POLAR SEA ICE
AND THE CLIMATE CATASTROPHE NARRATIVE

J. Ray Bates

The Global Warming Policy Foundation
Note 28

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Contents

About the author

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1. Introduction

The recent publication of the book *Unsettled* by Steven Koonin has led to the likelihood of increased scrutiny of the perception of a climate emergency,[1] an idea which has become so widely established in recent years. Koonin, a former scientific advisor to the Obama administration, has demonstrated that what the public are being told by the media is not necessarily what the scientists are saying. He has also shown that what is being relayed in the national and UN climate assessments has often been written for the purpose of persuading rather than informing.

Unsettled clearly shows that important aspects of climate science, which the public have been persuaded to regard as beyond dispute are, in fact, quite unsettled. Climate scientists may have become accustomed to recognising this in private conversations among themselves, but they have not been accustomed to acknowledging it in public.

The political and economic consequences of the putative climate emergency are so enormous that scrutiny of the scientific basis for the belief that such a thing exists is not only legitimate, but essential for the public interest.

Although *Unsettled* covers a broad spectrum of climate topics, it does not treat in depth the issue of recent polar sea-ice trends, which are key indicators of changes in the global climate, and which have for decades been portrayed as providing a compelling reason for alarm. This paper shows that they are, in fact, no such thing: the susceptibility of polar sea-ice extent to increasing greenhouse gases (GHGs) is as unsettled as many other important aspects of climate science.

In this paper, sea-ice extent is defined as areas with more than 15% ice.[2] The analysis is based on the mean sea-ice extent for September in both hemispheres. A monthly mean is used because it tends to average out day-to-day variations that are often the result of short-term weather. September is the month when the Arctic sea-ice extent generally reaches its end-of-summer minimum and the Antarctic sea-ice extent generally reaches its end-of-winter maximum. Despite this antisymmetry, there are two distinct reasons why September is the most appropriate choice of month for both hemispheres for the purpose of the present analysis.

- Firstly, it is reasonable to expect that the susceptibility of sea-ice extent to GHG increase should be most clearly seen in the month when the geometry of coastlines has its smallest constraining influence.[3] In the Arctic, the influence of coastlines is least in summer, when the ice edge is at its maximum distance from land; in the Antarctic, it is least in winter, when the ice edge again has its maximum distance from land.
- Secondly, in relation to testing sea-ice model projections against observations, the IPCC has reported that the CMIP5 models project the strongest GHG influence on the absolute sea-ice extent in both hemispheres in September.[4]

2. Arctic sea ice

Since the introduction of passive-microwave satellite observations in the late 1970s, polar sea-ice extent has been among the most accurately observed climate indicators.[5] Sea-ice volume, on the other hand, is much more difficult to measure.

Some of the most alarming (and as yet unrealised) statements about climate change have been made in relation to Arctic sea-ice changes. In December 2007, former US vice-president Al Gore, in his Nobel Peace Prize acceptance speech in Oslo, referred to scientific studies warning that the Arctic sea ice was 'falling off a cliff'. He highlighted forthcoming model results that projected largely ice-free Arctic summers in 'as little as seven years'.[6] He repeated this warning two years later at the 2009 COP15 climate meeting in Copenhagen.[7]

Gore's claim was based on a study by researchers from the US Naval Postgraduate School, who used a regional model of the sea ice–ocean system in the Arctic, constrained using observational data for the 12-year period 1996–2007, and concluded that the Arctic would be nearly ice-free in summer by 2016 (plus or minus three years).[8] Soon after Gore's speech, they revealed their findings in a scientific forum – the annual meeting of the American Geophysical Union in San Francisco – and were prominently reported by the BBC.[9] The detailed results were presented in a journal article in 2012.

