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Arctic climate response to extreme events in synoptic and planetary scale atmospheric energy transport

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Atmospheric energy transport into the Arctic (>70° N) has been shown to greatly alter the Arctic temperatures and the development of the Arctic weather and climate. Recent research suggests that latent energy transport into the Arctic by large, planetary-scale atmospheric systems cause a stronger and more long-lasting impact on near surface temperatures, than energy transported by smaller, synoptic scale systems. This implies that Rossby waves impact Arctic climate more than synoptic cyclones. Therefore, shifts in circulation patterns driving atmospheric energy transport into the Arctic on different scales have a potential to change Arctic climate.

Here, we show that the annual mean impact of latent energy transport on Arctic temperatures is dominated by the winter season transport. Furthermore, by examining the ERA5 dataset for the years 1979-2018, we find that over the past four decades, there has been a shift in the mean winter season latent energy transport, from smaller, synoptic scale systems (-0.03 PW/decade), towards larger, planetary scale systems (+0.05 PW/decade) which as mentioned, have a larger climatic impact. As a consequence, this shift is estimated to have increased the Arctic temperatures. We find that the trends are driven by an increase in the extreme transport events (here we examine the upper 97.5th percentile). The upper extremes have increased more than the average on the planetary scale, and decreased more on the synoptic scale. The decrease in extreme synoptic scale transport at 70° N has been confirmed in other analyses of high vorticity weather systems. By examining the extreme transport events on seasonal scales, we reveal differences in the temporal distribution of planetary vs. synoptic scale extreme events, and identify areas of the Arctic that receive the strongest impact with respect to increases in near-surface temperatures.