Mean Precipitation 1981–2010

Abstract
The maps depicting the mean monthly, seasonal, and annual precipitation for the standard normal period 1981–2010 are based on grid data set Rnorm of MeteoSwiss. For catchments with an area of 20 km^2 or larger, area mean values can be displayed and downloaded from the maps.

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1 Introduction

Precipitation data provide an important quantitative basis for answering questions regarding water management and hydrology, agriculture and ecology, in energy and civil engineering, and many more. The maps presented here depict mean precipitation of the norm period 1981–2010 for a calendar year, the twelve calendar months, and the four seasons composed of three months each.

The normal period 1981–2010 was introduced in 2013 by the Federal Office of Meteorology and Climatology MeteoSwiss. In so doing, MeteoSwiss followed the 2011 recommendation of the World Meteorological Organization (WMO) to introduce a new 30-year normal period every ten years, in addition to the non-overlapping WMO standard reference periods 1901–1930, 1931–1960, 1961–1990, and so on [1]. The Hydrological Atlas depicts the mean precipitation of the last completed normal period, as these data are relevant to addressing current questions.

2 Data and methods

The maps of mean annual and monthly precipitation are based on the data sets RnormY [2] and RnormM [3]. RnormY and RnormM are spatial analyses of precipitation normals, derived from measurements at 418 stations for the normal period 1981–2010 [1]. The grid data sets cover the territory of Switzerland and provide a detailed picture of the spatial distribution of precipitation, with a resolution of 1.6 km x 2.3 km. However, the effective spatial resolution of interpolated data sets always depends on the density of the measurement network and the distribution of underlying measurement stations. In the Rnorm data sets, neighbouring measurement stations display a typical separation of 10–20 km.

The following steps were required to create the grid data sets:

1. The annual and monthly station values for the years 1981–2010 were summarised as mean values for the 30-year normal period.

2. The relative anomalies from (1) were calculated in relation to the climatological mean values for the period 1971–1990.

3. For spatial interpolation of measurement-site anomalies, a modified version of the SYMAP algorithm [4], [5] was applied.

4. The anomaly fields from step (3) were multiplied by the corresponding climatological precipitation analyses of the period 1971–1990 [6], [7], [8].

Systematic measurement errors and interpolation errors can impact the accuracy of spatially interpolated data sets. Accordingly, the accuracy of RnormM and RnormY depend, on the one hand, on the quality of the underlying measurement values, and, on the other, on the ability of the interpolation scheme to reproduce precipitation at unmeasured locations.

Systematic errors occur when wind, evaporation and wetting cause measurement instruments to miss some of the precipitation water. According to [9], the bias in Switzerland ranges from approximately 4% at low altitudes in summer to more than 40% at altitudes above 1500 m a.s.l. in winter. In general, the measurement values underestimate the actual precipitation amounts.

Interpolation errors affect the grid cells between measurement sites. Interpolation errors can be calculated by means of leave-one-out cross-validation. This analysis yielded a relative standard error of about ± 20 % for grid point estimates in the Jura and the Central Lowlands, and ± 25–30% in the Alps and the southern side of the Alps. Seasonal variation of error is low. Particularly large relative interpolation errors occur in dry calendar months, in inner Alpine valleys (e.g. Valais) and at high elevations. As the number of grid cells used for spatial-mean calculation increases, the expected rate of interpolation error decreases (see also [10]).

In the Hydrological Atlas, grid values from RnormY and RnormM for catchments 20 km^2 or larger are spatially aggregated and indicated as an area mean. For catchments composed of more than 5% foreign territory, no area mean is calculated because RnormY and RnormM data are only provided for areas within Switzerland.

3 Results

In the normal period 1981–2010, an average of 1397 mm of precipitation fell over Switzerland per year. High precipitation levels can be observed at the elevations of the alpine foothills, along the Bernese Alps,

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the Gotthard Massif, in the Ticino Alps, and in the western part of the Swiss Jura. Peak values are estimated for the southern flank of the Jungfrau Massif. But as a result of the small number and poor representativity of stations in this region, these estimates are very uncertain. By contrast, exceptionally low precipitation levels occur in the inner Alpine valleys, namely the Valais Rhône Valley, the Matter Valley, and in Engadin. In the Central Lowlands, mean annual precipitation ranges between 900 and 1300 mm/y. Figure 1 shows the average monthly precipitation levels across Switzerland. The largest monthly sums occur in the months of May to August. Between 140 mm/month and 144 mm/m of precipitation fall in these months. The least precipitation occurs in February at 82 mm/month. The monthly precipitation amounts increase by 58 mm between February and May, and decrease from 144 mm/m to 82 mm/month between August and February.

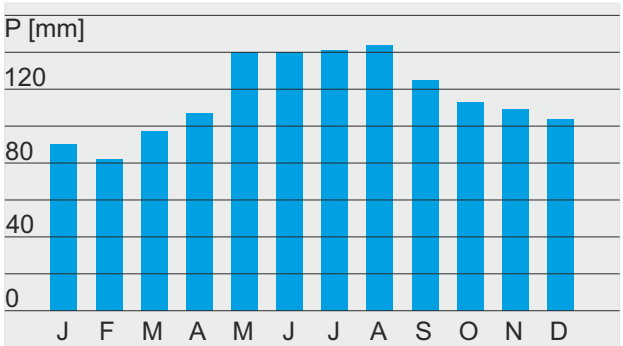

Figure 1. Mean monthly precipitation (P) in the standard normal period 1981–2010: area means for Switzerland

The spatial distribution of precipitation in individual months is generally similar to that of the year. The largest precipitation amounts occur along the mountain ridges of the Jura, in the alpine foothills, and in the Bernese Alps. The driest regions also consistently remain along the floor of the Rhône Valley between Martigny and Brig, in the valleys to the south, as well as in Engadin along the River Inn. In Ticino, it is much drier in December, January, February, and March than in the other months. In April, the precipitation amounts in Ticino increase, remaining at roughly the same level until November with a peak in October. North of the Alps, the season begins with larger precipitation amounts in May and lasts until August.

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