# MeteoSwiss Spatial Climate Analyses: Documentation of Datasets for Users

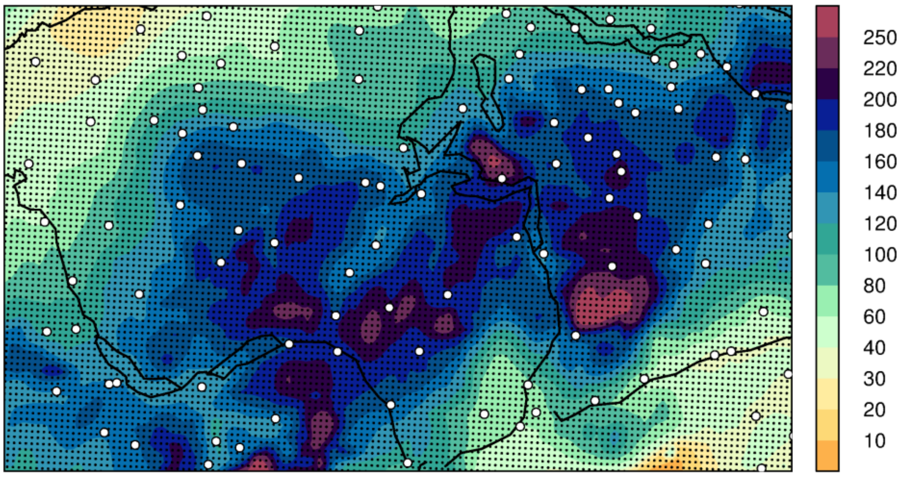


*Figure 1:* Distribution of the 48-hour precipitation (in mm) of 21-22 August 2005 in central Switzerland. White points indicate stations from which data was integrated, black points indicate the 1-km grid of the analysis.

**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 alone. Spatial analysis integrates measurements (from weather stations, satellites and radar), with knowledge on the representativity of 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, sunshine, radiation and clouds. 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-realtime) 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 other characteristics. Table 1 lists currently available data products. For most of the products, or groups of products, there are detailed documentations 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 |
| RnormY9120 | Mean yearly precipitation (norm value, 1991-2020) | N |
| RnormM9120 | Mean monthly precipitation (norm value, 1991-2020) | N |
| R9120m6190Y | Ratio in yearly precipitation norm values (1991-2020 / 1961-1990) | N |
| R9120m6190M | Ratio in monthly precipitation norm values (1991-2020 / 1961-1990) | N |
| RhiresY | Yearly precipitation (1961 – present) | Y |
| RrecabsY*NNNN* | Yearly precipitation (long-term consistent since *NNNN*=1864, 1901, 1961) | Y |
| RanomY9120 | Yearly precipitation anomaly (relative to 1991-2020, 1961 – present) | Y |
| Rrecanom9120Y*NNNN* | Yearly precip anomaly (long-term consistent since *NNNN*=1864, 1901, 1961) | Y |
| Rrecanom6190Y*NNNN* | Yearly precip anomaly (similar to Rrecanom9120Y but wrt 1961-1990) | Y |
| RhiresM | Monthly precipitation (1961 – present) | M |
| RrecabsM*NNNN* | Monthly precipitation (long-term consistent since *NNNN*=1864, 1901, 1961) | M |
| RanomM9120 | Monthly precipitation anomaly (relative to 1991-2020, 1961 – present) | M |
| Rrecanom9120M*NNNN* | Monthly precip anomaly (long-term since *NNNN*=1864, 1901, 1961) | M |
| Rrecanom6190M*NNNN* | Monthly precip anomaly (similar to Rrecanom9120M but wrt 1961-1990) | 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)*

