Becoming a CityCLIM Citizen Scientist: A Comprehensive Guide

Comprehensive guidelines on becoming a Citizen Scientist in CityCLIM, covering aspects from understanding the concept of a Citizen Scientist, their role in the CityCLIM ecosystem, to the processes for becoming one, collecting data, submission practices, and the rewards and recognition they can receive.

October 2023

Foreword

Dear Reader,

We are delighted to present this guide to understand the contributions of citizen scientists to our CityCLIM project, and to guide you on your journey to becoming a citizen scientist.

Citizen science is a transformative concept that empowers individuals like you to contribute to scientific understanding and innovation. By participating in CityCLIM as a Citizen Scientist, you will have the opportunity to actively contribute to the study of our urban climates, adding to our collective knowledge and taking meaningful action.

The manual is aimed at citizens who live in the CityCLIM pilot cities (Karlsruhe, Valencia, Thessaloniki and Luxembourg) and want to provide us with weather data measured by weather stations, citizens who use the sensors provided in the project to measure small-scale weather data, or citizens who live in and outside the CityCLIM pilot cities and want to provide us with historical meteorological data. Especially, meteorological data such as air temperature, humidity, air pressure, wind speed, wind direction, rainfall, UV levels and light intensity are of interest for the CityCLIM project. We do not distinguish between mandatory and optional data. Data is always valuable to us. It does not matter whether you can provide only one or several parameters from this list. The collected data are mainly used to verify the CityCLIM model after a successful plausibility check and therefore a significant part of the improvement of the CityCLIM services. Finally, you could provide data to evaluate and visualize the changing urban climate in the pilot regions.

This guide will provide you with information on what it means to be a citizen scientist and the types of data that can be collected in general, and will guide you through the process of becoming a citizen scientist with CityCLIM, from understanding the basics of your possible contributions, to the specifics of the sensors used, data collection and submission. It will also introduce you to the reward and recognition system we propose to thank you for your valuable contributions.

We believe that everyone has a role to play in shaping the future of our cities, and by participating as a citizen scientist you can make a real and tangible impact. We hope this guide will inspire and enable you to take this important step.

We look forward to embarking on this exciting journey with you.

Sincerely,

The CityCLIM Consortium

Content

1 What is a Citizen Scientist?

1.1 What does it generally mean to be a citizen scientist?

Citizen scientists are not trained scientists, but ordinary people who take part in scientific activities such as collecting and analysing data. They give their time and skills to support professional scientists in fields as diverse as ecology, astronomy and biology, even without formal training. Their involvement includes tasks such as collecting data, observing things, analysing information and finding solutions in areas such as environmental monitoring. New technologies such as apps and dashboards allow citizen scientists to actively participate in research by sharing local observations, participating in online data analysis, and contributing to large-scale data collection projects.

The contributions of citizen scientists are incredibly valuable to scientists. They extend research projects by collecting data at larger, more detailed scales and over longer periods of time than scientists could manage alone. This team approach to science combines the efforts of many people to tackle complex scientific questions and challenges that would be difficult or impossible for a small group of researchers to tackle alone. In this way, citizen science empowers individuals to play an important role in the scientific process, makes research more inclusive, and speeds up the collection and analysis of data, leading to the discovery of new knowledge that might otherwise remain undiscovered.

The key aspects of the concept of citizen scientists include following points:

Citizen Science Projects Bring People Together	Citizen science projects want to include a mix of participants. This means people from different backgrounds, ages, and experiences can join in. This mix of people can help us see scientific questions from different angles and might help us find new patterns or ideas.
People Volunteer for Science	Citizen scientists are regular people who volunteer their time and effort because they're curious and interested in science. They're not paid for their work; they do it because they genuinely care about the topics.
Helping with Data	Citizen scientists can do a few different tasks. They might watch animals, note down the weather, check the air quality, look at stars, or even study pictures or information online
Teamwork with Experts	Citizen scientists usually work with real scientists who guide them. These experts make sure the data collected is good and trustworthy.
Tech Makes It Easier	New technology like smartphones, sensors, and websites help citizen scientists take part from far away. They can also share what they find with other people and scientists.
More than Just Data	Citizen science projects don't only gather data. They also want to get people interested in science and help them learn more. These projects can teach things and make people feel like they're a part of science.
All Sizes of Projects	Citizen science projects can be small, like in a community, or huge, covering the whole world. People might watch over a local river or help map out plants and animals everywhere.
Important Impact	Good data from citizen scientists can change the way the politicians make decisions and rules and take care of things, especially for the environment and public health.

The role of citizen scientists in science is really important in many ways. Usually, they make science fairer and more understandable for everyone by:

- gathering lots of data in many different places, so they collect more data than scientists alone could
- helping to study large areas and often over long time periods
- their local knowledge, give scientists information they might not know
- Being a cheaper alternative to researchers; people volunteer because they love the subject.
- Learn by doing; citizen science projects teach people about science and helps them to . learn more and get curious about science.
- Data from citizen scientists can influence rules and decisions. Policy makers might listen to this data when they make plans for the environment.
- Citizen scientists use new tools like phone apps and sensors. These help find new ways to collect and study data.
- Citizen science is open. It helps people trust science and researchers.
- Citizen scientists help with significant problems of the present such as climate change and health diseases.

Your support is needed in the CityCLIM project.

1.1.1 What kind of data are collected by Citizen Scientist in general?

Citizen scientists can collect a wide range of data that can contribute to a variety of different research projects. The type of data they can collect depends on the nature of the project, the goals of the research, and the resources available to the participants. Some examples are recording sightings of plants, animals, insects and birds in specific locations; collecting water samples to analyse factors such as pH, temperature and nutrient levels; tracking local weather conditions by recording temperature, humidity, wind speed and precipitation; noting the timing of leafing, flowering, fruiting and other seasonal changes in plants (phenology); measuring noise levels in urban and rural areas to assess noise pollution; collecting samples from rivers, lakes or coastal areas to assess water quality and potential pollution, participating in disease surveillance by reporting symptoms, potential disease vectors, or public health concerns; documenting historical sites, artefacts, or landmarks in their local area; conducting surveys or interviews related to social or cultural aspects of a community; collecting data on changes in land use, urban expansion, or deforestation in an area; helping to analyse and classify images on online platforms; and observing animal behaviour, such as bird nesting habits or animal interactions. Citizen scientists can contribute to research by collecting, recording and sharing this type of data.
These examples show that the opportunities for citizen scientists to get involved are many and varied.

1.1.2 What are the steps to become a citizen scientist in general?

Are you curious about the natural world around you? Do you have a passion for discovery? Then you're in the perfect position to become a citizen scientist! Support the research community, where your observations and contributions can help researchers uncover new insights and make a real difference.

Figure 1: Workflow to become a citizen scientist in general

1.2 What does it mean to become a Citizen Scientist in CityCLIM?

Did you know that many cities frequently experience heat waves during the summer, and due to the urban heat island effect, the inner city is 7 degrees warmer than the surrounding rural area (often due to high humidity).

In the **CityCLIM project**, we aim to provide advanced weather and climate services tailored specifically for cities, so that we can gain insight and better plan for events such as heat waves, which can kill tens of thousands of people in urban centres. Part of the data for the CityCLIM climate service comes from citizens themselves. We are looking for citizen scientists to help us understand our local urban climate so that we can better plan for events such as heatwaves, which can heavily affect the health of citizens in urban centres. So anyone who is interested in climate action and wants to collect their own weather data, evaluate the data and services, and co-design climate adaptation strategies for their local community can get involved.

Join us in the CityCLIM project and don't let climate change win.

Become a weather observer.

1.2.1 How can you support our CityCLIM project?

In the **CityCLIM project** you can provide a valuable input in our research by:

	We are looking for	To participate, you will need to
Becoming a mobile weather sensor!	**Bicycle commuters** or those that use bicycles as their main mode of transportation or exercise. If you have an interest in climate science and meteorology, that's great! But you don't need to have any prior training or knowledge, just an interest. The interactive events and workshops in this project will give you an understanding of the scientific method and give you the chance to be a part of the solution.	Own or purchase a portable weather sensor called a **MeteoTracker** for your bicycle. If you don't have a MeteoTracker but still want to participate, we have a limited amount (10 MeteoTrackers, https://meteotracker.com/) that we can lend out. However, it is preferable to have your own MeteoTracker because they are inexpensive and you can keep using it to learn and understand about local climate even after the project finishes. The data you collect from the MeteoTracker over 3 months (May, June, July) will be used to generate climate information maps like the one below.
Sending us your weather station data	**Weather enthusiasts and amateur meteorologists** that own a stationary weather station. If you have an interest in climate science and meteorology, but you don't yet own a weather station and would like to participate, we have a limited amount (10 National Geographic Weatherstations) that we can lend out. However, it is preferable to have your own weather station because they are inexpensive and you can keep using it to learn and understand about local climate even after the project finishes. There are many websites such as Weather Underground that allow you to see people's weather stations and to connect yours. The interactive events and workshops in this project will give you an understanding of the scientific method and give you the chance to be a part of the solution.	Own or purchase a **stationary weather sensor** (preferably the National Geographic 7-in-1 Weatherstation, https://www.bresser.de/en/Weather-Time/NATIONAL-GEOGRAPHIC-WIFI-Colour-Weather-Station-with-7in1-Sensor.html). If you don't have a weather station but still want to participate, we have a limited amount (10 National Geographic Weatherstations) that we can lend out. The reason we prefer the National Geographic Weatherstation is because we know that we are able to connect these stations directly to our API, where the data will be sent automatically and we can then analyse and visualize the data. If you own another type of weather station, you may need to download the data periodically and send it to us manually. The data you collect from the stationary sensors over 3 months (May, June, July) will be used to generate climate visualisations and see trends like the charts below. You will be able to see these on an exclusive e.g., Stadt Karlsruhe platform to look at the data you collected. This data will contribute to city climate services that provide insights for climate adaptation strategies.

