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Comparison of past and future, high and low extremes of precipitation and river flow for the Mediterranean as projected using different statistical downscaling methods

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Our lives are intimately related to the hydrological cycle. We need water resources for our activities and we are affected by hydrological extremes. This cycle is part of the climate system and, therefore, it will change as the whole climate changes. Hence the need for studies into the future evolution of these hydrological extremes. This is especially true for the Mediterranean region as it is expected that, in this region, the effects of climate change will be particularly intense. We analysed how the current tools and methodologies available are able to reproduce high and low hydrological extremes and their future evolution. Our focus was on the differences between three downscaling and unbiasing techniques, used to downscale and correct the bias of a RCM simulation, in order to force a physically based and distributed hydrological model on the Mediterranean basins of France. We show that both the quantile mapping method and a method based on weather regimes are able to reproduce the high and low precipitation extremes in the region of interest. We also show that when the hydrological model is forced with these downscaled data, there are important differences in the outputs. This shows that the model amplifies the differences and that the downscaling of other atmospheric variables might be very relevant when simulating river discharges. We also found that a third method, the simple anomalies method, performs better than expected in terms of river flow. Concerning the future anomalies of the extremes of river flow, the methods reproduce qualitatively similar futures. However, quantitatively, there are still significant differences on the individual gauging stations. According to the RCM simulation used and the downscaling techniques applied, it is expected that, in the middle of the 21st century (2035-2064), the monthly low flows will have diminished almost everywhere in the region of our study by as much as 20%. Regarding high flows, there will be important increases in the area of the Cévennes, which is already seriously affected by flash-floods. For some gauging stations of this area, the frequency of what was a 10-year return flood at the end of the 20th century is expected to increase, with such return floods then occurring every two years in the middle of the 21st century. Similarly, the 10-year return floods at that time are expected to carry 100% more water than the 10-year return floods experienced at the end of the 20th century. In the northern part of the Rhône basin, these extremes will be reduced.