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Emergence and detection of climate change-driven trends in oceanic oxygen concentration

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Climate change is expected to modify ecological responses in the ocean, with the potential for important effects on the ecosystem services provided to humankind. As part of the effort towards detection of long-term trends, a network of ocean observatories and time series stations provide high quality data for a number of key parameters, such as oxygen concentration. The temporal and spatial scales over which observations of thermocline oxygen concentration must be made to robustly detect a long-term trend are assessed. As a global average, continuous time series are required for ~ 26 years to distinguish a climate change trend in oxygen concentration from natural variability. Regional differences are extensive, with temperate latitudes generally requiring shorter time series (<~30 years) to detect trends than other areas. In addition, the 'footprint' of existing and planned time series stations, that is the area over which a station is representative of a broader region, is quantified. The existing network of observatories is representative of oxygen concentrations over only 9% of the global ocean.
Climate-driven changes in oxygen concentration are unlikely to occur in isolation and multiple factors may act additively or synergistically to increase the impact of deoxygenation. How rapidly multiple drivers of marine ecosystem change, including oxygen concentration, develop in the future ocean is assessed. By analysing an ensemble of models we find that, within the next 15 years, the climate change-driven trends in multiple ecosystem drivers emerge from the background of natural variability in 55% of the ocean and propagate rapidly to encompass 86% of the ocean by 2050 under a 'business-as-usual' scenario. However, we the exposure of marine ecosystems to climate change-induced stress can be drastically reduced via climate mitigation measures; with mitigation, the proportion of ocean susceptible to multiple drivers within the next 15 years is reduced to 34%. Mitigation slows the pace at which multiple drivers emerge, allowing an additional 20 years for adaptation in marine ecological and socio-economic systems alike.

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