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Shaping climate change in the North Atlantic sector: The role of the atmospheric response to local SST changes vs. large-scale changes

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Climate change simulations robustly show a warming hole in the sub-polar North Atlantic that results from slowing of the AMOC countering the global warming signal. Here we investigate how the distinct SST spatial structures, which include a sharpening of the Gulf Stream SST gradients, influence climate change in the NA sector in winter. For this we analyse the RCP8.5 scenario simulation of the MPI Earth System Model. Additional sensitivity experiments with the atmospheric model component, ECHAM5, are performed to deconstruct the effect of the local spatial structure of the SST change from those arising from large-scale warming of the ocean, remote SST pattern changes and changed radiative forcings.

The MPI model simulation shows a signifcant decrease in precipitation to the south of the GS extension region in the future, despite a strong increase in underlying SST. While directly to the north there is a significant increase in precipitation. These distinct features in the precipitation response over the North Atlantic result from the local SST. Over the Gulf Stream, the differential structure of the precipitation changes reflects the changes of the local SST gradients there. Over the subpolar gyre the increase in precipitation is partly suppressed. In this region the Subpolar Gyre the weakened AMOC causes a SST warming, that is much weaker than the warming other regions of the ocean show at the same latitude.

The large-scale response, which includes the overall increase in precipitation over the NA is due to the overall warming, remote SSTs and/or directly connected to the radiative forcing.