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How much have variations in the meridional overturning circulation contributed to sea surface temperature trends since 1850? A study with the EC-Earth global climate model

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The surface of the worlds' oceans has been warming since the beginning of industrialisation mainly due to larger atmospheric greenhouse gas concentrations. In addition to that multidecadal SST variations of internal origin exist. Evidence points to the North Atlantic Ocean as exhibiting the strongest multidecadal SST variations and that these variations are connected to the overturning circulation.

In this work we investigate the extent to which these internal multidecadal variations have contributed to enhancing or diminishing the trend induced by the external radiative forcing globally and in the North Atlantic. We do so in a model study where we combine the analysis of a long control simulation with constant forcing corresponding to preindustrial conditions and an ensemble of simulations with historical forcing from 1850 until 2005.

First we note that global SST trends calculated from the different historical simulations are similar, while there is a large disagreement between the North Atlantic SST trends. Then we analyse the control simulation, where we identify a relationship between SST anomalies and anomalies in the Atlantic Meridional Overturning Circulation (AMOC) for multidecadal and longer time scales. This relationship enables us to extract the AMOC-related SST variability from each individual member of the ensemble of historical simulations and then to calculate the SST trends with the AMOC-related variability excluded. For the global SST trends this causes only a little difference while SST trends with AMOC related variability excluded for the North Atlantic show closer agreement than with the AMOC-related variability included. From this we conclude that AMOC variability contributed significantly to North Atlantic SST trends since the mid 19th century.