

e-shape Pilots Showcase: Urban resilience to extreme weather – climate service

14 - 15 February 2023

9.30 – 17.00 CET

Valletta, Malta

Malta Council for Science and Technology

**Presenters: Saskia Buchholz (DWD), Maja Žuvela-Aloise
(GeoSphere Austria)**


e-shape

An event co-organised by



The Malta Council for
Science & Technology

eurisy
ACTING COLLECTIVELY TO
BRIDGE SPACE AND SOCIETY

Pilot Overview

S7 Climate showcase

P2 Urban resilience to extreme weather

Goal: strengthen urban resilience and preparedness to extreme weather and climate using sub-seasonal, seasonal and climate projection data



ILMATIETEEN LAITOS

Sub-seasonal and seasonal forecast products for the city of Helsinki

Climate projection products for various Austrian cities



GeoSphere
Austria

Seasonal forecasts products for state capital cities in Germany

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



FMI – Sub-seasonal and seasonal predictions for winter street maintenance activities in Helsinki

Otto Hyvärinen, Andrea Vajda, Mika Rantanen, Andreas Tack, Markus Mellin

Finnish Meteorological Institute

- Serving City of Helsinki authorities
 - in planning their activities,
 - improving winter safety and
 - optimizing maintenance costs
- Winter street maintenance activities include
 - snow removal from streets,
 - street sanding,
 - cleaning streets of sand and grit in spring



<https://pixabay.com/photos/car-under-snow-winter-helsinki-car-5994674/>

DWD – **Seasonal climate forecast products for German state capital cities**

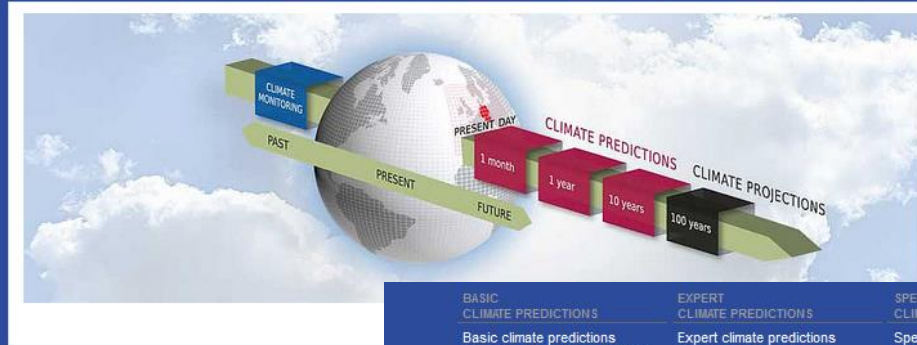
Saskia Buchholz, Andreas Paxian, Birgit Mannig, Amelie Hoff
Deutscher Wetterdienst

- Seasonal climate forecast products for city authorities
 - decrease the vulnerability of urban population to hazardous weather events and risks caused by climate variability (e.g., for periods of anomalous high temperatures, so that preventive measures can be taken in the occupational health and safety sectors)
 - provide the scientific basis for midterm planning decisions (decadal climate predictions)
- Use of the German Climate Forecast System Version (GCFS) Version 2.1
 - hindcasts: 30 ensemble members, forecasts: 50 ensemble members
 - ECMWF Atos BullSequana XH2000, Bologna Italy, post-processing DWD HPC architecture
- Increase of the GCFS spatial resolution to 5km x 5km via a statistical down-scaling approach called EPISODES

www.dwd.de/climatepredictions

The e-shape pilot is accessible via the "Basic Climate Predictions" and "Seasonal Climate Predictions", as well as "Decadal Climate Predictions"

Climate Predictions for the Next Weeks to Years DE

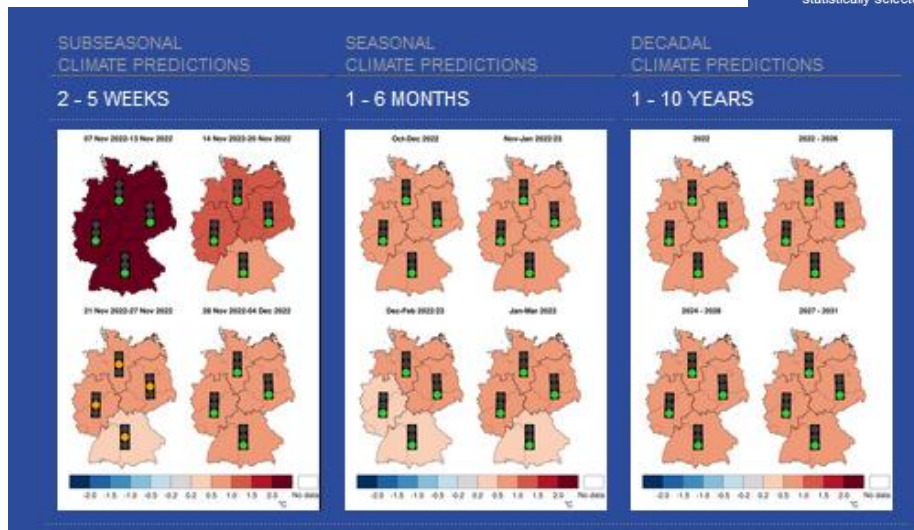
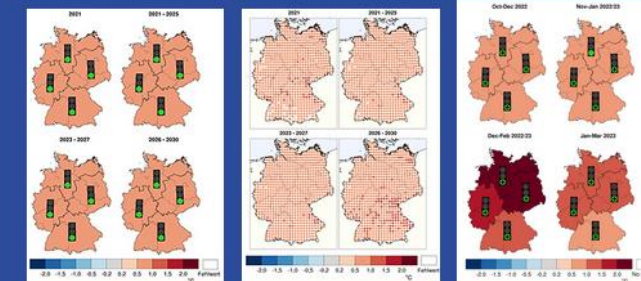


This is the website of the Deutscher Wetterdienst (DWD) for consistent selection of available climate predictions and corresponding timescales (weeks, seasons, years) and varying regions (Germany, Europe, World). All climate predictions on this website are improved continuously.

