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Arctic climate and sea-ice changes in CMIP5/PMIP3 simulations over the last millennium

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Arctic sea ice extent has been declining dramatically over the last five decades and a recent long-term reconstruction indicates that summer sea-ice extent is now about two million square kilometers less than during most of the last millennium. Using reconstructions for pan-arctic temperature and sea-ice changes we assess the ability of the models to reproduce observed changes and to identify mechanisms driving variations on interdecadal to centennial time-scales. The long-term evolution of near-surface temperature is simulated in accordance with reconstructions and sea-ice changes are most often in anti-phase with temperature anomalies. We compare simulations driven by natural (orbital, volcanic, solar) and anthropogenic (land-cover-changes, greenhouse-gas-increase) forcings with control experiments and identify the role of individual drivers. We demonstrate that the current decline in Northern Hemisphere sea ice appears to be clearly outside the range of natural and internal variability over the last 1200 years. The unforced control simulations also exhibit events of sudden growth and decline of sea-ice extent that capture some elements of recently described variations in sea ice reconstructions over the last millennium. We explore the role of ocean heat advection and atmosphere-ocean-sea ice coupling in driving such multidecadal variations.