), 480-491. <https://doi.org/10.1016/j.ecolmodel.2007.10.046>

Presentation

How Data and Methodological Choices Affect Satellite-Based Estimates of Boreal Vegetation Resilience

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The Arctic-Boreal Zone is warming considerably faster than the global average, with major consequences for vegetation dynamics, disturbance regimes, carbon cycling, and climate feedbacks. Boreal ecosystems store large amounts of carbon, but their responses to warming are spatially heterogeneous. While some regions show increasing vegetation activity, others experience browning, drought stress, fire damage, insect outbreaks, or structural vegetation change. Assessing whether these ecosystems can resist and recover from such pressures is therefore essential. However, quantifying vegetation resilience from satellite observations is particularly difficult in the Arctic-Boreal Zone because of limited data availability, strong seasonality, persistent cloud and snow cover, and relatively short observation periods. Existing studies also differ substantially in their choice of Earth observation datasets, preprocessing procedures, temporal resolution, and resilience indicators, which may partly explain contrasting reported trends. In this study, we compare multiple satellite datasets and several approaches for estimating vegetation resilience across the Arctic-Boreal Zone. These include commonly used statistical indicators such as temporal autocorrelation and variance, empirically estimated recovery rates following disturbances such as wildfires, and a recently developed eigenvalue-based resilience indicator. We assess the consistency of these approaches and evaluate how strongly the resulting resilience estimates depend on the selected dataset and methodological choices. Based on this comparison, we aim to identify robust approaches for large-scale resilience assessment in boreal ecosystems. The most suitable approach will subsequently be used to map spatial and temporal patterns of vegetation resilience and to attribute observed changes to potential climatic and disturbance-related drivers.

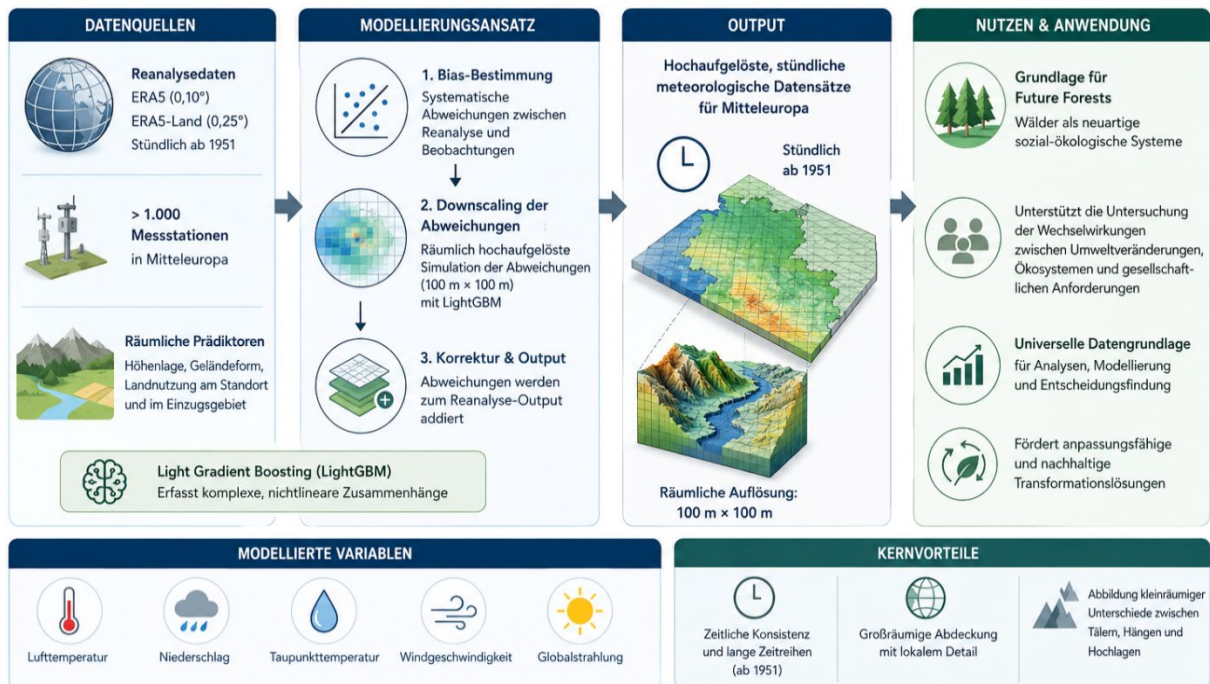
Presentation

Raumzeitlich hochaufgelöste meteorologische Daten für Umweltfragen

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Das Exzellenzcluster Future Forests untersucht Wälder als neuartige sozial-ökologische Systeme und entwickelt eine Basis für anpassungsfähige und nachhaltige Transformationslösungen. Eine zentrale Voraussetzung für die Umsetzung der Clusterziele sind meteorologische Daten, die klimatische Bedingungen auch auf kleinstem räumlichen Maßstab abbilden. Daher werden konsistente meteorologische Datensätze mit einer räumlichen Auflösung von 100 m × 100 m und einer zeitlichen Auflösung von einer Stunde ab 1951 in Mitteleuropa entwickelt. Als Grundlage dienen stündliche ERA5- und ERA5-Land-Reanalysedaten mit einer Auflösung von 0,10° bzw. 0,25° sowie Beobachtungen von mehr als 1.000 meteorologischen Messstationen in Mitteleuropa. Mithilfe statistischer Downscaling-Verfahren werden die großräumigen Informationen räumlich verfeinert und mit lokalen Eigenschaften der Landschaft verknüpft. Berücksichtigt werden unter anderem Höhenlage, Geländeform und Landnutzung am Standort sowie dessen Einzugsgebiet. Die Modellierung basiert auf einem Light Gradient Boosting-Ansatz. Zunächst werden systematische Abweichungen zwischen den Reanalysedatensätzen und Beobachtungen ermittelt. Diese Abweichungen werden anschließend räumlich hochaufgelöst simuliert und zum Output der Reanalyse addiert. Der Ansatz verbindet damit die zeitliche Konsistenz und großräumige Abdeckung der Reanalysedaten mit der lokalen Information von Messungen und räumlichen Prädiktoren. Dadurch können komplexe, nichtlineare Zusammenhänge berücksichtigt und kleinräumige Unterschiede zwischen Tälern, Hängen und Hochlagen abgebildet werden. Die Modellierung wird für Lufttemperatur, Niederschlag, Taupunkttemperatur, Windgeschwindigkeit und Globalstrahlung umgesetzt. Die entstehenden Datensätze ermöglichen eine universelle Grundlage für die Analyse lokaler klimatischer Bedingungen und unterstützen die Untersuchung der Wechselwirkungen zwischen Umweltveränderungen, Ökosystemen und gesellschaftlichen Anforderungen.



Raumzeitlich hochaufgelöste meteorologische Daten für Umweltfragen.

Poster Abstracts

Poster

A Comparative Analysis of Air Temperature and Mean Radiant Temperature Variability between Kassel and Trier based on observations from multiple weather stations

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Urban structure, vegetation and thermal characteristics can strongly influence temperature variability, particularly between daytime and nighttime conditions in an urban environment. In this study, we examined air temperature (T_a) and mean radiant temperature (MRT) variability between two selected cities in Germany (Kassel and Trier) during a recent heat wave period. We compared the datasets using statistical measures such as mean, standard deviation, diurnal temperature range and location of weather stations in both cities. We identified the influence of urbanization, urban heat island (UHI) effect and local climatic conditions during the comparative analysis of the T_a and MRT observations. Our results indicated that the location of the weather station and microclimate factors such as ground surface typology, radiation, the height of nearby trees, buildings, and vegetation, along with wind patterns, influence air temperature observation values. The results of this study will help in understanding urban thermal patterns and the importance of careful site selection of a weather station in an urban environment.

Poster

Climate Walking: An App-Supported Citizen Science Approach

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As part of the City of Bamberg's 'MitMachKlima' initiative, climate walks have become an established educational offering for residents. As a low-threshold citizen science approach, they are designed to increase public understanding of local climate and urban climate effects. During climate walks, participants measure air temperature at different locations along a walking route. They relate the measurements to surrounding environmental conditions such as sun exposure, vegetation, and urban structures. This enables participants of the climate walk to identify local climate phenomena such as urban heat islands or cooling effects caused by green areas and cold-air flows. Although comprehensive assessments of human thermal comfort require multiple meteorological parameters, many relevant local climate effects can be demonstrated through accurate air temperature measurements.

Previously, measurements were recorded on paper, resulting in fragmented datasets, increased effort for data processing, and limited possibilities for participants to directly explore their collected data. To improve data quality, accessibility and engagement, a digital support system consisting of a mobile air temperature measuring device with dual radiation shielding and ventilation, and a measurement accuracy of ≤ 0.2 K, educational material and a mobile application for data collection and analysis was developed.

The presented mobile application was developed and designed in close collaboration with a meteorological expert to address both scientific requirements and educational objectives. It enables participants to digitally record air temperature measurements while automatically assigning location and timestamp information. Integrated consistency checks support reliable data collection, while visualizations during and after the climate walk provide immediate feedback and promote interactive learning about urban microclimates. Recorded walks can be reviewed and analyzed, including a linear trend correction to account for temporal temperature changes during the walk. Datasets can also be exported for further use. The application supports the transition from manual data collection towards a standardized digital workflow and improves the accessibility and usability of citizen-generated climate data.

The presented concept demonstrates how digital tools can strengthen citizen science activities in urban climate education. By combining accurate measurements with direct visualization and educational guidance, the approach enables citizens and students to actively explore local climate characteristics and develop a better understanding of climate challenges. By enabling participants to collect and interpret their own observations, climate walks can contribute to public engagement, climate awareness, and the identification of local adaptation potentials.

