MeteoSwiss Spatial Climate Analyses: Documentation of Datasets for Users

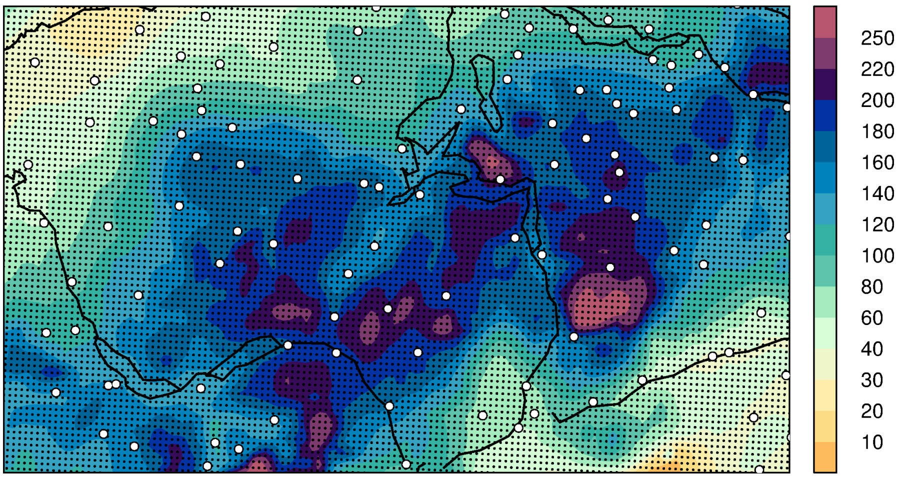

Figure 1: Distribution of the 48-hour precipitation (in mm) of 21-22 August 2005 in central Switzerland. White points indicate stations from which data was integrated, black points indicate the 1-km grid of the analysis.

Overview

Spatial climate analyses are estimates of the distribution of weather and climate at the earth surface. They are commonly provided on a regular grid (grid datasets) and offer spatially more comprehensive information than measurements at weather stations. Spatial analysis integrates measurements (from weather stations, satellites and radar), knowledge on the retrieval and representativity measurements and physical understanding of atmospheric processes in order to infer information for locations without measurements.

Spatial analyses are required in disciplines that apply distributed quantitative models to examine effects of weather and climate. Forecasting of river flow, understanding the retreat of glaciers and assessing crop suitability, for example, require spatially comprehensive meteorological input. Grid datasets also serve a number of native meteorological applications, such as climate monitoring and forecast evaluation.

MeteoSwiss has established a suite of ready-made spatial climate analyses for the territory of Switzerland. These encompass several parameters, are regularly updated and can be distributed to customers in one-time or repeated deliveries. The present documentation provides an overview of available datasets. It accompanies a set of more specific documentations for individual data products.

Products

The suite of climate analyses encompasses datasets for several parameters, currently precipitation, air temperature and sunshine duration. Products are usually available for several time aggregations (H: hourly, D: daily, M: monthly, Y: yearly or N: climate norm values) and as anomalies with respect to the norm. Most of the datasets range back till 1961, a few as far as 1864.

For some parameters and aggregations, several products are provided, which were constructed with different procedures in order to meet the variable requirements of different user groups. For example, daily precipitation is available as a preliminary real-time estimate, based on a smaller set of automatic measurements, and a final high-resolution analysis that integrates all available (also non real-time) measurements. Some new datasets are probabilistic, i.e. they are offered as ensembles allowing the user to trace analysis uncertainty into applications.

Each product is denoted with an acronym indicating the parameter, time aggregation and, if relevant, specific characteristics of the dataset. Table 1 lists currently available data products. For most of the products, or groups of products, detailed documentations are available.

Table 1: Spatial climate analyses available at MeteoSwiss (Coding of aggregation time is: N for norm values, Y for yearly, M for monthly, D for daily, and H for hourly.)

