Documentation of MeteoSwiss Grid-Data Products

Daily Precipitation (preliminary analysis): RprelimD

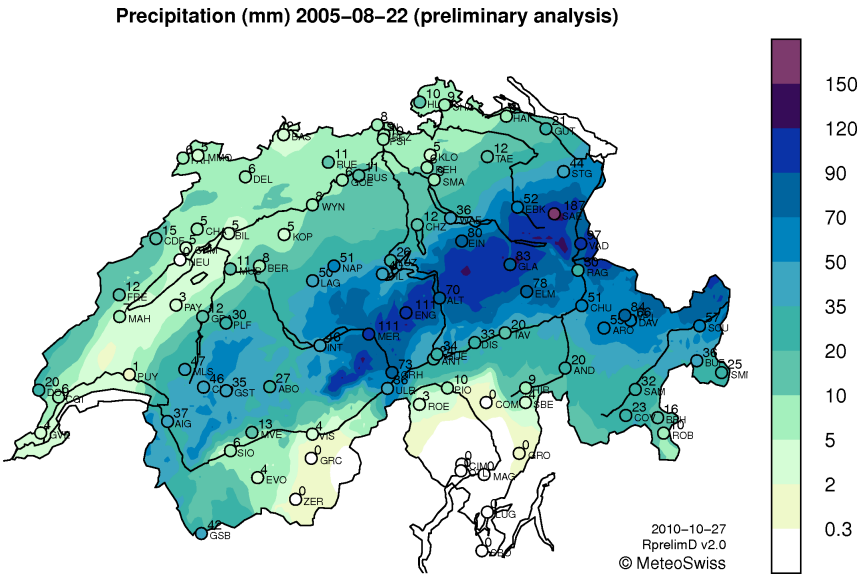

Figure 1: Preliminary analysis of daily precipitation (mm) for 22. August 2005. (Final analysis see Fig. 1 of product documentation for RhiresD.)

Variable

Daily precipitation on day D, corresponding to rainfall and snowfall water equivalent accumulated from 06:00 UTC of day D to 06:00 UTC of day D+*1*. In millimeters (equivalent to liters per square meter).

Application

Real-time precipitation monitoring. Water resources and hydropower management. Hydrology, agriculture and tourism.

Overview

RprelimD is a near real-time analysis of the distribution of daily precipitation in Switzerland. The analysis for a day becomes readily available on the following day. The restriction to real-time measurements implies that RprelimD is a “preliminary analysis”, which is superseded by a more reliable “final analysis” from all (including manual) measurements after a delay of about one month (see RhiresD). RprelimD is addressed to qualitative or semi-quantitative applications in water resources and hydropower management.

Preliminary Daily Precipitation: RprelimD

Data base

RprelimD is based on measurements at stations with a near real-time data delivery into the MeteoSwiss central data archive. This involves approximately 95 mostly automatic stations from SwissMetNet (Konzelmann et al. 2007, MeteoSwiss 2010). The underlying station network (see Fig. 1) has an average inter-station distance of about 30 km and encompasses mostly flatland and valley floor stations, with high-mountain regions relatively underrepresented.

The number of stations used for RprelimD is almost constant in time. The statistical approach of the analysis requires that only stations with a multi-year record can be integrated. Hence, measurements from newly installed automatic stations, such as those from ongoing extensions of the network by MeteoSwiss, can be integrated with some delay only.

The rain gauges of the automatic network of MeteoSwiss are tipping bucket gauges with an orifice of 200 cm^2 positioned 1.5 m above ground. Additional manual gauges with real-time data delivery are of the Hellmann type.

Method

The method of analysis used for RprelimD adopts a reconstruction technique, very different from conventional interpolation approaches. It builds on a statistical relationship between high- and coarse-resolution data, which is calibrated from past data. To this end, the method of Reduced Space Optimal Interpolation (RSOI, Kaplan et al. 1997, Schmidli et al. 2001) has been adopted. It's application for RprelimD is described in Schiemann et al. (2010).

In brief, RSOI for RprelimD encompasses: (1) the application of a Principal Component Analysis (PCA) to high-resolution precipitation fields from 10 years of product RhiresD; (2) the representation of precipitation variability by a restricted number of principal components; (3) the calibration of a linear relationship between the real-time station measurements and the retained PCA scores; (4) the application of this relationship to estimate a quasi high-resolution analysis for a day from the real-time measurements of that day.

