Arctic Sea Ice Minimum

Media briefing, August 2012

Introduction

Sea ice is frozen sea water that waxes and wanes in response to the cooling and warming of the Arctic throughout the year. The ice pack reaches its greatest extent at the end of the winter, during March, and its lowest point at the end of the summer, usually in mid-September. This point is known as the sea ice minimum.

Since the early 1970s scientists have been using satellites to monitor the amount of Arctic sea ice present throughout the year. Data suggests that during this period the amount of sea ice in the Arctic has decreased by around 3% every ten years but, worryingly, they have discovered that the rate of melting has increased significantly in recent years.[1]

Recent Arctic summer sea ice cover

Year	Extent (million sq. km)
2002	5.96
2003	6.15
2004	6.04
2005	5.57
2006	5.89
2007	4.28
2008	4.67
2009	5.36
2010	4.90
2011	4.61

Source: September Average Extents, 2002-2011: Calculated by Walt Meier, National Snow and Ice Data Centre. All values in table estimated based on the NSIDC Sea Ice Index.

The lowest ever sea ice minimum was in 2007,[2] when the Arctic covered 4.13 million square kilometres on September 16th.[3] The 2011 minimum was the second lowest on record[4] and scientists are now suggesting that the extent of summer sea ice in 2012 could reach a new low.

Measuring sea ice

There are two main ways to measure the amount of sea ice in the Arctic: 'extent' or 'volume.' Though the minimum generally refers to the lowest annual extent of the sea ice, it is important to consider both factors when looking at the overall rate of Arctic melt. As a scientist from the University of Washington's Polar Science Centre said, "the real story is the decline over the past 30 years in both extent and thickness."[5]

Sea ice extent refers to the area of ocean covered by at least 15% ice. It is a two-dimensional measure often used by scientists as it helps avoid potential underestimation of ice cover (mainly caused by satellites misinterpreting surface melt),[6] though it only tells part of the story.

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Sea ice volume is a measurement of ice extent and its thickness. Understanding how fast the ice is being depleted by volume is crucial to working out how quickly we are approaching an ice-free Arctic summertime because thinner ice can be more vulnerable to future melting. As one expert noted, "there comes a point when large parts of the ice pack become so thin that it doesn't matter what the weather does…the train keeps chugging along, even when the weather isn't so great for melt"[7]

What will happen to sea ice extent in 2012?

Although it is impossible accurately predict beforehand when the summer sea ice minimum will be and precisely what extent it will cover, indications are that this year will be extremely bad for the Arctic.

By mid-August, experts at the US National Snow and Ice Data Centre (NSIDC) confirmed that the extent of sea ice was 5.09 million km^2, 2.69 million km^2 below the 1979-2000 average.[8] Although a number of weeks of melting remain before a possible minimum, sea ice extent is now nearly 500,000km^2 below the previous record low level for the same date set in 2007.[9] This means that over 100,000km^2 of ice is disappearing from the Arctic every day, with scientists admitting that this rate is "rapid."[10]

According to a NSIDC spokesman, "unless the melting really, really slows down, there's a very real chance of a record. In the last week or so it's dropped precipitously. There's definitely a chance it'll dip below 4 million square kilometres." [11] He added that this year's melt was fuelled by higher summer temperatures in the Arctic, where the climate was between 2-3°C warmer than usual.[12]

Because of these factors, NSIDC has said that "a new daily record...would be likely by the end of August. Chances are it will cross the previous record while we're still in sea ice retreat."[13] Elsewhere, research now suggests that the North Pole could be totally ice-free during the summer within decades.[14, 15]

What about sea ice volume?

As with sea ice extent, volume appears to be in sharp decline in the Arctic. Although ice volume naturally increases and decreases during the seasons, scientists using the Pan-Arctic Ice Ocean Modelling and Assimilation System (PIOMAS) have identified that the amount of ice has been steadily falling since the 1970s. [16, 17]

PIOMAS calculated[18] that the average sea ice volume for September between 1979 and 2011 was 12,300 km^3. In 2011 the ice volume during the September minimum was just 4,200 km^3, 66% lower than average, whilst early assessments for 2012 indicate that the volume of Arctic sea ice in July 2012 was 8,300 km^3. This figure is around 700 km^3 less than at the same time the previous summer and 55% below average.

