



60 YEARS OF TREATY-SUPPORTED
ANTARCTIC SCIENCE

Ozone Depletion Still Matters

The discovery of the ozone hole by British Antarctic scientists, and swift realisation of the implications for life on Earth, yielded an unprecedentedly rapid, globally-endorsed response to phase out the anthropogenic chlorofluorocarbons (CFCs) responsible for ozone depletion. Proving a causal link between the observed strengthening and poleward shift of the westerly winds over the Southern Ocean, along with their influence on Antarctic and Southern Ocean life, has been transformative. There is now increasing evidence that the ozone hole is beginning to shrink, with indications that such change might already be having broad effects on Antarctic environments, such as changes to sea ice. Nonetheless, some complexity remains, with indications that despite the universal ratification of the Montreal Protocol and its instruments, CFC-11 (trichlorofluoromethane) concentrations in the atmosphere have been increasing.

Prepared for the
Antarctic Parliamentarians Assembly

2 - 3 December 2019, London



The Scientific
Committee on
Antarctic Research

Part 1 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



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Antarctica In Your Backyard... or Not?

It's no secret that the East and West Antarctic Ice Sheets have the potential to change sea level around the globe. Anthropogenic climate change means that, at the moment, our main concern is by how much, when and where, sea level will rise. Reducing that uncertainty requires investigations of the oceans, atmosphere and the cryosphere – including sea ice, ice shelves and ice sheets. Much of our understanding is very recent, and concerted further research is needed. How much sea level rise coastal cities will experience, by when, and how effects differ among the world's regions needs concerted further research. This question is arguably Antarctic and Southern Ocean research's most pressing global one, particularly because the data generally show an increasing rate of ice mass loss for the region. Answering this question will also influence decision-making about Antarctic environments because of expected changes to the extent and distribution of ice-free areas on the continent.

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Part 2 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.

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History Trapped

Understanding the climate history of the planet through analysis of ice cores from the Arctic, Antarctic and high mountain glaciers is one of polar science's most important stories. That story has unfolded in a remarkable way in Antarctica, producing a 420 000-year record from the Vostok Ice Core, and a 740 000-year record from the Dome C ice core. These records demonstrate the close relationship between Antarctic air temperature and atmospheric carbon dioxide concentration. They also show that current atmospheric concentrations of CO₂ and methane are unprecedented over their historical records. The search is now on for a record extending to a million years or more, which will provide much-needed insights into the Earth System's history and functioning.

