Climate Change Report Card
Climate Change Report Card

Submitted by ASOC

Summary

The Antarctic and Southern Ocean Coalition (ASOC) provides an annual climate change report card, updating the Antarctic Treaty Consultative Meetings on Antarctic climate science research findings and news headlines. The table below summarizes key findings since the 2016 ATCM.

Table 1. Climate trends 2017.

<table>
<thead>
<tr>
<th>WHAT WE KNOW</th>
<th>HOW WE KNOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antarctic sea ice extent reached a record low in 2017.</td>
<td>Observations and long-term environmental monitoring</td>
</tr>
<tr>
<td>Antarctic Peninsula surface temperature has risen overall since the 1950s but has cooled approximately 0.5°C per decade since the 1990s due to stronger summer winds. These declines are predicted to be short-lived, however.</td>
<td>Instrumental records</td>
</tr>
<tr>
<td>Central West Antarctica is one of the fastest-warming regions on the planet.</td>
<td>Instrumental records</td>
</tr>
<tr>
<td>Ice sheets, particularly those in West Antarctica, show signs of disintegration, which could lead to significant global sea level rise.</td>
<td>Paleo-climate research, direct and long-term observation (both in the field and through remote sensing), global climate models</td>
</tr>
<tr>
<td>Ocean acidification will have negative effects on some key Antarctic species.</td>
<td>Studies of species under predicted conditions</td>
</tr>
<tr>
<td>Short-term climate change related climate anomalies may have long-term impacts.</td>
<td>Studies of climate anomalies in subsequent years, modeling of predicted responses</td>
</tr>
<tr>
<td>Adélie and chinstrap penguin populations in the West Antarctic Peninsula are likely to decline significantly in the next several decades.</td>
<td>Direct analysis of population trends in colonies; results of modeling.</td>
</tr>
</tbody>
</table>

Climate Change Overview

There is longstanding and robust scientific evidence that climate change is happening now, is projected to intensify in the short- to long-term, and is caused by emissions from human activities. The endeavors of Antarctic researchers to understand anthropogenic climate change have been highly influential in building our knowledge about climate change in Antarctica and globally.

---

1 Lead authors Claire Christian and Jessica O’Reilly, with contributions from Chris Johnson and edits by Ricardo Roura and Rodolfo Werner. ASOC also thanks scientific reviewers Heather Lynch, Mike Sparrow, Tristy Vick-Majors and Casey Youngflesh.

Below, ASOC presents some of the key research findings in Antarctic climate change since the last ATCM.

**Antarctic Sea Ice**

Climate scientists project that warming of the Southern Ocean and Antarctica will accelerate through this century, with increased heating from the ocean and the atmosphere. Although the Ross Sea is currently seeing increased sea ice extent, the overall area of sea ice in the Antarctic is likely to be reduced.  

2017 saw the lowest extent of Antarctic sea ice since record keeping began in 1979—the previous lowest extent occurred in 1997. The sea ice reached its minimum extent on March 3, 2017 with 2.106 million square kilometers covered. This season contradicts recent years of increasing Antarctic sea ice extent, including the October 2014 record maximum sea ice extent. The lower cover could produce a feedback effect as more, darker ocean is exposed, absorbing heat, warming the ocean, and causing further decreases.

**Temperature**

While long-term global warming is fact, not everywhere on the planet is warming at the same rate. With a temperature increase of about 2.4°C from 1958 – 2010, Central West Antarctica is one of the fastest-warming regions on the planet. A new study by Turner et al. found that, while the Antarctic Peninsula has been rapidly warming since the 1950s, there has been a cooling since the 1990s, at a rate of about 0.5°C per decade. This is due to stronger summer winds. The cooling does not offset the overall warming trend of the Antarctic Peninsula since the 1950s and, according to the researchers, falls into the range of natural variability. These trends are linked to larger, global-scale patterns of atmospheric circulation. The oceans surrounding the Peninsula are also warming. The temperature of the upper ocean west of the Antarctic Peninsula has risen by nearly 1.5°C since the 1950s. 596 of the 674 glaciers along the west coast of the Antarctic Peninsula have retreated since records began in the 1940s. Ocean warming is the primary cause.