The advantage of the reconstruction approach is that information is included not only from the actual real-time measurements but also – in a statistical manner – from past measurements of all stations (i.e. additional 300 non real-time stations). This enhances the effective resolution compared to that achievable from the real-time measurements alone. In particular recurring mesoscale imprints of the topography are reproduced more realistically than with conventional interpolation.

Target users

RprelimD is addressed to users with a need for fast access times (quasi real-time) but prepared to accept compromises in accuracy. It is meant to provide an overview of recent rainfall activity in Switzerland for qualitative or rough quantitative management tasks in hydrology, hydropower and water resources management. Agronomy, insurance and tourism are other sectors of potential application.

Accuracy and interpretation

RprelimD is a timely available, yet preliminary estimate of the distribution of precipitation in Switzerland. The way it is constructed, RprelimD attempts to approximate, from a limited station sample, the high-resolution analysis (RhiresD) that would be produced from a complete yet unavailable station sample. Therefore, even in the case of perfect reconstruction, RprelimD embodies the errors and uncertainties of the final analysis RhiresD (see the corresponding the product documentation). However, the limited number of measurements available for RprelimD imposes additional uncertainties:

The difficulties of automated rain-gauge measurement under windy and freezing conditions pose limitations to the accuracy of the measurements and constrain the placement of stations (maintenance). Moreover, gross errors may be discovered and corrected only with

some delay. Therefore, the real-time analysis RprelimD is prone to more substantial measurement errors compared to RhiresD and the limited topographic representativity of the network involves additional risks for systematic error, especially at high altitudes.

The skill for reconstructing fine-scale precipitation variations from a coarser resolution network depends on the nature of these variations (see Schiemann et al. 2010): Recurring “climatic” features, such as the imprints of topography under similar flow situations, are resolved quite effectively by the reconstruction process. In contrast, patterns resulting from processes that are not geographically anchored, such as maxima from quasi-stationary cells or streaks from moving thunderstorms, are less well represented, and happen to be missing when they occur between stations. As a result, there is a remarkable case-by-case variation in how accurately RprelimD can reproduce RhiresD: Explained spatial variance fraction for daily totals (Nash-Sutcliffe Efficiency) varies between 0.25 and 0.98 with a median value of 0.83 in winter, and 0.76 in summer. Hence the reliability of RprelimD is clearly limited during summer days when precipitation systems are particularly small scale and of convective nature.

Fields of RprelimD generally have a smoother appearance than their high-resolution counterparts from RhiresD. Local extremes tend to be underestimated and rainfall areas tend to be smeared out into dry areas, even more so than in RhiresD. As a result, the effective resolution of RprelimD is considerably coarser, likely in the order of 30-50 km.

Nevertheless, the statistical incorporation of data from the past makes RprelimD more accurate in systematic and random errors compared to interpolation techniques based on direct observations only (such as that applied for RhiresD). The added value of past data is extensively illustrated and quantified in Schiemann et al. (2010).

In summary, RprelimD provides an overview and rough estimate of precipitation activity in Switzerland. It is aimed primarily for qualitative monitoring or quantitative applications with a supra-regional focus (scales larger than about 50 km). Users should not expect local extremes (dry or wet) to be accurately reproduced. Quantitative applications will have to tolerate errors of several ten percent even for area means estimates of several 100 km^2.

Related products

RhiresD: The final analysis of daily precipitation with all station measurements included, noteably the manual measurements not available in real time. Compared to RprelimD, RhiresD is qualitatively more accurate, has a higher effective resolution but is accessible only with a delay of about one month. It is recommended to update RprelimD data with RhiresD, as soon as it becomes available.

CPC: An hourly precipitation dataset obtained from a formal statistical combination of simultaneous radar and rain-gauge measurements. This data product is available in near real-time and addresses user needs for very high temporal resolution. (See the corresponding documentation.) Aggregation of CPC over one day does not replicate RhiresD.

Grid structures

RprelimD is available in the following grid structure:

ch02.lonlat, ch01r.swisscors

Versions

Current version: RprelimD v2.0

Previous versions:

RprelimD v1.0: Based on interpolation as described in RhiresD, but using real-time measurements only. (This version was not distributed outside MeteoSwiss).

Update cycle

RprelimD is updated every day. The analysis for day *D* is available at 10:00 of day *D+1*.

References

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