Precipitation

Acronym	Description	Aggreg. in Time
RnormY8110	Mean yearly precipitation (norm value, 1981-2010)	N
RnormM8110	Mean monthly precipitation (norm value, 1981-2010)	N
R8110m6190Y	Ratio in yearly precipitation norm values (1981-2010 / 1961-1990)	N
R8110m6190M	Ratio in monthly precipitation norm values (1981-2010 / 1961-1990)	N
RhiresY	Yearly precipitation (1961 – present)	Y
RrecabsY*NNNN*	Yearly precipitation (long-term consistent since *NNNN*=1864, 1901, 1961)	Y
RanomY8110	Yearly precipitation anomaly (relative to 1981-2010, 1961 – present)	Y
Rrecanom8110Y*NNNN*	Yearly precip anomaly (long-term consistent since *NNNN*=1864, 1901, 1961)	Y
RhiresM	Monthly precipitation (1961 – present)	M
RrecabsM*NNNN*	Monthly precipitation (long-term consistent since *NNNN*=1864, 1901, 1961)	M
RanomM8110	Monthly precipitation anomaly (relative to 1981-2010, 1961 – present)	M
Rrecanom8110M*NNNN*	Monthly precip anomaly (long-term since *NNNN*=1864, 1901, 1961)	M
RhydchprobD	Daily precipitation (ensemble analysis for hydrological units, 1961 – present)	D
RwarnchprobD	Daily precipitation (ensemble analysis for warn regions, 1961 – present))	D
RhiresD	Daily precipitation (final analysis, 1961 – last month))	D
RprelimD	Daily precipitation (preliminary analysis, for past two months))	D
APGD	Daily precipitation over the Alpine Region (1971-2008)	D
CPC	Hourly precipitation from radar and stations (real-time analysis, 2005-present)	H

Table 1 (continued)

Temperature		
Acronym	Description	Aggreg. in Time
TnormY8110	Mean yearly mean temperature (norm, 1981-2010)	N
T8110m6190Y	Difference in mean yearly temperature norm (1981-2010 – 1961-1990)	N
TminnormY8110	Mean yearly daily minimum temperature (norm, 1981-2010)	N
TmaxnormY8110	Mean yearly daily maximum temperature (norm, 1981-2010)	N
TnormM8110	Mean monthly mean temperature (norm, 1981-2010)	N
T8110m6190M	Difference in mean monthly temperature norm (1981-2010 – 1961-1990)	N
TminnormM8110	Mean monthly daily minimum temperature (norm, 1981-2010)	N
TmaxnormM8110	Mean monthly daily maximum temperature (norm, 1981-2010)	N
TnormD8110	Mean calendar day temperature (norm, 1981-2010)	N
TabsY	Yearly mean temperature (1961 – present)	Y
TrecabsY*NNNN*	Yearly temperature (long-term consistent since *NNNN*=1864, 1901, 1961)	Y
TanomY8110	Yearly temperature anomaly (relative to 1981-2010, >1961 – present)	Y
Trecanom8110Y*NNNN*	Yearly temp. anomaly (long-term consistent since *NNNN*=1864, 1901, 1961)	Y
TminY	Yearly mean of daily minimum temperature (1961 – present)	Y
TmaxY	Yearly mean of daily maximum temperature (1961 – present)	Y
TabsM	Monthly mean temperature (1961 – present)	M
TrecabsM*NNNN*	Monthly temperature (long-term consistent since *NNNN*=1864, 1901, 1961)	M
TanomM8110	Monthly temperature anomaly (relative to 1981-2010, 1961 – present)	M
Trecanom8110M*NNNN*	Monthly temp. anomaly (long-term consistent since *NNNN*=1864, 1901, 1961)	M
TminM	Monthly mean of daily minimum temperature (1961 – present)	M
TmaxM	Monthly mean of daily maximum temperature (1961 – present)	M
TabsD	Daily mean temperature (1961 – present)	D
TanomD8110	Daily mean temperature anomaly (relative to 1981-2010, 1961 – present)	D
TminD	Daily minimum temperature (1961 – present)	D
TmaxD	Daily maximum temperature (1961 – present)	D
LSTY	Yearly satellite-based land surface (skin) temperature (1991 – present)	Y
LSTM	Monthly satellite-based land surface (skin) temperature (1991 – present)	M