The climate prediction products on this website are based on the fact that there is no method that provides equally successful predictions for all regions. For some constellations, we therefore offer no climate prediction products for Germany in the winter half-year. Statistically selected seasonal climate predictions are used (if available, we will always explicitly mention this).

Between basic, expert and - as a complete package - as a complete package. Background information is available via feedback you may have on the website.

BASIC CLIMATE PREDICTIONS	EXPERT CLIMATE PREDICTIONS	SPECIFIC CLIMATE PREDICTIONS	Data and publications
Basic climate predictions consist of predictions for four regions in Germany and include information on the prediction skill displayed in traffic light format. Seasonal climate predictions are also available for a selected range of German cities.	Expert climate predictions provide more complex predictions for Germany, Europe and the whole world. The prediction skill is shown by the size of the dots representing the grid boxes. In addition, there are map representations of the prediction skill available.	Specific climate predictions are offered that deal with questions going beyond the general differentiation between basic and expert climate predictions. For example, one such topic is El Niño.	Animations > Access to data > Publications > Related products and links >



User Selection

Prediction Period (Month):

The seasonal climate prediction runs from the 1st of each month and is calculated for the next six months

Start of Prediction (Year):

The start year of the prediction can be selected

Region:

The predictions are available for different German regions, as well as for the capitals of the German federal states and Aschaffenburg

Variable:

temperature and precipitation

Type of Visualisation:

map, time series or table

Prediction Type:

ensemble mean prediction or probabilistic prediction

Data provision: ESGF Node at DWD, project ClimatePredictionsDE

Urban district of Stuttgart Probability of the Categories Dry/Normal/Wet in Comparison to the Climate Characteristics for 1991-2020				
Time Period	Category Normal	Dry	Normal	Wet
Jan-Mar 2022	100 - 137 l/m ²	40%	36%	24%
Feb-Apr 2022	80 - 145 l/m ²	36%	40%	24%
Mar-May 2022	109 - 183 l/m ²	34%	36%	30%
Apr-Jun 2022	163 - 211 l/m ²	26%	40%	34%

Probabilistic prediction for precipitation:

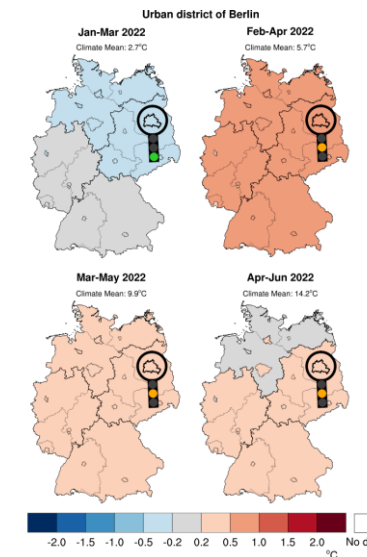
The table represents the probabilities of the three categories (Dry/Normal/Wet) of the climate prediction (3-month sum) in comparison to the climate characteristics for the time period 1991-2020.

Prediction skill:

The traffic light shows the prediction skill in the evaluation period 1990-2020:

- significantly worse than the observed climate mean
- comparable to the observed climate mean
- significantly better than the observed climate mean

© DWD: generated on 07 Jan 2022

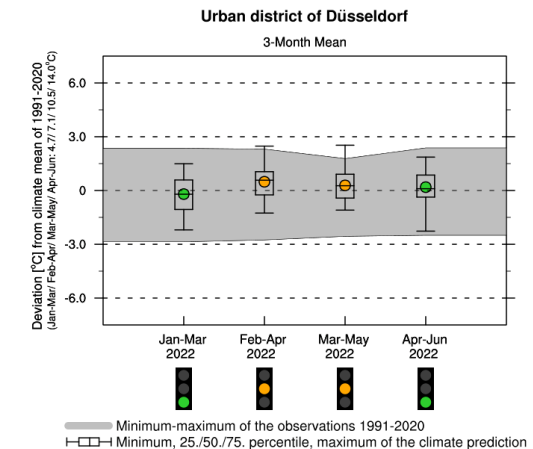


Ensemble mean prediction for temperature:
The colour represents the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1990-2020:

- significantly worse than the observed climate mean
- comparable to the observed climate mean
- significantly better than the observed climate mean

© DWD: generated on 06 Jan 2022



Ensemble mean prediction for temperature:

The coloured dots represent the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020. The box-whisker represent the distribution of the prediction ensemble. The area in gray shows the spread of the observations in the time period 1991-2020.