The period 2013–2019 – during which the Arctic was projected to have become ice-free at the end of summer – has come and gone, and the model projections are far from being borne out. Figure 1 is a time series of observed mean Arctic sea-ice extent for September, over the period of satellite observations (1979–2021).[10] There was a marked sea-ice decline for a period following 1996. However, since

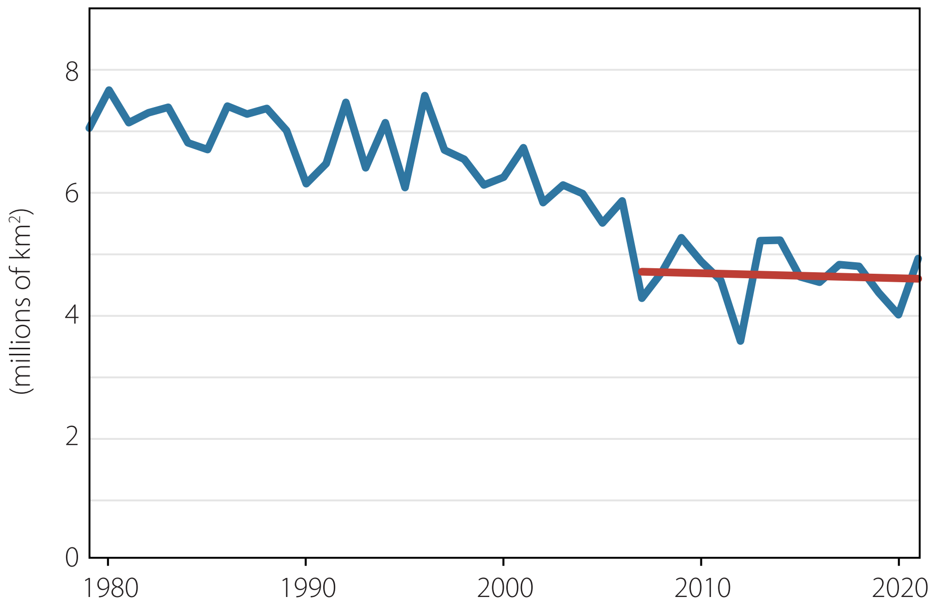

Figure 1: September mean Arctic sea ice extent 1979–2021

The regression line for the 15-year period 2007–21 is shown in red; its slope is −0.008214 Mkm^2/yr.
Data source: https://nsidc.org/data/seaice_index/archives.

2007, rather than disappearing as projected, the September sea ice has exhibited a much slower rate of decline, remaining in the region of 4.5 million km^2. If the statistical trend in the most recent 15-year period were maintained, it would take over 500 years for the Arctic to become ice-free in September.[11] While strong reliance cannot be placed on a linear trend measured over such a short period, it must be remembered that the dramatic projections of sea-ice loss publicised by Al Gore were based on a model that used observational data over an even shorter period.

The current slowdown in the rate of sea-ice loss was not expected, and the reasons for it are uncertain. It is known from submarine measurements that much of the multi-year Arctic sea ice was lost in the decade following 1996; what is now seen each summer is largely new ice that formed over the previous winter. It is well known that thin ice grows faster in winter than does thick ice. It has been proposed that the winter growth–thickness feedback can become a stabilising influence on the Arctic sea-ice cover when the thickness decreases to a certain point.[12] This could, then, be one reason for the slowdown in ice loss.

Any objective discussion of the recent Arctic sea-ice decline also requires that some consideration be given to the evidence regarding past natural variability on a multi-decadal timescale. In the pre-satellite era, reliable data on sea-ice coverage was sparse. However, recent studies have shown that there is a strong relationship between sea-ice extent and temperatures measured at Arctic stations. The temperature records go back much further, and show long-period variations, with Arctic warming occurring between the 1900s and 1940s, followed by cooling until the 1970s, and then renewed warming until the present. By combining the temperature and partial sea-ice records, statistical reconstructions of the total sea-ice extent going back to the early 1900s can be created. Some of these reconstructions indicate that between the 1900s and 1940s, Arctic sea-ice extent comparable to the present reduced levels may have occurred.[13]

These past temperature records and sea-ice reconstructions are supported by independent evidence. For example, a report to the US State Department from the American Consul at Bergen, Norway, in October 1922, entitled *The Changing Arctic*, stated that:

> The Arctic seems to be warming up. Reports from fishermen, seal hunters and explorers who sail the seas about Spitzbergen and the Eastern Arctic all point to a radical change in climatic conditions, and hitherto unheard-of high temperatures in that part of the Earth's surface.[14]

Another example is the decision by the Soviet government in 1932, made on the basis of disappearing sea ice, to develop the northern seas as a regular transport route from Europe to Asia.[15,16] The project was later abandoned when the sea ice returned after cooling later set in. It is clear that multi-decadal natural variability, which is poorly simulated by climate models, gave rise to large variations in Arctic sea ice in the past and may be a factor in what is being seen at present.

