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Investigating the links between mid-latitude aerosol emissions, oceans and Arctic Amplification

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Aerosols can play an important role in modifying local and remote climate through a variety of atmospheric and oceanic processes. Previous studies have used the Norwegian Earth system model (NorESM) to show that the reduction of anthropogenic sulfate emissions from Europe since the 1980s could potentially explain a large fraction of the observed rapid rates of warming in the Arctic. The warming in the model is accompanied by an increase in poleward ocean heat convergence in the Arctic suggesting that aerosol-driven changes to ocean circulation and heat transport may play an important role in determining Arctic amplification. However, the mechanisms that drive these changes remain poorly understood.

Here, we elaborate on these links between aerosol emissions and changes in ocean circulation, heat transport and surface heat fluxes using idealized simulations of a general circulation model NorESM1 in both fully coupled and mixed-layer ocean configurations. Comparing the results of the fully-coupled model with the mixed-layer ocean model, allows us to isolate the role of meridional ocean heat transport in the sub-polar regions in setting the rate and magnitude of Arctic warming.

Simulations with the fully coupled model differ in their regional sulfate aerosol emissions (i.e. emissions are modified from Europe, North America, East Asia, and South Asia), picked such that the global radiative forcing from the emission changes are the same for all simulations. Preliminary results suggest that a decrease in aerosol emissions from Europe, North America, East and South Asia results in a weakening of the Atlantic meridional overturning circulation in the mid-latitudes (<60ºN), an increase in poleward heat transport in the sub-polar regions (60ºN-70ºN), and an increased ocean-to-atmosphere heat flux in the Arctic.