Elsewhere, scientists using the European Space Agency (ESA) CryoSat-2 satellite recently announced that the volume of Arctic sea ice is disappearing 50% faster than most modelling scenarios suggested.[19] Though the analysis of the CryoSat data is preliminary, ESA are extremely confident of the satellite's accuracy, saying "CryoSat is working extremely well. Its data are very reliable and the measurements we have match reality."[20] One of the researchers who lead the project said that

these findings "suggest that the Arctic might be ice-free in summer for a day at least by the end of the decade."[21]

How significant is current Arctic sea ice melt?

The Arctic is undergoing rapid and fundamental change: over the last 30 years, the annual trend has been one of significant reduction in the overall ice extent by the end of the summer.[22] Although NSIDC admitted that it doubts there has been "another year that had as rapid an early August retreat"[23] as in 2012, how significant is the ice melt we're now seeing compared to what may have occurred previously?

Natural geological and climatological processes have unquestionably caused warming and cooling of the Arctic region in the past,[24] although "there is minimal baseline information about the speed, timing, causes and impacts of Arctic temperature change and sea ice decline or disappearance."[25] That said, paleontological evidence suggests that the Arctic was ice-free 65million years ago during the late Cretaceous period.[26] After this, the high north was likely free of summer ice during the Eemian interglacial around 125,000 year ago.[27] Scientists believe that the last time the Arctic was ice-free in summer was likely to have been during the early Holocene period roughly 11,000 years ago.[28]

However, the melting we have witnessed in the Arctic in modern times appears to be unparalleled in recent geological history.

Based on a meta-analysis of over 300 studies, scientists at Ohio State University found that current ice loss, which started in the 19th Century, "appears to be unmatched over at least the last few thousand years and unexplainable by any of the known natural variables."[29] The research team added that "the picture is very troubling. We are losing ice very fast."[30] A team of scientists from NSIDC and Penn State University drew similar conclusions, noting that "the size and speed of the summer sea ice loss over the last few decades appear anomalous compared to events from previous thousands of years."[31]

In addition, the link between disappearing ice and temperature in modern times is now becoming much clearer. Since the Massachusetts Institute of Technology doubled its estimation of possible global warming, warning that temperatures around the planet could rise by 5.2°C by 2100,[32] the US National Oceanic and Atmospheric Administration (NOAA) has said that the Arctic "has reached a new state…characterised by less sea ice (both extent and thickness)," adding that "the decline in total sea ice extent has been accompanied by an unprecedented loss of old, thick multiyear ice."[33] Or, as one commentator noted, Arctic sea ice loss is now "being driven by human emissions."[34]

The importance of Arctic sea ice

Sea ice cover plays a crucial role in regulating global climate[35] and scientists are concerned that the loss of Arctic sea ice could create a positive feedback system that increases future climate warming. Put simply, white coloured sea ice reflects solar radiation whilst dark coloured open water absorbs the sun's energy. As the Arctic ice melts, less energy is reflected back into space and more heat is absorbed by the darker coloured ocean, leading to further warming and even more melting. This "ice-albedo feedback process"[36] could trap the northern sea ice in a vicious

circle of ever-increasing melting and more rapid ice loss, resulting in the breakdown of the planet's air-conditioning system. This has led some experts to suggest that Arctic sea ice is entering a "death spiral."[37]

In addition, sea ice affects ocean circulation: the saltier and denser water found under the Pole sinks and is transported south via an oceanic conveyor belt called a thermohaline. This flow helps generate "heat engines" that regulate the global climate.[38] The strength of the thermohaline depends on the amount of sea ice[39] and as it disappears it could disrupt the normal functioning of ocean currents and impact atmospheric conditions.

The loss of summer sea ice will affect many Arctic animals, such as polar bears, seals, walruses, and seabirds. The ice edge is prime habitat for marine organisms and some Arctic species travel halfway around the world to exploit the life forms that flourish there. A drastic reduction in sea ice or a change in the timing of its appearance and disappearance would have profound consequences for all Arctic life. At the same time, less icy summers have resulted in the Northern Sea Route[40] and Northwest Passage[41] remaining open to shipping for far longer than in the past, which has potentially significant implications. Many of these shipping routes are inadequately surveyed,[42] accidents remain a risk and the release of "black carbon" from ship engines could add to local climate change.[43]

Even if the 2012 sea ice minimum does not turn out to be the lowest on record, which seems increasingly unlikely, the disappearing Arctic still serves as a stark warning to us all. Data shows us that the frozen north is teetering on the brink. The level of ice "has remained far below average" and appears to be getting thinner, leaving it more vulnerable to future melting.[44] The consequences of further rapid ice loss at the top of the world are of profound importance to the whole planet. This is not a warning we can afford to ignore.

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