

Interactive comment on “On the variability of return periods of European winter precipitation extremes over the last five centuries” by A. Pauling and H. Paeth

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All comments on the manuscript "On the variability of return periods of European winter precipitation extremes over the last three centuries" contain important points, and the authors wish give their view on the two major ones that appear in all comments.

1. The most important concern mentioned several times is the possibility that changing return values of extremes may be an statistical artefact that is due to the decreasing number (and quality) of the predictors back in time. We agree that this issue is of prime importance and we attempted to show that not only the mean but also the extremes of the used precipitation reconstructions are robust. To address these concerns we reconstructed winter precipitation 1901-83 using just the predictors that are available in

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1500 for the four regions we analysed in the paper (Ireland, Spain, eastern and central Europe). The time period 1901-83 is due to predictor availability. The reconstruction methods included multiple regression (for fitting) and cross-validation (for achieving the predictions). Then we compared these predictions (reconstruction) with the CRU data to verify if there are significant differences between 20-year return values (RVs) of dry/wet extremes of the two time series. No significant difference implies correct reconstruction of the RVs by the predictors available in 1500. We performed the significance estimate of the differences using the Monte Carlo technique that is described now in detail in the paper. We repeated this procedure using the predictor sets available in 1700 and 1800 (the predictors available for 1600 are identical with the ones available for 1500). For the predictor set available in 1500 significant differences were detected for all regions while the predictors available in 1700 and 1800 are able to realistically reconstruct the RVs. Therefore we exclude all data prior to 1700 from our analyses on the changes of return periods.

2. Another important point is the uncertainty that arises from the estimation of the Gamma parameters used to fit the data. We completely agree that the Gamma fit, as every fit of a theoretical distribution to a sample of limited size, is subject to some uncertainty. Therefore, we do not rely on this fit but construct an uncertainty range for each parameter of the Gamma distribution from a parametric bootstrap approach with 1000 iterations. The method is based on random samples which lead to a mean estimate of the Gamma parameters and their confidence intervals given a certain error level. Thus, the time series in Figs. 4 and 6 in the final draft do not represent the direct (and uncertain) Gamma fit to the data but arise from this probabilistic Monte Carlo view. In addition, the bootstrapping is used to estimate changes in the occurrence of extremely wet and dry years. This is now made clearer in section 2 of the final draft.

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