Poster

Identifizierung mikroskaliger Umweltrisikogebiete: Analyse multipler Umweltstressoren zur Verbesserung der städtischen Gesundheit

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Extreme Wetterereignisse wie zunehmende Hitzeperioden aufgrund des Klimawandels in Kombination mit urbaner Luftbelastung durch z.B. Feinstaub oder Ozon sowie eine zunehmend intensivere und verlängerte Pollensaison¹ gefährden die öffentliche Gesundheit erheblich. Es ist von entscheidender Bedeutung, dass die verschiedenen Umweltbelastungen, insbesondere in Städten, nicht isoliert voneinander auftreten, sondern auf komplexe Weise miteinander interagieren. Mit fortschreitender Urbanisierung steigt demnach die Notwendigkeit den genannten Herausforderungen mit präventiven Maßnahmen zu begegnen und Anpassungsstrategien für klimaresilientere Städte zu entwickeln.

Bisherige Studien zu gesundheitlichen Auswirkungen aufgrund des Klimawandels konzentrieren sich hauptsächlich auf die getrennte Analyse der Umweltvariablen Hitze, Luftschadstoffe und Pollen² oder untersuchen deren Zusammenwirken lediglich auf großräumiger Skala, sodass unzureichend verstanden bleibt, wie die genannten multiplen Umweltstressoren sich insbesondere auf mikroskaliger Ebene gegenseitig beeinflussen und gesundheitliche Effekte verstärken können. Darüber hinaus gibt es derzeit nur eingeschränkte Prognosen für deren Veränderungen sowie kombinierten Auswirkungen auf Krankheitsverläufe bei verschiedenen Klimaszenarien. Es ergibt sich ein konkreter Forschungsbedarf interdisziplinärer Analysen synergistischer Umweltfaktoren und deren Auswirkungen auf die städtische Gesundheit.

Unsere Studie folgt einem Exposom-Ansatz, bei dem innerstädtische Belastungshotspots anhand der Wechselwirkungen von Hitzeereignissen, Luftschadstoffbelastung und Pollenflug in den Großstädten Augsburg und München analysiert werden. Dazu werden zunächst potenzielle Umweltrisikogebiete anhand vorhandener Messdaten identifiziert, um anschließend die multiplen Effekte mit mikroskaligen Umweltmessungen zu erforschen. Der Schwerpunkt liegt dabei auf der Untersuchung kleinräumiger Unterschiede, welche durch strukturelle innerstädtische Besonderheiten, Vegetation und lokales Mikroklima beeinflusst werden. Daran schließt sich die statistische Analyse der Synergieeffekte sowie deren Modellierung unter Anwendung von multivariaten Regressionsverfahren sowie Distributed Lag Non-Linear Models (DLNM) an, um nichtlineare und verzögerte Zusammenhänge zwischen Umweltstressoren und Gesundheitseffekten abzubilden. Die Abschätzung der zukünftigen Krankheitslast für hitze- und umweltassoziierte Erkrankungen wie Asthma, Allergien sowie Herz- und Kreislauferkrankungen erfolgt unter Einbeziehung von ambulanten Notfallversorgungs- und Krankenkassendaten sowie Klimasimulationen verschiedener Global Warming Levels (+2°C, +3°C, +4°C). Ziel ist es, eine

räumlich hochaufgelöste Bewertung kombinierter Umweltbelastungen zu ermöglichen und damit die Identifizierung innerstädtischer Umweltrisikogebiete und deren klimawandelbedingter Veränderungen zu verbessern. Gleichzeitig generieren unsere Ergebnisse eine wissenschaftliche Grundlage zur Entwicklung klimaangepasster Maßnahmen in den Bereichen Stadtplanung, Umweltmanagement und Gesundheitsvorsorge.

Poster

Climatology of Urban Precipitation Effects in Berlin-Brandenburg

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The influence of urban surfaces on precipitation remains a debated topic in climatology. Although urban precipitation impacts have been observed in several studies, their magnitude and direction depend strongly on local geography and climate. Possible drivers include the urban heat island, which may enhance convective mixing and instability, increased surface roughness from buildings that can slow winds and promote convergence, urban pollution that alters cloud microphysics, and reduced evapotranspiration caused by impervious surfaces and limited vegetation.

Berlin provides an especially useful study area because it has relatively little topographic variation and is surrounded mainly by rural land, making it easier to isolate possible urban effects on rainfall. Earlier studies based on interpolated station data suggest that Berlin can both intensify and reduce precipitation depending on the type of rainfall. Convective showers often show a positive lee-side anomaly, while large-scale frontal or advective precipitation tends to be weaker over the urban area.

This study investigates long-term urban precipitation effects in the Berlin-Brandenburg region by examining precipitation along a wind corridor extending away from the city. By separating this wind corridor into individual, equally sized segments in the upwind and downwind zones, the analysis allows for a detailed investigation of how precipitation varies with distance, season, wind regime, and extreme-event magnitude. The three research questions ask whether an urban influence can be detected along the corridor, how precipitation patterns differ by season and wind conditions, and how return levels of precipitation extremes change across the urban-rural transition. By combining average precipitation behavior with extremes, the study aims to improve understanding of how urbanisation shapes the local hydroclimate and to support future climate adaptation in a growing metropolitan region.

Poster

Assessment of future changes to the Universal Thermal Climate Index (UTCI) under +2 and +3K global warming levels using ICON-CLM

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Various temperature-based climate indices, such as the number of summer days or tropical nights, are reported to increase under global warming. However, these indices defined by the ETCCDI and ET-SCI are not directly linked to human health. The Universal Thermal Climate Index (UTCI) is a bioclimatic index that describes the physiological comfort of the human body in specific meteorological conditions (Bröde et al., 2012). It is based on air temperature, relative humidity, wind speed, and solar and thermal radiation. As of August 6 2026, Berlin had already recorded 23 days with a daily maximum air temperature of 30°C, 5 days with 35°C and 2 days with 39°C (source: DWD Berlin-Tempelhof weather station). The impact of the June 2026 heatwave was shown on Berlin's emergency medical services with 23% more emergency cases (Kruppke-Hansen, 2026).

In our study, we employ UTCI on the first multi-decadal and multi-model convective-scale ensemble for Germany, with a spatial resolution of 3 km. This ensemble is provided by the NUKLEUS project (Nutzbare Lokale Klimainformationen für Deutschland, funded by the BMFTR). The NUKLEUS ensemble combines three CMIP6 general circulation models (MPI-ESM1-2-HR, EC-Earth3-VEG and MIROC6) which have been dynamically downscaled by regional climate models (e.g., ICON-CLM) for the SSP3-7.0 scenario to detect robust future changes over Germany.

The main objective of this study is firstly to analyse future changes to the Universal Thermal Climate Index (UTCI) in Germany. Secondly, it will assess the impact of climate change on urban heat islands by comparing urban areas (e.g. Berlin) with their surrounding rural areas. For this we use comparisons between the historical period (1961–1990) and future projections for global warming levels of +2K and +3K. For evaluation we compare the NUKLEUS simulations with the ERA5-HEAT dataset (Di Napoli et al., 2021).

Poster

An Introduction to the VDI Standards on Urban Climate

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VDI standards are technical regulations and recommendations established by the Association of German Engineers (Verein Deutscher Ingenieure, VDI). With more than 2,100 valid standards covering engineering, industry, energy, environmental applications and related fields, they are widely recognized as state-of-the-art benchmarks. Developed through a voluntary consensus process involving experts from industry, academia, and public authorities, VDI standards translate scientific knowledge into standardized methods and practical guidance.

In the field of urban climate, the VDI 3787 series provides a comprehensive standardization framework for urban climate analysis, planning, and design. Comprising 13 parts, it addresses key aspects such as thermal comfort, climate adaptation, heat-risk management, urban air quality and urban wind environments. For example, VDI 3787 Part 1 (2026) "Climate in spatial planning" provides methodological guidance on how climatic information can be analyzed, mapped, evaluated, and integrated into urban planning processes. It is widely regarded as the most mature and operationally proven standard worldwide in this field and is currently contributing to the development of an international ISO standard. VDI 3787 Part 2 (2022) describes methods for the human-biometeorological assessment of thermal environments based on the human heat balance, enabling evaluation of thermal conditions for humans and applications in urban and regional planning, building design, public health, and related fields. VDI 3787 Part 3 (2022) introduces methods for considering air quality in urban and regional planning, while VDI 3787 Part 4 (2020) describes methods for evaluating wind conditions and wind comfort in built-up areas. VDI 3787 Part 8 (2020) introduces quantified climate and air-hygiene assessments, supporting urban planning decisions and the development of adaptation measures in the context of climate change. VDI 3787 Part 13.1 to 13.3 describe short term and long term measures to be taken by communities and the health system to act on extreme heat.

The VDI 3787 series is intended for urban planners, urban climate researchers, governmental and municipal authorities, architects, landscape architects, and engineering consultancies. This presentation introduces the VDI standards framework and an overview of the VDI 3787 series, highlighting its role in supporting urban planning, urban design, and adaptation to climate change.

Please note: This contribution is identical to the poster contribution to the 9th Japanese-German Meeting on Urban Climatology (JGM9), which took place from 28 September to 2 October 2026 in Berlin, Germany.

Poster

Spatial Correlations between SST Patterns and Rainfall in the Galápagos Archipelago

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Rainfall is the principal freshwater input to the Galápagos Archipelago and is therefore essential for ecosystems, agriculture, water availability, and the daily life of island communities. The archipelago lies where complex oceanographic currents converge, where the Intertropical Convergence Zone (ITCZ) and the South Pacific Anticyclone (SPA) regulate distinct hydroclimatic seasons. Convective rainfall dominates the Hot Season (HS; January–May), whereas the Cool Season (CS; June–December) is characterized by a stable trade-wind inversion (TWI), persistent low-level stratus clouds, and drizzle (locally called *garúa*). Seasonal ocean–atmosphere conditions are further modulated by ENSO, although its effects are not expressed uniformly. However, uncertainty remains regarding how the rainfall is regulated by oceanic variability in combination with elevation, island location.

This study evaluates how the spatial and temporal variability of rainfall is organized by seasonal conditions and local geography, and how these rainfall patterns relate to SST variability. We used high-resolution observations from 11 automatic weather stations distributed across Isabela, Santa Cruz, and San Cristóbal, spanning coastal to upper elevation environments. From March 2022 to December 2024, we characterized rainfall patterns across gradients of elevation, island position, and wind exposure using observations of air temperature, relative humidity, and wind direction. Furthermore, seasonal rainfall variability was related to satellite-derived sea surface temperature (SST) using spatial correlation analysis to assess the influence of SST on rainfall patterns across the Galápagos Archipelago during different ENSO phases, including the La Niña phase (2022), the El Niño phase (2023), and neutral conditions (2024).

