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Drivers and distribution of global ocean heat uptake over the last half century

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Since the 1970s, the ocean has absorbed almost all of the additional energy in the Earth system due to greenhouse warming. However, our knowledge of where ocean heat uptake (OHU) has occurred and where this heat is stored today is limited by sparse observations. Here, we use a global ocean-sea ice model forced by observationally constrained atmospheric fields to conduct hindcast simulations that are initialised from an equilibrated control simulation that improves on commonly used spin-up approaches. The hindcast with full interannual forcing captures the observed global ocean heat content evolution better than most previous ocean-sea ice model simulations. Applying trends in only surface winds or thermal properties reveals that each can explain 50% of the total ocean warming signal. These contributions, when restricted to the Southern Ocean, account for nearly all of the global OHU of 5.4×10^{21} J year^{-1}. Integrated over the Southern Ocean, the sensible heat flux drives 75% more OHU than the longwave radiative flux in the simulation with only surface wind trends, while it is the opposite in the simulation with only trends in thermal properties. Almost 50% of the additional Southern Ocean-sourced heat signal is exported into the Atlantic Ocean where two-thirds of this added heat is then lost to the atmosphere.