| Near Surface Air Temperature | | |
|---|---|---|
| *Acronym* | *Description* | *Aggreg. in Time* |
| *TnormY9120* | *Mean yearly mean temperature (norm, 1991-2020)* | *N* |
| *T9120m6190Y* | *Difference in mean yearly temperature norm (1991-2020 – 1961-1990)* | *N* |
| *TminnormY9120* | *Mean yearly daily minimum temperature (norm, 1991-2020)* | *N* |
| *TmaxnormY9120* | *Mean yearly daily maximum temperature (norm, 1991-2020)* | *N* |
| *TnormM9120* | *Mean monthly mean temperature (norm, 1991-2020)* | *N* |
| *T9120m6190M* | *Difference in mean monthly temperature norm (1991-2020 – 1961-1990)* | *N* |
| *TminnormM9120* | *Mean monthly daily minimum temperature (norm, 1991-2020)* | *N* |
| *TmaxnormM9120* | *Mean monthly daily maximum temperature (norm, 1991-2020)* | *N* |
| *TnormD9120* | *Mean calendar day temperature (norm, 1991-2020)* | *N* |
| *TabsY* | *Yearly mean temperature (1961 – present)* | *Y* |
| *TrecabsYNNNN* | *Yearly temperature (long-term consistent since NNNN=1864, 1901, 1961)* | *Y* |
| *TmaxrecabsYNNNN* | *Same as TrecabsYNNNN, but for mean daily maximum temperature* | *Y* |
| *TminrecabsYNNNN* | *Same as TrecabsYNNNN, but for mean daily minimum temperature* | *Y* |
| *TanomY9120* | *Yearly temperature anomaly (relative to 1991-2020, 1961 – present)* | *Y* |
| *Trecanom9120YNNNN* | *Yearly temp. anomaly (long-term consistent since NNNN=1864, 1901, 1961)* | *Y* |
| *Trecanom6190YNNNN* | *Yearly temp. anomaly (similar to Trecanom9120YNNNN but wrt 1961-1990)* | *Y* |
| *Tmaxrecanom9120YNN* | *Same as Trecanom9120YNNNN, but for mean daily maximum temperature* | *Y* |
| *Tminrecanom9120YNN* | *Same as Trecanom9120YNNNN, but for mean daily minimum temperature* | *Y* |
| *TminY* | *Yearly mean of daily minimum temperature (1971 – present)* | *Y* |
| *TmaxY* | *Yearly mean of daily maximum temperature (1971 – present)* | *Y* |
| *TabsM* | *Monthly mean temperature (1961 – present)* | *M* |
| *TrecabsMNNNN* | *Monthly temperature (long-term consistent since NNNN=1864, 1901, 1961)* | *M* |
| *TmaxrecabsMNNNN* | *Same as TrecabsMNNNN, but for mean daily maximum temperature* | *M* |
| *TminrecabsMNNNN* | *Same as TrecabsMNNNN, but for mean daily minimum temperature* | *M* |
| *TanomM9120* | *Monthly temperature anomaly (relative to 1991-2020, 1961 – present)* | *M* |
| *Trecanom9120MNNNN* | *Monthly temp. anomaly (long-term consistent since NNNN=1864, 1901, 1961)* | *M* |
| *Trecanom6190MNNNN* | *Monthly temp. anomaly (similar to Trecanom9120MNNNN but wrt 1961-1990)* | *M* |
| *Tmaxrecanom9120MNN* | *Same as Trecanom9120MNNNN, but for mean daily maximum temperature* | *M* |
| *Tminrecanom9120MNN* | *Same as Trecanom9120MNNNN, but for mean daily minimum temperature* | *M* |
| *TminM* | *Monthly mean of daily minimum temperature (1971 – present)* | *M* |
| *TmaxM* | *Monthly mean of daily maximum temperature (1971 – present)* | *M* |
| *TabsD* | *Daily mean temperature (1961 – present)* | *D* |
| *TanomD9120* | *Daily mean temperature anomaly (relative to 1991-2020, 1961 – present)* | *D* |
| *TminD* | *Daily minimum temperature (1971 – present)* | *D* |
| *TmaxD* | *Daily maximum temperature (1971 – present)* | *D* |
| *TabsH* | *Hourly mean temperature (2018 – 2024)* | *H* |

*Table 1 (continued)*

*Land Surface Temperature*

| *Acronym* | *Description* | *Aggreg. in Time* |
|---|---|---|
| *LST_PMW* | *Land Surface (Skin) Temperature from 1991 to now* | *H* |

*Sunshine*

| *Acronym* | *Description* | *Aggreg. in Time* |
|---|---|---|
| *SnormY9120* | *Mean yearly relative sunshine duration (norm, 1991-2020)* | *N* |
| *S9120m6190Y* | *Ratio in mean yearly sunshine duration. (1991-2020 / 1961-1990)* | *N* |
| *SnormM9120* | *Mean monthly relative sunshine duration (norm, 1991-2020)* | *N* |
| *S9120m6190M* | *Ratio in mean monthly sunshine duration. (1991-2020 / 1961-1990)* | *N* |
| *SrelY* | *Yearly relative sunshine duration (1971 – present)* | *Y* |
| *SanomY9120* | *Yearly sunshine duration anomaly (relative to 1991-2020, 1971 – present)* | *Y* |
| *SrelM* | *Monthly relative sunshine duration (1971 – present)* | *M* |
| *SanomM9120* | *Monthly sunshine duration anomaly (relative to 1991-2020, 1971 – present)* | *M* |
| *SrelD* | *Daily relative sunshine duration (1971 – present)* | *D* |

