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Atmospheric Blocking Trends and Variability in CMIP6-Simulations

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Atmospheric blocking describes a quasi-stationary weather pattern in midlatitudes which is characterised by a disruption of the westerly flow. Within the blocking anticyclone, large-scale subsidence of air effects dissipation of clouds. Intensive solar radiation during summer leads to a positive radiation balance whereas the balance is negative during winter. Therefore, a longer blocking event is often related to temperature extremes. On the one hand, the positive radiation balance in summer causes heatwaves which are intensified by adiabatic warming of subsiding air and warm air advection from the south on the western side of the block. On the other hand, cold spells occur in winter, especially on the eastern side of the block where advection of cold air from the north intensifies the effect of negative radiation balance. In case of longer persistence of the anticyclone, dry episodes can extend to droughts. The drought can be flanked by flood events due to quasi-stationary low-pressure systems. These weather phenomena have high socio-economic impacts and are good indicators to evaluate the accuracy of models. Thus, futural occurrence of blocking is of interest. We investigate the simulated blocking frequency by CMIP6 global climate models in different scenarios with focus on seasonal and regional trends. To assess the reliability of the models, we compare the historical simulations to centennial reanalyses. The comparison shows that the models underestimate the blocking frequency over Europe, the Northern Atlantic and the Northern Pacific. Furthermore, the models are apparently not able to represent variability and trends during the 20th century as detected by the reanalyses. The scenarios show a general decrease of blocking frequency in Northern Hemispheric midlatitudes during the 21st century. The decreasing trend in the simulations is stronger the stronger the emission of greenhouse gases is. This trend could be related to weakening of Atlantic Meridional Overturning Circulation (AMOC) which is expected to be stronger in high-emission scenarios. However, a closer analysis of the ensemble mean of the models indicates regional and seasonal differences. For example, a strong decrease is simulated over the Northern Atlantic during winter whereas the models simulate an increase of blocking frequency over Eastern Europe and Siberia during summer. Furthermore, we developed an approach for an ensemble mean weighted by mean square error (MSE) to improve the confidence in the simulations. The weighted ensemble mean confirms the trends of the non-weighted ensemble mean and shows only slight differences. Thus, the application of a weighted ensemble mean yields only small improvements.