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Forcing of global ocean models using an atmospheric boundary layer model: assessing consequences for the simulation of the AMOC

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Current practice in the atmospheric forcing of ocean model simulations can lead to unphysical behaviours. The problem lies in the bulk formulation of the turbulent air-sea fluxes in conjunction with a prescribed, and unresponsive, atmospheric state as given, e.g., by reanalysis products. This forcing formulation corresponds to assuming an atmosphere with infinite heat capacity, and effectively damps SST anomalies even on basin scales. It thus curtails an important negative feedback between meridional ocean heat transport and SST in the North Atlantic, rendering simulations of the AMOC in such models excessively sensitive to details in the freshwater fluxes. As a consequence, such simulations are known for spurious drift behaviors which can only partially controlled by introducing some (and sometimes strong) unphysical restoring of sea surface salinity.
There have been several suggestions during the last 20 years for at least partially alleviating the problem by including some simplified model of the atmospheric boundary layer (AML) which allows a feedback of SST anomalies on the near-surface air temperature and humidity needed to calculate the surface fluxes. We here present simulations with a simple, only thermally active AML formulation (based on the 'CheapAML' proposed by Deremble et al., 2013) implemented in a global model configuration based on NEMO (ORCA05). In a suite of experiments building on the CORE-bulk forcing methodology, we examine some general features of the AML-solutions (in which only the winds are prescribed) in comparison to solutions with a prescribed atmosperic state. The focus is on the North Atlantic, where we find that the adaptation of the atmospheric temperature the simulated ocean state can lead to strong local modifications in the surface heat fluxes in frontal regions (e.g., the 'Northwest Corner'). We particularly assess the potential of the AML-forcing concept for obtaining AMOC-simulations with reduced spurious drift, without employing the traditional remedy of salinity restoring.