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Modified seasonal cycle in the Atlantic meridional heat transport in climate projections

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Seasonal to decadal climate predictions of the Atlantic meridional overturning circulation (AMOC) and the Atlantic meridional heat transport rely on predicting deviations from a climatological seasonal cycle. Longterm climate projections suggest modulations in the strength and in the seasonal cycle of the AMOC and the meridional heat transport under global warming. These potential changes might have implications for decadal predictions of the AMOC and the meridional heat transport, also in near future (e.g., 2050-2060).

As a prerequisite for a potential predictability analysis, we present our analysis of potential changes in the seasonal cycle of the North Atlantic meridional heat transport. In CMIP5 climate projections performed with the global coupled Max-Planck-Institute Earth System Model (MPI-ESM-LR) we analyse changes in the RCP8.5 climate change scenario in near future (2050s) relative to the historical simulation (1850-2005). Until 2050, the meridional heat transport reduces by 10-20% relative to the historical period. This reduction is accompanied by a 1-4 months shift in the seasonal cycle, mostly in the subtropical gyre. The changes in the seasonal cycle result from both a modified Ekman heat transport and geostrophic heat transport. We find similar changes in RCP4.5.

To support our analysis of the near future, we analyse RCP8.5 for the period 2200-2300 relative to the historical simulation: the meridional heat transport reduces by 30-50%, accompanied by a 2-4 months shift in the seasonal cycle relative to the historical simulation in both the subtropical gyre and the subpolar gyre. These longterm changes in the seasonal cycle of the meridional heat transport result mostly from an equatorward shift of the atmospheric jet in summer and a northward shift for the rest of the year, which leads to a changed seasonal cycle in the westerlies. In turn, the Gulf stream front is also shifted northward by 2200-2300. Further, the geostrophic heat transport is also shifted by 1-3 months, accompanied by an intensification of the seasonal cycle in the subtropical gyre. These changes in the seasonal cycle in the meridional heat transport might have a considerable impact on summer and winter temperatures over the North Atlantic and adjacent regions, and may further have implications for the potential predictability of the AMOC and the Atlantic meridional heat transport.