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European extreme precipitation: Uncertainties of estimation and climate variability

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Europe is characterized by strong changes in mean and extreme precipitation over the last few decades. European precipitation extremes result in disastrous flash and river flooding largely affecting European economy and life conditions. However, estimates of extreme precipitation over Europe are as important as uncertain. Using long-term time series of observations at the rain gauges we analyse trends and variability in different characteristics of extreme precipitation. First, we address the uncertainties of estimation of three major groups of extreme precipitation metrics: absolute extremes, relative extremeness, and precipitation timing, i.e. the durations of the wet and dry periods and their impact on the magnitudes of extremes. For these characteristics we suggest new methods establishing more truth in quantitative estimates. Over most of Europe absolute extremes exhibit growing tendency during the last several decades with the magnitudes from 2 to 4% per decade. In the Western and central Europe this tendency is primarily associated with the change in the shape of probability distribution of extreme precipitation during the cold season, while in summer there is a clear indication of the decreasing of the intensity of absolute precipitation extremes. Relative extremeness (i.e. the fraction of seasonal total during the most wet days) also shows a clear seasonality in linear trends with increasing intensity during cold season and the downward tendency in the relative extremeness during warm season. Analysis of the duration of the Eurasian wet spells shows that during the last 60 years wet periods have become longer over most of Europe by about 15-20%. Becoming longer, wet periods in Europe are now characterized by more abundant precipitation. Heavy precipitation events during the last two decades have become much more frequently associated with longer wet spells and intensified in comparison with 1950s and 1960s. Importantly, the regrouping of wet days during the last decades resulted in changing duration of dry spells. Over considerable parts of Europe trends in the duration of wet and dry spells are significantly positive. This shows that European hydrological cycle undergoes significant changes with clustering wet and dry days in prolonged episodes.