Table 1 (continued)

Sunshine, Radiation and Coulds

Acronym	Description	Aggreg. in Time
SnormY8110	Mean yearly relative sunshine duration (norm, 1981-2010)	N
S8110m6190Y	Ratio in mean yearly sunshine duration. (1981-2010 / 1961-1990)	N
SnormM8110	Mean monthly relative sunshine duration (norm, 1981-2010)	N
S8110m6190M	Ratio in mean monthly sunshine duration. (1981-2010 / 1961-1990)	N
SrelY	Yearly relative sunshine duration (1961 – present)	Y
SanomY8110	Yearly sunshine duration anomaly (relative to 1981-2010, 1961 – present)	Y
SrelM	Monthly relative sunshine duration (1961 – present)	M
SanomM8110	Monthly sunshine duration anomaly (relative to 1981-2010, 1961 – present)	M
SrelD	Daily relative sunshine duration (1961 – present)	D
SISY	Yearly satellite-based global radiation (2004 – present)	Y
SISM	Monthly satellite-based global radiation (2004 – present)	M
SISD	Daily satellite-based global radiation (2004 – present)	D
SISDIRY	Yearly satellite-based direct radiation (2004 – present)	Y
SISDIRM	Monthly satellite-based direct radiation (2004 – present)	M
SISDIRD	Daily satellite-based direct radiation (2004 – present)	D
CFCY	Yearly satellite-based cloud fractional cover (1991 – present)	Y
CFCM	Monthly satellite-based cloud fractional cover (1991 – present)	M
CFCD	Daily satellite-based global cloud fractional cover (1991 – present)	D

Accuracy and interpretation

MeteoSwiss has adopted advanced techniques for the generation of its data products, and it is active in research collaborations for the ongoing development of methodologies. Spatial analysis is, however, always associated with limitations and uncertainties. Notably the topography of the Alps and the attendant small-scale variations of the climate in Switzerland are a major challenge. Also, the retrieval of climate information from remote sensing measurements (satellite, radar) is subject to uncertainties. The nature of uncertainties and the magnitude of errors in the data products differ markedly between parameters, aggregation times, region of interest, season and time period.

For each data product, a detailed analysis was carried out of the characteristics and magnitude of analysis uncertainties. The most important results and their implications for practical applications are summarized in the section “accuracy and interpretation” of the individual product documentations. We recommend that users seek an understanding of the relevance of uncertainties for their application. The developers at MeteoSwiss can be approached for further assistance.

Two types of error are worth mentioning in general: Firstly, the underlying station networks are much coarser than the spacing of the target grid. The fine-scale structures evident in the grid datasets rely mostly on relationships of the parameter in question to geo-topographical factors and, hence, the ability to recover fine-scale structures depends on the strength of these relationships. As a result, the effective spatial resolution in a spatial analysis may be coarser than the grid spacing. The user should therefore be careful in relying on data at single or few grid points. Some recent datasets for precipitation provide quantitative measures of this type of uncertainty.

They offer an ensemble, instead of just a deterministic estimate. The members of the ensemble can be considered equally probable realities and, hence, ensemble spread a measure of the involved uncertainty.

Secondly, several of the grid datasets are affected by temporal variations of the station network, changes in instrumentation and position of stations. These can result in spurious or unrealistic temporal variations. Users requiring high climatological homogeneity should use datasets, which were explicitly derived for long-term monitoring. The reconstruction datasets (e.g. RrecabsM1901, Trecanom8110Y1864) are specifically developed for this purpose, yet at the (unavoidable) expense of reduced effective resolution.

