EGU2020-4589
https://doi.org/10.5194/egusphere-egu2020-4589
EGU General Assembly 2020

North Atlantic – European weather regimes in a changing climate: present and future

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We present findings from an analysis of weather regimes over the North Atlantic and Europe in present and future climate conditions. Weather regimes strongly influence the statistical distribution of surface weather variables. We use a recently developed, all-season North Atlantic - European weather regime classification with seven regimes. These regimes were originally identified in ERA-Interim reanalyses and, in this study, we investigate how they are represented in climate simulations using the CESM1 large ensemble for present-day and future (RCP8.5) climate conditions. With these regimes, the classification of the flow conditions in the considered region goes beyond the classical categorization according to the North Atlantic oscillation index; the weather regimes explicitly capture different flavors of strong zonal flows and the occurrence of blocking over Greenland, Scandinavia, and Central Europe, respectively. In ERA-Interim they explain 70% of the variability in geopotential height at 500 hPa year-round. Our analysis quantifies how well CESM1 represents the statistics of the weather regimes in present-day climate and how strongly their frequencies change in the future climate scenario. In addition, we identify statistical relationships between weather regimes and their resulting impacts on spatial patterns of surface variables such as precipitation. We compare those patterns and characteristics of the weather regimes identified in ERA-Interim to their characteristics in simulations of present and future climate conditions.

This analysis leads to insight into the representation of and changes in atmospheric circulation in one particular climate model, and, at the same time, it quantifies how well the climate model captures the observed link between surface weather and weather regimes. This approach contributes to improving our understanding of atmospheric circulation changes and their impact on a regional scale, and it may benefit the interpretation and communication of climate projections.