Sending us your historical weather data	**Weather enthusiasts and amateur meteorologists** that have been keeping their own records of local weather. Maybe you tracked temperature and rainfall to help with your farming or gardening projects? Maybe you had to keep a weather journal for school? Maybe you found a grandparent's old weather diaries? If you have any kind of historical weather data, we would like to see it!	Have **digital copies of your historical weather data**, you can enter the information in a web form manually on our website. The data you submit will be analysed by professional meteorologists who will use the data to create climate visualisations and see trends of how the weather has changed over time. You will be able to see these on an exclusive Stadt Karlsruhe platform to look at the data you collected. This data will contribute to city climate services that provide insights for climate adaptation strategies.

1.2.2 How can you additionally support our project CityCLIM?

We would like to take a moment to express our sincere appreciation for your potential diverse and invaluable contributions to our CityCLIM research project. Your diverse contributions go beyond mere data collection - they enhance the research process by fostering collaboration and broadening the impact of the project.

But that's not all! We invite you to consider taking your support even further. Your unique skills and experience can make a real difference:

1. If you're curious about patterns and numbers, you could help us analyse the data we've collected so far. Your insights could reveal hidden discoveries.
2. Ensuring data accuracy is vital. By validating the data collected by your fellow citizen scientists, you can help maintain the quality of our dataset.
3. Got a story to tell? Share your journey and findings with a wider audience and inspire others to get involved.
4. Your local networks are invaluable. Help us spread the word about our research project and inspire curiosity and engagement in your communities.
5. Empower newcomers by running training sessions and sharing your expertise in data collection techniques.
6. Your perspective matters. Work with us to refine our data collection methods, making them more effective and insightful.
7. Whether through blogging, social media or public speaking, your voice is important in extending the reach and impact of our project.
8. If you know people who have historical weather data, your efforts to collect this information could be incredibly valuable.
9. For those with a long-term commitment, monitoring a particular area over time will provide us with invaluable extended data.

Your involvement and contribution has the power to democratize science, making it more inclusive and dynamic. Together, we can uncover insights and create an impact that extends far beyond the confines of a research project. Thank you for being a possible essential part of our team.

1.2.3 How can CityCLIM acknowledge your valuable contribution

We know that you give your time and skills to support us in CityCLIM. To acknowledge your valuable contribution, it's crucial to reward and recognize your efforts. We assume that this not only motivates your ongoing participation but also cultivates a sense of gratitude within the community. Ways to achieve this recognition may include:

Certificates	Giving you a certificate to show you took part in this project and acknowledge your valuable contributions.
Your name in publications	Putting your name in reports, research papers or other publication to show you helped a lot.
Project-branded merchandise	Giving out some project-branded merchandise like shirts or hats. So you can proudly display your involvement in the CityCLIM project.
Annual Awards or Prizes	Giving prizes each year to the best citizen scientists in a ceremony
Online Profiles	Letting you make profiles online at the CityCLIM website to show what you did
Blogs and Articles	Asking you to write about your experiences which can be published in blogs or our social media channels
Special Events	Inviting you to special workshops or conferences to offer you the opportunity for further learning, networking, and engagement.
Co-Authors	For significant contributions, we will let you be a co-author on research papers.
Local Recognition	Place articles or other information about your support in local newspapers, community newsletters or public events to build community pride and showcase your commitment.
Project Involvement	We can involve you in project decision-making to increase your sense of ownership and recognition as a valued team member.
Personal Feedback	We can provide personalised feedback to let you know how your work has contributed to the CityCLIM project.
Learn New Things	Giving you the chances to learn new skills, such as data analysis techniques or using specialized equipment.
Collaboration	We creating avenues for you to collaborate directly with professional researchers on specific aspects of the CityCLIM project.
Stay Involved	We acknowledging the longevity of your participation by offering increasing levels of recognition for your continued involvement.

We want to show that we really appreciate and value your contributions to the CityCLIM project. At the moment CityCLIM is focusing our rewards on project branded merchandise products such as T-shirts and caps and personalized certificates. We are currently carrying out some surveys to find out which rewards are most appropriate from the citizens' point of view. The following reward strategies are possible:

Figure 2: Possible CityCLIM reward strategy

1.2.4 What are the steps to become a citizen scientist in CityCLIM?

As you have seen, your journey as a citizen scientist starts with a single step. You can join the CityCLIM team if you are interested in e.g. sensors, weather data and how to measure it, climate change especially in cities, being part of a community activity. There can be many different reasons why you would like to take part in the activities of our project.

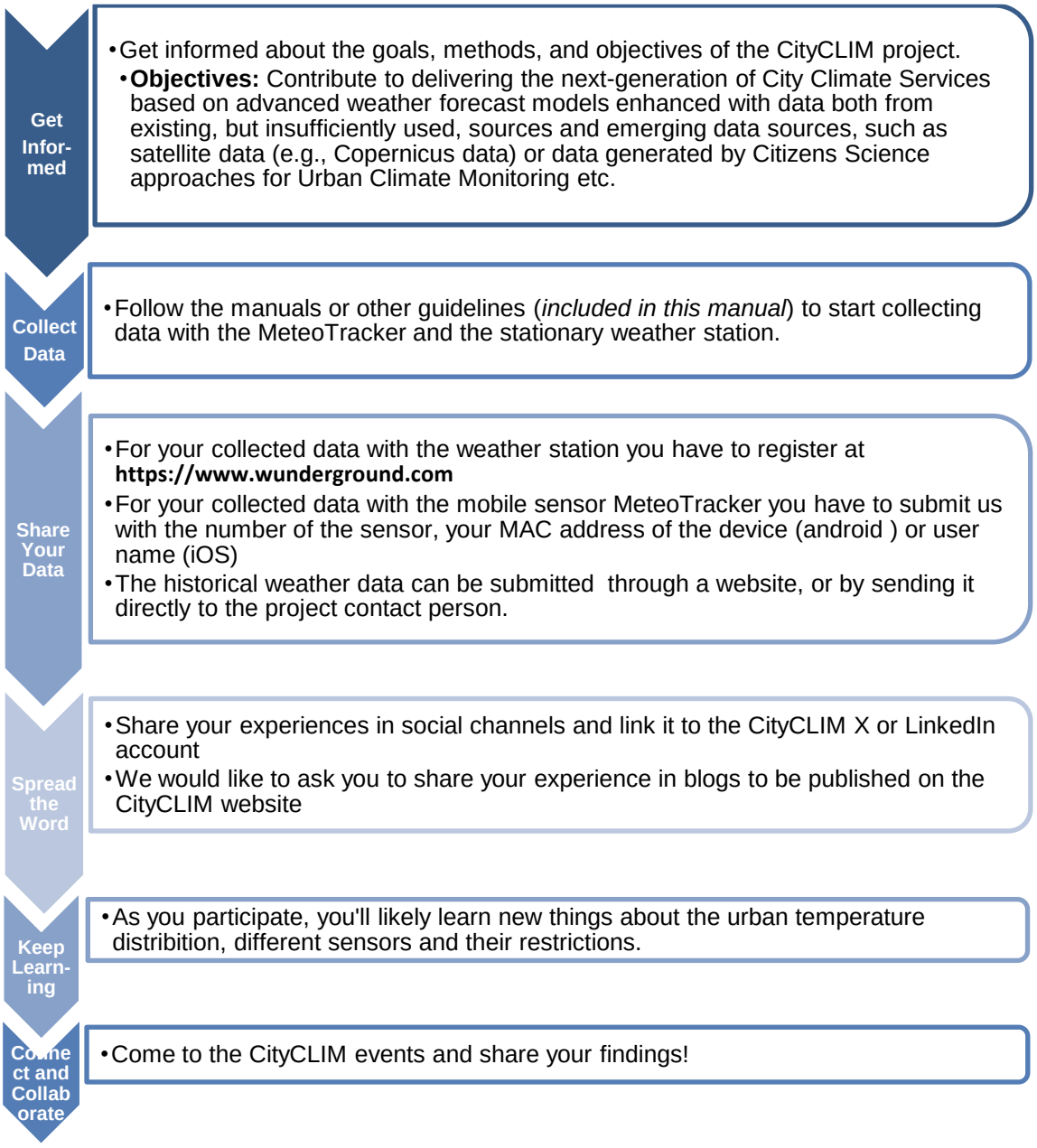


Figure 3: Workflow to become a citizen scientist in CityCLIM

2 How to become a Weather Observer?

2.1 What is Weather?

Weather refers to the atmospheric conditions at a particular place at a particular time and includes elements such as temperature, humidity, wind, air pressure, cloud cover, precipitation and various weather phenomena. Meteorologists analyse these factors to make forecasts that are essential for activities ranging from agriculture to disaster preparedness.
Usually citizens like you can contribute to the collection of weather data by measuring or observing:

- Air temperature at regular intervals.
- Relative humidity, which indicates the amount of moisture in the air.
- wind speed and wind vanes to determine wind direction using instruments like anemometers
- Atmospheric pressure, which helps in understanding changes in weather patterns.
- Cloud cover by describing the type and amount of cloud cover in the sky.
- Amount of rain, snow, or other forms of precipitation.
- Significant weather events, such as thunderstorms, fog, or visibility changes.

For example, since 1980, the National Weather Service has relied on some several thousand citizen scientists across the United States to track weather patterns and provide critical observations that help develop climate standards and improve our understanding of weather and climate over time. These volunteers make observations on farms, in urban and suburban areas, national parks, seashores, and mountaintops to provide near real-time observational weather data, typically consisting of daily high and low temperatures, snowfall, and 24-hour precipitation totals, to support NWS forecasts, warnings, and other public service programs.

