Plate 2.7 Mean Seasonal Precipitation throughout the European Alps 1971–1990

Introduction

The present plate shows mean seasonal and monthly precipitation for the entire Alpine mountain chain. Seasonal variations in precipitation influence the composition of the natural vegetation and the choice of cash crops and are also partly responsible for the discharge regime of the river systems (cf. plate 5.2). In addition, to a certain extent conclusions can be drawn from the seasonal precipitation data concerning the temporal occurrence of extreme events (avalanches, storms, periods of drought). For these reasons it is not surprising that the seasonal variation of precipitation represents an important factor in practical climatology (climatic zones according to Köppen [5] for example).

In the early days of climatological mapping of the Alps an overall picture of total precipitation was very inaccurate owing to the small number of observation stations. For this reason the emphasis was then on investigating precipitation on the basis of seasonal variation. Using 249 precipitation series with monthly values Raulin [7] classified the whole of the Alpine chain «from Vienna to Marseille» according to four types of precipitation patterns. His classification revealed the Alps not only as a dividing line between areas with maximum precipitation in spring and/or autumn and those with a maximum in summer, but also revealed modifications of this pattern that were linked to the Alps. These analyses were later refined (e.g. [6]) and interpreted in terms of seasonal weather patterns [2].

Data and methods

The data on which the spatial analyses for this plate are based is the same as that used for annual precipitation (see table 1 in plate 2.6 and [4]). The values given are all for the reference period 1971–1990. In order to guarantee consistency between the seasonal and annual analyses the annual totals measured using the totalisators were broken down into monthly values with the help of nearby rain gauges and included in the analysis.

As in plate 2.6, it was not possible to adjust the values for the systematic measurement error since the necessary data concerning winds was not available for all networks. The results of investigations [9] show that the measurements underestimate summer precipitation by between 1 and 8 %. As far as concerns the figures for winter, the rate of underestimation is around 4 % for the southern edge of the Alps, 10 % for the lowlands to the north and as much as 20–50 % for zones above 1500 m. The fact that the systematic measurement error is not taken into account results in underestimations for winter precipitation, in particular at high elevations, and thus a slightly distorted picture of seasonal variation. Below altitudes of around 1500 m the systematic measurement error is much smaller than the seasonal variation.

Again precipitation values were interpolated using PRISM (cf. plate 2.6 and [1]) on a grid with a resolution of 1.25 minutes (approx. 2 km x 2 km). The relative interpolation errors depend very little on the season [8], so that the error rates indicated in plate 2.6 also apply to the analyses on which the present plate is based.

Results

Mean precipitation values for the whole area covered by the map show a winter minimum of 237 mm, a summer maximum of 280 mm and a slight difference between spring (265 mm) and autumn (270 mm). Patterns of spatial distribution are similar to those already described in plate 2.6 such as the two zones of higher precipitation on the northern and southern edges of the Alps and in the peripheral ranges and drier areas within the mountains. The prominence of these patterns varies from season to season.

Winter: In comparison with the other seasons, winter precipitation is below average throughout the Alps; the wet zone on the southern edge of the Alps is less marked. The zones within the mountains, as well as Lower Austria and Carinthia (Kärnten), are particularly dry. The northern peripheral ranges, however (Jura, Vosges Mountains, Black Forest), receive more rain and snow than at any other time. Low pressure sytems over northern Europe with embedded fronts and weather situations with flow from the north-west are characteristic of this distribution pattern.

Spring: In comparison with winter, there is less difference between precipitation values for the northern edge of the Alps and the peripheral ranges on the one hand and the lowlands on the other. Values are especially high for the southern edge of the Alps (Tessin, Carnic and Julian Alps). Frequent weather situations with flow from the south and the onset of thunderstorm activity in late spring are responsible for these anomalies.

Summer: The Mediterranean coast and the Apennines receive little rain, while the central and eastern Alps are very wet. The highest rate of precipitation is to be found along the northern edge of the Alps. The corresponding band of high precipitation extends farther down into the central lowlands than at other times of the year. This pattern can be explained mainly by thunderstorms in the high Alps and the peripheral ranges.

Autumn: The distribution in autumn is similar to that in spring, the Massif Central, the Julian and Carnic Alps, as well as the Dinaric Alps having an especially high rate of precipitation. High levels of evaporation from the warm surface of the sea and frequent low pressure areas in the western part of the Mediterranean cause large amounts of humidity to be transported from the Mediterranean into the Alps. For this reason heavy rainfall is especially frequent along the southern edge of the Alps in autumn [3].

On a monthly scale the mean precipitation pattern is subject to some abrupt variations (fig. 2) which are particularly marked in the summer months. The onset of thunderstorm activity to the north of the main ridge of the Alps is clearly seen in the marked change in precipitation from May to June. In southern Switzerland and northern Italy the high summer rainfall rate drops slightly in July to rise again in August. The sudden decrease in rainfall from August to September marks the end of the summer thunderstorms over the Alps. The monthly pattern in autumn shows that October is especially wet on the southern face of the Alps.

Figure 1 shows the annual precipitation cycle for selected areas. Four main regimes can be identified:

- maximum precipitation in summer: Bavarian Alps, Munich area
- minimum precipitation in summer: Maritime Alps
- high precipitation rates in summer and winter: southern Black Forest, Jura – Franche Comté
- high precipitation rates in spring and autumn: Lake Maggiore – Sottoceneri area, Julian Alps.

The boxplots also show the inter-annual variations in monthly precipitation over the period 1971–1990. The large range of variation indicates that the precipitation pattern in a single year may differ considerably from the average annual cycle. In addition there are clear seasonal differences in the degree of inter-annual variability. Various areas show a smaller rate of inter-annual variation in the summer months than from autumn to spring (see for example Vienna area, Lake Maggiore – Sottoceneri area, Julian Alps).

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