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Probabilistic precipitation and temperature downscaling of the Twentieth Century Reanalysis over France

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This work proposes a daily high-resolution probabilistic reconstruction of precipitation and temperature fields in France over the last century built on the NOAA 20th century global extended atmospheric reanalysis (20CR, Compo *et al*., 2011). It aims at delivering appropriate meteorological forcings for continuous distributed hydrological modelling over the last 140 years. The longer term objective is to improve our knowledge of major historical hydrometeorological events having occurred outside of the last 50-year period, over which comprehensive reconstructions and observations are available. It would constitute a perfect framework for assessing the recent observed events but also future events projected by climate change impact studies.

The Sandhy (Stepwise ANalogue Downscaling method for Hydrology) statistical downscaling method (Radanovics *et al*., 2013), initially developed for quantitative precipitation forecast, is used here to bridge the scale gap between 20CR predictors – temperature, geopotential shape, vertical velocity and relative humidity – and local predictands – precipitation and temperature – relevant for catchment-scale hydrology. Multiple predictor domains for geopotential shape are retained from a local optimisation over France using the Safran near-surface reanalysis (Vidal *et al*., 2010). Sandhy gives an ensemble of 125 equally plausible gridded precipitation and temperature time series over the whole 1871-2012 period. Previous studies showed that Sandhy precipitation outputs are very slightly biased at the annual time scale. Nevertheless, the seasonal precipitation signal for areas with a high interannual variability is not well simulated. Moreover, winter and summer temperatures are respectively over- and underestimated. Reliable seasonal precipitation and temperature signals are however necessary for hydrological modelling, especially for evapotranspiration and snow accumulation/snowmelt processes.

Two different post-processing methods are considered to correct monthly precipitation and temperature time series. The first one applies two new analogy steps, using the sea surface temperature (SST) and the large-scale two-meter temperature. The second method is a calendar selection that keeps the closest analogue dates in the year for each target date. A sensitivity study has been performed to assess the final number of analogues dates to retain for each method. A comparison to Safran over 1958-2010 shows that biases on the interannual cycle of precipitation and temperature are strongly reduced with both methods. Using two supplementary analogy levels moreover leads to a large improvement of correlation in seasonal temperature time series. These two methods have also been validated before 1958 thanks to both raw observations and homogenized time series.

The two post-processing methods come with some advantages and drawbacks. The calendar selection allows to slightly better correct for seasonal biases in precipitation and is therefore adapted in a forecasting context. The selection with two supplementary analogy levels would allow for possible season shifts and SST trends and is therefore better suited for climate reconstruction and climate change studies.

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