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The Arctic Ocean's seasonal cycle must change

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This paper discusses anticipated changes to the seasonal cycle of the Arctic Ocean along with Arctic surface climate due to the reduction of seasonal sea ice cover expected in the 21st century. Net surface shortwave radiation is a function of surface reflectivity and atmospheric transparency as well as solar declination. Recent observational studies and modeling results presented here strongly suggest that this excess heat in the summer is currently being stored locally in the form of ocean warming and sea ice melt. This heat is lost in winter/spring through surface loss through longwave and turbulent processes causing ocean cooling and the refreezing of sea ice.

A striking feature of Arctic climate during the 20th century has been the enhanced warming experienced during winter in response to increases in anthropogenic greenhouse gasses. The amplitude of the seasonal cycle of surface air temperature is declining by gradually warming winter temperatures relative to summer temperatures. Bintanja and van der Linden (2013) show this process will eventually cause the 30C seasonal change in air temperature to reduce by half as seasonal sea ice disappears. The much weaker seasonal cycle of ocean temperature, which is controlled by the need to store excess surface heat seasonally, is also going to be affected by the loss of sea ice but in quite different ways. In particular the ocean will need to compensate for the loss of seasonal heat storage by the ice pack. This study examines consequences for the Arctic Ocean stratification and circulation in a suite of CMIP5 models under future emissions scenarios relative to their performance during the 20th century and to explore a range of model ocean responses to declining sea ice cover on the Arctic Ocean.