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The dependence of Arctic interannual and decadal variability on the state of the climate

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Understanding natural climate fluctuations is of vital importance in a warming world. Long-term climate variations may amplify or dampen (humaninduced) trends in temperature, even more so since variability itself may change with a changing climate. Here we quantify the magnitude and other characteristics of interannual to decadal variability in Arctic temperature and their dependence on the climate state. Moreover, we identify the processes responsible for the state-dependency of the variations, using five quasiequilibrium climate simulations of a state-of-the-art global climate model with 0.25, 0.5, 1, 2 and 4 times present-day atmospheric CO_2 forcing. The natural fluctuations in Arctic temperature, including their dependence on the state of the climate, are linked to anomalous atmospheric and oceanic heat transports towards the Arctic. Model results suggest that atmospheric heat transport leads (and also controls) Arctic temperature variations on interannual timescales, whereas oceanic transport is found to govern the fluctuations on decadal timescales. This time-scale transition of atmospheric to oceanic dominance for Arctic temperature variations is most obvious when there is interannual to decadal variability in Arctic sea ice cover. In warm climates (without Arctic sea ice cover), there is no correlation between oceanic transport and surface air temperature on any timescale. In cold climates (with full Arctic sea ice cover), interaction between ocean and atmosphere is limited, leaving poleward atmosperic heat transport to be the primary driver on all timescales (interannual and decadal).