

Australian Centre for Excellence in Antarctic Science

ACEAS 2022 ANNUAL REPORT HIGHLIGHTS

Director's Message

In 2022 ACEAS moved from being an idea to a reality, with a team of more than 100 researchers working together to understand the rapidly changing East Antarctic and Southern Ocean region. Amongst our team are dozens of early career researchers who are developing their skills in science, research and communication—whilst also being trained in Antarctic policy and governance.

We held our inaugural Annual Research Forum in November. The 4-day event was also our first in-person gathering of the entire ACEAS community: the leadership team, investigators from across the university partner nodes, PhD students, post-docs, early career researchers, industry and government partners, and board members.

We have generated new knowledge this year that has significant implications for how society responds to climate change. But we also experienced some setbacks, particularly due to delays in the delivery of RSV *Nuyina* and the resulting disruptions to parts of the Australian Antarctic Science fieldwork program. We continue to manage such risks as we plan for our (now) first largescale fieldwork in the vast Denman Glacier system, commencing in late 2023.

In looking to our research ahead, we note that the surprises emerging from Antarctica are not always going to be a delight. Thank you to all our researchers, staff and collaborators. Together, we hope to better inform humanity's response to the challenges of global warming—and in doing so, help safeguard our planet for generations to come.

Matt King - Director





Chair's Message

The ARC Australian Centre for Excellence in Antarctic Science (ACEAS) was a hive of activity in 2022, as we began our first full year of operations and research.

We held our official launch at ACEAS headquarters within the IMAS building in Hobart in October. The launch was attended by Senator Catryna Bilyk, CEO of the ARC Ms Judi Zielke PSM and representatives from many of our stakeholders.

As we develop and train dozens of early career researchers, ACEAS builds a sovereign capability that allows us to understand the Antarctic—and to develop appropriate responses to changes either already underway or emerging.

At ACEAS, we recognise the urgency of translating our science into actionable insights. We work closely with national and international partners to find and reveal the climate risks emerging from East Antarctica and the Southern Ocean. And then we translate our findings to help communities across the world prepare for these risks.

Some of our many significant research findings across 2022 are listed in this report. Throughout the year, our publications contributed even more evidence of the direct impact of climate change on Antarctica and the Southern Ocean.

The work of ACEAS will continue to build in coming years, delivering vital new knowledge of how the Antarctic is changing—and its relevance for all of us.

Mary O'Kane – Chair



Report Highlights









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PROGRAM HIGHLIGHTS



Projections: sea level and Southern Ocean temperature





Major assessment: Antarctic Ozone depletion



Review: response of the East Antarctic Sheet to past and future climate change

Evaluated: characteristics, data biases and

impacts of geothermal heat flow

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New insights into changes in Antarctic sea-ice cover over

study of the patterns and trends in the exposure of

Antarctic ice-shelf fronts to ocean swells via sea ice-free corridors connected to the open Southern Ocean.

Australian Antarctic Science Project: 'Macquarie Island Wildlife Monitoring Program: strategic monitoring for applied conservation and management'



Analysis: change and variability in Antarctic coastal exposure to sea-ice

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annual Antarctic sea-ice extent, concentration, and seasonality



Synthesised: sea-level and deep-sea temperature variations over the past





Machine Learning assisted maps: sedimentary basins beneath ice





ANSTO collaboration: Synchrotron experiment on sediment cores to reconstruct the input of bioavailable iron to Antarctic waters

ACEAS Research

Study exposes role of sea ice in protecting Antarctic coast

Dr Rob Massom helped develop a new method for detecting and monitoring change in the exposure of the Antarctic coastline to the dynamic Southern Ocean.

Change in coastal exposure duration and location has important flow-on effects for the Antarctic coastal environment, including ice shelf stability.

"When sea ice is present, it largely damps ocean waves to minimise their impact on the coastal areas. So sea-ice loss can lead to more dynamic and turbulent ocean conditions at the coast."

This work could improve environmental monitoring and modelling of Antarctic ice loss and sea level rise.

PAPER: Reid P, Massom R. (2022). 'Change and variability in Antarctic coastal exposure, 1979–2020'. *Nature Communications*. DOI: <u>10.1038/s41467-022-28676-z</u>

Small window of opportunity left to preserve Antarctica's 'sleeping giant'

The worst effects of global warming on Earth's largest ice sheet can be avoided if the world meets the climate targets outlined in the Paris Agreement—but if we fail, then the melting of the ice sheet will have a drastic impact on sea level rise.

An international team that includes the Director and Deputy Directors of ACEAS— Professor Matt King, Professor Nerilie Abram, Professor Matthew England warns that we risk awakening a 'sleeping giant' if global temperatures go beyond two degrees Celsius above pre-industrial levels.