Typically, these observers can use either specialised equipment or low-cost sensors in conjunction with established protocols to ensure the accuracy and consistency of their observations. It is important to consider factors such as ease of use, data accuracy, durability and cost when selecting sensors for volunteers or citizen science projects.
The data collected by volunteers or citizen scientists contributes to the compilation of weather reports and forecasts, helping society make informed decisions related to agriculture, transportation, emergency management, and more.

Become a Weather Observer if you are interested in weather, sensors and want to contribute to weather reports and forecasts.

A weather observer is a person who collects and records various meteorological data for the purpose of monitoring and analysing weather conditions. You as an observers play a crucial role in providing accurate and up-to-date information about the current state of the atmosphere. This information is essential for many things such as weather forecasting, climate research, and emergency actions.

2.2 Why become a weather observer in CityCLIM

Europe's cities are increasingly suffering from the effects of climate change. Prolonged heat waves pose a threat to public health. To counter this threat, it is important to understand its causes and to identify appropriate countermeasures in good time. This is why the EU is funding the project "Next Generation City Climate Services Using Advanced Weather Models and Emerging Data Sources", or CityCLIM for short, as part of its Horizon 2020 programme. The aim of the project is to develop a cloud-based platform that provides a range of weather and climate services specifi-

cally for urban areas, based on data from weather models, earth observation and in-situ measurements. The project will be implemented by a consortium of companies in collaboration with scientific working groups and four European pilot cities.

As a result of climate change, heat waves are becoming more frequent. Densely populated areas are particularly affected by high temperatures, as the heat tends to last longer and temperatures rarely drop at night. For this reason, the health burden of heat in cities is significantly higher than in the surrounding areas. The CityCLIM project therefore aims to develop a weather forecast model tailored to the needs of large cities. Unlike conventional forecast models, which typically have a resolution of several kilometres, the new model will have a resolution of one hundred by one hundred metres. In addition, the model will combine data from weather satellites with measurements from the air and information collected on the ground. Data sources to be integrated are existing services of the European Earth observation programme Copernicus as well as information from the population itself. The calculations produced by the improved model will be made available to the general public in the form of various weather and climate services. In addition, further services are planned specifically for city councils and other authorities. Among other things, these will make it possible to examine the impact of urban planning measures in response to climate change. For example, analysis of the impact of green spaces and water bodies on the urban climate will be considered. The CityCLIM project is also working closely with four pilot cities to ensure that the weather and climate services provided are as application-oriented as possible. These are Karlsruhe in Germany, the city of Luxembourg, Valencia in Spain and Thessaloniki in Greece. The cities contribute to the project by defining their specific requirements for the urban climate services and the data platform, supporting the provision of data and enabling the validation of the project results in a real-world environment.

Observe meteorological parameters and become part of the CityCLIM project

Your support is needed for providing stationary or mobile meteorological observation in your city

2.3 What weather data are of interest and how will this data be used in CityCLIM

All meteorological data such as air temperature, humidity, air pressure, wind speed, wind direction, rainfall, UV levels and light intensity are of interest for the CityCLIM project. We do not distinguish between mandatory and optional data. Data is always valuable to us. It does not matter whether you can provide only one or several parameters from this list. Every data point from each parameter you provide helps to build a more complete picture of our dynamic world and helps researchers in their quest to understand and combat climate change.

The collected data will mainly be used to verify the CityCLIM model after a successful plausibility check. Therefore, your data are an important part of the improvement of the CityCLIM services, but also to evaluate and visualise the changing urban climate, especially in the pilot regions.

2.4 Weather Stations

2.4.1 What are weather stations?

A weather station is like a scientific kit that helps us understand the weather. It's packed full of instruments that measure things like temperature, humidity, wind speed and more. These stations are carefully placed in specific locations to monitor the sky and their surroundings, giving us real-time information that's vital for predicting the weather or studying the climate. Such weather stations can provide stationary data on various meteorological parameters. Imagine a weather station as a puzzle, and each piece of the puzzle is a sensor that provides real-time information on

temperature, humidity, wind speed, barometric pressure, rainfall and other relevant weather parameters. Typically, citizens use home weather stations, which are smaller devices designed for personal use, often placed in backyards or on balconies. These stations come in a range of sizes and features and are compact and easy to set up, affordable, usually have wireless technology, display the data collected by the sensors and have the ability to log historical data to allow users to review past weather conditions and track changes over time.

2.4.2 Requirements to set up a weather station?

To set up a weather station, you need to carefully choose the right location and consider various factors to ensure accurate data collection. Requirements may vary depending on the purpose of the station (research, amateur, agricultural) and the instruments used. Here are some basic guidelines for installing a weather station:

- ✓ **Choose an open site:** Find a site without obstructions such as tall buildings or trees that could disrupt airflow and affect wind measurements.
- ✓ **Keep obstructions away**: Place the station a safe distance from anything that could cast shadows or disrupt wind patterns - generally at least ten times the height of nearby obstructions.
- ✓ **Level Ground:** Install the Weather Station on level ground to prevent tipping and inaccurate readings.
- ✓ **Ensure access**: The site should be easily accessible for maintenance and data retrieval and should be safe for personnel.
- ✓ **Avoid heat sources:** Keep away from heat generating objects such as air conditioners, radiators or vents as they can cause higher temperature readings.
- ✓ **Elevation is important:** Take into account the height above ground level for accurate readings, especially for wind speed and temperature. Follow the manufacturer's recommendations for proper installation.
- ✓ **Power and Connectivity if needed:** Ensure a reliable source of power (electricity, solar panels, batteries) and a way to transmit data when needed (wired or wireless connection).
- ✓ **Lightning protection:** install appropriate lightning protection to protect the station and the surrounding area
- ✓ **Consider the local climate:** Consider the local climate, prevailing winds and typical weather patterns to represent the area you're monitoring.
- ✓ **Calibration and maintenance:** Calibrate and maintain your Weather Station regularly to keep your readings accurate.

2.4.3 What kind of weather station we provide in CityCLIM?

The WIFI Colour Weather Station with 7-in-1 sensor is a convenient way to monitor weather conditions. It requires WIFI to operate and comes with professional outdoor sensors. These sensors measure wind speed, wind direction, humidity, temperature, rainfall, UV levels and light intensity. The station provides a local weather forecast for the next 12 hours using weather icons on the display. The WIFI feature allows users to share their data on weather platforms such as AWEKAS, Weather Underground or Weather Cloud. WIFI also enables internet time synchronisation and firmware updates. Special features include temperature alarms, a frost/ice alarm for extreme cold and a poor indoor climate alarm.

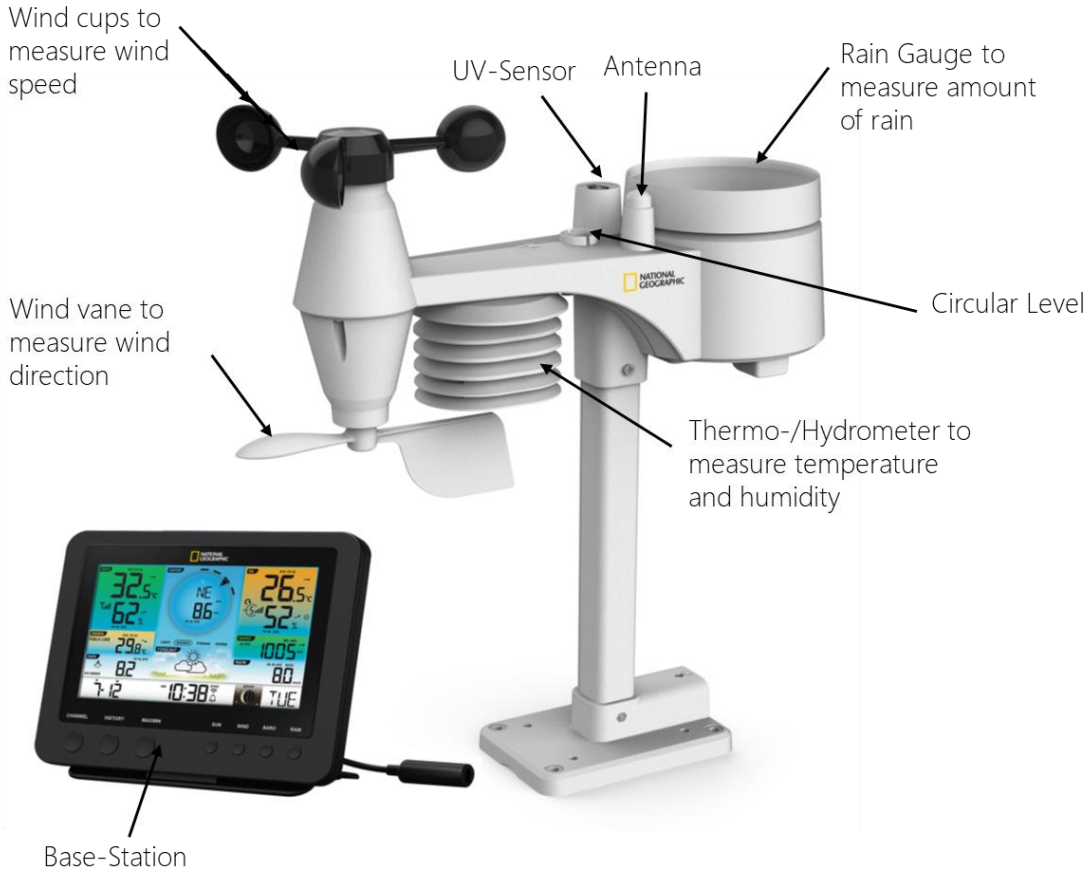


Figure 4: Parts of the CityCLIM CS weather station

2.4.3.1 Special Points to be taken care when setting up this weather station

- Ensure that the top of the vane is at least 1.5 metres above the ground.
- When using the circular spirit level in the sensor head, ensure that it is absolutely horizontal. The anemometer must always be pointing north.
- Please register at https://www.wunderground.com