3. Antarctic sea ice

In the Antarctic, meanwhile, there has been no significant change in annual mean sea-ice extent over the period of reliable satellite measurements, despite model projections of a decline similar to that in the Arctic. Observations are again presented for September, this being a month in which the models project significant changes to occur. In the Southern Hemisphere, September is the month in which the sea-ice extent reaches its late-winter maximum.

Figure 2 shows the September means for the period 1979–2021. It can be seen that, contrary to what the models have been projecting, the trend during this period is in the direction of slightly increasing Antarctic sea-ice extent.

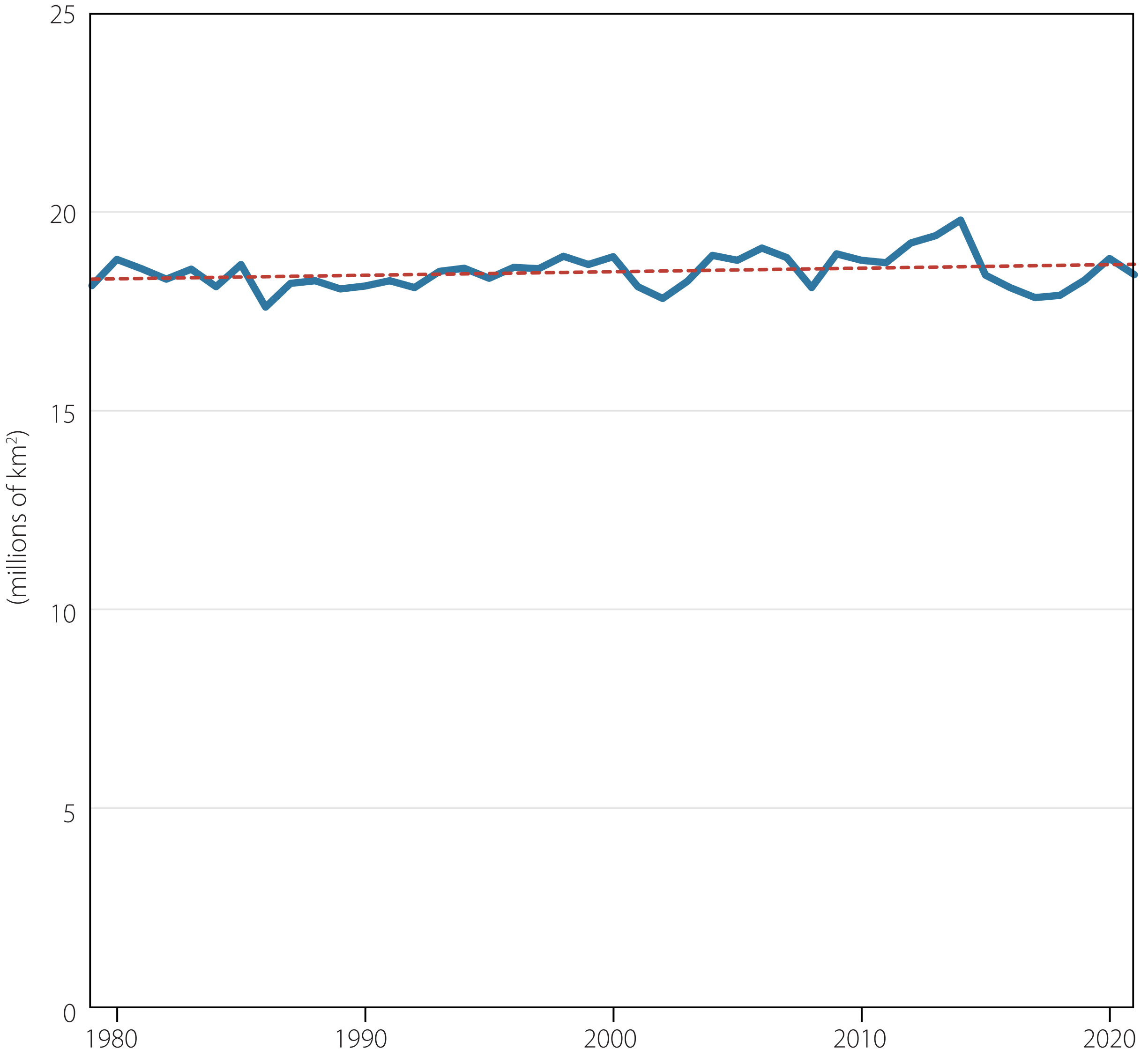

Figure 2: September mean Antarctic sea ice extent 1979–2021.
Regression slope = +0.008488 M km2/yr. Data source: https://nsidc.org/data/seaice_index/archives.