The results show that elevation provides the clearest geographic differentiation on rainfall, while island position and wind exposure modified it. The patterns of SST and rainfall variability were strongly dependent on season. In HS, warmer and moist conditions with episodic convective storms coincided with stronger and more spatially coherent SST–rainfall correlations. During CS, the shallow marine boundary layer (MBL), southeasterly trade winds, and stratiform *garúa* coincided with weaker, fragmented, and geographically differentiated correlation patterns. However, the influence of SST on rainfall varied among the islands, particularly across different ENSO phases. While San Cristóbal exhibited comparatively stable rainfall throughout the study period, Isabela and Santa Cruz showed a much stronger response to ENSO-related SST variability.

Poster

Unprecedented warming over the past 30 years in Berlin, Germany, unaffected by urban effects

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Increasing air temperatures due to climate change results in amplified hazards for human health by excessive heat. Cities typically show elevated air temperatures compared to their non-urban surroundings, which causes urban dwellers to be even more threatened by heat in warmer conditions. Until now, research could not conclusively clarify how climate change and urban effects on air temperature interact with each other over time scales covering decades. This is due to the fact that multi-decadal measurements from urban climate observation networks are generally scarce. Here, we present robust air-temperature trends for the Climate Normal 1991–2020 using quality-controlled data from eleven urban and 14 non-urban weather stations in the Berlin region, Germany. The stations cover a wide range of urban and non-urban settings. We analyse trends for four daily variables as annual and seasonal mean values, as well as during heatwaves. Our findings highlight that climate change and the city interact linearly on the analysed time scales regarding air temperature. This results in similar air-temperature trends in urban and non-urban areas, although at different absolute levels. An exception to this is the daily minimum air temperature in spring, which shows different trends for urban and non-urban stations. Investigation of the built-up area around the stations and in the study region shows no significant change during the study period. This highlights that the observed warming is due to regional climate change and not related to urbanisation processes. By comparing trends for the last 30 years (1991–2020) with observational data since the end of the 19th century, we show that the recent rise in air temperature is unprecedented in the study region, indicating accelerated regional climate change.

Poster

Integrating downscaled weather and air quality forecasts for predicting environmental related hospitalization risks

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Extreme weather events and air pollution are increasingly recognized as major public health threats, particularly for individuals with cardiovascular diseases, respiratory conditions and pregnancy-related hypertension disorders. A predictive tool that provides vulnerable patient groups with advance information regarding health risks associated with upcoming weather events could therefore offer substantial clinical and public health benefits. To support reliable prediction of environmental related health risks, meteorological and air quality variables from coarse-resolution reanalysis and forecast products, including ERA5, CAMS reanalysis, DWD ICON and CAMS air quality forecast, are downscaled to finer spatial resolution (500 m) using a machine learning based Random Forest (RF) model. The data downscaling enables environmental conditions to be characterized more accurately at the locations where patient symptoms or hospitalizations occur, thereby improving the representation of local weather and air quality variability in the predictive model. The downscaled meteorological and air quality data are currently being used to develop machine learning based eXtreme Gradient Boosting (XGBoost) model to predict the patient-specific hospitalization risks. From the primary environmental variables, additional predictors are derived to represent short-term changes, lagged and cumulative responses, and extreme weather or pollution events. To reduce model complexity and avoid overfitting issues, the initial list of input predictors goes through a feature selection process to identify the most informative variables. The selected predictors will be subsequently used to train and evaluate the final prognosis model for identifying periods of elevated hospitalization risk among vulnerable patient groups. By integrating robust modelling approaches with validated, high-resolution environmental data, this framework aims to advance the development of practical, location-specific tools for forecasting environment-related health risks.

Poster

Physiologische Reaktion auf thermischen Diskomfort im urbanen Rad- und Fußverkehr

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Hitzestress im Alltag bildet ein gesundheitliches Risiko. Der Sommer 2026 stellte in Deutschland sowie in weiten Teilen Europas neue Allzeithitzerekorde auf und zeigt, vor welche Herausforderungen Extremwetterereignisse wie Hitzewellen die kommunale Planung stellen. Das Thema der Klimawandelanpassung im Radverkehr wurde bislang allerdings kaum beachtet. Im Rahmen des Projekts Active2030+ werden die Möglichkeiten sowie die Wirksamkeit von Klimawandelanpassungsmaßnahmen für aktive Mobilitätsformen untersucht. Ziel dieser Studie ist zunächst die Hitzebelastung und die individuelle physiologische Reaktion im Rad- und Fußverkehr am Beispiel der Stadt Trier zu erfassen und Zusammenhänge von thermischen Belastungen und Verkehrsinfrastruktur aufzuzeigen. Die Methodik basiert auf einer Kombination von tragbarer Sensortechnik (Wearables), welche es mittels nicht-invasiver Messungen ermöglicht, physiologische Daten einer Person sowie Umgebungsdaten wie die Lufttemperatur oder die Sonneneinstrahlung zu erfassen.

Das Poster zeigt den Aufbau sowie erste Ergebnisse der Feldstudie mit über 70 Teilnehmenden und diskutiert Herausforderungen sowie die Limitationen der Methode. Zusätzlich wird ein Ausblick auf die weiteren Ziele des Forschungsprojektes gegeben.

Poster

A low-cost automated chamber for distributed soil CO₂ efflux monitoring in heterogeneous urban landscapes

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Soil respiration is a major term in the global carbon cycle, with a recent median estimate of 93 Pg C per year, but in cities it remains poorly constrained. Urban soils are highly heterogeneous, and soil respiration varies accordingly in space and time. Resolving urban soil fluxes therefore requires high spatial and high temporal resolution at the same time. Achieving both means running many chambers in parallel, so cost per unit becomes the limiting factor. Manual sampling is labour-intensive, and commercial automated systems are too costly to replicate across a site. Eddy covariance integrates over a mixed surface, so the measured net flux cannot be partitioned among the surfaces that produce it.

We present a low-cost automated non-steady-state closed chamber for distributed deployment, built from components costing about 400 EUR per unit. The design builds on the open-source Fluxbot chambers of Forbes et al. (2023) and Pan et al. (2024), and extends them with a servo-actuated hemispherical dome, a second CO₂ sensor of a different type, a custom interface board, and multi-band cellular connectivity that allows identical units to operate in most countries on a single roaming SIM. Air temperature, relative humidity, soil temperature, soil moisture and barometric pressure are recorded with every flux measurement. The chamber closes and reopens on an hourly cycle, entering a low-power sleep between cycles, so a single powerbank supports multi-week unattended operation. Data are stored locally and uploaded daily over the mobile network.

We report the system design, the validation protocol, and first data from a two-unit pilot in Berlin that precedes array deployment. The system is being validated by paired field comparison with a LI-COR LI-6800. Running the two CO₂ sensors in parallel allows a direct comparison of how their documented limitations affect flux estimates under field conditions. Deployed alongside an eddy covariance tower, chambers of this kind can support interpretation of the tower flux by constraining its soil component.

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Poster

Transport of heat at the neighbourhood scale: preliminary insights from PALM simulations in an urban environment

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Understanding heat transport mechanisms at urban neighbourhood scales is essential for assessing urban thermal comfort and mitigating heat stress. As part of the [HICSS-project URBANLINE](#), this study investigates the role of horizontal heat transport in an urban environment. It looks at how heat transport is influenced by the size of a heat source and different wind speeds. For this purpose, several simulations with the Large Eddy Simulation model PALM were conducted based on an idealised setup for a hot summer day developed within the project [Urban Climate under Change \[UC²\]](#): a different number of modified buildings served as heat source. In a next step, initial wind speeds will be varied.

Preliminary results indicate that horizontal heat transport at low wind speeds mainly takes place during the morning hours. Between early noon and late afternoon, vertical transport dominates due to turbulent mixing. However, cyclic boundary conditions, commonly used for simple urban LES setups introduce a critical challenge: with multiple buildings heating up with sunrise, heat accumulates during the simulation period. This results in an average relative warming of about half a degree across the entire boundary layer by the end of the simulation, compared to a base scenario without heating, masking any effect of horizontal heat transport.

In this poster we are discussing the possibilities to handle the boundary induced feedback. In a next step, the horizontal heat transport will be investigated under higher wind speeds.

Poster

Ecuadorian Latent Heat Flux Projections through 2100

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Latent heat flux regulates the exchange of energy and water vapor between the land surface and the atmosphere, making it a critical driver of regional climate stability and hydrological cycles. In Ecuador, a country characterized by extreme topographic complexity and rapid land-cover transitions, modeling future latent heat flux in the montane rain forest is essential to anticipate how shifts in vegetation will impact ecosystem resilience. This study simulates the annual mean of daytime daily latent heat flux across seven distinct land-use and vegetation scenarios in the montane rain forest in Ecuador from 2022 to 2100. The results demonstrate a permanent structural separation based entirely on land cover types. Natural and managed forested ecosystems (Forest, *Alnus*, *Pinus*, and Secondary forest) maintain the highest overall energy exchange, fluctuating stably between 290 and 310 W m⁻². Conversely, deforested and degraded landscapes (Intense pasture, New deforestation, and Abandoned land) exhibit the lowest energy exchange, dropping to a minimum range of 220 to 250 W m⁻², while standard Pasture remains entirely isolated as a middle baseline around 265 W m⁻². These findings indicate that Ecuador's future surface energy balance is highly resilient to progressive late-century climate shifts but remains strictly dictated by local land-management decisions.

Poster

A climate-model-informed framework for stress-testing urban critical infrastructure under extreme heat scenarios

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Extreme heat is among the most dangerous climate hazards for cities to which the operators of urban critical infrastructure increasingly need to prepare for. Such preparation requires more than a probability range. It requires concrete, physically plausible heat events against which their systems can be stress-tested. Climate projections are usually communicated as ensemble means and spread, which blend two sources of uncertainty, internal variability and model uncertainty, and which obscure the individual, internally consistent trajectories the ensemble contains. However, these trajectories are required for stress-testing, with each one representing a physically consistent realisation. At the urban scale this potential remains barely used, since the decisive factor, the urban heat island (UHI), is poorly represented by regional climate models (RCMs).

