Documentation of MeteoSwiss Grid-Data Products

Monthly and Yearly Precipitation: RhiresM and RhiresY

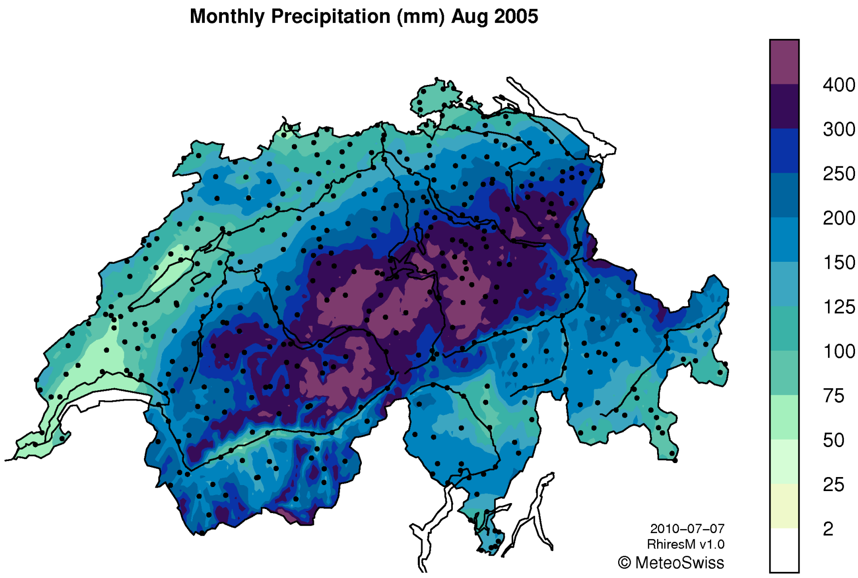

Figure 1: Monthly precipitation total (mm) and incorporated station measurements for August 2005

Variable Precipitation accumulated over the calendar months (the year), including rainfall and snowfall water equivalent. In millimeters (equivalent to liters per square meter).

Application Climate monitoring, ecology and agriculture, water resources, glaciology, hydropower, tourism.

Overview RhiresM and RhiresY are spatial analyses of monthly and yearly precipitation respectively, covering the entire territory of Switzerland and providing detailed spatial information. It exploits all available station measurements of the MeteoSwiss operational network (more than 420 each month), and covers a multi-decadal period (1961-present). The two products address requirements of agronomists, ecologists and glaciologists running environmental process models. Moreover, it delivers a basis for planning and management tasks on water resources, hydropower, engineering and tourism.

Data base

RhiresM/RhiresY are based on monthly/yearly precipitation totals measured at the high-resolution rain-gauge network of MeteoSwiss. It uses all station measurements available for a particular month to ensure maximum possible effective resolution. Therefore, the station base varies over time (from month to month). The number of stations increases from 420 in the early 1960ies to about 520 in the mid 1970ies and gradually decreases thereafter, reaching 430 after 2005. 270 rain gauges (about 50% of the stations) come with an uninterrupted record since 1961.

The geographical distribution of rain-gauge stations in Switzerland is reasonably balanced in the horizontal (see e.g. Fig. 1), but there is a clear imbalance in the vertical, with regions above 1200 mMSL being comparatively under-represented (see e.g. Frei and Schär 1998, Konzelmann et al. 2007).

The majority of the rain gauges operated since 1961 are/were manual Hellmann type gauges with an orifice of 200 cm^2 positioned 1.5 m above ground. Since the early 1980ies approximately 70 stations are equipped with automatic tipping bucket gauges.

Method

A field of precipitation in month MM is obtained through the following procedure: (1) Spatial interpolation of the climatological mean precipitation measurements for the calendar month of MM (reference period 1971-1990); (2) Calculation of relative anomalies of measured precipitation with respect to the climatological mean from step 1; (3) Spatial interpolation of relative anomalies; (4) Multiplication of the resulting anomaly field with the climatological mean field.

The interpolation in step 1 adopts regionally varying precipitation – topography relationships, estimated by local weighted linear regression. A version of the PRISM algorithm by Daly et al. (1994, 2002) is applied and adjusted for the Alpine region (Schwarb et al. 2000, Schwarb et al. 2001). The purpose of using a climatological reference field for the interpolation of monthly precipitation is to reduce the risk of systematic errors due to the under-representation of measurement stations at high elevations (Widmann and Bretherton 2000).

