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The Impact of Extratropical Cyclones on the Greenland Ice Sheet

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The Greenland Ice Sheet (GrIS) stores enough freshwater to raise global sea level by more than 7 m, so its response to climate variability and change is of considerable societal significance. In this context, extratropical cyclones are known to impact the surface mass budget (SMB) via their influence on precipitation and the surface energy budget (SEB). However, there has so far been limited research on these pathways. We address this by expanding process-based knowledge of cyclones and their influence on the GrIS. Using a 58-year integration of the Model Atmospherique Regional (MAR) along with a cyclones`dataset covering the Northern Hemisphere for the same period, we show the mean standardized anomalies of SMB and SEB over the GrIS when cyclones are in close proximity. Overall, our results, show a positive contribution of extratropical cyclones to the SMB during warm and cold seasons alike, especially via snowfall. In both winter and summer, cyclones enhance the downwelling longwave radiative flux due to higher temperatures and increased humidity. In summer an increase (decrease) of long-wave downward and relative humidity (sensible heat flux and temperature) is observed. In winter the impact on these surface energy variables is similar, apart for temperature which have an opposite sign. Overall, cyclones suppress melt and run-off, especially in the ablation zone and peripherals areas of the Ice Sheet during the warm season. Results from this study will contribute to better understanding of how the GrIS may respond in terms of SMB and SEB to changes in the North Atlantic storm tracks under global warming scenarios.