We present a framework that turns RCM ensembles into a large pool of plausible urban heat extreme scenarios for the Hamburg region, designed for local stakeholders to draw on for stress-testing critical infrastructure. We use two ensembles that span the relevant uncertainties: the 50-member CRCM5-LE single-model initial-condition large ensemble samples internal climate variability, while the multi-model EURO-CORDEX ensemble samples model uncertainty. All simulations are first bias adjusted against a rural gridded observational reference near Hamburg (HYRAS, E-OBS), chosen rural so it does not absorb the urban-heat signal the models lack. The UHI is then added explicitly by a machine-learning emulator, trained on the observed urban-rural heat-island intensity of Hamburg (station pair Quickborn-Neuwiedenthal; daily June–August, 1975–2025) from meteorological drivers such as temperature, relative humidity, wind speed and incoming solar radiation, and applied to the bias-adjusted rural simulations. The result is a pool of thousands of physically consistent urban-heat summers, spanning present-day conditions and global warming levels of +1.5, +2 and +3 K.

Because every summer in the pool is a physically consistent trajectory rather than a statistical average, it can serve as a tailored stress-test. Heat extremes are characterised per member by intensity, duration and frequency, showing how these differ across the two ensembles and how the added UHI shifts them. Building on this, the framework is designed to identify with local stakeholder needs and with factors that most strain their systems, such as intensity, duration, timing or environmental and socio-economic compound events, and to draw matching stressing scenarios for present and future climate. As a stakeholder-driven climate service, it provides a transparent, plausibility-based scenario pool for stress-testing critical infrastructure.

Poster

GROW – Stärkung der Gesundheits-Resilienz junger Menschen in Städten in Zeiten von Klima- und Umweltveränderungen

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GROW hat zum Ziel die Gesundheitsresilienz junger Menschen (10–24 Jahre alt) in Städten unter Klima- und Umweltwandel zu analysieren. Junge Menschen in unseren Städten leben in einer anthropogen geprägten Umwelt, die oft limitiert ist, adäquate Ressourcen für ihre Gesundheit und Wohlbefinden zur Verfügung zu stellen. GROW betrachtet nicht nur pathogene Faktoren der physischen, sozialen und digitalen Stadtumwelt, sondern auch salutogene Faktoren, die die Gesundheit fördern. Vier gesundheitliche Resilienzfaktoren stehen im Vordergrund: (1) körperliche Aktivität, motorische Fähigkeiten, Gewicht und Übergewicht, (2) mentale Gesundheit und Wohlbefinden, (3) kognitive Regulierung und Aufmerksamkeit, und (4) Risikowahrnehmung und –verhalten. Zur Untersuchung der Zusammenhänge werden derzeit zwei Pilotstudien in der Stadtregion Augsburg durchgeführt.

Die übergeordnete Forschungsfrage der ersten Pilotstudie lautet, inwiefern die städtischen Rahmenbedingungen für körperliche Aktivität und Ernährung mit der Darmgesundheit, der Darm–Hirn–Interaktion und den psychischen Gesundheitszuständen wie Stresswahrnehmung, Depressionen und Angstzuständen junger Menschen zusammenhängen. Im Bereich der atmosphärischen Expositionen findet eine statistische Modellierung des Stadtklimas und der Luftverschmutzung auf Basis von Messungen statt, um die atmosphärischen Belastungen der Jugendlichen zu charakterisieren. Diese werden dann mit Endpunkten der körperlichen und psychischen Gesundheit in Beziehung gesetzt.

Die übergeordnete Forschungsfrage der zweiten Pilotstudie lautet, wie die städtische Umgebung die kognitive Regulierung, die Top–down–Kontrolle und das damit verbundene Risikoverhalten junger Menschen beeinflussen. Es wird untersucht, ob der Aufenthalt in naturnahen Umgebungen im Gegensatz zu urbanen Gebieten mit hoher Lärm- und Luftbelastung die kognitiven Leistungen verbessert.

Das Projekt wird im Rahmen eines Seed–Fundings von der Universität Augsburg gefördert.

Poster

The *ceilometer-toolbox*: streamlining state-of-the-art tools for seamless end-to-end processing and data management of LiDAR-ceilometer data

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LiDAR-ceilometers are increasingly deployed in research and operational monitoring networks to provide continuous observations of aerosols, clouds, and the atmospheric boundary layer (ABL) and its sub-layers. As the number of instruments and manufacturers has grown, a common sequence of processing steps has emerged. These include standardizing device-specific data formats, deriving and applying median dark measurement profiles, retrieving the atmospheric boundary layer height (ABLH) and mixed layer height (MLH), and performing quality control on the resulting products.

Despite the availability of these established processing tools, efficient, reproducible, and standardized end-to-end processing remains challenging. Existing workflows typically combine multiple independent software packages, custom scripts, and different programming languages. Such fragmented processing chains are difficult to deploy, automate, and maintain, particularly for near-real-time applications.

We present the **ceilometer-toolbox**, an open-source Python package that streamlines established tools such as raw2l1¹, STRATfinder², and STRATfinder QC³ into a seamless end-to-end processing and data management workflow. Core functionalities include raw data ingestion using raw2l1, derivation and subtraction of a median dark measurement profiles, ABLH and MLH detection using STRATfinder, quality control, and visualizations. In addition, the toolbox organizes processed datasets in a consistent structure and provides interfaces for efficient downstream analysis of long-term time series. The framework is designed to be extensible, enabling users to adapt individual processing steps while maintaining transparent workflows and has been tested with CL61 and CHM15k ceilometers.

By consolidating the processing chain into a single framework, the *ceilometer-toolbox* addresses the need for a unified software solution that reduces complex setups. The *ceilometer-toolbox* provides an accessible yet scalable platform for both research and near-realtime operational applications, reducing the complexity and burden of software integration.

Poster

¹ Marc-Antoine Drouin and contributors (<https://github.com/madrrouin>)

² Kotthaus, S., Haeffelin, M., Drouin, M.-A., Dupont, J.-C., Grimmond, S., Haefele, A., Hervo, M., Poltera, Y., & Wiegner, M. (2020). Tailored Algorithms for the Detection of the Atmospheric Boundary Layer Height from Common Automatic Lidars and Ceilometers (ALC). *Remote Sensing*, 12(19), 3259. <https://doi.org/10.3390/rs12193259>

³ Melania Van Hove and contributors (<https://gitlab.in2p3.fr/ipsi/sirta/mld/stratfinder/qc-sf-python>)

Elevation-dependent changes in the annual land surface temperature cycle across Arctic mountain ranges (2000–2020)

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Climate change drives rapid environmental transitions in mountain regions, which are often stratified by elevation, leading to elevation-dependent climate change (EDCC). Arctic mountain ranges, despite being situated within a region experiencing strong climate change amplification, remain poorly investigated from an EDCC perspective. To address this research gap, this study examines elevation-dependent changes in the annual cycle of land surface temperature (LST) across Arctic mountain ranges and assesses how these changes vary spatially across the Arctic.

The annual LST cycle is represented by three annual cycle parameters (ACPs), including mean annual LST (MAST), yearly amplitude of LST (YAST), and phase shift relative to the spring equinox. The ACPs were derived from a harmonic model fitted to the MODIS/Terra daily LST product⁴. Regression-based analyses are used to assess how ACP trends over 2000–2020 vary with elevation as well as additional topographic and geographic gradients across mountain ranges and selected reference lowlands north of 60°N. Additionally, changes in snow cover, vegetation, and cloudiness are evaluated as potential drivers of the observed spatial and topographic variability.

Preliminary results indicate widespread Arctic warming, with median MAST trends of 0.69 and 0.83 K decade⁻¹ for daytime and nighttime, respectively. Mountain ranges generally exhibit significantly weaker MAST trends than reference lowlands. Within mountain ranges, elevation shows the strongest relationship with MAST trends among the topographic parameters examined. The relationship indicates a negative elevation dependence, with MAST trends decreasing progressively with elevation. Across the Arctic, MAST trends increase with latitude, although the strength and shape of this relationship vary substantially among mountain ranges and with elevation. Together, these findings indicate that warming is both elevation- and latitude-dependent, but that topography and latitude alone cannot fully explain the observed spatial variability.

The subsequent analysis will investigate the roles of changing snow cover, vegetation, and cloudiness in explaining this variability. Together with the other ACPs, this analysis will provide a more comprehensive understanding of elevation-dependent changes in the annual LST cycle across Arctic mountain ranges.

⁴ Bechtel, B. 2015. A new global climatology of annual land surface temperature. *Remote Sensing* 7(3): 2850–70. doi:10.3390/rs70302850.

Poster

Nighttime cooling conditions in Dortmund: Development of an empirical potential model based on local site factors and comparison with KLAM_21

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Urban heat patterns are not determined solely by urban structures. In addition to urban climatic influences, topoclimatic processes shape the spatial variability of nighttime air temperatures. This applies to cities with varied topography, where cold air formed over vegetation-covered open spaces can move downslope via the katabatic effect and accumulate in depressions or valley areas. The empirical linking of point-based measurements of nighttime temperature minima with widely available land-use, topographic, and flow parameters offers a comparatively simple approach to mapping these spatial temperature patterns. Using Dortmund as an example, local site predictors were identified and combined into an empirical potential model. The model's accuracy and spatial validity were then compared with the process-oriented cold air parameters from KLAM_21.

Air temperature measurements from a total of 25 locations in Dortmund were used for the evaluation. Of these, eight additional measurement sites were specifically established in areas where cold air is likely to form, flow out, or accumulate, while 17 stations from the Data2Resilience measurement network provided a citywide temperature context. For the year 2025, 20 summer radiative nights were analyzed, for which the site-specific median minimum temperatures were considered. These were compared with the KLAM_21 cold air contents modeled at resolutions of 20 m and 50 m, as well as with GIS-based land use, topography, and flow parameters. At eight locations, the vertical air temperature difference between 2 m and 1 m was also compared with the modeled cold air heights. Potential site predictors examined included impervious surface coverage, urbanization, types of green spaces and the size of contiguous green areas, relative low-lying elevation, topographic catchment areas, distance to potential cold-air outflow structures, and flow velocities derived using SAGA GIS.