*Radiation*

| *Acronym* | *Description* | *Aggreg. in Time* |
|---|---|---|
| *Albedo* | *Surface albedo from satellites 1991 to now* | *H, D, M, Y, N* |
| *SIS* | *Surface incoming solar radiation from satellites 1991 to now with and without horizon* | *H, D, M, Y, N* |
| *SISCF* | *Clear sky surface incoming solar radiation from satellites 1991 to now with and without horizon* | *H, D, M, Y, N* |
| *SISDIF* | *Diffuse surface incoming solar radiation from satellites 1991 to now with and without horizon* | *H, N* |
| *SISDIR* | *Direct surface incoming solar radiation from satellites 1991 to now with and without horizon* | *H, D, M, Y, N* |
| *SISDIRCF* | *Clear sky direct surface incoming solar radiation from satellites 2004 to now with and without horizon* | *H, D, M, Y, N* |
| *SISDNI* | *Direct normal incoming solar radiation from satellites 2004 to now with and without horizon* | *H, N* |
| *KI* | *Cloud Index from satellites 2004 to now* | *H* |
| *SDL* | *Surface downward longwave radiation from satellites 1991 to now* | *H, D, M, Y, N* |
| *SOL* | *Surface outgoing longwave radiation from satellites 1991 to now* | *H, D, M, Y, N* |
| *NSR* | *Net shortwave radiation from satellites 1991 to now* | *H, D, M, Y, N* |
| *NLR* | *Net longwave radiation from satellites 1991 to now* | *H, D, M, Y, N* |
| *SRB* | *Surface radiation budget from satellites 1991 to now* | *H, D, M, Y, N* |
| *BB_EM* | *Broad band emissivity from satellites 1991 to now* | *D, N* |

*Table 1 (continued)*

*Clouds*

| *Acronym* | *Description* | *Aggreg. in Time* |
|---|---|---|
| *CMASK* | *Cloud mask from satellites 2004 to now* | *H* |
| *CFC* | *Cloud fractional cover from satellites 1991 to now* | *H, D, M, Y, N* |
| *CTH* | *Cloud top height from satellites 1991 to now* | *H* |
| *CTT* | *Cloud top temperature from satellites 1991 to now* | *H* |

**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 uncertainty. 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 uncertainty. The level of uncertainty and, hence, the accuracy of the estimates varies 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 estimation errors. 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 is coarser than the grid spacing. This also affects the statistical properties of the estimates, notably is the frequency of extremes underestimated in general. 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 the involved 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 is a measure of the involved uncertainty.

A second general limitation to be noted is that many of the offered datasets are affected by the temporal variation 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, Trecanom9120Y1864) 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 lead to a major extension of the product or 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 provided on the nodes of a regular grid, defined in some geographic coordinate system and covering the territory of Switzerland. Some products are provided over *hydrological Switzerland*, encompassing also areas outside the national border. 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 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.

Ensemble analyses of daily precipitation are also 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. As for the Swiss coordinate grids, MeteoSwiss uses the CH1903+ convention introduced with LV95 (see swisstopo.admin.ch). Many of the data products 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<br>ch02h.lonlat | Grids in regular longitude and latitude increments with a spacing of 1.25 degree minutes (0.02083 deg), corresponding to approximately 2.3 km (1.6 km) in the North-South (West-East) direction. *ch02.lonlat* covers the territory of Switzerland (5.75-10.75 deg E, 45.75-47.875 deg N, 241x103), with grid points outside the country border flagged. *ch02h.lonlat* is similar but covers the larger domain of *hydrological Switzerland* (5.75-10.75 deg E, 45.625-48.125 deg N, 241x121) |
| ch05.lonlat<br>ch05h.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). *ch05h.lonlat* is similar but covers the larger domain of *hydrological Switzerland* (5.025-10.975 deg E, 45.025-48.975 deg N, 241x121) |

| | |
|---|---|
| ch01r.swiss.lv95<br>ch01h.swiss.lv95 | A 1 km grid in the Swiss coordinate system CH1903+ (LV95). Grid points are located on the 500 m nodes. *ch01r.swiss.lv95* is defined on a window covering Switzerland (2’474’500 – 2’843’500, 1’064’500 – 1’303’500, 370x240) but grid points outside the country border are flagged. *ch01h.swiss.lv95* is similar but covers the domain of *hydrological Switzerland* (2’474’500 – 2’843’500, 1’059’500 – 1’323’500, 370x265). |
| ch.cosmo1.rotpol<br>ch.cosmo2.rotpol<br>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 5 km 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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