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Significant contribution of insolation to Eemian melting of the Greenland ice sheet

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The Eemian (130 to 114 ky BP) was characterized by a warmer Northern Hemisphere climate and by higher summer insolation. As a result, the Greenland ice sheet was 30 to 60% smaller than today. The primary driver of this retreat was enhanced surface melt. Although most energy for melt is provided by short wave radiation, temperature is regarded as the key parameter to determine surface melt. In this model study, we show that Eemian changes in insolation were as important as Eemian temperature changes. For this, four regional climate model simulations are preformed with Eemian or preindustrial climate and with Eemian or preindustrial orbital parameters. These four simulations separate the individual contributions of insolation and temperature on the Eemian ablation increase.

About 55% of the Eemian ablation increase, compared to preindustrial climate, is due to increased temperatures. The other 45% is due to stronger insolation and non-linear effects. Temperature-melt relations neglecting insolation fail to reproduce this effect. These result show that the direct effect of insulation cannot be neglected if simplified melt relations are used. Furthermore, it shows that the Eemian is not a good analogue of future Greenland melt. Since insolation changes not significantly on timescales of one century, the response of the Greenland ice sheet to future warming is less strong than on the Eemian warming.