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Future uptake of anthropogenic carbon in the North Atlantic

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The uptake of CO2 by the ocean depends on, amongst other things, the ocean's buffering capacity due to carbonate ions. The reduction in buffering capacity caused by the uptake of anthropogenic CO2 would be likely to lead, on some timescale, to a reduction in ocean-atmosphere carbon fluxes, dependent on the future anthropogenic output of CO2. For regions of net CO2 uptake, a reduction in the net amount of carbon absorbed by the ocean to below pre-industrial levels would amount to an outgassing of anthropogenic CO2. Studies with a simple box model suggest that the circulation regime in the North Atlantic could lead to outgassing of anthropogenic CO2 by around the year 2100, not taking climate change effects into account.

Here we use two models of differing sophistication to assess how the results obtained with the box model depend on model resolution and the sophistication of the ocean physics. The further effects of CO2-induced climate change are also included to assess on what timescale this effect might be seen in reality. We find that increasing resolution above the level of the box model significantly increases the timescale until anthropogenic outgassing occurs. However, the generally improved physics (including reduced diapycnal mixing) of the more sophisticated model acts to reduce the timescale somewhat. When the warming and circulation-change effects of climate change are also included the timescale is again reduced. Including all effects, our model predicts outgassing of anthropogenic CO2 in the North Atlantic by around 2150. This timescale is shown to be rather sensitive to model details, underlining the need for realistic physics when modelling the ocean carbon cycle.