Based on the identified predictors, a weighted potential model was developed using the soil sealing index, relative elevation, and the potential flow velocity modeled with the SAGA GIS "Cold Air Flow" module, and this model was applied to the urban area using a raster-based approach. Its predictive performance was tested using cross-validation. To ensure a methodologically consistent comparison, the KLAM_21 editions were evaluated using the same training and test splits as well as the same quality metrics.

The imperviousness index proved to be the strongest single predictor of nighttime minimum temperatures, while weaker negative correlations were found for relative low-altitude location and potential flow velocity. No significant correlation could be demonstrated between the modeled cold-air height and the near-surface vertical temperature gradients at the eight sites. In repeated cross-validation, the empirical potential model explained 42% of the variance in observed minimum air temperatures with a mean absolute deviation of 0.78 °C. The KLAM_21 outputs evaluated on identical test subsets explained between 8% and 19% of the variance, depending on the cold air size and spatial resolution; their mean absolute deviation ranged between 1.09 and 1.14 °C. Thus, they

exhibited lower predictive quality. The empirical potential model particularly captures the spatial gradation of warmer and cooler locations and enables a regional classification of nocturnal cooling conditions, although the moderate explained variance suggests the presence of other processes.

Poster

Spatiotemporal characteristics of the June 2026 heat wave in Dortmund and Bochum in a long-term context

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Heat waves are caused by persistent large-scale weather patterns and, in addition, are modified in urban environments by urban-climate processes such as altered radiation and energy balances. Consequently, their thermal characteristics can vary both between cities and at small scales within urban areas. An event-specific assessment therefore requires the combined consideration of the temporal evolution, peak thermal exposure, and spatial differentiation of a heat event within the city, as well as its classification within long-term measurement records.

Investigating the heat wave from June 25th to 29th, 2026, as a case study, the thermal exposure in Dortmund and Bochum is analyzed using data from urban monitoring networks: the Bochum Urban Climate Monitoring Network BoKliNet, the Dortmund Data2Resilience monitoring network, and long-term observations from the professional Ludger Mintrop Urban Climate Station in Bochum. Additionally, available crowdsourced data from private weather stations are evaluated for their suitability for even further increasing the spatial coverage of the institutional monitoring networks. This combination allows the event to be placed in a climatological context and its spatial and temporal characteristics and associated thermal exposure to be analyzed, thereby providing a comprehensive characterization of the extreme event. The analysis includes the evolution of air temperature, peak heat exposure, and spatial differences within and between Dortmund and Bochum. The long-term measurement record is used to place the temperatures measured during the heat wave within their climatological context. Finally, the requirements that urban climate monitoring networks must meet to capture heat events with sufficient spatial and temporal differentiation are assessed.

Poster

The Urban Climate Observatory (UCO) Berlin for integrative research on atmospheric processes in cities

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The Urban Climate Observatory (UCO) Berlin, Germany, is an open and long-term infrastructure for integrative research on urban climate, hydro-meteorology, and air quality. Quality-controlled observations are carried out to study interactions between atmospheric processes and urban structures, as well as climate variability and climate change in urban environments. It enables multi-scale, three-dimensional atmospheric studies, integrating observational and numerical modelling methods. The UCO Berlin includes the following components:

The Urban Climate Observation Network (UCON) Berlin provides long-term observations of atmospheric variables (e.g., air temperature, relative humidity, precipitation) in the urban canopy layer at various locations since the 1990s. Since 2015 freely-available data from private weather stations in Berlin and surroundings have systematically been collected via crowdsourcing.

Two radiation- and energy-balance towers in distinctly-different urban settings measure four-component radiation fluxes, turbulent fluxes of sensible and latent heat, and carbon-dioxide fluxes using eddy covariance systems since 2014 and 2018. One tower is an associate site of the European research infrastructure Integrated Carbon Observation System (ICOS) and part of the national ICOS-D network (ID: DE-BeR). The seasonal development of the vegetation in the visible and near-infrared range is observed at both locations using PhenoCams (phenocam.nau.edu).

Ground-based remote sensing is used to study the urban boundary layer and beyond since 2017. Two Doppler-wind lidar systems provide profiles of horizontal and vertical wind speed and direction, as well as information on atmospheric turbulence. Cloud height, cloud cover, and aerosol layers are recorded with ceilometers in an urban and a non-urban setting. A microwave radiometer provides vertical profiles of air temperature and absolute humidity. Finally, an X-band Doppler weather radar with dual polarization for precipitation research is in operation since autumn 2022. This contribution provides an overview of the UCO Berlin and uses selected findings to highlight benefits of the multi-scale observations for urban atmospheric research.

Poster

Using digital and AI-based tools to assess risks and potentials in urban climate-related issues

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Projected temperature changes resulting from human-induced climate change are leading to an overall increase in urban vulnerability. Therefore, adaptation measures are necessary in municipal planning. To successfully adapt to climate change, it is crucial to identify areas of local climatic risk and potential in order to optimise their design with regard to adaptability. The matrix method established by Fabisch and Henninger (2015) is well-suited to the systematic identification of these areas. This method involves comparing various locally relevant climate indicators in assessment matrices to estimate the probability of relevant urban climatological phenomena occurring. The required indicators are initially recorded using subjective and visual methods. Automating the baseline analysis and the further processing using freely accessible geodata and digital, AI-supported methodologies transforms the subjective, error-prone and labour-intensive process of analysing baseline risk and potential areas into an intuitive, resource-efficient process. This enables financially constrained local authorities, among others, to carry out an initial assessment of the local climate and subsequently formulate the necessary adaptation measures.

The matrix method uses the complex interplay of local climatic factors to identify areas of risk and potential, employing a wide range of urban climate-relevant indicators. These include general land cover types and associated surface features, such as vegetation structures. The identification of these areas can also be automated using artificial intelligence-based methods. Based on a deep learning algorithm for identifying land cover types and associated structures, it is possible to assess risk and potential areas both as part of a holistic inventory using the automated matrix method and as a dedicated, standalone procedure focusing solely on vegetation areas. This can be achieved by intersecting the identified green structures with a rough model of the mean radiation temperature based on freely available elevation models. This allows indicative values to be determined regarding the local climatic impact of the respective composition of green spaces. These values can then be used to efficiently formulate further necessary adaptation measures in line with local requirements, both in parallel with and as a complement to the holistic concept of the matrix method, taking into account the local climatic impact of the green spaces.

Poster

CarBotAs – Understanding the Carbon–Water–Energy Nexus of High–Andean Wetlands

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High–Andean wetlands (*bofedales*) are groundwater–dependent ecosystems that regulate the coupled carbon, water and energy cycles of tropical mountain catchments. Besides storing substantial amounts of soil organic carbon, they buffer seasonal water availability and provide essential ecosystem services for pastoralist communities. However, despite their ecological importance, the functioning of these ecosystems and their response to climate and land–use change remain poorly understood because long–term observations from the tropical high Andes are scarce.

The CarBotAs project aims to improve our understanding of the interactions between the energy and water cycles and the sequestration and storage of carbon within the *bofedales* pastoralist system. In particular, the project addresses two overarching research questions:

- (i) How do variations in *bofedales* pasture management and environmental factors, including heat, solar radiation and moisture, impact the energy, water and carbon fluxes within the soil–vegetation–atmosphere continuum and thus the stability of the carbon sink function?
- (ii) What is the spatio–temporal role of water storage in *bofedales* for above– and below–ground carbon balances?

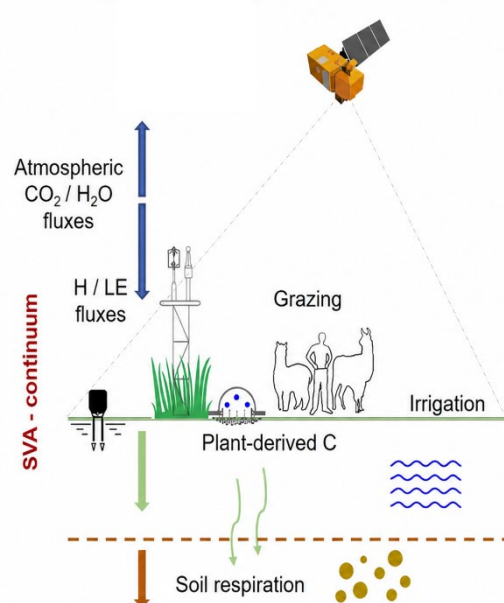


Fig. 2: Work flow of the project.

To address these questions, CarBotAs combines continuous field observations of energy, water and carbon fluxes with measurements of groundwater dynamics, soil carbon storage and vegetation characteristics across contrasting *bofedal* types in the Cordillera Vilcanota (Peru). These observations are complemented by Earth observation data to investigate the spatial variability of groundwater availability, vegetation vitality and carbon storage, and to facilitate the integration of plot–scale measurements into landscape–scale assessments.

This contribution introduces the scientific concept of CarBotAs and presents the current status of the project. Initial activities focus on establishing the observation infrastructure, implementing long–term groundwater monitoring, and developing methodologies for

integrating field observations with Earth observation data. We conclude with an outlook on how these data will contribute to a process–based understanding of the carbon–water–energy nexus of high–Andean wetlands and their resilience under changing climatic and land–use conditions.

Poster

Compound risk from extreme convective events and drought

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Extreme convective events (ECEs), including hailstorms, heavy precipitation and severe wind gusts, are among the most damaging natural hazards, causing substantial economic losses across multiple sectors. Agriculture is particularly vulnerable, as crop damage can result not only from the direct impacts of convective storms but also from concurrent environmental conditions. In this context, drought and severe convective events may interact as compound events, potentially altering both the characteristics of the hazard and its impacts.

To understand these interactions, it is essential to examine both atmospheric drivers and sectoral vulnerabilities. From an atmospheric perspective, drought modifies the local environment in which convection develops through changes in soil moisture availability, surface heating, and boundary layer characteristics. These land-atmosphere interactions may influence the occurrence, intensity, and spatial distribution of extreme convective events. From an impact perspective, pre-existing drought can deplete soil moisture, weaken soil structure, and reduce crop resilience, thereby amplifying the damage caused by subsequent convective storms.