Prediction skill:

The traffic light shows the prediction skill in the evaluation period 1990-2020:

- significantly worse than the observed climate mean
- comparable to the observed climate mean
- significantly better than the observed climate mean

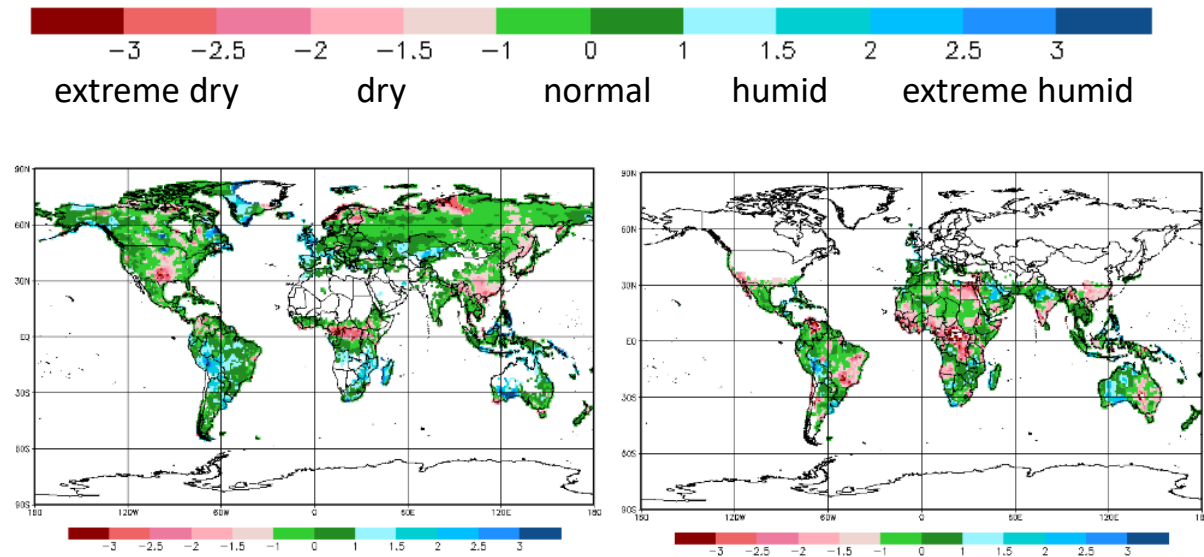
© DWD: generated on 06 Jan 2022

Outlook to planned extensions

Interactive presentation and selection of combined maps and time series for basic climate predictions

Further user-oriented products (e.g. drought and heat extreme values)

- SPI: Standardized Precipitation Index, not in very arid regions [McKee et al. 1993]
- SPEI: Standardized Precipitation Evapotranspiration Index, not in cold regions [Vicente-Serrano et al. 2010]



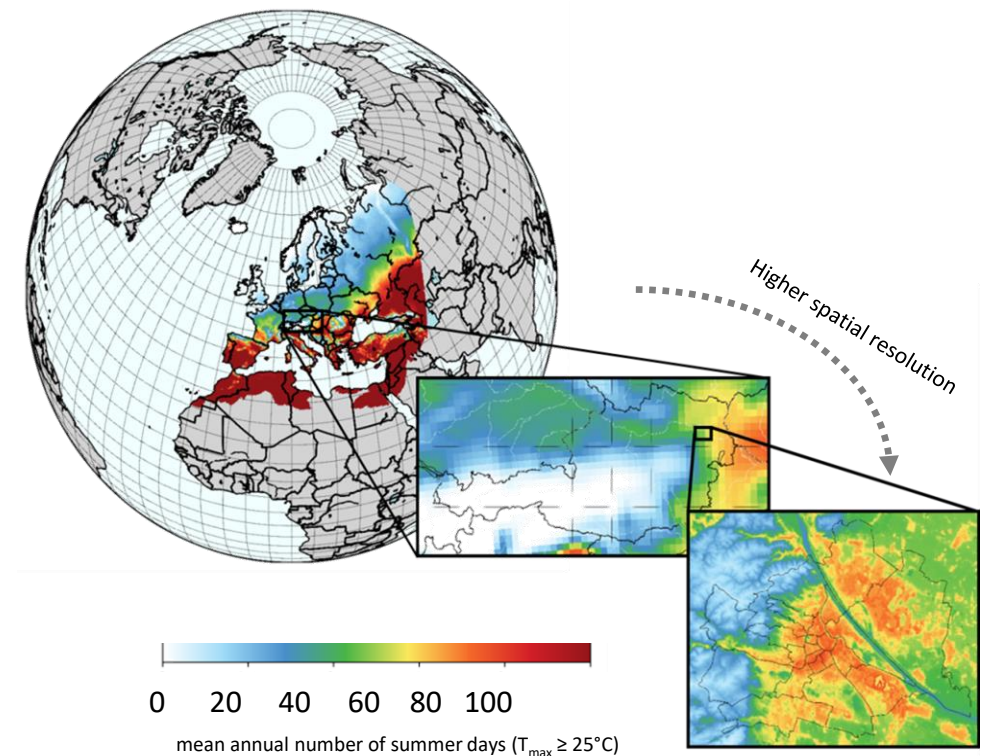
Ziese et al. 2014

GeoSphere Austria – Future climate projection of heat indices for major cities in Austria

Michael Avian, Sandro Oswald, **Maja Žuvela-Aloise**, Chris Schubert

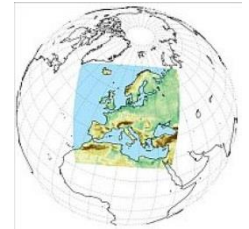
GeoSphere Austria – Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie, Vienna, Austria

- Climate scenarios on city-scale based on urban climate model simulations and climate projections from global (GCM) and regional climate model (RCM) outputs
- Product: High spatial resolution maps of heat indices including Climate Change and Urban Heat Island information
- Data are used as input for urban development plans, risk management, environmental protection
- Stakeholders: city administrations

