WEGENERNET
Climate Station Network

from local measurements to weather and climate data products at 1 km-scale resolution

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WegenerNet - Brief Overview

The WegenerNet climate station network (WegenerNet) is a pioneering weather and climate observation experiment at very high resolution in south-eastern Austria. The network comprises 151 observational stations within an ~ 20 km x 15 km area in the Alpine foreland (one station per ~ 2 km²). Measurements every 5 min include the meteorological parameters air temperature, humidity, precipitation, and others at selected sites (e.g., wind speed and direction). The data processing is part of an automatic system containing four steps: (1) data transfer, (2) quality control, (3) preparation, and (4) presentation. The resulting data set consists of station data and gridded data on various temporal scales since January 1, 2007. All data are provided at the WegenerNet data portal and represent a new resource for climate and environmental reasearch on regional to local scale.

- pioneering experiment of 151 meteorological stations (~1.4 km x 1.4 km station grid)
- air temperature, rel. humidity, precipitation (main parameters) completed by wind and soil parameters at selected sites, and air pressure and net radiation at the reference station
- measurements with 5 min sampling (30 min for soil parameters)
- automatic processing system including data transfer, quality control, preparation, and presentation
- interpolated regular grids for the main parameters (UTM: 1 km x 1 km; lat/lon: 0.01° x 0.01°)
- station and gridded data since Jan 1, 2007 (5 min, half-hourly, hourly, daily, monthly, seasonal and annual data)
- data provision at the data portal with data latency less than 1-2 hours in standard operation

(1) Data Transfer

At the inital step of the automatic processing system, the measurements are transfered via GPRS/internet-attached data loggers (i-logs, hourly transfer in standard operation) and are stored in a relational database (PostgreSQL).

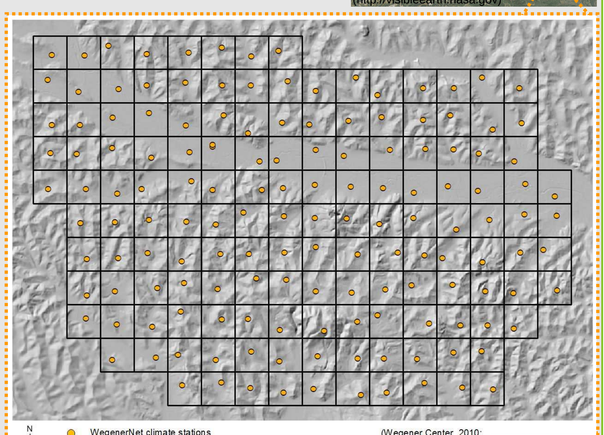


Fig. 1: Orographic map of the study region and location of the WegenerNet sites in the station grid (~1.4 km x 1.4 km). Data transfer is performed by i-logs.

(2) Quality Control System

The incoming raw data get tested for their technical and physical plausibility by a quality control system (realized in Python). Each data value gets marked by an appropriate quality flag as follows:

- problems detected: quality flag = $\sum_{i=1}^{n} 2^n$ (n is the number of quality layer within problems occurred)
- no problems occurred: quality flag = 0

Layer No.	Quality layer
0	operations check
1	availability check
2	sensor check
3	climatological check
4	time variability check
5	intrastation check
6	interstation check
7	external check

Table 1: Quality layers of the quality control system include basic checks for data availability and technical threshold values up to tests of higher complexity.

station_id	meas_time	data_value	quality_flag
47	2007-07-25 05:00:00+00	13.8	0
47	2007-07-25 05:05:00+00	13.86	0
47	2007-07-25 05:10:00+00	13.78	0
47	2007-07-25 05:15:00+00	13.67	0
47	2007-07-25 05:20:00+00	13.72	0
47	2007-07-25 05:25:00+00	13.7	0
47	2007-07-25 05:30:00+00	13.68	0
47	2007-07-25 05:35:00+00	13.8	0
47	2007-07-25 05:40:00+00	13.83	0
47	2007-07-25 05:45:00+00	14.3	0
47	2007-07-25 05:50:00+00	14.67	0
47	2007-07-25 05:55:00+00	15.21	0
47	2007-07-25 06:00:00+00	-61.21	4
47	2007-07-25 06:05:00+00	223.33	4
47	2007-07-25 06:10:00+00	208.94	4
47	2007-07-25 06:15:00+00	212.71	4
47	2007-07-25 06:20:00+00	208.88	4
47	2007-07-25 06:25:00+00	206.57	4
47	2007-07-25 06:30:00+00	22.15	64
47	2007-07-25 06:35:00+00	19.74	0
47	2007-07-25 06:40:00+00	18.15	0
47	2007-07-25 06:45:00+00	18.65	0
47	2007-07-25 06:50:00+00	18.85	0
47	2007-07-25 06:55:00+00	18.95	0
47	2007-07-25 07:00:00+00	19.43	0
47	2007-07-25 07:05:00+00	19.62	0
47	2007-07-25 07:10:00+00	19.84	0
47	2007-07-25 07:15:00+00	20.66	0
47	2007-07-25 07:20:00+00	20.54	0
47	2007-07-25 07:25:00+00	20.23	0

Fig. 2: Example for the detection of erroneous values in the temperature series of the WegenerNet station No. 47.

