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Influence of the Indian Monsoon on marine productivity during late Pliocene-early Pleistocene at IODP Site U1445 (western Bay of Bengal)

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The Indian Summer Monsoon (ISM), a subsystem of the Asian Monsoon, is a conspicuous example of the interaction between solid Earth and atmospheric processes, and a key expression of low-latitude hydroclimate, in that it carries large amounts of heat and moisture towards the western Bay of Bengal. Yet the pattern of variability and its main climatic controls remain elusive. In this study, we present results gained at Site U1445 (ca. 17°45′N, 84°47′E, water depth 2,510 m), drilled off Mahanadi basin in the northwestern Bay of Bengal during IODP Exp353. Site U1445 is uniquely located in the core convective region of the ISM, and offers the potential to track terrestrial-oceanic-atmospheric processes at a relatively high resolution by extracting the strong seasonal signature of the ISM through rainfall and river runoff received at this site. Here we present a multiproxy approach, using micropaleontological (marine and freshwater diatoms, phytoliths) and geochemical (biogenic silica, XRF-measured elements) parameters across the late Pliocene into the early Pleistocene (ca. 3.6-2.5 Ma). Diatoms are silica precipitating primary producers, responsible for one-fourth of the present global primary production and play a major role in the biological pump. Unlike the majority of other phytoplankton, they depend on the availability of dissolved silica to construct their cell walls. At U1445, marine diatoms dominated the downcore siliceous community. In addition to marine diatoms, several freshwater diatoms and phytoliths (silica bodies of epidermic grass cells) are abundant throughout. Since the occurrence of freshwater diatoms and phytoliths in marine sediments represents a land-derived signal from the eastern Indian Continent, their presence at U1445 is interpreted to reflect ISM-mediated precipitation on land (aridity/humidity changes), fluvial runoff and wind intensity. The strikingly positive correlation between the total diatom concentration and the phytoliths content suggests that the input of land-derived nutrients –dependent on ISM Monsoon rainfall and weathering intensity variations on land– might have played an important role in driving surface water productivity in the western Bay of Bengal for the interval 3.6-2.5 Ma. This scenario is supported by the good correlation between total diatom concentration and Si/Ti. Generally, diatom and phytolith data are muted prior to ca. 3.3-3.4 Ma, when ISM Monsoon was weaker, weathering intensity weaker and SST warmer. The rapid increase of total diatom and phytolith concentration around 3.3 Ma matches, suggest a first strengthening of the ISM prior to the Northern Hemisphere Glaciation (2.7 Ma). A second major increase around 3.08 Ma roughly corresponds with the end of the mid Picenzian Warm Period. A switch in the amplitudes and the length of variation periods of marine diatoms and phytoliths occurred around 3.1 Ma. Strong cyclicity is recognized in all records generated. The mechanism for high amplitude cyclic variability, indicative of glacial-interglacial (obliquity) or perhaps precessional driven, will be explored and presented after putting these records in context with robust age model.