As part of the EU-LIFE Adapt'Est project, we investigate the co-occurrence and interacting processes between drought and extreme convective events in Central Europe focusing on the Grand Est region in France and the neighboring Breisgau region in Germany. The study region is particularly interesting as convection-allowing models for climate warming scenarios project opposing trends of convective activity with widespread increases to the east but decreases to the west. Together with a strongly increasing drought occurrence, this transition zone of opposing trends is particularly suited to study the underlying processes.

For this, we first examine and present first results of how hazard characteristics vary when drought precedes or coincides with severe convective weather. Using radar- and lightning-based observations of ECE and multiple drought indicators across different spatial and temporal scales, we explore patterns of ECE occurrence under dry and non-dry conditions and provide an overview of compound drought-ECE events in the study region.

Through better understanding these compound hazards we aim to contribute to improving integrated risk assessments and supporting the development of effective climate adaptation and risk mitigation strategies, particularly in the agricultural sector.

Poster

Performance of a modernized RCM in capturing heatwaves and their impact on human discomfort over India

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Heatwaves have become one of the most serious climate-related risks for India in recent years, affecting human health, the cryosphere, regional economies, and ecosystems. Rising surface temperatures and changing land-atmosphere interactions across the region are expected to intensify the frequency, duration, and severity of such extreme heat events in the coming decades, making reliable regional-scale simulation of heatwaves an urgent priority. In this study, we assess the ability of an updated regional climate model, REMO2020, and its interactive vegetation version, REMO2020-iMOVE, to simulate heatwave events and their impact on human discomfort across India. Simulations were performed at a horizontal resolution of 0.11° for the period 1985–2016, using ERA-Interim as lateral boundary forcing. We have examined various heatwave indices, such as the frequency and duration of heatwave spells over the region. Human discomfort is quantified using Thom's discomfort index and the percentage of warm nights. By comparing the standard and vegetation-coupled model versions, this study aims to evaluate whether interactive vegetation dynamics improve the representation of land surface feedback relevant to heatwave development and human thermal stress. The findings are expected to inform the suitability of REMO2020-iMOVE for future climate-impact assessments of extreme heat over the region.

Poster

Thermal Patterns and Their Interactions with Land Use and Land Cover across Mt. Kilimanjaro's Altitudinal Gradient: Insights from a High-Resolution Multimodal Airborne Campaign

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Mount Kilimanjaro exhibits steep environmental gradients and an exceptional diversity of habitats, making it an ideal natural laboratory for investigating environmental and climate change. At the same time, the high density and small-scale complexity of its ecosystems present challenges for spatial studies. Orographically driven processes such as cloud formation and thermal inversions shape the mountain's climate, and changes in these dynamics have already been linked to shifts in vegetation belts, underscoring the need to resolve fine-scale thermal variability across the mountain's altitudinal gradient.

While satellite-based observations offer broad spatial coverage at a lower resolution, measurements taken at the ground have a very limited spatial extent. High-resolution airborne remote sensing offers a way of bridging this gap between scales. This study provides first insights into ongoing work on a multimodal high-resolution airborne campaign conducted in 2025 on Mt. Kilimanjaro as part of the Kili-SES Phase 2 Subproject 6 (Indirect and direct anthropogenic drivers: population increase, land management and conservation). The goal of the work presented here is to assess thermal dynamics and patterns in relation to Land-Use-Land-Cover (LULC) across the mountain's aspects and altitudinal gradient, as these have the potential to directly influence processes such as cloud formation and, consequently, the mountain's water budget.

To do so, thermal infrared imagery and LiDAR-derived products on terrain and vegetation structure are combined with a multispectral LULC classification. Thermal patterns are analysed along a network of transects distributed across different elevation belts and aspects of the mountain, together covering its full range from lowland to high-altitude zones. By combining the different data modalities at high spatial resolution, the study explores the relationships between thermal patterns, structural attributes and LULC characteristics of the landscape at a near object-level scale. First, preliminary results suggest potential asymmetries in the relationships between thermal patterns and environmental characteristics across elevation zones and aspects, patterns that may remain unresolved in coarser resolution analyses. These initial insights provide a basis for a better understanding of the role of micro- and meso-climatological dynamics in shaping the mountain environment and its response to climate change.

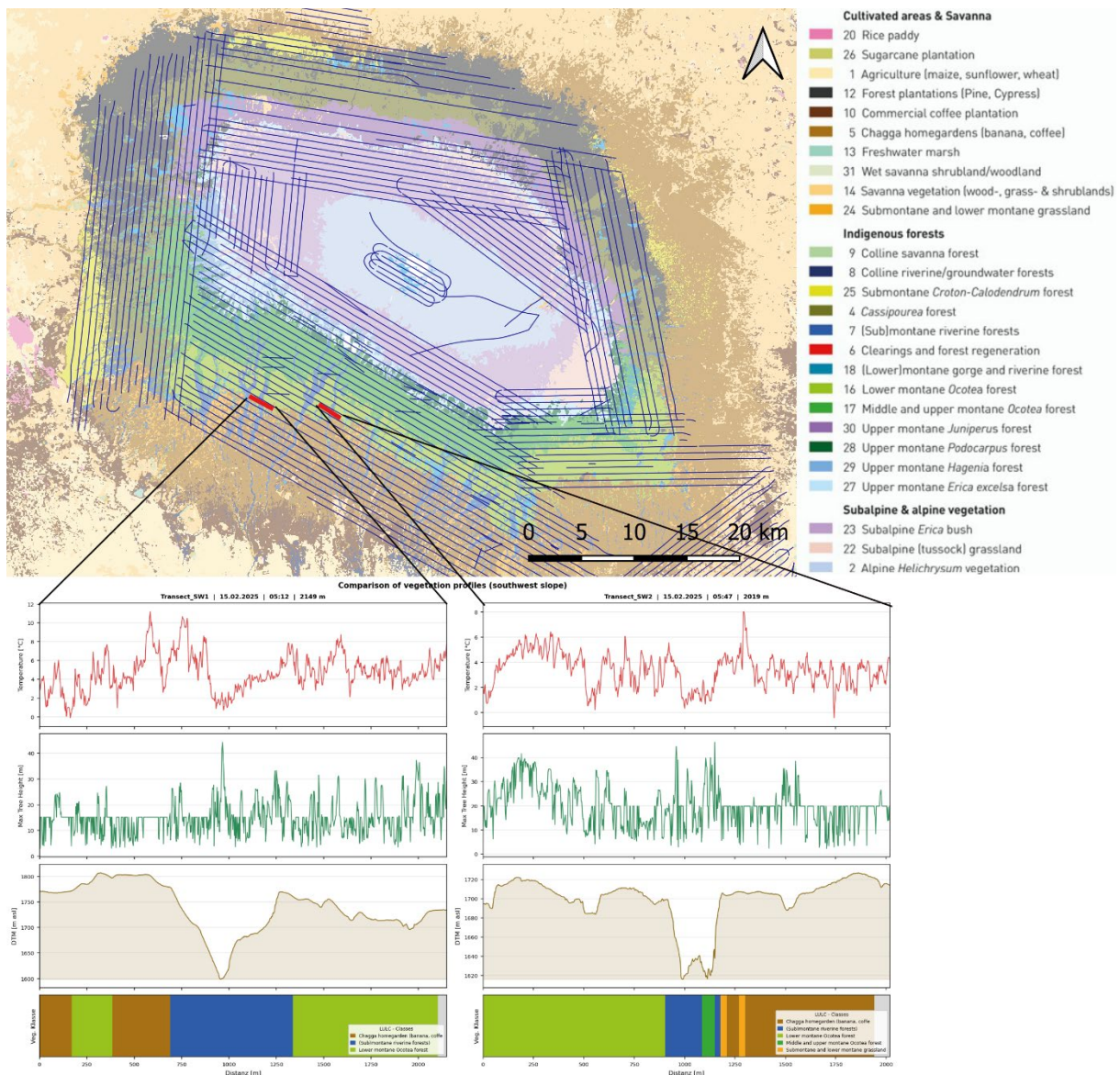


Figure 3: LULC classification of the Kilimanjaro with the flightpaths (blue), as well as two selected transect-subsets (red) (top). Both subsets show temperature, tree height, elevation and LULC classification along their length (bottom).

Poster

Reconstructing Urban Surface Temperatures: A Deep Learning Approach to Bridging Temporal Gaps in High-Resolution LST Data

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Urban heat islands and extreme heat events are intensifying due to climate change, especially in densely built environments. Remote sensing of land surface temperatures (LST) offers valuable insights for analyzing and mitigating urban heat risks. However, a major limitation of satellite-derived LST data is the trade-off between spatial and temporal resolution. High-resolution products such as those from Landsat provide fine spatial detail but suffer from low temporal coverage, limiting their usefulness for time-critical analyses.

In this study, a deep learning approach is presented to reconstruct high-resolution urban LST data in sub-daily time steps by bridging temporal gaps using observations from the ECOSTRESS sensor on board the ISS. Using Madrid as a case study a U-Net Convolutional Neural Network (CNN) was trained on ECOSTRESS LST data together with a comprehensive set of explanatory variables, including local weather and radiation measurements, ERA5 reanalysis data and Sentinel-2 surface reflectance indices.

The trained model was then used to predict LST for periods without ECOSTRESS coverage. Preliminary results show that the model is capable of reconstructing LST with a mean absolute error of approximately 1.3 °C on independent test data. These findings highlight the potential of data-driven methods to overcome observational limitations and generate continuous, high-resolution thermal datasets across the diurnal cycle.

By improving the temporal density of urban LST data, this work contributes to a better understanding of intra-urban temperature dynamics and supports targeted heat mitigation and climate adaptation strategies. The approach might be transferred to other cities and extended to broader spatial or temporal scales in the future.