(3) Data Product Generator

Weather and climate data products are derived on the basis of best quality station data (flag 0) for single stations and regular grids on various temporal scales ranging from 5 min to annual data (implemented with Python).

Gridded data sets are realized in

- *UTM (1 km x 1 km)* and
- *lat/lon (0.01° x 0.01°)*

coordinates, by inverse distance squared weighting interpolation ($1/r^2$), for

- *temperature* (at reference altitude of 300 m and two orographic grids based on a 10 m x 10 m DEM).
- *precipitation* and
- *relative humidity.*

Fig. 3: Example for linear/bi-linear regression line for vertical temperature interpolation; 1 hour time window of station data at all altitudes centered at 2009-07-09 23:50 (UTC).

Fig. 4: Gridded daily data products in UTM of *(a)* temperature and *(b)* precipitation on July 9, 2009. Higher temperatures reflect the course of the Raab valley from Northwest to East. Cooler conditions and higher precipitation amounts are seen in the hilly landscape of the southeastern part.

(4) WegenerNet Data Portal

All data products and further meta-information to the network (incl. observational sites and sensors) are provided at the WegenerNet data portal. Station data and gridded data are prepared for download (csv, NetCDF) and visualization (quick-look feature).
The main interface is based on the functionality of MapServer to import spatial data by its database interface and to generate images of static geographic formats (Fig. 5).

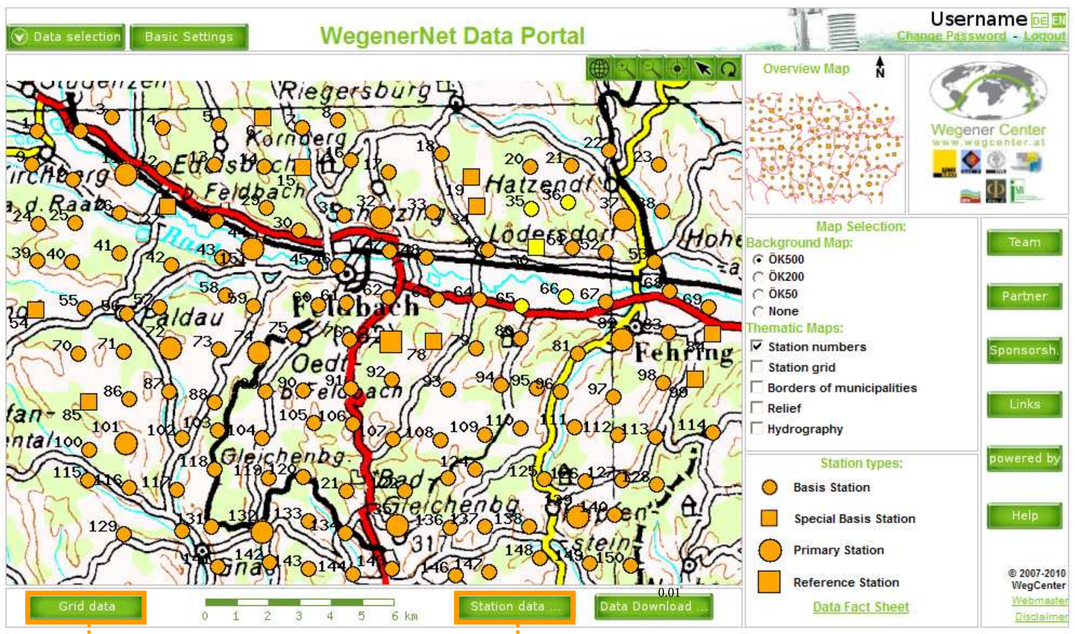


Fig. 5: Main window of the WegenerNet data portal

Station data products and additional meta-data are requested from the database and shown in the station data window in Fig. 6. On the left, daily mean temperatures of stations selected at the main window (marked yellow in Fig. 5) are visualized as time series. Some information on the selected stations is given on the right.

