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Statistical downscaling increases Antarctic ice sheet surface melt rate

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Although recent mass loss of the Antarctic ice sheet (AIS) is predominantly driven by ice shelf thinning and increased solid ice discharge, surface processes also directly affect mass changes. Snowfall fluctuations control the variability in surface mass balance (SMB) of the grounded AIS, while meltwater ponding threatens the viability of floating ice shelves. Surface processes are thus essential to quantify present and project future AIS mass loss, but remain poorly represented in climate models running at 25-100 km spatial resolution. Here we present new, daily Antarctic SMB products at 2 km resolution, statistically downscaled from the output of RACMO2.3p2 at 27 km resolution, for the contemporary climate (1979-2021) and a low, moderate and high-end warming scenario until 2100. We show that statistical downscaling to 2 km resolution modestly enhances contemporary SMB (+8%) but strongly increases melt (+50%), notably in the vicinity of the grounding line, in better agreement with both in situ and remote sensing records. The melt increase in the downscaled products persists in the future projections irrespective of the scenario, suggesting a systematic underestimate in low-resolution (regional) climate models.