Versions

A versioning system is adopted individually for each dataset. It includes, the “version” number, similar to standard software versioning, which allows users to track changes in the procedures or method configuration adopted in the construction of the dataset. A new version is generally introduced if methodological advancements show a clear improvement in interpolation accuracy. Apart from that, each dataset is associated with a “production date”, reflecting the status of the MeteoSwiss station database at calculation time. Grid datasets are re-calculated periodically to yield updated products, which translate improvements in the quality of the station data with time. For example, grid data calculated close to real time may be affected by gross errors in station data. Updates, typically calculated one month later, incorporate amendments in data quality that have been made later in the data processing chain.

Geolocation

By default, the climate analyses are distributed on the nodes of a regular grid, defined in some geographic coordinate system and covering the territory of Switzerland. Most datasets can be obtained in several different grid structures in order to serve users with different traditional modeling coordinates. Table 2 summarizes the grid structures commonly used and the documentation of an individual product lists the grid structures available for that product. It is recommended to use the analyses on the provided grid(s), rather than making a re-interpolation. The latter can substantially degrade the accuracy of the data.

Users interested in the climate for specific locations (rather than a grid) can ask to receive the analyses directly at these locations. MeteoSwiss will, however, charge the costs for such a user-defined processing of our analyses.

Ensemble analyses of daily precipitation are available as area-average precipitation for either a hydrology-based areal partitioning of Switzerland (Basis- and Bilanz Regions in the Hydrological Atlas of Switzerland) or warn regions (as defined by MeteoSwiss).

The most common grid structures are in longitude-latitude coordinates and in swiss coordinates, at a grid spacing of about 5, 2 and 1 km respectively. Many of the analyses are also available on the grid of the COSMO forecasting model in rotated longitude latitude coordinates (see Table 2).

Table 2: Grid structures used for the data products

ch02.lonlat	A grid in regular longitude and latitude increments covering the territory of Switzerland (5.75-10.75 deg E, 45.75-47.875 deg N). Grid points outside Switzerland are flagged. The grid spacing is 1.25 deg minutes (0.02083 deg) in longitude and latitude, corresponding to approximately 2.3 km (1.6 km) in the North-South direction (West-East direction).
ch05.lonlat	A grid in regular longitude and latitude increments covering the territory of Switzerland (5.5-11.0 deg E, 45.5-48.0 deg N). Grid points outside Switzerland are flagged. The grid spacing is 0.05 degrees in longitude and latitude, corresponding to approximately 5.6 km (3.9 km) in the North-South direction (West-East direction).
ch01r.swisscors	A 1 km grid in the Swiss coordinate system CH1903. Grid points are located on the 500 m nodes. The grid window (474'500 – 843'500, 64'500 – 303'500) covers entire Switzerland. Grid points outside the country are flagged.
ch01h.swisscors	A 1 km grid over the domain of "hydrological Switzerland", i.e. encompassing catchments draining to Swiss territory. Grid nodes are defined like for ch01r.swisscors but the window is larger (474500 – 843500, 59500 – 323500).
ch.cosmo1.rotpol ch.cosmo2.rotpol ch.cosmo7.rotpol	A 0.01-degree (0.02, 0.06 degree) grid in rotated pole longitude/latitude coordinates, including all of Switzerland. Resolution approx. 1.1 km (2.2, 6.6 km). These are the grids of the MeteoSwiss NWP models COSMO-1, 2 and 7 respectively.
al05.etrs.laea	A 5km grid over the Alpine Region in the ETRS89-LAEA coordinate system (4.8-17.5°E / 43-49°N, 47.6°N in France).

Data format The standard data format for delivering MeteoSwiss spatial climate analyses is NetCDF (CF standard > v1.4). Some datasets can also be delivered in ASCII format or as GeoTIFF.

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