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How reliable are the estimates of climate variability in extreme precipitation?

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Existing estimates of climate variability and trends in precipitation extremes are highly uncertain when quantified from daily and higher resolution rain gauge observations. The major sources of uncertainties are associated with the conceptual definition of extreme precipitation, inhomogeneity of different data types and inaccuracy of statistical methods applied for estimation of precipitation extremes. We assess the impact of these uncertainties on climate variability in extreme precipitation over European continent using different collections of European rain gauge data. We try to discriminate the role of changing precipitation totals and varying characteristics of frequency distributions in forming observed changes in precipitation extremes. These two factors have strong seasonal dependence over Europe with winter growth up to 5% per decade being associated with change in precipitation distribution and summer decrease of 3% per decade primarily implied by changes in total. Changes in extreme precipitation in Western Europe are primarily dominated by frequency distribution characteristics while in the Eastern Europe they are closely linked to the changes in totals. Considering limitations of precipitation metrics based on raw data, we argue for the revision of extreme precipitation indices whose applicability is conditioned by the finite number of wet days and propose a set of new indices based on the newly derived distribution of fractional contribution (DFC) of daily precipitation to the total. The extended indices are more stable compared to the routine ones. In winter new set of indices clearly reveals an increasing occurrence of extreme precipitation in Western European Russia (up to 4% per decade) while during summer a downward tendency in the fractional contribution of very wet days is found in Central Western Europe. Newly established indices also allow to better associate European extreme precipitation with the North Atlantic Oscillation and associated modes of atmospheric circulation variability. Analysis of extreme European precipitation was also extended to the consideration of precipitation duration periods which allow for discrimination of impacts of heavy and extreme rainfalls on regional hydroclimates and for better association of extreme precipitation with cyclone activity. For this analysis we derived 2-dimensional probability distributions of precipitation intensities and durations and quantify temporal variability in the properties of these distributions.