

Would limiting global warming to 1.5 or 2°C prevent an ice-free Arctic?

James Screen and Daniel Williamson

Department of Mathematics, University of Exeter, Exeter, United Kingdom (j.screen@exeter.ac.uk)

The Paris Agreement to combat climate change includes an aspirational goal to limit global warming to 1.5°C above pre-industrial levels, substantially more ambitious than the previous target of 2°C. One of the most visible and iconic aspects of recent climate change is the dramatic loss of Arctic sea-ice, which is having profound implications on the environment, ecosystems and human inhabitants of this region and beyond. The concept of an ‘ice-free Arctic’ has captured scientific attention and public imagination. Scientists commonly define this as when the Arctic first becomes ice-free at the end of summer. Without efforts to slow manmade global warming, an ice-free Arctic would likely occur in summer by the middle of this century. But would limiting warming to 1.5°C, or even 2°C, prevent the Arctic ever going ice-free? Different climate models give vastly different projections of the lowest sea-ice extent given global warming of up to 1.5°C or up to 2°C. Models that over-estimate (or under-estimate) sea-ice extent in the last ten years are also those that project more ice (or less ice) remaining into the future. Here we use this relationship to observationally constrain climate model projections of future Arctic sea-ice cover. We obtain an observationally-constrained central prediction of 2.9 million square kilometres for the minimum sea-ice extent if global warming is limited to 1.5°C, or 1.2 million square kilometres if global warming remains below 2°C. Using Bayesian statistics allows us to compare estimates of the probability of an ice-free Arctic for the 1.5°C or 2°C target. We estimate there is less than a 1-in-100000 (exceptionally unlikely in IPCC parlance) chance of an ice-free Arctic if global warming is stays below 1.5°C, and around a 1-in-3 chance (39%; about as likely as not) if global warming is limited to 2.0°C. We suppose then that a summer ice-free Arctic is virtually certain to be avoided if the 1.5°C target of the Paris Agreement is met. However, the 2°C target may be insufficient to prevent an ice-free Arctic. Furthermore, our analysis suggests that the Intended Nationally Determined Contributions submitted by countries to support the Paris Agreement (which imply warming of 2.6 to 3.1°C) would likely (66 to 74%) lead to the Arctic going ice-free.