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Global changes in extreme events from multi-model GCM ensembles: Regional and seasonal dimension

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We systematically analyze the complete IPCC AR4 ensemble of GCM simulations with respect to changes in extreme event characteristics at the end of the 21st century compared to present-day conditions. This complements previous studies by investigating a more comprehensive database and considering seasonal changes beside the annual time scale in the analysis. Confirming previous studies, the agreement between the GCMs is generally high for temperature-related extremes, indicating increases of warm day occurrences and heatwave lengths, and decreases of cold extremes. However, we identify issues with the choice of indices used to quantify heatwave lengths, which do overall not affect the sign of the changes, but strongly impact the magnitude and patterns of projected changes in heatwave characteristics. Projected changes in precipitation and dryness extremes are more ambiguous than those in temperature extremes, despite some robust features, such as increasing dryness over the Mediterranean and increasing heavy precipitation over the Northern high latitudes. We also find that the assessment of projected changes in dryness depends on the index choice, and that models show less agreement regarding changes in soil moisture than in the commonly used `consecutive dry days' index, which is based on precipitation data only. Finally an analysis of the scaling of changes of extreme temperature quantiles with global, regional and seasonal warming shows that much of the extreme quantile changes are due to a seasonal scaling of the regional annual-mean warming. This emphasizes the importance of the seasonal time scale also for extremes. Changes in extreme quantiles of temperature on land scale with changes in global annual mean temperature by a factor of more than 2 in some regions and seasons, implying large changes in extremes in several countries, even for the commonly discussed global 2∞C-warming target. Depending on their availability in the coming months, similar analyses will be provided for AR5 GCM simulations. This will allow for a first evaluation of differences between the two GCM ensembles with respect to extreme event indices.