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Sedimentary records of eutrophication and hypoxia in the Changjiang Estuary over the last 100 years

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We selected two cores in the Changjiang Estuary, one within the region of seasonal hypoxia and the other nearby but outside the hypoxia region. The total organic carbon (TOC), total nitrogen (TN), biogenic silica (BSi) and stable carbon isotopic ratios (δ13 Corg), major elements and trace elements were determined on the 210Pb-dated sediment cores. The concentrations of BSi were almost the constant, the concentrations of TOC and TN increased before 1940s-1950s and δ13 Corg increased before 1970s in the core sediments outside the hypoxia region, which reflected the biomass and the productivity hardly changed in the past several decades. For the core sediments within the hypoxia region, the concentrations of TOC, TN, BSi as well as their sedimentation fluxes have increased in some degree since 1970s. TOC, TN fluxes increased about 45%, 36% respectively. The average δ13 Corg value of the core was -23.67% which remained nearly constant before the twentieth century. The δ13 Corg values increased after 1900s, two marked increases were observed from 1950s and 1970s. A simple δ13 Corg model was used to estimate the contribution of terrestrial and marine organic matter inputs for the sediment, which indicated the increase in accumulation since 1970s was almost exclusively marine. The increasing of marine organic matter accumulation (TOC, TN and BSi) was corresponding with the increasing of fertilizer consumption and the NO3-N budgets from the Changjiang River. The riverine runoff of fertilizers and nutrients stimulated the algae blooming. Enhanced primary production resulted in an enrichment of organic matter in the sediment. These data support the hypothesis that anthropogenic nutrient loading has been a significant factor on the eutrophication in Changjiang Estuary.

The distributions of most elements in the core sediment outside the hypoxia region were controlled by “grain size effects”. In the core sediment within the hypoxia region, some redox sensitive elements (RSEs) just like the Mo, Cd, As et al. have been enriched significantly, which concentrations increased about 83%, 73% and 50% respectively since the late 1960s to 1970s. Conversely the Mn has been depleted since 1970s. The results indicate the redox environment of the bottom water-sediment interface has been changed which might be caused by the eutrophication and hypoxia in the Changjiang Estuary. The concentrations of biogenic elements as well as Ca, Sr, P have also increased about 129%, 65% and 38% respectively since the late 1960s, which reflected the increasing of productivity and biomass influenced by the anthropogenic activities during the last forty years. The results showed that the contents of carbon stable isotope, fluxes of TOC, biogenic elements as well as Ca, Sr, P and some RSEs just like Mo,Cd, As, Mn in sediment could be used to trace or reconstruct history of the coastal eutrophication and hypoxia in the high productivity zone in the Changjiang Estuary over the last 100 years.

These parameters gave the same conclusions consistently: the estuary eutrophication in the Changjiang Estuary and its adjacent region began in 1950s and accelerated in 1970s, then the enhanced eutrophication has caused and developed hypoxia since 1970s which has been fueled and showed the increasing trend.