Weaker Indian monsoon due to glacial ventilation

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Precessional signals in speleothem records from southeastern China have firmly demonstrated that orbital forcing exerts a strong influence on the strength of the Asian monsoon. Subsequent studies showed that the isotopic signals in these records may not reflect local changes in hydroclimate, and instead, could be related to changes in the Indian summer monsoon (ISM). Some of these records also show changes with a 100,000-year cyclicity, however the drivers of the associated glacial-interglacial changes in monsoon strength remain unclear. We addressed this issue focusing on the Last Glacial Maximum (LGM), the period ca. 21,000 years ago, when ice sheets reached their maximum extent. Using model simulations of this climate interval we identify a mechanism that could explain dry conditions over India and pronounced cooling over the Arabian Sea inferred from proxies. According to our mechanism, these responses are initiated by cooling of the Northern Hemisphere by the higher albedo of the Laurentide ice sheet (LIS). During boreal summer, dry, cold glacial air is ventilated into the tropics limiting the seasonal advance of the monsoons systems over Africa and Asia. Weakening of the ISM is amplified by cooling of the Arabian Sea, a complex response involving stronger monsoonal winds, yet reduced rainfall because of the dominant effect of ocean surface cooling on moisture availability. The isotope-enabled version of our model shows that these processes cause more isotopically enriched rainfall over a vast region extending from India to southwest China. Together these results demonstrate that ISM is sensitive to ice sheet cooling of the northern hemisphere – however, with an isotopically heterogeneous imprint throughout east Asia.