"Earth's largest ice sheet, the East Antarctic Ice Sheet (EAIS), contains the equivalent of 52 metres of sea level."

The ice sheet could remain mostly stable over coming centuries, adding less than half a metre to sea-level rise by the year 2500, if urgent action is taken now to limit global warming.

PAPER: Chris R. Stokes, et al. (2022). Response of the East Antarctic Ice Sheet to Past and Future Climate Change. *Nature*. DOI: <u>10.1038/s41586-022-04946-0</u>

Southern Ocean takes on the heat of climate change

Of all the oceans on Earth, the Southern Ocean does the lion's share at slowing the pace of climate change by absorbing most of the excess heat trapped in the planet's atmosphere.

"Antarctica, which is surrounded by the Southern Ocean, is also surrounded by strong westerly winds. These winds influence how the waters absorb heat. Around Antarctica they can exert this influence while remaining uninterrupted by land masses – this is key to the Southern Ocean being responsible for pretty much all of the net global ocean heat uptake."

But, while ocean warming helps slow the pace of climate change, it is not without cost said Professor Matthew England, Deputy Director of ACEAS. Sea levels rise as heat causes water to expand and ice to melt, ecosystems undergo unprecedented heat stress, and the frequency and intensity of extreme weather events is changing.

To better understand how Southern Ocean heat uptake continues to evolve, the researchers call for ongoing monitoring of this remote ocean and stress the urgency of reducing greenhouse gas emissions.

PAPER: Maurice F. Huguenin, Ryan M. Holmes & Matthew H. England. (2022). 'Drivers and distribution of global ocean heat uptake over the last half century'. *Nature Communications*. DOI: <u>10.1038/s41467-022-32540-5</u>



Spotlight on our researchers

Mareen Lösing

UWA Research Associate Antarctic Crustal Geophysics and Bed Evolution

The sub-glacial geology of the Antarctic continent is of fundamental importance to understanding ice sheet dynamics. Topography, composition, and properties of the bedrock control how fast the ice sheet slides and interacts with the underlying terrain. Additionally, areas with high heat producing rocks can contribute to increased geothermal heat flow, leading to basal melt and affecting the overall stability and flow dynamics of the ice sheet.

Mareen's research focuses on advancing the understanding of subglacial geology in the Wilkes Land area. Her aim is to provide new interpretations to characterise the ice sheet bed and constrain conditions that influence glacial processes.

To achieve this, she will analyse geophysical data including gravity, magnetic and radar data. This will potentially generate information on bedcharacteristics, which in collaboration with ACEAS, can be linked to ice sheet and ocean science outcomes.

Katharina Hochmuth

UTAS Postdoctoral Research Associate Tectonics and Ice Sheets

The sedimentation offshore the Australian East Antarctic margin was strongly influenced by the dynamics of the East Antarctic ice sheet as well as the tectonic remnants of the opening of the Southern Ocean and the separation between Australia and Antarctica.

As part of ACEAS, Katharina will focus on the reconstruction of sedimentation behaviour from various ice streams through time, revealing regional changes in the ice sheet and erosional dynamics and closely collaborates with other geologists, and geophysicists as well as the modelling community within ACEAS and beyond.

As part of the Denman glacier voyage, she hopes to collect new datasets in this so far completely unsurveyed part of the continental shelf to work towards a better understanding of this vulnerable part of the East Antarctic ice sheet.



Yuhao Dai

ANU Research Associate Marine Biogeochemistry

Yuhao investigates the carbon cycle in the Southern Ocean during the Miocene—the last time the atmospheric CO2 level was comparable to the present. He uses stable isotopes and trace elements of microfossils to reconstruct the Southern Ocean seawater chemistry of the past. Based on these reconstructions, he aims to understand the feedback between CO2 and the Southern Ocean phytoplankton productivity in a warm climate.

Yuhao hopes this work can provide insights into the responses of Earth's climate to future atmospheric CO2. He will also investigate modern Polar Southern Ocean biogeochemistry using samples from upcoming Antarctic research voyages.



ACEAS LAUNCH

Monday 17 October 2022

The ACEAS official launch was held at ACEAS headquarters within the IMAS building in Hobart.

"This centre is even more important now than when it was originally conceived."—Professor Rufus Black on how ACEAS research will inform humanity's response to climate change.

Images, top to bottom:

Dr Katharina Hochmuth, Dr David Green, ACEAS COO Indi Hodgson-Johnston, Tim Ault (DFAT).

University of Tasmania Vice-Chancellor Professor Rufus Black opens the event.

CEO of the ARC Ms Judi Zielke PSM.





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