2.4.3.2 Needed information to collect/submit data to CityCLIM

- Number of weather station from the display or station
- A photo of the place where it is installed, best a 360° photo

Example:

Figure 5: Example for a 360 degree picture around the installed weather station

- We ask you to register at https://www.wunderground.com. Please inform us about your weather underground ID from the “My Devices” dashboard:

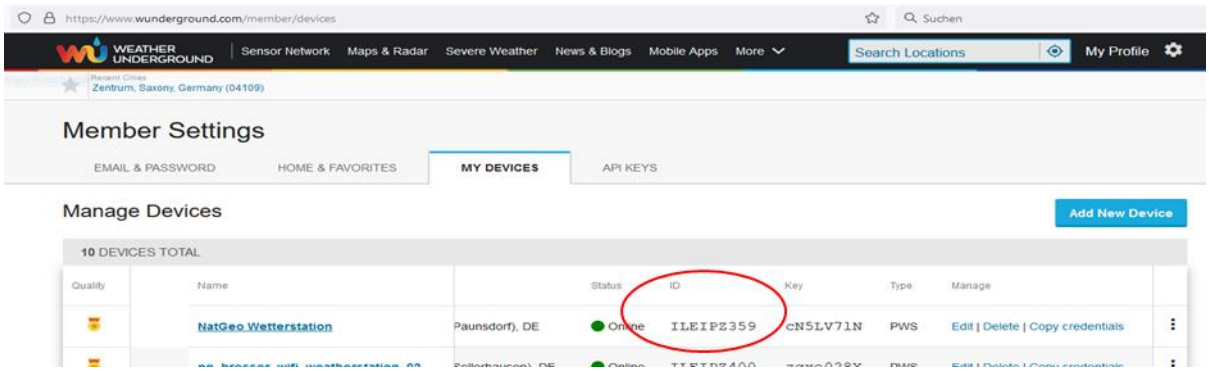


Figure 6: Example of the wunderground.com dashboard

2.5 Quick guide for the CityCLIM Weather Station

This quick guide will walk you through the steps to set up and operate your weather station, helping you keep a close eye on weather conditions in real time.

- ✓ **Unboxing and Components** Start by unpacking your weather station and ensuring you have all the components: the main display unit, the 7-in-1 sensor, power adapters, and any necessary cables.

- ✓ **Account Creating:** Create an account at https://www.wunderground.com/ and add the station to your account: “My Devices” -> “Add new Device” -> Under “Select a Device Type” select “other” -> enter your address or GPS-location -> give your station a name, enter elevation and leave “Device Hardware”: “other”-> accept Terms -> note the station ID and key.

- ✓ **Power base station:** Insert the 3V battery type CR2032 in the base station.

- ✓ **Powering Up the Main Display Unit:** Plug in the main display unit using the provided power adapter. The unit will boot up and start searching for sensor signals. Wait until the indoor temperature is displayed.

- ✓ **Power Sensor:** Insert the 3 AA-Batteries in the Sensor and the base station connects automatically with the sensor and the outdoor temperature is displayed.

- ✓ **Sensor Mounting:** Mount the wireless sensor.

- ✓ **Placing the Weather Station:** Choose an appropriate outdoor location for your station. Ideally, it should be away from walls, trees, and structures that could affect data accuracy. Mount it at a level height of at least 1.5 metres above the ground for accurate wind speed and rainfall readings. When using the circular spirit level in the sensor head, ensure that it is absolutely horizontal. The anemometer must always be pointing north.

- ✓ **Pairing the Sensor** Press and hold the sensor's pairing button until its LED starts blinking. Within a few moments, the display unit will detect the sensor's signal and display the data on the screen.

- ✓ **Connecting to WiFi** Using the control buttons on the main display, navigate to the WiFi settings. Connect the display unit to your home WiFi network by entering your network's credentials using the provided keypad or touchscreen.

- ✓ **Display Configuration** Set your preferred display units (Fahrenheit or Celsius, mph or km/h) and choose the time format. Customize the colour themes and screen layout to your liking.

- ✓ **Data and Forecast** Now that your weather station is set up, you can enjoy real-time weather data. Check temperature, humidity, wind speed, rainfall, and more. The station might also provide weather forecasts based on collected data.

- ✓ **Data Logging and Connectivity**: Your weather station will send all collected data to the https://www.wunderground.com/ as a cloud service. You can view your collected weather data via web or app.

- ✓ **Maintenance** Regularly check the sensor's solar panel and keep it clean from debris. Replace batteries when necessary. Calibrate the unit if you notice any discrepancies in readings.

2.6 Sensors for collecting data on the move

2.6.1 Mobile Sensors to measure meteorological parameters

Mobile sensors for measuring meteorological parameters are becoming increasingly common and accessible due to advances in sensor technology, miniaturisation and the integration of sensors into smartphones and other portable devices. These sensors can provide real-time data on various meteorological parameters (e.g. temperature, humidity, barometric pressure, wind speed and direction), enabling users to gather valuable information about their environment. It's important to note that these sensors vary in accuracy and precision, and are mostly not suitable for highly specialised meteorological research but they provide data for a general environmental monitoring, personal weather tracking and educational purposes. Mostly, there are dedicated mobile applications that make use of these sensors to provide the user with real-time weather information based on the data collected by the device.
The collection of data from a distributed network of mobile sensors when aggregated in a large number can improve the accuracy and coverage of weather observations and our understanding of local and regional climate patterns.

2.6.2 MeteoTracker- the mobile sensor used by CityCLIM

MeteoTracker is a fully portable mini weather station for measurements on the move. It can be mounted on a vehicle or bicycle with an optional bracket and provides high accuracy temperature and humidity readings. This device measures temperature [oC, accuracy +/- 0.1° C], humidity [%, accuracy +/- 0.5%] and air pressure [hPa; accuracy +/- 0.03 hPA] in an operating temperature range down to -55oC and provides GPS and altitude data. It connects to a smartphone via Bluetooth and sends readings to an interactive map via the MeteoTracker app (free in the iOS and Android stores) and the data analysis of the measured data can be done using the MeteoTracker dashboard.

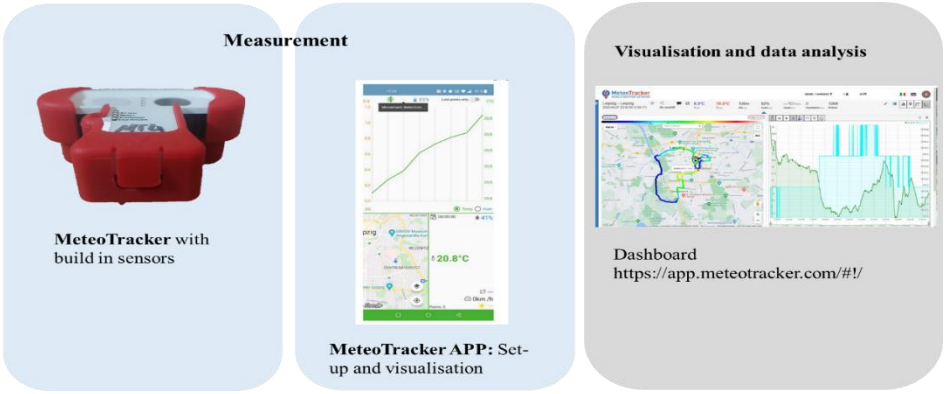
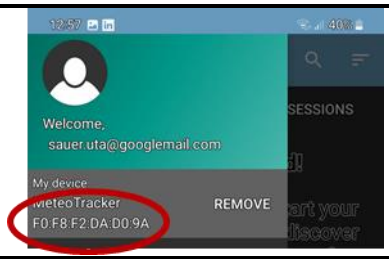


Figure 7: Components of the MeteoTracker sensor solution: sensor, app and dashboard

2.6.2.1 Needed information to collect/submit data to CityCLIM

The following information will be required from each participant in the user agreement that will need to be signed:

- Number of MeteoTracker
- MAC address of the device (Android) or user name (iOS)

Android	
iOS	User name

2.6.2.2 Quick guide for the mobile MeteoTracker sensor

This quick guide will walk you through the steps to set up and operate your mobile sensor in a proper way.

- ✓ **Unboxing and Charging** Begin by unboxing your MeteoTracker sensor and ensuring all components are present.
- ✓ **App Installation:** If not done already, install MeteoTracker App on the mobile phone (Google Play Store or Apple App Store).
- ✓ **Sensor Charging:** Connect the charging cable to the charging unit using the USB-C port. Charge the MeteoTracker for 2-3 hours. When charging is complete, the charging LED will turn off automatically.
- ✓ **App Sign up:** To sign in to the app, you could sign up using a google account, an Apple-ID or a Facebook account.
- ✓ **Power On:** A short press on the start button switches the unit on. The yellow BT ADV LED is flashing meaning that the device is switched on and is searching for a Bluetooth connection with a smartphone. If the Yellow BT ADV LED goes off then the Smartphone is connected with the sensor (check in the app!).

- ✓ **App Settings and Connections:** Add your device. Please make sure that the device is switched on. If the device is registered, the MeteoTracker number is displayed. Change the minimal distance settings in the app to 1m.

- ✓ **Sensor Installation:** This mini-station is provided with a 3-magnets base for installation on ferromagnetic surface, like car rooftop or can be installed on a bicycle handlebar. Ensure that you follow the safety instruction in the manual.

- ✓ **Measurement start:** To start of a measurement in the APP by pressing the START button. Check before whether the session type is anonymous. If not please change that setting to public anonymous.

- ✓ **Measurement stop:** Press stop button in the APP and short press of the start button on the MeteoTracker.

- ✓ **Data Display** Once connected, the app will display real-time weather data collected by the sensor. You'll see information of different parameters such as temperature, humidity, atmospheric pressure.