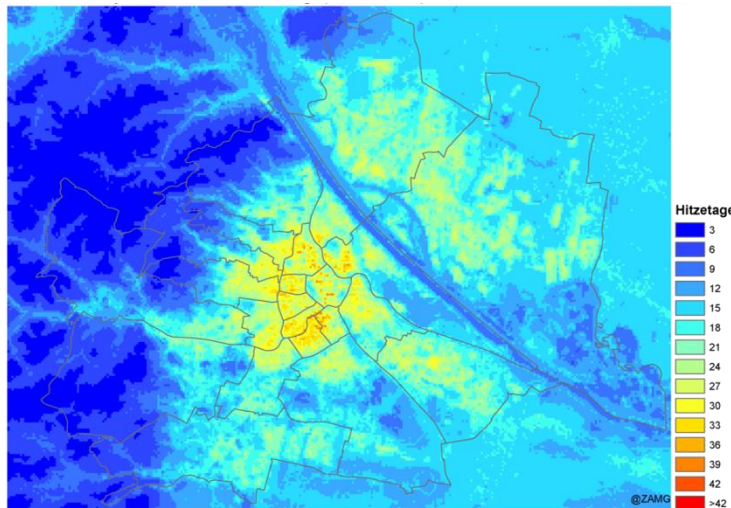


Pilot case developed for Vienna:

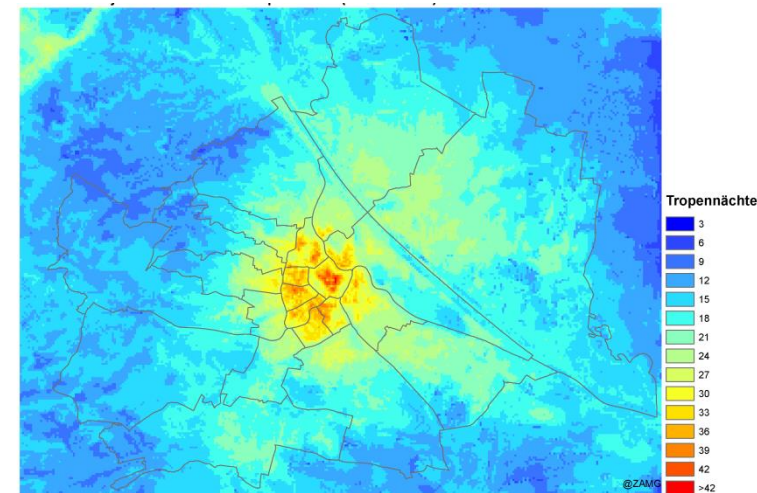
- Input EO data: Urban Atlas, Copernicus Land Monitoring Services, Land Information System Austria
- Input GCM/RCM data: EURO-CORDEX, IPCC RCP4.5 and RCP8.5
- Time period: 2011 - 2100
- Climate indices maps with 100 m horizontal resolution:
 - Mean annual number of summer days ($T_{\max} \geq 25^{\circ}\text{C}$), hot days ($T_{\max} \geq 30^{\circ}\text{C}$), tropical nights ($T_{\min} \geq 20^{\circ}\text{C}$)



