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The Sea-Level Fingerprints of Ice-Sheet Collapse During Interglacial Periods

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Peak sea level highstands during previous interglacials provide important insight into the stability of polar ice sheets in a warming world. In most previous analyses of such highstands, site-specific sea-level records are first corrected for the ongoing effects of glacial isostatic adjustment (GIA) and the residual is then interpreted as representing the net eustatic signal associated with any excess melting of the polar ice sheets relative to their present-day volumes. However, it is now well understood that the collapse of polar ice sheets produces a distinct geometry, or fingerprint, of sea-level change. These sea-level fingerprints must be accounted for in order to accurately estimate peak eustatic sea level from site-specific (GIA-corrected) highstand records. To investigate this issue, we compute fingerprints associated with the collapse of the Greenland Ice Sheet, West Antarctic Ice Sheet, and marine sectors of the East Antarctic Ice Sheet. We demonstrate that these fingerprints are, in contrast to those computed for modern melt scenarios, relatively insensitive to the detailed geometry of ice sheet collapse. Moreover, using these fingerprints, we: (1) isolate regions that would have experienced greater-than-eustatic sea-level change during an interglacial regardless of the melt scenario; and (2) demonstrate that some previous analyses of sea-level records from past interglacials may have overestimated peak eustatic sea level (and thus the net excess melting of polar ice sheets) by 1-2 m. Finally, we emphasize, through numerical examples, that mapping an estimate of peak eustatic sea level into a change in ice volume will depend on the accommodation space for meltwater in exposed marine-based sectors at the time of ice-sheet collapse. The volume of the accommodation space will, in turn, depend on when the ice-sheet collapse took place within the interglacial time window.