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Estimating Greenland surface melt is hampered by melt induced dampening of temperature variability

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The positive degree-day (PDD) model provides a particularly simple approach to estimate surface melt from land ice solely on the basis of air temperature. Here, we use a climate and snow pack simulation of the Greenland Ice Sheet (Modèle Atmosphérique Régional, MAR) as a reference, to analyze this scheme in three realizations that incorporate the sub-monthly temperature variability differently: (i) by local values, (ii) by local values that systematically overestimate the dampened variability associated with intense melting, or (iii) by one constant value. Local calibrations reveal that incorporating local temperature variability, particularly resolving the dampened variability of melt areas, renders model parameters more temperature-dependent. This indicates that the negative feedback between surface melt and temperature variability introduces a non-linearity into the temperature - melt relation. To asses the skill of the individual realizations, we hindcast melt rates from MAR temperatures for each realization. For this purpose we globally calibrate Greenland-wide, constant parameters. Realization (i) exhibits shortcomings in the spatial representation of surface melt, unless temperature-dependent instead of constant parameters are calibrated. The other realizations perform comparatively well with constant parametrizations. The skill of the PDD model primarily depends, however, on the consistent calibration rather than on the specific representation of variability.