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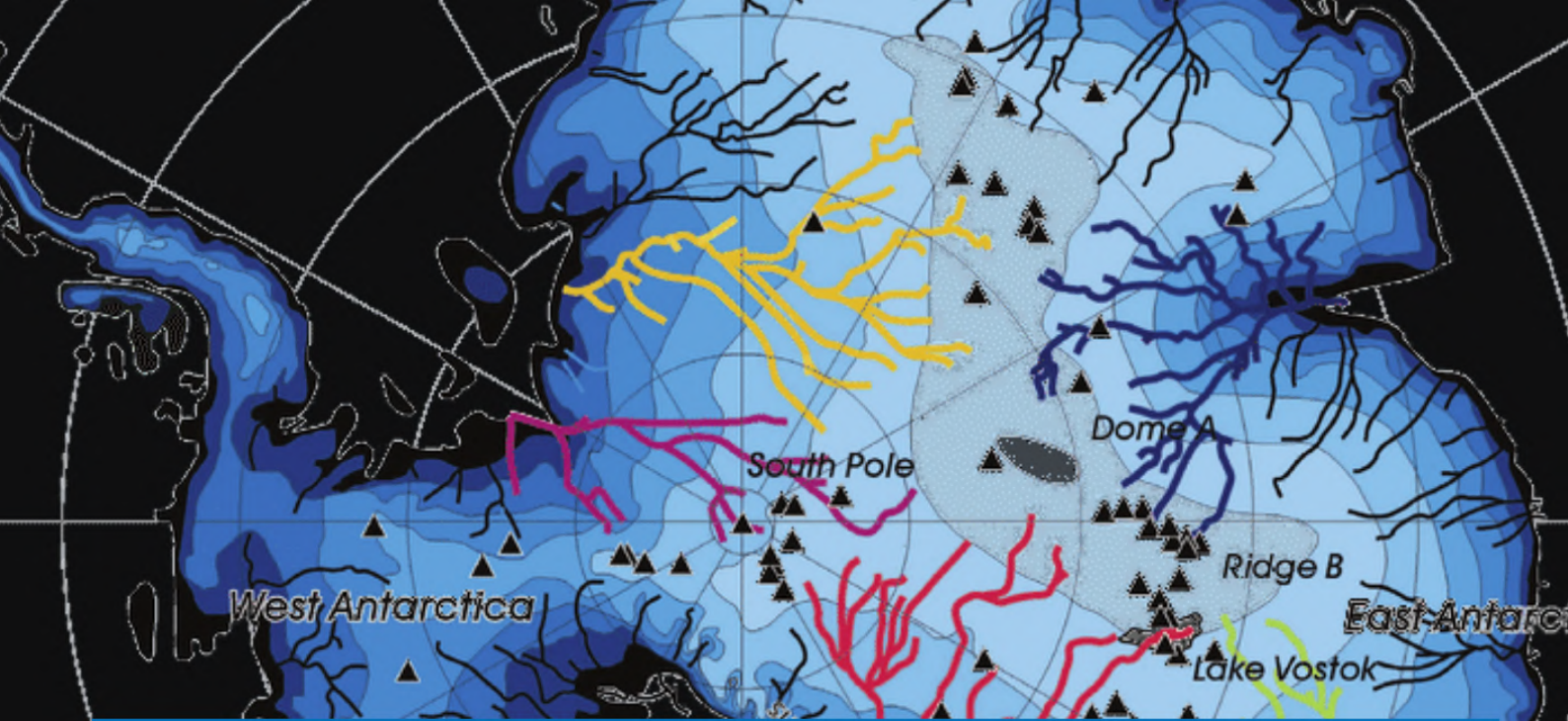
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The Scientific
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Part 3 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.

www.scar.org



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Under the Ice and Thriving

In the 1970s, international collaboration using radio echo-sounding discovered the first subglacial lake and quickly went on to document many such features, including the extraordinary Lake Vostok. By 2012, Lake Vostok had been accessed by Russian scientists. Throughout, significant discussion had been ongoing, including about how to ensure that any life was not contaminated by efforts to investigate it. In 2014, subglacial Lake Whillans was accessed using clean methods. The international team discovered abundant microbial life forming an ecosystem driven by chemosynthesis, which can have an influence on Southern Ocean geochemical and biological systems. The expectation is that life will be commonly found below the Antarctic ice sheets given that more than 400 subglacial lakes have now been discovered.

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The Scientific
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Part 4 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.

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ANTARCTIC SCIENCE

The Emperor of Birds

One of the planet's most well-known birds remains one of its most mysterious: the emperor penguin. The only bird known to breed predominantly on fast ice and in the winter. Little was understood about its life cycle until the 1950s, when pioneering work under difficult conditions revealed the remarkable circumstances of the species' winter breeding biology. While much of the emperor penguin's life cycle within colonies is now known, its at-sea ecology remains poorly documented. New applications of satellite remote sensing have revealed 54 colonies around the Antarctic continent, with an estimated breeding population of > 256 000 pairs. Yet spectacular and repeated failures of one of the largest colonies have also been detected in recent years, with future prognoses raising concerns about the species. This symbol of Antarctica needs concerted research attention and policy interventions to ensure its survival.

