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Recalibrating Extremes for Decadal Predictions

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Decadal predictions have become essential for near-term decision making and adaptation strategies. In parallel, interest in weather and climate extremes has increased strongly in the past. Thus, a combination of decadal predictions and extreme value theory is reasonable and necessary. Since decadal predictions suffer from typical discrepancies, such as start- and lead-year dependent conditional and unconditional biases, many ways for their recalibration have been proposed (Eade et al., 2014; Fučkar et al.,2014; Fyfe et al., 2011; Kharin et al., 2012; Kruschke et al., 2016; Raftery et al., 2005; Sansom et al., 2016; Sloughter et al., 2007). However, in previous studies, extremes have not been considered. Therefore, the aim of this study is to investigate how extremes from decadal predictions can be adequately recalibrated and how this affects forecasting skill. Pasternack et al. (2018) introduced a parametric Decadal Climate Forecast Recalibration Strategy (DeFoReSt 1.0), based on estimating polynomial adjustment terms (Gangstø et al., 2013). DeFoReSt assumes normality for the probability distribution (PDF) to be recalibrated and optimizes the cross-validated continuous ranked probability score (CRPS) with this assumption build in Gneiting et al. (2005). For a proof of concept, Pasternack et al. (2018) introduced a toy model for generating pseudo decadal forecast-observation pairs. For toy model data and surface temperatures from MiKlip hindcasts, improvement of forecast quality over a simple calibration from Kruschke et al. (2016) has been found. We extend these methods to extreme values with two modifications: (1) Follow DeFoReSt, but assume general extreme value (GEV) distributed forecasts. Again the CRPS is optimized but with the GEV build into the score (Friederichs and Thorarinsdottir, 2012). Both DeFoReSt strategies (DeFoReSt-normaland DeFoReSt-GEV) and the calibration from Kruschke et al. (2016) are compared to a forecast based on climatology. (2) The toy model is modified to generate pseudo decadal forecast-observation pairs with GEV distributed observations. For validation, a bootstrapping scheme is applied to temperature maxima hindcasts from MiKlip verified with HadEX2 observations. After recalibration, both DeFoReSt strategies perform similar for the toy model and MiKlip hindcasts, none significantly outperforms the other. However, they consistently show considerable improvements over the climatological forecast for the lower and upper quartiles in the toy model data. For the recalibrated MiKlip hindcasts, the findings are in accordance, but not as considerable, presumably due to their very small ensemble size (Sienz et al., 2016). This suggests that extremes may be directly recalibrated with the assumption of a Normal distribution, as long as this represents the characteristics of the decadal forecast ensemble. Thus, the forecasting skill of recalibrations appears to be unaffected by the underlying distribution of the observations.