4. Current projections

The Summary for Policymakers (SPM) of the IPCC's recently released Sixth Assessment Report projects a continuing decline in Arctic sea-ice cover,[17] with practically ice-free conditions projected for September near mid-century under mid and high greenhouse gas emissions scenarios.[18] No reference is made in the SPM to the minimal September sea-ice trend observed in the Arctic over the past 15 years, as shown in Figure 1.

A more detailed version of the CMIP6 model projections for the Arctic in September than that given in the SPM figure is shown in Figure 3. This includes the observations, which are not shown in the SPM figure. The model projections show a very wide spread. Some models indicate a nearly ice-free Arctic (<1 million km^2) in September as early as 2020. A majority of the models project ice-free conditions before 2050.

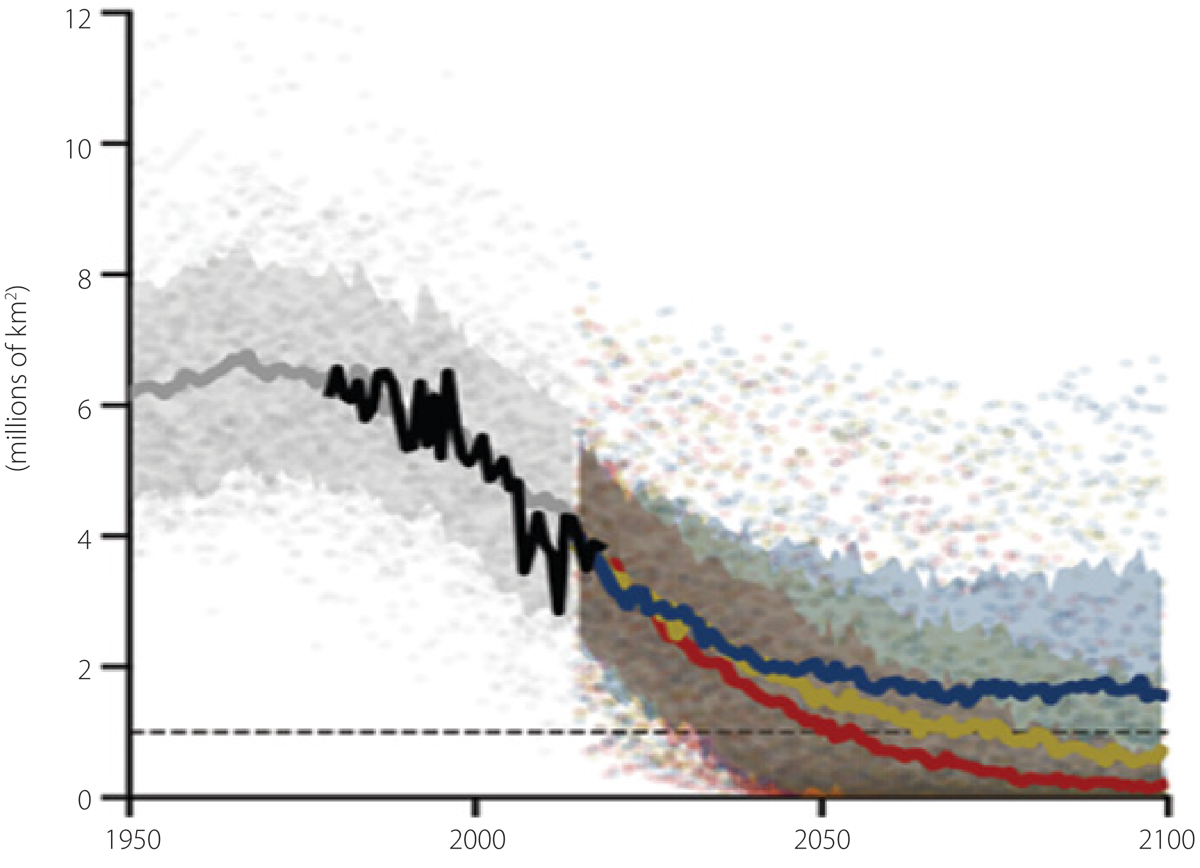

Figure 3: Simulations of September Arctic sea ice area

Simulations over 1950–2014 and projections to 2100 using an ensemble of 40 CMIP6 models. Thick lines denote the multi-model mean and the shading indicates one standard deviation; faint dots denote individual model output. Grey denotes the historical simulation, while the blue, yellow and red colours denote projections using the SSP1–2.6, SSP2–4.5 and SSP5–8.5 emission scenarios. The thick black line denotes observations. Reproduced from Figure 2(f) of Notz and SIMIP.[19]