EURO-CORDEX - Coordinated
Downscaling Experiment -
European Domain

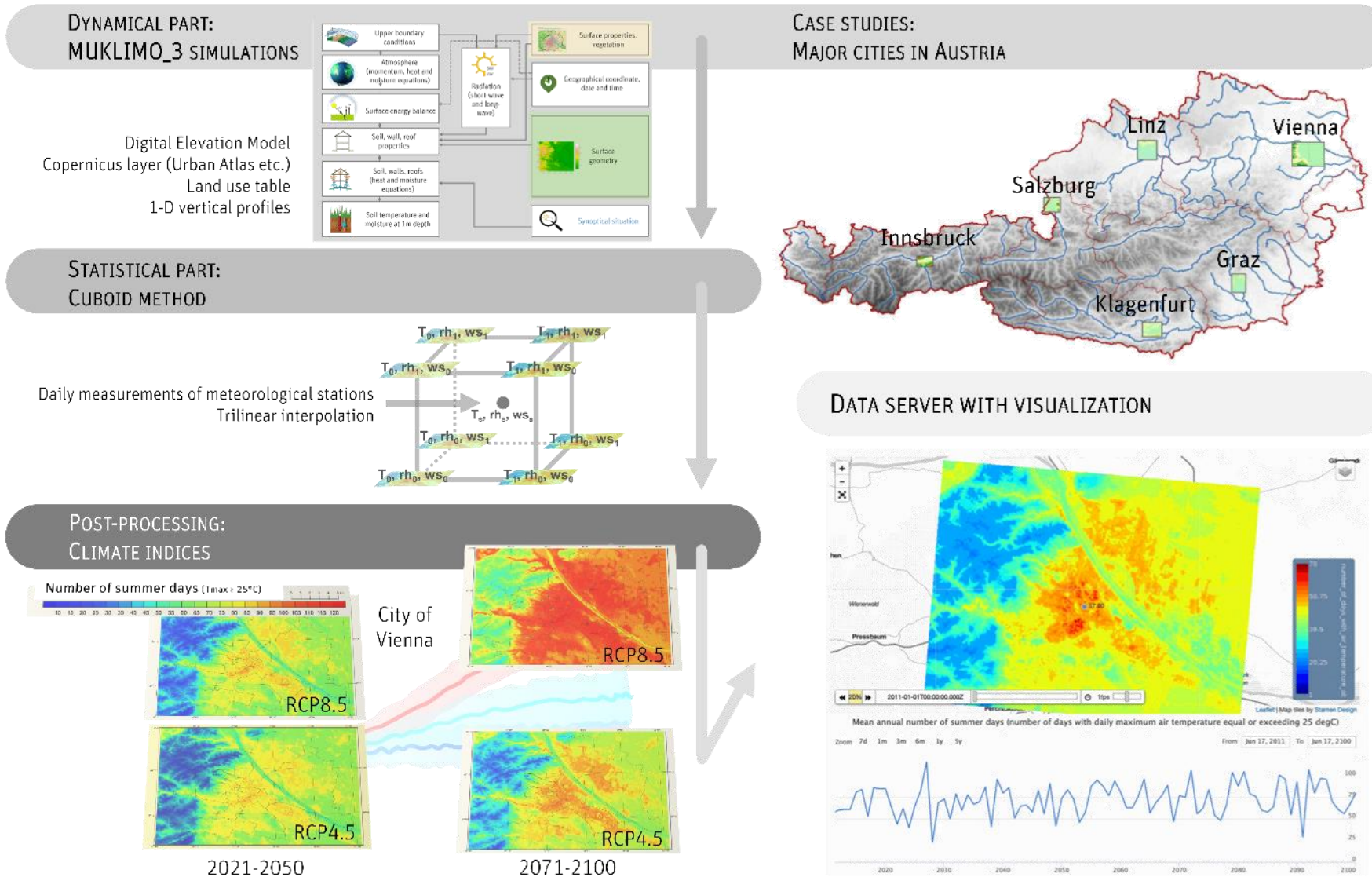


Mean annual number of **hot days** for the time period
1991 -2020

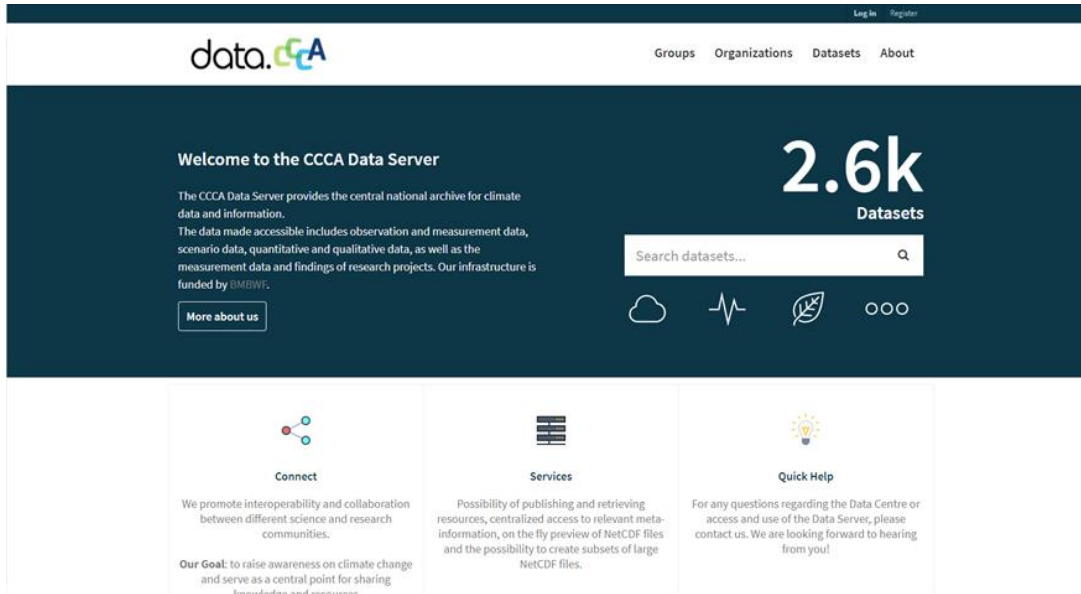


Mean annual number of **tropical nights** for the time
period 1991 -2020

Methodology



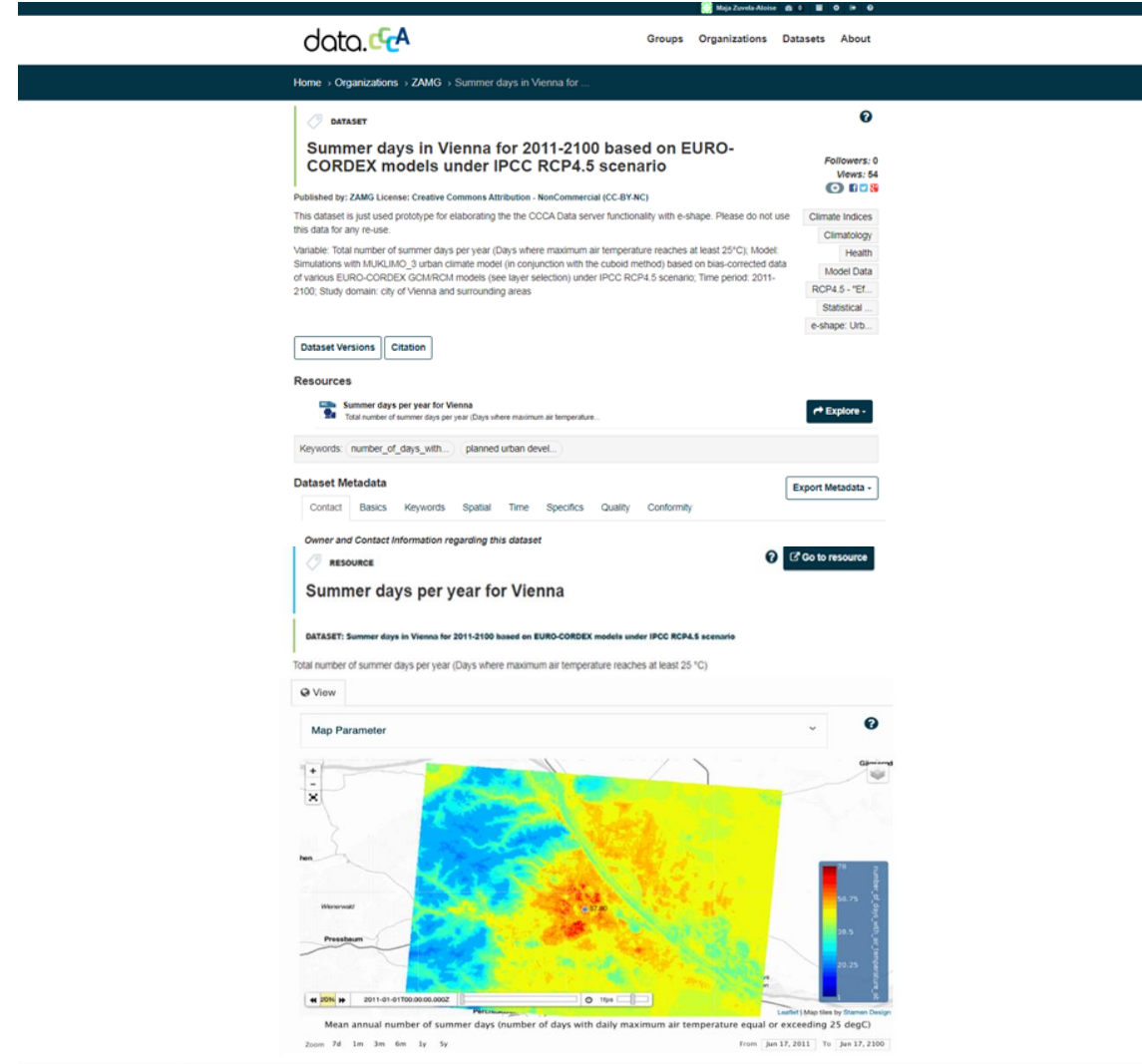
Data access



The screenshot shows the homepage of the CCCA Data Server. At the top, there's a navigation bar with 'data.ccca' logo and links for 'Groups', 'Organizations', 'Datasets', and 'About'. Below this, a large dark blue banner contains the text 'Welcome to the CCCA Data Server' and '2.6k Datasets'. A search bar is present with the placeholder 'Search datasets...'. Below the banner, there are three columns of information: 'Connect' (promoting interoperability), 'Services' (publishing and retrieving resources), and 'Quick Help' (contact information). At the bottom, there's a 'More about us' button.

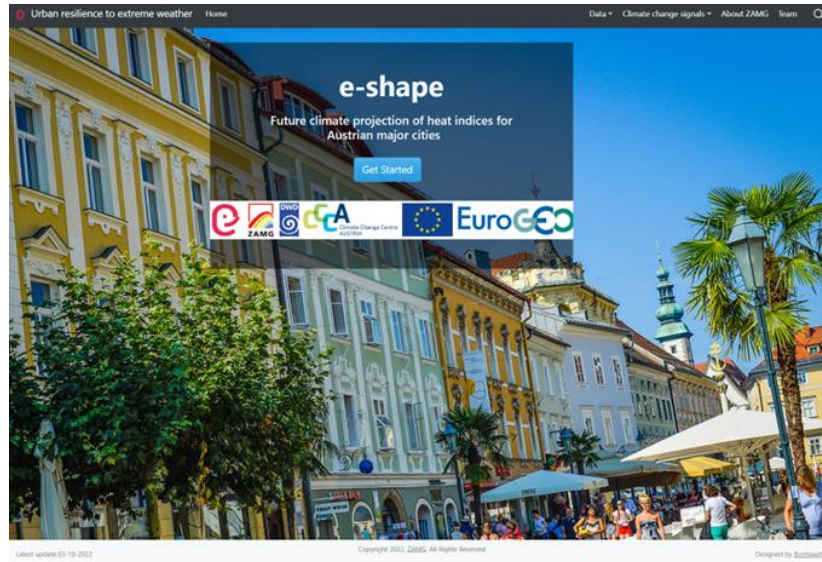
- Data available at Climate Change Center Austria (CCCA) Data Server (data.ccca.ac.at)
- Data download in netcdf Format
- Export of metadata, citation and version tracking
- Visualization of maps and timeseries

Urban resilience to extreme weather - climate service