The Antarctic continental record high of 17.5°C from March 24, 2015 at Esperanza Base (Argentina), was confirmed by the World Meteorological Organization (WMO) this year. Other Antarctic temperature extremes confirmed by WMO include the highest temperature on the Antarctic Plateau at -7.0°C on December 28, 1989 and the highest temperature for the Antarctic Region on northerly Signy Research Station, with a temperature of 19.8°C on January 30, 1982.

**Ice Sheets**

---

8 Ibid.
13 Ibid.
The Antarctic Ice Sheet consists of two major ice sheets, the more stable East Antarctic Ice Sheet and the less-stable, marine-based West Antarctic Ice Sheet. Both have been losing mass and have areas of concern, but the most significant concern is assessing the likelihood of rapid disintegration of the West Antarctic Ice Sheet and the resulting global sea level rise of about 5 meters. Additionally, research demonstrates that the East Antarctic ice sheet may be more vulnerable to rising temperatures in the Weddell Sea than previously thought. Major programs of research on the ice sheets’ past, present, and future are underway among several National Antarctic Programs.

Pine Island Glacier is one of the most dynamic glacier areas of West Antarctica. Riffs have formed on Pine Island Glacier inland from the margins of the ice sheet. One initiated iceberg calving in 2015; other rifts remain. This rifting behavior could signal below-ice melting through warmer seawater intrusions in basal crevasses.

This austral summer (2016-2017), a substantial and rapidly growing crack in the Larsen C ice shelf hinted that its calving may be imminent, following the collapse of Larsen A in 1995 and Larson B in 2002. Ice shelves float over water but often act as plugs for continental ice sheets, which may flow rapidly into the sea after the ice shelves are removed. Finally, surface drainage systems on ice sheets appear to be much more extensive than previously realized, which researchers believe could “accelerate future ice-mass loss from Antarctic, potentially via positive feedbacks between the extent of exposed rock, melting and thinning of the ice sheet.”

**Ocean Acidification**

With ocean acidification (OA) expected to affect large areas of the Southern Ocean by 2030, understanding resulting changes to species and ecosystems is important so that the Antarctic Treaty System can take appropriate actions to protect the environment. A new study indicates that acidification at levels predicted to occur in the Antarctic by the end of the century, in conjunction with changes in light levels due to the retreat of sea ice, could have a negative impact on Antarctic diatoms, including two species which play major roles in carbon and silicon cycles in the Southern Ocean. Thus, essential biogeochemical cycles could be altered, with potentially serious consequences for the ecosystem as a whole. Other diatom species may experience enhanced growth. However, it appears that under temperature and pH scenarios predicted for the end of the century, pteropod larvae will experience “synergistic, negative impacts.”

Local biological and oceanographic characteristics are another important factor in how OA might affect the Southern Ocean. Primary production, mixing of Circumpolar Deep Water with surface water, and sea ice melt all were found to influence pH as well as levels of calcium carbonate in Ryder Bay in the West Antarctic Peninsula. This further highlights the complexity of this phenomenon, and the urgency of additional work to predict its near-term effects. New advances in computer modeling may assist in

---

understanding how ocean acidification in combination with other changes might affect microbial communities, as well as guide future research.\textsuperscript{24}

\textbf{Ecosystems}

A climate anomaly occurring from September 2001 until February 2002 resulted in significantly warmer temperatures than normal in the McMurdo Dry Valleys, as well as in record high snowfall and a decrease in sea ice extent in the West Antarctic Peninsula.\textsuperscript{25} Recent research has examined the impacts on the ecosystems at the National Science Foundation’s Long Term Ecological Research Program (LTER) sites in each of these regions and found that even this short anomalous period had ecosystem repercussions during that period. Krill, salp, and pteropod populations increased at the West Antarctic site, but the increased snowfall resulted in "the worst breeding season for Adélie penguins in the 40-year records available for this species."\textsuperscript{26}