Poster

SMART-TWIN: Integrating PALM-4U into a geospatial digital twin for urban climate planning

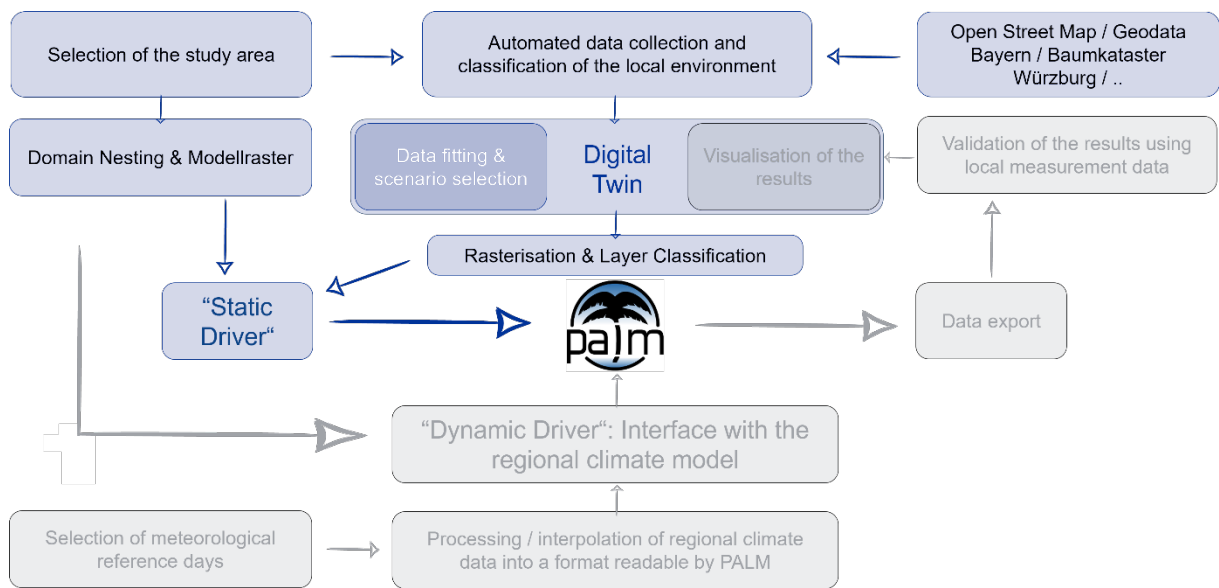
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This work presents the EU-project “SMART-TWIN – AI-supported planning tool for a climate-adapted green urban development in Bavaria”.

Climate resilience is becoming increasingly important in urban planning, particularly regarding adapting to extreme weather events and mitigating potential climate risks. To promote more sustainable and efficient urban and spatial planning, the SMART-TWIN project is developing an AI-supported digital planning tool for the city of Würzburg. The main objective of the project is to expand the existing digital twin by integrating the PALM-4U urban climate model. This tool enables local authorities and planning offices to simulate various scenarios for actual or potential construction projects, as well as for changes to green and blue infrastructure, and to assess their impact on the urban climate under both current and future (extreme) weather conditions. We aim to provide scientific climate analysis as a guide for decision-making local authorities in form of maps and 3D visualisation within the digital twin. In this way, planning processes can be carried out more precisely, quickly and cost-effectively in the future.

In this work the focus is the interface and the geoprocessing of the geodata of the digital and the static input information for PALM-4U. The tool can automatically retrieve all necessary (geo)data from the digital including the modified or added data from different urban planning scenarios. As the computing capacity for the model is limited, we use a nesting approach with different domain and grid sizes. A fixed root domain with a grid size of 100 m covers the entire city of Würzburg. Within this root domain a second domain with 10 m resolution is nested. The third domain is the focus area with 1 m resolution where the user changed the urban landscape. That means the second and third domain will automatically be adjusted to the user's area of interest. The data from the digital will be rasterised to the different domain sizes and the different surfaces classes such as pavement and vegetation will be classified so it can be interpreted by PALM-4U. Additionally the user can also choose from a range of characteristic (extreme) weather conditions to be simulated in the selected area, e.g. a hot day, a tropical night or a day with intense solar radiation.



Methodological approach of the project (Source: Own figure).

Poster

Decoding Urban Heat Risk – Towards Multi-Scale Urban Heat Risk Typologies for Climate Adaptation

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The frequency, intensity and duration of heat events increases globally, posing growing challenges for municipal stakeholders in public health and urban planning. Heat-related health risks are unevenly distributed within cities due to the interaction of local urban structures, socio-demographic characteristics of local residents as well as local exposure conditions. While many heat risk assessments have been conducted nationally and internationally, only few aim to translate heat risk patterns into planning-relevant information.

Building on a previously developed extended Heat Risk Index (HRI) framework (Rupp et al., 2026), the estimation and comparison of heat risk and socio-demographic vulnerability across German cities has been performed. Subsequently, standardized urban heat risk types on a city scale were derived. To this end, optimized non-hierarchical k-means clustering (SANDRA) was applied to classify cities based on their heat risk intensity and variability, urban thermal conditions, and morphological characteristics of the built environment. SANDRA is an advanced clustering algorithm that combines simulated annealing and diversified randomization to produce more stable and reproducible cluster solutions (Philipp et al., 2007).

Moving from the city scale to the intra-urban scale, hotspot types were derived to characterize recurring patterns of heat risk within cities. Hotspots were defined as areas of particularly high heat risk based on the HRI. Heat risk hotspots were analysed together with their surrounding Local Climate Zones (LCZ) to incorporate the surrounding urban structures using five-minute walking isochrones generated with OpenRouteService (OpenRouteService, 2026). This enabled the classification of recurring hotspot environments according to their urban structure and potential accessibility of different urban structures.

First results indicate that heat risk in urban environments is characterized by recurring spatial and socio-demographic patterns rather than isolated local phenomena. Heat risk might affect different population groups in varying urban structural contexts, emphasizing the need for differentiated adaptation strategies. The proposed typologies reveal characteristic combinations of urban form, social vulnerability and heat risk, and provide a framework to explore how different hotspot patterns are distributed across city types, thereby making spatial inequalities and planning priorities visible. By translating complex heat risk patterns into actionable urban typologies, the framework supports targeted context-sensitive climate adaptation.

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Poster

Weltweite Globalstrahlung: Harmonisierte Kennzahlen aus qualitätskontrollierten Messzeitreihen

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Der Anteil der Sonneneinstrahlung, der die Erdoberfläche erreicht, ist entscheidend für biogeochemische und atmosphärische Prozesse und bestimmt eine Vielzahl menschlicher Aktivitäten. Verlässliche Daten der Globalstrahlung sind daher sowohl für die Forschung als auch für gesellschaftlich relevante Anwendungen in Meteorologie, Hydrologie, Biologie, Ökologie, Gebäudeplanung, Energiewirtschaft, Landwirtschaft und Forstwirtschaft von großer Bedeutung. Bodengebundene, radiometrische Messungen gelten als die genaueste Datenquelle zur Abschätzung der Globalstrahlung und werden häufig zur Validierung anderer Datenprodukte wie Satelliten- oder Modelldaten herangezogen. Allerdings können zuverlässige Langzeitmessungen weltweit nur an einer begrenzten Anzahl von Standorten kontinuierlich durchgeführt werden, was auf die komplexe Messtechnik, hohe Installationskosten sowie Herausforderungen bei Wartung und Kalibrierung zurückzuführen ist. Viele Messnetzwerke außerhalb des etablierten Baseline Surface Radiation Network (BSRN), die im Rahmen von Initiativen für erneuerbare Energien, Forschungsprogrammen oder nationalen Wetterdiensten aufgebaut wurden, werden in der wissenschaftlichen Literatur selten genutzt und hinsichtlich ihrer Vollständigkeit und Zuverlässigkeit nur unzureichend evaluiert.

In diesem Beitrag wird ein neuer, harmonisierter und qualitätskontrollierter Datensatz von Solarindikatoren vorgestellt, der auf 14 bodengestützten Globalstrahlungsdatensätzen, darunter BSRN, basiert. Die ursprünglichen Messdaten umfassen mehr als 2,000 Stationen in über 50 Ländern, die im Zeitraum 1991–2020 in mindestens zwei aufeinanderfolgenden Jahren Globalstrahlung mit stündlicher oder höherer zeitlicher Auflösung gemessen haben. Nach einheitlicher Qualitätskontrolle und Filterung blieben rund 1,600 Standorte für die Berechnung der Kennzahlen übrig, die je nach Länge der verbleibenden Messzeitreihe kategorisiert wurden. Aus diesen Daten wurden Indikatoren zu klimatologischen Strahlungsmittelwerten, zur Saisonalität, zu Trends, zu Schwellenwertüberschreitungen sowie zur Variabilität und Persistenz der Globalstrahlung abgeleitet. Die resultierenden Indikatoren ermöglichen einen kompakten, quantitativen klimatologischen Vergleich globaler Standorte, ohne dass die zugrunde liegenden heterogenen Zeitreihen im Detail verarbeitet werden müssen. Hieraus lassen sich präzise Analysen der räumlichen und zeitlichen Variabilität der Globalstrahlung ableiten, die zugleich eine fundierte Grundlage für die Bewertung der Verfügbarkeit, Variabilität und Persistenz von Solarressourcen bilden, etwa im Rahmen der Standortwahl und Machbarkeitsanalysen von Photovoltaikanlagen. Zur Veranschaulichung des Potenzials des Datensatzes werden globale Karten der Indikatoren sowie eine Clusteranalyse vorgestellt, welche regionale und internationale Gruppierungen von Standorten mit ähnlichen Strahlungscharakteristiken identifiziert. Zudem werden charakteristische tages-, jahreszeitliche und interannuelle Strahlungsverläufe aufgezeigt, die die Bedeutung dieses standardisierten und frei zugänglichen Datensatzes für die Charakterisierung der globalen Solarressource unterstreichen.

Poster

GArua – From synoptic forcing to boundary layer response: cross-scale mechanisms of cloud and precipitation in a changing climate

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The water balance of the ecosystems of the Galápagos Archipelago is governed to a large extent by the moisture input from low-level clouds. During the garúa season, cloud immersion and the resulting cloud water interception play a crucial role in the water budget of the tropical montane cloud forests. The underlying atmospheric processes operate across various scales. Large-scale subsidence in the descending branch of the Hadley cell controls the thermal stratification of the lower troposphere and the depth of the planetary boundary layer, while the small-scale topography of the islands modifies local cloud and precipitation formation. On interannual timescales, the state of the El Niño–Southern Oscillation modulates these conditions. Global climate models cannot resolve an archipelago of this size, so that regional estimates of future changes in water input remain highly uncertain.

