Documentation of MeteoSwiss Grid-Data Products

Energy indicators

		D		PLZ		
hgt		M		BFS_center		abs
atd	_	Y	_	municipality	_	anom
cdd		S		district		norm
		U		canton		
				country		

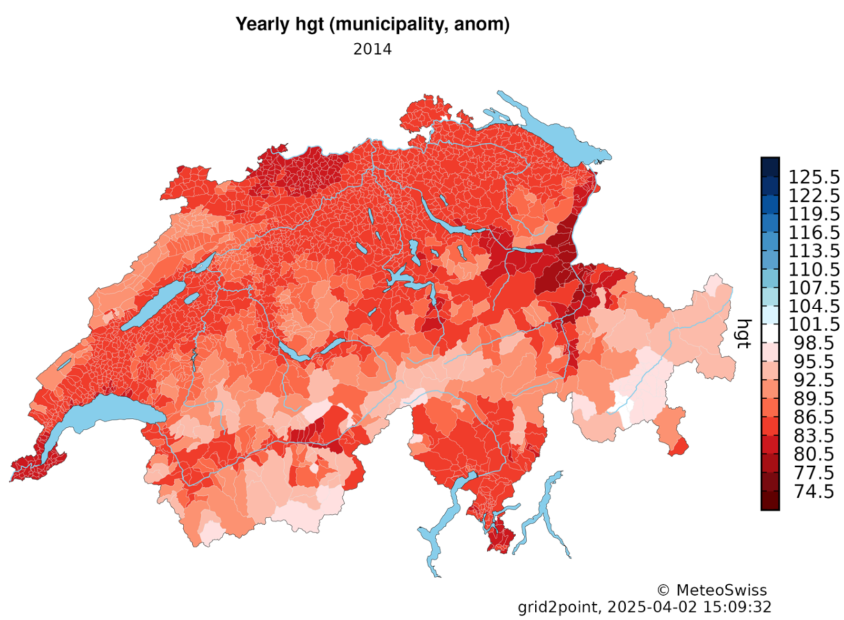

Figure 1. Yearly heating degree days anomaly (from period 1991-2020) (%) for 2014 in Switzerland.

Product: hgt_Y_municipality_anom.

Variables

Following the nomenclature of the file names:

Variable name ("energy indicators"):

- heating degree days ("HDD", "HGT" in german, in degrees Celsius)
$$HGT = \sum_{i=1}^{n} (20°C - T) \quad for\ T \leq 12°C$$
- cumulated temperature differences ("ATD", in degrees Celsius)
$$ATD = \sum_{i=1}^{n} (12°C - T) \quad for\ T < 12°C$$
- cooling degrees days ("CDD", in degrees Celsius).
$$CDD = \sum_{i=1}^{n} (T - 18.3°C) \quad for\ T \geq 18.3°C$$

Time aggregation:

- daily ("D" in the product nomenclature)
- monthly ("M")
- seasonal ("S")
- yearly ("Y")
- special intervals ("U", e.g. from 1st of October to March) of:

Spatial aggregation:

- postcodes ("PLZ")
- municipalities ("municipality")
- districts ("district")
- cantons ("canton")
- countries ("country")
- values at the municipality center defined by the Federal Statistical Office ("BFS_center").

Type of analysis:

- absolute values ("abs")
- normal values ("norm"). Note: In the tables for daily norm values the first column (time) has the format DDMM (day and month) .
- anomalies ("anom"): Anomalies are the ratio compared to the mean value during the actual norm period 1991-2020.

Please note: Not all combinations of time and space aggregations are provided as standard. The choice of which products are currently available is based on customer requests. If you are missing a product, please contact MeteoSwiss customer service.

Application

Energy sector, civil engineering. Applications that need values at municipality, canton, district or country level. For Switzerland and Lichtenstein.

Overview

The "energy indicators" products are based on daily grid data for temperature. From this data, time series of temperature are calculated at approximately 4000 points in Switzerland using additional interpolation. The required indices are then calculated from these time series and aggregated in terms of time and space.

Data base

The "energy indicators" products are based on daily grid data for temperature (see the product description for "TabsD" for details), which describe the km-scale distribution of day-to-day temperature variations in Switzerland during the past decades (1961-present). It utilizes approximately 90 homogenous long-term station series.

Method

The starting point for all analyses is the definition of a center point for each six-digit postcode region ("PLZ6" polygon, the first four digits are the usual postcodes, followed by two additional digits, e.g. for larger municipalities or cities that are further subdivided. Smaller municipalities have just "00"). This is defined by the Swiss Post as population-weighted centroid; sometimes there is more than one point for a PLZ6 polygon. At each of these approximately 4000 points, the required variable (e.g., HGT) time series is calculated by interpolating from the MeteoSwiss daily temperature grid with a resolution of 1 km ("TabsD", see the product description for details) to the respective points. This is done with a local linear regression with height using the values from the surrounding grid cells at the respective heights to determine local time series (LTS). This additional interpolation is used at MeteoSwiss in several products and for customer inquiries and is described in the document for "Climate data for user-defined locations".

