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Dominant Northern Hemisphere climate control over millennial-scale glacial sea-level variability

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The pattern, timing, and source of global sea-level changes associated with millennial-scale climate fluctuations during the last glacial is crucial for a comprehensive understanding of glacial climate and ocean variability. The timing and shape of the presently available millennial-scale sea-level records have strong similarities to the rather symmetric and gradual Southern Hemisphere temperature variations as known from Antarctic ice-cores and are thus markedly different from the abrupt and more asymmetric changes recorded in Greenland ice-cores. Here we present a new sea-level reconstruction from the northern Red Sea covering the last ~80,000 years in the context of already published sea-level records. A major strength of our new continuous sea-level record is a reliable, independent age model based on extensive 14C-AMS dating and a detailed magnetic paleointensity record beyond the range of radiocarbon dating. Our results demonstrate that global ice volume on millennial timescales, although showing an "Antarctic-type" shape, is rather coupled to Northern Hemisphere climate; a view that is generally accepted for orbital-scale variability. We observe pronounced sea level rises of up to 25 m during Northern Hemisphere warmings as recorded in Greenland ice-cores whereas sea-level lowstands mostly occur during cold phases. Results of experiments with the CLIMBER-2 model suggest a considerable negative change in mass balance of the NH ice sheets with the transition from stadial to interstadial conditions. This experiment is fully consistent with our record and shows that the negative mass balance during interstadials is caused by enhanced ablation at the southern margins of the Fennoscandian and, even more pronounced, the Laurentide ice sheet. As freshwater input in the mid-latitudes due to melting of the southern

flanks of the NH ice sheets during warm interstadial conditions is much less efficient in affecting the ocean circulation compared to the melting of icebergs released from the northern part of the ice sheets directly into the area of deep water formation, this aspect would require a rethinking of the role of climate-ice sheet-sea-level interaction.