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Evaluating cloud cover as a link between high pressure systems and Greenland melt

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In the past two decades, persistent high pressure, atmospheric blocking conditions have become more frequent over the Greenland Ice Sheet (GrIS), contributing to record-breaking melt events and a warming trend since the mid-1990s. Proposed mechanisms connecting blocking to enhanced melt on daily to monthly time scales include adiabatic warming of air via sinking motion; the advection of warm, southerly air onto the western GrIS; or, more recently, the radiative impact of cloud cover changes associated with high pressure systems. As understanding the factors promoting GrIS melt will be essential for predicting the effects of freshwater fluxes and sea level rise globally, further research is needed to clarify the role and relative importance of cloud cover as a link between blocking and melt. Using satellite observations, reanalysis data, and regional climate model output, we analyze the influence of recently enhanced atmospheric blocking over the GrIS on the vertical and horizontal cloud cover distribution and composition, and the impact of these cloud changes on the surface energy budget and surface melting. High pressure anomalies in recent extreme melt seasons are found to promote northerly winds over central Greenland which interact with GrIS orography in the northeast to promote stronger upslope flow and therefore increased cloud cover, while in the south promoting stronger downslope flow and reduced cloud cover. The increase of cloud cover at height and the high ice sheet albedo promote the primary surface energy budget impact of longwave warming in the northeast, while in the south the reduction of cloud cover at lower altitudes combined with the lower albedo in this region allows shortwave warming to dominate. This link between blocking and cloud cover differs from the previously suggested mechanism of large-scale sinking, with the surface energy budget response strongly dependent on the vertical and lateral distribution of cloud cover changes. The relative importance of warm air advection in comparison to radiative impacts of cloud cover changes is also explored to further understand the mechanisms linking GrIS melt to high pressure conditions.