The impact of the anomaly on microbial communities was also examined, and it was found that variations in ice cover due to the anomaly had long and short-term impacts on the sensitive ecosystems in both regions, with potential implications for biodiversity.\textsuperscript{27} The authors caution that continued climate change may result in "tipping points" being reached for these communities that could change the communities significantly.\textsuperscript{28}

In the case of the West Antarctic Peninsula, this could have implications for higher trophic levels, since the productivity of bacterial communities is linked to that of primary producers (phytoplankton).\textsuperscript{29} With increasing climate anomalies expected to occur in a warming world, ecosystems may be subjected to periods of intense change.

\textbf{Species}

Echoing the findings that climate anomalies can have long-term ecosystem impacts, scientists predict that years that are bad for Adélie penguins in the Antarctic Peninsula in terms of survival or breeding will exacerbate the risk of significant decreases in population size.\textsuperscript{30} Research into penguins on Signy Island finds trends similar to those seen on the Peninsula, namely that gentoos are increasing (255\% over 38 years) while chinstraps and Adélies are on the decline (68\% and 42\% over 38 years, respectively).\textsuperscript{31} Furthermore, modeling suggests that 30\% of Adélie penguin colonies could be shrinking by as soon as 2060 due to warming in the Western Antarctic Peninsula.\textsuperscript{32}

Somewhat surprisingly, however, changes in the timing of sea ice retreat and phytoplankton blooms, both of which are thought to play a role in the ability of Adélies to successfully forage during the breeding season, do not appear to have a substantial effect on breeding success - these penguins are buffered from phenological variability in the environment. This does not discount the importance of prey availability, but


\textsuperscript{26} Ibid.


\textsuperscript{28} Ibid.

\textsuperscript{29} Ibid.


rather highlights the importance of a number of other factors, such as weather, for breeding success in this species.33

Antarctic krill are also highly vulnerable to climate change. Reiss et al. highlight the importance of studying krill during the austral winter as sea-ice extent declines.34 This situation may allow increased winter fishing in areas such as the Bransfield Strait, with unknown effects on the krill population and on krill predators.35 Glacial melt may act as another stressor on krill. Mass coastal strandings of krill on King George Island that occurred between 2003-2012 were likely caused by the ingestion of sediments from glacial meltwater.36

**Recommendations**

ASOC recommends individual ATCPs and/or the ATCM and related bodies (including SCAR and WMO) to continue to:

- Invest in robust monitoring of the Antarctic region to understand total patterns and anomalies of the Earth’s climate system.
- Invest in ecological monitoring, which is imperative for understanding responses to environmental changes among species and ecosystems, including from immediate and diffuse human impacts.
- Develop a mechanism for ATCM reporting of Antarctic climate information to the broader public.
- Develop precautionary or rapid-response management plans in place to address sudden climate-related events. For example, CCAMLR recently agreed Conservation Measure (CM) 24-04, *Establishing time-limited Special Areas for Scientific Study in newly exposed marine areas following ice-shelf retreat or collapse in Statistical Subareas 48.1, 48.5 and 88.3*, which automatically designates these areas after a CCAMLR Member notifies the Secretariat and the Secretariat notifies other Members. The designation limits activities that can take place inside the Special Areas and therefore allows scientists time to gather data and understand the environmental changes that have occurred. The ATCM may wish to consider similar measures for terrestrial or coastal areas newly exposed by ice-shelf retreat or collapse.
- Establish protected areas that can be used as reference areas to attribute changes to climate change with no or minimal interference from local and regional activities.

---


35 Ibid.