In the next step spatial aggregations of these local time series (e.g., to the municipal, district, cantonal or even national level) are performed. The spatial aggregations are population-weighted. The population is determined for each PLZ6 polygon ("Official index of cities and towns") using the grid dataset of the population (residents) per hectare (100mx100m) of the Federal Statistical Office (FSO).

As the population changes over time, other of these hectic data sets are used at regular intervals. By default, the one from 2000 is used for the period up to 2010, the one from 2010 for the period 2011-2020, the one from 2020 from 2021 and so on.

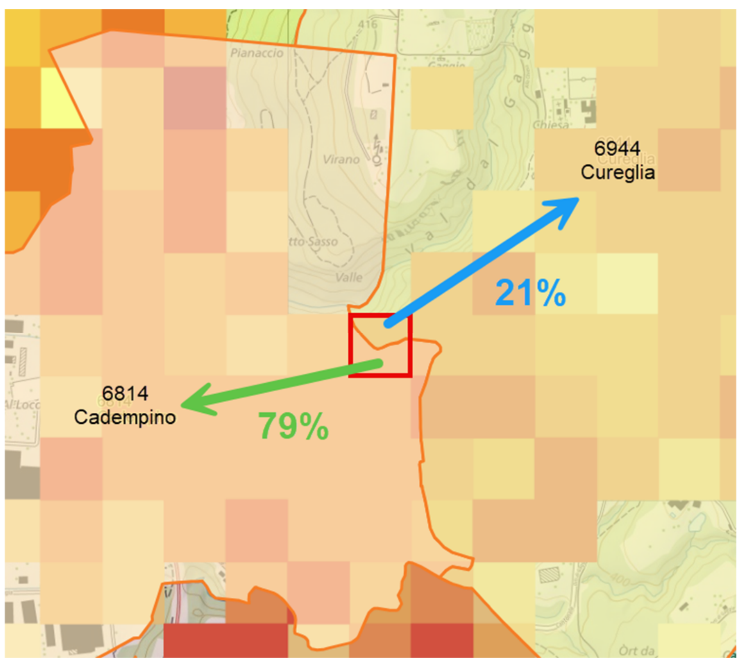

Figure 2. Percentage allocation of the number of people in the red-bordered grid cell to the municipality in the west (79%, Cadempino) and in the east (21%, Cureglia). The orange lines are the municipal boundaries and the colored grid cells are the number of residents per hectare.

For the grid cells that are located in more than one polygon, the number of people is allocated to the corresponding polygon in proportion to the area (see Figure 2). In the aforementioned rare cases, in which there is more than one point per PLZ6 polygon, the population value for each point in the same PLZ6 polygon is determined by distributing the total population of the PLZ6 polygon to each point according to the weight given by the population within a radius of 1 km from the respective point.

A cantonal aggregation, for example, means that all the points and related polygons in the canton are considered and the cantonal values are calculated in a weighted manner based on the population per postcode polygon.

An example of an aggregation at the municipal level is illustrated in Figure 3 and 4 for the municipality of Ollon in the Canton of Vaud. Ollon consists of three postcodes (1867, 1884, 1885), with seven subdivisions in PLZ6 areas (1867(00) Ollon, 1867(02) St-Triphon, 1867(03) Panex, 1884(00) Villaz-sur-Ollon, 1884(02) Arveyes, 1884(03) Huémoz, 1885(00) Chesières), each with a point at which the HGT was calculated (red circles in Fig. 4). These 7 points (red points in Fig. 4, one for each PLZ6 polygon), population-weighted according to the total population in the corresponding PLZ6 polygon, contribute to the calculation of the municipal HGT.

The blue circle in Fig. 4 represents the product with the point defined for each municipality by the Federal Statistical Office ("BFS_centre", so-called center coordinates, which were positioned manually in the main village of each municipality, e.g. location of the village church, the municipal administration, the central village square, the main road junction, etc.). Those points are not used for further spatial aggregations (e.g. for cantonal HGT values).

