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Frequency and within-type variations of North-Atlantic-European circulation types and their relevance for temperature and precipitation variability in Central Europe since 1780

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The present study analyzes the relevance of frequency and within-type changes of objectively derived North-Atlantic-European circulation types for long-term temperature and precipitation variability in Central Europe since 1780.

The analysis of the continuous changes in Central European climate since 1780 involving the decomposition of monthly climate variations into different parts that are caused by frequency and within-type changes of atmospheric circulation types revealed the dependency of the long-term climate variability on frequency fluctuations as well as climatic within-type changes of North-Atlantic-European circulation types. Large parts of the low-frequent Central European climate variations can not be sufficiently explained through varying frequencies of circulation types, pointing to the fact that also modifications of type internal climate characteristics play a significant role in generating long-term climatic variations.

Integrated over the whole period analysed frequency and within-type variations of circulation types account for roughly the half of the observed temperature and precipitation variations respectively. Furthermore it could be shown that the relevance of variations of internal characteristics and frequency varies between seasons and climatic parameters and also exhibits distinct fluctuations on the decadal to multidecadal time-scale.

Moreover it has shown that only a limited number of objectively derived circulation types contribute substantially to the observed temperature and precipitation variations

in Central Europe since 1780 through frequency changes as well as within-type climatic variations.

Looking for example at the long-term evolution of temperature and precipitation in January both characterised through long-term positive trends the relevance of within-type variations for climate change in Central Europe becomes distinctly apparent. Increasing temperatures as well as increasing precipitation sums rely for large parts on corresponding changes concerning within-type climate characteristics of January westerly and southwesterly circulation types (especially during the 20^{th} century). Long-term fluctuations of both variables and for both circulation types may be well explained through the combined effects of corresponding variations of vorticity and intensity connected to these two circulation types.

Although for several selected circulation types with particular importance for the long-term temperature and precipitation variations during the period 1780 to 1995 it could be shown that large parts of the observed within-type variations of climate characteristics can be explained through corresponding variations of the dynamic features of these circulation types it became clear that there are also distinct variations of type-internal climatic characteristics with great importance for the overall climatic variability that can not be sufficiently explained through corresponding variations of internal dynamic features such as vorticity or intensity. This points to the fact that additional reasons for climatic within-type variations have to be considered (e.g. spatial sub-grid scale features, atmospheric circulation variations on the synoptic time-scale not resolved by monthly data, variations of climatic boundary conditions).