The corresponding projections of the CMIP6 models for the Antarctic are shown in Figure 4. Again, the projections show a very wide spread. The multimodel mean of the simulations over the period of satellite observations suggests a continual sea-ice decline, whereas the observations show a slightly increasing trend. The projections to 2100 also show a continuing decline, at rates similar to those shown for the Arctic in Figure 3. It is noteworthy that while the observed sea-ice changes in the Arctic and Antarctic over recent decades are very different in character, the model projections for the two regions are very similar in terms of absolute changes.

It would appear unwarranted to place strong faith in model projections to 2100 given:

- their very wide spread in outputs for the historical period
- their failure to indicate the recent marked slowdown in Arctic sea-ice decline or the continuing slow Antarctic sea-ice gain
- their general inability to replicate the very different characteristics of the sea-ice evolution north and south.

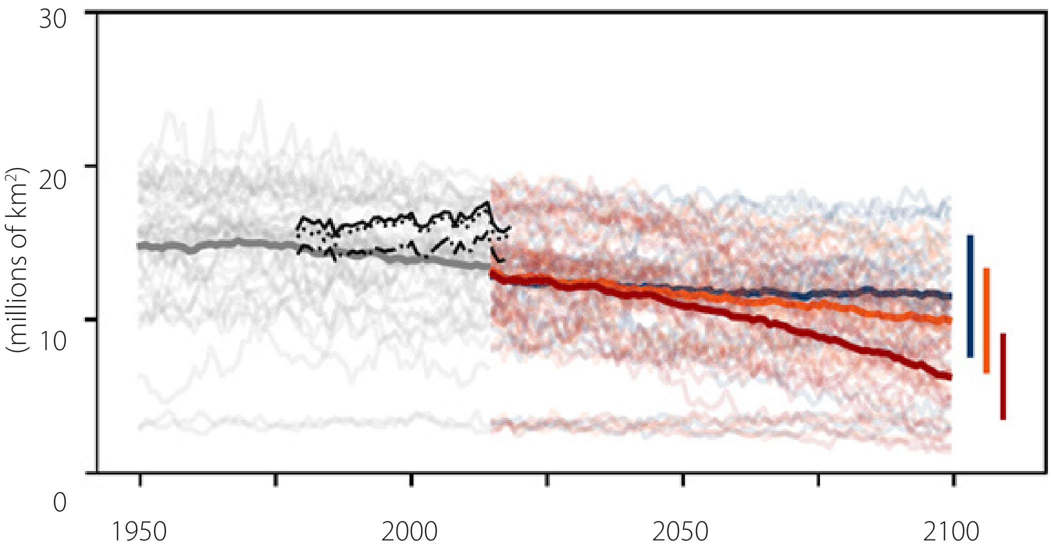

Figure 4: Simulations of September Antarctic sea ice area

Thick coloured lines denote multimodel means and faint lines show individual model trajectories. Grey denotes the historical simulation 1950–2014, while the blue, red and brown colours refer to projections using the SSP1–2.6 , SSP2–4.5 and SSP5–8.5 emission scenarios. The vertical bars on the right show the multimodel means plus or minus one standard deviation. Three observational datasets are shown in black. Reproduced from Figure 4(c) of Roach et al.[20]

5. Conclusions

The evidence presented here indicates that the response of polar sea ice to increasing greenhouse gases should be counted among the many unsettled aspects of climate science. In the Arctic, widely publicised and very influential predictions that end-of-summer sea ice would have disappeared before now have not been borne out. Instead, the September extent, after showing a marked decline in the years following 1996, has remained largely unchanged, at around 4.5 million km^2, over the past 15 years. On present trends, it would take many centuries to decline to zero. The reasons for the slowdown in the rate of decline are uncertain, but it is possible that a physical stabilising mechanism may have come into play.

