How does anthropogenic aerosol forcing drive a strengthening of the AMOC in CMIP6 historical simulations?

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Abstract

Previous work has shown that anthropogenic aerosol emissions drive a strengthening in the Atlantic Meridional Overturning Circulation (AMOC) in CMIP6 historical simulations over _˜1850-1985. However, the mechanisms driving the increase are not fully understood. Previously, forced AMOC changes have been linked to changes in surface heat fluxes, changes in salinity, and interhemispheric energy imbalances. Here we will show that across CMIP6 historical simulations there is a strong correlation between ocean heat loss from the subpolar North Atlantic and the forced change in the AMOC. Furthermore, the model spread in the surface heat flux change explains the spread of the AMOC response and is correlated with the strength of the models' aerosol forcing. However, the AMOC change is not strongly related to changes in downwelling surface shortwave radiation over the North Atlantic, showing that anthropogenic aerosols do not drive AMOC change through changes in the local surface radiation budget. Rather, by separating the models into those with 'strong' and 'weak'

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aerosol forcing, we show that aerosols appear to predominantly imprint their impact on the AMOC through changes in surface air temperature over the Northern Hemisphere and the consequent impact on latent and sensible heat flux. This thermodynamic driver (i.e. more heat loss from the North Atlantic) is enhanced both by the increase in the AMOC itself, which acts as a positive feedback, and by a response in atmospheric circulation.