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Time of Emergence of anthropogenic deoxygenation and warming in the thermocline

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Multiple lines of evidence from observation- and model-based studies show that anthropogenic greenhouse gas emissions cause ocean warming and oxygen depletion, with adverse impacts on marine organisms and ecosystems.

Temperatures increase is a primary indicator for climate change. However, in the thermocline, changes in oxygen and other biogeochemical tracers might be detectable before warming (Hameau et al., 2019a).

Here, we compare the local time of emergence (ToE) of anthropogenic temperature and oxygen changes in the thermocline within an ensemble of Earth system model simulations from the CMIP5 dataset (Hameau et al., 2019b).

Generally, warming emerges from internal variability prior to changes in oxygen.

Yet, in 35$\pm$11\% of the global thermocline, anthropogenic deoxygenation is detectable before warming.

Earlier emergence of oxygen changes is typically related to decreasing trends in ventilation, which reduce the supply of oxygen-rich surface waters to the thermocline.

In addition, reduced ventilation slows the propagation of anthropogenic warming from the surface into the ocean interior, further contributing to the delayed emergence of warming compared to deoxygenation.

As the magnitude of simulated interval variability and of simulated anthropogenic changes vary considerably across models, we introduce the relative ToE metric. This reduces the inter-model spread, allowing for a better comparison among models.

Our results underline the importance of an ocean biogeochemical observing system and that the detection of anthropogenic impacts becomes more likely when using multi-tracer observations.