The screenshot shows a dataset page on the data.ccca.ac.at website. The dataset is titled 'Summer days in Vienna for 2011-2100 based on EURO-CORDEX models under IPCC RCP4.5 scenario'. It includes a description of the dataset, a search bar, and a 'Dataset Versions' section. Below this, there's a 'Resources' section with a link to 'Summer days per year for Vienna'. The page also features a 'Dataset Metadata' section with tabs for 'Contact', 'Basics', 'Keywords', 'Spatial', 'Time', 'Specifics', 'Quality', and 'Conformity'. A 'Map Parameter' section is visible, showing a map of Vienna with a color-coded overlay representing the number of summer days. The map is titled 'Mean annual number of summer days (number of days with daily maximum air temperature equal or exceeding 25 degC)' and shows a color scale from 15 to 25. The map is set for the year 2100 and the location is Vienna, Austria.

Pilot webpage



- More information available on pilot webpage:

<https://e-shape.egitlab.zamg.ac.at/e-shape/>

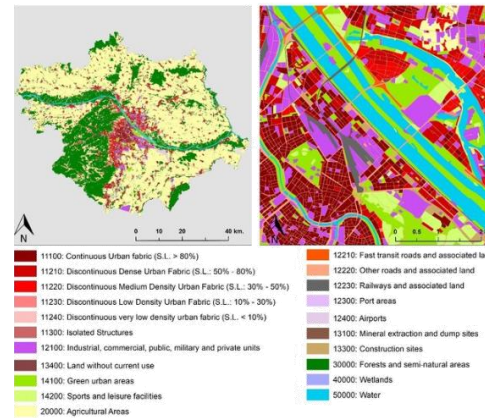
- Method and input data description
- Climate change signals and links to data download

Land use and land cover

Classification to distinguish between urban areas, vegetation, bare soil and water

1 Urban Atlas

The Land Use (LU) classification of the Urban Atlas (UA) was merged with information obtained from the local municipal authority, including nearby districts, to statistically analyze the LU characteristics. These classification were used to characterize each LU class's basic urban features such as the fraction of buildings, streets, vegetation and bare soil (see below).



