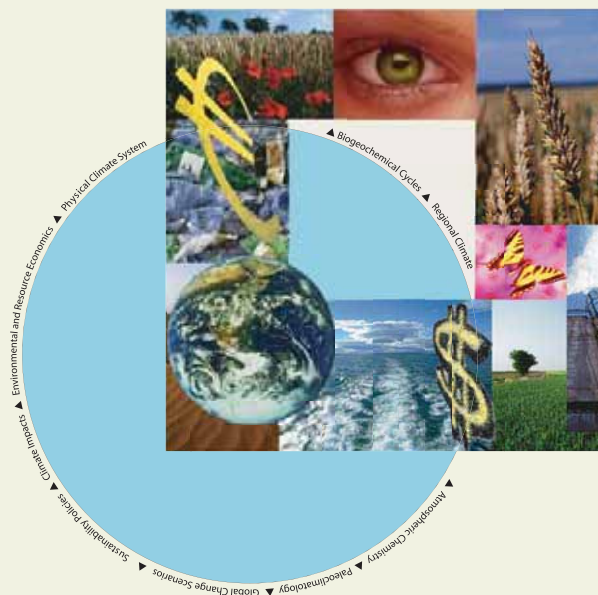


# International Max Planck Research School on EARTH SYSTEM MODELLING

## Extreme Climate Events and Euro-Atlantic Atmospheric Blocking in Present and Future Climate Model Simulations

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PhD Thesis prepared within the  
International Max Planck Research School on  
Earth System Modelling



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# Abstract

The study focuses on the analysis of the occurrence and changes of extreme temperature and precipitation events in global climate simulations of the present and future climate. Two approaches are followed to identify and analyze these extreme events in data of the global climate model ECHAM5/MPI-OM.

First, indices for extreme events, which capture moderate and statistical robust extreme events, are calculated on the basis of model data and are compared with indices from the global observational dataset HadEX. This comparison shows that the model is able to realistically capture the observed climatological large-scale patterns of the extreme indices, although the quality of the simulations depends on the index and region under consideration. In the future climate, as represented by the IPCC emission scenarios B1 and A1B, all considered temperature-based indices (yearly minimum and maximum temperatures and frequency of tropical nights) encounter a significant increase worldwide. The precipitation-based indices (max. 5-day precipitation amount and 95th percentile of precipitation) also increase significantly, particularly in those regions that are relatively wet already in present climate. Analogously, dry spells increase especially in regions with dry conditions under present climate. The future changes of the indices reveal distinct regional and seasonal patterns as shown exemplarily in three European regions.

Further, it is investigated whether the occurrence of extreme events and their changes in a warming climate are related to large-scale circulation patterns. This study particularly concentrates on the influence of Euro-Atlantic atmospheric blocking on extreme events in Europe. First, it is analyzed how well the model is able to represent blocking conditions in summer and winter by comparing blocking frequencies and their spatial and seasonal distributions with ERA-40 re-analysis data. Secondly, correlations between blocking frequency and selected monthly indices for extreme events are calculated. Blocking frequencies and their seasonal distribution are well captured by the model and especially for the winter minimum temperature significant correlations with blocking events are found in central Europe. In the future climate, the blocking frequency is slightly diminished but the influence on the European winter climate remains robust.

The second approach to identify extremes in global model data concentrates on the statistical modeling of extreme values. Here, the Generalized Extreme Value distribution (GEV) is fitted to monthly minima (maxima) of winter minimum (maximum) temperatures in Europe. The behavior of the distribution's parameters and 20-year return values are analyzed for present and future climate conditions. Compared to the extreme indices, similar regional warming patterns in Europe can be found in the A1B scenario. Finally, an attempt is made to improve the fit of the GEV by conditioning the parameters on a covariate derived from Euro-Atlantic atmospheric blocking. It is demonstrated that including atmospheric blocking as covariate improves the GEV fit particularly to the minimum temperature data in certain regions of Europe. This has also considerable impact on the return values.