

## Pacific contribution to the early 20th century warming in the Arctic

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Instrumental records show that there were two periods of enhanced global warming during the 20th century, the early warming from 1910-1940 and a later period from the end of the 1970s. There is evidence that both these warming periods were more pronounced in the Arctic. The cause of the early warming in the Arctic is not fully understood, but seems to be a combination of both external forcing and internal variability. Since decadal variability in the Pacific has been linked to ‘hiatuses’ and accelerated warming trends in global temperatures, we hypothesize that the Pacific could also impact temperature trends in the Arctic. To investigate this, we have performed two ensembles of historical all-forcing 20th century simulations with the Norwegian Earth System Model (NorESM): one fully coupled ensemble and one ensemble where daily momentum flux anomalies from reanalysis are prescribed over the Indo-Pacific Ocean to constrain Pacific sea surface temperature variability. Using this method, we find that the phasing of decadal variability in the Pacific was a key contributor to the early 20<sup>th</sup> century warming in the Arctic, through two mechanisms: adiabatic heating from a weakening polar vortex and horizontal heat advection from a deepening Aleutian Low. These results have implications for our understanding of the present Arctic warming and future climate variations in the Arctic.

Keywords: Decadal climate variability, Arctic temperature trends, Pacific Decadal Oscillation (PDO), Aleutian Low, Early 20th century warming, Norwegian Earth System Model (NorESM)