2 LISA

In addition, data from the Land Information System Austria (LISA) were used, which covered huge areas of Austria with a 1 m resolution. LISA provides extensive land cover data derived from satellite pictures from 2014 to 2016 and includes eleven distinct land cover types, such as buildings, steets, trees, annual crops, and cobblestone sidewalks.



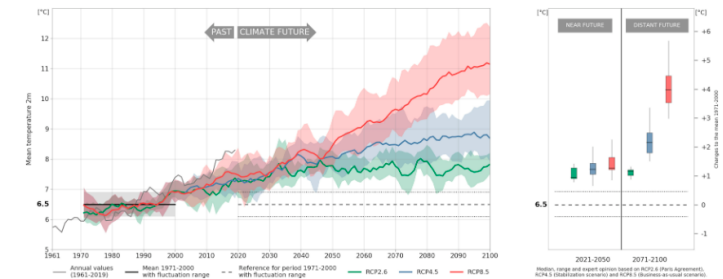
Climate projections

Representative concentration pathways

1 EURO-CORDEX

The World Climate Research Programme launched the Coordinated Regional Downscaling Experiment (CORDEX) with the goal of supporting, coordinating, and improving regional climate scenarios through global collaboration. The EURO-CORDEX research project for Europe aggregated future climate forecasts through Regional Climate Models (RCMs) at 50 and 12.5km spatial resolution based on RCPs as established in the Intergovernmental Panel on Climate Change's Fifth Assessment Report. These models give data on key meteorological characteristics through 2100 under various climate change scenarios.

We used model outputs from three different RCMs combined with six Global Climate Models at the 12.5km spatial resolution under RCP4.5 and RCP8.5 for the time period 2011-2100 to estimate possible future urban climate scenarios from the EURO-CORDEX model database. RCP4.5 is a scenario in which CO₂ emissions peak by 2040, whereas RCP8.5 represents a more extreme scenario in which CO₂ emissions continue to climb until 2100.



Past observed (1961–2019) and future projected (5-year running mean regional climate model simulations for scenarios RCP2.6, RCP4.5, and RCP8.5 in the period 1970–2100) annual mean temperatures for Austria (left) and climate change signal compared to the 1971–2000 period (right). Shaded hues represent the bandwidth per scenario provided by the various climate models, whereas solid lines represent the model median. Source: [Olefs et al. \(2021\)](#)

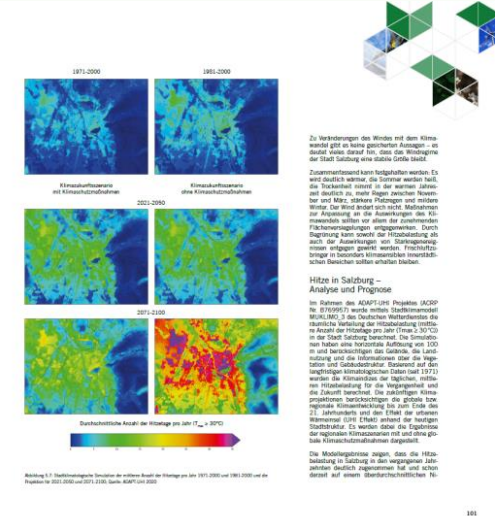
Applications in Austrian cities

Salzburg:

- Assessment of urban climate conditions for the new spatial development concept (REK-Räumliche Entwicklungskonzept)
- Evaluation of climatological measurements, modelling of cold air outflow and urban heat load, as well as future scenarios



<https://www.stadt-salzburg.at/rek-grundlagenbericht/>



Innsbruck:

- Urban climate analysis in scope of the Action plan 2020/21 of the Innsbruck climate change adaptation strategy
- Climate assessment and urban climate modelling with MUKLIMO_3 model



<https://www.ibkinfo.at/stadtklimaanalyse>



Development of Climate Services for urban areas



01

Urban Climate Assessment

measurements, modelling

02

Future Climate and Urban Development

regional climate scenarios, urban climate modelling

03

High-resolution Climatological and Environmental Analysis

measurements, modelling, thermal and wind comfort, fresh air circulation, environmental impact assessments

04

Basis for Decision-Making Process and Urban Planning

climate analysis maps, solar potential, urban planning guidelines

05

Weather Forecast for urban areas

heat waves and extremes, thermal comfort

06

Consulting

Stakeholders, knowledge transfer



Pilot publications: Research Letters - e-shape special issue

Received 26 Nov. 2021, accepted 31 May 2022, first online 02 Jun. 2022, published 02 Sep. 2022

Seasonal climate predictions for German cities to strengthen urban resilience to climate variability

SASCHA BUCHHOLZ, ANDREAS PAXIAN, BIRGIT MANNIG, AMELIE HOFF
Deutscher Wetterdienst

11 | FHS CLIMATE BULLETIN: RESEARCH LETTERS 1/2022

DOI: 10.3390/RS14247234-234-8408-1R-2022-08-RL

Future climate projection of heat indices for Austrian major cities: strengthening urban resilience and meeting user needs

Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Vienna, Austria
Vienna University of Technology (TU Wien)

