



Indian monsoon variations during three contrasting climatic periods: the Holocene, Heinrich Stadial 2 and the last interglacial-glacial transition

Coralie Zorzi (1,2), Maria Fernanda Sanchez Goñi (1,2), Krishnamurthy Anupama (3), Srinivasan Prasad (3), Vincent Hanquiez (2), Joel Johnson (4), and Liviu Giosan (5)

(1) EPHE, PSL Research University, Laboratoire Paléoclimatologie et Paléoenvironnements Marins, F-33615 Pessac, France, (2) Université de Bordeaux, EPOC, UMR 5805, F-33615 Pessac, France, (3) Laboratory of Palynology & Paleoecology, French Institute of Pondicherry PB 33 UMIFRE 21 CNRS-MAEE / USR 3330, Pondicherry 605001, India, (4) University of New Hampshire, Department of Earth Sciences, James Hall, Durham, NH 03824-3589, USA, (5) Geology & Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

In contrast to the East Asian and African monsoons the Indian monsoon is still poorly documented throughout the last climatic cycle (last 135,000 years). Pollen analysis from two marine sediment cores (NGHP-01-16A and NGHP-01-19B) collected from the offshore Godavari and Mahanadi basins, both located in the Core Monsoon Zone (CMZ) reveals changes in Indian summer monsoon variability and intensity during three contrasting climatic periods: the Holocene, the Heinrich Stadial (HS) 2 and the Marine Isotopic Stage (MIS) 5/4 during the ice sheet growth transition. During the first part of the Holocene between 11,300 and 4,200 cal years BP, characterized by high insolation (minimum precession, maximum obliquity), the maximum extension of the coastal forest and mangrove reflects high monsoon rainfall. This climatic regime contrasts with that of the second phase of the Holocene, from 4,200 cal years BP to the present, marked by the development of drier vegetation in a context of low insolation (maximum precession, minimum obliquity). The historical period in India is characterized by an alternation of strong and weak monsoon centennial phases that may reflect the Medieval Climate Anomaly and the Little Ice Age, respectively. During the HS 2, a period of low insolation and extensive iceberg discharge in the North Atlantic Ocean, vegetation was dominated by grassland and dry flora indicating pronounced aridity as the result of a weak Indian summer monsoon. The MIS 5/4 glaciation, also associated with low insolation but moderate freshwater fluxes, was characterized by a weaker reduction of the Indian summer monsoon and a decrease of seasonal contrast as recorded by the expansion of dry vegetation and the development of *Artemisia*, respectively. Our results support model predictions suggesting that insolation changes control the long term trend of the Indian monsoon precipitation, but its millennial scale variability and intensity are instead modulated by atmospheric teleconnections to remote phenomena in the North Atlantic, Eurasia or the Indian Ocean.