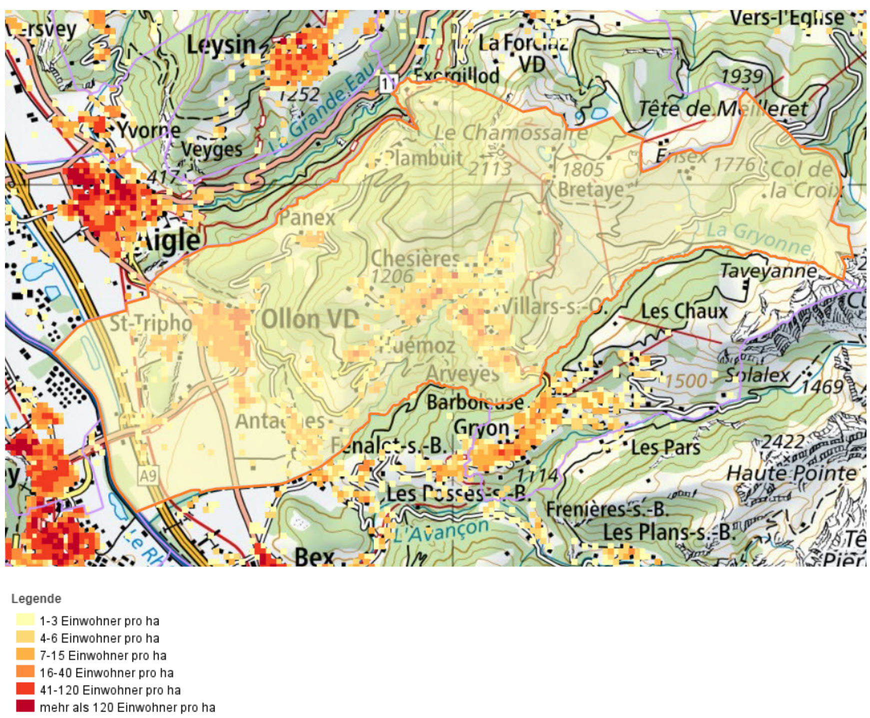

Figure 3: Municipality of Ollon VD (Swisstopo) with population density (colored pixels, according to the legend). © Data: swisstopo.

Energy indicators

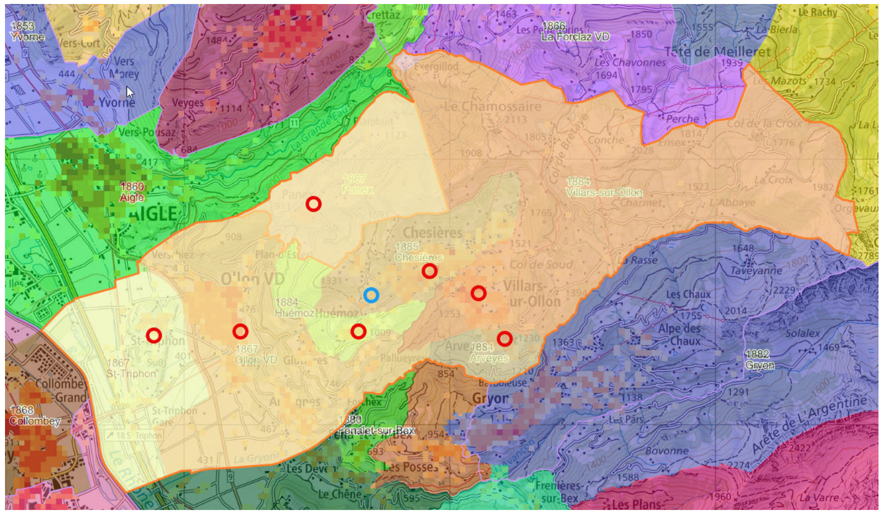

Figure 4: Municipality of Ollon (municipal boundary in orange line) and PLZ6 polygons in color. Red circles are the calculation locations for each PLZ6 Polygon, blue circle is the municipal center according to the dataset of the Federal Statistical Office (“BFS_centre”). © Data: swisstopo.

Target users

The energy indicator products meet needs for local or aggregations at postcodes, municipalities, districts, cantons or country level of the energy and civil engineer sector.

Accuracy and interpretation

The accuracy is directly dependent on the accuracy of the base data and the additional interpolation on the individual points.

In short (details on the product documentation of TabsD), for the base data (TabsD grid dataset), we expect limited accuracy of the estimation of temperatures for non-instrumented locations despite its specific design for a mountainous area and the comparatively dense measurement network. One main reason are the unresolved scales (small-scale effects on the temperature distribution not modeled in the analysis, as land cover effects from lakes, and the influence of local topography as for valley cold pools), resulting in underestimation of the spatial variability. Another aspect is the interpolation uncertainty, which is dependent on the season and the region, with highest absolute errors in winter. Particularly large errors are met in inner Alpine valleys, mostly due to systematic overestimates in the cold air pool environments. Please note that the long-term homogeneity is compromised in TabsD, and this is also valid for the energy indicators. This calls for caution for long-term climate trend studies. For more detail see Frei (2014, section 4d).

In addition, the subsequent interpolation from the grid to the points is an additional source of uncertainty. Cross-validation tests show that generally the error in the grid datasets largely dominate while the contribution from the additional interpolation to the points is comparatively small. In general, the user should be careful because the interpretation of the values as local point estimations leads to substantial interpolation errors compared to the interpretation as area mean values.

In addition to the accuracy issues, it is important for the interpretation of the results to be clear about the approach to calculating the products (see ‘Method’ section), particularly the population-weighted spatial aggregation.

Related products

Original temperature daily grid dataset (TabsD).

Versions

Current version: v1.0

Previous versions: none

Production cycle

The daily and monthly tables and plots are produced typically on the 25^{th} of the following month to include all available manual measurements and to await all the regular processing for data quality. The yearly tables and plots are available typically on the 25^{th} of January of the following year. All products are fully updated if major changes are made in the temperature grid dataset.

References

For the data basis (temperature grid dataset):

Frei, C., 2014: Interpolation of temperature in a mountainous region using non-linear profiles and non-Euclidean distances. Int. J. Climatol., 34, 1585-1605. doi: 10.1002/joc.3786.

May 2025