PM's CLIMATE BULLETIN, RESEARCH LETTERS | 2022 | 19

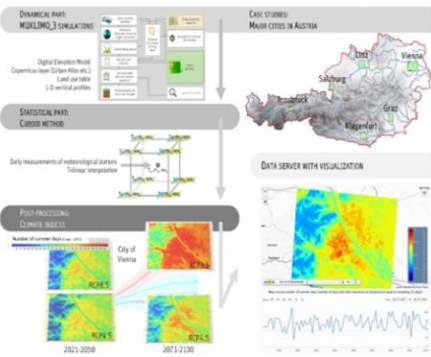
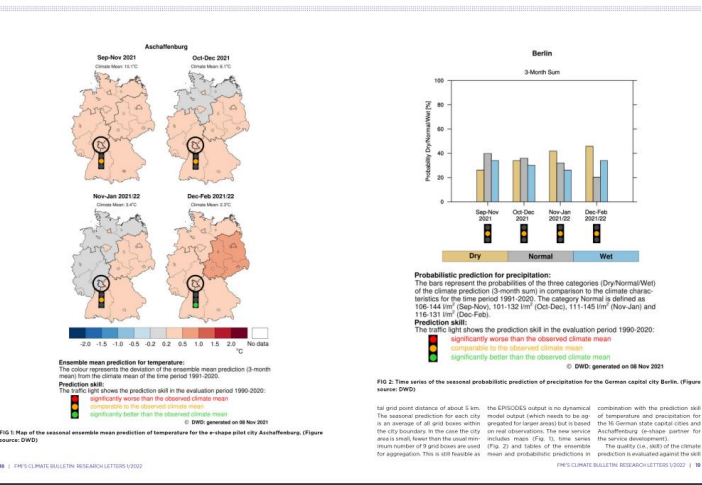


FIG 1: Schematic workflow of deriving climate indices based on EO data, urban climate model simulations and regional climate projections for the major cities in Austria. Top and mid left: Modelling system including integration of the EO data and below the cuboid method is illustrated. Lower left: Number of summer days for the city of Vienna as a 30-year average for the scenarios RCP4.5 and RCP8.5 as well as the periods of 2021-2050 and 2071-2100. Lower right corner: Number of summer days for Vienna (spatial information, time series) visualised on the Climate Change Centre Austria (CCCA) data server. Download [here](#) for full-size image. (Source: ZAMG)

Urban climate model simulations. density etc.) as input data to describe future distribution within urban areas

and the cooperation with Germany's National Meteorological Service (DWD), the ZAMG carried out urban climate model simulations with the MUKLIMO_3 model (Siewers 2016), which allows utilization of various

TIME-SCALE	OUTLOOKS	WEATHER CONDITIONS DESCRIBED	VARIABLES USED IN RISK DEVELOPMENT
------------	----------	------------------------------	------------------------------------

Low level snow (less than 10 cm)	Breasing and mild weather	\pm temperature	90% of a day period
	Snowfall or snow melting followed by successive days with freezing weather conditions	\pm temperature	>90% of a day period
	Mild weather > 7 consecutive days with warmer weather conditions	2 m temperature	Tmean > 0 °C during > 90% of a day period
Snow accumulation	Probability of weekly average snow depth	Snow depth, snow density	Weekly average snow depth
Slippery conditions for pedestrians	Weather conditions favourable for slippery conditions on sidewalks	2 m temperature, total precipitation, snow depth	Tmin = -2...-21°C Precip = 0.1 mm OR Snow > 1 cm
Conditions for spring street cleaning	Freezing weather conditions without road salt needed anywhere on the streets	2 m temperature, snow depth	Tmin < 0 °C and snow > 1 cm

TABLE 1: The winter preparedness outlooks developed for and with the City of Helsinki

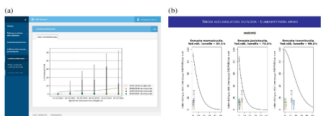


FIG 1: Examples of winter preparedness outlooks for the City of Helsinki: (a) weekly snow accumulation issued on 15 Nov 2021 on the [linstatic](#) portal, (b) monthly snow accumulation outlook published on the [seasonal.fmi.fi](#) portal on 17 Nov 2021.

of FMI and disseminated through the Instat/Inmet platform developed within FMI. The seasonal product, snow accumulation outlook, is processed in WEGEO, a Copernicus DIAS service and disseminated through the seasonal.fmi.fi web portal. Examples of weekly and monthly snow depth outlooks are presented in Fig. 1. The service was deployed, and the first weekly outlooks published in December 2020. The project timeline is divided into two Sprints, and Sprint 1 has been completed at the time of writing. During Sprint 1, sub-seasonal temperatures and seasonal snow accumulation have been bias-adjusted. The bias adjustment of sub-seasonal snow

DOI: 10.3390/1959-234-8408-1R-2022-04-RL

Urban resilience to extreme weather - sub-seasonal and seasonal forecasts for winter maintenance activities in Helsinki

OTTO HYVÄRINEN, ANDREA VAJDA, MIKA RANTANEN, ANDREAS TACK, MÄRKUS SILVENNOINEN
University of Jyväskylä, Department of Mathematics

The outlooks for slippery conditions were used as background information. Moreover, as decisions to sand or not to sand are made on a daily basis, the outlooks for slippery conditions were also used for the near future. This is planned for sub-models snow depth and 2 m temperature validation have been presented

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Journal of Animal Ecology, **75**,
1001–1012

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FMI'S CLIMATE BULLETIN

RESEARCH LETTERS
1/2022

<https://issuu.com/fmi-ik/docs/rl-e-shape> special issue-1-2022

Thank you!



www.e-shape.eu