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Variability of the Arabian Sea nitrogen cycle on different time scales: information from sediment and water column investigations

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The Arabian Sea nitrogen cycle was very susceptible to monsoon climate during the Pleistocene as is evident from fluctuations of the sedimentary delta15N records by more than 5‰Ṫhese fluctuations reveal changes in mid-water oxygenation as denitrification occurs at very low oxygen concentrations and enhances the delta15N of residual nitrate in subsurface waters. This nitrate is transported into surface waters by upwelling and deep mixing, taken up by phytoplankton and transported into sediments with sinking particles. Sea surface temperatures (SST) were positively correlated with productivity proxies and delta15N in the Pleistocene. Denitrification was enhanced during warm interstadials probably due to stronger monsoons with enhanced upwelling and primary productivity. During the cold phases such as the Younger Dryas and Heinrich events the water column was probably oxygenated which was attributed to deep convective winter mixing and reduced upwelling during phases of weak monsoons leading to reduced productivity.
Our investigations of the present seasonal and interannual variations of the oxygen minimum suggest that enhanced upwelling is associated with increased mid-water oxygenation by inflowing intermediate water masses. Thus, at present years of stronger monsoons are characterized by enhanced reoxygenation of mid-water masses. This mechanism may maintain a more or less constant oxygen minimum during the Holocene with is also suggested by high resolution monsoon records. It may, moreover, explain that there is no evidence of a expansion of the Arabian Sea oxygen minimum despite global warming. In contrast, the longer residence time of intermediate water masses may have been responsible for the relatively rapid changes of mid-water oxygenation in the Pleistocene.