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Disentangling the dynamics of the subpolar gyre and its interaction with the AMOC in the CMIP6 ensemble

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The subpolar gyre (SPG) is one of the climate tipping elements which could have a large impact on the climate in the northern hemisphere. Improving our understanding of its dynamics is key to assessing the likelihood of it passing a tipping point. Some CMIP6 models exhibit abrupt transitions in the sea surface temperature in the SPG region, but the majority does not. The differences in the model response can be related to the stratification bias, with many models having a too strong stratification preventing them from exhibiting bistable gyre dynamics.

To better understand the SPG we study the (lagged) partial correlations between the relevant aspects of its dynamics in the CMIP6 ensemble. In contrast to standard correlations, partial correlations correct for the effect of autocorrelation and the effect of (the past of) other relevant variables. Therefore, it gives a better indication of there being a causal relation. Based on the partial correlation between the sea surface temperature and mixed layer depth we split the ensemble into two groups (strong or negligible relation) and for each select one model to study its dynamics in detail. In addition, we discuss the interaction of the SPG with the Atlantic Meridional Overturning Circulation (AMOC) using the same methods. These results can help in better informing more conceptual climate models of the SPG, AMOC and their interactions, which can be used to study potential tipping dynamics.