Atmospheric teleconnections and atmospheric regime behaviour under future climate projections

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How anthropogenically related climate change might influence the patterns of natural variability and therefore atmospheric flow regimes requires extended analyses of multimodel ensemble integrations for control conditions, present day conditions and future climate scenarios. To contribute to an improved understanding of this issue, we study the projected low-frequency variability of several IPCC AR4 model simulations on the basis of the concept of atmospheric circulation regimes. Special emphasis is put on the question, how the regime-like behaviour in the Northern hemisphere is influenced by future changes of the external forcing according to the IPCC scenario A1B.

In this study the dominant teleconnection patterns and their temporal behaviour are determined for the 20th century and for the projections of the 21st century and compared with results of the control simulations. The concept of circulation regimes is applied to monthly winter (DJF) data in the middle troposphere. We determined circulations regimes by studying the probability density function in a low-dimensional state space, spanned by the first three empirical orthogonal functions. Circulations regimes are related to regions of unexpected high recurrence probability.

The detected regimes project onto the well-known teleconnection patterns like the North Atlantic Oscillation (NAO), the Pacific North America (PNA) pattern and the cold ocean warm land (COWL) pattern.

By comparison of the simulated regime behaviour for the control simulations, for the 20th century and for the projections of the 21st century, we study, whether the frequency of fixed regimes changes or new regimes arises due to the changes in the external forcings. This comparison reveals different sensitivity of the regime behaviour of different models: Some models did not show any changes of spatial regime structure, whereas for other model new regimes appeared/regimes disappeared under future climate projections. The frequency of occurrence of regimes changed in all model simulations. The most pronounced regime changes are the appearance of the COWL pattern and of the PNA+/NAO- pattern in all model simulations of the 21st century, which was not the case for the 20th century simulations.