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Evaluating permafrost vulnerability in Greenland using satellite temperature data

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The stability of permafrost in the Arctic is important for stable infrastructure in populated areas as well as for conserving the substantial quantities of stored carbon at northern latitudes. Important feedback mechanisms degrading the permafrost could be accelerated due to climate warming. It is therefore important to locate areas with vulnerable permafrost near communities, as well as mapping the extent of permafrost zones to assess the magnitude of potential degradation. Currently, we lack detailed mapping of permafrost in Greenland. Temperature datasets in Greenland are based on measurements biased towards low-lying coastal regions, or downscaled reanalysis data that is either dependent of these measurements or calibrated to the Greenlandic ice-sheet temperature regime. Here we show the applicability of 15 years of satellite-derived (MODIS) land surface temperatures as a fully independent dataset, with the potential to capture important local temperature trends and features such as inversion layers. We have corrected the satellite-based land surface temperature data for cloud cover contamination and present the validation of the temperatures across the ice-free part of Greenland. The corrected temperature data is used as the primary input to a steady-state permafrost model. We estimate that a limited extent of the permafrost in Greenland is highly vulnerable; however, the likely changes are observed where most people live today. We show the importance of high spatial resolution (1 km) data to guide local decision-making, and since Greenland represents significant climate gradients of north/south coast/inland/distance to large ice-sheets, the methods and conclusions are relevant in an upscaling to most Arctic areas.