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Does Arctic sea ice melt affect the Eurasian snow?

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The Arctic climate has been changing rapidly in recent decades. This is evident through the amplification of the more generally rising surface air temperatures and the intensification of the freshwater cycle. A feedback associated with Arctic summer sea ice loss plays an important role in affecting these pan-Arctic climatic changes. Land-surface snow is not only vulnerable to these climatic changes but also plays an important role in the feedback mechanisms. Moreover, recent studies show significant changes in land-surface snow over the high-latitude regions of Northern Hemisphere; though the sign of changes varies over space. We investigate the response of Eurasian snow to the declining Arctic sea ice. Using both observational data and climate model simulations, we search for a sea ice related signal in snow. We begin our investigation by employing empirical analyses of observed sea ice and snow cover. The primary signal of covariability between Arctic sea ice and Northern Hemisphere snow extent between 1979 and 2007 indicates that a decreasing trend in September sea ice over the Pacific sector is correlated with an increasing trend in fall and early winter snow over Siberia. Historical and future simulations of the fully-coupled Community Climate System Model (CCSM3) shows the emergence of a similar Siberian snow signal during the last half of the 21st century most strongly during late winter; though the hemispheric-scale diminishment of snow is apparent much earlier. These sets of analyses do not alone imply any cause and effect relationship between snow and sea ice. To address the question of causality we used a suite of Community Atmosphere Model (CAM3) experiments in order to identify snow response to different boundary forcings. Comparisons of five specific experiments allow us to discriminate between changes associated with Arctic sea ice / sea surface temperature variations and changes associated with forcing from other regions. Our results suggest a key role played by the high-latitude surface forcings (sea ice and sea surface temperature) in generating the Siberian signal. Using atmospheric fields, we investigate the physical mechanisms linking sea ice and snow. In summary, this study establishes a causal link between sea ice and snow, which so far is weak and inconclusive in the observed climate, but is expected to strengthen over the coming decades.