In this subproject of the GArua research project, we examine these cross-scale mechanisms and their sensitivity to climate change. The methodological bases are dynamical downscaling to create long-term, convection-permitting datasets and process-based regional climate simulations at very high spatial resolution.

The work builds on an existing high-resolution dataset for the archipelago (Galápagos Archipelago Refined Analysis, GAR), which is extended in time and evaluated against station measurements from the DARWIN measurement network. Composite analyses and process-based simulations then serve to characterise subsidence and boundary-layer regimes and to quantify moisture flux convergence and cloud water interception, before CMIP6 projections are dynamically downscaled to estimate the resulting changes in moisture input.

Our aim is to generate a process-level understanding of the coupling between synoptic forcing and the boundary layer response, together with spatially differentiated estimates of future changes in water input. The poster presents the objectives, hypotheses and methodological approach of the subproject.

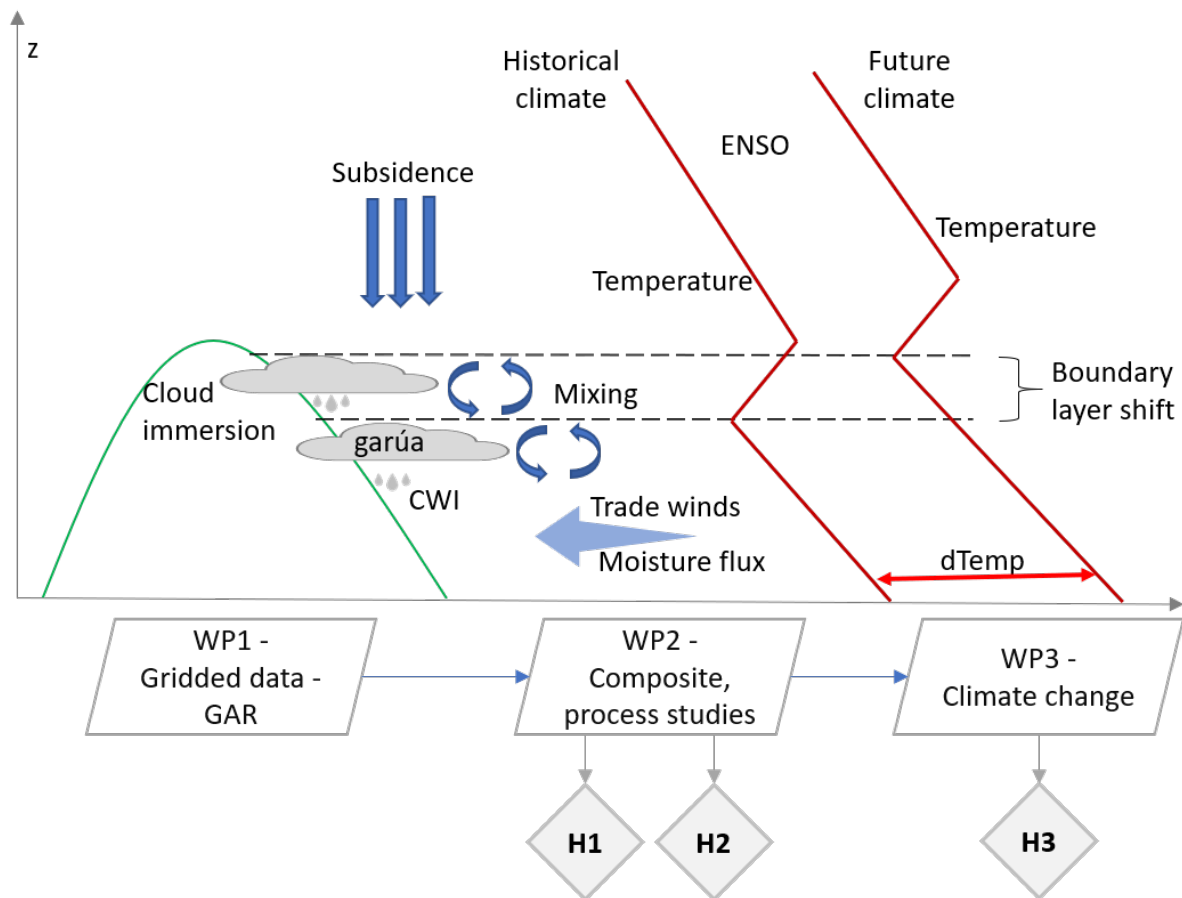


Fig. 1 | Scheme of work done in three work packages. WP1 consists of the extension of the GAR data and their evaluation with focus on atmospheric dynamics and thermodynamics. WP2 will test we conduct composite analyses and process-based modelling studies with the focus on subsidence, boundary layer height, cloud immersion and cloud water interception. In WP3 a dynamical downscaling of CMIP6 data will be applied to produce regional climate change projections and to test H03.

Poster

Mobile microclimate and human physiological responses across urban forest structures

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Urban and peri-urban forests offer many regulating, provisioning, and cultural ecosystem services and have positive effects on human health and mental well-being. Mixed forests have emerged as particularly promising forest structures that foster resilience against pests and diseases, severe storms, and droughts. They also buffer the microclimate and provide favourable conditions for human thermal comfort by mitigating both daytime peak temperatures and nighttime radiative cooling. Open land structures, like heathlands, on the other hand, offer less thermal relief but foster biodiversity, are aesthetically pleasing, and may induce higher levels of subjective well-being than denser forest structures. Moreover, it remains unclear to what extent positive human bioclimatic conditions in green spaces translate into measurable physiological responses and if and how these responses are mediated by forest structure.

To examine these complex effects, we invited participants to walk through three forest structures – mixed forest, pine forest, and heathland – located in the urban forest of Augsburg on six summer and six autumn days in 2024. We continuously measured participants' heart rate during the walks. Cortisol levels were measured from saliva samples collected once before and twice after the walks. Subjective perceptions were acquired through surveys during and after the walks. Accompanying mobile climate measurements were conducted along the participants' walking tracks and simultaneously in up to three additional green space areas, including the aforementioned forest structures.

To characterise the experienced microclimatic conditions, principal component analysis was used to reduce measured climate variables, including temperature, relative humidity, wind speed, and globe temperature, to orthogonal components, which were subsequently used to cluster walking tracks according to their microclimatic characteristics. Preliminary results suggest that more open structures, characterised by greater exposure to solar radiation, were associated with higher heart rates, while denser forest structures provided more favourable biometeorological conditions and were associated with lower heart rates. Cortisol levels decreased continuously across samples, with mixed forests showing the lowest levels overall, suggesting potentially stronger stress-reducing effects. Physiological and climate effects are compared with subjective perceptions and perceived thermal stress levels along the walks. The findings contribute to a better understanding of how urban forest structure shapes the microclimatic and physiological conditions experienced by people and may inform the design and management of urban green spaces for both climate adaptation and human well-being.

Poster

Bridging the resolution gap: From convection-permitting climate models to high-resolution hydrological models using Random Forest

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The hydrological simulation of flash floods in fast-responding catchments with diverse land use/land cover requires very high-resolution meteorological forcing data. Convection-permitting regional climate models (CPRCMs) represent a step stone in providing process-based high-resolution climate model data, yet remain too coarse for driving high-impact flash flood simulations. We study the suitability of a Random Forest (RF) model for bridging the resolution gap between CPRCMs and high-resolution hydrological models, and investigate the cascading effect on flash flood simulation. We set up a synthetic experiment design in which we aim to bring adjusted hourly radar data (RADOLAN), conservatively upscaled to the standard resolution of CPRCMs (3 km), back to its native resolution of 1 km using a RF model approach. We train the RF model specifically on extreme precipitation events with the aim to downscale flash-flood-producing storms. As an application case study, we present the downscaling of CPRCM data from REMO2020-iMOVE at 3 km resolution to 1 km resolution using a RF model for the heavy precipitation event of July 2021 over the Ahr valley. This event led to one of the most severe and devastating floods in Europe in recent times. We investigate the effect of the conducted RF-based downscaling of heavy precipitation CPRCM data on the hydrological simulation of the 2021 flood using the fully-distributed physically-based hydrological model WaSiM.

Poster

Evaluating Dortmund's SOLWEIG-based thermal comfort now-casting service

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3: Arizona State University, The GAME School, Tempe, USA

Heat is one of the most important issues cities face for ensuring a sustainable, safe, and comfortable future under a changing climate. To implement effective heat actions and sensible adaptation measures, the status quo needs to be assessed to further identify hot spots and prioritize measures. While observations deliver high temporal resolution, spatial variability is often not captured in detail. Here, urban climate models can be used to generate data with high spatial and temporal resolution. In this study, the SOLWEIG radiation model was applied to the city of Dortmund, Germany, to model the mean radiant temperature (MRT) at 3 m resolution and integrate it into a now-casting service for thermal comfort across the entire city. We realized this by decoupling SOLWEIG from its original QGIS dependencies and running it via a parallel tile-based processing workflow. Since April 2025, the city has also operated a professional weather station network at 76 locations, with 25 of these stations measuring biometeorology in addition to air temperature and relative humidity. These in-situ measurements complement the modelled MRT in the now-casting service to calculate high-resolution rasters of the Universal Thermal Climate Index (UTCI). For evaluation, observation data from the 25 + 6 additional biometeorological stations were collected. Two types of model runs were executed for the summer of 2025 (May, June, July, August): hourly runs of SOLWEIG across the city, as in the service, and 5-minute-resolution runs in the area of the 6 additional stations to further analyze temporal resolution. This work presents and discusses the evaluation results of the developed service based on UTCI and the input meteorological variables, specifically MRT. Therefore, this also includes an assessment of the SOLWEIG model's performance at different times of day (including nighttime), as preliminary results indicate diurnal variations in model error. The relation between station location and model accuracy is discussed along with other potential reasons for offsets between these two data sets.