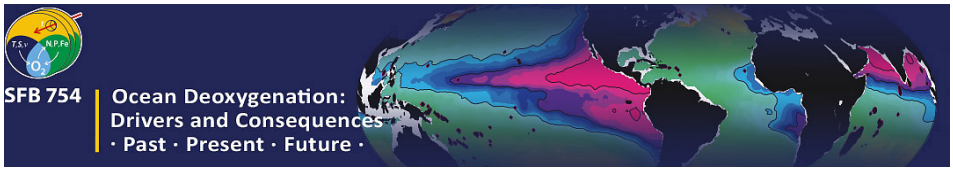

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Oxygen minimum zone variations during the Holocene from transient model simulations

Climate and marine biogeochemistry changes over the Holocene are investigated based on transient global climate and biogeochemistry model simulations over the last 9,500 yr. The simulations are forced by accelerated and non-accelerated orbital parameters, and atmospheric pCO2, CH4, and N2O, respectively. The analysis focuses on key climatic parameters, the processes that determine the strength of the marine carbon pumps, and on the oxygen minimum zones (OMZs) in the world ocean. The most pronounced changes occur in the eastern equatorial Pacific (EEP) OMZ, where a substantial increase in volume of the OMZ in the EEP continuing into the late Holocene was found in the non-accelerated simulation. The concurrent increase of age of the water mass within the EEP OMZ suggests that this growth is driven by a slow down of the circulation in the interior of the deep Pacific. This results in large scale deoxygenation in the deeper Pacific and hence the source regions of the EEP OMZ waters from mid-to-late Holocene. The simulated expansion of the OMZ in the late Holocene raises the question whether the currently observed deoxygenation is a continuation of the orbitally and greenhouse gas driven decline in oxygen, or a result of climate change from anthropogenic forcing as widely assumed. An additional explanation would be that the anthropogenic forcing amplifies the natural forcing.

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