- ✓ **Data Sharing:** The app might offer the option to share your weather data with others or upload it to a cloud service.

- ✓ **Sensor Handling:** Please follow the instructions in the manual (attached in the supplementary)

- ✓ **Maintenance:** Keep your MeteoTracker sensor clean. Regularly check the charge it as needed before heading out.

2.7 Historical data collection

Historical weather data isn't just a collection of past records - it's a treasure trove of insights that can shape our understanding of the present and future. There are many reasons why historical weather data is important. For example, comparing past and present weather patterns helps us understand climate change over time, which aids climate research. In addition, studying historical data helps meteorologists predict short-term weather changes by recognising recurring patterns.

If you have digital copies of your historical weather data, you can enter the information in a web form manually on our website. The data you submit will be analysed by professional meteorologists who will use the data to create climate visualisations and see trends of how the weather has changed over time. You will be able to see these on an exclusive Stadt Karlsruhe platform to look at the data you collected. This data will contribute to city climate services that provide insights for climate adaptation strategies.

We created a form in German, Greek, Spanish and English to collect all essential information.

As an example you can access following form: https://survey.hifis.dkfz.de/544485/lang/de/

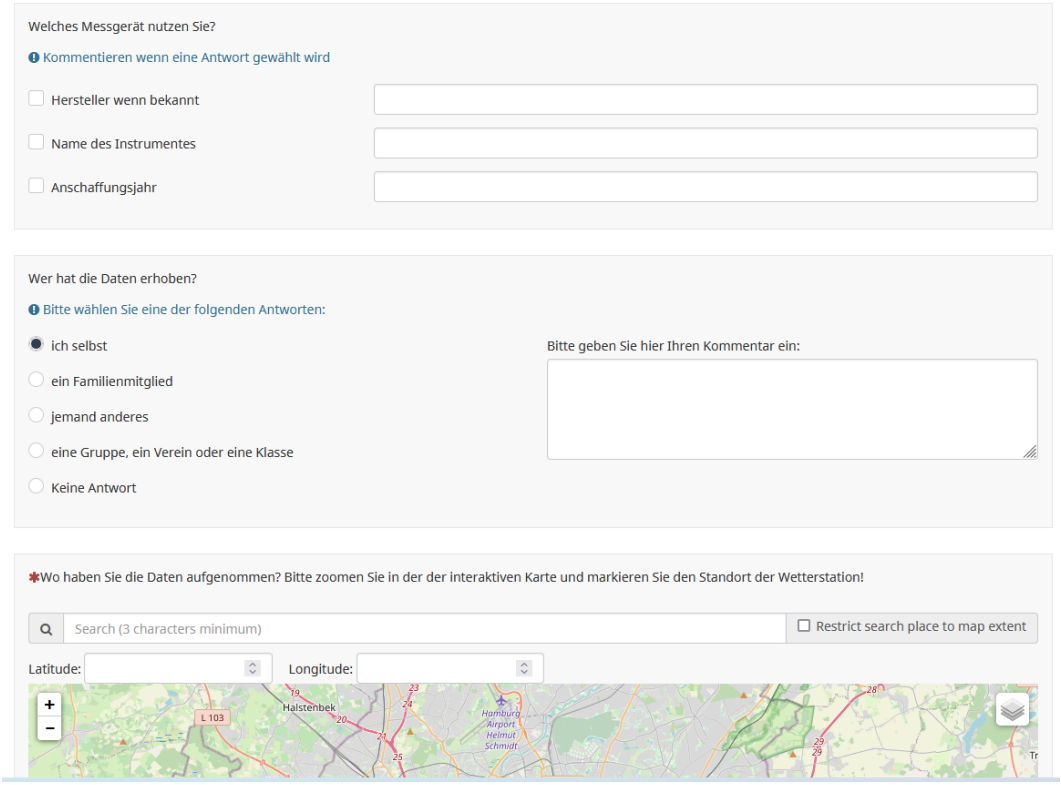


Figure 8: Example of the questionnaire regarding historical data

Furthermore, a web tool has been established to allow for an easy and direct data upload. By simply uploading a CSV file of your observed weather data to our platform, you become part of a global solution to climate change. Every data point you provide helps to build a more complete picture of our dynamic world and helps researchers in their quest to understand and combat climate change. No scientific background? No problem! Anyone can be a citizen scientist. All it takes is curiosity, dedication and your unique local data. Your participation in this global endeavour not only enriches our collective knowledge, but also fosters a sense of community and shared responsibility for our planet.

- In German: https://kachelmannwetter.com/de/info/citizenscience
- In English: https://meteologix.com/ua/info/citizenscience

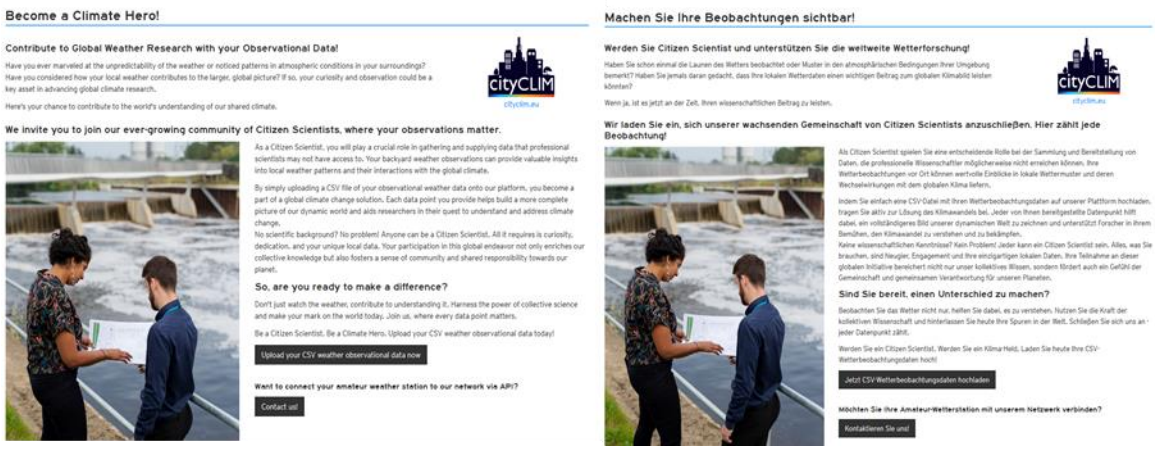


Figure 9: Example of the web tool regarding historical data in English and German

3 Call to Action

Are you passionate about weather and curious about the world around you? We invite you to take the exciting step of becoming a citizen scientist with CityCLIM. This document is your gateway to a journey of discovery, where you can contribute to our understanding of meteorological phenomena especially temperature variations in your city.

Your Role as a Citizen Scientist
This document serves as your starting point to dive into the world of weather observation. You'll be part of CityCLIM's Citizen Scientist initiative, where your observations play a pivotal role in shaping the scientific knowledge of local weather patterns.

The Significance of Your Contribution
As a Citizen Scientist in CityCLIM, you're not just an observer – you're a vital part of a collective effort. Your data will contribute to a broader understanding of urban climate, which can lead to improvements in weather forecasts, climate research, and more.

Ready to Take the Next Step?
If you're eager to get involved, it's as simple as reaching out. You can contact us through the information provided below. We're here to guide you, answer your questions, and help you embark on your journey as a weather observer.

Connect with Us and Stay Informed
For updates, news, and insights, be sure to follow us on the channels listed at the bottom of this document. Your involvement doesn't end here – it's just the beginning of a rewarding adventure in citizen science.

Looking Forward
We understand that you might have questions that this document hasn't covered yet. Don't worry – more comprehensive manuals are on the horizon. In March, we'll be releasing further resources to address any queries you might have as we move forward with the project.

Your Journey Starts Here
Embark on an exciting journey of scientific discovery. By becoming a weather observer with CityCLIM, you're contributing to a more accurate understanding of urban weather. Take the next step now – reach out, get involved, and watch as your observations make a lasting impact.

Contact Us: Email: uta.koedel@ufz.de

Phone: +49 341 60252220

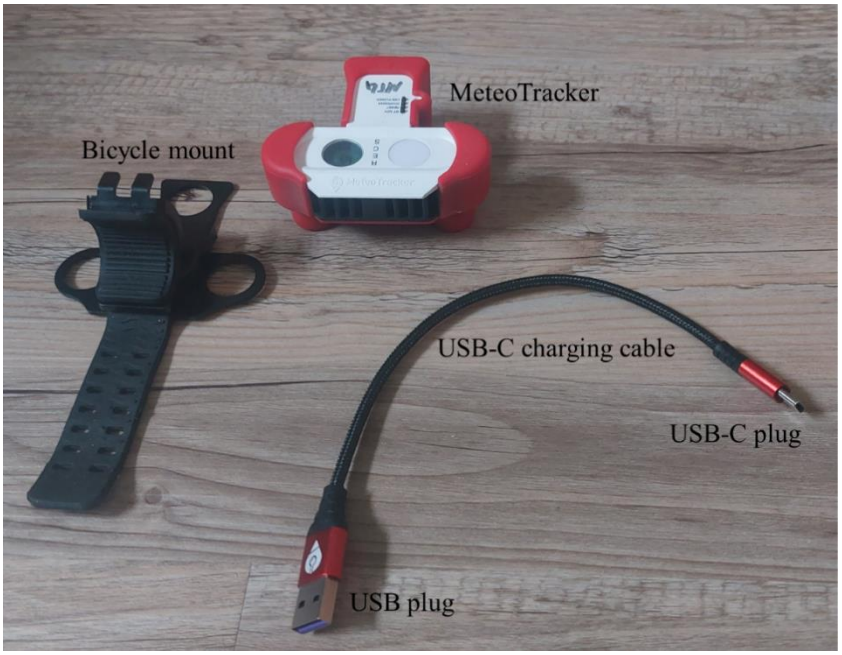
Follow Us:

cityclim.eu twitter.com/cityclim linkedin.com/company/cityclim

Thank you for joining us in the CityCLIM team. Your curiosity and dedication will help us uncover the secrets of our city's weather patterns.

