

Street-level weather station network in Freiburg, Germany: Station documentation

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Abstract

This report documents 42 stations of an urban street-level automatic weather station network in Freiburg, Germany installed and operated by the University of Freiburg and with support of the City of Freiburg and selected surrounding municipalities. The purpose of the network is to collect local and context-specific weather and climate data on temperature, humidity, precipitation and at selected stations also wind, solar radiation and black-globe temperature. This report documents all 42 stations with their position, address, land cover, orography as well as nearby objects that are relevant for the data interpretation. Maps are provided for each weather station detailing the location within the network, the local-scale siting, and the microscale surrounding. The report also documents mounting structures, sensors operated, operation periods and changes. Station photographs, panoramic images and sky-view images provide details on the siting and surroundings.

Keywords: Urban weather station network, automatic weather station, street-level weather station, meta-data, site documentation, Freiburg, Germany

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Abbreviations, definitions and measurement units

- **Coordinates** are given in decimal degrees (according to the Coordinate Reference System (CRS) WGS84).
- **Sensors deployed:**
 - o ClimaVue: ClimaVUE50 by Campbell Scientific Inc., Logan, UT, USA
 - o Pessl LoRain: Pessl LoRain (NBloT) by Pessl Instruments, Weiz, Austria
 - o Black Globe: BLACKGLOBE-L by Campbell Scientific Inc., Logan, UT, USA
- **Topographic elevation** refers to the ground level in meters above mean sea level and was extracted from a digital elevation model available at LGL¹ (CRS: ETRS89/UTM, spatial resolution: 1 m, creation date: 2000-2015).
- **Elevation above ground** refers to the vertical offset of the mounting structure base ground level from the surrounding ground level.
- **Local Climate Zones** refer to Stewart and Oke, 2012².
- **Urban Atlas Classes** refer to Montero et al, 2014³.
- **Center of mounting structure base** refers to the horizontal center of the respective pole at ground level.
- **x:** Horizontal distance in meters from center of mounting structure base.
- **z:** Vertical distance in meters from center of mounting structure base.
- **α :** Azimuth of respective object relative to mounting structure given in degrees (accuracy: approx. 20°).

External sources and tools

- Source of background for *aerial photographs*: LGL¹ (photographs taken in 2023).
- Source of background for *local-scale maps*: OSM⁵.
- Sky View factors were calculated from hemispherical photos at the location of the top of the Pessl LoRain or ClimaVue rain gauge, using the calculation method according to RayManPro⁶⁻¹⁰.
- All maps were created using QGIS⁴.

1: LGL, www.lgl-bw.de, use permitted under "Data licence Germany -attribution -Version 2.0".

2: Stewart, I.D., Oke, T.R., 2012. Local climate zones for urban temperature studies. Bulletin of the American Meteorological Society 93, 1879–1900.

3: Montero, E., Van Wavelaer, J., Garzón, A., 2014. The European Urban Atlas. Springer Netherlands, Dordrecht. pp. 115–124.

4: QGIS.org (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. <http://qgis.org>

5: OpenStreetMap. Available online at <https://wiki.openstreetmap.org>.

6: Matzarakis, A., Rutz, F., Mayer, H., 2007: Modelling Radiation fluxes in simple and complex environments - Application of the RayMan model. International Journal of Biometeorology 51, 323-334.

7: Matzarakis, A., Rutz, F., Mayer, H., 2010: Modelling Radiation fluxes in simple and complex environments - Basics of the RayMan model. International Journal of Biometeorology 54, 131-139.

8: Matzarakis, A., Fröhlich, D. 2018: Influence of urban green on human thermal bioclimate - application of thermal indices and micro-scale models. Acta Horticult. 1215, 1-9. Doi: 10.17660/Acta Horticult.2018.215.1

9: Matzarakis, A., Gangwisch, M., Fröhlich, D., 2021: RayMan and SkyHelios Model. In: Palme, M., Salvati, A. (eds) Urban Microclimate Modelling for Comfort and Energy Studies. Springer, Cham., 339-361, https://link.springer.com/chapter/10.1007/978-3-030-65421-4_16

10: Fröhlich, D., Gangwisch, M., Matzarakis, A., 2019: Effect of radiation and wind on thermal comfort in urban environments - Application of the RayMan and SkyHelios model. Urban Climate 27, 1-7.

<https://www.sciencedirect.com/science/article/pii/S2212095518303225>