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Evolution of the Indian Summer Monsoon eastern branch and terrestrial vegetation since the Last Glacial

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The Indian summer monsoon (ISM) is one of the major climatic phenomena on the planet and supports the living of over a billion people. Thus, understanding its natural driving forces and ecological consequences are a matter of first importance. We provide a continuous record of the ISM precipitation and continental vegetation over the Ganges-Brahmaputra-Meghna lower catchment and the Indo-Burman ranges for the last 18,000 years (18 ka), based on terrestrial biomarkers of a sediment core from the northern Bay of Bengal (NBoB). Compound-specific stable isotope analysis of hydrogen (δD) and carbon (δ^{13}C) on plant wax-derived n-alkanes was conducted to reconstruct changes in precipitation and vegetation composition, respectively. The results are compared to results from an isotope-enabled general atmospheric circulation model (IsoCAM) for selected time-slices (pre-industrial, mid-Holocene and Heinrich Stadial 1 [HS1]). Our findings indicate that changes in the δD of precipitation and plant waxes around the NBoB were mainly driven by the amount effect, and strongly influenced by summer monsoon precipitation. Model results also support the hypothesis of a constant moisture source (i.e. the NBoB) throughout the study period. Qualitative precipitation changes inferred from our alkane δD record suggest that, overall, the Holocene (last 10 ka) was moister than the late glacial (18-10 ka BP). Precipitation was strongest during the early Holocene (8.6–8.4 ka BP), whereas the most arid conditions were recorded during the HS1 (16.9–15.4 ka BP). These changes are comparable in timing and magnitude to those detected in other ISM records from central and western Asia [1, 2, 3, 4], suggesting simultaneous variability of the western (Arabian Sea) and eastern (Bay of Bengal) ISM branches. Downcore n-alkane δD anomalies were used to evaluate past changes in the precipitation isotopic signature and the observed anomalies were similar to those obtained from the IsoCAM model. Quantitative estimations of summer precipitation amount by the IsoCAM model predict, relative to the pre-industrial period, 20% more rain during the mid-Holocene and 20% less during HS1, respectively. Vegetation changes deduced from the n-alkane δ^{13}C record indicate a shift from C_4-plant dominated ecosystems during the Late Glacial to mixed C_3/C_4-plant vegetation during the Holocene. Comparison of the δD and δ^{13}C records suggests that vegetation composition is strongly linked to precipitation variability.

References

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