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The effect of global warming on the internal variability of tropical Atlantic rainfall - a large ensemble modelling study

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The effect of global warming on the projected distribution of rainfall has been addressed by many studies. While there is some consensus on changes of the mean state, changes of the internal variability are more difficult to analyse and have not been discussed as much despite their importance for understanding changes in extreme events, such as droughts or floodings.
In our study, we analyse changes in the rainfall variability in the tropical Atlantic region. We use a 100-member ensemble of historical (1850-2005) model simulations with the Max Planck Institute for Meteorology Earth System Model (MPI-ESM1) to identify changes of internal rainfall variability. To investigate the effects of global warming on these patterns, we employ an additional ensemble of model simulations with stronger external forcing (1% CO_2-increase per year, same integration length as the historical simulations) with 68 ensemble members.
The focus of our study is on anomalous meridional shifts of the oceanic Atlantic ITCZ that are separated into different patterns using an EOF analysis. We find that the internal variability of rainfall over the tropical Atlantic does change due to global warming and that these changes in variability are larger than changes in the mean state in some regions. From splitting the total variance into patterns of variability, we see that the variability on the southern flank of the ITCZ becomes more dominant, i.e. explaining a larger fraction of the total variance in a warmer climate. In agreement with previous studies, we find that changes in the mean state show an increase and narrowing of the ITCZ.
The large ensembles allow us to do a statistically robust differentiation between the changes in variability that can be explained by internal variability and those that can be attributed to the external forcing. Furthermore, we argue that internal variability in a transient climate is only well defined in the ensemble domain and not in the temporal domain, which requires the use of a large ensemble.