The interpolation in step 3 adopts a weighting scheme, which emphasizes the contribution of measurements which are close to the analysis point and/or which exhibit a high degree of directional isolation in the neighborhood of the analysis point. For this purpose a modified version of the SYMAP algorithm by Shepard (1984) is employed. Details of the interpolation scheme are described in section 4.1 of Frei et al. (2006) and in Frei and Schär (1998).

Target users

Thanks to its multi-decadal extent (more than 50 years) and high effective resolution, RhiresM/RhiresY address the needs of a wide range of applications. In climatology, it is the primary data product for regional climate monitoring, research on climate variability and climate change downscaling. Moreover, it is suitable as input into environmental process models in a variety of fields such as agriculture, ecology, hydrology and glaciology. Also, it provides an interesting data base for socio-economic planning and management tasks, such as for water resources, hydropower and tourism.

Accuracy and interpretation

The accuracy of RhiresM/RhiresY depends on the accuracy of the underlying rain-gauge measurements and the capability of the interpolation scheme to reproduce precipitation at un-gauged locations.

Measurement errors: Measurements by rain gauges are subject to systematic errors. Wind-induced deflection of hydrometeors over the gauge orifice results in an underestimation of true precipitation. The “gauge undercatch” is comparatively larger during episodes with strong wind, or at wind-exposed stations and during weather with small rainfall intensity or with snowfall (Neff 1977, Yang et al. 1999). Sevruk (1985) estimates the systematic measurement error in Switzerland to range from about 4% at low elevations in summer to occasionally more than 40% above 1500 mMSL in winter. RhiresM must therefore be expected to generally underestimate precipitation particularly in months and at locations with snowfall.

Interpolation errors: A “leave one out” cross-validation reveals a relative standard error of +/– 20% in point estimates for Jura and the Swiss Plateau and of +/– 25-30% for the Alps and the Alpine south side. Seasonal variation of errors is small. Particularly large relative errors occur during dry months and in inner Alpine valleys (e.g. the Valais) as well as at high elevations in the Alps. The average fraction of explained spatial variance is 75% (Nash-Sutcliffe Efficiency, Nash and Sutcliffe 1970). It is to be noted that estimates of area mean values (obtained by averaging gridpoint values) are much more accurate with error statistics decreasing quickly with the size of the area (see also Frei et al. 2008).

Temporal homogeneity: Temporal variations in the station network invoke climatological inhomogeneities in RhiresM. These are expected primarily on a local to regional scale, while they tend to average out for larger scale averages. Users requiring climatological homogeneity are referred to product RanomM8110, however this is associated with a compromise in the effective spatial resolution.

Grid spacing vs. effective resolution: The km-scale spacing of gridpoints does not imply that these short scales are fully resolved in RhiresM. The short scale patterns (e.g. those evident in Fig. 1) are reflecting the climatological topography-precipitation relationships. The effective resolution of RhiresM is in the order of 15-20 km, corresponding to the average inter-station distance. Frei et al. (2008) give a thorough discussion of short-scale uncertainties in gridded precipitation products.

Related products

RhiresM and RhiresY are related: The same analysis procedure is used for both products. RhiresM takes monthly, RhiresY yearly precipitation measurements from stations. As a result, there is no strict consistency between the two products, i.e. adding the months of a year from RhiresM does not reproduce RhiresY exactly. This is due to differences in the underlying measurement data, when stations only cover part of the year. Differences are however insignificant in practice.

RhiresD: Similar to RhiresM but for the daily precipitation sum. Again, there is no strict consistency between the two products, i.e. adding the days of a month from RhiresD does not reproduce RhiresM/RhiresY exactly. Differences are however small in practice. If a monthly time-resolution is sufficient, product RhiresM should be preferred over the aggregation from RhiresD, because of higher reliability.

RanomM8110: Deviation from the climatological mean precipitation (reference norm period 1981-2010). This product is based on the sub-sample of stations for which there exist approved norm values. Hence RanomM8110 is of slightly inferior effective spatial resolution. RanomM8110 is recommended for applications where long-term homogeneity is required.

Grid structures

RhiresM and RhiresY are available in the following grid structures:

ch02.lonlat, ch01r.swisscors, ch.cosmo1.rotpol, ch.cosmo2.rotpol, ch.cosmo7.rotpol,

Versions

Current versions: RhiresM v1.0, RhiresY v1.0

Previous versions: none

Update cycle

RhiresM is updated every month, RhiresY every year. The analysis for month *M* is available after day 25 of month *M+1*. The analysis for year *Y* is available in February of year *Y+1*.

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