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Arctic warming amplified by infrared radiation feedbacks

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A major feature of observed and modelled climate change is the pronounced warming in the Arctic region, often referred to as Arctic Amplification (AA). This feature is generally attributed to sea-ice and snow retreat and the associated surface-albedo feedback. Global compilations of surface temperature over the last century exhibit clear signs of AA, in particular during the last decades, which were accompanied by drastic recent reductions in sea-ice cover and thickness. It was recently shown, however, that Arctic warming results from a complex interplay of multiple processes. In order to accurately predict future changes, it is thus imperative to identify and disentangle the mechanisms that amplify Arctic warming using both modelling and observations. By using a state-of-the-art global coupled climate model in idealised climate change experiments, together with reanalyses data, we show that AA depends strongly on the efficiency by which the climate system is able to lose thermal energy to space. By quantifying the individual surface and atmospheric contributions, we find that the ability of the Arctic wintertime atmosphere to radiate extra energy to space is severely hampered by the predominant surface temperature inversion. Most of the additionally emitted atmospheric thermal energy is instead directed downward, thereby amplifying surface warming. Simulations with altered stable boundary-layer mixing show that the inversion strength governs Arctic atmospheric radiation loss to space, and thereby surface warming. Hence, the predominant Arctic wintertime temperature inversion in conjunction with the infrared cooling efficiency is a key player in amplifying Arctic warming.