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# Detection of anthropogenic influence on multi-decadal changes in ocean stratification

Oliver Andrews and Corinne Le Quéré

Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, United Kingdom (o.andrews@uea.ac.uk)

Signals of anthropogenic climate change have been identified in the ocean system using established detection and attribution methods to examine historical records of ocean temperature, salinity and dissolved oxygen concentration. Strengthened stratification of the upper ocean is another likely consequence of climate-driven warming and freshening of near surface waters. However, whilst qualitative links have been made between climate forcing and observed and projected future ocean stratification, the relative contribution of natural and anthropogenic processes remains uncertain. Elevated density stratification reduces physical exchange between the surface and interior ocean, impacting upon ventilation processes and biogeochemical cycling. Here, we combine recent temperature and salinity measurements to assess the extent to which large-scale changes in ocean stratification between the 1960s and 2000s can be attributed to anthropogenic climate change using a suite of coupled climate model simulations. Applying formal, regression-based fingerprinting methods we show that external climate forcing has had a detectable influence on observed changes in density stratification and that these changes cannot be explained by climate variability or natural external factors such as volcanism or solar output. Our study indicates that human influence has already significantly altered the density structure of the upper ocean. We discuss the implications and potential for detecting the variability and trends in carbon and oxygen storage in the ocean and in heat uptake efficiency.