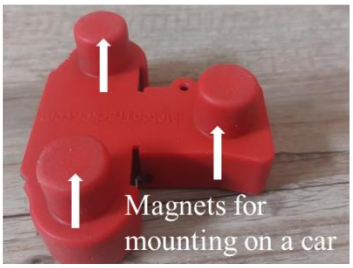
4 Supplementary: Manual of the MeteoTracker

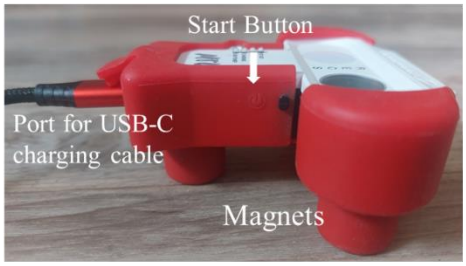
4.1.1 Components of the MeteoTracker



Following components are required:

1. Measuring device – MeteoTracker
2. USB-C charging cable to charge the MeteoTracker in 2-3 hours
3. Bicycle mount to attach the MeteoTracker to the handlebars of the bike





The sensors are placed inside the housing.

The mini-station is provided with a 3-magnets base for installation on ferromagnetic surface, like car rooftop. Please see **Chapter 4** for installation on the car.

Ensure that the conditions for a safe installation are met. If not, do not use the mini-station on moving vehicles.

(1) **Bluetooth status** : green link will blink

(2) **Reset** : light when start button is pressed for more than 10 seconds

(3) **Status of charging**: yellow light when charging

(4) **Status of power source:** green light when okay

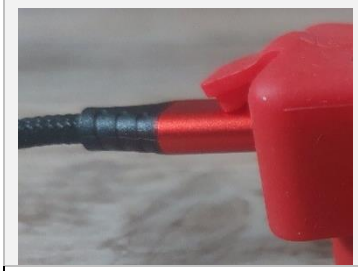
(5) **Lightness sensor**

(6) **Radiation correction**

A short press on the start button switches the unit on and off. Pressing the button for more than 10 seconds will reset the settings. The RESET status lights red.

4.1.2 Charging of MeteoTracker

It takes **2-3 hours** to charge the MeteoTracker. The battery is rechargeable (200 mAh) and has a battery life of more than 250 hours.

	Open the USB-C port in the rear of the device.
	Connect the charging cable to the USB-C port. Connect a charger (e.g. computer) via the USB cable.
	Charging related LED will switch-on. When charging is complete, the charging LED will turn off automatically.

4.1.3 Installation of the MeteoTracker

4.1.3.1 Installation on a car rooftop

The mini-station is provided with a 3-magnets base for installation on ferromagnetic surface, like car rooftop. **Ensure that the surface on which the mini-station is to be installed is:**

- ferromagnetic
- flat and clean
- is free of ice and snow
- and, there is no obstacle or object that could reduce the magnetic strength of the 3 magnets placed in the base of the mini-station.

If any of the above conditions are not met, or if the installation is not safe for any other reason, do not use the mini-station while the vehicle is moving.

In the event of snow and/or freezing rain, the abrupt reduction in the coefficient of friction may cause the unit to slip significantly, resulting in its detachment.

It is also recommended that:

	Device should be secured with a wire passed through the wire holder on the left side of the unit. This should be done especially if there is snow/ice on the car roof.
	Make sure that both sensors are equally exposed to sunlight.
	The mini-station is aligned with the direction of the air flow. Place the mini-station in such a way that the air flow is directed into the two openings at the front of the unit. Make sure that the front openings are perpendicular to the air flow.

- **Do not use your smartphone while driving!**
- **Pay attention to traffic while driving!**
- **Ensure that the unit is firmly seated on the roof of the car!**
- **In case of snow/ice on the car roof, secure the unit with a wire rope.**
- **Air inlet points in direction of travel**
- **Maximum speed: 130km/h**

4.1.3.2 Installation on a bicycle handlebar

			
Insert the MeteoTracker into the bicycle holder. Ensure that it is firmly attached!	Place the rubber holder on the handlebar.	Fasten with rubber fastener.	Align the device that • brightness sensors point vertically upwards. • air inlet points in the direction of travel

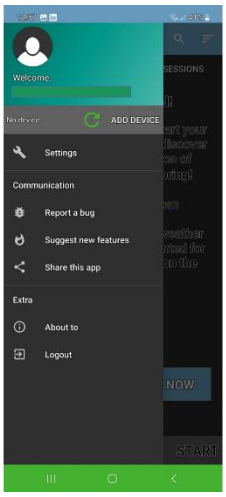
- **Do not use your smartphone while cycling!**
- **Pay attention to traffic while cycling!**
- **Ensure that the unit is firmly seated in the bicycle holder!**
- **Air inlet points in direction of travel**

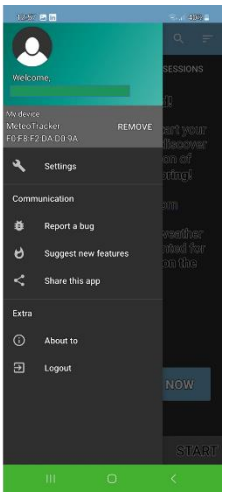
4.1.4 Measurement

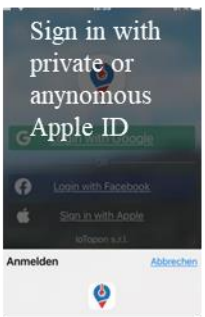
 	• Connect the charging cable to the charging unit using the USB-C port. • Charge the MeteoTracker for 2-3 hours • When charging is complete, the charging LED will turn off automatically.
	• If not done already, install MeteoTracker App on the mobile phone (Google Play Store or Apple App Store)

- Installation of the MeteoTracker e.g. on bicycle handlebar following the instructions in Chapter 4 or 5

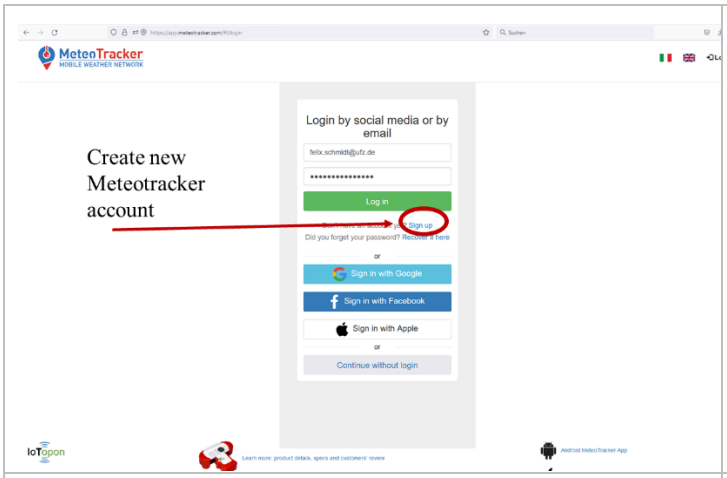
1. A short press on the start button switches the unit on. The yellow BT ADV LED is flashing meaning that the device is switched on and is searching for a Bluetooth connection with a smartphone
2. Yellow BT ADV LED goes off → Smartphone is connected (check in the app!)
3. If the yellow BT ADV LED goes out after 30s, the device is switched off and you have to start again with point 1.

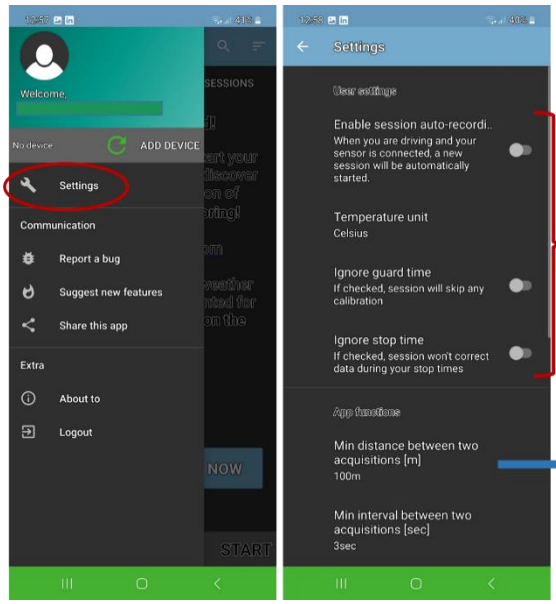


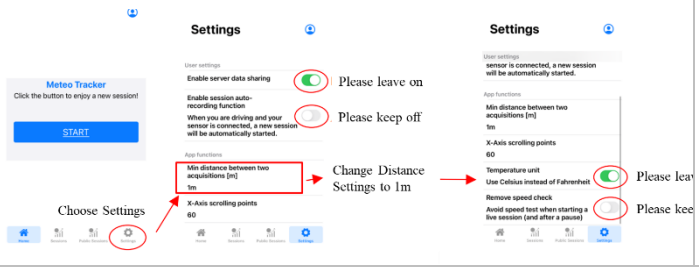




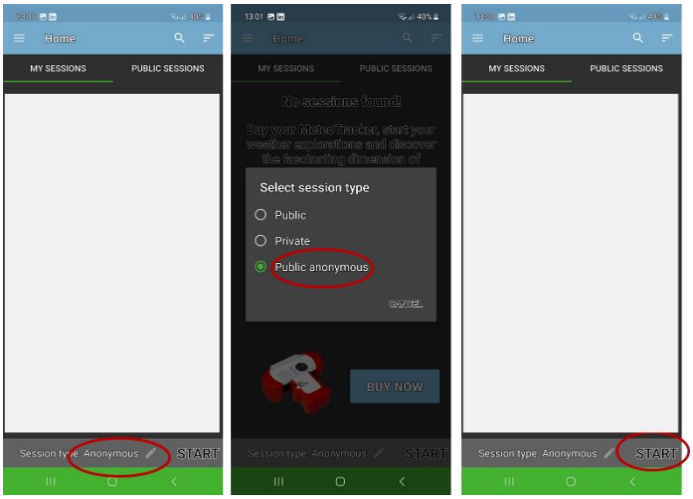
- To sign in to the app, there are following options:
  - You could sign up using a google account
  - Apple-ID
  - Facebook account
  - Or a MeteoTracker account which can be created at https://app.MeteoTracker.com/#!/login
- Select menu
- Add your device. Please make sure that the device is switched on.
- If the device is registered, the MeteoTracker number is displayed







- Change the minimal distance settings in the app to 1m.
- Do not change any other setting.



