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Clouds increase uncertainty in surface melt projections over the Antarctic ice shelves

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Recent warm atmospheric conditions have damaged the ice shelves of the Antarctic Peninsula through surface melt and hydrofracturing, and could potentially initiate future collapse of other Antarctic ice shelves. However, model projections with similar greenhouse gas scenarios suggest large differences in cumulative 21st century surface melting. So far it remains unclear whether these differences are due to variations in warming rates in individual models, or whether local surface energy budget feedbacks could also play a notable role. Here we use the polar-oriented regional climate model MAR to study the physical mechanisms that will control future surface melt over the Antarctic ice shelves in high-emission scenarios RCP8.5 and SSP585. We show that clouds enhance future surface melt by increasing the atmospheric emissivity and longwave radiation towards the surface. Furthermore, we highlight that differences in meltwater production for the same climate warming rate depend on cloud properties and particularly cloud phase. Clouds containing a larger amount of liquid water lead to stronger melt, subsequently favouring the absorption of solar radiation due to the snow-melt-albedo feedback. Since liquid-containing clouds are projected to increase the melt spread associated with a given warming rate, they could be a major source of uncertainties related to the future Antarctic contribution to sea level rise.