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Arctic decadal variability in a warming world

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The Arctic is currently warming much faster than other parts of the world, and sea ice is rapidly diminishing. Superimposed on these temperature and sea ice trends is a strong decadal variability, which can reinforce or oppose the trends, depending on its phase. It is therefore imperative to know not only the characteristics of current variability but also how (patterns of) Arctic decadal variability (ADV) might change as the climate warms.
We evaluated the ADV characteristics in three long, equilibrium climate simulations for present-day, doubled, and quadrupled atmospheric CO_2 forcing. These simulations show that ADV changes non-linearly with increasing CO_2 concentrations, with maximum variability occurring in the CO_2 doubling climate when sea ice becomes more vulnerable to melt over vast stretches of the Arctic. The dominant region of variability, which is located over the Barents Sea and the Greenland Sea in the current climate, shifts to the central Arctic and Siberian regions as the climate warms.
Furthermore, the links between dominant atmospheric circulation modes and Arctic climate characteristics vary strongly with climate change. For instance, a positive Arctic Oscillation (AO) index is associated with a colder Arctic region in warmer climates, instead of a warmer Arctic at present. Such changing relationships are partly related to the retreat of sea ice because altered wind patterns influence the sea ice distribution and hence the associated local surface fluxes.
The atmospheric pressure distributions governing ADV also change with climate warming. The Aleutian and Icelandic Lows both play a key role in the changing mean state and the associated variability of the large-scale circulation. Whereas ocean heat transport is firmly associated with ADV in the current and the CO_2 doubling climate, the importance of the atmospheric heat transport increases in even warmer climates, suggesting that the large-scale dynamics associated with ADV change as well.
The changing character of the ADV when climate warms shows that it is vital to consider ADV (and the changes therein) when addressing Arctic warming in climate model projections of the future climate.