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Recent trajectory of ocean heat uptake estimated from novel 1972-2017 ocean sea-ice model hindcast simulations

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Uptake and storage of heat by the ocean plays a critical role in modulating the Earth's climate system. In the last 50 years, the ocean has absorbed over 90% of the additional energy accumulating in the Earth system due to radiative imbalance. However, our knowledge about ocean heat uptake (OHU), transport and storage is strongly constrained by the sparse observational record with large uncertainties. In this study, we conduct a suite of historical 1972–2017 hindcast simulations using a global ocean-sea ice model that are specifically designed to account for a cold start climate and model drift. The hindcast simulations are initialised from an equilibrated control simulation that uses repeat decade forcing over the period 1962-1971. This repeat decade forcing approach is a compromise between an early unobserved period (where our confidence in the forcing is low) and later periods (which would result in a shorter experiment period and a smaller fraction of the total OHU). The simulations are aimed at giving a good estimate of the trajectory of OHU in the tropics, the extratropics and individual ocean basins in recent decades. Many modelling studies that look at recent OHU rates so far use a simpler approach for the forcing. For example, they use repeating cycles of 1950-2010 Coordinated Ocean Reference Experiment (CORE) forcing that is consistent with the Ocean Model Intercomparison Project 2 (OMIP-2). However, this approach cannot account for model drift. The new simulations here highlight the dominant role of the extratropics, and in particular the Southern Ocean in OHU. In contrast, little heat is absorbed in the tropics and simulations forced with only tropical trends in atmospheric forcing show only weak global ocean heat content trends. Almost 50% of the heat taken up from the atmosphere in the Southern Ocean is transported into the Atlantic Ocean. Two-thirds of this Southern Ocean-sourced heat is then subsequently lost to the atmosphere in the North Atlantic but nevertheless this basin gains heat overall. Our results help to estimate the large-scale cycling of anthropogenic heat within the ocean today and have implications for heat content trends under a changing climate.