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The importance of insolation changes for paleo ice sheet modeling

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The growth and retreat of continental ice sheets in the past has largely been a response to changing climatic forcing. Thus, the calculation of surface melt is an important aspect of paleo ice sheet modeling. Changes in insolation are often not accounted for in calculations of surface melt, under the assumption that the near-surface temperature transmits the majority of the climatic forcing to the ice sheet. To assess how this could affect paleo simulations, here we investigate the importance of different orbital configurations for estimating melt on the Greenland ice sheet. We find that during peak Eemian conditions, increased insolation contributes 20-50% to the surface melt anomaly. However, this percentage depends strongly on the temperature anomaly at the time. Furthermore, the spatial pattern of surface conditions in terms of temperature and albedo exert a strong influence on the relative importance of insolation in the melt calculations. In coupled simulations, the additional insolation-induced melt translates into up to threefold more ice volume loss, compared to output using a model that does not account for insolation changes. We also introduce a simple correction factor that allows reduced complexity melt models to account for changes in insolation.