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Arctic climate and sea-ice changes in CMIP5/PMI3 simulations over the last millennium

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Arctic climate is characterized by pronounced variations on multidecadal to centennial time scales. Model simulations demonstrate that both internal variability and the response to external forcing show aspects of Arctic amplification. 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.