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Effect of North Atlantic sea-surface temperature biases on the simulated atmospheric response

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Like many state-of-the-art coupled ocean-atmosphere models, the Earth System Model (ESM) of the Max Planck Institute for Meteorology (MPI-M) simulates strong sea surface temperature (SST) biases in the extra-tropical North Atlantic region. A series of SST-sensitivity experiments are performed with the corresponding atmospheric model component ECHAM6 to investigate the effect of the North Atlantic SST biases on the atmospheric response in particular on precipitation, storminess and atmospheric circulation. The atmosphere-only model ECHAM6 was forced by a seasonally varying climatology of observed global SSTs. Through the superposition of a varying extra-tropical North Atlantic bias pattern extracted from the MPI-M ESM on top of the control field, the relevance of the seasonal variation of extra-tropical North Atlantic biases for the simulated response is analysed.

Results show that the SST biases have a substantial effect on the pressure distribution in the North Atlantic region in all season. Anomalous warmer SSTs are associated with an increase in the geopotential height and vice versa. The resulting large-scale pressure gradient modification induces a significant southward shift of the zonal wind system including the jet. To first order the precipitation change follows the SST bias pattern. An analysis of the thermodynamic and dynamic mechanisms for the changes in the hydrological cycle shows that the dynamic components modify the precipitation response not only locally over the SST bias region, but even have a significant effect on the American and European continents. The SST bias pattern has a substantial effect on the Eady growth rate leading to a reduction of the storminess mainly in the northern part of the North Atlantic.