To start of a measurement in the APP

- Check whether the session type is anonymous.
- If not please change that setting to public anonymous.

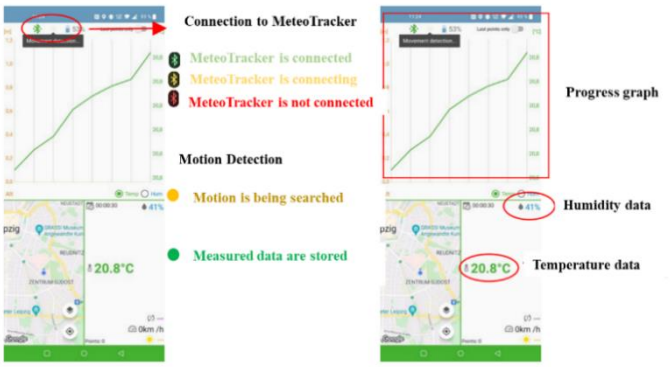
Types of Sessions:

Public: Data is stored with a pseudonym on the server

Public anonymous: Data is stored anonymous on the server

Private: Data is only stored locally

Press Start button



- The **flashing green circle** indicates an initial guard time, which means that an initial 'guard time' is automatically activated at the start of the session to ensure that the initial temperature data is not affected by the initial thermal status of the mini-station.
- When the measurement is started in the APP, the following measurement summary is displayed in the APP.

To stop the measurement

- Press stop button in the APP
- Short press of the start button on the MeteoTracker

It is possible to pause the measurement by pressing the pause button in the APP.

4.1.5 Handling Instructions

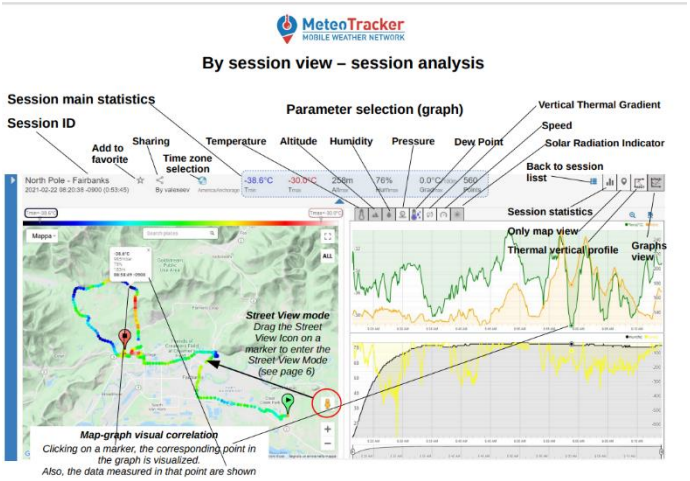
- Device is splash-proof, i.e. a rain shower/snowfall is unproblematic, but **do not immerse the device under water**!
- **Do not disassemble** the device! Do not loosen or remove the silicone protection!
- **During heavy rain, please note that there may be a problem with the sensors.** Water can get into the sensor through the air inlet holes. Especially, when using the sensors on car roofs, it can have an impact due to the increased speed.

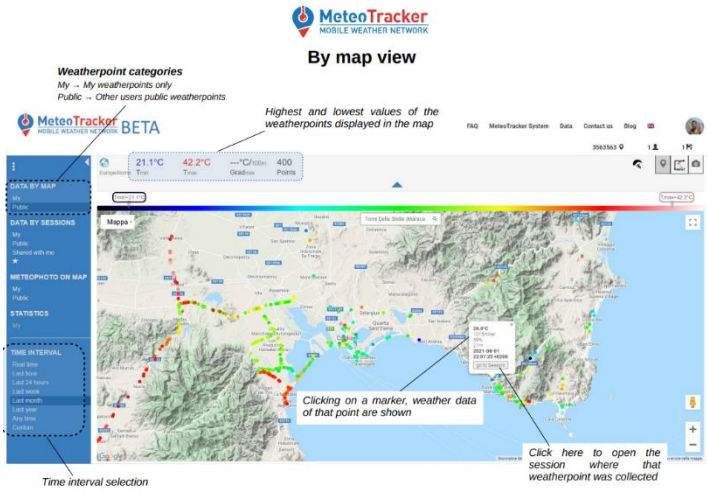
4.1.6 Measured parameters

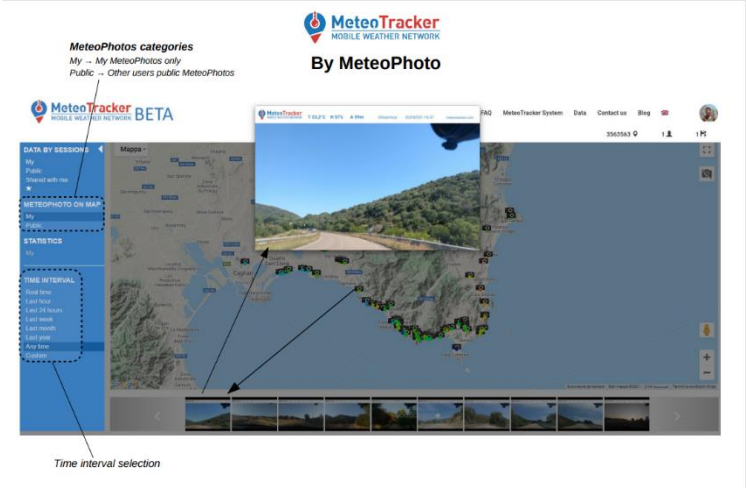
Temperature **[° C or °F]**	**Accuracy:** +/- 0.1° C (typ, sensors) | +/- 0.5° C (under solar radiation) **Operative range:** -40° C (-40° F) - +125° C (257° F) **Measurement speed:** 15° C variation over a 30 seconds time interval at 20 km/h **Speed** > 7 km/h --> patented Radiation Error Correction System RECS) real-time, maximum, minimum and average values of the session
Relative Humidity [%]	**Accuracy:** +/- 2% **Operative range:** from 0% to 100% real-time, maximum, minimum and average values of the session
Air pressure [hPa]	**Accuracy:** +/- 3 Pa (relative) | +/-50 Pa (absolute)
Dew-point temperature	real-time, maximum, minimum and average values of the session
Altitude above sea level - QNH	**Accuracy:** +/- 10 m real-time, maximum, minimum and average values of the session
Vertical thermal gradient	real-time, maximum, minimum and average (RMS) values of the session algorithm based on detected path slope
Solar Radiation Intensity Indicator	real-time, maximum, minimum and average values of the session

4.1.7 Data Visualisation and Export

APP (Android or iOS – smartphone version)	• real-time visualization on map, graphs and numeric format • Archived sessions visualization on map, graphs and numeric format • Sessions statistics • Global statistics (related to all the data collected)
Web platform (smartphone and stand-alone version) **With different possible views**	• real-time visualization on map, graphs and numeric format • Archived sessions visualization on map, graphs and numeric format • Sessions statistics • Global statistics (related to all the data collected) • Sharing functions are available to share the session with friends and MeteoTracker community members


MeteoTracker
MOBILE WEATHER NETWORK
By session view – session analysis
Session main statistics
Session ID
Add to favorite
Sharing
Time zone selection
Parameter selection (graph)
Temperature
Altitude
Humidity
Pressure
Dew Point
Vertical Thermal Gradient
Speed
Solar Radiation Indicator
Back to session lisst
Session statistics
Only map view
Thermal vertical profile
Graphs view
Street View mode
Drag the Street View Icon on a marker to enter the Street View Mode (see page 6)
Map-graph visual correlation
Clicking on a marker, the corresponding point in the graph is visualized.
Also, the data measured in that point are shown


MeteoTracker
MOBILE WEATHER NETWORK
By map view
Weatherpoint categories
My → My weatherpoints only
Public → Other users public weatherpoints
Highest and lowest values of the weatherpoints displayed in the map
MeteoTracker BETA
Clicking on a marker, weather data of that point are shown
Click here to open the session where that weatherpoint was collected
Time interval selection


MeteoTracker
MOBILE WEATHER NETWORK
By MeteoPhoto
MeteoPhotos categories
My → My MeteoPhotos only
Public → Other users public MeteoPhotos
MeteoTracker BETA
Time interval selection

Data export and integration on third party platform

- CSV Format in plot type
  - Parameter vs. time (X-axis→ time | y-axis → parameter selected (temperature, humidity, etc.)
  - Vertical profile (X-axis temperature/dew point | Y axis → pressure/altitude)

