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Documentation of MeteoSwiss Grid-Data Products

Monthly and Yearly Mean Temperature: TabsM and TabsY

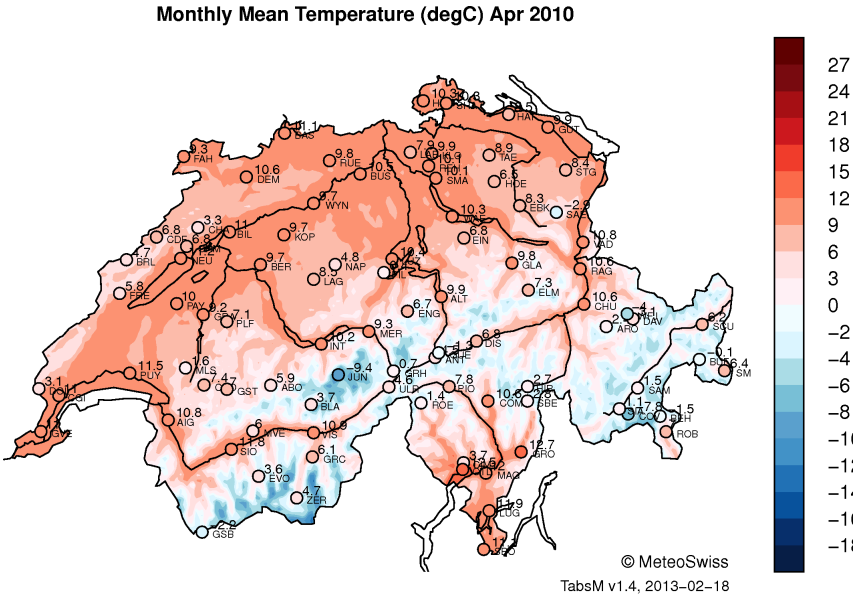

Figure 1: Monthly mean surface temperature (degrees C) for April 2010.

Variable

Temperature two meters above surface, averaged over calendar months (years) in degrees Celsius. Mean values are determined by averaging daily mean values calculated from automatic 10-minute measurements, i.e. the average covers day-time and night-time conditions.

Application

Climate monitoring, agriculture and ecology, glaciology, tourism, climate change downscaling.

Overview

TabsM and TabsY are spatial analyses of monthly and yearly mean surface temperature covering the territory of Switzerland. They are based on homogeneous measurement time series at about 80 stations and cover a multi-decadal period (1961-present). The interpolation is estimated using a km-scale digital elevation model with non-linear and regionally variable topography temperature relationships. The datasets are intended for quantitative applications such as in agricultural planning and the modeling of ecosystems and glaciers. Moreover they are a reference for long-term climate monitoring and can serve to calibrate climate change downscaling methods.

Monthly and Yearly Temperature: TabsM and TabsY

Data base

TabsM and TabsY are calculated from monthly and yearly mean temperature values of all MeteoSwiss climate stations that dispose of a sufficiently complete time series to calculate norm values and attendant anomalies. For the period 1981 till present, the station network is virtually constant with 86-91 stations measuring at any point in time. Before that, the station number gradually increases from 62 to 69 between 1961 and 1977 and then more rapidly in then following few years. In the Alps, the station network consists mainly of valley floor and mountain top stations. Slope conditions are comparatively underrepresented. The current MeteoSwiss network (SwissMetNet) is described in MeteoSwiss 2010.

The time series used for the interpolation have been homogenized to preserve long-term consistency of measurements in case of station relocations and instrument changes. (See Begert et al. 2003, 2005 for methodological detail.) However, accurate homogenization can only be effected with several years of measurement after the change. As a result, effects from station changes are not corrected immediately and inhomogeneities of the recent past (a few years back) may still be present in some records. Periodic recalculation of the analyses after major homogenization steps will correct those inconsistencies over time.

Since 1981, monthly/annual mean temperatures are calculated by averaging automatic station measurements taken in 10-minute intervals. In the pre-automatic period, mean values were originally calculated from a weighted average of three daily measurements. Inconsistencies in the averaging schemes are compensated by homogenization (Begert et al. 2003).

Method

Fields of TabsM and TabsY are calculated using a similar method as for TabsD. (See Frei (2014) and the product documentation of TabsD for details.) However, unlike for TabsD, only homogenous station records are integrated. In brief, the interpolation is based on a regionalized non-linear vertical temperature profile and a non-Euclidean “climatological” distance weighting of anomalies from the vertical profile. The underlying digital elevation model is USGS GTOPO30 (see http://eros.usgs.gov) for the 2-km grid, and SRTM (Farr et al. 2007) for the 1-km grid. The digital elevation model(s) can be requested with the data products.

Target users

Due to the use of homogenized time series in their construction, the primary purpose of TabsM and TabsY is the monitoring of year-to-year temperature variations in Switzerland, including the study of its regional variations and height dependencies (see e.g. Ceppi et al. 2010). Moreover, these products (possibly together with other monthly gridding products) can serve as input to quantitative models for applications where monthly resolution is sufficient. Possible examples are empirical glacier or ecosystem models. Other areas of possible interest are tourism, architecture and engineering. Finally, area covering temperature fields can be valuable for deriving local-scale climate change scenarios by statistical downscaling.

