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On the value of bias correction to improve pan-European hydrological simulation of extreme events

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Simulated projections of future changes in the hydrological cycle and in extreme events are an essential aspect for robust policy-making aiming at coping with potential impacts of climate change. In this context, consistent and validated forcing data employed for hydrological simulation of future extreme events become a key element of the modeling exercise. In a pan-European context, it has been noticed that climate models tend to overestimate warm summers in south-eastern Europe, whereas precipitation in winter time is too abundant in northern Europe. As precipitation and temperature form the main drivers of hydrological models, some form of bias correction is required if a realistic description of the hydrology is sought.

The aim of this work is to present an assessment of the simulation of hydrologic extreme events at pan-European scale employing the bias correction method recently developed by Piani et al. (2010). This bias correction technique corrects daily total precipitation (respecting the original snow to total precipitation ratio) and daily mean, maximum and minimum surface temperatures. The latter is extremely useful since the hydrological model used, LISFLOOD (van der Knijff, 2010), employs values of total precipitation, temperature and evapotranspiration to simulate hydrology at pan-European scale. We employ a daily high-resolution gridded-data set of temperature and precipitation developed for the ENSEMBLES project (E-OBS) to implement the bias correction method. Future daily precipitation and temperature time series are obtained from climate simulations derived from the RCM HIRHAM5 of the Danish Meteorological Institute, driven by the boundary conditions obtained from the GCM ECHAM5 of the Max Planck Institute for Meteorology (downloaded from the FP6 ENSEMBLES project webpage http://ensemblesrt3.dmi.dk/). We implement the bias correction method for the control period 1961-1990, and perform hydrological simulations for the control period and four time slices of 30 years each in the period 1980-2099.

Clear improvements on average statistics (annual and seasonal) for precipitation and temperature after implementing the bias correction procedure are observed compared to the not bias corrected climate simulations. These improvements on forcing input data resulted fundamental to obtain more robust hydrological simulations of extreme events at Pan-European scale. Notwithstanding the overall good agreement between observed (554 gauging stations) and simulated discharges, large discrepancies do occur at a small number of stations in which the relative errors can be 1 or 2 orders of magnitude. These discrepancies can be attributed to errors in the hydrological model (LISFLOOD), its static input data and its calibration and regionalization of its parameters, and, potentially, to river regulation not accounted for in the current modeling setup.

For future recurrence intervals, the internal variability of the climate model is clearly showed for each time slice. This suggests that for some areas a past event (e.g. 100 years) might be more frequent in a given time slice whereas in the next 30 years the same event could be observed less frequently. Despite the latter, some trends are observed for both not bias corrected- and bias corrected-based recurrence intervals. First, in northern Italy and a large part of Great Britain there is a clear tendency towards more frequent events. Second, a slight tendency to less frequent events more persistently observed for time slices driven by not bias corrected forcing data is observed. This suggests that the recurrence levels based on not bias corrected forcing data might wrongly indicate less frequently a current event of 100 years, thus, giving a misinterpretation of the flooding risk based on present flood events.