CSV file download

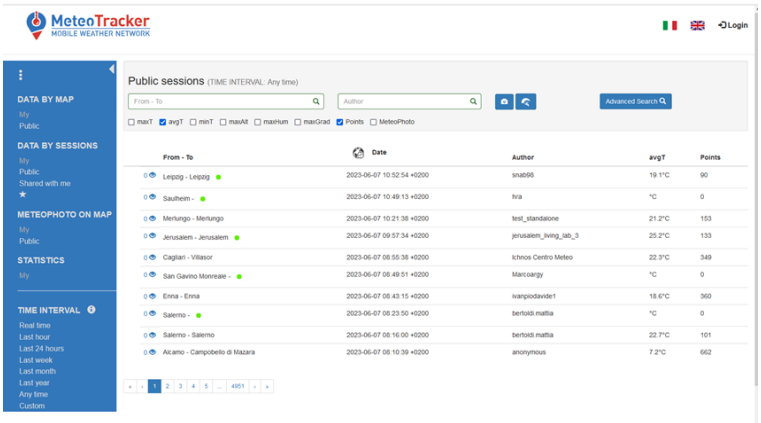
	time	lon	lat	T[C]	Alt[m]	Hum[%]	Speed[km/h]	Tdp[°C]	Grad[°C/100m]
274	2021-08-25T21:24:53.000Z	9.3427368	39.1875548	26.2	40	85	60	23.2	-1.0
275	2021-08-25T21:24:59.000Z	9.3428284	39.1867341	26.3	46	85	54	23.3	-1.0
276	2021-08-25T21:25:02.000Z	9.3435175	39.1864177	26.4	51	85	59	23.4	-1.0
277	2021-08-25T21:25:08.000Z	9.3443101	39.1858182	26.4	55	84	54	23.2	-1.0
278	2021-08-25T21:25:11.000Z	9.3448627	39.1857481	26.4	58	84	55	23.2	-1.0
279	2021-08-25T21:25:14.000Z	9.3454695	39.1856506	26.4	61	84	56	23.2	-1.0
280	2021-08-25T21:25:17.000Z	9.3458121	39.1853302	26.4	61	84	51	23.2	-1.0
281	2021-08-25T21:25:23.000Z	9.3459842	39.1845588	26.4	66	84	55	23.2	-1.0
282	2021-08-25T21:25:29.000Z	9.3461496	39.1837394	26.3	70	84	57	23.1	-1.0
283	2021-08-25T21:25:32.000Z	9.3463235	39.183304	26.3	71	84	61	23.1	0.2
284	2021-08-25T21:25:38.000Z	9.346752	39.182447	26.3	75	84	60	23.1	0.2
285	2021-08-25T21:25:41.000Z	9.3468748	39.1820053	26.3	77	84	60	23.1	0.2
286	2021-08-25T21:25:47.000Z	9.3475433	39.181323	26.2	79	84	58	23.0	0.2
287	2021-08-25T21:25:53.000Z	9.3485527	39.1809932	26.1	78	84	54	22.9	0.2
288	2021-08-25T21:25:56.000Z	9.3490688	39.1809397	26.1	76	85	54	23.1	0.2
289	2021-08-25T21:26:02.000Z	9.3498231	39.1803504	26.1	73	85	56	23.1	0.2
290	2021-08-25T21:26:08.000Z	9.3503742	39.1795825	26.1	70	85	52	23.1	0.2
291	2021-08-25T21:26:11.000Z	9.3505671	39.1792045	26.1	68	85	52	23.1	0.2
292	2021-08-25T21:26:17.000Z	9.3515368	39.1790822	26.1	65	86	39	23.3	0.2

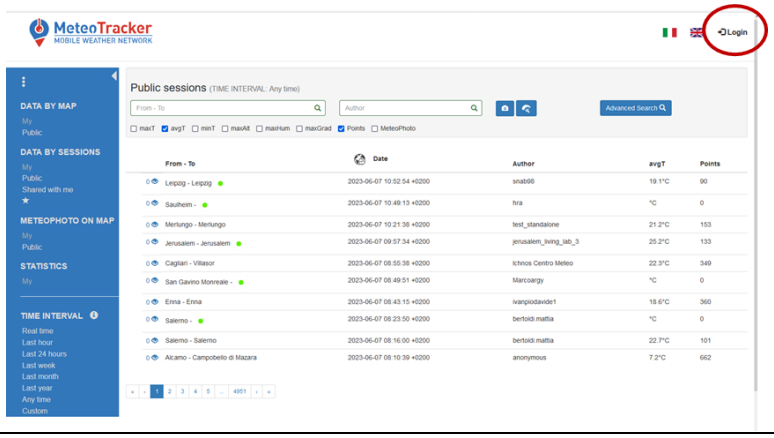
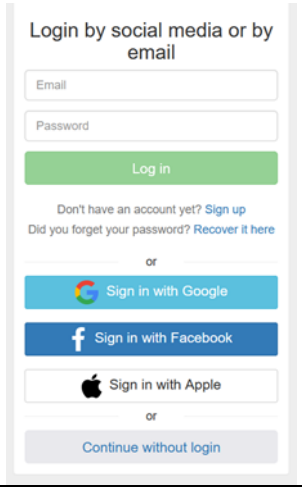
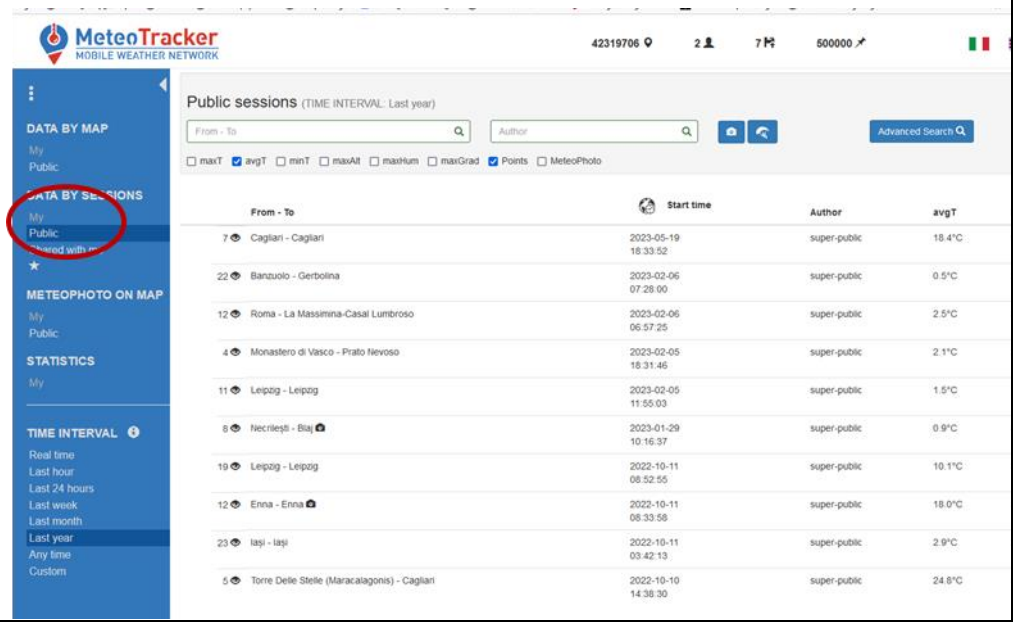
4.1.8 Dashboard

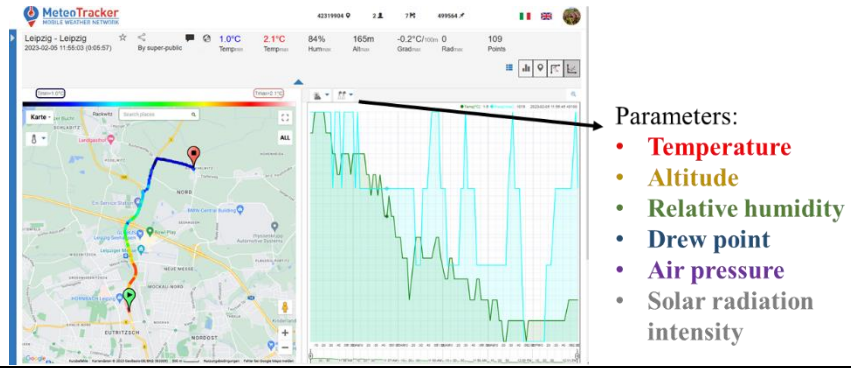
Access the evaluation dashboard web page

https://app.MeteoTracker.com/#!/

Choose language



Press login button	
Sign in with your Google Account or Apple ID	
Display of own measured data press MY button And choose one set of measured data on the right hand side	

Evaluation of the measurement series as a map (left) or graph (right):	

Website with original manuals: https://MeteoTracker.com/en/manuals/

About CityCLIM

The strategic objective of CityCLIM is to significantly contribute to delivering the next-generation of City Climate Services based on advanced weather forecast models enhanced with data both from existing, but insufficiently used, sources and emerging data sources, such as satellite data (e.g., Copernicus data) or data generated by Citizens Science approaches for Urban Climate Monitoring etc. For City Climate Services, data products of interest related to land surface properties, atmospheric properties (e.g., aerosol optical thickness), geometry etc. For all of those, information of interest concerns e.g., Copernicus data products and services that are already existing (e.g., based on Sentinel-3/OLCI, PROBA-V, SPOT, Sentinel-1, MetopASCAT data), will exist in the near future (based on already flying satellites such as Sentinel-2), or will exist in the mid-term (based on satellites currently under development) and long-term (based on satellites soon starting concept phase) future. The project will establish; (i) an open platform allowing for efficient building of services based on access to diverse data; (ii) enhanced weather models based on data from diverse existing and emerging sources; (iii) a set of City Climate Services customizable to specific needs of users in cities; and (iv) a generic Framework for building next generation of Urban Climate Services. CityCLIM will be driven by 4 Pilots addressing diverse climate regions in Europe (Luxembourg, Thessaloniki, Valencia, Karlsruhe) which will define requirements upon the tools to be developed, support specification and testing of the services and serve as demonstrators of the selected approaches and the developed technologies. The consortium will elaborate business plan to assure sustainability of the platform and services.

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