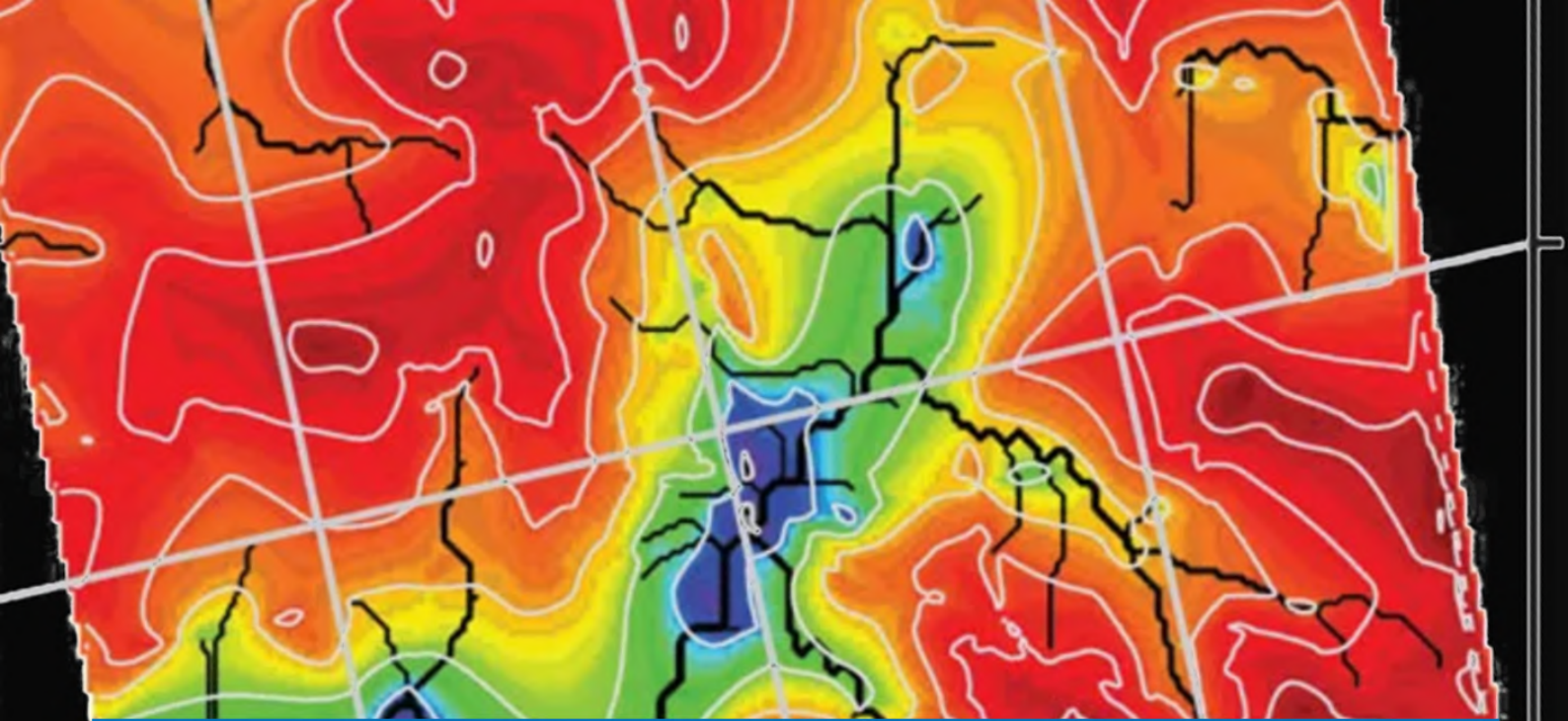
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The Scientific
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Part 5 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



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Massively Important Subglacial Mountains

Despite their discovery in 1958, the first detailed radar survey of the Gumburtsev mountains was made by Chinese scientists as part of the International Polar Year Program in the mid-2000s. Their work revealed a classic Alpine topography likely to have formed during the initial phases of Antarctic glaciation (from ca. 34 million years ago onwards), contributing a main centre for ice sheet growth. Later work using a combination of techniques and data revealed a 2500 km rift system in East Antarctica surrounding the Gumburtsev mountains. Complex geological processes, possibly taking place over 1 billion years, explain the high elevation (maximum of 3000 m and a median of 1400 m) and general relief of these mountains, which remain covered by hundreds of metres of ice. These mountains reveal how important understanding the bedrock topography of Antarctica is for our knowledge of the Earth System.