In the Antarctic, model projections of a marked sea-ice decline have not materialised. On the contrary, the extent in September, when the annual maximum is reached, has slightly expanded over the satellite era, 1979–2021.

These facts deserve to be recognised when the notion of a climate emergency, requiring the most drastic and immediate changes to the world's economy, is being put forward. Some concern might also be shown among those involved for the increasing eco-anxiety being inflicted on the younger generation.

Notes

1. Koonin, S. *Unsettled: What climate science tells us, what it doesn't, and why it matters*. BenBella Books, 2021. (Professor Koonin was Undersecretary for Science in the US Department of Energy during the Obama administration.)

2. Per NSIDC. See http://nsidc.org/arcticseaicenews/faq/#averaging.

3. Eisenman, I., Schneider, T., Battisti, D.S. and Bitz, C.M. (2011): Consistent changes in the sea ice seasonal cycle in response to global warming. *Journal of Climate* 2011; 24: 5325–5335.

4. Stocker, T.F. et al. (eds). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 2013. (See p. 1087 in relation to Arctic sea ice extent and p. 1092 in relation to Antarctic sea ice extent.)

5. Parkinson, C.L. and Cavalieri, D.J. Antarctic sea ice variability and trends, 1979–2010. *The Cryosphere* 2012; 6: 871–880.

6. Gore, A. Nobel Peace Prize Acceptance Speech, Oslo, 10 Dec 2007. https://www.nobelprize.org/prizes/peace/2007/gore/26118-al-gore-nobel-lecture-2007/.

7. Gore, A. YouTube Video, COP15 Meeting, Copenhagen. 14 Dec 2009, 'Al Gore warns polar ice may be gone in five years'. https://www.youtube.com/watch?v=MsioIw4bvzI.

8. Maslowski, W., Kinney, J.C., Higgins, M. and Roberts, A. 'The future of Arctic sea ice'. In: *Annual Review of Earth and Planetary Sciences* 2012; 40: 625–654.

9. BBC News Report, 12 Dec 2007: 'Arctic summers ice-free by 2013'. The report features an interview with Prof. W. Maslowski of the US Naval Postgraduate School at the AGU meeting in San Francisco. http://news.bbc.co.uk/2/hi/7139797.stm.

10. Sea-ice extent is defined as the area covered by data cells within each of which the ice coverage is at least 15%. http://nsidc.org/arcticseaicenews/faq/#averaging.

11. The linear regression line for the Arctic sea ice extent, y (in Mkm^2), in the period 2007–2021 is $y = a + bx$, where $a = 4.7117$ Mkm^2, $b = -0.008214$ Mkm^2/yr and $x = year - 2006$.

12. Bitz, C.M. and Roe, G.H. 'A mechanism for the high rate of sea ice thinning in the Arctic Ocean'. *Journal of Climate* 2004; 17: 3623–3632.

13. Connolly, M., Connolly R. and Soon, W. (2017). 'Re-calibration of Arctic sea ice extent datasets using Arctic surface air temperature records'. *Hydrological Sciences Journal* 2017: 62(8): 1317–1340. See also references therein.

14. 'The changing Arctic' by George Nicolas Ifft, American Consul at Bergen, Norway. Submitted to the State Department, Washington, DC on 10 October 1922. Reproduced in *Monthly Weather Review*, p. 589, November 1922.

15. Mahoney, A.R., Barry, R.G., Smolyanitsky, V. and Fetterer F. 'Observed sea ice extent in the Russian Arctic, 1933–2006', *Journal of Geophysical Research* 2008: 113: C11005.

16. Barr, W. 'The Arctic Ocean in Russian history to 1945', in *The Soviet Maritime Arctic*, edited by L.W. Brigham, pp. 11–32, Belhaven, London, 1991.

17. Masson-Delmotte, V. et al., (eds.). Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. (At the time of writing, the interior chapters of the Report are still under embargo pending editing to ensure they are consistent with the Summary for Policymakers; the latter was published on 9 August 2021.) https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf.

18. Figure SPM.8, Panel b.

19. Notz, D. and SIMIP Community. 'Arctic sea ice in CMIP6'. *Geophysical Research Letters* 2020: 47: e2019GL086749.

20. Roach, L.A., Dörr, J., Holmes, C.R., Massonnet, F., Blockley, E.W., Notz, D., et al. (2020). 'Antarctic sea ice area in CMIP6'. *Geophysical Research Letters* 2020; 47: e2019GL086729.

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