Accuracy and interpretation

The method of spatial interpolation adopted for TabsM and TabsY is more accurate than popular interpolation with linear temperature height relationships. The explicit consideration of temperature inversions and the use of a data-driven weighting scheme can account for topographic effects more flexibly. It can be expected that major features of the temperature variation, including inversions over the Swiss Plateau as well as winter-time cold pools and summer-time heating of valleys, are reproduced in these products.

However, several physical effects are not modeled in the analysis. Among these are lake effects and urban heat islands. In fact, no effects related to land use or land cover were considered so far. A reliable estimate of these seemed to be difficult, given the complex topographic effects superimposed and the limited number of stations available. In addition, there are limitations for the representation of topographic effects at small-scales. For example, the vertical extent and long-valley distribution of winter-time cold pools can hardly be deduced from the station network alone, not least because of the small number of valley slope stations. As a result, it must be expected that local-scale temperature variations are generally underestimated. (Too smooth distributions.) Moreover the temperature anomalies from resolved topographic effects may display with considerable error in extent and amplitude. This is particularly true for valley cold pools: Their reproduction by the analysis critically depends on the existence of in-situ measurements. Hence cold anomalies may be missing completely in un-instrumented valleys.

A "leave-one-out" cross-validation reveals considerable seasonal and spatial variations of the interpolation accuracy. For winter months the standard error varies between 0.6 degrees over the Swiss Plateau and Jura to 1.8 degrees in the Alps and in Ticino. Errors are smaller in summer: 0.5 degrees over the Swiss Plateau/Jura and 0.7 degrees in the Alps/Ticino. The corresponding standard errors for annual mean temperature (TabsY) are 0.5 and 1.0 degrees for the Plateau/Jura and the Alps/Ticino respectively.

Even though the time series underlying our analyses are of good long-term consistency, the homogeneity of TabsM and TabsY may be compromised by changes in the station network. We have compared TabsY to a similar experimental analysis using continuous station time series only and found that the resulting long-term trends are comparable at larger scales, but can significantly deviate in some areas. (See also Frei 2014.) We therefore recommend to be careful in using the datasets for applications where long-term homogeneity is essential. Datasets with robust long-term properties are currently under development.

It is to be noted, that TabsY is calculated directly from the annual station values. Non-linearities in the analysis scheme lead to slight differences between TabsY and the mean value determined from monthly fields (TabsM). It is recommended to use TabsY in applications where yearly time resolution is sufficient.

Related products

TanomM9120 and TanomY9120: Anomalies of monthly and yearly mean temperature, relative to the mean of 1991-2020.

TnormM9120 and TnormY9120: Mean monthly and yearly temperature of 1991-2020.

Note: There is full consistency of TabsM and TabsY with these related products because anomalies are directly calculated from the grids for the norm and absolute values.

TminM, TmaxM, TminY and TmaxY: Monthly and yearly means of daily minimum and maximum temperatures. These analyses are constructed similarly like those for TminD and TmaxD, but by reference to TabsM and TabsY. (See documentation for TminD and TmaxD.)

TabsD, TminD, TmaxD: Analyses of daily mean, minimum and maximum temperature.

Grid structures

TabsM and TabsY are available in the following grid structure:

ch02.lonlat, ch01r.swiss.lv95, ch.cosmo1.rotpol, ch.cosmo2.rotpol, ch.cosmo7.rotpol (analyses on cosmo grids are provided upon special request only)

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Versions

Actual versions: TabsM v1.4, TabsY v1.4

Previous versions:

TabsM v1.2 and TabsY v1.2 were derived with a similar method like version v1.4 but using less robust estimation procedures for the profile and layering scheme.

TabsM v1.0 and TabsY v1.0 were derived with an older method using spatial interpolation of anomalies with respect to the long-term mean.

Update cycle

TabsM is updated monthly. The analysis for a month is usually available at the beginning of the following month. TabsY is updated yearly and is available in January.

References

Begert M, Seiz G, Schlegel T, Musa M, Baudraz G, Moesch M. 2003. *Homogenisierung vom Klimareihen der Schweiz und Bestimmung der Normwerte 1961 – 1990. Schlussbericht des Projekts NORM90*. Veröffentlichung der MeteoSchweiz, **67,** 170 pp. Available from www.meteoswiss.ch.

Begert, M., T. Schlegel and W. Kirchhofer, 2005: Homogeneous temperature and precipitation series of Switzerland from 1864 to 2000. *Int. J. Climatol.,* **25,** 65-80.

Ceppi, P., Scherrer, S. C., Fischer, A. M. and Appenzeller, C. 2010: Revisiting Swiss temperature trends 1959-2008. Int. J. Climatology, **32,** 203-213. DOI: 10.1002/joc.2260

Farr, T. G., Rosen, P. A., Caro, E., Crippen, R., Duren, R., Hens- ley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J., Umland, J.,Werner, M., Oskin, M., Bur- bank, D., and Alsdorf, D.: The shuttle radar topography mission, Rev. Geophys., 45, RG2004, doi:10.1029/2005RG000183, 2007.

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.

MeteoSwiss, 2010: SwissMetNet: Ein Messnetz für die Zukunft. Federal Office of Meteorology and Climatology MeteoSwiss, Zürich, 2 pp. Available from www.meteoswiss.ch

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