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Magnitude and pattern of Arctic warming governed by the seasonality of radiative forcing

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Observed and projected climate warming is strongest in the Arctic regions, and maximum in autumn/winter. Attempts to explain this feature have focused primarily on identifying the associated climate feedbacks, particularly the ice-albedo and lapse-rate feedbacks. However, the impact of seasonally varying climate forcing has not been identified and quantified. Here we use a state-of-the-art global climate model in idealized seasonal forcing simulations to show that Arctic warming is very sensitive to the season in which the radiative forcing occurs. More specifically, Arctic warming and sea ice decline (especially in winter) are particularly sensitive to forcing in spring, during which the energy is effectively 'absorbed' by the ocean (through sea ice melt and ocean warming, amplified by the ice-albedo feedback) and consequently released to the lower atmosphere in autumn and winter, mainly along the sea ice periphery. In contrast, wintertime radiative forcing yields a more evenly distributed winter warming, which, surprisingly, in certain regions is even smaller than that due to spring forcing. The dependence of the magnitude and pattern of Arctic warming on the seasonality of the climate forcing has important implications in terms of projected increases in anthropogenic forcing. For instance, shipping-induced emissions such as those of black carbon are projected to peak in the ice-free summer and will thereby exert a comparatively strong impact on Arctic warming.