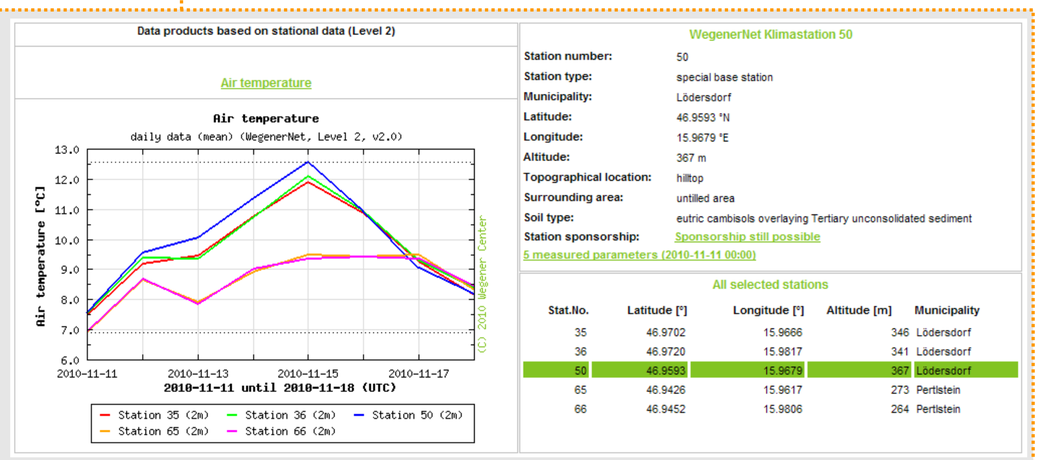


Fig. 6: Station data window with visualized daily temperatures from November 11 to 18, 2010, on the left and station meta-information on the right.

The main page of the available map products uses the web-GIS-framework OpenLayers. All geographic information is displayed with MapServer and maps of meteorological parameters are generated on the fly by a Python CGI script. The visualized grid products and geographic data are provided as optional layers. In Fig. 7 the daily mean temperature grid is transparently overlayed on the base layer OpenStreetMap. A brief statistic of the entire grid is given within the temporal resolution of the selected data product. All gridded data are prepared for download as NetCDF-files.

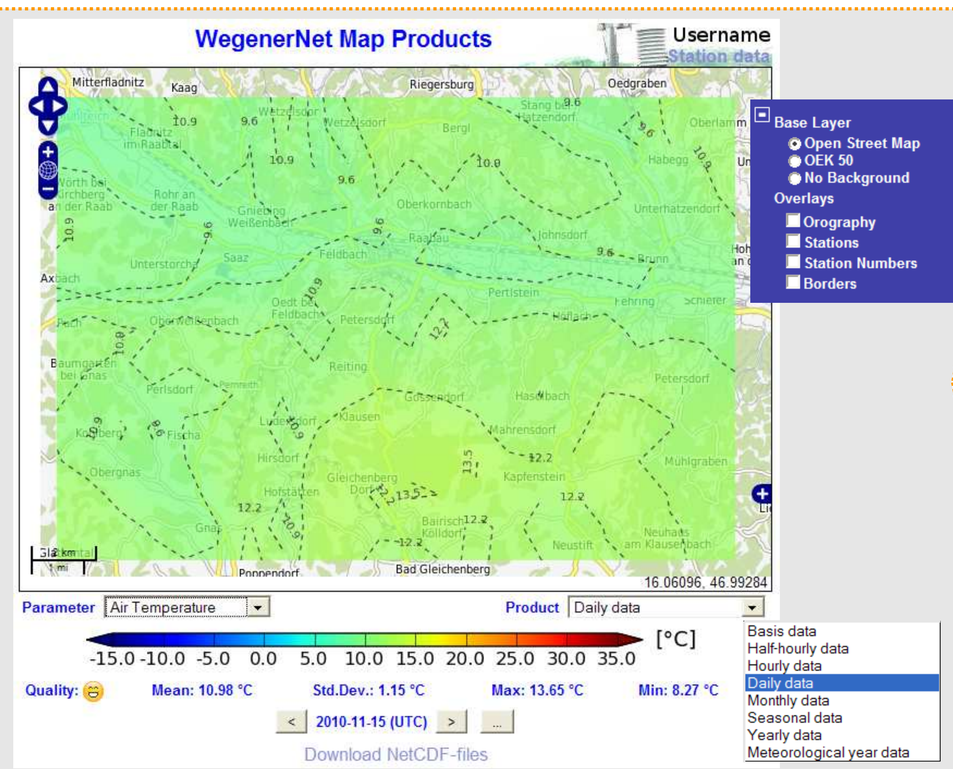
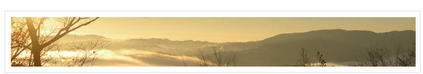


Fig. 7: Grid data window with daily mean temperatures on November 15, 2010, overlayed on the base layer OpenStreetMap. Optional layers are seen in the upper pop-up window and the provided map products in the pull-down menu below.

Conclusions & Outlook



The WegenerNet provides a new data set of meteorological parameters with high temporal and spatial resolution for many climate and environmental research themes on regional to local scale. All measurements are integrated in an automatic processing system from the data transfer and preparation up to the provision of derived data products at the WegenerNet data portal (data latency less than 1-2 hours in standard operation).

The next steps focus on further development of the data processing and the data products including gridded data of other measured and derived parameters (e.g., wind, heat index).
For further information on the WegenerNet (incl. sponsors and support partners) and data access see:

- WegenerNet homepage: www.wegcenter.at/wegenernet
- WegenerNet data portal: www.wegenernet.org