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The Scientific
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Part 6 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



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The Dry Valleys are Not Dead

Even as late as the 1970s, the McMurdo Dry Valleys were described as sterile, with the search for analogues of lunar and Martian environments suggesting that the Dry Valley soils contained, if anything, low levels of viable microbiota. Now we know that the converse is true. Thanks to advances in genomic and other techniques, the Dry Valley microbiota is understood to be diverse, spatially variable, and extraordinary from a global perspective. These discoveries have driven a broad program to discover how life exists in seemingly ultra-harsh Antarctic environments. One of the most recent findings demonstrates that microbes can eke out an existence using an extraordinary mechanism to scavenge hydrogen gas from the atmosphere, so providing an alternative to typical solar or geological energy sources. Trace-gas scavenging may provide new insights for exobiology – the biology of putative life beyond earth.

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The Scientific
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Part 7 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



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Earth as a Camera

Earlier this year, a suite of papers from The Event Horizon Telescope Collaboration revealed to the world the first picture of the edge of a black hole – the event horizon. The creation of the image required more data than any experiment so far undertaken, and the use of the ‘entire Earth as a telescope’ – or at least a network of eight observatories around the globe, including the South Pole Telescope, and some clever techniques.

The work has confirmed the predictions, in a spectacular way, of Albert Einstein’s general theory of relativity.

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The Scientific
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Part 8 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



60 YEARS OF TREATY-SUPPORTED
ANTARCTIC SCIENCE

A Southern Ocean Engine for Fish

The Southern Ocean is widely known as a region relatively poor in the numbers of fish species that inhabit it, compared with tropical systems such as coral reefs.

Indeed, the global latitudinal gradient in species richness – a pattern of high numbers of species in the tropics and lower numbers of species in polar regions – is one of biodiversity's strongest global signals. New work, using novel genomics and biodiversity informatics approaches, has revealed that the engine for the production of new species, that is speciation rate, runs fastest in the polar regions and especially the Antarctic. Despite low overall species diversity, new species of fishes have formed in the Southern Ocean at a faster rate than in any other marine region. This surprising result reveals how important the Antarctic is for the Earth System in ways other than just the climate.

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The Scientific
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Part 9 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



60 YEARS OF TREATY-SUPPORTED
ANTARCTIC SCIENCE

Time Has Not Run Out

The Paris Climate Agreement presents us with a choice. Either we will have, within the next 60 years, an Antarctic and Southern Ocean region that is markedly different to the one the Antarctic Treaty Parties have come to know over the 60-year history of the agreement, and on a trajectory for even bigger change, or one that stays familiar. In essence, we have about 11-30 years of CO₂ emissions at the 2017 level to stay within a target of 1.5°C. Though large uncertainties remain about how the future will play out, the science is clear about the fact that we have little time left to avert changes we will struggle to undo, and which will have dangerous consequences for life as we have come to know it.

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The Scientific
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Part 10 of a series celebrating 60 years of Antarctic Treaty-supported science. The successes of international scientific cooperation in the harshest environment on Earth have delivered extraordinary benefits to humankind, and demonstrated how nations working together can accomplish more than any nation working alone, providing a roadmap for action in an uncertain future.



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The Scientific Committee on Antarctic Research



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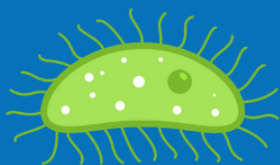
MASSIVELY IMPORTANT SUBGLACIAL MOUNTAINS

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